

LINEAR SCALE DRO SYSTEMS

SCALE UNITS AND DISPLAY COUNTERS



Accurate and Affordable DRO Systems from Mitutoyo

Mitutoyo's Linear Scale System tightly couples linear scale units with dedicated Digital Readout (DRO) units to provide precise detection and display of axial displacement for machine tools and measuring equipment. The Linear Scale System can be customized to suit your specific application, whether it involves machining or measuring. This customization is achieved by selecting an appropriate combination of scale unit and display unit. Scale units are available in various measuring length ranges, and display units feature remote zero setting, switchable resolution, and versatile one-touch macro keys. The Linear Scale System offers superior user-friendliness and reliability, both of which significantly enhance machining accuracy and efficiency.

Table of contents

Scale Unit Selection Guide.....	3
AT715, ABSOLUTE and High Environmental Resistance Type.....	4
AT103, Standard-size Type.....	6
AT113, Slim Type.....	8
Scale Unit Features.....	11
Display Unit Selection Guide.....	13
KA-200 Counter.....	14
Display Unit Functions.....	16
Connecting to External Devices.....	18
Traceability System.....	22
Optional Accessories.....	24
Optional Adapters.....	26
Precautions when mounting and handling Linear Scales.....	28
Scale systems for various multi-axis machine tools.....	31

Key features of linear scale system

- The digital counter value display enables quick and accurate readout of displacement, greatly enhancing work efficiency.
- Zero-setting or presetting is possible at any position, eliminating the need for calculations or complex key operations for positioning.
- Various external output features allow you to send current display values or various data to external devices such as PCs or sequencers, facilitating easy data processing.
- Two types of display units are available: high-performance type and limit signal type.
- Both linear scale and display units conform to CE marking standards.
- Mitutoyo is committed to global environmental conservation. Our products comply with the chemical content standards of the RoHS Directive as prescribed in the EU. (As of May 2015)

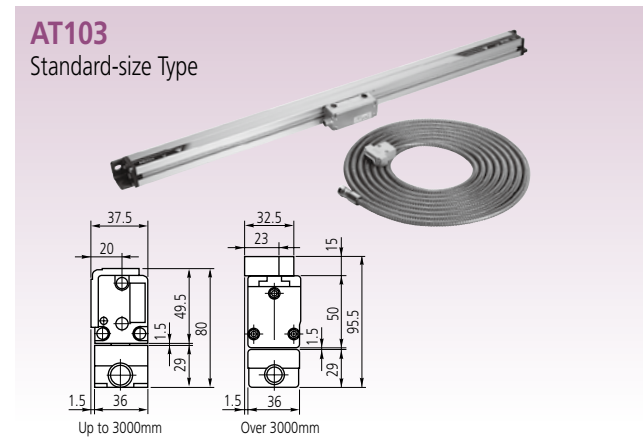
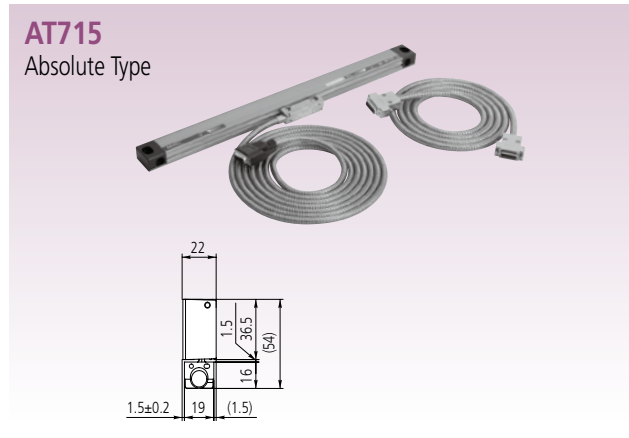


Precision manufacturing 11 meters underground

Mitutoyo's Kiyohara Plant, a facility dedicated exclusively to the production of Linear Scales and other precision scales, features a comprehensive system for manufacturing master scales used in finished products such as CMMs, vision measuring systems, profile projectors, and measuring microscopes. To enhance scale accuracy and quality control, the Kiyohara Plant's integral laboratory is situated eleven meters underground. This unique underground setting provides an optimal environment (cleanliness factor: 100) for ultra-precise scale manufacturing and evaluation. The laboratory's innovative design and construction isolate it from external vibrations, ensuring minimal variations in temperature and humidity.



Scale Unit Selection Guide



Specifications

Model	AT715	AT103	AT113
Measurement method	Electromagnetic induction system	Photoelectric (transparent linear encoder)	
Light source	—	LED	
Receptor	—	Phototransistor	
Output wave form	—	2-phase sine curves with a phase difference of 90°	
Effective length (for high accuracy type)	100 - 3000mm	1600 - 6000mm (1600 - 2000mm)	100 - 1500mm (100 - 1500mm)
Accuracy* [high accuracy type]	±5μm (Effective length: 100 - 500mm) ±7μm (Effective length: 600 - 1800mm) ±10μm (Effective length: 2000 - 3000mm)	(5+5L ₀ /1000)μm* ¹ [(3+3L ₀ /1000)μm]	(5+5L ₀ /1000)μm [(3+3L ₀ /1000)μm]
* Excluding quantizing error of ±1 count			
Maximum response speed	50m/min.	120m/min.* ³	120m/min.
Scale reference point	—	At every 50mm interval	
Linear expansion coefficient	—	(8±1)×10 ⁻⁶ /°C	
Power supply	5V±5% DC	5V±5% DC	
Max. current consumption	70mA	70mA* ⁴ (60mA: AT113)	
Operating temperature		0°C to 45°C	
Storage temperature		-20°C to 70°C	
Relative humidity		20 - 80%RH	
Head Cable length	—	—	* ⁶
Sliding force	5N or less	5N or less	
Single cable* ⁵	Standard accessory (refer to individual specifications for the length)		
Dust/water protection level	IP67	IP53	

*1: (5+8L₀/1000)μm for models over 3250mm effective length

*3: 50m/min. for models over 3250mm effective length

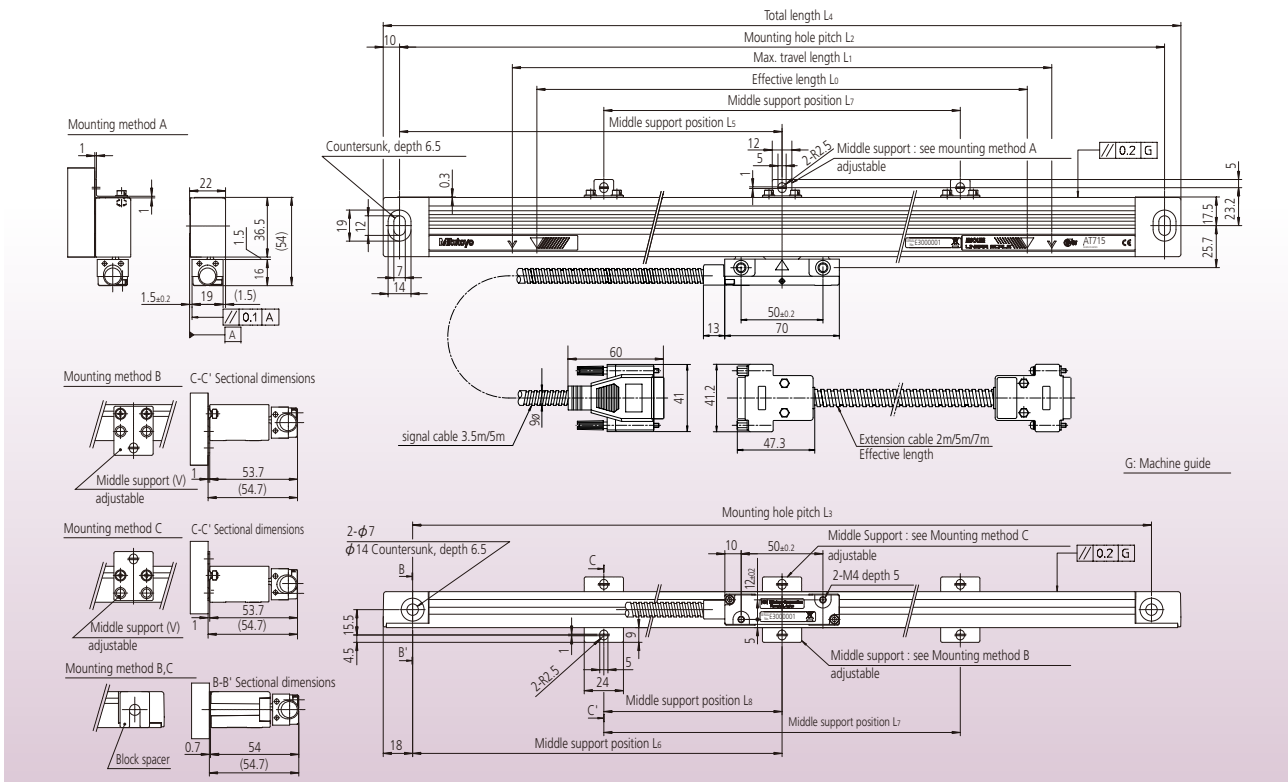
*4: 140mA for models over 3250mm effective length

*5: Vinyl-coated type single cable and extension cable are available on request.

*6: AT103:0.3m

AT715, ABSOLUTE and High Environmental Resistance Type

Utilizing the ABSOLUTE® Electromagnetic Induction System



Order No. and mounting dimensions

Order No. / Model No.	Effective length L ₀	Maximum travel length L ₁	Mounting hole pitch L ₂	Mounting hole pitch L ₃	Overall length L ₄	L ₅	Middle support positions L ₆	L ₇	Signal cable length
539-801R / AT715-100	100	120	258	242	278	—	—	—	3500 (137.80)
539-802R / AT715-150	150	170	308	292	328	—	—	—	
539-803R / AT715-200	200	220	358	342	378	—	—	—	
539-804R / AT715-250	250	270	408	392	428	—	—	—	
539-805R / AT715-300	300	330	468	452	488	—	—	—	
539-806R / AT715-350	350	380	518	502	538	—	—	—	
539-807R / AT715-400	400	430	568	552	588	—	—	—	
539-808R / AT715-450	450	480	618	602	638	—	—	—	
539-809R / AT715-500	500	540	678	662	698	339	331	—	
539-811R / AT715-600	600	640	778	762	798	389	381	—	
539-813R / AT715-700	700	740	878	862	898	439	431	—	
539-814R / AT715-750	750	780	918	902	938	459	451	—	
539-815R / AT715-800	800	840	978	962	998	489	481	—	
539-816R / AT715-900	900	940	1078	1062	1098	539	531	—	
539-817R / AT715-1000	1000	1040	1178	1162	1198	589	581	—	
539-818R / AT715-1100	1100	1140	1278	1262	1298	424	416	430	5000 (196.85)
539-819R / AT715-1200	1200	1240	1378	1362	1398	459	451	460	
539-820R / AT715-1300	1300	1340	1478	1462	1498	494	486	490	
539-821R / AT715-1400	1400	1440	1578	1562	1598	524	516	530	
539-822R / AT715-1500	1500	1540	1678	1662	1698	559	551	560	
539-823R / AT715-1600	1600	1640	1778	1762	1798	459	451	430	
539-824R / AT715-1700	1700	1740	1878	1862	1898	479	471	460	
539-825R / AT715-1800	1800	1840	1978	1962	1998	459	451	530	

Extension cable*

Order No.	Cable length
09AAB674A	2m
09AAB674B	5m
09AAB674C	7m

Mounting parts (provided as standard)

Items included	Quantity	Notes
• Hex-socket head screw (M6x25)	2 pcs.	
• Hex-socket head screw (M4x25)	2 pcs.	
• Hex-socket head screw (M4x8)	6 pcs.	
• Plain washer (6mm nominal)	2 pcs.	
• Plain washer (4mm nominal)	2 pcs.	
• Cable clip	6 pcs.	
• Spacer (0.3, 0.4, 0.5, 0.6mm)	1 pc. each	

*: Use an extension cable so that the total length including the signal cable is less than 15m.

