Scratch Tester
CSR-1000
Instruction Manual

Ver. 1.5 Second Edition

Issued on 2016 February

Accuracy and Reliability

RHESCA

<Blank page>

Safety Precautions

(Be sure to read the information below.)

To ensure safety during the use of this product, correct operation and regular maintenance are essential. Read through this manual carefully and sufficiently understand the safety precautions described in this instruction manual before using the product.

In this manual, safety precautions and other information that requires special attention to safety are described together with safety symbols indicating "warning" and "caution."

(1) Safety Symbols

Warning: Failure to observe the instruction with this symbol can result in death or serious injury to personnel.

Caution: Failure to observe the instruction with this symbol can result in minor injury or physical damage. Minor injury refers to any injury that does not involve long-term hospital visit or hospitalization for medical treatment. Physical damage refers to any damage to the product, or to the surrounding objects such as houses and property (consequential damage).

(2) Where to put the warning label

The following warning labels are attached to this product. Do not scratch or tear off the labels. In case the warning labels should be tainted or torn off, contact us or the agent from whom you purchased this product. (Refer to the end of this manual.)

1) **Warning about fuses (Fig. B-(1))**

To protect the product and the user from danger such as fire, be sure to use rated fuses. To avoid danger such as electric shock, turn off the product (switch: O side) and unplug the power cord when replacing an older fuse with a new one.

2) **Warning about grounding (Fig. B-(2))**

Failure to connect the product to the ground can result in electric shock. Use the grounding terminal on your distribution panel to properly ground the product. Do not use a water pipe as a grounding terminal because it is often made of non-metal. Do not use a gas pipe either for safety reasons.

Fig. A CSR-1000 Main unit

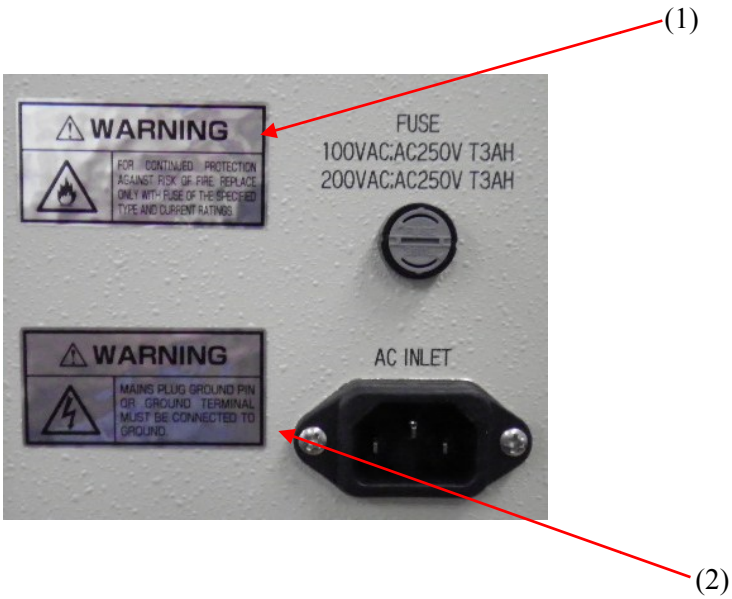


Fig. B Warning label location

Preface

This manual is a guidebook of the CSR-1000 Scratch Tester. This manual is prepared for both beginners and experienced users. Even experienced users can find it useful to clarify and confirm their knowledge and experiences on this product. Carefully read through and sufficiently understand the manual before using the product. Keep this manual nearby for handy reference. After use, keep the manual in good custody. In case you should lose this manual, contact us, or the agent from whom you purchased this product.

Contact: Person in charge of scratch tester, Technology Department , RHESCA Co., Ltd.
1-15-17 Hino-honmachi, Hino-shi, Tokyo, 191-0011 Japan
TEL: +81-42-582-4711
FAX: +81-42-589-4686

Cutomer Service

When you need customer service, firstly verify the condition of your product before contacting us, or the agent from whom you purchased the product.

Consumable supplies are also available. Contact us, or the agent, specifying the items you need. If you are unsure of the names of the items, provide us with the model name of your product.

We do not accept any contaminated part or product that can pose a danger to public health.

Disclaimer

1) RHESCA is not liable for any direct or indirect damage that may occur as a result of using this product.
2) Prohibited items regarding the use of the accompanying Software:
   - You may not reproduce a whole or part of the Software or pertinent material for any purpose other than backup without RHESCA's approval.
   - You may not transfer, sell, or license the Software to third parties.
   - You may not disclose the Software to any third party
   - You may not modify or adapt the Software.
   - You may not use the Software through a network or by any other means on two or more workstations or terminals.
3) This instruction manual is subject to change without prior notice as improvements are made from time to time.
4)
5) RHESCA has made every effort to produce this manual. However, if you have any questions, or if you find errors, omissions, etc., please let us know.
6) The Manual shall not be construed as license of the use or exercise of any intellectual property right, such as patent right or copyright.
7) Company names and product names are trademarks or registered trademarks of their respective owners.

Installation Conditions

For safety operations, observe the following conditions:

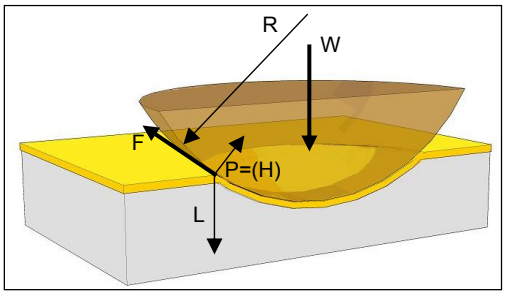
1) Use the product indoors.
   Note: Power supply voltage should not fluctuate 10% more or less than the rate value. Otherwise, a failure may occur.
2) Use a 3-pin plug (with a third earth pin), or a 2-pin plug with a grounding terminal as the power plug. When your plug is a 2-pin type, use the accompanying plug adapter. Be sure to connect the grounding wire to earth ground.
3) Use the product in an environment where temperature fluctuations are small.
   Ambient temperature range should be 5- 40°C.
4) Ambient humidity range should be 80%RH or lower.
5) Ambient atmospheric pressure range should be 750-1060 hPa.
6) The product should not be exposed to a strong magnetic field or high frequency waves.
   Normal operation may not be ensured when the product is near a source of strong magnetic lines or high frequency waves.
7) Avoid shock and vibration.
8) Avoid exposure to dusts and harmful gases such as corrosive gases.
9) Avoid exposure to direct sunlight.
10) Avoid exposure to direct wind from air-conditioners.

Note: These conditions shall not be construed as those that guarantee the performance and specifications of the product.

Technical Terms

This Instruction Manual includes technical terms used somewhat differently from their general meanings. These terms are defined in this chapter to help you better understand their meaning. Refer to this chapter for their meaning or definition when you read the technical description in Chapter 3 of this manual.

1) Scratch test method



The scratch test method can be performed for a film with high adhesion strength, such as the superalloy films of machine tools. In this scratching method, a hard (diamond) indenter (with a fixed curvature radius) is pressed on a film surface (Fig. C) and then the film surface is scratched while gradually increasing the applied load in order to calculate the film adhesion strength based on the load value (critical load value) at which destruction of film occurs. When the shear stress (which affects an interface when the indenter is pressed on the film surface and is used to make scratches) becomes higher than the film adhesion strength, fracturing at the interface occurs.
To detect the destruction of film, the friction force of load cells is monitored to detect changes associated with destruction. Besides the above, there is also a film destruction detection method (Acoustic Emission (AE) measurement method) where a microphone is used to detect sounds associated with destruction. Although both methods can be used to calculate a fracture point (or destruction point), it is necessary to observe the scratch traces using a microscope or similar tool and locate the point of destruction in order to increase the accuracy of the measurement result. Based on the critical load value (W) obtained, the film adhesion strength (F) can be found by using the following formula in terms of maximum stress that affects an interface at the periphery of indentation. (R: Curvature radius of indenter, H: Brinell hardness of a substrate)

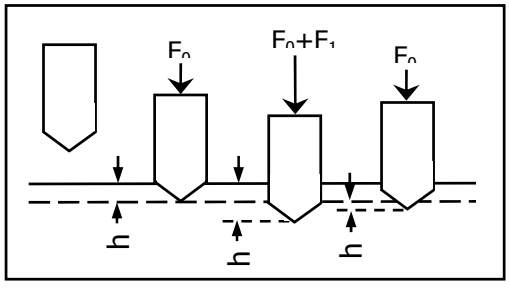
$$F = \frac{H}{\sqrt{\frac{\pi H}{W} R^2 - 1}}$$

2) Critical load
The critical load is a load applied to the indenter when a thin film has been separated from its substrate.

3) Scratching speed
This is the moving speed of a indenter with respect to a sample. When the CSR-1000 Scratch Tester is used, the stage moves with a sample placed on it. The setting range is from 0.01mm/second to 2mm/second.

4) Stress signal
This signal is the output of load cells in the Y-axis direction of a sensor. The output is in proportion to the friction force of film surface.

5) Rockwell superficial hardness measurement method



This measurement method complies with the JIS Z2245 standard method. As shown in Fig. D, an initial test force is applied at first and then a test force is applied. The load value is returned to the initial test force and the test force is applied in this method. The above procedure finds the hardness from the difference (h) in the indentation depths of a indenter between first and second time of applying the initial test force. The

indenter is made of diamond, steel, or cemented carbide balls that have a tip like a cone with an angle of 120 degrees and a radius of 0.2mm. The symbol “HR” is used to express the hardness value and it is standardized in accordance with the type of indenter, initial force, and test force. An initial test force of 29.42N (3Kgf) is applied to measure the Rockwell superficial hardness of a material.

Fig. D Rockwell hardness

Product Warranty

This warranty is valid for a period of one year from the delivery date of the product. Should this product be defective due to our fault, we will repair it free of charge.

Products under warranty:

Main unit, excluding consumable supplies such as chip.

Warranty Coverage:

1) Damaged products during shipment or transportation
2) Products that are used under proper operational conditions in terms of, for example, temperature range and supply voltage, but fail to satisfy basic specifications.

The following failures and items, however, are not covered by the warranty even if they are still under warranty period.

1) Failures arising from improper installation conditions.
2) Failures arising from improper usage
3) Failures arising from the fact that the product has been moved, repaired, or modified after installation by anyone other than us, or our authorized agents
4) Failures arising from the use of unspecified parts
5) Failures arising from the use of parts significantly deteriorated by strongly corrosive solvents, or sample liquids.
6) Failures or damage arising from natural disaster such as fire, floods, or earthquakes.
7) Failures or damage arising from war or armed conflict
8) Consumables or parts that are not under warranty period

Note that when any part is repaired, the warranty period for the repaired part also starts from the first delivery date.

Repair of products that are out of warranty period:

We take all possible measures to provide you with good customer service even when your product is out of warranty period. Contact us, or the agent from whom you purchased the product, and make sure if it can be repaired. Do not forget to specify the model name of your product. The defective product shall be repaired at your own expense.

Contents

1 Unpacking and Inspection

When unpacking, check all the accessories included in the package. If accessories should be missing or damaged, contact us or the agent from whom you purchased the product.

- Sensor

Fig. 1-1 Sensor

- Diamond chip

Fig. 1-2 Diamond chip

- Power cord

- Calibration jigs (optional)

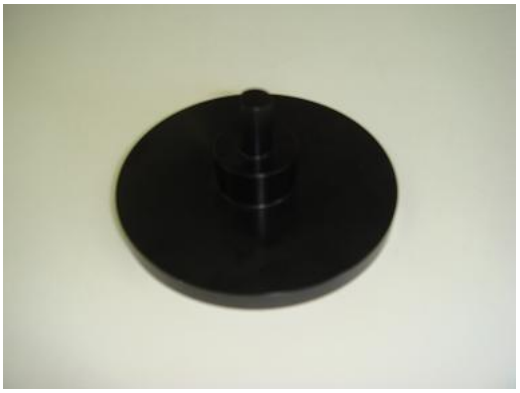


Fig. 1-3 Load axis calibration jig

Fig. 1-4 Stress axis

・ AE sensor, AE sensor amplifier, and BNC cable (optional)

Fig. 1-5 AE sensor and BNC cable

Fig. 1-6 AE sensor amplifier

・ Hardness measuring stage and standardized hardness test block (optional)

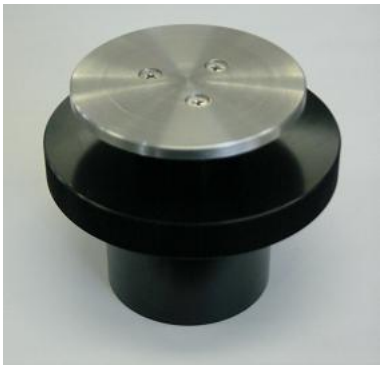


Fig. 1-7 Hardness measuring stage

Fig. 1-8 Standardized hardness test block

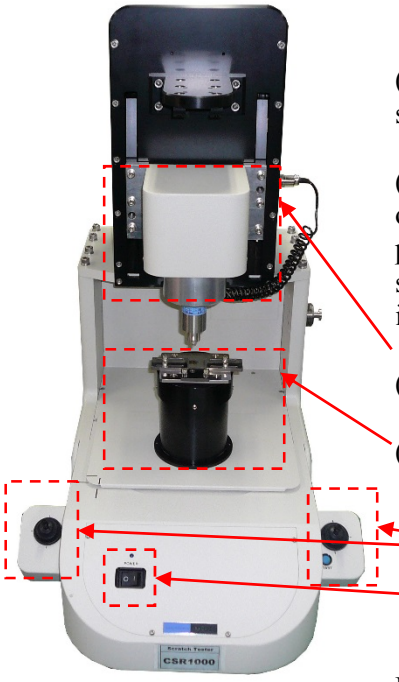
・

・ Data loading software and USB cable

・ This Instruction Manual

2 Scratch Tester Familiarization

2-1 Scratch Tester Front Side



(1) The power switch is located on the front of the main unit. When the scratch tester is turned on (switch: 1 side), a blue LED lights.

(2) The joysticks for moving the sample stage and sensor are provided on both sides of the main unit. Use the left joystick to move the head part of the upper main body up and down and right joystick to move the sample stage forward and backward and left and right. For more information, refer to “5-3-1 Joysticks”.

(3) The head part to which a sensor is attached is located here.

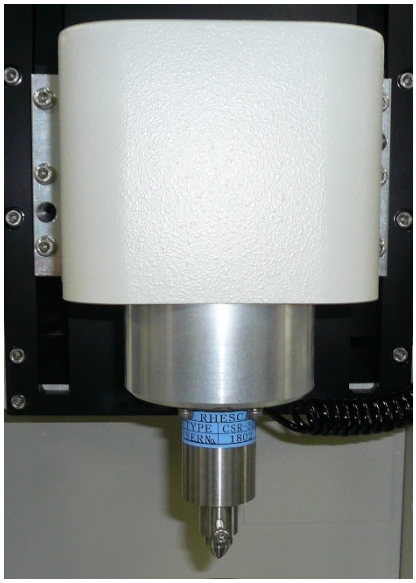
(4) The sample stage that holds a sample is located under the sensor.

(2) Joysticks

(1) Power switch

Fig. 2-1 Front view of main unit

2-2 Sensor Section



The sensor is attached to the head part in the upper front side of the main unit (see Fig. 2-1-(3)).
The diamond chip is attached to the sensor.
To attach and detach the sensor, see “5-4 ”.

Fig. 2-2 Sensor section

2-3 Periphery of the Sample Stage

The holder for fixing a sample is provided on the sample stage.

The holder can be customized in accordance with requirements of user samples.

Fig. 2-3 Periphery of the sample stage

2-4 Scratch Tester Rear Side

The AC INLET and USB terminal are located on the back panel of the main unit.

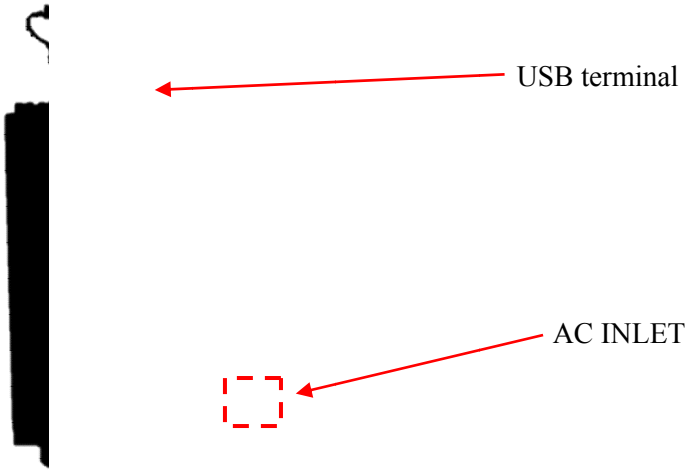


Fig. 2-4 Rear view of main unit

3 General Information

3-1 Introduction

CSR-1000 Scratch Tester measures surface characteristics and adhesion strength between a hard film or plated film (formed by Physical Vapor Deposition (PVD) or Chemical Vapor Deposition (CVD)) and a base material by scratching the film surface with an applied load.
In addition, CSR-1000 Scratch Tester uses a simple function to perform the Rockwell superficial hardness measurement and Acoustic Emission (AE) measurement.

3-2 Operating Principle (I)

The diamond indenter is attached to the tip of a load sensor that senses two axes. The load sensor is moved on the film surface in a horizontal direction while gradually increasing the load. The critical load value (such as film adhesion strength and fracture strength) at the time of the above operation is calculated.

As shown in Fig. 3-1, when the applied load (W) is gradually increased, the surface of a thin film starts to wear and eventually destruction or fracture of the film occurs. By analyzing the change in the load sensor output signal during the above process, the point of film fracture can be identified and the load value applied at the time of fracture is measured. This load value is referred to as the critical fracture load value. The scratch tester is used for selecting the film forming conditions and confirming the condition of the formed film by checking the critical fracture load value of a thin film.

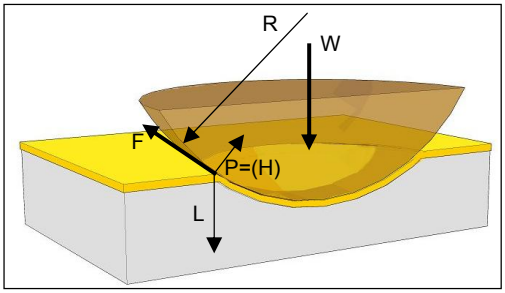


Fig. 3-1 Operating principle of Benjamin Weber

Based on the critical load value (W) obtained, the film adhesion strength (F) can be calculated using the following formula in terms of the maximum stress that affects an interface at the periphery of indentation. (R: Curvature radius of indenter, H: Brinell hardness of a substrate)

$$F = \frac{H}{\sqrt{\frac{\pi H}{W} R^2 - 1}}$$

Furthermore, CSR-1000 Scratch Tester can receive the acoustic signals produced during film destruction or fracture using an AE sensor (which makes contact with the underside of a sample) while the scratch test is performed. (The AE sensor is optional.)

3-3 Operating Principle (II)

The Rockwell superficial hardness measurement is performed in the following manner: the initial test load (Z axis) is applied in the direction vertical to the target film surface (depth: h1μm) without scratching a film surface, with movement fixed in the horizontal direction; the applied load is increased until the preset test load value; the load is maintained for a certain time after reaching the preset test load value (2 seconds when using this tester); and then a load same as the initial test load value is applied. (Depth after restoring the initial load value: h2μm)
The hardness “H” is displayed based on the following formula for calculating the difference in the indentation depths (h2 – h1 (μm)) of the diamond cone between first and second time of applying the initial test load.

H = 100 - (h2 – h1)

Cautions: To perform the hardness measurement, an optional hardness measuring stage and standardized hardness test block are required.

*** Use the dedicated stage for performing the scratch test and hardness measurement.**

3-4 Data Graphs Obtained from CSR-1000

When CSR-1000 Scratch Tester is used, the applied load (red) and stress (blue) signals are output from the attached load sensor. When the applied load increases, the friction force becomes higher and causes the stress signal to increase. The output signals change in accordance with the condition of the film surface. When the shear stress (which affects an interface when the indenter is pressed on the film surface to make scratches) becomes higher than the film adhesion strength, it causes interface fractures. When the applied load is low and before a film fractures, the film surface is smooth and therefore stress signals gradually increase as shown by portion (a) in Fig. 3-2. When the applied load exceeds critical point and the film fractures, the film surface becomes rough and the stress signal fluctuates significantly as shown by portion (b) in Fig. 3-2.

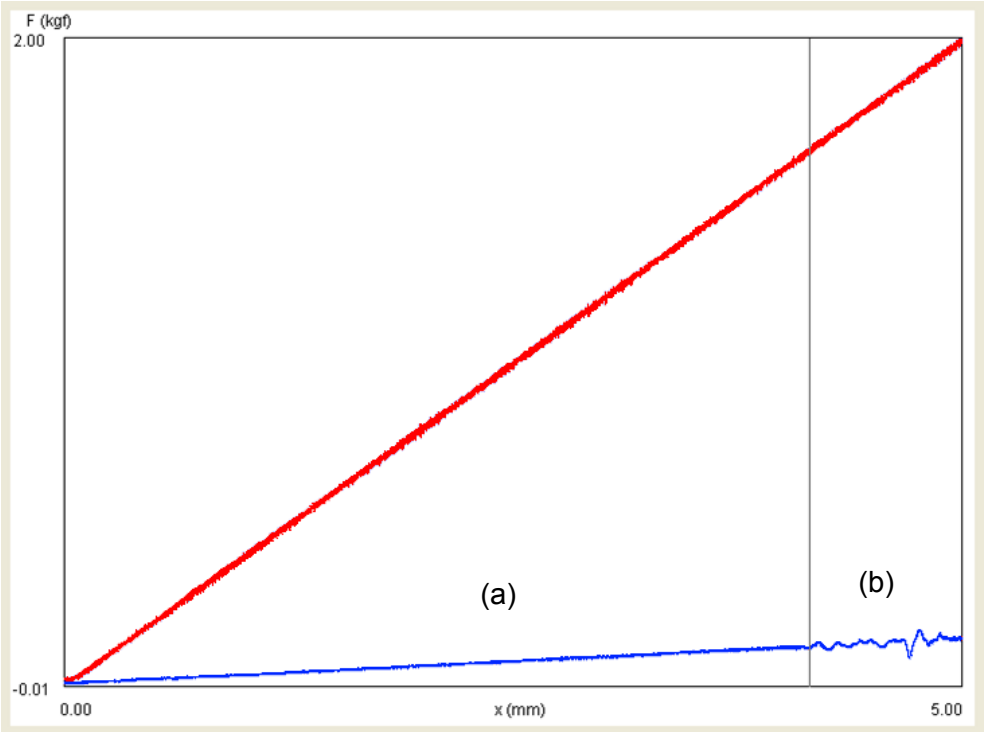


Fig. 3-2 Example of measured data graph

3-5 Comparison Between Measured Data Graph and Fracture Surface Observation Photo Through a Metallurgical Microscope

CSR-1000 Scratch Tester moves a sample as it applies the load to the sensor. As a result, linear scratch traces caused by pressure are produced on the sample surface. These scratches are referred to as scratch traces. In the previous section, there is an example of the measured data graph. You can identify a fracture point based on the measured data graph. If you, however, compare the measured data while observing scratch traces on the film surface through a microscope, you can identify a critical point more accurately. Fig. 3-3 shows an example of the measured data graph (enlarged display of stress only) compared with the observed microscope photograph.

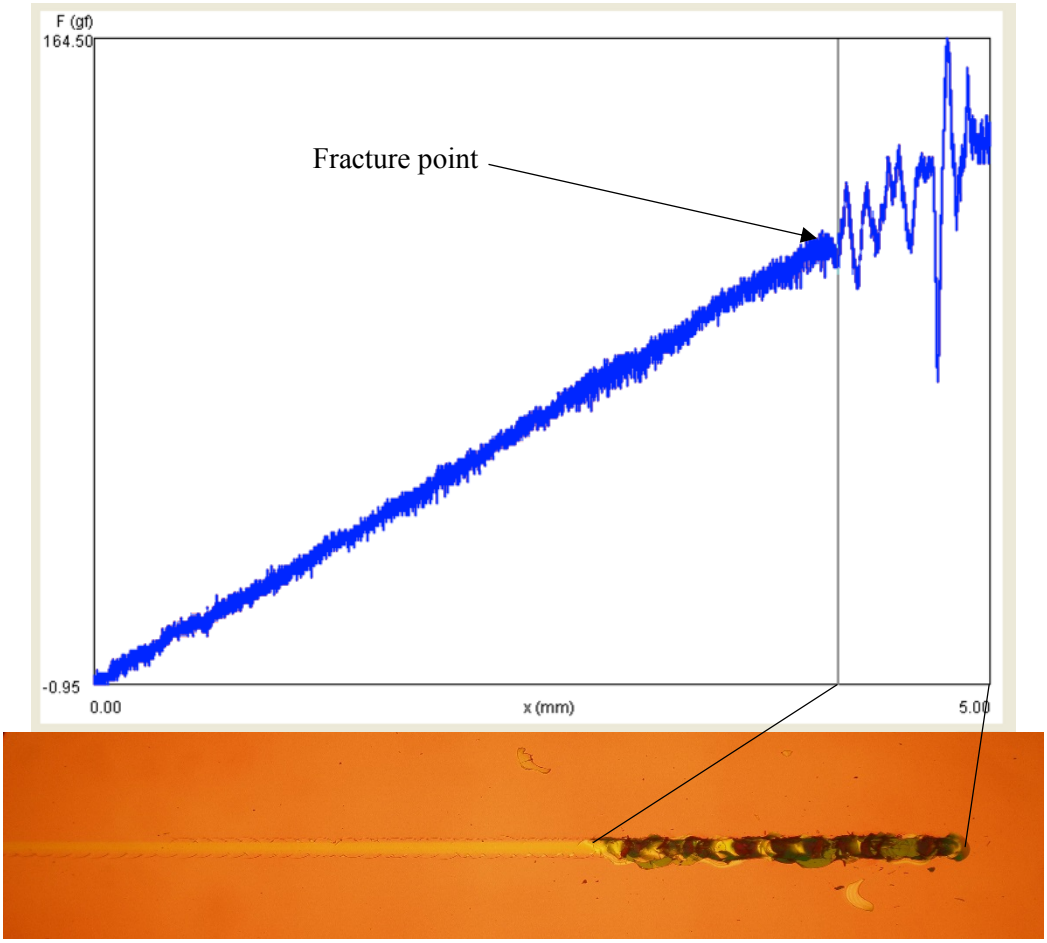


Fig. 3-3 Comparison between measured data graph and optical thin-film fracture surface observation photo through a metallurgical microscope

3-6 System Configuration

CSR-1000 Scratch Tester consists of a sensor section for scratching a film surface, load control section, scratching speed control section, and data processing section. Fig. 3-4 shows the configuration of this system.

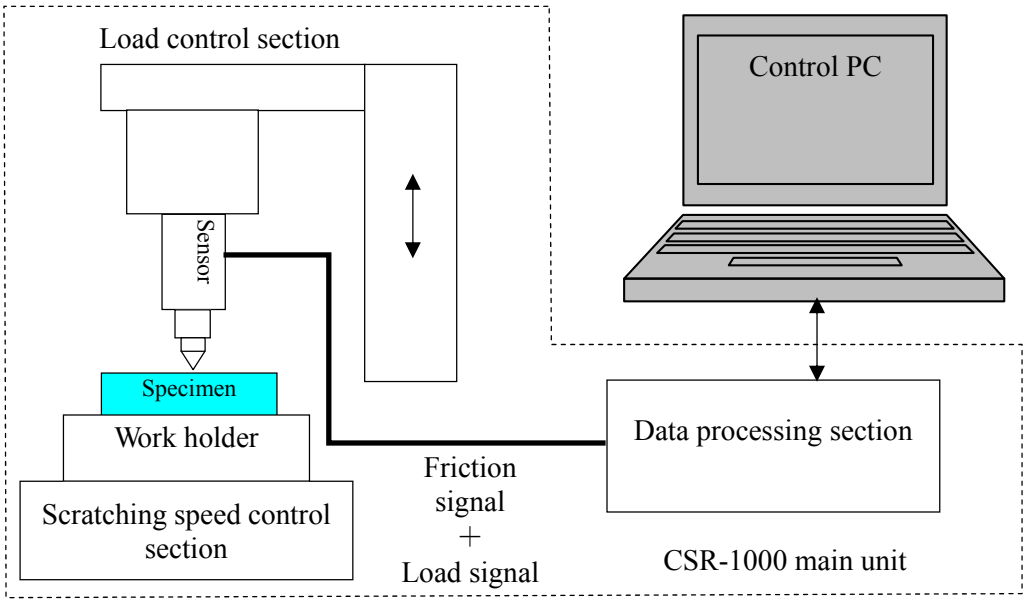


Fig. 3-4 System configuration

Basic operation is as follows:

1. Make sure that the main unit of CSR-1000 and your control PC are properly connected. (5-1)
2. Turn on the CSR-1000 main unit and the control PC.
3. Start the CSR-1000 control program on your PC.
4. Calibrate the load sensor. (Guideline: Perform calibration once a year.)
5. Attach the load sensor to the main unit. (This step is required only when the load sensor is removed.)
6. Measure the spring constant. (Guideline: Perform measurement once a year.)
7. Mount a diamond chip on the sensor. (This step is required only when the chip is removed.)
8. Fix a specimen.
9. Operate the joystick to move the tip of the chip to the measuring location of a sample.
10. Set required measurement parameters on the PC.
11. Start measurement.

