

MEASURING TOOLS

LINEAR SCALES

Linear scales

AT103 Standard Spar Type
ABS AT715 Slim Spar Type
Counter (KA-200, KLD-200)

L-002
L-003
L-004-005

USP GROUP

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Linear Scales AT103

SERIES 539 — Standard Type



- A wide variety of measuring ranges are available in this standard type scale unit.
- Connectable to the **KA-200** counter, **KLD-200** counter, or **PSU-200**.

SPECIFICATIONS

Model	AT103
Effective range	100 to 6000mm (42 models)
Accuracy (20°C)	Effective range 100 to 3000: (5+5L0/1000)μm Effective range 3250 to 6000: (5+8L0/1000)μm
Output signal	Two 90° phase-shifted sinusoidal signals
Maximum response speed	120m/min (50m/min when the effective measuring length is 3250 to 6000mm)
Signal output pitch	20μm
Scale reference point	Output in 50mm pitch
Operating temperature	0 to 45°C

Note 1: High precision model **AT103F** (JIS Class 0, (3+3L0/1000)μm) is also available to special order for the effective range of 100 to 2000 mm.

Note 2: Ultra-high precision model **AT103S** (2+2L0/1000)μm is also available to special order for the effective range of 100 to 500 mm.

Note 3: The indication accuracy does not include quantizing error. L0: Effective range (mm)

AT103		Effective range* L0 (mm)	Signal cable length (m)
Order No.	Model		
539-111-30	AT103-100	100 (4")	3
539-112-30	AT103-150	150 (6")	
539-113-30	AT103-200	200 (8")	
539-114-30	AT103-250	250 (10")	
539-115-30	AT103-300	300 (12")	
539-116-30	AT103-350	350 (14")	
539-117-30	AT103-400	400 (16")	
539-118-30	AT103-450	450 (18")	
539-119-30	AT103-500	500 (20")	
539-121-30	AT103-600	600 (24")	
539-123-30	AT103-700	700 (28")	
539-124-30	AT103-750	750 (30")	
539-125-30	AT103-800	800 (32")	5
539-126-30	AT103-900	900 (36")	
539-127-30	AT103-1000	1000 (40")	
539-128-30	AT103-1100	1100 (44")	
539-129-30	AT103-1200	1200 (48")	
539-130-30	AT103-1300	1300 (52")	
539-131-30	AT103-1400	1400 (56")	
539-132-30	AT103-1500	1500 (60")	
539-133-30	AT103-1600	1600 (64")	
539-134-30	AT103-1700	1700 (68")	
539-135-30	AT103-1800	1800 (72")	7
539-136-30	AT103-2000	2000 (80")	
539-137-30	AT103-2200	2200 (88")	
539-138-30	AT103-2400	2400 (96")	
539-139-30	AT103-2500	2500 (100")	
539-140-30	AT103-2600	2600 (104")	
539-141-30	AT103-2800	2800 (112")	
539-142-30	AT103-3000	3000 (120")	
539-143-30	AT103-3250	3250 (130")	
539-144-30	AT103-3500	3500 (140")	
539-145-30	AT103-3750	3750 (150")	10
539-146-30	AT103-4000	4000 (160")	
539-147-30	AT103-4250	4250 (170")	
539-148-30	AT103-4500	4500 (180")	
539-149-30	AT103-4750	4750 (190")	
539-150-30	AT103-5000	5000 (200")	
539-151-30	AT103-5250	5250 (210")	
539-152-30	AT103-5500	5500 (220")	
539-153-30	AT103-5750	5750 (230")	15
539-154-30	AT103-6000	6000 (240")	

* Models for the effective range 3250mm or more are made-to-order.

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Linear Scales ABS AT715 SERIES 539 — Slim Type

IP67

ABSOLUTE™



- The electromagnetic induction principle adopted means these scales are unaffected by contamination on the sensors.
- Absolute scales have eliminated the need for origin restoration, also drastically reducing power consumption.



