

# Humidity and Dew-Point Calibration

Instruments, Systems  
& Services



# Michell Instruments

## has 40 years' experience providing moisture measurement & calibration solutions to our customers

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# Michell Instruments

## Global leader for trace moisture, humidity and oxygen analysis

Michell Instruments is an international leader in high-precision sensing, with 40 years experience in the field, specializing in instrumentation for dew point, relative humidity and oxygen analysis.

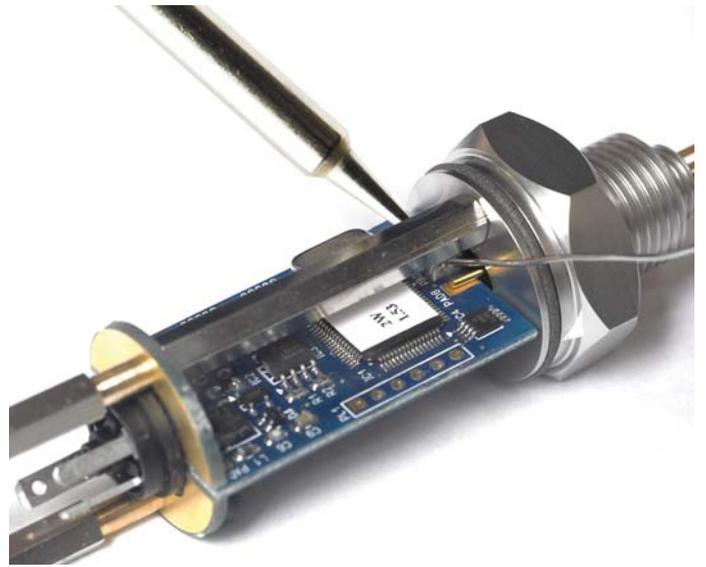
Michell Instruments has a long history in the field of humidity calibration, originating in the design and provision of the Transfer Standard Dew-point Hygrometer (TSDH) to provide traceability to NIST (National Institute of Standards and Technology) for European calibration laboratories. As the largest manufacturer of dew-point sensors in Europe, Michell Instruments has over 2000 sensors under calibration at any moment in time, in our own production facility in Ely, UK, in addition to local calibration centres in situated in the Netherlands, France, Italy, Germany, China, Japan and USA. The development and optimization of our own calibration systems has helped us to build a comprehensive portfolio of calibration products and solutions that enable our customers to perform their own on-site humidity calibrations.

## Manufacturing, Research and Development

Michell Instruments has two manufacturing and R&D locations: Oosterhout, The Netherlands; and Ely, UK. The UK location is the main BS EN ISO 9001:2008 certified manufacturing facility.

## Service and Support

Michell Instruments offers practical and flexible after-sales service: Whether you prefer on-site maintenance, return to base or service exchange; we provide the simplest way to maintain your measurement. Michell Instruments operates extensive network of subsidiaries and distributors stretching across 56 countries, offering the services of trained application engineers. Service centres and calibration laboratories are located on three continents: North America, Europe and Asia.



## Accreditations

Michell Instruments understands and endorses the need to conform to recognized standards for quality and calibration. Our calibration laboratory maintains full traceability to British (NPL) and American (NIST) Humidity Standards.

### UKAS

Michell Instruments Limited has been accredited to ISO 17025 by UKAS (United Kingdom Accreditation Service) for the calibration of dew-point hygrometers since 1986 (laboratory number 0179) and our current dew-point calibration range is -90 to +90°C (-130 to +194°F). For full details of our measurement capability please see our Schedule of Accreditation. Our traceability to NIST (National Institute of Standards & Technology) is over the range -75 to +20°C (-103 to +68°F).

### NVLAP

Our UKAS accreditation is commonly recognised elsewhere in the world as EAL, or NVLAP (National Voluntary Laboratory Accreditation Program) in the USA.

### ISO 9001

Michell Instruments Ltd UK manufacturing facility has been continuously registered to BS EN ISO9001 since 1989.

### Hazardous Area Products

Michell Instruments also produces instruments specifically designed for use within hazardous areas. All such products are independently assessed and certified to many international standards, including, but not limited to, ATEX (European), IECEx, CSA, FM, UL, GOST-R and GOST-K. Accreditations and certificates for these products can be downloaded from the [www.michell.com](http://www.michell.com) under the Product Documents/Accreditations section.





## A Background to Calibration

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The following guide will provide you with some essential knowledge about humidity calibration, helping you to better understand your own requirements when selecting an appropriate solution from our comprehensive range of humidity calibration equipment.

### Why is Calibration Important?

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Reputable manufacturers will provide calibration certificates with instruments or sensors at the time of purchase. However, this is not a guarantee of the measurement performance throughout the entire lifetime of the equipment. Over time, the ageing of mechanical and electronic components can cause changes in the characteristics of sensors or instruments. More critically, once the device has been used in the field, and possibly introduced to contaminants which can have an impact on accuracy, it is difficult to say with any degree of certainty whether or not the original calibration is still valid.

When the readings provided by a sensor or instrument are critical to a process or testing procedure, it is vital to know that the device is still performing within its original specifications, or if new correction factors need to be applied.

When an instrument is re-calibrated, a report is provided showing the calibration corrections before, and after, any adjustment was performed. For many hygrometer users, these 'readings before' are crucial, as they can be retrospectively applied to readings taken in the period before calibration.

In order to minimize uncertainty and have confidence in measurements made with the instrument, it is important to have the quality assurance of a regular, accredited calibration procedure.

### What is Calibration?

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Calibration is the process of comparing a measuring instrument against an authoritative reference to identify any bias or systematic error in the readings. The reference instrument in any calibration should ideally be at least 10 times as accurate as the instrument under test to avoid the tolerances of the reference influencing whether the test instrument is classed as a 'pass' or 'fail'. Generally, a calibration will be performed by repeating the process of comparison at a representative selection of points across the measurement range.

Calibration is often interpreted as 'adjustment of an instrument to read correctly', but this is a misconception. Adjustment of an instrument to match a calibrated reference is a separate concept. It is a process which is usually carried out by the equipment manufacturer, by internally applying the calibration corrections to bring the output readings into line with the indications of the calibration reference. At the end of the calibration, a certificate is issued.

## Calibration Standards and Traceability

The best way to ensure accuracy of measurement is through traceability to attested standards. This leads to consistency of measurements across different instrumentation, locations and users. Traceability is an unbroken chain of calibrations which relate a working hygrometer back to a national standard.

Most countries hold their own authoritative national standard for dew point and humidity, which forms the primary measurement standard. Alternatively, reference standards are shared across a region. The reference instruments of calibration facilities in the country or region are calibrated against this primary standard, and are then used as references or 'transfer standards' to calibrate other instruments. This approach can be represented by the pyramid graphic (Fig. 1).

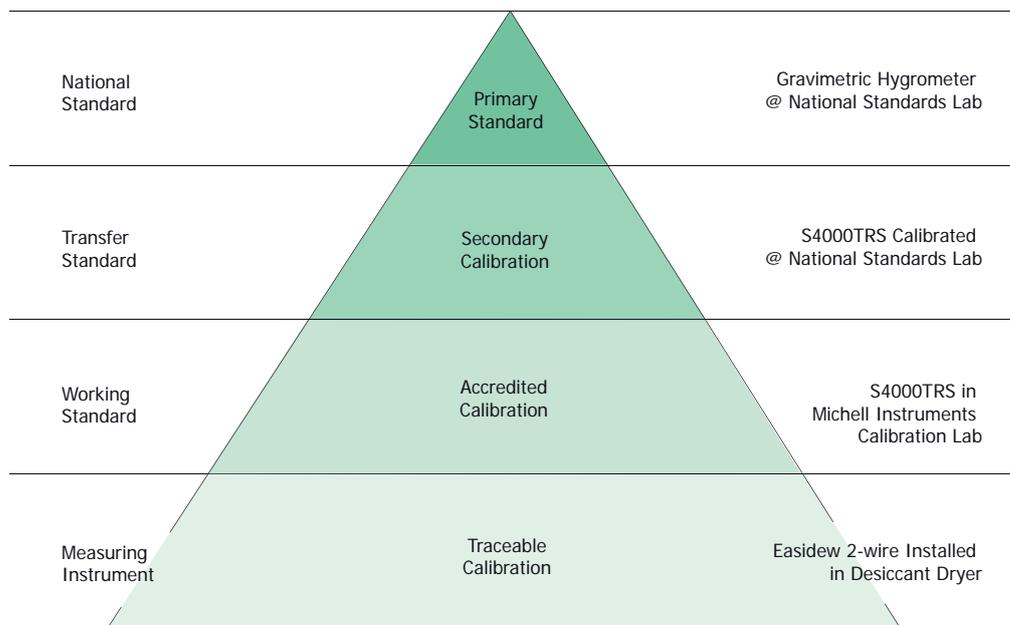


Fig. 1 - Calibration Standards and Traceability Pyramid

## Humidity Calibration Theory

Humidity calibrations involve generating a stable level of humidity in a sample gas, measuring this with a suitable fundamental reference instrument and the instrument under calibration, and making a comparison of the readings.

A humidity calibration system comprises of:

- A dry air source
- A humidity generator to provide the desired moisture content
- A reference instrument which is more accurate than the instrument under test - to provide an authoritative measurement
- A manifold to supply calibration gas to the sensors/instruments under test

If the calibration is being performed in terms of relative humidity and temperature, then the manifold must be temperature controlled or placed in a temperature-controlled environment in order to determine the relative humidity by associating the generated dew-point value with the temperature.

**Michell Instruments is the only supplier to offer complete dew-point calibration systems and individual calibration components, all of which are designed and built in-house.**

# Typical Calibration Certificate

## Information that should be included on the calibration certificate:

**CERTIFICATE OF CALIBRATION**

Certificate Number **00000**  
Date of Issue **04<sup>th</sup> January 2012**



**MICHELL Instruments**

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e-mail: uk.info@michell.com  
Website: www.michell.com

Approved Signatory  
Mr G. Daines

0179

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**Customer** Sample Customer  
**Customer address** Sample Address  
**Customer order number** Sample Order Number  
**Received** 07<sup>th</sup> December 2011  
**Instrument** Michell Dewpoint meter  
**Model** Optidew Vision  
**Serial number Instrument** 123456  
**Sensor** 123456. **Temperature probe** 123456  
**Michell reference number** T12345  
**Measurements performed** 19<sup>th</sup> to 22<sup>nd</sup> December 2011  
**Laboratory temperature** 21 ±2 °C  
**Laboratory humidity** 35 ±10 %rh

The hygrometer was calibrated by comparison using reference instruments with UKAS calibration certificates.

The Dewpoint sensor was placed in a sensor block through which the sample air passed. The sample air was divided to give one path through the reference hygrometer and the other through the test hygrometer.

At 21 °C, the sensor temperature was controlled, by placing the sensor in a liquid cooled sample block, and circulating fluid through it. The fluid temperature is controlled by a re-circulating bath to within ±1.0 °C of the nominal value and ±0.5 °C stability. At the higher temperatures the calibration was performed in a climatic chamber to within ±0.3 °C of the nominal value.

The temperature probe was placed approximately 10 mm from the two reference probes. The calibration was performed in a climatic chamber.

The optical surfaces of the hygrometers were cleaned using de-ionised water, prior to the calibration.

The output used from the hygrometer was the digital display with a resolution to 0.1 °C.

This certificate is issued in accordance with the laboratory accreditation requirements of the United Kingdom Accreditation Service. It provides traceability of measurement to recognised national standards, and to units of measurement realised at the National Physical Laboratory or other recognised national standards laboratories. This certificate may not be reproduced other than in full, except with the prior written approval of the issuing laboratory.

A unique reference number identifying the certificate or calibration run

Calibration location

Customer details, sometimes including the customers address, customer number or order number

Any serial numbers that identify the instrument, and associated measuring components

The date of the calibration, and sometimes the date when the subsequent calibration is due

A list of calibrated equipment used during the calibration, or a list of unique identifiers corresponding to that equipment (not shown on this example certificate)

## A calibration certificate will contain a table with a list of calibration points:

The 1st column shows the measured value indicated by the reference instrument

The 2nd column shows the measured value indicated by the instrument under calibration

The 4th column shows the correction that should be applied to any measured values obtained from the instrument under calibration

The correction is derived from the difference between the measured value indicated by the reference instrument and that indicated by the instrument under calibration.

Generally, if the instrument under calibration has multiple ways to report the measured value, (i.e. built-in display, digital output, analog voltage or current outputs), then the values taken from these different outputs will also be shown on the certificate at each calibration point.

An estimation of uncertainty over the range of the calibration

**CERTIFICATE OF CALIBRATION**

UKAS Accredited Calibration Laboratory 0179

Certificate Number **00000** Page 2 of 2

At each Dewpoint, time was allowed to ensure that the calibration conditions had stabilised. This was confirmed while recording the 10 readings (at 2 minute intervals) that are averaged to give the figures recorded in this certificate.

No adjustment was made to the hygrometer before the calibration was performed.

The measured sample flow rate through the Dewpoint sensor was 1.0 l/m.

Generated Dewpoint °C	Test hygrometer			
	Dewpoint °C	Sensor Temperature °C	Dewpoint Correction °C	Expanded Uncertainty °C
-20.37	-20.2	21	-0.2	±0.21
-5.03	-4.9	21	-0.1	±0.19
10.26	10.2	21	+0.1	±0.18
25.06	25.1	45	0.0	±0.25
39.98	39.9	45	+0.1	±0.25
70.10	70.1	75	0.0	±0.25

Applied Temperature °C	Test hygrometer		
	Temperature °C	Temperature Correction °C	Expanded Uncertainty °C
10.03	10.0	0.0	±0.19
25.05	25.0	+0.1	±0.19
40.07	40.0	+0.1	±0.19
70.01	70.0	0.0	±0.18

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor  $k=2$ , providing a level of confidence of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

The uncertainties quoted in the Certificate of Calibration only apply to the measured value obtained during the period of calibration and are not indicative of the long-term stability of the instrument under test.



## In-House Calibration vs. External Calibration

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Meteorological organizations, standards laboratories, pharmaceutical manufacturing plants, and other businesses or institutions that operate many calibrated instruments or sensors must have an effective calibration system in place. It is usually more sensible to perform calibrations in-house, rather than managing the cost and downtime (or availability of replacement calibrated sensors) associated with sending equipment away to an external commercial calibration laboratory.

However, purchasing and operating a dedicated humidity calibration system can be a significant commitment in terms of initial cost, personnel training, record keeping, and in some cases physical space. For companies that use a small number of humidity instruments, sending these to a commercial calibration laboratory for regular calibration is the most cost-effective solution.

## Michell Instruments Calibration Services

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Michell Instruments offers a calibration service for most moisture sensors and instrumentation, carried out against test equipment traceable to NPL (National Physical Laboratory, London, UK) and NIST (National Institute of Standards & Technology, Maryland, USA) through Michell's ISO/IEC 17025 UKAS (United Kingdom Accreditation Service) accreditation.

We provide traceable calibration from -100 to +90°C (-148 to +194°F) dew point, or full ISO/IEC 17025 accredited calibrations from -90 to +90°C (-130 to +194°F) dew point. We can also provide ISO/IEC 17025 accredited Relative Humidity calibrations from 0 to 95 °C up to 98% RH at our sister company Rotronic UK.

## Michell Instruments Service Exchange Scheme

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In some cases it is not practical for a user to remove a working sensor in order to return it to our lab for recalibration. For this reason Michell Instruments offers an exchange program for sensors, to help customers keep their processes running cost effectively with virtually no down-time. Before re-calibration is due, the customer orders an exchange sensor from Michell Instruments or one of our global representatives.

Once received at the customer's premises, the original sensor is removed and replaced with the exchange sensor, and the original is returned to Michell Instruments. All calibration data is stored within the sensor, so no additional work is required. Each sensor comes with a traceable calibration certificate as standard.

The returned sensor is refurbished and fitted with a replacement sensor tile, and is then used for future service exchange replacements. This means that the service can be offered for the same price as a return-to-base re-calibration. Michell Instruments also offer a range of extended maintenance policies, which cover annual servicing, recalibration & software upgrades for a wide range of instruments.