4 Installing the Software

CSR-1000 Scratch Tester has been designed and produced to be used with software.
Be sure to install the software when you set up the tester.

・License Agreement

This software is licensed to be used on one computer only.
RHESCA Co., Ltd. owns the copyright of this software.

・Limitation of Liability

RHESCA is not held responsible for any derivative, collateral, and/or indirect damage (including damages caused due to loss of operating profit, interruption of business, loss of marketing data, etc.) caused by using this software, even if a third party gives prior notice of the possibility of such damage.

・Operating environment

PC: AT-compatible desktop machine with USB port
CPU: Pentium 4　2GHz or higher
Memory: 2GB or higher
OS supported:　Windows 7, Windows 8, Windows 8.1
Display: Resolution 1024x768 or higher, 32-bit color

・Cautions

- Some of notebook computers cannot run this software.
- RHESCA does not guarantee operation of this software on OS other than the abovementioned.
- This software may be changed without prior notice for improvement.
- When the screen saver or system standby state is activated, measured data may not be received any more.

This manual contains screens of this software for explanation. The screens are of the software operated on Windows 7.
Nevertheless, the basic operations are the same on either Windows version.

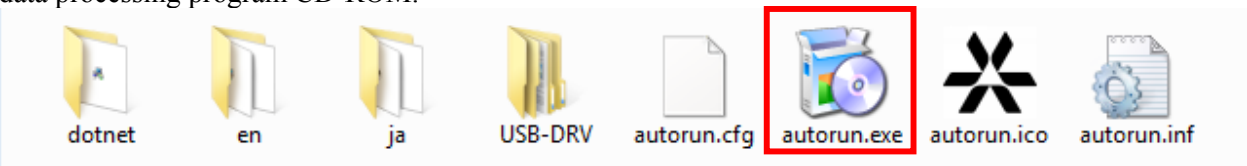
4-1 Installing the USB Driver for Windows

Login as administrator to install the software.

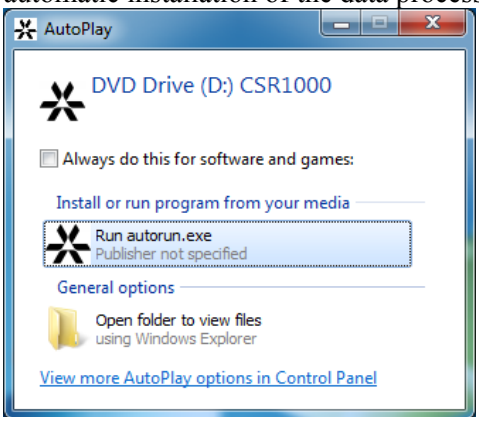
Do not turn on the CSR-1000 main unit and connect the USB cable between CSR-1000 and your computer until you have installed the USB driver.

(1) Insert the CD-ROM containing the CSR-1000 data processing program into the CD drive of your computer.

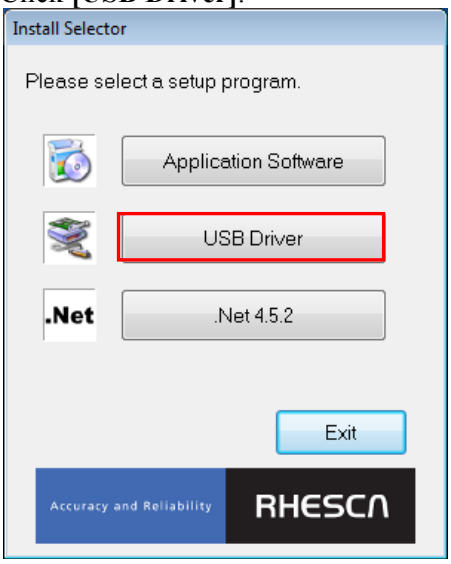
If “software and games" in “AutoPlay Settings Menu” is set to “Install or run program form your media”, the installation program executes automatically.
If the program does not execute automatically, manually select and execute "autorun.exe" in the data processing program CD-ROM.



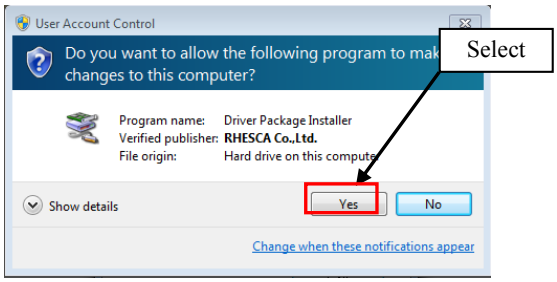
(2) On Windows Vista or Windows 7, you are prompted to confirm whether or not to execute automatic installation of the data processing program. Select "**Run autorun.exe**"



(3) The "**Install Selector**" dialog appears.
Click **[USB Driver]**.

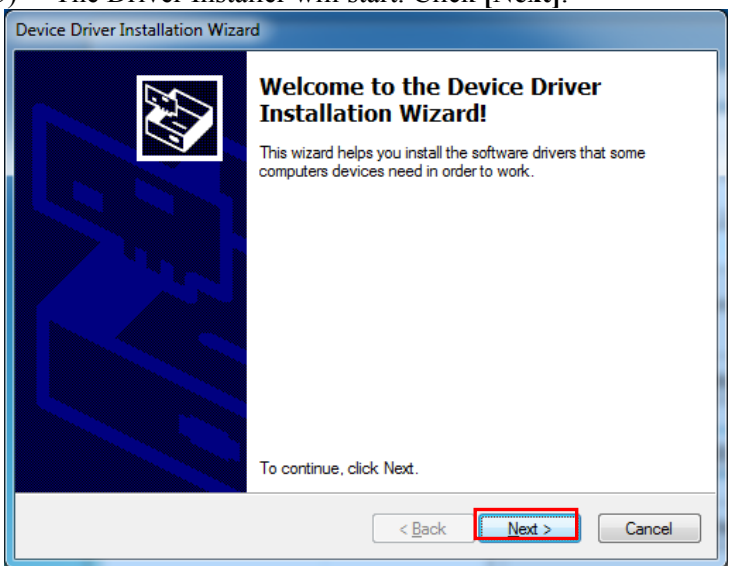


(4) On Windows Vista or Windows 7, if your user account control is enabled, the "**User Account Control**" dialog will appear. Click **[Yes]** or **[Allow]** in this dialog.



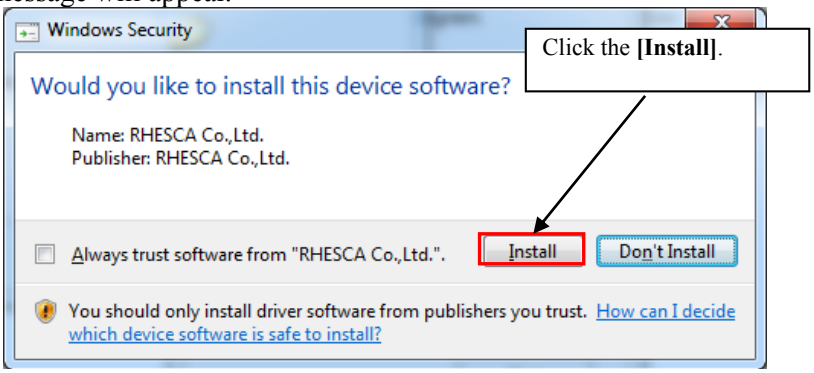
Windows 7

(5) The Driver Installer will start. Click **[Next]**.



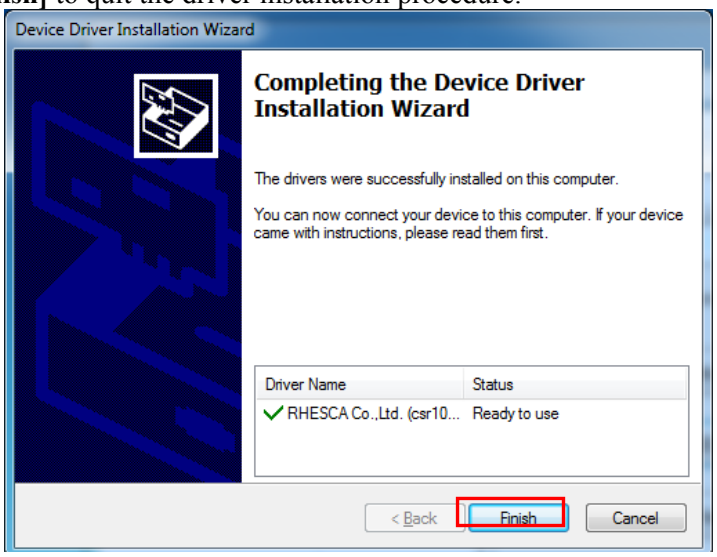
(6) Installation of the driver will start.
On Windows 7, a warning message for issuer verification will appear, click "**Install this driver software anyway**"

Note: Since RHESCA's USB driver does not have an electronic signature, a warning message will appear.



Issuer verification for Windows 7

(7) After the driver is installed, a dialog similar to the one below will appear. Click **[Finish]** to quit the driver installation procedure.



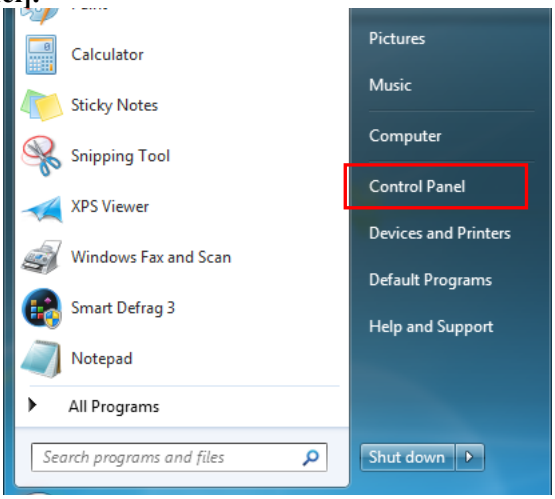
Once the computer recognizes the driver correctly, it will identify CSR1000 as "Rhesca CSR."

4-2 Uninstalling the USB driver

Caution	**If you add the USB driver using Automatic Detect for device or Device Manager instead of installing the driver using the Driver Installer, you cannot uninstall the driver.**

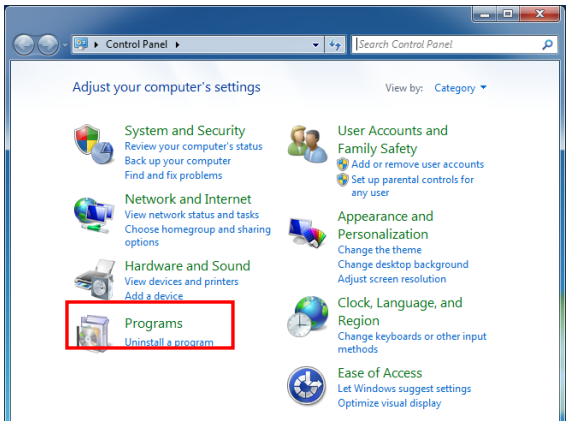
Select **Control Panel** > **Add or Remove Programs**.

(1) Open **[Control Panel].**



Windows 7

(2) From **[Control Panel]**, select **[Programs]**.



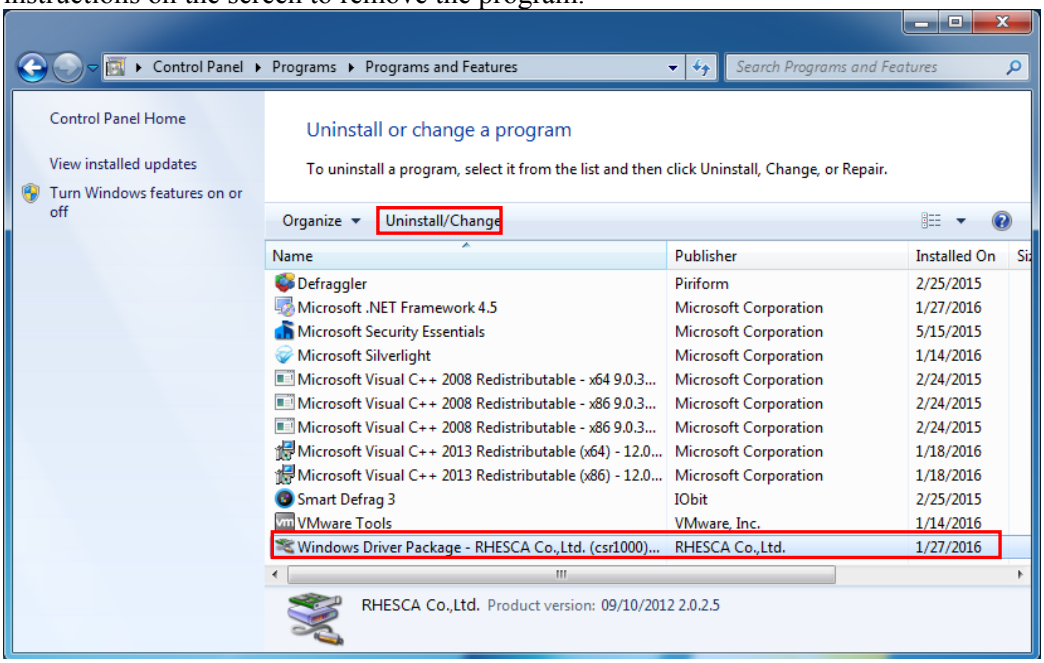
Windows 7

On Windows 7, click **[Uninstall a program].**

(3)Select "CSR-1000" from the list of installed programs displayed in the window and remove the program.

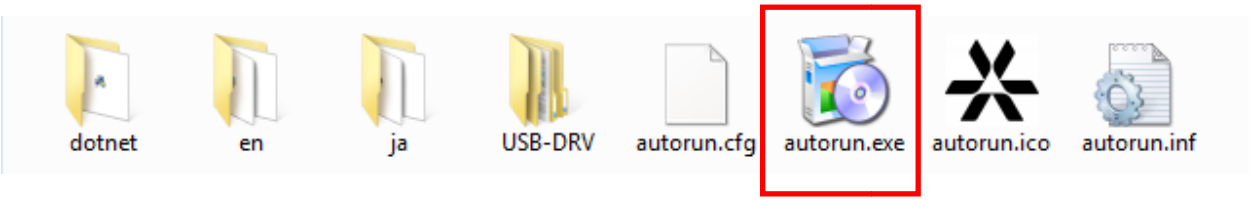
Windows 7:

Select "**RHESCA Co.,Ltd. (csr1000) USB**" and click **[Uninstall/Change]**. Follow the instructions on the screen to remove the program.

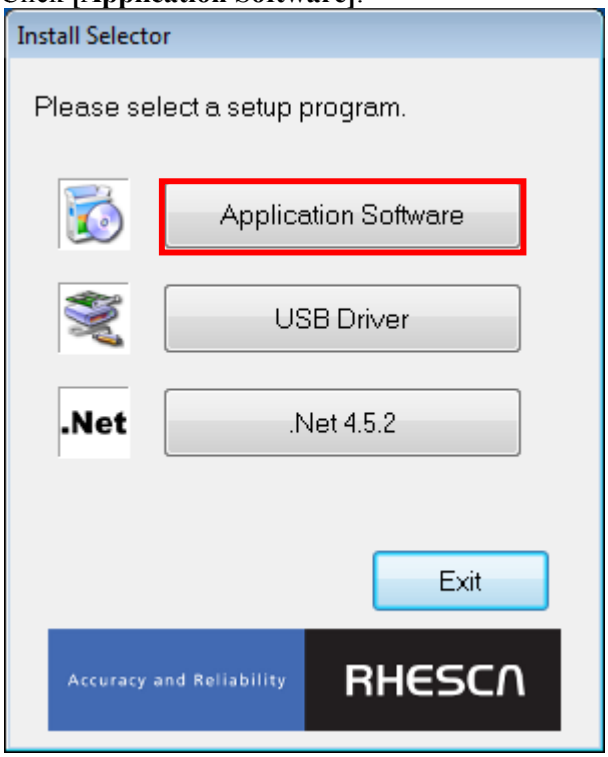


4-3 Installing the application software

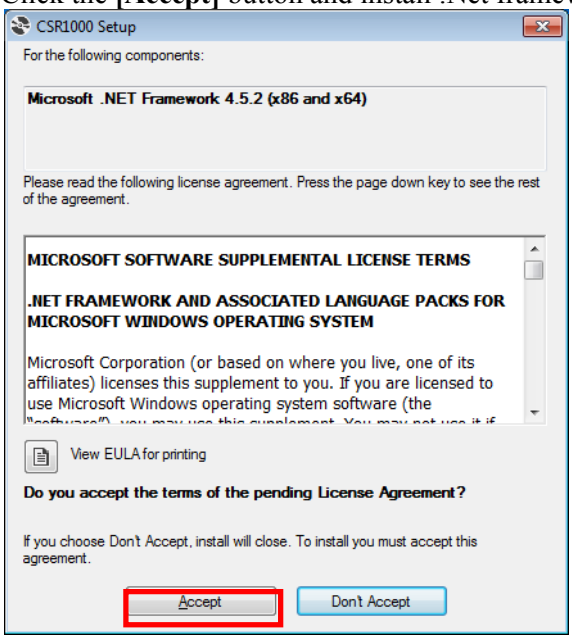
Execute "autorun.exe" in the CSR1000 program CD-ROM.



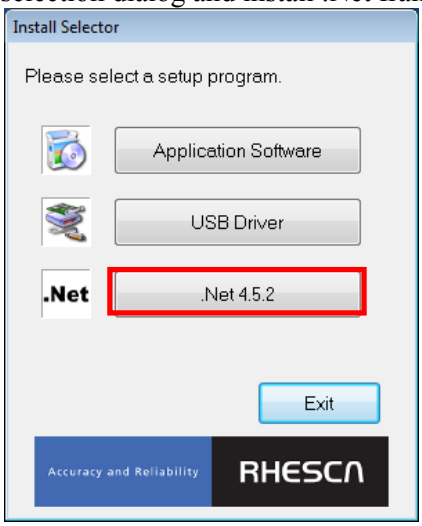
The "**Install Selector**" dialog appears.
Click **[Application Software]**.



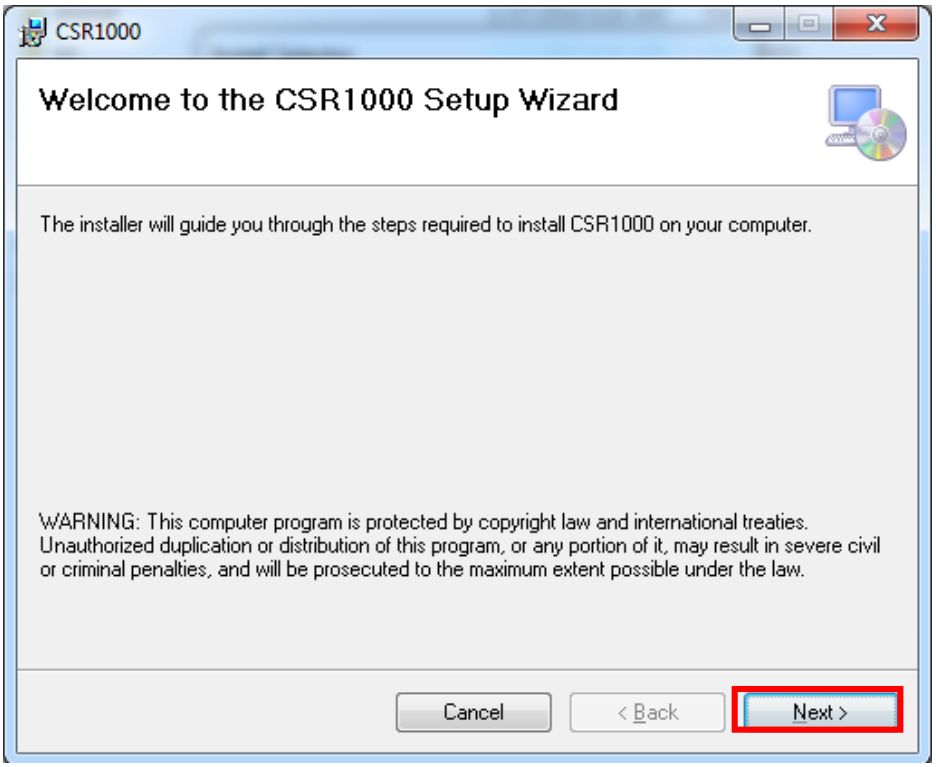
Installation of the CSR1000 program is performed.
If .Net framework 4.5.2 is not installed on your computer, installation of .Net framework 4.5.2 will be performed.
Click the **[Accept]** button and install .Net framework 4.5.2.



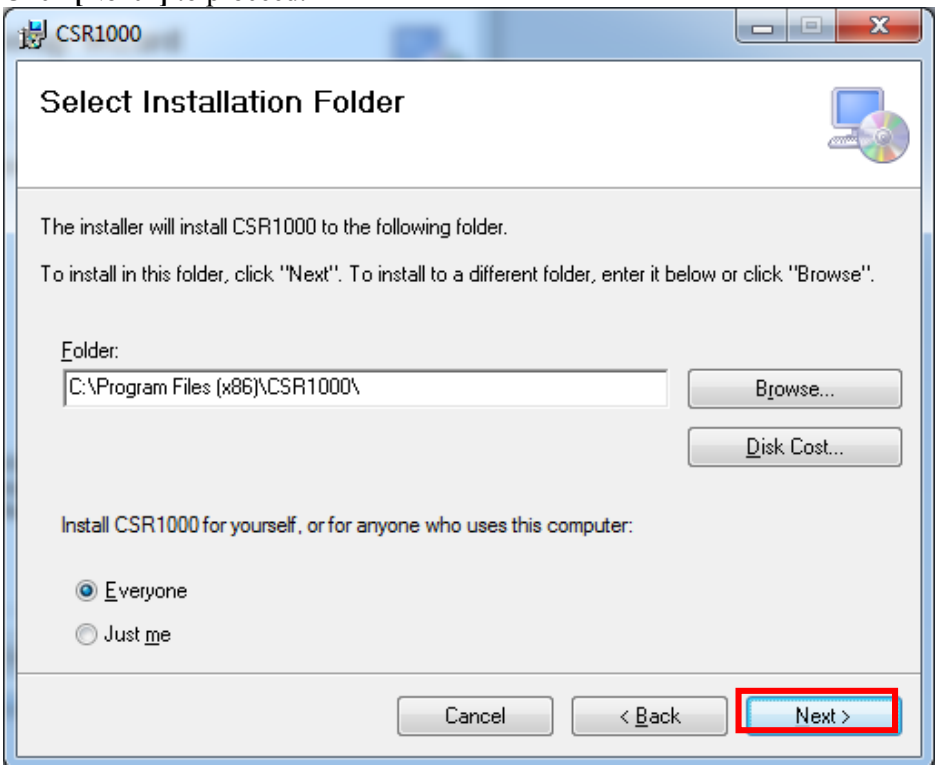
If .Net framework 4.5.2 installation does not start, click **[.Net 4.5.2]** in the installation target program selection dialog and install .Net framework 4.5.2.



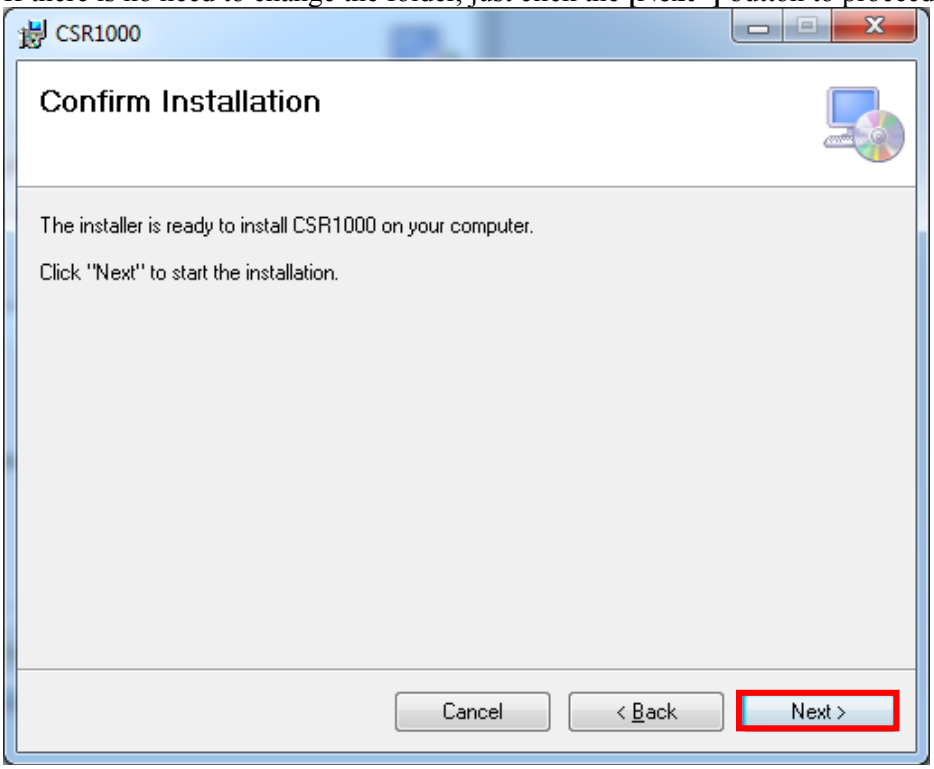
When .Net framework 4.5.2 is installed, CSR1000 program installation will start.



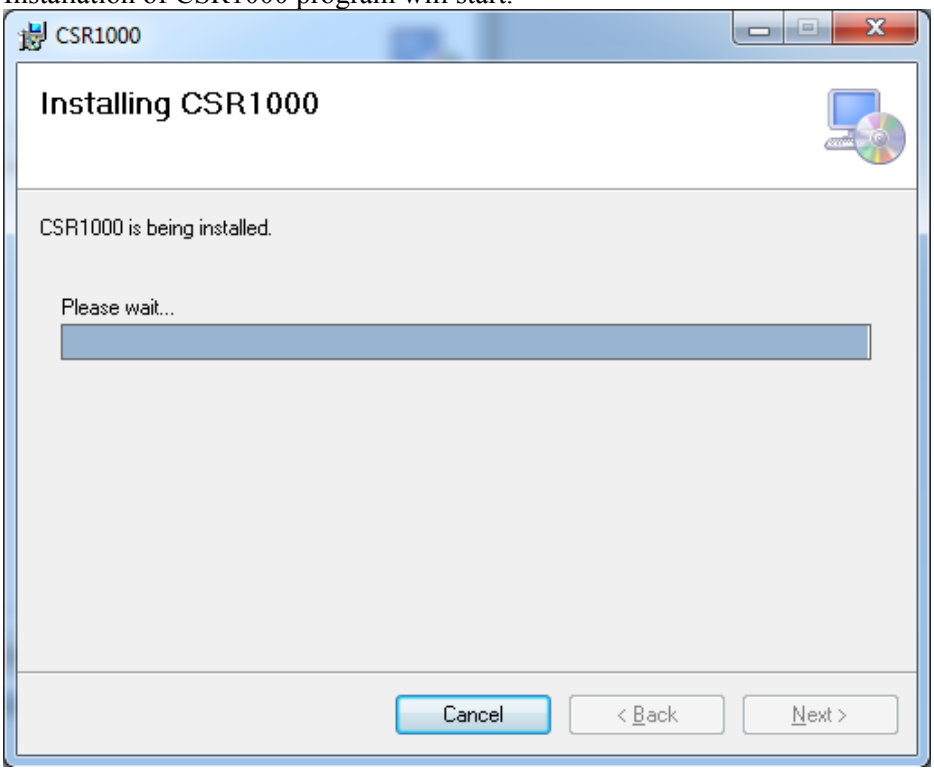
Click **[Next>]** to proceed.



