

In-line CNC Coordinate Measuring System MICROCORD MACH Series

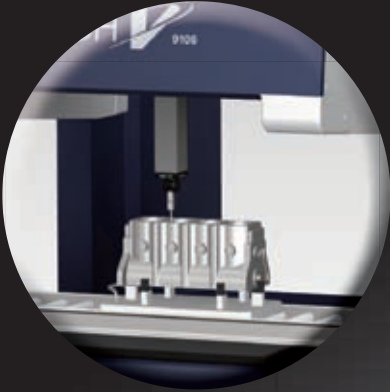
Catalog No.E16010(2)



**A Production-line Coordinate Measuring System
Designed for the Needs of Today**

Mitutoyo

In-line CNC Coordinate Measuring System **MACH series**



Vertical and Flexible

MACH-V

MACH-V substitutes a flexible measurement system for a series of gauge measurements on a powertrain manufacturing line. The high acceleration, high-speed probe movement results in high-throughput measurement.

MACH

Mitutoyo

Much-awaited, Fastest In-line Coordinate Measuring Machine, Bursting out of the Inspection Room.

An absolute requirement for a measuring machine to operate around the clock in a factory is the structural design: with due consideration given to superior durability for stable operations, significant reduction in measuring time, accuracy assurance under a wide range of temperature environments, security and ease of maintenance. The MACH series is Mitutoyo's in-line CNC coordinate measuring system that meets these demanding criteria. The proof is the fact that this series has established trust and a track record, particularly in the automobile industry at home and abroad.

Horizontal and High-speed Driven

MACH-3A

This is a horizontal CNC coordinate measuring system that achieves high throughput by increased drive speed, acceleration, and measuring speed. Space-saving and durability characteristics are compatible with line-side/in-line installation.



Agile Measuring System

MACH Ko-ga-me

MACH Ko-ga-me can be used in standalone applications or integrated into work cells.

- If required, the system can measure workpiece features that exceed the Ko-ga-me's X stroke by mounting the workpiece, or the Ko-ga-me, on an auxiliary X axis



MACH-V

An Optimal and Flexible Measuring System in Place of Dedicated Gauge Measurement in a Production Line

High-speed drive up to a maximum of 866mm/s

The world's fastest CNC vertical axis, in-line coordinate measuring machine with world-beating acceleration ($8,480\text{mm/s}^2$), measuring speed (at the moment of contact: 20mm/s) as well as drive speed. This system contributes to the reduction in total cost as an auto-measurement system, either in a line or at line side where a reduction in measurement time is required, and can also serve as a dedicated machine or a substitute system for gauges.

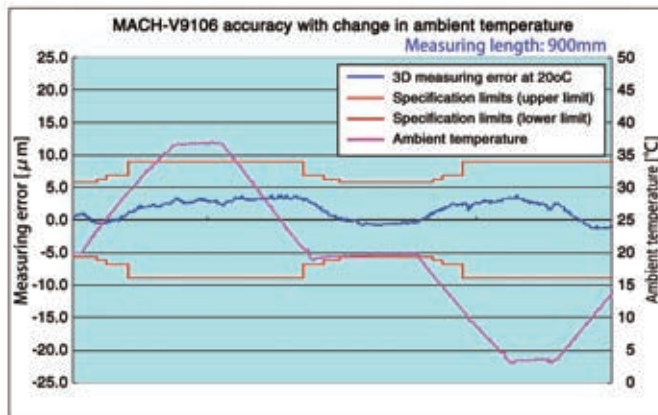
Space-saving design helps installation in a production line

In consideration of installation between processing machines, the width of this machine has been reduced by 15% compared with its predecessor, thus contributing to a reduction in line length. Open access to the measuring area from the front/back and left/right has increased flexibility in the routing arrangements for a workpiece.

Accuracy assurance throughout a wide temperature range (5 to 35°C)

Real-time thermal compensation applied to measurements and origin-setting assure excellent accuracy (referred to 20°C) over a much wider range of ambient temperature than conventional CMMs. The graph below shows the effectiveness of the scheme in maintaining accuracy over a range of more than 30°C .

