HIOKI

INSTRUCTION MANUAL

3550

BATTERY HiTESTER

HIOKI E. E. CORPORATION

Contents

Introduction

Thank you for purchasing the HIOKI "3550 BATTERY HiTESTER." To obtain maximum performance from the product, please read this manual first, and keep it handy for future reference.

Inspection

When you receive the product, 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.

Accessories

9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR
9382 CARRYING CASE
Six LR6 alkaline batteries
Instruction Manual
Dust cover (for the printer interface)

Shipping

Use the original packing materials when reshipping the product, if possible.

Safety

⚠DANGER

This product is designed to conform to 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 product. 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 product defects.

Safety symbols

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

	• The ⚠ symbol printed on the product indicates that the user should refer to a corresponding topic in the manual (marked with the ⚠ symbol) before using the relevant function. • In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the product.
	Indicates DC (Direct Current).
	Indicates the ON side of the power switch.
	Indicates the OFF side of the power switch.

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

⚠DANGER	Indicates that incorrect operation presents an extreme hazard that could result in serious injury or death to the user.
⚠WARNING	Indicates that incorrect operation presents a significant hazard that could result in serious injury or death to the user.
⚠CAUTION	Indicates that incorrect operation presents a possibility of injury to the user or damage to the product.
NOTE	Advisory items related to performance or correct operation of the product.

Measurement categories (Overvoltage categories)

This product conforms to the safety requirements for CAT I measurement products.

To ensure safe operation of measurement products, IEC 61010 establishes safety standards for various electrical environments, categorized as CAT I to CAT IV, and called measurement categories. These are defined as follows.

CAT I : Secondary electrical circuits connected to an AC electrical outlet through a transformer or similar device.

CAT II : Primary electrical circuits in equipment connected to an AC electrical outlet by a power cord (portable tools, household appliances, etc.)

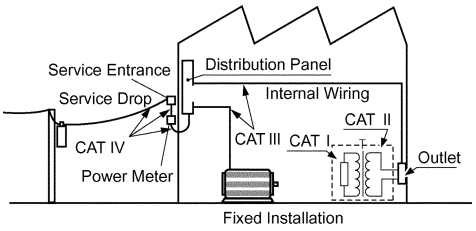
CAT III : Primary electrical circuits of heavy equipment (fixed installations) connected directly to the distribution panel, and feeders from the distribution panel to outlets.

CAT IV : The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).

Higher-numbered categories correspond to electrical environments with greater momentary energy, so a measurement product designed for CAT III environments can endure greater momentary energy than one designed for CAT II. Using a measurement product in an environment designated with a higher-numbered category than that for which the product is rated could result in a severe accident, and must be carefully avoided.

Never use a CAT I measuring product in CAT II, III, or IV environments.

The measurement categories comply with the Overvoltage Categories of the IEC60664 Standards.



Precautions

Follow these precautions to ensure safe operation and to obtain the full benefits of the various functions.

⚠DANGER

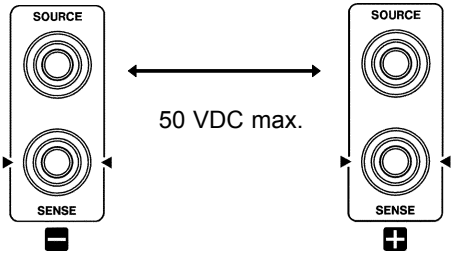
- **The floating voltage between input terminals and ground is 450V DC/AC. Attempting to measure voltages exceeding 450V with respect to ground could damage the product and result in personal injury.**
- **When voltages higher than 30 Vrms, 42.4 Vpeak or battery circuits with more than 60 VDC are to be measured, be sure to establish the floating state first. Carrying out such measurements in the grounded state involves the risk of electric shock.**
- **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.**
- **To avoid electric shock accidents, when measuring batteries being charged wear proper protective gear such as rubber gloves.**

⚠WARNING

- **Do not allow the product to get wet, and do not take measurements with wet hands. This may cause an electric shock.**
- **Do not use the product where it may be exposed to corrosive or combustible gases. The product may be damaged or cause an explosion.**

⚠WARNING

- **Before using the product, make sure that the insulation on the leads is undamaged and that no bare conductors are improperly exposed. Using the product in such conditions could cause an electric shock, so contact your dealer or Hioki representative for replacements. (Model 9460)**
- **Be sure to connect the SOURCE and SENSE terminals (banana plugs), and TEMP SENSOR terminal (mini-plug) correctly. See Section 4.2, "Measurement" for details of the connections.**
- **To avoid injury or damage to the product, do not attempt to measure AC voltage, or DC voltage exceeding 50 V.**



- **Do not apply a voltage between the SOURCE(+) and SENSE(+) or SOURCE(-) and SENSE(-) terminals. This could result in damage to the unit.**

⚠CAUTION

- This product is not designed to be entirely water- or dust-proof. To avoid damage, do not use it in a wet or dusty environment.

⚠CAUTION

- Do not store or use the product where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the product may be damaged and insulation may deteriorate so that it no longer meets specifications.
- Do not use the product near a device that generates a strong electromagnetic field or electrostatic charge, as these may cause erroneous measurements.

NOTE

- Use the specified 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR when this tester is used.
- Correct measurement may be impossible in the presence of strong magnetic fields, such as near transformers and high-current conductors, or in the presence of strong electromagnetic fields such as near radio transmitters.

Service

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

Organization of this Manual

This manual consists of the following chapters.

"Introduction", "Inspection", "Safety", "Precautions" include some important notes which you should read before using the unit.

Chapter 1 Overview
describes an outline of the unit, and lists its features.

Chapter 2 Names and Functions of Parts
lists the names of the parts of the unit, and the functions of all of the indications, terminals, and switches.

Chapter 3 Specifications
lists the specifications of the unit.

Chapter 4 Standard Measurement
describes the basic operation of the unit.

Chapter 5 Advanced Measurement Functions
describes miscellaneous functions.

Chapter 6 Maintenance
gives troubleshooting information.

Chapter 1
Overview

The 3550 is designed for measuring the internal resistance, open-circuit voltage, and terminal temperature of secondary batteries, including lead-acid batteries, nickel-cadmium batteries, nickel-metal hydride batteries, and lithium-ion batteries.

Features

- Since it uses the AC four-terminal method to measure the internal resistance, it provides accurate results with the lead resistances and contact resistances eliminated.
- It is possible to display the readings for the battery internal resistance, voltage, and terminal temperature, without changing functions. Moreover, a composite comparator function, which can be set on resistance and voltage values, enables reliable detection of battery deterioration.
- The unit's memory function also allows a number of sets of readings to be stored at a touch, and later output to a printer.
- These functions make this an ideal tool for checking batteries which are under constant trickle charging and cannot be disconnected.

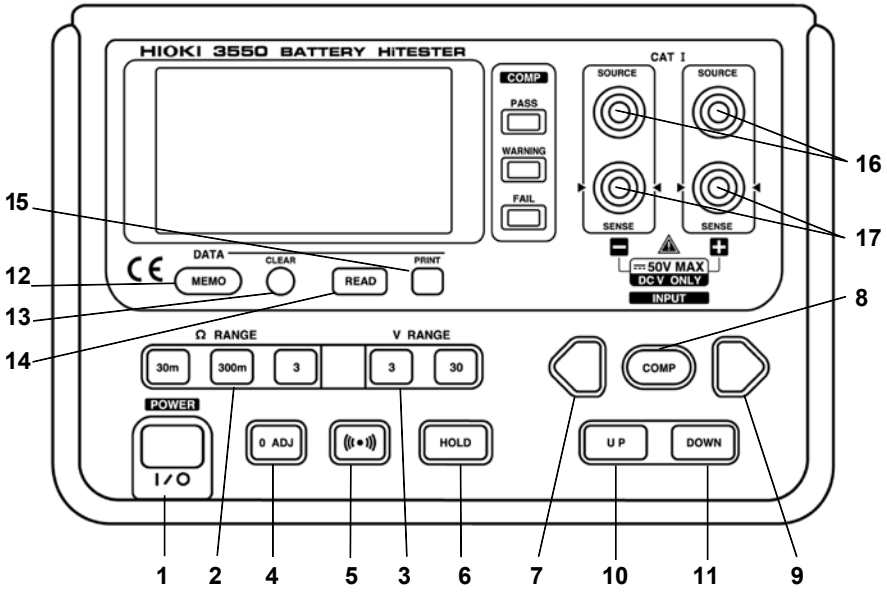
NOTE

Measurements are taken by using noise reduction technology to attenuate noise at frequencies other than the measurement frequency (1 kHz). Incorrect measurements may result if a large 1-kHz noise component from the charger is present at the battery terminals.

