Optidew
Chilled Mirror Hygrometer
User's Manual

Kahn Instruments, Inc. October 2019

Optidew

For Kahn Instruments' contact information please go to
www.kahn.com

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Safety

The instrument is designed to be completely safe when installed and operated correctly in accordance with the information provided in this manual.

This manual contains all the required information to install, operate and maintain this product. Prior to installation and use of this product, this entire manual should be read and understood. Installation and operation of this product should be carried out by suitably competent personnel only. The installation and operation of this product must be in accordance with the instructions provided and according to the terms of any associated safety certificates. Incorrect installation and use of this product other than those described in this manual and other than its intended purpose will render all warranties void.

Electricity and pressurized gas can be dangerous. This product must be installed and operated only by suitable trained personnel.

No user serviceable parts inside

Warnings

Where this hazard warning symbol appears in the following sections, it is used to indicate areas where potentially hazardous operations need to be carried out and where particular attention to personal and personnel safety must be observed.

Where this symbol appears in the following sections it is used to indicate areas of potential risk of electric shock.

Electrical Safety

Insure electrical safety is complied with by following the directions provided here and observing all local operation & installation requirements at the intended location of use.

This product is completely safe when using any options and accessories supplied by the manufacturer of this product for use with it. Refer to Section 2 (Installation) of this manual for further details.

Pressure Safety

For this product to operate satisfactorily, pressurized gas must be connected to it. Observe all the information contained within this manual and all local operation & installation requirements at the intended location of use. Refer to Section 2 (Installation) of this manual for further details.

Calibration (Factory Validation)

Prior to shipment, the instrument undergoes stringent factory calibration that is traceable to national standards. Due to the inherent stability of the instrument, regular factory calibration is not required, however recalibration is recommended to maintain measurement traceability.

Kahn Instruments can provide a fully traceable factory calibration service for the instrument and it is recommended that this is considered at intervals of every year of the analyzer's life. Please contact Kahn Instruments for further details (www.kahn.com).

Repair and Maintenance

Apart from user-replaceable components required for routine operational maintenance described above, the instrument must only be maintained either by the manufacturer or an accredited service agent.

Abbreviations

The following abbreviations are used in this manual:

A	ampere
AC	alternating current
atm	pressure unit (atmosphere)
bara	pressure unit (=100 kP or 0.987 atm) (absolute)
barg	pressure unit (=100 kP or 0.987 atm) gauge
°C	degrees Celsius
°F	degrees Fahrenheit
EU	European Union
hr	hour
Hz	Hertz
IEC	International Electrotechnical Commission
IP	Internet protocol
ml/min	milliliters per minute
mg/m^3	milligrams per cubic meter
lbs/MMscf	pounds per million standard cubic feet
mA	milliampere
mins	minutes
mmHg	millimeter of mercury
Pa	pascal
ppm_V	parts per million (by volume)
ppm_W	parts per million (by weight)
psia	pound(s) per square inch (absolute)
psig	pound(s) per square inch (gauge)
RH	relative humidity
RS485/232	standards defining the electrical characteristics of drivers & receivers
RTC	real time clock
RTU	Remote Terminal Unit
SD	storage device card
UART	universal asynchronous receiver/transmitter
USB	Universal Serial Bus
V	Volts
"	Inch
Δ	delta
%	percentage
Ω	ohms

1 INTRODUCTION

The Optidew chilled mirror hygrometer is based on the proven, fundamental condensation temperature dewpoint principle, giving unmatched long-term drift-free performance.

Kahn offers three highly durable sensor options, which are suitable for measuring in a wide variety of different samples.

1.1 Optidew Series

The Optidew series is available in two different enclosures:

Figure 1 *Optidew Wall Mount and Optidew Bench Top*

The Optidew Wall Mount features a compact ABS enclosure with an aluminium base plate and 4 external lugs for easy mounting to a panel or wall. It is available with a 5.7" touch screen display, or as a blind "transmitter only" version.

A weatherproof version of the Optidew Wall Mount enclosure is available with a modified connector panel to improve ingress protection to IP65/NEMA 4. Note that the Ethernet and SD card options are not available in combination with the weatherproof version.

The Optidew Bench Top is designed to be easy to handle and transport, and is ideal for laboratory or service use. It has a 5.7" touch screen LCD equipped as standard.

1.2 Optidew Sensor

The new Optidew sensor is available with either a single or dual stage thermoelectric cooler and with a choice of sensor head materials making it suitable for use in air/inert gases or in corrosive environments. The following tables show the capabilities of each sensor type:

	Single Stage Standard Sensor	***Dual Stage Standard Sensor***	***Harsh Environment Sensor***
Approximate maximum depression at ambient	108°F/60°C	126°F/70°C	126°F/70°C
Maximum operating temperature	194°F/90°C	194°F/90°C	248°F/120°C
Lowest Measurable Dewpoint			
Sensor temperature at 23°C ambient	-13°F/-25°C	-40°F/-40°C	-40°F/-40°C

For more detailed information on the performance of the sensor across its whole operating temperature range, see section 4.5.

All versions are rated for use at pressure up to 362 psig (2500 kPag).

2 INSTALLATION

2.1 Mounting

Optidew Wall Mount

The Optidew can be wall mounted using the four mounting points on each corner (see figure 2 for mounting point dimensions). It is possible to install the Optidew Wall Mount outside, providing it is shielded from direct sunlight and the climate is within the environmental requirements listed in Appendix A Technical Specifications. It is highly recommended to choose the weatherproof option if the installation will be outdoors.

Installation

Install using quantity 4 machine screws + washer. Unit must be secured to a solid surface (e.g. brick, concrete, wood min 0.4"/10mm thick) or to a metal chassis plate of minimum 0.12"/3mm thickness.

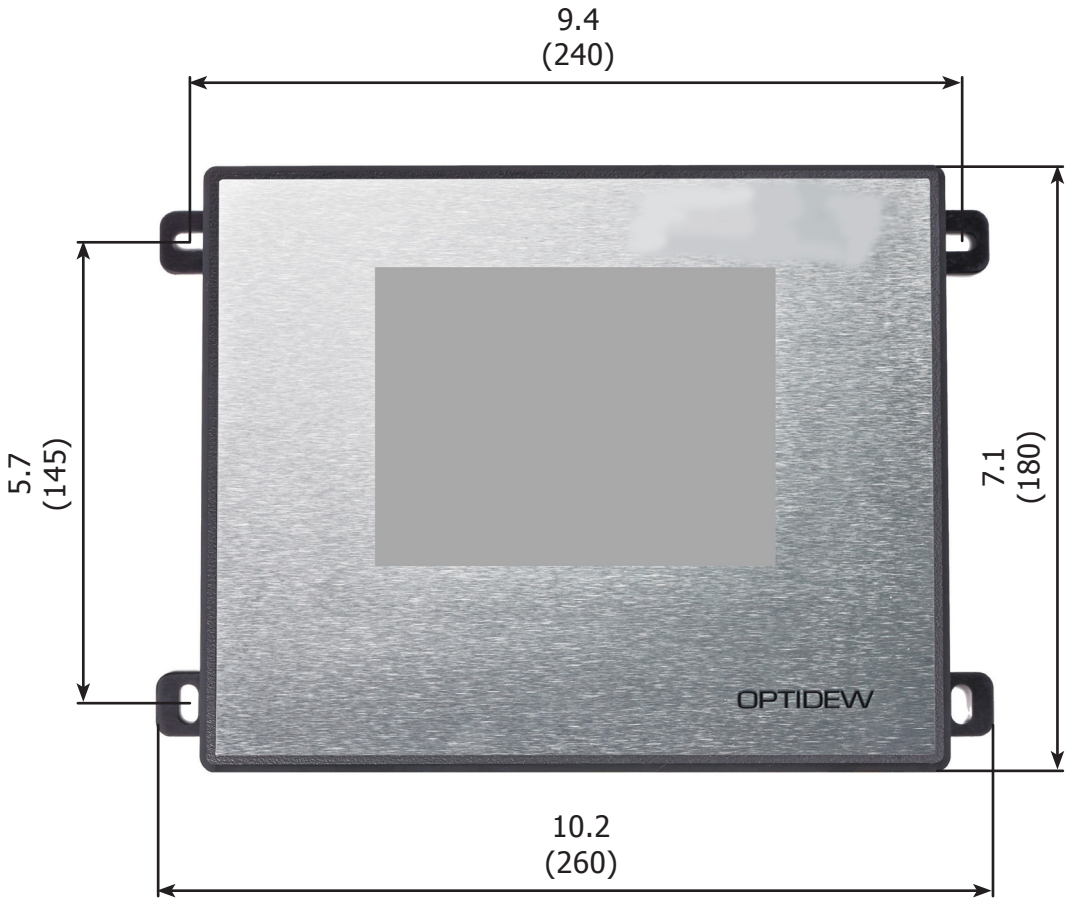

Figure 2 *Optidew Wall Mount mounting points*

Optidew Bench Top

The Optidew Bench Top is designed to be placed on a bench or table to operate. Alternatively it can be used directly from within the optional Transport Case.

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2.2 Instrument Connections

2.2.1 Optidew Wall Mount

Front Panel (Display version)

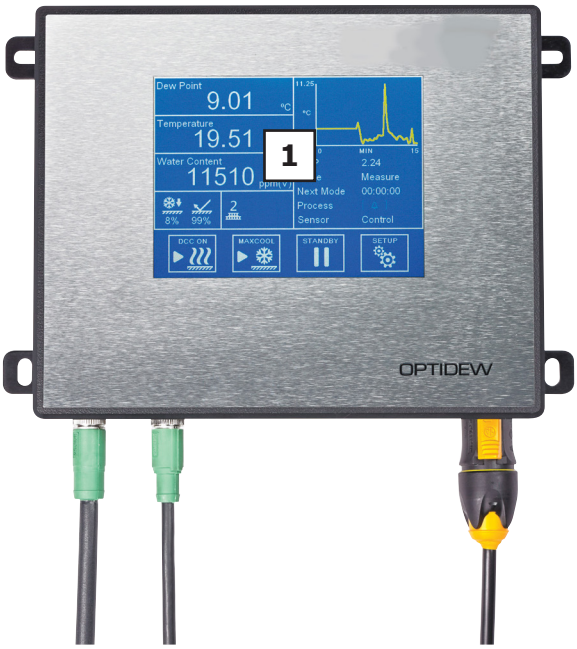


Figure 3 *Optidew Wall Mount display front panel*

Number	Description
1	**Display** Shows measured and calculated parameters, controls all instrument settings and functionality.

Front Panel (Non-display version)

Figure 4 *Optidew Wall Mount non-display front panel*

Number	Description
1	DCC Control/ Status indicator

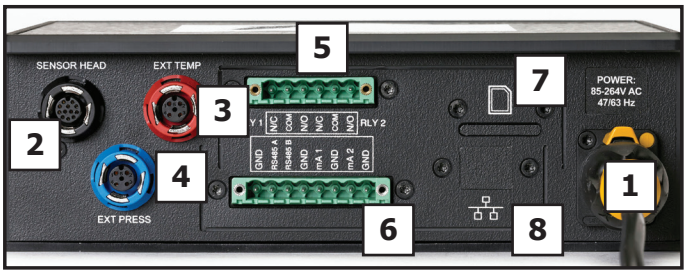


Figure 5 *Optidew Wall Mount bottom panel*

Bottom Panel

Number	Description
1	Power Connector
2	Sensor Cable connector
3	Temperature probe cable connector
4	Pressure transmitter cable connector
5	Alarm contacts connector
6	RS485 and analog output connector
7	SD Card slot (optional)
8	Ethernet port (optional)

2.2.2 Optidew Bench Top

Top Panel

Figure 6 *Optidew Bench Top top panel*

Number	Description
1	Display

Figure 7 *Optidew Bench Top left side panel*

Left Side Panel

Number	Description
1	Power Connector
2	Power Switch

Figure 8 *Optidew Bench Top right side panel*

Right Side Panel

Number	Description
1	SD Card slot

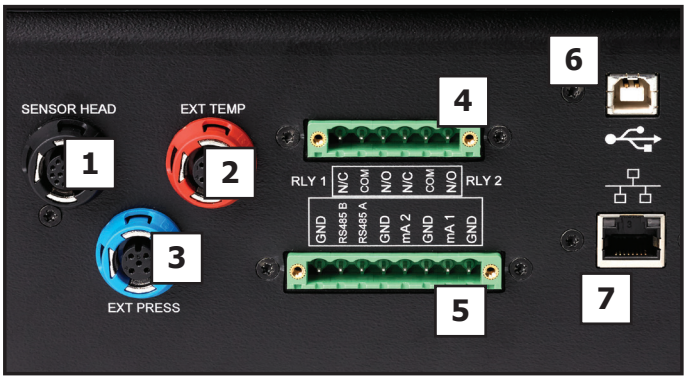


Figure 9 *Optidew Bench Top rear panel*

Rear Panel

Number	Description
1	Sensor Cable connector
2	Temperature probe cable connector
3	Pressure transmitter cable connector
4	Alarm contacts connector
5	RS485 and analog output connector
6	USB port
7	Ethernet port (optional)

2.3 Electrical Connections

2.3.1 Electrical Supply

WARNING:

The instrument must be GROUNDED

The Optidew accepts a power supply of the following specification:

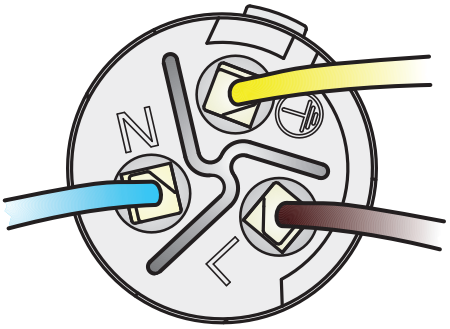
Voltage	100-240V AC
Frequency	50 – 60Hz
Power Consumption	30VA max

See Appendix A, Technical Specification, for full operating parameters.

Optidew Wall Mount

The wall mount is supplied with a connector wired to a 6 foot cable.

This power connector is wired as follows:



NOTE: The Optidew Wall Mount is designed for continuous operation and therefore does not feature a power on/off switch. As soon as power is applied, the display (or DCC button on the transmitter version) will illuminate and the transmitter will initiate a DCC cycle. Refer to Section 4.4.1.

Replacement power cables are available - contact Kahn Instruments.

Optidew Bench Top

The Optidew Bench Top is supplied with a 6 foot IEC cable. The IEC socket on the side of the instrument features an integrated ON/OFF switch.

Fuse

This product is provided with an externally mounted fuse located next to the power connector.

The fuse is rated at 5 x 20mm medium acting:

Power 230 V AC 2.5 A

A replacement fuse can be obtained by contacting Kahn Instruments Service Department.

Equipment Ratings

This product is designed to be safe at least under the following conditions: between a temperature range of -40°F/C to +140°F/+60°C, in maximum 80% relative humidity for temperatures up to +88°F/+31°C decreasing linearly to 50% RH at +122°F/+50°C. Overvoltage Category II. Pollution Degree 2. Altitudes up to 2000m. Indoor use only but an IP65 unit is offered as an option.

See Appendix A, Technical Specification, for full operating parameters.

2.3.2 Analog and Digital Communications

Note: When using screened cable, the screen should only be connected to a ground point at either the Optidew installation side, or at the receiving equipment. Failure to observe this precaution can result in ground loops and equipment malfunction.

2.3.2.1 Digital Communications

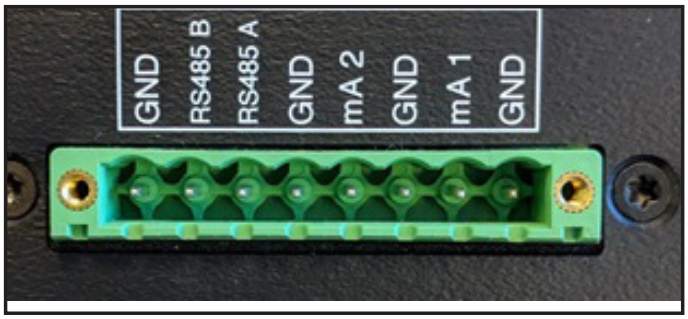


Figure 10 *RS485 & analog output connector*

The leftmost four pins of this connector are used for RS485 communications.

Pin Label	Description
GND	Ground
RS485 A	RS485 Data A
RS485 B	RS485 Data B
GND	Ground

The Optidew provides Modbus RTU over RS485 or USB (Bench Top only). An Ethernet module is optionally available for both instruments, and provides Modbus TCP communication.

The Modbus register map can be found in Appendix B.

The application software provided can be used to communicate with the instrument.

Refer to the Application Software section at the end of the manual.

2.3.2.2 Current Outputs

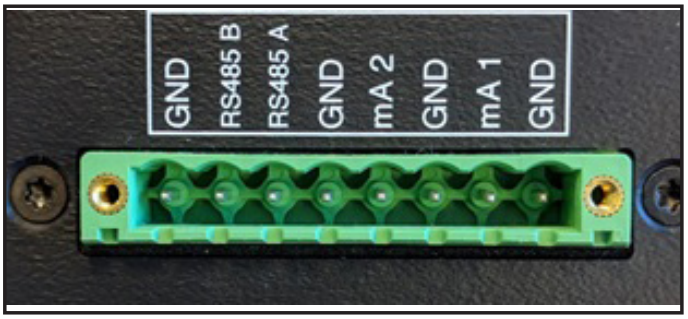


Figure 11 *Analog output connector*

The rightmost four of the pins on this connector are used for mA outputs.

See section 3.2 for information on configuring the analog outputs

Pin Label	Description
mA2	Channel 2 Current Output
GND	Channel 2 Ground
mA1	Channel 1 Current Output
GND	Channel 1 Ground

2.3.2.3 Relay Contacts

There are two sets of relay contacts available via the output connector:

Process Alarm (Relay 1)

This relay changes state to indicate that the process variable has exceeded the alarm set point value. See section 3.2 for details on how to configure the process alarm trip criteria. This alarm can also be used to give an early indication that the optics require cleaning.

System Alarm (Relay 2)

This relay changes state to indicate a fault has occurred which requires operator intervention. See section 4.6 for detailed information on faults.

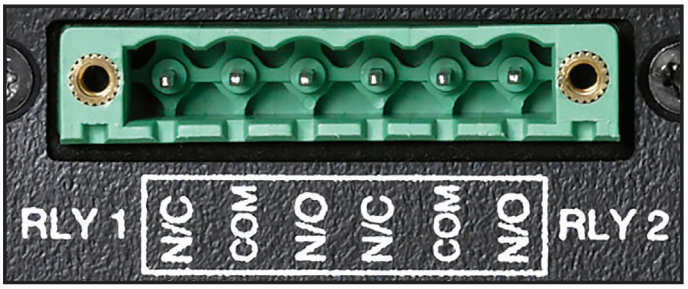


Figure 12 *Relay contact connector*

Pin Label (from left to right as shown)	Description
N/C	Relay 1 Normally Closed
COM	Relay 1 Common
N/O	Relay 1 Normally Open
N/C	Relay 2 Normally Closed
COM	Relay 2 Common
N/O	Relay 2 Normally Open

2.4 Sensor Installation

The dewpoint sensor contains the optical system and the chilled mirror. It is equipped with a 12-pin M12 connector to allow easy and secure connection to the instrument using the supplied sensor cable.

