Leitz PMM-G
Coordinate Measuring Machine
Assured decisions. Act economically.

Uncertainty of measurement can finally be made a thing of the past; as tolerances are becoming tighter the decision as to whether a part is rejected or not becomes highly reliant on the measurement certainty of the process. What is required is a coordinate measuring machine with as high a measurement certainty as possible.

How big can a measurement uncertainty actually be? In order to answer this question clearly, the tolerance that will be checked must also be taken into consideration. With this in mind, a Directive of the Association of the German Automotive industry has this to say: »The capability of the measuring device is determined by the ratio of its measurement uncertainty to the tolerance.« This expert panel requires that the uncertainty of the testing process should only be one-tenth to one-fifth of the feature tolerance.

Economic rules of metrology
With parts becoming more and more complex and tolerances becoming ever smaller, the requirements in metrology are changing. The selection of the correct measuring device is becoming more and more important. In order to make a certain decision for the measuring device to be used, the capability of the measuring device must be proven for every feature that is to be measured.

The high-precision coordinate measuring machines of the Leitz brand from Hexagon Metrology ensure low measurement inaccuracies in production, which remain stable over a long period. They ensure definite decisions in the production process.

...with Leitz, the measurement accuracy in production is perfect, for our stringent requirements. That is why we decided on such a coordinate measuring machine.

Geert van Landuyt, C.O.O., TOELEVERINGSBEDRIJF VAN LANDUYT NV
Measuring device capability $C_p$:

The ratio of the standard deviation to the tolerance ($s/T$) is critical.

Measuring device suitability:

$$C_p = \frac{0.2 \cdot T}{4 \cdot s} \geq 1.33$$

Given $s \leq \frac{0.2 \cdot 10 \, \mu m}{4 \cdot 1.33}$

$s = 0.38 \, \mu m$

$T = $ smallest tolerance to be measured, e.g. $10 \, \mu m$

$C_p = $ Measuring device capability index for testing devices, e.g. $C_p \geq 1.33$

Leitz PMM-G: Powerful and precise.

Day after day, our commercial decisions are directed at the cost-effective manufacturing of products or the optimization of processes.

As is known, the manufacturing costs of products are influenced by the production costs as well as by the reworking and rejection costs. With that, the testing costs in the quality assurance are an important decisive factor for the selection of the correct coordinate measuring machine. Owing to an excellent range of capabilities and the orientation towards large parts, the Leitz PMM-G from Hexagon Metrology is repeatedly the favoured option.

Apart from a correctly selected measurement accuracy, short measurement cycle times and high throughput are a necessity to satisfy the requirements of production. Important specifications for a coordinate measuring machine with the maximum possible throughput and low testing costs are:

- high probing rates
- High-Speed-Scanning (HSS)
- fast axis accelerations
- fast movement speeds
- Variable High-Speed-Scanning (VHSS)

Selecting a measurement uncertainty that is as small as possible gives the production a greater scope for the exploitation of the permissible component tolerances. Specific savings can be obtained from the correct decisions regarding the measured parts.
The sustained trend towards automation of industrial production sequences in conjunction with the demands for product quality in the meaning of ISO 9001 resulted, in recent years, in a number of innovative solutions in the area of metrological systems and plants. This particularly applied to the measurement of large volumes of workpieces in completely different production areas.

The Leitz PMM-G coordinate measuring machine has been conceived with a view to the challenging measurement tasks and the highest precision in quality and process control with regard to large and very large parts.

**High accuracy – complex geometries**
The Leitz PMM-G carries out any measurement task with the highest precision regardless of whether on prismatic workpieces or parts with highly complex geometries – such as gearbox parts or gears. In particular, part measurements with narrow tolerances require a coordinate measuring machine such as the PMM-G.

Thus, for example, in the case of mirror elements for telescopes, pillars for printing machines, crankcases and cylinder heads for marine assemblies, satellite components or large parts from aviation technology, a few 1/1000ths of a mm decide their quality and whether they can be deployed.

