HIOKI

3550 series BATTERY HiTESTER

Component Measuring Instruments

Model 3551 for high-capacity batteries completes line-up

Model 3550 for medium-capacity alkali and lead-acid storage batteries: UPS and similar applications
Model 3551 for high-capacity alkali and lead-acid storage batteries
Model 3555 for compact storage batteries: portable telephones and similar applications

Instantaneous Check on Battery Deterioration

[NOTE]
* The comparison threshold values depend on the battery manufacturer, type, and capacity, and these must be established by the user.

ISO 9001 ISO14001
JMI-0216 JQA-E-90091

In today's multimedia age, the maintenance of storage batteries used in information technology devices is taking on increased importance.

The 3550 series of BATTERY HiTESTERS can give instantaneous results on the state of a battery, on a three-rank scale of Pass, Warning, or Fail, using a composite decision based on the internal resistance and the voltage.

Choose from 3 models to suit your application: Model 3550 for testing medium-capacity alkali and lead-acid storage batteries, Model 3555 for compact storage batteries, and Model 3551 to reliably measure high-capacity alkali and lead-acid storage batteries.

3550, 3551 BATTERY HiTESTER

Conveniently check the battery in an Uninterruptible Power Supply (UPS) without shutting down

With repeated charging and discharging of a storage battery over a long interval, the battery performance gradually deteriorates, and the internal resistance increases until charging is no longer possible. Faults may also be caused by internal short-circuits, reducing the battery voltage, making the battery over-heat, or in the case of a short-circuit caused by corrosion, possibly even leading to a fire.

The 3550/3551 BATTERY HiTESTER takes on-the-spot measurements of the internal resistance and voltage of alkali and lead-acid batteries, principally for UPS and similar applications. It then determines the state of the battery immediately, without needing to shut off the battery.

3550 BATTERY HiTESTER

Model 3551: support for high-capacity batteries*

Generally speaking, the higher the capacity of a battery, the lower the internal resistance, and in the case of high-capacity batteries the check decision requires accurate measurement of an extremely small internal resistance of a few tens or hundreds of microohms. The 3551 has a resolution of $1\mu\Omega$, an order of magnitude finer than the 3550, and with the special-purpose 9465 PIN TYPE LEADS, provides decisions for high-capacity batteries.
*The term "high-capacity battery" is used here to mean one with a capacity of at least 500 Ah, and internal resistance not exceeding $0.5\mu\Omega$.

Simultaneous measurement of resistance, voltage, and temperature*

The operational life of a battery varies greatly, depending on the pattern of use (frequency of power failures, continuous operating time, and so forth) and also on the environmental conditions. It is therefore necessary to measure the internal resistance and voltage of the battery, and also the temperature of the battery or of the environment, in order to assess the state of the battery.
* Temperature measurement with the 3551 requires the optional 9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR.

Three-rank rating of battery state: Pass, Warning, or Fail

The Pass/Warning/Fail assessment of a battery's state is based on a six-way combination of comparisons* against upper and lower resistance limits and a voltage threshold. This result is then indicated by LEDs and a beeper.

[NOTE]
* The comparison threshold values depend on the battery manufacturer, type, and capacity, and these must be established by the user.

Voltage \ Resistance	Low	In range	High
Low	Warning (amber)	Warning (amber)	Fail (red)
High	Pass (green)	Warning (amber)	Fail (red)

Lower resistance limit ▼   ▼ Upper resistance limit

Voltage threshold value ►

The LED indicator colors are shown in parentheses.

Safely measure without shutting down the battery

For a UPS in a hospital or computing facility, where a break in the supply cannot be tolerated, battery maintenance must be carried out with the battery live. Models 3550 and 3551 are designed to be able to take measurements even while the battery is being charged.
* The tester includes circuitry to attenuate noise at frequencies other than the measurement frequency (1 kHz). If, however, noise is present at close to the measurement frequency, a stable reading may not be obtained.

