Scale Units and Display Counters

Linear Scale DRO Systems

Catalog No. E13000(5)
**Overview**

- The assembly-type Linear Scale (ALT) is a scale protected by a frame. Our product line-up now fully covers both incremental/absolute systems for table position control of machine tools.

**Features of the Linear Scale System**

1. Digital counter value display allows quick and accurate readout of displacement. Working efficiency thus greatly improved.
2. Zero-setting or presetting possible at any position. Versatile functions eliminate calculations or complicated key operations for positioning.
3. Various external output features allow output of current display values or various data to external devices such as PCs or sequencers. Easy data processing can be performed.
4. Two types of display units available: high-performance type and limit signal type.
5. Both linear scale and display units conform to CE marking standards.

**Detection principle of linear scales**

- **Overview**
  - The assembly-type Linear Scale (ALT) is a scale protected by a frame. Our product line-up now fully covers both incremental/absolute systems for table position control of machine tools.

- **Features**
  - 1. Excellent environment resistance, vibration resistance and shock resistance.
  - 2. Requires no signal adjustment and easy-to-install.
  - 3. A high degree of freedom for detection head mounting.
  - 4. Solid and simple structure.

**Operating Principle of AT103/AT113 Models**

The assembly-type Linear Scale™ uses a highly accurate glass scale grating pitch of 20 µm as its basic standard of length. The grating is inscribed with parallel light generated with a light-emitting diode (LED) and collimator lens. The parallel light transmitted through the grating generates an interference pattern with the same pitch as that of a grating on the photodiode array of the light-receiving device. The receiver output signal is 2-phase square-wave signals by the interpolation circuit. The much smaller working resolution is achieved by detecting the cyclic variation in light intensity incident on the receiver array, as the scale is displaced in a measuring direction, and interpolating accordingly to output a corresponding displacement value.

**Detecting Principle Added to AT715**

The Absolute system type linear scale AT715 employs a unique, Mitutoyo-proprietary, electromagnetic induction principle that is highly resistant to environmental contamination. Achievement of true absolute scale with a resolution of 1 µm thanks to a multi-track configuration, enables the user to obtain absolute position information from the scale immediately upon the output of the counter.

Note: 1. Export to EU Member Countries

When you intend to export this product to any of the EU member countries, you may be required to provide Ular’s Manuals (in English and the EU Declaration of Conformity) in English (under certain circumstances, Ular’s Manuals) in the declaration country’s official language and the EU Declaration of Conformity in the declaration country’s official language. For detailed information, please contact Mitutoyo in advance.

Note: 2. The WEEE Directive

The WEEE Directive - a directive that mandates appropriate collection and recycling of electrical and electronic equipment wastes. The purpose of this directive is to increase the reuse and recycling of these products, and seeks eco-friendly product design. To differentiate between equipment waste and household waste, a crossed-out wheeled-bin symbol is marked on a product. We will promote eco-friendly design for our products.

**Linear Scale Unit**

**Model**

<table>
<thead>
<tr>
<th>Model</th>
<th>AT715</th>
<th>AT103</th>
<th>AT113</th>
</tr>
</thead>
<tbody>
<tr>
<td>AT103</td>
<td><strong>ABSOLUTE and High Environmental Resistance Type</strong></td>
<td><strong>Standard-size Type</strong></td>
<td><strong>Slim Type</strong></td>
</tr>
</tbody>
</table>

**Sectional dimensions**

- **Section size 22 × 54 mm**
- **Section size 37.5 × 80 mm**
- **Section size 22 × 52 mm**

**Measurement method**

- Electromagnetic induction system
- Photoelectric, Transparent linear encoder

**Output range**

- 100 - 3000 mm

**Accuracy (20°C)**

- ± 5 µm ± 10 µm
- (Refer to page 16)

**Effective range**

- AT715, AT113: (5+L0/1000) µm, Effective range
- AT103: (5+5L0/1000) µm, Effective range (High-accuracy type) is (3+5L0/1000) µm

**Maximum resolution**

- 0.3 µm

**Mounting method**

- Block spacer
- Middle support (V)

**Absolute scale unit with excellent resistance to harsh environments**

**Absolute scale unit with excellent resistance to harsh environments**

**Reference dimensions for mounting**

**Effective range 100 - 3000 mm**

**Mounting method 1**

- Mounting method 1: C/C of Section dimension

**Signal cable**

- Standard accessory (refer to individual specifications for the length)

**Measurement**

- Electromagnetic induction system
- Photoelectric, Transparent linear encoder

**Output range**

- 100 - 3000 mm

**Accuracy (20°C)**

- ± 5 µm ± 10 µm
- (Refer to page 16)

