New generation of humidity sensors, several methods for the measurements

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Abstract ***–In today's age of automation and control, humidity sensors are gaining more and more significance in diverse areas of measurement and control technology.***
In addition to an interest on sensor properties, such as accuracy and long-term drift, it is now also focused on durability in different environments, component size, digitization, simple and quick system integration, and last but not least, price.
The paper presents several methods for the measurement of humidity, comfort index using the new generation of the humidity sensors SHT xx sensors.
The SHT xx is a new generation of completely integrated, digital, and calibrated humidity and temperature sensors.
The factors that have relevant influence on the comfort index of occupant's spaces can be grouped in environmental and personal factors. Environmental factors: temperature, thermal radiation, humidity, air speed. Personal factors: activity, clothing.
The use of a combined humidity and temperature sensor can greatly enhance the well being of persons in indoor environments, since it is scientifically approved, that there exists a comfort zone defined by various factors, but mainly determined by humidity and temperature.

Keywords: ***comfort index, humidity sensors SHT xx, measurements, data acquisition and processing.***

I. PRESENT BACKGROUND

Humidity sensors represent a new generation of fully integrated relative humidity 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. Additionally, the sensor system features combine relative humidity and temperature measurement. Its digital output provides simple access to the sensor signal – plug and play. The linear output signal is fully calibrated and allows sensor systems to be interchanged without additional calibration.
The hardware which is included supports all humidity sensors were developed for evaluation and reference design.

New generation of humidity sensors - In today's age of automation and control, humidity sensors are gaining more and more significance in diverse areas of measurement and control technology. In addition to an interest on sensor properties, such as accuracy and long-term drift, it is now also focused on durability in different environments, component size, digitization, simple and quick system integration, and last but not least, price.
In order to be able to integrate all these demands into one sensor, completely new technology is required. The phrase "intelligent sensor" is gaining more and more meaning.
In addition to the resistive method, the capacitive measurement principle, above all, established and proved itself as a standard in the past. For this principle, the sensor element is built out of a film capacitor on different substrates - glass, ceramic, etc. The dielectric is a polymer which absorbs or releases water proportional to the relative environmental humidity, and thus changes the capacitance of the capacitor. This change in capacitance can be measured by an electronic circuit. This allows the relative air humidity to be determined.
Weaknesses of capacitive analog systems are:
•Poor long-term stability - As humidity sensors are exposed to certain external influences.
•Complicated calibration - Before use, capacitive humidity sensors must undergo a complicated calibration process. The end user must have complex and expensive calibration and reference systems, as well as external electronic components, such as memory components.
• Analog technology: Additional problems arise directly from the analog measurement principle, which links, e.g., the stability of the operating voltage inseparably to the sensor accuracy. This problem can only be counteracted by increased spending on electronics and inevitably leads to higher integration costs.
New generation based on CMOSens® Technology - combined CMOS Chip Technology with Sensor Technology and released undreamed-of synergy with this new standard. The result is a highly integrated and extremely small humidity sensor.
A "micro-machined" finger electrode system with different protective and polymer cover layers forms the capacitance for the sensor chip, and, in addition to providing the sensor property, simultaneously protects the sensor from interference in ways previously not achieved. Total coverage with condensation or even immersion in liquid

present no problems whatsoever. The temperature sensor and the humidity sensor together form a single unit. This also enables an accurate and point-precise determination of the dew point, without incurring errors due to temperature gradients between the humidity and the temperature sensors. The advantages of such a system are obvious:
-The signal amplification near the sensor allows the polymer layers to be optimized not for the signal strengths, but rather for long-term stability, which is significant for numerous applications
-The analog-to-digital conversion, which is also performed "in place," makes the signal extremely insensitive to noise
-A checksum generated by the chip itself is used for additional reliability
-the calibration data loaded on the sensor chip guarantees humidity sensors have identical specifications and thus they can be replaced 100%
-the very short response times: 4 sec at 1/e, high precision: 1.8% to 4.5% according to configuration
-Very low power consumption: < 0.3µA standby
-The sensor chip can be connected directly to any microprocessor system by means of the digital 2-wire interface, which minimizes the system development times, saves costs, and leads to a significant advantage, especially for high-volume applications.
The main applications of the SHT xx sensors are:

