**SURFACE TEXTURE
MEASURING INSTRUMENT**

SURFCOM FLEX

Operation guide

TOKYO SEIMITSU CO., LTD.

Contents

Contents

Contents

Contents

Contents

Contents

1. Introduction

1-1   Introduction

Congratulations on purchasing the SURFCOM FLEX series product.
This instrument was developed through the combined efforts of all our precision-focused engineers, and elaborately manufactured in modern facilities by skilled engineers. It has passed many strict tests and can deliver excellent performance so that you can use it with peace of mind.
This guide simply explains safe handling procedures, inspection, maintenance, and other matters relevant to this instrument as well as information required by those who use it on a day-to-day basis. We recommend that you read this guide thoroughly and gain a thorough understanding of the contents so that you can master the use of this instrument.

1-2   Operating precautions and requests

- To use this instrument safely, be sure to read this guide before starting to use the instrument.
- Keep this guide at hand for quick reference when necessary.
- This guide uses the following symbols to indicate dangerous operation or handling. Be sure to pay careful attention to instructions provided with the symbols to prevent personal injury and damage to property.

⚠ Warning	Warning	Failure to follow the instructions provided with this indication may result in death or serious injury.
⚠ Caution	Caution	Failure to follow the instructions provided with this indication may result in property damage.
☞	Operation	This indication shows instrument operating tips or information that you need to know.

⚠ Warning

Connect the AC adapter to the outlet that supplies the proper voltage as indicated on the adapter.
Connecting to an inappropriate power supply may result in an electric shock or fire.

Never use a damaged AC adapter.
A hazardous current may flow through the AC adapter, causing an electric shock or fire.

Do no splash water, oil, or chemical on the AC adapter.
Doing so may result in an electric shock or fire. Do no splash water, oil, or chemicals on this instrument. Doing so may result in an electric shock or fire.

Never insert a foreign object (in particular a metal flake or other conductive material) into any clearance in this instrument.
Doing so may result in an electric shock or fire.

Be sure to only use the attached AC adapter.
Use of another AC adapter may result in an electric shock or fire.

Do not disassemble this instrument.
Doing so may result in an electric shock.

Avoid exposing this product to moisture, waterdrops, dust, greasy fumes, direct sunlight, shock, and vibration.
Otherwise, the product may fail or, more seriously, cause an electric shock or fire.

Be sure that power of the instrument is turned off before connecting or disconnecting the AC adapter.
Otherwise, an electric shock may result.

⚠**Caution**

The operating temperature of this instrument is in the range from 10 deg C to 40 deg C. Use the instrument within this range.

Do not apply any excessive force or shock to the stylus.

Carefully protect the stylus from dust and dirt.

Wipe off any contamination with a soft cloth dampened with neutral detergent after it has been wrung. Do not use organic solvent or alcohol.

Do not pull the cable forcefully.

1. Introduction

1-3 System configuration

Specifications of this instrument differ depending on the model you purchased. For details, see (18. Main Specifications).
The model name of this instrument differs depending on the system configuration, combination of driver and data processor.

Model name	Driver
SURFCOM FLEX -50	Driver (-50)
SURFCOM FLEX -35	Driver (-35)
SURFCOM FLEX -40	Driver (Retract -40)
SURFCOM FLEX -45	Driver (Side trace -45)

System block diagram
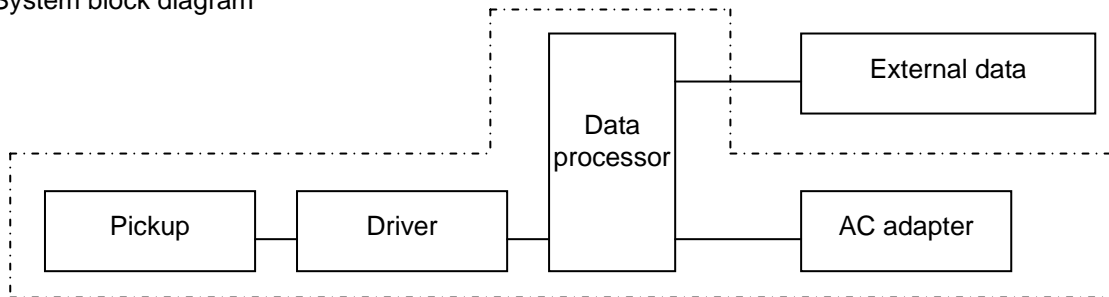
External appearance

☐ Driver (-35/Retract -40/Side trace -45)
☐ Pickup
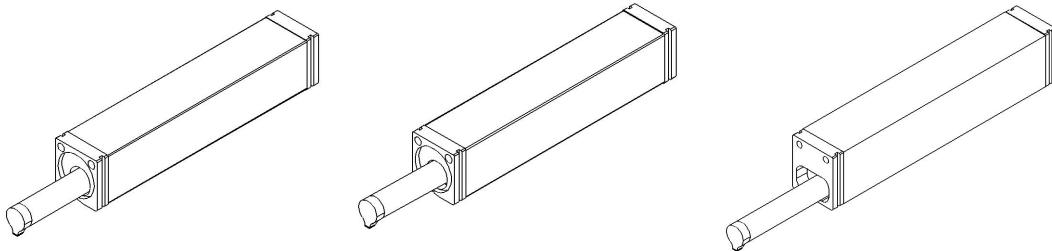
☐ Driver (-50)
☐ Pickup (for -50)
☐ Stylus
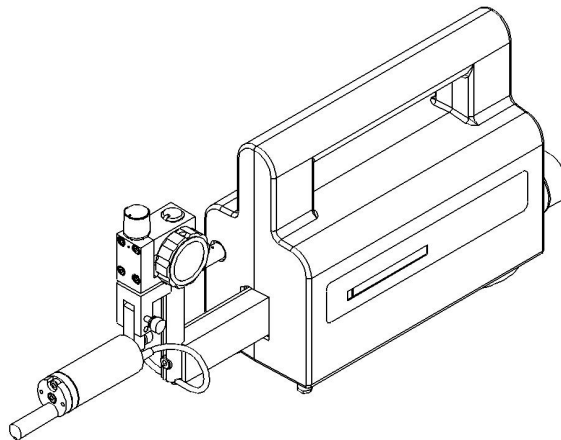
□ Data processor
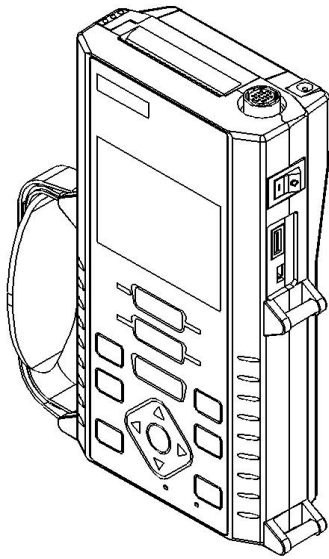
Front   Rear
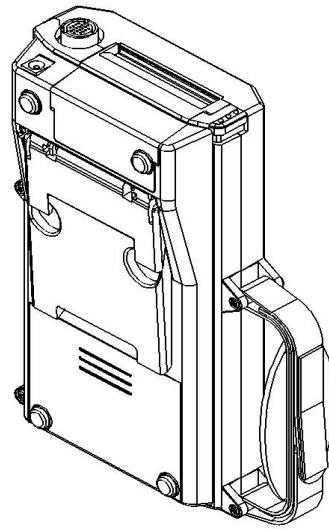
□ Driver connection cable (for -35/-40)
□ Driver connection cable (for -45)
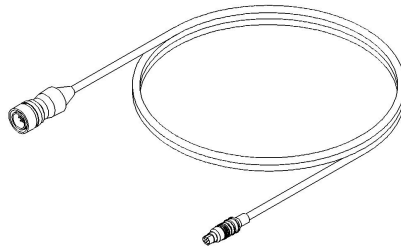
□ Driver connection cable (for -50)
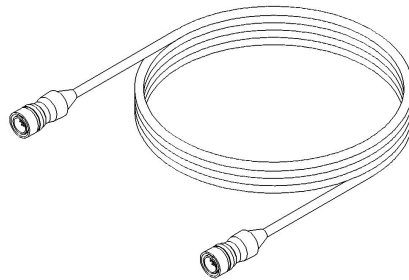
□ AC adapter
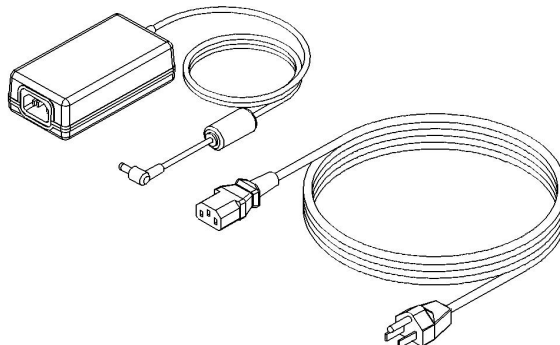
1. Introduction

1-3-1 SURFCOM FLEX -50

Model -50 is combined with small genuine type driver (-50).
- Compact but capable of skidless and waviness measurements
- Can be installed on the compact measurement table (optional)

```
Standard configuration
    ☐ Driver (-50)
    ☐ Pickup (for -50)
    ☐ Stylus
    ☐ Driver connection cable (for -50)
    ☐ Data processor
    ☐ AC adapter
```

1-3-2 SURFCOM FLEX -35

Model -35 is combined with standard type driver.
- Capable of measuring in any orientation; slope, vertical surface, or even ceiling surface, as well as horizontal surface.

```
Standard configuration
    ☐ Driver (-35)
    ☐ Pickup (for -35/-40)
    ☐ Data processor
    ☐ Driver connection cable (for -35/-40)
    ☐ AC adapter
```

1-3-3 SURFCOM FLEX -40

Model -40 is combined with retract type driver.
- The pickup retracts (upward) in standby mode to reduce damage to the pickup during setup of workpiece.
- Can be used as a detector embedded in automated equipments

```
Standard configuration
    ☐ Driver (-40)
    ☐ Pickup (for -35/-40)
    ☐ Data processor
    ☐ Driver cable (for -35/-40)
    ☐ AC adapter
```

1-3-4 SURFCOM FLEX -45

Model -45 is combined with side trace type driver.
- Dedicated to measure narrow surface such as the pin or journal of crankshaft that was difficult to measure with previous models.

```
Standard configuration
    ☐ Driver (-45)
    ☐ Pickup (for -45)
    ☐ Data processor
    ☐ Driver cable (for -45)
    ☐ AC adapter
```

1-4   How to read this guide

First read "3. Names of Parts and Their Functions", "4. Installation and Connection", and "5. Basic Operation" to check the outline of this instrument.

Following chapters, "6. Preparation for Measurements", "7. Measurements", and "8.Display of Measurement Results" describe information relevant to measurements. Be sure to read these chapters.

Chapter "9.Menu" describes details of operating screen. Read this chapter if necessary.

If you think the device is faulty, first check Chapter "15 Troubleshooting".

2. Before Using This Product for the First Time

This chapter describes the information you need to know before using this product for the first time.

Daily handling and maintenance

Observe the following instructions regarding daily handling of this product.

● Operating environments
Temperature: 10 deg C to 40 deg C. Humidity: 40% to 80%, no condensation.

● Do not use or store this product in the following places.
Where the product will be subject to direct sunlight.
Where the product will be exposed to high or low temperatures.
Where the product will be exposed to sharp temperature fluctuations.
Where the product will be exposed to a strong electromagnetic field (for example, near a speaker, etc.).
In an excessively dusty area.
Where the floor vibrates excessively.
Where a large amount of chemical gas is present.
Where the product will come in contact with chemicals.

● Wipe off any contamination on the instrument using a soft dry cloth.
To wipe off extreme contamination, use a cloth dampened with water after wringing it out first. However, do not use a dampened cloth on unpainted metal parts (driver, pickup). Do not use benzine, thinner, or other solvents.

● Do not disassemble the product.
Do not remove screws, or open the inside of the main body. Doing so may result in an electric shock or cause the product to fail.

● Be careful not to insert foreign objects.
Be careful not to drop any clip or staples into a clearance. Be careful not to spill any drinks or other types of liquid onto the instrument.

Precautions for carrying the product

Observe the following instructions when carrying the product. Otherwise, an electric shock or product failure may occur.

● Do not subject the product to extreme shock (by dropping or striking).
● Do not expose the product to sharp temperature fluctuations (for example, by moving it from a cold area outdoors to a warm indoor location).

☞ It is recommended that you keep the original package as it can be used for transportation or long-term storage of the product.

Charging the battery

To use the product with a battery, charge the battery in advance. For how to charge the battery, see Section 4-3 [Preparation of the data processor]. Charging of the battery will be completed after approximately three hours. The part surrounding the battery may become hot during the charging process, but this is not an abnormal phenomenon and you can continue using the product.

Precautions when using a USB memory stick

● A preliminary process may be required for some commercial USB memory stick before use. It may have to be formatted for the FAT32 file system, which can be executed with your PC.
● A write-protected USB memory stick cannot be used. Release the write protect before using it.

If an abnormality or failure occurs

● If you detect an abnormal smell or extreme heat, pull out the power cable and connection cable immediately.
● If an abnormality or failure occurs, contact our servicing office or sales representative for repairs.

3. Names of Parts and their Functions

This chapter explains the names of the parts and their functions.

3-1 Data processor
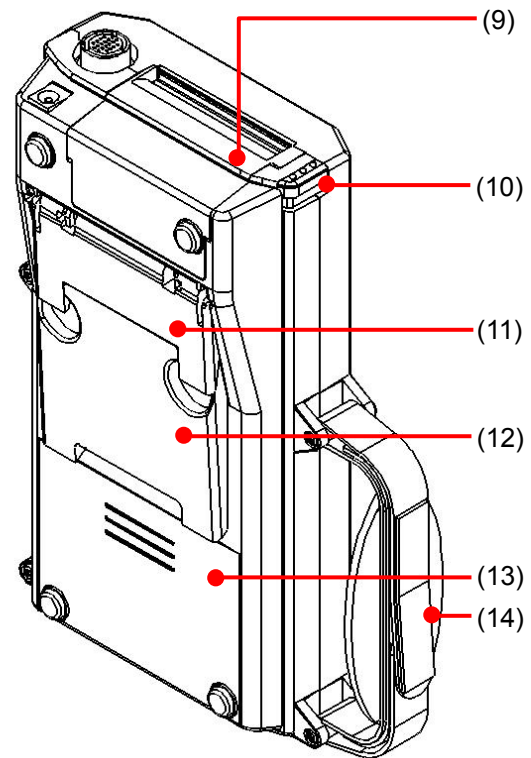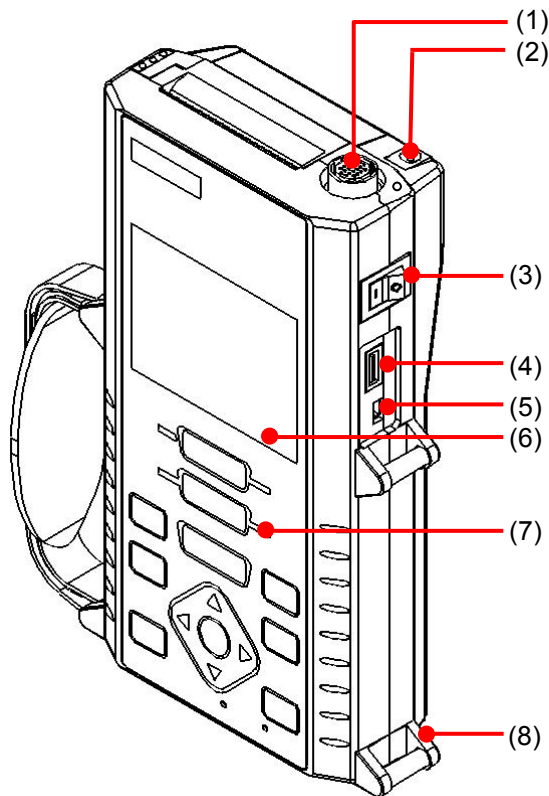
(1) Driver connector
Used to connect a driver via each driver cable.
(2) Power connector
Used to connect the AC adapter for power supply.
(3) Power switch
Used to switch the power on or off.
(4) USB memory stick connector
Used to connect an optional USB memory stick for saving or loading data.
(5) USB communication connector
Used to connect a USB communication cable for communication with PC.
(6) Liquid crystal display
Displays operational information and measurement results.
(7) Operation panel
This panel is used for any operation of this instrument.
(8) Hand belt supporter
A hand belt can be attached to this supporter, making it easier to hold the processor unit by hand.

(9) Printer cover
Recording paper used for printing is inside this cover.
(10) Printer open button
Used to open the printer cover to insert recording paper.
(11) Tilt holder (small)
Used to tilt the data processor when it is placed on a flat surface. This holder tilts the processor unit by a small angle. (approx. 15 deg)
(12) Tilt holder (large)
Used to tilt the data processor when it is placed on a flat surface. This holder tilts the processor by a large angle. (approx. 36 deg)
(13) Battery cover
The internal battery is inside this cover.
(14) Hand belt
A hand belt can make it easier to hold the processor unit by hand.

● Operation panel

(1) MEAS./STOP button
   Press this button to start measurement. Press it again during the measurement to stop it.
(2) GRAPH/PARAM. button
   Press this button to display measurement results. Waveform and parameter result are switched each time this button is pressed,
(3) CONDITION button
   Press this button to display the measurement preparation screen. The screen can be switched to that for selecting and loading the measurement conditions stored in the internal memory.
(4) FUNCTION button
   Press this button to select a command from the bottom of the screen.
(5) BACK button
   Press this button to return to the previous screen.
(6) MENU button
   Press this button to display the Menu screen.
(7) ENTER button
   Used to select and confirm various items.
(8) Up/Down/Right/Left buttons
   Used to select or input an item, and scroll the screen.

(9) PRINT button
   Press this button to start printing. Pressing it again during the measurement stops the printing.
(10) FEED button
   Press this button to feed printer paper. The recording paper is discharged while this button is pressed.
(11) RETURN button
   Press this button to return the pickup to the position where the last measurement started. Press it again to return the pickup to the front limit position. Pressing it once again during return operation stops the operation.
(12) CHARGE lamp
   Lights up in red while the battery is charged.
(13) SLEEP lamp
   Blinks in blue while in the sleep state.

3. Names of Parts and their Functions

3-2 Driver

3-2-1 Driver (-35/-40/-45)
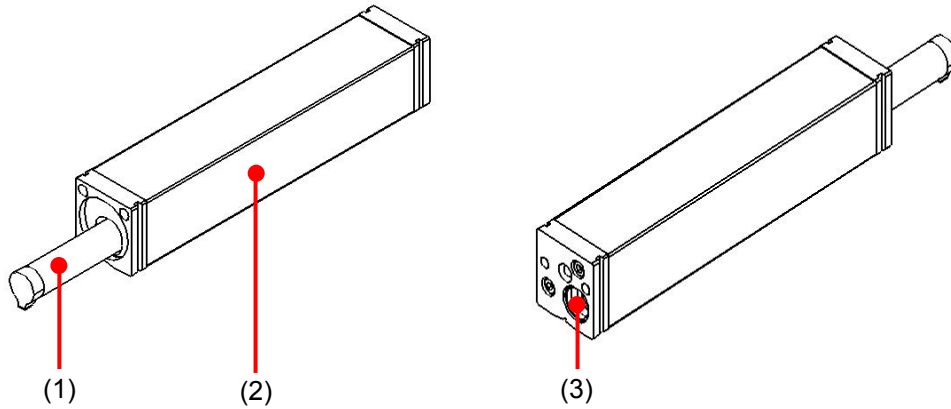
(1) Pickup
A detector that checks the surface roughness of the workpiece inspected.
(2) Driver
Moves the pickup.
(3) Connector
Insert the driver cable plug into this connector to connect the data processor.

3-2-2   Driver (-50)
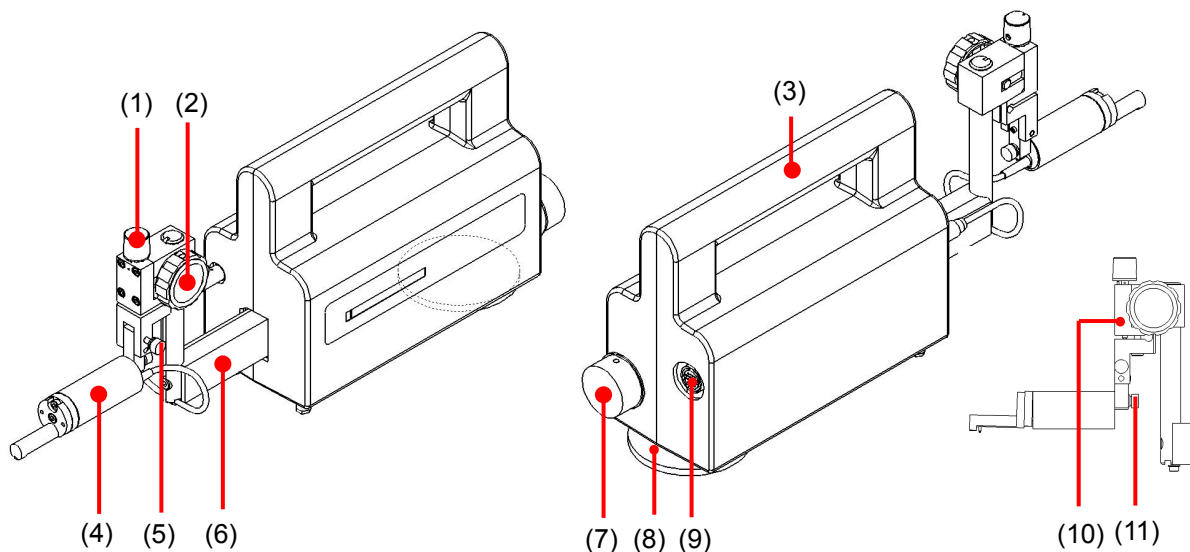
(1) Height (fine) adjustment knob
Used to adjust the height between the installed pickup and a measuring plane.

(2) Height (rough) adjustment knob
Used to adjust the height between the installed pickup and a measuring plane.

(3) Handle
Used to carry the driver unit.

(4) Pickup/stylus
A detector that checks the surface roughness of the workpiece inspected.

(5) Skid/skidless measurement switching knob
Used to switch measurement methods.
For skidless measurement, tighten this knob to secure the pickup.
For skid measurement, loosen this knob to adjust the pickup according to a measuring plane.

(6) Shaft
This shaft moves the pickup.

⚠ **Caution**   **The shaft tends to be rusty. Be careful not to touch it with bare hand. If you touched the shaft, wipe it out lightly with a soft cloth on the spot.**

(7) Driver manual positioning knob
Used to adjust the position to start measurement.

⚠ **Caution**   **Rotating the driver manual positioning knob too fast will cause quick acceleration or deceleration, and the deceleration mechanism in the driver may be damaged. Be sure to rotate the knob slowly.**

(8) Driver leveling knob
Used to adjust the levelness between the drive direction and a measuring plane.
This knob does not function when the driver is installed on the compact measurement table.

⚠ **Caution**   **When you rotate the driver manual positioning knob or driver leveling knob, hold the driver main body with your hand so that it does not move.**

(9) Connector
Into this connector, insert the plug of driver cable to connect the data processor.

(10) Height adjuster
Used to adjust the height of the pickup.

(11) Pickup clamp knob
Used to install the pickup on to the driver.

4. Installation and Preparation

This chapter explains the installation and preparation.

4-1 Driver (-35/-40/-45) preparation

4-1-1 Installing the pickup

When installing the pickup on to the driver, take the following steps and pay careful attention.

● Preparing the driver

1. Check the position of receptacle holes to which the pickup is connected.
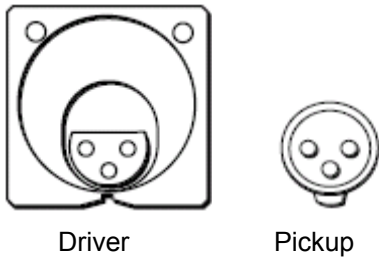
Driver   Pickup

2. Align pickup pins with receptacle holes, and insert the pickup straight.

Pins

Pickup

Turn the stylus to point down.
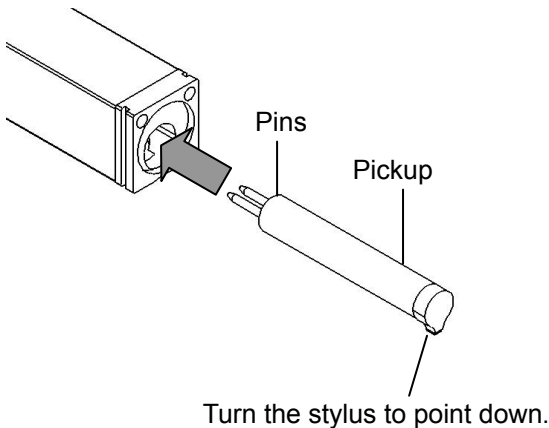
⚠ **Caution** **Be careful not to apply a 90 N (9 kgf) or greater force to the pickup.**
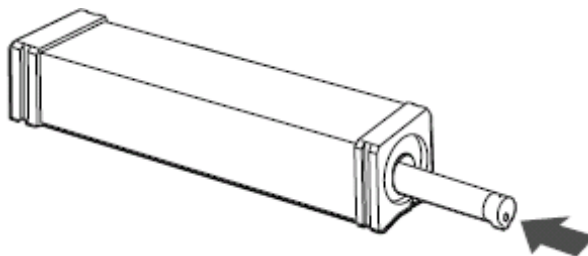
4-1-2 Connecting with the data processor

⚠ **Caution** **Before connecting the driver to the data processor, make sure that the power is turned off.**

● Connecting the driver

1. Connect the plug of the driver cable to the driver connector on the data processor. Align the male part of the connector with the female part of the plug, and insert the plug.

Data processor   Driver cable

2. Connect the plug of the driver cable to the connector on the rear of the driver. Align the male part of the connector with the female part of the plug, and insert the plug.
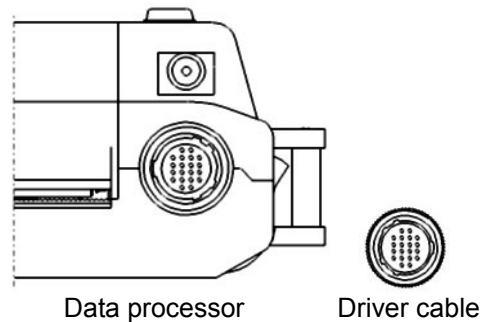
Driver   Driver cable

⚠ **Caution** **When installing or removing the plug, do not apply excessive force to the connector and plug.**
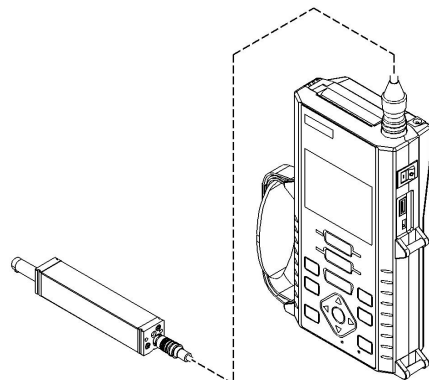
4-2   Driver (-50) preparation

4-2-1   Installing the pickup

When installing the pickup on to the driver, take the following steps and pay careful attention.

● Preparing the driver

1. Install the height adjuster on to the driver. Remove the screw at the top of the driver shaft using the attached hex-head wrench (width across flats: 3 mm), and tighten the screw by aligning the orientation of the height adjuster. When tightening the screw, hold the block of the height adjuster. Do not hold the driver, as doing so may apply force to the sliding mechanism in the driver and reduce its performance.
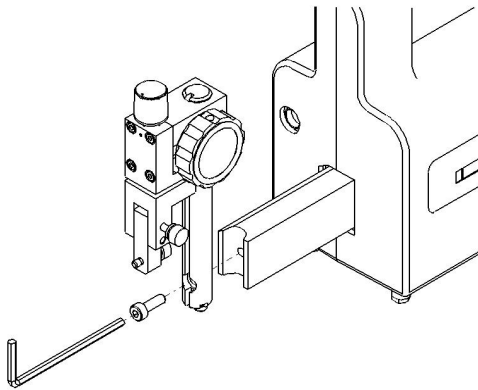
2. Install the pickup on to the height adjuster. Align the screw hole on the rear of the pickup with the pickup clamp knob of the height adjuster, and rotate the knob and tighten it securely.
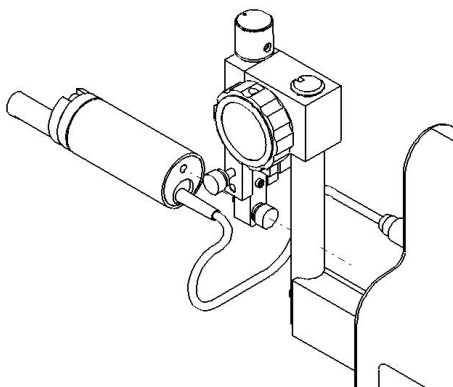
3. Secure the pickup cable to the bottom of the height adjuster. Secure the screw with the attached hex-head wrench (width across flats: 2.5 mm) at the position 185 mm to 195 mm from the top of the plug of the pickup cable (or 80 mm to 90 mm from the rear end of the pickup).

⚠ **Caution**   **Be sure to secure the cable. This is required to assure accuracy.**

185 to 195
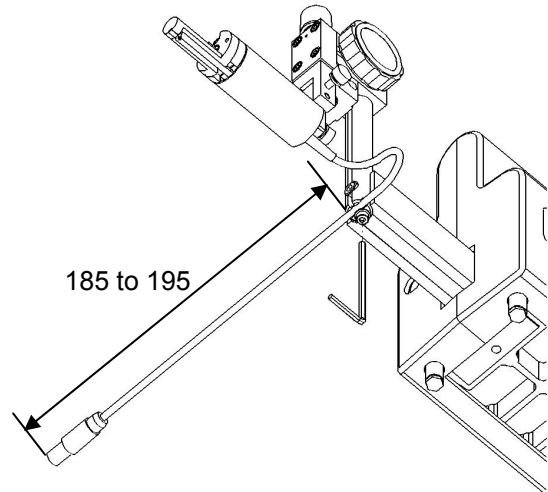
4. Connect the plug of the pickup cable to the connector on the front of the driver. Turn up the red mark on the plug, and insert the plug straight into the connector.

Mark

21
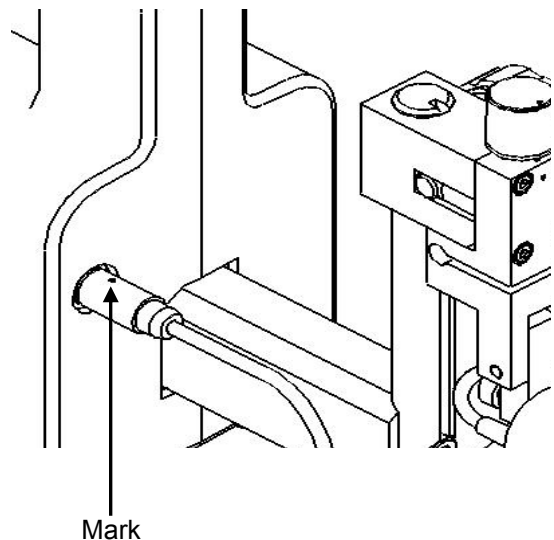
4. Installation and Preparation

4-2-2　Connecting with the data processor

⚠️ **Caution** **Before connecting the driver to the data processor, make sure that the power is turned off.**

● Connecting the driver

1. Connect the plug of the driver cable to the driver connector on the data processor. Align the male part of the connector with the female part of the plug, and insert the plug.
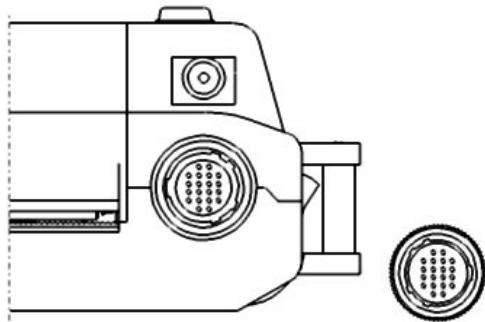
Data processor   Driver cable

2. Connect the plug of the driver cable to the connector on the rear of the driver. Align the male part of the connector with the female part of the plug, and insert the plug.
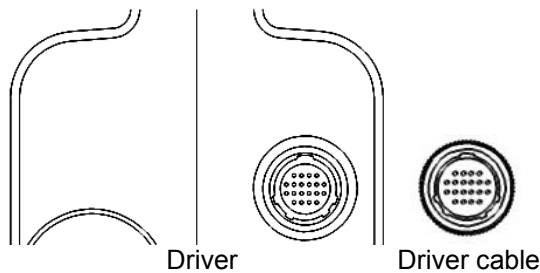
Driver   Driver cable

* When installing or removing the plug, do not apply excessive force to the connector and plug.
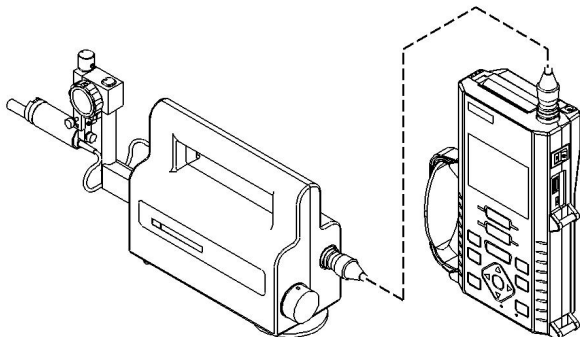
4-2-3　Preparing for skidless measurement

Before starting skidless measurement, prepare the pickup by taking the following steps.

● Preparing for skidless measurement

1. If the stylus contacts the workpiece, rotate the rough adjustment knob on the height adjuster to move the pickup upward.

2. Rotate the skid/skidless switching knob on the height adjuster to set it to skidless measurement. At this time, make sure that the pickup and the height adjuster are securely fixed and that there is no looseness between them.

Rough adjustment knob

Skid/skidless switching

Skid adjusting screw

Skid mounting screw

Nosepiece

Pickup clamp knob
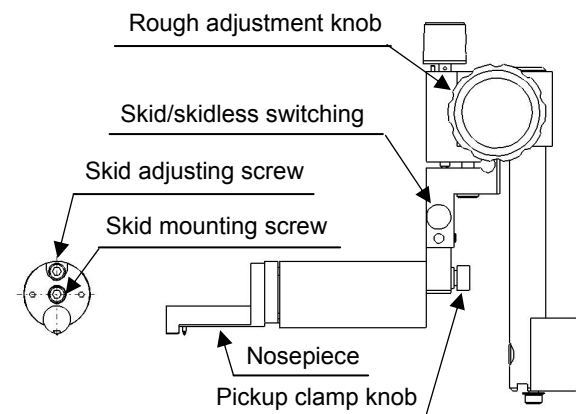
3. Skidless measurement is also enabled by loosening the skid adjusting screw on the pickup. Particularly for the purpose of protecting the stylus, measurement is possible while the nosepiece is attached.

⚠️ **Caution** **When performing measurement while the nosepiece is attached, be careful not to allow the skid to come in contact with the measuring plane.**

4. Rotate the rough adjustment and fine adjustment knobs on the height adjuster to lower the pickup, and contact the stylus with the measuring plane. Be careful so that displacement of the stylus does not exceed +400 micro-m.

5. Make sure that the stylus is in a vertical orientation to the measurement plane. If not, elevate the pickup once, loosen the pickup clamp knob on the height adjuster to adjust the angle to the vertical position, and then tighten the knob.
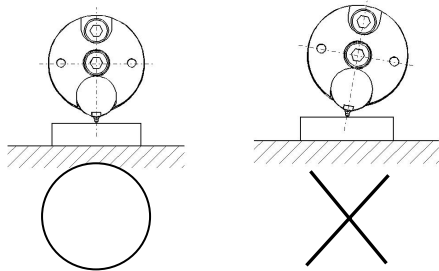
6. Adjust the position and tilt of the workpiece and driver, so that the measuring plane and the drive direction are in parallel with each other.

☞ By using the tilt correction function, you can position the driver to be nearly parallel with the measuring plane with a single tilt adjustment. For details, see (6-2-4) Tilt correction.

4-2-4　Preparing for skid measurement

Before starting skid measurement, prepare the pickup by taking the following steps.

● Preparing for skid measurement

1. If the stylus contacts the workpiece, rotate the rough adjustment knob on the height adjuster to move the pickup upward.

Rough adjustment knob

Skid/skidless switching

Skid adjusting screw

Skid mounting screw

Nosepiece
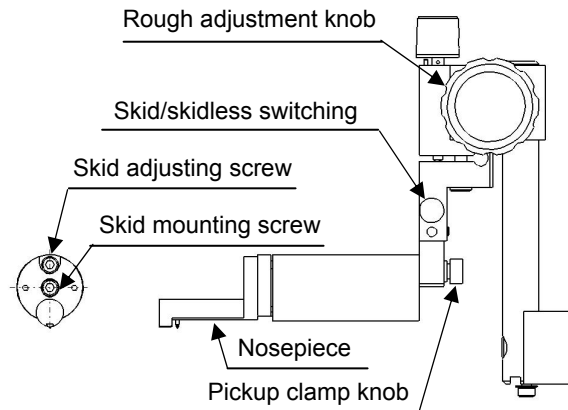
Pickup clamp knob

2. If the nosepiece is removed, install it.

3. Make sure that the stylus is in a vertical orientation to the measurement plane. If not, elevate the pickup once, loosen the pickup clamp knob on the height adjuster to adjust the angle to the vertical position, and then tighten the knob.
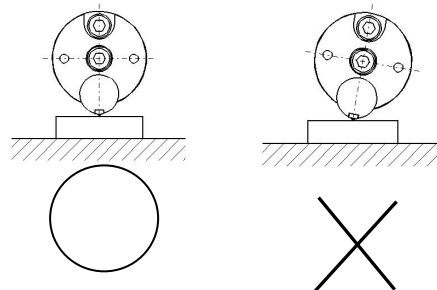
4. Installation and Preparation

4. Loosen the skid/skidless switching knob on the height adjuster and set it to skid measurement. At this time, check that the pickup can fluctuate smoothly to the height adjuster.
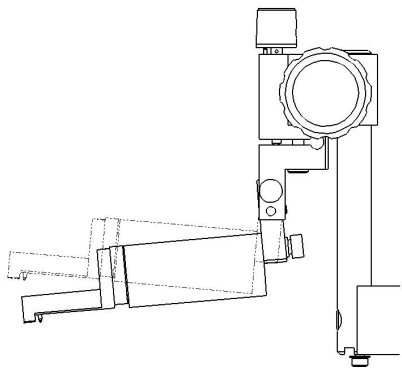
5. Rotate the rough adjustment and fine adjustment knobs on the height adjuster to lower the pickup, and contact the stylus with the measuring plane. Adjust height of the height adjuster so that the pickup and the measuring plane are in parallel with each other.
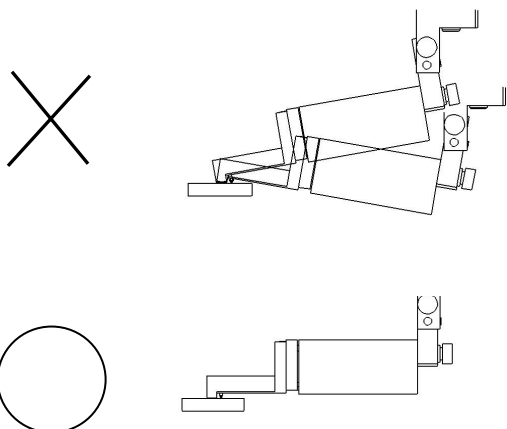
6. Turn the power on, and press the [CONDITION] button on the operation panel to display the measurement display screen.
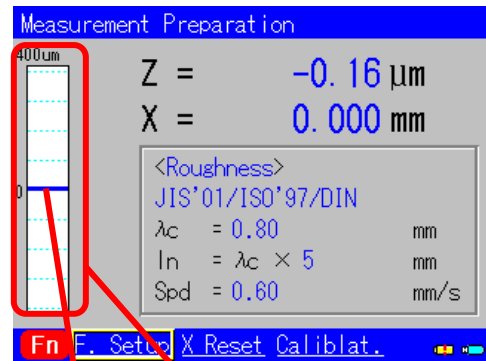
Level meter

Level bar

Rotate the skid adjusting screw with the attached hex-head wrench (width across flats: 2.5 mm) to adjust height of the skid, so that the level bar in the level meter is set to the zero (center) position.

☞   For the procedure about turning on the power, see Section 5-1.
☞   For information about screen operation, see Section 5-2.

4-3   Preparation of the data processor

4-3-1   Connecting and charging the AC adapter

● Connecting the AC adapter

Connect the power cable to the AC adapter, and connect the AC adapter plug to the power connector on the data processor. Do not connect or disconnect the AC adapter during measurements. Doing so may seriously reduce measuring accuracy.
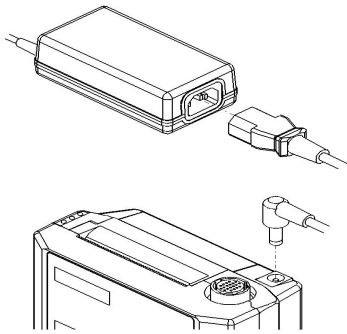
● When the AC adapter is connected

When the battery is not fully charged, the CHARGE lamp lights up on the operation panel. When the charge process is completed, the CHARGE lamp goes off.
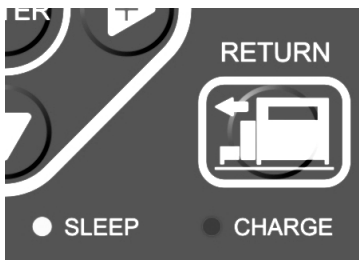
● When the AC adapter is not connected

Power is supplied from the internal battery. If the battery level is low, the battery icon blinks in the bottom of the screen. If you want to use the unit continuously, connect the AC adapter and charge the battery.

4-3-2   Inserting recording paper

● Inserting recording paper

1. Press down the printer open button. When the printer cover floats up, turn the cover manually to open it completely.
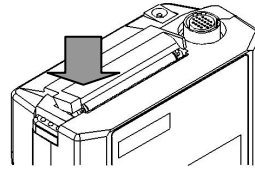
2. Pull out the end of recording paper in the orientation as shown the figure, and set the paper.
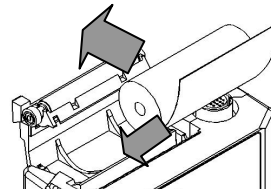
3. Set the paper so that its end comes out of the cover, and then close the printer cover. Push it down securely until it clicks.
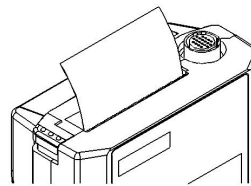
4. To cut the recording paper, hold the fed paper and pull it to the front side of the data processor. The paper can be easily cut if you move it slightly to right or left while pulling it.
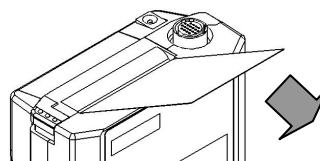
4. Installation and Preparation

4-3-3   How to use the tilt mechanism

Using the tilt mechanism on the rear of the data processor, the data processor can be tilted on the flat surface.

● Using the tilt mechanism

1. If you want to tilt the processor unit only slightly, raise the (small) tilt holder. Put your finger in the depressed portion at the center and pull it up completely.
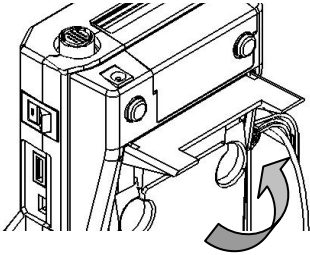
2. If you want to tilt the processor unit by a large angle, raise the (large) tilt holder. Put your finger in the depressed portion at the bottom and pull it up completely. This also pulls up the (small) tilt holder.
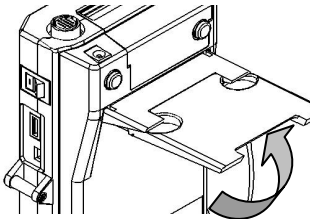
4-3-4   How to remove the tilt mechanism

To remove the tilt mechanism on the rear of the data processor, take the following steps.

● Removing the tilt mechanism

1. Raise the (small) tilt holder by 30 deg to 40 deg.
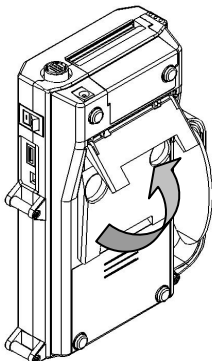
☞   Do not raise the (large) tilt holder. If it is raised, retract the holder to the rear cover.

2. While pushing the right and left protrusions of the (small) tilt holder inside, pull it out from the rear cover.
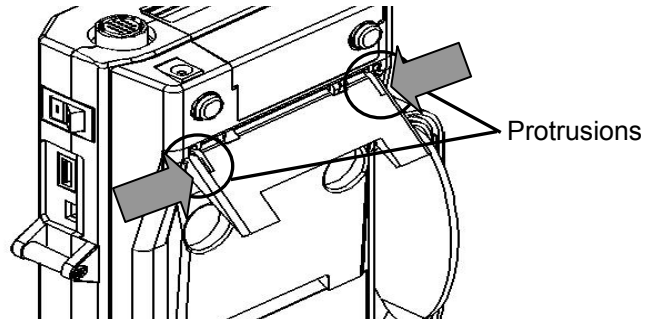
Protrusions

☞   If the angle of the (small) tilt holder does not reach 30 deg to 40 deg, the protrusions cannot be pushed inside.
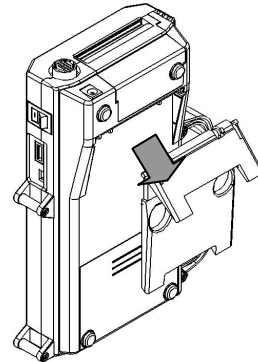
☞   The (large) and (small) tilt holders can be removed together.

3. After removing the (large) and (small) tilt holders from the rear cover, rotate them as shown in the figure.
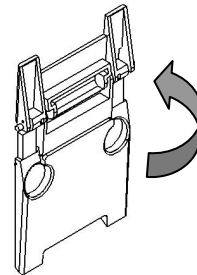
4. While pushing the right and left protrusions of the (large) tilt holder inside, pull it out from the (small) tilt holder.
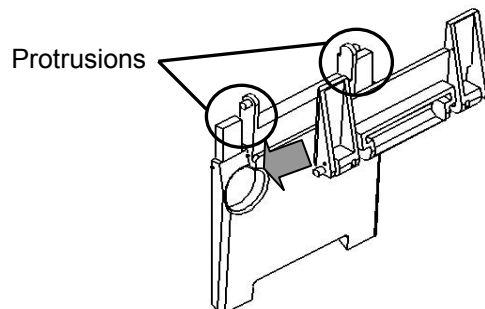
Protrusions

5. While pushing the right and left protrusions of the (small) tilt holder inside, insert it into the rear cover.
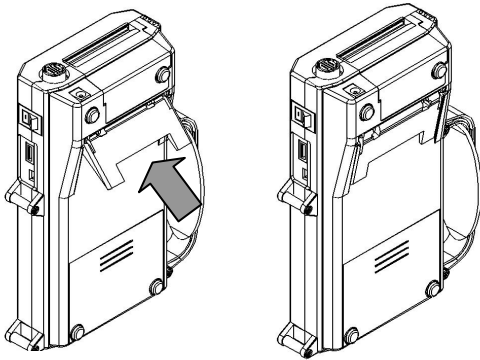
4-3-5 How to attach the hand belt

To attach the hand belt to the data processor, take the following steps. (It can be attached to either right or left side of the data processor.)

1. Pass the end of the hand belt through the upper hand belt supporter.
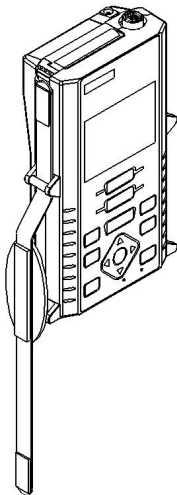
2. Fold back the belt at the correct position and secure it using a hook and loop fastener.
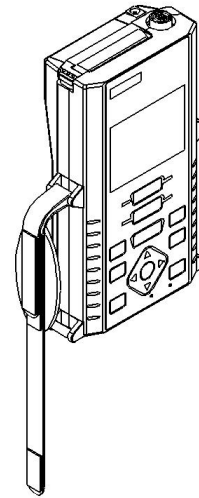
3. Similarly, pass the belt through the lower hand belt supporter and secure it using a hook and loop fastener.
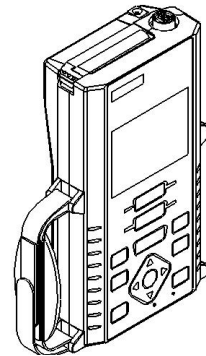
4. Check that the belt has been secured tightly.

5. Basic Operation

This chapter explains basic operation of this instrument.

5-1 Turning the power on or off

⚠ **Caution** **Before turning on the power of this instrument, be sure to prepare the driver and the data processor as described in Chapter 4 Installation and Connection.**

● Turning the power on

1. Press "|" on the power switch.

Power switch
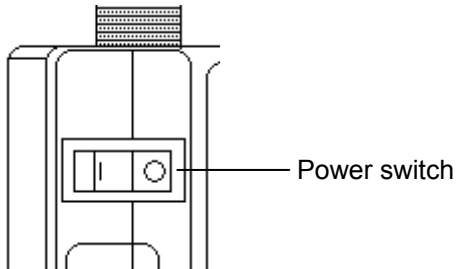
The start screen appears for a few seconds, and then the measurement preparation screen appears.

Start screen

SURFCOM
FLEX

⚡ ACCRETECH

Ver. 1.00

↓

Measurement preparation screen

Measurement Preparation
400um

Z = -134. 69 μm
X = 0. 000 mm

<Roughness>
JIS'01/ISO'97/DIN
λc = 0.80   mm
ln = λc × 5   mm
Spd = 0.60   mm/s

Fn F. Setup X Reset Caliblat.
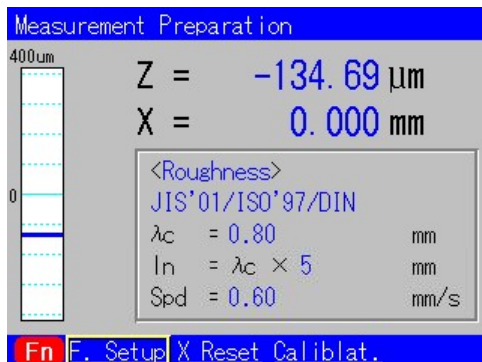
⚠ **Caution** **Following the start screen, a screen other than the measurement preparation screen may appear. In that case, follow the message on the screen to proceed. For details about the messages, see Section 16-2 Message list.**

☞ If you do not operate this instrument for a while after turning the power on, the sleep function activates. In the sleep state, the screen blacks out and the SLEEP lamp on the operation panel blinks in blue. For details about the sleep function, see Section 9-6-3 Sleep function.

● Turning the power off

1. Press "○" on the power switch. This turns the power off.

⚠ **Caution** **When you change drivers, turn the power off in advance. Otherwise, the product may develop a fault, or the model may not be correctly recognized, which may affect the measuring operation.**

● Model recognition
The model is recognized at power-on by the driver that is currently connected.
If the current driver differs from that used previously, the following message appears:

The drive part and cab-
le which are connected
do not suit.

Please push 【BACK】 key.
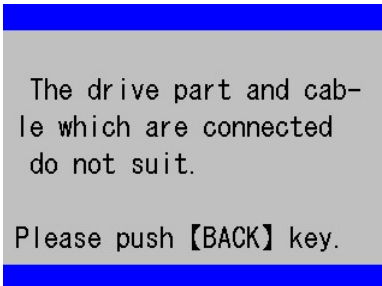
Press the **[BACK]** button. This changes the screen to the measurement preparation screen.
<Initialized items>
- Measurement condition information
- Analysis condition information
- Output parameter information
- System information
  (Excluding language and display unit)
- Various kinds of setting information
  (Excluding sleep function and date/time setting)
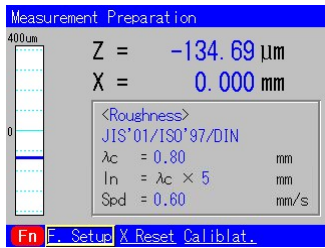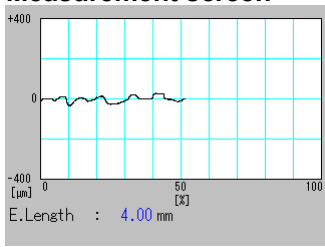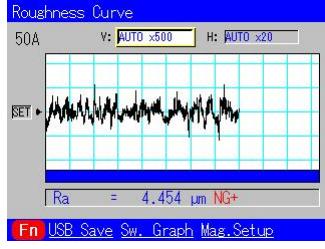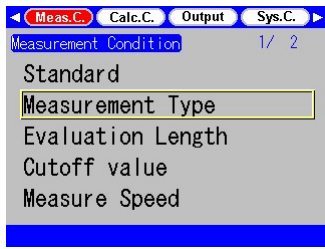
5-2 Screen operation

This section explains how to view displays in the operating screen and how to operate them.

● Operating screen

The operating screen types are roughly divided into measurement preparation, measurements, results, and menu.

The measurement preparation, measurements, results, and menu can be displayed respectively by pressing the following buttons.

Button	Button name	Description	Display screen
	CONDITION	Preparing measurements, and configuring measurement conditions	**Measurement preparation screen** Measurement Preparation 400μm Z = −134.69 μm X = 0.000 mm \<Roughness\> JIS'01/ISO'97/DIN λc = 0.80 mm ln = λc × 5 mm Spd = 0.60 mm/s **Fn** F.Setup X Reset Caliblat.
	MEAS./STOP	Starting or stopping measurement	**Measurement screen** +400 0 −400 [μm] 0 50 100 [%] E.Length : 4.00 mm
	GRAPH/PARAM.	Displaying measurement results, and switching between waveform and numerical value displays.	**Graph screen** Roughness Curve 50A V: AUTO x500 H: AUTO x20 SET Ra = 4.454 μm NG+ **Fn** USB Save Sw. Graph Mag.Setup
	MENU	Displaying menu	**Measurement condition screen** Meas.C. Calc.C. Output Sys.C. Measurement Condition 1/ 2 Standard Measurement Type Evaluation Length Cutoff value Measure Speed

5. Basic Operation

● How to view displays
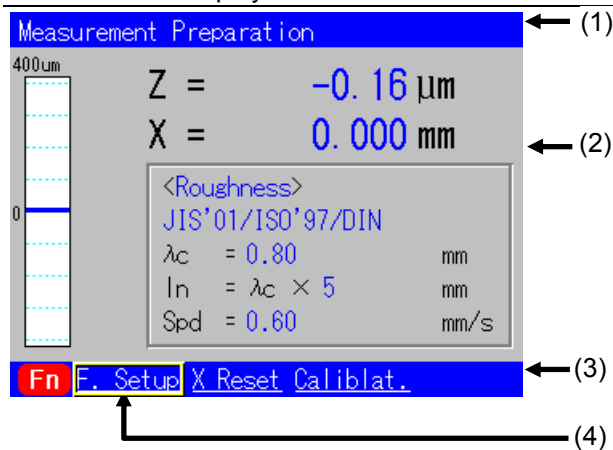
(1) Screen title and tab
This area displays the title characters or tab of the selected screen.
For information about the tab display, see the subsequent <Tab display> description.

(2) Main display
This area displays the selected screen.

(3) Fn function
This area displays the function of the selected screen.

(4) Cursor
The selected item is encircled by ☐ in yellow.
Use ▲, ▼, ▲, and ▼ buttons to move the cursor.
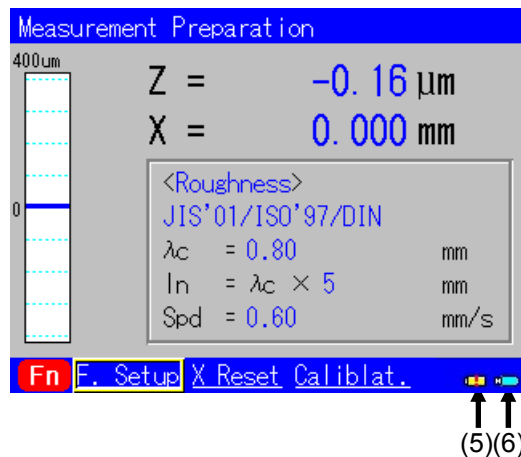
(5) Battery icon
This icon blinks when the battery needs to be charged. The sleep function activates after approximately five minutes, and the screen blacks out. Connect the power supply to use continuously.

☞ If this icon appears, the sleep function activates even when it is set to "off".
☞ For details about the sleep function, see **Section 9-6-3 Sleep function**.

(6) USB icon
This icon appears when a USB memory stick is plugged into the USB memory connector on the data processor.

☞ If you remove the USB memory stick while this icon appears, files stored in the USB memory stick may be destroyed. Be sure to see **Section 11-2-4 Removal** to remove the memory stick.
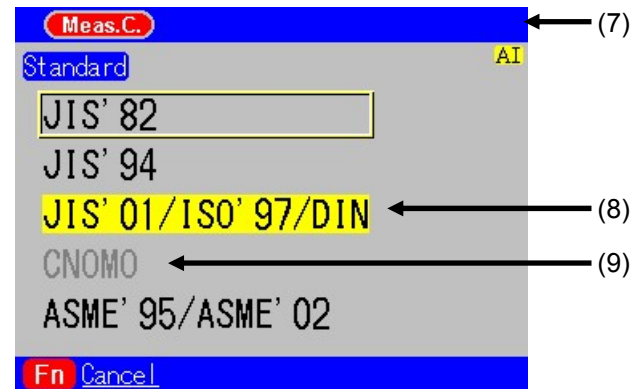
(7) AI icon
This icon appears when the AI function is used.

(8) Selected item
The item currently selected is highlighted in yellow.

(9) Deselected item
A grayed out item indicates that the item is not available under the current settings. The cursor does not stop on grayed out items.

<Tab display>
While the menu screen is displayed, icons appear to indicate the current hierarchical level.

▪ Example of the first screen display

▪ Example of the second screen display

Meas.C. indicates that it is currently selected, and Meas.C. indicates not selected.

● Entering data

The setting of the selected item can be changed with the ► button or the ◄ button. For numerical value data, the data input screen can be displayed by pressing the **ENTER** button. In the data input screen, press the **ENTER** button to apply the entered numerical value and return to the original screen. To cancel the entered numerical value, press the **BACK** button.

Item setting

Calc.C.
BC Graph Cut Level
Unit   Relative
Level   10.00 %

Fn Cancel

► ◄

Calc.C.
BC Graph Cut Level
Unit   Absolute
Level   10.00 μm

Fn Cancel

Numerical value setting

Calc.C.
Peak Count Level
Upp-L   0.00 μm
Low-L   0.00 μm

Fn Cancel

↓ ENTER

Data input

Peak Count Level
Upp-L
☐ ☐☐0 0 1 0.0 0 μm
0.00 ～ 2000.00

(ENTER) Set   (⬅) Cancel

← Change

ENTER   BACK

Calc.C.
Peak Count Level
Upp-L   10.00 μm
Low-L   0.00 μm

Fn Cancel

Calc.C.
Peak Count Level
Upp-L   0.00 μm
Low-L   0.00 μm
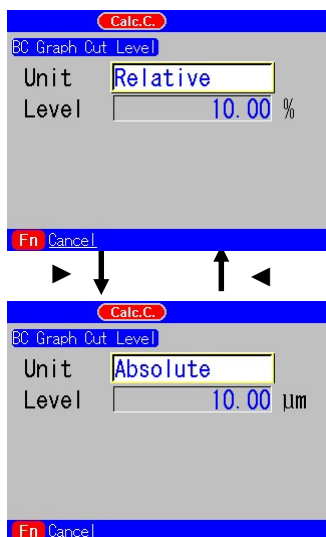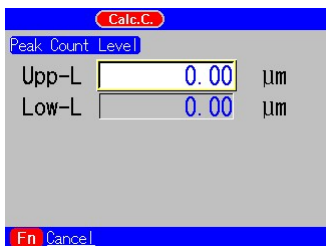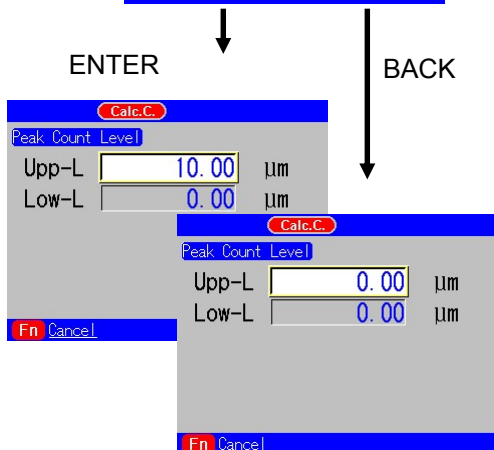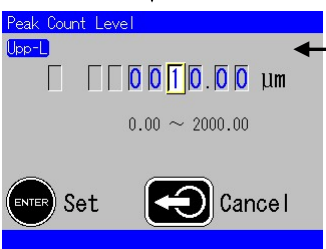
Fn Cancel

● Canceling the change

The information entered in each setting screen or changed by selecting operation can be returned to the original state by selecting "Cancel" in [Fn item].

Before change

Meas.C.
Standard
JIS' 82
JIS' 94
JIS' 01/ISO' 97/DIN
CNOMO
ASME' 95/ASME' 02
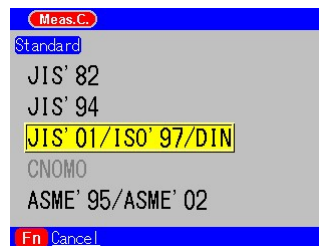
Fn Cancel

↓ Changed to JIS' 94

After change

Meas.C.
Standard
JIS' 82
JIS' 94
JIS' 01/ISO' 97/DIN
CNOMO
ASME' 95/ASME' 02
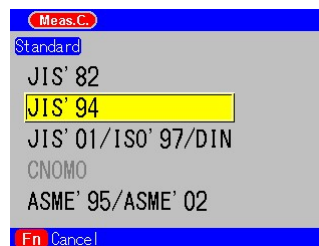
Fn Cancel

↓ Selecting "Cancel" in [Fn item]

Cancel

Meas.C.
Standard
JIS' 82
JIS' 94
JIS' 01/ISO' 97/DIN
CNOMO
ASME' 95/ASME' 02
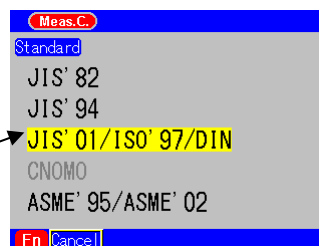
Fn Cancel

Returned to the state before change

☞ For information about [Fn item], see the next section ● Operation - FUNCTION.

5. Basic Operation

● Setting all items or canceling all items

In the screen where to select multiple items, you can select all items by selecting "All" in [Fn item], or cancel the all items by selecting "None" in [Fn item].

Output
Output Parameter   1/ 2
Ra   Rmax   Rz. J
Ry   Rz   Sm
S   Rq   Rp
Rt   Pc   AVH
Hmax   Hmin   Tp
Fn Cancel All None Judgement
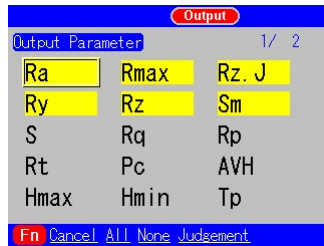
↓ Selecting "All" in [Fn item]

After selecting all items

Output
Output Parameter   1/ 2
Ra   Rmax   Rz. J
Ry   Rz   Sm
S   Rq   Rp
Rt   Pc   AVH
Hmax   Hmin   Tp
Fn Cancel All None Judgement
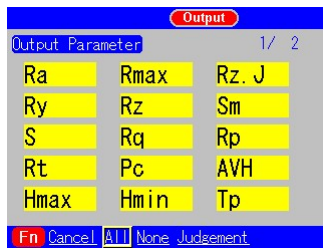
↓ Selecting "None" in [Fn item]

After clearing all items

Output
Output Parameter   1/ 2
Ra   Rmax   Rz. J
Ry   Rz   Sm
S   Rq   Rp
Rt   Pc   AVH
Hmax   Hmin   Tp
Fn Cancel All None Judgement
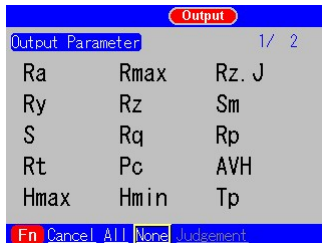
☞   For information about [Fn item], see the next section ● Operation - FUNCTION.

● Operation

The following explains the buttons used in the operating screen.

FUNCTION: Function button

Each time this button is pressed, [Basic item] selection and [Fn item] selection are switched in each screen.

Functions used in each screen are assigned to [Fn item], you can use them with this operation.

[Basic item] selection

Measurement Preparation
400um
$\overline{Z}$ =   0. 24 μm
X =   0. 000 mm
<Roughness>
JIS'01/ISO'97/DIN
λc = 0.80   mm
ln = λc × 5   mm
Spd = 0.60   mm/s
Fn F. Setup X Reset Caliblat.

Fn ↓   ↑ Fn

[Fn item] selection

Measurement Preparation
400um
Z =   −0. 16 μm
X =   0. 000 mm
<Roughness>
JIS'01/ISO'97/DIN
λc = 0.80   mm
ln = λc × 5   mm
Spd = 0.60   mm/s
Fn F. Setup X Reset Caliblat.
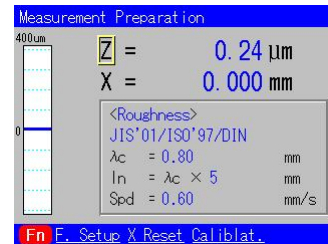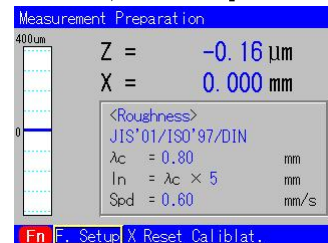
BACK: Back button

Press this button to return to the previous screen. It can also be used to return from the message screen.

☞ Pressing this button usually returns to the previous screen, but it does not work while any of the following screens is displayed.

- Measurement Preparation
- Output Setting
- Profile
- System
- Result
- Recalculation
- Measurement Condition
- Various Settings
- Analysis Conditions
- Save - Load

[Before transition]
Measurement preparation screen
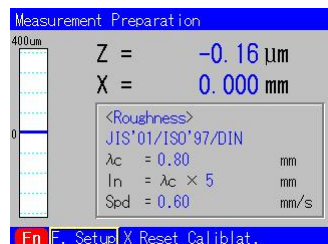
[After transition]
Function Setup screen
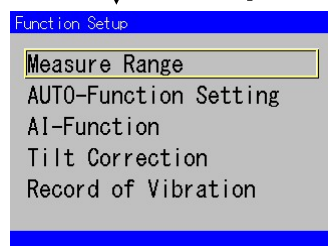
BACK

[Before transition]
USB memory Save screen
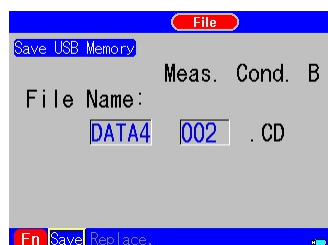
BACK
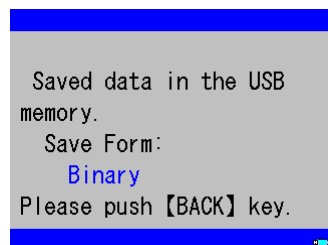
▲/▼/◄/►: Up/Down/Right/Left buttons

Each time the button is pressed in each screen, cursor or tab can be moved, or a setting value can be changed.

