TRIOPTICS

TRIOPTICS GMBH · OPTISCHE INSTRUMENTE

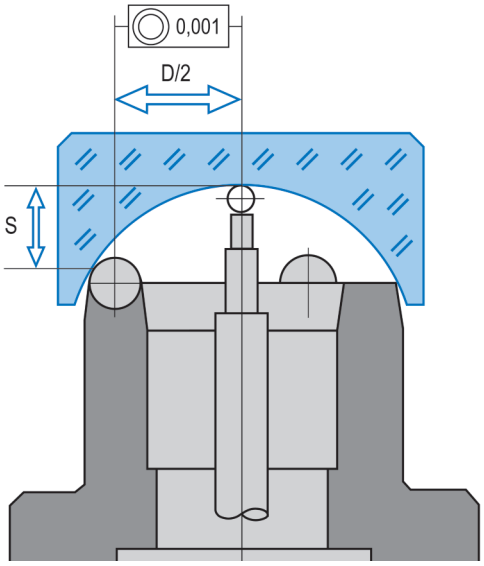
Spherometers

Tactile Radius Measurement and Calibration of Test Plates

The TRIOPTICS Spherometers are on use in hundreds of optical companies and laboratories worldwide for precise measurement of radius of curvature. Our spherometers have become an industry standard for ultra accurate radius measurement and calibration of test plates. The long term accuracy and automated features make our spherometers the preferred instruments for laboratory and production environments.

Operating Principle

A precision flat is put on the selected spherometer ring. This is the reference (zero) position for the subsequent sample measurement. In the second step the lens or test plate is put on the ring. The spherometer measures the sagittal height of the curved surface of the lens. The radius of curvature can be quickly derived using the relationship between sag and radius:



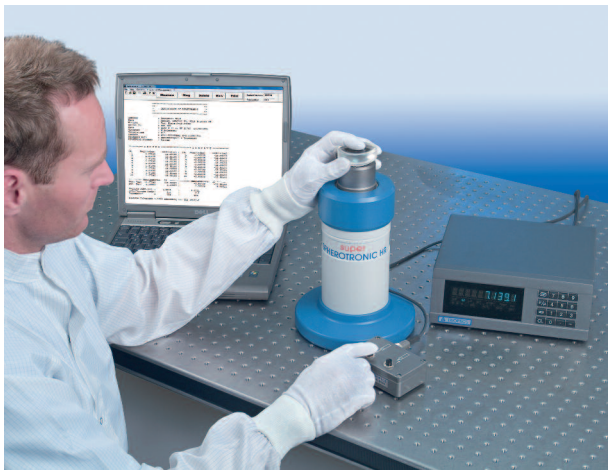
$$R = \frac{(D/2)^2 + S^2}{2S} \pm d/2$$

R = Radius of curvature
D = Diameter of calibrated ring
S = Sagittal height
d = Diameter of ring ball
± = Correction for concave/convexe

The values of D and d are determined with extreme accuracy during the calibration procedure and are certified in the individual calibration sheet supplied with the instrument.

SuperSpherotronic® HR
for high-precision measurements

SuperSpherotronic® HR is an automatic three ball contacting spherometer designed to meet the highest test plate calibration requirements. SuperSpherotronic® HR can measure the radius of curvature to an accuracy of 0.01%.



To ensure that the highest available accuracy values of radius measurement are obtained, all SuperSpherotronic® HR components have been optimized and perfected so that residual errors are negligible:

- The mainframe components locating the probe are made of massive stainless steel, hardened and fine ground on machine-tools to the highest achievable accuracy. Concentricity of mainframe components to the probe is less than 1 micron (0.00004").

- The spherometer rings represent one of the key components of the Super-Spherotronic® HR including an incredible amount of work to eliminate any possible error

source. Made of heat-treated high quality stainless steel, the rings are machined on high accuracy grinding machine tools and finally fine-lapped. An ingenious design combined with a special electro-erosion procedure allows the ball and the ball location site to be matched with highest accuracy. Each ring is deliverd with a calibra tion certificate. The measuring accuracy is directly traceable to NIST standards.