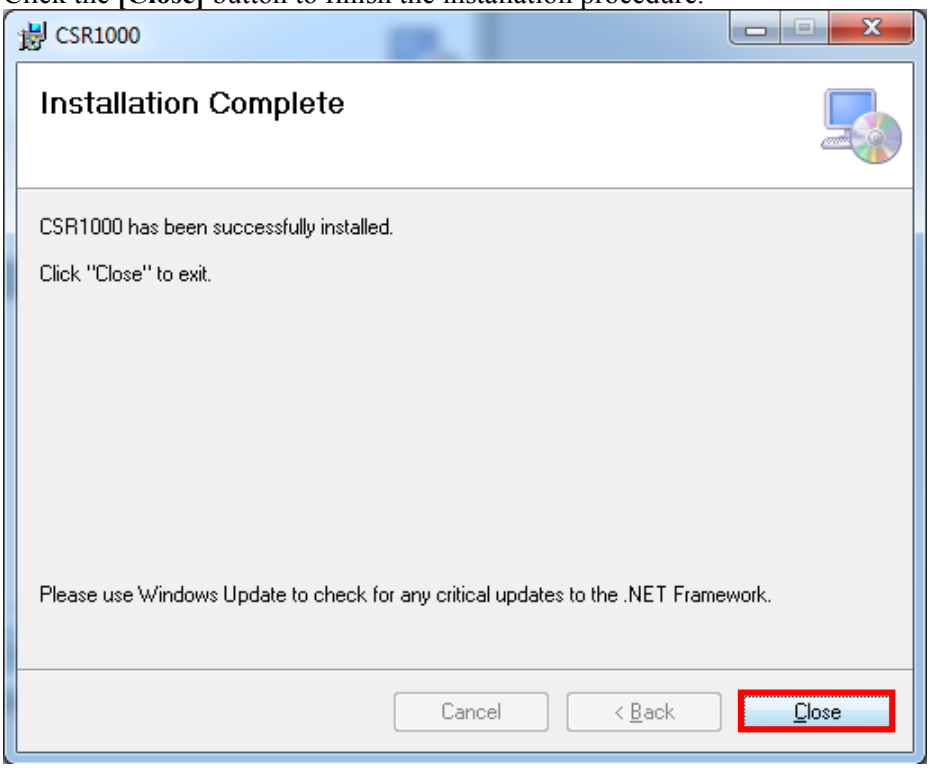
The window for selecting the folder in which the software is installed appears.
If there is no need to change the folder, just click the **[Next>]** button to proceed.



Installation of CSR1000 program will start.



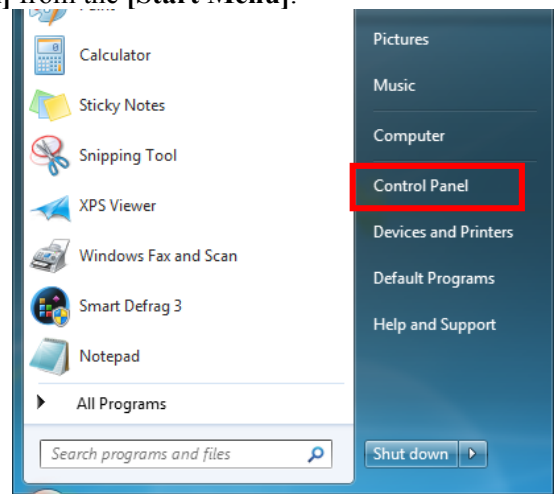
When installation of CSR1000 program is completed, the installation complete window appears. Click the **[Close]** button to finish the installation procedure.



4-4 Uninstalling the CSR1000 Data Processing Program

Upgrading a CSR1000 data processing program will require the uninstallation of older programs. To uninstall older programs, go through the following steps.

(1) Open the **[Control Panel]** from the **[Start Menu]**.



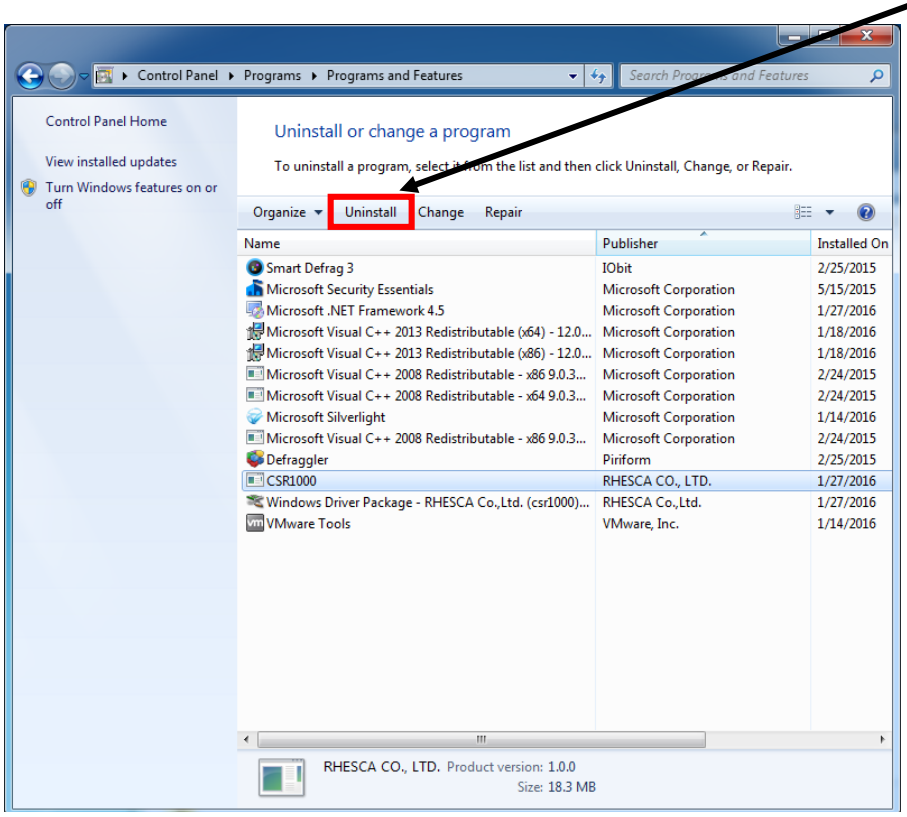
Windows 7

(2) From Control Panel, select **[Programs]**.

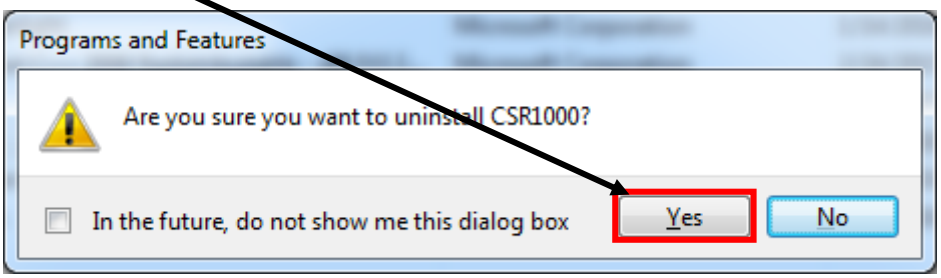
Windows 7

For Windows 7, run **[Uninstall a program]**.

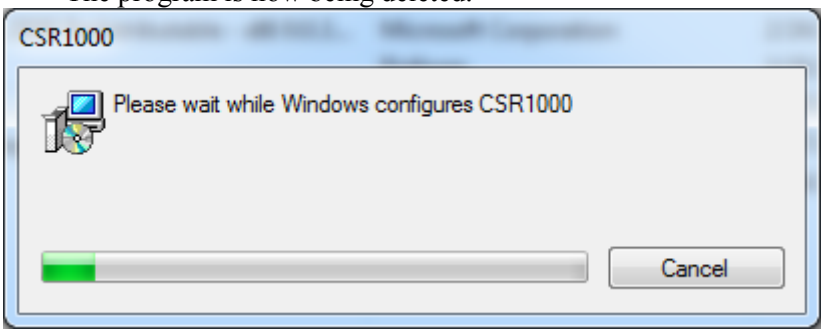
(3) For Windows 7, the following window appears. Select CSR1000, click **[Uninstall]**, and follow the instructions that will appear on the screen.



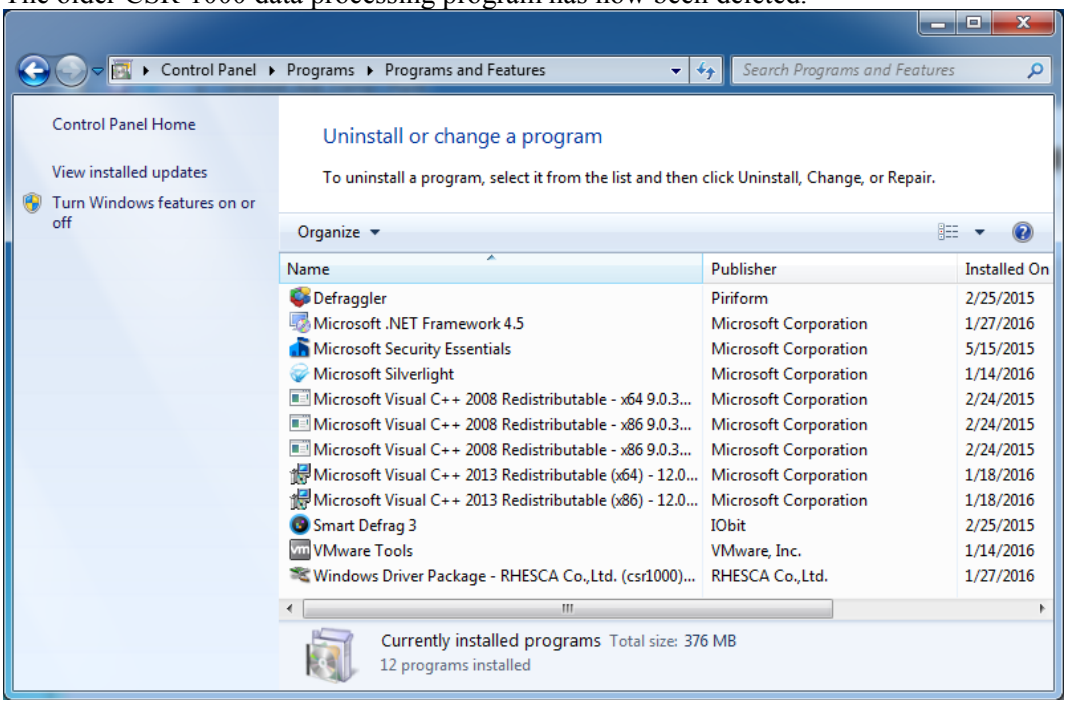
(4) For Windows 7 the following window appears, confirming whether or not to delete the program. Click the **[Yes]** button to proceed.



The program is now being deleted.



The older CSR-1000 data processing program has now been deleted.



5 Getting CSR-1000 Ready for Measurement

5-1 Connecting the Cables

Refer to Fig. 5.1 for proper cable connection.

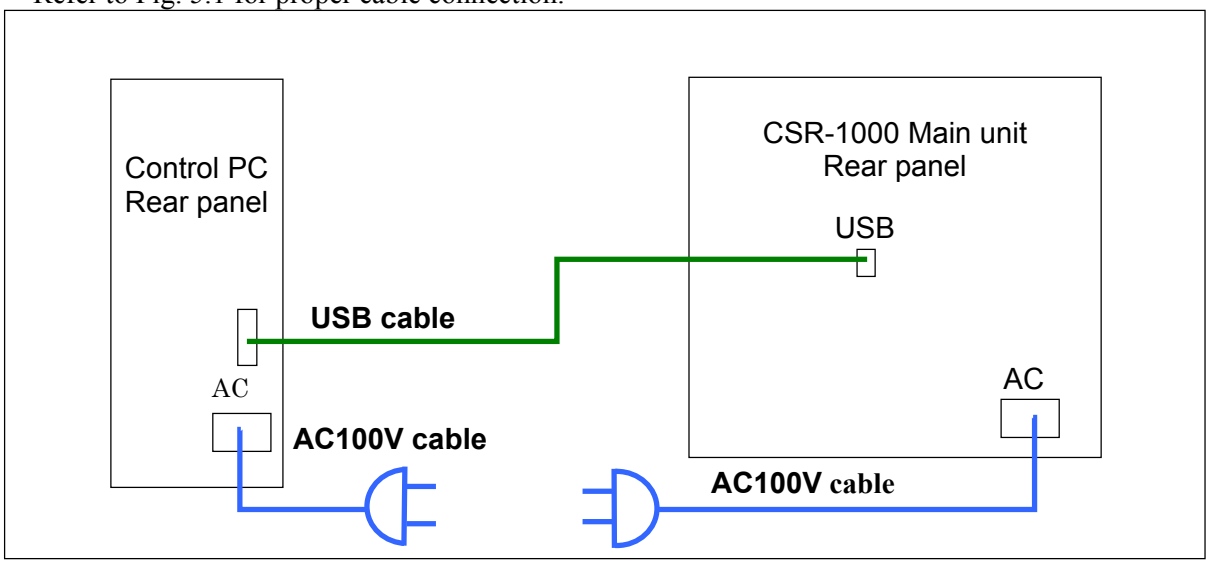


Fig. 5.1

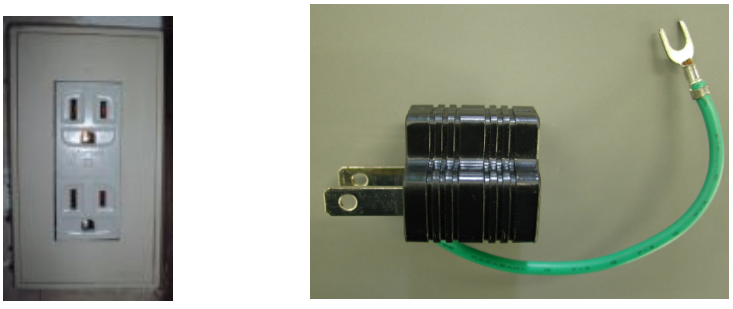
5-2 Additional Information on Cable Connection

Warning about grounding

Failure to connect the product to the ground can result in electric shock. Use the grounding terminal on your distribution panel to properly ground the product. Do not use a water pipe as a grounding terminal because it is often made of non-metal. Do not use a gas pipe either for safety reasons.

Make sure the **[POWER]** switch is turned off (switch: 0). After you confirm that the switch is turned off, insert the power cord into the main unit and AC outlet.

When the plug is the 3P-power cord shown in Fig. 5-2 (A), an automatic grounding connection is made for the unit. If the AC outlet does not have a grounding terminal, use the supplied 3P-2P adapter shown in Fig. 5-2 (B). When you use the adapter, be sure to connect the grounding wire of the adapter to earth ground.



(A) Fig. 5-2 AC outlet and adapter (B)

Note: For accurate measurement, turn on the power switch of CSR-1000 and wait for at least 60 minutes for preheating.

5-3 Operating the Joysticks, Sample Stage, and Sensor

5-3-1 Joysticks

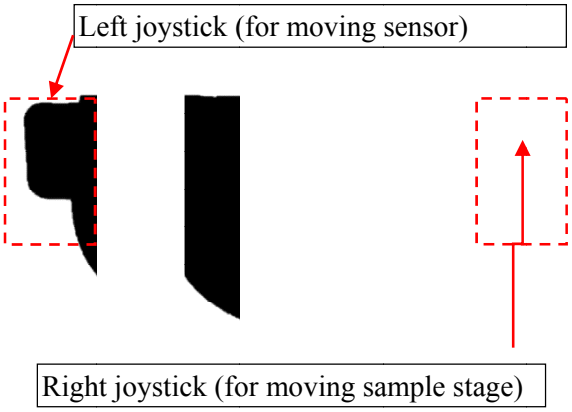


Fig. 5-3 Joysticks

The joysticks are provided on both sides of the main unit. Use these joysticks to adjust the position of the sample or vertical position of the sensor.
The right joystick is used for moving the sample stage forward/backward and left/right. While the sample stage is moving, you can use the left joystick to change the moving speed. If you press down the left joystick to the left or right while moving the stage using the right joystick, you can move the stage in high-speed mode.

The left joystick is used for moving the sensor up and down. If you press down the right joystick to the left or right while moving the sensor using the left joystick, you can move the sensor up or down in high-speed mode.

5-3-2 X-Y stage

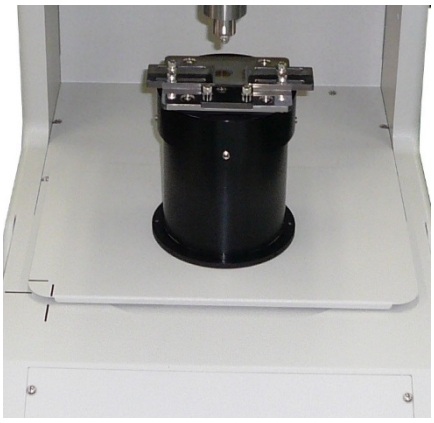


Fig. 5-4 X-Y stage

The X-Y stage is operated using the right joystick.
Use the right joystick to move the sample to its measuring location under the chip of the sensor.

5-3-3 Sensor

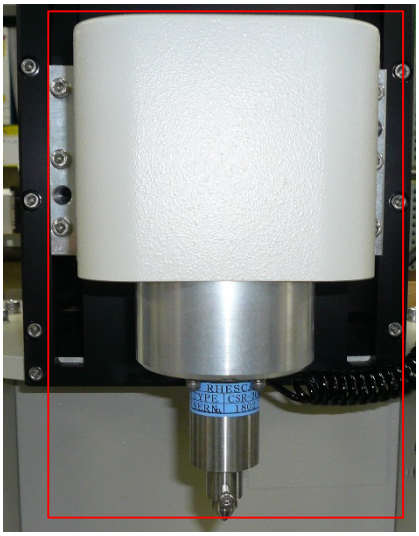


Fig. 5-5 Sensor section

The sensor, which is shown in the red frame on the left figure, moves up or down when you operate the left joystick.
You can use the left joystick to move the sensor upward when you replace the sensor. You can also use the right joystick to move the sensor downward in order to shorten the distance between the sensor and sample.
The use of joystick can help reducing the measurement time.

5-4 Attaching and Detaching the Sensor

Make sure the power switch of the main unit is turned off (switch: 0 side) when you attach or detach the sensor.

5-4-1 Attaching the sensor

Attach the sensor to the high-load block. Attach the sensor so that the sensor cable will be on the same side as the attachment groove.

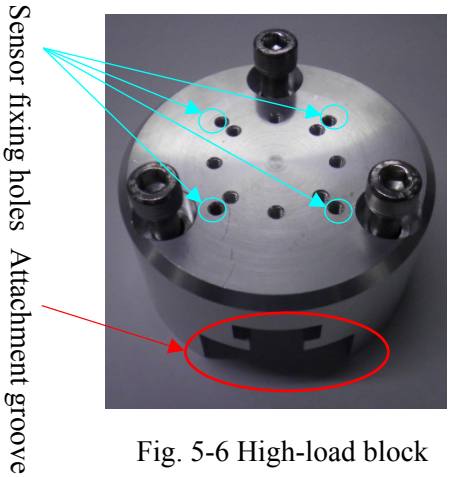


Fig. 5-6 High-load block

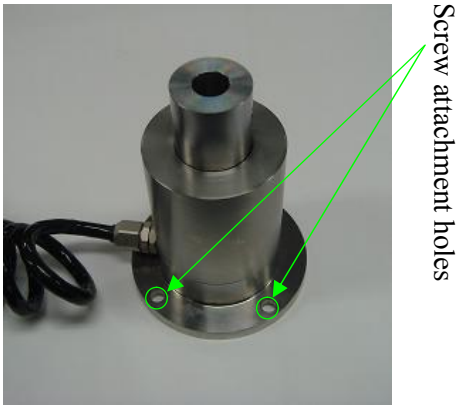


Fig. 5-7 Sensor

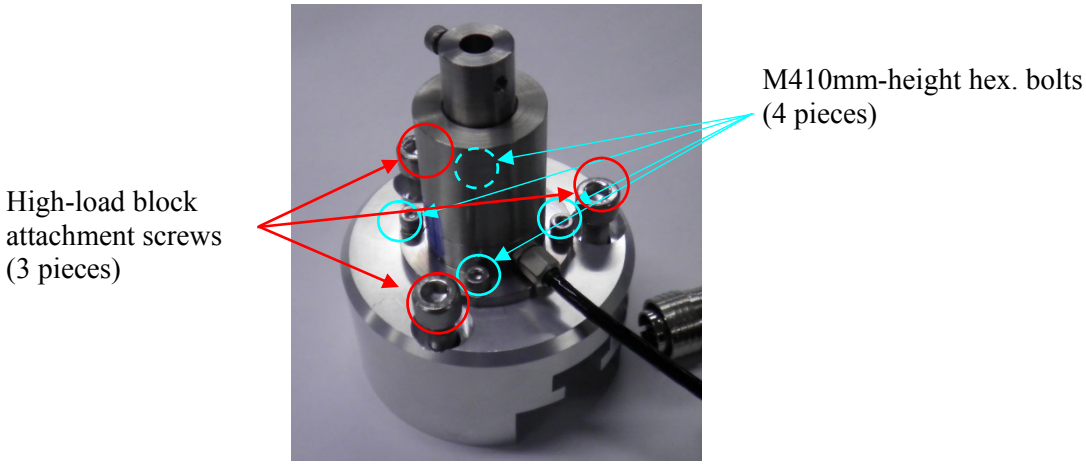


Fig. 5-8 Attaching the sensor to the block

Attach the high-load block to the sensor attachment shaft of the main unit and fix the sensor with screws so that the sensor cable will be at the rear side of the main unit.

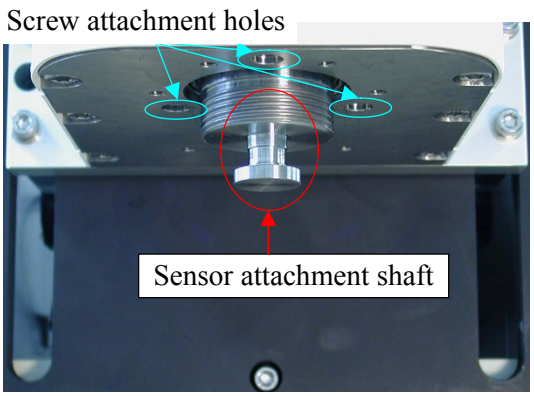


Fig. 5-9 Sensor fixing section

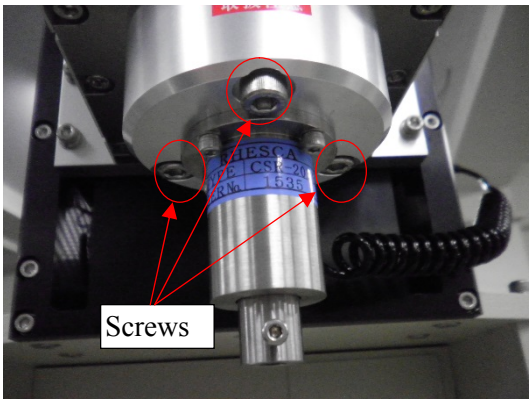


Fig. 5-10 Attaching the sensor

After fixing the sensor to the main unit, connect the sensor cable to the SENSOR connector on the right side panel of the main unit.

Fig. 5-11 SENSOR connector

Fig. 5-12 After connecting the cable to the SENSOR connector

5-4-2 Detaching the sensor

Detach the sensor in reverse order of the procedure for attaching the sensor.

1. Unplug the sensor cable from the SENSOR connector on the right panel of the main unit.
2. Loosen the screws of the high-load block and detach the sensor from the sensor attachment shaft.
3. Loosen the screws of the sensor main body and detach the sensor from the high-load block.

Caution: Do not apply excess force or shock to the sensor when you replace it.

5-5 Attaching the Diamond Chip

Insert the diamond chip into the chip attachment hole of the sensor. Fix the chip using hex. bolt (M4).

Fig. 5-13 Diamond chip

Fig. 5-14 Chip attachment hole

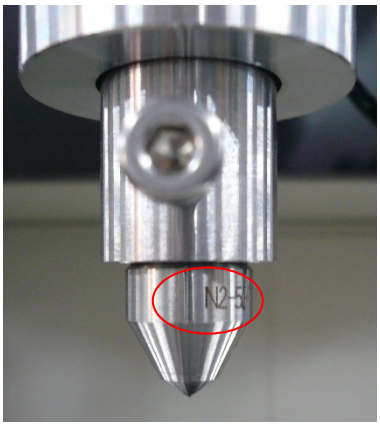


Fig. 5-15 Sensor attached with chip

Take caution not to drop the diamond chip on the floor when you attach or detach it.
Attach the chip in the direction so that the left-side number marking (example: N2-1234) faces the front side of the sensor as shown in Fig. 5-15.

5-6 Attaching the Sample

1. Place a sample on the sample stage and fix the sample stopper.
2. Press down the left and right holding plates over a sample and fix the sample.
   Make sure that the sample is pressed down by the sample stopper.

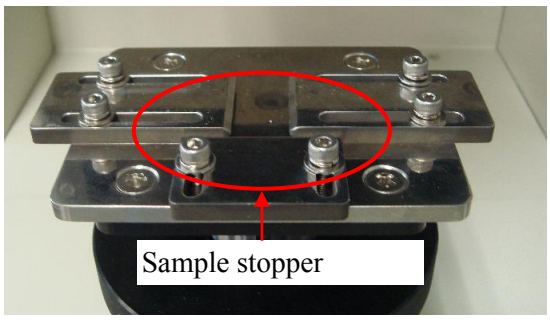


Fig. 5-16 Sample stage

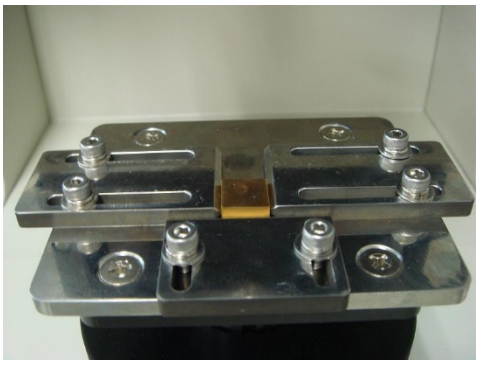


Fig. 5-17 Fixing a sample on the stage

<Blank page>

6 Starting the CSR-1000 Data Processing Program

The following program icon appears on the screen when the installation of the CSR-1000 data processing program has been installed. Double-click the icon to start up the program.

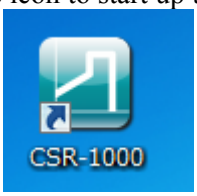


Fig. 6-1 Icon for CSR-1000 data processing program

If the CSR-1000 main unit is not turned on, you can perform analysis of already measured data only. (In this state, the message “USB device initialization error” appears in the “Result” box at the top of the screen.)

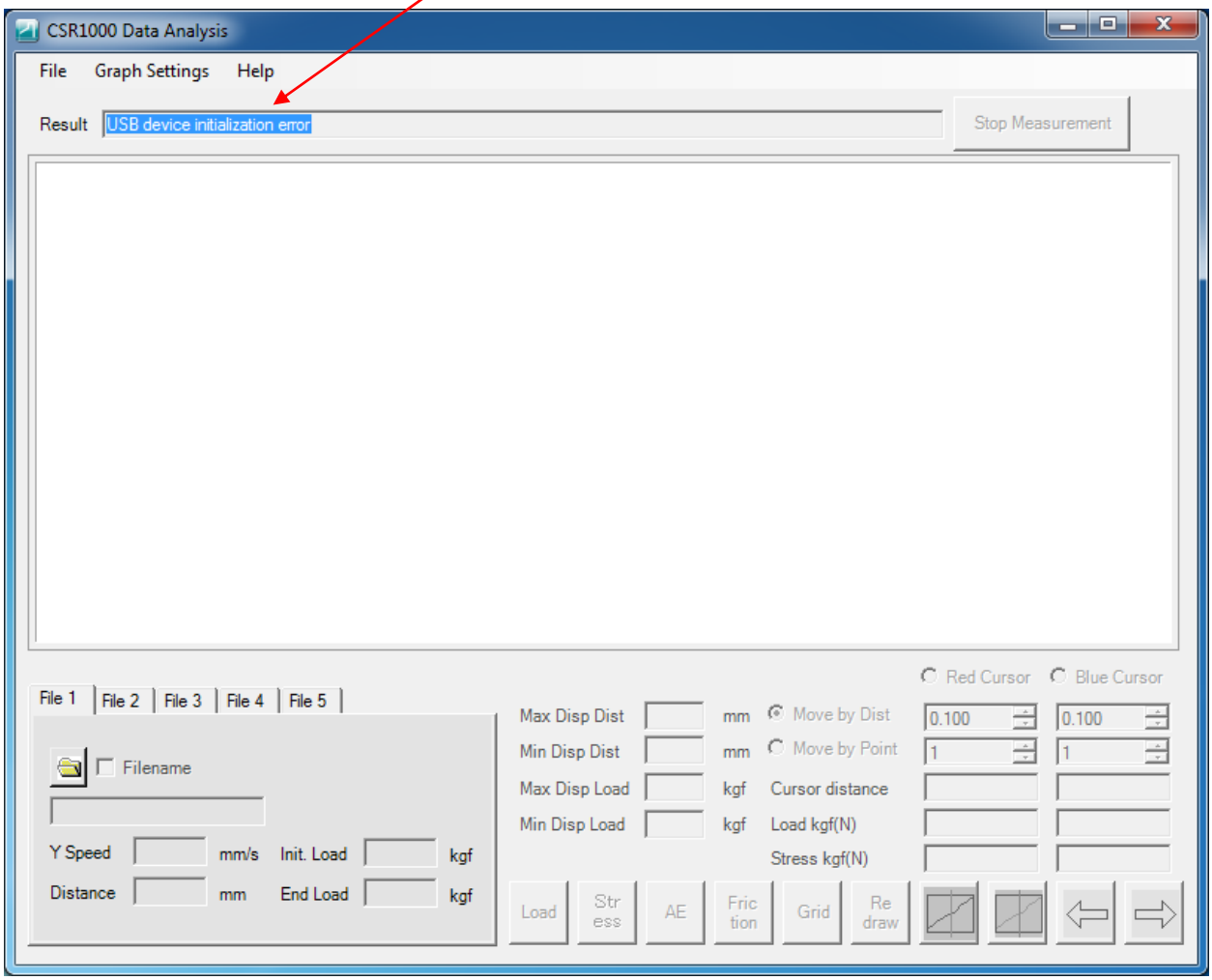


Fig. 6-2 Start-up screen during USB device initialization error

When the main unit of CSR-1000 is turned on, the following start-up screen appears. If you turn on the main unit after starting up the control program, you can connect your computer to the main unit by selecting **[File (F)]** in the menu bar and then clicking the **[Device Connect]** submenu.

