

MANUAL TR-220

Surface roughness tester



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1. GENERAL INTRODUCTION

TR-220 hand-held Roughness Tester is a new product and it is applicable to production site, scientific laboratories and factory measure chambers. It can be used to measure the surface roughness of various machine-processed parts. It can work out corresponding parameters according to measuring conditions chosen and show them on LCD screen clearly. The parameters of this instrument meet the requirements of GB/T 3505-2000 "Geometric technical specification for product, surface structure, profile method, description about surface structure, definition, and parameter".

Features:

- Multi-parameters measurement: Ra, Rq, Rz, Rt, Rp, Rv, Ry, RS, RSm, RSk, Rz (JIS), R3z, Rmax, R_{Pc}, Rk, Rpk, Rvk, Mr1, and Mr2
- High precision inductance transducer
- Four filtering methods: RC, PC- RC, Gauss, and D-P
- 128x64 lattice LCD, can display Chinese and English characters, all parameters, & images;
- DSP chip is used for control and data processing, high speed and low power consumption
- Built-in control circuit and rechargeable Li-ion chargeable battery with following features: high capacity, no memory effect, short recharge time, long operating time that is over 20 hours.
- Electrically and mechanically integrated design, small dimension, light weight and easy to operate;
- Measure data saving and storage data reading functions;
- User-defined system clock: display current clock when starting, and can record time and display time when saving the measurement data;
- Built-in standard RS232 interface that can communicate with PC;
- Built-in standard RS232 interface that can be connected to TA-220s printer and print all parameters and images.
- Provide auto shutdown, memory, and various kinds of prompt information;
- Optional accessories including curve sensor, pinhole sensor, depth sensor, measuring platform, sensor jacket, extending rod, and so on;

1.1 MEASUREMENT PRINCIPLES

When measuring the roughness of an object's surface, the sensor is put on the surface to be measured. Then it traces the surface in an even speed driven by the driving system of the instrument with a sharp stylus always in contact with the surface texture to acquire the roughness of the surface. Meanwhile, the roughness gives rise to changes of the position of stylus, which in turn leads to corresponding changes in the inductance of electromagnetic coils in the sensor. As a result, analog signals in proportion to the roughness of surface being measured are generated and exported from phase-sensitive rectifier. After amplification and level conversion, the signals are transferred to data collecting system.

The data collected are further digitally filtered and processed for parameter calculation by DSP microchip. In the end, the results of measurement show on LCD screen. They can be also saved or printed out, or be used to make communication with PC.

1.2 STANDARD CONFIGURATION

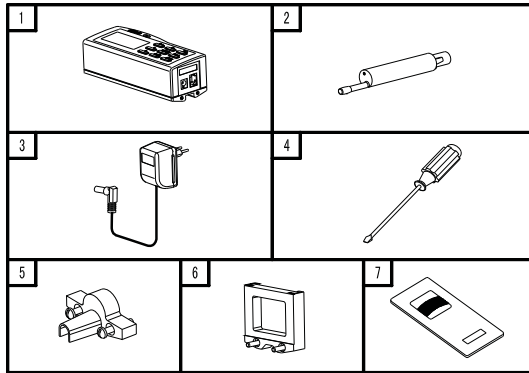


Figure 1.2: Standard configuration

- | | | | |
|----|----------------------------|----|-----------------------|
| 1. | TR-220 unit | 2. | TS100 standard sensor |
| 3. | Power supply adaptor | 4. | Screw drive |
| 5. | Sensor jacket | 6. | Adjustable rack |
| 7. | Ra value standard template | | |

1.3 NAMES OF INSTRUMENT COMPONENTS



Figure 1.3-1: TS100 Pickup

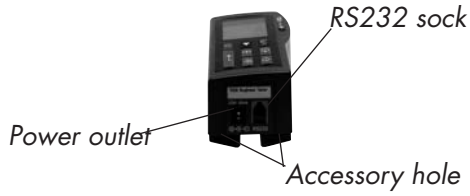


Figure 1.3-2: Instrument name (a)

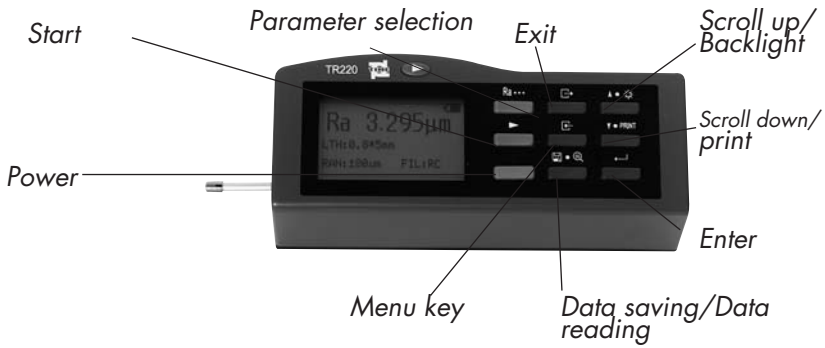


Figure 1.3-3: Instrument name (b)

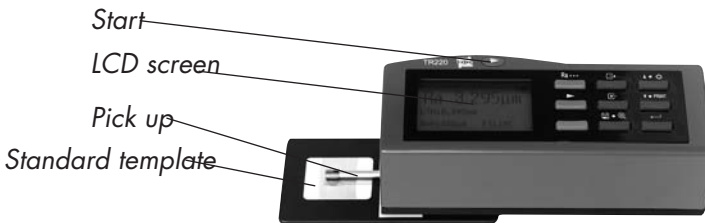


Figure 1.3-4: Instrument name (b)

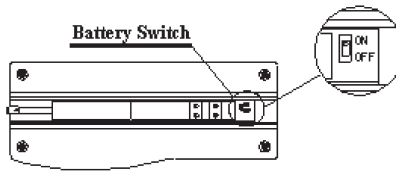


Figure 1.3-4: Instrument name (c)

1.4 BASIC CONNECTION METHOD

1.4.1 Installation and removal of sensor

For installation, hold the body of sensor with hand, insert it into the sheath at the bottom of the instrument as illustrated in Figure 1.4.1-1 and push gently until it meets the end.

For removal, hold the body of sensor or the root of sheath and pull it out slowly.

Connecting sheath

Pick up

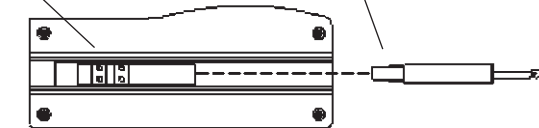


Figure 1.4.1: Installation and removal of sensor

Prompts:

1. The stylus is the crucial part of sensor and worth special care.
2. When installing or removing the sensor, the stylus should be specially protected from being touched for fear of damages and undesirable effect on measurement.
3. When installing the sensor, all connection should be safe and reliable.

1.4.2 Power adaptor and battery charging

When the battery is too low, the symbol "☐" will be highlighted on the screen indicating it should be charged as soon as possible. To charge the battery, first check and make sure the switch at the bottom of instrument is put in ON position. Then insert the plug of power adaptor into the outlet of instrument before inserting in the adapter at power 220V 50Hz as illustrated in Figure 1.4.2-1. After that, charging begins. The input voltage of power adaptor is 220V alternating current, output 6V direct current, max charging current 500mA and max charging time about 2.5 hours. The instrument adopts Li-ion battery, which is free of memory effect and rechargeable at any time, and works normally in charging.

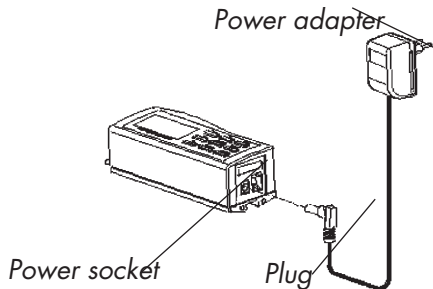


Figure 1.4.2 Connection of power adaptor

When the battery is charging, the symbol "◼" will twinkle on the screen, indicating that the charging is in progress. After the battery is fully charged, LCD will flash, indicating that the power supply shall be turned off as quickly as possible. Turn off power supply and start machine again, battery prompt symbol ■ will be displayed on LCD, where, the black part in the symbol represents the capacity of battery.

Prompts:

1. The meanings of battery voltage prompt symbol:
 - ☐ : Indicates that the voltage is normal, and measurement can be carried out, where, the black part in the symbol represents the capacity of battery.
 - ☐ : Indicates that the voltage is too low, and the battery has to be charged as soon as possible;
 - ◼ : Charging;
 - ◼ : Charging operation is finished, and power supply shall be turned off as soon as possible;

2. When measuring workpiece under the charging status, the layout of connection cables shall not influence the measurement.
3. Charge battery as soon as possible when the voltage is low, and turn off power supply in time after charging.
4. Monitor the charging situation when charging, do not turn off instrument under the charging status, and the instrument will be auto turned on if it is turned off.

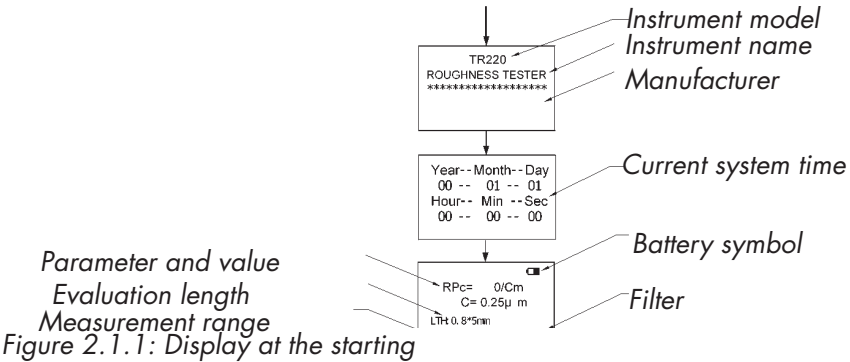
2 MEASUREMENT OPERATION

2.1 PREPARATION BEFORE MEASUREMENT

2.1.1 Start up

Start up the instrument via pressing down power key "Ⓞ", and the LCD will auto display model, name, and manufacturer information. Then, the current system time will be displayed, and the elementary measurement status will be entered. Besides, LCD will also display the preset measurement condition, parameter, unit, sampling length, evaluation length, measurement range, and filter, please see figure 2.1.1.

Press Ⓞ to start up



Description:

1. The battery switch on the bottom of instrument is set at OFF position when the instrument is delivered. If it is not used for long period, the battery switch on the bottom of instrument shall be also set to OFF position to prolong the battery lifespan in general. Thus, please check if the battery switch is set to ON position before the first start up of machine, else the instrument cannot be turned on except special cases, such as charging socket is connected with power adaptor, in such case, the instrument can be powered by power supply instead of battery.
2. The LCD will display the original setup of instrument for the first starting up, and the system time display will be 00-01-01 and 00-00-80. Please setup it according to the actual time, and refer to section 2.5.5 about the setup of system time. In addition, the measurement condition will also be the factory setup, and the user setup contents and measurement data will be displayed when it is started next time.
3. Do not press down and hold power key when starting up.

