HIOKI

3554

Instruction Manual

BATTERY HiTESTER

EN

Feb. 2015 Revised edition 6
3554A981-06 15-02H

Contents

Introduction

Thank you for purchasing the HIOKI “Model 3554 BATTERY HiTESTER.” To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.

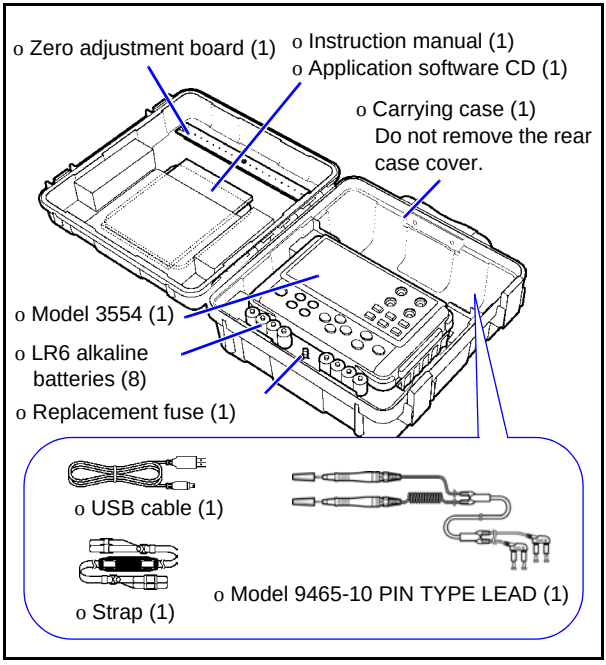
Registered Trademark

Windows and Excel are registered trademarks of Microsoft Corporation in the United States and/or other countries.

Verifying Package Contents

- When you receive the instrument, inspect it carefully to ensure that no damage occurred during shipping. In particular, check the accessories, panel switches, and connectors. If damage is evident, or if it fails to operate according to the specifications, contact your dealer or Hioki representative.
- When transporting the instrument, use the original packing materials in which it was shipped, and pack in a double carton. Damage occurring during transportation is not covered by warranty.

Verifying Package Contents



Options

- Model 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR
- Model 9465-90 TIP PIN (for the 9465-10 PIN TYPE LEAD)
- Model 9466 REMOTE CONTROL SWITCH
- Model 9467 LARGE CLIP TYPE LEAD
- Model 9772 PIN TYPE LEAD
- Model 9772-90 TIP PIN (for the 9772 PIN TYPE LEAD)

Safety Information

⚠DANGER This instrument is designed to comply with IEC 61010 Safety Standards, and has been thoroughly tested for safety prior to shipment. However, mishandling during use could result in injury or death, as well as damage to the instrument. Using the instrument in a way not described in this manual may negate the provided safety features.
Be certain that you understand the instructions and precautions in the manual before use. We disclaim any responsibility for accidents or injuries not resulting directly from instrument defects.

Safety Symbols

This manual contains information and warnings essential for safe operation of the instrument and for maintaining it in safe operating condition. Before using it, be sure to carefully read the following safety precautions.

⚠	In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the instrument.
	The ⚠ symbol printed on the instrument indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function.
⎓	Indicates DC (Direct Current).
⏛	Indicates a fuse.
⏚	Indicates a grounding terminal.

The following symbols in this manual indicate the relative importance of cautions and warnings.

	Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.
	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
	Indicates that incorrect operation presents a possibility of injury to the user or damage to the instrument.
	Indicates advisory items related to performance or correct operation of the instrument.

Notation of the This Manual

	Indicates a prohibited action.
(P.)	Indicates the location of reference information.
	Indicates quick references for operation and remedies for troubleshooting.
*	Indicates that descriptive information is provided below.

Accuracy

We define measurement tolerances in terms of f.s. (full scale), rdg. (reading) and dgt. (digit) values, with the following meanings:

f.s. (maximum display value or scale length)

The maximum displayable value or scale length. This is usually the name of the currently selected range.

rdg. (reading or displayed value)

The value currently being measured and indicated on the measuring instrument.

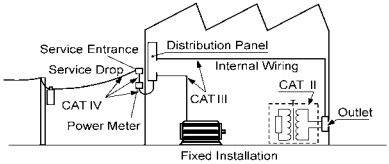
dgt. (resolution)

The smallest displayable unit on a digital measuring instrument, i.e., the input value that causes the digital display to show a "1" as the least-significant digit.

Measurement Categories

To ensure safe operation of measurement instruments, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT II to CAT IV, and called measurement categories.

CAT II:	Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.) CAT II covers directly measuring electrical outlet receptacles.
CAT III:	Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.
CAT IV:	The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).



Using a measurement instrument in an environment designated with a higher-numbered category than that for which the instrument is rated could result in a severe accident, and must be carefully avoided.
Use of a measurement instrument that is not CAT-rated in CAT II to CAT IV measurement applications could result in a severe accident, and must be carefully avoided.

Operating Precautions

Setting Up the Instrument

Operating temperature and humidity:
0 to 40°C (32 to 104°F), 80%RH or less (non-condensating)

Accuracy guarantee for temperature and humidity:
23 ± 5°C (73 ± 9°F), 80%RH or less (non-condensating)

Avoid the following locations that could cause an accident or damage to the instrument.

Exposed to direct sunlight
Exposed to high temperature

Exposed to liquids
Exposed to high humidity or condensation

Exposed to high levels of particulate dust

In the presence of corrosive or explosive gases

Exposed to strong electromagnetic fields
Near electromagnetic radiators

Subject to vibration

Preliminary Checks

Before using the instrument the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

⚠WARNING Before using the instrument, make sure that the insulation on the test leads is undamaged and that no bare conductors are improperly exposed. Using the instrument in such conditions could cause an electric shock, so contact your dealer or Hioki representative for replacements. (Model 9465-10)

Handling the Instrument

⚠DANGER To avoid electric shock, do not remove the instrument's case. The internal components of the instrument carry high voltages and may become very hot during operation.

⚠CAUTION To avoid damage to the instrument, protect it from physical shock when transporting and handling. Be especially careful to avoid physical shock from dropping.

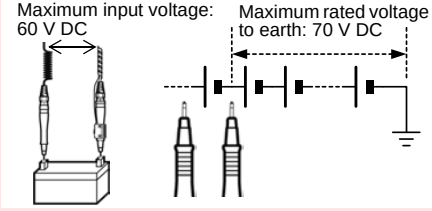
NOTE

- To avoid corrosion from battery leakage and problems with battery operation, remove the batteries from the instrument if it is to be stored for a long time.
- After use, turn OFF the power.

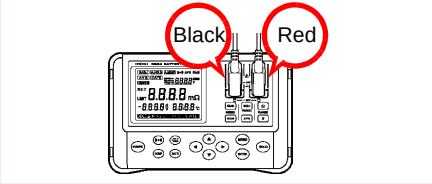
Measurement Precautions

⚠ DANGER Observe the following to avoid electric shock and short circuits.

- Do not measure voltages of 60 V DC or higher.
- Do not measure grounded voltages of more than 70 V DC.
  <Ex.> Ground Battery System



- Do not measure alternating voltage.
- Be sure to connect the test leads properly.

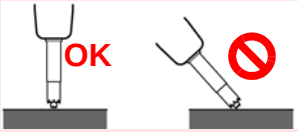


- Wear rubber gloves or gloves of similar material during measurement.
- When measuring batteries, always ensure sufficient ventilation. Sometimes sparks may occur when the test leads are connected to batteries, which can ignite any accumulated inflammable gases such as hydrogen.

Handling the Test Leads

⚠CAUTION

- For safety reasons, when taking measurements, only use the 9465-10 PIN TYPE LEAD provided with the instrument or the optional test leads.
- To avoid breaking the test leads, do not bend or pull them.
- The ends of the test leads are sharp. Be careful to avoid injury.
- To avoid damaging the test lead, grasp the connector, not the cable, when unplugging the test lead.
- To avoid damage, do not contact the 9465-10 PIN TYPE LEAD tip against the battery at a tilted angle.



Handling the CD

⚠CAUTION

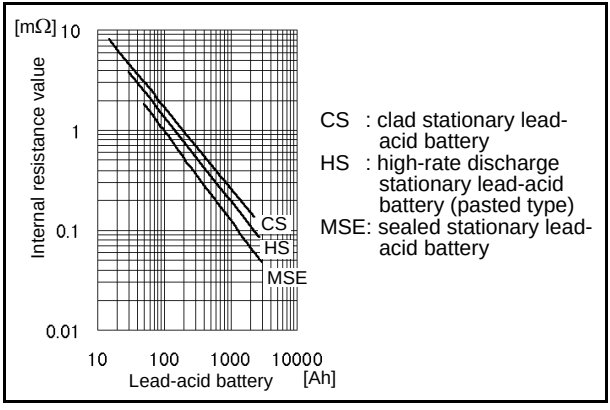
- Always hold the disc by the edges, so as not to make fingerprints on the disc or scratch the printing.
- Never touch the recorded side of the disc. Do not place the disc directly on anything hard.
- Do not wet the disc with volatile alcohol or water, as there is a possibility of the label printing disappearing.
- To write on the disc label surface, use a spirit-based felt pen. Do not use a ball-point pen or hard-tipped pen, because there is a danger of scratching the surface and corrupting the data. Do not use adhesive labels.
- Do not expose the disc directly to the sun's rays, or keep it in conditions of high temperature or humidity, as there is a danger of warping, with consequent loss of data.
- To remove dirt, dust, or fingerprints from the disc, wipe with a dry cloth, or use a CD cleaner. Always wipe radially from the inside to the outside, and do no wipe with circular movements. Never use abrasives or solvent cleaners.
- Hioki shall not be held liable for any problems with a computer system that arises from the use of this CD, or for any problem related to the purchase of a Hioki product.

Overview Chapter 1

1.1 Measuring Battery Wear

For determining battery wear, first measure internal resistance in a new or good battery.

The graph below shows the relation between storage capacity and initial value of internal resistance in a lead-acid battery. "CS," "HS," and "MSE" denote JIS (Japanese Industrial Standard) lead-acid battery types.
Internal resistance of an MSE (sealed stationary lead-acid battery) can be read at approximately 1 mΩ (100 Ah) and approximately 0.13 mΩ (1000 Ah). Under conditions of battery wear, internal resistance rises to 1.5 - 2 times its initial value (reference values).



NOTE

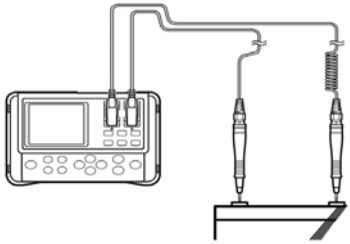
- For an MSE (sealed stationary lead-acid battery), when internal resistance reaches approximately 1.5 times its initial value, a warning will be issued. Wear (failure) values vary by manufacturer.
- Initial values of internal resistance may vary among batteries with the same capacity, depending on battery type or manufacturer. Refer to the graph on the previous page.
- Internal-resistance warnings and failures vary by manufacturer.

Source: Lead-acid battery technician certification textbook, Battery Association of Japan (BAJ)

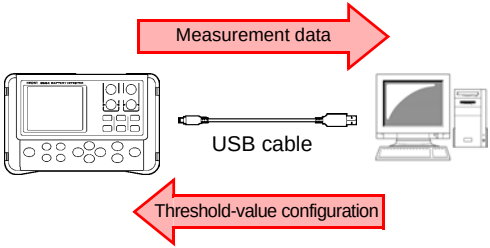
1.2 Product Overview

The 3554 BATTERY HiTESTER is a measuring instrument for judging battery wear by measuring internal resistance, voltage, and terminal temperature* of lead-acid, nickel-cadmium, nickel-hydrogen, and other types of batteries.

* Temperature measurement requires the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR.



By connecting the instrument to a personal computer after measurement, using the included USB cable, measurement data can be loaded to the personal computer.



1.3 Features

Enables measurement without shutting down UPS systems

This instrument uses high-precision AC resistance measurement technology. Since it is capable of live-wire measurement without shutting down the UPS system, it makes it possible to shorten the time required for measurement.

Reliable measurement values

Since it uses the four-terminal AC method to measure internal resistance, this instrument can obtain reliable measurement values unaffected by lead or connector resistance.

Simultaneous display of resistance, voltage, and temperature

Without changing functions, this instrument can display battery internal resistance, voltage, and terminal temperature simultaneously. Temperature measurement requires the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR.

Comparator feature

Using this instrument's comparator feature makes it possible to set threshold values for internal resistance and for voltage, thus enabling even more reliable measurement of battery wear.

Large memory capacity

Combining currently measured values (resistance, voltage, temperature, and comparator measurement results) into a set, this instrument can store up to 4,800 sets of data. It can be used to measure up to 12 sets of 400-cell cubicles.

Auto-memory feature

Enabling this function results in measurement data being stored to the instrument's internal memory automatically, the instant it is held. This increases operational efficiency.

PC interface

Measurement data can be loaded onto a personal computer.

Compact size

With a compact size with width and length approximately equivalent to the dimensions of an A5-sized sheet of paper, this instrument is highly portable. Designed to have a weight of only about 790 grams, it can be used for measurement over a long period of time without tiring the user.

Model 9772 PIN TYPE LEAD (optional)

Using the optional 9772 PIN TYPE LEAD — with a pin point designed to fit in holes only five millimeters in diameter — makes measurement possible without removing terminal covers. Since the pin can be inserted diagonally in hard-to-reach spots, it also makes measurement possible in virtually any location. Furthermore, pin strength has been improved from that of previous Hioki products.

A remote control switch for storing measurement values

Using the optional 9466 REMOTE CONTROL SWITCH makes it possible to store and hold measurement values through a simple press of a button. This is useful for cases when both of the operator's hands are occupied.

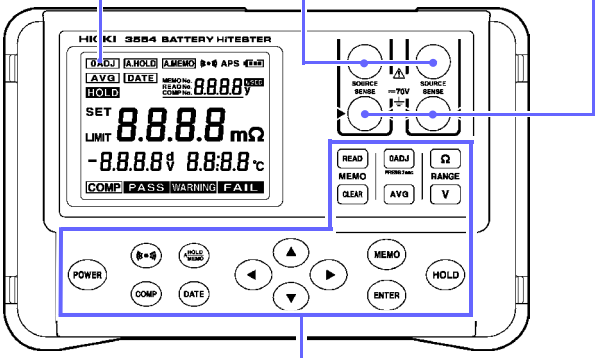
1.4 Names and Functions of Parts

Front Panel

SOURCE Terminal
Used for connecting the test lead's banana plug to the source

SENSE Terminal
Used for connecting the test lead's banana plug to the sense

Display
(p.20)



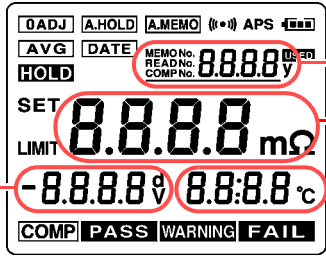
Key Operations

Key Operations

POWER	Used for turning the power on or off.
((•))	Used for turning the comparator buzzer on or off.
COMP	Used for turning the comparator feature on or off and configuring thresholds and other values.
A HOLD MEMO	Used for turning the auto-hold and auto-memory features on or off.
DATE	Used for displaying the current date and time. Press this key for at least two seconds to set the clock.

	Used for selecting configuration settings and changing their values.
MEMO	Used for storing displayed values to memory.
ENTER	Used for setting configuration values.
HOLD	Used for holding or canceling the displayed values.
READ	Used for recalling stored measurement values.
CLEAR	Used for deleting stored measurement values.
0ADJ	Used for implementing the zero-adjust feature.
AVG	Used for setting the number of measurements used in averaging. Press this key once to display the current setting. Keep the key pressed to switch settings through the cycle shown below. OFF → 4 → 8 → 16 ↑
Ω	Used for switching the resistance range. Press this key once to display the current range. Keep the key pressed to switch settings through the cycle shown below. 3.000 mΩ → 30.00 mΩ → 300.0 mΩ → 3.000 Ω ↑
V	Used for switching the voltage range. Press this key once to display the current range. Keep the key pressed to switch settings through the cycle shown below. 6.000 V ↔ 60.00 V

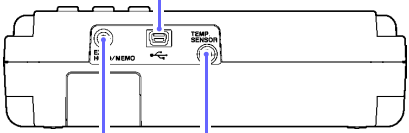
Display



0ADJ	Displayed when the zero-adjust feature is enable.
A.HOLD	Displayed when the auto-hold feature is enable.
A.MEMO	Displayed when the auto-memory feature is enable.
(•))	Displayed when the comparator button is turned on.
APS	Displayed when the auto-power-save feature is enable.
	Indicates the remaining battery power.
AVG	Displayed when the averaging feature is enable.
DATE	Displayed when showing or setting the date and time.
HOLD	Displayed when measurement values have been held.
MEMO No.	Displayed when the memory feature is turned on. Ordinarily, it shows the next number to be stored.
READ No.	Displayed when recalling data from memory.
COMP No.	Displayed when setting the comparator.
USED	Displayed when the memory number selected is already in use.
SET	Displayed when configuring the settings for various features.
LIMIT	Displayed when setting comparator threshold values.
COMP	Displayed when the comparator feature is enable.
PASS	Displayed when the battery subject to measurement can be used.
WARNING	Displayed when the battery subject to measurement is wearing out.
FAIL	Displayed when the battery subject to measurement has worn out.

Upper Panel

USB Terminal
Used for connecting the USB cable.



EXT.HOLD/MEMO Terminal
Used for the 9466 REMOTE CONTROL SWITCH.

