IR5050
IR5051

HIOKI

Instruction Manual

HIGH VOLTAGE INSULATION TESTER

The latest edition of the instruction manual

Read carefully before use.
Keep for future reference.

EN

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IR5050A961-00

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Contents

Introduction

Thank you for choosing the Hioki IR5050/IR5051 High Voltage Insulation Tester. To ensure you get the most out of this instrument over the long term, please read this instruction manual carefully and keep it available for future reference.
Please review the separate Operating Precautions before using this instrument.

The IR5051 adds PV insulation resistance measurement functionality to the IR5050.

Product registration

Register your product in order to receive important product information.
https://www.hioki.com/global/support/myhioki/registration/

Target audience of this instruction manual

This instruction 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).

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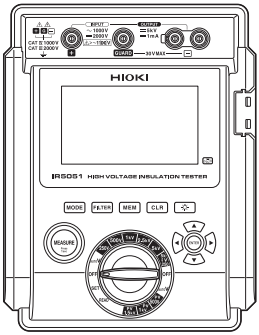
Checking Package Contents

When you receive the product, inspect it for damage or anomaly. If you find any damage or discover that the product does not perform as indicated in the specifications, please contact your authorized Hioki distributor or reseller.

Check if the contents of the package are correct.

- ☐ IR5050/IR5051 High Voltage Insulation Tester (in protector)



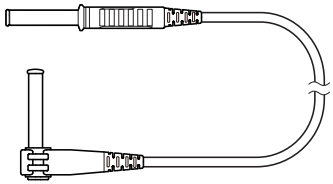
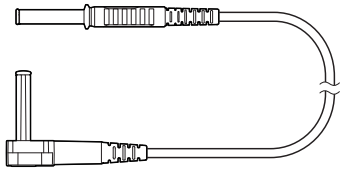
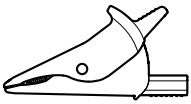
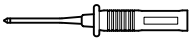
- ☐ L9850-01 Test Lead Red, 3 m
- ☐ L9850-02 Test Lead Black, 3 m, shielded cable
- ☐ L9850-03 Test Lead Blue, 3 m
- ☐ L9851-01 Alligator Clip Red, for L9850
- ☐ L9851-02 Alligator Clip Black, for L9850
- ☐ L9851-03 Alligator Clip Blue, for L9850
- ☐ C0212 Carrying Case
- ☐ LR6 Alkaline battery × 8 Installed in instrument
- ☐ Instruction Manual (this manual)
- ☐ Operating Precautions (0990A907)
- ☐ L9852 Test Pin Set Red and black, for L9850
  (IR5051 and IR5051-90*1 only)
- ☐ Z3210 Wireless Adapter (IR5051-90*1 only)

*1. Model IR5051-90 includes IR5051 and Z3210 as a set.

Options (Sold Separately)

The options listed below are available for the instrument. To purchase options, please contact your authorized Hioki distributor or reseller. Options are subject to change with no advance notice. Check Hioki's website for the latest information.

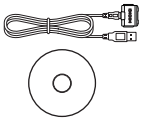
Connection cables

L9850-01	Test Lead	Red, 3 m	
L9850-11	Test Lead	Red, 10 m	
L9850-03	Test Lead	Blue, 3 m	
L9850-13	Test Lead	Blue, 10 m	
L9850-02	Test Lead	Black, 3 m, shielded cable	
L9850-12	Test Lead	Black, 10 m, shielded cable	
L9851-01	Alligator Clip	Red, for L9850	
L9851-02	Alligator Clip	Black, for L9850	
L9851-03	Alligator Clip	Blue, for L9850	
L9852	Test Pin Set	Red and black, for L9850	

Maximum rated line-to-ground voltage: 5000 V DC/2 mA (insulation resistance measurement),
1000 V (Measurement category IV),
2000 V (Measurement category III)

Rated current: 4 A

Other

C0212	Carrying Case	
Z3210	Wireless Adapter For wireless communications	
DT4900-01	Communication Package (USB) With the DT4900-01, you can send data saved in the instrument's memory to a PC and change instrument settings from a PC. Control of measurement is not supported. The application on the included CD is not used with this instrument.	

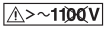
Symbols and Abbreviations

Safety

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	Indicates information or content particularly important for operating or maintaining the product.
	Indicates a high voltage hazard. Failure to verify safety or improper handling of the product will lead to an electric shock, a burn, an injury, or a death.
	Indicates a prohibited action.
	Indicates a mandatory action.

Symbols on the product

	Indicates the presence of a potential hazard. See the “Precautions for Use” (p. 15) and safety notes listed at the beginning of each operating instruction in the instruction manual and the accompanying document entitled Operating Precautions.
	Indicates that dangerous voltage can be present at this terminal.
	Indicates the product is protected throughout by double insulation or reinforced insulation.
	Indicates a grounding terminal.
	Indicates that the product can be used for direct current (DC).
	Indicates that the product can be used for alternating current (AC).
	Indicates that the product must not be used with an AC distribution system that exceeds 1100 V.

Symbols for various standards

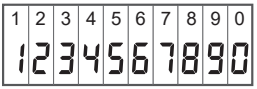
	Indicates that the product is subject to the Directive on Waste Electrical and Electronic Equipment (WEEE) in EU member nations. Dispose of the product by local regulations.
CE	Indicates that the product complies with standards imposed by EU directives.

Additional notation

*	Indicates additional information is presented below.
(p.)	Indicates the page number to reference.
[ ]	The names of user interface elements on the screen are enclosed in brackets ([ ]).
MODE (bold)	Indicates the names of the control keys.

Screen display

The instrument screen displays the alphanumeric characters as follows.



Accuracy labeling

The accuracy of the measuring instrument is expressed using a combination of the formats shown below:

- By defining limit values for errors using the same units as measured values.
- By defining limit values for errors as a percentage of the reading and in terms of digits.

Reading (displayed value)	Indicates the value displayed by the measuring instrument. Limit values for reading errors are expressed as a percentage of the reading (% of reading or % rdg).
Digit (resolution)	Indicates the minimum display unit (in other words, the smallest digit that can have a value of one) for a digital measuring instrument. Limit values for digit errors are expressed using digits (dgt).

Safety Information

This instrument has been designed to conform to the international standard, IEC 61010, and thoroughly tested for safety before shipment. However, using the instrument in a way not described in this instruction manual may negate the provided safety features.
Carefully read the following safety notes before use.

⚠ DANGER

■ **Familiarize yourself with the contents of this instruction manual before use.**

Otherwise, the instrument will be misused, resulting in serious bodily injury or damage to the instrument.

⚠ WARNING

■ **If you have not previously used electrical measuring instruments, ensure adequate supervision by a technician with experience in electrical measurement.**

Failure to do so could cause the user to experience an electric shock. It could also cause serious events such as heat generation, fire, or arc flash due to a short-circuit.

■ **Wear electrically insulating personal protective equipment (PPE) according to laws and regulations.**

Performing measurement using this instrument involves live-line work. Failure to wear PPE could cause the user to experience an electric shock.

Measurement categories

IEC 61010 defines measurement categories to facilitate safe use of measuring instruments. Test and measurement circuits are classified into three categories according to the type of mains to which they are intended to be connected.

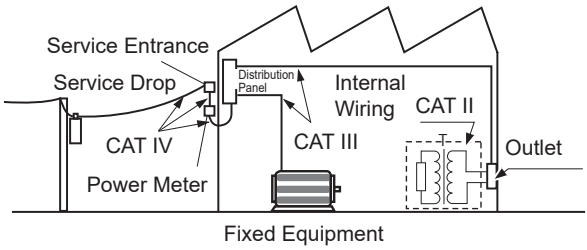
⚠ DANGER

- **Do not use a measuring instrument and options with a lower measurement category rating than that determined according to the type of the mains for measurements on mains.**
- **Do not use a measuring instrument and options without a measurement category rating for measurements on mains.**

Otherwise, the user will suffer from a serious bodily injury or the instrument and the mains installation will be damaged.

This product conforms to CAT III 2000 V and CAT IV 1000 V.

Measurement category II (CAT II)	Applicable to test and measuring circuits connected directly to utilization points (socket outlets and similar points) of the low-voltage mains installation. EXAMPLE: Measurements on household appliances, portable tools, and similar equipment, and on the consumer side only of socket-outlets in the fixed equipment.
Measurement category III (CAT III)	Applicable to test and measuring circuits connected to the distribution part of the building's low-voltage mains installation. EXAMPLE: Measurements on distribution boards (including secondary meters), photovoltaic panels, circuit breakers, wiring, including cables, bus-bars, junction boxes, switches, socket-outlets in the fixed equipment, and equipment for industrial use and some other equipment such as stationary motors with permanent connection to the fixed equipment.
Measurement category IV (CAT IV)	Applicable to test and measuring circuits connected at the source of the building's low-voltage mains installation. EXAMPLE: Measurements on devices installed before the main fuse or circuit breaker in the building installation.



Precautions for Use

Observe the following precautions to ensure the safe use of the instrument and the effective use of its capabilities.
Use of the instrument should conform not only to its specifications but also to the specifications of all equipment to be used, including accessories, options, and batteries.

Placement

⚠ WARNING

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

- Locations exposed to direct sunlight
- Locations exposed to high temperatures
- Locations exposed to high humidity or condensation
- Locations exposed to corrosive or explosive gases
- Locations exposed to powerful electromagnetic radiation
- Close to objects carrying an electric charge
- Close to inductive heating devices (such as high-frequency inductive heating devices and IH cooktops)
- Locations characterized by a large amount of mechanical vibration
- Locations exposed to water, oil, chemicals, or solvents
- Locations with an excessive amount of dust

Doing so could damage the instrument or cause it to malfunction, resulting in bodily injury.

For more information about the instrument's operating temperature and humidity range, see "7.1 General Specifications" (p. 93).

Handling the instrument

⚠ CAUTION

■ **Do not subject the instrument to vibration or mechanical shock while transporting or handling it.**

■ **Do not drop the instrument.**

Doing so could damage the instrument.

Measurement precautions

⚠ DANGER

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

Doing so could cause damage to the instrument or overheating, resulting in serious bodily injury.

■ **Do not cause a short-circuit between a wire to be measured and another wire with the metal part of test leads.**

Doing so will cause an arc flash, resulting in serious bodily injury or damage to the device or other equipment.

■ **Never touch the metal parts on test leads during measurement.**

Doing so could cause serious bodily injury or a short-circuit fault.

IMPORTANT
If the instrument or test leads becomes dirty, that may affect the insulation resistance measurement. Be sure to clean them if they are dirty.

Shipping precautions

Store the packaging material after unpacking the instrument. Use the original packaging when shipping the instrument.

1 Overview

1.1 Product Overview

The IR5050/IR5051 is an insulation resistance tester with a wide measurement range, for use in such environments involving low to high voltage.
This instrument is designed for measurement of the following:
Purpose: Inspection of high-voltage electrical facilities
Location: High-voltage receiving station or transforming station
Object under measurement: Large motors, transformers, cables, PV panels, etc.

The instrument has the functions and purposes given below.

Measurement functions

Function	Purpose	Reference
Insulation resistance measurement	To test the insulation resistance of an electrical facility.	p. 41
Voltage measurement	To measure the voltage of an external circuit, e.g., commercial power supply.	p. 50
PV insulation resistance measurement (IR5051 only)	To measure the insulation resistance of a PV panel.	p. 53

Insulation diagnosis functions

Function		Purpose	Reference
TIMER	Timer test	To automatically end the test after a predetermined time.	p. 59
PI	Polarization index	To check whether the insulation resistance increases with time after a voltage is applied.	p. 61
DAR	Dielectric absorption ratio		
SV	Step voltage test	To determine whether the insulation resistance of an object under measurement is affected by a change in test voltage.	p. 63
Ramp	Ramp voltage test		p. 66
DD	Dielectric discharge	To diagnose a multi-layer insulator.	p. 68

The available insulation diagnosis functions differ depending on the measurement function.

Available: ✓, not available: –

	Measurement functions		
Insulation diagnosis functions	Insulation resistance measurement	Voltage measurement	PV insulation resistance measurement (IR5051 only)
Timer test	✓	–	✓
Polarization index	✓	–	–
Dielectric absorption ratio	✓	–	–
Step voltage test	✓	–	–
Ramp voltage test	✓	–	–
Dielectric discharge	✓	–	–

Other functions

Function	Purpose	Reference
Comparator function	To compare the measured value against a preset value and make a pass/fail judgment.	p. 71
PC communication	To create tables or graphs on a PC of the data saved in the instrument's memory for reports, etc.	p. 79
Wireless communications function (GENNECT Cross)	To check the measurement data saved in the instrument's memory and create measurement reports with a mobile device.	p. 74
Data memory function	To save the measurement data.	p. 85

1.2 Features

Wide test voltage range

Generates a wide range of test voltages, from 250 V to 5 kV.
The voltage may be chosen from the commonly used presets of 250 V, 500 V, 1 kV, 2.5 kV, and 5 kV; or set to a desired level by increments or decrements of 10 V or 25 V.
See “Rotary switch” (p. 24).

Insulation diagnoses

Equipped with a variety of insulation diagnosis functions.

- Automatic calculation and indication of PI (polarization index), DAR (dielectric absorption ratio), and DD (dielectric discharge)
- SV (step voltage test) and Ramp (ramp voltage test)

See “Insulation Diagnosis Functions” (p. 59).

Large memory

Stores up to 1000 manual records and 10 logging records. The stored data may be displayed on the LCD or downloaded to a PC.
See “Recording Measurement Data (Data Memory Function)” (p. 85).

Large, clear display

The large display provides easy viewing. Measurements may also be displayed using a bar graph, offering the feel of an analog meter.
The LCD is backlit, enabling measurement in poor lighting conditions.

PV insulation resistance measurement function (IR5051 only)

Measures the insulation resistance of a PV panel without the effect of current generated by power generation.

Comparator function

Compares measured values with the preset values and judges whether the result is PASS or FAIL. Lights up the backlight in red for a FAIL judgment.

Improved work efficiency with wireless communications function

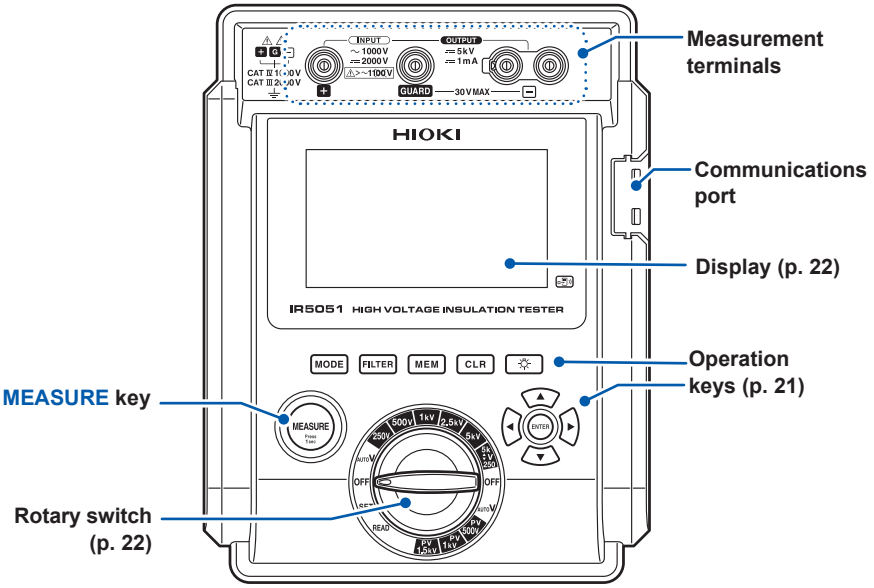
GENNECT Cross (free-of-charge application) allows you to create measurement reports efficiently. The Z3210 Wireless adapter is required.
See “5.3 Wireless Communications Function (GENNECT Cross)” (p. 74).

Improved noise resistance

Uses a shielded cable for L9850-02 and L9850-12 Test Lead for stable measurements.

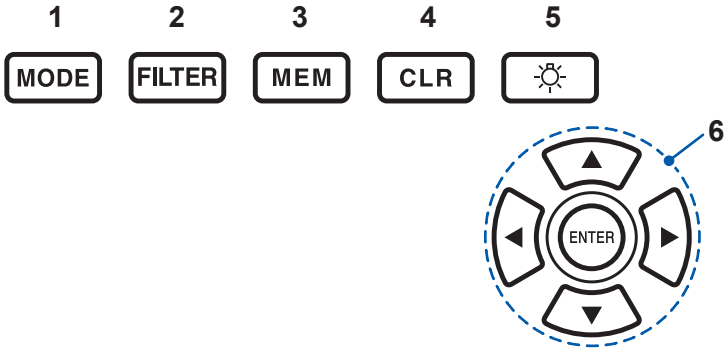
1.3 Part Names and Functions

Front (IR5051)



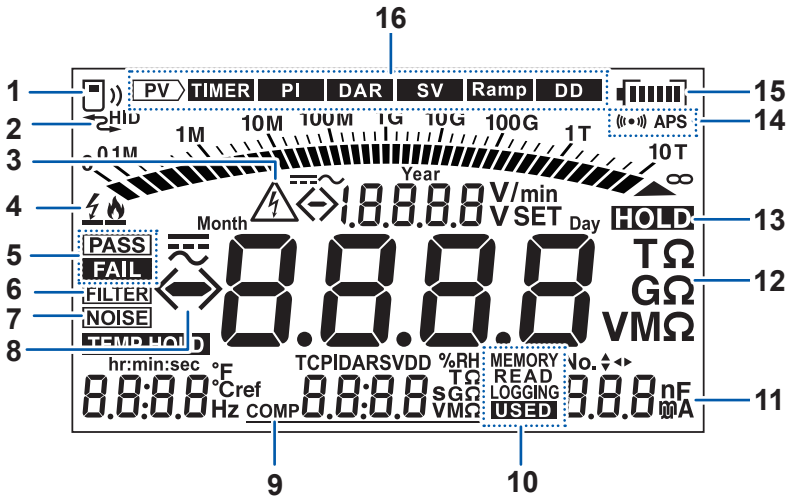
MEASURE key (Live line warning display)	Starts and stops the insulation resistance measurement. Blinks in the following cases: • When a voltage is generated • When a voltage of 30 V or more is input • During discharge
Measurement terminals	**+** terminal: Connect the red test lead to this terminal. **−** terminal: Connect the black test lead to this terminal. **GUARD** terminal: Connect the blue test lead to this terminal.
Communications port	Connect the DT4900-01 communications package (option) to download saved data to a PC. See “5.6 Communicating with PC” (p. 79).

Operation keys



1	MODE	Switches the insulation diagnosis function. The function will change in the following order each time the key is pressed. No function displayed*1 → [TIMER] → [PI] → [DAR] → [SV] → [Ramp] → [DD] → No function displayed *1. Insulation diagnosis function is not available. (The reference value is displayed when the comparator is set.)
2	FILTER	Turns the filter function on and off.
3	MEM	Saves the measured data to the instrument's memory. Held down for more than one second to display the date and time.
4	CLR	Clears the saved data in the instrument's memory.
5	LIGHT key	Turns the backlight on and off.
6	UP (▲) key	Changes the set voltage and numerical values.
	DOWN (▼) key	
	LEFT (◀) key	Moves to locations in a setting and switches the display. Example: t_1 display ↔ t_2 display Example: Change from year to month in the time setting
	RIGHT (▶) key	
	ENTER key	Confirms the setting.