**Longest ever Z-axis**
In the zone of the large gears with pitch circle diameters up to 3800 mm, so far, there were no suitable measuring instruments for gears available. With high-precision coordinate measuring machines of the Leitz brand, Hexagon Metrology offers the ideal metrological solution that covers a broad range of the various metrological applications. The Leitz PMM-G provides the longest Z-axis in the world, which means almost limitless possibilities for this coordinate measuring machine.

The coordinate measuring machine Leitz PMM-G is available in the measurement ranges 3000 x 3000 x 2000 mm to 6000 x 4000 x 3000 mm.
Short measurement times.  
High throughput.

The characteristic feature of the Leitz PMM-G is the new kind of bridge construction in «Overhead-Design» with minimized movement of mass. The stable machine base in U-form made of reinforced concrete forms the basis for the highest accuracy and high throughput of the Leitz PMM-G.

In detail, the Leitz PMM-G offers the following:

**Solid granite guides** – in X and Y, fastened to a 2 point support, ensure the straightness of the guiding tracks even after years.

**Air bearings in all axes** – specially developed precision bearings with failsafe running properties and electronic air gap monitoring – guarantee precise, wear-free guidance and hence a long life.

**Ceramic ram** – the ceramic Z-spindle with oversize cross-section is extremely resistant to torsion and has an automatic weight counterbalance. The machine accuracy is reached without any limitation even when the ram has been fully extended.

**Vibration isolation** – a special isolation against ground vibrations of the machine and machine base is ensured through the integrated active pneumatic damping.

The foundation level is regulated independently of the workpiece load with a height control system. In this manner, the functions are guaranteed even under difficult ambient conditions. This is achieved by means of a very robust design of the machine.

**Dual drive and length measurement systems** – the X-axis is fitted with a dual drive- and length measurement system. This has a positive effect on the machine dynamics and guarantees absolutely synchronous running. Measurement errors owing to expansion, perpendicularity deviations and contouring errors are avoided with certainty.

**Collision protection** – All sensitive parts, the stylus, the probe and the ram are equipped with collision protection – only the coordinate measuring machines of the Leitz brand provide such a complete protection.
Superior machine design. Proven materials.

The basic mechanical principle of the Leitz PMM-G was developed from the proven PMM bridge series. The result is a very intrinsically rigid and solid construction which purposefully realizes the principle of the overhead crossbeam, the »Gantry Design«. Superior machine design forms the basis of the successful deployment in production-related areas.

The definitive material that is used in the sides and the crossbeam is granite. Aluminum has been avoided in all the structures that determine the accuracy, in order to ensure insensitivity to temperature and a high degree of stability.

Solid granite guide ways

The »Gantry Design« comprises a stable machine base of reinforced concrete, the two granite guideways in the X-direction, a moveable granite crossbeam (Y) with measurement carriage and a Z-ram. The crossbeam is driven on both sides by precise ball screws, which are connected to the crossbeam by means of a patented coupling mechanism in such a way that no undesired lateral forces are transmitted.

The construction of the Leitz PMM-G is robust and compact. It guarantees the rigidity of the measuring axes and is the basis of a high, uniform accuracy in the entire measurement volume. Deformations during the movement processes as well as when probing and scanning are eliminated and do not have any effect on the measurement result. The decisive materials have been selected in a way that their coefficient of expansion is almost the same, so that deflections owing to the influences of temperature are not possible.

Air bearings support and guide crossbeam

The crossbeam has supporting and guiding air bearings and is guided exactly at the granite surface. Next to these are the precision scales, which contain »Dual Scales« in both X-directions. Thus, every measurement position of the crossbeam is acquired exactly and taken into consideration in the measurement values. All moving components are guided in a friction-free manner by means of pre-stressed, wear-free air bearings that have failsafe running properties.