Highly effective thermal compensation of the MACH-V9106



Improved dust resistance

This series has improved dust resistance relative to its predecessor by installing all drive system and scale units in the dust-tight enclosure on the machine top. The control unit and PC are installed in the dust-tight rack.

Improved ease of maintenance

The ease-of-maintenance construction and air-free operation means less chance of maintenance problems occurring.

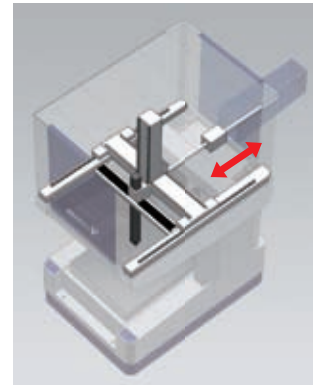


*Sub-plate is optional.

Higher speed and accuracy with barycentric drive

When the components of a CMM slide are driven by a force offset from the combined mass center, a rotation-inducing torque is produced that is detrimental to accuracy. To prevent this torque generation, the MACH-V series employs the barycentric drive system, achieving an ideal drive that minimizes slide rotation, especially under high drive acceleration conditions, by applying the drive force directly through the mass center of the slide.

This technique enables high-speed measurement with minimum accuracy deterioration compared with commonly-used CMMs.

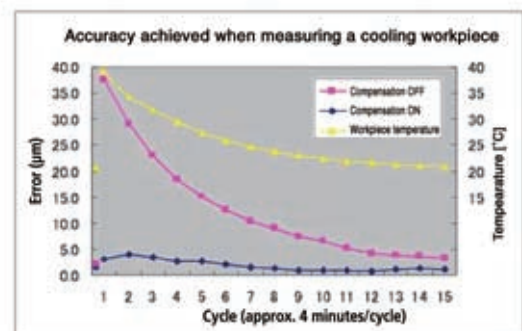


Workpiece thermal compensation - essential for in-line measurement

Generally, during production, the temperature of a workpiece differs from that of the measuring machine due to processing and washing and is always changing.

To support in-line operations, the machine must continue accurate measurement (referred to 20°C) even while the size of a workpiece is changing due to this temperature difference.

The following graph shows the high degree of compensation resulting when a MACH-V series machine (at 20°C) measured a certain workpiece while it cooled from 40°C towards 20°C .



| Item | Model | MACH-V9106 |
|---|----------------|--|
| Measuring range | X axis | 900mm |
| | Y axis | 1000mm |
| | Z axis | 600mm |
| Resolution | | 0.0001mm (0.1μm) |
| Guide system | | Linear guide on each axis |
| Operating speeds | CNC Mode | Drive speed: each axis 8 to 500mm/s; all axes 866mm/s |
| | | Measuring speed: 1 to 20mm/s |
| | Joystick mode | 0 to 80mm/s (High Speed) |
| | | 0 to 3mm/s (Low Speed) |
| | | 0.05mm/s (Fine Speed) |
| Maximum drive acceleration | | Each axis 4,900mm/s ² ; all axes 8,480mm/s ² |
| Scale type | | Linear encoder |
| Workpiece | Maximum height | 800mm |
| | Maximum mass | 150kg |
| Mass of machine (including the mounting stand and controller) | | 4650kg |

| | | Temperature |
|-------------------------------|-----------------------|---------------------------|
| Accuracy assurance conditions | Temperature range | 5 to 35°C |
| | Temperature variation | 2°C or less per hour |
| | | 10°C or less per 24 hours |
| | | Temperature gradient |