- The supporting balls are also concentrically positioned with an extreme accuracy of less than 1 micron (0.00004"). This highly accurate positioning of the ring balls is an essential and destinctive feature of the SuperSpherotronic® HR, ensuring excellent repeatability. To avoid any thermal and mechanical deformation, the supporting balls are made of wolfram carbide (an extremely hard metal), while the probe center is an ultra precision ruby ball.
  This completely eliminates any errors intro duced by metallic probe centers used in other spherometers.

- The probe itself is a high precision Heidenhain encoder, specifically selected for this use, having a total systematic and random error of less than 0.2 microns (0.000008").

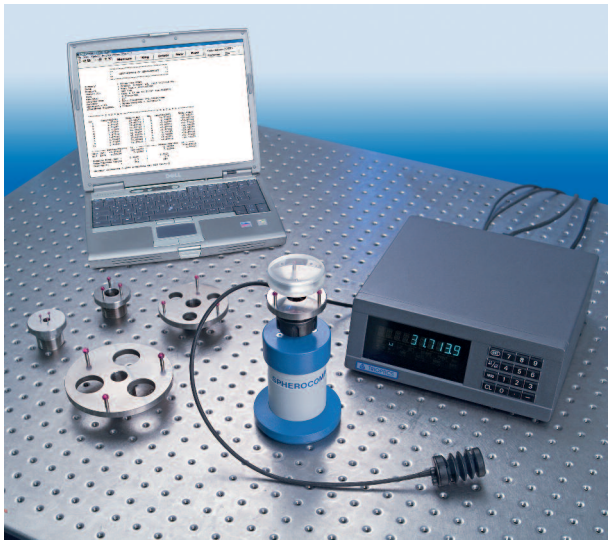
- The test plates used for calibration of the instrument are manufactured to high quality standards to an accuracy better than 1/10 wave for sphericity. The test plates are certified by NIST of USA, so that the accuracy of SuperSpherotronic® HR is directly traceable to international standards.

The fitting of ring diameters to test plates diameters has a significant influence on the measurement accuracy. As a general rule, to obtain best accuracy, a test plate must be measured with the ring having the largest possible diameter still fitting the test plate. In this case the largest sagittal height is measured and the smallest relative error results.

The SuperSpherotronic® HR is equipped with a standard set of 8 precision rings with diameters ranging from 7.8 to 120 mm. An additional set of precision rings is also available: diameters 48 mm, 75 mm, 150 mm, 225 mm. Normally the standard ring set is sufficient for most applications. However, when the highest possible accuracy is required or most of the measuring test plates do not fit optimally with the standard ring set, the use of the additional ring set or individual rings belonging to this set are recommended.

SpheroCompact®
for production and quality control

SpheroCompact® is an accurate and easy to use instrument designed for sagittal measurement of both concave and convex surfaces.



SpheroCompact®

- SpheroCompact® is the first hand held spherometer with a high precision linear encoder which features bright digital read out, micron resolution and excellent absolute accuracy.

- The calibrated rings have precision grinded reference surfaces and are machined of high quality stainless steel. Ultra- precision ruby balls guarantee highest hardness and unsurpassed thermal stability. The deviation from sphericity is less than 1/10 of a micron.

- The diameter of each ring is certified and the instrument is calibrated using test plates with Certified Radius, traceable to NIST. The calibration is done for both concave and convex spherical surfaces. The radius difference between the concave and convex test plates used in calibration is smaller than λ/10.

- Easily removable rings of different diamters increase the versatility of the instrument and feature a very large measuring range covering almost all applications in optical manufacturing.

- The SpheroCompact® can be used either as a hand-held instrument to take measurements directly on the machine or as a stand-alone instrument in the laboratory.