2.1.2 Inspect the necessary conditions for measurement

- Start up the instrument and check if battery voltage is normal,
- Clean the surface of object to be measured,
- Refer to Figure 2.1.2-1 to place the instrument on the surface of object in a stable and correct way,
- Refer to Figure 2.1.2-2 to make sure the sliding direction of instrument is perpendicular to lines by machining on the surface of object.

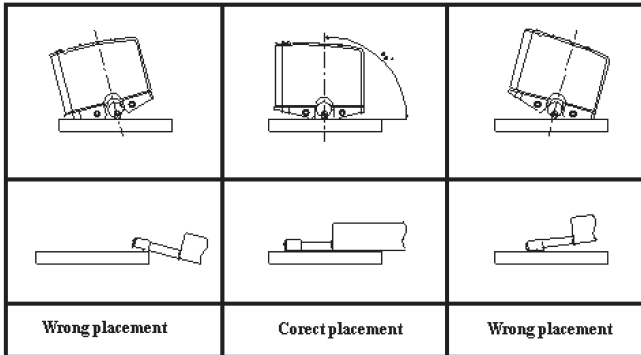


Figure 2.1.2-1: Correct placement of instrument

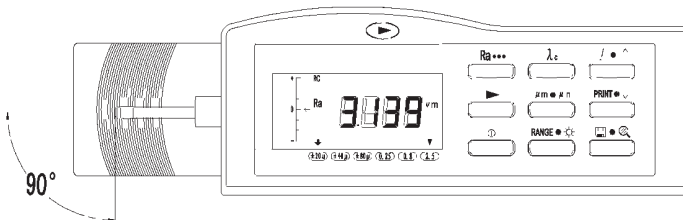


Figure 2.1.2-2: Measurement direction

2.1.3 Zero-position adjustment

Touch enter key \leftarrow , and the LCD will display the relative position of stylus at this time. When the position cursor of stylus is below "0" position, it means that the current position of stylus is higher, and some adjustment shall be made for the relative position of workpiece to be measured or instrument, aiming to guarantee that the position cursor of stylus is at "0" position and the best measurement results can be acquired. Use the accessories of TR-220 instrument reasonably and skillfully, such as adjustable rack and measurement platform, adjust the position of stylus, and facilitate the operation.

2.1.4 Selection of measurement condition

Setup the required parameters before measurement, and set sampling length, evaluation length, measurement range and filter according to the conditions of workpiece.

Rules for selection:

Please refer to section 9.2 for the recommended sampling length.

For the evaluation length, first choose the standard recommended value " $ln=5l$ ", that is, the evaluation length contains 5 sampling length units. If the dimension of workpiece surface to be measured is shorter than 7 sampling length units (where, two sampling length units are used for filtering calculation), the 5-sampling length units can be chosen. However, please note, the smaller the sampling length units is selected, the poorer the value repeatability will be. It is recommended to start selection from the minimal measurement range. If error related with over measurement range occurs, increase the measurement range accordingly.

There are four filtering methods for this instrument:

- RC: traditional filter, it is common in old analog instrument, but is often implement via digital filtering technology now. Its profile shape will deform after filtering, which has little influence to Ra parameter value, but dos have some influence to other parameters. Now, this filtering method is also used when calibrating instrument with attached sample template. However, it is not recommended under other cases.
- PC-RC: make phase correction to RC, and its profile shape will keep unchanged after filtering. Its amplitude transfer features are similar to the ones of RC.
- Gauss: new standard filter which will replace traditional RC. Its profile shape will keep unchanged after filtering.
- D-P: only get the middle value of minimum mean-square value for the un-filtered profile. Please refer to section 2.3 for specific setup operation.

2.2 MEASUREMENT

After preparation, press start key "▶" to begin measurement (see figure 2.2). Sensor slides on the surface to be measured, and LCD display progress bar "▬▬▬", indicating that the sensor of instrument is collecting information. When the progress bar is "full" and reset to change rapidly, it means that the sampling operation is finished and filtering is in progress. When the progress bar is "full" again, the filtering process is finished, and LCD will display "Calculating parameter". After the measurement is finished, the result of this measurement will be displayed on LCD.

Press ► key to start measurement

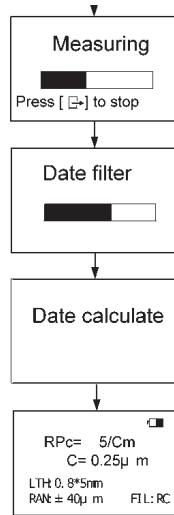


Figure 2.2: Measurement process

Prompt:

1. If power key is touched accidentally during the measurement to turn off the instrument, the sensor of instrument will be reset after turning on again. If so, do not interfere with sensor of instrument when it is operated, and the instrument will wait for new launching instruction after reset.
2. When LCD displays "Measuring", if you press key "⏏", the current measurement operation will be stopped, the sensor will be reset to the initial position to wait for new measurement, and the LCD will display "0" measurement value.

2.3 SETUP MEASUREMENT CONDITION

Under the basic measurement status, press menu key "⏏" to enter menu operation status, and it will select the default measurement condition. Press Enter key "↵" to enter submenu for measurement condition setup, and this submenu contains seven menu items: sampling length, evaluation length, measurement range, filter, parameter, C (RPC μm) setup, and C (RPC %) setup. Press scroll key "⬅" or "➡" at this time, you can perform selection and page turning operation. Pressing key "↵", you can modify the value of current selected item (see figure 2.3).

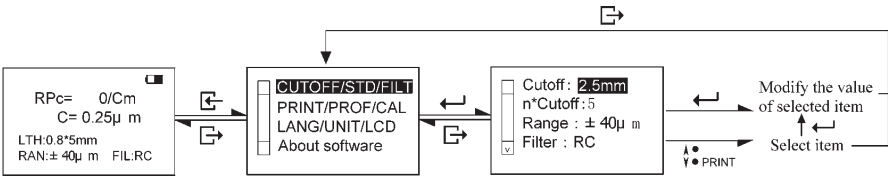


Figure 2.3: Setup measurement condition

2.3.1 Setup the sampling length

Under the basic measurement status, press menu key "⏏" and then Enter key "↵", you can access the submenu "Setup measurement condition", and the item "Sampling length" will be selected by default. Direct pressing Enter key "↵" again, the various sampling lengths will be displayed in cycle "0.25mm, 0.8mm, 2.5mm, auto". When the required setup value is displayed, press scroll key "⬅" and "➡" to access next item such as the modification of evaluation length, or press exit key "⏏" twice to return to the basic measurement status. At this time, the corresponding LCD will display the modified sampling length value (see figure 2.3.1)

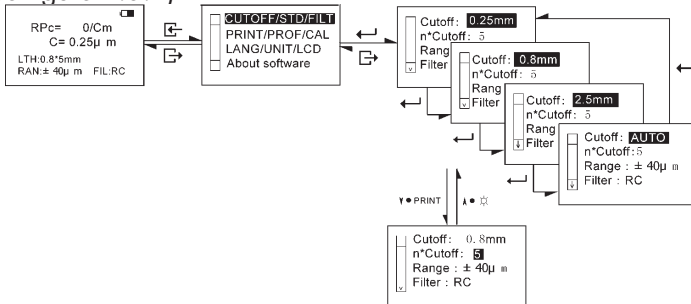


Figure 2.3.1: Setup sampling length

2.3.3 Setup measurement range

Under the basic measurement status, press menu key "☰" and then Enter key "↵", you can access the submenu "Setup measurement condition". Move cursor to "measurement range" via pressing scroll key "▼•PRINT", and then press Enter key "↵", the various measurement range values will be displayed in cycle "±20µm, ±40µm, ±80µm, auto". When the required setup value is displayed, press scroll key "▲•✱" and "▼•PRINT" to access next item such as the modification of filter, or press exit key "☰" twice to return to the basic measurement status. At this time, the corresponding LCD will display the modified measurement range value "RAN:" (see figure 2.3.3).

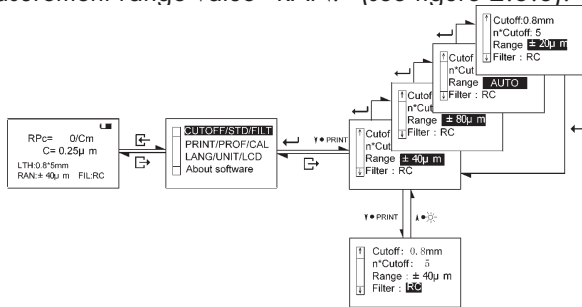


Figure 2.3.3: Setup measurement range

2.3.4 Setup filter

Under the basic measurement status, press menu key "☰" and then Enter key "↵", you can access the submenu "Setup measurement condition". Move cursor to "Filter" via pressing scroll key "▼•PRINT", and then press Enter key "↵", the various filters will be displayed in cycle "RC, PC-RC, Gauss, D-P". When the required filter is displayed, press exit key "☰" twice, the LCD will display "Filtering", which indicates that the instrument is re-filtering the previous measured value according to the selected filter, and auto return to the basic measurement status after finishing it. At this time, the corresponding LCD will display the parameter value after re-filtering, and display corresponding filter next to "FIL:" field (see figure 2.3.4).

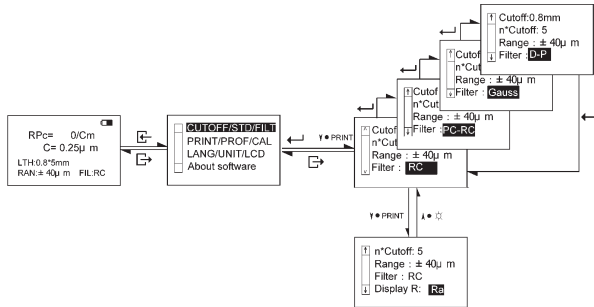


Figure 2.3.4: Setup filter

2.3.5 Setup parameter

Under the basic measurement status, press menu key "⏏" and then Enter key "←", you can access the submenu "Setup measurement condition". Move cursor to "Parameter setup" line via pressing scroll key "▼•PRINT", and then press Enter key "←", the various parameters will be displayed in cycle "RPC, Rk, Ra, Rz, Ry, Rmax, Rq". When the required parameter is displayed, press scroll key "▲•✱" and "▼•PRINT" to access next item to be modified, or press exit key "⏏" twice to return to the basic measurement status. At this time, the corresponding LCD will display the modified parameter and relevant value (see figure 2.3.5).