| Probe used | Temperature range | Max. permissible length measurement error | Repeatability range of E_0 |
|--|---|---|------------------------------|
| SP25M (Stylus: $\varnothing 4 \times 50 \text{ mm}$) | 19 - 21°C | $E_0, \text{MPE} = 2.5 + 3.5L/1000 \mu\text{m}$ | $R_0, \text{MPL} = 2.2$ |
| | | $E_{150}, \text{MPE} = 2.5 + 3.5L/1000 \mu\text{m}$ | |
| | 18 - 22°C | $E_0, \text{MPE} = 2.7 + 3.8L/1000 \mu\text{m}$ | |
| | | $E_{150}, \text{MPE} = 2.7 + 3.8L/1000 \mu\text{m}$ | |
| | 15 - 25°C | $E_0, \text{MPE} = 2.9 + 4.3L/1000 \mu\text{m}$ | |
| | | $E_{150}, \text{MPE} = 2.9 + 4.3L/1000 \mu\text{m}$ | |
| 5 - 35°C | $E_0, \text{MPE} = 3.6 + 5.8L/1000 \mu\text{m}$ | | |
| | $E_{150}, \text{MPE} = 3.6 + 5.8L/1000 \mu\text{m}$ | | |
| TP7M (Stylus: $\varnothing 4 \times 20 \text{ mm}$) | 19 - 21°C | $E_0, \text{MPE} = 2.5 + 3.5L/1000 \mu\text{m}$ | $R_0, \text{MPL} = 2.5$ |
| | 18 - 22°C | $E_0, \text{MPE} = 2.7 + 3.8L/1000 \mu\text{m}$ | |
| | 15 - 25°C | $E_0, \text{MPE} = 2.9 + 4.3L/1000 \mu\text{m}$ | |
| | 5 - 35°C | $E_0, \text{MPE} = 3.6 + 5.8L/1000 \mu\text{m}$ | |

| Probe used | Max. permissible single stylus form error |
|---|---|
| SP25M (Stylus: $\varnothing 4 \times 50 \text{ mm}$) | PTU, MPE = 2.2 |
| TP7M (Stylus: $\varnothing 4 \times 20 \text{ mm}$) | PTU, MPE = 2.5 |

| | |
|-------------------------|---|
| Applied probe | Maximum permissible error (scanning mode) (MPE _{THP}) |
| SP25M (stylus: ø4x50mm) | 4.0 |

Technical drawing of the 3D printer showing front, side, and top views with dimensions in mm.

Front View Dimensions:

- Overall width: 973
- Overall height: 1533
- Base width: 201
- Base height: 668
- Print volume height: 2901
- Print volume width: 2042
- Print volume depth: 332
- Print volume height offset: 871
- Print volume width offset: +Z
- Print volume depth offset: +Y

Top View Dimensions:

- Overall width: 1477
- Overall depth: 900
- Print volume width: 900
- Print volume depth: 900
- Print volume width offset: +Z
- Print volume depth offset: +X



MACH-3A

Long-awaited Horizontal Coordinate Measuring System Appropriate for a Horizontal Machining Line

High-speed drive up to a maximum of 1,212mm/s

The world's fastest CNC horizontal axis, in-line coordinate measuring machine with world-beating acceleration ($11,882\text{mm/s}^2$) and measuring speed (at the moment of contact: 30mm/s) as well as drive speed. This system contributes to the reduction in total cost as an auto auto-measurement system, either in a line or at line side where a reduction in measurement time is required, and can also serve as a dedicated machine or a substitute system for gauges.

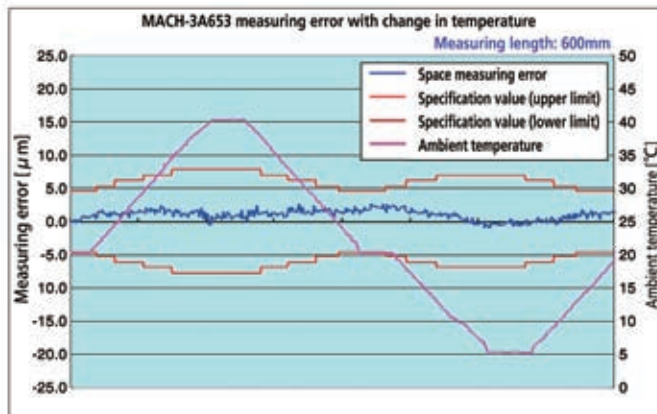
Space-saving design helps installation in a production line

This series comprises horizontal coordinate measuring machines intended for installation between processing machines. The horizontal-axis design allows this system to use the same workpiece handling and routing as the processing machines use.

Accuracy assurance throughout a wide temperature range (5 to 40°C)

Real-time thermal compensation applied to measurements and origin-setting assure excellent accuracy (referred to 20°C) over a much wider range of temperature than conventional CMMs. The graph below shows the effectiveness of the scheme.

