



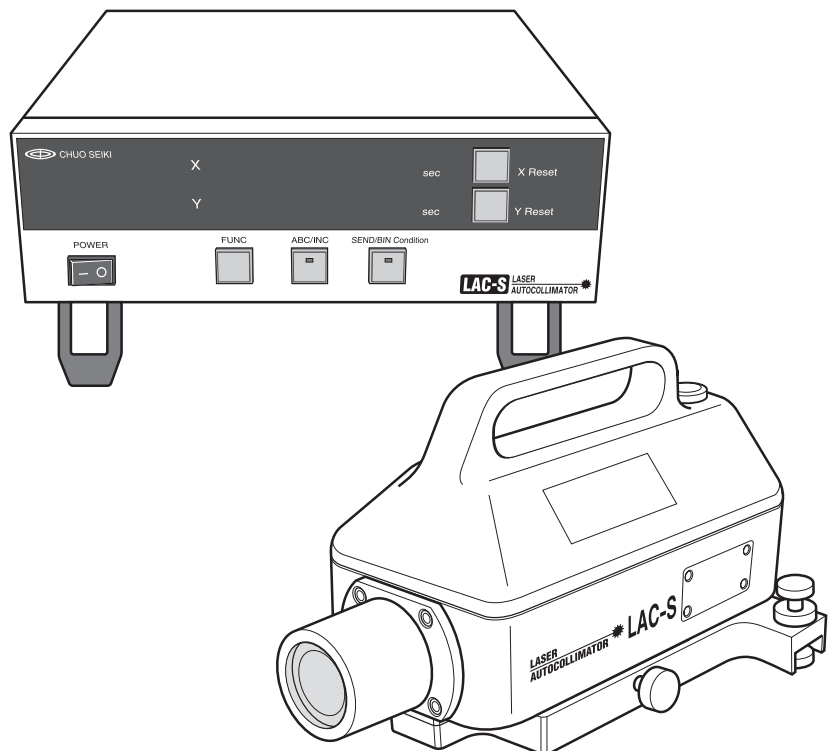
LASER AUTOCOLLIMATOR

LAC-S

Instruction Manual

Thank you for purchasing our product.

This manual describes the accurate, safe usage of the product, so please read it thoroughly before actually using the devices and keep it where it can be referred to at any time.



CHUO PRECISION INDUSTRIAL CO., LTD.

1 Preface

Thank you for purchasing LAC-S, our Laser Autocollimator.
 This manual describes the accurate and safe way to use the product, so please read it thoroughly before you actually use LAC-S and keep it where it can be referred to at any time.

Features

LAC-S is a small and lightweight autocollimator with the light source being semiconductor laser. Unlike many conventional autocollimators, the optical axis can be seen, so the initial settings and other settings can be done easily.

Main Applications

- Measuring the straightness of the displacement platform
- Measuring the parallelism of the edge surfaces
- Measuring the squareness
- Measuring the angle of rotation
- Measuring the straightness of the secured guide surface

Before Using LAC-S

Combination of LAC-S and the counter

Please set LAC-S and the counter to the same product number as they came in when purchased. LAC-S and the counter are adjusted as a set, so precision cannot be guaranteed if the product numbers are different.

Operating environment

The operating environment that guarantees precision is $20 \pm 1^\circ\text{C}$. We recommend that measuring is performed in this environment.

Boot time

For LAC-S, a certain amount of time is required for the internal sections to warm up in order to secure precision. Please wait at least 30 minutes after power is turned ON before using the device.

Reflector for measuring

We recommend that a reflector with an effective diameter of at least ϕ 8mm and parallelism of $\lambda / 4$ or above is used for measuring.

Components and Accessories

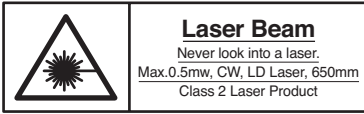
Components	Accessories
Main body 1	Signal cable..... 1
Counter 1	Image signal cable 1
Remote box..... 1	Power cable 1
	Instruction manual (this book) 1
	Warranty..... 1
	Registration card..... 1

Contents

1	Preface.....	2	10	Examples of Measuring.....	25
2	Precautions.....	4		Measuring the straightness of the	
	2.1 Concerning laser.....	4		displacement base (Yawing and Pitching) ..	25
	2.2 Safety Precautions	5		Measuring the straightness of the	
3	Names and Functions of Each Part	6		fixed guide surface.....	25
	3.1 LAC-S body.....	6		Measuring split accuracy using a reference	
	3.2 Counter	7		polygon mirror	26
	3.3 Remote box.....	8		Measuring camming	27
4	Connections.....	9		Measuring the internal squareness of	
5	Installation.....	10		a specimen.....	27
	5.1 Basic installation method.....	10		Measuring parallelism of	
	5.2 Adjusting laser beam	11		both edge surfaces – 1	28
	5.3 Attaching and detaching the base	12		Measuring parallelism of	
6	Various Modes.....	13		both edge surfaces – 2	28
	6.1 Changing modes.....	13		Squareness of a cuboid.....	29
	6.2 Measuring mode	14		Measuring the minute change in length.....	29
	6.2.1 Two measuring modes.....	14		Measuring deflection of an elastic piece... 	30
	6.3 Setting mode	16	11	Main Specifications	31
7	Measuring Method	19	12	Warranty & Repair / Miscellaneous	32
	7.1 Measuring the straightness of				
	the surface plate.....	19			
	7.2 Measuring results.....	20			
8	Communication Function.....	21			
	8.1 RS-232C communication				
	specifications.....	21			
	8.1.1 RS-232C cable specifications	21			
	8.2 GP-IB communication specifications ..	21			
	8.2.1 GP-IB connector specifications ..	21			
	8.3 Setting RS-232C baud rate and				
	GP-IB address	22			
	8.4 Setting [SEND] function.....	22			
9	Commands.....	23			
	9.1 Command format.....	23			
	9.2 Command list	23			
	9.3 Data reply format	24			

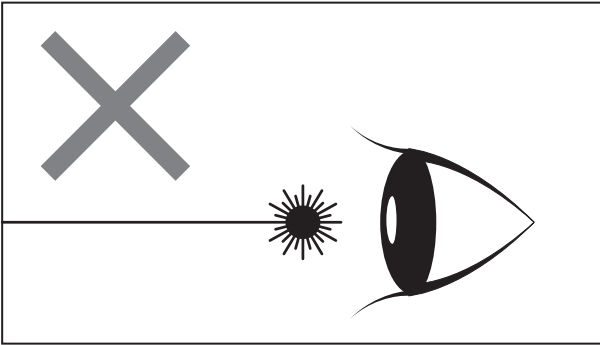
2 Precautions

2.1 Concerning laser

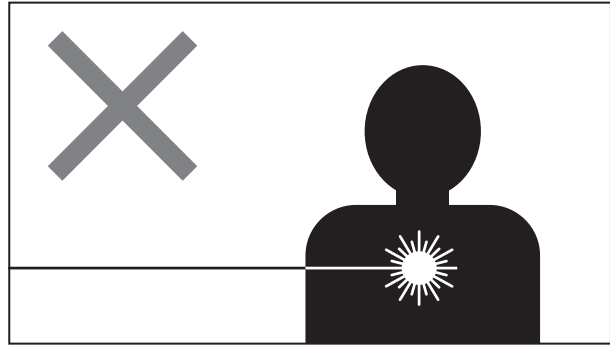


LAC-S is a “Class 2 Laser Product” equipped with a semiconductor of 650nm wavelength.

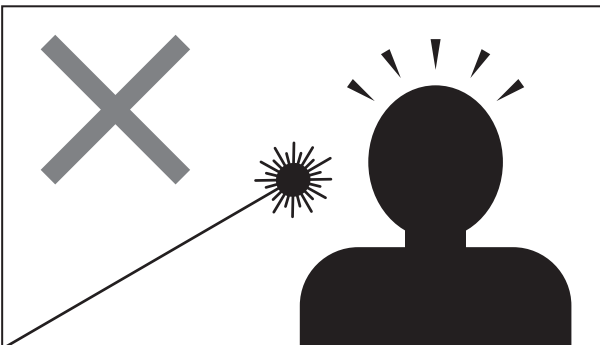
Please read the following precautions and secure safe operation.



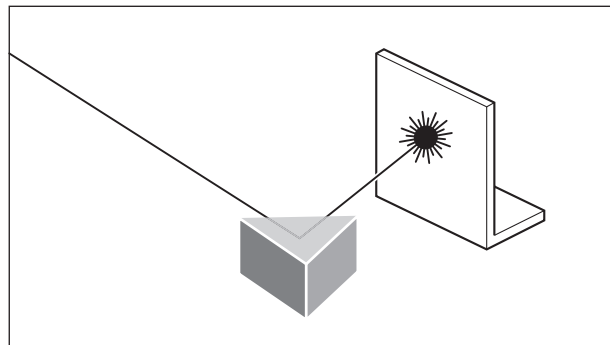
Be careful not to let laser get into the eye.



Do not point laser beam to a person intentionally.

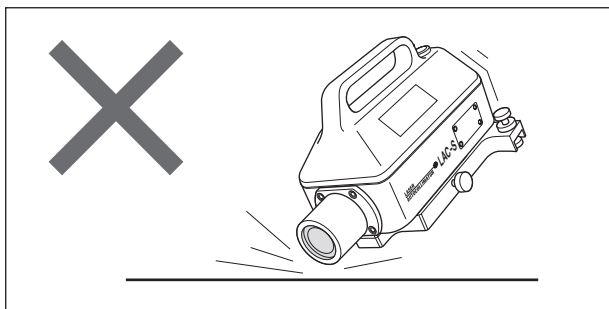


Do not point laser to the height of a human face.

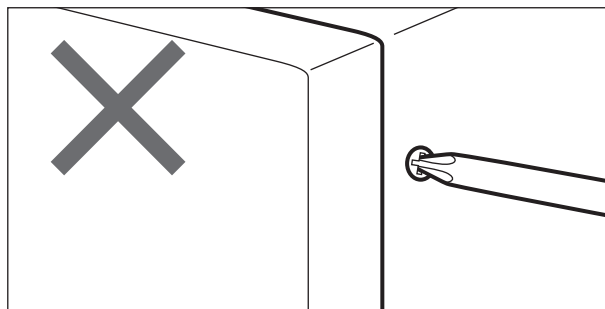


If laser beam does not always return to LAC-S, set a screen and terminate the beam path.

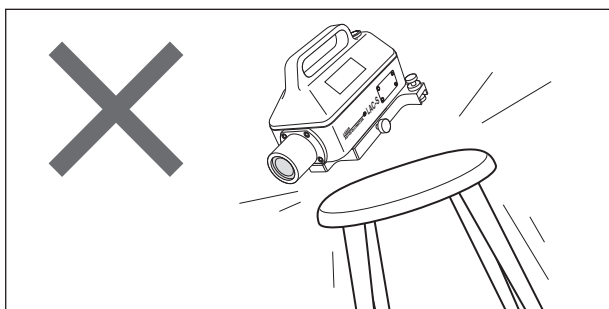
2.2 Safety Precautions



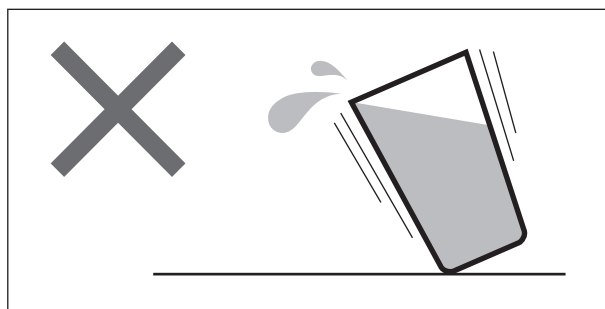
Do not use the device in an environment subject to excessive vibration as it is made of very precise components. It may drop or go on and cause injuries. Vibration exerts bad influence on the precision of measurement.



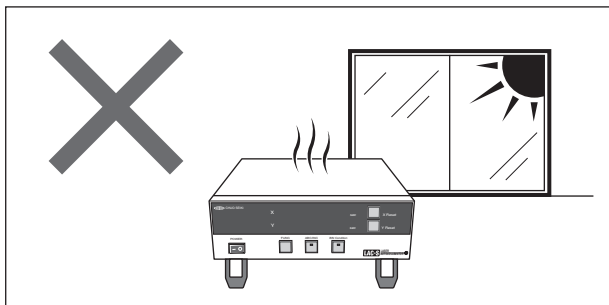
Never remove the secured panels or covers on the device, or attempt to modify the device.