● Moving the cursor up or down in the selected item screen
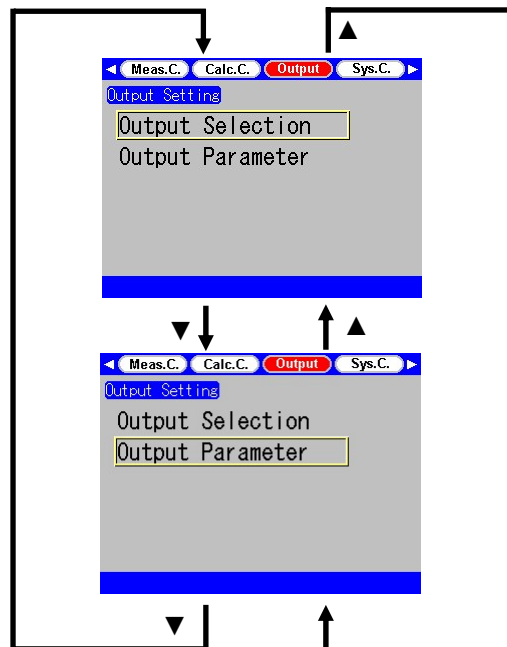
● Moving the cursor up or down in the setting item screen

33
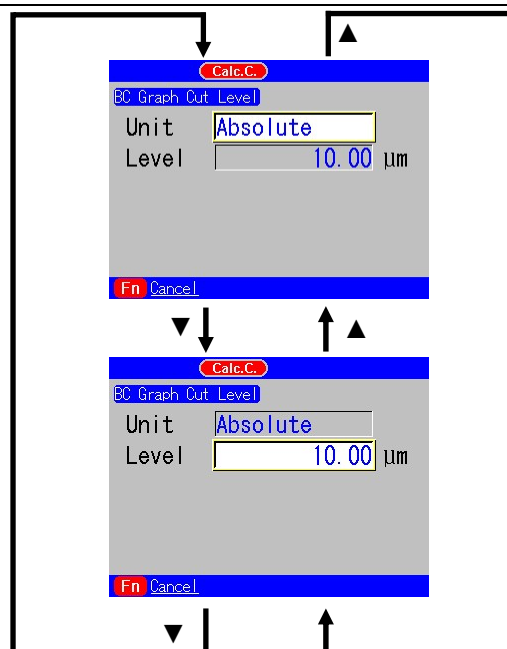
5. Basic Operation

● Moving the cursor right or left in the selected item screen
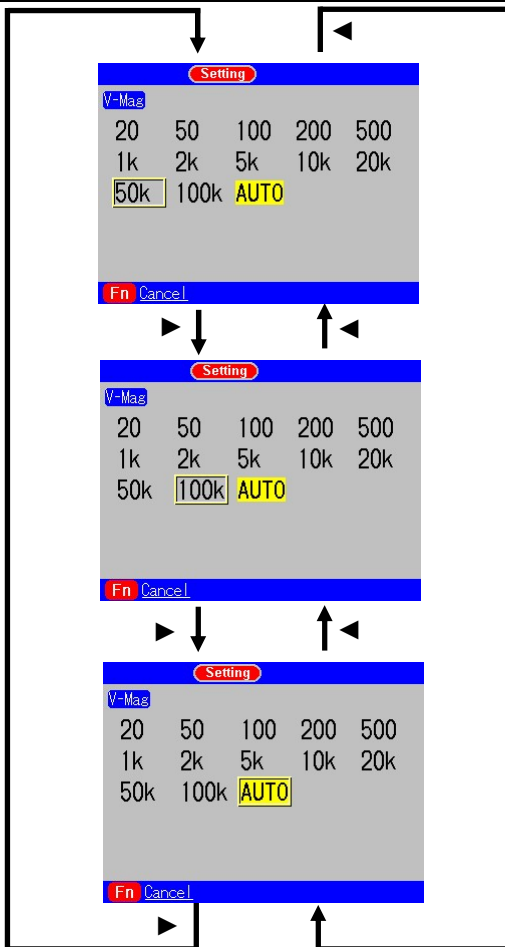
● Changing a setting value in the setting item screen
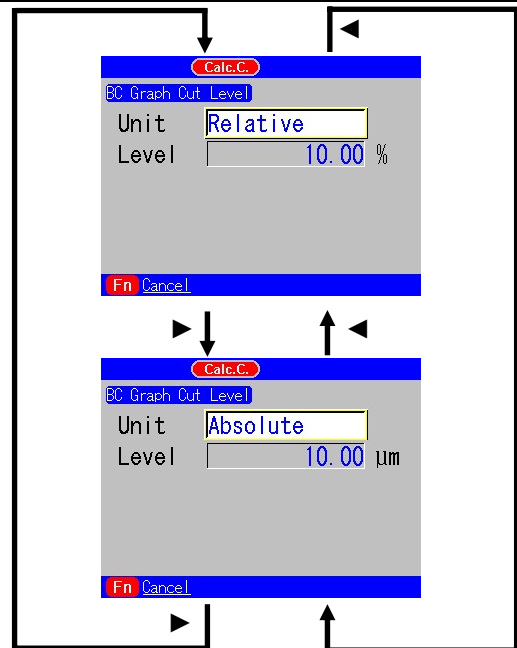
● Changing a setting value in the setting item screen (items displayed in right and left)
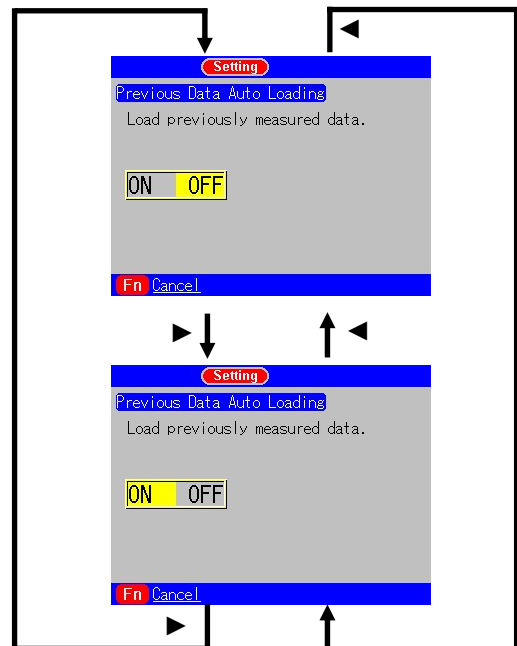
Fn+▲/Fn+▼: Function + Up/Down buttons

Each time the ▲ or ▼ button is pressed while pressing and holding the Fn button, the pages can be changed. (This function is only available for the screen having multiple pages.)

● Switching pages in the profile screen
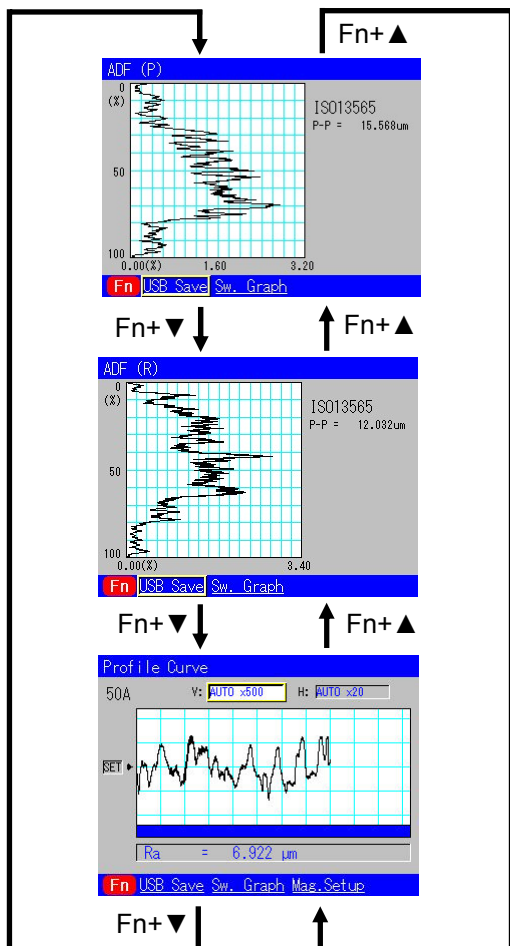
● Switching pages in the measurement data read or save screen

35
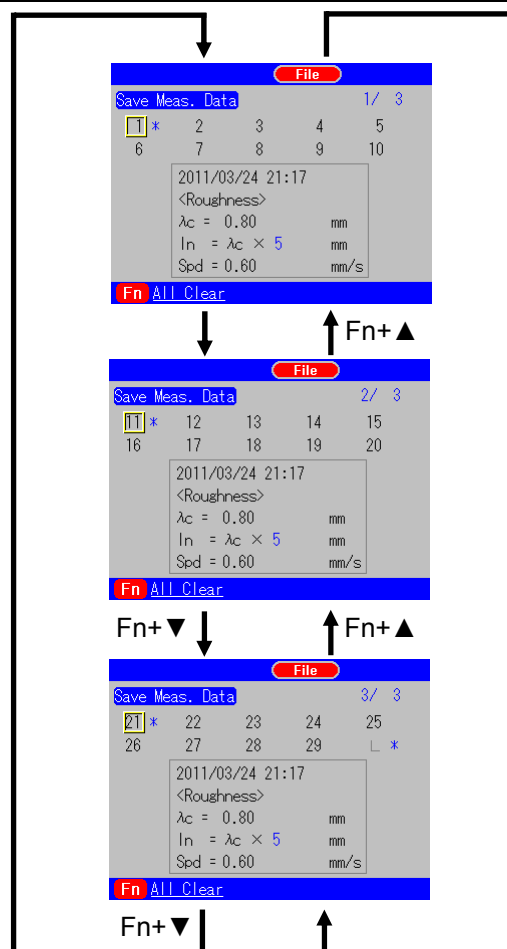
5. Basic Operation

ENTER: Enter button

Each time this button is pressed, the screen can be transitioned to a subordinate screen, selected item can be changed, or the item can be executed.

● Transition to a subordinate screen
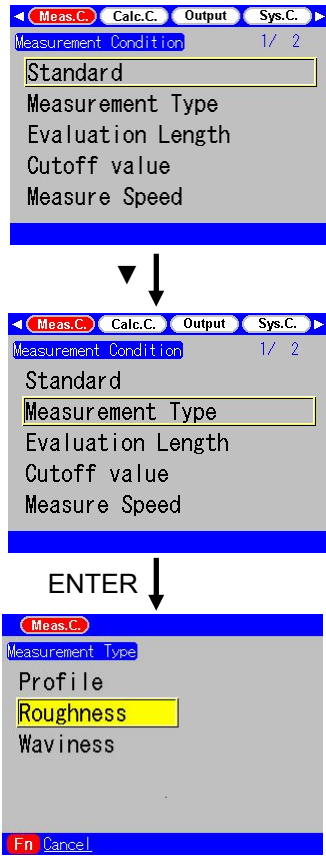
● Changing the selected item
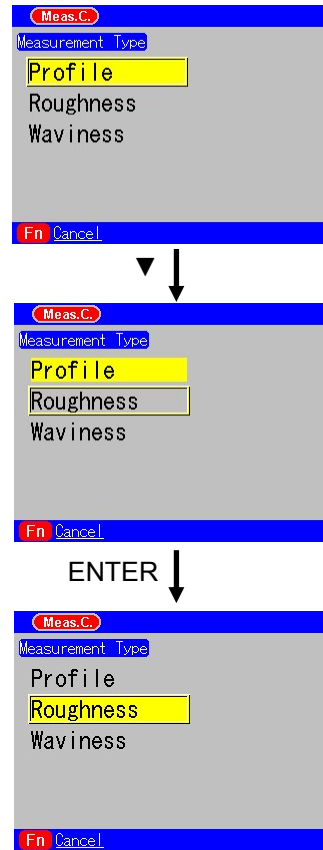
● Executing the selected item
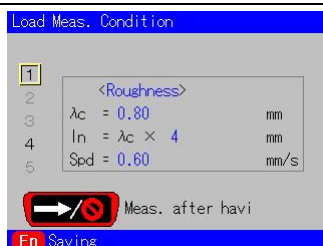
ENTER ↓
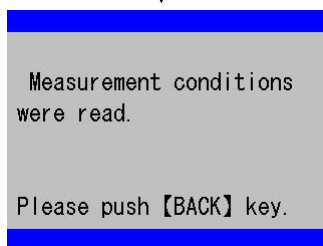
● Executing the Fn item

► ↓
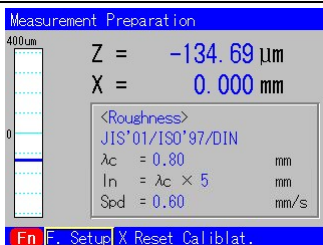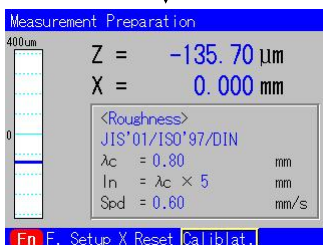
ENTER ↓
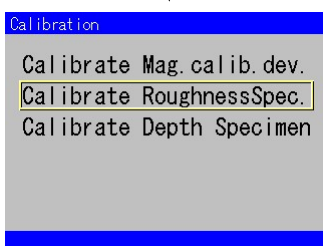
5. Basic Operation

5-2-1 Screen configuration

A screen displayed by pressing the CONDITION, MEAS./STOP, GRAPH/PARAM., or MENU button is called the "first screen". The Measurement Preparation screen, Measurement screen, Graph screen, and Measurement Condition screen are the first screens. A screen displayed by selecting an item or operating the Fn item in the first screen is called the "second screen".
In addition, a screen displayed by an operation carried out in a second screen is called the "third screen", and a screen displayed by an operation carried out in a third screen is the "fourth screen".

```
                        Selected          Selected          Selected

  First screen  ◄──►  Second screen  ◄──  Third screen  ◄──  Fourth screen

                       Second screen       Third screen       Fourth Output
  First screen                                                  Setting
         ⋮                   ⋮                  ⋮                   ⋮

                        Fn item            Fn item            Fn item

                       Second screen  ◄──  Third screen  ◄──  Fourth screen

                       Second screen       Third screen       Fourth screen
                            ⋮                  ⋮                   ⋮
```
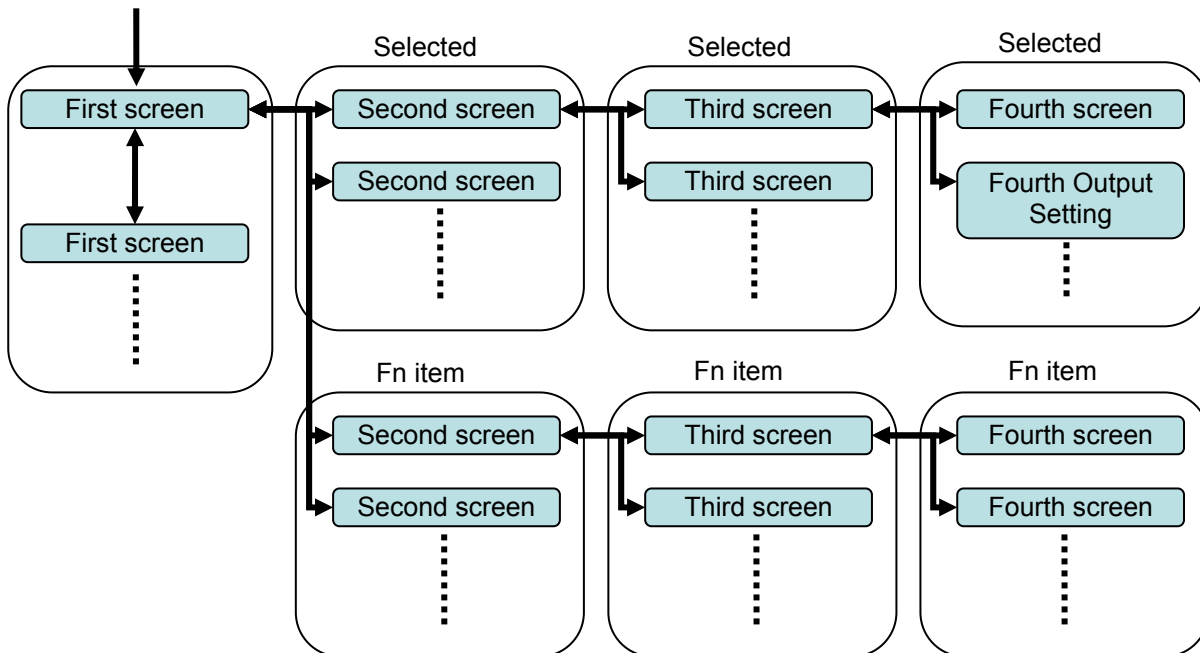
The following pages explains each screen and describes its configuration.

5-2-2   Measurement Preparation screen

The Measurement Preparation screen displays the level meter or measurement conditions.
The screen can be transitioned to that reads and saves cutoff value, evaluation length, measure speed, and measurement condition data.

First screen	Second screen	Third screen	Fourth screen

```
Measurement
Preparation ──┬── F. Setup ──┬── Measure Range
              │              │
              │              ├── AUTO-Function
              │              │   Setting
              │              │
              │              ├── AI-Function
              │              │
              │              ├── Tilt Correction
              │              │
              │              └── Record of Vibration
              │
              ├── Calibrate ──┬── Calibrate Mag. calib.
              │               │   dev.
              │               │
              │               ├── Calibrate Roughness
              │               │   Spec.
              │               │
              │               └── Calibrate Depth
              │                   Specimen
              │
              ├── Cutoff value
              │   (λc)
              │   (λf yes)
              │   (λf no)
              │
              ├── Evaluation Length
              │   (Fixed)
              │   (Arbitrary)
              │
              ├── Measure Speed
              │
              ├── Load Meas.
              │   Condition
              │
              └── Save Meas.
                  Condition
```

☞ Each of the Cutoff value, Evaluation Length, Measure Speed, Load Meas.Condition, and Save Meas. Condition screens of the menu is displayed.

5. Basic Operation

5-2-3 Measurement screen

The Measurement screen displays the progress of measurement in realtime. The horizontal axis represents the measuring length, and vertical axis represents the measuring range.
As this screen displays the waveform of the workpiece, you can roughly confirm the shape of the workpiece currently being measured.

First screen	Second screen	Third screen	Fourth screen
➡/🚫			
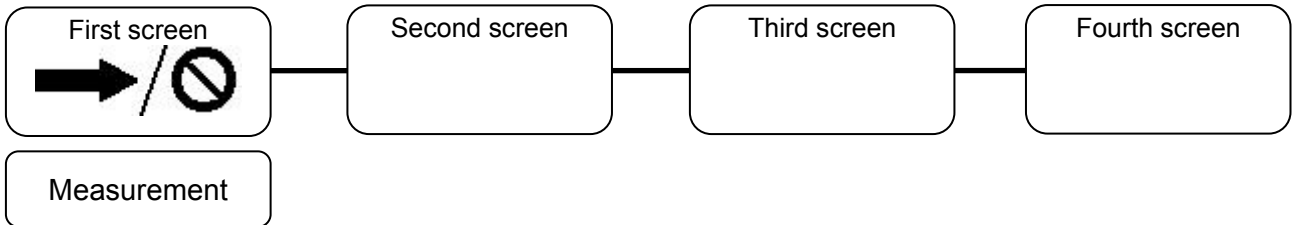
Measurement

5-2-4 Result screen

The Result screen displays the various shapes and parameter calculation results.

First screen	Second screen	Third screen	Fourth screen
〰/Ra			

Graphs
(Profile Curve)
(Roughness Curve)
(Filtered Waviness Curve)
(Waviness Profile Curve)
(ISO13565 Profile)
(Roughness Motif)
(Waviness Motif)
(BAC Graph P)
(BAC Graph R)
(BAC Graph WC)
(ADC Graph P)
(ADC Graph R)
(ADC Graph WC)
(Record of Vibration)
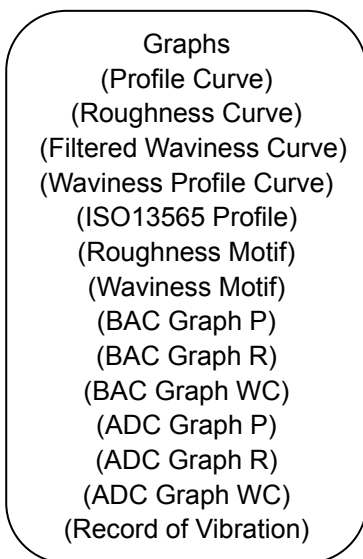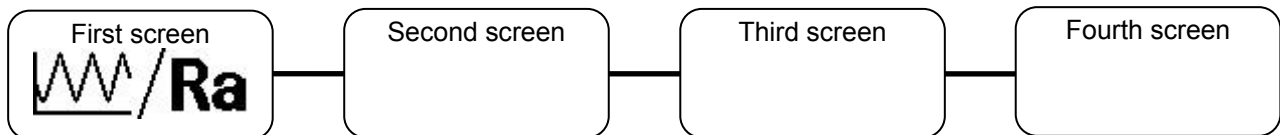
☞ The default Graph screen varies depending on the measurement type.
☞ If two or more bodies are provided, the Graph screens can be switched using the graph switching function.
☞ When the record of vibration has been executed, the Record of Vibration screen is displayed.

Result	Section Parameter

40
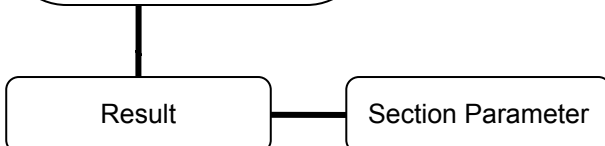
5-2-5　Menu screen

The menu screen configures condition, output, system, and other settings.
It can also read or save data from/to the internal memory and a USB memory stick.

```
┌─────────────┐   ┌─────────────┐   ┌─────────────┐   ┌─────────────┐
│ First screen│───│Second screen│───│ Third screen│───│Fourth screen│
│     ▤       │   │             │   │             │   │             │
└──────┬──────┘   └─────────────┘   └─────────────┘   └─────────────┘
       │
┌──────┴──────┐   ┌─────────────┐
│ Measurement │───│  Standard   │
│  Condition  │   └─────────────┘
└──────┬──────┘
       │         ┌─────────────┐
       ├─────────│Measurement Type│
       │         └─────────────┘
       │
       │         ┌─────────────┐        ☞  Appearance of the
       ├─────────│Evaluation Length│      Evaluation Length screen
       │         │   (Fixed)   │        varies depending on the
       │         │  (Arbitrary)│        designation.
       │         └─────────────┘
       │
       │         ┌─────────────┐        ☞  Appearance of the
       ├─────────│Cutoff value │        Cutoff Value screen
       │         │    (λc)     │        varies depending on
       │         │   (λf yes)  │        the measurement type.
       │         │   (λf no)   │
       │         └─────────────┘
       │
       │         ┌─────────────┐
       ├─────────│Measure Speed│
       │         └─────────────┘
       │
       │         ┌─────────────┐
       ├─────────│Pre. Drive Length│
       │         └─────────────┘
       │
       │         ┌─────────────┐
       ├─────────│ Form Remove │
       │         └─────────────┘
       │
       │         ┌─────────────┐
       ├─────────│ Filter Type │
       │         └─────────────┘
       │
       │         ┌─────────────┐
       ├─────────│  Ls Filter  │
       │         └─────────────┘
       │
       │         ┌─────────────┐
       └─────────│Return Speed │
                 └─────────────┘
┌─────────────────────┐
│ Continued to the next│
└─────────────────────┘
```

5. Basic Operation

```
┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐      ┌─────────────────┐
│  First screen   │──────│  Second screen  │──────│  Third screen   │──────│  Fourth screen  │
│  [≡]            │      └─────────────────┘      └─────────────────┘      └─────────────────┘
└─────────────────┘
```

Continued from the previous page

```
┌──────────────────┐      ┌──────────────────────┐
│ Analysis Condition│──────│  Peak Count Level    │
└──────────────────┘      └──────────────────────┘
                          ┌──────────────────────┐
                          │     Cut Level        │
                          └──────────────────────┘
                          ┌──────────────────────┐
                          │  Motif Calculation   │
                          └──────────────────────┘
                          ┌──────────────────────┐
                          │    Step Height       │
                          │    Calculation       │
                          └──────────────────────┘
                          ┌──────────────────────┐
                          │  Notch calculation   │
                          └──────────────────────┘

┌──────────────────┐      ┌──────────────────────┐
│  Output Setting  │──────│   Output Selection   │
└──────────────────┘      └──────────────────────┘
                          ┌──────────────────────┐      ┌──────────┐      ┌──────────────────────┐
                          │  Output Parameter    │──────│ Judgment │──────│  Judgment Parameter  │
                          └──────────────────────┘      └──────────┘      └──────────────────────┘
                                                                          ┌──────────────────────┐
                                                                          │     Judgment         │
                                                                          │   Parameter 1        │
                                                                          └──────────────────────┘
                                                                          ┌──────────────────────┐
                                                                          │     Judgment         │
                                                                          │   Parameter 2        │
                                                                          └──────────────────────┘
                                                                          ┌──────────────────────┐
                                                                          │     Judgment         │
                                                                          │   Parameter 3        │
                                                                          └──────────────────────┘
                                                                          ┌──────────────────────┐
                                                                          │      16% rule        │
                                                                          └──────────────────────┘
```

Continued to the next

First screen	Second screen	Third screen	Fourth screen

Continued from the previous page

System	Language

Display Unit

Stop-Calc.

Pickup

Display Sel. After Meas.

USB Memory Save Type

Recalculation

Various Settings	V-Mag.

H-Mag.

Sleep ON/OFF

Date/Time

Previous Data Auto Loading

Initialize

Maintenance	Communication Condition

Continued to the next

5. Basic Operation

```
┌──────────────┐   ┌──────────────┐   ┌──────────────┐   ┌──────────────┐
│ First screen │───│ Second screen│───│ Third screen │───│ Fourth screen│
│  ▤           │   └──────────────┘   └──────────────┘   └──────────────┘
└──────────────┘
```

Continued from the previous

```
┌──────────────┐     ┌──────────────┐     ┌──────────────┐     ┌──────────────────┐
│  Save/Load   │──┬──│Internal Memory│──┬──│Save Meas. Data│───│Meas. Data Clear All│
└──────────────┘  │  └──────────────┘  │  └──────────────┘     └──────────────────┘
                  │                     │  ┌──────────────┐
                  │                     ├──│Read Meas. Data│
                  │                     │  └──────────────┘
                  │                     │  ┌──────────────┐
                  │                     ├──│  Save Meas.  │
                  │                     │  │Communication │
                  │                     │  └──────────────┘
                  │                     │  ┌──────────────┐
                  │                     └──│  Load Meas.  │
                  │                        │  Condition   │
                  │                        └──────────────┘
                  │  ┌──────────────┐     ┌──────────────┐
                  ├──│  USB Memory  │──┬──│     Save     │
                  │  └──────────────┘  │  └──────────────┘
                  │                     │  ┌──────────────┐
                  │                     └──│ Load-Delete  │
                  │                        │  Stop-Calc.  │
                  │                        └──────────────┘
                  │  ┌──────────────┐     ┌──────────────┐
                  └──│Internal Mem to USB│─┬─│Meas. Data Whole│
                     │     Mem      │    │  │    Copy      │
                     └──────────────┘    │  └──────────────┘
                                          │  ┌──────────────┐
                                          └──│Meas. Cond. Whole│
                                             │    Copy      │
                                             └──────────────┘
```

5-3 Measurements

● Starting or stopping measurement
To start or stop measurement, press the following button.

Button	Button name	Description	Display screen
➡/🚫	**MEAS./STOP**	**Starting or stopping measurement**	Measurement screen Measurement Stop screen Measurement has stopped. Please push 【BACK】 key.
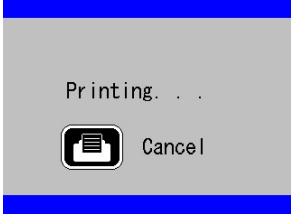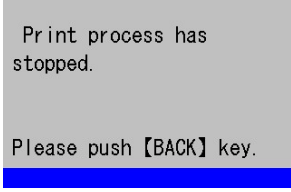
☞ For detailed explanation about measurements, see **Chapter 6 Measurement Preparation**, and **Chapter 7 Measurements**.
☞ The Measurement Stop screen cannot be displayed when "Stop-Calc." is turned on.

5-4 Print and Paper Feed

● Starting or stopping printing, or feeding paper
To start or stop printing, or feeding paper, press the following buttons.

Button	Button name	Description	Display screen
🖨	**PRINT**	**Starting or stopping printing**	Printing screen Printing. . . 🖨 Cancel Print stop screen Print process has stopped. Please push 【BACK】 key.
🖨	**FEED**	**Feeding paper**	—

☞ No messages appear during paper feedings.
☞ For detailed explanation about printing, see **Chapter 10 Printing**.
☞ Pressing the **[FEED]** button once feeds the paper by 7 mm to 8 mm.
☞ If you press and hold the **[FEED]** button, the paper is fed continuously.

5. Basic Operation

5-5 Return the driver

● Returning the driver (The pickup moves)
To return the driver, press the following button

Button	Button name	Description	Display screen
	RETURN	**Starting or stopping the return**	Returning screen Returning. . . Stop

☞ No screen is provided for messages to stop the return process.

Press the **[RETURN]** button to return the driver to the predefined position.

Timing the **[RETURN]** button is pressed	Position where the driver returns
Before measurement	Minus limit position
After measurement	Measurement start point If the **[RETURN]** button is pressed again afterward, the driver returns to the minus limit position.

☞ For driver (-35/-40/-45), the driver always returns to the minus limit position.

6. Measurement Preparation

The measurement preparation screen has functions to display the level meter and main measurement conditions, and prepare for measurements.

Item	Description
Measurement Preparation	Displays and configures the level meter and main measurement conditions.
F. Setup	Prepares measure range, AUTO-function setting, and others before measurements.
X Reset	Sets the X-axis value to 0.
Calibrate	Adjust the scale to maintain accuracy of this instrument.
Measurement Condition Data	Loads or saves measurement condition data.

6-1   Measurement preparation

The Measurement Preparation screen displays and configures the level meter and main measurement conditions.

Item	Description
Axis level	Displays the level meter and the axis level.
Measurement condition	Displays the measurement type, cutoff value, evaluation length, and measure speed. The cutoff value, evaluation length, and measure speed can be moved to each setting screen.
Offset adjustment	Adjust offset of the Z-axis.

● Displaying the Measurement Preparation screen.
1. Press the **[CONDITION]** button.
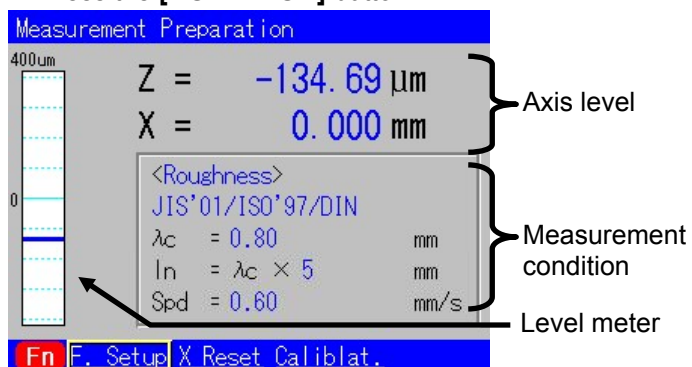
6. Measurement Preparation

6-1-1 Displaying the axis level
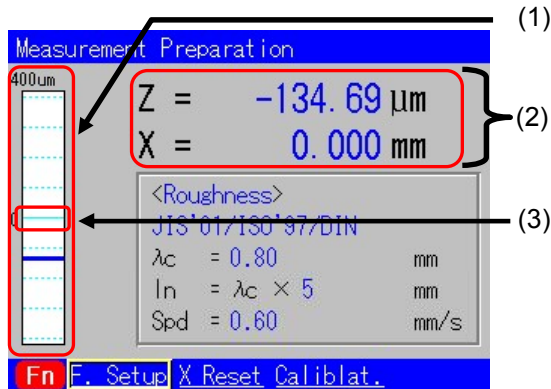
(1) Level meter range
Displays the Z-axis level by meter.
The measure range value is also displayed.
(2) Axis level
Displays the Z-axis level and the X-axis level by value.
If the Z-axis level exceeds the range, "++++"("----") is displayed.
(3) Level bar
Indicates the position of the Z-axis level.
If the position is within the range, this bar appears in blue. Otherwise, it appears in red.

6-1-2 Displaying measurement conditions
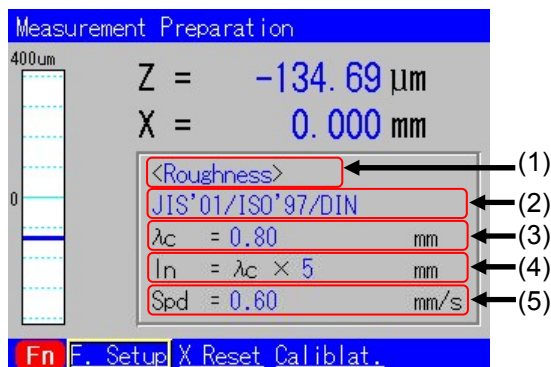
(1) Measurement type
Displays the type of measurement currently selected.
(2) Standard
Displays the currently selected standard.
(3) Lc (Cutoff value)
Displays the cutoff value currently selected.
(4) Ln (Evaluation length)
Displays the evaluation length currently configured.
Usually, five times the cutoff value is specified as an evaluation length, but it can also be set to any other value.
(5) Spd (Measure speed)
Displays the measure speed currently selected.

6-1-3   Adjusting offset

●Adjusting the Z-axis offset
1. Press the **[CONDITION]** button, then **[Fn]**.

2.**Change the Z-axis level using with the [►] and [◄]** buttons.

   [►] button: Moves by 0.1 micro-m (0.1 micro-inch) in the positive direction

   [◄] button: Moves by 0.1 micro-m (0.1 micro-inch) in the negative direction
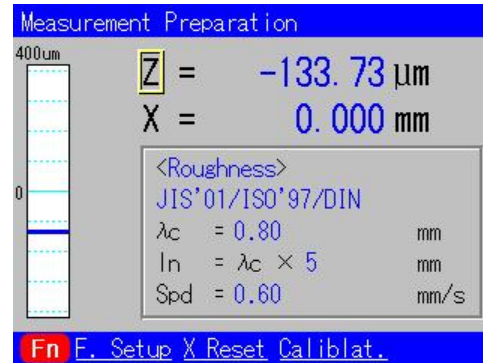
The adjusting range is +/- 64 micro-m (+/-2519.7 micro-inches).

6-1-4   Cutoff value

●Setting the cutoff value
1. Press the **[CONDITION]** button, then **[Fn]**.

2. Select **"Lc"** using the **[▲] and [▼]** buttons, and press the **[ENTER]** button.
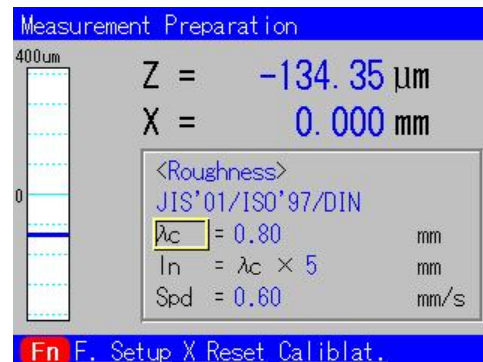
The Cutoff Value screen appears. For the procedure to set the cutoff value, see **Section 9-1-4 Cutoff value**.

is fixed to 0.60 mm/s (0.0240 inches/s) by default.

6-1-5　Evaluation length

●Setting the evaluation length

1. Press the **[CONDITION]** button, then **[Fn]**.

2. Select **"Ln"** using the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

```
Measurement Preparation
400um
           Z =    -134. 45 μm
           X =       0. 000 mm
           <Roughness>
           JIS'01/ISO'97/DIN
0
           λc   = 0.80           mm
           In  = λc × 5          mm
           Spd  = 0.60          mm/s
 Fn  F. Setup  X Reset  Caliblat.
```
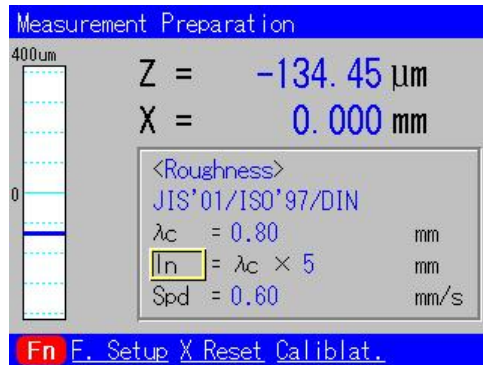
The Evaluation Length screen appears. For the procedure to set the evaluation length see **Section 9-1-3 Evaluation length**.

6-1-6　Measure speed

● Setting the measure speed

1. Press the **[CONDITION]** button, then **[Fn]**.

2. Select **"Spd"** using the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

```
Measurement Preparation
400um
           Z =    -134. 38 μm
           X =       0. 000 mm
           <Roughness>
           JIS'01/ISO'97/DIN
0
           λc   = 0.80           mm
           In  = λc × 5          mm
           Spd  = 0.60          mm/s
 Fn  F. Setup  X Reset  Caliblat.
```
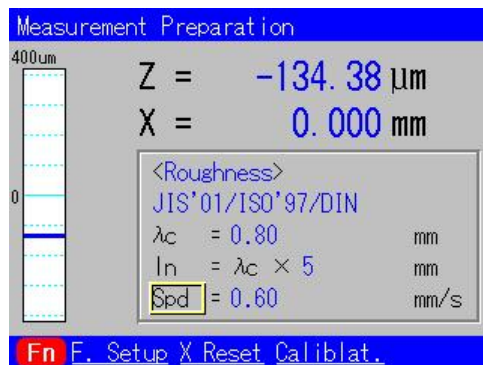
The Measure Speed screen appears. For the procedure to set the evaluation length see **Section 9-1-5 Measure speed**.

☞　The measure speed can be configured only for Model -50.

☞　For Models -35/-40/-45, the measure speed

49

6. Measurement Preparation

6-2 Function setup

The Function Setup screen selects the functions such as measure range and AUTO-function setting that are used for preparation of measurements.

Item	Description
Measure Range	Switches measure ranges.
AUTO-Function Setting	Configure items you want to automatically activate for measurements.
AI-Function	Calculate the optimal cutoff value to evaluate the roughness.
Tilt Correction	Calculate the tilt of a workpiece to adjust the tilt.
Record of Vibration	Records the vibration while stopping the pickup.

● Displaying the Function Setup screen.

1. Press the **[CONDITION]** button, then **[ENTER]**.

```
Function Setup

 Measure Range
 AUTO-Function Setting
 AI-Function
 Tilt Correction
 Record of Vibration
```
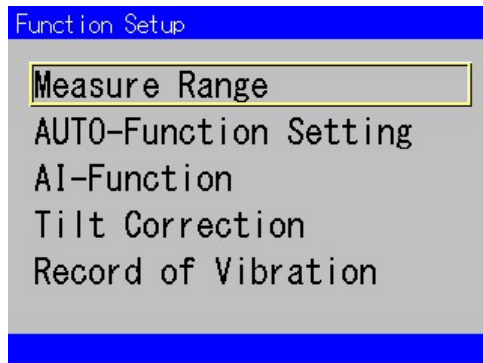
☞ For models -35/-40/-45, Measure range, Tilt correction and Record of vibration does not function.

6-2-1 Measure range

● Setting the measure range

1. Press the **[CONDITION]** button, then **[ENTER]**.

2. Using the **[▲] and [▼]** buttons, select **"Measure Range"** and press the **[ENTER]** button.

3. Using the **[►] and [◄]** buttons, specify the **"Measure Range"** value.

```
Measure Range
400um
     ±400   µm
  Z =   -136.18 µm
  X =      0.00 mm
0

 Fn Cancel Z Reset X Reset
```
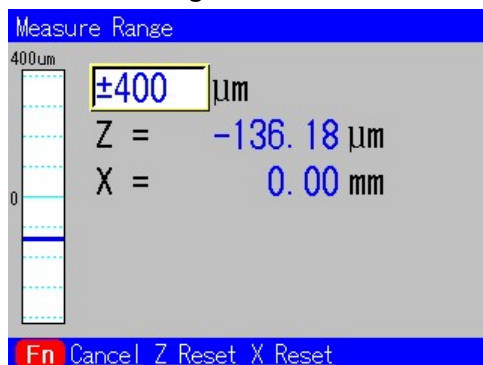
☞ This item can be configured only for Model -50.

☞ For Models -35/-40/-45, the measure range is fixed to +/-160 micro-m (+/-6299 micro-inches).

<Selectable measure range>

Standard pickup	1/2 sensitivity pickup
±400 µm	±800 µm
±40 µm	±80 µm
±4 µm	±8 µm

50

6-2-2 AUTO-function setting

● Configuring the AUTO-function setting

1. Press the **[CONDITION]** button, then **[ENTER]**.

2. using the **[▲] and [▼]** buttons, Select **"AUTO-Function Setting"** and press the **[ENTER]** button.

3. Using the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

AUTO-Function Setting

AI

AUTO-PRINT

Return

Data Output

USB Memory Save

Zero-Offset

Fn Cancel All None
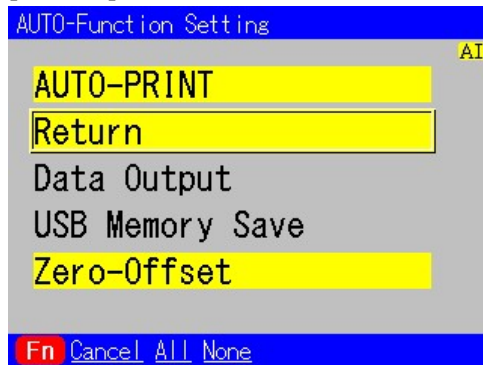
☞ Return and Zero-Offset are not available for Models -35/-40/-45.

● Items available for AUTO-function setting

Item	Description
AUTO-PRINT	Prints the measurement and analysis results after the processes are completed.
Return (This function is only available for Model -50)	The driver takes an action after measurement so that the pickup can automatically return to the measurement start point.
Measurement data output	Outputs measurement data to the PC connected via USB communication after completion of measurement and analysis processes.
USB Memory Save	Saves measurement data to a USB memory stick after completion of measurement and analysis processes.
Zero-Offset (This function is only available for Model -50)	Adjust the zero point software-wise, so that the Z-axis level can turn to zero at the measurement start point.

☞ To enable all AUTO-function settings, select **"All"** in **[Fn item]** and press the **[ENTER]** button. (To cancel all settings, select **"None"** and press the **[ENTER]** button.)

6-2-3 AI-function

● What is AI-function?
The AI-function determines the optimal cutoff value and evaluation length, and evaluates the roughness. The optimal cutoff value and evaluation length are determined according to the set standards and objective parameters.

● Using the AI-function

1. Press the **[CONDITION]** button, then **[ENTER]**. Using the **[▲] and [▼]** buttons, select **"AI-Function** and press the **[ENTER]** button.

2. Using the **[▲] and [▼]** buttons, Select **"AI-Function"** and press the **[ENTER]** button.

3. Select the item with the **[▲] and [▼]** buttons, and configure it with the **[►] and [◄]** buttons.

AI-Function

AI

Execute   ON   OFF

Objec.Param.   R a

Cutoff U-Lim   0.25 mm

Fn Cancel
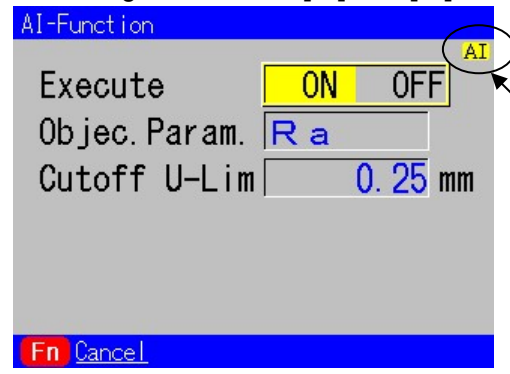
The "AI" indication appears when the AI-function is turned on.

☞ For the objective parameters that can be configured, see **Section 14-9 Measurement procedure, measurement condition selection and evaluation method.**
☞ The evaluation length is five times the cutoff upper limit value that has been set. For example, if "Cutoff U-Lim" has been set to 0.25 mm, then the measuring length in the AI-function is 1.25 mm.

4. Press the **[MEAS./STOP]** button to start measurement.

The analysis is executed after the measurement. It determines the optimal cutoff value and evaluation length, and calculates parameters.

☞ The method of determination to be referenced varies depending on the set standard. Details are described in **Section 14-9 Measurement procedure, measurement condition selection and evaluation method**.
☞ The AI-function is only available for measurement of roughness. An error message appears if another measurement type is selected. In that case, change the measurement type and execute the function again.

51

5. When the setup screen for the calculated cutoff value appears, select Yes or No with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

```
AI-Function
Most appropriate cutoff value was      AI
calculated out.
   λc = 0.25  mm
Do you use this value for the next
time measurement and thereafter?

 Yes : Set the cutoff value and turn
        off the AI function.
 No  : Do not set the cutoff value.
 Fn  Yes  No
```
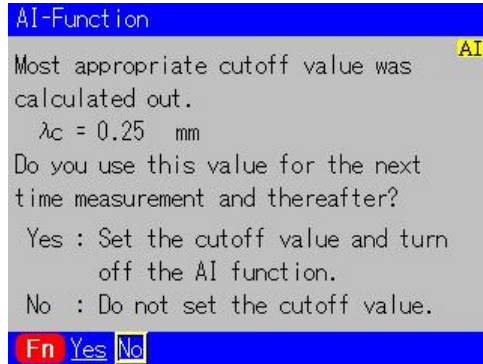
6-2-4 Tilt correction

● What is tilt correction?
The tilt correction function is used to set up a workpiece during preparation of measurement.

☞   This function is only available for Model -50.

● Using tilt correction

1. Set up a workpiece of a measuring object and prepare for measurement.

☞   Before using this function, adjust the level roughly so that it is within the following adjustable range.

         Adjustable range: +/-1.0 deg

2. Press the **[CONDITION]** button, then **[ENTER]**.

3. Using the **[▲] and [▼]** buttons, select **"Tilt correction"** and press the **[ENTER]** button.

4, Press the **[MEAS./STOP]** button.

A preparatory measurement starts for calculating the amount of tilt. After the measurement, analysis is executed to yield the amount of tilt.

```
Tilt correction
                                       AI
 Press MEAS switch to
 execute preparatory
 meas. so as to calc.
  tilt volume.
```
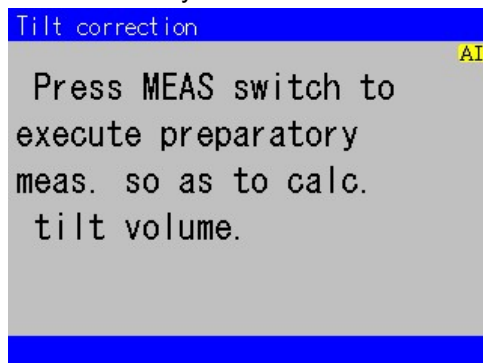
▪ Depending on the yielded amount of tilt, one of the following result screens appears.

(1) If the amount of tilt is less than 10 deg as a rotation amount of the driver leveling knob, adjustment is not required. Perform the measurement without adjusting tilt.

```
Tilt correction

 Tilting angle is within
 the range. Proceed with
 measurement.
```
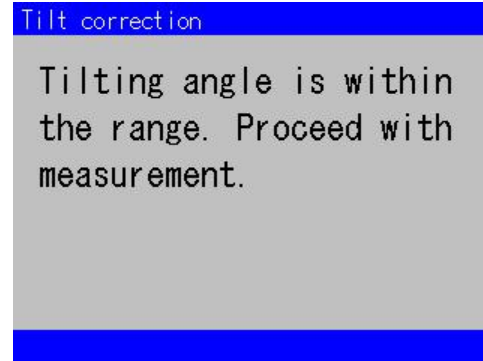
(2) If the amount of tilt is within the adjustable range, follow the message displayed on the screen to rotate the driver leveling knob.
Note that, by rotating the driver leveling knob, the zero point may shift and the measure range may be exceeded.
If this occurs, adjust the level meter to the zero position using height adjustment and fine height adjustment knobs.
After the adjustment, rotate the driver leveling knob again.

```
Tilt correction

Tilted approx.
  Tilting angle -0.29°
adjustment amount
  0 turns and 250°
 (Anti-clockwise)
```
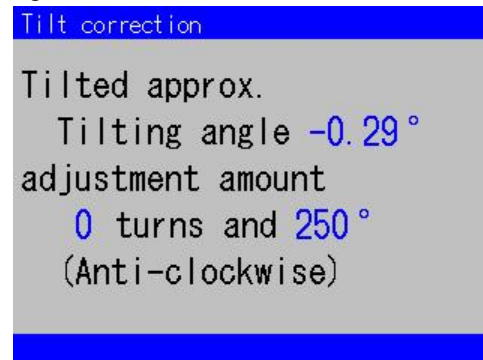
(3) If the amount of tilt is out of the adjustable range, use some jig or tool to adjust the tilt, so that the tilt may be within the adjustable range, within +/-1.0 deg vs. reference plane of the driver.
After carrying out the adjustment, rotate the driver leveling knob again.

```
Tilt correction

Outside adjustment range
  Tilting angle -1.75°
Please execute it again
after it measures it by
the eye measurement.
```
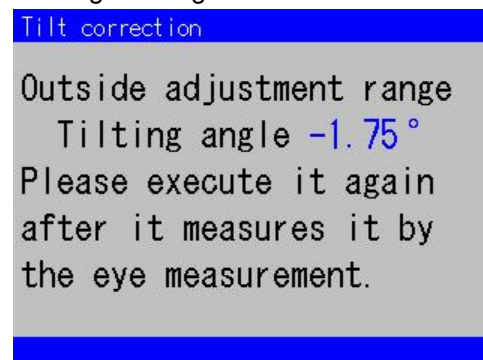
6-2-5   Record of vibration

● What is the record of vibration?
This function records time-shifting displacement while stopping the pickup. It can be used as a simple vibration recorder, or used to check influence of floor vibration.

☞   This function is only available for Model -50.

● Using the record of vibration
1. Apply the stylus to the object.

☞   Adjust the zero point with the level meter.

2. Press the **[CONDITION]** button, then **[ENTER]**.

3. Using the **[▲] and [▼]** buttons, select **"Record of Vibration"** and press the **[ENTER]** button.

4. Press the **[MEAS./STOP]** button.

<Screen during the record of vibration>

<Screen for result of the record of vibration>
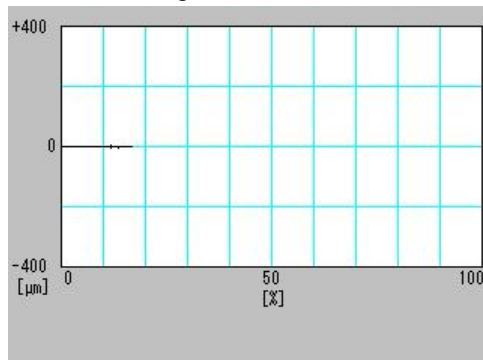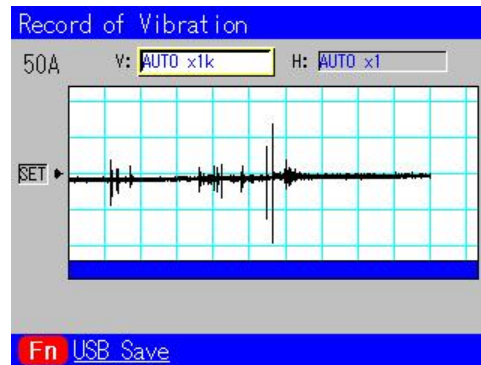
☞   Each recording time is 60 seconds. When this time is reached, the recording terminates automatically and the screen for result of the record of vibration appears.
☞   To abort the recording in the process, press the **[MEAS./STOP]** button.

6-2-5-1   Saving results of the record of vibration to USB

Results of the record of vibration can be saved to a USB memory stick.

● Saving to USB
1. In the Record of Vibration screen, press **[Fn]**, then press the **[ENTER]** button.
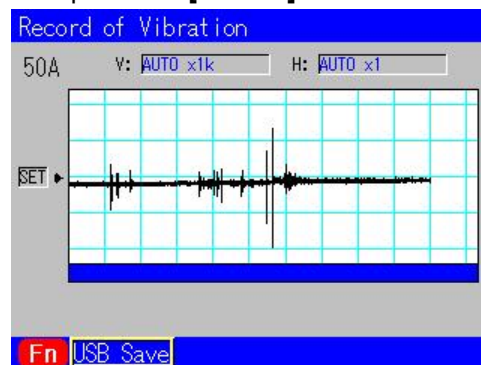
☞   The result can be saved in either text or binary format. For how to specify the file format, see **Section 9-4-6 USB memory save type**.
☞   For how to view the result file of the record of vibration, see **Section 11-4-2 How to interpret vibration data**.

6-2-5-2   Printing results of the record of vibration

Results of the record of vibration can be printed with a printer.

● Printing
1. In the Record of Vibration screen, press the **[PRINT]** button.

☞   To abort the printing in the process, press the **[PRINT]** button again.

6. Measurement Preparation

6-3　X reset

● What is X reset?
This function sets the current value of the X-axis to 0.

☞　This item can be configured only for Model -50.

● Performing the X reset

1. Press the **[CONDITION]** button, then **[ENTER]**.

2. Using the **[►] and [◄]** buttons, select **"X Reset"** and press the **[ENTER]** button.

<Before X reset>

<After X reset>
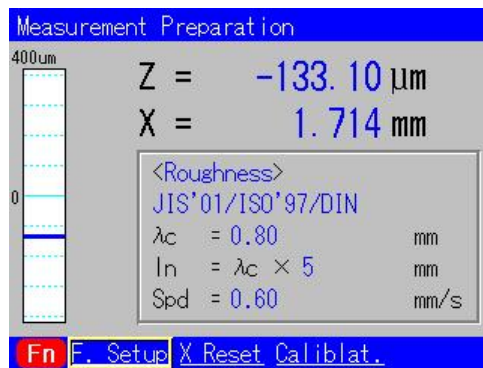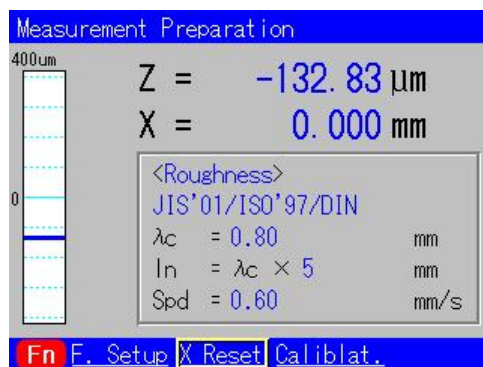
6-4 Calibration

Calibration is a sensitivity adjustment to reduce the error of a measuring instrument.Calibrate your instrument at least once a month. Also be sure to calibrate the instrument when you have replaced the pickup or stylus, or changed sensitivity.

Item	Description
Calibrate Mag. calib. dev.	A magnification calibration device (E-MC-50B) can be used for calibration. This function is only available for Model -50.
Calibrate Roughness Spec.	A roughness specimen (E-MC-S24B) can be used for calibration.
Calibration Depth Specimen	A depth specimen (E-MC-S57A, etc.) can be used for calibration. This function is only available for Model -50.

● Displaying the Calibration screen

1. Press the **[CONDITION]** button, and select **"Calibration"** using the **[▶] and [◀]** buttons and press the **[ENTER]** button.
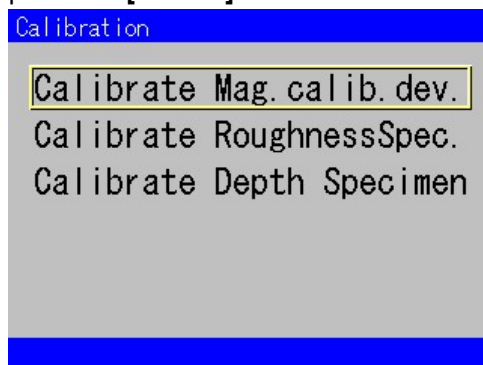
● Preparing for calibration

1. Turn the power off.

2. Install the pickup or stylus you want to use on to the driver.

3. Turn the power on.

⚠ **Caution** **As the detector may drift, wait more than 15 minutes after power-on before starting calibration.**

6-4-1 Calibration with magnification calibration device

● Using calibration with magnification calibration device (only for Model -50)

1. Press the **[CONDITION]** button, and select **"Calibration"** using the **[▶] and [◀]** buttons and press the **[ENTER]** button.

2. Using the **[▲] and [▼]** buttons, select **"Calibrate Mag.calib.dev."** and press the **[ENTER]** button.

3. Select the item with the **[▲] and [▼]** buttons, and set it with the **[▶] and [◀]** buttons.
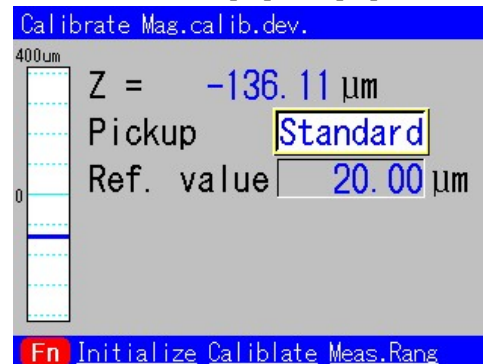
4. Set the pickup to the skidless measurement.

5. Prepare the magnification calibration device and block gauge (with thickness 2 mm/0.0787 inch approx.) and wring the block gauge on to the magnification calibration device.

Block gauge
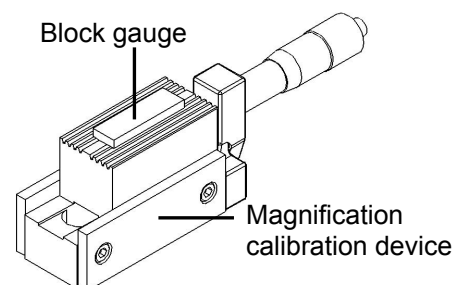
Magnification calibration device

6. Position the magnification calibration device to point the pickup style at the block gauge, and lower the pickup.

☞ Adjust the level meter until it comes to the proximity of zero.

7. Press **[Fn]**, and select **"Calibrate"** using the **[▶]** and **[◀]** buttons. Press the **[ENTER]** button.

8. Rotate the micro meter knob of the magnification calibration device twice in clockwise to apply displacement by 20 micro-m.

9. Press the **[ENTER]** button.

```
Calibrate Mag.calib.dev.

  Z =        0.64 μm


  20.00   μm
  Exec. cal. after hav-
  ing given above displ.

 Fn  Caliblate
```
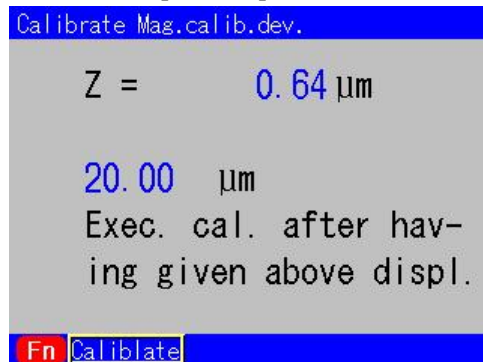
· When the calibration process has been completed, the following result screen appears.

(1) The magnification calibration process ends when message "Calibration is completed." appears.

```
  Calibration is complet-
ed.



Please push 【BACK】 key.
```
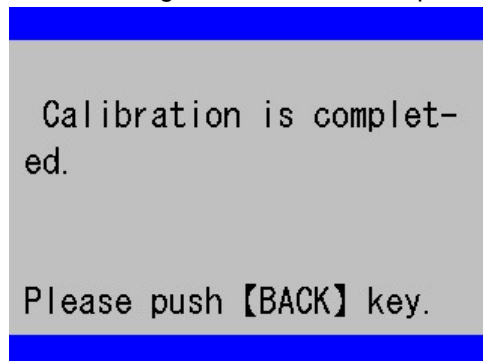
☞ Turn the knob on the magnification calibration device at least five times in counter-clockwise. Then rotate it in clockwise to the same rotation amount as it rotated in counter-clockwise. If the Z-axis indication has returned within the range +/-0.2 micro-m vs. "0.000", the calibration has been completed successfully.

(2) If message "Calibration error..." appears, execute <Initialization> as shown in the following, and use this function again.

```
  Calibration error.
  Confirm calibration
setting, and try again.


Please push 【BACK】 key.
```
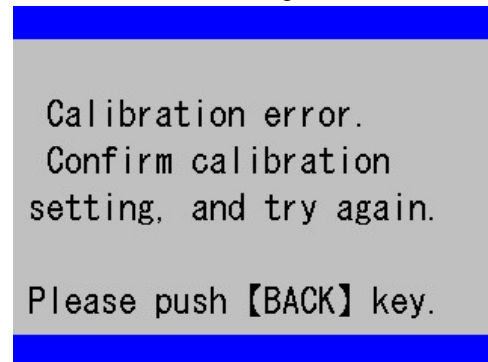
<Initialization>
1) Press the **[BACK]** button and display the **Calibrate Mag. calib. dev. screen**.
2) Press **[Fn]** and select **"Initialize"** using the **[▼]** and **[▲]** buttons, and press the **[ENTER]** button.

6-4-2 Calibration with roughness specimen

● Using calibration with roughness specimen

1. Press the **[CONDITION]** button, and select **"Calibration"** using the **[►] and [◄]** buttons and press the **[ENTER]** button.

2. Using the **[▲] and [▼]** buttons, select **"Calibrate Roughness Spec."** and press the **[ENTER]** button.

3. Select the item with the **[▲] and [▼]** buttons, and set it with the **[►] and [◄]** buttons.
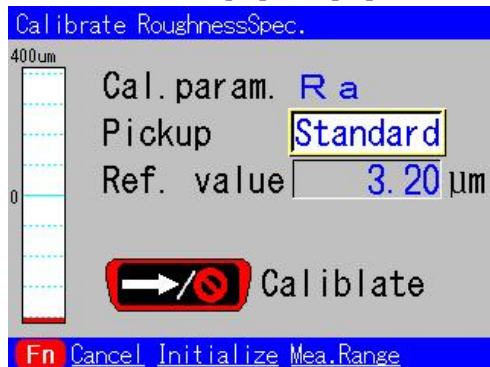
☞ When using the attached roughness specimen, use the CALIBRATION side of the dual sides.Configure the parameter, pickup, and reference value based on the data printed on the specimen.

4. Press the **[RETURN]** button to return the stylus to the return limit position (the foremost part of pickup).

5. Position the roughness specimen so that the pickup stylus may touch the CALIBRATION pattern, and lower the pickup.

☞ Adjust the level meter until it comes to the proximity of zero. (For Model -50)
☞ Adjust levelness between the driver and the measuring plane with the attached adjusting tool, so that they are in parallel with each other. (For Model -35/-40/-45)
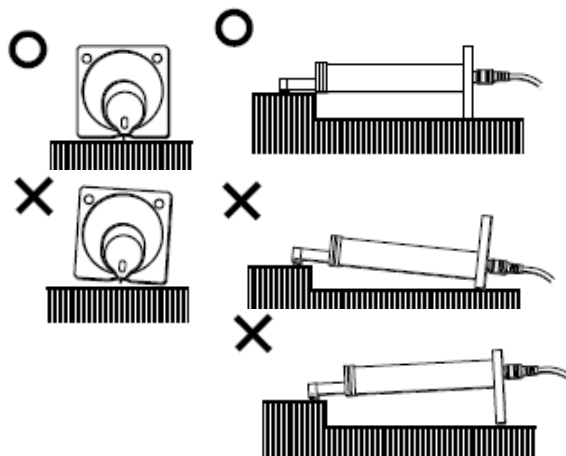
6, Press the **[MEAS./STOP]** button.

● The following table shows the measurement conditions for calibration with roughness specimen. Use the current settings for other conditions.

Measurement Type	Roughness Measurement
Evaluation Length	λc X 5
Cutoff value	0.8 mm (0.03 inch)
Measure Speed	0.6 mm/s (0.024 inch/s)
Pre. Drive Length	Cutoff value/3
Form Remove	Straight
Filter type	Gaussian
Ls Filter	Cutoff ratio 300

· When the measurement has been completed, the following result screen appears.

(1) The Standard block calibration process ends when message "Calibration by Standard block completed." appears.
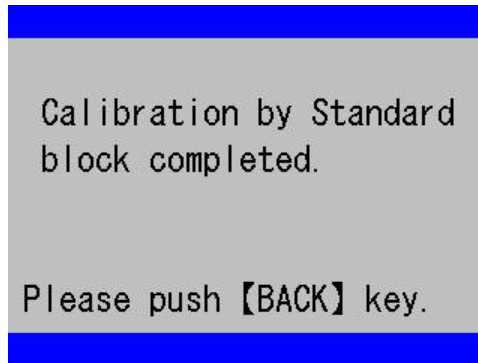
(2)If message "Calibration error..." appears, execute <Initialization> as shown in the following, and use this function again.
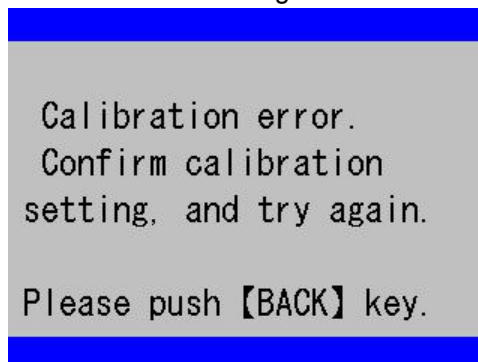
<Initialization>
1) Press the **[BACK]** button and display the **Calibrate Roughness Spec. screen**.
2) Press **[Fn]** and select **"Initialize"** using the **[►] and [◄]** buttons, and press the **[ENTER]** button.

6. Measurement Preparation

6-4-3 Calibration with depth specimen

● Using calibration with depth specimen (only for Model -50)

1. Press the **[CONDITION]** button, and select **"Calibration"** using the **[►] and [◄]** buttons and press the **[ENTER]** button.

2. using the **[▲] and [▼]** buttons, Select **"Calibrate Depth Specimen"** and press the **[ENTER]** button.

3. Select the item with the **[▲] and [▼]** buttons, and set it with the **[►] and [◄]** buttons.
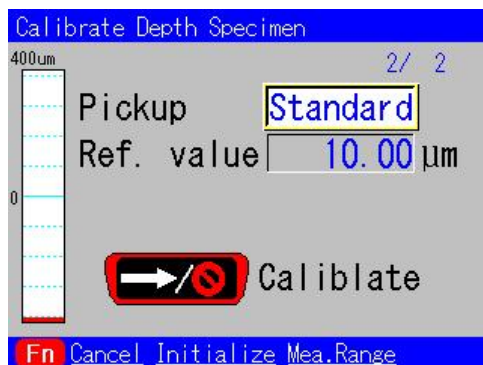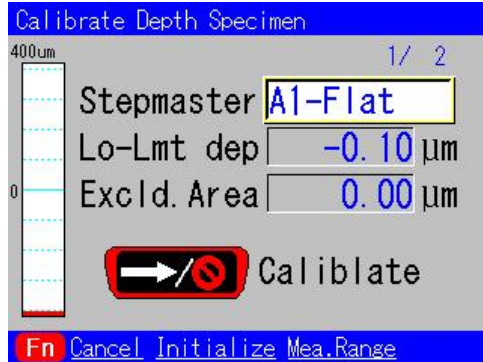
☞ When using the depth specimen manufactured by TOKYO SEIMITSU (E-MC-S57A), select depth specimen type S57A (large) or S57A (small).

S57A (small)　　　　S57A (large)

Set the measurement start point at approximately these positions.
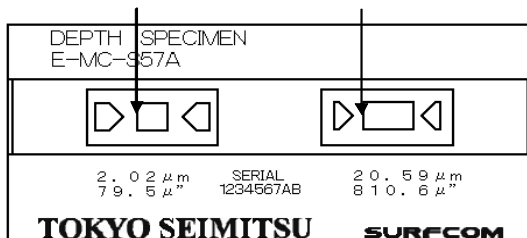
☞ With reference to the search depth ("Lo-Lmt dep"), a ditch with depth equal to or less than the value set from the reference line is recognized as a ditch.

Reference line

Search depth

Recognized as a ditch

Not recognized as a ditch
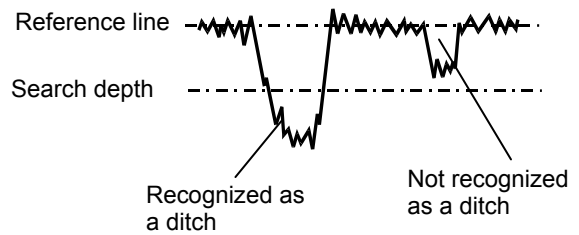
☞ Set the excluded areas ("Excld.Area") if you want to exclude shapes on both sides of a ditch.
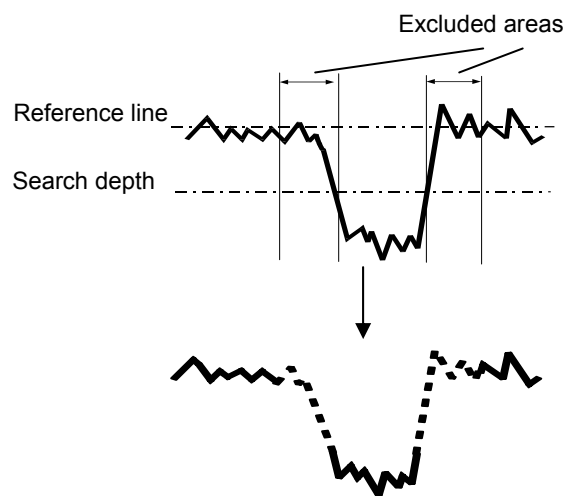
Excluded areas

Reference line

Search depth

4. Press the **[RETURN]** button to return the stylus to the return limit position (the foremost part of pickup). If the stylus stops on the way, press the **[RETURN]** button again.

5. Position the depth specimen so that the pickup stylus may touch the depth specimen, and lower the pickup.

☞ Adjust the level meter until it comes to the proximity of zero.

6, Press the **[MEAS./STOP]** button.

● The following table shows the measurement conditions of calibration with depth specimen. Use the current settings for other conditions.

・A1 (Square ditch), A2 (Round ditch)

Measurement Type	Profile
Evaluation Length	Arbitrary
Cutoff value	-
Measure Speed	0.3 mm/s (0.012 inch/s)
Pre. Drive Length	Cutoff value/3
Form Remove	Straight
Filter type	-
Ls Filter	None
Measure Range	Arbitrary

・ S57A (Large)

Measurement Type	Profile
Evaluation Length	8.00 mm (0.315 inch)
Cutoff value	-
Measure Speed	0.15 mm/s (0.006 inch/s)
Pre. Drive Length	Cutoff value/3
Form Remove	Straight
Filter type	-
Ls Filter	N/A
Measure Range	+/-40 micro-m (+/-1575 micro-inches)

・ S57A (Small)

Measurement Type	Profile
Evaluation Length	5.5 mm (0.2165 inch)
Cutoff value	-
Measure Speed	0.15 mm/s (0.006 inch/s)
Pre. Drive Length	Cutoff value/3
Form Remove	Straight
Filter Type	-
Ls Filter	N/A
Measure Range	+/-40 micro-m (+/-1575 micro-inches)

・ When the measurement has been completed, the following result screen appears.

(1) The Step master calibration process ends when message"Calibration by Step master completed."
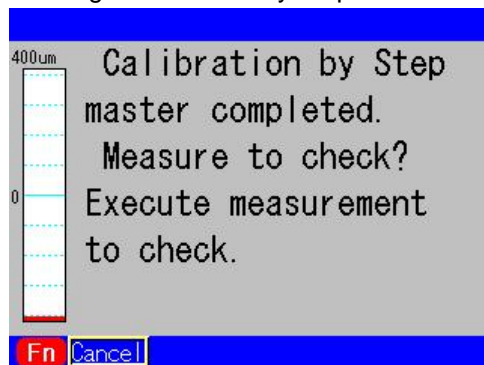
☞ Press the **[MEAS./STOP]** button to perform the measurement of calibration with depth specimen and display the calibration results.
☞ Before this measurement, set the start point correctly.

(2) If the message "Calibration error..." appears, check the settings of calibration, execute <Initialization> as shown in the following, and perform the calibration again.

<Initialization>
1) Press the **[BACK]** button and display the **Calibrate Depth Specimen screen**.
2) Press **[Fn]** and select **"Initialize"** using the **[►]** and **[◄]** buttons, and press the **[ENTER]** button.

(3) If the following message appears, check the type of the depth specimen and measuring area, execute <Initialization> as shown in the following, and perform the calibration again.

<Initialization>
1) Press the **[BACK]** button and display the **Calibrate Depth Specimen screen**.
2) Press **[Fn]** and select **"Initialize"** using the **[►]** and **[◄]** buttons, and press the **[ENTER]** button.

59

6. Measurement Preparation

6-5 Saving or loading measurement conditions

This instrument can save the current measurement conditions to the internal memory.
Also by loading the stored measurement conditions, measurements can be prepared more smoothly.

Item	Description
Save Meas. Condition	Saves the current measurement conditions to the internal memory.
Load Meas. Condition	Loads the measurement conditions stored in the internal memory.

6-5-1 Saving measurement conditions

● Saving measurement conditions
1. Press the **[CONDITION]** button twice.

