

Using of Humidity Sensors in Measuring System. Actual Tendencies and Problems

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Abstract—This paper presents a condensed review of nowadays humidity sensor technology, problem implicated and some tendencies. Capacity relative humidity sensors are widely used in industrial, commercial and weather telemetry applications. Humidity capacitive sensors show an excellent long term stability, highest reproducibility of the sensor characteristic, are wet table and very resistant to pollutants. The most known and used families of humidity capacitive (HC) sensors are HC E+E Elektronik producer by JLC International. The SHTxx sensor is a chip for simultaneous measurement of relative humidity and temperature, in a multi sensor modulus with a digitally calibrated output that allows a simple and high-speed integration in the system. Considering the huge possibilities of using humidity sensors, as well as the range existing on market, it is possible to make a good selection, according to well established criteria depending on applications.

Index Terms— relative humidity, dew point, data acquisition and processing, hive internal humidity and temperature.

I. INTRODUCTION

Humidity sensors have bigger and bigger signification in various measurement environments as well in automatic conduction technology. Producers not only that improve their durability in different environments, at the same time reducing the size and the price.

The improvement of the measurement means has conditioned and allowed new discoveries in science and technique. This thing has reflected upon the achievement of some exact, quick and flexible measurement means. At present, the target is the achievement of as many facilities as possible from the measurement instruments: easy configuration and utilization, automation of measurements, flexibility, and means of quick adjustment to different lab necessities or industrial processes.

The paper presents an overview regarding new complex models of measurement system, which will include the humidity sensors. The main characteristics and classification of humidity sensors are presented below.

II. HUMIDITY SENSORS PARAMETERS

I made a classification of the humidity sensors:

Capacitive relative humidity sensors (RH) are widely used in industrial, commercial, and weather telemetry applications.

These sensors are characterized by low temperature coefficient full recovery from condensation, ability to function at high temperatures – up to 200° C, and reasonable resistance to chemical vapors. The response time ranges from 30 to 60 seconds for a 63% RH step change, [1].

Humidity measurements can be stated in a variety of terms and units. Humidity refers to the water vapor content in air or other gases. The two commonly used terms are: absolute humidity and relative humidity (RH).

Absolute humidity can be calculated from known RH, temperature, or wet bulb or it can be measured directly.

Relative humidity refers to the ratio of the moisture content of air compared to the saturated moisture level at the same pressure and temperature.

The nominal capacitance is the capacity of the sensor at a certain relative humidity, at temperature of 20 °C or 30 °C and operating frequency of 20 kHz.

Dew point is the temperature at which a given sample of moist air is saturated. The temperature dependence is the deviation in %RH per °C at different humidity and temperature values.

The humidity capacitive sensors (HC) can operate within the specified frequency limits. For best results it is recommend an operating frequency of 20 kHz.

The humidity capacitive sensors (HC) series of E+E Elektronik are capacitive humidity sensors produced in thin film technology. All humidity sensors HC show excellent long term stability, highest reproducibility of the sensor characteristic, are wet table and very resistant to pollutants. They are used in all E+E standard transmitter series. The excellent linearity enables the use of a simple, cost effective oscillator circuitry with an easy accurate calibration procedure. A capacitive humidity sensor is in fact a plate capacitor.

The most known and used families of HC E+E Elektronik humidity sensors are produced by JLC International: HC 103, HC 104, HC 105, HC 201. Working range is between 0% and 100% RH, having the linearity error less than 1.5% RH. Working range for HC 201 type is between 10% and 95% RH, having the linearity error less than 2% RH.

For example, typical applications for HC 103 type are automotive or home appliances. They present excellent measuring characteristics such as: high reproducibility of the sensor data and outstanding linearity over the whole humidity range; the temperature dependence is also highly reproducible and allows software temperature compensation. This means high accuracy over a wide temperature range, which is essential for instance to calculate dew point temperature. The dispersion of nominal capacity of HC 104 model is reduced to a minimum by a special laser to trimming process in a lot of applications. Time consuming humidity calibration is not necessary any longer, [2].

Manufacturers have lately introduced a new generation of

humidity and integrated temperature digitally and calibration sensors.

SHTxx, the new product, is a chip for simultaneous measurement of relative humidity and of temperature, in a multi-sensor modulus with a digitally calibrated output that allows a simple and high-speed integration in the system.

