DT01021-R001-E1

Instruction manual

Portable Surface Finish Measuring Instrument

HANDYSURF

E-35A/B

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1. Preface

1-1 Preface

Thank you for purchasing the Handysurf E-35A/B. This unit is a super-compact tracer type surface roughness measuring machine, which was developed on the basis of our unique technology. Compact, lightweight, this machine is easy and simple to use and will provide you with instantaneous results. It enables you to measure not only horizontal surfaces, but also vertical, sloping or ceiling surfaces from any position.
Furthermore, by using with an exclusive printer, it provides you with printouts of curvilinear records and measurement results.
This also enables to you transfer data to a personal computer via standard equipped RS232C port.
Measurement data can be stored up to 10 numbers of data, by which it enables to make processing the measured data by connecting to a printer or a PC after measurement.
Please read through this manual to make the best use of this machine.

1-2 Main features

Compact, light and handy type
The whole unit is compact, light and easy to carry. Even if the work is unmovable, measurement is still possible by placing the unit directly on the work.

High level analysis functions
Although this is a “handy” type, the unit is equipped with high level analysis functions including 28 parameters and standards of each country.

Display to cope with 7 languages
Display is available in 7 languages : Japanese, English, German, French, Italian, Spanish and Portuguese.

Personal computer communication function
RS-232C I/F is equipped in standard, which enables to transfer data to a personal computer.

10 data saving function
Measured data can be saved up to 10 data. This enables to transfer those data together to a printer and personal computer after measurement.

Multi-position measurement
The pick-up and driver unit can be used for measurement in any position. Not only horizontal surfaces, but also inclined, vertical and ceiling surfaces can readily be measured with this unit.

Built-in power source for on-site measurement
The built-in rechargeable battery enables you to remove the AC power source cable for on-site measurement.

Automatic range switching function
The range is changed automatically according to the size of the surface roughness to be measured. Simply press the MEAS button and the measurement will be completed.

AI function
Automatic functions to calculate the suitable cutoff value fitted for standard of each country according to the roughness value on measuring surface then make calculate parameters are provided. This enables to measure without setting its cutoff value before starting measurement.

Correspondence to RoHS commands
HandySurf E-35B is a product responded to RoHS commands and lead-free.
As for the specification and the function of E-35A and E-35B, it is the same.

1-3 Precautions for safety use

- Please surely read through this instruction manual for your safety use before starting to use of this machine.
- Please keep this manual at hand for making you to be able to solve your problem at any time.
- In order to prevent previously an injury to customers and the other people and to prevent damage to property, the following symbols are used in this manual according to the operation and handling which involve danger.

Warning : Incorrect operation or handling of this machine by being neglected to this symbol include possibility to cause death, a serious injury and ham to human body.
Caution : Incorrect operation or handling of this machine by being neglected to this symbol include possibility to cause physical damage.
Note : This symbol gives a hint for operation of this machine and includes contents of being required to get to know.

Warning


Make sure that the voltage specified on the AC/DC adapter is supplied when the adapter is plugged into the receptacle.
Due to the failure, it may cause electric shock or fire.


Hazardous electric current is being flown in the AC/DC adapter.
NEVER use a damaged AC/DC adapter, because it may cause electric shock or fire.


Avoid water, oil and chemicals dropping on the AC/DC adapter. It may cause electric shock or fire.


Avoid water, oil and chemicals dropping on the equipment. It may cause electric shock or fire.


NEVER insert any kind of the extraneous objects, especially avoid an electrically conductive objects such as piece of metal, into the equipment crevice. It may cause electric shock or fire.


Make sure to use the included AC/DC adapter. Use of the AC/DC adapters may cause electric shock or fire.


Do not disassemble this equipment. It may cause electric shock or fire.


For removing the AC/DC adapter from the receptacle, always confirm to TURN OFF the Mains line POWER. It may cause electric shock or fire.


Avoid high humidity, water drop, dust, oily smoke, direct sunlight, strong impact, heavy vibration, etc. It may cause failure of the equipment and it also may cause electric shock or fire.

Caution


Use this equipment at a stable temperature between 10°C - 30°C.


Do not apply excessive strength or shock to the stylus.


Prevent dirt and dust from sticking to the stylus.


For stain removal, rub the machine gently with a soft cloth soaked in neutral detergent. Do not use organic solvent or alcohol.


Do not pull the cable by force.

1-4 System structure

System structure table (E-35A*1)

Name	Model	Number of units
Amplification indicator	E-MD-S157A	1
Pick-up	E-DT-SM10A	1
Driver unit	E-RM-S129A	1
Reference specimen	E-MC-S24B	1
AC/DC adapter (AC 100 V)	E-SC-S119A	1 from these adapters
AC/DC adapter (AC 120 V)	E-SC-S121A	
AC/DC adapter (AC 220 V)	E-SC-S125A	
AC/DC adapter (AC 230 V)	E-SC-S192A	

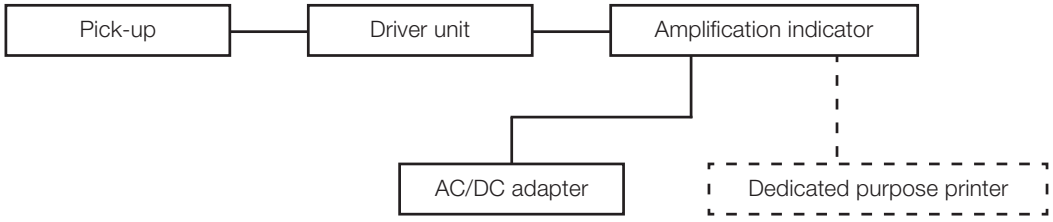
System structure table (E-35B*2)

Name	Model	Number of units
Amplification indicator	E-MD-S180A	1
Pick-up	E-DT-SM10A	1
Driver unit	E-RM-S173A	1
Reference specimen	E-MC-S24B	1
AC/DC adapter (AC 100 V)	E-SC-S372A	1 from these adapters
AC/DC adapter (AC 120 V)	E-SC-S373A	
AC/DC adapter (AC 220 V)	E-SC-S374A	
AC/DC adapter (AC 230 V)	E-SC-S371A	

*1 E-35A is a product not responded to RoHS commands

*2 E-35B is a product responded to RoHS commands

System block chart



1-5 How to make use of the manual

1. Refer to “20. Guide for operation” for an outline of operation procedure.
2. Refer to “15. Trouble and trouble shooting” for being suspected of a possibility of trouble.
3. Refer to “6. Normal mode” for setting of ordinary condition to be used, and refer to “8. Setting mode” for setting of the other condition.
4. Refer to “12-3 Example of command” for connection with a Personal Computer.
5. Be noted that the unit of inch is indicated and printed out as ‘in’, however it is indicated as ‘ " ’ in this manual.

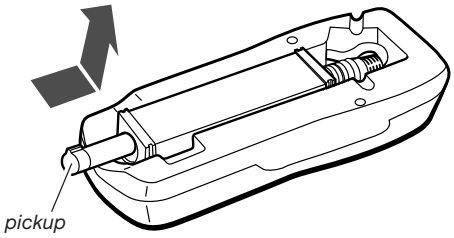
2. Before starting

Recharge the battery before using Handysurf. Refer to chapter 4-5.
Handysurf with a built-in battery is unable to be switched on when its battery power is insufficient, or it indicates unusual display and becomes not available to be operated at all.
In this case, make the following operation.

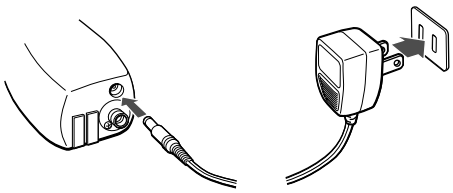
1 Take out the driver unit from the amplification indicator.

Take out the driver unit in the direction indicated by the arrow by pressing its back to Rear of the docking part.

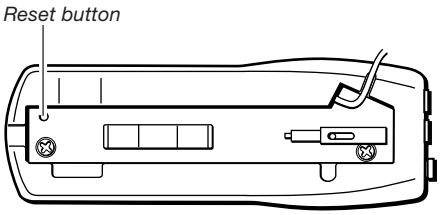
Note : Do not hold the pickup when pressing the driver. It may be damaged.



2 Insert a plug of the AC/DC adapter to the power source cable connector on the back of the amplification indicator.



3 Press the reset button at the back of the amplification indicator.



4 When pressing the ON button, the following screen is displayed for approx. 3 seconds, and then the normal operation screen is displayed.

E-35A

HandySurf
E-35A Ver. 1.06

E-35B

HandySurf
E-35B Ver. 1.06

By the above operation, it returns to the state of normal function.

3. Each part and functions

3-1 Amplification indicator

Buttons of ❶ ❷ ❸ are changed their function by the modes and screens.

	OFF	Normal mode		Setting mode
		Parameter screen	Condition set screen	
❶  SEL・ALT		Display screen is changed by pressing shortly (about 0.5 sec.). It is changed to setting mode by pressing it longer (about 2 sec. or longer).	Display screen is changed by pressing shortly (about 0.5 sec.). It is changed to setting mode by pressing it longer (about 2 sec. or longer). The other function is indicated as ^ in the display unit.	Display screen is changed by pressing shortly (about 0.5 sec.). It is changed to normal mode by pressing it longer (about 2 sec. or longer). The other function is indicated as ^ in the display unit.
❷  ON・PRT・▼	Set power to ON.*	Print output is started and stopped. Data output is started and stopped.	Setting value is lowered. The other function is indicated as ▽ in the display unit.	Setting value is lowered. The other function is indicated as ▽ in the display unit.
❸  MEAS・▲		Measurement is started and stopped.	Setting value is increased. The other function is indicated as △ in the display unit.	Setting value is increased. The other function is indicated as △ in the display unit.

* The power is automatically off when the automatic power off setting is ON and the time lapse about 30 seconds after operating the button.
However, under being input and output of data to the PC, it is stopped automatically in about 10 minutes after input and output of the data.

❹ Display
The results and conditions of measurement, each setting and function of the switches of ❶ ❷ ❸ are displayed on this screen.

❺ Driver unit signal cable
This is connected to the driver unit.

❻ Data output and input connector
This is connected to a printer or PC.

❼ Power source cable connector
AC/DC adapter is connected.

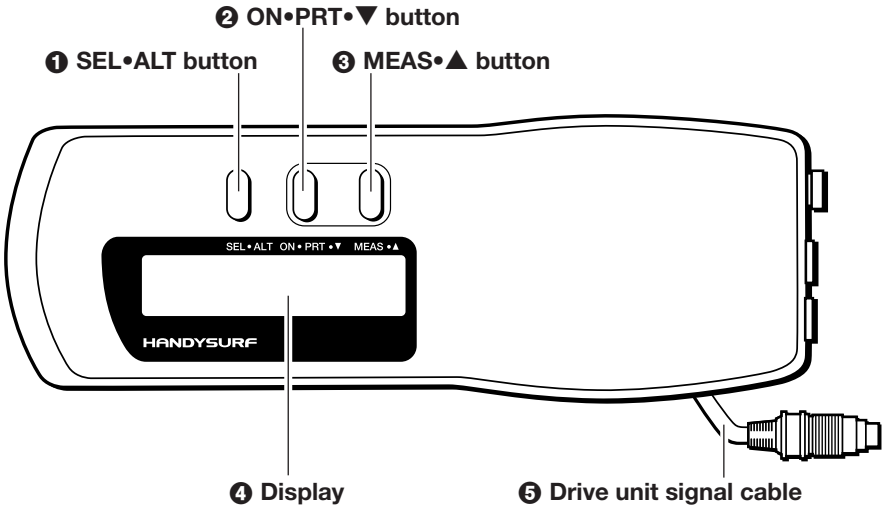
❽ Dip switch 1
This is the switch to set calculation standards, languages and devices to be connected.

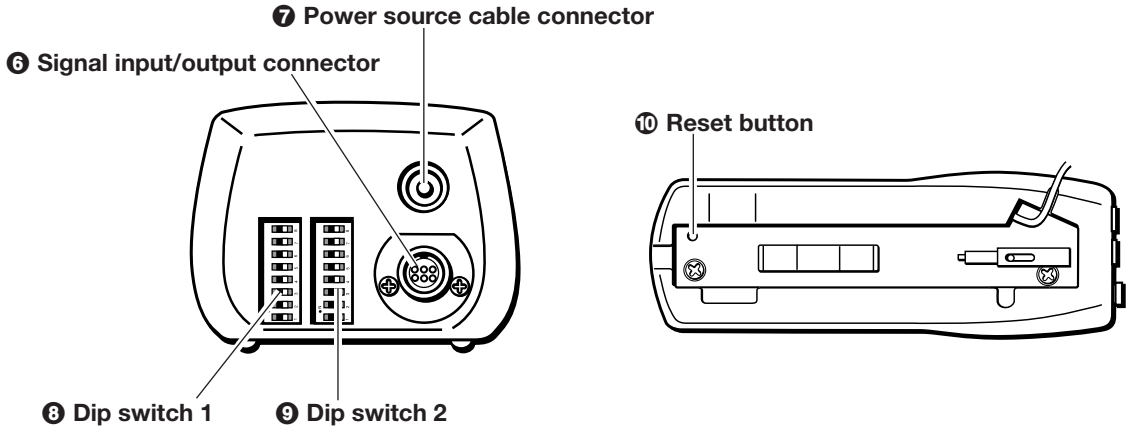
❾ Dip switch 2
This is the switch to set measuring and display conditions. For further details, refer to “9. DIP switch setting”.
Note : When the Dip switch is changed under the state of the power supply, wait until it automatically become the state of the power off, then supply the power again.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

❿ Reset button
This is the button to make reset the amplification indicator in case of being occurred incorrect movement, etc.

Two modes of normal and setting are prepared in a display screen. In a normal mode, measurement, printout and data output are available to be made. It also can be changed setting of conditions such as a cutoff value and so on which are usually used very often.
In a setting mode, change of setting conditions such as selection of output parameters and so on and initialization of each setting of conditions can be made.
By pressing the SEL•ALT button longer, it can be changed to each mode.

Amplification indicator

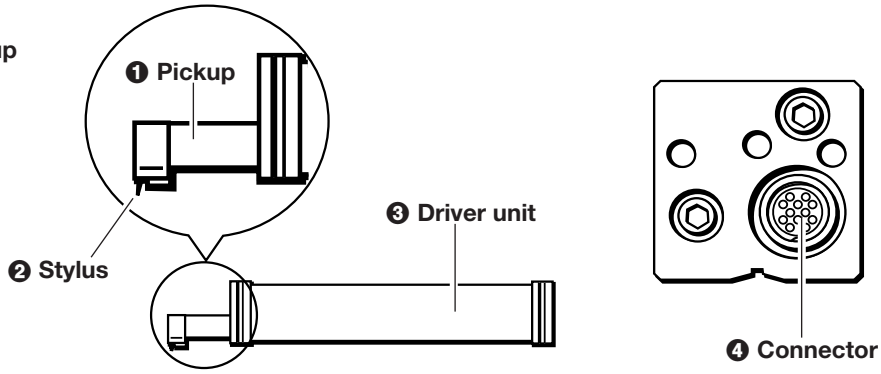




3-2 Driver unit and pick-up

❶ Pick-up
❷ Stylus
❸ Driver unit
❹ Connector

Drive unit and pick-up



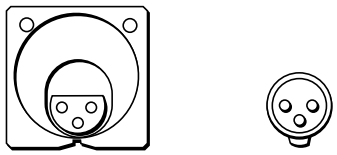
4. Installation and connection

This machine is used with the pick-up, driver unit and amplification indicator assembled or separated depending on the conditions of the work piece and the measurement site.

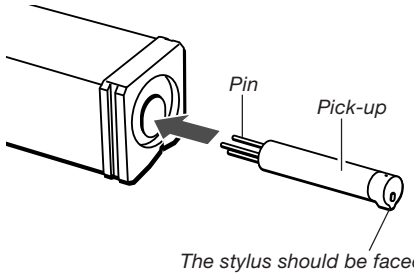
4-1 How to install the pick-up

Follow carefully the instructions below on how to install the pick-up to the driver unit.

1 Identify the position of the socket to which the pick-up is to be connected.

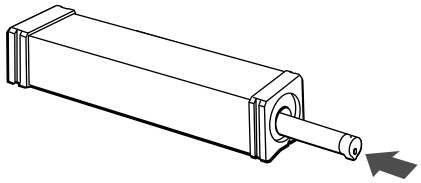


2 Insert the pick-up in a straight line at the position where the pin of the pick-up fits into the hole of the socket.



The stylus should be faced downward.

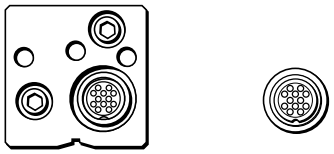
3 Do not push the pick-up by force of more than 90N (9 Kgf).



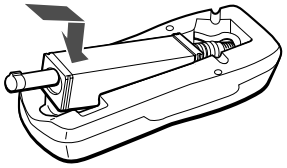
4-2 How to install the pick-up and the driver unit to the amplification indicator

Make sure that the power of the amplification indicator is off (display is off) before starting this installation.

1 Connect the plug on the amplification indicator to the connector on the back of the driver unit. Make sure that the connector and the plug are in the right position for inspection.



2 Push the driver unit in the direction indicated by the arrow by pressing its back to the rear of the docking part.

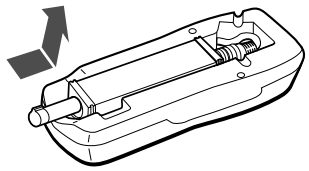


Note : Do not hold the pickup when pressing the driver. It may be damaged.
Note : Even though the pick-up and driver unit are connected to the amplification indicator, they might be disconnected if held and shaken violently. Handle the machine with care when carrying it to ensure that the driver unit does not come off.
Note : Do not apply excessive force to the plug of the amplification indicator and the connector during installation or removal.

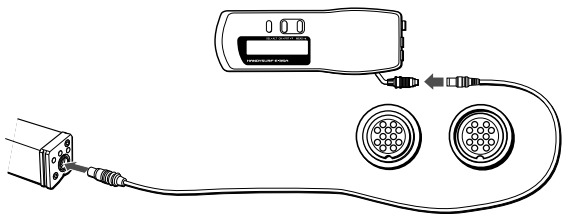
4-3 How to separate the pick-up and the driver unit from the amplification indicator

Make sure that the power of the amplification indicator is off.

1 Take out the driver unit in the direction indicated by the arrow by pressing its back To the rear of the docking part.



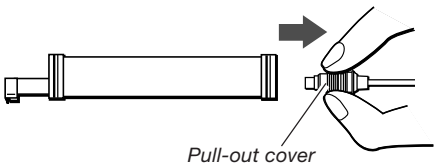
2 Remove the plug of the amplification indicator from the connector on the back of the driver unit and connect the extension cable of an accessory.



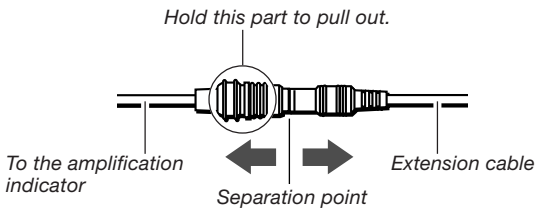
Note : Do not hold the pick-up when installing and removing the driver unit to and from the amplification indicator. It may be damaged.

Install or remove the connector of the driver unit by following to the instructions below.

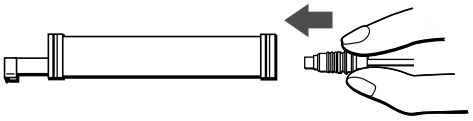
The way of removal
Hold the pull-out cover on the connector plug and pull it.



Note : Do not twist the connector plug when pulling out. It may be damaged.



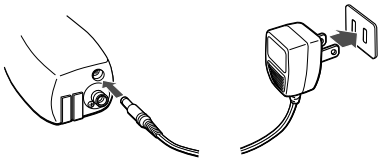
The way of installation
Hold the rear of the connector plug and push it in.



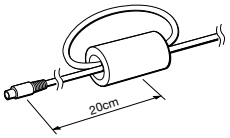
Note : Do not hold the pull-out cover on the connector plug when inserting it inside. The cover may come off.

4-4 How to connect the AC/DC adapter

Insert the plug of the AC/DC adapter to the power source cable connector on the back of the amplification indicator. Measurement is possible during recharge of the machine while connected to an A/C power source. Before connecting or disconnecting the cable, make sure the power is off.



(Attachment of a ferrite core)
Assemble an attached ferrite core to an AC adapter cable in the manner of a figure of below.



* Turn round a cable once at 20 cm apart from a plug.

4-5 Built-in rechargeable battery

- Insert the plug of the AC/DC adapter into the power source cable connector on the back of the amplification indicator.
- Charging time is approximately 10 hours when the power of the machine is OFF. Note that the charging time can be up to 16 hours. Beyond this limit, the battery is overcharged and may be short-lived or damaged.
- With a fully charged battery, this machine can work for approximately 3 hours although it will vary depending on the working conditions and environment.
- The built-in battery is a Ni-Cd battery.
  It is recommended to change it every 5 years or after every 500 recharges. These numbers will vary. The battery should be changed if the massage “BATTERY EMPTY” display immediately after a full recharge.
- In such a case, contact your supplier.

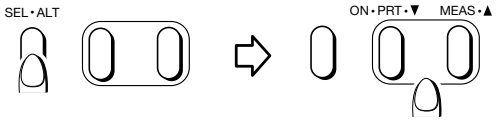
5. Calibration

"Calibration" means "Adjustment of a scale", and this is an important job for maintaining accuracy of the instrument.
In accordance with the following procedure, make this calibration.
In the following cases, be sure to make calibration.
(1) When this instrument is used for the first time.
(2) When the pick-up is exchanged.
(3) When it was not used for long period.
(4) When it was reset with the reset switch.
(5) When the Drive unit was replaced.
As for the period of maintaining of the accuracy, it depends on frequency of the use. When it is used daily, it is recommended to make calibration once a week. In the other case, it is recommendable to make calibration at least once a month.

1 **Set the AI function to OFF (by setting No.8 of Dip switch 2 to OFF).**

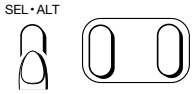
2 **Press the SEL•ALT button shortly for about 0.5 second, and indicate the cutoff value screen.**
Note : In case of not being indicated the cutoff value screen
Unavailable to change the conditions.
➔ Set No.4 of the dip switch 2 to OFF.
Showing the setting mode.
➔ Continue to press the SEL•ALT button more than 2 seconds, then it becomes normal mode ↔ setting mode.

By pressing the ON•PRT•▼ button or MEAS•▲ button, select the CUTOFF value 0.8 mm.



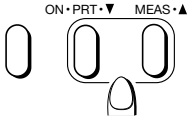
^SET ▼DEC ▲INC
CUTOFF 0.8 mm

3 **Press the SEL•ALT button shortly for about 0.5 second, and indicate the evaluation Length.**
Note : In case of being indicated the cutoff value screen but not being indicated the evaluation length, the evaluation length is fixed to CUTOFF✻5 so that it is unnecessary to be set.

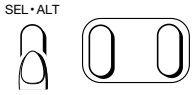


^SET ▼DEC ▲INC
LENGTH 4.0 mm

4 **Set the evaluation length to 4.0 mm with the ON•PRT•▼ button or MEAS•▲ button.**



5 **Press the SEL•ALT button to indicate "Ra". Then the Ra value measured previously will be shown.**
Note : In case of not being indicated the "Ra" in the parameter selection of the setting mode, the other parameters are also acceptable.



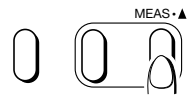
When the evaluation length is set to 4.0 mm, it is displayed as L = 4.0 mm.

λc = 0.80 L = λc✻5 mm
Ra = 2.56 μm

6 **Prepare the reference specimen.**

7 **Place the pick-up on the CALIBRATION side of the reference specimen.**
Note : Adjust the driver unit to become parallel with the measuring surface by using the included adjusting device.
(Refer to " 7-1 Measurement ")

8 **Press the MEAS•▲ button to measure the reference specimen.**



Under measurement

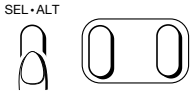
λc = 0.80 L = λc∗5 mm
meas □□□□□

9 **Result of measurement of the reference specimen is indicated.**

End of measurement

λc = 0.80 L = λc∗5 mm
Ra = 2.77 μm

10 **Press the SEL•ALT button shortly for about 0.5 second, and indicate the CAL-Ra screen.**

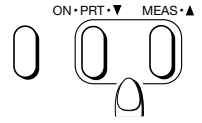


Match this value to the Ra value indicated on the reference specimen.

^SET ▼DEC ▲INC
CAL-Ra 2.77 μm

11 **The Ra value measured at this time is indicated.**

12 **Press the ON•PRT•▼ button or MEAS•▲ button to match the value to the Ra value indicated on the reference specimen.**

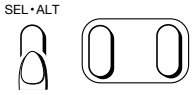


When the value indicated on the reference Specimen is 2.95 μm.