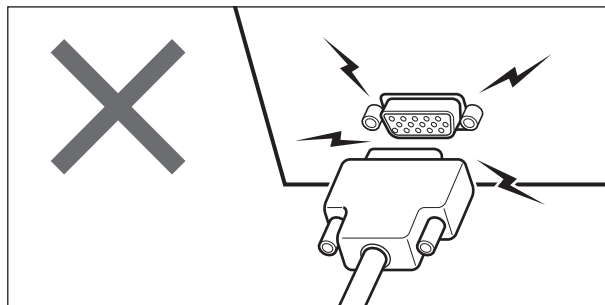
Do not place the device on an unstable base (shaky or inclined platform).



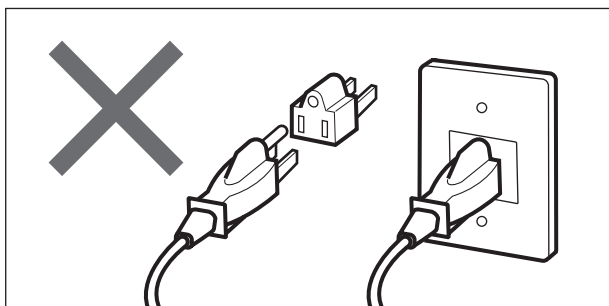
Never use the device where there is a risk of contact with water as it could lead to serious damage.



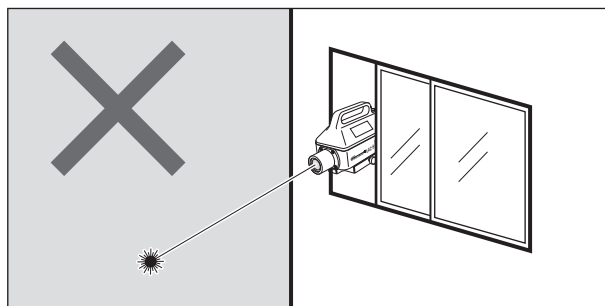
Never set the device where it is exposed to direct sunlight, or near an air conditioner or heating device where the temperature could change dramatically. A change in temperature affects precision of measurement greatly so please be careful.



Never attach or detach the connector with the power ON as it may damage the device.



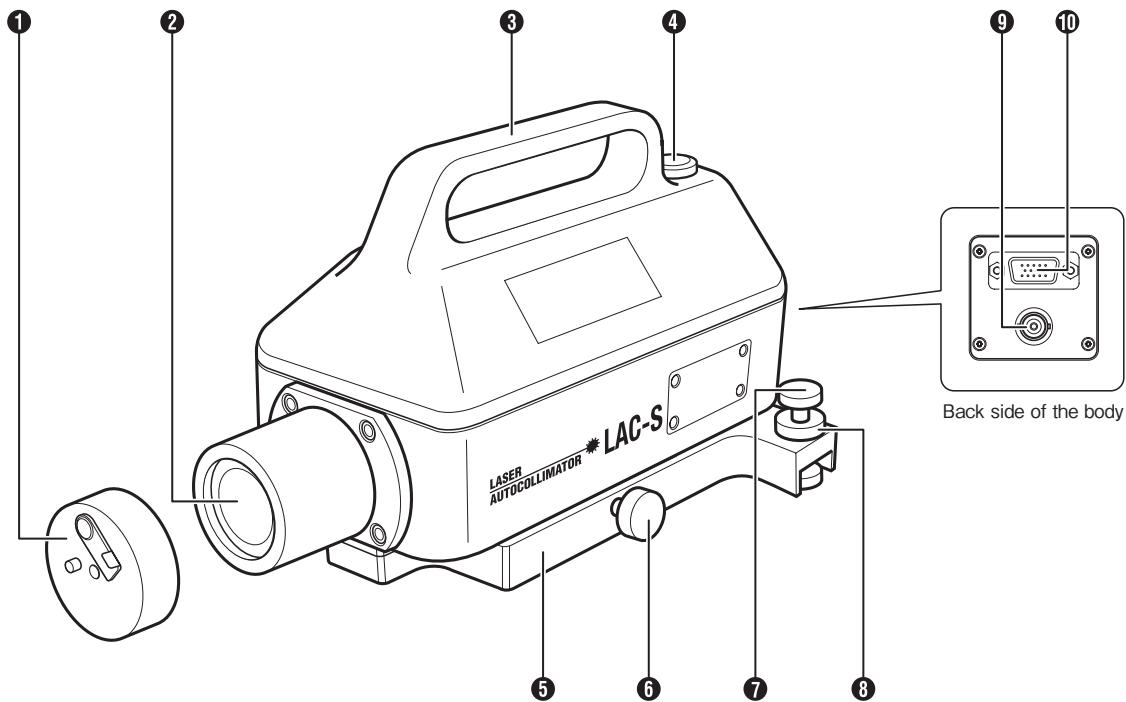
Be sure that the outlet for the 100V AC cable is a 3-pin grounding-type receptacle. Do not use a 3-pin to 2-pin conversion adaptor.



Please do not use the device for purposes other than the measuring operations which are recommended in this manual.

3 Names and Functions of Each Part

3.1 LAC-S body



1 Lens cover

The injection hole can be opened and shut with the manual shutter. Open the shutter and adjust the position so that laser beam returns to this injection hole.

- After adjusting the position, remove the lens cover before measuring.
- If you are not using LAC-S, attach the lens cover to protect the lens.

2 Lens section

Injects laser beam and receives reflected light.

3 Handle

Use this handle to lift up or carry LAC-S.

⚠ CAUTION

Do not hold the lens section as it may damage the device or hinder the level of precision.

4 Leveling instrument

This gives an approximation of the horizontal level when setting LAC-S.

5 Base (removable)

The posture of LAC-S can be adjusted from the base for setting LAC-S. The base can also be detached to install an LAC-exclusive adjustable base.

6 Base set screw

The screw secures LAC-S to the base.

7 Posture adjustment screw

The posture of LAC-S can be adjusted using the screws located on both sides.

8 Screw clamp

This clamp secures the posture adjustment screw.

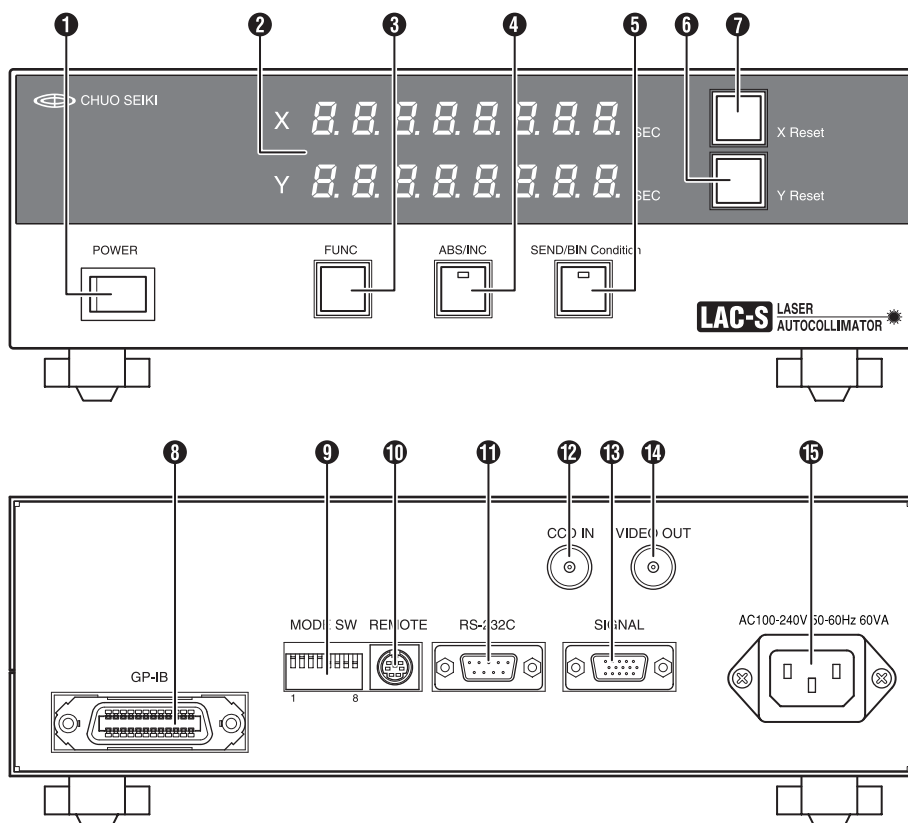
9 Image signal connector

Connection to "CCD IN" on the counter is made with the coaxial cable (accessory).

10 Signal connector

Connection to "SIGNAL" on the counter is made with the signal cable (accessory).

3.2 Counter



❶ POWER (Power switch)

Turns ON/OFF the power of the counter and LAC-S.

⚠ CAUTION

We recommend that you turn the power ON 30 minutes before using the device in order to stabilize precision. When the device is not being used, turn the power OFF to secure safety.

❷ Display Section

Measured values and various setting status are displayed.

❸ FUNC (Function)

During “Measuring mode”: The displayed digit is changed between “0.01sec” - “0.1sec” - “1sec” each time [FUNC] is pressed.

When [FUNC] is pressed along with [X Reset], the mode changes from “Measuring mode” to “Setting mode”.

During “Setting mode”: The mode changes from “Measuring mode” by pushing [FUNC].

❹ ABS/INC (Display change)

During “Measuring mode”, selection can be made between absolute value display (ABS) and incremental value display (INC). The “ABS/INC” lamp illuminates when absolute value display is selected.

⚠ CAUTION

During absolute value display, the center of the light

receiving sensor is “0,0”. When a reset button ([X Reset] or [Y Reset]) is pressed during incremental value display, the current position of the pressed axis becomes “0”.

NOTE

Angle detection is performed by the light receiving sensor equipped inside LAC-S.

❺ SEND/BIN Condition

SEND function: SEND function is entered by pressing [SEND/BIN Condition] during “Measuring mode”. The numerical data displayed at the time when pressing the button is sent to RS-232C connector. For details on the data format for sending, please see “9.3 Data reply format” (P.24).

⚠ CAUTION

SEND function can only be used with RS-232C. It cannot be used with GP-IB.

BIN Condition function: BIN Condition function is entered by pressing [SEND/BIN Condition] during the “Setting mode”. This function enables you to adjust sensitivity for receiving when the amount of light returning to LAC-S is low.

❻ Y Reset

During “Measuring mode”: Resets Y-axis during incremental value display.

During “Setting mode”: Changes the contents of each setting.

7 X Reset

During “Measuring mode”:

- Resets X-axis during incremental value display.
- Changes the mode from “Measuring mode” to “Setting mode” when pressed along with [FUNC].

During “Setting mode”:

- Selects an item for each setting.
- Changes the mode from “Setting mode” to “Measuring mode” when pressed along with [FUNC].

8 GP-IB Connector

Makes connection with the host computer via GP-IB.

9 MODE SW

Performs communication settings such as RS-232C baud rate setting, GP-IB address setting, and invalidating the SEND function.

10 REMOTE (Remote box connector)

Connects the remote box (accessory).

11 RS-232C Connector

Makes connection with the host computer via RS-232C.

12 CCD IN (Image signal input connector)

Makes connection with the image signal connector of LAC-S using a coaxial cable (accessory).

13 SIGNAL Connector

Makes connection with the signal connector of LAC-S using a signal cable (accessory).

14 VIDEO OUT Connector

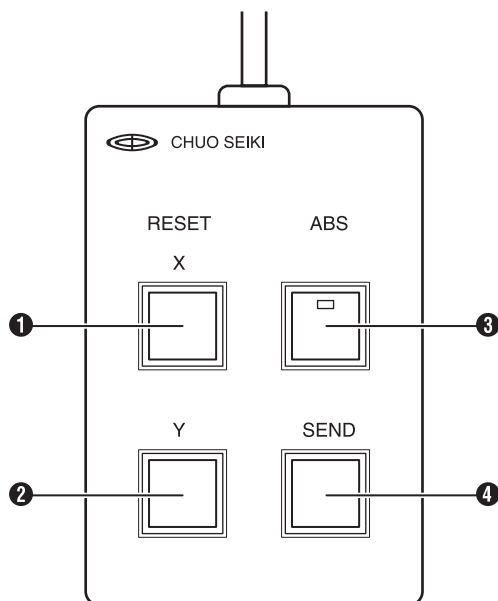
Sends an image. Makes connection with external devices such as a TV monitor.

