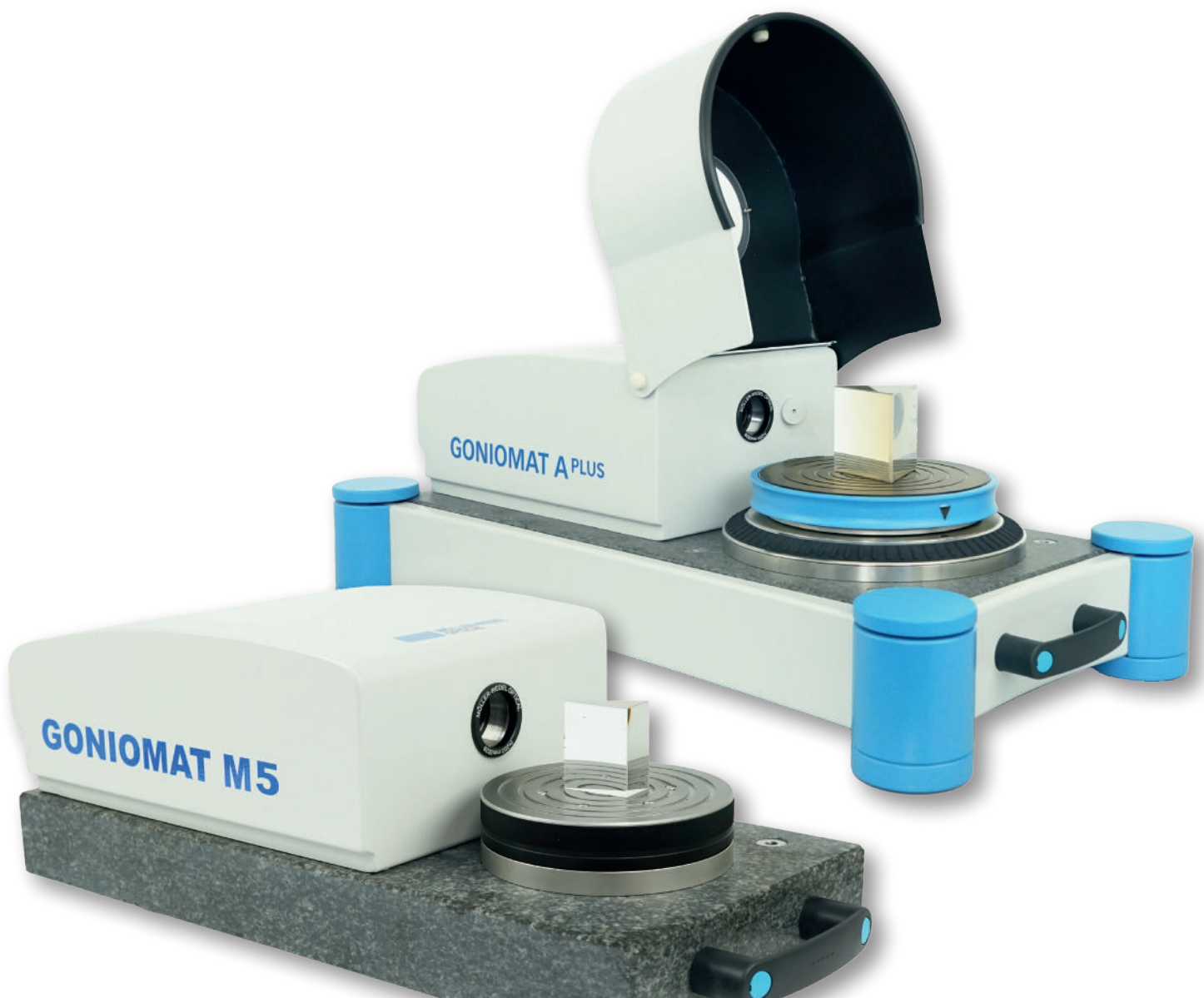




GONIOMAT Product Series

High-Precision Goniometer for Optical
Angle Measurement

Instruments You Can Trust

HS MÖLLER-WEDEL
OPTICAL



Möller-Wedel Optical GmbH

High-Precision Optical Measurement Systems

Möller-Wedel Optical GmbH is an internationally active company headquartered in Wedel, near Hamburg. For over 50 years, we have been developing, manufacturing, and distributing high-precision optical measurement systems for applications including mechanical engineering, the automotive and semiconductor industries, the optical industry, film camera services, and calibration and research laboratories.

Our systems enjoy an excellent reputation worldwide – thanks to technical excellence, durability, and true precision. As a company certified to DIN EN ISO 9001:2015, we stand for reliable quality at the highest level.

What drives us: We don't just want to supply measuring instruments; we want to create solutions – tailored, flexible, and based on a deep understanding of our customers' requirements. Our interdisciplinary team of experts in technical optics, optoelectronics, metrology, physics, and precision engineering continuously works on new developments to reliably solve even complex measurement tasks.

