Mitutoyo

Mitutoyo Quality

Ultra-high Accuracy CNC Coordinate Measuring Machine

LEGEX Takumi

Coordinate Measuring Machines

Catalog No.E16034(3)


Mitutoyo
LEGEX 9106
SMS

An artisan's touch, for ultimate accuracy

Mitutoyo provides quality through craftsmanship.

When tracing a surface,
only an artisan can feel even the slightest imperfection
and can hone it to a straightness unattainable by machine.

Inheriting the techniques and history of Mitutoyo,
our master artisans, known as "Takumi"*,
have created the ultimate measuring machine.

LEGEX Takumi

Today, the world standards are changing.

Click here for a video introduction to the LEGEX Takumi model

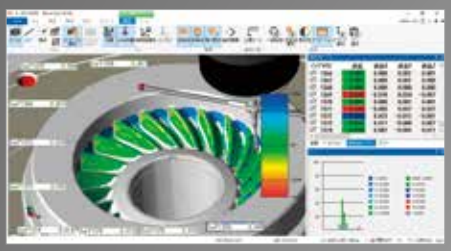
* Takumi is a Japanese word meaning "artisan" with superb craftmasnship.

Mitutoyo

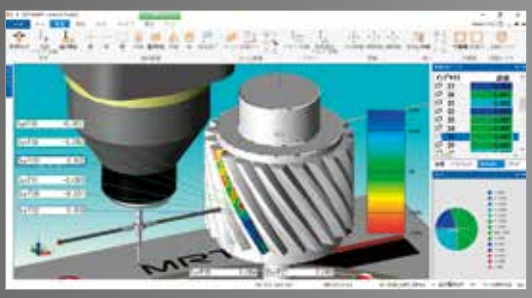
Gear molds

As forged products are becoming more sophisticated, complex, and diverse, there is demand for molds that have precision on the micron level.
The LEGEX Takumi model contributes to mold manufacturing that requires ultra-high precision by combining outstandingly high-accuracy measurement with a variety of applications.

Gear Mold



Point cloud data obtained through scanning measurements can be compared with 3D CAD. By displaying a color map on the CAD surface, errors can be intuitively detected, allowing quick feedback to the machining process.



Provided courtesy of ZENO TECH Co., LTD.

Lens Mold

Lens molds

With the global spread of smartphones and the dramatic improvement in the performance of cameras mounted on mobile devices accompanying the increasing number of social media users, mass-produced compact lenses are now required to have the precision and stability to match. The potential of the LEGEX Takumi model can be fully demonstrated even when measuring lens molds that require dimensions and forms to be grasped with high accuracy.

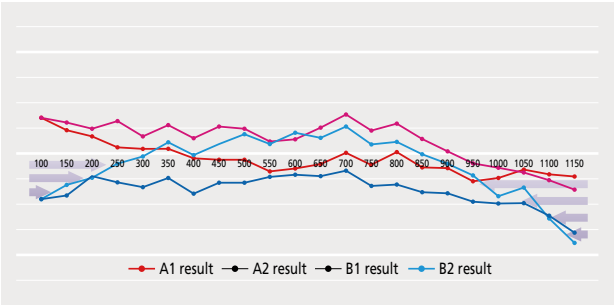
Accuracy that only a craftsman can achieve

The ultimate ultra-high-accuracy CNC coordinate measuring machine, which builds on the innovative design and advanced parts processing and assembly technologies of LEGEX and perfects it with outstanding craftsmanship. That is the LEGEX Takumi model.

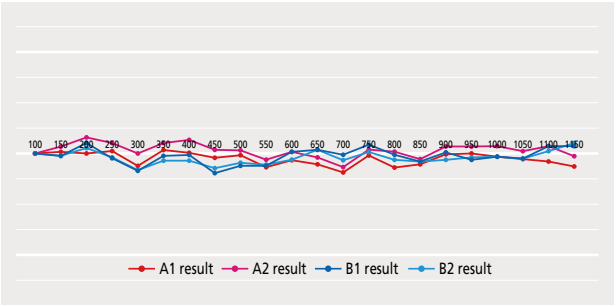
Freely lapping over a wide range and polishing to outstanding precision

In a typical lapping process, the workpiece is rubbed and polished on top of a lapping surface plate, but with the LEGEX Takumi model, because the area to be polished is large, a lapping surface plate is placed on top of the fixed frame. The amount of polishing depends on the amount of pressure applied, the lapping material used, and the surface property of the polished surface. The technique of freely polishing a selected area by only the desired amount demands a high level of skill backed by a deep level of experience and know-how.

Before lapping



After lapping



Perfecting the straightness for straight sliding

The straightness of the base guide surface, which is essential to Y-axis drive, is improved by repeatedly measuring the worked surface and lapping over the uneven areas to increase accuracy. There are guides on both the left and right sides of the base (p6: Figure 1) and each have differences in height, inclination, and undulations. To make the table slide straight, a craftsman's skill is required, with consideration of the straightness and parallelism of both guide surfaces, as well as the deflection caused by assembly of the measuring table.

Assembled with a thorough eye for right angles to create a distortion-free measurement space

A distortion-free measuring space cannot be achieved simply by assembling a collection of high-precision parts. Assembly and adjustment work that improves accuracy beyond what can be achieved with mechanical assembly is a process that is only possible through skilled craftsmanship.