The available options for sensor installation are:

- via a permanently installed sample port into which the remote sensor can be inserted or
- via a sensor block immediately attached to the sensor around which the sample circulates or
- in an ambient environment where the sample is diffusing through the sensor.

NOTE: Insure that the mirror surface is cleaned before installation. See Section 5 (Maintenance) for cleaning details.

Connect the remote sensor cable to the sensor and to the instrument via the connector on the rear panel. The connector is a standard M12. Align the locating pin with the slot on the socket and press the connector into place. Rotate the outer collar of the cable-mounted part in a clockwise direction until finger tight.

If exchanging the sensor, refer to section 5.2.

2.4.1 Environmental monitoring

If the instrument is to monitor the conditions in an environment, the sensor must be located in a representative position, i.e. not under an air conditioning vent.

A sensor wall mounting bracket is available to conveniently secure the sensor to a wall or panel.

NOTE: It is recommended that the sensor is equipped with the porous aluminium guard to baffle it from flowing air currents.

2.4.2 Sample flow monitoring

If the sensor is installed within a sealed gas system it must be fixed securely without any possibility of leaks. Insure that the sample flow across the sensor is correctly regulated.

The gas connections for the remote sensor are either via a permanently installed sample port into which the remote sensor can be inserted or via a sensor block immediately attached to the sensor around which the sample circulates. Gas sample entry into the sensor block is via couplings that can be installed into the provided ⅛" NPT female threads. A bonded seal is provided to fill the connection between the sensor and the block.

Insure that all connections to and from the sensor block are made with appropriate materials and fittings for moisture measurement. For guidance on suitable apparatus, see section 4.3.

2.4.3 Integral Sensor mounting

If the sensor is to be positioned into a sealed but open environment (glove box, environmental chamber or area to be monitored) a female thread of M36 x 1.5-6H is required to suitably thread onto the sensors mail M36 x 1.5-6g thread. The bonded seal provided will require a good surface finish (0.8 Ra) across a minimum sealing face of DIA 46.0mm to insure leak free operation up to the max operating pressure of the sensor (25barg). The bonded seal will also require a strong hand tightening to insure leak free sealing of the two mating faces.

Insure that the sensor is suitably secured to prevent any movement and that it is located in a position that will see a representative flow of the sample to be measured.

2.5 Temperature Probe Installation

The temperature probe is supplied pre-wired and simply requires fitting to the connector on the Optidew control unit prior to use.

Take into consideration how you will use the readings from your temperature probe before installing it. If the measurement will be used in combination with the dewpoint measurement to calculate % RH, then the temperature probe should be installed in a location which is most representative of the temperature of your environment or sample.

Be aware that when depressing the mirror temperature by more than 40°F the Optidew dewpoint sensor will generate a small amount of heat in the surrounding area. Try to situate the temperature probe upstream of the dewpoint sensor and at least 6 inches away.

Refer to section 4.4.5 for more information on calculated parameters and which measured inputs are used to derive them.

2.6 Pressure Transmitter Installation

Pressure transmitters are available for the Optidew in several ranges. Any 4-20mA pressure transmitter can be wired into the Optidew control unit via the 4-pin M12 connector.

Kahn can supply a pressure transmitter with the Optidew, which is installed via a 1/8" NPT male thread.

For ease of use, the dewpoint sensor and pressure transmitter should be installed so they are operating at the same pressure; i.e. either both at atmospheric pressure or both at line pressure.

For information on the pressure compensation feature refer to section 4.4.5.

3 USER INTERFACE

There are two different local user interfaces available, either a 5.7" touch screen on the Display model, or a button with multicolor LED indicator on the transmitter version.

All functionality through the local user interface is available when running the Kahn Application Software. The Optidew offers three interfaces to connect to a PC or network:

- RS485
- USB (only available on Bench-Top unit)
- Ethernet (Optional)

3.1 Main Display

The Optidew features a 5.7" color touch screen display.

Then the instrument is switched on, an 'initializing' overlay will be shown while the menu system loads.

After the menu system has loaded, the Main Screen will show.

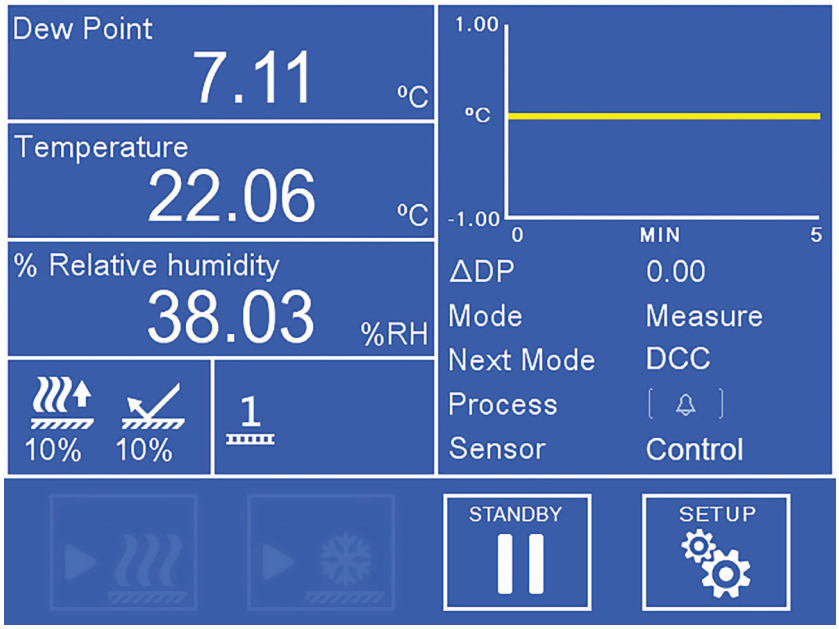


Figure 13 *Main screen*

3.1.1 Main Screen

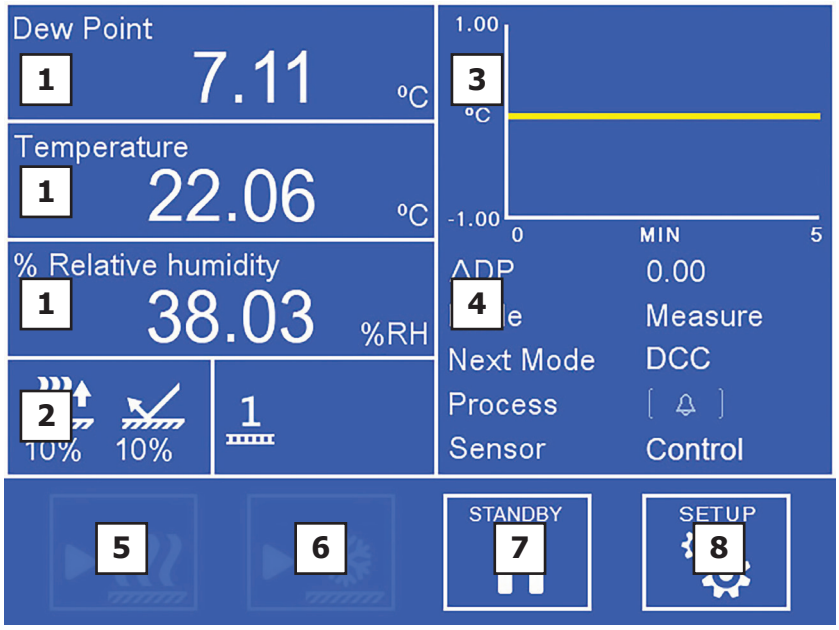


Figure 14 *Main screen layout*

No.	Name	Description
1	Customizable Readouts	Display measured and calculated parameters. See section 3.1.2 for additional information
2	Sensor Status Display	Displays both thermo-electric cooler (TEC) drive and optical signal condition. Also indicates whether TEC is 1 or 2 stage. See section 3.1.5 for additional information
3	Trend Graph	Plots measured dewpoint over time. Time base can be changed in display settings. Touch the readout once to enter full screen mode.
4	Operational Status Display	See section 3.1.4 for a detailed description of this area.
5	DCC On/Off	Initiates or cancels a DCC. See section 4.4.1 for an explanation of the DCC function. See section 3.2 for DCC setup parameters.
6	Max Cool On/Off	Initiates or cancels a Max Cool. See section 4.4.2 for an explanation of the Max Cool function.
7	Standby/Operate	Toggles between Measure and Standby modes. When switching to Measure mode a DCC cycle will be initiated.
8	Setup	Access the Setup menu. See section 3.1.3 for information on the menu structure and options.

3.1.2 Customizable Readouts

The three readouts on the Main Screen can be configured by the User to show any of the following parameters:

- Dew Point
- Temperature
- Pressure
- % Relative Humidity
- g/m^3
- g/kg
- ppm_v
- Twb
- wvp (water vapor pressure)
- Dew Point (pressure corrected)

To change a parameter:

1. Touch the readout once to enable parameter selection
2. Touch the left or right arrows to select the parameter to be displayed
3. Touch the center of the readout to confirm selection

Full Screen Mode
Any of the readouts can be shown in full screen mode by touching and holding the readout.

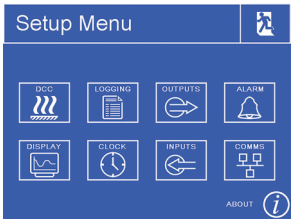
3.1.2.1 Locking the Analyzer

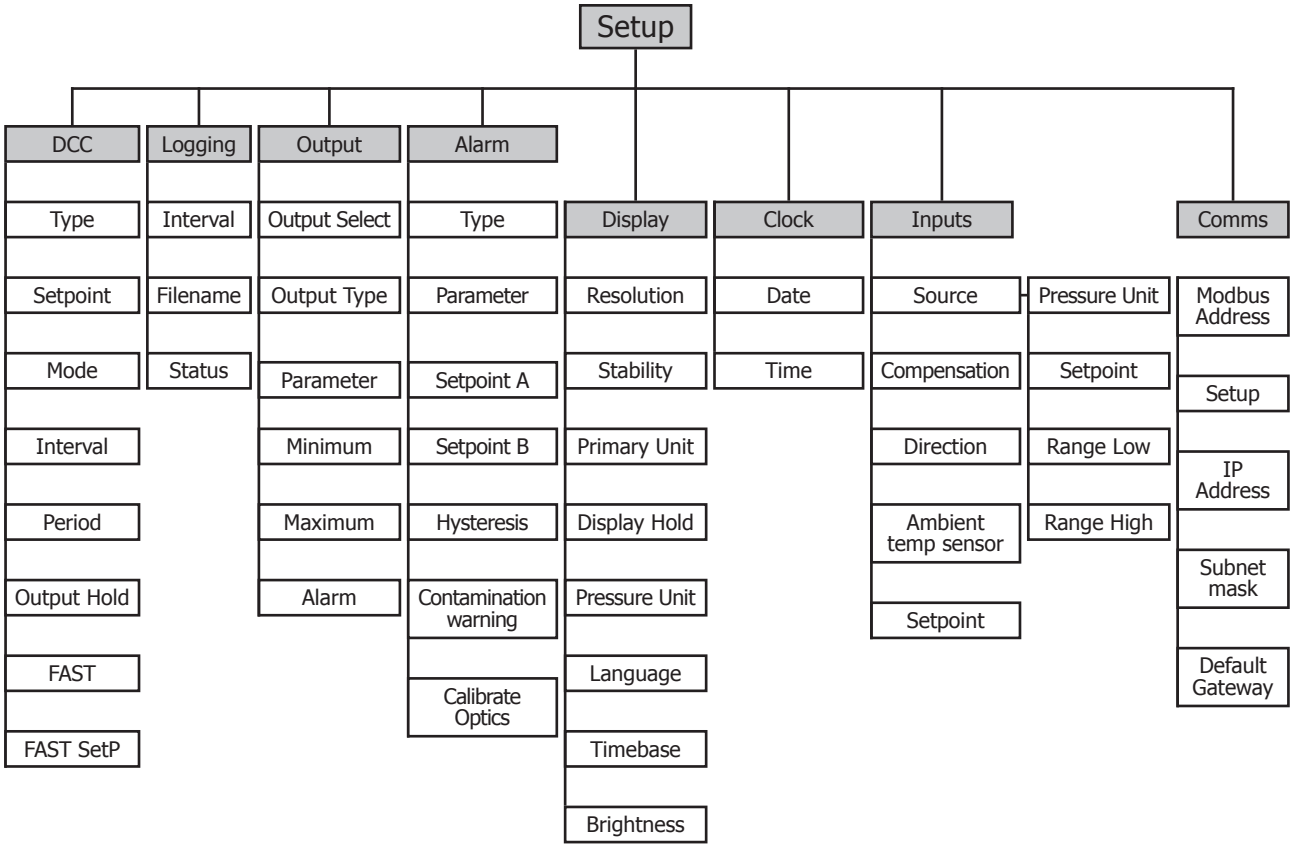
From firmware version 1.0.1 onwards it is possible to lock the analyzer so unauthorized users cannot change any settings. Go to the SETUP page and in the bottom left hand corner there is a padlock icon on that is greyed out. Pressing it will bring up the passcode entry screen where you will need to enter 5491. The padlock icon will become solid to show it is now activated.

After five minutes, this function will lock the analyzer (you will need to return to the main screen). To unlock the screen you must enter 5491.

It is possible to deactivate the function before it is triggered or after activation by simply pressing the solid padlock item in the Settings Menu.

3.1.3 Menu Structure





3.1.4 Operational Status Display

ΔDP	Shows total change in measured dewpoint over the time base of the trend graph
Mode	Shows current operation mode:
Next Mode	Measure, Standby, DCC, Max Cool, Data Hold
Process	Status of Process Alarm.  Alarm is active  Alarm is inactive For further information on alarm configuration see sections 3.2 and 4.6.
Sensor	Indicates whether the sensor has established a condensate formation, or if the system is in a transient condition: Heating, Cooling, Control.

3.1.5 Sensor Status Display

TEC Drive		Indicates the whether the sensor is heating or cooling the mirror: Also indicates the power level applied as a percentage to total possible.
Optical Signal		Indicates the reflectivity of the mirror, and whether this is clean or has a condensate formation. The target is 100% signal level, which indicates the optimal film thickness has been achieved. 0% indicates that the mirror is free of condensate. For further information see section 4.2.1.
Connected sensor		Shows the sensor type that the control unit is configured for. To connect a 1-Stage sensor to a control unit configured for 2-Stage or vice-versa, you must first use the PC Application Software to enter the sensor configuration code found on the calibration certificate. Refer to section 6.2 Exchanging Sensors.
Logging		When shown, the Optidew is currently logging data to SD. See section 4.4.6 for further information.

3.2 Setup Menus

DCC (Dynamic Contamination Correction)

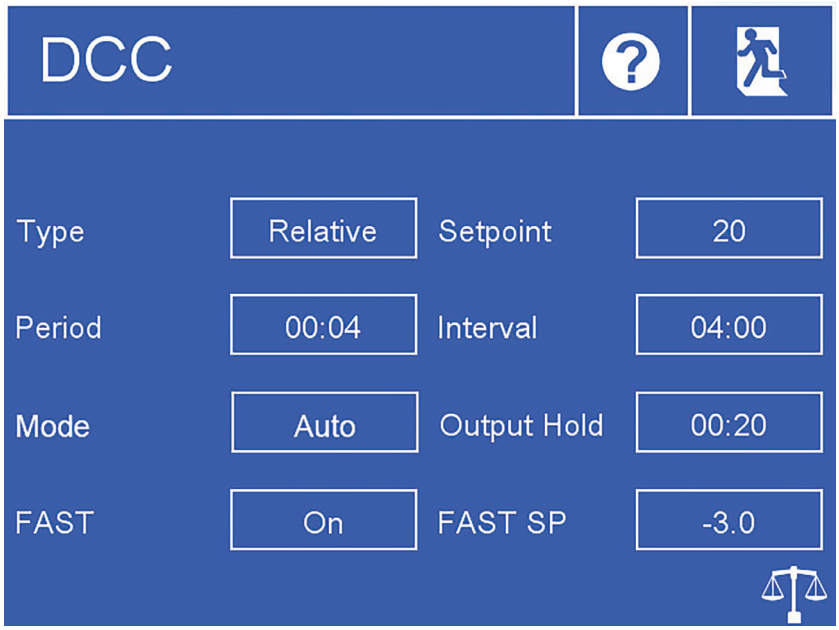


Figure 15 *DCC menu*

Type	DCC heating temperature can either be relative to last measured dewpoint or an absolute temperature. Actual temperature or Δ is defined by 'Setpoint'. **Available input:** Relative, Absolute
Setpoint	Mirror heating temperature during DCC, either absolute or relative to last measured dewpoint. See 'Type' option above. **Available input:** 1 to 120°C
Mode	DCCs can either be triggered automatically at every Interval, or they can be manually triggered only. **Available input:** Manual, Auto
Interval	Time between automatic DCCs **Input format:** hh:mm **Limits:** 01:00 to 99:00
Period	Duration of a DCC **Input format:** hh:mm **Limits:** 00:01 to 00:59
Output hold	Minimum time to hold analog outputs after finishing a DCC **Input format:** hh:mm **Limits:** 00:04 to 00:59
FAST	Turns frost assurance on or off. See section 4.4.3 for further information **Available input:** On, Off
FAST SetP	Passing this mirror temperature will trigger the frost assurance function without a DCC **Available input:** -28 to -2°C

Logging

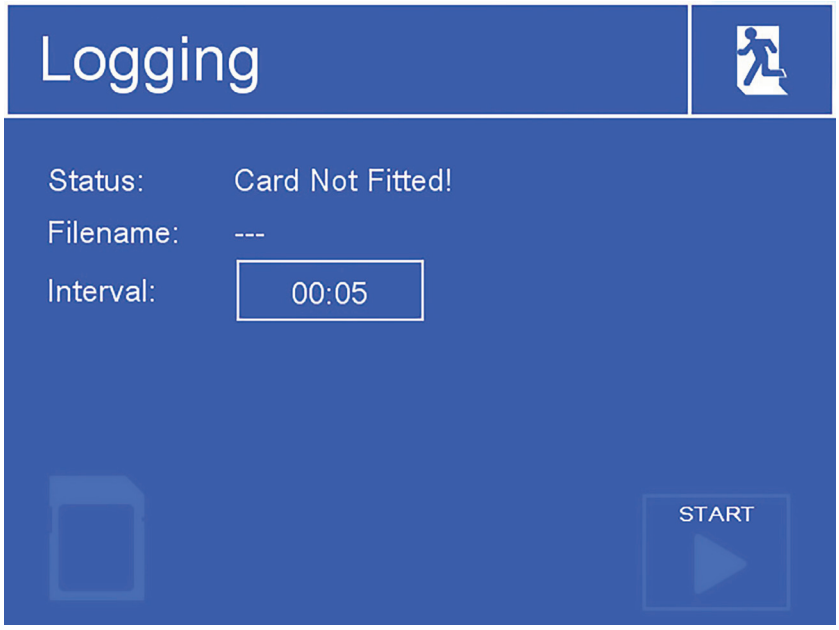


Figure 16 *Logging screen*

Interval	Changes the interval at which data is recorded **Input format:** mm:ss – **Limits:** 00:05 to 10:00	
SD status indicator:	Indicates status of inserted SD card:	
		No SD Card inserted
		Ready to log
		Initializing card
		Error occurred
		SD Card is write protected
		Logging
Start/Stop	Begins a new log (file name is generated automatically), or ends a log in progress.	

