

Moisture Measurement in Rough Vacuum

Moisture measurement at low pressures is currently not possible at a low price point. This work tested cheap moisture sensors specified for atmospheric pressures in a rough vacuum around 1 mbar. Sensirion SHT45 produced linear, precise measurements under system conditions.



Vacuum chamber for setting precise environmental conditions

Introduction

The Hyperloop is a train running in a concrete tube. Removing the air from the tube enables the train to reach speeds of up to 1000 km/h very efficiently. Because there is no air in the tube, thermal management of the train makes use of evaporative cooling. This introduced moisture must be recondensed. Therefore, the humidity inside the tube must be known.

Challenge

The challenge was to find a low-cost sensor that will produce an accurate

measurement of the humidity at vacuum conditions near 1 mBar.

Idea

The main idea consisted of using a common humidity sensor specified for use at atmospheric pressures and testing it under vacuum to see if it can also work outside its specified environmental conditions.

Work

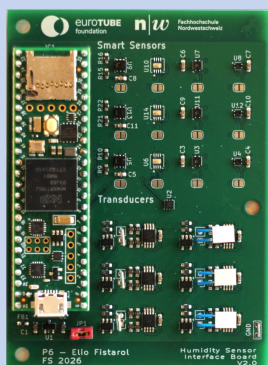
A selection of five contenders was made and the sensors were integrated on a custom measurement PCB. Then a vacuum cham-

ber was fitted with heaters and an air/vapour mixture system to achieve any possible humidity, pressure and temperature combination. The sensors were then characterized at two different temperatures and four different humidities.

Results

Out of the five sensors, two produced no readings. The other three were able to successfully measure the humidity levels. The temperature compensated smart sensor SHT45 produced precise and linear ($R^2 = 0.95$) readings and is recommended for further use.

Infobox



The sensor board interfaces the smart, I²C-connected sensor ICs and implements a capacitance to frequency conversion circuit for measurement of the capacitive humidity transducers. The measurement data is then transmitted over USB-serial.

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