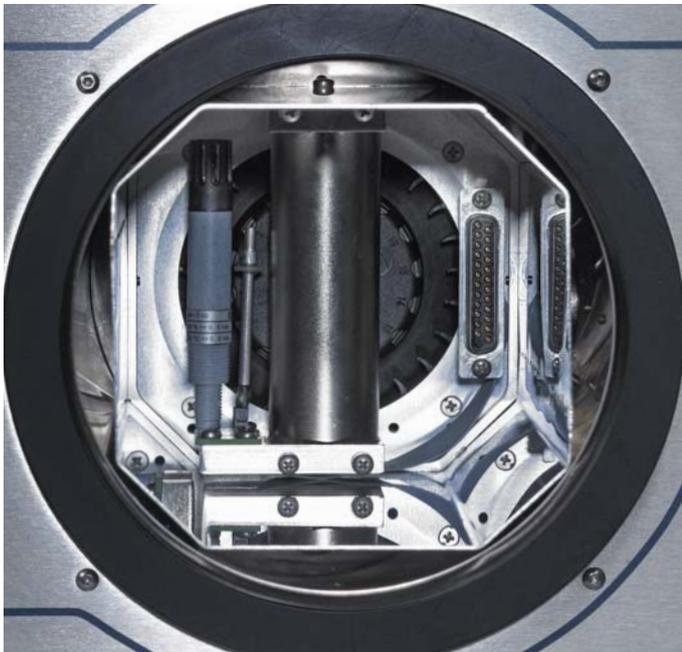
# Choosing the Correct Moisture Calibration System

## Measurement Parameter

The process of deciding which calibration system is best suited to your needs is dependent on the devices to be calibrated and their measurement parameters.

### Dew Point

If the devices are measuring dew point, then the calibration manifold is usually situated in an ambient temperature environment. As dew-point calibration systems are frequently intended to produce very low moisture contents, the manifold needs to be of a high integrity design; working with the sealing mechanism of the sensor to ensure that moisture ingress from the ambient environment is prevented. For extremely low dew points ( $<-80^{\circ}\text{C}$  ( $<-112^{\circ}\text{F}$ )) it is sometimes necessary, (depending on the ambient conditions) to enclose the manifold in a chamber which can be purged with dry air, thus limiting the effects of ingress.



S904/OptiCal Calibration Chamber

### Relative Humidity and Temperature

There are two different approaches to calibrating relative humidity sensors.

One approach is to place the sensors directly into a calibration 'chamber', which is a temperature and humidity controlled self-contained environment. This functions in a similar way to a climatic chamber, only on a much smaller scale and with much greater uniformity. Calibration chambers without temperature control also exist, meaning that the selected relative humidity will be generated at the prevailing ambient temperature—however, it is important to ensure that when these types of generator are used, they are placed into an environment with a stable temperature.

The second approach is to use an external dew-point generator to pass a flow through a manifold into which the sensors are mounted. The manifold is placed inside a larger, temperature controlled chamber.

**The advantages of this second approach are:**

- The volume of the manifold is quite small, and there are few ingress points, so step changes tend to happen more quickly.
- Using a volumetric mixing dew-point generator allows much lower humidities to be achieved compared with a calibration chamber.

**The disadvantages are:**

- The components involved are physically much larger.
- They can be significantly more expensive than a self-contained chamber.

### Measurement Range

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The next deciding factor is measurement range. The questions to ask here are:

- What is the complete operating range of your devices? (Also consider temperature range if the probes in question are measuring relative humidity).
- Do you need to calibrate across the complete range, or do you have a specific area or areas of interest?

### Relative Humidity

The range of an RH calibration system depends on the ability to control two separate parameters: the temperature range of the chamber and the relative humidity range (the lowest RH point being the limiting factor in most cases).

All Michell relative humidity chambers (S904, OptiCal) are capable of drying their internal volumes to just 10% RH at any temperature within their operating range. It is challenging to dry a comparatively large volume below this point, as the system is simply extracting the air, drying it with a desiccant cartridge and re-injecting it with a slightly lower moisture content. It is possible to humidify the chamber up to 90% RH which, generally speaking, is a sensible limit set for the purpose of preventing condensation. If condensation should occur, it would take a long period of time (and a significant strain on the desiccant cartridge) to dry the chamber out again.

The Michell Instruments' HG10 uses an external humidity generator to feed a stream of air, with a precisely controlled humidity, directly into a manifold within a temperature controlled chamber. The humidity generator is fed with fresh dry air from a pressure swing dryer, and can achieve very low humidities at a specific temperature, with a total range of 1 to 95% RH.

### Dew Point

Dew-point calibration systems generally produce much lower absolute humidities than RH calibration systems. The generation range of dew-point systems depends on two factors:

- The output dew point of the pressure swing dryer used to provide the dry air source to the humidity generator (sometimes referred to as 'full dry').
- The resolution of the dew-point generator—which is its ability to mix specific quantities of full dry and saturated air together, in stages, to achieve accurate outputs of very low moisture content. Where volumetric flow mixing generators are concerned; the more stages of mixing, the lower the dew point the generator can control to. For example, a single stage DG3 can only control to a minimum dew point of approximately  $-40^{\circ}\text{C}$  ( $-40^{\circ}\text{F}$ ), no matter how dry the input air is; whereas a two stage DG2 can generate dew points to  $-75^{\circ}\text{C}$  ( $-103^{\circ}\text{F}$ ). Three stages of mixing give the capability to generate dew points to  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ).

## Calibration Technology

### Air Sources

Michell Instruments' dew-point calibration systems require clean and dry compressed air to operate correctly. The required specification of this air varies depending on the model of pressure swing dryer selected, but typically it should be at a pressure of approximately 7 barg (100 psig). For calibration systems designed to generate  $<-80^{\circ}\text{C}$  ( $<-112^{\circ}\text{F}$ ) dew point (generally those utilizing the PSD4), the supply air will need to be pre-dried to  $<-40^{\circ}\text{C}$  ( $<-40^{\circ}\text{F}$ ) dew point, in order to maximize the effectiveness of the pressure swing dryer.

For users who do not have a supply of compressed, or instrument air readily available on site, Michell Instruments can provide compressors suited to each type of system, and a pre-dryer for use with systems designed for  $<-80^{\circ}\text{Cdp}$  ( $<-112^{\circ}\text{Fdp}$ ) capability. See the PSD2 & PSD4 datasheet and the related order codes section for details.

### Pressure Swing Dryers

Michell Instruments' air dryers operate on the 'pressure swing' principle. Two desiccant columns are connected to each other in parallel. Compressed air from the dryer inlet is passed through the first desiccant column to remove virtually all of the moisture present. The majority of the dry air from this column is partially expanded to further reduce the dew point and then directed to the dryer outlet. The remaining dry air is used to purge the second, off-line desiccant column to sweep away the moisture it collected during its on-line cycle to the atmosphere.

After a pre-determined period of time, the function of the two columns is switched - the first column is re-generated while the second column is on-line, producing a flow of dry air. As part of the changeover, the off-line column is rapidly de-pressurized which causes the moisture adsorbed by the desiccant to be released and purged away. One cycle of this operation is represented diagrammatically in Fig. 2.

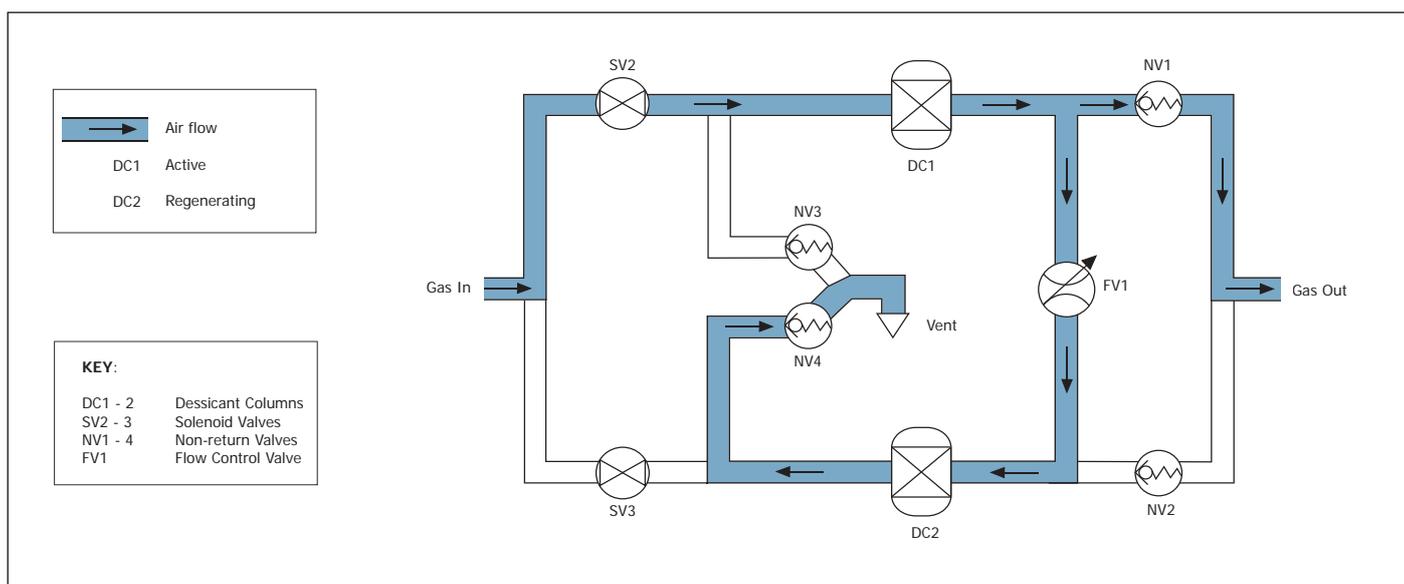


Fig. 2. One dryer cycle of the PSD2

The dryers require minimal maintenance and, under normal operating conditions, only require a desiccant change approximately once every 5 years. The highly efficient purge/regenerate system enables the dryer to operate at the same high performance levels throughout the lifetime of the desiccant.

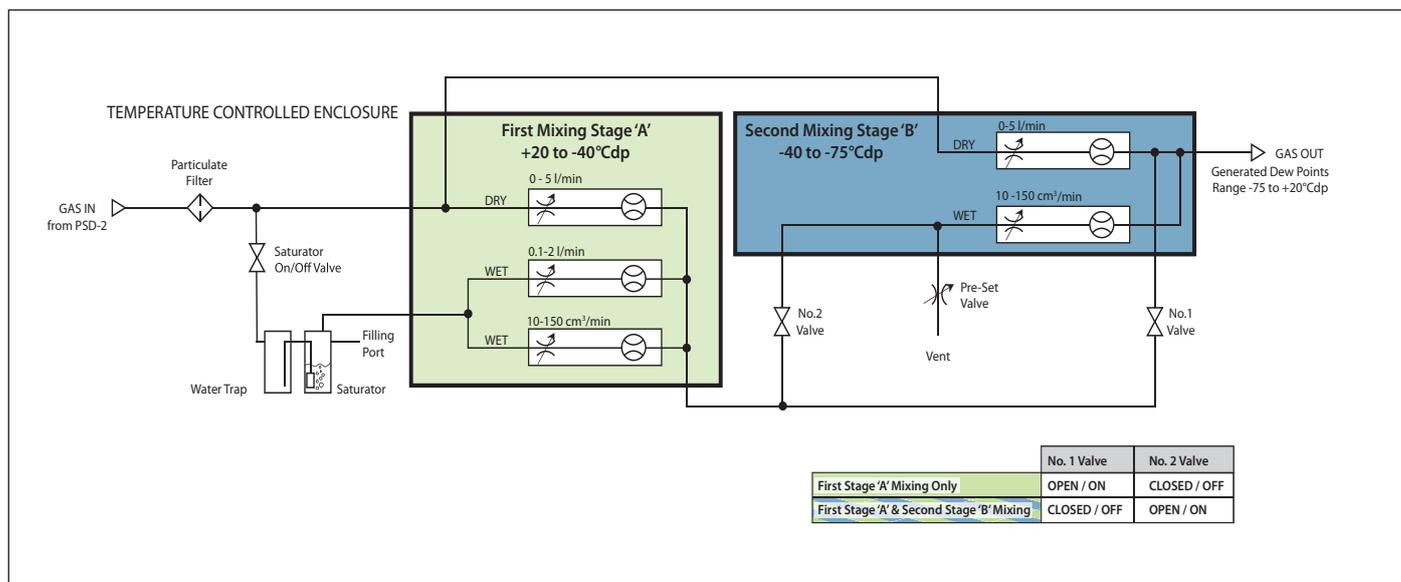
#### There are two models of dryer in Michell's PSD range:

- The PSD-2 gives an output of  $-80^{\circ}\text{C}$  ( $-112^{\circ}\text{F}$ ) dew point air or better.
- The PSD-4 gives an output of  $-100^{\circ}\text{Cdp}$  ( $-148^{\circ}\text{Fdp}$ ) or better (the PSD-4 requires an input source of dry instrument or calibration air of  $-40^{\circ}\text{Cdp}$  ( $-40^{\circ}\text{Fdp}$ )).

## Dew-Point Generators

The DG Series dew-point generators are based on the volumetric mixing of dry and wet gases. This gives the fastest response when changing between set points when compared to other dew-point generation technologies, (such as two-temperature, two-pressure or the combination of both). The mixing is either controlled by flow metering valves for a manual control of the target dew point, or automated using a bank of preset metering valves, selected by actuating combinations of solenoids to switch between the different wet-dry mixing ratios.

A dry gas source is fed to the generator from a pressure swing dryer, and split into two streams. One stream is bubbled through liquid water via a sintered glass nozzle, ensuring it is completely saturated with water vapor, while the other stream remains dry. The two gas streams are then mixed at atmospheric pressure, in a single or multi-stage process to generate the target humidity level. The entire enclosure is insulated and temperature controlled ensuring the saturation, and therefore the output, is always consistent.



Flow diagram for DG2 showing mixing stages

A single stage of mixing provides a coarse adjustment, limited to around  $-40^{\circ}\text{Cdp}$  ( $-40^{\circ}\text{Fdp}$ ). In order to generate drier dew points the output of this first stage, is mixed with the dry gas source a second time, providing finer adjustments for low moisture concentrations down to  $-75^{\circ}\text{Cdp}$  ( $-103^{\circ}\text{Fdp}$ ). For trace moisture levels, a third stage can be added, where the output of the second stage is again mixed with the dry gas source, giving the possibility to generate dew points as low as  $-90^{\circ}\text{Cdp}$  ( $-130^{\circ}\text{Fdp}$ ). The  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ) dew point is taken directly from the output of the dryer.

## Manual Mixing – DG2 & DG3

The DG3 with manual single-stage mixing has the ability to generate dew points ranging from  $-40$  to  $+20^{\circ}\text{Cdp}$  ( $-40$  to  $+68^{\circ}\text{Fdp}$ ). Drier dew points, down to  $-75^{\circ}\text{Cdp}$  ( $-103^{\circ}\text{Fdp}$ ), can be reached by the DG2 which has a second stage of gas-flow mixing. The great strengths of the DG2 and DG3 are their ease of use and flexibility in manually generating an accurate target dew point by fine tuning the gas mix via the flow metering valves. A table of nominal flows is supplied with the generator to guide the user in setting the metering valves appropriately for each desired set point.

## Automatic Mixing – DG4

The DG4 uses a two-stage flow mixing system with calibrated needle valves controlled by solenoid drivers to mix dry air and saturated air in precisely pre-metered proportions. This allows the operator to generate a range of dew-point levels from  $-75$  to  $+20^{\circ}\text{C}$  ( $-103$  to  $+68^{\circ}\text{F}$ ). The exact number of presets can be specified at the time of order (normally, 11 are chosen), giving  $+10^{\circ}\text{Cdp}$  ( $+18^{\circ}\text{Fdp}$ ) intervals across the range. The generator can be driven by computer software, the RS232 interface, or via the front panel manual override switches.

## Automatic Mixing – VDS

In order to generate dew points down to  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ), a more sophisticated system is required. The software controlled Vapor Delivery System (VDS) generator gives precise, repeatable and flexible control of the generated dew point. Individual, three-stage, mass flow controllers select precise proportions of wet and premixed air. Humidity injection is achieved by a liquid mass flow controller and controlled evaporation system. The entire system is controlled by dedicated PC software, allowing automatic calibration programs to be created, or set points to be triggered manually.

## Control

There are **three options of set point control**, which vary between models. This is an important factor to consider, as some systems may have a greater requirement for automation.