Outputs

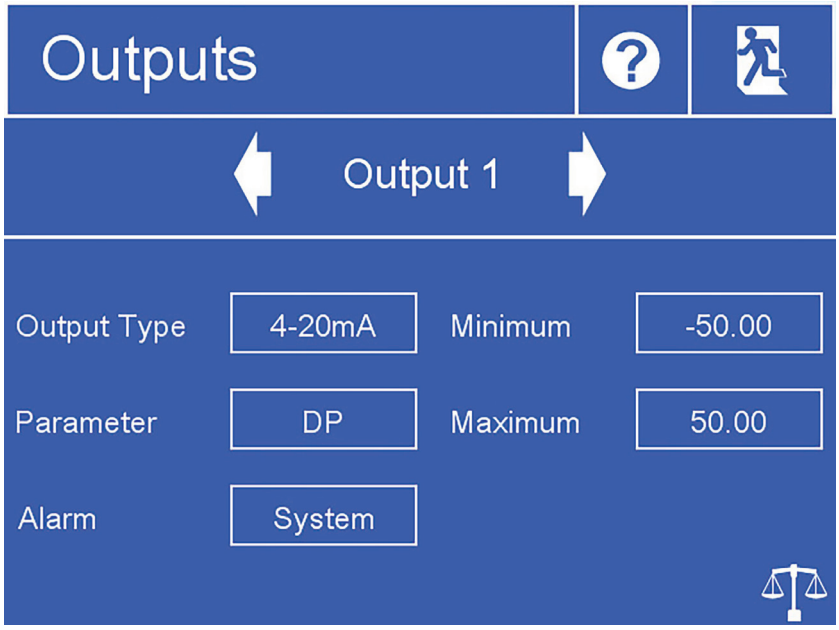


Figure 17 *Outputs screen*

Output selector arrows	Selects the output to be adjusted
Output Type	Determines the mA output range **Available input:** 0-20mA, 4-20mA
Parameter	Assigns the chosen calculated or measured parameter to this output channel **Available input:** DP, Temperature, Pressure, %RH, wvp, g/m^3, g/kg, ppm$_V$, Wet Bulb
Alarm	If the selected alarm is tripped, then this output will be forced to Namur alarm level (20.6mA). **Available input:** None, System, Process, Both
Minimum	The minimum output range for the selected parameter **Available input:** Dependant on parameter
Maximum	The maximum output range for the selected parameter **Available input:** Dependant on parameter

Alarm

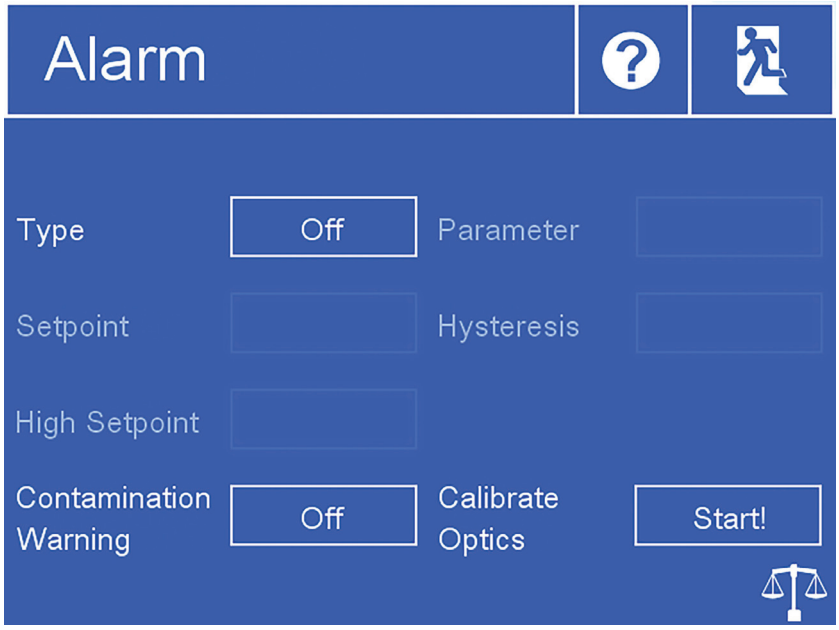


Figure 18 *Alarm screen*

Type	Sets the trip criteria for the process alarm **Available input:** Over, Under, In. Band, Out. Band, Off
Parameter	Sets the parameter associated with the process alarm **Available input:** DP, Temperature, Pressure, %RH, wvp, g/m^3, g/kg, ppm$_V$, ppmW, Wet Bulb
Setpoint	Sets the trip point for Over or Under alarm types **Available input:** Depending on parameter
Low Setpoint	Sets the low trip point for Band alarm types **Available input:** Depending on parameter
High Setpoint	Sets the high trip point for Band alarm types **Available input:** Depending on parameter
Hysteresis	Sets the deviation from trip point before the alarm deactivates **Available input:** Depending on parameter
Contamination Warning	Sets whether an Optics Warning trips the process alarm. Refer to sections 4.6 and 5.2 for information about the optics warning. **Available input:** On, Off
Calibrate Optics	It is necessary to run this function whenever the mirror is cleaned, or if a different dewpoint sensor is installed. Following this, a DCC will begin.

Display

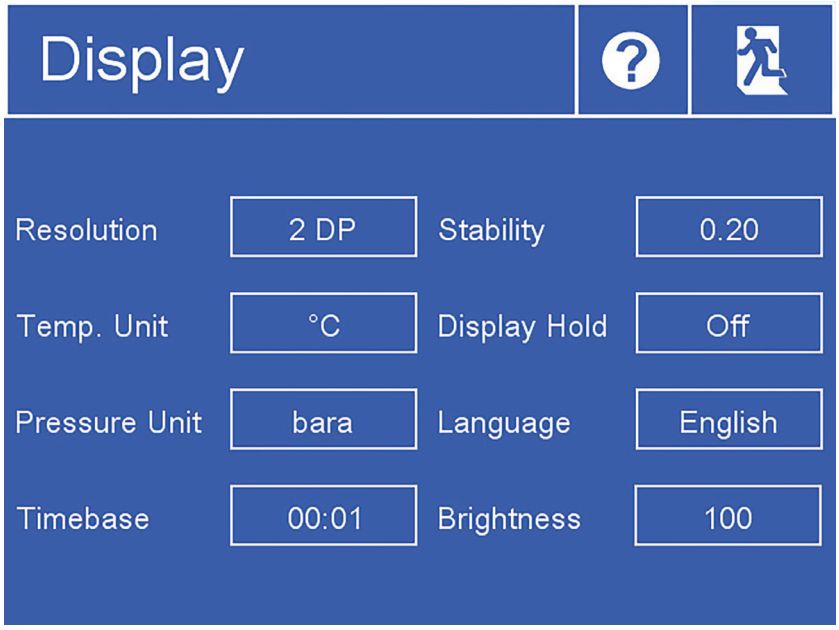


Figure 19 *Display screen*

Resolution	Changes the number of decimal places for all displayed parameters **Available input:** 1 DP, 2 DP
Temperature Unit	Measurement unit for temperature values **Available input:** °C, °F
Pressure Unit	Measurement unit for pressure values **Available input:** kPa, psig, psia, barg, bara
Timebase	X axis span for trend graph on main screen **Input format:** hh:mm **Limits:** 00:01 to 10:00
Stability	Determines a stable measurement following DCC, which is conditional to release Data Hold. Entered value is ΔDP over 30s. **Available input:** 0.2 to 20
Display Hold	When enabled, values on display are also held during Data Hold **Available input:** Off, On
Language	Sets User Interface language **Available input:** English, Deutsch, Español, Français, Italiano, Português, USA, Russian, Chinese, Japanese
Brightness	Display backlight control **Available input:** 0 to 100%

Clock

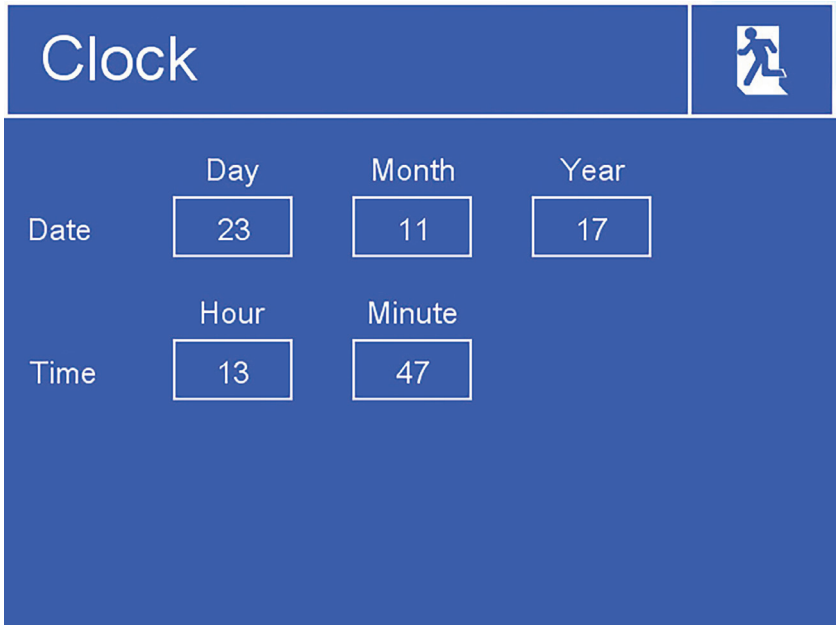


Figure 20 *Clock screen*

Date	Current date
Time	Current time

Inputs

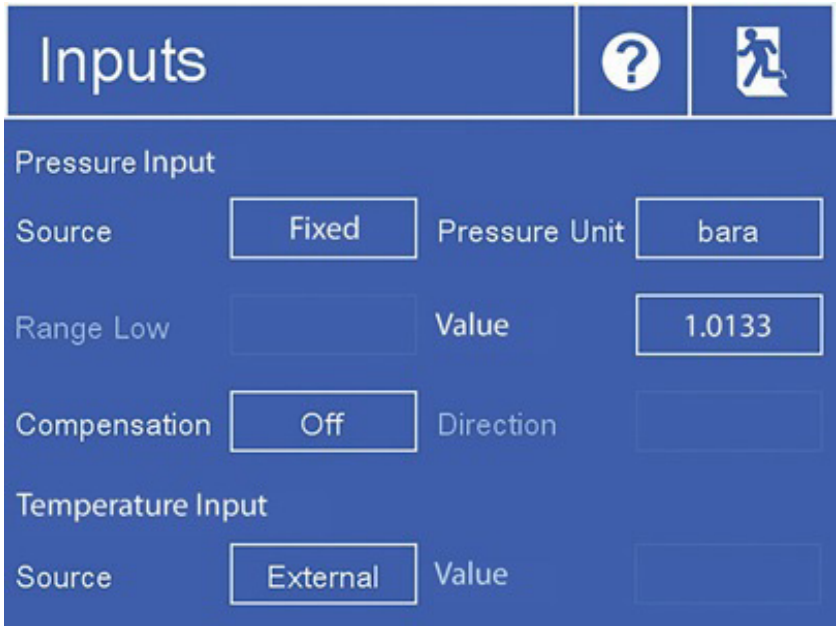


Figure 21 *Inputs screen*

Source (Pressure Input)	Changes between pressure input from external 4-20mA transmitter or a fixed value **Available input:** Fixed, External
Pressure Unit	Measurement unit for pressure inputs **Available input:** kPa, psig, psia, barg, bara
Value (If 'Fixed' selected)	Sets pressure used for internal calculations
Range Low (If 'External' selected)	Sets the low range of the connected pressure transmitter
Range High (If 'External' selected)	Sets the high range of the connected pressure transmitter.
Compensation	Recalculate dewpoint based on pressure input **Available input:** Off, On
Direction (If 'Compensation' On)	Select 'From Atmos' if dewpoint sensor is at atmospheric pressure. Select 'To Atmos' if dewpoint sensor is at entered fixed pressure or pressure measured by transducer.
Source (Temperature Input)	Changes between temperature input from external PT100 or a fixed value. **Available input:** Fixed, External
Value (If 'Fixed' selected)	Sets temperature used for internal calculations

Comms Screen

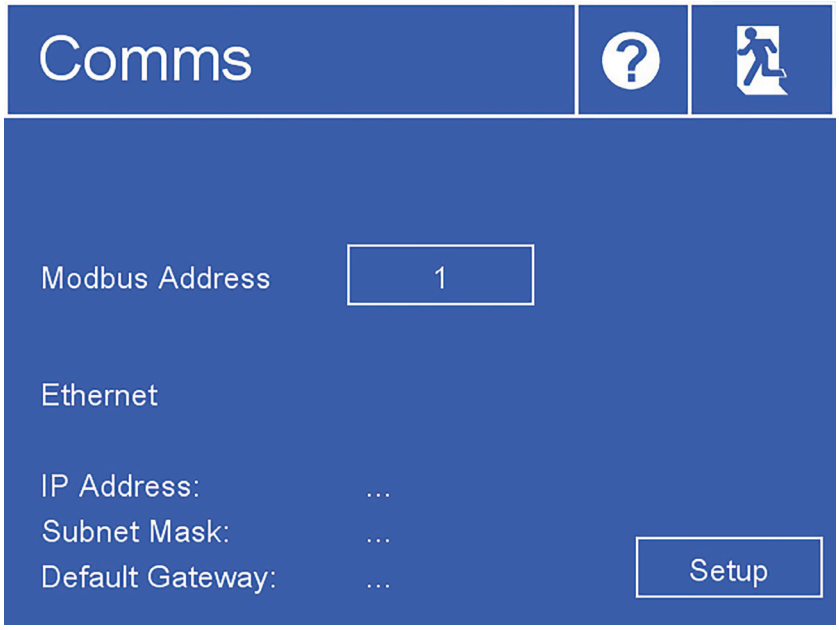


Figure 22 *Comms screen*

Modbus Address	Sets the Modbus slave address for this Optidew
Setup	Access the TCP/IP Network Settings page

Network Settings

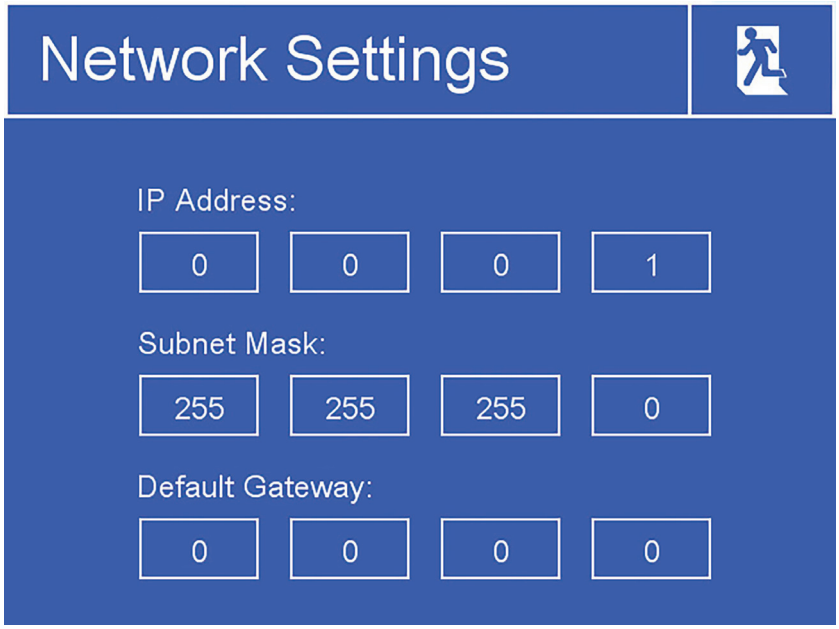


Figure 23 *Network settings screen*

IP Address	The IP address of the instrument (default 10.0.50.100)
Subnet Mask	Determines network subnet address (default 255.255.255.0)
Default Gateway	Default gateway address (default 10.0.50.254)

3.3 Transmitter Version

The Optidew can also be ordered as a transmitter version without a touch-screen display. This unit comes with a single button and multi-color LED indicator which displays the current instrument status.

The indicator changes color and pulse depending on the instrument status

Meaning	LED Color
Initialization	White
DCC	Blue
DCC Plus	Flashing Blue (Fast)
Optics balance	Flashing Blue
Searching for dewpoint	Flashing Green
Searching for dewpoint - Optics contaminated	Flashing Magenta
Optics contaminated & Process alarm off	Magenta
Optics contaminated & Process alarm on	Flashing Red/Magenta
Measuring	Green
Measuring & Process alarm on	Flashing Red
MaxCool	Blue
Standby	Flashing Yellow
Standby – Optics contaminated	Flashing Yellow/Magenta
System Fault	Red

Pressing the button has two different effects, depending on the mode that the instrument is in:

In DCC or DCC Plus mode – pressing the button returns to standby

In all other modes - pressing the button initiates manual DCC

3.3.1 Optics Calibration

After power is applied the LED indicator on the front of the instrument will turn white for the first 5 seconds. Pressing the button during this phase will initiate an optics calibration. The indicator will flash indicating the button-press has been registered.

4 OPERATION

4.1 Operating Cycle

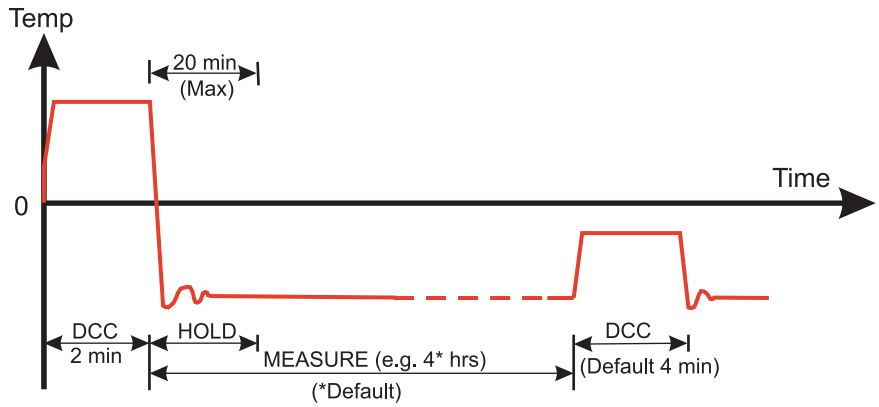


Figure 24 *Typical operating cycle*

At initial switch-on, the instrument enters a DCC cycle for 2 minutes. During this time the mirror is heated above the prevailing dewpoint to ensure that all condensate is driven off the surface of the mirror. The degree of heating is determined by the configuration of the 'Type' and 'Setpoint' parameters in the DCC menu (see section 3.2 for further information).

The mirror is maintained at this temperature for the DCC period (default 4 minutes) or 2 minutes on switch-on. During the DCC process, Data Hold fixes the analog outputs at the same value(s) as before DCC commenced. Data Hold typically lasts 4 minutes from the end of a DCC cycle, or until the instrument has reached the dewpoint. This procedure is in place to prevent any system which is connected to the outputs from receiving a 'false' reading.

