Humidity Sensor Comparison Guide

Relative Humidity (RH) sensors play a critical role in modern systems where precise environmental sensing underpins performance, safety, and longevity. These sensors measure the presence of water vapor in the air to provide host systems critical information regarding the ambient conditions. As industries incorporate more technologies to safeguard equipment, humidity sensing has become foundational across diverse applications—ensuring optimal thermal balance in data centers, safeguarding machinery in industrial automation, protecting sensitive battery systems in electric vehicles, and enabling resilient smart infrastructure. This product overview aims to provide an informative overview of TI's current portfolio of humidity sensors. All TI RH sensors include an integrated temperature sensing and heater element. Figure 1 illustrates a simplified construction of TI's capacitive RH sensors, while Figure 2 provides an overview of all featured RH sensor's in TI's portfolio.

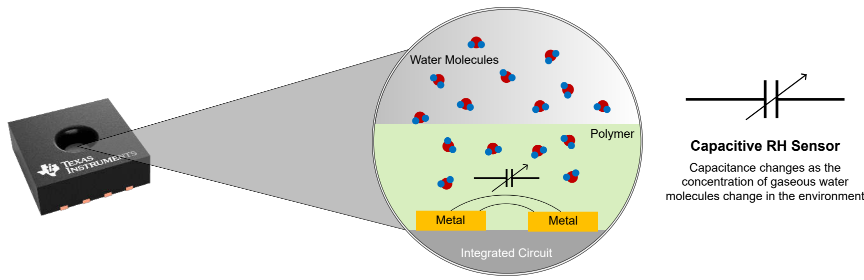

Figure 1. Simplified Construction of Capacitive RH Sensors

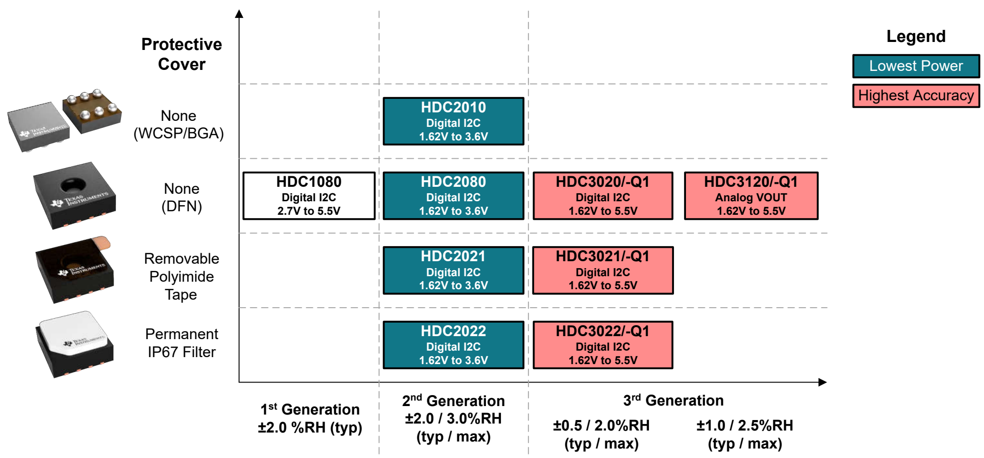

Figure 2. Featured Humidity Sensors

- HDC3x devices have the highest %RH Long-Term Drift performance, accuracy, and are NIST traceable.
- HDC2x devices feature the lowest power with 50nA sleep, and 0.55µA average current.
- HDC2010 is the smallest, most cost-effective RH sensor at 1.5 × 1.5mm in a WCSP package.
- HDC3120 is TI's first analog output humidity sensor, featuring a ratiometric output voltage.
- HDC3x and HDC2x devices offer protective cover options: removable tape or an IP67 filter.
- Automotive-grade Q100 and functional safety-capable:
  - Digital: HDC3020-Q1, HDC3021-Q1 (Tape), HDC3022-Q1 (IP67)
  - Analog: HDC3120-Q1

Key Specifications Comparison For TI Humidity Sensors

Table 1 provides a comparison of key specifications of all humidity sensors currently offered by Texas Instruments.

