# Ürün bilgileri

## Hassas 3B ölçüm istasyonu MarForm MarForm MFU 200




Malzeme no.: **5440580**

**Ürün özellikleri**
Mahr tarafından geliştirilen **MarForm MFU 200 Aspheric 3D** ile optik bileşenler, hızlı bir şekilde ve üretim alanının yakınında 2D / 3D olarak test edilebilir. MarForm ölçme makineleri yıllardır hassaslıkları ve dengeleri ile tanınmaktadır. **MarForm MFU 200 Aspheric 3D** ile bu deneyim artık optik bileşenler sektöründe kullanılabilir.

**Hassaslık**
**MarForm MFU 200 Aspheric 3D** son derece düşük belirsizlik oranıyla süreç optimizasyou gereksinimleriniz için ideal bir hassas ölçüm aletidir.

**Ölçme prensibi**
**MarForm MFU 200 Aspheric 3D** optik bileşenlerin topografisini ölçer. Lens tepe noktasında profil ile hızlı 2D ölçümü kaydedilebilir. 90° ofsetli iki doğrusal profilin 3D ölçümünde öncelikle tek sekansta lens tepe noktasında ölçüm yapılır. Ardından eşmerkezli polar profiller C ekseni döndürülerek kaydedilir. Bu ölçüm noktaları topografi oluşturmak için kullanılır. Tam konumlandırılabilir prob kolu ile kesintisiz yüzeyler ölçülebilir.
Ölçme istasyonunun titreşimi engelleyen bir bölmede kullanılması ölçülen nesnelerin titreşim ve toz gibi dış etkilerden korunmasını sağlar.

**Ölçüm prosedürü**
Ölçüme başlamadan önce normal form tipini seçin ve parametreleri beklenen referans lensine ayarlayın. Sonraki adımda ölçüm verileri kaydedilir ve lens için nominal verilerle karşılaştırılır. RMS değeri, PV değeri ve eğim hatası parametre olarak gösterilir. R0 eğim yarıçapı, k konik sabiti ve Ai asferik katsayılar gibi asferik özellikler ile ilgili parametreler yazılımda, nominal asferik değerin asferik değere uyacak şekilde ayarlanması sırasında ölçüm sonuçlarına göre ayarlanabilir.
Ölçülen değerler ile nominal lens arasındaki farklı topografi, renk kodlu bir çizgi grafik şeklinde görüntülenir. 2D profiller ve diferansiyel topografi, makine aracı için düzeltme amacıyla

### Teknik veriler

| | |
|---|---|
| **Pos.-/Meas. path X-axis** | 200 mm |
| **Pos.-/Meas. path Z-axis** | 320 mm |
| **Positioning speed C-axis** | 0.1 - 200 1/min |
| **Konumlandırma hızı (mm/sn), X ekseni** | 0.1 - 100 mm/s |
| **Positioning speed Z-axis** | 0.1 - 100 mm/s |
| **Workpiece diameter max. (mind moment of inertia max.)** | 280 mm |
| **Açı çözünürlük (skala)** | 0.0001° |
| **Eksenel salgı sapması (µm+µm/mm ölçüm yarıçapı) *** | 0.02 + 0.0002 µm/mm*measuring radius (acc. to DIN EN ISO 1101) |
| **Straightness deviation X-axis** | 0.075 µm/measuring path (according to DIN EN ISO 1101) |
| **Straightness deviation Z-axis** | 0.1 µm/measuring path (according to DIN EN ISO 1101) |
| **Positioning uncertainty X-axis** | 2 µm (according to VDI/DGQ 3441) / 0.5 µm (with probe backlash) |
| **Positioning uncertainty Z-axis** | 2 µm (according to VDI/DGQ 3441) / 1 µm (with probe backlash) |
| **Çalışma sıcaklığı** | 20 °C |
| **Merkezleme ve doğrultma tablası** | otomatik |
| **Tabla çapı (mm)** | 180 mm |
| **Table load max.** | 20 kg |
| **Prob sistem tipi** | Tactile 1D |
| **Special equipment** | CNC-Tisch und dynamische Echtzeitkompensation |
| **Depolama ve taşıma sıcaklığı** | -10 °C - 50 °C |
| **Sound pressure level** | < 70 dB(A) |
| **Nem (metin)** | max. 70 % relative humidity; non-condensing |
| **Mains voltage** | 230 V |
| **Mains frequency** | 50 Hz |
| **Weight basic unit** | 850 kg |
| **Standart aksesuarları (metin)** | T7W probe system (incl. probe arm 3 x 60 mm) |

# Ürün bilgileri

## Hassas 3B ölçüm istasyonu  MarForm  MarForm MFU 200

bilinen formatlarda dışa aktarılabilir.
Yukarıda anlatılan şekilde küre ve asferik öğe ölçümünün yanı sıra diğer simetrik döner nesneler de, konik profil olarak nominal form veya 3D tarama şablonu Sagitta açıklaması kullanılarak ölçülebilir veya değerlendirilebilir.