After the DCC period has finished, the measurement period commences, during which the control system decreases the mirror temperature until it reaches the dewpoint. The sensor will take a short amount of time to form a film of condensate and control on the dewpoint. The length of this stabilization time depends upon the dewpoint temperature. When the measurement is stable or tracking very slow changes in dewpoint, the Sensor indicator in the Operational Status display will indicate 'Control'. Note that at dry dewpoints (below around -4°F/-20°C) the sensor may display 'Control' when the mirror temperature is still slowly oscillating, always use the trend graph on the display as a secondary indication.

The end of a DCC cycle re-sets the interval counter, meaning that another DCC will start (by default) after 4 hours have elapsed. Once the measurement is stable, Data Hold will release, and the analog outputs will resume their normal operation. At this point the Status area of the Operational Status display will change to 'Measure'.

4.2 Operating Guide

4.2.1 Description

Once the Optidew has been powered on and has carried out its' initial DCC, it will attempt to find the dewpoint. In order to measure the dewpoint a Chilled Mirror hygrometer must control a thin film of condensed water or ice on the mirror.

To initially form the condensate layer the mirror must be cooled past the actual dew or frost point. The control system will then gradually heat the mirror to reduce the thickness of this condensate layer. It typically takes several heating/cooling cycles until the instrument has achieved the optimal film thickness where evaporation and condensation are occurring in equilibrium. This is the true dew/frost point of the sample.

After finding the true dewpoint, the control system will continue to maintain the film thickness at a constant level. Any decrease in actual sample dewpoint will cause evaporation from the condensate film to increase – reducing its thickness and causing the control system to cool the mirror to compensate. Likewise if the dewpoint increases then condensation on the mirror will increase, and the control system will heat to compensate.

In extreme cases where the dewpoint decreases very abruptly, then the condensate will be completely evaporated from the mirror. In these scenarios the system will 'search' for the dewpoint again by cooling, resulting in cooing past the dewpoint as described above. A similar situation occurs when the dewpoint increases abruptly, however the condensate film can be lost here by the control system heating to compensate and exceeding the new dewpoint.

4.2.2 Operating Practice

There are two basic methods of measuring with the Optidew:

In-situ measurements are made by placing the sensor(s) inside the environment to be measured.

Extractive measurements are made by installing the sensor into a block within a sample handling system, and flowing the sample outside of the environment to be measured through this system

Extractive measurements are recommended when the conditions in the environment to be measured are not conducive to making reliable measurements with the product. Examples of such conditional limitations are:

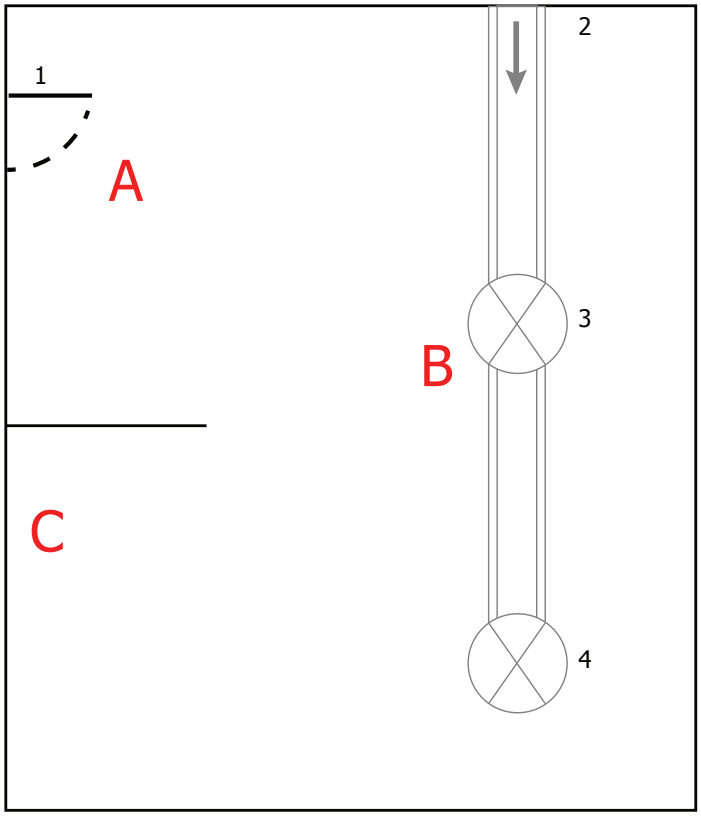
- Excessive flow rate
- Presence of particulates matter
- Presence of entrained liquids
- Excessive sample temperature
- Dew point is beyond depression capability at sample temperature

The basic considerations for each measurement type are as follows:

<u>In-Situ</u>

1. **Dewpoint Sensor position** – will the sensor see an area of the environment that is representative of what you want to measure? For

example; you are looking to measure the Relative Humidity of a room which is controlled by an HVAC vent at either end (see figure 25) you will get very different readings depending on whether the sensor is positioned at point A, point B or point C. Point C provides the most representative sampling point given that it won't be disturbed by the vent or the door.



1. Door
2. HVAC Duct, air into room
3, 4. Ceiling Vents

Figure 25 *Room measurement example*

2. **Gas speed** – if you are planning on installing the sensor in a duct, consider how fast the sample gas is moving through it. Excessive flow speed will cause displacement of the condensate layer on the mirror, leading to unstable measurement.

   If this is the case, then a guard equipped over the sensor can mitigate the effects of excessive gas speed by dissipating the sample throughout it's surface area. An appropriate guard can be purchased from Kahn Instruments, or your local representative.

3. **Particulates** – particulates passing over the sensor can build up on the mirror over time. This can cause a loss of mirror reflectivity. DCC will compensate for this by taking into account anything on the surface of the mirror when resetting the optical condition, however if the problem becomes too severe, the 'mirror contamination warning' symbol will be displayed in the Sensor Status display.

Figure 26 *Mirror contamination warning symbol*

4. **Sample temperature** – consider the difference between the sample temperature and the dewpoint temperature. Make sure that the sensor you are using has the cooling capability to make the measurement (see section 4.5. for further information). If the sensor does not have the necessary cooling capability, then you should consider an extractive system so the sample can be cooled prior to measurement.

5. **Sample pressure** – If you are interested in readings in terms of ppm_V or g/m^3 Insure that the sensor is positioned in an environment of known pressure. You can then either enter this pressure into the Optidew via the 'Inputs' screen (see section 3.2), or connect a pressure sensor directly to the point of measurement (see section 2.6).

Extractive

If the sensor will be mounted into a sample conditioning system, then the above points are still of relevance, but the following should also be considered:

1. **Extraction point** – make sure that the chosen extraction point is representative of the process, i.e. that the sample of interest is flowing past the extraction point, and it is not being pulled from a dead volume.

2. **Enclosure and sample line heating** – if the sample has a dewpoint greater than ambient temperature, then all components upstream of the sensor will need to be heated to at least 18°F/10°C above the sample dewpoint to ensure the water remains in vapor phase.

3. **Sample block flow path** – the sensor block must be configured with gas inlet and outlets installed in the side ports. The top is either blanked or used to install a pressure transmitter. **If replacing an old Optidew installation then be aware that using the old sensor block will result in poor response speed at low dew-points, as it does not allow enough flow across the mirror.**

4.3 Good Measurement Practice

4.3.1 Sampling Hints

Measurement of moisture content is a complex subject, but does not need to be difficult.

This section aims to explain the common mistakes made in measurement situations, the causes of the problem, and how to avoid them. Mistakes and bad practices can cause the measurement to vary from the expectation; therefore a good sampling technique is crucial for accurate and reliable results.

Transpiration and Sampling Materials

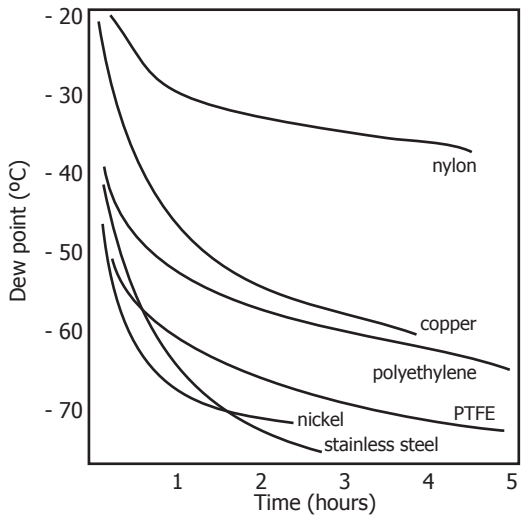


Figure 27 *Material permeability comparison*

All materials are permeable to water vapor, as the water molecule is extremely small compared to the structure of solids, even when compared to the crystalline structure of metals. The graph above shows the dewpoint inside tubing of different materials when purged with very dry gas, where the exterior of the tubing is in the ambient environment.

Many materials contain moisture as part of their structure, particularly organic materials (natural or synthetic), salts (or anything which contains them) and anything which has small pores. It is important to ensure that the materials used are suitable for the application.

If the partial water vapor pressure exerted on the outside of a compressed air line is higher than on the inside, the atmospheric water vapor will naturally push through the porous medium causing water to migrate into the pressurized air line. This effect is called transpiration.

Adsorption and Desorption

Adsorption is the adhesion of atoms, ions, or molecules from a gas, liquid, or dissolved solid to the surface of a material, creating a film. The rate of adsorption is increased at higher pressures and lower temperatures.

Desorption is the release of a substance from or through the surface of a material. In constant environmental conditions, an adsorbed substance will remain on a surface

almost indefinitely. However, as the temperature rises, so does the likelihood of desorption occurring.

In practical terms, as the temperature of the environment fluctuates, water molecules are adsorbed and desorbed from the internal surfaces of the sample tubing, causing small fluctuations in the measured dewpoint.

Sample Tubing Length

The sample point should always be as close to the critical measurement point as possible, in order to obtain a truly representative measurement. The length of the sample line to the sensor or instrument should be as short as possible. Interconnection points and valves trap moisture, so using the simplest sampling arrangement possible will reduce the time it takes for the sample system to dry out when purged with dry gas.

Over a long tubing run, water will inevitably migrate into any line, and the effects of adsorption and desorption will become more apparent. It is clear from the graph shown above that the best materials to resist transpiration are stainless steel and PTFE.

Trapped Moisture

Dead volumes (areas which are not in a direct flow path) in sample lines, hold onto water molecules which are slowly released into the passing gas; this results in increased purge and response times, and wetter than expected readings. Hygroscopic materials in filters, valves (e.g. rubber from pressure regulators) or any other parts of the system can also trap moisture.

Sample Conditioning

Sample conditioning is often necessary to avoid exposure of sensitive measuring components to liquids and other contaminants which may cause damage or affect the accuracy over time, depending on the measurement technology.

Particulate filters are used for removing dirt, rust, scale and any other solids that may be in a sample stream. For protection against liquids, a coalescing filter should be used.

The membrane filter is a more expensive but highly effective alternative to a coalescing filter. It provides protection from liquid droplets, and can even stop flow to the analyzer completely when a large slug of liquid is encountered.

Condensation and Leaks

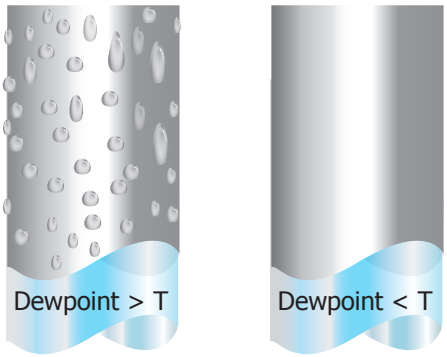


Figure 28 *Formation of condensation*

Maintaining the temperature of the sample system tubing above the dewpoint of the sample is vital to prevent condensation. Any condensation invalidates the sampling process as it changes the water vapor content of the gas being measured. Condensed liquid can alter the humidity elsewhere by dripping or running to other locations where it may re-evaporate.

The integrity of all connections is also an important consideration, especially when sampling low dew points at an elevated pressure. If a small leak occurs in a high pressure line, gas will leak out but vortices at the leak point and a negative vapor pressure differential will also allow water vapor to contaminate the flow.

Flow Rates

Theoretically flow rate has no direct effect on the measured moisture content, but in practice it can have unanticipated effects on response speed and accuracy. The optimal flow rate varies depending on the measurement technology, and can always be found in the instrument or sensor manual.

An inadequate flow rate can:

- Accentuate adsorption and desorption effects on the gas passing through the sampling system.
- Allow pockets of wet gas to remain undisturbed in a complex sampling system, which will then gradually be released into the sample flow.
- Increase the chance of contamination from back diffusion: ambient air that is wetter than the sample can flow from the exhaust back into the system. A longer exhaust (sometimes called a pigtail) can also help alleviate this problem.
- Slow the response of the sensor to changes in moisture content.

An excessively high flow rate can:

- Introduce back pressure, causing slower response times and unpredictable effects on equipment such as humidity generators.
- Result in a reduction in depression capabilities in chilled mirror instruments by having a cooling effect on the mirror. This is most apparent with gases that have a high thermal conductivity such as hydrogen and helium.

POSSIBLE INJURY! The tubing, valves and other apparatus attached to this instrument must be adequate for the maximum pressure which will be applied, otherwise physical injury to the operator or bystander is possible.

Before disconnecting the instrument from the gas line it is essential to vent the system to atmospheric pressure, otherwise severe injury could result.

4.3.2 First Time Operation

Before using the instrument, please read through the Installation, Operation and Maintenance sections of this manual. This instruction assumes that all recommendations within these sections have been followed, and that the control unit and sensors are physically installed and all electrical connections complete.

1. Insure that all sample connections are in good condition, of appropriate materials and are leak-tight
2. Clean the mirror according to the instructions in section 5.1
3. Control the flow rate to within 0.2 to 4 SCFH/0.1 to 2Nl/min (2.5 SCFH optimal; 1l/min optimal)
4. Power on the instrument

NOTE: if the dewpoint sensor has been swapped, refer to section 5.2

4.4 Operational Functions

4.4.1 DCC Function

Dynamic Correction Control (DCC) is a system designed to compensate for the loss of measurement accuracy which results from mirror surface contamination.

During the DCC process the mirror is heated to a default temperature of 36°F/20°C above the dewpoint to remove the condensation which has formed during measurement.

The surface finish of this mirror, with the contamination which remains, is used by the optics as a reference point for further measurements. This removes the effect of contamination on accuracy.

After switch-on, the mirror is assumed to be clean, therefore the instrument will only run a DCC for 2 minutes to quickly establish a clean mirror reference point. By default, every subsequent DCC is 4 minutes in duration and will automatically occur every 4 hours.

At certain times it may be desirable to disable the DCC function in order to prevent it from interrupting a measurement cycle, e.g. during a calibration run. This is achieved by setting 'Mode' to 'Manual' in the DCC menu. See section 3.2 for further details.

A manual DCC can be initiated or cancelled by touching the DCC button on the Main Screen. The DCC button is context sensitive, i.e. if DCC is on, the Main Screen shows DCC OFF as being selectable. Similarly if DCC is off, DCC ON is shown.

It is possible to change the parameters relating to the DCC cycle on the DCC Setup Screen, refer to Section 3.2.

DCC Plus

DCC Plus is a feature designed to further control the build-up of contaminants on the mirror surface without physical intervention from the operator. The function operates immediately prior to either a scheduled automatic DCC or a manual DCC, by cooling the mirror for a few seconds before heating it.

This cooling causes additional condensation on the mirror, which dissolves water-soluble matter, and dislodges non water-soluble matter. When the surface is then heated and the water evaporated, the contamination will cluster together leaving areas of clean mirror between, which has less overall impact on the optics.

4.4.2 MAXCOOL Function

The MAXCOOL function overrides the dewpoint control loop and applies maximum cooling drive to the Peltier heat pump. It can be used to determine:

- What temperature the mirror can be driven down to with reference to the sensor body.
- Whether or not the instrument is controlling at the dewpoint and whether it is able to reach it. This situation could, for instance, arise when attempting to measure very low dewpoints where, possibly due to a high ambient temperature, the Peltier heat pump is unable to depress the temperature far enough to reach the dewpoint.
- Whether the instrument is controlling by switching MAXCOOL on for a short period and then switching back to MEASURE. This will depress the mirror temperature briefly and when it is switched back to MEASURE the control loop should be able to stabilize the mirror temperature at the dewpoint again.

The MAXCOOL function can be turned on by touching the MAXCOOL button on the Main Screen.

4.4.3 Frost Assurance Technology (FAST)

In carefully controlled laboratory conditions, super-cooled water can exist in temperatures as low as –54°F/48°C. However, when using a chilled mirror instrument it only occurs on the mirror at temperatures down to around, -22°F/–30°C.

A gas in equilibrium with ice is capable of supporting a greater quantity of water vapor at a given temperature than a gas in equilibrium with liquid water. This means that a measurement below 32°F/0°C taken over water will read approximately 10% lower than the same measurement taken over ice.

There are two modes of FAST operation, enabling and disabling FAST acts on both modes:

Following DCC: the Optidew makes an initial dewpoint measurement. If the initial measurement is between +26°F and -22°F (-3°C and -30°C) then the mirror is driven down to below -31°F/-35°C to ensure the formation of ice on the mirror surface. The instrument then continues operation as normal.

Dynamic: whenever the measured dewpoint drops below the value set as 'FAST SetP', the mirror is driven down to below -31°F/-35°C to insure the formation of ice on the mirror surface. The instrument then continues operation as normal.

Note that Data Hold is active whenever FAST is active.

For further information, see section 3.2

4.4.4 STANDBY Mode

In STANDBY mode, the Peltier heat pump is disabled.

The main use for this feature is during set up (when measurements are not required), i.e. when flow rates are being adjusted and the analog outputs are being configured.

4.4.5 Parameter Conversions & Pressure Compensation

Many parameters which are calculated by the Optidew require a temperature or pressure reading in addition to dewpoint to ensure the calculated value is correct.

These additional readings can either come from a sensor connected to the Optidew, or from a fixed (manual) input. See section 3.2 for details on external inputs.

Calculated Parameter	Temperature input required	Pressure input required
%RH	✓	×
wvp	×	×
g/m^3	✓	×
g/kg	×	✓
Wetbulb	✓	✓
ppm_v	×	✓
ppm_w	×	✓

If external sensors are used to generate the inputs, then the sensors should be positioned in the same location so that they are making a measurement representative of the environment seen by the dewpoint sensor.

4.4.6 Data Logging

The data logging function allows all of the measured parameters to be logged at a user specified interval on the supplied SD card via the SD card slot on the base or side of the instrument. The filename for each log file is generated automatically from the instrument date and time.

Log files are saved in CSV (comma separated value) format. This allows them to be imported easily into Excel or other programs for charting and trend analysis. To set-up data logging refer to Section 3.2.

4.5 Minimum Measurable Dewpoints

The minimum dewpoint that can be measured is determined by the sensor temperature, and whether the sensor can be maintained at that temperature. The following chart assumes operation in a climatic chamber, where the air speed is sufficient to remove any excess heat generated by the sensor.