**Effective range**

- AT715, AT113: (5+L0/1000) µm, Effective range
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**Maximum resolution**

- 0.3 µm

**Mounting method**

- Block spacer
- Middle support (V)

**Absolute scale unit with excellent resistance to harsh environments**

**Reference dimensions for mounting**

**Effective range 100 - 3000 mm**

**Mounting method 1**

- Mounting method 1: C/C of Section dimension

**Signal cable**

- Standard accessory (refer to individual specifications for the length)
Effective range 100 – 1500 mm

Reference dimensions for mounting

AT113

Slim type with cross-sectional dimensions of 22 x 35 mm

Note 2: Ultra-high precision model (2+2L0/1000) µm is also available to special order for the effective range 100 to 500 mm.

AT113F

Note 1: High precision model (JIS Class 0, 3+3L0/1000) µm is also available to special order.

Order No. Model

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>1590 (62 in)</td>
<td>1540 (60.63 in)</td>
<td>1678 (66.06 in)</td>
<td>1662 (65.43 in)</td>
<td>1696 (66.77 in)</td>
<td>560 (22.05 in)</td>
<td>530 (20.87 in)</td>
<td>490 (19.29 in)</td>
<td>460 (18.11 in)</td>
<td>430 (16.93 in)</td>
<td>400 (15.74 in)</td>
<td>380 (15.00 in)</td>
<td>350 (13.78 in)</td>
<td>320 (12.60 in)</td>
<td>300 (11.81 in)</td>
<td>270 (10.63 in)</td>
<td>250 (9.84 in)</td>
<td>220 (8.66 in)</td>
<td>180 (7.08 in)</td>
</tr>
<tr>
<td>3598 (141.6 in)</td>
<td>3548 (139.4 in)</td>
<td>3686 (145.6 in)</td>
<td>3670 (144.5 in)</td>
<td>3704 (145.6 in)</td>
<td>1230 (48.43 in)</td>
<td>1210 (47.64 in)</td>
<td>1170 (46.06 in)</td>
<td>1150 (45.31 in)</td>
<td>1120 (44.49 in)</td>
<td>1090 (43.31 in)</td>
<td>1060 (41.33 in)</td>
<td>1030 (40.49 in)</td>
<td>1000 (39.37 in)</td>
<td>970 (38.35 in)</td>
<td>940 (37.01 in)</td>
<td>910 (35.83 in)</td>
<td>880 (34.65 in)</td>
<td>850 (33.47 in)</td>
</tr>
<tr>
<td>5898 (231.2 in)</td>
<td>5848 (229.4 in)</td>
<td>5986 (236.3 in)</td>
<td>5970 (235.4 in)</td>
<td>5994 (236.3 in)</td>
<td>2250 (88.6 in)</td>
<td>2230 (88.1 in)</td>
<td>2190 (86.6 in)</td>
<td>2170 (86.1 in)</td>
<td>2140 (85.3 in)</td>
<td>2110 (84.6 in)</td>
<td>2080 (83.9 in)</td>
<td>2050 (83.2 in)</td>
<td>2020 (82.5 in)</td>
<td>1990 (81.8 in)</td>
<td>1960 (81.1 in)</td>
<td>1930 (80.4 in)</td>
<td>1900 (79.8 in)</td>
<td>1870 (79.1 in)</td>
</tr>
</tbody>
</table>

Dimensions L5, L6 and L7 indicate the recommended positions of intermediate supports for scale units with an effective range greater than 500 mm.

Effective range (mm) Middle Support

<table>
<thead>
<tr>
<th>1500 – 1550</th>
<th>8 – C, D points</th>
</tr>
</thead>
</table>

Display Unit (counter)

High performance

Function

Zero-setting

Preset

Resolution setting

Measurement direction setting

mm/inch conversion

Diameter display

Scale reference point setting

1/2 calculation

Coordinate system switching

Bolt hole circle machining

Pitch machining

Zero approach machining (INC mode)

Addition of 2-scale data

Linearity error compensation

Pitch error compensation

Smoothing

Memory backup

Scaling ratio

Lower digit blanking out

External zero-setting

RS-232C interface unit

USB output

Limit signal output

Error message

Type

KA-200 Counter

KA-213

KA-215

KA-217

KA-219

KA-221

Note 3: The indication accuracy does not include quantizing error L: Effective range (mm)

Note 1: High precision model AT113F (JIS Class 0, 3+3L0/1000) µm is also available to special order.

Note 2: Ultra-high precision model AT113F (2+2L0/1000) µm is also available to special order for the effective range 100 to 500 mm.

