HIOKI

Instruction Manual

POWDER IMPEDANCE MEASUREMENT SYSTEM

The latest edition of the instruction manual

EN

Oct. 2024 Edition 1
SA2653A961-00

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Introduction

Thank you for choosing the Hioki Powder Impedance Measurement System.
To ensure you get the most out of this system over the long term, please read this manual carefully and keep it available for future reference.

Request for product user registration

This system may be upgraded for improvements or specification changes.
We kindly request that you visit the following link to register your product to receive critical updates and information about the product:
https://www.hioki.com/global/support/myhioki/registration/

Below are all the resources you can choose from based on your specific application.

Type	Manual contents	Hard copy	Electronic version (PDF)
Powder Impedance Measurement System Instruction Manual (this document)	Instructions for operating this system and how to use the SA2653 Measurement Software	–	✓
SA2653 Measurement Software Guide for Instruction Manual	Guide to accessing the instruction manual download page (QR code)	✓	–
SA2654 Sensor Unit Instruction Manual	How to use the Sensor Unit	✓	–
SA9003 Press Unit Instruction Manual	How to use the Press Unit	✓	–
SA9004-01 Test Fixture Instruction Manual	How to use the Test Fixture	✓	–
SA9005 Mold Release Unit Instruction Manual	How to use the Mold Release Unit	✓	–
L2280-01/L2280-03 Connection Cable Instruction Manual	How to use the connection cables	✓	–
Operating Precautions (0990A905)	Information regarding the safe use of this system Please review the separate *Operating Precautions* before using this system.	✓	–

Target audience

This manual has been written for use by individuals who use the system or provide information about how to use the system.
In explaining how to use the system, it assumes the user has knowledge equivalent to that of a graduate from a technical high school program specializing in electrical and powdery substances.

Trademarks

Microsoft, Microsoft Edge, and Windows are trademarks of the Microsoft group of companies.

System Configuration

The Powder Impedance Measurement System consists of the following products.
Upon receiving the products, inspect them for any damage or anomalies. If you discover any damage or find that the product does not perform as indicated in the specifications, please contact your authorized Hioki distributor or reseller.

Product	Included accessories
SA2653 Measurement Software The latest version is available for download from Hioki's website.	• PC Application CD (Measurement Software) • USB license key • USB cable (Type A to Type B) • Guide for Instruction Manual (SA2653A964) • Operating Precautions (0990A905)
SA2654 Sensor Unit	• Instruction Manual • Power cord • USB cable (Type A to Type B) • Functional ground cable (for SA9003 functional ground connection) • CD (USB driver) • Operating Precautions (0990A905)
SA9003 Press Unit	• Instruction Manual • Ratchet handle • Quick spinner • Short-compensation block
SA9004-01 Test Fixture	• Instruction Manual
SA9005 Mold Release Unit	• Instruction Manual
L2280-01 Connection Cable (80 cm, for the IM3533 LCR Meter and the IM3570 Impedance Analyzer)	• Instruction Manual
L2280-03 Connection Cable (80 cm, for the RM3545A Resistance Meter)	• Instruction Manual
IM3570 Impedance Analyzer	See the Instruction Manual for the measuring instrument.
IM3533 LCR Meter	
RM3545A Resistance Meter	

Notations

Safety notations

This manual classifies seriousness of risks and hazard levels as described below.

⚠ DANGER	Indicates an imminently hazardous situation that, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation that, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation that, if not avoided, could result in minor or moderate injury or potential risks of damage to the supported product (or to other property).
IMPORTANT	Provides important information and content necessary for operating or maintaining the system.
	Indicates prohibited actions.
	Indicates mandatory actions.

Symbols on the products

	Indicates the presence of a potential hazard. See “Precautions for Use” (p. 11) and warning messages listed at the beginning of each operating instruction in the instruction manual, as well as the accompanying document entitled *Operating Precautions*.
	Indicates the on position of the power switch.
	Indicates the off position of the power switch.
	Indicates the functional ground terminal.
	Indicates that the product can be used to measure direct current (DC) voltage/current or can be powered by a DC source.
	Indicates that the product can be used to measure alternating current (AC) voltage/current or can be powered by utility AC power.

Symbols for various standards

CE	Indicates that the product complies with standards mandated by EU directives.

Other notations

Tips	Provides useful capabilities and advice you should be aware of.
(p.)	Indicates the page number to reference.
START (bold)	Indicates the names of user interface elements on the screen, which appear in bold or are enclosed in brackets.
[ ]	
Windows	Unless otherwise noted, the term *Windows* is generically used to refer to *Windows 8.1*, *Windows 10*, and *Windows 11*.

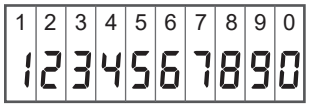
Accuracy labeling

The thickness measurement accuracy of the SA9003 is expressed by defining limit values for errors using the same measurement unit as measured values.
The load measurement accuracy of the SA9003 is expressed by defining limit values for errors as a percentage of the full scale.

Full scale (rated load value)	Indicates a value with a rating of 60 kN. Limit values for full-scale errors are expressed as a percentage of the full scale (*% of full scale* or *% f.s.*).

Screen display

The screen of the SA2654 Sensor Unit displays the alphanumeric characters as follows.



Safety Information

This system has been designed in accordance with the international standard IEC 61010 and has undergone rigorous safety testing prior to shipment. However, using the system in a way not specified in this manual may compromise its safety features.
Carefully read the following safety notes and the instruction manual for the measuring instrument to be connected before use.

⚠ DANGER

- **Familiarize yourself with the contents of this manual before use.**
  Failure to follow this guidance will result in misuse, leading to serious bodily injury or damage to the products.

⚠ WARNING

- **If you have not previously used electrical measuring instruments, ensure adequate supervision by a technician with experience in electrical measurement.**
  Failure to follow this guidance could result in electric shock.
  It could also cause serious incidents, such as heat generation, fire, or arc flash due to a short-circuit.

Precautions for Use

Observe the following precautions to ensure the safe use of the system and to maximize its capabilities.
Ensure that use of the system conforms not only to its specifications but also to the specifications of all products to be used, including accessories and optional equipment.
For the IM3570 Impedance Analyzer, the IM3533 LCR Meter, and the RM3545A Resistance Meter, see the instruction manual for each instrument.

⚠ WARNING

■ **Do not measure anything other than powder.**

Failure to follow this guidance could damage the products, resulting in bodily injury.

Placing the products

⚠ WARNING

■ **Do not use the products in locations such as the following:**

- Where it would be subject to direct sunlight or high temperatures
- Where it would be exposed to corrosive or explosive gases
- Where it would be exposed to powerful electromagnetic radiation or close to objects carrying an electric charge
- Where it would be close to an inductive heating device (such as high-frequency inductive heating devices and IH cooktops)
- Where it would be subject to a large amount of mechanical vibration
- Where it would be exposed to water, oil, chemicals, or solvents
- Where it would be exposed to high humidity or condensation
- Where it would be exposed to an excessive amount of dust
- Where it would be unstable or inclined

Failure to follow this guidance could damage the products or cause them to malfunction, resulting in bodily injury.

■ **Place the products, leaving enough space around them to facilitate unplugging the power cords.**

If there is not enough space left around, the power cannot be shut off immediately in an emergency. Failure to follow this guidance could result in bodily injury, fire, or damage to the products.

■ **Before plugging the power cord into outlet, ensure that your supply voltage falls within the supply voltage range indicated close to the power inlets of the products.**

Supplying a voltage outside the specified range to the products could damage them, causing bodily injury.

Check before use

Inspect the products for malfunctions or damage and check them for proper operation before use. If there is any malfunction or damage, please contact your authorized Hioki distributor or reseller.

⚠ DANGER

■ **Do not use the products for measurements on any circuits that exceed the ratings or specifications of the products.**

Failure to follow this guidance will cause damage to the products or overheating, resulting in serious bodily injury.

Precautions during measurement

⚠ WARNING

■ **First, connect the protective conductor terminal to the ground.**

Failure to follow this guidance could result in electric shock while connecting other wires.

■ **Ensure to ground the protective conductor terminal.**

Failure to follow this guidance could result in electric shock.

■ **Connect the power cord to a grounded two-prong power outlet.**

Connecting the power cord to an ungrounded power outlet could result in electric shock.

⚠ CAUTION

■ **Do not disconnect the USB cable while the products are sending or receiving data.**

Failure to follow this guidance could damage the products or the computer.

Handling cables

⚠ CAUTION

■ **When disconnecting cables, disengage the lock and then pull out the BNC connector while gripping it at the connection point, rather than pulling on the cable itself.**

Failure to follow this guidance could damage the BNC connector or connection point.

IMPORTANT

Do not use a connection cable where the insulation is damaged and the metal part is exposed. Failure to follow this guidance could affect measurements.

Disclaimer

When incorporating this system into any other system or reselling it, Hioki cannot be held responsible for any any direct or indirect damages at the end destination.

Handling the instrument

The IM3570 Impedance Analyzer, the IM3533 LCR Meter, the RM3545A Resistance Meter, and the SA2654 Sensor Unit are classified as Class A devices under the EN 61326 standard.
Use of the instruments in a residential setting such as a neighborhood could interfere with reception of radio and television broadcasts.
If this occurs, take appropriate steps to counteract the issue.

Precautions when transporting the SA9003 Press Unit

⚠ CAUTION

- **Hold the left and right side handles.**

  Device weight: Approx. 20.7 kg
- **Follow your company's safety guidelines, such as using anti-slip gloves and safety boots.**

  Failure to follow this guidance could cause bodily injury.

Shipping Precautions

When shipping the products, use the original boxes and packaging materials in which they were delivered. However, do not use the original boxes and packaging materials if they are damaged.

⚠ CAUTION

Observe the following when shipping the products:

- **Do not subject the products to strong shocks such as vibration or dropping.**

  Failure to follow this guidance could cause damage to the products during shipment.

- **Remove accessories and optional equipment from the products**
- **Use the original packaging materials in which the products were delivered, and then place them in additional boxes.**

  Failure to do so could cause damage the product during shipment.

Precautions related to disc usage

- Exercise care to keep the recording surface of the disc free of dirt and damage.
- If you need to label the disc, for example with text, use a marker with a soft tip.
- Store discs in protective cases. Avoid exposing discs to direct sunlight, high temperatures, or high humidity.
- Hioki is not liable for any computer system issues that arise in connection with the use of this disc.

Measurement Procedure

Before using the system, see “Precautions for Use” (p. 11).

“Preparing for Measurement” (p. 27)

- Check the system for abnormalities.
- Prepare for measurement.
- Turn on each measuring instrument.
- Start the SA2653 Measurement Software.

“Configuring the SA2653 Measurement Software” (p. 51)

- Configure the SA2653 Measurement Software.
- Perform calibration and compensation.

“Making Measurements” (p. 93)

- Put powder into the SA9004-01 Test Fixture.
- Apply a load to the powder.
- Start a measurement.
- Stop the measurement.
- Take out the powder from the SA9004-01 Test Fixture.

“Measurement Results Display” (p. 107)

- Use the system to graphically display and analyze the measurement results.

“Cleaning up the products after measurement” (p. 106, p. 149)

- Clean the SA9003 Press Unit and the SA9004-01 Test Fixture.

Measurement completed.

1 Overview

1.1 Overview and Features

The Powder Impedance Measurement System can analyze the electrical characteristics of powders from various perspectives.
While pressing powder at a pressure of up to 764 MPa, the system measures the impedance and the thickness of the molded powder simultaneously.
By comparing variations in material lots, powder shape, type, material content, granulation conditions, and surface treatment conditions, it is possible to evaluate batteries at an earlier stage of battery manufacturing processes.

Multifaceted analysis of the electrical characteristics of powders

The Powder Impedance Measurement System provides multifaceted analysis of electrode materials, solid electrolytes, and conductive materials in batteries.
The SA2653 Measurement Software performs everything from data acquisition and automatic conductivity calculation to multifaceted analysis.

Measurement items

- Volume resistivity (Ω·cm)
- Conductivity (S/cm)
- Ionic conductivity (S/cm)
- Bulk density (g/cm^3)
- Filling factor, porosity (when the true density is entered, %)
- Press pressure (MPa)

Size available for use in a glove box

The SA9003 Press Unit is small enough to be used inside a glove box.

Impedance measurement is possible under high pressurized conditions

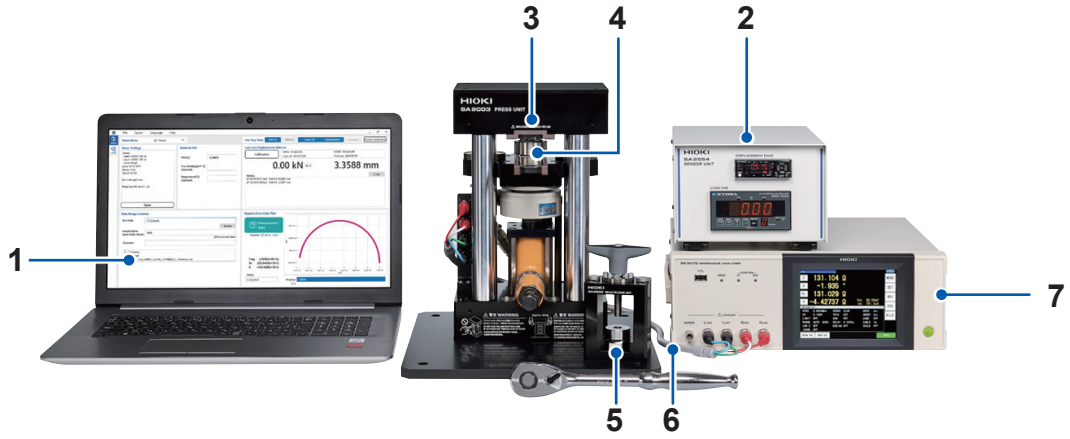
Measurements with high reproducibility are possible due to the minimal effects of gaps and contact resistance.

Capable of measuring resistance for both AC and DC

Different measuring instruments can be used depending on the type of powder you wish to measure.
For example, a DC resistance meter can be used to measure conductors, while an impedance analyzer can be used to measure dielectrics.

1.2 Part Names and Functions

Powder Impedance Measurement System (an example with the IM3570 included)



No.	Product	Function	Reference page
1	SA2653 Measurement Software	Stores information acquired from the measuring instrument, displacement meter, and load cell to analyze powders used as battery electrode materials, solid electrolytes, or conductive materials from various perspectives.	p.26
2	SA2654 Sensor Unit	Displays the displacement meter and load cell measurements of the SA9003 Press Unit.	p.20
3	SA9003 Press Unit	Applies load to the powder filled in the SA9004-01 Test Fixture.	p.22
4	SA9004-01 Test Fixture	Allows the powder to be positioned in the SA9003 Press Unit.	p.24
5	SA9005 Mold Release Unit	Allows the powder to be removed from the SA9004-01 Test Fixture.	p.25
6	L2280-01 Connection Cable (80 cm, for the IM3533 LCR Meter and the IM3570 Impedance Analyzer)	Connects the SA9003 Press Unit and the measuring instrument.	p.25
	L2280-03 Connection Cable (80 cm, for the RM3545A Resistance Meter)		
7	IM3570 Impedance Analyzer	Measures AC impedance at frequencies ranging from 4 Hz to 5 MHz.	p.17
	IM3533 LCR Meter	Measures AC impedance at frequencies ranging from 1 mHz to 200 kHz.	
	RM3545A Resistance Meter	Measures DC resistance.	p.19

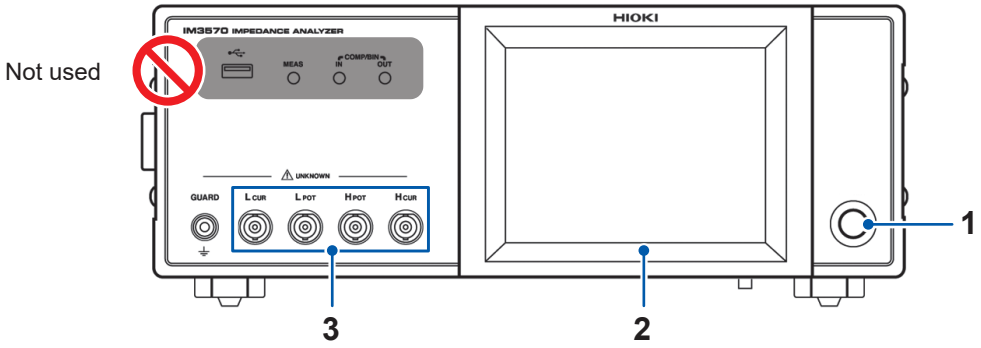
Tips

For the external dimensions of each product, see “7.7 External Views” (p.147).

IM3533 LCR Meter and IM3570 Impedance Analyzer

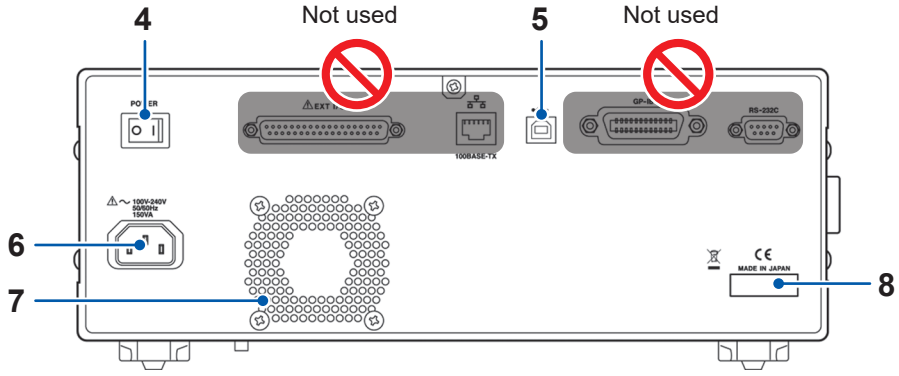
For details about the IM3533 LCR Meter and the IM3570 Impedance Analyzer, see the instruction manual for each instrument.

Front side (example: IM3570)



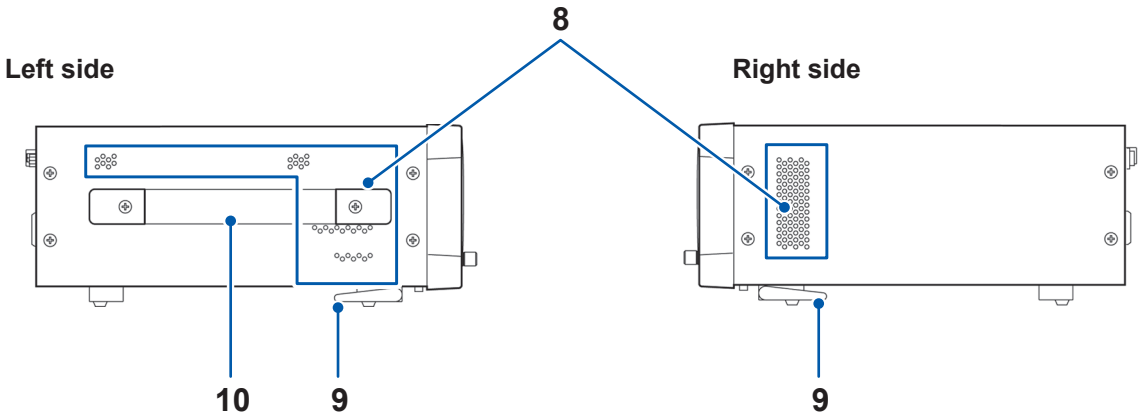
No.	Name	Function	
1	Start button	Press to turn the instrument on and off when the main power switch is set to the on position. (The power switch is located on the rear.)	
2	Liquid crystal display	Displays the progress of the compensation. (p.55)	
3	Measurement terminals	Connect the L2280-01 Connection Cable here. (p.35)	
		• L_{CUR} terminal	Current sensing terminal
		• L_{POT} terminal	Low-side voltage sensing terminal
		• H_{POT} terminal	High-side voltage sensing terminal
		• H_{CUR} terminal	Current generating terminal

Back side (example: IM3570)



No.	Name	Function
4	Power switch	Use to turn the instrument on and off.
5	USB connector	Connect the USB cable here. (p.39)
6	Power inlet	Connect the power cord here.
7	Vents	Prevent the inside of the instrument from overheating by providing ventilation. Do not block these vents or insert foreign objects.
8	Serial number	The first four digits of the 9-digit number indicate the year (its last two digits only) and the month of manufacture. Do not remove this sticker because the number is required for product tracking.

Sides (example: IM3570)

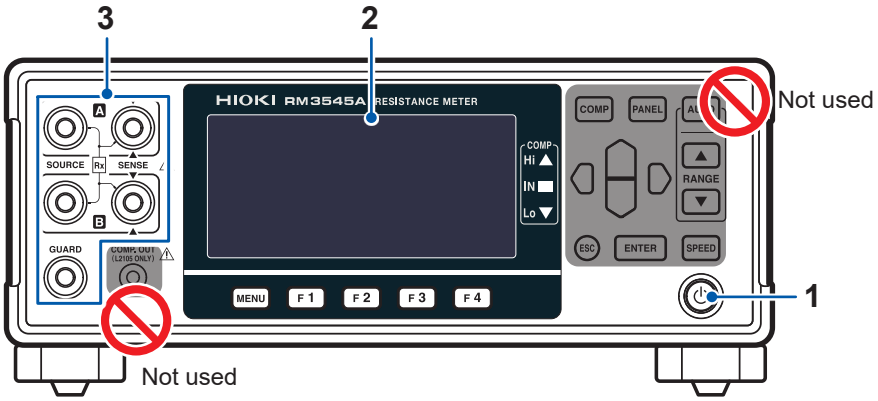


No.	Name	Function
8	Vents	Prevent the inside of the instrument from overheating by providing ventilation. Do not block these vents or insert foreign objects.
9	Stands	Extract to tilt the instrument.
10	Handle	Grasp to carry the instrument.

RM3545A Resistance Meter

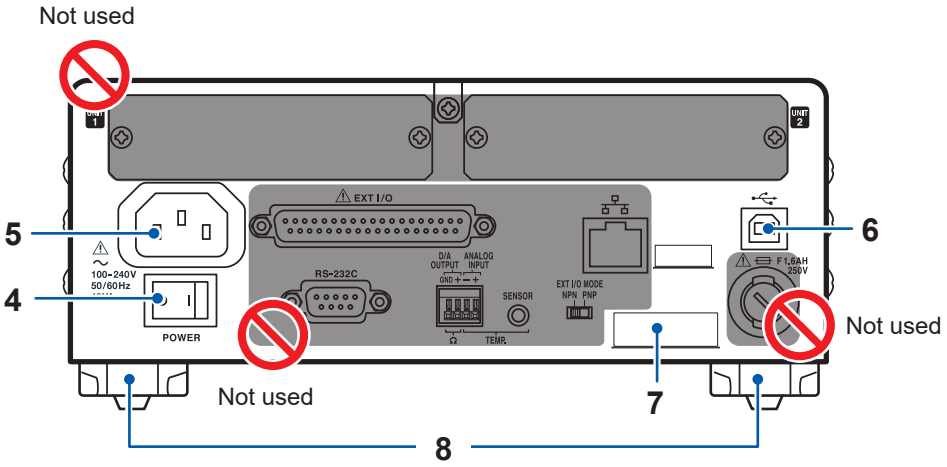
For details about the RM3545A Resistance Meter, see the instruction manual for the instrument.

Front



No.	Name	Function
1	Start button	Press to turn the instrument on and off when the main power switch is set to the on position. (The power switch is located on the rear.)
2	Display	Displays the progress of the compensation. (p.55)
3	Measurement terminals	Connect the L2280-03 Connection Cable here. (p.35)
		• Source A terminal Current sensing terminal • Source B terminal Current generating terminal • Sense A terminal Voltage sensing terminal • Sense B terminal Voltage sensing terminal • Guard terminal Guard terminal

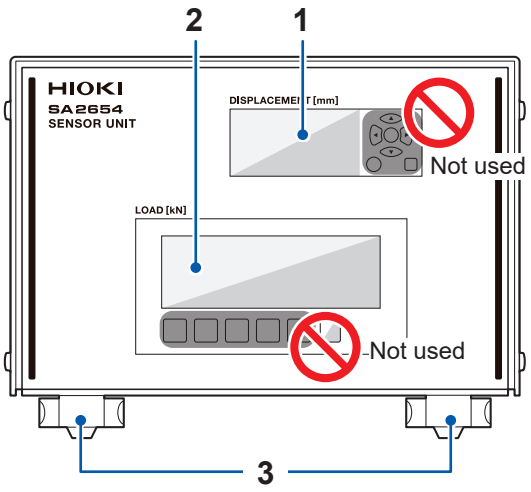
Rear



No.	Name	Function
4	Power switch	Use to turn the instrument on and off.
5	Power inlet	Connect the power cord here.
6	USB connector	Connect the USB cable here. The RS-232C setting is chosen by default. When connecting the cable, change the communications setting to USB. (p.39)
7	Serial number	The first four digits of the 9-digit number indicate the year (its last two digits only) and the month of manufacture. Do not remove this sticker because the number is required for product tracking.
8	Stands	Extract to tilt the instrument.

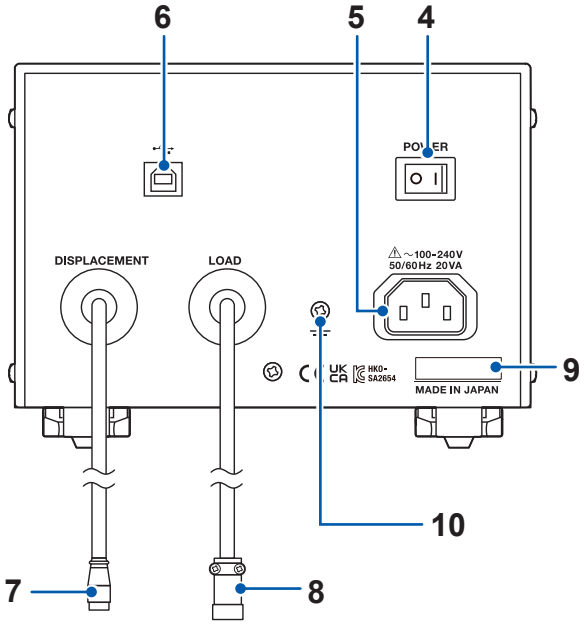
SA2654 Sensor Unit

Front



No.	Name	Function
1	Displacement-meter display	Displays displacement-meter measurements of the SA9003 Press Unit.
2	Load-cell display	Displays load-cell measurements of the SA9003 Press Unit.
3	Stands	Extract to tilt the instrument.

Rear



No.	Name	Function
4	Power switch	Use to turn the instrument on and off.
5	Power inlet	Connect the power cord here.
6	USB connector	Connect the USB cable here.
7	Displacement-sensor connector	Connect to the displacement-meter terminal of the SA9003 Press Unit.
8	Load-cell connector	Connect to the load-cell connector of the SA9003 Press Unit.
9	Serial number	The first four digits of the 9-digit number indicate the year (its last two digits only) and the month of manufacture. Do not remove this sticker because the number is required for product tracking.
10	Functional ground terminal	Reduces the effect of noise. For use in noisy locations, connect the functional ground terminals of the SA2654 Sensor Unit and the SA9003 Press Unit using the functional ground cable supplied with the Sensor Unit.

SA9003 Press Unit

⚠ CAUTION

■ **Place the device on a flat surface.**

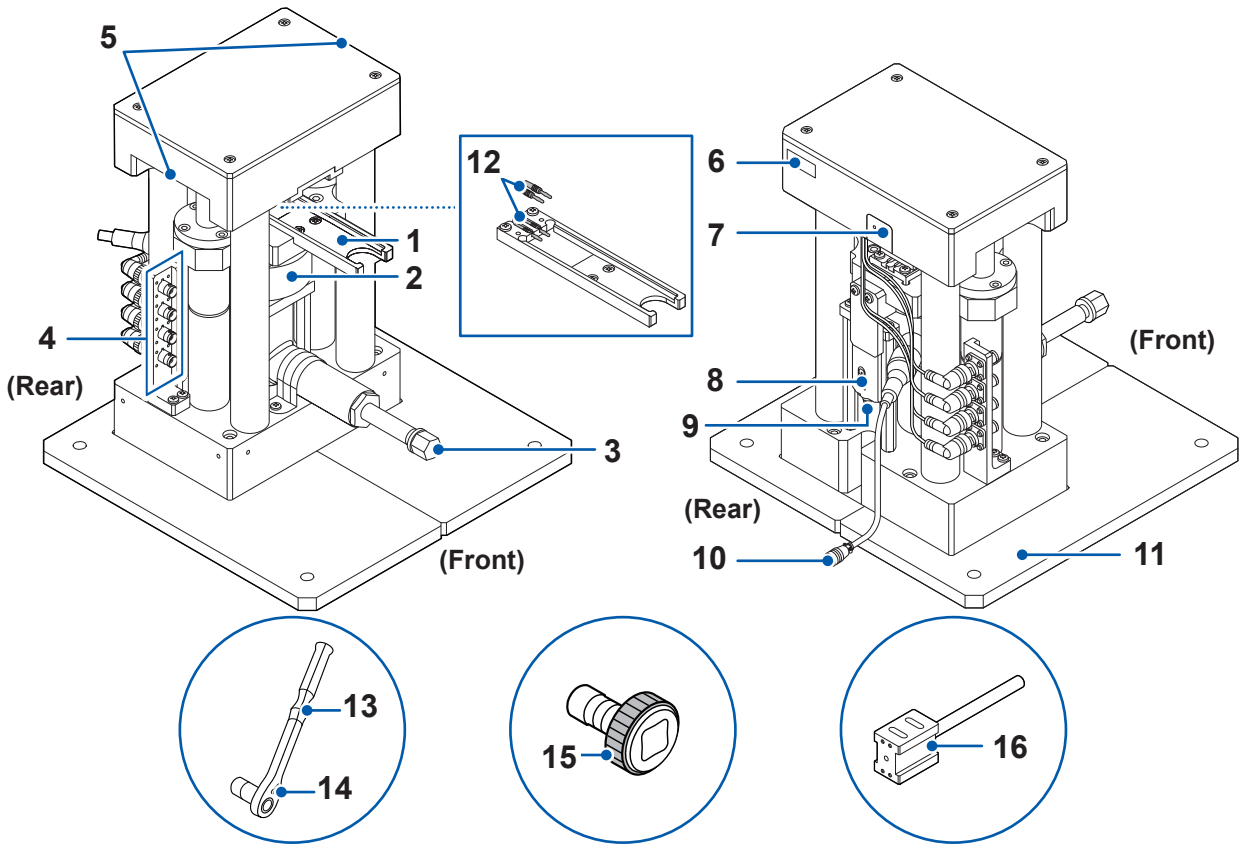
Failure to follow this guidance could damage the device.

■ **Use the handles to carry the SA9003 Press Unit.**

Failure to follow this guidance could result in dropping the device, causing damage to it or bodily injury.

■ **Use the ratchet handle to change the load of the SA9003 Press Unit.**

Using electric tools could result in damage to the device or bodily injury.



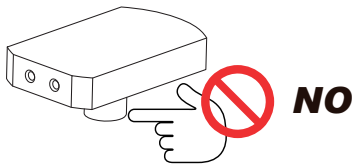
No.	Name	Function
1	Rail	Allows the SA9004-01 Test Fixture to be inserted.
2	Load cell	Measures the load on the powder.
3	Hydraulic jack	Applies load to the powder filled in the SA9004-01 Test Fixture.
4	BNC terminals	Connect the L2280 Connection Cable here.
5	Handles	Grasp to carry the device.
6	Serial number	The first four digits of the 9-digit number indicate the year (its last two digits only) and the month of manufacture. Do not remove this sticker because the number is required for product tracking.
7	Functional ground terminal	Reduces the effect of noise. For use in noisy locations, connect the functional ground terminals of the SA2654 Sensor Unit and the SA9003 Press Unit using the functional ground cable supplied with the Sensor Unit.
8	Displacement meter	Measures the load on the powder.
9	Displacement-meter terminal	Connect the displacement-meter connector of the SA2654 Press Unit here.
10	Load-cell connector	Connect the load-cell connector of the SA2654 Press Unit here.
11	Bases	Prevent the SA9003 Press Unit from falling. Use the four M12 screw holes on the bases for fixing.
12	Banana plugs	Connects to the SA9004-01 Test Fixture terminals.
13	Ratchet handle	Attach to the hydraulic jack of the SA9003 Press Unit to apply the load. The ratchet handle comes with a socket. (width between parallel sides: 17 mm)
14	Switch lever	Use to switch between two ratchet handle modes: tightening mode (clockwise) and loosening mode (counterclockwise). (p.98)
15	Quick spinner	Attach to the hydraulic jack of the SA9003 Press Unit to adjust the gap between the upper electrode of the Test Fixture and the Press Unit.
16	Short-compensation block	Use to perform the short compensation.

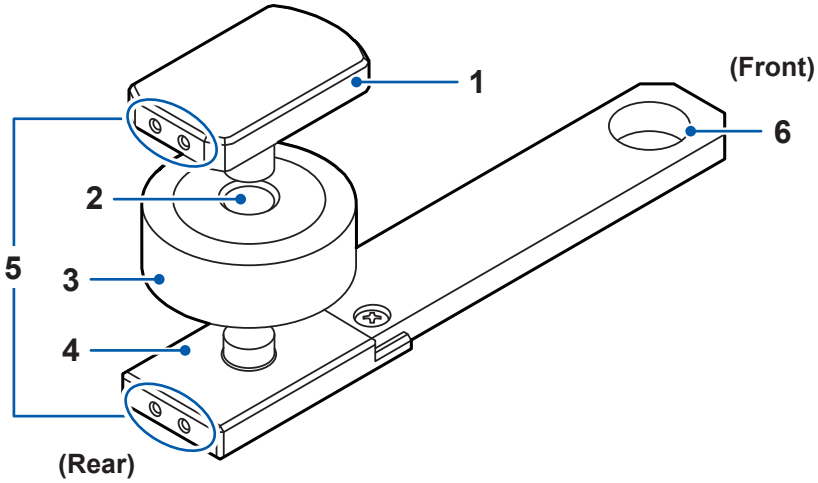
SA9004-01 Test Fixture

⚠ CAUTION

■ **Do not touch the edges of the cylindrical parts of the upper and lower electrodes.**

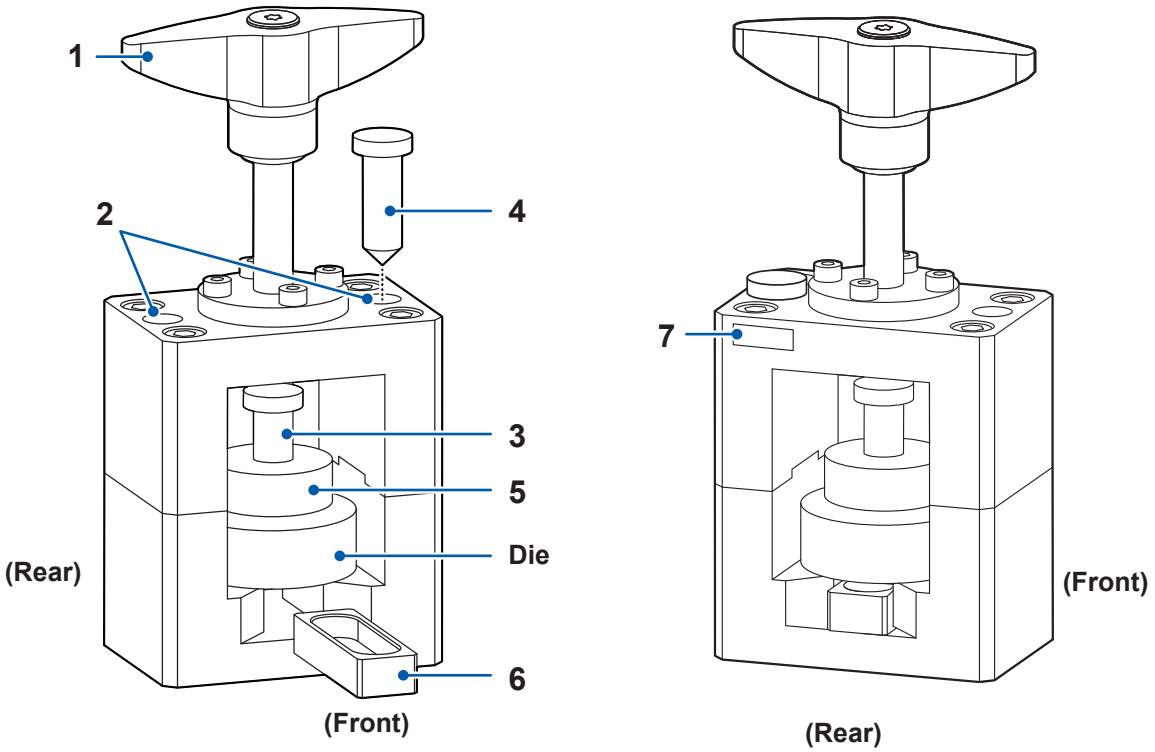
Failure to follow this guidance could cause bodily injury.





