Laser Interferometer with Optical Fiber / Measurement System for Machine Tool

DISTAX 300A

Optical fiber coupled
Max. 2-axis automatic measurement
Easy attachment

TOKYO SEIMITSU CO., LTD.
Full Automation of Machine Tool Accuracy Inspection!

- The 3-axis measuring head and machine tool dedicated software (DISTAX MANAGER) provide full-automatic measurement in measurement ▶ correction ▶ inspection.
- The optical fibers provide easy attachment.
- The compact body allows you to easily carry.

Flexible attachment of optical fiber cables!

This product can be easily attached even to a horizontal-type machining center and a machine with a slant angle, which have been difficult to measure with a laser gage interferometer. In addition, the interference optical head and the fibers are screwed in, providing easy replacement. The fiber cables are covered with stainless steel and therefore not entangled.

Conventional

[Measurement Method]

- Space for a tripod is necessary. This takes time to install.

DISTAX

- The adopted optical fiber cables allow flexible installation anywhere! Example:

Example: Composite finishing machine

Conventional

A conventional tripod-type measuring machine cannot measure an axis with a slant angle.

Even though a model in which the beam is deflected to a slant angle with a mirror is available, it is very difficult to attach and takes time to start measurement.

DISTAX

DISTAX enables attachment of the measuring head to the main axis, providing easy attachment in the same way as a horizontal axis.

Example: Horizontal type machining center

Conventional

When the Y axis of a horizontal type machining center needs to be measured, the stroke reaches the underside of the table and therefore, unless a laser is attached to the main axis, the full-stroke measurement cannot be performed.

DISTAX

DISTAX enables the measurement without any problems since the measuring head can be attached to the main axis.
Angle Indexing System

Easy and a short-time Measurement (former a Ratio 1/3)
- Easy attachment!
- Measurement at high speed!
- Full automatic measurement!

Comparative example on angle indexing measurement process

<table>
<thead>
<tr>
<th>Hirth coupling method</th>
<th>DISTAX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attachment (10 min.)</td>
<td>Attachment (3 min.)</td>
</tr>
<tr>
<td>Alignment (15 min.)</td>
<td>Alignment (5 min.)</td>
</tr>
<tr>
<td>10° turn</td>
<td>10° turn</td>
</tr>
<tr>
<td>10° reverse (Measurement)</td>
<td>Stop (Measurement)</td>
</tr>
<tr>
<td>360° turn</td>
<td>360° turn</td>
</tr>
<tr>
<td>End (40 min. in total)</td>
<td>End (13 min. in total)</td>
</tr>
</tbody>
</table>
Stage Behavior Measurement

Non-contact measurement of behavior of stage moving at high speed!

- Laser interferometer anyone can use!
- High sampling rate that does not miss even slight motion First in this class!
- The 2-axis simultaneous measurement provides the relation between the position and the posture.

The motion analysis system includes two types of software programs: Dynamic measurement software and data link software.

Dynamic measurement software

- Distance, Speed, and Acceleration display function
- Graph’s partial enlargement function
- Yawing/Pitching measurement and straightness measurement are supported.

Data link software

- The trigger for positioning can be selected from the following three types:
  - Keyboard input
  - Auto input: Determination of Stop/Move based on the standard deviation and automatic input at the time of stop
  - Timer input: Input based on the clock in the personal computer Effective in long-time measurement etc.

Achievement of both of the industry’s first simultaneous 2-axis synchronous measurement and an industry leading high sampling rate of 1 MHz!

**Positioning measurement (Stage-related)**
- Linear guide motor
- Actuator precision stage

**Behavioral analysis**
- Stage speed ripple test
- Stage statically determinate / stop state measurement
- Various vibration measurements

**Dimension measurement**
- Wafer warp inspection
- Long-time positional variation (Thermal displacement, Vehicle body deformation)
- Gage test equipment
- Universal end measuring machine scale

- Machine tool positioning test
- Semiconductor manufacturing device
- Bonder, Visual inspection device
- Stepper lens test equipment
- Liquid crystal test equipment
- Color filter dimensional inspection
- Visual inspection device
- Mounting machine
- Mounter/Sorter
- Printed circuit board exposure device
- PCB substrate drilling device
- Automatic welding machine positioning test
- Printing machine positioning test
- Printer/Plotter
- Scanner positioning test
Example: Dynamic measurement

Multistage
A multistage consisting of a coarse stage, a fine stage, a rotary stage, etc. has many degrees of freedom but its Abbe error is high since the height difference from the position control encoder is great when stages are stacked. The dynamic measurement contributes not only to startup and statically determinate characteristics but also to construction of a high accuracy and high-speed positioning stage by determining the exact behavior of the stage through yaw pitch analysis.