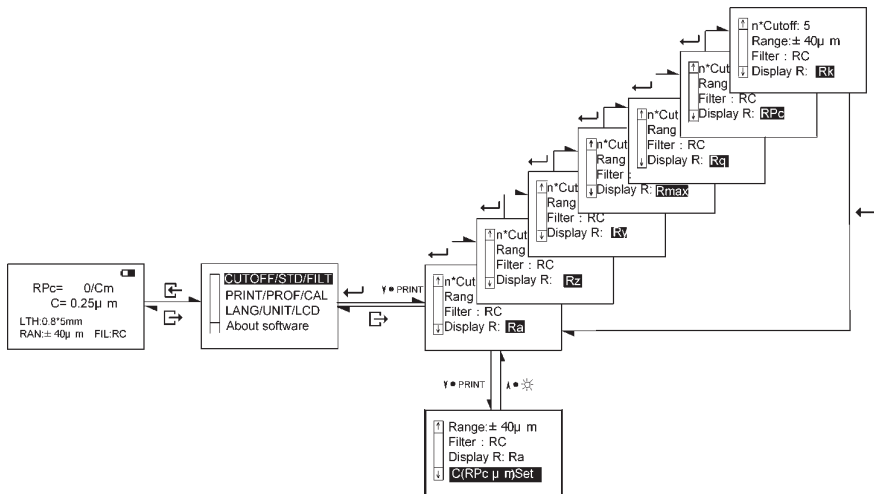


Figure 2.3.5: Setup parameter

Prompt:

1. These seven parameters are regular parameters to be measured, which can be displayed on LCD directly after setup under the basic measurement status. Please note, they are different from the parameters that can be measured by instrument. There are 19 parameters that can be measured by this instrument. If you want to query all parameter values after each measurement, please refer to section 4.1.
2. If the parameter setup is Rk, when exiting the setup, the LCD interface under measurement status is different from the interface for other parameter, and LCD will display 5 parameter values of Rk parameter set, but not displaying the current set evaluation length, measurement range, filter, etc.

2.3.6 C (RPc μ m) setup

Under the basic measurement status, press menu key "☰" and then Ente key "←", you can access the submenu "Setup measurement condition". Move cursor to "C (RPc μ m) setup" item via pressing scroll key "▼_{PRINT}", and then press Enter key "↵" to enter C (RPc μ m) setup status. Via pressing "▲✳" and "▼_{PRINT}", the value shown at the place where the cursor locates currently can be increased or decreased. The cursor position can be moved via pressing Enter key "↵". Setup value of C via using three keys mentioned above, and press exit key "☰" three times to return to the basic measurement status.

2.3.7 C (RPc %) setup

It is same as the one mentioned in section 2.3.6.

2.4 FUNCTION SELECTION

After entering menu operation status via pressing menu key "E" under basic measurement status, the default "measurement condition setup" item will be selected. Press scroll key "Y•PRINT" to move cursor to "function selection" item, and press Enter key "↵" to access submenu of "Function selection". This submenu contains five menu items: print, graph, stylus position, showing value calibration, and statistics (PC software). At this time, you can press scroll key "A•*" and "Y•PRINT" to make item selection or page turning, and modify the value of current selected item via pressing "←" (see figure 2.4).

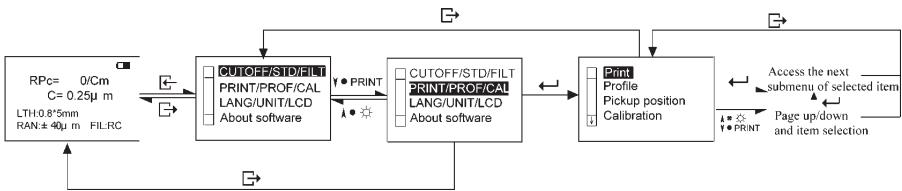


Figure 2.4: Function selection

2.4.1 Print

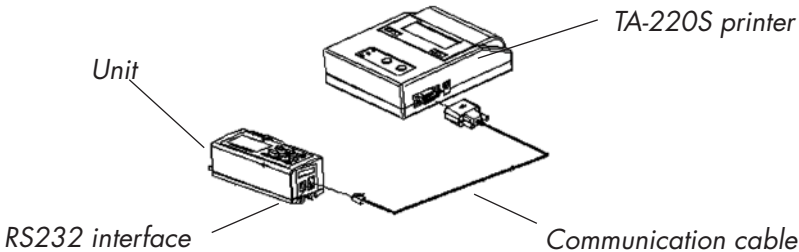


Figure 2.4.1: Connect printer

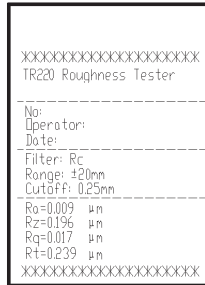


Figure 2.4.1.1-1: Print selected parameter-1

Before printing, connect instrument and printer with communication cable as shown in figure 2.4.1, set the baud rate of printer to 9600, and let printer in online state.

2.4.1.1 Print selected parameter

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "Function selection" via pressing scroll key "Y•PRINT", press Enter key "↵" to access "Print" option (see figure 2.4), press Enter key "↵" twice to access "Print selected parameter" submenu, move cursor to parameter to be printed via pressing scroll key "▲•✱" and "Y•PRINT", and then press Enter key "↵", the symbol "✓" next to this parameter on LCD indicates this parameter is selected for printing, and the cursor will auto jump to next parameter. If symbol "✓" ext to parameter already exists, symbol "✓" will be unchecked after pressing Enter key "↵", which means that this parameter will be cancelled from print queue. After selecting all parameters to be printed, press exit key "⏏", the LCD will autoreturn to previous upper menu (see figure 2.4.1.1-2), and the printer will print the selected parameters and values (see figure 2.4.1.1-1).

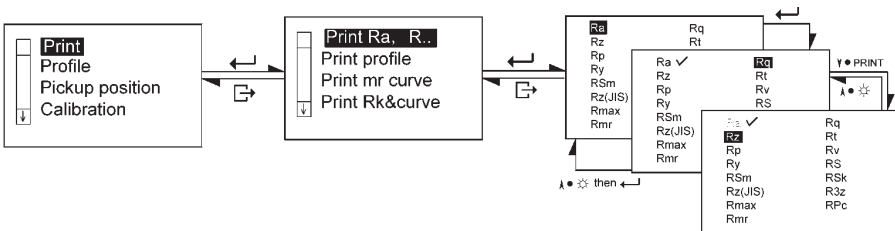


Figure 2.4.1.1-2: Print selected parameters-2

2.4.1.2 Print profile

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "Function selection" via pressing scroll key "▼•PRINT", press Enter key "↵" to access "Print" option (see figure 2.4), move cursor to "Print profile graph" via pressing scroll key "▼•PRINT", and then press Enter key "↵", LCD will display "Printing" (see figure 2.4.1.2-1) and printer will print out the profile graph (see figure 2.4.1.2-2). The LCD will return to print submenu after printing. Press scroll key "▲•✱" and "▼•PRINT" to select other contents to be printed, or press exit key "⏏" to exit.

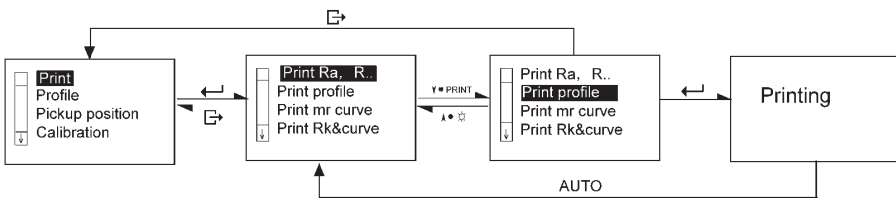


Figure 2.4.1.2-2: Print profile graph-1

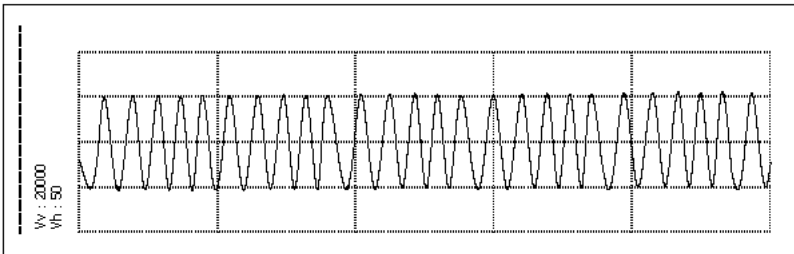


Figure 2.4.1.2-2: Print profile graph-2

2.4.1.5 Print parameter and graph

Under basic measurement status, after pressing menu key \square to enter menu operation status, move cursor down to "Function selection" via pressing scroll key \blacktriangledown PRINT, press Enter key \leftarrow to enter "Print" option (see figure 2.4), move cursor to "Print parameter and graph" via pressing scroll key \blacktriangledown PRINT, and then press Enter key \leftarrow , LCD will display "Printing" (see figure 2.4.1.5-2) and printer will print out all parameter values (except Rk parameters) measured currently, Rmr value and profile graph (see figure 2.4.1.5-1). The LCD will return to print submenu after printing. Press scroll key \blacktriangleleft * and \blacktriangledown PRINT to select other contents to be printed, or press exit key \square to exit..

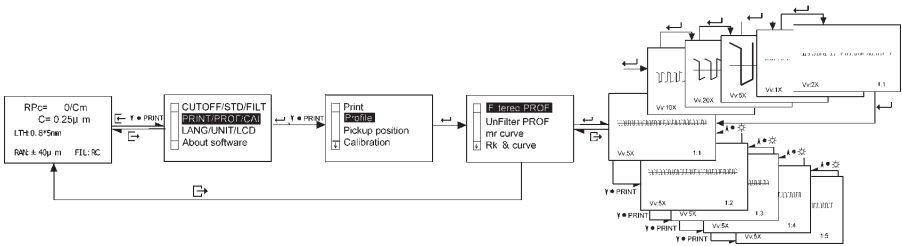


Figure 2.4.1.5-1: Print parameter and graph-1

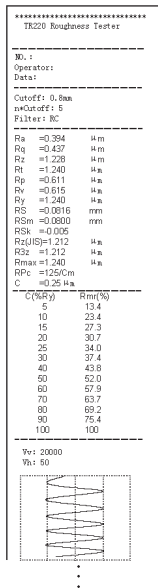


Figure 2.4.1.5-2: Print parameter and graph-2

2.4.2 Profile

This menu includes five submenus: Filtering profile, No filtering profile, Supporting rate curve, Rk parameter graph, and direct profile.

