



RM2610 Probe Maintenance Guide

Introduction

Thank you for using the RM2610 electrode resistance measurement system.

This system is the first of its kind in that it is able to separately obtain the composite layer resistivity and interface (contact) resistance between the composite layer and current collector of the electrode sheet for lithium-ion secondary batteries. This revolutionary capability enables users to perform rational and quantitative evaluation of electrode sheets and provides a new index for screening and quality evaluation.

A proper understanding and use of this product is essential for obtaining correct measurement results. This guide explains the proper probe maintenance procedures for the following purposes.

- Improving measurement accuracy by keeping the probes in proper condition
- Prolonging the lifespan of the probes
- Being able to quickly notice when it needs to be replaced

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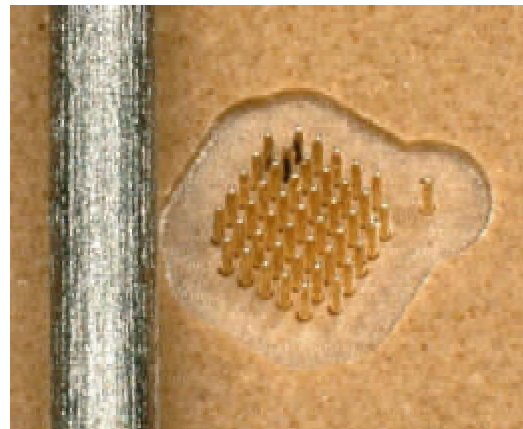
1. Overview of the Electrode Resistance Measurement System and the Probe's Role



The RM2610 calculates the composite material layer's resistivity and interface resistance from the voltage or electric potential (hereafter referred to as "potential") of the electrode sheet. It measures the potential by applying a constant current through the electrode sheet, then measuring the potential at multiple points of the surface.

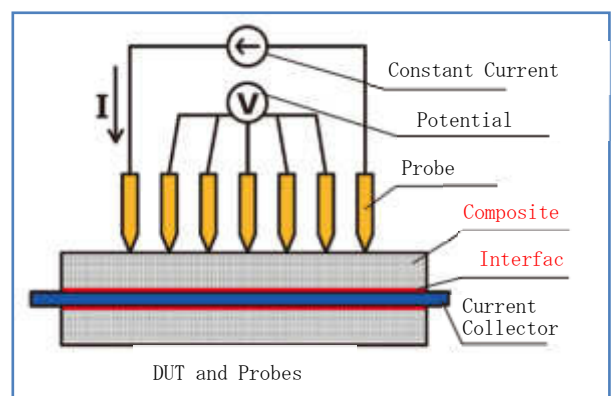
The needle-like components that directly contact the electrode sheet and send currents or measure the potential are called "probes." In this product, 46 probes are equipped at the tip (bottom) of the test fixture RM9004 (see the photo on the right).

The probes are arranged in a grid pattern at intervals of approximately 120 μm and the tips of the needles are $\phi 75 \mu\text{m}$. Although it protrudes about 250 μm from the contact surface, it is a special probe with a spring-like



46 Probes

To the left is a 0.5 mm mechanical pencil lead



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property. Such probes are known as a "buckling probes." It is designed to not stick into the electrode sheet (although it may, depending on the softness of the composite layer). Since each probe has a spring-like quality, it contacts the electrode sheet with an appropriate force while simultaneously adjusting to the irregularities in shape of the electrode sheet. Since the probes are very small and thin, they must be handled with great care. And for accurate measurement, daily probe maintenance is essential.

2. Daily Inspection

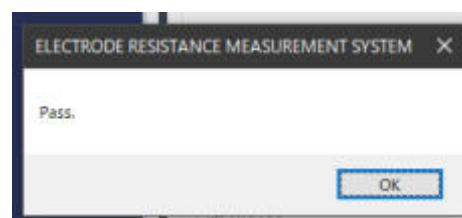
In order to quickly find probe contact failure, insulation failure, probe abnormalities, etc., please perform inspection. Inspections can be divided into two major types.

- **SHORT and OPEN Inspection:** checking for electrical conduction/insulation
- **Probe Tip Observation:** visually checking the probe status

We recommend these two inspections before the first use of the day.