Memory function and printed output

A UPS consists of a number of cells connected either in series or parallel, and data for each of these cells must be obtained rapidly, and recorded. The BATTERY HiTESTERs have a built-in internal memory function which retains the measurement values and the decision result: Model 3550 holds 260 sets of

3551 BATTERY HiTESTER

The increasing importance of battery testing

With the advancing information age, UPS applications will become important over a wide range of locations, from office buildings to hospitals and research institutions. Accordingly, battery maintenance is a field that can be expected to grow in importance. Also, in the development of practical electrically powered vehicles, the environment for lead-acid storage batteries is changing rapidly, and these changes indicate a great opportunity for Models 3550 and 3551 BATTERY HiTESTERS.
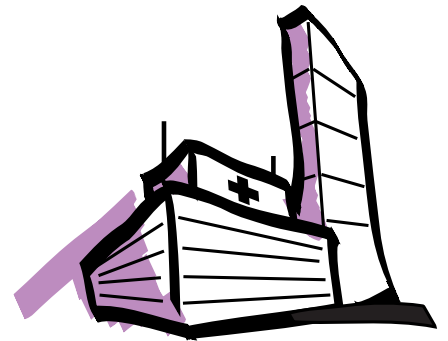
# What about conventional maintenance methods?

The traditional technique for checking the state of a backup battery is based on a measurement of the specific gravity of the electrolyte. But as sealed batteries have become the norm, this is no longer possible. The 3550 and 3551 take measurements from the battery terminals, and can therefore function with completely sealed batteries.
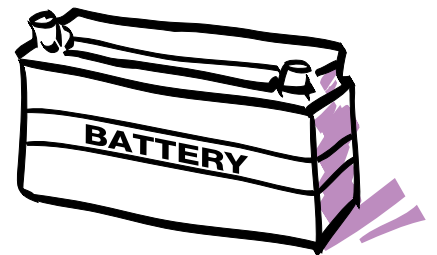
Relationship between charging time and charge capacity or internal resistance

The operational life of a battery depends on the frequency of use (number of charge/discharge cycles). The graph on the right illustrates the relationship between the time required for charging the battery and the charge capacity and internal resistance, and shows that as the charging time increases, the charge capacity decreases, while the internal resistance rises.

There are various methods for determining whether a battery has reached the end of its operational life, but the method based on measuring the internal resistance and
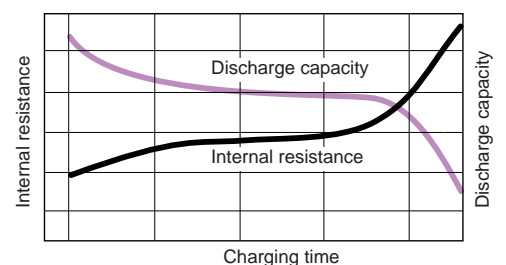
3555 BATTERY HiTESTER

On-the-spot testing of compact storage batteries used in mobile phones and similar handheld devices

With improvements in battery technology, the range of applications in portable devices is growing rapidly: not only mobile phones, but also video cameras, laptop computers, and other electronic devices. But the performance of these devices depends on the lifetime and performance of the batteries. Because of the wide variation in battery lifetime depending on the charging frequency and pattern of use, battery maintenance tools are indispensable.

The 3555 BATTERY HiTESTER provides a simple, on-the-spot assessment of the state of compact storage batteries, including nicad (Ni-Cd) and nickel metal hydride (Ni-MH) batteries.

3555 BATTERY HiTESTER

Simultaneously measure resistance and voltage

Model 3555 uses the same AC four-terminal method* as that used on Models 3550 and 3551 for testing lead-acid batteries to measure the internal resistance, and simultaneously measures the battery voltage, to give an immediate Pass/Warning/Fail result.