Applications

Due to its extreme accuracy and repeatability SuperSpherotronic® HR is primarily used for calibration of master test plates, but also for any measuring problem requiring high precision evaluation of radius of curvature:

- Concave/convex optical parts
- Ground or polished optical parts
- Spheres and balls

SuperSpherotronic® HR can also be used to measure both concave and convex polishing tools, assuring quality standards of tools and thus reducing subsequent rejected elements.

SpheroCompact® which is an affordable but accurate instrument, can be used either for in-process measurement of lenses and polishing tools or for the calibration of test plates.

Equipped with special rings, it can measure radius of cylindrical surfaces.

Compared with other radius measuring methods (e.g. interferometers) the spherometric measuring method provides a multitude of advantages:

- the precision spherometers offer for comparable accuracy dramatically reduced costs.

- the measurement time for PC-controlled spherometers is a fraction of the time needed to set up, to align and to take a measurement with interferometers.

- since the measuring procedure is so simple, no highly qualified personnel is required.

Advantages

- when it comes to measure large aperture optics or radii longer than 1m, the interferometers become impractical due to the high costs or impossibility to realize the extra-long mechanical set up.

- using spherometers the radius can be accurately measured before polishing, when a correction of the lenses is still possible.

- the accuracy of measurement is directly traceable to international standards, since Trioptics spherometers are calibrated with (NIST and NPL) certified test plates.

UltraSpherotronic®

General Description

The UltraSpherotronic®, the latest addition to our line of automatic spherometers, is the response to increased accuracy requirements in measurement of radii of curvature of optical components. The heart of the new spherometer is a special linear encoder featuring the highest measurement accuracy worldwide.

Under constant temperature conditions the absolute measurement error of the linear encoder is less than 0.05µm. The resolution is selectable: 0.01/0.05/0.1µm. The typical high quality mechanical components and the stability of TRIOPTICS spherometers have been further optimized and perfected during the development of the UltraSpherotronic®.

The probe is a ruby ball centered precisely to the encoder spindle. The use of ruby ball probe excludes the accidental damage of valuable test plates during measurement. The precise centering of the ruby ball is a key factor in obtaining the high repeatability of the UltraSpherotronic®. When accuracy really counts, there is no replacement for UltraSpherotronic®: the unsurpassed accuracy of the linear encoder combined with the high quality of the mechanics leads to new levels of accuracy of radius measurement.

Depending on the diameter of the spherometer ring used, a radius measurement accuracy of approx. 0.005% and a repeatabilty of 0.001% are achievable.

Operation

In order to further increase the operation comfort, the probe travel is motorized. By simply pressing a button, the spindle of the linear encoder can be smoothly moved up and down.

Moreover, the contact force of the probe is always constant, this contributing to superior repeatabilty of the measurement results. To adapt to different applications, the requested contact force can be selected by simply switching a three-position selector.

The travel of the linear encoder has been increased to 60mm. This enables a significant increase in the range of measurable radii of curvature.