No.	Name	Function
1	Upper electrode	Makes contact with the top surface of the cylindrical powder pellet to measure impedance. (ϕ10 mm)
2	Container section	Contains the powder.
3	Die	Forms the powder into a cylinder with a diameter of 10 mm.
4	Lower electrode	Makes contact with the bottom surface of the cylindrical powder pellet to measure impedance. (ϕ10 mm)
5	Terminals	Connect to the banana plugs of the SA9003 Press Unit.
6	Handle	Hold to insert the SA9004-01 Test Fixture into the SA9003 Press Unit.

SA9005 Mold Release Unit



No.	Name	Function
1	Handle	Turn to push the power release pin downward.
2	Holes for the powder release pins	Holds the powder release pins.
3	Powder release pin (flat)	Extrudes the powder stuck in the die.
4	Powder release pin (60-degree conical)	Use when the flat powder-release pin was not able to remove the powder. Crushes and extrudes the powder stuck in the die.
5	Guide plate	Guides the powder release pin for perpendicular insertion into the die.
6	Tray	Retrieves the powder extruded from the die.
7	Serial number	The first four digits of the 9-digit number indicate the year (its last two digits only) and the month of manufacture. Do not remove this sticker because the number is required for product tracking.

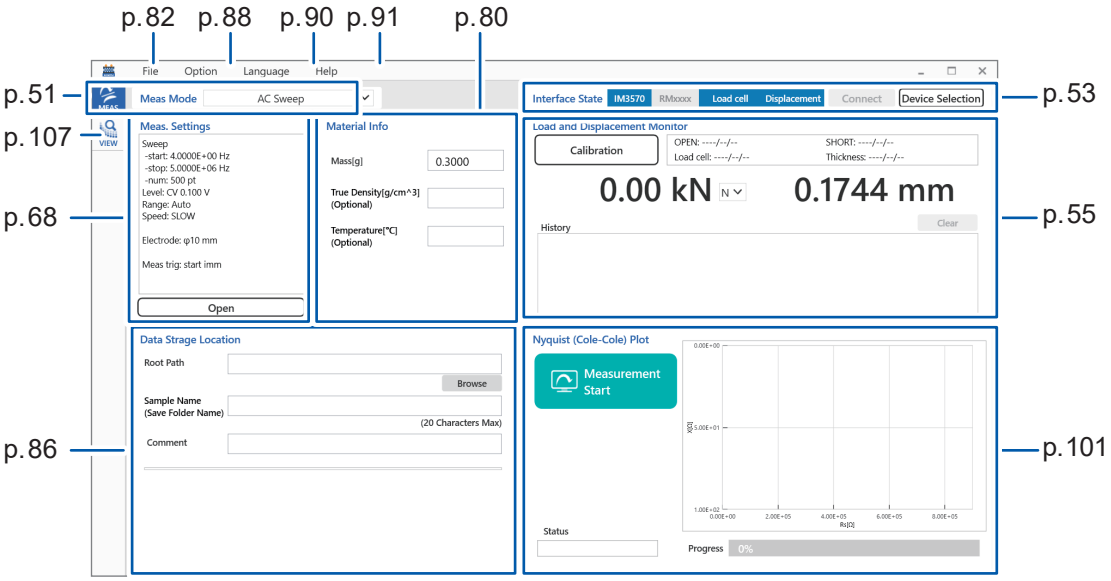
L2280-01 and L2280-03 Connection Cable

L2280-01	Connection cable for use with the IM3570 and the IM3533
L2280-03	Connection cable for use with the RM3545A

1.3 SA2653 Measurement Software

The SA2653 Measurement Software stores information acquired from the measuring instrument, the displacement meter, and the load cell to analyze powders used as battery electrode materials, solid electrolytes, or conductive materials from multiple perspectives.

See “3 Configuring the SA2653 Measurement Software” (p.51).



SA2653 Measurement Software (home screen)

2 Preparing for Measurement

2.1 Conducting a Pre-start Inspection

Inspect the system for malfunctions or damage and check it for proper operation before use. If there is any malfunction or damage, please contact your authorized Hioki distributor or reseller.

Check item	Solution
The power cords do not have any damaged insulation or exposed metal.	Do not use them if they are damaged, because this could result in electric shock or a short-circuit. Contact your authorized Hioki distributor or reseller.
The cables do not have any damaged insulation or exposed metal.	Do not use them if they are damaged, because this could cause unstable readings or errors. Replace them with undamaged ones.
The instrument is not damaged.	If the instrument is damaged, contact your authorized Hioki distributor or reseller for repair.
• For the IM3570 and the IM3533 The splash screen displaying the model number and the firmware version appears after the instrument is turned on. • For the RM3545A The start button lights up green or red after the instrument is turned on.	If the splash screen does not appear or the start button does not light up, the power cord may have a break or the instrument may be damaged internally. Arrange for repair.
No error is displayed on the splash screen.	If an error (**Err**) is displayed, the instrument may be internally damaged. Arrange for repair.
The electrodes and die of the SA9004-01 Test Fixture have no chips, cracks, or other damage.	Do not use them if they are damaged, because this could cause unstable readings or errors. Replace them with undamaged ones. (p.149)

2.2 Installing the SA2653 Measurement Software

Check and note about installation

⚠ CAUTION

■ **Do not connect the IM3570 Impedance Analyzer, the IM3533 LCR Meter, or the RM3545A Resistance Meter to the computer until the SA2653 Measurement Software installation is complete.**

Failure to follow this guidance could result in improper installation of the SA2653 Measurement Software.

System configuration (recommended)

Operating system	Windows 11 Windows 10 (32-bit or 64-bit)
.Net library	.Net Framework 4.7.2 or later
Processor	Depends on the operating environment of the above operating systems.
RAM	Depends on the operating environment of the above operating systems.
Storage	3 GB free space or more
Display	Resolution: 1,366 × 768 or higher Display colors: 65,536 colors or more
Interface	USB 2.0 or later (with 3 ports)

Installation procedure

Install all of the following software on the computer:
Refer to the instruction manual included with each measuring instrument for the software installation procedure.

- Microsoft .NET Framework 4.7.2 or later
- USB driver for the SA2654 Sensor Unit
- SA2653 Measurement Software

Installing Microsoft .NET Framework 4.7.2

Download the Microsoft .NET Framework Runtime from Microsoft's website (URL below) and install it on the computer.
If the computer has Microsoft .NET Framework 4.7.2 installed, proceed to "Installing the USB driver for the SA2654 Sensor Unit" (p.29).

https://dotnet.microsoft.com/download/dotnet-framework/net472

Refer to Microsoft's website for the installation procedure of Microsoft .NET Framework 4.7.2.

Installing the USB driver for the SA2654 Sensor Unit

When connecting the SA2654 Sensor Unit to the computer for the first time, install the dedicated USB driver.
If the dedicated USB driver has already been installed on the computer, skip the steps below.
The USB driver execution file is available from the CD included with the SA2654 Sensor Unit.
You can download it from the following website.
https://www.hdl.co.jp/en/faspc/Drivers/
Do not connect the instrument to the computer until the USB driver installation is complete.

Example: For Windows 10

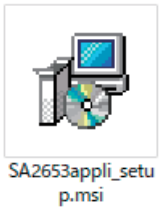
1. **Exit all applications running on the computer.**
2. **Remove the USB cable connecting the SA2654 Sensor Unit to the computer.**
3. **Double-click [setup.exe] in the USB driver folder (USBDRV-CDM*xxxxxxx-xxx*) on the CD that came with the SA2654 Sensor Unit to execute. (You can download the execution file from the following website.)**
   https://www.hdl.co.jp/en/faspc/Drivers/

   The installer starts.
4. **Follow the on-screen instructions to proceed with the installation.**
   In certain environments, it may take some time for the dialog box to appear. Be patient and wait for the dialog box.
5. **Connect the SA2654 Sensor Unit to the computer using the USB cable.**
   The SA2654 Sensor Unit is automatically recognized.

Installing the SA2653 Measurement Software

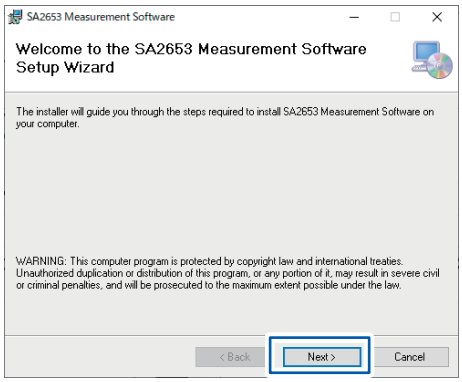
1 **Log on to the computer with *administrator* or other supervisor privileges.**

2 **Exit all applications running on the computer.**



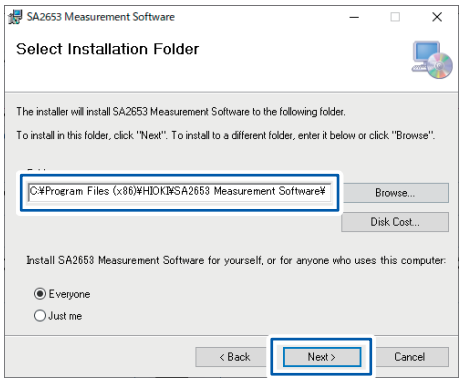
3 **Double-click [SA2653appli_setup.msi] on the SA2653 Measurement Software Installation Disc to execute.**

The installer starts.

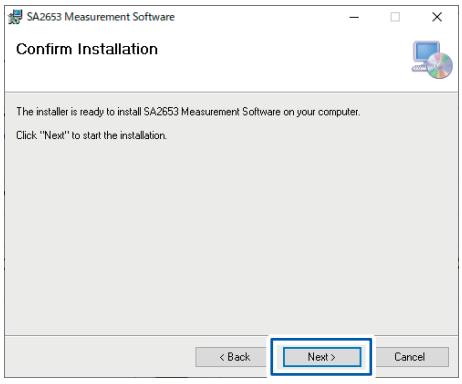


4 **Click [Next].**

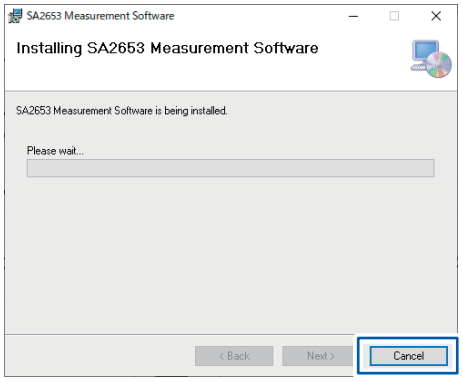
The setup wizard starts.



5 **Specify the folder where the program will be installed, then click [Next].**

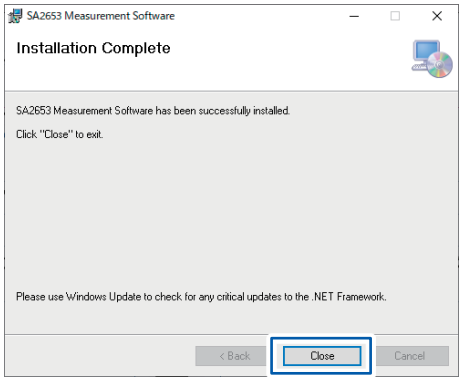


6 **Click [Next].**



The installation continues.

Click **[Cancel]** to stop the installation.



The installation completes.

7 **Click [Close] to close the window.**

The icon is created on the desktop.

Tips

The SA2653 Measurement Software will not start without the USB license key.

Uninstalling the SA2653 Measurement Software

If you no longer need the SA2653 Measurement Software, uninstall it.

1 **Select [Start] > [Control Panel] > [Uninstall a program].**

2 **Right-click [SA2653 Measurement Software].**

3 **Click [Uninstall] on the shortcut menu.**

2.3 Connecting the Power Cord to the Instrument

This section explains how to connect the power cord to the instrument.

⚠ WARNING

■ **Do not use the cords with exposed metal parts due to melted insulation.**

Failure to follow this guidance could result in electric shock or burns.

■ **Connect the power cord to a grounded two-prong power outlet.**

Connecting the power cord to an ungrounded power outlet could result in electric shock.

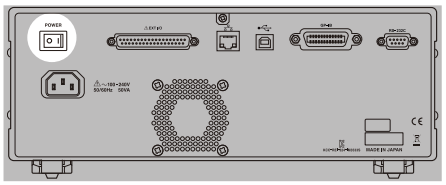
⚠ CAUTION

■ **Do not short-circuit the measurement terminals or apply voltage between the measurement terminals.**

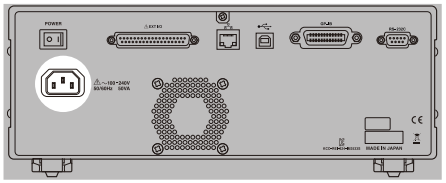
Failure to follow this guidance could damage the instrument.

■ **Before plugging the power cord into an outlet, ensure that your supply voltage falls within the supply voltage range indicated close to the power inlet of the instrument.**

Supplying a voltage outside the specified range to the instrument could damage it, causing bodily injury.



1 **Check that the rear-mounted power switch of the instrument is set to the off position. (example: IM3570)**



2 **Connect the power cord supplied with the instrument to the power inlet.**

3 **Connect the plug of the power cord to the outlet. (100 V to 240 V AC)**

2.4 Connecting the Sensor Unit and the Press Unit

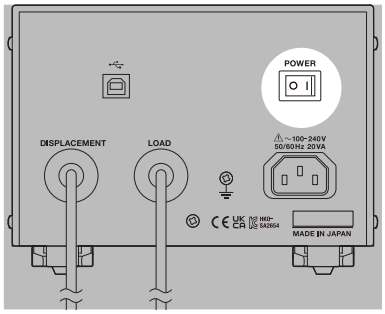
This section explains how to connect the SA2654 Sensor Unit and the SA9003 Press Unit.

⚠ CAUTION

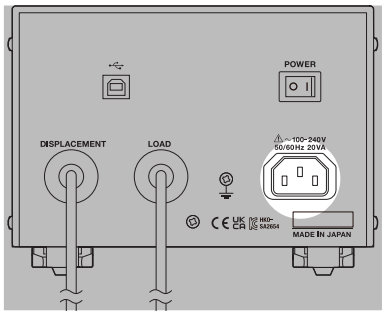
■ **When connecting the displacement-sensor connector to the displacement-meter terminal, insert it so that it is not tilted, and tighten the screw on the end of the displacement-sensor connector firmly.**
(Recommended tightening torque: 0.4 N·m to 0.5 N·m)

If the connector becomes loose, for example, due to vibration, the terminal may have poor contact, resulting in inaccurate measurements.

1 **Check that the rear-mounted power switch of the Sensor Unit is set to the off position (○).**



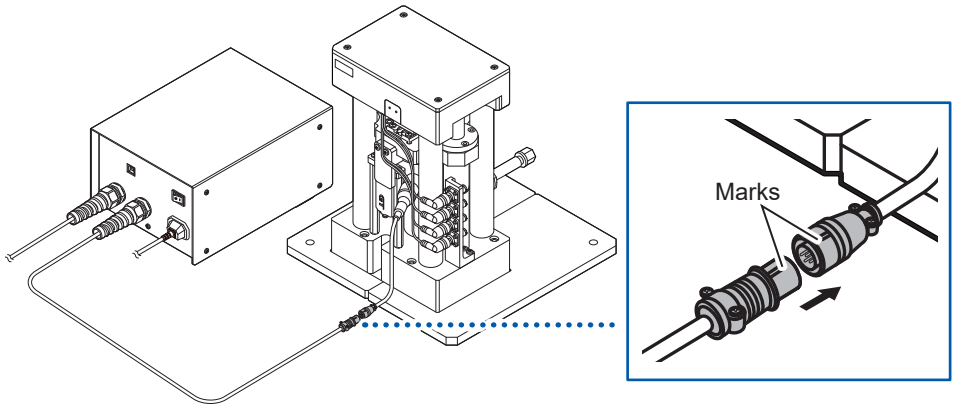
2 **Connect the accompanying power cord to the power inlet of the instrument.**



3 **Connect the plug of the power cord to the outlet. (100 V to 240 V AC)**

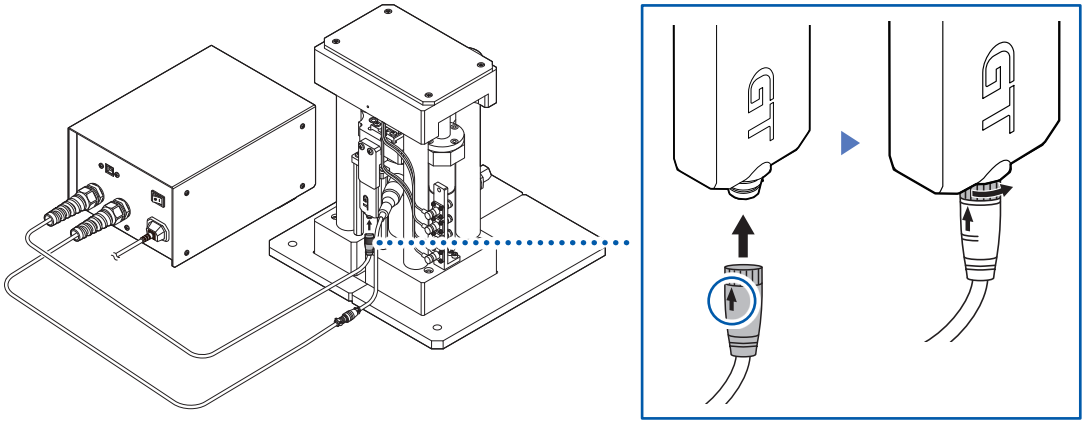
4 **Connect the load-cell connector of the Sensor Unit to that of the Press Unit.**

Align the marks and insert the connector until it sounds.



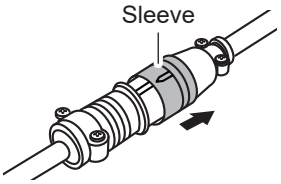
5 **Connect the displacement-sensor connector to the displacement-meter terminal of the Press Unit.**

Insert the displacement-sensor connector with its arrow facing the left side of the displacement-meter terminal, then rotate the collar on the end of the displacement-sensor connector to secure it.

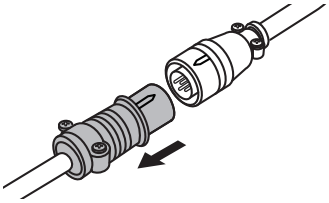


Removing the Sensor Unit from the Press Unit

1 **Slide the sleeve of the Press Unit's load-cell connector to unlock it.**

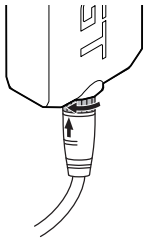


2 **Once unlocked, pull out the load-cell connector of the Sensor Unit.**



Removing the displacement-sensor connector form the displacement-meter terminal

Rotate the collar on the end of the displacement-sensor connector to unlock it, and then pull out the connector.

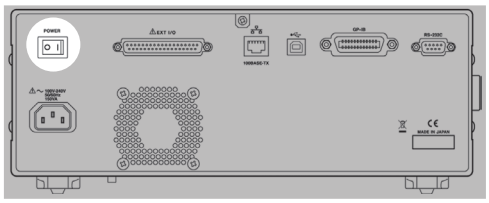


2.5 Connecting the Measuring Instrument and the Press Unit Using the Connection Cable

This section explains how to connect the measuring instrument and the SA9003 Press Unit using the L2280-01 Connection Cable or the L2280-03 Connection Cable.
Use the L2280-01 Connection Cable for the IM3533 LCR Meter and the IM3570 Impedance Analyzer, and use the L2280-03 Connection Cable for the RM3545A Resistance Meter.

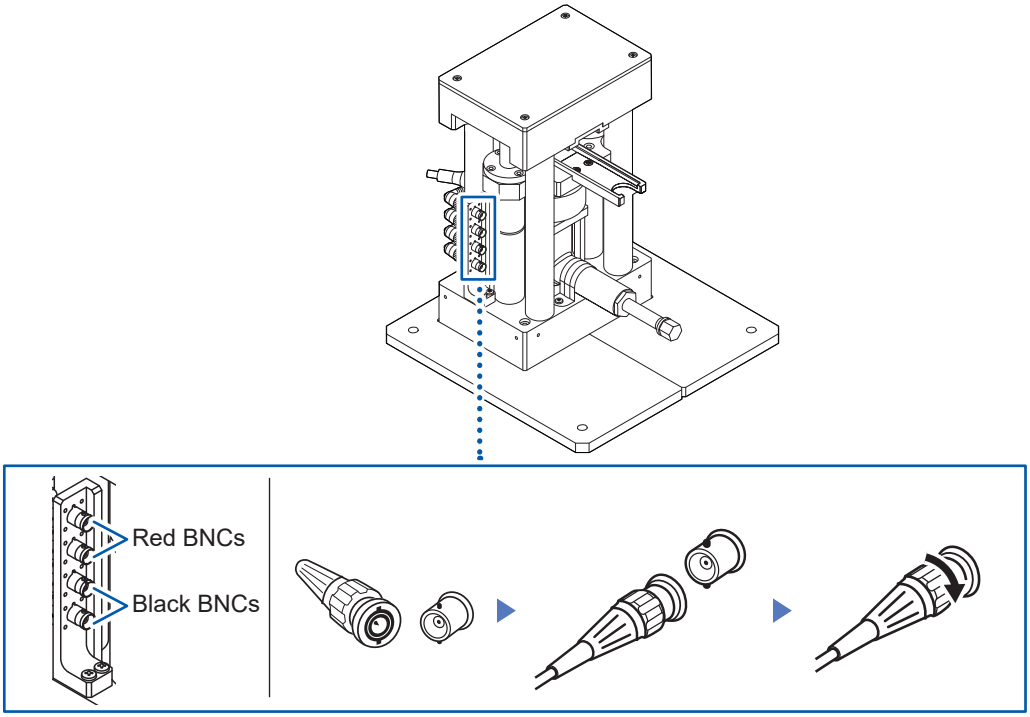
Example: IM3570

1 **Check that the rear-mounted power switch of the instrument is set to the off position (○).**



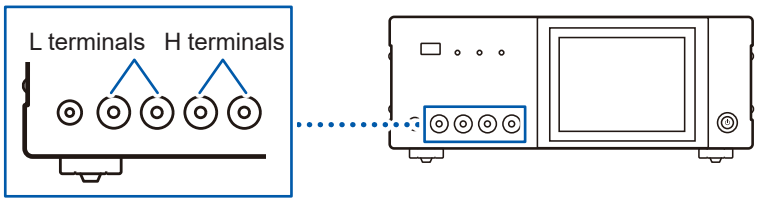
2 **Connect the Connection Cable to the four BNC terminals of the Press Unit.**

As shown in the figure, connect the red plugs of the Connection Cable to the red BNC terminals, and connect the black plugs of the Connection Cable to the black BNC terminals.



3 Connect the Connection Cable to the instrument.

Connect the red plugs of the Connection Cable to the H terminals (H_{CUR} and H_{POT}) and the black plugs to the L terminals (L_{CUR} and $L_{POT)}$.



When connecting to the RM3545A, connect the red plugs to the Source A and Sense A terminals, the black plugs to the Source B and Sense B terminals, and the guard plug to the Guard terminal.

2.6 Connecting the Instrument and the Computer

Connect the instrument and the computer using the USB cable (included accessory of the SA2653 Measurement Software).

⚠ CAUTION

■ **Do not disconnect the USB cable while the instrument is sending or receiving data.**

Failure to follow this guidance could damage the instrument or computer.

■ **Before connecting the cable to the computer, make sure to install the SA2653 Measurement Software on the computer.**

Installing the SA2653 Measurement Software after connecting the cable to the computer could cause malfunctions or damage.

■ **Ground the ground terminals of the instrument and the computer at a same location.**

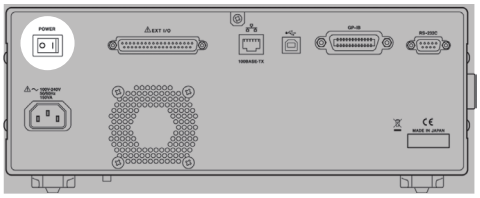
Connecting the cable when there is a difference in ground potentials between them could cause damage or malfunction.

Connecting the IM3533 or IM3570 to the computer via USB

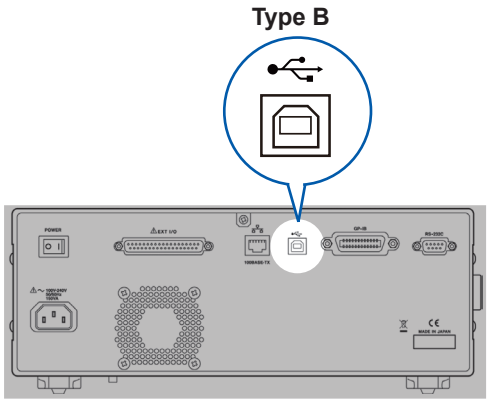
The IM3570 Impedance Analyzer has a default communications setting of RS-232C. Change the communications setting to USB.
See “Setting the SYSTEM” in the IM3570 Instruction Manual.

Example: IM3570

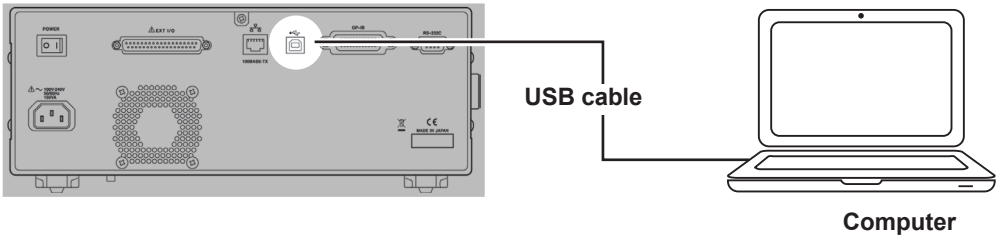
1 **Check that the rear-mounted power switch of the IM3570 is set to the off position (○).**



2 **Connect the USB cable to the USB connector of the IM3570.**



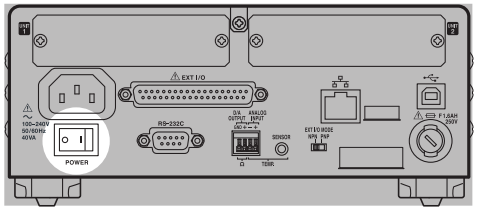
3 **Connect the USB cable to the computer.**



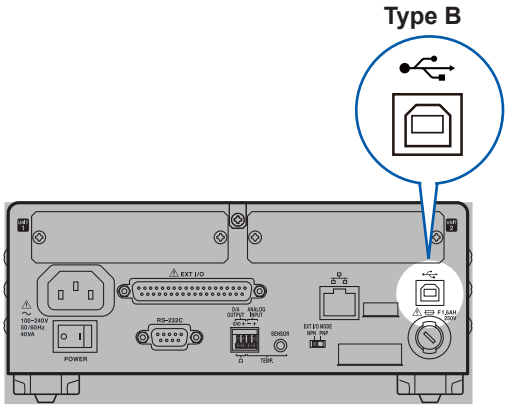
Connecting the RM3545A to the computer via USB

The RM3545A Impedance Analyzer has a default communications setting of RS-232C. Change the communications setting to USB.
See “Communications” in the RM3545A Instruction Manual.

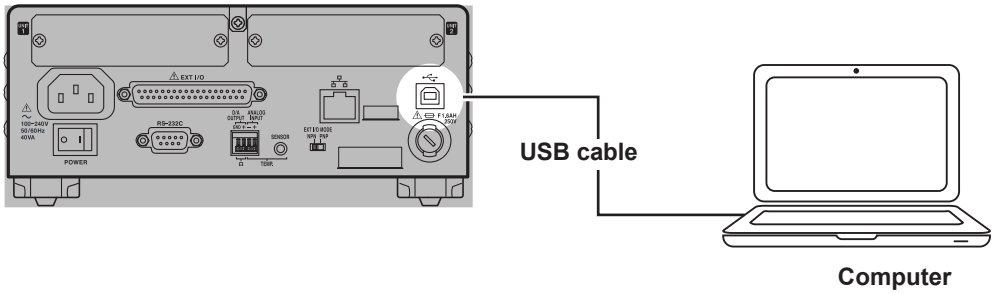
1 **Check that the rear-mounted power switch of the RM3545A is set to the off position (○).**



2 **Connect the USB cable to the USB connector of the RM3545A.**



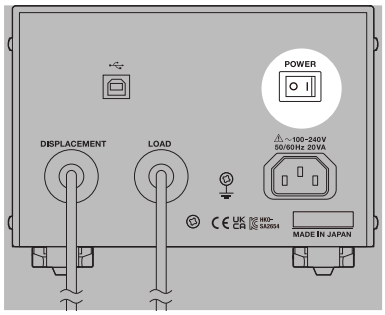
3 **Connect the USB cable to the computer.**



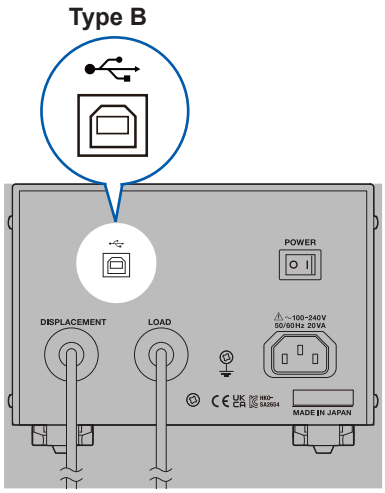
2.7 Connecting the Sensor Unit and the Computer

This section explains how to connect the SA2654 Sensor Unit and the computer.

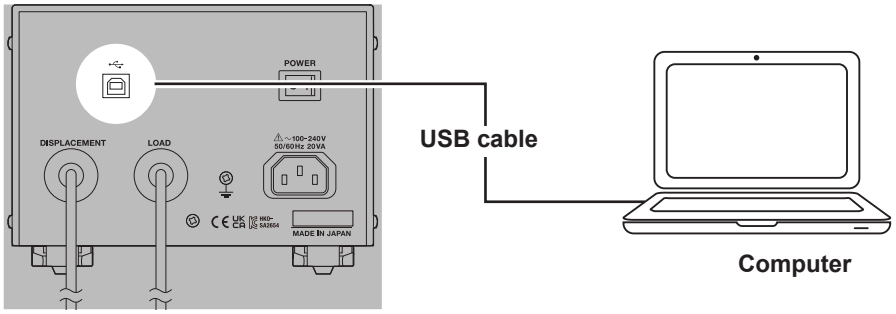
1 **Check that the rear-mounted power switch of the Sensor Unit is set to the off position (○).**



2 **Connect the USB cable to the USB connector of the Sensor Unit.**



3 **Connect the USB cable to the computer.**



2.8 Using the SA9003 and the SA2654 in a Glove Box

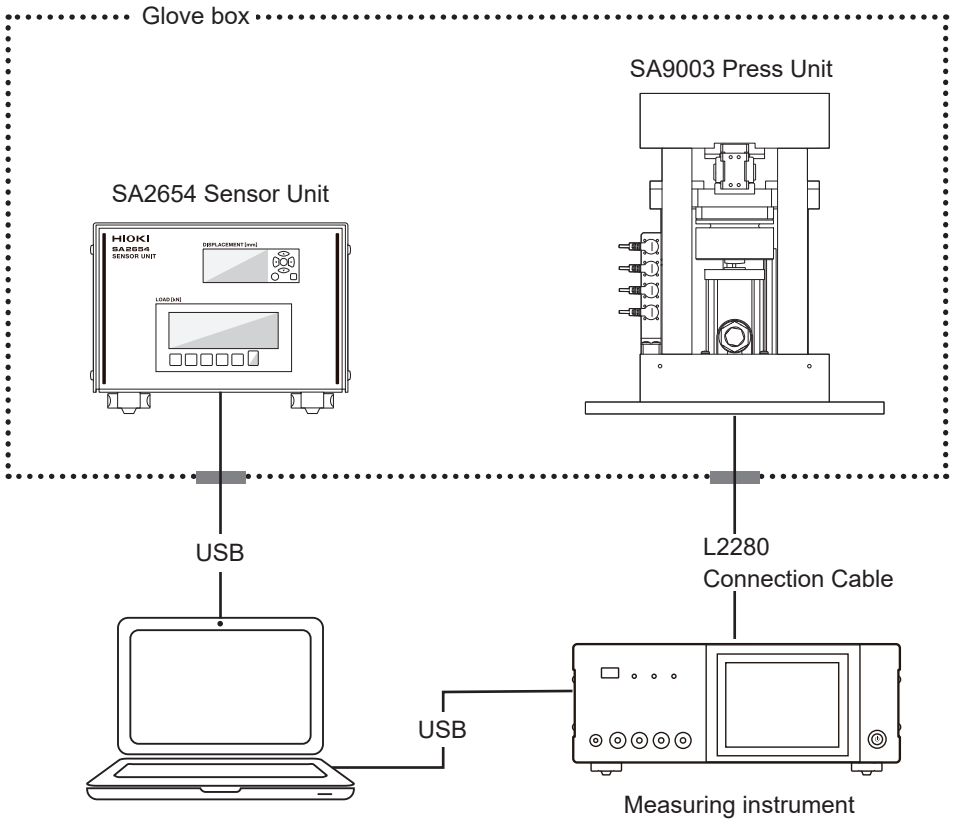
The SA9003 Press Unit and the SA2654 Sensor Unit can be used in a glove box for making measurements.
If you require a connection cable other than the standard one, please contact your authorized Hioki distributor or reseller.

⚠ WARNING

■ **Do not remove the products from the glove box if sulfide powder is adhering to them.**

Failure to follow this guidance could cause hydrogen sulfide to be generated, resulting in bodily injury.

Conceptual example of use inside the glove box



Tips

- The L2280 Connection Cable is 80 cm long. If you wish to use a flange to introduce the cable into the glove box, you can request this by special order. Contact your authorized Hioki distributor or reseller.
- When using powders that can cause corrosion, you can protect the SA2654 Sensor Unit by covering it with a plastic bag or other material to reduce corrosion.

Inserting the SA9003 Press Unit through the pass box into the glove box

⚠ CAUTION

■ **Do not depressurize the pass box.**

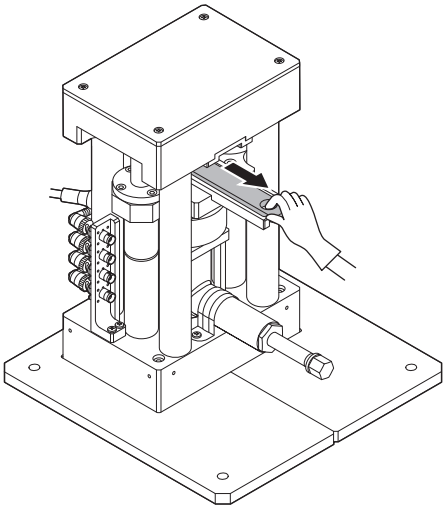
If the pass box is depressurized while the device is inside, the device could be damaged.