A machine base that thoroughly eliminates error factors

In order to achieve ultra-high accuracy, we have paid special attention to the material of the machine base, and also thoroughly pursued high rigidity and high damping performance.

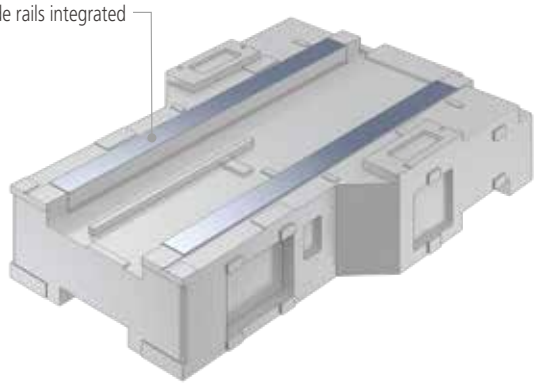
Utilizing cast iron ideal for the pursuit of measurement accuracy

The machine base is made of ductile cast iron FCD600, which has a high level of hardness and great toughness, giving it the properties of good machinability and wear resistance. Furthermore, it utilizes cast iron manufactured through a method that eliminates cavities and pinholes (defects) of 0.1 mm or more.

A structure that integrates the Y-axis guide rails and base

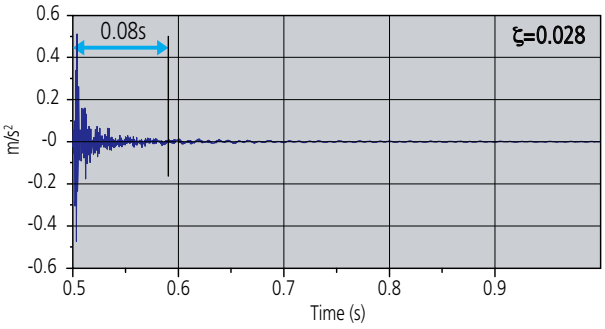
In order to further improve rigidity and thermal stability, this model utilizes a structure that integrates the Y-axis rails and the machine base.

Figure 1

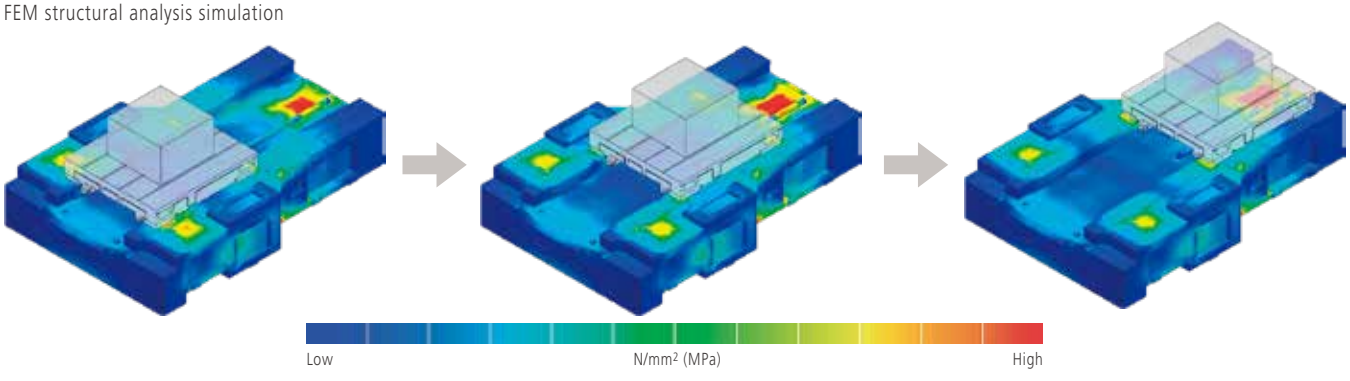


High rigidity and high damping properties improve the accuracy of scanning measurement

The machine base is made highly rigid through thorough stress analysis using FEM structural analysis, and as a result, load fluctuation deformation caused by table movement is kept to a minimum, ensuring excellent geometric motion accuracy.
Additionally, the sealed structure improves rigidity, and by having molding sand retained inside the structure, the friction of the sand acts to quickly damp vibrations.



FEM structural analysis simulation



Mechanism and control technology that thoroughly eliminates dynamic error factors

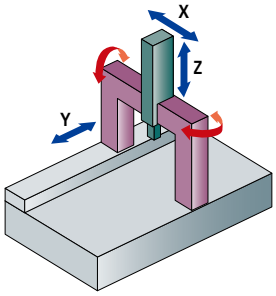
We have achieved the world's highest level of accuracy by thoroughly eliminating dynamic error factors such as deformation, vibration, and wobbling that occur with sliding motion, and by adopting an ultra-high-accuracy measuring unit that we have developed and manufactured ourselves.

Elimination of pitching and yawing errors with a fixed-bridge structure

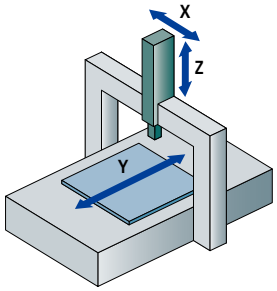
With a moving-bridge structure, the X beam and columns are integrated into a bridge, which is actuated by the columns, and thus, pitching and yawing errors occur during movement.
The LEGEX Takumi model adopts a fixed-bridge, moving-table structure to eliminate these error factors and achieve higher accuracy.