ABSOLUTE®

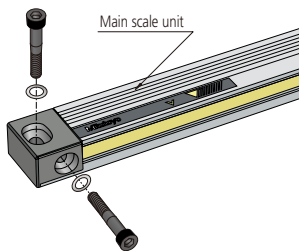
IP67



Safety
Dust- and
Water-
Protected
www.tuv.com
ID: 000007235

Key Features

- Incorporates the ABSOLUTE® electromagnetic induction system* to achieve robust IP67 environmental resistance.
- Instantly detects and outputs an absolute position - eliminating the need for reference point setup upon every power-on.
- Immune to abnormal calculations caused by electrical noise, ensuring accurate measurements.
- Specifically optimized for X-axis mounting on small lathes, delivering exceptional precision in machining.
- Dual mounting orientations of the main scale unit facilitate easy installation on machine tools with challenging mounting setups.



* Registered patent in Japan, USA, India, China, Germany, UK, France, Switzerland



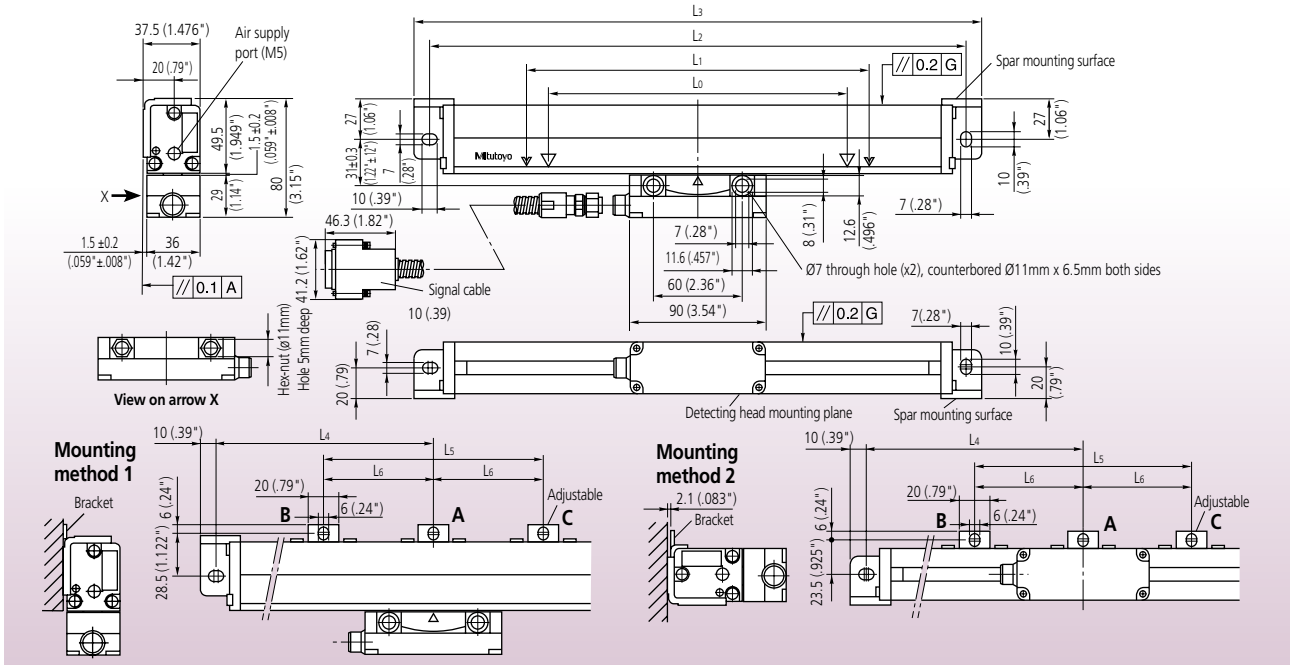
Order No. and mounting dimensions

mm

Order No. / Model No.	Effective length L ₀	Maximum travel length L ₁	Mounting hole pitch L ₂	Mounting hole pitch L ₃	Mounting hole pitch L ₄	Middle support positions			Signal cable length
						L ₅	L ₆	L ₇	
539-860R / AT715-2000	2000	2040	2178	2162	2198	539	531	550	7000*1 (275.60)
539-861R / AT715-2200	2200	2240	2378	2362	2398	469	461	480	
539-862R / AT715-2400	2400	2440	2578	2562	2598	509	501	520	
539-863R / AT715-2500	2500	2540	2678	2662	2698	529	521	540	
539-864R / AT715-2600	2600	2640	2778	2762	2798	549	541	560	
539-865R / AT715-2800	2800	2840	2978	2962	2998	489	481	500	
539-866R / AT715-3000	3000	3040	3178	3162	3198	529	521	530	

*1: Signal cable length is the combination of signal code and extension cable (2m).

AT103 – Standard-size Type

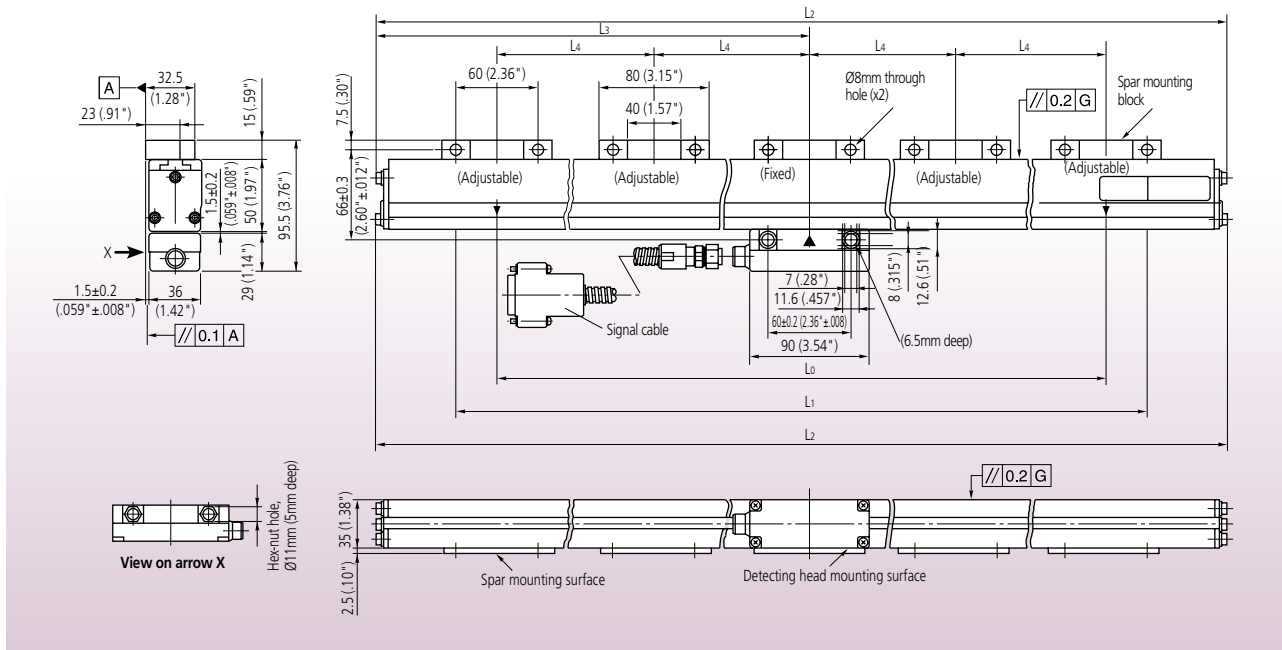


Order No. and mounting dimensions

mm

Order No. / Model No. () : suffix for high accuracy type	Effective range L ₀	Travel range L ₁	Mount interval L ₂	Overall length L ₃	Supporting bracket position			Signal cable length	Mass kg
					L ₄	L ₅	L ₆		
539-133-30 (-40) / AT103-1600 (F)	1600	1690	1818	1838	—	610	—	5m	5.1
539-134-30 (-40) / AT103-1700 (F)	1700	1790	1918	1938	—	650	—	5m	5.3
539-135-30 (-40) / AT103-1800 (F)	1800	1890	2018	2038	—	670	—	5m	5.5
539-136-30 (-40) / AT103-2000 (F)	2000	2100	2228	2248	—	740	—	5m	6.0
539-137-30 / AT103-2200	2200	2300	2428	2448	—	800	—	5m	6.4
539-138-30 / AT103-2400	2400	2500	2628	2648	1314	1300	650	7m	7.1
539-139-30 / AT103-2500	2500	2600	2728	2748	1364	1340	670	7m	7.3
539-140-30 / AT103-2600	2600	2700	2828	2848	1414	1400	700	7m	7.5
539-141-30 / AT103-2800	2800	2900	3028	3048	1514	1500	750	7m	7.9
539-142-30 / AT103-3000	3000	3100	3228	3248	1614	1600	800	7m	8.3

Note: When selecting a scale unit size for your application, ensure that the maximum travel range of the scale unit (L₁) exceeds the maximum travel range of your machine. Additionally, consider choosing a size where the scale unit's accuracy is guaranteed within the effective measuring length (L₀) range.



Order No. and mounting dimensions

mm

Order No. / Model No.	Effective range L ₀	Travel range L ₁	Overall length L ₂	Supporting bracket position		Signal cable length	Mass kg
				L ₃	L ₄		
539-143-30 / AT103-3250	3250	3350	3464	1725	800	10m	10.8
539-144-30 / AT103-3500	3500	3600	3714	1850	850	10m	11.4
539-145-30 / AT103-3750	3750	3850	3964	1975	930	10m	12.0
539-146-30 / AT103-4000	4000	4100	4214	2100	1000	10m	12.6
539-147-30 / AT103-4250	4250	4350	4464	2225	1050	10m	13.2
539-148-30 / AT103-4500	4500	4600	4714	2350	1100	10m	13.8
539-149-30 / AT103-4750	4750	4850	4964	2475	800	15m	15.2
539-150-30 / AT103-5000	5000	5100	5214	2600	830	15m	15.8
539-151-30 / AT103-5250	5250	5350	5464	2725	870	15m	16.4
539-152-30 / AT103-5500	5500	5600	5714	2850	910	15m	17.0
539-153-30 / AT103-5750	5750	5850	5964	2975	950	15m	17.6
539-154-30 / AT103-6000	6000	6100	6214	3100	1000	15m	18.2

Note: When choosing a scale unit size for your application, ensure that the maximum travel range of the scale unit (L₁) exceeds the maximum travel range of your machine. Additionally, consider selecting a size where the scale unit's accuracy is assured only within the effective measuring length (L₀) range.

