

**LSM-500S/501S/503S/
506S/512S/516S**

**Laser Scan
Micrometer
(Measuring Unit)**

User's Manual

Read this User's Manual thoroughly
before operating the instrument. After reading,
retain it close at hand for future reference.

Mitutoyo

CONVENTIONS USED IN USER'S MANUAL

Mitutoyo manuals use various safety signs. The visual cues and the contents of description appended to each cue are described below.

Safety Precautions

To ensure that instruments are operated correctly and safely, Mitutoyo manuals use safety signs (Signal Words and Safety Alert Symbols) to identify and warn against hazards and potential accidents.

The following signs indicate **general** warnings:



DANGER

Indicates an imminently hazardous situation which, if not avoided, will result in serious injury or death.



WARNING

Indicates a potentially hazardous situation which, if not avoided, could result in serious injury or death.



CAUTION

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

The following signs indicate **specific** warnings or prohibited actions, or indicate a mandatory action:



Alerts the user to a specific hazardous situation. The given example means "Caution, risk of electric shock".



Prohibits a specific action. The given example means "Do not disassemble".



Specifies a required action. The given example means "Ground".

CONVENTIONS USED IN USER'S MANUAL

Various Types of Notes

The following types of **notes** are provided to help the operator obtain reliable measurement data through correct instrument operation.

-
- IMPORTANT**
- An *important note* is a type of note that provides information essential to the completion of a task. You cannot disregard this note to complete the task.
 - An *important note* is a type of precaution, which if neglected could result in a loss of data, decreased accuracy or instrument malfunction/failure.
-

NOTE A *note* emphasizes or supplements important points of the main text. A note supplies information that may only apply in special cases (e.g., Memory limitations, equipment configurations, or details that apply to specific versions of a program).

TIP A *tip* is a type of note that helps the user apply the techniques and procedures described in the text to his or her specific needs.
It also provides reference information associated with the topic being discussed.

Mitutoyo assumes no liability to any party for any loss or damage, direct or indirect, caused by use of this instrument not conforming to this manual.
Information in this document is subject to change without notice.

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NOTES FOR EXPORTING

Before exporting this product confirm the final purpose of use at the export destination to prevent the product from being used for developing weapons of mass destruction or military affairs. In the case of export to the U.S., this product requires an application for prior approval of CDRH (Center for Devices and Radiological Health) in FDA (Food and Drug Administration). An additional cost generates in application procedure. For detailed information consult a Mitutoyo sales office. Also, if this product is exported with it incorporated in equipment, the final product requires an application for FDA approval. If this is the case, note that the client must file an application for approval.

INSTALLATION CONDITIONS

The Mitutoyo Laser Scan Micrometer LSM-500H series is an instrument for indoor use. Also, this series is a precision optical instrument and a precision electronic instrument. Therefore, it must be carefully installed and the following conditions must be taken into account to attain the highest possible accuracy. Mitutoyo assumes no liability for any accident or damage caused by use of this instrument not conforming to these conditions.

1. Vibration

Install the LSM in a place with minimum vibration. If the LSM is subjected to vibrations for a long period of time, precision components in the system may malfunction, thus affecting the measuring accuracy.

If the vibrations are significant, minimize them by laying a vibration damping rubber pad, etc.

2. Dust/Grit

Dust, if present in the installation site, will affect the optical components such as protection glass (in the measuring unit) and electronic components (in the display unit). Install the LSM in a place that is as free as possible from dust/grit.

3. Direct sunlight

If this instrument is exposed to direct sunlight, the heat may deform the instrument and adversely affect the measuring accuracy.

If this instrument must be placed by a window where it will be subject to direct sunlight, protect the instrument by shading it with curtains, etc.

4. Blow from the air conditioner

If the measuring place is exposed to hot or cool air blow from the air conditioner, the laser beam may be refracted due to the difference in air density and adversely affect the measuring accuracy.

If this is the case, block direct air flow with curtains, etc.

5. Ambient temperature and humidity

Avoid installing this instrument in an environment where there is rapid temperature or humidity change. Otherwise, it may reduce measuring accuracy. This instrument must be operated in the following ambient conditions.

Temperature: 0°C to 40°C

Humidity: 35%RH to 85%RH

WARRANTY

This instrument has been manufactured under rigorous Mitutoyo quality control. Should it malfunction under normal use within one year from the date of original purchase, it will be repaired or replaced, at our option, free of charge. Contact your dealer or the nearest Mitutoyo representative for more information.

However, the following damages may be subject to a repair charge even if damage occurs within the warranty period:

1. Unit malfunction or damage arising from improper handling, or unauthorized retrofit or repair by the user.
2. Unit malfunction or damage as the result of moving, dropping, or transporting after purchase.
3. Unit malfunction or damage due to fire, salt, gas, abnormal voltage, or natural catastrophe.

This warranty is not transferable and is only valid within the country of the original purchase.

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SERVICE NETWORK

MEMO

1

INTRODUCTION

This chapter describes the maintenance and inspection of the Laser Scan Micrometer (LSM) measuring unit.

1.1 Outline

The Laser Scan Micrometer is a high-precision laser measuring system that performs non-contact dimensional measurements with a high-speed scanning laser beam.

With non-contact measurement capability, this system features high-precision measurement of workpieces that are difficult for conventional measuring systems to measure, including hot workpieces, brittle or elastic workpieces, workpieces that must be kept free from contamination, and soft workpieces subject to the measuring force.

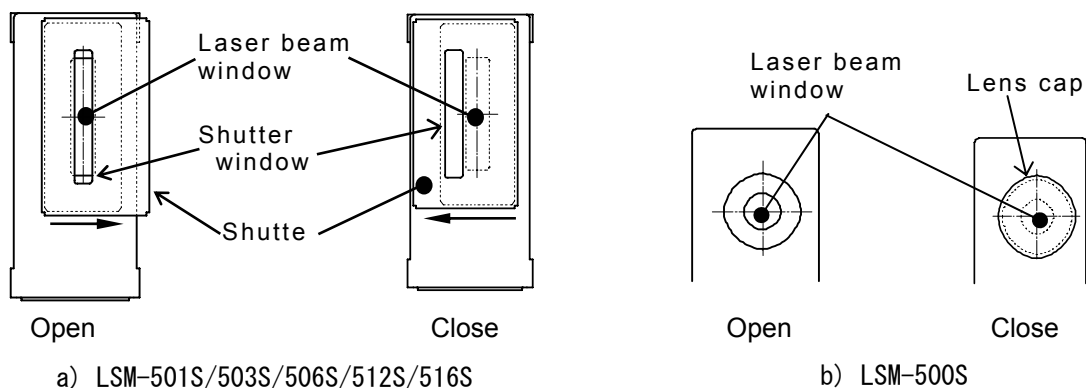
1.2 Introduction

This measuring unit is used with the display unit of the LSM-6200. Since this User's Manual primarily describes the specifications of the measuring unit, please refer to the User's Manual of the LSM-6200 for details about connection with a display unit, functions, and measurement procedures.

The measuring unit is provided with a shutter or cap on the emission unit and reception unit. Laser equipment has such safety precautions.

During measurement: Open the shutter by sliding it as shown in the below left diagram of fig-a), or remove the lens cap as shown in the below left diagram of fig-b).

During no-measurement: Close the shutter by sliding it as shown in the below right diagram of fig-a), or mount the lens cap as shown in the below right diagram of fig-b).

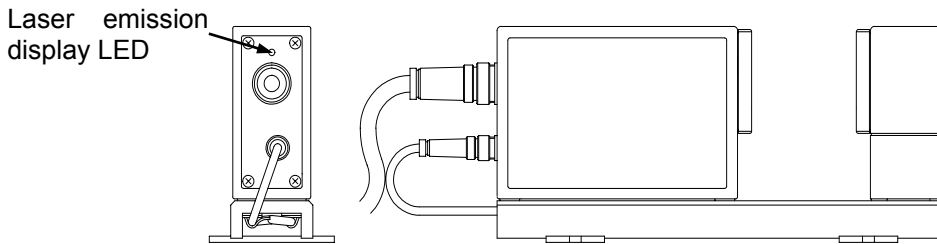


1.3 Inspection and Maintenance

This section describes the inspection and maintenance procedures of the measuring unit.

1.3.1 Laser emission display LED

The Laser Emission Display LED that is provided on the rear side lights while the laser is being emitted to call the operator's attention for safety. Do not look the laser beam.



1.3.2 Cleaning optical parts

To clean the optical parts, turn off the power switch and disconnect the signal cable for safety.

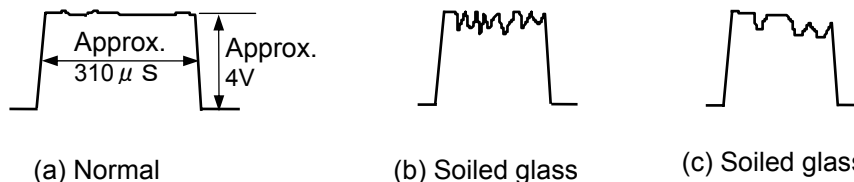
Always keep the protective glass of the emission unit and reception unit clean. Soiled protective glass will not only result in reduced measurement accuracy, but possibly produce erroneous measurements due to dust and foreign particles being treated as part of the workpiece.

For cleaning, use a blower brush or use gauze slightly dampened with ethyl alcohol to gently wipe clean soiled portions using very light pressure.

- Checking the contamination of the protective glass using an oscilloscope

A monitor connector, "SCAN SIG.-1", of the reception light signal is provided on the rear panel of the display unit. Check the reception light signal by connecting the probe of the oscilloscope with the monitor connector. Oscilloscope setup is as follows:

- Vertical sensitivity: 0.1V/DIV (with a probe of 10:1)
- Horizontal sensitivity: 100 μ s/DIV

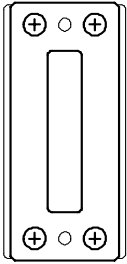


If the waveform generated by the oscilloscope looks like either of the ones shown in (b) or (c), clean the protective glass to reduce the disorder of waveform to less than 0.3V.

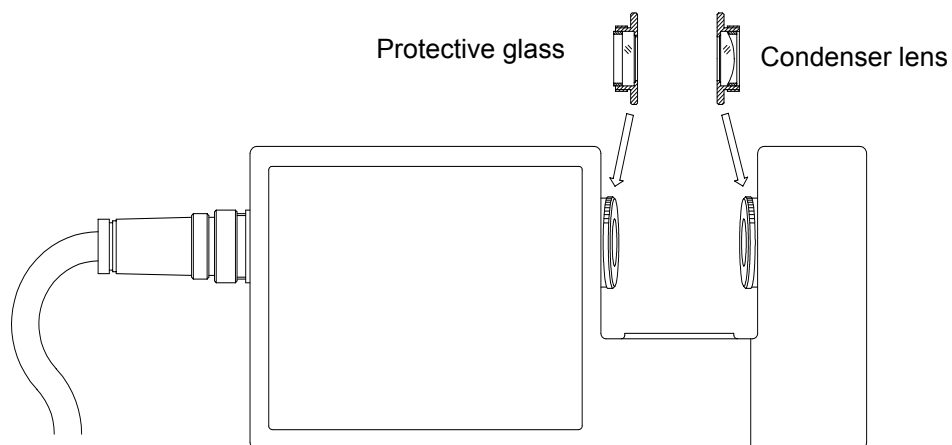
NOTE · The protective glass of the windows is a precision optical part. Handle with care so as not to scratch the glass.