The precision scales of the Leitz PMM-G are made of steel and are continuously scanned optically. In this manner, the expansion coefficients of the machine and the workpiece are the same. The measurement deviations in case of temperature changes are avoided. The electronic interpolation of the scales results in a resolution of 20 nanometers.
Setting the standards. Stability and durability.

The intelligent and stable construction of the Leitz PMM-G makes precision measurements over a very long period possible. Here, mechanical changes are mostly eliminated.

Economical usage in the production process over several years is ensured:

• The machine base of granite, casting and steel components is constructed to be stable over a long period and the moving drive units work in a wear-free manner.

• For operator safety, electronical and mechanical safety functions set a new standard.

• Servo-drives with a patented linkage to the ball screws make positioning accuracies in the nano-zone possible.

• An electronic controller constructed according to the most modern specifications, carries out the complex movement sequences and measurement data evaluations. If customer service is required, the Remote Diagnostic function facilitates fast assessments and hence keeps the downtimes short.

• The Leitz PMM-G has the most comprehensive safety and anti-collision system amongst all coordinate measuring machines: The probe, styli and the Z-ram are protected by sensors, which set the machine into emergency stop mode in case of a collision. Expensive repairs will not be required, the cost of ownership is minimal across the operating time.
High-Speed-Scanning of known and unknown contours.

The LSP-S series provides functions like:

- single point probing
- self-centering probing
- High-Speed-Scanning (HSS)
- self-centering scanning
- Variable High-Speed-Scanning (VHSS)

The deflection of the probing system is acquired and interpolated electromagnetically with high resolution. During the dynamic single point probing, many measurement points are recorded very fast along the linear sensor characteristic. From this, a precise measurement point is calculated.

The probing reproducibility is obtained from the large bearing base of the stylus collet. This is a precondition for the horizontal stylus extensions up to 800 mm length and 1000 g weight for measurement on large components.

With the automatic stylus changing for more throughput, different styli configurations can be changed quickly and without any re-calibration.

The measurement head has a large linear-active measurement range with highly sensitive sensors for obtaining the measurement value. Deflection exceeding the linear measurement range leads into a safety zone for protection from damage in case of unwanted deflection.

With its outstanding P-value*, the Leitz-LSP-S probing system also makes form and roundness measurements possible, even with very small tolerances.

The axes of the probe head are not clamped during the measurement, this means that the deflection of the measurement system always takes place perpendicular to the workpiece surface. The actual direction of the normal to the surface is determined in every scan point.

What is involved here is an almost maintenance-free measurement head, since no maintenance-intensive, self-moving parts or active force generators are present.

There is an optional temperature sensor to automatically acquire workpiece temperatures during the measurement process. This results in more flexibility and a significant time saving.

* P = volumetric probing deviation according to ISO 10360-2

Highly accurate sensors. Very long styli.

Taking measurements fast and accurately with high-precision sensors – that is what the measurement heads of the LSP-S series have been developed for and are used in the PMM-G.
High-Speed-Scanning. Fast and precise.

With High-Speed-Scanning, a very large number of measurement points is determined in the shortest possible time. The focus is on the exact evaluation of profiles or contours with a high measurement throughput. With the large quantity of measurement points, standardized filters can be used for a clear depiction of the contour.

Scanning with high speeds places the most stringent demands on the rigidity of the instruments, the electronic controller as well as the application software. With its innovative design, the Leitz PMM-G is among the most accurate and fastest measuring instruments in its class.

**HSS / VHSS scanning of known contours**

The HSS controls the movements of the machine with maximum speed. Here known contours from CAD calculations or previous measurements are used. The speed gets set automatically with reference to the specified parts tolerance: The smaller the tolerance, the more precise is the movement. Parts with a greater tolerance are scanned that much faster.

Part contours with different curves are scanned optimally with regard to accuracy and throughput. Whereas gentle curves can be moved through quickly, the speed through sharp curves is reduced by the Variable High-Speed-Scanning (VHSS). Typical examples are holes, turbine blades and gears.

