DRO System

Bulletin No. 1715

Linear Scales & Counters

Mitutoyo

Accuracy, yet Affordable, DRO System is Available with Linear Scales and Counters!

AT115▪AT102▪AT111▪AT112▪AT181
KL Counter▪KLL Counter▪KM Counter▪KC Counter▪KS Counter▪KLD Counter

Mitutoyo's DRO (Digital Readout) system integrates the AT100 Series Linear Scales (AT115/AT102/AT111/AT112/AT181) with the K Series dedicated digital counters (KL/KLL/KM/KC/KS/KLD Counter), to offer accurate detection and display of axial displacements of machine tools and measuring equipment. The DRO system can be configured to best meet your specific application, such as turning, milling, or grinding. Choose a suitable combination of scale unit and counter. Scale units have diverse measuring length ranges and counters feature remote zero setting, switchable resolution, and multipurpose one-touch macro keys. The DRO system has superior ease-of-use and is reliable, both of which dramatically improve machining accuracy and efficiency. Mitutoyo strongly recommends implementation of the DRO system whatever possible.

With the DRO system, you can:

1. Simplify machining procedure.

Procedures such as layout and setup can be completely omitted and simplified.

2. Shorten machining time.

In addition to simplifying machining procedure, the operator is free from the drudgery of measuring dimensions, positioning, and calculating feeding lengths, greatly shortening the time required for machining. The more complicated the machining procedure, the more effective the DRO system is as a time-saver.

3. Reduce errors.

The counter clearly displays the travel and the cutting depth, thereby reducing such errors as misreading of graduation, miscounting of knob rotation, and miscalculation of dimensions. Dimensions are always consistent and are independent of operators.

4. Eliminate manual calculations.

The counter's calculation function will display dimensions such as diameters of a rotating workpiece in design drawing notation if machine feed knob is turned.

5. Reduce machining costs.

Streamlined, labor-saving, and defective-free machining drastically reduces machining costs.

Ultra Psrecision Manufacture Eleven Meters Underground

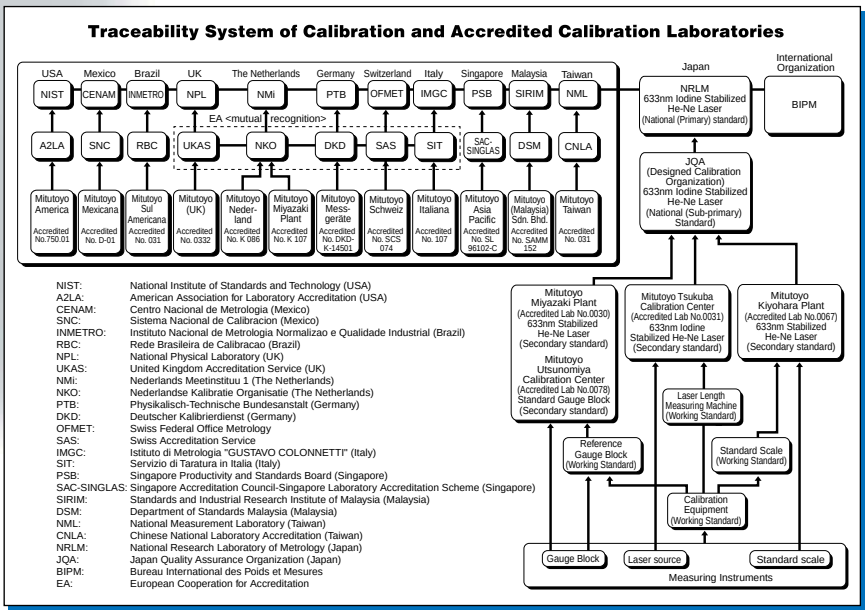
Mitutoyo Kiyohara Plant, which is a factory exclusively for the production of Linear Scales and other precision scales, has a complete system for producing master scales to be used in finished products, such as CMM, vision measuring system, profile projectors, and measuring microscopes. To improve the accuracy of scales and quality control technologies, the integral laboratory of Kiyohara Plant was constructed eleven meters underground. It provides an optimum environment (cleanliness factor:100) for the ultra-precision manufacture and evaluation of scales. Its unique design and construction isolate the laboratory from external vibrations and ensure minimal variations in temperature and humidity.

Products with CE Marking

Each model of Mitutoyo Linear Scales and counters bears the CE mark. CE stands for Conformité Européenne. It indicates that the product complies with the requirements drawn up by the European Community for safety, health, environment and customer protection.

Traceability System of Mitutoyo

Mitutoyo, a manufacturer of precision measuring instruments, offers a wide range of measuring machines and instruments that are in full compliance with the national standards of various countries. They are traceable to the national standards through the physical standards, which are calibrated by specified secondary standards owned by Mitutoyo. Our calibration laboratories are accredited to provide calibration services in three fields of length-measurement: length-measuring laser units, gauge blocks, and line standards.



DRO System
Using Mitutoyo Linear Scales

*KM Counter is not available in the US market.

Display Units

KL Counter
Standard Type
for Milling Machine

mm/inch | 1-AXIS | 2-AXIS | 3-AXIS

KLL Counter
Standard Type
for Lathe

mm/inch | 3-AXIS

KM Counter*
Multi-function Type

mm/E | mm/inch | 1-AXIS | 2-AXIS | 3-AXIS

KC Counter
Multi-function Type with Data Output

mm/E | mm/inch | 1-AXIS | 2-AXIS | 3-AXIS

KS Counter
Basic Type

mm/E | mm/inch | 1-AXIS | 2-AXIS | 3-AXIS

KLD Counter
Special Purpose Type
with Limit Signal Output

mm/inch | 1-AXIS

2-STEP LIMIT
4-STEP LIMIT

8-STEP LIMIT

Scale Units

Linear Scale AT115
Slim Spar
From 100mm up to 1,500mm

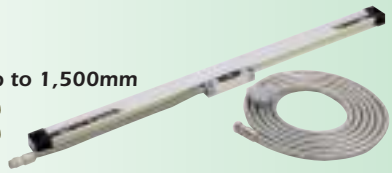
STANDARD

Linear Scale AT102
Standard-size Spar
From 100mm up to 6,000mm

STANDARD
HIGH-ACCURACY

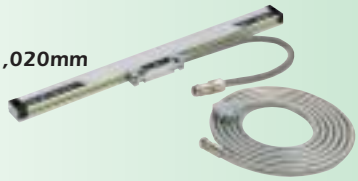
Linear Scale AT111
Slim Spar
From 100mm up to 1,500mm

STANDARD
HIGH-ACCURACY



Linear Scale AT112
Super Slim Spar
From 50mm up to 1,020mm

STANDARD
HIGH-ACCURACY

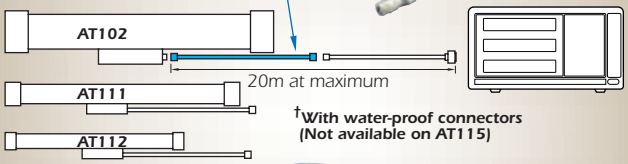


Linear Scale AT181
Panger Type
From 100mm up to 600mm

STANDARD
HIGH-ACCURACY

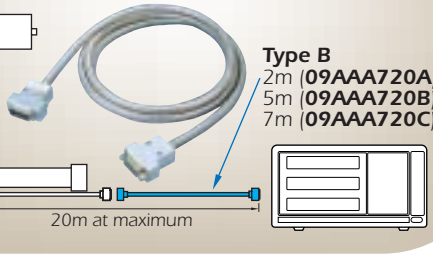
Extension Cables

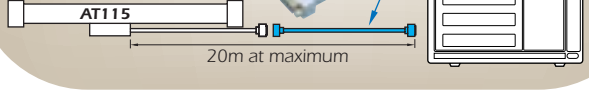
Type A†
2m (**09AAA033A**)
5m (**09AAA033B**)
7m (**09AAA033C**)



†With water-proof connectors
(Not available on AT115)

Type B
2m (**09AAA720A**)
5m (**09AAA720B**)
7m (**09AAA720C**)





Display Unit Functions

Functions	KL Counter (See page 9.)	KLL Counter (See page 10.)	KM Counter (See page 11.)	KC Counter (See page 12.)	KS Counter (See page 14.)	KLD Counter (See page 15.)	
Zero-Setting	●	●	●	●	●	●	See page 6.
Zero-set remote controller			○	○	○		See page 6.
Preset	●	●	●	●	●	●	See page 6.
Resolution setting	●*1	●*1	●*1	●*1	●*1	●*1	See page 6.
Counting direction setting	●	●	●	●	●	●	See page 6.
mm/inch conversion	●	●	●	●	●	●	See page 6.
1/2 calculation	●	●	●	●	●	●	See page 6.
ABS/INC coordinate selection	●*2	●*2	●*2	●*2	●*2		See page 6.
Lower digit blanking out	●	●	●	●	●		See page 6.
Memory backup	●	●	●	●		●	See page 6.
Expansion/contraction coefficient setting			●	●		●	See page 6.
Zero approach machining [ABS mode]			●	●			See page 6.
Zero approach machining [INC mode]	●	●	●	●			See page 6.
Bolt-hole circle machining	●*3		●*3	●*3			See page 6.
Touch-signal probe	○		○	○		○	See page 7.
Scale reference point setting	●	●	●	●		●	See page 7.
Addition/subtraction			●	●			See page 7.
Maximum/minimum value hold						●	See page 7.
Diameter display	●	●	●	●	●	●	See page 7.
Addition of 2-scale data	●*4	●*4	●*4	●*4	●*4		See page 7.
Direct data entry with Digimatic gage			●	●			See page 7.
Cutting tool selection		●*5	●*5	●*5			See page 7.
Coordinate data copy			●	●			See page 7.
One-touch macro key			●	●			See page 8.
Part-program setting			●	●			See page 8.
Programmable remote controller			○	○			See page 8.
Linearity error compensation	●	●	●	●	●	●	See page 8.
Pitch error compensation			●	●			See page 8.
Lost motion compensation			●	●			See page 8.
Smoothing		●	●	●	●	●	See page 8.
RS-232C Interface Unit	○	○	○	○	○	○	See page 8.
Limit signal output via RS-232C				○			
BCD Code Out				○		○	See page 8.
Digimatic Code Qut				○			See page 8.
GP-IB Interface				○			See page 8.
Limit signal output				●		●	See page 8.

●: Provided as standard
○: Optional accessory

*1 Resolutions to be set differ depending upon the type of Counters.
*2 6 absolute (ABS) coordinates and 5 incremental (INC) coordinates are provided for the KM/KC Counter.
1 absolute (ABS) coordinate and 1 incremental (INC) coordinate are provided for the KL/KLL/KS Counter.
*3 Not available on the 1-axis Counters.
*4 Not available on the 1-axis Counters and the 2-axis KL Counter.
*5 5 cutting tools can be specified on the KM/KC Counter. 10 cutting tools can be specified on the KLL Counter.

BASIC FUNCTIONS

ZERO Zero-setting

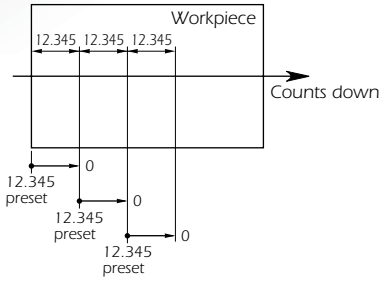
The display can be set to "0" (zero) at any scale position.

Zero-set remote controller

The optional zero set remote controller (09CAA335) allows the displayed value to be remotely zero set.

P.SET Preset

This function allows the user to enter a numeric value on the counter display. Any preset value can be retrieved whenever necessary.

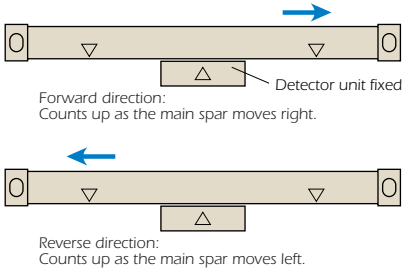


0.001 / 0.01 Resolution setting

The most easy-to-read resolution can be selected to meet measuring applications. Available resolutions depend upon the Counter to be used.

Counting direction setting

The counting up direction can be selected.



mm/E mm/inch conversion

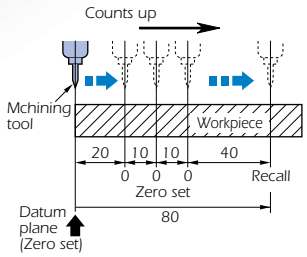
The counting unit can be changed between "mm" and "inch" (or between "mm" and "E (=1/25.4mm)" depending on the model.)

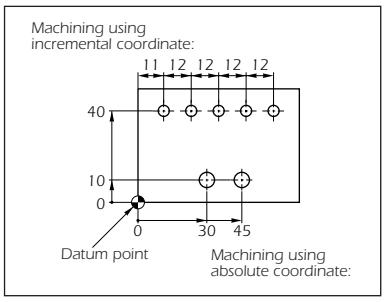
1/2 1/2 calculation

This function halves the display value.

Absolute/incremental coordinate selection

For each axis, the measured value can be obtained in either absolute (ABS) or incremental (INC) coordinate system. This function is useful, for example, if the following operation is performed. Set the datum point for a workpiece in the absolute mode. Then, after performing zero setting, presetting, etc., in the incremental mode, return to the absolute mode. In this way the absolute distance from the datum point can be easily displayed.





123 Lower digit blanking out

Unnecessary lower digits (up to 9 digits of the lowest digits) can be blanked out.

Memory backup

The backup battery retains the most recent display value even when the counter is off.

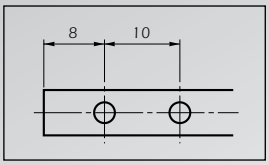
Expansion/contraction coefficient setting

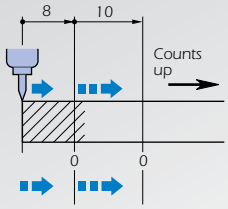
This function compensates for the expansion/ contraction of a melted material in a mold within a range of -20% to 20%.

FOR MILLING MACHINES

Zero approach machining [INC mode]

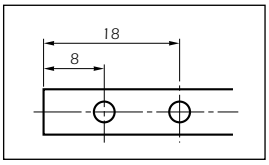
Zero approach machining can be repeated at a preset interval without error. Since the counter keeps the total displacement in the absolute coordinate system, the error is automatically compensated for at each tool position.

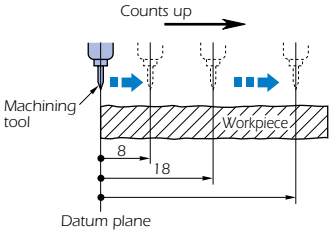




Zero approach machining [ABS mode]

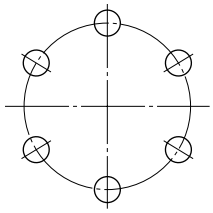
In milling, the tool can be positioned with the following method: first preset the distance from the current tool position to the machining position, then feed the table until the counter value reads zero. This method of machining is called "zero approach machining". Since this method maintains consistency with the drawing, effective machining operations can be made error-free. (There are two zero approach machining modes: incremental zero approach mode and absolute zero approach mode.)





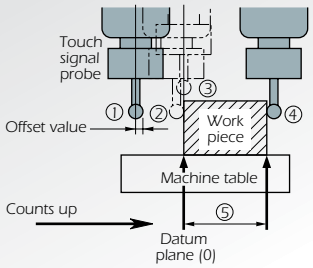
Bolt-hole circle machining

In milling, the drilling positions along the circumference of the base circle in the absolute zero approach mode can be easily displayed by entering the center coordinates, diameter, and number of divisions of the base circle.



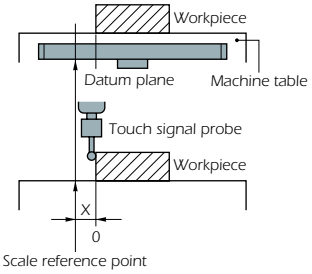
Touch-signal probe

The optional touch-signal probe makes it easy to perform such operations as datum point setting (detecting the workpiece edge and setting the counter display to zero), workpiece centering, and dimensional measurement (detecting the workpiece end point and holding the counter display).



SET Scale reference point setting

The linear scale has scale reference points at 50mm intervals. When one of the points is detected, the linear scale issues a signal to hold/restart counting. If the distance from a scale reference point to the machine origin is registered as the offset value, it will be retained even when the power is off (hold function). When the power is turned on, the machine origin or machining datum can be easily recalled (set function).



FOR SURFACE GRINDERS

+ Addition/subtraction

A value can be added to/subtracted from the display value by entering the value with the numeric keys.

FOR EDM

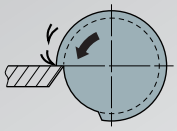
MAX/MIN Maximum/minimum value hold

The counter's display values fluctuate in processes as electrical discharge machining, during which the electrode volume is increased or decreased. The maximum/minimum value hold function allows the counter to hold maximum or minimum values, thus allowing more precise controls of the machining position.

FOR LATHES

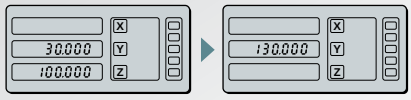
DIA Diameter display

The doubled scale displacement can be displayed. This convenient feature can be used to display the diameter of a workpiece that results in a lathe cutting operation.



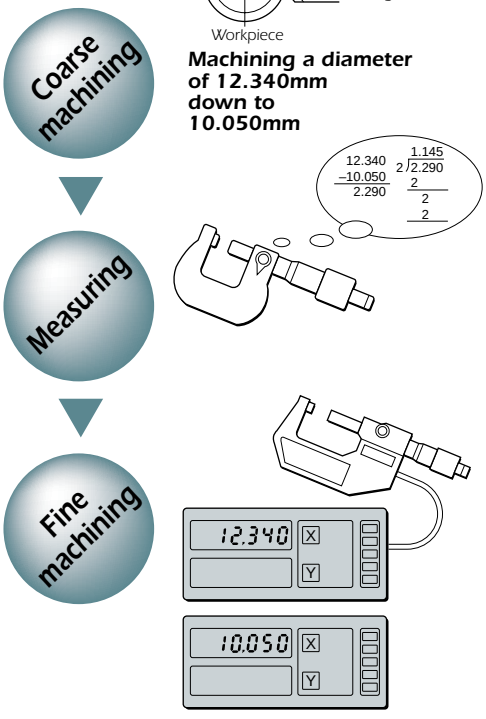
Z1+Z2 Addition of 2-scale data

The sum of the displayed values of two axes can be displayed. If a machine has two feed components, fine feed and coarse feed, each with its own scale, this function can be used to sum the two feed values.