2. Press **[Fn]**, then the **[ENTER]** button.
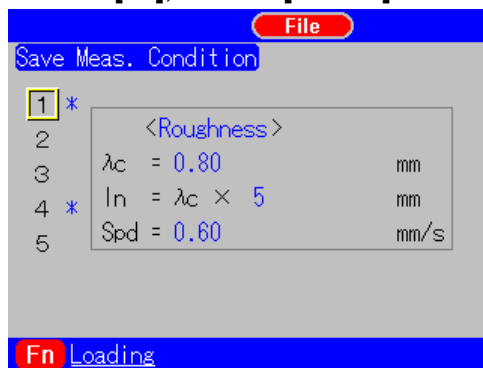
☞ For the operation of the Save Meas. Condition screen, see **Section 11-1-4 Saving measurement conditions**.

6-5-2 Loading measurement conditions

● Loading measurement conditions
1. Press the **[CONDITION]** button twice.
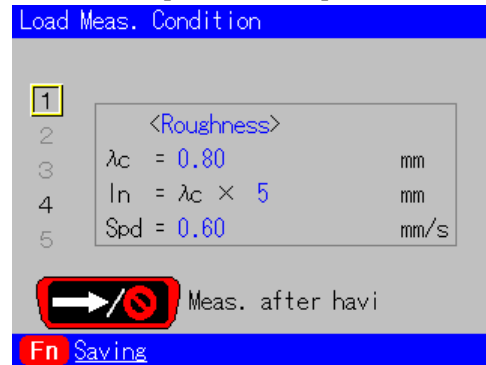
☞ For the operation of the Load Meas. Condition screen, see **Section 11-1-5 Loading measurement conditions**.

7. Measurements

This chapter explains the following measurement procedures.
(1) Flow of measurement
(2) Flow of measurement using stored data
(3) Measurement of various workpieces.

7-1　Flow of measurement

The following describes the basic flow of measurement.

(1) Configure system conditions.

☞ For how to configure system conditions, see **Section 9-4 System conditions**.

(2) Configure measurement conditions.

☞ For information about how to configure measurement conditions, see **Section 9-1 Measurement conditions**.

(3) Configure analysis conditions.

☞ For information about how to configure analysis conditions, see **Section 9-2 Analysis conditions**.

(4) Configure output settings.

☞ For information about how to configure output settings (output items and output parameters), see **Section 9-3 Output settings**.

(5) Configure measure range and AUTO-function setting in the measurement preparation screen.

☞ For information about how to configure settings in the measurement preparation screen, see **Section 6-2 Function setup**.

(6) Adjust the height of the detector (pickup) and make it come in contact with a measuring plane.

☞ In the measurement preparation screen, adjust the level bar of the level meter to the proximity of 0.

(7) Press the **[MEAS./STOP]** button to start measurement. During measurement, the profile screen appears, which displays the shape of the measured object in real-time.
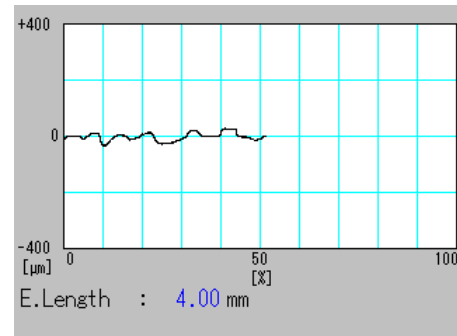
☞ The **[MEAS./STOP]** button is available when the measurement preparation screen is displayed and also when other screen is displayed.

⚠ Caution **To abort the measurement, press the [MEAS./STOP] button.**
When the measurement is aborted, the Stop-Calc ON/OFF setting determines whether or not to analyze the measured data up to that moment.
For the Stop-Calc setting, see Section 9-4-3 Stop-calculation.

(8) When the measurement is completed, the "Analyzing" screen appears, and the analysis of the measurement data starts automatically.
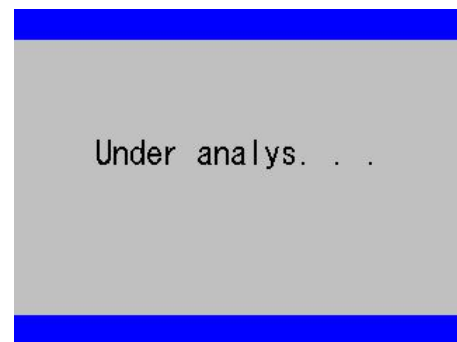
☞ If return is set for the AUTO-function in the measurement preparation screen, the return operation is activated.

(9) When the analysis of the measurement data has been completed, the following results are displayed according to items selected in the Display Sel. After Meas. menu.

☞ For the Display Sel. After Meas. menu, see **Section 9-4-5 Display select after measurement**.

7. Measurements

(1) If **"Graph Display"** is selected in the Sel. After Meas. menu, the Graph screen appears when the analysis of the measurement data has been completed.
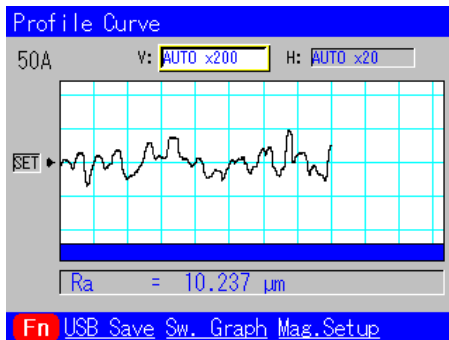
☞ For details about the graph display, see **Section 8-3 Graph display**.

(2) If **"Meas. Result Display"** is selected in the Sel. After Meas. menu, the Result screen appears when the analysis of the measurement data has been completed.
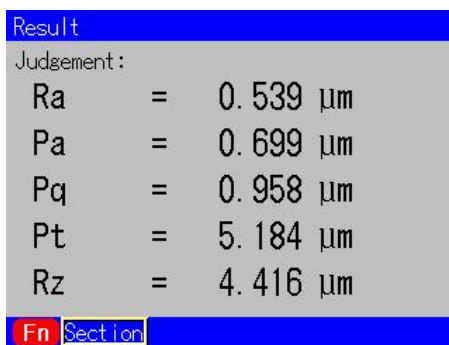
☞ For details about the result display, see **Section 8-4 Result display**.

If "Meas. Criteria Display" **is selected in the Sel. After Meas. menu, the Measurement Preparation screen appears when the analysis of the measurement data has been completed.** The measurement results are not displayed then. To display the measurement results, press the **[GRAPH/PARAM.]** button.
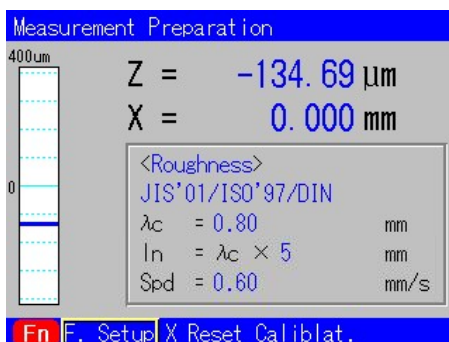
7-2   Flow of measurement using stored data

Measurement data and conditions stored in the internal memory or USB memory sticks can be loaded for performing a new measurement in the same conditions as those stored. You can also change some measurement conditions for the new measurement.
The following describes the flow of measurement using the stored measurement data and conditions.

(1) Load measurement data or conditions stored in the internal memory or a USB memory stick.

☞ For information about how to load measurement data stored in the internal memory, see **Section 11-1-3 Loading measurement data**.
☞ For information about how to load measurement conditions stored in the internal memory, see **Section 11-1-5 Loading measurement conditions**.
☞ For information about how to load measurement data or conditions stored in USB memory sticks, see **Section 11-2-3 Loading or deleting data**.

(2) When performing a new measurement without changing the conditions, go to Step (3). When changing some conditions, reconfigure the measurement conditions, analysis conditions, or output settings first.

(3) Adjust the height off the pickup, and apply the stylus to the measuring plane.

☞ In the measurement preparation screen, adjust the level bar of the level meter to the proximity of 0.

(4) Press the **[MEAS./STOP]** button to start measurement.

(5) When the measurement is completed, the "Analyzing" screen appears, and the analysis of the measurement data starts automatically.

(6) When the analysis of the measured data has been completed, the measurement results appear.

7-3 Various methods of measurements

This section describes the following various methods of measurements. The following measurements are only available for Model -50.
(1) Measurements of curves
(2) Measurements of steps
(3) Measurements of workpieces with an excluded area

7-3-1 Measuring curves

The following describes the measurement using curve compensation as a method to measure the surface roughness of a circular shape.
The measurement using curve compensation can calculate parameters from a profile curve or a roughness curve only by adjusting the level.
As a workpiece with circular shape is measured linearly, however, the measuring length is limited as shown in the following.
Furthermore, if a large measuring length is assumed, then the θ value in the following figure increases. That means a larger angle is required vs. the original measuring direction (tangential direction), generating a distortion of waveform.

Measuring length: $L \leq 2R \cdot SIN\ 20°$ (R = Radius of curvature of workpiece) ... Condition 1
Therefore, $L\ \ \ 0.684 \times R$

Configure the settings within the range Condition 1 is satisfied.

Start point   End point

L

40°

θ

Tangential direction

R

$L <= 2R \cdot SIN\ 20°$
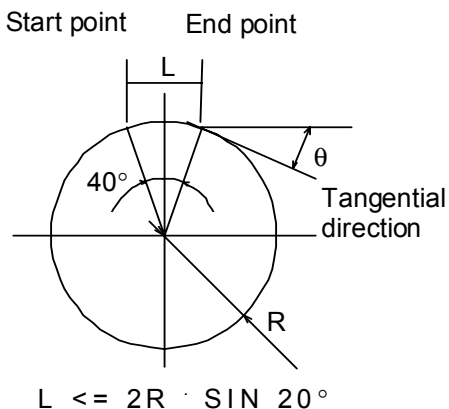
●Performing measurement using curve compensation

1. In the second page of the measurement condition menu, move the cursor on the **"Form Remove"** and press the **[ENTER]** button.
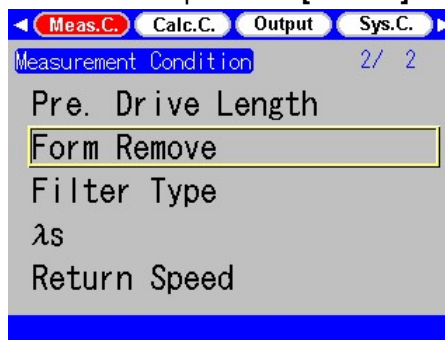
2 In the Form Remove screen, move the cursor on **"R-curve"** and press the **[ENTER]** button.
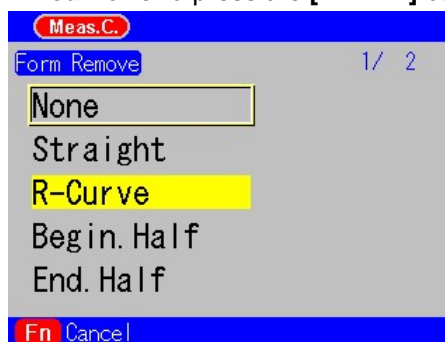
3. Press the **[CONDITION]** button and go to the Measurement Preparation screen. Go to the Measure Range screen in the function setup items, and set the measure range that should be appropriate for the workpiece.
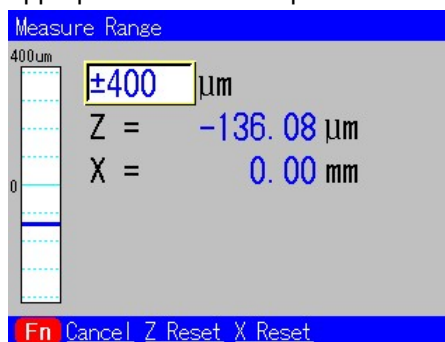
☞ For information about how to set the measure range, see **Section 6-2-1 Measure range**.

⚠ **Caution** **The smaller the measure range, the shorter the measurable length becomes.**

7. Measurements

4. Rotate the rough and fine height adjustment knobs on the driver to lower the pickup, and apply the pickup to the workpiece.

Workpiece

```
Measurement Preparation
40um
         Z =        -4.51 μm
         X =        0.000 mm
0
         <Roughness>
         JIS'01/ISO'97/DIN
         λc   = 0.80           mm
         In   = λc × 5         mm
         Spd  = 0.60           mm/s
  Fn  F. Setup  X Reset  Caliblat.
```
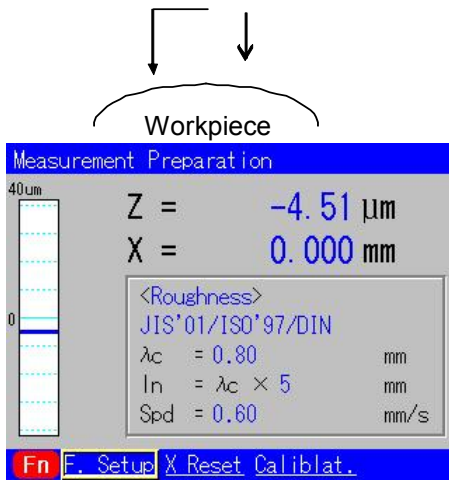
☞ In the measurement preparation screen, adjust the level bar of the level meter to the proximity of 0.

---

5. Adjust the rough and fine height adjustment knobs on the driver to align the pickup position with the top of the arc (the bottom of valley for a concave shape)

Workpiece

---
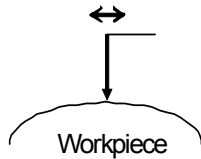
6. Adjust the height or the zero point of the pickup, so that the mark may be positioned slightly lower than the top point within the range of level meter (for the bottom point of a concave shape, slightly upper of the bottom point within the range of level meter).

Workpiece

```
Measurement Preparation
40um
         Z =        35.63 μm
         X =        0.000 mm
0
         <Roughness>
         JIS'01/ISO'97/DIN
         λc   = 0.80           mm
         In   = λc × 5         mm
         Spd  = 0.60           mm/s
  Fn  F. Setup  X Reset  Caliblat.
```

---
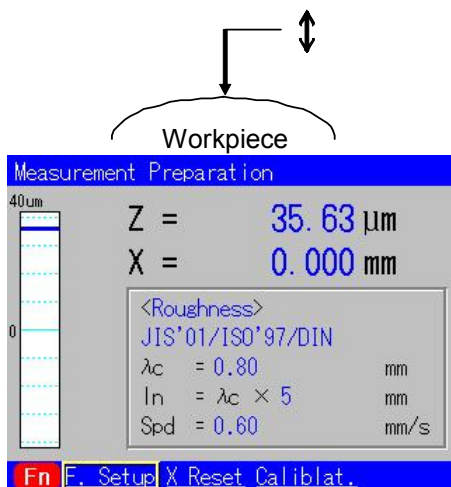
7. Rotate the rough and fine height adjustment knobs on the driver, and move the pickup to right or left by half of the measuring length, and check that the mark is within the range of level meter display in the Measure Range screen throughout the area. (If the mark appears in red at the end, the mark is outside the range.) If the mark is outside the range, shorten the measuring length or lower the measure range.

Measure range

Within measure range

```
Measurement Preparation
40um
         Z =        35.63 μm
         X =        0.000 mm
0
         <Roughness>
         JIS'01/ISO'97/DIN
         λc   = 0.80           mm
         In   = λc × 5         mm
         Spd  = 0.60           mm/s
  Fn  F. Setup  X Reset  Caliblat.
```

---
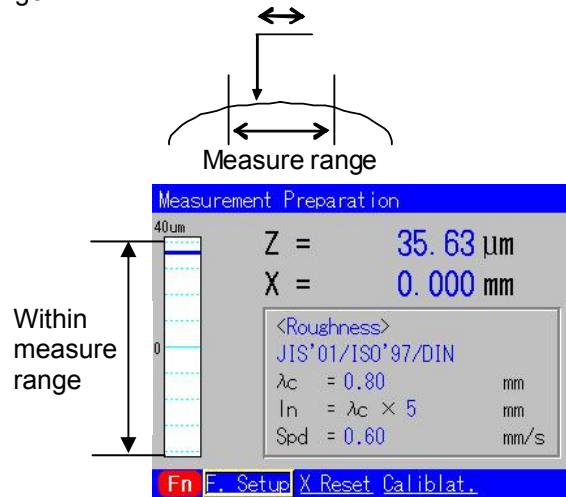
8. Rotate the rough and fine height adjustment knobs on the driver to align the stylus with the measurement start point.
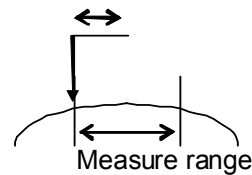
Measure range

---

9. Go to the AUTO-Function Setting screen in the function setup items in the Measurement Preparation screen, and cancel the selection of **"Zero-Offset"**.

```
AUTO-Function Setting

  AUTO-PRINT
  Return
  Data Output
  USB Memory Save
  Zero-Offset

  Fn  Cancel  All  None
```
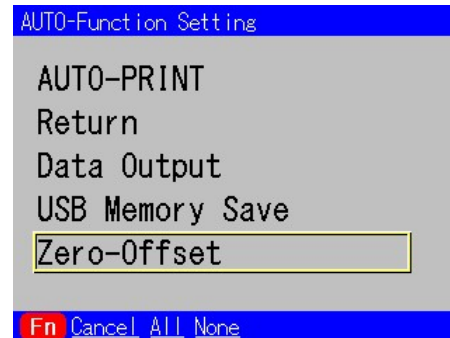
10. Configure measurement conditions, analysis conditions, output settings, and output parameters.

☞ For information about how to configure measurement conditions, analysis conditions, output settings, and output parameters, see **Section 7-1 Measurements**.

11. Press the **[MEAS./STOP]** button to start measurement.
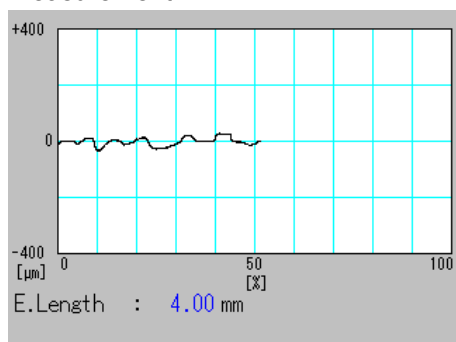
12. Check the measurement results.

☞ For information about how to check the measurement results, see **Chapter 8 Display of Measurement Results**.

7-3-2 Measuring steps

To measure a work plane with comparatively large difference in height, take the following steps.

● Measuring a work plane with large difference in height

1. Rotate the rough height adjustment knob to move the pickup upward once.

2. Rotate the rough and fine height adjustment knobs to position the highest part of the work plane right under the stylus.

3. Rotate the rough and fine height adjustment knobs on the driver to lower the pickup, and apply the pickup to the workpiece.
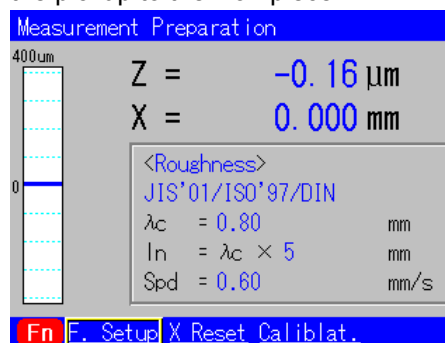
☞ In the measurement preparation screen, adjust the level bar of the level meter to the proximity of 0.

4. In the Measurement Preparation screen, adjust the level bar of the level meter, so that it may be positioned slightly lower than the top point in the measure range.
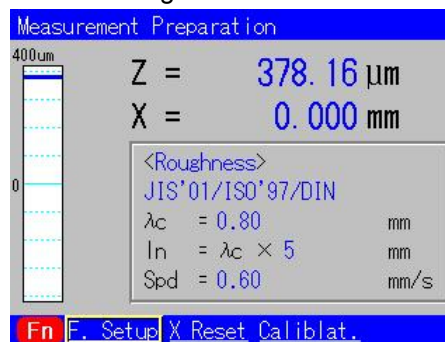
5. Rotate the manual knob on the driver to position the stylus to the measurement start point.

6. Configure measurement conditions, analysis conditions, output settings, and output parameters.

☞ For information about how to configure measurement conditions, analysis conditions, output settings, and output parameters, see **Section 7-1 Measurements**.

7. Go to the AUTO-Function Setting screen in the function setup items in the Measurement Preparation screen, and cancel the selection of **"Zero-Offset"**.
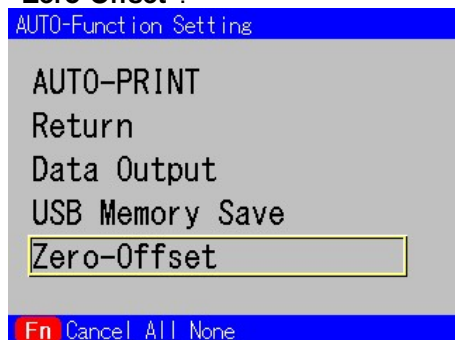
8. Press the **[MEAS./STOP]** button to start measurement.
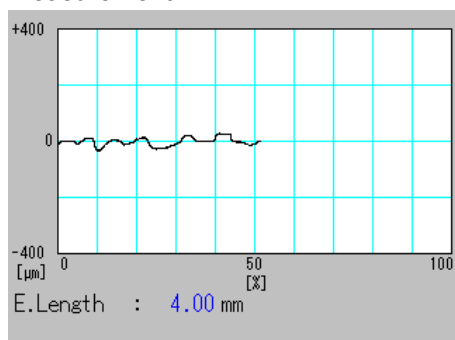
9. Check the measurement results.

☞ For information about how to check the measurement results, see **Chapter 8 Measurement results**.

7-3-3 Measuring workpieces with an excluded area

To differentiate damage and dust from original roughness and waviness in measurements of a damaged workpiece, the upper and lower limit levels must be set to define a range. Then the values outside the range must be excluded to calculate parameters.

● Measuring a workpiece with an excluded area

1. In the analysis condition menu, move the cursor on the **"Notch Calculation"** and press the **[ENTER]** button.
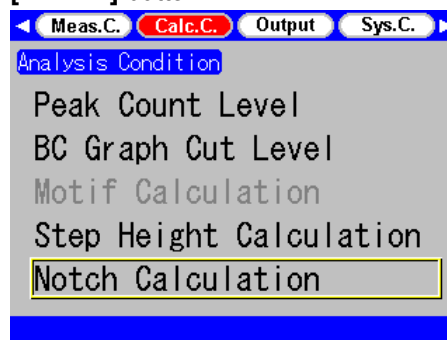
2. Configure the following conditions for notch calculation.
・Execute ON/OFF (Select "ON")
・Delete length
・Upper-limit level
・Lower-limit level

3. Configure measurement conditions, analysis conditions, output settings, and output parameters.

☞ For information about how to configure measurement conditions, analysis conditions, output settings, and output parameters, see **Section 7-1 Measurements**.

4. Press the **[CONDITION]** button and go to the Measurement Preparation screen. For example for the driver (-50), adjust the height of the pickup with the rough and fine height adjustment knobs to contact it with the measuring plane. At this time, adjust the level bar of the level meter to the proximity of 0.
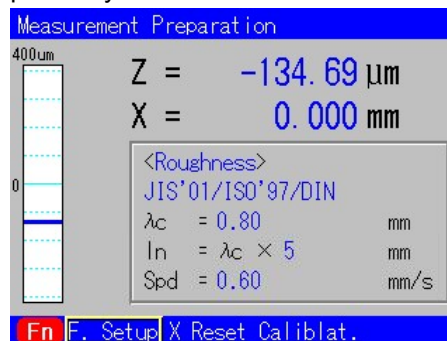
☞ For information about how to operate the Measurement Preparation screen, see **Chapter 6 Measurement Preparation**.

5. Press the **[MEAS./STOP]** button to start measurement.

E.Length : 4.00 mm
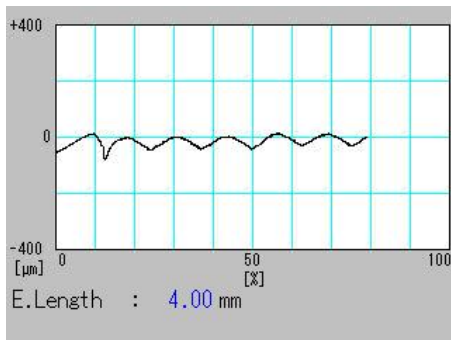
6. Check the measurement results.

☞ For information about how to check the measurement results, see **Chapter 8 Measurement results**.

<Example of calculation when notch calculation is not executed>
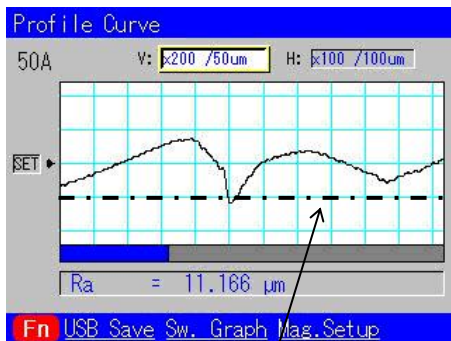
Lower-limit level

<Example of calculation when profile is excluded>
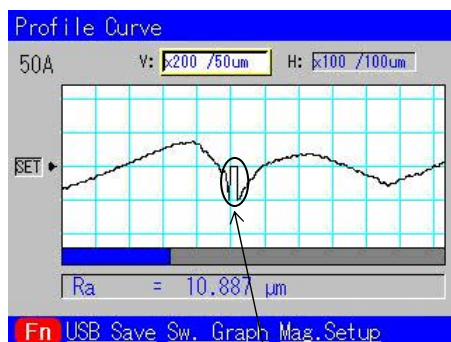
Excluded area

8. Display of Measurement Results

8-1   Contents of measurement results displayed

After measurements, the results can be checked in the measurement result screen. There are two types of measurement result screens as shown in the following.
(1) Graph screen
    Displays a form curve graph, a bearing area curve graph, or an amplitude distribution curve graph.
(2) Result screen
    Displays parameter values and section parameter values. The result of judgment is also displayed.

The following lists the types and contents displayed in the Graph screen and the Result screen.

Screen type	Screen name	Description
Graph	Profile curve	Displays a profile curve graph.
	Roughness curve	Displays a roughness curve graph.
	Filtered waviness curve	Displays a filtered waviness curve.
	Waviness profile curve	Displays a waviness profile curve graph.
	ISO13565 Curve	Displays a ISO13565 curve graph.
	Roughness Motif	Displays a roughness motif graph. Combined display with a profile curve is possible by specifying it in the Motif Calculation screen.
	Waviness Motif	Displays a waviness motif graph. A upper envelope curve is displayed together.
	BAC (P)	Displays a bearing area curve graph calculated from a profile curve. In the CNOMO standard, however, it is calculated from an upper envelope curve.
	BAC (R)	Displays a bearing area curve graph calculated from a roughness curve.
	BAC (WC)	Displays a bearing area curve graph calculated from a waviness profile curve.
	ADF (P)	Displays an amplitude distribution curve graph calculated from a profile curve. In the CNOMO standard, however, it is calculated from an upper envelope curve.
	ADF (R)	Displays an amplitude distribution curve graph calculated from a roughness curve.
	ADF (WC)	Displays an amplitude distribution curve graph calculated from a waviness profile curve.
Result screen	Measurement results (Parameter value)	Displays the parameter value list. For a parameter for which the judgment condition is set, the result of the judgment is also displayed.
	Section Parameter	Displays the parameter value, the maximum value, parameter value +/- standard deviation, and parameter value for each section. For a parameter for which the judgment condition is set, the result of the judgment is also displayed.

The contents displayed in the Graph screen and the Result screen vary depending on the measurement type and standard.
The following tables list the contents displayed in the Graph screen and the Result screen.

● Lists of contents displayed in the Graph screen and the Result screen
<Profile>
○...Shown   ×...Hidden

Output item \ Standard	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95 / ASME'02
Profile curve	○	○	○	○	○
Roughness curve	×	×	×	×	×
Filtered waviness curve	×	×	×	×	×
Waviness profile curve	×	×	×	×	×
ISO13565 Curve	×	×	×	×	×
Roughness Motif	×	×	×	○	×
Waviness Motif	×	×	×	○	×
BAC (P)	○	×	○	○	×
BAC (R)	×	×	×	×	×
BAC (WC)	×	×	×	×	×
ADF (P)	○	×	○	○	×
ADF (R)	×	×	×	×	×
ADF (WC)	×	×	×	×	×
Result (Parameter value)	○	○	○	○	○
Section Parameter	×	×	×	×	×

<Roughness>
○...Shown   ×...Hidden   △...Shown only when a parameter with sections is selected

Output item \ Standard	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95 / ASME'02
Profile curve	○	○	○	○	○
Roughness curve	○	○	○	×	○
Filtered waviness curve	×	×	×	×	×
Waviness profile curve	×	×	×	×	×
ISO13565 Curve	×	×	○	×	○
Roughness Motif	×	×	×	○	×
Waviness Motif	×	×	×	○	×
BAC (P)	○	×	○	○	×
BAC (R)	×	○	○	×	○
BAC (WC)	×	×	×	×	×
ADF (P)	○	×	○	○	×
ADF (R)	×	○	○	×	○
ADF (WC)	×	×	×	×	×
Result (Parameter value)	○	○	○	○	○
Section Parameter	×	×	△	×	×

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45

8. Display of Measurement Results

\<Waviness profile curve with no Lf\>

○...Shown   ×...Hidden

Standard / Output item	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95 / ASME'02
Profile curve	○	○	○		○
Roughness curve	×	×	×		×
Filtered waviness curve	○	○	○		○
Waviness profile curve	×	×	×		×
ISO13565 Curve	×	×	×		×
Roughness Motif	×	×	×		×
Waviness Motif	×	×	×		×
BAC (P)	×	×	○		×
BAC (R)	×	×	×		×
BAC (WC)	×	×	×		×
ADF (P)	×	×	○		×
ADF (R)	×	×	×		×
ADF (WC)	×	×	×		×
Result (Parameter value)	○	○	○		○
Section Parameter	×	×	×		×

\<Waviness profile curve with Lf\>

○...Shown   ×...Hidden   △...Shown only when a parameter with sections is selected

Standard / Output item	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95 / ASME'02
Profile curve	○	○	○		○
Roughness curve	×	×	×		×
Filtered waviness curve	○	○	○		○
Waviness profile curve	○	○	○		○
ISO13565 Curve	×	×	×		×
Roughness Motif	×	×	×		×
Waviness Motif	×	×	×		×
BAC (P)	×	×	○		×
BAC (R)	×	×	×		×
BAC (WC)	×	×	○		×
ADF (P)	×	×	○		×
ADF (R)	×	×	×		×
ADF (WC)	×	×	○		×
Result (Parameter value)	○	○	○		○
Section Parameter	×	×			×

8-2 Measurement result screen

8-2-1 Starting the measurement result screen

The following shows the timing the measurement result screen starts.
(1) After measurement is completed
(2) After loading measurement data from the internal memory or a USB memory stick
(3) After recalculation
(4) When the **[GRAPH/PARAM.]** button is pressed

The measurement result screen can display the latest results whenever the **[GRAPH/PARAM.]** button is pressed if measurement, loading measurement data, and recalculation have been performed.

8-2-2 Switching the Graph screen and the Result screen

To switch the Graph screen and the Result screen, press the **[GRAPH/PARAM.]** button.

● Switching the Graph screen to the Result screen

1. While the Graph screen is displayed, press the **[GRAPH/PARAM.]** button.

Profile Curve
50A   V: AUTO x200   H: AUTO x20
SET ►
Ra   =   10.237 μm
Fn USB Save Sw. Graph Mag.Setup

2. The Result screen appears.

Result
Judgement:
Ra   =   10.237 μm
Pa   =   12.804 μm
Pq   =   16.013 μm
Pt   =   81.680 μm
Rz   =   45.142 μm
Fn Section
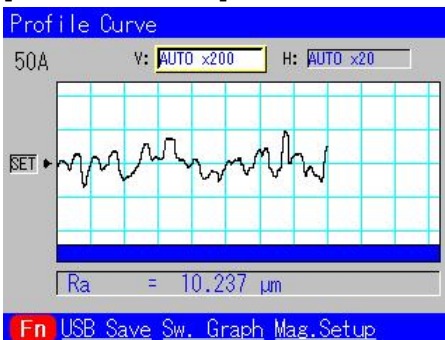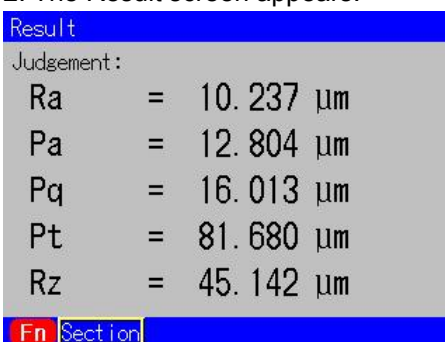
● Switching the Result screen to the Graph screen

1. While the Result screen is displayed, press the **[GRAPH/PARAM.]** button.

Result
Judgement:
Ra   =   10.237 μm
Pa   =   12.804 μm
Pq   =   16.013 μm
Pt   =   81.680 μm
Rz   =   45.142 μm
Fn Section

2. The Graph screen appears.

Profile Curve
50A   V: AUTO x200   H: AUTO x20
SET ►
Ra   =   10.237 μm
Fn USB Save Sw. Graph Mag.Setup
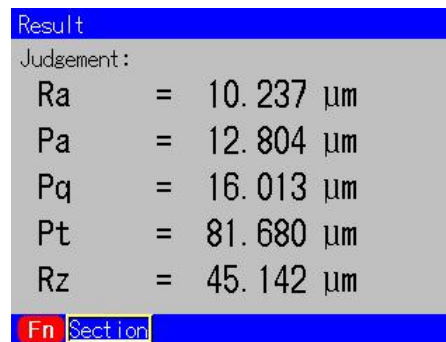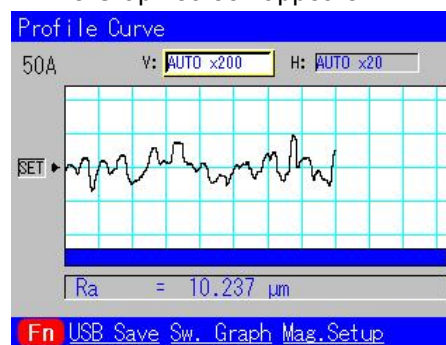
8-2-3 Exiting the measurement result screen

To exit the Graph screen or the Result screen, take the following steps.
(1) Press the **[MEAS./STOP]** button.
   ⇒ The measurement starts.
(2) Press the **[CONDITION]** button.
   ⇒ The Measurement Preparation screen appears.
(3) Press the **[MENU]** button.
   ⇒ The menu that was displayed last time appears.

8. Display of Measurement Results

8-3　Graph display

8-3-1　Form curve graph

● How to view displays
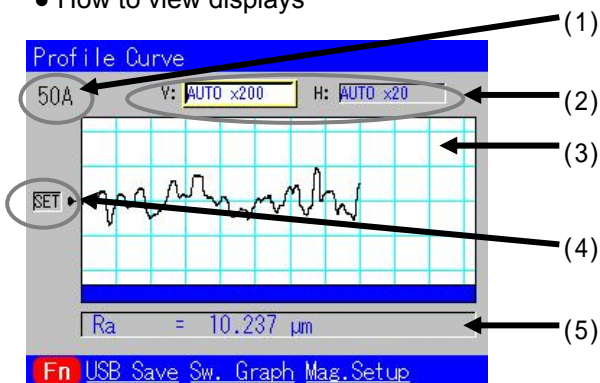
(1) Driver type display area
Displays the driver type used for measurement.

Driver type	Displayed string
Driver (-50)	50A
Driver (-35)	35A
	35B
Driver (-40)	40A
Driver (-45)	45A

(2) **"V"**: Vertical magnification setting item, **"H"**: Horizontal magnification setting item.
Changes the vertical and horizontal magnifications of graph display. The changed magnifications apply to printing as well as graph display.
To apply the configured vertical and horizontal magnifications to subsequent graph display and printing, execute "Mag. Setup" in **"Fn item"**.

☞ The vertical and horizontal magnification values can also be changed respectively in the V-Mag. or H-Mag. screen in the Various Settings menu.
For how to change the vertical and horizontal magnifications in the Various Setting menu, see **9-6-1 Vertical magnification** and **9-6-2 Horizontal magnification** respectively.

(3) Graph item
Displays a form curve graph. Usually, this area first displays the graph that was displayed last time. However, immediately after the system starts or if the measurement type has been changed, the following graph is displayed according to the measurement type.

Measurement type	Displayed curve
Profile	Profile curve
Roughness measurement	Roughness curve
Waviness profile curve with no λf	Filtered waviness curve
Waviness profile curve with λf	Waviness profile curve

When a form curve graph is displayed, horizontal scroll is possible with the **[►] and [◄]** buttons, and vertical scroll with the **[▲] and [▼]** buttons while an **"item to graph"** is selected.
The low, middle, or high speed can be selected for horizontal scrolling.
On the other hand, the low or middle speed can be selected for vertical scrolling.
For details of scrolling, see **Section 8-3-1-4 Scrolling**.

(4) Vertical resetting item
When the position to display graph is moved in vertical direction with the vertical scroll function, the vertical reset function returns the display position in vertical direction to the center.

(5) Parameter display item
Displays the parameter name, parameter value, unit, and judgment result as results of calculating the parameter selected in the output parameter setting screen. However, the judgment result is displayed only for the parameter for which judgment condition is set.

☞ For how to configure judgment conditions, see **Section 9-3-2-1 judgment**. Also for how to view the judgment results, see **Section 8-4 Results**.

The parameter items to display can be switched with the **[►] and [◄]** buttons. Only the selected parameters can be switched in the order as they are displayed in the output parameter setting screen.

8-3-1-1 Vertical and horizontal magnifications

When vertical or horizontal magnification has been changed, the form curve graph is displayed in the corresponding magnification ratio. The vertical or horizontal magnification ratio is maintained even when the form curve graph is switched to another graph.

● Changing the vertical magnification

1. Select vertical magnification setting item "V:" **with the [▲] and [▼]** buttons.
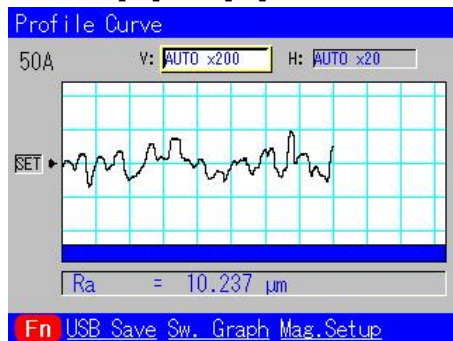
2. Select the vertical magnification with the **[►] and [◄]** buttons.
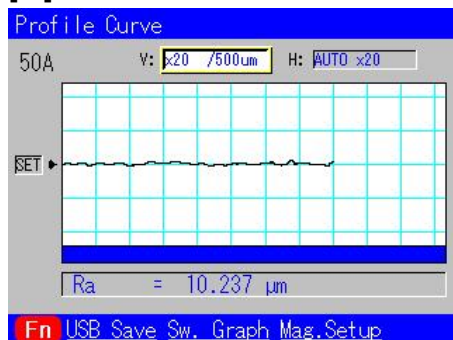
☞ The following shows vertical magnifications you can select with the **[►]** and **[◄]** buttons.
- × 20   • × 50   • × 100   • × 200
- × 500   • × 1K   • × 2K   • × 5K
- × 10K   • × 20K   • × 50K   • × 100K
- AUTO × V

☞ Upon pressing [ENTER], "AUTO XV" is set.

● Changing the horizontal magnification

1. Select horizontal magnification setting item "H:" with the **[▲]** and **[▼]** buttons.
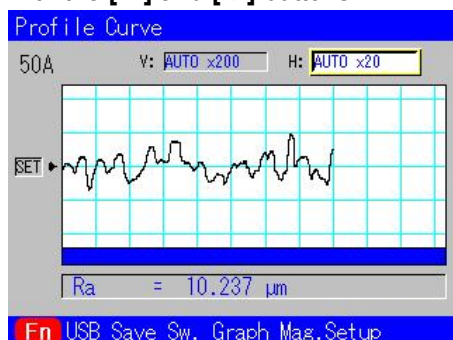
2. Select the horizontal magnification with the **[►]** and **[◄]** buttons.
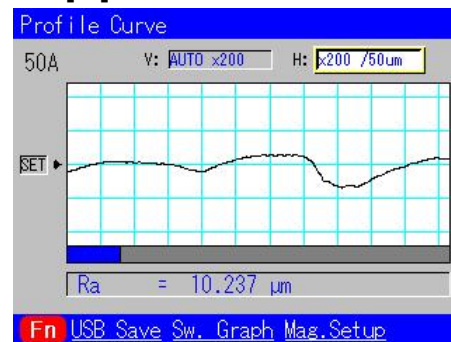
☞ The following shows horizontal magnifications you can select with the **[►]** and **[◄]** buttons.
- × 1   • × 2   • × 5   • × 10
- × 20   • × 50   • × 100   • × 200
- × 500   • × 1K   • AUTO × H

☞ Upon pressing [ENTER], "AUTO XH" is set.

8-3-1-2 Setting the magnification

You have changed the vertical or horizontal magnification in **Section 8-3-1-1 Vertical and horizontal magnifications**. To apply the change to graph display and printing in the subsequent measurements, execute the magnification setup.

● Applying the vertical or horizontal magnification setting to graph display

1. Take the procedure provided in **Section 8-3-1-1 Vertical and horizontal magnifications** to change the magnification of graph.
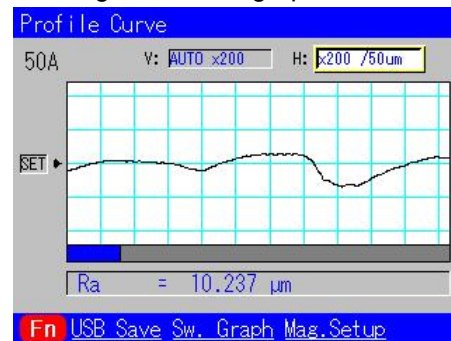
2. Press **[Fn]**, and select **"Mag. Setup"** with the **[►]** and **[◄]** buttons. Press the **[ENTER]** button.

73
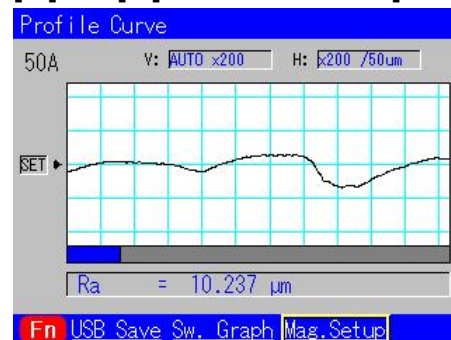
8. Display of Measurement Results

3. Message **"Magnification setup has been executed."** appears.

Magnification setup was done.

Please push 【BACK】 key.

8-3-1-3   Switching parameters

The parameter currently displayed can be switched to another parameter while a form curve is displayed.

● Switching parameters

1. While a form curve graph is displayed, select a **"parameter item to display"** with the **[▲]** and **[▼]** buttons.

Profile Curve

50A   V: AUTO x200   H: x200 /50um

SET ▶

Ra   = 10.237 µm

Fn USB Save Sw. Graph Mag.Setup
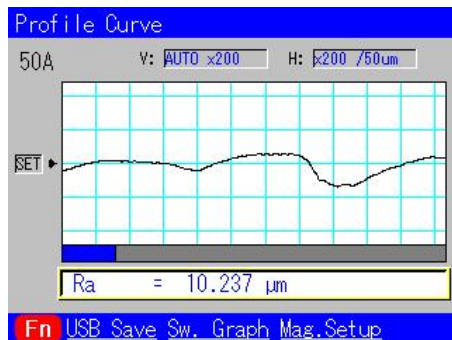
2. Switch the parameters with the **[►]** and **[◄]** buttons.

Profile Curve

50A   V: AUTO x200   H: x200 /50um

SET ▶

Pa   = 12.804 µm

Fn USB Save Sw. Graph Mag.Setup
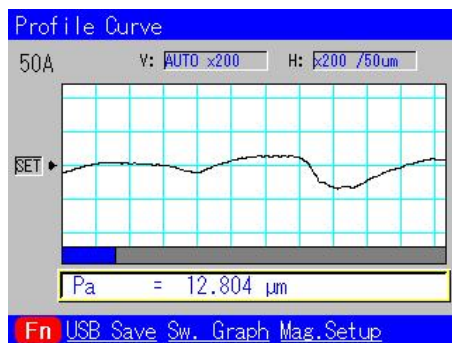
☞ If you press the **[◄]** button while the first parameter is displayed, then the last parameter is displayed. If you press the **[►]** button while the last parameter is displayed, then the first parameter is displayed.

8-3-1-4   Scroll

The low, middle, or high speed can be selected for horizontal scrolling.
On the other hand, the low or middle speed can be selected for vertical scrolling.

● Scrolling the graph horizontally at the low or middle speed

1. Press **[Fn]**, and select an **"item to graph"**.

Profile Curve

50A   V: AUTO x200   H: x200 /50um

SET ▶

Pa   = 12.804 µm

Fn USB Save Sw. Graph Mag.Setup
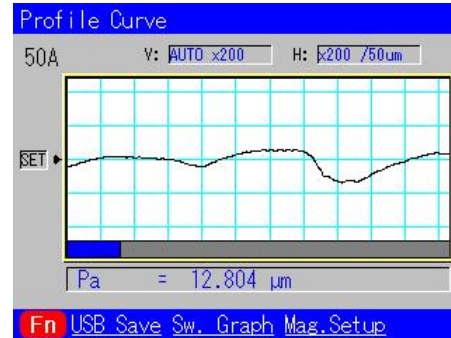
2. To scroll the graph horizontally at the low speed, press the **[►]** or **[◄]** button. To scroll the graph horizontally at the middle speed, press and hold the **[►]** or **[◄]** button.

Profile Curve

50A   V: AUTO x200   H: x200 /50um

SET ▶

Pa   = 12.804 µm

Fn USB Save Sw. Graph Mag.Setup
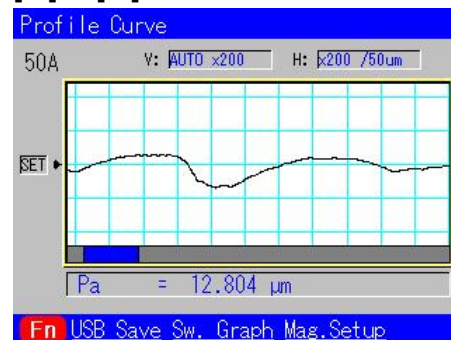
● Scrolling the graph horizontally at the high speed

1. To enable high-speed scroll mode, press **[Fn]** and select an **"item to graph"**. Press the **[ENTER]** button.

Profile Curve

50A   V: AUTO x200   H: x200 /50um

SET ▶

Pa   = 12.804 µm

Fn USB Save Sw. Graph Mag.Setup
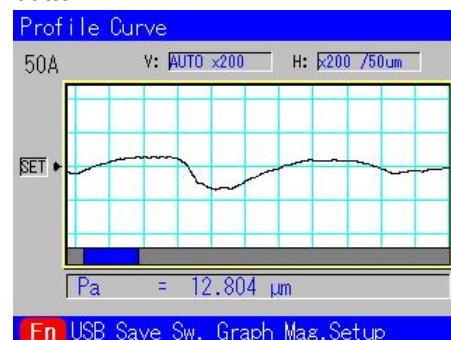
2. When high-speed scroll mode is enabled, use the **[►]** or **[◄]** button to scroll the graph at the high-speed.
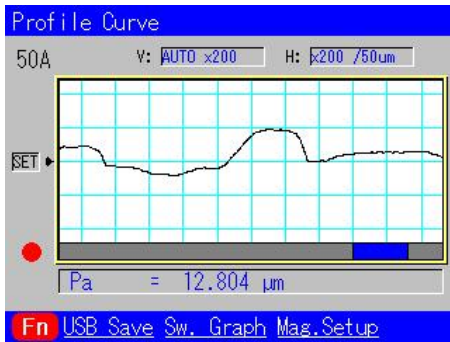
☞ During the high-speed scrolling, a ● mark appears on the left of the horizontal scroll bar.

● Disabling the high-speed scroll mode

1. In the high-speed scroll mode, press the **[ENTER]** button.
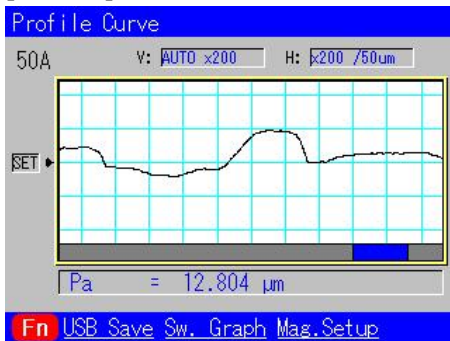
☞ The ● mark on the left of the horizontal scroll bar disappears, and the high-speed scroll mode is disabled.

● Scroll the graph vertically

1. Press **[Fn]**, and select an **"item to graph"**.
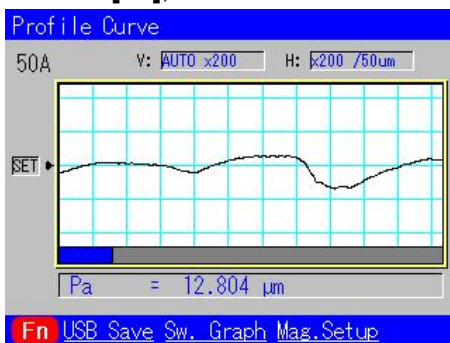
2. To scroll the graph vertically at the low speed, press the **[▼]** or **[▲]** button. To scroll the graph vertically at the middle speed, press and hold the **[▼]** or **[▲]** button.
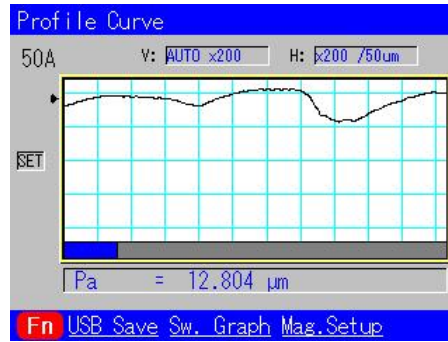
8-3-1-5 Vertical resetting

To return the display position in vertical direction to the center, execute vertical reset.

● Executing vertical reset

1. Select vertical resetting item "SET" with the **[▲]** and **[▼]** buttons.
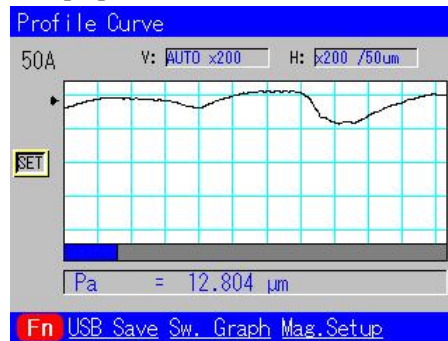
2. Press the **[ENTER]** button.
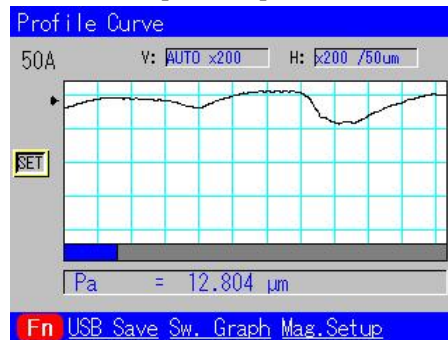
3. The display position in vertical direction is returned to the center, and the graph is displayed.

75
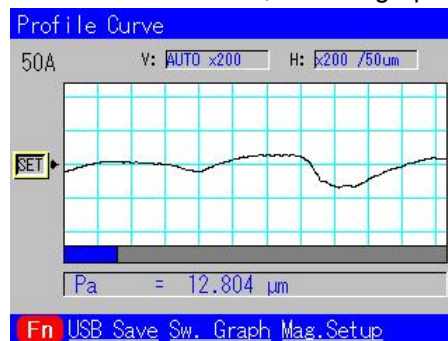
8. Display of Measurement Results

8-3-1-6 Save to USB

Measurement data can be saved to a USB memory stick while a form curve graph is displayed.

● Saving measurement data to a USB memory stick
1. Insert a USB memory stick, press **[Fn]**, and select **"USB save"** with the **[►][◄]** buttons. Press the **[ENTER]** button.
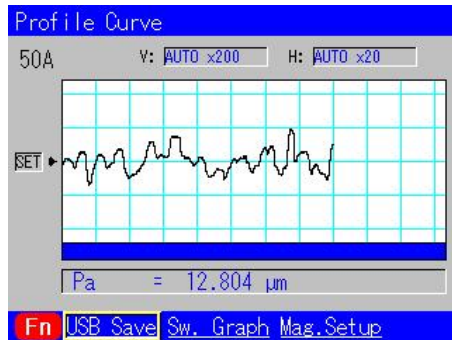
2. Measurement data is saved to the USB memory stick.

☞ The "Save Form" displayed in the saving completed message varies depending on the file format used for saving data to the USB memory stick.

☞ For how to set the file format used for saving data to USB memory sticks, see **Section 9-4-6 USB memory save type**.

☞ A file is saved in a USB memory stick with the same name as that displayed in the Save USB Memory screen in the save/load menu. After the save, the serial number is incremented by 1 as shown in the following example. If the same file name exists, a confirmation message appears, asking you to confirm whether you want to overwrite the existing file.

<Example of adding a new file name>
  DATA0003 ⇒ DATA0004

8-3-1-7 Switching graphs

The following methods are available for switching graphs.
(1) Press **"Sw. graph"** in **[Fn item]** to switch the current graph to the next one.

(2) Use the **[Fn]+[▼]** buttons to switch the current graph to the next one, or **[Fn]+[▲]** buttons to the previous one.

A form curve graph, bearing area curve graph, and amplitude distribution curve graph are displayed in this order as a next graph. When you switch the current graph to the next one and the current graph is the last, the first graph is displayed.
When you switch the graph to the previous one with the **[Fn]+[▲]** buttons, the graphs are displayed in reverse order.

● Switching the current graph to the next one using **"Sw. graph"** in **[Fn item]**
1. Press **[Fn]**, and select **"Sw. graph"** with the **[►]** and **[◄]** buttons. Press the **[ENTER]** button.
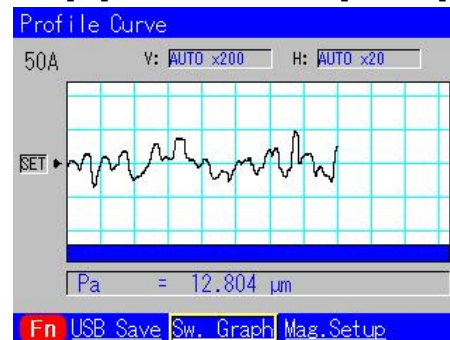
2. The next curve graph is displayed.
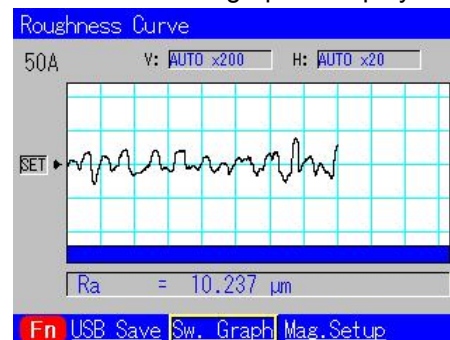
● Switching the current graph to the next one with the **[Fn]+[▼]** buttons

1. While pressing and holding **[Fn]**, press the **[▼]** button.
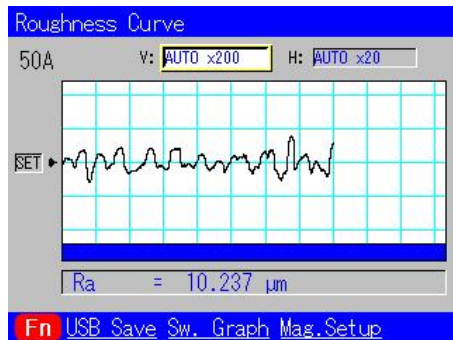
2. The next curve graph is displayed.
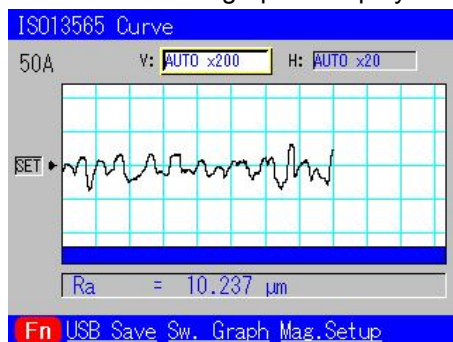
● Switching the current graph to the previous one with the **[Fn]+[▲]** buttons

1. While pressing and holding **[Fn]**, press the **[▲]** button.
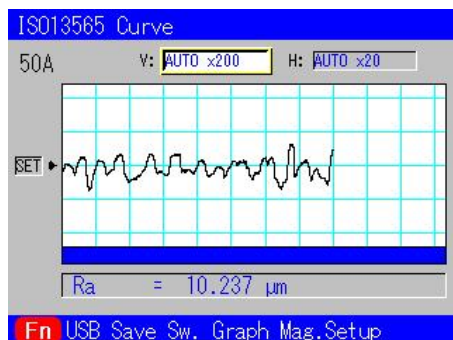
2. The previous curve graph is displayed.
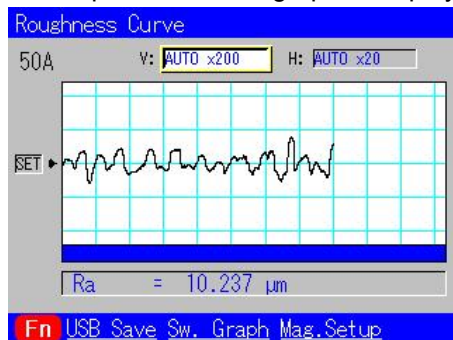
8-3-2   Bearing area curve graph and amplitude distribution curve graph

● How to view displays
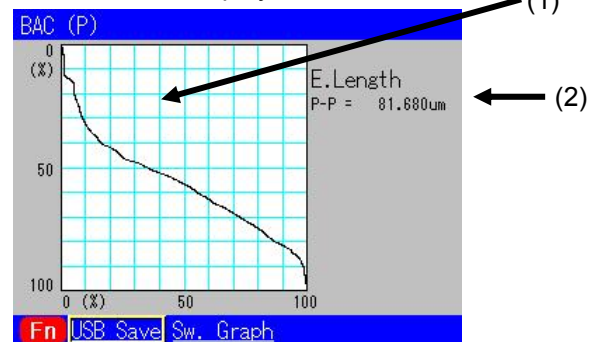
(1) Graph display item
Displays a bearing area curve graph or an amplitude distribution curve graph.

(2) Calculation method and P-P value display item
Displays the method to calculate a bearing area curve graph or an amplitude distribution curve graph. The P-P value is also displayed.
The following shows the methods to calculate bearing area curve graphs and amplitude distribution curve graphs.

Standard	Measurement type	BAC graph/ Cut level unit	Calculation method
JIS'82	-	-	Evaluation length
JIS'94	-	Absolute	Sampling length absolute
	-	Relative	Sampling length relative
JIS'01/ ISO'97/ DIN	Roughness	BAC (P)	Evaluation length
		BAC (R)	ISO13565
	Other than roughness	BAC (P)	Evaluation length
ASME'95/ ASME'02	-	-	ISO13565
CNOMO	-	-	Upper envelope curve

8-3-2-1 Save to USB

For operation of saving data the USB memory sticks, see **Section 8-3-1-6 Save to USB**.

8-3-2-2 Switching graphs

For operation of switching graphs, see **Section 8-3-1-7 Switching graphs**.

8. Display of Measurement Results

8-4   Display of measurement results

8-4-1   How to view the measurement results

● Measurement results

(1) Result of judgment
If judgment parameters are configured, the result of all judgment parameters are displayed. If no judgment parameters are configured, the OK or NG result is not displayed.
　・OK: When all judgment results are positive.
　・NG: When any of the judgment results is negative.

(2)Page No./total pages
If the measurement results cover multiple pages, the current page No. vs. total pages is displayed.

(3) Parameter calculation result
Displays the result of parameter calculation and result of judgment. The following are the items displayed in this section.
　・Parameter name (Example: Pa)
　・Parameter value (Example: 11.280)
　・Unit (Example: μm)
　・Judgment result (Example: NG+)
　　The judgment result is displayed only for the parameter for which judgment condition is set.

　　☞ For how to view judgment results, see **Section 8-2-2 Displaying the result of judgment**.

● Section parameter (Header area)

(1) Parameter name and unit
Displays the name and unit of the section parameter.

(2) Page No./total pages
Displays the current page No. vs. total pages of the section parameter display.

(3) Section parameter value
Displays the average of the section parameter values. The following are the items displayed in this section.
　・Parameter name (Example: Rz)
　・Parameter value (Example: 7.155)
　・Unit (Example: μm)

(4) The maximum parameter value
Displays the maximum of the parameter values. The following items are displayed.
　・Parameter name +max (Example: Rzmax)
　・Sectional maximum value (Example: 9.344)
　・Unit (Example: μm)
　・Judgment result (Example: OK)
　　The judgment result is displayed only for the parameter for which judgment condition is set when the judgment method is set to maximum.

(5) Parameter value +/- standard deviation
Displays the parameter value +/- standard deviation. The following items are displayed.
　・Parameter name +/-sd (Example: Rz + sd)
　・Parameter value +/- standard deviation
(Example: 8.207 6.104)
　・Unit (Example: μm)
　・Judgment result (Example: OK NG-)
　　The judgment result is displayed only for the parameter for which judgment condition is set when the judgment method is set to 16% rule (sigma rule).

● Section parameter (Section parameter area)

Sections (1) and (2) are the same as those in the section parameter (Header area).

(3)Section number

Display the section number of the section parameter value.

(4)Section parameter value

Displays the parameter value for each section, values for eight sections max. per page. The following items are displayed.

- ・ Section parameter value
- ・ Judgment result (Example: NG-)
  The judgment result is displayed only for the parameter for which judgment condition is set when the judgment method is set to 16% rule (standard).

(For example: Left:001-004 Right:005-008)

8-4-2　Displaying the result of judgment

Judgment methods can be configured in five different ways as shown in the following, and each method has different items to display.

- ・ No judgment
- ・ Average
- ・ Maximum
- ・ 16% rule (standard)
- ・ 16% rule (sigma rule)

The judgment result is not displayed in the following cases.

- ・ When "No judgment" is selected
- ・ If no judgment parameters are set
- ・ If both the upper-limit and lower-limit values of a judgment parameter are set to "0.0"
  ☞ For how to set judgment, see **(Section 9-3-2-1 judgment)**.

● Judgment method: Average

For a parameter in measurement results, the judgment result is displayed after determining whether the parameter value falls within the upper-limit and lower-limit values.
Section parameters (header area and section parameter area) do not display the judgment result.

- ・OK : The parameter value falls within the upper-limit and lower-limit values.
- ・NG+: The parameter value is higher than the upper-limit value.
- ・NG-: The parameter value is lower than the lower-limit value.

● Judgment method: Maximum

If the judgment method is set to maximum, the display method varies depending on whether the parameter has sections or not.
<Parameter without sections>
Items displayed are the same as those when the judgment method is set to average.

<Parameter with sections>
For the sectional maximum value of a section parameter (header area), the judgment result is displayed after determining whether the parameter value falls within the upper-limit and lower-limit values.
The measurement result and section parameter (section parameter area) do not display the judgment result.

- ・OK : The sectional maximum value falls within the upper-limit and lower-limit values.
- ・NG+: The sectional maximum value is higher than the upper-limit value.
- ・NG-: The sectional maximum value is lower than the lower-limit value.

●Judgment method: 16% rule (standard)

If the judgment method is set to 16% rule (standard), the display method varies depending on whether the parameter has sections or not.
<Parameter without sections>
Items displayed are the same as those when the judgment method is set to average.
<Parameter with sections>
For a section parameter (section parameter area), the judgment result is displayed after determining whether the parameter value for each section falls within the upper-limit and lower-limit values.
Section parameter (header area) does not display the judgment result.

- ・OK : The section parameter value falls within the upper-limit and lower-limit values.
- ・NG+: The parameter value is higher than the upper-limit value.
- ・NG-: The parameter value is lower than the lower-limit value.

For a parameter with sections in measurement results, the judgment result is displayed after determining whether a maximum of 16% of total section parameter values are out of the set range.

- ・OK : A maximum of 16% of section parameter values vs. the total number of sections are out of the upper-limit and lower-limit range.
- ・NG : Higher than 16% of section parameter values vs. the total number of sections are out of the upper-limit and lower-limit range.

● Judgment method: 16% rule (sigma rule)

If the judgment method is set to 16% rule (sigma), the display method varies depending on whether the parameter has sections or not.
<Parameter without sections>
Items displayed are the same as those when the judgment method is set to average.

79

8. Display of Measurement Results

<Parameter with sections>
For a section parameter (header area), the judgment result is displayed after determining whether the parameter value +/- standard deviation falls within the upper-limit and lower-limit values. Section parameter (section parameter area) does not display the judgment result.
  <Parameter value + standard deviation>
・OK : The parameter value + standard deviation is lower than the upper-limit value.
・NG+: The parameter value + standard deviation is higher than the upper-limit value.
  <Parameter value - standard deviation>
・OK : The parameter value - standard deviation is higher than the lower-limit value.
・NG-: The parameter value - standard deviation is lower than the lower-limit value.

For a parameter with sections in measurement results, the judgment result is displayed after determining whether the parameter value +/- standard deviation falls within the set range.
・OK : Both the parameter value + and - standard deviation fall within the set range.
・NG+ : Only the parameter value + standard deviation is out of the set range.
・NG- : Only the parameter value - standard deviation is out of the set range.
・NG± : Both the parameter value + and - standard deviation are out of the set range.

● Judgment method for a single section in 16% rule
The following shows the measurement method for the case the number of sections is 1 in 16% rule (standard or sigma rule) and when "judgment using 70% or lower upper-limit value and 130% or higher lower-limit value for a single section" is set to "ON".
・OK : (70% of the upper-limit ≥ Parameter value) AND
(130% of the lower-limit ≤ Parameter value)
・NG : (70% of the upper-limit < Parameter value) OR
(130% of the lower-limit > Parameter value)

The following shows the measurement method for the case when "judgment using 70% or lower upper-limit value and 130% or higher lower-limit value for a single section" is set to "OFF"
・OK : (Upper-limit ≥ Parameter value) AND
(Lower limit ≤ Parameter value)
・NG : (Upper-limit < Parameter value) OR
(Lower limit > Parameter value)

● An abnormal value of parameter
<A "*" mark before the parameter name>

Result		
Judgement:NG		2/ 5
Rz	= 7.155 μm	NG
Rzmax	= 9.344 μm	
*RSm	= 34.736 μm	
Rq	= 1.991 μm	
Rp	= 3.560 μm	
Fn Section		

Section Parameter		
		1/ 4
RSm (μm)		
*RSm	= 34.736 μm	
RSmmax	= 62.400 μm	
RSm+sd	= 50.276 μm	
RSm-sd	= 19.195 μm	

If a "*" mark appears before the parameter name, the mark indicates that the number of peaks or valleys required for parameter calculation is insufficient. Or, at least one parameter could not be calculated that should have been obtained by dividing and averaging data for each reference length.

<Indication "--------" for a section parameter>

Section Parameter	
	2/ 4
RSm (μm) 001-008	
--------	22.500
--------	38.200
--------	54.900
--------	--------

If indication "--------" is displayed for a section parameter, it means that the parameter could not be calculated in that section.

<**An Error Message** displayed for a parameter value>

If an **Error Message** appears for a parameter value, check the error message, remove the factor causing the anomaly, and perform the measurement again.

The following list shows the **Error Messages** displayed for a parameter value.

<Error Message list>

Error Message	Description of error
No P's & V's	This message appears when no peaks and valleys are present in Rz, Sm, RSm, WSm, WC-Sm, or WCC-Sm.
No local peak	This message appears when no local peaks are present in S.
Small amplitude	This message appears when a bearing area curve graph cannot be created because of too low amplitude of a form curve.
Incorrect data	This message appears when a bearing area curve graph does not have a form suitable for calculation in Rk, Rpk, Rvk, Mr1, Mr2, Vo, or K.
<100%>	This appears when the Z value set in Tp, Pmr, Rmr, or Wmr is too high.
Invalid calc condition	This message appears when a condition setting value is too high in step height calculation (AVH, Hmax, or Hmin).
No peak	This message appears when no peaks are present in a motif parameter (R, Rx, AR, W, Wx, AW, or Wte).
No motif	This message appears when no motifs are present in a motif parameter (R, Rx, AR, W, Wx, AW, or Wte). As the following parameters are calculated only when at least three motifs are present, this message appears even when one or two motifs are present. (Parameters calculated when at least three parameters are present: R, AR, W, and AW)

8. Display of Measurement Results

8-4-3 How to operate measurement results and section parameters

After measurements, recalculation, or loading measurement data, or when the **[GRAPH/PARAM.]** button is pressed, the first page of the measurement results is displayed. The following describes the procedure to operate the measurement results and section parameters.

● Viewing the next page of measurement results

1. To view the next page, press the **[▼]** button.

```
Result
Judgement:NG                    1/ 5
 Ra       =     1.422 μm    OK
 Pa       =    11.280 μm    NG+
 Pq       =    12.968 μm
 Pt       =    47.616 μm
 Rz.J     =    45.395 μm
 Fn  Section
```

2. The next page is displayed.

```
Result
Judgement:NG                    2/ 5
 Rz       =     7.155 μm    NG
 Rzmax    =     9.344 μm
*RSm      =    34.736 μm
 Rq       =     1.991 μm
 Rp       =     3.560 μm
 Fn  Section
```

☞ If you press the **[▼]** button while the last page is displayed, then the first page is displayed.

● Viewing the previous page of measurement results

1. To view the previous page, press the **[▲]** button.

```
Result
Judgement:NG                    2/ 5
 Rz       =     7.155 μm    NG
 Rzmax    =     9.344 μm
*RSm      =    34.736 μm
 Rq       =     1.991 μm
 Rp       =     3.560 μm
 Fn  Section
```

2. The previous page is displayed.

```
Result
Judgement:NG                    1/ 5
 Ra       =     1.422 μm    OK
 Pa       =    11.280 μm    NG+
 Pq       =    12.968 μm
 Pt       =    47.616 μm
 Rz.J     =    45.395 μm
 Fn  Section
```

☞ If you press the **[▲]** button while the last page is displayed, then the first page is displayed.

