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Accuracy Specification

Digital RH&T Family

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1. Introduction

Since there is no generally accepted standard for humidity sensor specifications, the readability of relative humidity sensors often appears to be unsatisfactory. The testing of sensors based on specifications may need clarification, statements may be misleading, and the comparison among different sensors often proves to be difficult. The purpose of this document is to eliminate these uncertainties and describe the specifications of E+E humidity and temperature sensors.

This document is applicable for all digital humidity and temperature sensors from E+E Elektronik:

- HTE501
- HTE301

2. Accuracy

2.1. Calibration Accuracy

The accuracy of the humidity and temperature measurement specified in the data sheet is based on the measurement of an ensemble of sensors against an accurate reference. The dispersion of these measurement data defines the accuracy to be expected, which is made dependent on two conditions. First, it is assumed that the observed dispersion is subject to a normal distribution, and second, the uncertainties relate exclusively to a normal operating range, as shown in Figure 1.

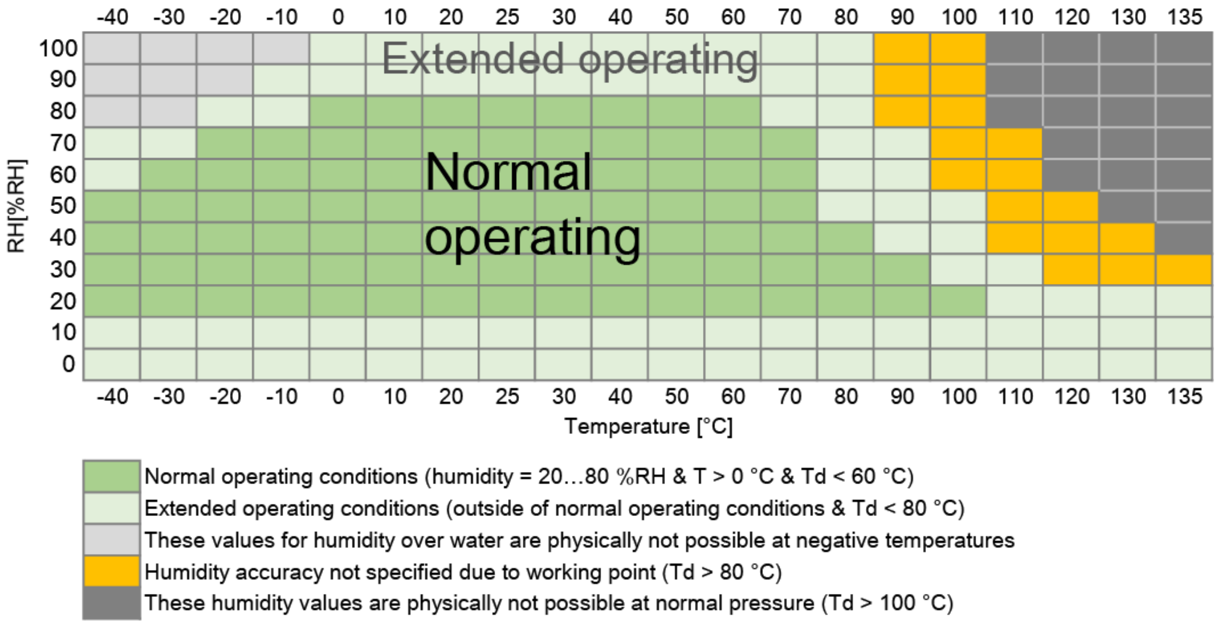


Figure 1: Definition of the operating ranges of the digital sensor elements.

The accuracy within this operating range is divided into two fields via the standard deviation σ of the normal distribution. The *typical* accuracy refers to a measured value dispersion of 2σ, i.e., more than 95% of the E+E sensor elements meet the specified accuracy. The *maximum* accuracy, on the other hand, expands the acceptable measurement field to 4σ but represents an absolute limit. All determined tolerances consider the temperature dependence of the humidity measurement and vice versa.

On the other hand, using the digital sensor elements outside the defined standard ranges for temperature and humidity can lead to deviating accuracy depending on the duration of the load.

2.2. Hysteresis Compensation

Hysteresis is an effect that applies to all polymer-based capacitive humidity sensors. It results in a delayed change in the humidity response of the sensor due to the humidity load itself. Depending on changes (duration and speed) in the ambient humidity, this effect appears to varying degrees and affects the measurement accuracy in a time-dependent manner.