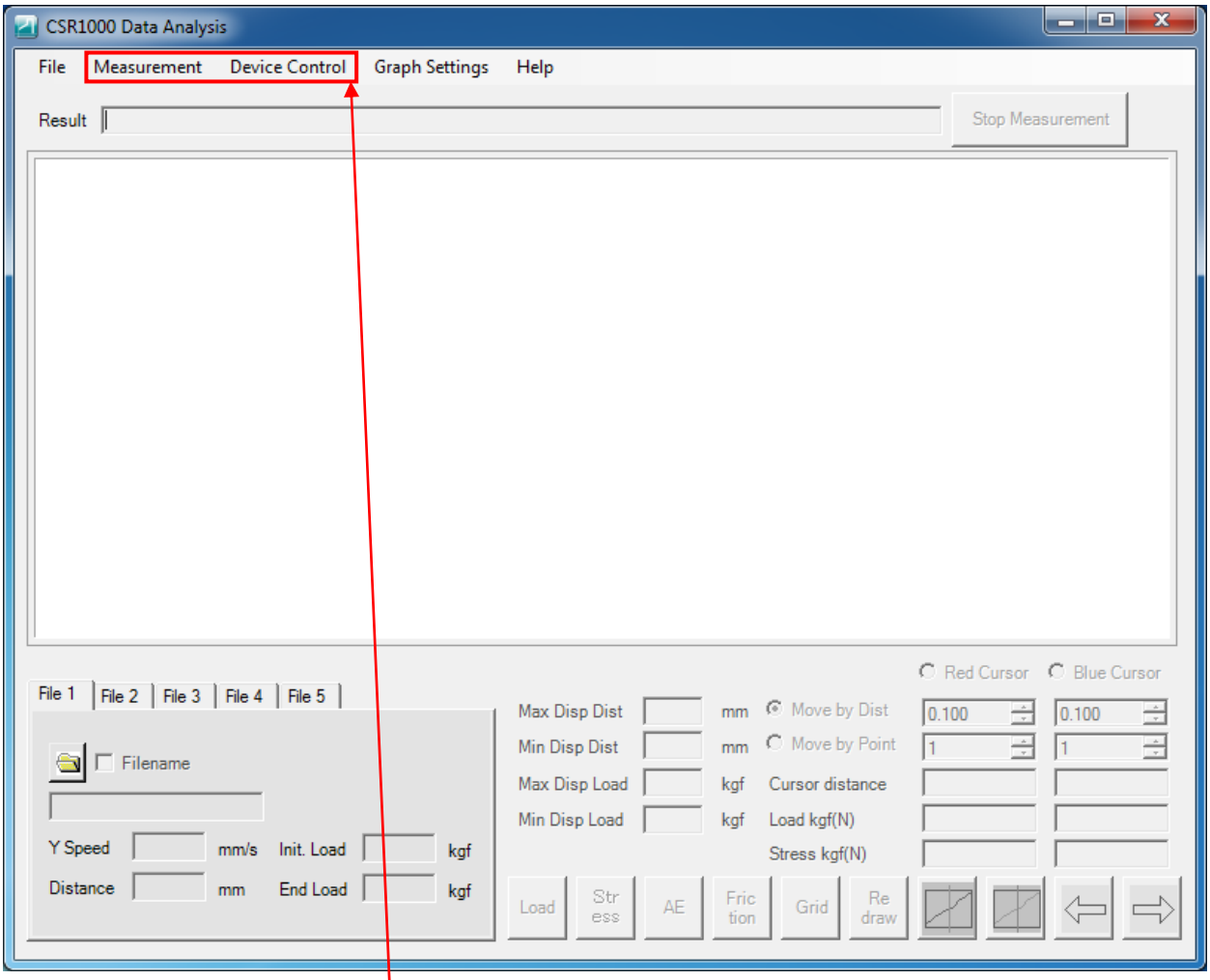


Fig. 6-3 Start-up screen of successful communication between main unit and computer

When communication between the main unit and the computer is established at start-up or by selecting "Device Connect" submenu, the **[Measurement]** and **[Device Control]** menus appear on the menu bar and you are ready to start measurement.

7 Performing the Scratch Measurement and Constant Load Measurement

Caution: For accurate measurement, turn on the power switch of CSR-1000 and wait for at least 60 minutes for preheating.

7-1 Setting the Measurement Conditions

When you click **[Measurement]** on the menu bar, the following three submenus appear.

[Execute Measurement]: Performs measurement using the conditions set using the "Set Conditions" menu.

[Set Conditions]: Sets the measurement conditions and transmits the measurement conditions to the main unit.

[Set Conditions and Execute Measurement]: Sets the measurement conditions and starts measurement after the measurement conditions are sent to the main unit.

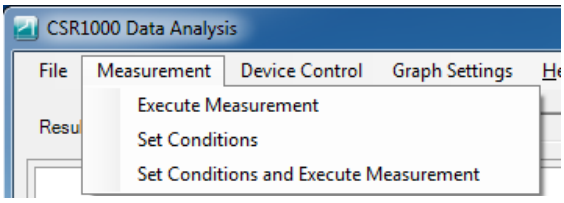


Fig. 7-1 "Measurement" menu

When **[Set Conditions]** or **[Set Conditions and Execute Measurement]** is selected, the "Measurement Conditions" window (Fig. 7-2) appears.

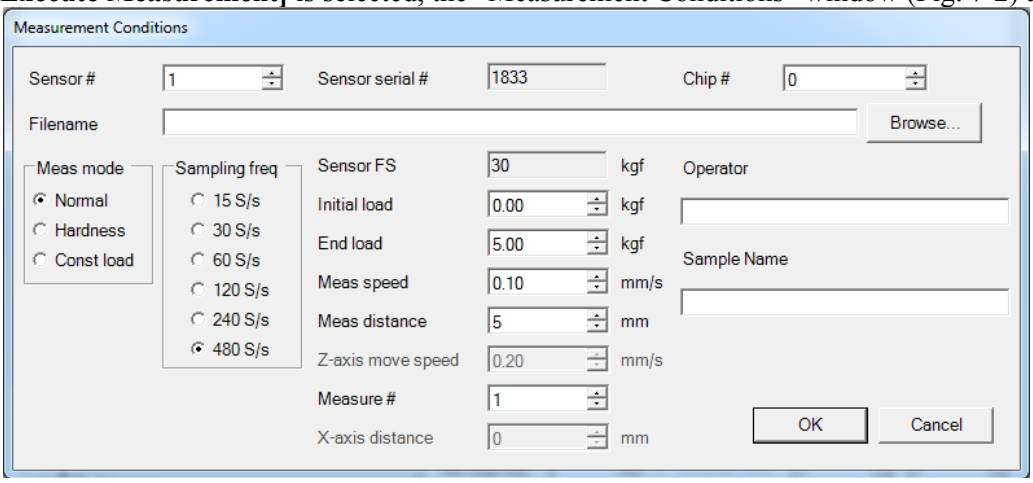


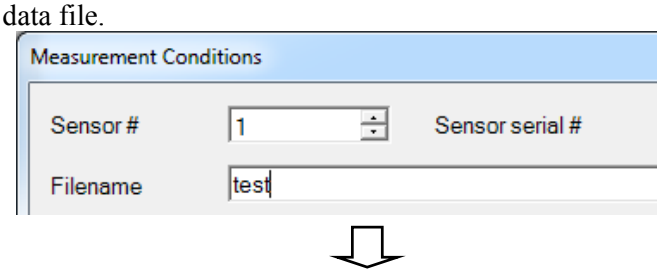
Fig. 7-2 "Set measurement conditions" window

The measurement conditions you can set are as follows.

Sensor No.: Number of the sensor to be used. (Normally select "1".)

Serial No.: Serial number of the selected sensor.

Filename: Enter the name of the file in which measured data is stored.
When you move the cursor to another measurement condition setting item after entering a filename, the extension ".csr" is automatically attached to the name of the data file.



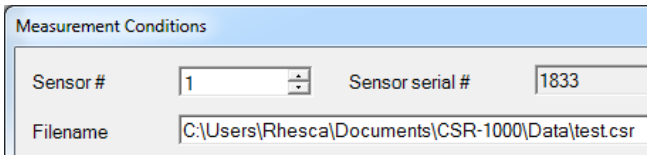


Fig. 7-3 Directly entering a filename

When you specify a filename and storage location, click the **[Browse…]** button.

The "Save As" dialog appears. Enter a filename and storage location folder and click the **[Save]** button.

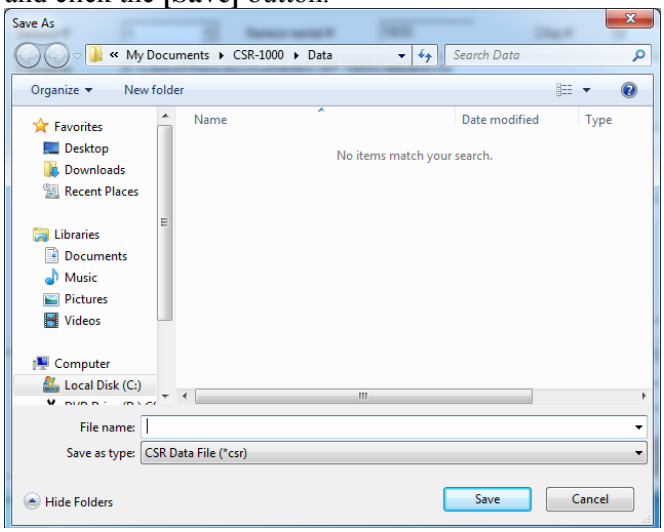


Fig. 7-4 Dialog for entering a measurement data filename

Meas Mode: You can select from "Normal", "Hardness ", and "Const load ".

Normal: Performs the scratch operation while increasing the load in the normal way.

Hardness: Performs the hardness measurement using the Rockwell hardness number HR-15N.
Before performing the hardness measurement, you must perform hardness correction.
To perform the hardness measurement, you need to purchase optional hardness measurement accessories.
Refer to "Chapter 9. Performing the Hardness Measurement" for the optional accessories required.

Const load: Performs the scratch operation while maintaining the load at a constant value (measurement starting load).

Sampling freq: Number of data captured in a second
Select the sampling speed from 15, 30, 60, 120, 240, and 480 times per second.

Sensor FS: Full-scale value of the sensor (Indicates selected sensor value.)

Initial load: Load applied at the start of measurement.
Select the initial test load from 0Kgf to the measurement end load value.

End load: Load applied at the end of measurement.
Select the end load value between the initial test load value and the full-scale value of the sensor.

CSR-1000 controls the load to be applied so that it increases linearly toward the preset measurement end load value.
(Measurement end load: The load is controlled by moving the sample stage up and down using physical equipment control.)

Meas speed: Speed at which the Y-axis is moved to perform the scratch operation.
Select the moving speed from 0.01 to 1.00 mm per second.
Normally, 0.17 mm per second
(=10mm/min. JSME S 010) is used.

Meas distance: Distance for which the Y-axis is moved to perform the scratch operation.
Select the moving distance from 1 to 30 mm.
Although the moving distance varies depending on the size of a sample, normally select 10mm.

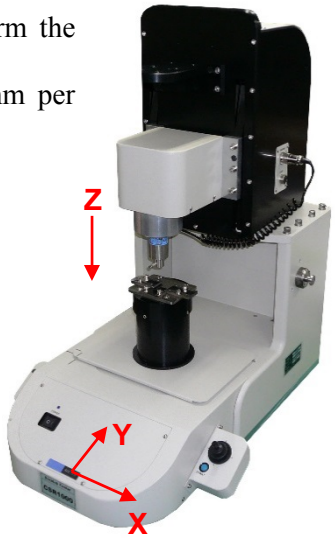


Fig. 7-5 X-,Y-, and Z-axis directions

Z-axis move speed: Speed at which the Z-axis is lowered during hardness measurement.
Select the moving speed from 0.01 to 1.00 mm per second.
Normally, a speed between 0.01 and 0.02 mm per second is used.

Measure #: Number of measurements to be repeated.
Select the number of measurements from 1 to 100 times.
When you set the number of measurements to "2" or higher, the setting for the X-axis moving distance will be enabled.

X-axis distance: Distance for moving the X-axis in repeating measurements.
Select the moving distance from -100 to 100 mm.
If you set the distance to "0mm," measurement is repeated at the same location.
When the number of repeat measurements is completed, the X-axis will return to the X-axis measurement start position.

Fig. 7-6 Moving direction of stage for repeat measurements

When you finish setting the measurement conditions, click the **[OK]** button.
When you set the measurement conditions by selecting the **[Set Conditions]** submenu, the previous window reappears. To perform a measurement, select **[Execute Measurement]** from the **[Measurement]** menu.
When you set the measurement conditions by selecting the **[Set Conditions and Execute Measurement]** submenu, the dialog for the **[File (F)]** menu appears.

7-2 Starting the Measurement

When you select the **[Measure after setting conditions (P)]** submenu from **[Measurement (M)]** in the menu bar and click the **[OK]** button on the **[Set measurement conditions]** window, or if you select the **[Execute measurement (E)]** submenu from **[Measurement (M)]** in the menu bar, the dialog for starting measurement (Fig. 7-7) appears.

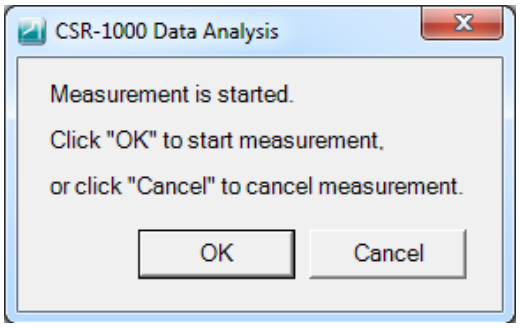


Fig. 7-7

Click the **[OK]** button to start the measurement. To cancel the operation, click the **[Cancel]** button.
When you click the **[Cancel]** button, measurement is canceled and the initial screen reappears.
When you click the **[OK]** button, measurement will start and the measured data is displayed on the screen. While the measurement is performed, the measured data is displayed for the range of higher and lower 5% of the entire data based on the applied initial test load and measurement end load values.

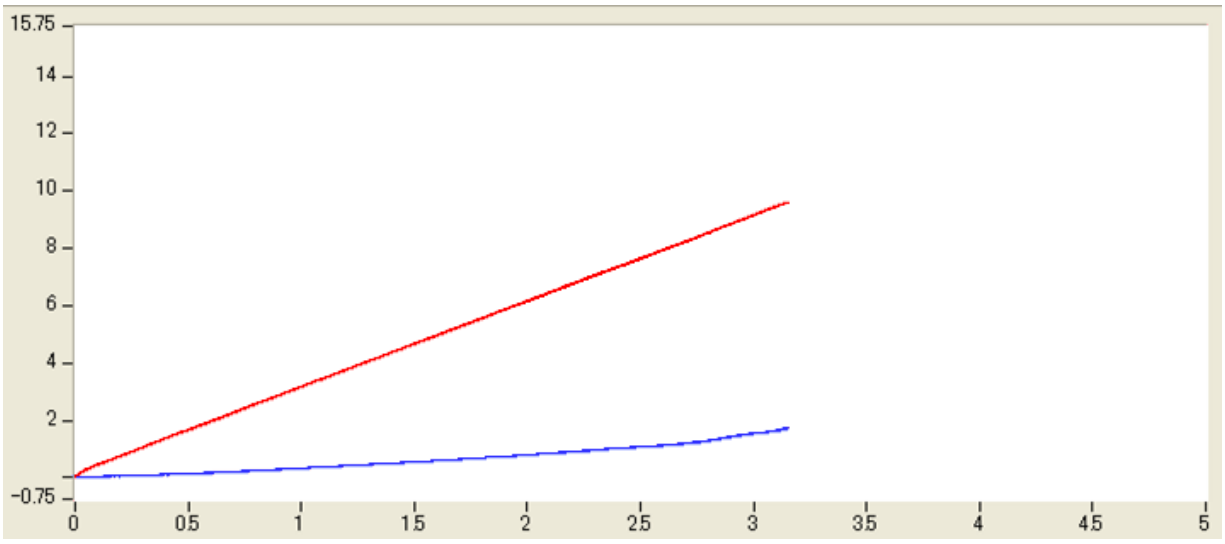


Fig. 7-8 Example of graph display during measurement

When the measurement is performed, two lines: a red line (stress value) and a blue line (load value) are displayed in a graph. When the measurement is completed, the graph is displayed after it is automatically scaled so that the entire data can be displayed. The Y-axis grid is also displayed.

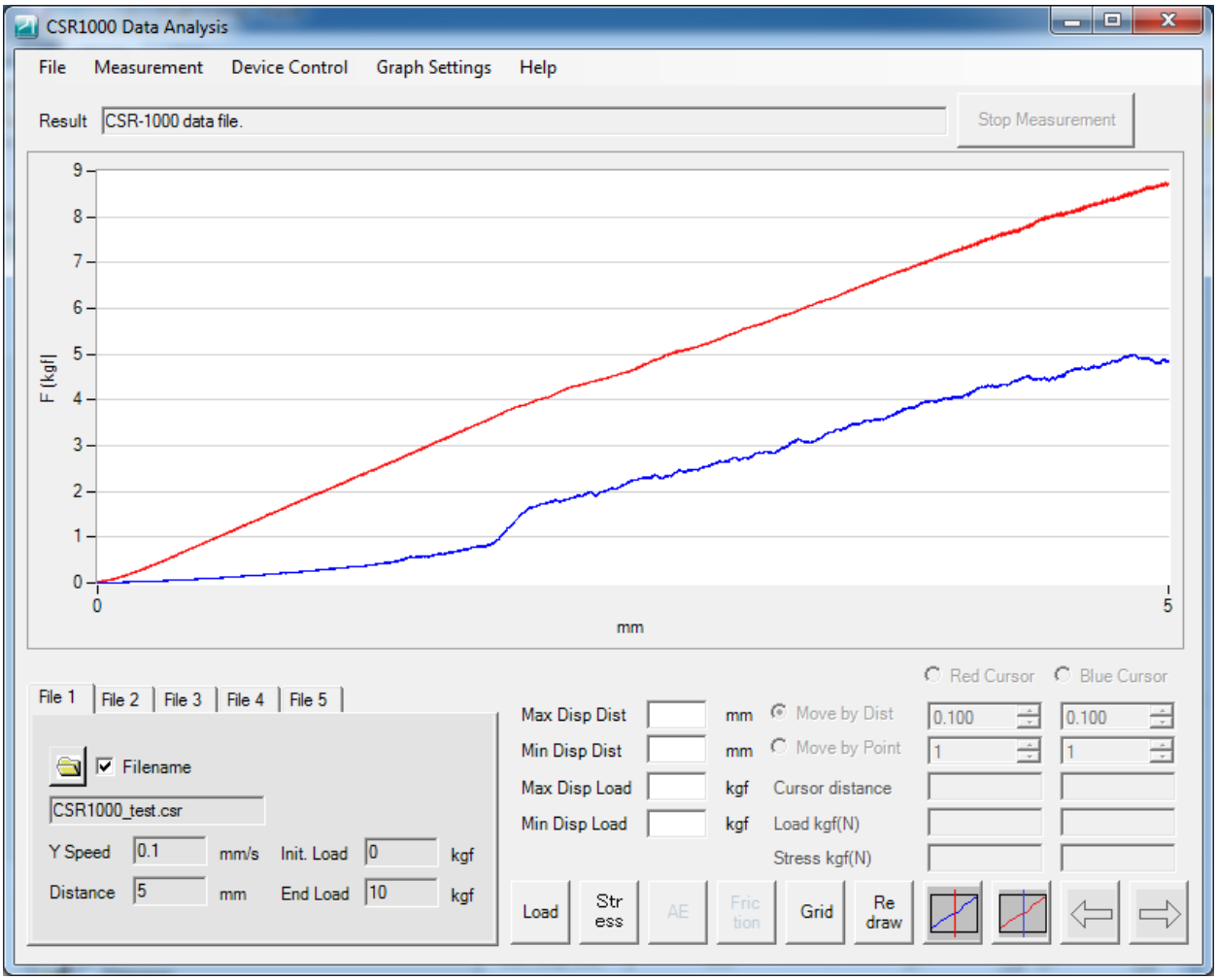


Fig. 7-9 Graph display at measurement end time

<Blank page>

8 Measured Data Display

Once data is saved into the control PC after measurement, it can be displayed in various forms.

8-1 Displaying the Measured Data

Click a file number (**[File 1]** to **[File 5]**) tab (at the lower side of the CSR-1000 program screen) to select the file number of a file to be loaded. Next, click the file selection button.

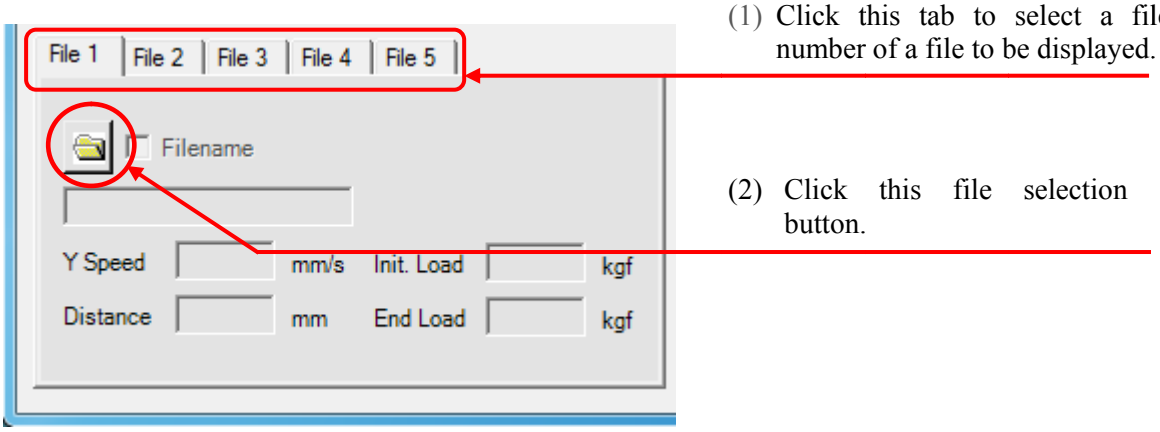


Fig. 8-1

(This procedure is necessary if the measured data is not being displayed or when you want to perform analysis of data that is currently not displayed.)
The “Open” window appears.

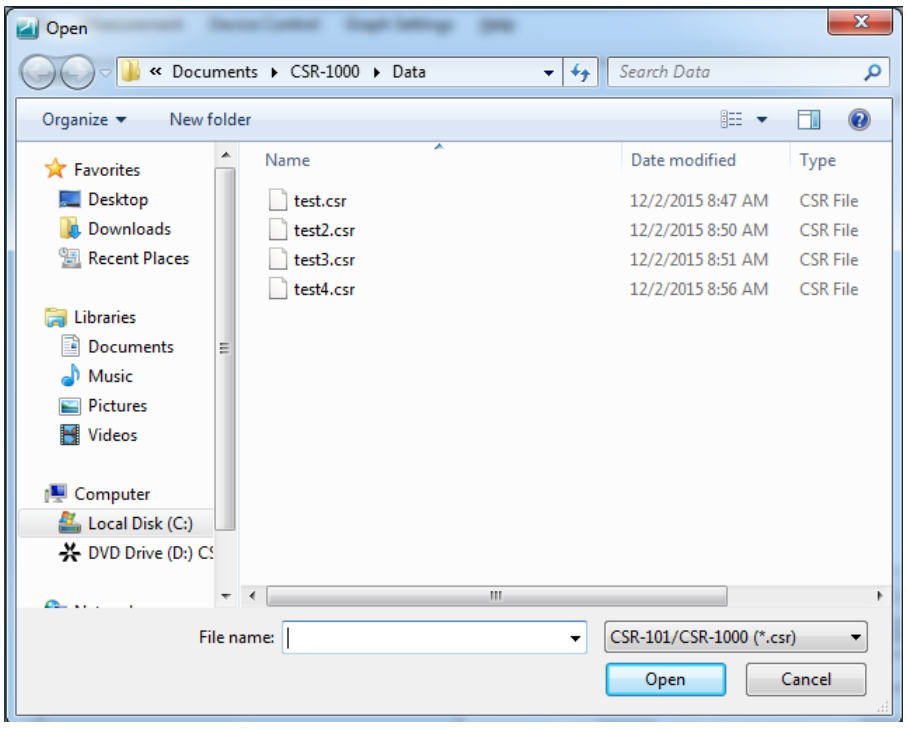


Fig. 8-2

Select a file you want to use for data analysis on the “Open” window. After a file is read, put a check mark for the “Filename” box on the right side of the file selection button to display the measured data.
Display of the measured data varies broadly depending on the data acquisition interval, scratch distance, and scratching speed. For example, if data is acquired under the following conditions: scratching speed 0.5mm/second, scratch distance 5mm, and data acquisition interval 480 times/second, then the measured data is displayed in a graph in about 10 seconds.

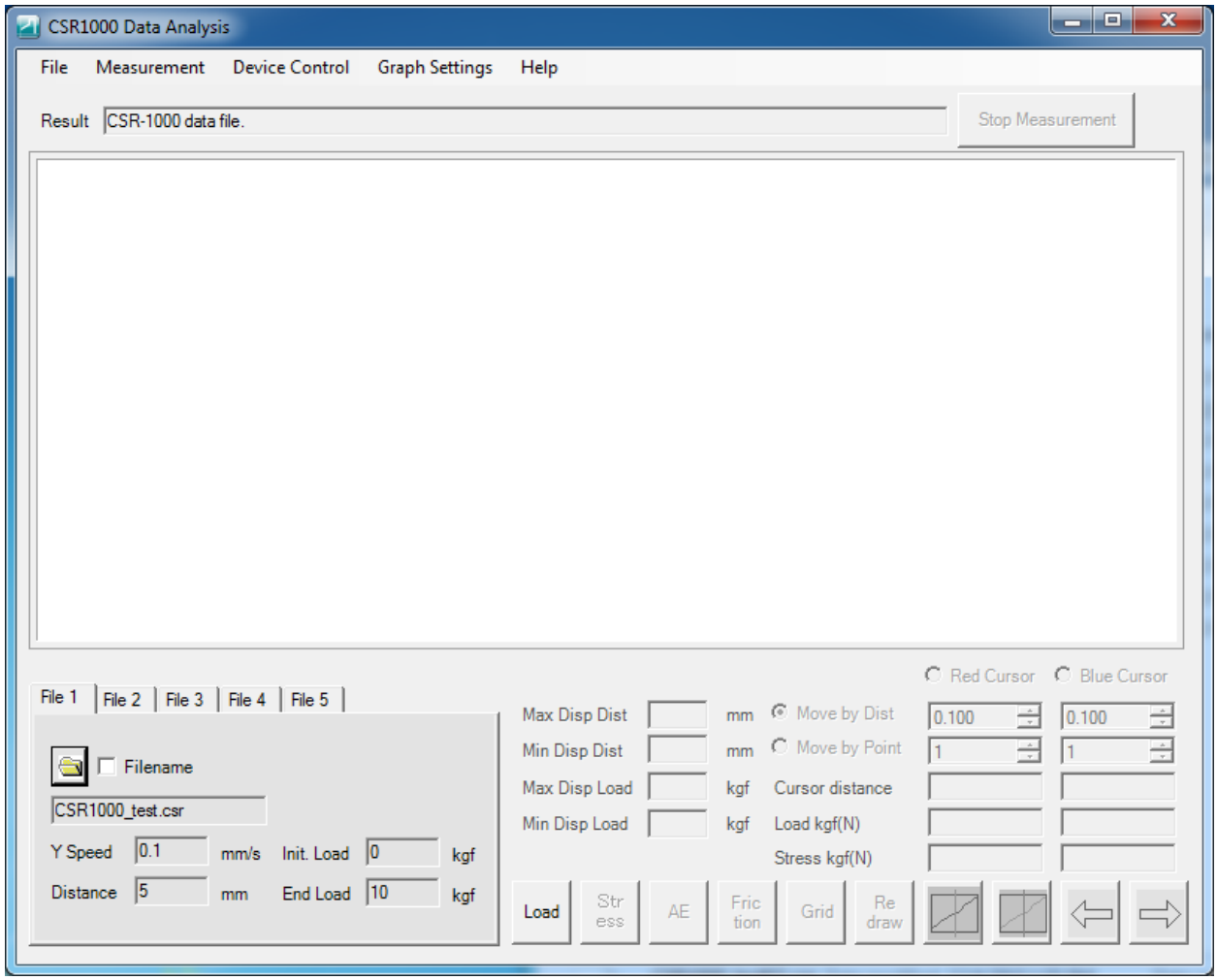


Fig. 8-3 After reading measured data (At this point, a graph is not displayed yet.)