1.3.3 Replacing the protective glass and the condenser lens

Follow the procedures below to remove the protective glass for replacement or cleaning. To replace the protective glass, first turn off the power switch, then disconnect the signal cable for safety.

Model	LSM-501S/LSM-503S/LSM-506S/LSM-512S/LSM-516S	
Removing steps	Unscrew the screws that secure the protective glass. Remove the protective glass and the rubber packing.	
Remounting steps	Remount the protective glass by reversing the steps above.	
NOTE	Dust will enter the enclosure if the protective glass is not re-installed. In a humid environment damp air will enter the enclosure, causing reduced optical clarity. So, ensure that the work is done in an air-conditioned room that is free from dust.	

Model	LSM-500S	
Removing steps	Remove the protective glass and the condenser lens by rotating them counterclockwise. Remove the O-ring.	
Remounting steps	Attach the O-ring. Mount the protective glass and the condenser lens in place by rotating them clockwise, as shown below. If mounted in the wrong order, measurement cannot be taken.	
NOTE	Dust will enter the enclosure if the protective glass is not re-installed. In a humid environment damp air will enter the enclosure, causing reduced optical clarity. So, ensure that the work is done in an air-conditioned room that is free from dust.	



MEMO

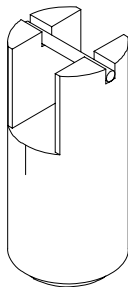
2

CALIBRATION

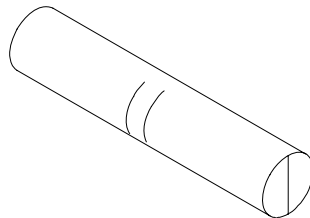
The accuracy of the instrument has been verified by two-point calibration using two reference gages.

High-precision calibration is possible and simple to perform, as mentioned in the User's Manual attached to the display unit. Calibrate the instrument properly. Types and sizes of the calibration gages are as follows:

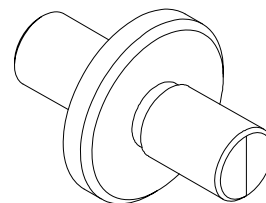
Model		LSM-500S	LSM-501S	LSM-503S	LSM-506S	LSM-512S	LSM-516S
LOW CAL GAGE	Size	φ0.1mm		φ 1mm		φ 20mm	
	Type	With-holder				Stepped	
HIGH CAL GAGE	Size	φ 2mm	φ 10mm	φ 30mm	φ 60mm	φ 120mm	φ 160mm
	Type	With-holder	Straight	Stepped			



With-holder type



Straight type



Stepped type

2.1 Calibration Gage

2.1.1 With-holder type :

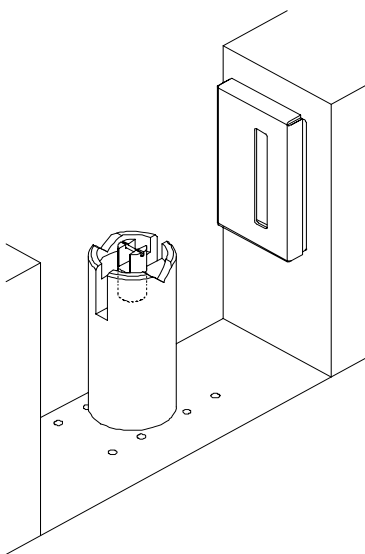
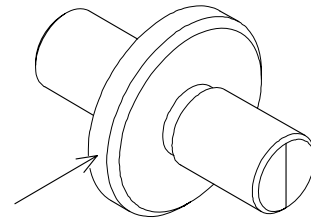
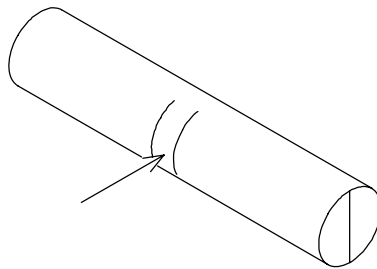
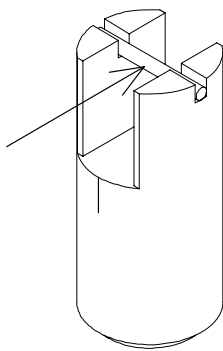
- The center point of the gage, which is indicated by an arrow (\rightarrow), is the calibration point.
- Set up the gage on the stand so that the laser beam is aligned with the vertical line (|) marked on the side of the gage holder.

2.1.2 Straight type :

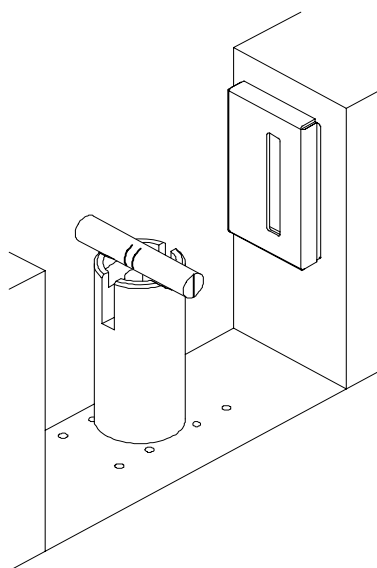
- The center point of the marks (||) of the gage, which is indicated by an arrow (\rightarrow), is the calibration point.
- Set up the gage on the stand so that the mark (|) on the end face of the gage comes to vertical.

2.1.3 Stepped type :

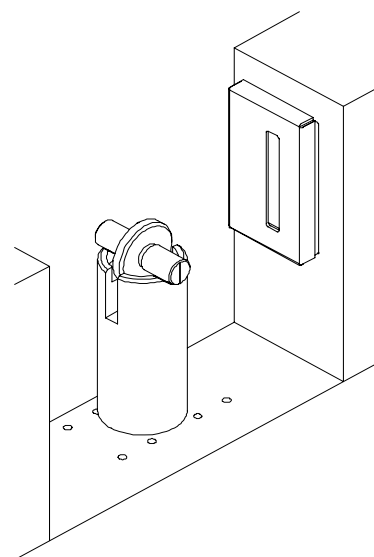
- The center point of the gage, which is indicated by an arrow (\rightarrow), is the calibration point.
- Set up the gage on the stand so that the mark (|) on the end face of the gage comes to vertical.



With-holder type



Straight type



Stepped type

3

SPECIFICATIONS OF MEASURING UNIT

This chapter gives the specifications of the following models.

Model	Measuring range	Code No.
LSM-500S	ϕ 0.005mm to ϕ 2mm	544-532
LSM-501S	ϕ 0.05mm to ϕ 10mm	544-534
LSM-503S	ϕ 0.3mm to ϕ 30mm	544-536
LSM-506S	ϕ 1mm to ϕ 60mm	544-538
LSM-512S	ϕ 1mm to ϕ 120mm	544-540
LSM-516S	ϕ 1mm to ϕ 160mm	544-542

3.1 LSM-500S

(1) Specifications

MODEL	LSM-500S	
Order No.	544-532	
Applicable display unit	LSM-6200	
Laser scanning range	mm(inch)	Up to 12.5(.49") (Detecting regions is limited to about 10 mm (.4") approx.)
Measuring range	mm(inch)	0.005 to 2 (.0002" to .08") 0.1 to 2 (.004" to .08")[*1]
Resolution	μm(inch)	0.01 to 10 (.00001" to .0005") [Selectable]
Repeatability[*2]	μm(inch)	±0.03 (±.000012") [*3]
Linearity [*2]	μm(inch)	±0.3 (±.000012") [*4]
Positional error [*2][*5]	μm(inch)	±0.4 (±.000016")
Measuring region	mm(inch)	1 × 2 (.04" × .08") [Optical axis direction × Scanning direction]
Number of scans for averaging	scan	16 to 2048[*6]
Laser classification	Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)	
Number of laser scans	/sec	3200
Laser scanning rate	m/sec (inch/sec)	76(2992"/sec)
Protection level	IP64	
Operation environment	Temperature	0 °C to 40 °C
	Humidity	35 %RH to 85 %RH [without condensation]
	Altitude	2000 m or less
Storage environment	Temperature	-15 °C to 55 °C
	Humidity	35 %RH to 85 %RH [without condensation]

[*1] : Measuring range available when set to "No extra-fine wire measurement" or "Edge specification" in the basic setup mode.

[*2] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*3] : The value of $\pm 2\sigma$ with a 2mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*4] : The value of measurements in the center of the measurement region.

[*5] : Error due to the positional shift of the workpiece in the optical axis direction or scanning direction.

[*6] : Averaging scans between 1 and 8 times can be made if "No extra-fine wire measurement" is specified in the basic setup mode. The measuring range, however, is limited to 0.1 mm to 2 mm in this case.