This is especially applicatory if the system is being designed to calibrate a large volume of sensors:

- Manual flow mixing (DG3, DG2) – The wet and dry flows are manually altered by metering valves on the front panel of the generator. On the DG2 these are monitored by means of a flow meter for each valve. A table of nominal flow values for each set point is provided, and full analog adjustability is possible across the complete range of the device.
- Locally controlled automatic flow mixing (DG4) – The generator is supplied with a number of user-defined (at the time of order) humidity set points (minimum of 4, including full dry, maximum of 11), which are selected by means of buttons on the front panel.
- Remote controlled automatic flow mixing (DG4, VDS3) – Control is implemented by sending serial commands to the generator via RS232, or USB, either through dedicated control software (which can run user-defined sequences), or via the customer's own system.

## Reference Instrument

Michell Instruments' chilled mirror hygrometers are precision instruments for critical measurement and control applications. Chilled mirror sensors measure a primary characteristic of moisture - the temperature at which condensation forms on a surface.

**This means that chilled mirror instruments:**

- Have no drift: the temperature at which condensation forms is measured directly so there are no calculated variables that could shift over time.
- Are inherently repeatable, giving reliable results every time.

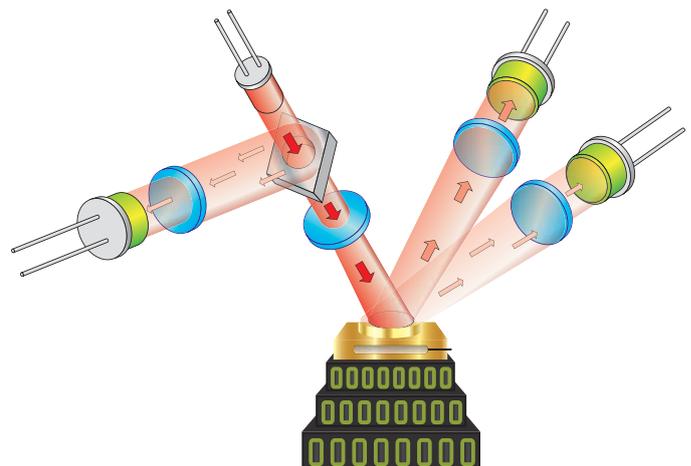
### Chilled Mirror Operation

The chilled mirror sensor consists of a temperature controlled mirror and an advanced optical detection system.

A beam of light from an LED is focused on the mirror surface with a fixed intensity. As the mirror is cooled, less light is reflected due to the scattering effect of the condensate formed on the mirror surface. The levels of reflected and scattered light are measured by two photo-detectors and compared against a third reference detector measuring the intensity of light from the LED.

The signals from this optical system are used to precisely control the drive to a solid state thermoelectric cooler (TEC), which heats or cools the mirror surface. The mirror surface is then controlled in an equilibrium state whereby evaporation and condensation are occurring at the same rate. In this condition the temperature of the mirror, measured by a platinum resistance thermometer, is equal to the dew-point temperature of the gas.

In the S8000 RS and S4000 TRS, an auxiliary cooling system is used to remove heat from the 'hot' side of the TEC. This supplements the depression capabilities of the heat pump, and enables measurement of very low dew points.



### Choosing a Reference Instrument

The two most important considerations when choosing an appropriate reference instrument for performing traceable, credible calibrations are accuracy, and measurement range. As explained earlier in this guide, the accuracy of the reference should ideally be better than the accuracy of the units under calibration. Measurement range should be chosen to match the generation range of the operators humidity generation equipment.

Michell Instruments' range of chilled mirror reference hygrometers have measurement capabilities matched to the performance of each of the different RH and dew-point generator options.

When using a chilled mirror reference to perform relative humidity calibrations, it is necessary to calculate relative humidity from dew-point, and therefore a measurement of ambient temperature is also required.

The actual formula used is: 
$$RH\% = \frac{e}{e_s} \times 100$$

Vapor pressure ( $e$ ) is determined by solving the Sonntag (1990) formula for the current dew-point temperature, and saturation vapor pressure ( $e_s$ ) is found by repeating the process for the ambient temperature.

This calculation is recognized and published in the National Physical Laboratory's 1996 publication 'A Guide to the Measurement of Humidity'. Its use will, in most cases, still yield lower uncertainties of measurement than can be achieved with hygrometers which directly measure relative humidity.

### Calibration

Although Michell Instruments' chilled mirror hygrometers are fundamental and do not drift, in order to maintain the traceability of your reference it is advisable to return it to Michell Instruments to be calibrated against one of our transfer standards on an annual basis.

### Manifold

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Standardized or customized designs of manifold are available for Michell Instruments' sensors depending on how many sensors are intended to be calibrated on the system at any one time. Manifolds to accept non-Michell sensors or instruments can also be custom designed; the optimal configuration can be designed from the dimensions of the device and its mounting arrangement.

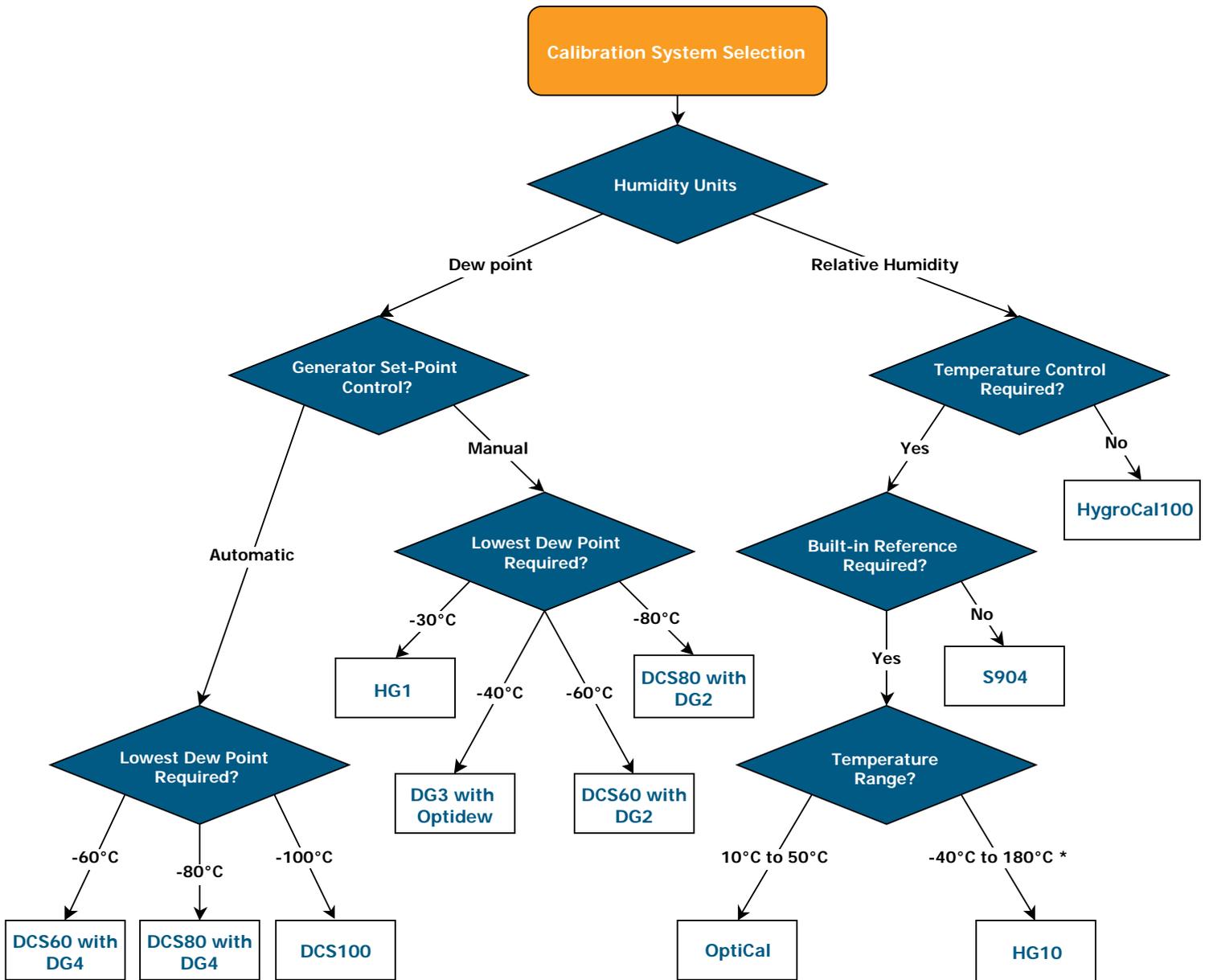
### Integration

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Integration of the system components, such as logging of sensors under test, the reference instrument and other further enhancements, can be realized. Please contact a Michell Instruments' representative for further details.

# Calibration System Selection Guide

The following flow chart is designed to aid the process of selecting an appropriate calibration system:



\* Typical range, dependent on customers specification at time of order



**Our sophisticated range of calibration instruments and integrated systems can provide traceable calibration of humidity sensors in your own laboratory**

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# **Calibration Instruments**

**Technical Specifications & Detailed Information**

# Pressure Swing Dryers

Pressure Swing dryers provide a source of very dry compressed air for use as a zero gas in humidity calibration systems, or for general laboratory applications.

## PSD2 & PSD4 Pressure Swing Dryers



The Michell PSD Series Pressure Swing Dryers use two columns filled with 4Å molecular sieve desiccant, which are used alternately on a switching cycle. The PSD dryers are designed to operate continuously, using a small proportion of the dried air to regenerate the offline column - generally giving desiccant life in excess of five years. This type of heatless regeneration uses significantly less energy than a 'heated' dryer.

The PSD2 is fitted with inlet and outlet pressure regulation, and delivers up to 7 NI/min (14.8 scfh) of dry air with a moisture content of 1 ppm<sub>v</sub> or better.

The PSD4 is supplied with stainless steel internals and larger volume desiccant columns. These factors, combined with high integrity VCR couplings deliver an output of up to 90 NI/min (optional) with a moisture content better than 14 ppb<sub>v</sub>.

### Highlights

- Excellent long term stability
- Maintenance free except for a desiccant change once every 5 years
- Completely self-contained
- Low power consumption

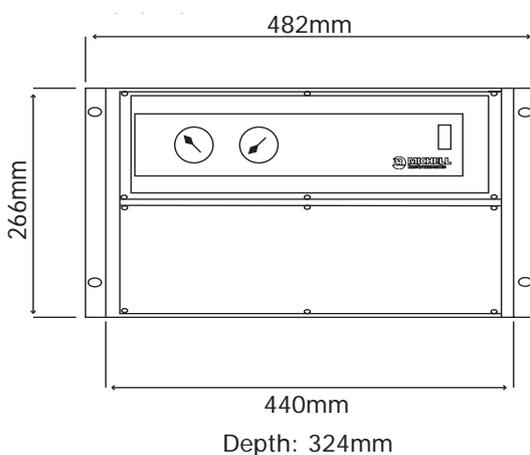
# Pressure Swing Dryers

## Technical Specifications

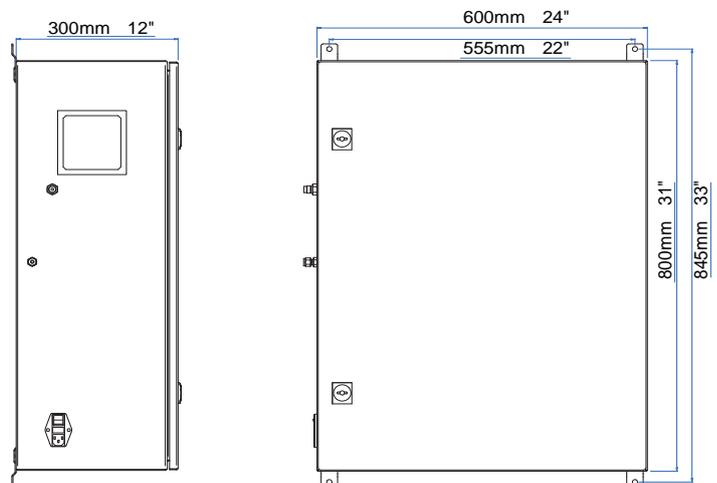
Model	PSD2	PSD4-STD (Standard)	PSD4-HFV (High flow volume)	PSD4-HPO (High pressure output)
<b>Performance</b>				
<b>Gas output</b>				
Flow	7 NI/min (14.8 scfh)	30 NI/min (63.6 scfh)	90 NI/min (109.7 scfh)	30 NI/min (63.6 scfh)
Pressure		0.5 barg (7 psig)		User-settable up 8 barg (116 psig)
Moisture content	<1ppm <sub>v</sub>	<13.8 ppb <sub>v</sub>		
<b>Input Requirements</b>				
<b>Gas supply</b>				
Flow	10 NI/min (21.2 scfh)	30 NI/min (63.6 scfh)	90 NI/min (109.7 scfh)	30 NI/min (63.6 scfh)
Pressure	5 to 7 barg (70 to 100 psig)	6 to 10 barg (87 to 145 psig)		
Moisture content	Oil and liquid water-free	<16ppm <sub>v</sub>		
<b>Electrical Input</b>				
Power	100 to 115 OR 220 to 240 VAC, 50/60Hz	100 to 240VAC 50/60Hz		
Power Connection		IEC socket		
<b>Environmental Conditions</b>				
Operating temperature	+5 to +35°C (+41 to +95°F)	+10 to +40°C (+50 to +104°F)		
Storage temperature	-40 to +35°C (-40 to +95°F)	-40 to +50°C (-40 to +122°F)		
<b>Mechanical Specifications</b>				
Type		Twin column desiccant, pressure swing		
Desiccant		4 Ångström Molecular sieve bead (4-8 mesh)		
Timer	Mechanical cam	Programmable relay		
<b>Gas connections</b>				
Inlet	Swagelok® ¼"	¼" VCR Swagelok®		
Outlet	Swagelok® ¼"	¼" VCR Swagelok®	½" VCR Swagelok®	¼" VCR Swagelok®
<b>Filters</b>				
Outlet	None	Millipore Wafergard IIF Micro Inline (sealed type) with PTFE membrane element rated at >99.999% retention of 0.003µm particles		
Vent	None	Bonded glass microfiber rated at >99.999% retention of 0.1µm particles		
Construction	Rack mount: 19" x 6U x 324mm (12.8")	304 stainless steel wall mounting enclosure: 800x600x300mm (31.5x24x12")		
Weight	12.5kg (27.5lbs)	30Kg (66lb)	35Kg (77lb)	32Kg (70lb)

### Dimensions - PSD2

#### FRONT VIEW



### Dimensions - PSD4



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: PSD2 and PSD4\_97160\_V4\_UK\_0618

# Dew-Point Generators

The Michell range of dew-point generators provides flexibility and control at a competitive price. Based on the volumetric mixing of dry and wet gases, the instruments can be controlled either manually or automatically to suit a wide range of calibration applications.

## Generator Overview

Feature	Product	DG3	DG2	DG4	VDS3
Generation range		-40 to +20°Cdp (-40 to +68°Fdp)	-75 to +20°Cdp (-103 to +68°Fdp)	-75 to +20°Cdp (-103 to +68°Fdp)	-95 to +20°Cdp (-139 to +68°Fdp)
Temperature controlled		Yes	Yes	Yes	Yes
Control method		Manual Mixing	Manual Mixing	Automatic – Local or Remote control	Automatic – Remote control

## DG3

### Dew-Point Generator



## Technical Specifications

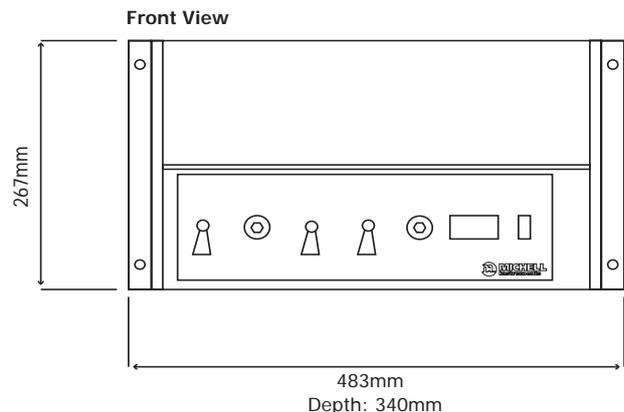
Mixing stages	1 stage
Humidity range	-40 to +20°Cdp (-40 to +68°Fdp)
Gas supply	6 NI/min (12.7 scfh) air @ 0.75 barg (11 psig) and -75°Cdp (-103°Fdp)
Gas output	1 to 5 NI/min (2.1 to 10.6 scfh) air @ 0.5 to 1 barg (7 to 15 psig)
Filter	Particulate filter
Saturator	Polycarbonate and porous polyethylene sinter
Heating	Finned heating elements, 500 watts, fan circulation
Power supply	220 to 240 V, 50Hz or 100 to 120 V; 60Hz
Storage temperature	+5 to +40°C (+41 to +104°F) (with saturators empty)
Operating temperature	+18 to +24°C (+64 to +75°F)
Enclosure size	19" sub-rack x 6U high x 340mm (13.4") deep
Weight	9kg (20lbs)

The DG3 is our entry-level, single-stage mixing humidity generator. It is operated by manually mixing the two gas streams using flow control valves. The DG3 provides flows up to 5 NI/min (10.6 scfh) and generates dew points ranging from -40 to +20°Cdp (-40 to +68°Fdp). Infinite mixing is achievable within its working range.