* The AC four-terminal method supplies an AC current from the source terminals to the battery being tested and measures the voltage drop with the sense terminals. This cancels out the contact resistance and lead resistance, and provides accurate measurement of low resistances. See also the enlarged illustration of the tip of the 9461 Pin-Type Leads.

Three-rank rating of battery state: Pass, Warning, or Fail

The Pass/Warning/Fail assessment of a battery's state is based on a six-way combination of comparisons against upper and lower resistance limits and a voltage threshold.* This result is then indicated by LEDs and a beeper.

* The comparison threshold values depend on the battery manufacturer, type, and capacity, and these must be established by the user.

Simple operation

Once the appropriate comparison values for the battery being tested have been entered or recalled from memory, measurement is as simple as touching the pin-type probes to the battery terminals. Since the tester is battery-operated, it can also be used anywhere.

Battery diagnosis

Once a compact storage battery, typically one used in a mobile phone, exceeds the manufacturer's guaranteed limit on charge-discharge cycles, its charging capacity gradually deteriorates, and the operating time on a single charge may become extremely short.
A simple test is therefore required to determine whether an apparently faulty device simply has a failing battery. In cases such as these, the 3555 BATTERY HiTESTER gives exactly the guidance needed to determine whether or not to replace the battery.

3550, 3551 BATTERY HiTESTER

Comparison of models in the 3550 series

	3550	3551	3555
Maximum resolution	10 μΩ (30 mΩ/300 mΩ/3 Ω ranges)	1 μΩ (3 mΩ/30 mΩ/300 mΩ ranges)	100 μΩ (3 mΩ/30 mΩ/300 mΩ ranges)
Battery types tested	Medium-capacity alkali and lead-acid	High-capacity alkali and lead-acid	Compact storage batteries
Test leads supplied as standard	9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR	9465 PIN TYPE LEADS Can be fitted with 9466 REMOTE CONTROL SWITCH for memory capture without letting go of the leads.	9461 PIN TYPE LEADS
Temperature measurement	-10 °C to 60 °C (resolution 0.1 °C) 14°F to 140°F (resolution 0.18°F)	(Measurement possible with 9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR)	—
Comparator values / memory capacity	10 sets / 260 sets of data (latest values retained)	99 sets / 250 sets of data (arbitrary values can be overwritten)	10 sets / —
Printed output	Measurement values and decision results from memory	Measurement values and decision results from memory	—
Moving average function	For stabilizing fluctuating readings	For stabilizing fluctuating readings	—
Power supply	Battery only	Battery or AC adapter	Battery only

Probes * Lengths are approximate, and are cable lengths only, excluding the probes.
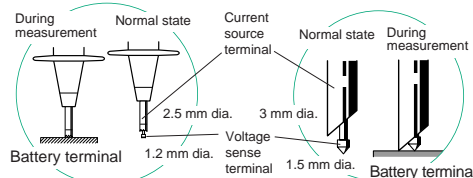
For 3550, 3551

9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR
(Cable length: connector to fork 1.7 m, fork to probes 25 cm; maximum clip diameter 15 mm)
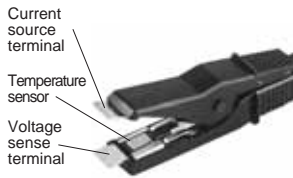
For 3550, 3551

9465 PIN TYPE LEADS and 9466 REMOTE CONTROL SWITCH
(Cable length: connector to fork 1.7 m, fork to probes 10 cm; coiled expanding section maximum 55 cm)
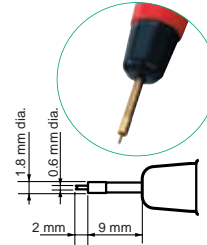
For 3555