15 AC100-240 (Power connector)

The attached power cable is connected to 100-240V 50/60Hz.

3.3 Remote box

The function of each key is the same as the function of [X Reset], [Y Reset], [ABS/INC], and [SEND] on the counter. This remote box enables you to control system from a remote place.

**1 X Reset**

Resets X-axis during incremental value display in “Measuring mode”.

2 Y Reset

Resets Y-axis during incremental value display in “Measuring mode”.

3 ABS/INC (Display change)

During “Measuring mode”, selection can be made between absolute value display (ABS) and incremental value display (INC). The “ABS/INC” lamp illuminates when absolute value display is selected.

4 SEND

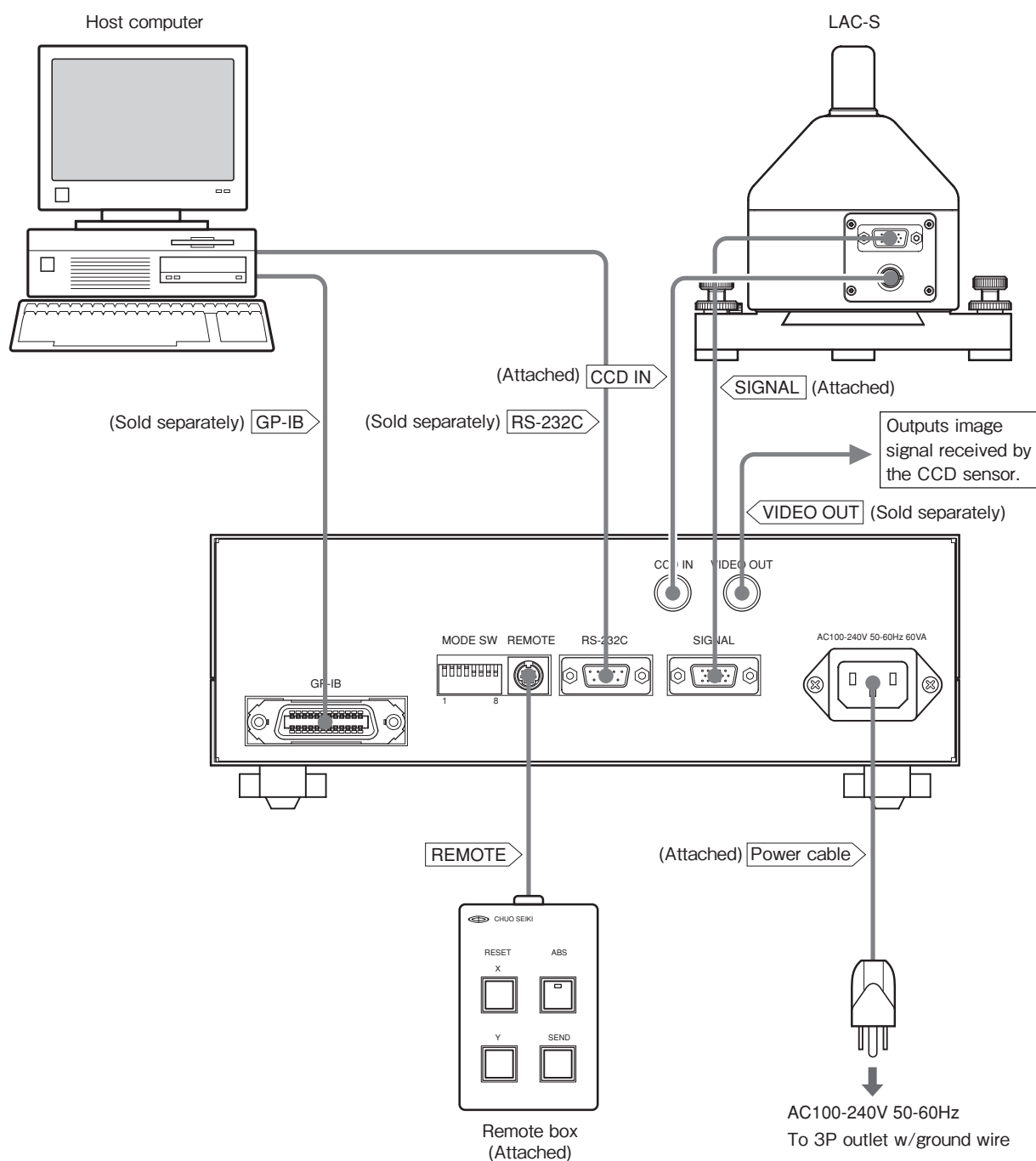
SEND function is entered by pressing [SEND] during “Measuring mode”. The numerical data displayed at the time when pressing the button is sent to the RS-232C connector.

4 Connections

Refer to the following figure and connect the devices.

⚠ CAUTIONS

- Plug the power cable to the outlet after all connections are completed.
- Be sure to make connections to each device with the power turned OFF. Plugging and unplugging cables while the power is ON will not only lead to damages but may cause laser to inject unexpectedly.
- Make sure that LAC-S is connected before turning the power ON. Turning the power ON or operating a device without LAC-S being connected may damage the counter circuit.
- A communication cable to connect to a computer is not attached with this product.
(Please purchase our ACB-RS-2 <RS-232C straight cable>, ACB-GP-2 <GP-IB cable>, or a cable with equivalent specifications.)
- A cable to connect to an external device such as a TV monitor is not attached with this product. (Please purchase a coaxial cable equipped with a BNC plug.)

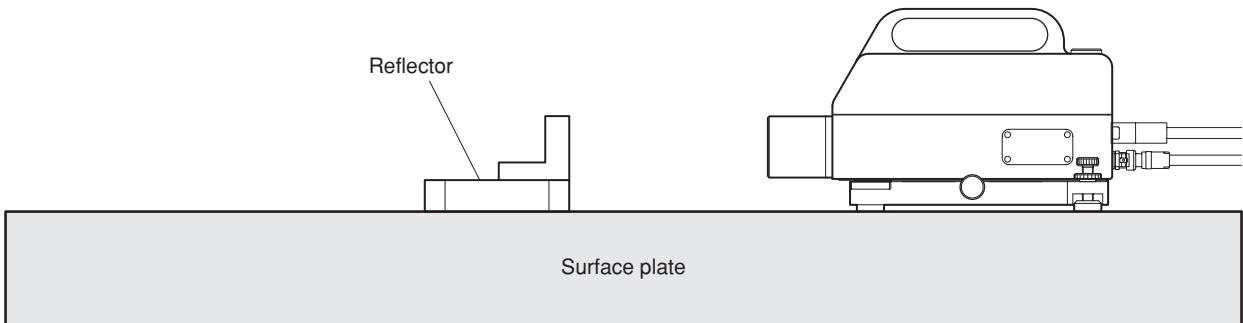


5 Installation

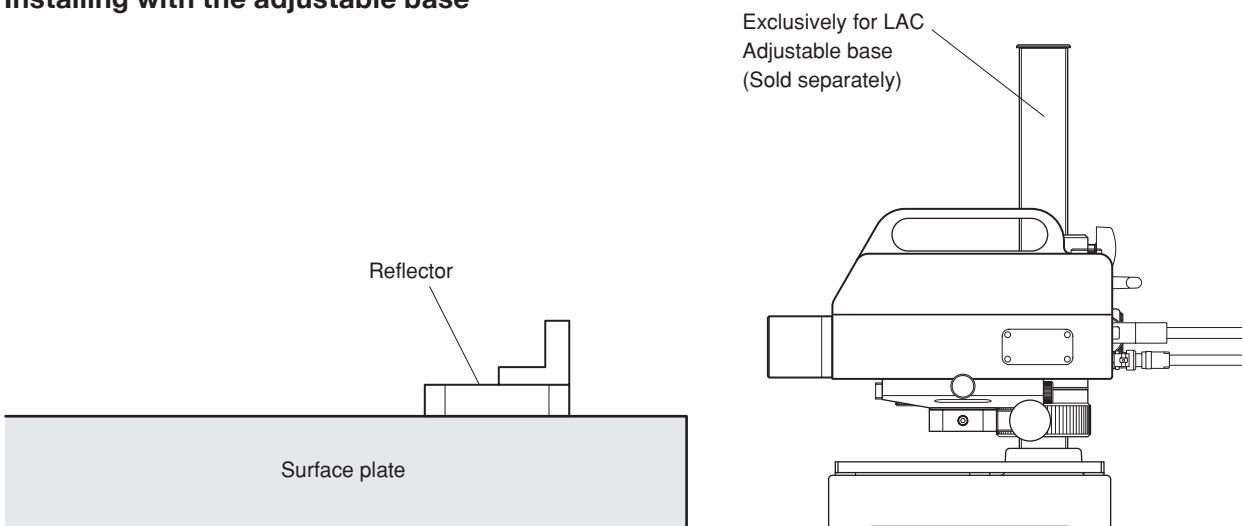
5.1 Basic installation method

The figure is an example of measuring the straightness of the surface plate. Install LAC-S on the surface plate, a secure platform, or use a LAC-exclusive adjustable base (sold separately). Set the reflector where laser beam injected from LAC-S reflects sufficiently.

Installing on the surface plate

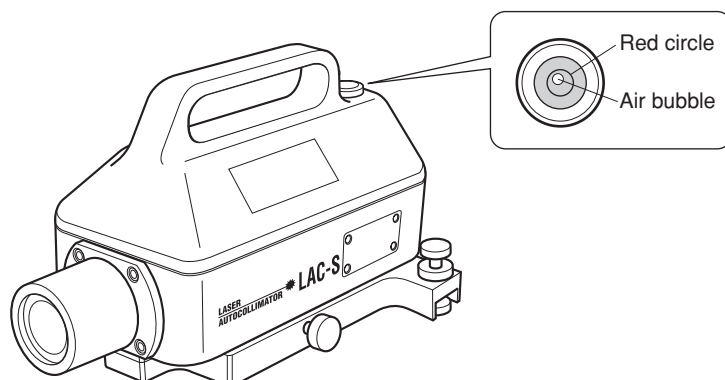


Installing with the adjustable base



Leveling instrument

Adjust the (horizontal) level of LAC-S with the leveling instrument as necessary. If the bubble on the leveling instrument is within the red circle, the posture of LAC-S is within $\pm 30''$ of level.



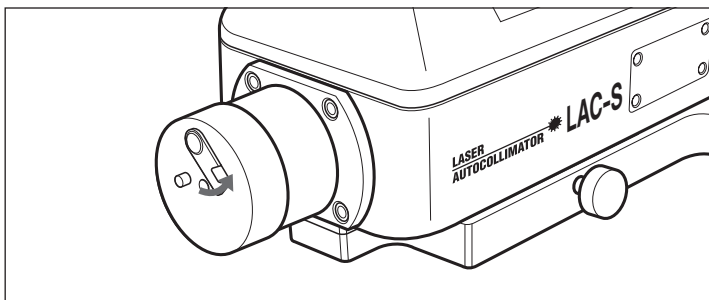
5.2 Adjusting laser beam

CAUTION

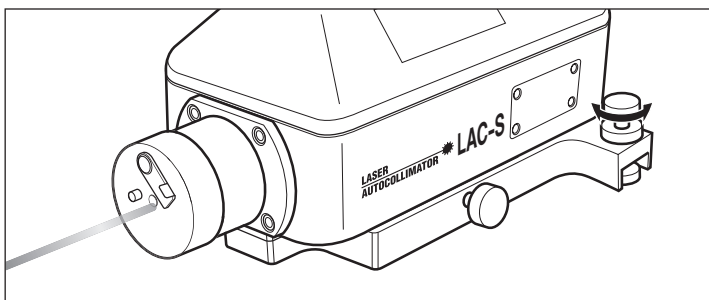
Make sure that the “Measuring mode” on the counter is set to ABS (absolute value display) when you are going to adjust the position of laser beam. For details on “Measuring mode”, please see “6.2.1 Two measuring modes” (P.14).

The following is a basic method for adjusting position, mainly for those who are going to use LAC-S for the first time. For details on the actual measuring, please see “9 Measuring Method” (P.19).