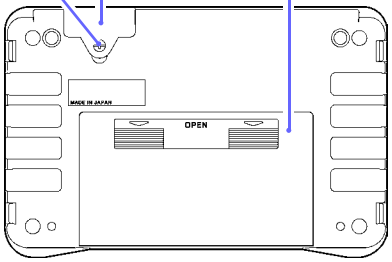
TEMP.SENSOR Terminal
Used for connecting the miniplug of the optional 9460 with temperature sensor.

Rear Panel

Fuse Cover
This is the cover for the internal fuse.

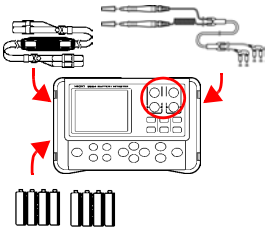
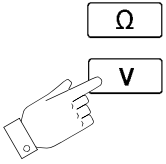
Battery Cover
This is the cover for the batteries.

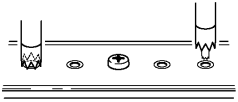
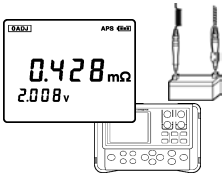
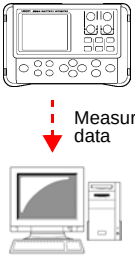
Tightening screw



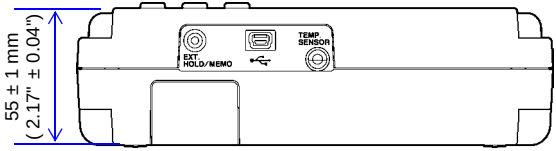
1.5 Measurement Flowchart

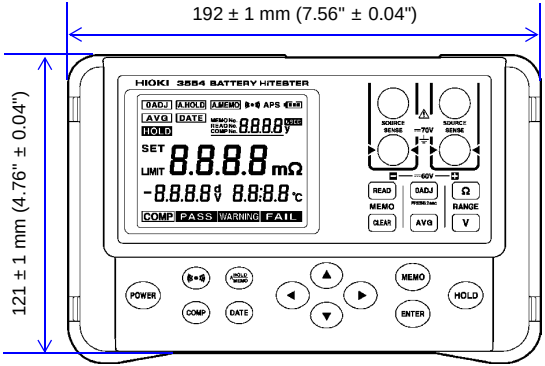
The measurement workflow is described below.

Measurement Preparations (p.25) 	1. Attaching the strap 2. Check the instrument's remaining battery power 3. Connecting the test lead 4. Turning the power on 5. Setting clock
Setting Range (p.36) 	1. Setting the resistance range 2. Setting the voltage range • When you want to stabilize measurement values: **(p.73)** • When you want to set threshold values by which to judge measurement values: **(p.55)** • When you want to hold measurement values: **(p.44)** • When you want to store measurement values: **(p.64)**

Zero-adjustment (p.37)  When using the 9465-10	Implement the zero-adjust feature in accordance with the zero-adjust method for the test lead used.
Starting Measurement 	1. Connect the test lead to the subject of measurement. 2. Read the measurement values. 3. Hold the measurement values. 4. Store the measurement values.
Ending Measurement 	1. Disconnect the test lead and turn off the power. 2. If you want to load the stored measurement data to a personal computer, connect the instrument to the computer using the USB cable and transfer the data. (This requires installation of data-transfer software.) (p.81)

1.6 External Dimensions



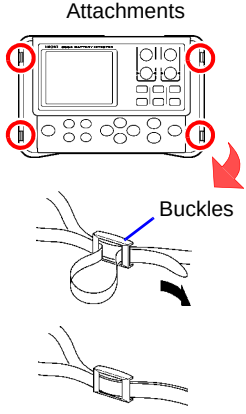


Measurement Preparations Chapter 2

2.1 Attaching the Strap

By attaching the strap, the instrument can be used hung it from the operator's neck. Attach the strap as described below.

⚠CAUTION Attach four ends of the Strap securely to the instrument.
If insecurely attached, the instrument may fall and be damaged or result in injury when carrying.



1. Turn off the power to the instrument and remove the test lead.
2. Run the strap through the two attachments on either side of the instrument and fasten it in place with the buckles.
3. Adjust the length of the strap.

The instrument can be placed in the portable case even with the strap attached.

2.2 Installing or Replacing the Batteries

When using the instrument for the first time, insert eight AA (LR6) alkaline batteries. Before attempting measurement, check to make sure enough battery charge remains. When the battery charge gets low, replace the batteries.

⚠WARNING

- To avoid electric shock, turn off the power and disconnect the test lead before replacing the batteries. After replacing the batteries, replace the cover before using the instrument.
- Do not mix old and new batteries, or different types of batteries. Also, be careful to observe battery polarity during installation. Otherwise, poor performance or damage from battery leakage could result.
- Battery may explode if mistreated. Do not short-circuit, recharge, disassemble or dispose of in fire.
- Handle and dispose of batteries in accordance with local regulations.

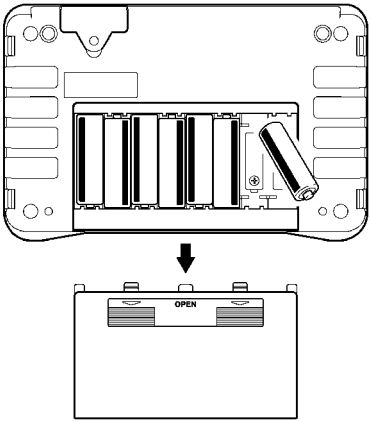
NOTE The ▭ indicator flashes when battery voltage becomes low. Replace the new batteries soon.

1. Turn off the power to the instrument and remove the test lead.

2. Open the battery compartment cover on the rear of the instrument.

3. Insert eight batteries, taking care to use the proper polarities.

4. Replace the battery compartment cover.

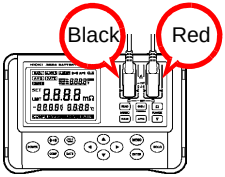


2.3 Connecting the Test Lead

⚠WARNING To avoid electric shock, be sure to connect the test leads properly.

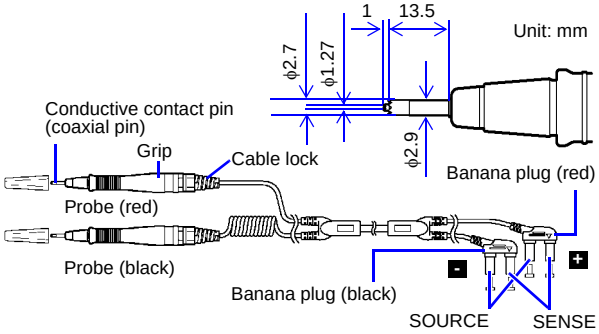
⚠CAUTION
- For safety reasons, when taking measurements, only use the test lead provided with the instrument.
- The ends of the test leads are sharp. Be careful to avoid injury.

Connect the test lead to the instrument. Be sure to connect all four terminals: SOURCE (+, -) and SENSE (+, -).



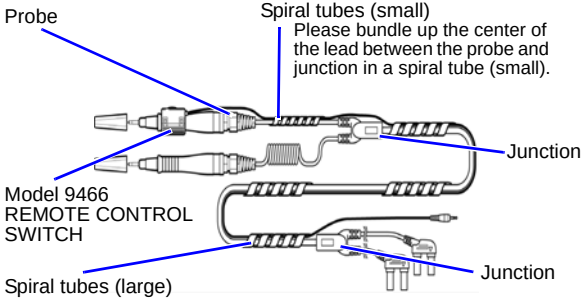
When using the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with temperature sensor, connect the miniplug to the TEMP. SENSOR terminal. "Section 3.7 Temperature Measurement" (p.51)

External Dimensions of the 9465-10 PIN TYPE LEAD



Connecting the Test Lead and Remote Control Switch

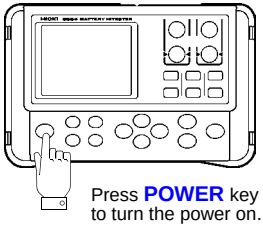
The 9465-10 or the 9772 PIN TYPE LEAD (optional) and the 9466 REMOTE CONTROL SWITCH (optional) can be combined as shown below.
Connect the switch to the probe of the lead, and join the two cables using the supplied spiral tube.



2.4 Turning the Power On and Off

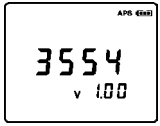
Use POWER key to turn the power on and off. Check the clock settings when using the instrument for the first time.

Powering On

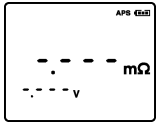


Press **POWER** key to turn the power on.

All screen elements displayed



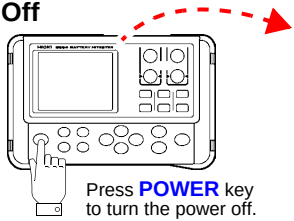
Model and version number



Measurement display

NOTE The ▭ indicator flashes when battery voltage becomes low. Replace the new batteries soon.

Powering Off



Press **POWER** key to turn the power off.

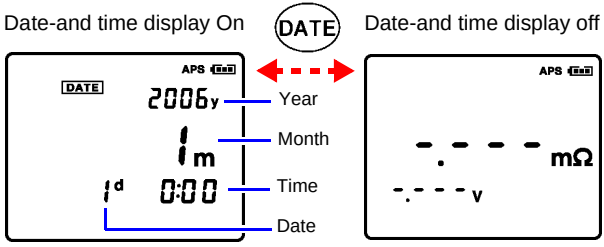
All screen elements turned off

2.5 Clock-setting

You can display the date and time by pressing DATE key. Check the clock settings when using the instrument for the first time.

2.5.1 Turning Date-and-time Display On and Off

Press DATE key to switch date-and-time display on and off.



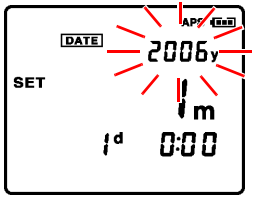
(0:00, January 1, 2006)

NOTE
- The time is displayed using a 24-hour clock.
- The instrument's calendar recognizes leap years automatically.

2.5.2 Setting the Clock

1. Press (DATE) key for two seconds or longer.

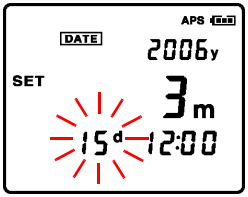
This will display the clock-setting screen.



(0:00, January 1, 2006)

2. Use (▲)/(▼) keys to change the date and time settings.

Use (◀)/(▶) keys to switch between settings.



(12:00, March 15, 2006)

3. Press (ENTER) key to save the date and time settings.

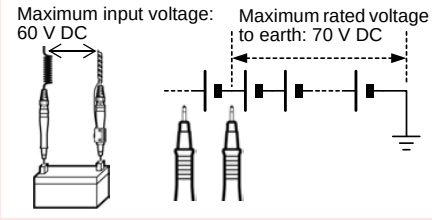
NOTE If you exit the clock-setting screen without pressing (ENTER) key, your settings will not be saved.

Measurement Chapter 3

To ensure safe measurement, be sure to read this section prior to measuring.

⚠ DANGER Observe the following to avoid electric shock and short circuits.

- Do not measure voltages of 60 V DC or higher.
- Do not measure grounded voltages of more than 70 V DC.
  <Ex.> Ground Battery System



- Do not measure alternating voltage.

⚠ CAUTION

- Note that the instrument may be damaged if the applied voltage or current exceeds the measurement range.
- After measuring a high-voltage battery, before continuing to measure a low-voltage battery first short the test leads together. This will discharge the DC elimination capacitor which is connected across the leads. Otherwise an excess voltage may be applied to the low-voltage battery, witch is may cause damage.

NOTE

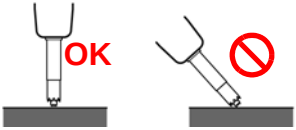
- Internal battery resistance varies considerably depending on charge or discharge status. In order to increase measurement precision, measure under similar conditions (e.g., full battery charge).

- Lead-acid batteries (subjects of measurement) have high levels of terminal resistance. For this reason, resistance values may differ between the case side and the tip of a terminal. Be sure to connect the test lead to the terminals at a fixed location. "Section 10.4 Effects of Current Density" (p.137)

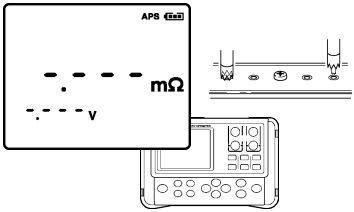
- To measure battery temperature, use the optional CLIP TYPE LEAD WITH TEMPERATURE SENSOR or, for safety purposes, a non-contact thermometer such as a radiation thermometer.

- Measurement may be impossible for insulated terminals, due to an insufficient flow of current for measurement. In such a case, clean the terminal (removing the insulation) before measurement.

- To avoid damage, do not contact the 9465-10 PIN TYPE LEAD tip against the battery at a tilted angle.



3.1 Pre-operation Inspection

Subject of inspection	Method of checking
Is the fuse worn out? Is the test lead disconnected?	Touch the test lead to the zero-adjust board. If the resistance display still shows a value of "- - . - -" the fuse might be worn out or the test lead disconnected. 
Is sufficient power remaining in the battery?	The icon in the upper right-hand area of the screen indicates the current battery status. If the following icon is displayed, the batteries are almost empty: Replace the batteries.
Inspecting batteries	Measurement may be impossible for insulated terminals, due to an insufficient flow of current for measurement. In such a case, clean the terminal (removing the insulation) before measurement.

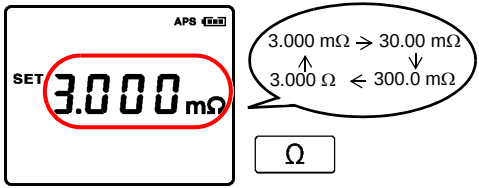
3.2 Setting the Measurement Range

Set resistance and voltage measurement ranges as described below.

Resistance Range	3 mΩ / 30 mΩ / 300 mΩ / 3 Ω
Voltage Range	6 V / 60 V
Temperature Range	(Single range) Since temperature measurement uses a signal range, range setting is unnecessary.

Resistance Measurement Range

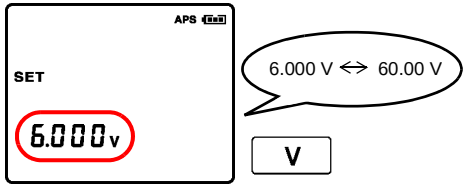
Press [Ω] key to display the current settings. Press the key repeatedly to select the desired range.



After approximately one second passes with no settings made, the settings displayed will be entered and the instrument will return to the measurement screen.

Voltage Measurement Range

Press [V] key to display the current settings. Press the key repeatedly to select the desired range.



After approximately one second passes with no settings made, the settings displayed will be entered and the instrument will return to the measurement screen.

3.3 Zero-adjustment

Using the zero-adjust feature makes more reliable measurements possible by adjusting the resistance-range and voltage-range zero values of the instrument. Using the zero-adjust feature is recommended prior to measurement. The zero-adjust feature sets the current measurement value (adjusted value) at 0 and displays subsequent measurement results.

⚠WARNING To prevent short circuits, do not place the zero-adjust board on top of the battery.

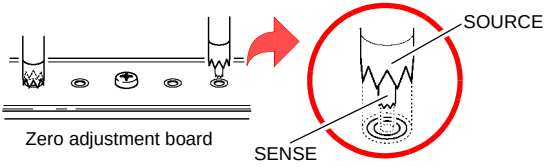
NOTE

- The zero-adjust feature takes approximately four seconds.
- Using the zero-adjust feature adjusts the zero points of all ranges.
- Even after turning off the power to the instrument, the adjusted values will remain and the zero-adjust feature will not be cancelled.
- After replacing the test lead, be sure to use the zero-adjust feature prior to measurement.
- Be sure to use the included zero-adjust board for the zero-adjust feature.
- Be sure to keep the test lead shorted during use of the zero-adjust feature. Keep the tip of the test lead away from the metal components.

3.3.1 Shorting Methods for Various Test Leads

Model 9465-10 PIN TYPE LEAD

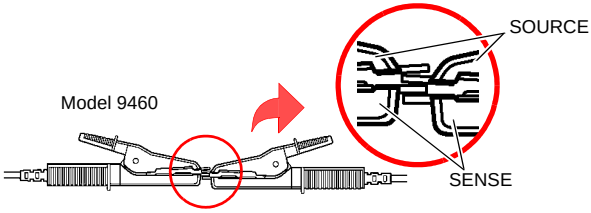
Short the test leads using the four-terminal AC method, with the included zero-adjust board. As shown in the illustration below, select a hole suited to the distance between terminals on the battery subject to measurement. Press it in a way symmetrical to the central screw on the zero-adjust board. Keep the zero-adjust board at least 10 centimeters away from the instrument.



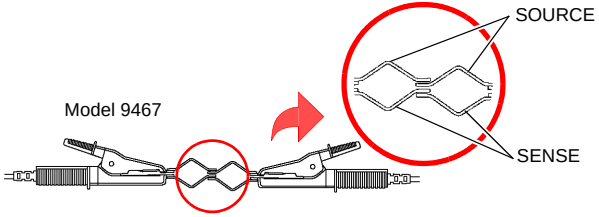
NOTE

- Be sure to use the included zero-adjust board for the zero-adjust feature. Also, be sure to connect each of the SOURCE and SENSE terminals by inserting the tip of the pin into the holes on the zero-adjust board as shown in the illustration.
- Do not place the zero-adjust board on top of the battery or any pieces of metal. Electromagnetic induction effects could result in unstable measurement values. In such a case, separate the zero-adjust board from any metal components.
- Conducting zero adjustment by connecting the tips of pin-type leads or using a metal sheet other than the included zero-adjust board will result in inaccurate adjustment.
- When the distance between the terminals on the battery subject to measurement is greater than the distance between the holes on the zero-adjust board, use the holes in the corners for the zero-adjust feature.