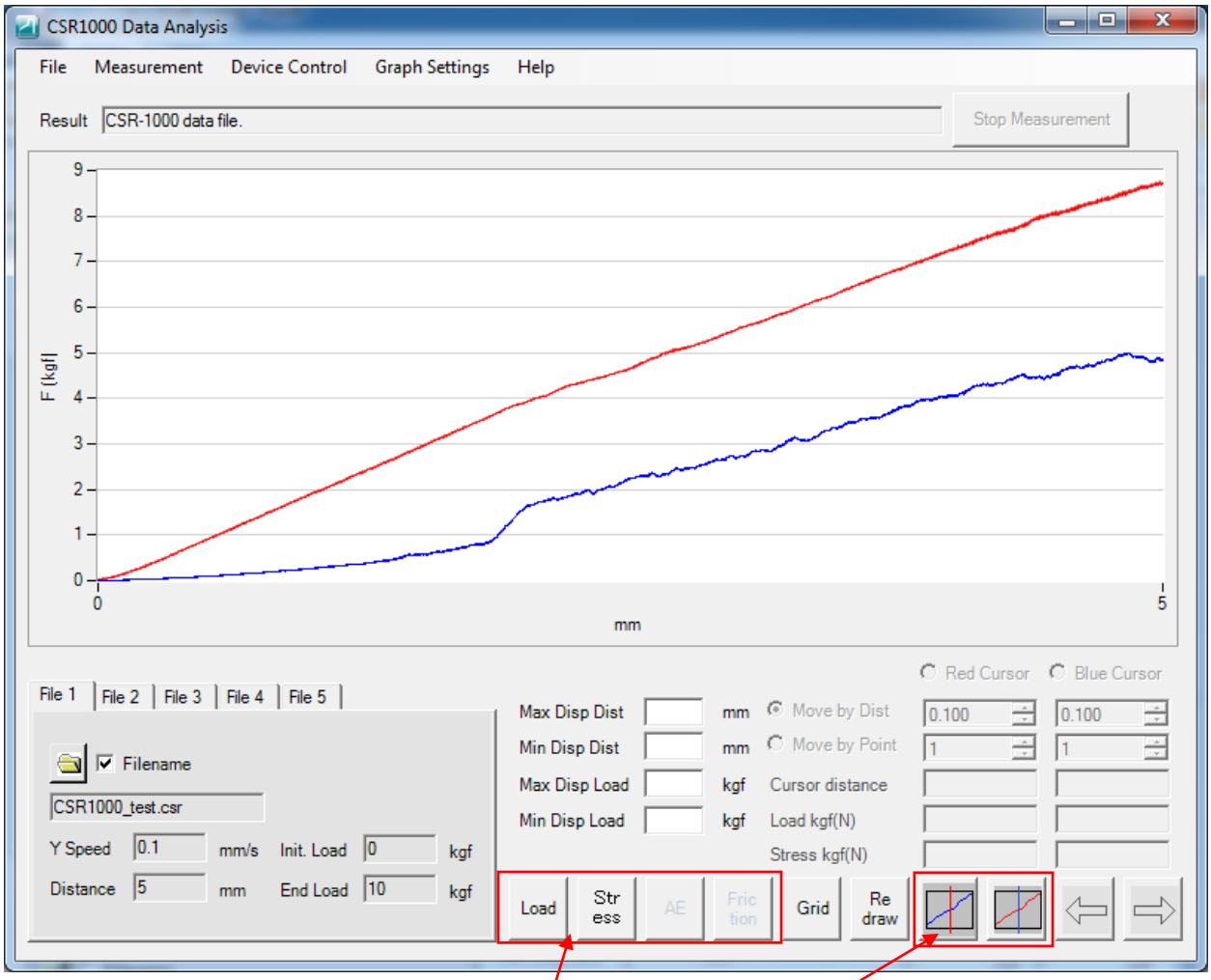


Fig. 8-4 Example of graph display

When the measured data is displayed, you can display the cursor or enlarge data (change scale).
You can also click the **[Load]**, **[Stress]**, **[AE]**, or **[Friction]** button to turn on and off displaying the data of the button you just clicked. (The letters of the button whose data display you turned off is grayed out.)
You can select either the **[AE]** or **[Friction]** button, but not both at the same time.
When you display the cursor, you can more accurately identify the point of change in stress value.
You can move the cursor left and right by clicking **[⇐][⇒]**with the mouse. Specify the distance to move by setting the **[Move by Dist]** or **[Move by point]** value.
When the cursor is being displayed, the screen shows the cursor position and load value and stress value of the measured data of the file number tab (File 1 to File 5) selected at that time.

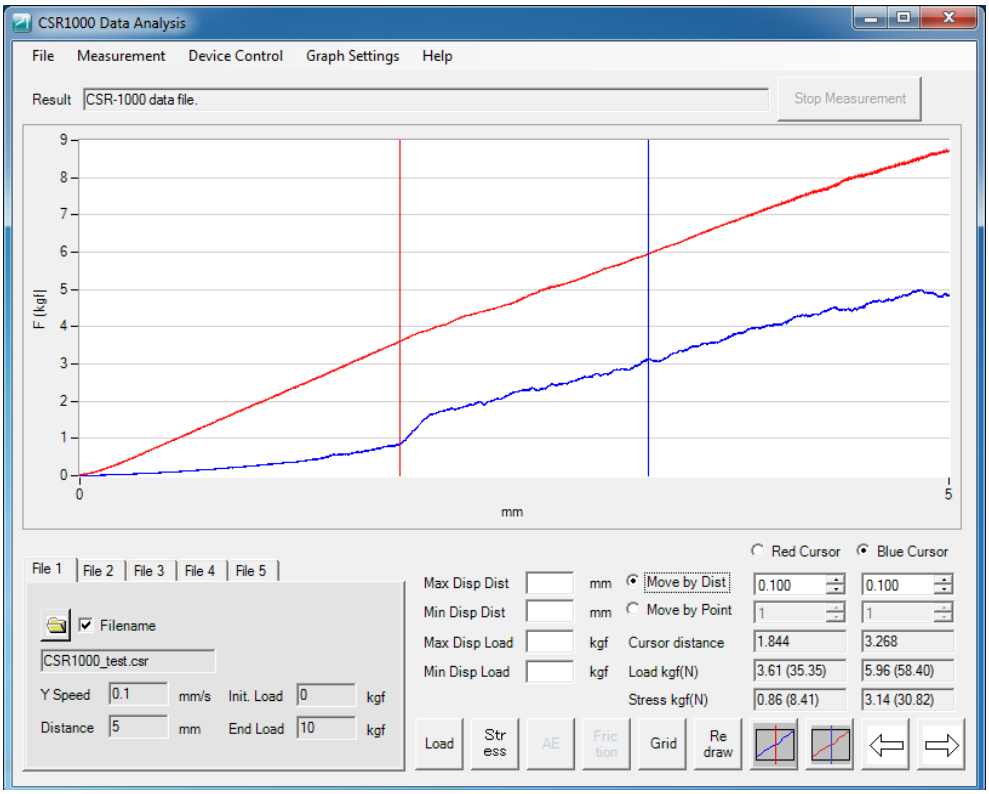


Fig. 8-5 Example of graph display with cursors

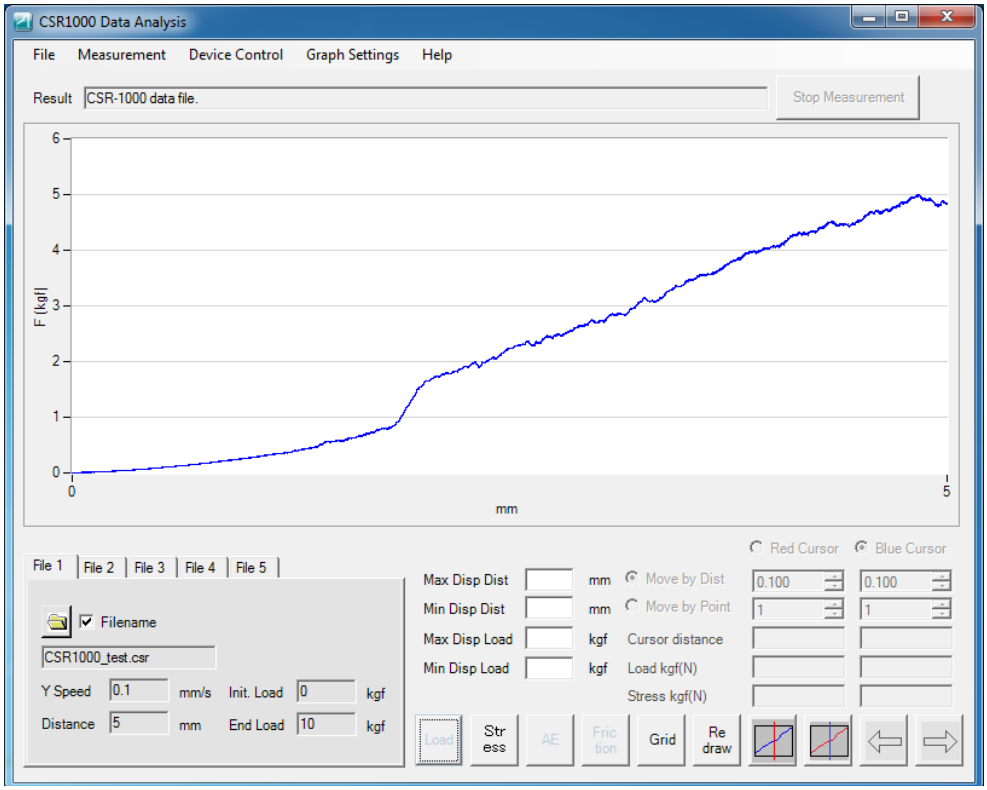


Fig. 8-6 Example of graph display with stress data only

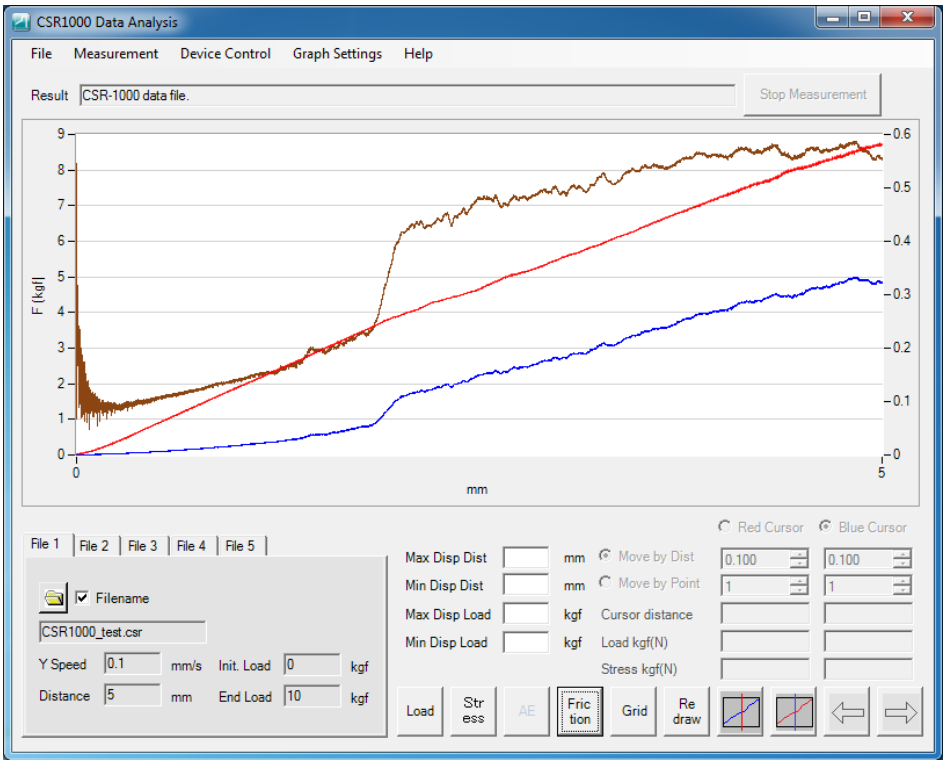


Fig. 8-7 Example of graph display with friction coefficient data

8-2 Comparing the Measured Data

You can overlay up to five measured data of selected files to compare data.

To overlay two or more data of selected files in the graph window, select the file number tab (File 1 to File 5). Next, click the file selection button and select a data file.

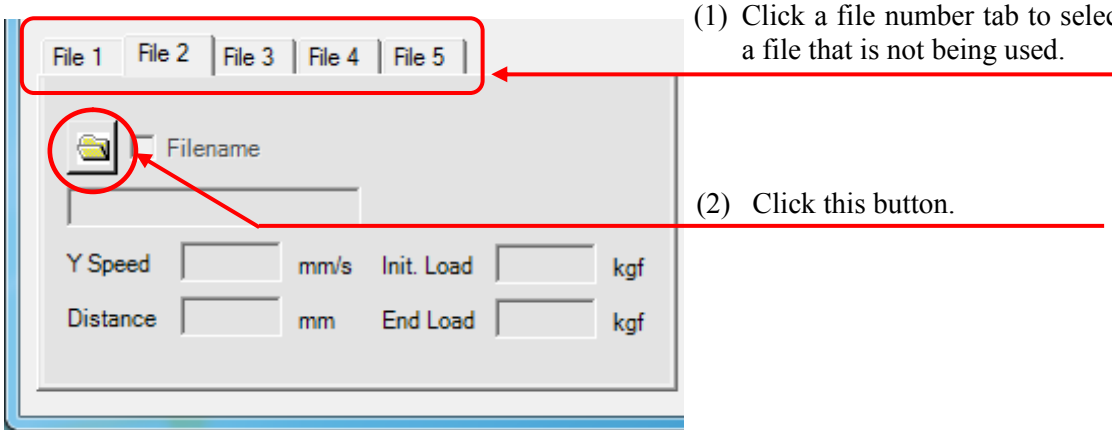


Fig. 8-8 Selecting a file for overlaying data

After a file is read, put a check mark in the “Filename” box on the right side of the file selection button. You can overlay up to five measured data.

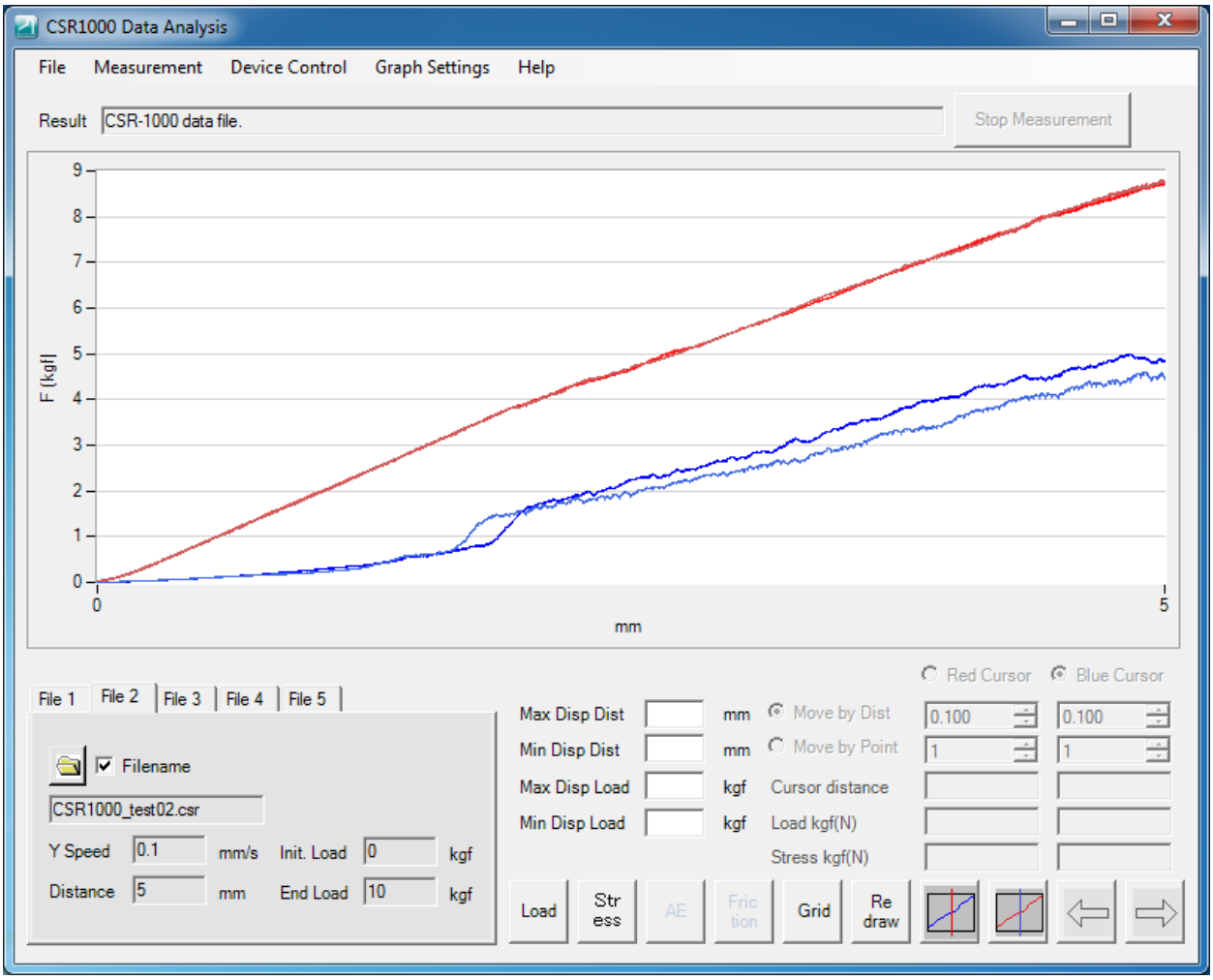


Fig. 8-9 Example of overlaid graph display

When data of the selected files is overlaid in the graph window, the load value and stress value are displayed using the following colors.

	File 1	File 2	File 3	File 4	File 5
Load value	Red	Indian red	Fire brick	Crimson	Deep pink
Stress value	Blue	Royal blue	Dodger blue	Cornflower blue	Deep sky blue
AE data	Green	Medium sea green	Lime green	Pale green	Lime
Friction coefficient	Saddle brown	Chocolate	Sandy brown	Peru	Dark orange

8-3 Enlarging the Measured Data (Changing Scale)

To enlarge the measured data, enter the desired values in the “Max. display distance”, “Min. display distance”, “Max. display load”, and “Min. display load” input boxes and click the **[Redraw]** button. If you enter only the distance (horizontal axis) value, the maximum and minimum values within the range of that value are searched to determine the display range of the load axis. If you enter only the load (vertical axis) value, the entire measuring range within the specified range of load value is displayed.

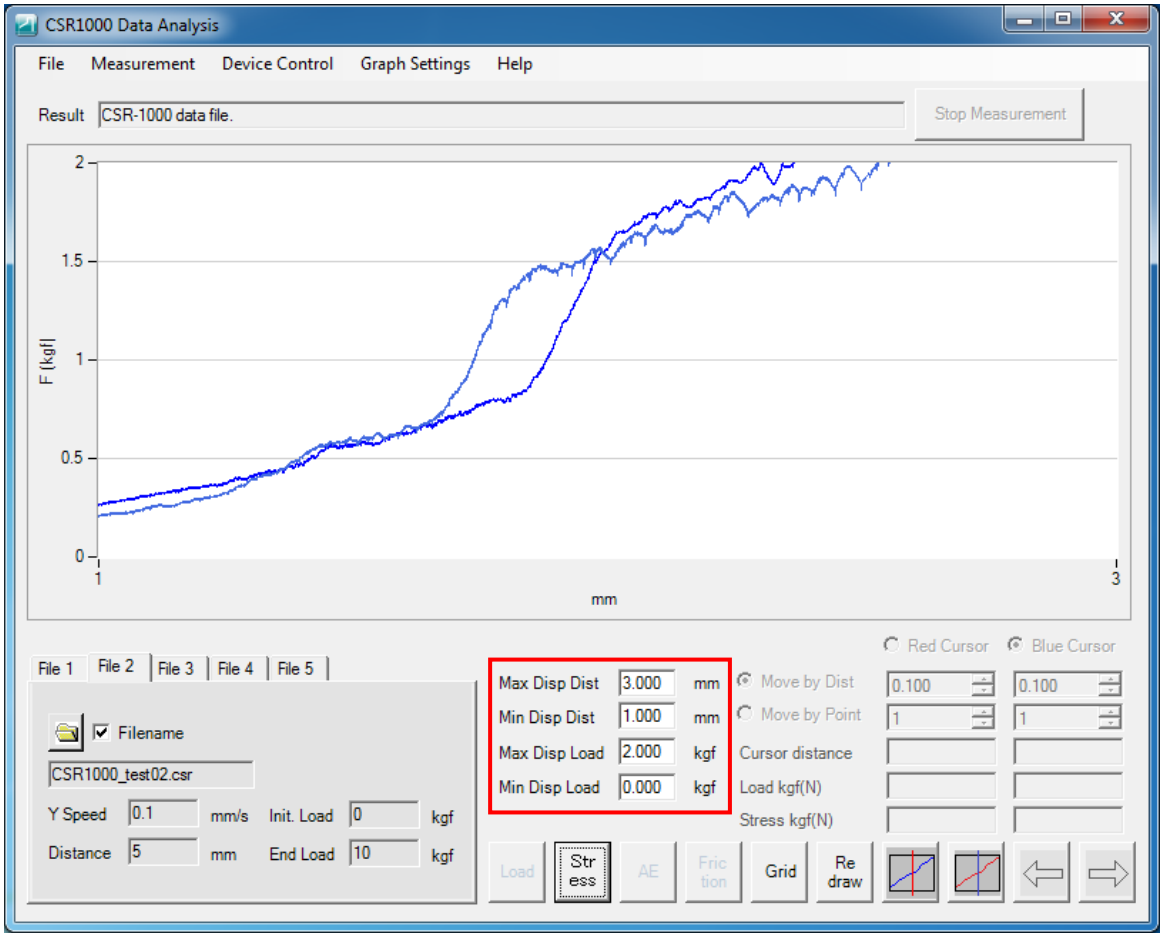


Fig. 8-10 Example of enlarged display by specifying both distance and load values

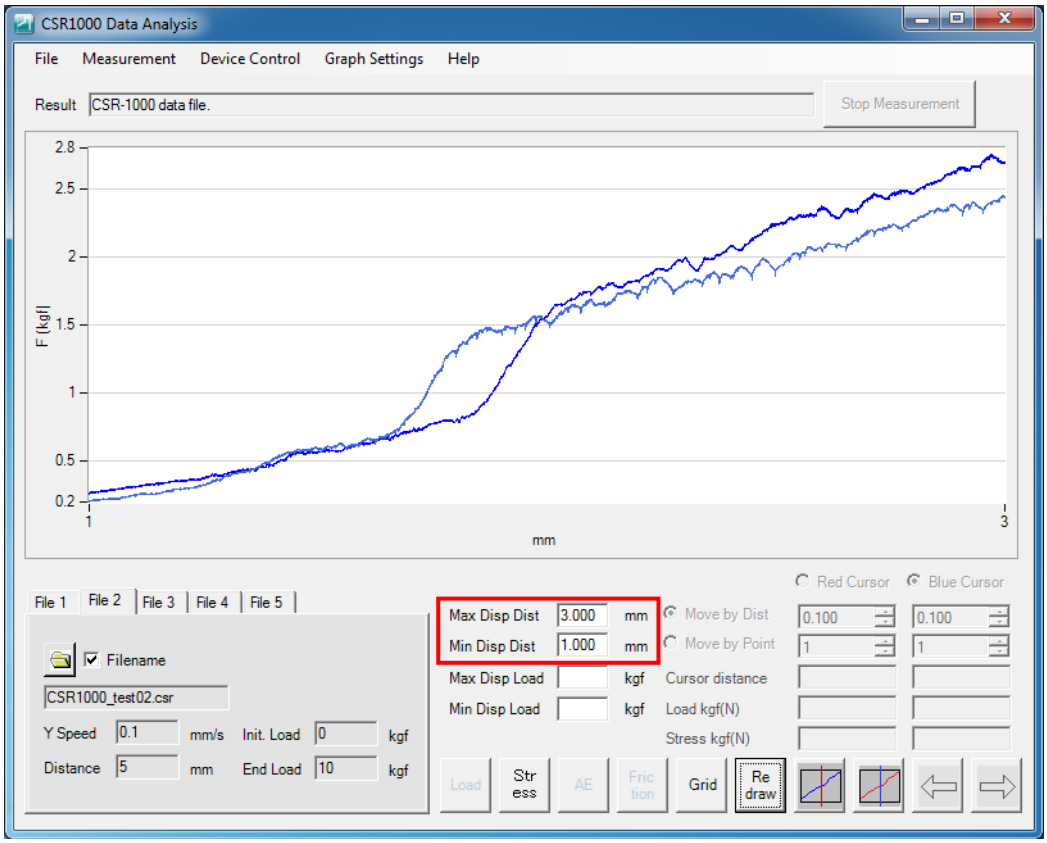


Fig. 8-11 Example of enlarged display by specifying distance values only

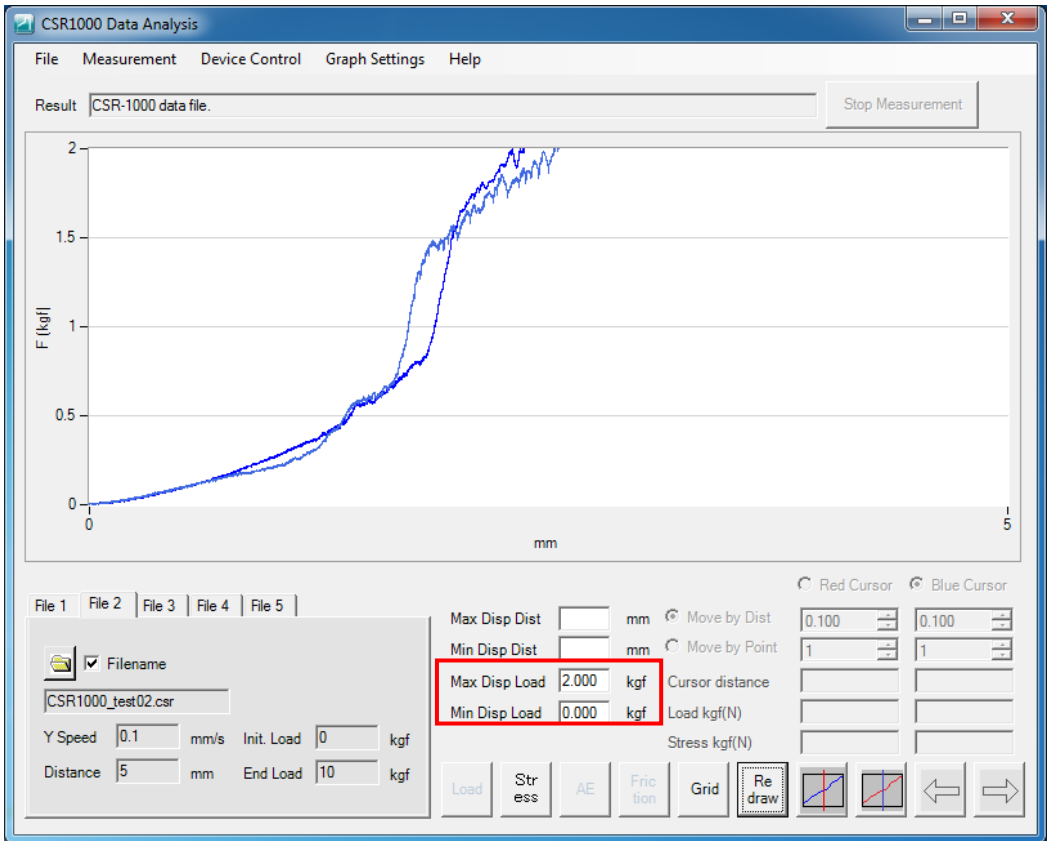


Fig. 8-12 Example of enlarged display by specifying load values only

You can also enlarge the area enclosed with a frame on a graph by clicking and dragging the mouse in the graph display area. To return to the original scale of the graph, click the **[Redraw]** button.