9461 PIN TYPE LEADS
(Cable length: connector to fork 40 cm, fork to probes 25 cm)

For 3555

9770 PIN TYPE LEADS
(Cable length: connector to fork 40 cm, fork to probes 25 cm)

For 3555

9771 PIN TYPE LEADS
(Cable length: connector to fork 40 cm, fork to probes 25 cm)
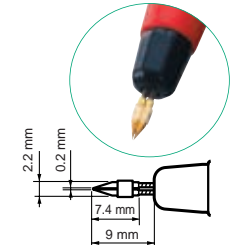
For 3550, 3551

9467 LARGE CLIP TYPE LEADS
(Cable length: connector to fork 85 cm, fork to probes 25 cm)

For 3555

9452 CLIP TYPE LEADS
Cable length : connector to fork 80 cm, fork to probes 20 cm)
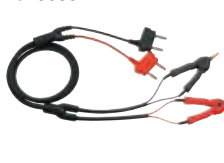
For 3555

9287-10 CLIP TYPE LEADS
(Cable length: connector to fork 80 cm, fork to probes 10 cm)

For 3555

9453 FOUR TERMINAL LEADS
Cable length : connector to fork 80 cm, fork to probes 20 cm)

9454 ZERO ADJUSTMENT BOARD
For zero-adjustment when 9461 or 9465 is used.

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3550, 3551 BATTERY HiTESTER and 9203 DIGITAL PRINTER

Print out field data back at the office

In addition to basic data and decision result printing, this printer can also produce statistics on the data, including maximum, minimum, mean, and standard deviation values, as well as histograms. Take advantage of this versatile tool for desk analysis and trend-spotting from data gathered in the field.
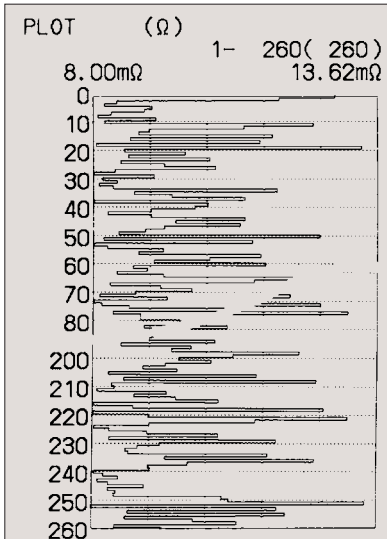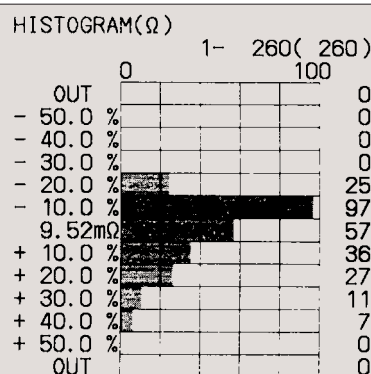
- Data memory function and printout function allow a single technician to perform efficiently a job which formerly required two individuals.
- Standard deviations, histograms, and other statistical results are computed automatically and printed.
- Data handling capacity: 99,999 values (maximum 5000 values for histogram and graph printing; maximum memory capacity of 3550 is 260 sets of data, and capacity of 3551 is 250 sets)
- Separate statistics, histograms, and graphs can be printed for each of the resistance, voltage, and temperature values held in memory.
- Graphical printing functions make trends in data clear at a glance.
- Thermal print head produces high speed output.