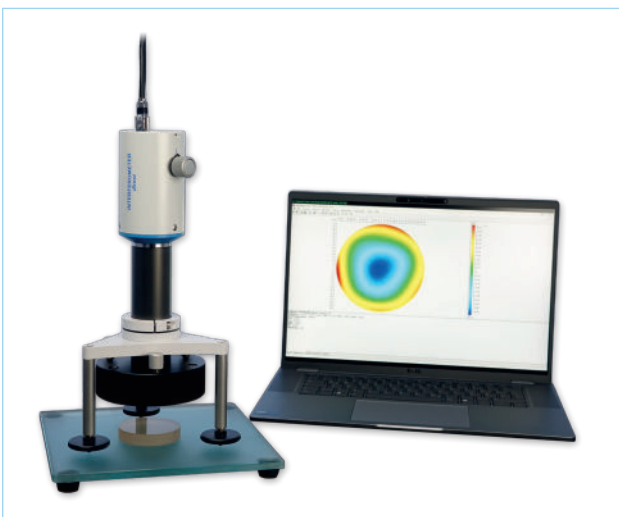
In doing so, we combine state-of-the-art technologies with traditional craftsmanship for technical solutions that set the standard today and in the future.



Electronic Autocollimators



High-Precision Goniometers



Fizeau Interferometer

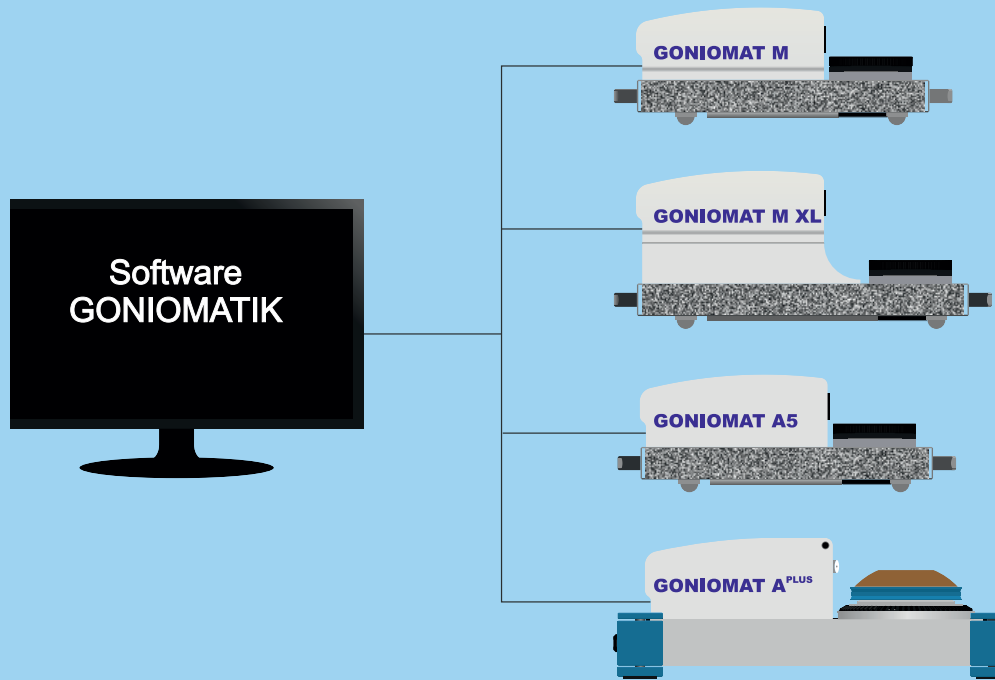


Visual Optical Instruments

GONIOMAT

Product Series Overview

High-precision goniometers from the GONIOMAT product series are an indispensable measuring instrument for manufacturing and quality control. They enable the measurement and inspection of angles on optical prisms, polygon mirrors, wedge plates, and angle gauge blocks with measurement accuracies up to 0.4 arcsec. The combination of an angle-encoded precision rotary table, a high-precision electronic autocollimator, and our software-assisted image analysis enables both rapid alignment of the test specimen and high measurement accuracy.



UNIQUE SELLING POINTS OF OUR DEVICES

- Elimination of interfering retroreflections
- Reliable differentiation between double and multiple images
- Special feature: Virtual tilting table for quick measurement without time-consuming alignment of the test specimen
- Low sensitivity to ambient light thanks to a special design
- Patented method for measuring ground surfaces (optional)

ADDITIONAL FEATURES OF OUR DEVICES

- Measurement accuracy up to 0.4 arcsec
- Models with manually or automatically operated rotary tables
- Measurement and calculation of pyramidal errors

ITEMS INCLUDED WITH EACH GONIOMAT

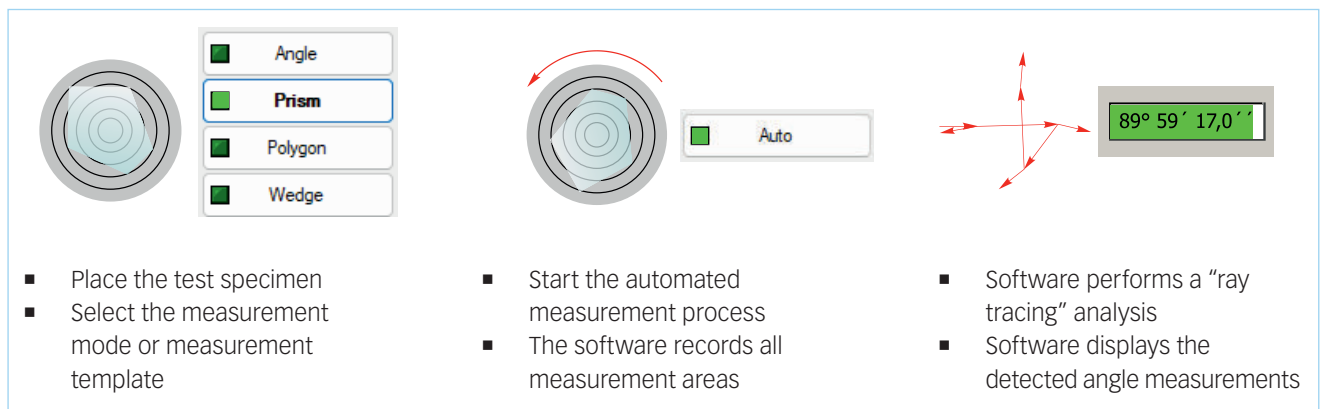
- High-precision electronic autocollimator with a wide measurement range
- High-precision rotary table with integrated angle encoder
- Support table, maintains stable position relative to the rotating unit
- GONIOMATIK Software for evaluation (Excluding a PC running the Windows® operating system)
- Angular standard for calibration verification