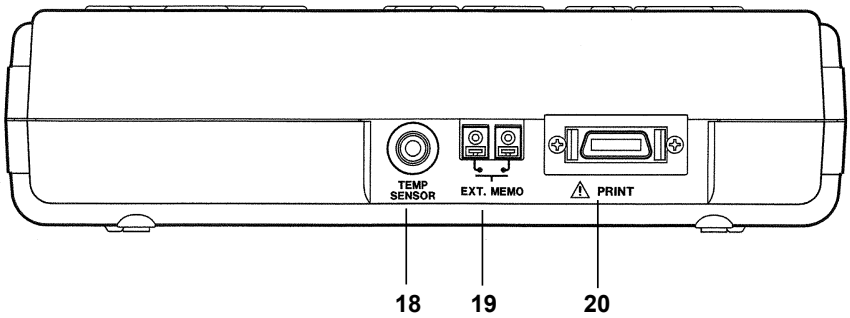
Chapter 2
Names and Functions of Parts

This chapter explains the keys, input and output terminals, display, LED indicators, and leads.

Front Panel



Side Panel



● Keys and input/output terminals

1. **POWER** key — Turns the power on or off.

2. 30m Ω key, 300m Ω key, 3 Ω key — Selects the resistance range.

3. 3 V key, 30 V key — Selects the voltage range.

4. 0 ADJ key — Zero adjustment key.

5. (((•))) key — Turns the beeper on and off.

6. HOLD key — Locks out changes to the display.

7. ◁ key — Left cursor (flashing) key.

8. COMP key — Switches the comparator on and off, and changes display to the comparator setting screen.

9. ▷ key — Right cursor (flashing) key.

10. UP key — Increases the value of a numeric setting.

11. DOWN key — Decreases the value of a numeric setting.

12. MEMO key — Stores the display data in memory.

13. **CLEAR** key — Clears data captured with the MEMO key.

14. READ key — Reads data captured with the MEMO key.

15. **PRINT** key — Prints data captured with the MEMO key.

16. **SOURCE** — Connects to the 9460 banana plug on the SOURCE side.

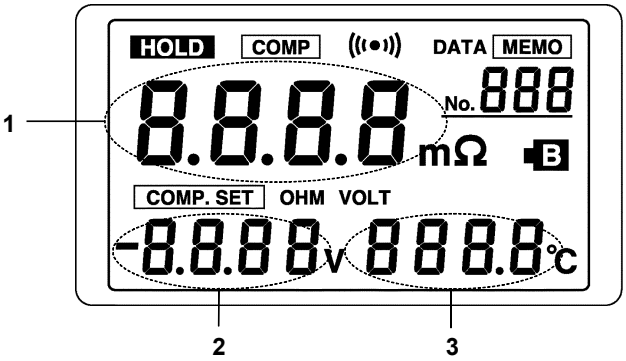
17. **SENSE** — Connects to the 9460 banana plug on the SENSE side.

18. **TEMP SENSOR** — Connects to the 9460 mini-plug.

19. **EXT.MEMO** — Connects to an external foot switch or similar, and stores the displayed data in memory.

20. **PRINT** — Connects to the printer.

● LCD (view with all elements displayed)



● Display

1. Measured resistance

2. Temperature measurement value **[**comparator resistance lower limit setting**]**

3. Temperature measurement value **[**comparator resistance lower limit setting**]**

mΩ	Indicates the unit of resistance.
V	Indicates the unit of voltage.
℃	Indicates the unit of temperature.
HOLD	Appears when the display is locked.
COMP	Appears when the comparator function is on.
(((•)))	Appears when the beeper is turned on.
DATA	Indicates that data captured data with the (MEMO) key is present.
No.	Indicates the number of data points captured with the (MEMO) key. Usually, this is the number of the last data point captured. **[**The comparator table number.**]**

[ ]: Appears in on the comparator setting screen.

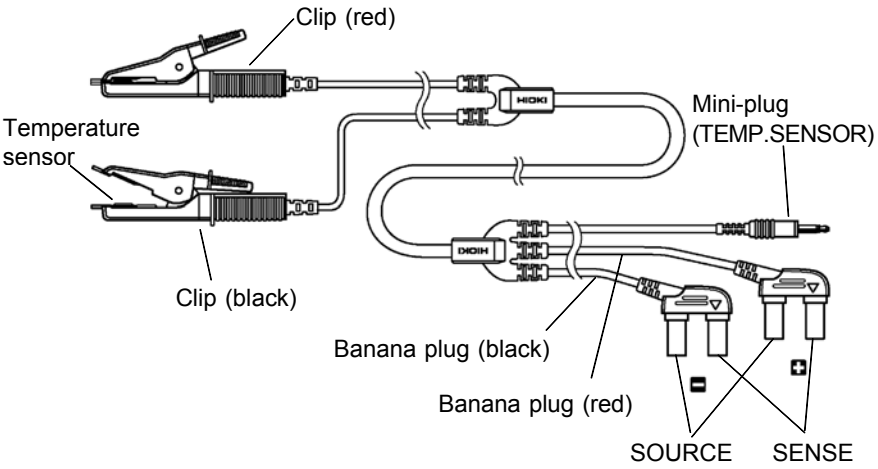
MEMO	Flashes once when the (MEMO) key is pressed.
B	Appears when the battery voltage of the tester is low, to prompt the user to replace the battery.
COMP.SET	Appears during display of the comparator setting screen.
OHM	Appears during display of the screen for setting the comparator resistance upper and lower limit values.
VOLT	Appears during display of the screen for setting the comparator voltage threshold value.

● LEDs

PASS	Indicates that the tested battery is satisfactory for operation.
WARNING	Indicates that the tested battery is beginning to deteriorate.
FAIL	Indicates that the tested battery has deteriorated.

These indications appear when the upper and lower comparator limits for internal resistance and the comparator threshold value for voltage are all set.

● 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR



Chapter 3 Specifications

3.1 General Specification

■ Measurement method	Resistance: AC four-terminal method. Temperature: platinum temperature sensor.
■ A/D conversion	Double integration method.
■ Display	LCD and LEDs (comparator output)
■ Panel abbreviations and symbols	HOLD , COMP , (((•))) , DATA , MEMO , No. ___ , m, Ω , B , COMP.SET , OHM , VOLT , V , °C
■ Sampling rate	0.83 sets (resistance, voltage, and temperature measurements)/second.
■ Open-circuit terminal voltage	5 V max.
■ Input overflow	"OF" indication
■ Battery low detection	"B" indication (indicates at 6.4 V with LR6 X 6)
■ Constant current fault detection	"----" indication.
■ Moving average function	measurement (can be set to on or off)
■ Zero adjustment function	Circuit offset voltage is displayed as 0 V.
■ Hold function	Display is held.

■ Beeper function
Audible output for warning and fail results.
Can be turned on and off.

■ Auto power off
Power off automatically after about 30 minutes.

■ Comparator settings
Resistance upper and lower limits and voltage lower limit.

■ Number of comparator settings
Ten sets.

■ Comparator output
LEDs for **PASS** (green), **WARNING** (amber), and **FAIL** (red) results.
Audible tone for **WARNING** and **FAIL** results.

Voltage \ Resistance	LO	IN	HI
LO	**WARNING** (Amber)*1	**WARNING** (Amber)	**FAIL** (Red)
HI	**PASS** (Green)	**WARNING** (Amber)	**FAIL** (Red)

*1 Voltage low and internal resistance low: amber flashing

■ Data save
Save measurement value in memory when (MEMO) key pressed or EXT.MEMO terminals shorted.
Memory holds 260 sets of resistance, voltage, and temperature values, and comparator result.
The LED for warning flashing is stored in memory as a WARNING result.

■ Data readout
Data in memory is read out to display.

■ Data clear
Clear the data in memory.