■ **Do not drop the device.**

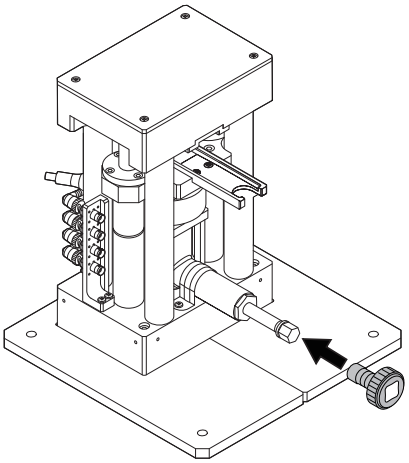
Failure to follow this guidance could damage the device or result in bodily injury.

1 **Remove the Test Fixture from the Press Unit.**

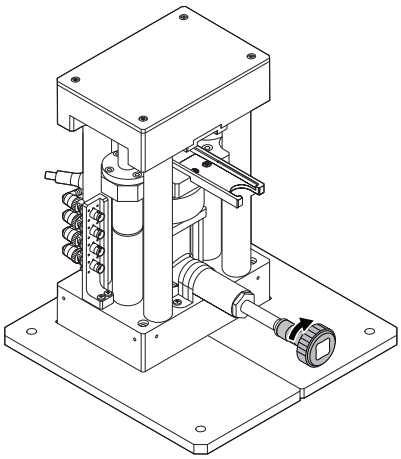
Pulling it out roughly could cause the Test Fixture to fall off the rail.



2 **Attach the quick spinner to the hydraulic jack of the Press Unit.**

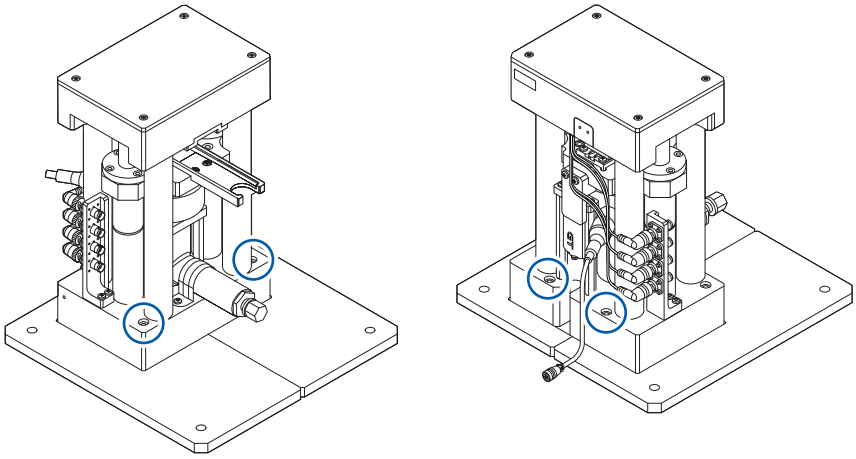


3 **Turn the quick spinner to minimize the protrusion of the hydraulic jack screw.**

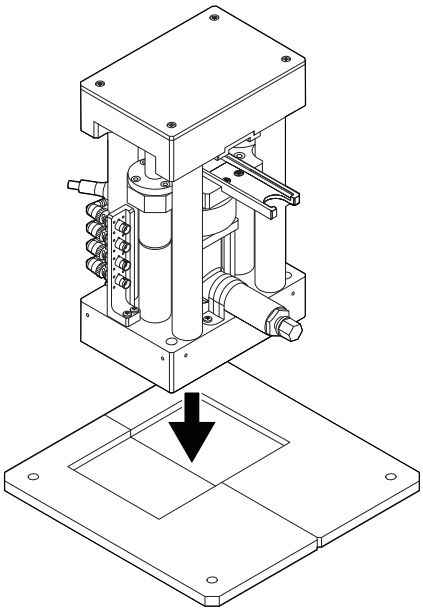


4 **Remove the quick spinner.**

5 **Remove the four screws (M6 × 50).**



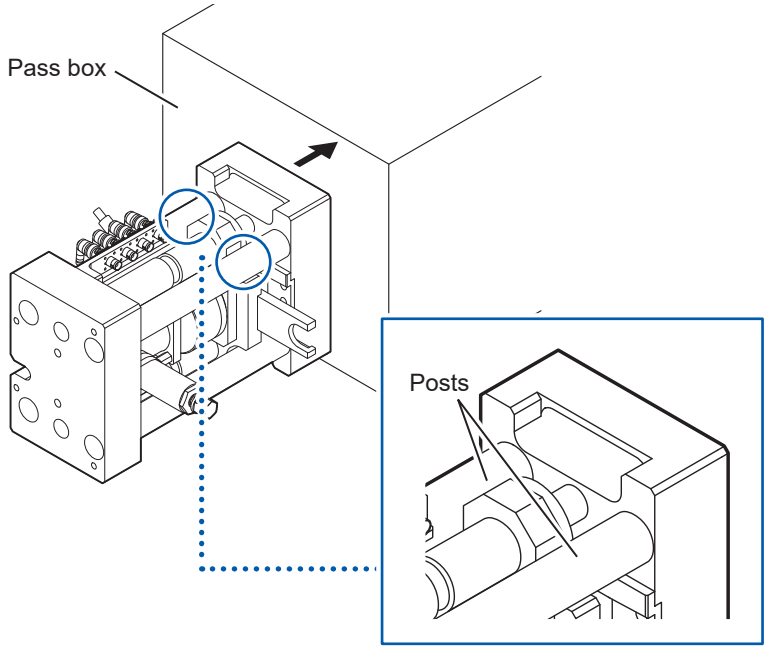
6 **Remove the bases.**



7 **Insert the bases through the pass box into the glove box.**

8 **Tilt the Press Unit sideways.**

9 **Grasp the 30 mm-diameter posts to insert the Press Unit into the glove box through the pass box.**

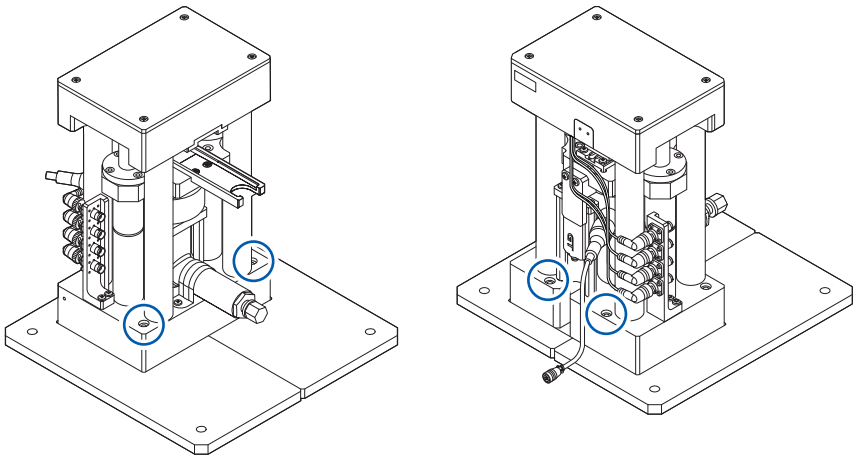


10 **Insert the Press Unit through the pass box into the glove box.**

11 **Inside the glove box, place the Press Unit on the bases.**

12 **In the glove box, position the Press Unit on the bases and tighten the four screws (M6 × 50).**

Recommended tightening torque: 5 N·m



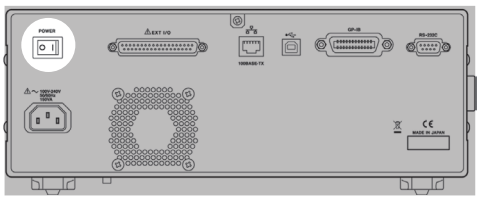
2.9 Turning On the Instrument

Before turning on the instrument, see its Instruction Manual.
Once the rear-mounted power switch is set to the on position, the instrument can be turned on and off using the front-mounted start button.

Turning on the instrument

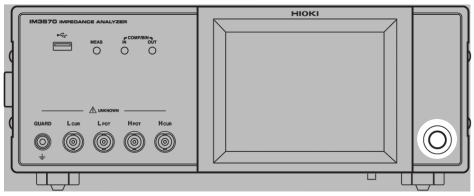
Example: IM3570

1 Set the rear-mounted power switch to the on position (I).



2 Press the start button

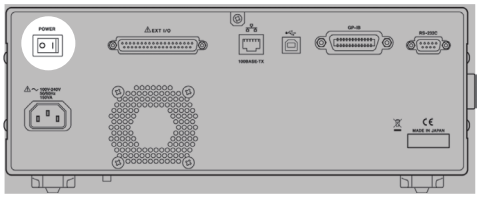
The start button lights up green.



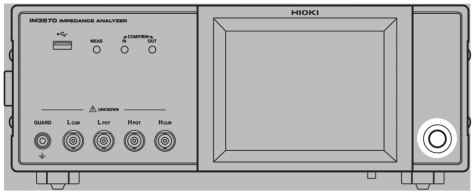
Turning off the instrument

Example: IM3570

Set the rear-mounted power switch to the off position (○).



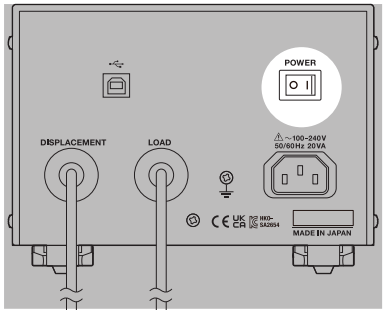
The start button turns off.



2.10 Turning On the SA2654 Sensor Unit

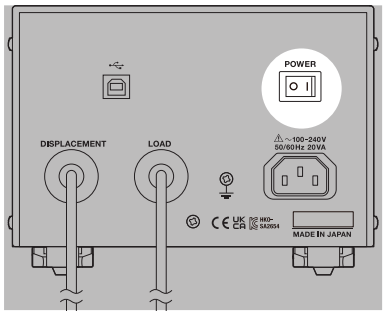
Turning on the Sensor Unit

Set the rear-mounted power switch of the Sensor Unit to the on position (I).



Turning off the Sensor Unit

Set the rear-mounted power switch of the Sensor Unit to the off position (○).



2.11 Starting the SA2653 Measurement Software

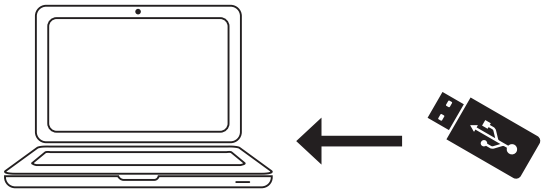
This section explains how to start the SA2653 Measurement Software.
Inserting the USB license key into the computer enables you to use the SA2653 Measurement Software.

⚠ CAUTION

■ **Before handling the USB license key, discharge static electricity from your body.**

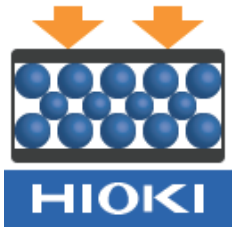
Failure to follow this guidance could damage the USB license key or cause the system to malfunction.
Additionally the system could fail to start.

1 **Insert the USB license key into the USB port of the computer where the measurement software will run.**



2 **Double-click the Measurement Software icon.**

The SA2653 Measurement Software starts.



IMPORTANT
Do not remove the USB license key while the application is running. If the USB license key is removed while the application is running, the application will not run properly, for example, measurements will not start.

2.12 Entering the Load-Cell Calibration Value to the SA2653 Measurement Software

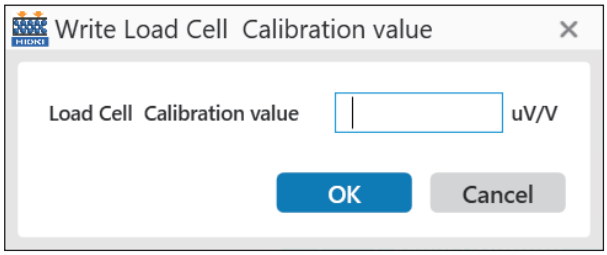
This section explains how to enter the calibration value of the load cell.

1 **Start the SA2653 Measurement Software. (p.47)**

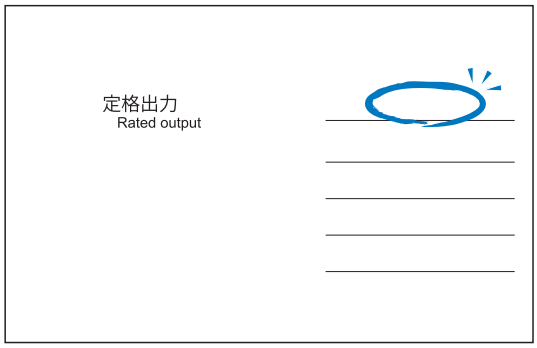
Once the connection between the instrument and the computer is established, the calibration-value entry screen appears. (first time only)

If the calibration-value entry screen does not appear, check that the instrument and the computer are correctly connected.

If you wish to change the calibration value, change it in **[Option]**. (p.49)



2 **Enter the rated output value from the Test Data Sheet of the load cell included with the Press Unit into the Load Cell Calibration value box, illustrated in step 1.**



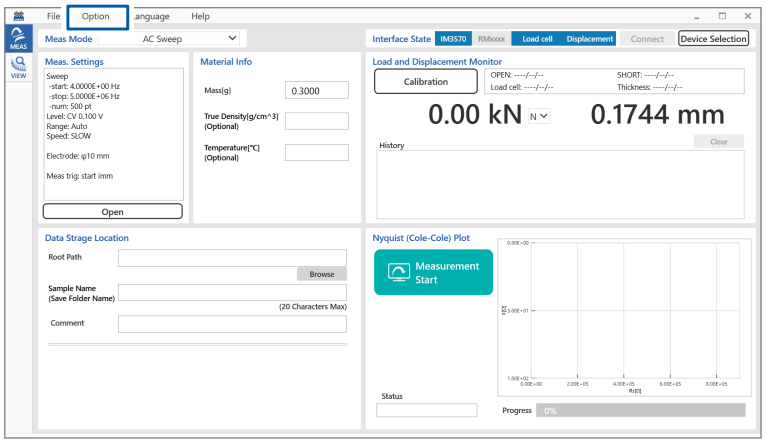
Test Data Sheet

IMPORTANT

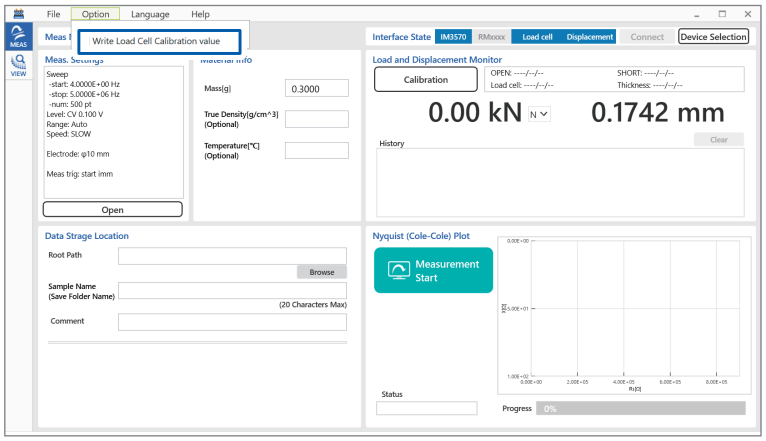
The rated output may be expressed in a different unit than that displayed in the software. Convert the value to the unit displayed in the software before entering it.

Correcting the calibration value

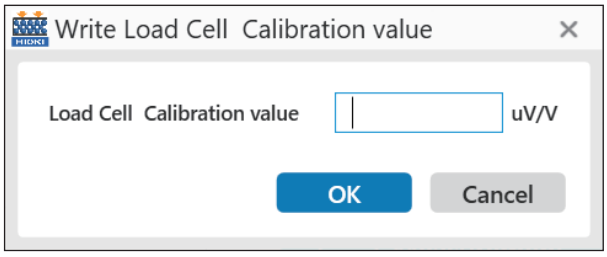
1 Select [Option].



2 Select [Write Load Cell Calibration value].



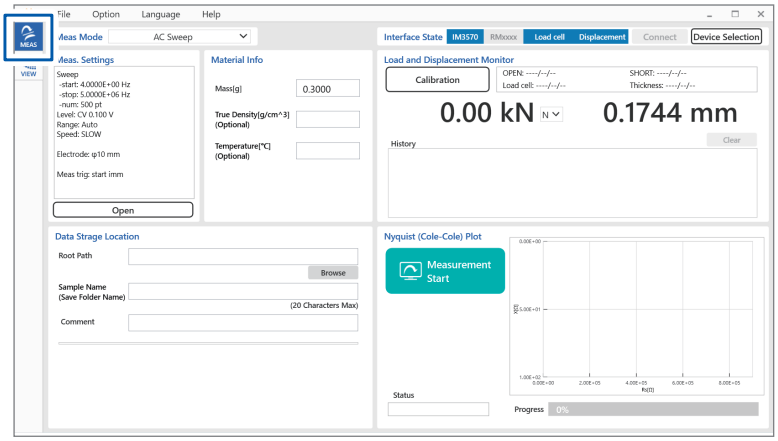
3 Enter the numerical value.



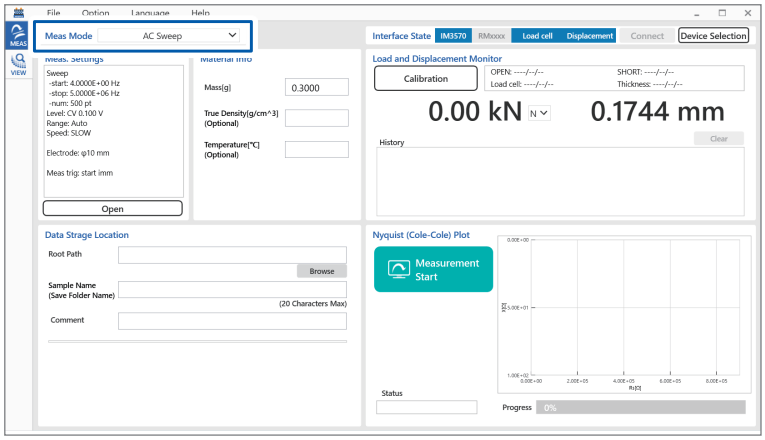
3 Configuring the SA2653 Measurement Software

3.1 Selecting the Measurement Mode

1 **Click the [MEAS] tab.**



2 **Click [Meas Mode] to select the measurement mode.**



Measurement mode

AC Sweep	Measures the impedance of the powder using an AC frequency sweep signal. The R value is automatically calculated from the Nyquist plot data and used as a parameter for the graphical display.
AC Continuous	Measures the impedance of the powder using an AC frequency sweep signal. Measurements can be made over the time series.
DC	Measures the resistance of the powder using a DC signal. Measurements can be made over the time series.

IMPORTANT

When the measurement mode is set to **[DC]**, the measurement current of the RM3545A is set to Low.

The measurement current of the RM3545A varies depending on the range. If you wish to fix the measurement current, turn off the auto-ranging feature of the RM3545A and set the range that corresponds to the desired measurement current.

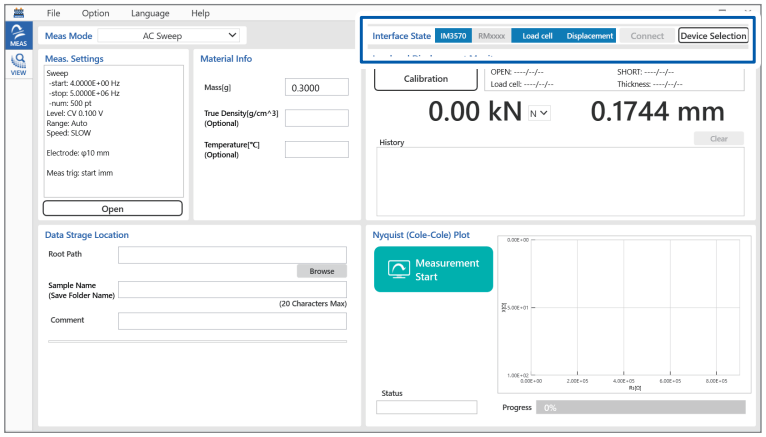
For details about the measurement current of the each range, see the instruction manual for the instrument.

3.2 Checking the Connection Between the Measuring Instrument and the Computer

This section explains how to check the equipment connection status.

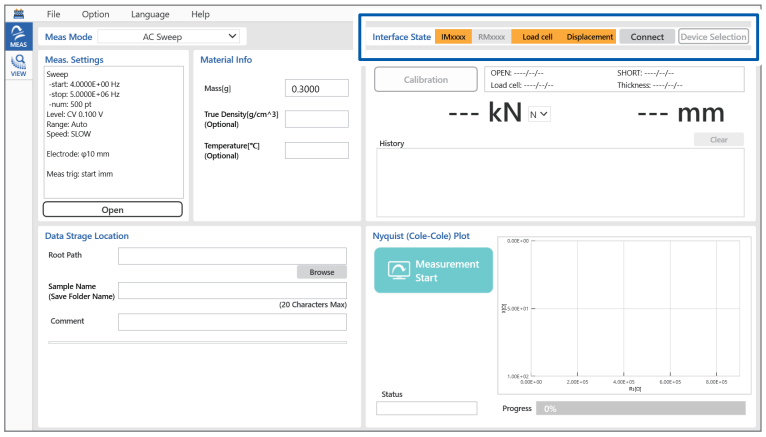
Checking if the measuring instrument is properly connected

Once the connection of the measuring instrument is completed and the Measurement Software is started, the measuring instrument and the Measurement Software are automatically connected. If the connection is successful, the background of the equipment names in the **[Interface State]** will turn blue.



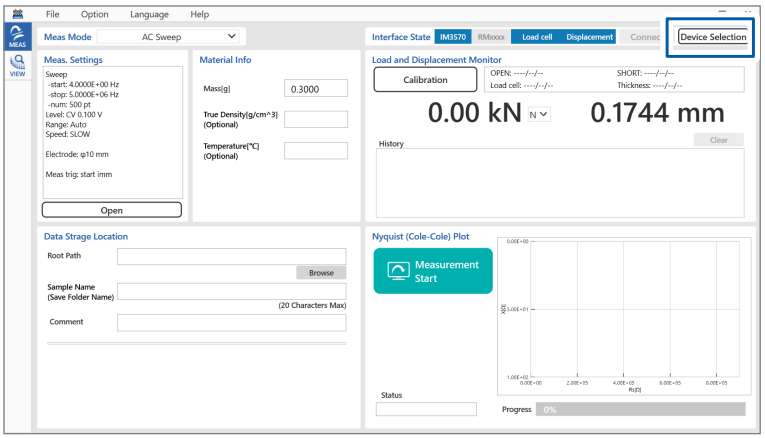
When there is an abnormality in the connection with the measuring instrument

If the instrument is not connected properly, the background of the equipment names in the **[Interface State]** will turn orange. Check the connection status of the instrument with the equipment names that have orange background and click **[Connect]**. (p.27)

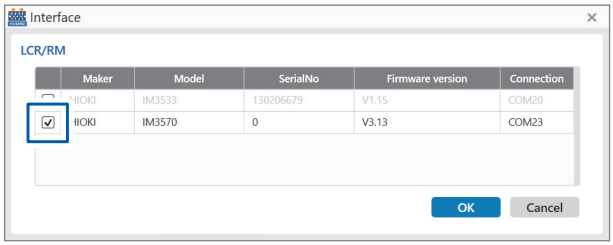


Selecting a measuring instrument

1 **Click [Device Selection].**



2 **Select the measuring instrument to be used and click [OK].**



3.3 Performing Calibration and Compensation

Perform calibration and compensation each time the instrument is turned on. These processes take a few minutes. The progress of the compensation is displayed on the instrument's screen.

⚠ CAUTION

■ **Do not move the hydraulic jack during calibration and compensation.**
Failure to follow this guidance may result in errors in calibration or compensation.

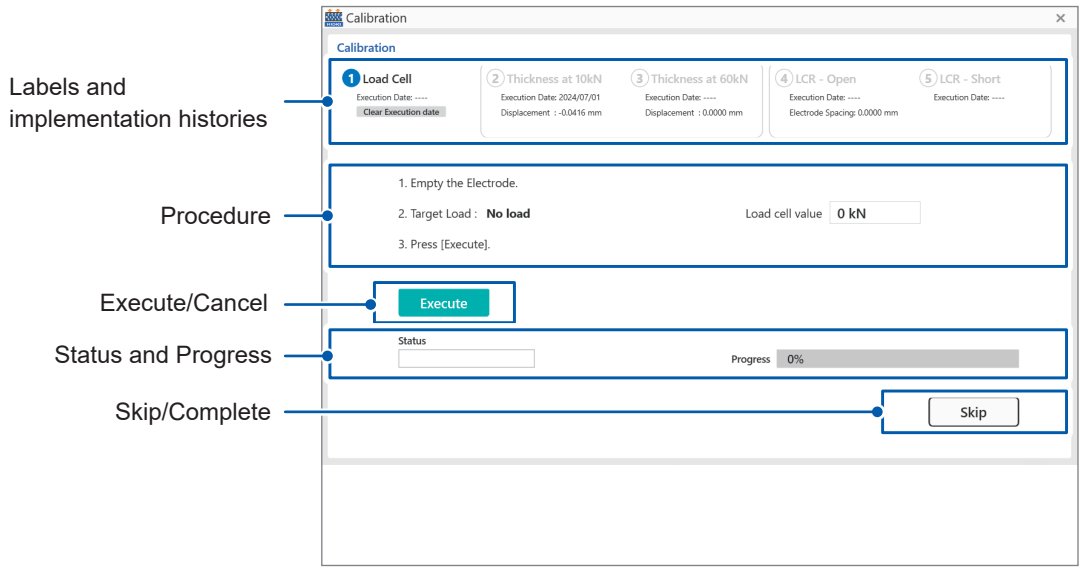
■ **Securely insert the SA9004-01 Test Fixture deep into the rail.**
Failure to follow this guidance could result in damage to the Press Unit.

■ **Use the ratchet handle when adjusting the load on the SA9003 Press Unit.**
Using electric tools could damage the Press Unit or bodily injury.

Before performing calibration and compensation, check the following:

- After turning on the instrument, allow it to warm up for at least 60 minutes.
- Whenever the Test Fixture, the Press Unit, or the Connection Cables are replaced, perform the calibration and compensation again. If measurements are made with the calibration and compensation applied before replacement, accurate measurement values cannot be obtained.
- Perform the calibration and compensation in a location where there are no nearby noise sources. Noise may cause errors during the calibration and compensation processes.
  Examples of noise sources: servo motors, switching power supplies, and high-voltage lines
- Perform the calibration and the compensation under the same conditions as those of the actual environment in which the powder is measured.

Example of the calibration screen in AC Sweep mode and AC Continuous mode

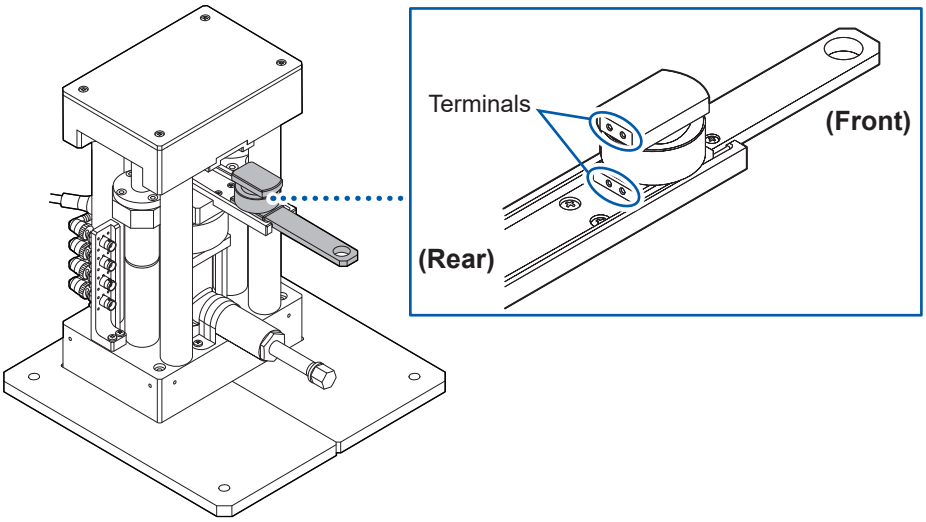


Performing the load-cell calibration

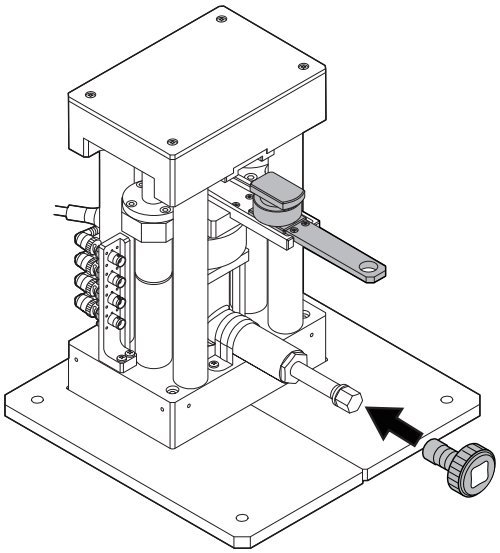
This section explains how to calibrate the load cell by performing a digital zero adjustment with no load applied. The digital zero adjustment of the load cell defines the reference point for the SA2654 Sensor Unit, thereby improving measurement accuracy.

1 **Position an empty Test Fixture on the rail of the Press Unit.**

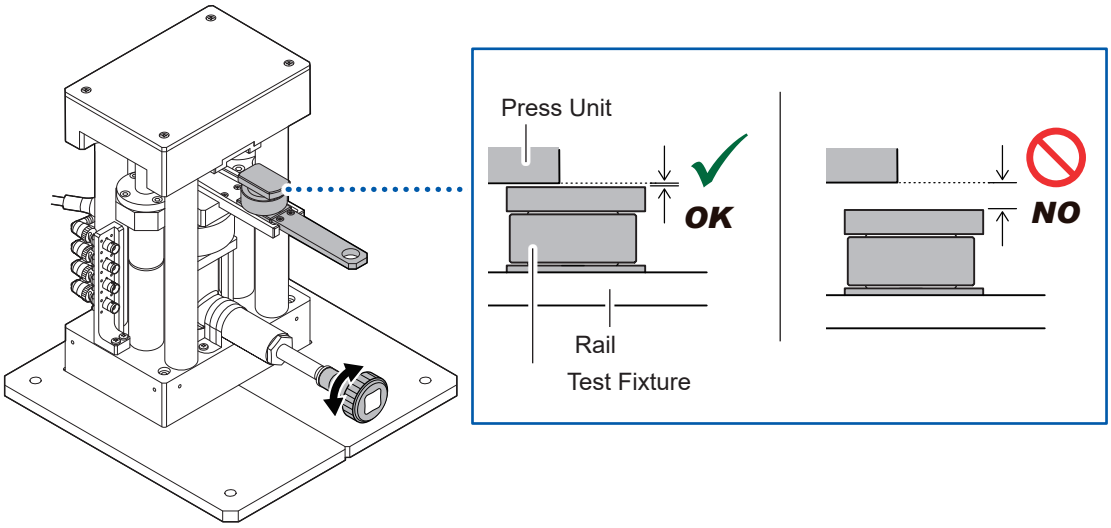
Position the Test Fixture so that its terminals face the rear of the Press Unit.



2 **Attach the quick spinner to the hydraulic jack of the Press Unit.**

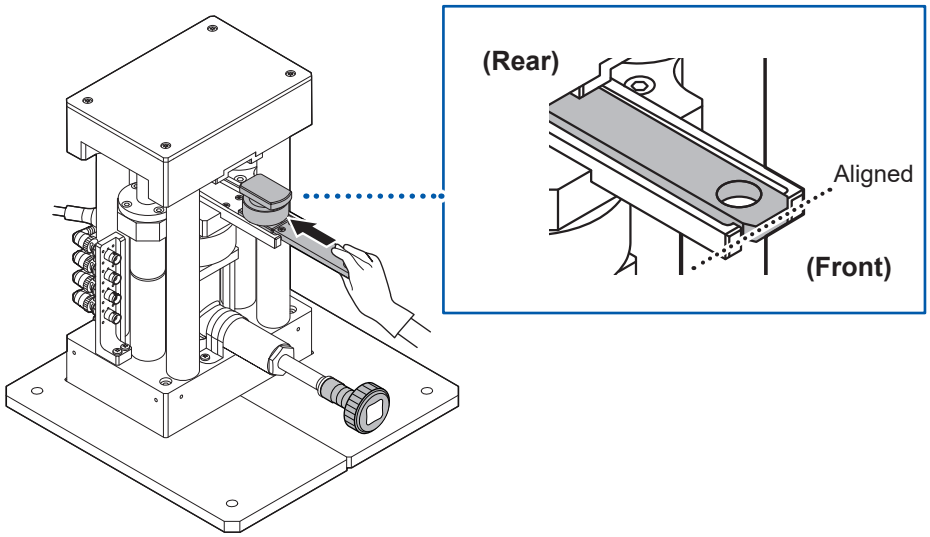


3 **Turn the quick spinner to adjust the height of the Test Fixture so that its upper electrode does not contact the Press Unit, and the gap between them is as small as possible.**



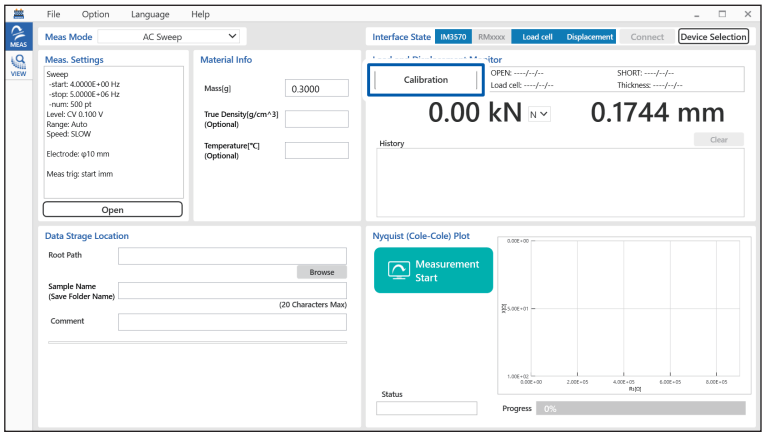
4 **Securely insert the Test Fixture deeply into the rail.**

When the Test Fixture is fully inserted into the rail, the handle of the Test Fixture aligns with the end of the rail. If the handle of the Test Fixture protrudes from the end of the rail, pull out the Test Fixture and adjust the height of the rail according to step **3**.



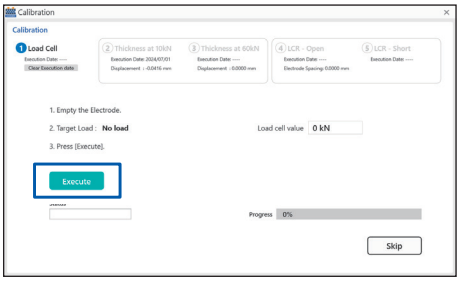
5 **Click [Calibration].**

The calibration screen is displayed.



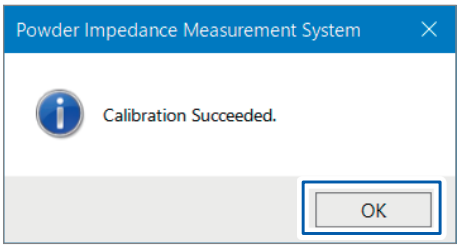
6 **With no load applied to the Test Fixture, click [Execute].**

The load-cell calibration for the Press Unit starts.