Note 3: The indication accuracy does not include quantizing error L: Effective range (mm)

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Note 3: The indication accuracy does not include quantizing error L: Effective range (mm)
**KA-200 Counter**

High performance display unit with many functions.

- Can be used as a "standard counter" or "lathe counter" by modifying parameters.
- Downsizing, weight saving and multiple functionality have been realized.
- Sub display for easy operation.
- The optional external interface RS-232C enables connection to a PC and printer.
- Test data can be output using the optional USB interface.
- Two-year guarantee

**FEATURES**

- Can be used as a standard counter or lathe counter by modifying parameters.
- Downsizing, weight saving and multiple functionality have been realized.
- Sub display for easy operation.
- The optional external interface RS-232C enables connection to a PC and printer.
- Text data can be output using the optional USB interface.
- Two-year guarantee

**Dust-proof cover:**

- Code: 06AEU075
- Lead wire (4 m): 09C9A985
- Seal set (1 pc.): 06AEU080
- D-SUB15P Connector cap: 06AFC149
- User’s Manual (1 set): 99MBE083A

**Optional Accessories**

- Code out unit: 06AEUT95
- External extension cable: 06ACP641
- Foot switch for measurement: 937799T

**DIMENSIONS**

- 1.8 m AC cable (provided with counter. Please see the below table for the combination)

<table>
<thead>
<tr>
<th>Order No. and suffix for counter</th>
<th>Country/Region</th>
<th>Power supply standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>T174-183A/T174-185A</td>
<td>North America, Canada</td>
<td>UL, CSA</td>
</tr>
<tr>
<td>T174-183B/T174-185B</td>
<td>Europe</td>
<td>CEE</td>
</tr>
<tr>
<td>T174-183C/T174-185C</td>
<td>Australia</td>
<td>AS</td>
</tr>
<tr>
<td>T174-183D/T174-185D</td>
<td>China</td>
<td>CCC</td>
</tr>
<tr>
<td>T174-183E/T174-185E</td>
<td>Korea</td>
<td>EK</td>
</tr>
</tbody>
</table>

**SPECIFICATIONS**

- Display ON/OFF switch:
  - Turns ON/OFF the display on the front panel.
- DIA:
  - Lights up while the diameter is displayed.
- Scaling:
  - Lights up when a scaling ratio is applied.
- Main display:
  - Displays each axis count value with 1-digit sign and 8-digit numbers.
- Zero reset key:
  - Resets the display of each axis to zero.
- Sub-display:
  - Displays set coordinates and operation information.
- Lock:
  - Lights up when a function is locked.
- MODE key:
  - Keys to execute functions used with numeric keys.
- Four arithmetic operation keys:
  - Keys to execute arithmetic operations.
- Trigonometric function keys:
  - Keys to execute trigonometric operations.
### Basic functions

**Zero-setting**
- The display can be set to “0” (zero) at any scale position.

**Lower digit blanking out**
- Unnecessary lower digits (up to 4 digits of the lowest digit) can be blanked out.

**Resolution setting**
- The display resolution can be selected from among 0.05, 0.01, 0.005, 0.002, 0.001, 0.0005 and 0.0001 mm. (When AT100 Series is connected.)
- When the AT115 is connected, the display resolution can be selected from among 0.01, 0.005, 0.002 and 0.001 mm.

### Special functions

#### Linear error compensation
- Machine errors caused due to workpiece weight, inaccurate table adjustment, etc., are linearly compensated to reduce the positioning error.

#### Smoothing function
- Turning on “smoothing” slows display updates to enable the display to be read more easily when a measurement value is rapidly oscillating due to machine vibration. Measurement speed remains unaffected.

#### Display value backup
- The displayed value at power-off is preserved in memory and restored at the next power-on.

#### Expansion/contraction coefficient setting
- This function multiplies the actual counter measurements by a constant factor. This is useful in, for example, mold manufacture by allowing the mold to be machined to the actual-molded component dimensions directly, without having to increase the machining dimensions manually to allow for material shrinkage after molding. Tedium work can thus be reduced and the risk of mistakes in calculation eliminated.

### Measurement direction setting
- The readout can be set to count up or down in either direction of scale movement, whichever is more convenient for the operator.