### Highlights

- Consistently dry output over long time periods
- Full analog control of generated dew points across -40 to +20°Cdp (-40 to +68°Fdp) operating range
- Generated output responds quickly to a change of set-point
- Stable humidity generation
- Compact packaging

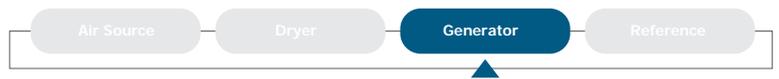
## Dimensions



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Issue No: DG3\_97334\_V1\_UK\_0718

# DG2

## Dew-Point Generator



### Technical Specifications

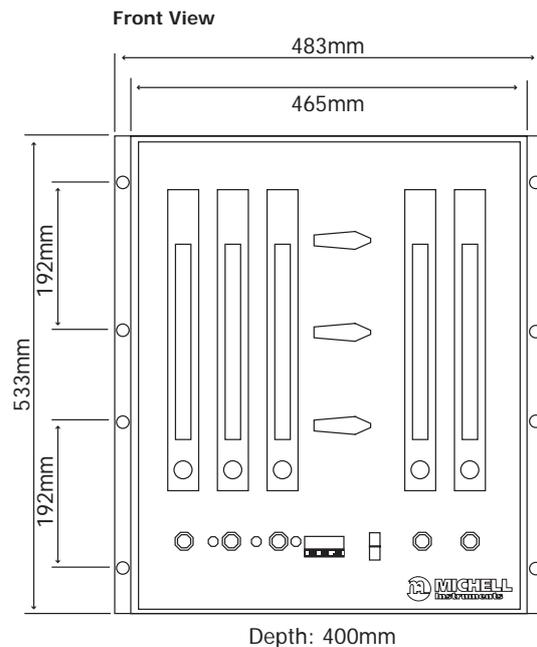
Mixing stages	2 stage
Humidity range	-75 to +20°Cdp (-103 to +68°Fdp)
Gas supply	8 NI/min (17 scfh) -1 air @ 1 barg (11 psig) and -75°Cdp (-103°Fdp)
Gas output	1 to 5 NI/min (2.1 to 10.6 scfh) (dependent on set point) @ ATM
Filter	Particulate filter
Saturator	Polycarbonate and porous polyethylene sinter
Heating	Finned heating elements, 500 watts, fan circulation
Power supply	220 to 240 V, 50Hz or 100 to 120 V; 60Hz
Storage temperature	+5 to +40°C (+41 to +104°F) (with saturators empty)
Operating temperature	+18 to +24°C (+64 to +75°F)
Enclosure size	19" sub-rack x 12U high x 400mm (15.8") deep
Weight	20kg (44lbs)

The DG2 has two stages of gas-flow mixing which allow it to generate dew points down to -75°Cdp (-103°Fdp). The great strengths of the DG2 are its ease of use and its flexibility in manually generating an accurate target dew point by fine tuning the gas mix via its flow metering valves. Infinite mixing is achievable within its working range.

### Highlights

- Operation range of -75 to +20°Cdp (-103 to +68°Fdp) suiting the vast majority of calibration requirements
- Simple operation through manual flow mixing
- Flexibility in generating precise target dew-point temperature
- Generated output responds quickly to a change of set-point
- Stable humidity generation

### Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: DG2\_97333\_V1\_UK\_0718

# DG4

## Dew-Point Generator

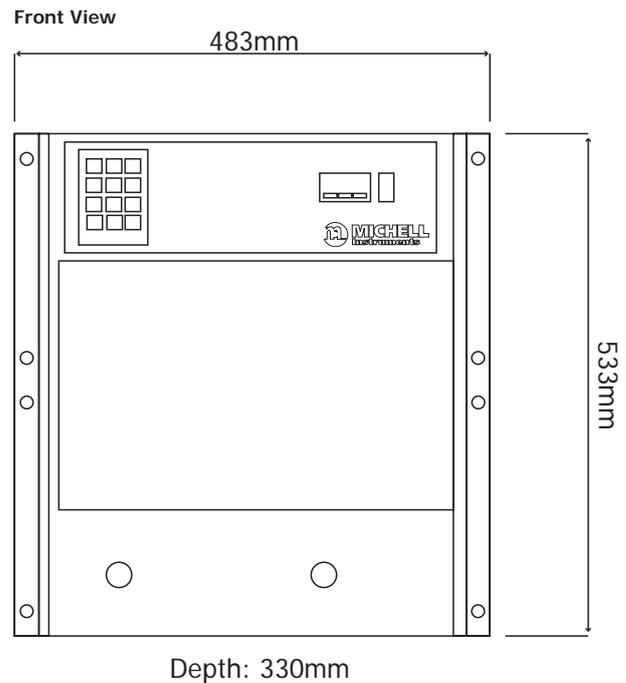


### Technical Specifications



Mixing stages	2 stage
Humidity range	-75 to +20°Cdp (-103 to +68°Fdp)
Gas supply	8 NI/min (16 scfh) (max) @ 0.7 barg / 11 psig and -75°Cdp (-103°Fdp)
Gas output	1 to 5 NI/min (2.1 to 10.6 scfh) (dependent on set point) @ ATM
Filter	Particulate filter
Saturator	Polycarbonate and porous polyethylene sinter
Heating	Finned heating elements, 300 watts, fan circulation
Power supply	220/240V, 50Hz or 100/120V; 60Hz
Storage temperature	+5 to +40°C (+41 to +104°F) (with saturators empty)
Operating temperature	+18 to +24°C (+64 to +75°F)
Enclosure size	19" sub-rack x 6U high x 330mm (13") deep
Weight	25kg (55lbs)

### Dimensions



The DG4 is a two-stage push-button dew-point generator which operates in the range of -75 to +20°Cdp (-103 to +68°Fdp). It can be delivered with between 3 and 10 factory-set dew point settings, selectable from the front panel keypad. Its RS232 communication port enables set points to be selected remotely by a PC or other device. The DG4 offers maximum flexibility via its pre-set values combined with optional manual mixing above -40°C (-40°F) dew point.

### Highlights

- Operation range of -75 to 20°Cdp (-103 to +68°Fdp) suiting the vast majority of calibration requirements
- Simple operation through push-button switching of set points
- Remote control via RS232 comms
- Generated output responds quickly to a change of set point
- Stable humidity generation

Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: DG4\_97335\_V2\_UK\_0718

# VDS3

## Dew-Point Generator



## Technical Specifications



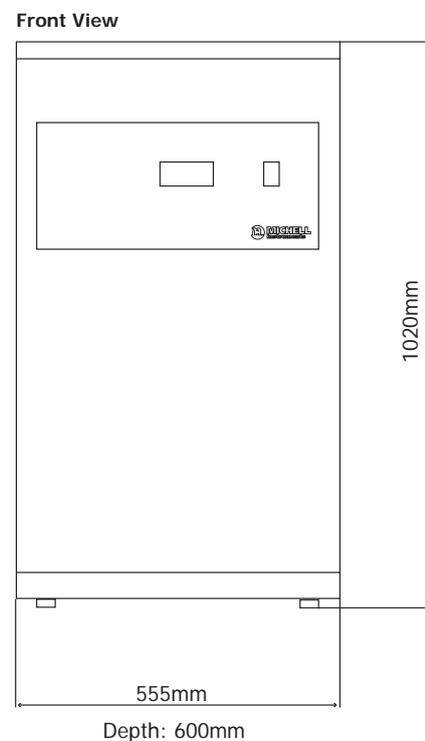
<b>Dew-point range</b>	-100 to +20°Cdp (-148 to +68°Fdp) (factory default preset values= -100, -90, -80, -70 -60, -50, -40, -30, -20, -10, 0, +10 and +20°C (+68°F))
<b>Output stability</b>	±0.5°C (±0.9°F)
<b>Required gas supply</b>	30 NI/min (63.6 scfh) @ 4.8 barg (70 psig) pressure and <13.8 ppb <sub>v</sub> (-100°C / -148°F atmospheric dew-point) moisture content, or 90 NI/min (190.7 scfh) for high-flow output version
<b>Gas output</b>	10 NI/min (21.2 scfh) @ 0.5 barg (7.3 psig) or 30 NI/min (63.6 scfh) for high-flow output version
<b>Cable connection</b>	USB (type B) for PC Control RS485 (9 way D plug) for Setup
<b>Water reservoir</b>	Material= ABS Capacity= 1 liter
<b>Power supply</b>	220 to 240 V AC or 100 to 120 V AC 50/60 Hz
<b>Power consumption</b>	500 Watt maximum
<b>Power connector</b>	3 pin IEC
<b>Power supply fuse</b>	3A (F) quick blow
<b>Operating temperature</b>	+10 to +40°C (+50 to 104°F)
<b>Construction</b>	Painted diecast aluminum enclosure with smoked glass door
<b>Dimensions</b>	1020 x 555 x 600mm (40 x 22 x 24") h x w x d
<b>Weight</b>	65kg (143lbs) maximum

The VDS3 is a sophisticated computer-controlled dew-point generator that operates in the range of -100 to +20°Cdp (-148 to +68°Fdp). Individual three-stage mass flow controllers select precise proportions of wet and pre-mixed air. Humidity injection is achieved by a liquid mass flow controller and controlled evaporation system. The Vapor Delivery System (VDS) gives repeatable and flexible control of the generated dew point and can be programmed with up to 13 presets that can be activated manually or as part of an automatic calibration program.

### Highlights

- Operation range of -100 to +20°Cdp (-148 to +68°Fdp) suiting the calibrated range of almost all dew-point sensors
- Fully automated remote control
- Mass flow controlled mixing of wet and dry flows ensures complete repeatability of set-points
- Generated output responds quickly to a change of set-point
- System optimized for excellent output stability (±0.5°C / ±0.9°F)

### Dimensions



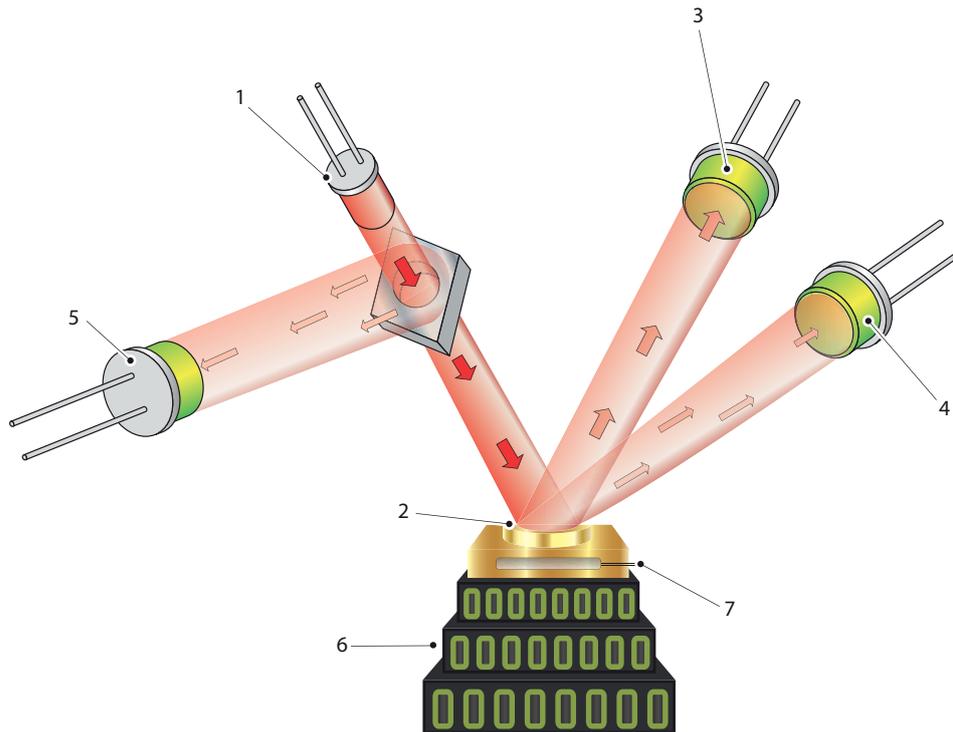
Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: VDS3\_97336\_V1.2\_UK\_0718

# How Does Chilled Mirror Technology Work?

The Chilled Mirror sensor consists of a temperature-controlled mirror and an advanced optical detection system.



Michell Instruments S8000 sensors utilize our **RRS Optical System** to guarantee 0.01°C sensitivity and the fastest dynamic response to dew points as low as -90°C. The system employs active monitoring and adjustment to automatically rebalance the optics to accommodate any changes in the signal level not associated with condensed moisture.



A beam of light from an LED (1) is focused on the mirror surface (2) with a fixed intensity. As the mirror is cooled, less light is reflected due to the scattering effect of the condensate formed on the mirror surface. The levels of reflected and scattered light are measured by two photo-detectors (3 & 4) and compared against a third reference detector (5) measuring the intensity of light from the LED.

The signals from this optics system are used to precisely control the drive to a solid state thermoelectric cooler (TEC) (6), which heats or cools the mirror surface. The mirror surface is then controlled in an equilibrium state whereby evaporation and condensation are occurring at the same rate. In this condition, the temperature of the mirror, measured by a platinum resistance thermometer (7), is equal to the dew-point temperature of the gas.

In the **S8000 RS**, and **S4000 TRS**, an auxiliary cooling system is used to remove heat from the "hot" side of the TEC. This supplements the depression capabilities of the heat pump, and enables measurement of very low dew points.



# Chilled Mirror Product Comparison Table

Product	Dew-Point Measurement Range from 20°C Ambient (°C)	Maximum Measureable Dew Point (°C)	Minimum Measurable Dew Point with Additional Cooling (°Cdp)	Accuracy (°C)	Integrated Auxiliary Cooling
<b>Optidew</b> 	-40/+20 (-40/+68°F)	+120°C (+248°F)	-40 (-40°Fdp)	±0.15 (0.27°F)	No
<b>S8000 Remote</b> 	-40/+20 (-40/+68°F)	+120°C	-40°C	±0.1 (±0.18°F)	No
<b>S8000</b> 	-60/+40 (-76/+104°F)	+40 (+104°F)	Not applicable	±0.1 (±0.18°F)	No
<b>S8000 RS</b> 	-90/+20 (-130/+68°F)	+20 (+68°F)	Not applicable	±0.1 (±0.18°F)	Yes
<b>S4000 TRS</b> 	-100/+20 (-148/+68°F)	+20 (+68°F)	Not applicable	±0.1 (±0.18°F)	Yes

# Optidew 401

## Optical Dew-Point Meter



The Optidew precision dew-point meter is based on the proven, fundamental optical dew-point measurement principle, giving long-term drift-free performance. It offers a wide measurement range from the equivalent of <math><0.5</math> to 100% RH at ambient temperature (dew point range:

### As a calibration reference

The Optidew is an excellent entry level calibration reference, supplied as standard with a fully traceable in-house calibration or optional UKAS-certified calibration. Its simple operation makes it possible for anyone to use with minimum training. Simply connect the instrument, power it up and measurement will begin automatically.

### Data communication and application software

The instrument provides two linear 4-20 mA outputs and Modbus RTU over USB, RS485 or optionally Modbus TCP over Ethernet, allowing configuration and monitoring by a suitable computer, data logger or other device. The comprehensive application software provides an interface to configure and control instrument functions, and enables all measured and calculated parameters to be graphed or logged over time.

### Dynamic Contamination Control (DCC) Plus

DCC Plus is an improved version of our Dynamic Contamination Control. This feature is designed to manage the contamination on the mirror surface, extending operation in harsh or dirty environments without the need to stop the process to manually clean the mirror.