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SPECIFICATIONS

Model	ABS AT715	
Detection method	Electromagnetic induction	
Minimum resolution	0.001mm to 0.01mm (Changeable by parameter on the KA-200/KLD-200 counter)	
Effective range	100 to 3000mm	
Accuracy (20°C)*	±5μm (L0: 100 to 500mm), ±7μm (L0: 600 to 1800mm), ±10μm (L0: 2000 to 3000mm) L0: Effective range (mm)	
Maximum response speed	50m/min	
Protection level	IP67	
Sliding force	5N or less	
Signal cable	Standard Accessories Refer to the dimension table shown below for the length.	
Extension cable (optional)	Length	Order No.
	2m	09AAB674A
	5m	09AAB674B
	7m	09AAB674C
Connectable counter	KA-200 Counter / KLD-200 Counter	

AT715		Effective range L0 (mm)	Signal cable length (m)
Order No.	Model		
539-801	ABS AT715-100	100 (4")	3.5
539-802	ABS AT715-150	150 (6")	
539-803	ABS AT715-200	200 (8")	
539-804	ABS AT715-250	250 (10")	
539-805	ABS AT715-300	300 (12")	
539-806	ABS AT715-350	350 (14")	
539-807	ABS AT715-400	400 (16")	
539-808	ABS AT715-450	450 (18")	
539-809	ABS AT715-500	500 (20")	
539-811	ABS AT715-600	600 (24")	
539-813	ABS AT715-700	700 (28")	5
539-814	ABS AT715-750	750 (30")	
539-815	ABS AT715-800	800 (32")	
539-816	ABS AT715-900	900 (36")	
539-817	ABS AT715-1000	1000 (40")	
539-818	ABS AT715-1100	1100 (44")	
539-819	ABS AT715-1200	1200 (48")	
539-820	ABS AT715-1300	1300 (52")	
539-821	ABS AT715-1400	1400 (56")	
539-822	ABS AT715-1500	1500 (60")	7**
539-823	ABS AT715-1600	1600 (64")	
539-824	ABS AT715-1700	1700 (68")	
539-825	ABS AT715-1800	1800 (72")	
539-860	ABS AT715-2000	2000 (80")	
539-861	ABS AT715-2200	2200 (88")	
539-862	ABS AT715-2400	2400 (96")	
539-863	ABS AT715-2500	2500 (100")	
539-864	ABS AT715-2600	2600 (104")	
539-865	ABS AT715-2800	2800 (112")	
539-866	ABS AT715-3000	3000 (120")	

*1: Combination of a 5m signal cable and a 2m extension cable

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KA-200 Counter

SERIES 174 — Standard Type



**174-185
KA-213**

- The KA-200 Counter has a lathe function as well as standard functions (parameter selection).
- Compact, light and multifunctional.
- The RS-232C interface enables connection to a PC or printer.

Optional Accessories

- Code out unit: **06AET993**

SPECIFICATIONS

Order No.	174-183□	174-185□
Model	KS-212	KA-213
Number of axes to be displayed	2	3
Resolution	(Changeable according to the parameter) When AT100 is connected: 0.05 - 0.0001mm When AT715 is connected: 0.01 - 0.001mm	
Display/digit	Main display: 9 digits including sign Sub display: 8 digits	
Power supply voltage	100 to 240 V AC, 50/60 Hz	
Dimensions	300(W)x70(D)x167(H)mm	
Output (optional)	RS-232C	
Mass	1.25 kg	1.3 kg

□: To denote your AC power cable add the following suffixes to the order No. :
A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

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KLD-200 Counter

SERIES 174 — Special Purpose Type with Limit Signal Output



**174-147
KLD-214**

- Counter designed to signal when a linear scale displacement value and a preset limit value coincide.
- Two types of limit settings are available:
2-step (**KLD-212**) and 4-step (**KLD-214**).

