

White Paper:

Catching the Drift

What RH Measurement Spec Sheets aren't telling you...

Understanding how humidity measurement devices function and how product specifications can be misrepresented can mean the difference between purchasing an expensive system with inherent measurement flaws and getting a system that measures accurately between calibrations.

Knowing what to look for in product specs will allow you to scrutinize product information to select a system that fits your application. Basic knowledge of humidity measurement also reveals that, far too often, the product specifications *not* listed on a measurement product's data sheet can be more revealing than those listed.

Measuring Humidity: How hard can it be?

One of the hardest parameters to accurately measure, relative humidity is a critical factor across a broad spectrum of industries. Moreover, humidity has the potential to impact critical applications in ways that are often hard to detect until something goes catastrophically wrong. In calibration, stability testing, and quality assurance processes, the uncertainty of humidity measurement can be a major source of unnecessary cost, skewed data, and lost revenues.

The Inevitable Drift of Humidity Sensors

It's an immutable law of RH measurement: humidity sensors drift. They do so for the simple reason that they're "air breathers." Unlike temperature sensors, humidity sensors must be in direct contact with the environment. Not only is the air constantly changing temperature, it contains countless contaminants that affect the sensor. Unlike temperature sensors, the internal structure of the RH sensor is has no protective barrier from airborne elements, so the sensor's ability to accurately measure degrades over time.

This is why, even if the calibration process were perfect (it isn't), once exposed to the real world, the measurement accuracy inevitably decreases until the next time the device is calibrated. However, between setting up a recently calibrated RH sensor and recalibration, what critical processes and products are affected by the drifting accuracy of the sensor?

A Tale of Two Accuracies (Initial vs. One Year Later)

When looking at any RH measuring device's product specifications, there are two key accuracy values that must be considered. The first is initial accuracy, or, the accuracy of the device when first deployed; the other value is one-year accuracy or the accuracy of the device when you go to recalibrate it (six months to one year after deployment). However, it is important to note that not all initial accuracies are created equal; to be complete, initial accuracy must factor *in all known uncertainties*.

This is where product specifications can differ greatly from sensor to sensor. In an ideal world, RH system data sheets would all include the following sources of error:

- Calibration Uncertainty
- Temperature Effect & Mathematical Fit
- Hysteresis
- Measurement Resolution

If these values can't be found on your product's specifications, how can you be certain they have been included in calculating that device's accuracy?

Accuracy One Year Later

(How long have you been OOS and by how much?)

Although a critical value, one-year accuracy is rarely included on product specifications for humidity measuring instruments. However, this percentage is actually more important than initial accuracy because all data gathered since the last calibration is based solely on its accuracy upon re-calibration. If your RH device is found Out-Of-Spec when you go to re-calibrate, you will be faced with some hard questions. What products or tests were affected and to what extent?

What to Look for in Humidity Product Specs

You may be able to find specs on the accuracy of an RH measuring device after a year of typical use and over a wide temperature range, but first you'll have to know what to look for and secondly, you'll have to look at a lot of product spec sheets.

If the values don't appear, you may have to just ask the sales representative. However, this comes with a proviso; the manufacturer should provide documentation that shows the accuracy values of their devices at the end of the calibration cycle, *before* re-calibrating.

The question is: why is the inclusion of these values on product specifications so rare within the industry? To answer, it's vital to understand the three main elements that determine sensor accuracy:

- Sensor characteristics
- Calibration
- Sensor Measurement System (Electronics)

A device may have the best RH sensor available; however, as already stated, all RH sensors drift. To maximize overall accuracy, it is crucial to reduce errors that occur during the calibration process and within the entire sensor measurement system. These elements, well controlled, will create a bit of room for the device to drift, and still maintain a reasonable amount of accuracy.

In other words, to anticipate the drift of a device, calibration must achieve optimal accuracy, virtually eliminating all other sources of error in the device, and in doing so, give the product some room for drift.

Sources of Error & Their Impact:

Calibration Uncertainty

All humidity calibration chambers have an associated uncertainty, a major source of which is temperature non-uniformity, which must be factored into a measuring device's accuracy specification. In the case of RH sensor equipped data recorders, the manufacturers must perform a high-accuracy temperature calibration. Each recorder's measured temperature is then able to compensate for chamber non-uniformity during RH calibration — greatly reducing this source of error.

Interestingly, the location of the temperature and RH sensors inside a data recorder can have an effect. Inside the best available data recording devices, you will find temperature sensor is placed right beside the RH sensor. Proximity allows both sensors to read the same environment, eliminating any discrepancies (however small) between their measurements.

Temperature Effect & Mathematical Fit

Most RH measuring devices are calibrated to measure at one specific temperature (typically 25°C). But, unless the device will only measure humidity at that temperature, there can be significant temperature-related inaccuracies.

To solve this, a manufacturer can include tables that correlate humidity measurement over a wide range of calibrated temperatures in the memory of the device. Ideally, no two data recorders have the same set of tables because each set is calibrated to the unique components of every recorder.

This creates a more intelligent device because the tables contain explicit information on how to measure humidity over a wide temperature range. This is critical in the case of ICH (stability) applications.

Hysteresis

Hysteresis is the tendency of measuring devices to not return completely to their original state after a change has been measured. It's also a major source of error. Unfortunately, despite its ubiquity, too few data sheets include hysteresis as a factor in their accuracy values. If it appears at all, it's often de-emphasized by being placed far apart from the total accuracy specification. Hysteresis unmentioned or disconnected textually from an accuracy value could be considered product misrepresentation to a discerning purchaser.

Measurement Resolution

Resolution is simply the smallest measurable increment that the device can detect. A good device will feature a 12-bit high-resolution system that detects changes of as small as 0.05%RH.

Electronics

A significant element that affects a device's accuracy is its electronic components. Electronics systems are greatly impacted by temperature, which in turn affects overall accuracy. One challenge that manufacturers face is trying to get the electronic system to remain stable over wide temperature ranges.

As an example, Veriteq Instruments, a manufacturer of high-end industrial Temp/RH measurement systems, found that a synchronous bridge measurement system features low power and superior stability.¹ This unique combination greatly reduced the electronics-associated error in humidity measurement.

Conclusion

Product specifications², often one of the key pieces of information decision makers use to select a suitable measurement system, must be explicit, easy-to-understand, and straightforward. All of the known influences and sources of error — calibration uncertainty, temperature effect, measurement resolution, and hysteresis — should be included in the accuracy value stated on any data sheet.

If these values are not mentioned on a product data sheet, the consumer is left to ask: have they been included in that product's stated accuracy? Until those who equip laboratories are better informed on other factors that contribute to inaccuracy in humidity measuring devices, manufacturers confronted with their own out-of-spec devices upon re-calibration, can always blame drift.

1. For an in-depth description of this system, see ["Methods of Accurately Measuring Capacitive RH Sensors"](http://www.veriteq.com/download/Methods-of-Accurately-Measuring-Capacitive-RH-Sensors.pdf) at: <http://www.veriteq.com/download/Methods-of-Accurately-Measuring-Capacitive-RH-Sensors.pdf>

2. To see a sample of "Initial Accuracy" and "One Year Accuracy" specifications, see [VL 2000 data loggers](http://veriteq.com/validation-data-loggers/validation-humidity-specs.htm) at <http://veriteq.com/validation-data-loggers/validation-humidity-specs.htm>

Author: Kevin Bull, CEO, Veriteq Instruments, Inc. 13775 Commerce Parkway, Richmond, BC, V6V 2V4 1-800-683-8374. For further information, please contact customersupport@veriteq.com.