Independence of X-axis motion and Y-axis motion

By adopting a fixed-bridge, moving-table structure, the XZ and Y axes of movement are completely independent, making them less susceptible to the effects of each other's movements.



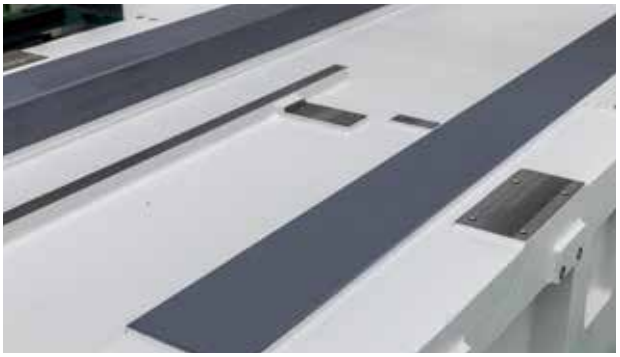
Moving-bridge structure



Fixed-bridge, moving-table structure

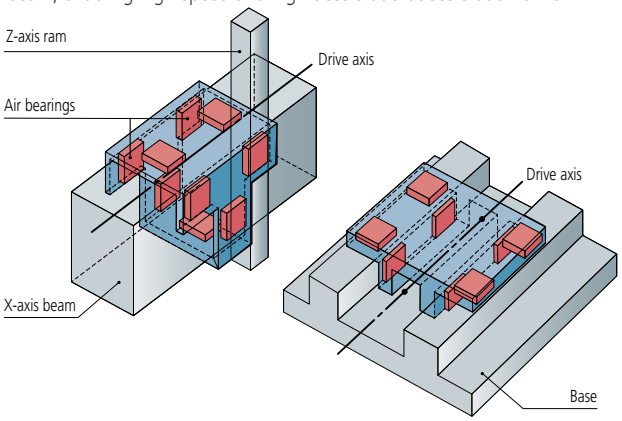
Each axis sliding part coated with ceramic plasma thermal spray

The sliding parts of the Y-axis guide rails and X-axis beam are coated with a ceramic plasma thermal spray to create a surface that is ideal for air bearing sliding.
It also has excellent rust and corrosion resistance.



Adopts a center drive system for all axes

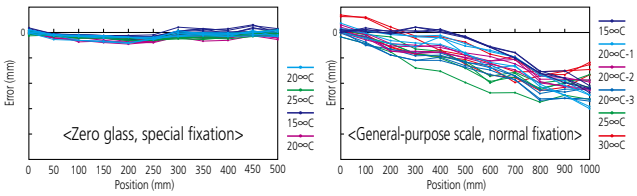
Since the drive system for each axis is located at the center of gravity of each moving part, moments of inertia around the drive axis are reduced, and there is almost no structural deformation during acceleration or deceleration.
Additionally, the X-axis guide uses an original structure with Mitutoyo's proprietary high-rigidity air bearings placed on all surfaces of the X-axis beam, enabling high-speed and high-acceleration/deceleration drive.



Utilizes a high-accuracy glass scale with a linear expansion coefficient of ≃0

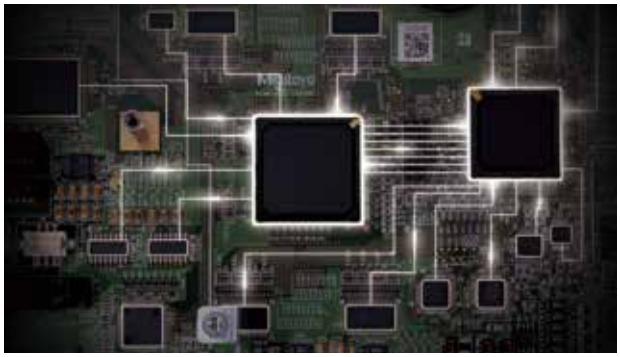
The machine is equipped with an ultra-high-accuracy measuring unit that combines an ultra-high-accuracy crystallized glass scale that has almost no thermal expansion, having a linear expansion coefficient of 0.01×10 $^{-6}$/ °C, and a high-performance reflective linear encoder with a minimum resolution of 1/100 µm.
This scale's unique fixing method minimizes hysteresis errors caused by differences in thermal expansion with the mounting surface.

Ultra-high accuracy crystallized glass scale



Improved control of measuring operations for keener measuring accuracy

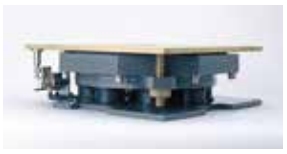
Through improvements in algorithms, we have adjusted the timing of switching from probe movement to probe stopping during measurement and of reading measured values relative to probe motion, so as to minimize deviations in three-dimensional coordinate values and therefore reduce noise factors in the acquisition of measured values.



A vibration isolator that controls external vibration and keeps the main unit horizontal

When performing ultra-high-accuracy measuring, even the slightest external vibration can affect accuracy. The LEGEX Takumi model comes with a dedicated high-performance auto-leveling pneumatic vibration isolator as a standard feature. This eliminates external vibrations, and detects movement of the measuring table or load movement from the object being measured, so as to promptly restore the main unit to a horizontal position.