Display (IR5051)

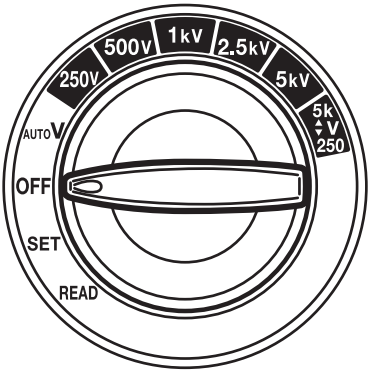


1		Displays the status of the wireless communications function (Z3210). Blinking: Connected to a mobile device Lit: Communications function is on Not lit: Communications function is off
2		Indicates the instrument is communicating with the PC (p. 79).
	HID	Indicates the HID function is enabled (p. 76).
3		Live line warning display Blinks during the insulation resistance measurement and when there is voltage between the measurement terminals.
4		Displayed when insulation breakdown is detected in the object under measurement during the insulation resistance measurement. See “Breakdown function” (p. 109).
5	PASS	Indicates the comparator gives a pass judgment.
	FAIL	Indicates the comparator gives a fail judgment.
6	FILTER	Indicates the filter function is enabled.
7	NOISE	Displayed when noise is detected during the insulation resistance measurement.
8		Displayed as **[–]** when the voltage is negative and as **[>]** or **[<]** when the voltage is overrange.
9	COMP	Displayed when the comparator is set.
10	MEMORY	Displayed when recording measured data to the instrument.
	READ	Displayed when reading measured data recorded to the instrument.
	LOGGING	Displayed for logging recording.
	USED	Displayed when there is saved data.

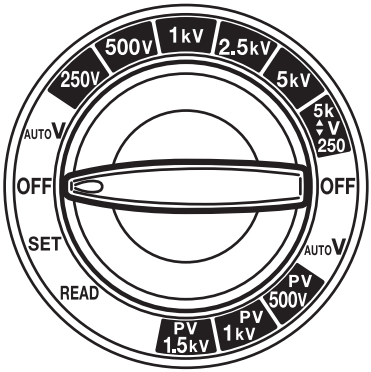
11	**Current value Static capacitance value**	Alternates between the current value and static capacitance value. (Automatically switches every two seconds.)
12	**Unit**	Displays the unit that corresponds to the measured value.
13	**HOLD**	Displayed when the measured value is retained.
14	((•))	Indicates the comparator is enabled.
	APS	Indicates the automatic power save function enabled.
15		Indicates the remaining battery level.
16	**PV**	Displayed during a PV insulation resistance measurement. (IR5051 only)
	TIMER	Displayed during a TIMER measurement.
	PI	Displayed during a PI (polarization index) measurement.
	DAR	Displayed during a DAR (dielectric absorption ratio) measurement.
	SV	Displayed during an SV (step voltage) measurement.
	Ramp	Displayed during a Ramp (ramp voltage) measurement.
	DD	Displayed during a DD (dielectric discharge) measurement.

Rotary switch

IR5050



IR5051

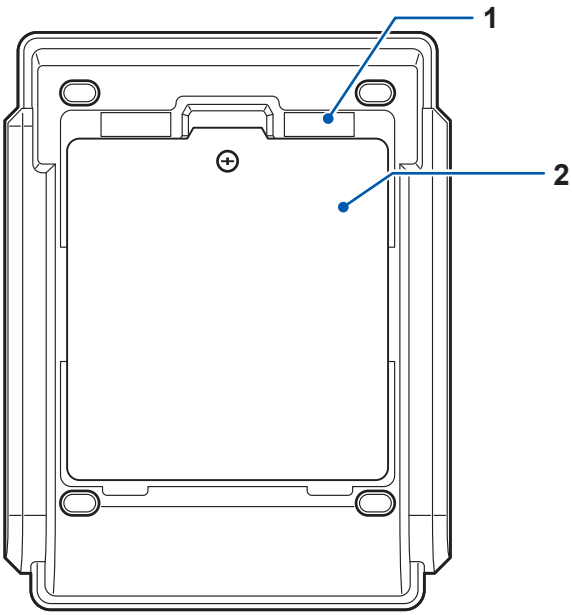


Switches the measurement function and sets the test voltage.

OFF	Turns off the instrument's power. (IR5051: The same operation is performed for both left and right **OFF**.)
AUTO V	Used in voltage measurement. (IR5051: The same operation is performed for both left and right **AUTO V**.)
250V, **500V**, **1kV**, **2.5kV**, and **5kV**	The test voltage for the insulation resistance measurement. The test voltage can be set in greater detail by pressing the ▲ and ▼ keys in each range.*1
5k **▲▼V** **250** (User-defined voltage function)	The test voltage for the insulation resistance measurement. Use the ▲ and ▼ keys to set the desired test voltage.*1 The setting is retained even when the rotary switch is set to off.
PV500V, **PV1kV**, and **PV1.5kV** **(IR5051 only)**	The test voltage for the PV insulation resistance measurement. The test voltage can be set in greater detail by pressing the ▲ and ▼ keys in each range.*1
READ	Reads saved data.
SET	Sets and changes the functions.

*1. Setting resolution
250 V to 1 kV: 10-V steps
1 kV to 5.2 kV: 25-V steps

Back



1	**Serial number**	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 because the number is important. The serial number can also be displayed on the LCD. (p. 83)
2	**Battery cover**	The cover that stores the batteries and the Z3210.

2 Preparing for Measurement

2.1 Inserting/Replacing Battery

When using the instrument, insert eight LR6 Alkaline batteries or eight fully charged HR6 Nickel-metal hydride batteries. In addition, confirm that the battery status is sufficient before the measurement. When the battery status is low, replace the batteries.

Battery indicator

	Sufficient charge
	When the charge decreases, the bars disappear from the left.
	Low charge. Replace as soon as possible.
	 blinks when the batteries have no charge. In this case, measurement is not possible. Replace the batteries.

⚠ WARNING

■ **When removing the battery cover, turn the rotary switch to OFF and remove the test leads from the object under measurement.**

Failure to do so could cause the user to experience an electric shock.

■ **Do not short-circuit the batteries.**

■ **Do not charge alkaline batteries.**

■ **Do not disassemble batteries.**

■ **Do not throw batteries in a fire or heat them.**

Doing so could cause the batteries to rupture, resulting in bodily injury.

■ **After replacing the battery, attach the battery cover and tighten the screw before using the instrument.**

Using the product without the battery cover result in bodily injury.

■ **Secure the battery cover with the screw attached to the instrument at the time of shipment.**

If the battery cover is secured with other screws, the instrument could be damaged, resulting in bodily injury. If you have lost a screw or find that the screw is damaged, contact your authorized Hioki distributor or reseller.

⚠ CAUTION

■ **Do not mix batteries of different ages or types.**

■ **Do not use batteries that have passed their recommended expiration date.**

■ **Do not reverse the battery polarity.**

■ **Do not leave exhausted batteries in the instrument.**

Doing so could cause the battery to leak, damaging the instrument.

■ **Use the specified batteries only (LR6 Alkaline battery or fully charged HR6 Nickel-metal hydride batteries).**

■ **Remove the batteries from the instrument when it will not be used for an extended period.**

Failure to do so could cause the battery to leak, damaging the instrument.

Nickel-metal hydride batteries

⚠ WARNING

■ **Do not expose the batteries to strong impacts and do not throw them around.**

■ **Do not get the batteries wet.**

Doing so could damage the batteries and the instrument, resulting in bodily injury.

■ **Do not use the batteries in excessively humid locations or locations exposed to rain.**

Doing so could damage the batteries and the instrument, resulting in bodily injury.

■ **If you find any battery abnormality (for example, leakage, odor, overheating, discoloration, and deformation) while using, charging, or storing batteries, stop using them immediately.**

Contact your authorized Hioki distributor or reseller.

⚠ CAUTION

■ **Do not mix LR6 Alkaline batteries and nickel-metal hydride batteries.**

Doing so could cause the battery to leak, damaging the instrument.

IMPORTANT

- The operating temperature range of the batteries included with the instrument when shipped is from −10°C to 45°C. If the instrument will be used outside this temperature range, use batteries made for low and high temperatures. (Example: Lithium batteries)
- The capacity of nickel-metal hydride batteries decreases due to self-discharge. Be sure to charge the batteries before initial use. If the battery capacity remains very low after correct recharging, replace the batteries with new batteries.

Equipment

- Phillips screwdriver (No. 2)
- LR6 Alkaline battery × 8 or HR6 Nickel-metal hydride battery × 8

1 **Disconnect the test leads from the instrument.**

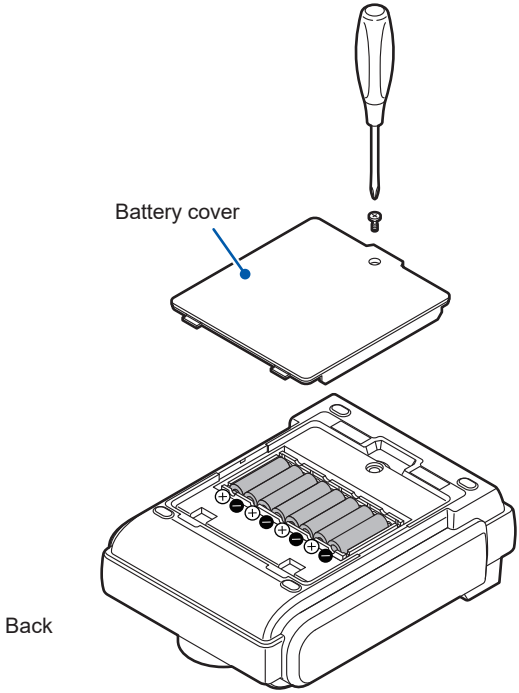
2 **Turn the rotary switch on the instrument to off.**

3 **Loosen the screw and remove the battery cover.**

4 **When replacing the batteries, remove all of the old batteries.**
Replace all eight batteries.

5 **Insert the new batteries while being careful about the correct polarity.**

6 **Reattach the battery cover and tighten the screw.**



2.2 Installing the Z3210 Wireless Adapter

Install the Z3210 wireless adapter (option) in the instrument to allow the use of the wireless communications function.
See “5.3 Wireless Communications Function (GENNECT Cross)” (p. 74).

⚠ WARNING

■ **When removing the battery cover, turn the rotary switch to OFF and remove the test leads from the object under measurement.**

Failure to do so could cause the user to experience an electric shock.

■ **After installing the Z3210, attach the battery cover and tighten the screw before using the product.**

Using the product without the battery cover result in bodily injury.

■ **Secure the battery cover with the screw attached to the instrument at the time of shipment.**

If the battery cover is secured with other screws, the instrument could be damaged, resulting in bodily injury. If you have lost a screw or find that the screw is damaged, contact your authorized Hioki distributor or reseller.

⚠ CAUTION

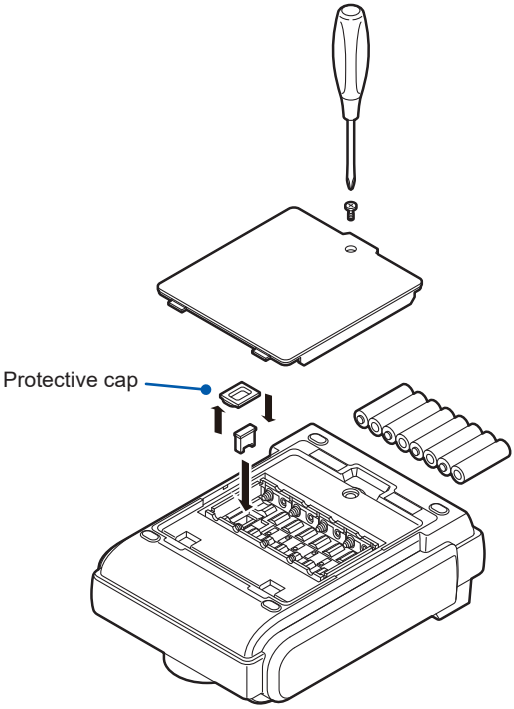
■ **Before handling the Z3210, eliminate static electricity on your body by touching any metallic part, such as a doorknob.**

Failure to do so could cause static electricity to damage the Z3210.

Equipment

- Phillips screwdriver (No. 2)
- Flathead screwdriver
- Z3210 wireless adapter (option)

1. **Disconnect the test leads from the instrument.**
2. **Turn the rotary switch on the instrument to off.**
3. **Loosen the screw and remove the battery cover.**
4. **Remove batteries.**
5. **Remove the protective cap from the instrument.**
6. **Insert the Z3210 completely while being careful about the correct orientation.**
7. **Reattach the protective cap.**
8. **Insert batteries.**
9. **Reattach the battery cover and tighten the screw.**
   When removing the Z3210, use a tool such as a flathead screwdriver to remove it.

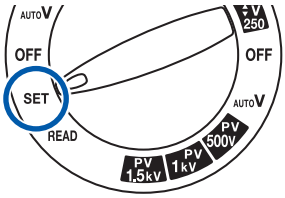


2.3 Setting and Checking Date and Time

Set or check the time and date before use of the instrument.
Use the Gregorian calendar.

Setting date and time

1 **Turn the rotary switch to SET.**



2 **Hold down the MEM key for more than one second.**
The year, month, day, hours, minutes, and seconds appear.
The selected location starts blinking.

3 **Press the ◀ key or ▶ key and move to the location to set.**

4 **Press the ▲ key or the ▼ key to set the numerical value.**
Hold down a key for fast increase/decrease of the numerical value.

5 **Press the ENTER key to confirm the numerical value.**
The LCD returns to the previous display.
The clock starts to run as soon as the **ENTER** key is pressed.

The time can also be set from a PC.

- The date and time can be set up on a PC using Sequence Maker.
- Sequence Maker must be installed on the PC.

See “5.6 Communicating with PC” (p. 79).

Checking date and time

1 **Turn the rotary switch to any position other than OFF.**

2 **Hold down the MEM key for more than one second.**

Displays the currently set year, month, day, hours, minutes and seconds.

Press any key to return to the original display.

2.4 Connecting Test Leads

⚠ DANGER

■ **Check that the insulation on the leads is not damaged and that the conductors in the leads are not exposed before use.**

Using test leads or an instrument that are damaged could lead to serious bodily injury. If you find any damage, replace with a Hioki-specified part.

⚠ WARNING

■ **Do not use the instrument with the test leads connected for measurements that exceed any of the ratings marked on them.**

Using the product for measurements that exceed any ratings could cause the user to experience an electric shock.

■ **Use only Hioki-specified test leads with the instrument.**

Using an unspecified test lead could result in bodily injury or a short-circuit fault.

⚠ CAUTION

■ **Do not bend or pull on cables at temperatures of 0°C or lower.**

Cables could harden in low temperatures. Bending or pulling a cable under these conditions could cause a break in the cable or damage the insulation, resulting in an electric shock.

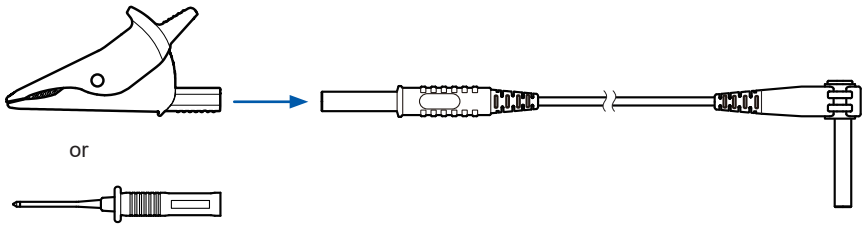
■ **Do not allow test leads to contact each other or place objects on test leads.**

Doing so could cause measurement errors and malfunctions.

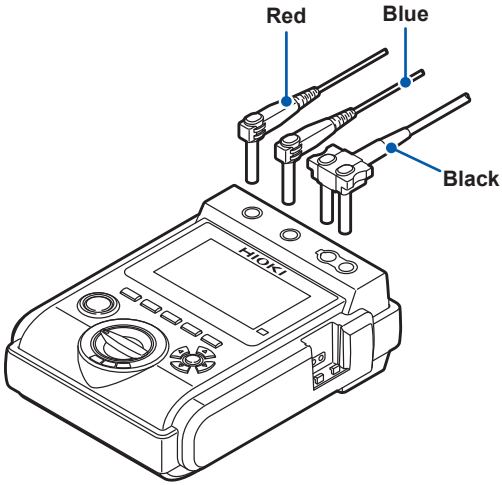
IMPORTANT

Be sure to clean test leads after use. If test leads are dirty, they may deteriorate.

1 **Connect alligator clips or test pins (IR5051 only) to the ends of test leads.**
Insert it fully.



2 **Connect the red test lead to the + terminal and the black test lead to the − terminal.**
For insulation resistance measurement, connect the blue test lead to the GUARD terminal*1 if necessary.
Insert it fully.



*1. A **GUARD** terminal is used to prevent the surface electrical resistance of an insulating material affecting measurement, enabling correct measurement of the entire volume resistivity of the material.
See “3.6 Use of GUARD Terminal” (p. 48).

3 Making Measurements

3.1 Measurement Procedure

Always read the information in “Precautions for Use” (p. 15) before using the instrument.

Preparations

Insert the batteries. (p. 27)

Prepare other options as necessary.

Set the date and time. (p. 33)

Perform the pre-operation inspection. (p. 38)

Measurement (insulation resistance)

Make sure that power supply to the object under measurement is turned off.

Set the test voltage with the rotary switch.

Connect the test leads to the instrument.

Connect the test leads to the object under measurement.

Generate voltage and start measurement.

Check the displayed value.

With the test leads connected to the object under measurement, press the MEASURE key to end voltage generation and measurement.

Discharge remaining electric charge with automatic discharge function.

Stop

Turn the rotary switch to OFF and remove the test leads from the object under measurement.

3.2 Pre-Operation Inspection

⚠ DANGER

■ **Inspect the instrument and verify proper operation before use.**

Use of the instrument while it is malfunctioning will result in serious bodily injury.

If you find any damage, contact your authorized Hioki distributor or reseller.

Inspecting the instrument

Inspection item	Action
The battery level is sufficient.	Turn the rotary switch to any position other than OFF. With the power on, check the battery indicator at the top-right corner of the LCD. If the ▭ symbol is blinking, the battery level is low. Replace the batteries with fresh ones. When using nickel-metal hydride batteries, charge the batteries. See “2.1 Inserting/Replacing Battery” (p. 27).
The display has no missing segment.	Check with the fully lit display. If any parts are missing, request repair. See “5.7 Power On Options List” (p. 82).
The live line warning display (**MEASURE** key) works properly.	Check with the following procedure. 1. Turn the rotary switch to one of the selections between **250 V** and **5k ⇕V 250** . 2. Press the **MEASURE** key for at least one second. 3. Check if the **MEASURE** key is blinking. 4. Press **MEASURE** key to end the check. If the key is not blinking, do not use the instrument and request for repair.
The instrument does not have any damage or cracks.	Check visually. If the instrument is damaged, do not use it. Request repair.
The measurement terminals do not have any foreign matter, such as sand, in them.	Remove any foreign objects if any. If the foreign objects cannot be removed, request repair.

Inspecting the accessories and options

Inspection item	Action
The test leads or cables have no damaged insulation or no exposed inner white parts or metal.	If you find any damage, there is a risk of electric shock. Replace the parts with Hioki-specified parts.
The clips or test pins does not have any damage or cracks.	Check visually. Do not use if damaged. Replace the parts with new parts.