7 **Click [OK].**

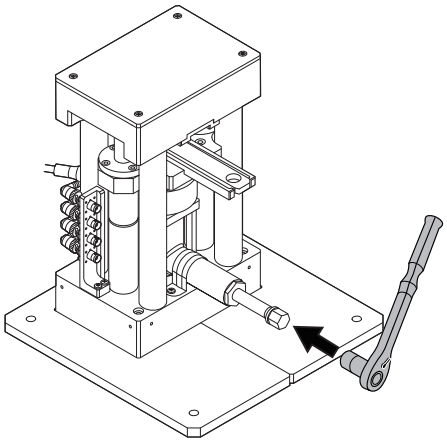
The next step is to perform the thickness-measurement calibration.



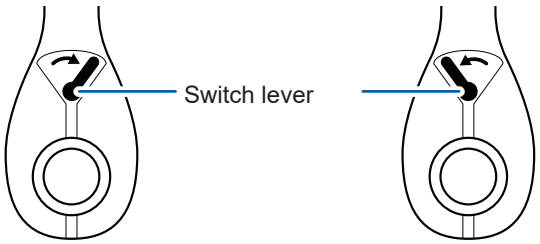
Performing the thickness-measurement calibration

Performing the thickness-measurement calibration reduces the effect of deformation in the SA9003 Press Unit, there by improving measurement accuracy.

8 **Attach the ratchet handle to the hydraulic jack of the Press Unit.**



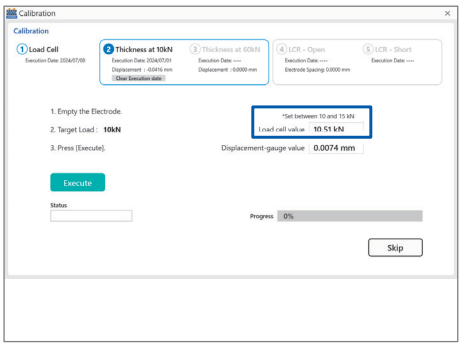
Using the switch lever of the ratchet handle can switch between two ratchet handle modes: tightening mode (clockwise) and loosening mode (counterclockwise).



(Tightening mode) (Loosening mode)

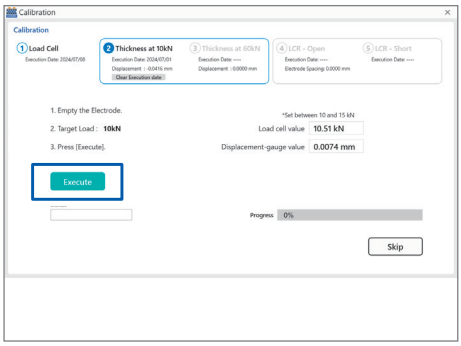
9 **Apply a load until the [Load cell value] box displays a value between 10 kN and 15 kN. (p.98)**

When the load falls within the specified range, the **[Execute]** button becomes clickable.

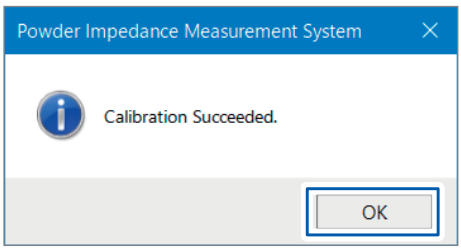


10 **Click [Execute].**

The confirmation screen is displayed.

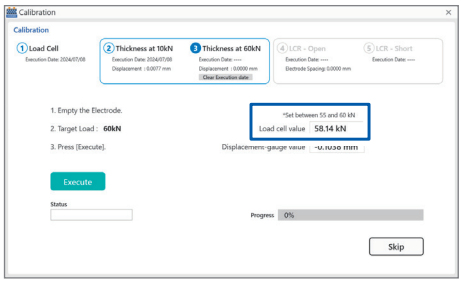


11 **Click [OK].**



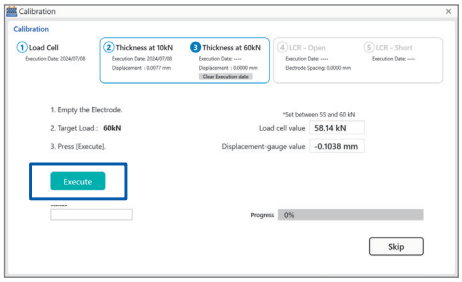
12 **Apply a load until the [Load cell value] box displays a value between 55 kN and 60 kN. (p.98)**

When the load falls within the specified range, the **[Execute]** button becomes clickable.



13 **Click [Execute].**

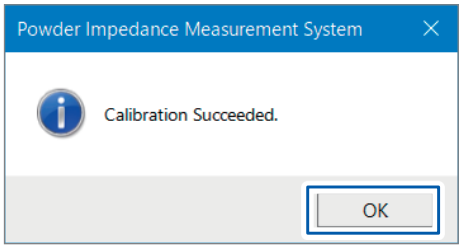
The confirmation screen is displayed.



Tips

The load value tends to be smaller immediately after applying pressure due to the descent of the hydraulic jack. Click **[Execute]** even if the load value is still fluctuating within the specified load range.

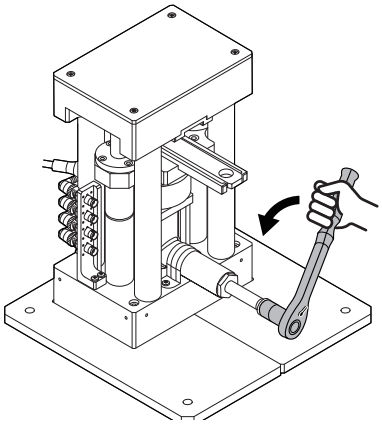
14 **Click [OK].**

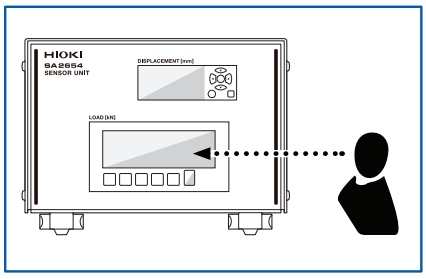


15 **Use the ratchet handle in loosening mode to turn the hydraulic jack screw counterclockwise and zero the load on the Test Fixture positioned in the Press Unit.**

The Sensor Unit displays the load on the Test Fixture positioned in the Press Unit.

The next step is to perform the compensation of the instrument.



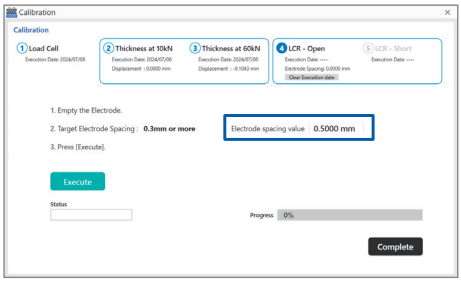


Performing the compensation of the instrument.

The next step is to perform open and short compensations of the measuring instrument. (For the RM3545A, only short compensation can be performed.)
The Press Unit and the Test Fixture have stray admittance and residual impedance, which affect the measured values. The open and short compensations reduce the effects of stray admittance and residual impedance in the Test Fixture, thereby improving measurement accuracy.

Open compensation	Reduces the influence of stray admittance in connection cables, thereby improving measurement accuracy.
Short compensation	Reduces the influence of residual impedance in connection cables, thereby improving measurement accuracy.

16 Adjust the distance between the upper and lower electrodes of the Test Fixture using a quick spinner while checking the value in the [Electrode spacing value] box. (p.98)

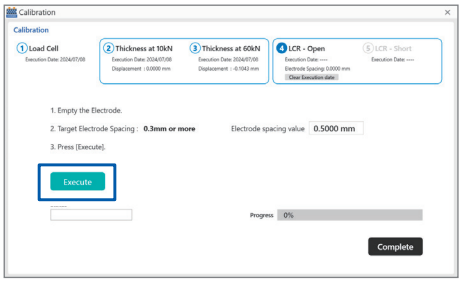


Tips

To improve measurement accuracy, adjust the distance so that the value in the **[Electrode spacing value]** box is close to the thickness of the compressed powder.

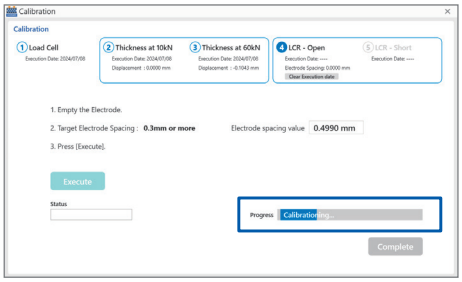
17 Click [Execute].

The open compensation of the measuring instrument starts.



The text **[Calibrating...]** is displayed to the right of **[Progress]** while the compensation is on going.

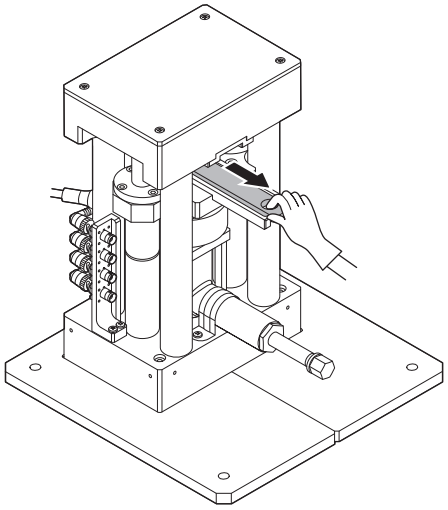
The Measurement Software screen does not display progress percentages. To check the progress percentage, refer to the screen of the instrument.



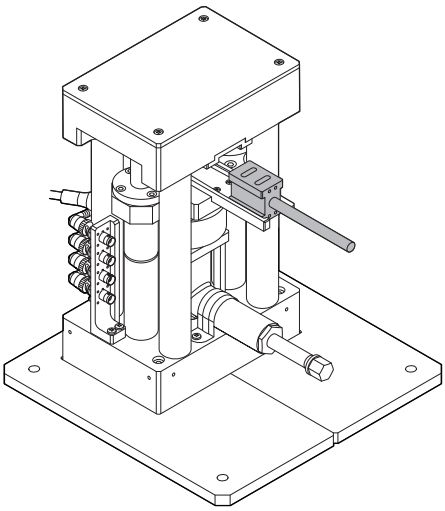
When the open compensation is successfully completed, the short compensation starts.

18 Remove the Test Fixture from the Press Unit.

Slowly pull out the Test Fixture, because pulling it out roughly could cause it to fall off the rail.

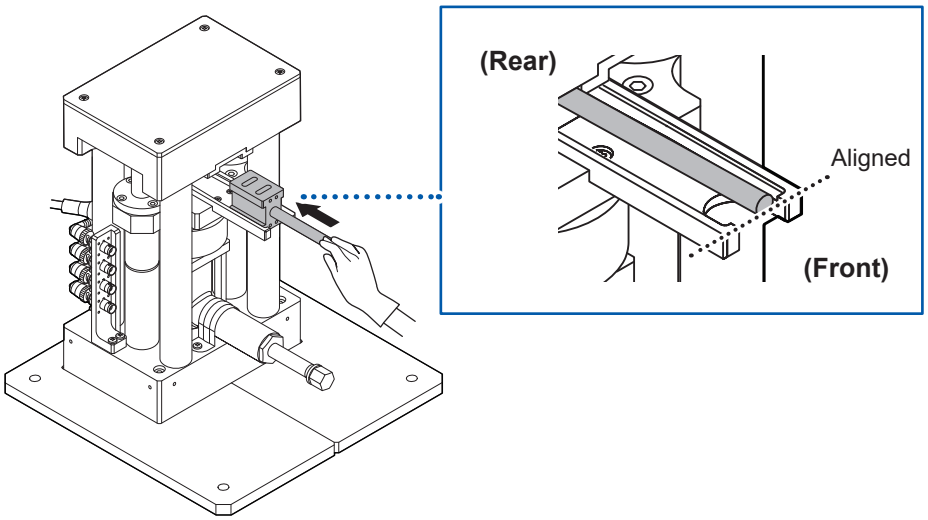


19 **Position the short-compensation block on the rail of the Press Unit.**



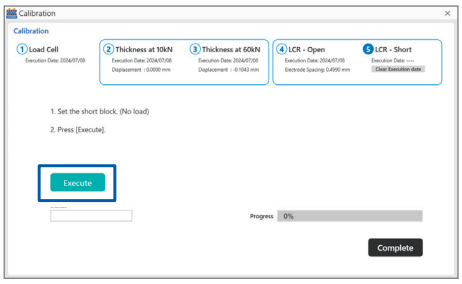
20 Insert the short-compensation block deeply into the rail.

When the short-compensation block is inserted fully into the rail, the handle of the short-compensation block aligns with the end of the rail.



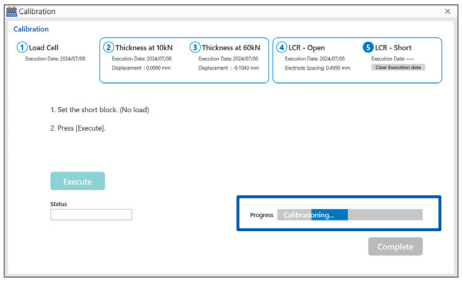
21 Click [Execute].

The short compensation of the measuring instrument starts.



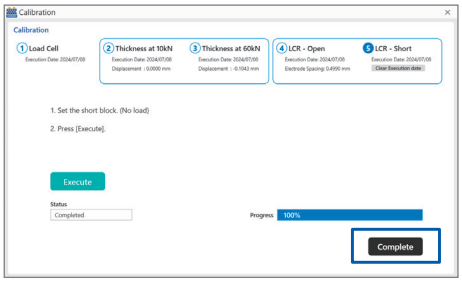
The text **[Calibrating...]** is displayed to the right of **[Progress]** while the compensation is on going.

The Measurement Software screen does not display progress percentages. To check the progress percentage, refer to the screen of the instrument.



22 Click [Complete].

The compensations are complete.

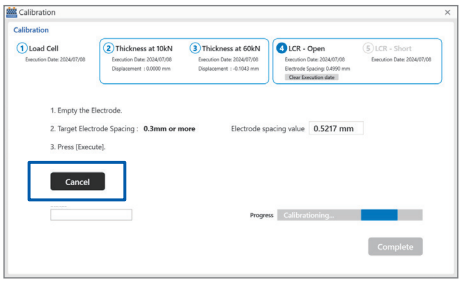


Canceling the compensation (IM3533 only)

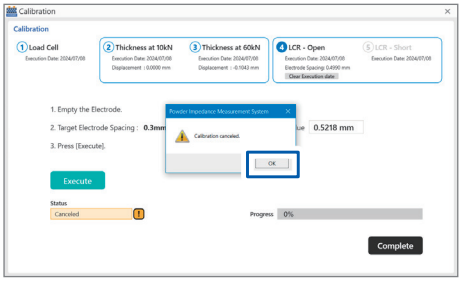
When using the IM3570 or RM3545A, the compensation cannot be canceled from the Measurement Software screen. To cancel the compensation, select Cancel on the screen of the instrument.

1 **Click [Cancel].**

The confirmation screen is displayed.

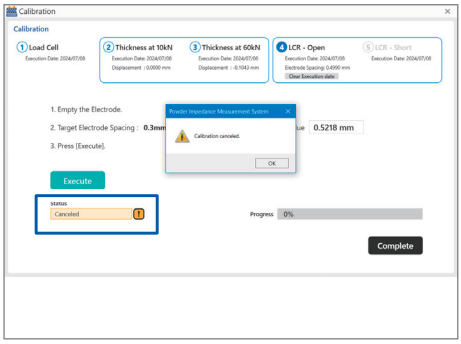


2 **Click [OK].**



Checking the compensation result

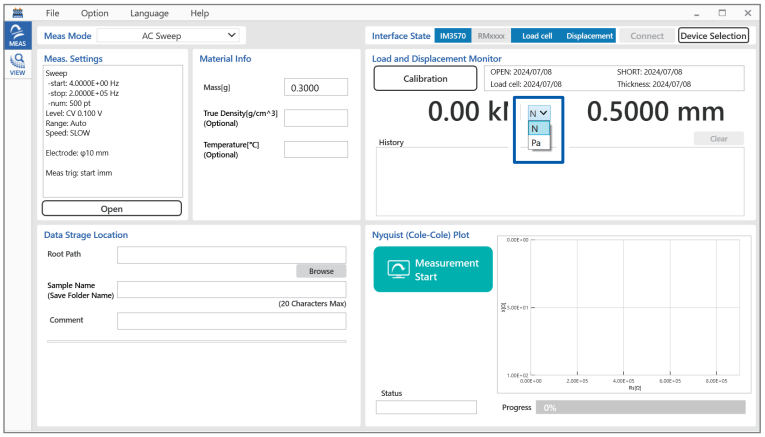
The compensation result is displayed under **[Status]**.



3.4 Checking the Load and Thickness

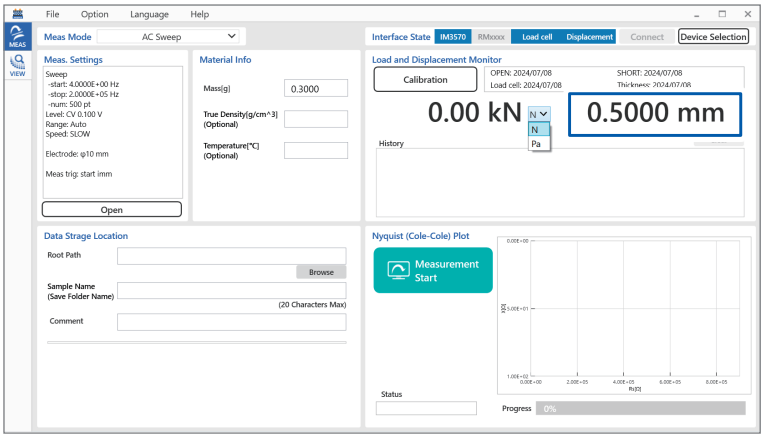
This section explains how to check the information on the SA2654 Sensor Unit.

1 Select the displayed type of force applied to the powder from the drop-down list.



N	**Force applied on the powder**
Pa	**Force per unit area applied on the powder**

2 Check the powder thickness information.



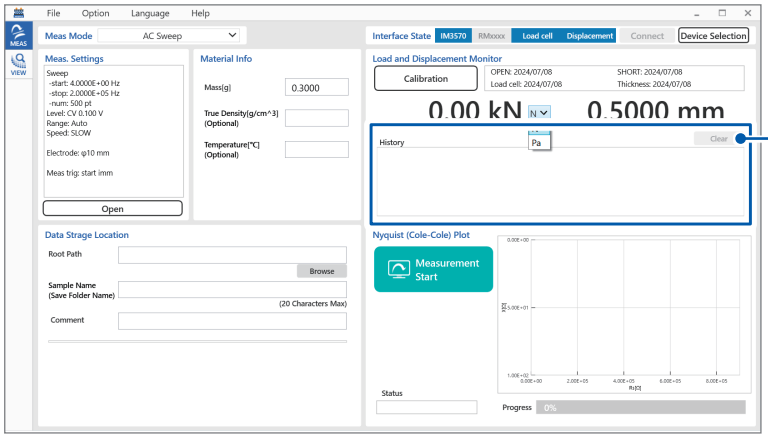
IMPORTANT

Make measurements under a constant temperature environment. Temperature changes may cause the Press Unit and the Test Fixture to contract or expand, potentially resulting in incorrect thickness measurements.

Value for reference purposes: A 1°C change in temperature will affect thickness measurements by 1 µm. (at an applied load of 10 kN)

Checking past measurement history

The **[History]** field displays past measurement history information for the SA2654 Sensor Unit. Click **[Clear]** to delete the history.



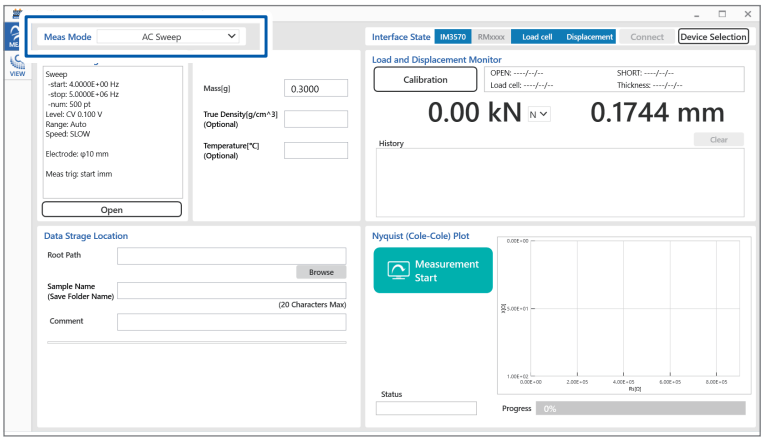
3.5 Opening the Measurement Conditions Setting Window

The settable parameters vary depending on the selected measurement mode. Set the necessary parameters.

Settable parameters

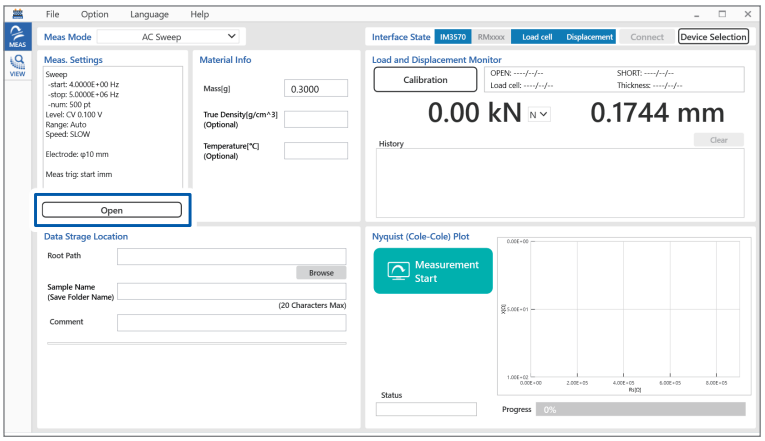
AC Sweep AC Continuous	Frequency, Number of measurements, Interval, Measurement signal level, Measurement trigger, Electrode information, Measurement speed, Connection cable length, Resistance range
DC	Number of measurements, Interval, Measurement trigger, Electrode information, Measurement speed, Resistance range

1 **Select a measurement mode. (p.51)**

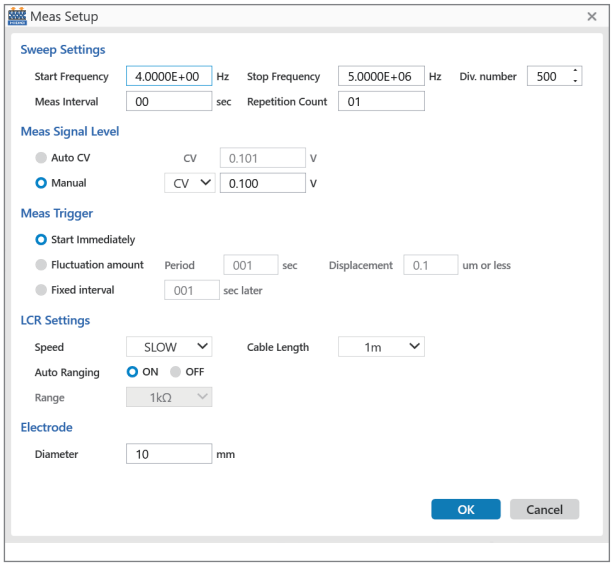


2 **Click [Setup].**

The settings window opens.



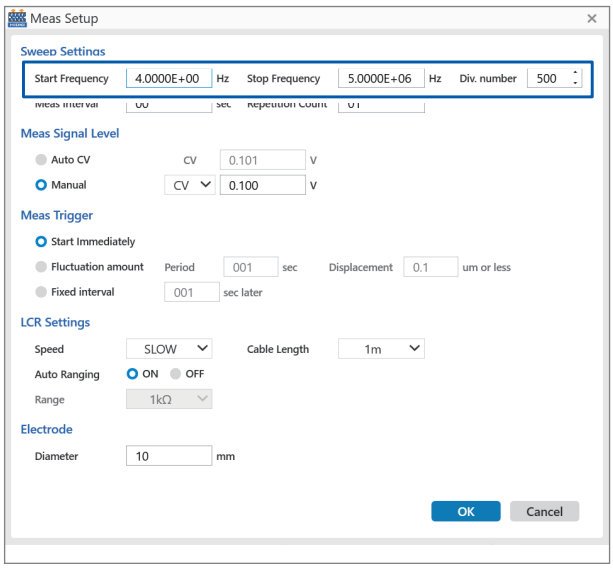
3 **Define each measurement condition.**



3.6 Setting the Measurement Frequency

If the measurement mode is set to AC Sweep or AC Continuous, set the measurement frequency.

1 Open the measurement conditions setting window. (p.68)



Example of the AC Sweep mode screen

2 Set the sweep frequencies.

AC Sweep

Start frequency **Stop frequency**	Valid input range	IM3570 4 Hz to 5 MHz IM3533 1 mHz to 200 kHz
	Input type	Decimal or exponential form
Div. number	Number of measurement points between the start and end frequencies	
	Valid input range	500 to 999
	Input type	Three-digit integer in the form *000* (default value: 500)
	Interpolation method	Log

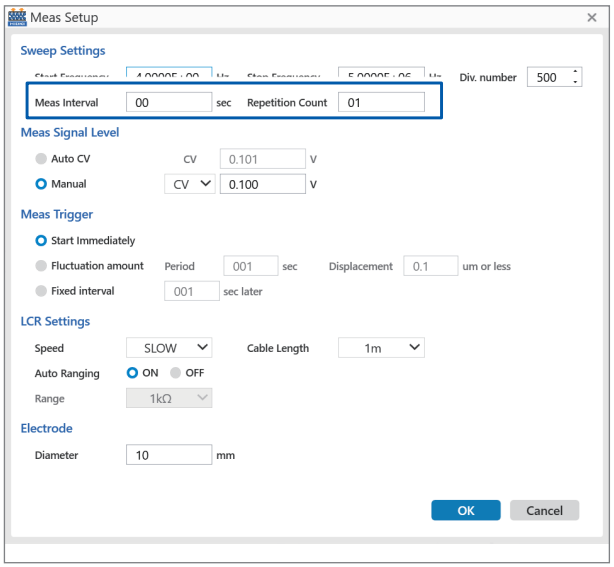
AC Continuous

Measurement frequency	Valid input range	IM3570 4 Hz to 5 MHz IM3533 1 mHz to 200 kHz
	Input type	Decimal or exponential form

3.7 Setting the Number of Measurements and the Measurement Interval

This section explains how to set the number of measurements and the measurement interval.

1 Open the measurement conditions setting window. (p.68)



Example of the AC Sweep mode screen

2 Set the number of measurements and the measurement interval.

AC Sweep

Meas Interval	Time between the end of one sweep-frequency measurement and the start of the next	
	Valid input range	0 to 99
	Input type	Two-digit integer in the form *00* (default value: 00) If zero is entered, the minimum interval is set.
Repetition Count	Valid input range	1 to 99
	Input type	Two-digit integer in the form *00* (default value: 01) If **[Stop]** is clicked during the measurement, the measured data up to that point is saved.

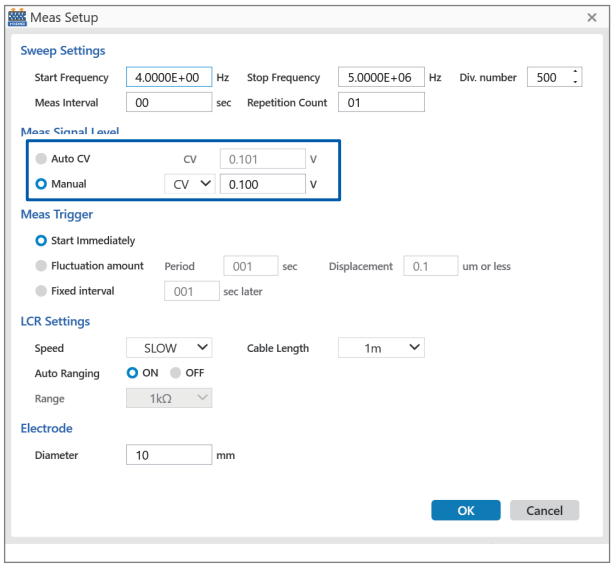
AC Continuous
DC

Meas Interval	Valid input range	0 to 99
	Input type	Two-digit integer in the form *00* (default value: 00) If zero is entered, the minimum interval is set.
Repetition Count	Valid input range	1 to 9999
	Input type	Four-digit integer in the form *0000* (default value: 0001) If **[Stop]** is clicked during the measurement, the measured data up to that point is saved.

3.8 Setting the Measurement Signal Level

When the measurement mode is set to AC Sweep or AC Continuous, set the measurement signal level. The measurement signal at the set level is applied to the powder.

1 Open the measurement conditions setting window. (p.68)



Example of the AC Sweep mode screen

2 Set the measurement signal level.

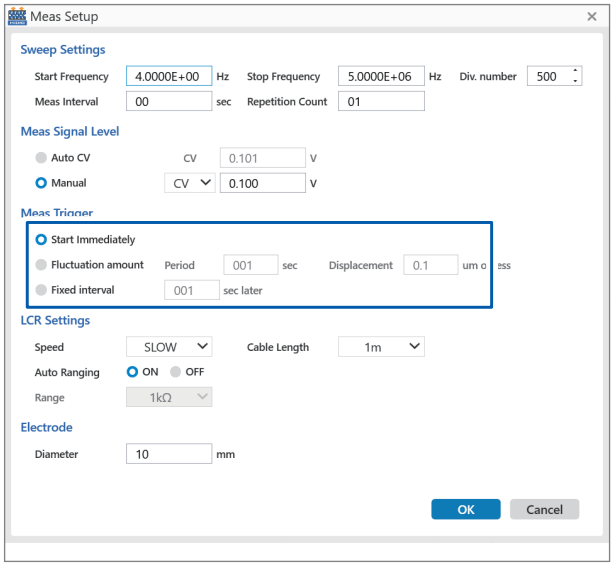
Auto CV	The level of the measurement signal at the maximum measurement frequency set in “3.6 Setting the Measurement Frequency” (p.70) is automatically adjusted to ensure constant voltage measurement. This is achieved by reducing the measurement signal level by 0.01 V from the predefined constant voltage value. The optimum constant voltage value is determined before measurement, reducing the occurrence of constant voltage measurement errors. (If the Impedance Analyzer fails to acquire the impedance or if the monitor value of the Impedance Analyzer is less than 80% of the CV setting, the measurement will not start even if the voltage value is set with Auto CV.)
Manual (measurement signal mode, default setting)	Open-terminal voltage (V) mode, constant voltage (CV) mode, or constant current (CC) mode can be selected. (default setting: CV)

IM3570	Open-terminal voltage (V) mode or constant voltage (CV) mode	
	Valid setting range	10 mV to 1 V (default value: 0.100 V)
	Setting resolution	In 1 mV increments
	Constant current (CC) mode	
	Valid setting range	10 µA to10 mA
	Setting resolution	In 10 µA increments
IM3533	Open-terminal voltage (V) mode or constant voltage (CV) mode	
	Valid setting range	10 mV to 1 V
	Setting resolution	In 1 mV increments
	Constant current (CC) mode	
	Valid setting range	10 µA to10 mA
	Setting resolution	In 10 µA increments

3.9 Setting the Measurement Trigger

This section explains how to set the measurement start timing.
The thickness of the powder may not be stable immediately after load application. Selecting **[Fluctuation amount]** allows you to start the measurement after the powder thickness has stabilized.

1 Open the measurement conditions setting window. (p.68)



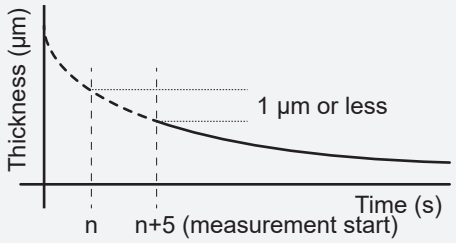
Example of the AC Sweep mode screen

2 Select a measurement trigger option.

Start immediately	Measurement starts by clicking **[Measurement Start]**.	
Fluctuation amount	Measurement starts when the thickness change is less than or equal to the predefined amount within the predefined time frame.	
	Period (sec)	Enter the time.
	Valid input range	1 to 999
	Input type	Three-digit integer in the form *000*
	Displacement (µm)	Enter the amount of thickness change.
	Valid input range	0.1 to 5.0
	Input type	Valid to one decimal place
Fixed interval	Measurement starts when the predefined time elapses.	
	Valid input range	1 to 999
	Input type	Three-digit integer in the form *000*

Tips

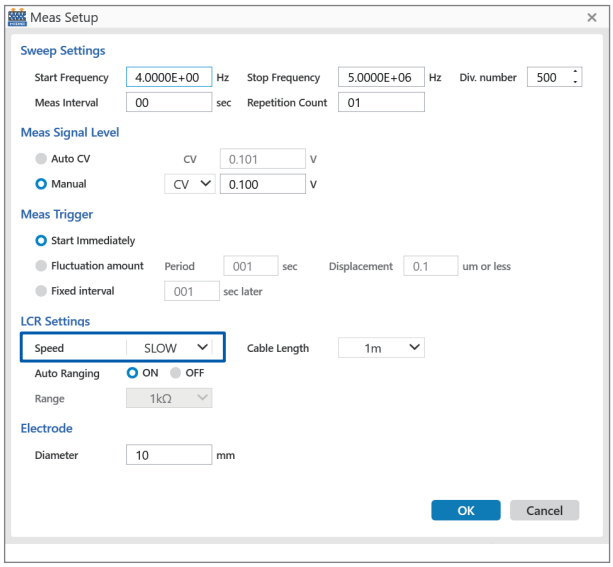
When **[Fluctuation amount]** is selected, with the setting time at 5 seconds and **[Displacement]** set to 1 µm, measurement starts when the thickness change is less than 1 µm within a duration of 5 seconds.



3.10 Setting the Measurement Speed

The measurement speed can be selected from four levels: FAST, MED, SLOW (or SLOW1), and SLOW2.

1 Open the measurement conditions setting window. (p.68)



Example of the AC Sweep mode screen

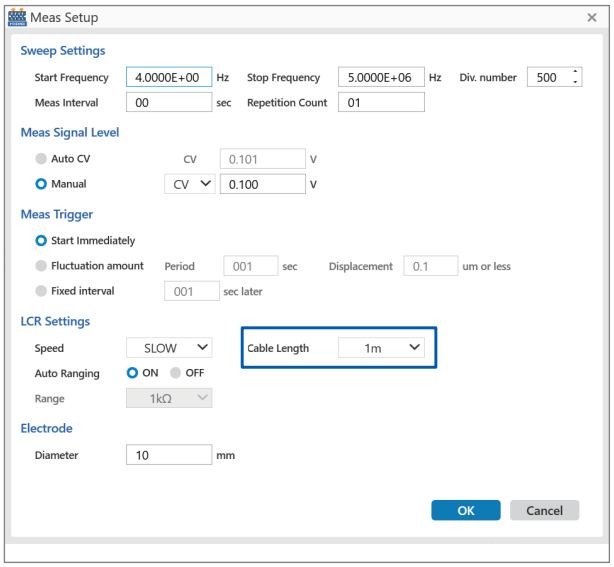
2 Set the measurement speed.

Speed	MED, SLOW, and SLOW2 are more accurate than FAST and are less sensitive to external environmental influences. However, the measurement takes longer with MED, SLOW, and SLOW2 than with FAST.	
	AC Sweep AC Continuous	FAST, MED, SLOW, SLOW2 (default setting: SLOW)
	DC	FAST, MED, SLOW1, SLOW2 (default setting: SLOW1)

3.11 Setting the Connection Cable Length

If the measurement mode is set to AC Sweep or AC Continuous, set the length of the connection cable. If the cable length changes, the settable range and measurement frequency also change. See the Instruction Manual for the measuring instrument.