(2) Standard accessories

Part No.	Item	Qt.
—	ID unit [*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

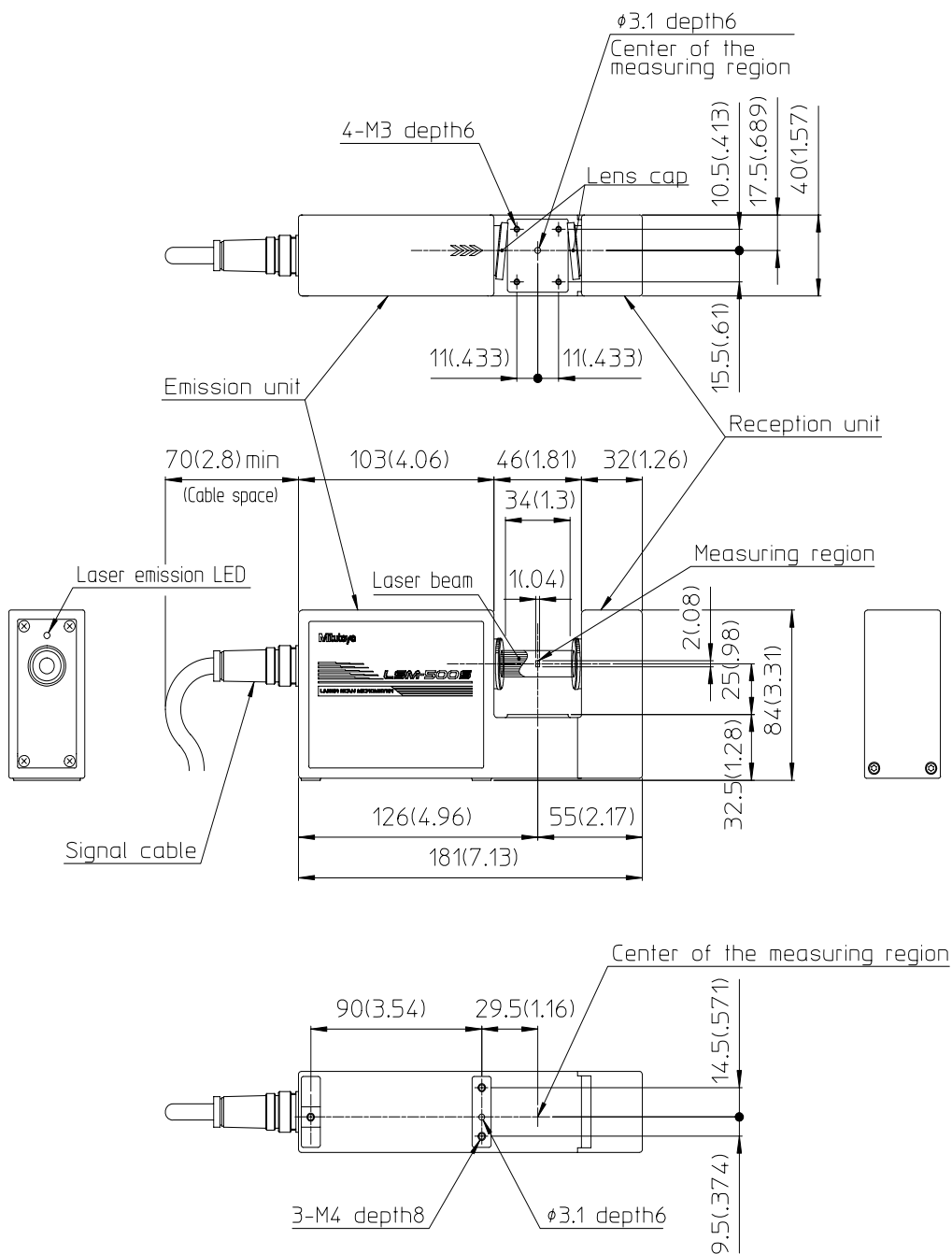
Order No.	Item
02AGD110	Calibration gages set ϕ 0.1 mm ϕ 2 mm
02AGD200	Guide pulley unit for LSM-500H (also available for LSM-500)
02AGD220	Air-blow unit for LSM-500H (also available for LSM-500)
02AGN780A/B	Extension signal cables (5m/10m)(16ft/32ft)[*8] [*9]

[*8] : The signal cable can be extended up to 20 m(64ft).

[*9] : The length of the signal cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



Unit : mm (inch)

【Mass】

- Measuring unit : 1.0 kg
- Signal cable : 0.5 kg

3.2LSM-501S

(1) Specifications

MODEL		LSM-501S	
Order No.		544-534	
Applicable display unit		LSM-6200	
Laser scanning range	mm(inch)	Up to 19 (.74")	
Measuring range	mm(inch)	0.05 to 10 (.002" to .4")	
Resolution	μm(inch)	0.01 to 10 (.000001" to .0005) [Selectable]	
Repeatability [*1]	μm(inch)	±0.04 (±.0000016")[*2]	
Linearity [*1]	Whole range	μm(inch)	±0.5 (±.00002")[*3]
	Narrow measuring range	μm	±(0.3 + 0.1 ΔD)
inch		±(.000012" + .000004" ΔD)	[*3][*4]
Positional error [*1][*5]	μm(inch)	±0.5 (±.00002")	
Measuring region	mm(inch)	2 × 10(.08" × .4") (Measuring region: 0.05 to 0.1(.002" to .004")) 4 × 10 (.16" × .4") (Measuring region: 0.1 to 10(.004" to .4")) [Optical axis direction × Scanning direction]	
Number of scans for averaging	scan	1 to 2048	
Laser classification		Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)	
Number of laser scans	/sec	3200	
Laser scanning rate	m/sec(inch/sec)	113(4449"/sec)	
Protection level		IP64	
Distance between the laser emission unit and reception unit	mm(inch)	Standard 68(2.68") Max. 100 (3.93") [*6]	
Operation environment	Temperature	0 °C to 40 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	
	Altitude	2000 m or less	
Storage environment	Temperature	-15 °C to 55 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	

[*1] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*2] : A value of ±2σ with a 10mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*3] : The value of measurements in the center of the measurement region.

[*4] : ΔD is the difference in diameter of the workpiece and the master gage.

[*5] : Error due to the positional shift of workpiece in optical axis direction or scanning direction.

[*6] : The distance between the laser emission unit and reception unit other than the standard, may affect the accuracy .

(2) Standard accessories

Part No.	Item	Qt.
—	ID unit [*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

Order No.	Item
02AGD120	Calibration gages set φ 0.1 mm φ 10 mm
02AGD210	Guide pulley unit for LSM-501H (also available for LSM-501)
02AGD230	Air-blow unit for LSM-501H (also available for LSM-501)
02AGD270	Workstage for LSM-501 / 503 / 902 (also available for LSM-501)
02AGD400	Adjustable Workstage for L SM-501(also available for LSM-501)
02AGN780A/B	Extension signal cables (5m/10m)(16ft/32ft)[*8][*10]
02AGD150 A	Extension connecting cables(1m)(3.2ft)[*9][*10]

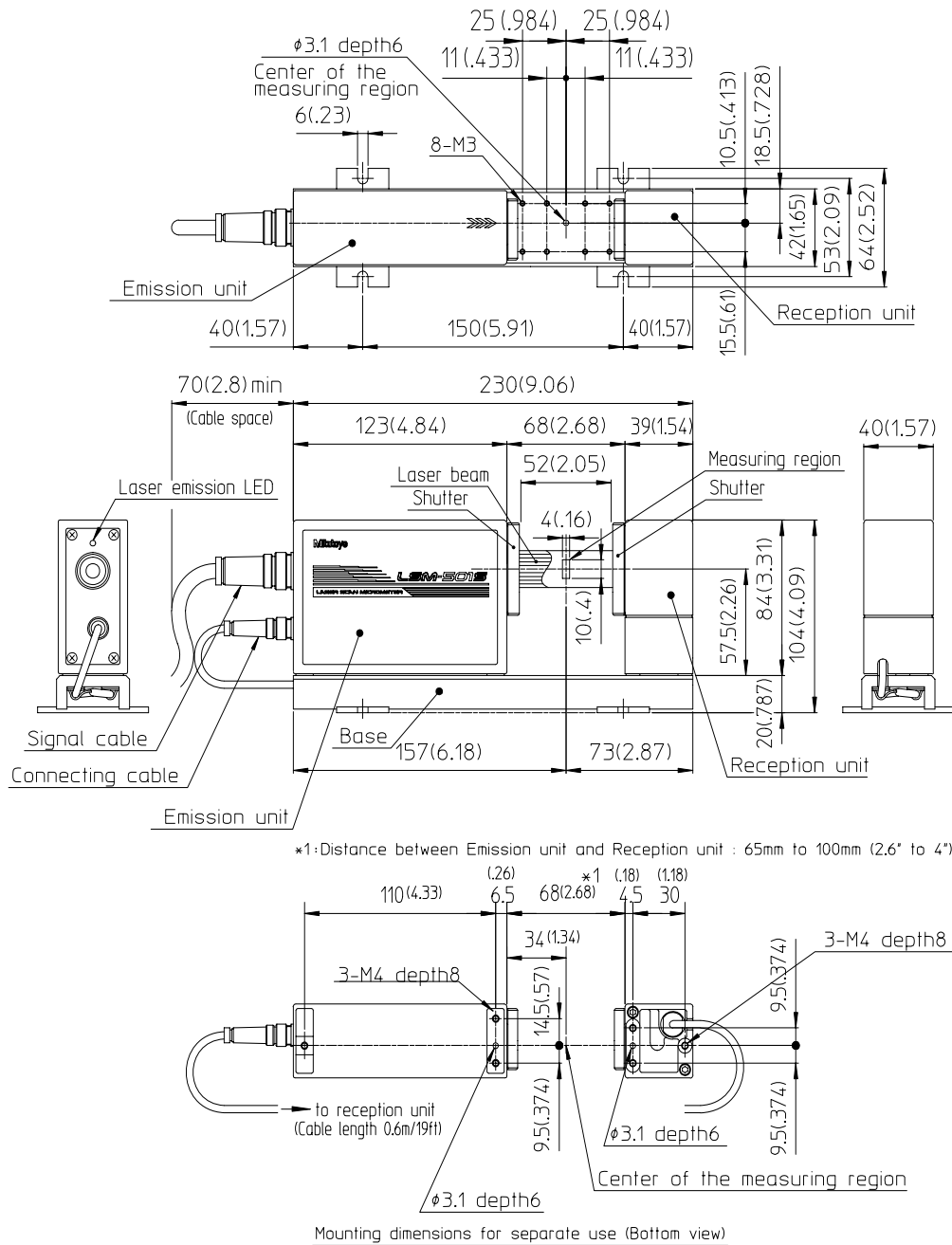
[*8] : The signal cable can be extended up to 20 m(64ft).

[*9] : The connecting cable can be extended up to 2 m(6.4ft).

[*10] : The length of the signal cable and the connecting cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



Unit : mm (inch)

【Mass】

- Emission unit : 0.7 kg
- Reception unit : 0.4 kg
- Base : 0.3 kg
- Signal cable : 0.5 kg

3.3LSM-503S

(1) Specifications

MODEL		LSM-503S	
Order No.		544-536	
Applicable display unit		LSM-6200	
Laser scanning range	mm(inch)	Up to 34 (1.3")	
Measuring range	mm(inch)	0.3 to 30 (.012" to 1.18")	
Resolution	μm(inch)	0.02 to 100 (.000001" to .005") [Selectable]	
Repeatability [*1]	μm(inch)	±0.11 (±.000004")[*2]	
Linearity [*1]	Whole range	μm(inch)	±1.0 (±.00004")[*3]
	Narrow measuring range	μm inch	±(0.6 + 0.1 ΔD) ±(.000024" + .000004" ΔD)
Positional error[*1][*5]	μm(inch)	±1.5(±.00006")	
Measuring region	mm(inch)	10 × 30 (.4" × 1.18") [Optical axis direction × Scanning direction]	
Number of scans for averaging	scan	1to2048	
Laser classification	Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)		
Number of laser scans	/sec	3200	
Laser scanning rate	m/sec(inch/sec)	226 (8898"/sec)	
Protection level	IP64		
Distance between the laser emission unit and reception unit	mm(inch)	Standard 130(5.12")	
		Max. 350 (13") [*6]	
Operation environment	Temperature	0 °C to 40 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	
	Altitude	2000 m or less	
Storage environment	Temperature	-15 °C to 55 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	

[*1] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*2] : A value of ±2σ with a 30mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*3] : The value of measurements in the center of the measurement region.