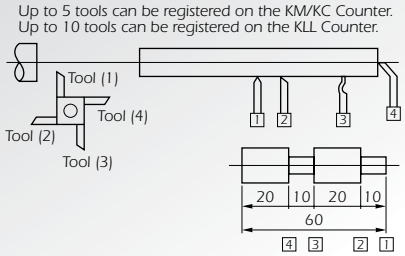
Direct data entry with Digimatic gage

A Mitutoyo SPC gage, such as the Digimatic Micrometer, Digimatic Caliper, etc., can be connected to the counter (requires an optional connecting cable). Measurement data from the gage does not require data conversion. This function can be used in conjunction with the diameter display function to greatly improve turning efficiency.



TOOL Cutting tool selection

Multiple absolute and incremental coordinates can be set for an axis. If individual cutting tools installed on a lathe are assigned dedicated coordinates, the tools can be used whenever necessary by simply selecting the tool, without resetting the machining datum point each time.



Coordinate data copy

Coordinates for cutting tools on a lathe can be set by copying the coordinate data (display values, datum points, and preset values) from one tool to another.

Conventional method

(1) Measure the diameter (12.340mm).
(2) Subtract the desired dimension from the measured value.
(3) Halve the difference (2.290mm).
(4) Feed the cutter by 1.145mm.

With KM/KC Counter

(1) Diameter of 12.340mm is automatically preset. (Press the appropriate button on the counter or Digimatic micrometer.)
(2) Feed the cutter until the counter displays the target dimension (10.050mm). (The diameter calculation function has been activated.)

Four groups of one-touch macro keys

For milling machine	For lathe (1)	For lathe (2)	For grinding machine
Switch absolute/incremental coordinate	Switch absolute/incremental coordinate	Switch absolute/incremental coordinate	Switch absolute/incremental coordinate
Select coordinates (0 to 5)	Select Tool 1	Select coordinates (0 to 5)	Select coordinates (0 to 5)
Zero approach machining [ABS mode]	Select Tool 2	Coordinate data transfer	Zero approach machining [ABS mode]
Bolt-hole circle machining	Select Tool 3	Zero approach machining [ABS mode]	Zero approach machining [INC mode]
Datum point setting with touch signal probe	Select Tool 4	Zero approach machining [INC mode]	Direct data entry with Digimatic gage
Centering with touch signal probe	Zero approach machining [ABS mode]	Direct data entry with Digimatic gage	1/2 calculation
Datum point registration using scale reference point	Zero approach machining [INC mode]	Datum point registration using scale reference point	Addition/subtraction
Datum point recall using scale reference point	Direct data entry with Digimatic gage	Datum point recall using scale reference point	Datum point recall using scale reference point

SPECIAL FUNCTIONS

MACRO One-touch macro keys

Eight frequently used functions are registered to the touch keys (called "one-touch macro keys"). Each of these functions can easily be executed at a single touch. Four groups of functions are provided for use with lathes, milling machines, grinding machines, etc. Only one of the groups, which should be selected so that it is suitable for application, is registered to one-touch operation keys at a time.
The one-touch operation keys can be easily customized, by replacing unnecessary functions with others, so that the counter can be operated as effectively as possible.

The milling functions are registered to the one-touch macro keys of the KM/KC Counter prior to shipment.

PROG. Part-program setting

The part program setting function is convenient in such cases where multiple workpieces of the same type must be machined. Sequences of machining operations, including presetting, zero setting, zero approach, etc., can be registered and executed as necessary. Up to 9 sequences (programs) can be regisitered by specifying operations with keys or by recording operations during machining (which is called the "teaching function").

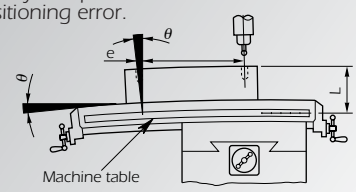
Programmable remote controller

The optional programmable remote controller (**09CAA384**) can be used to edit registered part programs by deleting or inserting machining operations.

ERROR COMPENSATION

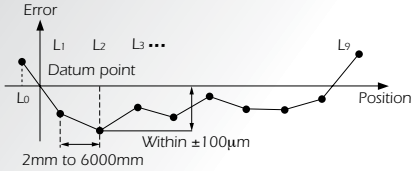
Linearity error compensation

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



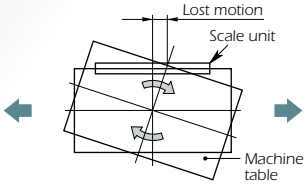
Pitch error compensation

The positioning error of a machine tool can be reduced by approximating the errors with a nine section graph. This function provides more accurate compensation than linearity error compensation.



Lost motion compensation

This function compensates for the forward and backward positioning errors that occur when the table is fed.



1234 Smoothing

Smoothing makes the display value easier to read when a minimum reading fluctuates due to machine vibration.

DATA OUTPUT

RS-232C OUTPUT RS-232C Interface Unit

The EIA standard RS-232C connector provides data transfer to/from a personal computer with an RS-232C Interface Unit. Not only can coordinate data be output from this connector, but it can also receive signals from the personal computer to perform zero setting, presetting, etc.

BCD OUTPUT BCD Code Out

Coordinate data can be converted into parallel BCD code and sent to the external printer, etc.

DIGIMATIC OUTPUT Digimatic Code Out Unit

The Digimatic Mini-processor DP-1HS can be connected for easy coordinate data printout.

GP-IB OUTPUT GP-IB Interface

Data can be transfered to/from an external device with a GP-IB Interface. Not only can coordinate data be output using this interface, but it can also be used to receive signals from an external device to perform zero setting, presetting, etc.

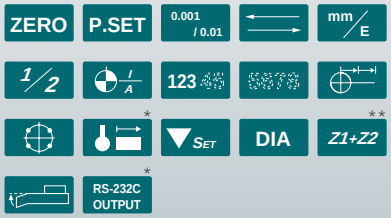
LIMIT OUTPUT Limit Signal Output

If tolerances or the upper and lower limits have been preset, the counter issues signals to turn on/off tolerancing lamps on the external device according to the scale movement. This function is usefull when scale units are mounted on the measuring machine to perform GO/NG judgment on workpieces or dimensions.

KL Counter

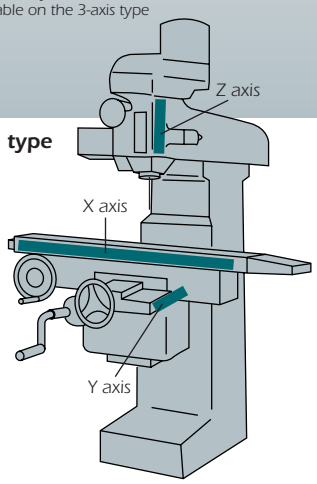
- Zero-setting and 1/2 calculation of the displayed value can be performed by just a touch of a key.
- Preset value can be easily entered using the numeric keys.
- A power voltage ranging from 100V AC to 240V AC can be used. No switching between voltages is required.
- The machine origin and the reference point for machining can be easily reproduced, using the scale reference point signal.
- Can be connected to a personal computer by installing an RS-232C Interface Unit (optional).

Functions included



*Optional accessory
**Only available on the 3-axis type

Photo: 2-axis type

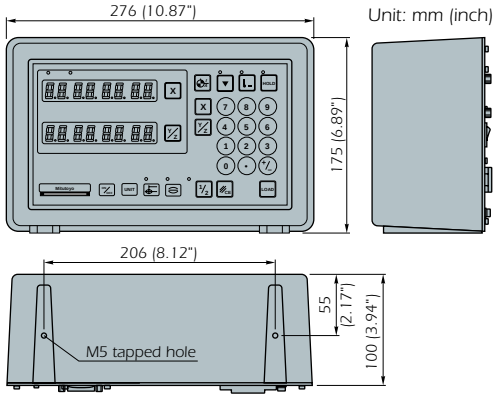


Standard Type with Ease of Use

Especially for Milling Machines

Dimensions

Unit: mm (inch)



Optional accessories

09CAA954	RS-232C Interface Unit
938140	Touch-signal probe (shank dia.: 20mm)
935094	Touch-signal probe (shank dia.: 32mm)
902329	Touch-signal probe (shank dia.: 1/2")

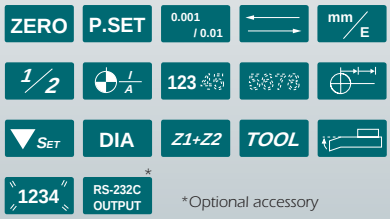
SPECIFICATIONS

Model		KL Counter		
Type		mm/inch		
Number of scale inputs		1-axis	2-axis	3-axis
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-161**	**174-163**	**174-165**
	120V AC	**174-161A**	**174-163A**	**174-165A**
	230/220V AC	**174-161D**	**174-163D**	**174-165D**
	240V AC (UK)	**174-161E**	**174-163E**	**174-165E**
	240V AC (Australia)	**174-161F**	**174-163F**	**174-165F**
Resolution		0.001mm/0.005mm/0.01mm/.0001"/.0005"/.001"		
Maximum counting digits		7 digits (with a negative [-] sign and a floating decimal point)		
Display		LED (green)		
Maximum response speed		100kHz (The maximum response speed of each model of the AT100 Series linear scales acceptable.)		
Power consumption		Approx. 25VA (at maximum)		
Power supply		100-240V AC, 50/60Hz		
Operation temperature		0°C to 40°C		
Dimensions (WxDxH)		276x177x100mm (10.87"x6.97"x3.94")		
Mass		2.4kg (5.28 lbs.)		
Standard accessories		Power cord (2m), grounding lead wire (4m), dust cover, user's manual, warranty		

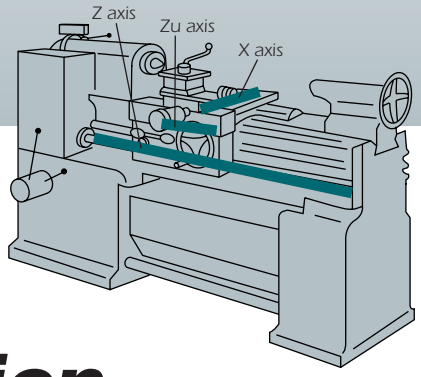
KLL Counter

- With its design based on the KL Counter, the KLL Counter is a dedicated lathe-machining counter with convenient functions.
- By the 2-scale data addition function, a total value of readings by the two scales is displayed as a displacement on the Z-axis; one scale is attached to the fine-feed table and the other to the coarse-feed table.
- Can store offset values of a maximum of 10 different kinds of tools in the memory. This eliminates tedious value inputs when changing tools.
- Can be connected to a personal computer by installing an RS-232C Interface Unit (optional).

Functions included



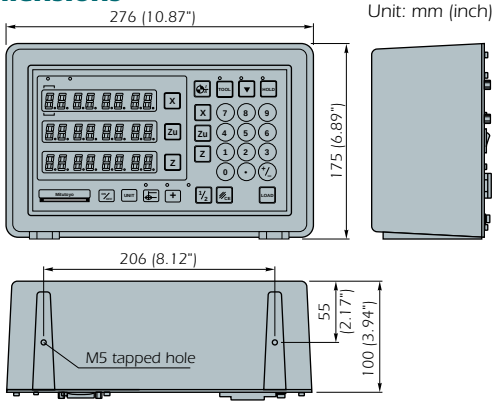
*Optional accessory



Special Version of KL Counter for Lathes

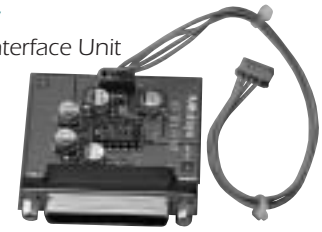
Dimensions

Unit: mm (inch)



Optional accessory

09CAA954 RS-232C Interface Unit



SPECIFICATIONS

Model		KLL Counter
Type		mm/inch
Number of scale inputs		3-axis
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-167B**
	120V AC	**174-167A**
	230/220V AC	**174-167D**
	240V AC (UK)	**174-167E**
	240V AC (Australia)	**174-167F**
Resolution	X-axis	0.001mm/0.002mm/0.01mm/.0001"/.0002"/.001" (in DIA mode)
	Zu-axis, Z-axis	0.001mm/0.005mm/0.01mm/.0001"/.005"/.001" (in RAD mode)
Maximum counting digits		7 digits (with a negative [-] sign and a floating decimal point)
Display		LED (green)
Maximum response speed		100kHz (The maximum response speed of each model of the AT100 Series linear scales acceptable.)
Power consumption		Approx. 25VA (at maximum)
Power supply		100V-240V AC, 50/60Hz
Operation temperature		0°C to 40°C
Dimensions (WxDxH)		276x177x100mm (10.87"x6.97"x3.94")
Mass		2.4kg (5.28 lbs.)
Standard accessories		Power cord (2m), grounding lead wire (4m), dust cover, user's manual, warranty

KM Counter†

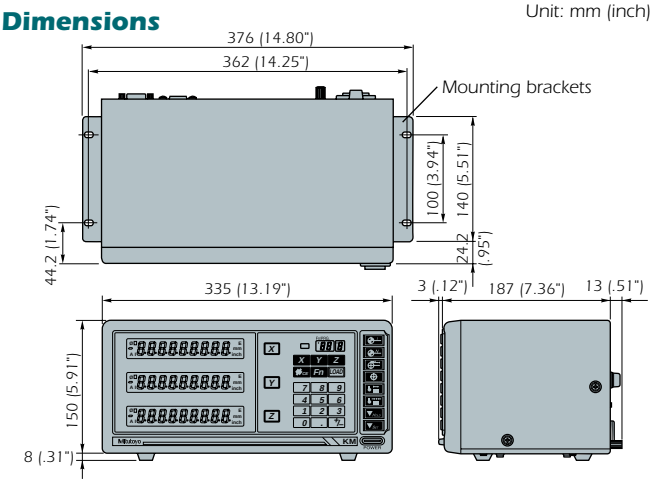
- A multi-functional counter equipped with various functions convenient for various machine tools such as lathes, milling machines, and grinding machines.
- One-touch operation of various functions using the macro keys.
- Preset value can be easily entered using the numeric keys.
- The machine origin and the reference point for machining can be easily reproduced, using the scale reference point signal.
- The optional Zero-set Remote Controller allows wireless zero-setting.
- Measuring procedures can be stored in the memory, using the part program setting function.

Photo: 2-axis type

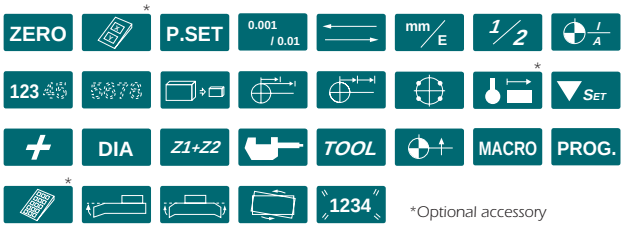
Multi-function Type

Dimensions

Unit: mm (inch)



Functions included



*Optional accessory

Optional accessories

09CAA335	Zero-set remote contoller
09CAA384	Programmable remote controller
938140	Touch-signal probe (shank dia.: 20mm)
935094	Touch-signal probe (shank dia.: 32mm)
902329	Touch-signal probe (shank dia.: 1/2")

SPECIFICATIONS

Model		KM Counter					
Type		mm/E (=1/25.4mm)			mm/inch		
Number of scale inputs		1-axis	2-axis	3-axis	1-axis	2-axis	3-axis
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-111**	**174-113**	**174-115**	**174-112**	**174-114**	**174-116**
	120V AC	**174-111A**	**174-113A**	**174-115A**	**174-112A**	**174-114A**	**174-116A**
	230/220V AC	**174-111D**	**174-113D**	**174-115D**	**174-112D**	**174-114D**	**174-116D**
	240V AC (UK)	**174-111E**	**174-113E**	**174-115E**	**174-112E**	**174-114E**	**174-116E**
	240V AC (Australia)	**174-111F**	**174-113F**	**174-115F**	**174-112F**	**174-114F**	**174-116F**
Resolution		0.0005mm/0.001mm/0.002mm/ 0.005mm/0.01mm			0.0005mm/0.001mm/0.002mm/0.005mm/0.01mm/ .00002"/.00005"/.0001"/.0002"/.0005"/.001"		
Maximum counting digits		8 digits (with a negative [-] sign and a floating decimal point)					
Display		Luminous fluorescence tube (green)					
Maximum response speed		100kHz (The maximum response speed of each model of the AT100 Series linear scales are acceptable.)					
Power consumption		Approx. 30VA (at maximum)					
Power supply		100-120V/200-240V AC, 50/60Hz					
Operation temperature		0°C to 40°C					
Dimensions (WxDxH)		335x187x158mm (13.19"x7.36"x6.22")					
Mass		3.3kg (7.26 lbs.)	3.4kg (7.48 lbs.)	3.5kg (7.7 lbs.)	3.3kg (7.26 lbs.)	3.4kg (7.48 lbs.)	3.5kg (7.7 lbs.)
Standard accessories		User's manual, power cord (2m), grounding lead wire (4m), spare fuze, macro key lables, dust cover, mounting brackets (1 set), warranty					

†KM Counter is not available in the US market.

KC Counter

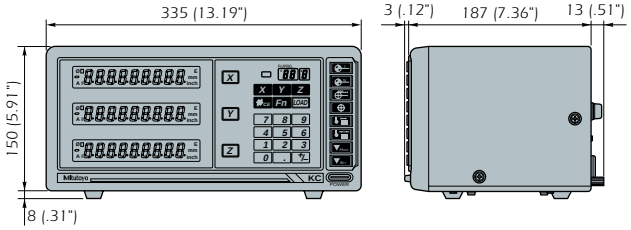
- Equipped with similar functions to that of the KM Counter, the KC Counter is a multi-functional counter to which various interfacing units can be attached for data output.
- Select an output specification from five types: RS-232C, GP-IB, BCD, Digimatic, and Limit Signal outputs.

Photo:
3-axis type

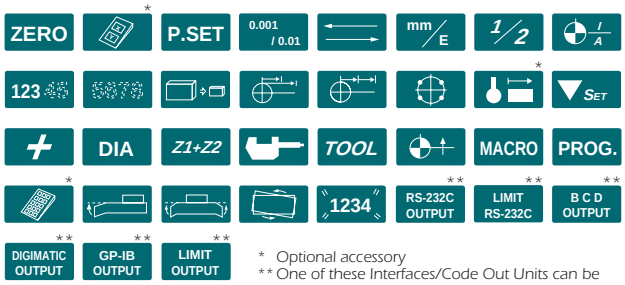
RS-232C/BCD/GP-IB/Digimatic/ Limit Signal Outputs Available.

