HIOKI

INSTRUCTION MANUAL

3551

BATTERY HiTESTER

HIOKI E. E. CORPORATION

Contents

Introduction

Thank you for purchasing the HIOKI "3551 BATTERY HiTESTER." To obtain maximum performance from the instrument, please read this manual first, and keep it handy for future reference.

Inspection

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.

Accessories

9465 PIN TYPE LEAD
9466 REMOTE CONTROL SWITCH
Spiral tubes large (4), small (2)
9377 CARRYING CASE
Zero adjustment board
Six LR6 alkaline batteries
Instruction Manual
Dust cover (for the printer interface)

Shipping

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

Safety

⚠ 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. 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 the instrument, be sure to carefully read the following safety notes.

	• 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. • In the manual, the ⚠ symbol indicates particularly important information that the user should read before using the instrument.
	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 instrument.
NOTE	Indicates advisory items related to performance or correct operation of the instrument.

Measurement categories (Overvoltage categories)

This instrument complies with CAT I safety requirements. To ensure safe operation of measurement instruments, 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.

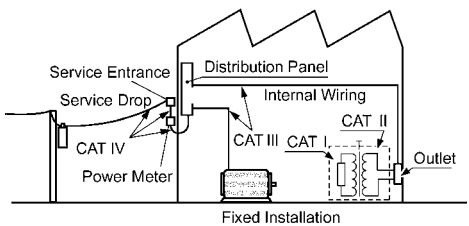
CAT IV: The circuit from the service drop to the service entrance, and to the power meter and primary overcurrent protection device (distribution panel).

Higher-numbered categories correspond to electrical environments with greater momentary energy. So a measurement device designed for CAT III environments can endure greater momentary energy than a device designed for CAT II.

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.

Never use a CAT I measuring instrument 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.

Preliminary Check

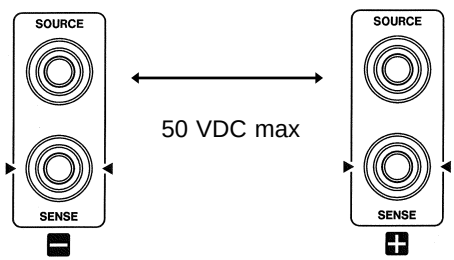
Before using the instrument the first time, verify that it operates normally to ensure that the no damage occurred during storage or shipping. If you find any damage, contact your dealer or Hioki representative.

⚠ DANGER

- **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 instrument to get wet, and do not take measurements with wet hands. This may cause an electric shock.**
- **Do not use the instrument where it may be exposed to corrosive or combustible gases. The instrument may be damaged or cause an explosion.**
- **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 PIN TYPE LEAD).**
- **Be sure to connect the SOURCE and SENSE terminals (banana plugs) correctly. When using the 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR, also connect the TEMP SENSOR terminal (miniplug). See Section 4.2, "Measurement Batteries" for details of the connections.**
- **To avoid injury or damage to the instrument, do not attempt to measure AC voltage, or DC voltage exceeding 60 V.**
- **Do not apply a voltage between the SOURCE(+) and SENSE(+) or SOURCE(-) and SENSE(-) terminals. This could result in damage to the instrument.**



⚠CAUTION

- This instrument is not designed to be entirely water- or dust-proof. To avoid damage, do not use it in a wet or dusty environment.
- Do not store or use the instrument where it could be exposed to direct sunlight, high temperature or humidity, or condensation. Under such conditions, the instrument may be damaged and insulation may deteriorate so that it no longer meets specifications.
- This instrument is designed for use indoors. It can be operated at temperatures between 0 and 40 °C without degrading safety.
- Do not use the instrument near a source of strong electromagnetic radiation, or near a highly electrically charged object. These may cause a malfunction.

NOTE

- 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.
- For safety reasons, when taking measurements, only use the 9465 PIN TYPE LEAD provided with the instrument or optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR.

Service

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.

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 instrument.

Chapter 1 Overview
Describes an outline of the instrument, and lists its features.

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

Chapter 3 Specifications
Lists the specifications of the instrument.

Chapter 4 Standard Measurement
Describes the basic operation of the instrument.

Chapter 5 Advanced Measurement Functions
Describes miscellaneous functions.

Chapter 6 Maintenance
Gives troubleshooting information.

Chapter 1
Overview

1.1 Product Overview

The 3551 is designed for measuring the internal resistance, open-circuit voltage, and terminal temperature of secondary batteries, including lead storage cells, nickel-cadmium batteries, nickel-metal hydride batteries, and lithium-ion batteries.

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.

1.2 Features

(1) 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.

(2) It is possible to display the readings for the battery internal resistance, voltage, and terminal temperature, without changing functions.

(3) A composite comparator function, which can be set on resistance and voltage values, enables reliable detection of battery deterioration.

(4) The instrument's memory function also allows a number of sets of readings to be stored at a touch, and later output to a printer.

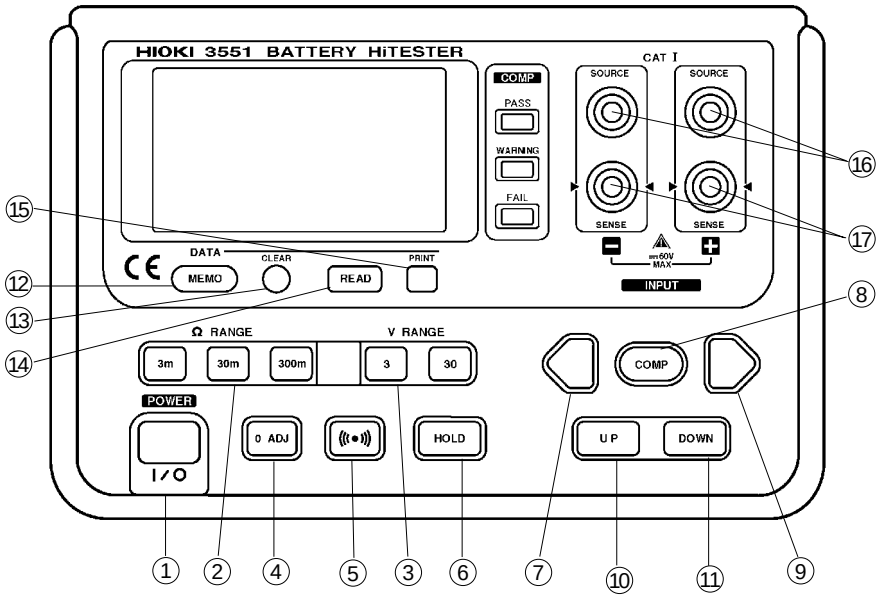
(5) These functions make this an ideal tool for checking batteries which are under constant trickle charging and cannot be disconnected.

NOTE To measure the terminal temperature, use the optional 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR.

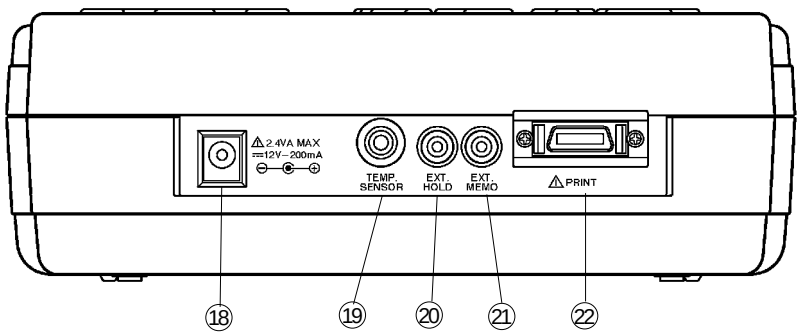
Chapter 2
Names and Functions of Parts

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

Front Panel



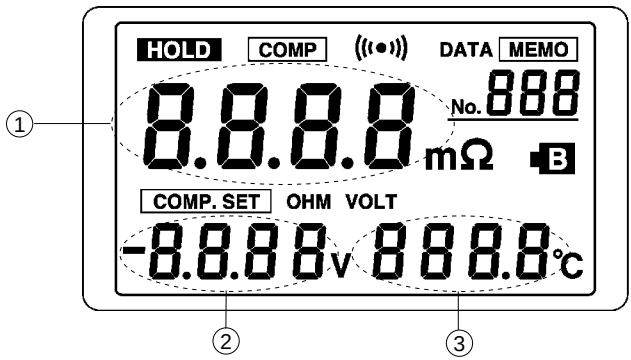
Side Panel



■ Keys and input/output terminals

① **POWER** key	Turns the power on or off.
② 3m Ω key 30m Ω key 300m 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 banana plug of the 9460 on the SOURCE side.
⑰ **SENSE**	Connects to the banana plug of the 9460 on the SENSE side.
⑱ **AC adapter**	Connects the 9418-10 AC ADAPTER (PSA-30U-120, PHIHONG).
⑲ **TEMP.SENSOR**	Connects to the miniature phone plug of the 9460.
⑳ **EXT.HOLD**	Connects to the 9466 switch and stores the displayed data in memory.
㉑ **EXT.MEMO**	Connects to the 9466 switch, and stores the displayed data in memory.
㉒ **PRINT**	Connects to the printer.