GONIOMAT Automated vs. Manual Rotary Table

GONIOMAT A ^{PLUS}, A5

ADVANTAGES OF AN AUTOMATED ROTARY TABLE

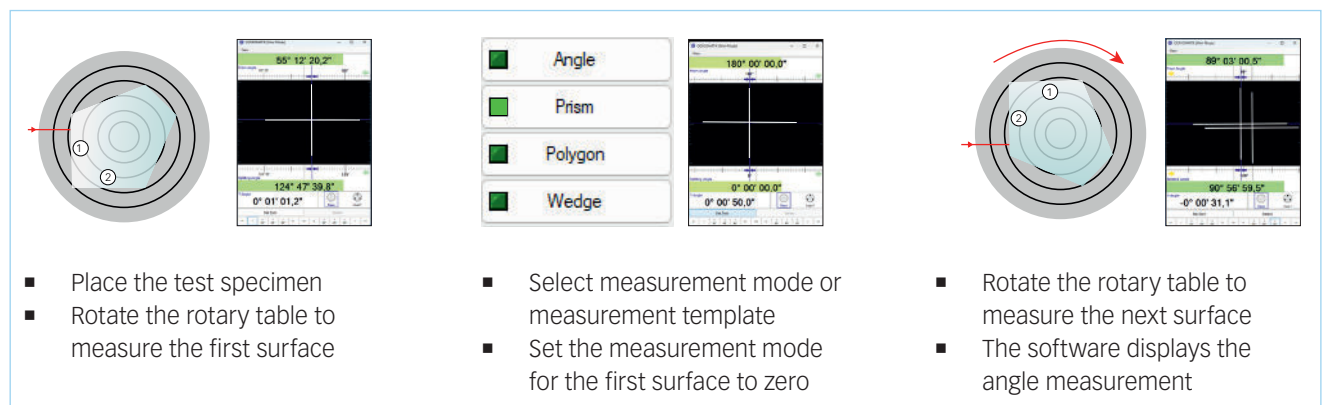
- Fully automated measurement with very low measuring uncertainty
- Inspection of components with high accuracy requirements
- Software-assisted analysis
- Serial inspection for large production batches
- High repeatability
- Maintenance-free drive unit
- High-precision measurement of pyramidal prism angles
- Avoidance of subjective measurement errors through electronic image analysis
- Easy to use measuring system
- Mobile operation thanks to compact design



GONIOMAT M5, M5 XL

ADVANTAGES OF A MANUAL ROTARY TABLE

- Manually operated precision rotary table with low measuring uncertainty
- Particularly suitable for in-process monitoring and incoming and outgoing inspection
- Fast measurement of frequently changing workpiece types
- Accurate measurement of pyramidal prism angles
- Software-assisted analysis
- Avoidance of subjective measurement errors through electronic image analysis
- Easy to use measuring system
- Mobile operation thanks to compact design

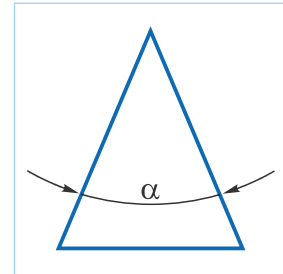


Measuring Tasks

Typical Applications

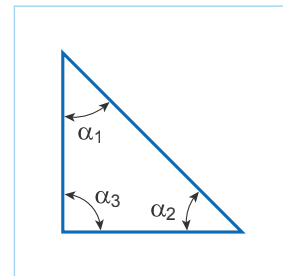
Angular Measurement

During the serial production of prisms and angle gauge blocks, the angle between two surfaces can be measured directly during the manufacturing process. Optionally, the pyramidal prism error relative to the base surface can also be determined. The software evaluates both individual measurements as well as the mean value and standard deviation within a production batch. This enables any necessary process corrections to be identified quickly and implemented directly during production.



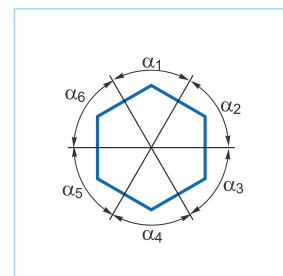
Prism Measurement

To verify the conformity of prisms, all specified angles can be measured and checked in a single measurement process. The reflections from the individual prism surfaces are recorded sequentially, and the GONIOMATIK software automatically calculates the dihedral angles, pyramidal prism angles and deviation angles. In addition to the measurement wavelength, deviation angles can also be calculated and displayed for other wavelengths. The ability to specify tolerance limits simplifies incoming and outgoing inspection processes, enabling fast and reliable verification of prism conformity.