Optional Accessories

- External zero-set box (1 axis): **936551**
- External load box (1 axis, for RS-232C output): **937326**



























SPECIFICATIONS

Order No.	174-146□	174-147□
Model	KLD-212	KLD-213
Number of axes to be displayed	1	
Number of limit values to be set	2	4
Resolution	(Changeable according to the parameter) When AT100 series is connected: 0.05 to 0.0001mm When AT715 is connected: 0.01 to 0.001mm	
Output	RS-232C (provided as standard)	
Display	7-segment LCD/ 7 digit*1	
Power supply voltage	100 V to 240 V AC, 50/60 Hz	
Power consumption	25 VA	
Operating temperature/humidity range	0 to 45°C / 20 to 80%	
Dimensions	332(W)x204(D)x163(H) mm	
Mass	3.0kg	3.1kg

*1: Count range when the minimum reading is 0.001mm: 99999.999 to -9999.999
Count range when the minimum reading is 0.005mm: 99999.995 to -9999.995

□: To denote your AC power cable add the following suffixes to the order No. :
A for UL/CSA, D for CEE, DC for CCC, E for BS, K for KC, C and No suffix are required for PSE.

Functions

Function	Type	High performance	Limit signal output
		 KA-200 Counter	 KLD-200 Counter
Zero-setting		●	●
Preset		●	●
Resolution setting		●	●
Measurement direction setting		●	●
mm/inch conversion		●	●
Diameter display		●	●
Scale reference point setting ⁻¹		●	●
1/2 calculation		●	●
Coordinate system switching		●	—
Bolt-hole circle machining		● ⁻²	—
Pitch machining		●	—
Zero approach machining (INC mode)		●	—
Addition of 2-scale data		● ⁻³	—
Linearity error compensation		●	●
Pitch error compensation		● ⁻¹	—
Smoothing		●	●
Memory backup		●	●
Expansion/contraction coefficient setting		—	●
Lower digit blanking out		●	●
External zero-setting		▲ ⁻⁴	●
RS-232C interface unit		▲ ⁻⁴	●
USB output		▲ ⁻⁵	—
Limit signal output		—	●
Error message		●	●

●: Standard function, ▲: Optional function, —: Not available

⁻¹: Only available when connecting with AT100 series.

⁻²: Not available in single-axis use

⁻³: Only available for 3-axis model (KA-213)

⁻⁴: Code out unit (06AET993) is required.

⁻⁵: Text can be output by interface unit and foot switch

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Tests for Evaluating Linear Scales

1. Testing within the service temperature range
Confirms that there is no performance abnormality of a unit within the service temperature range and that data output is according to the standard.
2. Temperature cycle (dynamic characteristics) test
Confirms that there is no performance abnormality of a unit during temperature cycling while operating and that data output is according to the standard.
3. Vibration test (Sweep test)
Confirms that there is no performance abnormality of a unit while subject to vibrations of a frequency ranging from 30Hz to 300Hz with a maximum acceleration of 3g_n.
4. Vibration test (Acceleration test)
Confirms that there is no performance abnormality of a unit subject to vibrations at a specific, non-resonant frequency.
5. Noise test
The noise test conforms to EMC Directive EN61326-1.
6. Package drop test
This test conforms to JISZ0200 (Heavy duty material drop test)

Glossary

■ Absolute system

A measurement mode in which every point measurement is made relative to a fixed origin point.

■ Incremental system

A measurement mode in which every point measurement is made relative to a certain stored reference point.

■ Origin offset

A function that enables the origin point of a coordinate system to be translated to another point offset from the fixed origin point. For this function to work, a system needs a permanently stored origin point.

■ Restoring the origin point

A function that stops each axis of a machine accurately in position specific to the machine while slowing it with the aid of integrated limit switches.

■ Sequence control

A type of control that sequentially performs control steps according to a prescribed order.

■ Numerical control

A way of controlling the movements of a machine by encoded commands created and implemented with the aid of a computer (CNC).

A sequence of commands typically forms a 'part program' that instructs a machine to perform a complete operation on a workpiece.

■ Binary output

Refers to output of data in binary form (ones and zeros) that represent numbers as integer powers of 2.

■ RS-232C

An interface standard that uses an asynchronous method of serial transmission of data over an unbalanced transmission line for data exchange between transmitters located relatively close to each other. It is a means of communication mainly used for connecting a personal computer with peripherals.

■ Line driver output

This output features fast operating speeds of several tens to several hundreds of nanoseconds and a relatively long transmission distance of several hundreds of meters. A differential-voltmeter line driver (RS422A compatible) is used as an I/F to the NC controller in the linear scale system.