■ LCD (view with all elements displayed)



■ Displays

① Measured resistance

② Measured voltage **[**comparator resistance upper limit setting and comparator voltage setting**]**

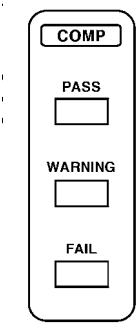
③ Temperature measurement value (when using the 9460) **[**comparator resistance lower limit setting**]**

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. Appears when the data is read out.
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.

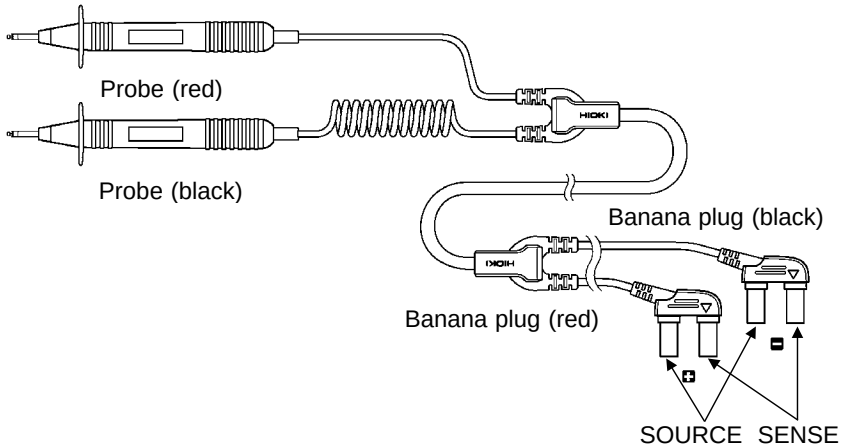
■ LEDs



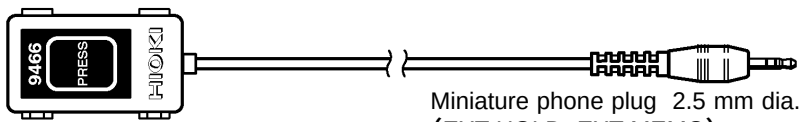
PASS	Indicates that the tested battery is satisfactory for operation.
WARNING	Indicates that the tested battery is beginning to deteriorate.
FAIL	Indicates that the tested battery has deteriorated.

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

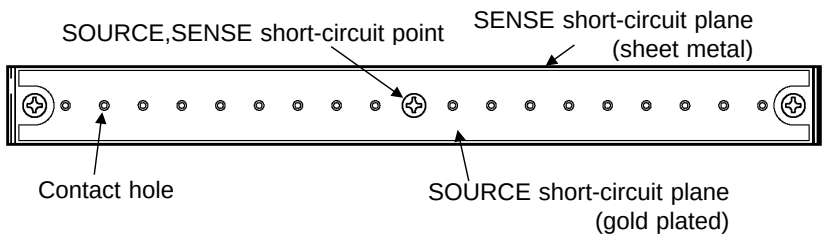
■ 9465 PIN TYPE LEAD



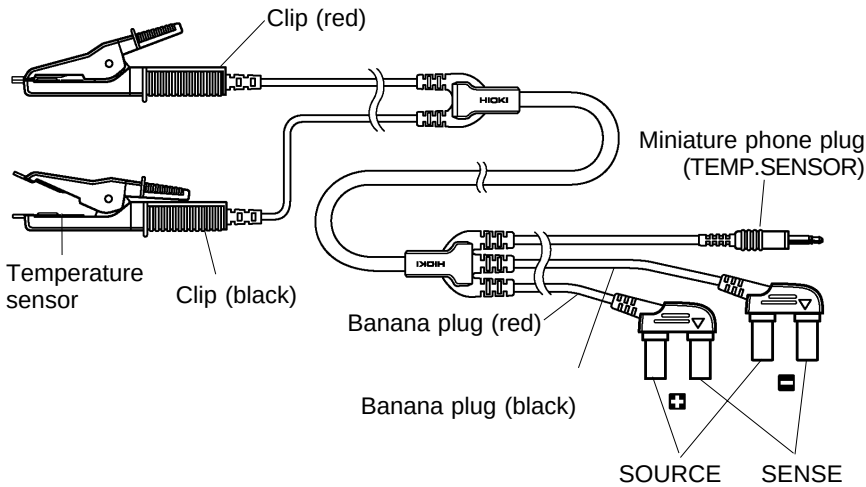
■ 9466 REMOTE CONTROL SWITCH



■ Zero adjustment holds



■ 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR (Option)



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., **mΩ**, B, COMP.SET, **OHM**, **VOLT**, **V**, **℃**
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 or less)
Constant current fault detection	"----" indication
Moving average function	10 times for only resistance measurement (can be set to on or off)
Zero adjustment function	Cancellation of induced voltage in circuits and test leads
Hold function	Display is held when the HOLD key is pressed or the EXT.HOLD terminal is shorted.
Beeper function	Audible output for warning and fail results. Can be turned on and off.

Auto power off	If no key was operated for 30 minutes, or constant-current error detection has continued for 30 minutes
Comparator settings	Resistance upper and lower limits and voltage comparison value setting
Number of comparator settings	99 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 flashing)	**WARNING** (amber)	**FAIL** (red)
HI	**PASS** (green)	**WARNING** (amber)	**FAIL** (red)

Data save	Save measurement value in memory when the (MEMO) key is pressed or EXT.MEMO terminals are shorted. Remote operation using remote control switch for pin type leads possible Memory holds 250 sets of resistance, voltage, 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℃ to 40℃(32°F to 104°F) 80% RH (no condensation)
Storage temperature and humidity range	-10℃ to 50℃(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×6 9418-10 AC ADAPTER (PSA-30U-120, made by PHIHONG) Rated supply voltage: 100 to 240 VAC (Voltage fluctuations of ±10% from the rated supply voltage are taken into account.) Rated supply frequency: 50/60 Hz Rated output voltage: 12 DCV
Maximum rated power	2.4 VA
Continuous operating time	Approx. 5 hours 30 minutes (at 3 mΩ range, comparator ON, beeper ON, with LR6 batteries)
Location for use	Indoors. altitude up to 2000 m (6562-ft.)
Dimensions and mass	Approx. 196W× 130.5H×65D mm, (7.72"W×5.14"H×2.56"D) Approx.860g /30.3oz(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 2, Measurement Category I (anticipated transient overvoltage 2500 V)
Accessories	9465 PIN TYPE LEAD 9466 REMOTE CONTROL SWITCH (with spiral tubes) 9377 CARRYING CASE Instruction Manual Dust cover (for the printer interface) Zero adjustment board Six LR6 alkaline batteries

Options	9418-10 AC ADAPTER (PSA-30U-120, made by PHIHONG) 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR 9466 REMOTE CONTROL SWITCH 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 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".