2.4.2.1 Filtered profile

Under basic measurement status, after pressing menu key \square to enter menu operation status, move cursor down to "Function selection" via pressing scroll key \blacktriangledown •PRINT, press Enter key \leftarrow and scroll key \blacktriangledown •PRINT to move cursor to "Graph" field, press Enter key \leftarrow to enter graph submenu, which is "filtering profile" by default, press Enter key again, and the LCD will display this graph. Under this status, via pressing Enter key, it is possible to zoom in the graph in vertical direction to 1X, 2X, 5X, 10X, 20X, or 50X. Via pressing scroll key \blacktriangle •* and \blacktriangledown •PRINT, you can display profile curve corresponding to each sampling length, or return to upper menu via pressing exit key \square (see figure 2.4.2.1).

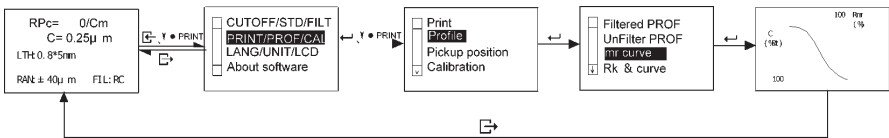


Figure 2.4.2.1: Filtering profile

2.4.2.2 No filtering profile

Under basic measurement status, after pressing menu key \square to access menu operation status, move cursor down to "Function selection" via pressing scroll key \blacktriangledown •PRINT, press Enter key \leftarrow and scroll key \blacktriangledown •PRINT to move cursor to "Graph" field, press Enter key \leftarrow to access graph submenu, select "no filtering profile" via pressing scroll key \blacktriangle •* and \blacktriangledown •PRINT, and press Enter key, LCD will display this graph curve. Under this status, via pressing Enter key, it is possible to zoom in the graph in vertical direction to 1X, 2X, 5X, 10X, 20X, or 50X. Via pressing scroll key \blacktriangle •* and \blacktriangledown •PRINT, you can display profile graph corresponding to each sampling length, or return to previous upper menu via pressing exit key \square , please see figure 2.4.2.1 for operational block diagram.

2.4.2.3 Mr curve

Under basic measurement status, after pressing menu key \mathbb{E} to enter menu operation status, move cursor down to "Function selection" via pressing scroll key $\blacktriangledown_{\text{PRINT}}$, press Enter key \leftarrow and scroll key $\blacktriangledown_{\text{PRINT}}$ to move cursor to "Graph" field, press Enter key to enter graph submenu, select "Supporting rate curve" field via pressing scroll key $\lambda \cdot \ast$ and $\blacktriangledown_{\text{PRINT}}$, and press Enter key, LCD will display this graph. Press exit key to return to upper menu (see figure 2.4.2.3). Please refer to section 2.4.1.3 for the print reference of this curve.

2.4.2.4 Rk Parameter

Under basic measurement status, after pressing menu key \mathbb{E} to access menu operation status, move cursor down to "Function selection" via pressing scroll key $\blacktriangledown_{\text{PRINT}}$, press Enter key \leftarrow and scroll key $\blacktriangledown_{\text{PRINT}}$ to move cursor to "Graph" field, press Enter key \leftarrow to access graph submenu, select "Rk parameter graph" via pressing scroll key $\lambda \cdot \ast$ and $\blacktriangledown_{\text{PRINT}}$, and press Enter key, LCD will display this graph curve. Press exit key \mathbb{E} to return to previous upper menu. Please refer to figure 2.4.2.3 for operational block diagram and section 2.4.1.4 for the print reference of this curve.

2.4.2.5 Direct profile

Under basic measurement status, after pressing menu key \mathbb{E} to access menu operation status, move cursor down to "Function selection" via pressing scroll key $\blacktriangledown_{\text{PRINT}}$, press Enter key \leftarrow and scroll key $\blacktriangledown_{\text{PRINT}}$ to move cursor to "Graph" field, press Enter key \leftarrow to access graph submenu, select "Direct profile" field via pressing scroll key $\lambda \cdot \ast$ and $\blacktriangledown_{\text{PRINT}}$, and press Enter key, LCD will display this graph curve. Press exit key \mathbb{E} to return to previous upper menu. Please refer to figure 2.4.2.3 for operational block diagram and section 2.4.1.2 for the print reference of this curve.

2.4.3 Pickup position

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "Function selection" via pressing scroll key "▼•PRINT", press Enter key "↵" and scroll key "▼•PRINT" to move cursor to "Stylus position" field, and press Enter key "↵" to access stylus position display (see figure 2.4.3). When the cursor of stylus position is below "0", it means that the current stylus position is too low, and the current stylus position is too high if it is beyond "0". When the cursor of stylus position is at "0", the actual measurement range of instrument will be in accordance with the selected measurement range, being the maximal one. In order to guarantee that the measurement range will not be exceeded, please adjust the cursor of stylus position to "0" position as closely as possible. Of course, under the precondition that the measurement value will not exceed the measurement range, the up/down position of stylus will not influence the measurement value. The stylus position can be adjusted via using the attachments of TR-220 instrument reasonably, such as adjustable rack and measurement platform, and facilitate the operation, but the description about necessary measurement condition specified in section 2.1.2 must be met. Pickup position

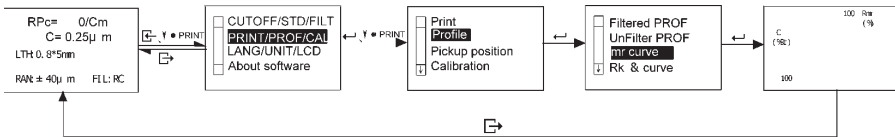


Figure 2.4.3: Pickup position

2.4.4 Showing value calibration

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "Function selection" via pressing scroll key "▼•PRINT", press Enter key "↵" and scroll key "▼•PRINT" to move cursor to "Showing value calibration" field, and press Enter key "↵" to access showing value calibration interface (see figure 2.4.4). At this time, press Enter key "↵", move the cursor to the line corresponding to measurement range for showing value calibration, use scroll key "▲•✱" to adjust the positive coefficient, and increase the number by one for each pressing operation. You can use scroll key "▼•PRINT" to adjust the negative coefficient, and decrease the number by one for each pressing operation, until the showing value calibration is reached. The value for showing value calibration is in unit of percentage, and the maximal and minimal values are $\pm 20\%$. After setup, you can press exit key "⏏" to exit showing value calibration status.

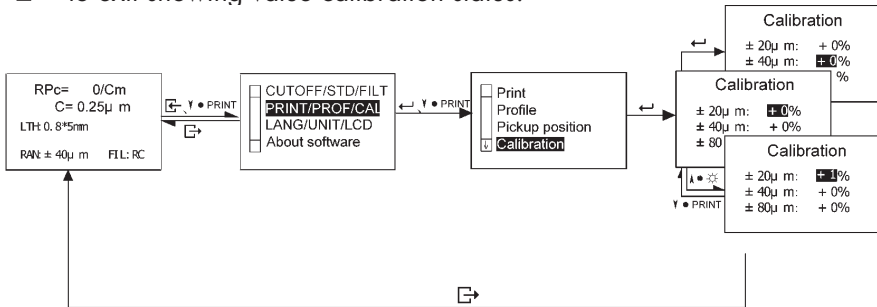


Figure 2.4.4: Showing value calibration

Description:

1. When measuring the attached template with correct measurement method, if the actual measured value is over the nominal value for template by $\pm 10\%$, please use showing value calibration function to make correction according to the percentage of actual deviation, and the correction range shall not exceed $\pm 20\%$.
2. In general, all instruments will pass strict test before delivery, and the error of showing value is far less than $\pm 10\%$. Under such cases, it is recommended that user shall not use showing value calibration function frequently.
3. When the value of showing value calibration is set at "0" and confirmed, all calibration sets will be cleared, and factory set will be resumed.
4. Keep the setup for power switch "close" calibration unchanged, but close the battery switch at the bottom of instrument, all calibration sets will be cleared and be resumed to "0".

2.5 SYSTEM SETUP

System setup menu includes five submenus: language, unit, LCD backlight, LCD brightness, and time calibration.

2.5.1 Language

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "System setup" via pressing scroll key "Y•PRINT", press Enter key "↵", and the instrument will choose "Language" field by default. Press Enter key "↵", choose "Simplified Chinese" or "English" via pressing scroll key "⏏" and "Y•PRINT", press Enter key "↵" again, and the displayed menu on LCD will be changed to the language selected (see figure 2.5.1). After setup, you can press scroll key "Y•PRINT" to select other system configuration items, or press exit key "⏏" to return

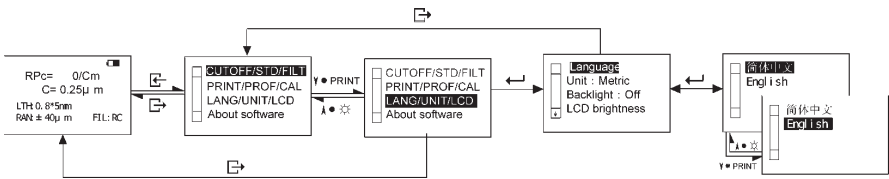


Figure 2.5.1: Language setup

2.5.2 Unit

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "System setup" via pressing scroll key "Y•PRINT", press Enter key "↵" and scroll key "Y•PRINT" to move cursor to "Unit" line, press Enter key "↵" again, and then you can switch between "English system" and "Metric system" (see figure 2.5.2). After setup, you can press scroll key "⏏" and "Y•PRINT" to select other system configuration items, or press exit key "⏏" to return to upper menu.

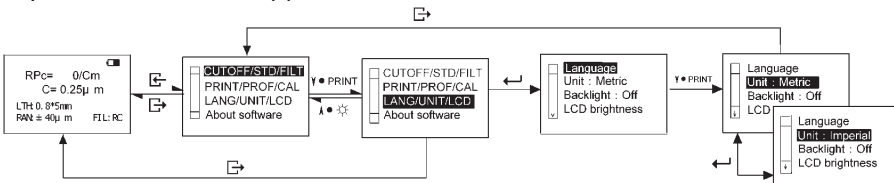


Figure 2.5.2: Unit setup

2.5.3 LCD backlight

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "System setup" via pressing scroll key "▼•PRINT", press Enter key "↵" and scroll key "▼•PRINT" to move cursor to "LCD backlight" line, press Enter key "↵" again, and then you can switch between "On" and "Off". After setup, you can press scroll key "▲•✱" and "▼•PRINT" to select other system configuration items, or press exit key "⏏" to return to upper menu.

Prompt:

1. Turn on "Backlight" function when the instrument is used in poorer environment.
2. Turn off "Backlight" function when it is not necessary, aiming to decrease power consumption.
3. Please refer to section 4.2 for shortcut method about turning on "Backlight" function.

2.5.4 LCD brightness

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "System setup" via pressing scroll key "▼•PRINT", press Enter key "↵" and scroll key "▼•PRINT" to move cursor to "LCD brightness" field, press Enter key "↵" again, and access "LCD brightness adjustment". At this time, you can increase the LCD brightness via pressing scroll key "▲•✱" or decrease LCD brightness via pressing "▼•PRINT" (see figure 2.5.4). After setup, you can press exit key "⏏" to return to upper menu.