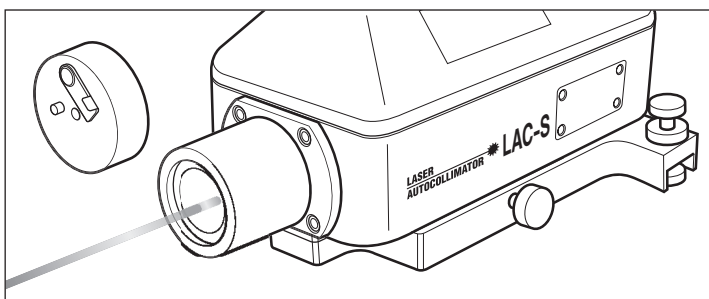
1 Turn the counter ON and open the shutter of the lens cover.



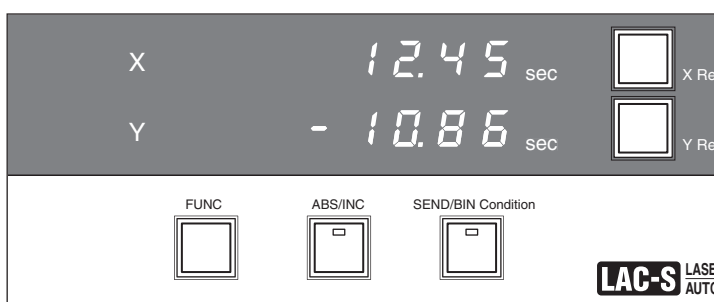
2 Adjust LAC-S with the posture adjustment screw and adjust the reflector so that laser beam hits the reflector and returns to the injection hole on the lens cover.



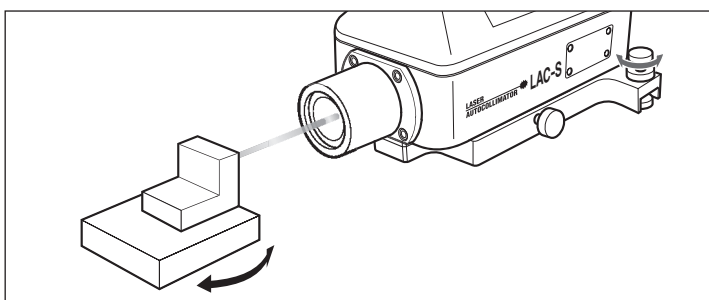
3 If laser beam returns to the injection hole properly, remove the lens cover.



4 The measured value appears on the display. If no value appears, reconfirm the above Steps 1 to 3.



5 Make further minute adjustment of the reflector and LAC-S so that the values for both X and Y axes become “0 sec”.

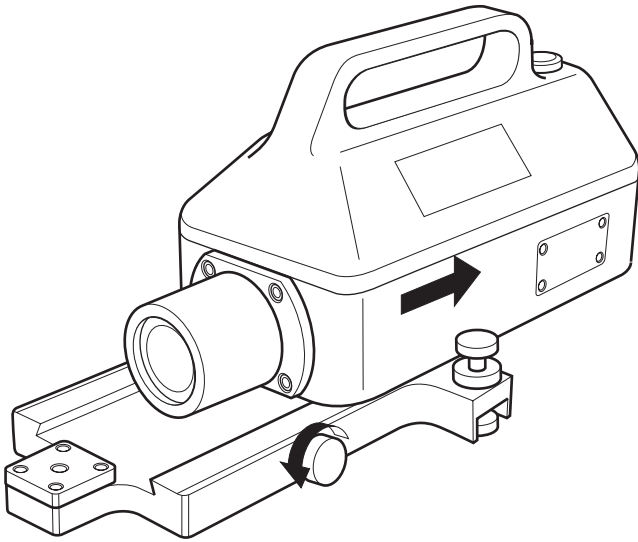


Adjusting sensitivity

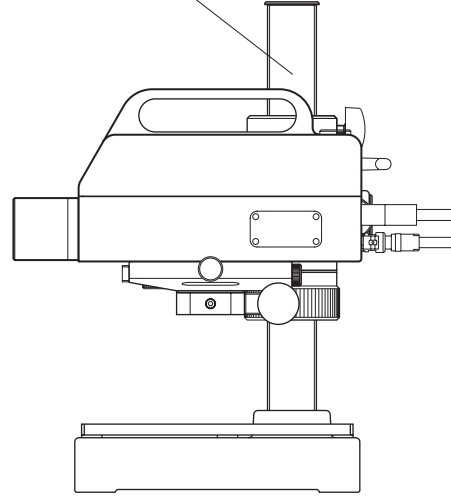
If intensity of the laser reflection is weak and the result of measurement is unstable, adjust the sensitivity of light reception (See “6.3.1 Adjusting CCD sensor sensitivity” P.16). If you are going to use the same specimen, adjustment is not necessary for each measurement.

5.3 Attaching and detaching the base

The base (platform) can be detached. When using an LAC-exclusive adjustable base or tripod, loosen the base set screw, detach the base, and set LAC-S directly to the base or tripod.

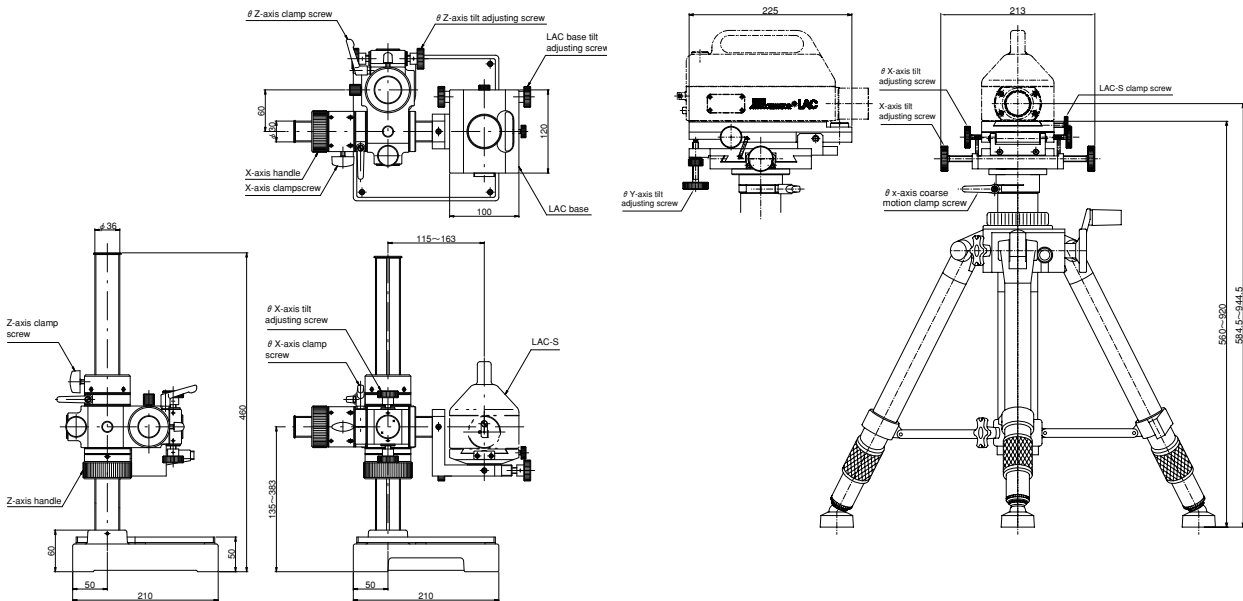


Exclusively for LAC
Adjustable base
(Sold separately)



**LAC-exclusive adjustable base
(sold separately)**

LAC-exclusive tripod (sold separately)



6 Various Modes

LAC-S has 2 modes: “Measuring mode” for normal measurement and “Setting mode” to perform various settings. LAC-S will always boot up in the “Measuring mode” and absolute value display (ABS).

Counter display at power-on

When the power switch is turned ON and the version and self-diagnosis result appear on the display section, LAC-S enters “Measuring mode”.

Version display



Self-diagnosis result



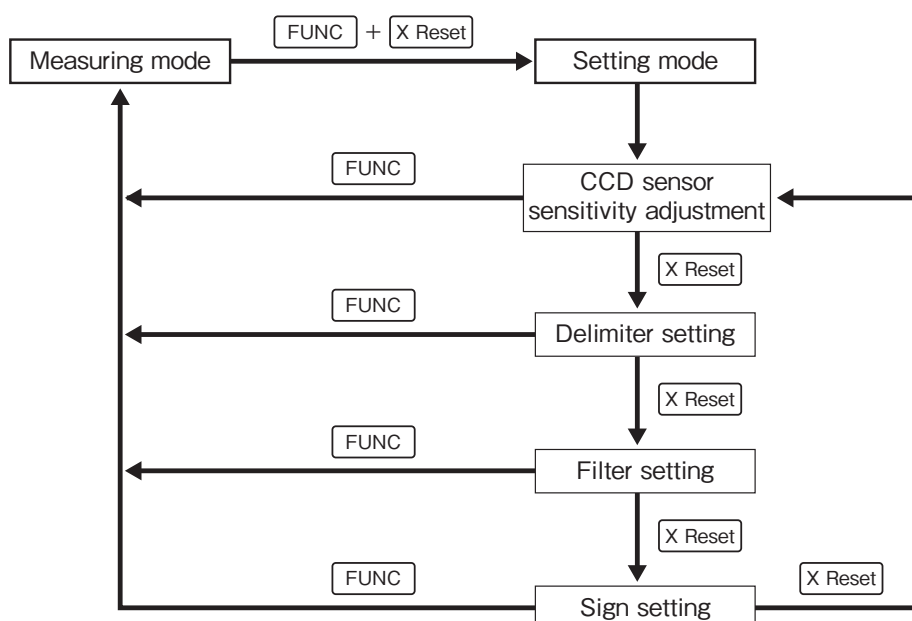
“OK” appears when the self-diagnosis result is normal and “NG” appears when some sort of abnormality is detected. The device may be damaged if “NG” appears, so stop the operation and contact our sales department.

6.1 Changing modes

“Setting mode” is entered by pressing [FUNC] along with [X Reset] during “Measuring mode” (*). In “Setting mode”, items subject to setting can be selected by pressing [X Reset].

When setting is completed, press [FUNC] and return to “Measuring mode”.

* If this operation is performed when incremental value display (INS) is selected, the display for X-axis becomes “0”.

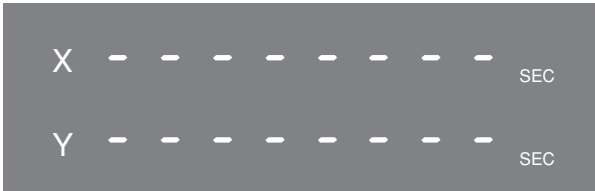


6.2 Measuring mode

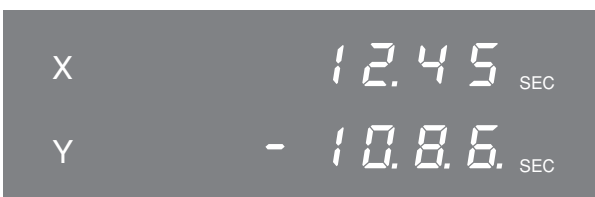
Display during “Measuring mode”

“-” appears when laser beam does not return to the lens (non-measuring time) or when the lens cap is attached. The measured value appears if laser beam returns to the lens properly.

Display when measuring is not performed



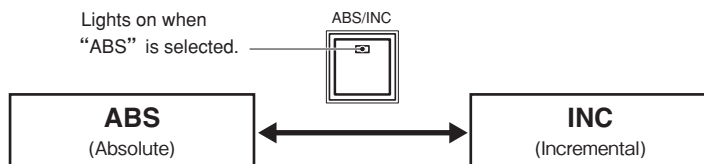
Display of measured value



- The above is an example of displaying values of X and Y axes.
- During absolute value display, the display range is approx. ± 200 sec from the center of the sensor.

6.2.1 Two measuring modes

Absolute value display (ABS) and incremental value display (INC) are the two modes for displaying measured values. The mode change from one to the other each time “ABS/INC” is pressed.



ABS (Absolute value display)

When ABS is selected, the measured value is calculated upon assuming that the center of the sensor is “0,0”.

CAUTION

The “ABS/INC” lamp illuminates when absolute value display is selected.

INC (Incremental value display)

When a reset button ([X Reset] or [Y Reset]) is pressed during incremental value display, the current position of the pressed axis becomes “0”. The next measuring point is displayed as an absolute value assuming that the previous measuring point was “0”.