### Improved frost assurance

### Increased reliability at low dew points

It is possible for water to exist in liquid phase below

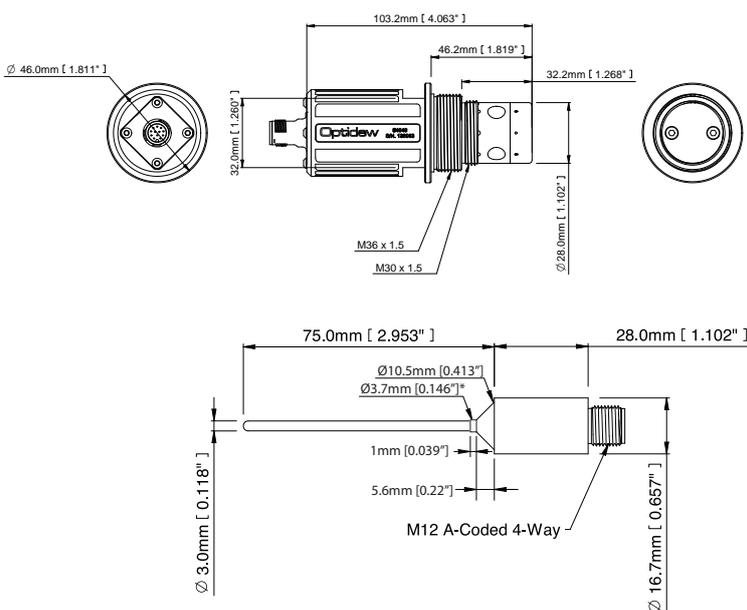
The new adaptive FAST system gives certainty about the state of the mirror condensate, detecting when supercooled water could form during measurement, and cooling the mirror sufficiently to freeze it, without the need for a DCC.

# Technical Specifications

# Optidew 401

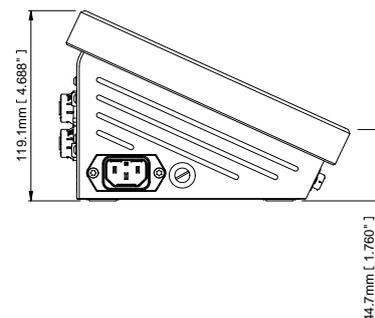
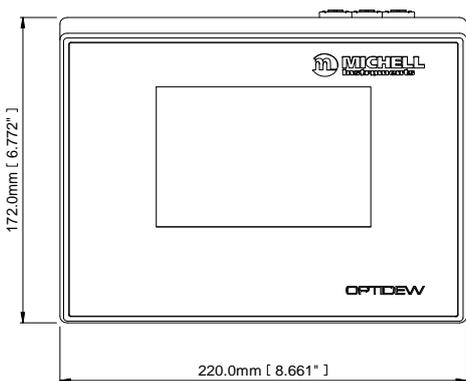
Performance			
Dew Point Measurement Accuracy	±0.15°C		
Reproducibility	±0.05°C		
Sensitivity	±0.01°C		
Response	Stable measurement at +10°C dp within 1 minute		
Dew-Point Sensor			
Sensor	Single Stage	Dual Stage	Harsh Environment
Dew Point Range (°C)	-25 to +90°C	-40 to +90°C	-40 to +120°C
Temperature Range (°C)	-40 to +90°C	-40 to +90°C	-40 to +120°C
% RH Range @ 23°C	2.25 to 100% RH	0.45 to 100% RH	0.45 to 100% RH
Mirror Temperature Measurement	Pt1000, Class A		
Corrosion & Saturation Protection	ACIS (Active Component Isolation System)		
Recommended Sample Flow	Ambient (environmental measurements) to 2Nl/min (flowing sample)		
Pressure	2500 kPa max		
Sensor Cable	Standard: 90°C max. High temperature: 125°C max.		
Cable Length	0.3, 3, 5, 10 and 20m lengths available		
Process Connection	M36x1.5		
Remote PRT			
Temperature Measurement Accuracy	±0.1°C		
Cable Length	0.3, 3, 5, 10 and 20m lengths available		
Temperature Measurement	PT100, Class A		
Remote Pressure Sensor (Optional)			
Pressure Measurement Accuracy	±0.25% FS		

Pressure Measurement Range	0-160 kPa OR 0-2500 kPa
Process Connection	1/8" NPT-M
Output	4-20mA
Control Unit	
Resolution	1 or 2 decimal places selectable
Measurement Units	°Cdp or °Fdp, Relative humidity - %, Absolute humidity - g/m <sup>3</sup> , ppm <sub>v</sub> , Mixing Ratio - g/kg, Wet Bulb Temperature (Twb) - °C, °F, Water Vapor Pressure (wvp) - Pa, Ambient Temperature - °C, °F, Pressure converted DP - °C, °F, Pressure - kPa, Bara, Barg, Psia, Psig
Enclosure	Bench Top - Optidew 401
Material	ABS
Analog Outputs	Two 0/4-20mA outputs (maximum load 500Ω)
Digital Communications	Modbus RTU over: USB (standard) RS485 (standard) Modbus TCP over Ethernet (optional)
Alarms	1x Process Relay, 1x Alarm Relay, Both Form C, 1A, 30Vdc
Inputs	4-20mA for pressure sensor
Data Logging	SD card slot (standard)
Ingress Protection	IP54
Dimensions	220x175x118mm
Weight	Control unit: 1.5kg, Sensor: 200g
Display	5.7" colour touch screen
Environmental Conditions	-20 to +50°C, up to 100%RH non-condensing (optional) 100% RH condensing with IP65 connector version
Supply Voltage	100 to 240VAC, 50 to 60Hz
Power Consumption	30VA max



\*Weld burr may extend 1mm from collar to towards tip of probe

Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: Optidew Vision\_97144\_V7\_UK\_0718



# S8000 Chilled Mirror Series Features

As the largest dew-point sensor manufacturer in Europe we know how important it is to have an accurate and reliable calibration reference. Our S8000 Series of chilled mirror reference hygrometers provide extremely accurate and precise measurement of dew point, relative humidity and temperature and are constantly in use in our own production environment, 24/7 calibration facility and service center. Michell's 40 years of expertise in the field of moisture measurement is built into each and every chilled mirror hygrometer design and our technical experts are always on hand to provide support and advice where needed.

## Supplied with Traceable Calibration

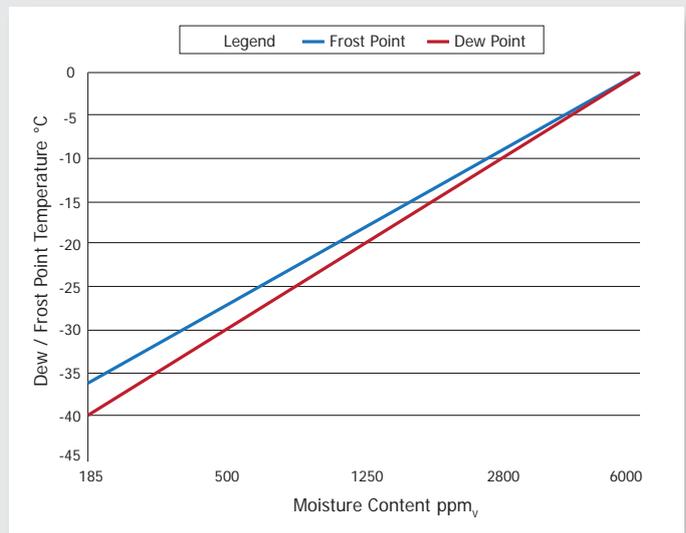
Chilled mirror is free from temperature dependence and remains accurate and drift-free across the entire measurement range. The S8000 Series of instruments are delivered fully calibrated and traceable to NPL and NIST national standards through Michell's world class UKAS accredited humidity calibration laboratory.



## Frost Assurance

All S8000 Series instruments feature FAST, the frost assurance technology that forces ice formation on the mirror so all dew-point measurements made below 0°C (+32°F) are guaranteed to be 'over ice'. The FAST system works by rapidly cooling the mirror until a film of ice has formed on the mirror of pre-determined thickness – once ice has been formed, control returns to the instrument and measurement can begin.

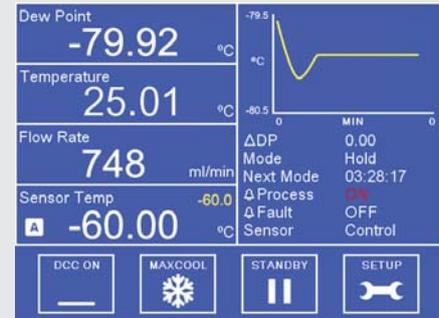
A viewing microscope is also available for the S8000 and S8000 RS. This enables the user to inspect the mirror surface during the measurement process, enhancing confidence in the formation of the correct phase of water condensate (dew or frost) on the mirror surface and therefore measurement accuracy.



Frost Point vs. Dew-Point temperatures below 0°C

## Display & Outputs

A clear, bright and highly visible LCD display is capable of showing any three user-selectable parameters in large clear text. The display also features a stability graph and displays the operational status of the unit. An easy to use menu system enables the operating parameters of the instrument to be quickly customized to suit the target application. The S8000 Series also comes with customizable analog outputs and one or more alarms, enabling integration into an existing process or automated test and calibration system.



## Built-in Data Logging

A sophisticated logging system provides the facility to log the values of all the instrument parameters at operator specified intervals. The log files are saved directly onto a removable SD memory card (supplied), allowing the logs to be easily transferred to a PC for analysis or correlation with test results.



## Application Software

S8000 Series instruments feature a digital communications port (Modbus over USB, RS232, RS485 or Ethernet, depending on model) and multiple analog outputs, allowing configuration and monitoring by a suitable computer, data logger or other device. Adjustable isolated alarm contacts allow the S8000 Series to be used for direct process control.

Comprehensive application software is supplied with our chilled mirror hygrometers free of charge, to provide an interface to configure and control instrument functions, and enable all measured and calculated parameters to be graphed or logged over time.



# S8000

## Precision Chilled Mirror Hygrometer



The S8000 is the base model of the S8000 Series and is suitable for a range of calibration applications. The integrated sensor head enables the S8000 to function as a stand-alone instrument, allowing measurement to  $-60^{\circ}\text{Cdp}$  ( $-76^{\circ}\text{Fdp}$ ).

The hygrometer provides a direct measurement of dew point, temperature and pressure. Dew-point measurement is based on the proven, fundamental optical chilled mirror measurement principle, giving long-term drift-free humidity measurement over the entire operating range. The S8000 uses this measurement to offer a range of available measurement units including  $\text{ppm}_v$ , absolute humidity, relative humidity and  $\text{ppm}_w$ .

To further improve the accuracy of pressure-derived calculated values ( $\text{ppm}_v$ ,  $\text{ppm}_w$  absolute humidity), an optional internal pressure transducer can be supplied, which provides real-time pressure. This allows for continued humidity measurement stability even during fluctuations in sample pressure.

A pair of adjustable isolated alarm contacts allow the S8000 Chilled Mirror Hygrometer to be used for direct process control. A high-contrast touch screen LCD display provides entirely customizable local indication of the measured values, along with a trend graph and fault warnings.

### Highlights

- $\pm 0.1^{\circ}\text{Cdp}$  ( $\pm 0.18^{\circ}\text{Fdp}$ ) accuracy
- Fundamental, accurate and drift-free measurement
- Simple configuration and operation via touch screen interface
- Precision measurements to  $-60^{\circ}\text{C}$  ( $-76^{\circ}\text{F}$ ) dew point
- FAST – guaranteed frost formation below  $0^{\circ}\text{C}$  ( $+32^{\circ}\text{C}$ )
- Measure at pressures up to 2 MPa (20 barg)
- USB, Ethernet, RS485 or RS232 connectivity
- Datalogging to SD card or via digital comms

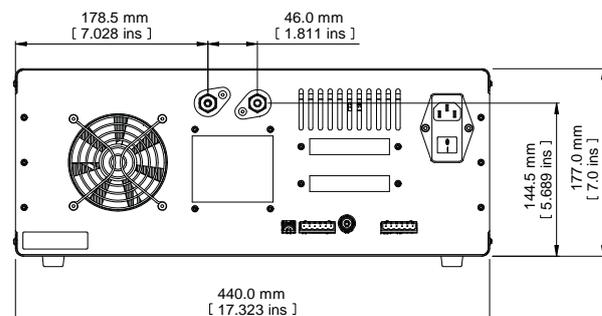
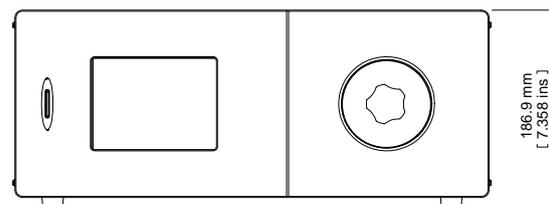
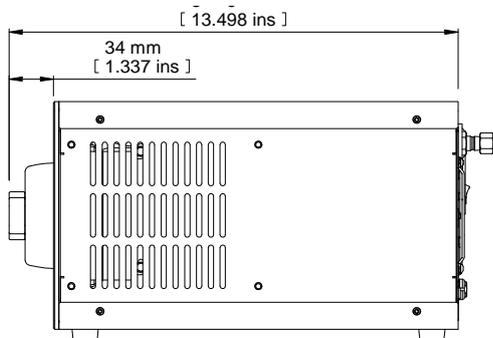
## Technical Specifications

Dew-Point Sensor Performance	
Measurement technology	Chilled Mirror
Accuracy*	±0.1°C (±0.18°F)
Reproducibility	±0.05°C (±0.09°F)
Measurement range	-60 to +40°Cdp (-76 to +104°Fdp)
Operating pressure	
Low pressure version	0 to 1 barg / 14.5 psig
High pressure version	0 to 20 barg / 290 psig
Sample flow rate	0.1 to 1 NI/min (0.2 to 2.1 scfh)
Detection system	RRS Triple Detection
Remote PRT Probe (Optional)	
Temperature measurement	4 wire Pt100, 1/10 DIN class B
Measurement accuracy	±0.1°C (±0.18°F)
Cable length	2m (6.6') (250m (820') max)
Flow Sensor	
Measurement accuracy	Typical ±5% uncalibrated
Measurement range	0 to 1000 ml/min
Integrated Pressure Sensor (Optional)	
Measurement range	0 to 25 bara (0 to 377 psia)
Measurement accuracy*	0.25% Full Scale
Measurement units	psia, bara, KPa or MPag
Monitor	
Resolution	User-selectable to 0.001 dependant on parameter
Measurement units	°C and °F for dew point and temperature %RH, g/m <sup>3</sup> , g/kg, ppm <sub>v</sub> , ppm <sub>w</sub> (SF <sub>6</sub> ), for calculated humidities
Outputs	
Analog	3 channels, user-selectable 4–20 mA, 0–20 mA or 0–1 V
Digital	Modbus RTU over USB, and optional Modbus RTU over RS232, RS485 or Modbus TCP over Ethernet
Alarm	Two volt-free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	5.7" LCD with touchscreen, white on blue graphics
Data logging	SD Card (512Mb supplied) and USB interface SD Card (FAT-32) — 32Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental conditions	-20 to +40°C (-4 to +104°F)

Power supply	85 to 264 V AC, 47/63 Hz
Power consumption	100 V A
EMC - Class A Emissions	Complies with EN61236:1997 (+A1/A2/A3)
Industrial Location Immunity	
Mechanical Specifications	
Dimensions	187 x 440 x 343mm (7.36 x 17.32 x 13.5") h x w x d
Weight	11.4kg (25.1lb)
General	
Process connections	6mm Swagelok® or 1/4" Swagelok®
Storage temperature	-20 to +50°C (-40 to +122°F)
Calibration	3-point traceable in-house calibration as standard UKAS accredited calibrations optional — please consult Michell

\* Measurement accuracy means maximum deviation between instrument under test and corrected reference. To this must be added the uncertainties associated with the calibration system and the environmental conditions during testing or subsequent use.

## Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: S8000 MKII\_97509\_V2\_UK\_Datasheet\_0618-Cat

# S8000 Remote

## High Precision Dew-Point Hygrometer



The S8000 Remote has all the great features of the other S8000 Series chilled mirror hygrometers, but with a convenient and compact remote sensor design. The field-proven sensor boasts upgraded temperature control for extremely accurate dew-point measurement. Coupled with the standard  $\pm 0.1^{\circ}\text{C}$  ( $0.18^{\circ}\text{F}$ ) accuracy ambient temperature sensor, it provides fundamentally derived, high precision relative humidity readings necessary for validating the results of environmental tests.