**Measurement direction setting**
- Absolute/incremental coordinate system switching (KA-200 Counter)
  - Although both the scale and the counter use the incremental system, detecting the origin point on the scale enables using them as absolute coordinates.
  - Thus two coordinate systems are available:
    - Absolute coordinate system
      - When measuring by defining an arbitrary coordinate point as a reference setting the machine origin to 0 is convenient. This coordinate system is also usable when an arbitrary workpiece point is set as a reference point, and setting a datum point on the workpiece to 0 is convenient in this case.
    - Incremental coordinate system
      - Use this system when successively measuring with an arbitrary point as a reference point. In this case, performing zero-setting each time when reaching an arbitrary point is convenient.

**Absolute coordinate**
- Moved from a reference point by the set value.
  - Absolute points of the scale are engraved every 50 mm between the effective range marks (“-” marks).

**Incremental coordinate**
- Preset at the arbitrary position by using absolute coordinate. The counter can zero-set/preset at the arbitrary position by using incremental coordinate.

**Point 0**
- The position reference marked on the glass scale is the absolute origin point and it can display the position reference marked on the glass scale. If the counter is zero-set/preset at this position, the preset value is automatically corrected to the next target value.

**Point 1**
- The doubled scale displacement can be displayed.

**Pitch 0**
- The pitch and spindle position can be displayed.

**Pitch 1**
- The pitch and spindle position can be displayed.

**Point 3**
- The pitch and spindle position can be displayed.

**Point 4**
- The pitch and spindle position can be displayed.

**Diameter display**
- The doubled scale displacement can be displayed. This convenient function can be used to display the diameter of a workpiece during a turning operation.

**Memorization of machining reference point for each cutting tool (KA-200 Counter)**
- Absolute coordinate and incremental coordinate can be switched by every one of four cutting tools. The counter can memorize the center of a machining point for each tool. The counter can zero-set/preset at the arbitrary position by using incremental coordinate.

**Zero approach machining**
- Zero approach machining can be repeated at preset intervals. Since the counter keeps the total displacement in absolute coordinates, a positioning error made by the operator at one tooling position has no effect on the remaining positions.

**Zero-setting**
- The readout can be set to count up or down in either direction of scale movement, whichever is more convenient for the operator.

**Preset**
- This function allows the user to enter a numeric value on the counter display for the next move.

**Measurement direction setting**
- The readout can be set to count up or down in either direction of scale movement, whichever is more convenient for the operator.

**Parameter All Clear**
- Clears the setup parameter data and returns to the default data.

**Cutting tool**
- The KA-200 Counter can also connect with a line-driver output type scale and a linear gage. For detailed information, refer to page 16.
Special accessories are available for the Mitutoyo linear scale to support various measurement methods.

**External Load Box**
Outputs counter value just by pressing the button when using the counter’s data output function. (For KA-200 Counter (equipped with RS-232C output)

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Number of axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>937244</td>
<td>3-axis</td>
</tr>
</tbody>
</table>

**External Zero-set Box**
Performs zero-setting by touch and outputs the currently displayed counter value to external equipment. (For KA-200 Counter (equipped with RS-232C output)

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Number of axes</th>
</tr>
</thead>
<tbody>
<tr>
<td>980053</td>
<td>3-axis</td>
</tr>
</tbody>
</table>

Note 1: Both of the counter and the external zero-set box have to have the same number of axes.

Note 2: When using for KA-200 Counter, a cable for external connection is also required.

**External Load Foot Switch**
Outputs counter value just by stepping on the switch when using the counter’s data output function. (For KA-200 Counter (equipped with RS-232C output)

<table>
<thead>
<tr>
<th>Order No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>965004</td>
</tr>
</tbody>
</table>

Note: When using for KA-200 Counter, a cable for external connection is also required.

**Digimatic Mini-Processor DP-1VA LOGGER**
Display data printing becomes available by connecting the RS-232C output connector of the KA-200 Counter and DP-1VA LOGGER. For connection, use RS-232C Counter cable (1 m). (For KA-200 (RS-232C output) Counter)

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Product name</th>
</tr>
</thead>
<tbody>
<tr>
<td>09AAA0494</td>
<td>RS-232C Counter cable</td>
</tr>
</tbody>
</table>

**Code Out Unit (For KA-200 Counter)**
This is a code out unit for RS-232C output. Communication with a PC is available using each command. Text data output using USB becomes available in combination with a foot switch.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Product name</th>
</tr>
</thead>
<tbody>
<tr>
<td>09AAA1983</td>
<td>Code out unit</td>
</tr>
<tr>
<td>9371991</td>
<td>Foot switch</td>
</tr>
</tbody>
</table>

**Cable for External Connection**
External zero-set box, external load box and external load foot switch can be used when connected with RS-232C output of KA-200 Counter. Combination use with RS-232C output is available.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Product name</th>
</tr>
</thead>
<tbody>
<tr>
<td>09AAA9741</td>
<td>RS-232C counter cable</td>
</tr>
</tbody>
</table>

**Extension Cable**
Extends the cable length of a Linear Scale when there is a distance between the Linear Scale and a counter.