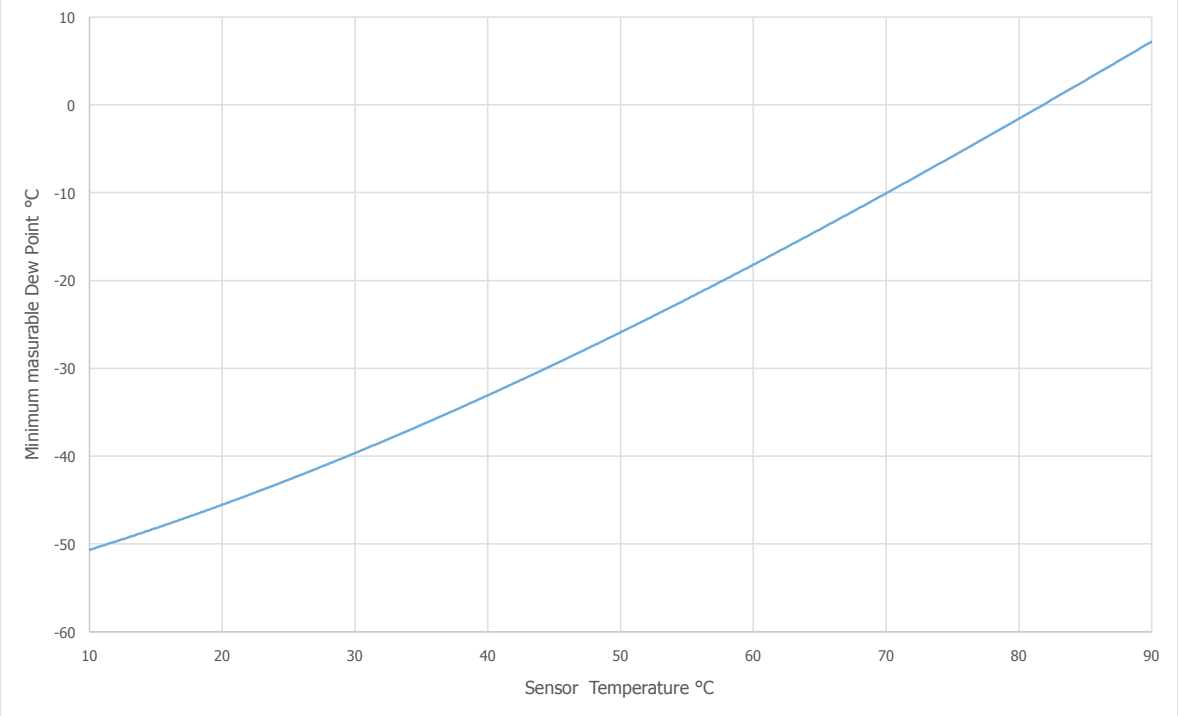


Figure 29 *2-Stage minimum measurable dewpoint*

4.6 Warnings and Faults

The Optidew contains a comprehensive self-diagnosis system to alert the user whenever there is an issue which could affect the measurement. These alerts are divided into two categories:

Warnings – A problem which is not currently affecting the measurement but requires attention.

Faults – A problem which requires immediate attention. Whenever a fault is triggered, the Optidew will switch to 'Standby' and remain in this mode until the operator intervenes.

When a Fault is present, the System Alarm symbol will appear over the sensor status display on the main screen. Pressing the System Alarm symbol will display all current faults and warnings. At any other time, active warnings can be viewed by pressing the right-hand side of the sensor status display. A system fault will usually be accompanied by one or more warnings, which describe the problem in more detail.

Once a fault has been resolved, it is necessary to run a DCC cycle to return the instrument to normal operation.

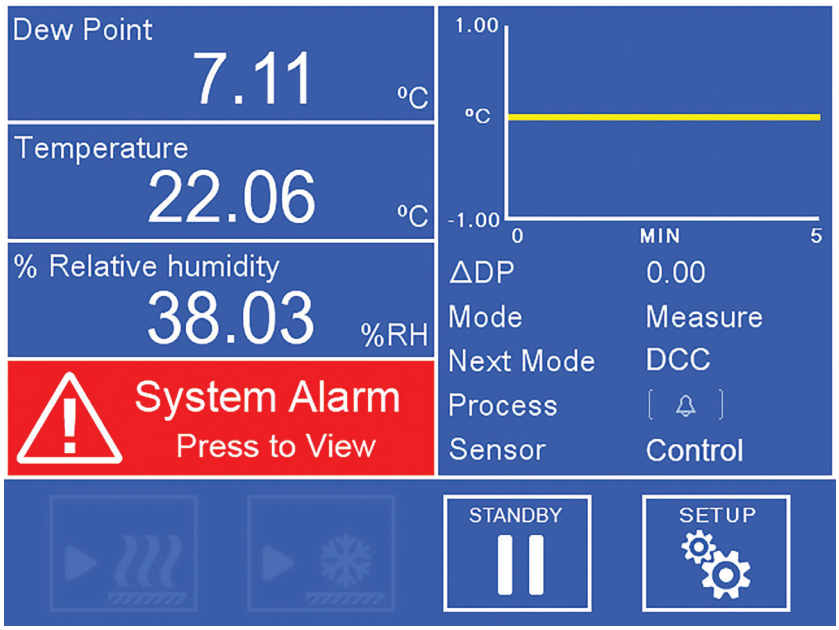


Figure 30 *System alarm*

Possible Fault Codes

No.	Name	Description
06	Mirror Overheat	Mirror Temperature above 266°F/130°C
02	Optics Fault (Search Fail)	Unable to establish clean mirror condition
03	Optics Fault (< Min Limit)	Signal below allowable limit
04	Optics Fault (> Max Limit)	Signal above allowable limit
08	Heating Saturation	TEC drive saturated in heating mode beyond allowable time limit
09	Cooling Saturation	TEC drive saturated in cooling mode beyond allowable time limit
01	Mirror Pt1000 Fault	Chilled Mirror sensor internal Pt1000 fault
04	Temp. Probe Fault	External temperature probe fault
07	Pressure Tx. Fault	External pressure transmitter fault
17	Mirror Contaminated	Mirror requires cleaning followed by Optics Calibration
11	Mirror Pt1000 Fault (Open)	Chilled Mirror sensor Pt1000 open circuit
12	Mirror Pt1000 Fault (Low)	Chilled Mirror sensor Pt1000 short circuit/below lower limit
13	Mirror Pt1000 Fault (High)	Chilled Mirror sensor Pt1000 above upper limit
08	Temp. Probe Fault (Open)	External temperature probe open circuit
09	Temp. Probe Fault (Low)	External temperature probe short circuit/below lower limit
10	Temp. Probe Fault (High)	External temperature probe above upper limit
14	Pressure Tx. Fault (Open)	Pressure transmitter signal < 0.2mA (open circuit)
15	Pressure Tx. Fault (Alarm)	Pressure transmitter signal 3.6-3.8mA OR 20.5-21mA
16	Pressure Tx. Fault (Fail)	Pressure transmitter signal > 21mA, or < 3.6mA

5 MAINTENANCE

5.1 Mirror Cleaning

Throughout the life of the instrument, periodic cleaning of the mirror surface and optics window may be required. The frequency of this depends upon operating conditions and the potential in the application for contaminants to be deposited on the mirror.

The Optidew will notify the user on the state of mirror contamination. The instrument will initially give a warning in the sensor status display (or as a Magenta/flashing Magenta indication on the transmitter version) when contamination is detected, but will continue to operate. Cleaning the mirror, then running a DCC is necessary when this warning is displayed.

If the contamination reaches levels which will drastically affect performance, a fault alarm will trip, causing the instrument to switch to standby mode until action is taken.

For remote indication of an optics warning, the process alarm contact can be set to trip whenever the optics warning is active. See sections 3.2 and 4.6 for further information.

Figure 31 *Mirror contamination warning*

The cleaning procedure is as follows:

1. Set the instrument to Standby
2. If mounted in a sample block, disconnect the sensor cable and remove the sensor from the block.
3. Clean the mirror surface and optics window firstly with a cotton bud/Q-Tip soaked in distilled water, then with one of the following solvents: methanol, ethanol, or isopropyl alcohol. To avoid damage to the mirror surface do not press too firmly on the cotton bud/Q-Tip when cleaning. Allow the cleaning solvent to fully evaporate.
4. Press the 'Calibrate Optics' button in the 'Alarms' screen. For the Optidew Wall Mount without display, refer to section 3.3.1.

Figure 32 *Sensor cleaning*

5.2 Exchanging Sensors

It is recommended to keep the dewpoint sensor with the control unit that it was originally ordered with. However if it is necessary to replace the sensor or exchange it for a spare, there are two steps which need to be taken.

1. Connect to the control unit via the application software (as detailed in the Application Software section at the end of the manual) and click the 'Enter Sensor Configuration' button at the Main Options window and enter the password 7316Sens.

   Enter the 12 character configuration code found on the calibration certificate for the sensor you are connecting.

2. Connect the new sensor, then navigate to the 'Alarms' screen, and press the 'Calibrate Optics' button. A DCC will follow, which cannot be canceled. Do not disconnect the sensor during this time.

Appendix A
Technical Specifications

Appendix A Technical Specifications

Performance			
Dew Point Measurement Accuracy	±0.27°F/0.15°C		
Reproducibility	±0.09°F/±0.05°F		
Sensitivity	±0.02°F/±0.01°F		
Response	Stable measurement at +10°C dp within 1 minute		
Dew-Point Sensor			
Sensor	**Single Stage**	**Dual Stage**	**Harsh Environment**
Dewpoint Range	-13 to +194°F (-25 to +90°C)	-40 to +194°F (-40 to +90°C)	-40 to +248°F (-40 to +120°C)
Temperature Range	-40 to +194°F (-40 to +90°C)	-40 to +194°F (-40 to +90°C)	-40 to +248°F (-40 to +120°C)
% RH Range @ 73°F/23°C	2.25 to 100	0.45 to 100	0.45 to 100
Mirror Temperature Measurement	Pt1000, 1/10 DIN Class A		
Corrosion & Saturation Protection	Active Component Isolation System		
Recommended Sample Flow	Ambient (environmental measurements) to 4SCFH or 2Nl/min (flowing sample)		
Pressure	2500 kPag max		
Sensor cable	Standard: 194°F/90°C max temperature High temperature: 125°C max temperature		
Cable length	0.3, 3, 5, 10 & 20m lengths available		
Process connection	M36x1.5-6g		
Remote PRT			
Temperature Measurement Accuracy	±0.18°F/±0.1°C		
Cable length	0.3, 3, 5, 10 & 20m lengths available		
Temperature Measurement	PT100 1/10 DIN Class A		
Remote Pressure Sensor (Optional)			
Pressure Measurement Accuracy	±0.25% FS		
Pressure Measurement Range	0-160KPa OR 0-2500KPa		
Process Connection	1/8" NPT-M		
Output	4-20 mA		

Control Unit		
Resolution	1 or 2 decimal places selectable	
Measurement Units	°Fdp or °Cdp Relative humidity - % Absolute humidity - g/m^3, ppm$_V$ Mixing Ratio - g/kg Wet Bulb Temperature (Twb) - °F, °C Water Vapor Pressure (wvp) - Pa Ambient Temperature - °F, °C pressure converted DP - °F, °C pressure - Bara, Barg, Psia, Psig, KPa	
Enclosure	**Wall Mount**	**Bench Top**
Material	ABS	ABS
Analog Outputs	Two mA outputs, selectable 0-20, 4-20 (maximum load 500Ω)	Two mA outputs, selectable 0-20, 4-20 (maximum load 500Ω)
Digital Communications	Modbus RTU over RS485 (standard) Modbus TCP over Ethernet (optional)	Modbus RTU over: USB (standard) RS485 (standard) Modbus TCP over Ethernet (optional)
Alarms	1x Process Relay, 1x Alarm Relay, Both Form C, 1A, 30V DC	1x Process Relay, 1x Alarm Relay, Both Form C, 1A, 30V DC
Inputs	4-20mA for pressure sensor	4-20mA for pressure sensor
Data Logging	SD card slot (optional)	SD card slot (standard)
Ingress Protection	IP54 (standard) IP65/NEMA 4 (optional)	IP54 IP65/NEMA 4
Dimensions	8.7"x6.9"x3.0" 220x175x75mm	8.7"x6.9"x3.0" 220x175x118mm
Weight	Control unit: 3.3lbs/1.5kg Sensor: 7oz/200g	Control unit: 3.3lbs/1.5kg Sensor: 7oz/200g
Display	5.7" color touch screen (optional)	5.7" color touch screen
Environmental Conditions	-4 to +122°F / -20 to +50°C, up to 100%RH non-condensing (optional) 100% RH condensing with IP65 version	
Supply Voltage	100 to 240V AC, 50 to 60Hz	
Power consumption	30VA max	

Appendix B
Modbus Register Map

Appendix B Modbus Register Map

All the data values relating to the Optidew are stored in 16-bit wide holding registers. Registers can contain either measured or calculated values (dewpoint, temperature, relative humidity etc.), or configuration data (analog output or alarm settings).

Modbus RTU Implementation
This is a partial implementation of the Modbus RTU Standard with the following codes implemented:

Function Code	Description
3	Read Holding Register
6	Write Holding Register
16	Write Multiple Holding Registers

Register Types

Data Type	Description
float	IEE754 32 bit single precision floating point, spans 2 16-bit holding registers. First register contains the most significant bits.
uint16	16 bit unsigned integer, can contain options list e.g. 0 = Dew Point, 1 = Temperature.
int16	16 bit signed integer.
boolean	Can be treated like a uint16, where 0 = false/disabled, and 1 is true/enabled.

Communications
In order to communicate with the instrument over a USB connection, first install the Kahn application software which contains a USB->UART bridge driver. The Optidew will then appear in Device Manager as a virtual serial port.

Serial Port Settings (USB/RS485)
9600 Baud Rate, 8 Data Bits, No Parity, 1 Stop Bit, No Flow Control

Modbus TCP
If using the Ethernet connection, the instrument uses the Modbus TCP protocol instead of Modbus RTU. Refer to resources online for the key differences.

Further Reading

	http://www.simplymodbus.ca/FAQ.htm is an excellent resource covering the basics of the Modbus protocol. Full descriptions of the function codes (FC03/FC06/FC16) can be found in the sidebar.
	https://www.scadacore.com/tools/programming-calculators/online-hex-converter/ is an excellent resource for determining register types/byte order issues in raw received Modbus data.

Register Address

Dec	Hex	Access	Data Type	Description	Comment
Instrument Information					
0	0000	R|W	uint16	Instrument Modbus Address	
2	0002	R	uint32	Instrument Serial MS	
3	0003			Instrument Serial LS	
4	0004	R	uint16	Instrument Firmware Version	
5	0005	R	uint16	Register Map Version	
Measured and Calculated Values					
6	0006	R	float	Dew/Frost point MS	Units = Temperature Unit
7	0007	R		Dew/Frost point LS	
8	0008	R	float	Ambient Temp MS	Units = Temperature Unit
9	0009	R		Ambient Temp LS	
10	000A	R	float	Pressure MS	Units = Pressure Unit
11	000B	R		Pressure LS	
12	000C	R	float	Relative Humidity MS	
13	000D	R		Relative Humidity LS	
14	000E	R	float	ppm (vol) MS	Default = Dry Basis, register 105 for wet basis
15	000F	R		ppm (vol) LS	
16	0010	R	float	ppm (wt.) MS	Mol weight of carrier set in register 108
17	0011	R		ppm (wt.) LS	
18	0012	R	float	Absolute Humidity MS	Units = g/m3
19	0013	R		Absolute Humidity LS	
20	0014	R	float	Mixing Ratio MS	Units = g/kg
21	0015	R		Mixing Ratio LS	
22	0016	R	float	Wet Bulb MS	Units = Temperature Unit
23	0017	R		Wet Bulb LS	
24	0018	R	float	Water Vapor Pressure MS	Units = Pascal
25	0019	R		Water Vapor Pressure LS	
30	001E	R	uint16	Temperature Unit	Set using register 100
				0=°C 1=°F	

31	001F	R	uint16	Pressure Unit	Set using register 101
				0=psig 1=psia 2=barg 3=bara 4=kPa	
Instrument Status					
33	0021	R	uint16	Operating Mode	
				5=MaxCool 6=DCC 7=Hold 8=Measure 9=Standby 10=FAST 13=System Failure	
34	0022	R	uint16	Mode Hrs Left	
35	0023	R	uint16	Mode Mins Left	
36	0024	R	uint16	Mode Secs Left	
37	0025	R	uint16	Sensor Status	
				1=Cooling 2=Heating 3=In-Control 4=Idle	
38	0026	R	uint16	Fault Status 1	
				0=OK 1=Optics Search Fail 2=Optics Min Limit 4=Optics Max Limit 8=Ambient Pt100 Fail 16=Mirror Pt100 Fail 32=Mirror Overheat 64=Loop Fail (Pressure Tx) 128=Heating Saturation 256=Cooling Saturation	
39	0027	R	uint16	Fault Status 2	
				0=OK 1=Ambient Pt100 Open 2=Ambient Pt100 Low 4=Ambient Pt100 High 8=Mirror Pt100 Open 16=Mirror Pt100 Low 32=Mirror Pt100 High 64=Loop Open (Pressure Tx) 128=Loop Alarm (Pressure Tx) 256=Loop Fail (Pressure Tx) 512=Contaminated	
40	0028	R	uint16	Alarms Status	

				0=No Alarm 1=System 2=Process	
41	0029	R	uint16	Logging Status	
				0=Not Equipped 1=No Card 2=Ready 3=Logging 4=Writing 5=Mount Error 6=Write Error 7=Mounting 8=Write Protected 9=Unknown	
42	002A	R	boolean	Data Hold Active	
43	002B	R	boolean	Display Hold Active	
50	0032	R	int16	Peltier Drive %	
51	0033	R	uint16	Optics Signal %	
Calculation Parameters					
100	0064	R|W	uint16	Set Temp Unit	
				0=°C 1=°F	
101	0065	R|W	uint16	Set Pressure Unit	
				0=psig 1=psia 2=barg 3=bara 4=kPa	
103	0067	R|W	boolean	%RH - Force Over Water WVP	wvp calculated over water in %RH calculation (Not Recommended)
104	0068	R|W	boolean	%RH - Force Over Water SWVP (WMO standard)	swvp calculated over water in %RH calculation as per WMO standard
105	0069	R|W	boolean	ppm(vol) Wet Basis	Use wet basis calculation method
106	006A	R|W	float	Atmospheric Pressure MS	Atmospheric pressure used for pressure conversion
107	006B	R|W		Atmospheric Pressure LS	
108	006C	R|W	float	Mol Weight MS	Carrier gas molecular weight for Mixing Ratio / ppm(wt.), default air
109	006D	R|W		Mol Weight LS	