Table 1. Key Specifications Comparison For TI Humidity Sensors

Device	Cover	Interface	%RH Accuracy (Typical)	RH Response $\tau_{63\%}$	Temp Accuracy (Typical)	Area (x × y)	Supply Range	Avg. Current (Typical)	Sleep Current (Typical)	Auto Q100	NIST	Alert Pin	CRC
HDC3020	—	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	—	Yes	Yes	Yes
HDC3020-Q1	—	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	Yes	Yes	Yes	Yes
HDC3021	Tape	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	—	Yes	Yes	Yes
HDC3021-Q1	Tape	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	Yes	Yes	Yes	Yes
HDC3022	IP67	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	—	Yes	Yes	Yes
HDC3022-Q1	IP67	I2C	±0.5 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	0.9µA	0.36µA	Yes	Yes	Yes	Yes
HDC3120	—	Analog	±1.0 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	250µA	50µA	—	Yes	—	—
HDC3120-Q1	—	Analog	±1.0 %RH	4s	±0.1°C	2.5 × 2.5mm	1.62V to 5.5V	250µA	50µA	Yes	Yes	—	—
HDC2080	—	I2C	±2.0 %RH	8s	±0.15°C	3.0 × 3.0mm	1.62V to 3.6V	0.33µA	0.05µA	—	—	Yes	—
HDC2021	Tape	I2C	±2.0 %RH	8s	±0.15°C	3.0 × 3.0mm	1.62V to 3.6V	0.33µA	0.05µA	—	—	Yes	—
HDC2022	IP67	I2C	±2.0 %RH	8s	±0.15°C	3.0 × 3.0mm	1.62V to 3.6V	0.33µA	0.05µA	—	—	Yes	—
HDC2010	—	I2C	±2.0 %RH	8s	±0.15°C	1.5 × 1.5mm	1.62V to 3.6V	0.33µA	0.05µA	—	—	Yes	—
HDC1080	—	I2C	±2.0 %RH	15s	±0.15°C	3.0 × 3.0mm	2.7V to 5.5V	1.3µA	0.1µA	—	—	—	—
RH Typical Range: 20-50%RH | Temperature Typical: 30°C													

Humidity Sensor Protective Cover Options

Unlike most ICs, RH sensors have an open cavity which directly exposes the polymer-based sensor directly to ambient air. This results in unique considerations, including protecting the sensor from liquids, particulates, process chemistry (flux, conformal coatings, and potting), and debris. Protective options include:

- **Removable Kapton™ Polyimide Tape**: Protects the sensor during manufacturing and assembly—often used during conformal coating, potting, and/or PCB wash steps. Tape must be removed before use.
- **IP67 ePTFE Membrane**: Permanent—provides protection both during manufacturing (example, PCB wash) and end-application. Membrane shields sensing element from dust, liquid, and light while allowing water vapor to pass. IP67-rated, waterproof up to 1 meter. Not intended to protect from gaseous contaminants.
- **Bottom-Side Sensor**: Sensor located on the under-belly of the device, typically facing the PCB. This sensor placement limits exposure to dust and debris.

A conceptual cross-section of all available TI protective cover options is shown in Figure 3.

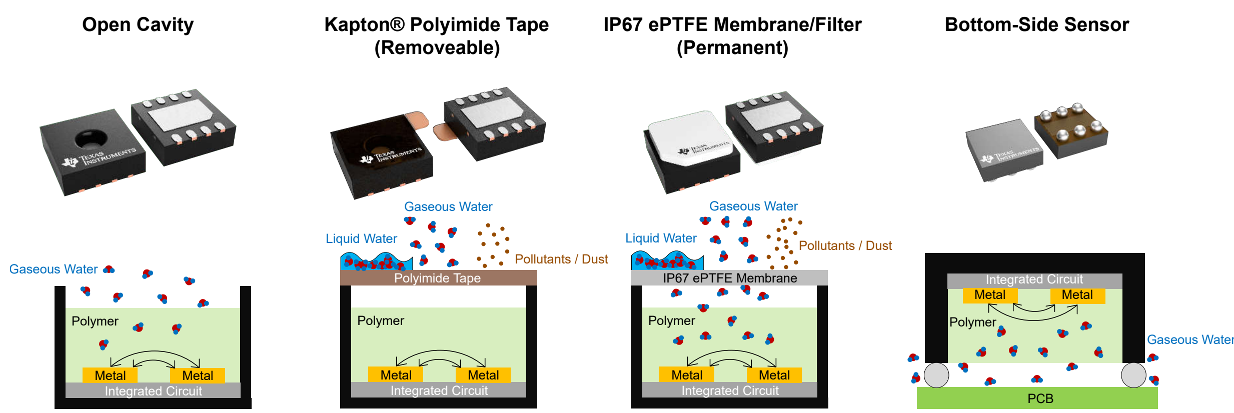

Figure 3. Humidity Sensors: Protective Cover Conceptual Cross-Section

PCB Footprint Comparison

Figure 4 provides a visual representation of the different package sizes of TI's humidity sensors.