Checking the insulation resistance measurement

Inspect the following before starting a test to use the instrument safely.
Inspect whether the measured resistance matches the prepared resistance.
If a problem exists, do not use the instrument and request repair.

Equipment:
Recommended resistance: GS Series High Voltage, High Resistance Thick Film Resistor or equivalent product (pay attention to the operating voltage and power)
Manufacturer: KOA Corporation

⚠ CAUTION

■ **Do not allow the test voltage (power) to exceed the rated voltage (power) of the prepared resistor.**

Doing so could damage the resistor.

Setting example: When the insulation resistance of the object under measurement is 100 MΩ

Maximum operating voltage	1000 V
Rated power	0.5 W
Test voltage	500 V

1. **Prepare the resistor.**
2. **Confirm that the test voltage is less than the maximum operating voltage of the prepared resistor.**
   Test voltage < Maximum operating voltage of prepared resistor
   (Example: 500 V < 1000 V)
3. **Confirm that the value calculated from the test voltage and resistance is less than the rated power of the prepared resistor (if the value calculated from the test voltage and resistance is greater than the rated power of the prepared resistor, change the resistor or change the test voltage).**

$$\frac{\text{Square of test voltage}}{\text{Resistance}} < \text{Rated power of prepared resistor}$$

$$\left(\text{Example: } \frac{500\ \text{V} \times 500\ \text{V}}{100\ \text{M}\Omega} = 0.0025\ \text{W} < 0.5\ \text{W}\right)$$

4. **Set the test voltage to 500 V.**

5 **Clip the resistor with the red and black test leads connected to the instrument.**

6 **Hold down the MEASURE key for more than one second to start insulation resistance measurement.**

See “3.3 Measuring Insulation Resistance” (p. 41).

7 **Check to see if the voltage monitor value reading of the instrument is between 500 V and 550 V.**

8 **Check to see if the insulation resistance reading of the instrument is 100 MΩ.**

9 **Press the MEASURE key to end the insulation resistance measurement.**

10 **Short-circuit the tips of the clips of the red and black test leads of the instrument.**

11 **Set the test voltage to 500 V.**

12 **Hold down the MEASURE key for more than one second to start insulation resistance measurement.**

13 **Check to see if the insulation resistance reading of the instrument is 0.00 MΩ.**

14 **Press the MEASURE key to end the insulation resistance measurement.**

3.3 Measuring Insulation Resistance

⚠ DANGER

■ **To avoid an electric shock and a short-circuit, make sure to observe the following precautions.**

1. Check Table 1 before connecting test leads to the instrument.
2. Check to see if the object under measurement is not live or electrically charged using a high-voltage detector or other similar instrument, before connecting test leads to it.

Table 1

Check item	Result	Action
Are the ⚠ mark and **MEASURE** key lamp off?	Off	Connect test leads to the instrument and check 2 above. If safe to proceed, connect the test leads to the object under measurement. Go to Table 2.
	Blinking	Press the **MEASURE** key to stop voltage generation.

Table 2

Check item	Result	Action
Are the ⚠ mark and **MEASURE** key lamp blinking?	Not blinking	A measurement can be performed.
	Blinking	Immediately disconnect the test leads from the object under measurement and turn off power to the object or discharge the electric charge using a discharge rod.

⚠ WARNING

■ **Do not measure insulation resistance while an object under measurement is energized.**

Doing so could damage the instrument, resulting in bodily injury.
Shut off the power to the object under measurement before measurements.

■ **Do not touch the connecting part of terminals and alligator clips during measurement.**

Doing so could damage the test leads, causing the user to experience an electric shock.

■ **Do not touch the object under measurement or disconnect the test leads after measurement has been completed until the automatic discharge function is completed.**

Electric shock may result due to high voltage and stored charge.

■ **Check the position of the rotary switch before measurement.**

■ **Remove the test leads from the object under measurement before changing the position of the rotary switch.**

Failure to do so could cause serious bodily injury, a short-circuit fault or damage to the instrument.

■ **If the instrument's power is lost during measurement, such as due to battery consumption, when the rotary switch is in a position other than OFF, discharge the object under measurement using a discharge rod.**

The automatic discharge function will not operate fully and electric shock may result.

⚠ CAUTION

■ **Do not measure the insulation resistance between the terminals of capacitors (with a capacitance of over 25 µF).**

Doing so could damage the instrument during discharge.

■ **Do not short-circuit the tips of the clips of the red test lead (+ terminal) and the blue test lead (GUARD terminal).**

Doing so could damage the instrument.

■ **Be sure to check the test voltage before starting measurement.**

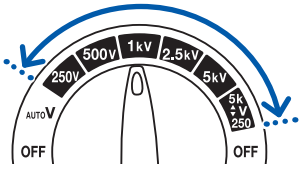
Otherwise there is a risk of damage to the object under measurement.

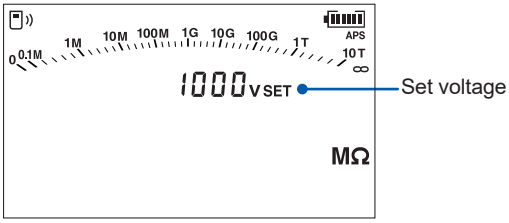
IMPORTANT

- Insulation resistance is unstable. The indication may not stabilize depending on the object under measurement.
- Depending on the charging current flowing to the capacitance component of the object under measurement and the associated absorption current, a value smaller than the actual resistance value may be displayed after measurement starts. The display value may then gradually increase and approach the actual resistance value.
- During measurement, if the resistance of the object under measurement suddenly drops or if the test lead tips are short-circuited, the instrument stops voltage generation as a safety measure. (This applies to a test voltage of 1100 V or more.) See “Breakdown function” (p. 109).
- If the rotary switch is turned off during measurement, automatic discharge is performed before power is turned off.
- If the battery runs low during measurement, the instrument automatically stops measurement. After automatic discharge is performed, the display changes as follows and the power is turned off.
  [Lo bAtt] → [P.oFF]
- When measuring a capacitive load, the current may flow in reverse if the voltage charged in the object under measurement is larger than the set output voltage and for other reasons such as output voltage fluctuations. If the measured current value is negative, the current indication blinks.
- Turn the rotary switch to OFF after use.

1 **Turn the rotary switch to one of the selections between test voltage 250 V and 5k ▲▼ V 250 .**

You can also press the ▲ and ▼ keys to set the desired test voltage.



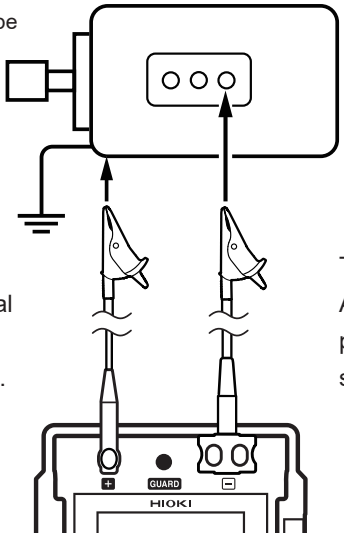


2 **Connect the test leads to the instrument. (p. 35)**

3 **Connect the test leads to the object under measurement.**

Clip the alligator clip at the end of each test lead to the object under measurement.

Example of the object to be measured: Motor

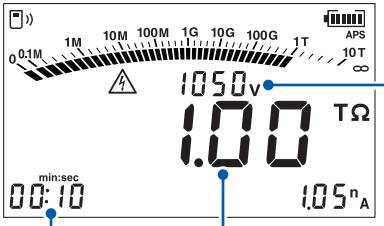


Test lead (Red)
Attach to a metal chassis or a ground terminal.

Test lead (Black)
Attach to a metal part of the power supply terminal.

4 **Hold down the MEASURE key for more than one second to start measurement.**

Voltage is generated, and the ⚠ mark and **MEASURE** key start blinking.
The display changes from the set voltage to the actual output voltage. A voltage approximately 5% higher than the set level is output.



Actual output voltage

Set voltage

Press the ▲ key to display the set voltage for two seconds.

Elapsed time

Insulation resistance

- During measurement, if the output voltage is lower than the set voltage, the voltage indication blinks.
- During measurement, if the measured current is negative, the current indication blinks.

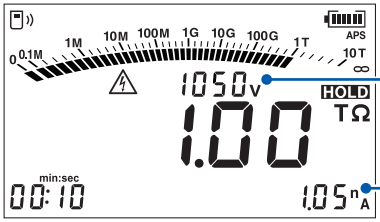
5 **When the display has stabilized, check the value.**

If the indication is unstable, enable the filter function. An average of the measured value is displayed.

See “3.5 Filter Function” (p. 47).

6 **With the test leads connected to the object under measurement, press the MEASURE key to end measurement.**

The last measurement is retained ([HOLD] is lit) and voltage generation and measurement are stopped.



When measuring for 1 min. or more, the 1-min. value can be displayed with the ◀ or ▶ key, either during or after measurement.

7 **Discharge the electric charge that remains in the object under measurement.**

After measurement has been completed, the discharge circuit in the instrument automatically discharges the electric charge remaining in the object under measurement.

See “3.4 Automatic Discharge Function” (p. 46).

Retention of the measured value

IMPORTANT

The retained measured values are cleared when power is turned off. To save the data, use the memory function.

See “Recording Measurement Data (Data Memory Function)” (p. 85).

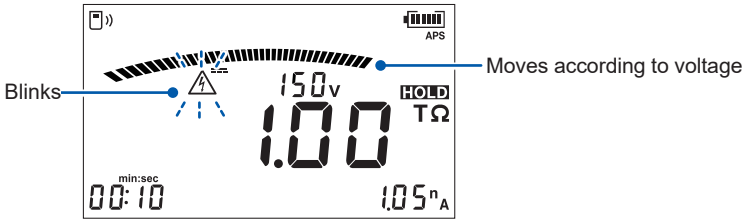
Deleting the retained data

To clear the data, press the **CLR** key.

3.4 Automatic Discharge Function

After the measurement, discharge the electric charge in the object under measurement.
When insulation resistance with a capacitance component is measured, this component remains charged with a high-voltage equivalent to the test voltage, which is dangerous.
This instrument can automatically discharge remaining electric charge using the internal circuit after measurement.

With the test leads connected to the object under measurement, press the MEASURE key to end measurement.
The charge remaining in the object under measurement is automatically discharged with the discharge resistance inside the instrument.
During discharge, the voltage is displayed and the ⚠ mark and **MEASURE** key continue blinking.
The bar graph decreases according to the voltage.



During discharge

Discharging stops when the residual voltage falls below 30 V. The ⚠ mark goes out.
The discharge time varies depending on the capacitance.

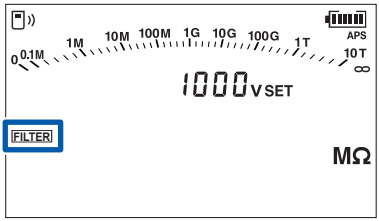
3.5 Filter Function

If the indication is unstable, the average of the measurement is shown.

Setting method

Hold down the **FILTER** key to enable or disable the function.

When the filter function is enabled, **[FILTER]** appears on the LCD.



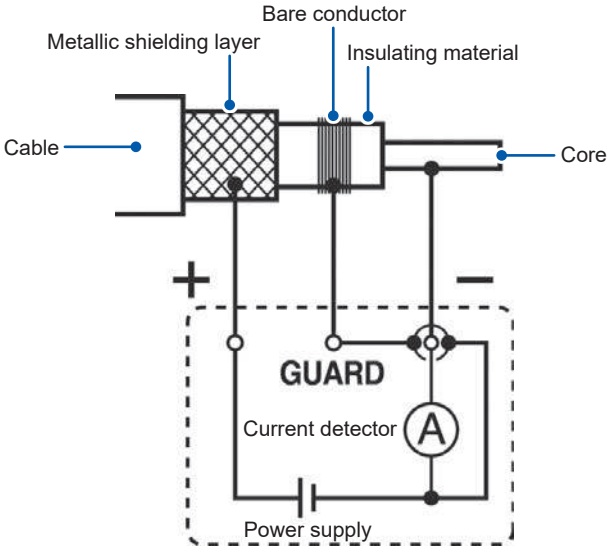
While **[FILTER]** is enabled, display update interval is four seconds. But in the following cases, the interval is one second.

- During 15 seconds after the measurement started
- During 5 to 10 seconds after the measurement range changed

3.6 Use of GUARD Terminal

Measurement unaffected by surface electrical resistance

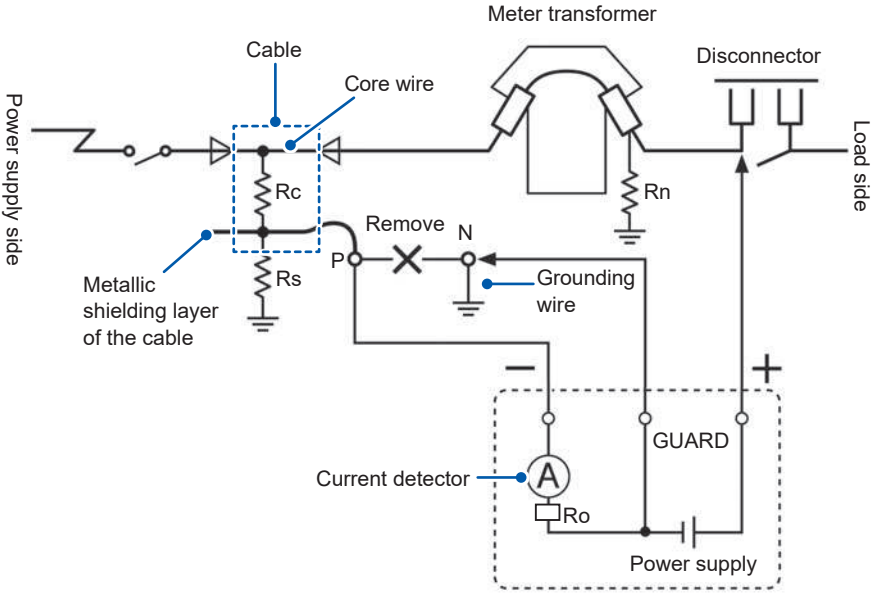
A **GUARD** terminal is used to prevent the surface electrical resistance of an insulating material affecting measurement, enabling correct measurement of the entire volume resistivity of the material.



When testing the insulation of a cable, as shown in the diagram above, wind a bare conductor around the surface of the insulating material and connect the conductor to the **GUARD** terminal. This prevents the leakage current on the surface of the insulating material flowing into the current detector, which enables the actual resistance of the entire volume of the insulating material to be measured.

Measurement using G (GUARD) terminal grounding

G terminal grounding is used for measuring the insulation resistance between the core and the metallic shielding layer of a high-voltage cable with the cable connected to other high-voltage equipment. The diagram below shows an example of measurement.



Rc: Insulation resistance of the insulating material of the high-voltage cable (Between core and metallic shielding layer)

Rs: Insulation resistance of the sheath of the high-voltage cable (Between metallic shielding layer and ground)

Rn: Insulation resistance between insulator or high-voltage equipment and ground

Ro: Instrument's internal resistance (approx. 3 kΩ)

Influence of Rs and Rn is removed and solely Rc is measured.

For details, refer to regulations for high-voltage power receiving facility.

3.7 Measuring Voltage

The instrument measures the voltage of an external circuit, e.g., commercial power supply. It automatically determines AC voltage or DC voltage.

⚠ DANGER

■ **Do not allow the tip of test leads to short-circuit two wires across which a voltage is applied.**

Doing so will cause a short-circuit fault, resulting in serious bodily injury.

⚠ WARNING

■ **When measuring power line voltage, use test leads that satisfy the following conditions:**

- IEC 61010 or EN 61010 safety standard-compliant
- Rated for measurement category III or IV
- Rated voltage higher than voltage being measured

Failure to do so could cause the user to experience an electric shock. The test leads included with the instrument comply with the EN 61010 safety standard. Observe the measurement category and rated voltage indicated on the test leads during use.

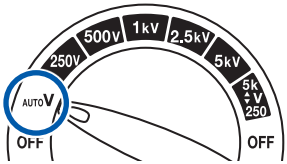
⚠ CAUTION

■ **Do not input voltage from an external source when the rotary switch is set to OFF.**

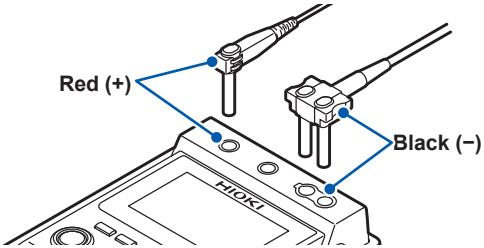
■ **Do not input voltage from an external source to GUARD terminal.**

Doing so could damage the instrument.

1 **Turn the rotary switch to AUTO V.**



2 **Connect the test leads to the instrument. (p. 35)**



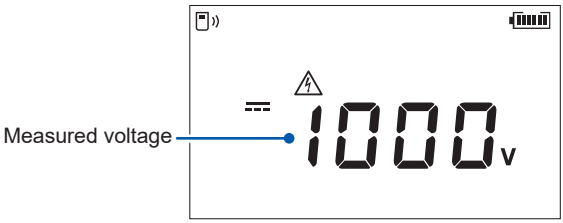
3 **Connect the test leads to the object under measurement.**

Clip the alligator clip at the end of each test lead to the object under measurement.

4 **Check the value.**

When a voltage of 30 V or more is input, the ⚠ mark and **MEASURE** key start blinking.

Example: Direct current (DC)



You can retain the measured value by pressing the **MEASURE** key. (**[HOLD]** lights up.)

To cancel the held value, press the **MEASURE** key again.

3.8 Negative Voltage Notification Function (IR5051 Only)

This function checks if the P and N connections are reversed when measuring the open voltage of a PV string.

ON (default)	When the voltage is −10 V or less, the backlight lights up alternating between white and red.
OFF	Disabled

Checking and changing the setting

1 **Turn off the power by turning the rotary switch to OFF.**

2 **While holding down the ▶ (RIGHT) key, turn the rotary switch to any position to turn on the power.**

The current setting appears.

3 **To change the setting, repeat steps 1 and 2.**
The setting is saved even when the power is turned off.

3.9 PV Insulation Resistance Measurement Function (IR5051 Only)

This function can accurately measure the insulation resistance between a PV panel and ground without being affected by power generation. For a measurement between the connection box output terminal and ground and between the power conditioner and ground, use the insulation resistance measurement function, not the PV insulation resistance measurement function (p. 41).

⚠ WARNING

■ **Do not measure insulation resistance while an object under measurement is energized.**

Doing so could damage the instrument, resulting in bodily injury. Shut off the power to the object under measurement before measurements.

■ **Do not touch the object under measurement or disconnect the test leads after measurement has been completed until the automatic discharge function is completed.**

Electric shock may result due to high voltage and stored charge.

■ **Do not directly touch the metal parts of the connection box, disconnector, and other devices.**

Electric shock may result due to high voltage from power generation.

■ **Securely connect the measurement cables to the measurement terminals.**

Loose terminals could increase contact resistance and cause the instrument to overheat, resulting in instrument burnout or fire.

■ **When measuring a PV panel, make sure to turn off the disconnector or other device to separate the panel from the power conditioner.**

■ **Make the measurement using sufficient caution to protect against electric shock because PV cells always generate power and hazardous voltage during the day.**

Failure to do so could cause the user to experience an electric shock.