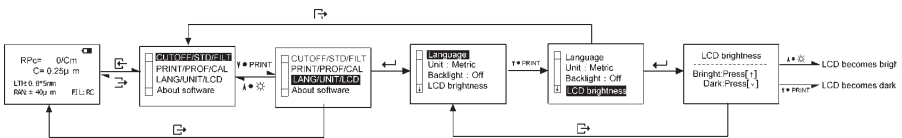


Figure 2.5.4: LCD brightness

2.5.5 Time calibration

Under basic measurement status, after pressing menu key "⏏" to access menu operation status, move cursor down to "System setup" via pressing scroll key "Y•PRINT", press Enter key "↵" and scroll key "Y•PRINT" to move cursor to "Time calibration" field, press Enter key "↵" again, and access "System time setup", including year, month, date, hour, minute, and second setup. At this time, move cursor to the required value via pressing Enter key "↵", and press scroll key "▲•⚙" and "Y•PRINT" to increase or decrease value. After setup, move cursor via using Enter key "↵", and set next item, until all six items are setup according to the requirements(see figure 2.5.5). Press exit key "⏏" to return to upper menu.

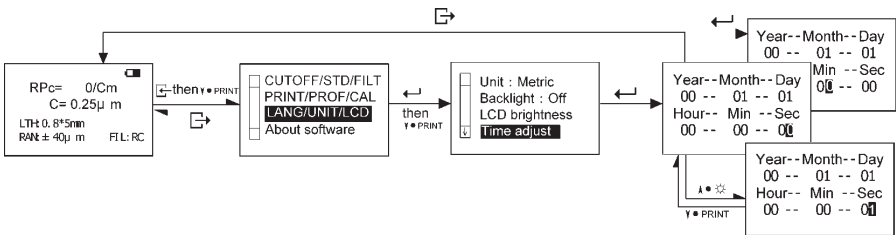


Figure 2.5.5: Time calibration

Prompt:

1. When first starting up instrument, the displayed system time is the original factory setup value. User shall setup it manually according to the actual time; else the system time will never change, and be always 00-01-01 and 00-00-80.
2. The switching on/off power switch will not influence system time. After time calibration, the displayed system time will be based on the modified value for next starting up, and will be changed with time.
3. If the battery switch at the bottom of instrument is turned off because it is not used for long time, when battery switch is turned on again, the system time will be reset to the original value "00-01-01 and 00-00-80". If so, user shall calibrate the time again.
4. When the storage function of instrument is used, the current system time will also be recorded.

2.6 COMMUNICATION WITH PC

As shown in figure 2.6, before communication with PC, use dedicated communication cable for this instrument to connect instrument and serial interface of PC, and access dedicated operating software Data View for this instrument from PC.

Description:

Dedicated Data View software is required for the communication between this instrument and PC. Please refer to software operation manual for specific operation methods. RS232 interface Communication cable PC

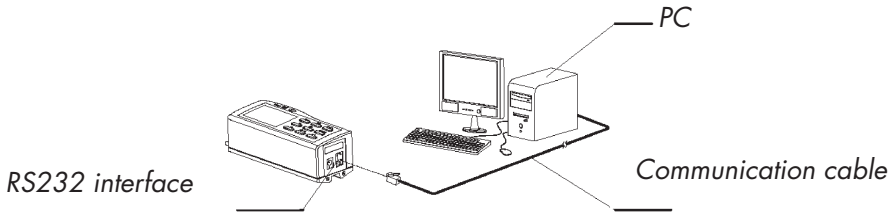


Figure 2.6: Connect PC

3 SHUT DOWN

You can touch power key “⊙” to shut down the instrument after using, and all configurations before turning off instrument will be maintained when it is turned on again. If there is no operation to the instrument within 5 minutes, the instrument will be auto turned off, and all configurations before turning off instrument will be maintained when it is turned on again.

If the instrument will not be used for long time, you can turn off battery switch at the bottom of instrument, and all configurations will be reset to the original ones when it is turned on again.

4 THE USING OF SHORTCUT KEYS

4.1 Ra... KEY

4.1.1 Setup parameters other than Rk

When parameters other than Rk are set in measurement condition, such as R_{Pc}, R_a, R_z, R_y, R_{max} and R_q (please refer to section 2.3.5 for specific operation), LCD will display the settings of parameter, cutoff, journey, measurement range, and filter. At this time, press the parameter key Ra... for the first time, all parameters for this measurement will be displayed (except Rk parameters), and you can press scroll key $\lambda \bullet \star$ and $\Psi \bullet \text{PRINT}$ to page up/down. Press the key again, the graph corresponding to the first cutoff of this measurement will be displayed. Pressing the scroll key $\lambda \bullet \star$ and $\Psi \bullet \text{PRINT}$, the profile graph corresponding to each cutoff can be displayed. Press Enter key \leftarrow at this time, the graph will be displayed in cycle with vertical magnification 1X, 2X, 5X, 10X, 20X, and 50X. If the parameter key is pressed for the third time, the supporting rate graph for this measurement will be displayed, and the R_{mr} value can be displayed via pressing scroll key $\lambda \bullet \star$ and $\Psi \bullet \text{PRINT}$. Pressing the key again, the previous displayed contents will be repeated. The gauge will always return to the basic measurement status when the exit key \rightarrow is pressed at any time. (see figure 4.1.1)

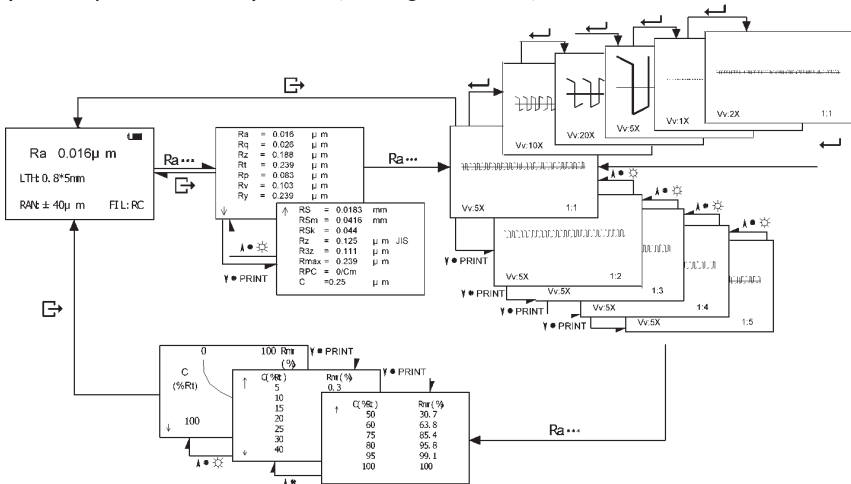


Figure 4.1.1: Using method 1 for parameter key

4.1.2 Setup Rk parameter

When Rk is the parameter to be set in measurement condition setup (see section 2.3.5 for more information), LCD will display all parameter values in Rk parameter set directly under basic measurement status, including parameter values Rk, Rpk, Rvk, Mr1, and Mr2. Press parameter key "Ra..." one time, the Rk evaluation curve will be displayed, and you can press exit key "⏪" to return to basic measurement status (see figure 4.1.2).

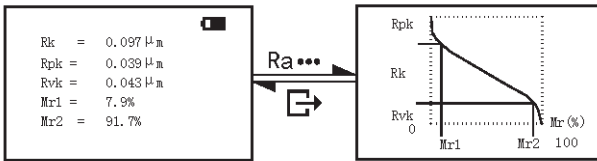


Figure 4.1.2: Using method 2 for parameter key


4.2 ▲•✳ KEY

When it is under the basic measurement status, key "▲•✳" can only be used as backlight key, but not scroll key. Except under the basic measurement status, key "▲•✳" will only be used as scroll key, but not backlight key. Under the basic measurement status, touching key "▲•✳" can enable or disable backlight function, and its effect is equivalent to the LCD backlight setup described in section 2.5.3.




4.3 ▼•PRINT KEY PRINT


When it is under the basic measurement status, key "▼•PRINT" can only be used as print key, but not scroll key. Except under the basic measurement status, key "▲•✳" will only be used as scroll key, but not print key. Under the basic measurement status, touching key "▼•PRINT" can print measurement parameters and graphs on printer, and its effect is equivalent to the LCD backlight setup described in section 2.4.1.5.

4.4 KEY

When it is under the basic measurement status, via touching key "", you can save current measurement data or read the previous saved data.

4.4.1 Save measurement value

When it is under the basic measurement status, via touching key "", LCD will display highlighted "Save current data". If the Enter key " " is pressed directly, LCD will display that the data will be saved to nth group, as well as saving time. If you plan to save dat , please press Enter key " ", and then the current data will be saved to nth position of memory.

At this time, LCD will indicate that the saving operation is in progress, and return to the previous step after it is finished. If you do not want to save data, press exit key " ", and exit from current data saving status (see figure 4.4.1).

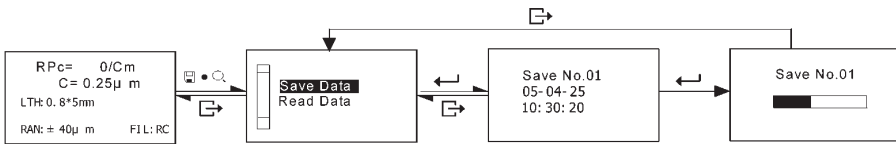


Figure 4.4.1: Save value

This instrument can save 15 groups of data. The position where the current data is saved will be auto recorded by instrument, from 01 to 15. When 15 groups of data are saved, the position will return back to 01, and the new contents will be recorded to replace the original ones. If the original contents are important, please backup them ahead.

4.4.2 Read storage value

When it is under the basic measurement status, via touching key "☰•Q", LCD will display highlighted "Save current data". Press scroll key "Y•PRINT" to select "Read historic data" and then press Enter key "↵", LCD will display that the nth group of data will be read, as well as the storage time. Make page up/down operation via pressing scroll key "▲•✱" and "Y•PRINT", find the group of data to be read (storage time can be referred) and press Enter key "↵", then LCD will display reading progress bar, and return to the first step after complete. Press exit key "☰" again to return back to basic measurement status, and LCD will display the value for the group of data read just. Via using other keys, you can view all information about the data in this group (see figure 4.4.2).

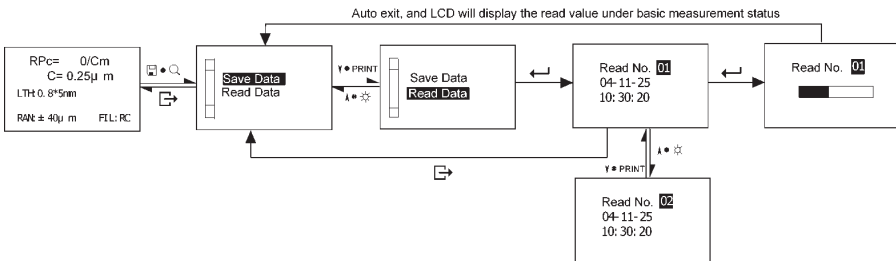


Figure 4.4.2: Read storage value

4.5 ← KEY

Under the basic measurement status, you can touch key "←" to display the stylus position in real time. It is same as the operation described in section 2.4.3.