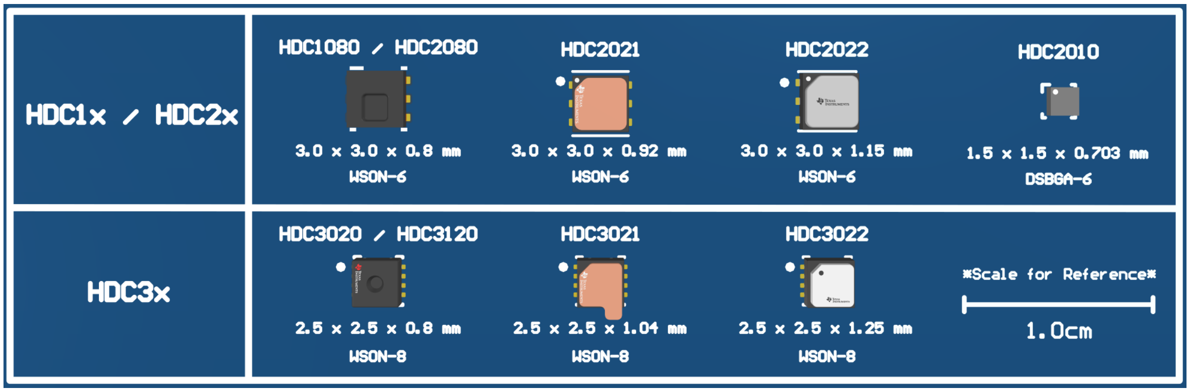

Figure 4. Humidity Sensor Size Comparison

Humidity and Temperature Accuracy Performance Comparison

The typical Relative Humidity (RH) performance for all featured sensors is shown in Figure 5, and the maximum RH performance is shown in Figure 6. Typical temperature accuracy performance for TI humidity sensors is presented in Figure 7, while Figure 8 shows the maximum temperature accuracy performance.