Mounting parts (provided as standard)

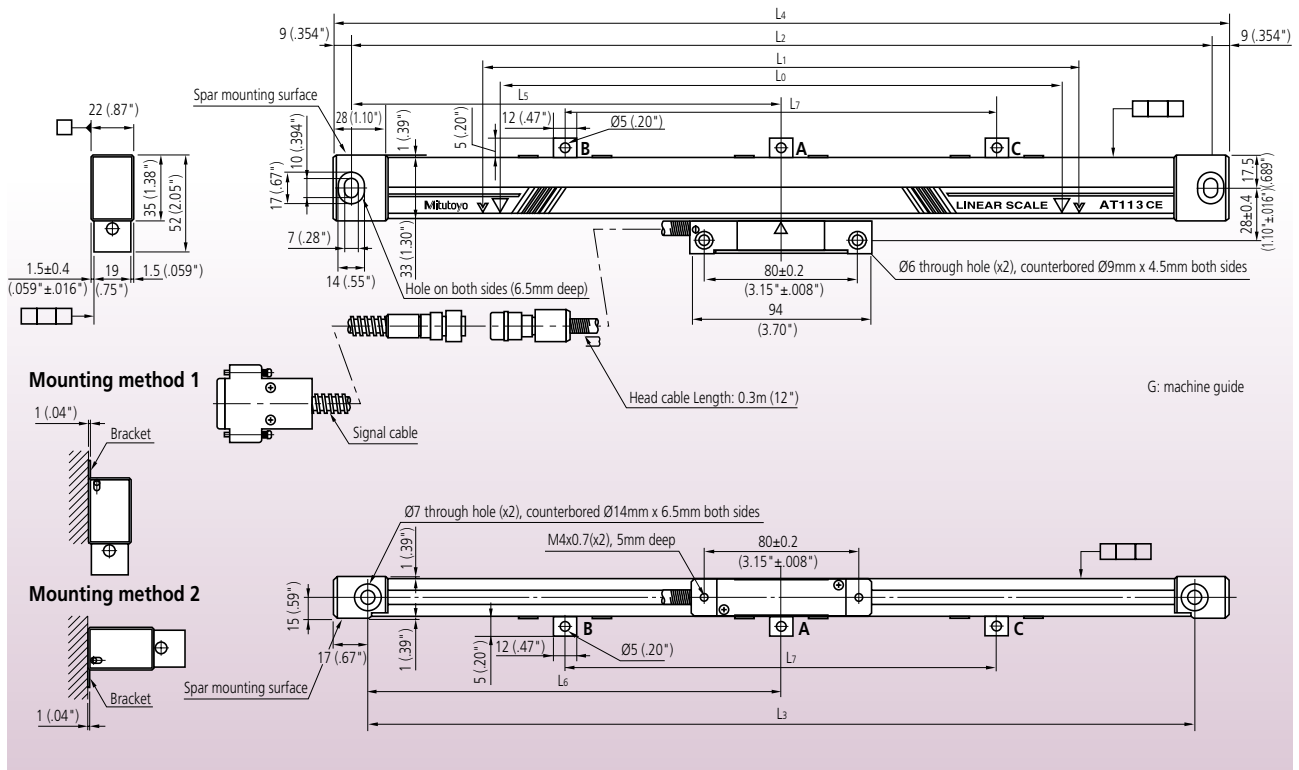
Type of spar	Standard-size	Extra-long
Effective range L ₀	1600mm - 3000mm	3250mm - 6000mm
Items included	<ul style="list-style-type: none"> Hex-socket head screw (M6x1x40) 2 pcs. Hex-socket head screw (M6x1x16) 2 pcs. Hex-socket head screw (M4x0.7x8) 6 pcs. Spring washer (6mm nominal) 2 pcs. Plain washer (6mm nominal) 2 pcs. Cable clip 5 pcs. Spacer (0.3mm) 1 pc. Spacer (0.4mm) 1 pc. Spacer (0.5mm) 1 pc. Spacer (0.6mm) 1 pc. 	<ul style="list-style-type: none"> Hex-socket head screw (M6x1x40) 2 pcs. Hex-socket head screw (M6x1x30) 14 pcs. Hex-socket head screw (M4x0.7x8) 7 pcs. Spring washer (6mm nominal) 14 pcs. Plain washer (6mm nominal) 14 pcs. Cable clip 7 pcs. Spacer (0.3mm) 1 pc. Spacer (0.4mm) 1 pc. Spacer (0.5mm) 1 pc. Spacer (0.6mm) 1 pc.

Remarks: Enhance the dust and splash resistance of the AT103 model scale units by providing clean and dry air to the main spar. (Required air pressure: 50kPa, Recommended air flow rate: 10 to 20 normal liters per minute)

Extension cable

Order No.	Cable length
09AAA033A	2m
09AAA033B	5m
09AAA033C	7m

AT113 – Slim Type



Order No. and mounting dimensions

Order No. / Model No. (): suffix for high accuracy type	Effective range L ₀	Travel range L ₁	Mount interval L ₂	Mount interval L ₃	Overall length L ₄	Supporting bracket position			Signal cable length	Mass kg
						L ₅	L ₆	L ₇		
539-201-30 (-40) / AT113-100 (F)	100	120	258	242	276	—	—	—	3m	0.9
539-202-30 (-40) / AT113-150 (F)	150	170	308	292	326	—	—	—	3m	0.9
539-203-30 (-40) / AT113-200 (F)	200	220	358	342	376	—	—	—	3m	0.9
539-204-30 (-40) / AT113-250 (F)	250	270	408	392	426	—	—	—	3m	1.0
539-205-30 (-40) / AT113-300 (F)	300	330	468	452	486	—	—	—	3m	1.0
539-206-30 (-40) / AT113-350 (F)	350	380	518	502	536	—	—	—	3m	1.1
539-207-30 (-40) / AT113-400 (F)	400	430	568	552	586	—	—	—	3m	1.1
539-208-30 (-40) / AT113-450 (F)	450	480	618	602	636	—	—	—	3m	1.1
539-209-30 (-40) / AT113-500 (F)	500	540	678	662	696	339	331	—	3m	1.2
539-211-30 (-40) / AT113-600 (F)	600	640	778	762	796	389	381	—	3m	1.3
539-213-30 (-40) / AT113-700 (F)	700	740	878	862	896	439	431	—	3m	1.3
539-214-30 (-40) / AT113-750 (F)	750	780	918	902	936	459	451	—	3m	1.4
539-215-30 (-40) / AT113-800 (F)	800	840	978	962	996	489	481	—	3m	1.4
539-216-30 (-40) / AT113-900 (F)	900	940	1078	1062	1096	539	531	—	3m	1.5
539-217-30 (-40) / AT113-1000 (F)	1000	1040	1178	1162	1196	589	581	—	5m	1.9
539-218-30 (-40) / AT113-1100 (F)	1100	1140	1278	1262	1296	—	—	430	5m	1.9
539-219-30 (-40) / AT113-1200 (F)	1200	1240	1378	1362	1396	—	—	460	5m	2.0
539-220-30 (-40) / AT113-1300 (F)	1300	1340	1478	1462	1496	—	—	490	5m	2.1
539-221-30 (-40) / AT113-1400 (F)	1400	1440	1578	1562	1596	—	—	530	5m	2.2
539-222-30 (-40) / AT113-1500 (F)	1500	1540	1678	1662	1696	—	—	560	5m	2.2

Note: When choosing a scale unit size for your application, ensure that the maximum travel range of the scale unit (L1) surpasses the maximum travel range of your machine. Additionally, bear in mind that the scale unit's accuracy is ensured exclusively within the effective measuring length (L0) range.

Extension cable

Order No.	Cable length
09AAA033A	2m
09AAA033B	5m
09AAA033C	7m

Mounting parts (provided as standard)

Items included		
• Hex-socket head screw (M6x1x25)	2 pcs.	
• Hex-socket head screw (M4x0.7x25)	2 pcs.	
• Hex-socket head screw (M4x0.7x8)	6 pcs.	
• Spring washer (4mm nominal)	2 pcs.	
• Plain washer (4mm nominal)	2 pcs.	
• Cable clip	5 pcs.	
• Connector clamp	1 pc.	
• Spacer (0.3mm)	1 pc.	
• Spacer (0.4mm)	1 pc.	
• Spacer (0.5mm)	1 pc.	
• Spacer (0.6mm)	1 pc.	

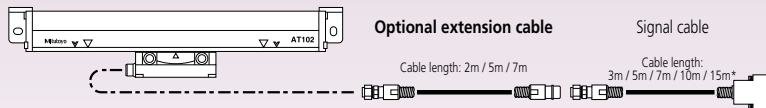
Scale Unit Features



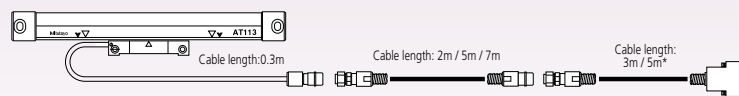
KA-200 Counter, standard type

When using an optional extension cable

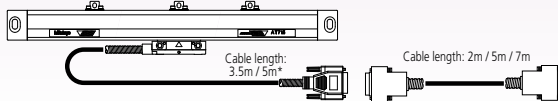
AT103



AT113

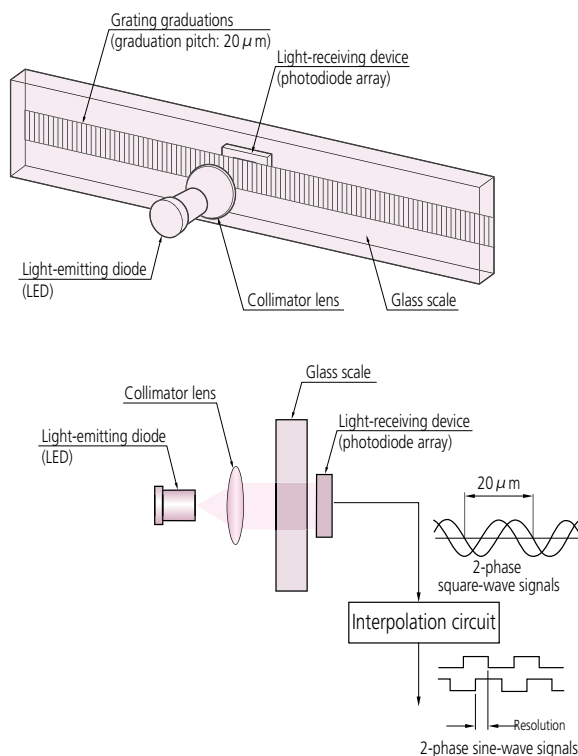


AT715



*Depending on the size of scale unit

Operating Principle of AT103/AT113 Models



The assembly-type Linear Scale® employs a highly accurate glass scale grating pitch of 20 μm as the fundamental standard of length. A Light-Emitting Diode (LED) and collimator lens generate parallel light, which is directed onto the grating. This parallel light, upon passing through the grating, creates an interference pattern matching the pitch of the grating on the photodiode array of the light-receiving device. The output signal from the receiver is a 2-phase sinusoidal waveform with a wavelength of 20μm, mirroring the grating graduations. This signal is electrically converted into 2-phase square-wave signals through the interpolation circuit. By detecting cyclic variations in light intensity on the receiver array as the scale is displaced, and subsequently interpolating, the system achieves a finer working resolution, generating accurate displacement values.

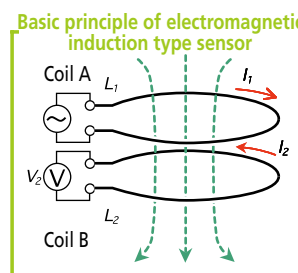
Detection Principle Employed in AT715

The Absolute system-type linear scale AT715 utilizes a unique electromagnetic induction principle developed by Mitutoyo, known for its exceptional resistance to environmental contaminants. This inventive principle enables the AT715 to function as a complete absolute scale with a remarkable resolution of 1μm, made possible through a multi-track configuration. The user gains immediate access to absolute positional information from the scale the moment power is supplied to the counter.

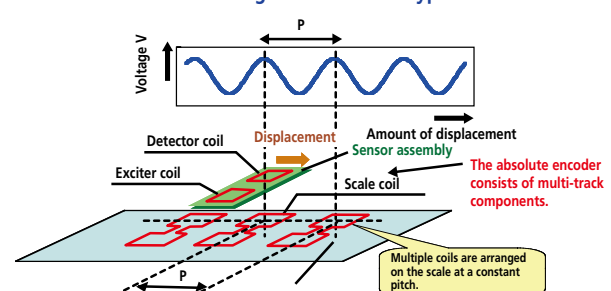
- When a time-varying current I_1 flows through coil A, it generates a magnetic flux within the coil.
- Coil B responds with a current I_2 , counteracting the buildup of the magnetic flux.