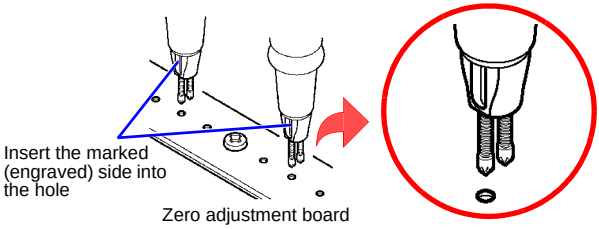
Model 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR



Model 9467 LARGE CLIP TYPE LEAD



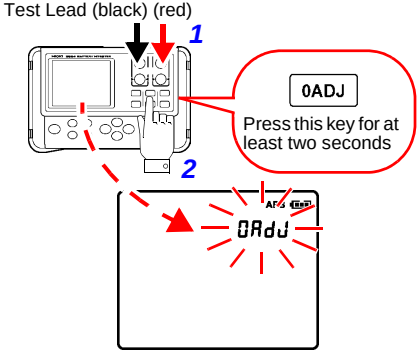
Model 9772 PIN TYPE LEAD



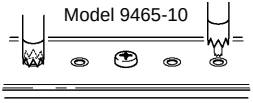
3.3.2 Implementing the Zero-adjust Feature

1. Check to ensure that the test leads are connected properly.
If a lead is connected to the subject of measurement, disconnect it.

2. Press [0ADJ] key for at least two seconds.
This will cause the instrument to wait for adjusted values.



3. While the display is blinking (for approximately 10 seconds), short the test leads using the zero-adjust board.



If the test leads are not shorted while the display is blinking, an error will result.

NOTE The zero-adjust function will begin even if a key is pressed after the test lead has been shorted.

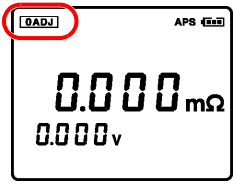
4. Begin automatic obtaining of adjusted values.

(3 mΩ range) (30 mΩ range)

(3 Ω range, voltage range) (300 mΩ range)

Keep the test leads shorted until the zero-adjust operation is complete.

5. When the zero-adjust operation is complete, the **0ADJ** icon will be displayed and the instrument will return to the measurement state:



When the screen displays the message "Err":

An error results when the zero-adjusted values cannot be obtained correctly. This error could result from any of the following causes:

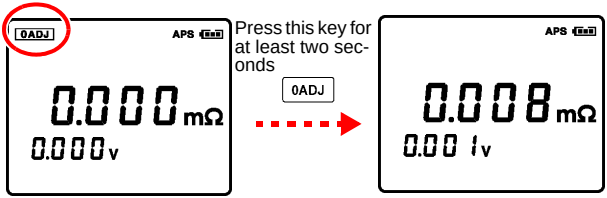
- The fuse might be worn out.
  Check the fuse: Refer to "Section 9.4 Replacing the Fuse" (p.127)

- The adjusted values obtained exceed the 300 count, for either resistance or voltage values.
  →Ensure the test lead is connected to the instrument properly.
  →The test lead may be broken. Try using a new test lead.
  →Try cleaning the zero-adjust board.

- Approximately 10 seconds have passed with the instrument awaiting adjusted values.
  (i.e., displaying: "- - - -")
  →Try the zero-adjust operation again.

3.3.3 Canceling the Zero-adjust Operation

Pressing the 0ADJ key for at least two seconds while the zero-adjust feature is active will cancel the zero-adjust operation:



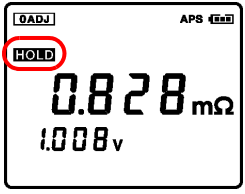
Canceling the zero-adjust

3.4 Holding the Display

3.4.1 Holding

Holding the measurement values displayed on screen

Press (HOLD) key. The **HOLD** icons will be displayed, and the measurement values will be held:

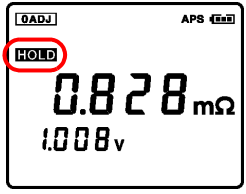


Holding cannot be conducted when the following values are displayed: "- - - -"

3.4.2 Canceling a Hold

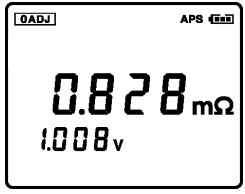
Press (HOLD) key again to cancel the hold.

Holding



HOLD

Canceling a hold



NOTE

- Holding cannot be conducted when the following values are displayed: "- - - -"
- Changing configuration conditions will cancel the hold.
- Turning off the power will cancel the hold.

3.4.3 Holding Using the EXT.HOLD/MEMO Terminal

The EXT.HOLD/MEMO terminal can be used for the same purposes as (HOLD) key. This requires the optional 9466 REMOTE CONTROL SWITCH.

1. Disconnect the test lead from the battery subject to measurement.
2. Insert the miniplug of the 9466 REMOTE CONTROL SWITCH into the EXT.HOLD/MEMO terminal.
3. Press the **PRESS** button on the 9466 to hold the measurement values.
4. To cancel the hold, press the PRESS button on the 9466 switch or press (HOLD) key on the instrument.

NOTE

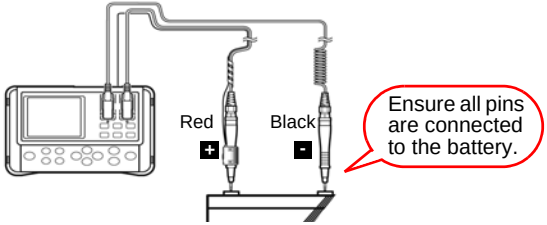
- Holding cannot be conducted when the following values are displayed: "- - - -"
- Be sure not to insert or remove the miniplug while the test lead is connected to the battery subject to measurement. Connect the handy switch only after disconnecting the test lead from the battery.
- Do not insert the miniplug of the 9466 REMOTE CONTROL SWITCH into the TEMP.SENSOR terminal.

3.5 Determining Battery-wear Judgment Values

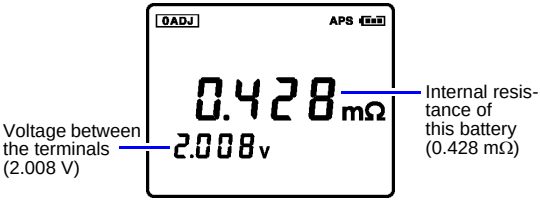
For determining battery wear, first measure internal resistance in a new or good battery, and then set values for judging battery wear.

Ex.: When values measured for a new battery are 0.428 mΩ and 2.008 V, set the internal resistance caution value at 0.6 mΩ (1.5 times the initial value) and the internal resistance warning value at 0.8 mΩ (2 times the initial value) and set the voltage caution value at 1.8 V (90% of the initial value).

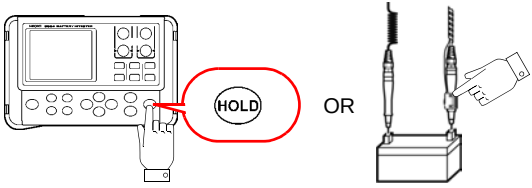
1. Referring to "Section 3.1 Pre-operation Inspection" (p.35), configure the range and conduct the zero-adjust operation.
2. Connect the test lead to a new or good battery.



3. Read the measurement values.



4. Hold the measurement values by pressing HOLD key or the **PRESS** button on the remote control switch.



5. Use these measurement values to determine battery wear judgment values.

As a battery wears out, in general its internal resistance will grow to approximately 1.5 - 2 times (reference values) that of a new or good battery. Note that this varies by manufacturer and model of battery. (p.13)
In this example, the internal resistance caution value (upper limit no. 1) has been set at 0.6 mΩ and the internal resistance warning value (upper limit no. 2) at 0.8 mΩ, and the voltage caution value (lower limit) has been set at 1.8 V.

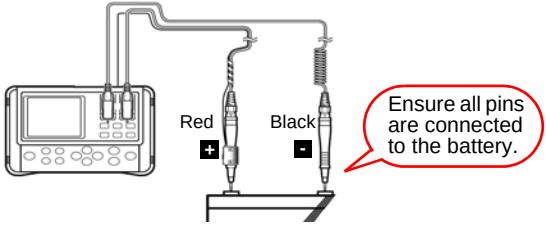
Stabilizing measurement values	(p.73)
Storing measurement values	Measurement values can be stored by pressing MEMO key while the values are being held. (p.64)
Loading stored data to a personal computer	(p.89)
Configuring threshold values and judging battery wear	Based on these wear judgment values, threshold values can be configured for judging battery wear. (p.53)

3.6 Battery Measurement

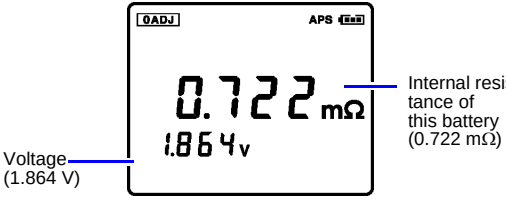
For determining battery wear, first measure internal resistance in a new or good battery, and then set values for judging battery wear. (p.46)

In this example, where values measured for a new battery were 0.345 mΩ and 2.200 V, the internal resistance caution value has been set at 0.518 mΩ (1.5 times the initial value) and the internal resistance warning value at 0.690 mΩ (2 times the initial value), and the voltage caution value has been set at 1.980 V (90% of the initial value).

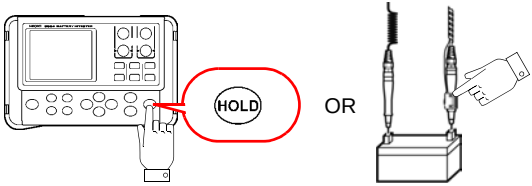
1. Referring to "Section 3.1 Pre-operation Inspection" (p.35), configure the range and conduct the zero-adjust operation.
2. Connect the test lead to the battery.



3. Read the measurement values.

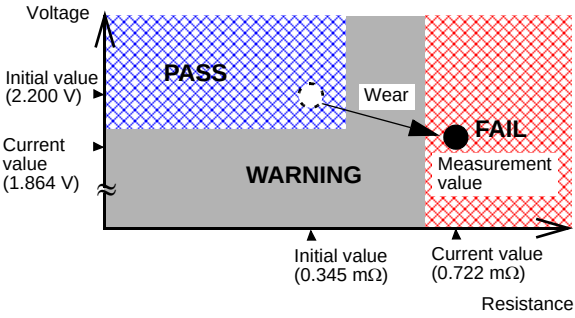


4. Hold the measurement values by pressing HOLD key or the **PRESS** button on the remote control switch.



5. Use the measurement values to judge battery wear.

<Ex.>



As shown above, this battery needs to be replaced.

Stabilizing measurement values	(p.73)
Storing measurement values	Measurement values can be stored by pressing MEMO key while the values are being held. (p.64)
Loading stored data to a personal computer	(p.89)
Configuring threshold values and judging battery wear	Based on these wear judgment values, threshold values can be configured for judging battery wear. (p.53)

NOTE

- A measurement value display of "OF" indicates that the resistance or voltage values displayed exceed the relevant measurement range.
- If the voltage input is "OF," a buzzer will sound.
- A resistance value display of "- - - -" indicates that the test lead is open or measurement cannot be conducted due to an electrical current irregularity caused by a disconnected test lead or other reasons. "- - - -" will also be displayed when the test lead is not correctly connected to the subject of measurement or the subject's resistance is substantially greater than the measurement range.
- When measuring resistance of a relay or a connector, note the maximum open circuit voltage of this instrument (approximately 5 V). There is a possibility that such measurement could damage the connectors or oxidized coating of the subject of measurement, leading to incorrect measurement.

Ending the Measurement

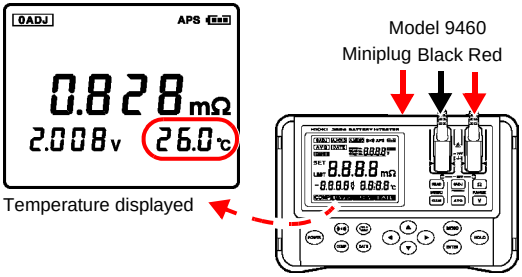
Remove the test lead from the battery and turn off the power to the instrument by pressing POWER button.

3.7 Temperature Measurement

Use the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with temperature sensor to measure battery temperature.
Connect the red connector of the clip-type lead with temperature sensor to the SENSE terminal, the black connector to the SOURCE terminal, and the miniplug to the TEMP. SENSOR terminal. The instrument will detect the temperature sensor and display the measured temperature automatically.

⚠CAUTION

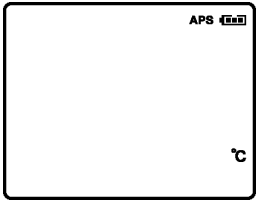
- For safety reasons, when taking measurements, only use the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with the instrument.
- The sensor used in the temperature probe is a thin, precision platinum film. Be aware that excessive voltage pulses or static discharges can destroy the film.
- Avoid subjecting the temperature probe tip to physical shock, and avoid sharp bends in the leads. These may damage the probe or break a wire.



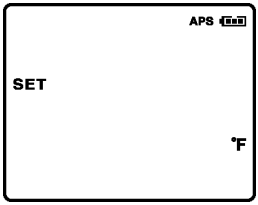
Changing the Unit of Temperature (°C ⇔ °F)

1. Press POWER key to turn the power off.

2. While holding ◀, ▶, and HOLD key down, press POWER key.



3. Press ((•)) key for three seconds or longer.



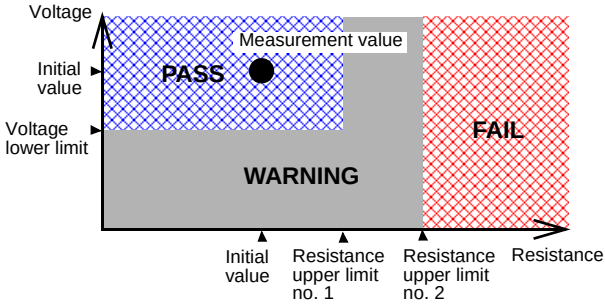
Setting changes

4. This will restart the instrument.

Comparator Feature Chapter 4

4.1 Overview

The comparator feature can be used to determine in which of the following ranges measurements fall, by comparing them with preset permissible values and battery measured values: pass, warning, or fail. Up to 200 comparator conditions can be set. Refer to "Section 1.1 Measuring Battery Wear" (p.13) for how to determine permissible values.
Under the initial configuration, when a measurement falls in the warning or fail range, a buzzer will sound.
For more information, refer to "Section 4.4 Setting the Comparator Buzzer" (p.61).
Permissible values include the following: resistance upper limit no. 1 (caution), resistance upper limit no. 2 (warning), and the voltage lower limit (caution).

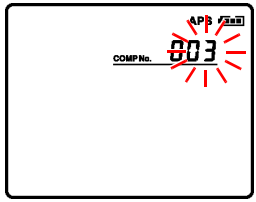


4.2 Turning On the Comparator

1. Press (COMP) key.
The comparator no. will flash.

Press (COMP) key again to return to ordinary settings.

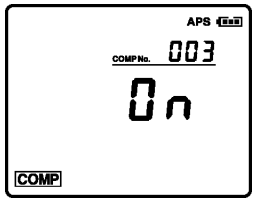
2. Press (▲) / (▼) keys to select the comparator no.
Press (◀) / (▶) keys to select digits.

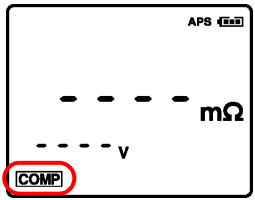


In this example, comparator no. 3 has been selected (available range: 0 - 200)

3. Press (ENTER) key to save the settings.

The message "On" will appear on the screen, indicating that the comparator feature has been turned on.





4.3 Setting Comparator Permissible Values

Set the comparator permissible values (resistance upper limit no. 1, resistance upper limit no. 2, and the voltage lower limit).

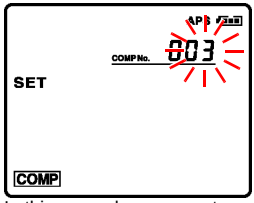
<Example>

Permissible values for a battery with initial values (i.e., resistance and voltage values when new or in good condition) of 0.4 Ω and 2 V:
Resistance upper limit no.1: 0.6 Ω (1.5 times initial value)
Resistance upper limit no.2: 0.8 Ω (2 times initial value)
Voltage lower limit: 1.8 V

Select the Comparator No.

1. Press (COMP) key for two seconds or longer.
The comparator no. will flash.
Press (COMP) key again to return to ordinary settings.

2. Press (▲)/(▼) keys to select the comparator no.
Press (◀)/(▶) keys to select digits.

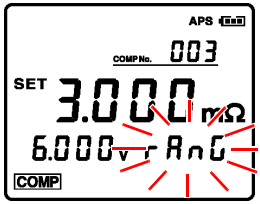


In this example, comparator no. 3 has been selected (available range: 0 - 200)

3. Press (ENTER) key to complete the setting of comparator nos. and return to the range-setting screen.

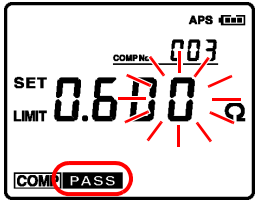
Setting Range

1. Press [Ω] key to select resistance range.
Press [V] key to select voltage range.
(The position of the decimal point will move.)



2. Press (ENTER) key to save the settings.

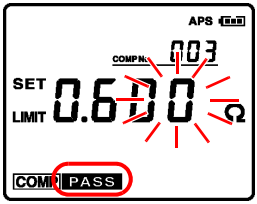
Resistance upper limit no. 1 is flashing, and PASS icon is displayed.