● Viewing section parameters

1. To view section parameters, press the **[ENTER]** button.

```
Result
Judgement:NG                    1/ 5
 Ra       =     1.422 μm    OK
 Pa       =    11.280 μm    NG+
 Pq       =    12.968 μm
 Pt       =    47.616 μm
 Rz.J     =    45.395 μm
 Fn  Section
```

2. The first page of first section parameter is displayed among parameters with sections.

```
Section Parameter
                                1/ 4
 Ra(μm)
 Ra       =     1.422 μm
 Ramax    =     1.788 μm
 Ra+sd    =     1.599 μm    OK
 Ra-sd    =     1.245 μm    OK
```

● Viewing the next page of the section parameter

1. To view the next page, press the **[▼]** button.

```
Section Parameter
                                1/ 4
 Ra(μm)
 Ra       =     1.422 μm
 Ramax    =     1.788 μm
 Ra+sd    =     1.599 μm    OK
 Ra-sd    =     1.245 μm    OK
```

82

2. The next page is displayed.

```
Section Parameter
                    2/ 4
Ra(μm)    001-008
   1.464 OK      1.438 OK
   1.560 OK      1.509 OK
   1.467 OK      1.485 OK
   1.498 OK      1.098 OK
```

☞ If you press the **[▼]** button while the last page is displayed, then the first page is displayed.

● Viewing the previous page of the section parameter

1. To view the previous page, press the **[▲]** button.

```
Section Parameter
                    2/ 4
Ra(μm)    001-008
   1.464 OK      1.438 OK
   1.560 OK      1.509 OK
   1.467 OK      1.485 OK
   1.498 OK      1.098 OK
```

2. The previous page is displayed.

```
Section Parameter
                    1/ 4
Ra(μm)
  Ra      =    1.422 μm
  Ramax   =    1.788 μm
  Ra+sd   =    1.599 μm   OK
  Ra-sd   =    1.245 μm   OK
```

☞ If you press the **[▲]** button while the last page is displayed, then the first page is displayed.

● Viewing the next section parameter

1. To view the next section parameters, press the **[►]** button.

```
Section Parameter
                    1/ 4
Ra(μm)
  Ra      =    1.422 μm
  Ramax   =    1.788 μm
  Ra+sd   =    1.599 μm   OK
  Ra-sd   =    1.245 μm   OK
```

```
Section Parameter
                    2/ 4
Ra(μm)    001-008
   1.464 OK      1.438 OK
   1.560 OK      1.509 OK
   1.467 OK      1.485 OK
   1.498 OK      1.098 OK
```

2. The first page of next section parameter is displayed no matter what page of the current section parameter is displayed.

```
Section Parameter
                    1/ 4
Rz(μm)
  Rz      =    7.155 μm
  Rzmax   =    9.344 μm
  Rz+sd   =    8.207 μm
  Rz-sd   =    6.104 μm
```

☞ If the last section parameter is displayed, then the first page of the first parameter is displayed.

8. Display of Measurement Results

● Viewing the previous section parameter

1. To view the previous section parameters, press the **[◄]** button.

```
Section Parameter
                          1/ 4
 Ra(μm)
  Ra      =    1.422 μm
  Ramax   =    1.788 μm
  Ra+sd   =    1.599 μm   OK
  Ra-sd   =    1.245 μm   OK
```

```
Section Parameter
                          2/ 4
 Ra(μm)    001-008
      1.464 OK      1.438 OK
      1.560 OK      1.509 OK
      1.467 OK      1.485 OK
      1.498 OK      1.098 OK
```

2. The first page of previous section parameter is displayed no matter what page of the current section parameter is displayed.

```
Section Parameter
                          1/ 4
 Rp(μm)
  Rp      =    3.560 μm
  Rpmax   =    5.984 μm
  Rp+sd   =    5.552 μm
  Rp-sd   =    1.568 μm
```

☞ If the first section parameter is displayed, then the first page of the last parameter is displayed.

9. Menu

Configure measurement and analysis conditions in the menu screen.

Item	Description
Measurement condition **Meas.C.**	Configure measurement conditions such as calculation standards and measurement types.
Analysis Condition **Calc.C.**	Configure analysis conditions such as peak count level and cut level.
Output Setting **Output**	Configure output items and output parameters.
System **Sys.C.**	Configure system settings including language and display units.
Recalculation **Re-Cal.**	Recalculates the measurement data.
Various Settings **Setting**	Configure the display magnification expansion, sleep ON/OFF, date/time, auto loading, initialization, and maintenance.
Save/Load **File**	Save or load measurement data and measurement conditions to/from the internal memory and USB memory stick.

9-1   Measurement conditions

Configure calculation standards and measurement types in the Measurement Condition screen.

Item	Description
Standard	Set the standard such as JIS-'82, JIS-'94, or JIS'01/ISO'97/DIN.
Measurement Type	Select the measurement type from profile, roughness, and waviness. (Available only for Model -50)
Evaluation Length	Set the evaluation length.
Cutoff value	Set the cutoff value.
Measure Speed	Set the measure speed. (Available only for Model -50)
Pre. Drive Length	Set the preliminary drive length. (Available only for Model -50)
Form Remove	Set the method to remove forms such as straight lines and curves.
Filter Type	Set the filter type such Gaussian or 2RC.
λs	Set λs filter which eliminates vibration.
Return Speed	Set the return speed. (Available only for Model -50)

☞   For details about the measurement condition items, see **Chapter 14 Parameter Description**.

● Displaying the Measurement Condition screen
1. Press the **[MENU]** button, and select "Meas.C" using the **[▶]** and **[◀]** buttons.
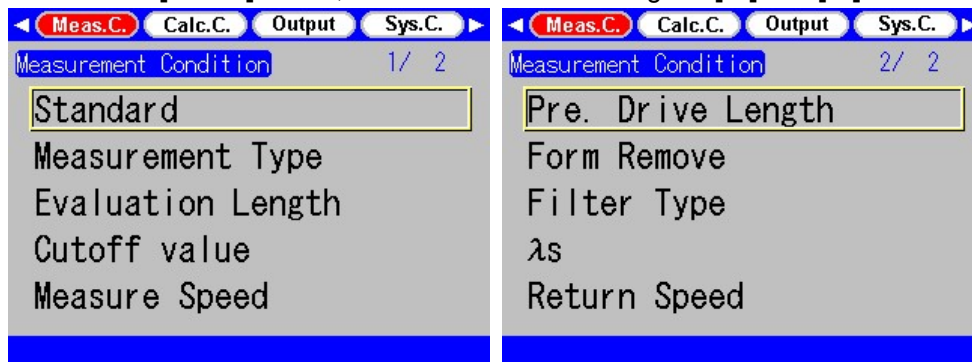
9. Menu

9-1-1 Standard

● Set the standard

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Measurement Type"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.
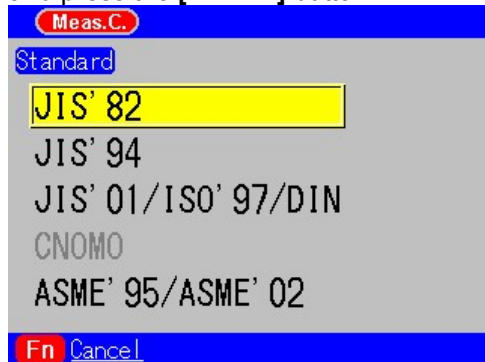
9-1-2 Measurement type

● Setting the measurement type (Available only for Model -50)

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Measurement Type"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.
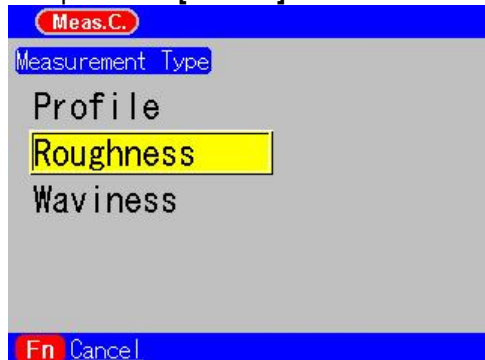
9-1-3 Evaluation length

The method to set evaluation length can be selected from fixed mode and flex mode.

☞ Press **[Fn]** to switch between fixed mode and flex mode.

● Setting the evaluation length in fixed mode

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Evaluation Length"** and press the **[ENTER]** button.

☞ If the flex evaluation length screen appears, press **[Fn]** to switch it to the fixed evaluation length screen. After setting, the screen is displayed in the set mode.

2. Using the **[►]** and **[◄]** buttons, specify the **"Evaluation Length"**.
[Numerical value setting screen]
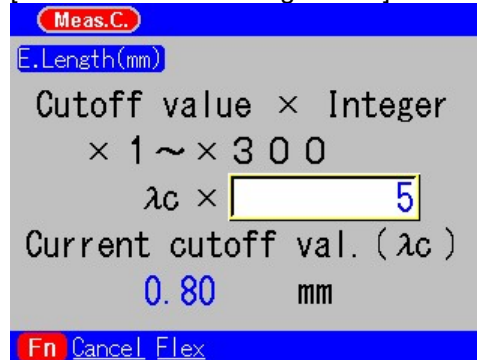
[►]: Increments the current evaluation length by 1.
[◄]: Decrements the current evaluation length by 1.

The configurable range of the evaluation length varies depending on the measure type and with or without the λf filter.
<Model -50>

Measurement type	λf filter	Range
Profile	-	Cannot be selected
Roughness measurement	-	$\lambda c \times 1$ to $\times 300$
Waviness measurement	Without λf filter	$\lambda c \times 1$ to $\times 300$
	With λf filter	$\lambda f \times 1$ to $\times 300$

<Models -35/-40/-45>
$\lambda c \times 1$ to $\times 5$

☞ Press **[ENTER]** to switch the screen to [Data input screen].
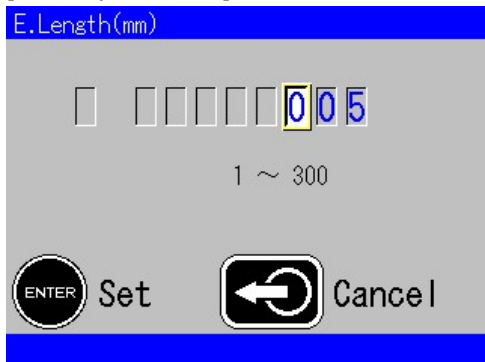
[Data input screen]

```
E.Length(mm)
       ⬜ ⬜⬜⬜⬜⬜0 0 5
              1 ~ 300
   (ENTER) Set    (⬅) Cancel
```

[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

● Setting the evaluation length in flex mode

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Evaluation Length"** and press the **[ENTER]** button.

☞ If the fixed evaluation length screen appears, press **[Fn]** to switch it to the flex evaluation length screen. After setting, the screen is displayed in the set mode.

2. Using the **[►]** and **[◄]** buttons, specify the **"Evaluation Length"**.
[Numerical value setting screen]

```
(Meas.C.)
E.Length(mm)

        4.00     mm

Fn Cancel Fixed
```
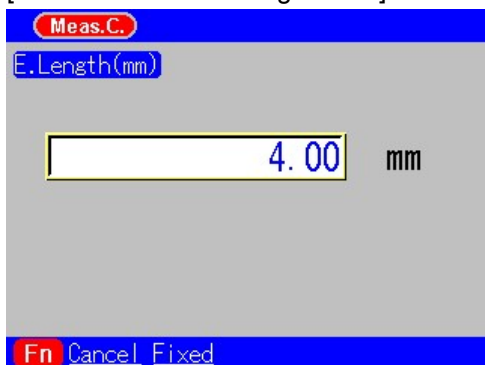
[►]: Increments the current evaluation length by 0.01 mm.
[◄]: Decrements the current evaluation length by 0.01 mm.

The configurable range of the evaluation length varies depending on the measure speed.
<Model -50>

Measure speed	Configurable range
0.15 mm/s (0.006 in/s)	0.10 mm to 50.00 mm (0.0039 in to 1.9685 in)
0.3 mm/s (0.012 in/s)	0.10 mm to 50.00 mm (0.0039 in to 1.9685 in)
0.6 mm/s (0.024 in/s)	0.30 mm to 50.00 mm (0.0118 in to 1.9685 in)
1.5 mm/s (0.06 in/s)	0.75 mm to 50.00 mm (0.0295 in to 1.9685 in)

<Models -35/-40>
0.40 mm to 12.50 mm (0.0157 inch to 0.4921 inch)

<Model -45>
0.40 mm to 4.00 mm (0.0157 inch to 0.1575 inch)

☞ Press **[ENTER]** to switch the screen to [Data input screen].
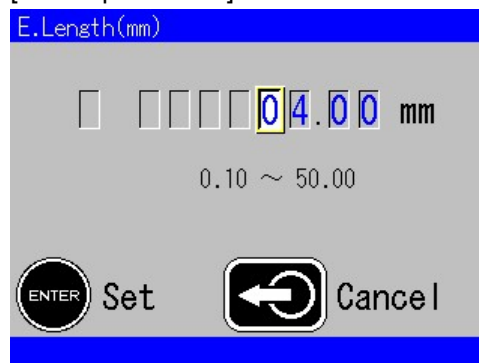
[Data input screen]

```
E.Length(mm)
     ⬜ ⬜⬜⬜⬜0 4.0 0  mm
            0.10 ~ 50.00
   (ENTER) Set    (⬅) Cancel
```

[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

9-1-4   Cutoff value

The cutoff value is an item to be specified for roughness or waviness measurement.

☞   It cannot be specified for cross section measurement.

● Setting the cutoff value for roughness measurement

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Cutoff value"** and press the **[ENTER]** button.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.
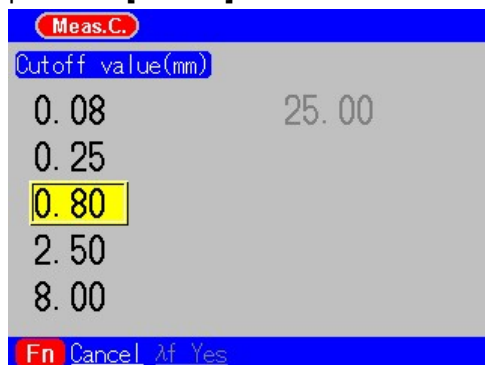
☞   Only **"0.08/0.25/0.8"** can be selected for Model -45.

● Setting the cutoff value for waviness measurement

・ Without λf

1. Press the **[MENU]** button, and select **"Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Cutoff value"** and press the **[ENTER]** button.

☞   If the "With λf" setting screen appears, switch it to the "Without λf" screen using **[Fn]**.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.
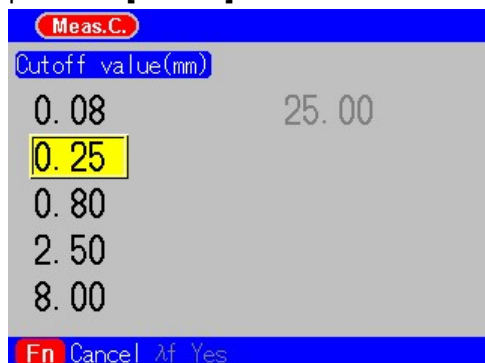
☞   Only **"0.08/0.25/0.8"** can be selected for Model -45.

・ With λf

1. Press the **[MENU]** button, and select "**Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Cutoff value"** and press the **[ENTER]** button.

☞   If the "Without λf" setting screen appears, switch it to the "With λf" screen using **[Fn]**.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.
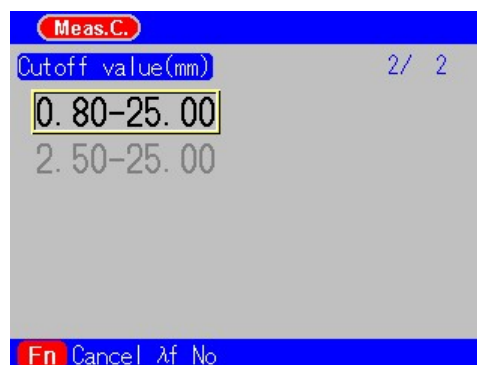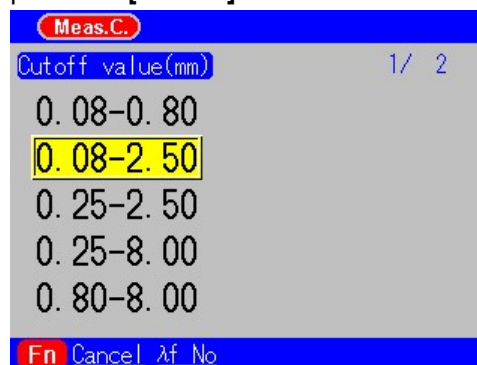
☞   When the second page item has been selected, the second page is displayed.

9-1-5 Measure speed

● Setting the measure speed (Available only for Model -50)

1. Press the **[MENU]** button, and select "**Meas.C**" using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Measure Speed"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

Meas.C.
M.Speed(mm/s)
0.15
0.30
0.60
1.50
Fn Cancel
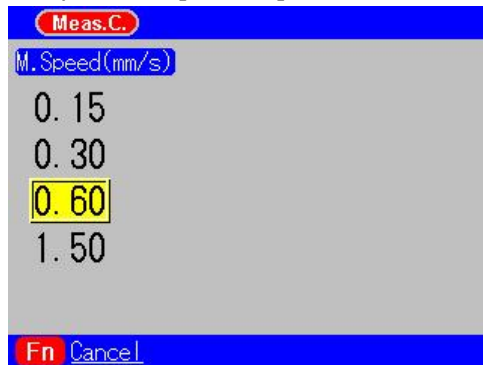
☞ The value is fixed to **"0.6 mm/s"** for Models -35/-40/-45.

9-1-6 Pre. drive length

● Setting the preliminary drive length (Available only for Model -50)

1. Press the **[MENU]** button, and select "**Meas.C**" using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Pre. Drive Length"** and press the **[ENTER]** button.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.

Meas.C.
Pre. Drive Length
Cutoff
Cutoff/2
Cutoff/3
Fn Cancel
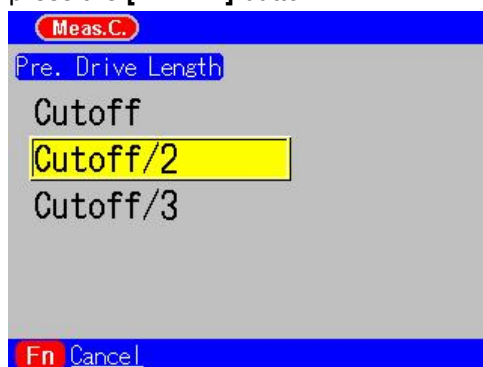
☞ The value is fixed to **"Cutoff value/3"** for Models -35/-40/-45.

9-1-7 Form remove

● Setting the form remove

1. Press the **[MENU]** button, and select "**Meas.C**" using the **[►]** and **[◄]** buttons. Using the **[▲] and [▼]** buttons, select **"Form Remove**" and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

Meas.C.
Form Remove   1/ 2
None
Straight
R-Curve
Begin.Half
End.Half
Fn Cancel

Meas.C.
Form Remove   2/ 2
Begin-End
Fn Cancel

☞ When the second page item has been selected, the second page is displayed.

☞ "Curves" are not available for models -35/-40/-45.

9-1-8 Filter type

● Setting the filter type

1. Press the **[MENU]** button, and select "**Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Filter Type"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

Meas.C.
Filter Type
Gaussian
2RC
2RC(P.C.)
Fn Cancel
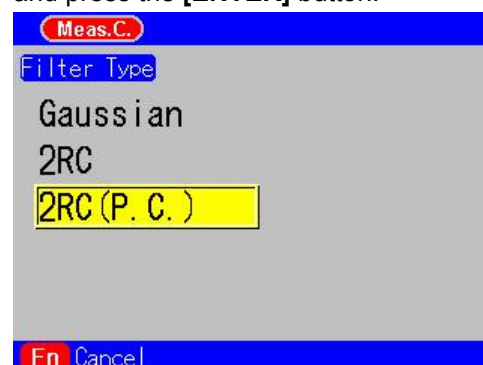
9-1-9　Ls filter

● Setting the Ls filter
1. Press the **[MENU]** button, and select "**Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Ls Filter"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

＜Profile, Waviness measurement＞

＜Roughness measurement＞
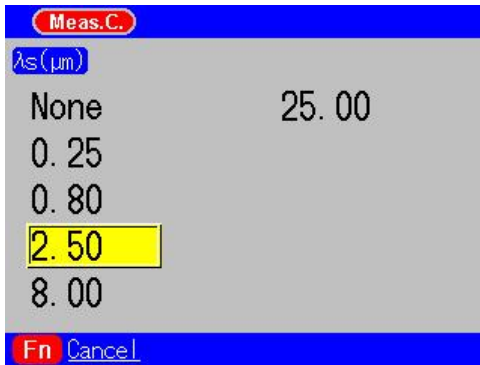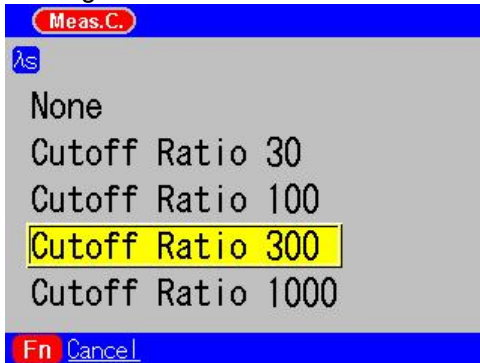
9-1-10 Return speed

● Setting the return speed (Available only for Model -50)
1. Press the **[MENU]** button, and select "**Meas.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Return Speed"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.
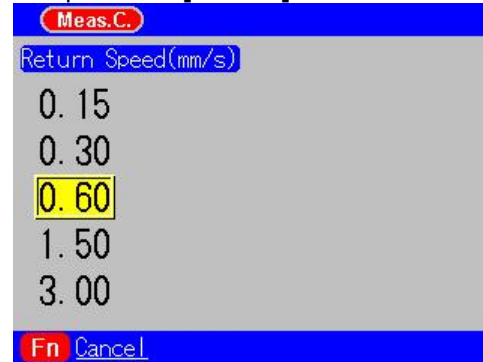
☞　The value is fixed to **"0.6 mm/s"** for Models -35/-40/-45.

9-2   Analysis conditions

Configure peak count level, BC graph cut level, and others in the Analysis Condition screen.

Item	Description
Peak Count Level	Set the upper and lower values of the peak count level.
BC Graph Cut Level	Set the BC graph count level.
Motif Calculation	Set the upper limit length of motif and turn ON or OFF the combined display.
Step Height Calculation	Set the reference height and delete length.
Notch Calculation	Set the upper limit value and delete length of notching.

☞   For details about the analysis condition items, see **Chapter 14 Parameter Description**.

● Displaying the Analysis Condition screen
1. Press the **[MENU]** button, and select **"Calc.C"** using the **[►]** and **[◄]** buttons.
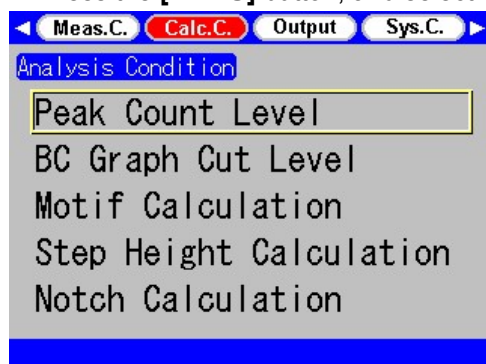
9-2-1   Peak count level

● Setting the peak count level
1. Press the **[MENU]** button, and select **"Calc.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Peak Count Level"** and press the **[ENTER]** button.

2. Select the item with the **[►]** and **[◄]** buttons, and configure it with the **[▼]** and **[▲]** buttons.
[Numerical value setting screen]
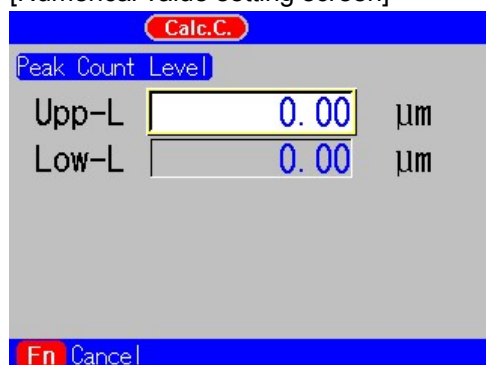
<Upper limit and lower limit>
[►]: Increments the current value by 0.01 μm.
[◄]: Decrements the current value by 0.01 μm.

<Selectable range>

Driver	Upper Limit	Lower Limit
-50	-2000.00 to 2000.00 μm (-78740.2 to 78740.2 μin)	-2000.00 to 2000.00 μm (-78740.2 to 78740.2 μin)
-35/ -40/ -45	0.00 to 160.00 μm (0.00 to -160.00 μin)	-160.00 to 0.00 μm (0.00 to -160.00 μin)

☞   Press **[ENTER]** to switch the screen to [Data input screen].

9. Menu

[Data input screen]
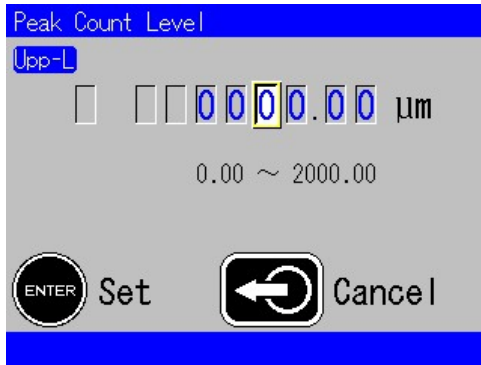
[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

9-2-2   BC graph cut level

● Setting the BC graph cut level

1. Press the **[MENU]** button, and select **"Calc.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"BC Graph Cut Level"** and press the **[ENTER]** button.

2. Select the item with the **[▼]** and **[▲]** buttons, and configure it with the **[►]** and **[◄]** buttons.
[Numerical value setting screen]
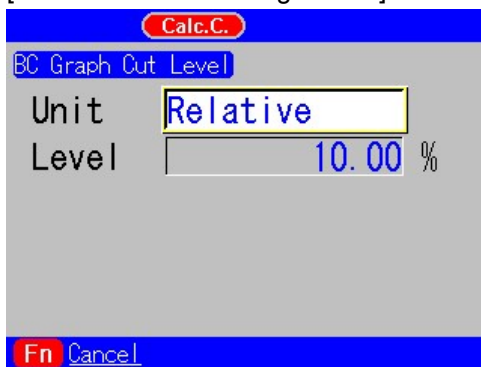
<Unit>
[►][◄]: Select Relative or Absolute.

<Level when Relative is selected>
[►]: Increments the current value by 0.01%.
[◄]: Decrements the current value by -0.01%.
Selectable range: 0.00 to 99.99

<Level when Absolute is selected>
[►]: Increments the current value by 0.01 μm.
[◄]: Decrements the current value by 0.01 μm.
Selectable range: 0.00 to 4000.00 μm (0.00 to 157480.3 μ inch)

☞ Press **[ENTER]** to switch the screen to [Data input screen].
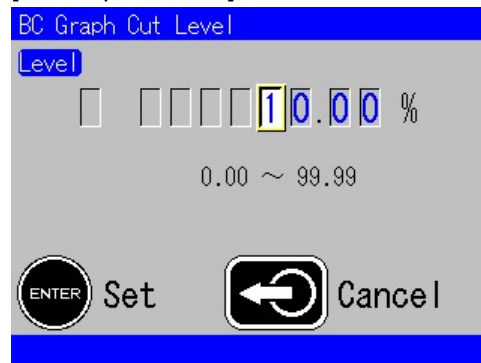
[Data input screen]

[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

9-2-3   Motif calculation

● Setting the motif calculation

1. Press the **[MENU]** button, and select **"Calc.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Motif Calculation"** and press the **[ENTER]** button.

2. Select the item with the **[▼]** and **[▲]** buttons, and configure it with the **[►]** and **[◄]** buttons.
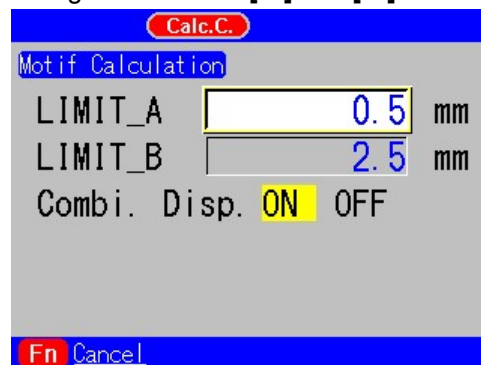
<LIMIT_A>
[►][◄]: Select from 0.02/0.1/0.5/2.5 mm (0.0008/0.004/0.02/0.1 inch)

<LIMIT_B>
[►][◄]: Select from 0.1/0.5/2.5/12.5 mm (0.004/0.02/0.1/0.5 inch)

<Combined display>
[►][◄]: Select ON or OFF.

☞ For Model -45, only the following items are selectable.
・LIMIT_A:
  0.02/0.1/0.5 mm (0.0008/0.004/0.02 inch)
・LIMIT_B:
  0.1/0.5/2.5 mm (0.004/0.02/0.1 inch)

9-2-4 Step height calculation

● Setting the step height calculation
1. Press the **[MENU]** button, and select **"Calc.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Step Height Calculation"** and press the **[ENTER]** button.

2. Select the item with the **[▼]** and **[▲]** buttons, and configure it with the **[►]** and **[◄]** buttons.
[Numerical value setting screen]
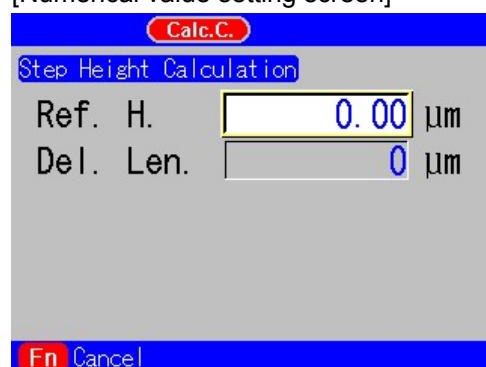
<Reference height>
[►]: Increments the current value by 0.01 μm.
[◄]: Decrements the current value by 0.01 μm.
 Selectable range: -4000.00 to +4000.00 μm
 (-157480.3 to 157480.3 μ inch)

<Delete length>
[►]: Increments the current value by +1 μm.
[◄]: Increments the current value by -1 μm.
 Selectable range: 0 to 9999 μm (0 to 393661
 μ inch)

☞ Press **[ENTER]** to switch the screen to [Data input screen].
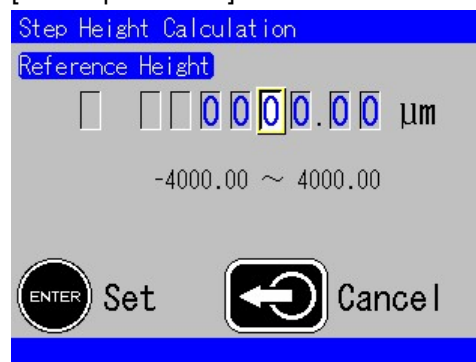
[Data input screen]

[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

9-2-5 Notch calculation

● Setting the notch calculation
1. Press **[MENU]**, and select **"Calc.C"** using the **[►]** and **[◄]** buttons.
Select **"Notch Calculation"** using the **[▲]** and **[▼]** buttons and press **[ENTER]**.

2. Select the item using the **[▼]** and **[▲]** buttons, and configure it using the **[►]** and **[◄]**buttons.
[Numerical value setting screen]
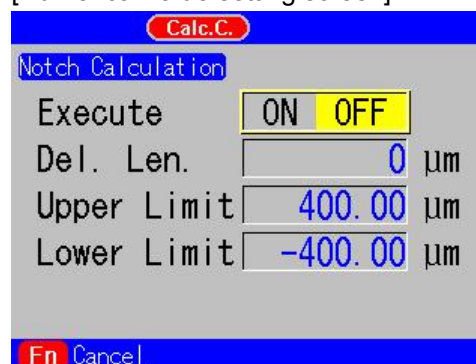
<Execute>
[►][◄]: Selects ON or OFF.

<Del. Len>
[▼]: Increments the current value by 1 μm.
[▲]: Decrements the current value by 1 μm.
Selectable range: 0 to 9999 μm (0 to 393661 μin)

☞ Press **[ENTER]** to switch the screen to [Data input screen].

9. Menu

<Upper-limit/Lower-limit levels>
[►]: Increments the current value by 0.01 μm.
[◄]: Decrements the current value by 0.01 μm.
Selectable range: -800.00 to 800.00 μm
(-31496.0 to 31496.0 μin)

☞　Press **[ENTER]** to switch the screen to [Data input screen].

[Data input screen]

[►]: Moves the cursor to the next digit to the right.
[◄]: Moves the cursor to the next digit to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

☞　Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

94
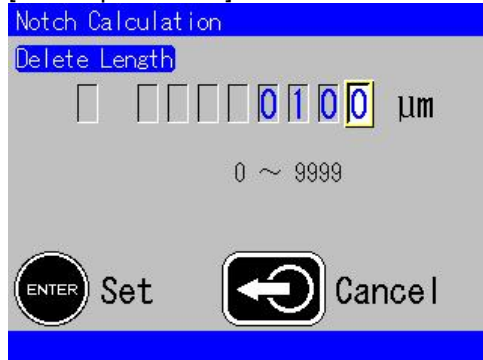
9-3 Output settings

In the output setting screen, configure output items and parameters relevant to printing, digital output (USB communication), and output to files (USB memory sticks).

Item	Description
Output Selection	Set measurement date, measurement condition, and other output items.
Output Parameter	Set output parameters and configure the judgment setting.

● Displaying the Output Selection screen

1. Press the **[MENU]** button, and select "Output" using the [►] and **[◄]** buttons.

◄ Meas.C. Calc.C. Output Sys.C. ►

Output Setting

Output Selection
Output Parameter
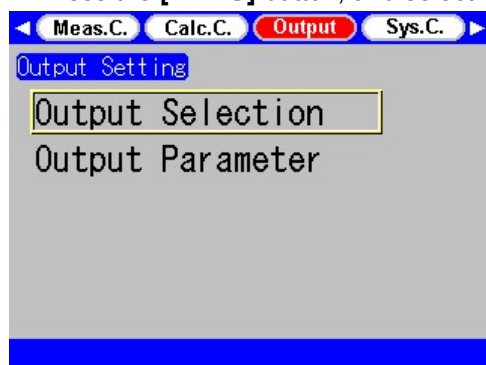
9-3-1 Output Selection

● Setting the output selection

1. Press the **[MENU]** button, and select **"Output"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Output Selection"** and press the **[ENTER]** button.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.

Output

Output Selection   1/ 4

Measure Date
Measurement Condition
Parameter
Section
BAC (P)

Fn Cancel All None

Output

Output Selection   2/ 4

BAC (R)
BAC (W)
ADF (P)
ADF (R)
ADF (W)

Fn Cancel All None

Output

Output Selection   3/ 4

Profile Curve
Roughness Curve
Filtered Waviness Curve
Waviness Profile Curve
ISO13565 Curve

Fn Cancel All None

Output

Output Selection   4/ 4

Roughness Motifs
Waviness Motifs

Fn Cancel All None
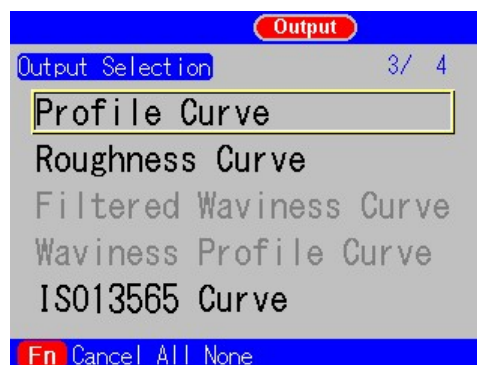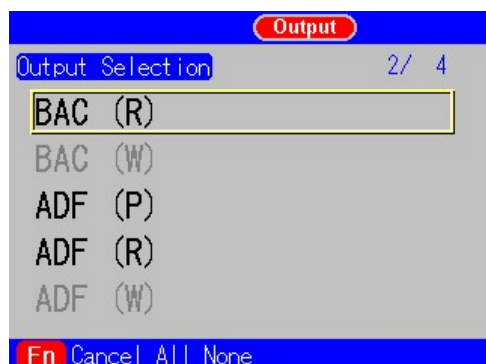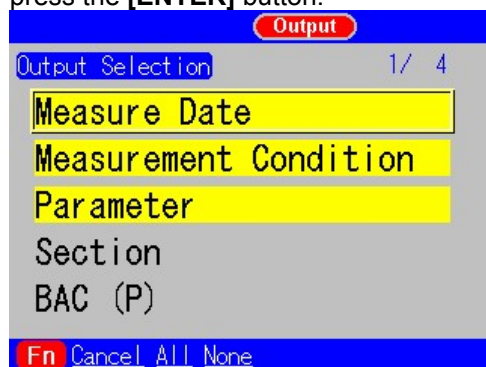
☞ To enable all Output Selection items, select **"All"** in **[Fn]** and press the **[ENTER]** button. (To cancel all items, select **"None"**.)

☞ Selectable items vary depending on the standard and measure type. For details, see **Chapter 8 ● Lists of contents displayed in the Graph screen and the Result screen**.

9-3-2 Output parameters

● Setting output parameters
1. Press the **[MENU]** button, and select **"Output"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Output Parameter"** and press the **[ENTER]** button.

2. Select the item with the **[▲], [▼], [►], and [◄]** buttons, and press the **[ENTER]** button.
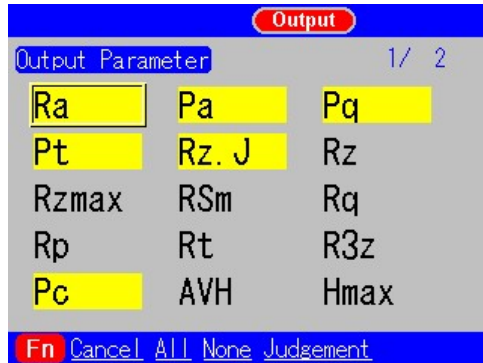
☞ To enable all Output Selection items, select **"All"** in **[Fn]** and press the **[ENTER]** button. (To cancel all items, select **"None"**.)

☞ For explanation of parameters, see **Section 16-1 Parameter list**.

9-3-2-1 Judgment

● Configuring the judgment setting
1. Press **[Fn]** in the Output Parameter screen, select **"Judgment"** using **[►]** and **[◄]**, and then press the **[ENTER]** button.
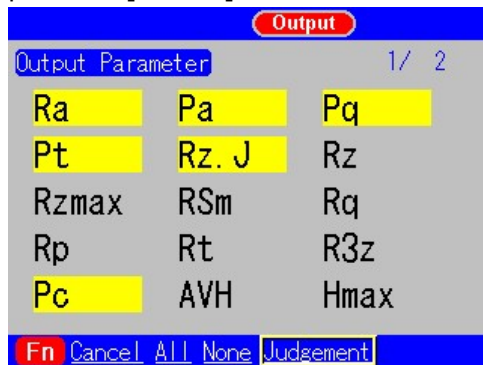
2. Select **"Judg. Meth."** with the **[▲]** and **[▼]** buttons, and select the item with the **[►]** and **[◄]** buttons.
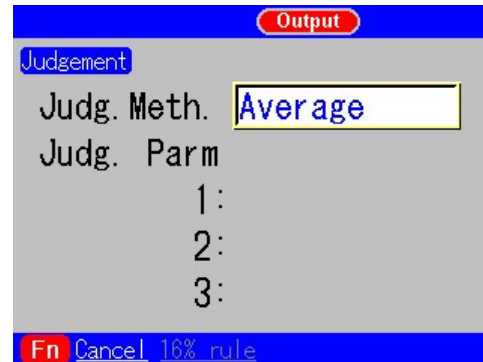
<Selectable items for Judg. Meth.>
Max./Average/16% rule/None

☞ If Judg. Meth. is set to "16% rule", the 16% rule can be configured. The 16% rule setting is explained in **Section 9-3-2-2 The 16% rule** .

3. Using the **[▲]** and **[▼]** buttons, select **"Judg. Param"** and press the **[ENTER]** button.
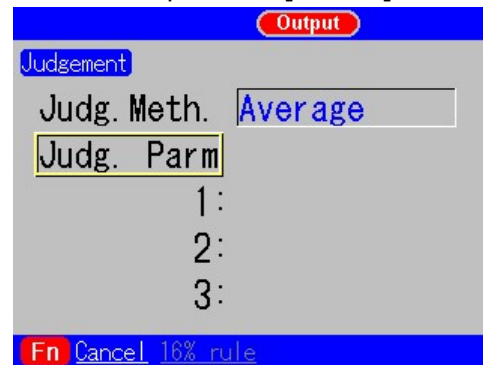
4. Select the item with the **[▲], [▼], [►], and [◄]** buttons, and press the **[ENTER]** button.
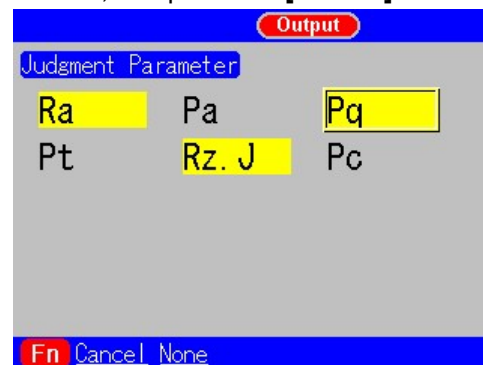
☞ Up to three judgment parameters can be selected.

☞ To cancel all judgment parameters, select **"None"** in **[Fn]** and press the **[ENTER]** button.

5. Press the **[BACK]** button to return to the Judgment screen.
To set the judgment value, select one of **"Judg. Param 1 to 3"** using the **[▲]** and **[▼]** button, and press the **[ENTER]** button.
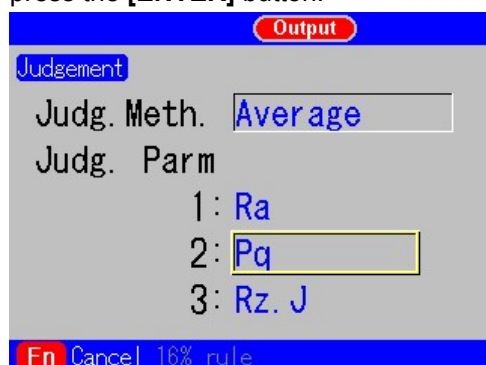
6. Select the item with the **[▼]** and **[▲]** buttons, and specify the upper and lower limit values with the **[►]** and **[◄]** buttons.
[Numerical value setting screen]
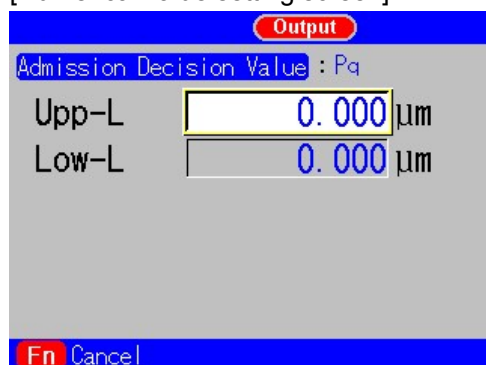
    <Upper limit and lower limit values>
[►]: Increments the current value by +0.001 µm.
[◄]: Increments the current value by -0.001 µm.
  Selectable range: 0.000 to 4000.000 µm (0.00 to 157480.3 µin)

    ☞ Press **[ENTER]** to switch the screen to [Data input screen].
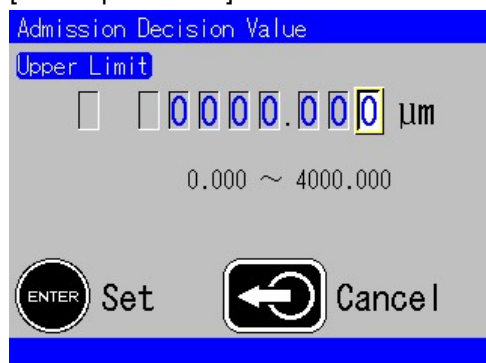
[Data input screen]

    [►]: Moves the cursor to the next digit to the right.
    [◄]: Moves the cursor to the next digit to the left.
    [▲]: Increments the current value by one.
    [▼]: Decrements the current value by one.

   ☞ Press **[ENTER]** to apply the setting and switch the screen to [Numerical value setting screen].

9-3-2-2   16% rule

Based on the 16% rule, a pass/fail judgment is made for each intersection value of a parameter, and if the ratio of failed intersections vs, all intersections is 16% or less, it is determined as a pass.
For a detailed explanation of the 16% rule, see **Section 8-2-2 Displaying the result of judgment**.

● Setting the 16% rule

1. In the Judgment screen, select **16% rule** for the judgment method.
Press **[Fn]**, select **"16% rule"** using the **[►]** and **[◄]** buttons, and press the **[ENTER]** button.
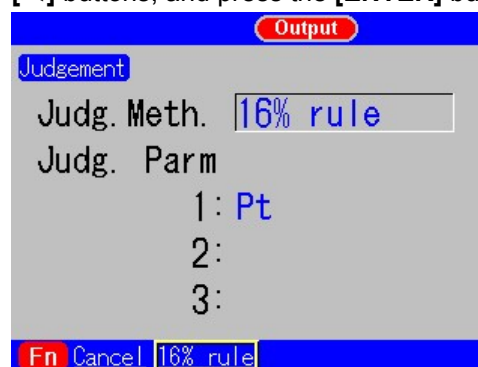
2. Select the item with the **[▲]** and **[▼]** buttons, and configure it with the **[►]** and **[◄]** buttons.
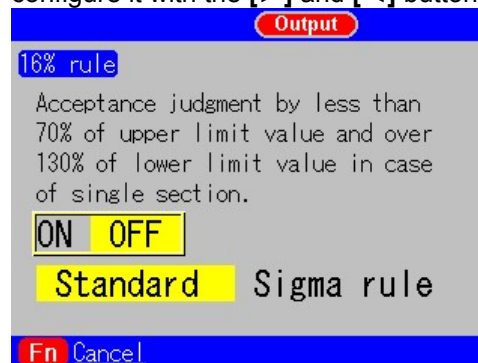
9. Menu

9-4   System

Configure the language, display unit, and other system settings in the System screen.

Item	Description
Language	Select the language from English, Japanese, and others.
Display Unit	Select the display unit from mm, μm and " (inch) ,μin.
Stop-Calc.	Set whether or not process analysis within the measured range even when the measurement is aborted.
Pickup	Set the pickup type.
Display Sel. After Meas.	Set the screen to be displayed after measurements.
USB Memory Save Type	Set the format of files to be saved on a USB memory stick.

● Displaying the System screen

1. Press the **[MENU]** button, and select "Sys.C" using the **[►]** and **[◄]** buttons.
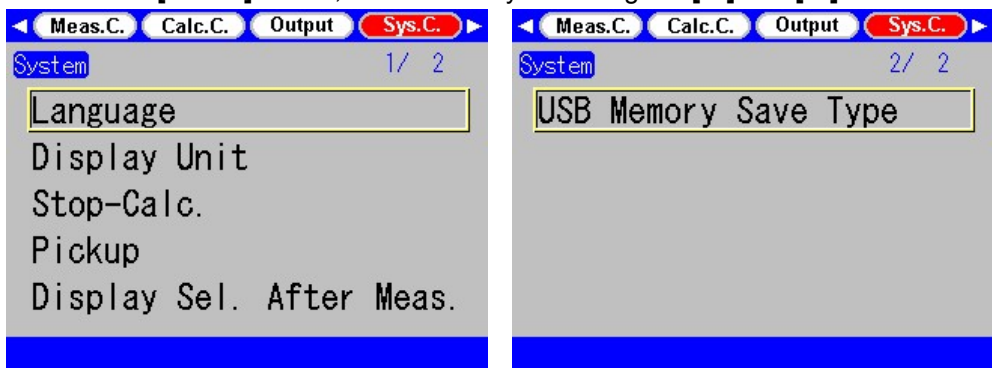
9-4-1   Language

Select the language used for display and printing.

● Selecting the language

1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Language"** and press the **[ENTER]** button.

2. Select the item with the **[▲], [▼], [►],** and **[◄]** buttons, and press the **[ENTER]** button.

9-4-2   Display unit

Select the display unit.

● Selecting the display unit

1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Display Unit"** and press the **[ENTER]** button.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.
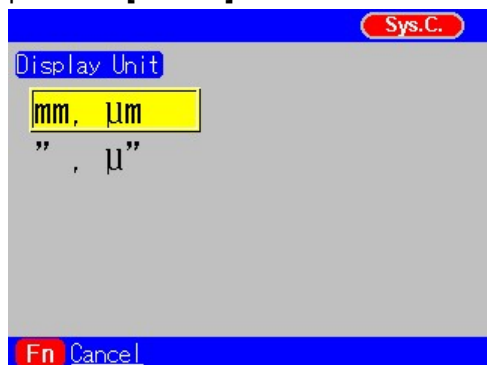
9-4-3   Stop-calculation

Set whether or not process analysis (calculate parameter) within the measured range when the measurement is aborted. If Stop-Calc. is set to ON, the parameter is calculated within the measured range. However, if the minimum evaluation range (see **Section 9-1-3 Configurable range of the evaluation length**) is not exceeded, the parameter is not calculated.

● Set Stop-Calc. ON or OFF

1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Stop-Calc."** and press the **[ENTER]** button.

2. Select the item with the **[►]** and **[◄]** buttons, and press the **[ENTER]** button.
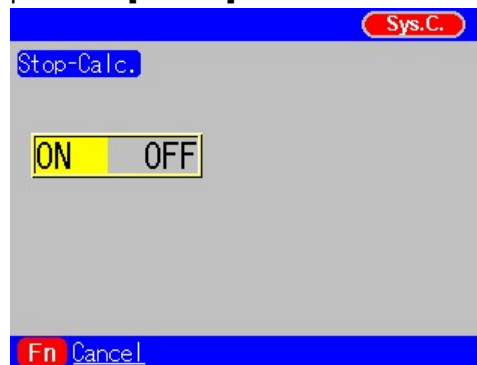
9-4-4   Pickup

Select the pickup setting.

● Setting the pickup type

1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Pickup"** and press the **[ENTER]** button.

2. Select the item with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.

9-4-5   Display select after measurement

Set the screen to be displayed immediately after measurements.

● Setting the screen displayed after measurements
1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Display Sel. After Meas."** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

Sys.C.

Display Sel. After Meas.

Graph Display
Meas. Result Display
Meas. Criteria Display

Fn Cancel
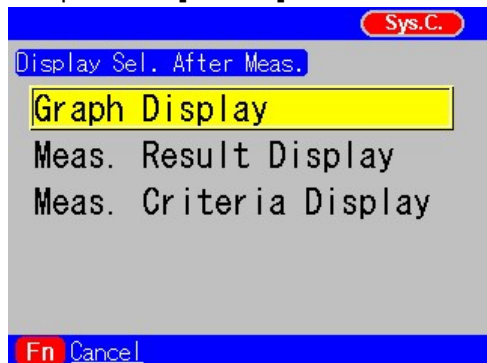
9-4-6   USB memory save type

Set the format of file to save measurement data to a USB memory stick.

● Setting the USB memory save type
1. Press the **[MENU]** button, and select **"Sys.C"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"USB Memory Save Type"** and press the **[ENTER]** button.

2. Select the item with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.

Sys.C.

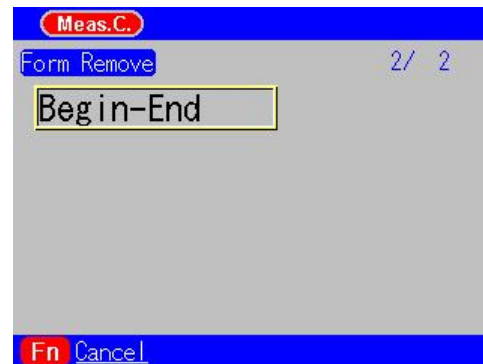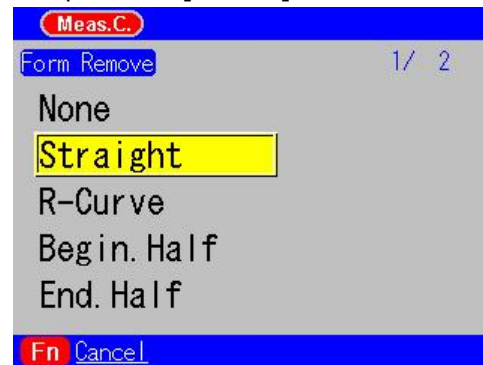USB Memory Save Type

Text
Binary
Text & Binary

Fn Cancel
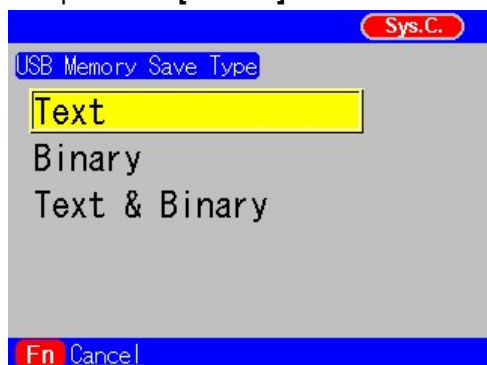
Text: A file in the ASCII format that can be displayed on PCs. However, this instrument cannot load this format. The file size varies depending on the selected output items up to approximately 540K bytes.

Binary: This instrument can only load this format. The file size is approximately 65K bytes.

9-5   Recalculation

Recalculate the measurement data in the Recalculation screen.

● Executing recalculation
1. Press the **[MENU]** button, and select **"Re-Cal."** using the **[►]** and **[◄]** buttons and press the **[ENTER]** button.

◄ Re-Cal. Setting File ►

Recalculation

ENTER Execution of recalculation.
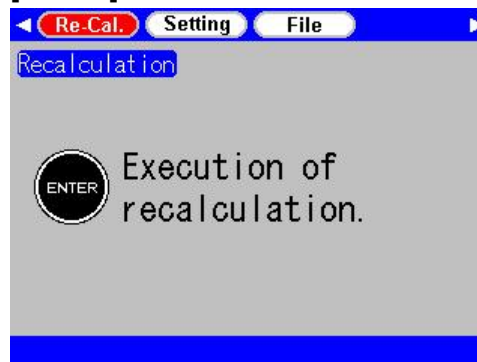
☞ Analysis conditions can be changed to execute recalculation for this instrument. The data currently displayed is recalculated.

9-6　Various settings

Configure the display magnification, sleep function, and other various settings in the Various Settings screen.

Item	Description
V-Mag	Set the vertical magnification for displaying and printing form curves.
H-Mag	Set the horizontal magnification for displaying and printing form curves.
Sleep ON/OFF	Set the time until a sleep state is entered.
Date/Time	Set the date and time.
Previous Data Auto Loading	Set whether or not to load the previous data automatically upon power-on.
Initialize	Initialize the system information such as measurement conditions and analysis conditions.
Maintenance	Set display of version No. and connected device information, and communication conditions.

● Displaying the Various Settings screen
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons.
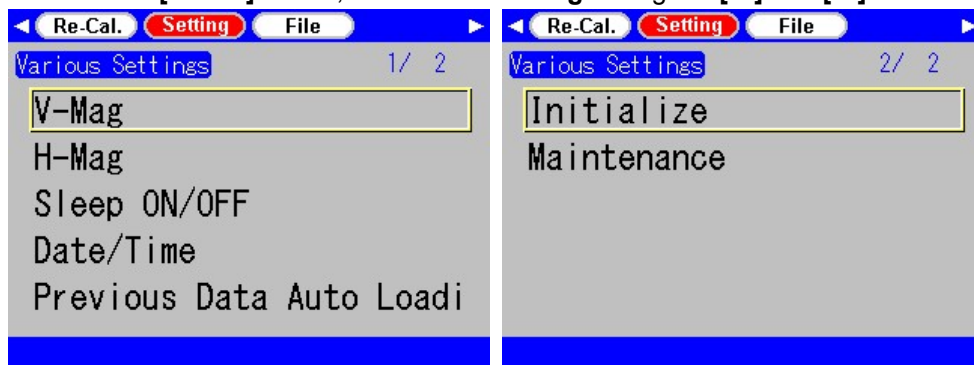
9-6-1　Vertical magnification

Set the vertical magnification for displaying and printing form curves (profile curves, roughness curves, and waviness profile curves).

● Setting the vertical magnification
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"V-Mag"** and press the **[ENTER]** button.

2. Select the item with the **[▲], [▼], [►], and [◄]** buttons, and press the **[ENTER]** button.
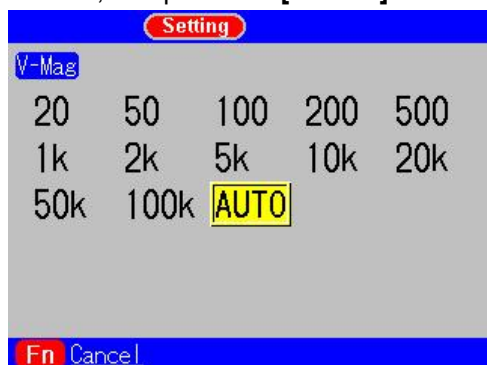

☞　For V-Mag AUTO, select the maximum magnification that can display the whole shape within the height of the profile frame.

9-6-2　Horizontal magnification

Set the horizontal magnification for displaying and printing form curves (profile curves, roughness curves, and waviness profile curves).

● Setting the horizontal magnification
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"H-Mag"** and press the **[ENTER]** button.

2. Select the item with the **[▲], [▼], [►], and [◄]** buttons, and press the **[ENTER]** button.
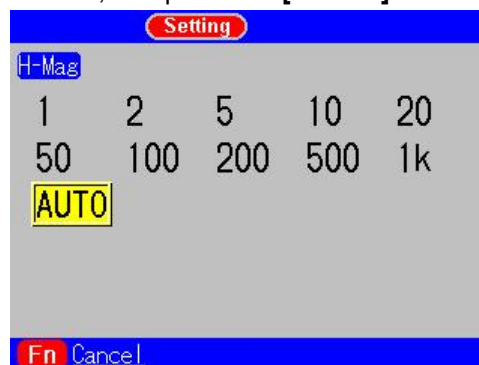
☞　For H-Mag AUTO, select the maximum magnification where the total recorded shape length falls within the range of 180 mm.

9. Menu

9-6-3 Sleep function

The sleep function saves power consumption in non-operating state where the power is kept turning on.
If you do not operate any button on the operating panel during the preset time, a sleep state is entered. The sleep state can be released by pressing a button.

● Setting the time until a sleep state is entered

1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]**buttons, select **"Sleep ON/OFF"** and press the **[ENTER]** button.

2. Select the item with the **[▲], [▼], [►], and [◄]** buttons, and press the **[ENTER]** button.
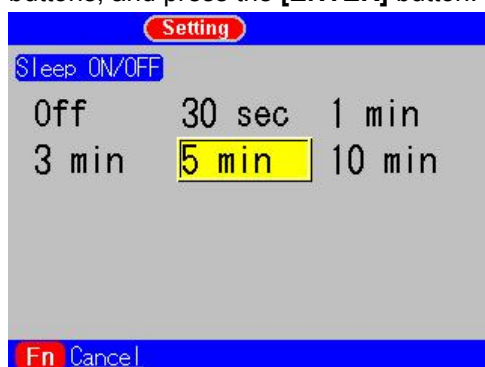
9-6-4 Date/time settings

Set the date and time.

● Setting the date and time

1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Date/Time"** and press the **[ENTER]** button.

2. Select the item with the **[►]** and **[◄]** buttons, and configure it with the **[▲]** and **[▼]** buttons.
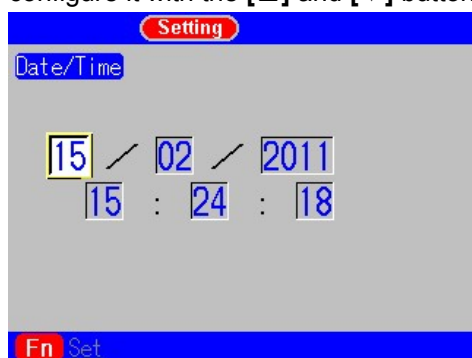
[►]: Moves the cursor in the order of
Year→Month→Date→Hour→Minute→Second.

[◄]: Moves the cursor in the reverse order, that is,
Year←Month←Date←Hour←Minute←Second.

[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

9-6-5 Previous data auto loading

Set whether to display, upon power-on, the measurement data displayed when the power was turned off last time.

● Setting previous data auto loading

1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Previous Data Auto Loading"** and press the **[ENTER]** button.

2. Select **"ON/OFF"** with the **[▲] and [▼]** buttons, and press the **[ENTER]** button.
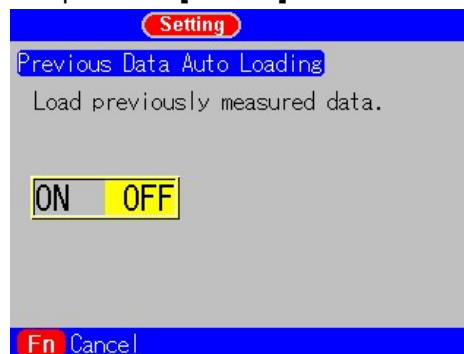
9-6-6 Initialization

The "Initialize" menu initializes the following items.

<Initialized items>
Measurement condition information/Analysis condition information/Output parameter information/ System information (excluding language and display unit)/
Various setting information (excluding sleep function and date/time setting)

☞ For the initial value of each initialized item, see **Section 16-3 List of initial values**.

● Initializing various system conditions

1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Initialize"** and press the **[ENTER]** button.

2. Press the **[ENTER]** button.
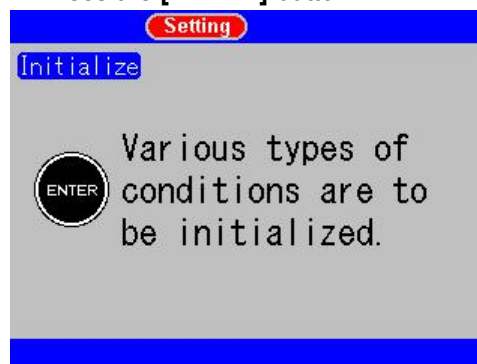
9-6-7 Maintenance

In the maintenance screen, set display of version No. and connected device information, and communication conditions.

9-6-7-1 Version No.

● Displaying the version No.
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Maintenance"** and press the **[ENTER]** button.

☞   You can also check **"Version No."** in the startup screen and the header of printed paper.

9-6-7-2 Connected devices

● Displaying the connected device information
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Maintenance"** and press the **[ENTER]** button.

☞   When no device is connected, the screen displays "Not connected".

9-6-7-3 Communication conditions

If you install on to your PC the USB driver attached to this instrument, this instrument can communicate with the PC via USB cable. In that case, you must set the same communication conditions for both the PC and this instrument.

● Setting the communication conditions
1. Press the **[MENU]** button, and select **"Setting"** using the **[►]** and **[◄]** buttons. Using the **[▲]** and **[▼]** buttons, select **"Maintenance"** and press the **[ENTER]** button.

2. Select "Communication condition" with the **[▲]** and **[▼]** buttons, and press the **[ENTER]** button.

3. Select the item with the **[▲]** and **[▼]** buttons, and configure it with the **[►]** and **[◄]** buttons.
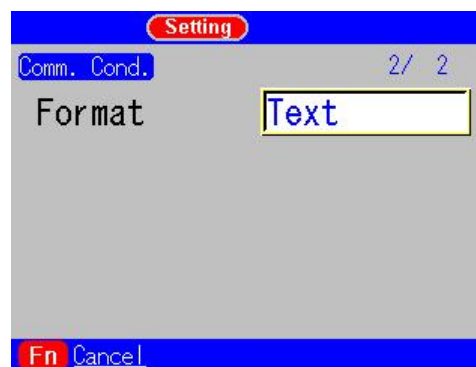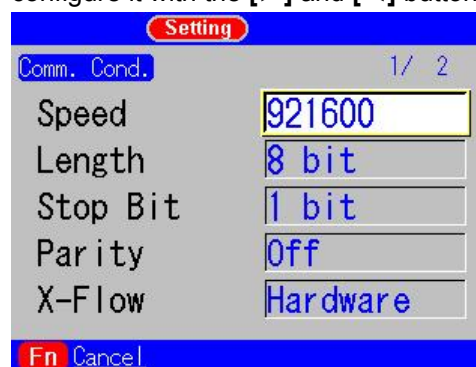
<Selectable items>
Speed: 9600/19200/38400/56700/
              230400/460800/921600
Data length: 7 bits/8 bits
Stop bit: 1 bit/2 bits
Parity :   Even/Odd/None
X-Flow: Hardware/On/Off
Format: Text/SPC/Hex

9-7 Save/Load

In the Save/Load screen, you can save to the internal memory or USB memory sticks the measurement data currently displayed and various conditions that have been configured. You can also load the data stored in the internal memory and USB memory sticks.

Item	Description
Internal Memory	Saves or loads measurement data or measurement conditions to/from the internal memory.
USB Memory	Saves or loads measurement data or measurement conditions to/from a USB memory stick.
Internal Mem to USB Mem	Copies data in the internal memory to a USB memory stick.

● Displaying the Save/Load screen

1. Press the **[MENU]** button, and select "File" with the **[►]** and **[◄]** buttons.

9-7-1 Internal memory

This menu enables you to save current measurement data and configured various conditions to the internal memory. You can also load the data stored in the internal memory.

Item	Description
Save Meas. Data	Saves the measurement data to the internal memory.
Save Meas. Data	Load the measurement data from the internal memory.
Save Meas. Condition	Saves the measurement conditions to the internal memory.
Load Meas. Condition	Load the measurement conditions from the internal memory.

● Displaying the Internal Memory screen

1. Press the **[MENU]** button, and select **"File"** with the **[►]** and **[◄]** buttons. Select **"Internal Memory"** with the **[▲]** and **[▼]** buttons.
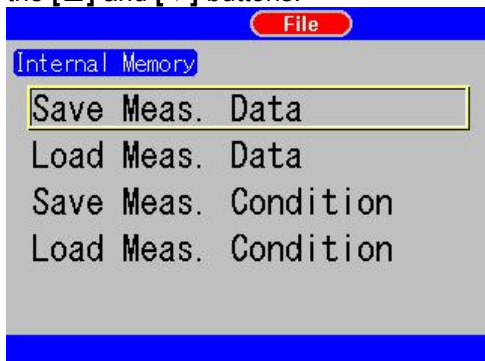
☞ For information about operating the internal memory, see **Section 11-1 Internal Memory**.

9-7-2 USB memory

This menu enables you to save current measurement data and configured various conditions to USB memory sticks. You can also load the data stored on USB memory sticks.

Item	Description
Save	Saves measurement data or conditions to a USB memory stick.
Load-Delete	Load function Load the measurement data or conditions from a USB memory stick.
	Delete function Deletes measurement data or conditions in a USB memory stick.
Removal	Makes it possible to remove the USB memory stick.

● Displaying the USB Memory screen

1. Press the **[MENU]** button, and select **"File"** with the **[►]** and **[◄]** buttons. Select **"USB Memory"** with the **[▲]** and **[▼]** buttons.
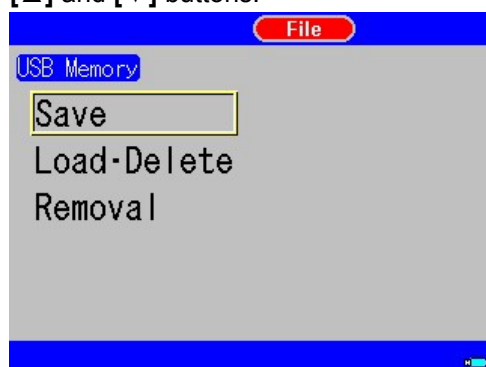
☞   For operation of the USB memory sticks, see **Section 11-2 USB Memory**.

9-7-3 Internal memory to USB memory

This menu enables you to copy data in the internal memory to a USB memory stick.

Item	Description
Meas. Data Whole Copy	Copies all measurement data in the internal memory to a USB memory stick.
Meas. Cond. Whole Copy	Copies all measurement conditions in the internal memory to a USB memory stick.

● Displaying the Internal Mem to USB Mem screen

1. Press the **[MENU]** button, and select **"File"** with the **[►]** and **[◄]** buttons. Select **"Internal Mem to USB Mem"** with the **[▲]** and **[▼]** buttons.
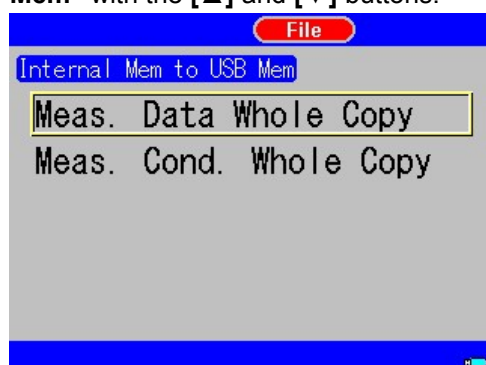
☞   For operation of the Internal Mem to USB Mem, see **Section 11-3 Internal Mem to USB Mem**

10. Print Output

The print output prints measurement conditions and results. Items that are printed are output items and output parameters that are specified in **9-3 Output selection**. The printable items of the output items and output parameters vary depending on the measurement type and standard.

The following are printable items of the output items and output parameters.

● List of printable items of output items
<Profile>
○: Print can be specified. ×: Print cannot be specified.

Standard / Output Items	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Measurement date	○	○	○	○	○
Measurement Condition	○	○	○	○	○
Parameter + Section	○	○	○	○	○
BAC Graph (P)	○	×	○	○	×
BAC Graph (R)	×	×	×	×	×
BAC Graph (WC)	×	×	×	×	×
ADC Graph (P)	○	×	○	○	×
ADC Graph (R)	×	×	×	×	×
ADC Graph (WC)	×	×	×	×	×
Profile Curve	○	○	○	○	○
Roughness Curve	×	×	×	×	×
Filtered Waviness Curve	×	×	×	×	×
Waviness Profile Curve	×	×	×	×	×
ISO13565 Curve	×	×	×	×	×
Roughness Motifs	×	×	×	○	×
Waviness Motifs	×	×	×	○	×

<Roughness Measurement>
○: Print can be specified. ×: Print cannot be specified.

Standard / Output Items	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Measurement date	○	○	○	○	○
Measurement Condition	○	○	○	○	○
Parameter + Section	○	○	○	○	○
BAC Graph (P)	○	×	○	○	×
BAC Graph (R)	×	○	○	×	○
BAC Graph (WC)	×	×	×	×	×
ADC Graph (P)	○	×	○	○	×
ADC Graph (R)	×	○	○	×	○
ADC Graph (WC)	×	×	×	×	×
Profile Curve	○	○	○	○	○
Roughness Curve	○	○	○	×	○
Filtered Waviness Curve	×	×	×	×	×
Waviness Profile Curve	×	×	×	×	×
ISO13565 Curve	×	×	○	×	○
Roughness Motifs	×	×	×	○	×
Waviness Motifs	×	×	×	○	×

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45

<Waviness profile curve with no λf>

○: Print can be specified. ×: Print cannot be specified.