Thermal displacement analysis of machine column
For a column of a machine tool a measuring machine, etc. thermal displacement occurs due to temperature change in the column itself or the ball screw. This would be the most troublesome issue for a machine requiring positioning accuracy due to the tradeoff relation between weight reduction and rigidity. Thermal displacement can be measured for a long period of time by lengthening the sampling time in DISTAX dynamic measurement. When there is a constant relation between the body temperature and the thermal displacement, the thermal displacement can also be corrected.

HDD face runout analysis / Shaft eccentricity analysis
A body of rotation can be sampled and its runout can be analyzed.

Printer head behavioral analysis
The positioning and statically determinate time of a printer head can be measured, contributing to accurate printing and print speed enhancement.

Compact slider behavioral analysis
DISTAX with a high sampling rate can measure a compact slider which is used for semiconductor etc.

Digital camera zoom behavioral analysis
The power zoom distance of a digital camera can be analyzed. A corner cube is attached to the lens part for measurement.

Example: Static measurement

Positioning test of plotter, bonder, etc.
The positioning accuracy of cutting plotters for apparel and wire bonders for semiconductors can be measured.

Test equipment reference of various gages
References of various gages which must be accurate can be correctly measured.

Measurement of slight displacement of cantilever
A slight displacement of a cantilever can be correctly measured using a piece of very small mirror.

Mirror wafer warp measurement
When a condensing lens is equipped, a slight wafer warp can be measured.
### Basic Components

#### System

<table>
<thead>
<tr>
<th>Specification</th>
<th>LI-02A</th>
<th>LI-04A</th>
<th>LI-03BH</th>
<th>LI-02C</th>
<th>LI-02D</th>
<th>LI-02E</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Length measurement interference head</td>
<td>Ultrasmall length measurement interference head</td>
<td>Length measurement interference head</td>
<td>Single beam interference head</td>
<td>Interference head</td>
<td>Interference head</td>
</tr>
<tr>
<td>Remarks</td>
<td>For distance measurement (up to 10m)</td>
<td>For distance measurement (up to 3m)</td>
<td>Plane mirror type for distance measurement (up to 5m)</td>
<td>Single beam type for distance measurement (up to 5m)</td>
<td>For angle measurement (yawing/pitching) (up to 5m)</td>
<td>Reflecting prism for straightness measurement (up to 3m) (Left)</td>
</tr>
</tbody>
</table>

#### Unit

- **Product code**: 903182
- **Product Name**: Length measurement interference head
- **Model**: LI-02A
- **Remarks**: For distance measurement (up to 10m), Corner cube of ø20 (supplied)

- **Product code**: 4500603
- **Product Name**: Ultrasmall length measurement interference head
- **Model**: LI-04A
- **Remarks**: For distance measurement (up to 3m), Corner cube of ø10 (supplied)

- **Product code**: 903350
- **Product Name**: Length measurement interference head
- **Model**: LI-03BH
- **Remarks**: Plane mirror type for distance measurement (up to 5m), The plane mirror is a build-to-order product.

- **Product code**: 4500155
- **Product Name**: Single beam interference head
- **Model**: LI-02C
- **Remarks**: Single beam type for distance measurement (up to 5m), Corner cube of ø10 (supplied)

- **Product code**: 903258
- **Product Name**: Interference head
- **Model**: LI-02E
- **Remarks**: Reflecting prism for straightness measurement (up to 3m) (Left), Polarizing prism (Right): 1 prism supplied for each

### Software

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>4500119</td>
<td>NC error measurement program</td>
<td></td>
</tr>
<tr>
<td>4500120</td>
<td>ISO standard measurement program</td>
<td></td>
</tr>
<tr>
<td>4500125</td>
<td>VID standard measurement program</td>
<td></td>
</tr>
<tr>
<td>4250988</td>
<td>DISTAX data link software</td>
<td></td>
</tr>
<tr>
<td>903268</td>
<td>Straightness measurement program</td>
<td>Win 7 version</td>
</tr>
</tbody>
</table>