A. SHORT and OPEN Inspection

Setting the "probe inspection board" (included with the RM9004) in the place of an electrode sheet, perform the SHORT inspection and OPEN inspection of the electrode resistance calculation



software RM2612. (Refer to the RM2610 instruction manual.) The inspection result will be displayed in a dialog box. If the "Pass" dialog box appears in both inspections, the probe contact is good.

If the "Abnormal contact resistance" or "Abnormal insulation resistance" dialog box appears, repeat the check several times. If the error still occurs, perform the next inspection, "2. B. Probe tip observation" and maintenance methods, "3. How to Maintain the Probes," outlined below. After completing those steps, execute SHORT inspection and OPEN inspection again.

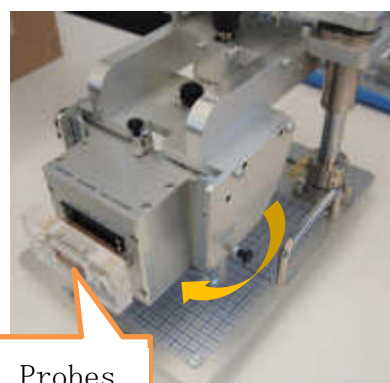
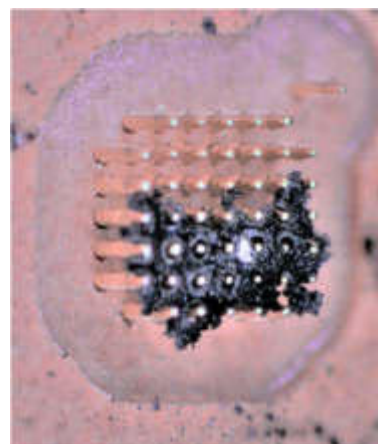
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B. Probe Tip Observation

Even if the SHORT inspection and OPEN inspection results are “Pass,” electrode material may be attached to the probe tip (left figure). It is highly possible that these materials will cause contact failure and insulation failure, and will adversely affect the performance of the probe. Thus, it is necessary to remove them before measurement.

Also, confirm by observation that the probe is not broken or deformed. For checking, use the tilt mechanism of the press unit RM9003 to direct the probe tips of the RM9004 to the front for easier observation. (Refer to the RM2610 and RM9003 instruction manuals for tilt mechanism operation.)

With the tip of the probe facing you, use a magnifying glass or similar tool to check the probe for breakage, deformation, and clogging with electrode composite material. If you find any abnormality, please follow "3. How to Maintain the Probes."



【Note】

With this system, it is still possible to measure even if a few probes are broken. For such situations, refer to “4. Error Data Removal Function”. If many contact fails occur or there is too much damage, the probes will need to be replaced.

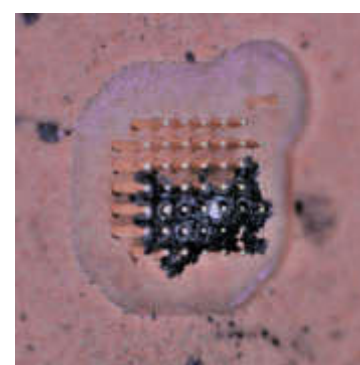
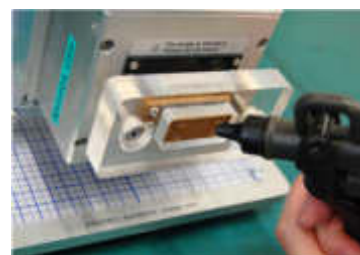
3. How to Maintain the Probes

This section describes the cleaning methods for removing electrode composite material and other material attached to the probe. This will reduce contact failure and insulation failure, and will remove factors that adversely affect the probe operation.

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A. Air Cleaning [Recommended]

As a general rule, compressed air is recommended for cleaning the probe. When contact failure or insulation failure occurs, and during daily inspection (even when there is no error), please perform cleaning with compressed air. Air compressors or similar devices can be used to apply compressed air to the probe in order to blow off the attached electrode composite material. There are no particular rules regarding the direction in which air is applied, but please note the following points.



- For safety purposes, please keep the air pressure below 207 kPa (2.1 kgf/cm², 30psi). This is to prevent air embolism accidents.
- Only oil-free compressed air should be used.
- Use protective goggles and a dust mask to protect yourself from the electrode material particles blown by the compressed air.
- Hold the air compressor firmly before discharging the air so that the gun nozzle of the air compressor does not hit the probes.