SEND function

If you press [SEND/BIN Condition] on LAC-S or [SEND] on the remote box during “Measuring mode”, the numerical data currently displayed will be sent to RS-232C just one time. Data subject to being sent is set based on “8.1 RS-232C communication specifications” (P.21) and with the reply format in “D” command in “9.3 Data reply format” (P.24). One data (in “D” command) is sent.

- The red lamp of the [SEND/BIN Condition] switch on LAC-S illuminates when [SEND/BIN Condition] or [SEND] on the remote box is pressed. When the red lamp is illuminating, numerical data cannot be sent even by pressing [SEND/BIN Condition] or [SEND] on the remote box. Furthermore, data will not be sent continuously even by keeping the button pressed.
- When the red lamp is illuminating, the [SEND] switch and commands from RS-232C are disabled.
- In order to validate “SEND” function, be sure to set MODE SW “No. 3” on the back side of LAC-S to “ON (= Valid)”. “SEND” does not function when it is set to “OFF (= Invalid)”.

CAUTION

- Data is sent via RS-232C. A device such as a PC and application software is required to obtain and/or display data that was sent. A PC and application software must be provided by each customer.
- “SEND” function can only be used with RS-232C. It cannot be used with GP-IB.
- When using GP-IB interface, set MODE SW “No. 3” to “OFF (= Invalid)” to prevent faulty operations.

Switch for setting “SEND” function valid/invalid

You can select whether to make “SEND” function valid or invalid by setting the MODE SW “No. 3” on the back side of LAC-S. The initial setting is “ON (= Valid)”. It must be set to “OFF (= Invalid)” in the following cases.

- 1. When obtaining data using a communication function with GP-IB interface.**
- 2. When running a program to obtain data continuously using a communication function with RS-232C interface.**
- 3. To invalidate “SEND” function.**

When this switch is set to “OFF (= Invalid)”, data will not be sent to RS-232C even by pressing [SEND/BIN Condition] on LAC-S or [SEND] on the remote box.

6.3 Setting mode

The following 4 items can be set in “Setting mode”.

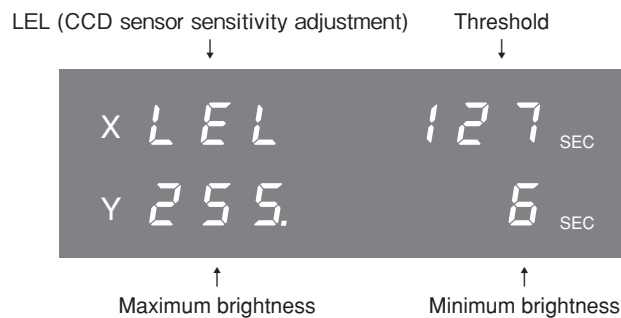
- CCD sensor sensitivity adjustment
- Delimiter setting
- Filter setting
- Sign setting

6.3.1 Adjusting CCD sensor sensitivity

LAC-S uses CCD as a light receiving sensor to process an image and detect an angle. The result of measurement may be unstable if the intensity of the laser reflected from the specimen is weak and sufficient amount of laser is not returned.

In such a case, adjust the CCD sensor sensitivity.

- If you are going to use the same specimen continuously, adjustment is not necessary for each measurement.



Procedure for adjusting

- 1 Press [X Reset] while pressing [FUNC] in “Measuring mode”. “LEL (CCD sensor sensitivity adjustment)” will appear. “Maximum brightness” and “Minimum brightness” of the CCD sensor will appear. “Threshold” indicates the level of image processing.

CAUTION

The maximum value of brightness is “255”. A value above “255” will not be displayed.

- 2 “Threshold” increases by “5” each time [Y Reset] is pressed, so set an arbitrary value.
 - “0” appears when “255” is exceeded.
 - When [BIN Condition] is pressed, the threshold becomes “Maximum brightness/2” (recommended value).
e.g.) The maximum brightness becomes approx. “40” at a reflection rate of 4%. The recommended threshold at this time is “20”.

CAUTION

If threshold is set to a value larger than the maximum brightness, the angle indication of the counter may become unstable. Please reset the threshold at such a time.

- 3 When finished, press [FUNC] and return to “MEASURING mode”.

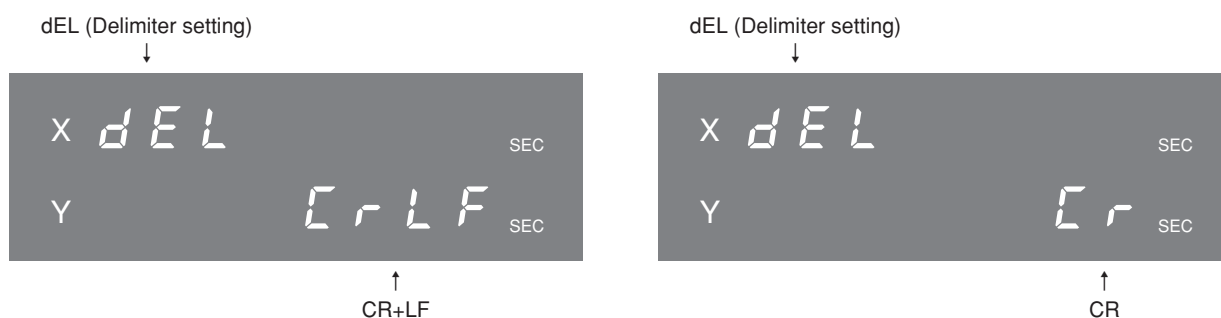
CAUTION

The device can cope with laser reflection rate between 4% and 100% (approximation), but the indication may become dispersed when the reflection rate is low.

6.3.2 Delimiter setting

LAC-S is standardly equipped with RS-232C and GP-IB communication interfaces which can be used for communicating with the host computer.

Select “CR+LF” or “CR”. (The initial setting is “CR+LF”)

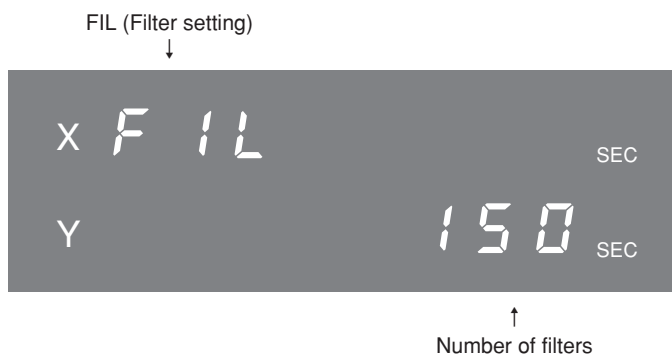


Procedure for Setting

- 1 Press [X Reset] along with [FUNC] in “Measuring mode” and then, press [X Reset] one more time. “dEL (delimiter setting)” will appear.
- 2 Press [Y Reset] and select “CR+LF” or “CR”.
- 3 When finished, press [FUNC] and return to “MEASURING mode”.

6.3.3 Filter setting

Filter setting for LAC-S is to lessen the dispersion of the display which is caused by force of air. The display will be more stable by setting a larger number of filters, but response will become blunt. Please set filters according to the aim of the measurement.

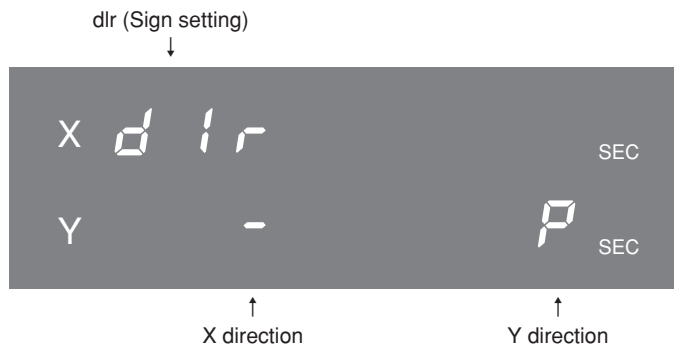


Procedure for Setting

- 1 Press [X Reset] along with [FUNC] in “Measuring mode” and then, press [X Reset] two times. “FIL (filter setting)” will appear.
- 2 10 filters at a time, from 0 to 240, can be set each time you press [Y Reset].
The filter value indicates the time for filtering. Filter “10” is equivalent to approx. 0.3 seconds. For example, if you set filters to “150”, the time for filtering will be approx. 5 seconds.
- 3 When finished, press [FUNC] and return to “MEASURING mode”.

6.2.4 Sign setting

“X” on the counter indicates the tilt angle in the horizontal direction and “Y” indicates that in the vertical direction. Sign setting enables you to change the tilting direction (+/- directions) for X and Y. (The initial setting is “PP”.)



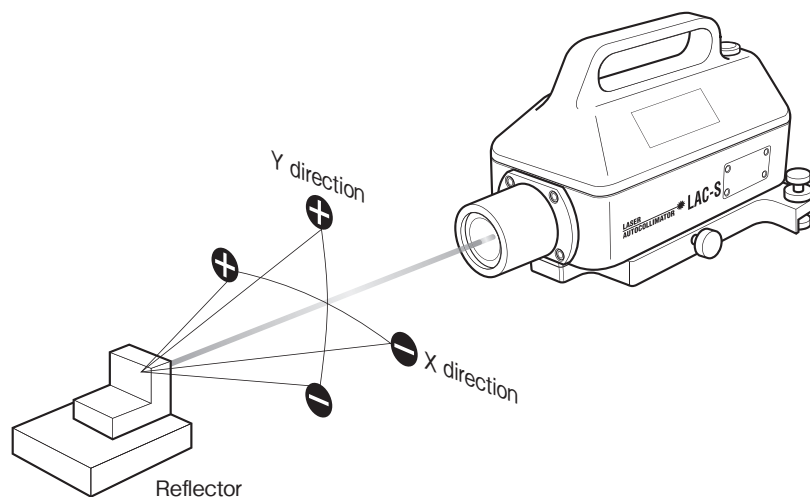
The display changes between [PP], [-P], [P-], and [--] each time you press [Y Reset].

Procedure for Setting

- 1 Press [X Reset] along with [FUNC] in “Measuring mode” and then, press [X Reset] three times. “dlr (sign setting)” will appear.
- 2 The display changes between “PP”, “-P”, “P-”, and “--” each time you press [Y Reset]. Sign setting can be selected from the above 4 patterns. “P” stands for plus and “-” stands for minus. The direction of “+” or “-” will be reversed when changed.
- 3 When finished, press [FUNC] and return to “MEASURING mode”.

Position when “P-P” is selected

The following position shows the tilt of the reflector and sign.



7 Measuring Method

The following “Measuring the straightness of the surface plate” is an example of a basic measuring method. Please do an actual measurement based on this method.

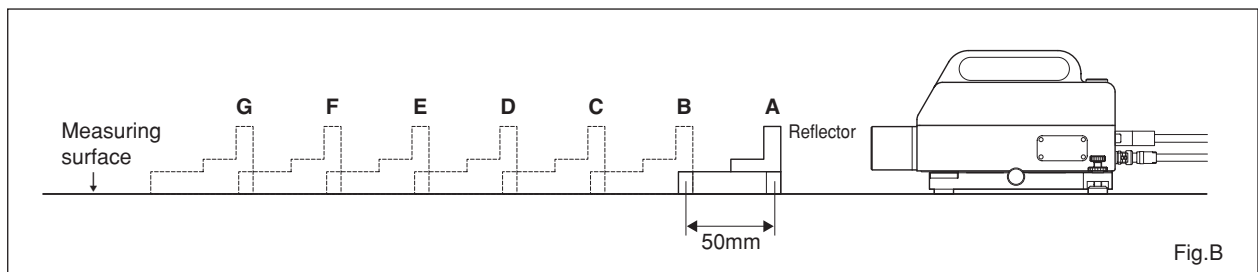
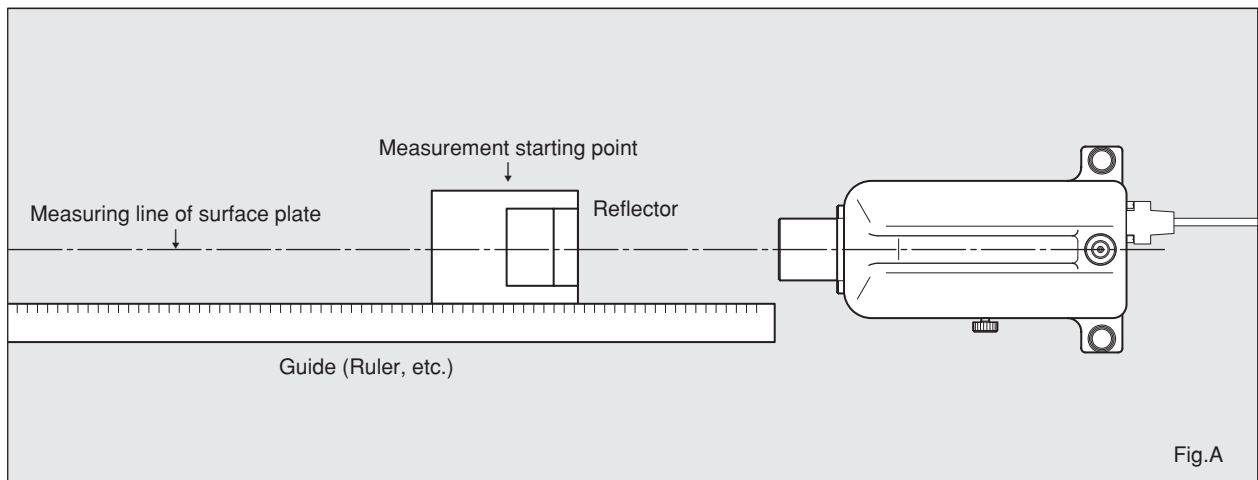
For other measuring methods, see “10 Examples of Measuring” (P.24).