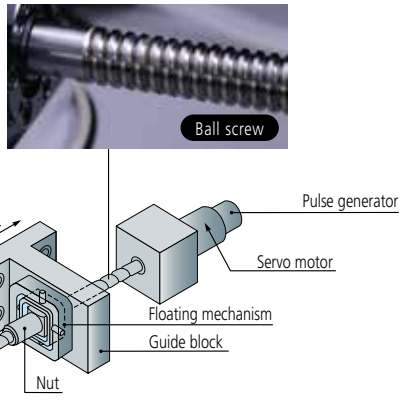
Auto-leveling pneumatic vibration isolation platform



Internal vibration countermeasures

The drive system uses ball screws (X-axis and Y-axis) and a DC servo motor. In addition, a special ball screw with a floating mechanism located at the nut is used as a countermeasure against conical motion around the ball screw axis and vibration in the plane perpendicular to the axis.
The floating mechanism absorbs ball screw runout, allowing high-speed drive without affecting motion accuracy.
Furthermore, various internal vibration countermeasures have been implemented, including our proprietary high-rigidity, low-vibration air bearings that suppress vibrations and a special vibration damping mechanism on each axis guide rail.

Diagram of ball screw structure with floating mechanism



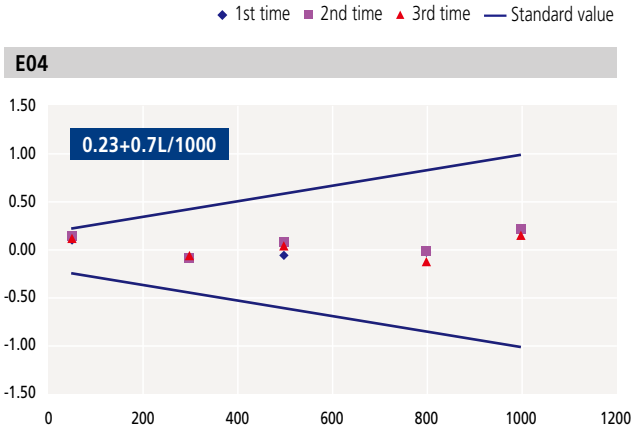
Newly developed calibrator that ensures accuracy in previously uncharted territory

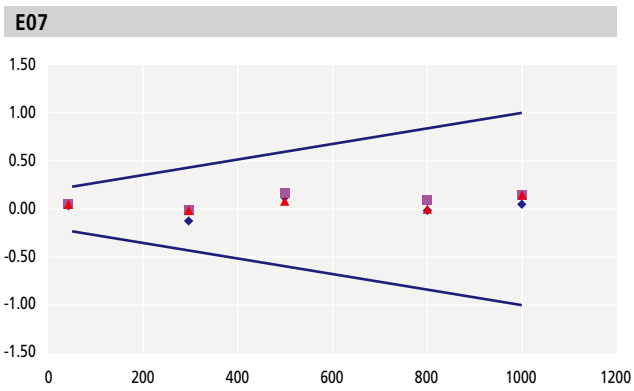
In order to guarantee ultra-high accuracy with a CMM, it is important not only to push advances in the main unit to the maximum extent, but also to reduce uncertainty in inspections.
The LEGEX Takumi model uses a low-expansion ceramic gauge block calibrated with the newly developed long gauge block optical interferometer LGBI II to perform inspections, reducing measurement uncertainty by approximately 55% compared with conventional models.
Supported by these core technologies possessed by Mitutoyo, this model achieves world-class accuracy.

Performance evaluation (first mass production unit)

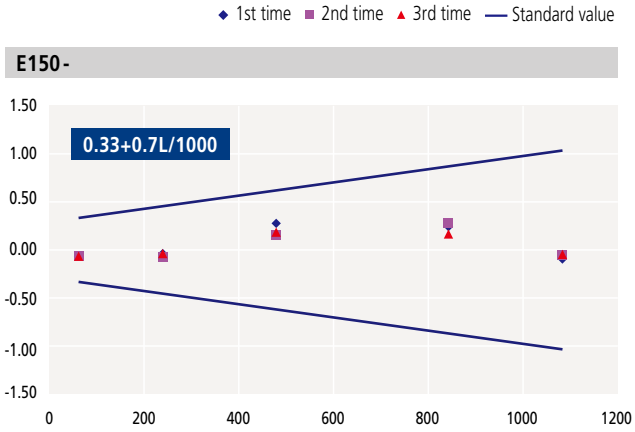
Combining the skills of master craftsmen (“Takumi Meister” skills) and a number of technologies, we have achieved highly stable measurement results.