# **MarForm MFU 200 –** Reference form measuring machine



# **The close-to-production form measuring station –** ultraprecise and universal

Economical, low-emission motors, micromechanical elements from the optics and electronics sectors, high-performance hydraulics for the aerospace industry, medical diagnostic devices – all these applications require increasingly accurate, more reliable components. Not only should these components comply with the requisite dimensions, they should also have the required form. For companies to be able to produce these parts in a reliable and thus economical way, highly accurate form measurements are required. The more accurately a form measuring device measures actual deviations, the more economical the process will be: absolute and repeatable, close to production and resistant to external influences.

Especially when it comes to rotationally symmetrical parts with tolerances in the range of a thousandth of a millimeter, conventional measuring instruments are often incapable of meeting these requirements. At best, several expensive measuring instruments must be used to test the tools for a variety of features, which is very time-consuming. The MarForm MFU 200, on the other hand, uses technologies that enable the measurement of form and position characteristics as well as high-precision dimensional inspection close to production and at low cost.

**Advantages of high-precision Mahr form metrology:**

- Highly precise thanks to measurements accurate to the nanometer
- Versatile thanks to comprehensive workpiece assessment as per DIN ISO 1101
- Reliable thanks to high repeatability
- Economical thanks to the use of unique technologies
- Impervious to environmental and operator influences

# **Highly precise, universal measurement** of form and position

Mahr developed the highly precise and universal MarForm MFU 200 form measuring machine to test rotationally symmetrical components with tolerances below a thousandth of a millimeter quickly and close to production – all while excluding as many influencing factors as possible. The MarForm MFU 200 can also measure a number of features: Form and position tolerances, e.g. roundness, straightness, cylindricity, run-out as well as absolute measurement, i.e. diameter, taper angle, distances. It is equipped with the T7W probe system, featuring a motorized rotational axis. The magnetic holder makes it easy to change the probe arms. The proven Mahr software platform MarWin features intuitive, cascaded user guidance which offers extensive options for analyzing the measuring data using the Easy, Advanced or Professional modules.

**Users benefit from the following advantages:**

- Optimized for use in the measuring room to achieve reference quality
- High reproducibility of measuring results thanks to dynamic real-time compensation which measures and corrects even the smallest deviations in the measuring routine
- Productivity thanks to high temperature stability over a long period of time – as a result, no calibration necessary, whether daily or several times a day
- Maximum precision thanks to highly accurate rotational axis with Mahr precision guides: Roundness deviation of < 20 nm
- Expandable with optical point sensor (IPS) for combined use as an optical and tactile measuring center
- User-friendly operation for fast and easy access to the measuring record




**Most reliable repeatability**

With an absolute positioning accuracy of 0.001 mm within the space, this provides the best possible reproducibility and process capability.

Z-axis with

**320 mm**

measuring path

Y-axis with

**6 mm**

measuring path
with motorized T7W

X-axis with

**200 mm**

measuring path




Centering and tilting table

**0,5 µm**

accuracy of alignment

### Measurements without user intervention

The fully automated measuring process with motorized centering and tilting means that user intervention is no longer required, ensuring process stability.

C-axis with

**200 rpm**

rotational speed

### Maximum precision

The MarForm MFU 200 concept ensures accuracy in the nanometer range, even for workpiece tolerances of 0.5 µm.

### High-performance testing

The motorized probe and multi-point probe arms ensure automatic, flexible scanning.

### Shorter measuring times

The quickly rotating C-axis features a stiff mechanical bearing. This accelerates the measurements considerably, increasing productivity.

# **Perfectly equipped** for close-to-production form measurement

The MarForm MFU 200 allows users to benefit from Mahr's expertise and years of experience in form measurement. The machine is equipped so that customers can check their rotationally symmetrical workpieces extremely quickly and with high accuracy. Sophisticated functions and processes as well as the appropriate accessories ensure quick and reliable measurement, reduce user intervention as much as possible to attain reliable and reproducible measuring results.