**Unknown contours – free-formed surfaces**

Workpiece contours for which there is no desired or set path are often measured, for the highest precision using the «Closed-Loop-Scanning», scanning in a closed control loop. This applies equally to «Reverse Engineering». Typical examples are gears, cams, screws and compressors.

**Self-centering scanning**

Often, the task consists of centering in specially shaped recesses or grooves – for example, with a turbine root profile – and scanning along the grooves. The measurement head controls the measuring machine across its spatial deflection in such a way that the stylus ball remains permanently centered during the scanning process.
Intelligent software. Benefit from alternatives.

The total system is rounded off by an intelligent, powerful software. There is a choice between two solutions here: PC-DMIS or QUINDOS. User-friendly and CAD-based, both guarantee efficient programming as well as a highly efficient evaluation of the measurement data.

**PC-DMIS** is the software for CAD-based, computer-simulated program generation. The software offers: easy program generation, use of CAD-data, graphics-oriented, user-friendly interface and powerful tools for depiction of the result. With **PC-DMIS CAD++**, apart from the measurement of regular geometries, acquisition of free-formed surfaces is also possible. With it, three-dimensional surfaces can be measured very fast using the scanning function.

**QUINDOS** is the software for almost all industrial applications – from simple parts to complex geometries. With more than thirty options, this software provides a vast selection. Another focal point is the measurement of gears of all types, as well as gear cutting tools. Coordinate measuring machines of the Leitz brand can therefore also be used with the QUINDOS software as gear measurement centers.

**QUINDOS 7** has a built-in CAD-Core. Thus, all geometries can be displayed in the 3D-depiction: special set points, the touched points, calculated elements and coordinate measurement systems. With the option »QplusViewer«, 3D-CAD models can be imported, within which the measurement points can be generated, displayed and evaluated.
The choice of the correct coordinate measuring machine for different applications is the first definitive decision for ensuring quality in production. The second decision aims at integration and at a concept directed at added value: systems engineering.

The essential features of systems engineering are:

**Measurement rooms** – innovative climate controlled rooms provide the foundation for ultra-accurate measurement results, possible only on the basis of constant temperature.

**Measurement programs** – the generation of part measurement programs together with the training of the personnel involved with the coordinate measuring machine to establish the quality assurance of the production over the long term.

**Clamping devices** – professional clamping of the workpieces as the basis of reproducibility of the measurement results.

**Feeding systems** – automatic feeding of workpieces to keep idle times as short as possible and if required, to even use unmanned shifts for measurements.

**Network integration** – linking to databases and CAD systems.

**Support** – Hexagon Metrology makes available detailed drawings for the machine base to be made at the user’s site.

Apart from the procurement costs for a coordinate measuring machine, the associated system integration is a one-off investment decision for ensuring, in the long term, a comprehensive economical viability for the user.

Every measurement that is to be carried out for the quality assurance in production can only be as meaningful as the executing technology allows it and the concept of the system integration actually ensures this.
Leitz
The Leitz brand as part of Hexagon Metrology stands for high accuracy coordinate measuring machines, gear inspection centers and probes. Leitz measurement systems master quality assurance tasks equally well both in metrology labs as well as on the shop floor. The development and production are located in Wetzlar, Germany. For more than 30 years Leitz has been offering its customers the best innovative measurement technology available. The primary goal remains offering modern solutions for demanding measurement tasks.

Hexagon Metrology
Hexagon Metrology is part of the Hexagon group and brings leading brands from the field of industrial metrology under one roof.

Hexagon Metrology GmbH
Leitz Division
Siegmund-Hiepe-Straße 2 – 12
35578 Wetzlar
Germany

E-mail contact.leitz@hexagonmetrology.com
Phone +49 (0) 6441 207 0
Fax +49 (0) 6441 207 122

www.leitz-metrology.com
www.hexagonmetrology.com