110	006E	R|W	boolean	Pressure Correction Enabled	
111	006F	R|W	uint16	Pressure Correction Direction	
				0=To atmospheric 1=From atmospheric	
Pressure Sensor Configuration					
112	0070	R|W	uint16	Pressure Sensor Source	
				0=External 1=Manual	
113	0071	R|W	uint16	Pressure Sensor Unit	
				0=psig 1=psia 2=barg 3=bara 4=kPa	
114	0072	R|W	float	Manual Pressure MS	
115	0073	R|W		Manual Pressure LS	
116	0074	R|W	float	Pressure Range Low Ma MS	4mA
117	0075	R|W		Pressure Range Low Ma LS	
118	0076	R|W	float	Pressure Range High Ma MS	20mA
119	0077	R|W		Pressure Range High Ma LS	
120	0078	R|W	float	Pressure Range Low MS	Pressure Sensor Zero
121	0079	R|W		Pressure Range Low LS	
122	007A	R|W	float	Pressure Range High MS	Pressure Sensor Span
123	007B	R|W		Pressure Range High LS	
Temperature Sensor Configuration					
124	007C	R|W	uint16	Temperature Sensor Source	
				0=External 1=Manual	
125	007D	R|W	float	Manual Temperature MS	
126	007E	R|W		Manual Temperature LS	
Instrument Configuration					
127	007F	R|W	uint16	DCC Setpoint Mode	
				0=Absolute 1=Relative	
128	0080	R|W	int16	DCC Temperature Setpoint	(Degrees * 100)
129	0081	R|W	uint16	DCC Interval Mode	
				0=Auto (Recommended) 1=Manual	
130	0082	R|W	uint16	DCC Interval Mins	
131	0083	R|W	uint16	DCC Duration Mins	

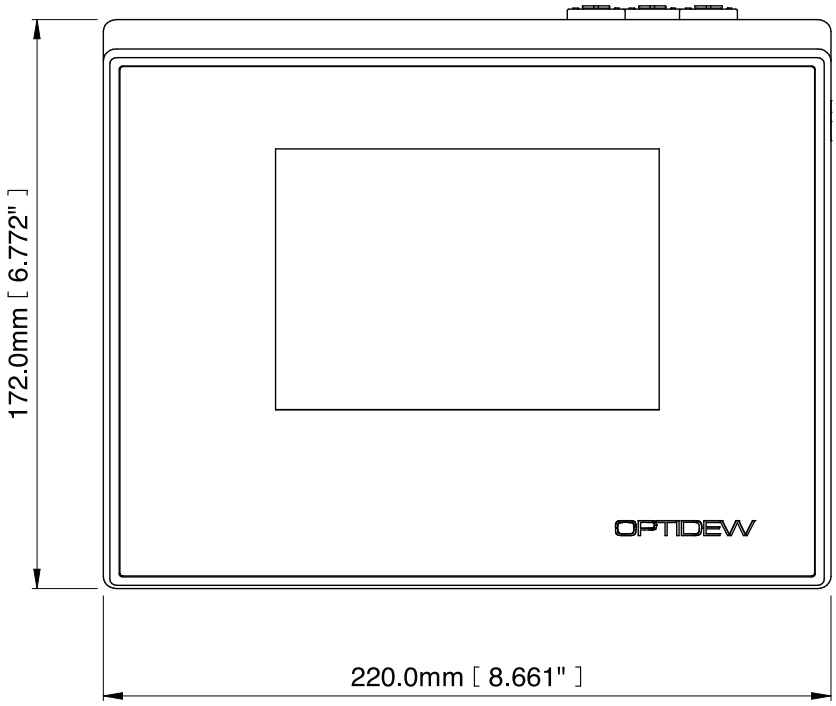
133	0085	R|W	boolean	FAST Enable	
134	0086	R|W	float	FAST Setpoint MS	
135	0087	R|W		FAST Setpoint LS	
136	0088	R|W	uint16	Peltier Stages	
				1=1 Stage 2=2 stage	
137	0089	R/W	uint16	Stability Band	(Degrees * 1000) .. Threshold to end Data Hold
140	008C	W	uint16	Stability Band	(Degrees * 1000) .. Threshold to end Data Hold
141	008D	W	uint16	Set Mode	
				1=Standby 2=DCC 4=MaxCool 8=Cancel MaxCool 16=Calibrate Optics	
Display Parameters					
145	0091	R|W	uint16	Language	
				0=English 1=German 2=Spanish 3=French 4=Italian 5=Portuguese 6=USA 7=Russian 8=Japanese 9=Chinese	
146	0092	R|W	uint16	Decimal Places	
147	0093	R|W	uint16	Displayed Parameter 1	
				0=Dew/Frost point 1=Temperature 2=Pressure 3=Relative Humidity 4=ppm(vol) 5=ppm(wt.) 6=Mixing Ratio 7=Absolute Humidity 8=Wet bulb 9=WVP	
148	0094	R|W	uint16	Displayed Parameter 2	
149	0095	R|W	uint16	Displayed Parameter 3	
150	0096	R|W	boolean	Enable Display Hold	

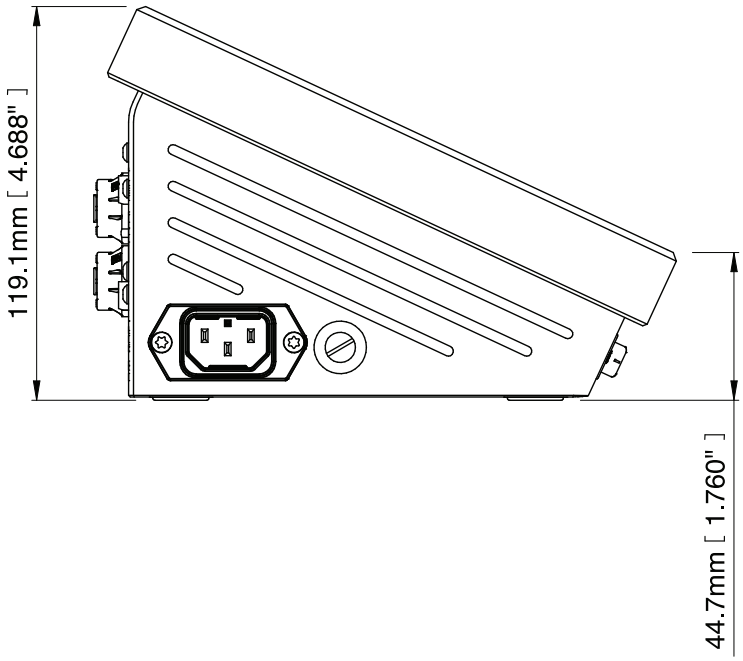
Analog Output Settings					
155	009B	R|W	uint16	Analog 1 Type	
				0=0-20mA 1=4-20mA	
156	009C	R|W	uint16	Analog 1 Parameter	
				0=Dew/Frost point 1=Temperature 2=Pressure 3=Relative Humidity 4=ppm(vol) 5=ppm(wt.) 6=Mixing Ratio 7=Absolute Humidity 8=Wet bulb 9=WVP	
157	009D	R|W	float	Analog 1 Range Low MS	
158	009E	R|W		Analog 1 Range Low LS	
159	009F	R|W	float	Analog 1 Range High MS	
160	00A0	R|W		Analog 1 Range High LS	
161	00A1	R|W	uint16	Analog 2 Type	
162	00A2	R|W	uint16	Analog 2 Parameter	
163	00A3	R|W	float	Analog 2 Range Low MS	
164	00A4	R|W		Analog 2 Range Low LS	
165	00A5	R|W	float	Analog 2 Range High MS	
166	00A6	R|W		Analog 2 Range High LS	
167	00A7	R|W	uint16	Analog 1 Alarm Type	
				0=None 1=System Only 2=Process Only 3=Both	
168	00A8	R|W	uint16	Analogue 2 Alarm Type	
171	00AB	R|W	uint16	Process Alarm Parameter	
				0=Dew/Frost point 1=Temperature 2=Pressure 3=Relative Humidity 4=ppm(vol) 5=ppm(wt.) 6=Mixing Ratio 7=Absolute Humidity 8=Wet bulb 9=WVP	
172	00AC	R|W	uint16	Process Alarm Type	