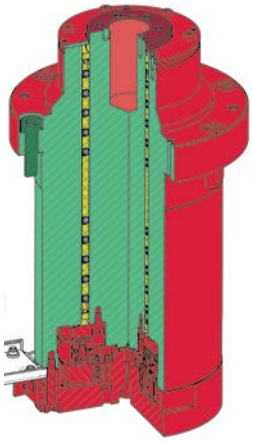


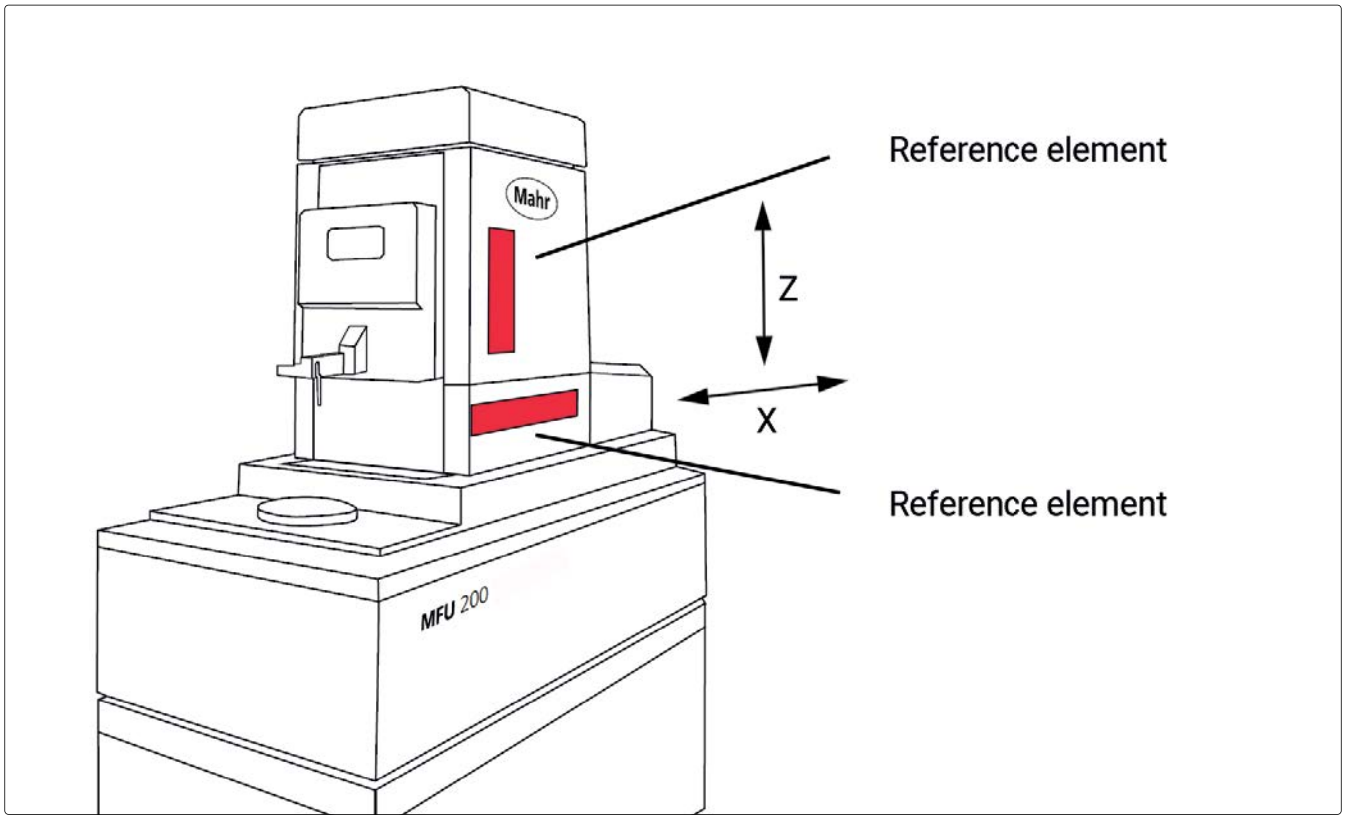
**Centering and tilting table with quick clamping device**

The MarForm MFU 200 features an automated centering and tilting table, here concealed by the base clamp, which sustainably reduces user interventions. The centering and tilting table and base clamp serve to position the workpieces quickly and automatically in the form tester, reducing set-up times and user intervention and ensuring reproducibility.