### The perfect reference for environmental chambers

The relative humidity in climatic chambers will always deviate from the set point. Even in high precision chambers this deviation is typically between 1-3% RH, which can have a considerable effect on the results of many tests. The S8000 Remote can reduce this uncertainty to just 0.5% RH, depending on set point.

The compact remote sensor takes up minimal space in the chamber and features an open cell design, removing the need for any complex heated sampling arrangements or an external pump. Installing the sensor is simply a matter of placing it in an appropriate position within the chamber, and routing the cable externally to the instrument. An optional aluminum sensor head provides a swift response to changes in temperature, preventing any risks of condensation occurring during rapid transitions between temperature set points.

### Highlights

- Fundamental, accurate and drift-free measurement
- Remote sensor
- Open design allows remote sensor to be mounted into a sample flow or simply placed in an environment to be monitored
- $-40$  to  $+120^{\circ}\text{C}$  ( $-40$  to  $+194^{\circ}\text{F}$ ) dew-point range with  $0.1^{\circ}\text{C}$  ( $0.18^{\circ}\text{F}$ ) accuracy
- Data logging to USB or SD card
- 'FAST' guarantees frost formation below  $0^{\circ}\text{C}$  ( $+32^{\circ}\text{F}$ )
- Sensor operates in pressures up to 20 barg (290 psig)

# Technical Specifications

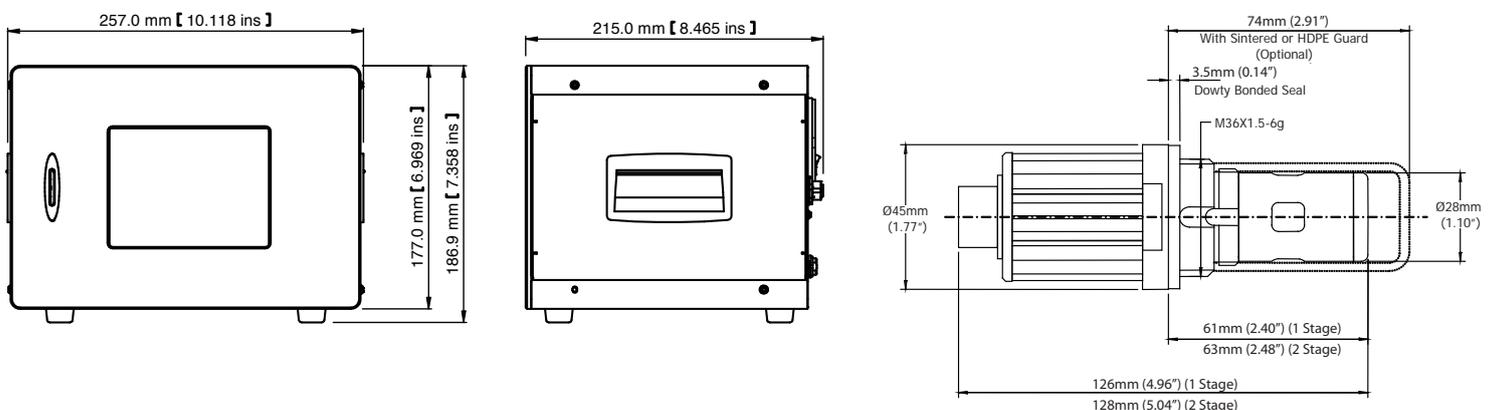
# S8000 Remote

Dew-Point Sensor Performance			
Accuracy	±0.1°C (±0.18°F)		
Reproducibility	±0.05°C (±0.09°F)		
Measurement technology	Chilled Mirror		
Sensor	2-Stage	High Temp PEEK	Climatic head
Dew-point range	-40°Cdp @ sensor temp of +20°C +90°Cdp @ sensor temp of +90°C	-40°Cdp @ sensor temp of +20°C +120°Cdp @ sensor temp of +120°C	-10°Cdp @ sensor temp of +20°C +120°Cdp @ sensor temp of +120°C
Temperature range	-40 to +90°C	-40 to +120°C	-40 to +120°C
%RH range	<0.5 to 100%	<0.5 to 100%	10 to 100%
Min measured dew point @ 20°C	-40°C	-40°C	-10°C
Mirror material options	Gold plated copper (standard), gold stud, Platinum stud**		
Sensor body material options	Acetal (standard), high temperature PEEK, Anodized aluminum**		
Response speed	1°C/sec (1.8°F/sec) plus settling time		
Operating pressure	20 barg (290 psig) standard High pressure version: 250 barg (3625 psig) max		
Remote PRT			
Temperature measurement	4 wire Pt100, 1/10 DIN class B		
Accuracy	±0.1°C (±0.18°F)		
Cable length	2m (6.6ft) (250m (820ft) max)		
Optional Remote Pressure Sensor			
Measurement range	0 to 25 bara (0 to 377 psia)		
Accuracy	0.25% Full Scale		
Measurement units	psia, bara, KPa or MPa		
Pressure transducer thread	1/8" NPT		

Monitor	
Resolution	User-selectable to 0.001 dependant on parameter
Measurement units	°C and °F for dew point and temperature %RH, g/m <sup>3</sup> , g/kg, ppm <sub>v</sub> , %Vol, ppm <sub>w</sub> (SF <sub>6</sub> ), for calculated humidities
Outputs	<b>Analog</b> 3 channels, user selectable 4–20 mA, 0–20 mA or 0–1 V <b>Digital</b> Modbus RTU over USB and optionally Modbus RTU over RS232 or RS485, or Modbus TCP over ethernet. <b>Alarm</b> Two volt free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	5.7" LCD with touchscreen
Data logging	SD Card (512Mb supplied) and USB interface SD Card (FAT-16) – 2Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental conditions	-20 to +50°C (-4 to +122°F)
Power Supply	85 to 264 V AC, 47/63 Hz
Power Consumption	100 V A
Mechanical Specifications	
Dimensions (instrument)	190 x 255 x 215mm (7.5 x 10.0 x 8.4") h x w x d
Dimensions (sensor)	ø45 x 128mm with M36 x 1.5-6g mounting thread
Weight	4.2kg (9.26lbs)
Cable lengths	3, 5 or 10m (9.8, 16.4 or 32.8ft)
General	
Storage temperature	-40 to +60°C (-40 to +140°F)
Detection system	Single optics detection system with auto adjustment
Calibration	4-point traceable in-house calibration as standard; UKAS accredited calibrations optional – please consult Michell Instruments

\*\*Recommended for special applications only. Consult Michell Instruments before ordering.

## Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: S8000 Remote\_97307\_V4\_UK\_0318-Cat

# S8000 RS

## High Precision Dew-Point Hygrometer



The S8000 RS is at the cutting edge of chilled mirror reference technology. The advanced sensor design has been refined over several generations and is accurate, reliable and highly sensitive. A sophisticated auxiliary cooling system allows the instrument to precisely measure dry dew points to  $-90^{\circ}\text{C}$  ( $-130^{\circ}\text{F}$ ) (100 ppb<sub>v</sub>) with no need for additional, external cooling equipment. Combined with its  $\pm 0.1^{\circ}\text{C}$  ( $\pm 0.18^{\circ}\text{F}$ ) accuracy this makes it the most cost-effective and convenient hygrometer in its class.

The S8000 RS comes with all the features you would expect from a modern laboratory instrument including a large touch screen interface, built in data-logging, Ethernet / USB connectivity and dedicated application software. It is also the smallest and lightest of the instruments in its class, weighing just 22.4 kg (49.3 lbs), and is suitable for rack mounting.

### Improved touch screen display

The S8000 RS features an upgraded display offering touch screen operation and a larger viewing area, while retaining all of the functionality of the original S8000 display. A powerful new menu system optimized for touch screen usage makes configuration of instrument parameters quick and easy.

### New sensor head design for uncompromising accuracy

The S8000 RS sensor is optimised for measurement of low dew points, and incorporates a high precision Pt100 to measure the mirror temperature. Combined with a sensitive optical detection system and high integrity

internal sampling, featuring welded stainless steel tubing and VCR fittings, this provides  $\pm 0.1^{\circ}\text{C}$  ( $\pm 0.18^{\circ}\text{F}$ ) accuracy of dew-point measurement and the fastest possible response time to very low dew points.

To further improve the accuracy of pressure-derived calculated values an optional pressure transducer can be installed, which provides a real-time pressure input for these parameters. This allows for continued measurement accuracy, even during sample pressure fluctuations.

### Highlights

- Accuracy of  $\pm 0.1^{\circ}\text{C}$  ( $\pm 0.18^{\circ}\text{F}$ )
- Precision measurement to  $-90^{\circ}\text{Cdp}$  ( $-130^{\circ}\text{Fdp}$ ) (100 ppb<sub>v</sub>) with no need for additional cooling
- Simple configuration and operation via touch screen interface
- Sensor head optimized for fast response to low moisture levels
- High measurement sensitivity
- Microscope for visual inspection of condensate on mirror
- Compact 19" x 4U package for flexibility of installation
- Ethernet or USB connections
- SD card datalogging

## Technical Specifications

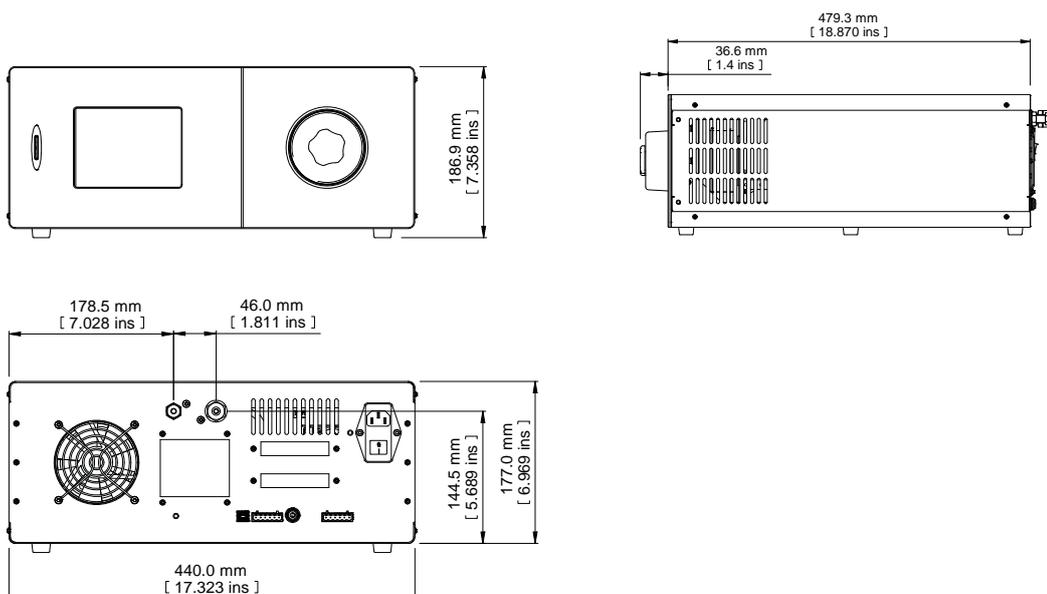
# S8000 RS

Dew-Point Sensor Performance	
Measurement Accuracy*	±0.1°C
Reproducibility	±0.05°C
Measurement Technology	Chilled Mirror
Measurement Range	RS80: -80 to +20°Cdp (-112 to +68°Fdp) RS90: -90 to +20°C dp (-130 to +68°Fdp)
Mirror	Gold plated copper
Temperature Measurement	4 wire Pt100, 1/10 DIN class B
Sample Flow Rate	500 to 1000 ml/min (1 to 2.1 scfh)
Sample Gas Pressure	1 MPa (10 barg) max
Remote PRT	
Temperature Measurement	4 wire PT100, 1/10 DIN class B
Measurement Accuracy	±0.1°C
Cable Length	2 metres (250 metres max)
Flow Sensor	
Measurement Range	0 to 1000ml/min
Optional Integrated Pressure Sensor	
Measurement Range	0 to 1.6 MPa (0 to 16 bara)
Measurement Accuracy	0.25% Full Scale
Measurement Units	barg, psig, kPa, MPa

\* Measurement accuracy means maximum deviation between instrument under test and corrected reference. To this must be added the uncertainties associated with the calibration system and the environmental conditions during testing or subsequent use.

Monitor	
Resolution	User selectable to 0.001°C, depending on parameter
Measurement Units	<b>Moisture:</b> °C dp or °F dp, % RH, g/m <sup>3</sup> , g/kg, ppm <sub>w</sub> , ppm <sub>w</sub> (SF6) <b>Temperature:</b> °C or °F <b>Pressure:</b> barg, psig, kPa, MPa
Outputs	<b>Analog:</b> Three channels, user selectable 4-20 mA, 0-20 mA or 0-1 V <b>Digital:</b> Modbus RTU over USB and optionally Modbus RTU over RS232 or RS485, or Modbus TCP over ethernet. <b>Alarm:</b> Two volt-free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	5.7" LCD with touchscreen
Data Logging	SD Card (512 Mb supplied) and USB interface. Supports SD Card (FAT-32) - 32 Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental Conditions	5 to 30°C, max 80% RH
Power Supply	85 to 264 V AC, 47/63 Hz
Power Consumption	250 VA
Mechanical Specification	
Dimensions	190 x 445 x 550mm (7.48 x 17.51 x 21.65 in) (h x w x d)
Weight	22.4kg (49.38lbs)
Sample Gas Circuit	316 Stainless steel
Sample Gas Connections	<b>Inlet:</b> ¼" VCR <b>Outlet:</b> ¼" Swagelok
Optional Integrated Sample Pump	Flow rate: 1.4l/min maximum Sample gas connections: 1/4" Swagelok with bypass loop
General	
Calibration	5-point in-house calibration, national standards traceable as standard UKAS ISO17025 accredited calibrations optional – please consult factory

## Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: S8000 RS\_97316\_V3\_UK\_0318-Cat

# S4000 TRS

## Precision Dew-Point Hygrometers



The Michell Instruments S4000 TRS is designed for very dry dew point measurements to  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ).

The S4000 Series is supplied with all the standard features of our other chilled mirror hygrometers including dynamic contamination control, a microscope for visual identification of the condensate, RS232 digital communications, and both current and voltage analog outputs.

### S4000 TRS

The S4000 TRS is Michell Instruments' industry proven chilled mirror reference hygrometer, offering  $\pm 0.1^{\circ}\text{C}$  ( $\pm 0.18^{\circ}\text{F}$ ) dew point and temperature accuracy, across a wide range of dew points from  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ) ( $14 \text{ ppb}_v$ ) to  $+20^{\circ}\text{C}$  ( $+68^{\circ}\text{F}$ ).

The S4000 TRS was selected to provide transfer of the trace humidity standard between the NPL (National Physical Laboratory, London UK) and NIST (National Institute of Standards & Technology, Washington DC, USA), on account of its excellent stability and reproducibility. It is now widely used in calibration and standards laboratories worldwide, in recognition of these characteristics.