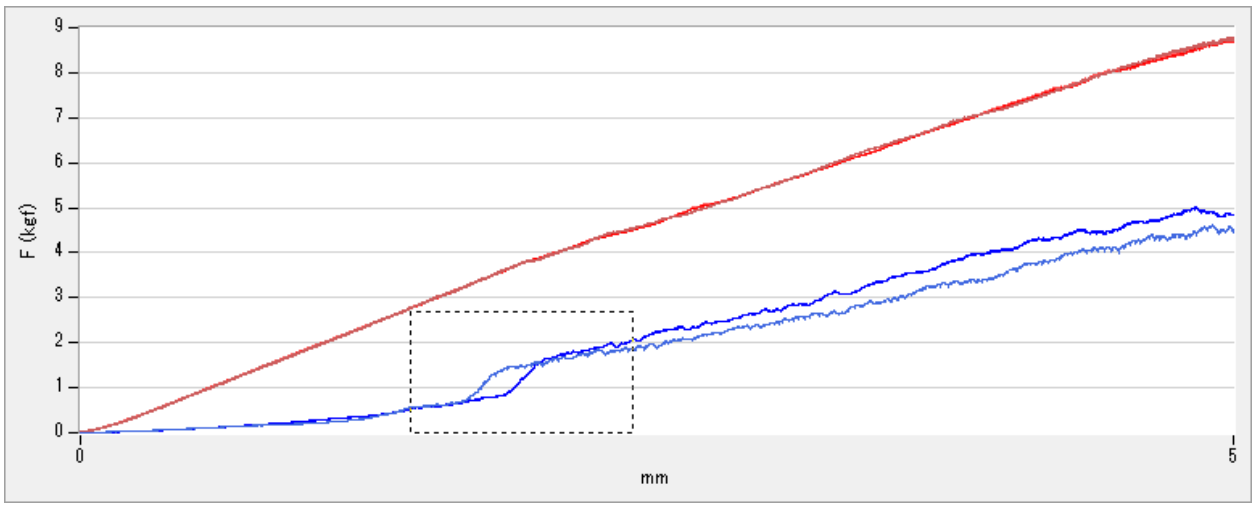


Fig. 8-13 Specifying the enlargement area by setting the range

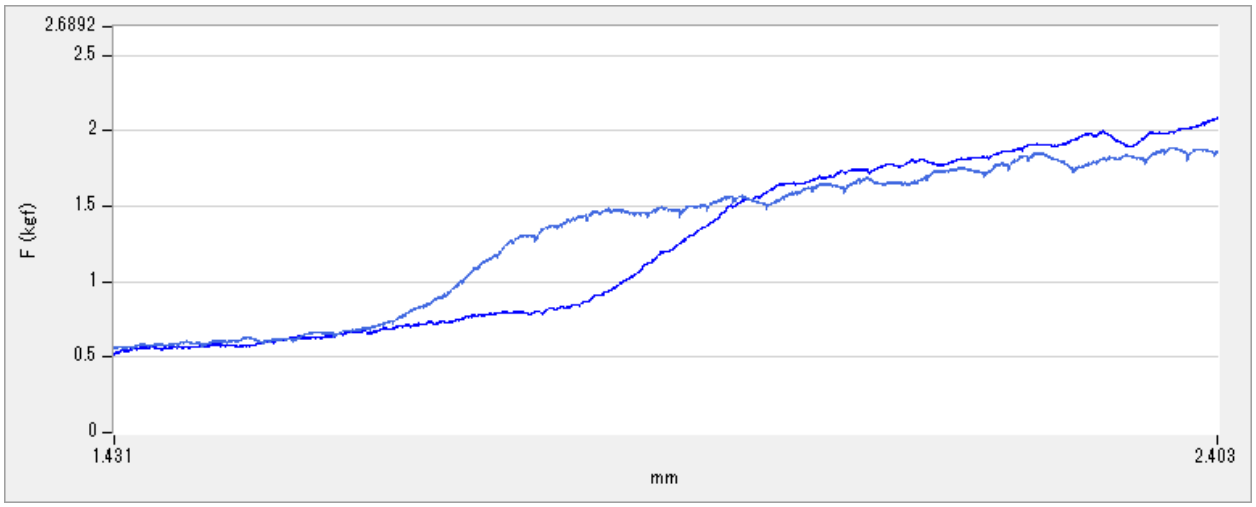


Fig. 8-14 Result of enlarged display by setting the range

8-4 Displaying the Graph Grid

You can click the **[Grid]** button on the lower right side of the main screen to turn on and off the grid on a graph. When you put check marks in the "Display" boxes of "X-axis grid setting" and "Y-axis grid setting," the grids are displayed. When you remove the check marks, the grids are cleared.

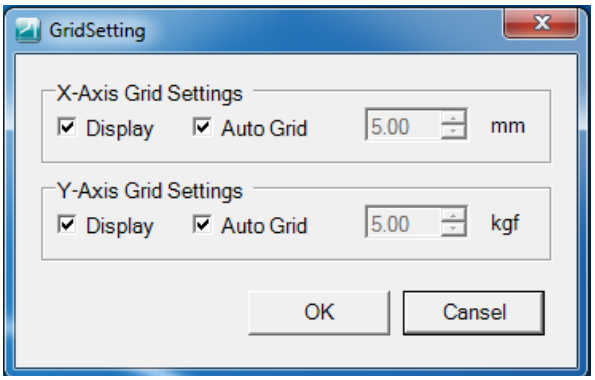


Fig. 8-15 Setting graph grid

When you put a check mark in the "Auto grid" box, the appropriate grid is displayed on the display graph.
When the X-axis grid interval is set to "0.50 mm" and the Y-axis grid interval is set to "1.00 kgf" as shown in Fig. 8-15, the following graph (Fig. 8-16) is displayed.

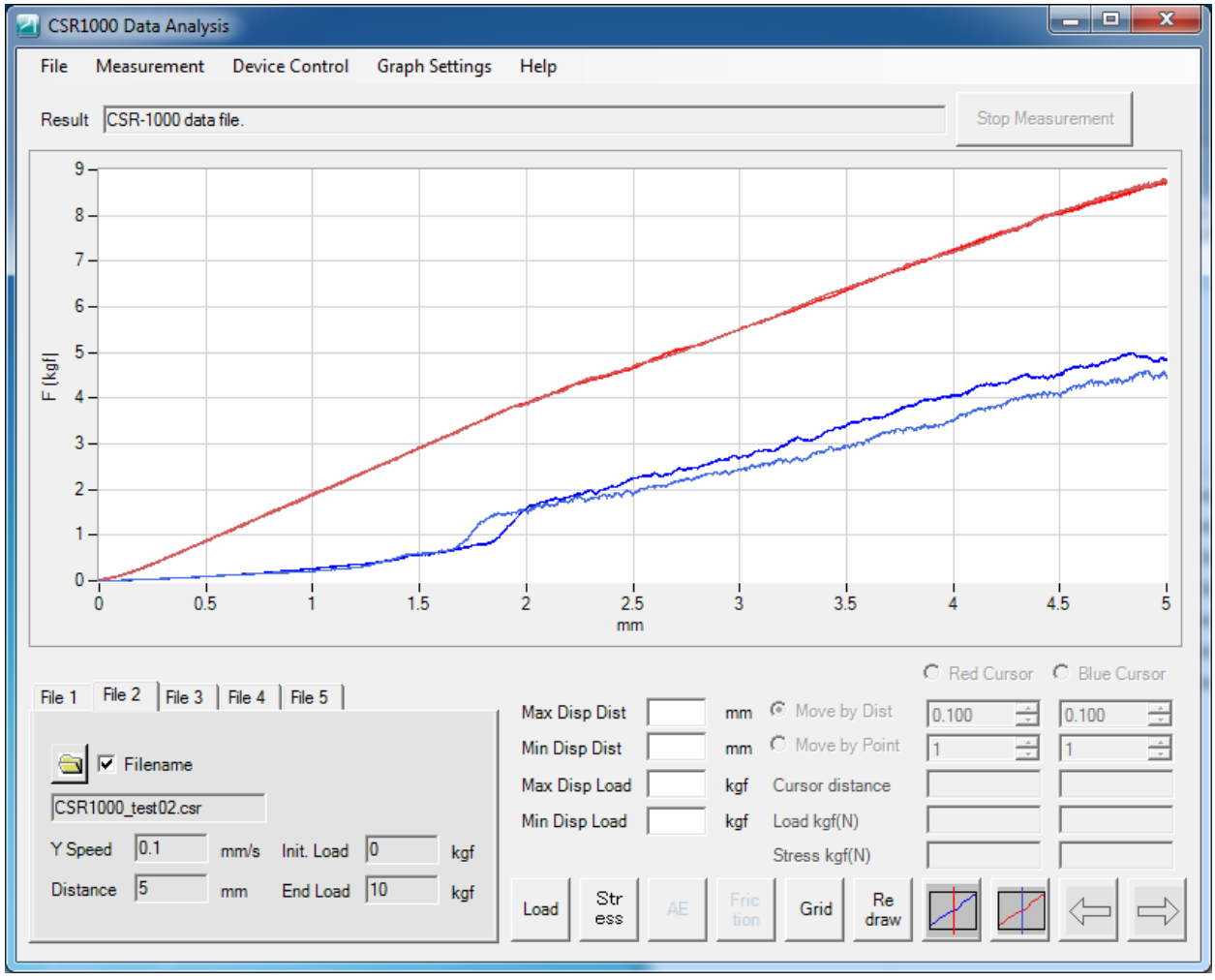


Fig. 8-16 Example of a graph based on grid settings

8-5 Converting the Measured Data in CSV Format

You can select **[File (F)]** in the menu bar and then click the **[Save CSV file (S)…]** submenu to save a data file as a Comma Separate Value (CSV)-formatted text file.
Turn on the radio button of "Save entire data file" to save the entire file or "Save range of data file being displayed" to save only the specified range of the data file being displayed, in a CSV file.

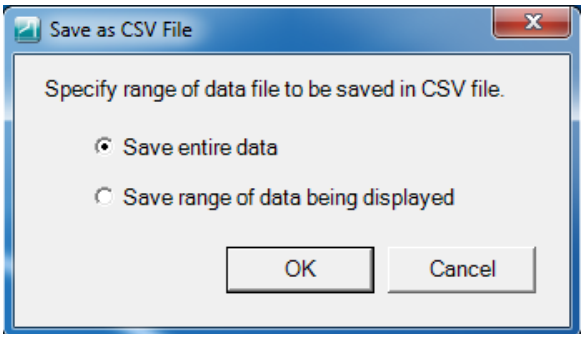


Fig. 8-17 Specifying the range of data file to be saved in a CSV file

When you specify the range of data to be saved, the window for entering a name of the file to be saved appears.

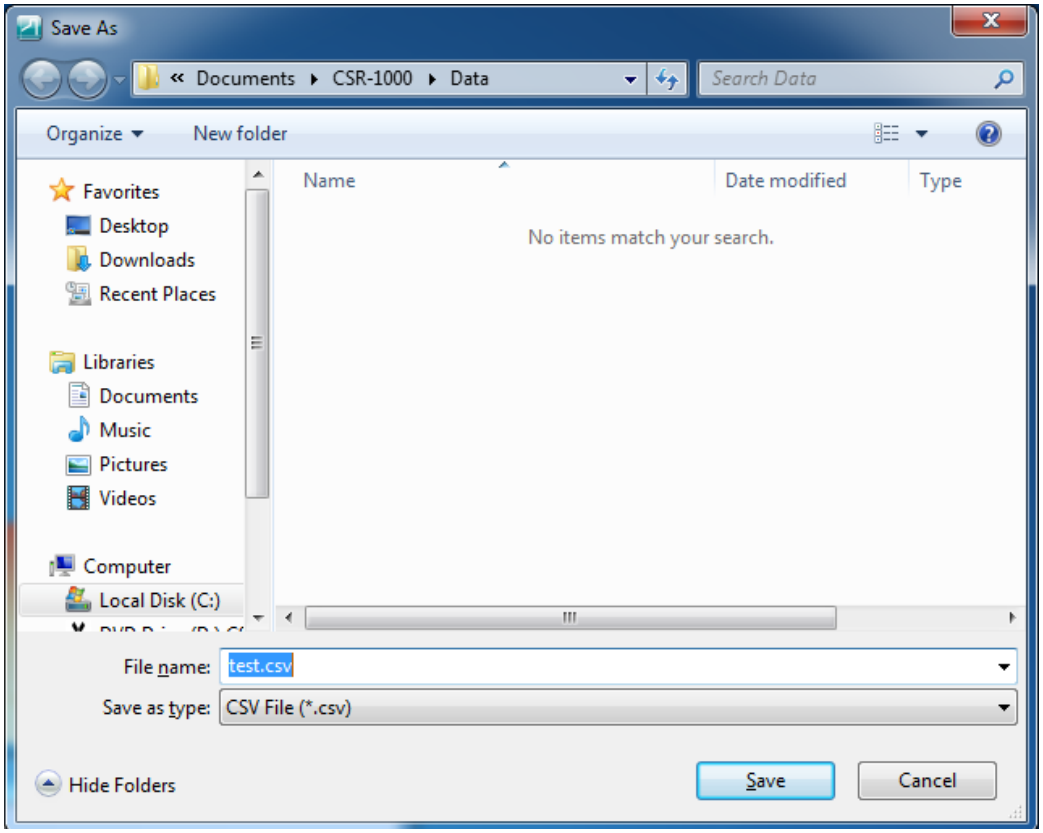


Fig. 8-18 Specifying a CSV file name

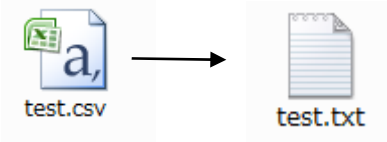
A data filename is automatically displayed in the filename input box. To change the filename, enter a new filename in the box and click the **[Save (S)]** button.

The data are saved in the following format.

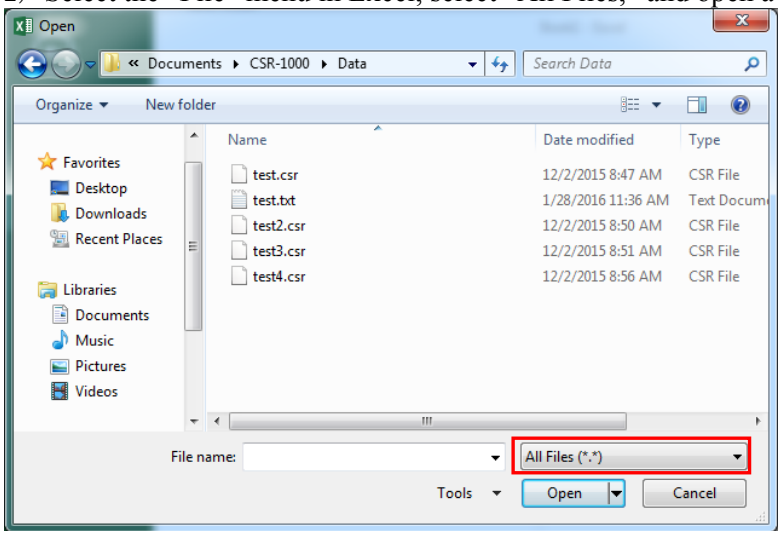
CSR-1000 Test Report	Title
Meas Date,2013-06-01	Measured date
Meas Time,12:00:00	Measured time
Operator,	Name of operator who performed measurement
Sample Name,	Sample name
Test Mode,Normal	Measurement mode
Y Full Sc,30 [Kgf]	Maximum stress value of sensor
Z Full Sc,30 [Kgf]	Maximum load value of sensor
Y Speed,0.1 [mm/s]	Scratching speed
Distance,5 [mm]	Scratch distance
Start Ld,0 [Kgf]	Initial test load
End Ld,15 [Kgf]	Measurement end load
Samp Speed,480 [pt/s]	Sampling speed
Distance, Stress, Load, AE	Data title
0.0000, 0.0000, 0.0427, 17	Distance, Stress data, Load data, AE data
0.0002, -0.0014, 0.0455, 18	
0.0004, 0.0000, 0.0441, 18	
0.0006, -0.0014, 0.0455, 18	
0.0008, 0.0027, 0.0427, 19	

When the Japanese characters are garbled
Retrieve external data in Microsoft Excel.
Select UTF-8 character-set encoding for source file format using the Get External Data setting.
You may be able to correct the problem by performing Microsoft Update.

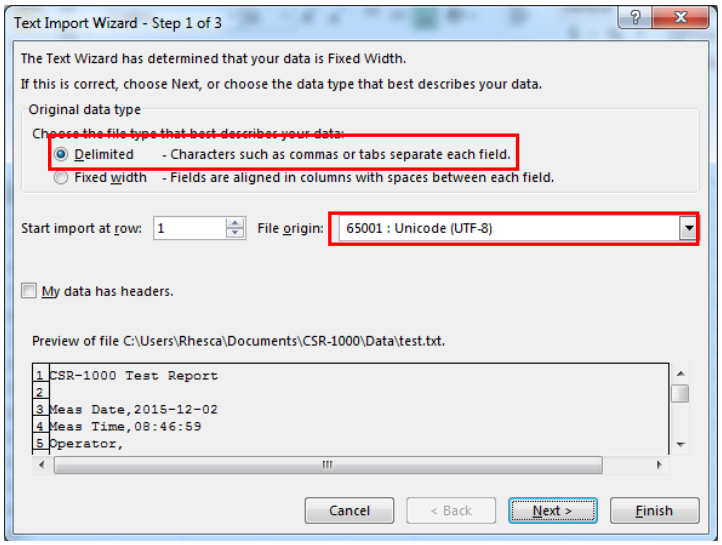
1) Change a filename extension from csv to txt.



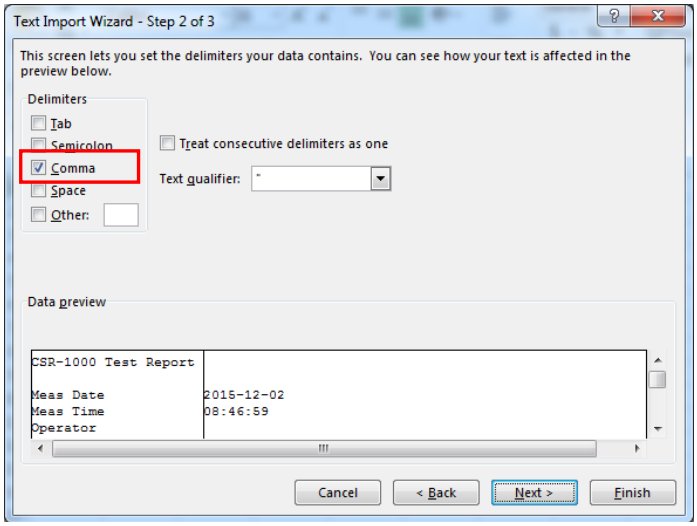
2) Select the “File” menu in Excel, select “All Files,” and open a txt file.



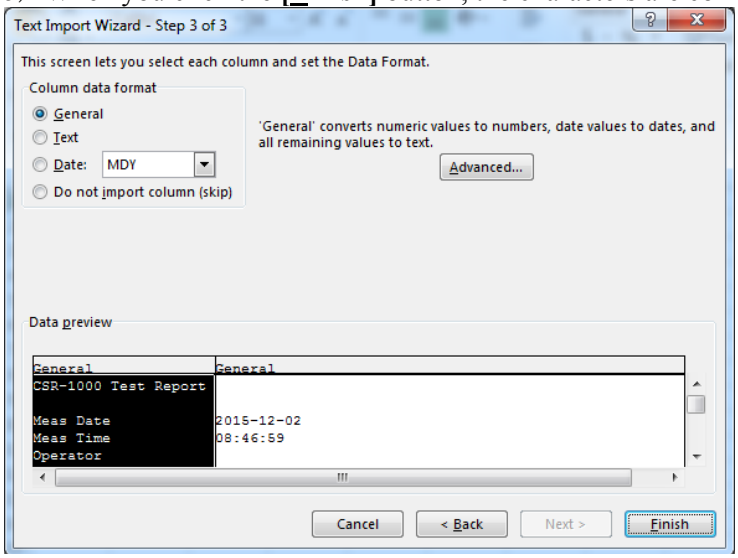
3）Check the “Delimited” in “Choose the type that best describes your data:”, and change a source file format to UTF-8.



4）Select the “Comma” as a Delimiters.



5）When you click the **[Finish]** button, the characters are corrected.



8-6 Printing the Measured Data

You can select **[File]** in the menu bar and then click the **[Print]** submenu to print measured data.

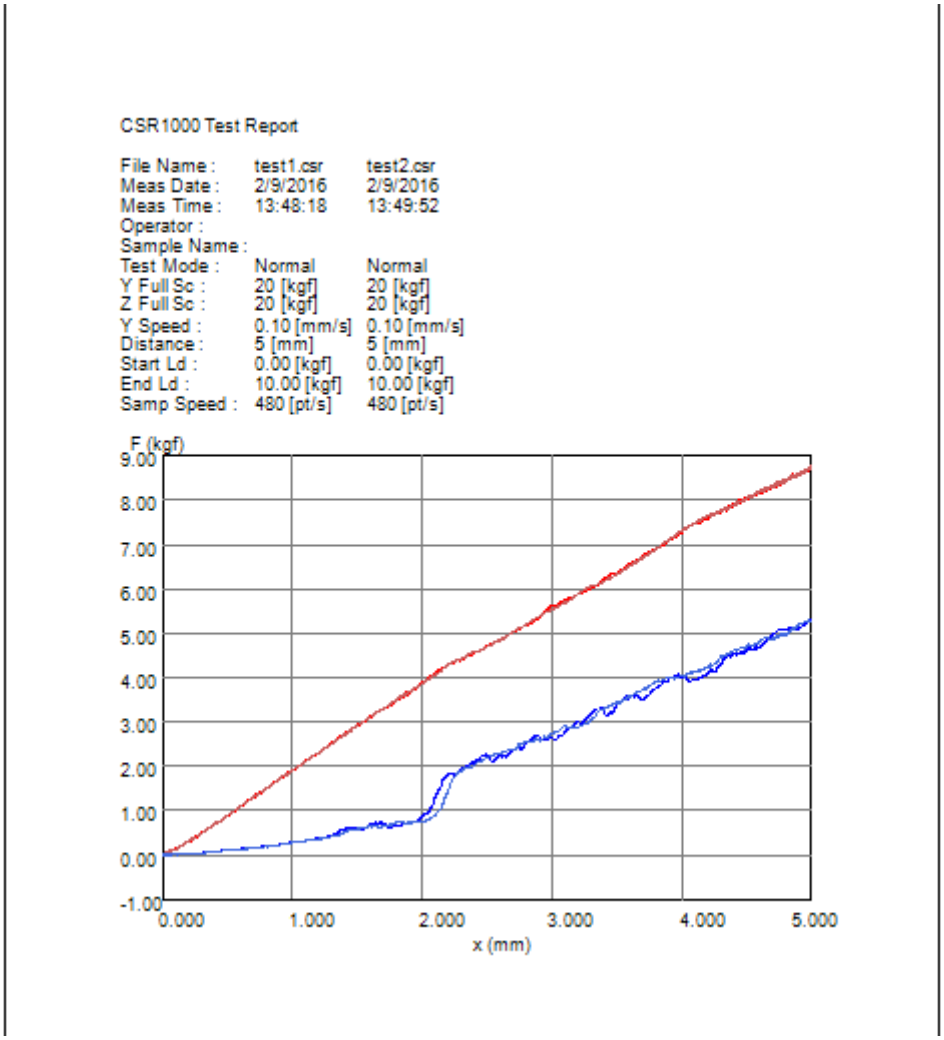


Fig. 8-19 Example of printout of measured data

The “Print (P)” submenu allows you to print measure conditions, measured results, and graph. When the cursor is displayed, distance of cursor position (Cursor X Value), stress values of File 1 to File 5 (Cursor Y Value), and load value (Cursor Z Value) are also printed.

You can select **[File]** in the menu bar and click the **[Print Preview]** submenu to preview the printout of the measured data.

8-7 Setting the Second-axis Scale

You can set the AE and friction coefficient scale values when **[AE]** or **[Friction]** is selected using the corresponding button.

Select the **[Graph Settings]** menu in the menu bar and click the **[2nd-axis Scale]** submenu to perform the second-axis scale setting.

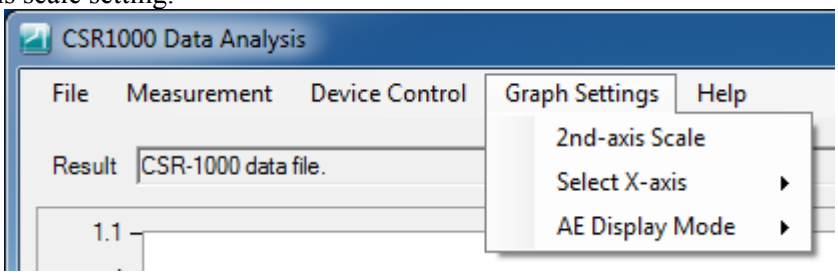


Fig. 8-20 Selecting the "2nd -axis scale" submenu

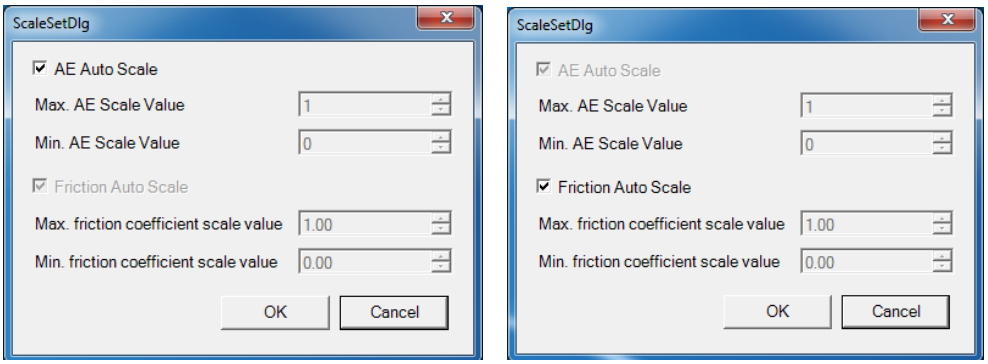


Fig. 8-21 Second-axis scale setting dialog

(Left dialog: when AE is selected; Right dialog: when friction coefficient is selected.)

When you put a check mark in the box on the left of "AE Auto Scale" or "Friction coefficient auto scale," the optimal scale for data is automatically set.

If you remove a check mark from the auto scale box, you will be able to enter maximum and minimum scale values. Enter the desired values and click the **[OK]** button.

8-7 Setting the X-axis Display Mode

Select the **[Set scale]** menu in the menu bar and move the cursor to the **[Select X-axis]** submenu to select the X-axis display mode.

