DeFelsko®

Calibration Procedure

DeFelsko PosiTest Oven Temperature Logger (OTL)

Table of Contents

1 Introduction and UUC Performance Requirements

1.1 This procedure describes the calibration of the DeFelsko PosiTest Oven Temperature Logger (OTL) with the following specifications:

Table 1-1 Measurement Ranges

Function	Measurement Range	Resolution
Temperature	-100 to 1000°C (-148 to 1832°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.

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
Temperature	-100 to 1000°C (-148 to 1832°F)	± 0.5°C (±0.9°F)	Temperature Calibrator

Table 2-2 Minimum Use Specifications

Function	Range	Accuracy
Temperature	-100 to 1000°C (-148 to 1832°F)	± 0.125°C (0.225°F)

Table 2-3 Actual Equipment Specifications

Equipment Name Manufacturer/Model #'s Applicable	Actual Equipment Specifications	
	Range	Accuracy
Type K compensator (cold junction)	0°C (32°F)	0.05°C (0.9°F)
Keithley DMM6500 Multimeter	Up to 100 mV	See below

Keithley DMM 6500 Multimeter accuracy calculation
From ASTM E230 Table 14 for Type K Thermocouple
Temperatures at 0°C (0.000mV), 250°C (10.153mV) and 450 °C (18.516mV)
Scale Range → 100 mV with 1 year accuracy = 30 ppm of reading + 35 ppm of range
Accuracy @ 0°C   = (30 ppm x 0.000mV) + (35 ppm x 100 mV)

$$= 3.500 \text{uV}$$
$$= 3.500 \text{uV}/(39 \text{ uV } /°C)$$
$$= 0.090°C$$

Accuracy @ 250°C
$$= (30 \text{ ppm x } 10.153 \text{ mV}) + (35 \text{ ppm x } 100 \text{ mV})$$
$$= 3.805 \text{uV}$$
$$= 3.805 \text{uV}/(41 \text{ uV } /°C)$$
$$= 0.093 °C$$

Accuracy @ 450°C
$$= (30 \text{ ppm x } 18.516 \text{ mV}) + (35 \text{ ppm x } 100 \text{ mV})$$
$$= 4.055 \text{uV}$$
$$= 4.055 \text{uV}/(42 \text{ uV } /°C)$$
$$= 0.097 °C$$

Emf to °C formula error $= 0.05°C$ per ASTM E230 Table 46

Ice Bath accuracy= 0.002°C per ASTM E563

OTL ADC resolution $= 0.001°C$

Combined Temperature Accuracy @ 0°C $= (DMM6500^2 + \text{Formula Error}^2 + \text{Bath}^2 + \text{Thermocouple}^2 + ADC^2)^{0.5}$
$$= (0.090^2 + 0.05^2 + 0.002^2 + 0.05^2 + 0.001^2)^{0.5}$$
$$= 0.115°C$$

Combined Temperature Accuracy @ 250°C $= (DMM6500^2 + \text{Formula Error}^2 + \text{Bath}^2 + \text{Thermocouple}^2 + ADC^2)^{0.5}$
$$= (0.093^2 + 0.05^2 + 0.002^2 + 0.05^2 + 0.001^2)^{0.5}$$
$$= 0.117°C$$

Combined Temperature Accuracy @ 450°C $= (DMM6500^2 + \text{Formula Error}^2 + \text{Bath}^2 + \text{Thermocouple}^2 + ADC^2)^{0.5}$
$$= (0.097^2 + 0.05^2 + 0.002^2 + 0.05^2 + 0.001^2)^{0.5}$$
$$= 0.120°C$$

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 2-4 Calibration Environment and Warm-Up Requirements

Measurement Standards & Support Equipment Environmental Requirements:	Temperature: $23 \pm 5°C$. Relative Humidity: Less than 95% Barometric Pressure 30 ± 1.5 in Hg $(1016 \pm 50 \text{mbar})$
Measurement Standards & Support Equipment Warm-up and Stabilization Requirements:	Keithley DMM 6500: 30 minutes Ice Bath: 15 minutes

3   Preliminary Operations

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

3.1   Visual Inspection
3.1.1   Visually inspect the UUC for:
- Wear or damage to the probe body or tip

- Missing parts
- Proper identification

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

3.2 Prepare an ice bath per ASTM E563. Connect the ice bath compensator lead to the Keithley DMM6500 Multimeter. Make sure to allow time for the multimeter to warm up and the ice bath to stabilize.