5 OPTIONAL ATTACHMENTS AND THEIR USING

5.1 ADJUSTABLE RACK AND SENSOR SHEATH

When the workpiece surface to be measured is smaller than the bottom of instrument, the optional attachments of TR-220 series can be selected, such as sensor sheath and adjustable rack acting as assistant support, to complete the measurement (see figure 5.1-1 and 5.2-2).

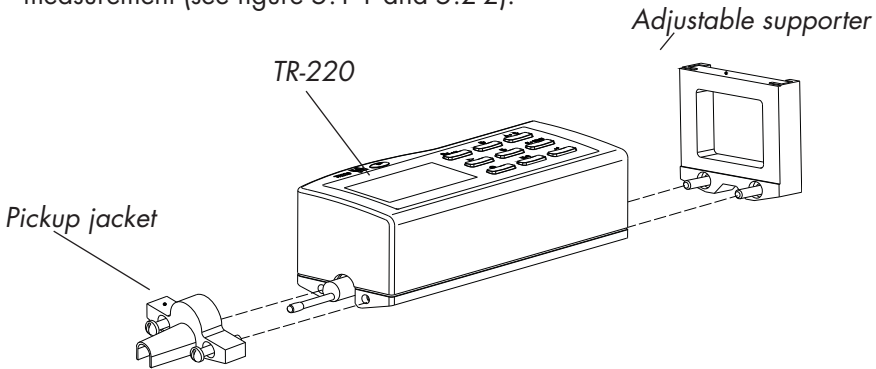


Figure 5.1-1: Connection for adjustable rack and sensor sheath

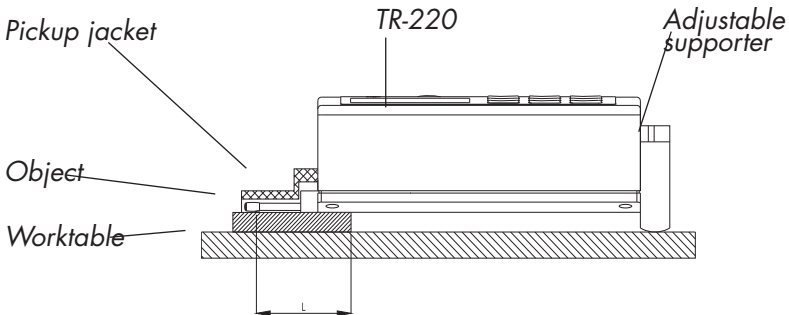


Figure 5.1-2: The using method for adjustable rack and sensor sheath

Prompt:

1. As shown in the figure, L shall not be shorter than the drive stroke of this measurement, aiming to prevent sensor from falling beyond the workpiece during the measurement, which may cause failure because the returned sensor may contact with workpiece.
2. The adjustable rack shall be fixed reliably.
3. Do not use adjustable rack to adjust the stylus position during the measurement, but shall adjust the adjustable rack to the required height, and measure it with calipers.

5.2 MEASUREMENT PLATFORM

With measurement platform of TA series, the position of instrument relative to the workpiece to be measured can be adjusted easily, the operation will be more flexible and table, the using scope will be wider, and the roughness for surface of spare parts with complicated shape can measured. When it is used with measurement platform of TA series, it is possible to adjust the stylus position more accurately, and the measurement will be more stable. If the Ra value for surface to be measured is smaller, it is recommended to use measurement platform.

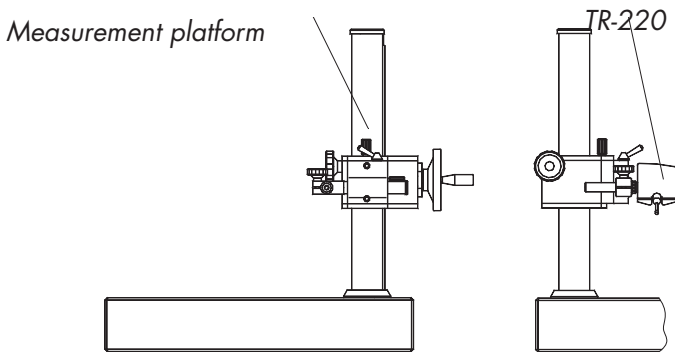


Figure 5.2: measurement platform

5.3 EXTENSION BAR

With extension bar, it is possible to increase the depth of sensor in workpiece, and the length of extension bar is 50mm.

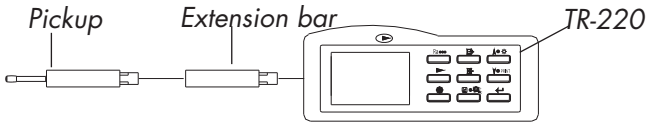


Figure 5.3: Extension bar

5.4 COUPLING BAR FOR MAGNETIC GAGE STAND

With coupling bar for magnetic gage stand, you can connect the instrument and magnetic gage stand, and measure various workpiece surfaces (see figure 5.4). it is very suitable for production field.

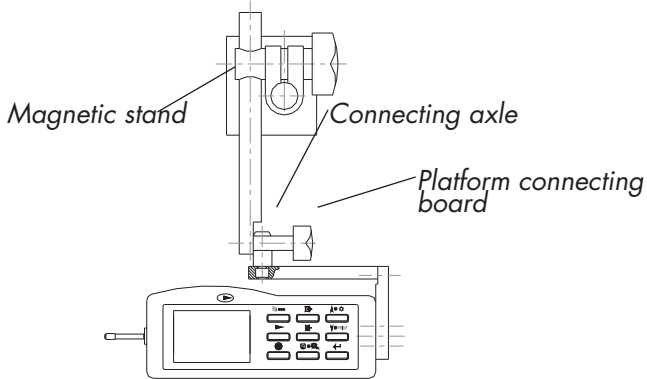


Figure 5.4: Connect magnetic gage stand

5.5 SENSOR

5.5.1 TS100 standard sensor

This sensor is the standard spare part delivered with TR-220 together. Please see figure 5.5.1.

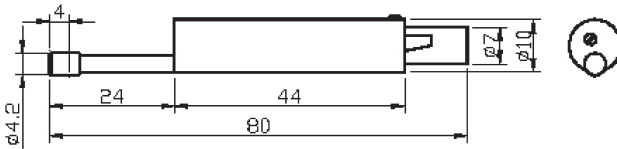


Figure 5.5.1: TS100 sensor

5.5.2 TS110 curved surface sensor

With TS110 curved sensor, it is possible to measure surface of workpiece with concave/convex curved surface and 3+ mm curvature radius, please see figure 5.5.2-1 and 5.5.2-2.

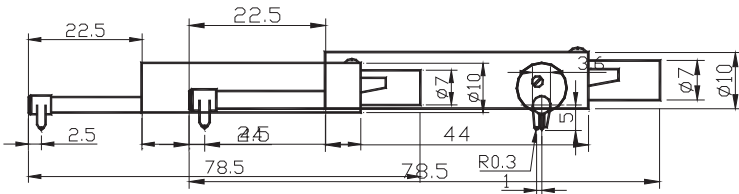


Figure 5.5.2-1: Dimension of TS110 sensor

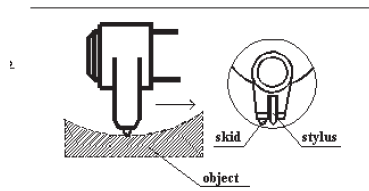


Figure 5.5.2-2: Curved surface sensor

5.5.3 TS120 pinhole sensor

With TS120 pinhole sensor, it is possible to measure roughness of inner surface with the hole diameter larger than 2m, please see figure 5.5.3.

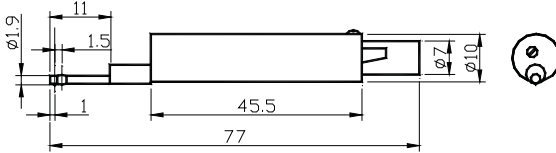


Figure 5.5.3: Pinhole sensor

5.5.4 TS130 quirk sensor

With TS130 quirk sensor, it is possible to measure groove with width wider than 2mm and depth deeper than 3mm, or the surface roughness of step with height less than 3mm, please see figure 5.5.4-1, 5.5.4-2, and 5.5.4-3.

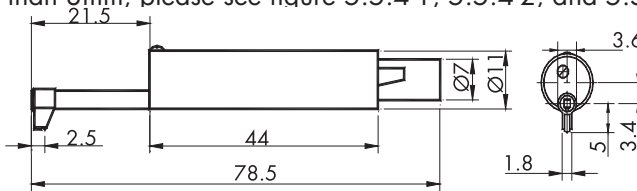


Figure 5.5.4-1: TS130 quirk sensor

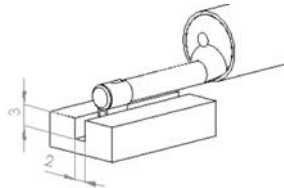


Figure 5.5.4-2: Measure groove with TS130 quirk sensor

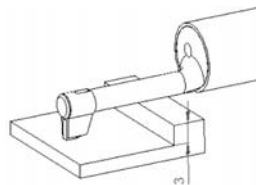


Figure 5.5.4-3: Measure step with TS130 quirk sensor

5.5.5 TS131 quirk sensor

With TS131 quirk sensor, it is possible to measure groove with width wider than 3mm and depth deeper than 10mm, or the surface roughness of step with height less than 10mm, please see figure 5.5.4-1, 5.5.4-2 and 5.5.4-3 for detailed dimension.

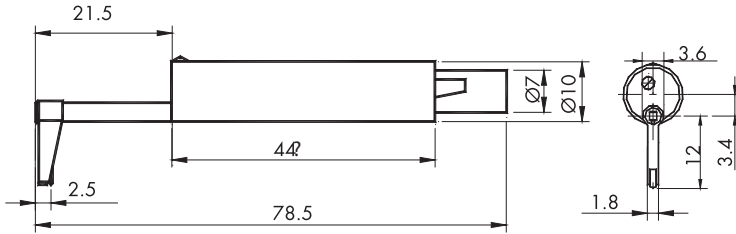


Figure 5.5.5-1: TS131 quirk sensor

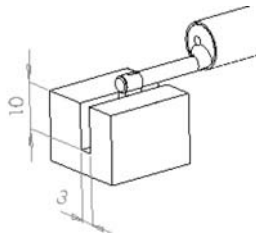


Figure 5.5.5-2: Measure groove with TS131 quirk sensor

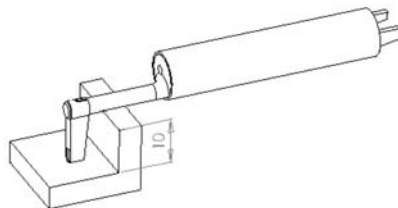


Figure 5.5.5-3: Measure step with TS131 quirk sensor

6 TECHNICAL PARAMETERS

6.1 PICKUP

-	Measurement principle:	inductance
-	Measurement range:	160µm
-	Angle of Stylus:	90°
-	Lengthwise radius of skid:	45mm
-	Pinpoint material:	diamond
-	Pinpoint radius	Test force for stylus
	2µm±0.5µm	0.7mN (0.07gf)
	5µm±1µm	4mN (0.4gf)

Notes:

sensor with 2µm pinpoint radius is for exported machine.