3.2 Measurement Range

Conditions to guarantee accuracy

Temperature and humidity	23°C±5°C, 80% RH or less (no condensation)
Zero adjustment	After zero adjustment for each range
Test leads	9465 PIN TYPE LEAD, 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR
Warming up time	At least 10 minutes
Period of guaranteed accuracy	1 year

(1) Resistance Measurement

Range	Maximum indication	Resolution	Measurement current	Accuracy	
3 mΩ	3.100 mΩ	1 μΩ	50 mA	Six months 1 year	±1.0% rdg.±8 dgt. ±1.5% rdg.±8 dgt.
30 mΩ	31.00 mΩ	10 μΩ	50 mA	Six months 1 year	±0.8% rdg.±6 dgt. ±1.2% rdg.±6 dgt.
300 mΩ	310.0 mΩ	100 μΩ	5 mA	Six months 1 year	±0.8% rdg.±6 dgt. ±1.2% rdg.±6 dgt.

Temperature coefficient: 3 mΩ range (±0.01% rdg.±0.8 dgt.)/°C
30, 300 mΩ range (±0.01% rdg.±0.5 dgt.)/°C
Measurement current accuracy: ±10%
Measurement current frequency: 1 kHz±30 Hz

(2) Voltage Measurement

Range	Maximum indication	Resolution	Accuracy	
3 V	±3.100 V	1 mV	Six months 1 year	±0.1% rdg.±6 dgt. ±0.15% rdg.±6 dgt.
30 V	±31.00 V	10 mV	Six months 1 year	±0.1% rdg.±6 dgt. ±0.15% rdg.±6 dgt.

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

(3) Temperature Measurement (when using the 9460)

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

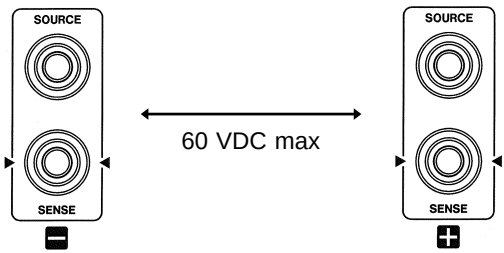
Reference

- If zero adjustment was carried out using 9465 in the 3 mΩ range or if the lead arrangement during measurement was changed significantly, indication fluctuates by about 15 dgt.
- Using the 9460 (option), temperature measurement is possible, but indication will fluctuate by about 15 dgt. in the 3 mΩ range of the 9460, depending on lead arrangement.

3.2.1 Maximum Input Voltage

⚠ DANGER

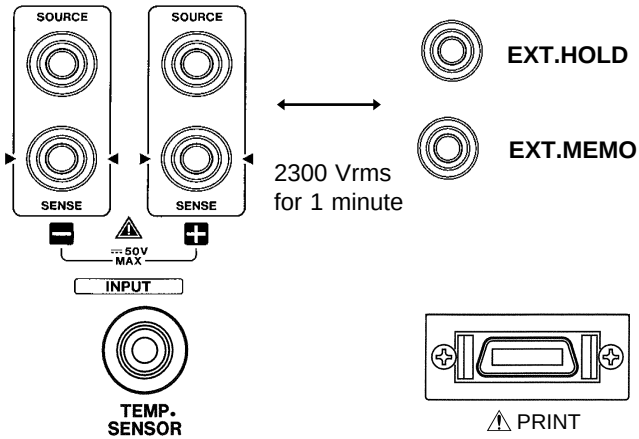
- **The maximum input voltage is 60V DC. Attempting to measure voltage in excess of the maximum input could destroy the instrument and result in personal injury or death.**
- **To avoid electrical hazards and damage to the instrument, do not apply voltage exceeding the maximum input to the measurement terminals.**



60 V DC maximum
No AC voltage input

3.2.2 Dielectric Strength

⚠ DANGER **Between input terminals and output terminals (including the EXT.HOLD and EXT.MEMO terminals), and between input terminals and case: 2300 Vrms maximum for 1 minute.**



Chapter 4
Standard Measurement

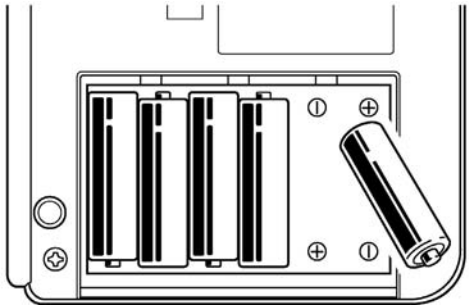
4.1 Preparing for Measurement

The 3551 can be used with the six LR6 alkaline batteries, six R6P manganese batteries, or optional 9418-10 AC ADAPTER (PSA-30U-120, PHIHONG).
The AC adapter has priority. Even if batteries are inserted, they will not be used as long as the AC adapter is connected.

4.1.1 Replacing the Batteries

⚠WARNING

- **To avoid electric shock when replacing the batteries, first disconnect the test 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.**
- **To avoid the possibility of explosion, do not short circuit, disassemble or incinerate batteries.**
- **Handle and dispose of batteries in accordance with local regulations.**
- **After replacing the batteries, replace the cover before using the instrument.**



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

   Immediately after inserting the batteries, the internal capacitor for data backup is charged. During this interval (about 15 seconds), the instrument will not be operative.

NOTE

- When the batteries are removed, measurement data are preserved for about 15 minutes by the internal capacitor. After a longer interval without batteries, stored measurement data will be lost.
- If the batteries were fully depleted before being when removed, the backup interval may be short.
- The "B" indicator appears when battery voltage becomes low. Replace the batteries as soon as possible.
- Pressing the **POWER** key when the batteries are not installed resets and clears all measurement data from memory. After resetting, the auto power off function is set to 30 minutes, with the beeper on. (See Section 5.10, "Reset.")
- Be sure to press the **POWER** key to power the instrument off before removing the batteries. If the batteries are removed while the instrument is powered on, the previous comparator number may not be recovered.

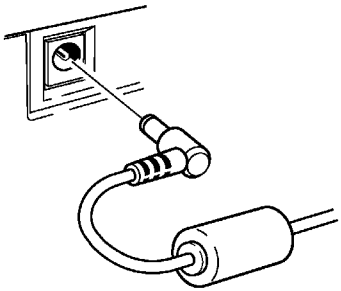
・To avoid problems with battery operation, remove the batteries from the instrument if it is to be stored for a week or more.
Even when the power to the main instrument is switched off, a very small current (approximately 0.7 mA) is drawn from the batteries to back up internal data. Therefore if the instrument is left switched off with new batteries installed, they will become fully drained within 2 to 2.5 months.

4.1.2 Connecting the 9418-10 AC ADAPTER

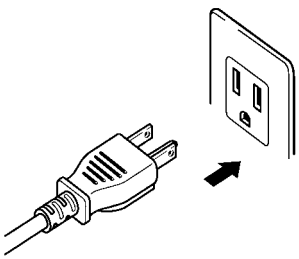
⚠WARNING

- **Use only the specified Model 9418-10 AC ADAPTER (PSA-30U-120, PHIHONG). AC adapter input voltage range is 100 to 240 VAC (with ±10% stability) at 50/60 Hz. To avoid electrical hazards and damage to the instrument, do not apply voltage outside of this range.**
- **Turn the instrument off before connecting the AC adapter to the instrument and to AC power.**

1. Remove the leads from the battery to be tested.
2. Press the **POWER** key to turn off the power.



3. Connect the output plug of the 9418-10 AC ADAPTER (PSA-30U-120, PHIHONG) to the jack for the AC adapter of the instrument.



4. Verify that the rated voltage of the AC adapter matches the rated voltage of the AC outlet. Then plug the AC adapter into the outlet.

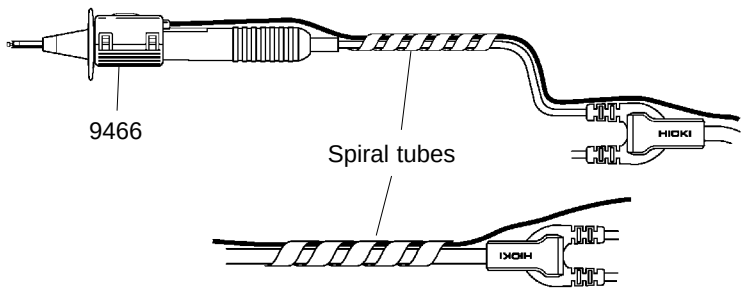
NOTE

- When the output plug of the AC adapter is connected to the instrument and the AC adapter is not plugged into the outlet, the 3551 is reset after about 15 minutes. In this case, while the power switch is pressed, the 3551 is also reset.
- Make sure the power is turned off before connecting or disconnecting the AC adapter. The 3551 is reset and the measurement data stored in memory are cleared.

