DeFelsko®

Management Procedure 2581
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Calibration Procedure

DeFelsko PosiTector Dew Point Meter DPM & DPMD Probes

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1 Introduction and UUC Performance Requirements

1.1 This procedure describes the calibration of the DeFelsko PosiTector Dew Point Meter (DPM) Built-in and (DPMD) cabled probes with the following specifications:

Table 1-1 Measurement Ranges

Function	Measurement Range	Resolution
Air Temperature	-40 to 80 °C (-40 to 175 °F)	0.1°C (0.1°F)
Relative Humidity	0 to 100% RH	0.1%
Surface Temperature (DPM only)	-40 to 190 °C (-40 to 375 °F)	0.1°C (0.1°F)

1.2 The unit being calibrated will be referred to as the UUC (Unit-Under-Calibration).

2 Measurement Standards and Support Equipment Performance Requirements

2.1 The UUC accuracy requirements are based upon the published UUC performance specifications.

2.2 The test uncertainty ratio applied in this calibration procedure is 4:1 unless otherwise stated. The surface temperature uncertainty ratio for the range -40 to 80 °C is 2.2:1.

2.3 Minimum-Use-Specifications are the minimum test equipment specifications required to meet all the UUC accuracy requirements and the test uncertainty ratio applied.

Table 2-1 UUC Accuracy Requirements and Description

UUC Function	Range	Accuracy	Test Method
Air Temperature	-40 to 80 °C (-40 to 175 °F)	± 0.5 °C (1.0 °F)	Humidity Generator
Relative Humidity	0 to 100% RH	± 3.0 %	
Surface Temperature	-40 to 80 °C (-40 to 175 °F)	± 0.5 °C (1.0 °F)	Temperature Calibrator
	>80 to 190 °C (175 to 375 °F)	± 1.5 °C (3.0 °F)	

Table 2-2 Minimum Use Specifications

Function	Range	Accuracy
Air temperature	-40 to 80 °C (-40 to 175 °F)	± 0.125 °C (0.25 °F)
Relative Humidity	0 to 100% RH	± 0.75%
Surface Temperature	-40 to 80 °C (-40 to 175 °F)	± 0.125 °C (0.25 °F)
	>80 to 190 °C (175 to 375 °F)	± 0.375 °C (0.75 °F)

Table 2-3 Actual Air Temperature & Relative Humidity Equipment Specifications

Manufacturer/Model #'s Applicable	Actual Equipment Specifications	
	Range	Accuracy
Thunder Scientific Model 2500 Humidity Generator	0 to 70 °C (32 to 158 °F)	± 0.06 °C (± 0.11 °F)
	10 to 95% RH	± 0.5%

Table 2-4 Actual Surface Temperature Test Equipment Specifications

Equipment Name Manufacturer/Model #'s Applicable	Actual Equipment Specifications	
	Range	Accuracy
1. Type K Thermocouple	-200 – 1250 °C (-328 – 2282 °F)	0.138°C
2. Distilled Water Ice Bath	N/A	0.05 °C
3. Keithley 2000 Multimeter	Up to 100 mV	0.090 °C
4. EDL STS-SC2 Calibrator	40 °C 100 °C	0.16 °C 0.25°C

Keithley 2000 Multimeter calculation

Use ITS-90 (International Temperature Standard) Table for Type K Thermocouple

Temperatures at 40°C (1.612 mV) and 100 °C (4.096mV)

Scale Range → 100 mV with 1 year accuracy = 50 ppm of reading + 35 ppm of range

Accuracy @ 40°C = (50 ppm x 1.612 mV) + (35 ppm x 100 mV)
= 3.580 uV
(40°C /1.612mv) * 0.003580mv = .089°C

Accuracy @ 100°C = (50 ppm x 4.096 mV) + (35 ppm x 100 mV)
= 3.704 uV
(100°C /4.096mv) * 0.003704mv = 0.090 °C

Surface Temperature Combined Accuracy @ 40°C = $(\text{Thermocouple}^2 + \text{Bath}^2 + \text{Keithley}^2 + \text{Surface plate}^2)^{0.5}$
$= (0.138^2 + 0.05^2 + 0.089^2 + 0.16^2)^{0.5}$
= 0.23 °C

Surface Temperature Uncertainty Ratio (-40 to 80 °C): = (0.5 °C / 0.23 °C) =2.2:1

Surface Temperature Combined Accuracy @ 100°C = $(\text{Thermocouple}^2 + \text{Bath}^2 + \text{Keithley}^2 + \text{Surface plate}^2)^{0.5}$
$= (0.138^2 + 0.05^2 + 0.090^2 + 0.25^2)^{0.5}$
= 0.30 °C

Surface Temperature Uncertainty Ratio (80 to 190 °C): = (1.5 °C / 0.3 °C) = 5:1

***Caution*:** The instructions in this Calibration Procedure relate specifically to the equipment and conditions listed in this section. If other equipment is substituted, the information and instructions must be interpreted accordingly.