6.2 DRIVE PARAMETERS

-	Maximal drive stroke:	17.5mm/0.71inch
-	Drive speed	
	During measurement:	
	When sampling length =	0.25mm Vt=0.135mm/s
	When sampling length =	0.8mm Vt=0.5mm/s
	When sampling length =	2.5mm Vt=1mm/s
	After Returning:	V=1mm/s

6.3 SHOWING VALUE ERROR

Showing value error is less than ±10%.

6.4 VARIABILITY OF SHOWING VALUE

Variability of showing value is less than 6%.

6.5 DISPLAY CONTENTS

6.5.1 Menu

The menu includes measurement condition setup, function selection, system setup, and software information.

The measurement condition setup menu includes seven items: sampling length, evaluation length, measurement range, filter, parameter, C (RPC μm) setup, and C (RPC %) setup.

The function selection menu includes five items: print, graph, stylus position, showing value calibration, and statistic PC software.

The system setup menu includes five items: language, unit, LCD backlight, LCD brightness, and time calibration.

6.5.2 Graph

Via menu selection, the following graphs can be displayed on LCD: filter profile, no filter profile, supporting rate curve, Rk parameter graph, and direct profile (see section 2.4.2 for detailed operation). Via pressing shortcut key "Ra...", the supporting rate curve or Rk evaluation curve can also be displayed (please refer to section 4.1).

6.5.3 Parameter

Via parameter setup in measurement condition setup (see section 2.3.5 for details), following parameters can be displayed on LCD under basic measurement status: Ra, Rz, Ry, Rmax, Rq, RPC or Rk, Rpk, Rvk, Mr1, Mr2.

Via touching parameter key "Ra...", besides the parameters mentioned above, following parameters can also be displayed (see section 4.1 for more information): Rt, Rp, Rv, RS, RSm, RSk, Rz (JIS), and R3z.

6.5.4 Prompt information

Measurement information, storage information, reading information, error information, power capacity of battery, and shut-down prompt information

6.6 PROFILE AND FILTER

Table 1

Profile	Filter
Filter profile	RC
Filter profile	PC-RC
Filter profile	Gauss
Direct profile	D-P

6.7 SAMPLING LENGTH

There are three kinds of sampling lengths: 0.25mm, 0.8mm, and 2.5mm.

6.8 EVALUATION LENGTH

There are five sampling lengths (5L) in evaluation length.

6.9 ROUGHNESS PARAMETER AND DISPLAY RANGE

Table 2

Parameter	Display range
Ra	0.005 μ m ~ 16 μ m
Rq	0.005 μ m ~ 16 μ m
Rz	0.02 μ m ~ 160 μ m
R3z	0.02 μ m ~ 160 μ m
Ry	0.02 μ m ~ 160 μ m
Rt	0.02 μ m ~ 160 μ m
Rp	0.02 μ m ~ 160 μ m
Rv	0.02 μ m ~ 160 μ m
Rz (JIS)	0.02 μ m ~ 160 μ m
Rmax	0.02 μ m ~ 160 μ m
RSk	0 ~ 100%
RS	1 mm
RSm	1 mm
Rmr	0 ~ 100%

6.10 MEASUREMENT RANGE AND RESOLUTION

Table 3

Measurement range	Resolution
Auto	0.01 μ m ~0.04 μ m
\pm 20 μ m	0.01 μ m
\pm 40 μ m	0.02 μ m
\pm 80 μ m	0.04 μ m

6.11 POWER SUPPLY

One chargeable Li-ion battery for TR-220 instrument

6.12 TEMPERATURE/HUMIDITY RANGE

- Operating environment:
 Temperature: 0°C~ 40°C
 Humidity: < 90% RH
- Storage and transportation environment:
 Temperature: - 25°C~ 60°C
 Humidity: < 90% RH

6.13 EXTERNAL DIMENSION AND WEIGHT

The external dimensions of TR-220 instrument is 140x52x48mm, and the weight is about 440g.

6.14 PRINTER CONNECTION

Please only connect TA series printers, such as TA-210 and TA-220s, and print relevant print parameters.

6.15 PC CONNECTION

Standard RS-232 serial communication

7 DAILY MAINTENANCE AND REPAIR

- Avoid collision, intense vibration, heavy dust, moisture, oil pollution, strong magnetic field, and other unfavorable environment.
- Sensor is the precision part of instrument, and it shall be maintained carefully. Please put it back to the packing contains after each using.
- Please keep the attached standard template under proper condition, and prevent scuffing, else the instrument calibration may be inaccurate.

7.1 TROUBLESHOOTING

If failure occurs in this instrument, please try to solve according to the measures described in the following section "Failure information". If it cannot be solved, please return it back to the factory for repair. User shall not dismantle and repair it without authorization. For the instrument returned back to factory for repair, the warranty card and attached standard template shall be provided also, as well as description about failure.

7.2 FAILURE INFORMATION

Table 4

Failure	Reason	Measures
Beyond the measurement range	The maximal value of tested signal is beyond the measurement range.	Press exit key to return; Enter menu setup status, increase measurement range, and press exit key to return; Adjust the position of instrument, and let the position of stylus display at the middle as closely as possible. Measure again.
There is no measurement data	Measurement fails because of error operation.	Press exit key to return; Check whether the preparation before measurement is correct. Turn on. And measure again.
A/D chip error	Hardware circuit failure;	Schema 1: turn off and then turn on again; Schema 2: Press reset key; Schema 3: Return factory for repair;
Motor stops running	Mechanical failure;	Schema 1: turn off and then turn on again; Schema 2: Press reset key; Schema 3: Return factory for repair;
Sensor in return way	Sensor is in the auto return process	1. Press exit key to return; and wait the sensor returning to original position; 2. Measure again.
Instrument works		1. Turn off and then turn on again; abnormally 2. Turn off battery switch, and turn it on after 10 seconds;

8 REFERENCE MATERIAL

8.1 PROFILE AND FILTER

8.1.1 Profile

For this instrument, the parameter calculation is made according to filter profile and direct profile, and all calculations can meet the requirements of GB/T 3505-2000 "Geometric technical specification for product, surface structure, profile method, terms about surface structure, definition, and parameter".

- Original profile: only filter noise profile among the profiles picked up by sensor;
- Filter profile: the profile gotten from original profile after removing wave composition by roughness filter;
- Direct profile: the profile calculated from original profile via using least square method;

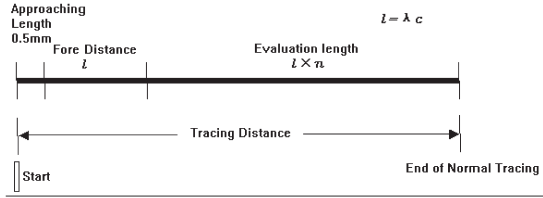
8.1.2 Filter

- RC: traditional second-order RC filter meeting the requirements of old standard, it is reserved in this instrument as a transition because it is also used by some users. Certain phase difference between input of filter and output signal exists.
- PC-RC: a filter gotten via digital phase correction based on RC filter, and its amplitude transfer characteristics are same as the ones of RC filter, but there is almost no phase difference. The amplitude parameters gotten from RC and PC-RC filters are same.
- Gauss (Gauss filter): the latest roughness filter, meeting the requirements of GB/T 18777-2002 "Geometric technical specification for product, surface structure, profile method, and measuring characteristics of phase correction filter".
- D-P: direct profile, adopting least square method

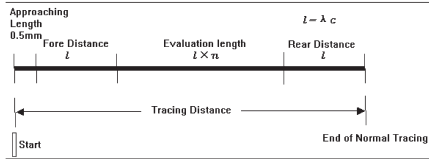
8.2 LENGTH OF DRIVE STROKE

The actual sliding length of sensor for this instrument is related with the selected filter and evaluation length, and please refers to the following figure when it is used.

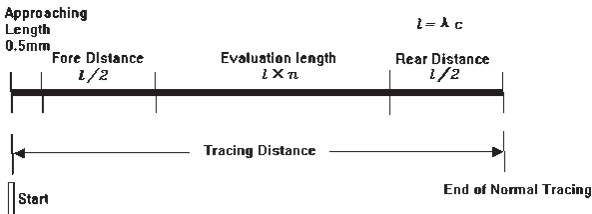
8.2.1 RC filter



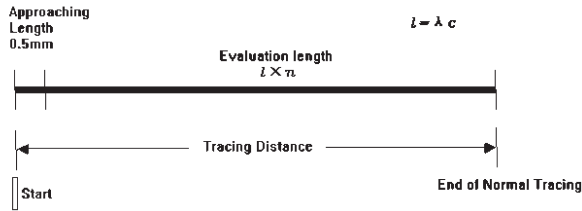
8.2.2 PC-RC filter



8.2.3 Gauss filter



8.2.4 D-P direct profile

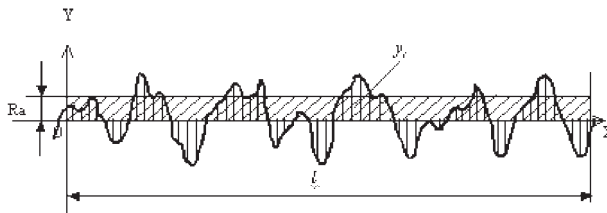


8.3 DEFINITION OF TR-220 ROUGHNESS PARAMETER

The parameter calculation for this instrument complies with GB/T 3505-2000 "Geometric technical specification for product, surface structure, profile method, terms about surface structure, definition, and parameter".

8.3.1 Arithmetic mean deviation Ra of profile

$$Ra = \frac{1}{n} \sum_{i=1}^n |y_i|$$



Get arithmetic mean value for absolute values of vertical coordinates in one sampling length:

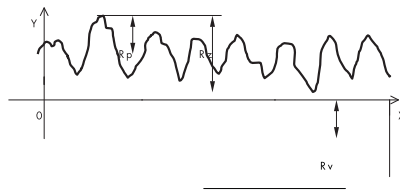
8.3.2 Root mean square deviation Rq of profile

Get root mean square value of vertical coordinates in one sampling length:

$$Rq = \left(\frac{1}{n} \sum_{i=1}^n y_i^2 \right)^{\frac{1}{2}}$$

8.3.3 Maximal height Rz of profile

The sum of maximal profile peak height Rp and maximal profile peak valley depth Rv in one sampling length.