■ BCD

A notation of expressing the numerals 0 through 9 for each digit of a decimal number by means of four-bit binary sequence. Data transmission is one-way output by means of TTL or open collector.

■ RS-422

An interface standard that uses serial transmission of bits in differential form over a balanced transmission line. RS-422 is superior in its data transmission characteristics and in its capability of operating with only a single power supply of +5V.

■ Accuracy

The accuracy specification of a scale is given in terms of the maximum error to be expected between the indicated and true positions at any point, within the range of that scale, at a temperature of 20°C. Since there is no international standard defined for scale units, each manufacturer has a specific way of specifying accuracy. The accuracy specifications given in our catalog have been determined using laser interferometry.

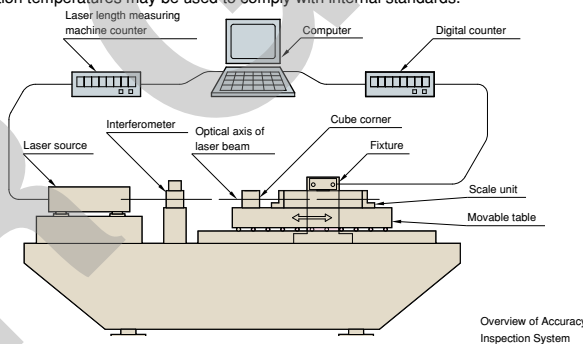
■ Narrow range accuracy

Scale gratings on a scale unit normally adopt 20μm pitch though it varies according to the kind of scale. The narrow range accuracy refers to the accuracy determined by measuring one pitch of each grating at the limit of resolution (1μm for example).

Specifying Linear Scale Accuracy

Positional Indication accuracy

The accuracy of a linear scale is determined by comparing the positional value indicated by the linear scale with the corresponding value from a laser length measuring machine at regular intervals using the accuracy inspection system as shown in the figure below. As the temperature of the inspection environment is 20 °C, the accuracy of the scale applies only in an environment at this temperature. Other inspection temperatures may be used to comply with internal standards.



The accuracy of the scale at each point is defined in terms of an error value that is calculated using the following formula:

$$\text{Error} = \text{Value indicated by laser inspection system} - \text{Corresponding value indicated by the linear scale}$$

A graph in which the error at each point in the effective positioning range is plotted is called an accuracy diagram.

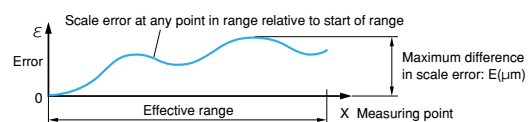
There are two methods used to specify the accuracy of a scale, unbalanced or balanced, described below.

(1) Unbalanced accuracy specification - maximum minus minimum error

This method simply specifies the maximum error minus the minimum error from the accuracy graph, as shown below. It is of the form: $E = (\alpha + \beta L)\mu\text{m}$. L is the effective range (mm), and α and β are factors specified for each model.

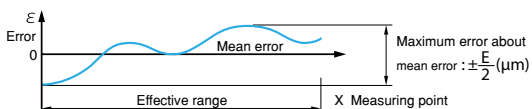
For example, if a particular type of scale has an accuracy specification

$$\text{of } (3 + \frac{3L}{1000})\mu\text{m} \text{ and an effective range of } 1000 \text{ mm, } E \text{ is } 6 \mu\text{m}.$$



(2) Balanced accuracy specification - plus and minus about the mean error

This method specifies the maximum error relative to the mean error from the accuracy graph. It is of the form: $e = \pm \frac{E}{2} (\mu\text{m})$. This is mainly used in separate-type (retrofit) scale unit specifications.



A linear scale detects displacement based on graduations of constant pitch. Two-phase sinusoidal signals with the same pitch as the graduations are obtained by detecting the graduations. Interpolating these signals in the electrical circuit makes it possible to read a value smaller than the graduations by generating pulse signals that correspond to the desired resolution. For example, if the graduation pitch is 20 μm, interpolated values can generate a resolution of 1 μm. The accuracy of this processing is not error-free and is called interpolation accuracy. The linear scale's overall positional accuracy specification depends both on the pitch error of the graduations and interpolation accuracy.