- heating, ventilation and air-conditioning technology (HVAC): intelligent building controls
- measurement and control technology: high precision sensor module for "smart" transmitters
- Automation and process control
- Automotive: digital, SMD-capable air-conditioning sensor modules
- Data logging: integration within the smallest space
- Consumer Electronics

II. SCIENTIFIC AND TECHNICAL DESCRIPTION OF THE SYSTEMS

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

A. Humidity and temperature sensmitter SHTxx trough serial RS 232

Application of industrial CMOS processes with patented micro-machining CMOSens® technology ensures highest reliability and excellent long term stability. The 2-wire serial interface and internal voltage regulation allows easy and fast system integration. Its tiny size and low power consumption makes it the ultimate choice for even the most demanding applications.
In figure 1 is present a measurement system. The system includes:

- A computer;
- MAX 232;
- Microcontroller type 89S51;

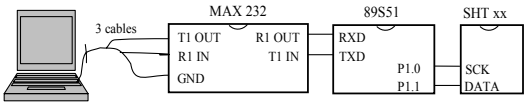

Fig.1: The measurement system

- A digital humidity and temperature sensor SHT xx.

It includes code for:
• Readout of humidity (RH) or temperature (T) from SHT xx with basic error handling;
• Calculation of RH linearization and temperature compensation;
• Access to status register;
• Dew point calculation from RH and T;
• UART handling (to send the final data away, to a PC).
The MAX 232 type of line drivers/receivers is intended for all EIA/TIA-232E and V.28/V.24 communications interfaces, particularly applications where ±12V is not available, [1].
These parts are especially useful in battery-powered systems, since their low-power shutdown mode reduces power dissipation to less than 5µW.
The applications of the MAX 232 are:

- Portable Computers
- Low-Power Modems
- Interface Translation
- Battery-Powered RS-232 Systems
- Multidrop RS-232 Networks

The MAX 232 contain the following sections:

- Dual charge-pump DC-DC voltage converters. The MAX 232 have two internal charge-pumps that convert +5V to ±10V (unloaded) for RS-232 driver operation;
- RS-232 drivers - The typical driver output voltage swing is ±8V when loaded with a nominal 5kΩ RS-232 receiver and VCC = +5V
- RS-232 receivers. The receiver input hysteresis is typically 0.5V with a guaranteed minimum of 0.2V. This produces clear output transitions with slow-moving input signals, even with moderate amounts of noise and ringing. The receiver propagation delay is typically 600ns and is independent of input swing direction.

"The great thing about standards is there are so many to choose from."
Perhaps the most successful serial-data standard for PC and telecom applications is the RS-232.

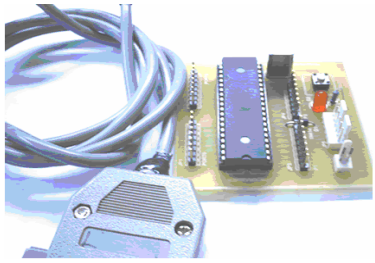
Fig.2: The microcontroller 89S51 type

The microcontroller programmer and target 89S51: is ready to run with Atmel programmer will program AT89S51, AT89S52, AT89S53, and AT89S8252; is easy to use Windows Programming software that is included; connects to standard computer parallel port and includes connection cable. The microcontroller works from a 5Vdc power source, [2].
The features of the microcontroller are:

- programs most MCS-51 AT series microcontrollers
- small and lightweight unit
- Windows Software included
- connects to standard Computer Parallel/ LPT Port
- all I/O pins connected to headers for easy external connections.
- download Software and Sample Code included
- circuit schematic included

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

- precise dew point calculation possible;
- absolute RH accuracy: ± 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, [3].

