



Brandon Fisher

## ABSTRACT

Humidity sensors are unique electronic components because their sensing elements must be exposed to the environment in order to sense the environment's humidity level. Whether their sensing elements are based on resistive or capacitive technology, the sensors' accuracy could potentially degrade or damage could occur to the sensor itself if they are not properly protected. For this reason, there are different protective covers available for humidity sensing components.

This application report discusses the different mechanical protective options available to humidity sensing devices and the nature of these protective covers. This discussion is specific to integrated, capacitive-based humidity sensors which are not only cost-effective and compact, but also known to have much higher accuracy and superior sensitivity compared to resistive-based humidity sensors.

These integrated, capacitive-based sensors are also available in a single integrated circuit, which can help reduce bill of material costs and system complexity. These humidity sensors are not only capable of measuring relative humidity but also temperature. The humidity and temperature values measured are converted to a digital value, so no calibration is required. The types of humidity sensors that will be discussed are standard humidity sensors, removable protective tape, and permanent cover.

---

## Table of Contents

<b>1 Standard Humidity Sensors</b> .....	2
1.1 Removable Tape Humidity Sensors.....	3
1.2 Permanent Cover Humidity Sensors.....	3
<b>2 References</b> .....	4

## List of Figures

Figure 1-1. HDC2080 (left) and HDC2010 (right) Packages.....	2
Figure 1-2. Capacitive Humidity Sensing Element.....	2
Figure 1-3. Internal Block Diagram of HDC2.....	2
Figure 1-4. Removable Protective Cover.....	3
Figure 1-5. Permanent Protective Cover.....	3

## Trademarks

All trademarks are the property of their respective owners.

## 1 Standard Humidity Sensors

Figure 1-1 shows two [standard humidity sensor](#) components whose sensing elements are exposed on the top (HDC2080) and on the bottom (HDC2010). These sensors have integrated ADCs and are designed to accurately and reliably measure and output the percentage relative humidity (%RH) and temperature data on an I2C-bus.

The capacitive sensing element is composed of a moisture-sensitive polymer as a dielectric and comb metal structure as the capacitance's electrodes. A change in humidity correlates with the capacitance change with the entire sensing element structure is integrated on a top layer of a standard CMOS technology process. The capacitance value is converted to analog output voltage that is fed to the ADC and the proprietary linearization engine, and as a result, the percent RH value is computed and output is consistent, predictable, and accurate.

The sensor dielectric's polymer is generally dust resistant and excellent for any normal environmental sensing application imaginable. As always with an exposed cavity, care must be taken during the assembly process because the polymer can be damaged by chemical or assembly cleaning and the scrubbing process.

### Note

Humidity sensors require additional storage and handling guidelines that must be followed. More information is available in our [HDC20xx Silicon User's Guide](#).