Calibration

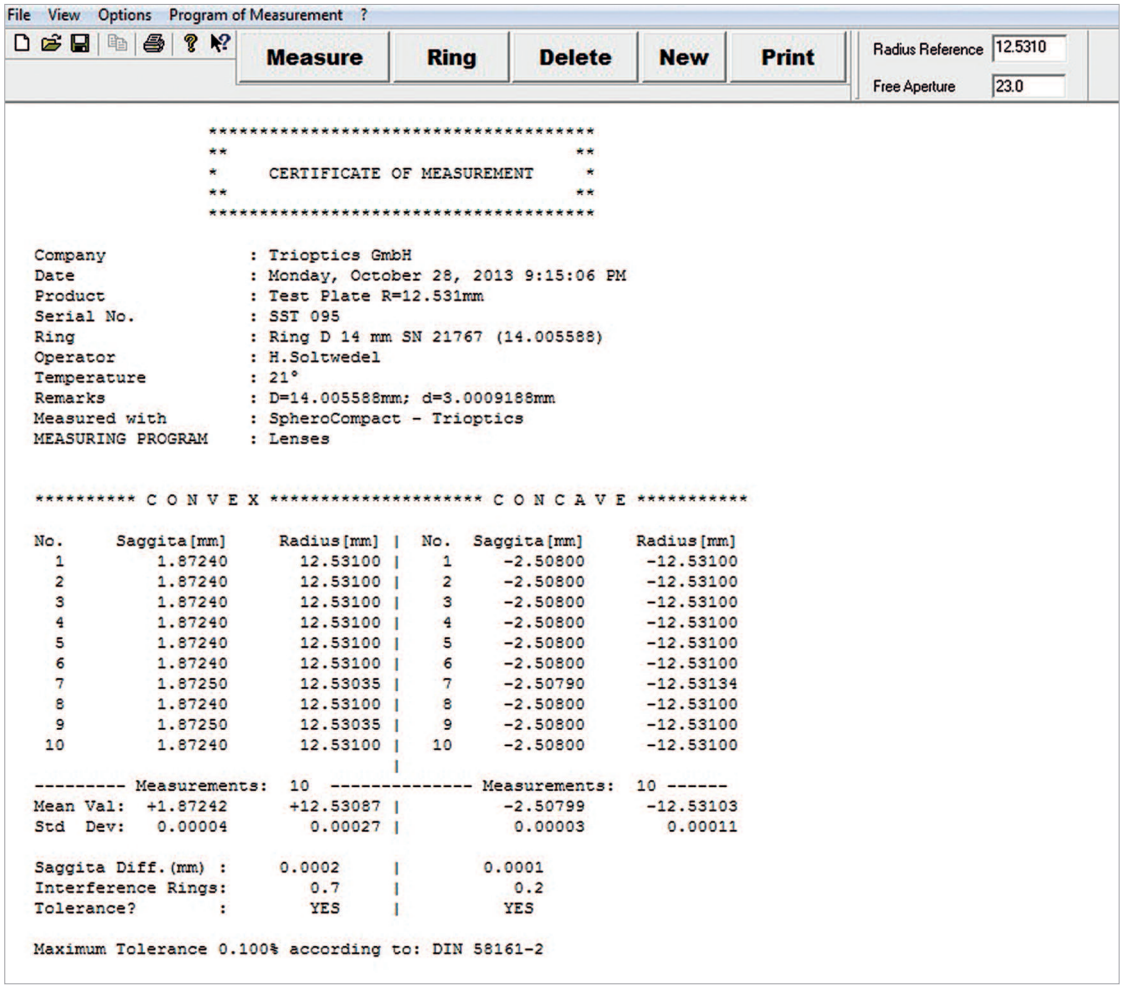
The test plates used for calibration of the instrument are manufactured to high quality standards and certified by national standard organisations. The long term calibration is directly traceable to international standards (NIST and NPL).

Rings and precision flats

Advanced Software

UltraSpherotronic® SuperSpherotronic® and SpheroCompact® represent not only the most accurate but also the most useful and efficient spherometers available today. User-oriented software has been developed to really meet the requirements of an easy, quick and errorless measurement.

- The SPHEROWIN-Software package runs under all Windows platforms in German and English. The measurement results can be displayed in „mm" or „inch".
- The software automatically recognizes when measuring convex and concave surfaces and also records automatically the difference when measuring pairs of test plates or individual lenses. This significantly speeds up the measuring procedure and avoids measurement errors.
- The sagittal height, radius of curvature, the current number of the measurement and the type of surfaces (convex/concav) will be automatically displayed and printed out as a certificate of measurement.
- It provides a statistic evaluation of the measurements including mean value and standard deviation.
- Easy selection of the rings. Calibration data of the rings can be easily stored, displayed or modified.
- Online help shows the necessary steps to take a measurement.