### OPPRION

- **4500224**: Inkjet printer, Paper size: A4
- **42811074**: Printer USB cable, Length: 1.8m
- **4500411**: Carrying case MODEL1, For laser gage interferometer
- **4500412**: Carrying case MODEL2, For data processor
## Machine tool measurement selection

### Basic component

### Table 1: Machine tool measurement selection

<table>
<thead>
<tr>
<th>Product Code</th>
<th>Product Name</th>
<th>Model</th>
<th>Interference head</th>
<th>Reflective mirror</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>4500371</td>
<td>Machine tool measurement system L-IM-301-02</td>
<td>LI-42A</td>
<td>Corner cube specification</td>
<td></td>
<td>One axis of a machine tool can be automatically measured. A changeover is necessary for each measurement axis. Most basic system</td>
</tr>
<tr>
<td>4500156</td>
<td>National standard measurement system L-IM-301-02-3D</td>
<td>LI-42A</td>
<td>Corner cube specification</td>
<td></td>
<td>Three axes of a machine tool can be automatically measured, in which the optical axes are changed in order. A changeover is not necessary for each axis. Full automatic measurement is achieved.</td>
</tr>
<tr>
<td>4500158</td>
<td>X-Y stage measurement system L-IM-301-22</td>
<td>LI-42A</td>
<td>Plane mirror interference head</td>
<td></td>
<td>Best for measurement with a plane mirror attached to the X-Y stage side</td>
</tr>
<tr>
<td>4500320</td>
<td>X-Y stage measurement system L-IM-301-62</td>
<td>LI-42A</td>
<td>Ultrasmall length measuring head</td>
<td></td>
<td>The ultrasmall body is effective also for the fine stage measurement which cannot be weighted. Low cost compared to a plane mirror</td>
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</table>

### Table 2: Machine tool measurement selection

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### Table 3: Machine tool measurement selection

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<th>Model</th>
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<th>Reflective mirror</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0903321</td>
<td>Motion analysis system (1-axis) (Win XP version)</td>
<td>Li-02D</td>
<td>Laser interference system (Transmission and reception fiber of 3m, LI-02A interference optical head reflector, Interference head mounting jig, Reflector mounting jig)</td>
<td></td>
<td>Laser interference system (Transmission and reception fiber of 3m, LI-02A interference optical head reflector, Interference head mounting jig, Reflector mounting jig)</td>
</tr>
<tr>
<td>0903322</td>
<td>Motion analysis system (2-axis) (Win XP version)</td>
<td>Li-02D</td>
<td>Dynamic measurement software, Data link software</td>
<td></td>
<td>Dynamic measurement software, Data link software</td>
</tr>
</tbody>
</table>

### Notes:

- The laser wavelength is influenced by temperature, air pressure, and humidity when transmitted through the air. The environment sensor automatically corrects change in wavelength with high precision in the installation environment. The object temperature sensor is used to calculate the thermal expansion of a device under test and to automatically corrects to the condition at 20°C.
Unit combinations provide various measurements. 2-axis simultaneous measurement is also available!

Various 2-axis simultaneous measurements are available by unit combinations, such as Distance x Distance, Distance x Yawing, Distance x Straightness, Pitching x Yawing, Horizontal straightness x Vertical straightness, etc.

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**Positioning measurement**

A corner cube is attached to the stage side (1-axis) for inspection of the moving accuracy. The use of a plane mirror enables 2-axis simultaneous inspection of the X and Y axes. An interference pattern occurs due to an interference phenomenon caused by composition of the light wave reflected from a fixed reference mirror and the light wave reflected from a moving mirror, and measurement is performed by counting as the travel distance changes.

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**Yawing/Pitching measurement**

A dual corner cube is attached to the stage for inspection of yawing/pitching with an angle measuring head. Yawing/Pitching are measured based on an optical path length difference between two beams from an interference head onto a reflector and the center of the reflector of the dual corner cube.