Dimensions

Unit: mm (inch)



Functions included

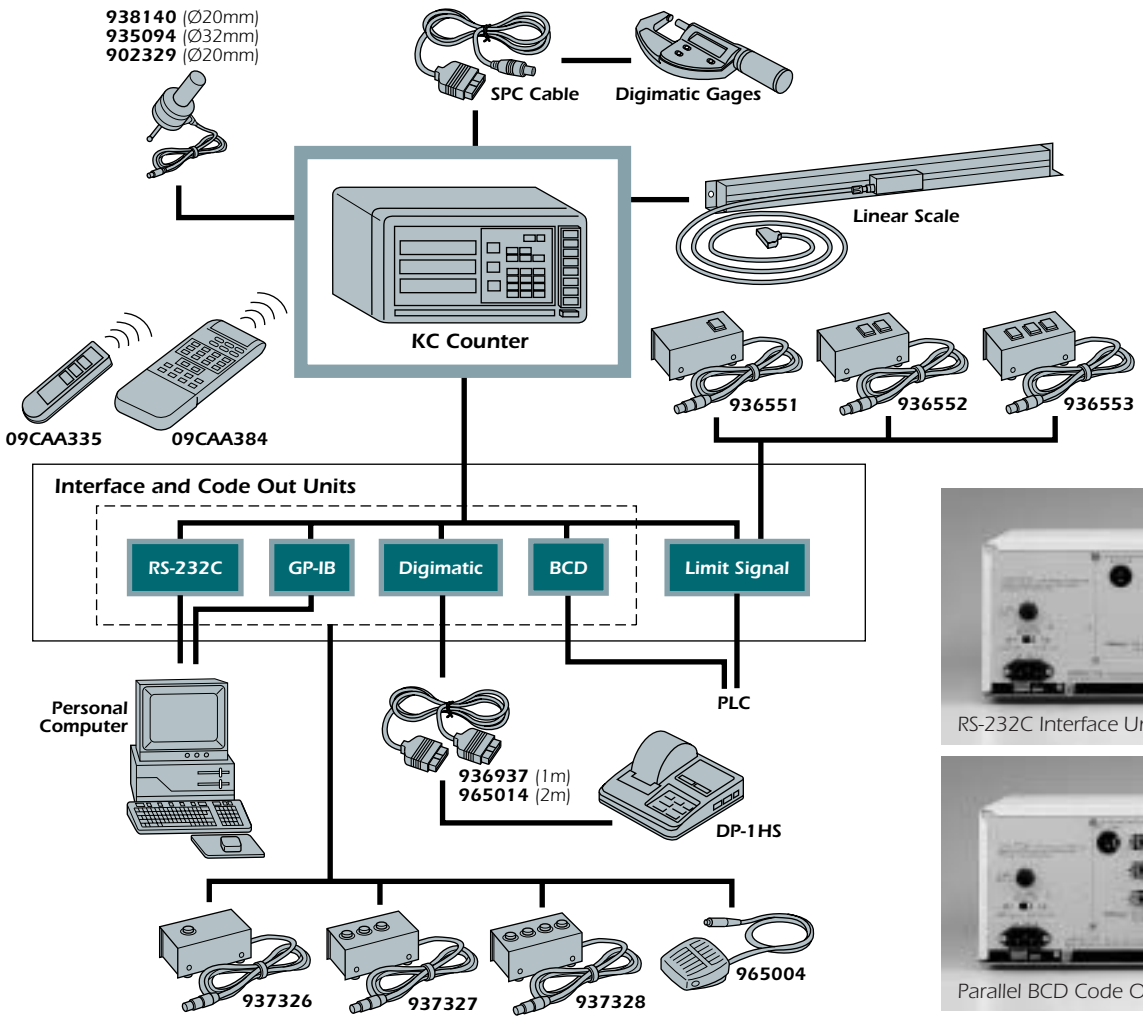


* Optional accessory
** One of these Interfaces/Code Out Units can be installed (optional).

SPECIFICATIONS

Model		KC Counter					
Type		mm/E (=1/25.4mm)			mm/inch		
Number of scale inputs		1-axis	2-axis	3-axis	1-axis	2-axis	3-axis
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-121-11***1 **174-121-13***2 **174-121-14***3 **174-121-15***4 **174-121-16***5	**174-123-11***1 **174-123-13***2 **174-123-14***3 **174-123-15***4 **174-123-16***5	**174-125-11***1 **174-125-13***2 **174-125-14***3 **174-125-15***4 **174-125-16***5	**174-122-11***1 **174-122-13***2 **174-122-14***3 **174-122-15***4 **174-122-16***5	**174-124-11***1 **174-124-13***2 **174-124-14***3 **174-124-15***4 **174-124-16***5	**174-126-11***1 **174-126-13***2 **174-126-14***3 **174-126-15***4 **174-126-16***5
	120V AC	**174-121A***6	**174-123A***6	**174-125A***6	**174-122A***6	**174-124A***6	**174-126A***6
	230/220V AC	**174-121D***6	**174-123D***6	**174-125D***6	**174-122D***6	**174-124D***6	**174-126D***6
	240V AC (UK)	**174-121E***6	**174-123E***6	**174-125E***6	**174-122E***6	**174-124E***6	**174-126E***6
	240V AC (Australia)	**174-121F***6	**174-123F***6	**174-125F***6	**174-122F***6	**174-124F***6	**174-126F***6
Resolution		0.0005mm/0.001mm/0.002mm/ 0.005mm/0.01mm			0.0005mm/0.001mm/0.002mm/0.005mm/0.01mm/ .00002"/.00005"/.0001"/.0002"/.0005"/.001"		
Maximum counting digits		8 digits (with a negative [-] sign and a floating decimal point)					
Display		Luminous fluorescence tube (green)					
Maximum response speed		100kHz (The maximum response speed of each model of the AT100 Series linear scales are acceptable.)					
Power consumption		Approx. 30VA (at maximum)					
Power supply		100-120V/200-240V AC, 50/60Hz					
Operation temperature		335x187x158mm (13.19"x7.36"x6.22")					
Dimensions (WxDxH)		0°C to 40°C					
Mass		3.5kg (7.7 lbs.)	3.6kg (7.92 lbs.)	3.7kg (8.14 lbs.)	3.5kg (7.7 lbs.)	3.6kg (7.92 lbs.)	3.7kg (8.14 lbs.)
Standard accessories		User's manual, power cord (2m), grounding lead wire (4m), spare fuze, macro key lables, dust cover, mounting bracket (1 set), warranty					

*1 Provided with a parallel BCD Code Out Unit as standard
*2 Provided with an RS-232C Interface Unit as standard
*3 Provided with a GP-IB Interface as standard
*4 Provided with a Digimatic Code Out Unit as standard
*5 Provided with a Limit Signal Output Unit as standard
*6 Data output unit is optional.



Optional accessories

09CAA335	Zero-set remote contoller
09CAA384	Programmable remote controller
09CAA402	RS-232C Interface Unit
09CAA412	Parallel BCD Code Out Unit (1-axis)
09CAA424	Parallel BCD Code Out Unit (2-axis)
09CAA430	Parallel BCD Code Out Unit (3-axis)
09CAA462	Digimatic Code Out Unit
09CAA452	GP-IB Interface Unit
09CAA472	Limit Signal Output Unit
937326	External load box (1-axis)*
937327	External load box (2-axis)*
937328	External load box (3-axis)*
965004	External load foot switch (for all axes)*
936551	External zero-set box (1-axis)**
936552	External zero-set box (2-axis)**
936553	External zero-set box (3-axis)**
938140	Touch-signal probe (shank dia.: 20mm)
935094	Touch-signal probe (shank dia.: 32mm)
902329	Touch-signal probe (shank dia.: 1/2")
936937	SPC cable (1m) for connecting with DP-1HS***
965014	SPC cable (2m) for connecting with DP-1HS***
264-503	DP-1HS Digimatic Mini-processor (100V AC)***
264-503A	DP-1HS Digimatic Mini-processor (120V AC)***
264-503D	DP-1HS Digimatic Mini-processor (230V AC)***
264-503E	DP-1HS Digimatic Mini-processor (240V AC)***

*RS-232C Interface Unit, BCD Code Out Unit, Digimatic Code Out Unit, or GP-IB Interface Unit is required.
Limit Signal Output Unit (09CAA472**) is required.
***Digimatic Code Out Unit (**09CAA462**) is required.


RS-232C Interface Unit (**09CAA402**)


Parallel BCD Code Out Unit (**09CAA430**)


Digimatic Code Out Unit (**09CAA462**)


GP-IB Interface Unit (**09CAA452**)


Limit Signal Output Unit (**09CAA472**)

KS Counter

- A counter with basic functions. Suitable for reading displacement of measuring fixtures and an X-Y table.
- One-touch operation of Zero-setting and 1/2 calculation.
- Can be connected to a personal computer by installing an RS-232C Interface Unit. (1 or 2-axis type only.)

Functions included

ZERO · * · P.SET · 0.001 / 0.01 · mm/E · 1/2 · I/A · 123 · DIA · Z1+Z2 · 1234 · * RS-232C OUTPUT

*Optional accessory

Photo: 2-axis type

Basic Function Type for Measuring Equipment/ Surface Grinders

RS-232C Interface Unit (optional)

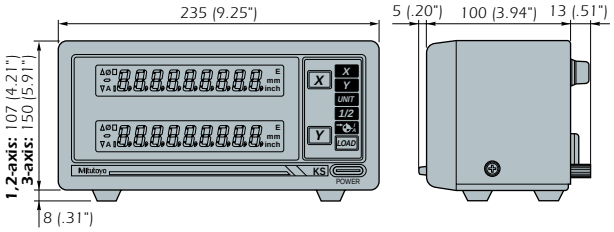
Optional accessories

09CAA335	Zero-set remote controller
09CAA762	RS-232C Interface Unit*
937326	External load box (1-axis)**
937327	External load box (2-axis)**
965004	External load foot switch (for all axes)**
936551	External zero-set box (1-axis)**
936552	External zero-set box (2-axis)**

*Only available on the 1 or 2-axis KS Counter.
RS-232C Interface Unit (09CAA762**) is required.

Dimensions

Unit: mm (inch)



SPECIFICATIONS

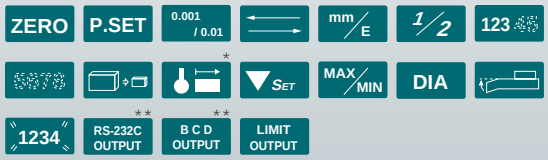
Model		KS Counter					
Type		mm/E (=1/25.4mm)			mm/inch		
Number of scale inputs		1-axis	2-axis	3-axis	1-axis	2-axis	3-axis
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-101-1**	**174-103-1**	**174-105**	**174-102-1**	**174-104-1**	***174-106***
	120V AC	**174-101-1A**	**174-103-1A**	**174-105A**	**174-102-1A**	**174-104-1A**	**174-106A**
	230/220V AC	**174-101-1D**	**174-103-1D**	**174-105D**	**174-102-1D**	**174-104-1D**	**174-106D**
	240V AC (UK)	**174-101-1E**	**174-103-1E**	**174-105E**	**174-102-1E**	**174-104-1E**	**174-106E**
	240V AC (Australia)	**174-101-1F**	**174-103-1F**	**174-105F**	**174-102-1F**	**174-104-1F**	**174-106F**
Resolution		0.0005mm/0.001mm/0.002mm/0.005mm			0.0005mm/0.001mm/0.002mm/0.005mm/ .00002"/.00005"/.0001"/.0002"/.0005"		
Maximum counting digits		8 digits (with a negative [-] sign and a floating decimal point)					
Display		Luminous fluorescence tube (green)					
Maximum response speed		100kHz (The maximum response speed of each model of the AT100 Series linear scales are acceptable.)					
Power consumption		Approx. 30VA (at maximum)					
Power supply		100-120V/200-240V AC, 50/60Hz					
Operation temperature		0°C to 40°C					
Dimensions (WxDxH)		235x100x115mm (9.25"x3.94"x4.53")	235x100x115mm (9.25"x3.94"x4.53")	235x100x158mm (9.25"x3.94"x6.22")	235x100x115mm (9.25"x3.94"x4.53")	235x100x115mm (9.25"x3.94"x4.53")	235x100x158mm (9.25"x3.94"x6.22")
Mass		1.9kg (4.18 lbs.)	2.0kg (4.18 lbs.)	2.2kg (4.84 lbs.)	1.9kg (4.18 lbs.)	2.0kg (4.18 lbs.)	2.2kg (4.84 lbs.)
Standard accessories		User's manual, power cord (2m), grounding lead wire (4m), spare fuze, dust cover, mounting bracket (1 set), warranty					

KLD Counter

- A 1-axis counter dedicated to sending signals when a linear scale displacement value and a preset limit value coincide.
- Three types of limit settings are available: 2 steps, 4 steps, and 8 steps.
- For controlling a vertical position of an EDM or a grinding machine.
- Can be connected to a personal computer or a sequencer by installing an RS-232C Interface Unit or a BCD Code Out unit. (Both interface units are optional accessories.)

Photo: 4-step limit setting type

Functions included



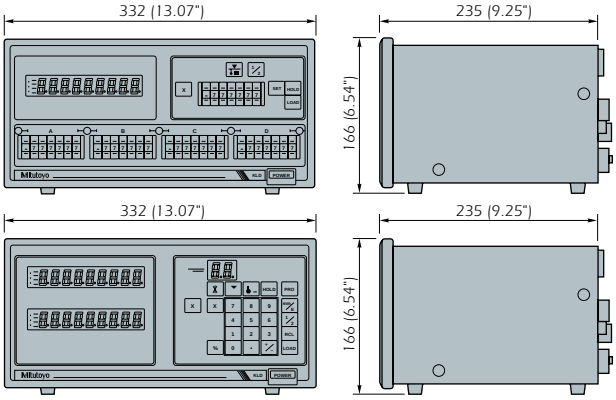
*Optional accessory
**Either of these units can be installed (optional).

With Limit Signal Outputs

Photo: 8-step limit setting type

Dimensions

Unit: mm (inch)



Optional accessories

907569	RS-232C Interface Unit
907570	BCD Code Out Unit
965004	External load foot switch*
937326	External load box*
936551	External zero-set box
938140	Touch-signal probe (shank dia.: 20mm)
935094	Touch-signal probe (shank dia.: 32mm)
902329	Touch-signal probe (shank dia.: 1/2")

*RS-232C Interface Unit (**907569**) is required.

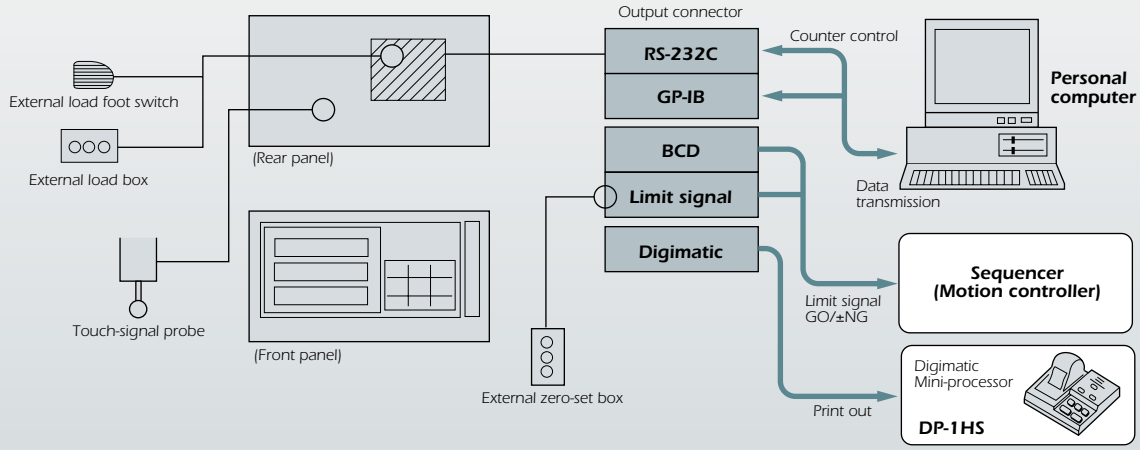
SPECIFICATIONS

Model		KLD Counter		
Type		mm/inch		
Number of scale inputs		1-axis		
Limit signal output		2-step	4-step	8-step
Order no. (Each order number suffix denotes the AC power cord type included.)	100V AC	**174-141**	**174-143**	**174-145**
	120V AC	**174-141A**	**174-143A**	**174-145A**
	230/220V AC	**174-141D**	**174-143D**	**174-145D**
	240V AC	**174-141E**	**174-143E**	**174-145E**
Resolution		0.0005mm/0.001mm/0.002mm/0.005mm/0.01mm/.00002"/.00005"/.0001"/.0002"/.0005"/.001"		
Maximum counting digits		9 digits (with a negative [-] sign and a floating decimal point)		
Display		Luminous fluorescence tube (green)		
Limit value setting method		Digital swithch	Digital swithch	Ten-keyboard
Maximum response speed		50kHz (60m/min. with the AT100 Series linear scales)		
Power consumption		Approx. 20VA (at maximum)		
Power supply		100-120V/200-240V AC, 50/60Hz		
Operation temperature		0°C to 40°C		
Dimensions (WxDxH)		332x165.5x235mm (13.07"x6.52"x9.25")		
Mass		4.5kg (9.9 lbs.)		
Standard accessories		User's manual, power cord (2m), grounding lead wire (4m), spare fuze, warranty		

Connection with External Devices

System diagram

Mitutoyo's Linear Scales accurately detect and display the displacement of machine tools or measuring equipment, and output the measurement data to a peripheral device such as PC or Sequencer via an interface. A variety of interfaces are available for various outputs such as RS-232C, BCD, GP-IB, limit signal, and Digimatic outputs. Each output board is optional.



RS-232C Interface Unit

- **The external load box, foot switch, or touch signal probe allows the measurement data in the RS-232C format from the RS-232C Interface Unit to be output to a peripheral device.**
- **The RS-232C Interface Unit enables measurement data output, as well as Zero-Setting, Preset, and Limit Setting of counter by commands from the computer.**
- **With the use of the RS-232C Interface Unit, the counter can be set to output measured data at a specified interval (Interval Mode).**

[KL/KLL/KC/KS/KLD Counter]

Specifications

(1) Receptacle used

- D-Sub 25-pin (female)
- Threads specified in mm

Note) A connecting cable or connector is not included in the RS-232C Interface Unit.

