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Federal Institute of Metrology METAS

Test report No 111-18954

Object	**Goniometer G-01L** Manufacturing date 10.2019 Serial No. 191001
Order	Performance test according to procedure as specified by the applicant
Applicant	**ZG Optique SA** Fin-de-Praz 24 CH-2024 St. Aubin
Traceability	The reported measurement values are traceable to national standards and thus to internationally supported realizations of the SI-units.
Date of test measurements	27 November 2019
Marking	Calibration label METAS 11.2019

CH-3003 Bern-Wabern, 4 December 2019

For the Measurements	Dr Rudolf Thalmann
Approved by	Dr Felix Meli, Head of Laboratory Laboratory for length, nano- und microtechnology

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Test procedure and conditions

The measurements and the evaluation of the data have been carried out according to a procedure specified by the applicant (see appendix to this report). The optical polygon used for these measurements was 8-sided, from glass, and calibrated at METAS at the same time using independent equipment (certificate no 111-18953). The entire procedure was performed two times. In the following, the results of the second measurement are reported.

The laboratory temperature during the measurements was (20 ± 0.5) °C.

Measurement results

Average standard deviation

u_1 = 0.024"

Type B uncertainty contributions

u_2 = 0.06"

u_3 = 0.035"

Combined standard uncertainty

u_c = 0.07"

Comparison of polygon measurements

Pitch angles between adjacent faces

Position	$\tilde{\varphi}_i$ (G-01L)	φ_i^{tr} (METAS)	$\delta = \tilde{\varphi}_i - \varphi_i^{tr}$
1-2	−0.13	−(0.10 ± 0.10)"	−0.04"
2-3	0.81	(0.83 ± 0.10)"	−0.01"
3-4	1.88	(1.82 ± 0.10)"	0.06"
4-5	−0.81	−(0.76 ± 0.10)"	−0.05"
5-6	−1.97	−(1.99 ± 0.10)"	0.01"
6-7	0.35	(0.35 ± 0.10)"	0.00"
7-8	−0.27	−(0.29 ± 0.10)"	0.01"
8-1	0.10	(0.13 ± 0.10)"	−0.03"

Appendix to Test Report No 111-18954

Test procedure for Automatic Goniometer GA-1L in goniometer mode

1. The procedure of the performance test should be carried out by means of standard n-faced optical polygon (OP) calibrated by the Federal Institute of Metrology (METAS) or by the Physikalisch-Technische Bundesanstalt (PTB).

2. The procedure of performance test considers the evaluation of the following parameters:
   - Standard uncertainty;
   - Combined standard uncertainty.

3. The central angles φ_i of the OP are measured.

4. The OP is turned relative to the rotary table by the nominal angle between two adjacent faces of the OP.

5. The central angles of the OP are measured again.

6. Then the points 4 and 5 are repeated until n measurement are made, where n is the number of the OP faces. As a result, we get an array of angle values φ_{im} where i is a number of angle between faces i and $i + 1$, and m is the number of the OP position.

7. The mean values of the angle $\tilde{\varphi}_i$s are estimated using the averaging upon the different positions of the OP:

$$\tilde{\varphi}_i = \frac{1}{n}\sum_{m=1}^{n}\varphi_{im}$$

8. The uncertainty (type A) is determined as average of standard deviations σ_{im} over all faces and all positions

$$u_1 = \sqrt{\frac{\sum\limits_{i}^{n}\sum\limits_{m}^{n}\sigma_{im}^2}{n\cdot n}}$$

9. The uncertainty (type B) is determined as

$$u_2 = \frac{\max|(\tilde{\varphi}_i - \varphi_{im})|}{\sqrt{3}},$$

$$u_3 = \frac{\max|(\tilde{\varphi}_i - \varphi_i^{tr})|}{\sqrt{3}}$$

   where φ_i^{tr} are the METAS calibrated values of central angles of the OP.

10. The combined standard uncertainty is determined as

$$u_c = \sqrt{u_1^2 + u_2^2 + u_3^2}$$

Note*: The single measurement for G-01L is considered as the measurement during 16 revolutions of the rotary table. φ_{im} and σ_{im} are the results of the single measurement of the central angle value and the standard deviation, correspondingly.*

Prof. Dr. Yuri Filatov