The electromagnetic induction sensor maintains consistent magnetic permeability between the coils regardless of the medium – whether air, water, or oil.

This results in superior water and oil resistance for the sensor.



Operating Principle of Electromagnetic Induction Type Encoder



Display Unit Selection Guide

Functions

Counter		KA-200 Counter	
Function			
Zero-setting	ZERO		
Preset	P.SET		
Resolution setting	0.0005 / 0.1		
Measurement direction setting			
mm/inch conversion	mm / inch		
Diameter display	DIA		
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	Z1+Z2	³	
Linearity error compensation			
Pitch error compensation		¹	
Smoothing	1234		
Memory backup			
Expansion/contraction coefficient setting		—	
Lower digit blanking out	123		
External zero-setting	ZERO SET IN PUT	⁴	
RS-232C interface unit	RS-232C OUTPUT	⁴	
USB output	USB	⁵	
Limit signal output	LIMIT OUTPUT	—	
Error message	Error		

I: Standard function, s: 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

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

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

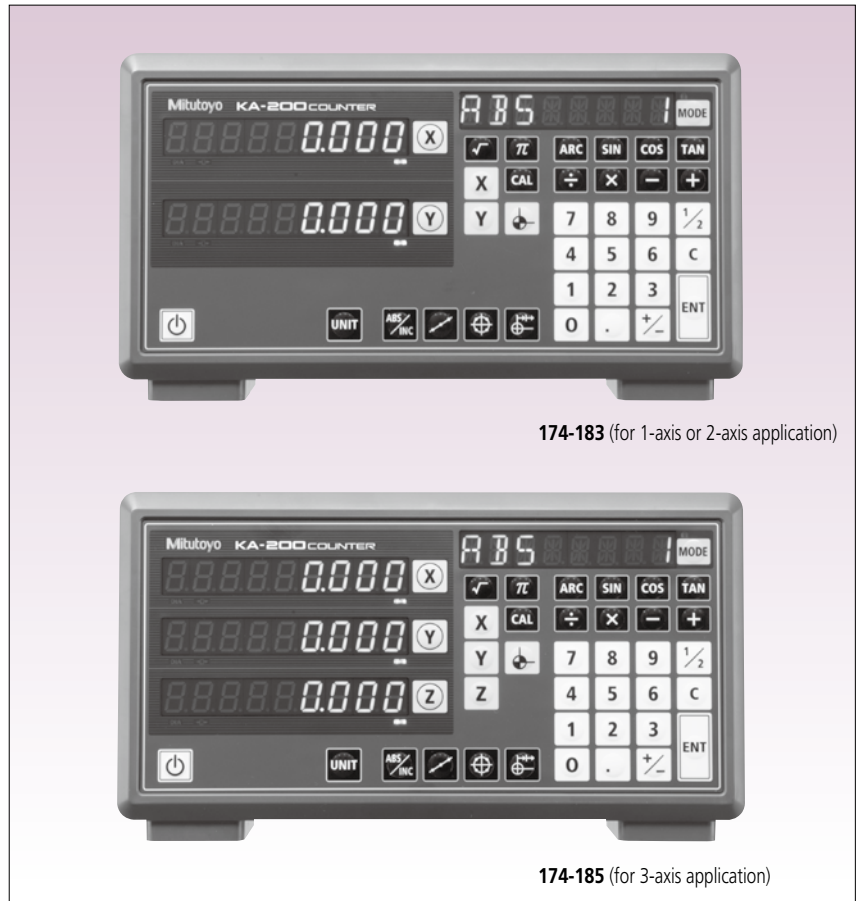
KA-200 Counter

Key Features

- **Versatility:** The KA-200 Counter offers the flexibility to function as both a "standard counter" and a "lathe counter," with parameter adjustments.
- **Compact Design:** Benefit from a lightweight, space-saving solution that doesn't compromise on functionality.
- **Enhanced Functionality:** Experience multiple functions combined into a single unit for improved efficiency.
- **User-Friendly Sub Display:** The inclusion of a sub display streamlines operation and enhances usability.
- **Text Data Output:** Utilize the optional USB interface to conveniently output text data.
- **External Connectivity:** Seamlessly connect to a PC or printer via the optional RS-232C external interface.

Specifications

Model	KA-200 Counter
Resolution	With AT100 Series: 0.05 - 0.0001 mm With AT715: 0.01 - 0.001 mm
Scale input ports	2 or 3
Display type / digit	7-segment, 8-digit + sign + 8-character alphabet LED display
Output (optional)	RS-232C / USB
Macro functions	Rectangular drilling and round milling newly added
Main features	Feed speed display; taper machining function; tool data; multipoint compensation; scale check function; calculation function
Dimensions	Size (WxDxH) 30×168×70mm



Standard Accessories

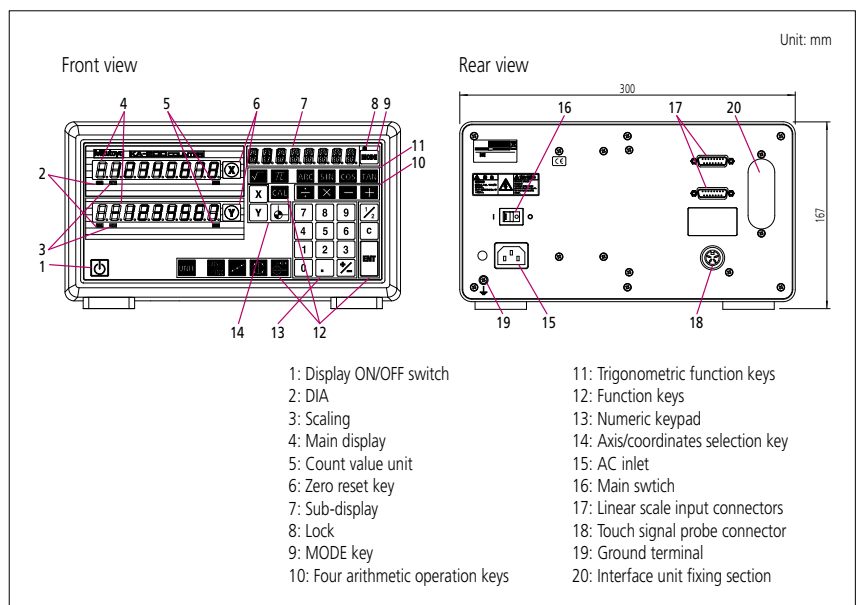
- 02ZAA000:** 1.8m AC cable (Japan)
- 02ZAA010:** 1.8m AC cable (USA, Canada)
- 02ZAA020:** 1.8m AC cable (Europe)
- 02ZAA030:** 1.8m AC cable (UK)
- 02ZAA040:** 1.8m AC cable (China)
- 02ZAA050:** 1.8m AC cable (Korea)
- 06AEU075:** Dust-proof cover
- 09CAA985:** GND lead wire (4m)
- 06AEU080:** Seal set (1 pc.)
- 06AFC149:** D-SUB15P Connector cap
- 99MBE083A:** User's Manual (1 set)

Optional Accessories

- 06AET993:** Code out unit
- 06ACF941:** External extension cable
- 937179T:** Foot switch for measurement data output (USB interface)

Note: The touch-probe has been discontinued.

DIMENSIONS



Display Unit Functions

BASIC FUNCTIONS

123

Zero-setting

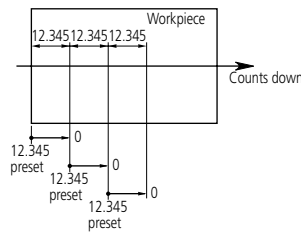
Set the display to "0" (zero) at any scale position.



P.SET

Preset

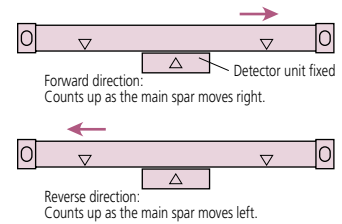
Enter a numeric value on the counter display for retrieval.



← →

Measurement direction setting

Choose the measurement direction as needed.



123

Lower digit blanking out

Blank out unnecessary lower digits (up to 9 digits).

1/2

1/2 calculation

Halve the display value.

mm/inch

mm/inch conversion

Switch between "mm" and "inch" counting units.

0.001 / 0.01

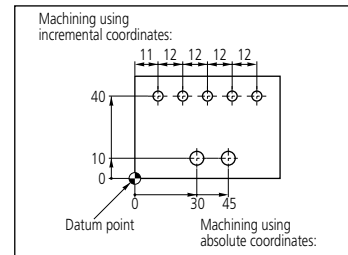
Resolution setting

Select the most suitable resolution based on counter compatibility.

I/A

Absolute/incremental coordinate system switching

Obtain measured values in absolute (ABS) or incremental (INC) coordinates. Useful for setting a datum point in absolute mode, then switching to incremental mode. This function proves especially beneficial in scenarios like the following: Set the datum point for a workpiece in absolute mode. Then, execute zero setting, presetting, and related actions in incremental mode. Finally, switch back to absolute mode to effortlessly display the absolute distance from the datum point.

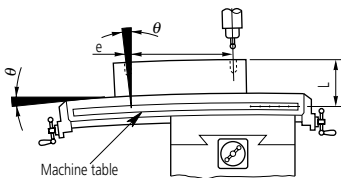


SPECIAL FUNCTIONS

123

Linearity error compensation

Compensate for machine errors caused by factors like workpiece weight.



1234

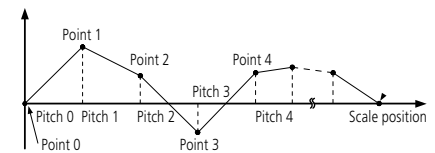
Smoothing Function

Enable "smoothing" to ease display reading during rapid oscillations.

1234

Pitch Error Correction (KA-200 Counter & AT100 series)

Correct machine errors to enhance positioning accuracy.



0078

Display value backup

The displayed value is retained in memory when the power is turned off and restored when the power is turned on again. When an AT715 scale is connected to the counter, the stored display value is accurately adjusted if the detector head is moved during power-off. This ensures that the display consistently presents the accurate displacement from the origin upon power-on.

1234

Expansion/contraction coefficient setting

Involves multiplying the actual counter measurements by a constant factor. It proves particularly advantageous in scenarios like mold manufacturing, where it enables direct machining of the mold to match the dimensions of the actual molded component. This eliminates the need for manual adjustments to machining dimensions to accommodate material shrinkage after molding. This functionality significantly reduces labor-intensive tasks and minimizes the potential for calculation errors.

1234

Function Lock (KA-200 Counter)

Prevent accidental changes to operational settings.

A CLR

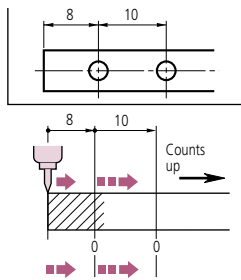
Parameter All Clear

Clear setup parameter data and reset to default.

MILLING MACHINE FUNCTIONS

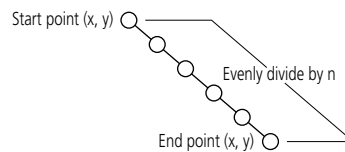
Zero approach machining [INC mode]

Zero approach machining can be executed at predefined intervals. The counter maintains the cumulative displacement in absolute coordinates, ensuring that a positioning error made by the operator at one tooling position does not impact the accuracy of subsequent positions.