^SET ▼DEC ▲INC
CAL-Ra 2.95 μm

13 **Press the SEL•ALT button shortly for about 0.5 second, and finish the calibration screen then it terminates the calibration.**

When the message for confirming the setting is displayed, it shows an excess of the calibration range. Then make measurement again. If it repeats to indicate the same message, following reasons are considered.
(1) Incorrect measurement, (2) Malfunction of the instrument, (3) Improper reference specimen.



Error screen

^SET ▼DEC ▲INC
CAL-Ra →CHECK

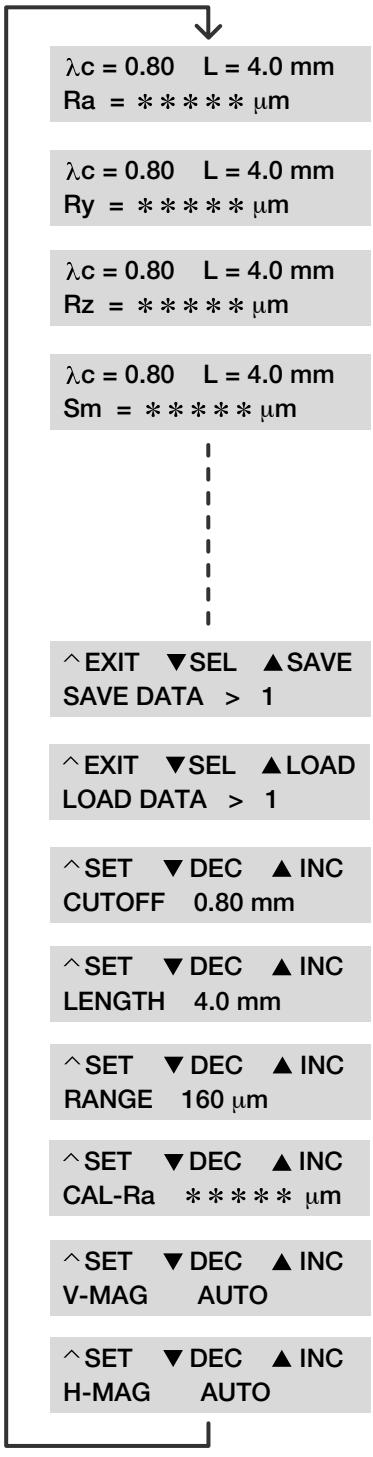
Note 1 : If the same part of the reference specimen is measured over and over again, it may cause abrasion of the surface which will result in a smaller value of the result of measurement. For each calibration measure a different part of the reference specimen.
Note 2 : Set the measuring range to the automatic range when calibration is made (by setting No.1 of Dip switch 2 to OFF), or set the optional range to 40 μm.
Note 3 : When it is used under the JIS '82 standard, make calibration under the standard of others then return the standard to JIS '82. (Refer to "9-1 DIP switch 1" for setting parameter calculation standard.)

Note 4 : When ON•PRT•▼ button or MEAS•▲ button is pressed in the calibration screen, the calibration value will be changed. In case of unexpectedly being pressed ON•PRT•▼ button or MEAS•▲ button in this screen, return it to the former value or make the calibration again. It also can be set to non-condition change in the normal mode (by setting No.4 of Dip switch 2 to ON).
Note 5 : When the Dip switch setting was changed in the state of power ON, turn the power to set ON again after confirming to become the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to "8-6 Automatic power off setting"

6. Normal mode

This is the mode for making measurement, printout and basic condition setting. There are two screens of parameter indication and condition setting.

In each time to press the SEL•ALT button shortly for about 0.5 second, parameter indication screen and condition setting screen are appeared as shown below.
Note : Except for the normal mode, there is the setting mode. When the SEL•ALT button is kept to be pressed more then 2 seconds, Normal mode ↔ Setting mode are changed alternately.



Measurement parameter indication screen (This is shown as ∗∗∗∗∗ for no data.)

The upper line shows 0.8 mm for cutoff value and 4.0 mm for evaluation length.
Note : When the evaluation length is set to CUTOFF✻5 (by setting No.3 of Dip switch 2 to OFF), it is indicated as L = λc✻5 mm.

By pressing the MEAS•▲ button in the parameter indication screen, it starts measurement. And by pressing the ON•PRT•▼ button, the result of measurement will be printed out.

Note 1 : When the operation function is set to the basic function (by setting No.7 of Dip switch 2 to OFF), the parameters to be displayed are restricted. (Refer to "9-3 Operation function".)
Note 2 : Parameters to be indicated in the setting mode can be selected. (Refer to "8-2 Parameter selection" of "8. Setting mode".)

Condition setting screen

The upper line shows the function of switches.

Note : When the condition setting is not available due to the setting of the Dip switch 2 to No.4, screens of below are not displayed.

Data saving screen - This is the screen to save measured data. This can be stored up to 10 data numbers. (Refer to "6-3 Saving and reading of measured data".)

Data reading screen - This is the screen to read out stored data. (Refer to "6-3 Saving and reading of measured data".)

Cut off value screen - Cut off value is changed in this screen. (Refer to "6-1 Cutoff value setting".)
Note : When AI mode function mode is set (by setting No.8 of the Dip switch 2 to ON), it displays it however it is unable to make the setting.

Evaluation length screen - Evaluation length is changed in this screen. (Refer to "6-2 Evaluation length setting".)
Note : When the evaluation length is set to CUTOFF✻5 (by setting No.3 of Dip switch 2 to OFF), this is not indicated.

Measuring range screen - Measuring range is changed in this screen.
Note : When the measuring range is set to Automatic range (by setting No.1 of Dip switch 2 to OFF), this is not indicated.

Calibration screen - Sensitivity calibration is made in this screen. (Refer to "5. Calibration".)

Recording vertical magnification screen - Vertical magnification of waveform data for making print out is set in this screen.
Note : When the connection devices are set up in a PC (Turn ON No.7 and No.8 of the dip switch1), it is not displayed.

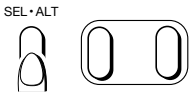
Recording horizontal magnification screen - Horizontal magnification of waveform data for making print out is set in this screen.
Note : When the connection devices are set up in a PC (Turn ON No.7 and No.8 of the dip switch1), it is not displayed.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to "8-6 Automatic power off setting"

6-1 Cutoff value setting

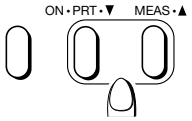
When AI function mode is set (by setting No.8 of the Dip switch 2 to ON), it displays it however it is unable to make the setting.

1 **Press the SEL•ALT button shortly for about 0.5 second and indicate the cutoff value screen.**



2 **Set to the required cutoff value with the ON•PRT•▼ button or MEAS•▲ button.**

Select the cutoff value from 0.08 mm / 0.25 mm / 0.80 mm / 2.50 mm.
(0. 003 in / 0.01 in / 0.03 in / 0.1 in)



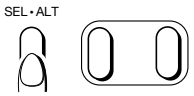
^SET ▼DEC ▲INC
CUTOFF 0.08 mm

^SET ▼DEC ▲INC
CUTOFF 0.25 mm

^SET ▼DEC ▲INC
CUTOFF 0.80 mm

^SET ▼DEC ▲INC
CUTOFF 2.50 mm

3 **After making set of the above, press the SEL•ALT button shortly for about 0.5 second for changing to the other screen. Then the value will be made setting.**



Note : In case of not being indicated the cutoff value changing screen

When the parameter only is indicated, it is under the sate of not being available to be changed the condition.
➔ Set No.4 of Dip switch 2 to OFF.

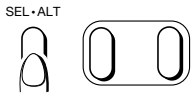
It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it becomes normal mode ↔ setting mode.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting.
Refer to “8-6 Automatic power off setting”

6-2 Evaluation length setting

In normal measurement, an evaluation length 5 times as large as the cutoff value is used. But it can be set to an arbitrary length.

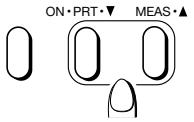
1 **Press the SEL•ALT button shortly for about 0.5 second and indicate the evaluation length screen.**



^SET ▼DEC ▲INC
LENGTH 4.0 mm

2 **It goes down by pressing the ON•PRT•▼ button, and it goes up by pressing the MEAS•▲ button.**

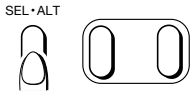
This can be set in between the minimum 0.4 mm (0.02 in) and the maximum 12.5 mm (0.50 in) at each 0.1 mm (0.01 in).
When it continues to be pressed the ON•PRT•▼ button or MEAS•▲ button, it can be moved faster.



^SET ▼DEC ▲INC
LENGTH 12.5 mm

^SET ▼DEC ▲INC
LENGTH 0.4 mm

3 **Press shortly the SEL•ALT button for about 0.5 second after the setting and change to the other screen, then the value will be indicated.**



Note : In case of not being indicated the evaluation length screen

When the parameter only is indicated, it is under the state of not being available to change the condition.
➔ Set No.4 of Dip switch 2 to OFF.

The evaluation length is fixed to CUTOFF ✻5.
➔ Set No.3 of Dip switch 2 to ON.

Parameter Ra screen

λc = 0.8 L = λc ✻5 mm
Ra = 2.58 μm

It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it becomes normal mode ↔ setting mode.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

Note : Between the measurement starting time and the actual reading, the pickup will move by the following preliminary drive distance. Therefore the pickup travel will be longer than the evaluation length.

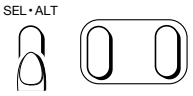
Cutoff	Preliminary drive length
0.08 mm	Less than 0.8 mm
0.25 mm	Less than 0.9 mm
0.80 mm	Less than 1.3 mm
2.50 mm	Less than 2.4 mm

6-3 Saving and reading of measured data

6-3-1 Saving and clearing of measured data

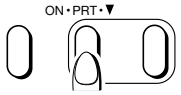
Measured data can be stored up to 10 numbers with this instrument.

1 **Press the SEL•ALT button shortly for about 0.5 second and indicate the data storage screen.**



2 **Specify the data No. (0 - 9) by pressing the ON•PRT•▼ button.**

Data No. with a mark of ✻ shows that no stored data are in it.



^EXIT ▼SEL ▲SAVE
SAVE DATA > 1 ✻

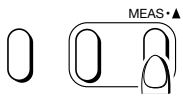
Data No.0 shows no data inside.

^EXIT ▼SEL ▲SAVE
SAVE DATA > 9

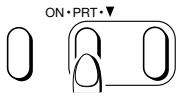
Data No.9 shows existing data inside.

3 **By pressing the MEAS•▲ button, the latest measured data are stored.**

Note : When measured data is stored in the data No. without the mark of ✻, the old data will be deleted.
Note : Take note that this has no function of UNDO (deletion).



4 **By going on to press the ON•PRT•▼ button, it shows the data clear screen after the data No.9.**

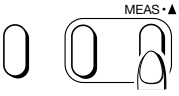


Data clear screen

^EXIT ▼SEL ▲CLEAR
SAVE DATA > ALL

5 **By pressing the MEAS•▲ button, all data are deleted.**

Note : The data of an individual No. is unavailable to be deleted.
Note : This has no function of UNDO (deletion).



Note : In case of not being indicated the data saving screen

When the parameter only is indicated, it is under the sate of not being available to be
changed the condition.
➔ Set No.4 of Dip switch 2 to OFF.

It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it becomes normal mode ↔ setting mode.

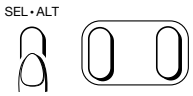
Note : If automatic printout or data output is required after reading of the data, set No. 5 of the dipswitch 2 to ON.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting.
Refer to “8-6 Automatic power off setting”

6-3-2 Reading of measured data

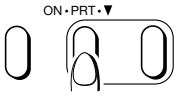
Stored measured data are read.

1 **Press the SEL•ALT button shortly for about 0.5 second and indicate the data reading screen.**



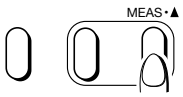
2 **Specify the data No. (0 - 9) by pressing the ON•PRT•▼ button.**

A No. without stored data is not indicated.



^EXIT ▼SEL ▲LOAD
LOAD DATA > 3

3 **By pressing the MEAS•▲ button, measured data of the data No. is read and the latest measured data are deleted.**



The state of being set before reading data

λc = 0.80 L = λc ✻ 5 mm
Ra = 2.58 μm

To be indicated under the condition at being stored the data

4 **When the data will have been read, it shows the parameter indication.**

Note : Indication parameter is displayed in the state of being stored the data.
Note : Indication of measuring condition shows the state of having been set before reading of the data.
Note : Data to be sent to a printer and a PC are output in the state of having been stored for both of parameter and measuring condition.
Note : This has no function of UNDO (deletion).

Note : In case of not being indicated the data reading screen

It does not exist the data to be read.
When the parameter only is indicated, it is under the sate of not being available to be changed the condition.
➔ Set No.4 of Dip switch 2 to OFF.

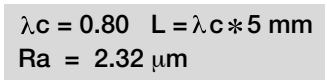
It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it becomes normal mode ↔ setting mode.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting.
Refer to “8-6 Automatic power off setting”

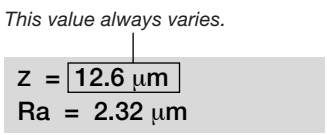
6-4 Indication of Z-axis level

Indication of Z-axis level enables to check whether or not a pickup is properly positioned on a workpiece or the zero position of a pickup is shifted.
By making set No.6 of the Dip switch 2 to ON, the Z-axis level will be displayed on the upper line in the parameter display screen.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off. It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”



Normal parameter indication screen



Parameter indication screen in which Z-axis level is indicated

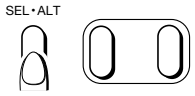
6-5 Setting of measuring range

Measuring ranges of 20, 40, 80 and 160 μm are provided, and it can be selected at any range by setting at arbitrary range.

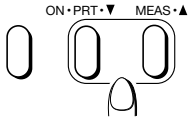
Note : When the basic function is set in the operation function, it must be selected from either 40 or 160 μm.
The basic function is selected by setting No.7 of the Dip switch 2 to OFF, and the all function is selected by setting it to ON.

When it is set to the automatic range, the range can be automatically changed in corresponding to the Z-axis data range.
The automatic range can be selected by setting No.1 of the Dip switch 2 to OFF, and the arbitrary range is selected by setting it to ON.

1 Press the SEL•ALT button and indicate the measuring range screen.



2 Select the required measuring range with the ON•PRT•▼ button or MEAS•▲ button.



^SET ▼DEC ▲INC
RANGE 40 μm

3 When it is changed to the other screen with the SEL•ALT button, the range will be fixed.

Note : In case of not being indicated the measuring range screen

It is set to the automatic range.
It is under the sate of not being available to be changed the condition.
➔ Set No.4 of Dip switch 2 to OFF.

It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then the mode will be changed between the normal mode ↔ setting mode.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting.
Refer to “8-6 Automatic power off setting”

Followings are the relationships between each range and resolution.

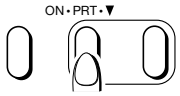
Z-axis range	Measuring range	Resolution	Indication resolution of Ra, etc.
Less than ±20 μm	20 μm	0.01 μm	0.01 μm
Less than ±40 μm	40 μm	0.02 μm	0.01 μm
Less than ±80 μm	80 μm	0.04 μm	0.1 μm
Less than ±160 μm	160 μm	0.08 μm	0.1 μm
More than ±160 μm	Being impossible for measurement		

Note : In case of the automatic range, the number of figures for display will be decreased when the Z-axis range exceeds ±40 μm.
Note : In case of the arbitrary range, an error message of over range will be indicated and it becomes unable to be measured when it exceeds the each Z-axis range.
Note : Regardless of the range setting, when the Z-axis range exceeds ±160 μm, An error message of over range will be indicated and it becomes unable to be measured.

7-1 Measurement

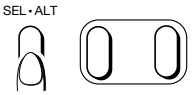
When the AI function is ON the cutoff screen is only for the display, it is not possible to change the setting.

1 **Press the ON•PRT•▼ button to turn the power of the amplification indicator on.**



2 **Press the SEL•ALT button shortly for about 0.5 second and select the cutoff value screen.**

Note : In case of not being indicated the cutoff value change screen
It is under the state of not being available to change the condition.
➔ Set No.4 of Dip switch 2 to OFF. When it is unnecessary to change the condition, this operation is unnecessary.
It is under the state of setting mode. ➔ Press the SEL•ALT button more than 2 seconds, then it will become the normal mode ↔ setting mode.

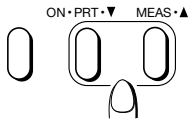


Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after confirming auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

^SET ▼DEC ▲INC
CUTOFF 0.80 mm

3 **Select the required cutoff value by pressing the ON•PRT•▼ button or MEAS•▲ button.**

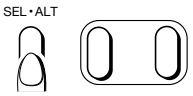
Note : In case of uncertainty for selecting the cutoff value, make use of the AI function. (Refer to “7-4 AI funcion”.)



4 **Press the SEL•ALT button shortly for about 0.5 second and indicate the Ra screen.**

In this time, the Ra value measured previously will be shown.

Note : When the parameter Ra was not selected in the setting mode, the Ra screen will not be indicated. In this case, select the other parameter screen. (Refer to “8-2 Parameter selection” of “8. Setting mode”.)



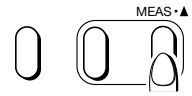
λc = 0.80 L = λc∗5 mm
Ra = 2.55 μm

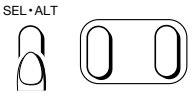
In case of no data existing,
∗∗∗∗∗ *is displayed.*

5 **Press the MEAS•▲ button and then measurement will start.**

When the measurement is completed, the measuring result will be displayed.

In each time of pressing the SEL•ALT button shortly for about 0.5 second, measuring result of the preliminary selected parameter will be displayed. (Refer to “8-2 Parameter selection” of “8. Setting mode” for the selection of parameters.)





λc = 0.80 L = λc∗5 mm
meas □□□□□

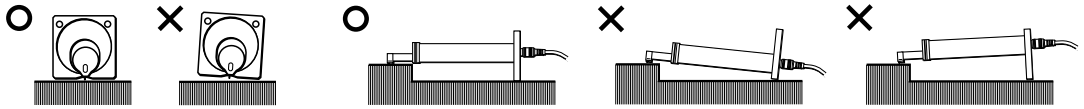
λc = 0.80 L = λc∗5 mm
meas →□□□□

λc = 0.80 L = λc∗5 mm
meas →→→→→

λc = 0.80 L = λc∗5 mm
– – calculate – –

λc = 0.80 L = λc∗5 mm
Ra = 2.95 μm

The measuring unit should be adjusted to be parallel with the side of the workpiece.



7-2 Print out of measured data

Measuring data can be printed out by connecting to the optional printer.

1 Prepare a printer and connect its exclusive connecting cable.

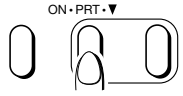
(The cable is different by the printer.)
It should be made after being confirmed that the power of amplification indicator is turned off.

2 Set the Dip switch 1 corresponding to the printer to be connected.

Printer type	Dip switch 1	
	No.7	No.8
E-RC-S23A (Small type) : DPU-201GS	OFF	OFF
E-RC-S24A (High speed) : DPU-3245	OFF	ON
E-RC-S25A OR : DPU-H245 E-RC-S29A (Small type Ⅱ)	ON	OFF

Note : When a printout is made setting in different way from the left table, it will appear deformed characters. But this is not a malfunction of the amplification indicator.
Note : E-RC-S29A is a product responded to RoHS commands.

3 Press the ON•PRT•▼ button and turn on the power of the Handysurf.



4 Turn on the power of the printer.

5 Select the items to be printed out.

① Set to the setting mode.

② Display the print output screen, then select the output items.

③ Display the parameter screen, then select the output parameters.
(Refer to “8-2 Parameter selection” and “8-3 Print output selection” of “8. Setting mode”.)

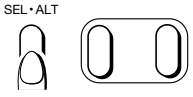
④ Return to the normal mode.
Press the SEL•ALT button more than 2 seconds, then it will become the normal mode ↔ setting mode.

6 Make setting of the conditions and so on, then start measurement.

(This step will be skipped when the data currently displayed are printed out.)

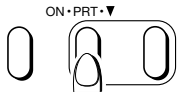
7 Press the SEL•ALT button shortly for about 0.5 second and indicate the parameter display screen in the normal mode.

Note : In case of not being indicated the parameter
It is under the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it will become the normal mode ↔ setting mode.



λc = 0.80 L = λc∗5 mm
Ra = 2.55 μm

8 **Press the ON•PRT•▼ button, then the contents of items having been preliminary set will be printed out.**



9 **Press the FEED button of the printer, then a paper will be fed without printing.**

10 **In order to stop printing, keep to press the ON•PRT•▼ button until disappearance of the display of "print".**

If the button is pressed several times, it will repeat the print and stop due to the time lag.

Note : By using the data storage function you can recall and print up to 10 data sets. (Refer to "6-3 Saving and reading of measured data".)
In this case, read out the data in each time and print out them.
Note : Read the instruction manual of the printer for its own function.
Note : If the appearance of the print out does not look good, please check the dip switch settings as described in step 2.

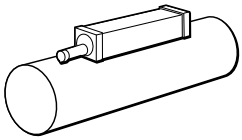
Note : Automatic print immediately after the measurement and reading of data is possible by making set No.5 of the Dip switch 2 to ON.
Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to "8-6 Automatic power off setting"

7-3 Various measuring methods

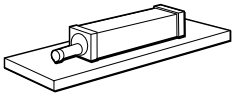
7-3-1 Placing a driver unit on a workpiece

Several kinds of measurement as shown below are applicable.

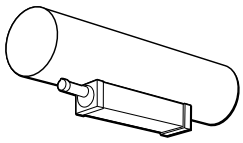
Measurement of a cylindrical surface



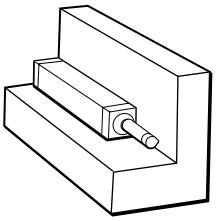
Measurement of a horizontal surface



Measurement of a ceiling surface



Measurement of a vertical surface



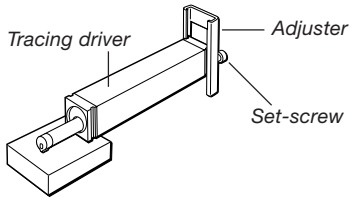
When using it with the driver unit installed connected with the amplification indicator, bring the bottom of the driver unit into contact with the workpiece.
Hold the tracing driver by hand if the measurement is executed on unstable places.

7-3-2 Unable to place a driver unit on a workpiece

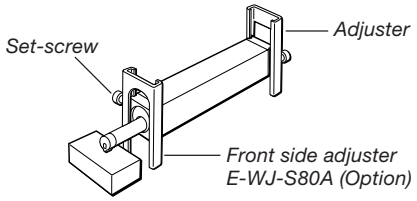
Some workpieces are unable to be directly placed the tracing driver on it. In this case, use the optional accessories as shown below.

1 For small size of a workpiece

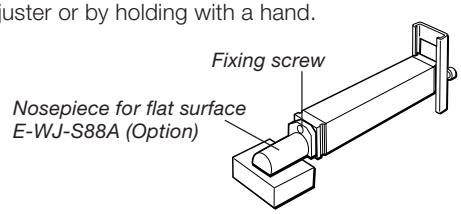
Use of an attached adjuster
Set the adjuster to a groove at the rear side of the tracing driver, and adjust the height of the tracing driver to become parallel between the workpiece surface and the tracing driver. Then fix it with the set-screw.



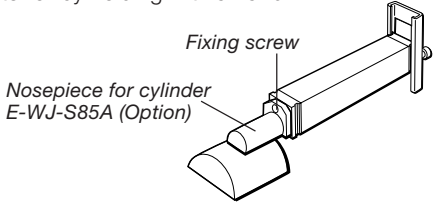
Use of an attached adjuster and an optional front side adjuster
Set the attached adjuster to a rear groove of the tracing driver and the front side adjuster to a front groove. Adjust the height of the tracing driver to become parallel between the workpiece surface and the tracing driver, then fix it with the set-screw.



Use of an optional nosepiece for flat surface
Set the nosepiece to the round shape groove at front side of the tracing driver, and fix it with a fixing screw.
This can be used in combination with the attached adjuster or by holding with a hand.

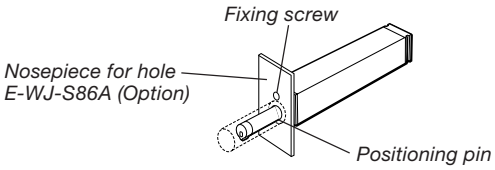


Use of an optional nosepiece for cylinder
Set the nosepiece to the round shape groove at front side of the tracing driver, and fix it with a fixing screw.
This can be used in combination with the attached adjuster or by holding with a hand.