⚠ CAUTION

■ **Do not measure insulation resistance if the PV panel is faulty.**

The bypass diode connected to the PV panel may be damaged.

IMPORTANT

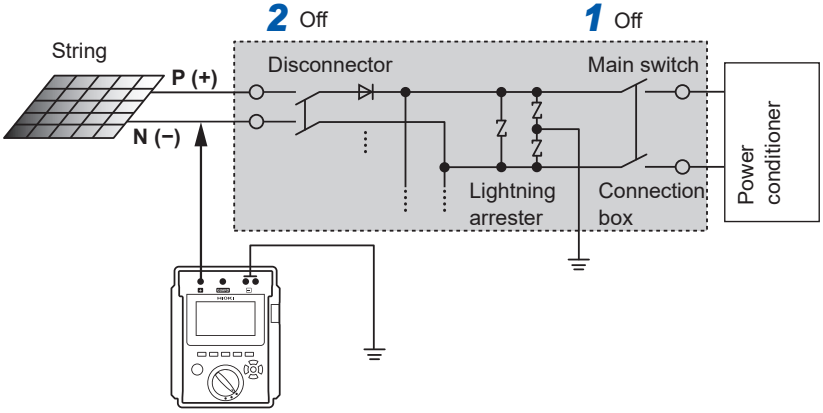
- Insulation resistance is the ratio of applied voltage to leakage current. The indication may not stabilize depending on the object under measurement, but this is not an instrument malfunction.
- During measurement, if the resistance of the object under measurement suddenly drops or if the test lead tips are short-circuited, the instrument stops voltage generation as a safety measure. (This applies to a test voltage of 1100 V or more.)
  See “Breakdown function” (p. 109).
- Turn the rotary switch to OFF after use.
- When testing a circuit connected to a device with low withstand voltage or a device/part with unknown withstand voltage using test voltage, taking the measurement by disconnecting the device/part is recommended.
- It may take time for the measured value to stabilize because a PV panel has a large ground capacitance.
- If the open voltage of a PV string is larger than the test voltage, correct measurement may not be possible.
- If a voltage is being generated greater than the test voltage, the buzzer beeps and measurement is not possible.
- For a measurement using the method that short-circuits between P-N, use an insulation resistance range other than one for PV insulation resistance.
- Use the method that short-circuits between P-N when the PV panel is not generating power, such as at night.
- PV insulation resistance measurement function is connected to approx. 660 kΩ of current-limiting resistance on the + (positive) terminal, so the output voltage is divided by approx. 660 kΩ and the resistance connected between the measurement terminals.
  Example: When a resistance of 10 MΩ was measured, the output voltage was divided by approx. 660 kΩ and 10 MΩ.

This section describes the insulation resistance measurement between a PV panel and ground using the method not to short-circuit between P-N.
See “9.7 Measurement Methods for Insulation Resistance of PV Array” (p. 125).
This instrument measures PV module insulation resistance in accordance with the IEC/EN 62446-1 guidelines.

Measurement preparations

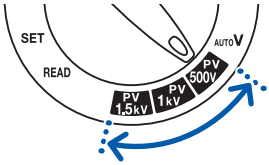
1. **In the connection box, turn off the main switch and disconnect the connection to the power conditioner.**
2. **Turn off the disconnectors for all PV strings.**
3. **Disconnect any lightning arresters on the measurement circuit.**
   For the case in the following diagram (solar power generation facility), the lightning arrester does not need to be disconnected because it is not on the PV string side of the disconnector.

Example: Solar power generation facility



Measurement

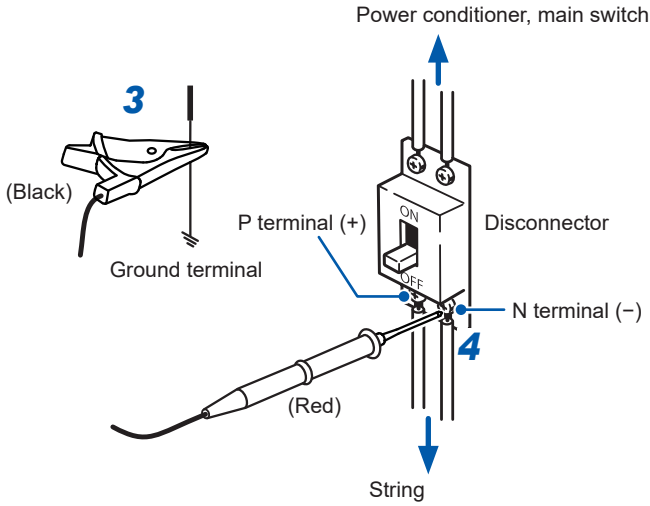
1 **Turn the rotary switch to test voltage PV500V, PV1kV, or PV1.5kV.**
You can also press the ▲ and ▼ keys to set the desired test voltage.



2 **Connect the test leads to the instrument. (p. 35)**

3 **Connect the black test lead to the ground terminal.**

4 **Connect the red test lead to the N terminal on the PV string side.**



There is a risk of insulation deterioration when voltage is generated between the N terminal and ground. When there is voltage in the object under measurement, the backlight blinks in red by the voltage detection function.

5 **Hold down the MEASURE key for more than one second to start measurement.**

Voltage is generated, and the ⚠ mark and **MEASURE** key start blinking.
Do not disconnect the test leads from the terminals during the measurement.
Correct measurement is not possible.

IMPORTANT
For the PV insulation resistance measurement, press the **MEASURE** key after the test leads are connected to the object under measurement. Correct measurement is not possible if the test leads are connected to the object under measurement when the **MEASURE** key has been pressed and voltage is being generated.

6 **When the resistance appears, check the value.**

If the indication is unstable, enable the filter function. An average of the measured value is displayed.
See “3.5 Filter Function” (p. 47).

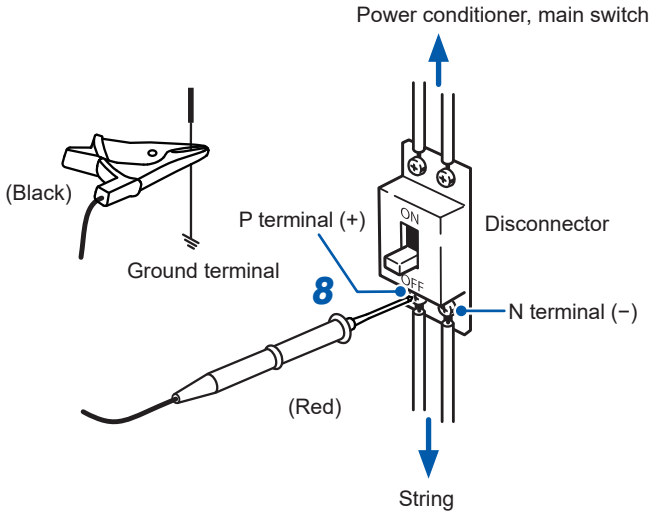
IMPORTANT
If there is insulation deterioration and the resistance is lower than the reference value, do not measure the P terminal side in step **8**. The PV panel may be damaged. For the insulation resistance reference value, check in the safety regulations and other information in advance.

7 **Press the MEASURE key to end measurement.**

Discharge is started, and the ⚠ mark and **MEASURE** key start blinking.
When the voltage falls to about 30 V, the instrument stops discharging and the ⚠ mark and **MEASURE** key are turned off.
The ⚠ mark may not be turned off when discharging is stopped because voltage is generated from the PV cells.

When measuring for 1 min. or more, the 1-min. value can be displayed with the ◀ or ▶ key, either during or after measurement.

8 **If there is no insulation deterioration in the measurement for the N terminal side, connect the red test lead to the P terminal on the PV string side and repeat steps 5 to 7.**



After the end of measurement

1 **After the insulation resistance of all PV strings has been measured, disconnect the black test lead from the ground terminal.**

2 **Reconnect any lightning arresters that were disconnected.**

3 **Turn on the disconnectors for all PV strings.**

4 **Turn on the main switch in the connection box.**

4 Insulation Diagnosis Functions

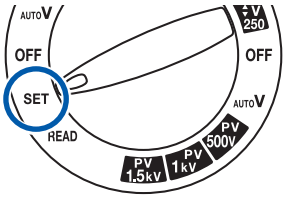
For PV insulation resistance measurement, timer test can only be performed.

4.1 TIMER Function (Timer Test)

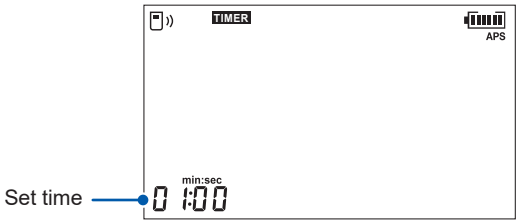
Used to set the instrument to automatically stop the test at a specified time.
If the timer is set during insulation resistance measurement, the measurement automatically ends at the set time.
Setting range: 10 sec. to 99 min.

Setting method

1 **Turn the rotary switch to SET.**



2 **Press the MODE key and select the [TIMER] display.**



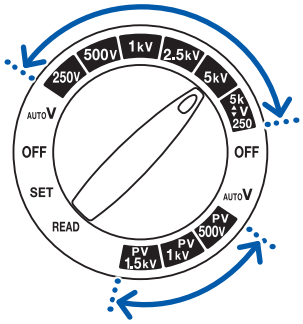
3 **Press the ▲ key or the ▼ key to set the numerical value.**
The time indication will blink. Hold down a key for fast increase/decrease of the numerical value.

4 **Press the ENTER key to confirm.**

Using timer

1 **Turn the rotary switch to one of the following .**

- Insulation resistance measurement: between **250 V** and **5k ▲▼ V 250**
- PV insulation resistance measurement: **PV500V**, **PV1kV**, or **PV1.5kV**



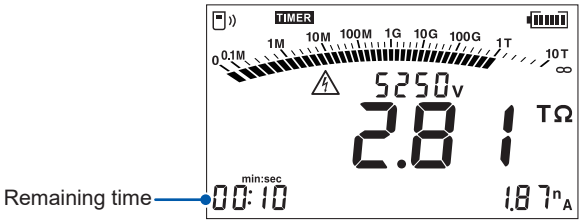
2 **Press the MODE key and select the [TIMER] display.**

The timer is set.

3 **Measure insulation resistance.**

See “3.3 Measuring Insulation Resistance” (p. 41).

The remaining time appears during the measurement.



After the set time has elapsed, the instrument automatically stops measurement.

If the **MEASURE** key is pressed, the instrument immediately stops measurement regardless of the remaining time.

When the timer is set, the automatic power save function is disabled.

When measuring for 1 min. or more, the 1-min. value can be displayed with the ◀ or ▶ key, either during or after measurement.

4.2 PI (Polarization Index) and DAR (Dielectric Absorption Ratio) Measurement

Used to check whether insulation resistance increases with time after a voltage is applied.

The instrument automatically calculates and displays PI*1 (polarization index) and DAR*2 (dielectric absorption ratio), which are used as the criteria to determine the quality of insulation. Both measurements show a degree of change in insulation resistance with time after a test voltage is applied.

When the PI value or the DAR value is less than 1, the instrument determines that the insulation of the object under measurement is deteriorated. The PI value and DAR value are not dependent on temperature because the temperature of the insulating material does not vary by a large degree during measurement.

See “9.4 Example of PI (Polarization Index) Criteria” (p. 123).

*1. Polarization Index

If the obtained measured value of insulation resistance is greater than 5000 MΩ one minute after voltage was applied, the PI value is not recommended in IEEE 43 because it may not be the insulation diagnosis index.

*2. Dielectric Absorption Ratio

DAR is used when the measured value stabilizes within one minute.

Overview of test

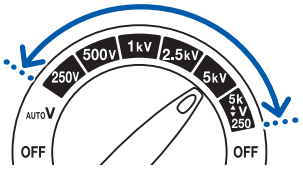
The results are calculated with the following formula from the resistance after the specified amounts of time (t_1 and t_2) have elapsed after the start of the insulation resistance measurement.

The specified amounts of time (t_1 and t_2) can be set to the desired times.

See “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70).

Calculation formula	Default value
$PI = \frac{t_2 \text{ resistance}}{t_1 \text{ resistance}}$	t_1 = 1 min. t_2 = 10 min.
$DAR = \frac{t_2 \text{ resistance}}{t_1 \text{ resistance}}$	t_1 = 30 sec. t_2 = 1 min.

1 **Turn the rotary switch to one of the selections between 250 V and 5k ▲▼V 250 .**

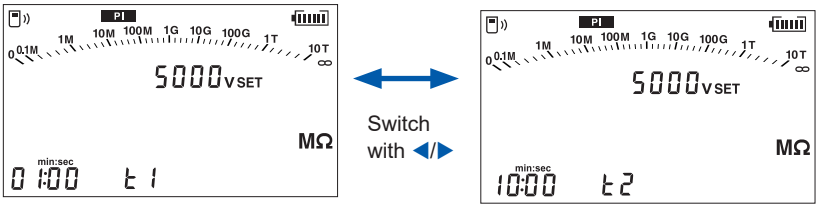


2 **Press the MODE key and select the [PI] or [DAR] display.**

The t_1 display appears.

Use the ◀ or ▶ key to display the t_2 display.

Example: PI measurement



t_1 display

t_2 display

3 **Specify amount of time (t_1 and t_2)**

Setting range: 10 sec. to 99 min.

See “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70).

4 **Measure insulation resistance.**

See “3.3 Measuring Insulation Resistance” (p. 41).

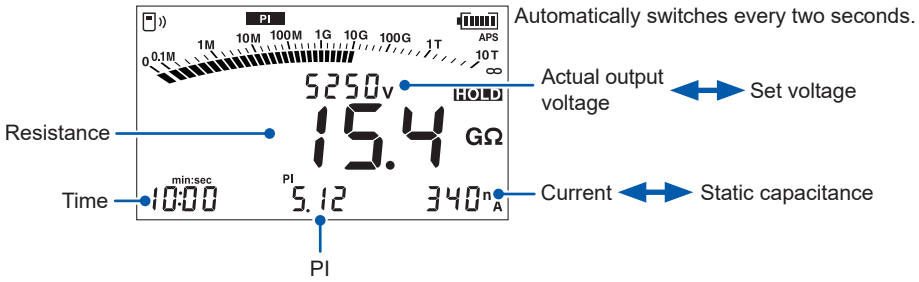
To determine PI, continue measurement for 10 minutes (for the default settings).

To determine DAR, continue measurement for one minute.

5 **Stop measurement.**

6 **Check the measured value.**

Use the ◀ or ▶ key to switch the t_1 display and t_2 display.



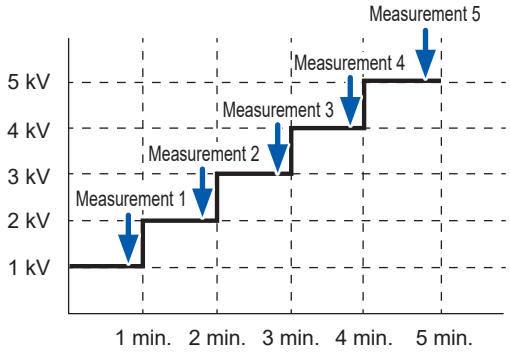
4.3 SV Measurement (Step Voltage Test)

Used to determine whether the insulation resistance of an object under measurement is affected by a change in test voltage.
The step voltage test is based on the following principle: An ideal insulating material shows the same resistance at all voltages. And the resistance of a deteriorated insulating material decreases when the applied voltage increases.
If the insulation resistance decreases as the test voltage increases, the object under measurement is damp or unclean and requires attention.
(Reference standard: IEEE 95)

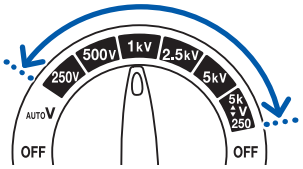
Overview of test

- The test voltage is increased in 5 steps of 20% each at regular intervals during insulation resistance measurement. The resistance and current are measured once at the end of every step.
- The voltage is increased when one minute has passed per step. When 5 minutes has passed in total, measurement automatically stops (default setting).
  The voltage application time per step can be changed. However, the voltage application time cannot be varied for each step.
  See “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70).

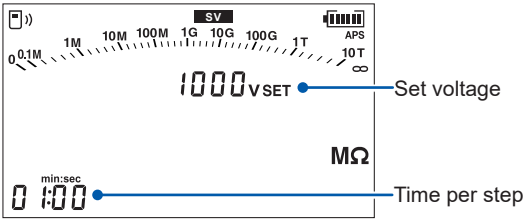
Example:
When set to test voltage: 5 kV and voltage application time per step: 1 min.
Order of applied voltage: 1 kV → 2 kV → 3 kV → 4 kV → 5 kV



1 **Turn the rotary switch to one of the selections between 250 V and 5k ▲▼ V 250 .**



2 **Press the MODE key and select the [SV] display.**



3 **Set the time per step.**

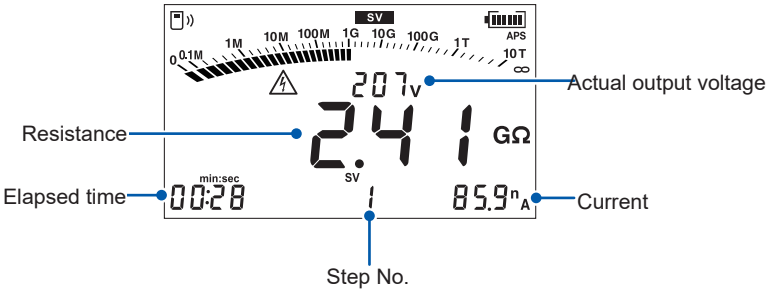
Setting range: 10 sec. to 10 min.

See “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70).

4 **Measure insulation resistance.**

See “3.3 Measuring Insulation Resistance” (p. 41).

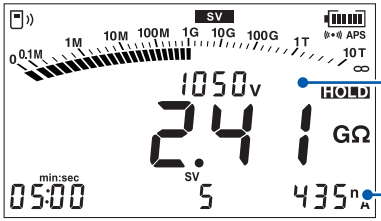
The test voltage rises each minute (default setting) and the measurement stops automatically.



The last data is retained and displayed (**[HOLD]** lights up).

5 **Check the measured value for each step.**

Use the ◀ or ▶ key to switch to the data display for each step.



Automatically switches every two seconds.