[*4] : ΔD is the difference in diameter of the workpiece and the master gage.

[*5] : Error due to the positional shift of workpiece in optical axis direction or scanning direction.

[*6] : The distance between the laser emission unit and reception unit other than the standard, may affect the accuracy .

(2) Standard accessories

Part No.	Item	Qt.
—	ID unit [*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

Order No.	Item
02AGD130	Calibration gages set φ 1 mm φ 30 mm
02AGD240	Air-blow unit for LSM-503 (also available for LSM-503)
02AGD270	Workstage for LSM-501 / 503 / 902 (also available for LSM-503)
02AGD490	Adjustable Workstage for L SM-503 (also available for LSM-503)
02AGN780A/B/D	Extension signal cables (5m/10m/20m)(16ft/32ft/64ft)[*8][*10][*11]
02AGD150A/B	Extension connecting cables(1m/3m)(3.2ft/9.6ft)[*9][*10][*11]

[*8] : The signal cable can be extended up to 30 m(96ft).

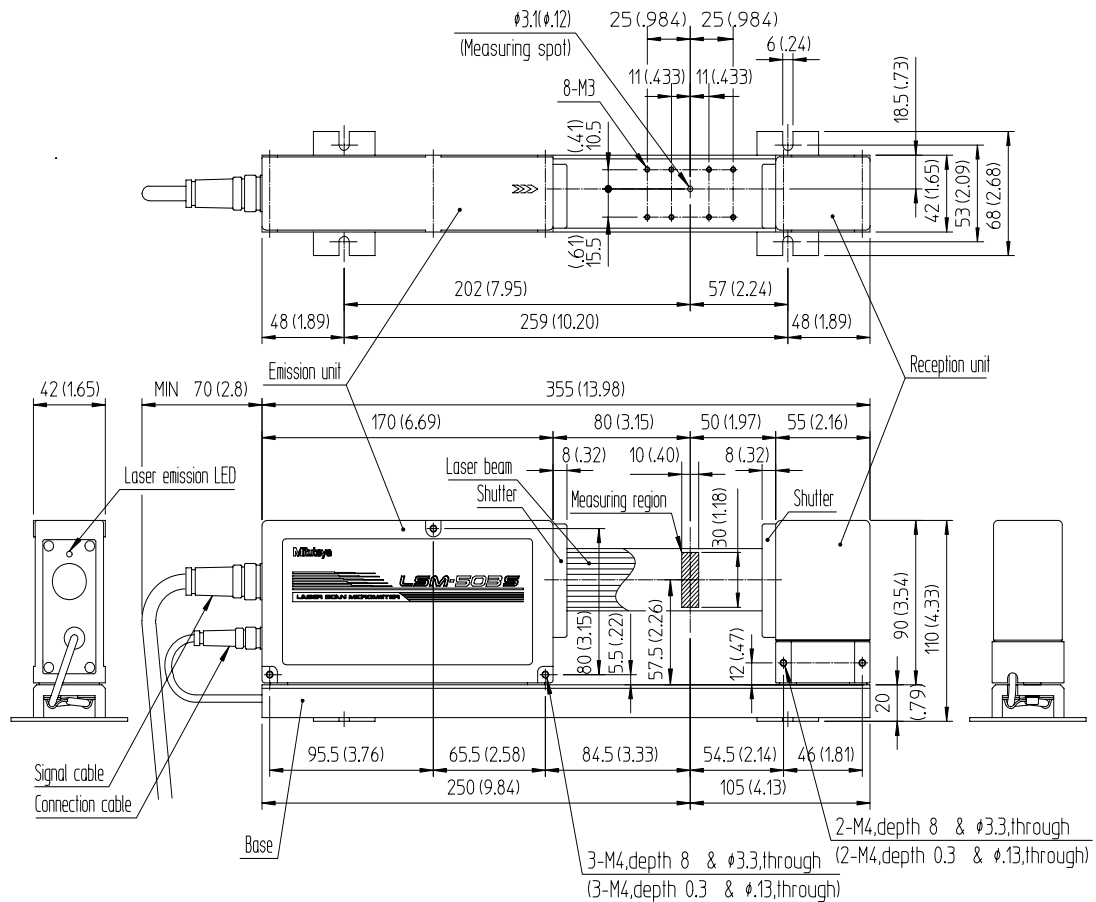
[*9] : The connecting cable can be extended up to 5 m(16ft).

[*10] : The total length of the signal cable and the intermediate cable can be extended up to 32 m.

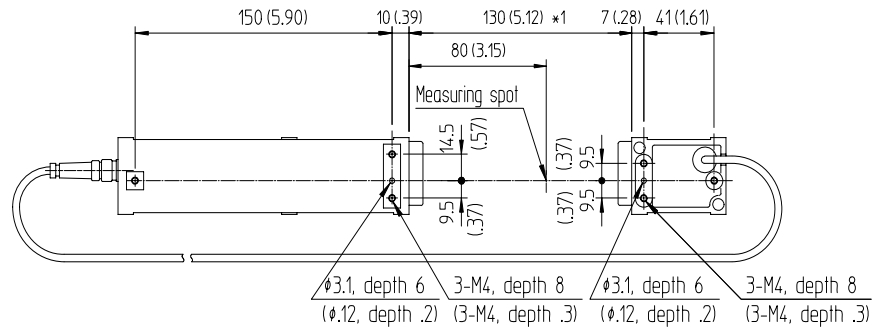
[*11] : The length of the signal cable and the connecting cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



*1: Distance between Emission unit and Reception unit: 100 to 350mm(4 to 13")



Bottom View of Emission unit and Reception unit

Unit : mm (inch)

【Mass】

- Emission unit : 1.1 kg
- Reception unit : 0.6 kg
- Base : 0.5 kg
- Signal cable : 0.5 kg

3.4LSM-506S

(1) Specifications

MODEL		LSM-506S	
Order No.		544-538	
Applicable display unit		LSM-6200	
Laser scanning range	mm(inch)	Up to 66 (2.6")	
Measuring range	mm(inch)	1 to 60 (.04" to 2.36")	
Resolution	μm(inch)	0.05 to 100 (.000002" to .005") [Selectable]	
Repeatability [*1]	μm(inch)	±0.36 (±.000014")[*2]	
Linearity [*1]	Whole range	μm(inch)	±3.0 (±.00012)[*3]
	Narrow measuring range	μm	±(1.5 + 0.5 ΔD)
		inch	±(.00006" + .00002" ΔD)
Positional error [*1][*5]	μm(inch)	±4.0 (±.00016)	
Measuring region	mm(inch)	20 × 60(.8" × 2.36") [Optical axis direction × Scanning direction]	
Number of scans for averaging	scan	1to2048	
Laser classification		Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)	
Number of laser scans	/sec	3200	
Laser scanning rate	m/sec(inch/sec)	452(17795"/sec)	
Protection level		IP64	
Distance between the laser emission unit and reception unit		Standard 273(10.75")	
	mm(inch)	Max. 700 (27") [*6]	
Operation environment	Temperature	0 °C to 40 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	
	Altitude	2000 m or less	
Storage environment	Temperature	-15 °C to 55 °C	
	Humidity	35 %RH to 85 %RH [without condensation]	

[*1] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*2] : A value of $\pm 2\sigma$ with a 60mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*3] : The value of measurements in the center of the measurement region.

[*4] : ΔD is the difference in diameter of the workpiece and the master gage.

[*5] : Error due to the positional shift of workpiece in optical axis direction or scanning direction.

[*6] : The distance between the laser emission unit and reception unit other than the standard, may affect the accuracy .

(2) Standard accessories

Part No.	Item	Qt.
—	ID unit [*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

Order No.	Item
02AGD140	Calibration gages set ϕ 1 mm ϕ 60 mm
02AGD250	Air-blow unit for LSM-506 (also available for LSM-506)
02AGD520	Adjustable Workstage for L SM-506 (also available for LSM-506)
02AGN780A/B/D	Extension signal cables (5m/10m/20m)(16ft/32ft/64ft)[*8][*10][*11]
02AGD150A/B	Extension connecting cables(1m/3m)(3.2ft/9.6ft)[*9][*10][*11]

[*8] : The signal cable can be extended up to 30 m(96ft).

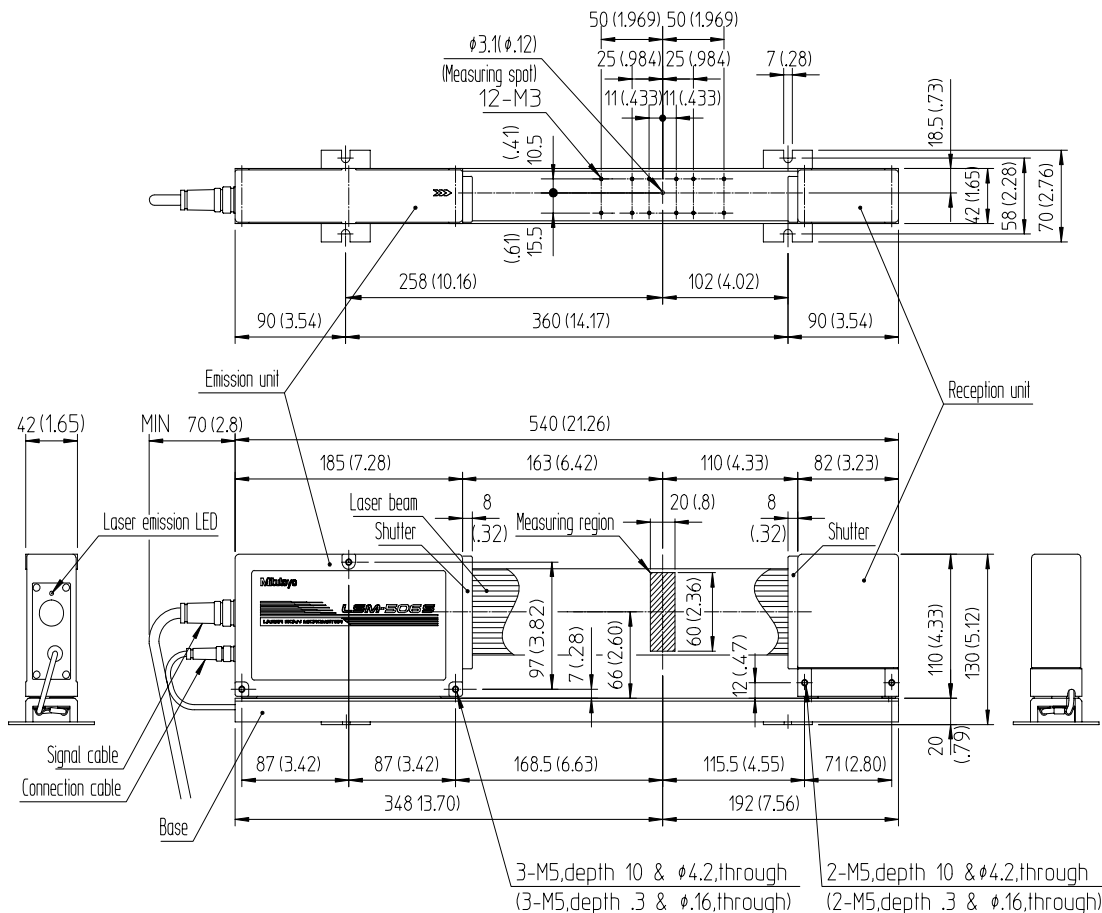
[*9] : The connecting cable can be extended up to 5 m(16ft).