Use of an optional nosepiece for measurement of a hole

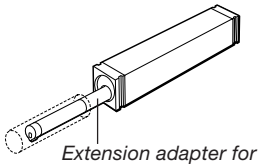
Set the nosepiece to the front side of the tracing driver with a fixing bolt.
Put a positioning pin to the measuring hole. Make adjustment of the measuring surface and tracing driver to become parallel.



2 For measurement of a long hole

Use of an optional extension adopter for measurement of a long hole

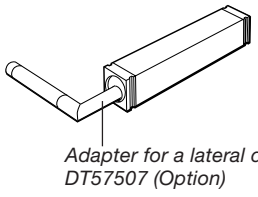
Insert the extension adopter to the tracing driver, and insert a pickup to the adopter.



3 For measurement to a lateral direction

Use of an optional adopter for measurement to lateral direction

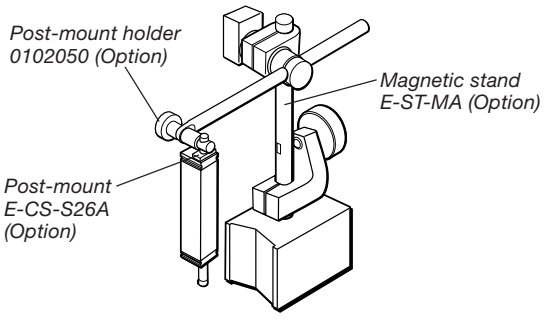
Insert the adopter for a lateral direction to the tracing driver, and insert a pickup to the adopter.



4 For measurement to several directions

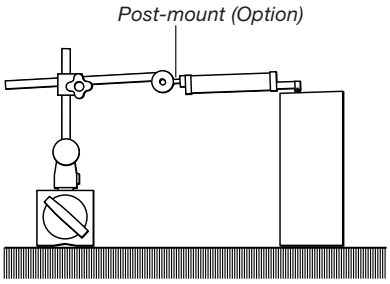
Use of an optional post-mount and post-mount holder

Fix the post-mount by making use of a tap hole at rear side of the tracing driver, and fix the post-mount to the post-mount holder. Fix these to an magnetic stand, etc., and fix them well by making align to the workpiece angle.



7-3-3 Use of the optional magnetic stand

The use of the optional magnetic stand makes it possible to measure at various heights and angles.



7-4 AI function

With the AI function, cutoff values suitable for each country are automatically calculated from the measuring profile and the calculation of parameters is executed based on the most suitable cutoff values.
This is the most suitable function for the unknown workpiece which is unable to be defined the cutoff value.
Cutoff value is defined according to the description of “13-8”.
The evaluation length is 5 times of the calculated cutoff value.

1 Select the AI function with the Dip switch.

Set No.8 of the Dip switch 1 to ON.

2 Follow the procedure of normal measurement hereafter.

(Refer to “7-1 Measurement”.)

Note : When the AI function is ON the cutoff screen is only for the display, it is not possible to change the setting.
Note : The cutoff value is not decided at the time of measurement, so that the evaluation length will be set to the maximum length of 12.5 mm.
The measuring length becomes about 15 mm, which includes the pre-drive distance. Therefore, a small workpiece less than the measuring distance of about 15 mm is not available to be measured with the AI function.
Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting.
Refer to “8-6 Automatic power off setting”
Note : Turn off the AI function (by setting No.8 of Dip switch 2 to OFF) for the stylus check.

7-5 Finish indication

λc = 0.80 L = λc∗5 mm
Ra = 0.11 μm ▼▼▼▼

Finish symbol

λc = 0.80 L = λc∗5 mm
Rmax = 12.32 μm ▼▼

λc = 0.80 L = λc∗5 mm
Rz = 1.82 μm ▼▼▼

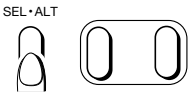
The finish symbol is indicated only in JIS ’82 for the parameter calculation standard. The finish symbol is indicated in the 3 parameters of Ra, Rmax and Rz to the end of the parameter result display.
Note : Refer to “9-1 DIP switch 1” for setting of the parameter calculation standard.

Note : This finish indication is fashioned according to JIS B0601-1976 and is shown here for reference.
Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting ”

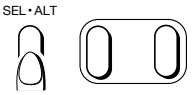
8. Setting mode

Further detailed setting is made in this mode.
In this setting mode, (1) Initialization, (2) Parameter selection, (3) Print output selection, (4) Calculation conditions setting and (5) Serial communication setting and (6) Automatic power off setting are made.

1 **Keep to press the SEL•ALT button for more than 2 seconds, and change the normal mode to the setting mode.**

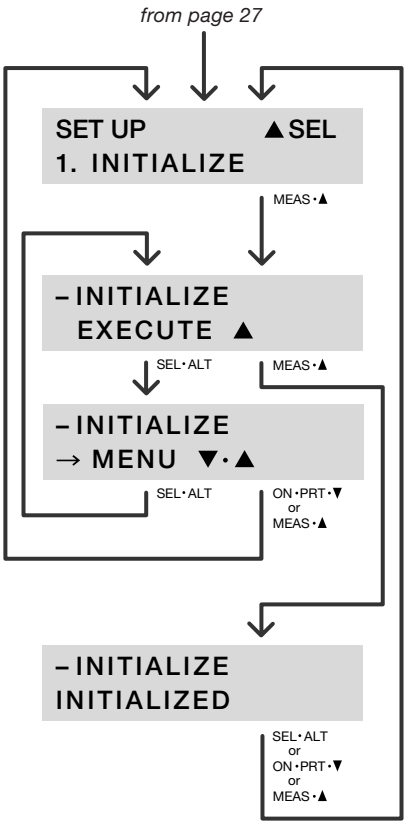


2 **Press the SEL•ALT button shortly for about 0.5 second and set to the required menu, and press the MEAS•▲ button.**



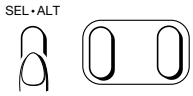
The change of the mode of "Setting mode ↔ Normal mode" can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

8-1 Initialization

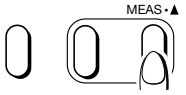


This is made initialization of measuring conditions.

1 **Press the SEL•ALT button shortly for about 0.5 second in the setting mode, and set the menu to "Initialization".**

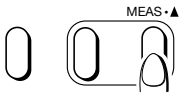


2 **Press the MEAS•▲ button and indicate the screen of initialization.**



3 **Press the MEAS•▲ button, then it executes initialization.**

After the execution, it is unable to be returned.
When the screen for return to the menu is displayed by pressing the SEL•ALT button shortly for about 0.5 second before executing the initialization and the ON•PRT•▼ button or the MEAS•▲ button is pressed, it will return to the setting mode menu without making execution of the initialization.



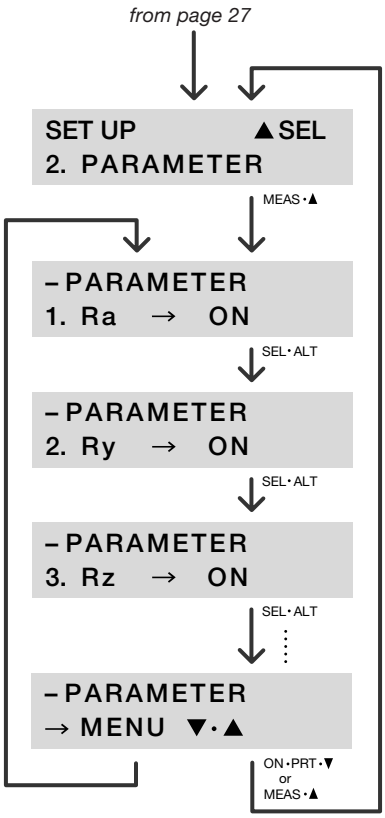
4 **Press any button shortly for about 0.5 second after execution of the initialization, then it returns to the setting mode menu.**

The change of the mode of "Setting mode ↔ Normal mode" can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

Initial value

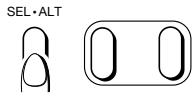
Evaluation length	: 4.0 mm (0.15 in)
Cutoff value	: 0.8 mm (0.03 in)
Cut level unit of bearing length ratio	: %
Cut level of bearing length ratio	: 10 %
Peak count level upper limit value	: 0.0 mm (0 μin)
Peak count level lower limit value	: 0.0 mm (0 μin)
Roughness motif upper limit length	: 0.5 mm (0.02 in)
Waviness motif upper limit length	: 2.5 mm (0.1 in)
Print vertical magnification	: AUTO
Print horizontal magnification	: AUTO
Communication conditions	
Communication speed	: 9600 bps
Parity	: None
Data length	: 8 bit
Stop bit	: 1 bit
X flow control	: OFF
Output type	: TEXT

8-2 Parameter selection

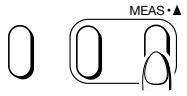


This is made selection of parameters display, print and data output.
The parameters are different by the calculation standard.

1 **Press the SEL•ALT button shortly for about 0.5 second in the setting mode, and set the menu to "Parameter".**

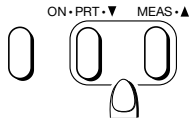


2 **Press the MEAS•▲ button and indicate the parameter setting screen.**

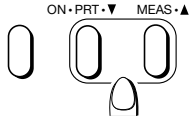


3 **Press the ON•PRT•▼ button or the MEAS•▲ button, then it changes the setting.**

The output parameters are different by the calculation standard.
(Refer to the figure of below.)



4 **Press the ON•PRT•▼ button or the MEAS•▲ button, then it returns to the setting mode menu.**



The change of the mode of "Setting mode ↔ Normal mode" can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

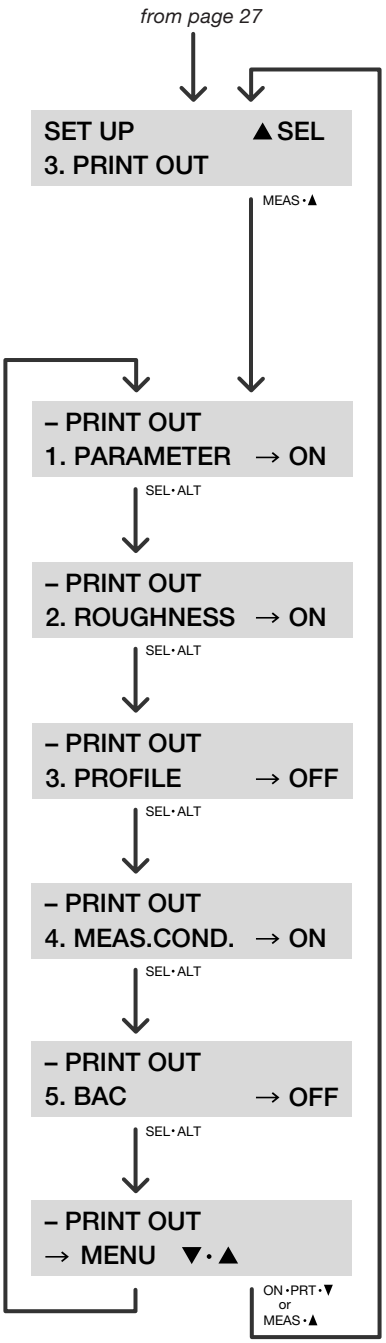
Calculation standards and parameters

	JIS '94	JIS '82	ISO '97 / JIS '01 / DIN	CNOMO	ASME '95
1	Ra	Ra	Ra	Ra	Ra
2	Ry	Rmax	Rz	R	Rmax
3	Rz	Rz	Rzmax	Rx	Rz
4	Sm	Rq	RSm	AR	RSm
5	Rq	Rp	Rq	Rz	Rq
6	Rp	Rt	Rp	Rmax	Rpm
7	Rt	Pc	Rt	W	Rp
8	Pc	tp	R3z	Wx	Rt
9	tp	Rk	Pc	AW	Pc
10	Rk	Rpk	Pt	Wte	Rmr
11	Rpk	Rvk	Rmr	Rmr	Rk
12	Rvk	Mr1	Rk	Rke	Rpk
13	Mr1	Mr2	Rpk	Rpke	Rvk
14	Mr2	V0	Rvk	Rvke	Mr1
15	V0	K	Mr1	Mr1	Mr2
16	K		Mr2	Mr2	V0
17			V0	V0	K
18			K	K	

Meshed parameters are unable to be set in the operation function which is set in No.7 of the Dip switch 2. In order to output all parameters, change the function to the operation all function.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off. It is necessary to turn on the automatic power off setting. Refer to "8-6 Automatic power off setting"

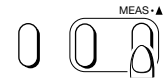
8-3 Print output selection



This is made setting of items for print (output) with a printer (Personal computer).

1 **Press the SEL•ALT button shortly for about 0.5 second in the setting mode, and set the menu to the print output selection screen.**

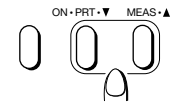
2 **Press the MEAS•▲ button and indicate the print output screen.**



3 **Press the SEL•ALT button shortly for about 0.5 second, then the print output screen will be changed.**

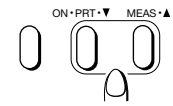
4 **Set the print output of parameters.**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button. Refer to “8-2 Parameter selection” for the individual parameter.



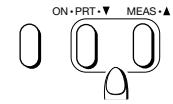
5 **Setting of the print output of a roughness curve.**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



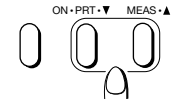
6 **Setting of the print output of a profile curve.**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



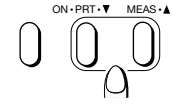
7 **Setting of the print output of measuring conditions.**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.

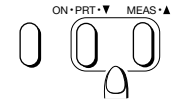


8 **Setting of the print output of a bearing area curve.**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



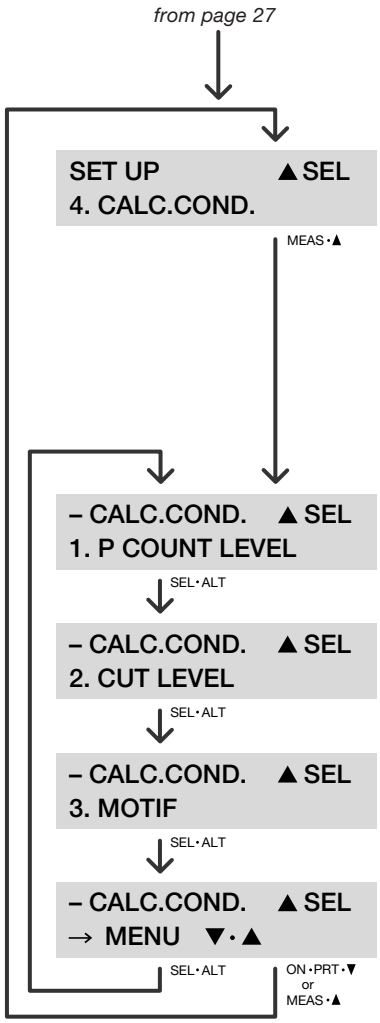
9 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, it returns to the menu screen of the setting mode.**



The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

When it is set to “CMONO” for the parameter calculation standard, it becomes possible to select “R MOTIF” and “W MOTIF”.

8-4 Calculation conditions setting

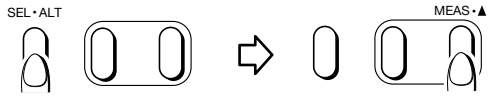


This is made setting of (1) Peak count level, (2) Cut level and (3) Motif.

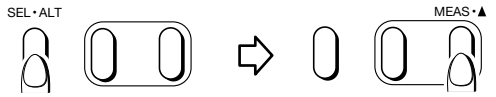
Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.

1 **Press the SEL•ALT button shortly for about 0.5 second, and set the menu to the calculation condition.**

Press the MEAS•▲ button and indicate the calculation conditions setting menu screen.



2 **Press the SEL•ALT button shortly for about 0.5 second, and press the MEAS•▲ button by setting the menu to the required calculation condition.**



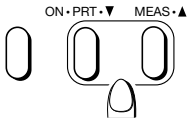
MEAS•▲ → **To “8-4-1 Peak count level”**

MEAS•▲ → **To “8-4-2 Cut level”**

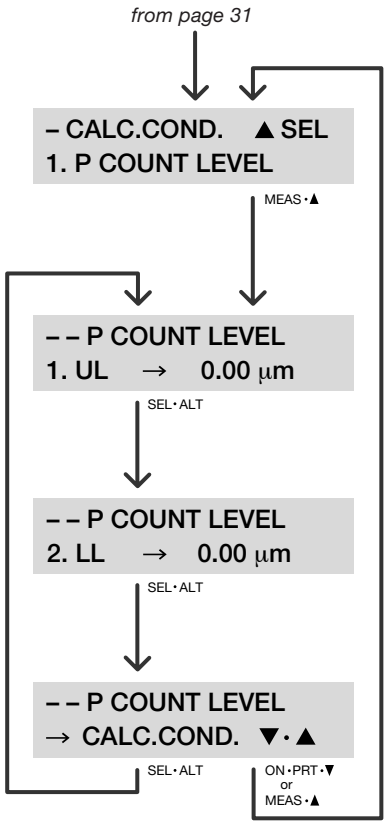
MEAS•▲ → **To “8-4-3 Motif”**

Note : The motif is only effective in case of CNOMO for the calculation standard. It is unable to be indicated in setting to the standard other than CNOMO.

3 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, it returns to the menu screen of the setting mode.**



The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

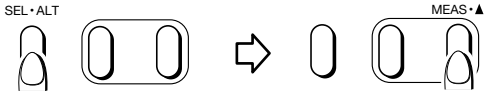


8-4-1 Peak count level

This is made setting of the upper limit and the lower limit of the peak count.

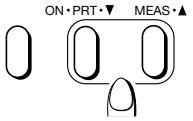
Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.

1 **Press the SEL•ALT button shortly for about 0.5 second, and press the MEAS•▲ button by setting to the peak count level screen in the calculation condition screen.**



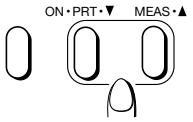
2 **Set the upper limit value (UL) of the peak count.**

Make this setting by pressing the ON•PRT•▼ button or the MEAS•▲ button.
This is set from 0.00 to 160.00 μm.
(In case of inch unit, this is set from 0 to 6400 μinch.)

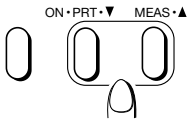


3 **Set the lower limit value (LL) of the peak count.**

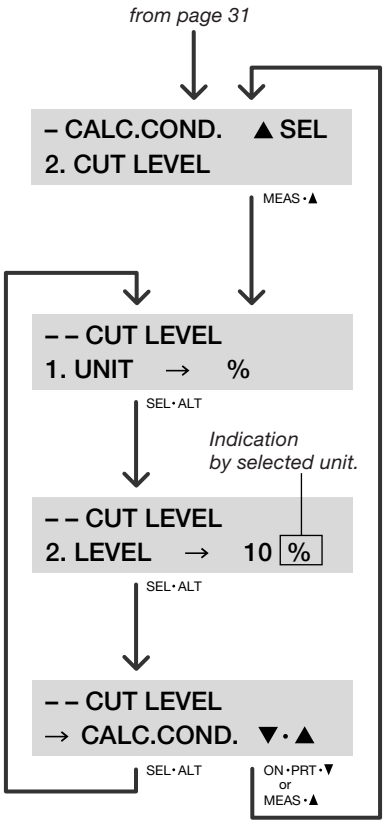
Make this setting by pressing the ON•PRT•▼ button or the MEAS•▲ button.
This is set from -160.00 to 0.00 μm.
(In case of inch unit, this is set from -6400 to 0 μinch.)



4 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, it returns to the calculation conditions screen.**



The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

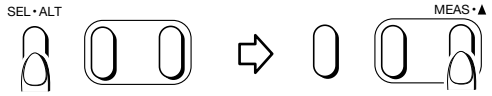


8-4-2 Cut level

This is made to set the cut level in bearing area curve.

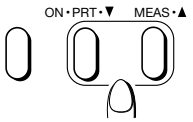
Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.

1 **Press the SEL•ALT button shortly for about 0.5 second, and press the MEAS•▲ button by setting to the peak count level screen in the calculation condition screen.**

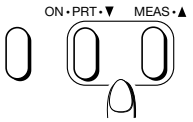


2 **Select the cut level unit from % or μm (μin).**

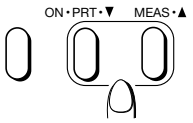
Make this setting by pressing the ON•PRT•▼ button or the MEAS•▲ button.
In case of % unit, this is set from 0 to 100.
In case of metric unit, this is set from 0.0 to 320.0 μm.
(In case of inch unit, this is set from 0 to 12800 μinch.)



3 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, set the cut level.**



4 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, return to the calculation condition screen.**

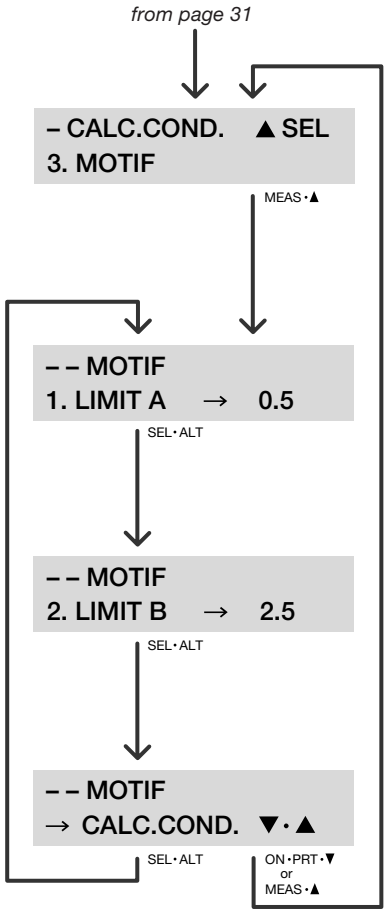


The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

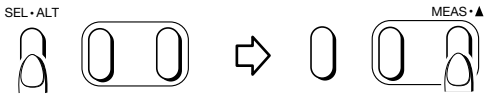
8-4-3 Motif

This is made to set the motif. (Refer to “13-7 Parameters for motif” for the motif.)

Note : The motif is only effective in case of CNOMO for the calculation standard. It is unable to be indicated in setting to the standard other than CNOMO.
Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.

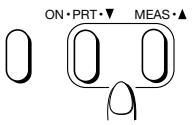


1 **Press the SEL•ALT button shortly for about 0.5 second, and press the MEAS•▲ button by setting to the motif in the calculation condition screen.**



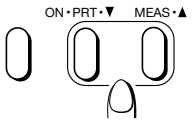
2 **Set the upper limit length (LIMIT A) of the roughness motif.**

Make this setting by pressing the ON•PRT•▼ button or the MEAS•▲ button.
Make this selection from 0.02, 0.1, 0.5, 2.5 mm (or 0.0008, 0.004, 0.02 and 0.1 in).

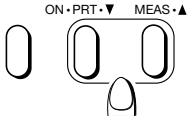


3 **Set the upper limit length (LIMIT B) of the waviness motif.**

Make this setting by pressing the ON•PRT•▼ button or the MEAS•▲ button.
Make this selection from 0.1, 0.5, 2.5, 12.5 mm (or 0.004, 0.02, 0.1 and 0.5 in).
Select the length to become the relation of LIMIT A < LIMIT B.
If it is not in the state of this, it is unable to get out of a motif screen.
And automatic power off function also becomes invalid.



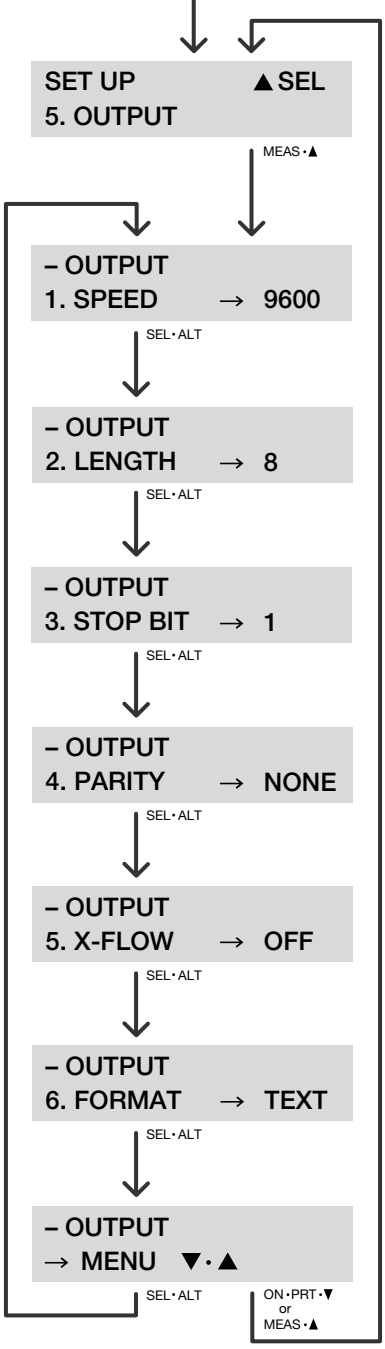
4 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, it returns to the calculation conditions screen.**



The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

8-5 Serial communication setting

from page 27



This is to make setting of the serial communication (RS-232C) condition between this instrument and a PC.