Actual output voltage ◀▶ Set voltage

Current ◀▶ Static capacitance (step 5 only)

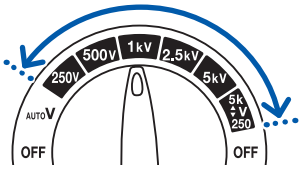
4.4 Ramp Measurement (Ramp Voltage Test)

Used to determine whether the insulation resistance of an object under measurement is affected by a change in test voltage, in the same manner as the step voltage test. This test subjects the object under measurement to less stress than the step voltage test because the test voltage is continuously increased in a gradual manner.
(Reference standard: IEEE 95)

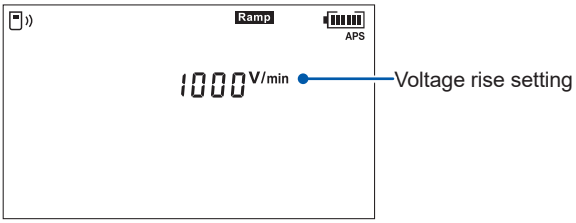
Overview of test

The applied voltage in the insulation resistance measurement is gradually raised until it reaches the set voltage. The measurement automatically ends once the applied voltage reaches the set voltage.
Default setting: 1000 V/min
See: “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70)

1 **Turn the rotary switch to one of the selections between 250 V and 5k ▲▼ V 250 .**



2 **Press the MODE key and select the [Ramp] display.**



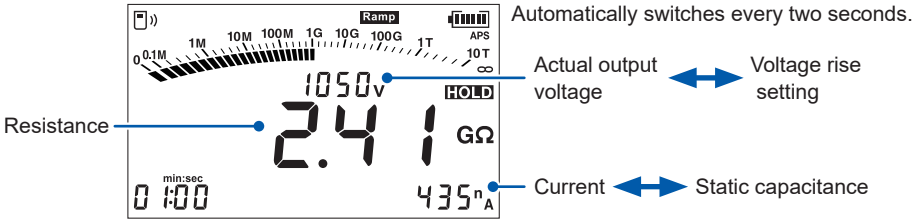
3 **Set the voltage rise value.**
Setting range: 100 V/min to 9000 V/min
See: “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70)

4 **Measure insulation resistance.**

See: “3.3 Measuring Insulation Resistance” (p. 41)

The test voltage gradually rises and the measurement stops automatically when the set voltage is reached.

5 **Check the measured value.**



4.5 DD Measurement (Dielectric Discharge)

Used to diagnose a multi-layer insulator.
Since the result of this test is dependent on discharge characteristics, the internal condition of the insulating material can be tested with little regard to surface contamination. When the condition of the insulating material is good, the instrument displays a DD value of less than 2.

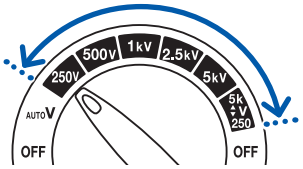
Overview of test

The result is calculated with the following formula by performing the insulation resistance measurement for the specified time and then using the discharge current one minute after the measurement has ended and the capacitance of the object under measurement.

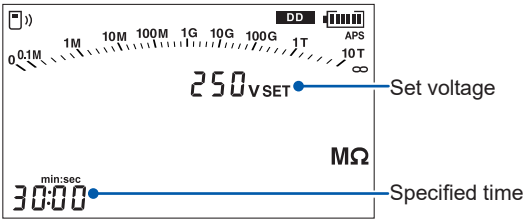
$$\text{DD (dielectric discharge)} = \frac{\text{Current 1 min. after end of measurement (nA)}}{\text{Voltage at end of measurement (V)} \times \text{Capacitance (μF)}}$$

Default setting: 30 min.
See: “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70)

1 **Turn the rotary switch to one of the selections between 250 V and 5k ▲▼ V 250 .**



2 **Press the MODE key and select the [DD] display.**



3 **Specify the amount of time.**

Setting range: 10 sec. to 98 min.

See: “4.6 Changing Settings for the Insulation Diagnosis Functions” (p. 70)

4 **Measure insulation resistance.**

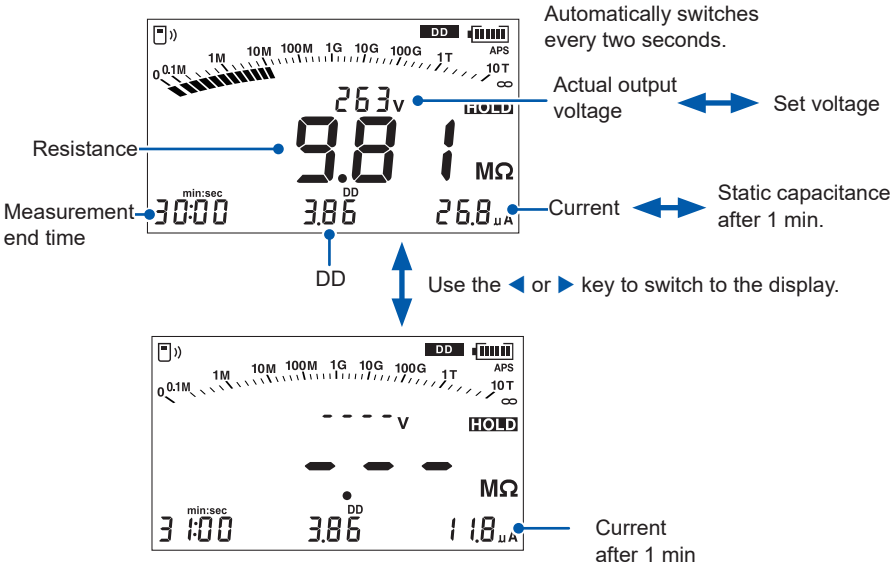
See: “3.3 Measuring Insulation Resistance” (p. 41)

After the set time has elapsed (default setting: 30 min.), the instrument automatically stops voltage generation.

The measurement continues for one minute after voltage generation is stopped.

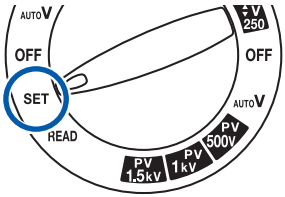
5 **Check the measured value.**

The current value 1 min. after measurement completes can be checked with the ◀ or ▶ key.



4.6 Changing Settings for the Insulation Diagnosis Functions

1 **Turn the rotary switch to SET.**



2 **Press the MODE key and select the display for the function to check or change.**

Each time the **MODE** key is pressed, the display changes in the following order.

[COMP] (p. 71) → **[TIMER]** → **[PI]** → **[DAR]** → **[SV]**→ **[Ramp]** → **[DD]** → returns to **[COMP]**

3 **Press the ▲ key or the ▼ key to change the setting.**
For [PI] and [DAR], use the ◀ or ▶ key to switch between [t1] and [t2].
The setting being changed will blink.
Press the **CLR** key while the setting is blinking to reset it to the default value.

4 **Press the ENTER key to confirm.**

Setting ranges of the insulation diagnosis functions

Function	Setting range (default setting)
TIMER	10 sec. to 99 min.(1 min.)
PI	10 sec. to 99 min.(t_1 = 1 min. and t_2 = 10 min.) Setting condition*1: $t_2 > t_1$
DAR	10 sec. to 99 min. (t_1 = 30 sec. and t_2 = 1 min.) Setting condition*1: $t_2 > t_1$
SV	10 sec. to 10 min. (1 min.)
Ramp	100 V/min. to 9000 V/min. (1000 V/min.)
DD	10 sec. to 98 min. (t = 30 min.)

*1. t_1 must be set to a value less than t_2. If the setting of t_1 cannot be increased, first set t_2 to a value larger than t_1, and then set t_1.

5 Other Functions

5.1 Comparator Function

This function compares the measured value against a preset value and makes a pass/fail judgment.
The comparator function is limited by the measurement and insulation diagnostic functions.

Available: ✓, not available: –

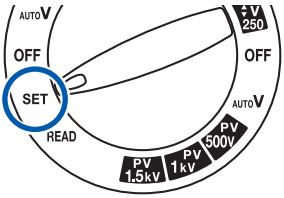
	Measurement functions		
Insulation diagnosis functions	Insulation resistance measurement	Voltage measurement	PV insulation resistance measurement (IR5051 only)
– (no diagnosis function)	✓	–	✓
Timer test	✓	–	✓
Polarization index	✓	–	–
Dielectric absorption ratio	✓	–	–
Step voltage test	✓	–	–
Ramp voltage test	✓	–	–
Dielectric discharge	✓	–	–

The comparator function operates as follows.

Judgment condition	Result	Display	Backlight	Beeping
Measured value ≥ reference value	Pass	PASS	No change	Intermittent
Measured value < reference value	Fail	FAIL	Lights up in red	Continuous

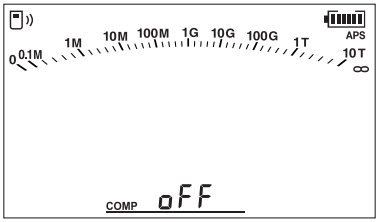
Reference value setting range: 0.1 MΩ to 100 GΩ/Off
Default setting: Off

1 Turn the rotary switch to SET.



The setting screen for the comparator appears.

The default setting is Off.

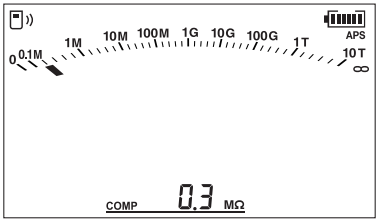


2 Press the ▲ key or the ▼ key to set the reference value.

The setting being changed will blink.

Disable the comparator function when it is not used.

Press the **CLR** key while changing to the setting to set to OFF.



3 Press the ENTER key to confirm.

The comparator setting is saved even when the power is turned off.

5.2 Automatic Power Save Function

This function can save battery consumption.
The instrument enters the automatic power save state and turns off the LCD after approximately 10 minutes from the last operation or from when the live line warning display (⚠) was last lit or blinking.
When the power is turned on, the automatic power save function is enabled automatically. (**[APS]** lights up)
[APS] will start blinking around 30 seconds before the instrument enters the automatic power save state.

Recovering from the automatic power save state

Use the rotary switch to turn the power off and on again. The LCD lights up and the instrument recovers from the automatic power save state.

Disabling automatic power save function

Use the rotary switch to turn off the power, and then while holding down the **MODE** key, use the rotary switch to turn on the power to cancel the automatic power save function.

IMPORTANT
The automatic power save function setting is not saved when the power is turned off.

5.3 Wireless Communications Function (GENNECT Cross)

Turn on the wireless communications function to check the measurement data saved in the instrument's memory and create measurement reports with a mobile device. For details, see the GENNECT Cross website.

1. **Install the Z3210 wireless adapter (option) in the instrument.**
   See: "2.2 Installing the Z3210 Wireless Adapter" (p. 31)
2. **Install GENNECT Cross on the mobile device.**
3. **Turn on the instrument's power.**
   When the power is first turned on after the Z3210 is installed, the wireless communications function is turned on automatically.
4. **Hold down the MODE key and the MEM key for more than one second to turn on the wireless communications function.**
   When the wireless communications function is turned on, appears in the LCD.
   Blinking: Connected to a mobile device
   Lit: Communications function is on
   Not lit: Communications function is off
   To turn on/off the wireless communications function, hold down the **MODE** key and the **MEM** key for more than one second.
5. **Start GENNECT Cross and register the connection with the instrument.**
6. **Select a function and take the measurement.**

- The communications distance is approximately 10 m line of sight. The distance at which communications is possible will vary greatly by the distance between the instrument and any obstacles (for example, walls or metal shielded objects) and the floor (ground). Confirm that the strength of the radio waves is sufficient for stable communications.
- GENNECT Cross is available free of charge. However, any internet connection charges incurred when downloading and using the application software are the responsibility of the customer.
- GENNECT Cross may not run correctly depending on the mobile device.

- The Z3210 uses wireless technology in the 2.4-GHz band. If the instrument is close to a device that uses the same frequency band, such as a wireless networking device (IEEE 802.11.b/g/n), it may not be possible to establish communications.
- When GENNECT Cross is first started (i.e., there are no registered devices), it starts with the connection settings screen.
- On the GENNECT Cross connection settings screen, the connection to the instrument is automatically registered if the instrument is close (up to eight instruments).
- Wait 5 to 30 seconds from when the instrument's power is turned on until the connection to the instrument is registered. If the instrument is not registered even after waiting for 1 minute, restart GENNECT Cross and the instrument.

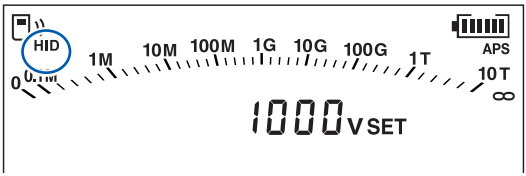
5.4 Excel Direct Input Function (HID Function)

HID (human interface device profile) is a function the Z3210 wireless adapter is equipped with and is a profile that allows the instrument to operate in the same manner as a wireless keyboard.
GENNECT Cross (p. 74) and the HID function cannot be used at the same time.
The instrument will stand by with an Excel file opened on a mobile device or PC and a cell selected. When the instrument's display is retained, the measured value can be entered in the selected cell.

HID ON	Measured values can be entered in an Excel file or text file. Communications with GENNECT Cross are not possible.
HID OFF	Select off when using GENNECT Cross.

Checking the HID setting

The HID function is on when **[HID]** is lit on the LCD.



Turning HID function on/off

The HID on/off setting is saved in the Z3210. The setting is not saved in the instrument.

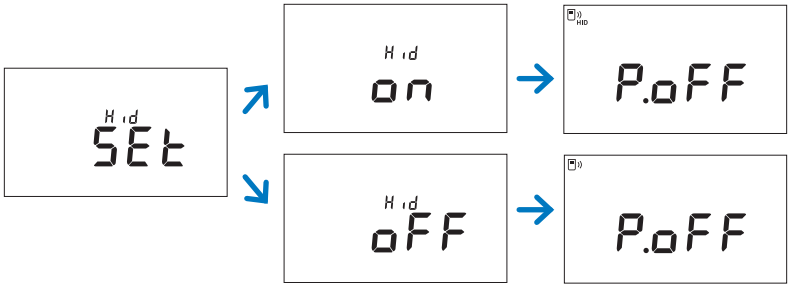
1 **Turn off the power by turning the rotary switch to OFF.**

2 **Install the Z3210 wireless adapter (option) in the instrument.**
See: “2.2 Installing the Z3210 Wireless Adapter” (p. 31)

3 **While holding down the MODE key and the MEM key, turn the rotary switch to turn on the power.**

MODE + MEM + (Any position)

After the setting appears, the power is turned off automatically.



When [oLd] appears

Use GENNECT Cross (version 1.8 or later) and update the Z3210 to the latest version.

IMPORTANT
To switch from the HID function to GENNECT Cross
If GENNECT Cross is started without unpairing the mobile device and instrument, the instrument may not be recognized as a connected device.
Use the following procedure and connect the instrument to GENNECT Cross again.
1. From the **Bluetooth**® settings for your mobile device, delete the instrument.
2. Turn off the Z3210’s HID function.
3. In the GENNECT Cross connected instrument settings, reconnect the instrument.

For details, see the Z3210 website.
https://z3210.gennect.net

Z3210 Website
Learn more here !

5.5 Version Upgrade Function

You can use GENNECT Cross (free application software) to upgrade the firmware in the instrument. For details, see the GENNECT Cross usage guide.

Conditions

GENNECT Cross	Version 1.8 or higher

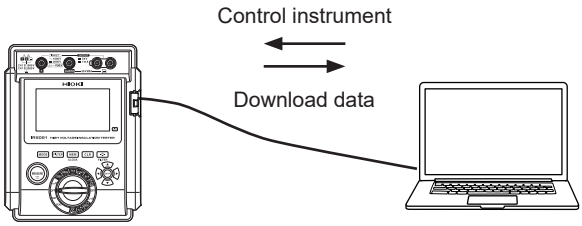
See “5.7 Power On Options List” (p. 82) to check the current version.

5.6 Communicating with PC

Data saved in the memory may be downloaded to a PC and the instrument settings may be changed from a PC by using the DT4900-01 communication package (option) and Hioki Sequence Maker*1. Used to make a table or graph of the data stored in the memory or create a report.

When performing communications with the DT4900-01, you cannot measure insulation resistance, leakage current, or voltage. The DT4900-01 cannot be used with this instrument to control measurement.

*1. Sequence Maker is an Excel add-in provided by Hioki for no additional charge. It allows communications and control with the instrument using simple operations that involve entering communications commands in an Excel worksheet, so no programming experience is required.



Install the USB driver on the PC (p. 80)

Install the Sequence Maker on the PC (p. 80)

Installing the Instrument Memory Download Tool (p. 80)

Install the communications adapter in the instrument (p. 81)

Connect the instrument to the PC

A virtual COM port on the PC is used for the USB interface. The virtual COM ports the instrument can recognized on are COM1 to COM256.

Communications method	Asynchronous serial communications over infrared (half duplex)
Content	Data saved in the instrument's memory
Speed	9600 bps
Data length	8 bits
Stop bit	1
Parity bit	None
Delimiter	CR+LF

Installing the USB driver

Before connecting the instrument to a PC for the first time, be sure to install the special USB driver on the PC. The USB driver can be downloaded from the software download page at Hioki's website.
https://www.hioki.com/global/support/download/software/

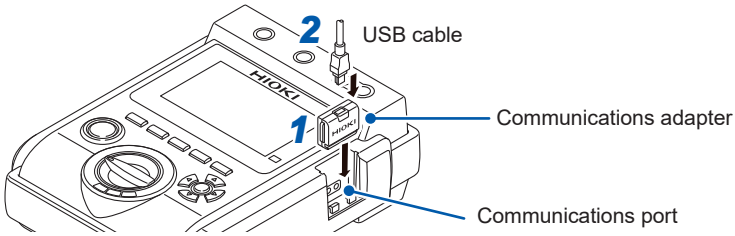
Installing the Sequence Maker

Before connecting the instrument to a PC for the first time, be sure to install Sequence Maker on the PC. You can download this software from the following special Sequence Marker website.
For details on the operating procedures and other information, see the website.
https://sequencemaker.hioki.com/

Installing the Instrument Memory Download Tool

You can use communications commands and the Instrument Memory Download Tool to change the settings in the instrument and to retrieve saved data.
A list of communications commands can be found in the Instrument Memory Download Tool file.
Download the Instrument Memory Download Tool from the software download page at Hioki's website.
https://www.hioki.com/global/support/download/software/

Installing the communications adapter in the instrument



1 Install the communications adapter in the instrument.

2 Connect a USB cable to the communications adapter.

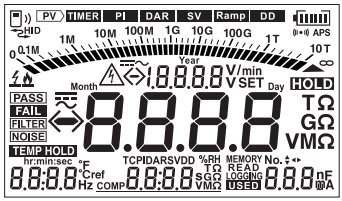
3 Communicate with the instrument using communications commands and the Instrument Memory Download Tool.

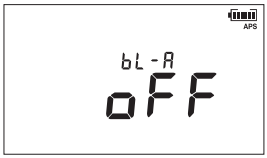
- Connect the cable in the correct direction.
- During communications, the mark appears on the LCD.
- When the mark is lit, the instrument's operation keys are disabled.
- Do not disconnect the USB cable during communications.
- When the wireless communications function (GENNECT Cross) is on, communications cannot be performed using the DT4900-01. To use the DT4900-01, turn off the wireless communications function or remove the Z3210.

5.7 Power On Options List

You can change and check the instrument's system settings.
The instrument changes to the measurement screen if the operation key is released.

+  **Turn off power, and then turn on power while holding down operation key**
(Turn rotary switch from OFF position)

Details	Method/Display
Disable automatic power save function	MODE + (Any position) 
Display fully lit LCD, live line warning, and backlight lit in white	ENTER + (Any position) 

Details	Method/Display
Display software version and model name	CLR + (Any position)  Software version Display changes after one second.  Model name
Display serial number	MEM + (Any position) 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. The following screen indicates the instrument was manufactured in April 2024. Serial number: 240410125 
Enable or disable backlight automatic-off function	☼ + (Any position) 
Disable hardware filter function	FILTER + (Any position)

5

Details	Method/Display
Turn HID function on/off (When the Z3210 is installed only) (p. 76)	MODE + MEM + (Any position) The HID on/off setting is saved in the Z3210.
Fix the voltage measurement to DCV	MODE + ☼ + (Any position)
Negative voltage notification function on/off (IR5051 only) (p. 52)	▶ + (Any position)
System reset (p. 118)	CLR + ENTER + (Any position)
Keep insulation diagnostics function (p. 59) enabled	MODE + ENTER + (Any position) The user can select whether to keep the insulation diagnostic function enabled even if the instrument is turned off. **[USEr SET on]** Keep enabled **[USEr SET oFF]** Do not keep enabled

6 Recording Measurement Data (Data Memory Function)

The instrument stores measurement data, settings, date, time, temperature, and humidity in the internal memory.
The data memory function can be used in insulation resistance measurements.
The recorded data is saved even when the power is turned off.