1 **Open the measurement conditions setting window. (p.68)**



Example of the AC Sweep mode screen

2 **Set the connection cable length.**

When using the IM3570 Impedance Analyzer or the IM3533 LCR Meter, set the length of the connection cable to **[1m]**, regardless of the type of cable used.

Cable length	IM3570 IM3533	1 m

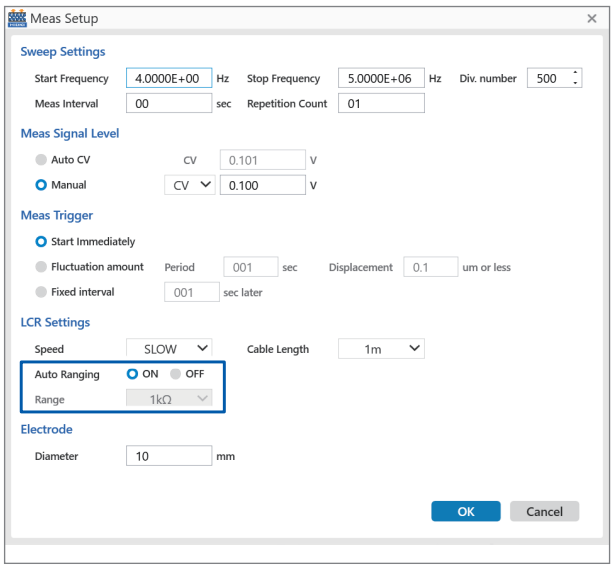
Tips

The cables (total length; 20 cm) are used inside the SA9003 Press Unit.
When the Connection Cable (total length: 80 cm) is connected to the SA9003 Press Unit, the total cable length becomes 1 m.

3.12 Switching the Resistance Range

The resistance range can be selected to match the powder being measured.

1 Open the measurement conditions setting window. (p.68)



Example of the AC Sweep mode screen

2 Set the resistance range.

Auto Ranging	The optimum measurement range is automatically selected.
	ON, OFF (default setting: ON)
Range	Available when Auto Ranging is set to OFF.
	You can select the ranges available for the measuring instrument. See the Instruction Manual for the measuring instrument.

3.13 Setting the Test Fixture Information

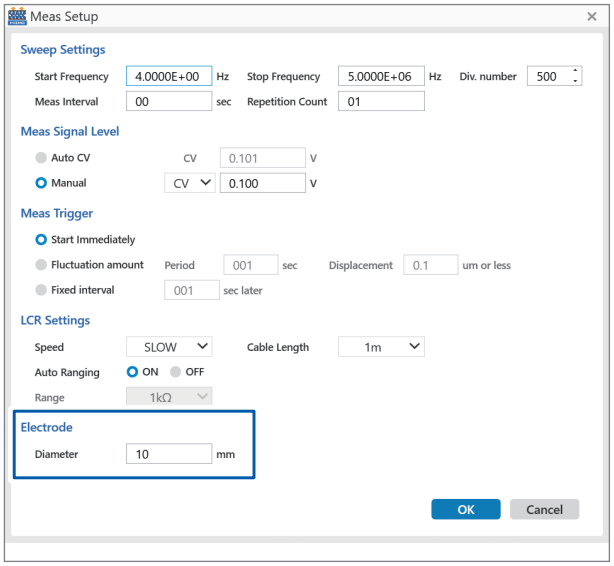
By setting the Test Fixture information, you can change the maximum press pressure (unit: MPa).

⚠ CAUTION

■ **Ensure that the electrode diameter of the Test Fixture to be used is correctly entered.**

If the diameter of the Test Fixture used differs from the entered electrode diameter, the measured values could be abnormal, potentially damaging the device.

1 **Open the measurement conditions setting window. (p.68)**



Example of the AC Sweep mode screen

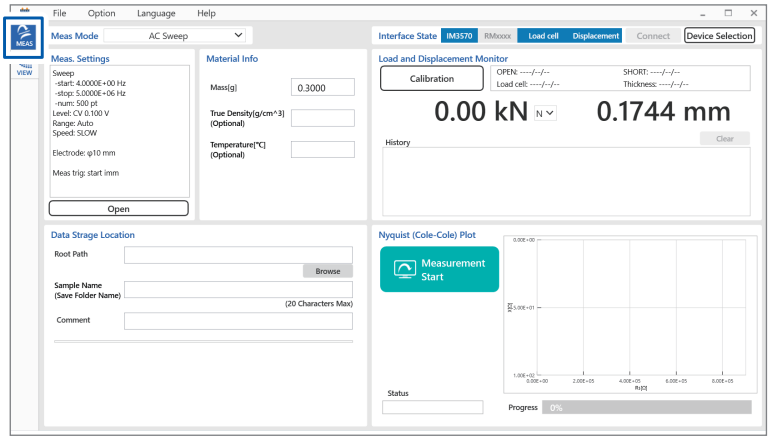
2 **Enter the diameter of the electrode.**

Diameter	Electrode diameter of the Test Fixture to be used	
	Valid input range	8 to 20
	Input type	Two-digit integer in the form *00* (default value: 10)

3.14 Entering the Information About the Powder to be Measured

This section explains how to enter the information about the powder to be measured.
This system cannot measure powder mass, true density, or temperature. Before making a measurement, measure the mass, true density, and temperature of the powder, and then enter these values accordingly.

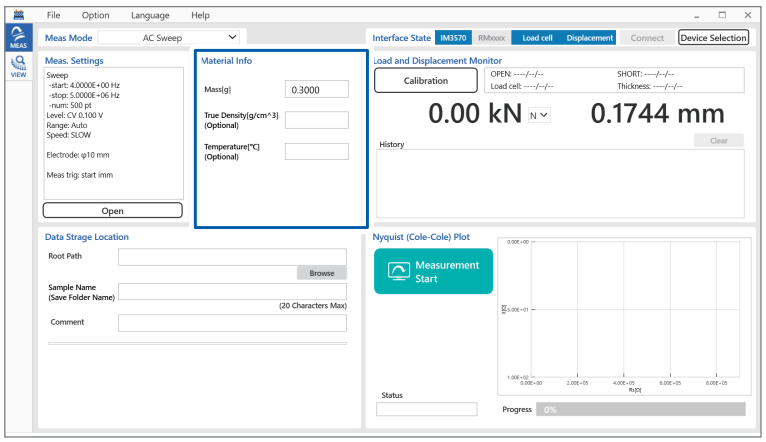
1 **Select the [MEAS] tab.**



2 **Measure the mass of the powder to be used for the impedance measurement with the electronic balance.**

Entering the true density and temperature is optional. Measure these values as needed.

3 **Enter the acquired material information into the [Material Info] field.**



Mass[g]	Mass of the powder	
	Valid input range	0.0000 to 99.9999
	Input type	Valid up to four decimal places (default value: 0.3000)
True Density[g/cm^3] (Optional)	True density of the powder	
	Valid input range	0.000 to 99.999 (A measurement can still be made even if the true density box is left blank.)
	Input type	Valid to three decimal places (default value: blank)
Temperature[°C] (Optional)	Temperature of the powder	
	Valid input range	−20.00 to 60.00 (A measurement can still be made even if the temperature box is left blank.)
	Input type	Valid to two decimal places (default value: blank)

IMPORTANT

The mass value affects bulk density (g/cm^3), filling factor (%), and porosity (%).
Enter the exact measured mass.

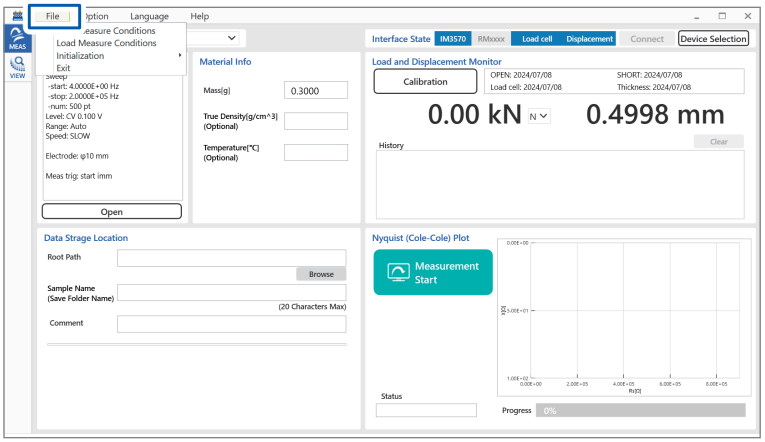
Tips

A measurement can still be made even if the true density and temperature boxes are left blank.
Once the true density is entered, you can select the X-axis of the graph display to show either filling factor and porosity. (p. 116)
When a temperature is entered, the value is saved in the CSV file.

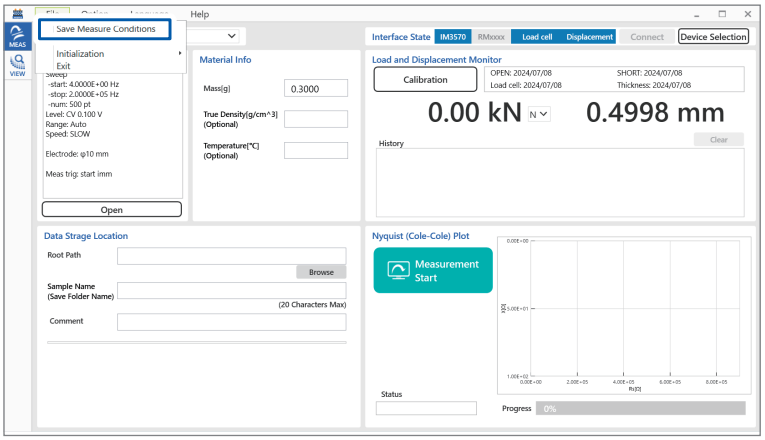
3.15 Saving the Measurement Conditions

If you save the measurement conditions, you can use the same conditions for future measurements.

1 **Select [File].**



2 **Select [Save Measure Conditions].**



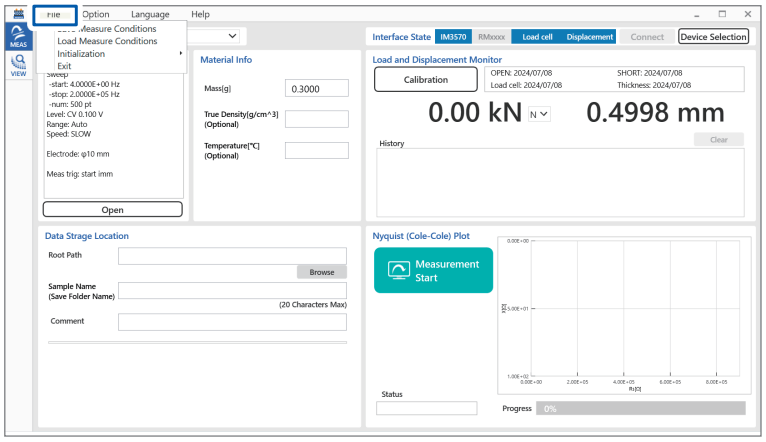
3 **Enter a file name and specify the save destination.**

4 **Click [Save].**

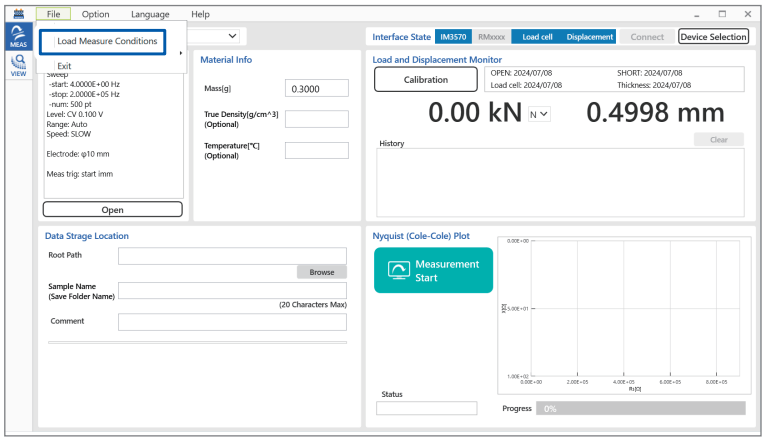
The measurement conditions are saved.

Loading the measurement conditions

1 **Select [File].**



2 **Select [Load Measure Conditions].**



3 **Select the measurement-conditions file you wish to load.**

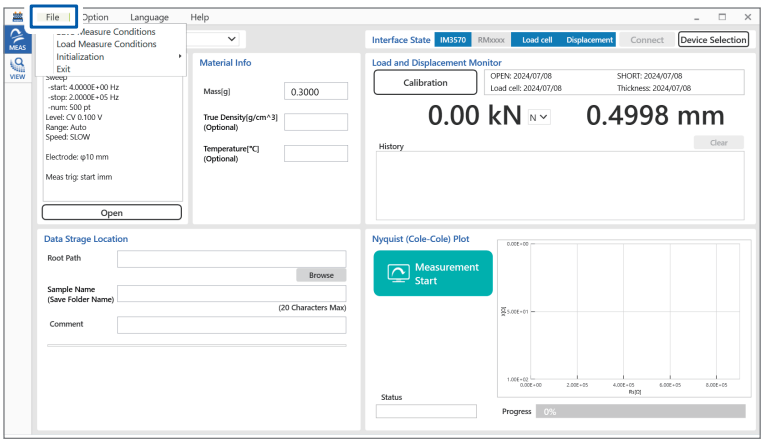
4 **Click [Open].**

The measurement conditions are loaded.

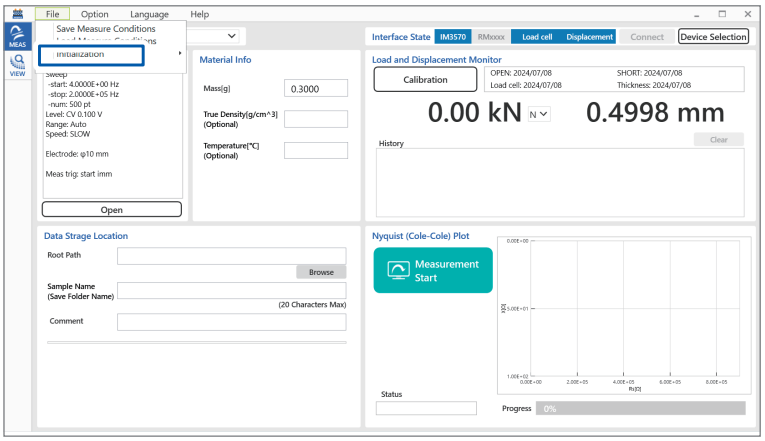
3.16 Resetting the Measurement Software Settings

This section explains how to reset the measurement conditions or all settings.

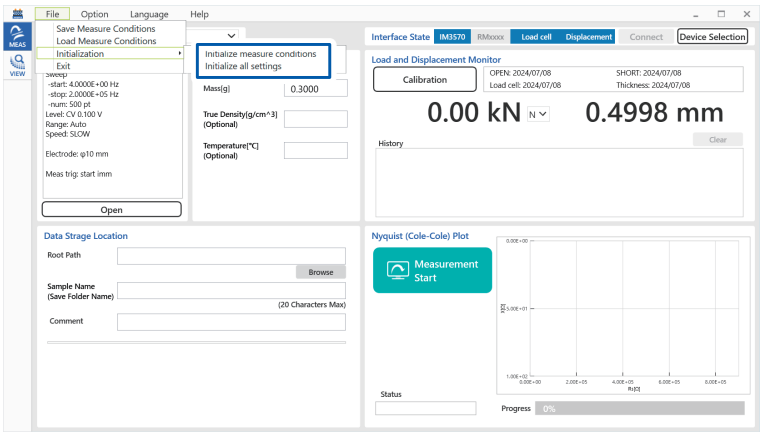
1 **Select [File].**



2 **Select [Initialization].**



3 Select parameters to be reset.



Initialize measure conditions	AC Sweep AC Continuous	Frequency, Number of measurements, Interval, Measurement signal level, Measurement trigger, Electrode information, Measurement speed, Connection cable length, Resistance range
	DC	Number of measurements, Interval, Measurement trigger, Electrode information, Measurement speed, Resistance range
Initialize all settings	Resets all settings.	

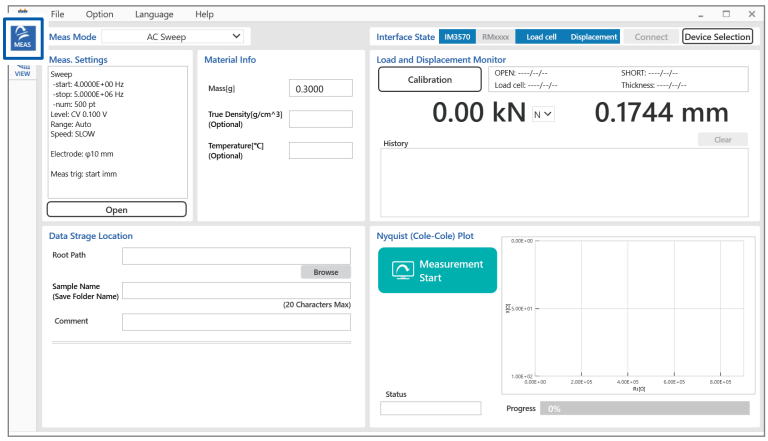
4 Click [Yes].

The selected parameters are reset.

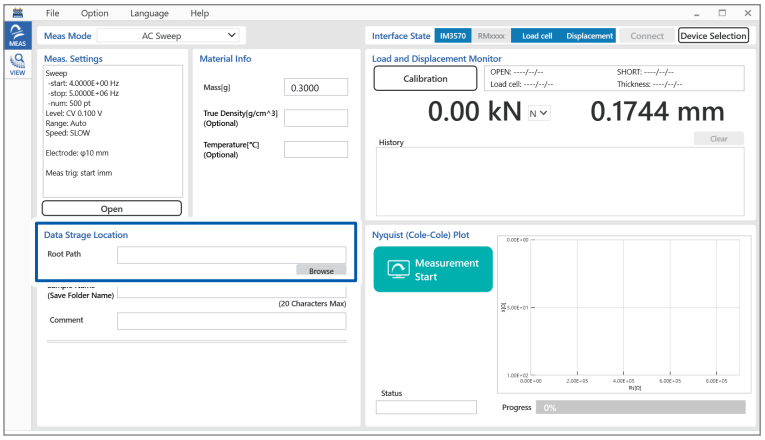
3.17 Setting the Save Destination for the Measurement Results

This section explains how to set the save destination for measurement results.

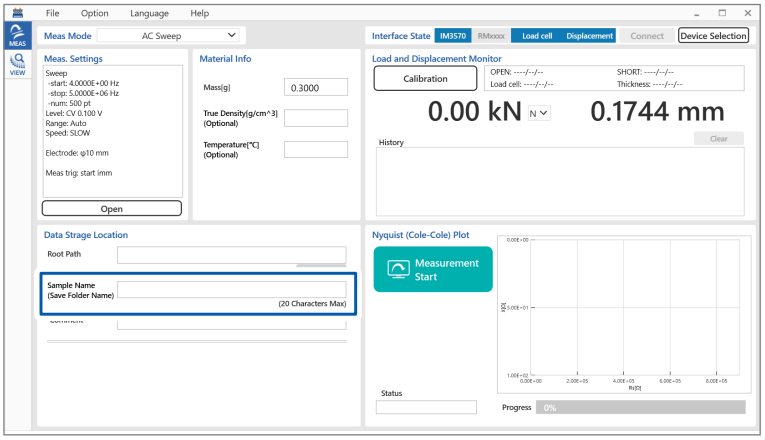
1 Select the [MEAS] tab.



2 Specify the save destination for the CSV files containing the measured data.

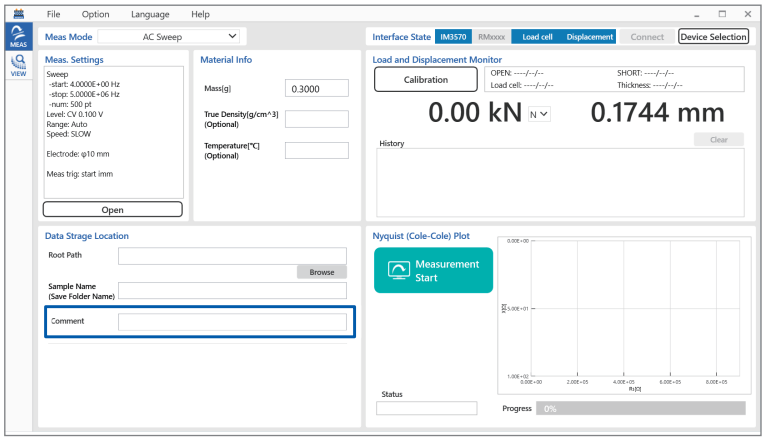


3 Enter the sample name (save folder name). (up to 20 characters)



4 **Optionally, enter comments.**

The comments you enter are listed in a CSV file.



5 **Make a measurement. (p.93)**

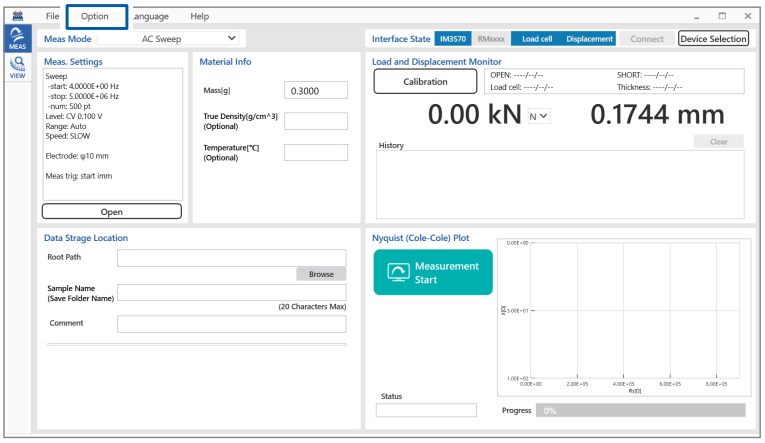
When the measurement is complete, the measured data is automatically saved to the predefined destination.

3.18 Configuring the Application Settings

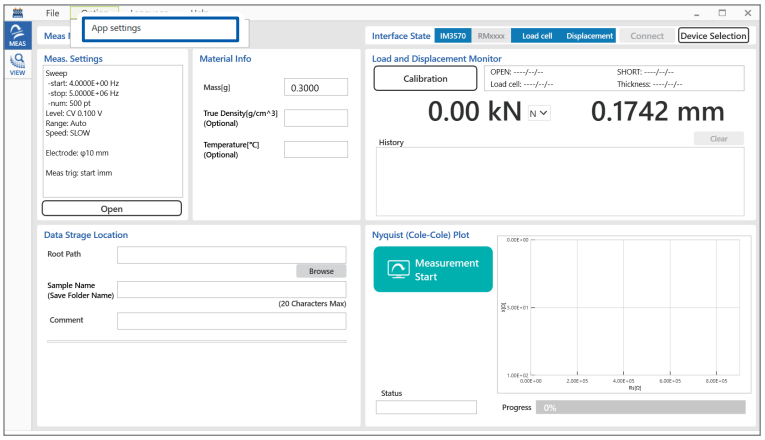
This section explains how to configure the application settings.

Receiving the Update Notification at Startup

1 **Select [Option].**

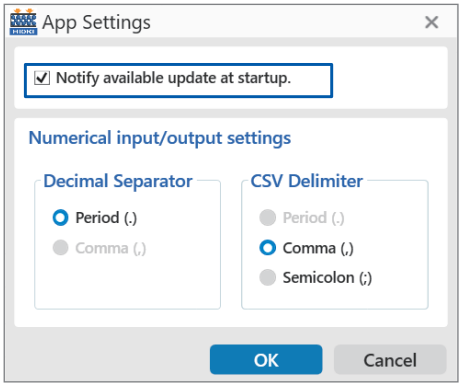


2 **Select [App settings].**



3 **Select whether to be notified of updates at startup.**

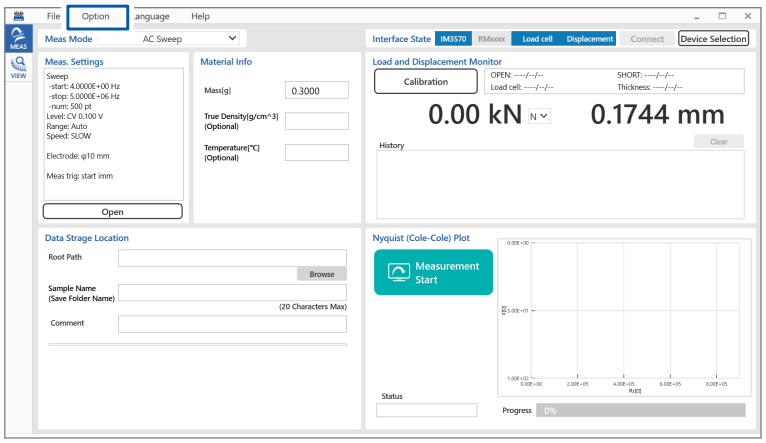
Selecting the check box will notify you at startup if an SA2653 Measurement Software update is available for download and installation.



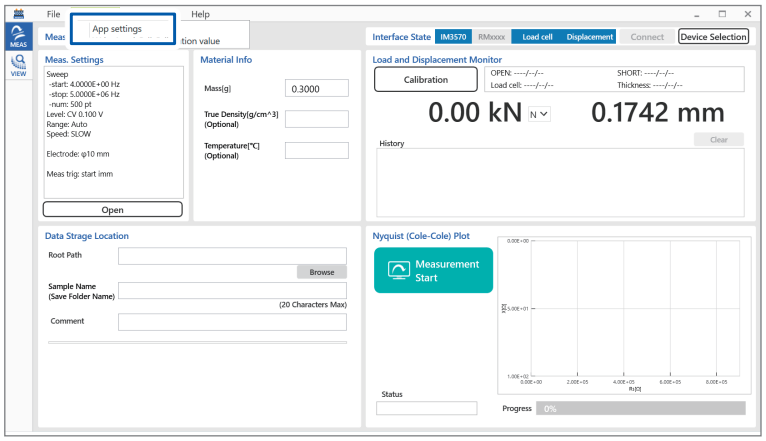
4 **Click [OK].**

Configuring the numerical input/output settings

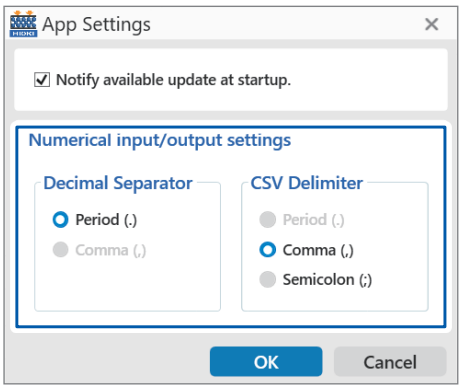
1 Select [Option].



2 Select [App settings].



3 Select the options for measured-value display formats used in the SA2653 Measurement Software.



Decimal separator

Period (.)	A period (.) is used as the decimal point.
Comma (,)	A comma (,) is used as the decimal point.

CSV delimiter

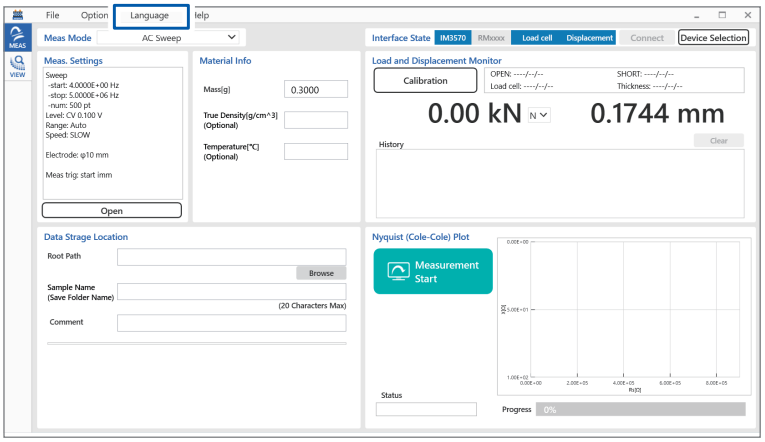
Period (.)	A period (.) is used as the data delimiter.
Comma (,)	A comma (.) is used as the data delimiter.
Semicolon (;)	A semicolon (;) is used as the data delimiter.

4 Click [OK].

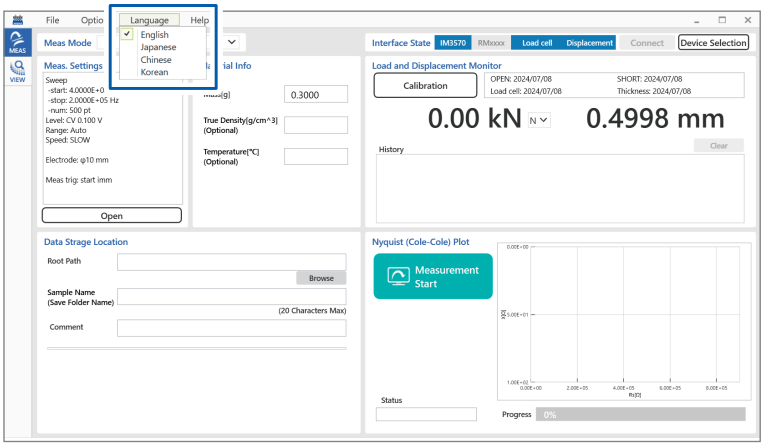
3.19 Switching the User Interface Language

This section explains how to select the user interface language in the SA2653 Measurement Software from Japanese, English, Chinese, and Korean.
The language chosen during installation is set as the default.

1 Select [Language].



2 Select the language you wish to use.

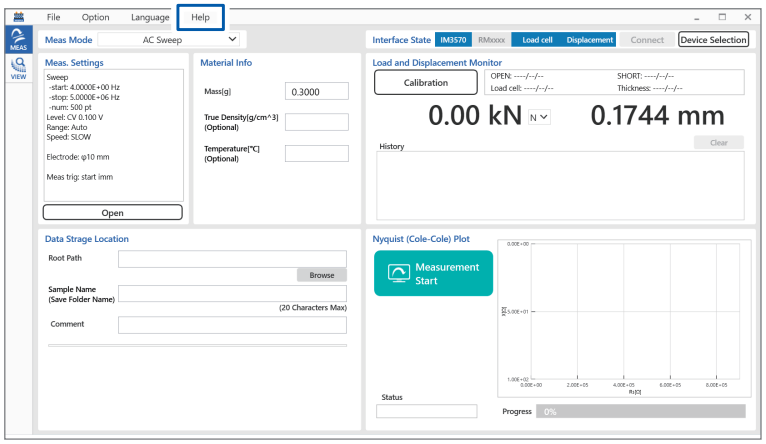


English	The user interface is displayed in English.
Japanese	The user interface is displayed in Japanese.
Chinese	The user interface is displayed in Chinese.
Korean	The user interface is displayed in Korean.

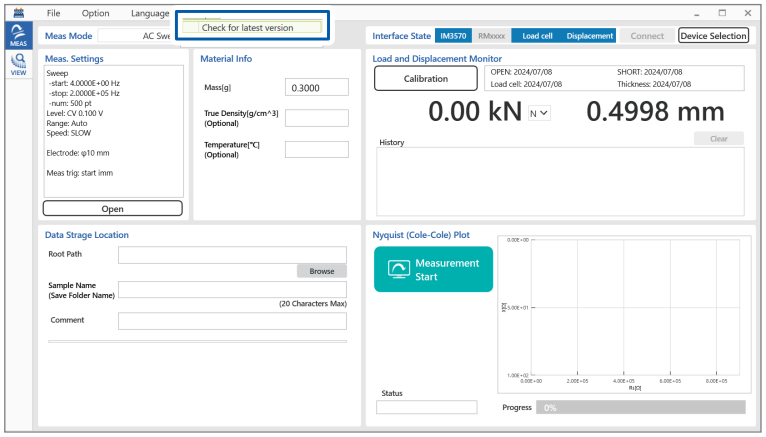
3.20 Updating the SA2653 Measurement Software

This section explains how to update the SA2653 Measurement Software. (Requires an Internet connection.)

1 **Select [Help].**



2 **Select [Check for latest version].**



If the version of the Measurement Software in use is not the latest, an update confirmation window opens.

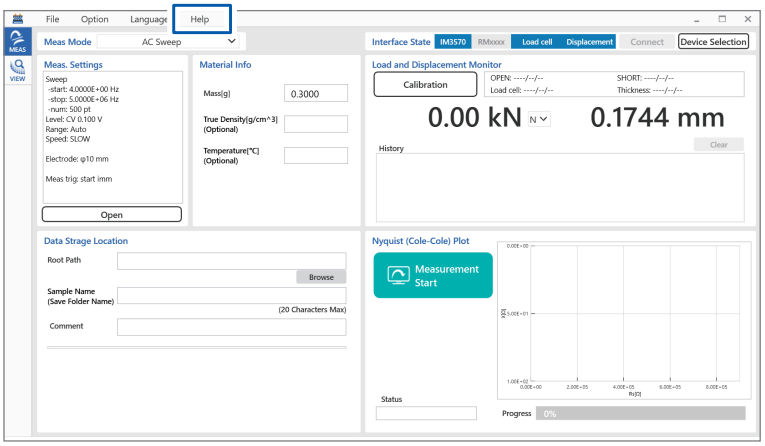
If it is the latest version, the version information is displayed.

3 **Click [OK].**

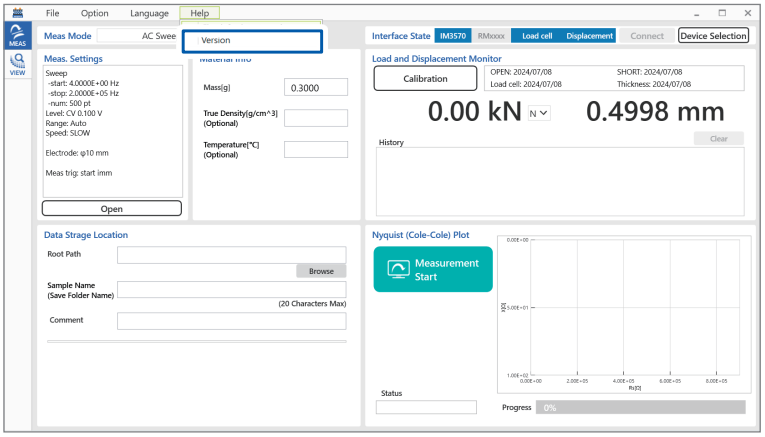
3.21 Checking the Software Version Number

This section explains how to check the version number of the SA2653 Measurement Software.

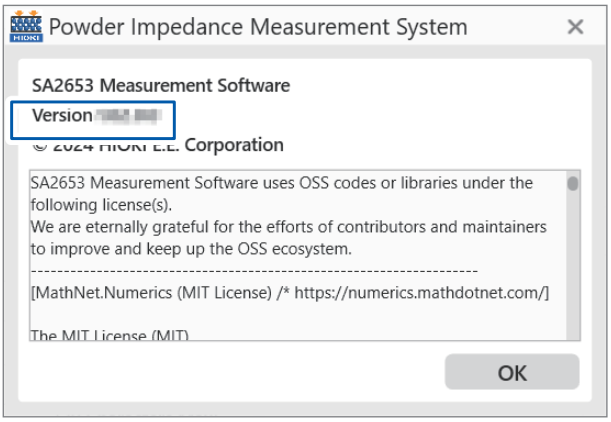
1 **Select [Help].**



2 **Click [Version].**



3 **Check the version information.**



4 Making Measurements

4.1 Placing the Powder into the SA9004-01 Test Fixture

The impedance measurements of powder vary with temperature and over time. The amount of change depends on the type of powder. Conduct measurements in an appropriate environment with consistent temperature and timing.

⚠ WARNING

■ **Do not handle powder in the presence of fire.**

If powder comes into contact with fire, it could burn or explode, resulting in damage to the products or bodily injury.