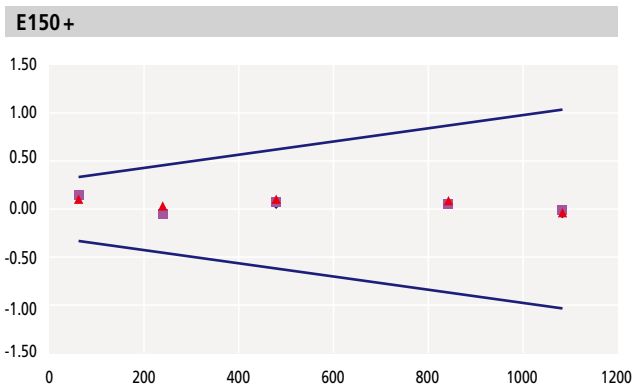
Maximum permissible length measurement error ($E_{0,MPE}$) measurement results in each direction



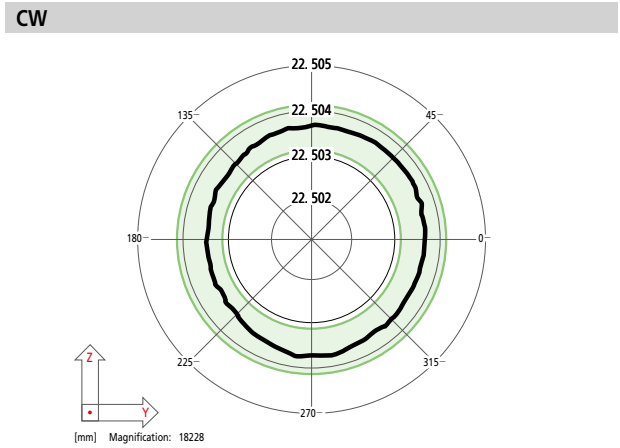


Maximum permissible length measurement error ($E_{150,MPE}$) measurement results



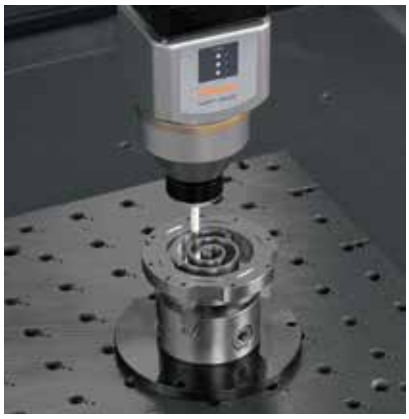


Ring gauge scanning measurement results



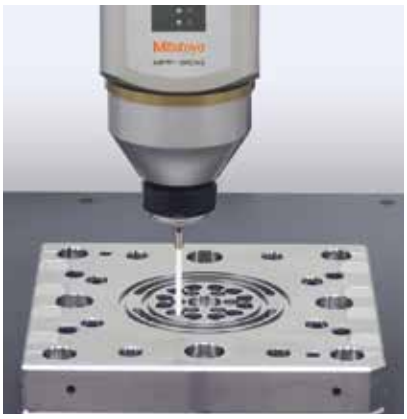
Measurement examples

Scroll compressors



For scroll compressors, managing the gap between the orbiting scroll and fixed scroll is important in order to improve compression performance, and high-accuracy contour evaluation is required.
The LEGEX Takumi model enables highly accurate contour evaluation using original scanning technology.

Lens molds



When measuring lens molds that require high precision at a level of 1 µm, the LEGEX Takumi model is the essential choice of machine, guaranteeing submicron precision.

Gauges

The LEGEX Takumi model is ideal for calibrating various gauges.
Mitutoyo has established a system that is traceable to national standards not only in Japan but also in overseas locations, so 'any' gauges you are using will also be traceable.

Gear molds by electrode machining

Die-sinking electric discharge machining can transfer contours to thin objects, long-axis objects, and irregularly shaped molds such as for helical gears that are otherwise difficult to machine at a level ranging from just a few µm to 20 µm.
The LEGEX Takumi model is capable of measuring complex-shaped molds produced by die-sinking electrical discharge machining with high accuracy.

Courtesy of Mitsubishi Electric Corporation, MST Corporation, and Toyo Tanso Co., Ltd.

Leading the way and carrying on the tradition of high accuracy with outstanding skills that cannot be mechanized or standardized

Visit here for details on the Takumi Meister system

There are over 600 unique techniques that support the high measurement accuracy of Mitutoyo products. Although the majority of these are mechanized and standardized to eliminate dependence on specific workers, there are some that require outstanding individual skills. These are considered to be the skills of craftsmen, and among them are some outstanding skills that cannot be mechanized. At Mitutoyo, we have institutionalized a system for our highly skilled craftsmen to pass on their skills to their successors, from the perspectives of "skills that should be passed on" and "skills that must be passed on," thereby contributing to both the company and society.

A Meister who refines precision impossible for machines

Visit here for details of the Takumi Meister interview

Medal with Yellow Ribbon

Master craftsman Fusa Ogane

Skill: Finishing
Role: High Precision Lap
Manufacturing Section 1
Production Engineering Development Center Headquarters

Lapping is a processing method for achieving a flat-surface finish by placing an abrasive material between the lapping tool and the finishing surface and rubbing them together, and when this process is performed manually it is called "hand lapping." This hand lapping technique is one of the most outstanding skills of Fusa Ogane, who has been involved in the development and assembly of CMMs and in-house production equipment for over 30 years. With machining, the heat generated by the process alters the finished surface, making it impossible to meet the required accuracy of straightness to 0.1 µm. In the manufacturing of CMMs, as the required level of accuracy becomes higher, the need for sophisticated and skilled hand-lapping techniques becomes all the more essential.
Start by accurately measuring the surface to ascertain its condition; lap with an aim for half the target value; measure to ascertain its condition; repeat lapping, aiming for half the target value. By steadily increasing surface accuracy little by little, relying on experience and touch, our craftsmen are able to achieve a straightness accuracy of 0.1 µm, impossible for machines.