The SHT 10 digital humidity and temperature sensor is fully calibrated and offers excellent long term stability and ease of use at lowest cost. The sensor offer:

- Measurement range: 0 ÷ 100% RH;
- Absolute RH accuracy: $\pm 0.5^\circ\text{C} \div 25^\circ\text{C}$;
- Fast response time < 4 seconds;
- Lowest cost;
- Lower power consumption;
- Typical $30\mu\text{W}$;
- Very easy-to-use due to calibration and digital 2-

Wire interface, [3].

First digital humidity and temperature sensor, the humidity sensor SHT 11 offer:

- precise dew point calculation possible;
- absolute RH accuracy: $\pm 3\%$ RH;
- calibrated and digital output (2-Wire interface);
- designed for high-volume applications;
- two sensors on one single chip, fully calibrated and ready to use, [4]. It is use in applications: high-volume consumer products; data logging; transmitter; automation and process control; automotive; test and measurement; humidifiers and dehumidifiers; medical, etc.

Humidity and temperature sensor SHT 75 is a single chip relative and temperature multi sensor module comprising a calibrated digital output, [5].

Application of industrial CMOS processes with patented micro-machining ensures highest reliability and excellent long term stability. The device includes two calibrated micro sensors for relative humidity and temperature, which are seamlessly coupled to a 14 bit analog to digital converter and a serial interface circuit on the same chip. The advantages are: in superior signal quality, a fast response time and insensitivity to external disturbance at a very competitive price. The 2-Wire serial interface and internal voltage regulation allows easy and fast system integration. Its tiny size and low power consumption makes in the ultimate choice for even the most demanding applications.

The SHTxx is a single chip relative humidity and temperature multi sensor module comprising a calibrated digital output.

The features of the SHTxx sensors are: relative humidity and temperature sensors; fully calibrated, digital output; dew point; small size; excellent long-term stability; ultra low power consumption; no external components required; surface mountable or 4-pin fully interchangeable; automatic power down. Each SHTxx sensor is individually calibrated in a precision humidity chamber.

The sensor performance specifications are presented in figure 1:

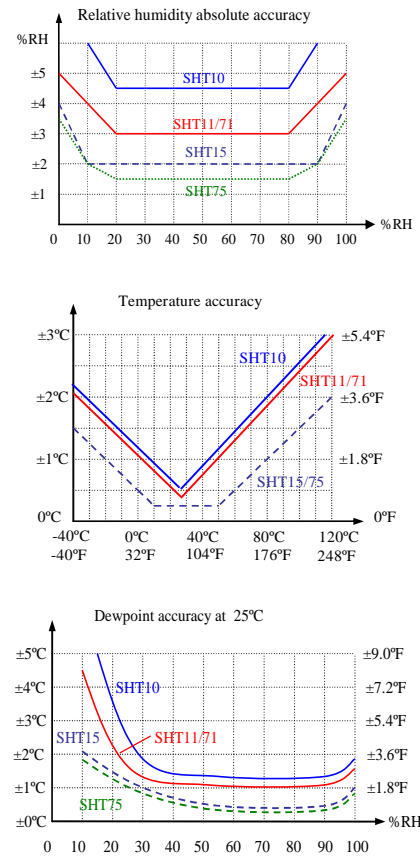


Figure 1. Relative humidity, temperature and dew point accuracies.

III. SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE SYSTEM

Humidity sensors have bigger and bigger signification in various measurement environments as well in automatic conduction technology.

Evaluation kit EK-H2 humidity and temperature, [4] – fully equipped with two sensors type SHT 11, two sensors type SHT 15, two sensors type SHT 75 and the filter cap SF1 the EK-H2 measures temperature, humidity and dew point in the same time. The filter cap provides protection against water, dust and other contaminants for the humidity and temperature sensors SHT 11 and SHT 15. It is a low cost part and very easy to use. The filter cap consists of a single piece of polypropylene including a filter membrane. It fits the outer dimensions of the SHT1x sensors and allows for compact system design. It is also serves as an adaptor for mounting the sensor directly into the wall of housing. Humidity sensors produced by Sensirion AG Company represent a new generation of fully integrated relative and temperature sensor systems with calibrated digital output. This integration of the sensor and readout circuitry on a single chip leads to an unbeatable price performance ratio and high reliability. The sensor system features combined relative humidity and temperature measurement. The linear output signal is fully calibrated and allows sensor systems to be interchanged without additional calibration. The humidity evaluation kit offers an easy-to-use environment to illustrate the unique features of the sensor system and to adapt it to specific application.