[*10] : The total length of the signal cable and the intermediate cable can be extended up to 32 m.

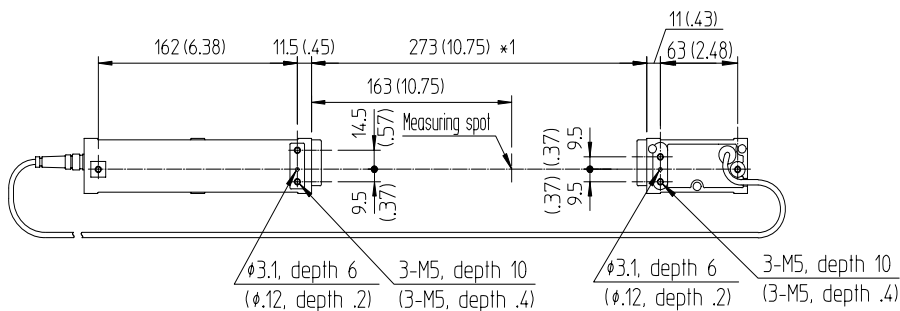
[*11] : The length of the signal cable and the connecting cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



*1: Distance between Emission unit and Reception unit: 200 to 700mm(8 to 27")



Bottom View of Emission unit and Reception unit

Unit : mm (inch)

【Mass】

- Emission unit : 1.4 kg
- Reception unit : 0.8 kg
- Base : 0.8 kg
- Signal cable : 0.5 kg

3.5LSM-512S

(1) Specifications

MODEL		LSM-512S	
Order No.		544-540	
Applicable display unit		LSM-6200	
Laser scanning range	mm(inch)	Up to 126 (5.0")	
Measuring range	mm(inch)	1 to 120 (.04" to 4.72")	
Resolution	μm(inch)	0.1 to 100 (.000005" to .005") [Selectable]	
Repeatability [*1]	μm(inch)	±0.85 (±.000033)[*2]	
Linearity [*1]	Whole range	μm(inch)	±6.0 (±.00024)[*3]
	Narrow measuring range	μm	±(4.0 + 0.5 ΔD)
		inch	±(.00016" + .00002" ΔD)
Positional error [*1][*5]		μm(inch)	±8.0 (±.0003)
Measuring region		mm(inch)	30 × 120 (1.2" × 4.72") [Optical axis direction × Scanning direction]
Number of scans for averaging		scan	1 to 2048
Laser classification		Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)	
Number of laser scans		/sec	3200
Laser scanning rate	m/sec(inch/sec)	904 (35590"/sec)	
Protection level		IP64	
Distance between the laser emission unit and reception unit	mm(inch)		Standard 321(12.64")
			Max. 700 (27") [*6]
Operation environment	Temperature		0 °C to 40 °C
	Humidity		35 %RH to 85 %RH [without condensation]
	Altitude		2000 m or less
Storage environment	Temperature		-15 °C to 55 °C
	Humidity		35 %RH to 85 %RH [without condensation]

[*1] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*2] : A value of ±2σ with a 120mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*3] : The value of measurements in the center of the measurement region.

[*4] : ΔD is the difference in diameter of the workpiece and the master gage.

[*5] : Error due to the positional shift of workpiece in optical axis direction or scanning direction.

[*6] : The distance between the laser emission unit and reception unit other than the standard, may affect the accuracy .

(2) Standard accessories

Part No.	Item	Qt.
—	ID uni[*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

Order No.	Item
02AGD150	Calibration gages set φ 1 mm φ 120 mm
02AGD260	Air-blow unit for LSM-512 (also available for LSM-512)
02AGN780A/B/D	Extension signal cables (5m/10m/20m)(16ft/32ft/64ft)[*8][*10][*11]
02AGD150A/B	Extension connecting cables(1m/3m)(3.2ft/9.6ft)[*9][*10][*11]

[*8] : The signal cable can be extended up to 30 m(96ft).

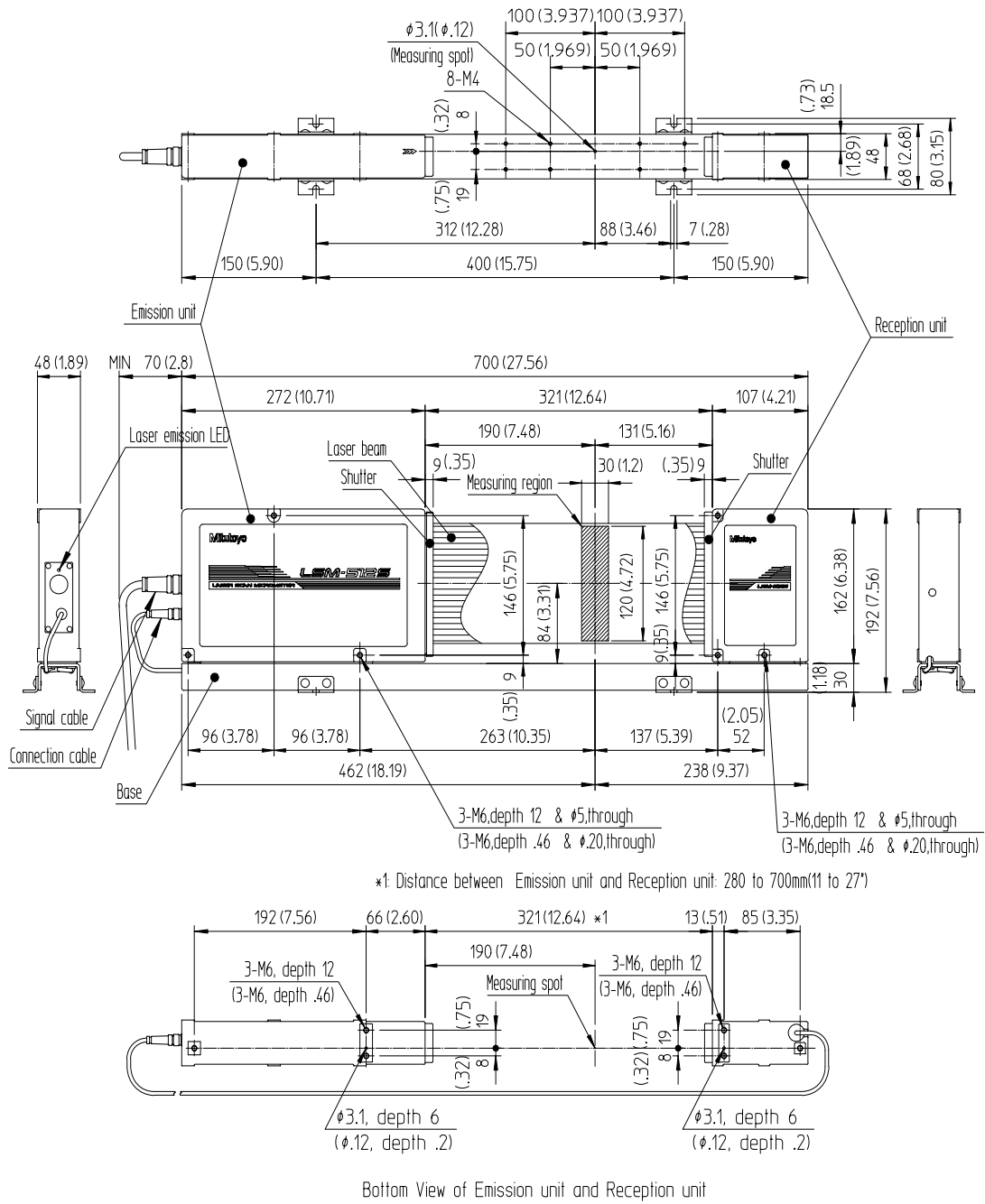
[*9] : The connecting cable can be extended up to 5 m(16ft).

[*10] : The total length of the signal cable and the intermediate cable can be extended up to 32 m.

[*11] : The length of the signal cable and the connecting cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



Unit : mm (inch)

【Mass】

- Emission unit : 3.0 kg
- Reception unit : 1.2 kg
- Base : 1.8 kg
- Signal cable : 0.5 kg

3.6LSM-516S

(1) Specifications

MODEL		LSM-516S	
Order No.		544-542	
Applicable display unit		LSM-6200	
Laser scanning range	mm(inch)	Up to 170 (6.7")	
Measuring range	mm(inch)	1 to 160 (.04" to 6.3")	
Resolution	μm(inch)	0.1 to 100 (.000005" to .005") [Selectable]	
Repeatability [*1]	μm(inch)	±1.4 (±.000055)[*2]	
Linearity [*1]	Whole range	μm(inch)	±7.0 (±.00028)[*3]
	Narrow measuring range	μm	±(4.0 +2.0 ΔD)
		inch	±(.00016" + .000079" ΔD)
Positional error [*1][*5]		μm(inch)	±8.0 (±.0003)
Measuring region		mm(inch)	40 × 160 (1.57" × 6.3") [Optical axis direction × Scanning direction]
Number of scans for averaging		scan	1 to 2048
Laser classification		Class 2 (Max. Output:1.3mW with a scanning laser, semiconductor laser: wavelength 650nm)	
Number of laser scans		/sec	3200
Laser scanning rate		m/sec(inch/sec)	1206 (47480"/sec)
Protection level		IP64	
Distance between the laser emission unit and reception unit		mm(inch)	Standard 400(15.74")
			Max. 800 (32.72") [*6]
Operation environment	Temperature		0 °C to 40 °C
	Humidity		35 %RH to 85 %RH [without condensation]
	Altitude		2000 m or less
Storage environment	Temperature		-15 °C to 55 °C
	Humidity		35 %RH to 85 %RH [without condensation]

[*1] : Environment for accuracy validation: 20°C ± 1°C temperature; 50% ± 10% humidity.

[*2] : A value of ±2σ with a 160mm-diameter gage has been measured for two minutes with a measurement interval of 0.32 seconds, where σ is the standard deviation.

[*3] : The value of measurements in the center of the measurement region.

[*4] : ΔD is the difference in diameter of the workpiece and the master gage.

[*5] : Error due to the positional shift of workpiece in optical axis direction or scanning direction.

[*6] : The distance between the laser emission unit and reception unit other than the standard, may affect the accuracy .