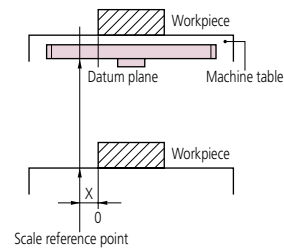
Pitch machining

Allows to bore holes between two arbitrary points on the X-Y plane with uniform spacing. By specifying the number of holes and indicating the start and end positions, you can effortlessly create holes at equal intervals. Any errors resulting from table positioning by the machine are automatically rectified, ensuring that the subsequent target value is accurately attained.



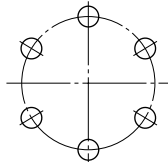
Scale reference point setting

The linear scale is equipped with scale reference points placed at intervals of 50mm. Upon detection of one of these points, the linear scale emits a signal to either pause or resume counting. Should the distance from a scale reference point to the machine origin be recorded as the offset value, this data remains stored even when power is turned off (using the hold function). When the power is subsequently restored, the machine origin or machining datum can be effortlessly retrieved (using the set function).



Bolt-hole circle machining

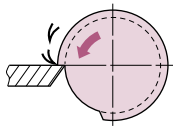
This function is particularly useful in milling operations, allowing you to effortlessly display the drilling positions along the circumference of a base circle. By inputting the center coordinates, diameter, and the number of divisions of the base circle, the counter provides a clear representation of the drilling points in the absolute zero approach mode.



LATHE FUNCTIONS

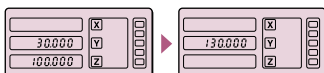
DIA Diameter display

This function allows the display of doubled scale displacement, making it convenient for presenting the diameter of a workpiece during a turning operation.



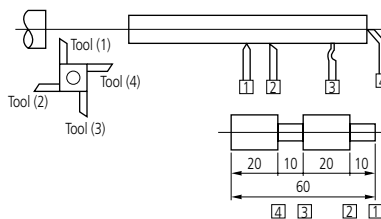
Z1+Z2 Addition of 2-scale data

This feature enables the display of the sum of values from two axes. In cases where a machine incorporates two feed components - fine feed and coarse feed - each equipped with its own scale, this function can be utilized to calculate and display the combined feed values.



TOOL Memorization of machining reference point for each cutting tool (for KA-200 Counter)

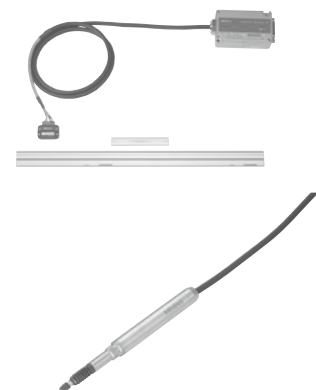
For the KA-200 Counter, both absolute and incremental coordinates can be switched for each of the four cutting tools. The counter has the capability to memorize the center of a machining workpiece as a reference point. It can display the diameter of the machine workpiece using absolute coordinates and zero set/preset at arbitrary positions using incremental coordinates.



SPECIAL FUNCTIONS

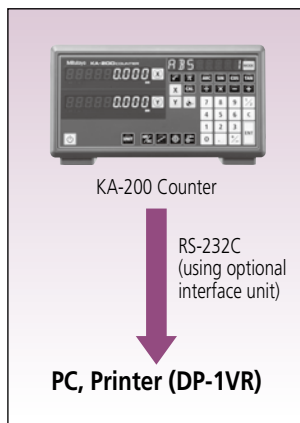
Connection with Line Driver Output Scale/Linear Gage

The KA-200 Counter is compatible with line-driver RS422 output type scales and linear gauges. To facilitate connection with these sensors, optional LINE conversion adapters are available. For detailed information, please refer to page 27.



Connecting to External Devices

Mitutoyo's DRO system precisely detects and presents the displacement of machine tool or measuring equipment slideways. Additionally, it sends measurement data and limit signals to peripheral devices like PCs or Sequencers via a built-in or optional interface.



RS-232C Interface

- The RS-232C interface unit facilitates the output of measurement data and zero-setting through commands from a computer.
- The RS-232 interface unit is a standard feature for the KA-200 Counter and is available as an optional accessory.

DATA OUTPUT MODE

Interval Mode (KA-200 Counter):
Measurement data can be periodically output at specified intervals.

SPECIFICATIONS

- Communication specifications

Home position	DCW
Communication method	Half-duplex, nonprocedural
Data transfer speed (Baud rate)	300, 600, 1200, 2400, 4800, 9600, 19200, 38400bps
Bit configuration	Start bit: 1 Data bit*: 7 or 8 Parity bit: 1 (even, odd), 0 (none) Stop bit: 1
Condition setting	By parameter switching.

- Data Output Operation:
Counter display values can be output using the following methods. Only one signal type can be used for input at a time.

Method	Counter mode	Output axis	Applicable counters
Data request command X CR LF Y CR LF Z CR LF A CR LF	Normal mode	X-axis Y-axis Z-axis All axes	KA-200 Counter
External extension cable and external load box	Normal mode	Axes that are selected by the external load box	KA
External extension cable and foot switch	Normal mode	All axes	KA

The KA-200 Counter can be externally controlled by executing specific commands through a computer or other means. Command codes should be entered in uppercase characters.

Function	Command code from PC
Zero-setting Sets the counter display values to zero.	RX CR LF: for X-axis RY CR LF: for Y-axis RZ CR LF: for Z-axis
Error cancellation Has the same effect as the CANCEL key on the counter.	CO CR LF

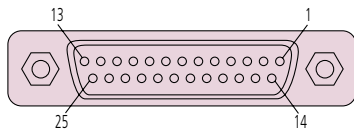
- Error code output:
When the counter is in an error state or when an incorrect command is issued during data output, the counter transmits a corresponding error code signal.

Counter display	Code out output
Count overspeed (Error20)	E20
Display overflow (Error30)	E30
Signal error (Error40)	E40
Digital switch setting error (Error50)	E50
Internal error (Error60)	No response
Startup display (-----)	E00

Notes

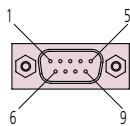
- Output data format is fixed at either 7 or 8 digits, without zero-suppression.
- For data output from multiple axes, a comma "," functions as a delimiter. For example: X +12345.678, Y +90123.456 CR LF
- Output data is presented in the same unit as used on the counter (mm or inch). However, the unit identifier itself will not be part of the output.

- RS-232C connector
Connector used: 25-pin (KA-200 Counter)



Applicable plug (female)
 • HDBB-25P (plug / HIROSE)
 • HDB-CHT (case / HIROSE)

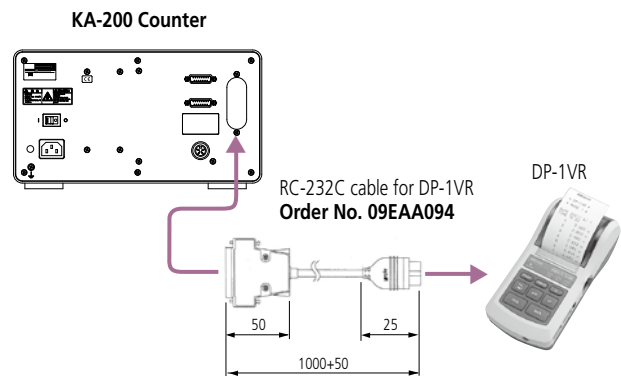
No. of pin	Signal	I/O	Remarks
1	FG	—	Frame grounding
2	SD	Input	Command
3	RD	Output	Data
4	—	—	Not used
5	CS	Output	"H" fixed
6	DR	Output	"H" fixed
7	SG	—	Signal grounding
8 to 12	—	—	Not used
13	—	Input	X-axis load
14	—	Input	Y-axis load
15	—	—	Not used
16	—	Input	Z-axis load
17 to 22	—	—	Not used
23	—	Input	X-axis zero-setting
24	—	Input	Y-axis zero-setting
25	—	Input	Z-axis zero-setting



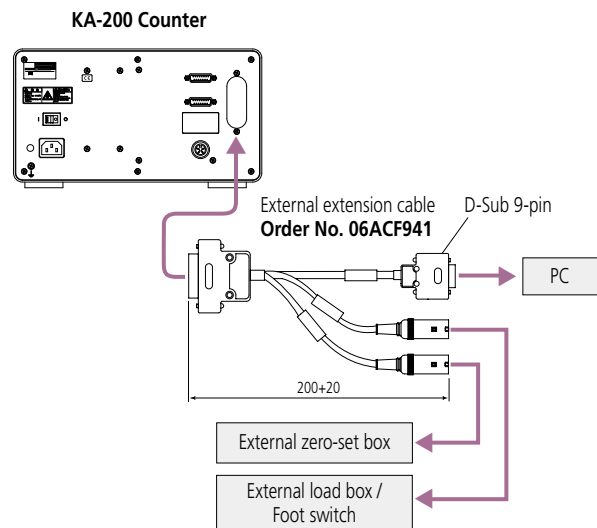
Applicable plug (female)
 • HDEB-9S (plug / HIROSE)
 • HDE-CHT (case / HIROSE)

No. of pin	Signal	I/O	Remarks
1	—	—	Not used
2	RD	Output	Data
3	SD	Input	Command
4	—	—	Not used
5	SG	—	Signal grounding
6	DR	Output	"H" fixed
7	—	—	Not used
8	CS	Output	"H" fixed
9	—	—	Not used

- Optional RS-232C code out unit for KA-200 Counter: **09CAB217**
The optional RS-232C code out unit empowers measurement data output to peripheral devices such as a PC or DP-1VR, while also enabling zero-setting through commands from a PC or an external zero-set box.



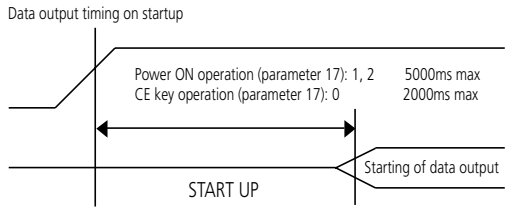
- External extension cable (KA-200 Counter only).
- Attaching an external extension cable to a KA-200 Counter + RS-232C code out unit allows connection to the optional external load box, foot switch, and external zero-set box. RS-232C outputs can be employed simultaneously.



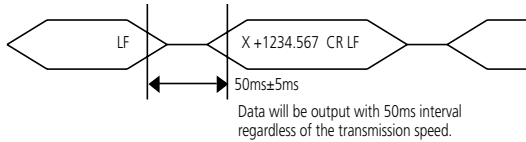
Connecting to External Devices

TIMING CHART

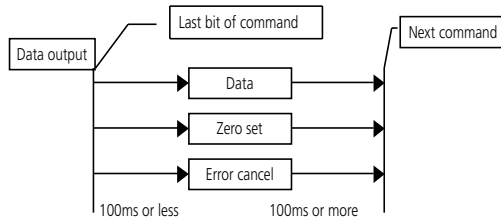
- Interval Mode (KA-200 Counter):
Measurement data can be periodically output at specific intervals.



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

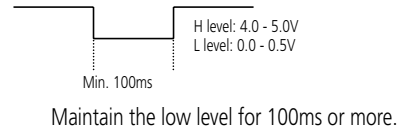


- Trigger Mode (KA-200 Counter):
Measurement data can be output through computer commands.