**Mechanical bearings**

Mahr's unique technology makes it possible to combine the robustness of mechanical bearings with the advantages of air bearings. This makes the mechanical bearings used in the MarForm MFU 200 up to 70 percent stiffer and thus more resistant to external influences like vibrations. They are produced by Mahr and result in outstanding radial runout properties.






**Dynamic real-time compensation**

With the MarForm MFU 200, Mahr has integrated a real-time compensation of errors in the room. This provides the machine and measurements with maximum protection from external influences like temperature and vibrations. It measures and corrects even the smallest deviations in the measuring routine via reference rulers in the two measuring axes, X and Z. The machine thus offers extreme reproducibility, even in changing measuring conditions.

**Measuring Y-axis**

One innovative component is the tangential Y-axis, unique to reference form testers. This makes it possible to perform a zenith search anytime during the measuring routine: during calibration, position finding on small workpieces or diameter measurement. The result is 100 percent process accuracy and repeatability.






### Measuring equipment capability

The MarForm MFU 200 even achieves the required capability values below a tolerance of 1 µm. To ensure that the measuring process can handle a customer-specific workpiece, Mahr offers the option of testing the process capability with customer-specific standards or workpieces.

### MarForm clamping concept

Measuring tasks with the narrowest of tolerances make it necessary to use appropriate and precise clamping devices to prevent deformations and to hold the workpiece to be tested firmly in place. That is why Mahr has developed its own concept with appropriate clamping devices. These devices not only hold the testpiece on the measuring device but they also use defined and constant force, are universally expandable and can still be individually adjusted to the testpiece and hold it in a specific position.

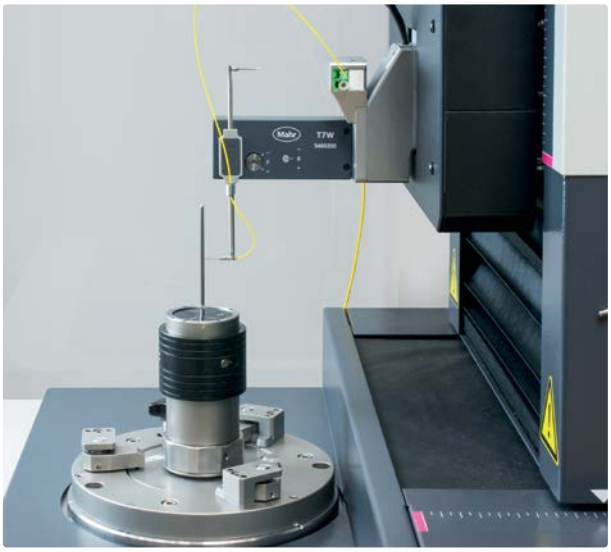


Rim chuck

### Tactile measuring probe T7W

The T7W measuring probe is fitted with a motorized rotational axis. This allows you to move the probe arm gradually into any desired contacting position. It can be used for measurements on both cylindrical surfaces and end faces. As a zero position probe, the T7W can also switch between inner and outer measurements or between top and bottom end face measurements automatically, without operator intervention. Fully automatic measuring sequences on complex workpieces can be performed without operator intervention. The T7W probe arms are interchangeable. With its motorized rotational axis you can also create multi-point probe arms, i.e. probe arms with multiple contact elements, allowing you to switch between different stylus ball geometries within a measuring run.





### MarForm IPS 15 optical sensor

The optical MarForm IPS 15 (Interferometric Point Sensor) provides the option of measuring and analyzing workpiece surfaces extremely quickly at up to 200 rpm. Thanks to the resolution of the IPS sensor in the sub-nanometer range and the outstanding signal quality, even fine waviness can be tested without measuring again, which saves time and money. It is even possible to combine optical and tactile sensors in one T7W probe arm unit to further increase the versatility of the possible applications.

# **Powerful software** for form measurement and more

The MarForm MFU 200 from Mahr not only provides universal hardware for form measuring tasks but also supplies the perfectly matched measurement and evaluation software based on the MarWin platform. MarWin has established itself in more than 60 countries and is used by many Mahr reference customers.

MarWin is the main software platform used to control various product ranges including the measuring machines in the MarForm range. Users will benefit from the intuitive, cascaded Easy, Advanced, and Professional user guidance and comprehensive options to analyze and further process the data. The user interface is clearly structured and easy to use in keeping with the motto: learn once, apply again and again.