Highly effective thermal compensation of the MACH-3A 653



Improved dust resistance

This system incorporates a control unit and a PC for measurement and has attained superior durability through a design targeted on 24-hour operation.

Improved ease of maintenance

The ease-of-maintenance construction and air-free operation means less chance of maintenance problems occurring.



All-in-one construction

In order to achieve further improved space-saving, dust resistance and adaptation to a wide range of temperatures, the MACH-3A employs an all-in-one construction.

The system integrates the main unit, data processor (PC) and monitor into one location on top of the mounting stand to achieve space-saving and ease of installation.

Additionally, to improve resistance to temperature environment and dust resistance, units other than the monitor are located in a cabinet in which a heat exchanger keeps the ambient temperature constant.

Thermal compensation - essential for in-line measurement

The MACH-3A series is provided with the same thermal compensation functions as the MACH-V series.

For detailed information, refer to page 4.

Specifications

| Item | Model | MACH-3A 653 |
|---|----------------|--|
| Measuring range | X axis | 600mm |
| | Y axis | 500mm |
| | Z axis | 280mm |
| Resolution | | 0.0001mm (0.1μm) |
| Guide system | | Linear guide on each axis |
| Operating speeds | CNC Mode | Drive speed: each axis 8 to 700mm/s; all axes 1212mm/s |
| | | Measuring speed for TP7M: 1 to 30mm/s Measuring speed for TP20: 1 to 20mm/s |
| | Joystick mode | 0 to 80mm/s (High Speed) |
| | | 0 to 3mm/s (Low Speed) 0.05mm/s (Fine Speed) |
| Maximum drive acceleration | | Each axis 6,860mm/s ² ; all axes 11,882mm/s ² |
| Scale type | | Linear encoder |
| Workpiece | Maximum height | 750mm |
| | Maximum mass | 200 kg (excluding optional accessories) |
| Mass of machine (including the mounting stand and controller) | | 1,500 kg (excluding optional accessories) |

Scanning accuracy ISO 10360-4:2000

| | |
|-------------------------|---|
| Probe used | Maximum permissible error (scanning mode) (MPE _{THP}) |
| SP25M (stylus: ø4x50mm) | 4.0 |

Operating environment

unit: μm

| | Temperature |
|-------------------------------|--|
| Accuracy assurance conditions | Temperature range |
| | 5 to 40°C |
| | Temperature variation |
| | 2°C or less per hour 10°C or less per 24 hours |
| | Temperature gradient |
| | Vertical: 1°C or less per meter Horizontal: 1°C or less per meter |

Point-to-point accuracy ISO 10360-2:2003

unit: μm

| Probe used | Maximum permissible error of measurement E _{0,MPE} | Maximum permissible error of probing P _{THU,MPE} |
|-------------------------|---|---|
| SP25M (stylus: ø4x50mm) | 2.2 + 3.5L/1000 (19 to 21°C) | 2.2 |
| | 2.5 + 4.2L/1000 (15 to 25°C) | |
| | 2.9 + 5.0L/1000 (10 to 30°C) | |
| | 3.2 + 5.7L/1000 (5 to 35°C) | |
| | 3.6 + 6.5L/1000 (5 to 40°C) | |
| TP7M (stylus: ø4x20mm) | 2.5 + 3.5L/1000 (19 to 21°C) | 2.5 |
| | 2.8 + 4.2L/1000 (15 to 25°C) | |
| | 3.2 + 5.0L/1000 (10 to 30°C) | |
| | 3.5 + 5.7L/1000 (5 to 35°C) | |
| | 3.9 + 6.5L/1000 (5 to 40°C) | |
| TP20 (stylus: ø3x10mm) | 2.7 + 3.5L/1000 (19 to 21°C) | 2.7 |
| | 3.0 + 4.2L/1000 (15 to 25°C) | |
| | 3.4 + 5.0L/1000 (10 to 30°C) | |
| | 3.7 + 5.7L/1000 (5 to 35°C) | |
| | 4.1 + 6.5L/1000 (5 to 40°C) | |