Standard / Output Items	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Measurement date	○	○	○		○
Measurement Condition	○	○	○		○
Parameter + Section	○	○	○		○
BAC Graph (P)	×	×	○		×
BAC Graph (R)	×	×	×		×
BAC Graph (WC)	×	×	×		×
ADC Graph (P)	×	×	○		×
ADC Graph (R)	×	×	×		×
ADC Graph (WC)	×	×	×		×
Profile Curve	○	○	○		○
Roughness Curve	×	×	×		×
Filtered Waviness Curve	○	○	○		○
Waviness Profile Curve	×	×	×		×
ISO13565 Curve	×	×	×		×
Roughness Motifs	×	×	×		×
Waviness Motifs	×	×	×		×

<Waviness profile curve with λf>

○: Print can be specified. ×: Print cannot be specified.

Standard / Output Items	JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Measurement date	○	○	○		○
Measurement Condition	○	○	○		○
Parameter + Section	○	○	○		○
BAC Graph (P)	×	×	○		×
BAC Graph (R)	×	×	×		×
BAC Graph (WC)	×	×	○		×
ADC Graph (P)	×	×	○		×
ADC Graph (R)	×	×	×		×
ADC Graph (WC)	×	×	○		×
Profile Curve	○	○	○		○
Roughness Curve	×	×	×		×
Filtered Waviness Curve	○	○	○		○
Waviness Profile Curve	○	○	○		○
ISO13565 Curve	×	×	×		×
Roughness Motifs	×	×	×		×
Waviness Motifs	×	×	×		×

☞ The printable items of the output parameters are specified in **9-3-1 Output items**.

10. Print Output

● List of printable items of output parameters

<Profile>

Standard				
JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Rmax	Rmax	Pa	R	Pt
Rz	Rz.J	Pq	Rx	Rz.J
AVH	AVH	Pt	AR	AVH
Hmax	Hmax	Rz.J	W	Hmax
Hmin	Hmin	AVH	Wx	Hmin
Tp		Hmax	AW	
Rk		Hmin	Wte	
Rpk		Pmr	Mr	
Rvk			Rke	
Mr1			Rpke	
Mr2			Rvke	
Vo			Mr1	
K			Mr2	
			Vo	
			K	

<Roughness Measurement>

Standard				
JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
Ra	Ra	Ra	R	Ra
Rmax	Rmax	Pa	Rx	Pt
Rz	Rz.J	Pq	AR	Rz.J
Rq	Ry	Pt	W	Rz
Rp	Rz	Rz.J	Wx	Rmax
Rt	Sm	Rz	AW	RSm
Pc	Rq	Rzmax	Wte	RSm
AVH	Rp	RSm	Mr	Rq
Hmax	Rt	Rq	Rke	Rpm
Hmin	Pc	Rp	Rpke	Rp
Tp	AVH	Rt	Rvke	Rt
Rk	Hmax	R3z	Mr1	Pc
Rpk	Hmin	Pc	Mr2	AVH
Rvk	Tp	AVH	Vo	Hmax
Mr1	Rk	Hmax	K	Hmin
	Rpk	Hmin		Rmr
	Rvk	Pmr		Rk
	Mr1	Rmr		Rpk
	Mr2	Rk		Rvk
	Vo	Rpk		Mr1
	K	Rvk		Mr2
		Mr1		Vo
		Mr2		K
		Vo		
		K		

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45.

< Waviness profile curve with λf >

Standard				
JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
WC-a	Wa	W-a		W-a
WC-q	Wq	W-q		W-q
WCM	WCM	W-t		W-t
WC-p	Wp	W-p		W-p
WC-v	Wv	W-v		W-v
WC-Sm	WSm	W-Sm		W-Sm
WCA	WCA	Wa		Wa
WCC-q	WC-q	Wq		Wq
WCC-m	WC-t	Wt		Wt
WCC-p	WC-p	Wp		Wp
WCC-v	WC-v	Wv		Wv
WCC-Sm	WC-Sm	WSm		WSm
		Wz		
		Wmr		

< Waviness profile curve with no λf >

Standard				
JIS'82	JIS'94	JIS'01/ ISO'97/ DIN	CNOMO	ASME'95/ ASME'02
WC-a	Wa	W-a		W-a
WC-q	Wq	W-q		W-q
WCM	WCM	W-t		W-t
WC-p	Wp	W-p		W-p
WC-v	Wv	W-v		W-v
WC-Sm	WSm	W-Sm		W-Sm

☞ The printable items of the output parameters are specified in **9-3-2 Output parameters**.

10-1 Print output of measurement results

● Printing measurement results
1. Press **[PRINT]**.

☞   During printing, your only choice is to stop print output.
☞   Printing is possible only if measurement data exists.
☞   If a message display appears, **see 16-2 List of messages**.

● Interrupting printing
1. Press **[PRINT]** during printing.

10-2 Results of print output

This section explains printed measurement results.

<Print image of results of print output>

```
    ACCRETECH        Ver.1.05
    SURFCOM FLEX-50A

Date: Jan/13/2011
Time: 15:23:46

Roughness Measurement
(JIS '01/ISO '97/DIN)

Evaluation Length:   4.00 mm
Measure speed:       0.3 mm/s
Cutoff value:        0.8 mm
Filter type:         Gaussian
Measure range:       ±400.0 µm
Form remove:         Line
Cutoff value:        300

Upper Limit of Pc:  10.00 µm
Lower Limit of Pc: -10.00 µm
Reference height of step:
                    50.00 µm
Delete length of step:
                    30 µm

 Ra:                0.498 µm ○
 Ra:                0.518 µm ↑
*Pq:                0.510 µm ●
  ↓
```

(1) Version Information
The version of software

(2) Measurement date
Date and time when the measurement was made.

(3) Measurement conditions
Include measurement type, evaluation length. measure speed and others.

(4) Analysis conditions
Include peak count condition, BAC graph cut level, and others.

(5) Output parameters
Output parameters are various parameter values.

☞   Items that have been specified in the parameter selection display are output.

(6) Results of judgment
Information about results of judgment.

○ : Passed
↑ : Failed because the value is greater than the upper limit value.
↓ : Failed because the value is less than the lower limit value.
● : Failed in 16%rule

(7) Calculation partly failed.
An asterisk (*) appears if it is not possible to perform calculations within the section of one standard length, or if there are not enough peaks and valleys to carry out the calculation.
The calculation result marked with an asterisk (*) is to be handled as a reference value.

10. Print Output

<Printed image of profile curve, roughness curve, and ISO13565 profile>

<Printed image of waviness profile curve and filtered profile curve>

110

<Printed image of BAC graph (P, R, WC) and ADF graph (P, R, WC)>

<Printed image of roughness motif and waviness motif>

10. Print Output

<Printed image of section parameters>

```
         ACCRETECH         Ver.1.05
         SURFCOM FLEX-50A

     Judgment method: 16% rule
     Ra    :      5.411 µm●
     Ramax :      5.457 µm
     Ra+sd :      5.442 µm
     Ra-sd :      5.380 µm
     Ra-1  :      5.413 µm↑
     Ra-2  :      5.430 µm↑
     Ra-3  :      5.457 µm↑
     Ra-4  :      5.382 µm↑
     Ra-5  :      5.373 µm↑
     Rz    :     21.194 µm●
     Rzmax :     21.552 µm
     Rz+sd :     20.461 µm
     Rz-sd :     21.927 µm
     Rz-1  :     21.552 µm↑
     Rz-2  :     21.072 µm↑
     Rz-3  :     20.896 µm↑
     Rz-4  :     20.976 µm↑
     Rz-5  :     21.472 µm↑
     RSm   :    245.010 µm●
     RSmmax:    248.700 µm
     RSm+sd:    250.118 µm
     RSm-sd:    239.902 µm
     RSm-1 :    248.700 µm↓
     RSm-2 :    247.650 µm↓
     RSm-3 :    245.400 µm↓
     RSm-4 :    248.250 µm↓
     RSm-5 :    235.050 µm↓
```

(1) Section parameters
These are section parameters values.

(2) Parameter judgment results
These are results of parameter judgment.
The displayed values are the results of the judgment made on the parameters based on the 16% rule.

112

11. Saving Data to and Loading Data from Memory

This chapter explains how to save, load, and delete measurement conditions and data, and how to make a bulk copy of measurement conditions and data that are saved in the internal memory onto a USB memory stick.
Measurement conditions to be saved in the internal memory and/or USB memory can be used as a backup of current set data. Loading such conditions saved in the internal memory and/or USB memory would serve to restore the set value for the entire system.
In the Measurement conditions (including system and analysis conditions) are saved all the data except for the following;
● Currently displayed language data
● Currently displayed display unit data (mm/inch)
● Currently set Sleep time.

11-1 Internal memory

Measurement data that is acquired with this instrument or specified measurement conditions can be saved in the internal memory. You can also load saved data to display it again.

11-1-1 Using the internal memory

The internal memory is used to save measurement conditions that are used on a daily basis and to temporarily save measurement data.

⚠ **The measurement data saved in the internal memory will be lost if the battery runs out.**
Caution **Be sure to save valuable data onto a USB memory stick.**

11-1-2 Saving measurement data

● Up to 29 measurement data items can be saved in the internal memory. (Numbers 1-29)
● The latest measurement data is automatically saved in a system specific area. (Number L)
● All the data you saved can be cleared simultaneously.

<Description of the Save Meas. Data screen>
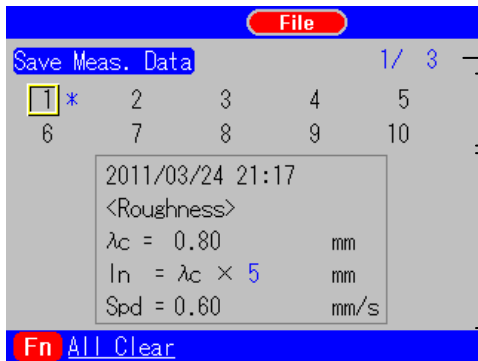
(1) Page number
Page number of the saving screen.

(2) Storage condition
Indicates how data has been saved. An asterisk (*) next to a number indicates that data has been saved.

(3) Overview of saved data
Provides an overview of data to be saved.
(Measurement date, measurement type, cutoff value, evaluation length. and measure speed are displayed from top to bottom in that order.)
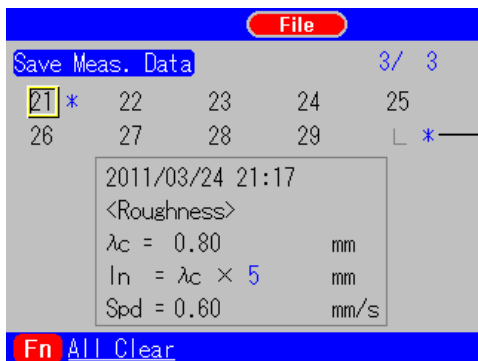
(4) Status of latest measurement data storage
"L *" is a system specific area that automatically saves the latest measurement data.

11. Saving Data to and Loading Data from Memory

11-1-2-1 Saving measurement data

● This section explains how to save measurement data in the internal memory.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"Internal Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Save Meas. Data"** and press **[ENTER]**.

4. Using **[▲], [▼], [►], and [◄]**, select **the number of the internal memory to save data to** and press **[ENTER]**.
An asterisk (*) appears next to the number of the selected destination and the data saving process finishes.
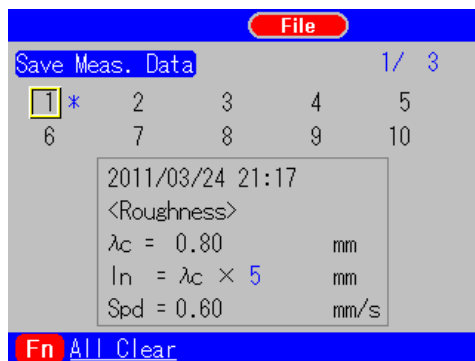
[►]: Moves the cursor to the right one item.
[◄]: Moves the cursor one item to the left.
[▲]: Moves the cursor up one item or moves to the previous page.
[▼]: Moves the cursor down one item or moves to the next page.
[Fn] + [▲]: Moves to the previous page.
[Fn] + [▼]: Moves to the next page.

☞   Select **the number of the internal memory to save data to** marked with an asterisk (*) and press **[ENTER]**. A confirmation message appears, asking you to confirm that you want to overwrite the destination. If you do want to overwrite the destination, press **[ENTER]**. If you do not want to overwrite it, press **[BACK]**.
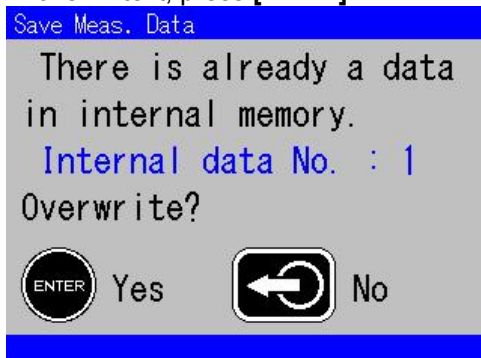
11-1-2-2 Clearing all measurement data

● This section explains how to clear all measurement data stored in the internal memory.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"Internal Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Save Meas. Data"** and press **[ENTER]**.

4. Press **[Fn]** and then press **[ENTER]**.
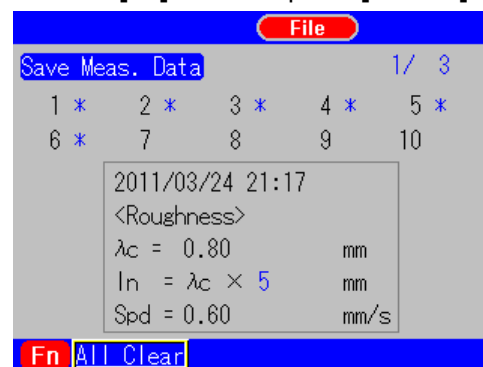
☞   Select ALL clear, when pressed **[ENTER]**, the measuring data ALL clear confirmation messages are displayed. When clearing all measured data, press **[ENTER]**, and when not clearing it, press **[BACK]**.
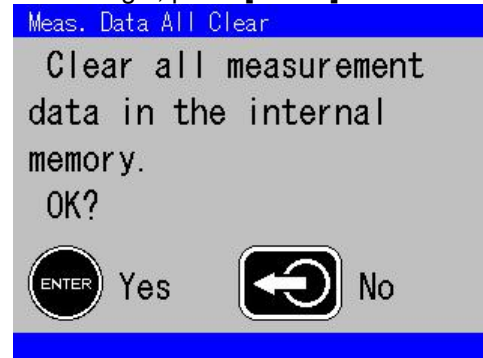
11-1-3 Loading measurement data

● Saved measurement data can be loaded to display it again.

<Description of the Save Meas. Data screen>
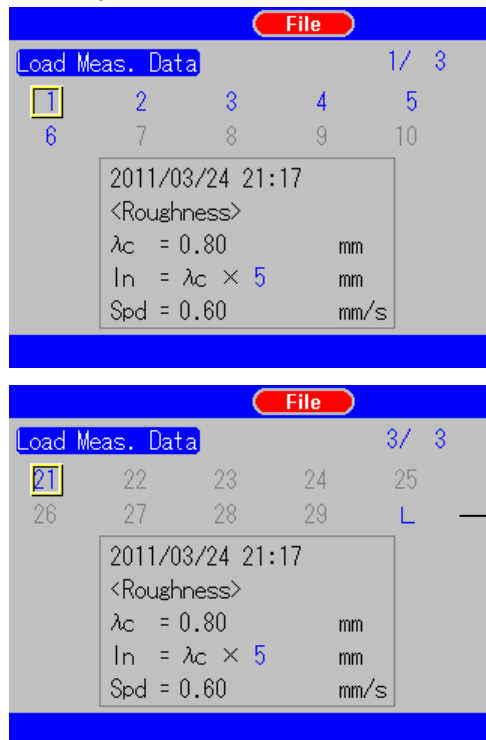
(1) Page number
Page number of the Save Meas. Data screen.

(2) Storage condition
Indicates how data has been saved. The number is displayed in blue if data has been saved. The number is displayed in gray if data has not been saved.

(3) Overview of saved data
Selecting a saved number gives you an overview of saved data.
(Measurement date, measurement type, cutoff value, evaluation length. and measure speed are displayed from top to bottom in that order.)

(4) Status of latest measurement data storage
"L" is a system specific area that automatically saves the latest measurement data. Measurement data is displayed in blue if it has been saved.

11-1-3-1 Loading measurement data

● This section explains how to load measurement data from the internal memory.

⚠ **Caution** **If the current connection drive differs from measurement data that performs loading and the drive type in the measurement condition, it is not possible to load the measurement data and measurement condition.**
If the driver is not connected, you can also load the measurement data and measurement condition.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"Internal Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Save Meas. Data"** and press **[ENTER]**.

☞ The settings for each of the condition setting screens are replaced with the loaded content.

4. Using **[▲], [▼], [►], and [◄]**, select **"the number of the internal memory to load data from"** and press **[ENTER]**.
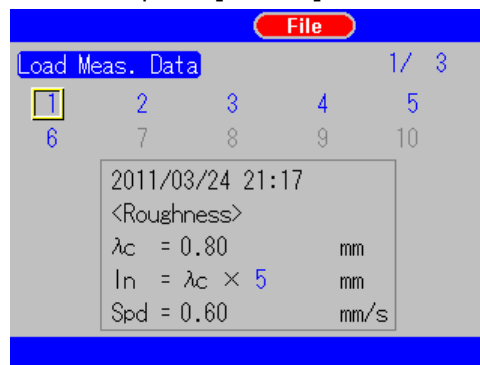
[►]: Moves the cursor one item to the right.
[◄]: Moves the cursor to the left one item.
[▲]: Moves the cursor up one item or moves to the previous page.
[▼]: Moves the cursor down one item or moves to the next page.
[Fn] + [▲]: Moves to the previous page.
[Fn] + [▼]: Moves to the next page.

5. Measurement results reappear on the measurement result screen.

11. Saving Data to and Loading Data from Memory

11-1-4 Saving measurement conditions

● Up to five measurement conditions can be saved in the internal memory.
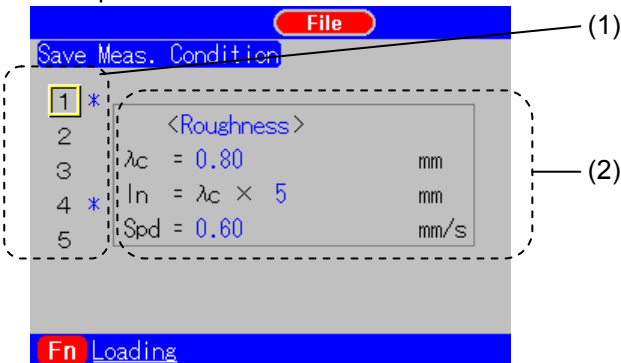
<Description of the Save Meas. Condition screen>

 — (1)

— (2)

(1) Storage condition
Indicates how data has been saved. An asterisk **(*)** next to a number indicates that data has been saved.

(2) Overview of saved data
Provides an overview of data to be saved. (Measurement type, cutoff value, evaluation length. and measure speed are displayed from top to bottom in that order.)

11-1-4-1 Saving measurement conditions

● This section explains how to save measurement conditions in the internal memory.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"Internal Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Save Meas. Condition"** and press **[ENTER]**.

4. Using **[▲] and [▼]**, select **the number of the internal memory to save data to** and press **[ENTER].**
An asterisk (*) appears next to the number of the selected destination and the data saving process finishes.
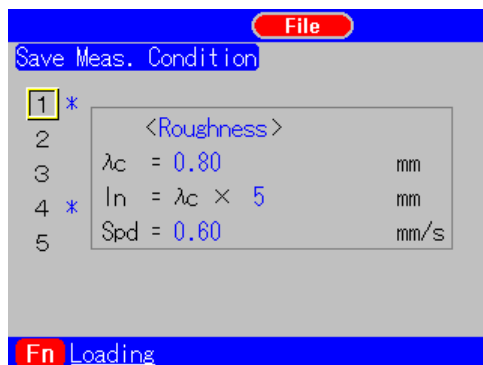
☞ If a number that is marked with an asterisk (*) is selected, it will be overwritten.
☞ To move to the Load Meas. Condition screen, press **[Fn]**, select **"Loading"** using **[►] and [◄]**, and then press **[ENTER]**.

116

11-1-5 Loading measurement conditions

● You can load a saved measurement conditions to display it again.

<Description of the Save Meas. Condition screen>
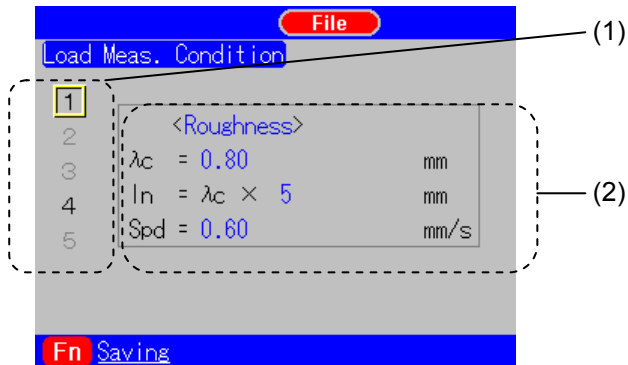
(1) Storage condition
Indicates how data has been saved. The number is displayed in black if there is saved data. The number is displayed in gray if data has not been saved.

(2) Overview of saved data
Selecting a saved number gives you an overview of saved data.
(Measurement type, cutoff value, evaluation length. and measure speed are displayed from top to bottom in that order.)

11-1-5-1 Loading measurement conditions

● This section explains how to load measurement conditions from the internal memory.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"Internal Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Load Meas. Condition"** and press **[ENTER]**.

4. Using **[▲] and [▼]**, select **the number of the internal memory to load data from** and press **[ENTER]**.
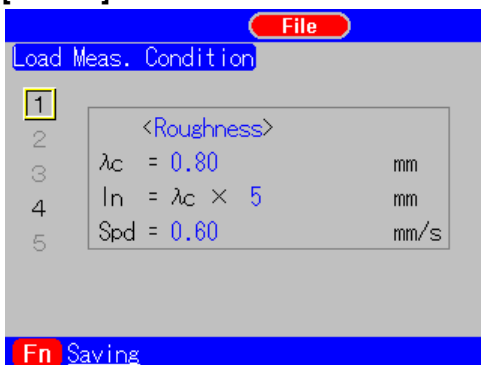
☞   To move to the Save Meas. Condition screen, press **[Fn]**, select **"Saving"** using **[►] and [◄]**, and then press **[ENTER]**.

5. The settings for each of the condition setting screens are replaced with the loaded content.

11. Saving Data to and Loading Data from Memory

11-2 USB memory stick

Measurement or vibration data that is acquired with this instrument or measurement conditions specified can be saved on a USB memory stick. You can also load saved data to display it again.

11-2-1 Using a USB memory stick

A USB memory stick is used to save and load measurement data, measurement conditions, and vibration data.

⚠️ **Warning** **When a USB memory stick is being accessed (save, load, or delete operation is in progress), do not remove the USB memory stick or battery. Do not turn off the power.**

⚠️ **Caution** **Be sure to save valuable data on a USB memory stick rather than in the internal memory and backup it in other storage media.**

⚠️ **Caution** **When removing the USB memory stick, follow the procedure described in 11-2-4, Removing.**

⚠️ **Caution** **To format a USB memory stick, choose FAT32 format with your PC. Be sure to format a commercial USB memory stick for proper operation.**

● **File saving formats**
Two types of files, binary and text formats, can be saved on a USB memory stick.
Use an appropriate format to your intended use.

File format	Use
Binary	Data that has been saved in binary can be loaded by this instrument to display it again. ☞ Data in text format can be created from data in binary format through two steps of operation (loading of binary data and saving data in text). (File size: Approximately 65K bytes)
Text	If you want to check measurement results on your PC, save them in text format. ☞ Data in text format cannot be loaded by this instrument. (Maximum file size: Approximately 540K bytes)

● **Destination folder**
Create a folder named "SFLEX" below the root folder of the USB memory and create a subfolder based on the appropriate file type.

Root (USB memory)

📁 **SFLEX**

📁 **MEASDATA_B** - A folder that holds measurement data in binary format.

📁 **MEASDATA_T** - A folder that holds measurement data in text format.

📁 **MEASCOND_B** - A folder that holds measurement conditions in binary format.

📁 **VIBDATA_B** - A folder that holds vibration data in binary format.

📁 **VIBDATA_T** - A folder that holds vibration data in text format.
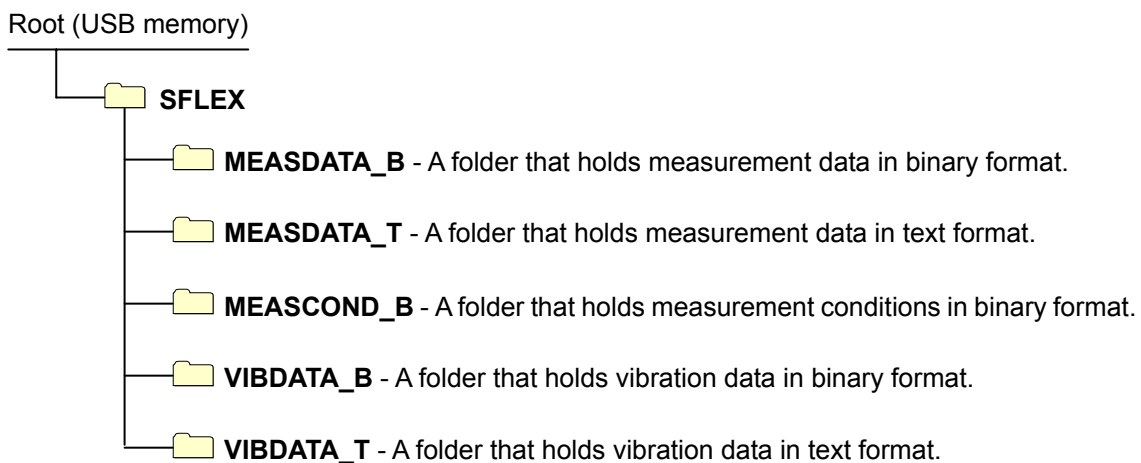
● **Names of files to be saved and maximum number of files to be saved**
The names of files to be saved and the maximum number of files to be saved vary depending the file type.

File type	Name of file to be saved	Maximum number of files to be saved
Measurement data, binary	DATA****.DT	500
Measurement data, text	DATA****.TXT	500
Measurement condition, binary	DATA****.CD	500
Vibration data, binary	DATA****.VB	500
Vibration data, text	DATA****.TXV	500

☞ Replace "****" in the name of file to be saved with a number (0001 to 9999).

11-2-2 Saving

● Measurement data, measurement condition, and vibration data can be saved on a USB memory stick.

<Description of the Save USB Memory screen>
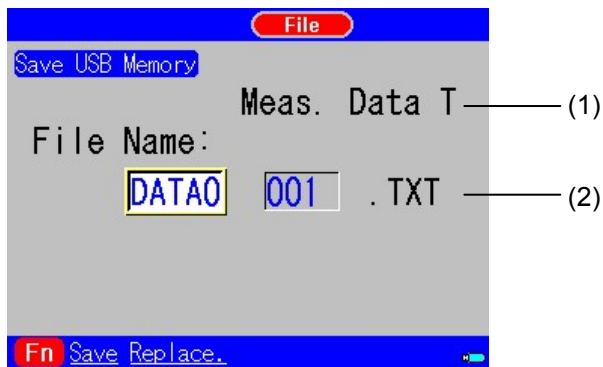
(1) File format
The data format of the file.
   <Symbol>
    T: Text format
    B: Binary format

(2) Name of file to be saved
A name of the file to be saved. Select one from DATA0 to DATA9 and a number from 001 to 999 as a file name. File extension is fixed based on the selected data type and data format.

11-2-2-1 Saving various data

● This section explains how to save various data onto a USB memory stick.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"USB Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Save"** and press **[ENTER]**.

4. Press **[Fn]**, and select "Replace" using **[►] and [◄]**.
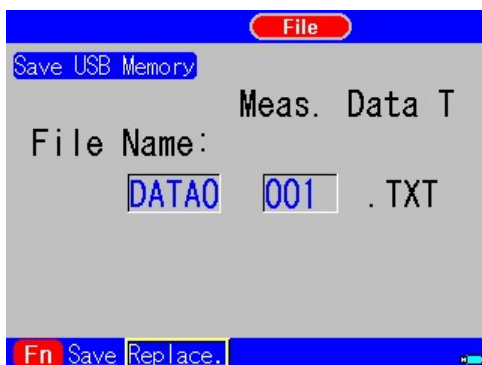
5. Press **[ENTER]** and select the format of file you want to save.

☞ The following file formats can be selected.
Measurement data B: Measurement data file in binary format
Measurement data T: Measurement data file in text format
Measurement condition B: Measurement condition file in binary format
Vibration data B: Vibration data file in binary format
Vibration data T: Vibration data file in text format

6. Press **[Fn]** and specify the name of file you want to save using **[▲], [▼], [►], and [◄]**.
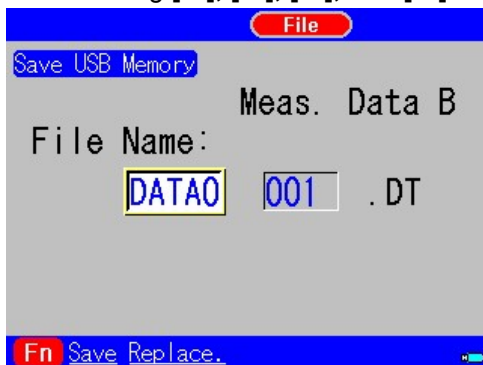
[►]: Moves the cursor one item to the right.
[◄]: Moves the cursor one item to the left.
[▲]: Increments the current value by one.
[▼]: Decrements the current value by one.

7. Press **[Fn]**, select **"Save"** using **[►] and [◄]**, and press **[ENTER]**.
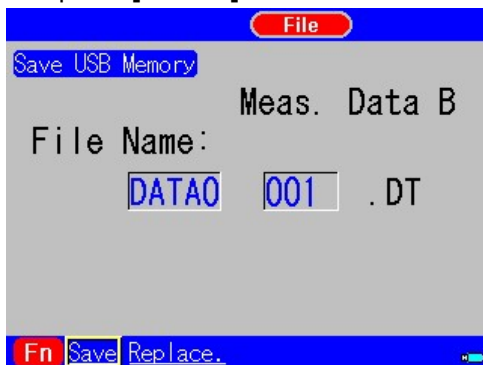
When the data has been successfully saved, the following message appears.

☞   When the selected files exist in the USB memory, the overwriting confirmation messages are displayed. When overwriting, press **[ENTER]**, and when not overwriting, press **[BACK]**.

11-2-3 Loading or deleting data

● You can load saved measurement or vibration data to display it again.
● Unwanted data can be deleted.

<Description of the Load USB Memory screen>
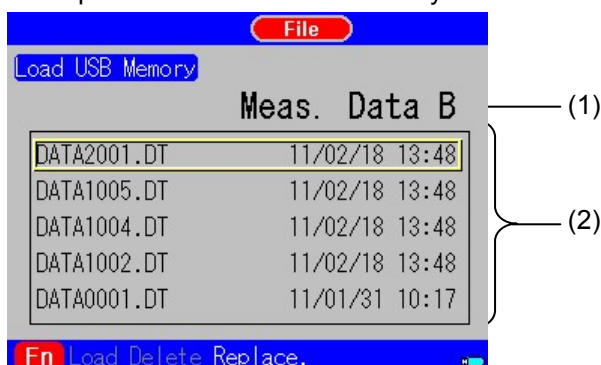
(1) File format
The data format of the file.
 <Symbol>
  T: Text format
  B: Binary format

(2) List of files
A list of files that can be loaded or deleted.
(File names and date and time the files were saved are displayed from left to right in that order.)

☞   Data in text format cannot be loaded. Data in text format can only be deleted.

11-2-3-1 Loading various data

● This section explains how to load various data from a USB memory stick.

⚠️ **Caution** **If the current connection drive differs from measurement data that performs loading and the drive type in the measurement condition, it is not possible to load the measurement data and measurement condition.**
If the driver is not connected, you can also load the measurement data and measurement condition.

1. Press **[MENU]**, and select "File" using **[▶] and [◀]**.

2. Using **[▲] and [▼]**, select **"USB Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Load-Delete"** and press **[ENTER]**.

4. Press **[Fn]**, and select "Replace" using **[▶] and [◀]**.
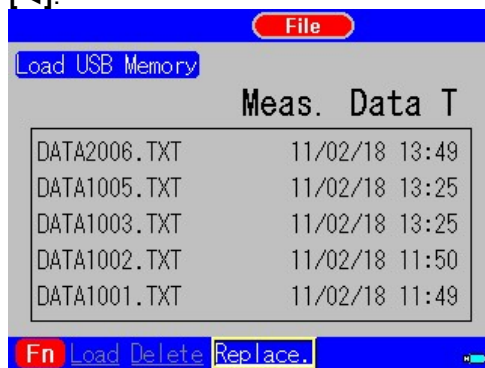
5. Press **[ENTER]** and select the format of file you want to load.

☞ The following file formats can be selected.
Measurement data B: Measurement data file in binary format
Measurement condition B: Measurement condition file in binary format
Vibration data B: Vibration data file in binary format

6. Press **[Fn]**, select the file you want to load using **[▲], [▼], [▶], and [◀]**, and press **[ENTER]**.
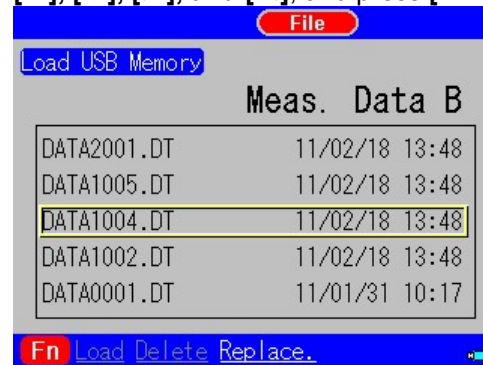
[▶]: Moves to the next page.
[◀]: Moves to the previous page.
[▲]: Moves the cursor up one item.
[▼]: Moves the cursor down one item.
[Fn] + [▶]: Moves to the 10th page.
[Fn] + [◀]: Moves back to the 10th page.

7. Press **[Fn]**, select **"Load"** using **[▶] and [◀]**, and press **[ENTER]**.
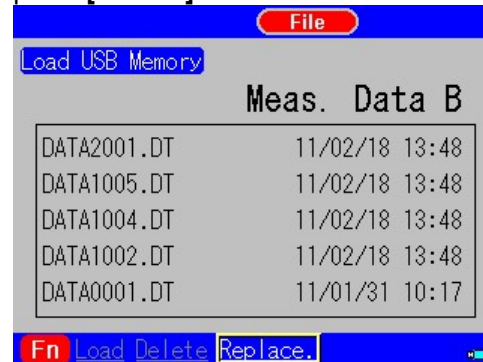
Based on the data loaded, the following screen appears.

(1) For measurement data B, an analysis process is executed and the Result screen appears.
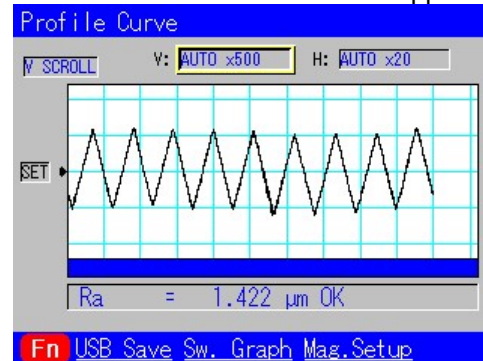
☞ The settings for each of the condition setting screens are replaced with the loaded content.

11. Saving Data to and Loading Data from Memory

(2) For measurement condition B, a message screen appears.

```
  Loaded data in the USB
memory.



Please push 【BACK】 key.
```
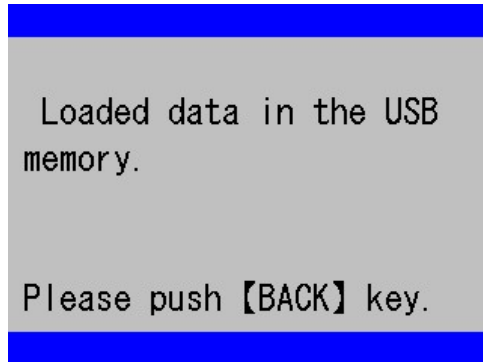
(3) For vibration data B, an analysis process is executed and the Record of Vibration screen appears.

Record of Vibration
50A   V: AUTO x200   H: AUTO x1

Fn USB Save
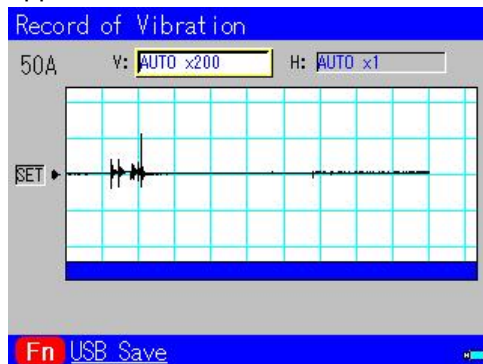
11-2-3-2 Deleting various data

● This section explains how to delete various data from a USB memory stick.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Using **[▲] and [▼]**, select **"USB Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Load-Delete"** and press **[ENTER]**.

4. Press **[Fn]**, and select "Replace" using **[►] and [◄]**.

File
Load USB Memory
                     Meas. Data B
DATA2001.DT   11/02/18 13:48
DATA1005.DT   11/02/18 13:48
DATA1004.DT   11/02/18 13:48
DATA1002.DT   11/02/18 13:48
DATA0001.DT   11/01/31 10:17
Fn Load Delete Replace.

5. Press **[ENTER]** and select the format of file you want to delete.

File
Load USB Memory
                     Meas. Cond. B
DATA2006.CD   11/02/18 13:50
DATA2005.CD   11/02/18 13:50
DATA2004.CD   11/02/18 13:49
Fn Load Delete Replace.
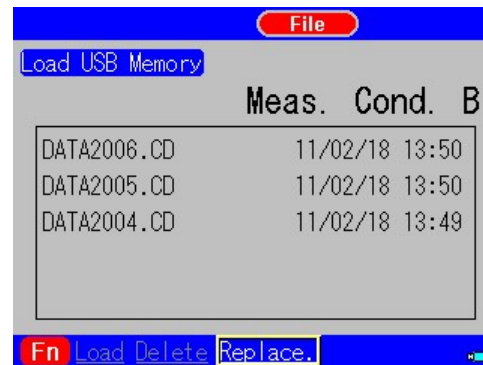
☞   The following file formats can be selected.
Measurement data B: Measurement data file in binary format
Measurement data T: Measurement data file in text format
Measurement condition B: Measurement condition file in binary format
Vibration data B: Vibration data file in binary format
Vibration data T: Vibration data file in text format

6. Press **[Fn]**, select the file you want to delete using **[▲], [▼], [►], and [◄]**, and press **[ENTER]**.
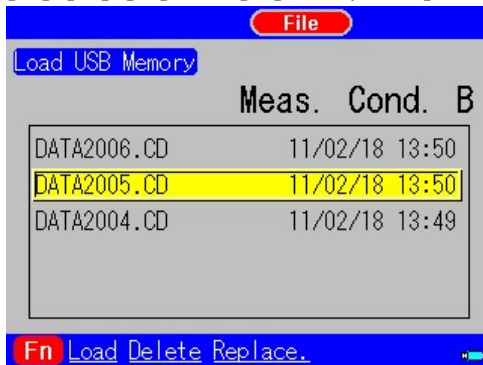
[►]: Moves to the next page.
[◄]: Moves to the previous page.
[▲]: Moves the cursor up one item.
[▼]: Moves the cursor down one item.
[Fn] + [►]: Moves to the 10th page.
[Fn] + [◄]: Moves back to the 10th page.

7. Press **[Fn]**, select **"Delete"** using **[►] and [◄]**, and press **[ENTER]**.
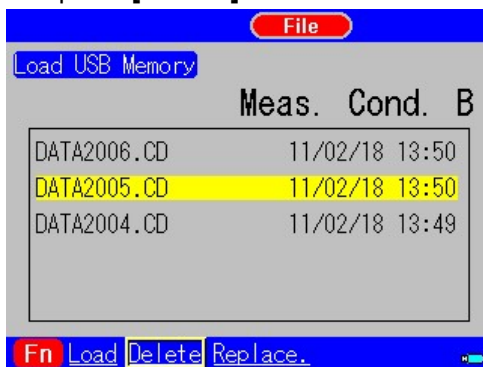
The selected file is deleted and the following screen appears.
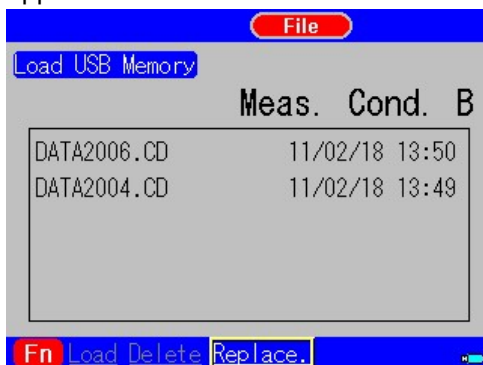
11. Saving Data to and Loading Data from Memory

11-2-4 Removing

● Make it possible to safely remove the USB memory stick.

1. Press **[MENU]**, and select "File" using **[▶] and [◀]**.

2. Using **[▲] and [▼]**, select **"USB Memory"** and press **[ENTER]**.

3. Using **[▲] and [▼]**, select **"Removal"** and press **[ENTER]**.

4. Make sure that the USB memory access indicator is off before removing the USB memory stick.

11-3 Internal Mem to USB Mem

This allows you to batch copy data saved in the internal memory to a USB memory stick. The formats of the files that can be copied is Binary.

The file name when data is batch copied to the USB memory begins with the file name that appears on the Save USB Memory screen in Save or Load menu. The file name is automatically updated to the subsequent number each time one file has been saved. If you want to specify the starting number for the file name, specify it in the Save USB Memory screen for each file type.

⚠ **If a file with the same name exists in the USB memory, it is overwritten.**
Caution

11-3-1 Meas. Data Whole Copy

● This function batch copies measurement data from the internal memory to a USB memory stick.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Select **"Internal Mem to USB Mem"** using **[▲] and [▼]**.

3. Using **[▲] and [▼]**, select **"Meas. Data Whole Copy"** and press **[ENTER]**.
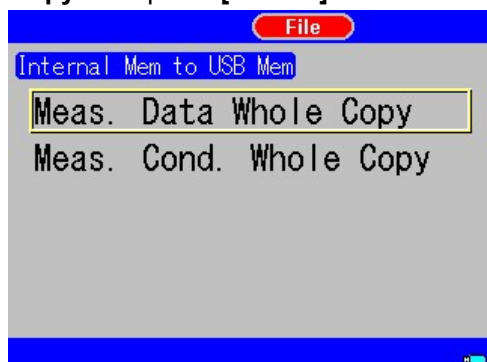
11-3-2 Meas. Cond. Whole Copy

● This function batch copies measurement conditions from the internal memory to a USB memory stick.

1. Press **[MENU]**, and select "File" using **[►] and [◄]**.

2. Select **"Internal Mem to USB Mem"** using **[▲] and [▼]**.

3. Using **[▲] and [▼]**, select **"Meas. Cond. Whole Copy"** and press **[ENTER]**.
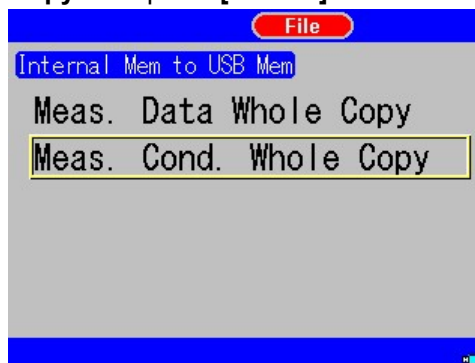
11. Saving Data to and Loading Data from Memory

11-4 Using data on your PC

The data that has been saved in the USB memory in text format can be referenced on your PC.

11-4-1 How to interpret measurement data

● This section explains how to interpret measurement data file.

<How to interpret measurement data file>

```
Date   =/25/2011
Time   =15:05:14
Roughness
(JIS'01/ISO'97/DIN)
Eval.Length =4.00mm
M.Speed     =0.3mm/s
Cutoff value=0.8mm
Cutoff      =Gaussian
Meas.Range  =400.0um
Tilt        =Straight
C.F.R.      =300
Pc Upp-L    =10.05um
Pc Low-L    =7.65um
Stp Ref-H   =2.55um
Stp Del-L   =1.00um

MM
Ra,5.411
Ramax,5.457
Ra+sd,5.442
Ra-sd,5.380
Ra-1,5.413
Ra-2,5.430
Ra-3,5.457
Ra-4,5.382
Ra-5,5.373
Pa,5.456
Pq,6.254
Pt,23.104

MM
P
4.00
13334
3.872
3.840
3.840
3.856
3.936
4.048
4.224
```

(1) Measurement date
Date and time when the measurement was made.

(2) Measurement conditions
These are measurement conditions.(Measurement type, standard, evaluation length. measure speed, cutoff value, filter type, measure range, form remove, and are cutoff ratio are displayed from top to bottom in that order.)

☞　The items that have been specified in **9-3-1 Output items** are output.

(3) Analysis conditions
These are analysis conditions.The upper and lower limits of peak count level, and reference height and deletion height in the step height calculation are displayed from top to bottom in that order.

(4) Output parameters
Information about various parameters.

☞　The items that have been specified in **9-3-2 Output parameters** are output.

(5) Unit
MM: Millimeter [mm], INCH: Inch [μ"]

(6) Section parameters
Information about section parameters.

(7) Results
Information about measurement results.

(8) Unit
MM: Millimeter [mm], INCH: Inch [μ"]

(9) Profile kind
P: Profile curve, R: Roughness curve
W: Filtered waviness curve, WC: Waviness profile curve

(10) Evaluation length (Unit: mm for MM, " for INCH)

(11) Data points

```
MM
BAC1
15.82
1001
REL
0.0,0.00
0.1,0.01
0.2,0.01
0.3,0.01
0.4,0.01
0.5,0.02
```

(12)
(13)
(14)
(15)
(16)
(17)

(12) BAC graph, ADC graph data
 Information about BAC and ADC graphs.

(13) Unit
MM: Millimeter [mm], INCH: Inch [μ"]

(14) Profile kind
BAC1: BAC Graph P, BAC2: BAC Graph R or WC
ADF1: ADC Graph P
ADF2: ADC Graph R or WC

(15) P-P value (Unit: mm for MM, " for INCH)

(16) Data points

(17) Unit of BAC graph cut level
 REL: Relative value
 ABS: Absolute value

11-4-2 How to interpret vibration data

● This section explains how to interpret vibration
data file.

<How to interpret vibration data file>

```
Date   =2011/01/02
Time   =11:44:20 AM

MM
PV
7851
0.012
0.011
0.008
0.004
-0.001
0.002
-0.003
0.008
0.002
0.004
-0.001
0.002
```

(1)
(3)
(4)
(5)
(2)

(1) Measurement date
Date and time when the measurement was made.

(2) Vibration measurement results
Information about vibration measurement results.

(3) Unit
MM: Millimeter [mm], INCH: Inch [μ"]

(4) Measurement type
PV: Vibration measurement

(5) Data points

127

12. Connecting with PC

12-1 Connecting with PC

This instrument provides the function to communicate external equipment, such as a personal computer, via a USB cable. You can change various settings for this instrument or obtain data from your PC.

A USB port of your PC functions as a virtual COM port if you install a driver that is included with the instrument. This allows an application on your PC to communicate with the instrument with no regard to the USB just as usual serial communication (e.g., RS-232C).
The USB cable for connecting the instrument with your PC is a USB Standard Type A - Mini B. (See the illustration below.)

"A" male connector   5-pin "mini-B" male connector

This instrument includes an application, "SupportWare", that allows you to connect the instrument with your PC and easily create an inspection report. For details, see "SupportWare Installation Guide" and "SupportWare Manual" that are stored in the CD-ROM provided.

☞ SupportWare is a freeware software. You can install it and use on multiple PCs.

12-1-1 Steps for installing the USB driver

To allow communication between the instrument and your personal computer, it is necessary to install the USB driver (VCP-Driver). Install the driver by referring to the "README.TXT" on the CD-ROM provided.

12-2 Setting communication conditions on the instrument

Make the communication conditions settings match the conditions on your personal computer.

☞ For the procedure to set the communication conditions, see Section 9-6-7-3, Communication conditions.

12-3 Setting communication conditions on your personal computer

Set the communication conditions for your personal computer following the instruction manual for the application you use.
If the SupportWare is used, see the "SupportWare Manual".

12-4 USB communications commands

12-4-1 Using communications commands

[**Commands to this instrument and responses**]

To control the instrument from your PC, use dedicated communication commands.

<Commands to this instrument and responses>

Example:
SMEAS
Measurement
Start

Example:
SMEAS"E"<cr>

PC
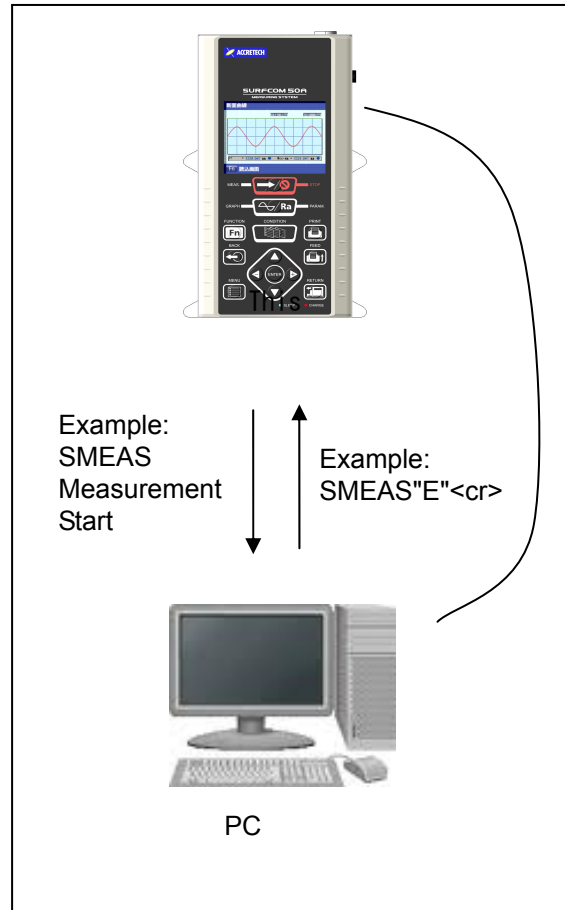
12-4-2 List of communications commands

The following is a list of commands that are used in this instrument.

	Command name	Command	Description
1	Measurement Start	SMEAS	A command that instructs the instrument to start measurement.
2	Move Detector	SMOVE	A command that instructs the instrument to move the detector.
3	Return Detector	SRETN	A command that instructs the instrument to return the detector.
4	Data Output	SDATA	A command that instructs the instrument to output measurement data.
5	Characteristics Graph Data Output	SGRPH	A command that instructs the instrument to output characteristics graph data.
6	Set V-Mag.	SVMAG	A command that sets the vertical magnification for displaying and printing.
7	Set H-Mag	SHMAG	A command that sets the horizontal magnification for displaying and printing.
8	Set Output Item	SOUTP	A command that sets output parameters when outputting various items.
9	Set Data Output Format	SFOMT	A command that sets the data output format.
10	Set System Condition	SSYSC	A command that specifies a system condition.s
11	Set Judgment	SJUDG	A command that sets a condition for judgment.
12	Set Measurement Condition	SMEAC	A command that sets a measurement condition.
13	Set Cutoff Value	SCUTC	A command that sets a measurement type and a cutoff value.
14	Set Evaluation Length	SLENG	A command that sets an evaluation length.
15	Set Move Speed	SMSPD	A command that sets measurement and return speeds.
16	Set Analysis Condition	SANAC	A command that sets an analysis condition.
17	Sleep Setting	SSLEP	A command that sets the sleep time.
18	Set Date	SDATE	A command that sets the information on date.
19	Set Time	STIME	A command that sets the information on time.
20	Set Automatic Item	SAUTO	A command that sets automatic items.
21	Record of Vibration	SCVIB	A command that performs the Record of Vibration.
22	Re-calc.	SRECA	A command that performs recalculation. The recalculation is performed by this instrument.
23	Data Save	SSAVE	A command that saves data. Data is saved in the internal memory of this instrument.
24	Read Data	SREAD	A command that reads data. The command reads data that has been saved in the internal memory by this instrument.
25	Meas Data Clear	SDELL	A command that deletes measurement data. The command deletes all measurement data that has been saved in the internal memory.
26	Set AI-Function	SAIST	A command that sets the AI function.
27	Initialize Conditions	SRSET	A command that sets condition settings to their default values.
28	Forced Termination	SSTOP	A command that terminates measurement or return movement and terminates data output process.

12-4-3 Details of communications commands

The following describes details of the commands.

1.**Measurement Start command**
・Format
SMEAS[,n]<cr>

・Description
A command that instructs the instrument to start measurement.

[,n] is a command that can be omitted. Specify a data number in which to save measurement data upon completion of measurement using a number between 1 and 29. If it is omitted, only measurement takes place and data is not saved.

* If you specify a data number in which measurement data has been saved, it is forcibly overwritten. Exercise great care when specifying it.

・Response
SMEAS"E"<cr>
"E" is an error code. A response code is output when the calculation of parameters has been completed.

When stop or a limit switch is activated during measurement or the Forced Termination command, "SSTOP", is input to stop the measurement, the "System Error", an error code, is "1".

Note: <cr> represents a return code (0DH). (Hereinafter the same meaning applies.)

---

2. **Move Detector command**
・Format
SMOVE,±****.***<cr>

・Description
A command that instructs the instrument to move the detector in the X axis direction. The detector can be moved from the current position to a length specified by +/-****.***. + is used to move the detector in the direction of measurement. - is used to move the detector in the return direction. This command is only available for the driver (-50).

・Setting range

Driver	Setting range
-50	0.10 to 50.00 mm
	0.0039 to 1.9685 inch

When specifying the setting range in millimeters, set a real number with two decimal places. When specifying the setting range in inches, set a real number with four decimal places.
Specify a real number in millimeters or inches depending on the unit setting at a given time.

☞   The move speed is 1.5 mm/s.
☞   This command is not available for the driver (-35/-40/-45).

・Response
SMOVE"E"<cr>
"E" is an error code. A response code is output when the specified move has been completed or a stop has occurred. The above error is returned for the driver (-35/-40/-45).

When stop or a limit switch is activated during a move or the Forced Termination command, "SSTOP", is input to stop the move, the "System Error", an error code, is "1".

---

3. **Return Detector command**
・Format
SRETN<cr>

・Description
A command that instructs the instrument to return the detector in the X axis direction. The command performs the same processing as when the RETURN button is pressed.

When the driver (-50) is connected, the command returns the driver to the measurement starting position after the measurement. If you continue to execute this command, the driver moves to the position of the limit switch at the end of return stroke. The driver moves to the position of the limit switch located at the end of return stroke not after the measurement. If the driver (-35/-40/-45) is connected, the command moves it to the limit of return end.
The return speed can be specified by the SMSPD command.

・Response
SRETN"E"<cr>
"E" is an error code. A response code is output when the return move has been completed or a stop has occurred.

When the stop switch is pressed during a move or the Forced Termination command, "SSTOP", is input to stop the move, the "System Error", an error code, is "1".

4. **Data Output command**

・Format
SDATA[,n]<cr>

・Description
A command that instructs the instrument to output measurement data.
[,n] is a command that can be omitted. Specify a data number in which measurement has been saved using a number between 1 and 29.

When it is omitted or a 0 is specified, the displayed measurement data is output.

Use the Set Data Output Format command (SFOMT) to specify the output format before executing this command. The default for the SFOMT command is "Text".

☞ If a data number is specified, the measurement results that are being displayed are cleared and the measurement results of the specified data number are displayed.

☞ For the measurement data in the driver (-35/-40/-45), waviness profile curve and filtered waviness curve are not output.

・Response
Data output is provided as a response. For an error, SDATA "E"<cr> is output.

When the stop switch is pressed during data output or the Forced Termination command, "SSTOP", is input to stop the data output, the "System Error", an error code, is "1".

☞ Only the parameter evaluation data is then output as measurement data. The preparatory drive data before and after is not output.

☞ Profiles are output based on the settings on the output items.

5.**Characteristics Graph Data Output command**
・Format
SGRPH[,n]<cr>

・Description
A command that instructs the instrument to output characteristics graph data (BAC and ADC graphs).
[,n] is a command that can be omitted. Specify a data number in which measurement has been saved using a number between 1 and 29.
When it is omitted or a 0 is specified, the displayed measurement data is output.

☞ If a data number is specified, the measurement results that are being displayed are cleared and the measurement results of the specified data number are displayed.

・Response
Data output is provided as a response. For an error, SGRPH "E"<cr> is output.
When the stop switch is pressed during data output or the Forced Termination command, "SSTOP", is input to stop the data output, the "System Error", an error code, is "1".

☞ Graphs are output based on the settings on the output items.

☞ If "Text" has not been specified for the data output format, no characteristics graph data is output.

6. **Set V-Mag command**
・Format
SVMAG,n<cr>

・Description
A command that sets the vertical magnification for displaying and printing. n is an integer and its possible values are given in the following table.

n	Setting	n	Setting
0	AUTO	7	$\times$ 2K
1	$\times$ 20	8	$\times$ 5K
2	$\times$ 50	9	$\times$ 10K
3	$\times$ 100	10	$\times$ 20K
4	$\times$ 200	11	$\times$ 50K
5	$\times$ 500	12	$\times$ 100K
6	$\times$ 1K		

・Response
SVMAG"E"<cr>

7. Set H-Mag command

・Format
SHMAG,n<cr>

・Description
A command that sets the horizontal magnification for displaying and printing. n is an integer and its possible values are given in the following table.

n	Setting	n	Setting
0	AUTO	6	× 50
1	× 1	7	× 100
2	× 2	8	× 200
3	× 5	9	× 500
4	× 10	10	× 1K
5	× 20		
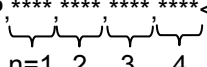
・Response
SHMAG"E"<cr>

8. Set Output Item command

This command is common to the display, print, and USB output item settings.

・Format
SOUTP,**** **** **** ****<cr>
　　　　n=1　2　　3　　4

・Description
A command that sets output parameters when outputting various items.
The four ****s are the set values that correspond to block numbers, 1 to 4, from left to right in that order.
The set value for each block number is 16-bit data. Each bit contains a parameter. If the appropriate bit is set to 1, that parameter is output.
**** is 16-bit data for each block that is expressed in four characters for hexadecimal representation. The content of each block is as given in the bit assignment table for output items.
n is a block number.

・Response
SOUTP"E"<cr>

Description
This section gives a detailed description of ****. This number represents the parameter that is selected for the group of each column in the bit assignment table for output items. (it is necessary to set <SOUTP> of the output item for each group.) Each column consists of 16 bits.
The numbers on the left side of the bit assignment table for output items corresponds to bits as shown below. They are converted to hexadecimal notation using four characters.

Bits	[15	14	13	12] [	11	10	9	8]
Weight	8	4	2	1	8	4	2	1
Example	O	O	O	O	O	O	●	O
Set value	0				2			

Bits	[7	6	5	4] [	3	2	1	0]
Weight	8	4	2	1	8	4	2	1
Example	●	●	O	O	●	O	O	●
Set value	C				9			

(Addition of each weight is represented in hexadecimal.)
O...Do not select. ●...Select.

(Example) SOUTP,0018,0000,10C0,4007<cr>

<JIS'82>
● Bit Assignment Table for Output Items (Profile)

Bit	n			
	1	2	3	4
15				
14				
13				
12			K<45>	
11			Vo<44>	
10			Mr2<43>	Profile curve
9			Mr1<42>	
8			Rvk<41>	
7			Rpk<40>	ADC graph P
6			Rk<39>	
5			Tp<38>	
4	Rz<5>			BAC graph P
3	Rmax<4>			
2			Hmin<35>	Parameter
1			Hmax<34>	Measurement condition
0			AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Roughness Measurement)

Bit	n			
	1	2	3	4
15				
14	Rt<15>			
13				
12	Rp<13>		K<45>	
11	Rq<12>		Vo<44>	Roughness curve
10			Mr2<43>	Profile curve
9			Mr1<42>	
8		Pc<25>	Rvk<41>	
7			Rpk<40>	ADC graph P
6			Rk<39>	
5			Tp<38>	
4	Rz<5>			BAC graph P
3	Rmax<4>			
2			Hmin<35>	Parameter
1			Hmax<34>	Measurement condition
0	Ra<1>		AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement without λf)

Bit	n			
	1	2	3	4
15				
14				
13				
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	WC-Sm<6>			
4	WC-v<5>			
3	WC-p<4>			
2	WCM<3>			Parameter
1	WC-q<2>			Measurement condition
0	WC-a<1>			Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement with λf)

Bit	n			
	1	2	3	4
15				
14				
13				Waviness profile curve
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	WC-Sm<6>		WCC-Sm<38>	
4	WC-v<5>		WCC-v<37>	
3	WC-p<4>		WCC-p<36>	
2	WCM<3>		WCC-m<35>	Parameter
1	WC-q<2>		WCC-q<34>	Measurement condition
0	WC-a<1>		WCA<33>	Date

The number enclosed in angle brackets is a parameter number.

<JIS '94>
● Bit Assignment Table for Output Items (Profile)

Bit	n			
	1	2	3	4
15				
14				
13				
12				
11				
10				Profile curve
9				
8				
7				
6				
5				
4	Rz.j<5>			
3	Rmax<4>			
2			Hmin<35>	Parameter
1			Hmax<34>	Measurement condition
0			AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

12. Connecting with PC

● Bit Assignment Table for Output Items (Roughness Measurement)

Bit	n			
	1	2	3	4
15				
14	Rt<15>			
13				
12	Rp<13>		K<45>	
11	Rq<12>		Vo<44>	Roughness curve
10	S<11>		Mr2<43>	Profile curve
9			Mr1<42>	
8	Sm<9>	Pc<25>	Rvk<41>	ADC graph R
7			Rpk<40>	
6	Rz<7>		Rk<39>	
5	Ry<6>		Tp<38>	BAC graph R
4	Rz.j<5>			
3	Rmax<4>			Section
2			Hmin<35>	Parameter
1			Hmax<34>	Measurement condition
0	Ra<1>		AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement without λf)

Bit	n			
	1	2	3	4
15				
14				
13				
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	WSm<6>			
4	Wv<5>			
3	Wp<4>			
2	WCM<3>			Parameter
1	Wq<2>			Measurement condition
0	Wa<1>			Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement with λf)

Bit	n			
	1	2	3	4
15				
14				
13				Waviness profile curve
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	WSm<6>		WC-Sm <38>	
4	Wv<5>		WC-v<37>	
3	Wp<4>		WC-p<36>	
2	WCM<3>		WC-t<35>	Parameter
1	Wq<2>		WC-q<34>	Measurement condition
0	Wa<1>		WCA<33>	Date

The number enclosed in angle brackets is a parameter number.

<JIS '01/ISO '97/DIN>
● Bit Assignment Table for Output Items (Profile)

Bit	n			
	1	2	3	4
15				
14				
13				
12				
11				
10				Profile curve
9				
8				
7				ADC graph P
6				
5				
4	Rz.J<5>			BAC graph P
3	Pt<4>		Pmr<36>	
2	Pq<3>		Hmin<35>	Parameter
1	Pa<2>		Hmax<34>	Measurement condition
0			AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Roughness Measurement)

Bit	n			
	1	2	3	4
15	R3z<16>			
14	Rt<15>			ISO13565 curve
13				
12	Rp<13>		K<45>	
11	Rq<12>		Vo<44>	Roughness curve
10			Mr2<43>	Profile curve
9			Mr1<42>	
8	RSm<9>	Pc<25>	Rvk<41>	ADC graph R
7	Rzmax<8>		Rpk<40>	ADC graph P
6			Rk<39>	
5	Rz<6>			BAC graph R
4	Rz.J<5>		Rmr<37>	BAC graph P
3	Pt<4>		Pmr<36>	
2	Pq<3>		Hmin<35>	Parameter + Section
1	Pa<2>		Hmax<34>	Measurement condition
0	Ra<1>		AVH<33>	Date

The number enclosed in angle brackets is a parameter number.
Shaded indicates the parameter having a section display.

● Bit Assignment Table for Output Items (Waviness measurement with λf)

Bit	n			
	1	2	3	4
15				
14				
13				Waviness profile curve
12				Filtered waviness curve
11				
10				Profile curve
9				ADC graph WC
8				
7			Wmr <40>	ADC graph P
6			Wz<39>	BAC graph WC
5	W-Sm <6>		WSm<38>	
4	W-v <5>		Wv<37>	BAC graph P
3	W-p<4>		Wp<36>	
2	W-t<3>		Wt<35>	Parameter + Section
1	W-q<2>		Wq<34>	Measurement condition
0	W-a<1>		Wa<33>	Date

The number enclosed in angle brackets is a parameter number.
Shaded indicates the parameter having a section display.

● Bit Assignment Table for Output Items (Waviness measurement without λf)

Bit	n			
	1	2	3	4
15				
14				
13				
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				ADC graph P
6				
5	W-Sm <6>			
4	W-v<5>			BAC graph P
3	W-p<4>			
2	W-t<3>			Parameter
1	W-q<2>			Measurement condition
0	W-a<1>			Date

The number enclosed in angle brackets is a parameter number.
Shaded indicates the parameter having a section display.

<ASME'95/ASME'02>
● Bit Assignment Table for Output Items (Profile)

Bit	n			
	1	2	3	4
15				
14				
13				
12				
11				
10				Profile curve
9				
8				
7				
6				
5				
4	Rz.J<5>			
3	Pt<4>			
2			Hmin<35>	Parameter
1			Hmax<34>	Measurement condition
0			AVH <33>	Date

The number enclosed in angle brackets is a parameter number.

12. Connecting with PC

● Bit Assignment Table for Output Items (Roughness Measurement)

Bit	n 1	2	3	4
15				
14	Rt<15>			ISO13565 curve
13	Rp<14>			
12	Rpm<13>		K<45>	
11			Vo<44>	Roughness curve
10			Mr2<43>	Profile curve
9	RS<10>		Mr1<42>	
8	RSm<9>	Pc<25>	Rvk<41>	ADC graph R
7	Rmax<8>		Rpk<40>	
6			Rk<39>	
5	Rz6>			BAC graph R
4	Rz.J<5>		Rmr<37>	
3	Pt<4>			
2	Pq<3>		Hmin<35>	Parameter + Section
1			Hmax<34>	Measurement condition
0	Ra<1>		AVH<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement with λf)

Bit	n 1	2	3	4
15				
14				
13				Waviness profile curve
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	W-Sm<6>		WSm<39>	
4	W-v<5>		Wv<44>	
3	W-p<4>		Wp<36>	
2	W-t<3>		Wt<42>	Parameter
1	W-q<2>		Wq<41>	Measurement condition
0	W-a<1>		Wa<33>	Date

The number enclosed in angle brackets is a parameter number.

● Bit Assignment Table for Output Items (Waviness measurement without λf)

Bit	n 1	2	3	4
15				
14				
13				
12				Filtered waviness curve
11				
10				Profile curve
9				
8				
7				
6				
5	W-Sm<6>			
4	W-v<5>			
3	W-p<4>			
2	W-t<3>			Parameter
1	W-q<2>			Measurement condition
0	W-a<1>			Date

The number enclosed in angle brackets is a parameter number.

<CNOMO>

● Bit Assignment Table for Output Items (Profile, Roughness Measurement)

Bit	n 1	2	3	4
15				
14				
13				Waviness motifs
12			K<45>	
11			Vo<44>	Roughness motif
10			Mr2<43>	Profile curve
9			Mr1<42>	
8			Rvke<41>	
7		Mr<24>	Rpke<40>	ADC graph P
6		Wte<23>	Rke<39>	
5		AW<22>		
4		Wx<21>		BAC graph P
3		W<20>		
2		AR<19>		Parameter
1		Rx<18>		Measurement condition
0		R<17>		Date

The number enclosed in angle brackets is a parameter number.

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45.

9. Set Data Output Format command

・Format
   SFOMT,n<cr>

・Description
   For details of the output data in each format, see
   12-4-5, Output data format. Possible values for n
   are given in the following table.

n	Output format
0	Hexadecimal number (no data compression)
1	Text
2	SPC

・Response

   SFOMT"E"<cr>

10. **Set System Condition command**

・Format
   SSYSC,n,m<cr>

・Description
   A command that specifies a system condition.
   The items you can specify are Language, Display
   Unit, Stop-Calc., Display Sel. After Meas., and
   USB Memory Save Type.

[Language]

n	m	Language
0	0	Japanese
0	1	English
0	2	Deutsch
0	3	Français
0	4	Español
0	5	Italiano
0	6	Portuguese
0	7	Chinese

[Display Unit]

n	m	Unit
1	0	Metric
1	1	Inch

[Stop-Calc.]

n	m	ON/OFF
2	0	OFF
2	1	ON

[Pickup]

n	m	Pickup
3	0	Standard
3	1	1/2

The Pickup can be specified only for the driver
(-50).An error is returned for the driver
(-35/-40/-45).

[Display Sel. After Meas.]

n	m	Display screen
4	0	Graph Display
4	1	Meas. Result Display
4	2	Meas. Criteria Display

[USB Memory Save Type]

n	m	Display screen
5	0	Text
5	1	Binary
5	2	Text & Binary

・Response
   SSYSC"E"<cr>

11. **Judgment command**

・Format
   SJUDG,n[,m,**,**,o,**,**,p,**,**]<cr>

・Description
   A command that sets a condition for judgment.
   Possible values for n, m, o, p, and ** are given
   in the following table.

[Judgment Type]

n	Judgment type
0	None
1	Average
2	Maximum value
3	16% rule

[Judg. Parm]
For m, o, or p, enter a parameter number that is to
be judged.
Up to three parameters can be judged.
If only n is specified, the judgment parameter that
is currently specified is not changed.
For **, enter upper and lower limit values.
If n = 0, m, o, p, and upper and lower limit values are
not changed.

For a number in millimeters, specify a real
number with three decimal places between 0
and **.**μm.
For a number in inches, specify a real number
with one decimal place between 0 and ****.*μin.
For a number in percentage, specify a real
number with two decimal places between 0 and
99.99%.

12. Connecting with PC

Example: To judge two parameters in JIS' 82 with the maximum value, Ra = 1 to 10 µm, and Rz = 20 to 30µm, the command is:SJUDG,2,1,10.000,1.000,5,30.000,20.000<cr>
The third parameter that is not entered is not set.

