

3550 series BATTERY HiTESTER

Components Measuring Instruments



New 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.



ISO14001
JQA-E-90091

With the coming of the multimedia age, the maintenance of storage batteries used in information technology devices is taking on increased importance.

The 3550 series of BATTERY HiTESTERS are able to 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.

To the existing models 3550, for medium-capacity alkali and lead-acid storage batteries, and 3555, for compact storage batteries, a new model, the 3551, is now added to support high-capacity alkali and lead-acid storage batteries. These three models will now meet battery maintenance requirements across a wide range of applications.

3550, 3551 BATTERY HiTESTER

Checking 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 even in the case of a short-circuit caused by corrosion, 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.

		Lower resistance limit ▼		▼ Upper resistance limit
		Low	In range	High
Voltage threshold value ►	Low	Warning (amber)	Warning (amber)	Fail (red)
	High	Pass (green)	Warning (amber)	Fail (red)

The LED indicator colors are shown in parenthesis.

Measurement 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 testers have an internal memory function which retains the measurement values and the decision result: Model 3550 holds 260 sets of data, and Model 3551 holds 250 sets. These can be recalled on the tester itself, or can be printed together with statistics, using the 9203 DIGITAL PRINTER option.

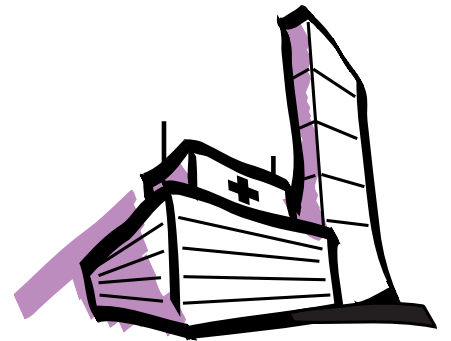
3550, 3551 BATTERY HiTESTER



3551 BATTERY HiTESTER

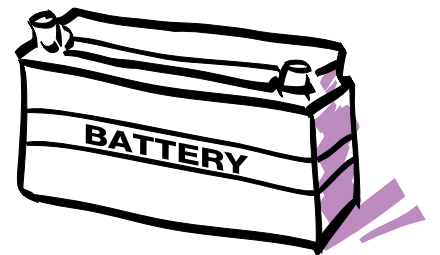
The increasing importance of battery testing

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 the Models 3550 and 3551 BATTERY HiTESTERS.



What about conventional maintenance methods?

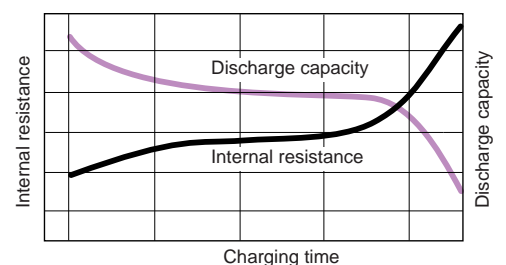
The conventional technique for checking the state of a backup battery is based on a measurement of the specific gravity of the electrolyte. But as sealed batteries have become the most common type, this is no longer possible. The 3550 and 3551 take measurements from the battery terminals, and can therefore 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, and also 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 voltage is fast and reliable.



3555 BATTERY HiTESTER

On-the-spot testing of compact storage batteries -- portable telephones and similar applications

With improvements in battery technology, the range of applications in portable devices is growing rapidly: not only portable telephones, but also video cameras, notebook 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, an increasing demand for battery maintenance tools can be expected.

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

Simultaneous measurement of resistance and voltage

This tester uses the same AC four-terminal method* as Models 3550 and 3551 use for 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 measured, 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 contacting the pin-type probes against 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 portable telephone, 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 instrument 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)

Options

9454 ZERO ADJUSTMENT BOARD

For zero-adjustment when 9461 or 9465 is used.



For 3550, 3551



9467 LARGE CLIP TYPE LEADS
(Cable length: connector to fork 85 cm, fork to probes 25 cm; maximum clip diameter 29 mm)

For 3555



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

For 3555

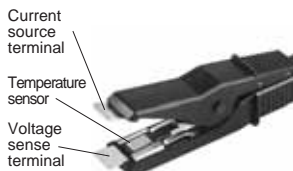


9287 CLIP TYPE LEADS
(Cable length: connector to fork 90 cm, fork to probes 10 cm)

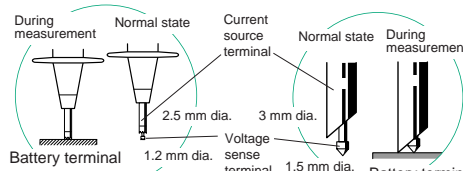
For 3555



9453 FOUR TERMINAL LEADS
Cable length : connector to fork 80 cm, fork to probes approx. 30 cm



9460 CLIP TYPE LEADS WITH TEMPERATURE SENSOR-- detail



9465 PIN TYPE LEADS -- detail

9461 PIN TYPE LEADS -- detail

3550, 3551 BATTERY HiTESTER and 9203 DIGITAL PRINTER

Printing 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, and also print histograms. You can use this versatile tool for desk analysis and trend-spotting in data gathered in the field.

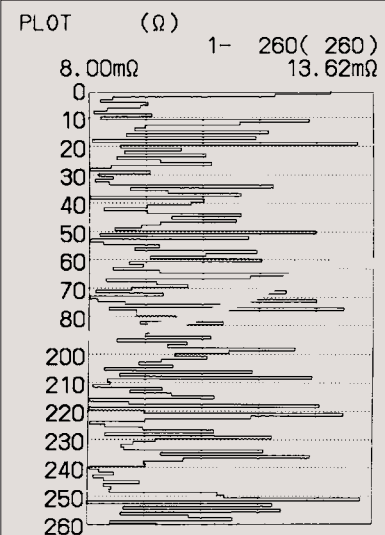
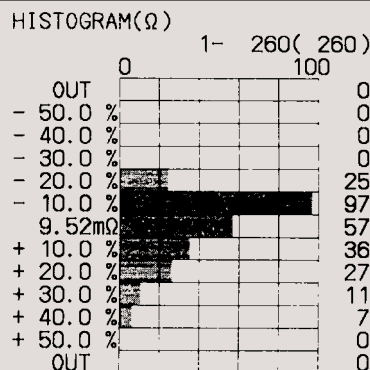


- Data memory function and printout function allow a single person to perform efficiently a job which formerly required two people.
- Standard deviations, histograms, and other statistical results are computed automatically and printed.
- Data handling capacity: 99,999 values (maximum 5000 values for 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.
- The 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 23.7
 5 9.17m 9.72
 6 9.01m 13.23 23.9 Pass
 7 8.35m 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
```



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.

* The process capability index is a numerical value representing degree to which a process reaches quality control targets.

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 five ranks below this center value.

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.

3550, 3551 BATTERY HiTESTER & 9203 DIGITAL PRINTER



The 9203 DIGITAL PRINTER can also be used with other models; 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 the 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 selection *1	: 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 :

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

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

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

Process capacity index :

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

$$\text{Bias: } C_{pk} = \frac{[(\text{upper limit}) - (\text{lower limit})] - [(\text{upper limit}) + (\text{lower limit}) - 2\bar{x}]}{6\sigma_{n-1}}$$

* Upper and lower values are those set on the 9203.

[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)

[Specification 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.

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 [Includes 9545], 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 / Include 3550)
9287 CLIP TYPE LEADS (for the 3555)

● 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

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)

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)