



ENS21xA

Application Note

Utilization of temperature and humidity sensors in automotive HVAC systems for enhanced energy savings and improved comfort and safety

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1 Why humidity & temperature sensing in vehicle cabins?

For almost 20 years, humidity sensing in car or truck cabins is recognized as an efficient way to better control HVAC energy consumption, improve safety and comfort, while increasing customer satisfaction. With the growing number of electric vehicles today, optimization of HVAC energy consumption has become inevitable for best possible battery range.

Various papers and reports assessing the HVAC system's impact on global vehicle energy consumption are available. One report¹ by Car and Driver magazine, testing a prominent electric vehicle in March 2020 on an FCA driving cycle, shows that depending on how the HVAC control is set up, the resulting battery range can vary by +/-13%. This demonstrates the need for smarter HVAC controls, utilizing measurement of temperature and humidity in both, HVAC system and cabin to comply with governmental CO₂ regulations and specified battery range in real life.

In more detail, this requires:

- **Optimization of HVAC energy consumption**
 - Fine tune usage of (recirculation) air damper to balance heating and cooling phases while preventing condensation (antifogging) in the cabin.
 - Adjust evaporator temperature to control humidity inside the cabin (especially when cooling), thereby balancing both, HVAC compressor and heat pump.
 - On hybrid electric vehicles utilize Stop/Start feature and balance transition from electric to ICE power usage and vice versa to save battery energy while preventing condensation (antifogging).
- **Optimization of cabin comfort**
 - Adjustment of cabin humidity and temperature levels, similar to comfort zone compliance of buildings.
 - Utilization of air quality sensors to maintain cabin air quality while preventing condensation (antifogging).

Depending on the cabin design, the vehicle's powertrain (ICE, hybrid or plain electric) and the HVAC architecture, temperature and humidity sensing may be attached to the wind shield (e. g combined with the rain sensor), at the foot of the rear mirror (most popular location) and / or close to the evaporator.

¹ [How Much Does Climate Control Affect EV Range?](#) by Maxwell B. Mortimer, Car and Driver magazine, 19.03.2020

2 Requirements for in-cabin humidity sensors

Due to the demanding environmental conditions in said application, only capacitive type humidity sensors reliably withstand wide automotive operating ranges in humidity (0 to 100% RH) and temperature (-40°C to 125°C). Humidity and temperature sensors have to comply with the following key characteristics:

- Operating temperature range: -40°C to 125°C
- Operating humidity range: 0% to 100%
- Sufficient measurement accuracies at high humidity (> 70% RH) in the temperature range from 5°C to 40°C that allow HVAC fine tuning according to section 1.
- Capability to withstand repeated condensation and freezing phases at no impairment of the sensor characteristics (i.e. no accelerated sensor drift or even damage).
- Ultra-fast response times to manage risk of flash fogging
- Excellent temperature measurement accuracies, especially at high humidity, for accurate dew point computation.

Needless to say that all above is associated with robust and qualified electrical characteristics.

3 Why SciSense's ENS21xA?

The ENS21xA family of automotive temperature and humidity sensors has demonstrated its performance according to the requirements stated in section 2 and validated its automotive suitability according to AEC Q100 grade 1, i.e. fully complies with requirements of cars and trucks.

Besides world class humidity accuracies and measurement ranges, the ENS21xA also offers unrivaled response times and temperature accuracies, thereby enabling energy savings and superior performance in modern automotive HVAC systems, particularly at high humidity.

For further information please refer to

- ENS210A datasheet for general purpose use in automotive applications.
- ENS213A (see ENS21xA datasheet) for premium accuracies at high humidity.

4 RoHS Compliance & SciSense Green Statement

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6 Revision information

Table 1: Revision history

Revision	Date	Comment	Page
1.0	2023-03-01	Initial release	All

Notes:

1. Page and figure numbers for the previous version may differ from page and figure numbers in the current revision.
2. Correction of typographical errors is not explicitly mentioned.

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