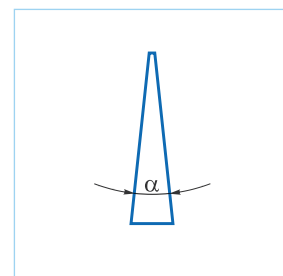
Polygon Mirror Measurement

The division angle between the surfaces of a polygon is determined in accordance with VDI 2605. The GONIOMATIK software calculates and displays the splitting angle of touching surfaces, the cumulative pitch error, as well as the angle referenced to the initial surface and the direction-reduced angle. This allows the angular error of the polygon to be analysed and corrected. To achieve the lowest possible measuring uncertainties, the rosette measurement method is implemented. Optionally, the pyramidal prism error can also be included in the results.



Wedge Angle Measurement

With the GONIOMAT series, parallel-sided plates and wedge plates can be measured using three different evaluation methods: evaluation of the double image in reflection, measurement on a turning plate, or against a mirror in transmission. Depending on the requirements, measurements can be performed with high precision, not affected of refractive index, or quickly. In addition, the direction of the wedge is specified, allowing it to be marked at the same time. The software can also calculate the deflection angle of the wedge.

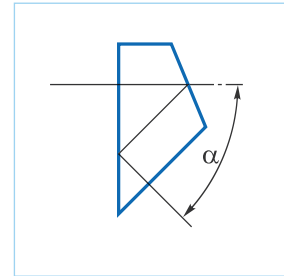


Measuring Tasks

Typical Applications

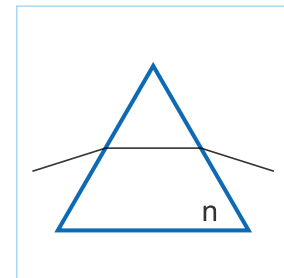
Deflection Angle Measurement

Both individual plano optical components and assemblies can be measured using this method. Here, too, there are three evaluation methods for deviation angle measurement. Depending on the requirements, these methods are highly accurate, simple, or fast. The precise method is comparable to the measurement principle of the "Reeve" method published by NIST (NBSIR 76-993), but unlike the "Reeve" method, it provides the deviation angle in accordance with ISO 10110.



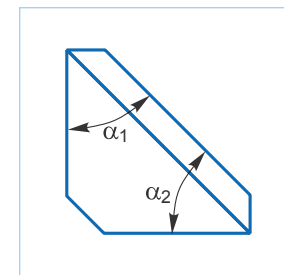
Refractive Index Measurement of Transparent Plano Optics

This method is based on the analysis of optical ray tracing. The refractive index of a prism can be determined using two evaluation methods. The first method is suitable for deviation angles up to 42° , as it is based on the principle of Abbe's refractive index measurement. In the second method, the deflection is measured as the beam passes through. It is not necessary to take a measurement at the minimum deviation. For the measurements, the wavelength of the autocollimator's internal LED is used and extrapolated to the C' line.



Measurement of Roof Prisms

Measurements can be performed on painted surfaces as well as directly on roof edges. This significantly simplifies both the incoming inspection of painted roof-edge prisms and in-process inspection during manufacturing. Internal reflections are used to determine the internal angles. Therefore, there is no need to remove coatings from the prism surfaces, nor is it necessary to attach support prisms or plates to the highly sensitive roof edges.



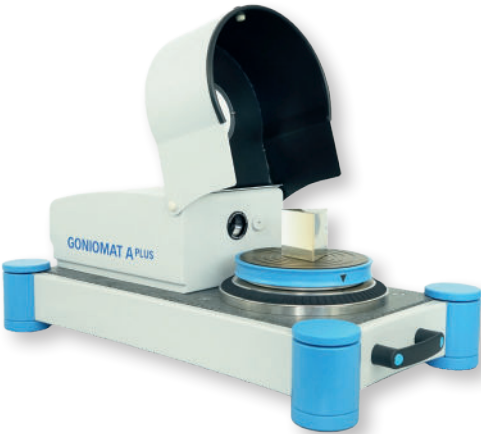
GONIOMAT A PLUS

The High-Precision Solution

Innovation meets fully automated measurement. This is what sets the GONIOMAT A PLUS apart. Test specimens as small as 0.5 mm² can be measured just as easily as those with a diameter of 210 mm. Its accuracy is unmatched in the GONIOMAT product series.

OVERVIEW

- Accuracy for multiple measurements: ± 0.4 arcsec
- Accuracy for individual measurements: ± 0.6 arcsec
- Fully automated measurement
- High-precision rotary bearing
- Backlash-free and maintenance-free drive
- Special feature: integrated laser finder
- Quick adaptation to different test specimens using three interchangeable support tables
- Integrated measuring cell
- Digital evaluation with GONIOMATIK software
- Mobile use thanks to compact design
- Protection against air turbulence via a hinged protective cover
- Can be upgraded for microprisms (see page 17)



Description	Test Field Ø [mm]	Optical Axis Height [mm]	Art. No.
GONIOMAT A PLUS	210	30/14/5	241 661

Scope of Delivery



Description	Usage	Art. No.
Angular standard	For on-site verification and calibration	241 612



Description	Usage	Art. No.
Support table H20	For prisms with a height of >30 mm	241 651
Support table H35	For prisms with a height of 10-40 mm	241 652
Support table H45	For prisms with a height of <15mm	241 653



GONIOMAT A5

The Multi-Purpose Solution

The GONIOMAT A5 combines a compact design with a wide range of applications. It enables both precise automated measurements and fast manual measurements. It is particularly well-suited for fatigue-free high-volume measurement of test specimens up to 125 mm in diameter.