This cleaning method will improve most SHORT and OPEN inspection errors. If it does not improve, proceed to the next sections, B and C.

B. Cleaning Film

Using a cleaning film to remove insulating material on the probe tip may restore electrical contact.

The surface of the cleaning film should be coated with a fine polishing agent. Placing

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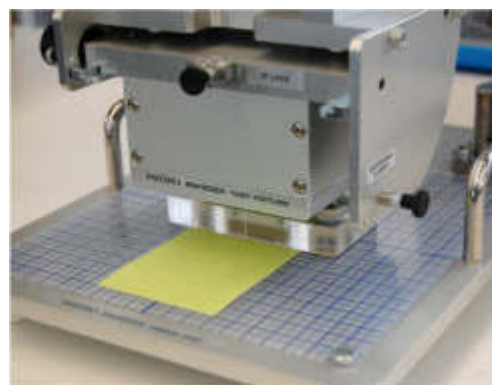
it on the measurement stage and moving the test fixture up and down onto it several times will clean the probe tips. However, as the polish coating is an abrasive material, excessive use is not recommended. Do not perform it unless there is contact error.

Hioki recommends the cleaning film "3M 262X Lapping Film, 1 Micron, Bogen 215,9

mm x 279 mm #58916". A possible source of supply is the company SKS GmbH.

Although cleaning films can be effective against errors during SHORT inspection, it is not expected to be effective against errors during OPEN inspection.

For the reasons for poor electrical contact, refer to "6. Reasons for Probe Contact Failure [Note]"



C. Cleaning with a Brush

This method should be considered a last resort. Cleaning with a brush is generally not recommended.

Please do so at your own risk.

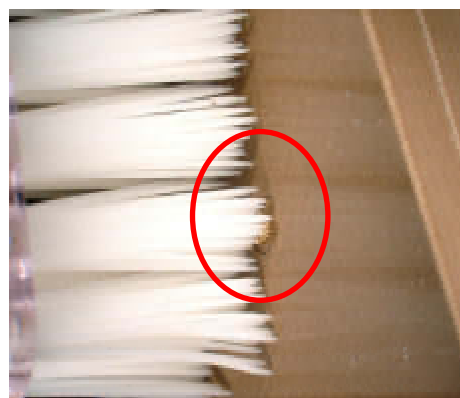
A brush should only be used when electrode composite material fail to come off with compressed air and a cleaning film.

For this method, use a soft brush whose tip is thin and dense in the following way:

1. Slowly apply the brush at a vertical angle to the probes
2. Move the brush in a small circle to scrape out the electrode material

Do not tilt the brush at an angle. When a force is applied to the probes from the side, there is a high probability that probes will break.

Although the use of a brush is not recommended, if a brush is used, we would recommend supper soft toothbrush.

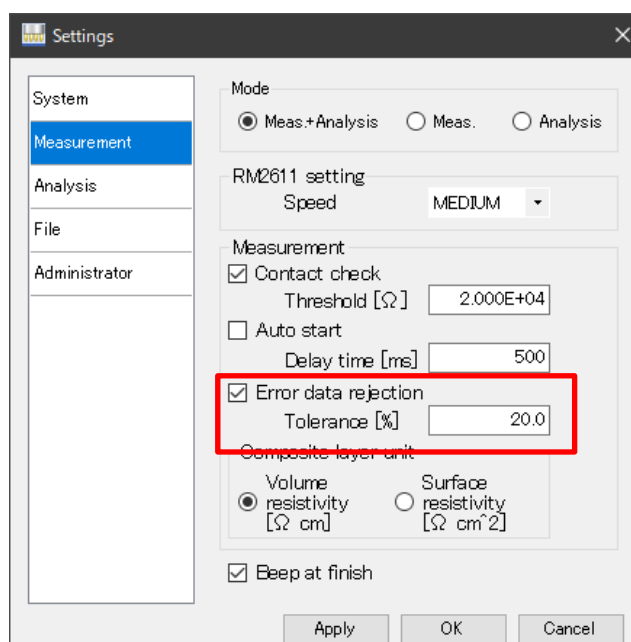


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4. Error Data Removal Function

Contact may not be improved even after cleaning. This system is equipped with an "error data removal function." As long as there are only a few probes that have poor contact causing the contact error, this function is able to delete the error data and perform the necessary calculations.

