Instrument Test Report ITR 654

Performance Tests on a Vaisala HMP35D Humidity/Temperature Probe

Glenn Bowkett
Physics Laboratory, OEB
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Authorisation

Tasia Livaditis
A/LAB
Physics Laboratory

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6 Pages

Introduction:

The Vaisala HMP35D humidity/temperature sensor was considered as a possible sensing unit in AWS systems. Tests were carried out on a probe to determine if it met the Bureau acceptance criteria for relative humidity and temperature output measurement accuracy [1]. The tests also considered whether the probe temperature output could be used as a dry bulb temperature input [2].

Experimental Procedure:

The HMP35D (s/n: T1340010) was placed in the Physics Laboratory's climate chamber and its relative humidity and temperature output logged on a notebook computer via a Datalogger Datataker500 (s/n: 0828-070). At each set point where the climate chamber was set at a particular temperature and relative humidity and allowed to stablize, approximately 15 to 25 readings were recorded. The relative humidity (RH) was a direct conversion of a voltage output (0 – 1 V equal to 0 to 100%RH) and the temperature is a four wire measurement of a PT100 resistance (α385 – 1/3 DIN 33760B). This temperature output was intended as an input to the dry bulb temperature channel of the Milos 500 AWS. Reference humidity and temperature were measured by a General Eastern Model 1500 Hygrocomputer (s/n: 3415) which has an uncertainty of 2.1% of the displayed reading in the relative humidity reading and an uncertainty of ±0.2°C in the temperature reading (95% confidence)[*]. The tests were conducted on 8,9,11 & 15 June 1999.

Firstly a calibration run was performed as in Physics Laboratory Procedure Number: RH01SCP01 (Calibration of Relative Humidity Probes); set and adjust if necessary at 25°C & 35%RH, then 25°C & 85%RH, and check back at 25°C & 35%RH again. Note: There is no adjustment for temperature on this probe.

Then there were four tests performed:
1. Constant temperature (25 ± 1 °C), variable humidity (17% to 88% RH).
2. Constant temperature (15 ± 1 °C), variable humidity (27% to 90% RH).
3. Constant humidity (47 ± 3%), variable temperature (15 to 35°C).
4. Several points were measured at high temperature and low humidity (30°C & 14% RH) and (40°C & 11% RH).

[*] CSIRO Measurement report (Ref:RS23883) on the Hygrocomputer gives an estimate of uncertainty of ±3.5% of the display reading with 99% confidence interval. Report (Ref:RS23856) on the digital thermometer gives an uncertainty of ±0.3°C with a 99% confidence interval. Using a degrees of freedom factor of four, the uncertainties with a 95% confidence interval were calculated.

Results:

The difference between the HMP35D and reference humidity was calculated for each reading at each set point. The mean results are plotted in figures 1 through 4 respectively for each test. The solid line in the figures indicates the Bureau's requirement on the limits of an acceptable mean measurement [1].

From all the relative humidity tests the mean of all the data points at each set point was found, and then a mean across the range was calculated.

Mean correction across the range (ref-probe measured) %RH = -0.09
Standard deviation of the mean correction %RH = 0.59

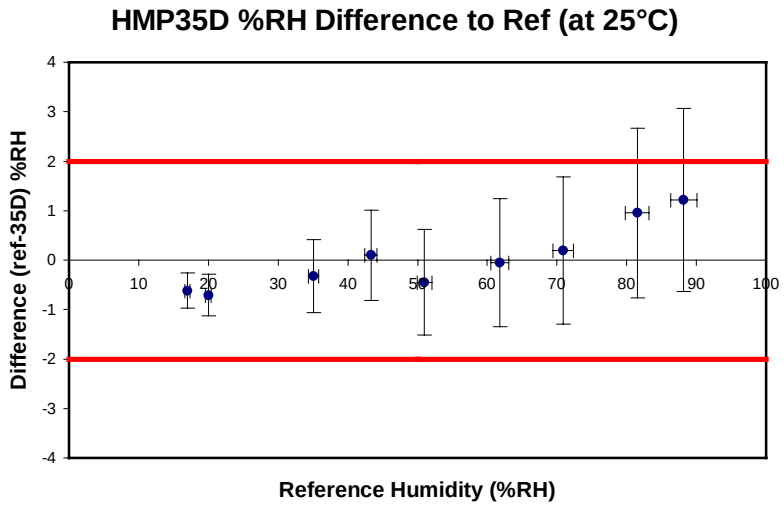

Figure 1:- Difference in relative humidity at a temperature of 25°C as given by the sensor when compared to the reference hygrocomputer. To meet Bureau requirements the mean sensor measurement must fall within the solid lines or ±2%.