(2) Applicable plug

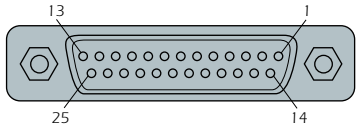
- D-Sub 25-pin (male)
- Threads specified in mm

(3) Communication specifications (conforming with EIA RS-232C)

Home position	DCE (Use a straight cable to connect to a personal computer.)
Communication method	Half-duplex, nonprocedural
Data transfer speed (Baud rate)	150*, 300, 600, 1200, 2400, 4800, 9600, 19200*bsp
Bit configuration	Start bit: 1 Data bit: 7 or 8* (ASCII code, upper-case characters) Parity bit: 1 (even, odd), 0 (none) Stop bit: 1 or 2*
Communication conditions	Can be set using the respective parameters.

*KLD Counter only

(4) Pin assignment



No. of pin	Signal	I/O	Remarks
1	FG	—	Frame grounding
2	TXD	Input	Data transfer
3	RXD	Outout	Data reception
4**	RTS	Input	Data demand
5	CTS	Output	Communication grant
6	DSR	Output	Data set ready
7	S.G	—	Signal grounding
8***	CD	Output	Carrier detect
9 to 19	—	—	Not used
20**	DTR	Input	Data terminal ready
21 to 25	—	—	Not used

**Not used on KL Counter and KLL Counter
***KLD Counter only

Data and Commands

(1) Data format

When the counter displays "12345.678".

X		+	1	2	3	4	5	.	6	7	8	CR	LF

When the counter displays "0.000".

X		+	0	0	0	0	0	.	0	0	0	CR	LF

- The output data format is fixed to either 7 or 8 digits, without zero-suppression. (7 digits only for KL and KLL Counters.)
- If data is output from multiple axes, a comma <,> is used as a delimiter.
  Example: X +12345.678, Y +90123.456 CR LF
- Data is output in the same unit that is used on the counter (mm or inch). However, the unit itself will not be output.
- When a touch signal probe is used with a KLD Counter, measurement data can be output only in the Hold Mode.

(2) Operation for data output

Counter display values can be output in the following ways. Be careful not to input more than one signal type simultaneously.

Trigger	Counter mode	Output axis	Applicable counters
Touch signal probe	Nonal mode	All axes	KL, KC, KLD
	HOLD mode	Specified axis only	
External load box	Nomal mode	Axes that are selected by the external load box	KC, KS, KLD
	HOLD mode	Axes that are specified for data hold and that are selected by the external load box	
Data request command:			KL, KLL, KC, KS, KLD
X CR LF		X axis	
Y CR LF		Y axis	
Z CR LF		Z axis	
A CR LF		All axes	
Interval output		All axes	KC

(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.

(4) Other commands

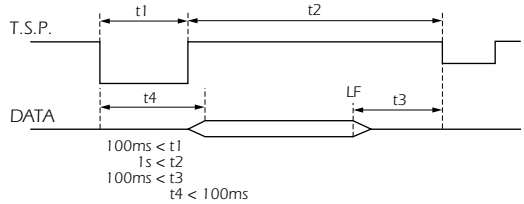
The counter can be controlled externally by executing the following commands through a computer, etc. Command codes must be entered in upper-case characters.

Function	Axis	Command code from PC	Applicable counters
Zero-setting Sets the counter display values to zero.	X axis Y axis Z axis All axes	RX CR LF RY CR LF RZ CR LF RA CR LF	KL, KLL, KC, KLD*
Error cancelation Has the same effect as the CANCEL key on the counter.	—	CO CR LF	KL, KLL, KC, KLD*
Preset Presets the counter display with the specified value.	X axis Y axis Z axis	C1X+00000000 CR LF C1Y+01234567 CR LF C1Z+99999999 CR LF	KC, KLD*
Key code By inputting the corresponding code, the counter can be controlled in the same way that the front panel key does.	—	KC Counter: C6 00000 CR LF └ 5-digit key code KLD Counter: K 00000 CR LF └ 5-digit key code	KC, KLD

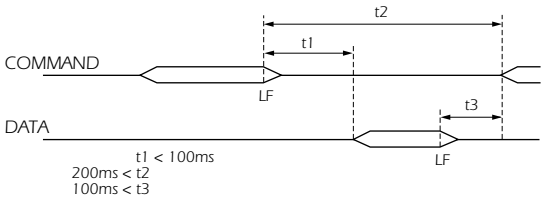
[KL/KLL Counter]

Timing chart

(1) Trigger Mode (Data output by signals from the touch signal probe)



(2) Trigger Mode (Data output by commands from the computer)

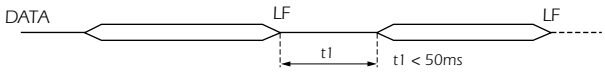


Note 1: Limits are set for t2 and t3 of KL and KLL Counters to describe accurate timing.
Note 2: KC and KS Counters hold counts at the same timing described above, also, to output count value data (X CR LF, etc.). The timing of a response to the Zero-setting command differs from the timing described above.

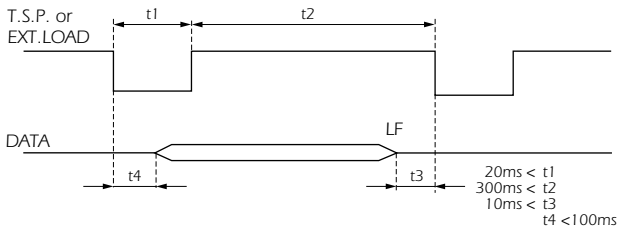
[KC/KS Counter]

Timing chart

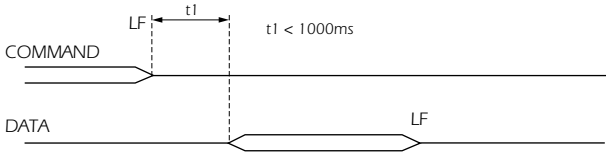
(1) Interval Mode (Automatic data output at a specified interval)



(2) Trigger Mode (Data output by a trigger signal from the touch signal probe or External Load Box)



(3) Trigger Mode (Data output by commands from the computer)



BCD Code Out Unit

The BCD Code Out Unit is an interface that performs conversion of measurement data to binary codes and the parallel output of these binary codes to an external device.

[KC Counter]

Connector

(1) Receptacle used

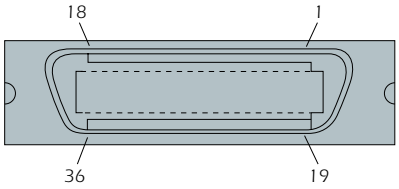
- Amphenol 36-pin (female) [57-40360-751 (DDK)]

(2) Applicable plug

- Amphenol 36-pin (male) [57-30360 (DDK) or equivalent]

Note: The connecting plug is not provided.

(3) Pin assignment



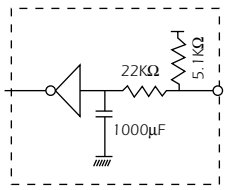
No. of pin	Signal	I/O
1	$1x10^0$	Output
2	$2x10^0$	Output
3	$4x10^0$	Output
4	$8x10^0$	Output
5	$1x10^1$	Output
6	$2x10^1$	Output
7	$4x10^1$	Output
8	$8x10^1$	Output
9	$1x10^2$	Output
10	$2x10^2$	Output
11	$4x10^2$	Output
12	$8x10^2$	Output
13	$1x10^3$	Output
14	$2x10^3$	Output
15	$4x10^3$	Output
16	$8x10^3$	Output
17	$1x10^4$	Output
18	$2x10^4$	Output

No. of pin	Signal	I/O
19	$4x10^4$	Output
20	$8x10^4$	Output
21	$1x10^5$	Output
22	$2x10^5$	Output
23	$4x10^5$	Output
24	$8x10^5$	Output
25	$1x10^6$	Output
26	$2x10^6$	Output
27	$4x10^6$	Output
28	$8x10^6$	Output
29	$\overline{\text{VALID}}$	Output
30	$\overline{\text{COMMAND}}$	Input
31	$\overline{\text{ACCEPT}}$	Input
32	$\overline{\text{READY}}$	Output
33	+5V*	Output
34	SIGN	Output
35	ALL-ZERO	Output
36	GND	Output

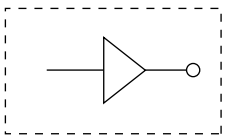
*Do not use this +5V current as an external power.

(4) I/O circuits

Input: Conforming to CMOS S4050



Output: Conforming to CMOS 74HC574



Operation

(1) Output of display values in the Interval Mode

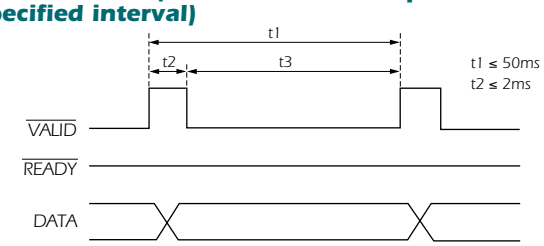
At the predetermined intervals counter display values will be output to the external device.

(2) Output of display values in the Trigger Mode

Trigger	Counter mode	Output axis
Touch signal probe	Nonal mode	All axes
	HOLD mode	Specified axis only
$\overline{\text{COMMAND}}$ signal from sequencer or external load box	Nomal mode	Axes that correspond to the command signal or that are specified by the ext. load box.
	HOLD mode	Axes that are specified for data hold and that are selected by the command signal or the ext. load box.

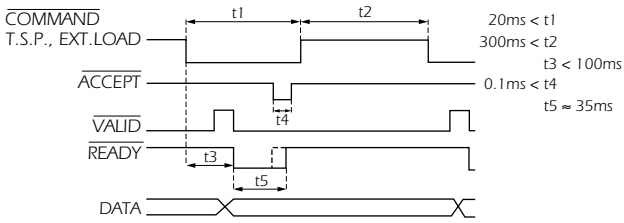
Timing chart

(1) Interval Mode (Automatic data output at a specified interval)



- Since the parallel data output is latched while $\overline{\text{VALID}}$ is in the LOW state, the data should be received during this interval (t3).
- The parallel data output remains latched at the rise or fall of $\overline{\text{VALID}}$. However, $\overline{\text{READY}}$ does not fall and remains at the HIGH state.

(2) Trigger Mode (Data output by a $\overline{\text{COMMAND}}$ signal input, trigger signal from the touch signal probe, or signal from External Load Box)



- If a $\overline{\text{COMMAND}}$ signal or a TSP (touch-signal probe) signal is input and t3 for readying data output has elapsed, $\overline{\text{READY}}$ output will remains LOW for a time interval of t5.
- It is also possible to receive data at a timing $\overline{\text{VALID}}$ falls.
- Input of an $\overline{\text{ACCEPT}}$ signal cancels the $\overline{\text{READY}}$ state within 35ms.

Note: Interval mode or trigger mode can be selected with the parameter setting (KC Counter).

Method of error output

(1) Error code output

If an error occurs in the error code output mode, the most significant 5 digits of the BCD output (Pin 9 to 24) and the sign (Pin 34) will be set to the HIGH state. Also, the error code will be output using the least significant 2 digits.

(2) High impedance state

If an error occurs in the high impedance mode, the output lines of all the BCD output digits (Pin 1 to 28) and the sign (Pin 34) will be set to the high impedance state.

(3) All-zero output

If an error occurs in the all-zero output mode, all the BCD output digits (Pin 1 to 28) will be set to the LOW state.
Note: The selection of error output modes can be set with the parameter setting (KC Counter).

[KLD Counter]

BCD-OUT connector

(1) Receptacle used

- Amphenol 36-pin (female) [57-40360-D39 (DDK)]

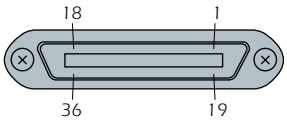
(2) Applicable plug

- Amphenol 36-pin (male) [57-30360-D39 (DDK) or equivalent]

Note: The connecting plug is not provided.

(3) Pin assignment

Note: The matching connector plug is not provided.



Pin	BCD Signal	I/O	Pin	BCD Signal	I/O	Pin	BCD Signal	I/O
1	$1x10^0$	Out	13	$1x10^3$	Out	25	$1x10^6$	Out
2	$2x10^0$	Out	14	$2x10^3$	Out	26	$2x10^6$	Out
3	$4x10^0$	Out	15	$4x10^3$	Out	27	$4x10^6$	Out
4	$8x10^0$	Out	16	$8x10^3$	Out	28	$8x10^6$	Out
5	$1x10^1$	Out	17	$1x10^4$	Out	29	$\overline{\text{VALID}}$	Out
6	$2x10^1$	Out	18	$2x10^4$	Out	30	$\overline{\text{COMMAND}}$	In
7	$4x10^1$	Out	19	$4x10^4$	Out	31	$\overline{\text{ACCEPT}}$	In
8	$8x10^1$	Out	20	$8x10^4$	Out	32	$\overline{\text{READY}}$	Out
9	$1x10^2$	Out	21	$1x10^5$	Out	33	+5V*1	Out
10	$2x10^2$	Out	22	$2x10^5$	Out	34	SIGN	Out
11	$4x10^2$	Out	23	$4x10^5$	Out	35	ALL-ZERO	Out
12	$8x10^2$	Out	24	$8x10^5$	Out	36	GND	Out

*1: Do not use this +5V current as an external power.
*2: The selection of the BCD signal or BIN signal can be set with the DIP switches on the codeout unit.

(4) Electric specification

Pin	Signal	Specifications
1 - 28	BCD code	CMOS 74HC373 output, positive logic
29	$\overline{\text{VALID}}$	TLP 521 (photo-coupler) output, negative logic
30	$\overline{\text{COMMAND}}$	CMOS 74HC14 input, negative logic
31	$\overline{\text{ACCEPT}}$	CMOS 74HC14 input, negative logic
32	$\overline{\text{READY}}$	TLP 521 (photo-coupler) output, negative logic
34	SIGN	CMOS 74HC373 output, HIGH level for "+"
35	ALL-ZERO	TLP 521 (photo-coupler) output, HIGH level for "all zero"

READY connector

(1) Receptacle used

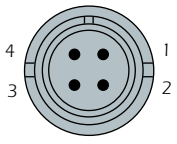
Female [RM-12BRD-4S (Hirose)]

(2) Applicable plug

Male [RM-12BPG-4P (Hirose)]

Note: The connecting plug is not provided.

(3) Pin assignment

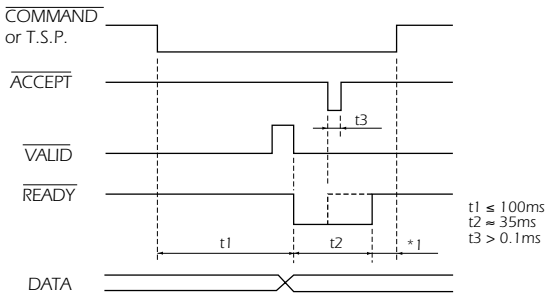


No. of pin	Signal
1	GND
2	$\overline{\text{READY}}$
3	$\overline{\text{VALID}}$
4	GND

- $\overline{\text{READY}}$ and $\overline{\text{VALID}}$ of the READY connector are connected to pins No.32 and No.29 of the BCD OUTPUT connector, respectively.

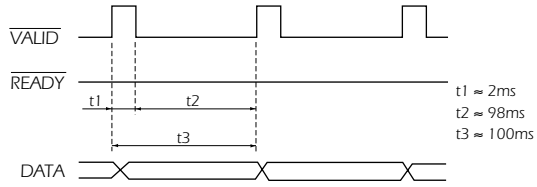
Timing chart

(1) Hold Mode (When using a touch probe signal or COMMAND signal input)



- If a $\overline{\text{COMMAND}}$ signal or a TSP signal is input and t1 for readying data output has elapsed, $\overline{\text{READY}}$ output will remains LOW for a time interval of t2. Since the data output is latched while $\overline{\text{READY}}$ is in the LOW state, the data should be received during this interval (t2). Input of an $\overline{\text{ACCEPT}}$ signal cancels the $\overline{\text{READY}}$ state within 35ms. It is also possible to receive data at a timing $\overline{\text{VALID}}$ falls.
- Display is on hold and output data are latched while a $\overline{\text{COMMAND}}$ signal or a touch signal is being input. When the data logging time is t2 or longer, input data during (t2)+(*1). If an error occurs, however, data is output according to the output format.

(2) Data Mode (When not using a touch signal or COMMAND signal input)



- Since the data output is latched while $\overline{\text{VALID}}$ is in the LOW state, the data should be received during this interval (t2).
- The data output remains latched at the rise or fall of $\overline{\text{VALID}}$. However, $\overline{\text{READY}}$ does not fall and remains at the HIGH state.

Method of error output

(1) Error code output

If an error occurs in the error code output mode, the most significant 5 digits of the BCD output (Pin 9 to 24) and the sign (Pin 34) will be set to the HIGH state. Also, the error code will be output using the least significant 2 digits.

(2) High impedance state

If an error occurs in the high impedance mode, the output lines of all the BCD output digits (Pin 1 to 28) and the sign (Pin 34) will be set to the high impedance state.

(3) All-zero output

If an error occurs in the all-zero output mode, all the BCD output digits (Pin 1 to 28) will be set to the LOW state.

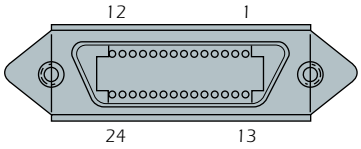
Note: The selection of error output modes can be set with the DIP switches on the counter.

GP-IB Interface

With the use of the GP-IB Interface, a maximum of 15 counters can be connected within one system. It is a standard interface that facilitates construction of a measuring system.

[KC Counter]

Pin assignment



Note: The matching connector plug and cable are not provided.

No. of pin	Signal	No. of pin	Signal
1	DI01	19	DI05
2	DI02	20	DI06
3	DI03	21	DI07
4	DI04	22	DI08
5	EOI	23	REN
6	DAV	24	GND
7	NRFD	25	GND
8	NDAC	26	GND
9	IFC	27	GND
10	SRQ	28	GND
11	ATN	29	GND
12	Sealed	30	GND

Specifications

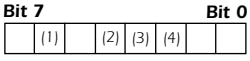
(1) Subset of GP-IB

SH1: Source handshake
AH1: Acceptor handshake
T5: Talker (without a secondary readdress)
L4: Listener (without a secondary readdress and listen only mode)
SR1: Service request
RL0: Does not use Remote local function.
DC1: Device clear
DT1: Device trigger
C0: Does not use Controller function.
PP0: Does not use Parallel poll function.