However, reliability of the results will be lower in such situations compared to when all probes are functioning properly. Although the reliability goes



down, measurement of electrode sheets with small variation will render comparable measurement results. The permissible rate [%] can be set with the PC software, but 20% or less is recommended.

5. Countermeasures for When Contact Failure Occurs Frequently

If contact failure or insulation failure occurs frequently even after performing probe cleaning, it is necessary to replace the probes. For probe replacement, please contact the sales subsidiary, branch office, or distributor of HIOKI E.E. CORPORATION from which you purchased the system. After contacting the seller, you will receive information as to where to send your unit for repairs. After receiving the unit, the Hioki factory will replace all probes and wash the plate, re-assemble and inspect, and then send it back to you. (The above services are at the expense of the user. Approximately 5 working days are required for the tasks of receipt to inspection).

6. Reasons for Probe Contact Failure 【Note】

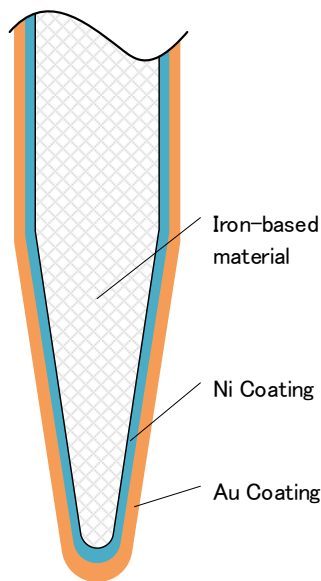
If something that does not conduct electricity adheres to the tip of the probe, it will cause poor contact. In this system, possible causes for contact failure are adhesion of insulators, and wear and corrosion of the probe tip.

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A. Adhesion of Insulators

If the electrode composite material adheres to the tip of the probe, although not always the case, it will be an insulator that blocks the flow of electricity. This will cause a contact error at the time of inspection, so perform the recommended cleaning (e.g. compressed air).

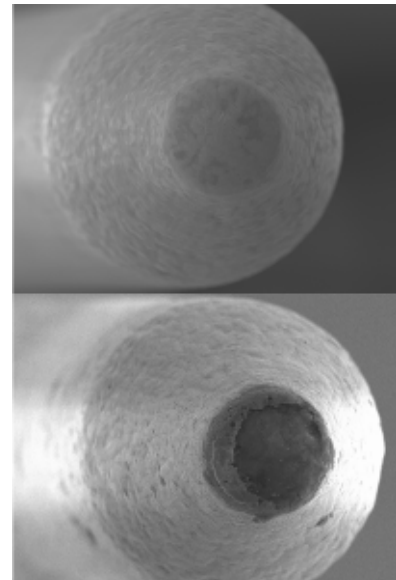
B. Corrosion of the Probe Tip



The base material of the probe is industrial steel. In its shipment state, it has two layers of coating on it. The coating improves electrical contact and protects against corrosion.

Composite material of electrode sheets are generally harder than this coating, as such, each use gradually scrapes away at the coating.

The picture above shows the tip of an unused probe observed by an SEM (Scanning Electron Microscope). The picture below is a SEM image of a probe tip after several hundred measurements. The base material is exposed because the tip is scraped, but this alone does not cause contact failure. As a result of Hioki's observation, we believe that oxidation formed on the tip surface of this iron-based material becomes an insulating substance, resulting in contact failure. Therefore, removing this oxidation may restore contact. For this please try "3. C. Cleaning Film."



