

**Catching the Drift:**  
*What RH Measurement Spec Sheets aren't telling you...*

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## **Introduction:**

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.

The ability to scrutinize product specs in greater depth will allow you to select a system that fits the measurement needs of your application. This, in turn can help with meeting compliancy and quality assurance requirements. However, far too often, RH product specifications not listed on a data sheet can be more revealing than those that are...

## **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 RH Sensors**

It's an immutable law of metrology: all sensors drift. Humidity sensors are uniquely prone to drift however, for the simple reason that they're "air breathers." Unlike temperature sensors, humidity sensors must be in direct contact with the environment.



*GxP Warehouse RH can be highly variable.*

Not only is the air constantly changing temperature, (which affects RH) but air also 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 measure degrades over time.

This is why, even if the calibration process were perfect (it isn't), once the sensor is exposed to the real world its measurement accuracy decreases until the next time the device is calibrated. The question then, is: between the time you set up your recently calibrated RH sensor and the time you go to recalibrate, what critical processes and products are have been measured with an out-of-specification RH device? Stability, especially in humidity sensors, is everything.

## **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 (6 months to 1 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 include each of the following sources of error:

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

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

### **What to Look for in Product Specs: RH Accuracy 1 Year Later...**

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

Although the stability of a humidity sensor—its staying power for accuracy over time—is crucial in GxP and many FDA-regulated applications, a one-year accuracy value is rarely included on product specifications for RH instrumentation. All the data collected since a device's last calibration is based on the accuracy of that data. This means that the accuracy percentage value at the *end* of a device's calibration interval (it's "as-found" accuracy) is actually more important than initial accuracy ("as-left" accuracy). 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?

You can get product specs on the accuracy of an RH measuring device after a year of typical use and over a wide temperature range. First, you'll have to know what to look/ask for from the device manufacturer. Second, you'll have to look at a lot of product spec sheets. If there are no values listed for a device at the end of its calibration interval, ask your sales representative. However, this recommendation 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.



*How can you know the RH sensor's accuracy after a year of field use?*

### **The Elements of Error**

To understand accuracy values and their inclusion or exclusion from spec sheets, it's vital to understand three major determinants of 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. When these elements are well controlled, it creates a bit of "head room" for the inexorable drift of the device.

In other words, to anticipate the drift of a device, optimal accuracy must be obtained at the calibration stage and the calibration must be performed in a way that factors in and controls all other sources of error.

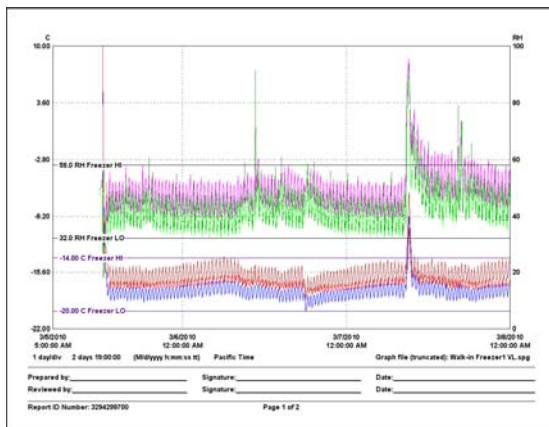
## Sources of Error & Their Impact

### 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 actually have an effect on the accuracy of the calibration. 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.



*Because relative humidity is temperature dependent, proximity of temperature and humidity sensors within an instrument counts in accurate measurement.*

### 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 kind of device-specific calibration is critical in the case of ICH (stability) applications due to the range of environments and accuracy required for compliance.

### 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.

Unfortunately, if hysteresis 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 & Electronics:

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.

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. A major 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. This unique combination greatly reduced the electronics-associated error in humidity measurement.

### **Conclusion: Catching the Drift Means Getting the Numbers**

Product specifications, often one of the key pieces of information used by decision makers in selecting measurement systems, must be explicit, easy-to-understand, and straightforward.

An explicit listing of all 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 in product specs 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 all 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.

### **Further Resources:**

1. Methods of Accurately Measuring Capacitive RH Sensors by Kevin Bull, presented at 5th International Symposium on Humidity & Moisture

[www.veriteq.com/download/Methods-of-Accurately-Measuring-Capacitive-RH-Sensors.pdf](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 Spec Sheet.

[www.veriteq.com/download/datasheets/Veriteq-2000-Series-Datasheet.pdf](http://www.veriteq.com/download/datasheets/Veriteq-2000-Series-Datasheet.pdf)

### **About Kevin Bull**

Kevin Bull is the founder and CEO of Veriteq Instruments, a leading supplier of environmental monitoring, alarming and validation solutions. With 30 years' experience designing process control and measurement systems, Mr. Bull also consults on instrumentation and measurement with several major North American organizations such as the US Navy and NASA. He is committed to developing systems that improve quality, preserve assets and protect people.

### **About Veriteq**

From pharmaceutical and biotech, calibration laboratories, aerospace engineering facilities, to storage facilities for sensitive products, Veriteq provides superior monitoring, alarming, and validation systems for controlled environments. With the only system to offer gap-free data in the event of power or network failures, Veriteq provides a fail-safe solution wherever the consequences of lost or inaccurate data are unacceptable.

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