Humidity Sensing

Introduction

Humidity, the presence of moisture in the air, is an important physical parameter in many industrial and commercial applications. For example, it is a key factor in determining the lifetime of perishable foodstuffs during storage and transportation. The amount of humidity strongly influences the rate of various industrial processes. The level of humidity in an environmental surrounding also affects human comfort levels and its measurement is therefore an important element in environmental control.

There are various measurements of humidity, for example

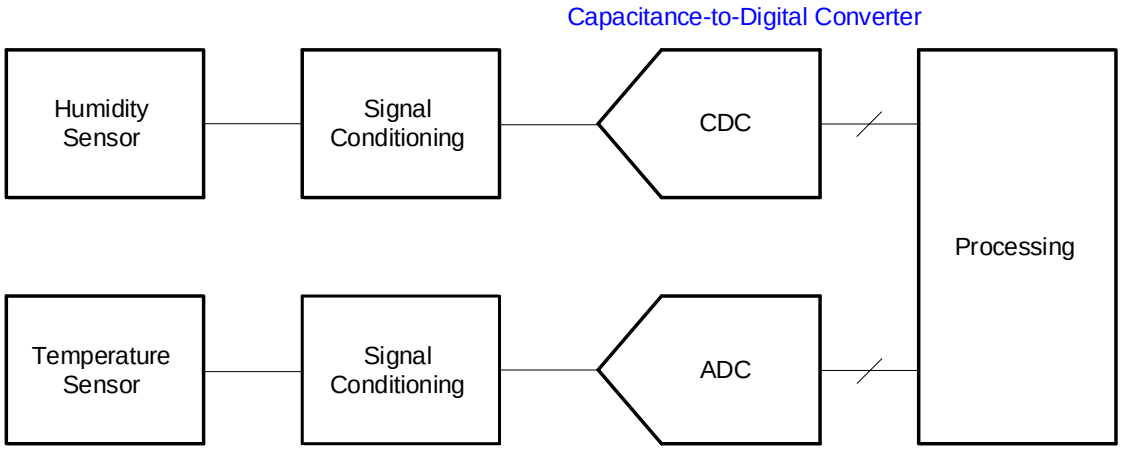
- absolute humidity, the amount of water vapour in the air
- specific humidity, the weight of water vapour contained in a unit weight (amount) of air
- relative humidity (RH), the amount of water vapour in the air relative to the maximum possible amount that could be in the air at that temperature. Relative humidity depends on temperature and pressure and is a key humidity metric in applications.

Relative humidity sensors

Relative humidity sensors usually rely on a variation of impedance. While resistive sensors exist, most sensors use a variation in capacitance with relative humidity. These sensors feature a hygroscopic polymer dielectric material whose dielectric constant increases as water is absorbed from the atmosphere. There exists then a direct relationship between the relative humidity and the capacitance of the sensor. The measurement of this capacitance, or more significantly its variation, allows the relative humidity to be estimated.

Capacitance to Digital converters (CDC)

The digitisation of the humidity sensor information is key to its use in humidity control applications. Making the measured humidity sensor capacitance data available for processing in a control system requires the use of a Capacitance-to-Digital Converter (CDC). Examples of CDCs include charge balancing ADCs based on sigma delta ADCs, charge amplifiers with ADCs and time-to-digital converters (TDCs). Each of these approaches requires its own signal conditioning and may require input range scaling to the sensor capacitance. In addition, it is critical in these approaches to account for the parasitic capacitance of the wires attaching the sensor to the measuring electronics and the variation of this capacitance.

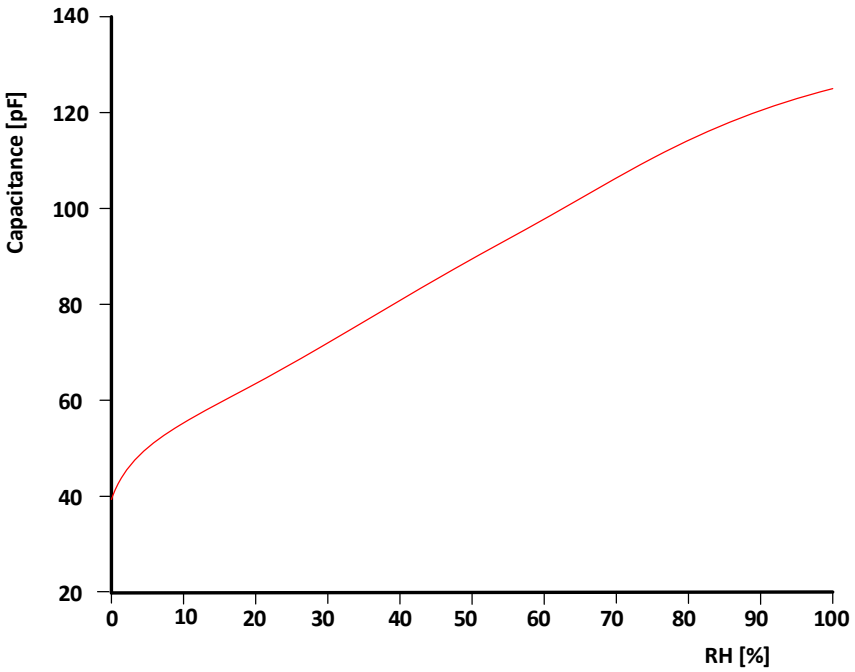


Humidity measurements

The estimation of relative humidity from sensor capacitance is dependent on the particular sensor and requires careful consideration. The relationship between sensor capacitance and relative humidity is not linear and necessitates calibration to improve accuracy. The sensor needs to be calibrated in a humidity-controlled environment and an estimation of the sensitivity made in terms of the change in capacitance for a given change in RH. The input range of the CDC needs to cover both the sensor bulk capacitance and the total change in capacitance over the full RH range.

As the hygroscopic properties of the sensor vary with temperature, some correction for the temperature-dependent change in the sensor dielectric is required for accurate humidity measurement. Therefore, a temperature sensor is also required in the system and the RH reading must be adjusted to account for temperature according to the data supplied by the sensor manufacturer. It is critical that the temperature is measured local to the humidity sensor. Often the humidity sensor and temperature sensor are sold as a single module.

Humidity sensors are also affected by hysteresis, giving higher readings of humidity in high humidity environments. It is difficult to eliminate this error but it can generally be minimised by post-processing humidity measurements and corresponding temperature data.



Adesto Humidity Measurement Solutions

Adesto's ASIC & IP division humidity measurement reference design can be readily incorporated into an SoC. The key constituent element is the S3AD01M16BGF65LPE, which a silicon proven high precision ADC consisting of a second order (Σ-Δ or charge balancing) modulator and a third order digital filter. It works as a CDC for the capacitive inputs and as a classic ADC for the voltage input or for the voltage from a temperature sensor. All other elements of the signal path, such as the signal conditioning and digital filtering can be readily integrated with the converters on a single SmartEdge™ ASIC. No more need for discrete components to build that humidity sensor.