There are two recording methods. (Combinable)

Manual recording	Records the measured value retained on the display.
Logging recording	Records the measured value at each set recording interval. (Set the recording interval or timer before measurement.)

- Logging recording can be used in insulation resistance measurement and PV insulation resistance measurement. For insulation diagnosis functions, timer test can only be used (p. 88).
- The content of a manual record is viewed on the display of the instrument. The recorded data can also be downloaded to a PC using the DT4900 communications package (option).
- For logging records, only the last value is viewed on the display of the instrument. The entire record is viewed on a PC using Sequence Maker.
  See: “5.6 Communicating with PC” (p. 79)
- Add memory number to data to record. The memory number serves as the address in the memory. The recording methods and configuration of memory number are shown below.

Recording method	Memory number
Manual recording	A00 - A99, B00 - B99, C00 - C99, D00 - D99, E00 - E99, F00 - F99, H00 - H99, J00 - J99, N00 - N99, P00 - P99 (1000 numbers in total)
Logging recording	Lr0 - Lr9 (10 numbers in total. Up to 60 minutes of logging per data)

• The table below shows storable data.

Recording method	Type of data	Data stored in one record
Manual recording	Standard measurement data	Memory number, date/time, elapsed time, temperature, humidity, set voltage, actual output voltage, resistance (final value), resistance (1-min. value), PI value, PI or DAR set time (t_1), PI or DAR set time (t_2), resistance set time (t_1), and resistance set time (t_2) (Even if PI is not selected as the function, PI is saved as the default setting. If the function is DAR, the DAR settings are saved instead of PI.)
	SV (step voltage) data	Memory number, date/time, elapsed time, temperature, humidity, set voltage (maximum value), actual voltage × 5, and resistance × 5
	Ramp (ramp voltage test) data	Memory number, date/time, elapsed time, temperature, humidity, set voltage (maximum value), actual voltage, resistance (final value), and voltage rise setting
	DD (dielectric discharge) data	Memory number, date/time, elapsed time, temperature, humidity, set voltage, actual output voltage, resistance (final value), DD value, current 1 min. after end of measurement, and capacitance
Logging recording	–	Memory number, date/time, measurement interval, temperature, humidity, set voltage, actual output voltage × number of times, and resistance × number of times

IMPORTANT

- In step voltage test resistance measurements, only the last measurement at the end of each step is recorded.
- Voltage measurement data cannot be recorded.

6.1 Recording Measurement Data

Manual recording (recording result of one measurement session)

The memory numbers available for manual recording are divided into the following 10 groups (100 records per group), thus up to 1000 records can be stored.

A00 - A99, B00 - B99, C00 - C99, D00 - D99, E00 - E99, F00 - F99, H00 - H99, J00 - J99, N00 - N99, P00 - P99

There are the following four types of data: standard measurement data, SV data*1, Ramp data, and DD data. These four data sets are stored separately.

*1. If step voltage test is stopped at any time, data cannot be recorded.

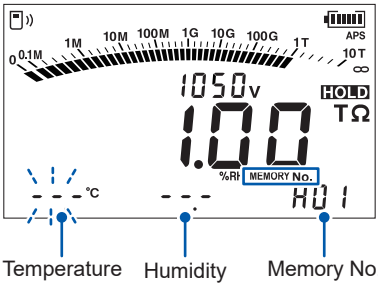
1 **Measure insulation resistance and stop.**

See: “3.3 Measuring Insulation Resistance” (p. 41)

If step voltage test is stopped at any time, data cannot be recorded.

2 **Press the MEM key.**

[MEMORY No.] and the number next to the last stored number appear, and the setting item blinks.



3 **Set the temperature, humidity, and memory number.**

◀ key or ▶ key: Changes the digit

▲ key or ▼ key: Changes the value

ENTER key: Confirm

Each press of the **ENTER** key moves to the next setting item in the following order.

Temperature → Humidity → Memory number

Logging recording (recording at regular intervals)

- Logging recording can be used in insulation resistance measurement and PV insulation resistance measurement. For insulation diagnosis functions, timer test can only be used (p. 88).
- A total of 10 memory numbers are used for logging records; Lr0 to Lr9.
- The maximum recording time per record is 60 minutes.
- The recording intervals that can be set are 5 seconds, 15 seconds, 30 seconds, 1 minute, 2 minutes, and 5 minutes.
- Maximum number of loggings vary depending on set recording interval (when the timer is set to off).
- When the timer is set, the instrument automatically stops measurement after the set time has elapsed.

IMPORTANT

- Continuous recording time is determined by the battery charge level.
- If the battery charge level becomes low during measurement, **[Lo bAt]** appears and the instrument records only the measurement data to that point.
- When a low resistance is measured, more power is consumed, thus the instrument may not be able to measure data equal to the maximum number of loggings.
- The comparator function is disabled during the logging recording.

Set the temperature, humidity, memory number, and recording interval

1 **Turn the rotary switch to one of the following selections.**

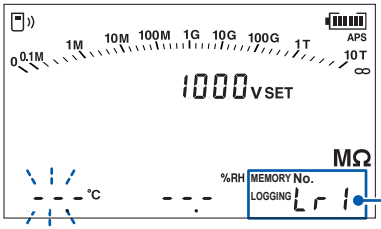
• For insulation resistance: 250 V to 5k ↕ V 250

• For PV insulation resistance: PV500V, PV1kV, or PV1.5kV

Set the timer to perform a timer test. (p. 59)

2 **Press the MEM key.**

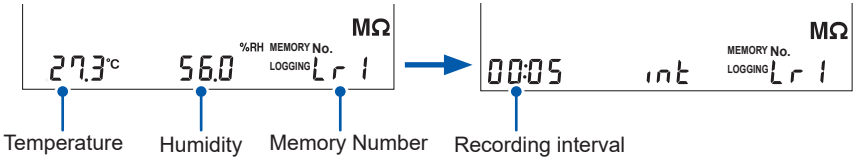
[MEMORY No.], **[LOGGING]**, and the memory number next to the last stored number appear, and the setting item blinks.



3 **Set the temperature, humidity, memory number, and recording interval.**

◀ key or ▶ key: Changes the digit
▲ key or ▼ key: Changes the value
ENTER key: Confirm

Each press of the **ENTER** key moves to the next setting item in the following order.
Temperature → Humidity → Memory number → Recording interval



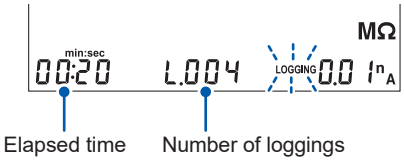
The instrument is in the measurement standby state.

Measure

4 **Start the insulation resistance measurement.**

See: “3.3 Measuring Insulation Resistance” (p. 41)

When the measurement is started, **[MEMORY No.]** and the set memory number disappear and the measurement display appears.
During measurement, **[LOGGING]** blinks.
Save processing is executed at each recording interval.



5 **Insulation resistance measurement stops under one of the three conditions below.**

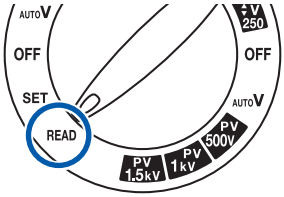
- Maximum recording time (60 min.) has elapsed.
- The set time of the timer has elapsed.
- The **MEASURE** key is pressed.

After measurement has been completed, **[LOGGING]** remains.

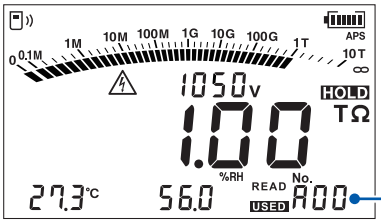
6.2 Checking Recorded Data

- The content of a manual record is viewed on the LCD of the instrument.
- For logging records, only the last value is viewed on the LCD of the instrument. The entire record is viewed on a PC using Sequence Maker.
  See: “5.6 Communicating with PC” (p. 79)

1 **Turn the rotary switch to READ.**



The recorded data appears.



2 **Press the ▲ key and ▼ key to choose the memory number you wish to view.**

The data stored under the number appears.

Use the ◀ key and ▶ key to switch to the next data.

PI and DAR measurement:	t_1 data and t_2 data
SV measurement:	Data of every step
DD measurement:	Data upon completion of the measurement and data one minute after completion

Hold down the **MEM** key for more than one second to check the recording date and time.

Press any key to return to the original display.

The recording method of the displayed record is identified as follows.

Memory number is [Lr]	Logging recording data
Memory number is not [Lr]	Manual recording data

The type of manual record is identified as follows.

[PI] is lit	PI (polarization index) data
[DAR] is lit	DAR (dielectric absorption ratio) data
[SV] is lit	SV (step voltage test) data
[Ramp] is lit	Ramp (ramp voltage test) data
[DD] is lit	DD (dielectric discharge) data

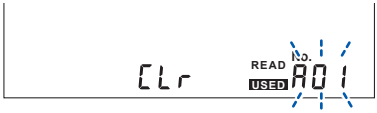
- For logging records, only the last data is displayed.
- For data that is not displayed on the LCD, you can display this data with the same key operations as for switching the display method during a test.

6.3 Deleting Recorded Data

Deleting data with the selected number

Select the data to be deleted, and delete only this selection.

1. **Turn the rotary switch to READ.**
   The recorded data appears.
2. **Press the ▲ key and ▼ key to choose the memory number of the data to delete.**
3. **Press the CLR key.**
   [CLr] appears and the memory number blinks.

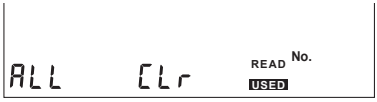


4. **Press the ENTER key.**
   [CLr] blinks and the data is deleted.

Deleting all data

Delete all the manual records and logging records simultaneously.

1. **Turn the rotary switch to READ.**
   The recorded data appears.
2. **Press the CLR key twice.**
   [ALL CLr] appears.



3. **Press the ENTER key.**
   [ALL CLr] blinks and all data is deleted.

7 Specifications

7.1 General Specifications

Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−20°C to 40°C (−4°F to 104°F), 80% RH or less (non-condensing) 40°C to 45°C (104°F to 113°F), 80% RH or less (non-condensing) 45°C to 50°C (113°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−25°C to 65°C (−13°F to 149°F), 80% RH or less (non-condensing)
Dust resistance and water resistance	IP40 (when the protector is attached; excluding terminals section) IP65 (C0212 Carrying Case) (EN 60529) The protection rating for the enclosure of this instrument (based on EN 60529) is IP40 or IP65. IP40, IP65: This indicates the degree of protection provided by the enclosure of the device for use in hazardous locations, entry of solid foreign objects, and the ingress of water. IP4X: Protected against access to hazardous parts with wire measuring 1.0 mm in diameter. The equipment inside the enclosure is protected against entry by solid foreign objects larger than 1.0 mm in diameter. IPX0: The equipment inside the enclosure is not protected against the harmful effects of water. IP6X: Protected against access to hazardous parts with wire measuring 1.0 mm in diameter. Dustproof type (Dust shall not penetrate the enclosure.) IPX5: The equipment inside the enclosure is protected against the harmful effects of water projected in jets against the enclosure from any direction.
Standards	Safety: EN 61010 EMC: EN 61326 Insulation tester: IEC 61557-1, IEC 61557-2
Power supply	Use one of the following. • LR6 Alkaline battery ×8 Rated supply voltage: 1.5 V DC ×8 • HR6 Nickel-metal hydride battery ×8 Rated supply voltage: 1.2 V DC ×8 Maximum rated power: 12 VA Effective range of battery: 8.8 V ±0.2 V to 13.6 V
Continuous operating time	Using LR6 Alkaline battery ×8 (Reference value at 23°C) Approx. 5 hours (Generating 5 kV, open between + & − terminals, backlight off, comparator off, and Z3210 not installed) Approx. 4 hours (Generating 5 kV, open between + & − terminals, backlight off, comparator off, Z3210 installed, and using wireless communications)
Backup battery life	Approx. 10 years (Reference value at 23°C)
Dimensions	Approx. 195W × 254H × 89D mm (Approx. 7.7"W × 10.0"H × 3.5"D)

Weight	Approx. 1.7 kg (Approx. 60.0 oz.) (Including battery and excluding other accessories)
Product warranty duration	3 years
Included accessories	See: “Checking Package Contents” (p. 8)
Options	See: “Options (Sold Separately)” (p. 9)

7.2 Input Specifications, Output Specifications, and Measurement Specifications

Basic specifications and accuracy specifications

Measurement item	Insulation resistance measurement: DC voltage application, voltage and current detection PV insulation resistance measurement: DC voltage application, voltage and current detection Leakage current measurement Voltage measurement: Mean-value rectification RMS value indication Capacitance measurement (DD function): Discharge method
Input/output terminals	+ terminal: Connect the red test lead to this terminal Insulation resistance measurement: Voltage output terminal (+) PV insulation resistance measurement: Voltage output terminal (+) Voltage measurement: + terminal
	− terminal: Connect the black test lead to this terminal Insulation resistance measurement: Terminal into which the current from the object under measurement flows (−) PV insulation resistance measurement: Terminal into which the current from the object under measurement flows (−) Voltage measurement: − terminal
	GUARD terminal: Connect the blue test lead to this terminal. This terminal is used only during insulation resistance and PV insulation resistance measurements.
Maximum rated voltage between terminals	1000 V AC/2000 V DC (voltage measurement, between + & − terminals)
Maximum rated line-to-ground voltage	1000 V (Measurement category IV), Anticipated transient overvoltage 12,000 V 2000 V (Measurement category III), Anticipated transient overvoltage 15,000 V
Rated operating conditions	Operating temperature and humidity range: See “Operating temperature and humidity range” (p. 93). Orientation: Horizontal ±90° Power supply voltage: Effective range of battery External magnetic field: 400 A/m or less (DC and 50 Hz/60 Hz)
Accuracy guarantee conditions	Accuracy guarantee duration: 1 year Accuracy guarantee temperature and humidity range: 23°C ±5°C, less than 80% RH

(1) Insulation resistance measurement

Output voltage	Output voltage range	250 V DC to 5.2 kV DC
	Preset test voltage	250 V, 500 V, 1 kV, 2.5 kV, 5 kV
	Setting resolution	250 V to 1 kV: 10 V steps 1 kV to 5.2 kV: 25 V steps
	Open circuit voltage	−0% and +10% of setting
	Lower limit of resistance that can maintain rated measurement voltage	Rated measurement voltage (setting) ÷ rated current
	Rated current	1 mA to 1.2 mA (Electric current that can be generated with the set test voltage is maintained)
	Short-circuit current	2 mA or less
Output voltage monitor	Display range	0 V to 5800 V
	Accuracy	±5% rdg ±5 dgt Add 5 dgt to the accuracy for the voltage of 30 V or less

Rated measurement voltage (setting)	Maximum displayed value	Accuracy guarantee range	Accuracy (inherent uncertainty A)
250 V	500 GΩ	0.00 MΩ to 2.50 GΩ	±5% rdg ±5 dgt
		2.51 GΩ to 250 GΩ	±20% rdg
		251 GΩ to 500 GΩ	
500 V	1.00 TΩ	0.00 MΩ to 5.00 GΩ	±5% rdg ±5 dgt
		5.01 GΩ to 500 GΩ	±20% rdg
		501 GΩ to 1.00 TΩ	
1000 V	2.00 TΩ	0.00 MΩ to 10.0 GΩ	±5% rdg ±5 dgt
		10.1 GΩ to 500 GΩ	±20% rdg
		501 GΩ to 2.00 TΩ	
2500 V	5.00 TΩ	0.00 MΩ to 25.0 GΩ	±5% rdg ±5 dgt
		25.1 GΩ to 500 GΩ	±20% rdg
		501 GΩ to 5.00 TΩ	
5000 V	10.0 TΩ	0.00 MΩ to 50.0 GΩ	±5% rdg ±5 dgt
		50.1 GΩ to 500 GΩ	±20% rdg
		501 GΩ to 10.0 TΩ	

Range configuration (auto range)

Range	Display range	Resolution
10 MΩ	0.00 MΩ to 9.99 MΩ	0.01 MΩ
100 MΩ	9.0 MΩ to 99.9 MΩ	0.1 MΩ
1000 MΩ	90 MΩ to 999 MΩ	1 MΩ
10 GΩ	0.90 GΩ to 9.99 GΩ	0.01 GΩ
100 GΩ	9.0 GΩ to 99.9 GΩ	0.1 GΩ
1000 GΩ	90 GΩ to 999 GΩ	1 GΩ
10 TΩ	0.90 TΩ to 9.99 TΩ	0.01 TΩ
	9.0 TΩ to 10.0 TΩ	0.1 TΩ

Operation uncertainty (B)*1	±30% rdg
Guaranteed range of operation uncertainty	Greater than or equal to 0.1 MΩ but less than or equal to the resistance value calculated by dividing the test voltage (setting) by 100 nA
Effect of supplied voltage (E2) *1	Accuracy × 0.5 and within accuracy specifications
Effect of temperature (E3) *1	Accuracy × 1.0 is added to the accuracy (applicable in the ambient temperature range excluding 18˚C to 28˚C) When the L9850-11 and L9850-12 test leads (10 m) are used, the accuracy of 501 GΩ or more is not guaranteed.
Effect of capacitance component	Within ±10% at a capacitance of 5 µF or less (including drift)
Number of possible measurements	200 or more
Overload protection	1100 V AC (for 10 sec. between + & − terminals) 6000 V DC (for 10 sec. between + & − terminals)
Display update	Once/sec. or more (when the filter is on, 0.25 times/sec.)
Response time	Measurement condition: Resistive load (output voltage 5000 V, resistive load 1 TΩ) Filter off: Within 3 sec. Filter on: Within 10 sec.
Induction noise removal	3 mA max

*1. B, E2, and E3 are the symbols specified by IEC61557.

(2) Current (leakage current) measurement

Electric current is measured with the test voltage generated, as in insulation resistance measurement.

Accuracy guarantee range	1.00 nA to 3.00 mA
Accuracy	±5% rdg ±1 nA

Range configuration (auto range)

Range	Display range	Resolution
10 nA	0.00 nA to 9.99 nA	0.01 nA
100 nA	9.0 nA to 99.9 nA	0.1 nA
1000 nA	90 nA to 999 nA	1 nA
10 µA	0.90 µA to 9.99 µA	0.01 µA
100 µA	9.0 µA to 99.9 µA	0.1 µA
1 mA	90 µA to 999 µA	1 µA
	0.90 mA to 3.00 mA	0.01 mA

Effect of temperature	Accuracy × 1.0 is added to the accuracy (applicable in the ambient temperature range excluding 18°C to 28°C) When the L9850-11 and L9850-12 test leads (10 m) are used, the accuracy is not guaranteed if the current is below the value obtained by dividing the test voltage (set value) by 500 GΩ.
Response time	Measurement condition: Resistive load (output voltage 5000 V, resistive load 1 TΩ) Filter off: Within 3 sec. Filter on: Within 10 sec.