All digital sensor elements from E+E Elektronik consider this effect, that means typical and maximum accuracies are understood to include hysteresis effects. An explicit consideration for the hysteresis within the humidity response is not necessary. This is possible because the internal logic of the E+E humidity and temperature sensors allows gradients in the relative humidity to be detected and recorded time dependent. This hysteresis compensation only occurs in "Periodic Measurement Mode“.

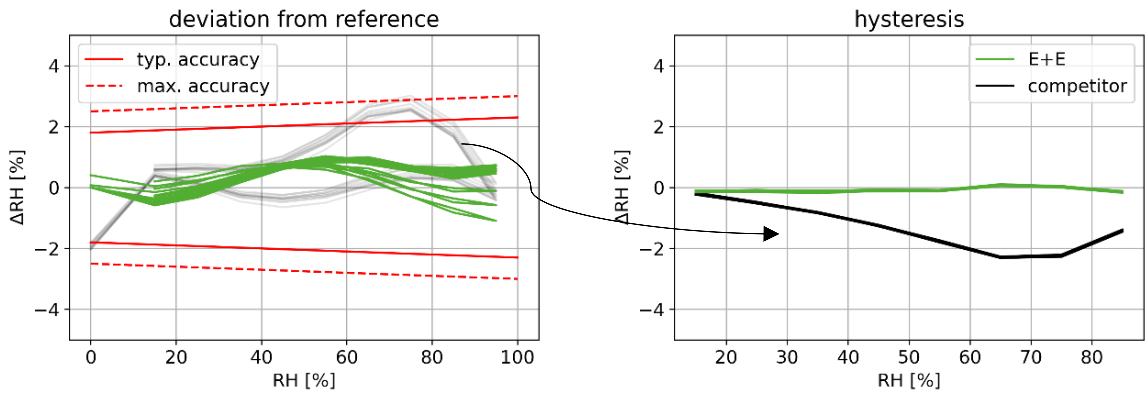
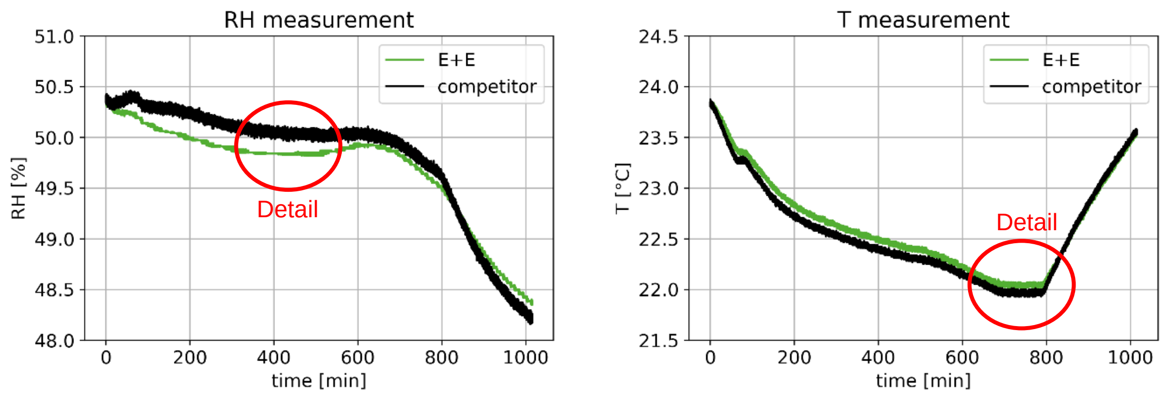


Figure 2: Deviation at relative humidity ΔRH to a defined reference (left), shown for an E+E sensor ensemble consisting of 10 sensors, at continuous change of relative humidity (0%RH → 85%RH → 20%RH). The resulting hysteresis of all sensors is also shown (right). The absence of hysteresis compensation is additionally highlighted by showing a competitor.

In Figure 2, a humidity sensor ensemble is used to demonstrate how traversing the entire humidity scale causes negligible hysteresis in all E+E sensors. This means that even after a high humidity load, measurement points can be reliably determined at low humidity. It should be emphasized that a correction of the hysteresis cannot be considered when using a SINGLE-SHOT command.

2.3. Noise

Any electrical circuit is subject to at least one thermal noise even in the hypothetical ideal case. Therefore, the measurement signal additionally reveals a dispersion of the measured value when repeatedly interrogated, which follows the individual statistics of the noise source.