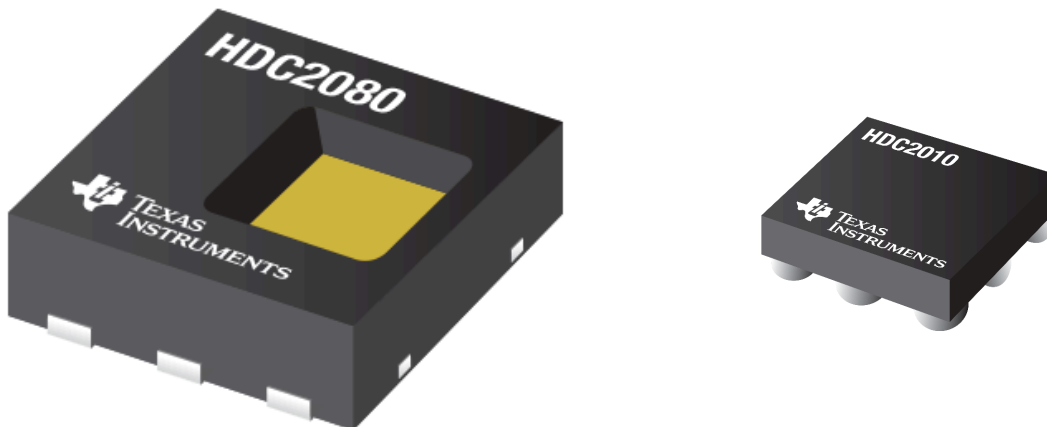


Figure 1-1. HDC2080 (left) and HDC2010 (right) Packages

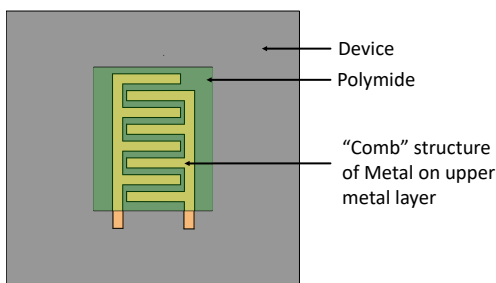


Figure 1-2. Capacitive Humidity Sensing Element

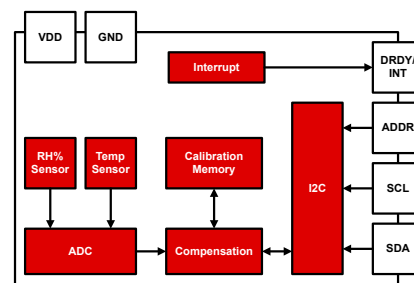


Figure 1-3. Internal Block Diagram of HDC2

## 1.1 Removable Tape Humidity Sensors

A removable protective cover is a thin polyimide tape that covers over the entire surface of the humidity sensing component. It is a shield for temporary protection of the sensing element from contaminants, and should be removed before being used. This cover can protect against pollution during the PCB cleaning and scrubbing process, hence allowing this component to go through a normal PCB wash process without damaging the sensor.

This protective cover also protects the sensor during a conformal coating or potting for such application as a humidity module where other components and PCB solder joints need to be shielded from long term harsh environmental exposure. The protective cover is robust and designed to withstand multiple reflow soldering cycles. It comes with an adhesive-free tab that is easily peeled off at the end of the assembly process, by either using tweezers or another piece of polyimide tape. [Figure 1-4](#) depicts a [humidity sensor with a removable protective cover](#), the HDC2021, which is pin- and software- compatible with the HDC2080.

---

### Note

- Without this removable protective cover, PCB cleaning wash must be avoided.
  - Humidity sensors require additional storage and handling guidelines that must be followed. More information is available in our [HDC20xx Silicon User's Guide](#).
- 

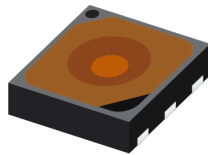


Figure 1-4. Removable Protective Cover

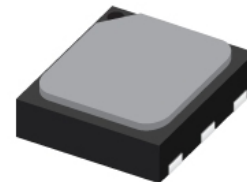


Figure 1-5. Permanent Protective Cover

## 1.2 Permanent Cover Humidity Sensors

A permanent cover is made of hydrophobic microporous PTFE membrane to protect against water and dust according to IP67 specification, and is designed to stay on the package over the product lifetime. This protective cover has a filtration of up to 99.99% efficiency filtering particle sizes down to 100nm. In addition to being water and dust proof per IP67, this PTFE material has extremely high-durability and low-friction to repel water, condensation droplets and debris, while maintaining sensor response time, making it most suitable for outdoor use and rugged environment applications. [Figure 1-5](#) depicts a [humidity sensor with a permanent protective cover](#), the HDC2022, which is pin- and software- compatible with HDC2080 and HDC2021.

Most applications can use non-protective cover humidity sensors because of its robust polymer sensing element. Also, all these sensors are based on the same core and inherently offer some of the lowest power consumption with high and consistent accuracy in the market. If an assembly line cannot provide special flow for standard humidity sensors or a sealed humidity sensing module is desired, then a removable protective cover humidity sensor, like the HDC2021 would be an excellent option. For outdoor use or harsh environment usage, where condensation is likely to occur or volatile organic compounds (VOCs) may be present, the HDC2022 would be the best choice.

---

### Note

Humidity sensors require additional storage and handling guidelines that must be followed. More information is available in our [HDC20xx Silicon User's Guide](#).

---

## 2 References

- Texas Instruments, [HDC20xx Silicon User's Guide](#)
- Texas Instruments, [HDC2010 Low-Power Humidity and Temperature Digital Sensors data sheet](#)
- Texas Instruments, [HDC2080 Low-Power Humidity and Temperature Digital Sensors data sheet](#)
- Texas Instruments, [HDC2022 High-Accuracy, Low-Power Humidity and Temperature Sensor with IP67 Rated Water and Dust Protection Cover data sheet](#)
- Texas Instruments, [HDC2021 High-Accuracy, Low-Power Humidity and Temperature Sensor with Assembly Protection Cover data sheet](#)

## IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATASHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES "AS IS" AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, or other requirements. These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI's products are provided subject to TI's Terms of Sale (<https://www.ti.com/legal/termsofsale.html>) or other applicable terms available either on [ti.com](https://www.ti.com) or provided in conjunction with such TI products. TI's provision of these resources does not expand or otherwise alter TI's applicable warranties or warranty disclaimers for TI products.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265  
Copyright © 2021, Texas Instruments Incorporated