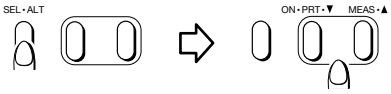
Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.

1 **Press the SEL•ALT button shortly for about 0.5 second, and set the menu to the serial communication.**

Press the MEAS•▲ button and indicate the calculation conditions setting menu creen.

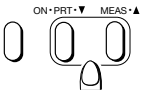
2 **Press the SEL•ALT button, then the output item screen will be changed.**

Set the data communication speed from 1200, 2400, 4800, 9600 and 19200 bps.
The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



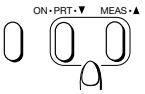
3 **Select the data length (7/8 bit).**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



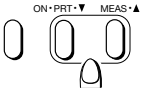
4 **Select the stop bit. (1/2)**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



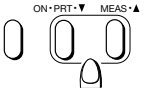
5 **Select the parity.**
(an odd number / an even number / None)

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



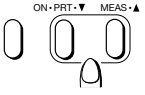
6 **Select the X flow control. (ON/OFF)**

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.

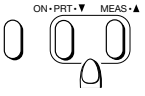


7 **Select the data format.**
(Text / SPC / 16 hexadecimal digit)

The setting will be changed by pressing the ON•PRT•▼ button or the MEAS•▲ button.



8 **By pressing the ON•PRT•▼ button or the MEAS•▲ button, it returns to the calculation conditions screen.**

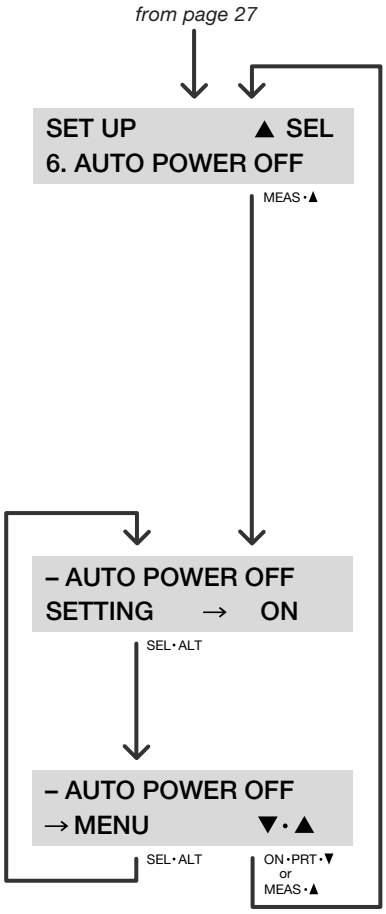


The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

8-6 Automatic power off setting

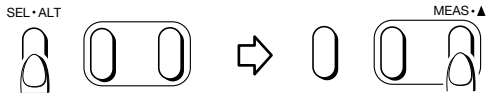
This is made to set the automatic power off.

Note : When the operation function is set to the basic function by setting No.7 of the Dip switch 2 to OFF, this is not indicated.



1 Press the SEL•ALT button shortly for about 0.5 second, and set the menu to the automatic power off.

Press the MEAS•▲ button and indicate the automatic power off setting menu screen.

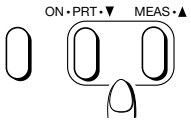


2 Select the automatic power off.

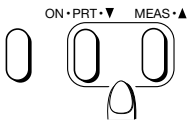
The setting will be changed by pressing the ON•PRT•▼• button or the MEAS•▲ button.

When SETTING is ON, the automatic power off function is valid. The power shall be turned OFF in case button operation is not conducted longer than 30 seconds.(Soon after RS command reception, the timing is extended 10 minutes)

The Auto Power Off function is invalid when the setting is OFF. Input the power OFF command “POFF” from the computer or the power is left as ON until the battery is out of charge.(If SETTING is turned ON, Power source shall be automatically turned OFF by automatic power off function.)



3 By pressing the ON•PRT•▼• button or the MEAS•▲ button, it returns to the calculation conditions screen.



The change of the mode of “Setting mode ↔ Normal mode” can be made at any screen by pressing the SEL•ALT button for more than 2 seconds.

9. DIP switch setting

Several kinds of settings are available with the Dip switch.
Remove the rubber cover in the back of the amplification indicator to set the Dip switch.

When the power is turned on, the Dip switch will be recognized.
When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

9-1 DIP switch 1 (Left side)

This makes settings for the parameter calculation standard, language and connecting devices.

1 / 2 / 3	**Selection of parameter calculation standard**	Set the calculation standard from JIS ’94, JIS ’82, ISO ’97 / JIS ’01 / DIN, CNOMO and ASME ’95.
4 / 5 / 6	**Selection of language**	Set the language from Japanese, English, German, French, Italian, Spanish and Portuguese.
7	**Selection of connecting Devices**	Set the peripheral devices either from a printer or PC.
8	**Selection of printer**	Set the printer to be connected. (E-RC-S23A, E-RC-S24A, E-RC-S25A or E-RC-S29A)

No.	JIS ’94	JIS ’82	ISO ’97 / JIS ’01 / DIN	CNOMO	ASME ’95
1	OFF	ON	OFF	OFF	ON
2	OFF	OFF	ON	OFF	ON
3	OFF	OFF	OFF	ON	OFF

Note : Non-phase compensation type 2RC filter is used for JIS ’82, and Gaussian type filter is used for the other standards.
Note : Finish symbol is indicated in JIS ’82 standard.
Note : Motif parameter can be calculated in CNOMO standard.

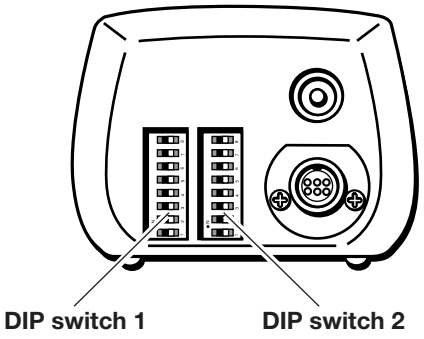
No.	Japanese	English	German	French	Italian	Spanish	Portuguese
4	OFF	ON	OFF	OFF	ON	ON	OFF
5	OFF	OFF	ON	OFF	ON	OFF	ON
6	OFF	OFF	OFF	ON	OFF	ON	ON

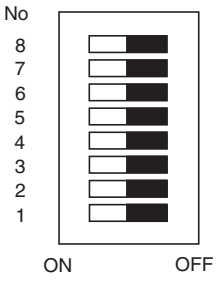
Note : Initial setting is different by each language.

No.	Small type printer (E-RC-S23A/ DPU-201GS)	High speed printer (E-RC-S24A/ DPU-3245)	Small type printer Ⅱ (E-RC-S25A or E-RC-S29A/DPU-H245)	Personal computer
7	OFF	OFF	ON	ON
8	OFF	ON	OFF	ON

Note : The printers other than above three types are unable to be used.
Note : E-RC-S29A is a product responded to RoHS commands.

The highlighted settings above are the manufacturer’s default settings.





9-2 DIP switch 2 (Right side)

This makes setting for conditions and other features.

1 Setting of the measuring range

This can be selected from 20, 40, 80 and 160 μm, but it can be selected at any range in the arbitrary range mode.
Note : When the basic function is set in the operation function, it must be selected from 40 and 160 μm. In this case it becomes an error of measurement by the excess of the value in the range.
However, the range can be changed automatically by the data volume in the automatic range.

2 Setting of the indication unit

Either mm/μm or in/μin can be selected.

3 Setting of the evaluation length

5 times length of the cutoff value is the standard for evaluation length. But by setting at arbitrary length, it can be set from the minimum 0.4 mm (0.02 in) to the maximum 12.5 mm (0.50 in) in every 0.1 mm (0.01 in) difference.

4 Setting of the conditions

This is to set the availability of changing each condition such as data saving, data reading, cutoff value, evaluation length, measuring range, calibration, recording vertical magnification and recording horizontal magnification in the normal mode.

5 Setting of the Print / Digital output

When this is set to AUTO, it can make print out and data output without pressing a button after measurement or reading of measured data.
When this is set to MANUAL, it can be made print out and data output by pressing the ON•PRT•▼ button.

6 Indication of the Z-axis level

When this is set to ON, the Z-axis level is displayed in the parameter screen.

7 Operation function

In the basic function, only the basic parameter and function become available to be used.

8 AI function

This is the function automatically to select the most suitable cutoff value and to make its calculation. (Refer to “7-4 AI function”.)

No.	Condition	OFF	ON
1	Measuring range	Automatic range	Arbitrary range
2	Indication unit	mm, μm	inch
3	Evaluation length	CUTOFF × 5	Arbitrary length
4	Change of conditions	Changeable	Unchangeable
5	Print / Digital output	MANUAL	AUTO
6	Z-axis level indication	OFF	ON
7	Operation function	Basic function	All function
8	AI function	OFF	ON

Note : The screen of measuring range is not displayed in the automatic range.
Note : In CUTOFF x 5, the “Evaluation length” screen is not displayed.
Note : When it is set to “AUTO” it is automatically print out or output the data without additional Operation after completion of the measurement.
Note : When the AI function is ON the cutoff screen is only for the display, it is not possible to change the setting.
Note : The rubber cover should always be back in place once completed the setting with the Dip switch.

The highlighted settings above are the manufacturer’s default settings.

9-3 Operation function

In spite of the small and compact appearance, this instrument has a lot of functions.
By selecting the operation function from the basic function and all functions, it can be set to use functions and parameters of being used frequently in the basic function.
The basic function can be selected by setting No.7 of the Dip switch 2 to OFF, and the all function can be selected by setting to ON.

Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

Limitation of functions in basic function

- Setting range of 20 and 80 μm in the range of 20, 40, 80 and 160 μm at arbitrary range setting.
- All of the calculation condition setting such as peak count level, cut level and motif in the setting mode.
- All of the serial communication setting in the setting mode.
- All about the auto power off setting in the setting mode.
- Highlighted parameters in the figure of below.

Calculation standard and parameters

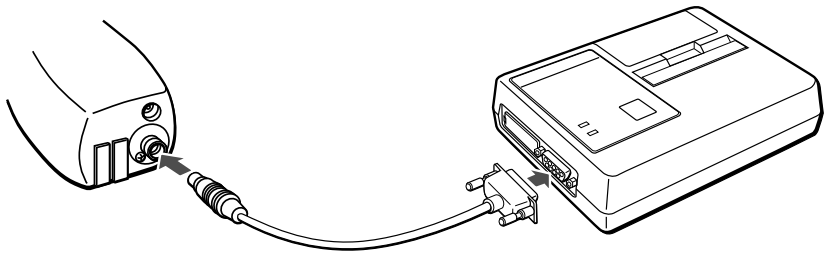
No.	JIS ’94	JIS ’82	ISO ’97 / JIS ’01 / DIN	CNOMO	ASME ’95
1	Ra	Ra	Ra	Ra	Ra
2	Ry	Rmax	Rz	R	Rmax
3	Rz	Rz	Rzmax	Rx	Rz
4	Sm	Rq	RSm	AR	RSm
5	Rq	Rp	Rq	Rz	Rq
6	Rp	Rt	Rp	Rmax	Rpm
7	Rt	Pc	Rt	W	Rp
8	Pc	tp	R3z	Wx	Rt
9	tp	Rk	Pc	AW	Pc
10	Rk	Rpk	Pt	Wte	Rmr
11	Rpk	Rvk	Rmr	Rmr	Rk
12	Rvk	Mr1	Rk	Rke	Rpk
13	Mr1	Mr2	Rpk	Rpke	Rvk
14	Mr2	V0	Rvk	Rvke	Mr1
15	V0	K	Mr1	Mr1	Mr2
16	K		Mr2	Mr2	V0
17			V0	V0	K
18			K	K	

10. Print out

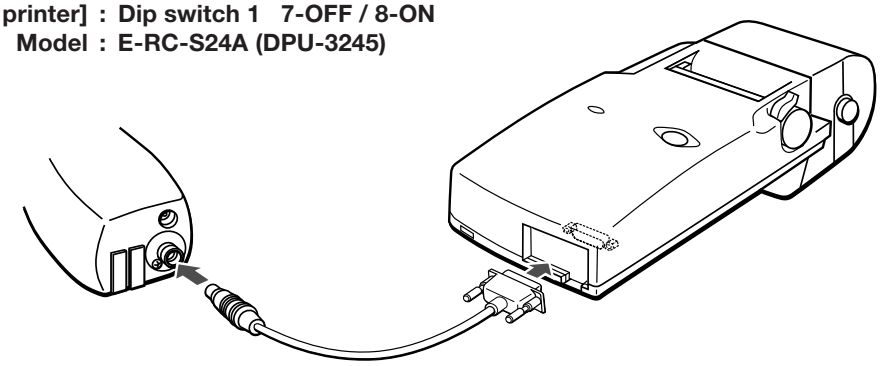
10-1 Printer connection

The exclusive cable prepared by the manufacture is necessary for the connection between the Handysurf E-35A/B and the printer.
Connection should be made as shown in the figure of below.
For the battery charging and the way to install the recording paper in detail, refer to the attached printer manual.

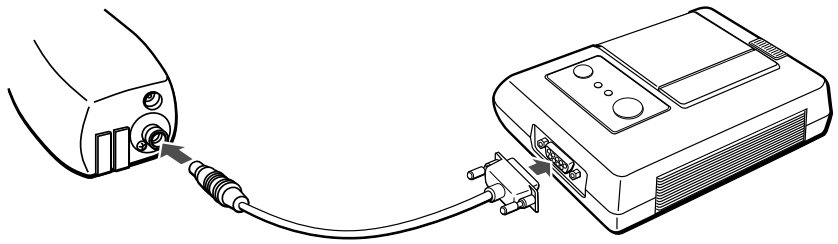
[Small type printer] : Dip switch 1 7-OFF / 8-OFF
Model : E-RC-S23A (DPU-201GS)



[High speed printer] : Dip switch 1 7-OFF / 8-ON
Model : E-RC-S24A (DPU-3245)



[Small type printer Ⅱ] : Dip switch 1 7-ON / 8-OFF
Model : E-RC-S25A or E-RC-S29A (DPU-H245)

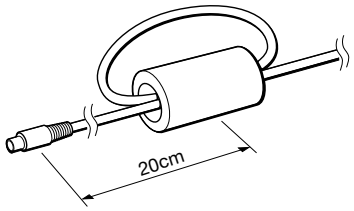


E-RC-S29A is a product responded to RoHS commands.

Note : Be sure to use attached cable to each printer because of the existence of different specifications of the cable.
Note : In case of appearance of an error in a printer, once turn off the power supply to the printer then turn off the power again and use the printer.

(Attachment of a ferrite core)

Assemble an attached ferrite core to a printer cable in the manner of a figure of below.

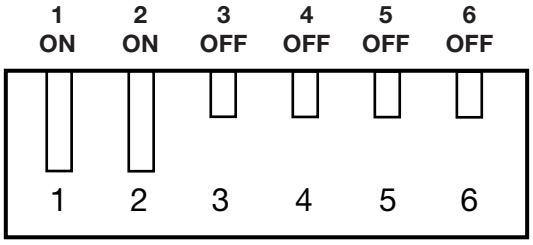


* Turn round a cable once at 20 cm apart from a plug.

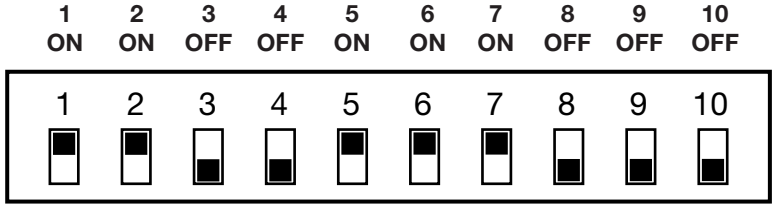
<Reference> Function setting of a printer

Function setting of a printer has already been made as shown below.
Once the setting is changed, it becomes unable to be made correct printing.
Be careful not to change the setting.

Small type printer
E-RC-S23A : DPU-201GS
It is made through a dipswitch. The setting is shown in the figure of below.



High speed printer
E-RC-S24A : DPU-3245
It is made through a dipswitch. The setting is shown in the figure of below.



Small type printer Ⅱ
E-RC-S25A or E-RC-S29A : DPU-H245
It is made through an operation switch. (Refer to the instruction manual attached to the printer for the detail.)
The setting is shown in the figure of below.

Command mode : DPU-H245 (mode B)
Character set : Graphics
Bit length : 8 bit
Parity : None
Busy control : RTS/CTS
Baud rate : 19200 bps

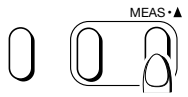
Note : E-RC-S29A is a product responded to RoHS commands.

10-2 Print output item setting

This is explained about the setting of print output item.

1 **Indicate the print output screen in the setting mode, and press the MEAS•▲ button.**

The selection screen of the print output item is displayed.

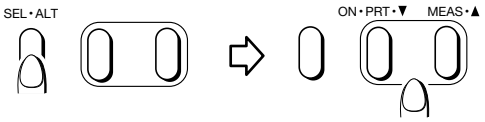


SET UP SEL ▲
3. PRINT OUT

– PRINT OUT
1. PARAMETER → ON

2 **In each time of pressing the SEL•ALT button, the items are switched over as shown below. By pressing the switch of [▼] or [▲], it can be set to ON (output) or OFF (non-output). (Refer to "8-3 Print output selection".)**

Print output items
1. Parameters (* Only the selected parameters.)
2. Roughness curve
3. Profile curve
4. Measuring conditions
5. Bearing area curve
6. Roughness motif (* Only when CNOMO is the selected standard.)
7. Waviness motif (* Only when CNOMO is the selected standard.)
Menu (* To return to the menu.)



10-3 Profile print magnification setting

After completion of the measurement, the print magnification can be changed.

1 **Indicate the recording vertical magnification screen or horizontal magnification in the normal mode.**

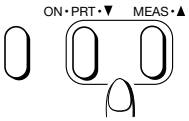
Note : When the connected devices are made setting through a personal computer, it is not displayed.

^SET ▼DEC ▲INC
V-MAG AUTO

^SET ▼DEC ▲INC
H-MAG AUTO

2 **Set the magnification with the [▼DEC] or [▲INC] switch.**

Setting of the following magnifications is available.
Vertical magnifications : 100, 200, 500, 1K, 2K, 5K, 10K, AUTO
Horizontal magnifications : 1, 2, 5, 10, 20, 50, 100, 200, AUTO



* AUTO in vertical magnification
The maximum magnification in which a whole profile will come into the frame is automatically selected from the above magnifications.

* AUTO in horizontal magnification
The maximum magnification in which a whole recording length of a profile will come into the size of 180 mm is automatically selected from the above magnifications.

10-4 Measurement result print output

Measuring result of the previous measurement or reading is output in a print.

How to start print out
While the parameter value screen is displayed, press the ON•PRT•▼ button, then the item set in the print output screen will be printed.

How to stop print out
Keep to press the ON•PRT•▼ button until disappearance of the display of “print”, then it stops the print out.

Automatic print output
When No.5 of the Dip switch 2 is set to ON, the setting of automatic print output is made. In this case, it will be automatically printed out after the completion of measurement (reading) and calculation.

Note : Roughness motif and waviness motif are not printed out when they were unable to be calculated in spite of their selection for output.

10-5 Reading of print output

This explains how to read the printed measuring result with examples.
The items selected in the print output screen are printed.
The output items with all printers are the same.
Here, the example of printing the high speed printer is used with E-35A.

```
TOKYO SEIMITSU
handysurf E-35A      Ver.1.00
```

Header / version No. (To be output always.)

```
LENGTH    =    4.00mm
CUTOFF    =    0.8mm
FILTER    =    Gaussian
RANGE     =    160μm
```

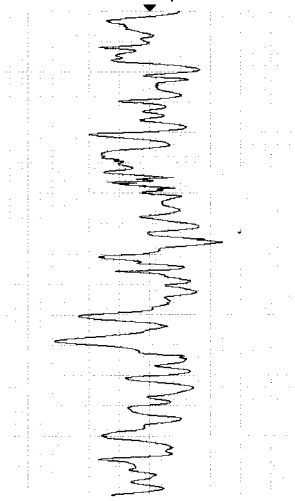
Measuring condition
Evaluation length is printed even when set in the fixed mode.

```
(ISO'97/DIN)
Ra        =    3.1μm
Rz        =    16.3μm
Rzmax     =    19.6μm
RSm       =    184.2μm
```

Calculation standard / parameter values
Items selected in the parameter screen are printed.

<PROFILE> **Profile curve (P curve)**

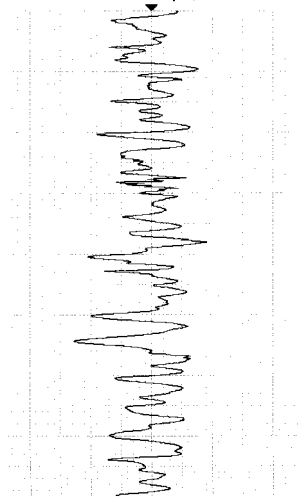
```
V-MAG     =    1000(AUTO)
H-MAG     =    20(AUTO)
V-DIV     =    10μm/ 10mm
H-DIV     =    500μm/ 10mm
```



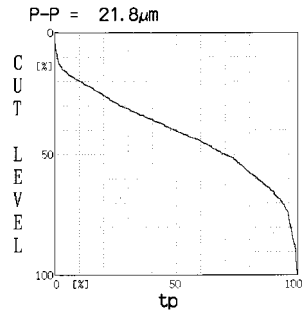
Right side is a peak side.

<ROUGHNESS> **Roughness curve (R curve)**

```
V-MAG     =    1000(AUTO)
H-MAG     =    20(AUTO)
V-DIV     =    10μm/ 10mm
H-DIV     =    500μm/ 10mm
```



<BAC> **Bearing area curve**



* A scale in horizontal direction
A scale in horizontal direction has already been adjusted so as to coincide with actual length, but there is a case of being expanded or contracted up to the maximum 5 % due to deterioration of a paper feed mechanism and a slip of the printer paper.

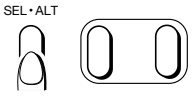
11. Stylus check

Although the stylus tip is made of diamond material, it will wear out with use or may become chipped.
If the stylus tip is worn or chipped, it may cause measurement errors. The tip must be checked regularly.

1 **Set the AI function to OFF (by setting No.8 of Dip switch 2 to OFF) while using its function.**

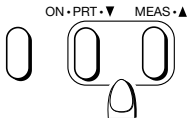
2 **Press the SEL•ALT button shortly for about 0.5 second and indicate the cutoff value screen.**

Note : In case of not showing the cutoff value screen
It is under the sate of not being available to be changed the condition.
➔ Set No.4 of Dip switch 2 to OFF.
It is in the state of setting mode.
➔ Press the SEL•ALT button more than 2 seconds, then it will become the normal mode ↔ setting mode.



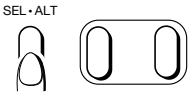
^SET ▼DEC ▲INC
CUTOFF 0.8 mm

3 **Select the cutoff value 0.8 mm by pressing the ON•PRT•▼ button or MEAS•▲ button.**



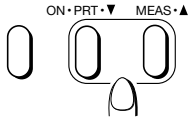
4 **Press the SEL•ALT button shortly for about 0.5 second and indicate the evaluation length screen.**

When the cutoff value screen is displayed but the evaluation length screen is not displayed, the evaluation length is fixed to CUTOFF✻5. Therefore it is not necessary to be set.



^SET ▼DEC ▲INC
LENGTH 4.0 mm

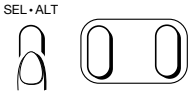
5 **Set the evaluation length to 4.0 mm by pressing the ON•PRT•▼ button or MEAS•▲ button.**



When the evaluation length is set to 4.0 mm, it is shown as L = 4.0 mm.

λc = 0.80 L = λc✻5 mm
Ra = 2.55 μm

6 **Press the SEL•ALT button shortly for about 0.5 second and indicate the Ra.**



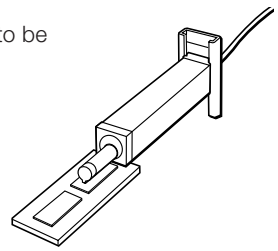
7 **The previous measuring result is displayed.**

Note : When the Ra is not selected at the parameter selection in the setting mode, select the Ra.
(Refer to “8-2 Parameter selection” of “8. Setting mode”.)

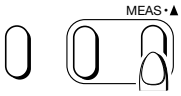
8 Prepare the attached reference specimen.