Setting Resistance Permissible Values

1. Press ▲/▼ keys to set the values of resistance upper limit no. 1.

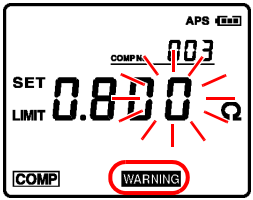
Press ◀/▶ keys to select digits.



In this example, 0.600 Ω has been selected

2. Press ENTER key to save the settings.

Resistance upper limit no. 2 and WARNING icon is flashing.



In this example, 0.800 Ω has been selected

3. Press ▲/▼ keys to set the values of resistance upper limit no. 2.

Press ◀/▶ keys to select digits.

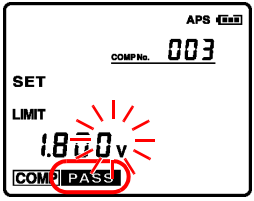
4. Press ENTER key to save the settings.

Voltage lower limit and PASS icon is flashing.

Setting Voltage Lower Limit

1. Press ▲ / ▼ keys to set the values of voltage lower limit.

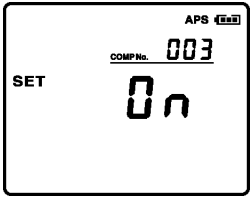
Press ◀ / ▶ keys to select digits.



In this example, 1.800 V has been selected

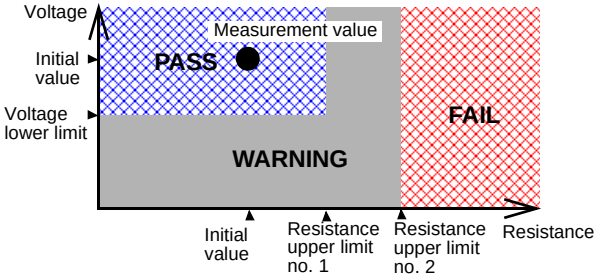
2. Press ENTER key to save the settings.

This will return the display to the measurement screen, with the comparator feature on.
At this point, configuration settings are saved.

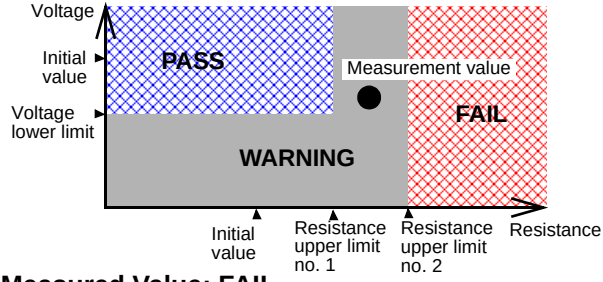


NOTE Voltage values are judged using absolute values. For this reason, judgment can be made even when the polarity of the test lead is reversed. (Data is also saved using absolute values.)

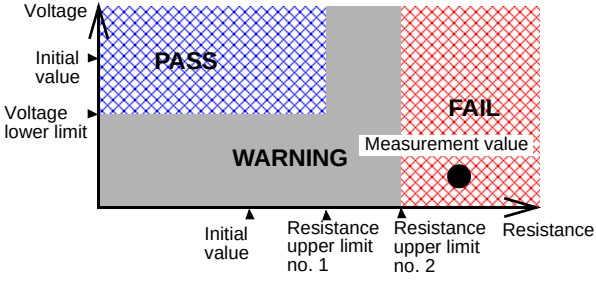
Measured Value: PASS



Measured Value: WARNING



Measured Value: FAIL



Comparator Comparison Table

Judgment is conducted using the display and the buzzer, as shown in the following table:

Resistance upper limit no. 1 ↓ Resistance upper limit no. 2 ↓

	Resistance (low)	Resistance (medium)	Resistance (high)
Voltage (high)	PASS	WARN	FAIL
Voltage (low)	WARN	WARN	FAIL

Voltage lower limit →

Boundary conditions are shown below:

Resistance PASS ≤ [Resistance upper limit no. 1] < Resistance WARN ≤ [Resistance upper limit no. 2] < Resistance FAIL

Voltage WARN < [Voltage lower limit] ≤ Voltage PASS

Examples of how to read the comparator output table

<Ex. 1> When the measured resistance value does not exceed resistance upper limit no. 1 and the measured voltage value is greater than the voltage lower limit, "Pass" will be displayed.

<Ex. 2> When the measured resistance value exceeds the resistance upper limit no. 1 and does not exceed the resistance upper limit no. 2, and the measured voltage value is greater than the voltage lower limit, "Warning" will be displayed and a buzzer sounded.

NOTE When the resistance upper limit no. 1 and no. 2 are set at the same value, the boundary conditions will be as shown below:

Resistance PASS ≤ [Resistance upper limit no. 1] = [Resistance upper limit no. 2] < Resistance FAIL

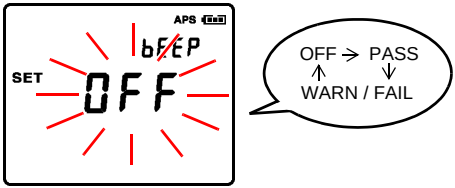
4.4 Setting the Comparator Buzzer

When using the comparator feature, the buzzer can be set to sound in accordance with judgment results. The following conditions can be set. The initial configuration is "warn/fail (on)."

OFF	No buzzer sounds regardless of the results of judgment.
PASS (ON)	The buzzer sounds when the results of judgment are "pass."
WARN/FAIL (ON)	The buzzer sounds when the results of judgment are "warning" or "fail."

NOTE The sound emitted when pressing the keys cannot be changed.

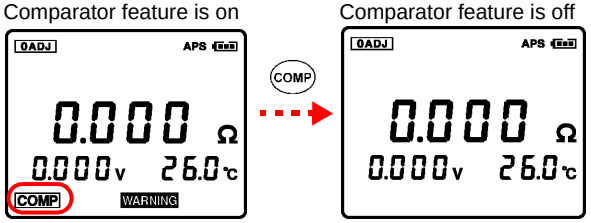
When you press key, the current comparator buzzer settings will be displayed. Keep the button pressed to switch between settings.



After approximately one second passes with no settings made, the settings displayed will be entered and the instrument will return to the measurement screen.

4.5 Turning Off the Comparator

Pressing (COMP) key when the comparator feature is on will turn off the comparator feature.



NOTE

- The range keys cannot be used while the comparator is turned on.
- If there are no measured values, "- - - -" will be displayed and comparator judgment cannot be conducted.
- Even when the power has been turned off, the comparator feature settings will be saved and the comparator feature will still be on the next time the power has been turned on.

Memory Feature Chapter 5

5.1 Overview

Up to 4,800 sets of currently measured values (date and time, resistance, voltage, temperature, comparator permissible values, results of judgment) can be saved. After measurement, saved data can be displayed or transferred to a personal computer.
The following table shows the structure of the internal memory:

Memory Structure

Unit (12 units)	Memory no. (400 cells)						
A	1	2	3	.....	398	399	400
b	1	2	3	.....	398	399	400
C	1	2	3	.....	398	399	400
d	1	2	3	.....	398	399	400
E	1	2	3	.....	398	399	400
F	1	2	3	.....	398	399	400
G	1	2	3	.....	398	399	400
H	1	2	3	.....	398	399	400
J	1	2	3	.....	398	399	400
L	1	2	3	.....	398	399	400
n	1	2	3	.....	398	399	400
P	1	2	3	.....	398	399	400

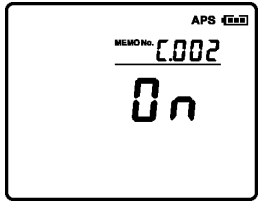
5.2 Saving to Memory

Pressing MEMO key will save the currently measured values.
Convenient feature: Auto-memory Feature (p.75)

5.2.1 Saving Measured Values to Memory

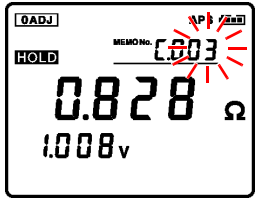
1. Press MEMO key.

The memory feature will turn on.



2. If you want to save the data under a different number than the memory no. displayed, use the ▲▼◀▶ keys to change the value.

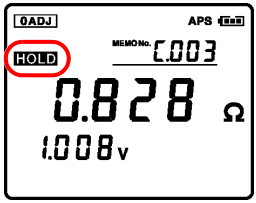
After approximately one second passes with no settings made, the settings displayed will be entered and the instrument will return to the measurement screen.
The settings can also be finalized by pressing ENTER key. This operation can be used at any time while the memory feature is in effect.



In this example, C.003 has been selected

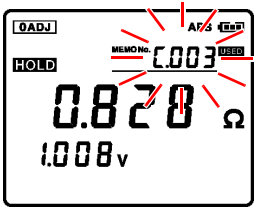
3. Use (HOLD) key to hold measured values.

When "- -.- -" is displayed, values cannot be held.



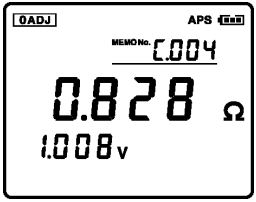
4. Use (MEMO) key to save measured values.

Measured values will be saved to the memory no. selected.



5. When saving is complete, the next memory no. for saving data will be displayed.

The hold will be released.



The last data saved can be deleted by holding CLEAR key down for two seconds or longer.

These values can be deleted only immediately after saving them. Using the keys to change settings or other operations will disable this feature.

5.2.2 Saving Using the EXT.HOLD/MEMO Terminal

The EXT.HOLD/MEMO terminal can be used for the same purposes as (MEMO) key. This requires the optional 9466 REMOTE CONTROL SWITCH.

⚠CAUTION To avoid damage to the instrument, do not enter voltage to the EXT.HOLD/MEMO terminal.

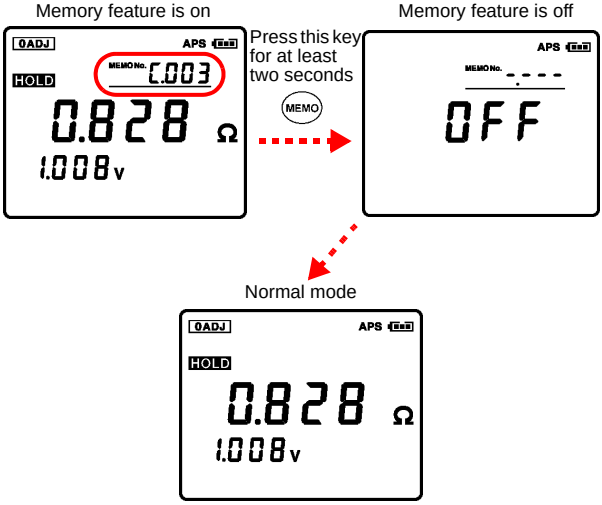
1. Disconnect the test lead from the battery subject to measurement.
2. Insert the miniplug of the 9466 REMOTE CONTROL SWITCH into the EXT.HOLD/MEMO terminal.
3. When pressing the **PRESS** button on the 9466 REMOTE CONTROL SWITCH, the measured values will be held. When pressing the button again, the data will be saved to the selected memory no.
4. The hold feature will be turned off.

NOTE

- Be sure not to insert or remove the miniplug while the test lead is connected to the battery subject to measurement. Connect the handy switch only after disconnecting the test lead from the battery.
- Do not insert the miniplug of the 9466 REMOTE CONTROL SWITCH into the TEMP.SENSOR terminal.

5.3 Turning Off the Memory Feature

To turn off the memory feature when it is on, hold MEMO key down for two seconds or longer.
"OFF" will be displayed, and the screen will return to the normal mode.



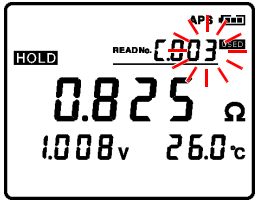
5.4 Reading Saved Data

Saved measured values can be read and displayed.

1. Press [READ] key.

This will display the reading screen.

2. Press ▲/▼ keys to select the memory no.
Press ◀/▶ keys to select digits.

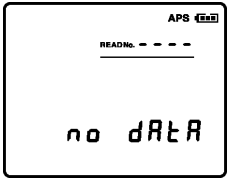


In this example, C.003 has been selected

The measurement values for the selected memory no. will be displayed.

NOTE

- Press (DATE) key to check the date and time of saving (which will be displayed while the key is depressed).
- The comparator results for the data being read will also be displayed.
- Numbers to which no data is saved cannot be selected.
- If no data has been saved, "- - - -" will be displayed in the space for the memory no. and the display will return to the measurement screen.



- For data measured using the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with temperature sensor, the temperature will also be displayed.

5.5 Deleting Saved Data

Saved measured values can be deleted as described below.

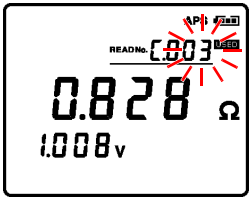
5.5.1 Deleting a Single Data Set

1. Press [READ] key.

This will display the reading screen.

2. Press ▲/▼ keys to select the memory no.

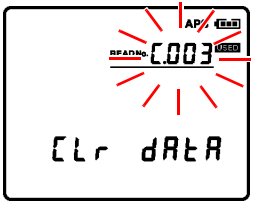
Press ◀/▶ keys to select digits.



In this example, unit C has been selected
(The measured values saved under C.003 will be displayed.)

3. Press [CLEAR] key.

If there is no activity for approximately three seconds, the reading screen will be displayed.



Memory no. flashes

4. Press (ENTER) key to save the settings.

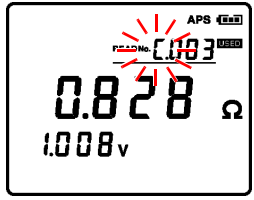
Data stored to the selected memory no. will be deleted.

5.5.2 Deleting an Entire Unit (400 sets)

1. Press [READ] key.

This will display the reading screen.

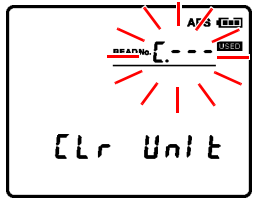
2. Press ▲/▼ keys to select the memory no.



In this example, unit C has been selected.

3. Press [CLEAR] key two times.

If there is no activity for approximately three seconds, the reading screen will be displayed.



Unit name is flashing
In this example, unit C has been selected.

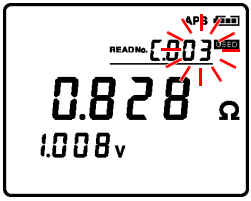
4. Press (ENTER) key to save the settings.

All data saved to the selected unit (400 sets) will be deleted.

5.5.3 Deleting All Data (12 units/4800 sets)

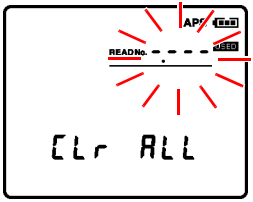
1. Press [READ] key.

This will display the reading screen.



2. Press [CLEAR] key three times.

If there is no activity for approximately three seconds, the reading screen will be displayed.



"-.- - -" is flashing
This display indicates that all units have been selected.

3. Press (ENTER) key to save the settings.

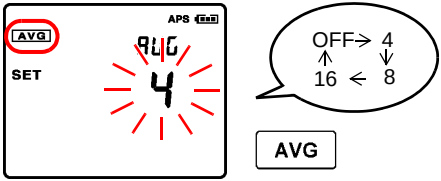
All data (12 units/4800 sets) will be deleted.

Other Features Chapter 6

6.1 Averaging Feature

When measured values are unstable, they can be stabilized using averaging. The number of times averaging is conducted can be selected from four, eight, or 16 times. When using the averaging feature, AVG icon is displayed on the screen. This feature is turned off under initial settings and after resetting the system.

Press AVG key to display the current number of times used for averaging. Keep this key depressed to switch the number of times set.



After approximately one second passes with no settings made, the settings displayed will be entered and the instrument will return to the measurement screen.

NOTE

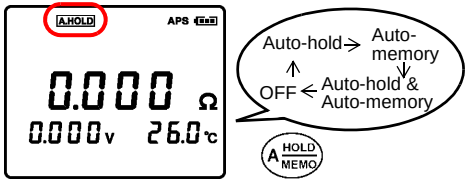
- The averaging feature is conducted for resistance values.
- The averaging feature can be used to change the rate of updating display of measured values.
- When not using the averaging feature, select "OFF."

6.2 Auto-hold Feature

This feature can be used to recognize automatically the stability of measured values and to hold measured values.

Configuring the Auto-hold Feature

Press several times (A HOLD/MEMO) key to display the A.HOLD icon.



Releasing the Hold

Release the hold by pressing (HOLD) key or the **PRESS** button on the 9466 REMOTE CONTROL SWITCH.

NOTE

- When "- - - -" is displayed, the auto-hold feature cannot be used.
- The auto-hold function can be used when "OF" is displayed on-screen.
- When using the auto-memory feature together with this feature, measured values can be saved automatically after holding them.
  In order to judge whether the "OF" display has resulted from mistaken range settings, using the comparator as well, or setting the comparator buzzer to "WARN/FAIL," is recommended.
  "Section 4.4 Setting the Comparator Buzzer" (p.61)

Releasing the Auto-hold Feature

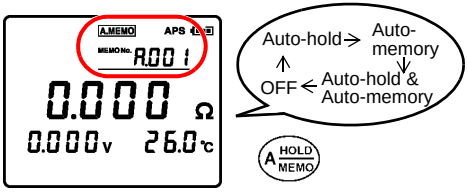
Press several times (A HOLD/MEMO) key to turn off the A.HOLD icon.

6.3 Auto-memory Feature

This feature saves measured values to memory automatically, immediately after the values have been held.