(3) Voltage measurement

Accuracy guarantee range	30 V AC to 1000 V AC (45 Hz to 65 Hz)
	±10 V DC to ±2000 V DC
Accuracy	±3% rdg ±3 dgt Add ±5 dgt to the accuracy for the voltage between −30 V and 30 V.

Range configuration

Range		Display range	Resolution
AC	1000 V	30 V to 1000 V	1 V
DC	2000 V	±5 V to ±2000 V Zero-display range: 4 count or less	1 V

DC/AC automatic judgment range	Judged as AC at 30 V or more (50 Hz/60 Hz). A flow on which a large AC component of 30 V or more is superimposed is judged as AC.
Input resistance	500 kΩ or more (DC, 45 Hz to 65 Hz)
Effect of temperature	Accuracy × 0.1 per 1°C (applicable in the ambient temperature range excluding 18°C to 28°C)
Overload protection	1100 V AC (for 1 min. between + & − terminals) 2200 V DC (for 1 min. between + & − terminals)
Display update	Once/sec. or more

(4) Capacitance measurement

Accuracy guarantee range	10.0 nF to 25.0 µF
Accuracy	±10% rdg ±5 nF

Range configuration (auto range)

Range	Display range	Resolution
100 nF	0.0 nF to 99.9 nF	0.1 nF
1000 nF	100 nF to 999 nF	1 nF
10 µF	1.00 µF to 9.99 µF 10.0 µF to 25.0 µF	0.01 µF 0.1 µF

Effect of temperature	Accuracy × 1.0 is added to the accuracy (applicable in the ambient temperature range excluding 18°C to 28°C)

- The capacitance measurement is automatically taken after the insulation resistance measurement ends.
- The capacitance measurement is not performed if the output voltage is 250 V or less during the insulation resistance measurement. The instrument will display **[---]** as the capacitance if it is unable to perform capacitance measurement.

(5) PV insulation resistance measurement

Output voltage	Output voltage range	250 V DC to 2.00 kV DC
	Preset test voltage	500 V, 1 kV, 1.5 kV
	Setting resolution	250 V to 1 kV: 10 V steps 1 kV to 2 kV: 25 V steps
	Open circuit voltage*1	−0% and +10% of setting
	Lower limit of resistance that can maintain rated measurement voltage	20 MΩ
	Rated current	Rated measurement voltage (setting) ÷ rated measurement voltage that can maintain open circuit voltage
	Short-circuit current	2 mA or less
Output voltage monitor	Display range	0 V to 5800 V
	Accuracy	±5% rdg ±5 dgt Add 5 dgt to the accuracy for the voltage of 30 V or less

*1. PV insulation resistance has approx. 660 kΩ of current-limiting resistance on the + terminal, so the output voltage is divided by 660 kΩ and the resistance connected between the measurement terminals.
Example: When open-circuit voltage is measured with a DMM with an input impedance of 10 MΩ, the voltage is divided by 660 kΩ and 10 MΩ.

Rated measurement voltage (setting)	Maximum displayed value	Accuracy guarantee range	Accuracy (inherent uncertainty A)
500 V	100 GΩ	0.00 MΩ to 5.00 GΩ	±5% rdg ±5 dgt
		5.01 GΩ to 100 GΩ	±20% rdg
1000 V	100 GΩ	0.00 MΩ to 10.0 GΩ	±5% rdg ±5 dgt
		10.1 GΩ to 100 GΩ	±20% rdg

1500 V	100 GΩ	0.00 MΩ to 20.0 GΩ	±5% rdg ±5 dgt
		20.1 GΩ to 100 GΩ	±20% rdg

Range configuration (auto range)

Range	Display range	Resolution
10 MΩ	0.00 MΩ to 9.99 MΩ	0.01 MΩ
100 MΩ	9.0 MΩ to 99.9 MΩ	0.1 MΩ
1000 MΩ	90 MΩ to 999 MΩ	1 MΩ
10 GΩ	0.90 GΩ to 9.99 GΩ	0.01 GΩ
100 GΩ	9.0 GΩ to 99.9 GΩ	0.1 GΩ
	90 GΩ to 100 GΩ	1 GΩ

Effect of supplied voltage	Accuracy × 0.5 and within accuracy specifications
Effect of temperature	Accuracy × 1.0 is added to the accuracy (applicable in the ambient temperature range excluding 18°C to 28°C)
Effect of capacitance component	Within ±10% rdg at a capacitance of 5 μF or less (including drift)
Number of possible measurements	1000 or more
Overload protection	1100 V AC (for 10 sec. between + & − terminals) 6000 V DC (for 10 sec. between + & − terminals)
Display update	Once/sec. or more
Response time	Measurement condition: Resistive load (output voltage 1500 V, resistive load 80 GΩ) Within 4 sec.

7.3 Insulation diagnosis functions

PI — Polarization index

Calculated with the following formula from the resistance after the specified amount of time has elapsed after the start of the insulation resistance measurement.

$$PI = \frac{t_2 \text{ resistance}}{t_1 \text{ resistance}}$$

Time setting
Setting range: 10 sec. to 99 min.
Setting resolution: 10 sec. to 1 min.: 1 sec.,
1 min. to 99 min.: 15 sec.
Default value: t_1 = 1 min., t_2 = 10 min.
Setting condition: $t_2 > t_1$

DAR — Dielectric absorption ratio

Calculated with the following formula from the resistance after the specified amount of time has elapsed after the start of the insulation resistance measurement.

$$DAR = \frac{t_2 \text{ resistance}}{t_1 \text{ resistance}}$$

Time setting
Setting range: 10 sec. to 99 min.
Setting resolution: 10 sec. to 1 min.: 1 sec.,
1 min. to 99 min.: 15 sec.
Default value: t_1 = 30 sec., t_2 = 1 min.
Setting condition: $t_2 > t_1$

DD — Dielectric discharge

Calculated with the following formula by performing the insulation resistance measurement for the specified time and then using the discharge current 1 min. after the measurement has ended and the capacitance of the object under measurement.

$$DD = \frac{\text{Current 1 min. after end of measurement (nA)}}{\text{Voltage at end of measurement (V)} \times \text{Capacitance (μF)}}$$

Time setting
Setting range: 10 sec. to 98 min.
Setting resolution: 10 sec. to 1 min.: 1 sec.,
1 min. to 98 min.: 15 sec.
Default value: t = 30 min.

SV	Step voltage test
	Gradually increases the set voltage in the insulation resistance measurement by 20% each time the set time has elapsed.
	Time setting per step Setting range: 10 sec. to 10 min. Setting resolution: 10 sec. to 1 min.: 1 sec., 1 min. to 10 min.: 15 sec. Default value: 1 min.
Ramp	Ramp voltage test
	The applied voltage in the insulation resistance measurement is gradually raised until it reaches the set voltage.
	Voltage rise setting Setting range: 100 V/min. to 9000 V/min. Setting resolution: 100 V/min. to 1000 V/min.: 100 V/min., 1000 V/min. to 9000 V/min.: 500 V/min. Default setting: 1000 V/min.
TIMER	Timer test
	The test is automatically ended after the set time has elapsed.
	Time setting Setting range: 10 sec. to 99 min. Setting resolution: 10 sec. to 1 min.: 1 sec., 1 min. to 99 min.: 15 sec. Default value: 1 min.

For PV insulation resistance measurement, TIMER can only be set.

7.4 Function Specifications

(1) Effective range of battery display

Operation Function for checking the voltage of the internal battery.

Display

Battery voltage			Status gauge
10.6 V ±0.2 V			6
10.2 V ±0.2 V	to	10.6 V ±0.2 V	5
10.0 V ±0.2 V	to	10.2 V ±0.2 V	4
9.8 V ±0.2 V	to	10.0 V ±0.2 V	3
9.5 V ±0.2 V	to	9.8 V ±0.2 V	2
8.8 V ±0.2 V	to	9.5 V ±0.2 V	1
	Up to	8.8 V ±0.2 V	0 (battery shape blinks)

Hysteresis: Even if the battery voltage rises, the status gauge will not increase once it has decreased until the power is turned off and on again.
A measurement cannot be taken when the status gauge is 0 (the measured value will not be displayed).

(2) Live line warning display

Operation Displays the voltage between the + & − terminals and the measurement status with the warning lamp on the **MEASURE** key.
This function works for all functions except when off.

Display

Function	Status	Voltage between terminals	Live line warning display
Insulation resistance PV insulation resistance	**MEASURE** key on	–	Blinks
	MEASURE key off and during automatic discharge	30 V DC or more	Blinks
	MEASURE key off and not during automatic discharge	30 V AC or more, +30 V DC or more, −30 V DC or less	Blinks
		Rated DC measurement voltage or more, 95 V AC or more*1	Blinks (Buzzer beeping*2)
Voltage	–	30 V AC or more, +30 V DC or more, −30 V DC or less	Blinks

*1. If induction noise is present, the instrument will output the test voltage.
*2. Voltage cannot be generated when the buzzer is beeping.

(3) Automatic power save function

Operation	Enters the automatic power save state after 10 min. ±1 min. from the last operation or from when the live line warning display was last lit or blinking. Setting method: Power on option Default setting: On

(4) Automatic discharge

Operation	Discharges remaining electric charge using discharge resistance after the insulation resistance measurement.
Display	During discharge, the live line warning display and ⚠ mark blink.
Discharge resistance	Approx. 600 kΩ
Discharge rate	3 sec./μF or less (discharge from 5 kV to 50 V)
Maximum capacitance load	25 μF

(5) Backlight

White	**Operation**	Turns the white backlight on and off when the LIGHT key is pressed. The backlight automatically turns off after 30 sec. ±5 sec. from the last operation or from when the live line warning display was last lit or blinking.
Red	**Operation**	Lights up in red when the comparator result is a failure. This provides notification of excessive or incorrect input.
Display	Display during incorrect input In the following cases, the backlight blinks in red. • Insulation resistance measurement function When a voltage is input that is greater than or equal to the voltage that lights up the live line warning. • Voltage measurement function When a voltage is input greater than or equal to the rated voltage.	

(6) Buzzer

Operation	Makes a beeping noise.

(7) Data memory manual recording

Operation	Records the measured value retained on the display. Measurement data can be saved, loaded, and deleted. Valid with insulation resistance measurements.
Amount of data	1000
Memory structure	100 items of data in 1 module (10 modules)
Module names	A, B, C, D, E, F, H, J, N, P
Memory number	Module name + 0 to 99
Saved content	Measurement data Data can be saved, loaded, and deleted using instrument operations. 1. Standard measurement data Memory number, date/time, elapsed time, temperature, humidity, set voltage, actual output voltage, resistance (final value), resistance (1-min. value) 2. PI or DAR data Memory number, date/time, elapsed time, temperature, humidity, set voltage, actual output voltage, resistance (final value), resistance (1-min. value), PI value, PI or DAR set time (t_1), PI or DAR set time (t_2), resistance (set time t_1), and resistance (set time t_2) 3. SV data Memory number, date/time, elapsed time, temperature, humidity, set voltage (maximum value), actual voltage × 5, and resistance × 5 4. Ramp data Memory number, date/time, elapsed time, temperature, humidity, set voltage (maximum value), actual voltage, resistance (final value), and voltage rise setting 5. DD data Memory number, date/time, elapsed time, temperature, humidity, set voltage, actual output voltage, resistance (final value), DD value, current 1 min. after end of measurement, and capacitance
Saving destination	Non-volatile memory (flash memory)

(8) Data memory logging recording

Operation	Records the measured value at each set recording interval. Measurement data can be saved, loaded, and deleted. Valid with insulation resistance measurements.
Amount of data	10
Module names	Lr
Memory number	Module name + 0 to 9
Logging time	Max. 60 min. per record
Recording interval	5 sec., 15 sec., 30 sec., 1 min., 2 min., and 5 min.
Saved content	Memory number, date/time, measurement interval, temperature, humidity, set voltage, actual output voltage × number of times, and resistance × number of times Data can be saved, loaded (final value only), and deleted using instrument operations.

Saving destination	Non-volatile memory (flash memory)

(9) Temperature/humidity input

Operation	Enter the temperature and humidity measured with an external thermometer/ hygrometer into the instrument using key operations.
Display	Temperature input range: −20.0 to 70.0°C Humidity input range: 0.0 to 99.9% RH

(10) Elapsed time display

Operation	Displays the elapsed time at the start of an insulation resistance or PV insulation resistance measurement.
Display range	0 sec. to 99 min. 59 sec.

(11) Clock function

Operation	Automatic calendar, automatic leap year detection, 24-hour clock
Precision	±100 ppm (±8.64 sec. per day)
Backup battery life	Approx. 10 years

(12) Filter

Operation	Averages the measured values in the insulation resistance measurement or leakage current measurement. (Digital values only. Bar graph is excluded.)
Display	**[FILTER]** lights up when the filter is active.

(13) Hardware filter

Operation	Operates automatically when the instrument detects noise during insulation resistance measurement to average insulation resistance and leakage current measured values. Operation is canceled automatically when insulation resistance measurement completes.
Display	**[NOISE]** and **[FILTER]** blinks.
Default setting	On This function can be turned on and off in the power on options.

(14) Hold

Operation	Retains the last data upon completion of measurement.
Display	Insulation resistance, leakage current, output voltage, elapsed time, results of the insulation diagnosis functions **[HOLD]** lights up when data is retained.

(15) System reset

Operation	Resets the settings to the factory default state (the memory data is not deleted). Setting method: Power on option

(16) USB communications function (when the DT4900-01 is installed only)

Operation	Performs USB communications using the DT4900-01. A response is returned after a command is received from the PC. USB communications is not possible when the wireless communications function is on.
Display	The  mark lights up after a command is received from the PC.
Communications method	Asynchronous serial communications over infrared (half duplex)
Content	Measurement data response Functions of key operations can be set from the PC
Speed	9600 bps
Data length	8 bits
Stop bit	1
Parity bit	None
Delimiter	CR+LF

(17) Wireless communications (when the Z3210 is installed only)

Operation	Turns the wireless communications function on and off.
Display	Wireless communications function is off: segment is not lit Wireless communications function is on: segment is lit During wireless communications: segment is blinking
Communication distance	Approx. 10 m line of sight

(18) HID switching function (when the Z3210 is installed only)

Operation	Turns the Z3210 HID function on and off. Off: Communications with GENNECT Cross On: Measured value transfer to spreadsheet or other software Setting method: Power on option Default value: Off
Display	HID function is off: HID segment is not lit HID function is on: HID segment is lit

(19) Version upgrade function

Operation	Upgrades the version of the instrument's firmware using GENNECT Cross. Condition: GENNECT Cross (Ver. 1.8 or higher)

(20) Comparator

Operation	Sets the reference value and makes the following judgments for the measured values.

Judgment	Display	Buzzer
Measured value < reference value	FAIL	Long beep
Measured value ≥ reference value	PASS	Short beep

Applicable range	Insulation resistance measurement and PV insulation resistance measurement
Reference value setting	0.1 MΩ to 100 GΩ / Off
Setting resolution	0.1 MΩ (0.10 MΩ to 1.00 MΩ) 0.5 MΩ (1.00 MΩ to 5.00 MΩ) 1 MΩ (5.00 MΩ to 10.0 MΩ) 10 MΩ (10.0 MΩ to 100 MΩ) 100 MΩ (100 MΩ to 1.00 GΩ) 1 GΩ (1.00 GΩ to 10.0 GΩ) 10 GΩ (10.0 GΩ to 100 GΩ)
Default setting	Off
Other	Saves the setting when the power is off.

(21) Bar graph

Operation	Valid with insulation resistance measurement and PV insulation resistance measurement. The insulation resistance value is displayed when the **MEASURE** key is on and when retaining a measured value. The remaining discharge amount is displayed during automatic discharge.
Display	0 to 10 TΩ

(22) Insulation diagnosis function switching

Operation	Switch the insulation diagnosis function each time the **MODE** key is pressed. Off → TIMER → PI → DAR → SV → Ramp → DD → Off Default value: Off (Off is not displayed)
Display	The icon for the selected insulation diagnosis function is displayed on the LCD.

(23) Breakdown function

Operation	Applicable range: Test voltage of 1100 V or more in an insulation resistance measurement or PV insulation resistance measurement Operation: If insulation breakdown (resistance rapidly decreases) is detected during the measurement, the voltage is automatically stopped to prevent damage to the object under measurement and for safety.
Display	 is lit

(24) Negative voltage notification function (IR5051 only)

Operation	Lights up the LCD backlight alternating between white and red when the voltage input is −10 V or less in the V range.
Default setting	On This function can be turned on and off in the power on options.

7.5 Specifications of the Options

Test leads

(1) Configuration

Model name	Color	Cable length	Weight	Remarks
L9850-01	Red	Approx. 3 m (118.11 in.)	Approx. 88 g (3.1 oz.)	
L9850-02	Black		Approx. 213 g (7.5 oz.)	Shielded cable
L9850-03	Blue		Approx. 88 g (3.1 oz.)	
L9850-11	Red	Approx. 10 m (393.70 in.)	Approx. 240 g (8.5 oz.)	
L9850-12	Black		Approx. 620 g (21.9 oz.)	Shielded cable
L9850-13	Blue		Approx. 240 g (8.5 oz.)	

(2) General specifications

Application	Dedicated accessory for the IR5050/IR5051 High Voltage Insulation Tester
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−20°C to 50°C (−4°F to 122°F), 80% RH or less (non-condensing))
Storage temperature and humidity range	−25°C to 65°C (−13°F to 149°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010
Maximum rated line-to-ground voltage	5000 V DC (2 mA) (insulation resistance measurement) 1000 V (Measurement category IV), Anticipated transient overvoltage 12,000 V 2000 V (Measurement category III), Anticipated transient overvoltage 15,000 V
Rated voltage	2000 V AC, 5000 V DC
Rated current	4 A

Alligator clips

(1) Configuration

Model name	Color	Total length	Weight	Remarks
L9851-01	Red	Approx. 115.5 mm (4.55 in.)	Approx. 27 g (1.0 oz.)	Used on the tip of the L9850 test lead.
L9851-02	Black			
L9851-03	Blue			

(2) General specifications

Application	Dedicated accessory for the IR5050/IR5051 High Voltage Insulation Tester
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−20°C to 50°C (−4°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−25°C to 65°C (−13°F to 149°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010
Maximum rated line-to-ground voltage	5000 V DC (2 mA) (insulation resistance measurement) 1000 V (Measurement category IV), Anticipated transient overvoltage 12,000 V 2000 V (Measurement category III), Anticipated transient overvoltage 15,000 V
Rated voltage	2000 V AC, 5000 V DC
Rated current	4 A

Test pin set

(1) Configuration

The set is composed of one red pin and one black pin.

Model name	Color	Dimensions	Weight	Remarks
L9852	Red and black	Total length: Approx. 111.5 mm (4.39 in.) Tip of pin (section with exposed metal): Approx. 3.7 mm (0.15 in.) Tip-to-protective finger guard length: Approx. 55.5 mm (2.19 in.)	Approx. 7 g (0.2 oz.)	Used on the tip of the L9850 Test Lead.