4.1.3 Connecting the Test Lead and Remote Control Switch

⚠CAUTION	If the spiral tube has a sharp edge at the end, round it with scissors to prevent possible injury.

The 9465 PIN TYPE LEAD and 9466 REMOTE CONTROL SWITCH 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.



4.2 Measurement Batteries

4.2.1 Notes On 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 instrument, do not attempt to measure AC voltage, or DC voltage exceeding 60 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 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, which is dangerous.
- The ends of the 9465 PIN TYPE LEAD are sharp. Be careful to avoid injury.
- To avoid short circuit between the terminals of battery, do not put the zero adjustment board on the battery.
- The zero adjustment board is fixed to the top cover of the carrying case. Take care not to accidentally unhook and drop the board during use.
- Carrying the instrument in the 9377 CARRYING CASE with the neck strap for a prolonged time may cause strain.

NOTE

- The impedance of a battery fluctuates considerably, depending on the charge state. For increased precision of evaluation, you should carry out multiple measurements under similar conditions (such as with the battery fully charged).
- When the measurement object is a lead-acid storage battery, apply the pin type test leads to the same spot on the electrodes for repeated measurements. Otherwise results will differ because electrode resistance causes different readings when the lead is applied to the tip or the bottom of the electrode.
- To measure the temperature of a battery, you can use the 9460 CLIP TYPE LEAD WITH TEMPERATURE SENSOR (option).
  For increased safety, you may wish to use a non-contact temperature sensor such as a radiation thermometer.
- If an insulating film has formed on an electrode, the measurement current from this instrument cannot enter the battery, making measurement impossible. In such a case, repeat the probing process several times to penetrate the insulating film.

4.2.2 Measurement

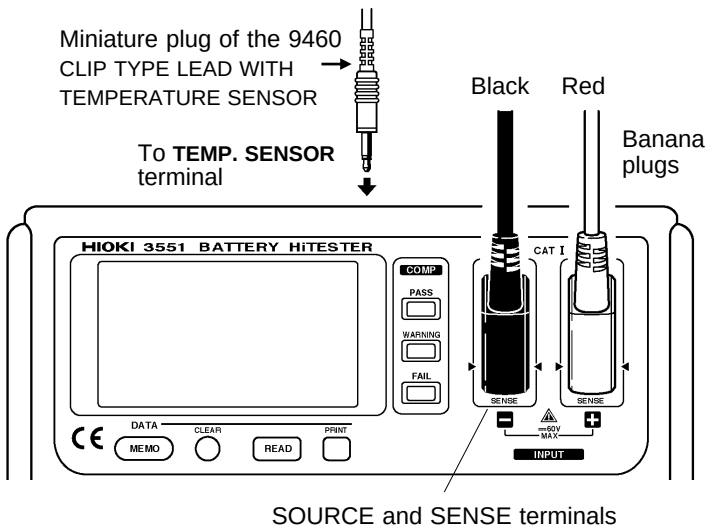
⚠CAUTION

- Avoid stepping on or pinching the cable, which could damage the cable insulation.
- Keep the cables well away from heat sources, as bare conductors could be exposed if the insulation melts.

NOTE

- Use only the specified test lead. Using a non-specified lead may result in incorrect measurements due to poor connection or other reasons.

1. Connect the 9465 leads as shown in the figure below. Connect leads to all four terminals; SOURCE +/−, SENSE +/−. (for 9460, five terminals)

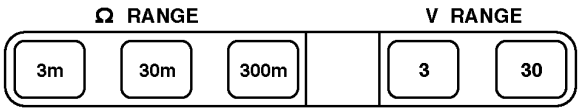


2. Press the **POWER** key to turn on the power and start measurement.

・After powering on, the comparator function is always set to on. If the comparator function is not used, press the (COMP) key to set to off.

・It is necessary to wait for ten minutes of warming-up time, to allow the instrument to stabilize after pressing the **POWER** key to power on.

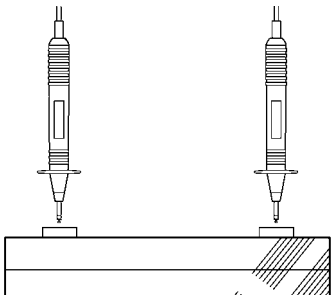
3. Using the range keys, select the voltage and resistance measurement ranges.



4. Carry out the zero adjustment (for details, see Section 5.6, "Zero Adjust Function.").

5. Connect the red probe to the positive (+) side of the battery to be tested and connect the black probe to the negative (−) side.

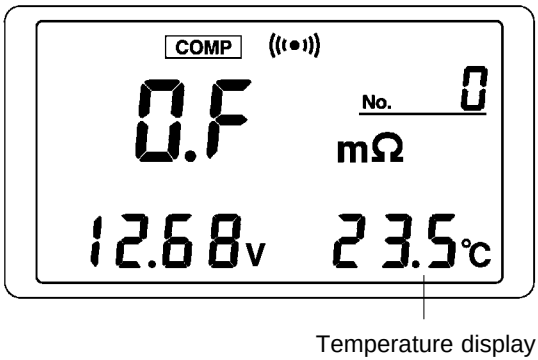
   The outer shield conductors of the leads are connected to the SOURCE terminals, and the inner pin conductors are connected to the SENSE terminals. When contacting the probes with the battery terminals, press so that the inner pin conductors are pushed inside, and all of the SOURCE and SENSE conductors make good contact.



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

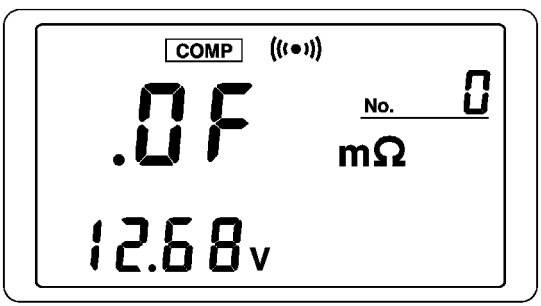
Measurement screen when using with the 9460

Connect the mini-plug of the 9460 to the TEMP.SENSOR terminal of the instrument, the temperature sensor is detected and the temperature is automatically displayed.

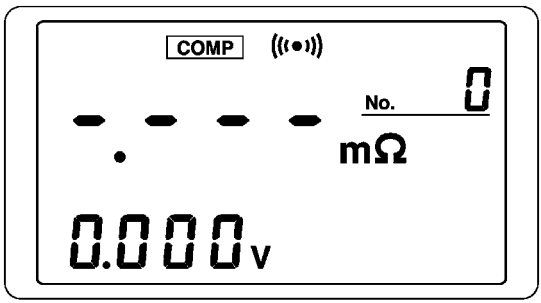


NOTE

- 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.
- If the leads are open-circuit, a spurious voltage indication may sometimes be given. This is not a malfunction.
- If two or more 3551 instruments are used in close proximity, mutual interference may falsify measurement results. Keep the instruments as far apart as possible.
- 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.



- 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 instrument, and correct measurement will no longer be possible.