⚠ CAUTION

With LAC-S, measuring cannot be performed so that two or more lights return to LAC-S. Furthermore, when light is reflected and returned from something other than the surface of the specimen, proper measuring results cannot be obtained.

7.1 Measuring the straightness of the surface plate

Set LAC-S along with a reflector and guide on the surface plate subject to measuring (Fig. A) and measure the 7 points from A to G (Fig. B).

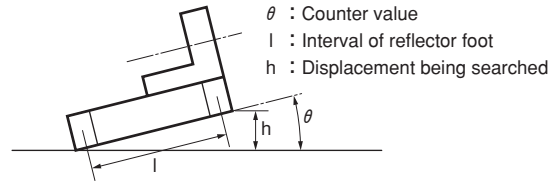


Procedure for Measuring

- 1 Set a ruler which becomes a guide for the reflector along the measuring line. Secure the ruler with adhesive tape if necessary.
- 2 Set the reflector at the starting point “A” of measurement.
- 3 Inject laser and adjust the position of LAC-S so that laser beam returns to the injection hole of the lens cap.
- 4 Remove the lens cover and start measuring. A measured value appears on the counter if measuring is done properly.
- 5 When measurement of “A” (first point) is finished, move the reflector along the guide to the next point “B”. Move the reflector by 50mm or 100mm (interval of reflector foot = when using measuring mirror for LAC-S) and measure each position.
- 6 Measure A to G and keep a record of the value of each position.

7.2 Measuring results

Obtain the displacement of each point from data acquired from “7.1 Measuring the straightness of the surface plate” and plot the accumulated value on a graph. Connect both ends of the graph and displacement from the straight line becomes the straightness.



NOTE

A method called “End-point”, where you adjust both ends of the graph to “0” (zero), makes it easy to obtain displacement from a graph. This method is applied below.

CAUTION

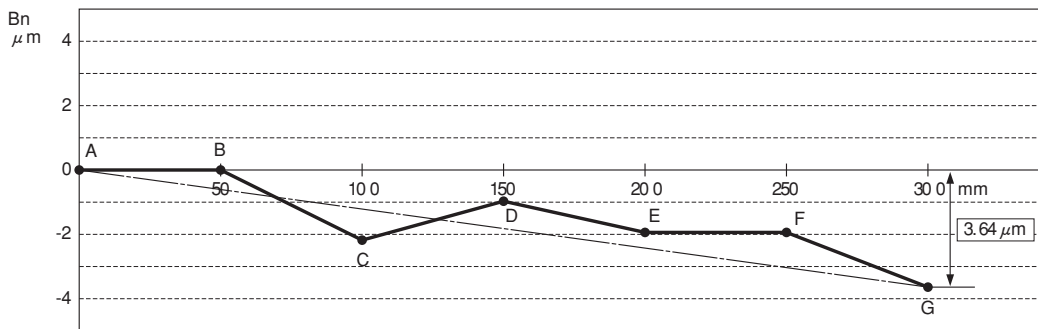
In the actual measurement, two directions, X and Y, are measured, but in this case, only the displacement of Y direction is used. Please ignore the X direction.

Measuring results and analysis results (End-point Method)

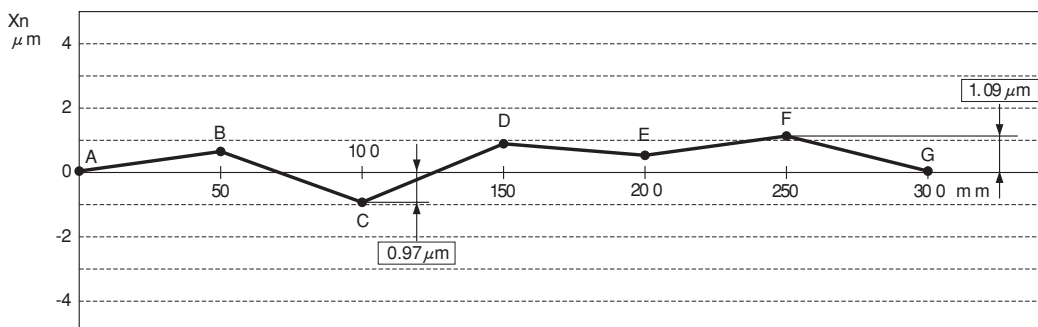
Measuring point	A	B	C	D	E	F	G
Number of times: n	0	1	2	3	4	5	6
Counter reading: θ_n (First is θ_1)	-	0"	+9"	-5"	+4"	0"	+7"
Displacement of 50mm: $A_n = -1 \cdot l \cdot \sin \theta_n (\mu m)$	0	0	-2.18	-1.21	-0.97	0	-1.7
Accumulated value: $B_n = A_n + A_{n+1} (\mu m)$	0	0	-2.18	-0.97	-1.94	-1.94	-3.64
Correction value: $C_n = \frac{n}{6} \times B_6$	0	-0.61	-1.21	-1.82	-2.43	-3.03	-3.64
Height difference from reference surface: $X_n = B_n - C_n$	0	0.61	-0.97	0.85	0.49	1.09	0

* When the reading of LAC-S increases, displacement decreases, so multiply -1.

Graph 1



Graph 2



8 Communication Function

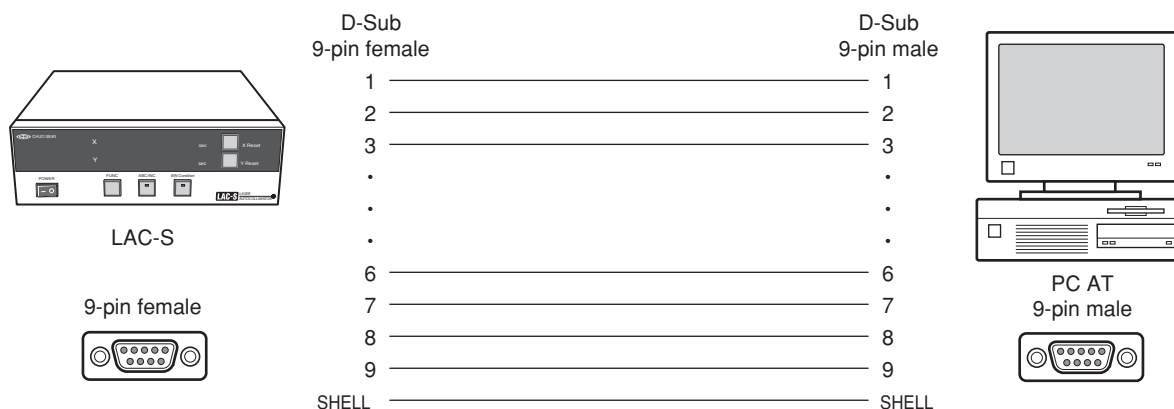
LAC-S is standardly equipped with RS-232C and GP-IB (IEEE-488) communication interface. By using these to send commands from the host computer to LAC-S, you can send measuring data from LAC-S back to the host computer.

8.1 RS-232C communication specifications

Set the following to communicate via RS-232C.

Baud rate	9600/19200	Set from MODE SW
Bit length	8-bit	Fixed
Parity	Even number	Fixed
Stop bit	2-bit	Fixed
Delimiter	CR+LF/CR	Set in "Setting mode"

8.1.1 RS-232C cable specifications



Pin configuration is the same as a standard PC AT compatible device. When using a commercially-available cable, use a straight type in which both ends are 9-pin (female).

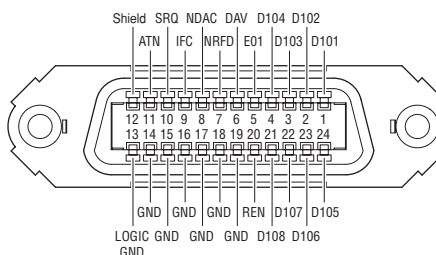
8.2 GP-IB communication specifications

Set the following "Delimiter" and "GP-IB address" to communicate via GP-IB.

Communication system	Conform to IEEE488 standard	-
Delimiter	CR+LF/CR	Set in "Setting mode" (EOI cannot be used.)
GP-IB address	1 to 15	Set from MODE SW
Connector type	24-pin IEEE type	-

8.2.1 GP-IB connector specifications

24-pin GP-IB connector
57-2040-D35 (equivalent to Amphenol product)

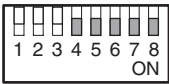


The GP-IB board we recommend is the PCI-GPIB made by Japan National Instruments. (Used under our evaluation)

8.3 Setting RS-232C baud rate and GP-IB address

RS-232C baud rate and GP-IB address are set from MODE SW “Dip SW No. 4 to 8” on the back side of the counter.

MODE SW



RS-232C baud rate	Dip SW No.4
GP-IB address	Dip SW No.5 to 8

CAUTION

Do not change Dip SW No.1 or 2.

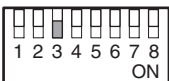
RS-232C baud rate	
No.4	Baud rate
OFF	9600
ON	19200

GP-IB address				
No.5	No.6	No.7	No.8	Address
OFF	OFF	OFF	ON	1
OFF	OFF	ON	OFF	2
OFF	OFF	ON	ON	3
OFF	ON	OFF	OFF	4
OFF	ON	OFF	ON	5
OFF	ON	ON	OFF	6
OFF	ON	ON	ON	7
OFF	OFF	OFF	OFF	8
ON	OFF	OFF	ON	9
ON	OFF	ON	OFF	10
ON	OFF	ON	ON	11
ON	ON	OFF	OFF	12
ON	ON	OFF	ON	13
ON	ON	ON	OFF	14
ON	ON	ON	ON	15

8.4 Setting “SEND” function

“SEND” function is set from MODE SW “Dip SW No. 3” on the back side of the counter.

MODE SW



“SEND” function setting Dip SW No.3	
OFF	Invalid
ON	Valid

CAUTION

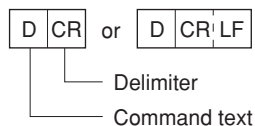
Do not change Dip SW No.1 or 2.

9 Commands

9.1 Command format

- Commands are represented in ASCII code.
- Commands that can be sent are indicated in one-byte characters.
- At the end of a command, CR or CR-LF. (“EOI” cannot be used.)

Command format



9.2 Command list

The following is a list of commands used with LAC-S.

Command	Function	Reply	Remarks
D	Data readout	Stated separately	
RX	X-axis reset	06h	Only during INC (Incremental)
RY	Y-axis reset	06h	Only during INC (Incremental)
RW	Both axes reset	06h	Only during INC (Incremental)
DX0	X-axis sign change 1	06h	Same as “P” on the counter
DX1	X-axis sign change 2	06h	Same as “-” on the counter
DY0	Y-axis sign change 1	06h	Same as “P” on the counter
DY1	Y-axis sign change 2	06h	Same as “-” on the counter
A	ABS display change	06h	Changes counter display and return value with “D” command to ABS (Absolute)
I	INC display change	06h	Changes counter display and return value with “D” command to INC (Incremental)
?	Version check	Stated separately	Returns version to host

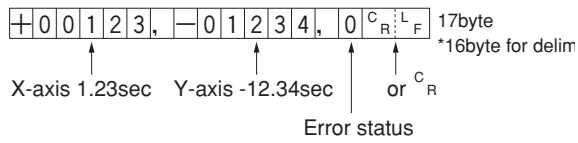
CAUTION

- “06h” (Acknowledge, affirmative reply) is sent as a reply when a reset command such as “RX” is sent during absolute value display, but the counter will not be reset.
- Operation may become abnormal if a character string other than the above command is sent. In such a case, turn the counter power OFF tentatively, and then turn it ON again to recover from the problem. Change the command to a normal character string to resume.