(2) General specifications

Application	Accessory dedicated for the IR5050/IR5051 High Voltage Insulation Tester
Operating environment	Indoor use, pollution degree 2, altitude up to 2000 m (6562 ft.)
Operating temperature and humidity range	−20°C to 50°C (−4°F to 122°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	−25°C to 65°C (−13°F to 149°F), 80% RH or less (non-condensing)
Standards	Safety: EN 61010
Maximum rated line-to-ground voltage	5000 V DC (2 mA) (insulation resistance measurement) 1000 V (Measurement category IV), Anticipated transient overvoltage 12,000 V 2000 V (Measurement category III), Anticipated transient overvoltage 15,000 V
Rated voltage	2000 V AC, 5000 V DC
Rated current	4 A

8 Maintenance and Service

8.1 Repair, Calibration, and Cleaning

⚠ WARNING

■ Do not attempt to modify, disassemble, or repair the instrument.

The internal components of the instrument carry high voltages. Modification, disassembly, or repair could cause electric shock to the operator or fire.

⚠ CAUSTION

Observe the following when shipping the instrument:

■ Remove the batteries, accessories, and options from the instrument.

■ When requesting repair, include a description of the malfunction.

■ Use the packaging in which the instrument was initially delivered and then pack that in an additional box.

Failure to do so could cause damage during shipment.

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 instrument.

Backing up your data

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

Cleaning

⚠ CAUTION

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

Solvents such as benzene, alcohol, acetone, ether, ketone, thinners, or gasoline could deform or discolor the instrument.

Wipe the display gently with a soft, dry cloth.

Lithium battery

The instrument contains a built-in backup lithium battery. This battery offers a service life of about 10 years. If the date and time deviate substantially when the instrument is switched on, it is the time to replace that battery. Contact your authorized Hioki distributor or reseller.

Test leads

Using soiled or deteriorated test leads may affect the measured values. Clean the test leads after use and replace deteriorated test leads.

8.2 Troubleshooting

If damage is suspected, read the “Before returning for repair” (p. 115) section to remedy problems. If this does not help you, contact your authorized Hioki distributor or reseller.

Before returning for repair

Check the following items if you notice a problem in the operation of the instrument.

Problem	Possible cause	Action	Reference
Power is not turned on.	• Batteries are not installed. • Battery level is low.	Replace with new batteries.	p. 27
	The batteries are installed incorrectly.	Check the polarity.	p. 27
Resistance measurement value is incorrect.	Test lead is broken.	Replace the test lead.	–
	Test lead is not fully inserted.	Insert the test lead fully.	–
	Wrong connection terminals.	Check the terminals.	p. 35
	Test lead insulation has deteriorated.	Replace with a test lead that has good insulation.	–
Monitored voltage during resistance measurement is low.	Resistance is low.	The output voltage is lowered for measurement of low resistance values.	p. 122
Power fails upon measuring insulation resistance.	Battery level is low.	Replace with new batteries.*1	p. 27
	The test leads connected to the GUARD terminal and the + terminal are short-circuited.	Check the connection to the test lead clips.	p. 44

Problem	Possible cause	Action	Reference
The measured value differs for each measurement, even though the object under measurement is the same.	Material of the object under measurement is having an effect.	After a measurement, wait a sufficient amount of time (1 hour to 1 day as a general rule) before taking a new measurement. The effect of polarization*2 will be more apparent for higher insulation resistance values.	–
	Temperature and humidity characteristics of the object under measurement are having an effect.	Measure in an environment with the same temperature and humidity. An insulating material typically has characteristics in which insulation resistance decreases as temperature and humidity increase. Reference: There are certain insulated cables in which the insulation resistance decreases to 1/4 or less when the temperature increases 10°C.	–

*1. Even with new alkaline batteries, it may not be possible to use batteries with a large internal resistance as the amount of obtainable energy will be low. If the instrument does not work when using new batteries, use batteries from a different manufacturer.

*2. Polarization: The phenomenon in which positive and negative charges on the atoms of a material move in opposite directions causing a shift of the center when an electric field is applied to the material.

If the cause is unknown, try resetting the system.

See: “8.4 System Reset” (p. 118)

8.3 Messages

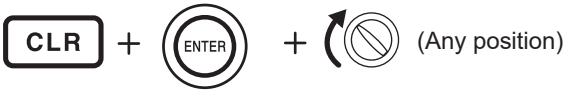
If an error appears on the LCD, the instrument must be checked or repaired. Contact your authorized Hioki distributor or reseller.

Display	Details	Action
[Err1]	The firmware has anomaly.	Contact your authorized Hioki distributor or reseller to request for repair.
[Err2]	Adjustment data is corrupted.	
[Err4]	Settings data is corrupted.	
[Err5]	01: The measuring circuit has anomaly. 02: The voltage generation circuit has anomaly. 03: Discharge relay has anomaly. 04: Backup battery has anomaly.	Turn the instrument off, then on. If the error is displayed repeatedly, the instrument has a failure. Contact your authorized Hioki distributor or reseller to request for repair.
[Err8]	The Z3210 fails to have communications (connection failure; Z3210 or hardware failure).	Take the following actions: • Reinsert the Z3210. • Insert another Z3210. See “2.2 Installing the Z3210 Wireless Adapter” (p. 31). If the error persists, the instrument has a failure. Contact your authorized Hioki distributor or reseller to request for repair.
[Err9]	Version upgrade execution error has occurred.	Use GENNECT Cross and attempt the version upgrade again.
[Gurd] ↔[Hi]	Voltage is applied to the GUARD terminal.	Disconnect the test leads from the object under measurement immediately and shut off the power supplied to the object or discharge the electric charge using a discharge rod. Verify that there is no voltage present at the object under measurement and then connect the test leads to it. If the error is displayed repeatedly, the instrument has a failure. Contact your authorized Hioki distributor or reseller to request for repair.
[Shid] ↔[Hi]	Voltage is applied to the negative terminal.	
[APS] → [P.oFF]	The auto-power-saving capability will put the instrument into auto-power saving mode soon.	Turn the instrument off, then on.
[bAtt] → [P.oFF]	The instrument will soon turn off because of low battery voltage.	Change the batteries. See “2.1 Inserting/Replacing Battery” (p. 27).
[v.UP]	GENNECT Cross is updating the instrument.	Do not operate the instrument until the update is completed.

8.4 System Reset

System reset returns the settings of the instrument to their defaults (excluding date and time).
The data saved using data memory function will not be cleared.

1 While holding down the CLR key and the ENTER key, turn the rotary switch to turn on the instrument.



The table below shows the default settings.

Item	Factory default state	Setting backup
Automatic power save function	Enabled	No
Backlight automatic-off function	Enabled	Yes
Wireless communications function setting	Enabled (When the instrument is first turned on with the Z3210 installed)	Yes (On/Off)
Setting values of insulation diagnosis function	Default values (p. 70)	Yes
Keep insulation diagnostics function enabled (p. 84)	Do not keep enabled	Yes
Comparator	Off	Yes
User-defined voltage function (insulation resistance)	250 V	Yes
Negative voltage notification function	Enabled	Yes
Hardware filter	Enabled	No

8.5 Disposing of the Instrument (Removal of Lithium Battery)

When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations. Dispose of other options in accordance with local regulations.

⚠ WARNING

■ **Store the removed battery out of reach of children.**

There is a risk a child may accidentally swallow the battery.

CALIFORNIA, USA ONLY
Perchlorate Material - special handling may apply.
See https://dtsc.ca.gov/perchlorate/

Handle and dispose of batteries by local regulations.

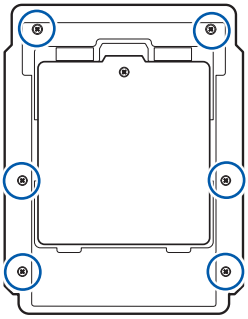
Equipment

- Phillips screwdriver (No. 1)
- Nut driver or needle-nose pliers
- Tweezers

1 **Turn the rotary switch on the instrument to OFF and remove the test leads.**

2 **Remove the protector.**

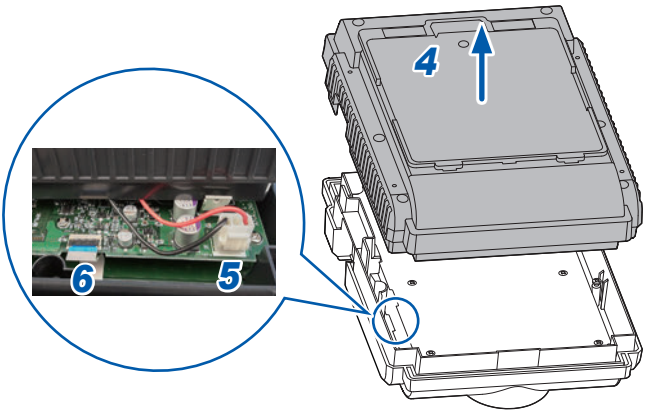
3 **Use the Phillips screwdriver and unscrew the six screws on the back of the instrument.**



4 **Remove the bottom case.**

5 **Disconnect the connector of the cable pulled out of the battery holder from the printed circuit board.**

6 **Using tweezers, disconnect the flat cable that connects the top and bottom printed circuit boards.**

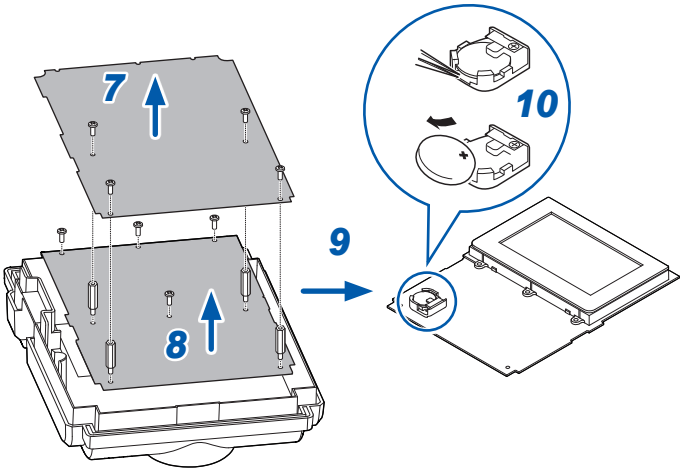


7 **Unscrew the four screws that fix the top circuit board, and then remove the top circuit board.**

8 **Unscrew the four screws that fix the bottom circuit board and the four supports, and then remove the bottom circuit board.**

9 **Flip over the bottom circuit board.**

10 **Insert the tweezers in between the battery and battery holder and pry up the battery to remove it.**

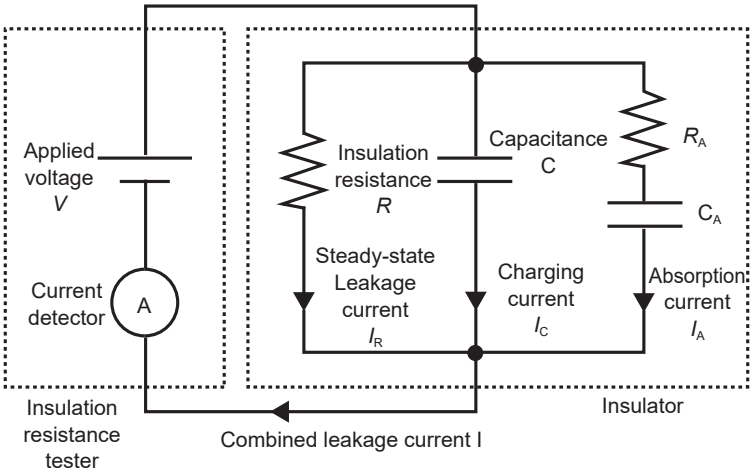


9 Appendix

9.1 Measurement Principles

Insulation resistance measurement

When a high DC voltage is applied to an object under measurement, a leakage current flows. The insulation resistance instrument measures the applied voltage *V* and the combined leakage current *I* and then calculates the insulation resistance *R*.
Calculation formula: *R* = *V*/*I*



I_c and I_A gradually decrease after the voltage is applied.

PV insulation resistance measurement (IR5051 only)

For resistance *Rx* of the object under measurement, voltage *V* is applied to that object, leakage current *I* that flows to the object and applied voltage *V* at that time are measured, and the resistance is calculated from (applied voltage *V*) / (leakage current *I*).
(The voltage and current generated by the object under measurement are subtracted.)

9.2 Reproducibility of Insulation Resistance Measurement

When measuring the same object repeatedly, the insulation resistance or leakage current indications may differ. This is caused by polarization*1, which occurs when a voltage is applied to an insulating material.

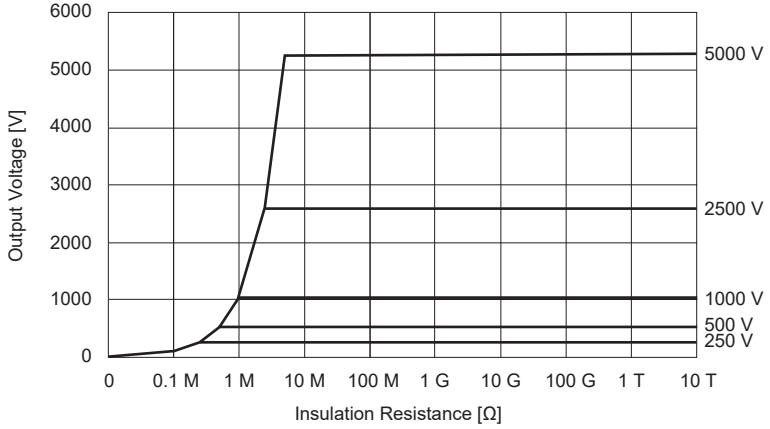
Typically, an insulating material is represented by an equivalent circuit as shown by the diagram on the previous page.

Absorption current due to relatively slow polarization is represented by I_A on that diagram. It takes time for the polarization caused by the previous measurement to disappear. Until it does, electric charge remains in C_A on that diagram. The electric charge level in C_A differs at the start of previous measurement and at the start of next measurement and thus absorption current I_A differs, too. Further, the combined leakage current and insulation resistance vary from measurement to measurement. This will be become more apparent for higher insulation resistance values.

To ensure reproducibility of measurement, leave a sufficient time interval between measurement sessions. Further, the ambient temperature and humidity should not vary.

*1. Polarization: The phenomenon in which positive and negative charges on the atoms of a material move in opposite directions causing a shift of the center when an electric field is applied to the material.

9.3 Test Voltage Characteristic Graph



9.4 Example of PI (Polarization Index) Criteria

IEEE 43 Recommended Practice for Testing Insulation Resistance of Rotating Machinery recommends the criteria as shown in the table below for insulation resistance testing of a motor.

Heat resistance class	Recommended lowest PI
Class 105 (A)	1.5 or more
Class 130 (B) and above	2.0 or more

9.5 Connecting the Insulation Resistance Tester to a Live Line (Energized Parts)

This instrument will not fail (within 10 seconds) when accidentally connected to a live line at the voltage level listed in the overload protection specifications when outputting voltage.
However, the rated voltage of the insulation resistance tester will be applied to the circuit of the connected object under measurement, or the short-circuit current (DC) listed in the product specifications will flow to that circuit. Make sure to first confirm that the line is not live before connecting the insulation resistance tester as there is a risk of damaging the circuit of the object under measurement.

9.6 Properties of Insulating Materials

An insulating material typically has the following properties.

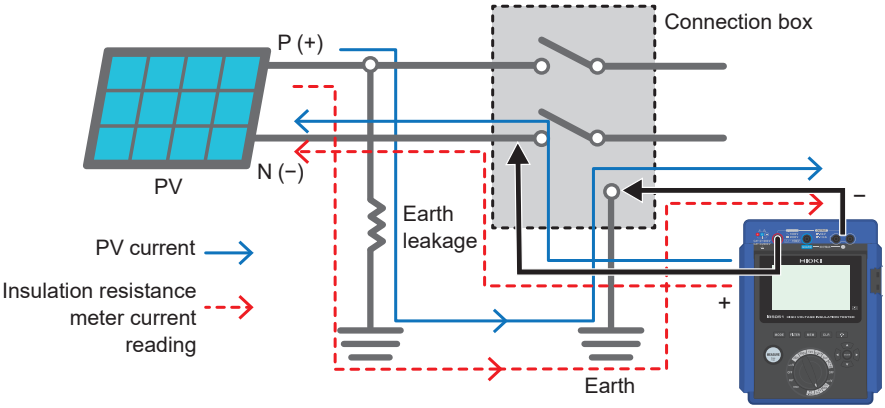
- **Resistance varies by temperature**
  Resistance decreases as temperature increases. In order to diagnose deterioration due to the change in insulation resistance over time, resistance measured at the same temperature or resistance for which temperature has been compensated must be used.
- **Resistance varies by measurement voltage**
  Resistance decreases the higher the applied voltage for measurement. Because of this property, you must measure the object with a voltage that is greater than or equal to the voltage used by the object.
- **Resistance decreases with absorption of moisture**
  Resistance decreases by a large degree under high humidity conditions. For this reason, resistance may be exceptionally low in rainy conditions. In addition, if condensation has formed on the insulating material, insulation resistance cannot be measured because a large current will leak on the surface of the insulating material.

9.7 Measurement Methods for Insulation Resistance of PV Array

There are two insulation resistance measurements for solar cell arrays.
Characteristics of them are as follows:

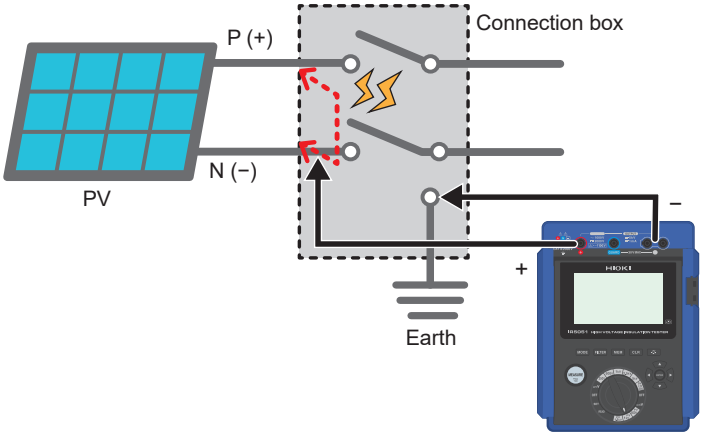
Method with P-N open

The PV insulation resistance measurement in this instruction manual is described according to this method. Since PV voltage affects the test voltage, accurate results may not be obtained. There is also a risk of damage to the PV panel if a mistake is made in the procedure. If current leaks due to a ground fault as shown in the following diagram, the current generated by power generation will affect the insulation resistance tester, and a normal insulation resistance tester cannot measure insulation resistance accurately.
The PV insulation resistance measurement in the IR5051 is capable of measuring insulation resistance accurately without being affected by power generation.



Method with P-N short-circuited

This method allows insulation resistance to be measured accurately, but it is extremely dangerous because of the arcing generated by the short-circuit. There is also a risk of fire from the state of deterioration in the PV panel.
If short-circuiting the connectors, make measurements at night, when there is no insolation.



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Warranty Certificate

HIOKI

Model	Serial number	Warranty period Three (3) years 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

1. The product is guaranteed to operate properly during the warranty period (three [3] years from the date of purchase). If the date of purchase is unknown, the warranty period is defined as three (3) years from the date (month and year) of manufacture (as indicated by the first four digits of the serial number in YYMM format).
2. If the product came with an AC adapter, the adapter is warrantied for one (1) year from the date of purchase.
3. The accuracy of measured values and other data generated by the product is guaranteed as described in the product specifications.
4. 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.
5. 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
6. 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
7. 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)
8. 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.

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