Table 2-5 Calibration Environment and Warm-Up Requirements

Measurement Standards & Support Equipment Environmental Requirements:	Temperature: 23 ± 5° C. Relative Humidity: Less than 95% Barometric Pressure 30 ± 1.5 in Hg (1016 ± 50mbar)
Measurement Standards & Support Equipment Warm-up and Stabilization Requirements:	Thunder Scientific Humidity Generator: 60 minutes EDL STS-SC2 surface temperature calibrator: 15 minutes

3 Preliminary Operations

Note: Review the entire document before starting the calibration process.

3.1 Visual Inspection

3.1.1 Damage or excess wear must be repaired prior to beginning the calibration process.

3.1.2 Visually inspect the UUC for:

- Wear or damage to the probe body or tip
- Missing parts
- Proper identification

3.2 If the probe has a protective cap, remove it before proceeding.

4 Humidity and Air Temperature Calibration Process

Refer to UUC and equipment instruction manual(s) for menu navigation instructions, details on features and operating instructions.

Note: Whenever a test requirement is not met as indicated in table 6-1, verify the results of the test and take corrective action before proceeding.

4.1 Attach the probe(s) to the adapter cable connectors in the humidity chamber. Multiple probes can be calibrated in the chamber simultaneously. Make note of what probe is attached to which body. Record the probe serial number(s) and the Barometric pressure (mbars).

Note: If adapter cables are not available, the entire Gage/Probe combination can be placed in the chamber. The gage would need to be set in data logging mode to obtain the readings. Refer to the gage user manual on how to set data logging mode.

4.2 Adjust the set point of the humidity chamber to 35 %RH and allow to stabilize for at least 60 minutes. After the stabilization time turn on the gage(s), wait about 1 minute to verify

the reading is stable, and record the gage and the chamber relative humidity and the gage and chamber air temperature readings.

Note: When turning on the gage do not perform a full reset.

4.3 Adjust the set point of the humidity chamber to 65 %RH and allow to stabilize for at least 60 minutes. After the stabilization time turn on the gage(s), wait about 1 minute to verify the reading is stable, and record the gage and the chamber relative humidity readings. Turn off the gage and disconnect the probe(s) from the connectors in the chamber.

5 Surface Temperature Calibration (DPM only)

5.1 Prepare an ice bath using distilled water per ASTM E 563-11. Connect the thermocouple to TC1 of the surface temperature calibrator, the ice bath and the Keithley 2000 Multimeter.

5.2 Set the surface temperature calibrator to 40 °C and allow to stabilize for at least 15 minutes.

5.3 Connect the probe to a body and turn on the gage. Place the DPM Probe on the center of the top surface of the surface temperature calibrator for 15 seconds and record the highest readings for the Keithley 2000 Multimeter* and the gage.

Note: The multimeter readings must be adjusted by the surface temperature offsets as indicated on the surface temperature calibrator calibration certificate.

5.4 Repeat steps 5.2 & 5.3 for 100 ^{o}C.

6 Performance Requirements

Note: The technician will collect the data needed to complete columns D and E. The technician shall then calculate the values for Column F and record all information as shown in table 6-1. Do not write in this procedure.

Table 6-1 Requirements and Calibration Data for DeFelsko PosiTector DPM & DPMD Probes

Reference (A)	Units (B)	Set Point (C)	Test Equipment Reading (D)	Gage Reading (E)	Probe Measurement Accuracy (F)	Allowable Tolerance (G)
Relative Humidity	%RH	35				± 3.0
Ambient Temperature	°C	N/A				± 0.5
Relative Humidity	%RH	65				± 3.0
Surface Temperature Low	°C	40				± 0.5
Surface Temperature High	°C	100				± 1.5

Note: To convert from °C to °F → $T_{\circ F} = 1.8 * T_{\circ C} + 32$

Management Procedure Change Notice

Procedure Number: MP 2581
Revision Level: E
Date of Change: May 26, 2023
Title: Calibration Procedure for DeFelsko PosiTector Dew Point Meter DPM & DPMD Probes

Reason for Change:

- Updated Tables

Description of Change:

- In Table 2-1 and 2-2 - Added the greater that (>)symbol to Surface Temperature ranges
- In Table 2-3 - Changed Thunder Scientific Model 1200 to Thunder Scientific Model 2500
- In Table 2-4 - Changed EDL STS-SC2 Calibrator 40 °C accuracy of 0.016 °C to 0.16 °C (+ associated accuracy formula)

I confirm I have read and understand the procedure and the change described above.

Printed Name	Signature	Date

Management Form 0010.02-05/1998