Appendix C
Dimensional Drawings

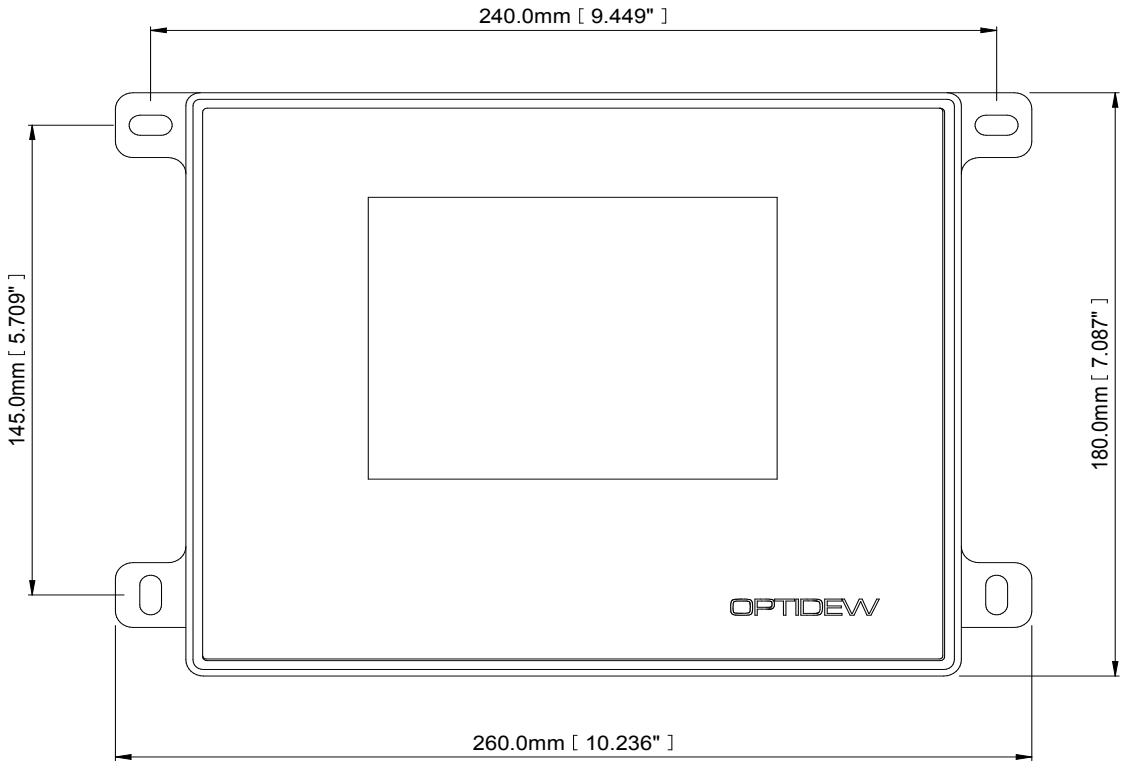
Appendix C Dimensional Drawings

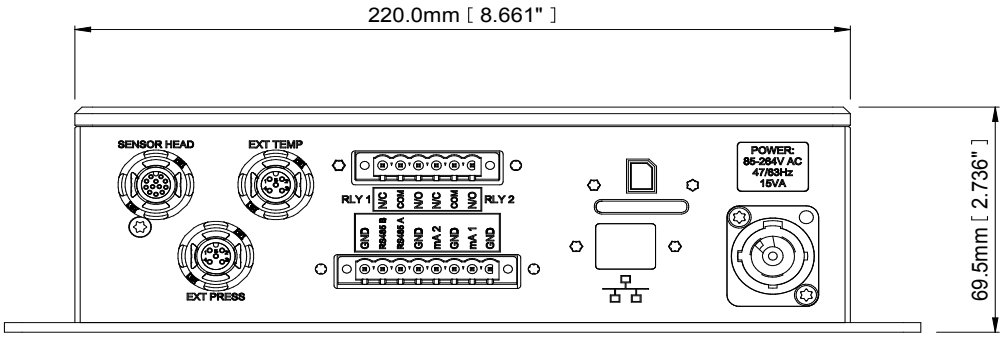
Optidew Bench Top Control Unit



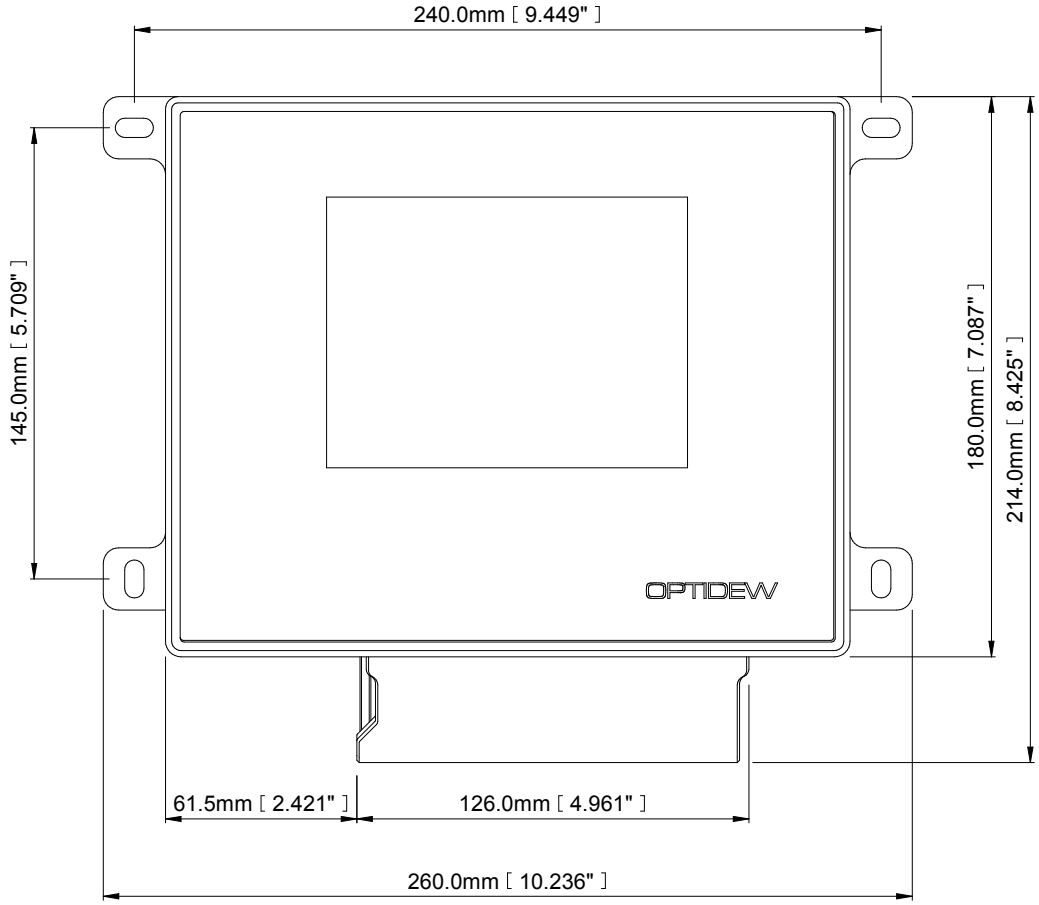


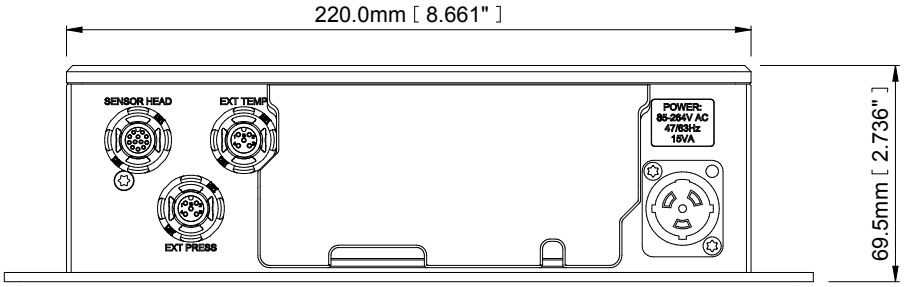
Optidew Wall Mount Control Unit – IP54



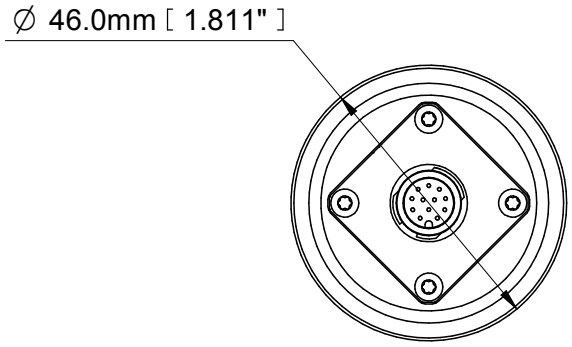


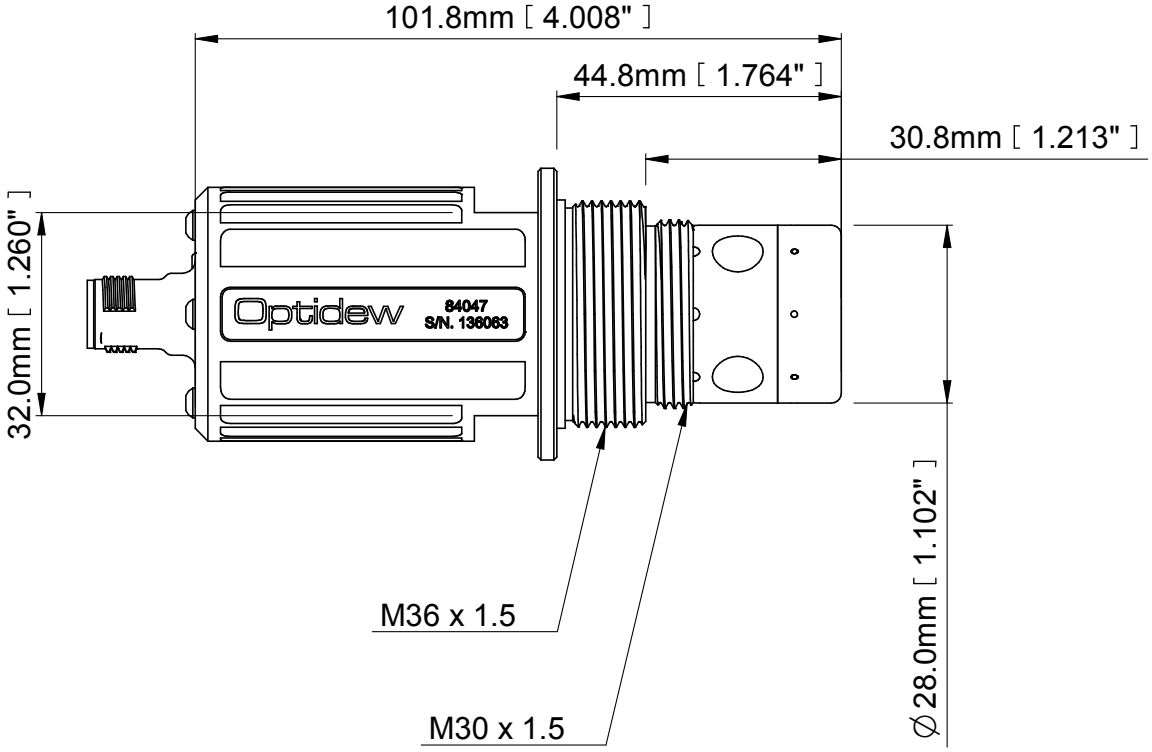
Optidew Wall Mount Control Unit – IP65



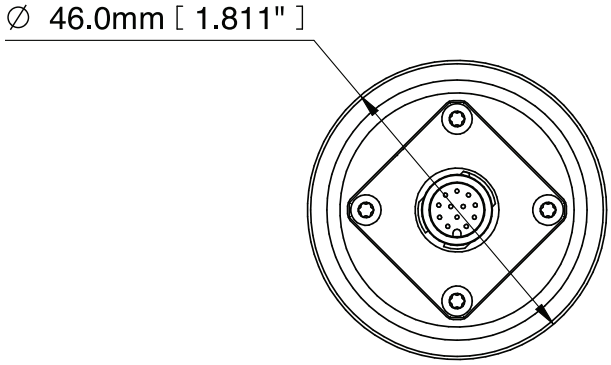


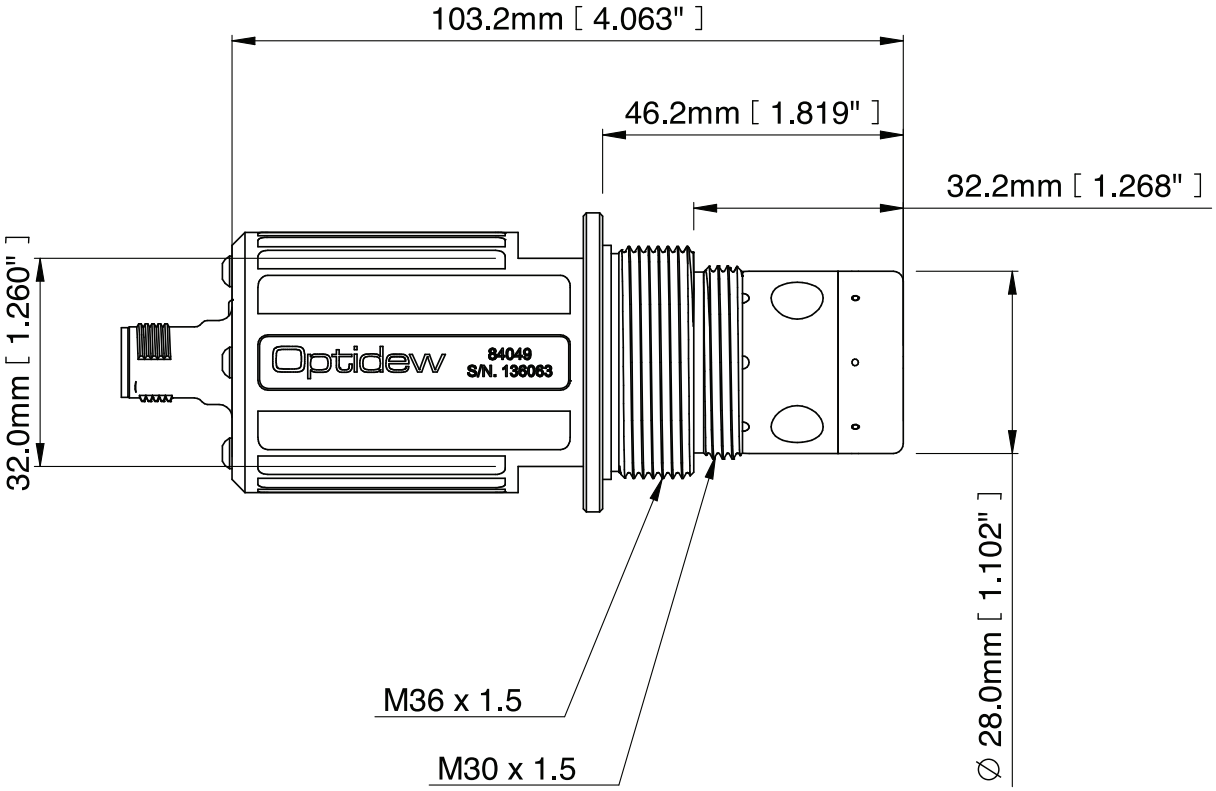
Single Stage Dewpoint Sensor



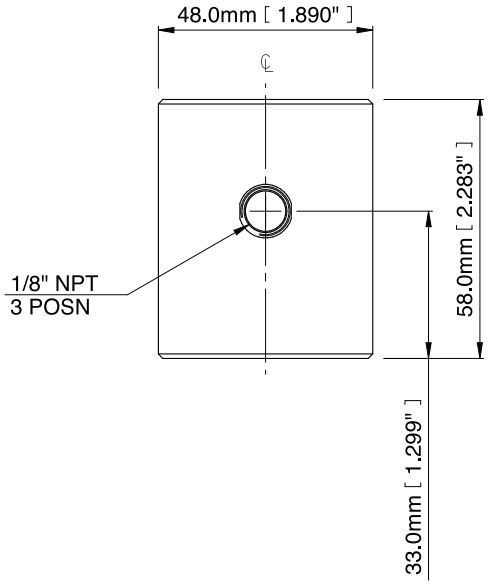


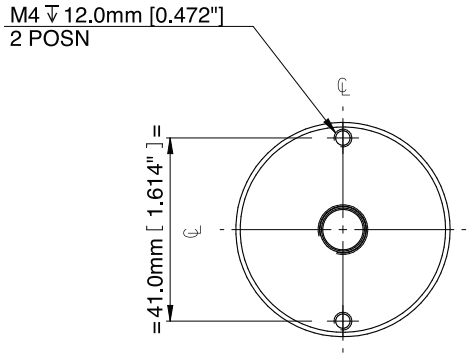
Dual Stage Dewpoint Sensor



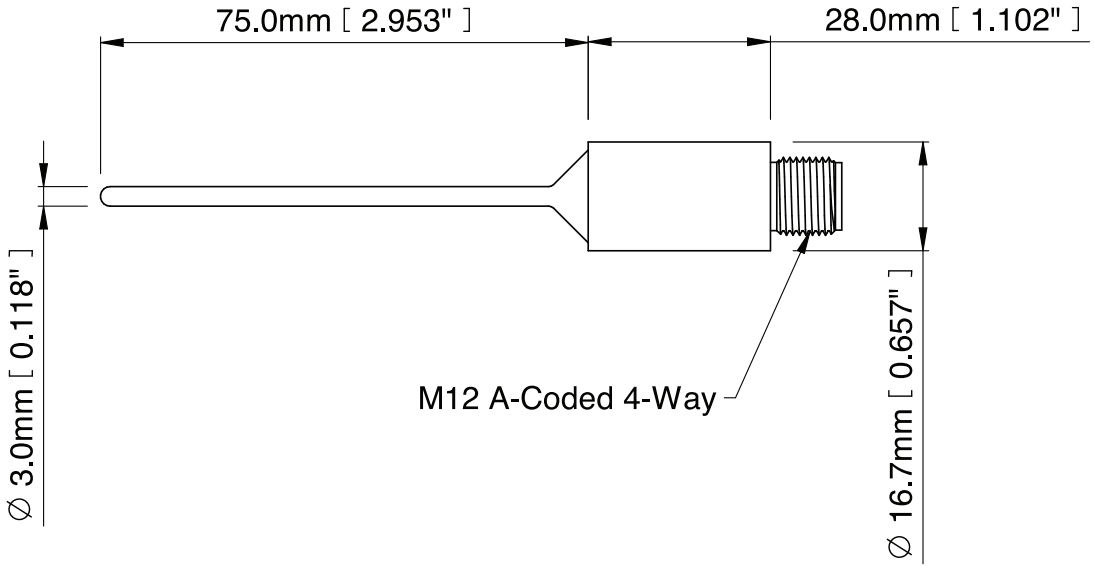


Sample Block



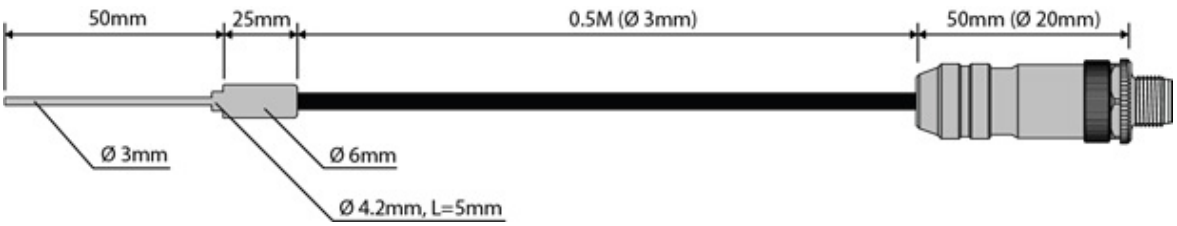


Standard Temperature Probe



***Weld burr may extend from 1 mm from colar to towards tip of probe.**
Probe and connector rated 90 °C.

High Temperature Probe



Maximum termperature measurement 120 °C.
Connector rated 120 °C.
Probe and cable rated 250 °C.

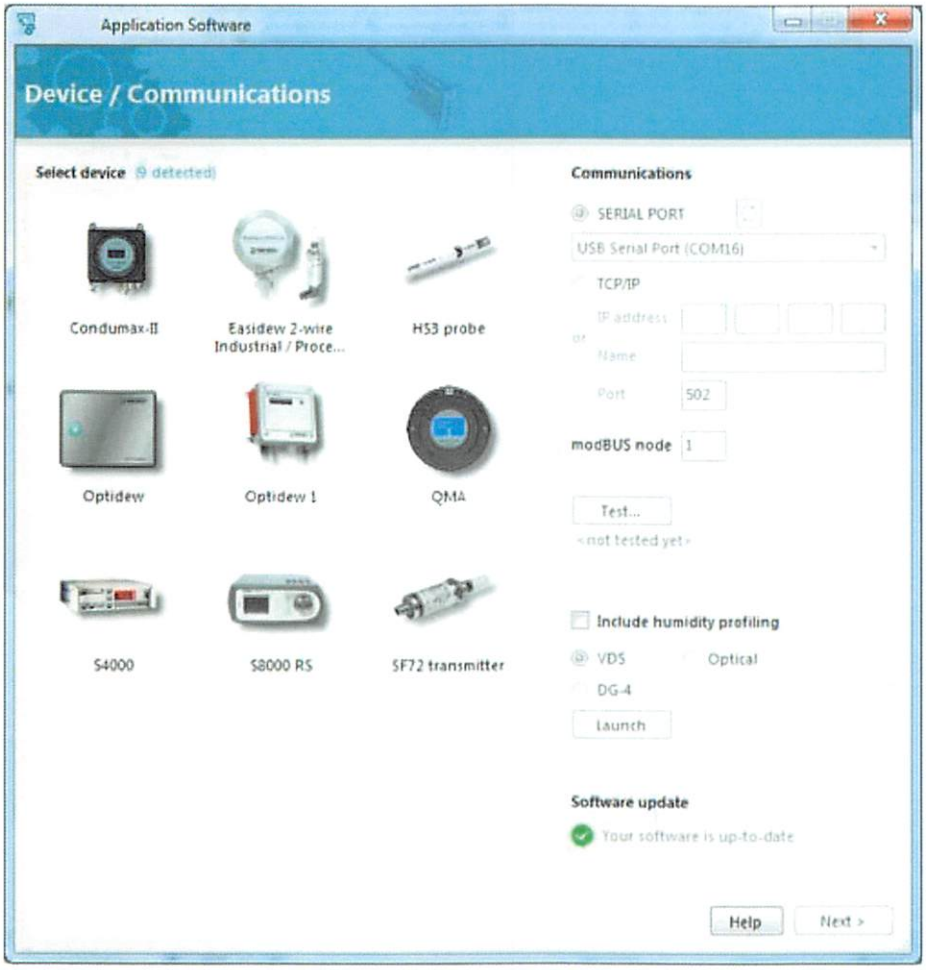
Application Software

Contents

Connecting a device

Physical connection

In order for the application to communicate with an instrument, it must be connected to the computer. This connection can be made via a serial, USB or Ethernet connection.



Select the Instrument

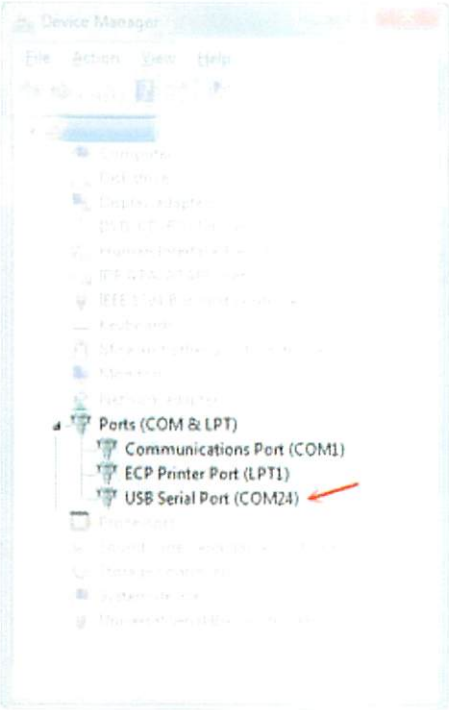
Choose (click to highlight) your instrument from the list on the left.

NOTE: Modbus TCP controls will only enable if the instrument supports it.

USB / Serial Connections

To connect to Instruments fitted with USB or direct serial (RS-232 / RS-485), select the communications port number from the com. port drop-down box.

Finding the correct Communications Port for your device



Modbus TCP Connections

To connect to an instrument fitted with Modbus TCP, select the Modbus TCP/IP radio button, enter the IP address of the device and the network port number.

NOTE: The default (recommended) Modbus TCP port number as defined in the Modbus standards is 502. For obtaining or changing the instrument IP address, refer to the device user guide or manual.

Node address

Once the serial or TCP/IP details have been selected, enter the device Modbus address (normally 1) into the Modbus node text box.

Test the connection

Click the [Connect...] button to test the communications between software and device.

After a short delay, the software will report whether a successful connection was made.

If not successful, check the physical connection, device power supply and software communications details and try again.

If successful, the [Next >] button will enable. Click it to move onto the main options window.

Humidity profiling

Enables communication with a Kahn humidity calibrator or generator – refer to following appendix section x.x

Main Options

The Main Options window presents an options list for the connected device.

Standard options (available for every device) include i) Data Acquisition and ii) Modbus Slave. Other setup and configuration options buttons on this window will be specific to the connected device.

Data acquisition

This button launches the main data acquisition window.

The data acquisition window provides:

Live display of device parameters

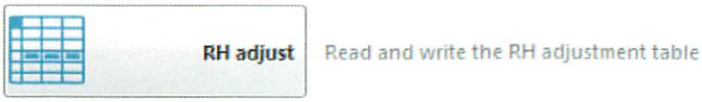
Live device parameter logging

Live device parameter strip-charting

Configuration

Configuration buttons with a tools icon represent a typical setup window, where various device parameters can be read and adjusted.

Buttons with a table icon represent a window where the device data is presented in tabular format. E.g. a calibration or correction table.



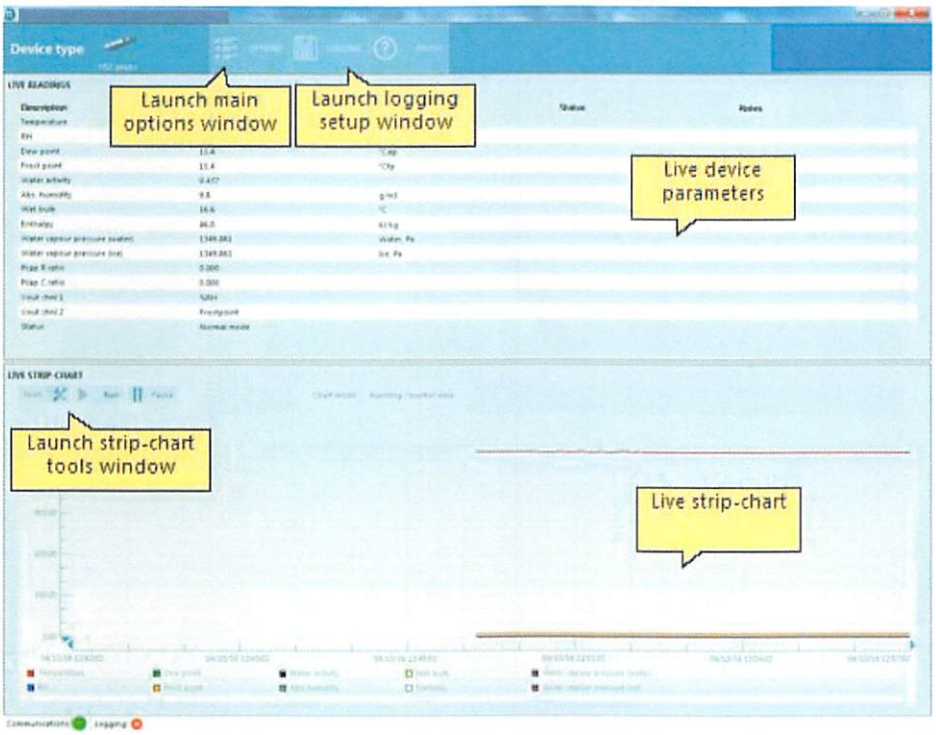
The text to the right of the buttons provides a brief explanation of the option.

Modbus slave

The Modbus slave window provides a Modbus TCP slave interface such that a Modbus TCP master can connect to and communicate with the device remotely, across a LAN or internet.

Data Acquisition

The Data Acquisition window provides display, strip-charting and logging of main device parameters.



Live device parameters

Live parameters are listed in the top half of the window. These include primary measurements (such as humidity and temperature), status information and any notes.

Any warnings or critical conditions together with associated notes are displayed in the Status and Notes columns of the display area. Status column text and is colored ORANGE for **WARNING** and RED for **CRITICAL**.

Strip-chart

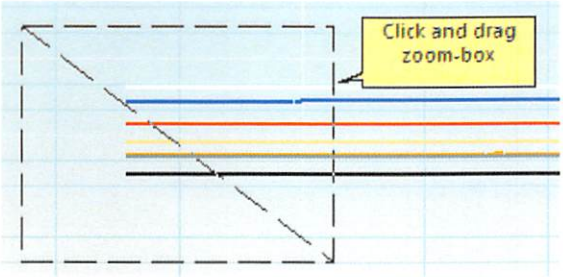
The strip-chart is located in the bottom half of the window and device parameter data is plotted on the graph from right to left.

The Y-axis automatically scales itself to cover all data, the date/time X-axis span is initially set to 2 minutes and the strip-chart update interval is 2 seconds.

NOTE: Each chart series is allocated a (circular) buffer size of 86,400 (eighty-six thousand, four hundred). With an update interval of 2 seconds, 48 hours of data can be stored, after which old data is removed to add new data.

Zooming

To zoom in on the strip-chart data, left-mouse click and drag a zoom box over the chart area of interest.



NOTE: While zoomed in, the chart mode (located at the top-centre of the chart) changes to "Zoomed in" and the chart will not display new data (although new data is recorded in the background).

Two controls to zoom out or reset zoom are provided in the upper left area of the chart.

The [Pause] button will stop the chart from updating with new data. The [Run] button resumes adding new data when the chart is paused.

Main options button

Clicking the [OPTIONS] button found at the top of the window will take you back to the main options window.

NOTE: Acquisition, charting and logging in the current session will stop if you go back to the main options window.