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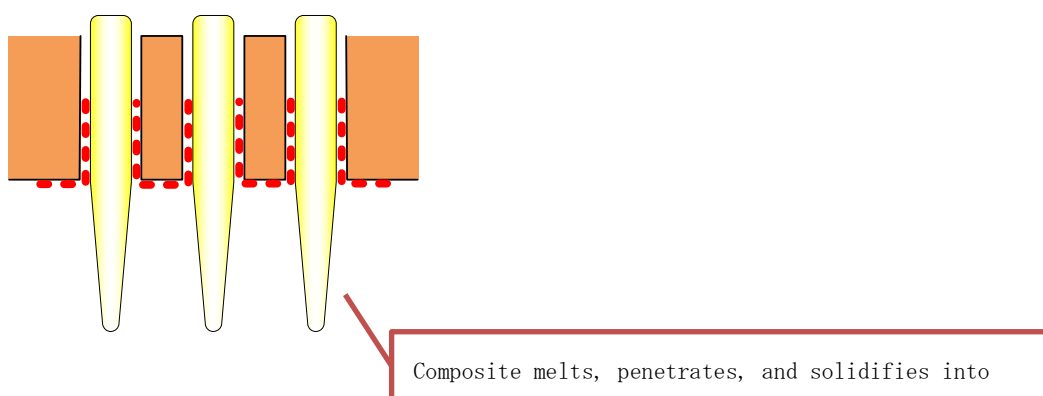
【Note】

Although electrode composite material clogged between the probes is considered unrelated to the contact failure at the probe tip, it may cause insulation failure between the probes or adversely affect the performance of the probes. Due to these reasons, it needs to be removed.

Other Points of Caution

Here are some cautionary points about the probe.

- The probes are very fine and sensitive. Please don't touch them.
- If the tip of the probe is clogged with electrode composite material, do not wipe it with substances such as fabric. The probe will almost certainly break.
- Please be careful not to bump the electrode sheet during measurement or touch the probes with an air compressor gun nozzle during cleaning as these actions would damage the probes.
- Do not wash with liquid. If the probe tip is cleaned with a liquid such as alcohol, water, or another solvent, the electrode composite material will melt and penetrate into the gap (see the figure below), and solidify. This will cause the probes to malfunction.



- **Storage environment:**

The storage environment for the RM9004 test fixture is 0°C to 50°C, 80% rh or less, and with no condensation. Condensation can damage the probes and as such should be stored in a dry environment.

- **Perform SHORT inspection and OPEN inspection before the first measurement of the**

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day.

- Dirt on the probe tip:

Clean the tip of the probe after and within the same day of measurement. Leaving material on the probe for a long time makes it harder to remove.

- It is not recommended to measure an electrode sheet that is soft enough for the probe to pierce. It will damage the probe. In addition, the measured value of such electrodes will be unstable, which will in turn affect the calculated value.

- The probe is a consumable item:

The probes used in this system can withstand hundreds of thousands of cycles if it is buckled in the vertical direction. However, the degree of wear and corrosion of the tip will vary depending on the measurement target. If the contact does not recover even after using cleaning methods described in this guide, please contact HIOKI EUROPE GmbH for probe replacement.

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RM9006

MAINTENANCE TOOL

Instruction Manual

June 2022 Edition 1
RM9006A961-00 22-06H



EN

HIOKI

www.hioki.com/



All regional
contact
information

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Warranty Certificate

HIOKI

Model	Serial number	Warranty period
		One (1) year from date of purchase (___ / ___)

Customer name: _____
Customer address: _____

Important

- Please retain this warranty certificate. Duplicates cannot be reissued.
- Complete the certificate with the model number, serial number, and date of purchase, along with your name and address. The personal information you provide on this form will only be used to provide repair service and information about HioKI products and services.

This document certifies that the product has been inspected and verified to conform to HioKI's standards. Please contact the place of purchase in the event of a malfunction and provide this document, in which case HioKI will repair or replace the product subject to the warranty terms described below.