Examples of printing

```
START     '96- 4-17 18:29:51
[N]     Ω      V     °C    COMP
  1   12.77m   13.55   23.7  Fail
  2   11.68m   13.94   23.2  Warn
  3    8.47m   13.24   23.6  Pass
  4    8.22m   12.88   23.
  5    9.17m    9.72
  6    9.01m   13.       23.9  Pass
  7    8.3    3.23   13.89   23.2  Warn
258   10.87m   13.80   23.7  Warn
259    8.45m   13.43   23.9  Pass
260    9.36m   13.21   23.4  Pass
END       '96- 4-17 18:32:18

STATISTICS(Ω)
  N   =        260    (*   260)
  AVE =      9.522mΩ
  MIN =      8.00mΩ  (   252)
  MAX =     13.62mΩ  (   103)
  σn  =      1.359mΩ
  σn-1 =     1.362mΩ
  Cp  =      0.00
  CpK =      0.00
```

```
HISTOGRAM(Ω)
                    1-  260( 260)
           0              100
  OUT                           0
 - 50.0 %                       0
 - 40.0 %                       0
 - 30.0 %                       0
 - 20.0 %                      25
 - 10.0 %                      97
  9.52mΩ                       57
 + 10.0 %                      36
 + 20.0 %                      27
 + 30.0 %                      11
 + 40.0 %                       7
 + 50.0 %                       0
  OUT                           0
```

```
PLOT      (Ω)
                    1-  260( 260)
  8.00mΩ             13.62mΩ
   0
  10
  20
  30
  40
  50
  60
  70
  80
 200
 210
 220
 230
 240
 250
 260
```

■ Statistics

The following values are printed: total number of data values, number of valid data values, maximum, minimum, and maximum values and their measurement numbers, standard deviation, process capability index*, and bias.

■ Histogram

In the automatic mode, the minimum and maximum valid values are found, and their mean is taken as the center value. Then the optimum scaling is found to classify values into five ranks above and

■ Graph

The minimum and maximum valid values are taken as the full-scale values, then the values are plotted in chronological sequence. This shows trends over time in the measured values.

The 9203 DIGITAL PRINTER can also be used with other HIOKI instruments; the following restrictions apply when it is used with the 3550/3551.

*1 These settings are ignored.
*2 Computed values, histograms, and graphs are printed for each of the three measurements of resistance, voltage, and temperature.
*3 The process productivity index is not computed for the voltage and temperature measurement values.
*4 Histograms for the voltage and temperature measurements are always created in auto mode.

■ 9203 DIGITAL PRINTER specifications

[General]

Printer	: Thermal line printer
Lifetime	: At least 2 million lines
Recording paper	: 9233 RECORDING PAPER, 58 mm × 10 m (approx. equivalent 3000 lines)
Clock	: Prints either real time or elapsed time
Withstand voltage	: Casing - power supply 1.5 kV A (current sensitivity 20 mA)
Insulation resistance	: Casing - power supply at least 100 MΩ

Operating temperature and humidity	: 0 to 40 °C (73.4˚F±9˚F), 80% rh or less (no condensation)
Maximum rated power consumption	: 30 VA
Power supply	: 100 to 240 V AC (±10%, 250 V max.), 50/60 Hz
Dimensions and mass	: Approximately 215(8.5")W × 160(6.3")H ×54(2.1")D mm; 1 kg(33.8 oz)
Supplied	: One power cord, 3-pin to 2-pin power adapter, one roll 9233 RECORDING PAPER, one spare fuse (T4A/250V)

[Printing data]

Maximum number of printed values	: 1 to 99,999
Printing data [*1] **selection**	: ALL, IN, HL, VAL (valid values only), OFF
Decision result printing	: Hi, In, Lo, Pass, Warn, Fail, OF, NG
Printing interval [*1]	: MANU/AUTO
MANU setting	: printing when PRINT key pressed
AUTO setting	: 1/2/5/10/15/20/30 seconds, 1/2/5/10/15/20/30 minutes, 1 hour
Cancel function [*1]	: Most recent data can be deleted (up to 5000 values)

[External input/output terminals]

Input	: PRINT/STOP
Output	: TRIG/ERROR (open collector)
Interface	: Centronics 9203: 36-pin (D-sub) 3550/3551: 20-pin half-pitch (D-sub) * using 9425 CONNECTION CORD

[Statistics functions] [*2]

Data handling capacity	: 99,999 values
Values computed	: Number of data values, maximum, minimum, mean, standard deviation, process capacity index [*3] (variation and bias, given upper and lower values)