### Highlights

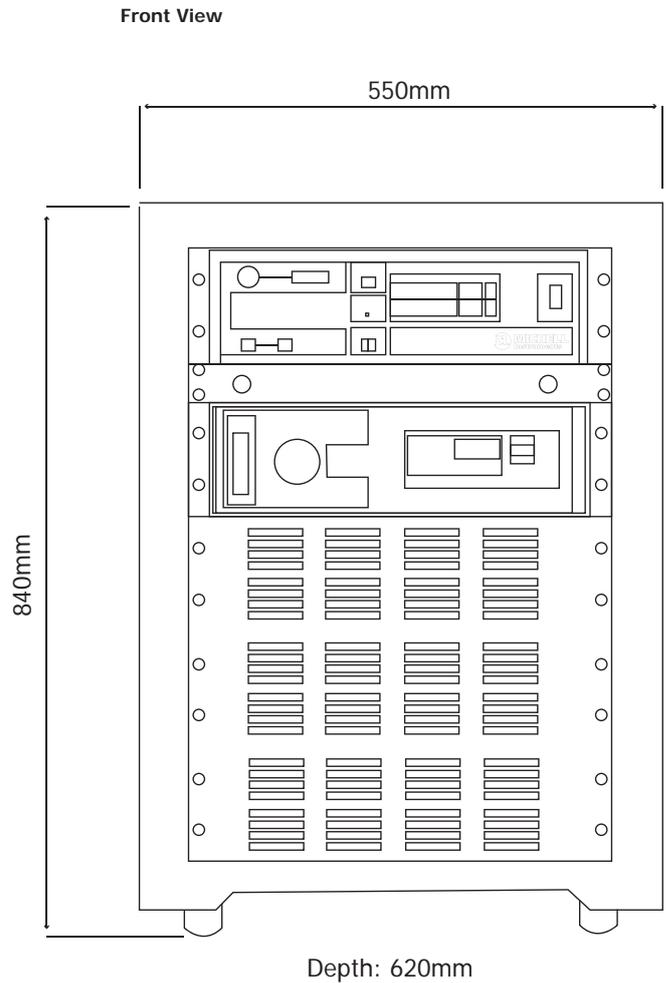
- $0.1^{\circ}\text{Cdp}$  ( $0.18^{\circ}\text{Fdp}$ ) accuracy
- Measurement range: S4000 TRS:  $-100$  to  $+20^{\circ}\text{Cdp}$  ( $-148$  to  $+68^{\circ}\text{Fdp}$ )
- Precision  $100 \Omega$  4 wire platinum resistance thermometer
- Dual optics detection system
- Available with VCR couplings for optimum trace moisture sampling (S4000 TRS)
- Dual multi-function LED display with unit indicator

# S4000 Series

## Technical Specifications

Model	S4000 TRS
<b>Performance</b>	
Measurement technology	Chilled Mirror
Measurement range	-100 to +20°Cdp (-148 to +68°Fdp)
Measurement accuracy	±0.1°Cdp (±0.18°Fdp) ±0.1°C (±0.18°F) temperature
Measurement units	°Cdp, °Fdp; °C, °F temperature; % RH, ppm <sub>v</sub> , ppm <sub>w</sub> , g/m <sup>3</sup> , g/kg, ppm <sub>w</sub> for SF <sub>6</sub>
Repeatability	Better than 0.1°C (0.18°F)
Resolution	0.01 (0.1 for % RH)
<b>Dew-Point Sensor</b>	
Mirror	Gold plated copper
Dual optics detection	Wide band red LED with dual photo sensors, all system insulated
Temperature measurement	4 wire Pt100, 1/10 DIN class B
Sample flow rate	0.1 to 0.7 NI/min (0 to 1.5 scfh) (recommended)
Integrated flowmeter	0 to 1 NI/min (0 to 2.1 scfh)
Sensor pressure	Atmospheric
Configuration	Integral
Auxiliary cooling	Internal refrigeration
<b>Remote PRT</b>	
Temperature measurement	4 wire Pt100, 1/10 DIN class B
<b>Monitor</b>	
Resolution	0.01°C (0.018°F)
Outputs	<b>Analog:</b> 2 channels, 10 mV/°Cdp, 4-20 mA <b>Digital:</b> RS232 <b>Logic:</b> Data hold, ABC Logic status, optics alarm
Auxiliary input pressure transducer	4-20 mA input for automatic compensation 0-0.34 MPa (0 to 3.4 barg / 0 to 50 psig) (optional)
Operating temperature	0 to +40°C (+32 to +104°F)
Dimensions	840 x 550 x 620mm (33 x 21.7 x 24.4") (h x w x d) - mini rack
Weight	85kg (187lbs)
Power supply	<b>Monitor:</b> 90 to 265 V AC; 50/60 Hz <b>Sensor:</b> 100 to 115 or 220 to 240 V AC; 50/60 Hz

## S4000 TRS Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: S4000 TRS\_97146\_V4\_UK\_0718-Cat

# DCS - Dew-Point Calibration Systems

## DCS60, DCS80, DCS100



DCS80 with S8000RS

The DCS system is a complete rack-mounted calibration station capable of producing a flow of air (or nitrogen) at a pre-specified range of dew-point temperatures from a minimum of  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ) to a maximum of  $+20^{\circ}\text{C}$  ( $+68^{\circ}\text{F}$ ).

When ordering this system, simply specify the required operating range, and Michell Instruments will determine the most economical way to construct your calibration system.

## Each DCS comprises the following components:

### Air Compressor

An oil-free laboratory mini compressor, used to generate clean compressed air to feed the air dryer system. The compressor can be housed within the calibration rack system ( $< 72$  dbA noise level) or in a separate room, with an air feed to the DCS system.

### Pressure Swing Dryer

The dryer provides a source of dry or super-dry air required by the generator. The PSD2 Dryer is used with the DCS80 calibration systems, and provides a supply of dry air with a dew point of  $-80^{\circ}\text{C}$  ( $-112^{\circ}\text{F}$ ) or less in continuous operation. The PSD4 supplied with the DCS100 system provides dry air of  $-100^{\circ}\text{Cdp}$  ( $-148^{\circ}\text{Fdp}$ ) dew point or less. An appropriate dryer will be selected for the calibration system, based on the dew-point range requirements specified.

### Generator

The dew-point generator produces, and allows adjustment of, the flow of humidity controlled calibration gas. A DCS60/80 system can be supplied with either a DG2 or DG4 generator.

The DG2 dew-point generator allows full manual, analog control of the generated dew point by means of metering valves on the front panel.

The DG4 dew-point generator provides automated control of the generated dew point by allowing the selection of the desired dew point either via push buttons on the front panel, or by remote control via RS232 communications. The pre-set dew points are chosen at the time of order.

The DCS100 is supplied with a Vapor Delivery System (VDS) generator, which can be controlled directly or programmed to cycle through a range of outputs by means of dedicated control software.

### Reference Hygrometer

The Reference Hygrometer serves to provide a dependable measurement of the calibration gas produced by the dew-point generator, to allow comparison against instruments under test.

A Chilled Mirror hygrometer directly measures the temperature at which condensation forms, and provides inherently repeatable, reliable results every time. Meaning is best suited for use as a reference instrument.

To ensure traceability to higher standards, the reference will be supplied with either a national standards traceable, or a UKAS accredited calibration.

### Highlights

- Complete dew-point calibration solution with optional compressor, dryer, dew-point generator, reference instrument and optional manifold
- Generated output responds quickly to a change of set point
- Stable humidity generation
- Simple operation through manual flow mixing or push-button switching of set points
- Remote control via RS232 comms (dependant on model)

# DCS - Dew-Point Calibration Systems

## DCS60

The DCS60 is supplied with an S8000, which is air cooled and has the capability to measure to dew points of  $-60^{\circ}\text{C}$  ( $-76^{\circ}\text{F}$ ).

## DCS80

The DCS80 is supplied with an S8000 RS, which features an automatically controlled auxiliary cooling system, and has the capability to measure to dew points of  $-90^{\circ}\text{C}$  ( $-130^{\circ}\text{F}$ ).

## DCS100

The DCS100 is supplied with an S4000 TRS, which utilizes a manually controlled auxiliary cooling system, and has the capability to measure to dew points of  $-100^{\circ}\text{C}$  ( $-148^{\circ}\text{F}$ ).



DCS100

## Calibration Manifold

Michell Instruments' dedicated systems engineering team can design and build for you a calibration manifold to suit any type of dew-point sensor, or a combination of sensors from different manufacturers. Just tell us the sensor type and we'll do the rest.

## Housing

The whole system is conveniently mounted in a 19" rack unit for ease of use. If using a high purity air or nitrogen supply, this may be chosen as a feed to the system instead of the integral compressor/dryer system. A Michell Instruments' technical sales representative can give advice on how to accommodate this variation.

## Technical Specifications

	DCS60	DCS80	DCS100
Range	-60 to $+20^{\circ}\text{Cdp}$ ( $-76$ to $+68^{\circ}\text{Fdp}$ )	-80 to $+20^{\circ}\text{Cdp}$ ( $-112$ to $+68^{\circ}\text{Fdp}$ )	-100 to $+20^{\circ}\text{Cdp}$ ( $-148$ to $+68^{\circ}\text{Fdp}$ )
Air dryer	PSD2 Dryer	PSD2 Dryer	PSD4 Super Dryer
Generator method	DG2 with manual flow metering DG4 with solenoid controlled needle valves	DG2 with manual flow metering DG4 with solenoid controlled needle valves	VDS system with mass flow controllers
Reference hygrometer	S8000 Chilled Mirror Hygrometer	S8000 RS Chilled Mirror Hygrometer	S4000 TRS Chilled Mirror Hygrometer
Calibration flow rate	2 to 5 NI/min (4.2 to 10.6 scfh)	2 to 5 NI/min (4.2 to 10.6 scfh)	10 NI/min (21.2 scfh)
Best system uncertainty	$\pm 0.2^{\circ}\text{C}$ ( $\pm 0.36^{\circ}\text{F}$ ) dew point ( $k = 2$ ) @ $+20^{\circ}\text{Cdp}$ ( $+68^{\circ}\text{Fdp}$ )		
Set point precision	$\pm 0.5^{\circ}\text{C}$ ( $\pm 0.9^{\circ}\text{F}$ ) dew point		
Carrier gas	Oil-free compressed air (compressor supplied)		
Operating temperature	$+15$ to $+30^{\circ}\text{C}$ ( $+59$ to $+86^{\circ}\text{F}$ )		
Traceability	Directly to NPL and NIST through Reference Hygrometer		
Power	220 to 240 V AC or 100 to 130 V DC, 50/60 Hz		
Housing	Wheeled 19" rack system, 1.9 m (74.8") high		
Weight	98kg (216lbs) (approx)	125kg (231lbs) (approx)	Varies

Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
Issue No: DCS\_97162\_V3\_UK\_0718

# Integrated Calibration Systems

## RH Calibration

### HygroCal100 Humidity Validator



The HygroCal100 provides a stable test chamber to quickly evaluate the performance of relative humidity sensors across a wide range of 5 to 95% relative humidity. The intuitive design allows the probes under test to be fully integrated with the chamber and user interface (UI), so up to 7 probes with a variety of diameters and output signals can be powered, monitored and logged simultaneously by one self-contained unit.

A 4.3" LCD touch-screen runs a powerful UI, which displays all measured values from the reference and probes under test, along with a graphical trend indication of chamber stability. It is also capable of automating complete validation procedures with ease, and providing a complete logged output in csv format straight to your USB memory device, to minimize the time you spend taking readings.

#### Chamber Integrity

The HygroCal100 has a test chamber milled from a solid piece of Acetal, with minimal sealing points, ensuring the integrity required to maintain <5% RH from laboratory ambient temperatures, and  $\pm 0.5\%$  RH uniformity across the chamber.

#### Portability

The HygroCal100 is fitted with a high capacity battery pack, which can power the generator and 7 sensors under test for up to 8 hours. The unit can also run from mains power while charging the battery.

A hard carry case is supplied with the unit, which has space for the HygroCal100 itself, in addition to the battery charger, spare water and desiccant.

#### Integrate Your Own Reference

The HygroCal interface allows you to assign any hygrometer with an analog output as your reference device, giving you the flexibility to incorporate your traceable reference in your validation routine.

#### Automated Validation

The HygroCal100's advanced UI allows you to define your own calibration procedure, point-by-point, assigning times to each condition to allow your probes under test to stabilize. The system always waits until the conditions in the chamber are completely stable before beginning the check.

#### Correct Chamber Control To Your Own Reference

To ensure continual long term stability of the chamber, the in-built calibration correction system can compare the readings of your traceable reference to a range of pre-set generated conditions – making adjustments to the control sensor to ensure that your set point always matches your own reference.

#### Highlights

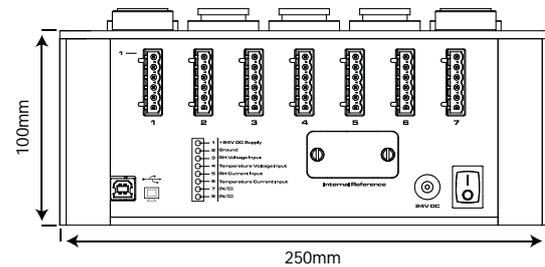
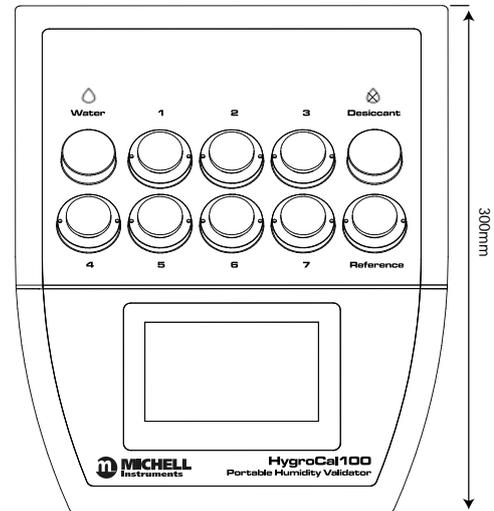
- Truly portable at 3.2kg, and completely self-contained
- Intuitive UI makes automating probe verification simple
- Integral battery pack means validation can be done without access to services
- Validate 7 probes simultaneously
- Automated validation procedures for complete hands-off probe verification
- Internal calibration correction cycle ensures continued confidence
- Optional chilled mirror reference hygrometer, allowing use as a calibrator
- Download logged verification data direct to USB memory

# HygroCal100

## Technical Specifications

Chamber	
Generation range	5 to 95% RH
RH stability	±0.5%
RH uniformity	±0.5%
Stabilization time	Typically <5 min for full stability from step changes of 10% RH
Control Probe	
RH accuracy	±0.8%
Temperature accuracy	±0.2°C (±0.36°C)
Long term stability	±1% per year
Electrical Specifications	
User interface	4.3" color LCD with touchscreen
Interface with probes	24 V excitation voltage, accepts signals: 0–20 mA, 4–20 mA, 0–1 V, 0–5 V, 0–10 V
Measurement units	%RH, temperature in °C, °F
Displayed resolution	0.1
Data logging	2Gb internal memory available for log files; or 10.6yrs storage at 5s intervals
Battery	1500 mAh
Power supply	24 V DC (100 to 240 V AC, 50/60 Hz adaptor included)
Mechanical Specifications	
Probe ports	8 - port adaptors to accommodate probes of diameters: 12mm, 13.5mm, 14mm, 15mm, 18.5mm, 19mm, 24mm, 25mm
Chamber volume	Approx 1050cm <sup>3</sup>
Maximum probe insertion depth	60mm (2.4")
Desiccant reservoir capacity	25cm <sup>3</sup> (1.5 In <sup>3</sup> )
Saturator reservoir capacity	25ml
Environmental conditions	+5 to +40°C (+41 to +104°F)
Dimensions	100 x 250 x 300mm (3.9 x 9.8 x 11.8") (h x w x d)
Weight	3.2kg (7lb)

## Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.

Issue No: HygroCal100\_97502\_V1.1\_UK\_Datasheet\_0616-Cat

# S904

## Humidity Calibrator



The S904 is a completely stand-alone and transportable calibrator for humidity sensors, requiring no external services other than mains power. The calibration chamber features 5 interchangeable ports to accommodate virtually any brand, type or model of sensor. This calibrator is ideal for companies or organizations looking to calibrate large numbers of probes in a laboratory or field setting.

The environment within the insulated calibration chamber is temperature controlled using a 4-zone fan-assisted Peltier arrangement for maximum stability, and minimum temperature gradient. The humidity of the circulating air is precisely regulated using a closed-loop control system that functions by proportionally mixing flows of dry and saturated air.

Two highly visible LED panels on the front of the S904 display the current humidity and temperature within the calibration chamber. The response time to a humidity or temperature step change is typically less than 10 minutes, so a simple 3-point calibration can be carried out in under an hour.

An optional integrated digital interface is available for the S904. This allows the humidity and temperature set points of the chamber to be controlled with the supplied PC application software, enabling the operator to create completely automated calibration profiles for unattended laboratory operation. The software also gives the ability to monitor, chart and log data from the connected probes and calibration reference on a PC for later analysis. Alternatively, the set points can be controlled manually with the front panel controls - making the S904 ideal for field calibrations where a PC is not available.

The S904 is easy to maintain. The desiccant changes color to indicate when it needs to be recharged and this is visible through a clear window on the front of the unit. Recharging the desiccant is simply a matter of heating it in a conventional oven at +150°C (+302°F) for 3 hours. The water reservoir at the front of the unit shows the current saturator fill level, and makes it easy to top-up with distilled water when required.