(2) Standard accessories

Part No.	Item	Qt.
—	ID uni[*7]	1
02AGN770A	Signal cable (5m / 16ft)	1
99MBC094A	User's manual	1

[*7] : The ID unit stores data unique to the measuring unit. A replacement ID unit is available at extra cost.

(3) Optional accessories

Order No.	Item
02AGM300	Calibration gages set for LSM-516H
02AGN780A/B/D	Extension signal cables (5m/10m/20m)(16ft/32ft/64ft)[*8][*10][*11]
02AGC150A/B	Extension connecting cables(1m/3m)(3.2ft/9.6ft)*9][*10][*11]

[*8] : The signal cable can be extended up to 30 m(96ft).

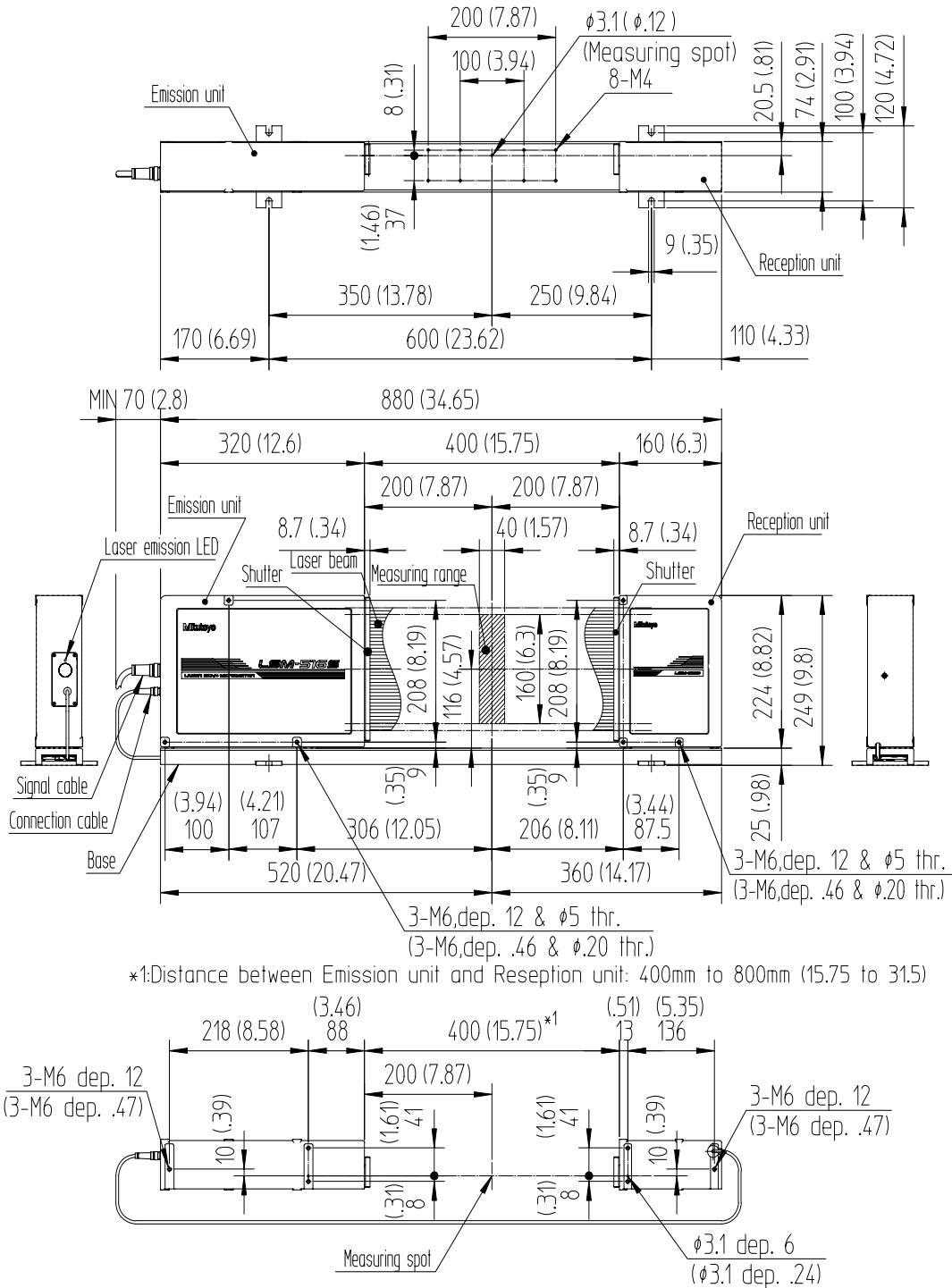
[*9] : The connecting cable can be extended up to 5 m(16ft).

[*10] : The total length of the signal cable and the intermediate cable can be extended up to 32 m(102ft).

[*11] : The length of the signal cable and the connecting cable other than the standard, may affect the accuracy .

3. SPECIFICATIONS OF MEASURING UNIT

(4) External dimensions



*1: Distance between Emission unit and Reception unit: 400mm to 800mm (15.75 to 31.5)

Bottom View of Emission and reception unit

Unit : mm (inch)

【Mass】

- Emission unit : 7.6 kg
- Reception unit : 3.7 kg
- Base : 2.8 kg
- Signal cable : 0.5 kg

MEMO

4

DESIGNING THE FIXTURES

This chapter describes precautions to be observed when attaching the emission unit and the reception unit, which have been detached from the support base of the measuring unit, to a specially arranged dedicated fixture.

4.1 Outline

In application, the emission unit and the reception unit may have to be detached from the support base of the measuring unit and attached to a dedicated fixture. If this is the case, the measuring accuracy cannot be ensured unless the emission unit and the reception unit are properly aligned on the dedicated fixture. Design a proper fixture according to this section.

4.2 Consideration to Calibration

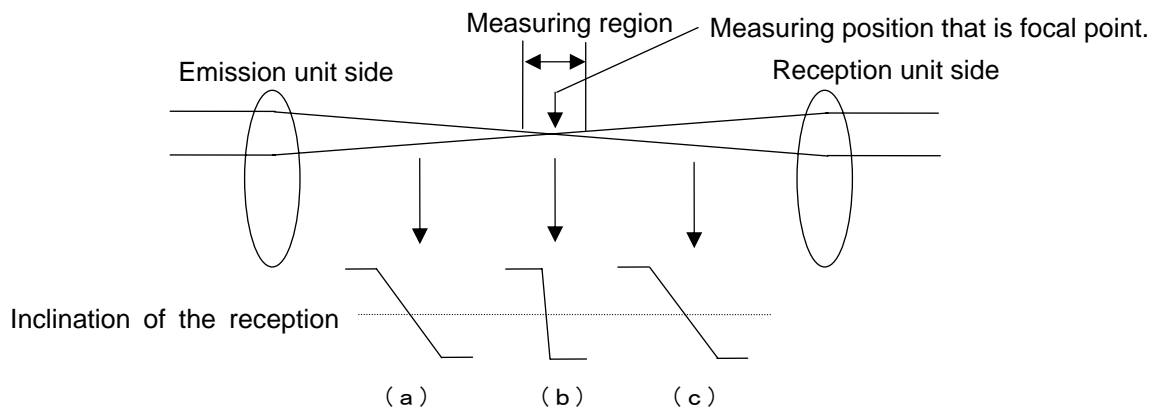
To ensure accurate measurements, design the fixture so that the workpiece to be measured can be positioned at the point of measurement that is the focal point of the emission unit. Also, make allowances for calibration and for a calibration gage to be mounted on the fixture.

4.2.1 Measuring position and resulting accuracy

As shown in the figure below, the scanning beam of the measuring unit is produced by reducing the thick beam to a beam of the minimum diameter at the measuring position that is the focal point.

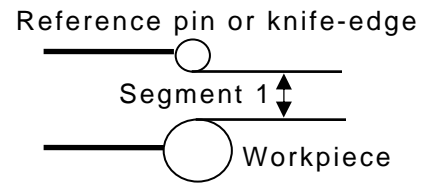
However, since the inclination of the reception signal is defined as “beam diameter/scanning speed”, the inclination will be the steepest at measuring point (b) and will be less steep at points (a) and (c), off from the measuring point.

The less steep the inclination of the reception signal, the more susceptible the signal is to noise and light disturbance, resulting in degraded repeatability. Thus, due attention should be paid to ensure that the workpiece is located at the measuring position.



4.2.2 On measuring gap

For measuring segment 1, as in the case of measuring the runout, be sure to arrange a reference pin or knife-edge at the focal point, as shown on the right. The inclination of the reception signal becomes large, resulting in degraded repeatability, unless the reference pin is provided.

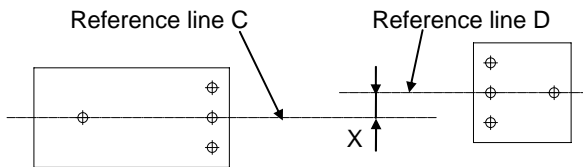


4.3 Optical Axis Alignment

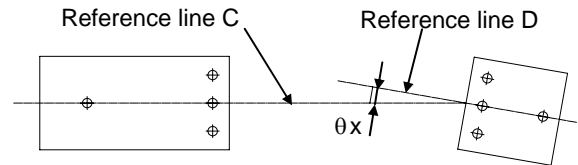
The optical axis of each measuring unit should be aligned to within the limits shown below.

4.3.1 Optical axis alignment in horizontal plane

a. Parallel deviation in reference lines C and D by X in width direction.

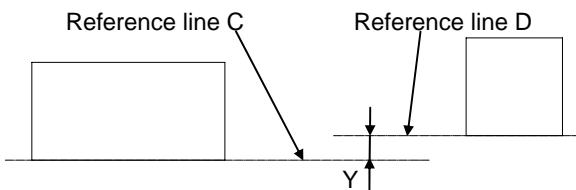


b. Angular deviation in reference lines C and D by θ_x in angle.

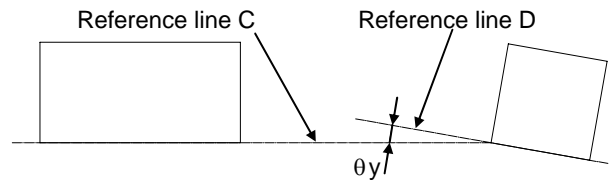


4.3.2 Optical axis alignment in vertical plane

c. Parallel deviation in reference planes A and B by Y in height.



d. Angular deviation in reference planes A and B by θ_y in angle.