9.3 Data reply format

“D” command

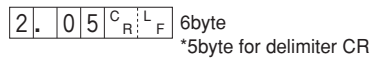
Position data is in 5-digit ASCII with sign and no decimal point. The order from the top is X-axis position, Y-axis position, error status, and delimiter. The unit is 0.01sec.



Error status	Definition
0	When light is returning to the sensor properly.
"<"	When sensor has no input, or when light is too weak to measure.

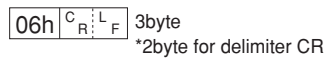
“?” command

Returns version of LAC-S to the host.



Other commands

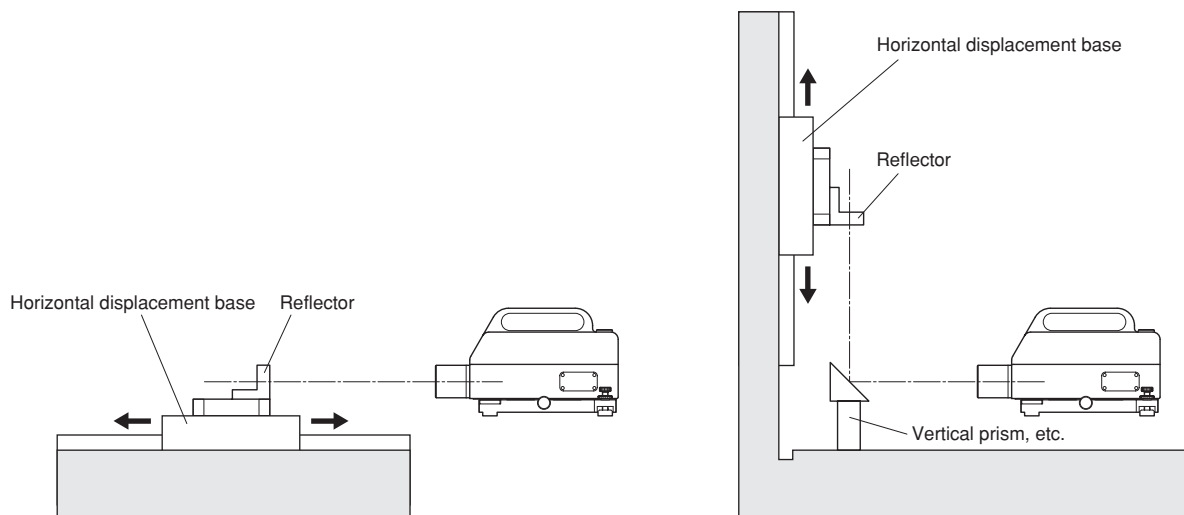
Returns ASCII code “06h”.



10 Examples of Measuring

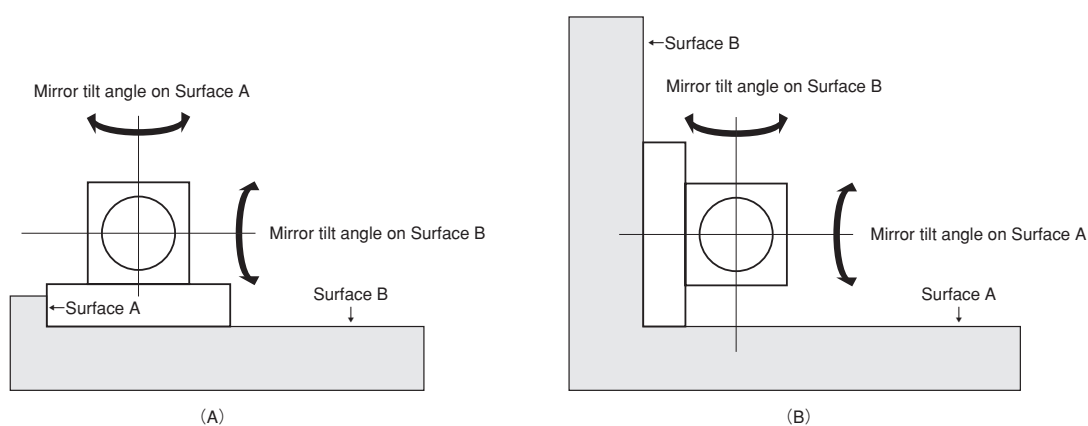
The following are examples of various types of measuring. Refer to the examples and measure in a method that conforms to your needs.

Measuring the straightness of the displacement base (Yawing and Pitching)



- 1 Set a reflector on the displacement base as shown above. Set the reflector so that it is at right angle to the moving direction of the base.
- 2 Set the displacement base at reference point and reset the counter. (INC value mode)
- 3 Yawing and pitching of the displacement base can be measured by moving the displacement base throughout the entire moving range and reading the counter value.

Measuring the straightness of the fixed guide surface



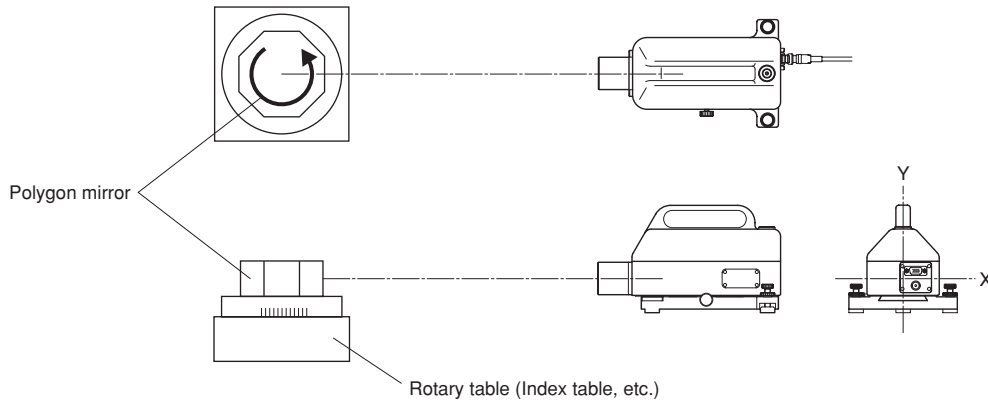
- 1 Set the reflector on the reference position of the fixed guide surface as in Fig. (A) or (B).
- 2 Reset the counter. (INC value mode)
- 3 Move the reflector by 50mm or 100mm (interval of reflector foot) and measure each position. Values of both X and Y directions can be measured in one movement.

Measuring split accuracy using a reference polygon mirror

Measure the split accuracy of a rotary table or index table using a polygon split in precise angles such as an octagon or dodecagon mirror.

CAUTION

Rotating a polygon results in spreading laser over an extensive area. Set the device so that laser axis extends lower than the eyes or block laser by setting a partition near the polygon mirror.



- 1 Set the polygon mirror at the center of the rotary table and set LAC-S so that it confronts one surface of the polygon mirror.
- 2 Set the counter to ABS value mode and set the position of LAC-S so that X and Y axes go near "0".
- 3 Adjust Y-axis of LAC-S to the rotary axis of the rotary mirror. (Refer to "Method for adjusting axis" indicated below.)
- 4 Reset the counter. (INC value mode)
- 5 The value for sending the split angle of the polygon mirror becomes the split accuracy of the rotary table.

Method for adjusting axis

Make adjustments so that the rotary axis of the polygon mirror and Y-axis of LAC-S become parallel.

- 1 Reset the counter and turn the polygon mirror slightly counterclockwise when viewing the mirror from above.
- 2 If Y-axis of the counter changes, make adjustment with LAC-S posture adjustment screw.
- 3 Repeat Steps 1 and 2 so that the value of Y-axis does not change when the polygon mirror is rotated. Adjustment can be made relatively easily by using an "adjustable base" (sold separately).

Calculation method

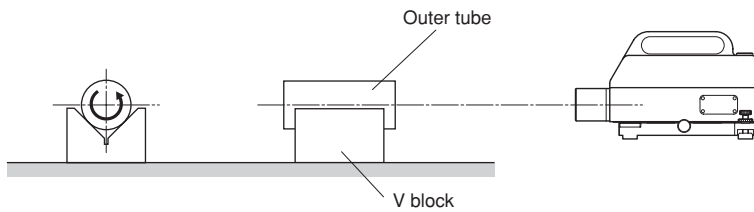
Split accuracy can be obtained with the following calculation formula even when the rotary axis of the rotary table is not parallel to Y-axis of LAC-S. When X and Y are values upon turning the rotary table sequentially,

$$\sqrt{X^2 + Y^2}$$

becomes the split accuracy.

Measuring camming

Measure the camming of the edge surface against the external diameter of the outer tube.

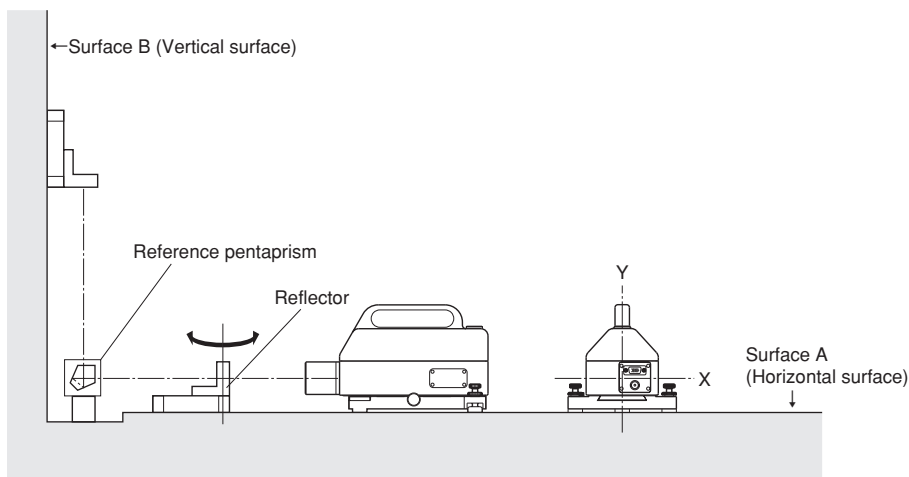


- 1 Set a V-block on the surface plate and place an external tube on top of the block.
- 2 Set LAC-S as shown in the figure and reset the counter. (INC value mode)
- 3 Turn the outer tube while reading the counter.
- 4 Read the value of X when Y becomes "0".
- 5 Read the value of Y when X becomes "0".
- 6 When the above values become X=a and Y=b, camming becomes

$$\frac{\sqrt{a^2 + b^2}}{2}$$

which is the right-angle tolerance against the external diameter of the cylinder of the edge surface.

Measuring the internal squareness of a specimen



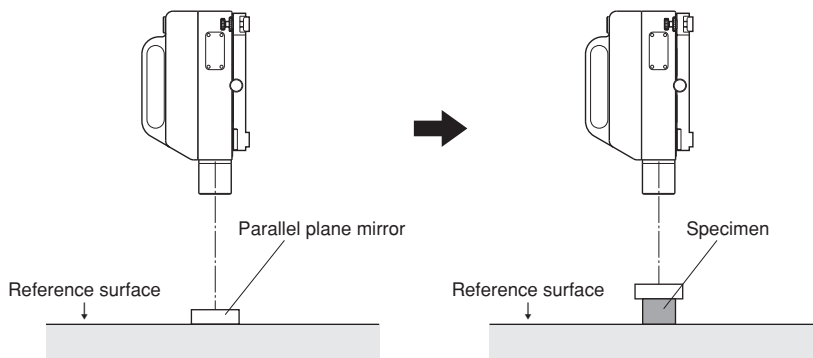
- 1 Set the reflector on the horizontal surface and swing the reflector slightly around the vertical axis.
- 2 Adjust the posture adjustment screw so that the value of Y-axis becomes steady. (Set the rotary axis of the reflector parallel to Y-axis of LAC-S. Also use the leveling instrument as reference.)
- 3 Reset the counter.
- 4 First, read the value of Y on Surface A and record the value.
- 5 Set the reference pentaprism as shown in the figure, move the reflector to Surface B, and pass laser through the pentaprism so that it returns to LAC-S.
- 7 Read the value of Y on Surface B and record the value.
- 8 Obtain the difference between the horizontal surface and vertical surface values. This value is the tolerance from the right angle.