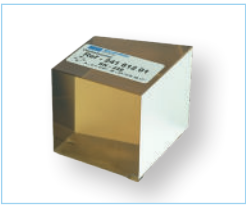
OVERVIEW

- Accuracy for multiple measurements: ± 1.0 arcsec
- Accuracy for individual measurements: ± 1.5 arcsec
- Fully automated measurement using a motorized rotary table
- Rapid test measurements possible via manual rotation
- Backlash-free and maintenance-free drive
- Easy to use measuring system
- Additional included support table H12 with three-point support
- Digital evaluation using GONIOMATIK software
- Portable thanks to its compact design
- Can be upgraded for measuring ground prisms and microprisms (see page 17)



Description	Test Field Ø [mm]	Optical Axis Height [mm]	Art. No.
GONIOMAT A5	125	24.6	241 631

Scope of Delivery



Description	Usage	Art. No.
Angular standard	For on-site verification and calibration	241 612



Description	Usage	Art. No.
Support table H12	For holding small test specimens	241 611

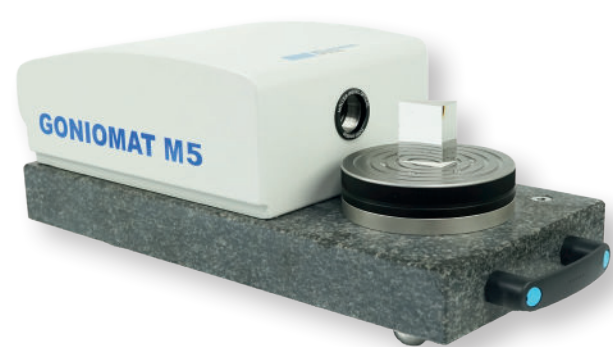
GONIOMAT M5

The Economical Compact Solution

The GONIOMAT M5 combines a compact design with a fast measurement. The simple operation makes it the ideal solution for applications involving frequently changing workpiece types. At the same time, it delivers low measurement uncertainty. It is particularly well-suited for incoming and outgoing inspection, as well as for in-process measurements on test specimens with diameters of up to 125 mm.

OVERVIEW

- Accuracy for multiple measurements: ± 1.5 arcsec
- Accuracy for single measurements: ± 2.5 arcsec
- Fast measurements via manual rotation
- Extremely easy to use measuring system
- Additional included support table H12 with three-point support
- Digital analysis using GONIOMATIK software
- Portable use thanks to its compact design
- Can be upgraded for measuring ground prisms and microprisms (see page 17)



Description	Test Field Ø [mm]	Optical Axis Height [mm]	Art. No.
GONIOMAT M5	125	24.6	241 605

Scope of Delivery



Description	Usage	Art. No.
Angular standard	For on-site verification and calibration	241 612



Description	Usage	Art. No.
Support table H12	For holding small test specimens	241 611

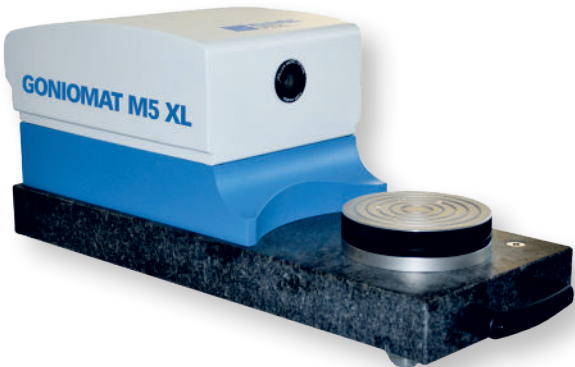
GONIOMAT M5 XL

Solution for Extra Large Specimens

The GONIOMAT M5 XL is particularly well-suited for measuring large prisms and plano optical components with a maximum diameter of 250 mm. It enables fast measurements with low measurement uncertainty.

OVERVIEW

- Accuracy for multiple measurements: ± 1.5 arcsec
- Accuracy for individual measurements: ± 2.5 arcsec
- Short measurement times thanks to manual rotation
- Extremely easy to use measuring system
- Digital evaluation using GONIOMATIK software
- Portable use thanks to its compact design
- Measurement of large test specimens up to 250 mm in diameter
- Height of the optical axis: 90 mm



Description	Test Field Ø [mm]	Optical Axis Height [mm]	Art. No.
GONIOMAT M5 XL	250	90	241 625

Scope of Delivery



Description	Usage	Art. No.
Angular standard	For on-site verification and calibration	241 612

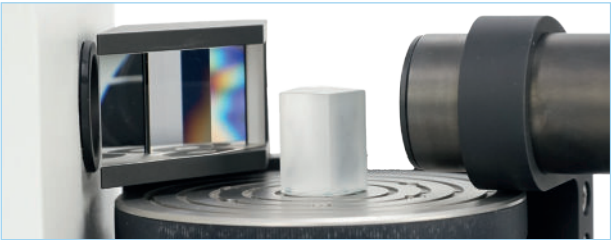
GONIOMAT A5 + M5

Extension for Ground Prisms

Another patented** unique selling point of our GONIOMAT A5 and M5 models is the optional add-on package, which allows measurements of fine grounded surfaces This package can be mounted directly onto the base plate without any additional system modifications.