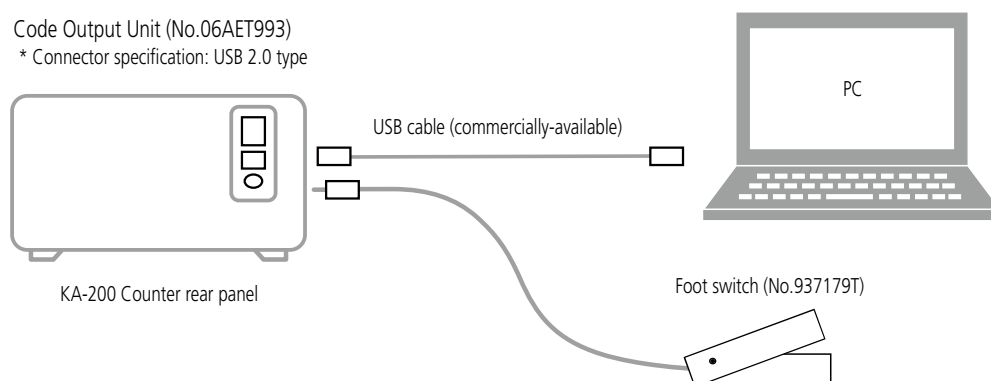
Each value in the timing chart indicates the response time to a command. It's important to note that this command might introduce a difference between a detected point and the actual point while the slider is in motion.

- External zero signal (KA-200 Counter)



USB Output

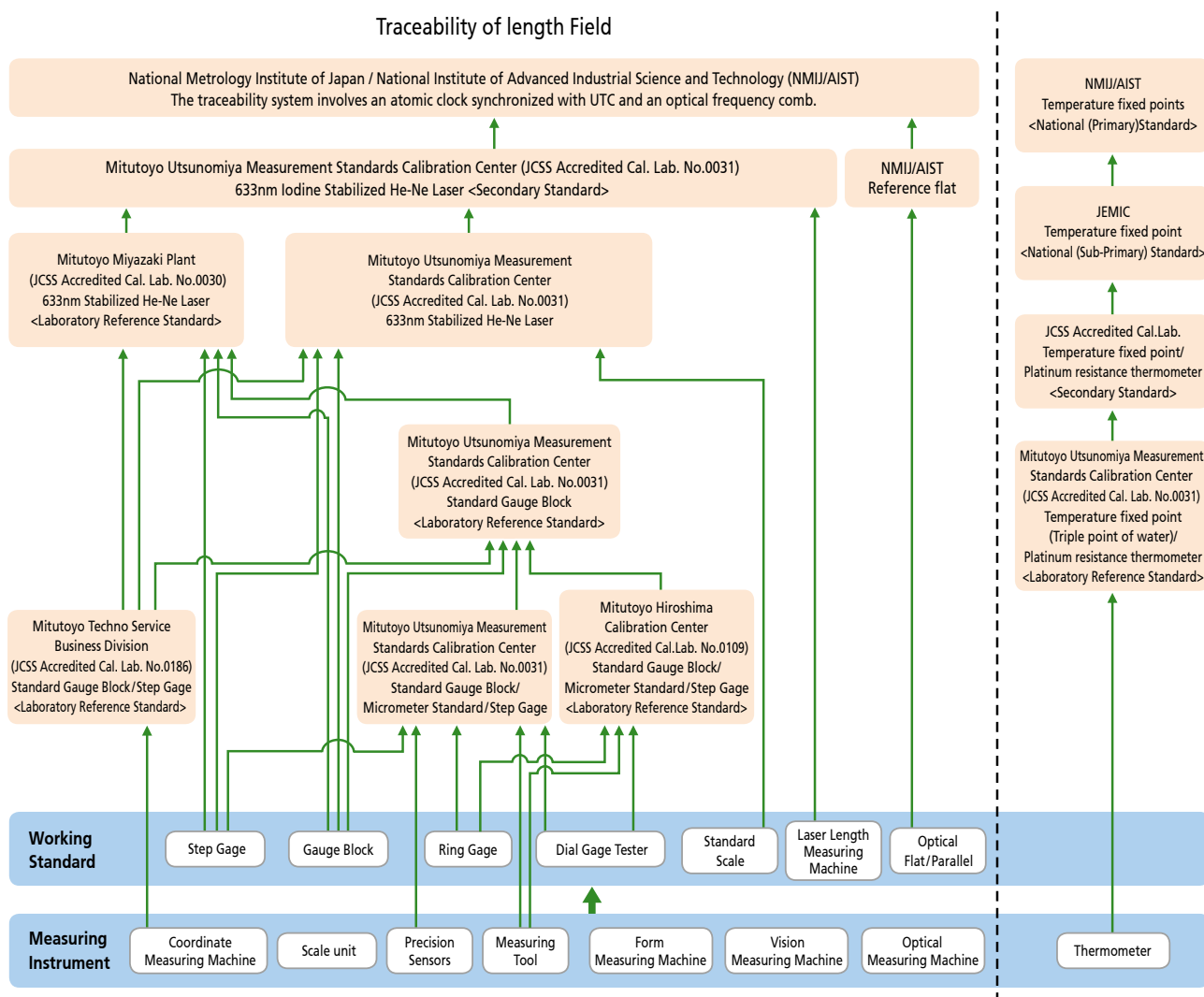
A KA-series counter has the capability to output measurement values as USB text data when used in conjunction with the optional code output unit and foot switch. These numeric values can be easily imported into applications such as Excel.



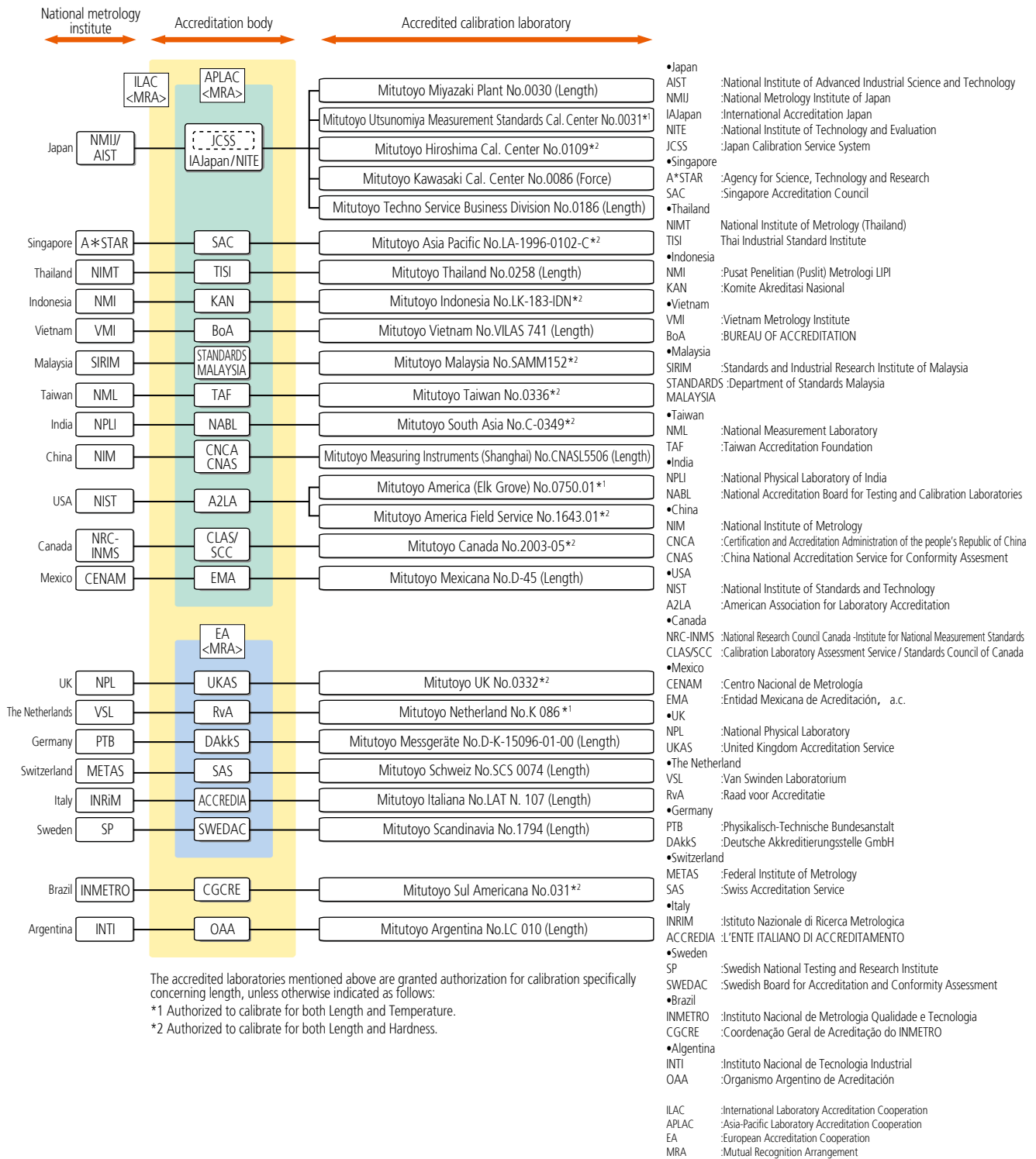
Traceability System

Mitutoyo employs a traceability system enabled by an in-house calibration organization that holds certification under the ISO/IEC 17025 international standard. This organization utilizes length standards directly linked to the highest-level national standards (stabilized He-Ne laser). The use of the stabilized He-Ne laser ensures a performance level equivalent to that of the national standard.

Furthermore, this national standard is acknowledged through mutual recognition by CIPM, and the certified calibration organization is also mutually recognized by ILAC. As a result, Mitutoyo products achieve the establishment and maintenance of traceability not only within Japan but also on an international scale.



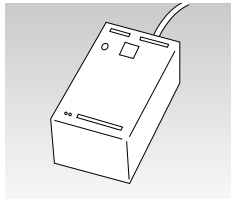
Calibration Laboratories Worldwide



Optional Accessories

External Load Box

- Outputs counter value with a simple button press when utilizing the counter's data output function.
- Compatible with KA-200 Counter (equipped with RS-232C output).

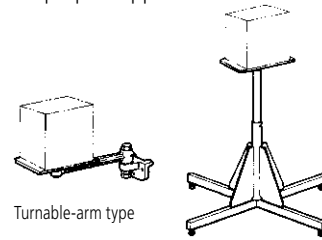


Part No.	Number of axis
937328	3-axis

Note 1: Both the counter and the external zero-set box must have the same number of axes.
 Note 2: When used with the KA-200 Counter, an external connection cable is also required.

Counter Support

Provides support for a range of counters, including desk-top, turnable-arm, turnable double-arm, stand, and special types. The specific support type depends on the counter. Kindly specify your counter model to ensure proper support selection.



Turnable-arm type

Digimatic Mini-Processor DP-1VR

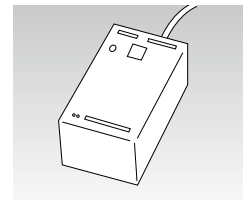
- Prints out displayed data when connected with the RS-232C output of KA-200 Counter.
- Requires an RS-232 Counter cable (1m) for connection.
- Designed for KA-200 (RS-232C output) Counter.



Order No.	Product Name
264-504	DP-1VR
Part No.	Product Name
09EAA094	RS-232C counter cable

External Load Box

- Enables the direct output of the counter value by simply pressing a button when utilizing the counter's data output function.
- Designed for KA-200 Counter (equipped with RS-232C output).

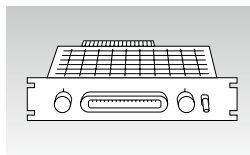


Part No.	Number of axis
936553	3-axis

Note 1: Both the counter and the external zero-set box must have the same number of axes.
 Note 2: When used with the KA-200 Counter, an external connection cable is also required.

Code Out Unit

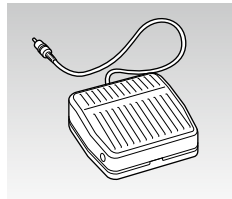
This RS-232C unit is designed to be mounted on the counter.
 - Intended for use with KA-200 Counter.