Chapter 5
Advanced Measurement Functions

5.1 Comparator Function

5.1.1 What is the Comparator Function?

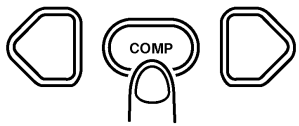
The comparator function compares the measurement values with preset lower and upper limit values for internal resistance and voltage level, and determines which range the measurement falls into, based on the preset conditions. It then lights the corresponding LED, and sounds a beeper for the WARNING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

5.1.2 Comparator Settings

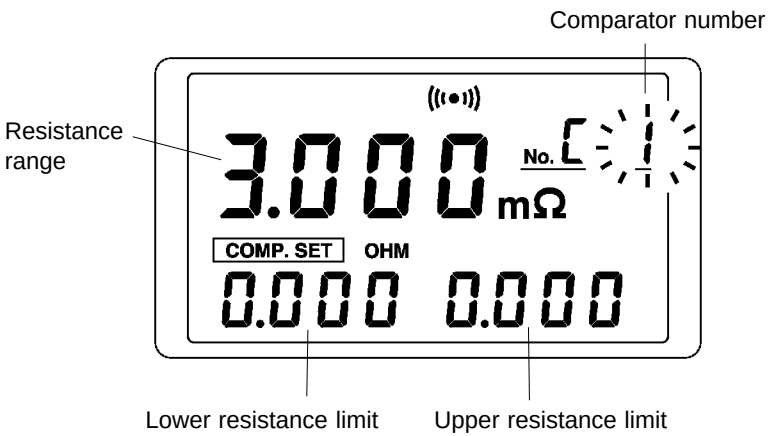
Before changing the settings

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.

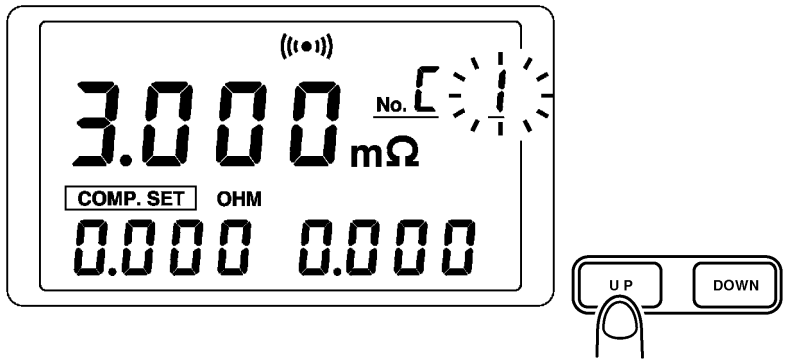


2. [COMP.SET] , **OHM** appears at the lower left of the screen, showing that you are ready to change the comparator settings.



Setting the comparator number

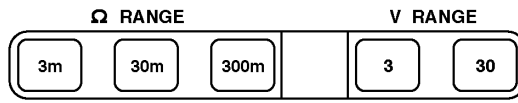
Change the comparator number with the UP and DOWN keys. You can select any comparator number up to 99.



Setting the resistance range

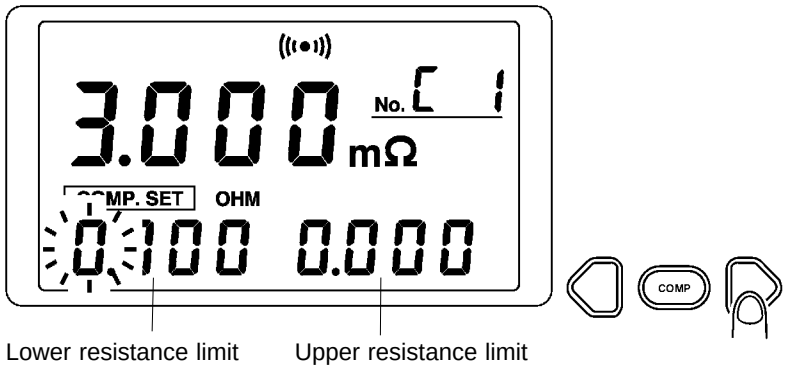
Press the resistance range key (**Ω RANGE:** 3m , 30mΩ , 300m) corresponding to the resistance to be measured.

The currently selected resistance range is displayed at the center on the screen.



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.

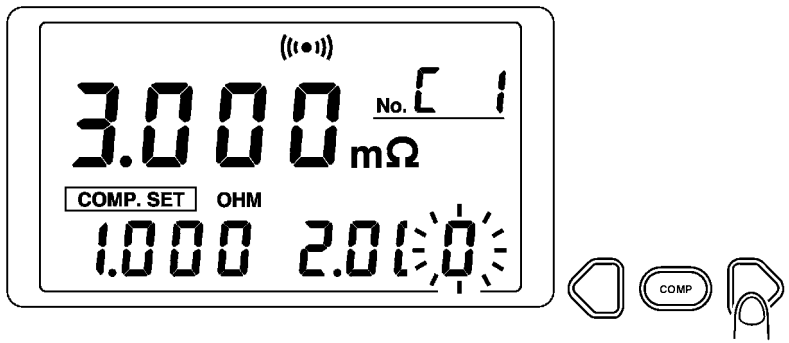


2. Set the lower and upper resistance limits with the UP and DOWN keys.

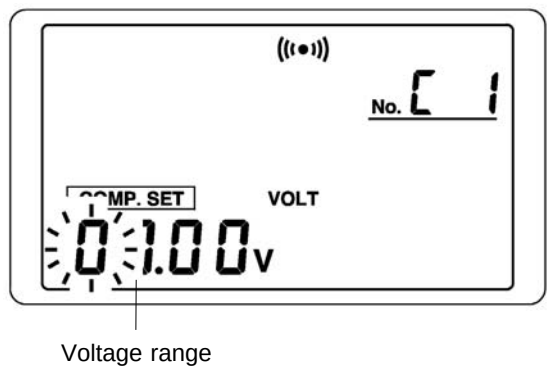
   Both the upper and lower resistance limits can be set to any value in the range 0 to 3100.

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.

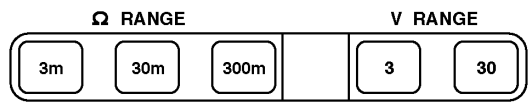


2. Press the ▷ key again to display the voltage comparison value setting screen will appear.
   COMP.SET and **VOLT** appear while setting the voltage comparison value.



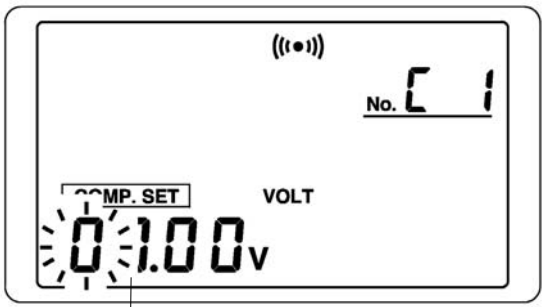
3. Press the voltage range key (**V RANGE:** 3 , 30) corresponding to the voltage to be measured.

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



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 -3100 to 3100.



Voltage comparison value

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 99 comparator numbers.

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.

Voltage \ Resistance	Lower resistance limit LO ↓	IN	Upper resistance limit ↓ HI
Voltage comparison value → LO	**WARNING** Amber (flashing)	**WARNING** Amber	**FAIL** Red
Voltage comparison value → HI	**PASS** Green	**WARNING** Amber	**FAIL** Red

- 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.

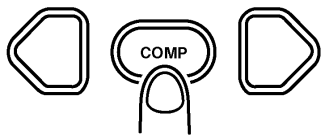
Example 2 When the measured resistance is greater than the lower resistance limit and lower than the upper resistance limit value, and the measured voltage is greater than the voltage comparison value (that is, resistance: IN, voltage: HI) the LED for **WARNING** (amber) lights and the beeper sounds.

NOTE If the resistance lower limit value is set as same as the resistance upper limit value, the boundary conditions are as follows.

$$\text{Resistance LO} \leqq \underline{\underline{\text{Lower resistance limit}}} < \text{Resistance HI}$$
$$\underline{\underline{\text{Upper resistance limit}}}$$
$$\text{Voltage LO} \leqq \underline{\underline{\text{Voltage comparison value}}} < \text{Voltage HI}$$

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.