Warranty terms

- The product is guaranteed to operate properly during the warranty period (one (1) year from the date of purchase). If the date of purchase is unknown, the warranty period is defined as one (1) year from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYYY format).
- If the product came with an AC adapter, the adapter is warranted for one (1) year from the date of purchase.
- The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
- In the event that the product or AC adapter malfunctions during its respective warranty period due to a defect of workmanship or materials, HioKI will repair or replace the product or AC adapter free of charge.
- The following malfunctions and issues are not covered by the warranty and as such are not subject to free repair or replacement:
 - 1. Malfunctions or damage of consumables, parts with a defined service life, etc.
 - 2. Malfunctions or damage of connectors, cables, etc.
 - 3. Malfunctions or damage caused by shipment, dropping, relocation, etc., after purchase of the product
 - 4. Malfunctions or damage caused by inappropriate handling that violates information found in the instruction manual or on precautionary labeling on the product itself
 - 5. Malfunctions or damage caused by a failure to perform maintenance or inspections as required by law or recommended in the instruction manual
 - 6. Malfunctions or damage caused by fire, storms or flooding, earthquakes, lightning, power anomalies (involving voltage, frequency, etc.), war or unrest, contamination with radiation, or other acts of God
 - 7. Damage that is limited to the product's appearance (cosmetic blemishes, deformation of enclosure shape, fading of color, etc.)
 - 8. Other malfunctions or damage for which HioKI is not responsible
- The warranty will be considered invalidated in the following circumstances, in which case HioKI will be unable to perform service such as repair or calibration:
 - 1. If the product has been repaired or modified by a company, entity, or individual other than HioKI
 - 2. If the product has been embedded in another piece of equipment for use in a special application (aerospace, nuclear power, medical use, vehicle control, etc.) without HioKI's having received prior notice
- If you experience a loss caused by use of the product and HioKI determines that it is responsible for the underlying issue, HioKI will provide compensation in an amount not to exceed the purchase price, with the following exceptions:
 - 1. Secondary damage arising from damage to a measured device or component that was caused by use of the product
 - 2. Damage arising from measurement results provided by the product
 - 3. Damage to a device other than the product that was sustained when connecting the device to the product (including via network connections)
- HioKI reserves the right to decline to perform repair, calibration, or other service for products for which a certain amount of time has passed since their manufacture, products whose parts have been discontinued, and products that cannot be repaired due to unforeseen circumstances.

HIOKI E.E. CORPORATION
http://www.hioki.com

18-07 EN-1

Introduction

Thank you for choosing the HioKI RM9006 Maintenance Tool. To ensure your ability to get the most out of this instrument over the long term, please read this manual carefully and keep it available for future reference. Please review the instruction manual of the RM2610 Electrode Resistance Measurement System and "Operating Precautions" that came with the RM2610 before using the device.

The latest edition of the instruction manual

The contents of this manual are subject to change, for example as a result of product improvements or changes to specifications. The latest edition can be downloaded from HioKI's website.

<https://www.hioki.com/global/support/download>



Target audience

This manual has been written for use by individuals who use the product or provide information about how to use the product.

In explaining how to use the product, it assumes electrical knowledge (equivalent of the knowledge possessed by a graduate of an electrical program at a technical high school).

Trademark

Microsoft is either a registered trademark or a trademark of Microsoft Corporation in the United States and other countries.

Overview

The instrument is used to maintain the RM9004 Test Fixture. You can clean a test fixture with air while observing its probes with the camera (microscope). Eight-direction air blasts are available.

Notations

Safety notations

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



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).



Indicates a mandatory action.



Indicates a prohibited action.

Symbol for a standard



Indicates that the product complies with standards imposed by EU directives.

Safety Information



CAUTION



■ Please review the safety information below before using the device.

Failure to do so could cause damage to the device.

Usage Notes

Be sure to follow the precautions listed below in order to use the device safely and in a manner that allows it to function effectively.



CAUTION



■ Do not place the device on an unstable stand or angled surface.

Failure to do so could cause improper use of the device, resulting in serious bodily injury or damage to the device.



■ Turn off the RM2611 Electrode Resistance Meter before connecting or disconnecting the RM9005 Connection Cable.

Failure to do so could cause damage to the device.

■ Do not unplug the USB cable while communications are ongoing.

Failure to do so could cause damage to the device and your computer.

The device requires a current of at least 100 mA to operate. Check the specifications of your computer or USB hub before use.

Inspection

Inspect the device for damage due to storage or transport and verify operation before use. If you find any damage, contact your authorized HioKI distributor or reseller.

Troubleshooting

If the device seems to be malfunctioning, contact your authorized HioKI distributor or reseller.