■ **Take measures to prevent the scattering of powder.**

If powder scatters, it could spread to the surrounding area, resulting in fire or explosion.

⚠ CAUTION

■ **Do not measure powders with electromotive force. (example: battery cell)**

Voltage applied from the powder could damage the instrument.

■ **Ventilate the area to prevent inhalation of powder.**

Failure to follow this guidance could adversely affect human health.

■ **Always wear personal protective equipment (PPE), such as a mask, gloves, and goggles, when handling powder.**

Failure to follow this guidance could adversely affect human health.

■ **Hold the handle of the lower electrode when moving the SA9004-01 Test Fixture.**

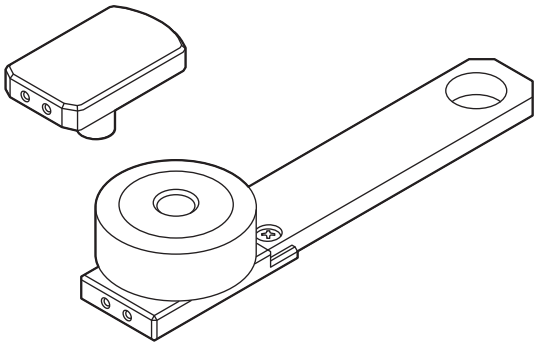
Holding anything other than the handle of the lower electrode could cause the lower electrode to fall, resulting in spilled powder or damaged electrodes.

You will need: an electronic balance, a medicine spoon, and PPE (a mask, gloves, and goggles).

1 **Wear the PPE.**

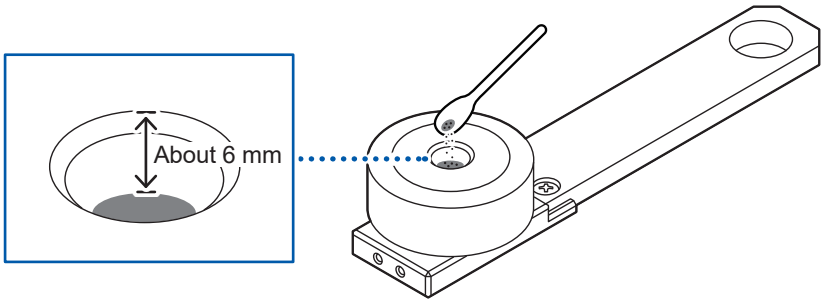
2 **Measure the mass of the powder to be used for the impedance measurement with the electronic balance.**

3 **Remove the upper electrode of the Test Fixture.**



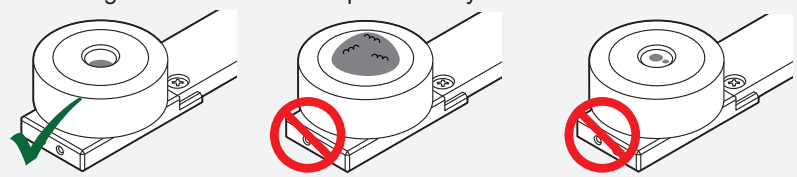
4 **Place the powder with the mass specified in the [Material Info] field (p.80) into the recess of the Test Fixture.**

Do not fill the powder more than about 6 mm from the top of the die.



Tips

Be aware that using too much or too little powder may result in inaccurate measurements.

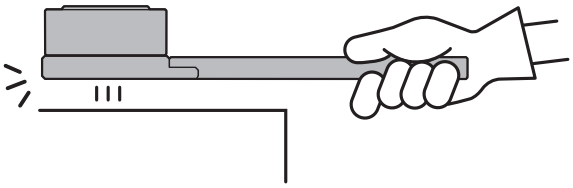


OK ***NO*** (insufficient) ***NO*** (excessive)

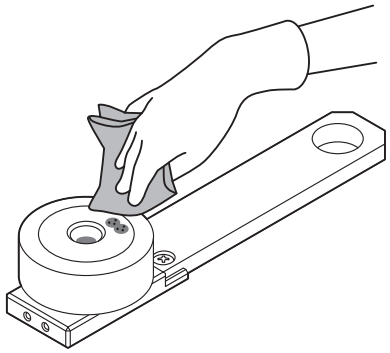
5 **Hold the handle of the lower electrode and tap it on a flat surface to remove air from the powder.**

While holding the handle of the lower electrode of the Test Fixture, tap it lightly on a flat surface. Deaerate the powder in the die until the surface becomes flat.

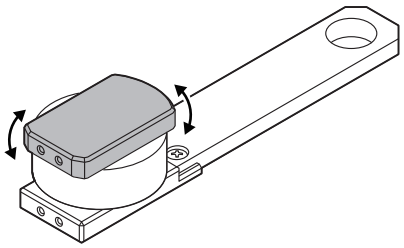
Hold the handle of the lower electrode when lifting the Test Fixture. Lifting up the die may create a gap between the die and the lower electrode, causing the powder in the die to spill out.



6 **Wipe off any powder adhering to areas other than the recess.**



7 **Position the upper electrode of the Test Fixture onto the die, and rotate the upper electrode several times to flatten the powder in the recess.**



IMPORTANT

- Before placing the powder into the SA9004-01 Test Fixture, check the die and the electrodes for contamination. Dirt on the die or electrodes could result in inaccurate measurements. (p.106)
- Remove any electrostatic charge from the operator before filling the powder into the SA9004-01 Test Fixture. Static electricity may cause the powder to adhere to the medicine spoon, electrodes, or die, resulting in inaccurate measurements.

4.2 Positioning the Test Fixture in the Press Unit

This section explains how to position the SA9004-01 Test Fixture in the SA9003 Press Unit.

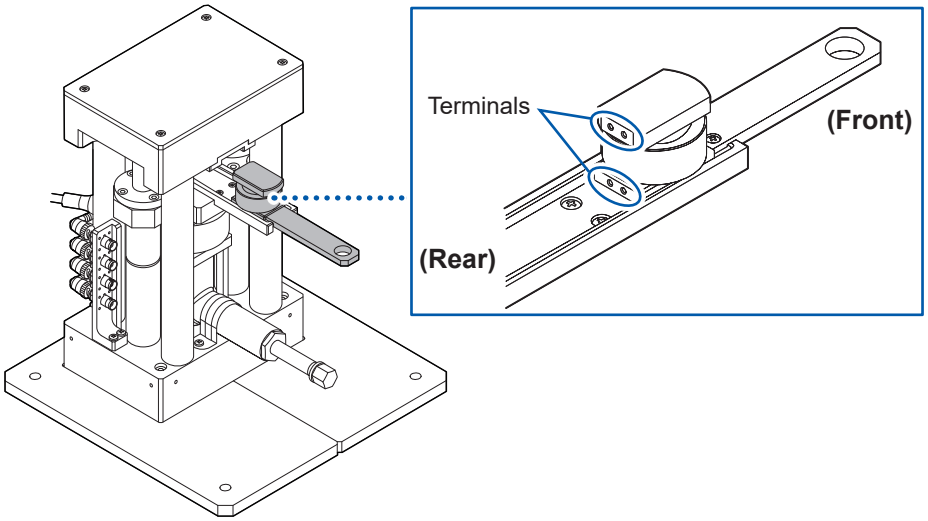
⚠ CAUTION

■ **Do not tilt the SA9004-01 Test Fixture.**
Tilting the powder in the Test Fixture could affect the measurements.

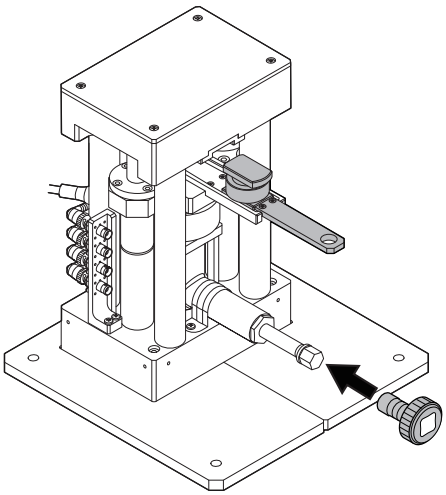
■ **Securely insert the SA9004-01 Test Fixture deep into the rail.**
Failure to follow this guidance could result in damage to the Press Unit.

1 **Position the Test Fixture on the rail of the Press Unit.**

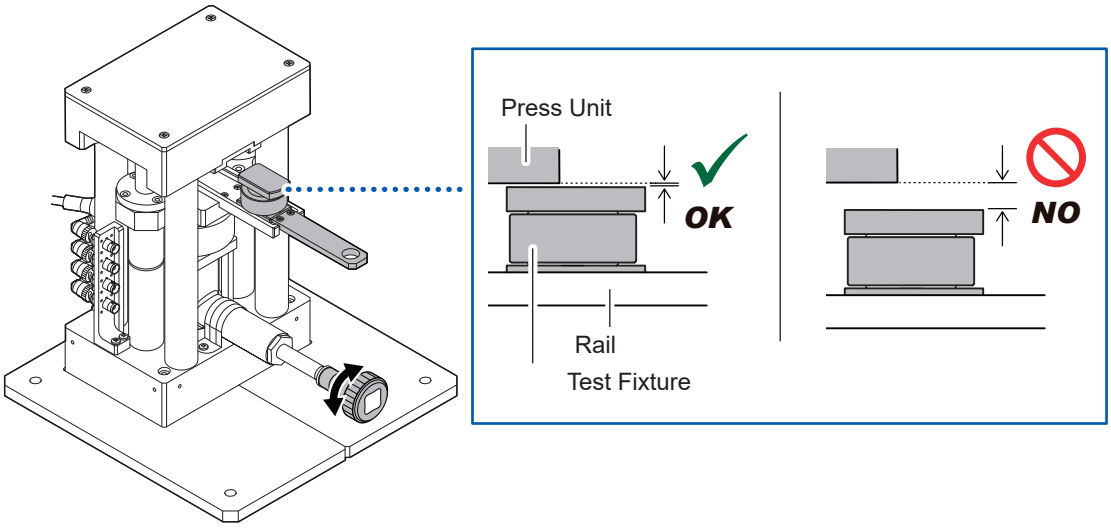
Position the Test Fixture so that its terminals face the rear of the Press Unit.



2 **Attach the quick spinner to the hydraulic jack of the Press Unit.**

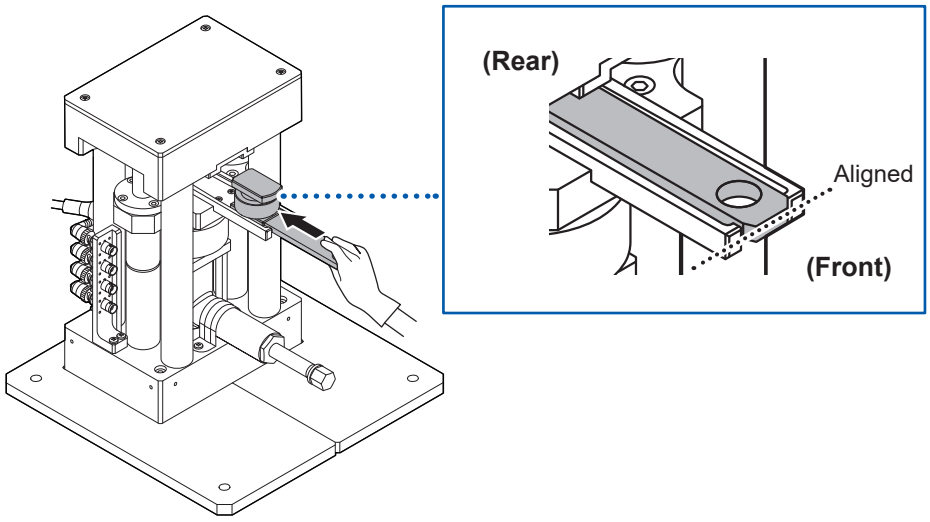


3 **Turn the quick spinner to adjust the height of the Test Fixture so that its upper electrode does not contact the Press Unit, and the gap between them is as small as possible.**



4 **Securely insert the Test Fixture deeply into the rail.**

When the Test Fixture is fully inserted into the rail, the handle of the Test Fixture aligns with the end of the rail. If the handle of the Test Fixture protrudes from the end of the rail, pull out the Test Fixture and adjust the height of the rail according to step **3**.



4.3 Applying a Load to the Powder

This section explains how to apply a load to the powder in the SA9003 Press Unit.

⚠ WARNING

- **Do not apply a load if fingers or objects other than the SA9004-01 Test Fixture are placed in the SA9003 Press Unit.**

  Failure to follow this guidance could result in bodily injury or damage the Press Unit.
- **Do not apply a load exceeding the rated capacity of 60 kN.**

  Failure to follow this guidance could result in bodily injury or damage the Press Unit.

⚠ CAUTION

- **Do not tilt the SA9004-01 Test Fixture.**

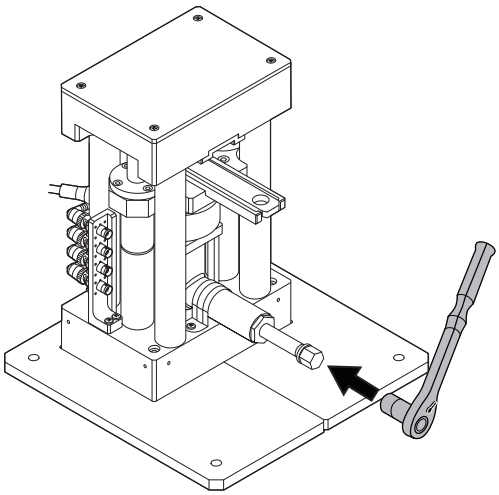
  Tilting the powder in the Test Fixture could affect the measurements.
- **Do not apply a load to the powder for a long time.**

  Failure to follow this guidance could damage the Press Unit.

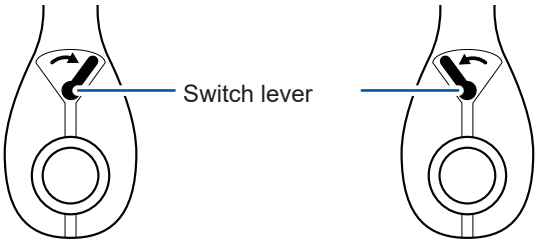
- **Use the ratchet handle to change the load of the SA9003 Press Unit.**

  Using electric tools could result in damage to the device or bodily injury.

1 **Attach the ratchet handle to the hydraulic jack of the Press Unit.**



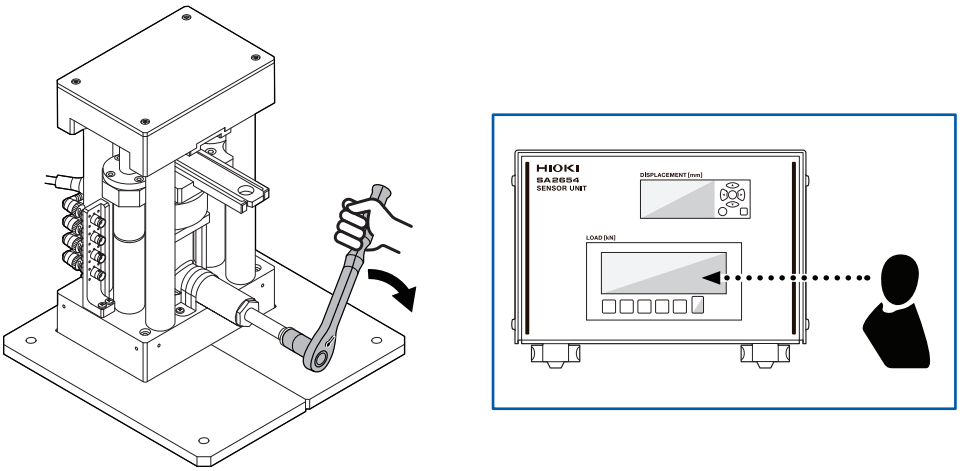
Using the switch lever of the ratchet handle can switch between two ratchet handle modes: tightening mode (clockwise) and loosening mode (counterclockwise).



(Tightening mode) (Loosening mode)

2 **Use the ratchet handle in tightening mode to turn the hydraulic jack screw clockwise and apply a load to the powder filled in the Test Fixture.**

The Sensor Unit displays the load to the powder filled in the Test fixture.



IMPORTANT

The applied load should be gradually increased from low to high. The powder may be plastically deformed under load. Once loaded, the powder will not return to its original state even if the load is reduced. If an excessive load is applied, replace the powder to be measured with new powder.

Tips

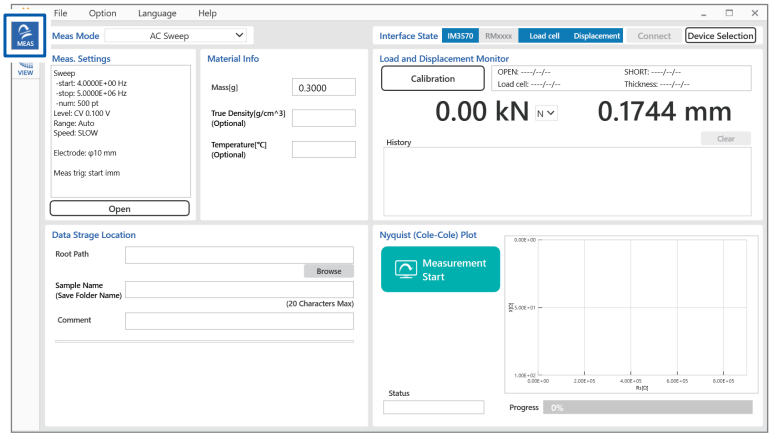
The load value tends to be smaller immediately after applying pressure due to the deformation of the powder and the descent of the hydraulic jack. Set the measurement trigger to start the measurement once the thickness of the compacted powder has stabilized. (p.74)

3 **After applying the required load, remove the ratchet handle.**

4.4 Starting the Measurement

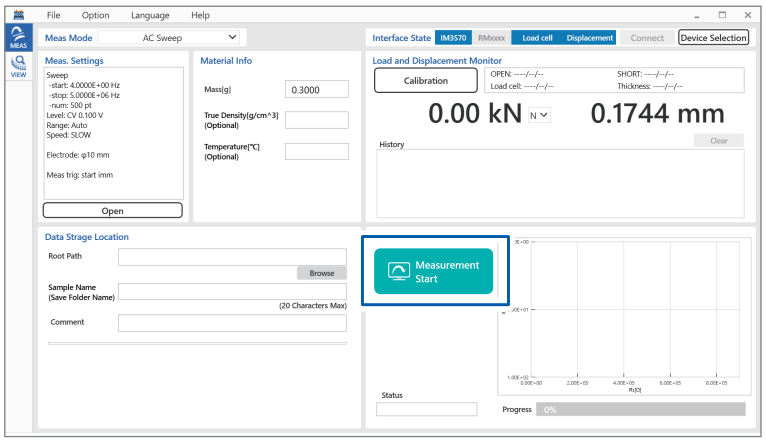
This section explains how to start the measurement.

1 **Select the [MEAS] tab.**



2 **Click [Measurement Start].**

The measurement starts. The ongoing measurement is displayed on a chart.

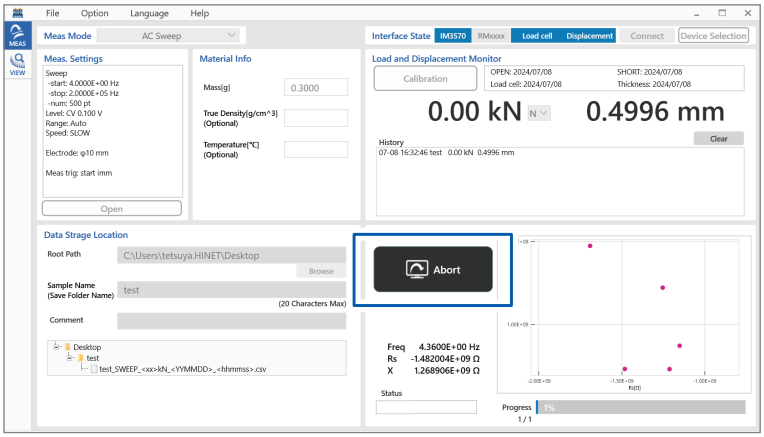


When the measurement is completed, the measured data file is automatically added to the file list for display on the **[View]** tab.

Stopping the measurement

Click **[Abort]**.

The measurement stops, and the data up to the point where it stopped is saved.



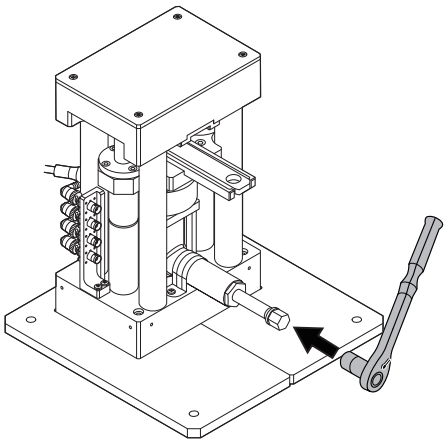
IMPORTANT

After **[Abort]** is clicked, the instrument executes the stop process. Wait until **[Measurement Start]** is displayed. If the predefined measurement frequency is low, the stop process may take some time.

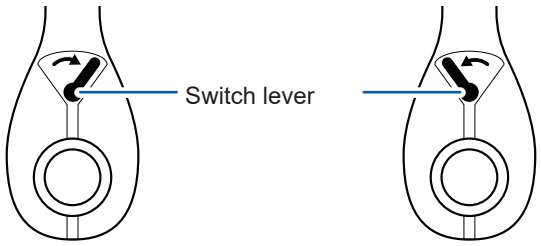
4.5 Removing the Test Fixture from the Press Unit

This section explains how to remove the SA9004-01 Test Fixture from the SA9003 Press Unit.

1 **Attach the ratchet handle to the hydraulic jack of the Press Unit.**



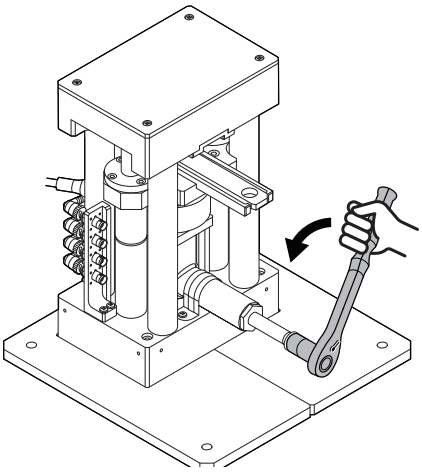
Using the switch lever of the ratchet handle can switch between two ratchet handle modes: tightening mode (clockwise) and loosening mode (counterclockwise).

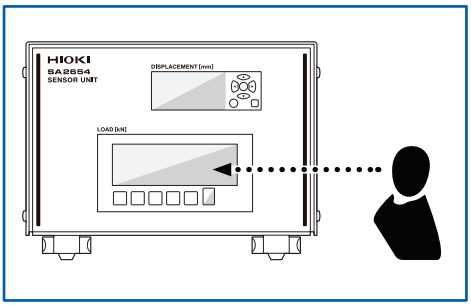


(Tightening mode) (Loosening mode)

2 **Use the ratchet handle in loosening mode to turn the hydraulic jack screw counterclockwise and zero the load to the powder filled in the Test Fixture.**

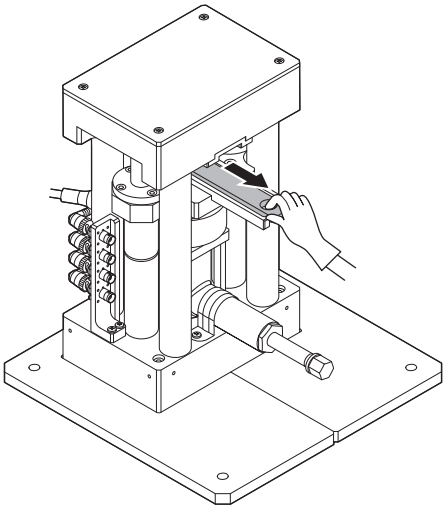
The Sensor Unit displays the load to the powder filled in the Test fixture.





3 **Remove the Test Fixture from the Press Unit.**

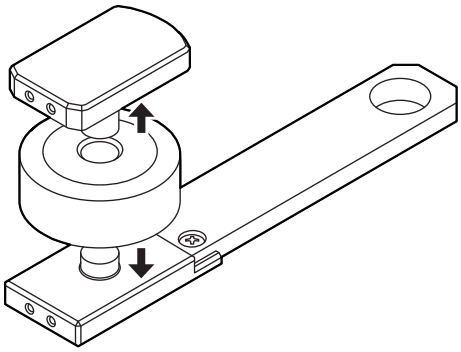
Pulling it out roughly could cause the Test Fixture to fall off the rail. Pull it out slowly.



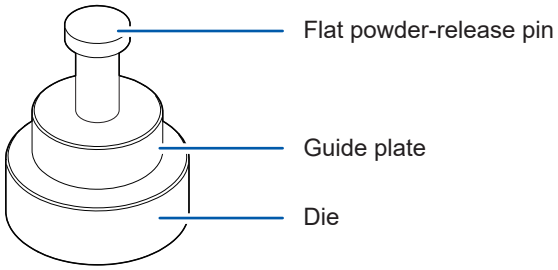
4.6 Removing the Powder from the Test Fixture

This section explains how to remove the powder from the SA9004-01 Test Fixture using the SA9005 Mold Release Unit.

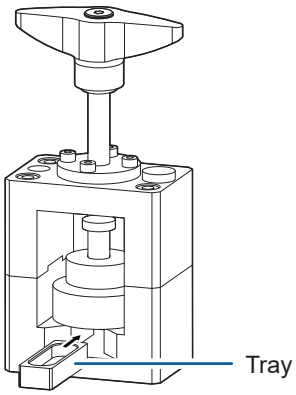
1 **Remove the upper and lower electrodes of the Test Fixture.**



2 **Position the powder release pin and the guide plate on the die.**

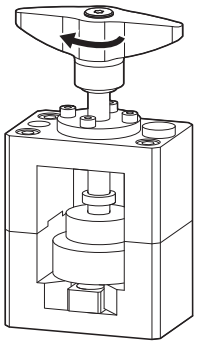


3 **Position the die, the guide plate, the powder release pin, and the tray in the SA9005 Mold Release Unit.**



4 **Turn the handle of the Mold Release Unit to push the flat powder-release pin.**

If the flat powder-release pin cannot remove the powder, use the 60-degree-cone power-release pin instead. It can crush ans remove the powder in the Test Fixture.



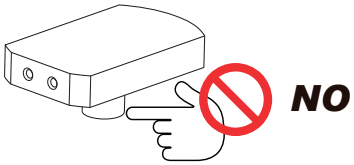
4.7 Cleaning the SA9004-01 Test Fixture

Always clean the SA9004-01 Test Fixture after removing the powder.

⚠ CAUTION

■ **Do not touch the edges of the cylindrical parts of the upper and lower electrodes.**

Failure to follow this guidance could cause bodily injury.

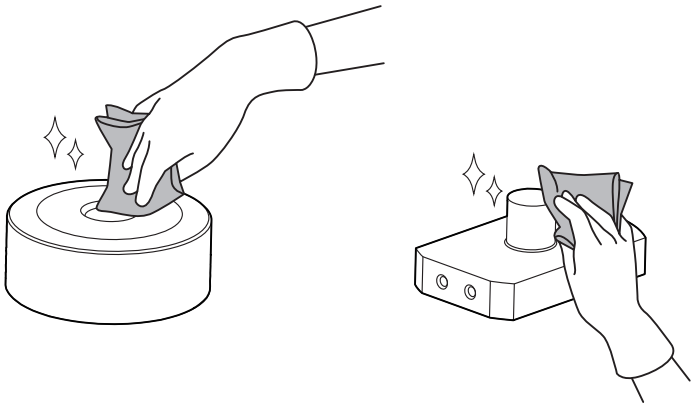


You will need: a soft cloth, alcohol, PPE (a mask, gloves, and goggles).

1 **Wear the PPE.**

2 **Wipe off the adhered powder using a soft cloth moistened with a small amount of alcohol. (the die and the upper and lower electrodes)**

If the powder gets inside the terminals of the electrodes, use a thin pin to remove it.



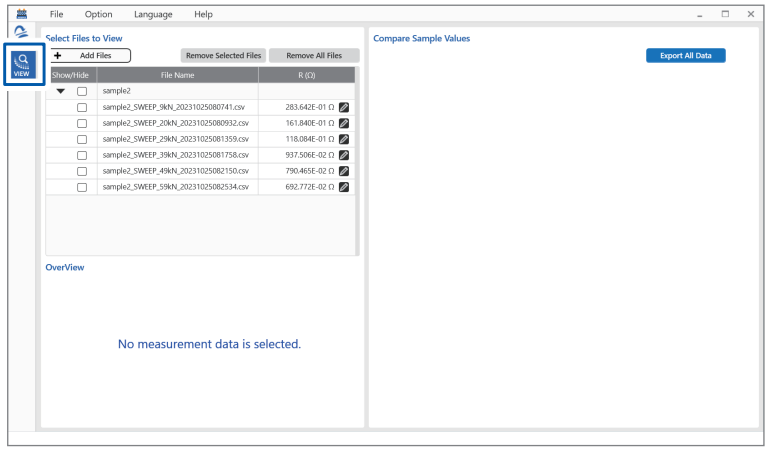
IMPORTANT

Clean the die and the electrodes after each use.
Dirt on the die or electrodes may affect the subsequent measurement.

5 Measurement Results Display

5.1 Examining the Measurement Results

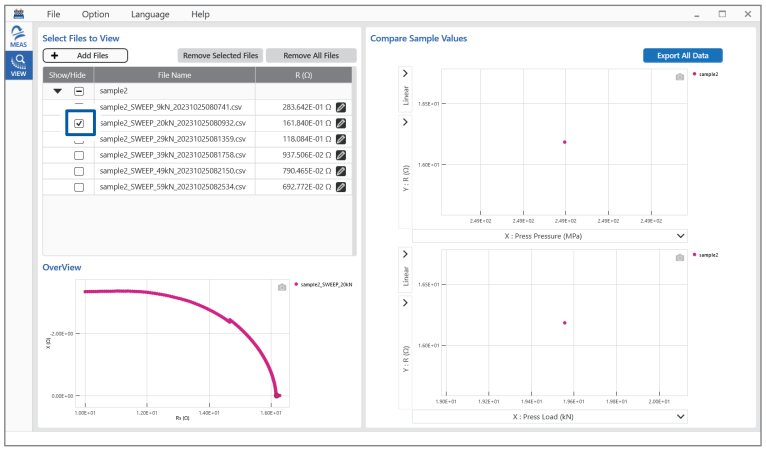
1 **Click the [VIEW] tab.**



2 **Select the check box for the data you wish to check.**

Selecting the check box next to the file name

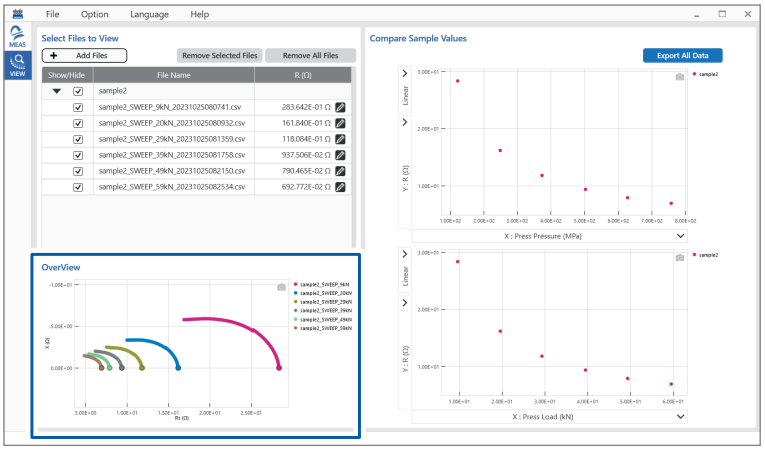
Selecting the check box next to the file name of the saved measured data displays only the data for the chosen powder.



Selecting the check box next to the material name

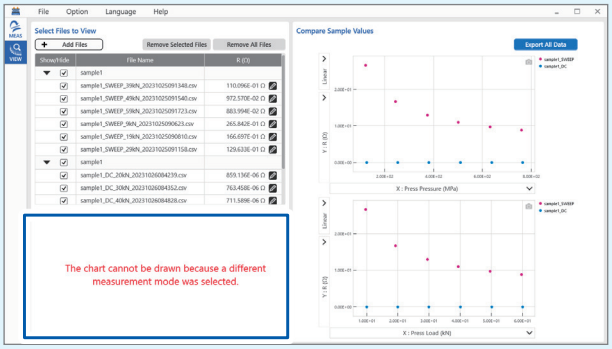
Selecting the check box next to the material name in the saved measured data displays all data for that material.

The Nyquist plot of the selected data is displayed.



IMPORTANT

If data sets acquired in different measurement modes are selected simultaneously, no preview of the measurement data will be displayed.



3 Examine the R values.

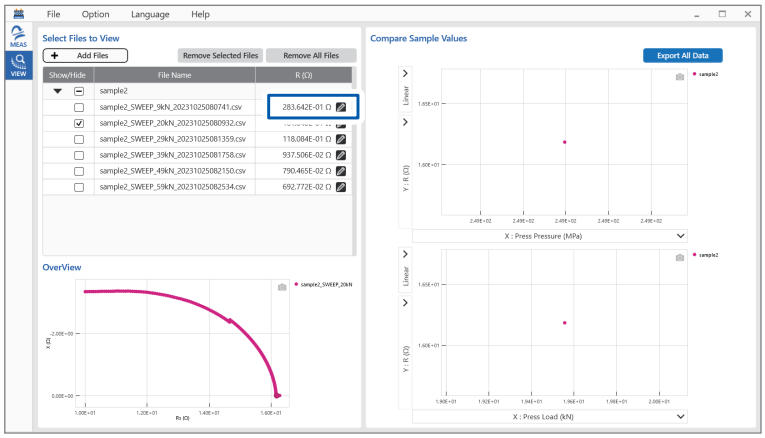
The method of obtaining the R value varies depending on the measurement mode. The R value is automatically calculated based on the measured data.

If the calculation cannot not be performed automatically, an **ERROR** message is displayed. Adjust the range of the measured data used for the R value and recalculate. (p. 111)

AC Sweep mode

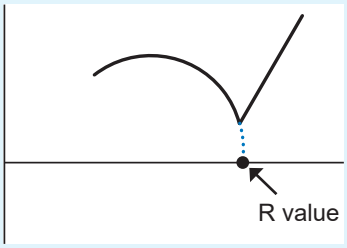
The R value is obtained from the Nyquist plot through circular fitting.

The calculated R value is plotted on the data preview screen.



IMPORTANT

- The R value corresponds to the intersection with the X-axis when the arc of the Nyquist plot is extended. If the R value does not correspond to the intersection with the X-axis when the arc of the Nyquist plot is extended, edit the R value. (p. 111)

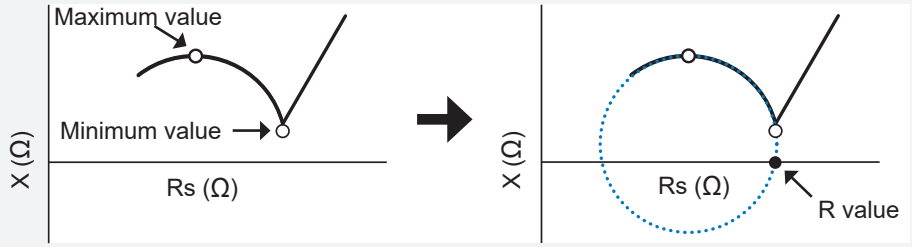


- Fitting may not be applicable depending on the shape of the Nyquist plot.
  See “Editing the R value” (p. 111).