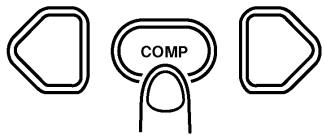
- When one of the range keys ([3m]Ω, [30m]Ω, [300m]Ω, [3]V, [30]V) is pressed and the range is changed, comparator operation stops even if the comparator function is being used. To use comparator function again, press the (COMP) key. The range reverts to the setting extant prior to the change.
- When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

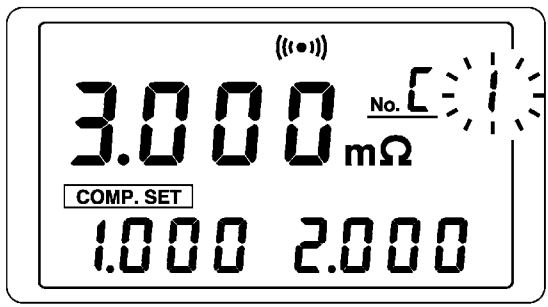
5.1.5 Changing the Comparator Number

To change the comparator number, do the following procedure.

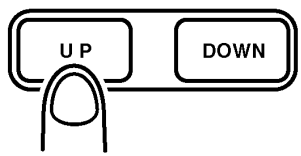
1. Press and hold the (COMP) key for at least 3 seconds. The resistance comparator setting screen appears.



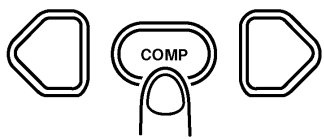
[COMP.SET] appears at lower left of the screen.



2. Select the comparator number with the [UP] and [DOWN] keys. You can select any number up to 99.



3. When the measurement 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

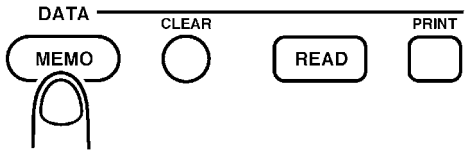
> **⚠WARNING** **To avoid damage to the instrument, do not apply voltage to the EXT.MEMO terminals.**

The currently measured values (resistance value, voltage value, temperature, and comparator result), taken as a set can be stored: up to 250 such sets of values can be held, and later displayed and printed as required.

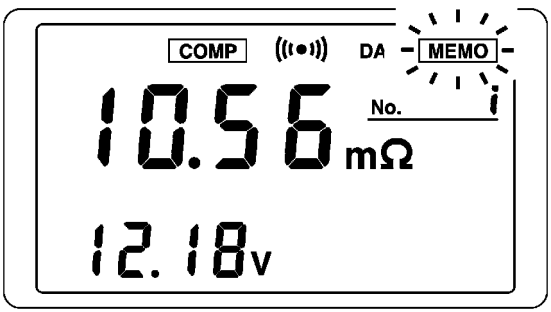
5.2.1 Memory

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. When the beep function has been set to ON, a short beep is heard.

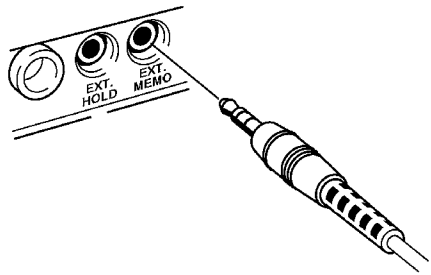


MEMO Screen

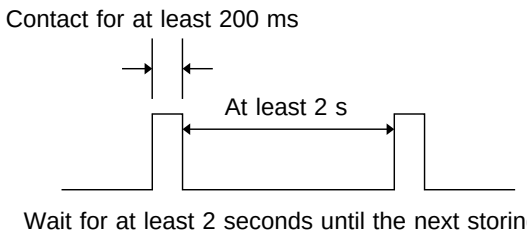
DATA is displayed at the upper right of the screen and the number of data points stored in memory is displayed.

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

1. Remove the lead from battery to be tested.
2. Insert the mini-plug of the 9466 to the EXT.MEMO terminal.



3. Press the 9466 switch for at least 100 ms 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
   When the beep function has been set to ON, a short beep is heard.



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

NOTE

- Do not insert or remove the mini-plug while the lead is connected to the batteries. Before replacing the plug, always remove the lead from the batteries.
- Do not connect the mini-plug of the 9466 to the TEMP.SENSOR terminal.

- If while the PRESS key of the 9466 is pressed together another key is pressed, then the values may be saved twice.
- If exhausted batteries are left in the instrument for a prolonged time, stored measurement data may be lost.

5.2.2 Overwrite

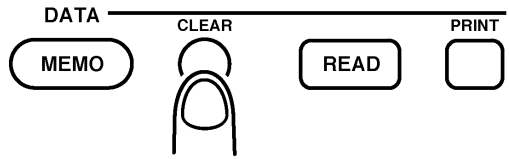
Measurement data stored in a memory number can be overwritten with new data.

1. Make a measurement and hold the measurement value. For holding data, see Section 5.4, "Hold Function."
2. Press the [READ] key. The [MEMO] indication appears in the upper right and the number of "No. " indication flashes. The flashing number is the number of the set of values currently displayed.
3. Pressing the [UP] key or [DOWN] key increments or decrements this number, to overwrite whichever set of data values is required.
4. Press the [MEMO] key to overwrite.
5. Press the [READ] key to return the measurement screen.

5.2.3 Clear

Clear the latest value in memory as follows.

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



2. To clear all data, press and hold the **CLEAR** key for 7 seconds.

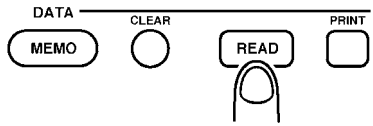
NOTE

Resetting also clears all data. For details, see Section 5.10, "Reset."

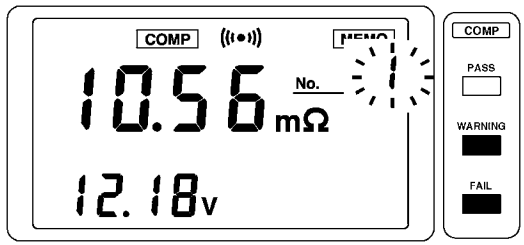
5.2.4 Readout

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).
- For the measurement data using with the 9460, the temperature value is displayed.

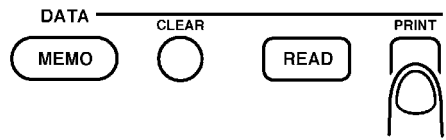
5.2.5 Printing

⚠WARNING

- **For safety, never connect the 3551 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 instrument, 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 instrument is a 20-pin half-pitch D-subminiature connector, DHA-RC20-R132N (Daiichi Electronics) or equivalent.
- Use the printer cable within 2 m.
- 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.

Output Example

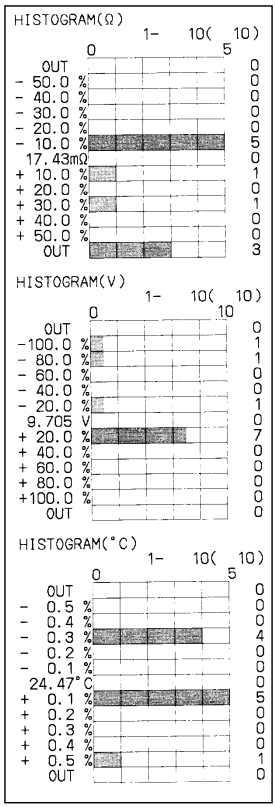
9203
Using with 9460

```
START      '97- 5-20  8:35:14
[N]  Ω          V        °C      COMP
  1  15.71m     12.41    24.5    Pass
  2  15.90m     12.41    24.4    Pass
  3  15.78m     12.41    24.4    Pass
  4  15.82m     12.41    24.4    Pass
  5  22.72m      0.32    24.4    Warn
  6  19.82m     12.41    24.5    Pass
  7  ------      8.31    24.5
  8  16.25m     12.41    24.5    Pass
  9      OF     12.42    24.5    Fail
 10      OF      1.54    24.6    Fail
END        '97- 5-20  8:35:20

STATISTICS(Ω)
 N     =        10    (*     7)
 AVE   =    17.429mΩ
 MIN   =   15.71mΩ   (      1)
 MAX   =   22.72mΩ   (      5)
 σn    =     2.555mΩ
 σn-1  =     2.760mΩ
 Cp    =      0.00
 CpK   =      0.00

STATISTICS(V)
 N     =        10    (*    10)
 AVE   =     9.705 V
 MIN   =     0.32 V   (      5)
 MAX   =    12.42 V   (      9)
 σn    =     4.560 V
 σn-1  =     4.807 V

STATISTICS(°C)
 N     =        10    (*    10)
 AVE   =   24.470°C
 MIN   =    24.4°C   (      5)
 MAX   =    24.6°C   (     10)
 σn    =    0.064°C
 σn-1  =    0.067°C
```