Computation expressions :

$$\text{Mean: } \bar{x} = \frac{\Sigma x}{n}$$

$$\text{Standard deviation: } \sigma_n = \sqrt{\frac{\Sigma x^2 - (\Sigma x)^2/n}{n}}$$

$$\sigma_{n-1} = \sqrt{\frac{\Sigma x^2 - (\Sigma x)^2/n}{n-1}}$$

Process capacity index :

$$\text{Variation: } C_p = \frac{|(\text{upper limit}) - (\text{lower limit})|}{6\sigma_{n-1}}$$

$$\text{Bias: } C_{PK} = \frac{|(\text{upper limit}) - (\text{lower limit})| - |(\text{upper limit}) + (\text{lower limit}) - 2\bar{x}|}{6}$$

[Histogram function] [*2]

Data handling capacity	: 5000 values (if more than 5000, most recent 5000 are used)
Operation mode	: MANU/AUTO [*4]
MANU setting	: Set center value (5-digit signed value, plus unit), and rank width 0.1/0.2/0.5/1/2/5/10/20% (±5 ranks) 0.1/0.2/0.5/1/2/5/10% (±10 ranks)
AUTO setting	: Center value and rank width set automatically

[Graph printing] [*2]

Data handling capacity	: Same as for histogram function
Operation mode	: AUTO only Measurement axis full-scale minimum to maximum values; time axis one value per line

■Specifications

[Specifications common to 3550, 3551, and 3555]

Measurements : Resistance (AC four-terminal method), temperature (platinum temperature sensor) Temperature measurement only on 3550 and 3551 (using 9460 leads)

A/D conversion : Double integration method

Indications : LCD panel and LED indicators (comparator results)

Panel display :
(all segments shown)

* The 3555 display does not include "DATA," "MEMO," and "°C."

Sampling rate : 0.83 times/second (3550/3551); 1.25 times/second (3555)

Beeper function : Audible alarm when comparator result is Warning or Fail (switchable on/off)

Input overflow : "OF" indication

Constant current fault detection : "----" indication

Open-circuit terminal voltage : 5 V maximum

Auto power off : Auto power off after 30 minutes

Comparator settings : Resistance upper and lower limits, and voltage lower limit

Number of comparator settings : Ten sets (3550/ 3555) or 99 sets (3551) of values held in memory

Comparator output : Pass (green), Warning (amber), and Fail (red) LEDs Audible output on Warning or Fail

Operating temperature and humidity : 0 to 40 °C (32°F to 104°F), 80% rh or less (no condensation)

Absolute maximum input voltage : 50 V DC maximum (3550/3555) / 60 V DC maximum (3551), No AC input

Withstand voltage : Between input terminals and output terminals (including EXT. MEMO. HOLD terminals): 1.35 kV AC rms, 1 minute (3550) 2.3 kV AC rms, 1 minute (3551) Between input terminals and casing: 350 V AC rms, 1 minute (3555)

Maximum rated power consumption : 1.8 VA (3550) / 2.4 VA (3551) / 1.0 VA (3555)

Continuous operating time : 7 hours (3550) / 5.5 hours (3551) / 18 hours (3555)

Power supply : LR6 (AA) / alkali batteries × 6; or 9418-10 AC adapter (option for 3551 only)

Approximate dimensions and mass : 196(7.7") W × 130(5.1") H × 50(2") D mm; 710 g(25 oz) including batteries (3550) 196(7.7") W × 130(5.1") H × 65(2.6") D mm; 860 g(30.3 oz) including batteries (3551) 196(7.7") W × 130(5.1") H × 50(2") D mm; 680 g(24 oz) including batteries (3555)

[Specifications for 3550/3551 only]

Data memory : Measurement values stored in memory by MEMO key or EXT. MEMO terminal short, or on-probe switch (for 3551) (resistance, voltage, temperature, and comparator results: 260 sets / 250 sets on 3551)