9 Place the pickup on the reference specimen on the side of STYLUS CHECK.

Note : The tracing driver should be adjusted to be parallel with the surface to be measured by using the included adjuster.



10 Press the MEAS•▲ button to measure the reference specimen.



Under measurement

λc = 0.80 L = λc∗5 mm
meas □□□□□

11 Measuring result of the reference specimen is displayed.

Measurement ended

λc = 0.80 L = λc∗5 mm
Ra = 0.39 μm

12 Compare the measured Ra value and the indicated value on the reference specimen, and judge the state of the stylus.

Print the profile curve and compare the result in case of the unit with the printer.

Stylus	Normal	Abrasion	Chipped
Record		Round peaks 	Flat peaks 
Ra value	Indicated value ±0.05 μm	Indication value –(0.05 - 0.1) μm	Indicated value –0.1 μm or less

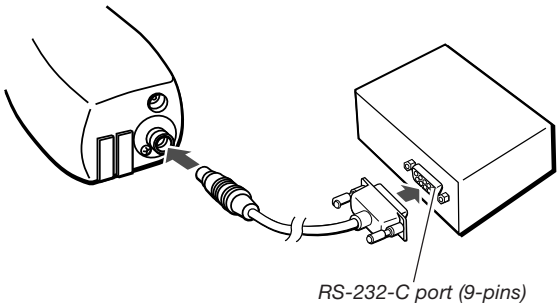
Exchange a pickup in case of being made judgment as “Wear” or “Chip”.

Note : The results of the measurement of the reference specimen may vary a little According to which part is measured. It is recommended to measure about three parts of the surface and take an average of the results.
Note : If the same part of the reference specimen is measured over and over again, it may cause abrasion of the surface which will result in a smaller value of the result of measurement. For each check measure a different part of the reference specimen.

Note : To stylus check, the measuring range must always be at the automatic range by setting No.1 of the Dip switch 2 to OFF or set it to 40 μm in the arbitrary range.
Note : When the Dip switch setting was changed in the state of power ON, turn the power supply to ON again after being confirmed the auto-power off.
It is necessary to turn on the automatic power off setting. Refer to “8-6 Automatic power off setting”

12-1 Connection to personal computer

An exclusive optional cable prepared by TSK is necessary for connection between the Handysurf E-35A/B and a personal computer. Connect the cable as shown in the figure of below.



Note : For connection of the Handysurf E-35A/B to a personal computer with an RC-232-C port of 25-pins, it requires to place a special order for the cable of a specified specifications.

12-2 Command function

12-2-1 Command from personal computer to Handysurf and the response

1 Power OFF command

Format : POFF <cr>
Function : This is the command to turn the power OFF.
Response : POFF "E" <cr>

* "E" is an error code.
<cr> shows a return code.

2 Measure command

Format : MEAS <cr>
Function : This is the command to start measurement.
Response : MEAS "E" <cr>

3 Data output command

Format : DATA <cr>
Function : This is the command of measurement data output directive.
Response : This is responded as data output. Refer to "12-2-4 Format of output data" for the contents.
But if errors occur, DATA "E" <cr>.

4 Measuring range setting command

Format : RANG, n <cr>
Function : This is the command to set measuring range. The "n" is an integer which becomes the figure of below. However, this is only effective when it is set to "arbitrary range" by the DIP SW. In case of being set to the "Basic Function" mode for the operation function, it is unable to be set to 80 μm and 20 μm.
Response : RANG "E" <cr>

n	Measuring range
0	160 μm (6400 μ")
1	80 μm (3200 μ")
2	40 μm (1600 μ")
3	20 μm (800 μ")

5 Vertical magnification setting command

Format : VMAG, n <cr>
Function : This is the command to set vertical magnification for record. The "n" is an integer which becomes the figure of below.
Response : VMAG "E" <cr>

n	Recording vertical magnification
0	AUTO
1	× 100
2	× 200
3	× 500
4	× 1K
5	× 2K
6	× 5K
7	× 10K

6 Horizontal magnification setting command

Format : HMAG, n <cr>
Function : This is the command to set Horizontal magnification for record. The "n" is an integer which becomes the figure of below.
Response : HMAG "E" <cr>

n	Recording horizontal magnification
0	AUTO
1	× 1
2	× 2
3	× 5
4	× 10
5	× 20
6	× 50
7	× 100
8	× 200

7 Cutoff value setting command

Format : COFF, n <cr>
Function : This is the command to set cutoff value. The "n" is an integer which becomes the figure of below.
Response : COFF "E" <cr>

n	Cutoff value
0	0.08 mm
1	0.25 mm
2	0.8 mm
3	2.5 mm

8 Evaluation length setting command

Format : LENG, ✻✻. ✻✻ <cr>
Function : This is the command to set evaluation length. The ✻✻. ✻✻ is set by a real number from 0.4 to 12.5 (mm) of up to one decimal place when the indication unit is set to metric. In case of that the unit is set to inch, it is set by a real number from 0.02 to 0.5 (") of up to two decimal places. However, this is only effective when it is set to "arbitrary range" by the DIP SW.
Response : LENG "E" <cr>

9 Peak count level setting command

Format : PCLV, ✻✻. ✻✻ <cr>
Function : This is the command to set a peak count level for parameter PC calculation. evaluation length. The "n" and "✻✻. ✻✻" are shown as follows.
Response : PCLV "E" <cr>

n	Item	✻✻.
0	Peak count level (upper limit) setting	• In case of metric unit, it is set by a real number from 0 to 160.00 μm of up to two decimal places. • In case of inch unit, it is set by a real number from 0 to 6400.0 μ" of up to one decimal place.
1	Peak count level (lower limit) setting	• In case of metric unit, it is set by a real number from -160.00 to 0 μm of up to two decimal places. • In case of inch unit, it is set by a real number from -6400.0 to 0 μ" of up to one decimal place.

10 Motif upper length setting command

Format : MOTIF, ✻✻✻ <cr>
Function : This is the command to set an upper limit length for calculation of The motif parameter. The "n" and "✻✻✻" are shown as follows.
Response : MOTIF "E" <cr>

n	Item	✻✻✻
0	Roughness motif upper limit length setting	This is set by a real number from 1 to 4. 1 : 0.02 mm (0.008") 2 : 0.1 mm (0.004") 3 : 0.5 mm (0.02") 4 : 2.5 mm (0.1")
1	Waviness motif upper limit length setting	This is set by a real number from 1 to 4. 1 : 0.1 mm (0.004") 2 : 0.5 mm (0.02") 3 : 2.5 mm (0.1") 4 : 12.5 mm (0.5")

11 Output item setting command

Format : OUTP, n, ✻✻✻✻ <cr>
Function : This is the command to set data output of LCD display, print output and digital output. The "n" is a block to be set and the parameter is designated by each bit of 16 bits data. When the applicable bit is set to 1, the parameter can be output.
The "✻✻✻✻" is the one which was converted the data of 1 bock 16 bits to HEX code. The contents of each block are as shown below.
Response : OUTP "E" <cr>

Explanation

This is explained more in detail about the "✻✻✻✻".
This numerical value shows the selection conditions of the vertical one line group in the parameter number table. (Setting of the output item <OUTP> is necessary to be made by each vertical one line group.) The vertical line is consisted of 16 bits.
The numeric values at left side of the parameter number table are corresponded to the each bit as shown below. This is converted to the HEX character code of each 4 bits.

Bit	**[15**	**14**	**13**	**12]**	**[11**	**10**	**9**	**8]**
Weight	8	4	2	1	8	4	2	1
Example	○	○	○	○	○	○	●	○
Set value			0				2	

Bit	**[7**	**6**	**5**	**4]**	**[3**	**2**	**1**	**0]**
Weight	8	4	2	1	8	4	2	1
Example	●	●	○	○	●	○	○	●
Set value			C				9	

(Addition of each weight is shown in hexadecimal number.)
○ ... Not to be selected.
● ... To be selected.

At the setting of JIS '82 : Parameter number table

	n			
bit	**1**	**2**	**3**	**4**
15				
14				
13				
12				
11				
10	Pc <11>			
9				
8				
7	Rt <8>		tp <40>	
6			K <39>	
5			V0 <38>	
4	Rp <5>		Mr2 <37>	Roughness curve
3			Mr1 <36>	Profile curve
2			Rvk <35>	Bearing area curve
1	Rq <2>	Rz <18>	Rpk <34>	Parameter
0	Ra <1>	Rmax <17>	Rk <33>	Measuring condition

* The number indicated in < > is the parameter number.

Example : When Ra, Pc and Rmax, Rz are going to be output in JIS '82:
OUTPUT, 1, 0401 <cr>
OUTPUT, 2, 0003 <cr>

At the setting of JIS '94 : Parameter number table

	n			
bit	**1**	**2**	**3**	**4**
15				
14				
13				
12				
11				
10	Pc <11>			
9	Sm <10>			
8				
7	Rt <8>		tp <40>	
6	Rz <7>		K <39>	
5			V0 <38>	
4	Rp <5>		Mr2 <37>	Roughness curve
3			Mr1 <36>	Profile curve
2	Ry <3>		Rvk <35>	Bearing area curve
1	Rq <2>		Rpk <34>	Parameter
0	Ra <1>		Rk <33>	Measuring condition

* The number indicated in < > is the parameter number.

At the setting of ISO '97 / JIS '01 / DIN : Parameter number table

	n			
bit	**1**	**2**	**3**	**4**
15				
14				
13				
12				
11				
10	Pc <11>			
9	RSm <10>			
8	R3z <9>			
7	Rt <8>		Rmr <40>	
6	Rp <7>		K <39>	
5			V0 <38>	
4			Mr2 <37>	Roughness curve
3	Rzmax <4>		Mr1 <36>	Profile curve
2	Rz <3>		Rvk <35>	Bearing area curve
1	Rq <2>		Rpk <34>	Parameter
0	Ra <1>	Pt <17>	Rk <33>	Measuring condition

* The number indicated in < > is the parameter number.

At the setting of CNOMO : Parameter number table

	n			
bit	**1**	**2**	**3**	**4**
15				
14		Wte <31>		
13		AW <30>		
12		Wx <29>		
11		W <28>		
10		AR <27>		
9		Rx <26>		
8		R <25>		
7			Rmr <40>	
6			K <39>	Waviness motif
5			V0 <38>	Roughness motif
4			Mr2 <37>	Roughness curve
3	Rmax <4>		Mr1 <36>	Profile curve
2	Rz <3>		Rvke <35>	Bearing area curve
1			Rpke <34>	Parameter
0	Ra <1>		Rke <33>	Measuring condition

* The number indicated in < > is the parameter number.

At the setting of ASME '95 : Parameter number table

	n			
bit	**1**	**2**	**3**	**4**
15				
14				
13				
12				
11				
10	Pc <11>			
9	RSm<10>			
8				
7	Rt <8>		Rmr <40>	
6			K <39>	
5	Rp <6>		V0 <38>	
4	Rpm <5>		Mr2 <37>	Roughness curve
3	Rmax <4>		Mr1 <36>	Profile curve
2	Rz <3>		Rvk <35>	Bearing area curve
1	Rq <2>		Rpk <34>	Parameter
0	Ra <1>		Rke <33>	Measuring condition

* The number indicated in < > is the parameter number.

Note : It is automatically shut off the power about 30 seconds later after the last operation by using a button. But in case of data input from a personal computer, it is automatically shut off the power about 10 minutes later after the last input of data.

Note : In order not to be automatically shut off the power, enter an invalid command within 10 minutes.

Example : CONT <cr>

Then it is replied as CERR80 <cr>.

Note : While being displayed a serial communication screen, input of command becomes ineffective.

12 tp, cut level setting command

Format : CLVL, n, ✻✻. ✻ <cr>

Function : This is the command to set a cut level. The "✻✻. ✻" is changed by the unit of the cut level as follows.
In case of the relative designation:
It is shown in a value from 0 to 99 (%).
In case of the absolute designation:
When the indication unit is set in metric, it is set by a real number from 0.0 to 320.0 (μm) of up to one decimal place.
But when the unit is set in inch, it is set by an integer from 0 to 12800 (μ").

Response : CLVL "E" <cr>

n	Unit of a cut level
0	Relative designation (%)
1	Absolute designation (μm/μ")

13 Stop command

Format : STOP <cr>

Function : This is the command to discontinue measuring operation and data output processing.

Response : STOP "E" <cr>

14 Data output format setting command

Format : FOMT, n <cr>

Function : This is the command to set the measuring data output format of digital output. The "n" is an integer and it becomes as shown below.

Response : FOMT "E" <cr>

n	Output format
0	Hexadecimal number
1	Text
2	SPC

15 Automatic power off setting command

Format : APOF, n <cr>

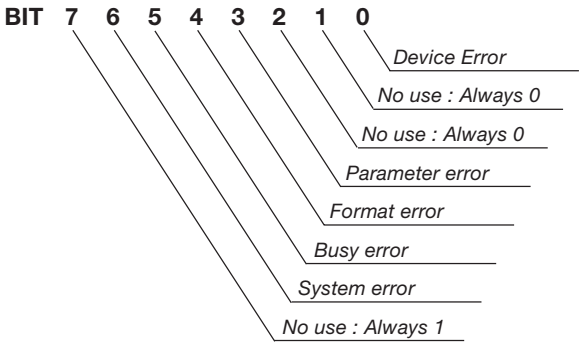
Function : This is the command to set automatic power off.
n is an integer functioning as shown below.

Response : APOF "E" <cr>

n	Automatic power off
0	OFF
1	ON

12-2-2 Error code

If an error occurs after Handysurf received the command, an error code will be returned as part of the response.
After the received command is executed, the error code information will be converted to HEX and returned as 2 bit value, as shown in the diagram below. (This corresponds to the part of “E”.)
The 7th bit is always shown as 1, and the 1st and 2nd bits are always shown as 0.
The bit numbers of 0 and from 3 to 6 become 1 when an error occurs.
If no error appears, it is shown as 0.



When the DEVICE ERROR of 0 bit appears in the returning error code, turn off the power supply once then turn on the power and transfer the command.
When a meaningless command or unrecognized command is entered, the Handysurf will repeat the response code of “CERR ‘E’ <cr>”.
In this case, the Handysurf makes no processing.

DEVICE ERROR	: If Hardware trouble occurs.
FORMAT ERROR	: If the command format is insufficient.
PARAMETER ERROR	: If the argument of command is out of range.
BUSY ERROR	: If the Handysurf is busy with other commands.
SYSTEM ERROR	: If unexpected errors occur.

Example : If the vertical magnification value is set too high by using the “VMAG” command, the response code shown below will be returned.

External connecting unit		Handysurf	
Command VMAG, 20 <cr>	...→		“Out of the setting range for 20”
Response	←...	VMAG88 <cr>	“PARAMETER ERROR”

12-2-3 Data output from the Handysurf to the personal computer

The Handysurf can output the measured data and parameters to the personal computer. The output is executed by pressing the ON•PRT•▼ button or by inputting the data output command (DATA <cr>). This time, the message of “Under output data” is indicated on the screen.
When the output needs to stop during data transfer, either press ON•PRT•▼ button or send the forced termination command (STOP <cr>) from the PC to the Handysurf, then data transfer will stop. The items that will be output during data output are those items selected on the print output screen and the parameter selection screen.

12-2-4 Format of output data

<In case of the hexadecimal number for the output type>

1 Out of measuring conditions

Format : COND, ✻✻✻, ✻✻✻, ✻✻✻ <cr>

Cutoff value (mm/") *Evaluation length (mm/")* *Measuring range (μm/μ")*

2 Output of parameters

Format : PARM, 1, ✻✻✻, 2, ✻✻✻, ..., n, ✻✻✻ <cr>

Parameter No. *Parameter value*

Note : The unit of the parameter value is the same as the screen display or the parameter value of the print output. Refer to the above parameter number table for the parameter number. The number in < > is the parameter number.

3 Output of measuring data

a Transfer of the profile curve data
Format :
PCRV, n, 1st point 2nd point 3rd point ..... n’th point <cr>
The “n” shows measured data point number, and its range is n ≦ 8192. The measuring data can be continuously output up to the n’th point as 4 bites 1 data after the HEX conversion.

b Transfer of the roughness curve data

Format :
RCRV, n, 1st point 2nd point 3rd point ..... n'th point <cr>
The "n" shows measured data point number, and its range is n ≦ 8192. The measuring data can be continuously output up to the n'th point as 4 bites 1 data after the HEX conversion.

Example :

MSB			LSB	
0 0 0 0	1 0 1 1	0 0 0 1	0 0 1 0	Measuring range
HEX conversion				
0	B	1	2	Output data

Output order
1 → 2 → 3 → 4

Weight of one bit (resolution) becomes as shown below by the measuring range.

Weight of 1 bit	Measuring range
0.08 μm / 3.15 μ"	160 μm / 6400 μ"
0.04 μm / 1.57 μ"	80 μm / 3200 μ"
0.02 μm / 0.79 μ"	40 μm / 1600 μ"
0.01 μm / 0.39 μ"	20 μm / 800 μ"

Note : The output data are output in the range from F800 to 07FF. (The negative number is explained by the complement of 2.)

4 Order of output

In output of the data, the same items of the printout are made output.
The order becomes as shown below.
COND, ... <cr> PARM, ... <cr> PCRV, ... <cr>
RCRV, ... <cr>

<In case of "SPC" for the output type>

Only the parameters which are set for the output are made output in the format of below.
The output order comes from the smaller parameter number.

✻✻✻, ✻✻✻ <CR> <LF>
✻✻✻, ✻✻✻ <CR> <LF>
✻✻✻, ✻✻✻ <CR> <LF>
•
•
•
✻✻✻, ✻✻✻ <CR> <LF>

<In case of "TEXT" for the output type>

Measuring data in TEXT format becomes as shown below. The order of output is the same as the printout.
- The curve data which is the same as the printout are made output.
- The data pitch is calculated with the formula of "Evaluation length / (Data point Number – 1)".

Output example	Description
Eval. Length = 4.000mm <CR>	: Evaluation length
Cutoff value = 0.8mm <CR>	: Cutoff value
Cutoff = Gaussian <CR>	: Filter type
Meas. Range = 160 um <CR>	: Measuring range
(JIS '94) <CR>	: Calculation standard
<CR>	: <Parameter>
MM <CR>	: Output unit (MM ; Metric / INCH ; Inch)
Ra = 6.7 <CR>	: Parameter mark, Parameter value (μm)
Ry = 28.3 <CR>	
Rz = 24.6 <CR>	
Rmax = 30.5 <CR>	
Sm = 86.4 <CR>	
Pc = 35 <CR>	
<CR>	: <Curve data>
MM <CR>	: Output unit (MM ; Metric /INCH ; Inch)
P <CR>	: Curve type (P ; Profile curve / R ; Roughness curve)
4.0 <CR>	: Evaluation length (mm)
3334 <CR>	: Data point number
9.75 <CR>	: Measuring data (μm), Portion of the point number
9.61 <CR>	* In order to create a profile curve by using
9.46 <CR>	drawing function in the spreadsheet
9.31 <CR>	application, select the measuring data only.
9.18 <CR>	
9.05 VCR>	
8.92 <CR>	
8.75 <CR>	
8.51 <CR>	

12-3 Example of command

This explains about examples of communication by using the application software program of “Hyper terminal” which is the standard program attached to the WindowsNT (Windows98). The Handysurf must be connected to the personal computer via serial cable before executing this communication.

Note : Though this is explained in the case of “Hexadecimal number” for the output type, it is also available to receive the other types as a text file. As it is sent in the “Decimal number” in case of the other types, it can be read by EXCEL as it is.
Note :“Hyper terminal” goes with Windows 2000 or XP as a standard and it is possible to be used in a similar way.

12-3-1 Communication condition setting at the side of Handysurf

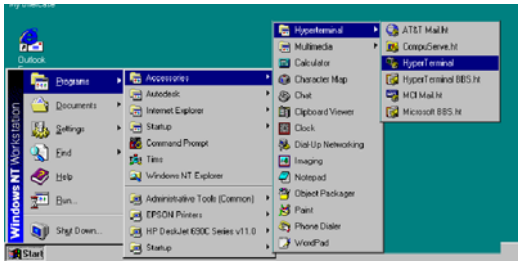
1 Open the “OUTPUT” in the setting mode screen.

Note : In case of that the screen of “OUTPUT” is not displayed, an operation function is in the state of a basic function.
➔ Set No.7 of the dipswitch 2 to ON.
Note : When the dipswitch was changed in the state of power ON, wait for becoming to the state of power OFF and supply the power again.

2 Make setting of each communication condition corresponding to the connecting computer.

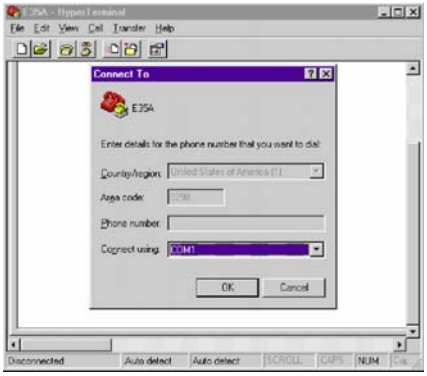
12-3-2 Communication condition setting at the side of computer

1 Select the “Start” button and choose “Programs”,



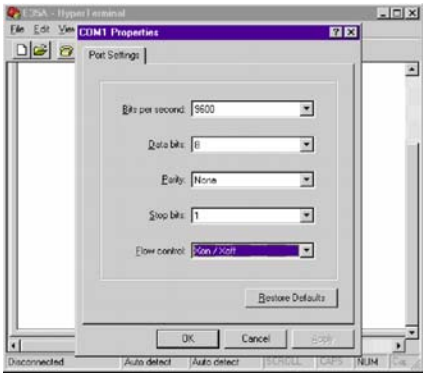
“Accessories”, “Hyperterminal” and “Hyper Terminal” in order. And open the folder of “Hyper Terminal”.

2 Double click the icon of “Hypertrm.exe”. When the dialogue box of “Connection setting” is displayed, enter “E35A” and press the “OK” button. When the dialogue box of “Telephone number” is displayed, set the direct to the communication port to be used in the “Connection method”.



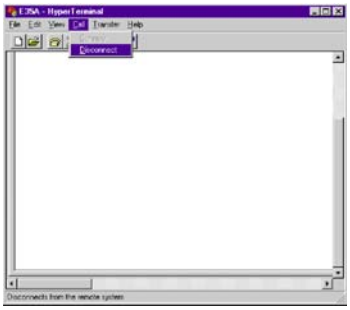
In case of the connection to com1 for example, select the “Direct to comz1” and press the [OK] button.

When the “Property of COM1” is displayed in the dialogue box, set the same condition setting as the Handysurf and press the [OK] button.

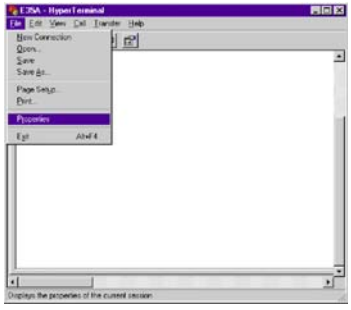


Note : Windows is trademark of Microsoft Corporation in the USA and other countries.

Then it starts the connection. Once select the “Disconnect” from the pulldown menu of the “Communication”, and make disconnection of the connection.



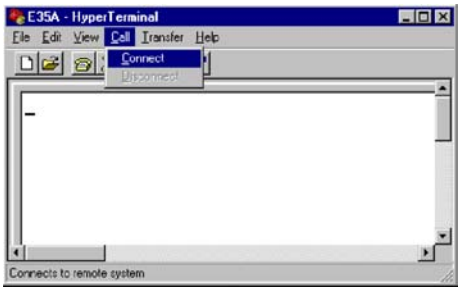
3 Finally make setting of the property.
Select the “Property” from the pulldown menu of the “File”, then the dialogue box of the “Property of E35A” is displayed. And select the tag of “Set”.



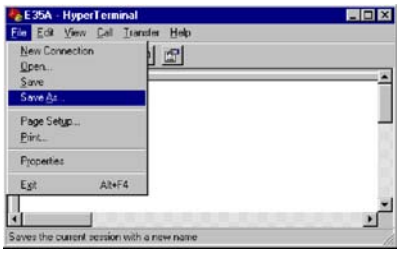
Press the [ASCII set] button and display the “ASCII set” dialogue box. And press the [OK] button after being set as shown below.

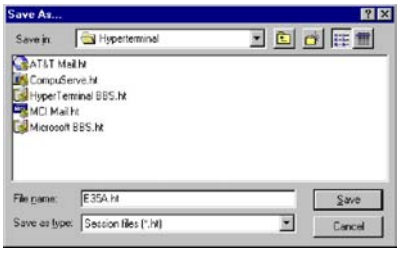
Put a check mark onto the “Local echo”, “Put a line feed character to the receiving data.” and “Turn at the right end.”.