■ Printer interface	Centronics (can be connected to the 9203 DIGITAL PRINTER)
■ Operating temperature and humidity range	0°C to 40°C(32°F to 104°F) 80 %RH (no condensation)
■ Storage temperature and humidity range	-10°C to 50°C(14°F to 122°F) 80 %RH (no condensation)
■ Power source	Six LR6 alkaline batteries or six R6P manganese batteries
■ Rated supply voltage	1.5 VDC X 6 (Voltage fluctuations of 10% from the rated supply voltage are taken into account.)
■ Location for use	Altitude up to 2000 m (6562-ft.)
■ Maximum power consumption	1.8 VA
■ Continuous operating time	Approx. 7 hours (at 30 mΩ range, comparator ON, beeper ON, with LR6 batteries)
■ Dimensions	Approx. 196W X 130H X 50D mm (7.72"W X 5.12"H X 1.97"D)
■ Mass	Approx. 710 g (25.0 oz.) (Including batteries)
■ Effect of radiated radio-frequency electromagnetic field	at 3V/m Resistance measurement ±3.0% f.s. Voltage measurement ±3.0%f.s.

■ Standards applying

EMC	EN61326:1997+A1:1998+A2:2001 +A3:2003
Safety	EN61010-1:2001 Pollution Degree 1, Measurement Category I (anticipated transient overvoltage 2500 V)

■ Accessories

9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR
9382 CARRYING CASE
Instruction Manual
Dust cover (for the printer interface)
Six LR6 alkaline batteries

■ Options

9203 DIGITAL PRINTER
9425 CONNECTION CABLE
(2-meter long for connecting to the 9203)
9233 RECORDING PAPER
(ten 10-meter rolls for the 9203)

● 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 the full length of the scale. This is usually the maximum value of the currently selected range.
- rdg. (reading or displayed value)
  The value currently being measured and indicated on the measuring product.
- dgt. (resolution)
  The smallest displayable unit on a digital measuring product, i.e., the input value that causes the digital display to show a "1".

3.2 Measurement Range

Conditions to guarantee accuracy:

- Temperature :23°C±5°C
- Humidity :80 %RH or less (no condensation)
- Zero adjustment :After zero adjustment for each range
- Warming up time :At least 10 minutes
- Period of guaranteed accuracy :1 year

(1) Resistance Measurement

Temperature coefficient: (±0.01% rdg.±0.5 dgt.)/°C

Measurement current frequency: 1 kHz±30 Hz

Range	Maximum indication	Resolution	Measurement current	Accuracy
30 mΩ	30.00 mΩ	10 μΩ	50 mA	Six months ±0.8% rdg.±6 dgt. 1 year ±1.2% rdg.±6 dgt.
300 mΩ	300.0 mΩ	100 μΩ	5 mA	Six months ±0.8% rdg.±6 dgt. 1 year ±1.2% rdg.±6 dgt.
3 Ω	3.000 Ω	1 mΩ	500 μA	Six months ±0.8% rdg.±6 dgt. 1 year ±1.2% rdg.±6 dgt.

(2) Voltage Measurement

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

Range	Maximum indication	Resolution	Accuracy
3 V	±3.000 V	1 mV	Six months ±0.1% rdg.±6 dgt. 1 year ±0.15% rdg.±6 dgt.
30 V	±30.00 V	10 mV	Six months ±0.1% rdg.±6 dgt. 1 year ±0.15% rdg.±6 dgt.

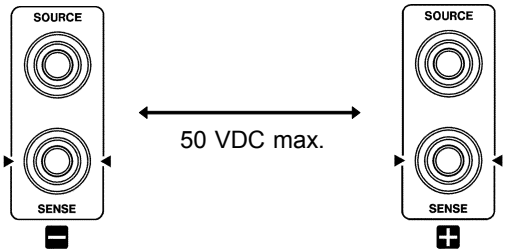
(3) Temperature Measurement

Measurement range	Resolution	Accuracy
-10°C to 60°C	0.1°C	Six months ±0.5% rdg.±10 dgt. 1 year ±0.75% rdg.±15 dgt.

3.2.1 Maximum Input Voltage

⚠DANGER

- **The maximum input voltage is 50 VDC. Attempting to measure voltage in excess of the maximum input could destroy the product and result in personal injury or death.**
- **To avoid electrical hazards and damage to the product, do not apply voltage exceeding the maximum input to the measurement terminals.**



50 VDC maximum
No AC voltage input

3.2.2 Floating Voltage

Between input terminals and ground, 450 VDC/AC maximum.

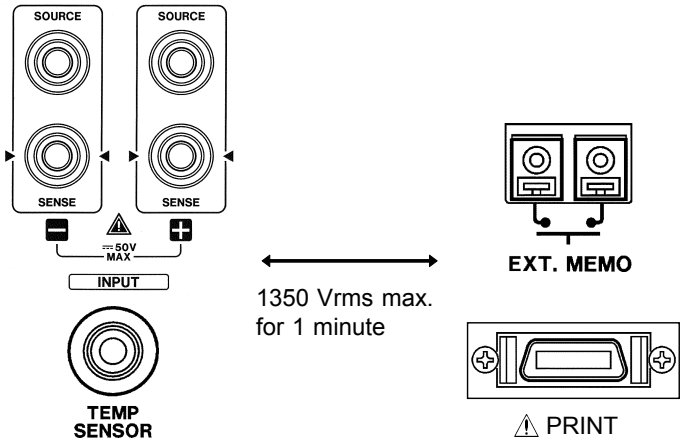
⚠DANGER

- **Do not input voltage in excess of this floating voltage to the measurement terminal. This could result in injury or damage to the unit.**
- **When voltages higher than 30 Vrms, 42.4 Vpeak or battery circuits with more than 60 VDC are to be measured, be sure to establish the floating state first. Carrying out such measurements in the grounded state involves the risk of electric shock.**

3.2.3 Dielectric Strength

Between input terminals and output terminals (including the **EXT.MEMO** terminal): 1350 Vrms maximum for 1 minute.

⚠DANGER



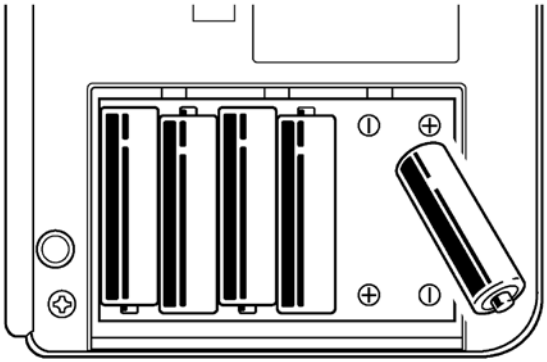
Chapter 4
Standard Measurement

4.1 Preparing for Measurement

⚠WARNING

- **To avoid electric shock when replacing the batteries, first disconnect the leads from the object to be measured.**
- **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.**
- **After replacing the batteries, replace the cover before using the product.**

1. Remove the battery cover.
2. Insert the batteries into the battery compartment as shown in the figure below.



⚠WARNING

- **To avoid the possibility of explosion, do not short circuit, disassemble or incinerate batteries.**
- **Handle and dispose of batteries in accordance with local regulations.**

NOTE

- The "B" indicator appears when battery voltage becomes low. Replace the batteries as soon as possible.
- Removing the batteries clears all measurement data from memory. (See Section 5.2, "Measurement Value Memory Function.")
- After replacing the batteries, the auto power off function is set to 30 minutes, with the beeper on.
- Be sure to press the **POWER** key to power the unit off before removing the batteries. If the batteries are removed while the unit is powered on, the previous comparator number may not be recovered.
- To avoid problems with battery operation, remove the batteries from the product if it is to be stored for a week or more. Even when the power to the main unit is switched off, a very small current (approximately 0.7 mA) is drawn from the batteries to back up internal data. Therefore if the unit is left switched off with new batteries installed, they will become fully drained within 2 to 2.5 months.