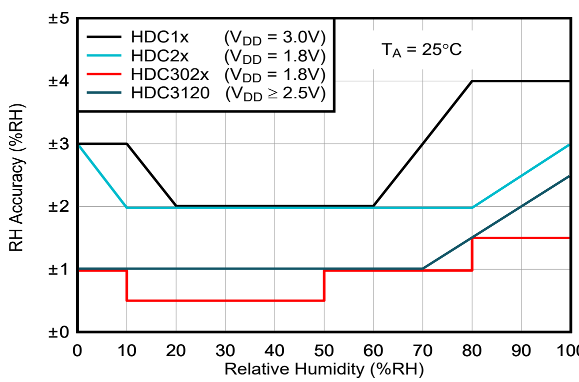

Figure 5. Typical %RH Accuracy

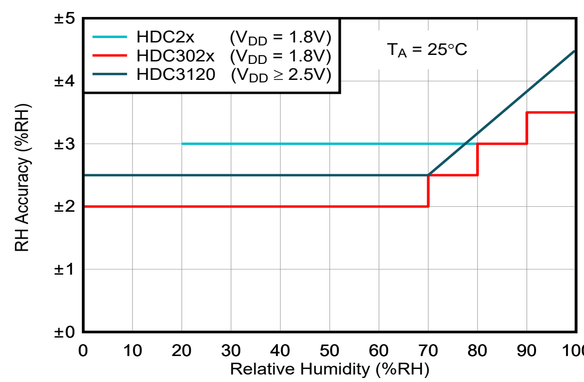

Figure 6. Maximum %RH Accuracy

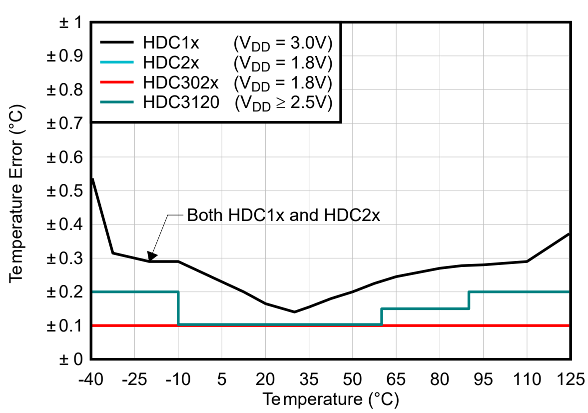

Figure 7. Typical Temperature Accuracy

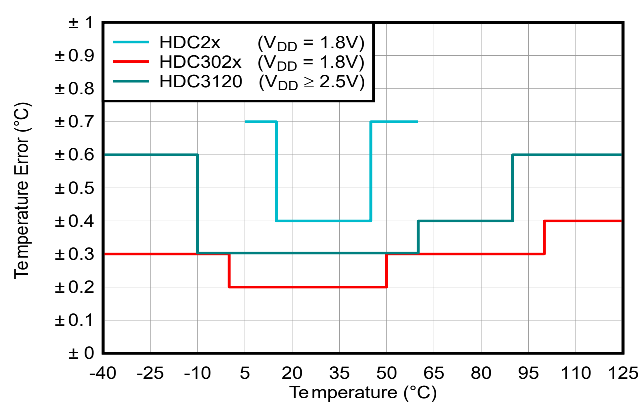

Figure 8. Maximum Temperature Accuracy

Figure 9 and Figure 10 illustrate the current and power consumption of all featured digital humidity sensors based on typical voltages provided in the previous graphs.

Note

For Figure 9 and Figure 10, the HDC302x was set to Low Power Mode 3, the HDC2x was configured to 9-bit output, and the HDC1x was in its default configuration.

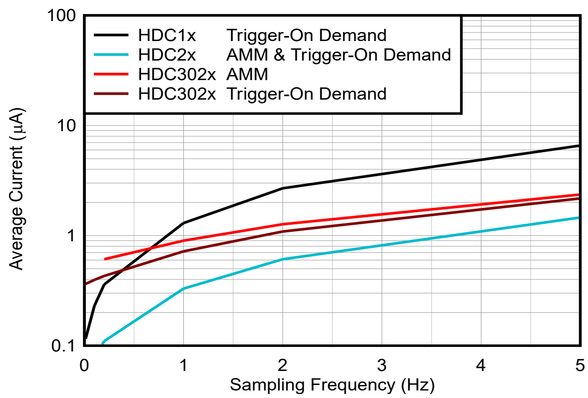

Figure 9. Average Current Consumption

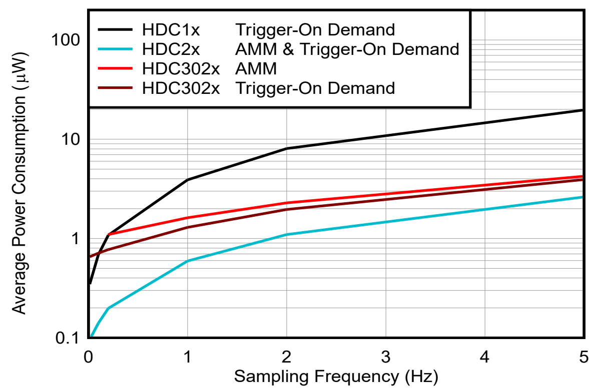

Figure 10. Average Power Consumption

On-Chip Heater Overview

All TI humidity sensors feature a resistive-based heating element. Depending on the humidity sensor model, this heater will operate either in a brief pulse, a non-programmable, continuous cycle, or a programmable, continuous cycle. Table 2 provides an overview on the heater capabilities of each featured humidity sensor.

Table 2. TI Humidity Sensor Integrated Heater Overview

Device	Typ. Power	V_{DD} Voltage	Heater Type
HDC1080	36mW	3.0V	Pulse; Non-Programmable
HDC2010, HDC2080, HDC2021, HDC2022	297mW	3.3V	Continuous; Non-Programmable
HDC3020, HDC3021, HDC3022/-Q1	249mW	3.3V	Continuous; Programmable
HDC3120/-Q1	67-249mW	3.3V	Continuous heater. EN pin controllable by GPIO

Learn More

- App Note: How to Read and Program TI's Humidity Sensors
  – Provides a helpful walk-though of programming and communicating with humidity sensors.
- App Note: How to Debug RH Accuracy Issues in RH Sensors
  – Offers explanations and prevention strategies for RH accuracy errors
- App Note: Humidity Sensor-Based Water Ingress Monitoring for Automotive Electronics
  – Offers a humidity sensor-based detection method utilizing the HDC3020 sensor to rapidly identify water ingress in sealed or vented electronic enclosures.
- User's Guide: HDC3x Silicon User's Guide
  – Helpful storage and handling guidelines for HDC3x family of sensors.
- User's Guide: HDC2x Silicon User's Guide
  – Helpful storage and handling guidelines for HDC2x family of sensors.
- Product Overview: NIST Traceability for Temperature and Humidity Sensors
  – Highlights NIST traceable devices and explains importance in modern applications.

Software Support

For rapid prototyping with Arduino®-based controllers, visit TI's GitHub® for environmental sensors to get started. This repository offers sample code for all available humidity sensors.

For deeper, C-based driver-level support, visit TI's GUI-based code generator, ASC Studio to get started.

For additional assistance, visit the TI E2E Sensors Support Forum.

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