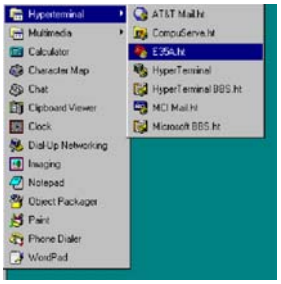
Press also the [OK] button of the “Property of E35A” dialogue box. This is the all procedure for the condition setting.
Select the “Telephone” from the “Communication” pull down menu and start the communication.



It is recommended to save this condition setting. Select “Save with a name.” from the “File” pulldown. When the dialogue of the “Save with a name” is displayed, press the “Save” button as the “Stored place” in the “Hyper Terminal” folder. Then the file of “E35A.ht” will be created in the “Start Menu”. For making use of this hereafter, double click this file then it can be used in the same condition.

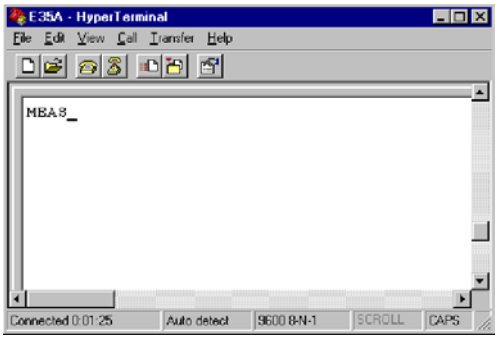






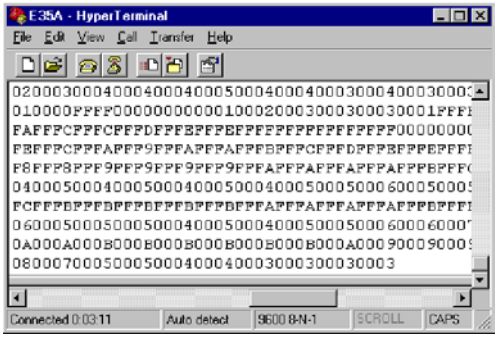
12-3-3 Sending of the control command

1 Enter the command to start measurement from the personal computer.
Enter MEAS with the keyboard and press the [Enter] key.



The command will be sent to the side of Handysurf and it starts measurement.

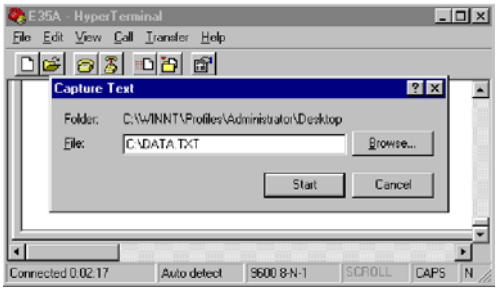
2 Enter the command of the measuring data output.
Enter DATA with the keyboard and press the [Enter] key.
The measuring data will be received and it is displayed.



* The other command can be used in the same procedure.

12-3-4 To store the measuring data

1 Select the “Capture of text” from the “Transfer” pulldown menu.
When the “Capture of text” dialogue is displayed, name the communication file and press the [Start] button. Then it will start to receive the data.
In case of already existing the file, the newly received measuring data are added to the bottom.

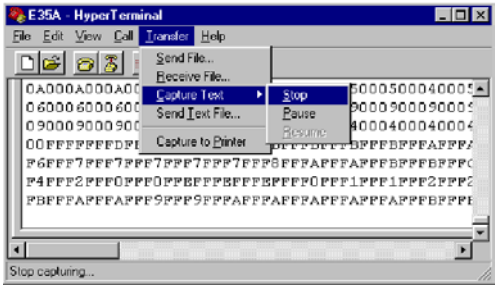


2 The measuring data are made output by the following methods.

① Set No.5 of the Dip switch 2 to ‘ON’. The measuring data are automatically making output after the measurement.
② After making the measurement, press the ON•PRT•▼ button with the operating switch of at the side of the Handysurf.
③ Enter the DATA command from the terminal screen at the personal computer and press the [Enter] key. Then the output of measuring data will be executed. In this case, the “DATA” will be included in the contents of the receiving file.

At the same time of receiving the measuring data, it will be stored in the text file designated in the above 1.

3 The transfer of the measuring data is terminated when the scroll display of the measuring data is stopped.
Select the “Text capture” - “Stop” from the “Transfer” pulldown menu, and receive the text file and terminate it. The received measuring data is stored in the text file that named “DATA-TXT”.



12-3-5 Measuring data file

1 There is a case that the size of the measuring data file is too big to read in the “Memo” included standard in the Windows98. In this case, use some other commercially available editor.

2 In the measuring data file, the measuring data are located after the “COND”.
And the P-curve is located after the “PCRV” and the R-curve is located after the “RCRV”.

Example : A sample of P-curve data file
PCRV, 6667, FF27FF26FF27FF26FF26FF25FF24FF23
FF22FF22FF1FFF1EFF1CFF1BFF1AFF18FF16FF14FF
13FF12FF12FF10FF10FF0FFF0EFF0FFFEFF0FF0EFF
F0FFF10FF10FF10FF10FF11FF11FF12FF12FF11FF12
FF11F11FF10FF10FF10FF0FFF0F
The above ‘6667’ shows the data point numbers of P-curve.
The hexadecimal data rows after the ‘6667’ shows the measurement data.

3 Conversion method of the measuring data
4 characters of hexadecimal number equals one data.
The data from the above example becomes.
(FF27), (FF26), (FF27), (FF26) .... .
One data point is contained in one set of parentheses ( ).
The conversion method to the decimal number is as follows.

Hexadecimal number
“H1-H2-H3-H4”

Decimal number
Positive : In case of 0000 - 7FFF,
$H1 \times 16^3 + H2 \times 16^2 + H3 \times 16 + H4$

Negative : In case of FFFF - 8000,
$(H1 \times 16^3 + H2 \times 16^2 + H3 \times 16 + H4) - 2^{16}$

Example : In case of the hexadecimal number (0154), it becomes (340) in the decimal number. And in case of the hexadecimal number (F956), it becomes (-1706) in the decimal number.

* The range of the measuring data in the decimal number becomes –2048 - 2047. By being multiplied by the “One bit weight” which is different depending on the measuring range, the measuring range will be converted to the “μm” unit. (Refer to the figure of below.)

1 bit weight	Measuring range
0.08 μm	160 μm
0.04 μm	80 μm
0.02 μm	40 μm
0.01 μm	20 μm

For example measuring range is 160 μm, and 340 for the decimal number, the measuring data become as follows.
(Measuring data) = 340 × 0.08 = 27.2 μm

By repeating the above conversion to all of the measuring points, the data point row of the hexadecimal number can be converted to the data row of the μm unit.

13-1 Roughness analysis terminology and definition

Profile :
This is a general term of total profile, primary profile, roughness profile and waviness profile.
(JIS B0651-2001, ISO 3274-1996)

Sampling Length (L) :
This is the length in the direction of traverse used for identifying the irregularities characterizing the profile under evaluation.
In a roughness profile, the sampling length is the same value as the cutoff value λc in principle.
In a profile curve, the sampling length is equal to the evaluation length.

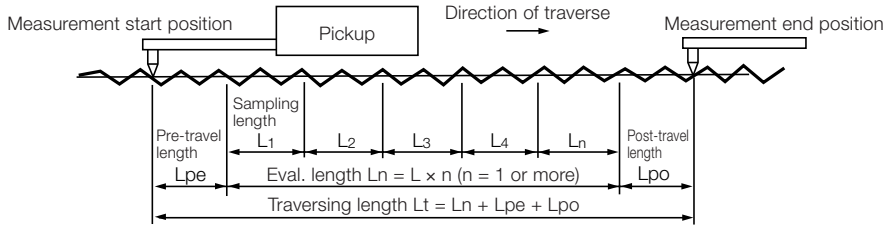
Evaluation Length (Ln) :
This is the length in the direction of traverse which includes one or more sampling length. (JIS B0601-2001, ISO 4287-1997)
The standard value of the evaluation length is five times of the sampling length for making calculation of the roughness curve. (JIS B0633-2001, ISO 4288-1996)
In calculation of a profile parameter, make it equal to the length of a shape to be measured.

Measuring Length (Lm) :
This is a evaluation length in order to calculate Ra (JIS B0601-1982), Ra75 (JIS B0601-1994 Annex).
The standard value is three times of the cutoff value.

Pre-travel :
This is the measuring length in front of the evaluation length.
Longer length is required to be set for the pre-travel in longer waviness component.
For setting with the phase correction filter, the cutoff value is λc/3.
For setting with the 2RC filter, it is set to two times of the value of the phase correction filter.

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 correction filter.
For setting with the phase correction filter, the cutoff value is λc/3.
For setting with the 2RC filter, it is set to zero because it is not necessary.

Traversing Length (Lt) :
This is the total length of including the pre-travel, evaluation length and post-travel which is the pickup traversing length for measurement of roughness.
Take note not to confuse the traversing length with the measuring length defined in the above JIS82.



Relation between Traversing Length, Evaluation Length and Sampling Length

Horizontal Magnification in Recording Chart (Vh) :
The enlargement magnification of recording chart to the displacement in traversing direction of the pickup.

Vertical Magnification in Recording Chart (Vv) :
The 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 to the pickup traversing direction.

Profile Peak :
An outwardly directed (from material to surrounding medium) portion of the assessed profile connecting two adjacent points of the intersection of the profile with the mean line. (JIS B0601-2001, ISO 4287-1997)

Profile Valley :
An inwardly directed (from surrounding medium to material) portion of the assessed profile connecting two adjacent points of the intersection of the assessed profile with the mean line. (JIS B0601-2001, ISO 4287-1997)

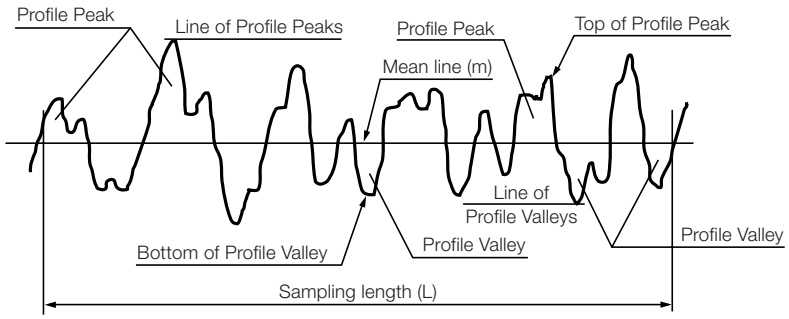
Top of Profile Peak :
A point of the highest altitude in the profile peak of roughness profile. (JIS B0601-1994)

Bottom of Profile Valley :
A point of the lowest altitude in the profile valley of roughness profile. (JIS B0601-1994)

Line of Profile Peaks :
Of the reference length sampled from the roughness profile, the line parallel to the mean line passing through the highest top of profile peak. (JIS B0601-1994, ISO4287/1)

Line of Profile Valleys :
Of the reference length sampled from the roughness profile, the line parallel to the mean line passing through the lowest bottom of profile valley. (JIS B0601-1994, ISO4287/1)

Profile section Level (c) :
A vertical distance between the top of profile peak line and the line parallel to the top of profile peak line intersecting the roughness profile. (JIS B0601-1994)



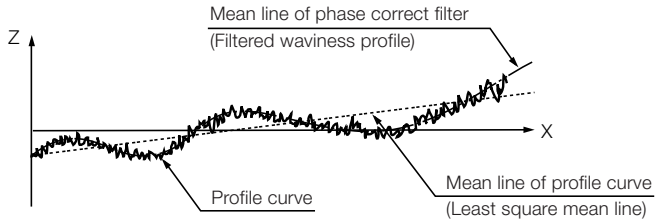
The name of roughness profile (Top of profile peak, Bottom of profile valley, etc)

13-2 Sample curves

Total profile :
Digital form of the traced profile relative to the reference profile, with the vertical and horizontal coordinates assigned to each other. (JIS B0651-2001, ISO 3274-1996)

Primary Profile (P) :
Total profile after application of the short wave length filter, λs. The primary profile is the basis for evaluation of the primary profile parameters. (JIS B0651-2001, ISO 3274-1996)
This instrument records profile curves which are made tilt correction.
In the figure of below, the Z-axis direction and X-axis direction are called as vertical direction and horizontal direction respectively.

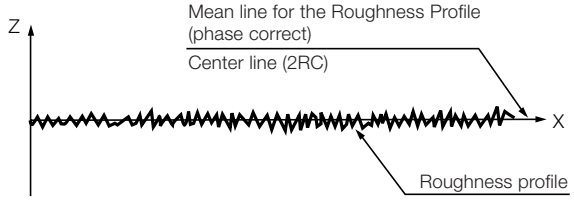
Mean line for the Primary Profile :
This is a line that is determined by fitting a least-squares line of nominal form through the primary profile. (JIS B0601-2001, ISO 4287-1997)
This is normally a straight line because the measurement is made on a plane surface, but there is a case that the mean line 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 which makes the “Straight line correction” to the profile curve. (Refer to Tilt-correction / reference line)



Roughness Profile (R) :
This is a profile that is delivered from the primary profile by suppressing the longwave component the profile filter λc. The roughness profile is the basis for evaluation of the roughness profile parameters. (JIS B0601-2001, ISO 4287-1997)

Mean line for the Roughness Profile :
This is a line that is corresponding to the longwave profile component suppressed by the profile filter λc. (JIS B0601-2001, ISO 4287-1997)
The roughness profile is the one which removes the filtered waviness curve from the profile curve, and the mean line at this time becomes a straight line to become Z = 0 of the roughness profile.

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.



Note : The difference between choosing a mean line or a center line comes from the type of filter in its standard, but both contents are the same.

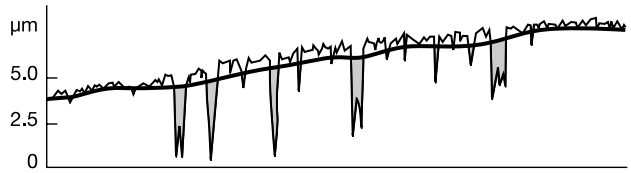
Traced Profile :
Locus of the centre of a stylus tip which features an ideal geometrical form (conical with spherical tip) and nominal dimensions with nominal tracing force, as it traverses the surface within the intersection plane.
(JIS B0651-2001, ISO 3274-1996)

Reference Profile :
Trace on which the probe is moved within the intersection plane along the guide. (JIS B0651-2001, ISO 3274-1996)

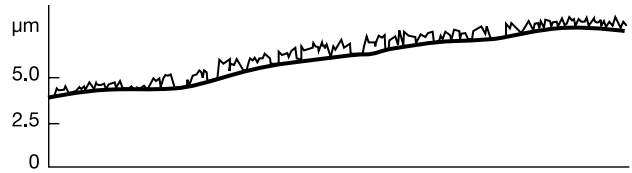
λc Profile Filter :
This is a filter which defines the intersection between the roughness and waveness components.
(JIS B0601-2001, ISO 4287-1997)

ISO13565 (DIN4776) Special Roughness Curve
On the basis of ISO 13565-1-1996 standard (and DIN 4776-1990), it is calculated in the order of below.

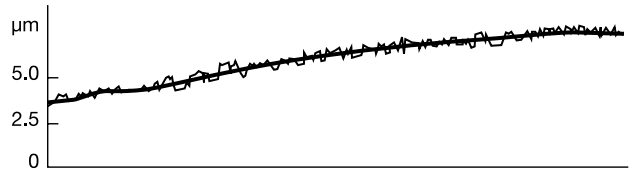
Step ① Obtain a phase compensation filtered waviness curve (Mean line) Wg from the profile curve P by using Gaussian phase correct filter.



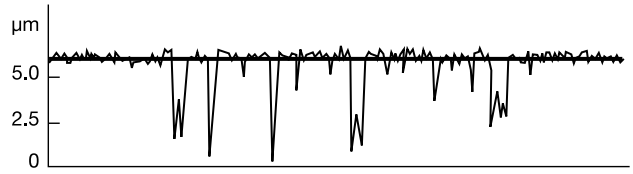
Step ② Connect the profile curve, P with the higher waviness positions of the phase correct filtered waviness curve, Wg obtained in Step ①, and create a curve in which valleys are removed.



Step ③ Apply the curve obtained by Step ② to the phase correct filter in Step ① to obtain a reference mean curve, Wg_2.



Step ④ Subtract the reference mean curve, Wg_2 in Step ③ from the profile curve and obtain the special roughness curve, Rg_2.



13-3 Cutoff value

What is CUTTOFF? :
Cutoff is to separate Profile Pattern into Roughness and Waviness and sample out only the necessary component. Reference wavelength that divides the pattern into “Roughness” and “Waviness” components is called as “Cutoff value λc”. In order to make the cutoff, a Filter is employed.

2RC Filter :
This is the filter defined in JIS B0601-1982, JIS B0601-1987, ANSI B46.1-1985 and ISO 3274-1976.
A two-RC filter consists of two R-C circuits with an equal time constant in series connection, and it provides with amplitude transmission characteristics as follows.

$$\frac{a_2}{a_0} = \frac{1}{1 + \frac{\lambda^2}{3 \times (\lambda c_{75})^2}}$$

a_2 : Amplitude after cutoff of applicable wavelength factor.
a_0 : Original amplitude of applicable wavelength factor.
λ : Applicable wavelength (mm)
λc_{75} : Cutoff value (mm)

The transmission ratio at $\lambda = \lambda c_{75}$ is $a_2 / a_0 = 75$ %.

(Gaussian) phase correct filter :
This will be adopted hereafter as an international standard of a filter which is pursuant to JIS B0632-2001, JIS B0601-1994, DIN 4777-1990 and ISO 11562-1996, and the amplitude transmission characteristic is shown as follows.

$$\frac{a_2}{a_0} = 1 - e^{-\pi (\frac{\alpha \times \lambda c}{\lambda})^2}$$

a_2 : Amplitude after cutoff of applicable wavelength factor.
a_0 : Original amplitude of applicable wavelength factor.
λ : Applicable wavelength (mm)
λc : Cutoff value (mm)
α : 0.4697

The transmission ratio at $\lambda = \lambda c$ is $a_2 / a_0 = 50$ %. (“Waviness” is removed.)

Short wavelength filter (λs filter) :
This is defined in JIS B0651-2001 / ISO 3274-1996 and this is used in order to remove the influence of microwave area error caused by the stylus tip radius. (Gaussian distribution characteristic) phase compensation filter is used as a filter. This filter is mounted in this instrument and the cutoff value λs is varies by the λc value of being set, which becomes as shown below. (Precise “Roughness” is removed.)

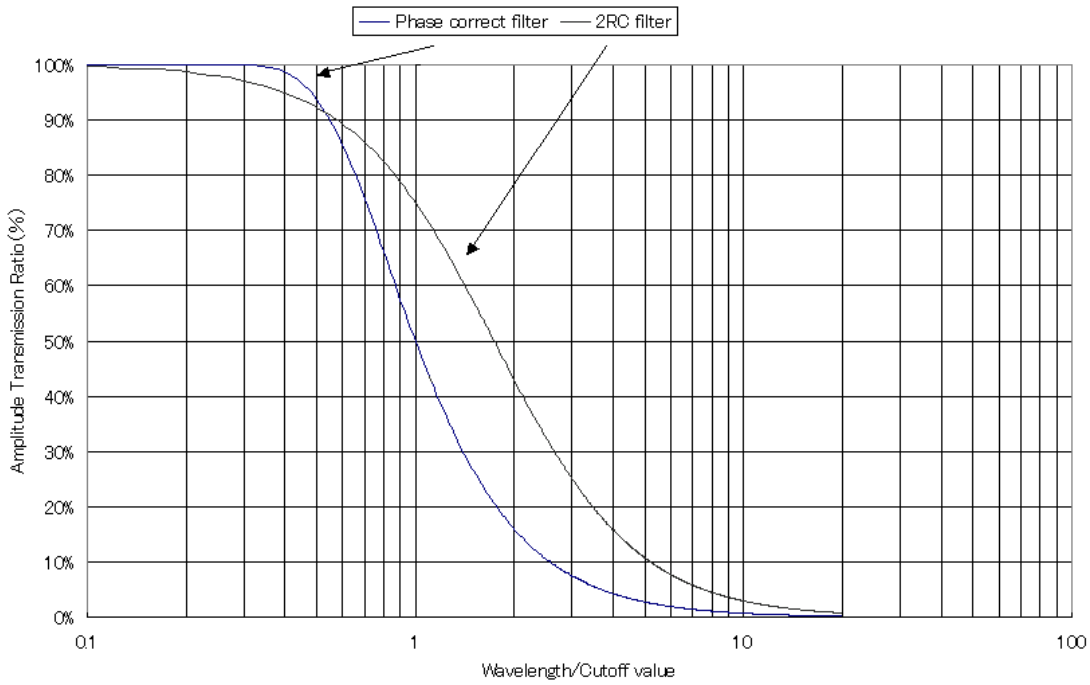
λc (mm)	0.08	0.25	0.8	2.5
λs (μm)	2.5	2.5	2.5	8

The amplitude transmission characteristics of λs filter is shown as follows.

$$\frac{a_1}{a_0} = e^{-\pi (\frac{\alpha \times \lambda s}{\lambda})^2}$$

a_1 : Amplitude after cutoff of applicable wavelength factor.
a_0 : Original amplitude of applicable wavelength factor.
λ : Applicable wavelength (μm)
λs : Short wavelength cutoff value (μm)
α : 0.4697

Transmission characteristics of roughness curve with Gaussian phase correct filter and 2RC filter

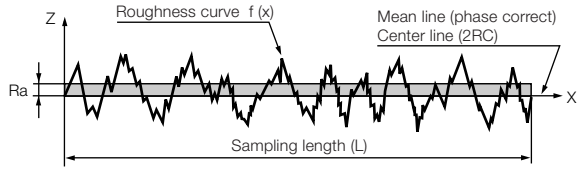


13-4 Parameters for amplitude

Arithmetic mean deviation of profile (Ra) :
This is the value obtained by the following formula when the sampling length (or evaluation length in JIS '82), L from the roughness curve, taking X-axis in the direction of the mean line and Z-axis in the direction of the longitudinal magnification of this sampled curve is expressed by Z = f (x). After having calculated the value in each reference length, the average value in the whole evaluation length is output. (In JIS '82, the value which has been calculated in the whole evaluation length is output.)

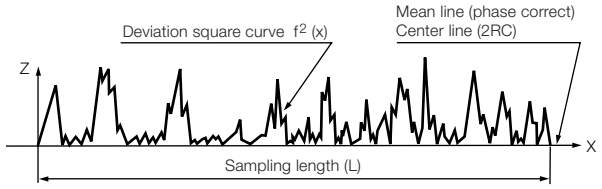
$$Ra = \frac{1}{L}\int_0^L \left| f(x) \right| dx$$

Namely, in the figure below, the arithmetic average represents the average deflection obtained by dividing the area of the portion surrounded by the roughness curve and the mean line by the measuring sampling length.



Root mean square deviation of profile (Rq) :
This is the value obtained by the following formula when the sampling length (or evaluation length in JIS '82), L from the roughness curve, taking X-axis in the direction of the mean line and Z-axis in the direction of the longitudinal magnification of this sampled curve is expressed by Z = f (x). After having calculated the value in each reference length, the average value in the whole evaluation length is output. (In JIS '82, the value which has been calculated in the whole evaluation length is output.)

$$Rq = \sqrt{\frac{1}{L}\int_0^L f^2(x)\, dx}$$

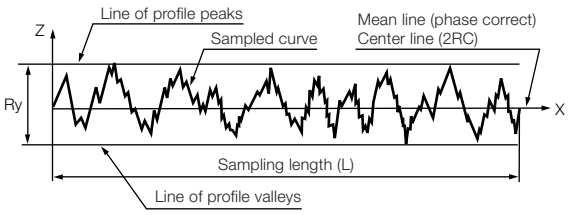


Namely, in the above figure, the root-mean-square represents the root mean square average deflection obtained by dividing the area of the portion between the curve, which is obtained by squaring the distance between the roughness curve and the center-line, and the center-line by the traversing length.
This is equivalent to standard deviation σ in statistics.

Maximum Height (Ry, Rmax, Rt, Rz, Rzmax, Pt) :
This is the distance between the line of profile peaks and the line of profile valleys measured in the vertical magnification direction within the portion extracted from the sampled curve Z = f (x) as the sampling (or evaluation) length, L. This is called with different symbols depending on the calculation standard and sampled curve. In case of the profile curve for the sampled curve, the value calculated by the whole evaluation length is output. However in case of the roughness curve, there are the following three types of output.
No.2 : The value calculated by the whole evaluation length is output.
No.3 : After being calculated in each sampled length, the average value in the whole evaluation length is output.
No.4 : After being calculated in each sampled length, the maximum value in the whole evaluation length is output.