(2) Occurrence of SRQ

An SRQ interruption occurs in the following conditions:
i) When an external trigger signal is issued by a touch signal probe or by an external load box.
ii) When the counter displays an error code

SRQ status byte



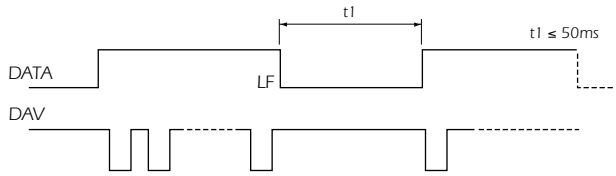
(1) 1: When SRQ has occured
0: When SRQ has not occured
(2) 1: When data is latched by an external trigger signal
0: When a serial poll or IFC has been received
(3) 1: Normal count
0: When a serial poll or IFC has been received
(4) 1: When an error has occured
0: When a serial poll or IFC has been received

(3) Others

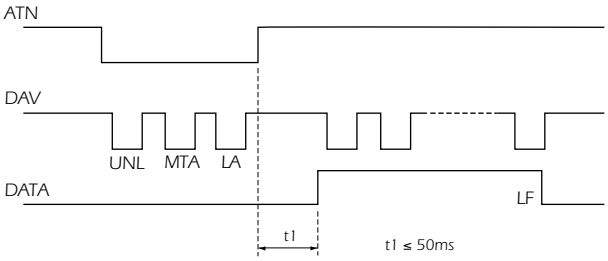
The following specifications follow the RS-232C Interface Unit (for KC Counter) specifications:
(1) Data format
(2) Operation for data output
(3) Error code output
(4) Other commands

Timing chart

(1) Interval Mode (Talk Only*)

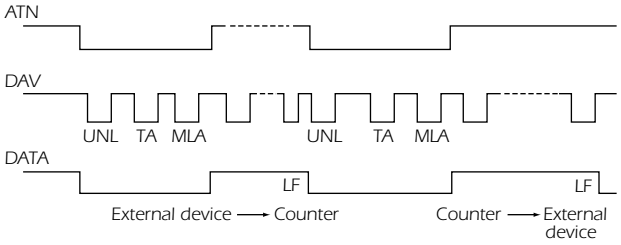


(2) Interval Mode (Normal Command*)

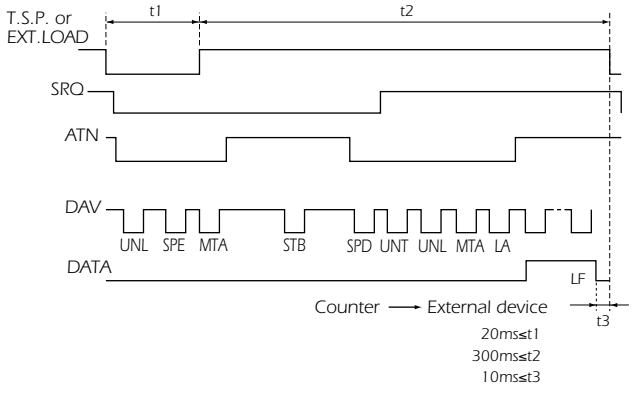


*Both "Talk Only" and "Normal Command" are methods to export data from the Interface. "Talk Only" simply export data without any control, while "Normal Command" controls communications (protocols.)

(3) Trigger Mode (Data output by a command from the personal computer)



(4) Trigger Mode (Data output by a trigger signal from the touch signal probe or External Load Box)



Limit Signal Output

An interface that outputs signals to an external device when the measurement value of the Linear Scale is the same as the preset limit value. Can be used for a GO/NG judgment and for an automatic control of a machine tool.

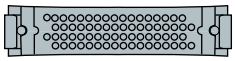
[KLD Counter]

Relay signal output connector (OUT-A)

This connector is used for outputting the relay signals. The limit signals will be output in the format of the relay's ON and OFF signals.

(1) Receptacle used

- MR-60RM (female) [Manufacturer: Honda Tsushin]



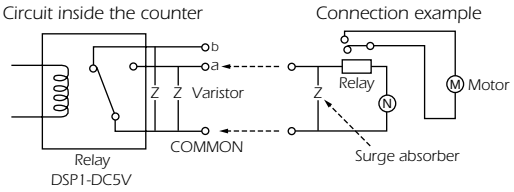
- When an error message is displayed, the alarm output will be set to ON. When this happens all relay outputs are set to ON.
- Limit signals numbered as many as the number of limit steps are existing, each uses a corresponding set of pins; 2-step type has up to limit signal 2, 4-step type has up to limit signal 4, 8-step type has up to limit signal 8. The other pins are not assigned.

Note: A connector plug (MR-60LF, Honda Tsushin) is provided as standard.

(2) Pin assignment (Example of a counter with 8 limit steps)

No. of pin	Signal	
1 - 3	Coincidence:	1= a contact, 2= common, 3= b contact
4 - 6	Alarm:	4= a contact, 5= common, 6= b contact
7 - 9	Limit signal 0:	7= a contact, 8= common, 9= b contact
10 - 12	Limit signal 1:	10= a contact, 11= common, 12= b contact
13 - 15	Limit signal 2:	13= a contact, 14= common, 15= b contact
16 - 18	Limit signal 3:	16= a contact, 17= common, 18= b contact
19 - 21	Limit signal 4:	19= a contact, 20= common, 21= b contact
22 - 24	Limit signal 5:	22= a contact, 23= common, 24= b contact
25 - 27	Limit signal 6:	25= a contact, 26= common, 27= b contact
28 - 30	Limit signal 7:	28= a contact, 29= common, 30= b contact
31 - 33	Limit signal 8:	31= a contact, 32= common, 33= b contact
34 - 60	Not connected	

Notes on the connection of relay signal output



Do not use the limit signal output through the relay of the KLD Counter to directly control other devices such as motors. Always route the relay output through another relay at the external device side, as shown in the diagram above. Although the relay contact circuit of the counter has varistors (threshold voltage: 300V), provide a surge absorber on the external device to be connected, which may generate surge current. For example, a varistor is recommended for an AC circuit, and an appropriate diode is recommended for a DC circuit.

Capacity of relay contact inside the counter
5V - 30V AC, 10mA - 500mA
5V - 30V DC, 10mA - 500mA

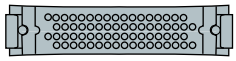
Select an external control device which does not exceed the contact capacity described above.

Photocoupler signal output connector (OUT-B)

This connector is used for outputting the photocoupler signals, which use the same logic as the relay signals.

(1) Receptacle used

- MR-50RM (female) [Manufacturer: Honda Tsushin]



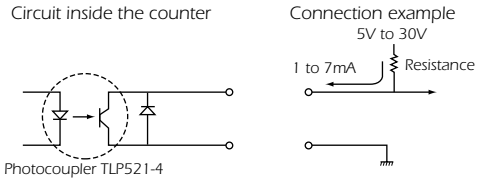
- When an error occurs, the alarm output will be set to ON.

Note: A connector plug (MR-50LF, Honda Tsushin) is provided as standard.

(2) Pin assignment (Example of a counter with 8 limit steps)

No. of pin	Signal	
1 - 2	Limit signal 0:	1= emitter, 2= collector
3 - 4	Limit signal 1:	3= emitter, 4= collector
5 - 6	Limit signal 2:	5= emitter, 6= collector
7 - 8	Limit signal 3:	7= emitter, 8= collector
9 - 10	Limit signal 4:	9= emitter, 10= collector
11 - 12	Limit signal 5:	11= emitter, 12= collector
13 - 14	Limit signal 6:	13= emitter, 14= collector
15 - 16	Limit signal 7:	15= emitter, 16= collector
17 - 18	Limit signal 8:	17= emitter, 18= collector
19 - 46	Not connected	
47 - 48	Coincidence:	47= emitter, 48= collector
49 - 50	Alarm:	49= emitter, 50= collector

Notes on the connection of photocoupler output



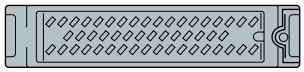
Recommended power supply to the transistor
5V - 30V, 1mA - 7mA

[KC Counter]

Pin assignment

(1) Receptacle used

- MR-50RMD2 (female) [Manufacturer: Honda Tsushin]



Note: A connector plug (MR-50M, Honda Tsushin) and case (MR-50LW, Honda Tsushin) are provided with the Limit Signal Output Unit.

(2) Pin assignment

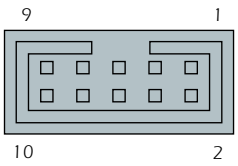
No. of pin	Signal	
1 - 2	Limit signal 0:	1= collector, 2= emitter
3 - 4	Limit signal 1:	3= collector, 4= emitter
5 - 6	Limit signal 2:	5= collector, 6= emitter
7 - 8	Limit signal 3:	7= collector, 8= emitter
9 - 10	Limit signal 4:	9= collector, 10= emitter
11 - 48	Not connected	
49 - 50	Alarm:	49= collector, 50= emitter

Digimatic Code Out Unit

By connecting the Digimatic Code Out Unit to Mitutoyo's Mini-processor DP-1HS, measurement data can be printed out easily.

[KC Counter]

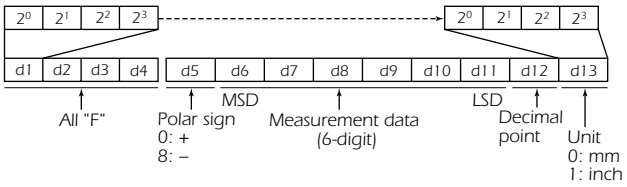
Pin assignment



No. of pin	Signal	I/O
1	GND	—
2	DATA	Output
3	CK	Output
4	RD	Output
5	REQ	Input
6 - 9	Not connected	—
10	GND	—

Data output format

- Digimatic data format consists of counting data of 13 hexadecimal digits (d1 to d13), each of which consists of 4 bits and is output serially, starting from the LSB (2^0) of d1 to the MSB (2^3) of d13.
- When an error occurs, "E" will be output for all the digits of d1 to d13.

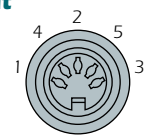


External load

Data on a desired axis or on all axes can be output to an external device by connecting the External Load Box to the KC Counter via an RS-232C Interface Unit, BCD Code Out Unit, GP-IB Interface Unit or Digimatic Code Out Unit.

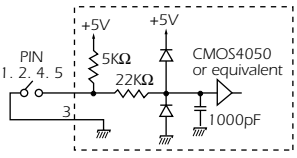
(1) Pin assignment

Applicable plug:
5-pin DIN connector



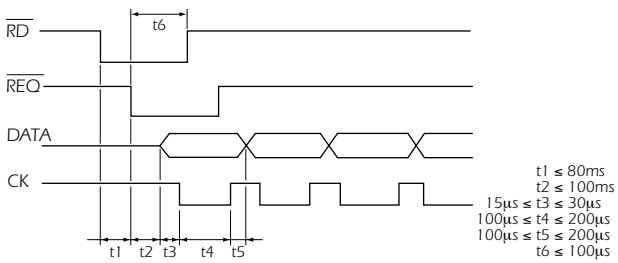
No. of pin	Signal
1	$\overline{XLOAD}$
2	$\overline{YLOAD}$
3	$\overline{GND}$
4	$\overline{ZLOAD}$
5	$\overline{ALL\ LOAD}$

(2) Inner circuit of External Load Box



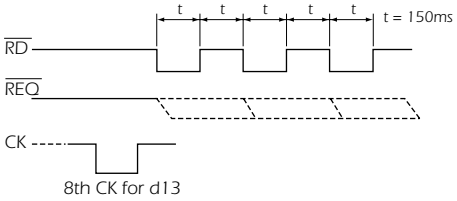
Timing chart

(1) Interval Mode



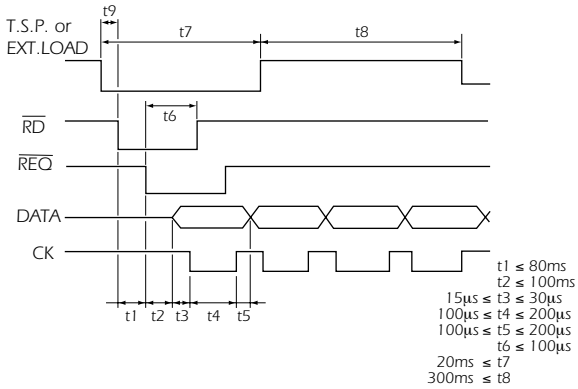
If an REQ signal is not input within 130ms after an RD signal, this interface continues to alternate between HIGH and LOW status of RD line at 150ms intervals, until an REQ signal is input.

(2) 2-axis or 3-axis output



After the output of 8th clock for d13, this interface continues to alternate between HIGH and LOW status of RD line at 150ms intervals, until an REQ signal is input (Timeout is set to 2s.)

(3) Input timing of a touch signal or External Load signal



Digimatic Mini-processor DP-1HS

264-503
(w/100V AC adapter)
264-503A
(w/120V AC adapter)
264-503D
(w/220V AC adapter)
264-503E
(w/220-240V AC adapter)

- When the DP-1HS is used with a two-axis or three-axis counter, pressing the DATA key on the DP-1HS will print out data of all axes. When a data printout of a specific axis is desired, input the data with the External Load Box (optional accessory) after specifying the axis for the data output.
- When connected to a KC Counter, the DP-1HS cannot perform a statistical data processing.
- When connected to a KC Counter, only the last six digits of the value displayed on the counter are printed out.

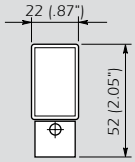
Optional accessories

936937	Connecting cable (1m)
965014	Connecting cable (2m)
965465	RS-232C cable for data output

AT100 Series Scale Units

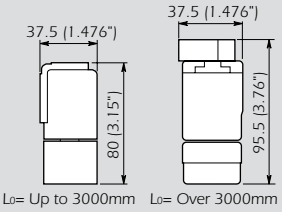
AT115

Type: Slim spar
MIN range: 100mm (4")
MAX range: 1,500mm (60")



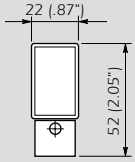
AT102

Type: Standard-size spar
MIN range: 100mm (4")
MAX range: 6,000mm (240")



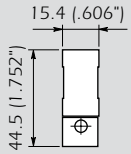
AT111

Type: Slim spar
MIN range: 100mm (4")
MAX range: 1,500mm (60")



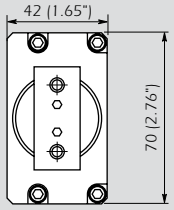
AT112

Type: Super slim spar
MIN range: 50mm (4")
MAX range: 1,020mm (40")



AT181

Type: Plunger
MIN range: 100mm (4")
MAX range: 600mm (24")



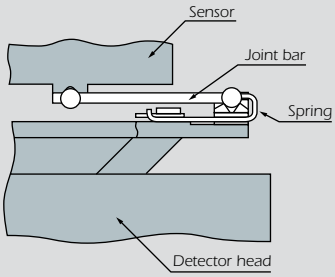
FEATURES

1. Low-priced model AT115

The low-priced version of Mitutoyo Linear Scale AT115 series are available. The mounting dimensions of all the AT115 models are the same as those of the AT111 series. Most suitable for mounting on a milling machine or an XY table.

2. Joint Structure of Detector

The ball joint structure is employed at the joint of the detector head and the slider (sensor unit) inside the scale. This structure prevents the slider movement from deviating from the normal moving directions when the detector head shifts to right and left, thus providing a normal scale reading and increasing flexibility in the scale installation. In addition, this structure is highly rigid and therefore has an excellent durability.



3. Water-proof Connector

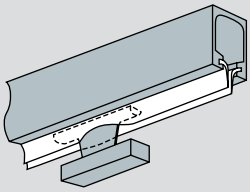
A waterproof/splash-proof connector is used to enable separation of the signal cable. Thus, an installation and maintenance of the Linear Scale can be easily performed. (The signal cable in AT115 cannot be separated.)

4. Conduit armored type signal cable

The signal cable is protected by the conduit system. Its exterior is made of stainless steel, which is free from rust and corrosion and withstands sustained use for many hours.

5. Unique rubber-lip openings

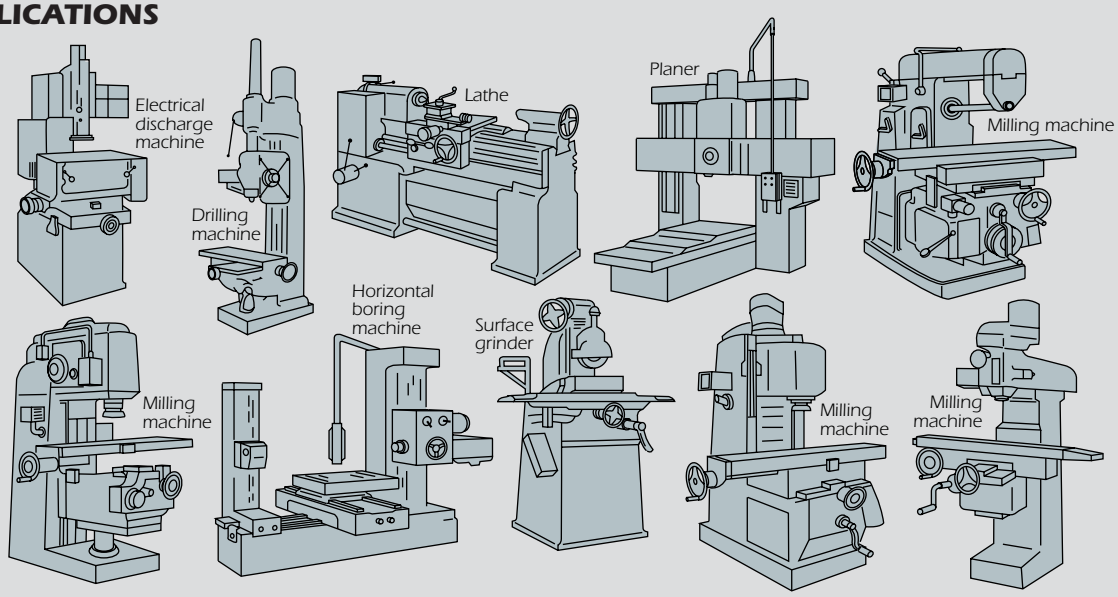
The rubber-lip openings are shaped like the bottom of a ship that plows the water.