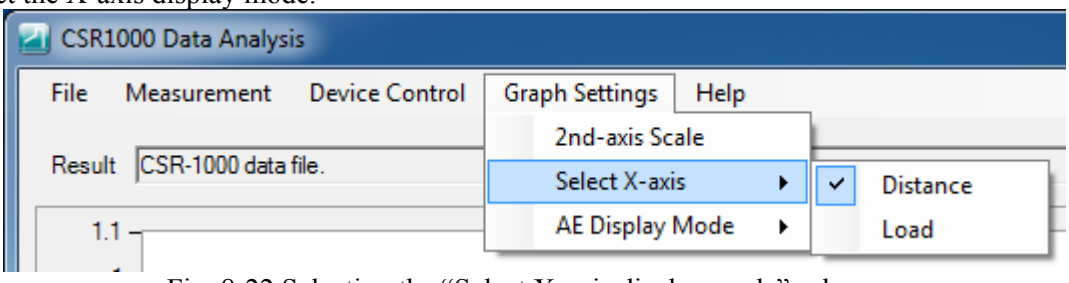


Fig. 8-22 Selecting the "Select X-axis display mode" submenu

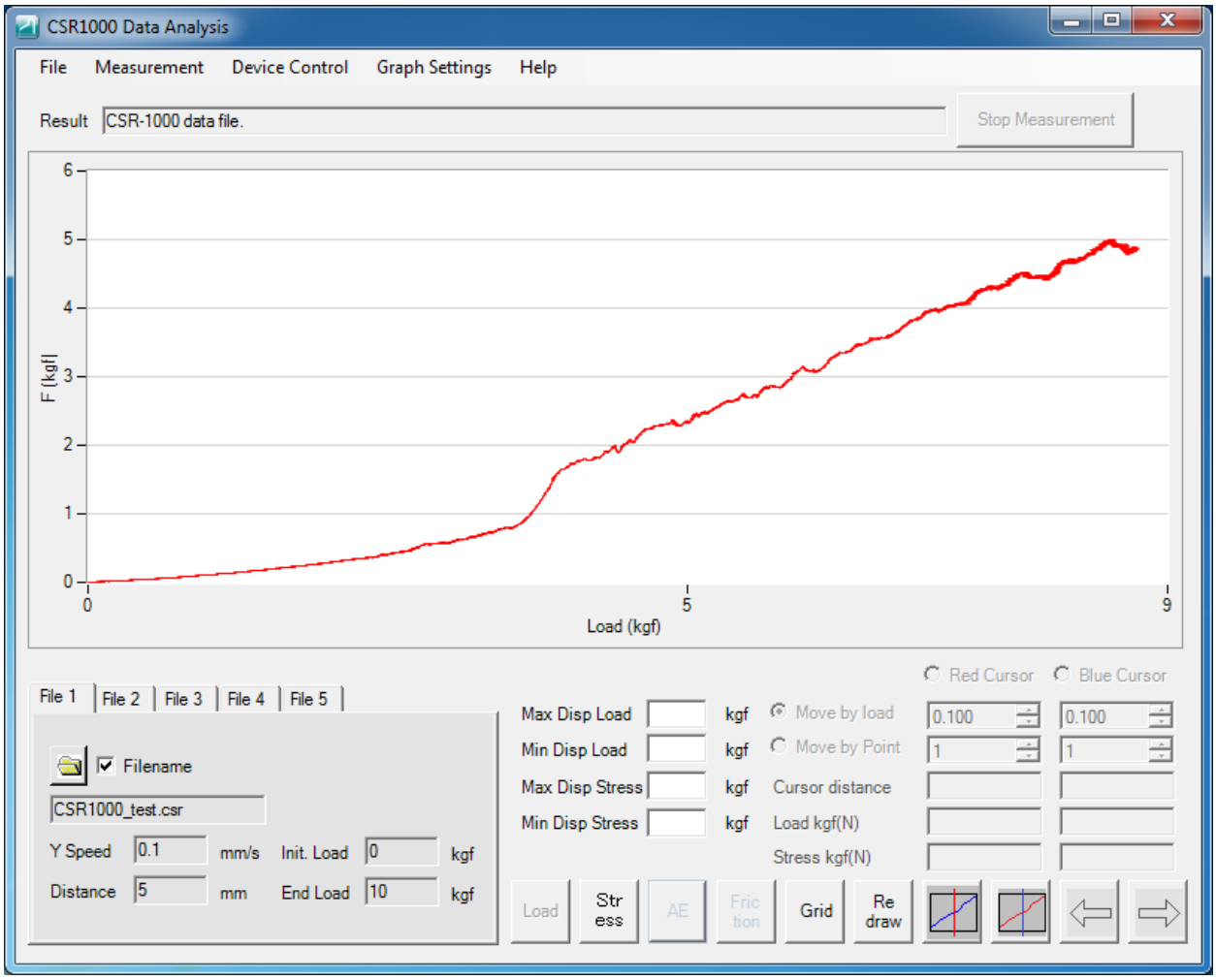


Fig. 8-23 Example of graph when the load-axis mode is selected

8-7 Displaying the Acoustic Emission (AE) Measurement Data

Select the **[Set scale]** menu in the menu bar and move the cursor to the **[Display AE data]** submenu to select the AE graph display format.

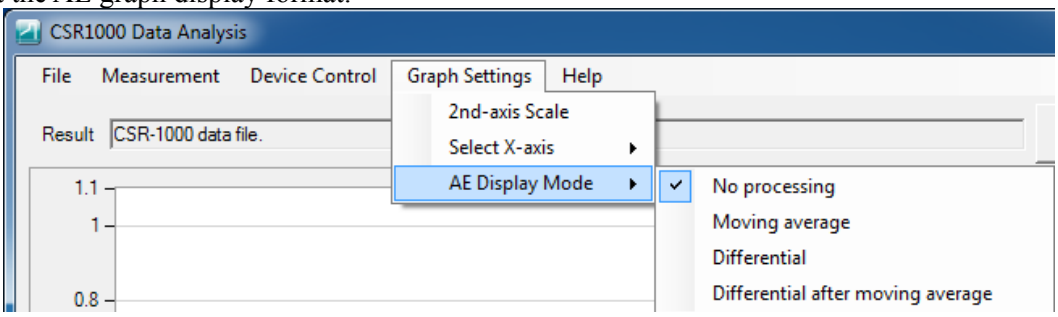


Fig. 8-24 Selecting the “Display AE data” submenu

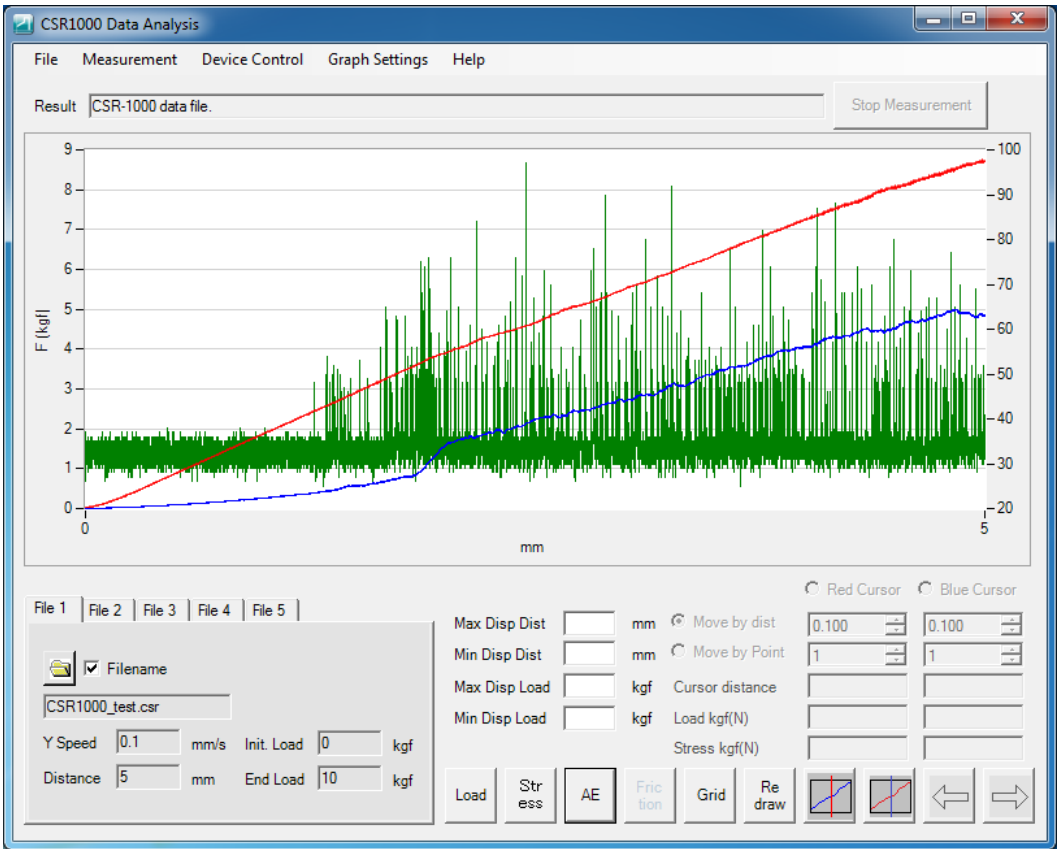


Fig. 8-25 Example of graph when “No processing” is selected

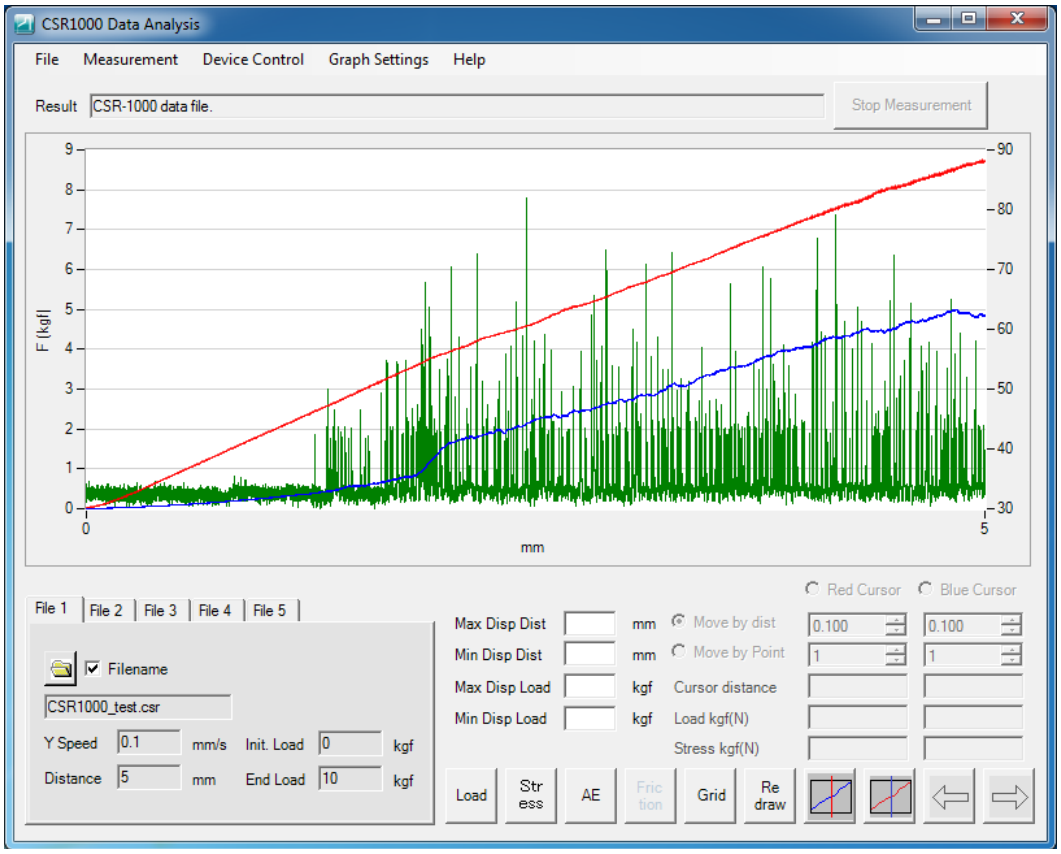


Fig. 8-26 Example of graph when “Moving average” is selected

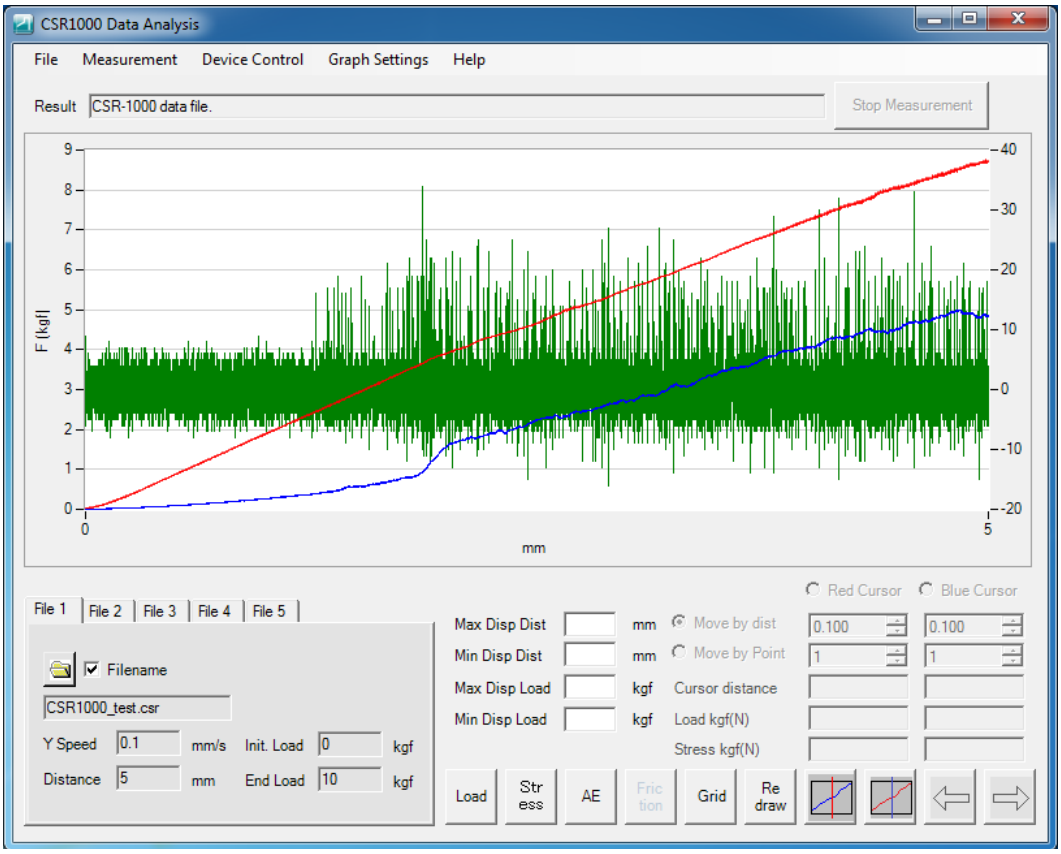


Fig. 8-27 Example of graph when “Differential” is selected

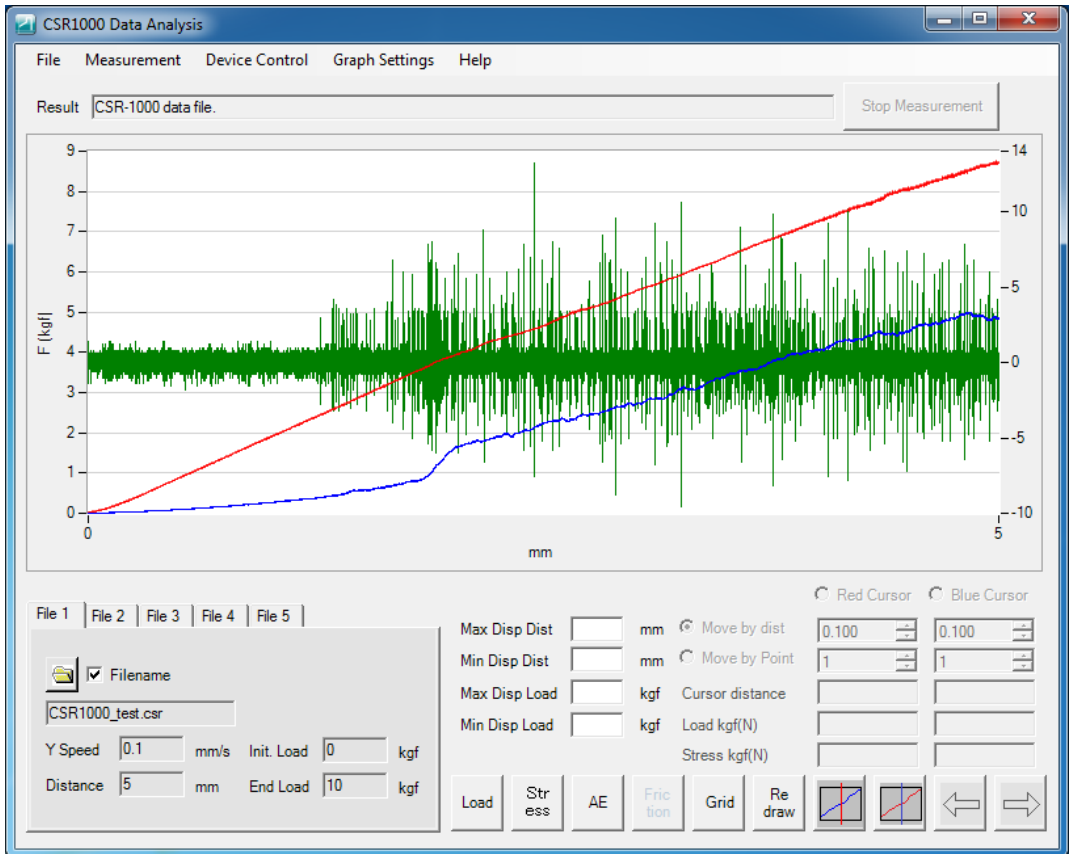


Fig. 8-28 Example of graph when “Differential after moving average” is selected

9 Performing the Hardness Measurement (Optional)

CSR-1000 Scratch Tester has optional accessories for performing the hardness measurement.
The Rockwell superficial hardness measurement method is used to measure hardness. Refer to page VI for details about the Rockwell superficial hardness measurement method.
Use the sensor with a maximum load of 20Kgf or higher due to the make-up of the Rockwell superficial hardness measurement method.
The optional accessories include the hardness measuring stage and standardized hardness test block.

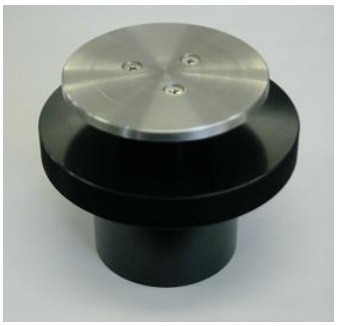


Fig. 9-1 Hardness measuring stage

Fig. 9-2 Standardized hardness test block

9-1 Measuring Hardness

Use the following procedure to perform the hardness measurement.

1) Place a sample on the center of the hardness measuring stage.
2) Move the stage so that the tip of the diamond chip will be above the measuring location.
3) Select the **[Set Conditions and Execute Measurement]** submenu from the **[Measurement]** menu in the menu bar.
4) Turn on the radio button of **[Hardness]** mode in the **[Measurement conditions]** window and confirm other measurement conditions.

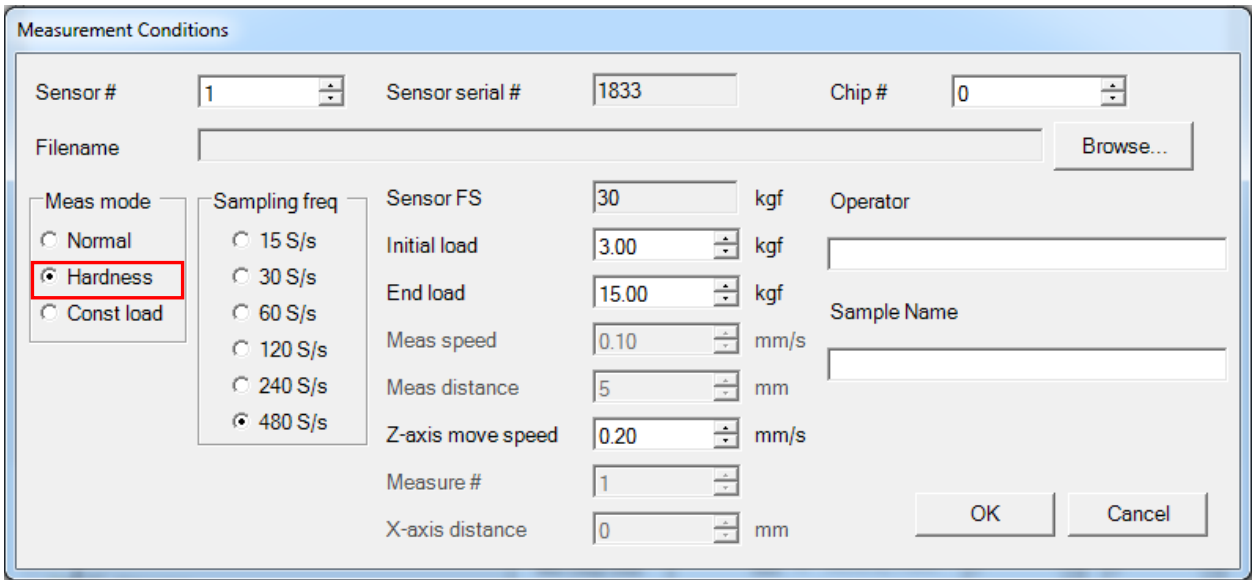


Fig. 9-3 “Set measurement conditions” window

The initial test load is normally set to 3Kgf, while the measurement end load is normally set to 15Kgf.

5) When you click the **[OK]** button, the measurement start dialog appears.

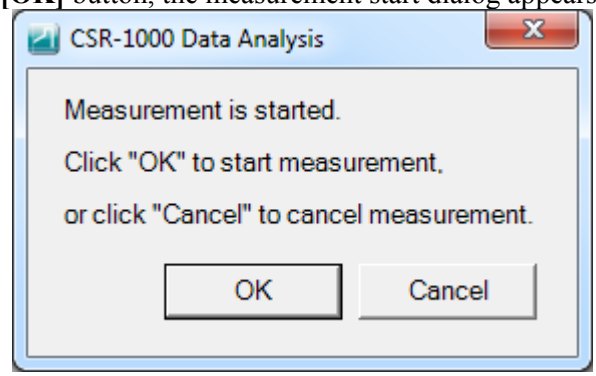


Fig. 9-4 Measurement start dialog

6) When you click the **[OK]** button in the measurement start dialog, the hardness measurement starts.
7) When measurement finishes, [HR Value = xx.*xx]* appears in the "Result" box at the top of the screen.

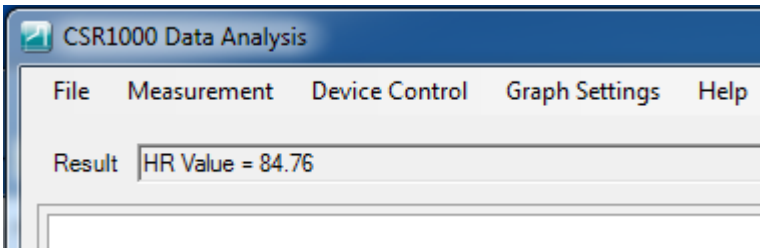


Fig. 9-5 Hardness measurement result

9-2 Setting the Hardness Correction Value

To perform the hardness measurement using CSR-1000 Scratch Tester, it is necessary to set a correction value for hardness measurement in advance.
Use the following procedure to set a correction value for hardness measurement.

1) Use three standardized hardness test blocks and measure the hardness of each block.
   Even though it is alright to use only one or two standardized hardness test blocks for this procedure, it is recommended to use three standardized hardness test blocks with different hardness in order to assure a higher accuracy measurement.
2) After you finish measuring the hardness of each standardized hardness test block, select **[Device Control]** in the menu bar, and then click **[HR correction value input]** submenu. The "**HR Correction Value Input**" dialog appears.

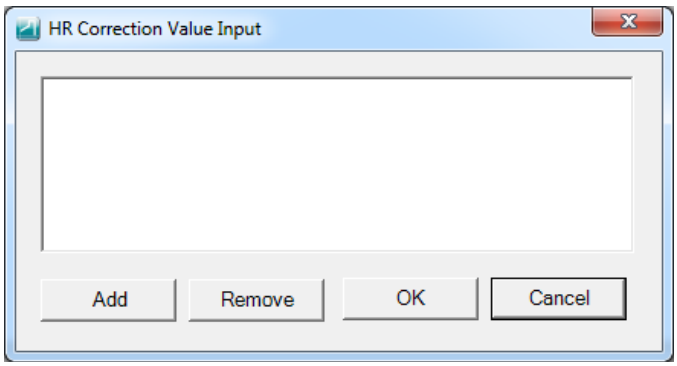


Fig. 9-6 "Hardness measurement correction value" dialog

3) Click the **[Add]** button to enter a correction value. The "Enter hardness data" dialog appears.

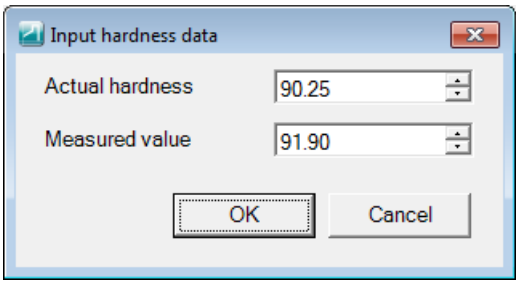


Fig. 9-7 "Enter hardness data" dialog

4) Enter an actual hardness of a standardized hardness test block in the "Actual hardness" input box of the "Enter hardness data" dialog. In the "Measured value" input box, enter the measurement result you got when you measured this specimen using CSR-1000 Scratch Tester.

5) The first value is the actual hardness of a measured sample and the second value is an actual measured value.

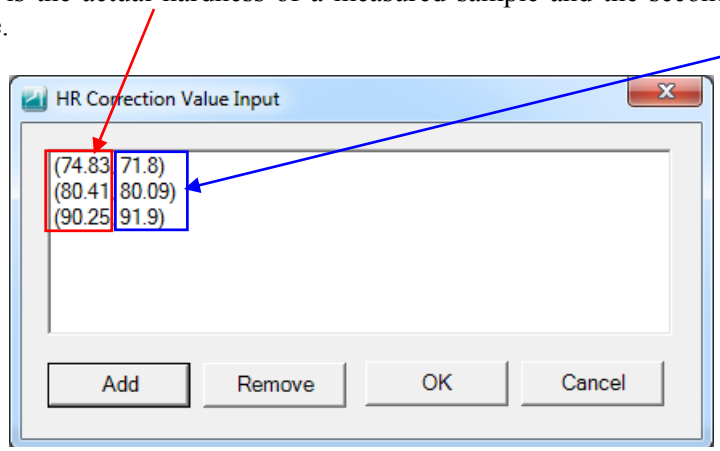


Fig. 9-8 After entering the hardness data

6) If you incorrectly enter hardness data, click on the incorrect data and click the **[Delete]** button to delete the data.

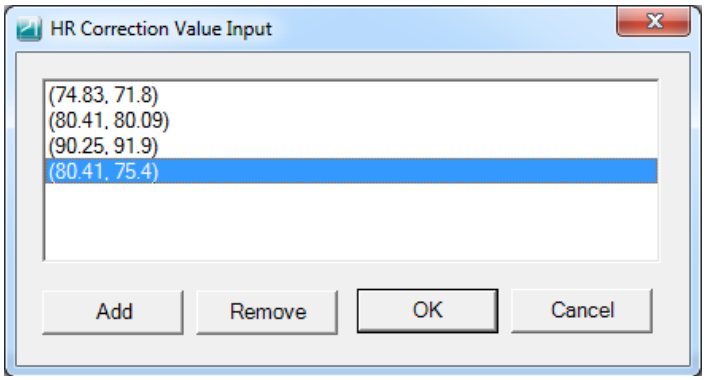


Fig. 9-9 Deleting hardness data

7) When you click the **[Delete]** button, the “Confirm deletion” dialog appears.

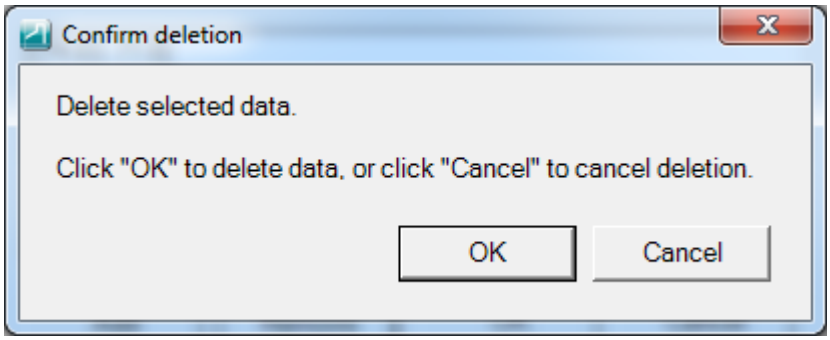


Fig. 9-10 “Confirm deletion” dialog

8) To delete the selected data, click the **[OK]** button in the “Confirm deletion” dialog. To cancel deletion, click the **[Cancel]** button.
9) When you click the **[OK]** button after entering hardness data, the hardness correction data is registered in CSR-1000 Scratch Tester.

No completion message for registering the hardness correction data is displayed after you have clicked the **[OK]** button.

Additional information: The correction method varies depending on the number of correction values used for hardness measurement.

The number of correction values and correction methods are summarized in the table below.

Number of correction values	Correction method
1	Offset correction
2	Linearity correction (This method uses a straight line that passes through two given points.)
3 or more	Linearity correction (This method performs the correction using a straight line that was calculated by applying the least-squares method using the given correction data.)

10 Operating the Sample Stage

You can operate the sample stage using the joysticks (Fig. 10-1) on both sides of CSR-1000 Scratch Tester.

Fig. 10-1 Joystick

The right joystick is used for moving the sample stage forward/backward and left/right. While the sample stage is moving, you can use the left joystick to change the moving speed. If you press down the left joystick leftward or rightward while moving the stage using the right joystick, you can move it in high-speed mode.

The left joystick is used for moving the sensor up and down. If you press down the right joystick leftward or rightward while moving the sensor up and down using the left joystick, you can move it up or down in high-speed mode.

Note that the START and Hi-Speed buttons provided with the joysticks of CSR-1000 do not function.