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                    ************************************
                    **                                **
                    *     CERTIFICATE OF MEASUREMENT     *
                    **                                **
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Company                 : Trioptics GmbH
Date                    : Monday, October 28, 2013 9:15:06 PM
Product                 : Test Plate R=12.531mm
Serial No.              : SST 095
Ring                    : Ring D 14 mm SN 21767 (14.005588)
Operator                : H.Soltwedel
Temperature             : 21°
Remarks                 : D=14.005588mm; d=3.0009188mm
Measured with           : SpheroCompact - Trioptics
MEASURING PROGRAM       : Lenses

********** C O N V E X ********************** C O N C A V E ***********

No.     Saggita[mm]     Radius[mm]  |  No.   Saggita[mm]     Radius[mm]
  1         1.87240       12.53100  |    1      -2.50800      -12.53100
  2         1.87240       12.53100  |    2      -2.50800      -12.53100
  3         1.87240       12.53100  |    3      -2.50800      -12.53100
  4         1.87240       12.53100  |    4      -2.50800      -12.53100
  5         1.87240       12.53100  |    5      -2.50800      -12.53100
  6         1.87240       12.53100  |    6      -2.50800      -12.53100
  7         1.87250       12.53035  |    7      -2.50790      -12.53134
  8         1.87240       12.53100  |    8      -2.50800      -12.53100
  9         1.87250       12.53035  |    9      -2.50800      -12.53100
 10         1.87240       12.53100  |   10      -2.50800      -12.53100
                                     |
--------- Measurements:  10  -------------- Measurements:  10 ------
Mean Val:  +1.87242      +12.53087  |          -2.50799      -12.53103
Std  Dev:   0.00004        0.00027  |           0.00003        0.00011

Saggita Diff.(mm) :     0.0002     |        0.0001
Interference Rings:       0.7      |          0.2
Tolerance?        :       YES      |          YES

Maximum Tolerance 0.100% according to: DIN 58161-2
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Specifiations

Measurement range	UltraSpherotronic®	SuperSpherotronic® HR	Spherocompact®
Radius (convex)	+ 3 mm to ∞	+ 3 mm to ∞	+ 2.5 mm to ∞
Radius (concave)	- 6 mm to ∞	- 6 mm to ∞	- 4 mm to ∞
Travel of linear encoder	± 30 mm	± 30 mm	± 12.5 mm
Diameter of part under test	6 mm to 500 mm	6 mm to 500 mm	6 mm to 500 mm
Accuracy			
Resolution of the linear encoder	0.01 / 0.05 / 0.1 µm	0.1 µm	0.1 µm
Absolute accuracy of the linear encoder	± 0.05 µm	± 0.2 µm	± 0.5 µm

Accessories for SuperSpherotronic® and UltraSpherotronic®

PRECISION BALL RINGS

- Standard set of high precision ball rings in wooden box ranging in sizes (diameters): 7.8 mm, 14 mm, 20 mm, 28 mm, 38 mm, 60 mm, 90 mm, 120 mm
- Optional: 48 mm, 75 mm, 150 mm, 225 mm
- Position accuracy of balls:

  ± 0.5 microns for diameters up to 60 mm;

  ±1 micron for diameters exceeding 60 mm.
- High precision hard metall balls: Sphericity less than ± 0.1 microns

DIMENSIONS AND WEIGHTS

- Mainframe: Dia. 90 x 260 mm (6.5Kg)
- Digital display: 240 x 240x70 mm (1.5Kg)
- Wooden box incl. ring set: 380 x 300 x 70 mm

Accessories for Spherocompact®

PRECISION RUBY BALL RINGS

- Standard set (diameters): 12.5 mm, 25 mm, 50 mm, 75 mm, 100 mm, 125 mm
- Special Sizes (diameters): 6 mm, 150 mm, 225 mm

DIMENSIONS AND WEIGHTS

- Mainframe: 180x70x56 mm
- Mainframe weight: 400 g.

Precision Flats to be used with Spherocompact® or/and SuperSpherotronic®

- **Precision Test Flat Dia. 30 mm λ/10**
- **Precision Test Flat Dia. 50 mm λ/10**
- **Precision Test Flat Dia. 100 mm λ/5**
- **Precision Test Flat Dia. 150 mm λ/3**
- **Precision Test Flat Dia. 250 mm λ/3**

TRIOPTICS

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