6. Excellent splash- and dust-proof rubber lip structure

The rubber lips are made of a strong, special urethane, and wires are inserted in these lips to improve the splash-proofing and dust-proofing of the scale (AT102 only).

APPLICATIONS

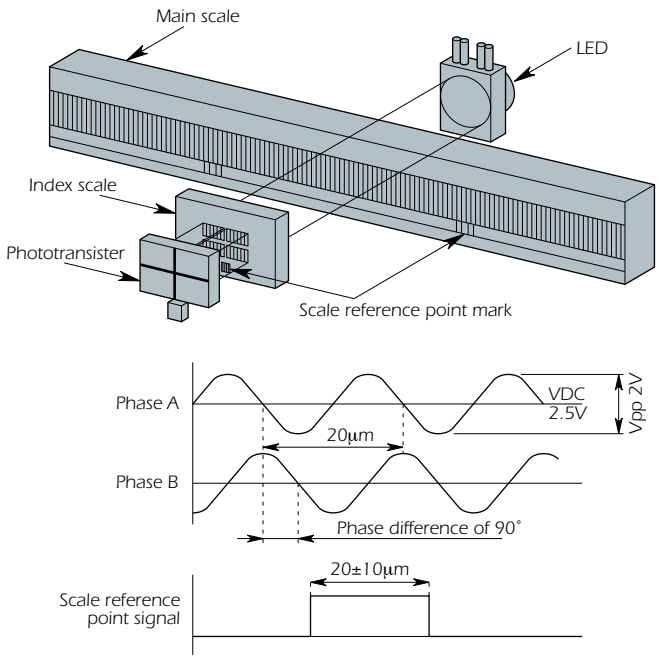


ORDER NUMBERS & SPECIFICATIONS OF SCALE UNITS

SPECIFICATIONS

Model	AT115/AT102/AT111/AT112	AT181
Detecting method	Photoelectric (transparent linear encoder)	
Light source	LED	
Receptor	Phototransistor	Photodiode
Output wave form	2-phase sine curves with a phase difference of 90°	
Scale grating pitch	20μm	
Resolution	0.0005mm - 0.01mm (depending upon the counter connected)	
Scale reference point	At every 50mm interval	Not provided
Coefficient of linear expansion	$(8\pm1)\cdot10^{-6}$/°C	
Power supply	5V±5% DC	
Current consumption	70mA at maximum	120mA at maximum
Sliding force	5N or less	6N or less
Dust/water protection	Conforming to IP-53	Conforming to IP-54
Operating temperature	0°C to 45°C	
Storage temperature	-20°C to 70°C	
Relative humidity	20% to 80% (no condensation)	

Detecting principle



The detector of each scale unit consists of a light source (LED) and a photoelectric device (phototransistor) which face each other with the main scale and index scale between them. When the main scale moves, relative to the index scale, the quantity of light that is transmitted through the gratings on the index scale varies with the same period as the grating pitch. This variation of light intensity is converted into electrical signals and output as two-phase (A and B) waves with a phase difference of 90°. The display unit divides these signals to determine the direction of the scale movement, and digitally displays the displacement of the scale.

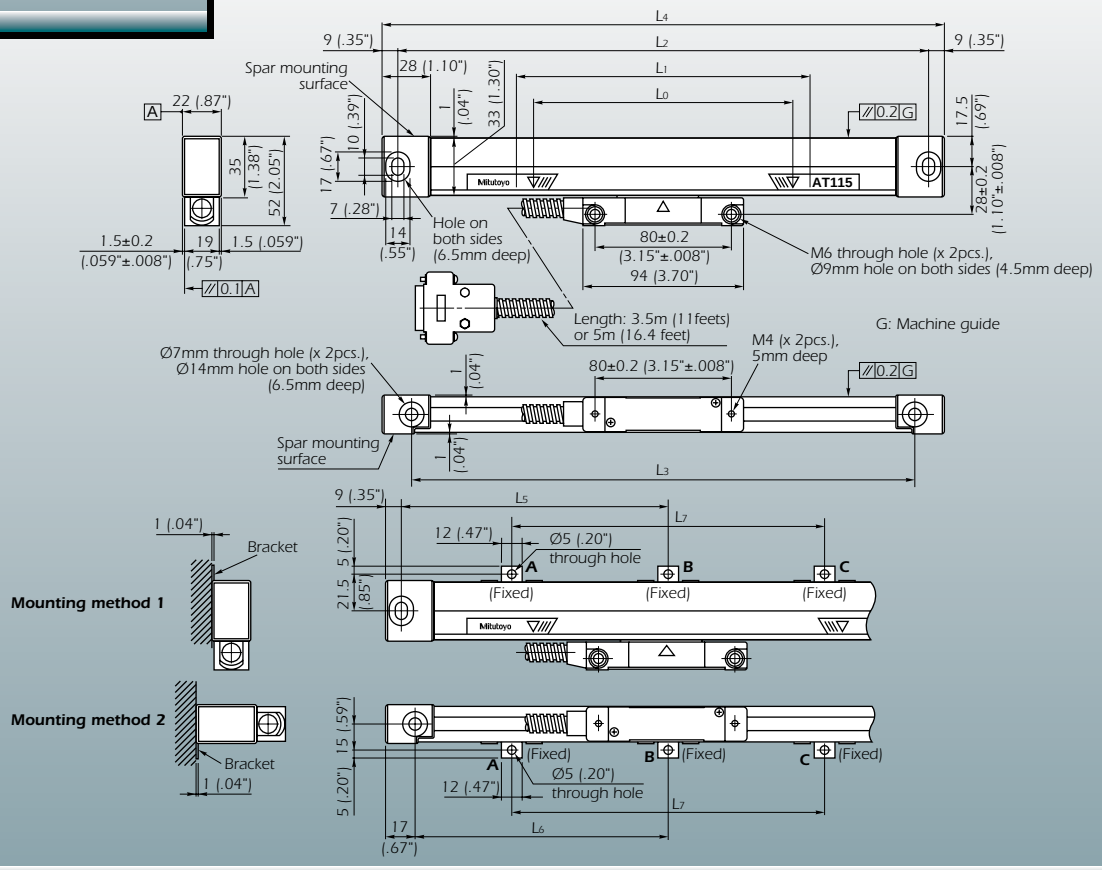
Spar type	Slim
Model	**AT115**
Accuracy at 20°C (μm) L_0: Effective range	STANDARD $5+5L_0/1000$
Maximum response speed	50m/min. (164ft/min.)
Order no. depending on L_0	
100mm (4")	**539-271**
150mm (6")	**539-272**
200mm (8")	**539-273**
250mm (10")	**539-274**
300mm (12")	**539-275**
350mm (14")	**539-276**
400mm (16")	**539-277**
450mm (18")	**539-278**
500mm (20")	**539-279**
600mm (24")	**539-281**
700mm (28")	**539-283**
750mm (30")	**539-284**
800mm (32")	**539-285**
900mm (36")	**539-286**
1000mm (40")	**539-287**
1100mm (44")	**539-288**
1200mm (48")	**539-289**
1300mm (52")	**539-290**
1400mm (56")	**539-291**
1500mm (60")	**539-292**
1600mm (64")	
1700mm (68")	
1800mm (72")	
2000mm (80")	
2200mm (88")	
2400mm (96")	
2500mm (100")	
2600mm (104")	
2800mm (112")	
3000mm (120")	
3250mm (130")	
3500mm (140")	
3750mm (150")	
4000mm (160")	
4250mm (170")	
4500mm (180")	
4750mm (190")	
5000mm (200")	
5250mm (210")	
5500mm (220")	
5750mm (230")	
6000mm (240")	

Standard-size		Extra-long	Slim	
AT102		**AT102**	**AT111**	
STANDARD	HIGH-ACCURACY	STANDARD	STANDARD	HIGH-ACCURACY
5+5L0/1000	3+3L0/1000	5+8L0/1000	5+5L0/1000	3+3L0/1000
72m/min. (236ft/min.)	72m/min. (236ft/min.)	50m/min. (164ft/min.)	72m/min. (236ft/min.)	72m/min. (236ft/min.)
539-111	**539-111-10**		**539-201**	**539-201-10**
539-112	**539-112-10**		**539-202**	**539-202-10**
539-113	**539-113-10**		**539-203**	**539-203-10**
539-114	**539-114-10**		**539-204**	**539-204-10**
539-115	**539-115-10**		**539-205**	**539-205-10**
539-116	**539-116-10**		**539-206**	**539-206-10**
539-117	**539-117-10**		**539-207**	**539-207-10**
539-118	**539-118-10**		**539-208**	**539-208-10**
539-119	**539-119-10**		**539-209**	**539-209-10**
539-121	**539-121-10**		**539-211**	**539-211-10**
539-123	**539-123-10**		**539-213**	**539-213-10**
539-124	**539-124-10**		**539-214**	**539-214-10**
539-125	**539-125-10**		**539-215**	**539-215-10**
539-126	**539-126-10**		**539-216**	**539-216-10**
539-127	**539-127-10**		**539-217**	**539-217-10**
539-128	**539-128-10**		**539-218**	**539-218-10**
539-129	**539-129-10**		**539-219**	**539-219-10**
539-130	**539-130-10**		**539-220**	**539-220-10**
539-131	**539-131-10**		**539-221**	**539-221-10**
539-132	**539-132-10**		**539-222**	**539-222-10**
539-133	**539-133-10**			
539-134	**539-134-10**			
539-135	**539-135-10**			
539-136	**539-136-10**			
539-137				
539-138				
539-139				
539-140				
539-141				
539-142				
		539-143		
		539-144		
		539-145		
		539-146		
		539-147		
		539-148		
		539-149		
		539-150		
		539-151		
		539-152		
		539-153		
		539-154		

Spar type	Super-slim	
Model	**AT112**	
Accuracy at 20°C (µm)	STANDARD	HIGH-ACCURACY
L0: Effective range	5+5L0/1000	3+3L0/1000
Maximum response speed	50m/min. (164ft/min.)	50m/min. (164ft/min.)
Order no. depending on L0		
50mm (1.5")	**539-251**	**539-251-10**
70mm (2.5")	**539-252**	**539-252-10**
120mm (4.5")	**539-253**	**539-253-10**
170mm (6.5")	**539-254**	**539-254-10**
220mm (8.5")	**539-255**	**539-255-10**
270mm (10.5")	**539-256**	**539-256-10**
320mm (12.5")	**539-257**	**539-257-10**
370mm (14.5")	**539-258**	**539-258-10**
420mm (16.5")	**539-259**	**539-259-10**
470mm (18.5")	**539-260**	**539-260-10**
520mm (20")	**539-261**	**539-261-10**
570mm (22")	**539-262**	**539-262-10**
620mm (24")	**539-263**	**539-263-10**
670mm (26")	**539-264**	**539-264-10**
720mm (28")	**539-265**	**539-265-10**
770mm (30")	**539-266**	**539-266-10**
820mm (32")	**539-267**	**539-267-10**
920mm (36")	**539-268**	**539-268-10**
1020mm (40")	**539-269**	**539-269-10**

Spar type	Plunger construction	
Model	**AT181**	
Accuracy at 20°C (µm)	STANDARD	HIGH-ACCURACY
L0: Effective range	5+5L0/1000	3+3L0/1000
Maximum response speed	50m/min. (164ft/min.)	50m/min. (164ft/min.)
Order no. depending on L0		
100mm (4")	**539-301**	**539-301-10**
150mm (6")	**539-302**	**539-302-10**
200mm (8")	**539-303**	**539-303-10**
250mm (10")	**539-304**	**539-304-10**
300mm (12")	**539-305**	**539-305-10**
350mm (14")	**539-306**	**539-306-10**
400mm (16")	**539-307**	**539-307-10**
450mm (18")	**539-308**	**539-308-10**
500mm (20")	**539-309**	**539-309-10**
550mm (22")	**539-310**	**539-310-10**
600mm (24")	**539-311**	**539-311-10**

AT115 Economy Type Slim Spars



Mounting dimensions

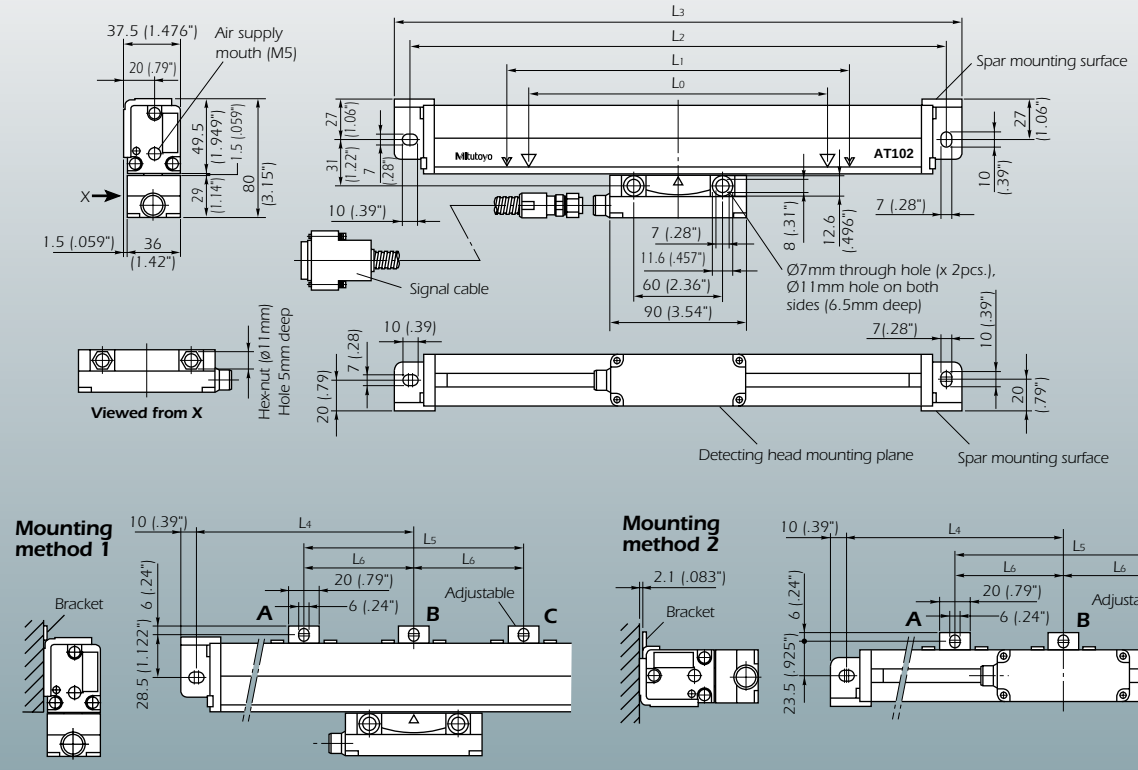
Effective range L_0 mm (inch)	Travel range L_1 mm (inch)	Mount interval L_2 mm (inch)	Mount interval L_3 mm (inch)	Overall length L_4 mm (inch)	Supporting bracket L_5 mm (inch)	Supporting bracket L_6 mm (inch)	Supporting bracket L_7 mm (inch)	Signal cable length m (feet)	Mass kg (lbs.)
100 (4")	120 (4.72")	258 (10.16")	242 (9.53")	276 (10.87")				3 (9.8)	1.0 (2.2)
150 (6")	170 (6.69")	308 (12.13")	292 (11.50")	326 (12.83")				3 (9.8)	1.0 (2.2)
200 (8")	220 (8.66")	358 (14.09")	342 (13.46")	376 (14.80")				3 (9.8)	1.0 (2.2)
250 (10")	270 (10.63")	408 (16.06")	392 (15.43")	426 (16.77")				3 (9.8)	1.1 (2.42)
300 (12")	330 (12.99")	468 (18.43")	452 (17.80")	486 (19.13")				3 (9.8)	1.1 (2.42)
350 (14")	380 (14.96")	518 (20.39")	502 (19.76")	536 (21.10")				3 (9.8)	1.1 (2.42)
400 (16")	430 (16.93")	568 (22.36")	552 (21.73")	586 (23.07")				3 (9.8)	1.2 (2.64)
450 (18")	480 (18.90")	618 (24.33")	602 (23.70")	636 (25.04")				3 (9.8)	1.2 (2.64)
500 (20")	540 (21.26")	678 (26.69")	662 (26.06")	696 (27.40")	339 (13.35")	331 (13.03")		3 (9.8)	1.2 (2.64)
600 (24")	640 (25.20")	778 (30.63")	762 (30.00")	796 (31.34")	389 (15.31")	381 (15.00")		3 (9.8)	1.3 (2.86)
700 (28")	740 (29.13")	878 (34.57")	862 (33.94")	896 (35.28")	439 (17.28")	431 (16.97")		3 (9.8)	1.3 (2.86)
750 (30")	780 (30.71")	918 (36.14")	902 (35.51")	936 (36.85")	459 (18.07")	451 (17.76")		3 (9.8)	1.3 (2.86)
800 (32")	840 (33.07")	978 (38.50")	962 (37.87")	996 (39.21")	489 (19.25")	481 (18.94")		3 (9.8)	1.4 (3.08)
900 (36")	940 (37.01")	1078 (42.44")	1062 (41.81")	1096 (43.15")	539 (21.22")	531 (20.91")		3 (9.8)	1.4 (3.08)
1000 (40")	1040 (40.94")	1178 (46.38")	1162 (45.75")	1196 (47.09")	589 (23.19")	581 (22.87")		5 (16.4)	1.8 (3.96)
1100 (44")	1140 (44.88")	1278 (50.31")	1262 (49.69")	1296 (51.02")			430 (16.93")	5 (16.4)	1.8 (3.96)
1200 (48")	1240 (48.82")	1378 (54.25")	1362 (53.62")	1396 (54.96")			460 (18.11")	5 (16.4)	1.9 (4.18)
1300 (52")	1340 (52.76")	1478 (58.19")	1462 (57.56")	1496 (58.90")			490 (19.29")	5 (16.4)	1.9 (4.18)
1400 (56")	1440 (56.69")	1578 (62.13")	1562 (61.50")	1596 (62.83")			530 (20.87")	5 (16.4)	2.0 (4.4)
1500 (60")	1540 (60.63")	1678 (66.06")	1662 (65.43")	1696 (66.77")			560 (22.05")	5 (16.4)	2.0 (4.4)

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.
	▪ Plain washer (4mm nominal)	2 pcs.
	▪ Plain washer (6mm nomina)	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.