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* The plane mirror is an option.
Straightness is inspected along with the stage guide. Manually pitch-feed the reflector mounted on the foot spacer between spacers along with the straight edge and measure the 2-point chain straightness from the posture angle of the measuring surface at each stop position.

A polarizing prism and a reflecting prism are attached to the stage to inspect horizontal/vertical straightness using straightness measuring head. Two light beams from the straightness interference head are deflected in a V shape through the polarizing prism and then enter into the reflecting prism. The beams are reflected on the same optical path through the reflecting prism. When the polarizing prism attached to the object to be measured moves in the horizontal or vertical direction, a difference occurs between the two optical paths and it is counted and measured to determine the straightness.
Controller requirements in automatic measurement (Manual measurement can be performed even if the requirements are not satisfied.)

- Various controllers are supported.
- The safety check program improves the safety, such as collision prevention of the measuring head!
- User-friendly with one-click startup, simplified settings, print preview etc.

<table>
<thead>
<tr>
<th>Interface</th>
<th>One of RS-232C ports; COM1 to COM16</th>
</tr>
</thead>
</table>
| Available NC controller | FANUC series 30i/31i/32i/300i/310i/320i/16/18/21/16i/18i/21i/160i/180i/210i/0i/0i Mate/15i/150i) *2 |}
| | MELDAS series 60i/605/70 * Automatic measurement needs an NC controller with RS-232 communication ports, programmable parameters, RS-communication DNC operation (RMT mode). |

NC pitch error correction software
(Supporting straight/rotation axis)

ISO230-2 Standard Measurement software
(Supporting straight/rotation axis)

VDI standard 3441/DGQ measurement software
(Supporting straight/rotation axis)

Correction values (positioning/backlash) are automatically calculated from the measured positioning value of the machine tool and input into the controller. Parameters of the machine tool are downloaded to adjust correction values to the controller and set up target values. This is achieved by retry + overwrite operation. G code programs for measurement are automatically created, enabling remote operation of the machine tool.

Machine tool inspection standard ISO230-2-compliant software Setting measurement positions automatically creates G code programs for measurement, enabling remote operation of the machine tool. The FY 1988 and FY 2006 formats required in customs clearance are supported. Tables and graphs following the standard can be printed.

Machine tool inspection standard VDI3441/DGQ-compliant software A sequence of positioning processes of the linear position, the origin reference point, and the turning point can be selected. G code programs for measurement are automatically created, enabling remote operation of the machine tool.
Posture/Straightness Level Measurement Software

Angle Measurements Software (Yawing, Pitching, 2-point chain straightness)

Posture changing with movement of the measuring object (Yawing/Pitching) is measured. The measurement value connecting function allows flexible measurement. This function is effective for a retry in the middle of measurement and sectional measurement in major axis measurement. In addition, 2-point chain straightness measurement is also available. This measurement calculates and chains straightness data from distance and angle data.

Straightness Measurement Software

Straightness changing with movement of the measuring object (Vertical/Horizontal direction) is measured. Two-way measurement is performed and start-to-end point and least square corrections are available.

Dynamic Measurement Software

Dynamic analysis software

Behavioral analyses of the vibration level and the stage acceleration/deceleration can be performed at a high sampling rate and thermal displacement analysis can be performed at a low sampling rate. Not only all of positioning, yawing/pitching, and straightness measurements can be selected but also simultaneous 2-axis measurement is also available. The comprehensive behavior consisting of positioning and posture can be analyzed. With full of user-friendliness with various functions including FFT and zooming functions, we are confident of this software.

Standard software

DATA Link Software (Excel Add-in Software)

This software comes standard with the DISTAX system.
For the direct input to Excel, the following three types of triggers are available:
(1) Keyboard input
(2) Auto input
  Measured values are automatically input by monitoring the degree of variation in measurement as the standard deviation and then determining Move -> Stop based on the specified thresholds of Stop/Move.
(3) Timer input
  A timer trigger time can be input based on the clock in the personal computer.
The flexible data handling in Excel provides simple and excellent user-friendliness. All of positioning, yawing/pitching, and straightness measurements are available.
Combination example of interference head and jig

3-axis measurement model (Interference unit)

3-axis measurement model (Interference unit)

Positioning measurement (Reflector)

Angle measurement (Reflector)

Please contact the following dealer to place an order.