Data recall : Data recalled from memory for display on screen

Moving average function : For resistance values only (switchable on/off)

Printer interface : Centronics (can be connected to 9203 or a general-purpose printer)

[Measurement accuracy]

Conditions to guarantee accuracy : 23°C ± 5°C (73.4°F±9°F), 80% rh or less (no condensation), after zero adjustment and warming up at least 10 minutes

● Resistance measurement

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

Measurement current frequency : 1 kHz ± 30 Hz

Measurement current accuracy : ±10 %

3551: 3 mΩ/ 30 mΩ / 300 mΩ   ranges
3550:   30 mΩ / 300 mΩ / 3 Ω   ranges
3555:   300 mΩ / 3 Ω / 30 Ω   ranges

Range	Maximum indication *	Resolution	Measurement current	Accuracy
3 mΩ	3.100 mΩ	1 µΩ	50 mA	± 1.0%rdg. ± 8dgt.
30 mΩ	30.00 mΩ	10 µΩ	50 mA	± 0.8%rdg. ± 6dgt.
300 mΩ	300.0 mΩ	100 µΩ	5 mA	± 0.8%rdg. ± 6dgt.
3 Ω	3.000 Ω	1 mΩ	500 µA	± 0.8%rdg. ± 6dgt.
30 Ω	30.00 Ω	10 mΩ	50 µA	± 0.8%rdg. ± 6dgt.

* The 3551 only has a maximum display value of 3100 for all resistance and voltage ranges.

● Voltage measurement (common to 3550/3551/3555)

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

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

● Temperature measurement
(3550 and 3551[with 9460 leads] only)

Measurement range	Resolution	Accuracy
-10°C to 60°C (14°F to 140°F)	0.1°C (0.18°F)	± 0.5%rdg. ± 10dgt.

[Note]

Note the following points about the 3 mΩ range:
• The accuracy guarantee depends on no change in the measurement lead configuration after zero adjustment.
• If the lead configuration changes significantly after zero adjustment, or when using the 9460 leads, add ±15 dgt. to the figure in the table on the left for the 3 mΩ range.
• For the 3 mΩ range only, the temperature coefficient is (± 0.01% rdg. ± 0.8 dgt.) / °C

3550 BATTERY HiTESTER

(Includes the 9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR, 9382 CARRYING CASE, dust cover, 6 ✕ LR6 batteries)

3551 BATTERY HiTESTER

(Includes the 9465 PIN TYPE LEADS, 9466 REMOTE CONTROL SWITCH, 9377 CARRYING CASE, dust cover, 6 ✕ LR6 batteries)

3555 BATTERY HiTESTER

(Includes the 9461 PIN TYPE LEADS, 6 ✕ LR6 batteries)

● Options
9382 CARRYING CASE (for the 3550, 3555 / Included with Model 3550)
9287-10 CLIP TYPE LEADS (for the 3555)

9452 CLIP TYPE LEADS (for the 3555)
9453 FOUR TERMINAL LEADS (for the 3555)
9454 ZERO ADJUSTMENT BOARD (for the 9461, 9465 / Include 3551)
9455 PIN TYPE LEADS (for high-density use / for the 3555)
9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR (for the 3550, 3551/ Include 3550)
9465 PIN TYPE LEADS (for the 3550, 3551 / Include 3551)
9467 LARGE CLIP TYPE LEADS (for the 3550, 3551)
9770 PIN TYPE LEADS (for high-density use / for the 3555)
9771 PIN TYPE LEADS (for high-density use / for the 3555)
9418-10 AC ADAPTER (for the 3551)
[universal 100 to 240V AC, 50/60Hz/12V DC-2.5A output]
9203 DIGITAL PRINTER (for the 3550, 3551)
9425 CONNECTION CORD (for connecting the 3550, 3551 to the 9203 / 2 meters)
9233 RECORDING PAPER (for the 9203/10meters, 10rolls)

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