



NATIONAL PHYSICAL LABORATORY

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Certificate of Calibration

THERMOMETER
19205E



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FOR: Facility for Airborne Atmospheric Measurements
Building 146
Cranfield University
Cranfield
Bedfordshire
MK43 0AL

For the attention of Dr Hannah Price

DESCRIPTION: Thermistor constructed by FAAM using a Rosemount Engineering housing

IDENTIFICATION: Type: E102AL, Serial No. 19205E

**PREVIOUS
CERTIFICATE:** 2014070095 dated 4 March 2015

**DATES OF
CALIBRATION:** 16 October to 22 October 2018

Reference: 2018080037-8

Date of issue: 31 October 2018

Checked by:

SLB

Signed:

Name: Mr P A Carroll

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(Authorised Signatory)

on behalf of NPLML



This certificate is consistent with the capabilities that are included in Appendix C of the MRA drawn up by the CIPM. Under the MRA, all participating institutes recognise the validity of each other's calibration and measurement certificates for the quantities, ranges and measurement uncertainties specified in Appendix C (for details see <http://www.bipm.org>).

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Continuation Sheet

MEASUREMENTS

The thermometer was calibrated in a test chamber, in air, by comparison against reference platinum resistance thermometers (PRTs). Traceability of measurement was provided by calibration of these thermometers to the International Temperature Scale of 1990 (ITS-90) through NPL Temperature Standards.

As requested the thermistor was measured as follows: thermistor 19205E was connected to a resistor of measured value $100.1\text{ k}\Omega$ at $23\text{ }^{\circ}\text{C}$, and an excitation voltage of nominally 5 volts was applied across the two components in series. The resulting signal voltage across the thermistor was measured at a range of temperatures in order to calibrate the sensor. The excitation voltage and the signal voltage across the thermistor were measured using an Agilent 34970A data acquisition unit with traceability to National Standards. Measurements were carried out at temperatures from $-60\text{ }^{\circ}\text{C}$ to $+50\text{ }^{\circ}\text{C}$ at intervals of $10\text{ }^{\circ}\text{C}$. At each temperature, a time of not less than 3 hours was allowed for temperature to equilibrate. A set of 10 readings were taken from the instrument under test with a logging interval of 1 minute. The entire calibration was then repeated with a second excitation voltage of nominally $5/\sqrt{2}$, in order to enable the evaluation of self-heating by the customer.

The values of the applied conditions (temperature and excitation voltage) are given in the first two columns of the tables below. The measured signal voltage across the thermistor, in volts, is given in the third column. The values in the final column show the expanded uncertainty of the measurement. The quoted uncertainty relates to the period of the calibration and is not an indication of the long-term stability of the thermistor.

The ambient conditions in the NPL humidity laboratory were $23\text{ }^{\circ}\text{C} \pm 3\text{ }^{\circ}\text{C}$ and less than 80 % relative humidity.

RESULTS

Table 1 – Excitation Voltage of 5 V

Applied Condition		Test Measurements	
Measured Temperature	Excitation Voltage	Signal Voltage	Expanded Uncertainty of the Temperature Measurement
°C	V	V	°C
-60.51 #	4.996	4.474	±0.17
-50.03 #	4.996	4.075	±0.08
-40.02	4.997	3.532	±0.08
-29.96	4.996	2.874	±0.08
-19.82	4.996	2.198	±0.06
-9.80	4.995	1.607	±0.06
+0.13	4.997	1.143	±0.05
+10.14	4.997	0.797	±0.04
+20.22	4.997	0.552	±0.04
+30.27	4.996	0.384	±0.04
+40.21	4.997	0.271	±0.04
+50.17	4.998	0.193	±0.04

NOTE: # Points below -40 °C are outside the range of NPL's UKAS accreditation for air temperature

Table 2 – Excitation Voltage of $5/\sqrt{2}$ V

Applied Condition		Test Measurements	
Measured Temperature	Excitation Voltage	Signal Voltage	Expanded Uncertainty of the Temperature Measurement
°C	V	V	°C
-60.54 #	3.534	3.167	±0.17
-50.02 #	3.535	2.887	±0.08
-40.04	3.535	2.507	±0.08
-29.89	3.535	2.040	±0.08
-19.83	3.533	1.564	±0.06
-9.78	3.533	1.143	±0.05
+0.07	3.532	0.814	±0.05
+10.13	3.534	0.566	±0.04
+20.21	3.533	0.391	±0.04
+30.25	3.533	0.273	±0.04
+40.22	3.532	0.192	±0.04
+50.18	3.534	0.137	±0.05

NOTE: # Points below -40 °C are outside the range of NPL's UKAS accreditation for air temperature

UNCERTAINTIES

The standard uncertainty of the applied condition represents a combination of the uncertainties arising from calibration and estimated stability of the reference standards, and from the method of transfer to the instrument under test.

The standard uncertainty of measurement is calculated by combining the uncertainty of the applied condition, the resolution of the instrument and its standard deviation for the period of the test. An uncertainty contribution has been included for rounding to give results an equivalent resolution of 0.01 °C.

The reported expanded uncertainty is based on a standard uncertainty multiplied by a coverage factor $k = 2$, providing a coverage probability of approximately 95 %. The uncertainty evaluation has been carried out in accordance with UKAS requirements.

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Checked by: *SAB*