No.	Sampled curve	JIS '82	JIS '94	ISO '97 / JIS '01 / DIN	CNOMO	ASME '95
1	Profile curve	Rmax	—	Pt	—	—
2	Roughness curve	Rt	Rt	Rt	—	Rt
3	Roughness curve	—	Ry	Rz	Rz	Rz
4	Roughness curve	—	—	Rzmax	Rmax	Rmax

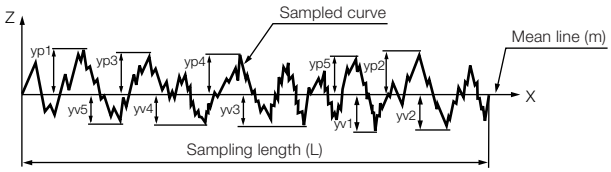
$$Ry = \max\left(f(x) \right) - \min\left(f(x) \right)$$



Ten point Height of Irregularities (Rz) :
This is the sum of the average value of absolute values of the height of five highest profile peaks (yp) and the average value of absolute valves of the depths of five deepest profile valleys (yv) which are measured in the vertical magnification direction from the mean line of the sampled portion by being extracted the sampled length (or evaluation length in JIS '82), L from the sampling curve.

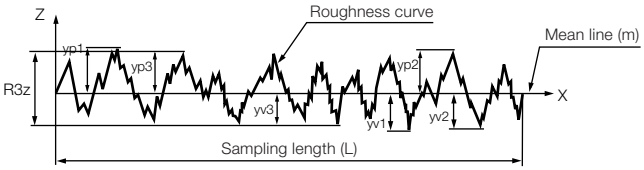
Sampled curve	JIS '82	JIS '94
Profile Curve	Rz	—
Roughness curve	—	Rz

$$Rz = \frac{1}{5}\left(\sum_{i=1}^{5}|ypi| + \sum_{i=1}^{5}|yvi|\right)$$



Base Roughness Depth (R3z) :
Extract the evaluation length which consists of n's continuous sampling lengths (same as the length of cutoff value) from the roughness curve. Then the height between the 3rd highest peak and the 3rd lowest peak in each of the divided sampling lengths is read out. The average value in the evaluation length is defined as base roughness depth / Averaged middle peak-to-valley height.
This parameter is a private standard. (Daimler-Benz-Specification N31007-1983)

$$R3z = \frac{1}{n}\sum_{i=1}^{n} R3zi$$



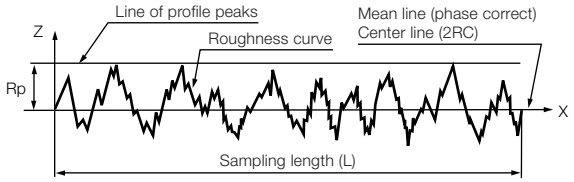
The figure above shows one sampling length. In the evaluation length, there are "n" set of the sampling length and their average value is calculated.

Maximum Profile Peak Height (Rp, Rpm) :
Extract the sampling length (or evaluation length in JIS '82), L from the roughness curve Z = f (x) and measure the distance between the line of profile peaks within the length of L and the mean line to the direction of vertical magnification. This is defined as the maximum profile peak height.
This is called with different symbols depending on the calculation standard.

No.	JIS '82	JIS '94	ISO '97 / JIS '01 / DIN	CNOMO	ASME '95
1	Rp	Rp	Rp	—	Rpm
2	—	—	—	—	Rp

No.1 : After being calculated in each sampled length, the average value calculated by the whole evaluation length is output. (In JIS '82, the value which has been calculated in the whole evaluation length is output.)
No.2 : After being calculated in each sampled length, the maximum value in the whole evaluation length is output.

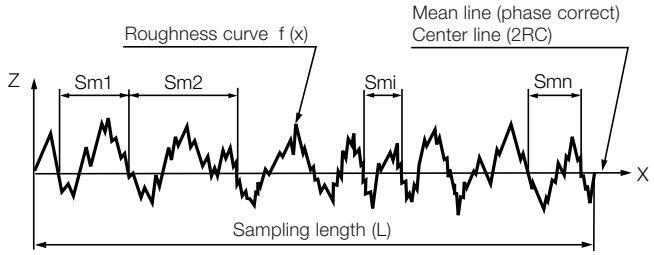
$$Rp = \max\left(f(x)\right)$$



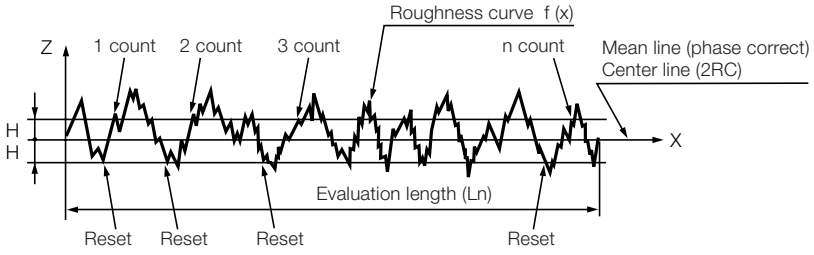
13-5 Parameters for wavelength

Mean width of the profile elements (Sm, RSm) :
Extract the sampling length, L from the roughness curve. When the sum of the length of the mean line corresponding to one of the profile peaks and its adjacent one profile valley (spacing of profile irregularities) is calculated, the mean spacing of profile / Average spacing of roughness peaks is the arithmetical mean value of many spacing of those irregularities.
When the spacing of irregularities between the point which goes across the mean line in the direction from one profile peak to one profile valley and the point of crossing in direction from the next one profile peak to one profile valley is made to Smi and the total numbers of the intervals are made to N, it can be obtained by the following formula.
After being calculated in each sampled length, the average value calculated by the whole evaluation length is output. It is called by different names depending on the calculation standard. In JIS, this is shown as Sm, and in the other standards it is shown as RSm.

$$Sm = \frac{1}{N} \sum_{i=1}^{N} Smi$$



Peak count (Pc) :
A specified reference level, H (Peak count level) is set in both negative and positive directions from the mean line of the roughness profile. Every time the positive reference height is exceeded after the negative reference level is exceeded, the number is counted. A count value when the number is counted to the end of evaluation length, Ln is called as the peak counts.



13-6 Parameters for bearing area curve

Profile Bearing Length Ratio (tp), Material Ratio of the Profile (Rmr) :
A sampling length (or evaluation length), L is extracted from the sampling curve, and the length of the surface cutting portion which was cut by a straight line of being parallel to the mean line of the reference length and of being located at the cutting level C from the maximum highest peak is expressed in percentage toward the whole length L. This is called by different sampled curves and symbols depending on the calculation standard.

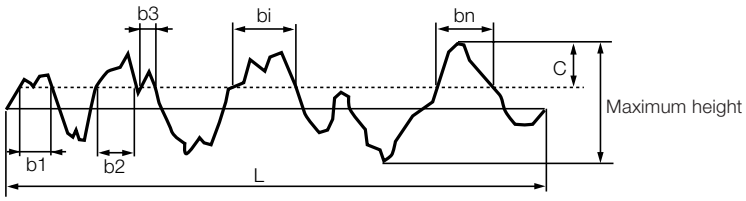
Calculation standard	Sampled curve	Calculation reference	Symbol
JIS '82	Profile Curve	Evaluation length	tp
JIS '94	Roughness curve	Sampling length	tp
ISO '97 / JIS '01 / DIN	ISO13565 Special roughness curve	Evaluation length	Rmr
CNOMO	Waviness motif upper envelope	Evaluation length	Rmr
ASME '95	ISO13565 Special roughness curve	Evaluation length	Rmr

$$tp\,(C) = \frac{100}{L} \sum_{i=1}^{n} bi\ \%$$

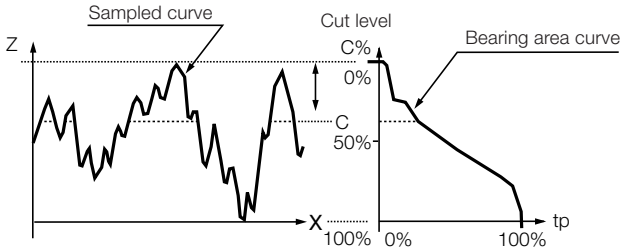
The cut level, C can be selected from the following two methods.

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 %.
In JIS '94 mode, each tpi is obtained at the cut level being set as 100 % for the maximum height to the each reference length L of the quantity of "n", and it is calculated as the average value of the quantity of "n".

2 μm method : This is shown as the depth in μm (μ") unit from the highest peak.
In JIS '94 mode, each tpi is obtained at the cut level C of the depth being set by the unit of μm (μ") as a zero point for the highest point to each reference length L of the quantity of "n", and it is calculated as the average value of the quantity of "n".



Bearing Area Curve (BAC) / Abbott-Firestone Curve / Material Ratio Curve (MRC) / Curve of the Profile Bearing Length Ratio (BC) :
This is the graphic representation in the relationship between every cut level C (% and μm, μ") in the sampled curve and the bearing length ratio tp (%) in the cut level.
This is equivalent to 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.



ISO13565 (DIN4776) Special Roughness Curve Parameters (Mr1, Mr2, Rpk, Rvk, Rk, V0, K) :
These are standards to evaluate lubrication characteristics of the bearing area curve by dividing into an initial abrasion portion, material contact portion and oil reservoir portions. (ISO13565-2, DIN 4776-1990)
This is mainly for plateau honing processing surfaces. The parameters below will be calculated with bearing area curve.

1 Material Portion 1 : Mr1
Take the width of 40 % in the direction of tp value on a bearing area curve, and find out the position where the slope of a least square straight line calculated from the data becomes the minimum. And then obtain the intersection “a” between the equivalent straight line and the limit line of tp = 100 %.
Set the intersection point between the horizontal line ‘ac’ from the point ‘a’ and the bearing area curve as ‘c’, and set the tp value at this time as Mr1. This represents bearing length ratio after initial abrasion.

2 Material Portion 2 : Mr2
Take the width of 40 % in the direction of tp value on a bearing area curve, and find out the position where the slope of a least square straight line calculated from the data becomes the minimum. And then obtain the intersection “b” between the equivalent straight line and the limit line of tp = 100 %.
Set the intersection point between the horizontal line ‘bd’ from the point ‘b’ and the bearing area curve as ‘d’, and set the tp value at this time as Mr2. This represents bearing length ratio after initial abrasion.

3 Reduced Peak Height : Rpk <Rpke : CNOMO>
Rpk is the height on the limit line of tp = 0 % which composes a right triangle with the side ‘ac’, and the area of this right triangle is equal to that of the portion surrounded by the lines of tp = 0 % limit line, the side ‘ac’ and the bearing area curve. This represents the abrasion height of the initial wear.

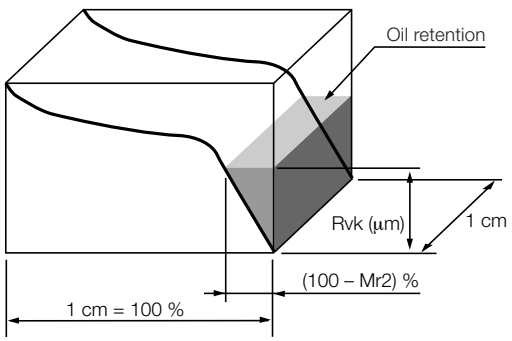
4 Reduced Valley Depth : Rvk <Rvke : CNOMO>
Rvk is the height on the limit line of tp = 100 % which composes a right triangle with the side ‘bd’, and the area of this right triangle is equal to that of the portion surrounded by the lines of tp = 100 % limit line, the side ‘bd’ and the bearing area curve. This represents the valley depth of the oil deposit.

5 Core Roughness Depth : Rk <Rke : CNOMO>
Rk is the difference of the heights between ‘c’ and ‘d’ obtained in the above.
This represents the height of abrasion whose plane will be worn away by the long term abrasion.

6 Oil Retention Volume : V0
This represents volume of oil which is deposited in the oil deposit valley per 1 cm^2.

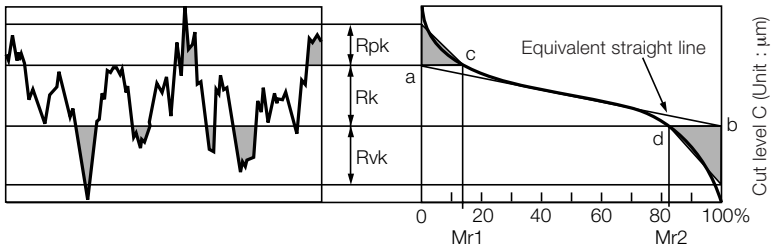
$$Vo = \frac{(100\text{-}Mr2) \times Rvk}{2000} \quad (mm^3/cm^2)$$

However, the unit (mm^3/cm^2) is not displayed due to the limited display space.
Please pay attention to this. Because it is of irregular expression.
Here, in the formula, Mr2 is expressed in %, while Rvk is in μm.
For these parameters, only those of mm unit notation are applicable, but those of inch are not displayed.



7 Reduced Valley Depth Ratio : K
This represents the ratio of oil deposit valley depth to the effective bearing area roughness, and the larger the value is the better the lubricating characteristic is.

$$K = Rvk / Rk \quad \text{(Non-dimensional number)}$$



Sampling curve on the objective surface

Bearing length ratio Mr (Unit : %)

However when it is calculated under CNOMO standard, the name of parameter will be changed because the sampled curve will be changed to waviness motif upper envelope. (ISO 12085-1996)

13-7 Parameters for motif

What is the motif calculation?

The motif calculation is prescribed in JIS B0631-2000 / ISO12085-1996. The motif calculation is the measurement method that is originally defined in the French automobile industry. This method is the individual investigation to distinguish the roughness from waviness, and by using the calculation method, it can evade a difference between the visual evaluation that is caused by a deformation of the waving form that have occurred frequently in the usual filter method.

Motifs upper limit length

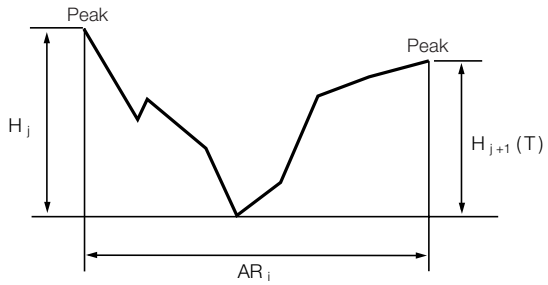
Although it was mentioned that filter processing is not done in the previous chapter, the equivalent process is needed to be performed to separate the roughness from waviness. The details will be mentioned later in this chapter, for the process, the indication value that is equivalent to the cutoff value in the filter processing is needed. The indication values are called as “Roughness motifs upper limit length (the operator A)” and “Waviness motifs upper limit length (the operator B)”. The former shows the fineness of the transverse directional texture (measurement direction) on the roughness motif calculation, and the latter shows the fineness of the transverse directional texture (measurement direction) on the waviness motif calculation.
The following is the combined setting value of the motifs upper limit length that are recommended by the ISO standard.

Roughness motifs Upper limit length (A) mm	Waviness motifs Upper limit length (B) mm
0.02	0.1
0.1	0.5
0.5	2.5
2.5	12.5

Note : As a rule set the evaluation length to become more than 2 times of the waviness motif upper limit length. (There is a possibility that the waviness motifs parameter cannot be calculated when it is less than twice.)
Note : Be sure to set the value of the waviness motif upper limit length which is larger than the value of the roughness motif upper limit length.

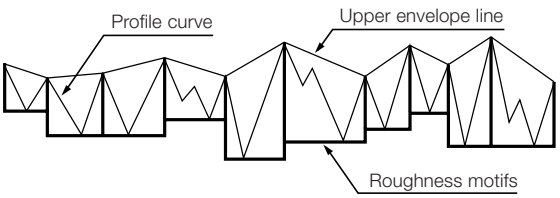
What is the motif?

A portion of the primary profile between the highest points of two local peaks of the profile.
The following marks are used to show the characters.
Depth : H_j and H_{j+1} (Roughness), W_j and W_{j+1} (Waviness)
Length (Width) : AR_i (Roughness), AW_i (Waviness)
Either of the peaks that is smaller in the depth : T



How to calculate the motifs

1 Roughness motifs and Upper envelope line



Roughness motifs : It is constituted by the consecutive roughness motifs.
Upper envelope line : The peaks of the roughness motifs are connected by a straight line.

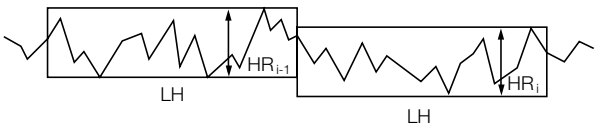
2 How to find the Roughness motifs

a Separate the evaluation length at intervals of the setting length (LH = Roughness motifs upper limit length/2).
(Regard the number of the division as n.)
Discard the fractions.

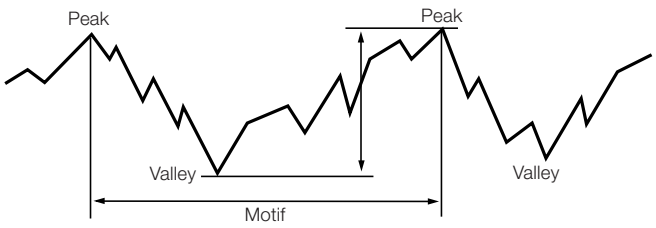
b Find the difference between the maximum value and the minimum value (HR_i) at the every setting length.

c Find the peaks height conditions (H_{min}). (It is 5 % of the average value of HR_i.)

$$H_{min} = 0.05 \cdot \frac{1}{n} \cdot \sum_{i=1}^{n} HR_i$$



d Find the peaks and valleys.
Peaks have the valleys that have the difference more than H_{min} on both sides.

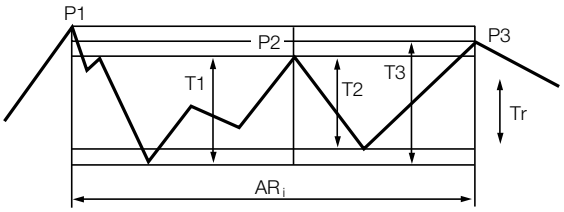


e Find the depth of the motifs.
The depth of the motifs is the difference of the height between the lower peaks on both sides and the valley.

f Constitute the Segment. (In the whole evaluation range.)
When there is the peak that is higher than the front peak, that is the first peak, in the range of the distance within LR from the front peak, the peak becomes the end peak and it makes the one segment from the front to the end motifs. When there is no higher peak in the range, regard the highest peak as the end peak and make the one segment as well. After this, find the end peak repeatedly by regarding the end peaks as the front peaks.
By the above way, constitute the segments with the succession of the made up motifs.

g Combine the motifs. (In each segment.)
The motifs are combined if they satisfy the conditions of (1) to (2) stated below in each segment.
To combine means that to make the two adjacent motifs 1 motif.

- Start from the first motif, operate for the i th motif and i th + 1st motif. When it is combined, do the same for the i + 2nd one and the i + 3rd one next, if it is not combined, operate for the i + 1st one and the i + 2nd one.
- When the last combination is finished and if any combination was made, do the combining operation again from the beginning, and repeat it until there are no motifs to be combined.



(1) Envelope condition
The height of the P2 that is the peak in the center must be less than either of the P1 or P3.

$$P2 \leqq P1 \quad or \quad P2 \leqq P3$$

(2) Enlargement condition
T3 that is the motif depth after the combination must be deeper the T1 and T2 that are the motif depth on both sides.

$$T3 \leqq T1 \quad or \quad T3 \leqq T2$$

(3) Depth condition
Either depth of the motifs in both sides must be less than Tr that is 60 % of T3 that is the motif depth when it assumes that the motif group is 1 motif.

$$T1 \leqq Tr \quad or \quad T2 \leqq Tr$$

(4) Length condition
AR_i that is the motif width after the combination must be less than the motifs upper limit length LR.

$$AR_i \leqq LR$$

h Combine the motifs. (In the whole evaluation length)
When the above conditions (1) - (4) are satisfied in the whole evaluation length, combine them.
In this case, T3 of the depth condition of above (3) becomes the depth of the motif when a pair of motif under being about to be combined is regarded as having been combined.

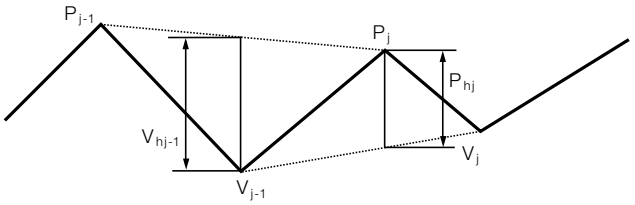
i Correct the height of the singular peaks and valleys.
Correct the independent peaks and valleys not to exert a bad influence on the upper envelope line.

(1) Preparation
Find the depth H_j, average of the whole $\overline{H_j}$ and the standard deviation σ_{Hj}.

$$\overline{H_j} = \frac{1}{n} \cdot \sum_{j=1}^{n} H_j \qquad \sigma_{Hj} = \sqrt{\frac{1}{n} \cdot \sum_{j=1}^{n} (H_j - \overline{H_j})^2}$$

And, find the reference height H_s.

$$H_s = \overline{H_j} + 1.65 \bullet \sigma_{Hj}$$



(2) Correct the peaks
Correct the P_{hj} value with comparing the H_s with P_{hj} and move the peak point of P_j to become $P_{hj} = H_s$ when $H_s < P_{hj}$.
P_{hj} : The height between P_j and the point of intersection of the perpendicular line from P_j and the line that connect V_{j-1} with V_j.

(3) Correct the valleys (Correct it after the correction of peaks.)
Correct the V_{hj-1} value with comparing the H_s with V_{hj-1} and move the valley point of V_{j-1} to become $V_{hj-1} = H_s$ when $H_s < V_{hj-1}$.
V_{hj-1} : The height between V_{j-1} and the point of intersection of the perpendicular line from V_{j-1} and the line that connect P_{j-1} with P_j.

j The preparation of roughness motifs are completed by the above, now calculate the parameter of roughness motifs next.

<Roughness motifs parameter>

R (Mean depth of roughness motifs) : Arithmetical mean value of the all roughness motifs depth within the evaluation length.

$$R = \frac{1}{m} \bullet \sum_{j=1}^{m} H_j$$

Rx (Maximum depth of profile irregularity) : Maximum value of the all roughness motifs depth within the evaluation length. (For all of H_j)

$$Rx = MAX\,(H_j)$$

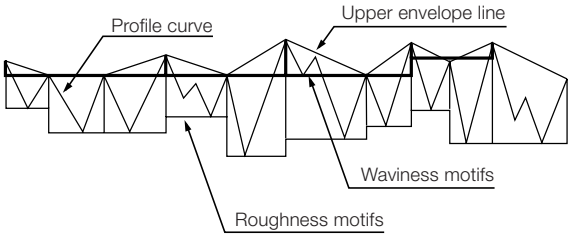
AR (Mean spacing of roughness motifs) : Arithmetical mean value of the all roughness motifs width within the evaluation length.

$$AR = \frac{1}{n} \bullet \sum_{i=1}^{n} AR_i$$

* m = 2n

Note : Rx should be calculated before correction of the height.
The others should be calculated after correction of the height. R and AR are calculated when 3 or more motifs exist.

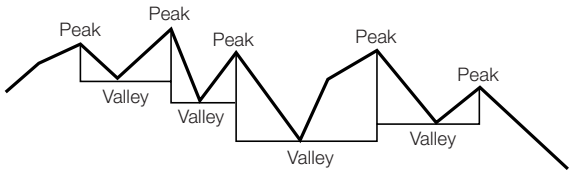
3 Waviness motifs curve



Waviness motifs : It is constituted by the consecutive waviness motifs.

4 How to find the Waviness motifs

a Find the peaks and valleys of the waviness motifs.
The data sequence that the peak 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 by the below method.
Find the point that the next point is lower than itself and make it the peak, and find the point that the next point is higher than itself and make it the valley.



b Combine the waviness motifs.
The method conforms to the case of the roughness motifs, only LR is replaced with LW (Waviness motifs upper limit length).

c The preparation of waviness motifs are completed by the above, now calculate the parameter of waviness motifs next.

<Waviness motifs parameter>

W (Mean depth of waviness motifs) : Arithmetical mean value of the all waviness motifs depth within the evaluation length.

$$W = \frac{1}{m} \cdot \sum_{j=1}^{m} W_j$$

Wx (Maximum depth of waviness) : Maximum value of the all waviness motifs depth within the evaluation length. (For all of W_j)

$$Wx = MAX\ (W_j)$$

AW (Mean spacing of waviness motifs) : Arithmetical mean value of the all waviness motifs width within the evaluation length.

$$AW = \frac{1}{n} \cdot \sum_{i=1}^{n} AW_i$$

Wte (Total depth of waviness) : P - P value of the upper envelope line.

* m = 2n

Note : W and AW are calculated when 3 or more motifs exist.

