DeFelsko®

Management Procedure 2553
Revision: C
Date Issued: October 9, 2014
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Calibration Procedure

Certified SPG Standards

Table of Contents

1 Introduction and UUC Performance Requirements

1.1 This procedure describes the calibration of DeFelsko Corporation Certified SPG Standards.

Table 1-1

Measurement Range
0 - 500 microns (0 - 20 mils)

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 The 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

Range	Performance Specifications	Test Method
0 - 500 microns (0 - 20 mils)	± 1.25 microns (± 0.05 mils)	Height Gage

Table 2-2 Minimum Use Specification

Range	Accuracy
0 - 500 microns (0 - 20 mils)	± 0.31 microns (± 0.01 mils)

Table 2-3 Actual Equipment Specification

Equipment Generic Name	Range	Accuracy	Manufacturer/Model #'s Applicable
Height Gage	0 – 25.4 mm (0 – 1")	± 0.10 microns (± 0.004 mils)	Heidenhain CT2501 with ND287 display

***Caution*:** The instructions in this Calibration Procedure relate specifically to the equipment and conditions listed in Section 2. If other equipment is substituted, the information and instructions must be interpreted accordingly.

Table 2-4 Calibration Environmental and Warm-up Requirements

Measurement Standards & Support Equipment Environmental Requirements:	Temperature: 23 ± 5° C. Relative Humidity: Less than 95%
Measurement Standards & Support Equipment Warm-up and Stabilization Requirements:	15 minutes

2.4 Examination of the measurement system uncertainty

2.4.1 One source of uncertainty is the change in thickness due to the temperature variation.

The temperature of the laboratory is controlled to ± 5°C. The coefficient of thermal expansion for sapphire is $5x10^{-6}$ °C. The sapphire plate is nominally 2032 um thick so the worst case expansion is $5x10^{-6}$ °C * 2032 um * 5°C = ± 0.05 um.

The coefficient of thermal expansion for the steel plate is $12.2x10^{-6}$ °C. The deepest pocket of the steel plate is 2540 um thick so the worst case expansion is $12.2x10^{-6}$ °C * 2540 um * 5 °C = ± 0.15 um.

Since both materials are expanding in the same direction it is actually the difference between the two that is desired so 0.15 um – 0.05 um = ± 0.1um.

2.4.2 The uncertainty of the height gage as previously stated is ± 0.1 um.

2.4.3 Using the sum of squares method the standard uncertainty of the measurement system is as follows:

$= ((\text{temp change})^2 + (\text{height gage})^2)^{0.5}$
$= ((0.1)^2 + (0.1)^2)^{0.5}$
$= 0.14$um

2.5 Factors Determining Accuracy

2.5.1 The best stated accuracy for any SPG probe is ± (5 um +5%) or ± 5 um at zero so the minimum required accuracy for the standard is ± 1.25 um as indicated in table 2-1.

The height gage is zeroed to the top surface of the steel plate so the variation in the plate surface determines the accuracy. Based on design specifications, the plate surface variation is ± 0.56 um over the diameter of the SPG probe foot.

Measurements are taken at the center of the sapphire plate so the parallelism of the steel surface supporting the sapphire or the sapphire surfaces themselves is not a factor.

Since the plate variation is less than the minimum product requirement the product specification is set to ± 1.25 um.

3 Preliminary Operations

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

3.1 For recertified product remove the plastic feet from the bottom of the steel plate so it will sit level. Clean off any adhesive residue using a cotton swab and alcohol or adhesive remover.

3.2 Inspect the top and bottom surfaces of the steel and sapphire plates for defects that could impact accuracy such as pits, burrs, contamination or corrosion.

3.3 Using a cotton swab and alcohol clean the top and bottom surfaces of the steel plate and the top surfaces of the sapphires.

4 Calibration Process

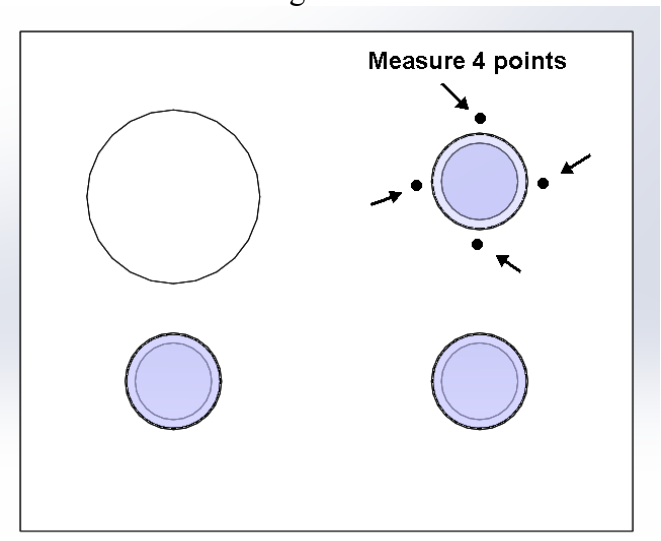
Note: Whenever the test requirement is not met, verify the results of each test and take corrective action before proceeding.