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Cable length</th>
</tr>
</thead>
<tbody>
<tr>
<td>09AAA233A</td>
<td>2 m</td>
</tr>
<tr>
<td>09AAA233B</td>
<td>5 m</td>
</tr>
<tr>
<td>09AAA233C</td>
<td>7 m</td>
</tr>
</tbody>
</table>

For AT7155:

<table>
<thead>
<tr>
<th>Order No.</th>
<th>Cable length</th>
</tr>
</thead>
<tbody>
<tr>
<td>09AAA537A</td>
<td>2 m</td>
</tr>
<tr>
<td>09AAA537B</td>
<td>5 m</td>
</tr>
<tr>
<td>09AAA537C</td>
<td>7 m</td>
</tr>
</tbody>
</table>

**Counter Support**
Supports for various counters. Desk-top, turnable-arm, turnable-double-arm, stand, and special type are available. (The support type depends on the counter. Please specify your counter so that we can select the appropriate support for you.)

**Various Adapters**
Mitutoyo provides a variety of adapters, meeting various applications. (Refer to Pages 22 to 23 for details.)

- Connecting adapters for former Linear Scales and existing counters (KA-200 Counter)
- Connecting adapters for existing Linear Scales (AT100 Series) and former counters.
- Connecting adapters for line-driver output Linear Scales, various sensors and existing counters (KA-200 Counter)
Connecting to External Devices

Connection diagram

Machine slide travel distance data and limit switch signals for a machine tool or measuring machine can be output to a PC using the optional RS232/USB interface. Digimatic input is also available (KA-200 Counter).

## RS-232C Input and Output

Data transmission/reception is available using request commands from a PC.

### Common specification

1. Communication specifications
   - Home position: DCE
   - Communication method: Full duplex
   - Data transfer speed: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps
   - Parity bit: NO (n/a), EVEN, ODD
   - Data bit: 7 bit
   - Stop bit: 1 bit
   - The setting is switchable by parameter.

2. Operation for data output
   - 1. Output of counter display value in the trigger mode
      - Counter display values can be output in the following ways. Only one signal type can be used for input at any one time.
   - 2. Control the counter from external equipment

3. Error code output
   - If a data output command is issued when the counter is in an error status, or when an incorrect command is issued, the counter outputs a corresponding error code signal.

### Connecting to External Devices

#### Digimatic

RS-232C output

USB output

Communication with a PC and printer is available using an RS-232C interface.

#### DATA OUTPUT MODE

Data output can be selected from two modes: the trigger mode that outputs data by commands input from an external load signal or a PC, and the interval mode that outputs data at regular intervals. The interval mode is supported by the KA-200 Counter and the trigger mode is supported by all models.

### SPECIFICATIONS

1) Communication specifications*
   - Home position: DCE
   - Communication method: Full duplex
   - Data transfer speed: 300, 600, 1200, 2400, 4800, 9600, 19200, 38400 bps
   - Parity bit: NO (n/a), EVEN, ODD
   - Data bit: 7 bit
   - Stop bit: 1 bit
   - The setting is switchable by parameter.

2) Operation for data output
   - 1. Output of counter display value in the trigger mode
   - Counter display values can be output in the following ways. Only one signal type can be used for input at any one time.

   - 2. Control the counter from external equipment
      - The counter is controllable from a PC using the following commands. Command codes must be entered in upper-case characters.

   - 3) Error code output
      - If a data output command is issued when the counter is in an error status, or when an incorrect command is issued, the counter outputs a corresponding error code signal.

   - **CAUTION**
     - 1. The output data format is fixed to either 7 or 8 digits, without zero-suppression.
     - 2. If data is output from multiple axes, a comma (,) is used as a delimiter.
     - 3. Data is output in the same unit that is used on the counter (mm or inch). However, the unit identifier itself will not be output.