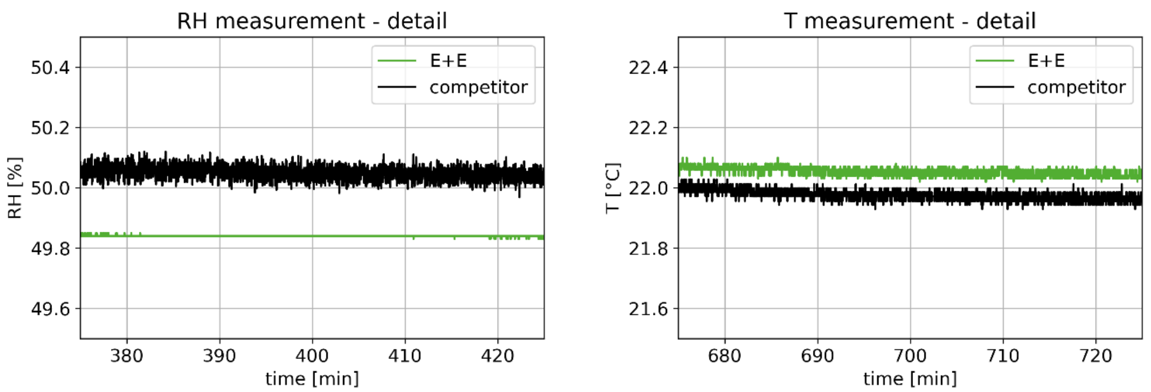


Figure 3: Humidity (left) and temperature (right) measurement noise of an E+E sensor in direct comparison with a competitor during continuous measurement for 1000 minutes under typical room conditions. A detailed image at indicated times is also shown.

E+E sensor elements convince by a suppressed noise behavior due to:

1. the high basic capacitance of the humidity capacitor and
2. temperature measurement via a semiconductor diode.

This fact is demonstratively shown in comparison to a typical competitor in Figure 3.

2.4. Long Term Drift

Long-term drift is generally specified as the change in measurement accuracy per year. Since drift values cannot be recorded directly for indefinite periods of time, the change in material properties is usually predicted by standardized load tests. For example, HTOL (High Temperature Operating Life) tests or temperature humidity loads (85°C / 85%RH) are applied in order to be able to infer the expected long-term behavior in normal operating conditions under extreme conditions (see, for example, Figure 4).

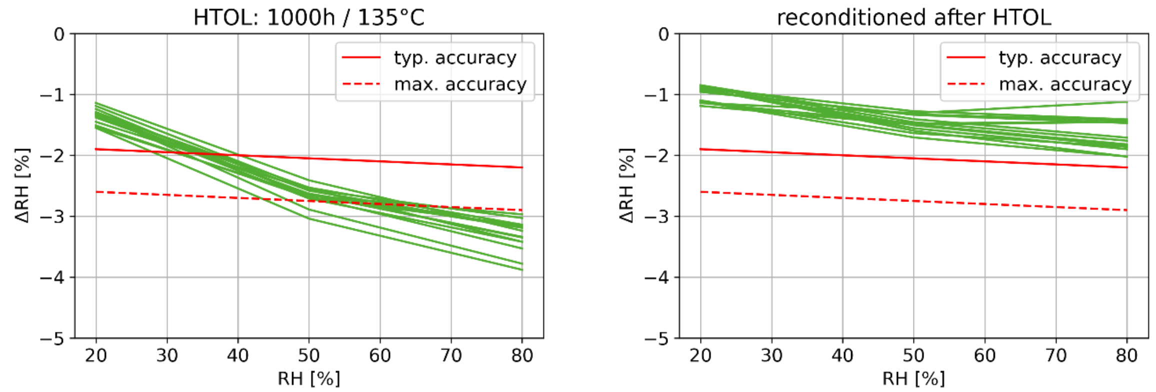


Figure 4: Display error in relative humidity ΔRH against a defined reference within the "normal operating" humidity scale of an E+E sensor ensemble consisting of 15 sensors after a HTOL test (left). The changes in sensor properties after extraordinary stress can be recovered by reconditioning and are reversible within the specification (right).

While this can be used to understand the degradation of semiconductor elements or corroding metals, these tests do not always reflect the more complex dynamics of the oxidative and hydrolytic chemistry of the humidity sensitive polymer used.

Therefore, values for long-term drift for E+E sensor elements are not only determined by accelerated aging procedures, but also represent empirical values, which are continuously verified by actual long-term outdoor (extended operation) and indoor (normal operation) tests (see corresponding data sheets for drift values per year).