8.3.4 Maximal height Ry of profile

Calculation method for Ry: calculate the distance between top of profile peak and bottom of profile valley in each sampling length, and get the maximal value among them, which is the Ry in evaluation length.

8.3.5 Total height Rt for peak and valley of profile

Sum of maximal profile peak height and maximal profile valley depth in evaluation length

8.3.6 Maximal peak height Rp of profile

Distance from top line of profile peak to middle line in sampling length;

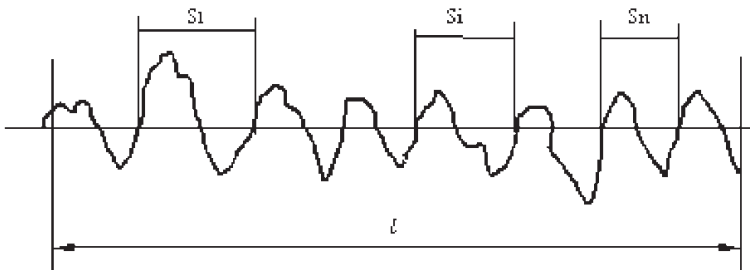
8.3.7 Maximal peak valley Rv of profile

Distance from bottom line of profile valley to middle line in sampling length;

8.3.8 Mean spacing for the microscopic roughness of profile RSm

Mean value of distances for microscopic roughness of profile in sampling length.

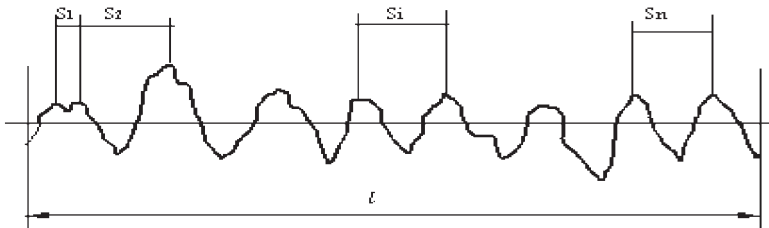
$$RSm = \frac{1}{n} \sum_{i=1}^{i=n} Si$$



8.3.9 Mean spacing between individual peaks of profile RS

Mean value of distances among peaks of profile in sampling length.

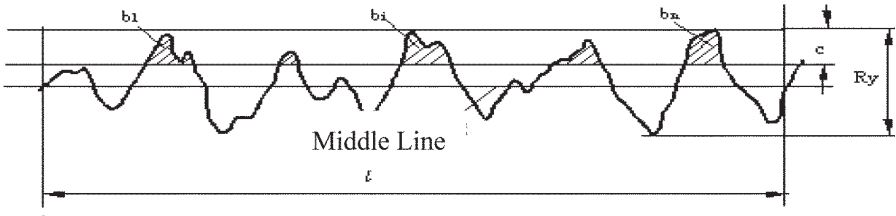
$$RS = \frac{1}{n} \sum_{i=1}^{i=n} Si$$



8.3.10 Supporting length ratio of profile Rmr

Ratio of profile supporting length to sampling length:

$$Rmr = \frac{\eta_p}{l}, \quad \eta_p = b_1 + \dots + b_i + \dots + b_n$$



8.3.11 Skewness of profile RSk

Measurement for the asymmetry of amplitude distribution, which will be determined via mean value of n profile offset distances in sampling length, and can be calculated via following formula:

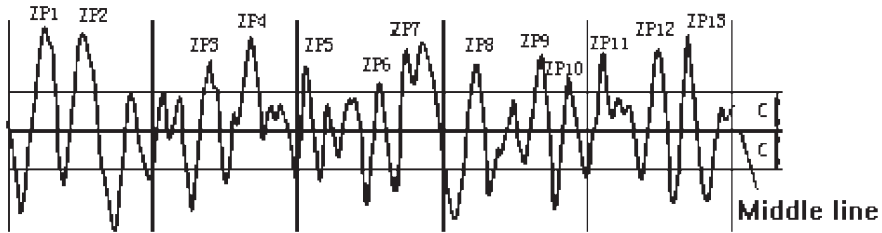
$$RS_k = \frac{1}{R_q^3} \times \frac{1}{n} \sum_{i=1}^n (y_i)^3$$

8.3.12 Mean value of height for the third peak valley R3z

R3z is the mean value of sum of the third profile peak height and the third profile valley depth for each sampling length in evaluation length.

8.3.13 Roughness peak counting RP_c

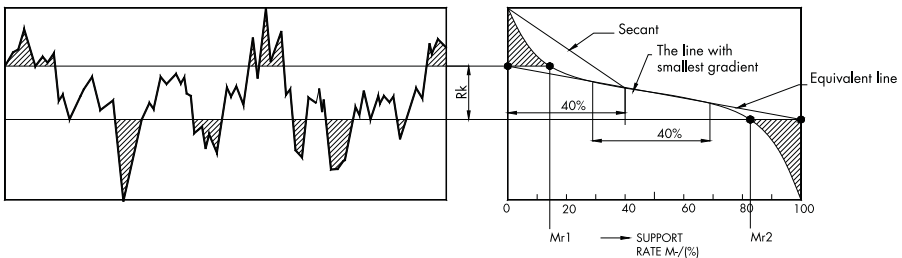
In the figure above, C is the distance from middle line to two lines paralleling to middle line. There are two kinds of methods for C selection: absolute method, where, C is the absolute value of actual distance; and percentage method. First determine the required C value for evaluation, and then calculate RP_c peak counts. One unit of peak count is composed of a peak higher than C and a valley lower than C. RP_c is calculated in evaluation length, and the formula is:



$$RP_c = \frac{\text{Peak counts}}{\text{Evaluation length (cm)}} = \text{Peak counts/cm}$$

8.3.14 Kernel roughness depth R_k

Depth of roughness kernel profile: as shown in the following figure, the line with smallest gradient among all $Mr=40\%$ secants is the equivalent line, and the vertical distance from equivalent line to the crossing point of $Mr=0\%$ and $Mr=100\%$ is R_k .

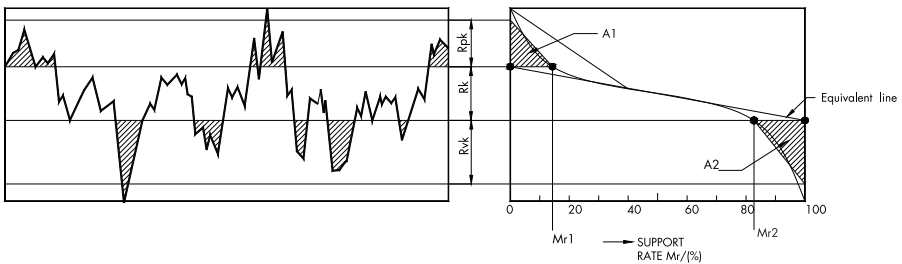


8.3.15 Supporting rate Mr1 and Mr2

Mr1 is the percentage value corresponding to the horizontal line determined by the intersecting line of roughness kernel profile and abrupt peak. Mr2 is the percentage value corresponding to the horizontal line determined by the intersecting line of roughness kernel profile and valley. As shown in the above figure, draw a horizontal line passing the crossing points of equivalent line and $Mr=0\%$ & $Mr=100\%$ to intersect with supporting rate curve, and the horizontal coordinates of crossing points are Mr1 and Mr2 respectively.

8.3.16 Removed peak height Rpk

The mean height of peak values higher than the kernel profile of roughness: as shown in the above figure, A1 is the triangle with same area as the peak area, bottom length is the distance from Mr1 to 0% length, and the height of A1 is Rpk.



8.3.17 Removed peak valley depth Rvk

The mean depth of valley values lower than the kernel profile of roughness: as shown in the above figure, A2 is the right triangle with same area as the valley area, bottom length is the distance from Mr2 to 100% length, and the height of A1 is Rk.

9 ATTACHED TABLES

9.1 THE MAGNIFICATION FACTOR FOR SCREEN DISPLAY

The following table gives the relation between magnification factor of LCD display and the full range of screen display. If the magnification factor doubles, the full range of screen display will be 1/2 of the original one. You can adjust it via pressing Enter key.

Magnification factor for screen display

Screen display

Full range

	x1	x2	x5	10x	20x	50x
±20µm	±20µm	±10µm	±4µm	±2µm	±1µm	±0.4µm
±40µm	±40µm	±20µm	±8µm	±4µm	±2µm	±0.8µm
±80µm	±80µm	±40µm	±16µm	±8µm	±4µm	±1.6µm

9.2 TABLE FOR THE RECOMMENDED SAMPLING LENGTHS

Ra (µm)	Rz (µm)	Sampling length (mm)
>5~10	>20~40	2.5
>2.5~5	>10~20	2.5
>1.25~2.5	>6.3~10	0.8
>0.63~1.25	>3.2~6.3	0.8
>0.32~0.63	>1.6~3.2	0.8
>0.25~0.32	>1.25~1.6	0.25
>0.20~0.25	>1.0~1.25	0.25
>0.16~0.20	>0.8~1.0	0.25
>0.125~0.16	>0.63~0.8	0.25
>0.1~0.125	>0.5~0.63	0.25
>0.08~0.1	>0.4~0.5	0.25
>0.063~0.08	>0.32~0.4	0.25
>0.05~0.063	>0.25~0.32	0.25
>0.04~0.05	>0.2~0.25	0.25
>0.032~0.04	>0.16~0.2	0.25
>0.025~0.032	>0.125~0.16	0.25
>0.02~0.025	>0.1~0.125	0.25

10 NON-WARRANTY PARTS

- Sheath of TR-100
- Pickup
- Battery
- Charger
- Communication cable

EC-DECLARATION OF CONFORMITY

This certifies that the following designated product
TR-220 (Surface roughness tester)
complies with the essential protection requirements of
Council Directive 89/336/EWG approximation of the laws of the
Member States relating to electromagnetic compatibility.

This declaration applies to all specimens manufactured
in accordance with the manufacturing drawings
which form part of this declaration.

Assessment of compliance of the product with the requirements relating
to the compatibility was based on the following standards:
EN55022, EN60555-2, EN60555-3, EN50082-1

This declaration is the responsibility of the manufacturer/importer:

Company name: INNOVATEST Europe BV
Address: Borgharenweg 140
Telephone / Telefax: +31-43-3520060 / +31-43-3631168
Name of the subscriber: Nicole Paulissen-Schiffer
Position: General Manager

Maastricht



City

Authorised representative signature

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