Configuring the Auto-memory Feature

Press several times (A HOLD MEMO) key to display the A.MEMO icon. At this point, the memory feature is in effect.



Use the keys to select the memory no. to which the data will be saved. When data has already been saved to the memory no. selected, the USED icon will be displayed.

NOTE

When using the auto-hold feature together with this feature, measured values can be saved automatically after holding them.
In order to judge whether the "OF" display has resulted from mistaken range settings, using the comparator as well, or setting the comparator buzzer to "WARN/FAIL," is recommended.
"Section 4.4 Setting the Comparator Buzzer" (p.61)

Releasing the Auto-memory

Press several times (A HOLD MEMO) key to turn off the A.MEMO icon.

6.4 Auto-power-save Feature (APS)

The auto-power-save feature can be used to control the instrument's power consumption. When any of the following conditions has continued for approximately ten seconds with no keys pressed, power to the instrument will be turned off automatically.

- When the resistance value displayed is "- - - -"
- Hold (measurement stopped)
- Conditions other than measurement conditions (each configuration screen, data reading screen)
- Conditions following completion of communication

"APS" will begin to flash one minute before the power turns off.

NOTE

- This feature is turned on under initial configuration conditions. When the auto-power-save feature is unnecessary, such as when using the instrument continuously, turn this feature off.

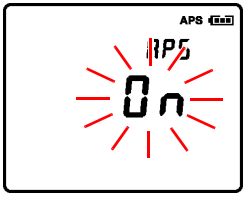
- When the auto-power-save screen has been displayed unintentionally, turn the power on again. The instrument's settings will be restored unchanged.

Turning the Auto-power-save Feature On and Off

1. Press POWER key to turn the power off.

2. While holding HOLD key down, press POWER key.

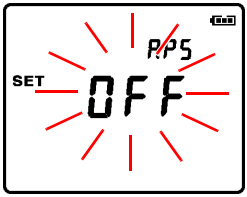
This will display the auto-power-save configuration screen.



On is flashing

3. Using ▲ ◀ ▶ ▼ keys, select "OFF."

To turn the auto-power-save feature on, select "On."



OFF is selected

4. Press ENTER key to save the settings.

This will finalize the configuration process and restart the instrument.
When turning off the power without finalizing the configuration process, the changes to settings will not be saved.

6.5 System Reset

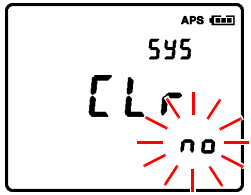
These steps can be used to restore the instrument to its initial configuration conditions.

NOTE However, note that the following settings will not be deleted:
- Date and time
- Saved measurement data (4,800 data sets)
- Comparator permissible values (200 sets)

1. Press POWER key to turn the power off.

2. While holding CLEAR key down, press POWER key.

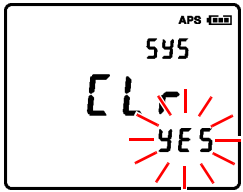
This will display the system reset screen.



no is flashing

3. Using ▲ ◀ ▶ ▼ keys, select "YES".

Select "no" to cancel the system reset.



YES is selected

4. Press ENTER key to save the settings.

This will finalize the configuration process and restart the instrument.

Initial Configuration Conditions (Factory Settings)

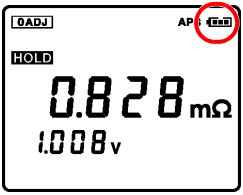
Resistance range	3.000 mΩ
Voltage range	6.000 V
Average range	OFF
Zero-adjustment feature	Not activated
Auto-hold feature	OFF
Auto-memory feature	OFF
Comparator feature	OFF
Comparator buzzer setting	WARNING/FAIL (ON)
Auto-power-save feature	ON

NOTE

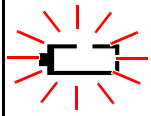
- When the system-reset screen has been displayed unintentionally, turn the power on again. The instrument's settings will be restored without resetting the system.
- Refer to "Section 5.5 Deleting Saved Data" (p.69) for methods of deleting saved measurement data.

6.6 Battery Level Indicator

The battery level indicator is displayed in the upper right-hand area of the screen.



Battery level indicator

Battery level indicator	Battery status
	Battery condition when new alkaline batteries have been inserted.
	Battery condition after approximately four hours of use.
	Battery condition after approximately seven hours of use.This indicator is displayed when the batteries are almost out of power. When this indicator is displayed, prepare replacement batteries.
	Battery condition after approximately ten hours of use (flashing). When this indicator is displayed, no further measurement can be conducted. Replace the batteries with new ones.

NOTE

- Using manganese batteries considerably shortens the time for which the instrument can be used continuously.
- The battery level indicator does not function accurately when using nickel metal hydride batteries.

Connecting with a Computer Chapter 7

Notation

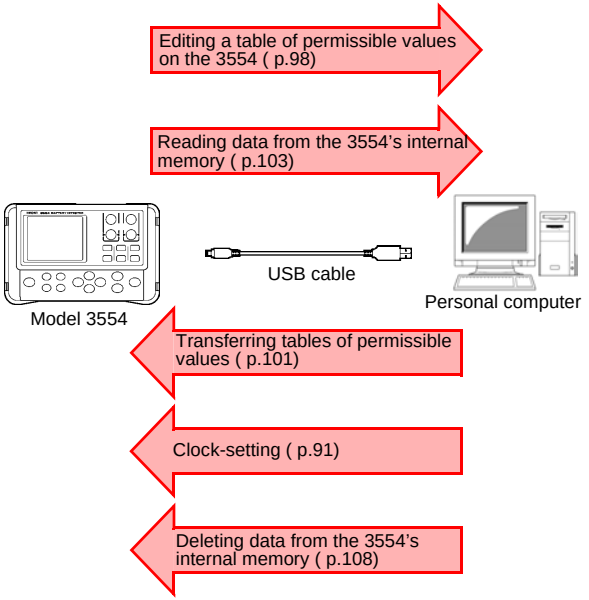
- Unless otherwise specified, “Windows” represents Windows Vista or Windows 7.
- Dialog box represents a Windows dialog box.
- Menus, commands, dialogs, buttons in a dialog, and other names on the screen and the keys are indicated in brackets.

Mouse Operation

Click	Press and quickly release the left button of the mouse.
Right-click	Press and quickly release the right button of the mouse.
Double click	Quickly click the left button of the mouse twice.
Drag	While holding down the left button of the mouse, move the mouse and then release the left button to deposit the chosen item in the desired position.
Activate	Click on a window on the screen to activate that window.

7.1 Overview

By connecting the instrument to a personal computer using the USB cable, measurement data stored in the instrument's internal memory can be transferred to the personal computer and comparator permissible values set on the personal computer can be loaded to the instrument. In addition, clock settings and measurement data can be deleted.



NOTE The following software must be installed in order to enable communication between the instrument and a personal computer. Each of these is included in the CD accompanying the instrument.

- Communication driver
- Application Software for 3554

7.1.1 Recommended Operating Environment

CPU	Pentium III 500 MHz or more
Compatible OS	Windows Vista, Windows 7
Resolution	1024 X 768 dots True Color (32 bit) or higher recommended
Memory	128 MB or more
HDD capacity	20 MB or more of disk space (Additional hard-disc space required for storing record data)
Interface	USB Ver.1.1 or later (Only one model 3554 instrument can be connected to the PC at a time.)

7.1.2 Composition of CD

Folder	Japanese English	Folder containing an application setup file for English or Japanese
Folder	Driver	Folder containing driver installation file
Files	install.exe AUTORUN.INF	Installation file Autorunning file

NOTE Select "Small Font" for use with the OS. Using "Large Font" may cause irregularities in screen indications.

7.2 Installing the Software

Before connecting the instrument to a personal computer, be sure to install USB driver. (p.87)

7.2.1 Installation

1. Start up the personal computer.
2. Stop all applications being executed on the computer (recommended).
3. Insert the CD that came with the instrument (Application Software for 3554) into the computer's CD-ROM drive.

Once the computer has detected the CD, the **[install]** screen will be displayed on the computer's screen.

4. Select the language to use.

* If the **[install]** dialog is not displayed automatically, execute the installation program from the following location: X:\English\Application3554v1.00E_setup.exe (for Ver. 1.00). ("X" in the above file location indicates the CD-ROM drive. The letter allocated to the CD-ROM drive may vary by computer.)

5. When the Setup Wizard appears, follow the instructions on your screen to install the application.

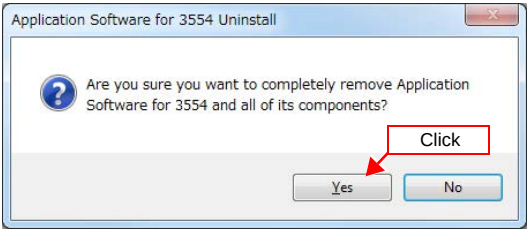
6. After the installation is complete, complete the installation process by ejecting the CD from the CD-ROM drive.

NOTE The latest version of Application Software for 3554 can be downloaded from the Hioki Website.
URL: http://www.hioki.com/

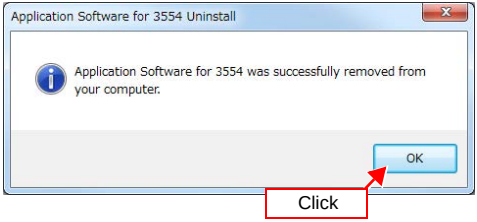
7.2.2 Uninstalling (removing) the Application

If Application Software for 3554 is active, be sure to close the application before uninstalling it.

1. Select the **[Start]-[All Programs]-[HIOKI]-[3554]-[Uninstall Application Software for 3554 English]**.
Click **[Yes]** to uninstall the software.



2. Click **[OK]** to finish the uninstall.



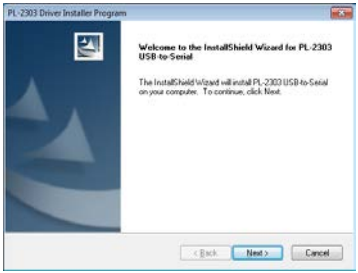
NOTE You can also click **[Start]-[Control Panel]-[Uninstall a program]** to uninstall the software.
(Delete the ”Application Software for 3554”.)

7.3 Installing the USB Driver

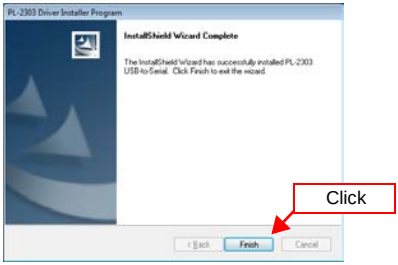
⚠CAUTION Do not plug in or unplug the USB cable while the instrument is operating.

1. In the accessary CD (Application software for 3554), double-click **[\Driver]**, and then run the driver installer.

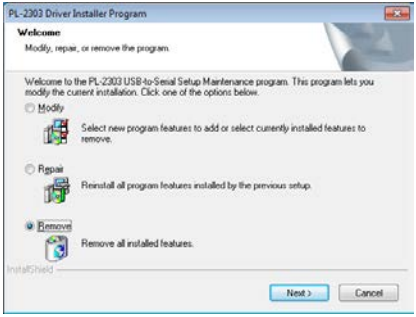
2. Install the driver, following instructions on dialog boxes.



3. Upon completion of the installation, click **[Finish]**.



NOTE To uninstall the driver, run the driver installer again, select **[Remove]**, and then follow instructions on dialog boxes.

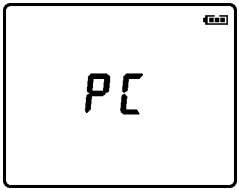


7.4 Using the Software

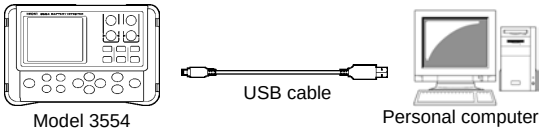
7.4.1 Connecting the 3554 to a Computer

1. Turn on the power to the instrument.
After turning on the power, check the instrument's remaining battery power.
If the remaining battery power is low, replace the batteries with new ones.
(p.26)

2. Connect the instrument to a personal computer using the included USB cable.



"PC" is displayed on the instrument's screen.



Model 3554

Personal computer

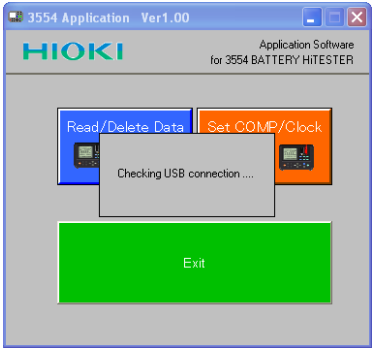
NOTE

- Only one 3554 instrument may be connected to a computer at one time.
- When connected to a computer using the USB cable, the instrument will shift to PC mode and cease measurement operations.
  Power to the internal measurement circuitry will be turned off, and the instrument will shift to low-power mode.
- The APS feature is disabled while the instrument is in PC mode.

7.4.2 Starting the Software

1. Double-click on the  icon on the computer's desktop.

The software's initialization screen will appear.



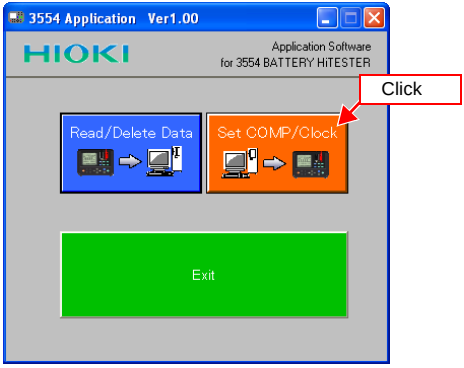
2. When the following message has been displayed, check the USB cable connection or the power supply and then click **[OK]**.

NOTE

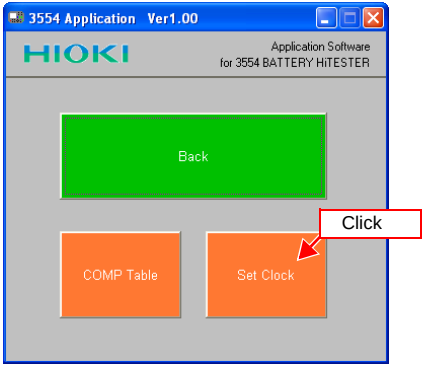
- If the USB cable is not connected, communication attempts will result in errors.
- Your computer's virtual COM port is used in the USB interface.

7.4.3 Clock-setting

1. Click **[SET COMP/Clock]** on the initialization screen.

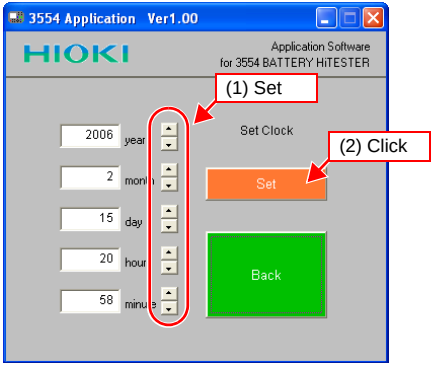


2. Click **[Set Clock]**.



3. Click on the [▲▼] arrows to set the current date and time (year, month, day, hour, and minute values), and then click **[Set]**.

The current data and time values of the computer's clock will be displayed by default. If these are correct, simply click **[Set]** without changing them.



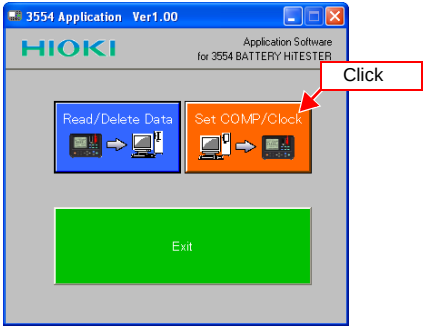
The clock settings will be finalized and transmitted to the 3554 instrument.

If you leave the clock setting screen by clicking **[Back]** without clicking **[Set]**, the clock settings will not be saved.

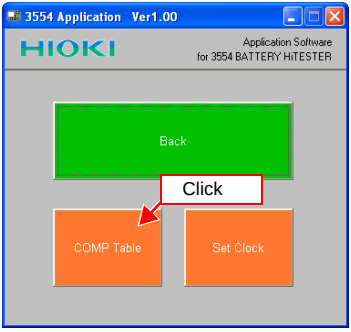
7.4.4 Preparing a New Table of Permissible Values

Up to 200 tables of comparator permissible values can be prepared.

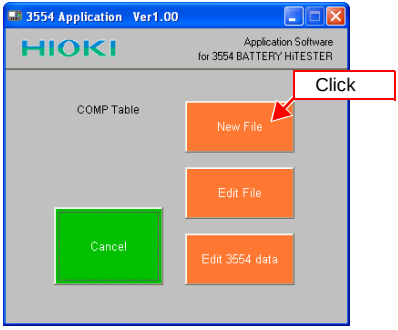
1. Click **[SET COMP/Clock]** on the initialization screen.



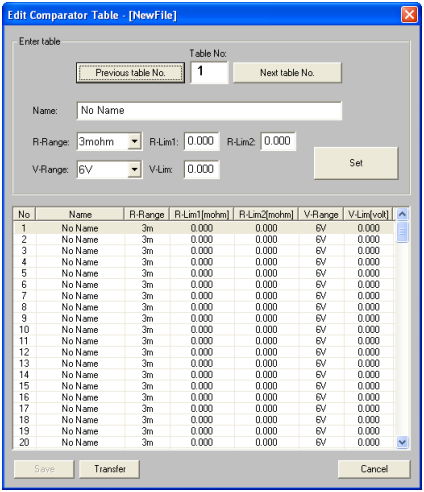
2. Click **[COMP Table]**.