<Upper and lower limit values>
The instrument has a function that compares the measurement results with nominal values set with this command.
Set the upper limit value so that it is equal to or greater than the lower limit value. If 0 is specified for both of the upper and lower limit values, judgment is not made.
For the setting range of the upper and lower limit values of the judgment for each parameter number and for each calculation parameter, see the next page.

● Setting range of upper and lower limit values of the judgment for the calculation parameter

<Roughness Measurement><Profile>

Calculation parameter	JIS '82	JIS '94	JIS '01 ISO '97 DIN	ASME'95 ASME'02	Setting range of upper and lower limit values
Arithmetical mean roughness	Ra <1>	Ra <1>	Pa <2> Ra <1>	Ra <1>	
Root mean square roughness	Rq <12>	Rq <12>	Pq, <3> Rq <12>	Rq <12>	
Maximum height of roughness	-	Ry <6>	Rz <6> Rzmax <8>	Rz <6> Rmax <8>	
Maximum roughness curve peak height	Rp <13>	Rp <13>	Rp <13>	Rpm <13> Rp <14>	
Ten-point height of irregularities of roughness curve (ISO) Ten-point height of irregularities (ISO)	-	Rz <7>	-	-	0.000 µm to 4000.000 µm (0.0 µin to 157480.3 µin)
Maximum section height of profile curve	Rmax <4>	Rmax <4>	Pt <4>	Pt <4>	
Maximum section height of roughness curve	Rt <15>	Rt <15>	Rt <15>	Rt <15>	
Ten-point height of irregularities of profile curve (JIS82) Ten-point height of irregularities (JIS82)	Rz <5>	Rz.J <5>	Rz.J <5>	Rz.J <5>	
Base roughness depth	-	-	R3z <16>	-	
Mean length of roughness elements	-	Sm <9>	RSm <9>	RSm <9>	0.000 mm to 400.000 mm
Mean spacing of local peaks of the roughness curve Mean spacing of local peaks	-	S <11>	-	RS <10>	(0.0000" to 15.7480")
Peak count	Pc <25>	Pc <25>	Pc <25>	Pc <25>	0 to 4000
Core roughness depth	Rk <39>	Rk <39>	Rk <39>	Rk <39>	0.000 µm to 4000.000 µm (0.0 µin to 157480.3 µin)
Reduced peak height	Rpk <40>	Rpk <40>	Rpk <40>	Rpk <40>	
Reduced valley depth	Rvk <41>	Rvk <41>	Rvk <41>	Rvk <41>	
Oil retention volume	Vo <44>	Vo <44>	Vo <44>	Vo <44>	0.0000 to 400.0000
Profile bearing length ratio 1 of the core	Mr1 <42>	Mr1 <42>	Mr1 <42>	Mr1 <42>	0.0% to 99.9%
Profile bearing length ratio 2 of the core	Mr2 <43>	Mr2 <43>	Mr2 <43>	Mr2 <43>	
Reduced valley depth ratio	K <45>	K <45>	K <45>	K <45>	0.00 to 99.99
Profile bearing length ratio	tp <38>	tp <38>	Pmr <36> Rmr <37>	Rmr <37>	0.0% to 99.9%
Average step height	AVH <33>	AVH <33>	AVH <33>	AVH <33>	-4000.000 µm to 4000.000 µm (-157480.3µin to 157480.3 µin)
Maximum step height	Hmax <34>	Hmax <34>	Hmax <34>	Hmax <34>	
Minimum step height	Hmin <35>	Hmin <35>	Hmin <35>	Hmin <35>	

The number enclosed in angle brackets is a parameter number.

12. Connecting with PC

\<Profile\>\< Roughness measurement \>

Calculation parameter	CNOMO	Setting range of upper and lower limit values
Average depth of roughness motif	R \<17\>	0.000 to 4000.000 µm (0.0 to 157480.3 µin)
Maximum depth of roughness motif	Rx \<18\>	
Average length of roughness motif	AR \<19\>	
Average depth of waviness motifs	W \<20\>	0.000 to 4000.000 µm (0.0 to 157480.3 µin)
Maximum depth of waviness motifs	Wx \<21\>	
Average length of waviness motif	AW \<22\>	0.00 to 20000.00 µm (0.0 to 787401.6 µin)
Overall depth of upper envelope line	Wte \<23\>	0.000 to 4000.000 µm (0.0 to 157480.3 µin)
Core roughness depth	Rke \<39\>	0.000 µm to 4000.000 µm (0.0 µin to 157480.3 µin)
Reduced peak height	Rpke \<40\>	
Reduced valley depth	Rvke \<41\>	
Oil retention volume	Vo \<44\>	0.0000 to 400.0000
Profile bearing length ratio 1 of the core	Mr1 \<42\>	0.0% to 99.9%
Profile bearing length ratio 2 of the core	Mr2 \<43\>	
Profile bearing length ratio (evaluation)	mr \<24\>	
Reduced valley depth ratio	K \<45\>	0.0 to 99.99

The number enclosed in angle brackets is a parameter number.

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45.

\<Waviness measurement\>

Calculate curve	Filtered waviness curve	Waviness profile curve	Setting range of upper and lower limit values
Centerline average	WC-a, Wa, W-a\<1\>	-	0.000 µm to 4000.000 µm (0.0 µin to 157480.3 µin)
Arithmetical mean waviness	-	WCA, Wa\<33\>	
Root mean square waviness	WC-q, Wq, W-q\<2\>	WCC-q, WC-q, Wq\<34\>	
Maximum filtered waviness	WCM, Wt, W-t\<3\>	-	
Maximum section height of waviness profile curve	-	WCC-m, WC-t, Wt\<35\>	
Maximum waviness profile curve peak height	WC-p, Wp, W-p\<4\>	WCC-p, WC-p, Wp\<36\>	
Maximum waviness profile curve valley depth	WC-v, Wv, W-v\<5\>	WCC-v, WC-v, Wv\<37\>	
Mean length of waviness profile elements	WC-Sm, WSm, W-Sm\<6\>	WCC-Sm, WC-Sm, WSm\<38\>	0.000 mm to 400.000 mm (0.0000" to 15.7480")
Maximum height of waviness	-	Wz \<39\>	0.000 µm to 4000.000 µm (0.0 µin to 157480.3 µin)
Profile bearing length ratio of waviness profile curve	-	Wmr \<40\>	0.0% to 99.9%

The setting range of the judgment upper and lower limit values is common to all standards.
The number enclosed in angle brackets is a parameter number.

12. **Set System Condition command**

・Format
　SMEAC,n,m<cr>

・Description
　A command that sets a measurement condition.
　The items you can specify are Standard, Pre.
　Drive Length, Form remove, and Measure range.
　Possible values for n and m are given in the
　following table.

[Standard]

n	m	Standard
0	0	JIS- '82
0	1	JIS- '94
0	2	JIS- '01/ISO- '97/DIN
0	3	CNOMO
0	4	ASME- '95/ ASME- '02

[Pre. Drive Length]

n	m	Pre. drive length
1	0	Cutoff value/3
1	1	Cutoff value/2
1	2	Cutoff value

The Pre. Drive Length can be specified only for
the driver (-50). An error is returned for the driver
(-35/-40/-45).

[Form Remove]

n	m	Tilt correction
2	0	No tilt correction
2	1	Straight
2	2	R-Curve
2	3	Begin. half
2	4	End. half
2	5	Begin-End

[Measure Range]

n	m	Measure range
3	0	±400 µm (±15748 µin)
3	1	±40 µm (±1575 µin)
3	2	±4 µm (±157 µin)

☞　The Measure range can be specified only for
the driver (-50).

・Response
　SMEAC"E"<cr>

13. **Set Cutoff Value command**

・Format
　SCUTC,n,m[,k]<cr>

・Description
　A command that sets a measurement type, a
　cutoff value, a filter type, and an Ls filter value.
　n, m, and k are integers and their possible values
　are given in the following table.
　k can be omitted. If it is omitted, 0 is assigned.

[Cutoff Value (mm)]
　　[Driver (-50)]

n		Cutoff value (mm)			
0	P	-	-	-	-
1	R	-	-	-	25.0
2	R	8.0	8.0	8.0	8.0
3	R	2.5	2.5	2.5	2.5
4	R	0.8	0.8	0.8	0.8
5	R	0.25	0.25	0.25	0.25
6	R	0.08	0.08	0.08	-
7	W	-	-	-	25.0
8	W	8.0	8.0	8.0	8.0
9	W	2.5	2.5	2.5	2.5
10	W	0.8	0.8	0.8	0.8
11	W	0.25	0.25	0.25	0.25
12	W	0.08	0.08	0.08	-
13	WC	-	-	-	2.5 to 25
14	WC	0.8 to 25	0.8 to 25	0.8 to 25	0.8 to 25
15	WC	0.8 to 8.0	0.8 to 8.0	0.8 to 8.0	0.8 to 8.0
16	WC	0.25 to 8.0	0.25 to 8.0	0.25 to 8.0	0.25 to 8.0
17	WC	0.25 to 2.5	0.25 to 2.5	0.25 to 2.5	0.25 to 2.5
18	WC	0.08 to 2.5	0.08 to 2.5	0.08 to 2.5	-
19	WC	0.08 to 0.8	0.08 to 0.8	0.08 to 0.8	-
		0.15mm/s	0.3mm/s	0.6mm/s	1.5mm/s
			Measure speed		

　P: Profile
　R: Roughness measurement
　WC: Waviness measurement (with λf)
　W: Waviness measurement (without λf)

・Response
　SCUTC"E"<cr>

12. Connecting with PC

[Driver (-35/-40/-45)]

n	Cutoff value (mm)	
3	-35/-40	2.5
4	-35/-40/-45	0.8
5	-35/-40/-45	0.25
6	-35/-40/-45	0.08
Measure speed (0.6 mm/s)		

[Driver (-35/-40/-45)]

n	Cutoff value (inch)	
3	-35/-40	0.1
4	-35/-40/-45	0.03
5	-35/-40/-45	0.01
6	-35/-40/-45	0.003
Measure speed (0.024 in/s)		

[Cutoff Value (inch)]
[Driver (-50)]

n		Cutoff value (inch)			
0	P	-	-	-	-
1	R	-	-	-	1.0
2	R	0.3	0.3	0.3	0.3
3	R	0.1	0.1	0.1	0.1
4	R	0.03	0.03	0.03	0.03
5	R	0.01	0.01	0.01	0.01
6	R	0.003	0.003	0.003	-
7	W	-	-	-	1.0
8	W	0.3	0.3	0.3	0.3
9	W	0.1	0.1	0.1	0.1
10	W	0.03	0.03	0.03	0.03
11	W	0.01	0.01	0.01	0.01
12	W	0.003	0.003	0.003	-
13	WC	-	-	-	0.1 to 1.0
14	WC	0.03 to 1.0	0.03 to 1.0	0.03 to 1.0	0.03 to 1.0
15	WC	0.03 to 0.3	0.03 to 0.3	0.03 to 0.3	0.03 to 0.3
16	WC	0.01 to 0.3	0.01 to 0.3	0.01 to 0.3	0.01 to 0.3
17	WC	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1	0.01 to 0.1
18	WC	0.003 to 0.1	0.003 to 0.1	0.003 to 0.1	-
19	WC	0.003 to 0.03	0.003 to 0.03	0.003 to 0.03	-
		0.006 in/s	0.012 in/s	0.024 in/s	0.06 in/s
		Measure speed			

P: Profile
R: Roughness measurement
WC: Waviness measurement (with λf)
W: Waviness measurement (without λf)

[Filter type]

m	Filter type
0	2RC
1	2RC (P.C.)
2	Gaussian

[Ls Filter Value]

k	When n = 1 to 6	When n = 0.7 to 19
0	None	None
1	Cutoff ratio 30	0.25 µm (10 µin)
2	Cutoff ratio 100	0.8 µm (30 µin)
3	Cutoff ratio 300	2.5 µm (100 µin)
4	Cutoff ratio 1000	8.0 µm (300 µin)
5	-	25.0 µm (1000 µin)

14. Set Evaluation Length command

・Format
 SLENG,n,**.**<cr>

・Description
 A command that sets an evaluation length.

[Evaluation Length]

n	**.**	Evaluation length
0	See the next page.	Fixed
1	See the next page.	Optional

The setting range of the evaluation lengths is given in the following table.

・When the evaluation length is option:
[Driver (-50)]

Measure speed	Setting range
0.15mm/s	0.10 to 50.00 mm
0.3 mm/s	0.10 to 50.00 mm
0.6 mm/s	0.30 to 50.00 mm
1.5 mm/s	0.75 to 50.00 mm
0.006 in/s	0.0039 to 1.9685 in
0.012 in/s	0.0039 to 1.9685 in
0.024 in/s	0.0118 to 1.9685 in
0.06 in/s	0.0295 to 1.9685 in

For the driver (-50), the minimum value for the setting range of the evaluation length is determined by the measure speed.
・When specifying the setting range in millimeters, set a real number with two decimal places. When specifying the setting range in inches, set a real number with four decimal places.

[Driver (-35/-40)]

Measure speed	Setting range
0.6 mm/s	0.40 to 12.50 mm
0.024 in/s	0.0157 to 0.4921 in

・When specifying the setting range in millimeters, set a real number with two decimal places. When specifying the setting range in inches, set a real number with four decimal places.

[Driver (-45)]

Measure speed	Setting range
0.6 mm/s	0.40 to 4.00 mm
0.024 in/s	0.0157 to 0.1575 in

・When specifying the setting range in millimeters, set a real number with two decimal places. When specifying the setting range in inches, set a real number with four decimal places.

・When the evaluation length is fixed:
Specify a coefficient (integer) of λc (λf).
Example: For SLENG,0,5<cr>, the evaluation length is $5 \times \lambda c$ (λf).

[Driver (-50)]

Measurement type	Setting range
Profile	Setting is not possible.
Roughness measurement	1 to 300
Waviness measurement	1 to 300

[Driver (-35/-40/-45)]

Measurement type	Setting range
Profile	Setting is not possible.
Roughness measurement	1 to 5

・Response
SLENG"E"<cr>

15. **Set Speed command**
・Format
SMSPD,n[,m]<cr>
・Description
A command that sets measurement and return speeds.
n and m are integers and their possible values are given in the following table.
m can be omitted. If it is omitted, 0 is assigned.
For the driver (-35/-40/-45), the measure speed is fixed to 0.6 mm/s. It is, therefore, set to 0.6 mm/s, regardless of the value of n. No error response is generated.
For the driver (-35/-40/-45). if this command is executed with m = 1 (return speed specified), the instrument ignores it. No error response is generated.

<Measure speed>

n	Measure speed
0	0.15 mm/s (0.006 in/s)
1	0.3 mm/s (0.012 in/s)
2	0.6 mm/s (0.024 in/s)
3	1.5 mm/s (0.06 in/s)

Note: When the driver (-35/-40/-45) is connected, the measure speed is fixed to 0.6 mm/s.

<Return speed>

n	Measure speed
0	0.15 mm/s (0.006 in/s)
1	0.3 mm/s (0.012 in/s)
2	0.6 mm/s (0.024 in/s)
3	1.5 mm/s (0.06 in/s)
4	3.0 mm/s (0.12 in/s)

Note: When the driver (-35/-40/-45) is connected, the measure speed is fixed to 0.6 mm/s.

<Selection of setting item>

m	Item
0	Setting of measurement speed
1	Setting of return speed

・Response
SMSPD"E"<cr>

16. **Set Analysis Condition command**
・Format
SANAC,n,m[,**.**]<cr>

・Description
A command that sets an analysis condition.
The items you can specify are Peak Count Level, Cut Level, Motif Calculation, Step Height Calculation, and 16% Rule.
Possible values for n, m, and **.** are given in the following table.
. is valid when specifying the peak count level, cut level, and step height calculation (n = 0, 1). If it is omitted, it is set to 0.
Otherwise, the input is ignored.

12. Connecting with PC

[Peak Count Level]
[Driver (-50)]

n	m	Item	Setting range (**.**)
0	0	Upper Limit	-2000.00 to 2000.00 µm It is to be specified as a real number with two decimal places. -78740.2 to 78740.2 µin It is to be specified as a real number with one decimal place.
0	1	Lower Limit	-2000.00 to 2000.00 µm It is to be specified as a real number with two decimal places. -78740.2 to 78740.2 µin It is to be specified as a real number with one decimal place.

[Driver (-35/-40/-45)]

n	m	Item	Setting range (**.**)
0	0	Upper Limit	0.00 to 160.00 µm It is to be specified as a real number with two decimal places. 0.0 to 6299.2 µin It is to be specified as a real number with one decimal place.
0	1	Lower Limit	-160.00 to 0.00 µm It is to be specified as a real number with two decimal places. -6299.2 to 0.0 µin It is to be specified as a real number with one decimal place.

[Cut Level]

n	m	Cut level	Setting range (**.**)
1	0	Relative unit	0 to 99%
1	1	Absolute unit	0.00 to 4000.00 µm It is to be specified as a real number with two decimal places. 0.0 to 157480.3 µin It is to be specified as a real number with one decimal place.

[Motif Calculation, Combined Display]

n	m	Set value
2	0	Combined display: OFF
2	1	Combined display: ON

[Motif Calculation, Setting of Upper Limit Length]
[Driver (-50), Driver (-35/-40)]

n	m	Set value
3	0	Setting of roughness motif upper limit length 0.02 mm (0.0008 in)
3	1	Setting of roughness motif upper limit length 0.1 mm (0.004 in)
3	2	Setting of roughness motif upper limit length 0.5 mm (0.02 in)
3	3	Setting of roughness motif upper limit length 2.5 mm (0.1 in)
4	0	Setting of waviness motif upper limit length 0.1 mm (0.004 in)
4	1	Setting of waviness motif upper limit length 0.5 mm (0.02 in)
4	2	Setting of waviness motif upper limit length 2.5 mm (0.1 in)
4	3	Setting of waviness motif upper limit length 12.5 mm (0.5 in)

[Driver (-45)]

n	m	Set value
3	0	Setting of roughness motif upper limit length 0.02 mm (0.0008 in)
3	1	Setting of roughness motif upper limit length 0.1 mm (0.004 in)
3	2	Setting of roughness motif upper limit length 0.5 mm (0.02 in)
4	0	Setting of waviness motif upper limit length 0.1 mm (0.004 in)
4	1	Setting of waviness motif upper limit length 0.5 mm (0.02 in)
4	2	Setting of waviness motif upper limit length 2.5 mm (0.1 in)

The driver (-45) has a different upper limit value since it has the minimum evaluation length of 4.0 mm.

[Step Height Calculation]

n	m	Item	Setting range (**.**)
7	0	Reference height	-4000.00 to 4000.00 µm (-157480.3 to 157480.3 µin)
7	1	Delete length	0 to 9999 µm (0 to 393661 µin)

[16% rule]

n	m	Setting
8	0	Control on judgment: OFF
8	1	Control on judgment: ON
9	0	16% rule: Standard
9	1	16% rule: Sigma rule

* The control on judgment is applied for the acceptance judgment by less than 70% of upper limit value and over 130% of lower limit value in case of single section.

[Notch calculation ON/OFF]

n	m	Setting
10	0	Notch calculation: OFF
10	1	Notch calculation: ON

[Notch calculation Del. Len]

n	m	Item	Setting range (**.**)
11	0	Del. Len.	0 to 9999 µm
			(0 to 393661 µin)

[Notch calculation Upper limit value/Lower limit value]

n	m	Item	Setting range (**.**)
11	1	Upper limit value	-800.00 to 800.00 µm
			It is to be specified as a real number with two decimal places.
			-31496.0 to 31496.0 µin
			It is to be specified as a real number with one decimal place.
11	2	Lower limit value	-800.00 to 800.00 µm
			It is to be specified as a real number with two decimal places.
			-31496.0 to 31496.0 µin
			It is to be specified as a real number with one decimal place.

· Response
 SANAC"E"<cr>

17. **Set Sleep command**

· Format
 SSLEP,n<cr>

· Description
 A command that sets the sleep time.
 Possible values for n are given in the following table.
 If n = 0 (OFF), the sleep function does not work.

n	Sleep Setting	n	Sleep Setting
0	OFF	3	3 minutes
1	30 seconds	4	5 minutes
2	1 minute	5	10 minutes

· Response
 SSLEP"E"<cr>

12. Connecting with PC

18. Set Date command

・ Format
SDATE,****,**,**<cr>

・ Description
A command that sets the information on time.
**** indicates a year. Specify a number between 2010 and ****.
** indicates a month. Specify a number between 01 and 12.
** indicates a day. Specify a number between 01 and 31.

・ Response
SDATE"E"<cr>

19. Set Time Info command

・ Format
STIME,**,**[,**]<cr>

・ Description
A command that sets the information on date.
** indicates an hour. Specify a number between 00 and 23.
** indicates a minute. Specify a number between 00 and 59.
** indicates a second. Specify a number between 00 and 59. The second can be omitted. If it is omitted, "00" is assumed.
☞　Please note that it is not possible to accurately set the time as far as seconds due to time lag in the processing.

・ Response
STIME"E"<cr>

20. Set Automatic Item command

・ Format
SAUTO,n,m<cr>

・ Description
A command that sets automatic items. n and m are integers and their possible values are given in the following table.

[Driver (-50)]

n	m	Set value
0	0	Setting of measurement data output: OFF
0	1	Setting of measurement data output: ON
1	0	Setting of zero-offset: OFF
1	1	Setting of zero-offset: ON
2	0	Setting of return: OFF
2	1	Setting of return: ON
3	0	Setting of print: OFF
3	1	Setting of print: ON
4	0	USB Memory Save: OFF
4	1	USB Memory Save: ON

[Driver (-35/-40/-45)]

n	m	Set value
0	0	Setting of measurement data output: OFF
0	1	Setting of measurement data output: ON
3	0	Setting of print: OFF
3	1	Setting of print: ON
4	0	USB Memory Save: OFF
4	1	USB Memory Save: ON

・ Response
SAUTO"E"<cr>

21. Record of Vibration command

・ Format
SCVIB<cr>

・ Description
A command that performs the Record of Vibration.

・ Response
SCVIB"E"<cr>

146

22. **Re-Calc command**

・ Format
SRECA<cr>

・ Description
A command that performs recalculation. The recalculation is performed by this instrument. If there is no measurement data, the command does not perform the recalculation and returns a parameter error.

・ Response
SRECA"E"<cr>

23. **Data Save command**

・ Format
SSAVE,n[,m]<cr>

・ Description
A command that saves data. Data is saved in the internal memory of this instrument.
When n = 0, the measurement conditions are saved.
m is the number in which measurement condition data is saved. Specify it using a number between 1 and 5.
m can be omitted. If it is omitted, data is saved in a smaller number in which no data has been saved.

When n = 1, the measurement data is saved.
m is the number in which measurement data is saved. Specify it using a number between 1 and 29.
m can be omitted. If it is omitted, data is saved in a smaller number in which no data has been saved.

・ Response
SSAVE"E"<cr>

24. **Read Data command**

・ Format
SREAD,n,m<cr>

・ Description
A command that reads data. The command reads data that has been saved in the internal memory by this instrument.

When n = 0, the measurement conditions are read.
m is the number in which measurement condition data is saved. Specify it using a number between 1 and 5.

When n = 1, the measurement data is read.
n is the number in which measurement data is saved. Specify it using a number between 1 and 30.

・ Response
SSAVE"E"<cr>

25. **Meas. Data Clear command**

・ Format
SDELL<cr>

・ Description
A command that deletes measurement data. The command deletes all measurement data that has been saved in the internal memory.

・ Response
SDELL"E"<cr>

12. Connecting with PC

26. **Set AI-Function command**

・ Format
SAIST,n,m<cr>

・ Description
A command that sets the AI function.
n and m are integers and their possible values are given in the following table.
If CNOMO or ASME'95/ASME'02 has been specified for the Standard, the command returns an error response if Execute ON (n = 0, m = 1) is specified.
(It does not return an error response if Execute OFF (n = 0, m = 0) is specified.)

[Execute]

n	m	Item
0	0	Execute OFF
0	1	Execute ON

[Objec. Param.]

n	m	JIS '94	JIS '82	ISO '97/ JIS '01/ DIN
1	0	Ra	Ra	Ra
1	1	Ry	Rmax	Rz
1	2	Rz	Rz	RSm
1	3	Sm	-	-
1	4	S	-	-

[Cutoff U-Lim]

n	m	Driver (-50)	Driver (-35/-40)	Driver (-45)
2	0	0.08	0.08	0.08
2	1	0.25	0.25	0.25
2	2	0.8	0.8	0.8
2	3	2.5	2.5	-
2	4	8.0	-	-
2	5	(25.0)	-	-

* The Cutoff U-Lim (25.0) for driver (-50) can only be set for JIS' 82 standard and Rmax and Rz are specified for the Objec. Param.

・ Response
SAIST"E"<cr>

27.**Initialize Conditions command**

・ Format
SRSET<cr>

・ Description
A command that sets various condition settings (other than Language, Display Unit, Sleep, and Date)to their default values.

・ Response
SRSET"E"<cr>

28. **Forced Termination command**

・ Format
SSTOP<cr>

・ Description
A command that terminates measurement or return movement and terminates data output process.

・ Response
No response.

12-4-4 Error codes

The instrument returns an error code as part of its response when it has received a command and executed the processing of it.

Upon execution of a command received, the information as shown below is converted to its hexadecimal equivalent and an error code consisting of two characters (0-9, A-F) is returned. (The code corresponds to [E].)

BIT7 is always 1 and BIT1 and BIT2 are always 0.

BIT7	BIT6	BIT5	BIT4	BIT3	BIT2	BIT1	BIT0
1	(1)	(2)	(3)	(4)	0	0	(5)

  (1) BIT6: System error ... It is set to 1 when an unexpected error has occurred.
  (2) BIT5: Busy error ... It is set to 1 when other processing is in progress.
  (3) BIT4: Format error ... It is set to 1 if the command format is invalid.
  (4) BIT3: Parameter error ... It is set to 1 when the specified argument of the command is out-of-range.
  (5) BIT0: Device error ... It is set to 1 is a hardware problem has occurred.

Error code 80 indicates that there is no error. If a device error has occurred, turn off the instrument power and turn it back on again before transferring the command.

If a command that cannot be recognized is entered, the instrument returns "CERR[E]<cr>" as a response code.
The instrument will do nothing.

Example: If a system error has occurred in processing the SMEAS command, "SMEASC0<cr>" is returned.

12. Connecting with PC

12-4-5 Output data format

The output formats for the Data Output command (SDATA) for each output type are as shown below.

<When the output type is "Hex">

● Output of a measurement condition
Format: SCND , * , * , * , * , * , * , * , * , * , * , * , * , * , * * * * * * * * , * * * * * *<cr>

(1) (2) (3) (4) (5) (6) (7) (8) (9) (10) (11) (12) (13) (14)

(1) Measurement Type: [0] Roughness Measurement, [1] Profile Measurement [2] Waviness Measurement
(2) Standard: [0] JIS '82, [1] JIS' 94, [2] ISO '01/JIS' 01/DIN
   [3] CNOMO, [4] ASME '95/ASME '02
(3) Evaluation length: 0.1 to 50.0 mm
(4) Cutoff values: Low- and high-pass filters are output in that order.

The following values are output based on the settings on the measurement type and cutoff values (only at waviness measurement).

Measurement type	Cutoff value	Value	
		Low-pass filter	High-pass filter
Profile		"1"	"1"
Roughness measurement		"1"	λc value
Waviness measurement	With λf	λc value	λf value
	Without λf	λc value	"1"

(5) Measure range
(6) Measure speed: [0] 0.15 mm/s (0.006 in/s), [1] 0.30 mm/s (0.012 in/s)
   [2] 0.60 mm/s (0.024 in/s). [3] 1.5 mm/s (0.06 in/s)
(7) Pre/Post Travel: [0] Cutoff Value/3 $\times$ 2, [1] Cutoff Value/2 $\times$ 2, [2] Cutoff Value $\times$ 2
(8) Pickup Type: [0] Standard, [1] 1/2
(9) Tilt correction
(10) Filter Type
(11) λs Filter
(12) Unit: [0] millimeters, [1] inches
(13) Date
(14) Time

Cutoff value
Measure range, Form remove, Filter Type, and Ls filter are the same as the content of each command value.
When the driver (-35/-40/-45) is connected, the value of the measure range is 3.

150

● Output of parameters (output to SDATA only)
Format: **SPRM**,1,***,2,*** . . . . . . ,n,***<cr>

         (1) (2)

(1) Parameter number
(2) Parameter value

☞   For the parameter number, see the bit assignment for the output items.

A parameter that has been specified for the judgment and has a section parameter is output as shown below.

Format: **SPRM**,1,***,***,***,***,2, ... ,n,***<cr>

   (1)   (2)   (3)   (4)   (5)
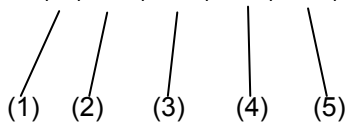
(1) Parameter number
(2) Parameter value
(3) Maximum value of section
(4) Parameter value - standard deviation
(5) Parameter value + standard deviation

☞   For the parameter number, see the bit assignment for the output items.

● Output of measurement data
For "SDATA" command
Format: ****,n,first point 2nd point 3rd point . . . . nth point

    (1) (2)   (3)
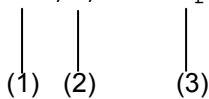
(1) Indicates a profile kind that is represented by four characters as shown below.
   Profile curve   : PCRV
   Roughness curve   : RCRV
   Waviness profile curve : FCWV
   Filtered waviness curve : FWAV
(2) Indicates measurement data points whose n value is equal to or less than 25000.
(3) For points following the first one, the measurement data is converted to hexadecimal equivalent and continuously output up to nth points as one piece of data consisting of four bytes. The value is any hexadecimal number from F800 through 07FF. Negative numbers are represented by the two's complement.

The following table shows the weight of each bit (resolution) that is based on the measurement range.

Weight of each bit	Measure range
0.016 µm/0.63 µin	400 µm/15748 µin
0.0016 µm/0.063 µin	40 µm/1574.8 µin
0.00016 µm/0.0063 µin	4 µm/157.48 µin
0.0064 µm/0.252 µin	160 µm/6299.2 µin

Example of output
   PCRV,6668,0001FFF3FFEDFFFF00080008FFFFFFFF3FFEFFFF5FFFDFFFD
    "PCRV,6668" indicates profile curve data points.
    The hexadecimal data string subsequent to "6668" is the measurement data.

12. Connecting with PC

● Output order
The data is output in the following order.
Profile data output is the same as the print output.

SCND, ... <cr> SPRM, ... <cr> PCRV, ... <cr> RCRV, ... <cr>

<<Supplementary information>> How to convert hexadecimal number data to a decimal number

Four hexadecimal characters constitute one piece of data. In the example above, the hexadecimal data is converted to decimal number as shown below.
(FF27),(FF26),(FF27),(FF26)------
Each group of four hexadecimal characters that are enclosed by parentheses represents one point of data.
The method for converting hexadecimal numbers to decimal numbers is:

Hexadecimal "H1-H2-H3-H4"   Decimal number

For a positive hexadecimal number from 0000 to 7FFF: $H1 \times 16^3 + H2 \times 16^2 + H3 \times 16 + H4$

For a negative hexadecimal number from FFFF to 8000: $(H1 \times 16^3 + H2 \times 16^2 + H3 \times 16 + H4) - 2^{16}$

Example: Hexadecimal number 0154 is converted to decimal number 340.
Hexadecimal number F597 is converted to decimal number -2665.

The range of measurement data in decimal is between -32768 and 32767.
Next, the measurement data is converted to a value in micrometers when it is multiplied by the weight of each bit which is dependent on the measurement range.
For example, when Standard Pickup is selected, the Measure range is set to +/- 400, and decimal number is 340:
(Measurement data) = $340 \times 0.016 = 5.44$ µm

Hexadecimal data points can be converted to data string in micrometers by repeating the above conversion as many measurement points.

When the output type is "Text"

The format for text measurement data is as follows:
The output order is the same as the print output.
Curve data output is the same as the print output.
The data pitch can be determined by dividing the evaluation length by (data points - 1).

<Example of output>

```
Roughness<cr>                    ──────── (1)
(JIS'82) <cr>                    ──────── (2)

Eval.Length=4.00mm<cr>           ──────── (3)
Meas. Speed=0.6mm/s<cr>          ──────── (4)
Cutoff value=0.8mm<cr>           ──────── (5)
Cutoff=Gausian<cr>               ──────── (6)
Meas. Range=160um<cr>            ──────── (7)
Tilt=Straight<cr>                ──────── (8)
Cutoff ratio=300<cr>             ──────── (9)
LIMIT A=0.5mm<cr>                ──────── (10)
LIMIT A=2.5mm<cr>                ──────── (11)
<cr>                             ──────── (12)
MM<cr>                           ──────── (13)
Ra=2.1<cr>
Ramax=2.2<cr>
Ramax=2.2<cr>
Ra-sd=2.3<cr>
Ra+sd=1.8<cr>
Ra-1=2.1<cr>
Ra-2=2.0<cr>
Ra-3=1.9<cr>
Ra-300=2.2<cr>                   ──────── (14)
Rmax=15.0<cr>
Rz=13.3<cr>
Rq=2.6<cr>
Rp=6.2<cr>
Rt=13.5<cr>
Pc=50<cr>
Tp=3.7<cr>
<cr>                             ──────── (15)
MM<cr>                           ──────── (16)
P<cr>                            ──────── (17)
4.00<cr>                         ──────── (18)
5000<cr>                         ──────── (19)
-0.96<cr>
-1.04<cr>
-1.04<cr>                        ──────── (20)
-1.12<cr>
```

<Description of content>

(1) Measurement type
(2) Standard
(3) Evaluation length
(4) Measure speed
(5) Cutoff value
(6) Filter type
(7) Measure range
(8) Tilt correction
(9) Cutoff ratio
(10) Roughness motif upper limit length
(11) Waviness motif upper limit length
(12) <Parameter>
(13) Output unit [mm] millimeters [INCH] inches
(14) Parameter symbol and value
(15) <Profile data>
(16) Output unit [mm] millimeters [INCH] inches
(17) Profile kind
   [P] Profile curve, [R] Roughness curve, [W] Filtered waviness curve
   [WC] Waviness profile curve
(18) Evaluation length (mm)
(19) Data points
(20) Measurement data (μm) as many data points

12. Connecting with PC

<When the output type is "SPC">
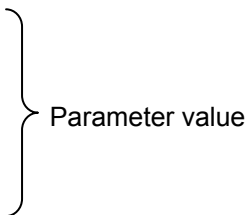
Only the parameters for which output settings have been configured are output in the following format.
The parameters are output in ascending order of parameter numbers.
For parameters containing section parameters, the maximum value of section, parameter + standard deviation, parameter - standard deviation are output after the parameter value.

```
***.***<cr><lf>
***.***<cr><lf>
***.***<cr><lf>
    ⋮
    ⋮
    ⋮
***.***<cr><lf>
```
⎫
⎬ Parameter value
⎭

12-4-6 Output data format for characteristics graph

The output formats for the Characteristics Graph Data Output command (SGRPH) for each output type are as shown below.

\<When the output type is "Hex"\>
Since only parameters are output, specifying this command will result in command execution error.

\<When the output type is "Text"\>
As in the output of measurement data, the format for text is as follows:
The output order is the same as the print output. (Characteristics data is output following the parameters.)

\<Example of output\>

```
MM<cr>            ──────── (1)
BAC1<cr>          ──────── (2)
5.47<cr>          ──────── (3)
1001<cr>          ──────── (4)
0.0,0.0<cr>  ⎫
0.1,0.0<cr>  ⎪
0.2,0.1<cr>  ⎪
0.3,0.1<cr>  ⎪
0.4,0.1<cr>  ⎬──────── (5)
0.5,0.1<cr>  ⎪
0.6,0.1<cr>  ⎪
0.7,0.1<cr>  ⎪
0.8,0.1<cr>  ⎭
```

\<Description of content\>
(1) Output unit [mm] millimeters [INCH] inches
(2) Graph type [BAC] BAC graph, [ADF] ADC graph
(3) P-P value (µm/µin)
(4) Data points
(5) Followed by as many X coordinate values (Notes 1 and 2) and Z coordinate values (%) as there are data points.

(Note 1)   The unit of X coordinate values vary depending on the unit of the cut level. When Relative is selected, the unit is "%". When Absolute is selected, the unit is "µm/µin".

(Note 2)   The values of X coordinate values are output as relative values even if Absolute is selected. Calculate absolute values from relative values with the value of P-P value given as 100%.

\<When the output type is "SPC"\>

Since only parameters are output, specifying this command will result in command execution error.

13. Maintenance

This chapter explains how to carry out daily maintenance of the instrument and how to replace batteries.

13-1 General maintenance

⚠️ **Warning** **Be sure to turn the instrument power off before carrying out maintenance checks.**

To help ensure correct operation of the instrument, periodic maintenance is required. Please note that inadequate maintenance may cause the instrument to malfunction or lead to incorrect measurement results.

(1) Calibrate your instrument at least once a month. If the instrument is in constant use, we recommend that you calibrate it at least once a week.
(2) Avoid moisture, water droplets, dust, oily smoke, direct sunlight, strong shock, and vibration.
(3) Wipe off the data processor cover and operation panel lightly with a soft cloth dampened with neutral detergent or alcohol. Do not use organic solvents.
(4) Wipe off the top of the optional compact measurement table, if used, with a soft cloth on a regular basis.

13-2 Checking stylus

The diamond tip of the stylus will gradually wear through use. Impact may damage the tip.
Use of a stylus that has a worn or damaged tip will lead to errors in the measurement results. Therefore, it is necessary to check the stylus before making measurements.
Be sure to check the stylus once a day before making measurement.

13-2-1 For the driver (-35/-40/-45)

1. Set the measurement conditions and various settings as shown below.

Measurement condition	Evaluation length	4.00 mm (0.1575 in)	Filter type	Gaussian
	Cutoff value	0.8 mm (0.03 in)	λ s	Cutoff Ratio 300
Various Settings	V-Mag	$\times$ 10K	H-Mag	$\times$ 200

2. Place the attached roughness specimen (E-MC-S24B) parallel to the measurement direction to measure the "STYLUS CHECK" surface (having a roughness of approximately 0.4 µmRa). (For -45, use the attached calibration stand.)

3. Determine the measurement results based on the tracing and the Ra value of the roughness curve given in the following table.

Judgment of measurement results	Good	Worn	Damaged
Tracing	∧∧∧∧	Peaks are rounded ∩∩∩∩	Peak tops are damaged ⋂⋁⋁⋁
Ra value	±0.04 µm (1.6 µin) for the displayed value	-0.04 to -0.1 µm (-1.6 to -3.9 µin) for the displayed value	Not more than -0.1 µm (-3.9 µin) for the displayed value

☞ If the stylus is worn or damaged, replace it with a new pickup.
☞ The displayed value of the reference specimen is the result that is obtained by measuring it with a stylus having a radius of 2 µmR.
For a pickup that has a stylus radius other than 2 µmR, measure the reference specimen and save the tracing and the Ra value at the time of purchase and check the stylus by comparing it with the saved tracing and the Ra value.
☞ The measurement value of the reference specimen slightly varies with location.
If the same place is repeatedly measured, the reference specimen may be worn to decrease the measurement value. Thus, measure it on three or more places to determine the measurement results based on the average.

13-2-2　For the driver (-50)

1. Set the measurement conditions, various settings, and measurement preparation as shown below.

Measurement condition	Measurement type	Roughness measurement	Measure speed	0.3 mm/s (0.012 in/s)
	Evaluation length	4.00 mm (0.1575 in)	Filter type	Gaussian
	Cutoff value	0.8 mm (0.03")	Ls Filter	Cutoff ratio 300
Various Settings	V-Mag	× 10K	H-Mag	× 200
Measurement Preparation	Measure range	±40 μm		

2. Place the supplied roughness specimen (E-MC-S24B) parallel to the measurement direction and lower the pickup until the stylus is brought to bear on the "STYLUS CHECK" surface (having a roughness of approximately 0.4 μmRa).

3. Adjust the tilt of the driver so that the measuring plane and the drive direction are in parallel with each other and make measurement.

4. Determine the measurement results based on the tracing and the Ra value of the roughness curve given in the following table.

Judgment of measurement results	Good	Worn	Damaged
Tracing		Peaks are rounded	Peak tops are damaged
Ra value	±0.02 μm (0.8 μin) for the displayed value	-0.02 to -0.1 μm (0.8 to 3.9 μin) for the displayed value	Not more than -0.1 μm (-3.9 μin) for the displayed value

☞　If the stylus is worn or damaged, replace it with a new stylus.
☞　The displayed value of the reference specimen is the result that is obtained by measuring it with a stylus having a radius of 2 μmR.
For a stylus having a stylus radius other than 2 μmR, measure the reference specimen and save the tracing and the Ra value at the time of purchase and check the stylus by comparing it with the saved tracing and the Ra value.
☞　The measurement value of the reference specimen slightly varies with location.
If the same place is repeatedly measured, the reference specimen may be worn to decrease the measurement value. Thus, measure it on three or more places to determine the measurement results based on the average.

13. Maintenance

13-3   Replacing the battery

Degraded battery may result in significant decrease in the number of times continuous measurement has been made on a full charge. If this is the case, battery replacement is recommended. Be sure to use batteries specified by us.

⚠️ **Caution** **The measurement data saved in the internal memory will be lost if the battery runs out. Be sure to save valuable data onto a USB memory stick.**

Turn off the power switch on the data processor and disconnect the AC adapter before replacing the battery. Follow the steps below to replace the battery.

1. Open the battery cover on the back of the data processor. Press the central part on the top of the battery cover and slide it down.

3. Remove the connector from the main unit.
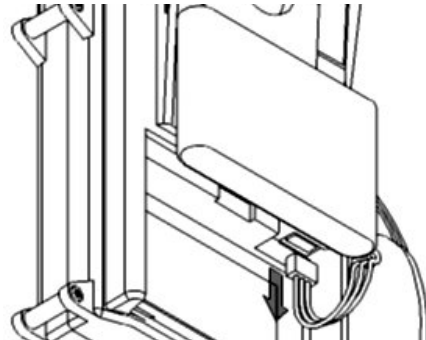
⚠️ **Caution** **Do no apply excessive force to the connector.**

⚠️ **Caution** **Pulling the cable may cause it to break, resulting in a malfunction. When disconnecting the cable, hold the cable connector and pull it out.**

2. Remove the battery.

⚠️ **Caution** **The battery is connected to the main unit through the cable. Do not use excessive force to pull out the battery.**

4. Insert the connector of the new battery into the connector in the main unit. Make sure that the connector is correctly oriented, and insert it all the way.
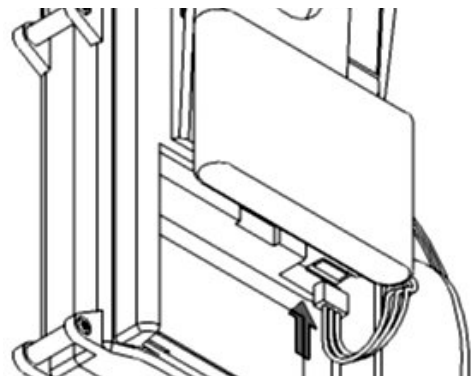
⚠️ **Caution** **Do no apply excessive force to the connector.**

5. Place the new battery in the main unit. Push the battery all the way in while pressing the cable to the sides of the battery storage space.

6. Reattach the battery cover.
Insert it securely until it clicks.
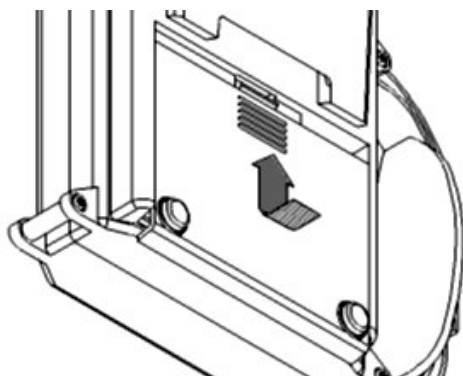
14. Parameter Description

The following explains the terminologies, the parameter calculation, the measurement procedure, and evaluation relating to instruments that measure surface roughness.
To describe this instrument accurately, this document covers some terms and calculation parameters that may not be used for the instrument.
Also, some calculation parameters of this instrument may not be covered by local standards.

14-1 Contour curve

ISO 4287:1997/JIS B0601:2001 and ISO 3274:1996/JIS B0651:2001 compliant
The surface parameters are calculated from the two-dimensional contour curve using different calculation methods.
The following explains definitions of this contour curve.

14-1-1 Real surface and profile curve

● **Coordinate system**
Coordinate system that defines surface parameters. The measurement direction of stylus that matches the mean line is assumed to be X-axis.
An axis perpendicular to the X-axis on the real surface is assumed to be the Y-axis, and the direction from the object side to the surrounding space is assumed to be the Z-axis.
The Z-axis direction of the contour curve is called the vertical direction, and the X-axis direction is called the horizontal direction.

● **Real surface**
A boundary of an object. This surface separates the object from the surrounding space.

● **Surface profile curve**
A curve appearing at a cut edge when the real surface is cut by the specified plane.

● **Traced curve**
A trace in the perpendicular plane at the center of a tip ball that has the ideal geometry (cone that has a spherical tip), certain measuring force and dimensions when the stylus moves on the target surface. In other words, the traced curve is the contour appearing at a cut edge when the target surface is cut by the plane perpendicular to the surface.
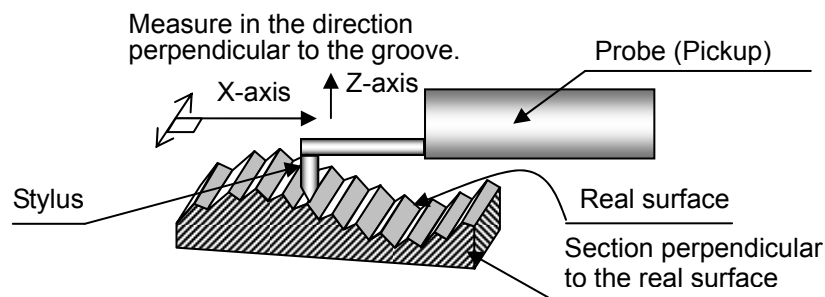
Figure 14-1-1 Section measurement using a stylus

● **Reference line**
This is a trace that is formed when the stylus moves along to the reference guide.

● **Measurement cross-section curve**
A digital-format measuring curve that has been obtained based on the reference line in the coordinates that have vertical and horizontal axes. Using the probe, this instrument traces the real surface to sample data at the same interval. This instrument sequentially converts the obtained analog data to the digital data, and then quantizes the data to obtain the string of discrete data points.

● **Contour curve**
A curve showing the section contour such as a profile curve, roughness curve or waviness profile curve that can be obtained by deformation of the measurement cross-section curve.

● **Profile curve (P)**
A curve that is obtained when the measurement cross-section curve is passed through the low-pass filter that has the λs cutoff value. The nominal contour and inclination assigned by the least square method are removed by the slope correction. The primary profile parameters are calculated from this curve. However, if the λs filter is not used, the primary profile parameters are calculated from the measurement cross-section curve.

14-1-2   Filtered mean line and roughness curve

● Mean line for profile curve

This is a curve indicating the nominal contour assigned to the profile curve using the least square method, or the curve that the sum of squares of the deflection from the profile curve becomes minimum. This is normally a straight line because the measurement is made on a plane surface, but there is a case where the mean line becomes a circle or specified curve on the curved surface or designated contour. In this instrument, the mean line is shown as the X-axis that has made the "Straight line correction" to the profile curve. (Refer to the "Tilt correction and reference line".)
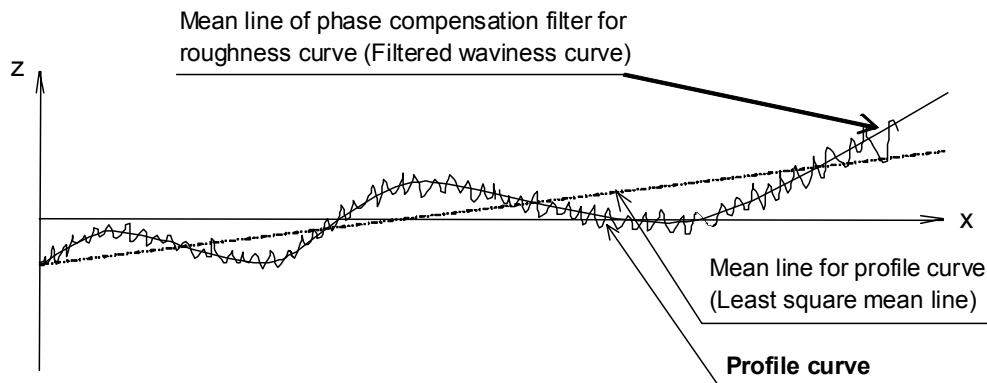
Figure 14-1-2 Profile curve and mean line for roughness curve

●Roughness curve (R)

This is a contour curve that has cut off any longer surface waviness components from the profile curve by a high-pass filter that has cutoff value λc. The roughness parameters are calculated from this curve. However, if the λs filter is not used, the measurement cross-section curve is passed through a high-pass filter that has cutoff value λc, and the resulting curve is used as the roughness curve.

● Mean line for the roughness curve

This is a contour curve that has cut off any shorter surface waviness components from the profile curve by low-pass filter having cutoff value λc. The roughness curve is the one that was created after the mean line was removed from the profile curve. The mean line is a straight line where Z=0 on this roughness curve.

●Center line

The center line is the straight line that when the straight line parallel to the mean line of a roughness curve passed 2RC filter is drawn, the areas surrounded by this straight line and roughness curve on both sides of the straight line are equal to each other. (Old JIS B0601-1982 standard)
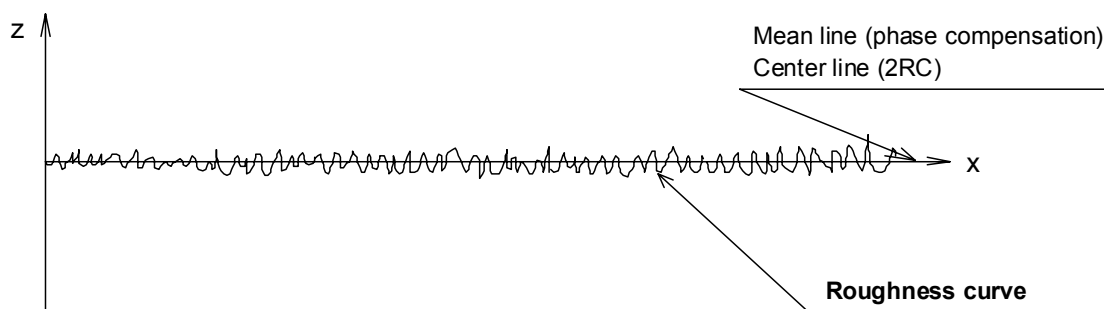
Figure 14-1-3 Roughness curve and mean line

14. Parameter Description

14-1-3   Filtered waviness curve

● **Waviness profile curve (W)**
This is a contour curve obtained from the profile curve by removing its components by a high-pass filter that has cutoff value λf and by low-pass filter that has cutoff value λc. The longer surface roughness components are cut off by the contour curve filter that has cutoff value λf, and the shorter surface roughness components are cut off by the contour curve filter that has cutoff value λc. The waviness parameters are calculated from this curve.

● **Mean line for waviness profile curve**
This is a contour curve obtained from the profile curve by removing the shorter surface roughness components by the low-pass filter that has cutoff value λf. The waviness profile curve is the one that was created after the mean line was removed from the mean line for the roughness curve. The mean line is a straight line where Z=0 on the waviness profile curve.

● **Filtered waviness curve (W_c)**
This is the curve, in Old JIS standards, obtained by removing the surface roughness components with short wavelengths from a profile curve. A 2RC low-pass filter of -12 dB/oct Note 1) attenuation is employed. (Old JIS B0610-1987)
In New JIS, it is called the "Mean line for roughness curve" using a phase compensation filter.
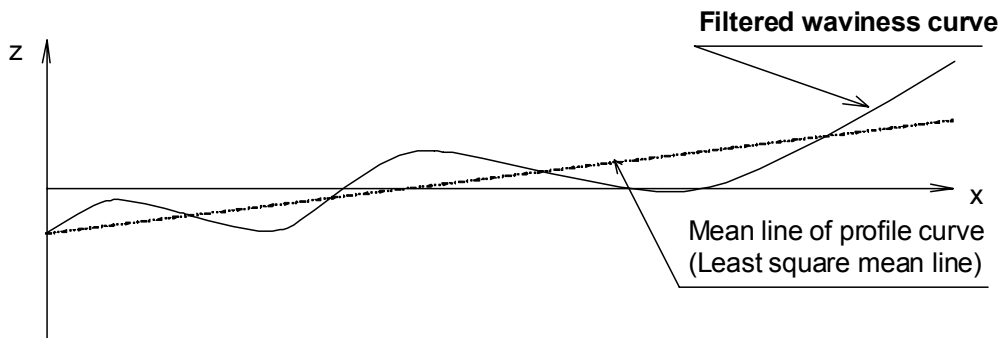
Figure 14-1-4 Old JIS filtered waviness curve

● **Filtered center line waviness curve (W_{CC})**
This is the curve obtained by removing the long wavelength components from a filtered waviness curve in the old JIS standard.
2RC high-pass filter of -12dB/oct attenuation is employed.(Old JIS B0610-1987)
In the new JIS standard, it is called the "waviness profile curve" by filtering with a phase compensation filter.
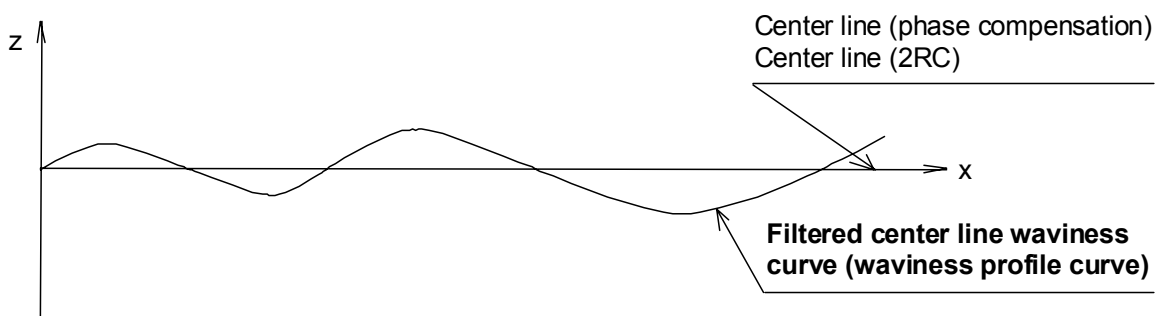
Figure 14-1-5 Old JIS filtered center line waviness curve

Note 1) "dB" is a "decibel" and is explained as follows. When the damping factor of input and output signals is set to "A" (output amplitude/input amplitude), it is shown as follows. Transfer factor (damping factor) dB = $20 * \log_{10} A$. Therefore, if A = 1/4, it is "-12dB". "oct" is an "octave" and it is twice the magnitude of a waveform. Therefore, "-12dB/oct" shows that when the size of the wavelength increases by a factor of 2, the amplitude shrinks by 75%.

162

14-1-4   ISO13565-1/JIS B0671-1/DIN4776 special roughness curve (R_{g2})

In the standard of ISO13565-1:1996/JIS B0671-1:2002 and DIN4776-1990, the special roughness curve R_{g2} is employed, from which waviness has been removed. ("R_{g2}" is the temporary symbol of this instrument.)
As this instrument has been created to calculate the bearing area curve in accordance with "ISO13565 or DIN4776", it is calculated in accordance with the standard through the following procedure.

Step (1)   Obtain mean line fro roughness curve W_{cg} from profile curve P by using Gaussian phase compensation filter.
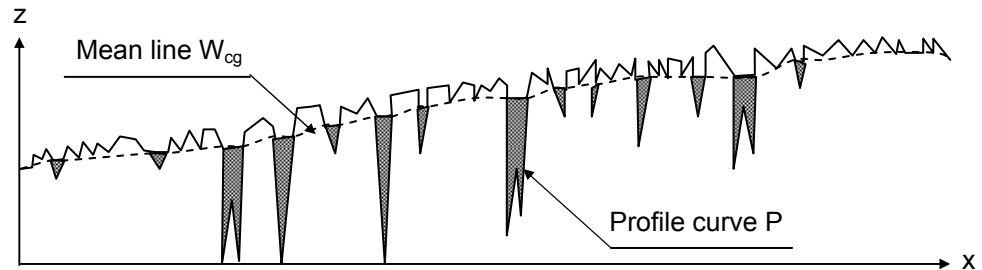
Figure 14-1-6 Calculating the mean line

Step (2)   Connect profile curve P to the higher waviness position of the mean line for the roughness curve W_{cg}, obtained in Step (1), and create a curve in which valleys are removed.
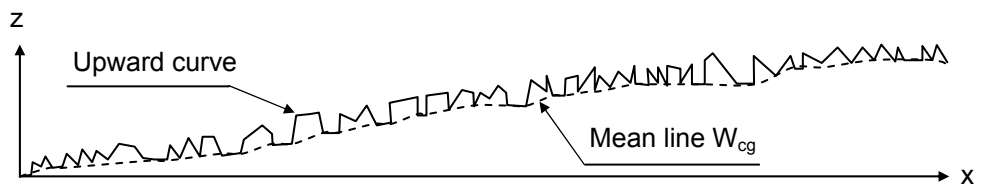
Figure 14-1-7 Calculating the upward curve

Step (3)   Apply the upward curve obtained by Step (2) to the phase compensation filter in Step (1) to obtain the reference mean curve, W_{cg2}.
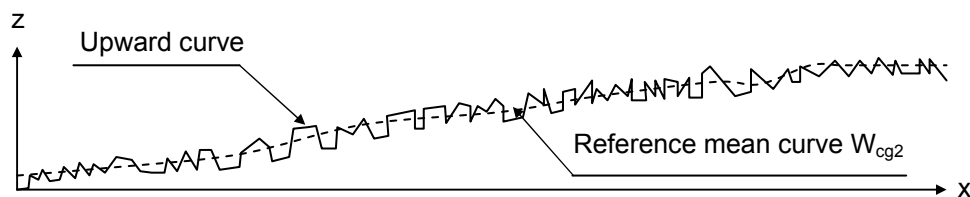
Figure 14-1-8 Calculating the reference mean curve

Step (4)   Subtract the reference mean curve, W_{cg2} in Step (3) from the profile curve P and obtain the special roughness curve R_{g2}.
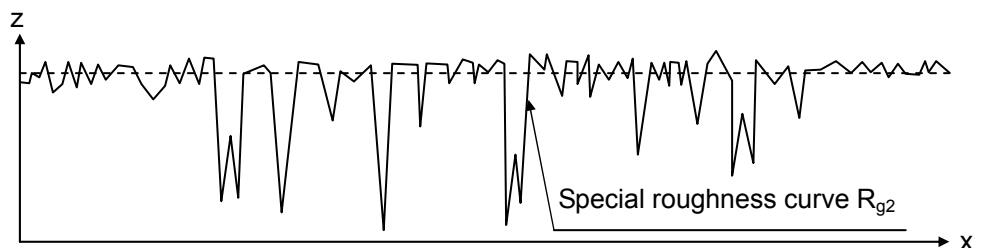
Figure 14-1-9 Calculating the special roughness curve

14. Parameter Description

14-1-5 Tile correction and reference line

● **Reference line and datum line**
This is the reference of the profile curve, which is selected from the following methods used to determine the reference.

● **Unshifted original profile:**
This is an actual profile curve that has not been shifted or corrected.
This profile is used for measuring height and tilting angle from the reference line being set at the beginning.
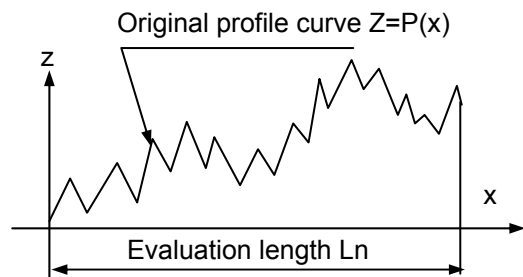
Figure 14-1-10 Unshifted original profile

● **Least square straight line correction**
This is a method used to obtain the mean line of all data within the range of evaluation length by the least square method, and to subtract it as the reference.
This is the mean line used as the profile curve on a linear profile.
This method is based on the ISO/JIS standard for roughness measurement.
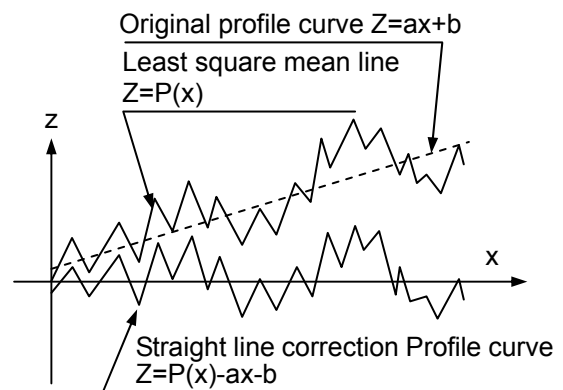
Figure 14-1-11 Least square straight line correction

● **Least square polynomial mean curve correction**
When a nominal profile is a curved surface of a circle and an involute function, etc.,
the evaluation must be made by using the reference line corresponding to the nominal profile.
In this instrument, it is approximated by a curve of a fourth degree polynomial expression in the least square method.
Note 1) In this case, a high-order term greater than the fifth degree function contained in the profile curve is not corrected.
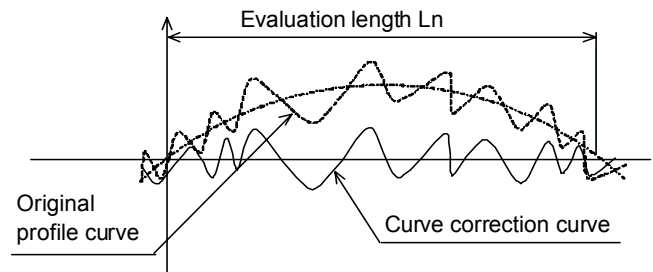
Figure 14-1-12 Least square polynomial mean curve correction

● **Before half least square mean line correction**
This is a method used to make correction to the least square mean line in the left portion (first half) of the step profile.
This is used for measuring the long step amount in the first half portion.
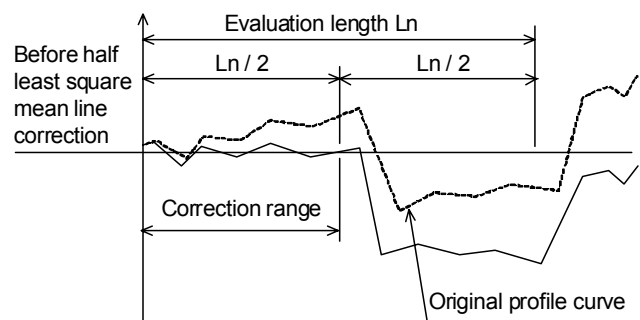
Figure 14-1-13 Before half least square mean line correction

● **Latter half lease square mean line correction**

This is a method used to make correction to the least square mean line in the right portion (second half) of the step profile.

This is used for measuring the long step amount in the second half portion.
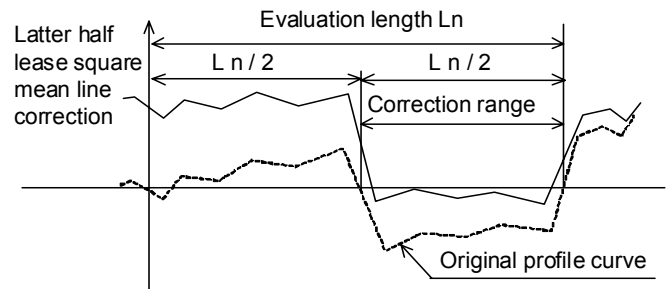
Figure 14-1-14 Latter half least square mean line correction

● **Beginning and end port connected line correction**

This is a method used to make a straight reference line to connect the right and left ends of the evaluation length in order to obtain the height of a projection in the belt on a plane surface board or the depth of a depression portion.
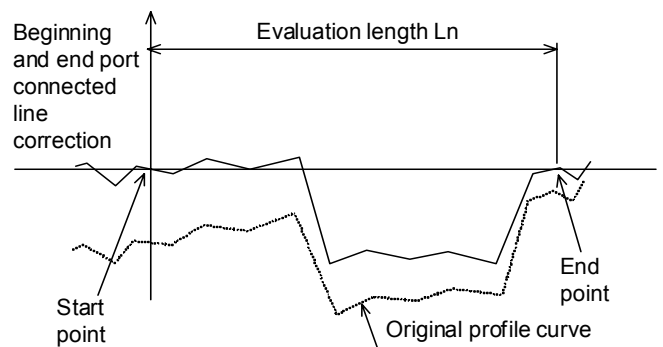
Figure 14-1-15 Beginning and end port connected line correction

165

14. Parameter Description

14-2 Cutting off and filters

14-2-1 What is the cutoff?

Irregularities on an object surface generally show complex patterns as shown in Figure (1). By taking a close look at the figure, you will see that it consists of a component with a fine short cycle of Figure (2), and a component with a gradual-slope long cycle of Figure (3), and that they are overlapped.
Cutoff is to separate Profile Pattern (1) into Roughness (2) and Waviness (3) and sample out only the necessary component.
Reference wavelength that divides the pattern into "Roughness" and "Waviness" components is called "Cutoff value λc (mm)".
In order to make the cutoff, a Filter (Wavelength filter) is employed.

Figure 14-2-1 Separation of roughness and waviness components

A filter used to remove waveform components greater than the cutoff value is called a high-pass filter, a short-pass filter, a long-wavelength cutoff filter, and other names.
Also, a filter used to remove waveform components less than the cutoff value is called a low-pass filter, a long-path filter, a short-wavelength cutoff filter, and other names.

14-2-2 2RC filter

This is the filter defined in old JIS B0601-1982, JIS B0610-1987, ANSI B46.1-1985, ISO3274-1976 and other standards. A two-RC filter consists of two R-C circuits with an equal time constant in series connection, and it provides amplitude transmission characteristics as follows.

$$\frac{a_2}{a_0} = \frac{1}{1 + \frac{\lambda^2}{3 \times (\lambda_{c75})^2}}$$

where,
a_2: Amplitude after cutoff of relevant wavelength components
a_0: Original amplitude of relevant wavelength components
λ: Relevant wavelength (mm)
λc_{75}: Cutoff value (mm)
If $\lambda = \lambda c_{75}$, the transmission rate is $a_2/a_0 = 75\%$.
In this case, the power of 2RC filtered waviness curve (square mean value $(RMS)^2$) that has the same cutoff value and the value that was added the power of this curve are nearly the same as the power of the profile curve.

Figure 14-2-2 Amplitude transmission characteristics of 2RC filter

The changing ratio of the attenuation rate is -12 dB/oct in the attenuation area.
But a waveform has a characteristic to change the phase similar to the change of the amplitude transmission rate caused by a change of the wavelength. It should be noted that it causes a distortion of the waveform to the roughness curve. There is a case where an outlook of the waveform is largely differ from the roughness parameter nor the bearing ratio curve is drastically changed when they are compared with the result obtained from the profile curve.

166

14-2-3   Phase compensation filter

A phase compensation filter eliminates a phase shift that occurs in transmission characteristics to solve the phase shift issue of the 2RC filter. Figure 14-2-3 shows a phase shift that may occur when rectangular waves are passed through the 2RC filter and through a filter that has phase compensation.

Filtering effects when the 2RC filter is used

Filtering effects when a phase compensation filter is used

Measuring profile (profile curve P)

Roughness curve R
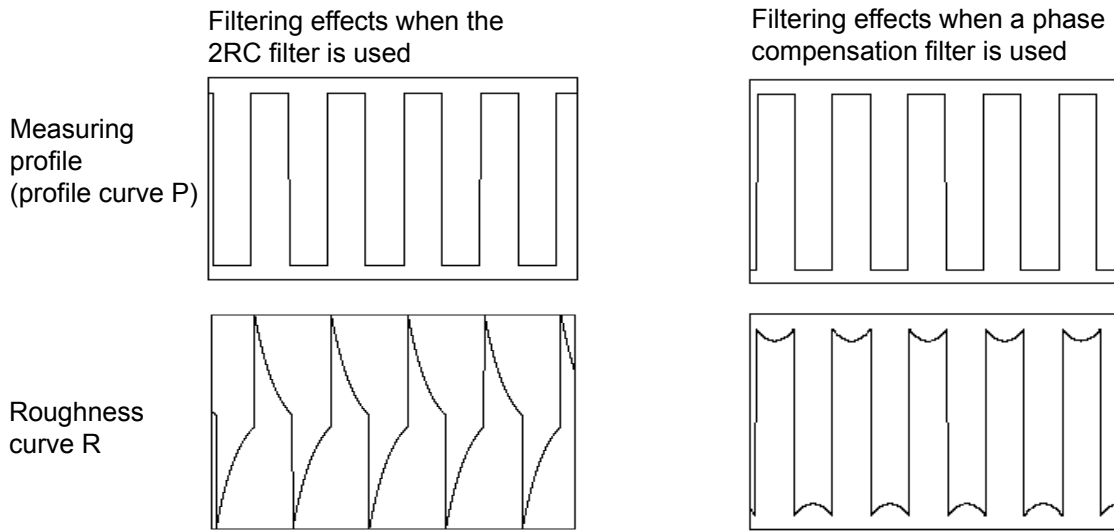
Figure 14-2-3 Filtering effects when 2RC filter and a phase compensation filter are used

There are two types of the phase compensation filters:

● **Gaussian phase compensation filter**
This is an international standard of filter that has been defined in ISO11562:1996 and JIS B0632:2001 standards. The parameter values are determined according to the following procedure.
(1) As weighed function for the normal probability density (Gauss distribution) function, the profile that was made convolution integral to the profile curve is made as the mean line of the phase compensation filter Wg.