### Adapter configuration

#### Applicable Models*

- **Square-wave-signal-output AT Scale**
  - AT211, AT230

- **Square-wave-signal-output ST Scale**
  - ST5062A, ST5062B, ST5062C

- **Linear Gage with origin point mark**
  - LG100 Series

- **Standard type Linear Gage**
  - LG200 Series

- **Digimatic input**
  - (KA-200 Counter)

#### Adapter A: 06AC8391

- **Square-wave-signal-output AT Scale**
- **Square-wave-signal-output ST Scale**
- **Linear Gage with origin point mark**
- **Standard type Linear Gage**

#### Adapter B: 06AC8392

- **Square-wave-signal-output AT Scale**
- **Square-wave-signal-output ST Scale**
- **Linear Gage with origin point mark**
- **Standard type Linear Gage**

#### Adapter C: 06AC8393

- **Square-wave-signal-output AT Scale**
- **Square-wave-signal-output ST Scale**
- **Linear Gage with origin point mark**
- **Standard type Linear Gage**

#### Adapter D: 06AC8395

- **Square-wave-signal-output AT Scale**
- **Square-wave-signal-output ST Scale**
- **Linear Gage with origin point mark**
- **Standard type Linear Gage**

### Adapter configuration

- **Adapter A** : 06AC8391
- **Adapter B** : 06AC8392
- **Adapter C** : 06AC8393
- **Adapter D** : 06AC8395

*1: For details regarding square-wave-signal-output scales and Linear Gages, refer to leaflet No. E13005 “NC Linear Scale Systems” and No. E13007 “LINEAR GAGE”.

*2: A cable between adapter B and the counter is required.

Use an optional connecting cable for ST Scale (2 m/3 m/5 m), or make a connecting cable to the counter using a connector provided with a ST Scale as standard. Other adapters than Adapter B can be directly connected to the counters.

### CAUTION

- When using adapters A to D, maximum response speed is determined by the resolution of the connected models.
- When the parameter 96 of the KA-200 Counter is set to 5 (input frequency 300 kHz), the output data format is fixed to either 7 or 8 digits, without zero-suppression.
- If data is output from multiple axes, a comma (,) is used as a delimiter.
- Data is output in the same unit that is used on the counter (mm or inch). However, the unit identifier itself will not be output.
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- Data is output in the same unit that is used on the counter (mm or inch). However, the unit identifier itself will not be output.

### Configuration of line-driver-output models and connecting adapters for the KA-200 Counter

- **Line Conversion Adapter**
- **Square-wave-signal-output AT Scale**
- **Square-wave-signal-output ST Scale**
- **Linear Gage with origin point mark**
- **Standard type Linear Gage**

### Applicable Models

- **Adapter A**: 06AC8391
- **Adapter B**: 06AC8392
- **Adapter C**: 06AC8393
- **Adapter D**: 06AC8395

For details regarding square-wave-signal-output scales and Linear Gages, refer to leaflet No. E13005 “NC Linear Scale Systems” and No. E13007 “LINEAR GAGE”.

For details regarding square-wave-signal-output scales and Linear Gages, refer to leaflet No. E13005 “NC Linear Scale Systems” and No. E13007 “LINEAR GAGE”.

When using adapters A to D, maximum response speed is determined by the resolution of the connected models.
Connecting to External Devices

4) RS-232C connectors
The output connector of the code out unit for the KA-200 Counter is a 25-pin type.

5) About connection cables
Use a straight cable to connect with a PC. No cable with compatible connectors is provided with the product. Please purchase commercial products separately.

6) Connecting to the DP-1VA LOGGER (KA-200 Counter only)
Display data printing becomes available by connecting the 25-pin output connector of the code out unit for the KA-200 Counter and DP-1VA LOGGER. When connecting, use the RS-232C counter cable (96AA5036) sold separately.

7) External extension cable
By attaching an external extension cable to a KA-200 Counter + RS-232C code-out unit, the optional external load box, foot switch and external zero-set box can be connected. RS-232C outputs can be used together.

USB Output
A KA-Series counter can output measurement values as USB text data in combination with the optional code output unit and foot switch. These numeric values can be imported to applications such as Excel.

<table>
<thead>
<tr>
<th>Pin No.</th>
<th>Signal</th>
<th>Remarks</th>
<th>Signal Direction (Counter to PC)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RS</td>
<td>Same grounding</td>
<td>—</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>Command</td>
<td>—</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>Data</td>
<td>—</td>
</tr>
<tr>
<td>4</td>
<td>—</td>
<td>Not used</td>
<td>—</td>
</tr>
<tr>
<td>5</td>
<td>—</td>
<td>10-pin lead</td>
<td>—</td>
</tr>
<tr>
<td>6</td>
<td>—</td>
<td>10-pin lead</td>
<td>—</td>
</tr>
<tr>
<td>7</td>
<td>16</td>
<td>Signal grounding</td>
<td>—</td>
</tr>
<tr>
<td>8 to 13</td>
<td>—</td>
<td>Not used</td>
<td>—</td>
</tr>
<tr>
<td>14</td>
<td>—</td>
<td>8-pin load</td>
<td>—</td>
</tr>
<tr>
<td>15</td>
<td>—</td>
<td>Not used</td>
<td>—</td>
</tr>
<tr>
<td>16</td>
<td>—</td>
<td>2-pin load</td>
<td>—</td>
</tr>
<tr>
<td>17 to 22</td>
<td>11</td>
<td>2-pin zero-setting</td>
<td>—</td>
</tr>
<tr>
<td>23</td>
<td>—</td>
<td>2-pin zero-setting</td>
<td>—</td>
</tr>
<tr>
<td>24</td>
<td>—</td>
<td>2-pin zero-setting</td>
<td>—</td>
</tr>
<tr>
<td>25</td>
<td>—</td>
<td>2-pin zero-setting</td>
<td>—</td>
</tr>
</tbody>
</table>