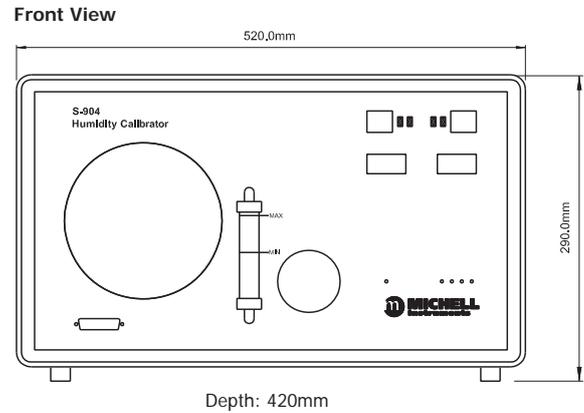
### Highlights

- Simple operation and maintenance
- Excellent chamber stability and uniformity
- Manual control or optional straightforward automated set point programming
- Optional in-built data-logging for reference probe and probes under calibration

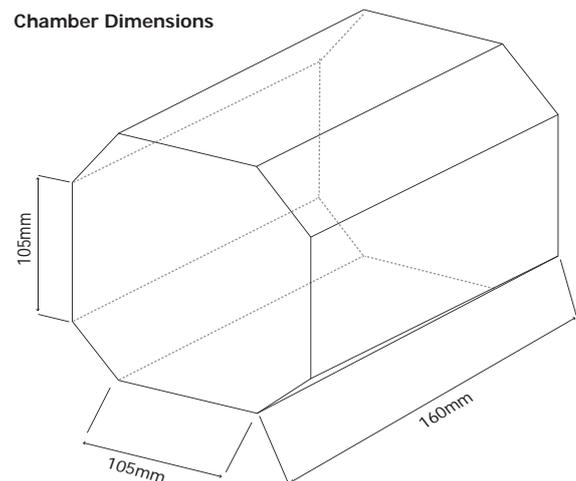
## Technical Specifications

Humidity	
Generation range	10–90% RH
Accuracy control element	≤±1% RH (10–70% RH) ≤±1.5% RH (70–90% RH)
Stability	±0.2% RH (20–80% RH)
Temperature	
Generated range	+10 to +50°C (+50 to +122°F) (lowest T set point = 10°C (18°F) below ambient)
Accuracy	±0.1°C (±0.2°F)
Stability	±0.1°C (±0.2°F)
Chamber	
Ramp rate from +20 to +40°C (+68 to +104°F) +40 to +20°C (+104 to +68°F)	1.5°C / minute (2.7°F / minute) 0.7°C / minute (1.2°F / minute)
Control element	Removable relative humidity sensor
General	
Probe ports	up to 5 – sensor body diameters 5 to 25mm (0.2 to 0.98") accommodated by port adapters
Chamber volume	2000cm <sup>3</sup> (122.1in <sup>3</sup> )
Chamber dimensions	105 x 105 x 160mm (4.13 x 4.13 x 6.3") (h x w x d)
Instrument dimensions	290 x 520 x 420mm (11.4 x 20.5 x 16.5") (h x w x d)
Set point resolution	0.1 for humidity and temperature
Displays	3 digit LED, 10mm (0.39") characters
Supply	85 to 264 V AC, 47/63 Hz, 150 VA
Weight	20kg (44lbs)

## Dimensions



## Chamber Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.

Issue No: S904\_97200\_V3\_UK\_0613-Cat

# OptiCal

## Humidity Calibrator



The OptiCal is a premium calibration solution for humidity sensors. The stand-alone and transportable calibrator requires no external services other than mains power, and features an integrated chilled mirror reference instrument to enable the operator to perform calibrations that are traceable to national standards.

The calibration chamber features 5 interchangeable ports to accommodate virtually any brand, type or model of sensor. The environment within the insulated calibration chamber is temperature controlled using a 4-zone fan-assisted Peltier arrangement for maximum stability, and minimum temperature gradient. The humidity of the circulating air is precisely regulated using a closed-loop control system that functions by proportionally mixing flows of dry and saturated air.

A bright and clear VFD (vacuum fluorescent display) displays the parameters measured by the reference instrument in various relative and absolute humidity units, alongside the temperature within the chamber.

The humidity and temperature set-points can be controlled either manually or automatically as part of a calibration program. Manual control is achieved by the switches on the front panel and response time to a humidity or temperature step change is typically quicker than 10 minutes. The supplied application software allows calibration programs to be created, enabling automatic time-based control of temperature and humidity set points. The software also allows the user to monitor, chart and log calibration reference data on a PC for later analysis.

The OptiCal is supplied with an integrated Optidew chilled mirror reference instrument with traceable calibration to national standards, which provides measurement integrity and traceability for the sensors being calibrated.

The desiccant changes color to indicate when it needs to be recharged, and is visible through a clear window on the front of the unit. Recharging the desiccant is simply a matter of heating it in a conventional oven at +150°C (+302°F) for 3 hours. The water reservoir at the front of the unit shows the current saturator fill level, and makes it easy to top-up with distilled water when required. No other maintenance is necessary, apart from periodic calibration of the chilled mirror reference.

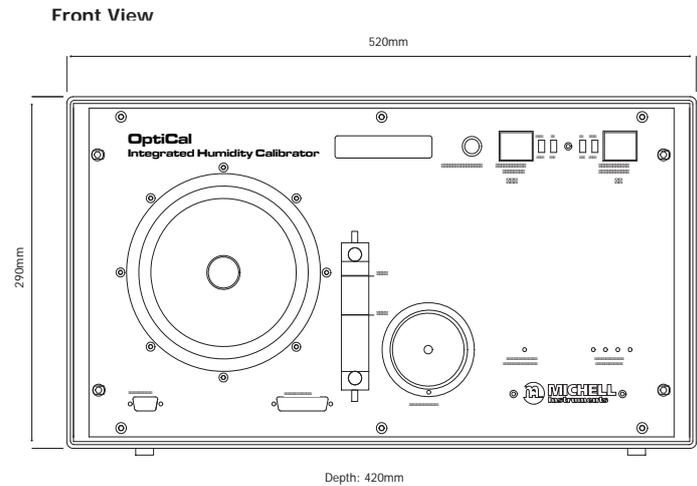
### Highlights

- Simple operation and maintenance
- Excellent chamber stability and uniformity
- Manual control or optional straightforward automated set point programming
- Generate 10 to 90% RH over +10 to +50°C (+50 to +122°F) temperature
- Built in precision chilled mirror reference instrument
- Transportable to allow on-site calibrations

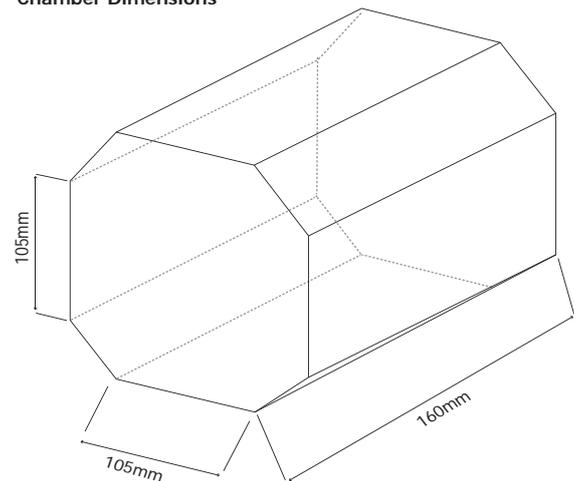
## Technical Specifications

Humidity	
Generated range	10 - 90% RH
Control element accuracy	≤ ±1% RH (10-70% RH) ≤ ±1.5% RH (70-90% RH)
Stability	±0.2% RH (20-80% RH)
Temperature	
Generated range	+10 to +50°C (+50 to +122°F) (lowest T set point = 10°C (18°F) below ambient)
Accuracy	±0.1°C (±0.18°F)
Stability	±0.1°C (±0.18°F)
Chamber	
Ramp rate from	
+20 to +40°C (+68 to +104°F)	1.5°C / minute (2.7°F / minute)
+40 to +20°C (+104 to +68°F)	0.7°C / minute (1.2°F / minute)
Control element	Removable relative humidity sensor
Reference	
Accuracy	
Dew Point	±0.2°C (±0.36°F)
Temperature	±0.1°C (±0.18°F)
Measurement units	
Dew Point	(°C/°F), % RH
Temperature	(°C/°F), gm <sup>-3</sup> , gkg <sup>-1</sup> , water activity (a <sub>w</sub> )
Outputs	
Analog	4-20 mA or 0-20 mA over user-settable output
Accuracy	±0.2°C (±3.6°F)
Digital	500 Ω maximum load resistance
Alarm	RS232 @ 9600 baud rate Volt free contact, 30 V, 100 mA maximum
General	
Probe ports	Up to 5 - sensor body diameters 5 to 25mm (0.2 to 0.98") accommodated by port adapters
Chamber volume	2000cm <sup>3</sup> (112.1in <sup>3</sup> )
Chamber dimensions	105 x 105 x 160mm (4.13 x 4.13 x 6.3") (w x h x d)
Instrument dimensions	290 x 520 x 420mm (11.4 x 20.5 x 16.5") (h x w x d)
Set-point resolution	0.1 for humidity and temperature
Displays	2 line Vacuum Fluorescent Display
Supply	85 to 264 V AC, 47/63 Hz, 150 VA
Weight	20kg (44lbs)

## Dimensions



## Chamber Dimensions



Please note: Michell Instruments adopts a continuous development program which sometimes necessitates specification changes without notice. Please contact us for latest version.  
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# HG10

## Humidity Calibrator



The Michell HG10 Humidity Calibration System is a highly flexible computer-controlled automatic calibration system for humidity sensors. The HG10 is capable of repeatable generation of temperature and relative humidity set points over the range 1 to 95% RH (-50 to +50°Cdp (-58 to +122°Fdp)) at temperatures of +20 to +50°C (+68 to +122°F) with excellent stability. The supplied chilled mirror reference instrument provides traceability directly to national standards, and makes the system suitable for use in high-level calibration laboratories.

The HG10 comprises three main components, the humidity generator, test chamber and reference hygrometer.

### Humidity Generator

The humidity generator used in the HG10 is based on the volumetric mixing of dry and wet gases, giving the fastest response when changing between set points in comparison to other dew-point generation technologies such as two-temperature, two-pressure or the combination of two-temperature and two-pressure. The mixing is automated using high-precision mass flow controllers to accurately control the ratio of wet to dry air, generating the required relative humidity.

A dry gas source is fed to the generator from a pressure swing dryer, and split into two streams. One stream is bubbled through liquid water via a sintered glass nozzle ensuring it is completely saturated with water vapor, while the other stream remains dry. The two gas streams are then mixed at atmospheric pressure to generate the target humidity level. The entire enclosure is insulated and temperature controlled ensuring the saturation, and therefore the output is always consistent.

The generated sample gas is passed directly to the hygrometers under test using a heated sample line. Three clear digital displays on the front panel of the generator indicate the generator temperature, heat traced sample line temperature and relative humidity set point.

### Test Chamber

The standard HG10 chamber has internal dimensions of 550 x 550 x 320mm (21.6 x 21.6 x 12.6"), (h x w x d) and can be controlled and operated at temperatures from -10 to +50°C (+14 to +122°F). Alternative test-chambers are available in a range of different sizes and configurations. Please contact a Michell Instruments' representative for further details.

### Reference Hygrometer

No calibration has validity unless it provides traceability to a recognized national standard. For this reason, the HG10 includes an S8000 Remote Precision Chilled Mirror Hygrometer for precise monitoring of the generated humidity. The S8000 Remote is calibrated in our UKAS laboratory, providing direct traceability to the UK national standard held by the National Physical Laboratory. Michell Instruments also maintains a traceable path directly to the NIST Humidity Standard in Washington, USA.

### Automated Operation

The supplied PC software allows the creation of automatic calibration programs, for evaluating the performance of humidity sensors over a range of operating conditions. The measured values from the chilled mirror reference are used in a closed control loop to enable repeatable set point generation, time and time again.

### Highlights

- No other single system generates as wide a range of wet to dry dew points
- High accuracy  $\pm 0.1^\circ\text{C}$  ( $\pm 0.18^\circ\text{F}$ ) fundamental reference
- User-configurable temperature and humidity profiling allows calibration cycles to be run without constant supervision
- Very fast changes between generated relative humidity points

## Technical Specifications

HG10	
<b>General</b>	
Enclosure	19" Rack System, H=2.1m (6.8')
Power supply	100-115 V or 220 to 240 V 50/60Hz
<b>Pressure Swing Dryer</b>	
Gas output	
Flow	7 NI/min (14.8 scfh)
Pressure	0.68 barg (10 psig)
Moisture content	<1ppm <sub>v</sub> (<-75°Cdp (<-103°Fdp))
Required gas supply	
Flow	10 NI/min (21.2 scfh)
Pressure	5 to 7 barg (70 to 100 psig)
Moisture content	Oil and liquid water-free
Type	Twin column desiccant, pressure swing
Desiccant	4 Ångström Molecular sieve bead (4-8 mesh)
Timer	Motorized cam
Operating temperature	+5 to +35°C (+41 to +95°F)
<b>Generator</b>	
Generation range	
Humidity	1 to 95% RH (-50 to +50°Cdp (-58 to +122°Fdp))
Temperature	Dependant on temperature chamber
Generated gas output	Air 2 NI/min (4.2 scfh) @ 0.5 barg (7 psig) via heat traced line
Dual stage MFC mixing	Dual mass flow controllers
Power consumption	550 V A maximum
Operating temperature	+5 to +40°C (+41 to -104°F); 10 to 90% RH
Enclosure	19" Rack System, H= 2.1m (6.8")
Control system	Closed loop feedback

S8000 Remote			
<b>Dew-Point Sensor Performance</b>			
Accuracy	±0.1°C (±0.18°F)		
Reproducibility	±0.05°C (±0.09°F)		
Measurement technology	Chilled Mirror		
Sensor	2-Stage	High Temp PEEK	Climatic head
Dew-point range	-40°Cdp @ sensor temp of +20°C +90°Cdp @ sensor temp of +90°C	-40°Cdp @ sensor temp of +20°C +120°Cdp @ sensor temp of +120°C	-10°Cdp @ sensor temp of +20°C +120°Cdp @ sensor temp of +120°C
Temperature range	-40 to +90°C	-40 to +120°C	-40 to +120°C
%RH range	<0.5 to 100%	<0.5 to 100%	10 to 100%
Min measured dew point @ 20°C	-40°C	-40°C	-10°C
Mirror material options	Gold plated copper (standard), gold stud, Platinum stud**		
Sensor body material options	Acetal (standard), high temperature PEEK, Anodized aluminum**		
Response speed	1°C/sec (1.8°F/sec) plus settling time		
Operating pressure	20 barg (290 psig) standard High pressure version: 250 barg (3625 psig) max		

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Remote PRT	
Temperature measurement	4 wire Pt100, 1/10 DIN class B
Accuracy	±0.1°C (±0.18°F)
Cable length	2m (6.6ft) (250m (820ft) max)
<b>Optional Remote Pressure Sensor</b>	
Measurement range	0 to 25 bara (0 to 377 psia)
Accuracy	0.25% Full Scale
Measurement units	psia, bara, KPa or MPag
Pressure transducer thread	1/8" NPT

Monitor	
Resolution	User-selectable to 0.001 dependant on parameter
Measurement units	°C and °F for dew point and temperature %RH, g/m <sup>3</sup> , g/kg, ppm <sub>v</sub> , %Vol, ppm <sub>w</sub> (SF <sub>6</sub> ), for calculated humidities
Outputs	
Analog	3 channels, user selectable 4–20 mA, 0–20 mA or 0–1 V
Digital	Modbus RTU over USB and optionally Modbus RTU over RS232 or RS485, or Modbus TCP over ethernet.
Alarm	Two volt free changeover contacts, one process alarm, one fault alarm; 1 A @ 30 V DC
HMI	5.7" LCD with touchscreen
Data logging	SD Card (512Mb supplied) and USB interface SD Card (FAT-16) – 2Gb max. that allows 24 million logs or 560 days, logging at 2 second intervals
Environmental conditions	-20 to +50°C (-4 to +122°F)
Power Supply	85 to 264 V AC, 47/63 Hz
Power Consumption	100 V A
<b>Mechanical Specifications</b>	
Dimensions (instrument)	190 x 255 x 215mm (7.5 x 10.0 x 8.4") h x w x d
Dimensions (sensor)	ø45 x 128mm with M36 x 1.5-6g mounting thread
Weight	4.2kg (9.26lbs)
Cable lengths	3, 5 or 10m (9.8, 16.4 or 32.8ft)
<b>General</b>	
Storage temperature	-40 to +60°C (-40 to +140°F)
Detection system	Single optics detection system with auto adjustment
Calibration	4-point traceable in-house calibration as standard; UKAS accredited calibrations optional – please consult Michell Instruments

\*\*Recommended for special applications only. Consult Michell Instruments before ordering.

















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