4.1 For new product review the Performance Requirements in Table 5-1. For standards being recertified record the thickness values in microns from the standard labels in column (A) of Table 5-2.

4.2 Take a height reading on the top of the steel plate within 3 mm (0.125”) of the hole of the first sapphire plate to be measured. Set this as the reference point by pressing “Reset” on the ND 287 display.

4.3 Take three additional readings at equal intervals around the hole. This will determine the errors due to the steel plate parallelism.

Figure 4-1



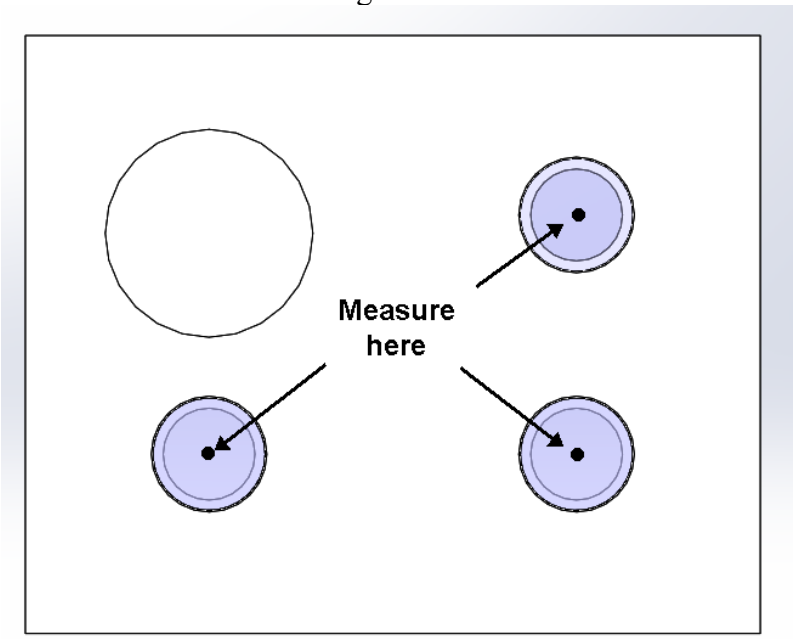
4.4 Verify the range of the readings is less than or equal to 1.32 microns. If the readings exceed this verify the measurement surfaces are clean and repeat steps 4.2 - 4.4.
Note: The specification of 1.32 microns is based on the parallelism of the plate as indicated in section 2.5.1 and the CT2501 accuracy.

4.5 To evenly distribute the errors from the plate parallelism, determine the midpoint of the readings. Set this as the reference point by lowering the measurement probe to the steel surface then press “Reset” on the ND 287 display.

For example, for the readings of 0.00, 0.70, 0.20 and -0.30 microns, the range is 1.00 micron. To evenly distribute the parallelism error to ± 0.5 microns, you need to re-zero the height gage at a reading of 0.20 microns. This makes the previous readings become -0.2, 0.5, 0.0 and -0.5 respectively.

4.6 Slide the UUC so the sapphire plate being measured is centered under the measurement probe.

Figure 4-2



4.7 Lower the probe and record the reading in the appropriate table in section 5, record all the digits displayed.

4.8 Raise the probe and repeat step 4.7 for a total of three readings.

4.9 Calculate the average and range of the three readings and round to the nearest 0.1 micron.

4.10 Verify the range of the readings is less than or equal to 0.2 microns, this is based upon the accuracy of the CT2501.

4.11 For recertification verify the average is within ± 1.25 microns of the labeled value.

4.12 Repeat steps 4.2 - 4.11 for the two remaining sapphire plates.

4.13 For recertified product re-attach the plastic feet to the bottom of the steel plate.

5 Performance Requirements

Note: The technician shall collect the data needed to complete the appropriate table below. Do not write in this procedure.

Table 5-1 Performance Requirements and Data

Nominal (microns)	Measurement 1 (microns)	Measurement 2 (microns)	Measurement 3 (microns)	Average (microns)	Range (microns)
51					
118					
508					

Range ≤ to 0.2 microns.

Table 5-2 Recertification Requirements and Data

Standard Thickness (microns)	Measurement 1 (microns)	Measurement 2 (microns)	Measurement 3 (microns)	Min. allowed (microns)	Max. allowed (microns)	Average (microns)	Range (microns)
A						B	

Min. allowed = A – 1.25 microns.
Max. allowed = A + 1.25 microns.
Range ≤ 0.2 microns.

Management Procedure Change Notice

Procedure Number: MP 2553
Revision Level: C
Date of Change: April 18, 2019
Title: Calibration Procedure, Certified SPG Standards

Reason for Change: • Update for clarification
Description of Change: • Update table 2-2 • Update table 2-4 • Complete re-write of section 2.4 and added 2.5 • Reworded section 4.1 • Update sections 4.4 based on section 2.5 • Update section 4.10 and 4.11 and notes in tables 5-1 and 5-2

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

Printed Name	Signature	Date

Management Form 0010.02-05/1998