4.2 Measurement

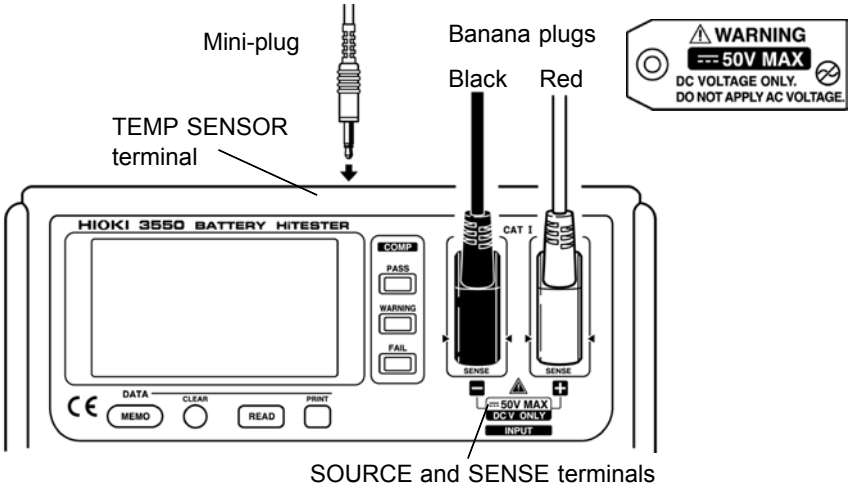
⚠WARNING

- **To prevent electric shock, before using this tester, fit the supplied dust cover for the printer interface over the PRINT terminal.**
- **To avoid injury or damage to the product, do not attempt to measure AC voltage, or DC voltage exceeding 50 V.**

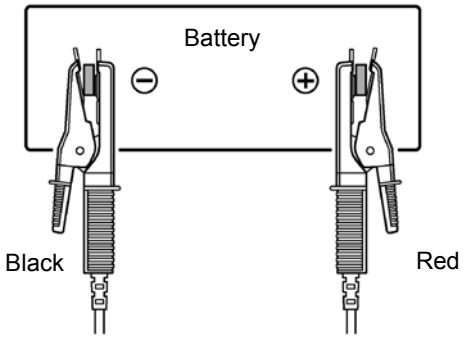
⚠CAUTION

- Do not attempt to measure the voltage of a generator. This would result in an AC voltage being applied to the voltage-generating output terminals, which is dangerous.
- After measuring a high-voltage battery, before continuing to measure a low-voltage battery first short the measurement 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, which is dangerous.

1. Connect the 9460 leads as shown in the figure below.
   Connect leads to all five terminals; SOURCE +/-, SENSE +/-, and TEMP SENSOR.

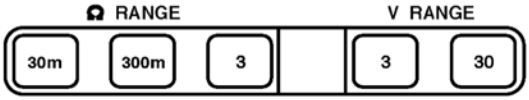


2. Press the **POWER** key to turn on the power and start measurement.
   After pressing the **POWER** key to power on, it is necessary to wait for ten minutes of warming-up time, to allow the unit to stabilize.
3. Connect the red clip to the positive (+) side of the battery to be tested and connect the black clip to the negative (-) side.
   Make the connections so that the temperature sensor is firmly in contact with the battery terminal.



4. Using the range keys, select the voltage and resistance

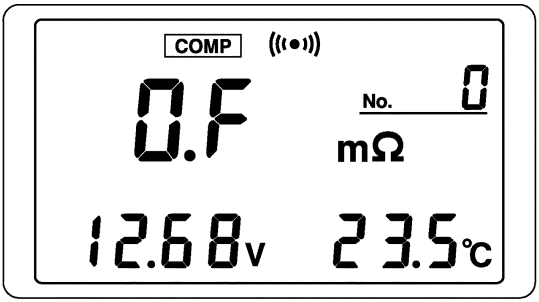
measurement ranges.



5. When the measurement is completed, disconnect the leads from the tested battery and press the **POWER** key to turn off the power.

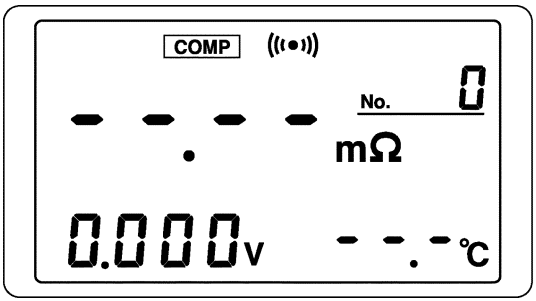
NOTE

- When measuring the contact resistance of a relay or connector, be careful of the open-circuit voltage across the test leads. It may not always be possible to destroy an oxide layer on the terminals of the object being measured in order to obtain an accurate reading.
- When the indication for a measurement value is "**OF**", this indicates that the measured voltage, resistance, or temperature value is outside the measurement range.



- A resistance indication "----" means that the measurement could not be made because there is a break in the test lead circuit. The "----" indication may also appear if the leads are not making good contact with the object to be measured, or if its resistance is extremely large compared with the measurement range.
- The "----" indication may also appear immediately after changing the resistance or voltage measurement range.

- A temperature indication "---" means that the temperature sensor is not connected. The "---" indication may also appear if there is a break in the test lead circuit.



- Except for setting the auto power off mode and the moving average function, do not press the **POWER** key in combination with other keys. (For details of the moving average settings, see Section 5.5, "Moving Average Function", and for details of the auto power off settings, see Section 5.8, "Auto Power Off".)
- If you do press a combination of the **POWER** key and other keys, and an "**INSP**" or "**Adju**" indication appears, immediately press the **POWER** key to power off and on again. Otherwise, continuing with key operations may destroy the calibration data for the unit, and correct measurement will no longer be possible.
- If the leads are open-circuit, a spurious voltage indication may sometimes be given. This is not a malfunction.

Chapter 5
Advanced Measurement Functions

5.1 Comparator Function

5.1.1 What is the Comparator Function?

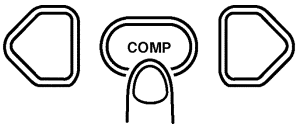
The comparator function compares the measurement values with preset lower and upper limit values for internal resistance and voltage level, and determines which range the measurement falls into, based on the preset conditions. It then lights the corresponding LED, and sounds a beeper for the WARNING and FAIL cases. (See Section 5.3 Beeper On/Off Function)

5.1.2 Comparator Settings

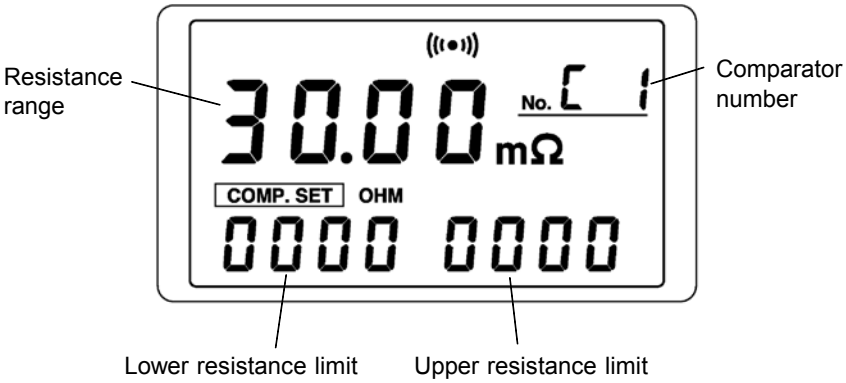
(1) Before changing the settings

To set the comparator (upper and lower resistance limits and voltage comparison value), do the following:

1. Press and hold the COMP key for at least 3 seconds. The upper and lower resistance limit settings appear.

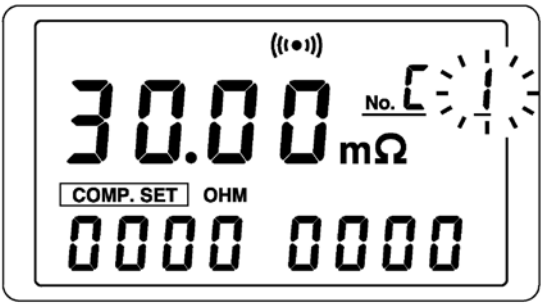


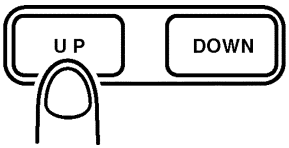
2. "COMP.SET" , "OHM" appears at the lower left of the screen, showing that you are ready to change the comparator settings.



(2) Setting the comparator number

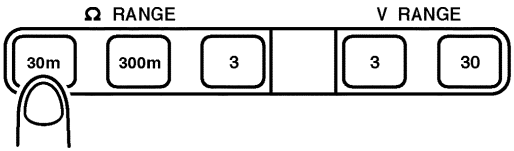
Change the comparator number with the **UP** and **DOWN** keys. You can select any comparator number up to 10.





(3) Setting the resistance range

Press the resistance range key (**ΩRANGE**: **30m** , **300m** , **3**) corresponding to the resistance to be measured. The currently selected resistance range is displayed at the center on the screen.