General-purpose Printer

Using with 9460

```
[  1], 15.71 mohm,  12.41 V,  24.5 C, Pass
[  2], 15.90 mohm,  12.41 V,  24.4 C, Pass
[  3], 15.78 mohm,  12.41 V,  24.4 C, Pass
[  4], 15.82 mohm,  12.41 V,  24.4 C, Pass
[  5], 22.72 mohm,   0.32 V,  24.4 C, Warn
[  6], 19.82 mohm,  12.41 V,  24.5 C, Pass
[  7],    --     ,   8.31 V,  24.5 C
[  8], 16.25 mohm,  12.41 V,  24.5 C, Pass
[  9],    OF     ,  12.42 V,  24.5 C, Fail
[ 10],    OF     ,   1.54 V,  24.6 C, Fail
[END]
```

NOTE When the 9465 is used to measure, the temperature value is displayed as "--."

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

The display values are held.

1. Press the [HOLD] key.
2. **HOLD** is displayed on the screen and the display is locked to prevent it from changing.

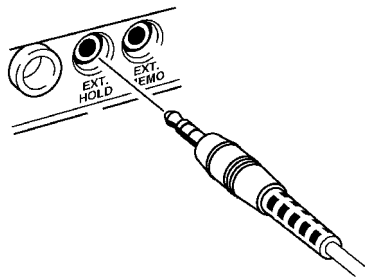
3. Press the [HOLD] key again, the hold state is released.

NOTE

- While the display is locked, the resistance and voltage range keys ([3m]Ω, [30m]Ω, [300m]Ω, [3]V [30]V), and the (COMP) keys are not effective.
- When the power is turned off, the display locked is released.

Using the EXT. HOLD terminals, the same effect as the [HOLD] key can be obtained.

1. Remove the lead from battery to be tested.
2. Insert the mini-plug of the 9466 to the EXT.HOLD terminal.



3. Press the 9466 switch for at least 100 ms to obtain the effect of pressing the [HOLD] key.
   The [HOLD] indication appears in the display, and the measurement values are held.
4. To release the hold condition, press the 9466 switch for at least 200 ms again or press the [HOLD] key.

NOTE

- Do not insert or remove the mini-plug while the lead is connected to the batteries. Before replacing the plug, always remove the lead from the batteries.
- Do not connect the mini-plug of the 9466 to the TEMP.SENSOR terminal.

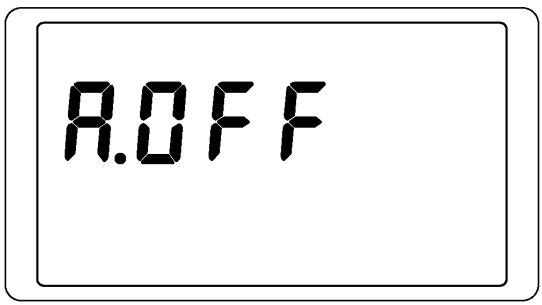
5.5 Moving Average Function

If the resistance measurement value is unstable, this can be corrected with the moving average function. This takes the average of 10 samples of the resistance value and displays the result.

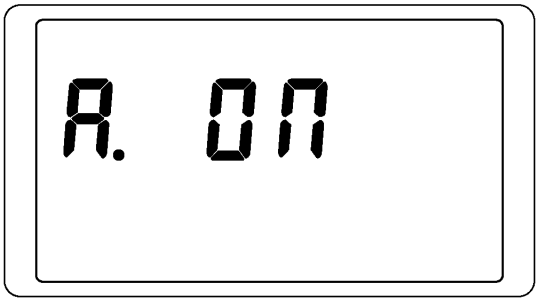
The moving average takes the sum of the current value and the previous 9 sampled values, and divides by 10.

To take the moving average, use the following procedure.

1. Power the instrument 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 instrument off.
6. Press the **POWER** key again to power the instrument 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 instrument 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. 10) 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

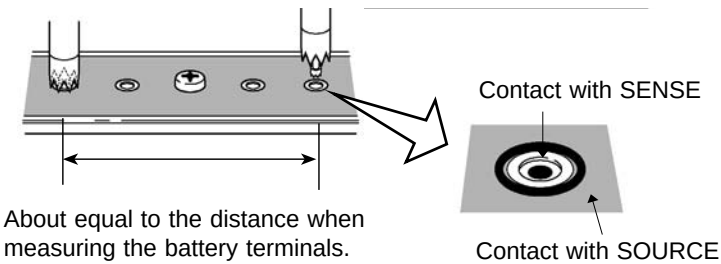
The zero adjustment function adjusts the zero position of the resistance and voltage ranges of this instrument. The value read during zero adjustment is taken as zero, and used to calibrate subsequent measurements.

5.6.1 9465 Zero Adjustment

Using the supplied zero adjustment board, zero adjustment can be carried out according to the AC four-terminal method.

1. Remove the 9465 PIN TYPE LEAD from the battery to be tested.
2. Insert the 9466 to the EXT.HOLD terminal.
3. As shown in the illustration, push the 9465 pin type leads onto two holes in the zero adjustment board. Choose holes symmetrically on both sides of the center screw, so that the distance between the leads is about equal to the distance when measuring the battery terminals.

   Move the zero adjustment board away from the instrument about 10 cm or more.



4. When the measurement value has stabilized, push the PRESS key on the 9466 REMOTE CONTROL SWITCH to freeze the display.

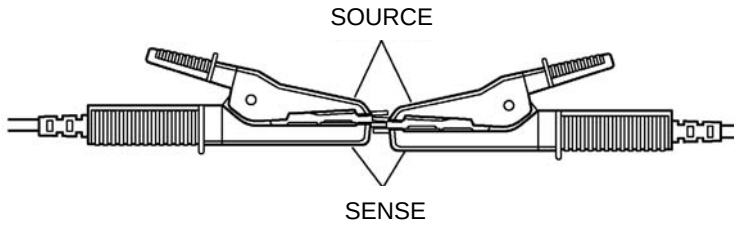
5. Remove the 9465 PIN TYPE LEAD from the zero adjust board, and press **0 ADJ** key.
6. During zero adjustment, "0Adj" is displayed in the resistance measurement display position.
7. When "0Adj" disappears and measurement starts, connect the leads to the battery to be tested.

NOTE

- Perform zero adjustment only with the supplied zero adjustment board, and make sure that the pin tip correctly makes contact with the SOURCE and SENSE rings, as shown in the illustration.
- Carry out the zero adjustment after moving the zero adjustment board away from the instrument about 10 cm or more.
- Do not put the zero adjustment board on the batteries or metals. The measured value may fluctuate as a result of electromagnetic induction. In this case, move the zero adjustment board away from the metal parts.
- If an attempt is made to perform zero adjustment by connecting the tips of the 9465 or by using another kind of metal plate other than the supplied zero adjustment board, correct results will not be obtained.
- If the terminal spacing of the battery to be measured is larger than the zero adjustment board, use the outermost holes for adjustment.
- The zero adjustment is valid for the currently selected range only, as long as the power remains on. Powering on the instrument 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.
- 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.

5.6.2 9460 Zero Adjustment

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.

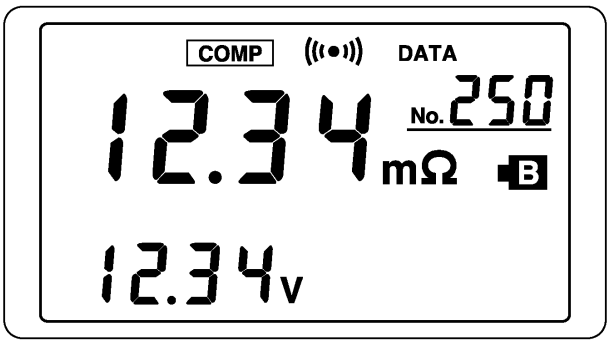
3. When "0Adj" disappears and measurement starts, connect the leads to the battery to be tested.