In addition to the applications for form measurement, MarWin also offers other software options to significantly expand the performance range of the MarForm MFU 200.



**Software option:**
**Roughness and contour measurementg**

Combined measurement: The MarForm MFU 200 checks the form and position features of the workpiece surface with high-precision roundness and linear axes in accordance with ISO 1101. The machine uses a diamond tip to deliver the roughness parameters and measures the contour using a special probe tip to follow-up the high-resolution linear axes. Finally, the MarWin software analyzes and records the measuring data.




**Software option: Contour measurement with path control (MCPC)**

The new path control function MCPC (Mahr Continuous Path Control) on the MarForm MFU 200 is used for moving along a reference profile in space by simultaneous measurement with two axes. Measuring speeds of up to 5 mm/s are achieved, 10 times faster than with previous systems. The measuring data is continuously recorded as a 3D point cloud - the world's first implementation of this kind of coordinate measurement.




**Software option:**
**Cam evaluation**

Camshafts are measured using the T7W probe and a tactile contact element. One wizard (Quick & Easy) combines all camshaft types – standard, double cams, tripods, eccentric shafts, concave and convex cam forms - in the "Cam evaluation" software option.

### Software option: QE QS-STAT data export

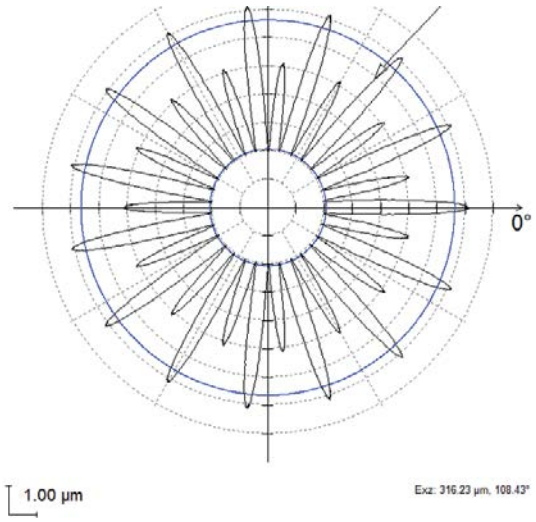
For users of the statistics software from Q-DAS, Mahr provides simple and convenient data export with the QE QS-STAT and QE QS-STAT Plus options, each of them tailored to the individual requirements of the user.

### The QE QS-STAT option currently supports the following 30 AutoKeys:

| AutoKey | Data |
|---|---|
| K0001 | Values |
| K0002 | Attribute |
| K0004 | Time/Date |
| K0009 | Text/Note |
| K0053 | Order |
| K0100 | Total number of features in the file |
| K1001 | Part number |
| K1002 | Part designation |
| K1053 | Order |
| K1086 | Machining operation/ operation |

| AutoKey | Data |
|---|---|
| K1103 | Department/cost center |
| K1201 | Testing setup number as text/number |
| K1202 | Testing setup designation |
| K1221 | Inspector's name |
| K1900 | Text/Note |
| K2001 | Feature number |
| K2002 | Feature designation |
| K2009 | Measurand, identifiers for the type of feature |
| K2022 | Number of decimal places |
| K2101 | Nominal size |

| AutoKey | Data |
|---|---|
| K2110 | Lower limit |
| K2111 | Upper limit |
| K2112 | Lower allowance |
| K2113 | Upper allowance |
| K2120 | Type of lower limit |
| K2121 | Type of upper limit |
| K2142 | Unit designation |
| K2402 | Testing setup designation |
| K2415 | Gage serial number |
| K2900 | Text/Note |




### Software option: Dominant roundness waviness

This software option is based on the DAIMLER factory standard MBN 10 455. It measures periodically occurring waviness in roundness profiles. Following the dominant waviness evaluation of stylus profiles (VDA 2007), an evaluation method is described that identifies existing periodic dominant shape characteristics, evaluates them using a roundness waviness profile and derives parameters from them. This option evaluates RONWDc, RONWDt, RONWDmax and RONWDn.



**Software option:**
**Diameter measurement**

The DIAMETER_LIB software option measures the diameter of workpieces, mandrels, rings and spheres as well as the length for gage blocks, and evaluates them. MarWin Professional features the option with a collection of highly complex and thoroughly tested measurement, evaluation and calibration programs for diameter and length measurements.