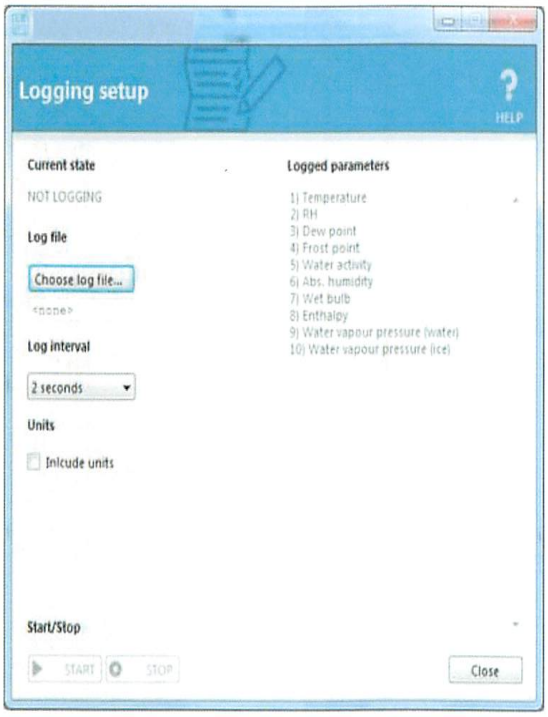
Logging button

Clicking the [LOGGING] button found at the top of the window will launch the logging setup window.

Logging Setup

The Logging Setup Window allows you to setup, start and stop a text log of device parameters.

The recorded log file is a tab-delimited-values text file for easy import into Microsoft Excel.



Setup and start a log

1. Click the [Choose log file...] button to pick a filename and save location.

2. Choose a log interval from the log interval drop-down menu. Interval options are shown below:

3. If you wish to include parameter units in the log file, check the "Include units" options.

The [START] button will now enable. Click it to start logging to the specified file at the chosen interval.

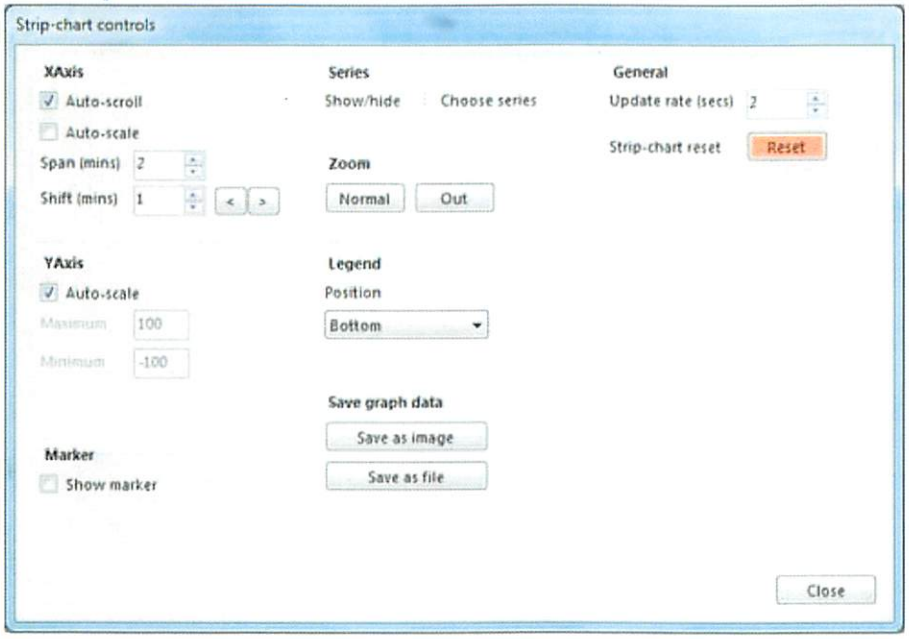
Stop a log

Click the [STOP] button to stop the current log.

Logged parameters

The list of parameters to be logged are shown on the right side of the window.

5.5 Strip Chart Controls



X-Axis

Auto-scroll

When checked, the strip-chart will scroll automatically as new data is added.

Auto-scale

When ticked, the strip-chart X-Axis will scale automatically to show all data recorded so far. You cannot manually adjust the X-Axis span or scroll left/right while auto-scroll is ticked.

Span

The X-Axis span can only be adjusted when Auto-scale is unchecked.

Use the numeric up/down span control to adjust the X-Axis span (in minutes).

Shift

The X-Axis can only be shifted left and right when Auto-scale is unchecked.

Use the back [<] and [>] forward buttons to shift the A-Axis back and forward in time by the amount of minutes specified in the shift up/down control.

Y-Axis

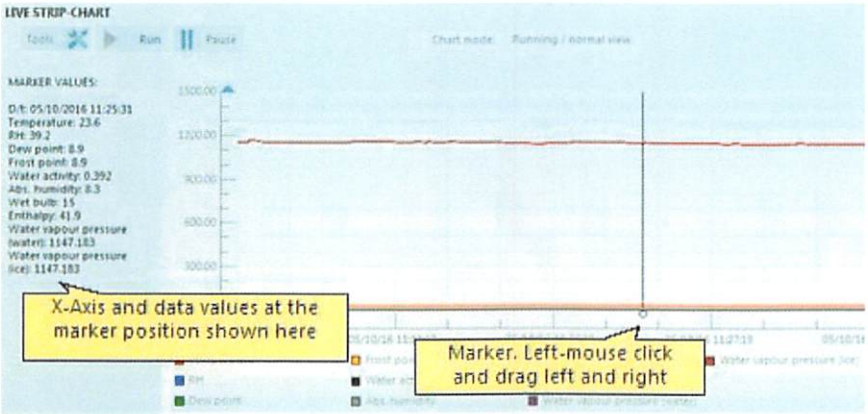
Auto-scale

When checked, the Y-Axis will scale Y-minimum and Y-maximum automatically so that all data present on the chart is visible.

When unchecked, manually set Y-minimum and Y-maximum using the text boxes provided.

Marker

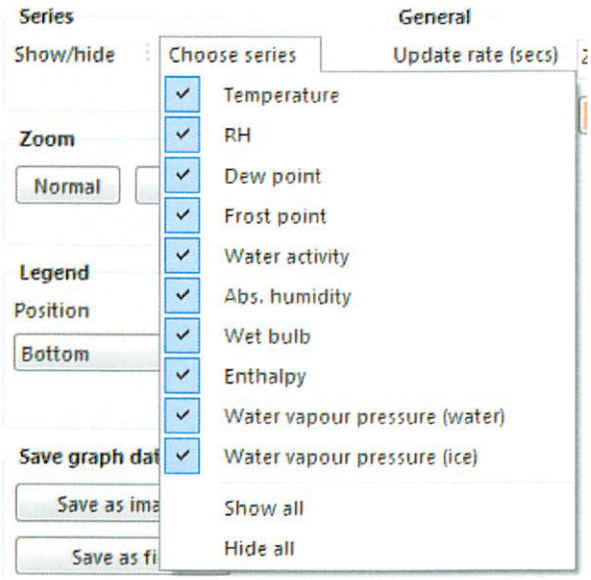
When checked, a vertical marker will appear on the strip-chart. Drag the marker left and right to see the actual X-Axis (date/time) and corresponding data values at the point of the marker.



Uncheck the marker to remove the marker and marker values from the strip-chart display area.

Series

You can hide or show individual series from the show/hide menu.



Zoom

Replicates functionality on the main chart to assist with choosing X/Y axis settings.

Normal resets the view. Out zooms out a further level.

Legend

Sets legend location.

Save graph data

Click [Save as image] to save the current strip-chart display area as a bitmap.

Click [Save as file] to save the entire strip-chart data to a text file. Series are delimited by a # (hash).

General

Update rate

Update rate is the update or refresh rate of the strip-chart. Range is 2 to 600 seconds.

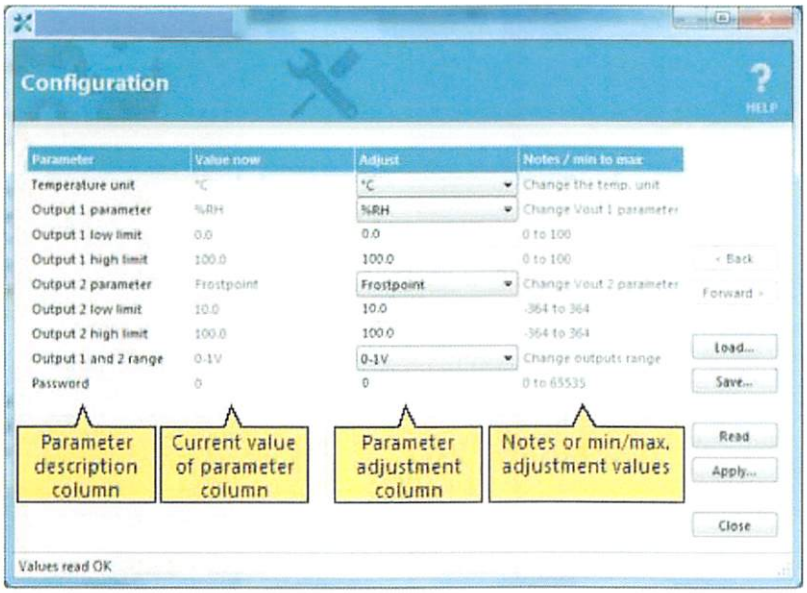
NOTE: The strip-chart circular buffer size for each series is 86,400. At a 2 second interval, this gives 48 hours of data. At a 600 second interval (10 minutes), this gives 14,400 hours (600 days) of data.

Strip-chart reset

Clicking the [Reset] button will clear all data from the chart.

Configuration Screens

Configuration screens offer the ability to both read and adjust device parameters.



Closing this window takes you back to the Main Options Window.

On launching a setup/configuration window, parameter values are read from the Instrument and displayed on the window, providing up-to-date information.

Adjusting a value

Where the parameter is a numeric value, the adjustment input will be a text box where you can type a new value.

Where the parameter has a fixed list of options, the adjustment input will be a drop-down list where you can choose a new value from the list.

After making any adjustments, apply them by clicking the [Apply...] button. The software checks that the adjustments have been applied successfully.

Read (refresh on-screen values)

Clicking the [Read] button refreshes the values in the "Value now" column.

Save

Clicking the [Save...] button allows you to save the configuration data on the current page to a file.

Load

Clicking the [Load...] button allows you to recall previously saved configuration data.

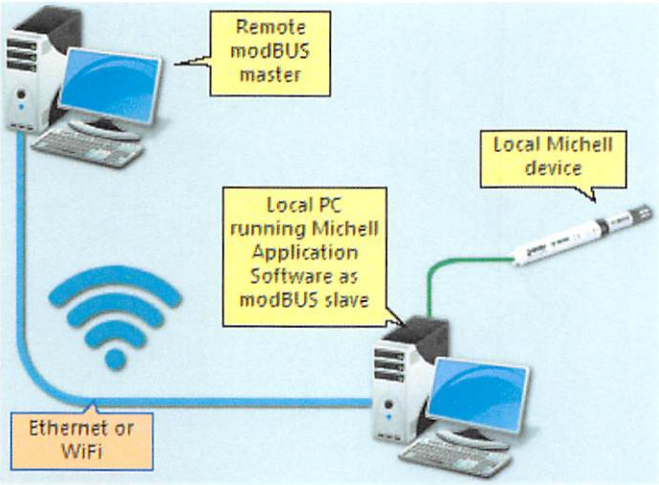
Back and Forward

The [< Back] and [Forward >] buttons are for special cases where device data can be stepped through, such as internally logged data.

These buttons are only enabled if the connected device offers this functionality.

Modbus Slave

The Modbus Slave Windows offers the ability to connect the software to a network as a Modbus TCP slave so that a Modbus master can connect to it over LAN or Internet.

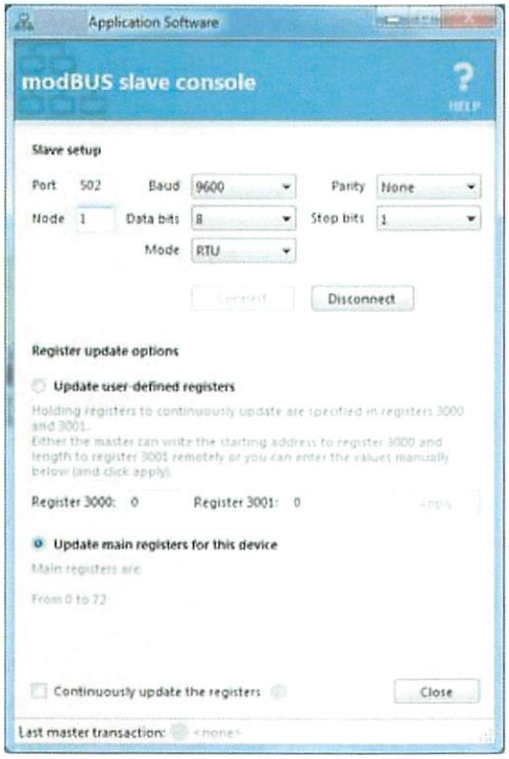


Slave setup

Firstly, the Modbus slave must be connected.

Enter the slave serial, TCP port and node setup details and then click the [Connect] button.

NOTE: The Modbus TCP standard recommends setting the port number to 502.



Once connected, the "Register update options" will enable.

NOTE: On a first slave connection, Windows Firewall (if active) may prompt to allow the TCP connection. If so - allow access.

Register update options

The software must keep the local copy of device registers up-to-date for the remote master and this is achieved by continuously polling the local device registers as fast as possible.

There are two choices on which registers to acquire as follows:

1. Update user defined registers

Here, the remote master can tell the slave which registers to update by writing the start address to register location 3000 and length to register location 3001.

The slave will continuously poll the registers specified in these locations.

The start address and length can be changed at any time without having to restart any polling.

This is the best method for flexibility and control where the master needs to change the registers it requires to read.

2. Update main registers for this device

The start and end address of registers to acquire are predefined by the software. These have been picked as the most common registers for the connected device.

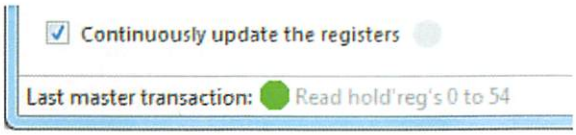
Continuously update the registers

Check this to start continuously polling the Instrument registers as specified in the register update options.

The indicator next to the "Continuously update the registers" text will flash blue to indicate the registers are successfully being acquired from the device.

Successful requests from the Modbus master

When the Modbus master makes a successful read or write request, the transaction details are shown in the bottom status bar of the window and the associated indicator flashes green.



Supported Modbus function codes

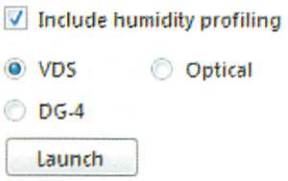
The Modbus slave interface supports the following Modbus function codes:

FC03 - Read Holding Registers

FC06 - Write Single Holding Register

Humidity Profiling

If automatic humidity switching (profiling) is required, tick the "Include humidity profiling" option on the main connection window:



NOTE: With the OptiCal that contains a built in Optidew 1, first choose the COM port for the Optidew 1 and click test. Next click "Launch" button to open the humidity profiling window, before finally clicking "Next" on the main connection window.

Choose the required humidity generator and then click the [Launch] button to launch the profiling window.

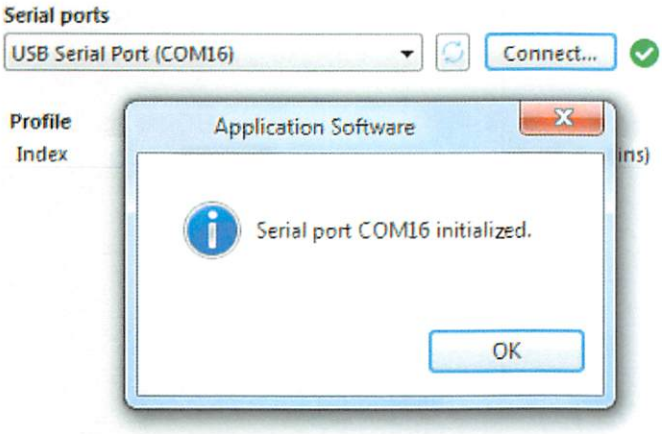
NOTE: A VDS generator is controlled using a USB digital I/O module. On selecting VDS and clicking [Launch], the software will first check if the I/O module is connected and installed correctly.

If the check fails a warning will appear and profiling will not be possible.
If the check passes the profiling window will appear and will be ready for use.

OptiCal generator and DG-4

If an Optidew-1 has already been connected through the connection window then no further connection needs to be made through the profiling window because the Optical generator and Optidew instrument share the same serial port.

Otherwise, select the serial port to which the OptiCal is connected from the ports list and then click the [Connect] button:



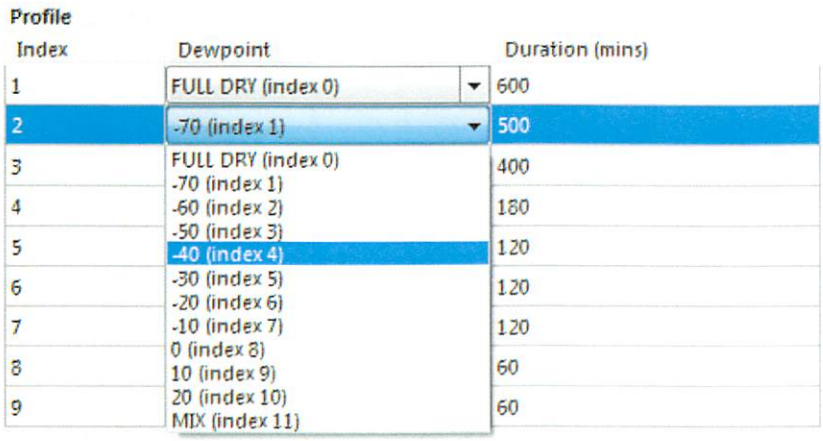
If using a DG-4; a serial port needs to be selected first, so select the serial port to which the DG-4 is connected from the ports list and then click the [Connect] button to test the connection.

The software will report whether the chosen serial port has been initialized successfully or not.

Writing a profile

Click the [Add] button to add rows to the profile table and enter the required humidity, temperature (Optical only) and duration into each row. Refer to the appropriate generator manual for value limits.

VDS and DG-4 generators provide fixed, factory-defined dew points. For ease of selection, default dew points are listed in a drop-down list within in the humidity column of the profile table.



NOTE: The default VDS and DG-4 dew points used a preset collection of dew points. However, for cases where the actual, factory-set dew points are different from the default set, you can edit them by clicking the [Edit Dp's...] button and entering your own dew point list. The software will use the new list from this point onward.

The Optical is an RH generator. Any RH and temperature (°C) value within the limits of the generator can be entered into the textual cells.

NOTE: Minutes may be entered as fractions. E.g. a value of 0.5 is 30 seconds. A value of 0.1 is 6 seconds.

Loading/saving a profile

Click [Save...] to save the on-screen profile to the PC.

Click [Load...] to load a previously saved profile into the profile table.

Start/pause/stop the profile

Click [START] to start the profile. The first point (table row or index 1) will be executed immediately.

A countdown timer appears at the bottom of the profile window indicating time left at the current point.

Click [PAUSE] to pause the profile. Click [START] to resume.

Click [STOP] to stop a profile. The generator will remain in the same state as it is stopped in.

NOTE: If a profile is running and a device is being logged simultaneously, the state of the profile is appended to the end of each device log.