OVERVIEW

- Angle measurement of prisms with fine grounded surfaces
- Roughness Rq = 1.0 µm or less required
- Measurement uncertainty of less than 10 arcsec
- Extension for GONIOMAT A5 and M5
- Optical axis height remains the same
- The GONIOMAT’s operating modes remain unchanged



ADVANTAGES

- Measurement of partial and full grounded prisms
- Measurement prior to the polishing process for determining the base accuracy
- Easy installation with two screws directly on the granite plate
- Software-assisted evaluation
- Measurement is performed depending on the GONIOMAT model, either manually or automatically
- Reduces time and costs in the manufacturing process
- Enables optimization of the fine grinding process and reduction of rejected prisms
- Potential for quality improvement in the manufacturing process, resulting in reduced costs



Description	GONIOMAT Extension for ground prisms
Art. No.	241 636
Accuracy *	Less than 10 arcsec
Maximum roughness of the prism surface	Rq = 1.0 µm for areas larger than 50 mm²
Smallest area size	9.0 mm² with a maximum roughness of Rq = 0.61 µm
Maximum test specimen diameter	58 mm

* The achievable accuracy and measurability depend on the surface area and roughness of the test specimen.

** US-Patent: US12298122B2 Device and method for measuring a semifinished prism

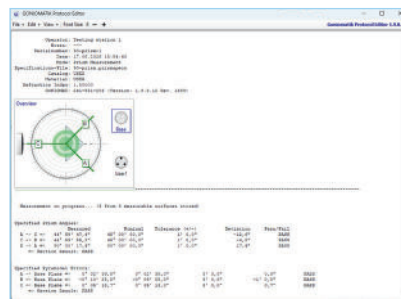
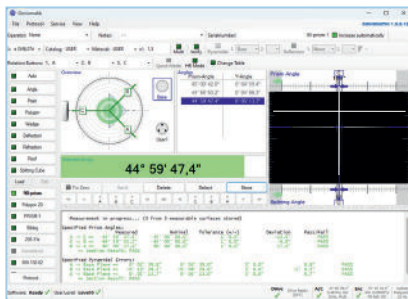
Software GONIOMATIK

An Overview of the Basic Functions

The GONIOMATIK software is always included with the GONIOMAT product series. It features a simple and well-designed user interface and runs on all current Windows® operating systems.

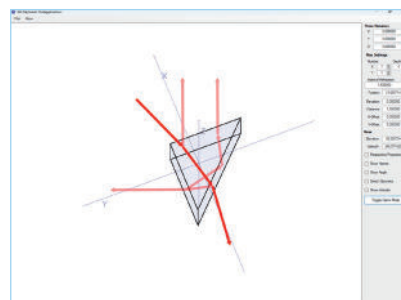
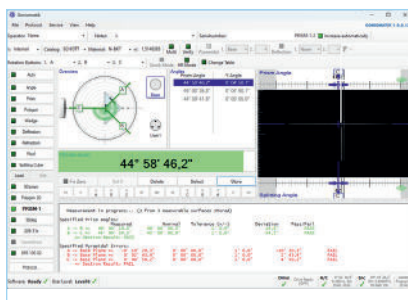
ADVANTAGES

- Standard-compliant measurement of plane angles (ISO 10110-1, VDI 2605)
- Comprehensive reporting functions
- Tolerance specification and verification
- Innovative beam calculation (see page 14)
- Creation of measurement templates with custom specifications for recurring measurements (see page 14)
- Included with every GONIOMAT purchase



INTEGRATED SOFTWARE FUNCTIONS

- Visualization of the autocollimated image and its deviation from the optical axis of the autocollimator
- Reading the encoder and the position of the autocollimation image, and calculating their relationship to determine the plane angle
- Consideration of the autocollimation image offset in the Y-direction
- Easy identification of reflections through pre-calculation of the target position (Reflection Forecast)
- Automatic reflection selection and reconstruction of the test specimen's geometry using a method based on ray tracing
- Measurement and/or calculation of deflection angles
- Measurement of roof edge angles and painted surfaces
- Standard procedures for testing prisms, polygons, and wedges
- Absolute testing of polygonal mirrors using the rosette method
- Generation of measurement reports for multiple or serial measurements
- Generation of measurement reports compliant with standards, including all common pyramidal prism error definitions



Software GONIOMATIK

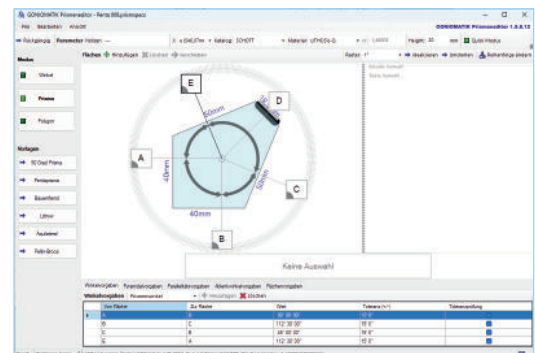
Template Creation and Calculations

Prism Editor

Using the prism editor integrated into GONIOMATIK, test specimens can be stored under a unique name together with their geometry and technical specifications for recurring measurements.