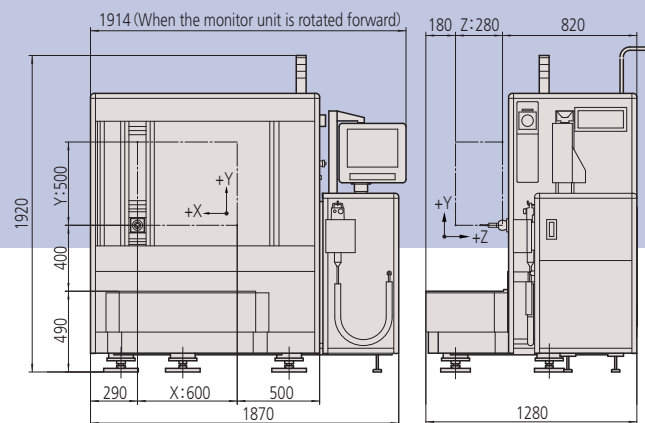
* L = Arbitrary measuring length (unit: mm)

Notes: 1) The index table is optional.

2) For information about the accuracy assurance conditions in a temperature range other than 5 to 40°C, contact your nearest Mitutoyo Sales Department.

External Dimensions

(Unit: mm)



Introduction to MACH-3A 483



- This is a high speed, versatile, shaft-measuring machine* appropriate for production line use.
- Dedicated gages cost a great deal of money for every design change to a workpiece. This measuring machine provides an economical alternative by accommodating such changes just by an easy edit of a part program, allowing dramatic cost-reduction to be achieved.
- This single machine enables fast and accurate measurement of all evaluation items on a crankshaft or camshaft.

* This is a custom-order product.

MEASURING SYSTEM

MACH-3A 653

MACH Ko-ga-me

A fast, highly accurate and flexible CNC measuring head

- Can be used in standalone applications or integrated into work cells.
- If required, the system can measure workpiece features that exceed the MACH Ko-ga-me's X stroke by mounting the workpiece, or the Ko-ga-me, on an auxiliary X axis.
- Ideal for inspection of large or small workpieces and offers a wide choice of measuring probes including touch-trigger and scanning types.

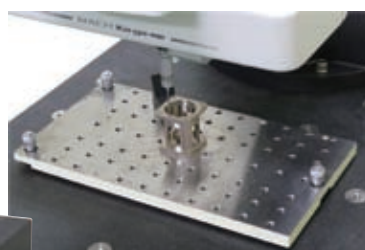


Standalone system

MACH Ko-ga-me



Stand*1



high speed measurement for a small workpiece

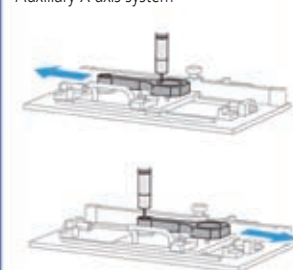
*1: The stand is option.

Moving-head system

Example of moving-head system



Auxiliary X axis system*2



*2: An auxiliary X-axis system shall be provided by the customer.

SPECIFICATIONS

| Model | KGM888-B | KGM12128-B |
|---|--|------------|
| Measuring range (mm) | 80×80×80 | 120×120×80 |
| Measuring accuracy (μm) | 19-21°C (2.0+5.0L/1000) 15-25°C (2.3+5.7L/1000) 10-30°C (2.7+6.5L/1000) 10-35°C (3.0+7.2L/1000) | |
| Drive speed (mm/sec) | Max. 200 (1 axis) / Max. 340 (Composition of 3 axes) | |
| Drive acceleration (mm/sec ²) | Max. 3900 (1 axis) / Max. 6750 (Composition of 3 axes) | |

*L=measured length (mm)

Guaranteed accuracy temperature for MACH Ko-ga-me

| | Temperature environment |
|-----------------------|--|
| Temperature range | 10 to 35°C |
| Temperature variation | 2.0°C or less/1hr |
| Temperature gradient | 1.0°C or less/1m (in horizontal/vertical direction) |

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Coordinate Measuring Machines

Vision Measuring Systems

Form Measurement

Optical Measuring

Sensor Systems

Test Equipment and
Seismometers

Digital Scale and DRO Systems

Small Tool Instruments and
Data Management