Cleaning



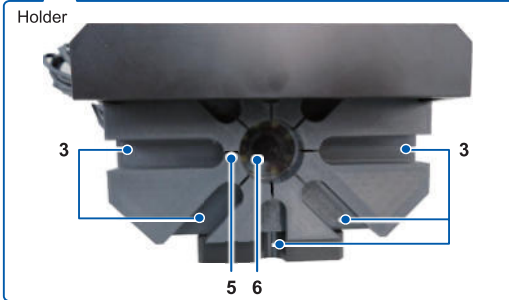
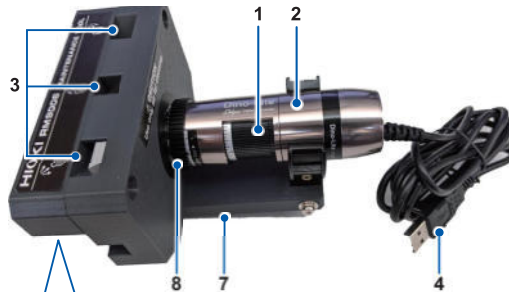
CAUTION



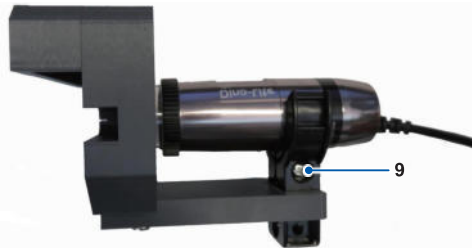
■ If the device becomes dirty, wipe the device clean with a soft cloth moistened with water or a neutral detergent.

Never use solvents such as benzene, alcohol, acetone, ether, ketone, thinners or gasoline. Doing so could deform and discolor the instrument.

Parts Names



Side



1	Focus magnification adjustment dial
2	Digital microscope*
3	Air supply ports (×8)
4	USB cable
5	Vent
6	Transparent protective cover
7	The serial number consists of nine digits. The first two digits indicate the year of manufacture, while the second two digits indicate the month of manufacture. Do not remove this sticker as the number is important.
8	Polarizing dial (adjustment unnecessary for this application)
9	Clip adjusting screw (adjustment unnecessary for this application)

* You can download specialized software from the digital microscope. The specialized software has a built-in image zoom function. For more information, visit the following website.
<https://www.dino-lite.com/download.php>

Specifications

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	0°C to 50°C (32°F to 122°F), 80% RH or less (non-condensing)
Model on which the device is mountable	RM9004 only
Dimensions	Approx. 110W × 91.5D × 135H mm (4.33"W × 3.60"D × 5.31"H)
Weight	Approx. 480 g (16.9 oz.)
Product warranty duration	1 year
Accessories	Instruction Manual Blower Cleaning film
Dimensions of air nozzles that can be inserted into the air supply ports	• Nozzle outer diameter: 1 mm to 9 mm • Nozzle length: 40 mm or more
Consumption current	0.5 A (at a voltage of 5 V)
Interface	USB 2.0
Operating environment (computer)	Windows 10, Windows 8, Windows 7

Basic Operation

⚠ CAUTION

■ Do not clean probes with liquid.

If the probe tips are cleaned with a liquid such as alcohol or water, the electrode material that has been attached to probes could melt, penetrate the gaps and solidify, preventing probes from moving.

■ Do not use any tool not specified by Hioki that makes direct contact with the probe.

Doing so could cause damage to probes.

■ Wear a dust mask and protective goggles during operation.

Failure to do so could cause splash of air to get into the eye or mouth.

■ Limit the projecting pressure of the air to 207 kPa (2.1 kgf/cm² or 30 psi).

Otherwise, the operator could suffer from air embolism.

You will need:

- Air (e.g., air duster spray, air gun, blower included accessories)
Keep in mind that if the air contains oil or other foreign objects, it could settle on the RM9004.
- Nozzle outer diameter: 1 mm to 9 mm
- Nozzle length: 40 mm or more
- Computer
Prepare a computer that matches the operating environment of the device.