The Meister who introduced LEGEX to the world and made the Takumi model a reality

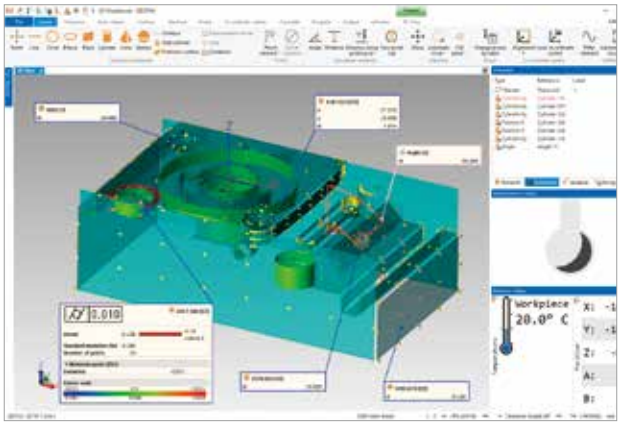
Visit here for details of the Takumi Meister interview

Takumi master Masao Suzuki

Skill: Finishing
Role: CMM Assembly
Production Engineering Section 2 Production Engineering Department
Microcord plant

For more than 40 years since joining the company in 1980, this craftsman has been primarily involved in prototyping three-dimensional measuring machines and overseeing assemblability evaluation and process design for mass production.
He is one of the members of the LEGEX series development and mass production project (1998), which pursued unprecedented accuracy. Looking back on his experiences, he explains, "With the single-minded desire to supply our customers with the world's best CMM with unsurpassed accuracy, I've been engaged in new development evaluation, renewal, and the assembly of custom-ordered products. By solving the many problems that have arisen in these areas, one by one, I've been able to deepen my knowledge and hone my skills."
In an area where cutting starting at an accuracy of 1 µm alone is difficult, LEGEX has proudly boasted the highest level of accuracy for Mitutoyo, achieving an unprecedented starting accuracy value of 0.3 µm or less. In order to surpass this conventional LEGEX, the LEGEX Takumi Development Project challenged the limits of human skill. The LEGEX Takumi model was created using the experience and technology cultivated through this project to create the ultimate machine that pushes mechanical accuracy to the limit.

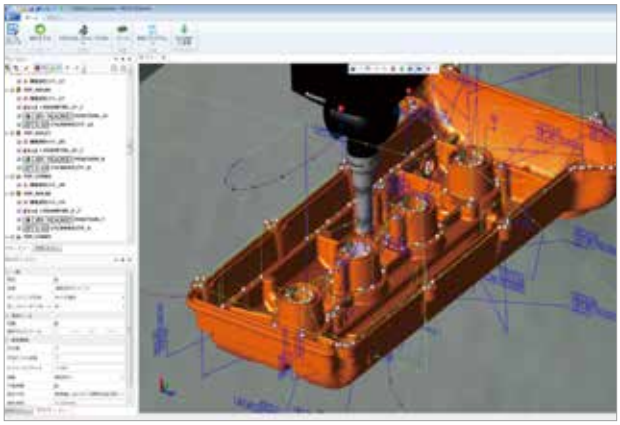
Software



MCOSMOS

(Data processing software for 3D measuring instruments)

Processing program family for 3D measuring instruments, running on Windows. The wide-ranging lineup of optional software supports various probes, enabling fully automated measurement of all kinds of workpieces.

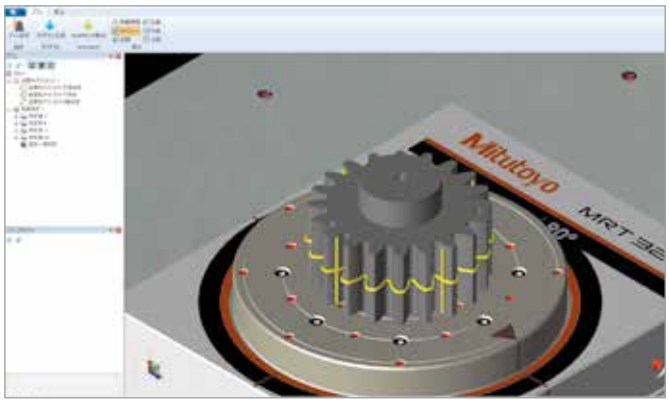


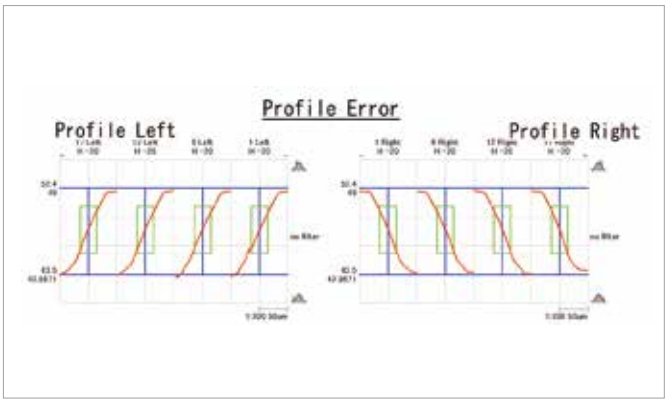
MiCAT Planner

(Automatic measurement program generation software for CMMs)

Tolerance information from a 3D CAD model is read to determine which features of the part should be measured to verify conformance to specification. Compared to conventional methods (teaching), this method creates more efficient measurement programs as well as saving time.