(4) Setting the resistance limits

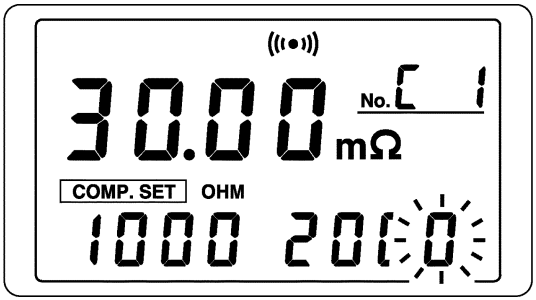
1. Using the ▷ key, move the flashing number to the most significant digit of the lower resistance limit setting at the lower left of the screen.

2. Set the lower and upper resistance limits with the **UP** and **DOWN** keys.

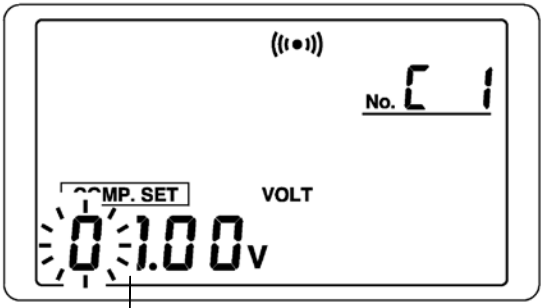
   Both the upper and lower resistance limits can be set to any value in the range 0 to 3000.

(5) Setting the voltage range

1. Using the ▷ key, move the flashing number to the least significant digit of the upper resistance limit setting at the lower right of the screen.

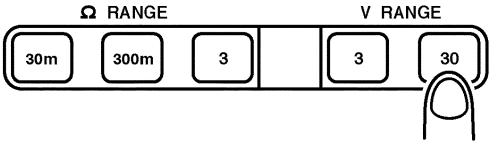


2. Press the ▷ key again to display the voltage comparison value setting screen will appear.
"**COMP.SET**" and "**VOLT**" appear while setting the voltage comparison value.



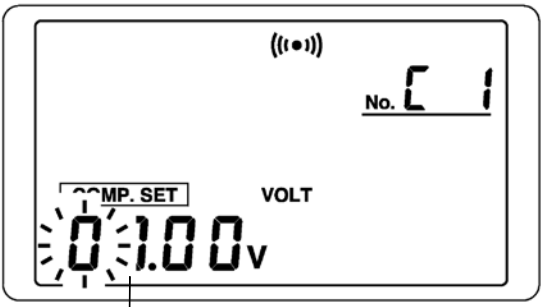
3. Press the voltage range key (**V RANGE**: **3** , **30**) corresponding to the voltage to be measured.

The position of the decimal point corresponds to the currently selected voltage range.



(6) Setting the voltage comparison value

1. Using the ▷ key and the **UP** and **DOWN** keys, set the voltage comparison value at the lower left of the screen. The allowable range of settings for the voltage comparison value is -3000 to 3000.



2. Move the flashing number to the least significant digit with the ▷ key.
3. Press the ▷ key again to display the upper and lower resistance limit settings.
4. Go on to set the next comparator number. You can make voltage comparison values for up to 10 comparator numbers.

(7) Ending setup

When done with comparator selection, press the **COMP** key. Display returns to the previous measurement screen.

NOTE

- When the settings are made by setting a comparator number, they are saved in memory at the point at which the comparator setting screen is exited.
- Comparator setting is not possible while the display is locked or while reading out measurement values from memory.

5.1.3 Comparator Decision Result Table

The decision result is indicated by the LEDs and by the beeper, as shown in the following table.

Resistance / Voltage	Lower resistance limit → LO	IN	Upper resistance limit → HI
Voltage comparison value → LO	**WARNING** Amber *1	**WARNING** Amber	**FAIL** Red
Voltage comparison value → HI	**PASS** Green	**WARNING** Amber	**FAIL** Red

*1 Voltage low and resistance low: amber flashing
Beeper sounds when the comparator result is WARNING or FAIL. (Refer to Section 5.3, "Beeper On/Off Function")

- A "**PASS**" result is shown by the green LED, a "**WARNING**" by the amber LED, and a "**FAIL**" by the red LED.
- The boundary conditions are as follows.

  Resistance LO ≦ Lower resistance limit < Resistance IN
  Resistance IN ≦ Upper resistance limit < Resistance HI
  Voltage LO ≦ Voltage comparison value < Voltage HI

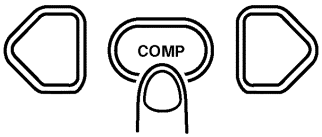
●Interpreting the comparator output table

Example 1 When the measured resistance is at or below the lower resistance limit, and the measured voltage is greater than the voltage comparison value (that is, resistance: LO and voltage: HI), the LED for **PASS** (green) lights. The beeper does not sound.

Example 2 When the measured resistance is greater than the lower resistance limit and lower than the upper resistance limit value, and the measured voltage is greater than the voltage comparison value (that is, resistance: IN, voltage: HI) the LED for **WARNING** (amber) lights and the beeper sounds.

5.1.4 Switching the Comparator On and Off

- Pressing the (COMP) key toggles the comparator function on and off. When the comparator is on, the " [COMP] " indication appears in the display, and the comparator operates as measurements are taken. When the comparator is off, the " [COMP] " indication disappears from the display, and the comparator does not operate.



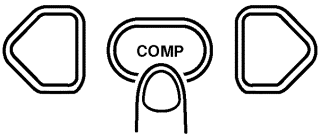
- When one of the range keys ([30m] Ω, [300m] Ω, [3] Ω, [3] **V**, [30] **V**) is pressed and the range is changed, comparator operation stops even if the comparator function is being used. To use comparator function again, press the (COMP) key. The range reverts to the setting extant prior to the change.
- When you turn on the power, the comparator is always set to ON.

NOTE If there is no measurement value, "----" is displayed and comparator operation is not enabled.

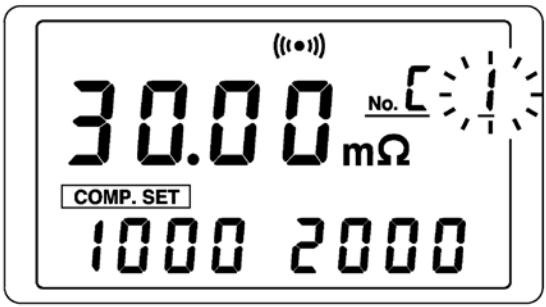
5.1.5 Changing the Comparator Number

To change the comparator number, do the following procedure.

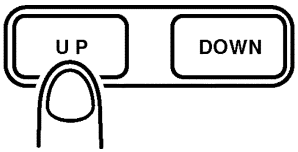
1. Press and hold the (COMP) key for at least 3 seconds. The resistance comparator setting screen appears.



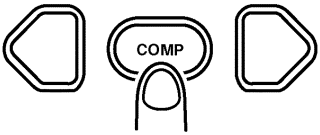
"**COMP.SET**" appears at lower left of the screen.



2. Select the comparator number with the **UP** and **DOWN** keys. You can select any number up to 10.



3. When the setting is completed, press the (COMP) key.



NOTE The selected comparator number remains in memory even when the power is turned off.

5.2 Measurement Value Memory Function

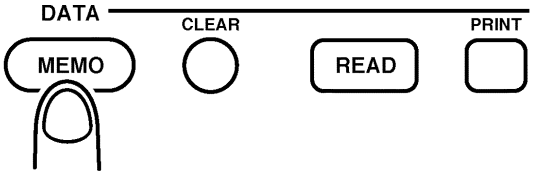
⚠WARNING **To avoid damage to the product, do not apply voltage to the EXT.MEMO terminals.**

The currently measured values (resistance value, voltage value, temperature, and comparator result), taken as a set can be stored: up to 260 such sets of values can be held, and later displayed and printed as required.

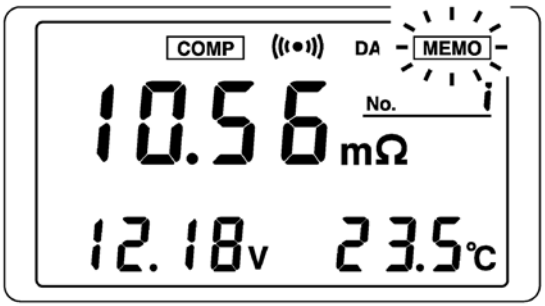
5.2.1 Memory

Store the current settings as follows.

Press the (MEMO) key.