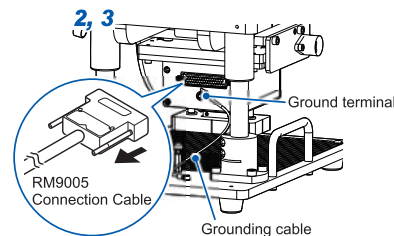
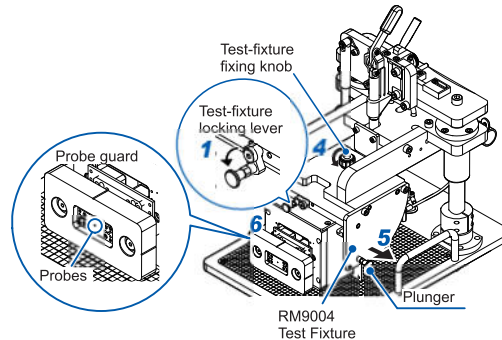
Check out the video on basic operation here.

https://www.hioki.com/global/products/resistance-meters/resistance/id_6740

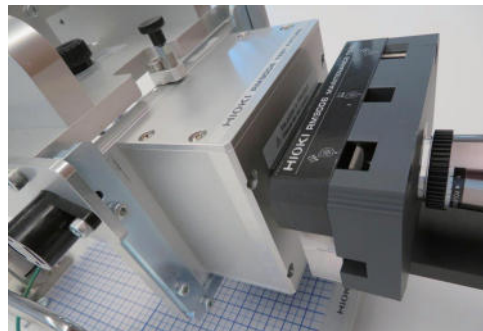
The customer is responsible for carrier charges.



- 1 Check that the locking lever of the RM9004 Test Fixture is lowered.
- 2 Disconnect the RM9005 Connection Cable from the RM9004.
- 3 Disconnect the grounding cable from the RM9004's ground terminal.
- 4 Turn the test fixture fixing knob counterclockwise to disengage the lock.
At this time, while pressing down the RM9004, turn the fixing knob on the Test Fixture to the UNLOCK side until the screw is completely removed.
The bottom of the RM9004 faces slowly.
- 5 Pull the RM9004's maintenance plunger outward to secure the RM9004 in place.



- 6 Hang the device on the probe guard.



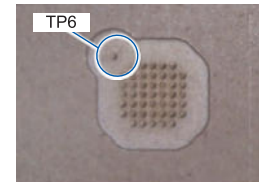
- 7 Connect the device's USB cable to your computer.



- 8 Use the computer's camera function to display the probe tips of the RM9004 on the display.

Rotate the focus magnification adjustment dial to focus on and observe the tips of the probes. If there are multiple cameras connected to the computer, switch the cameras so that the image from the device's camera is displayed.

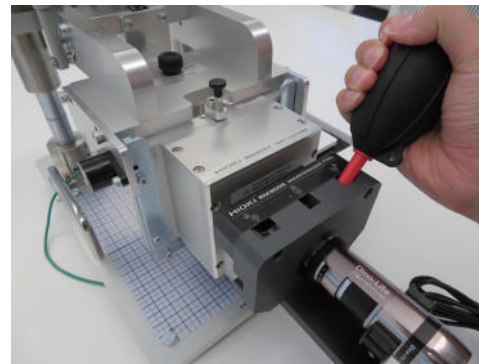
Turn the digital microscope so that the TP6 probe is visible in the position shown below.



- 9 Try to eliminate deposits on the tips of the probes by injecting air while checking the camera image.

Insert the blower's nozzle all the way into the vent before supplying air.

While observing deposits, spray air from multiple supply ports.



Operating precautions

- To ensure proper operation of the RM9004 over a long period of time, remove any probe deposits after you have finished working.
- Remove any deposits as soon as possible. Repeated measurements while there are deposits on probes will cause the deposits to settle between the probes, making it difficult to remove with air. Moreover, an error may be displayed during the open and short inspections of the RM2610.
- If deposits cannot be removed, have the test fixture repaired.
- If any objects adhere to the transparent protective cover of the device, remove them with air or a soft, dry cloth.

Cleaning film

Removing insulation at the tips of the probes using the included cleaning film may cause the electrical contact to resume. Use the cleaning film only when the short test of the RM2610 yields fail judgments frequently. The abrasive contained in the cleaning film could scratch the plating on the surface of the probes, causing it to oxidize, resulting in more liable to yield fail judgment during the short inspection.

How to use

- 1 Place the cleaning film on the measurement stage with the non-glossy side facing up.

- 2 Move the test fixture up or down several times and allow the probes to make contact with the cleaning film.

The tips of the probes are polished, resulting in better contact.

- Replace the film with a new one when it comes ineffective.
- If the short inspection of the RM2610 yields fail judgment frequently, even when a cleaning film is used, have the RM9004 repaired.