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 instrument 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.
- Even if the B mark will appear, do not connect the output plug of the AC adapter while powering on. Otherwise the instrument will be reset and the data stored in memory are cleared. Before connecting the AC adapter, turn off the power pressing the **POWER** key.

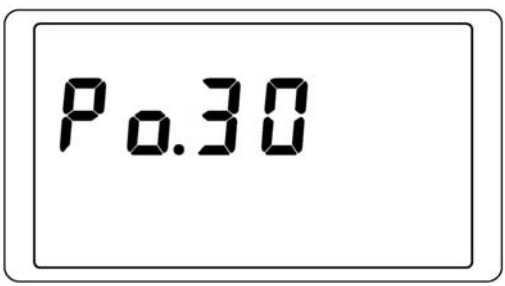
5.8 Auto Power Off

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

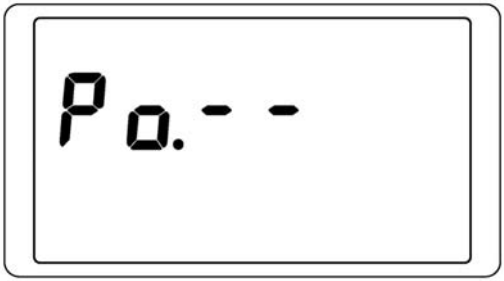
- When the resistance value is "----" indication.
- During hold
- On the comparator setting screen
- During the printing output
- During reading the memory data

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 instrument 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.

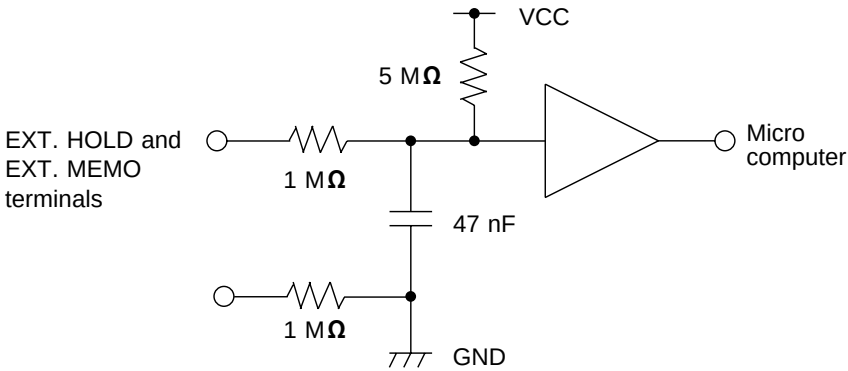


4. When the screen on the previous page appears, press the **POWER** key to turn off the power.
5. Press the **POWER** key again to turn the power on.
6. To set to the auto-power off, press the [HOLD] key in the auto power off setting screen and set the auto power off to 30 minutes.

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 instrument, and correct measurement will no longer be possible.
- After reset the data, the auto power off is set to 30 minutes.
- The set time of auto power off cannot be changed.
- If auto power off is disabled and the instrument is used for a long time, the batteries may become depleted and stored measurement data may be lost. When the ▪B indication appears on the display, replace the batteries as soon as possible.

5.9 Circuit Configuration between EXT.HOLD and EXT.MEMO



5.10 Reset

The steps described below will clear all measurement data and reset the instrument to the initial condition.

1. Remove the leads from the battery to be tested.
2. Remove all batteries from the 3551.
3. Press POWER key.
   After several seconds, the display becomes blank. The reset procedure is now completed.
4. Install all batteries. To replacing the batteries, see Section 4.1, "Preparing for Measurement".

Setting items and initialization

Measurement data: all clear

Auto-power off function: ON

Moving average function: same as previous settings before reset

Beeper setting: ON

Comparator setting: ON, same comparator number as settings before reset

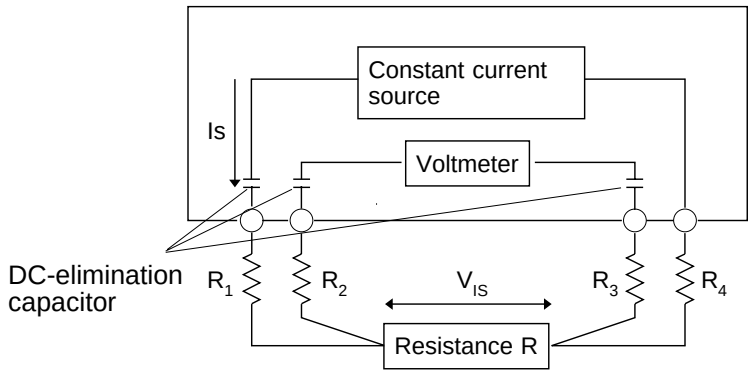
NOTE

- Reset will not clear comparator settings (measurement range, upper and lower limit etc.).
- If no comparator settings were made by the user, the factory default settings as shown below apply.

Resistance range: 3 mΩ
Voltage range: 30 V
Resistance value: upper limit 0.000, lower limit 0.000
Voltage value: 0.00 V

5.11 AC Four-Terminal Method

The 3551 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.

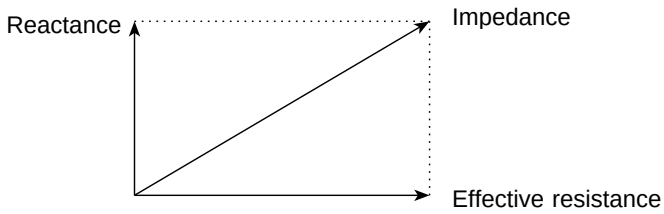
An AC current (Is) is supplied from the SOURCE terminals of the 3551 across the tested battery.

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.

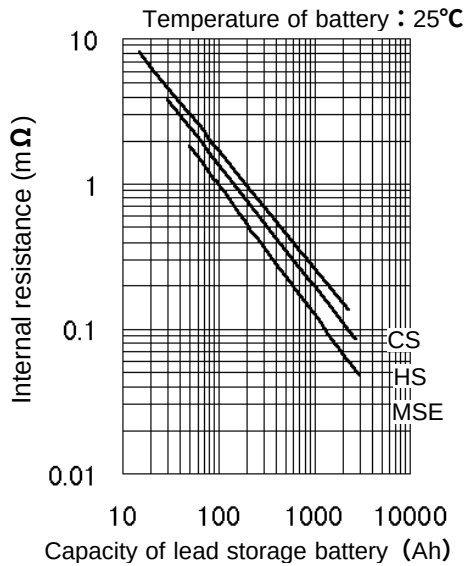
NOTE

In the 3551, a synchronized wave detection system is used, whereby the internal impedance is separated into effective resistance and reactance, and the resistive component only displayed.



5.12 Internal Resistance of Lead Storage Batteries

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



CS: Clad type stationary lead storage battery

HS: High rate discharge paste type stationary lead storage battery

MSE: Seal type stationary lead storage 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 storage 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.
	AC adapter is not correctly connected.	Connect the AC adapter correctly. See Section 4.1, "Preparing for Measurement."
	The capacitor for back-up is being charged.	Wait about for 15 seconds after connecting the battery or AC adapter. 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 Batteries."

Symptom	Cause	Follow-up
The temperature is not displayed when using the 9460.	The 9460 is not correctly connected.	Connect the 9460 correctly. See Section 4.2, "Measurement Batteries."
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."
Comparator result is not correct.	The comparator setting is not correct.	Set the comparator correctly. See Section 5.1, "Comparator 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 instrument if it is to be stored for a week or more.
- 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.

・Never modify the instrument. Only a Hioki service engineer can disassemble or repair the instrument. 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.
Po. --	The auto power off function is released.	See Section 5.8, "Auto Powe Off."
Po. 30	The auto power off function is set.	
A. OFF	Moving average function is released.	See Section 5.5, "Moving Average Function."
A. ON	Moving average function is set.	
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 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.
- 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 3551 BATTERY HiTESTER

Instruction Manual

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