Tips

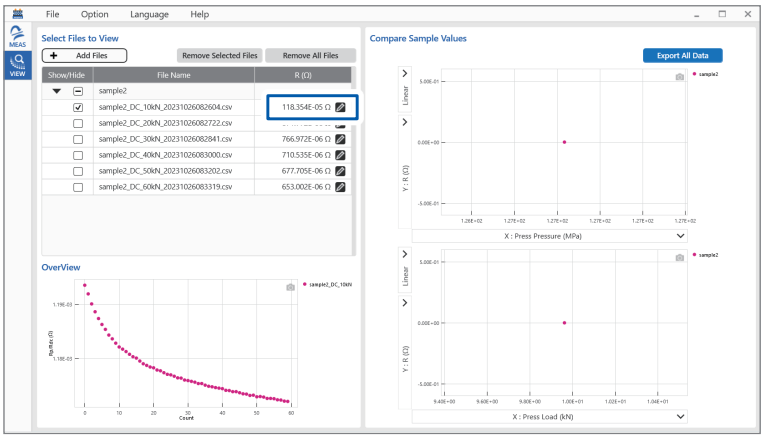
How to calculate the R value through circle fitting

The maximum and minimum X (Ω) values are automatically extracted from the arcs of the Nyquist plot. Circle fitting is performed on the data between the extracted maximum and minimum values, and the intersection with the X-axis is used to determine the R value.



AC Continuous mode, DC mode

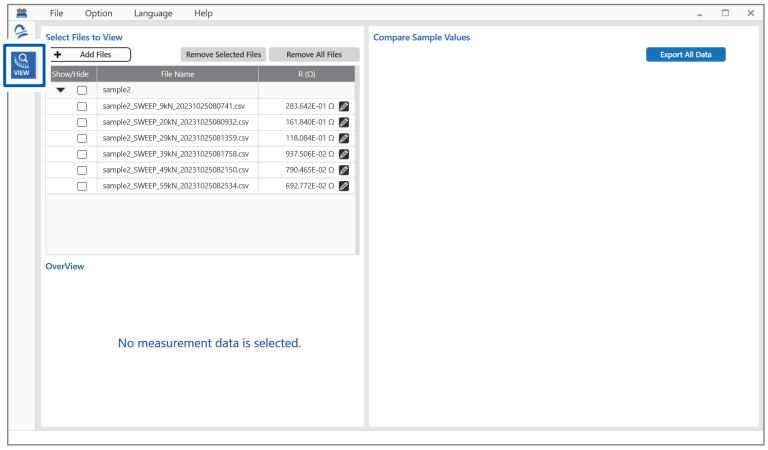
The R value is the average of all measured data.
The range of measured data used for the R value can be adjusted to recalculate it. (p. 111)



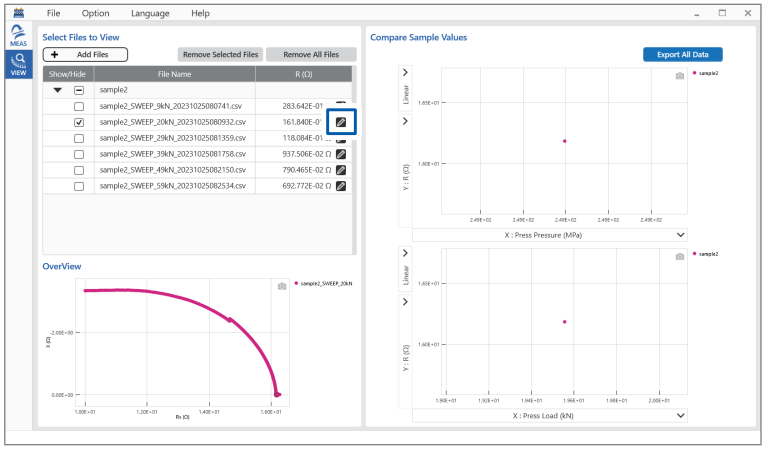
5.2 Editing the R value

The range of measured data used for the R value can be adjusted to recalculate it.

1 **Click the [VIEW] tab.**



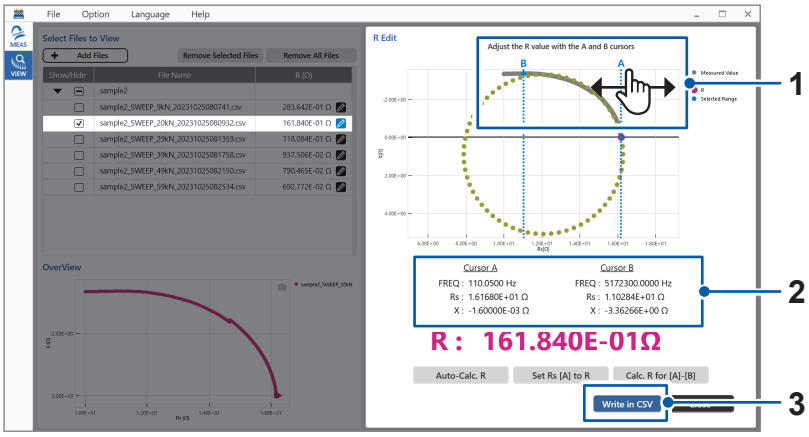
2 **Click the pen icon next to the data you wish to edit.**



The **R Edit** screen is displayed. (p. 112)

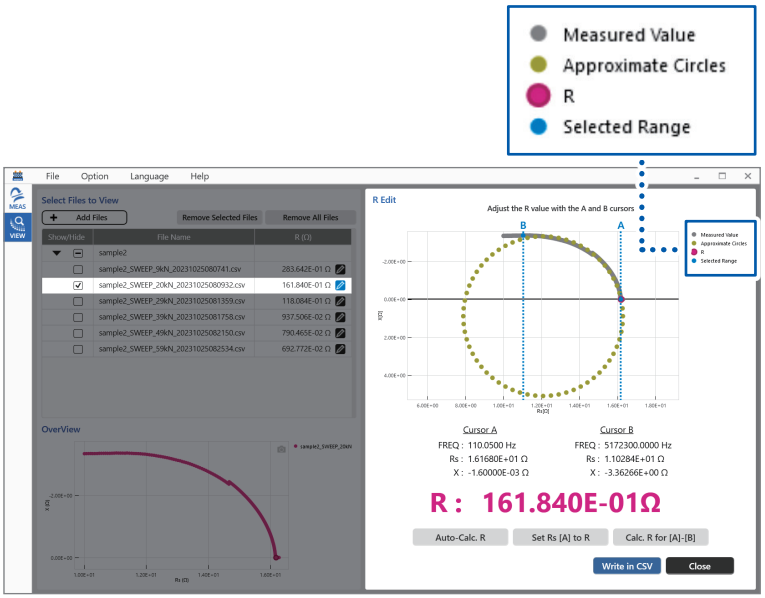
Edit the R value on the **R Edit** screen. The method of editing the R value varies based on the measurement mode.

Basic operations



No.	Name	Function
1	Cursor A Cursor B	Cursor A indicates the start position for calculating the R value. Cursor B indicates the end position for calculating the R value. The cursors can be moved by dragging the dotted or labeled areas.
2	Cursor positions	The values of the current cursor positions are displayed below the chart. If Cursor A and Cursor B overlap, they are shifted two pixels horizontally.
3	Write in CSV	Click to apply the edited R value.

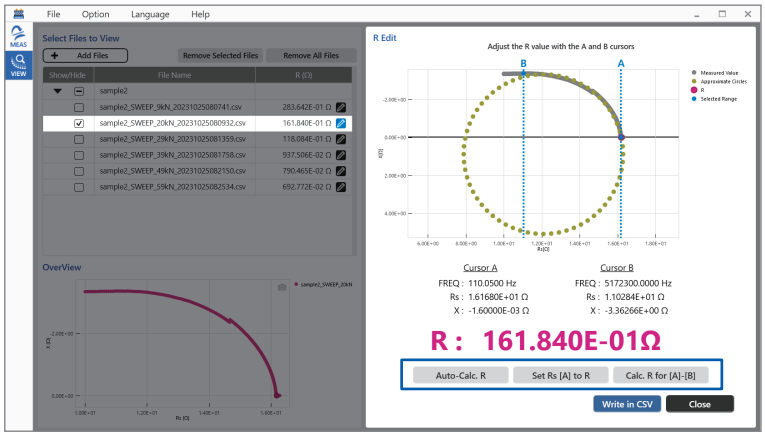
On-screen information



Items

Measured Value	Represents the actual measured values of the data acquired on the measurement screen.
Approximate Circles	Represents the approximate circle obtained by circle fitting.
R	Represents the present R value.
Selected Range	Represents the start and end positions of the range defined by the cursors.

AC Sweep mode

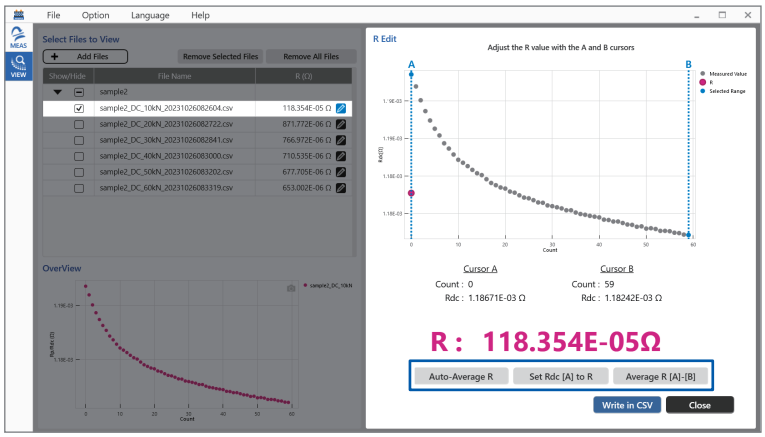


Items

Auto-Calc. R	Automatically calculates the fitting area. The R value is calculated within the calculated fitting area. When this is selected, the initial R value is displayed.
Set Rs [A] to R	Assigns the Rs value of Cursor A as the R value.
Calc. R for [A]-[B]	Calculates the R value within the selected circle fitting area from the Cursor A to Cursor B. Set Cursor B to the maximum value and Cursor A to the minimum value for a right-descending arc.

AC Continuous mode, DC mode

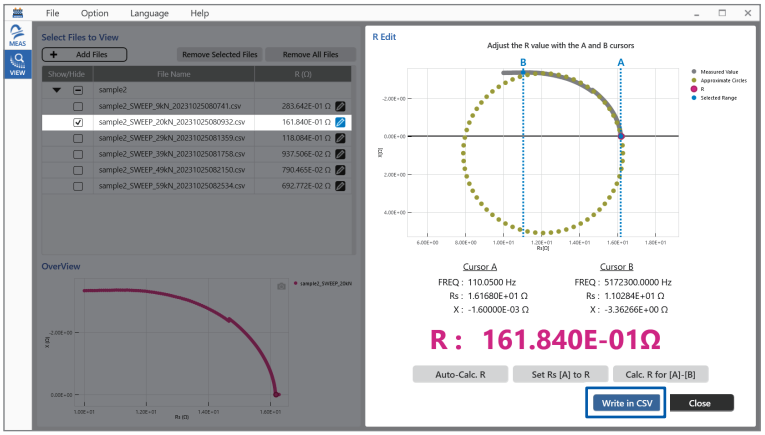
Rp	AC Continuous mode
Rdc	DC mode



Items

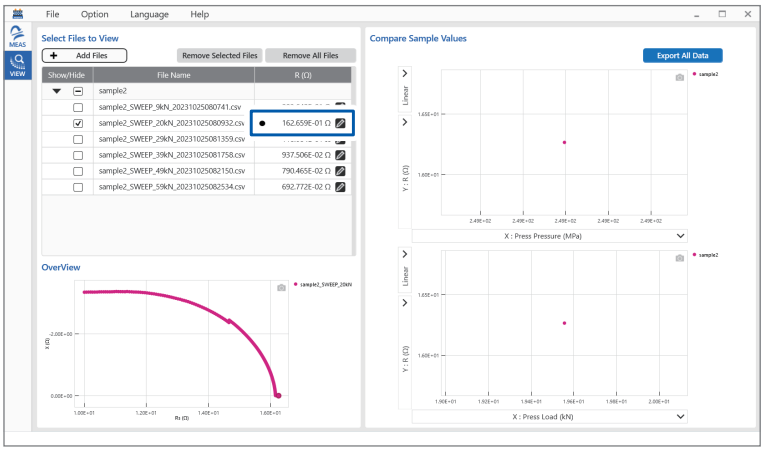
Auto-Average R	Calculates the R value from the average of all data. When this is selected, the initial R value is displayed.
Set Rp [A] to R (AC Continuous mode)	Assigns the Rp or Rdc value of Cursor A as the R value.
Set Rdc [A] to R (DC mode)	
Average R [A]-[B]	Assigns the average of the Rp or Rdc values within the selected range from Cursor A to Cursor B as the R value.

3 Click [Write in CSV].



Example of the AC Sweep mode screen

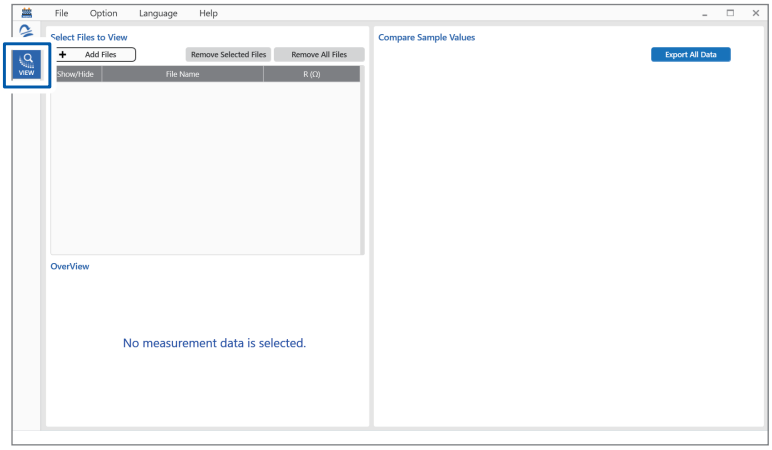
If the R value is edited (other than automatically calculated), a black circle (●) precedes the value.



5.3 Loading Saved Data

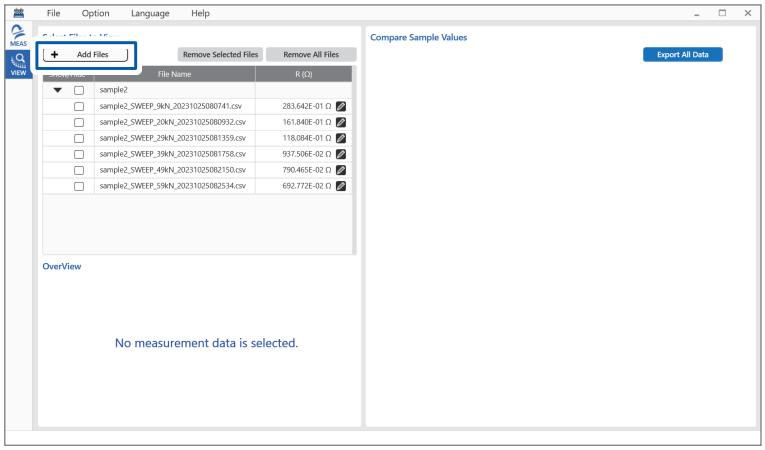
This section explains how to load previously saved data to create a Nyquist plot.

1 **Click the [VIEW] tab.**

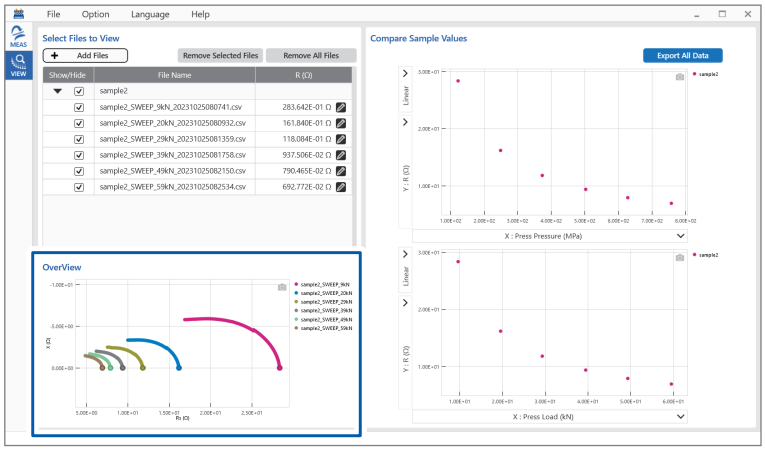


2 **Click [Add Files] and select the file you wish to load.**

You can drag and drop the file into the **[Select Files to View]** area to load it.



The Nyquist plot of the selected data is displayed.



5.4 Changing the Graph Display

This section explains how to customize the items assigned to X- and Y-axis of the graph.

1 **Use the screen to display the measured data. (p.107, p.115)**

2 **Click the chevron (⌄) on the X-axis or Y-axis.**

Items

X-axis	Selectable in all settings.	Press pressure (kN), Press pressure (MPa), Bulk density (g/cm^3), Filling factor (%), Porosity (%), Temperature (°C), Temperature (K)
Y-axis	Selectable in all settings.	R (Ω), Conductivity (S/cm), Volume resistivity (Ωcm), Ionic conductivity (S/cm), Relative permittivity, Thickness (mm), Bulk density (g/cm^3), Filling factor (%), Porosity (%)

IMPORTANT

- The filling factor (%) and porosity (%) are displayed graphically only when the true density is entered.
- The temperature (°C) and temperature (K) are displayed graphically only when the temperature is entered.
- The relative permittivity is displayed graphically only for data measured in AC Continuous mode.

3 **Click the chevron (⌄) next to Linear or Log.**

The vertical axis switches between logarithmic or linear scales.

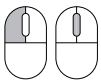
5.5 Changing the Graph to Optimal Settings (Auto-Scale Display)

This section explains how to change the graph to an easy-to-read display.

1 **Use the screen to display the measured data. (p.107, p.115)**

2 **Check the readability of the graph.**

The auto-scale display automatically adjusts the magnification of the graph to show all target data. The magnification rate of the graph can be adjusted using the mouse.

	To zoom in	• Drag the mouse cursor to select a display range. • Turn the mouse wheel up.
	To zoom out	Turn the mouse wheel down.
	To restore the original magnification	Click the right mouse button

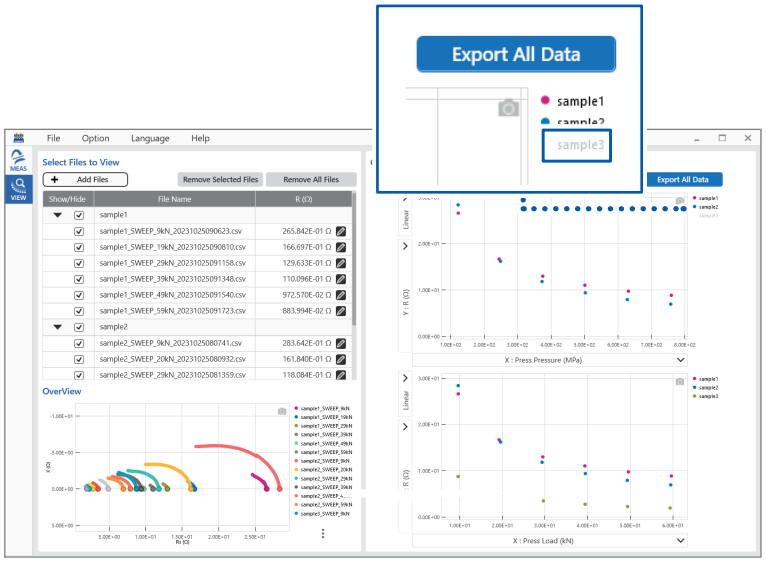
5.6 Displaying/Hiding the Series

This section explains how to show or hide the data for each series.

1 **Use the screen to display the measured data. (p.107, p.115)**

2 **Click the names of the data series you wish to hide.**

The data names are dimmed, and the corresponding data is hidden on the graph. To display the hidden data again, click the dimmed data name.



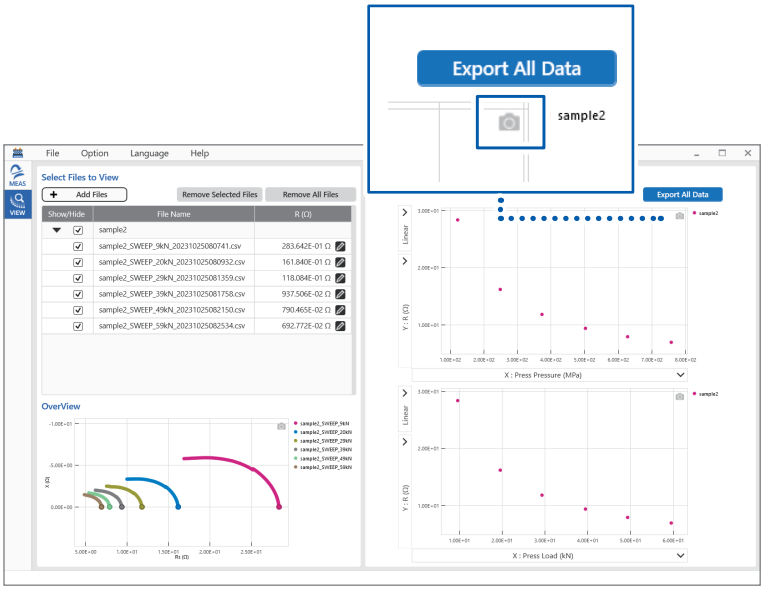
5.7 Saving the Screenshot of the Graph

This section explains how to save a screenshot of the graph.

1 **Use the screen to display the measured data. (p.107, p.115)**

2 **Click the symbol in the upper-right corner of the graph.**

The captured screenshot is saved to your clipboard.

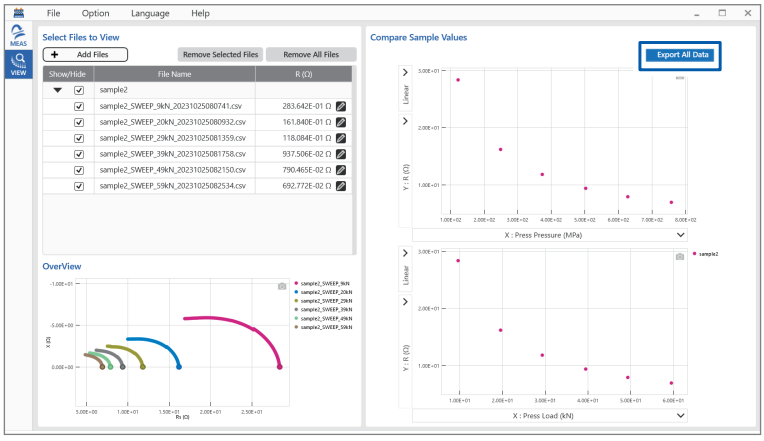


5.8 Saving Analyzed Data in CSV File Format

This section explains how to save analyzed data in CSV format.

1 **Use the screen to display the data you wish to save.**

2 **Click [Export All Data].**



3 **Enter a file name and specify the save destination.**

4 **Click [Save].**

The results file is saved.

Tips

The results file outputs not only the displayed parameters but also all parameters that can be selected for the X and Y axes.

5.9 Output File Format

The table below lists the output file formats for analysis data files.

Header	Description
APPVERSION	Version number of the Measurement Software
Filename	File name
Sample name	Sample name
Comment	Comment
Mode	Measurement mode
Diameter[mm]	Electrode diameter (mm, user-entered value)
Load[kN]	Load (kN)
Pressure[MPa]	Pressure (MPa)
Thickness[mm]	Powder thickness (mm)
Mass[g]	Powder mass (g, user-entered value)
True density[g/cm^3]	True density (g/cm^3, user-entered value)
Temperature[deg]	Temperature (degrees, user-entered value)
Temperature[K]	Temperature (Kelvin)
Bulk density[g/cm^3]	Bulk density (g/cm³)
Filling Factor[%]	Filling factor (%)
Porosity[%]	Porosity (%)
R[ohm]	Resistance (ohm)
Volume resistivity[ohm cm]	Volume resistivity (ohm cm)
Conductivity[S/cm]	Conductivity (S/cm)
Ion Conductivity[S/cm]	Ionic conductivity (S/cm)
Relative Permittivity	Relative permittivity (in AC Continuous mode only)

6 FAQ

6.1 What Types of Information Are Stored in Measurement Data Files?

Common section

Header	Description
APPVERSION	Version number of the Measurement Software
MODEL	Model name of the measuring instrument
SERIALNO	Serial number of the measuring instrument (The IM3570 does not display)
VERSION	Firmware version number of the measuring instrument
ERR MODE	Measurement mode
{ V[V] | CV[V] | CC[A] }	Measurement level
RANGE	Auto-ranging enabled/disabled, range used for measurement
SPEED	Measurement speed
OPEN	Open compensation enabled/disabled
SHORT	Short compensation enabled/disabled
CABLE [m]	Cable length
DIAMETER [mm]	Electrode diameter
MASS [g]	Powder mass (user-entered value)
TRUE DENSITY [g/cm^3]	True density (*NaN* when blank is acceptable)
SAMPLE NAME	Sample name
COMMENT	Comment

R-value calculation section

(1) AC Sweep mode

R	Direct current resistance (DCR) value obtained through fitting For a single Rs value, its Rs value is assigned.
IndexA	First data index number used for fitting For a single Rs value, its Index number is assigned.
IndexB	First data index number used for fitting For a single Rs value, its index number is assigned. (Same number as IndexA)
Calc status	Fitting: Fitting applied 1point: For a single Rs value
Fitting status1	Status code for data extraction step
Fitting status2	Status code for the DCR calculation step
Extraction method	Data extraction method
Fitting method	Fitting method
Calc dll version	Versions of fitting

(2) AC Continuous mode

R	Average of the Rp values (Ω)
IndexA	Default value: 0 After editing the R value: Index number of Cursor A is assigned.
IndexB	Default value: Last index number After editing the R value: Index number of Cursor B is assigned.
Calc status	Average: Average One-point measurement, selection: 1point

(3) DC mode

R	Average value of Rdc (Ω)
IndexA	Default value: 0 After editing the R value: Index number of Cursor A is assigned.
IndexB	Default value: Last index number After editing the R value: Index number of Cursor B is assigned.
Calc status	Average: Average One-point measurement, selection: 1point

Measured data section

Index	Index number Start from zero in the order of measurement.
DateTime	Date and time the data was obtained *YYYYY/MM/DD HH:MM:SS* format
Pressure [kN]	Load, calibrated value
Thickness [mm]	Powder thickness
Freq [Hz]	Measurement frequency (In AC Sweep or AC Continuous mode)
Rs [ohm]	Measured value Rs (In AC Sweep or AC Continuous mode)
X [ohm]	Measured value X (In AC Sweep or AC Continuous mode)
R [ohm]	Measured value R (In DC mode)
Temp [˚C]	Temperature (user-entered value)
Vmoni [V].	Voltage monitor value (In AC Sweep or AC Continuous mode)
Imoni[A]	Electrical current monitor value (In AC Sweep or AC Continuous mode)
Status	Measurement status

6.2 How are the output parameters calculated?

(1) User-entered values

Name	Unit	Description
Powder mass	g	Powder mass placed into the Test Fixture
True density	g/cm^3	Density of powder excluding void
Temperature	°C	Present test temperature
Electrode size ϕ	mm	Diameter of the Test Fixture

(2) Measured values

Name	Unit	Description
Thickness	mm	Sample thickness
Load	kN	Load

(3) Conversion equations between measured values

Equation for converting the measured values (R_s, X) to (R_p, C_p)

$$R_p = \frac{{R_s}^2 + X^2}{R_s}$$

$$C_p = -\frac{1}{2\pi f}\frac{{R_s}^2 + X^2}{X}$$

- π: pi, f: frequency of the specified point (Hz)
- The parallel resistor R_p is used in AC Continuous mode to determine R ($R = R_p$).
- The parallel resistor C_p is used in AC Continuous mode to determine the relative permittivity.

(4) Conversion equations between measured values

$$\text{Pressure (MPa)} = \frac{\text{Load (N)}}{\text{Surface area of electrode (mm}^2\text{)}}$$

(5) Calculation formulas for powder parameters

$$\text{Bulk density (g/cm}^3\text{)} = \frac{\text{Mass (g)}}{\text{Thickness (cm)} \times \text{Surface area of electrode (cm}^2\text{)}}$$

$$\text{Filling factor (\%)} = \frac{\text{Bulk density (g/cm}^3\text{)}}{\text{True density (g/cm}^3\text{)}} \times 100$$

$$\text{Porosity (\%)} = 100 - \text{Filling factor (\%)}$$

$$\text{Temperature in Kelvin (K)} = \text{Temperature in degrees Celsius (°C)} + 273.15$$

(6) Calculation formulas for electrical parameters

- Calculation formulas for conductivity

$$\text{Conductivity (S/cm)} = \frac{\text{Thickness (cm)}}{\text{Resistance } R\,(\Omega) \times \text{Surface area of electrode (cm}^2\text{)}}$$

- Calculation formula for ionic conductivity

$$\text{Ionic conductivity (S/cm)} = \frac{\text{Thickness (cm)}}{\text{Resistance } R\,(\Omega) \times \text{Surface area of electrode (cm}^2\text{)}}$$

- Calculation formula for volume resistivity

$$\text{Volume resistivity } (\Omega \cdot \text{cm}) = \frac{\text{Resistance } R\,(\Omega) \times \text{Surface area of electrode (cm}^2\text{)}}{\text{Thickness (cm)}}$$

- Calculation formulas for relative permittivity

$$\text{Permittivity (F/m)} = \frac{\text{Parallel capacitance } C_p\ \text{(F)} \times \text{Thickness (m)}}{\text{Surface area of electrode (m}^2\text{)}}$$

$$\text{Relative permittivity} = \frac{\text{Premittivity (F/m)}}{\text{Vaccum permittivity (F/m)}}$$

$$\text{Vaccum permittivity (F/m)} = 8.854 \times 10^{-12}$$

IMPORTANT

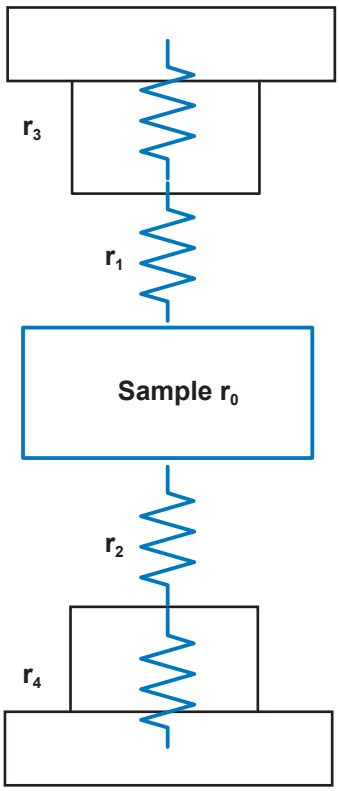
In AC Continuous or DC mode, when the number of repeated measurements is set to two or more, the powder parameters are supposed to be calculated for each individual measurement, and then their average value is determined.

Example: Bulk density calculation

1. The bulk density is calculated using the thickness of index 0. A single time-series-independent value is used for this calculation because the mass and the electrode surface area are user-entered values.
2. The bulk density is calculated using the thickness of index 1, as described in Item 1.
3. The bulk density values for all index numbers are calculated, and then their average bulk density is determined. This average represents the bulk density of the measured-data file.

6.3 What Are the Methods and Precautions for Measuring Impedance?

This system employs the two-terminal method for measuring impedance. In this measurement method, the contact resistance and the internal resistance of the electrodes are added to the resistance of the sample.
Note that the L2280 Connection Cable, which is connected to the SA9004-01 Test Fixture, allows measurements without being affected by wiring resistance because it uses a four-terminal connection.



Measured value $R = r_0 + r_1 + r_2 + r_3 + r_4$

r_1 and r_2: Contact resistance, varies depending on the DUT.
r_3 and r_4: Internal resistance of electrodes, 0.1 mΩ in total (a value for reference purpose).

7 Specifications

These product specifications apply to the Powder Impedance Measurement System.
For the specifications of the IM3570 Impedance Analyzer, the IM3533 LCR Meter, and the RM3545A Resistance Meter, refer to the Instruction Manual for each measuring instrument.

System configuration

Product configuration	SA2653	Measurement Software
	SA2654	Sensor Unit
	SA9003	Press Unit
	SA9004-01	Test Fixture
	SA9005	Mold Release Unit
	The connection cable should be selected from the following options based on the measuring instrument.	
	L2280-01	Connection Cable (80 cm, for use with the IM3533 LCR Meter or the IM3570 Impedance Analyzer)
	L2280-03	Connection Cable (80 cm, for use with the RM3545A Resistance Meter)
	The measuring instrument should be selected from the following products based on the measurement conditions.	
	IM3570	Impedance Analyzer (4 Hz to 5 MHz)
	IM3533	LCR Meter (1 mHz to 200 kHz)
	RM3545A	Resistance Meter
	No personal computers are not included.	

Basic specifications of the system

Measurement	Measures the thickness of the pressurized powder, load applied to the powder, and impedance (or resistance) of the powder.
Data to be acquired	The SA2653 Measurement Software acquires data from the measuring instrument. • SA2654 Sensor Unit Displacement meter readouts (powder thickness) Load cell readouts (load) • Measuring instrument (Impedance Analyzer or Resistance Meter) Measured values (impedance or resistance)
Measurement results display	Graphical representation The following parameters can be selected individually for the vertical and horizontal axes. • Vertical axis: Thickness, Bulk density, R, Conductivity, Volume resistivity, Ionic conductivity, Relative permittivity • Horizontal axis: Load (kN), Press pressure (MPa), Bulk density, Filling factor, Porosity, Temperature
Pressurizing method	Manual pressurization using a jack
Load measurement method	The built-in load cell of the SA9003 Press Unit is used. (0 kN to 60 kN)
Thickness measurement method	The built-in displacement sensor of the SA9003 Press Unit is used. Measures the displacement of the movable base and then converts it into a thickness value. (0 mm to 7 mm)
Impedance measurement method	• IM3570: Impedance Analyzer (4 Hz to 5 MHz) • IM3533: LCR Meter (1 mHz to 200 kHz) • RM3545A: Resistance Meter
Measurement mode	• AC Sweep Measures the impedance of the powder using an AC frequency sweep signal. • AC Continuous Measures the impedance of the powder using a fixed-frequency AC signal. • DC Measures the resistance of the powder using a DC signal.
Number of channels	1
Number of connectable measuring instruments	1 to 5
Communications method	USB connection
Standards	Depends on each product's specifications. • Effects of radiated radio-frequency electromagnetic field At a strength of 10 V/m, Z: ±8% rdg, θ: ±8° (with the IM3570 connected) • Effects of conducted radio-frequency electromagnetic field At a strength of 10 V, Z: ±15% rdg, θ: ±15° (with the IM3570 connected)

Measurable range

With the IM3570 connected

No.	Measurement range	Measurement frequency				
		1 kHz or less	10 kHz or less	100 kHz or less	1 MHz or less	5 MHz or less
1	100 MΩ	Measurable range				
2	10 MΩ					
3	1 MΩ					
4	100 kΩ					
5	30 kΩ					
6	10 kΩ					
7	3 kΩ					
8	1 kΩ					
9	300 Ω					
10	10 Ω					
11	1 Ω					
12	100 mΩ					

7.1 SA2653 Measurement Software

General specifications

System requirements (computer)	• Operating system	Windows 11 Windows 10 (32-bit or 64-bit)
	• .Net library	.Net Framework 4.7.2 or later
	• Processor	Depends on the operating environment of the above operating systems.
	• RAM	Depends on the operating environment of the above operating systems.
	• Storage	3 GB free space or more
	• Display	Resolution: 1,366 × 768 or higher Display colors: 65,536 colors or more
	• Interface	USB 2.0 or later (with 3 ports)
	• Methods for providing the PC application	CD included with the system, download
	• License management method	USB dongle key
Equipment to be controlled	• IM3570	Impedance Analyzer
	• IM3533	LCR Meter
	• RM3545A	Resistance Meter
	• SA2654	Sensor Unit
Security	• USB license key activation restrictions	
	• Automatic update function to the latest version (requires Internet connection)	
Included accessories	See p.8.	