4.3.3 Permissible error for optical axis alignment

Model	Distance between Emission unit and Reception unit	For both X and Y	For both θ_x and θ_y
LSM-501S	68mm or less	0.5 mm within	0.4° (7mrad) within
	100mm or less	0.5 mm within	0.3° (5.2mrad) within
LSM-503S	130mm or less	1 mm within	0.4° (7mrad) within
	350mm or less	1 mm within	0.16° (2.8mrad) within
LSM-506S	273mm or less	1 mm within	0.2° (3.5mrad) within
	700mm or less	1 mm within	0.08° (1.4mrad) within
LSM-512S	321mm or less	1 mm within	0.18° (3.6mrad) within
	700mm or less	1 mm within	0.08° (1.4mrad) within
LSM-516S	800mm or less	1 mm within	0.05° (0.9mrad) within

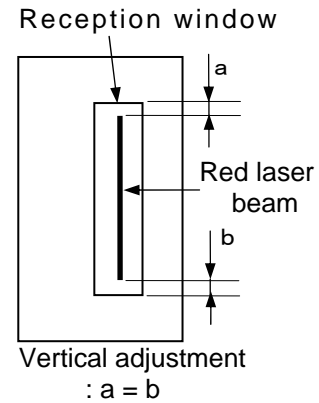
4.4 Confirming the Optical Axis

The optical axis of a measuring unit can be confirmed by the following methods.

4.4.1 Confirming with the laser beam

As shown on the right, the red laser beam is visible on a piece of white paper placed on the reception window. Adjust it so that the incidence of the laser beam is in the center of the reception window.

The incidence should be in the center horizontally and at the position where "a" is equal to "b" vertically. Make adjustments to reduce such deviations, as shown in the figures below, where (a) is the vertical deviation, (b) is the horizontal deviation, (c) is the inclination of the laser beam.



(a): Vertical orientation



(b): Horizontal orientation



(c): Laser beam inclination

NOTE The laser scanning range is defined by the distance between the emission unit and the reception unit mounted on the standard support base. If the distance between the emission unit and the reception unit is greater than standard, a slight machining error will be amplified to the extent it disables the proper reception of the scanning beam. This should be considered when designing a dedicated fixture.

4.4.2 Confirming the optical axis with an oscilloscope

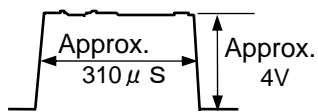
To monitor with an oscilloscope, use the two monitor connectors provided on the rear panel of the display unit, "SCAN SIG.-1" and "SCAN SIG.-2", for measuring unit 1 and measuring unit 2, respectively.

Oscilloscope setting:

- Vertical sensitivity : 0.1V/DIV for a probe of 1/10
- Horizontal sensitivity : 50 μ s/DIV

Among the waveforms shown below, (a) represents the waveform of normal light reception. If the light incidence is not normal to the light reception element, adjust the mounting position between the emission unit and the reception unit to ensure that the light comes to the center of the light reception element.

If the protective glass is soiled, a waveform such as that shown in (b) or (c) will result. If this is the case, clean the protective glass according to 1.3.2 Cleaning optical parts to reduce the disorder of the waveform to less than 0.3V.



(a) Normal



(b) Glass contaminated



(c) Glass contaminated

4.5 Measurement with Two Measuring Units

To perform dual measurement with a combination of two measuring units, each measuring unit must have been optically aligned.

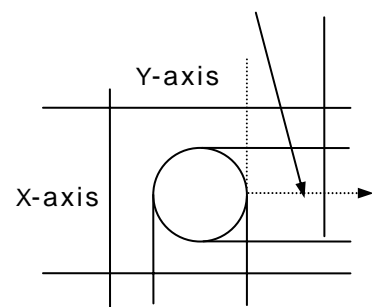
Refer to "4.3 Optical Axis Alignment" for more information.

Also note that the appropriate considerations must be taken into account according to the type of dual measurement, DXY type or DF type.

4.5.1 DXY type

If a workpiece with a high-reflection coefficient is measured with two measuring units being completely crossed (in a DXY-type setup), the scanning beam from one measuring unit will be reflected into the reception window of the other measuring unit, reducing the measuring accuracy. An arrangement is required in such a case so that the light from one measuring unit will not be reflected from the workpiece into the reception window of the counterpart measuring unit.

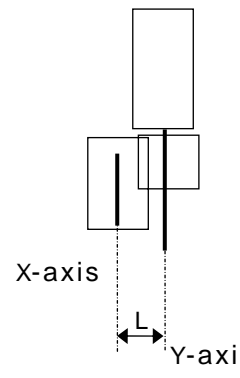
Light from the Y-axis reflected to the X-axis.



(1) Arrangement to provide a step

As shown on the right, arrange a step of L between the X axis and the Y axis.

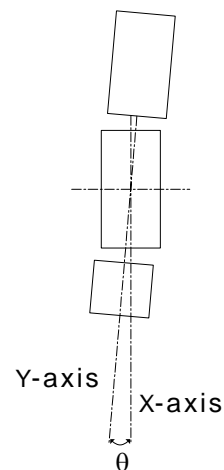
The step L should not be smaller than 10 mm.



(2) Arrangement to provide an angle

As shown on the right, arrange an angle θ between the X axis and the Y axis.

The angle θ should not be smaller than 15 degrees or 0.25 radians.



(3) Confirming the presence of reflecting light

- With the segment set to 1, close the shutter of the emission unit on the X axis, then check that the reflection light from the Y axis will not be directed into the reception window of the X axis. Allow 5 to 10 minutes for this check of the reflecting light as scanning beams from the X axis and the Y axis are asynchronous.

Under the normal state, the Err-0 message will be displayed.

Perform the same check with the Y axis.

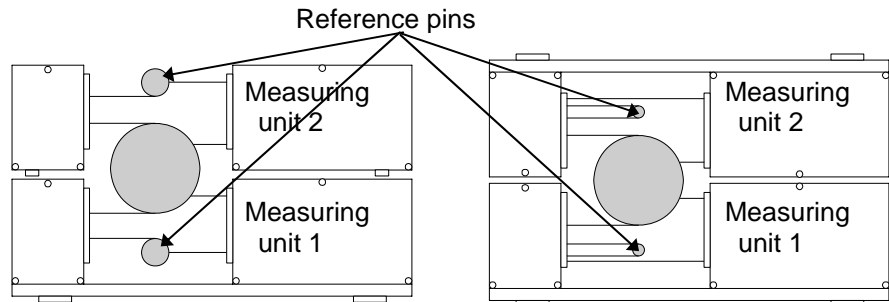
- With the oscilloscope connected to the monitor connector on the rear panel of the display unit, it is also possible to check for the presence of the reception signal due to the reflection light. For a model with a visible laser beam, the reflection light can be checked by placing a piece of paper on the reception window.

4.5.2 DF type

In a DF-type setup shown below, a workpiece of a larger diameter can be measured by measuring the gap between two measuring units 1 and 2 and referring to the predetermined offset value of the reference gage.

(1) Improvement of the measurement accuracy

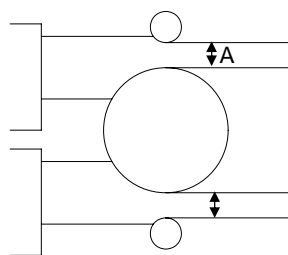
- To ensure better measuring accuracy of gap measurement, use reference pins or knife-edges as located at the focal point.



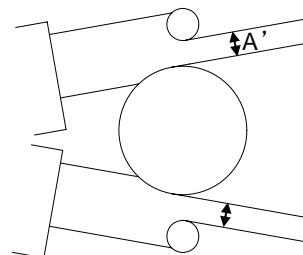
(a) Example of setup for stack of two units Segment (1 + 5)

(b) Example of setup for facing of two units Segment (1 + 5)

- The reference pin will help reduce the effect of possible fluctuation of the emission unit being subject to a force. In a setup without reference pins, the fluctuation of the emission unit due to some external force will produce a significant difference between the measurements B and B' as shown in (c) and (d) below.

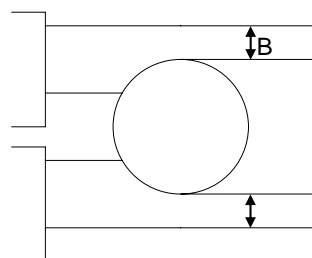


(a) Initial state incorporated with reference pins

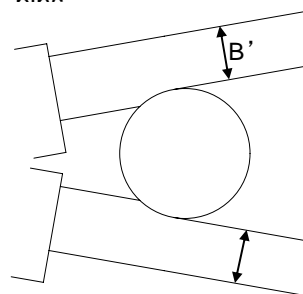


(b) Effect of fluctuation of the emission unit in a setup incorporating reference pins

Difference of A and A' : Small



(c) Initial state without reference pins



(d) Effect of fluctuation of the emission unit in a setup without reference pins.

Difference of B and B' : Large

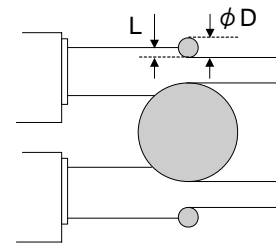


4. DESIGNING THE FIXTURES

- Size of reference pins

The diameter of the reference pin should be such that it can block the laser beam by more than 2 mm and the beam will not cross the pin. A pin of about 10 mm diameter would meet such a requirement.

The setup must also be fairly robust so that the gap between the reference pins will not change while in service.



(2) Parallelism adjustment

Set up two measuring units integrating the emission unit and the reception unit so that the parallelism of the two measuring units can be adjusted.

First align the optical axis of each measuring unit, then adjust the parallelism between the two measuring units.

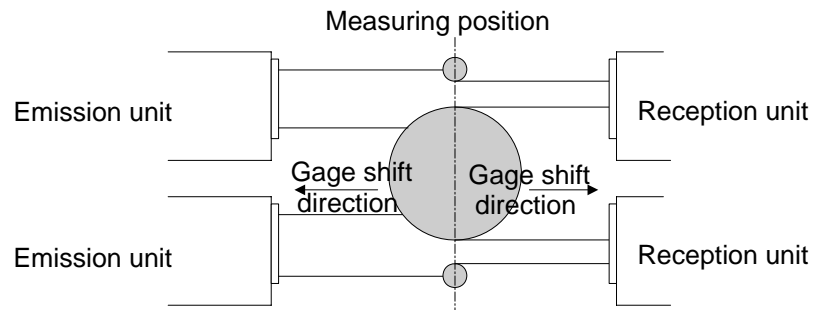
If the parallelism adjustment is inadequate, errors will generate when the workpiece is shifted in the optical axis direction.

The degree of accuracy to which the adjustment should be made depends on user requirements. For reference, three example accuracy ranges are given below:

- a. Should be ± 20 to ± 50 μm with the gage shifted within ± 50 mm from the measuring point.
- b. Should be ± 5 to ± 10 μm with the gage shifted within ± 10 mm from the measuring point.
- c. Should be ± 5 to ± 10 μm with the gage shifted within ± 5 mm from the measuring point.