Part No.	Product name
06AET993	Code Out Unit
937179T	Foot switch

External Load Foot Switch

Outputs counter value through a foot switch activation when utilizing the counter's data output function. Designed for KA-200 Counter (equipped with RS-232C output).

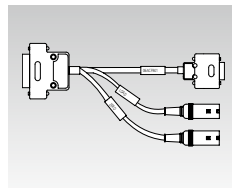


Part No.	965004
----------	--------

Note 1: When used with the KA-200 Counter, an external connection cable is also required.

Cable for External Connection

- Allows use of external zero-set box, external load box, and external load foot switch when connected to the RS-232C output of KA-200 Counter.
 - Can be combined with RS-232C output.



Part No.	06ACF941
----------	----------

Note 1: (Refer to Page-19 for details.)

Extension Cable

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



For AT100 Series

Part No.	Cable length
09AAA033A	2m
09AAA033B	5m
09AAA033C	7m

For AT715

Part No.	Cable length
09AAB674A	2m
09AAB674B	5m
09AAB674C	7m

Various Adapters

Mitutoyo offers a diverse range of adapters tailored to various applications. (Refer to Pages 26 to 27 for details.)

- Includes connecting adapters for former Linear Scales and existing counters (KA-200 Counter).
- Connecting adapters for existing Linear Scales (AT100 Series) and former counters.
- Adapters for limit signal output, to connect with the limit signal output connector after replacing the former limit output counter with the existing.
- Connecting adapters for line-driver-output Linear Scales, various sensors, and existing counters (KA-200 Counter).

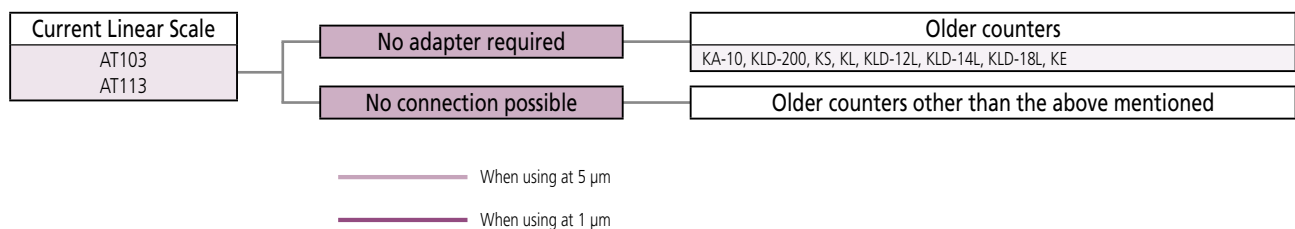
Optional Adapters

Adapters for Connecting between Older and Current Products

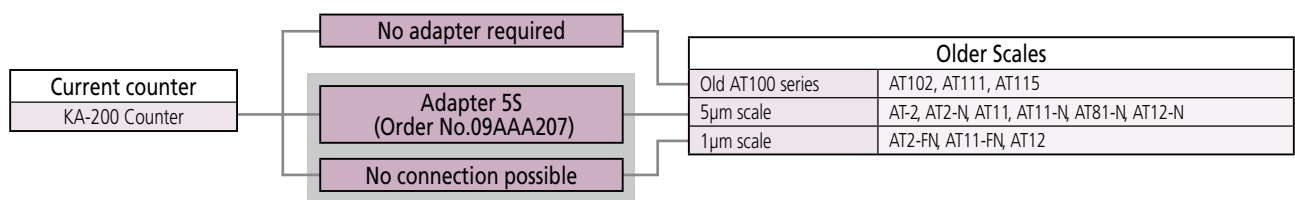
A specific adapter may be necessary for establishing a connection between an older product and a current product. For details about applicable connecting adapters, please refer to the provided configuration diagrams. The adapter is connected to the input connector on a counter.

- Note:
- It is not possible to connect a 1 μ m scale (old linear scale) with a current counter (KA-200 Counter).
 - A connection between linear scale AT715 and an older counter (other than KA-200 Counter) is not feasible.

Adapter Configurations for Connecting between a Current Linear Scale (AT100 Series) and an Older Counter



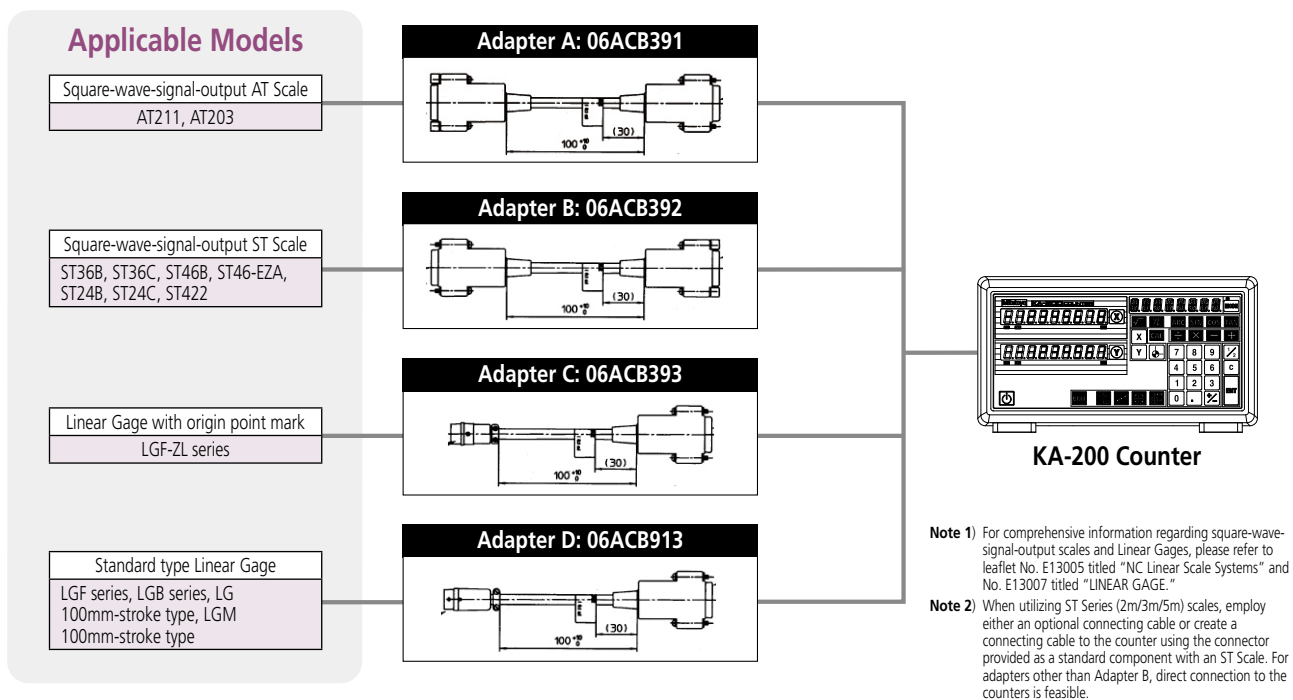
Adapter Configurations for Connecting between a Current Counter and an Older Linear Scale



Line Conversion Adapter

This adapter facilitates the connection between a line-driver-output Linear Scale, a Linear Gage, and a KA-200 Counter.

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



CAUTION



Important Information Regarding Adapters A to D:

When employing adapters A to D, the maximum response speed is determined by the resolution of the connected models.

When parameter 96 of the KA-200 Counter is adjusted to 5 (input frequency: 300kHz).

Connected model's resolution	Maximum response speed
1 μ m	300mm/s
0.5 μ m	150mm/s
0.2 μ m	60mm/s
0.1 μ m	30mm/s

Precautions when Mounting and Handling Linear Scales

Selecting the Scale Unit Mounting Position and Mounting Method

Four crucial points must be taken into consideration when determining the scale unit's mounting position and orientation.

Ease of mounting

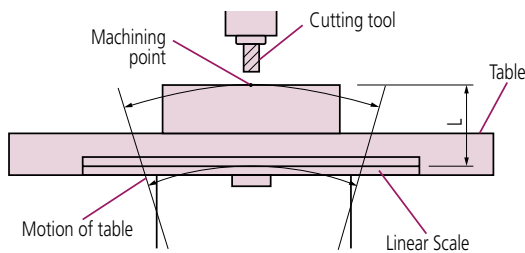
When mounting the scale unit, ensure that neither the unit, including the detector head and cables, nor the brackets interfere with any part of the machine. For seamless mounting, place the scale unit and brackets on machined surfaces whenever possible.

Protection from Machining Fluids and Swarf (Mounting Orientation)

Although the scale unit is designed to prevent easy entry of machining fluids and swarf into its interior, the openings are safeguarded by rubber seals against foreign materials. Avoid direct exposure of the scale unit to machining fluids and swarf. Carefully select the scale unit's mounting orientation, considering the direction in which machining fluids and swarf are dispersed and sprayed.

Accuracy Considerations

The total system accuracy of the machine on which the scale unit is mounted is not only determined by the scale unit accuracy but by the machine 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 curvilinearly, errors occur in proportion to the distance "L" between the scale unit and the machining point (cutter position). Thus, mount the scale unit in a position that minimizes "L".



Other Considerations

- When the detector head moves, the signal cables move correspondingly with the slide table. Account for this when arranging the signal cables. It is advisable to mount the scale unit on the moving part of the machine.
- Opt for a mounting location where the scale unit is not directly exposed to airflow. When utilizing an air gun to remove swarf, exercise caution to prevent flying swarf.
- Choose a mounting location that facilitates easy maintenance in case of unit malfunction.

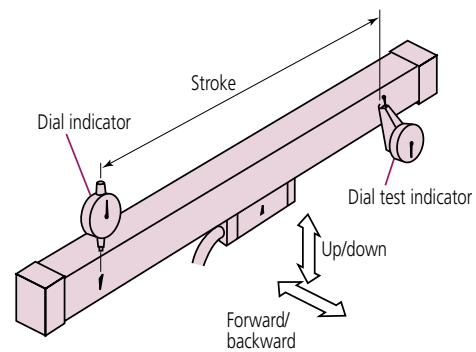
Checking Parallelism and Adjustment of Scale Unit

To achieve peak accuracy, the scale unit must be mounted parallel to the machine guide (machining axis). Incorrect mounting can cause the scale unit to bend or twist.

Checking Parallelism

Use a dial indicator as illustrated below. To adjust the parallelism between the scale unit and the machine guide, assess the parallelism while manually moving the machine's movable part, such as the slide table. Alternatively, gauge the parallelism in relation to the machine's guideways or an equivalent reference surface.

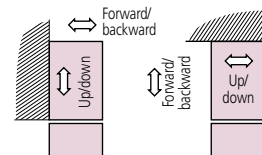
- Parallelism tolerance: Refer to the figures on dimensions.
- Checking direction: Back/forward direction on the mounting surface and directions along the mounting surface (up and down).
- Checking position: Position of the scale unit around the mounting blocks.



Adjusting Parallelism

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

- Adjusting the mounting surface back/forward: Realign the bracket mounting positions or insert spacers between the scale unit mounting surface and the mounting blocks.
- Adjusting along (up and down) the mounting surface: Slide the mounting block on the mounting surface to achieve the desired parallelism.



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

Supplying clean compressed air to the scale unit is recommended for enhancing the environmental resistance of assembly-type linear scales against dust and coolant. This is accomplished by directing air through one of the two M5 screw holes located on the sides of the scale unit.

* The AT103 model comes standard with an air supply fitting.