"**MEMO**" appears at the upper right of the screen and the measurement value and comparator result are stored.

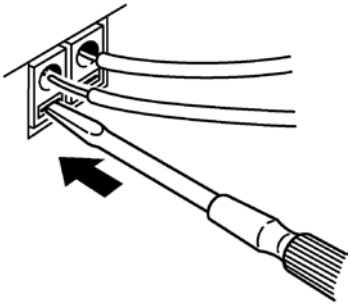


MEMO Screen

"**DATA**" is displayed at the upper right of the screen and the number of data points stored in memory is displayed.

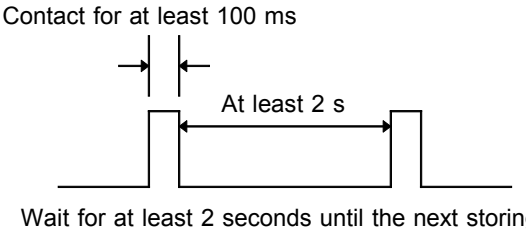
Using the **EXT. MEMO** terminals, the same effect as the (MEMO) key can be obtained.

1. Using a blade screwdriver or a similar tool, insert the individual leads into the terminal apertures. (Leads are not supplied.)
   When inserting or removing the leads, push in the terminal button with a screwdriver as shown in the figure below.



Recommended wire size	Single strand: 1.0 mm dia. (AWG #18) multi-strand: 0.75 mm^2
Usable limits	Single strand: 0.4 to 1.0 mm dia. (AWG #26 to #18) multi-strand: 0.3 to 0.75 mm^2 (AWG #22 to #20) minimum strand diameter: 0.18 mm
Standard insulation stripping length	10 mm
Button pressing tool	Blade screw driver (tip width 2.6 mm)

2. Contact the leads together for at least 100 ms (use a switch) to obtain the effect of pressing the (MEMO) key.
   The "MEMO" indication appears in the display, and one set of measurement values and comparator results are saved in memory.



"**DATA**" is displayed at the upper right of the screen along with the number of data points in memory.

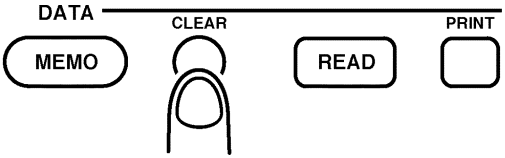
NOTE

- If while the **EXT.MEMO** terminals are shorted together another key is pressed, then the values may be saved twice.
- Even when the unit is powered off the values are preserved in memory.
- If the batteries are removed, the values in memory are cleared.

5.2.2 Clear

Clear the latest value in memory as follows.

1. Press the **CLEAR** key. This clears the most recently stored data point from memory.



2. To clear all data, press and hold the **CLEAR** key for five seconds.

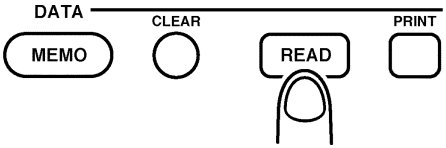
NOTE

Removing the batteries clears all data.

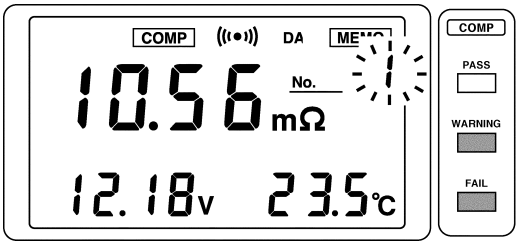
5.2.3 Readout

Redisplay a measurement value from memory as follows.

1. Press the **READ** key.



The "**MEMO**" indication appears in the upper right and the number of "No. " indication flashes.



MEMO means that the currently displayed readings are values recalled from memory.
The flashing number is the number of the set of values currently displayed.

2. Pressing the **UP** key or **DOWN** key increments or decrements this number, to display whichever set of data values is required.

NOTE

- The comparator result for previous data values read out from memory is also shown, but a "**WARNING**" result does not flash. In the case of a "**WARNING**" the display is permanently on.
- Data cannot be redisplayed when "**DATA**" does not appear at the upper right of the screen (when there is no data in memory).

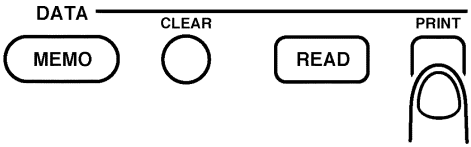
5.2.4 Printing

⚠WARNING

- **For safety, never connect the 3550 to the printer during measurement.**
- **To prevent electric shock, before using this tester, fit the supplied dust cover for the printer interface over the PRINT terminal.**
- **To avoid damage to the product, do not apply voltage to the PRINT terminal.**

Print the measurement value stored in memory as follows.

1. Disconnect the lead from the tested battery.
2. Connect this tester to the 9203 DIGITAL PRINTER with the 9425 CONNECTION CABLE (2 m). (Refer to the printer instruction manual for how to make printer settings.)
3. Press the **PRINT** key. "**Prnt**" appears on the screen and the data is printed.



4. To stop the printing, press the **PRINT** key.

NOTE

- Use the HIOKI 9203 DIGITAL PRINTER.
- It is also possible to connect a general-purpose printer with a Centronics interface. The connector used for this unit is a 20-pin half-pitch D-subminiature connector, DHA-RC20-R132N (Daiichi Electronics) or equivalent.
- It is not possible to print data while measurement is taking place.
- When printing comparator results, both a flashing "**WARNING**" and a constant "**WARNING**" are printed as "Warn."
- When "**DATA**" does not appear at the upper right of the screen (there is no data in memory), printing is not possible.

```
START     '96- 2-28 16:04:00
[N]  Ω       V      °C    COMP
 1  10.23m  12.58  23.1  Pass
 2  12.34m  12.68  23.2  Warn
 3  11.20m  11.34  23.1  Warn
 4  12.30m  12.54  22.8  Warn
 5  14.20m  10.18  23.1  Fail
 6  14.14m  13.12  23.2  Fail
 7   9.78m  12.54  23.1  Pass
 8   8.98m  12.17  23.0  Pass
 9  12.34m  12.32  23.0  Warn
10  10.20m  11.85  22.9  Warn
END       '96- 2-28 16:04:06

STATISTICS(Ω)
 N     =       10     (*    10)
 AVE   =    11.571mΩ
 MIN   =    8.98mΩ  (     8)
 MAX   =   14.20mΩ  (     5)
 σn    =     1.702mΩ
 σn-1  =     1.794mΩ
 Cp    =    0.00
 CpK   =    0.00

STATISTICS(V)
 N     =       10     (*    10)
 AVE   =   12.132 V
 MIN   =   10.18 V  (     5)
 MAX   =   13.12 V  (     6)
 σn    =    0.798 V
 σn-1  =    0.841 V

STATISTICS(°C)
 N     =       10     (*    10)
 AVE   =   23.050°C
 MIN   =    22.8°C  (     4)
 MAX   =    23.2°C  (     6)
 σn    =    0.120°C
 σn-1  =    0.127°C
```

```
HISTOGRAM(Ω)
                 1-    10(  10)
            0           5
      OUT                    0
 - 25.0 %                    0
 - 20.0 %                    1
 - 15.0 %                    1
 - 10.0 %                    2
 -  5.0 %                    1
  11.57mΩ                    0
 +  5.0 %                    3
 + 10.0 %                    0
 + 15.0 %                    0
 + 20.0 %                    1
 + 25.0 %                    1
      OUT                    0

HISTOGRAM(V)
                 1-    10(  10)
            0           5
      OUT                    0
 - 25.0 %                    0
 - 20.0 %                    0
 - 15.0 %                    1
 - 10.0 %                    0
 -  5.0 %                    1
  12.13 V                    3
 +  5.0 %                    4
 + 10.0 %                    1
 + 15.0 %                    0
 + 20.0 %                    0
 + 25.0 %                    0
      OUT                    0

HISTOGRAM(°C)
                 1-    10(  10)
            0           10
      OUT                    0
 -  2.5 %                    0
 -  2.0 %                    0
 -  1.5 %                    0
 -  1.0 %                    1
 -  0.5 %                    1
  23.05°C                    6
 +  0.5 %                    2
 +  1.0 %                    0
 +  1.5 %                    0
 +  2.0 %                    0
 +  2.5 %                    0
      OUT                    0
```

Output Example of the 9203

```
[  1],10.23mohm, 12.58V, 23.1C,Pass
[  2],12.34mohm, 12.68V, 23.2C,Warn
[  3],11.20mohm, 11.34V, 23.1C,Warn
[  4],12.30mohm, 12.54V, 22.8C,Warn
[  5],14.20mohm, 10.18V, 23.1C,Fail
[  6],14.14mohm, 13.12V, 23.2C,Fail
[  7], 9.78mohm, 12.54V, 23.1C,Pass
[  8], 8.98mohm, 12.17V, 23.0C,Pass
[  9],12.34mohm, 12.32V, 23.0C,Warn
[ 10],10.20mohm, 11.85V, 22.9C,Warn
[END]
```

Output Example of the General-purpose Printer

5.3 Beeper On/Off Function

Pressing the [(•)] key toggles the beeper on and off. When the beeper is on, the "(•)" indication appears in the display, and the beeper sounds when there is a "Warning" or "Fail" result. When the beeper is off, the "(•)" indication disappears from the display, and the beeper does not operate.

