

# Ground calibration of DREAMS-H relative humidity device

M. Komu, M. Genzer, T. Nikkanen, W. Schmidt, H. Haukka, O. Kempainen, and A.-M. Harri  
Finnish Meteorological Institute, Helsinki, Finland (maria.genzer@fmi.fi)

## 1. Introduction

DREAMS (Dust Characterization, Risk Assessment and Environmental Analyzer on the Martian Surface) instrument suite is to be launched as part of ESA ExoMars 2016/Entry, Descent and Landing Demonstration Module (EDM). DREAMS consists of an environmental package for monitoring temperature, pressure, relative humidity, winds and dust opacity, as well as atmospheric electricity of Martian atmosphere. DREAMS instruments and scientific goals are described in [1]. Here we describe ground calibration of the relative humidity device, DREAMS-H, provided to DREAMS payload by Finnish Meteorological Institute and based on proprietary technology of Vaisala, Inc. Same kind of device is part of REMS instrument package onboard MSL Curiosity Rover [2][3].

## 2. DREAMS-H humidity device

DREAMS-H transducer includes 3 Humicap® relative humidity sensor heads and 1 Thermocap® temperature sensor head manufactured by Vaisala, Inc. The transducer electronics are placed on a single multi-layer PCB protected by a metallic Faraday cage. The PCB is supported by a mechanical interface mounted on DREAMS MetMast. The total mass of DREAMS-H is less than 20 g and it consumes ~15 mW of power.

The Humicap® sensor heads contain an active polymer film that changes its capacitance as function of relative humidity, with 0% to 100% RH measurement range. The dynamic range of the device gets smaller with sensor temperature, being in -70°C approximately 30% of the dynamic range in 0°C [3]. The film reacts to the relative humidity, even if the instrument is not powered. Once powered, the output of the sensor heads can be read almost immediately. As relative humidity depends strongly on temperature, Thermocap® sensor head is included to

provide an accurate measurement of sensor temperature.

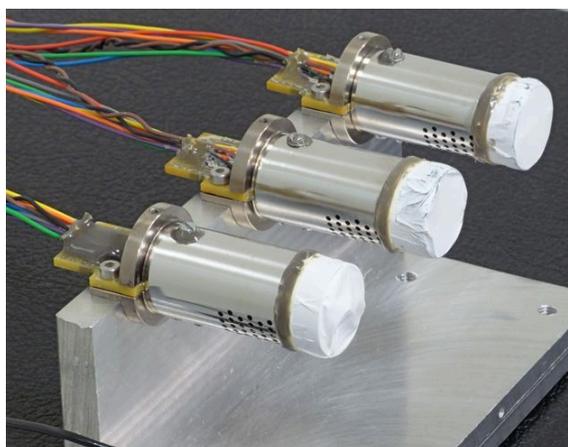


Figure 1: DREAMS-H Flight Model, Flight Spare and Reference model ready for calibration.

## 3. DREAMS-H Calibration

DREAMS-H calibration starts by calibrating the Thermocap® temperature sensor. Temperature calibration is done inside a climate chamber of Finnish Meteorological Institute, using Pt100 temperature sensors attached directly to DREAMS-H devices as references. The calibration of these Pt100s is traceable to national standards. Thermocap® calibration is done in at least 8 temperature points inside the desired operational temperature range. The stability criteria for the climate chamber temperature during calibration is  $\Delta T/\Delta t < 1^\circ\text{C}/\text{h}$ , and  $\Delta T < 0.1^\circ\text{C}$  during the measurement.

Basic humidity calibration of DREAMS-H is performed in a climate chamber, in room temperature, in 6 humidity points ranging from almost dry to almost wet. Commercial Vaisala temperature and humidity transmitter calibrated to national standards is used as reference in these measurements. The

temperature stability criteria are the same as in Thermocap® calibration, and the criteria for humidity is  $\Delta RH < 0.2\%$  during the measurement.

The main part of humidity calibration of DREAMS-H flight model is done in subzero temperatures in humidity generator of Finnish Center of Metrology and Accreditation (MIKES). 6-8 temperature points with stability criteria as in Thermocap® calibration are used. In each temperature point, several relative humidity points ranging from almost dry to almost wet are measured. The stability of the dew point of the humidity generator is  $\Delta T < 0.2^\circ\text{C}$ . The uncertainty of reference RH at MIKES facility is in order of 5%RH in  $-70^\circ\text{C}$  and 2.5%RH in  $-40^\circ\text{C}$  [4].

In addition to stable relative humidity points, measurements in changing relative humidity and temperature are done in order to get information about the lag of the sensor. In this measurement absolute humidity is kept stable and temperature of the chamber varied according to a simulated temperature cycle of Mars.

#### 4. Results

Calibration of the DREAMS-H flight model and spare model is scheduled for late spring and early summer 2014. The facilities, calibration principles and results for DREAMS-H device will be presented.

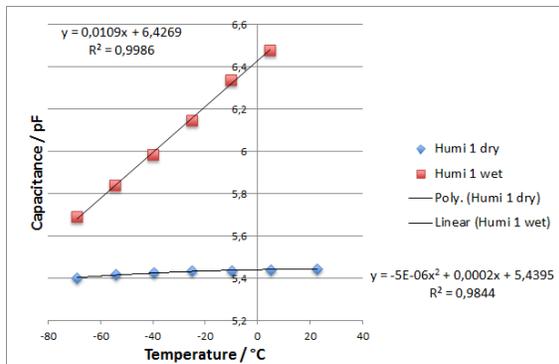


Figure 2. An example of Humicap® capacitance in dry and wet points as function of temperature. Measured with DREAMS-H Qualification model at calibration facility of Finnish Meteorological Institute.

#### References

[1] Esposito, F. et al: The DREAMS Experiment on the ExoMars 2016 Mission for the Study of Martian Environment during the Dust Storm Season, The Fifth International Workshop on the Mars Atmosphere, 13-16 January 2014, Oxford, UK, 2014.

[2] Gómez-Elvira, J. et al.: REMS: The Environmental Sensor Suite for the Mars Science Laboratory Rover, Space Sci. Rev., 170, pp. 583-640, 2012.

[3] Harri, A.-M. et al.: Mars Science Laboratory Relative Humidity Observations – Initial Results, Journal of Geophysical Research, submitted.

[4] Heinonen, M. et al, Measurement report M-11H074, Finnish Center of Metrology and Accreditation, 2011.