ADVANTAGES

- Specification of individual angular geometry
- Definition of angular tolerances
- Specification of pyramidal angle and deflection angle
- Specification of parallelism
- Custom naming of test specimen surfaces
- Preview of internal multiple reflections
- Specification of test specimen reflectivities and dimensions for accurate ray tracing
- Easy-to-use interface
- Simplification of serial measurements through "Pass" and "Fail" classification



Integrated Raytracer

Depending on the geometry of the test specimen, double and multiple reflections may occur during measurement. Selecting the correct primary reflection often poses a challenge for the user. The integrated raytracer serves as the ideal companion and autopilot for all measurement tasks by calculating the geometry of the test specimen and predicting their internal reflections.

ADVANTAGES

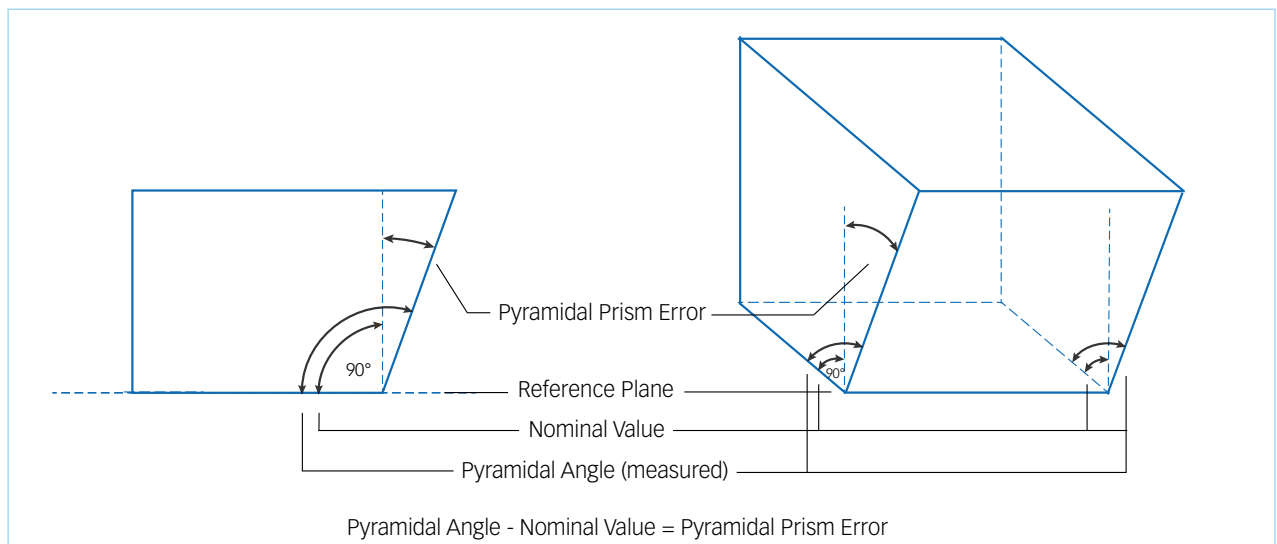
- Calculation of all internal reflections
 - For known test specimen geometries, expected multiple reflections are automatically calculated in the background
 - Multiple autocollimation images can be correctly separated, matched to one another, and evaluated based on objective criteria
- Identification of additional measurement positions with evaluable reflections
 - Use in automated and semi-automated measurements
 - Improving the identification of primary reflections
- Calculation of deflection angle measurement data from angle measurement values
 - Simplification of complex measurement setups
 - Elimination of an additional measurement
 - Determination of the deflection angle prior to the coating process
 - Input and output surfaces can be freely selected
 - The deflection angle corresponding to each specified surface is calculated
 - By default, the specification is set in accordance with the standard for a wavelength of 546 nm
 - Other reference wavelengths can be specified upon request

Software GONIOMATIK

Pyramidal Prism Error and Virtual Tilting Table

Pyramidal Prism Error

The pyramidal prism error is the deviation from the nominal value of the pyramidal angle, shown in the example below as a 90° angle. The pyramidal angle is the angle between the reference plane and the prism surface to be measured. The reference plane is defined either by the base or by two freely selectable optically active surfaces of the prism. In beam-deflecting prisms, this error leads to what is known as the pyramidal deflection error. This is defined as the deviation of the exit beam from the reference plane formed by the entrance and exit surfaces. In addition to the standard-compliant definition of the pyramidal prism error, there are various manufacturer-specific definitions, all of which can be modeled using the software.



Sample image for a nominal value of 90°

Integrated Virtual Tilting Table

In all measurements taken with the GONIOMAT, the 3D angle of the surface normals is recorded in three dimensions and stored as a combination of horizontal and vertical components. This three-dimensional recording of measurement values enables the software to precisely relate the individual measurement surfaces to one another.