5.4 Hold Function

This suspends measurement, with the display values held the same.

Press the **HOLD** key. " **HOLD** " is displayed on the screen and the display is locked to prevent it from changing.

NOTE

While the display is locked, the resistance and voltage range keys (**30m** Ω, **300m** Ω, **3** Ω, **3** V, **30** V), and the **0 ADJ** , **COMP**, ◁, ▷, **UP** , and **DOWN** keys are not effective.

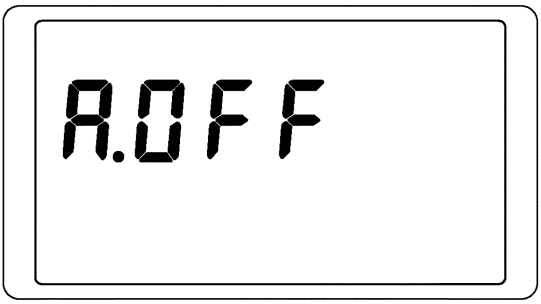
5.5 Moving Average Function

If the resistance measurement value is unstable, this can be corrected with the moving average function. This takes the average of four samples of the resistance value and displays the result.

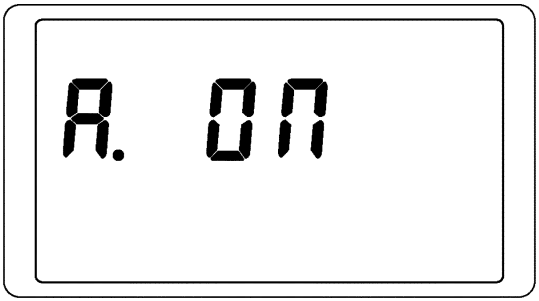
The moving average takes the sum of the current value and the previous three sampled values, and divides by four.

To take the moving average, use the following procedure.

1. Power the unit off.
2. Hold down the ▷ key while pressing the **POWER** key.
3. Hold down the ▷ key until a screen for setting the moving average appears.



4. Press the ▷ key once more.



5. When the above screen appears, press the **POWER** key to power the unit off.
6. Press the **POWER** key again to power the unit on.
7. To cancel the moving average function, in the moving average setting screen, press the ▷ key to cancel the moving average function.

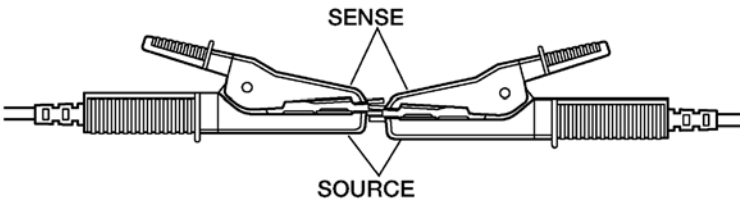
NOTE

- If you hold down a key other than the ▷ key while powering on, an "**INSP**" or "**Adju**" indication may appear. In this case, press the **POWER** key once more, and to power on the unit again. Continuing with other key operations will result in the calibration data being lost, as a result of which correct measurement will no longer be possible.
- It is not possible to change the number of samples (i.e. four) used for calculating the moving average.
- When using the moving average function, the time taken for the measurement value to stabilize is increased.

5.6 Zero Adjust Function

The zero adjustment function adjusts the zero position of the resistance and voltage ranges of this unit.
The value read during zero adjustment is taken as zero, and used to calibrate subsequent measurements.

1. Short the SOURCE and SENSE of the 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR together as shown in the figure below.



2. Press the **0 ADJ** key. During zero adjustment, "**0Adj**" is displayed in the resistance measurement display position.

3. When "**0Adj**" disappears and measurement starts, connect the leads to the battery to be tested.

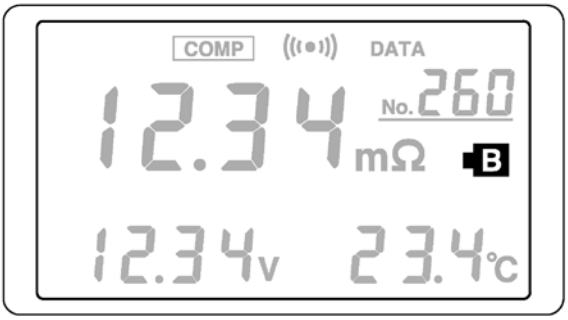
NOTE

- Keep the leads shorted together throughout the zero adjustment process.
- The zero adjustment is valid for the currently selected range only, as long as the power remains on. Powering on the unit resets all zero adjustment values.
- When the resistance or voltage value is displayed as "----", or when the reading is more than "**200**", "**FAIL**" is displayed. The zero adjustment is not carried out.

- Shorting only the **SENSE** terminals will not display 0 V. Always make sure that both the **SENSE** and **SOURCE** terminals are shorted together.
- If the leads are shorted but their ends are brought close to metal parts, the measured value may fluctuate as a result of electromagnetic induction. In this case, move the ends of the leads away from the metal parts.

5.7 Battery Low Warning

When the remaining battery capacity is low, the "B" indicator appears at the right of the display.
After printing out any held data values, replace the battery, referring to Section 4.1, "Preparing for Measurement."



NOTE

If the batteries are exhausted, you may be able to turn on the power, but soon the "B" mark will appear and the power will go off. (Momentary operation is possible because the battery partially regains its former voltage after resting, but soon declines to the exhausted state.) When the batteries wear out, replace them in accordance with the specified procedure.

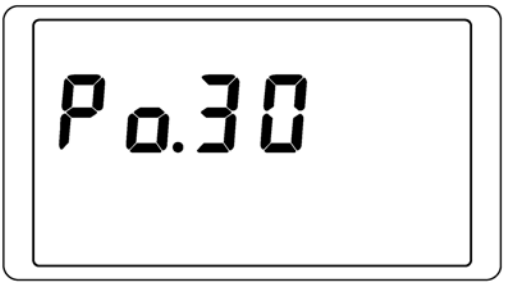
5.8 Auto Power Off

In the following states, if there is no switch operation for 30 minutes the unit automatically powers off.

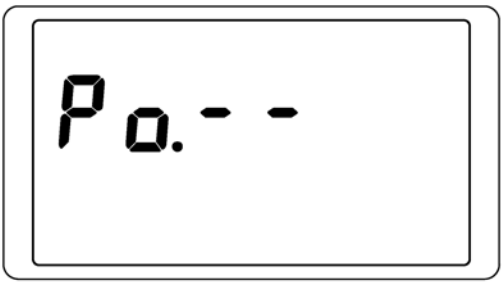
- When the resistance value is "----" indication.
- During hold
- On the comparator setting screen
- During the printing output
- During reading the memory data

For continuous measurement, in some cases it may be necessary to disable the auto power off function. Do this as follows.

1. Turn the power off.
2. Press the **POWER** key on the unit while holding down the **HOLD** key simultaneously. Press the **HOLD** key for a while. The auto-power off setting screen will appear.



