Application Brief

How TI Humidity Sensors Remove Device Condensation Using On-Chip Heaters

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Temperature and Humidity Sensing

To maintain accuracy and prolong the operating lifetime of a humidity sensor, it is important to keep the sensor in a controlled environment. For this reason, open-cavity Texas Instruments humidity sensors can be used in a non-condensing environment. The general humidity operating range is from 0% to 100% relative humidity (%RH) over –20°C to 70°C. Reference the device data sheet for the specific operating range. If a sensor continues to operate in ranges exceeding the ranges defined here, a shift in the sensor reading can be caused with a slower recovery time. When condensation is introduced to the system and physically covers the open cavity of the humidity sensor, there is a possibility of the condensation impacting performance.

Regardless of how well-intentioned the use of TI's humidity sensors can be, it is possible to have condensation occur on or around the sensor. Condensation can be an issue if the sensor is blocked since the device can give inaccurate results, and if there is prolonged exposure outside of the appropriate range, the device performance can be impacted. Fortunately, TI's humidity sensors such as the HDC2x and HDC3x are able to remove condensation on and around the sensor using their on-chip heaters so the sensor can properly sense the %RH of the air. Heating up the system reduces condensation because the high temperatures causes the air to warm up so the air can hold more moisture, allowing condensation to evaporate.

In particular, the HDC3020 includes a configurable heater which allows users to customize their heater settings and the power level required for evaporating the condensation. The heater is able to operate between 1.62 V and 5.5 V but for effective condensation removal, the current recommended operating conditions are from 2.7 V to 5.5 V. The tracking feature in this device can detect a potential condensing situation and activate the onboard heater to remove the moisture, tracking the change in %RH throughout the process of heating and returning to an ambient state. Dew point is important to know because the dew point is the point where condensation starts forming. More information about dew point and other important calculations is found in the *Using Relative Humidity to Derive Vapor Pressure, Dew Point, Absolute Humidity, and Enthalpy* application brief.

Details on the process of removing the condensation are found in the HDC3 Silicon user's guide. The on-chip heater evaporates condensation on or around the humidity sensor following the process outlined in this document.

It is important to constantly monitor the dew point and temperature so that there is preset action in case there is condensation. Figure 1 illustrates that TI Humidity sensors come with an alert function with threshold limits to trigger the microprocessor which can, in turn, enable the heater if the relative humidity (%RH) gets too high.

This graph shows how the alert function works when the user sets thresholds for humidity. The ALERT pin asserts or de-asserts when the threshold limits exceed or fall below their limits.

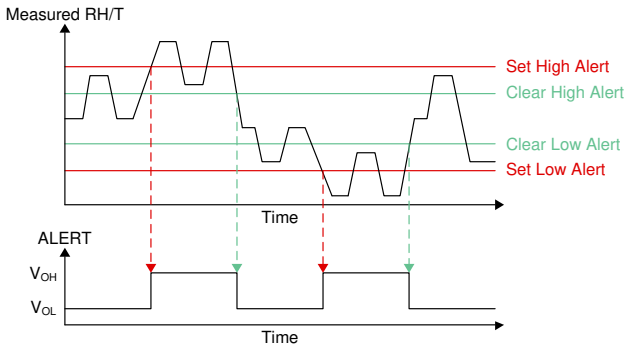

Figure 1. Graphical Illustration of ALERT Programmable Environmental Thresholds

Another important feature of the HDC3x is the built-in %RH offset error correction for accuracy deviation caused by contaminants, sensor aging, and extreme conditions. The HDC3x utilizes a TI-provided firmware based offset correction algorithm that calibrates the device. This is done using the Trigger-on-Demand mode on the device for measurement speed. The correction algorithm uses the on-chip heater to

eliminate the drift through the use of heat. The heater increases the temperature to a point where the measured %RH is the offset error. This is possible because when the amount of water in the air is constant, the %RH decreases as the temperature increases. More details on the offset correction algorithm is found in the HDC3 Silicon user's guide.

TI's offset error correction follows the general process explained in the User's Guide to make sure the device is reading as accurately as possible.

Applications

The main difference between outside and inside condensation is the ability to control the environments. If the system is indoors, controlling the environment is easier through the system whereas in an outdoor environment, the climate is uniform in the general area making it difficult to change the operating environment of the system.

Looking at an indoor environment, home bathrooms are the most common room to show signs of condensing due to hot showers and sinks. Bathroom fans are used in a majority of homes to remove the moisture from the air to reduce condensation on glass, mirrors, and walls. TI humidity sensors can be used to sense the humidity to automatically activate the fan. These sensors can also benefit from the on-chip heater since there is a higher chance that condensation occurs in this environment. Having a humidity sensor that can protect itself and the environment around the sensor is helpful with home management. This application can also be tied into new bathroom fans that have started to become popular – fans that include a Bluetooth® speaker and LED lights. Having a humidity sensor in the fan is even more valuable in this application to protect the electronics of the Bluetooth speaker. TI’s humidity sensor is able to recognize the humidity and act to remove condensation around the most important parts of the system.

Condensation is extremely common in HVAC environments both outside and inside. In an air conditioning system, the evaporator coil works to cool hot air by absorbing the heat and moisture from the air, causing condensation to form. Humidity sensors in this environment are important for the system to check if the system is running properly and in the best conditions. Being in a condensing environment, it is important for the humidity sensor to be able to get rid of any condensation that can find itself lodged on the chip, making the on-chip heater essential. If there are plans to use a TI humidity sensor in a condensing environment, the HDC3022 is the best fit due to the IP67 protective cover placed on the top of the device that prevents condensation from forming in the cavity.

Conclusion

Texas Instrument’s humidity sensing portfolio not only offers high performance and reliability, but also protective cover options in commercial and automotive grades that are well-equipped to handle different applications and environments. In this application, the on-chip heaters offer users a protective design to maintain the quality and accuracy of the sensor in the event that condensation occurs. Condensation can be removed either by using their on-chip built-in heaters by following the steps outlined in the Silicon User's Guide or by using TI humidity sensors with the IP67 protective cover option.

References

- Texas Instruments, HDC3020 product page
- Texas Instruments, HDC3022 product page

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