Use this QR code for details



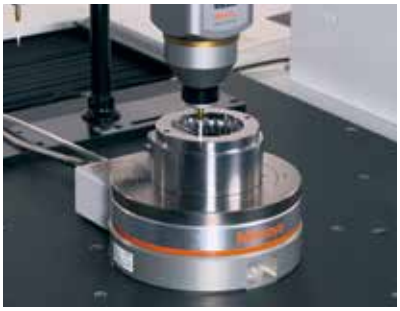


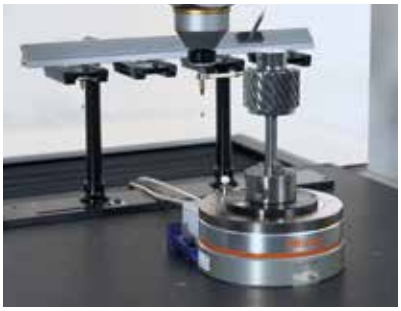
GEARPAK Express

(Gear Measurement and Evaluation Software for CNC Coordinate Measuring Machines)

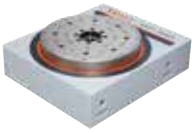
A 3D model created from the provided gear specifications enables you to visually and easily check whether measurement will be performed as intended. Furthermore, automatic program creation and on-screen measurement guidance help quick and easy setting of the coordinate system.

Rotary table





By synchronizing the movement of the CMM and the rotational movement of the rotary table, even objects that would have been conventionally measured using multiple probe positions can be measured in a short time and with high accuracy using fewer positions. It is ideal for measuring rotating workpieces (gears, rotors, shafts, impellers, blisks, cylindrical cams).



Specifications

Model		MRT240	MRT320
Dimensions [mm]	Depth	327	470
	Width	250	400
	Height	105	150
Table diameter [mm]		240	320
Mass [kg]*		20	120
Max. load [kg]		40	100
Accuracy	Indexing accuracy [°]	±0.7"	±0.7"
Max. drive speed [rpm]		6	9

* Main unit

Specifications

LEGEX Takumi

Model		LEGEX574	LEGEX774	LEGEX776	LEGEX9106
Measuring range	X axis	500 mm	700 mm		900 mm
	Y axis	700 mm			1000 mm
	Z axis	450 mm		600 mm	
Guide method		Air bearings on all axes			
Drive speed	CNC MODE (Key selector switch: AUTO)	Moving Speed: Max. 120 mm/s for each axis (maximum combined speed: 200 mm/s)			
		Measuring Speed 1 – 3 mm/s			
	CNC MODE (Key selector switch: MANUAL)	Moving Speed: Max. 120 mm/s for each axis (maximum combined speed: 200 mm/s)			
		Measuring Speed 1 – 3 mm/s			
	J/S MODE	Moving Speed 0 – 80 mm/s			
		Measuring Speed 0 – 3 mm/s			
		Fine Speed 0 – 0.01 mm/s			
Drive acceleration		0.588 m/s^2 for each axis (maximum combined acceleration: 0.98 m/s^2)			
Measuring method		Linear encoder			
Resolution		0.00001 mm			
Work table	Material	Cast iron			
	Size (table surface)	550 mm × 750 mm	750 mm × 750 mm		950 mm × 1050 mm
	Tapped inserts	M8×1.25			
Workpiece	Maximum height	700 mm		850 mm	
	Maximum mass	250 kg	500 kg		800 kg
Machine mass (includes the vibration-damping platform and controller, but not workpiece)		3500 kg	5000 kg	5100 kg	6500 kg
Power supply specifications	Power supply voltage	AC100-120/200-240 V ±10 % (50Hz or 60Hz)			
	power supply capacity (Probe and PC not included)	Max. 1.5 kW			
Air supply	Pressure	0.5 MPa (5 kgf/cm^2)			
	Consumption	120 L/min under normal conditions (air source: 160 L/min or less)			
Operating temperature range		10 to 30 ℃			

Accuracy

unit: µm

Title	Symbol	Standard	MPP-310Q	SP25M
Maximum permissible error of length measurement	$E_{0,MPE}$	ISO 10360-2:2009 JIS B 7440-2:2013	0.23+0.7L/1000	0.38+0.7L/1000
	$E_{150,MPE}$	ISO 10360-2:2009 JIS B 7440-2:2013	0.33+0.7L/1000	0.48+0.7L/1000
Maximum permissible limit of the repeatability range	$R_{0,MPL}$	ISO 10360-2:2009 JIS B 7440-2:2013	0.20	0.38
Maximum permissible scanning mode form error on a sphere	$P_{Form.Sph.Scan:PP:Tact,MPE}$	ISO 10360-5:2020 JIS B 7440-5:2022	0.8	1.1
Maximum permissible scanning mode time	$T_{Sph.Scan:PP:Tact,MPL}$	ISO 10360-5:2020 JIS B 7440-5:2022	60sec	60sec
Maximum permissible single-stylus form error	$P_{Form.Sph.1×25:SS:Tact,MPE}$	ISO 10360-5:2020 JIS B 7440-5:2022	0.35	0.45