The formula of the weight function is as follows:

$$S(x) = \frac{1}{\alpha\lambda_c} e^{-\pi\left(\frac{x}{\alpha\lambda_c}\right)^2}$$

where, X: Distance from the center of weight function
  λ_c: Cutoff value of the filter
  α: 0.4697

Transmission characteristics of the mean line of the phase compensation filter a_1/a_0 can be expressed as follows:

$$\frac{a_1}{a_0} = e^{-\pi\left(\frac{\alpha\lambda_c}{\lambda}\right)^2}$$

where, a_0: Amplitude of a sine profile curve before filtering
  a_1: Amplitude of a sign curve on the mean line
  λ: Wavelength of a sign curve
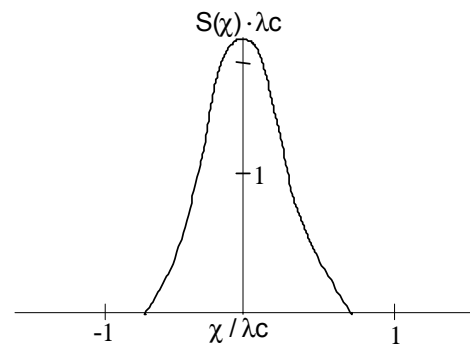
Figure 14-2-4 Weight function of the phase compensation filter

14. Parameter Description

(2) Roughness curve Rg is obtained from the profile curve if the mean line of the phase compensation filter is removed from this profile.
Transmission characteristics of the roughness curve (a_2/a_0) is as follows:

$$\frac{a_2}{a_0} = 1 - \frac{a_1}{a_0}$$

(3) The transmission ratio at λ=λc is a_2/a_0=50%. Therefore, the profile curve can be restored by adding the mean line of the phase compensation filter of the same cutoff value.
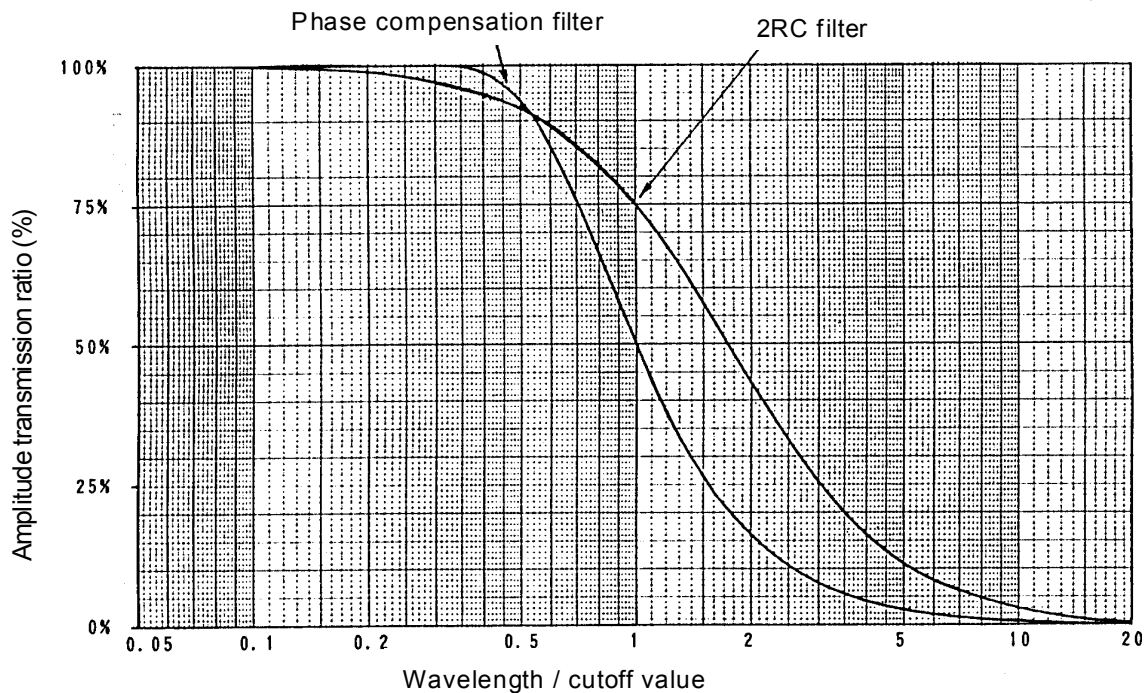
Figure 14-2-5 Transmission characteristics of roughness curve when the Gaussian phase compensation

filter and 2RC filter are used

● **2RC phase compensation filter**
This has the same cutoff characteristics as the 2RC filter and this filter has no phase shift.
The transmission ratio at λ=λc is a_2/a_0=75%.
However, this filter is not defined by the standards, and it is not used for the general surface roughness measurement.

14-2-4   Contour curve filter

A filter that separates the contour curve into longwave components and shortwave components.
The instrument uses the following three filters to obtain the roughness curve, waviness profile curve and profile curve.
All of them have the amplitude transmission characteristics defined by ISO11562:1996 and JIS B0632:2001 standards, but they have different cutoff values. (ISO4287:1997 and JIS B0601:2001)

● **λs contour curve filter:** Filter that separates roughness components and shorter wavelength components.
● **λc contour curve filter:** Filter that separates roughness components and waviness components.
● **λf contour curve filter:** Filter that separates waviness components and longer wavelength components.

168
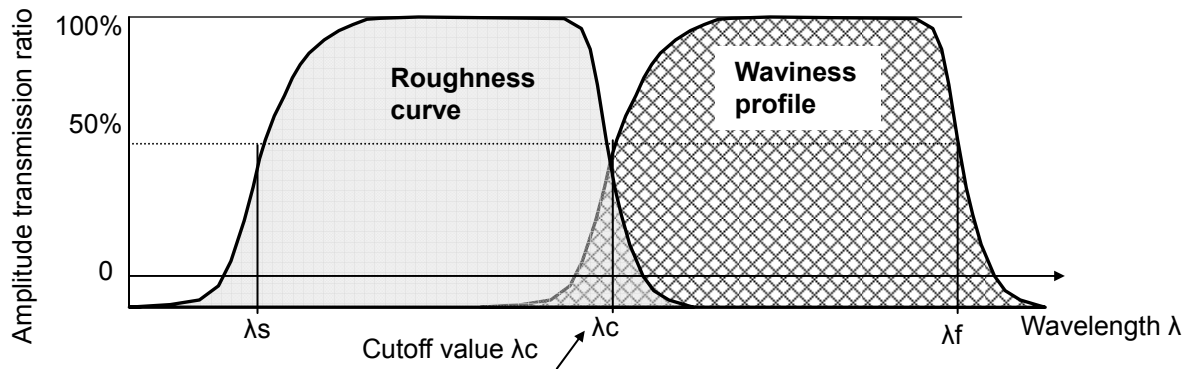
Figure 14-2-6 Contour curve filter and wavelength of filtered roughness and waviness profile curves

14-2-5   Short wavelength cutoff value λs and cutoff ratio

In the roughness curve and profile curve, the shortwave cutoff filter is used to remove the influence of microwave area error caused by the stylus tip radius. The cutoff value is called λs and it is defined as follows:
(1) The Gaussian phase compensation filter is used for filtering.
(2) The transmission characteristics is followed to transmission characteristic a_i/a_0 of the mean line of the phase compensation filter Wg.
(3) Shortwave cutoff value λs is selected from the following numeric values: 0.25, 0.8, 2.5, 8, 25, 80 μm.
(4) Cutoff ratio means the ratio of long wavelength cutoff value λs against short wavelength cutoff value λc of its provided transmission zone (λc/λs), which standard values are 30, 100 and 300.
Note: λs filter needs to be set before measuring. Even if the value of λs filter is changed when re-calculating, it is ignored, and it is calculated with λs filter set before measuring remained. Also, when measuring roughness, it is set by the cut off ratio.

\<Relations between long wavelength cutoff and stylus tip radius, and cutoff ratio\>
Unless otherwise specified, the relationship between the cutoff ratio and the standard value of stylus tip radius r_{tip} and the standard value of long and short wavelength cutoff values is recommended to use the following of the table below. (ISO3274:1996 and JIS B0651:2001)

Table 14-2-1 Stylus tip radius and cutoff

λc (mm)	λs (μm)	λc/λs	r_{tip} (μm)
0.08	2.5	30	2
0.25	2.5	100	2
0.8	2.5		2 or 5
2.5	8.0	300	5 or 2
8.0	25.0		10, 5 or 2

Requirement of short wavelength cutoff (λs filter)
No consideration of a short wavelength filter is required because of large basic periodic components of waviness or machining streaks and negligibly minute profiles in roughness curves of machined surfaces. However, the depth of valleys changes according to the cutoff value of short wavelengths and radius values of the stylus tip when minute streaks remain on high-precision machined surfaces due to lapping or other reasons. In general, when the cutoff ratio is large and the stylus tip radius is small, the roughness amplitude increases. To obtain the comparable data in an industrial setting, both the stylus tip radius and the cutoff value of a short wavelength filter need to be set for measurement.

14. Parameter Description

14-3   Terminologies and definitions of surface profiles

The following defines the terminologies used in this document in addition to those already defined in Sections 14-1 and 14-2.

14-3-1   Length of contour curve

● **Sampling length (l)**: This is the length of a sampled part removed in order to calculate parameters of the contour curve.
Sampling length of roughness curve **(lr)**: Same as cutoff value λc (ISO4287:1997 and JIS B0601:2001)
Sampling length of the profile curve **(lp)**: This is the same as the evaluation length, and is the length of the measured profile (JIS B0633:2001). In the old JIS standard, this is the length determined by the profile parameters (JIS B0601-1982).
Sampling length of waviness profile curve **(lw)**: Same as cutoff value λf. (JIS B0601:2001)
● **Evaluation length (ln)**: This is the length which includes one or more sampling length in the X-axis direction.
The standard value of the evaluation length is five times of the sampling length for the roughness curve. (ISO4288:1996 and JIS B0633:2001)
This is the same as the sampling length of the profile curve, and this is the length of the measured profile.(ISO4288:1996 and JIS B0633:2001)
This is generally a multiple of cutoff value λf for the waviness profile curve. (ISO1302:2002 and JIS B0031:2003)
● **Measuring length (lm)**: This is an evaluation length in order to calculate the old Ra (JIS B0601-1982) and Ra_{75} (JIS B0601-1994 Annex) using the 2RC filter. The standard value is three times of the cutoff value.
● **Start-up length/pre-travel**: This is the measuring length in front of the evaluation length.
This is used to remove an error due to the transitional response of cutoff filter.
It must be longer if waviness components are large. The phase compensation filter that has cutoff value λc, λc/2 or λc/3 must be selected for this instrument. If the 2RC filter is used, the cutoff value that is two times larger than the phase compensation filter is set.
● **Selection standard of travel:** If there are deep defects, burrs or deep valleys before or after the measuring length or if there is large waviness on the profile curve of plane, the travel must be set to the same length as cutoff value λc.
・The λc/2 length must be set for the general surface.
・If the target surface is short and has no margin, the λc/3 length must be set. A profile distortion before and after roughness curve should be considered.
As the pre-travel is not required for profile curve measurement, it is set to zero.
● **Run-out length/post-travel**: This is the measuring length in the rear of the evaluation length.
This is necessary to remove an error caused by the transitional response of the phase compensation filter.
The phase compensation filter that has cutoff value λc, λc/2 or λc/3 must be selected for this instrument. As this is not required for the RC2 filter, the cutoff value is set to zero.
As the post-travel is not required for profile curve measurement, it is set to zero.
● **Traversing length (lt)**: This is the total length, including the pre-travel, evaluation length, and post-travel, which is the pickup traversing length for roughness measurement. Do not confuse the traveling length with the measuring length defined in the old JIS standard explained above.
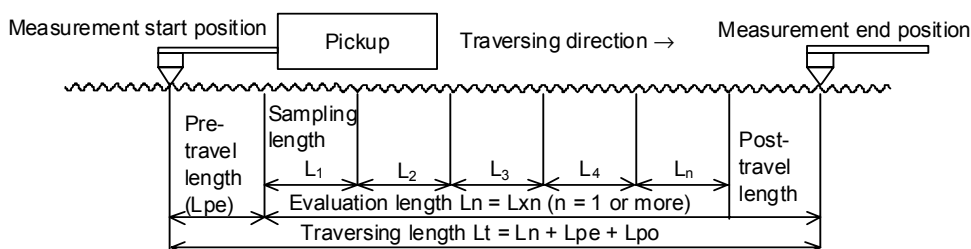
Figure 14-3-1 Relation between traversing length, evaluation length and sampling length

14-3-2   Recording magnification

● **Horizontal magnification in recording chart (Vh)**: This is an enlargement magnification of recording chart to the displacement in traversing direction of the pickup.
● **Vertical magnification in recording chart (Vv)**: This is an enlargement magnification of recording chart to the displacement in vertical direction against to the pickup traversing direction.
● **Vertical magnification direction (Z)**: This is the vertical direction against the pickup traversing direction.

14-3-3　Surface profile parameters

● **Profile parameter or P-parameter**: The parameter calculated based on the profile curve.
● **Roughness parameter or R-parameter**: The parameter calculated based on the roughness curve.
● **Waviness parameter or W-parameter**: The parameter calculated based on the waviness profile curve.

Parameter symbol notation in ISO4287/JISB0601 standard
A parameter code begins with uppercase letters, such as *Px*, *Rx* and *Wx*, and the first character represents a calculation curve.
P: Profile curve parameter
R: Roughness curve parameter
W: Waviness profile curve parameter

The parameter code is then followed by a code that represents parameter characteristics. The following lists the major codes.

p: Maximum peak height	*v*: Maximum valley depth	*z*: Maximum height
c: Mean height of curve element	*t*: Maximum profile height	*a*: Arithmetic mean height
q: Root mean square height	*sk*: Skewness	*ku*: Kurtosis
Sm: Mean length of curve element	*Δq*: Root mean square skewness	*mr*: Profile bearing length ratio

They can be combined to represent, for example, the "*Pa*" for the arithmetic mean height of the profile curve, "*RSm*" for the mean length of the roughness element, and "*Wmr*" for the profile bearing length ratio of waviness profile curve.
However, the following codes are continued to use for the parameters same as before.

Rz: Maximum roughness height	*Wz*: Maximum waviness height	*Ra*: Arithmetic mean roughness
Wa: Arithmetic mean waviness	*Rq*: Root mean square roughness	*Wq*: Root mean square waviness

14-3-4　Peak and valley and contour elements

● **Profile peak**: When the contour curve is cut by the X-axis (the mean line), the upper part above the mean line (in the direction from an object to the space) in the profile surrounded by the two adjacent intersections is called the profile peak. When the starting or ending portions of the sampling length are in upper side of the mean line, the part is regarded as the profile peak.
● **Profile valley**: When the contour curve is cut by the X-axis (the mean line), the lower part below the mean line (in the direction from the surrounding space to the object) in the profile surrounded by the two adjacent intersections is called the profile valley.
When the starting or ending portions of the sampling length are in the lower side of the mean line, the part is regarded as the profile valley.
● **Top of profile valley**: A point of the highest altitude in the peak of contour curve. (JIS B0601-1994)
● **Bottom of valley**: A point of the lowest altitude in the valley of contour curve. (JIS B0601-1994)
● **Contour curve peak height Zp:** A height from the X-axis (the mean line) to the top of profile peak.
● **Contour curve valley depth Zv:** A height from the X-axis (the mean line) to the bottom of profile valley.
● **Contour element**: A profile consisting of a profile peak and its adjacent valley.
● **Contour element height Zt:** The sum of the profile peak and profile valley of profile elements.
● **Contour element width Xs:** The length of an X-axis segment removed by contour elements.
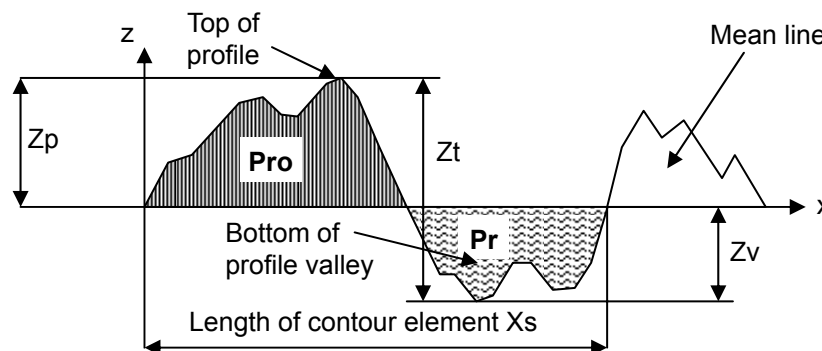
Figure 14-3-2 Peak and valley and contour elements

14. Parameter Description

14-4 Height direction parameters

14-4-1   Height direction mean parameters

● **Arithmetical mean deviation of the contour curve (*Ra, Pa, Wa, W_{EA}*)**
● **Center line average roughness (*Ra75, CLA*, arithmetic average AA, roughness height rating RHR)**

● **Center line average waviness (*W_{CA}, W_{EA}*)**
When sampling length L is removed from the contour curve in the direction of the mean line, an average of the absolute value of Z(X) of this sampled profile can be expressed as follows:

$$R_a = \frac{1}{l} \int_0^l | Z(x) | \, dx$$

This represents the average deflection of the area, which is surrounded by both the sampled curve and the mean line, divided by the sampling length.
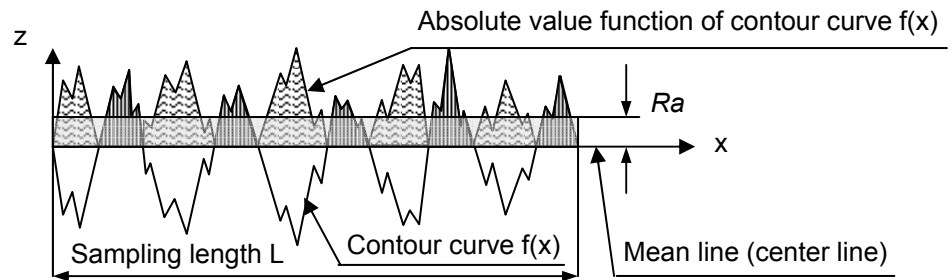
Figure 14-4-1 Arithmetic mean value

Note 1: In the present ISO/JIS complied system, the two operations are used. The first operation calculates the waviness for each sampling length and averages them for the entire evaluation length (called the averaging method) and the second operation compares all values of each sampling length against the acceptable value (called the 16% rule method and the Max rule method). (See Section 14-9.)
Note 2: As value Ra is the mean value of the entire sampling length, a large defect that appear in a limited area may not affect on the result.

● **Root mean square deviation of the contour curve (*Rq, RMS, Pq, Wq*)**
When sampling length L is removed from the contour curve in the direction of the mean line, the root mean square value of Z(x) of this sampled part can be expressed as follows:

$$Rq = \sqrt{\frac{1}{l} \int_0^l Z^2(x) \, dx}$$
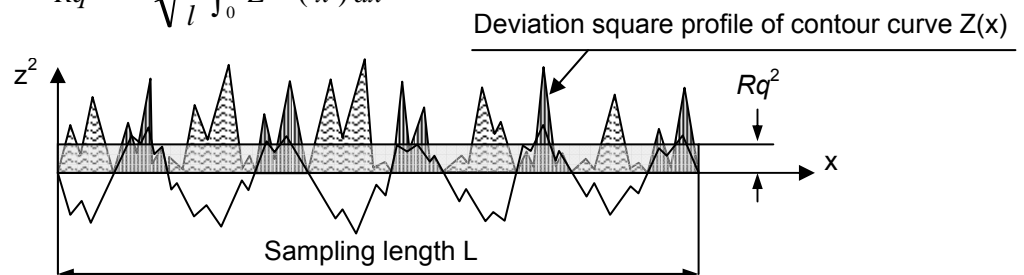
Figure 14-4-2 Root mean square value

Namely, in the above figure, the root-mean-square represents the root mean square average deflection obtained by dividing the area of the portion between the curve, which is obtained by squaring the distance between the contour curve and the mean line, and the center line. This is equivalent to standard deviation σ in statistics.

14-4-2 Peak and valley height parameters

● **Maximum peak height of the contour curve (*Rp, Rpm, Rp5, Pp, Wp*)**
This is the maximum value of profile peak height Zp of profile curve Z=Z(x) for sampling length L.

$$Rp = \max[Zp_i] = \max[Z(x)]$$
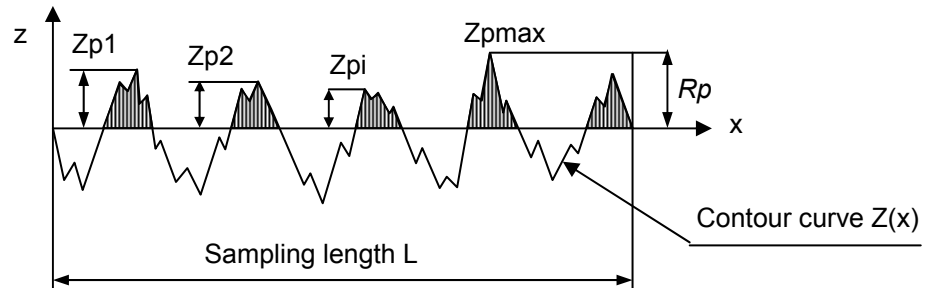
Figure 14-4-3 Maximum profile peak height

● **Maximum height of the contour curve (*Rz, Rz1max, Ry, Rymax, Rmax, Wz*)**
The sum of maximum value *Rp* for peak height Zp of contour curve in the sampling length and of maximum value *Rv* for valley depth |Zv|.
● **Total height of the contour curve (*Rt, Rmax, Pt, Wt, W_{CM}, W_{EM}*)**
The sum of maximum value *Rp* for peak height Zp of contour curve in the evaluation length and of maximum value *Rv* for valley depth |Zv|.

$$Rz = Rp + Rv = \max[Zp_i] + |\min[Zv_i]| = \max[Z(x)] + |\min[Z(x)]|$$
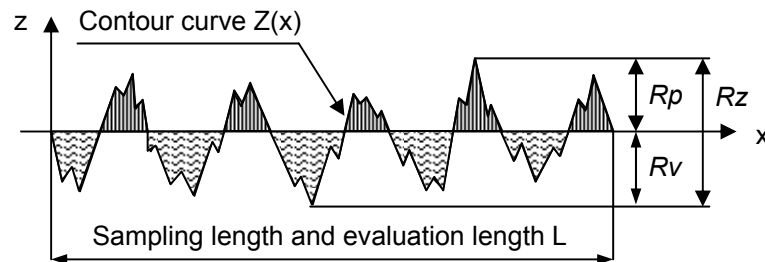
Figure 14-4-4 Maximum height and maximum profile height

Note 1: Because maximum height of the profile *Rt* and *Wt* are determined based on the evaluation length rather than the sampling length, they are always greater than maximum height *Rz* and *Wz*. However, if the sampling length is equal to the evaluation length, the *Pt* value becomes the same as the *Pz* value.
Note 2: Normal processing faces contain surface waviness to a certain degree. This causes the maximum height from roughness curve *Rt* to be smaller than the maximum height from the profile curve *Pt* (*Rmax*). But in some cases like cross sections with small waviness and complex waveform such as ground surface and honing surface, the *Rt* value is larger than the *Pt* value due to the effect of the transient characteristics of filter.
Note 3: For the maximum height, it is required to measure the workpiece surface excluding the outstanding flaw because the instrument reads this high value during sampling even if only a single flaw exists.

14. Parameter Description

● **Ten point height of irregularities (ISO and JIS)**

(Rz, Rz_{ISO}, Rz_J, Rz_{JIS82}, Rz_{JIS94})

Rz is the sum of the mean value of absolute values of height of five highest profile peaks (Zp) and the depth of five deepest profile valleys (Zv) measured in the vertical magnification direction from the mean line of the sampling length removed from the sampled curve.

This height was deleted from the ISO and JIS standards, and it was replaced by the same name of maximum height Rz.

$$R_{z \cdot JIS} = \frac{1}{5} \left(\sum_{i=1}^{5} | Zp_i | + \sum_{j=1}^{5} | Zv_j | \right)$$
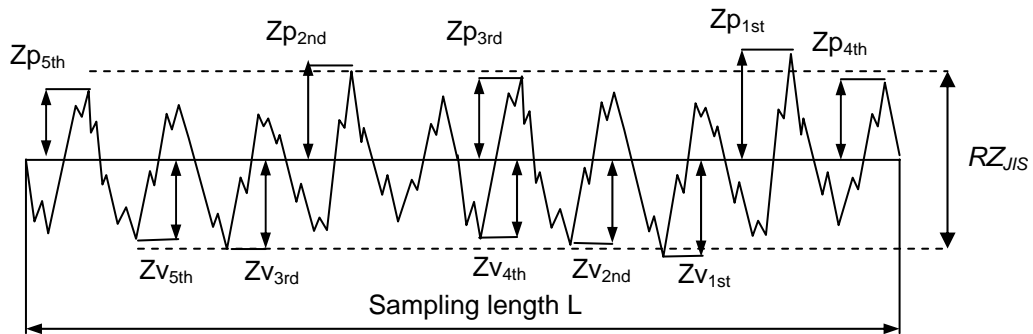
Figure 14-4-5 Ten point height of irregularities (ISO/JIS) Rz

Note 1: The ISO4287:1996 and ISO468-1982 standards specify as criterion for peak and valley that values under 10% of Ry shall not be recognized as an independent peak and valley. This instrument follows it in JIS94, DIN and ASME, and provides vertical dead bands witch are 10% of Ry on each side of the mean line.

Note 2: In case a long reference length cannot be taken, sometimes fewer than five peaks and valleys are found in it. In such a case, measurement results may not be obtained. This instrument calculates only the recognized peaks and valleys, and indicates it with an asterisk (*).

Note 3: The JIS B0601-1982 and JIS B0601-1976 standards specify this calculation based on the sampled length of certain portion sampled from the profile curve.

It provides the vertical dead bands of "0.5 mm/measuring magnification" both above and below the mean line so that the noise components in JIS82 mode are not judged as peaks or valleys.

(It provides each dead band of +/-0.5 µm in the measuring range of +/-400 µm, +/-0.05 µm in the measuring range of +/-40 µm, +/-5 nm in the measuring range of +/-4 µm, and +/-0.2µm in the measuring range of +/-160 µm.)

In this case, if the roughness peak or valley amplitude is small for the dead bands, a "No peak and valley" error message may be output. If it has occurred, the measurement scale must be increased during setup before measurement rather than the displace scale, and the measurement must be repeated. If the Rz_{JIS} value is not determined even at the highest scale, it means that the number of peaks or valleys is below five.

● **Height of step (*AVH, Hmax, Hmin, AREA*)**
This is the parameter to indicate an interval in the direction of vertical magnification of the protruded top end and section area of the protruding portion toward the reference line. (The same processing is also available for the concave portion.)
(1) Input parameters
   1) Height of step calculation mode deletion length: Start out portion of a step that is unnecessary for calculation and deleting length of falling down portion are specified.
   2) Height of step calculation mode reference height: Threshold value of the protruded height that becomes the subject of height of step calculation is input. This is a height from the mean line (correction line).
   3) Area calculation length: The area that becomes the subject of area calculation is specified.
(2) Tilt correction: Correction of both ends - A straight line that is the connected recording start point, and the recording end point is defined as a correction line.
(3) Calculation of the step difference parameter calculation range: In the protruding portion that is bigger than the numerical value of the height of the step calculation mode reference height, the deletion range of both ends of the numerical portion of the deleted length is defined as the step difference parameter calculation range.
(4) Calculation parameter: Three types of parameters below are calculated.
   1) *AVH* : Average height value within the range of the step difference parameter calculation

$$AVH = \frac{1}{k} \cdot \sum_{i=1}^{k} Z_i \qquad \text{(Zi: All data within parameter calculation range)}$$
$$\text{(k: Its data number)}$$

   2) *Hmax* : Maximum height value toward the reference line within the step difference parameter calculation
   3) *Hmin* : Minimum height value toward the reference line within the step difference parameter calculation
   4) *AREA* : Section area surrounded by profile within the step difference parameter calculation and the reference line
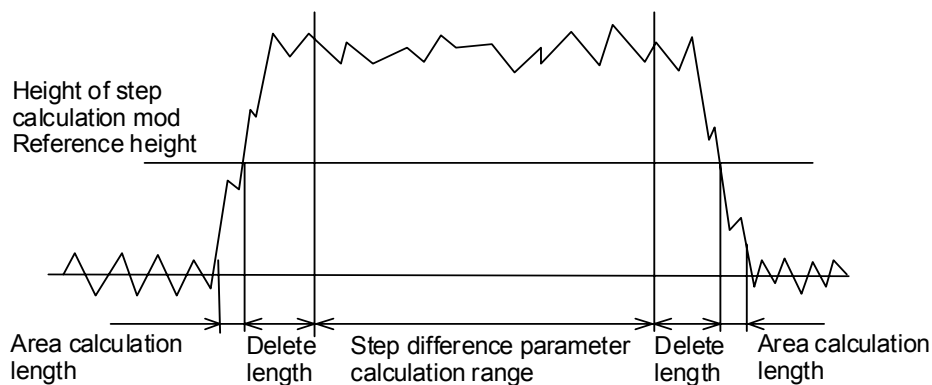
Figure 14-4-6 Height of step measurement parameters

Note 1: Usage - This is used for controlling the thickness of printed circuit (PC) boards, thick film ICs, etc. and electric resistance.
Note 2: This parameter is not included in the national standard.

14. Parameter Description

14-5 Horizontal direction and peak count parameters

14-5-1 Horizontal spacing parameters

● **Mean width of contour elements (*RSm*, *PSm*, *WSm*, *Sm*)**
This is the mean value of mean width of contour elements Xs in the sampling length. First, either the space between a point that directs from a peak to a valley across the mean line and a crossing point that directs from the next peak to a valley or a crossing point that directs from a valley to a peak is determined as length Xsi of contour elements. If the total number of these spaces is "m", the mean length can be obtained by the following expression.

$$RS_m = \frac{1}{m}\sum_{i=1}^{m} Xs_i$$
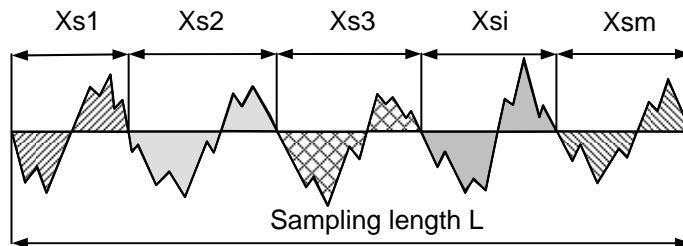
Figure 14-5-1 Mean width of contour elements

Note 1: The JIS01 and ISO97 standards specify how to identify the minimum height and the minimum length of a peak and a valley if the *Sm* parameter is given. The minimum height of a peak or a valley is 10% of maximum height *Rz*, *Pz*, *Wz*, and the minimum length is 1% of sampling length L. If the height or length is smaller than them, the peak or valley is not judged as an individual profile peak or valley.
Note 2: In the JIS 82 standard, the vertical dead bands of "0.5 mm/measuring magnification" are provided above and below the mean line in order to judge the minimum peak or valley height.
(It provides each dead band of +/-0.5 μm in the measuring range of +/-400 μm, +/-0.05 μm in the measuring range of +/-40 μm, +/-5 nm in the measuring range of +/-4 μm, and +/-0.2 μm in the measuring range of +/-160 μm.)
Note 3: In ASME95, JIS94, DIN90 and ISO84 standards, the vertical dead bands that are 10% of every RY values are provided above and below the mean line.
Note 4: Even if the waveforms contain short wavelength components, the *RSm* value tends to become a value equal to the long wavelength components that have the largest amplitude.

● **Mean spacing of local peaks of the profile (S)**
This is the arithmetic value of the spacing between the local peaks derived by calculating the mean line length (spacing of local peaks) that corresponds to the spacing between the adjacent local peaks within the sampling length L that has been removed from the roughness curve.

$$S = \frac{1}{n}\sum_{i=1}^{n} s_i$$
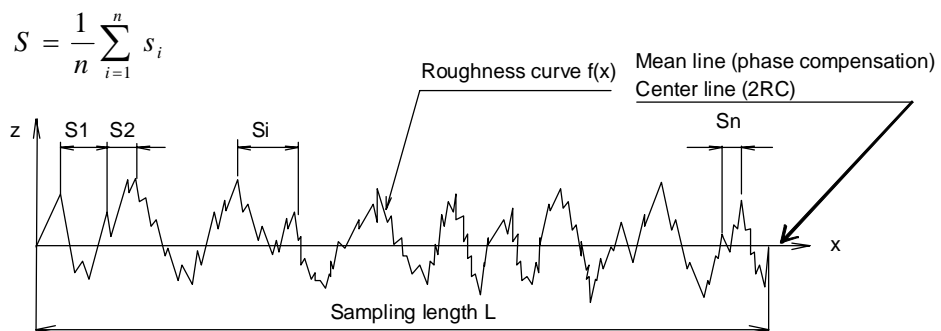
Figure 14-5-2 Mean spacing of local peaks of the profile S

Note 1） The height of less than 10% of *Rz* value is not regarded as one individual profile peak or valley as condition for judgment. The minimum value of the spacing between local peaks is 1% of the sampling length, and the spacing less than that is considered as a peak. Therefore, the *S* value is limited in the range of L/100 < *S* < L toward sampling length L.
Note 2） This parameter has been disused in ISO4287:1997 and JIS B0601:2001.

14-5-2   Peak count parameters

● **Peak count (*Pc, PPI, HSC*)**
A specified reference level, H is set in both negative and positive going directions from the mean line of the roughness curve. Every time the positive reference height is exceeded after the negative reference level is exceeded, the number is counted. This peak count is continued until it reaches evaluation length Ln, and the count value without units is displayed.
This parameter is specified by The Engineering Society for Advancing Mobility Land Sea Air and Space: SAE J911-JUN86 "Surface Texture Measurement of Cold Rolled Sheet Steel" in the USA. Under the SAE standard, the parameter name is *PPI* (Peaks per inch) and the peak count per inch is determined if evaluation length Ln is 1 inch (25.4 mm).
The normal cutoff conditions are 2RC cutoff λc75 = 0.03 inch (0.8 mm).
Also, width 2H between positive and negative reference levels is called the count level.
In SAE J911-JUN86 standard, any count level can be set and it needs to be stated in the measuring conditions.
The old SAE J911-1965 standard defined that 2H=50 µinches (1.27 µm).
In Europe, the symbol *Pc* is used and the peak count per centimeter of length is determined.
When the negative reference level is set to zero, it becomes high spot count *HSC*.
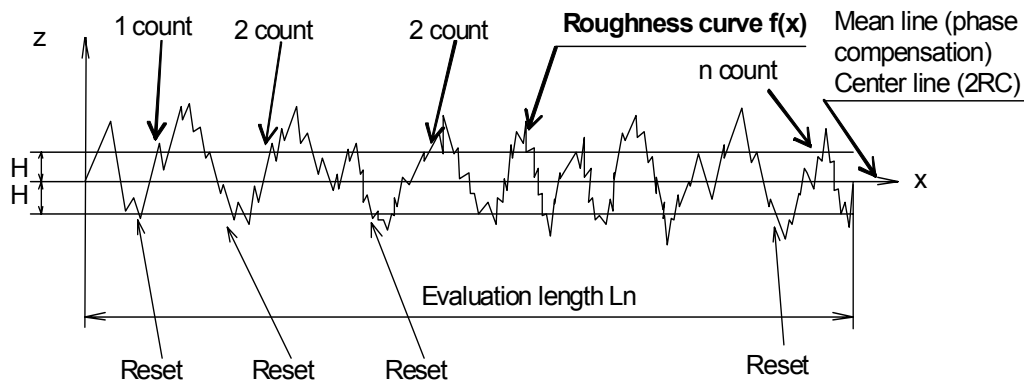
Figure 14-5-3 Peak count

Note 1: This instrument defines a peak counting (symbol *Pc*) from the roughness curve and displays the number of peaks per evaluation length. A count level in both negative and positive can be set at any level, which can cope with several kinds of standards.

14. Parameter Description

14-6 Parameters for bearing area curve

When a plane slides on another plane, peaks of surface roughness of both planes become worn. The area ratio changes between the contact portion of these planes and the concave portion where oil still remains, and this affects tribology characteristics such as lubrication, friction and abrasion. This section explains the roughness parameters of these lubrication characteristics.

14-6-1 Bearing area curve and basic parameters; ISO4287/JISB0601 compliant

● **Material length of the contour curve at level c (*Ml(c)*)**
This is the sum of the length at the object side of the contour curve that has been cut by the straight line that has height C in parallel to the X-axis (the mean line).
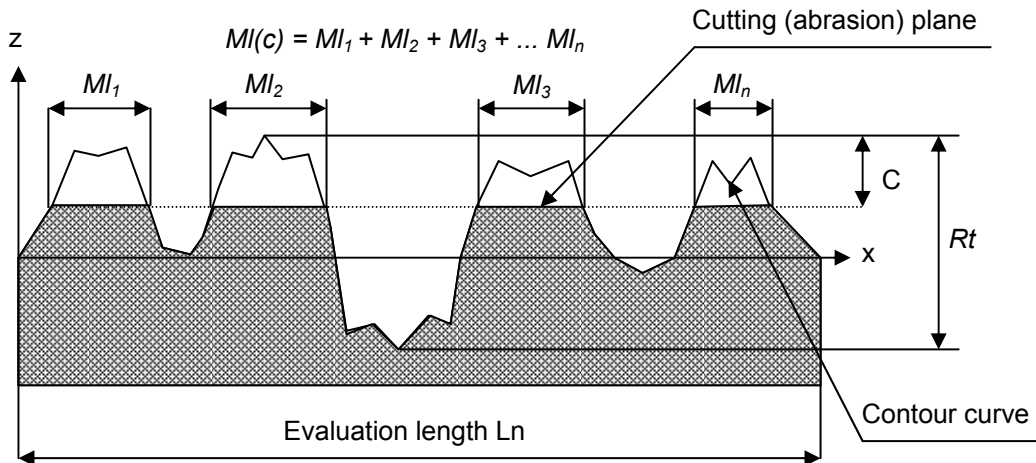
Figure 14-6-1 Bearing length of contour curve

Note 1: In the ISO4287/1-1984 and ASME B46.1-1995 standards, the profile bearing length is expressed using symbol "b".

● **Cutting level c**
This is the depth C from the peak of straight that is parallel to the X-axis (the mean line) and that cuts the contour curve.
Cutting level C can be selected from the following three methods.
(1) % method: This is shown as a percentage (%) when the level of the highest peak is set to 0% and the deepest valley is set to 100%.
(2) μm method: This is shown as the depth in μm from the highest peak.

Note 1: In ASME B46.1 standard, the cutting level is expressed using symbol p(%).

● **Material length ratio of the contour curve (*Mr(c), Rmr(c), Pmr(c), Wmr(c)*)**
Profile bearing length ratio (*tp(c)*)
When certain length L (evaluation length L or the reference length) is extracted from the contour curve, the length of the cut area of the surface that is cut by the straight line that is parallel to the mean line and that has cutting level C can be expressed in percentage form. That is, the ratio of the profile bearing length to entire length L can be expressed as the profile bearing length ratio.

$$Mr(c) = \frac{Ml(c)}{L} = \frac{100}{L} \sum_{i=1}^{n} Mli(c) \qquad (\%)$$

Note 1: In the JIS 82 standard, profile curve P is used for the sampled curve, but Gaussian phase compensation roughness curve Rg is used in another standard. In the JIS01/ISO97 standard, it can also be calculated based on profile curve P and waviness profile curve W.
Note 2: In case the 2RC roughness curve is employed, some profile curves may cause a phase shift and distortion in the waveforms by their cutoff, which results in a change in the bearing length ratio curve. Thus reliable evaluation will not be expected.

178

● **Material ratio curve of the profile (MRC), Bearing area curve (BAC)**
Abbott firestone curve
This is the graphic representation in the relationship between every cut level C (% or μm) in the contour curve and bearing length ratio Mr (c) (%) in the cut level.
This is equivalent to the cumulative density distribution function in statistics.
The upper part of the curve represents the operation characteristic upon the trial operation of machine, the mid part represents the prediction of abrasion and service life, and the lower part represents the size of the oil deposit on the bearing surface.
In 1933, Abbott and Firestone found that the distributed pattern of surface roughness played a significant role and introduced the concept of the bearing length ratio graph.
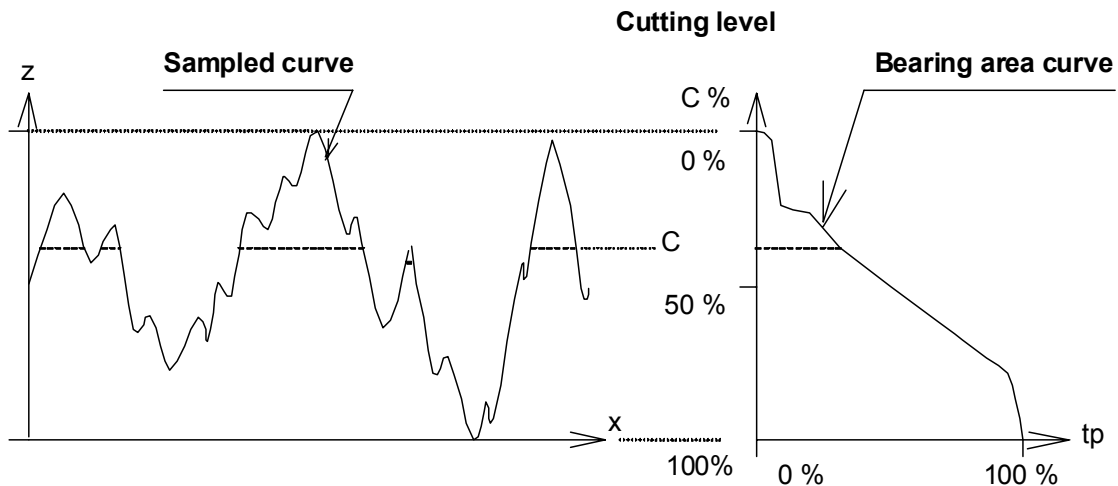
Figure 14-6-2 How to find the bearing area curve

14. Parameter Description

● Method of length reference

The following three types of methods are available for drawing a bearing curve according to the calculation method of the bearing length ratio.

(JMAS5021 standard defined by the Japan Precision Measuring Instruments Association)

(1) Evaluation length method (ISO4287:1996 or JIS B0601:2001):

The Rmr (Pmr, Wmr) value is determined for the entire evaluation length, and a profile is drawn in the % method or μm method.

(2) μm display reference length method (JIS B0601-1994):

This is drawn as tp by creating an average in each cut level of the μm method with combined peak lines of each reference line. That is, the highest point (or the highest point of mean line) of each reference line L is set as the zero point. From this point, each $tp(c)$ value is determined at cut level C having the depth in μm, and an average of reference length values is determined.

(3) % display reference length method (JIS B0601-1994):

This is drawn as tp by creating an average in each cut level % after being normalized with the maximum height Ryi in each reference length and displayed in %. That is, maximum height Rz of each reference length L is set to be 100%. Each $tp(c)$ value is determined at the cut level, and an average of reference length values is determined.
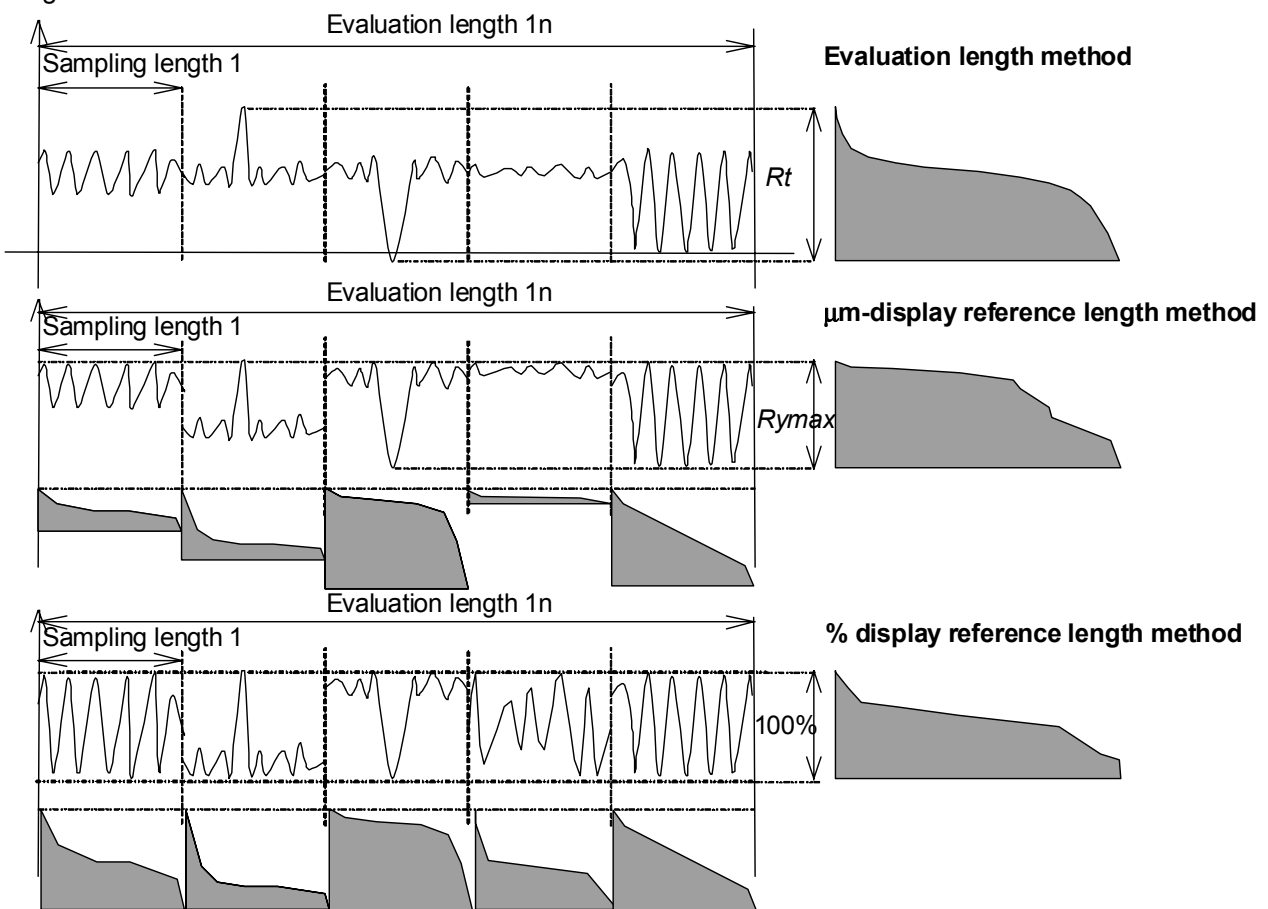
Figure 14-6-3 Bearing curves based on the method of length reference

14-6-2 Bearing area curve in special filter linear notation and parameters; ISO13565-2 or JIS B0671-2 compliant

These are standards used to evaluate lubrication characteristics of the bearing area curve by dividing it into three layers such as an initial abrasion portion, a material contact portion, and a oil reservoir portion.
This applies primarily to plateau honing surface machining.
For special roughness curve Rg2 described in Section **14-1**, the bearing area curve is determined in the evaluation length method and in the μm method, and various parameters are calculated.
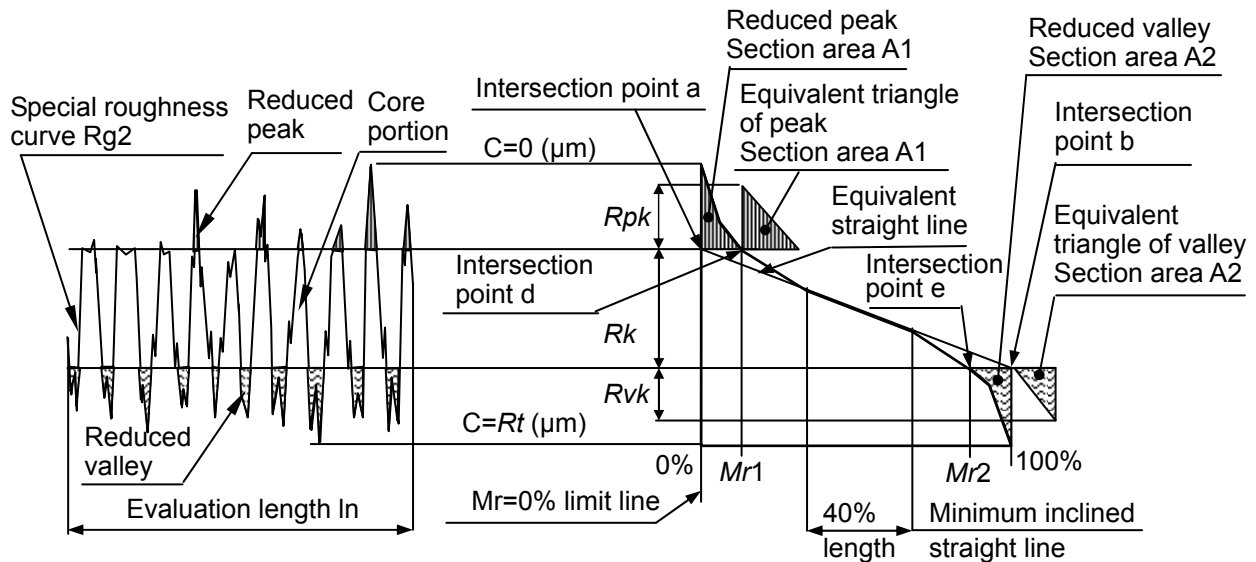
Figure 14-6-4 Parameters for linear representation bearing area curve

● **Profile bearing length ratio 1 of the core (Initial wear load factor) *Mr1* (Material portion 1) (Materialanteil 1)**
The 40% width is sampled from the bearing area curve in the Mr value direction, and a position is determined to have the minimum height difference between both of their ends. The least squares straight mean line is calculated from this 40% width data, and it is determined as the "equivalent straight line."
Intersection point a between the equivalent straight line and the Mr=0% limit line is determined.
An intersection point between horizontal line ad and the bearing area curve from this intersection point a is determined as point d. Also, its Mr value is determined as Mr1.
This represents the bearing length ratio after initial abrasion.

● **Profile bearing length ratio 2 of the core (Material portion) *Mr2* (Material portion 2) (Materialanteil 2)**
Intersection point b between the equivalent straight line and Mr=100% limit line is determined on the bearing area curve.
An intersection point between horizontal line be and the bearing area curve from this intersection point is determined as point e. Also, its Mr value is determined as *Mr2*.
This represents the bearing length ratio after initial abrasion.

● **Reduced peak height *Rpk* (Reduzierte Spitzenhohe)**
The height that is equal to the height of area A_1 surrounded by the 0% limit line, side ad, and the bearing area curve, and that is equal to the height of *Rmr*=0% limit line, forming a rectangular triangle with this side ad, is determined as *Rpk*. This represents the abrasion height of the initial wear.

$$Rpk = \frac{2A_1}{Mr_1}$$

● **Reduced valley depth *Rvk* (Reduzierte Riefentiefe)**
The height that is equal to the height of area A_2 surrounded by the 100% limit line, side be, and the bearing area curve, and that is equal to the height of the *Rmr*=100% limit line, forming a rectangular triangle having this side be, is determined as *Rvk*. This represents the valley depth of the oil deposit.

$$Rvk = \frac{2A_2}{(100 - Mr_2)}$$

181

14. Parameter Description

● Core roughness depth *Rk* (Kernrauhtiefe)

Rk is the difference between the heights of 'c' and 'd' obtained in the above.
This represents the height of abrasion that plane will be worn away by the long term abrasion.

● Oil retention volume *Vo*

This represents the volume of oil that is deposited in the oil deposit valley per square centimeter.

$$V_0 = \frac{(100 - Mr2) \times Rvk}{2000} \quad (\mathrm{mm}^3/\mathrm{cm}^2)$$

Note 1: However, the unit (mm^3/cm^2) is not displayed due to the limited amount of display space. Be attentive, because it is of irregular expression. Here, in the formula, *Mr2* is expressed in %, while *Rvk* in μm.
Note 2: For these parameters, only those of mm unit notation are applicable, but those of inch are not displayed.
Note 3: This is the civil standard and is not defined by the national standard.
Note 4: The previous SURFCOM models used the following unit system due to the limited amount of unit display.

$$V_0 = \frac{(100 - Mr2) \times Rvk}{200} \quad (\mu \mathrm{m})$$

This expresses the volume (μm^3) of oil retained in the reduced valley depth in each unit area of 1 μm^2.
Convert the numerical values of both unit notations by the following formula.

V_0 (mm^3/cm^2)= V_0(μm)/10
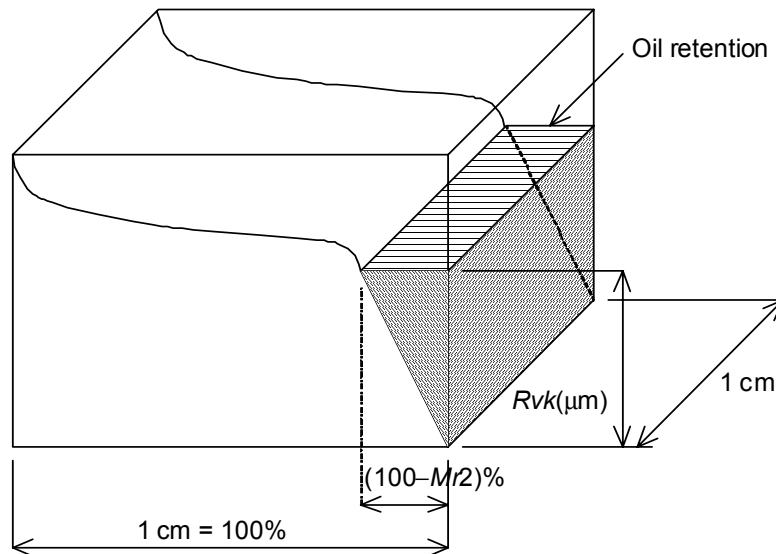
Figure 14-6-5 Oil retention volume *Vo*

● Reduced valley depth ratio *K*

This represents the ratio of the oil deposit valley depth to the effective bearing area roughness, and the larger the value is the better the lubricating characteristic is.

K = Rvk / Rk (Dimensionless number)

Note: A parameter with a profile coefficient was used before by the same "*K*" before.
Profile coefficient *K = Rv / Rmax*
This is the same kind of parameter as the oil deposit valley depth ratio *K* by which it can be calculated manually.

14-7   Parameters for probability density function

● **Profile height amplitude curve (ISO4287/JIS B0601)**
● **Amplitude distribution curve (ADC)**
    Amplitude density function (ADF)   (ASME B46.1-1995)

It is displayed as ADF on this instrument.
The amplitude distribution curve is a probability density function with height Z(x) that can be obtained from the evaluation length.
That is, this is a graphic display of probability P(c) to have the same level between all cut levels c of the contour curve and the cut level of the contour curve.

$$P(c) = \frac{Mr(c) - Mr(c + \Delta c)}{\Delta c}$$

where, expression $\Delta c = Rz/100$ (in each %) is used.
This is that the bearing area curve is differentiated by cut level c.
That is, if the bearing area curve is X=F(c) and the amplitude distribution curve is X=G(c),

$$G(c) = \frac{d}{dc} F(c)$$

The amplitude distribution curve of random waveforms such as the cutting surface becomes similar to the normal distribution.
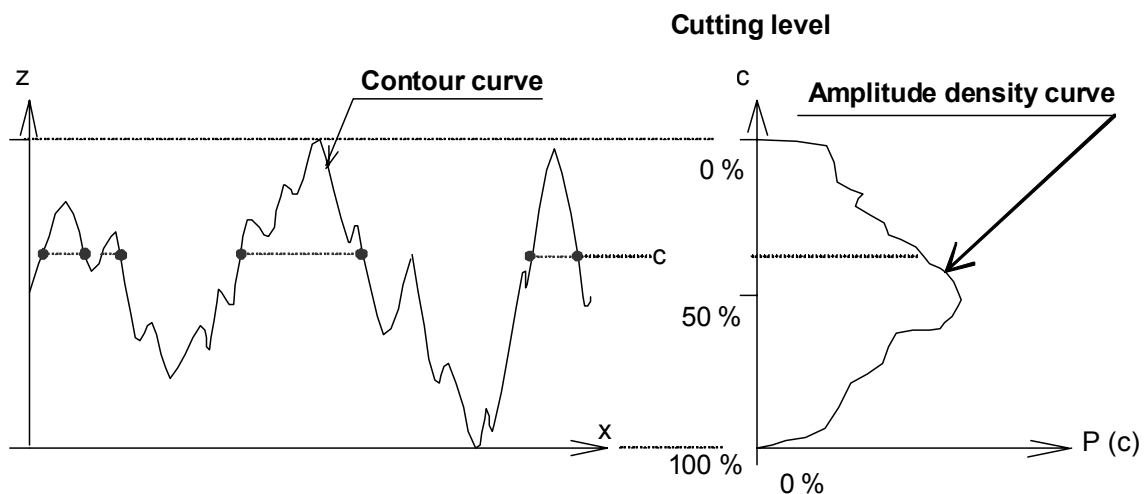
Figure 14-7-1 Probability density function

Note 1: In the JIS82 mode, the profile curve is used as the contour curve. In another mode, the roughness curve is used as the profile curve.
Also, when the filtered center line waviness curve is measured in the ISO97 or JIS01 mode, the (filtered center line) waviness profile curve is used as the contour curve.
During *Psk* and *Pku* measurement in ISO97/JIS01 mode, the profile curve that is passed through the λs filter is used as the contour curve.
Note 2: It has been defined in ISO4287:1997, JIS B0601:2001 and ASME B46.1-1995 standards.
Note 3: The cutting level method and the reference length method are the same as the bearing area curve.

14. Parameter Description

14-8 Parameters for motif calculation

14-8-1 What is the motif calculation?

The motif calculation method has been used in the French automobile industry and is called the CNOMO. It has been defined in the ISO12085:1996 and JIS B0631:2000 standards.

When sliding guides are lubricated or fitted together, only the roughness peak comes in contact with another component. The status of the peak has a significant affect on the contact status. Also, the amount of oil deposited in valleys, which can be calculated by the expression "space between peaks multiplied by valley depth divided by 2", affects on the lubricating property. Therefore, it is considered that the analysis, which considers the roughness as the "individual peak positions" and "depth of valleys between peaks" and considers the waviness as the "envelop curve between peaks", is very closely correlated to the tribology surface function.

The motif calculation is based on this concept and it evaluates the roughness by considering the position of roughness peaks.

Here, the filter is not used to distinguish the roughness and waviness. This can avoid a difference evaluation during a visual inspection caused by the waveform distortion that occurs frequently in the conventional filtering system. Also, the pre-travel length and post-travel length are no longer required.

14-8-2 What is the motif?

The motif is a portion between the highest points of two local peaks of the profile of profile curves or upper envelope lines.

It is expressed by the following length and depth.

Table 14-8-1 Motif parameters

Type	Roughness motifs	Waviness motifs
Sampled curve	Profile curve P	Upper envelope line (Note 1)
Two sets of depth from peak to valley in a vertical direction = Motif depth	H_j and H_{j+1}	HW_j and HW_{j+1}
Horizontal length between two peaks = Motif length	AR_i	AW_i
Smaller depth among two sets of motif depths	T_i	T_i
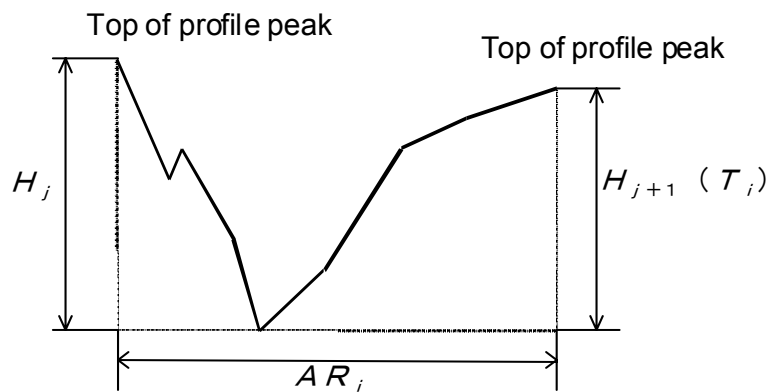
Figure 14-8-1 Roughness motifs

Note 1: The upper envelope line is a straight line between roughness motif peaks.
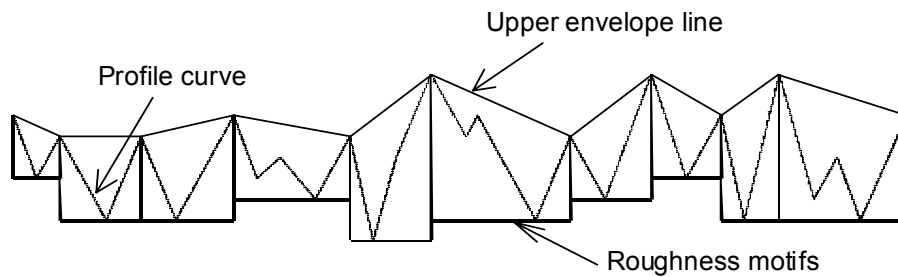
Figure 14-8-2 Profile curve, roughness motifs and upper envelope line

14-8-3   Settings of motif upper limit length

The motif calculation does not use a filter for roughness and waviness component separation. Instead, the X-axis length of the motif is restricted to have a similar effect to that of the cutoff value setting.

Roughness motif upper limit length A: The upper limit of the horizontal peak space to be used for roughness motif calculation

Waviness motif upper limit length B: The upper limit of the horizontal peak space to be used for waviness motif calculation

The following lists the standard combinations of motif upper limit length, evaluation length, and others.

Table 14-8-2 Motif upper limit length and evaluation length

Roughness motifs Upper limit length A mm	Waviness motifs Upper limit length B mm	Evaluation length ln mm	λs μm	Max. radius of stylus tip r_{tip} μm
0.02	0.1	0.64	2.5	2±0.5
0.1	0.5	3.2	2.5	2±0.5
0.5	2.5	16	8	5±1
2.5	12.5	80	25	10±2

Note 1: Unless otherwise specified, A=0.5 mm and B=2.5 mm are standard.
Note 2: When using a value different from the recommendation value, set the evaluation length which is two times or more of the motif upper limit length. (There is a possibility that the waviness motifs parameter cannot be calculated when it is smaller than twice the length.)

14. Parameter Description

14-8-4   How to fine the roughness motifs

The following describes the calculation processed by this instrument.

(1) Find all peaks and valleys to determine each roughness motif.
   1) Separate the evaluation length at each interval (A/2) and regard the number of division as n.
   Discard the fractions.
   2) Find the difference between the maximum value and the minimum value (HR_i) at every setting length (A/2).
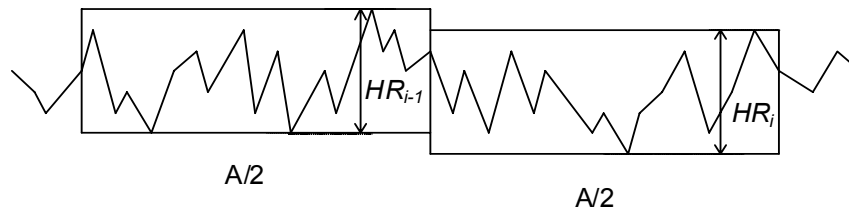
Figure 14-8-3 Judgment of setting length and peak height conditions of roughness motifs

3) Find the minimum motif depth (H_{min}) as 5% of the average of HR_i value.

$$H_{min} = 0.05 \bullet \frac{1}{n} \bullet \sum_{i=1}^{n} HRi$$

4) Identification based on the minimum motif depth
Determine the peaks and valleys by considering that a peak must have valleys with H_{min} or more depth at both sides.
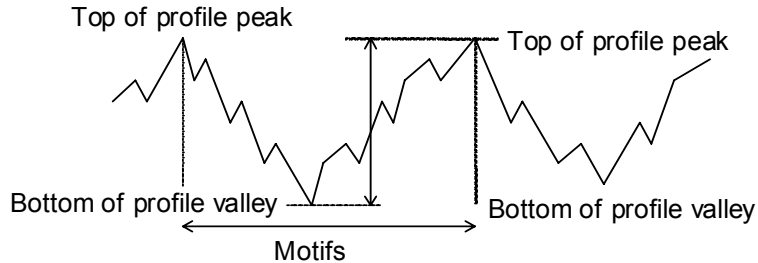
Figure 14-8-4 Identifying the minimum depth of roughness motifs

5) Determine depth T_i of each motif (the height difference between the smaller peak and a valley).
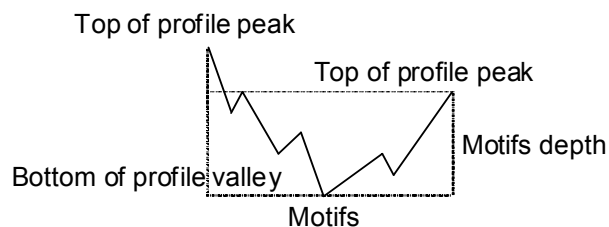
Figure 14-8-5 Calculating the motifs depth

186

(2) Combine the motifs.
　1) Constitute the segment.
　In the entire evaluation range, when there is a peak that is higher than the front peak within the distance A (Roughness motif upper limit length) from the front peak, the peak becomes the end peak and it forms one segment from the front to the end motifs.
　When there is no other higher peak in the distance A, regard the highest peak as the end peak and consider that to be one segment.
　After this, find the end peak on a repeated basis by regarding the end peaks as the front peaks. Using the above method, constitute the segments with the succession of the made up motifs.

　2) If conditions I to IV below are satisfied in each segment, the motifs are combined.
　Condition I　　Envelope requirement
　The height of P2 that is the peak in the center must be less than either of P1 or P3.
　　　P2 ≤ P1 or P2 ≤ P
　Condition II　　Motif length condition
　　Motif width ARi after being synthesized must be no more than roughness motif upper limit length A.
　　　ARi ≤ A
　Condition III　　Expansion condition
　　After being combined, motif depth T3 must be equal to or greater than motif depth T1 and T2.
　　　T3 ≥ T1 and T3 ≥ T2
　Condition IV　　Depth condition
　　If the segment is considered as a one piece motif, any depth of the right and left motifs must be less than the Tr value, which is 60% of motif depth T3.
　　　T1 ≤ Tr or T2 ≤ Tr

　This combination means that a single motif is created from two adjacent motifs.
・The first motif is combined with the second motif, and this is repeated for the i-th and i+1st motifs. If the combination is successful, the i+2nd motif is combined with the i+3rd motif. If not combined, the i+1st motif is combined with the i+2nd motif.
・After combination of the last two motifs has been attempted, if any combination has succeeded, the combination is tried again from the first motif. This combination is tried until all motifs are combined successfully.
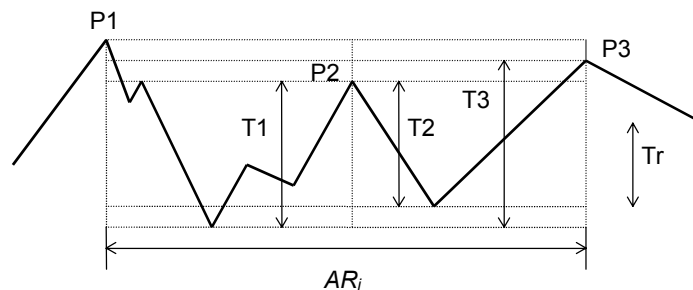
Figure 14-8-6 Segment configuration

　3) Motifs of the entire evaluation length are combined.
　If conditions I to IV above are satisfied over the entire evaluation length, the motifs are combined.
　In this case, T3 of condition III becomes the depth of motif if the combination of a pair of current motifs is regarded as being successful.

14. Parameter Description

(3) Correct the height of the singular peaks and valleys.
Correct the independent peaks and valleys so as not to exert a detrimental influence on the upper envelope line.

1) Preparation

Find depth H_j, the average of whole $\overline{H_j}$, and standard deviation σ_{Hj}.

$$\overline{H_j} = \frac{1}{n}\sum_{j=1}^{n} H_j$$

$$\sigma_{Hj} = \sqrt{\frac{1}{n}\sum_{j=1}^{n}\left(H_j - \overline{H_j}\right)^2}$$

And, find reference height Hs.

$$H_s = \overline{H_j} + 1.65 \times \sigma_{Hj}$$
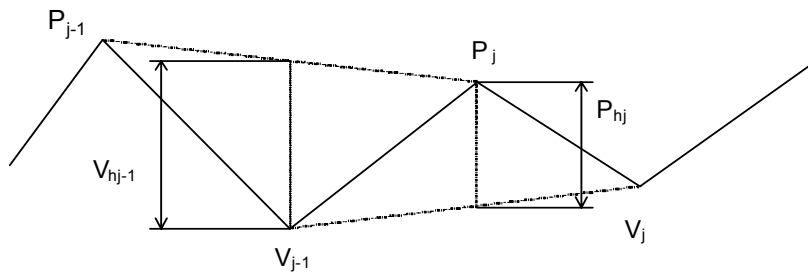
Figure 14-8-7 Correction of singular peak height

2) Correct the peaks.
H_s is compared with the following P_{hj} and if $H_s < P_{hj}$, the peak position of P_j is corrected to make $P_{hj} = H_s$, and value P_{hj} is corrected.

Here, P_{hj} is the height from an intersection point between the line from V_{j-1} to V_j and a vertical line from P_j, to point P_j.

3) Correct the valleys.
H_s is compared with the following V_{hj-1}, and the valley position of V_{j-1} is moved to make $V_{hj-1} = H_s$ if $H_s < V_{hj-1}$. Then, value V_{hj-1} is corrected.

Here, V_{hj-1} is the height from an intersection point between the line from P_{j-1} to P_j and a vertical line from V_{j-1}, to point V_{j-1}.

14-8-5   Roughness motif parameters

The following describes the calculation processed by this instrument.

(1) Parameters defined in ISO12085 or JIS B0631 standard
● **Mean spacing of roughness motifs *AR***
Arithmetical mean value of the all roughness motifs width within the evaluation length.

$$AR = \frac{1}{n} \bullet \sum_{i=1}^{n} AR_i$$

● **Mean depth of roughness motifs *R***
Arithmetical mean value of the all roughness motifs depth within the evaluation length.

$$R = \frac{1}{m} \bullet \sum_{j=1}^{m} H_j$$

<div align="center">where, m=2n</div>

● **Maximum depth of profile irregularity *Rx***
Maximum value of the all roughness motifs depth within the evaluation length.
Rx = MAX(H_j) (For all H_j)

Note: *Rx* should be calculated before the height is corrected. The others should be calculated after the height is corrected.
Also, values *R* and *AR* are calculated when 3 or more motifs exist.