13-8 Selection & evaluation method of cutoff value / Sampling length

Select the suitable cutoff value and reference length according to the specified roughness value size on the drawing after confirming the standard.

Pursuant to JIS82 (JIS B0601-1982 and JIS B0601-1994 Annex)

1 Cutoff Value and Measuring Length for Ra (Ra75)

2RC roughness curve is used for the sampling length.

Cutoff Value λc_{75} (mm)	Measuring Traverse Length Lm (mm)	Range of Ra (μm)
0.08	0.24 or more	—
0.25	0.75 or more	—
0.8	2.4 or more	12.5 or less
2.5	7.5 or more	12.5 - 100
8	24 or more	—

2 Sampling Length for Rmax, Rz

Profile curve is used for the sampling length.

Sampling Length L (mm)	Range of Rmax/Rz (μm)
0.08	—
0.25	0.8 or less
0.8	0.8 - 6.3
2.5	6.3 - 25
8	25 - 100
25	100 - 400

3 Evaluation Method of Measured Value

Excepting the part of a scratch, calculate the arithmetic mean value of the parameter in each part which was sampled at random from the workpiece surface (the objective surface). And make judgment whether or not the value is within the specified tolerance (or upper and lower limit values in case of being specified two positions).

Pursuant to JIS94 (JIS B0601-1994)

The Gaussian distribution characteristic phase correct roughness profile is used for the sampling curve.

1 Cutoff Value, Sampling Length and Evaluation Length for Ra, Ry, Rz

Cutoff Value λc (mm)	Sampling Length L (mm)	Evaluation Length Ln (mm)	Range of Ra (μm)		Range of Ry/Rz (μm)	
			Over	Under	Over	Under
0.08	0.08	0.4	(0.006)	0.02	0.025	0.1
0.25	0.25	1.25	0.02	0.1	0.1	0.5
0.8	0.8	4	0.1	2	0.5	10
2.5	2.5	12.5	2	10	10	50
8	8	40	10	80	50	200

2 Cutoff Value, Sampling Length and Evaluation Length for Sm and S

Cutoff Value λc (mm)	Sampling Length L (mm)	Evaluation Length Ln (mm)	Range of Sm/S (mm)	
			Over	Under
0.08	0.08	0.4	0.013	0.04
0.25	0.25	1.25	0.04	0.13
0.8	0.8	4	0.13	0.4
2.5	2.5	12.5	0.4	1.3
8	8	40	1.3	4.0

3 Evaluation Method of Measured Value

Excepting the part of a scratch, calculate the arithmetic mean value of the parameter in each part which was sampled at random from the workpiece surface (the objective surface).
And make judgment whether or not the value is within the specified tolerance (or upper and lower limit values in case of being specified two positions).

Pursuant to ISO97/JIS01/ASME/DIN (DIN ISO 4288-1996, JIS B0633-2001, DIN ISO 4288-1996 and ASME B46.1-1995)

The Gaussian distribution characteristic phase correct roughness curve is used for the sampling curve. (ISO 4287-1997 and ISO 11562-1996)

1 Cutoff Value, Sampling Length and Evaluation Length for Random Waveform Curve without Periodicity

Cutoff Value λc (mm)	Sampling Length L (mm)	Evaluation Length Ln (mm)	Range of Ra (μm)		Range of Rz (μm)	
			Over	Under	Over	Under
0.08	0.08	0.4	0.006	0.02	0.025	0.1
0.25	0.25	1.25	0.02	0.1	0.1	0.5
0.8	0.8	4	0.1	2	0.5	10
2.5	2.5	12.5	2	10	10	50
8	8	40	10	80	50	200

Note : The range of Ra is effective when the parameters of Ra, Rq, Rsk, Rku and RΔq are measured. (ISO 4288-1996) And the range of Rz is effective when the parameters of Rz, Rv, Rp, Rc and Rt are measured. (ISO 4288-1996)

2 Cutoff Value, Sampling Length and Evaluation Length for Periodic Curve

Cutoff Value λc (mm)	Sampling Length L (mm)	Evaluation Length Ln (mm)	Range of RSm (mm)	
			Over	Under
0.08	0.08	0.4	0.013	0.04
0.25	0.25	1.25	0.04	0.13
0.8	0.8	4	0.13	0.4
2.5	2.5	12.5	0.4	1.3
8	8	40	1.3	4.0

3 Evaluation Method of Measured Value (JIS B0633-2001, ISO 4288-1996)

① Visually check the way of processing, and make judgment of either periodic waveform or random waveform.
② When the tolerance value is specified, measure the parameter after specifing the measurement condition from the table above.
③ When the tolerance value is not specified, select the appropriate measuring condition from the calculated value. And then make the measurement again.
④ After obtaining the measured value, make judgment by the following method whether or not the value is within the specified tolerance on the drawing.

(a) When the upper limit value of the surface roughness parameter is specified, measure the portion where the roughness seems to be the maximum roughness value. And if the part which exceeds the illustrated value takes part of less than 16 % of the all measurement values, or if the value of $\mu + \sigma$ is less than the standard value, it can be accepted. In case of the following result, for example, it can be accepted.

- The first measurement value does not exceed 70 % of the illustrated value.
- The first measurement values for three times does not exceed the illustrated value.
- More than one measurement value out of the first six measurement values does not exceed the illustrated value.
- More than two measurement values out of the first twelve measurment values do not exceed the illustrated value.

(b) When the lower limit value of the surface roughness parameter is specified, measure the portion where the roughness seems to be the minimum roughness value. And if the part which is lower than the illustrated value takes part of less than 16 % of the all measurement values, or if the value of $\mu - \sigma$ is more than the standard value, it can be accepted.

(c) When the maximum value of the surface roughness parameter is specified, that is, the “max” is attached to the parameter mark, it can be passed in case of that all of the measurement values on the entire surface under measurement are less than the illustrated value.

13-9 Parameter list

<Profile curve parameters>

	JIS '82	JIS '94	ISO '97 / DIN / JIS '01	CNOMO	ASME '95
Parameters	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols
Maximum height (JIS82)	Rmax : P	----------	Pt : P	----------	----------
Ten point height of irregularities (JIS82)	Rz : P	----------	----------	----------	----------
Core roughness depth	Rk : P	----------	----------	----------	----------
Reduced peak height	Rpk : P	----------	----------	----------	----------
Reduced valley depth	Rvk : P	----------	----------	----------	----------
Material portion 1	Mr1 : P	----------	----------	----------	----------
Material portion 2	Mr2 : P	----------	----------	----------	----------
Oil retention volume	V0 : P	----------	----------	----------	----------
Reduced valley depth ratio	K : P	----------	----------	----------	----------
Profile bearing length ratio	Tp : P	----------	----------	----------	----------

<Motif parameters>

	JIS '82	JIS '94	ISO '97 / DIN / JIS '01	CNOMO	ASME '95
Parameters	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols
Mean depth of roughness motifs	----------	----------	----------	R : RM	----------
Maximum depth of profile irregularity	----------	----------	----------	Rx : RM	----------
Mean spacing of roughness motifs	----------	----------	----------	AR : RM	----------
Mean depth of waviness motifs	----------	----------	----------	W : WM	----------
Maximum depth of waviness	----------	----------	----------	Wx : WM	----------
Mean spacing of waviness motifs	----------	----------	----------	AW : WM	----------
Total depth of waviness	----------	----------	----------	Wte : WM	----------

<Roughness curve parameters ①>

	JIS '82	JIS '94	ISO '97 / DIN / JIS '01	CNOMO	ASME '95
Parameters	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols
Arithmetical mean deviation of profile	Ra : R	Ra : R	Ra : R	Ra : R	Ra : R
Root mean square deviation of profile	Rq : R	Rq : R	Rq : R	----------	Rq : R
Maximum height	----------	Ry : R	Rz : R	Rz : R	Rz : R
ditto (Maximum in division)	----------	----------	Rzmax : R	Rmax : R	Rmax : R
Maximum profile peak height	Rp : R	Rp : R	Rp : R	----------	Rpm : R
ditto (Maximum in division)	----------	----------	----------	----------	Rp : R
Ten point height of irregularities (ISO)	----------	Rz : R	----------	----------	----------

<Roughness curve parameters ②>

	JIS '82	JIS '94	ISO '97 / DIN / JIS '01	CNOMO	ASME '95
Parameters	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols	Parameter symbols
Total height of profile (ISO)	Rt : R	Rt : R	Rt : R	----------	Rt : R
Base roughness depth	----------	----------	R3z : R	----------	----------
Mean width of the profile elements	----------	Sm : R	RSm : R	----------	RSm : R
Peak count	Pc : R	Pc : R	Pc : R	----------	Pc : R
Core roughness depth	----------	Rk : R	Rk : D	Rke : UE	Rk : D
Reduced peak height	----------	Rpk : R	Rpk : D	Rpke : UE	Rpk : D
Reduced valley depth	----------	Rvk : R	Rvk : D	Rvke : UE	Rvk : D
Material portion 1	----------	Mr1 : R	Mr1 : D	Mr1 : UE	Mr1 : D
Material portion 2	----------	Mr2 : R	Mr2 : D	Mr2 : UE	Mr2 : D
Oil retention volume	----------	V0 : R	V0 : D	V0 : UE	V0 : D
Reduced valley depth ratio	----------	K : R	K : D	K : UE	K : D
Profile bearing length ratio (Sampling length)	----------	Tp : R	----------	----------	----------
Material ratio of the profile (Evaluation length)	----------	----------	Rmr : D	Rmr : UE	Rmr : D

Example
Ra : R Parameter symbols : Sample curve
P Profile curve
R Roughness curve
D ISO13565 (DIN4776) Special roughness curve
RM Roughness motifs
WM Waviness motifs
UE Upper envelope line

Note : Besides the parameters provided in each calculation standard, it can be calculated parameters which are effective for actual measurement with this instrument.
Refer to the manuals of below for details of each calculation standard.

JIS '01 : Japanese industrial standard (JIS B0601)
ISO '97 : International standard (ISO4287)
DIN : German industrial standard (DIN EN ISO 4287)
CNOMO : (JIS B0631, ISO12085, DIN EN ISO 12085)
ASME '95 : American society of mechanical engineers standard / An American national standard (ANSI/ASME B46.1)

14. Error message

Display	Explanation	Measures to cope with
^SET ▼DEC ▲INC CAL-Ra → CHECK	Unable to calibrate in sensitivity calibration. ➔ In case of exceeding the calibration range because of the abnormal measuring data.	The driver unit was not properly placed on the roughness specimen. ➔ Try again to put it properly on the roughness specimen, and calibrate it again.
	Unable to calibrate in sensitivity Calibration. ➔ The stylus is not in the correct position.	Indicate the Z position. Set the measuring range to automatic range. ➔ When the stylus portion is moved apart from the workpiece; Z = –160 - –164 μm (approx.) ➔ When the stylus portion is placed on the flat surface; Z = –20 - +20 μm (approx.) (This value may be slightly shifted depending on the surface condition. In case of out of range, contact our service representative.)
– – MOTIF LIMIT A > = LIMIT B	In the motif setting, the upper limit length of the roughness motif was set longer than that of the waviness motif.	Set the motif upper limit length for roughness motif to become smaller than the upper limit length of the waviness motif. Set this to become as follows; LIMIT A < LIMIT B Press any button, then the message will disappear.
λc = 0.80 L = λc∗5 mm FULL SCALE OVER	The data exceeded full range. (The measurement data become void.)	In case of being set at arbitrary range, set it in the larger range (width). When the range is set to 160 μm, it is unable to be measured. In case of automatic range, it is unable to be measured. Press any button, then the message will disappear.
λc = 0.25 L = λc∗5 mm PRINT ERROR	Paper ran out during print out.	Feed the paper and output the print Again. Press any button, then the message will disappear.
	Printer cable was disconnected.	Replacement of the cable is necessary. Press any button, then the message will disappear.
	The printer was not connected or no power was supplied to the printer, the ON•PRT•▼ button was pressed and output to the printer was started.	Connect the printer. Turn on the power of the printer. By pressing any button, the message will disappear.
	Error occurred in printer.	Release an error by making reference of a manual attached to the printer.
λc = 0.80 L = λc∗5 mm PRINT : NO DATA	In spite of no measuring data, the ON•PRT•▼ button was pressed and output to the printer was started.	Make the print output after measurement. By pressing any button, the message will disappear.
λc = 0.25 L = λc∗5 mm CHECK RS SETTING	While processing digital input and output, the data were failed in sending. ➔ Setting of the PC and this unit were not correct.	Set correctly the PC and this unit. (Refer to “8-5 Serial communication setting” of “8. Setting mode”.) By pressing any button, the message will disappear.
	Disconnection of the cable.	Replacement of the cable is necessary. Press any button, then the message will disappear.
	Failure on the PC side.	Check the PC. Press any button, then the message will disappear.
	An item required for output is not selected.	Select the required item for output. (Refer to “8-3 Print output selection”.)
λc = 0.80 L = λc∗5 mm OUTPUT : NO DATA	In spite of no measuring data, the ON•PRT•▼ button was pressed and data transfer to the PC was started.	Transfer the data after making of the measurement. By pressing any button, the message will disappear.

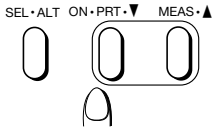
14. Error message

Display	Explanation	Measures to cope with
SYSTEM ERROR	Information being stored in the amplification indication unit could not be read.	Amplification indication unit may be broken down. If the message is repeatedly displayed, bring the system to the service factory.
MODEL CHNG. ^ SET E-35A → E-45A	Model setting being stored in the amplification indication unit was changed.	Confirm the connected drive part. When the connected drive part and the display of the right side are the same in display, determine it pressing SET/ALT button. In the cases other than it, the system may be broken down. If the message is repeatedly displayed in spite of being correctly connected, bring the system to the service factory.
λc = 0.80 L = λc∗5 mm DRIVING UNIT ERR	The setting between the connected drive part and the amplification indication unit is wrong.	Perform the setting while referring to the connected drive part and the following model setting during measuring.

Model setting

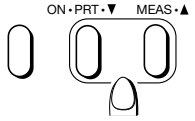
E-35B distinguishes whether or not there is wrong in between the model setting of amplification indication unit and the connected drive part during measuring. If there is wrong, since the following screen is displayed, set the model according to the following procedure.

1 **Press either button.**



λc = 0.80 L = λc∗5 mm
DRIVING UNIT ERR

2 **Since the model screen is displayed, select the model of your using Handy Surf with ON•PRT•▼button or MEAS•▲button.**



^SET ▼DOWN▲ UP
MODEL E-35B

3 **When pressing SEL/ALT button, the model is set, and the error returns to the previous screen before being displayed.**

4 **When returning to the previous screen, perform the same operation once again.**

Note : When the same error screen was displayed again after having set it, since failure of the amplification indication unit and the drive part is considered, after specifying the phenomena, send it back to your purchased store and our company service division attaching the warranty card.

Note : In the E-35A model, since the drive part is not discriminated, when connecting the other model drive part, the drive part may be broken, thus please do not measure connecting it.

15. Trouble and trouble shooting

Should you encounter any problems during the use of this machine, refer to the following recommendations.
If recommended countermeasures do not solve the trouble, contact our service representative.

Symptom	Cause	Countermeasure
The power does not turn on.	The battery is exhausted.	Recharge the battery. The unit can be used while connected to the AC adapter.
	Internal error.	Connect the AC adapter and press The RESET button. Turn the power on again.
The amplification indicator does not indicate an arrow on its display during measurement.	Is the cable connected?	Check the connection of the cable.
The measuring result is too different from the predicted value.	It is not calibrated.	Make calibration.
	Does the measuring unit lean toward the workpiece?	Place the measuring unit in parallel to the workpiece.
	The stylus tip does not come out from the pickup. ➔ Inferior stylus tip.	Contact our service representative for repair.
	Does the pickup work loose?	Reinstall the pickup to the driver unit.
The necessary parameter is not indicated.	Is the Dip switch set to the basic function in the operation function?	Set the operation function to all functions. (Set No.7 of the Dip switch 2 to ON.)
The necessary parameter is not printed.	Is the parameter output set to OFF in the setting mode?	Set the parameter to ON in the setting mode. (Refer to “8-2 Parameter selection” of “8. Setting mode”.)
	Is the parameter of the print output item set to OFF in the setting mode?	Set the parameter of the print output item to ON in the setting mode. (Refer to “8-3 Print out selection” of “8. Setting mode”.)
In spite of the small measuring data, it shows only up to one digit after the decimal point instead of two digits.	Does the range setting become 80 or 160 μm in the arbitrary range? (Refer to “6-5 Setting of measuring range”.)	Set the range to 20 or 40 μm.
	Due to the range over 20 and 40 μm in the automatic range, it was automatically shifted to 80 and 160 μm. ➔ Are the measuring unit and workpiece parallel?	Place the measuring unit and workpiece to become parallel.
	Does the drift of the zero point of the pickup become bigger?	Indicate the Z-axis level and place the measuring unit on the flat surface, then check the zero point. If it exceeds ±20 μm, the zero point is drifted. Contact our service representative. (Due to the surface condition and the placement of the measuring unit, the value will change a lot.)
The LCD screen is OFF after “EMPTY BATTERY” indicated.	The battery is insufficient.	Recharge the battery. Connect the unit to the AC adapter, the unit can be used while connected to the AC adapter.
The contents of setting cannot be changed by making changes to the Dip switch.	The Dip switch is recognized only when the power is turned on. Was the Dip switch setting made while the power was turned on?	Wait until the automatic power off. Then turn on the power again.
Print at printout is disordered.	Setting of a DIP switch is not suitable.	Change setting of the DIP switch. (Refer to “9. DIP switch setting”.)
	Temporary faulty data transmission was occurred.	Turn off a power switch of the printer, then turn on the switch again.
The power does not turn off	Is the Automatic power off setting off?	Set the Automatic power off setting to ON. Refer to “8-6 Automatic power off setting”

16. Major specifications

Model	**E-35A*1**	**E-35B*2**
Piick up	(E-DT-SM10A)	
Transducer	Differential inductance type (Displacement type)	
Stylus tip	Diamond, Cone with its elements making 90 degrees and Its vertex, 5 μmR in radius.	
Stylus force	4 mN (0.4 gf) or less	
Skid	Sapphire (40 mmR in tracing direction)	
Amplification indication unit	**(E-MD-S157A)**	**(E-MD-S180A)**
Parameter	JIS '94; Ra, Ry, Rz, Sm, Rq, Rp, Rt, Pc, tp, Rk, Rpk, Rvk, Mr1, Mr2, V0, K JIS '82; Ra, Rmax, Rz, Rq, Rp, Rt, Pc, tp, Rk, Rpk, Rvk, Mr1, Mr2, V0, K ISO '97 / JIS '01 / DIN; Ra, Rz, Rzmax, RSm, Rq, Rp, Rt, R3z, Pc, Pt, Rmr, Rk, Rpk, Rvk, Mr1, Mr2, V0, K CNOMO; Ra, R, Rx, AR, Rz, Rmax, W, Wx, AW, Wte, Rmr, Rke, Rpke, Rvke, Mr1, Mr2, V0, K ASME '95; Ra, Rmax, Rz, RSm, Rq, Rpm, Rp Rt, Pc, Rmr, Rk, Rpk, Rvk, Mr1, Mr2, V0, K	
Range of measurement	±160 μm	
Cutoff value method	Phase correct filter (JIS '94, ISO '97 / DIN, CNOMO, ASME '95), 2RC (JIS '82)	
Cutoff value (λs)	0.08, 0.25, 0.8, 2.5 mm (0.003, 0.01, 0.03, 0.1 inch)	
Short wave length cutoff value (λs)	It becomes as follows by λc value. λc (mm) 0.08 0.25 0.8 2.5 λs (μm) 2.5 2.5 2.5 8	
Evaluation length	Fixed mode; Cutoff value × 5 Fixed mode; 0.4 – 12.5 mm (0.02 – 0.5 inch) by 0.1 mm (0.01 inch)	
Data save	10 data	
Interface	Compliance with RS-232C 1CH / Output for dedicated printer	
Required power source	Designate either AC 100 V, AC 120 V, AC 220 V, AC 230 V, (iBuilt-in rechargeable battery)	
Power consumption	Approx. 1 VA	
Dimension, mass	186 (W) × 68 (D) × 54 (H) mm, approx.200g	
Driver unit	**(E-RM-S129A)**	**(E-RM-S173A)**
Tracing speed	0.6 mm/s	
Dimension, mass	117 (W) × 22 (D) × 23 (H) mm Approx. 200 g	
Standard accessories		
Adjusting tool (For back side)	E-WJ-S64A; 1 pc.	
Standard piece	E-MC-S24B; 1 pc.	
AC adapter	Either 1 piece out of E-SC-S119A (AC 100 V), E-SC-S121A (AC 120 V), E-SC-S125A (AC 220 V), E-SC-S192A (AC 230 V),	Either 1 piece out of E-SC-S372A (AC 100 V), E-SC-S373A (AC 120 V), E-SC-S374A (AC 220 V), E-SC-S371A (AC 230 V),
Cable extension	E-SC-S255A;1 pc.	
Handy case	E-MA-S35A; 1 pc.	
Operation manual	1 copy	
Optional accessories		
Adjuster (for front side)	E-WJ-S80A	
Magnet stand	E-ST-MA	
Post mount	E-CS-S26A	
Post mount holder	0102050	
Various types of pickup	E-DT-SM11A – E-DT-SM13A	
Extension adapter for long hole	DT57506	
Adapter for horizontal measurement	DT57507	
Small type printer Ⅱ *3	E-RC-S25A	E-RC-S29A
Small type printer Ⅱ cable	E-RC-S245A	E-RC-S365A
	(attached to a small type printer Ⅱ as standard)	
AC adapter for small type printer Ⅱ	(attached to a small type printer Ⅱ as standard)	
Printer paper for small type printer	E-CH-S25A	
Cable for RS-232C	E-SC-S248A	E-SC-S366A
	(For PC connection, with sample software)	
Nosepiece for surface measurement	E-WJ-S88A	
Nosepiece for cylinder measurement	E-WJ-S85A	
Adapter for bore measurement	E-WJ-S86A	

*1 E-35A is a product not responded to commands.
*2 E-35B is a product responded to commands.
*3 In addition to the small printer II, the small printer (E-RC-S23A) and the high speed printer (E-RC-S24A) are usable, but since they are the products not responded to RoHS commands, be careful for it.

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18. Guide of operation

A guide to operation of Handysurf E-35A/B
Described below is the flow of basic instruction for measurement.

Connection

Before connecting or disconnecting the cable, make sure the power is off.
Detach the driver unit from the docking part of the amplification indicator. (Note : Do not hold the pick-up at this time.)
Detach the driver unit signal cable from the driver unit, make a connection with the extension cable (accessory).
Install the adjuster to the terminal situated in the back of the driver unit, and fix with the screw.
Plug the AC adapter plug into the power source cable connector and connect the AC adapter to power socket.

Confirmation of the conditions

Press the ON button to turn the power on.
Press the SELECT button and confirm that “CUTOFF 0.80 mm (0.03")” is indicated.
If not, press the ▲ or ▼ button to select “CUTOFF 0.80 mm (0.03")”.

Calibration — Note : Make it once in a week.

Press the SELECT button in order to indicate “Ra”.
Confirm that “L = λc✻5” is indicated on the screen.
Put the pick-up against the CALIBRATION surface of the reference specimen. While doing this, use the adjuster so that the pick-up and the reference specimen should be parallel to each other.
Press the MEAS button and measure the CALIBRATION surface of the reference specimen.
Press the SELECT button in order to indicate “CAL-Ra” and confirm that the Ra value is within ±0.05 μm (2.0 μ") of the indicated value on the reference specimen.
If not, adjust by pressing the ▲ or ▼ button.
Press the SELECT button in order to indicate “Ra” and measure the CALIBRATION surface a second time.
Confirm that the Ra value is within ±0.05 μm (2.0 μ") of the indicated value on the reference specimen.

Stylus tip check — Note : To be done once a day before measurement.

Press the SELECT button in order to indicate “Ra”.
Press the MEAS button and measure the STYLUS CHECK surface of the reference specimen.
After measurement, confirm that the Ra value is within ±0.05 μm (2.0 μ") of the indicated value on the reference specimen.
Note : If not, the pick-up should be changed.

Work piece setting

Set the work piece and the pick-up so that the work piece surface and the pick-up are parallel to each other.
Set the pick-up and the work piece so that the direction of the work piece and the pick-up are at a right angle to each other.

Measurement

Press the SELECT button in order to indicate “Ra”.
Press the MEAS button. The pick-up returns to the forward moving position and measurement will begin.

Reading the results

After measurement, the measurement results Ra value will be indicated.
To see the Rmax and Rz measurement results, press the SELECT button. They will be shown after the Ra value.

End

If no operation is conducted for more than 30 seconds, whether after an operation or in an input waiting situation, the power will be turned off automatically.