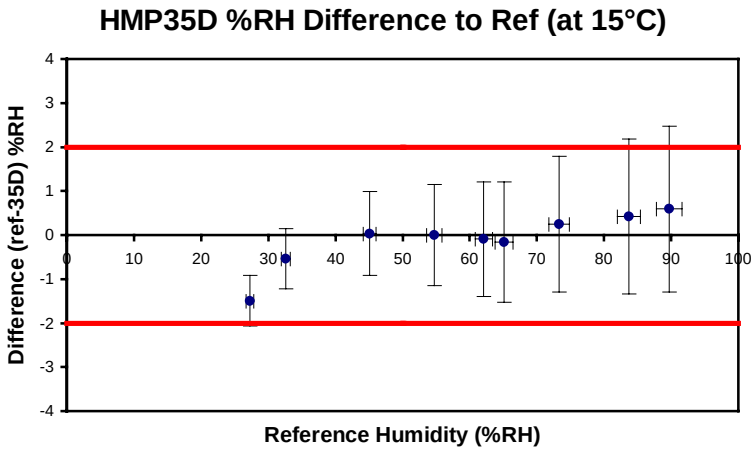

Figure 2:- Difference in relative humidity at a temperature of 15°C as given by the sensor when compared to the reference hygrocomputer. To meet Bureau requirements the mean sensor measurement must fall within the solid lines or ±2%.

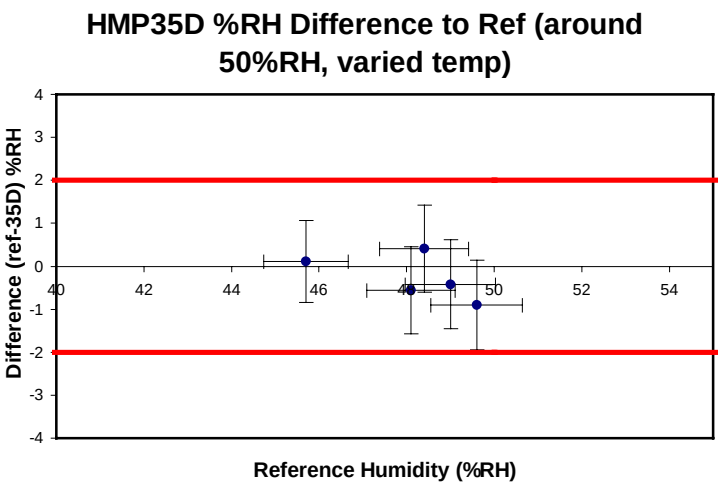

Figure 3:- Difference in relative humidity as given by the sensor when compared to the reference hygrocomputer. Given for an approximately constant %RH at varied temperatures. To meet Bureau requirements the mean sensor measurement must fall within the solid lines or ±2%.

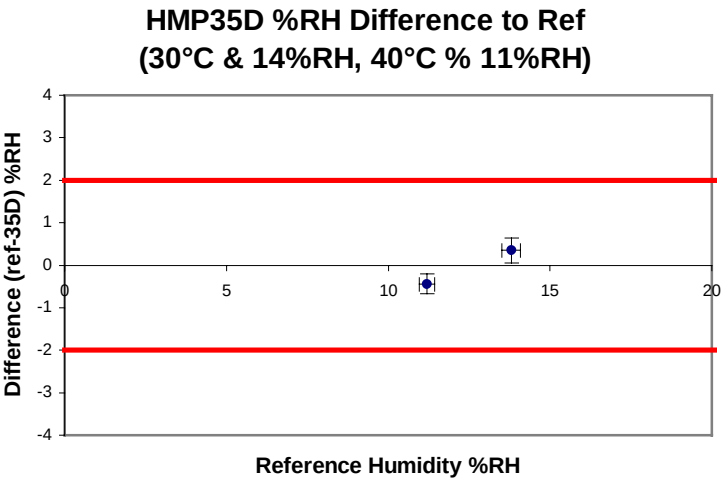

Figure 4:- Difference in relative humidity as given by the sensor when compared to the reference hygrocomputer at approximately 30°C & 14%RH and 40°C & 11%RH. To meet Bureau requirements the mean sensor measurement must fall within the solid lines or ±2%.

The temperature measured by the sensor during each of the tests was compared to the reference hygrocomputer temperature, and the differences plotted in figures 5 and 6. Figure 5 contains results across all the measured temperatures, while figure 6 contains results close to the calibration temperature.