Figure 3-1

3.3 If you do not already have it, contact DeFelsko (www.defelsko.com) to obtain and install the OTL calibration program on a computer running Windows. Open the OTL Calibration program.

3.4 Remove any batteries from the UUC before proceeding. Press and hold the Power and Record buttons then connect the UUC to the computer USB cable. Once the UUC is plugged in, the buttons can be released.

4 Calibration

4.1 Connect the FLUKE 917 to channel 1 of the UUC.

4.2 Set the Fluke 917 to simulate 0^oC, Record the UUC reading (^{o}C) as shown in the OTL Calibration software and multimeter voltage (mv).

Figure 4-1

S/N	T1	T2	T3	T4	T5	T6
976266	0.0	-1023.0	-1023.0	-1023.0	-1023.0	-1023.0

4.3 Set the Fluke 917 to simulate 250^oC, record the multimeter voltage and the UUC reading.

4.4 Set the Fluke 917 to simulate 450^oC, record the multimeter voltage and the UUC reading.

4.5   Repeat steps 4.2 – 4.4 until 5 readings have been obtained for each of the three set points.

4.6   Repeat steps 4.2 – 4.5 for the other 5 channels.

5   Performance Requirements

Note: The technician will collect the data needed to complete the readings. The technician shall then calculate the average values and record all information as shown in table 5-1. Do not write in this procedure.

Table 5-1 Calibration Data for DeFelsko PosiTest OTL

Channel	Set Point (^{o}C)	Reading 1 (^{o}C) / (mv)	Reading 2 (^{o}C) / (mv)	Reading 3 (^{o}C) / (mv)	Reading 4 (^{o}C) / (mv)	Reading 5 (^{o}C) / (mv)	Average (^{o}C) / (mv)
1	0	/	/	/	/	/	/
1	250	/	/	/	/	/	/
1	450	/	/	/	/	/	/
2	0	/	/	/	/	/	/
2	250	/	/	/	/	/	/
2	450	/	/	/	/	/	/
3	0	/	/	/	/	/	/
3	250	/	/	/	/	/	/
3	450	/	/	/	/	/	/
4	0	/	/	/	/	/	/
4	250	/	/	/	/	/	/
4	450	/	/	/	/	/	/
5	0	/	/	/	/	/	/
5	250	/	/	/	/	/	/
5	450	/	/	/	/	/	/
6	0	/	/	/	/	/	/
6	250	/	/	/	/	/	/
6	450	/	/	/	/	/	/

To convert the multimeter mv readings to ^{o}C use the formula from ASTM E230 Table 46.
$T = C_0 + C_1E + C_2E^2 + C_3E^3 \ldots + C_nE^n$ where E is the mv readings and C are coefficient listed below for voltages 0.0 to 20.644mv.

C0	0.0
C1	2.508355×10^{1}
C2	7.860106×10^{-2}
C3	-2.503131×10^{-1}
C4	8.315270×10^{-2}
C5	-1.228034×10^{-2}
C6	9.804038×10^{-4}
C7	-4.413030×10^{-5}
C8	1.057734×10^{-6}
C9	-1.052755×10^{-8}

Management Procedure Change Notice

Procedure Number: MP 2589
Revision Level: A
Date of Change: August 21, 2020
Title: Calibration Procedure for DeFelsko PosiTest Oven Temperature Logger (OTL)

Reason for Change:
• New product

Description of Change:
• New procedure

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

Printed Name	Signature	Date

Management Form 0010.02-05/1998