Note: Refer to “7) External extension cable” for how to use the external load box and external zero-set box.

Applicable plug (male): HDBB-25P (plug/HIROSE) HDB-CHT (case/HIROSE)

25-pin specifications (KA-200 Counter)

Timing Chart
1) Outputting data a fixed time after startup
(Internal Mode, KA-200 Counter only)

Timing chart: Output timing elsewhere

Note: The display mode at startup can be selected with a parameter (KA-200 Counter).

2) Inputting commands from external equipment

Timing chart: Error cancel

Note: Each value in the timing chart indicates response time to a command. Consequently, be aware that this command may cause a difference between the detected point value and the actual point value when the slider is moving.

3) External zero-set signal

Timing chart: Data output timing on startup

Note: Maintain the low level for 100 ms or more.
Selecting the scale unit mounting position and mounting method

It is important to keep in mind the following points when determining the scale unit mounting position and orientation.

- Ease of mounting
  Mount the scale unit making sure that the unit including the detector head and the cables does not interfere with any part of the machine. To facilitate mounting, mount the scale unit on machined surfaces wherever possible.

- Protection from machining fluids and swarf (mounting orientation)
  The scale unit is constructed in such a way that machining fluids and swarf cannot easily enter into the interior of the unit. However, since the openings are protected from entry of foreign material with rubber seals only, avoid directly exposing the scale unit to machining fluids and swarf. Slight the mounting orientation of the scale unit after carefully considering the direction in which machining fluids and swarf are sprayed and scattered.

- Accuracy considerations
  The total system accuracy of the machine on which the scale unit is mounted is not only determined by the scale unit mounting accuracy as well. Particularly for machines with slide tables, geometrical errors may occur, depending on the straightness of moving parts. Thus, the scale unit must be mounted in a way that these errors are minimized. If the slide table moves not linearly but cumulatively, errors occur in proportion to the distance $d^2$ between the scale unit and the mounting point (cutter position). Thus, mount the scale unit in a position that minimizes $d^2$.

- Adjusting parallelism
  Adjust the parallelism to within 0.2 mm. Spacers used in adjustment are not included in the accessories.
  - Adjusting the mounting surface back/forward
    Readjust the mounting position of the bracket, or adjust by inserting a spacer between the scale mounting surface and the mounting block or the mounting plate.
  - Adjusting (up and down)
    Mounting block.
  - Adjacent to the mounting bearing or the mounting plate onto the mounting surface.

Information about Air Supply (Improvement in Dust and Oil Resistance)

Feeding clean compressed air into the scale unit is provided as a means of improving the environmental resistance (to coolant and dust) of assembly-type linear scales. This is done by piping air to either of two MIS screw holes situated on the sides of the scale unit.

- Mount the scale unit in a place where it is not directly subjected to airflow.
- When removing swarf using an air gun, be careful of flying swarf.
- The scale unit must be mounted in a place where maintenance can be easily performed.

Adjusting parallelism

Adjust the parallelism to within 0.2 mm. Spacers used in adjustment are not included in the accessories.

- Adjusting parallelism
  Use a dial indicator as shown in the figure below. To adjust the parallelism between the scale unit and the machine guide, check the parallelism while manually moving the scale unit in the movable part such as the slide table, or measure the parallelism with reference to the guideways of the machine or equivalent reference surface.
  - Parallelism tolerance: Refer to scale specifications.
  - Checking direction: Backward/forward on mounting surface and directions along mounting surface (up and down).
  - Checking position: Position of the scale unit near the mounting plate and the mounting block.

Cautions on handling signal cable for linear scale

It is important to keep in mind the following points when deciding on the layout scheme for signal cables.