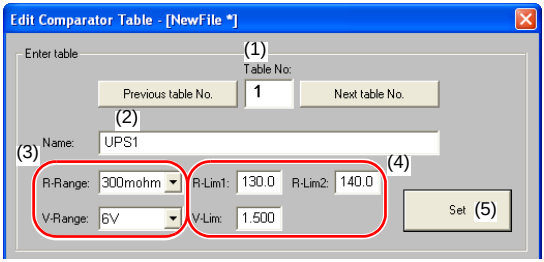
3. Click **[New File]**.



[Edit Comparator Table] will appear.



4. Entering configurations for each table.



(In the illustration above, resistance upper limit no. 1 has been set at 130.0 mΩ, resistance upper limit no. 2 at 140.0 mΩ [300 mΩ range], and the voltage lower limit has been set at 1.500 V [6 V range]).

(1) Enter the table no.
This number can be selected by clicking **[Previous table No.]** or **[Next table No.]**, or by clicking on the table.

(2) Enter the name to be assigned to the table no.
If no name is entered, the default value "No Name" will be used.

(3) Set the resistance and voltage ranges.

(4) Enter resistance upper limit no. 1 (R-Lim 1), resistance upper limit no. 2 (R-Lim 2), and the voltage lower limit (V-Lim).
Enter resistance input values in units of mΩ.
<Ex.>
When entering 6.25 mΩ in the 30 mΩ range, enter "6.25".
When entering 1.5 Ω in the 3 Ω range, enter "1500".

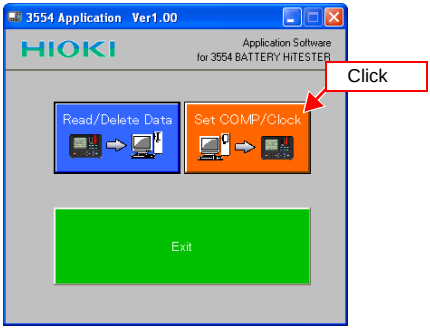
(5) Finalize the settings.

Configure all tables by repeating steps (1) - (5) above.

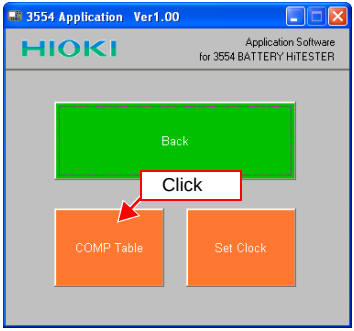
5. Save these configurations to a file by clicking **[Save]**.
See "Section 7.4.7 Transferring Tables of Permissible Values" (p.101) for details of transferring tables of permissible values.

7.4.5 Editing Files of Permissible Values

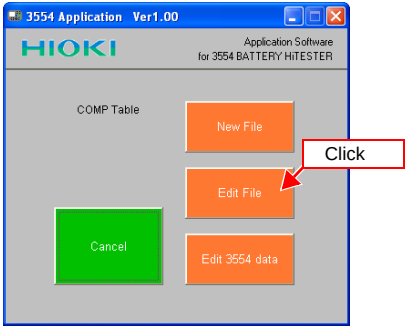
1. Click **[SET COMP/Clock]** on the initialization screen.



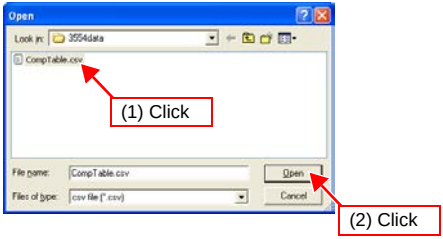
2. Click **[COMP Table]**.



3. Click **[Edit File]**.



4. Click comparator table file and then click **[Open]**.



5. Editing configurations for each table.

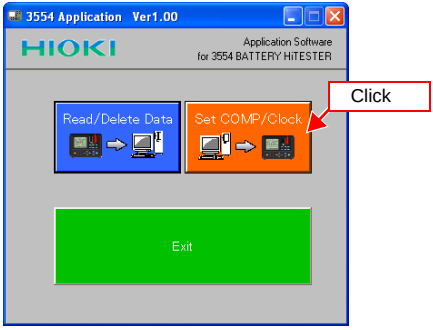
Refer to "Section 7.4.4 Preparing a New Table of Permissible Values" (p.93) for how to set.

NOTE

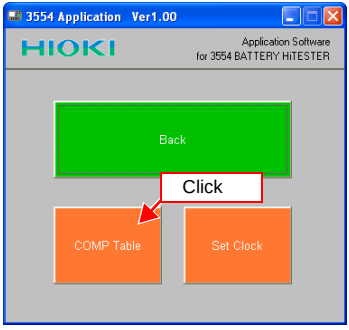
Editing the saved file using another application could make it unreadable by this application.

7.4.6 Editing a Table of Permissible Values on the 3554

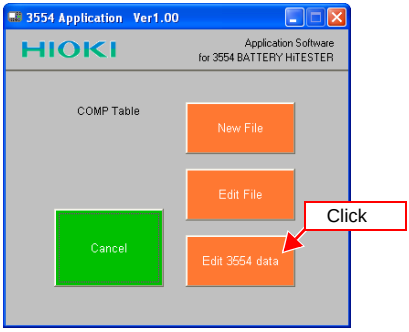
1. Click **[SET COMP/Clock]** on the initialization screen.



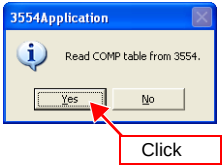
2. Click **[COMP Table]**.



3. Click **[Edit 3554 data]**.

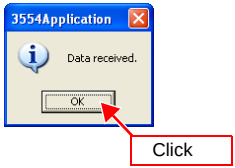


4. Following dialog box will appear and then Click **[Yes]**.



Receipt of the table of permissible values will begin.

5. After receipt of the table of permissible values is complete, click **[OK]**.



6. Editing configurations for each table.
Refer to "Section 7.4.4 Preparing a New Table of Permissible Values" (p.93) for how to set.

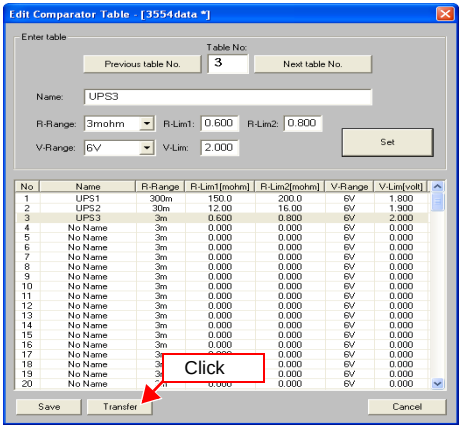
NOTE

Transfer takes approximately three seconds.

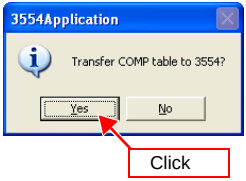
7.4.7 Transferring Tables of Permissible Values

NOTE Transferring tables of permissible values will overwrite all tables of permissible values stored on the instrument.

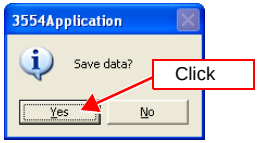
1. Click **[Transfer]** on the Edit Comparator Table dialog box.



Following dialog box will appear. Click **[Yes]** to transfer the data if desired.

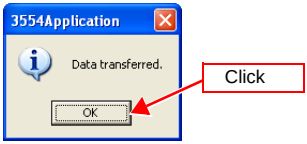


If the data has not already been saved, the following dialog box will appear. Click **[Yes]** to save the data if desired.



Tables of permissible value transfer will begin.

2. After tables of permissible value transfer is complete, click **[OK]**.



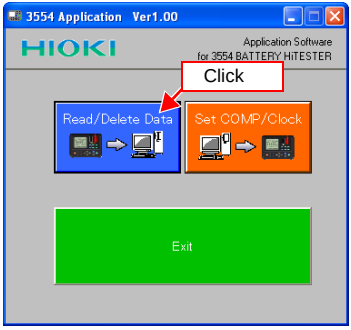
NOTE

- Transfer takes approximately six seconds.
- Do not turn off the power to the instrument or disconnect the USB cable during transfer. Doing so will damage the transfer of tables of permissible values.
- The transfer time given is an approximation. The actual time needed may vary depending on the processing speed of the personal computer used.

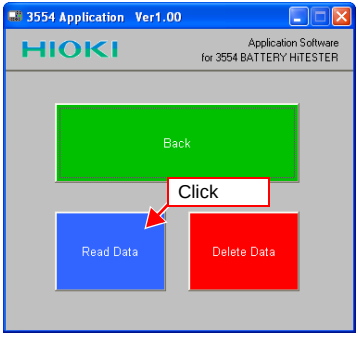
7.4.8 Reading Data from the 3554's Internal Memory

The application can be used to read measurement data saved to the instrument's internal memory.

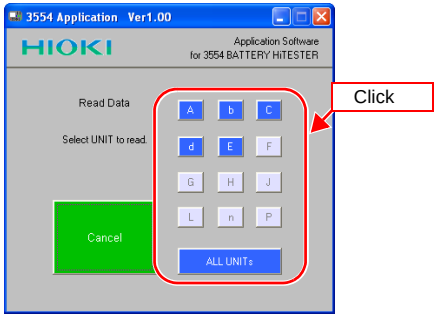
1. Click **[Read/Delete Data]** on the initialization screen.



2. Click **[Read Data]**.

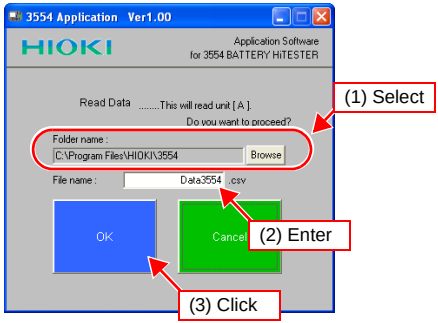


3. Click the number of the unit to read.
Click **[ALL UNITs]** to read all units.

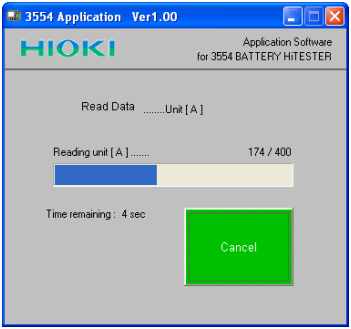


If no data has been saved to the instrument's internal memory, the unit numbers will be covered in a mesh-like pattern and will not be available for choosing.

4. Select the directory to which to save the read data, enter a filename, and then click **[OK]**.



Data transfer will begin.

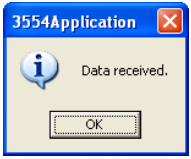


- Transfer of a single unit (400 units of data) takes approximately eight seconds.
- Transfer of all units (4,800 units of data) takes approximately 90 seconds.
- The transfer times given are approximations. The actual time needed may vary depending on the processing speed of the personal computer used.

NOTE

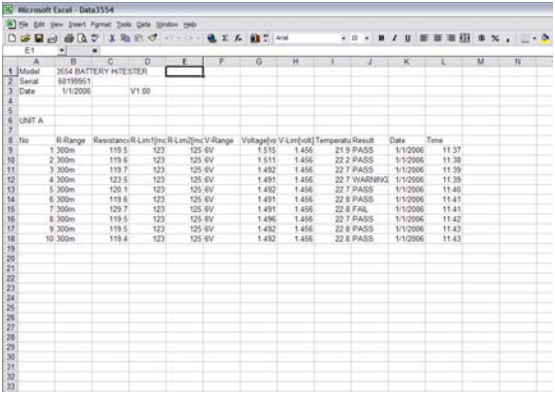
Directing the data to be saved in an "unrewritable folder" will result in a Windows error. Either remove the unrewritable status of the folder, or save the data in a "different folder that can be rewritten".

5.



When transfer is complete, the dialog box in the left will appear. Click **[OK]**.

6. To open the read data, open the file in the directory designated in step 4.



Microsoft Excel - Data3554

File Edit View Insert Format Tools Data Window Help

E1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	Model	3554 BATTERY HiTESTER												
2	Serial	60199651												
3	Date	1/1/2006		V1.00										
4														
5														
6	UNIT A													
7														
8	No	R-Range	Resistance	R-Lim1[mc	R-Lim2[mc	V-Range	Voltage[vo	V-Lim[volt]	Temperatu	Result	Date	Time		
9	1	300m	119.5	123	125	6V	1.515	1.456	21.9	PASS	1/1/2006	11:37		
10	2	300m	119.6	123	125	6V	1.511	1.456	22.2	PASS	1/1/2006	11:38		
11	3	300m	119.7	123	125	6V	1.492	1.456	22.7	PASS	1/1/2006	11:39		
12	4	300m	123.5	123	125	6V	1.491	1.456	22.7	WARNING	1/1/2006	11:39		
13	5	300m	120.1	123	125	6V	1.492	1.456	22.7	PASS	1/1/2006	11:40		
14	6	300m	119.6	123	125	6V	1.491	1.456	22.8	PASS	1/1/2006	11:41		
15	7	300m	129.7	123	125	6V	1.491	1.456	22.8	FAIL	1/1/2006	11:41		
16	8	300m	119.5	123	125	6V	1.496	1.456	22.7	PASS	1/1/2006	11:42		
17	9	300m	119.5	123	125	6V	1.492	1.456	22.8	PASS	1/1/2006	11:43		
18	10	300m	119.4	123	125	6V	1.492	1.456	22.8	PASS	1/1/2006	11:43		
19														
20														
21														
22														
23														
24														
25														
26														
27														
28														
29														
30														
31														
32														
33														

(Example: opening the data in Microsoft Excel)

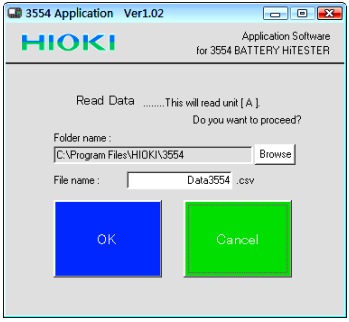
In this way, the data read from the instrument can be checked.

NOTE

- The data on the file generated by the Application Software for 3554 (measurement data, table of permissible values) is in CSV delimited text form. Commas [,] are used to separate text. Periods [.] are used for decimal points.
- Saved files of measurement data cannot be edited on Application Software for 3554.

Saving Data

1. As indicated below, it is possible that saved files cannot be found even when using Windows Explorer to access them in the event that data has been saved in the default folder created during installation. Even though there are cases in which a file cannot be found after searching a computer's hard drive, it will be displayed in the Application Software's file selection screen.



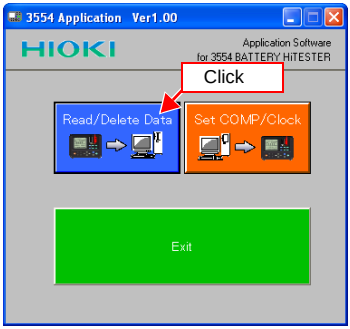
2. This type of file is saved in the following folder.

[UserName] → [AppData] → [Local] → [VirtualStore] → [Program Files] → [HIOKI] → [3554]

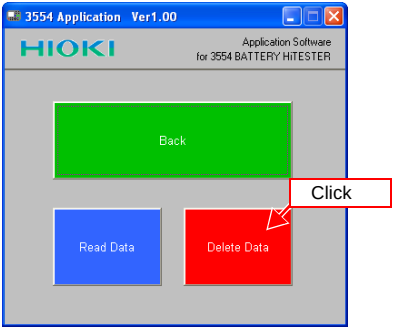
7.4.9 Deleting Data From the 3554's Internal Memory

The application can be used to read measurement data saved to the instrument's internal memory.

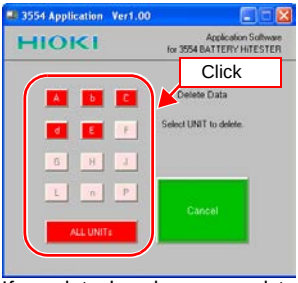
1. Click **[Read/Delete Data]** on the initialization screen.



2. Click **[Delete Data]**.

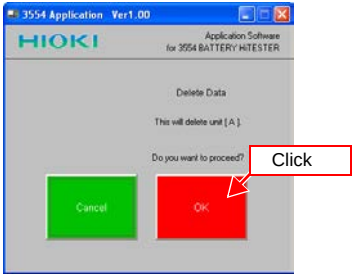


3. Click the number of the unit to delete.
Click **[ALL UNITs]** to delete all units.



If no data has been saved to the instrument's internal memory, the unit numbers will be covered in a mesh-like pattern and will not be available for choosing.

4. Click **[OK]**.

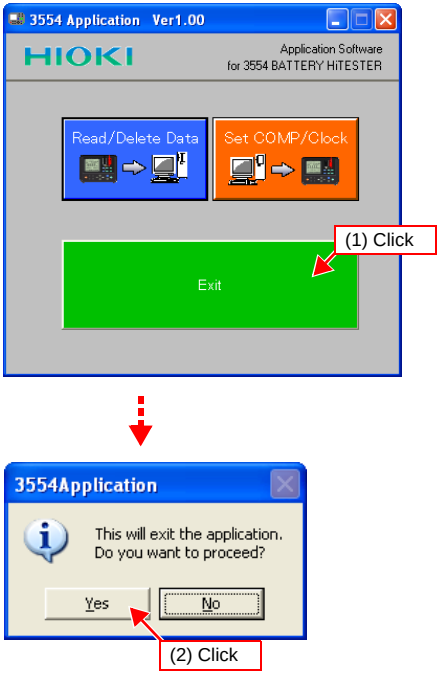


Data deletion will begin.
Click **[Cancel]** to return to the previous screen.