3. Press the **HOLD** key again.



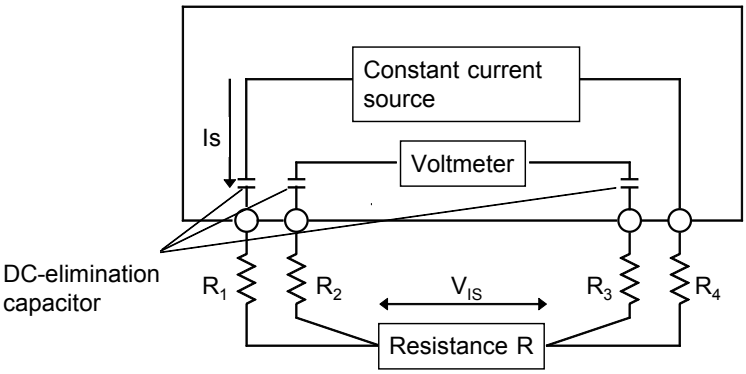
4. When the above screen appears, press the **POWER** key to turn off the power.
5. Press the **POWER** key again to turn the power on.
6. To set to the auto-power off, press the **HOLD** key in the auto power off setting screen and set the auto power off to 30 minutes.

NOTE

- If the **EXT.MEMO** terminals are continuously shorted together, the auto power off function does not operate.
- If the **POWER** key is pressed while another key, other than the **HOLD** key, is held down, and an "**INSP**" or "**Adju**" indication appears, immediately press the **POWER** key to power off and on again. Otherwise, continuing with key operations may destroy the calibration data for the unit, and correct measurement will no longer be possible.
- After the batteries are replaced, the auto power off is set to 30 minutes.
- The set time of auto power off cannot be changed.

5.9 AC Four-Terminal Method

The 3550 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 object to be measured and the leads canceled out. The following figure shows the principle of the AC four-terminal measurement method.



Resistance measurement circuit

Values R1 to R4 are the resistances of the test leads plus contact resistances.

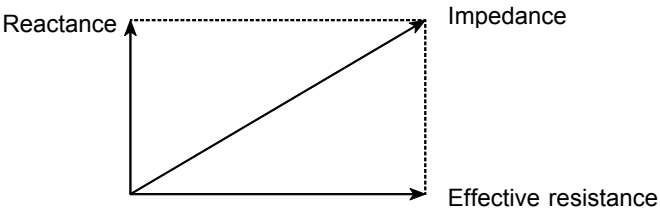
An AC current (Is) is supplied from the **SOURCE** terminals of the 3550 across the tested battery.

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 R2 and R3 which represent the lead resistances and contact resistances.

As a result, there is almost no voltage drop across the resistances R2 and R3. Thus the voltage drop due to the lead resistances and contact resistances is very small, and these can be canceled out.

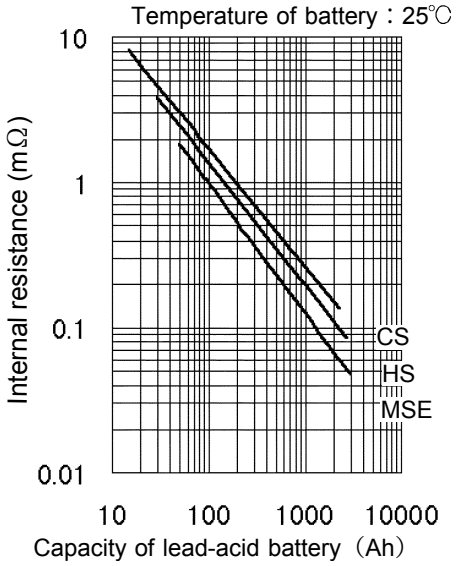
NOTE

In the 3550, a synchronized wave detection system is used, whereby the internal impedance is separated into effective resistance and reactance, and the resistive component only displayed.



5.10 Internal Resistance of Lead-Acid Batteries

This shows the relationship between the capacity for lead-acid batteries and the initial value for internal resistance. (Quote: Text from battery fitters qualification lecture notes, Battery Industry Association) The terms CS, HS, and MSE appearing in the figure are battery types defined by JIS (Japanese Industrial Standards).



CS : Clad type stationary lead-acid battery

HS : High rate discharge paste type stationary lead-acid battery

MSE : Seal type stationary lead-acid battery

- From the figure, MSE internal resistance can be read as approximately 1 mΩ (at 100Ah), or approximately 0.13 mΩ (at 1000 Ah).
- When the battery deteriorates, internal resistance rises to 1.5 to 2 times the initial value (reference value).
- With an MSE (seal type stationary lead-acid battery), battery condition is regarded as marginal when internal resistance reaches 1.5 times the initial value, and complete deterioration is assumed when internal resistance reaches 2 times the initial value.

NOTE

Even if different batteries have the same capacity, initial internal resistance may vary according to battery type and maker. The figure is only for reference.The internal resistance warning (WARN) and fail (FAIL) values vary according to maker.

Chapter 6
Maintenance

If damage is suspected, check the "Troubleshooting" section before contacting your dealer or Hioki representative.

6.1 Troubleshooting

Symptom	Cause	Follow-up
Nothing appears on the screen when the **POWER** key is pressed.	Batteries are exhausted, or not inserted.	Replace the batteries or reinsert them correctly. See Section 4.1, "Preparing for Measurement."
Measurement values are wrong. "---" is displayed. "OF" is displayed.	Leads are not correctly connected.	Connect leads correctly. See Section 4.1, "Preparing for Measurement."
	There is an electrical discontinuity in the leads.	Replace with a new lead.
	Zero adjustment is not correct.	Perform correctly zero adjustment. See Section 5.6, "Zero Adjust Function."
	The measurement range is not appropriate.	Select the appropriate range with the range key. See Section 4.2, "Measurement."
Comparator result is not correct.	The comparator setting is not correct.	Set the comparator correctly. See Section 5.1, "Comparator Function."

Symptom	Cause	Follow-up
Data in memory is not displayed when the **READ** key is pressed.	There is no data in memory.	Store data in memory. See Section 5.2, "Measurement Value Memory Function."
Printing is not possible.	There is no data in memory.	Store data in memory. See Section 5.2, "Measurement Value Memory Function."
	The comparator setting screen appears.	Exit the comparator setting screen, to return to the measurement screen. See Section 5.1, "Comparator Function."
	The connecting cable is not correctly connected.	Correctly connect the connecting cable.
	The printer is not ready.	Turn the printer power on and set correctly.

NOTE

- To avoid problems with battery operation, remove the batteries from the product if it is to be stored for a week or more.

- When sending the product 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.

- Never modify the product. Only a Hioki service engineer can disassemble or repair the product. Failure to observe these precautions may result in fire, electric shock, or injury.

6.2 Message Reference

Message	Meaning	Follow-up
FAIL	Zero adjustment cannot be carried out.	Connect correctly the lead and execute the zero adjustment. See Section 5.6, "Zero Adjust Function."
Prnt	Data is being sent to the printer.	Disappears when data output to the printer is completed.
0Adj	Zero adjustment is being carried out.	Disappears when zero adjustment is completed.
INI	Initialization after battery replacement.	This is not a malfunction.
INSP	Inspection and adjustment modes for factory use.	Press the **POWER** key to turn the power on.
Adju		
Er10 Er11 Er12 Er20 Er21 Er22 Er23 Er24	Internal variable error.	Servicing is required.

6.3 Cleaning

- To clean the product, 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.
- When cleaning the LCD, gently wipe with a soft dry cloth.

HIOKI

DECLARATION OF CONFORMITY

Manufacturer's Name:	HIOKI E.E. CORPORATION
Manufacturer's Address:	81 Koizumi, Ueda, Nagano 386-1192, Japan
Product Name:	BATTERY HiTESTER
Model Number:	3550, 3551, 3555
Accessories:	9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR (for 3550) 9465 PIN TYPE LEAD (for 3551) 9466 REMOTE CONTROL SWITCH (for 3551) 9461 PIN TYPE LEAD (for 3555)
Options:	9425 CONNECTION CABLE (for 3550, 3551) 9287-10 CLIP TYPE LEAD (for 3555) 9452 CLIP TYPE LEAD (for 3555) 9453 FOUR TERMINAL LEAD (for 3555) 9770 PIN TYPE LEAD (for 3555) 9771 PIN TYPE LEAD (for 3555)

The above mentioned products conform to the following product specifications:

Safety:	EN61010-1:2001
EMC:	EN61326:1997+A1:1998+A2:2001+A3:2003 ClassB equipment Portable test and measurement equipment

Supplementary Information:

The products herewith comply with the requirements of the Low Voltage Directive 73/23/EEC and the EMC Directive 89/336/EEC.

HIOKI E.E. CORPORATION

15 September 2006

T. Yoshiike

Tatsuyoshi Yoshiike

President

3550A999-08

HIOKI 3550 BATTERY HiTESTER

Instruction Manual

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