CAUTION

The precision of this measurement depends on the right-angle precision of the reference pentaprism.

Measuring parallelism of both edge surfaces – 1

“Measuring with a reference parallel plane mirror”

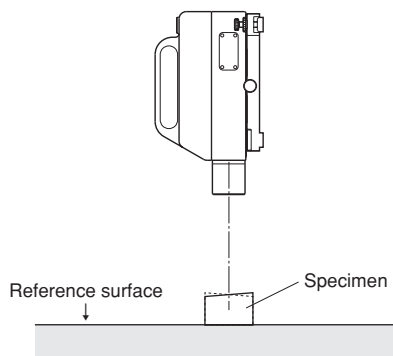


- 1 Set the parallel plane mirror on the reference surface and reset the counter. (INC value mode)
- 2 Set the same parallel plane mirror on the edge surface of the specimen.
- 3 When the counter value at this time is X and Y, and the parallelism of the specimen is A,

$$A = \sqrt{X^2 + Y^2} \text{ (sec)}$$

Measuring parallelism of both edge surfaces – 2

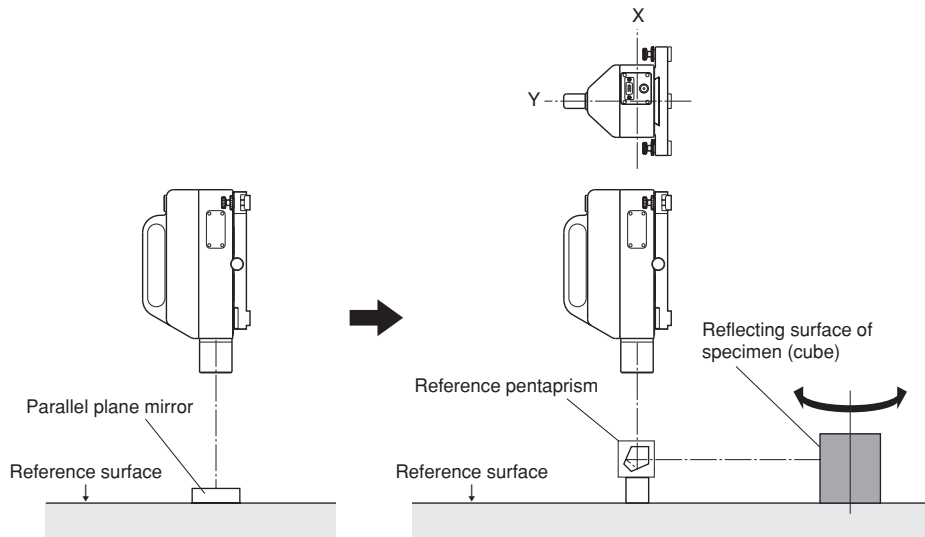
“Measuring without using a reference parallel plane mirror”



- 1 Set the specimen on the reference surface and reset the counter. (INC value mode)
- 2 Turn the specimen while watching the counter.
- 3 Read the X value when Y becomes “0” and record the value as X=A.
- 4 Read the Y value when X becomes “0” and record the value as Y=B.
- 5 When C is the parallelism of the specimen at this time,

$$C = \frac{\sqrt{A^2 + B^2}}{2} \text{ (sec)}$$

Squareness of a cuboid

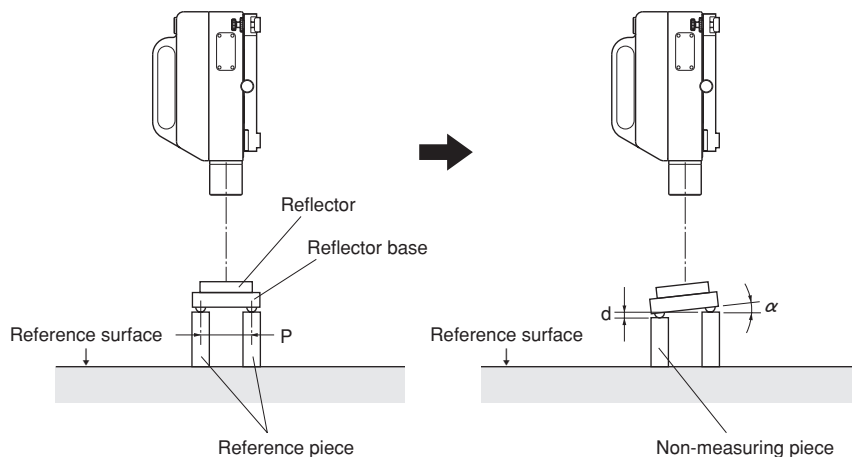


- 1 Set a parallel plane mirror on the reference parallel surface and reset the counter. (INC value mode)
- 2 Remove the parallel plane mirror and set a reference pentaprism.
- 3 Set the specimen on the reference surface, reflect laser from the surface through the reference pentaprism, and return laser to LAC-S.
- 4 Swing the specimen around an axis which is right-angle against the reference surface. Adjust the position of the reference pentaprism so that the value in the Y direction becomes steady at this time.
- 5 The value of Y becomes the tolerance of the bottom surface of the specimen and the right-angle of the reflecting surface.

⚠ CAUTION

- The reflection rate of the parallel plane mirror and specimen should be similar.
- The precision of this measurement depends on the right-angle precision of the reference pentaprism.
- Be careful not to move LAC-S.

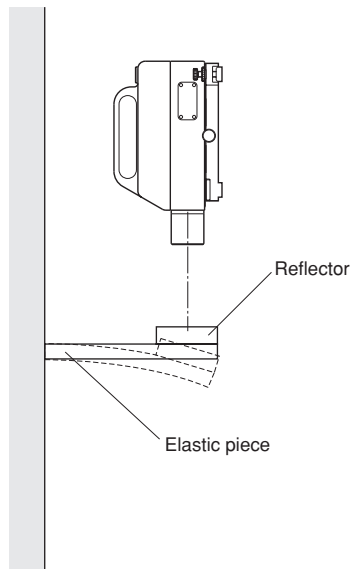
Measuring the minute change in length



- 1 Place a foot pitch p base between 2 reference pieces, secure the reflector on the base, and reset the counter. (INC value mode)
- 2 When the reading of one reference piece when converted to a non-measuring piece is X and Y, the change in angle at this time becomes

$$\alpha = \sqrt{X^2 + Y^2} \text{ (sec)}$$

- 3 The change in length can be obtained from $d = p \times \sin \alpha$.

Measuring deflection of an elastic piece

- 1 Secure the reflector on the elastic piece and reset the counter. (INC value mode)
- 2 When the counter value upon applying deflection to the elastic piece is X and Y, the deflection angle becomes

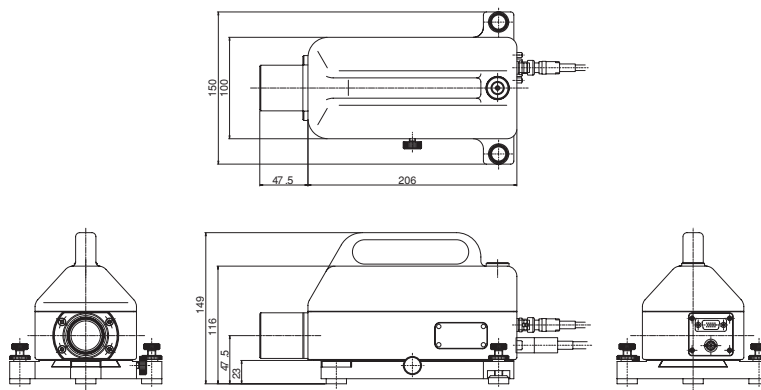
$$\sqrt{X^2 + Y^2} \text{ (sec)}$$

11 Main Specifications

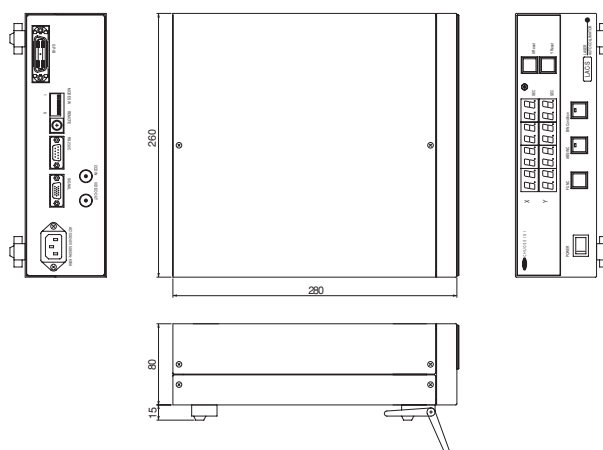
Light source	Semiconductor laser (650nm)	
Laser output from LAC-S	0.5mw or less (Class 2)	
Detection sensor	CCD sensor	
Power source	AC100-240V 50-60Hz 60VA (Cable length: 3m)	
Power consumption	0.7A	
Focal distance	600mm	
Measuring axis	Simultaneously 2 axes	
Measuring range	±180"	
Display	Shift between Absolute value (ABS) & Incremental value (INC)	
Display range	-200" to +200" (for ABS value display)	
Displayed digits	Shift between 1", 0.1", 0.01"	
Specimen reflection rate	4 to 100% (Sensitivity adjustable)	
Cycle for updating centroid data	1/30 sec.	
Temperature for guaranteeing precision	20±1°C	
Outer dimension	Main body	W150 x H149 x D253.5mm (projection not included)
	Counter	W260 x H95 x D280mm (projection not included)
External interface	RS-232C, GP-IB, external monitor output	
Measuring precision	Distance up to 1000mm	Range ±120" ±0.5"
		Range ±180" ±1.0"
	Distance up to 2500mm	Range ±180" ±1.0"

LAC-S dimension

Main body



Counter



12 Warranty & Repair / Miscellaneous

12.1 Warranty & Repair

Warranty

- Chuo Precision will make repairs without a fee based on the following regulations if the device goes out of order during the warranty period.
- The registration card that comes with the product must be sent in order to receive aftercare service. Be sure to fill out the form and send it to Chuo Precision.

Regulations on Free Warranty

The warranted period is one year from the time of delivery.

- 1) The product will be fixed at no cost if the problem occurred under normal operating conditions that are described in the Instruction Manual and the precautions described on the labels on the product were observed.
- 2) The warranty certificate must be submitted along with the product in order to obtain repair at no cost during the warranted period.
- 3) The warranted period is valid only in Japan. Products exported to other countries are not subject to the warranty.
- 4) A fee is charged in the following circumstances even during the warranted period.
 - Problems that were caused by improper usage, or faulty repair/modification.
 - Damage caused by dropping the product after purchase.
 - Damage caused by a natural calamity such as a fire, earthquake, flood, lightning, etc., or by pollution or abnormal voltage.
 - When a warranty certificate is not submitted.
 - When the damage is determined by Chuo Precision in advance not to be within the warranty range.

Repair During the Warranted Period

- Please contact Chuo Precision or the store where you purchased the product. Be sure to have your warranty certificate at that time.

Repair After the Warranted Period

- Please contact Chuo Precision or the store where you purchased the product even when the warranted period has expired. Depending on the level of damage, the damage may be repaired for a fee.
- The majority of maintenance parts will be available for a minimum of six years after production is ended. We may not be able to provide support after this term has passed. Furthermore, please acknowledge that we may not be able to fulfill this condition depending on the circumstances of the parts manufacturers.

12.2 Environmental Requests

When the product is not used

Be sure to turn OFF the power when the LAC-S or host computer is not being used. Furthermore, if you do not plan to use the machines for a long period of time, unplug the power cable from the outlet.

Disposing of the product, accessories, and packing materials

Dispose of the main unit, control box, and cables as non-flammable waste (industrial waste). In addition, dispose of the boxes, padding materials, and plastic bags that contained the product and its parts according to local regulations.

The contents of this manual are subject to change without notice.
In addition, we may reform the product itself without notice.

LAC-S Instruction Manual Ver. 2.2(E)

March 18, 2011 ADV.



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