14-8-6   Waviness motifs

The waviness motif is obtained from the upper envelope line based on waviness motif upper limit length B.
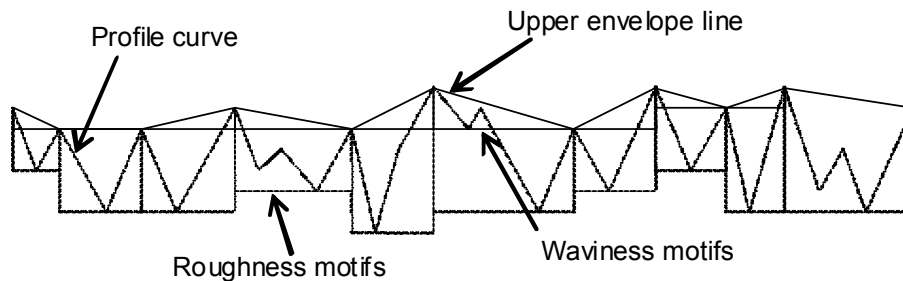
Figure 14-8-8 Waviness motifs

Note: Although official definitions are not given, this document uses the following terminologies for efficient operation of this instrument.
Roughness motif curve: The profile consisting of consecutive roughness motifs.
Waviness motif curve: The profile consisting of consecutive waviness motifs.

14. Parameter Description

14-8-7　How to find the waviness motifs

(1) Find the peaks and valleys of upper envelope line.
The data sequence that the peaks data were replaced with the evaluation data in the roughness motifs is called the upper envelope line and find the peaks and valleys on this curve from the next process.
Find the point where the next point is lower than itself and make it the peak, and find the point where the next point is higher than itself and make it the valley.
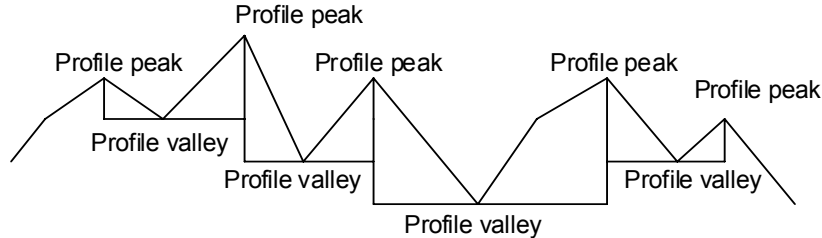
Figure 14-8-9 Identifying the highest peak and deepest valley of waviness motifs

(2) Combine the waviness motifs.
This is the same as for the roughness motifs. However, "roughness motif upper limit length A" should be replaced by "waviness motif upper limit length B" here.

14-8-8　Waviness motif parameters

(1) Parameters defined in ISO12085 or JIS B0631 standard

● **Mean spacing of waviness motifs** *AW*
The arithmetical mean value of all the waviness motifs width within the evaluation length.

$$AW = \frac{1}{n} \bullet \sum_{i=1}^{n} AW_i$$

● **Mean depth of waviness motifs** *W*
The arithmetical mean value of all the waviness motifs depth within the evaluation length.

$$W = \frac{1}{m} \bullet \sum_{j=1}^{m} HW_j \qquad \text{where, m=2n}$$

Note: Values *W* and *AW* are calculated when three or more motifs exist.

● **Maximum depth of waviness motifs** *Wx*
Maximum value of all the waviness motifs depth within the evaluation length.
　　　Wx = MAX(*HW_j*)　　　(For all *HWj* values)

14-8-9 Upper envelope line parameters

(1) Parameters defined in ISO12085 or JIS B0631 standard

● **Total depth of upper envelope line upper *Wte***

This is the vertical distance between the highest and lowest points of the upper envelope line.

● **Reduced peak height *Rpke***

A bearing area curve which is obtained from the upper envelope line and that is used as a parameter for the same evaluation as value *Rpk* in the ISO13565-2 or JIS B0671-2 standard.

The 40% width is sampled from the bearing area curve in the Mr value direction, and a position is determined to have the minimum height difference between both of their ends. The least squares straight mean line is calculated from this 40% width data, and it is determined as the "equivalent straight line."

Intersection point a between the equivalent straight line and the Mr=0% limit line is determined.

An intersection point between the horizontal line from this point a and the bearing area curve is determined as d.

The height that is equal to the height of area A_1 surrounded by the 0% limit line, side ad, and the bearing area curve, and that is equal to the height of the *tp*=0% limit line, forming a rectangular triangle with this side ad, is determined as *Rpke*.

$$Rpke = \frac{2A_1}{Mr_1}$$

● **Reduced valley depth *Rvke***

A bearing area curve that is obtained from the upper envelope line and that is used as a parameter for the same evaluation as value *Rvk* in the ISO13565-2 or JIS B0671-2 standard.

This means that intersection point b between the equivalent straight line and the Mr=100% limit line is determined on the bearing area curve.

An intersection point between the horizontal line from this point and the bearing area curve is determined as e.

This is the height that is equal to the height of area A_2 surrounded by the 100% limit line, side be, and the bearing area curve, and that is equal to the height of the 100% limit line, forming a rectangular triangle having this side be.

$$Rvke = \frac{2A_2}{(100 - Mr_2)}$$

● **Core roughness depth *Rke***

This is a difference in height between values a and b that have been determined above.
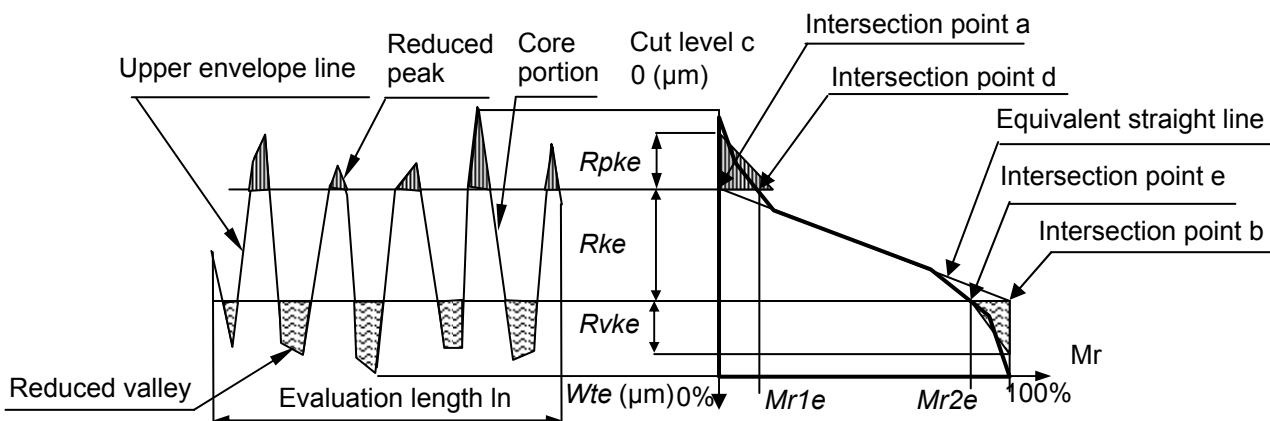
Figure 14-8-10 Parameters for bearing area curve from upper envelope line

14. Parameter Description

14-9 Measurement procedure, measurement condition selection and evaluation method

Sophisticated selection of measuring conditions is required to measure the surface profile, and the measurement conditions and evaluation method vary depending on the applicable standards and parameters. Check the applicable standards and measurement aim, and select the correct measurement procedure, cutoff value, sampling length, evaluation length and evaluation method for the measurement.

14-9-1 ISO97/JIS01 standard compliant

A. R-parameters and profile curve parameters
(1) Setting the measurement direction
・If the measurement direction is specified, select the specified direction for the measurement.
・If no measurement direction is specified, determine it as follows.
・Observe the object, and determine if grooves are angled in a single direction, crossing, or not angled in any direction.
・If grooves are angled in a single direction, adjust the stylus so that it moves at right angles to the grooves.
・If grooves are crossing, adjust the stylus to move in the midpoint direction of two grooves.
・If grooves are angled in different directions, try to adjust the stylus to move in the direction where the roughness pitch is small and the roughness height parameter is large.

(2) Extraction of the measurement position
  (2.1) When estimating the surface profile although no tolerance value is given
  Exclude the defect area such as scuffs, scratches and cavities from the target measurement area, and select a position to have an average of roughness height parameter values.

  (2.2) When making an admission decision if the drawing specifications and tolerance value are given
  To specify the upper limit tolerance (16% rule upper limit and maximum upper limit), exclude defective areas such as scuffs, scratches and cavities from the target measurement area, and select a position that has the maximum roughness height parameter value.
  To specify the 16% rule lower limit value (if the parameter is preceded by uppercase letter L), exclude defective areas such as scuffs, scratches and cavities from the target measurement area, and select a position that has the minimum roughness height parameter value.

(3) Selecting the measurement conditions (cutoff value, sampling length, and evaluation length)
  (3.1) If the cutoff value or sampling length is specified on the drawings or in the measurement specifications, set the cutoff value equal to the sampling length for the measurement.

  (3.2) If the cutoff value or sampling length is not specified on the drawings or in the measurement specifications, determine whether the waveforms are random or periodic by visually checking the surface or by checking the profile curve record.
    Random waveforms: milling, grinding, wrapping, horning, sand-blasting, casting, and forging of crossing crease
    Periodic waveforms: Triangular wave standard block, turning, milling, and other cutting works

  (3.2.1) When using random roughness curve (mean) parameters Ra, Rq, Rsk, Rku and $R\Delta q$ and when using the bearing area curve and probability density function and its parameters, observe the surface and estimate the Ra value or measure the Ra value temporarily by assuming the cutoff value of 0.8 mm, and determine which cutoff value of the next table meets this one.

Table 14-9-1 Sampling length for random contour curve roughness parameters *Ra*, *Rq*, *Rsk*, *Rku* and *RΔq* and for the bearing area curve and probability density function and its relating parameters(ISO4288:1996 Table 1)

Ra range (μm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
(0.006)	0.02	0.08	0.08	0.4
0.02	0.1	0.25	0.25	1.25
0.1	2.0	0.8	0.8	4.0
2.0	10.0	2.5	2.5	12.5
10.0	80.0	8.0	8.0	40.0

Here, if multiple sets of sampling length are used for judgment purposes, the mean value of *Ra* is used in this measurement.
・Use the judged cutoff value and re-measure judgment parameter Ra described above. Determine which cutoff value of Table 14-9-1 corresponds to the measured value again.
・If the measurement value of judgment parameter is outside the permissible range of temporary judgment parameters that have the measured cutoff value, replace it with the corresponding cutoff value of the table and repeat the above operation.
・If the measurement value of judgment parameter is within the permissible range of temporary judgment parameters that have the measured cutoff value, measure the judgment parameters using a shorter sampling length just to make certain. If the measured value becomes within the permissible range for the short sampling length, use this cutoff value.
・Measure the target parameters using the selected cutoff value, and determine the measurement result.

(3.2.2) Parameters *Rz*, *Rv*, *Rp*, *Rc* and *Rt* of random roughness curve
1) Observe the surface and estimate value *Rz*, or temporarily measure value *Rz* using cutoff value 0.8 mm. Then, determine which cutoff value of Table 14-9-2 corresponds to the measured value.

Table 14-9-2 Roughness parameters *Rz*, *Rv*, *Rp* and *Rc* of random contour curve, and the sampling length for *Rt* value (ISO4288:1996 Table 2)

Rz1max and *Rz* range (μm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
0.025	0.1	0.08	0.08	0.4
0.1	0.5	0.25	0.25	1.25
0.5	10.0	0.8	0.8	4.0
10.0	50.0	2.5	2.5	12.5
50.0	200.0	8.0	8.0	40.0

Here, use the mean value of each *Rz* value when the judgment is based on multiple sets of sampling lengths.
However, in order to determine the maximum profile peal height and valley depth parameters (*Rz1max*, *Rv1max*, *Rp1max* and *Rc1max*), use the *Rz1max* value (the maximum value of each Rz sampling length) for judgment purposes.

2) Use the judged cutoff value and re-measure judgment parameter *Rz* or *Rz1max* described above. Determine which cutoff value of Table 14-9-2 corresponds to the measured value again.

3) If the measurement value of judgment parameter is outside the permissible range of judgment parameter having the cutoff value, replace it with the corresponding cutoff value of the table and repeat the above operation.

4) If the measurement value of judgment parameter is within the permissible range of judgment parameter having the measured cutoff value, measure the judgment parameters using a shorter sampling length just to make certain. If the measured value becomes within the permissible range for the short sampling length, use this cutoff value.

5) Measure the target parameters using the selected cutoff value, and determine the measurement result.

14. Parameter Description

(3.2.3) *RSm* measurement for periodic roughness curve or random contour curve
1) Observe the surface and estimate value *RSm*, or temporarily measure value *RSm* using cutoff value 0.8 mm. Then, measure the approximate *RSm* value and determine which cutoff value of Table 14-9-3 corresponds to the measured value.

Table 14-9-3 Sample length for measurement of periodic roughness curve parameters and for *RSm* measurement of periodic or random contour curve (ISO4288:1996 Table 3)

RSm range (mm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
0.013	0.04	0.08	0.08	0.4
0.04	0.13	0.25	0.25	1.25
0.13	0.4	0.8	0.8	4.0
0.4	1.3	2.5	2.5	12.5
1.3	4.0	8.0	8.0	40.0

Here, use the mean value of each *RSm* value when the judgment is based on multiple sets of sampling lengths.

2) If the measurement value of judgment parameter *RSm* is outside the permissible range of *RSm* for the measured cutoff value, replace the cutoff value with the corresponding one listed on the table and repeat the above operation.

3) If the measured value of judgment parameter *RSm* is within the permissible range of *RSm* of the measured cutoff value, measure the target parameter using this cutoff value.

(3.2.4) Roughness parameter (plateau plane) of special bearing area curve ISO13565-2/ISO13565-3
Select the parameter from Table 14-9-4 regardless of the current waveforms.

Table 14-9-4 Cutoff value and evaluation length of special bearing area curve

Cutoff value λc (mm)	Evaluation length Ln (mm)	Remarks
0.8	12.5	Default value if not specified
2.5	12.5	It must be stated in the measurement condition if selected.

(3.2.5) Motif parameters (*R*, *Rx*, *AR*, *W*, *Wx*, *Wte*, *AW*, *Rke*, *Rpke*, *Rvke*, *Mr1e*, *Mr2e*)
Select the parameter from Table 14-8-2 regardless of the current waveforms.

(3.2.6) profile curve parameters (*Pp*, *Pv*, *Psk*, *Pku*, *PSm*, *PΔq*, *Pt*, *Pmr(c)*, *Pδc*, *Pmr*, *Ppq*, *Pvq*, *Pmq*)
A range of length specified by dimension lines on a drawing is determined as the evaluation length (that is, the sampling length).
If it is not specified, the entire length of profile is determined as the evaluation length (or the sampling length).
Here, the profile means a part of geometric shape, such as a sphere, a cylinder, a plane or others.

(4) Evaluation method of the measurement result
  (4.1) Determination of measurement value if no tolerance value is given
  ・Parameters obtained from the sampling length
    All of parameter values, that can be obtained from each sampling length among a single evaluation length, are arithmetically averaged and the average parameter is determined.

    The SURFCOM sets the judgment reference value of parameter judgment conditions as the "mean value" and evaluates the results.

    Also, the random measurement position is determined within the target plane, and multiple sets of evaluation length data are collected. To obtain a mean value of all these data sets, the mean value processing of Chapter 11 is carried out. The arithmetic average of all average parameters of every sampling length area values is used as the average parameter.

    Note: In the ISO/JIS standard, the average value is not used for judgment purposes.

  ・Roughness parameters and profile curve parameters obtained from evaluation length
          (*Rt*, *Rmr*, *Rδc*, *Rpk*, *Rvk*, *Rk*, *Mr1*, *Mr2*, *Rpq*, *Rmq*, *Rvq*, and
            Pp, *Pv*, *Psk*, *Pku*, *PSm*, *PΔq*, *Pt*, *Pmr(c)*, *Pδc*, *Pmr*, *Ppq*, *Pvq*, *Pmq*)
    The measurement is carried out at multiple points, and all parameter values obtained from each evaluation length are arithmetically averaged and the average parameter is determined.

    The SURFCOM sets the judgment reference value of parameter judgment conditions as the "mean value" and evaluates the results.
    The parameter values are averaged as described in Chapter 11, and the arithmetic average of each evaluation length parameter is determined as the average parameter.

    Note: In the ISO/JIS standard, the average value is not used for judgment purposes.

  (4.2) Judgment of 16% rule upper limit
  ・Parameters obtained from the sampling length
    a. Judgment by the number of measured values exceeding the standard value
    Among a single evaluation length, if the number of values, that exceed the request value of parameter values obtained from each sampling length, is 16% or less, the judgment result is accepted.

    For example, the following results are accepted.
    (- The first measured value is 70% or less of the standard value. (Note 1))
      - All of the second to fifth measured values are below the standard value.
      - One or less of the sixth to 11-th measured values exceeds the standard value.
      - Two or less of the 12-th to 17-th measured values exceed the standard value.

    Note 1: The standard of "If the number of sampling length sets of evaluation length is one, it is considered to be 70% of the standard value" is based on the concept of DIN 4775 standard, and it is only a reference example in the ISO and JIS standard. The 16% rule standard defines that "The measured value is equal to or less than the standard value."

    Note 2: In the ISO/JIS standard, the standard value for the number of sampling length sets of evaluation length is 5. Therefore, if the standard value is given, judgment of "All measured values are equal to or less than the standard value" is used for the 16% rule, similar to the maximum value rule.

14. Parameter Description

b. Judgment based on the $\mu+\sigma_5$ value
If value $\mu+\sigma_5$ is below the standard value, it is accepted.
However, if the number of sampling length sets "n" contained in the evaluation length is less than five, the following expression is used to convert the standard deviation of sample σ_n into the standard deviation of sample σ_5 with n=5 and it is judged.

$$\sigma_5 = \sigma_n \sqrt{\frac{n}{5}}$$

The SURFCOM uses the judgment standard value of "Average plus standard deviation" for parameter judgment, and it can set a judgment value within the single evaluation length and can judge it.
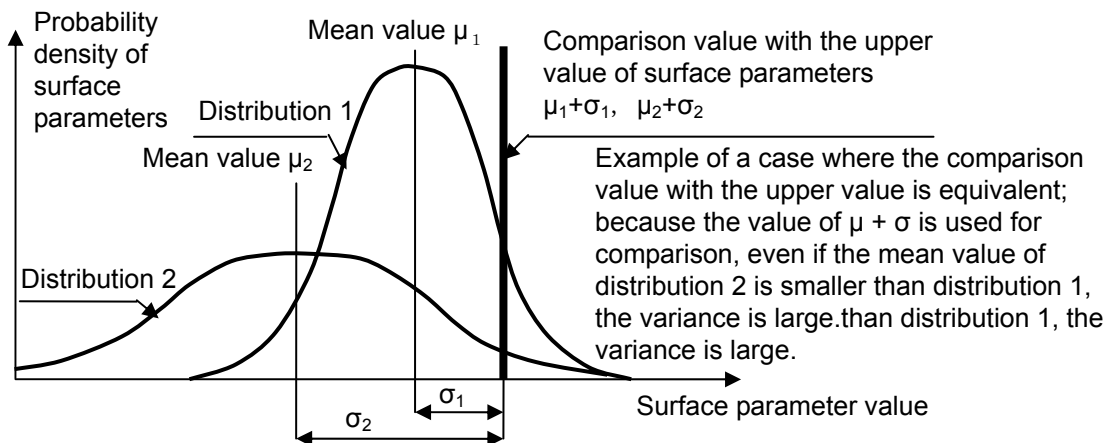
Figure 14-9-1 16% rule judgment standard, $\mu+\sigma$

・Roughness parameters and profile curve parameters obtained from evaluation length
(*Rt, Rmr, Rδc, Rpk, Rvk, Rk, Mr1, Mr2, Rpq, Rmq, Rvq,* and
Pp, Pv, Psk, Pku, PSm, PΔq, Pt, Pmr(c), Pδc, Pmr, Ppq, Pvq, Pmq)
A single evaluation length value is compared with the tolerance. If multiple sets are given, each value is considered to be less than the tolerance. However, this is not specified by the ISO4288 and JIS B0633 standards.

(4.3) Judgment of maximum rule (maximum upper limit) (the parameter having the "max" suffix)
If all parameter values, obtained from each sampling length (or evaluation length) among a single evaluation length, is less than the request value, they are accepted. The SURFCOM uses the judgment standard value of "Maximum value in the interval"for parameter judgment, and it sets a judgment value within a single evaluation length and judges the parameter value.

(4.4) Judgment of 16% rule lower limit
・Parameters obtained from the sampling length
a. Judgment by the number of measured values exceeding the standard value
Among a single evaluation length, if the number of values, that are less than the request value of parameter values obtained from each sampling length, is 16% or less, the judgment result is accepted.

For example, the following results are accepted.
(In some examples, the first measurement value may be 130% or more of the standard value.)
- If the number of sampling length sets is five or less, and if all measured values of each sampling length are above the standard value.
- If the number of sampling length sets is six or more but 11 or less, and if the number of measured values of sampling length, having the value less than the standard value, is one or less
- If the number of sampling length sets is 12 or more but 17 or less, and if the number of measured values of sampling length, having the value less than the standard value, is two or less

b. Judgment based on the μ-σ_5 value
If value μ-σ_5 is greater than the standard value, it is accepted.

However, if the number of sampling length sets contained in the evaluation length is less than five, the following expression is used to convert standard deviation σ_n into standard deviation σ_5 with n=5 and it is judged.

$$\sigma_5 = \sigma_n \sqrt{\frac{n}{5}}$$

The SURFCOM uses the judgment standard value of "Average minus standard deviation" for parameter judgment, and it sets a judgment value within a single evaluation length and judges it.

The 16% rule is not specified for evaluation length parameters and profile curve parameters.

B. Waviness parameters (ISO1302:2002 and JIS B0031:2003 standard compliant)
(1) Selecting the measurement conditions (sampling length and evaluation length)
Filter: Gaussian phase compensation band-pass filter is used.
High-pass cutoff value λc: It must be specified on the drawing.
                              If it is not known, it must be set to the same value as roughness cutoff value λc that is set simultaneously.
Low-pass cutoff value λf: It must be "n" times of sampling length L and it must be specified on the drawing.
                              This "n" value can be any integer.
                              The λf standard value of 2.5 mm, 8 mm, 25 mm or 80 mm is used by convention.
Sampling length L: This is the same value as low-pass cutoff value λf.
Evaluation length Ln: It must be "m" times of low-pass cutoff value λf, and it must be specified on the drawing.
                              This "m" value can be any integer.

(2) Evaluation method of the measurement result
Similar to the roughness parameters, each sampling length is determined and they are evaluated by the 16% rule.
If the parameter has the "max" suffix, it is evaluated by the Max rule.
The evaluation length parameter is judged by comparison of a single parameter measurement value with the tolerance.

14. Parameter Description

14-9-2 American ASME95 compliant (American ASME B46.1-1995 compliant)

A. Roughness parameter
1) Use either the phase compensation roughness curve of Gaussian distribution characteristics or the 2RC roughness curve as the sampled curve.
(ASME B46.1-1995, 3.3.19)
2) Visually check the surface or profile curve, and determine it as periodic waveforms or random waveforms.
3) Determine if cutoff value λc is equal to sampling length 1 or evaluation length L, by performing Steps (1) and (2) above.
If the evaluation length cannot be set to five times the sampling length, this must be stated and the evaluation length can be set to one to four times the sampling length l.

(1) Cutoff value, sampling length, and evaluation length for all parameters of the periodic waveform curve
When all parameters are measured with periodic waveforms, the measurement conditions are determined based on the **mean spacing *Sm* value**.
  (a) Graphically estimate mean spacing parameter *Sm* of surface roughness from the profile curve.
  (b) Use estimated parameter *Sm* and determine the recommended cutoff value based on the settings of Table 14-9-5.

Table 14-9-5 Cutoff value, sampling length, and evaluation length for determination of roughness parameters from the periodical waveform curve(ASME B46.1-1995, Table 3-1)

Sm range mm (in.)		Cutoff value	Evaluation length
Over	Under	λc mm (in.)	L mm (in.)
0.013 (0.0005)	0.04 (0.0016)	0.08 (0.003)	0.40 (0.016)
0.040 (0.0016)	0.13 (0.005)	0.25 (0.010)	1.25 (0.05)
0.13 (0.005)	0.40 (0.016)	0.80 (0.03)	4.0 (0.16)
0.40 (0.016)	1.3 (0.050)	2.5 (0.10)	12.5 (0.5)
1.3 (0.050)	4.0 (0.160)	8.0 (0.3)	40.0 (1.6)

(2) Cutoff value, sampling length and evaluation length for random roughness curve
For parameter measurement of random roughness curve, determine the measurement conditions based on the **_Ra_ value**.
  (a) Using the contour curve to be measured, estimate arithmetic mean roughness parameter *Ra*.
  (b) Determine the recommended cutoff value based on the estimated parameter *Ra* value and the value specified on Table 14-9-6.
  (c) Measure parameter Ra using the recommended cutoff value.
  (d) If the *Ra* measurement value exceeds the parameter range of the estimated cutoff value, change the cutoff value to the upper or lower area. Repeat this measurement and adjustment of cutoff value until both the cutoff value and parameter value meet those specified on Table 14-9-6.
  (e)   If the next short cutoff value than the cutoff value satisfying the table conditions has not yet been tried, use this short cutoff value for the measurement.
If the short cutoff value satisfies the conditions of Table 14-9-6, select this one as the cutoff value for measurement.
If the combination of this new cutoff value and *Ra* value does not match the conditions shown in Table 14-9-6, use the cutoff value determined in Step (d) for the measurement.

Table 14-9-6   Cutoff value, sampling length, and evaluation length for determination of roughness parameters of random roughness curve(ASME B46.1-1995, Table 3-2)

Ra range μm (μin.)		Cutoff value	Evaluation length
Over	Under	λc mm (in.)	L mm (in.)
-	0.02 (0.8)	0.08 (0.003)	0.40 (0.016)
0.02 (0.8)	0.10 (4.0)	0.25 (0.010)	1.25 (0.05)
0.10 (4.0)	2.0 (80.0)	0.80 (0.03)	4.0 (0.16)
2.0 (80.0)	10.0 (400.0)	2.5 (0.10)	12.5 (0.5)
10.0 (400.0)	-	8.0 (0.3)	40.0 (1.6)

(3) Evaluation method of measured values (This is the accepted practice and is not specified by the ASME B46.1-1995 standard.)
Determine whether the measured value is within the tolerance specified on the drawing (or between the upper and lower limits if two such values are specified).
During this time, do not use the 16% rule but simply compare whether or not the measured value satisfies the tolerance value.
However, use the maximum value of sampling length for *Rz*, *Rmax*, *Rp*, *Rv* and other peak and valley parameters. Also, use the mean value of evaluation length for *Ra*, *Rz*, *Rpm*, *Sm*, *tp*, *Rsk*, *Rku* and other mean parameters, and use a single data set of evaluation length for the *Rt* value.

B. Waviness parameters (ASME B46.1-1995)
Waviness profile curves whose high and low frequency components are removed as used.
Waviness parameter:
Waviness height W: The maximum height of evaluation length
High-frequency cutoff value λc: The same value as cutoff value λc of roughness measurement is used.
Low-frequency cutoff value λcw: Cutoff value λc of roughness measurement is multiplied by 10 and used.
Evaluation length L: Only the minimum evaluation length has been specified.
                             The "waviness evaluation length" must be specified for the measurement based on the length that is desired to be actually evaluated.

The cutoff values and minimum evaluation length are defined in the following table.

Table 14-9-7 Cutoff value, sampling length and evaluation length for waviness measurement

High-frequency cutoff value λc mm (in.)	Low-frequency cutoff value λcw mm (in.)	Minimum evaluation length L mm (in.)
0.08 (0.003)	0.8 (0.03)	1.6 (0.06)
0.25 (0.01)	2.5 (0.1)	5.0 (0.2)
0.8 (0.03)	8.0 (0.3)	16.0 (0.6)
2.5 (0.1)	25.0 (1.0)	50.0 (2.0)
8.0 (0.3)	80.0 (3.0)	160.0 (6.0)

14. Parameter Description

14-9-3 Old JIS94 standard compliant (Compliant JIS B0601-1994)

A. Roughness parameter

The roughness parameter is an arithmetic mean value of surface roughness parameters of each part that has been randomly sampled from the target surface.
The Gaussian distribution characteristic phase correct roughness curve is used for the sampled curve.
This standard does not specify the profile curve parameters.

(1) Cutoff value, sampling length and evaluation length for *Ra* value
Determine the measurement conditions according to the target *Ra* value.

Table 14-9-8 Reference of cutoff value and evaluation length to determine the Ra value
(JIS B0601-1994, Table 1)

Ra range (µm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
(0.006)	0.02	0.08	0.08	0.4
0.02	0.1	0.25	0.25	1.25
0.1	2.0	0.8	0.8	4.0
2.0	10.0	2.5	2.5	12.5
10.0	80.0	8.0	8.0	40.0

(2) Cutoff value, sampling length and evaluation length for *Ry* and Rz values
Determine the measurement conditions according to the target *Ry* and Rz values.

Table 14-9-9 Reference of sampling length and evaluation length to determine the *Ry* and *Rz* values
(JIS B0601-1994, Table 3 and Table 5)

Ry or *Rz* range (µm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
(0.025)	0.10	0.08	0.08	0.4
0.10	0.50	0.25	0.25	1.25
0.50	10.0	0.8	0.8	4.0
10.0	50.0	2.5	2.5	12.5
50.0	200.0	8.0	8.0	40.0

(3) Cutoff value, sampling length and evaluation length for *Sm* and *S* values
Determine the measurement conditions according to the target *Sm* value.

Table 14-9-10 Reference of sampling length and evaluation length to determine the *Sm* and *S* values
(JIS B0601-1994, Table 7 and Table 9)

Sm or *S* range (mm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	L (mm)	Ln (mm)
0.013	0.04	0.08	0.08	0.4
0.04	0.13	0.25	0.25	1.25
0.13	0.4	0.8	0.8	4.0
0.4	1.3	2.5	2.5	12.5
1.3	4.0	8.0	8.0	40.0

(4) Cutoff value sampling length for *Tp* value
Select any of the following six values. The selection method is not specified by the standard.
        0.08, 0.25, 0.8, 2.5, 8.0, 25.0 mm

(5) Cutoff value for Ra_{75} value
The 2RC roughness curve is used for the sampled curve.

Table 14-9-11 Reference of $λc_{75}$ value to determine the Ra_{75} value (JIS B0601-1994 Annex 1)

Ra_{75} range (μm)		Cutoff value $λc_{75}$ (mm)
Over	Under	
-	12.5	0.8
12.5	100.0	2.5

(6) Evaluation method of measured values
With the exception of scratches, calculate the arithmetic mean value of the parameter in each part that was sampled at random from the workpiece surface (the objective surface). And judge whether or not the value is within the specified tolerance (or upper and lower limit values in the case where there are two specified positions).
In other words, the roughness parameters are evaluated only based on the mean value of all measured values.

B. Waviness parameters (Old JIS B0610-1987)
The 2RC roughness curve is used for the sampled curve.

(1) Filtered maximum waviness profile curve W_{CM}
The filtered waviness curve passed through the 2RC filter is used as the sampled curve.
High-frequency cutoff value "fh" can be any of the following: 0.25, 0.8, 2.5, 8.0 mm.
Sampling length L can be any of the following: 0.25, 0.8, 2.5, 8.0, 25.0, 80.0 mm.

(2) Rolling circle maximum waviness profile curve W_{EM}
The profile, with a certain radius measured with the stylus tip, is used as the sampled curve.
The stylus tip radius can be any of the following: 0.08, 0.25, 0.8, 2.5, 8.0, 25.0 mm.
Sampling length L can be any of the following: 0.25, 0.8, 2.5, 8.0, 25.0, 80.0 mm.

(3) Filtered center line waviness curve W_{CA}
The filtered centerline waviness profile curve is used as the sampled curve.
High-frequency cutoff value "fh" can be any of the following: 0.25, 0.8, 2.5, 8.0mm.
Low-frequency cutoff value "fl" can be any of the following: 0.8, 2.5, 8.0, 25.0 mm. (Standard value is 8.0 mm).
The measuring length must be three times or more of the low-frequency cutoff value.

(4) Rolling circle center line waviness curve W_{EA}
The rolling circle traced profile, which is determined with the certain stylus tip radius, is passed through the 2RC filter for filtering of long wavelength. Then, the rolling circle center line waviness profile curve is used as the sampled curve.
Low-frequency cutoff value "fl" can be any of the following: 0.8, 2.5, 8.0, 25.0 mm. (Standard value is 8.0 mm.)
The measuring length must be three times or more of the low-frequency cutoff value.

(5) Evaluation method of measured values
Determine an arithmetic mean value of parameters of each part that has been randomly sampled from the target surface, and determine if it is within the tolerance specified on the drawing (or between the upper and lower limits if two such values are specified). In other words, the waviness parameters are evaluated only based on the mean value of all measured values.

14. Parameter Description

14-9-4　Old German DIN90 compliant (old German DIN4768-1990 compliant)

A. Roughness parameter

The driving direction must be in the direction where the roughness parameter reaches the maximum value. The Gaussian phase compensation roughness curve is used as the sampled curve. (DIN4777-1990) Determine the evaluation length in Steps (1) and (2). However, if a length that is five times longer than the sampling length cannot be obtained, state the reason for this and a length that is five or less integer times can be used.

　　　Example: Ra=1.1 μm with lm=3・le

(1) Cutoff value, sampling length, and evaluation length for all parameters of periodic waveform roughness curve

To measure all parameters using periodic waveforms, determine the measurement conditions based on the value of **parameter Sm indicating the mean space of grooves**.

Table 14-9-12 Cutoff value, sampling length, and evaluation length for periodic curve (DIN4768 Table 1)

Sm range (mm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	Le (mm)	Lm (mm)
0.01	0.04	0.08	0.08	0.4
0.04	0.13	0.25	0.25	1.25
0.13	0.4	0.8	0.8	4.0
0.4	1.3	2.5	2.5	12.5
1.3	4.0	8.0	8.0	40.0

(2) Cutoff value, sampling length and evaluation length for random roughness curve

For example, if the random roughness curve is produced by grinding, horizontal milling, tilted face milling, reaming, or casting, determine its measurement condition based on the Ra or Rz parameter value.

　(2.1) Rz and $Rmax$ parameters

　For the Rz and $Rmax$ parameters of random roughness curve, determine its measurement conditions based on the **Rz value**.

Table 14-9-13 Cutoff value, sampling length, and evaluation length for determination of Rz and $Rmax$ parameter values based on the random roughness curve(DIN4768 Table 2)

Rz range (μm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	Le (mm)	Lm (mm)
-	0.1	0.08	0.08	0.4
0.1	0.5	0.25	0.25	1.25
0.5	10.0	0.8	0.8	4.0
10.0	50.0	2.5	2.5	12.5
50.0	-	8.0	8.0	40.0

　(2.2) Ra parameter

　For the Ra parameter of random roughness curve, determine its measurement condition based on the **Ra value**.

Table 14-9-14 Cutoff value, sampling length, and evaluation length for determination of Ra parameter value based on the random roughness curve(DIN4768 Table 3)

Ra range (μm)		Cutoff value	Sampling length	Evaluation length
Over	Under	λc (mm)	Le (mm)	Lm (mm)
-	0.02	0.08	0.08	0.4
0.02	0.1	0.25	0.25	1.25
0.1	2.0	0.8	0.8	4.0
2.0	10.0	2.5	2.5	12.5
10.0	-	8.0	8.0	40.0

(3) Evaluation method of measured values
   1) Visually observe the surface or check the recorded waveforms of the profile curve, and determine whether the waveforms are periodic or random. Also, estimate the target roughness parameter value.
   2) Select the measurement conditions appropriate to the estimated value, measure the parameter values, and obtain the measured value.
   3) Select the measurement conditions appropriate to the measured value, and repeat the measurement with the changed cutoff value.
   4) If the cutoff value corresponding to the measured value matches the cutoff value that was used for the measurement, this is the correct measurement value and these measurement conditions are correct.
In the special case, for example, if the roughness and waviness profile curves overlap, condition $Rz<0.5$ µm is satisfied when the cutoff value is 0.25 mm, and if condition $Rz>0.5$ µm is satisfied when the cutoff value is 0.8 mm, use the smaller cutoff value of 0.25 mm.
   5) Determine whether the measured value is within the tolerance specified on the drawing or not. (DIN4768/DIN4775)
However, use the maximum value of each sampling length for the *Rmax* parameter.
Use the 16% rule and check if measured values of *Ra* and *Rz* parameters are within the tolerance or not.

B. Waviness parameters (DIN4774)

Here, use the "mean line for roughness curve," which removes short waveform components from the profile curve, as the waviness profile curve. This is also called the "filtered waviness curve" in the old JIS B0610 standard.

       Waviness parameters   Waviness height Wt: The maximum height of evaluation length
         Evaluation length Lmw   This is the same as "roughness evaluation length Lm".

14. Parameter Description

14-9-5   Old JIS82 compliant (JIS B0601-1982 compliant)

(1) Cutoff value and evaluation length for the *Ra* value
The 2RC roughness curve is used for the sampled curve.

Table 14-9-15 Cutoff value and measuring length to determine the Ra value

Ra range (µm)	Cutoff value λc_{75} (mm)	Measuring length Lm (mm)
-	0.08	0.24 or more
-	0.25	0.75 or more
12.5 or less	0.8	2.4 or more
12.5 to 100.0	2.5	7.5 or more
-	8.0	24.0 or more

(2) Sampling length for *Rmax* and *Rz* values
The profile curve is used for the sampled curve.

Table 14-9-16 Sampling length to determine the *Rmax* or *Rz* value

Rmax or *Rz* range (µm)	Sampling length L (mm)
-	0.08
0.8 or less	0.25
0.8 to 6.3	0.8
6.3 to 25.0	2.5
25.0 to 100.0	8.0
100.0 to 400.0	25.0

(3) Evaluation method of measured values
With the exception of scratches, calculate the arithmetic mean value of the parameter in each part that was sampled at random from the workpiece surface (the objective surface). And judge whether or not the value is within the specified tolerance (or upper and lower limit values in the case where there are two specified positions).
In other words, the roughness parameters are evaluated only based on the mean value of all measured values.

14-9-6   Exception of sampling length and evaluation length; if measurement fails when using the standard values

Select the above sampling length, cutoff value, measurement length and evaluation length in accordance with the adopted standard.
Depending on the size of the measurement object, the length may be changed as follows:

(1) If the reference value of the evaluation length cannot be selected
If evaluation length Ln that is five times cutoff value λc cannot be obtained, the cutoff value multiplied by an integer (that is less than five) can be used.
Therefore, in this case, select the evaluation length from integer multiples of the sampling length.

(2) If the evaluation length cannot be set to the cutoff value that is multiplied by an integer
If the length needs to be changed slightly according to the measurement target and purpose, sampling length L that is greater than cutoff value λc can be used as an exceptional case.
However, in such a case, clearly indicate the λc and L values in the measured results.
When these evaluation lengths are specified in this measuring instrument, the sampling length will be set as follows:

    1) If evaluation length Ln is less than the λc value (Ln<λc)
    $\rightarrow$ The evaluation length needs to have the λc value minimum, and result is L=Ln=λc.
    2) If evaluation length Ln is not equal to the λc value multiplied by an integer (nλc<Ln<(n+1)* λc)
    $\rightarrow$ Result is L=Ln/n.
    3) If evaluation length Ln is 300 times or more than the λc value (Ln>300×λc)
    $\rightarrow$ Result is L=Ln/300.

(3)   If target surface length Lt of workpiece is smaller than the sum of cutoff value λc and preparatory length Lp
(Lt<λc+Lpe+Lpo)
A preparatory length is necessary for making cutoff, but in the case of the small area where can be measured, it is not possible to get the parameter calculation specified in the standard.
In such case, the preparatory length is not required if the measurement type is set to the profile curve only.
The corresponding profile curve parameter can be used alternately.
For example, the following alternatives can be used:
・Maximum profile *Pt* (or *Rmax* of old JIS standard) instead of *Rz* and *Rt* values
・Ten point height of irregularities *Rz*$_{JIS82}$ and Pc instead of Rz (JIS94) and *Rc* values
・*Pa* value instead of *Ra* value
・*PSm* value instead of *RSm* value
・*Pmr(c)* calculation instead of *Rmr(c)* calculation.

15. Troubleshooting

This chapter explains steps to take if an error has occurred.

15-1　Problems on operations

Symptom	Description
Analysis processing started when the MEAS./STOP button was pressed to stop measurement.	Is "Stop-Calc." turned on? Check "Stop-Calc." on [System Display].
A parameter value that is different from the usual one is displayed.	Condition settings such as the cutoff value may be changed. Check the measurement conditions displayed on [Meas. Criteria Display]. To manage measurement condition settings, measurement conditions can be saved in the built-in memory using up to five methods. It will be useful to use those methods as measurement tasks.
To measure a step without tilt correction, the measurement starting point detection level was specified in the measurement range, but it exceeded the measurement range.	Is "Zero-Offset" selected? Check "Zero-Offset" on [AUTO-Function Setting Display]. This function is available for normal measurement; however, the detection level at the measurement starting point is automatically corrected in a measurement such as a step measurement in which the detection level is specified at the measurement starting point. To avoid such an operation, cancel this function.
Unnecessary parameter values are displayed and printed out.	Do not select unnecessary parameters. Only select the necessary parameters in Parameter Select of [Output Parameters Display].
The screen disappears if the machine is not used for a certain period of time.	Is the "Sleep" function specified? Check the setting on [Sleep Setting Display]. This function is available when the battery is used.
Cannot calibrate data.	Execute Initialize , and retry calibration. For the Driver section (-35/-40/-45), be careful to calibrate data so that the reference specimen is in parallel with the Driver section.
Cannot enter a numeric value.	The setting range is provided for each of items where to enter a numeric value. A numeric value cannot be entered over the specified range. Confirm the setting range.
When displaying the currently measured real-time profile, it will take some time for the profile to begin to be drawn after the MEAS./STOP button is pressed. The measurement will continue for a short period of time after drawing has ended.	Measurement data sampling covers the evaluation area (length specified with the evaluation length) as well as the pre/post travel to carry out filtering processing before and after. The real-time profile only displays a form in the evaluation area; therefore, it will take more time to process the pre/post travel.

15-2   Failures and actions

If any of the following symptoms occurs during operation, first take the appropriate action. If no effect is obtained or a symptom that is not shown in the list occurs, contact the customer support center.

<Customer support center> Contact your representative or the following center.
    If you do not know how to use an item or you have technical questions, please contact: Measurement center, TOKYO SEIMITSU CO., LTD.
      Telephone: 029-831-6899
    Inquiries about maintenance and inspection: Calling center, Tosei Engineering Corporation
      Telephone: 0120-995-633

Failure status	Cause	Action
・ No information appears on the screen of the data processor.	・ The power is not turned on.	・ Check the outlet voltage. ・ Charge the battery. ・ Replace the AC adapter. (To replace the AC adapter, contact the customer support center.)
・ The level bar of the level meter does not oscillate or is not stabilized on the Meas. Criteria Display of the data processor. Otherwise, the level bar remains run out.	<Driver section (-50)> ・ The stylus is not fully inserted. ・ The pickup cord is disconnected.	・ Insert the stylus to the back. ・ Connect the pickup cord.
	<Driver section (-50)> ・ Pickup cord disconnection ・ Pickup error	・ Contact the customer support center.
	<Driver section (-35/-40/-45)> ・ The pickup cord is not fully inserted.	・ Insert the pickup cord to the back.
	<Driver section (-35/-40/-45)> ・ Pickup error	・ Contact the customer support center.
・ The ⎢MEAS./STOP⎥ or ⎢RETURN⎥ button was pressed, but the Driver section did not run.	・ The driver cable is disconnected.	・ Connect the driver cable.
	・ The limit switch is turned on.	・ Turn the limit switch off.
・ The measurement result does not match the roughness size to be measured. ・ When the driver section was returned to the original position after a specific displacement was set to the detection level using the magnification calibration device, a significant difference was detected between the initial value of the detection level and the value obtained when the section returned to the original position.	・ The stylus is rubbed with the nose piece.	・ Adjust the nose piece installation position.
	・ Pickup error	・ Contact the customer support center.

15. Troubleshooting

Failure status	Cause	Action
・ A paper feeding error occurred in the printer.	・ The printer cover is not closed.	・ Securely close the printer cover.
	・ Printer error	・ Contact the customer support center.
・ Printer paper is fed correctly, but not printed out.	・ Recording paper is loaded incorrectly.	・ Correctly load recording paper.
	・ Printer error	・ Contact the customer support center.
・ The density is low.	・ Unspecified paper is used.	・ Purchase recording paper from us.
・ Significant variations were detected among measurement results. ・ The displacement of the detection level varied significantly when the stylus was applied to a measurement task. (Drift)	・ The ambient temperature changes significantly. ・ The machine is directly exposed to the airflow from the air-conditioning equipment.	・ Change the installation location. ・ Use the windbreak cover.
・ Fine-amplitude data is detected on a work form. (Large oscillation)	・ The clamp tab of the pickup is loosened. ・ If the measurement table is used, the clamp screws of the Driver section are loosened.	・ Securely fasten each setscrew.
・ A waveform error was detected when a reference specimen was measured.	・ Stylus error ・ The edge of the stylus contains notches.	・ Replace the stylus.
	・ Reference specimen damage	・ Measure an undamaged part if possible. ・ If damage is serious, replace the specimen.
	・ Dusty reference specimen	・ Carefully wipe off with a dry cloth.
・ The displayed or printed date and time are incorrect. ・ The specified measurement conditions are initialized when the power is turned off. ・ The measurement conditions and data saved in the built-in memory are erased.	・ The battery has run out.	・ Charge the battery. If runout occurred immediately after the battery was charged, replace the battery. $\Rightarrow$
・ The LCD has dimmed.	・ Service life of backlight	・ Contact the customer support center.
・ It is difficult to view information due to the screen being dusty.	—	・ Wipe off any dust on the screen with a cloth moistened with neutral detergent.

16. Materials

This chapter provides explanation of reference materials.

16-1 Parameter list

<Profile>
The parameters calculated in the profile mode are as follows.
Example: P: Profile, RM: Roughness Motifs, WM: Waviness Motifs, UE: Upper envelope curve

Correspondence between standards and parameters (Profile) Parameter symbol: Extracted curve

Display order	JIS'82	JIS'94	ISO'97/JIS'01/DIN	CNOMO	ASME'95/ASME'02
1	Rmax:P	Rmax:P	Pa:P	R:RM	Pt:P
2	Rz:P	Rz.J:P	Pq:P	Rx:RM	Rz.J:P
3	AVH:P	AVH:P	Pt:P	AR:RM	AVH:P
4	Hmax:P	Hmax:P	Rz.J:P	W:WM	Hmax:P
5	Hmin:P	Hmin:P	AVH:P	Wx:WM	Hmin:P
6	Tp:P	-	Hmax:P	AW:WM	-
7	Rk:P	-	Hmin:P	Wte:WM	-
8	Rpk:P	-	Pmr:P	Mr:UE	-
9	Rvk:P	-	-	Rke:UE	-
10	Mr1:P	-	-	Rpke:UE	-
11	Mr2:P	-	-	Rvke:UE	-
12	Vo:P	-	-	Mr1:UE	-
13	K:P	-	-	Mr2:UE	-
14	-	-	-	Vo:UE	-
15	-	-	-	K:UE	-

<Roughness>
The parameters calculated in the roughness mode are as follows.
Example: P: Profile, R: Roughness Curve, RM: Roughness Motifs, WM: Waviness Motifs, UE: Upper envelope curve

Correspondence between standards and parameters (Roughness) Parameter symbol: Extracted curve

Display order	JIS'82	JIS'94	ISO'97/JIS'01/DIN	CNOMO	ASME'95/ASME'02
1	Ra:R	Ra:R	Ra:R	R:RM	Ra:R
2	Rmax:P	Rmax:P	Pa:P	Rx:RM	Pt:P
3	Rz:P	Rz.J:P	Pq:P	AR:RM	Rz.J:P
4	Rq:R	Ry:R	Pt:P	W:WM	Rz:R
5	Rp:R	Rz:R	Rz.J:P	Wx:WM	Rmax:R
6	Rt:R	Sm:R	Rz:R	AW:WM	RSm:R
7	Pc:R	S:R	Rzmax:R	Wte:WM	RS:R
8	AVH:P	Rq:R	RSm:R	Mr:UE	Rq:R
9	Hmax:P	Rp:R	Rq:R	Rke:UE	Rpm:R
10	Hmin:P	Rt:R	Rp:R	Rpke:UE	Rp:R
11	Tp:P	Pc:R	Rt:R	Rvke:UE	Rt:R
12	Rk:P	AVH:P	R3z:R	Mr1:UE	Pc:P
13	Rpk:P	Hmax:P	Pc:R	Mr2:UE	AVH:P
14	Rvk:P	Hmin:P	AVH:P	Vo:UE	Hmax:P
15	Mr1:P	Tp:R	Hmax:P	K:UE	Hmin:P
16	Mr2:P	Rk:R	Hmin:P	-	Rmr:R
17	Vo:P	Rpk:R	Pmr:P	-	Rk:R
18	K:P	Rvk:R	Rmr:R	-	Rpk:R
19	-	Mr1:R	Rk:R	-	Rvk:R
20	-	Mr2:R	Rpk:R	-	Mr1:R
21	-	Vo:R	Rvk:R	-	Mr2:R
22	-	K:R	Mr1:R	-	Vo:R
23	-	-	Mr2:R	-	K:R
24	-	-	Vo:R	-	-
25	-	-	K:R	-	-

The shaded field shows a parameter with a section display.

☞ For measurement of roughness, CNOMO standard is only available for models -35/-40/-45. -

16. Materials

<Waviness>
The parameters calculated in the waviness mode are as follows.
   Example: W: Filtered waviness curve, WC: Waviness profile curve

Correspondence between standards and parameters (Waviness)   Parameter symbol: Extracted curve

Display order	JIS'82	JIS'94	ISO'97/JIS'01/DIN	CNOMO	ASME'95/ASME'02
1	WC-a:W	Wa:W	W-a:W	-	W-a:W
2	WC-q:W	Wq:W	W-q:W	-	W-q:W
3	WCM:W	WCM:W	W-t:W	-	W-t:W
4	WC-p:W	Wp:W	W-p:W	-	W-p:W
5	WC-v:W	Wv:W	W-v:W	-	W-v:W
6	WC-Sm:W	WSm:W	W-Sm:W	-	W-Sm:W
7	WCA:WC	WCA:WC	Wa:WC	-	Wa:WC
8	WCC-q:WC	WC-q:WC	Wq:WC	-	Wq:WC
9	WCC-m:WC	WC-t:WC	Wt:WC	-	Wt:WC
10	WCC-p:WC	WC-p:WC	Wp:WC	-	Wp:WC
11	WCC-v:WC	WC-v:WC	Wv:WC	-	Wv:WC
12	WCC-Sm:WC	WC-Sm:WC	WSm:WC	-	WSm:WC
13	-	-	Wz:WC	-	-
14	-	-	Wmr:WC	-	-

The shaded field shows a parameter with a section display.

⚠ **Caution**   **This machine provides a function that calculates parameters available for actual measurement as well as parameters defined in each standard.**

<Name and formula of each parameter>
For parameter symbols, refer to Section 14-3-3 "Surface Profile Parameters". For the name and formula of each parameter, refer to the following.

    Height parameters (*a, *q, *p, *z, *v, *t, WCA, WCM, AVH, Hmax, Hmin)   :14-4
    Horizontal and peak count parameters (*Sm, S, Pc)   :14-5
    BAC graph parameters (*mr, Rk, Rpk, Rvk, Mr1, Mr2, Vo, K)   :14-6
    Motif parameters (R, Rx, AR, W, Wx, AW, Wte)   :14-8

16-2   Message list

Error category	Message	Description
Measurement errors	There are no results.	This message appears when a graph display, print, or recalculation job has been executed before measurement or measurement data loading is carried out. Execute a graph display, print, or recalculation job after measurement or measurement data loading has been completed.
	Measurement error. Evaluated length is shorter than cutoff value. Check the measurement condition.	This message appears when the specified evaluation length is shorter than the specified cutoff value. It also appears when the actual evaluation length is shorter than the specified cutoff value when using the Stop-Calc. or notching function. The actual evaluation length refers to a length from the measurement starting point to the point where the stop switch was pressed, and a length excluding the notch section. Confirm the specified evaluation length and cutoff value.
	Measurement error. Cannot start measurement. Limit switch is turned ON.	This message appears when measurement was carried out while the limit switch was turned on. Return the driver section to the appropriate position, and retry measurement.
	Measurement error. Measurement has stopped. Limit switch is turned ON.	This message appears when the limit switch was turned on during measurement. Return the driver section to the appropriate position, adjust it so that the evaluation length is within the limit position, and retry measurement. However, this message does not appear when Stop-Calc. is turned on.
	Measurement error. Impossible to measure as the battery is short.	This message appears when the battery level is low. Charge the battery or connect the AC power cable.
	Measurement error. The Setting is wrong between measuring speed and cutoff value. Check the measurement condition.	This message appears when a consistency is not secured between the specified measurement speed and cutoff value. Check the specified measurement speed and cutoff value.
	Measurement error. Evaluation length is smaller than minimum value. Check the measurement condition.	This message appears when the specified evaluation length is less than the measurable minimum value. Check the specified evaluation length.
	Measurement error. Evaluation length is greater than maximum value. Check the measurement condition.	This message appears when the specified evaluation length is greater than the measurable maximum value. Correct the evaluation length, referring to Section 9-1-3.
	Measurement error. Peak Count Level: A lower limit value is greater than the upper limit value.	This message appears when the lower-limit value is greater than the upper-limit value in the peak count level setting. Check the peak count level setting.
	Measurement error. Set values with roughness motif limit < waviness motif limit	This message appears when the roughness motif upper limit length is greater than or equal to the waviness motif upper limit length in the motif calculation setting. Check the motif calculation setting.
	Measurement error. AI function is available only when measurement type is roughness measurement.	This message appears when the AI-function is performed while the measurement type is not set to Roughness Measurement. Set the measurement type to Roughness Measurement.

16. Materials

Error category	Message	Description
Measurement errors	Measurement error. Judgment: A lower limit value is greater than the upper limit value.	This message appears when the lower-limit value is greater than the upper-limit value in the judgment setting. Confirm the judgment setting.
	Measurement error. Please confirm drive department and the connection of the cable.	This message appears when the driver section or cables are not connected properly during measurement. Check the driver section and cable for connection.
	Measurement error. Notch Calculation: A lower limit value is greater than the upper limit value.	This message appears when the lower-limit level is greater than the upper-limit level in the notch calculation setting. Confirm the notch calculation setting.
Analysis errors	Analysis error. The amount of notch count is out of range.	This message appears when the number of notch parts exceeds the maximum value "100" during calculation. Adjust the evaluation length so that the number of notch parts is 100 or less, and retry measurement.
	Analysis error. Parameter calculation cannot be carried out by shortage of sampling data.	This message appears when the point count of sampling data is less than the minimum value required for calculation. In other words, it appears when the effective evaluation length is shorter than the minimum. The minimum evaluation length varies depending on the measurement speed. For details, refer to **9-1 Measurement conditions**. The effective evaluation length means ("actually measured length" - "notch length").
	Analysis error. The motif curve was uncomputable.	This message appears when a motif curve cannot be obtained although the specified analysis process was carried out. Change the motif upper limit length as needed, and retry measurement.
	Analysis error. Could not obtain the roughness motif curve or upper envelope curve.	This message appears when a motif curve cannot be obtained although the specified analysis process was carried out. Change the motif upper limit length as needed, and retry measurement.
	Analysis error. The surge motif was uncomputable.	This message appears when a motif curve cannot be obtained although the specified analysis process was carried out. Change the motif upper limit length as needed, and retry measurement.
	Analysis error. System error occurred during the analysis process. Please contact the customer support.	This message appears when a system error occurred during analysis processing. Turn the power off once and retry measurement. If this error recurs, contact the customer support center.
	Analysis error. Over range data exists.	This message appears when some data go outside the measuring range during the calculation process. Change measurement conditions as required, and retry measurement. This message does not appear when Notch calculation is turned on.

Error category	Message	Description
Calibration error	Calibration error. Confirm calibration setting, and try again.	This message appears when magnification calibration has failed. Carry out initialization, and check that the setting is correct.
	Calibration error. Error occurred during calibration.	This message appears when calibration processing is not performed correctly due to any of the following reasons. (1) Calibration processing was performed in a place with higher vibration. Carry out calibration processing in a place with lower vibration. The vibration check function is available when the driver section (-50) is used. (2) For driver section (-35/-40/-45) Carry out calibration while the reference specimen is even with the driver section. (3) If the stylus is worn or notched: Replace the stylus with a new one. The stylus check function is available. (4) Others Contact the customer support center.
Memory relation errors	USB memory cannot be removed. Execute again afterward.	This message appears when the USB memory device cannot be removed because it is being accessed. Retry the job after a while.
	There is no data to copy.	This message appears when the internal memory contains no measurement conditions and measurement data to be copied collectively. It is not possible to collectively copy data.
	USB mem. psvtn error The availabilities of a USB memory are insufficient.	This message appears when measurement data or measurement conditions cannot be saved because there is an insufficient amount of free space in the USB memory. Create a sufficient amount of free space in the USB memory.
	USB mem. psvtn error Data was not able to be saved in a USB memory.	This message appears when an error occurred while saving data in the USB memory. The USB memory may be set in the write-only mode. Check the USB memory.
	USB memory rdng error Reading of data was not completed from a USB memory.	This message appears when an error occurred while loading data from the USB memory. The USB memory is set to an invalid format, or it may be damaged. Check the USB memory.
	Intl. mem rdng. Error Since it is not in agreement in a drive part, it cannot read.	This message appears when measured data is loaded using a driver section different from the currently connected driver section. Turn the power off once and connect to the driver section used for measurement. Otherwise, start the driver section without connecting it, and retry loading.
Inspector errors	Tracing driver is not connected.	This message appears when the driver section is not connected. Check the driver section and cable for connection.
	The drive part and cable which are connected do not suit.	This message appears when the connected driver section does not match the cable type. Check the driver section and cable for connection.
	Because clock data fail by battery abnormality, please set it on the date and time.	This message appears when internal clock data is abnormal due to battery runout or battery error. Specify the date and time on the date and time setting screen.
	Connection of the drive department was changed. I initialize setting.	Condition settings were initialized because a driver section different from the previously connected driver section is connected. Specify conditions.

16. Materials

Error category	Message	Description
Inspector errors	Z reset error. Error occurred during Z reset.	This message appears when the displacement level of the detector exceeds the adjustable range. Turn the power off once, and retry the job. If this error recurs, contact the customer support center.
	Return error Cannot return tracing unit. Limit switch is turned ON.	This message appears when the driver section is over the returnable range. It is not possible to return the driver section any more.
Printer errors	Printout error Printer paper is out. Put in the record sheet.	This message appears when a paper-out occurred or the print switch was pressed during printing while no paper was loaded. Load paper.
	Data output error Output destination not found. Check the connection.	This message appears when an error occurred during data output processing. Check the connection with an external device and communication settings.
	Printout error Printer error.	This message appears when no response is returned from the printer. Turn the power off once, and retry printing. If this error recurs, contact the customer support center.

16-3   List of initial values

Using initialization processing configures conditions as shown below

Measurement condition	Standard		JIS '01/ISO '97/DIN
	Measurement Type		Roughness
	Evaluation Length		Fixed mode (5×λc)
	Cutoff value		0.8 mm
	Measure Speed		0.6 mm/s
	Pre. Drive Length		Cutoff value/3
	Form Remove		Straight
	Filter type		Gaussian
	λs		Cutoff ratio 300
	Return Speed		0.6 mm/s
Analysis Condition	Peak Count Level	Upp-L	0.0 µm
		Low-L	0.0 µm
	BC Graph Cut Level	Unit	Relative value
		Level	10.00 %
	Motif Calculation	LIMIT_A	0.5 mm
		LIMIT_B	2.5 mm
		Combi. Disp.	ON
	Step Height Calculation	Ref. H.	0.0 µm
		Del. Len.	0.0 µm
	Notch calculation	Execute	OFF
		Del. Len.	0.0 µm
		Upper-limit level	400 µm
		Lower-limit level	-400 µm
Output Setting	Output Selection	Measure Date	ON
		Measurement condition	ON
		Parameter	ON
		Section	OFF
		BAC Graph (P)	OFF
		BAC Graph (R)	OFF
		BAC Graph (WC)	OFF
		ADC Graph (P)	OFF
		ADC Graph (R)	OFF
		ADC Graph (WC)	OFF
		Profile Curve	ON
		Roughness Curve	ON
		Filtered Waviness Curve	OFF
		Waviness Profile Curve	OFF
		ISO13565 Curve	OFF
		Roughness Motifs	OFF
		Waviness Motifs	OFF
	Output Parameter		Specify only Ra, Pt, Rz.J, RZ, and RSm.
	Judgment	Judg. Meth.	Average
		Judg. Parm	Not specified
	16% rule	Judgment of one section	OFF
		Judgment method	Standard

16. Materials

System	Language		ENGLISH *1
	Display Unit		mm, μm *1
	Stop-Calc.		ON
	Pickup		Standard
	Display Sel. After Sel.		Meas. Result Display
	USB Memory Save Type		Text
Various Settings	V-Mag		AUTO
	H-Mag		AUTO
	Sleep ON/OFF		5 min. *1
	Date/Time		January 1, 2011 00:00:00 *1
	Previous Data Auto Loading		OFF
	Communication Condition	Speed	115200 bps
		Data Length	8 bits
		Stop bit	1 bit
		Parity	None
		X-Flow	Hardware
		Output type	Text
F. Setup	Measure Range	Driver section (-50)	±400 μm
		Driver (-35/-40/-45)	±160 μm
	AUTO-Function Setting	AUTO-PRINT	OFF
		Return	OFF
		Data Output	OFF
		USB Memory Save	OFF
		Zero-Offset	ON
	AI-Function	Execute	OFF
		Objec. Param.	Ra
		Cutoff U-Lim	0.25 mm
	Calibrate Mag. calib. dev.	Pickup	Standard
		Ref. value	20.00 μm
	Calibrate Roughness Spec.	Cal. param.	Ra
		Pickup	Standard
		Ref. value	3.20 μm
	Calibrate Depth Specimen	Stepmaster	A1 (Square ditch)
		Lo-Lmt dep	-0.10 μm
		Excld. Area	0.00 μm
		Pickup	Standard
		Ref. value	10.00 μm

⚠️ **Caution**

*1
The language, display unit, sleep function, and date/time setting are initialized only at the time of shipment from the factory or when forced initialization occurs (when started while holding down the ENTER button). They are not initialized at other initialization processes.

17. Main Specifications

This chapter describes main specifications.

17-1   SURFCOM FLEX -50

Measure Range	X axis	50 mm (1.9685 in)
	Z axis	±400/±40/±4 µm (±15748/±1574/±157 µin)
Evaluation Length	Interval 0.1 to 50 mm, 0.1-mm steps (Interval 0.0039 to 1.9685 in, 0.0001-inch steps)	
Measure Resolution	0.016/0.0016/0.00016 µm (0.6299/0.06299/0.06299 µin)	
Sensing method	Differential trans	
Measurement method	Skid or skidless measurement switching by installing and removing the nose piece	
Calibration method	Calibrate Mag. calib. dev., Calibrate Roughness Spec., Calibrate Depth Specimen	
Straightness precision	0.3 µm/50 mm (11.8110 µin/1.9685 in)	
Up/down distance	50 mm (1.9685 in)	
Tilt range	±1.5 °	
Measure Speed	0.15, 0.3, 0.6, 1.5 mm/s (0.0059, 0.0118, 0.0236, 0.0591 in/s)	
Return Speed	0.15, 0.3, 0.6, 1.5, 3.0 mm/s (0.0059, 0.0118, 0.0236, 0.0591, 0.1181 in/s)	
Reference stylus	Body	60-degree circular cone
	Tip radius.	2 µm R (78.74 µin R)
Measure Force	0.7 mN	
Measure Posture	Entire Posture	
Nose piece	Skid type	Edge skid
	Skid materials	Sapphire
	Skid shape	32 mm R (1.26 in R) (Trace direction)
Disp MTHD	3.5" color TFT LCD (320 x 240 dot)	
Printing	Thermal printer	
	Paper width	58 mm (2.2835 in)
	Print width	48 mm (1.8898 in)
Battery	Built-in type (Nickel-hydrogen storage cell NiMH)	
	Charge time	3 hours (Max.)
Power supply (AC adapter)	AC adapter input	100-240 V AC (50/60 Hz max. 2.5 A)
	Data processor input	12 V DC (max. 30 W)
	Power consumption	Max. 30 W (When printing while charging)
Standard	JIS '82, JIS '94,JIS '01/ISO '97/DIN, CNOMO, ASME '95/ASME '02	
Measurement Type	Profile, Roughness, Waviness	
Evaluation curve	Profile, Roughness, Filtered Waviness Curve, Waviness <ISO13565 Special roughness curve>, <Roughness Motif>, <Waviness Motif>, <Upper envelope curve> λs The curve enclosed in brackets < > does not support external output or file output by USB communication.	
Characteristic graph	BC Graph, ADC Graph	
Form Remove	Off, Straight, R-Curve, Begin. Half, End. Half, Begin-End	
Filter type	Gaussian, 2RC (Phase Compensation), 2RC (Phase Non-compensation)	
Cutoff value	Cutoff Ratio (λc/λs)	Off, 30, 100, 300, 1000 [Ratio]
	λs	Off, 0.25, 0.8, 2.5,8,25[µm] (Off, 10, 30, 100, 300, 1000[µin])
	λc	0.08, 0.25, 0.8, 2.5, 8, 25 [mm] (0.003, 0.010, 0.030, 0.100, 0.300, 1.000 [in])
	λf Yes	0.08-0.80, 0.08-2.50, 0.25-25.0, 0.25-8.00, 0.80-8.00, 0.80-25.00, 2.50-25.00 [mm] (0.003-0.030, 0.003-0.100, 0.010-0.100, 0.010-0.300, 0.030-0.300, 0.030-1.000, 0.100-1.000 [in])
	λf Off	0.08, 0.25, 0.8, 2.5, 8, 25 [mm] (0.003, 0.010, 0.030, 0.100, 0.300, 1.000 [in])
Section number	$\times$ 1 to $\times$ 300	

17. Main Specifications

17-2   SURFCOM FLEX -35/-40

Measure Range	X axis	12.5 mm (0.0157 in)
	Z axis	±160 µm (6299 µin)
Evaluation Length	Interval 0.4 to 12.5 mm, 0.1-mm steps (Interval 0.0157 to 0.4921 in, 0.0001-inch steps)	
Measure Resolution	0.0064 µm (0.2520 µin)	
Sensing method	Differential inductance	
Measurement method	Skid measurement	
Calibration method	Calibrate Roughness Spec.	
Measure Speed	0.6 mm/s (0.02362 in/s)	
Return Speed	1.0 mm/s (0.0394 in/s)	
Reference stylus	Body	90-degree circular cone
	Tip radius.	5 µm R (196.85 µin R)
Measure Force	4 mN	
Measure Posture	Entire Posture	
Skid	Skid type	Edge skid
	Skid materials	Sapphire
	Skid shape	40 mm R (1.575 in R) (Trace direction)
Disp MTHD	3.5" color TFT LCD (320 x 240 dot)	
Printing	Thermal printer	
	Paper width	58 mm (2.2835 in)
	Print width	48 mm (1.8898 in)
Battery	Built-in type (Nickel-hydrogen storage cell NiMH)	
	Charge time	3 hours (Max.)
Power supply (AC adapter)	AC adapter input	100-240 V AC (50/60 Hz max. 2.5 A)
	Data processor input	12 V DC (max. 30 W)
	Power consumption	Max. 30 W (When printing while charging)
Standard	JIS '82, JIS '94,JIS '01/ISO '97/DIN, CNOMO, ASME '95/ASME '02	
Measurement Type	Roughness	
Evaluation curve	Profile, Roughness Curve, <Roughness Motifs>, <Waviness Motifs>, <Upper envelope curve> The curve enclosed in brackets < > does not support external output or file output by USB communication.	
Characteristic graph	BC Graph, ADC Graph	
Form Remove	Off, Straight, R-Curve, Begin. Half, End. Half, Begin-End	
Filter type	Gaussian, 2RC (Phase Compensation), 2RC (Phase Non-compensation)	
Cutoff value	Cutoff Ratio (λc/λs)	Off, 30, 100, 300
	λc	0.08,0.25,0.8,2.5[mm](0.003,0.010,0.030,0.100,[in])
Section number	× 1 to × 5	

17-3 SURFCOM FLEX -45

Measure Range	X axis	4.0 mm (0.1575 in)
	Z axis	±160 µm (6299 µin)
Evaluation Length	Interval 0.4 to 4.0 mm, 0.1-mm steps (Interval 0.0157 to 0.1575", 0.0001 inch-steps)	
Measure Resolution	0.0064 µm (0.2520 µin)	
Sensing method	Differential inductance	
Measurement method	Skid measurement	
Calibration method	Calibrate Roughness Spec.	
Measure Speed	0.6 mm/s (0.0236 in/s)	
Return Speed	1.0 mm/s (0.0394 in/s)	
Detection method	Differential inductance	
Reference stylus	Body	90-degree circular cone
	Tip radius.	5 µm R (196.85 µin R)
Measure Force	4 mN	
Measure Posture	Down	
Skid	Skid type	Edge skid
	Skid materials	Sapphire
	Skid shape	40 mm R (1.575 in R) (Trace direction)
Disp MTHD	3.5" color TFT LCD (320 x 240 dot)	
Printing	Thermal printer	
	Paper width	58 mm (2.2835 in)
	Print width	48 mm (1.8898 in)s
Battery	Built-in type (Nickel-hydrogen storage cell NiMH)	
	Charge time	3 hours (Max.)
Power supply (AC adapter)	AC adapter input	100-240 V AC (50/60 Hz max. 2.5 A)
	Data processor input	12 V DC (max. 30 W)
	Power consumption	Max. 30 W (When printing while charging)
Standard	JIS '82, JIS '94,JIS '01/ISO '97/DIN, CNOMO, ASME '95/ASME '02	
Measurement Type	Roughness	
Evaluation curve	Profile, Roughness Curve, <Roughness Motifs>, <Waviness Motifs>, <Upper envelope curve> The curve enclosed in brackets < > does not support external output or file output by USB communication.	
Characteristic graph	BC Graph, ADC Graph	
Form Remove	Off, Straight, R-Curve, Begin. Half, End. Half, Begin-End	
Filter type	Gaussian, 2RC (Phase Compensation), 2RC (Phase Non-compensation)	
Cutoff value	Cutoff Ratio (λc/λs)	Off, 30, 100, 300
	λc	0.08, 0.25, 0.8 [mm](0.003, 0.010, 0.030 [in])
Section number	$\times$ 1 to $\times$ 5	