

The Fundamentals of Moisture Calibration

The following guide will provide you with a basic knowledge of humidity calibration, help you to understand your requirements and select an appropriate solution.



Why Humidity Calibration is Important

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 sensor 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.

How is the calibration data used?

When the readings provided by the 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 the correction factors have changed. When an instrument is recalibrated, 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 Humidity Calibration?

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 an equipment manufacturer, by internally applying the calibration corrections to bring the output readings into line with the indications of the calibration reference.

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 is represented by the pyramid graphic below (Figure 1).

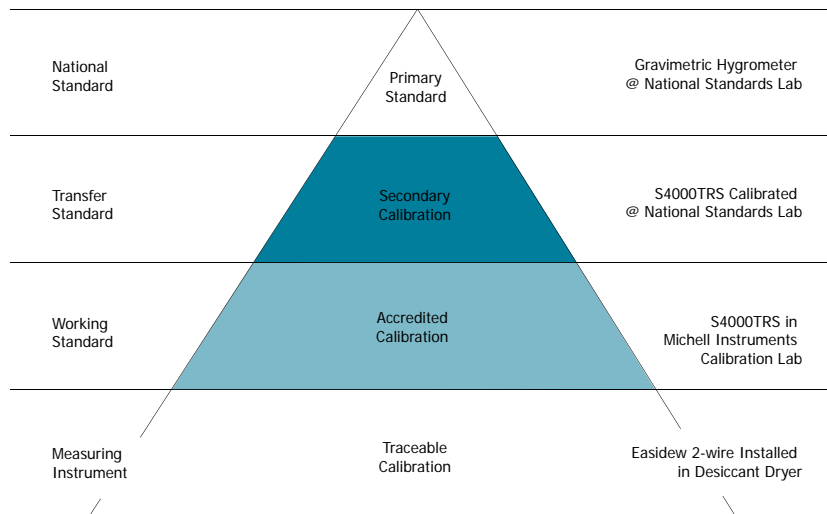


Figure 1



How is a Humidity Calibration Carried Out?

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

A Typical Calibration 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

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.

Other information that should be included on the calibration certificate is:

- 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

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.

Rated 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.

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, level 3 of the International System of Units (SI) through 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
- A list of calibrated equipment used during the calibration, or a list of unique identifiers corresponding to that equipment
- An estimation of uncertainty over the range of the calibration



In-House Calibration vs. External Calibration

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

Michell Instruments offers a calibration service for most moisture sensors and instrumentation, carried out in our ISO 17025, ISO 9001:2008 certified laboratories. Our four laboratories are accredited by UKAS (United Kingdom Accreditation Service), and maintain full traceability to NPL (National Physical Laboratory, London, UK) & NIST (National Institute of Standards & Technology, Washington DC, USA).

We provide traceable calibration from -100 to +90°C (-148 to +194°F) dew point, or full ISO 17025 accredited calibrations from -90 to +90°C (-130 to +194°F) dew point.

Michell Instruments' Service Exchange Scheme



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.

Please contact your Michell Instruments representative for pricing details on policies providing cover for up to 4 years.

About Michell Instruments

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 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 & Development

Michell Instruments has three manufacturing and R&D locations: Oosterhout, The Netherlands; Lyon, France 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 an 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 Michell website www.michell.com under the 'Product Documents/Accreditations' section'.



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Need advice or support? Contact us on 01353 658000, uk.info@michell.com