- When the cable is fixed
  The radius of curvature of the signal cable must be larger than 50 mm.
- When the cable is movable
  When the detector head is moving, the signal cable must be fixed onto the scale unit by using the wire guide. Test the movement of the signal cable and the wire guide with the scale unit in place. To do this, apply a slight force to the cable with two fingers to confirm that the cable is not chafed by the part of the machine.

- Other considerations
  The signal cable is durable enough to withstand repeated bending up to approximately 2 million times (when the bending radius is limited to more than 100 mm). When repeated bending exceeding 3 million times is expected, the signal cable should be considered as a consumable part. In such a case, carrying a spare cable will allow immediate replacement when necessary and to minimize machine downtime.

Resonance frequency of Linear Scale

Each object has a natural frequency of oscillation, depending on its shape, length, and the type of material. The linear scale frame is no exception. It has its natural frequency and thereby resonates at a certain frequency. In general, this will not cause a problem, since a machine tool and the linear scale frame have different natural frequencies under normal machining conditions. However, should the natural frequency of the machine tool and the linear scale coincide, which can lead to performance abnormalities due to excessive vibration amplitude, the following counter-measures can be taken.

- Remedy for scale
  1. Increase rigidity of the mounting bracket for the scale.
  2. Add a constraint to the middle of the scale to shift its resonance point higher.

- Remedy for machine
  1. Mount the Linear Scale at a place where vibrations from the machine tool cannot be easily transmitted.
  2. Limit the machine movement to be with in a specific range in which the natural frequencies of the machine tool and the scale do not coincide.

Precautions when mounting and handling Linear Scales

1. Joint structure of Detector
   A ball joint structure is employed at the contact area between the detector head and the scale (sensor unit) inside the scale. This arrangement prevents the scale movement from deviating from the normal moving directions when the detector head is slightly misaligned. In addition, this structure transmits a small amount of silicon lubricant to the contact area between the rubber and the detector head, which can lead to performance abnormalities due to excessive vibration amplitude, the following counter-measures can be taken.

- Remedy for scale
  1. Increase rigidity of the mounting bracket for the scale.
  2. Add a constraint to the middle of the scale to shift its resonance point higher.

- Remedy for machine
  1. Mount the Linear Scale at a place where vibrations from the machine tool cannot be easily transmitted.
  2. Limit the machine movement to be with in a specific range in which the natural frequencies of the machine tool and the scale do not coincide.

Maintenance of dust-proof seals

In order to maintain and extend the life of the dust-proof rubber seals, it is recommended to apply a small amount of silicon lubricant to the contact area between the rubber and the detector head once a year. (The maintenance frequency slightly differs depending on the operational conditions of the scale.)

Testing within the operating temperature range

Testing has proven that there is no abnormality of functions and signals when the Linear Scale is used within the specified operating temperature range.

Temperature cycle (dynamic characteristics) test

Testing has proven that there is no abnormality of functions when the Linear Scale is used within the specified range.

Vibration test (Sweep test)

Testing has proven that the Linear Scale functions without abnormality when subject to vibration within the frequency range 30 Hz to 300 Hz at a maximum acceleration of 5 G.

Vibration test (Acceleration test)

Confirms that there is no performance abnormality of a unit subject to vibration at a specific, non-resonant frequency. (Approx. 10 G)

Noise test

In accordance with the EMI Directive, EN61326-1

Crate Drop Test

In accordance with the heavy equipment drop test (ISO22000) specified in the standard.

Constructional features of the Linear Scale

1. Joint structure of Detector
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  1. Mount the Linear Scale at a place where vibrations from the machine tool cannot be easily transmitted.
  2. Limit the machine movement to be with in a specific range in which the natural frequencies of the machine tool and the scale do not coincide.

2. Water-proof Connector
   A waterproof/flap-proof connector is used to enable separation of the signal cable. Thus, installation and maintenance of the Linear Scale can be easily performed. (Only for AT100 Series)

3. Conduit armored type signal cable
   The signal cables are protected by the conduit system. Its exterior is made of stainless steel, which is corrosion-resistant and withstands continuous use.

4. Unique rubber seals
   The slider is shaped to glide smoothly through the rubber seal opening – almost like the keel of a boat through water.

5. Excellent splash- and dust-proof rubber seal structure
   The rubber seals are made of a strong, special urethane, and are inserted in these seals to improve the splash-proofing and dust-proofing of the scale.

Note: AT103 only

Linear Scale evaluation methods

- Testing within the operating temperature range
- Temperature cycle (dynamic characteristics) test
- Vibration test (Sweep test)
- Vibration test (Acceleration test)
- Noise test
- Crate Drop Test

In accordance with the heavy equipment drop test (ISO22000) specified in the standard.
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