**Software option:**
**Lead measurement**

The surface structure of the sealing surface of a shaft affects the flow behavior of the fluid in question and therefore has a major influence on the sealing function. The MarForm MFU 200 can analyze the macro lead in accordance with Mercedes Benz standard 31007-7.



# **MarForm MFU** 200

Item no. 5440580

| | |
|---|---|
| **Roundness measuring device, C-axis** | |
| Roundness deviation (µm+µm/mm measuring height)* | 0.02 + 0.0004 |
| Roundness deviation (µm+µm/mm measuring height)** | 0.01 + 0.0002 |
| Axial run-out deviation (µm+µm/mm measuring radius)* | 0.04 + 0.0002 |
| Axial run-out deviation (µm+µm/mm measuring radius)** | 0.02 + 0.0001 |
| Angle resolution interpolated (°) | 0.0001 |
| Measuring speed (rpm) | 0.1 - 200 |
| Positioning speed (rpm) | 0.1 - 200 |
| Position uncertainty P as per VDI 3441 (µm) | 2 |
| Position uncertainty P with probe feedback (µm) | 1 |
| **Centering and tilting table** | |
| Table diameter (mm) | 180 |
| Table load, centered *** (N) | 200 |
| Traverse path X,Y (mm) | ± 1.8 |
| Tilting angle A,B (°) | ± 0.6 |
| **Vertical straightness measuring device, Z-axis** | |
| Measuring path (mm) | 320 |
| Straightness deviation/320 mm measuring path (µm)* | 0.1 |
| Parallelism deviation Z/C-axis in tracing direction (µm) | 0.5 |
| Parallelism deviation Z/C-axis JMR9N5 testing cylinder (µm) | 0.2 |
| Measuring speed (mm/s) | 0.1 - 50 |
| Positioning speed (mm/s) | 0.1 - 50 |
| Position uncertainty P as per VDI 3441 (µm) | 2 |
| Position uncertainty P with probe feedback (µm) | 1 |
| Resolution interpolated (µm) | 0.001 |
| **Horizontal straightness measuring device, X-axis** | |
| Measuring path (mm) | 200 |
| Straightness deviation/200 mm measuring path (µm)* | 0.075 |
| Perpendicularity X/C-axis (µm)* | 0.3 |
| Measuring speed (mm/s) | 0.1 - 50 |

| | |
|---|---|
| Positioning speed (mm/s) | 0.1 - 50 |
| Position uncertainty P as per VDI 3441 (µm) | 2 |
| Position uncertainty P with probe feedback (µm) | 0.5 |
| Resolution interpolated (µm) | 0.001 |
| **Horizontal straightness measuring device, Y-axis** | |
| Measuring path (mm) | 6 |
| Straightness deviation (µm/5 mm), filter 0.25 mm | 0.5 |
| Perpendicularity Y/X-axis (µm/5 mm) | 1 |
| Resolution interpolated (µm) | 0.005 |
| **Connection data** | |
| Supply voltage (V)**** | 230 |
| Frequency (Hz) | 50 |
| Nominal output (VA) | 1800 |
| **Dimensions and weight** | |
| Length x width x height (mm) | 1400 x 800 x 2115 |
| Machine weight (kg) | approx. 850 |
| **Ambient conditions** | |
| Working temperature in measuring room | 20°C ± 2 K |
| Temperature gradient | |
| temporal (K/h) | < 1 |
| spatial (K/m) | < 1 - ceiling height |
| Storage/transport temperature range (°C) | -10 to +50 |
| Humidity (rel. humidity, non-condensing) | 30 % - 60 % |
| Air pressure (hPa) | 1000 ± 200 |
| Noise level/sound pressure (dB[A]) | < 70 |

* All values in accordance with DIN ISO 1101 at 20 °C ±1 K in a vibration neutral environment, filter 15 undulations/revolution LSC or 2.5 mm LSS at 5 rpm or 5 mm/s and standard probe arm with 3 mm sphere.

** Values as max. deviation from LSC reference circle, filter 15 undulations/revolution. Proof at the standard using error separation techniques.

*** Workpiece diameter ≤ Table diameter, Hworkpiece≤ Zmeasuring path

**** Other voltages only using UPS/enhanced voltage generator

We would be pleased to provide you with more technical data for the MarForm MFU 200 on request.
We reserve the right to make changes to the technical data.