Components of evaluation kit EK-H2 are: (1) six SHTxx sensors (2 SHT 11 sensors, 2 SHT 15 sensors and 2 SHT 75

sensors) and 4 filter cap for SHT1x sensors; (2) sensor interface able; (3) serial interface able; (4) power supply; (5) microprocessor board ASD11 which include LCD and RS 232 interface; (6) Humiview V3 software on CD; (7) Palm software on CD (Palm III and Palm IV); (8) adapter. They are show in figure 2:



Figure 2. Components of evaluation kit EK-H2.

With the ASD11 microprocessor board, the digital output signal of the SHTxx is recorded and adjusted for non-linearity and temperature dependency.

Another kit for evaluation of humidity and temperature for SHTxx sensors is EK-H3. With evaluation kit EK-H3, it is can easily and cost-effectively record the measurement values of up to 20 digital humidity and temperature sensors. The benefits are twofold thanks to the plug-and-play functionality. First, it is can then evaluate these results in a user friendly way in any standard computer. MultiHumiview software was developing especially for the EK-H3 kit allows the simultaneous measurement for all 20 sensors and records the three parameters of relative humidity, temperature and dew point for each individual sensor. The pluggable SHT75 high-end sensors of the CMOSens® series - measurement accuracy $\pm 1.8\%$ RH, $\pm 0.3^{\circ}\text{C}$ - guarantee high precision measurements with excellent long term stability even under the harshest test conditions, such as those in the automotive industry, building automation, or in laboratory and testing applications.

The features of the evaluation EK-H3 are: parallel logging of up to 20 humidity and temperature sensors; evaluation of measurement data on standard computer by special software; logging of three parameters for each sensor: relative humidity, temperature and dew point; humidity and temperature SHT 75 sensors with accuracy ± 1.8 RH; complete multi-logging system plug-and-play; simple measurement configuration on the computer; very simple off-line post-processing with any program.

Sensirion Company provides a data logging equipment suitable for all applications, where precise, easy-to-handle and simultaneous data logging of humidity and temperature is needed. The system consists of dedicated hard- and software. Up to 20 SHT 75 devices can be plugged into the EK-H3 logger and observed simultaneously.

The EK-H3 logger itself is connected to the serial port of a Personal Computer. Dedicated software allows the user to visualize the humidity, temperature and (calculated) dew points of each individual sensor. The EK-H3 is no stand-alone data logger. The EK-H3 runs only in conjunction with a personal computer, figure 3.

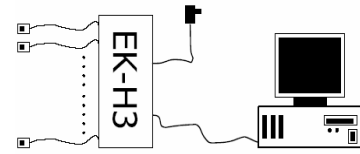


Figure 3. Typical measurement set-up with the EK-H3.

Contents of EK-H3:

- EK-H3
- Multi Humi-Viewer Software
- 20 CMOSens® humidity & temperature sensmitters - model SHT75, 2% accuracy
- 20 cables with RJ45 connectors, length 3m (10ft)
- Power supply (suitable for 100V-240V)
- RS-232 connector cable to PC for data readout
- American plug

A maximum of 20 SHT devices can be connected to the multi sensor board. The board requires a 4.5 V to 5 V power supply. A RS-232 serial cable to a Personal Computer enables data transmission.

The comfort index factors in the temperature at midday, humidity and wind speed to determine a comfort factor. This index is useful for people traveling to places with climates they aren't used to. The comfort zones also indicate what precautionary measures, if any, are recommended to protect you from prolonged exposure to the outdoors. Numerous indices have been developed over the years that give a measure of human physical comfort as it relates to weather conditions.

There are six factors that influence how a person will feel when going outside. They are sunlight, wind, evaporation cooling, temperature, humidity and clothing. The combination of these six factors determines whether a person feels cold, warm, comfortable or uncomfortable.

In figure 3 is present a measurement system of comfort index. The system includes:

- a digital humidity and temperature sensor SHT 11 type;
- a signal conditioning system (SCS);
- a Pentium 800 MHz (PC);
- a power supply (PS) ;
- a liquid-crystal display (LCD).

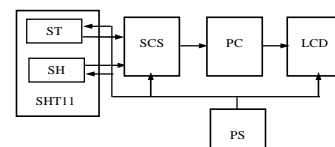


Figure 4. The measurement system of comfort index.

In order to measure the temperature, relative humidity and dew point the SHT11 product has been adapted.

IV. CONCLUSION

In this paper I presented a condensed review of nowadays of development of humidity sensors. The utilization of such up-to-date essential elements in any technical system is compulsory and followed by technical advantages and a better management.

Capacitive sensors provide wide RH range and condensation tolerance, and if laser trimmed are also

interchangeable. Considering the huge possibilities of using humidity sensors, as well as the range existing on market, it is possible to make a good selection, according to well established criteria depending on applications.

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