- Deletion of a single unit (400 units of data) takes approximately 0.5 seconds.
- Transfer of all units (4800 units of data) takes approximately three seconds.

7.4.10 Closing the Application

1. Click **[Exit]** on the initialization screen.



2. A confirmation dialog will appear. Click **[Yes]**.
Application Software for 3554 will close.

Specifications Chapter 8

8.1 General Specifications

Measurement modes	• Measurement of battery internal resistance • Measurement of battery terminal voltage (DC voltage only) • Temperature measurement
Measurement range • Resistance • Voltage • Temperature	(After 0 adjustment) 0.000 mΩ to 3.100 Ω (Four-range structure) 0.000 V to ± 60.00 V (Two-range structure) -10.0°C to 60.0°C / 14°F to 140°F (Single range)
Measurement method • Resistance • Temperature	 AC four-terminal method Open circuit voltage: 5 Vmax. Platinum temperature sensor (voltage-output method)
Measured current	1.5 mA to 150 mA (Fixed according to resistance measurement range)
Display update rate	Once/second (resistance, voltage, and temperature measured as a set)
Detection of constant-current irregularities	"- - - -" is displayed p.50 See note
Disconnect detection	"- - - -" is displayed p.50 See note
Processing excess input	"OF" is displayed

Input terminals	• Resistance, voltage measurement terminals Banana-plug type Maximum input voltage: DC ± 60 Vmax. (Not compatible with AC input) Input resistance: 20 kΩ or higher • Temperature-measurement input terminal Earphone-type jack (3.5 mm in diameter) • Switch input terminal Earphone-type jack (2.5 mm in diameter)

Averaging feature

Details of operation	Calculating a moving average of displayed resistance values
Initial status	OFF
Configuration method	Change number of times averaging is conducted by pressing the **AVG** key OFF (once) → 4 times → 8 times → 16 times → OFF...

Zero-adjustment

Details of operation	Measured values upon implementation (upon obtaining adjusted values) are set at zero
Initial status	OFF
Adjustment range	Up to 300 counts for each range (resistance, voltage)

Auto holding of measured values

Details of operation	Holding (ceasing updating of) displayed values
Hold method	(1) Pressing the **HOLD** key (2) Inputting signals to the EXT.HOLD/ MEMO terminal (3) Stabilizing measured values (when the auto-hold feature is on)

Comparator feature

Details of operation	Comparison of measured values with permissible values
Initial status	OFF
Setting method	Press the **COMP** key to select the comparator no. to use Configure resistance upper limit no. 1, resistance upper limit no. 2, and the voltage lower limit.
Settings saved	200

	Resistance (low)	Resistance (medium)	Resistance (high)
Voltage (high)	PASS	WARN	FAIL
Voltage (low)	WARN	WARN	FAIL

Memory Feature

Details of operation	While the measured values are being held, press the **MEMO** key to save them to the instrument's internal memory. When the auto-memory feature is on, measured values will be saved to the instrument's internal memory when held. Saved data can be deleted.
Data saved	Date and time, resistance, voltage, temperature, comparator permissible values, results of judgment
Number of data sets that can be saved	4,800
Memory structure	400 data sets per unit (12 units)
Unit names	A, b, C, d, E, F, G, H, J, L, n, P
Reading data	Conducted using the keys on the instrument or the PC application
Deleting data	Available (single data sets, single units, or all data)
Backup	Saved to internal EEPROM (nonvolatile memory)

Auto-hold Feature

Details of operation	Holds measured values automatically when stabilized
Releasing the hold	(1) Pressing the **HOLD** key (2) Inputting signals to the EXT.HOLD/MEMO terminal
Initial status	OFF

Auto-memory Feature

Details of operation	Saves measured value data automatically when held. Saved data can be cancelled by pressing the **CLEAR** key.
Initial status	OFF

Auto-power-save Feature (power on option)

Details of operation	Cuts off power to the instrument automatically when it has not been used for ten minutes or longer and detection of constant-current irregularities has continued for ten minutes or longer This feature is cancelled during data communication using the PC application

Comparator Buzzer

Details of operation	OFF ON (Sounds when result is PASS) ON (Sounds when result is FAIL / WARNING)
Initial status	ON (Sounds when result is FAIL / WARNING)

Battery Level Indicator

Details of operation	Remaining battery power shown as zero at 8.0 V (± 0.2 V) (Measurement functions stopped) Power turned off at 7.6 V (± 0.2 V)

System Reset (power on option)

Details of operation	All settings except data and time, comparator no., and saved data returned to initial configuration

Clock

Features	24-hour clock; automatically adjusts for leap year
Precision	+/- approximately 4 minutes/month
Other features	Runs on internal backup lithium battery Battery life: approximately 10 years

Data Stored (to internal EEPROM [nonvolatile memory])

Measurement range configuration, zero-adjust values, averaging settings, measurement data saved to memory, comparator permissible values, comparator nos., memory settings, memory nos., reading nos., buzzer settings, auto-hold settings, auto-memory settings, APS settings, temperature units

Operated using	Formed rubber keys (18)
Display	LCD (monochrome, 159 segments)
Guaranteed accuracy period	For one year
Operating temperature and humidity	0°C to 40°C (32°F to 104°F), 80%RH or less (non-condensating)
Storage temperature and humidity	-10°C to 50°C (14°F to 122°F), 80%RH or less (non-condensating)
Operating environment	Indoors, altitude up to 2000 m (6562-ft.), Pollution degree 2
Power supply	LR6 alkaline batteries × 8
Rated supply voltage	DC1.5 V × 8
Maximum rated power	2 VA
Continuous operating time	Approx. 10 hours When using alkaline batteries; may vary depending on conditions of use

Dimensions	Approx. 192W × 121H × 55D mm / 7.56"W × 4.76"H × 2.17"D (sans protrusions)
Mass	Approx. 790 g / 27.9 oz. (within batteries)
Dielectric strength	Between all measurement terminals and USB terminal: AC 1.5 kV; 15 seconds; cutoff current: 5 mA
Maximum input voltage	Between positive and negative measurement terminals: DC 60 V
Maximum rated voltage to earth	Between all measurement terminals and ground: DC 70 V
Applicable standards	EMC EN61326 Safety EN61010
Effect of radiated radio-frequency electromagnetic field	± 3.0% f.s. when measuring both resistance and voltage (at 3 V / m)

Accessories	Model 9465-10 PIN TYPE LEAD..... 1 USB cable ..... 1 Application Software CD ..... 1 Strap..... 1 Instruction manual..... 1 Carrying case ..... 1 Zeroadjustment board ..... 1 LR6 alkaline batteries..... 8 Fuse (216.315, Littelfuse,INC) (F315mAH / 250 V) 1
Options	Model 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR Model 9466 REMOTE CONTROL SWITCH Model 9467 LARGE CLIP TYPE LEAD Model 9772 PIN TYPE LEAD Model 9465-90 TIP PIN (For replacing the point of 9465-10) Model 9772-90 TIP PIN (For replacing the point of 9772)

8.2 Accuracy

Accuracy guarantee for temperature and humidity	23°C ± 5°C (73°F ± 9°F), 80%RH or less (non-condensating)
Guaranteed accuracy conditions	Warming up: not required Zero adjustment: implemented
Temperature coefficient	Calculated using temperature coefficient * (T - 23); T: temperature used (°C) 18 to 28°C: no temperature coefficient

Resistance measurement

- Temperature coefficient:
  3 mΩ range: (± 0.01 rdg. ± 0.8 dgt.)/°C
  Other range: (± 0.01 rdg. ± 0.5 dgt.)/°C
- Measurement current reliability: ± 10%
- Measurement current frequency: 1 kHz ± 30 Hz

Range	Maximum displayed value	Resolution	Accuracy	Measured current
3 mΩ	3.100 mΩ	1 μΩ	± 1.0 %rdg. ± 8 dgt.	150 mA
30 mΩ	31.00 mΩ	10 μΩ	± 0.8 %rdg. ± 6 dgt.	150 mA
300 mΩ	310.0 mΩ	100 μΩ		15 mA
3 Ω	3.100 Ω	1 mΩ		1.5 mA

DC Voltage Measurement

- Temperature coefficient; (± 0.005 %rdg. ± 0.5 dgt.) /°C

Range	Maximum displayed value	Resolution	Accuracy
6 V	± 6.000 V	1 mV	± 0.08 %rdg. ± 6 dgt.
60 V	± 60.00 V	10 mV	

Temperature Measurement

Range	Maximum displayed value	Resolution	Accuracy
-10 to 60°C (14 to 140°F)	60.0°C (140.0°F)	0.1°C (0.1°F)	± 1.0 °C (± 1.8°F)

Individual reliability under simulated input: ± 0.5°C (± 0.9°F)

8.3 Communications

USB Interface

Hardware	Uses RS-232C/USB converter
Operating method	When connecting the instrument to a personal computer via the USB cable, the instrument shifts to PC mode. Measurement ceases when in PC mode.
Details of communication	Output of various settings and saved data
Transfer method	Start-stop synchronization, Full duplex
Baud rate	38,400 bps
Data length	8 bit
Stop bit	1
Parity bit	None
Delimiter	CR+LF
Hand shake	None
XON / XOFF	Unused

Maintenance and Service Chapter 9

9.1 Troubleshooting

⚠CAUTION Never modify the instrument. Only Hioki service engineers should disassemble or repair the instrument. Failure to observe these precautions may result in fire, electric shock, or injury.

- If damage is suspected, check the "Troubleshooting" section before contacting your dealer or Hioki representative.
- The instrument contains a built-in backup lithium battery, which offers a service life of about ten years. If the date and time deviate substantially when the instrument is switched on, it is the time to replace that battery. Contact your dealer or Hioki representative.

NOTE When sending the instrument for repair, remove the batteries and pack carefully to prevent damage in transit. Include cushioning material so the instrument cannot move within the package. Be sure to include details of the problem. Hioki cannot be responsible for damage that occurs during shipment.

Before Returning for Repair

If the instrument appears to be operating unusually, check the following:

Symptoms	Items to check/countermeasures
Nothing displayed on screen even after pressing **POWER** key	Are the batteries out of power? →If so, replace them with new batteries. (p.26)
	Are the batteries inserted correctly? →Check to see whether the batteries have been inserted correctly. If not, reinsert them correctly. (p.26)
The zero adjustment cannot be conducted "Err" displayed on screen	Is the fuse burned out? →If so, replace it with a new fuse (p.127)
Unusual measured values obtained or "- - - -" displayed on screen or "OF" displayed on screen	Is the test lead attached correctly? →If not, attach the test lead correctly. (p.28)
	Does the test lead have a disconnection? →If so, replace it with a new test lead.
	Is the fuse burned out? →If so, replace it with a new fuse (p.127)
	Was the zero adjustment conducted correctly? →If not, conduct the zero adjustment correctly. (p.37)
	Has an appropriate range been selected? →If not, select an appropriate range using the range key. (p.36)
The Ω or **V** keys have no effect	Is the comparator feature in effect? →These keys cannot be operated when the comparator feature is in effect.

Symptoms	Items to check/countermeasures
The **MEMO** key has no effect	Has the data been held? →If not, use the **HOLD** key to hold the data.
No temperature displayed on screen when using the 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with temperature sensor.	Has the 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR with temperature sensor been connected correctly? →If not, connect it correctly. (p.51)
Nothing displayed on screen even after pressing **READ** key	This key cannot be used when no data has been saved.
Unusual comparator results	Have comparator permissible values been set incorrectly? →If so, set them correctly. (p.55)

9.2 Error Display

Conduct the following checks when an error message has been displayed on screen.

Error message	Details	Response
Err	Zero-adjust failure	Ensure the probe is connected correctly and conduct the zero adjustment again. (p.37)
no AdJ	Irregularity in adjustment data	Repairs required. Contact your dealer or Hioki representative.
Er10 Er11 Er12 Er20 Er21 Er22 Er23 Er24	Internal variable error	

NOTE The messages "- - - -" and "OF" displayed on screen are not indications of errors.

- "- - - -" is displayed when input terminals have been open.
- "OF" is displayed when the input values exceed the set range. Reset the range correctly.

9.3 Frequently Asked Questions

9.3.1 Can Manganese Batteries be Used?

The period for which the instrument can be used continuously (approximately 10 hours) is measured using alkaline batteries. **Note that use of manganese batteries will reduce this time considerably** (to approximately three hours).

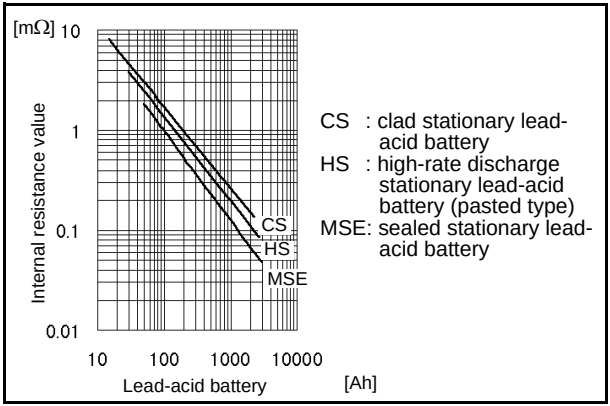
9.3.2 Can Nickel Metal Hydride Batteries be Used?

Since nickel metal hydride batteries discharge power in different ways than do alkaline batteries, when using nickel metal hydride batteries the instrument's battery level indicator will be highly inaccurate. **Note that there is a possibility under such conditions of the instrument losing power suddenly.**

9.3.3 Setting Permissible Values

For determining battery wear, first measure internal resistance in a new or good battery.

The graph below shows the relation between storage capacity and initial value of internal resistance in a lead-acid battery. "CS," "HS," and "MSE" denote JIS (Japanese Industrial Standard) lead-acid battery types.
Internal resistance of an MSE (sealed stationary lead-acid battery) can be read at approximately 1 mΩ (100 Ah) and approximately 0.13 mΩ (1000 Ah). Under conditions of battery wear, internal resistance rises to 1.5 - 2 times its initial value (reference values).



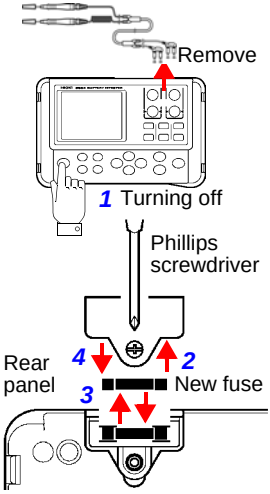
Source: Lead-acid battery technician certification textbook, Battery Association of Japan (BAJ)

9.4 Replacing the Fuse

When the instrument's fuse has burned out, replace it as described below.

⚠WARNING

- To avoid electric shock when replacing the fuse, first disconnect the test leads from the battery to be measured. After replacing the fuse, replace the fuse cover and screws before using the instrument.
- Replace the fuse only with one of the specified characteristics. Using a non-specified fuse or shorting the fuse holder may cause a life-threatening hazard.
  Fuse type: 216.315, Littelfuse, INC, fast-acting, F315mAH / 250 V, high breaking capacity 1,500A



1. Turn off the power to the instrument and remove the test leads.
2. Using a Phillips screwdriver, remove the battery cover on the rear of the instrument.
3. Remove the burned-out fuse and replace it with a new one that meets required specifications.
4. Replace the fuse cover and tighten the screw.

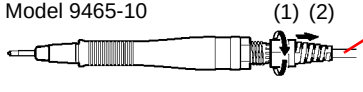
9.5 Replacing the Test Lead Pin

9.5.1 For the 9465-10 PIN TYPE LEAD

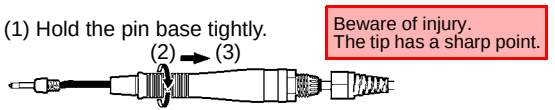
The conductive-tip contact pin is replaceable. Replace the pin with a new one if it is broken or worn. One-piece conductive-tip contact pins with a plastic pin base are available separately.

1. Turn off the power of the instrument and remove the cable.

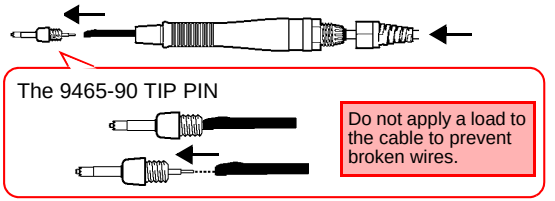
2. Unscrew the cable lock to unlock the cable.
(The cable is locked by screwing the cable lock.)



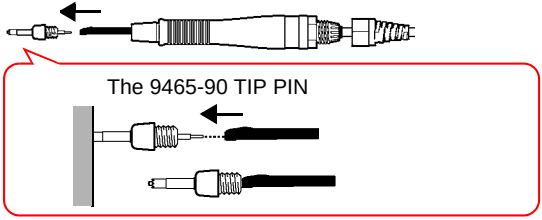
3. Hold the pin base so that the cable won't rotate, and then rotate the grip to loosen it.



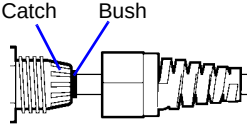
4. Pull off the connector and remove the pin.



5. Fasten a new pin. Press the tip of the pin against a hard board so that the pin won't spring out, and push the connector onto the pin.



6. Assemble the pin type lead in the reverse order of disassembling.
Do not pull or twist the cable.



- To prevent broken wires, fasten the bush approx. 1 mm higher than the catch.
- Be careful not to push the bush too deeply.

7. To avoid broken wires and contact failures, after tightening the cable lock, gently tug and twist the cable to check it is firmly held.

8. Check the performance. Measure an object with a known resistance. Make sure that the measured resistance is correct before using the pin type lead.