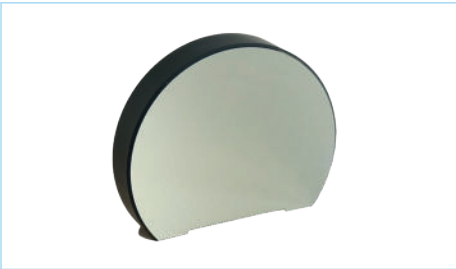
ADVANTAGES

- No mechanical tilting table required
- No need for time-consuming alignment of prisms
- The table is aligned directly via the software
- Angles can always be recorded in accordance with standards
- Dynamic output of pyramidal prism errors at any time
- According to all standard definitions, either the base or any two measurement surfaces can be selected as the reference surface
- Alternatively, detected pyramidal prism errors can be hidden
- The measurement report adjusts automatically

GONIOMAT Series

Optional Accessories

FOR EVERY GONIOMAT



Parallel Mirror 2" for Refractive Index Measurement

Tools that enable refractive index measurement when direct Abbe-type measurement (up to approx. 40°) is not possible, such as:

- Prisms with a refractive angle between 10° and approx. 80°
- Small prisms with insufficient back reflection

Description	Art. No.
Parallel mirror 2" D63	280 803



V-Prism for Parallel-Sided Plates & Wedges

- Secure mounting of wedge-shaped and parallel-sided plates with diameters between 40 mm and 60 mm
- Mounting device for determining the wedge angle
- Mounting device for measuring the angular deviation of the cylinder axis of the lateral surface relative to the optical axis

Description	Art. No.
V-Prism	280 624

FOR GONIOMAT A PLUS



Tiltable Support Table H35

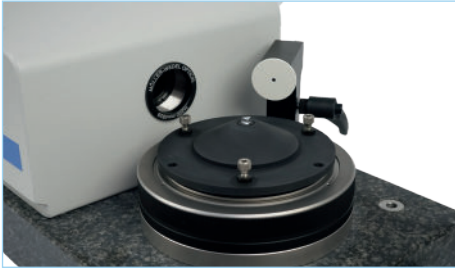
- Measurement of prisms with highly variable production tolerances
- Measurement of test specimens with significant pyramidal prism angle deviations from the base surface
- Compensation for the resulting tilt of the prism surfaces

Description	Art. No.
Tiltable support table H35	241 666

GONIOMAT Series

Optional Accessories

FOR GONIOMAT A ^{PLUS}, A5 AND M5

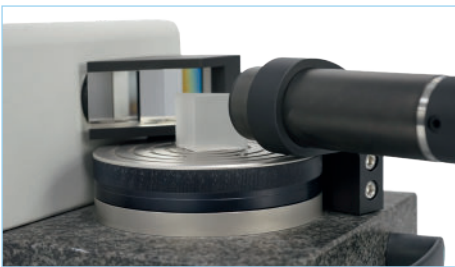


Alignment Aid for Micro-Prism

- Simplifies the positioning of test specimens on the GONIOMAT
- Reliable and easy alignment of particularly small prism surfaces measuring up to 0.5 mm²
- Included in the scope of delivery: an alignment laser for checking the tilting angle and a 3-point tiltable support table for compensation

Description	Art. No.
Alignment aid for micro-prisms A ^{PLUS}	241 667
Alignment aid for micro-prisms A5 and M5	241 616

FOR GONIOMAT A5 AND M5



Extension for Ground Prisms

- Allows for angle measurement on fine grounded surfaces
- Required surface roughness: R_q = 1.0 µm or less
- Easy mounting directly to the base plate of the GONIOMAT A5 or M5

Description	Art. No.
GONIOMAT- extension for ground prisms	241 636

FOR GONIOMAT A5, M5 AND M5 XL



Support Table H12

- For holding small test specimens
- Stable three-point support
- Height reduced by approximately 12 mm relative to the optical axis
- Included with the GONIOMAT A5 an M5

Description	Art. No.
Support table H12	241 611

Technical Specifications

Overview

Goniomat		A PLUS	A5	M5	M5 XL
Art. No.		241 661	241 631	241 605	241 625
Test Field	degree	360	360	360	360
Accuracy (multiple measurements) **	arcsec	± 0.4	± 1.0	± 1.5	± 1.5
Accuracy (single measurement) *	arcsec	± 0.6	± 1.5	± 2.5	± 2.5
Accuracy (pyramidal angle measurement) *	arcsec	±1.0	± 3.0	± 3.0	±3.0
Environmental conditions	°C	20 ± 1	20 ± 1	20 ± 2	20 ± 2
Minimum test specimen area (uncoated glass)	mm²	0.5	0.5	0.5	0.5
Maximum test specimen diameter	mm	210	125	125	250
Maximum test specimen weight	kg	10	10	10	10
Table diameter	mm	160/122/85	125	125	125
Height of the optical axis	mm	30/14/5	24.6	24.6	90
Maximum pyramidal angle	arcmin	20	20	20	20
Autocollimator focal length	mm	200	200	200	200
Autocollimator aperture	mm	28	28	28	28
Base area (excluding PC)	mm	610x340	530x200	530x200	560x200
Weight (excluding PC)	kg	35	19	19	26
PC connection		USB 3.0	USB 3.0	USB 3.0	USB 3.0
Power supply (plug-in power supply) input voltage	V/AC	100-240	100-240	100-240	100-240
Output voltage	V/DC	24	24	12	12

* in accordance with DIN 1319, test specimen $\lambda/20$ p-v, 15 x 15 mm

** in accordance with DIN 1319, with multiple measurements taken at four positions offset by 90°; test specimen $\lambda/20$ p-v, 15 x 15 mm

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