The $E_{0,MPE}$, $E_{150,MPE}$, and $R_{0,MPL}$ testing and evaluation methods comply with ISO 10360-2:2009 (JIS B 7440-2:2013).
The $P_{Form.Sph.Scan:PP:Tact,MPE}$, $T_{Sph.Scan:PP:Tact,MPL}$, and $P_{Form.Sph.1×25:SS:Tact,MPE}$ testing and evaluation methods comply with ISO 10360-5:2020 (JIS B 7440-5: 2022).
L = given measurement length (unit: mm)

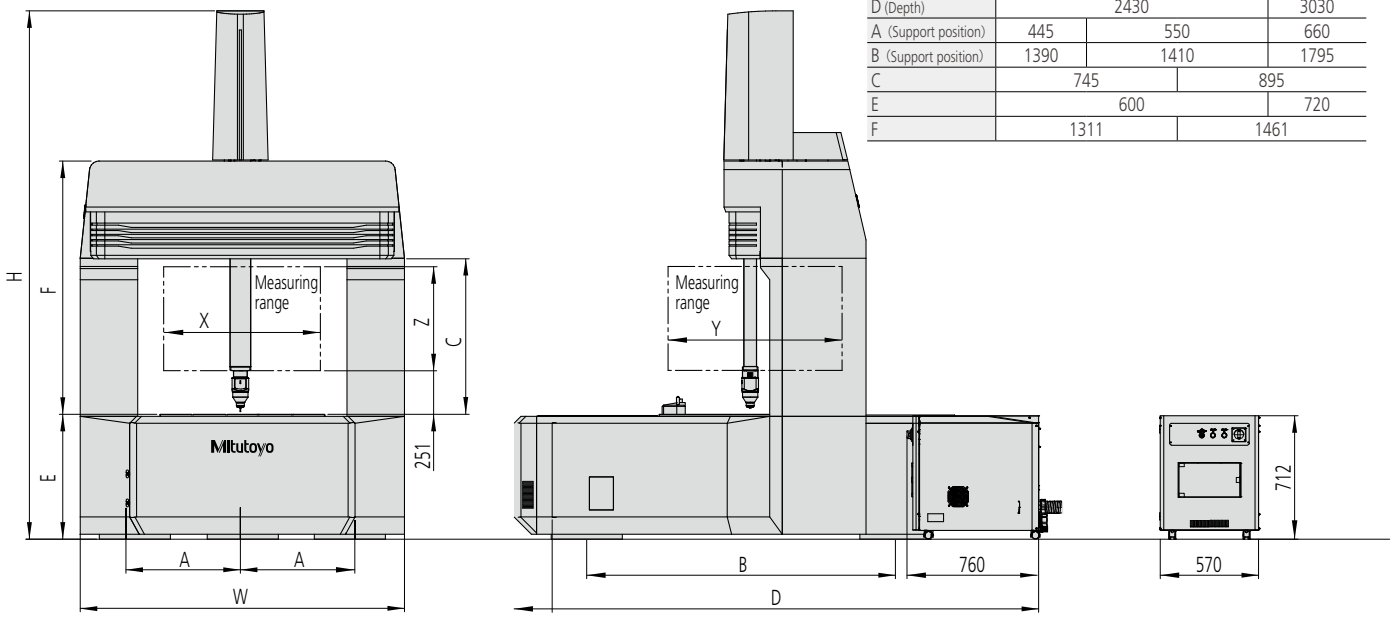
Guaranteed accuracy temperature environment

Temperature range		19 to 21 ℃
Temperature change	Per hour	0.5 ℃
	Per 24 hours	1.0 ℃
Temperature gradient	Vertical/ horizontal	1.0 ℃/m

Dimensions

unit: mm

Model	LEGEX574	LEGEX774	LEGEX776	LEGEX9106
W (Width)	1470	1670		1870
H (Height)	2630		2930	3050
D (Depth)	2430			3030
A (Support position)	445	550		660
B (Support position)	1390	1410		1795
C	745		895	
E	600			720
F	1311		1461	



2410(JP3), Printed in Japan

Coordinate Measuring Machines

Vision Measuring Systems

Form Measurement

Optical Measuring

Sensor Systems

Test Equipment

Digital Scale and DRO Systems

Small Tool Instruments and Data Management

Whatever your challenges are, Mitutoyo supports you from start to finish.

Mitutoyo is not only a manufacturer of top quality measuring products but one that also offers qualified support for the lifetime of the equipment, backed up by comprehensive services that ensure your staff can make the very best use of the investment.

Apart from the basics of calibration and repair, Mitutoyo offers product and metrology training, as well as IT support for the sophisticated software used in modern measuring technology. We can also design, build, test and deliver measuring solutions and even, if deemed cost-effective, take your critical measurement challenges in-house on a sub-contract basis.

Find additional product literature and our product catalogue

https://www.mitutoyo.co.jp/global.html

Notes on Export Regulations:
Do not commit an act, which could directly or indirectly, violate any law or regulation of Japan, your country or any other international treaty, relating to the export or re-export of any commodities.

Mitutoyo

Mitutoyo Corporation
20-1, Sakado 1-Chome,
Takatsu-ku, Kawasaki-shi,
Kanagawa 213-8533, Japan
T +81 (0) 44 813-8230
F +81 (0) 44 813-8231
https://www.mitutoyo.co.jp