

Management Procedure 2587 Revision: D Date Issued: December 3, 2019 Date Revised: June 13, 2024

Calibration Procedure

DeFelsko PosiTector Dew Point Meter Logger (DPML and DPML Plus) Probe

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1 Introduction and UUC Performance Requirements

1.1 This procedure describes the calibration of the DeFelsko PosiTector Dew Point Meter Logger (DPML and DPML Plus) probe with the following specifications:

| Tuble 1 1 Wedstrement Ranges | | | | | |
|------------------------------|------------------------------|---------------|--|--|--|
| Function | Measurement Range | Resolution | | | |
| Air Temperature | -10 to 60 °C (14 to 140 °F) | 0.1°C (0.1°F) | | | |
| Relative Humidity | 0 to 100% RH | 0.1% | | | |
| Surface Temperature | -10 to 100 °C (14 to 212 °F) | 0.1°C (0.1°F) | | | |

Table 1-1 Measurement Ranges

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 >0 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.

| UUC Function | Range | Accuracy | Test Method |
|---------------------|------------------------------|-----------------------------------|------------------------|
| Air Temperature | -10 to 60°C (14 to 140°F) | $\pm 0.5^{\circ}C (0.9^{\circ}F)$ | Humidity Concreter |
| Relative Humidity | 0 to 100% RH | ± 3.0 % | Humany Generator |
| | -10 to 0°C (14 to 32°F) | ± 1.5°C (2.7°F) | |
| Surface Temperature | >0 to 80°C (>32 to 176°F) | $\pm 0.5^{\circ}C (0.9^{\circ}F)$ | Temperature Calibrator |
| | >80 to 100°C (>176 to 212°F) | $\pm 1.5^{\circ}C (2.7^{\circ}F)$ | |

Table 2-1 UUC Accuracy Requirements and Description

| - · · · · · · · · · · · · · · · · | | | | | | |
|-----------------------------------|------------------------------|-------------------------------------|--|--|--|--|
| Function | Range | Accuracy | | | | |
| Air temperature | -10 to 60°C (14 to 140°F) | $\pm 0.12^{\circ}C (0.22^{\circ}F)$ | | | | |
| Relative Humidity | 0 to 100% RH | $\pm 0.75\%$ | | | | |
| | -10 to 0°C (14 to 32°F) | ± 0.37°C (0.67°F) | | | | |
| Surface Temperature | >0 to 80°C (>32 to 176°F) | ± 0.12°C (0.22°F) | | | | |
| | >80 to 100°C (>176 to 212°F) | $+0.37^{\circ}C(0.67^{\circ}F)$ | | | | |

Table 2-2 Minimum Use Specifications

| | Actual Equipment Specifications | | |
|---|---------------------------------|--------------------------|--|
| Manufacturer/Model #'s Applicable | 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 | $\pm 0.5\%$ | |

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

| Table 2-4 Actual | Surface | Temperature | Test E | quipment | Specifications |
|------------------|---------|-------------|--------|----------|----------------|
| | | | | 1 1 | 1 |

| Equipment Name | Actual Equipment Specifications | | |
|-----------------------------------|---------------------------------|-------------------|--|
| Manufacturer/Model #'s Applicable | Range | Accuracy | |
| 1. Type K Thermocouple | -200 – 1250 °С | 0.138°C | |
| | (-328 – 2282 °F) | | |
| 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 \rightarrow 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 @ $40^{\circ}C = (Thermocouple^2 + Bath^2 + Keithley^2 + Surface plate^2)^{0.5}$ = $(0.138^2 + 0.05^2 + 0.089^2 + 0.16^2)^{0.5}$ = $0.23 \ ^{\circ}C$ Surface Temperature Uncertainty Ratio (-40 to 80 \ ^{\circ}C) := $(0.5 \ ^{\circ}C / 0.23 \ ^{\circ}C) = 2.2:1$

Surface Temperature Combined Accuracy @ $100^{\circ}C = (Thermocouple^2 + Bath^2 + Keithley^2 + Surface plate^2)^{0.5}$ = $(0.138^2 + 0.05^2 + 0.090^2 + 0.25^2)^{0.5}$ = $0.30 ^{\circ}C$ Surface Temperature Uncertainty Patie (80 to 100 ^{\circ}C) = $(1.5 ^{\circ}C / 0.3 ^{\circ}C) = 5.1$

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.

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

Table 2-5 Calibration Environment and Warm-Up Requirements

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 Remove the battery cap, insert a battery and replace the cap.
- 3.3 Using a smart device, launch the PosiTector SmartLink app and verify the device detects the probe. Also verify the probe has at least 25% battery.

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 <u>before</u> proceeding.

- 4.1 Place the probe(s) in the humidity chamber. Multiple probes can be calibrated in the chamber simultaneously but the area with the sensor filter cannot be blocked. Record the probe serial number(s) and the Barometric pressure (mbars).
- 4.2 Adjust the set point of the humidity chamber to 35 % RH and allow to stabilize for at least 2 hours. After the stabilization time record the chamber <u>relative humidity</u> and <u>air</u> <u>temperature</u> readings. Use a smart device to access the UUC as describe in section 3.3. Record the UUC <u>relative humidity</u> and <u>air temperature</u>.

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

- Adjust the set point of the humidity chamber to 65 % RH and allow to stabilize for at least 2 hours. After the stabilization time record the chamber <u>relative humidity</u> reading. Use a smart device to access the UUC as describe in section 3.3. Record the UUC <u>relative humidity</u>.
- 4.4 Remove the probe(s) from the chamber and proceed to the surface temperature calibration.

5 Surface Temperature Calibration

- 5.1 Prepare an ice bath using distilled water per ASTM E563-11. 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 Place the DPML Probe on the center of the top surface of the surface temperature calibrator until the probe and meter readings stabilize then record the readings for the probe per 3.3 and the Keithley 2000 Multimeter*.

**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 °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.

| 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 |

Table 6-1 Requirements and Calibration Data for DeFelsko PosiTector DPML Probes

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

Management Procedure Change Notice

Procedure Number: MP 2587 Revision Level: D Date of Change: June 13, 2024 Title: Calibration Procedure for DeFelsko PosiTector Dew Point Meter Logger (DPML) Probe

Reason for Change:

- Add DPML Plus references
- Change accuracy statement for Ts < 0

Description of Change:

- In section 2.2 changed -10 to >0
- In Table 2-1 and 2-2 Updated Ts ranges
- In Table 2-1 and 2-2 –adjusted °F tolerance statements to increased significant digits
- Add DPMLS Plus to section 1.1

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

| Printed Name | Signature | Date |
|--------------|-----------|------|
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