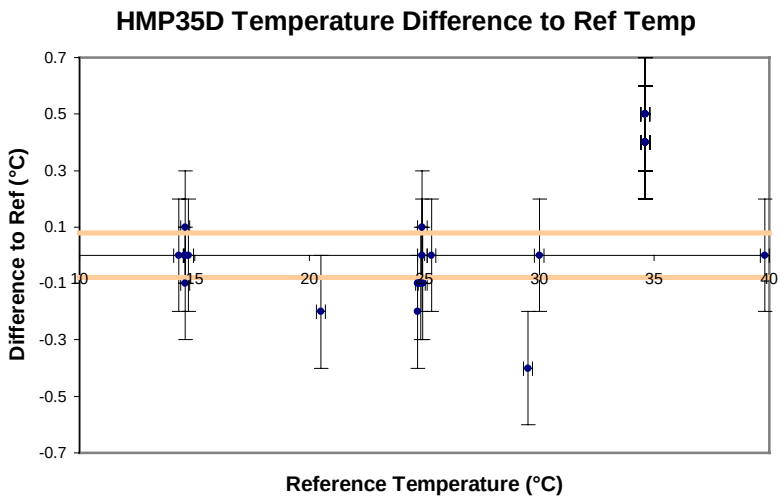

Figure 5:- Data from all tests showing the difference in sensor temperature in comparison to the hygrocomputer reference temperature. To meet the Bureau requirements for a temperature sensor the measurements must fall within the solid lines or ±0.08°C.

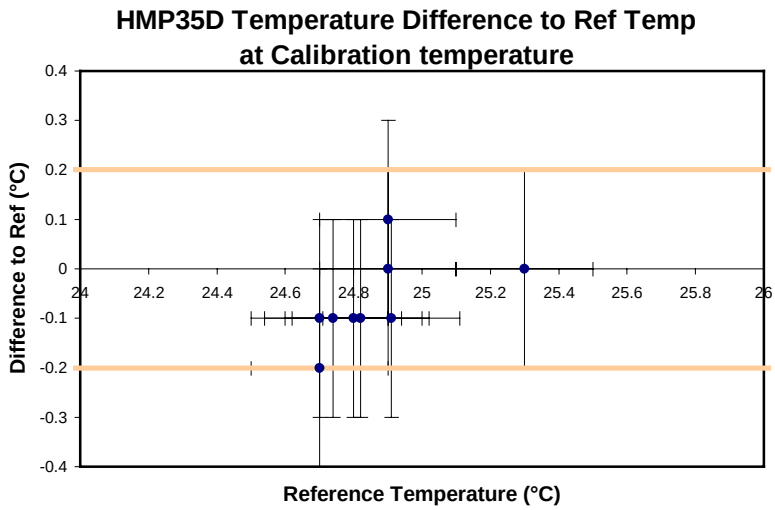

Figure 6:- Data showing the difference in sensor temperature in comparison to the hygrocomputer reference temperature, when held at approximately the calibration temperature (25°C). To meet the Bureau requirements for a RH probe the mean temperature results must full within the solid lines or ±0.2°C.

The temperature difference at the calibration temperature (~25°C) was 0.2°C maximum, with the measurements usually displaying a 0 or 0.1°C difference.

Discussion:

The relative humidity results from all the tests show that the tested HMP35D humidity probe meets the acceptance criteria for humidity accuracy of ±2% RH. From figure 6 it is seen that the sensor meets the relative humidity probe requirement of an accuracy of ±0.2° at the calibration temperature.
However, it is seen from the data in figure 5 that the probe temperature sensor was unsuitable as an AWS temperature sensor, with temperature sensor to reference differences of between -0.4 and +0.5°C.

Conclusions:

- The HMP35D humidity probe tested was found to be a suitable relative humidity probe for AWS applications.
- The temperature output from the probe is unsuitable for use as an AWS temperature sensor.
- Any HMP35D probes purchased by the Bureau are to be tested for calibration by the Physics Laboratory prior to issue. This requirement is standard for all RH probes used by the Bureau.

References:

1. The relative humidity measurement acceptance criterion is an accuracy of ±2%RH of the mean to the reference. This criterion is determined by considering the uncertainty of the test method[*]; the uncertainty quoted by the manufacturer for the instrument[**]; and the recorded specification for relative humidity measurements[***].

   The combination of uncertainties is of the same magnitude as the recorded specification, therefore the criterion for the mean measurement has been set at a level that is smaller than both of these. This is required to ensure that there is a 90% confidence level that the final reading is within the recorded specification.

   The measured temperature output of a relative humidity probe must also have an accuracy within ±0.2°C across the humidity range at the calibration temperature (generally 25°C). Which is either the manufacturer specification for these instruments, or the instrument is provided with adjustment to achieve this accuracy.

2. For a sensor to be used as either a wet or dry bulb temperature sensor it requires a calibration accuracy of equal to or better than ±0.08°C between –10 and +55°C, and ±0.05°C at 0°C. This requires the sensing element to conform to the accuracy standard 1/10 DIN (±0.03°C at 0°C up to ±0.08°C at –100 & +100°C), and also allows for an uncertainty of ±0.02°C in the calibration instruments and process.

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[*] see footnote page 2
[**] The accuracy specified for the HMP35D is ±1 %RH at 20°C, along with ±0.04 %RH/°C, with this adjusted to a minimum on initial calibration.
[***] Equipment Specification A2659, Guidance Specification (functional) for a general purpose Automatic Weather Station (AWS), E.E.Jesson, June 1989. [attachment 1, page 6]
Sensor and measurement system accuracy: 5% for RH to 50%, 3% for RH > 50%.