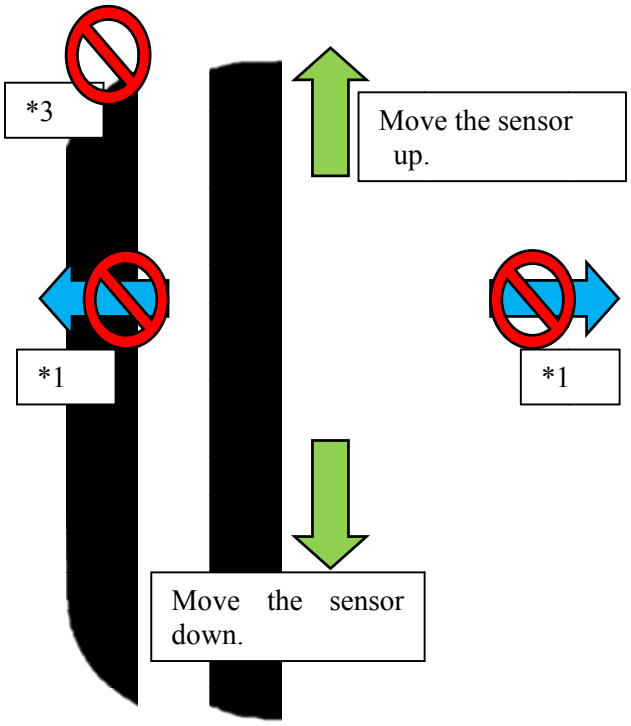


Fig. 10-2 Left joystick

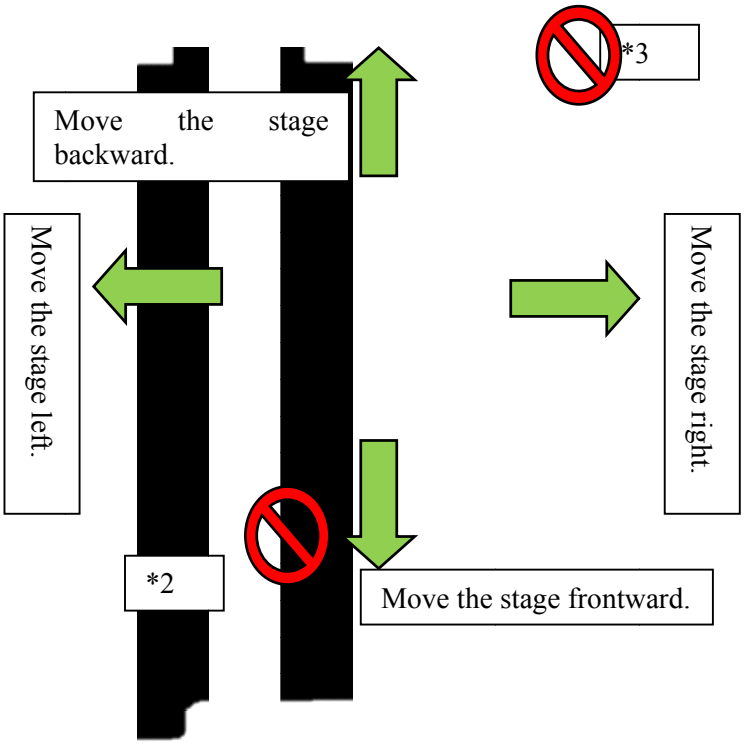


Fig. 10-3 Right joystick

*1 The left joystick of CSR-1000 cannot be moved sideways.
*2 The START button of the right joystick of CSR-1000 does not function.
*3 The Hi-Speed buttons of the left and right joysticks of CSR-1000 (rear side of joysticks) do not function.

<Blank page>

11 Maintenance and Calibration

11-1 Replacing the Fuse

CSR-1000 Scratch Tester uses one 3A fuse, as shown in Fig. 11-1. When you replace a fuse, be sure to turn off the **[POWER]** switch (switch: 0 side) and unplug the power cord from the AC outlet.

> **Warning: To protect the product and the user from danger such as fire, be sure to use rated fuses. To avoid danger such as electric shock, turn off the power switch and unplug the power cord from the AC outlet when replacing an older fuse with a new one.**

How to change fuses

1) Turn off the **[POWER]** switch (switch: 0 side) and unplug the power cord from the AC outlet.
2) Remove the fuse holder by turning it counterclockwise with a flat-head screwdriver.
3) Replace the old fuse with a new one.
   Be sure to use the rate fuse (T3AH).
4) Mount the fuse holder with the new fuse into the main unit by turning it clockwise.
5) If the new fuse blows out again after replacement, the scratch tester probably has a trouble. If that happens, contact us or the agent from whom you purchased the product.

Fig. 11-1 Main unit rear panel

11-2 Calibrating the Sensor

CSR-1000 Scratch Tester uses strain sensors for the measurements in the load direction (Z-axis direction) and stress direction (Y-axis direction). When you are unable to get a normal output (for example, when output data values become unstable or no value is output), you have to calibrate the strain sensors. Calibrations for the load direction and stress direction must be performed separately.

To perform the calibrations, you need a separate weight that is exclusively used for calibration.

Procure a weight that is compatible with the sensitivity of the sensor. Calibrating a high-load sensor (such as a sensor with a maximum load capacity of 30Kgf) is a cumbersome task, because of the heavy weight being used. Note, however, that the sensor of CSR-1000 can be calibrated using a weight that is 1/*n*th of the load value. For example, when you calibrate a standard sensor with a maximum load capacity of 30Kgf, procure a 5Kg weight. You can calibrate this sensor by setting the scale to x6 times. (The weight used for calibration is an optional part.)

11-2-1 Calibrating the Y-axis (stress value)

1) Turn off the power switch (switch: 0 side) of the main unit.
2) Remove the sensor from the main unit and then detach the diamond chip from the sensor. (Leave the high-load block attached to the sensor as is.)

Fig. 11-2 Sensor (attached with high-load block)

3) The sensor attachment shaft in a black cover is located on the right panel of the main unit. Remove the black cover.

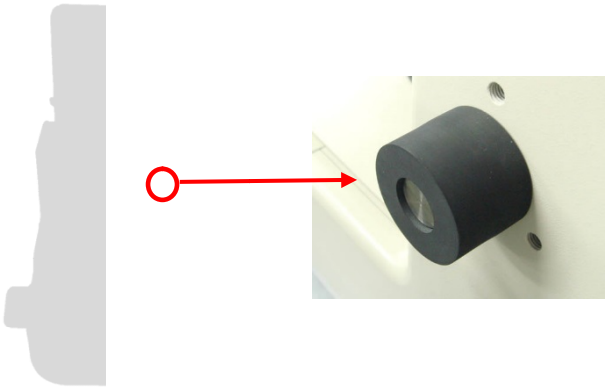


Fig. 11-3 Sensor attachment shaft cover

Fig. 11-4 Sensor attachment shaft

4) Put the sensor in the sensor attachment groove of the high-load block and fix it with screws from the upper side of the sensor attachment shaft so that the sensor cable is at the lower side.

Caution: Load sensor calibration in the stress direction using this attachment method can be performed when a weight used for calibration is 5Kg or less. When you calibrate a stress sensor with a maximum load heavier than 5Kg, enter the scale value of the sensor and perform calibration using a weight of less than 5Kg.

Fig. 11-5 Attaching the sensor

5) Insert the Y-axis calibration jig into the chip attachment hole of the sensor. Fix the jig using the hex. bolt.

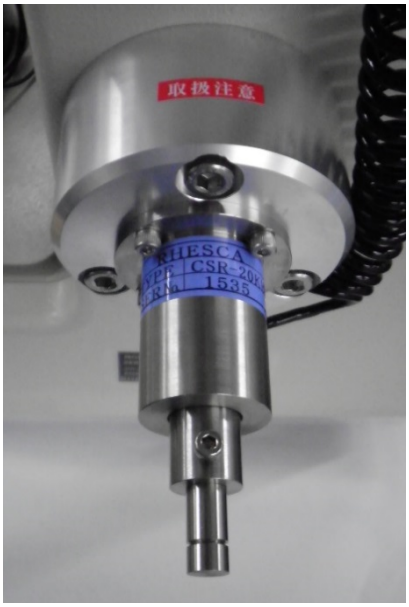


Fig. 11-6 Sensor attached with Y-axis calibration jig

6) Turn on the main unit and start the control program on your computer

7) When you select **[Device Control]** in the menu bar and click the **[Sensor calibration]** submenu, the “Sensor Calibration” dialog appears.

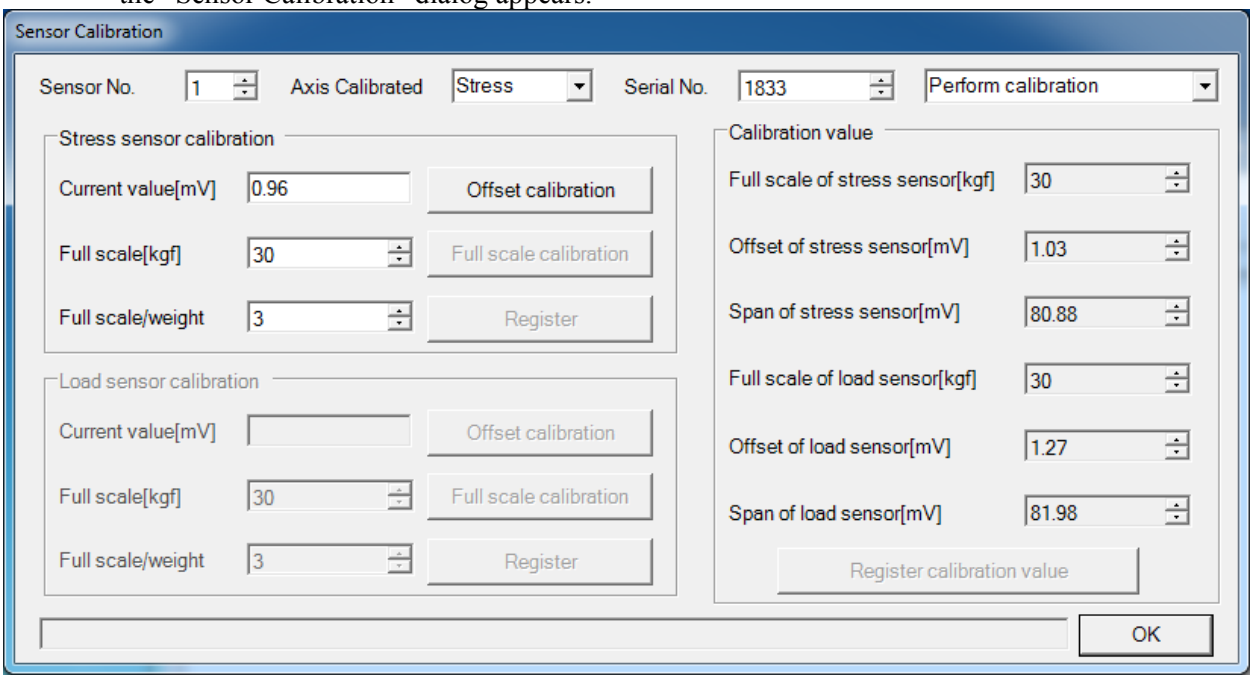


Fig. 11-7 “Sensor calibration” dialog

8) Select “Stress” for “Axis Calibrated” box.
9) Set the serial number of a sensor in the “Serial No.” box.
10) Set the full-scale value of the sensor in the “Full scale” box.
11) Set a value divided by the weight of the calibration weight (that uses the sensor full-scale value) in the “Full scale/weight” box. (Since you can set only an integer for this value, use a calibration weight with the weight corresponding to the value obtained by dividing the sensor full-scale value by the integer. For example, when you need to calibrate a sensor with a maximum load capacity of 30Kgf using a 5Kg calibration weight, you have to set “6” for x6 times as the scale in the “Full scale/weight” box.)
12) Click the **[Offset calibration]** button in the state of no-load applied to the sensor. When the measurement is finished, the offset A/D value of the stress sensor is displayed in the text box at the bottom.
13) When the calibration weight is attached to the Y-axis calibration jig and the “Stress sensor A/D value (monitor)” becomes stable, click the **[Full scale calibration]** button. When the measurement is finished, the A/D values captured at the time of applying the load of the calibration weight to the stress sensor are displayed in the text box at the bottom.

Fig. 11-8 Calibrating the stress axis

14) Click the **[Register]** button. When the calibration value is registered in the main unit, a message "Y-axis calibration value writing completed" is displayed in the text box at the bottom.

(The values registered by the above operation are the A/D value of the sensor in a no-load state that was converted from two measured A/D values, and the A/D value obtained at the time of maximum load.)

Now, the calibration of the Y-axis (stress) sensor is completed.

11-2-2 Calibrating the Z-axis (load value)

1) Turn off the power switch (switch: 0 side) of the main unit.
2) Remove the sensor from the main unit and detach the diamond chip from the sensor. (Leave the high-load block attached to the sensor as is.)

Fig. 11-9 Sensor (high-load block)

3) Place the sensor on a hard, flat, and stable surface.
4) Attach the calibration flange to the sensor and fix it using the hex. bolt.

Fig. 11-10 Sensor and calibration flange

5) Turn on the power switch (switch: 1 side) of the main unit and start the control program on your computer.

6) When you select **[Device Control]** in the menu bar and click the **[Sensor calibration]** submenu, the "Sensor calibration" dialog appears.

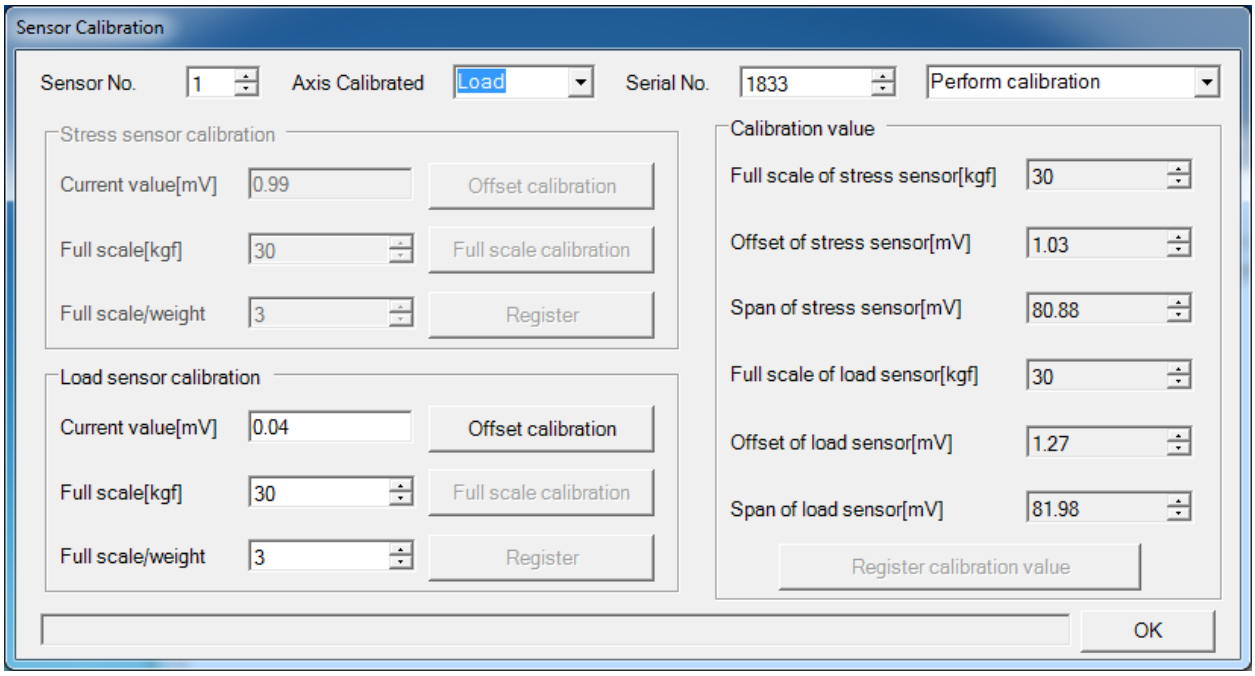


Fig. 11-11 "Sensor calibration" dialog

7) Select "Load" for "Axis Calibrated" box.
8) Set the serial number of a sensor in the "Serial No." box.
9) Set the full-scale value of the sensor in the "Full scale" box.
10) Set a value divided by the weight of a calibration weight (that uses the full-scale value of the sensor) in the "Full scale/weight" box. (Since you can set only an integer for this value, use a calibration weight with the weight corresponding to the value obtained by dividing the sensor full-scale value by the integer. For example, when you need to calibrate a sensor with a maximum load capacity of 30Kgf using a 5Kg calibration weight, you have to set "6" for x6 times as the scale in the "Full scale/weight" box.)
11) Place a calibration flange on the sensor and click the **[Offset calibration]** button in the state of no other load applied to the sensor. When the measurement is finished, the offset A/D value of the load sensor is displayed in the text box at the bottom.
12) When the calibration weight is placed on the calibration flange and the "Load sensor A/D value" becomes stable, click the **[Full scale calibration]** button. When the measurement is finished, the A/D values captured at the time of applying the load of the calibration weight to the load sensor are displayed in the text box at the bottom.

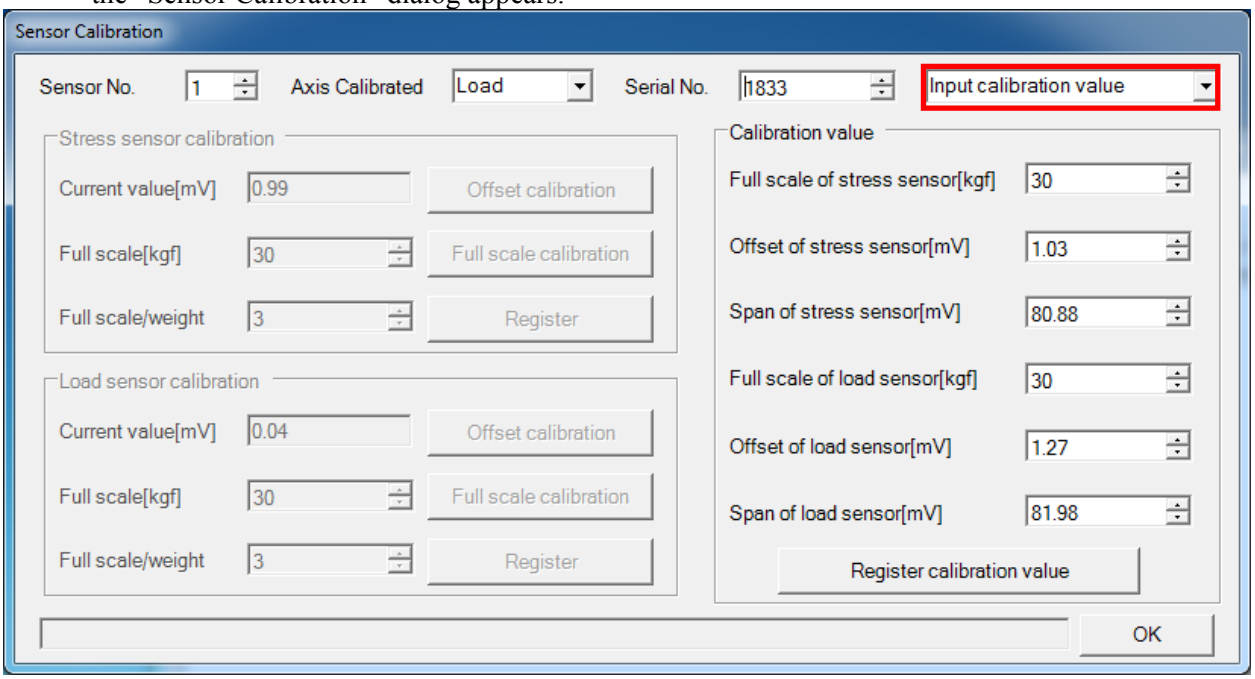
Fig. 11-12 Calibrating the load axis

(13) Click the **[Register]** button. When the calibration value is registered in the main unit, a message “Z-axis calibration value writing completed” is displayed in the text box at the bottom.
(The values registered by the above operation are the A/D value of the sensor in a no-load state that was converted from two measured A/D values, and the A/D value obtained at the time of maximum load.)
Now, the calibration of the Z-axis (load) sensor is completed.

11-2-3 Performing manual calibration

You can directly input a sensor calibration value when you already know it.

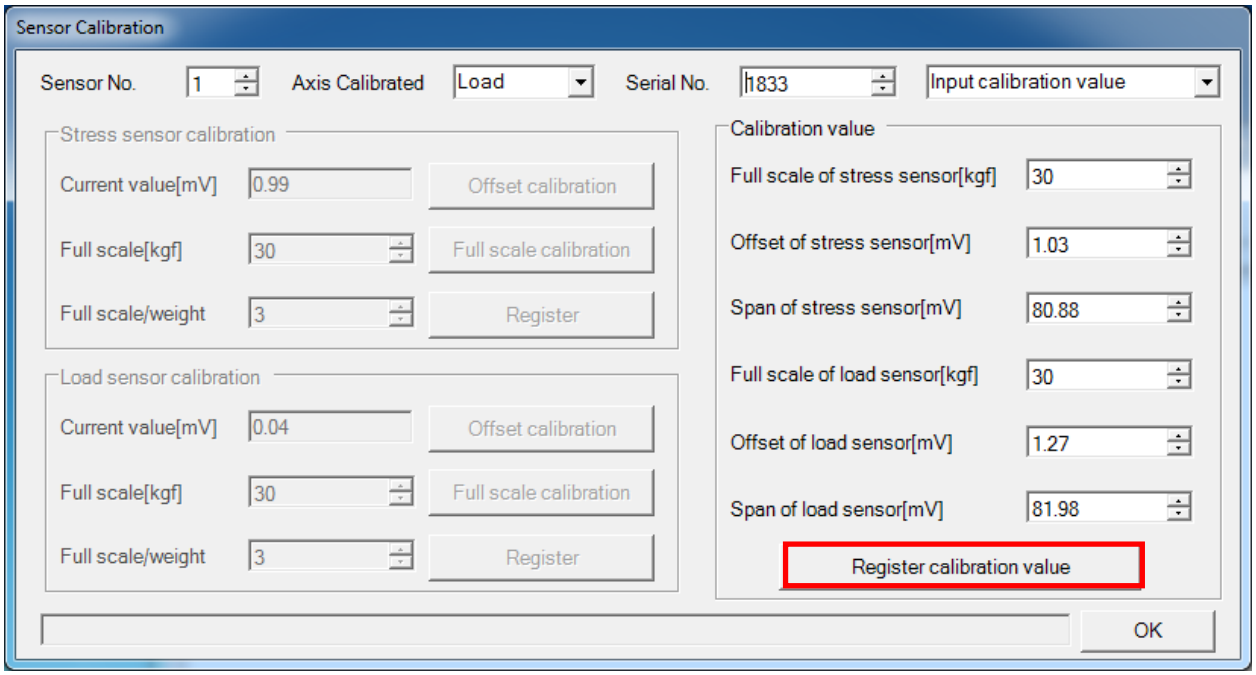
1) When you select **[Device Control]** in the menu bar and click the **[Sensor calibration]** submenu, the "Sensor Calibration" dialog appears.



2) Set a calibration value in the "Calibration value" box.

3) Enter a sensor calibration value.

4) Click the **[Register calibration value]** button. When the calibration value is registered in the main unit, a message "Calibration value writing completed" is displayed in the text box at the bottom.



11-3 Measuring the Spring Constant

CSR-1000 Scratch Tester uses a spring constant for controlling the load. The spring constant in this case indicates how much the load A/D values increase when the load control motor moves for the input of one pulse.

After you replace a spring in the sample stage or a sensor, the spring constant must be measured again.

Use the following procedure to measure the spring constant.

1) Detach the diamond chip from the sensor.
2) Remove a sample from the sample stage.
3) Move the sample stage so that the tip of the sensor is positioned above the center of the sample stage.
4) Select **[Control device]** in the menu bar and click the **[Measure spring constant]** submenu. The following dialog appears.

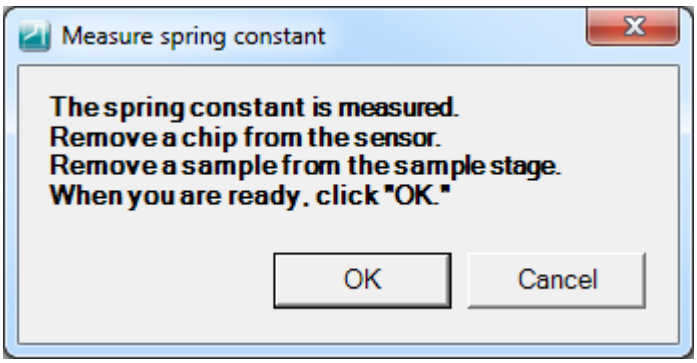


Fig. 11-13 “Measure spring constant” dialog

5) Make sure that the diamond chip is detached from the sensor and a sample is removed from the sample stage. Click the **[OK]** button.
6) When you click the **[OK]** button, the dialog will be closed and the sensor moves downward. The sensor will eventually touch the sample stage. In this state, the spring constant is measured. (The measurement is completed in about 30 seconds.)
7) When the spring constant measurement is completed, the spring constant value is displayed as “Spring constant: xxxxx” in the “Result” box on the main screen.

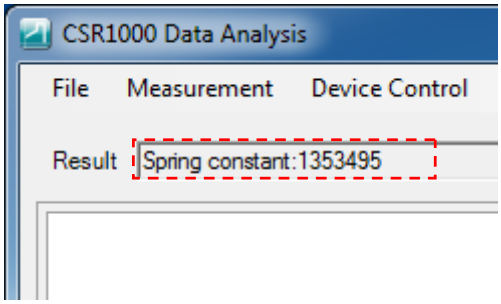


Fig. 11-14 Result of spring constant measurement

12 Specifications

Load range		Z axis: 30Kgf Max Y axis: 30Kgf Max
Load resolution		0.1% FS
Indenter		120-degree diamond cone, 0.2mm tip diameter
Measurement method	Scratch	1) In this measurement mode, a sample is moved in the horizontal direction while the user-defined load (vertical direction) applied to the sample is increased continuously.
	Constant load	2) In this measurement mode, a sample is moved in the horizontal direction while user-defined load (vertical direction) is applied continuously to the sample.
	Rockwell (optional)	3) In this measurement mode, the depth of permanent indentation is measured by applying the initial test load (3Kgf) to a sample, applying the test load (15Kgf) to the sample next, and then applying a load same as the initial test load value.
Applied load speed Z axis		The feedback control is performed for the applied load speed based on the measured time. During moving: 0.01 - 5.00mm/s (Any setting in steps of 0.01mm/s) Motor resolution: 0.036 degrees/step Drive screw lead: 1mm/rotation Drive feeding speed: 0.1μm/step During hardness measurement: 0.01 - 1.00mm/s (Any setting in steps of 0.01mm/s)
Scratching speed Y axis		During measurement: 0.01 - 2.00mm/s (Any setting in steps of 0.01mm/s) During moving: 0.01 - 5.00mm/s (Any setting in steps of 0.01mm/s) Motor resolution: 0.036 degrees/step Drive screw lead: 2mm/rotation Drive feeding speed: 0.2μm/step
Stage moving speedX axis		0.01 - 5.00mm/s (Any setting in steps of 0.01mm/s) Motor resolution: 0.036 degrees/step Drive screw lead: 2mm/rotation Drive feeding speed: 0.2μm/step
Moving range	X axis	±50mm
	Y axis	±50mm
	Z axis	Max 70mm
Z-axis load setting		30Kgf Max (Any setting in steps of 10g)
AE sensor (optional)	Input voltage	50mVp-p
	Frequency characteristics	100KHz
	Output voltage	0 – 50mV
Load sensor	Z axis	30Kgf FS
	Y axis	30Kgf FS
Spring Spring constant		3Kgf/mm(29.4N/mm)
Calibration		Calibration is enabled on the side panel of the scratch tester using a 5Kg weight. (The weight is optional.) An optional standardized hardness test block is used. (Use three types of blocks with HR15N hardness 75/80/90.)
Measurement conditions selection and setting		Measurement method, Z-axis initial test load/end load, Y-axis moving distance, Y-axis moving speed Z-axis moving speed during hardness measurement
Communication method		USB
Graph output		Graph output on a personal computer (runs on MS-Windows®) Graph horizontal axis: Scratch distance

	Graph vertical axis: Load, stress (Kgf)/AE sensitivity Real-time display Zoom function: Range selection by the mouse cursor. Range selection by value input.
Recommended sample size	20 x 10 x 1 to 50 x 50 x 5 (mm)
Input power	Single-phase 100-240VAC, ±10％ 50/60Hz
Outside dimensions	W485×D651×H790mm
Weight	80Kg (main unit only)

NOTE

Important Notice:

(1) The content of this document shall not be reprinted, either in whole or in part, without our permission.
(2) The content of this document is subject to change without prior notice.
(3) The content of this document is carefully prepared, but should you find any questions, errors, omissions, etc, please directly contact us, or our agent from whom you purchased this product.
(4) We shall not be liable for any incidental or consequential damages resulting from incorrect operation by the customer, or servicing, modification, etc. by a third party in lieu of us or our authorized agent.

RHESCA Co. Ltd. 1-15-17 Hino-honmachi, Hino City, Tokyo, 191-0011, Japan
Phone: 042-582-4711 FAX: (042)589-4686
URL:http://www.rhesca.co.jp