Note) When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L_1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L_0).

AT102 Standard-size Spars



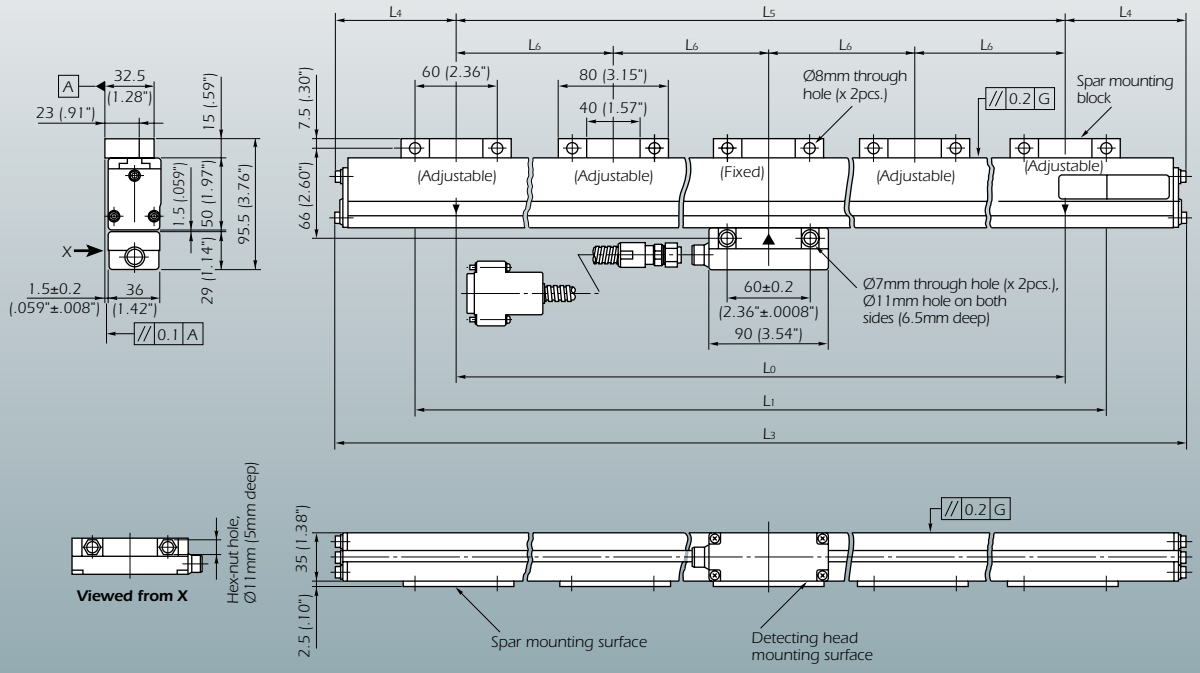
Mounting dimensions

Effective range L_0 mm (inch)	Travel range L_1 mm (inch)	Mount interval L_2 mm (inch)	Overall length L_3 mm (inch)	Supporting bracket L_4 mm (inch)	Supporting bracket L_5 mm (inch)	Supporting bracket L_6 mm (inch)	Signal cable length m (feet)	Mass kg (lbs.)
100 (4")	120 (4.72")	248 (9.76")	268 (10.55")				3 (9.8)	1.5 (3.30)
150 (6")	170 (6.69")	298 (11.73")	318 (12.52")				3 (9.8)	1.6 (3.52)
200 (8")	220 (8.66")	348 (13.70")	368 (14.49")				3 (9.8)	1.7 (3.74)
250 (10")	270 (10.63")	398 (15.67")	418 (16.46")				3 (9.8)	1.8 (3.96)
300 (12")	330 (12.99")	458 (18.03")	478 (18.82")				3 (9.8)	1.9 (4.18)
350 (14")	380 (14.96")	508 (20.00")	528 (20.79")				3 (9.8)	2.0 (4.40)
400 (16")	430 (16.93")	558 (21.97")	578 (22.76")				3 (9.8)	2.1 (4.62)
450 (18")	480 (18.90")	608 (23.94")	628 (24.72")				3 (9.8)	2.2 (4.84)
500 (20")	540 (21.26")	668 (26.30")	688 (27.09")				3 (9.8)	2.3 (5.06)
600 (24")	650 (25.59")	778 (30.63")	798 (31.42")				3 (9.8)	2.6 (5.72)
700 (28")	760 (29.92")	888 (34.96")	908 (35.75")				3 (9.8)	2.8 (6.16)
750 (30")	810 (31.89")	938 (36.93")	958 (37.72")				3 (9.8)	2.9 (6.38)
800 (32")	860 (33.86")	988 (38.90")	1008 (39.69")				3 (9.8)	3.0 (6.60)
900 (36")	960 (37.79")	1088 (42.83")	1108 (43.62")				3 (9.8)	3.3 (7.26)
1000 (40")	1060 (41.73")	1188 (46.77")	1208 (47.56")	594 (23.39")			5 (16.4)	3.7 (8.14)
1100 (44")	1160 (45.67")	1288 (50.71")	1308 (51.50")	644 (25.35")			5 (16.4)	4.0 (8.80)
1200 (48")	1260 (49.60")	1388 (54.65")	1408 (55.43")	694 (27.32")			5 (16.4)	4.2 (9.24)
1300 (52")	1360 (53.54")	1488 (58.58")	1508 (59.37")	744 (29.29")			5 (16.4)	4.4 (9.68)
1400 (56")	1460 (57.48")	1588 (62.52")	1608 (63.31")	794 (31.26")			5 (16.4)	4.6 (10.12)
1500 (60")	1560 (61.41")	1688 (66.46")	1708 (67.24")	844 (33.23")			5 (16.4)	4.8 (10.56)
1600 (64")	1690 (66.53")	1818 (71.57")	1838 (72.36")		610 (24.02")		5 (16.4)	5.1 (11.22)
1700 (68")	1790 (70.47")	1918 (75.51")	1938 (76.30")		650 (25.59")		5 (16.4)	5.3 (11.66)
1800 (72")	1890 (74.41")	2018 (79.45")	2038 (80.24")		670 (26.38")		5 (16.4)	5.5 (12.10)
2000 (80")	2100 (82.67")	2228 (87.72")	2248 (88.50")		740 (29.13")		5 (16.4)	6.0 (13.20)
2200 (88")	2300 (90.55")	2428 (95.59")	2448 (96.38")		800 (31.50")		5 (16.4)	6.4 (14.08)
2400 (96")	2500 (98.42")	2628 (103.46")	2648 (104.25")	1314 (51.73")	1300 (51.18")	650 (25.59")	7 (22.9)	7.1 (15.62)
2500 (100")	2600 (102.36")	2728 (107.40")	2748 (108.19")	1364 (53.70")	1340 (52.76")	670 (25.38")	7 (22.9)	7.3 (16.06)
2600 (104")	2700 (106.30")	2828 (111.34")	2848 (112.13")	1414 (55.67")	1400 (55.12")	700 (27.56")	7 (22.9)	7.5 (16.50)
2800 (112")	2900 (114.17")	3028 (119.21")	3048 (120.00")	1514 (59.60")	1500 (59.06")	750 (29.53")	7 (22.9)	7.9 (17.38)
3000 (120")	3100 (118.11")	3228 (127.09")	3248 (127.87")	1614 (63.99")	1600 (62.99")	800 (31.50")	7 (22.9)	8.3 (18.26)

Note) When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L_1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L_0).

Mounting parts for the AT102 Series scale units (standard accessories) are shown on the next page.

AT102 Extra-long Spars



Mounting dimensions

Effective range L0 mm (inch)	Travel range L1 mm (inch)	Overall length L3 mm (inch)	Mounting block				Signal cable length m (feet)	Mass kg (lbs.)
			Blocks included	L4 mm (inch)	L5 mm (inch)	L6 mm (inch)		
3250 (130")	3350 (131.88")	3470 (136.61")	5 pcs.	135 (5.32")	3200 (125.98")	800 (31.50")	10 (32.8)	10.8 (23.76)
3500 (140")	3600 (141.73")	3720 (146.46")	5 pcs.	160 (6.30")	3400 (133.86")	850 (33.46")	10 (32.8)	11.4 (25.08)
3750 (150")	3850 (151.57")	3970 (156.30")	5 pcs.	125 (4.92")	3720 (146.46")	930 (36.61")	10 (32.8)	12.0 (26.40)
4000 (160")	4100 (161.42")	4220 (166.14")	5 pcs.	110 (4.33")	4000 (157.48")	1000 (39.37")	10 (32.8)	12.6 (27.72)
4250 (170")	4350 (171.26")	4470 (175.98")	5 pcs.	135 (5.32")	4200 (165.35")	1050 (41.34")	10 (32.8)	13.2 (29.04)
4500 (180")	4600 (181.10")	4720 (185.83")	5 pcs.	160 (6.30")	4400 (173.23")	1100 (43.31")	10 (32.8)	13.8 (30.36)
4750 (190")	4850 (191.94")	4970 (195.67")	7 pcs.	85 (3.35")	4800 (188.98")	800 (31.50")	15 (49.2)	15.2 (33.44)
5000 (200")	5100 (200.78")	5220 (205.51")	7 pcs.	120 (4.72")	4980 (196.06")	830 (32.68")	15 (49.2)	15.8 (34.76)
5250 (210")	5350 (210.63")	5470 (215.35")	7 pcs.	125 (4.92")	5220 (205.51")	870 (34.25")	15 (49.2)	16.4 (36.08)
5500 (220")	5600 (220.47")	5720 (225.20")	7 pcs.	130 (5.12")	5460 (214.41")	910 (35.83")	15 (49.2)	17.0 (37.40)
5750 (230")	5850 (230.31")	5970 (235.24")	7 pcs.	135 (5.32")	5700 (224.41")	950 (37.40")	15 (49.2)	17.6 (38.72)
6000 (240")	6100 (240.16")	6220 (244.88")	7 pcs.	110 (4.33")	6000 (236.22")	1000 (39.37")	15 (49.2)	18.2 (40.04)

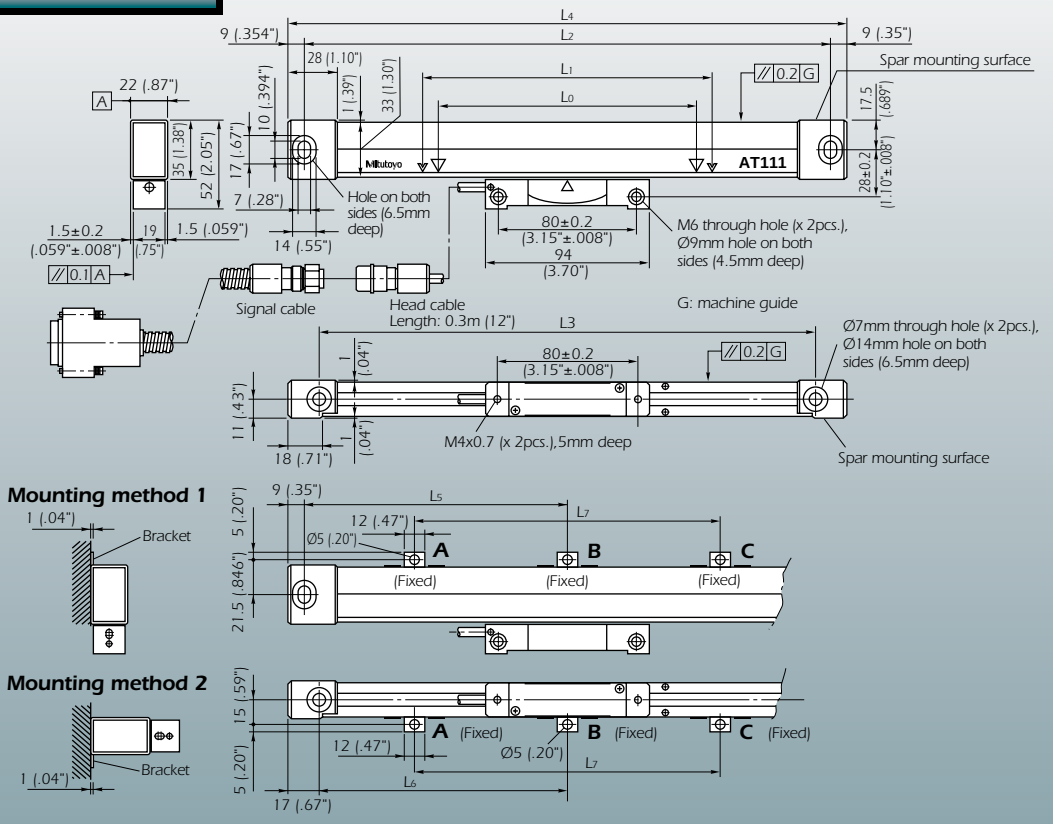
Note) *When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L0).*

Mounting parts (provided as standard)

Type of spar	Standard-size		Extra-long	
Effective range L0	100mm (4") - 3000mm (120")		3250mm (130") - 6000mm (240")	
Items included	▪ Hex-socket head screw (M6x1x40)	2 pcs.	▪ Hex-socket head screw (M6x1x40)	2 pcs.
	▪ Hex-socket head screw (M6x1x16)	2 pcs.	▪ Hex-socket head screw (M6x1x30)	14 pcs.
	▪ Hex-socket head screw (M4x0.7x8)	5 pcs.	▪ Hex-socket head screw (M4x0.7x8)	7 pcs.
	▪ Spring washer (6mm nominal)	2 pcs.	▪ Spring washer (6mm nominal)	14 pcs.
	▪ Plain washer (6mm nomina)	2 pcs.	▪ Plain washer (6mm nomina)	14 pcs.
	▪ Cable clip	5 pcs.	▪ Cable clip	7 pcs.
	▪ Spacers (0.3mm)	1 pc.	▪ Spacer (0.3mm)	1 pc.
	▪ Spacer (0.4mm)	1 pc.	▪ Spacer (0.4mm)	1 pc.
	▪ Spacer (0.5mm)	1 pc.	▪ Spacer (0.5mm)	1 pc.
	▪ Spacer (0.6mm)	1 pc.	▪ Spacer (0.6mm)	1 pc.

Remarks: *Dustproofing and splashproofing of the AT102 model scale units can be improved by supplying clean and dry air to the main spar.*
(Air pressure required: 50kPa, Air flow rate: 10 to 20 normal liters per minite)

AT111 Slim Spars



Mounting dimensions

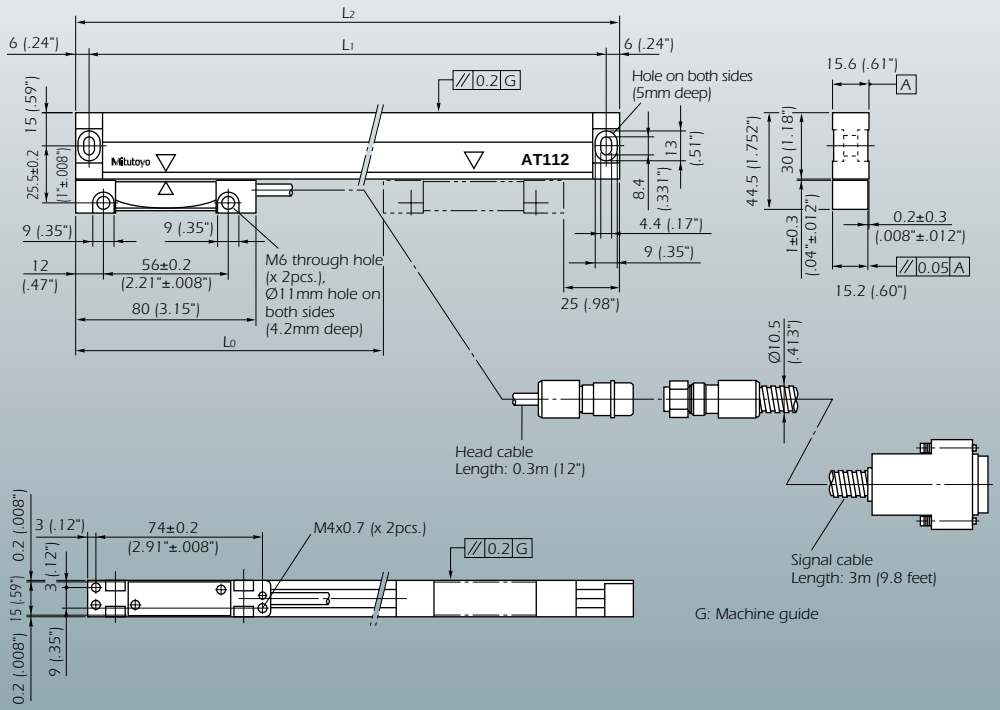
Effective range L_0 mm (inch)	Travel range L_1 mm (inch)	Mount interval L_2 mm (inch)	Mount interval L_3 mm (inch)	Overall length L_4 mm (inch)	Supporting bracket L_5 mm (inch)	Supporting bracket L_6 mm (inch)	Supporting bracket L_7 mm (inch)	Signal cable length m (feet)	Mass kg (lbs.)
100 (4")	120 (4.72")	258 (10.16")	242 (9.53")	276 (10.87")				3 (9.8)	1.0 (2.2)
150 (6")	170 (6.69")	308 (12.13")	292 (11.50")	326 (12.83")				3 (9.8)	1.0 (2.2)
200 (8")	220 (8.66")	358 (14.09")	342 (13.46")	376 (14.80")				3 (9.8)	1.0 (2.2)
250 (10")	270 (10.63")	408 (16.06")	392 (15.43")	426 (16.77")				3 (9.8)	1.1 (2.42)
300 (12")	330 (12.99")	468 (18.43")	452 (17.80")	486 (19.13")				3 (9.8)	1.1 (2.42)
350 (14")	380 (14.96")	518 (20.39")	502 (19.76")	536 (21.10")				3 (9.8)	1.1 (2.42)
400 (16")	430 (16.93")	568 (22.36")	552 (21.73")	586 (23.07")				3 (9.8)	1.2 (2.64)
450 (18")	480 (18.90")	618 (24.33")	602 (23.70")	636 (25.04")				3 (9.8)	1.2 (2.64)
500 (20")	540 (21.26")	678 (26.69")	662 (26.06")	696 (27.40")	339 (13.35")	331 (13.03")		3 (9.8)	1.2 (2.64)
600 (24")	640 (25.20")	778 (30.63")	762 (30.00")	796 (31.34")	389 (15.31")	381 (15.00")		3 (9.8)	1.3 (2.86)
700 (28")	740 (29.13")	878 (34.57")	862 (33.94")	896 (35.28")	439 (17.28")	431 (16.97")		3 (9.8)	1.3 (2.86)
750 (30")	780 (30.71")	918 (36.14")	902 (35.51")	936 (36.85")	459 (18.07")	451 (17.76")		3 (9.8)	1.3 (2.86)
800 (32")	840 (33.07")	978 (38.50")	962 (37.87")	996 (39.21")	489 (19.25")	481 (18.94")		3 (9.8)	1.4 (3.08)
900 (36")	940 (37.01")	1078 (42.44")	1062 (41.81")	1096 (43.15")	539 (21.22")	531 (20.91")		3 (9.8)	1.4 (3.08)
1000 (40")	1040 (40.94")	1178 (46.38")	1162 (45.75")	1196 (47.09")	589 (23.19")	581 (22.87")		5 (16.4)	1.8 (3.96)
1100 (44")	1140 (44.88")	1278 (50.31")	1262 (49.69")	1296 (51.02")			430 (16.93")	5 (16.4)	1.8 (3.96)
1200 (48")	1240 (48.82")	1378 (54.25")	1362 (53.62")	1396 (54.96")			460 (18.11")	5 (16.4)	1.9 (4.18)
1300 (52")	1340 (52.76")	1478 (58.19")	1462 (57.56")	1496 (58.90")			490 (19.29")	5 (16.4)	1.9 (4.18)
1400 (56")	1440 (56.69")	1578 (62.13")	1562 (61.50")	1596 (62.83")			530 (20.87")	5 (16.4)	2.0 (4.4)
1500 (60")	1540 (60.63")	1678 (66.06")	1662 (65.43")	1696 (66.77")			560 (22.05")	5 (16.4)	2.0 (4.4)

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.
	▪ Plain washer (4mm nominal)	2 pcs.
	▪ Plain washer (6mm nomina)	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.