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, [4].
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.

Fig. 3: The SHT 1x and SHT 7x humidity sensors

B. The measurement of comfort index

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.
All the six factors mentioned go into determining how a person will feel.
The combination of all these factors is so complex that no formula using all these factors has been developed. The two that are commonly used today are the wind chill and heat index. Wind chill considers wind and temperature while the heat index considers heat and humidity. These two indices do not take into account several other factors that determine how one will feel. The heat index does not consider wind and direct sunlight.
In summary, if you feel cold you can step into the sunlight, reduce the wind, increase the temperature, increase the humidity, and increase clothing. If you feel hot, you can step out of direct sunlight, increase the wind, decrease the temperature, decrease the humidity and take off clothes.
The temperature in the occupant's space should be:

- winter: 20÷24ºC;
- summer: 23÷26ºC.

The relative humidity shall be between 30% and 70% in winter as well as summer time. The limits are set to decrease the risk of unpleasantly wet or dry skin, eye irritation, static electricity, microbial growth and respiratory diseases. The diagram of the comfort zone is shown in figure 4.
In figure 5 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).

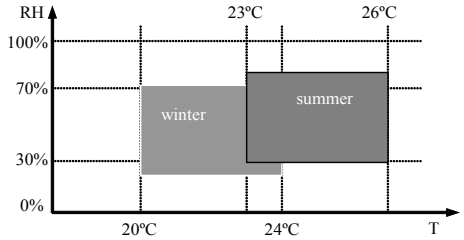

Fig.4: RH/T diagram – the comfort zone

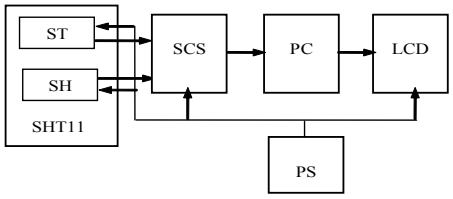

Fig.5: The measurement system of comfort index

The use of a combined humidity and temperature sensor can greatly enhance the well being of persons in indoor environments, since it is scientifically approved, that there exists a comfort zone defined by various factors, but mainly determined by humidity and temperature. There's also an environmental and financial aspect in using humidity sensors in HVAC applications, since power and money can be saved compared to simple temperature-only control systems. Sensirion's SHTxx series of humidity and temperature sensors are an excellent choice to meet the requirements in HVAC applications in homes, commercial buildings or other indoor environments such as cars.
In order to measure the temperature, relative humidity and dew point the SHT11 product has been adapted.

III. CONCLUSIONS

In today's age of automation and control, humidity sensors are gaining more and more significance in diverse areas of measurement and control technology.
In addition to an interest on sensor properties, such as accuracy and long-term drift, it is now also focused on durability in different environments, component size, digitization, simple and quick system integration, and last but not least, price.

The paper presents several methods for the measurement of humidity, comfort index using the new generation of the humidity sensors SHT xx sensors.
SHT xx is a new generation of completely integrated, digital, and calibrated humidity and temperature sensors. It comes from the factory in a tiny package that incorporates a precision analog to digital interface and an identical unit to unit calibration.
All that a microcontroller has to do is read out the humidity and temperature values, via the two-sire digital serial interface. The only math required is a simple and offset and temperature compensation.
The use of a combined humidity and temperature sensor can greatly enhance the well being of persons in indoor environments, since it is scientifically approved, that there exists a comfort zone defined by various factors, but mainly determined by humidity and temperature.

REFERENCES

[1] " MAX 220 – 249, Maxim Integrated Products. +5V-Powered, Multichannel RS-232 Drivers/Receivers", http://www.maxim-ic.com
[2] "Microcontroller Kits: Programmer and Target 89S51", http://www.sensirion.com
[3] "Humidity sensor SHT 11: First digital humidity & temperature sensor", http:// www.sensirion.com
[4] "SHT 1x/ SHT 7x Humidity & Temperature Sensor: Data Sheet", http://www.sensirion.com