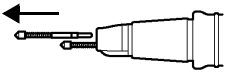
9.5.2 For the 9772 PIN TYPE LEAD

The conductive-tip contact pin is replaceable. Replace the pin with a new one if it is broken or worn. One-piece conductive-tip contact pins with a plastic pin base are available separately.

1. Turn off the power of the instrument and remove the cable.

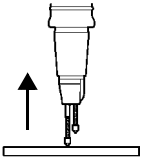
2. Pull out the pin tip to be replaced, using pliers or a similar tool.

The 9772-90
TIP PIN



3. Replace the 9772-90 pin tip by inserting a new pin into the socket and pressing against a hard board or other surface to fix the pin firmly in place.

The 9772-90
TIP PIN



4. Check the performance. Measure an object with a known resistance. Make sure that the measured resistance is correct before using the pin type lead.

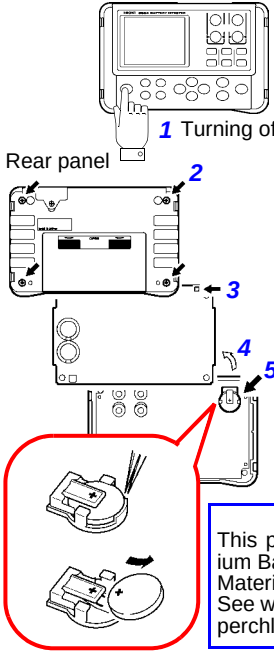
9.6 Cleaning

To clean the instrument, wipe it gently with a soft cloth moistened with water or mild detergent. Never use solvents such as benzene, alcohol, acetone, ether, ketones, thinners or gasoline, as they can deform and discolor the case.

9.7 Discarding the Instrument

⚠WARNING

- When disposing of this instrument, remove the lithium battery and dispose of battery and instrument in accordance with local regulations.
- To avoid electrocution, turn off the power switch and disconnect the test lead before removing the lithium battery.



1. Turn off the power to the instrument and remove the test leads.
2. Using a Phillips screwdriver, remove the four screws from the battery cover on the rear side of the instrument.
3. Remove the cable protruding from the battery holder.
4. Remove the upper panel.
5. Use tweezers or a similar tool to remove the lithium battery from the lower panel.

CALIFORNIA, USA ONLY
This product contains a CR Coin Lithium Battery which contains Perchlorate Material - special handling may apply. See www.dtsc.ca.gov/hazardouswaste/perchlorate

Appendix Chapter 10

10.1 Effects of Extending the Measurement Lead and Induced Voltage

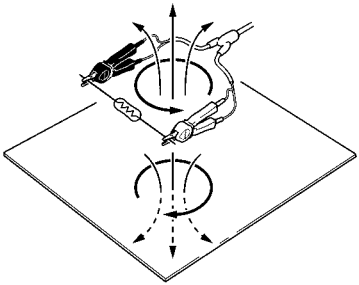
The test lead extension is normally performed by Hioki. If you want extension performed, contact your dealer or Hioki representative.
Users should not extend the measurement leads.

Reducing Induced Voltage

Since the instrument measures a minute resistance with AC power, it is affected by induced voltage. Induced voltage refers to voltage that allows the current generated in the instrument to build an inductive coupling in a lead and affect signal lines. Since the phase of the induced voltage is shifted from that of the AC current (reference signal) by 90 degrees, it can be eliminated with the synchronous detection circuit if the voltage is low. But for high levels, the induced voltage distorts the signals, causing incorrect synchronous detection. The instrument monitors induced voltage internally and generates an abnormal measurement signal if the level rises above a certain level. Reducing the length of the lead will lower induced voltage. Reducing the length of the branched section is particularly effective. Even when using the standard measurement lead, if in the 3 mΩ range the lead placement differs substantially between when the zero-adjust feature was used and when the measurements were taken, the effects of induced voltage will cause the values to fluctuate by approximately 15 dgt.

10.2 Effect of Eddy Currents

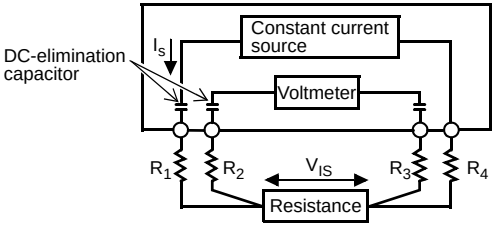
The AC current generated in the instrument induces eddy currents in the surrounding metallic plates, which generate induced voltage in the test lead. Since the phase of this induced voltage is shifted from that of the AC current (reference signal) by 180 degrees, it cannot be eliminated by the synchronous detection circuit, resulting in measurement errors. The influence of eddy currents is a phenomenon unique to ohmmeters that measure resistance with AC power. To protect the test lead from such effects, keep metallic parts, including metallic plates, at a suitable distance from the test lead (branched section).



10.3 AC Four-terminal Method

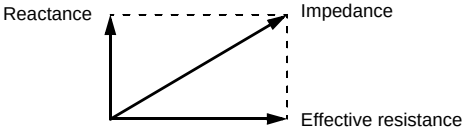
The instrument uses the AC four-terminal method, so that resistance measurement can be carried out with the resistance of the leads and the contact resistance between the leads and the object to be measured canceled out. The following figure shows the principle of the AC four-terminal measurement method.

Resistance measurement circuit



Values R_1 to R_4 are the resistances of the test leads plus contact resistances.

An AC current (I_S) is supplied from the SOURCE terminals of the instrument across the tested battery. The voltage drop across the internal impedance of the battery (V_{IS}) is measured by the SENSE terminals. At this point, since the SENSE terminals are connected to an internal voltmeter with a high impedance, almost no current flows through the resistances R_2 and R_3 which represent the lead resistances and contact resistances. As a result, there is almost no voltage drop across the resistances R_2 and R_3. Thus the voltage drop due to the lead resistances and contact resistances is very small, and these can be canceled out. In the instrument, a synchronized wave detection system is used, whereby the internal impedance is separated into resistance and reactance, and the resistive component only displayed.



If the lead resistance, the contact resistance between measured object and lead, or the contact resistance between the lead and the instrument increases, the instrument can no longer supply normal current to the measured object, resulting in an abnormal measurement status indicated by "- - -" within the measured resistance field. For more information on abnormal measurements (p.42)."

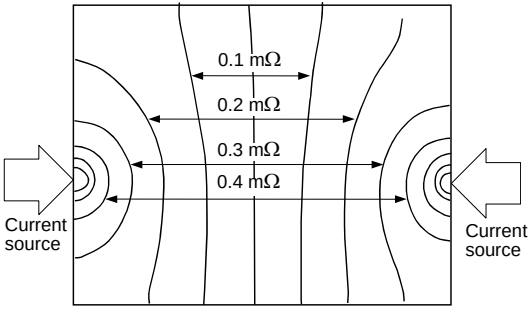
10.4 Effects of Current Density

When the subject of measurement is wide or thick

When the subject of measurement has width or thickness, such as when it is in plate or block form, it is difficult to get accurate measurements using clip-type or pin leads. Using such leads could result in variation measured values ranging from single to double digits in percentage points, due to contact pressure or angles. For example, when the subject of measurement is a metal sheet with the dimensions W 300 X L 370 X t 0.4, measured values taken from the same location may differ markedly as shown below:

When using a 0.2-mm-pitch pin lead: 1.1 mΩ
When using a 0.5-mm-pitch pin lead: 0.92 - 0.97 mΩ
When using a 9287-10 CLIP TYPE LEAD: 0.85 - 0.95 mΩ

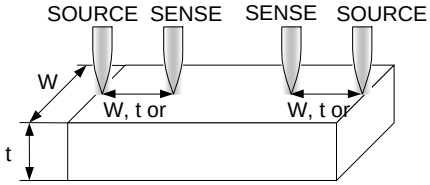
This is caused not by contact resistance between the probe and the subject of measurement but by current distribution in the subject of measurement.
Illustration 1 is an example of a plot of the equipotential lines of a metal plate. Just like the relationship between wind and the barometric charts used in weather forecasts, current density is higher where the equipotential lines are close to each other and lower where the lines are farther apart. The illustration shows that the potential gradient is greater near the sources of current. This is because these points are where the electric current is in the middle of spreading across the metal plate, leading to higher current density. For this reason, when a terminal for detecting voltage is placed near one of these sources of current, just the slightest change in contact position can lead to major variation in measured values. Use of Hioki's 9453 four-terminal lead or a similar lead to detect voltage on the inner side of the sources of current is desirable to avoid these effects. In other words, if measurement is conducted within the width (W) or thickness (t) of the subject of measurement, current distribution is likely to be stable.



(Illustration 1)

A plot of the equipotential lines of metal plate showing current distribution at 50 μV intervals when applying a 1 A current at the endpoints of the plate (W 300 X L 370 X t 0.4)

As shown in Illustration 2, it is desirable to locate the sensor terminals within the plate's W or t value of the sense terminals:



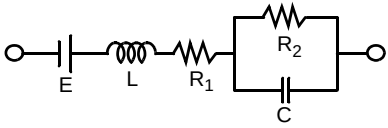
(Illustration 2)

Probing locations when the subject of measurement has width and thickness values

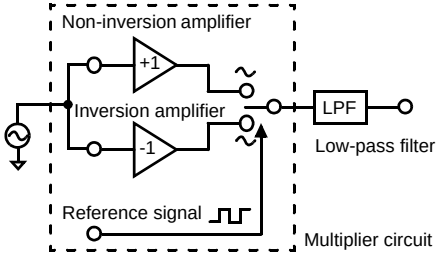
Since when judging battery wear it is important to ascertain changes arising from the passage of time, use the same measurement lead for each measurement.

10.5 Synchronous Detection System

The figure below shows an equivalent circuit for a battery. If the measured object exhibits other electrical characteristics in addition to resistance, as shown in this figure, we can use the synchronous detection system to obtain the effective resistance of the object. This synchronous detection system is also used to separate faint signals from noise.



The synchronous detection system picks up the reference signal and those signals having the same phase components. The figure below gives a simplified schematic diagram of the synchronous detection system. The system consists of a multiplying circuit that multiplies two signals and a low-pass filter (LPF) that picks up only DC components from the output.



Given "v1," a reference signal voltage for the AC current generated in the instrument, and "v2," the signal voltage for use in synchronous detection, these parameters may be expressed by the equation given below. θ of v2 shows the phase difference against v1 and is generated by the reactance.

$v1 = A\sin\omega t$

$v2 = B\sin(\omega t + \theta)$

When synchronous detection is applied to both v1 and v2, they are expressed as follows:

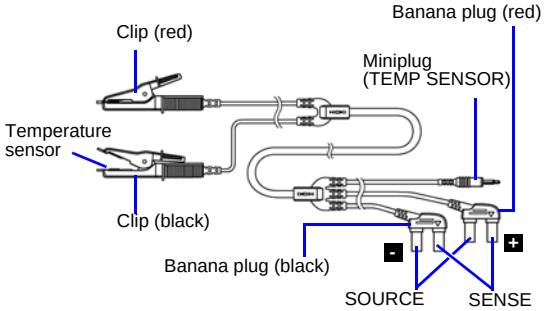
$v1 \times v2 = 1/2AB\cos\theta - 1/2AB\cos(2\omega t + \theta)$

The first term indicates effective resistance. The second term is attenuated by the LPF. The instrument displays the first term.

10.6 Test Lead Options

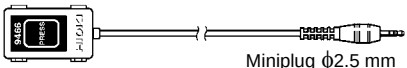
10.6.1 Model 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR

Resistance, voltage, and temperature can be measured simultaneously.



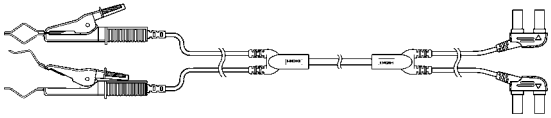
10.6.2 Model 9466 REMOTE CONTROL SWITCH

By attaching this switch to the test lead, values can be held during measurement.



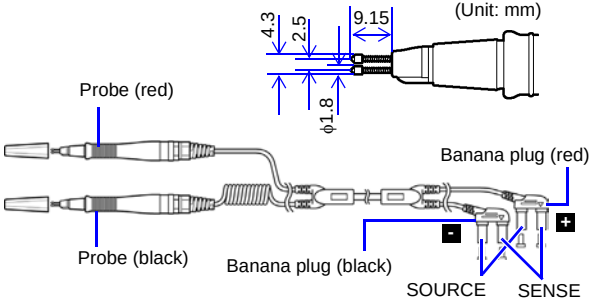
10.6.3 Model 9467 LARGE CLIP TYPE LEAD

These can be clipped to samples in relatively thick bar form. Four-terminal measurement can be conducted just by clipping these to the subject.
Distance between the split and the probe:
approximately 250 mm
Distance between the connector and the split:
approximately 850 mm
Maximum clip diameter: approximately 29 mm



10.6.4 Model 9772 PIN TYPE LEAD

This lead's pins are arranged parallel to each other. It is a strong, wear-resistant lead.



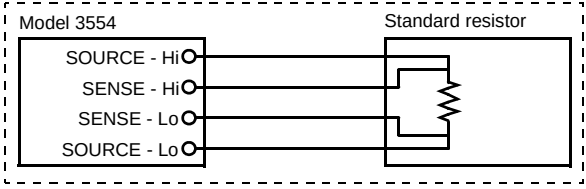
10.7 Calibration Procedure

⚠CAUTION To prevent damage to the instrument, do not input voltage between the positive SOURCE and SENSE terminals or between the negative SOURCE and SENSE terminals. Also, do not conduct measurement when the instrument is turned off.

Refer to the "Section 8.2 Accuracy" (p.118) concerning the calibration environment.

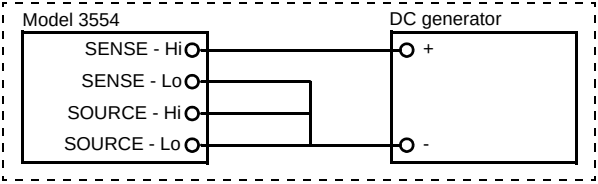
10.7.1 Resistometer Calibration

- Use a standard resistor resistant to wear from age and with strong temperature performance.
- Use a resistor with four terminals, in order to prevent effects due to the resistor lead lines.
- Be sure to assign resistor values in instruments of 1 kHz AC. Using a coil resistor will result in high inductance. For this reason, pure (DC) resistance will not equal effective resistance (impedance; displayed on the instrument).
- Connect the instrument to the standard resistor as shown below:



10.7.2 Voltmeter Calibration

- Use a generator that can output a DC voltage of 60 V.
- For connection of a generator to the instrument, see the figure below.



- Do not apply an alternating current from the instrument to the generator, as the generator may malfunction.
- Use a low-impedance (50 Ω or less) voltage source.

If "- - - -" (disconnect) is displayed on the screen, the instrument's disconnect-detection feature needs to be turned off.

Turning off the disconnect-detection feature

1. Turn off the power to the instrument
2. Press POWER key while holding down A HOLD MEMO key.
   "ON" is flashing.
3. Using ◄ ► ▲ ▼ keys, change the "ON" display to "OFF".
4. Press ENTER key.
   This will turn off the disconnect-detection feature and restart the instrument.

NOTE Restart the instrument after calibration. This will turn on the disconnect-detection feature again.

Warranty Certificate

Model	Serial No.	Warranty period One (1) year from date of purchase (___ / ___)

This product passed a rigorous inspection process at Hioki before being shipped.

In the unlikely event that you experience an issue during use, please contact the distributor from which you purchased the product, which will be repaired free of charge subject to the provisions of this Warranty Certificate. This warranty is valid for a period of one (1) year from the date of purchase. If the date of purchase is unknown, the warranty is considered valid for a period of one (1) year from the product's date of manufacture. Please present this Warranty Certificate when contacting the distributor.
Accuracy is guaranteed for the duration of the separately indicated guaranteed accuracy period.

1. Malfunctions occurring during the warranty period under conditions of normal use in conformity with the Instruction Manual, product labeling (including stamped markings), and other precautionary information will be repaired free of charge, up to the original purchase price. Hioki reserves the right to decline to offer repair, calibration, and other services for reasons that include, but are not limited to, passage of time since the product's manufacture, discontinuation of production of parts, or unforeseen circumstances.
2. Malfunctions that are determined by Hioki to have occurred under one or more of the following conditions are considered to be outside the scope of warranty coverage, even if the event in question occurs during the warranty period:
   a. Damage to objects under measurement or other secondary or tertiary damage caused by use of the product or its measurement results
   b. Malfunctions caused by improper handling or use of the product in a manner that does not conform with the provisions of the Instruction Manual
   c. Malfunctions or damage caused by repair, adjustment, or modification of the product by a company, organization, or individual not approved by Hioki
   d. Consumption of product parts, including as described in the Instruction Manual
   e. Malfunctions or damage caused by transport, dropping, or other handling of the product after purchase
   f. Changes in the product's appearance (scratches on its enclosure, etc.)
   g. Malfunctions or damage caused by fire, wind or flood damage, earthquakes, lightning, power supply anomalies (including voltage, frequency, etc.), war or civil disturbances, radioactive contamination, or other acts of God
   h. Damage caused by connecting the product to a network
   i. Failure to present this Warranty Certificate
   j. Failure to notify Hioki in advance if used in special embedded applications (space equipment, aviation equipment, nuclear power equipment, life-critical medical equipment or vehicle control equipment, etc.)
   k. Other malfunctions for which Hioki is not deemed to be responsible

*Requests
- Hioki is not able to reissue this Warranty Certificate, so please store it carefully.
- Please fill in the model, serial number, and date of purchase on this form.

13-09

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  - The latest revisions of instruction manuals and manuals in other languages.
  - Declarations of Conformity for instruments that comply with CE mark requirements.
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1407

Edited and published by Hioki E.E. Corporation Printed in Japan