Note) When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L_1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L_0).

AT112 Super-slim Spars



Mounting dimensions

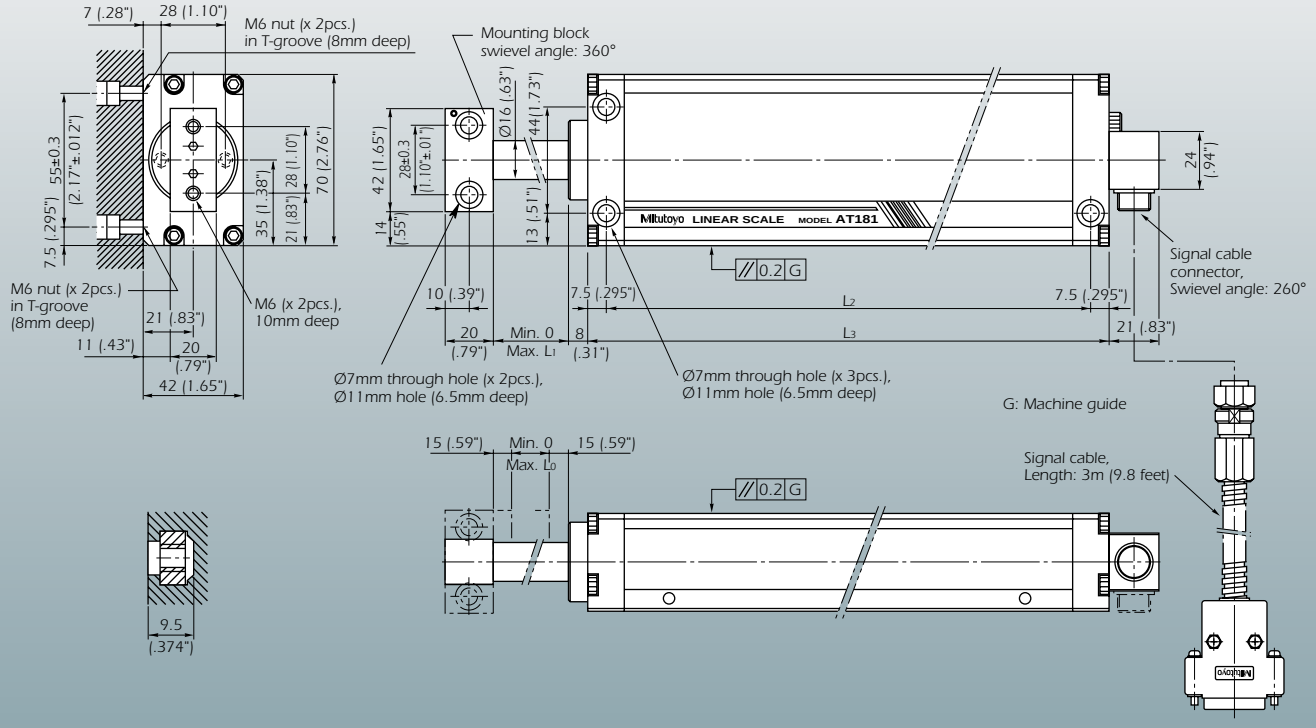
Effective range L0 mm (inch)	Mount interval L1 mm (inch)	Overall length L2 mm (inch)	Signal cable length m (feet)	Mass kg (lbs.)
50 (1.5")	143 (5.63")	155 (6.10")	3 (9.8)	0.72 (1.58)
70 (2.5")	163 (6.42")	175 (10.89")	3 (9.8)	0.74 (1.63)
120 (4.5")	213 (8.39")	225 (8.86")	3 (9.8)	0.80 (1.76)
170 (6.5")	263 (10.35")	275 (10.83")	3 (9.8)	0.85 (1.87)
220 (8.5")	313 (12.32")	325 (12.80")	3 (9.8)	0.90 (1.98)
270 (10.5")	363 (14.29")	375 (14.76")	3 (9.8)	0.95 (2.09)
320 (12.5")	413 (16.26")	425 (16.73")	3 (9.8)	1.00 (2.20)
370 (14.5")	463 (18.23")	475 (18.70")	3 (9.8)	1.05 (2.31)
420 (16.5")	513 (20.20")	525 (20.67")	3 (9.8)	1.10 (2.42)
470 (18.5")	563 (22.17")	575 (22.64")	3 (9.8)	1.15 (2.53)
520 (20")	613 (24.13")	625 (24.61")	3 (9.8)	1.20 (2.64)
570 (22")	663 (26.10")	675 (26.57")	3 (9.8)	1.25 (2.75)
620 (24")	713 (28.07")	725 (28.54")	3 (9.8)	1.30 (2.86)
670 (26")	763 (30.04")	775 (30.51")	3 (9.8)	1.35 (2.97)
720 (28")	813 (32.01")	825 (32.48")	3 (9.8)	1.40 (3.08)
770 (30")	863 (33.98")	875 (34.45")	3 (9.8)	1.45 (3.19)
820 (32")	913 (35.94")	925 (36.42")	3 (9.8)	1.50 (3.30)
920 (36")	1013 (39.88")	1025 (40.35")	3 (9.8)	1.56 (3.43)
1020 (40")	1113 (43.82")	1125 (44.29")	3 (9.8)	1.62 (3.56)

Note) When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L0).

Mounting parts (provided as standard)

Items included	▪ Hex-socket head screw (M4x0.7x20)	4 pcs.
	▪ Hex-socket head screw (M4x0.7x8)	6 pcs.
	▪ Spring washer (4mm nominal)	4 pcs.
	▪ Plain washer (4mm nomina)	4 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.

AT181 Plunger Type Spars



Mounting dimensions

Effective range L0 mm (inch)	Travel range L1 mm (inch)	Mount interval L2 mm (inch)	Main spar length L3 mm (inch)	Signal cable length m (feet)	Mass kg (lbs.)
100 (4")	130 (5.11")	255 (10.04")	270 (10.63")	3 (9.8)	1.7 (3.74)
150 (6")	180 (7.08")	305 (12.01")	320 (12.60")	3 (9.8)	1.9 (4.18)
200 (8")	230 (9.05")	355 (13.98")	370 (14.57")	3 (9.8)	2.1 (4.62)
250 (10")	280 (11.02")	405 (15.94")	420 (16.54")	3 (9.8)	2.3 (5.06)
300 (12")	330 (12.99")	455 (17.91")	470 (18.50")	3 (9.8)	2.5 (5.50)
350 (14")	380 (14.96")	505 (19.88")	520 (20.47")	3 (9.8)	2.7 (5.94)
400 (16")	430 (16.93")	555 (21.85")	570 (22.44")	3 (9.8)	2.9 (6.38)
450 (18")	480 (18.90")	605 (23.82")	620 (24.41")	3 (9.8)	3.1 (6.82)
500 (20")	530 (20.87")	655 (25.79")	670 (26.38")	3 (9.8)	3.3 (7.26)
550 (22")	580 (22.83")	705 (27.76")	720 (28.35")	3 (9.8)	3.5 (7.70)
600 (24")	630 (24.83")	755 (29.72")	770 (30.31")	3 (9.8)	3.7 (8.14)

Note) *When selecting the size of a Linear Scale for your application, make sure that the maximum travel range of the Linear Scale (L1) is larger than the maximum travel range of the machine. Also, take into consideration in selecting a size that the accuracy of the Linear Scale is guaranteed only within the range of the effective measuring length (L0).*

Caution in mounting and handling Linear Scales

Selecting the scale unit mounting position and mounting method

Take note of the following four points when determining the scale unit mounting position and orientation.

■ Ease of mounting

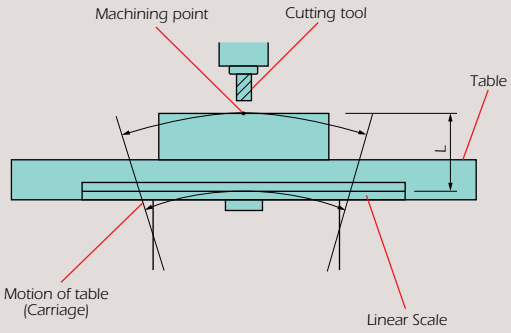
Mount the scale unit making sure that the unit including the detector head and the cables does not interfere with any part of the machine. To facilitate mounting, mount the scale unit and the brackets on machined surfaces wherever possible.

■ 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 lips only, avoid directly exposing the scale unit to machining fluids and swarf. Select the mounting orientation of the scale unit after carefully considering the direction in which machining fluids and swarf are sprayed and scattered.

■ Accuracy consideration

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 side 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

- If the detector head moves, the signal cables also move with the slide table. Thus, take note of this when laying out the signal cables. It is therefore recommended to mount the scale unit on the moving part of the machine.
- Mount the scale unit in place where it is not directly subjected to the 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 in case unit trouble occurs.

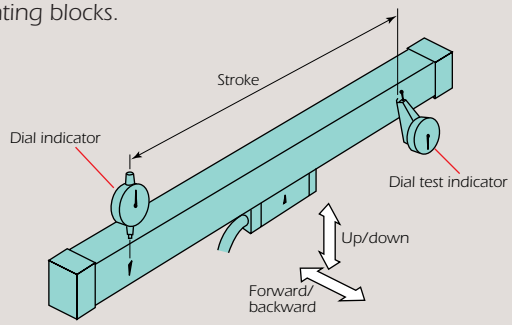
Checking parallelism and adjustment of scale unit

In order to get the most of the performance of the scale unit, the scale unit must be mounted parallel to the machine guide (machining axis). Take note that incorrect mounting may cause the scale unit to bend or twist.

■ Checking 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 machine's movable part such as the slide table, or measure the parallelism with reference to the guide rail of the machine or equivalent reference surface.

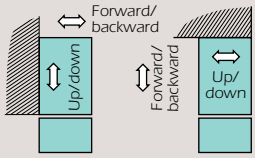
- Parallelism tolerance: Refer to each figure on dimensions.
- Checking direction: Back/forward direction on mounting surface and directions along mounting surface (up and down).
- Checking position: Position of scale unit around the mounting blocks.



■ Adjusting parallelism

Adjust the parallelism to within 0.2mm. Spacers used in adjustment are not included in the accessories. Please arrange for them as necessary.

- Adjusting the mounting surface back/forward: Readjust the mounting positions of the brackets or place spacers between the scale unit mounting surface and the mounting blocks.
- Adjusting along (up and down) the mounting surface: Adjust the parallelism by sliding the mounting block on the mounting surface.

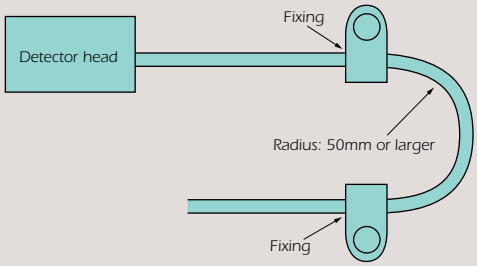


Layouting signal cable

Take note of the following points when layouting signal cables.

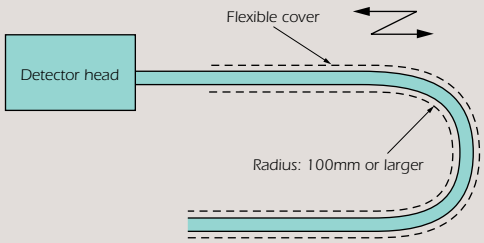
■ When the cable is fixed

The radius of curvature of the signal cable must be larger than 50mm.



■ When the cable is movable

When the detector head is movable, it carries the signal cable with it during operation. Take care, in such a case, that the radius of curvature of the signal cable is not smaller than 100mm and excessive force is not applied to the cable. It is a good idea to protect the cable with a flexible support cover.



Note: Take care that the signal cables does not interfere or are not rubbed with any part of the machine.

■ Other considerations

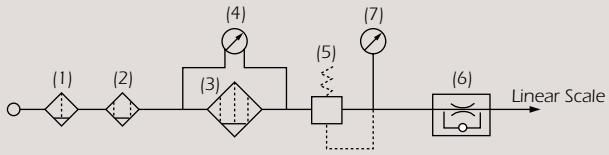
The signal cable is durable enough to withstand repeated bending up to approximately 2 million times (when the bending radius is 100mm). When repeated bending exceeding 2 million times is expected, the signal cable should be considered as a consumable part. Have an extension cable ready in such a case so that the slider unit can be replaced to facilitate maintenance.

Improving the dust- and splash-proofing

On the assembly type Linear Scale AT102 the dustproofing and splashproofing can be improved by supplying dry and clean air into the spar. Pipe to either of the screw holes (M5) located on the both ends of the main scale for the air supply.

- Applicable Linear Scale: AT102
- Supplied air pressure: 0.1MPa (approx. 1kgf/cm^2)
- Air flow rate: 10 to 20 liters/min.

Recommended air supply system



Air supply equipment	Specifications
(1) Air filter A	Filterability: 5μm
(2) Air filter B	Filterability: 0.3μm, Oil removal rate: 99.9% or more
(3) Air filter C	Filterability: 0.01μm, Oil removal rate: 99.9999% or more
(4) Differential pressure gage	For monitoring the life of the air filter C
(5) Air regulator	Pressure setting: 0.1MPa (1kgf/cm^2)
(6) Flow control valve	Flow setting: 10 to 20 liters/min.
(7) Pressure gage	Pressure: 0.1MPa (1kgf/cm^2)

Note 1: Do not supply excessive amount of air, since this may draw in the dust around the scale unit.
Note 2: When air in the air supply system contains humidity, connect an air dryer to the front of (1) Air filter A and dry the air.

Resonance point of Linear Scale

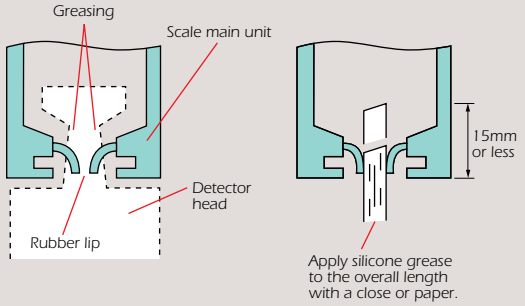
Each object has a natural frequency, depending on its shape, length, and the type of material. The Linear Scale frame is not an exception. It has its natural frequency and thereby resonates at a certain frequency. In general, this will not cause a problem, since a machine tool and the Linear Scale frame have different natural frequencies under normal machining conditions. However, when the natural frequency of the machine tool body and the Linear Scale coincide due to a special processing condition, the following counter-measures can be taken:

[What to do when the machine and the Linear Scale have the same natural frequency]

1. Increase rigidity of the mounting bracket for the scale.
2. Add a mid-support to the middle of the scale to shift its resonance point.
3. Mount the Linear Scale at a place where the frequency of the machine tool cannot be easily transmitted.
4. Limit the machine process conditions to be within a specific range in which the natural frequencies of the machine tool and the scale do not coincide.

Maintenance of Dust-proof rubber lips

In order to maintain and extend the life of the dust-proof rubber lips, it is recommended that a small amount of silicon lubricant be applied to the joint of the rubber and the detector head once a year.



Linear Scale Evaluation Methods

- **Testing within the operation temperature range**
  The test 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**
  The test has proven that there is no abnormality when the Linear Scale is used under the condition of which the ambient temperature continuously changes within the specific range.
- **Vibration test (Sweep test)**
  The test has proven that Linear Scale functions without abnormality when used within the frequency range between 30Hz and 300Hz at a given acceleration (3G).
- **Noise test**
  In accordance with the EMC Directives, EN55011:1991 Group 1 Class B, and EN50082-1:1992
- **Crate Drop Test**
  In accordance with the heavy equipment drop test (JISZ0200) specified in the JIS.

OPTIONAL ACCESSORIES

Touch-signal probes

Shank diameter	Order no.
20mm	938140
32mm	935094
.5"	902329

Foot switch

965004

Extension cables

Extension cables Type A for AT102/111/112/181

Cable length	Order no.
2m (6.5ft)	09AAA033A
5m (16.4ft)	09AAA033B
7m (22.9ft)	09AAA033C

Note) Do not allow the entire length of the cables to exceed 20m.

Extension cables Type B for AT115*

Cable length	Order no.
2m (6.5ft)	09AAA720A
5m (16.4ft)	09AAA720B
7m (22.9ft)	09AAA720C

*Also can be used for AT102/111/112/181.
Note) Do not allow the entire length of the cables to exceed 20m.

Zero-set remote controller

09CAA335

Programmable remote controller

09CAA384

Note: All information regarding our products, and in particular the illustrations, drawings, dimensional and performance data contained in this pamphlet, 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.

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