Basic specifications

Measured-data acquisition	Controls the equipment to acquire measured data.
Measurement mode	• AC Sweep Measures the impedance of the powder using an AC frequency sweep signal.
	• AC Continuous Measures the impedance of the powder using a fixed-frequency AC signal.
	• DC Measures the resistance of the powder using a DC signal.
Measurement results display	Graphical representation The following parameters can be selected individually for the vertical and horizontal axes. • Vertical axis: Thickness, Bulk density, R, Conductivity, Volume resistivity, Ionic conductivity, Relative permittivity • Horizontal axis: Load (kN), Press pressure (MPa), Bulk density, Filling factor, Porosity, Temperature

Functional specifications (File menu)

Measurement-conditions saving function	• Memorizes the previous conditions and restores them when the system is started again.
	• Measurement conditions can be saved to a file with any name, allowing users to freely save and load these conditions.

Functional specifications (Option menu)

CSV setting	Configures the output format of CSV files for the measured data.	
	• Decimal separator	Period (.), Comma (,)
	• Data delimiter	Period (.), Comma (,), Semicolon (;)
Automatic COM connection function	The application searches for and recognizes USB-connected devices at startup, then automatically connects them.	

Functional specifications (Language menu)

Languages	Japanese, English, Chinese, Korean

Functional specifications (Help menu)

Version information display	Displays the version number information.	
Automatic update function	Automatically updates the system to the latest version. (requires Internet connection)	
	Update check function at software startup	On, Off (default setting: Off)

Functional specifications (calibration)

Calibration (impedance measurement)	IM3570, IM3533, RM3545A (For the RM3454A, only the short compensation can be performed. Performs open and short compensations of the equipment to be controlled.)	
	• Open compensation	Reduces the influence of stray admittance in connection cables, thereby improving measurement accuracy.
	• Short compensation	Reduces the influence of residual impedance in connection cables, thereby improving measurement accuracy.
	• How to start calibration	Click **[Execute]** to start open/short compensation.
	• How to stop calibration	Click **[Cancel]** during the process to stop calibration. (for the IM3533 only)
	• Compensation date recording function	Records the date of the last compensation performed and displays this information on the form. Click **[Clear Execution Date]** to clear the recorded date.
Calibration (load measurement)	Performs the digital zero adjustment of the load cell when no load is applied.	

Calibration (thickness measurement)	Performs the digital zero adjustment and the thickness calibration.	
	• Digital zero adjustment	Sets a reference point on the display unit, thereby improving measurement accuracy.
	• Thickness calibration	Reduces the effect of deformation of the Press Unit, thereby improving measurement accuracy.
	• How to start calibration	Click **[Execute]** to start calibration.
	• How to stop calibration	Click **[Cancel]** during the process to stop calibration.
	• Calibration conditions recording function	Execution date: Records the date of the last calibration performed and displays this information on the form. Thickness calibration conditions: Records the value to be used for the calibration and displays this information on the form. Click **[Clear Execution Date]** to clear the recorded date and the calibration conditions.
	• How to perform thickness calibration	Add the calibration value to the displacement meter readouts.

Functional specifications (material information entry)

Material information that can be entered	• Powder mass entry (g)	
	Valid input range	0.0000 to 99.9999
	Input type	Valid to four decimal places
	Default value	0.3000
	• Powder true density entry (g/cm^3)	
	Valid input range	0.000 to 99.999 (blank acceptable)
	Input type	Valid to three decimal places
	Default value	Blank
	• Powder temperature entry (°C)	
	Valid input range (°C)	−20.00 to 60.00 (blank acceptable)
	Input type	Valid to two decimal places
	Default value	Blank

Function specifications (measurement condition settings)

Measurement frequency setting	**AC Sweep mode**		
	• Measurement frequency setting		
	Start and end frequencies, in Hz, can be entered.		
	Valid input range	IM3570	4 Hz to 5 MHz
		IM3533	1 mHz to 200 kHz
	Input type	Decimal or exponential form	
	Number of measurement points between the start and end can be entered.		
	Valid input range	500 to 999	
	Input type	Three-digit integer in the form *000* (default value: 500)	
	Measurement point calculation method	Logarithm	
	AC Continuous mode		
	• Measurement frequency setting		
	The frequency, in Hz, can be entered.		
	Valid input range	IM3570	4 Hz to 5 MHz
		IM3533	1 mHz to 200 kHz
	Input type	Decimal or exponential form	

Measurement times and interval settings	**AC Sweep mode** • Number of times repeated Valid input range: 1 to 99 Input type: Two-digit integer in the form *00* Default value: 1 Saves the measured data up to that point when **[Stop]** is clicked during the process • Measurement interval Wait time for a single measurement, with one frequency-sweep measurement counted as one measurement process The time interval between measurements, in seconds, can be entered. Valid input range: 0 to 99 Input type: Two-digit integer in the form *00* Default value: 0 (When *zero* is entered, the minimum interval is set.) **AC Continuous and DC modes** • Measurement times and interval settings The number of measurements can be entered. Valid input range: 1 to 9999 Input type: Four-digit integer in the form *0000* Default value: 1 Saves the measured data up to that point when **[Stop]** is clicked during the process The time interval between measurements, in seconds, can be entered. Valid input range: 0 to 99 Input type: Two-digit integer in the form *00* Default value: 0 (When *zero* is entered, the minimum interval is set.)

Measurement signal level	**AC Sweep and AC Continuous modes** • Selection of setting mode: Auto CV, Manual (default setting: Manual) • Manual mode Measurement signal mode: The following modes can be selected: Open-terminal voltage (V) mode, Constant voltage (CV) mode, and Constant current (CC) mode. (default setting: CV) Signal level setting The measurement signal level can be set. **Open-terminal voltage (V) mode, Constant voltage (CV) mode** Valid setting range: 10 mV to 1 V (default value: 0.100 V) Setting resolution: In 1 mV increments **Constant current (CC) mode** Valid setting range: 10 µA to 10 mA (default value: 10.00 mA) Setting resolution: In 10 µA increments • Auto CV mode Determines the optimal constant voltage value before measurement, thereby reducing the occurrence of constant voltage failure displays. Lowers the voltage with the predefined maximum measurement frequency from the predefined constant voltage value and automatically sets the voltage value to ensure that constant voltage measurement remains possible.
Measurement trigger	Sets the timing for the start of measurement. Can be chosen from the following: Start Immediately, Fluctuation amount, and Fixed interval. Default setting: Start immediately • Start immediately: Starts measurement when **[Measurement Start]** is clicked. • Fluctuation amount: Starts measurement when the change in thickness is less than or equal to the predefined thickness change within the predefined time period. Setting time, in seconds, can be entered. Valid input range: 1 to 999 Input type: Three-digit integer in the form *000* The change in thickness, in µm, can be entered. Valid input range: 0.1 to 5.0 Input type: Valid to one decimal place • Fixed interval: Starts measurement when the predefined time elapses. Setting time, in seconds, can be entered. Valid input range: 1 to 999 Input type: Three-digit integer in the form *000*
Electrode information entry	Electrode diameter, in mm, can be selected. Valid input range: 8 to 20 Input type: Two-digit integer in the form *00* (default value: 10)

Measurement speed	**AC sweep and AC Continuous modes**	
	Fast, Med, Slow, Slow2 (using the drop-down list, default setting: Slow)	
	DC mode	
	Fast, Med, Slow1, Slow2 (using the drop-down list, default setting: Slow1)	
Cable length	**AC sweep and AC Continuous modes**	
	Total length of the connection cable can be selected.	
	Cable length setting (for the IM3570 and the IM3533)	1 m (default setting: 1 m)
Resistance-range switching function	• Auto-ranging	On, Off (using the check box) Automatically selects the optimal resistance range for potential measurement (default setting: On).
	Auto-ranging: Uses the function of the measuring instrument, which can be configured using the computer software.	
	• Resistance range selection (only with auto-ranging set to off)	Depends on range switching of the equipment under control.

Functional specifications (Measurement screen)

Monitor display (load, pressure, and thickness)	Displays real-time monitored values for either load or pressure, as well as thickness.	
	• Load (kN), Pressure (MPa) (The unit can be switched using the drop-down list.)	
	Load (kN)	Display range 0.00 to 99.99 (Issues a warning for values of 65 kN or more.)
	Pressure (MPa)	Display range 0 to 9999 Issues a warning for values for 65 kN or more, converted to MPa. (Varies with the electrode diameter.)
	• Thickness (mm)	0.0000 (thickness-calibrated displacement-meter readouts)
On-screen readout	• Measurement mode **AC Sweep and AC Continuous**	Displays the measurement frequency, as well as the Rs and X values acquired during measurement.
	• Measurement mode **DC**	Displays the Rdc value acquired during measurement.
Graphical representation	**AC Sweep mode** Displays the Rs (Ω) and −X (Ω) values graphically. Horizontal axis: Rs (Ω) Vertical axis: X (Ω)	
	AC Continuous mode Displays the number of measurements (times) and Rs (Ω) graphically. Horizontal axis: Number of measurements (times). Vertical axis: Rs (Ω)	
	DC mode Displays the number of measurements (times) and Rdc (Ω) graphically. Horizontal axis: Number of measurements (times). Vertical axis: Rdc (Ω)	
	Auto-scale function	Adjusts the X- and Y-axes for optimal display.
Starting and stopping the measurement	• How to start measurement	Click **[Measurement Start]** on the application.
	• How to stop measurement	Click **[Measurement Stop]** on the application.
Measurement trigger status display	Displays the status of the predefined measurement trigger.	
	• With the *Start immediately* setting	No indication
	• With the *Fluctuation amount* setting	Displays the difference between the maximum and minimum thickness values. (Data is acquired at 0.5-second intervals) Example: *X.X*[µm]
	• With the *Fixed interval* setting	Displays the remaining time until measurement begins. Example: Start of measurement *XX*[s].
Measurement history display	Displays the measurement history.	
	On-screen information	Date and time, Sample name, Load, Thickness

Measurement progress display	Displays the progress of the predefined measurement count.	Progress bar and progression expressed in percent
Measurement error display	If an error occurs during measurement, it is displayed under **[Status]**.	
Monitoring function	When the press pressure exceeds the load range, a warning dialog box appears.	
Measured data Save destination setting items	• Root path setting • Sample name entry (A folder is created for each sample name.) • Method of automatic assignment of result file names	
Automatic registration of measured data	• After measurement, the measured data is automatically registered in the Viewer screen list.	
Automatic R-value calculation	• Automatically calculates the R value and saves it to the measured-data file. • Records the algorithm number used for the R-value calculation in a CSV file.	

Functional specifications (View screen)

Measured data loading	A measured-data file can be dragged and dropped into the list to display a Nyquist plot.	
R-value recalculation function	The automatically calculated R value can be edited on the data acquisition screen. Calculates the R value using either a frequency range or frequency selection.	
	AC Sweep mode	
	• Frequency range	By specifying the upper and lower limits of the range, a plot within this range is circle-fitted to find the intersection with the X-axis, thereby defining the R value.
	• Specific frequency selection	Assigns the Rs value at the specified frequency as the R value.
	• Reset function	
	• Records the algorithm number used for the R-value calculation in a CSV file.	
	AC Continuous mode	
	• Assigns the Rp value at any given point as the R value.	
	• Assigns the average of the overall Rp values as the R value.	
	DC mode	
	• Assigns the RDC value at any given point as the R value.	
	• Assigns the average of the overall RDC values as the R value.	

Graphical representation	Displays a graph using the calculated R value, in which the parameters assigned to the X- and Y-axes can be customized.	
	• X-axis	Load (kN), Pressure (MPa), Bulk density (g/cm^3), Filling factor, Porosity (Selectable only when the true density is entered.), Temperature (K), Temperature (°C, Selectable only when temperature is entered.)
	• Y-axis	Thickness (mm), Bulk density (g/cm^3), Filling factor, Porosity (Selectable only when true density is entered.), R (Ω), Conductivity (S/cm), Ionic conductivity (S/cm), Volume resistivity (Ω·cm), Relative permittivity
	• Auto-scale function	Adjusts the X- and Y-axes for optimal display.
	• Logarithmic/linear switching function for graphs	Switches between the two vertical-axis scales: logarithmic and linear.
	• Function to hide/unhide series	Clicking the legend on the graph hides or unhides each series.
Result-data saving function	Saves a screenshot of the graph and the X- and Y-axis data as a file.	
	• Saving a screenshot	Saves a screenshot of the graph representation.
	• Saving a file	Saves all the parameters of the selected measurement file in the list, allowing them to be assigned to the X- and Y-axes. File format: CSV

7.2 SA2654 Sensor Unit

General specifications

Dimensions	Approx. 180W × 120H × 245D mm (7.1W × 4.7H × 9.6D in., excluding protrusions and cables)	
Weight	Approx. 2.3 kg (5.1 lb.)	
Connection target	The SA9003 Press Unit only	
Sensor cable length	Displacement-sensor connector	Approx. 870 mm (34.3 in.)
	Load-cell connector	Approx. 870 mm (34.3 in.)
Interface	USB 2.0 compliant, Type B (female)	
Operating temperature and humidity range	23°C ±5°C (73°F ±9°F), 80% RH or less (non-condensing)	
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less	
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)	
Included accessories	See p. 8.	
Product warranty duration	1 year	
Standards	Safety	EN 61010
	EMC	EN 61326 Class A
Power supply	Rated supply voltage	100 V to 240 V AC (Assuming voltage fluctuation of ±10%)
	Rated power-supply frequency	50 Hz, 60 Hz
	Anticipated transient overvoltage	2500 V
Power consumption	Ordinary power consumption (a value for reference purpose)	5 W (with the SA9003 connected, in USB communication mode)
	Maximum rated power	20 VA

7.3 SA9003 Press Unit

General specifications

Dimensions	Approx. 300W × 322H × 300D mm (11.8W × 12.7H × 11.8D in., excluding protrusions)	
Weight	Approx. 20.7 kg (45.6 lb.)	
Frequency at which measurements can be made	DC to 8 MHz	
Structure	Four-terminal structure	
Connectable test fixture	SA9004-01 Test Fixture	
Residual impedance	Residual resistance when the terminals are short-circuited: 0.2 mΩ or less (with the short-compensation block connected, frequency: 100 Hz, with the L2280-01 connected) Stray capacitance between electrodes: 10 pF or less (the SA9004-01 electrode spacing: 1 mm, frequency: 1 MHz, with the L2280-01 connected)	
Connection means	Test Fixture	Banana plugs with a 2 mm diameter
	Connection cable	BNC connector
	Load cell	Dedicated connector
	Displacement meter	Dedicated connector
Product cables	1.5D-2V equivalent	length: 200 mm
Shield connection	Connects the shield of the L2280-01/L2280-03 Connection Cable and the body of the SA9003 Press Unit.	
Functional ground connection	The SA2654 Sensor Unit and the body of the SA9003 Press Unit are connected.	
Up/down stroke	Range of motion	0 mm to 8.5 mm
	Equipment	Hydraulic jack (screw type)
Load application	Load range	0 kN to 60 kN
	Equipment	Hydraulic jack (screw type)
Load measurement	Using the load cell	
	Measurement accuracy	±3% f.s.
Thickness measurement	Using the contact-type displacement meter	
	Measurement error	±10 µm
	(under a constant temperature environment, after calibration is performed)	
	(within a load range of 10 kN to 60 kN, only with increasing load)	
Handle position	Bottom of the top plate	
Operating temperature and humidity range	23°C ±5°C (73°F ±9°F), 80% RH or less (non-condensing)	
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less	
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)	
Included accessories	See p.8.	
Product warranty duration	1 year	

7.4 SA9004-01 Test Fixture

General specifications

Dimensions	Approx. 147W × 36H × 42D mm (5.8W × 1.4H × 1.7D in.)	
Weight	Approx. 470 g (16.6 oz.)	
Powder filling section size	Depth	13 ±0.3 mm (powder filling height: approx. 7 mm)
	Diameter	10 (+0.05, −0) mm
	Capacity	Approx. 0.5 ml
Electrodes	Type	Upper and lower electrodes
	Diameter	ϕ10 (+0, −0.05) mm (die mating area)
	Material	Cemented carbide
	Terminals	2 mm diameter holes
Structure	Two-terminal structure	
Die (powder contact area)	Inside diameter	ϕ10 (+0.05, −0) mm
	Material	Ceramics
Die (outer ring)	Material	Stainless steel
Operating temperature and humidity range	23°C ±5°C (73°F ±9°F), 80% RH or less (non-condensing)	
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less	
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)	
Included accessories	See p. 8.	

7.5 SA9005 Mold Release Unit

General specifications

Dimensions	Approx. 75W × 132H × 50D mm (3.0W × 5.2H × 2.0D in.)	
Weight	Approx. 880 g (31.0 oz.)	
Supported model	SA9004-01 Test Fixture	
Powder removal method	The screw mechanism converts torque into thrust, pushing the powder out of the Test Fixture.	
Powder release pin	Tip shape	Flat
	Tip shape	60-degree conical
Guide plate	Guides the powder release pin.	
Tray	Retrieves the powder extruded from the die.	
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)	
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)	
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less	
Product warranty duration	3 years	
Included accessories	See p.8.	

7.6 L2280-01 and L2280-03 Connection Cable

General specifications

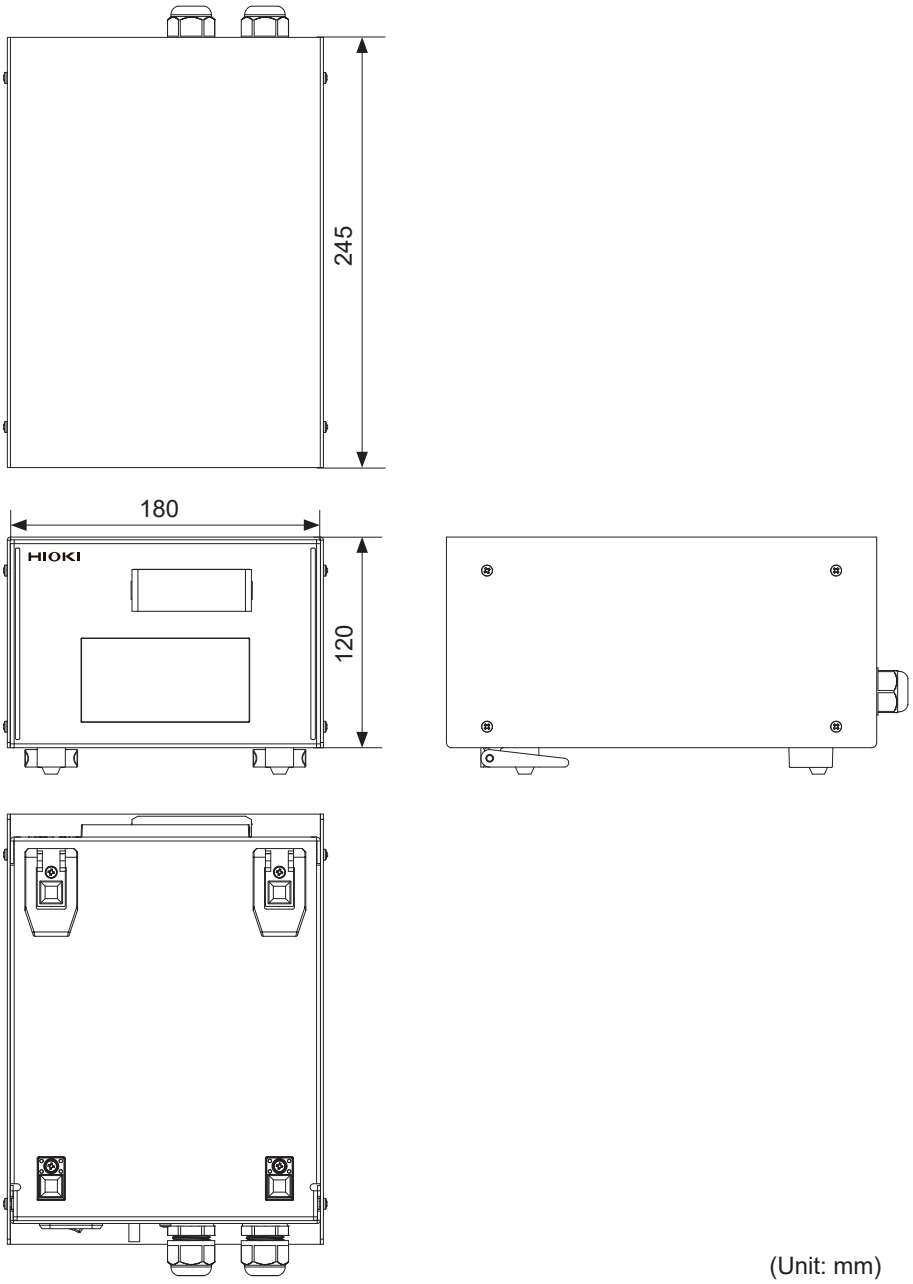
Length	L2280-01	Approx. 830 mm (32.7 in.)
	L2280-03	Approx. 850 mm (33.5 in.)
Weight	L2280-01	Approx. 200 g (7.1 oz.)
	L2280-03	Approx. 160 g (5.6 oz.)
Product cables	Equivalent to 1.5D-2V (for the L2280-01 only)	
Rated voltage	30 V AC rms or less, 42.4 Vp AC or less, 60 V DC or less (for the L2280-03 only)	
Rated current	3 A AC/DC, continuous (for the L2280-03 only)	
Connector and connection target		

	Connector	connection target
L2280-01	BNCs	SA9003 Press Unit
	BNCs	IM3533 LCR Meter or IM3570 Impedance Analyzer
L2280-03	BNCs	SA9003 Press Unit
	Banana plugs	RM3545A Resistance Meter

Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−10°C to 50°C (14°F to 122°F), 80% RH or less
Included accessories	See p.8.

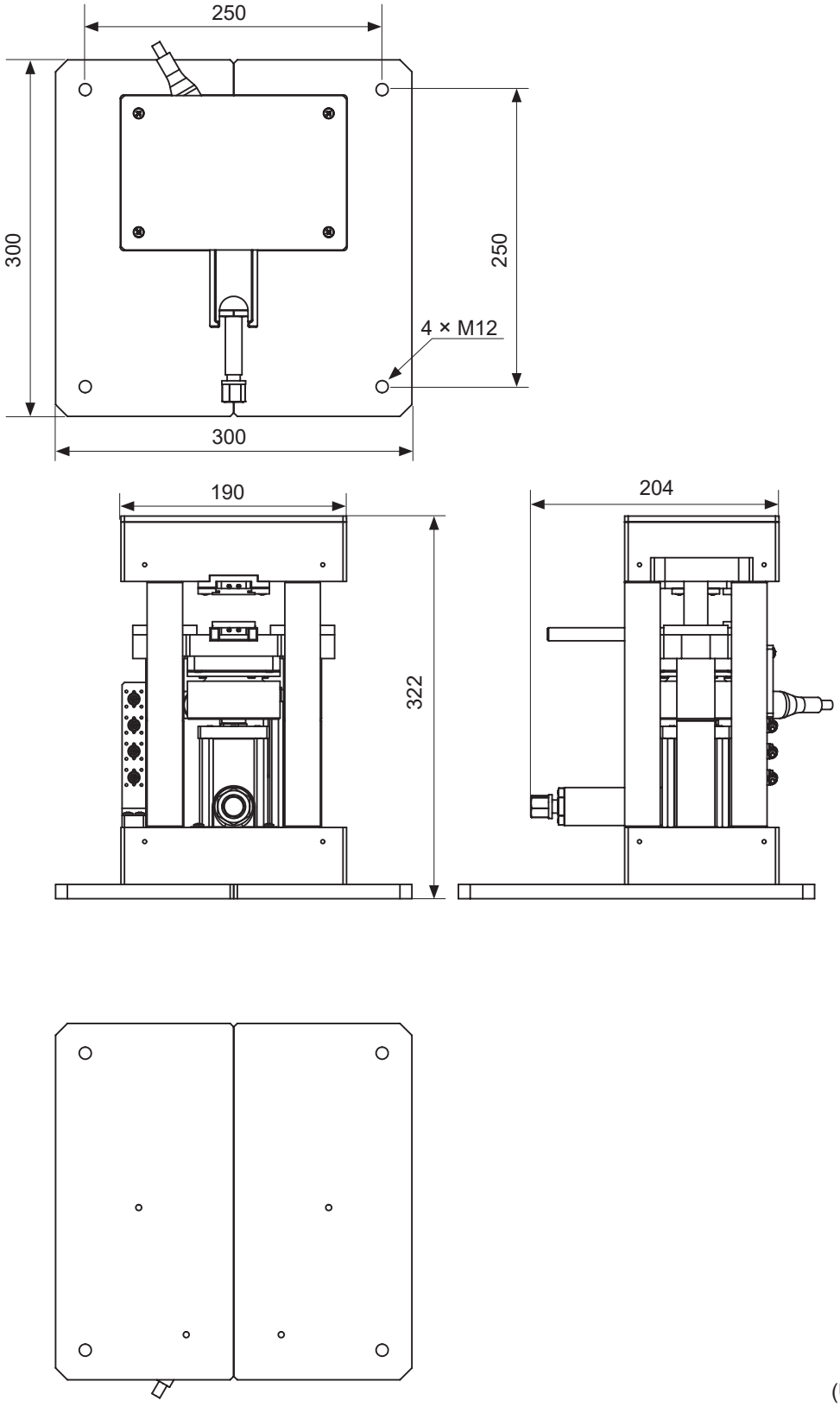
7.7 External Views

SA2654 Sensor Unit



(Unit: mm)

SA9003 Press Unit



(Unit: mm)

8 Maintenance and Service

8.1 Repair, Inspection, and Cleaning

Replaceable parts and service life

Some parts used in the products may deteriorate in characteristics after years of use.
It is recommended to replace these parts regularly to ensure long-term functionality.
To order replacements, please contact your authorized Hioki distributor or reseller.
Part service life varies with the operating environment and the frequency of use. Recommended replacement intervals do not guarantee continuous operation throughout the specified period.

Part name	Approximate replacement timing
SA9004-01 Test Fixture	When damage is found on the electrodes or die, such as chipping or cracking

Calibration

The appropriate schedule for calibration depends on factors such as the operating conditions and environment.
Determine the appropriate calibration interval based on your operating conditions and environment, and have Hioki calibrate the products accordingly.

Backing up your data

When repairing or calibrating the products, Hioki may reset them to factory settings or update them by installing the latest version of the firmware.
It is recommended to back up (save/write) data, such as the settings and measured data, before requesting service.

Transporting the products

Retain the packing materials after unpacking. Use the original packaging materials when shipping the products. Please note that we cannot guarantee against damage during transportation.

⚠ CAUTION

Observe the following when shipping the products:

■ **Do not subject the products to strong shocks such as vibration or dropping.**

Failure to follow this guidance could cause damage to the products during shipment.

■ **Remove accessories and optional equipment from the products**

■ **Include a description of the malfunction.**

■ **Use the original packaging materials in which the products were delivered, and then place them in an additional box.**

Failure to follow this guidance could cause damage to the products during shipment.

Cleaning

⚠ CAUTION

■ **To clean the products, wipe them using a soft cloth moistened with water or a neutral detergent.**

Using solvent-containing detergents, such as benzene, alcohol, acetone, ether, ketone, thinner, and gasoline, or wiping the products with excessive force could cause deformation or discoloration.

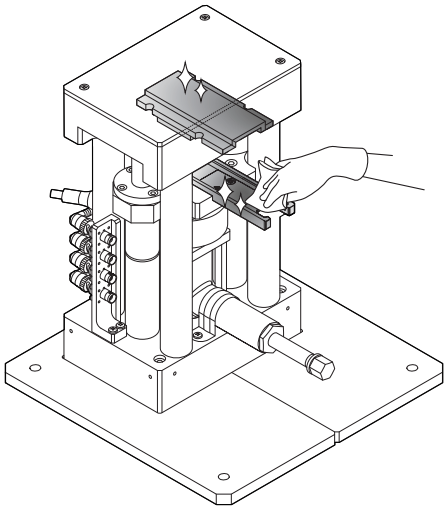
Clean the SA9004-01 Test Fixture according to the procedure described in “Cleaning the SA9004-01 Test Fixture” (p.106).

Performing maintenance on the SA9003 Press Unit

⚠ CAUTION

■ **Periodically clean the test fixture insertion area (top and bottom surfaces) of the Press Unit.**

Measurements taken with dirt or foreign matter adhering to the device could result in an unbalanced load, increasing measurement error or damaging the device.



8.2 Inspecting the System

Periodic inspections should be performed.

Thickness measurement

1. **Perform the thickness-measurement calibration. (p.58)**
2. **Position the empty Test Fixture into the Press Unit and apply a load.**
3. **Check the powder thickness information. (p.66)**

   Confirm that the measurement error is within the range specified in the product specifications, using 0 mm as a reference. (p.143)

Impedance measurement (residual resistance when the terminals are short-circuited)

1. **Operate the measuring instrument to cancel the compensation.**

   See the Instruction Manual for the measuring instrument.

   For the IM3570 and the IM3533: “When you Want to Make Short Compensation Data Invalid”

   For the RM3545A: “Canceling zero adjustment”
2. **Position the short-compensation block into the Press Unit. (p.63)**
3. **Measure impedance.**

IM3570 IM3533	Measurement mode	AC Continuous mode
	Measurement frequency	100 Hz
For the RM3545A	Measurement mode	DC mode

4. **Examine the impedance value.**

   Confirm that the residual impedance is within the range for short-circuit residual resistance in the product specifications. (p.143)

8.3 Troubleshooting

If damage is suspected, refer to “Before returning for repair” (p.151) to address issues.
If further assistance is needed, contact your authorized Hioki distributor or reseller.

Before returning for repair

Problem	Cause	Remedy, Reference page
The SA9003 Press Unit cannot be connected to the measuring instrument.	A BNC connector is deformed or damaged.	Purchase a new Connection Cable.

Problem	Cause	Remedy, Reference page
Measurements vary.	• Air gets mixed in when the powder is placing into the SA9004-01 Test Fixture. • The amount of powder is inappropriate.	“4.1 Placing the Powder into the SA9004-01 Test Fixture” (p.93)
	An electrode is damaged.	Use a new one.
The powder spills out of the SA9004-01 Test Fixture.	The SA9004-01 Test Fixture is worn or damaged.	Contact your authorized Hioki distributor or reseller.
The powder spills out of the die when the upper electrode of the SA9004-01 Test Fixture is placed on it.	Excessive powder is added.	“4.1 Placing the Powder into the SA9004-01 Test Fixture” (p.93)
The SA2653 Measurement Software and the measuring instrument cannot connect.	The instrument is not turned on.	Turn on the instrument. “2.9 Turning On the Instrument” (p.45)
	The measuring instrument and the computer are not connected using the cable.	Connect the instrument and the computer correctly using the cable. “2.6 Connecting the Instrument and the Computer” (p.37)
The SA2653 Measurement Software and the Sensor Unit cannot connect.	The instrument is not turned on.	Turn on the Sensor Unit. “2.10 Turning On the SA2654 Sensor Unit” (p.46)
	The Sensor Unit and the computer are not connected using the cable.	Connect the Sensor and the computer correctly using the cable. “2.7 Connecting the Sensor Unit and the Computer” (p.40)
The open compensation cannot be performed.	The SA9004-01 Test Fixture is dirty.	Clean the SA9004-01 Test Fixture before performing the compensation. “4.7 Cleaning the SA9004-01 Test Fixture” (p.106)
	The empty SA9004-01 Test Fixture is not properly positioned into the SA9003 Press Unit.	“3.3 Performing Calibration and Compensation” (p.55)
	The banana plugs on the SA9003 Press Unit are worn or damaged.	Contact your authorized Hioki distributor or reseller.
The short compensation cannot be performed.	The short-compensation block is dirty.	Clean the short-compensation block before performing the compensation.
	Poor contact occurs on the short-compensation block.	“3.3 Performing Calibration and Compensation” (p.55)
	The short-compensation block is not properly positioned into the SA9003 Press Unit.	Insert the short-compensation block into the banana plugs of the SA9003 Press Unit.
The SA2654 Sensor Unit is turned off suddenly.	It is affected by transient outages.	Set the rear-mounted power switch to the off position (○), wait about 10 seconds, and then set it to the on position (|).
The hydraulic jack screw on the SA9003 Press Unit is hard to turn.	The screw lacks the grease.	Apply grease on the hydraulic jack screw.

Problem	Cause	Remedy, Reference page
The upper electrode cannot be removed from the die.	The powder is entering the gap between the die and the upper electrode. (When the upper electrode moves in the pressurization direction, the air inside the powder is released, allowing the powder, especially fine powder, to enter the gap.)	Remove the upper electrode by turning it. If it does not come off, secure the upper electrode and turn the die with a tool such as pliers to remove it.
		Apply a low load (about 5 kN) to the Test Fixture. Remove the Test Fixture from the Press Unit and clean the sides of the upper electrode and the inner wall of the die to remove any adhering powder.
Thickness measurements are abnormal.	Due to a sudden change in temperature, negative pressure inside the displacement sensor prevents its contactor from moving.	Reconnect the displacement sensor connector to release the negative pressure. (p.34) Use the Sensor Unit in a stable temperature environment.

If the cause is unknown

Reset the measuring instrument (perform the system reset) and reconnect it.

Error messages

When an error is displayed, the instrument needs confirmation or repair. Contact your authorized Hioki distributor or reseller.
Refer to the following table to learn more about errors and how to address them.

Computer

Problem	Remedy, Reference page
[Fail] is displayed under **[Status]** for open compensation.	Verify the open compensation settings. “Performing the compensation of the instrument.” (p.61)
[Fail] is displayed under **[Status]** for short compensation.	Verify the short compensation settings. “Performing the compensation of the instrument.” (p.61)
The message **[Cannot connect to IM3570. Check the COM port.]** is displayed.	Verify the IM3570 USB settings. (See the Instruction Manual for the IM3570.)

SA2654 Sensor Unit

Error messages	Remedy
	• If the displacement-sensor connector is not connected Connect it with the displacement-meter terminal of the SA9003 Press Unit. • If the displacement-sensor connector has a break or is damaged Contact your authorized Hioki distributor or reseller.
	An overcurrent may flow through the displacement-sensor cable. Ensure that the output lines are not in contact with other lines or frames.
	Data may not have been read or written properly. Turn off the SA2654 Sensor Unit and then turn it on again.
	Connect the load-cell connector with that of the SA9003 Press Unit. If this error message is still displayed even after the connectors are connected, contact your authorized Hioki distributor or reseller.
	The load-cell connector may not be connected or the load-cell connector may have a break. If this error message is still displayed even after the connectors are connected, contact your authorized Hioki distributor or reseller.

8.4 Disposing of the Products

Before disposing of the SA9004-01 Test Fixture, remove any powder and dispose of it according to local regulations.

Dispose of the products in accordance with local regulations.
For disposal of measuring instruments, please refer to the “Maintenance and Service” chapter in the Instruction Manual for each instrument.

User's License Agreement

Important

Please read the following agreement carefully. This user's license agreement (hereafter referred to as Agreement) is a legal contract between the software user (individual or institution) and HIOKI E. E. CORPORATION (hereafter referred to as HIOKI). The term "software" includes any related electronic documentation and computer software and media, as well as any printed matter (such as the Instruction Manual).
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www.hioki.com/

All regional contact information

HIOKI E.E. CORPORATION
81 Koizumi, Ueda, Nagano 386-1192 Japan

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・EU declaration of conformity can be downloaded from our website.
・Contact in Europe: HIOKI EUROPE GmbH
Helfmann-Park 2, 65760 Eschborn, Germany hioki@hioki.eu