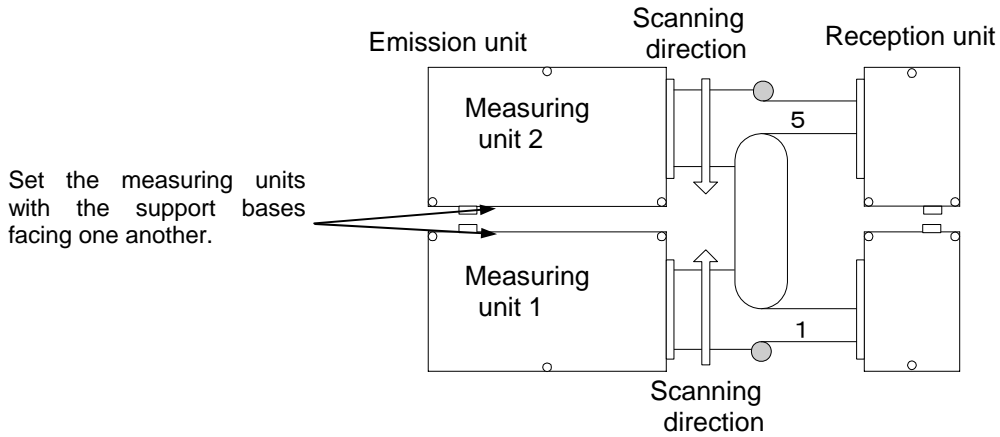
Generally, the larger the amount of shift of the gage, the easier will be the adjustment.

The most appropriate size of the gage would be the median value of the measuring range.



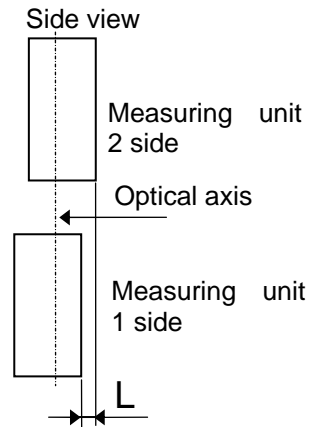
(3) Precautions for transparent object measurement

To measure a larger diameter transparent glass rod, the external diameter of a plastic object, or the width of a transparent sheet, arrange the measuring units with the support bases fitted so the scanning laser beams are opposing one another, and set the segment to (1 + 5). If the laser scanning direction of each unit is reversed to the direction shown below, measurement will be disabled.



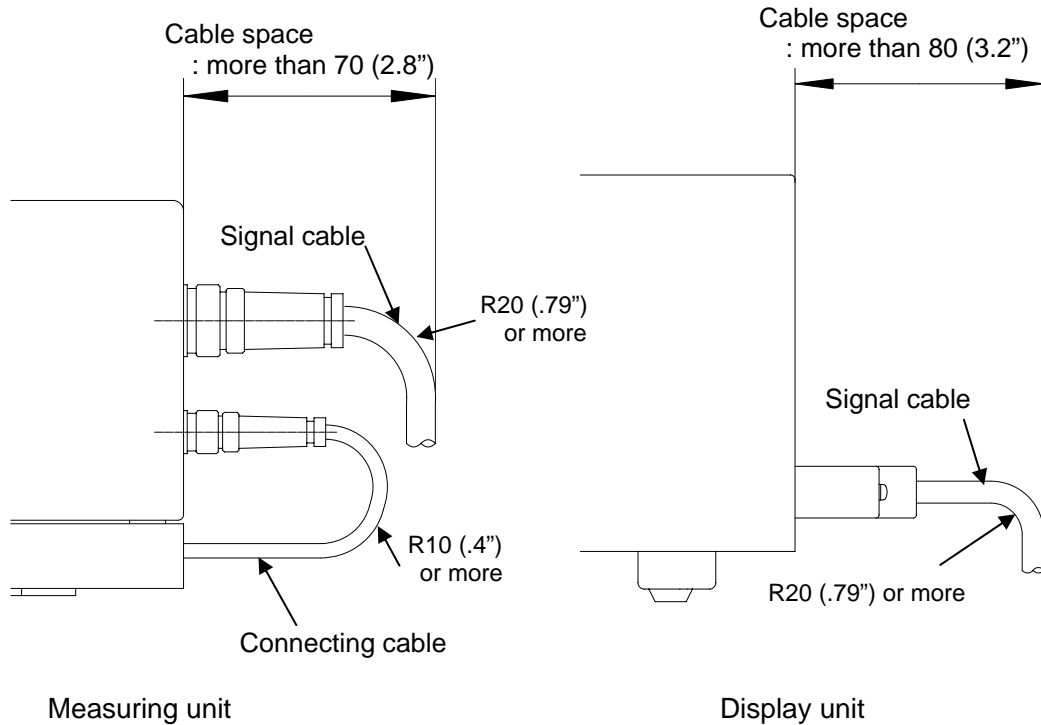
If two measuring units are set up with the support bases facing one another, a step L will be produced between the two units through inconformity of the optical axis of the two units, as shown at the right. The step values according to model are listed below.

Model	Step L
LSM-501S	10mm
LSM-503S	10mm
LSM-506S	10mm
LSM-512S	22mm
LSM-516S	33mm



4.6 Radius of Cable Bend

The signal cables and the connecting cable will break if bent to an excessively small radius. Allow sufficient space for bending cables according to the figures below.



Unit: mm(inch)

NOTE Supplied cables are not robot cables, which have superior flexibility in bending. Special cables with a high flexibility will be available at extra cost. Contact a Mitutoyo sales office.

MEMO

5

SAFETY PRECAUTIONS FOR LASER BEAM

5.1 Caution



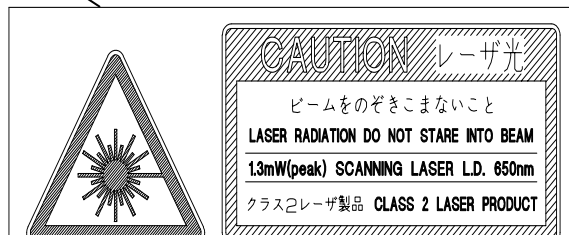
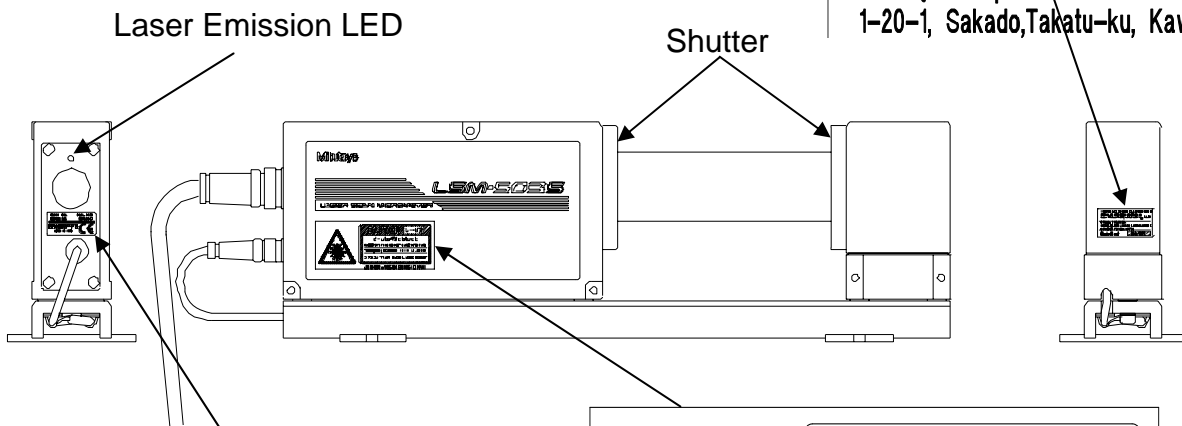
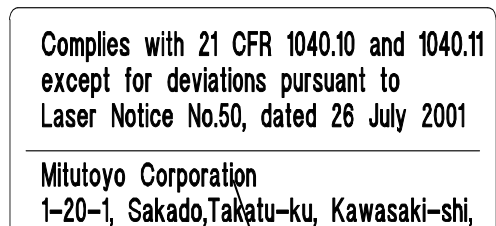
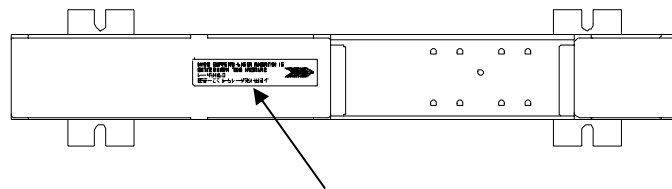
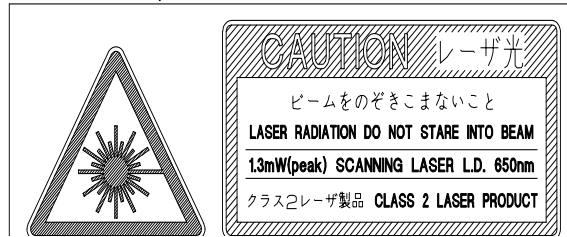
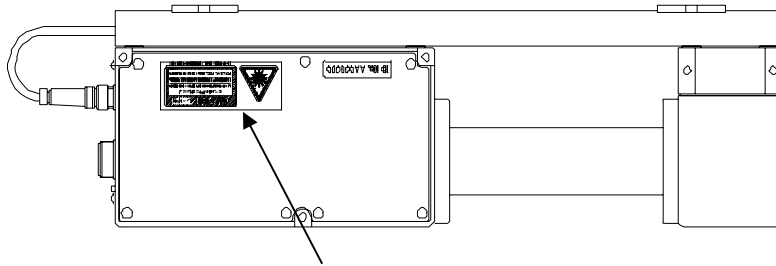
The LSM-500S series uses a low powered, visible laser beam which has been designed for safe operation. However, observe the following points when setting up and operating.

- 1) This measuring unit conforms to IEC 60825-1, the safety code for lasers. This code was established in January, 2001.
- 2) This unit is a "Class 2 laser product", as defined by IEC code.(Maximum output power: 1.3 mW, semiconductor laser with a wavelength of 650 nm)
- 3) IEC (International Electrotechnical Commission) defines IEC 60825-1 as an international standard. This unit satisfies EN-60825-1 (Europe), FDA / CDRH / Laser Notice No.50 (America), and JIS C 6802 (Japan) corresponding to this standard.
- 4) Safety precaution labels are described on page 5-2.
- 5) Do not remove the safety precaution labels on the unit.
- 6) Do not look directly into the laser beam.
(Never look into the emission window, even when the laser seems to be inactive.)
- 7) Do not observe the laser beam directly through an optical instrument, such as a magnifying lens.
- 8) When measuring flat objects with a mirror finish, do not look at the reflection on the surface.
- 9) If measuring a workpiece with reflective parts, avoid fixing your eyes on the measured surface.
- 10) Close the beam shutter when the measuring unit is not in use.
- 11) The laser beam doesn't harm human skin when irradiating.
- 12) "CAUTION — Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure."



Never open the cover on this measuring unit.

5.2 Safety Precaution Labels Located on LSM-500S Series



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