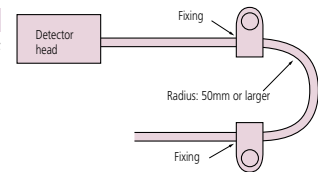
Caution: The air supply method serves as an optional safeguard for the scale. Proper installation of the air supply piping, as outlined in the manual, is crucial. The air should be filtered, and the filter should be replaced periodically based on the cleanliness of the air source. Continued use of a heavily contaminated filter might permit contaminants to enter the scale unit. For detailed information, please contact the Mitutoyo Sales Department.

Signal Cable Layout

Several key points should be considered when devising a layout plan for signal cables.

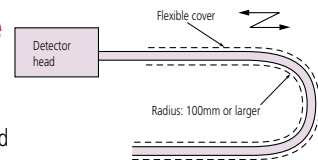
When the Cable Is Fixed

Ensure that the radius of curvature of the signal cable exceeds 50mm.



When the Cable Is Movable

If the detector head is in motion, it carries the signal cable with it during operation. In this scenario, the radius of curvature of the signal cable should not fall below 100mm, and excessive force should be avoided. Employing a flexible support cover to protect the cable is advisable.



Note: Guarantee that the signal cable does not interfere with any part of the machine and is not subject to abrasion.

Other Considerations

The signal cable is designed to endure repeated bending for approximately 2 million cycles (when the bending radius exceeds 100mm). When expecting repeated bending exceeding 2 million cycles, consider the signal cable as a consumable component. In such cases, having a spare cable on hand permits swift replacement when needed, reducing machine downtime.

Precautions When Mounting and Handling Linear Scales

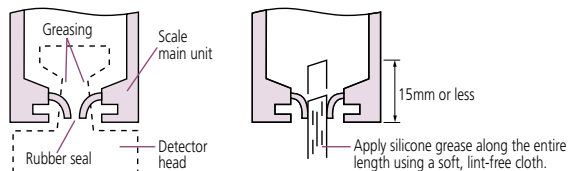
Resonance Point of Linear Scale

Every object possesses a natural frequency determined by its shape, length, and material composition, and the Linear Scale frame is no exception. It too has its natural frequency, causing it to resonate at a specific frequency. Typically, this does not pose an issue since a machine tool and the Linear Scale frame possess distinct natural frequencies during standard machining operations. However, if the natural frequency of the machine tool body coincides with that of the Linear Scale, the following counter-measures can be employed:

1. Enhance the rigidity of the mounting bracket for the scale.
2. Introduce a mid-support along the scale's middle section to shift its resonance point upwards.
3. Position the Linear Scale in a location where vibrations from the machine tool cannot easily transmit.
4. Limit the machine's operating conditions to a specific range where the natural frequencies of the machine tool and the scale do not overlap.

Maintenance of Dust-Proof Seals

To ensure the longevity and effectiveness of the dust-proof rubber seals, it is recommended to apply a small amount of silicone lubricant to the contact area between the rubber and the detector head once a year.



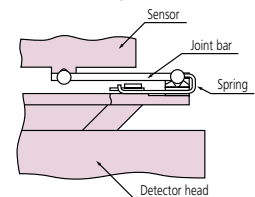
Linear Scale Evaluation Methods

- **Testing within the operating temperature range**
Functional and signal abnormalities have not been observed when using the Linear Scale within the specified operating temperature range.
- **Temperature cycle (dynamic characteristics) test**
The Linear Scale has exhibited no anomalies during usage under conditions where ambient temperature consistently varies within the specified range.
- **Vibration test (sweep test)**
The Linear Scale functions without abnormalities under vibration in the frequency range of 30Hz to 300Hz at a maximum acceleration of 3g.
- **Noise test**
In accordance with EMC Directives, EN61326-1+A1:1998.
- **Crate drop Test**
Conforms to the heavy equipment drop test (JISZ0200) stipulated in the JIS standard.

Constructional Features of the Linear Scale

Joint structure of detector

A ball joint structure is utilized at the contact point between the detector head and the slider (sensor unit) within the scale. This arrangement prevents slider movement from deviating from its normal path when the detector head experiences slight transverse misalignment. This not only ensures accurate scale readings but also facilitates flexible scale installation. Additionally, this structure is exceptionally rigid, ensuring long-lasting durability.



Water-proof Connector

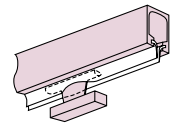
A waterproof/splash-proof connector permits easy separation of the signal cable, simplifying installation and maintenance of the Linear Scale. (The AT115 model's signal cable cannot be separated.)

Conduit armored type signal cable

Its exterior is composed of stainless steel, offering corrosion resistance and enduring continuous use.

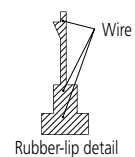
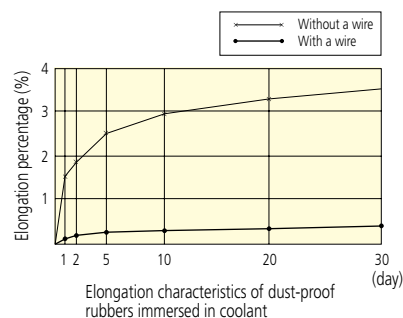
Unique rubber seals

The slider is designed to glide smoothly through the rubber-seal opening, much like a boat's keel through water.

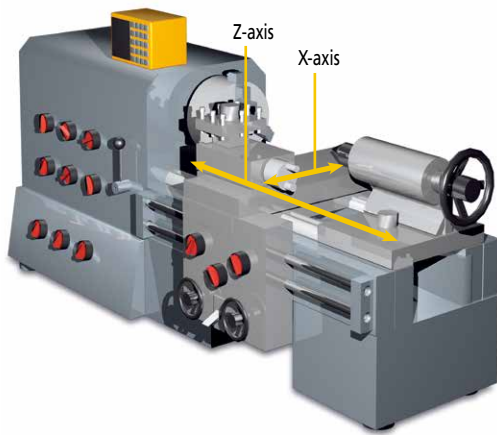


Excellent splash- and dust-proof rubber-seal structure

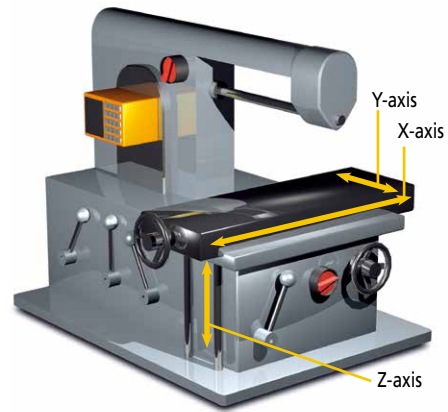
The rubber seals are fashioned from robust, specialized urethane, with wires inserted to enhance splash-proofing and dust-proofing (AT103 only).



Scale Systems for Various Multi-Axis Machine Tools

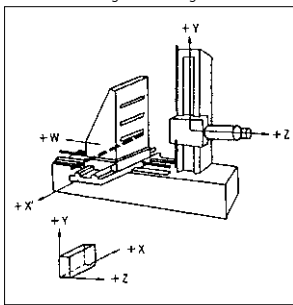


2-axes KA-200 Counter + two scales

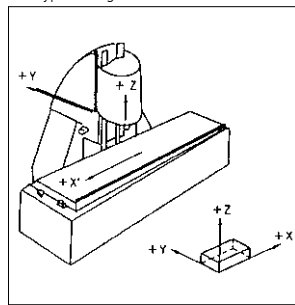


3-axes KA-200 Counter + three scales

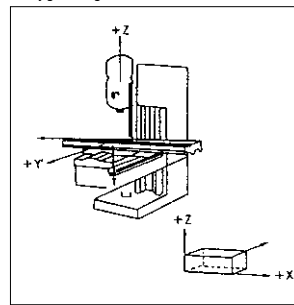
Horizontal boring and milling machine



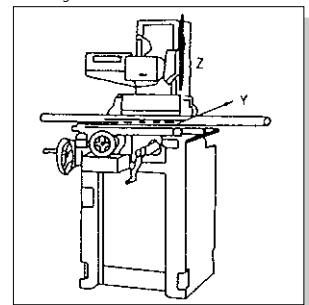
Bed-type milling machine



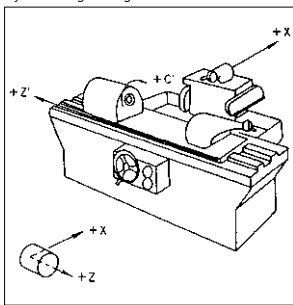
Knee-type milling machine, drilling machine, and jig boring machine



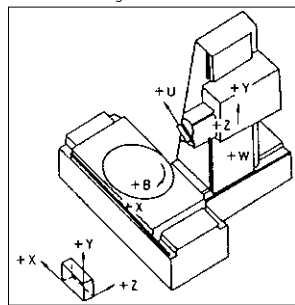
Grinding machine



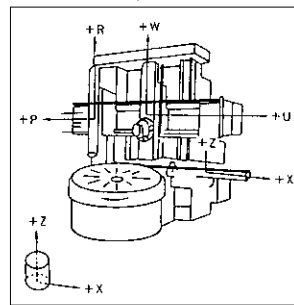
Cylindrical grinding machine



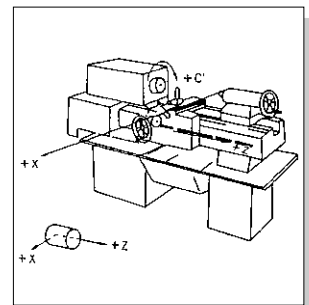
Horizontal boring machine



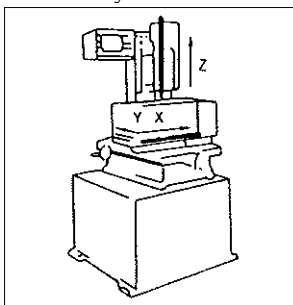
Vertical turret lathe, vertical lathe



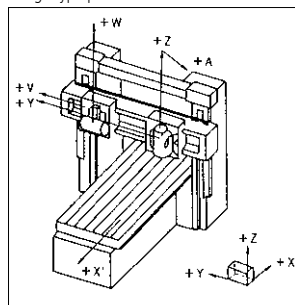
Centre lathe



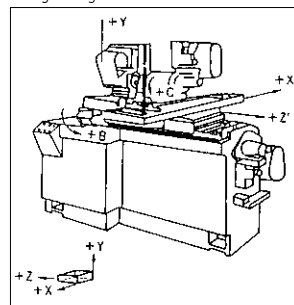
Electrical discharge machine



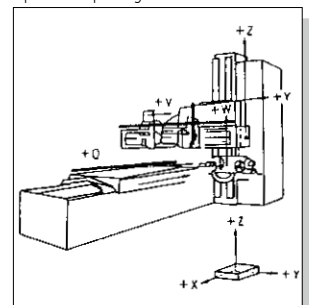
Bridge type planomiller



Tool grinding machine



Open-sided planing machine

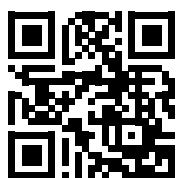




Whatever your challenges are, Mitutoyo supports you from start to finish.

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 bespoke 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 complete catalog here.

www.mitutoyo.eu

Note: All information regarding our products, and in particular the illustrations, drawings, dimensional and performance data contained in this printed matter as well as other technical data are to be regarded as approximate average values. We therefore reserve the right to make changes to the corresponding designs, dimensions and weights. The stated standards, similar technical regulations, descriptions and illustrations of the products were valid at the time of printing. In addition, the latest applicable version of our General Trading Conditions will apply. Only quotations submitted by ourselves may be regarded as definitive.

Mitutoyo

Mitutoyo Europe GmbH

Borsigstraße 8-10

41469 Neuss

Tel. +49 (0) 2137-102-0

info@mitutoyo.eu

www.mitutoyo.eu