



Test report No 111-01519


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| <i>Object</i> | Goniometer GA-1L 11.2004 Serial no: 09030302 |
| <i>Order</i> | Performance test according to procedure as specified by the applicant |
| <i>Applicant</i> | ZG Optique SA Fin-de-Praz 24 CH-2024 St. Aubin |
| <i>Traceability</i> | The reported measurement values are traceable to national standards and thus to internationally supported realizations of the SI-units. |
| <i>Date of test measurements</i> | 16 May 2006 |
| <i>Marking</i> | Calibration label METAS 05.2006 |

CH-3003 Bern-Wabern, 16 May 2006

For the measurements

Section Length, Optics and Time


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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 111-01518). 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 $(20 \pm 0.5) ^\circ\text{C}$.

Measurement results

Average standard deviation

$$u_1 = 0.026''$$

Type B uncertainty contributions

$$u_2 = 0.104''$$

$$u_3 = 0.019''$$

Combined standard uncertainty

$$u_c = 0.11''$$

Comparison of polygon measurements

Pitch angles between adjacent faces

| Position | $\tilde{\varphi}_i$ (GA-1L) | φ_i^{tr} (METAS) | $\delta_i = \tilde{\varphi}_i - \varphi_i^{tr}$ |
|----------|-----------------------------|--------------------------|---|
| 1-2 | 1.93'' | $(1.94 \pm 0.1)''$ | -0.01'' |
| 2-3 | 0.91'' | $(0.91 \pm 0.1)''$ | 0.00'' |
| 3-4 | -0.20'' | $-(0.17 \pm 0.1)''$ | -0.03'' |
| 4-5 | 0.09'' | $(0.08 \pm 0.1)''$ | 0.01'' |
| 5-6 | -0.20'' | $-(0.23 \pm 0.1)''$ | 0.03'' |
| 6-7 | 0.31'' | $(0.32 \pm 0.1)''$ | -0.01'' |
| 7-8 | -2.01'' | $-(2.02 \pm 0.1)''$ | 0.01'' |
| 8-1 | -0.83'' | $-(0.82 \pm 0.1)''$ | -0.01'' |



Appendix to Test Report No 111-01519

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 Swiss Federal Office of Metrology (METAS).
2. The procedure of performance test considers the evaluating of the following parameters:
 - Standard uncertainty,
 - Combined standard uncertainty.
3. The central angles of the OP φ_i are measured.
4. The OP is turned in relation to the rotary table on the angle that is equal to the nominal value of the central angle of the OP.
5. The central angles of the OP are measured again.
6. Then the points 4 and 5 are carried out again and so on until n measurement are made, where n is the number of the OP faces. As a result we have 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 angles $\tilde{\varphi}_i$ 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

$$u_1 = \sqrt{\frac{\sum_i^n \sum_m^n \sigma_{im}^2}{n \cdot n}}$$

9. The uncertainty (type B) is determined as

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

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

Where φ_i^r are the true values of central angles obtained at calibration 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 GA-1L is considered as the measurement during 16 revolutions of the rotary table. φ_{im} , σ_{im} are the results of the single measurement the central angle value and the standard uncertainty, correspondingly.

Prof. Dr. Yuri Filatov