HIOKI

New

BATTERY IMPEDANCE METER BT4560

Component measuring instruments

Determine Li-ion battery reliability in just 10 seconds

Low-frequency AC-IR measurement without charging/discharging substantially reduces the time needed to inspect the internal resistance of battery cells.

Incomparable Speed
Exceptional Accuracy
Unsurpassed Stability

Fast — Low-frequency AC-IR measurement enables faster measurement

No need to charge/discharge

Traditionally, the internal resistance of battery cells is measured by pre-charging the battery, then passing large currents and measuring the voltage drop (DC-IR measurement).
Pre-charging the battery, however, usually takes several minutes to several tens of minutes.
The **BT4560** eliminates the need for charging or discharging by measuring the internal impedance at a low frequency of 1 Hz or below (**AC-IR measurement**), enabling significant reduction in the time required for measuring battery cells.

Difference in speed

Comparison of time taken to measure battery cell internal resistance

DC-IR measurement (conventional method)

Requires 20 to 30 minutes to around one hour, including charging/discharging

AC-IR measurement (using **BT4560**)

Requires around 10 seconds*

* When measuring at a frequency of 1 Hz

The BT4560 Battery Impedance Meter substantially reduces the time required for inspecting Li-ion battery cells by measuring at low frequencies, providing a fast and accurate measurement of the battery status.

Accurate, stable measurements

High reliability guaranteed through proven performance

Measure very low impedance

3 mΩ minimum range with high noise suppression

Accuracy: ±0.4% rdg. ±8 dgt.*
Minimum resolution: 0.1 μΩ

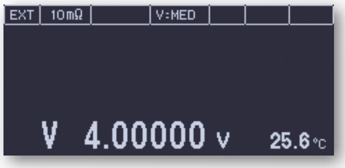
* When pure resistance is measured with measurement speed set to [SLOW]

Compared to the current used by traditional battery testers, 0.1A, the BT4560 uses a current 15 times stronger, 1.5 A, which improves the S/N ratio.
Enhanced noise suppression enables the device to provide reliable measurements for low-impedance batteries used for hybrid and plug-in hybrid vehicles.

Measure DC voltage with high accuracy

Voltage measurement accuracy comparable to high-end testers

Accuracy: ±0.0035% rdg. ±5 dgt.
Minimum resolution: 10 μV



The BT4560 can measure the voltage much more accurately than traditional resistance meters(±0.01% rdg. ±3 dgt.).
It guarantees highly accurate voltage measurement where greater accuracy than that of previous machines is required.

Circuit configuration highly tolerant of contact resistance

The circuit configuration in the BT4560 is not susceptible to contact and wire resistance, enabling stable measurement. Probe cables of up to 4 m are supported, improving the flexibility of cabling in production lines.

Measure without damaging batteries

The BT4560 employs AC-IR measurement with a small current load, enabling highly reliable measurement without damaging batteries.

Two types of dedicated probes for different purposes

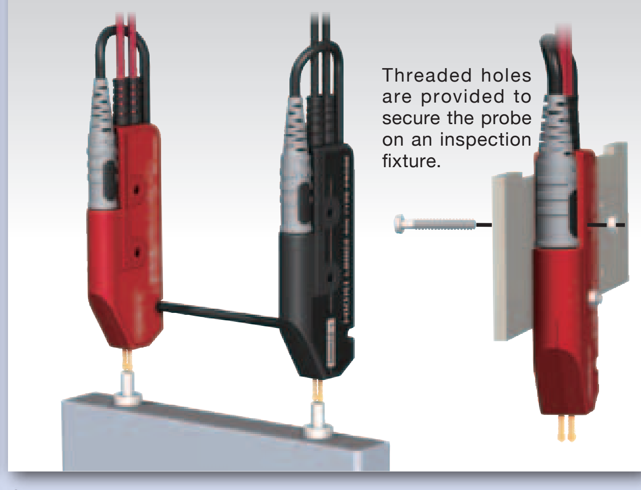
Dedicated probes with four-terminal structure enables stable measurement unaffected by environmental noise or cabling.

CLIP TYPE PROBE L2002

For measuring laminated sheet batteries

PIN TYPE PROBE L2003

For line-embedded applications and various other types of batteries



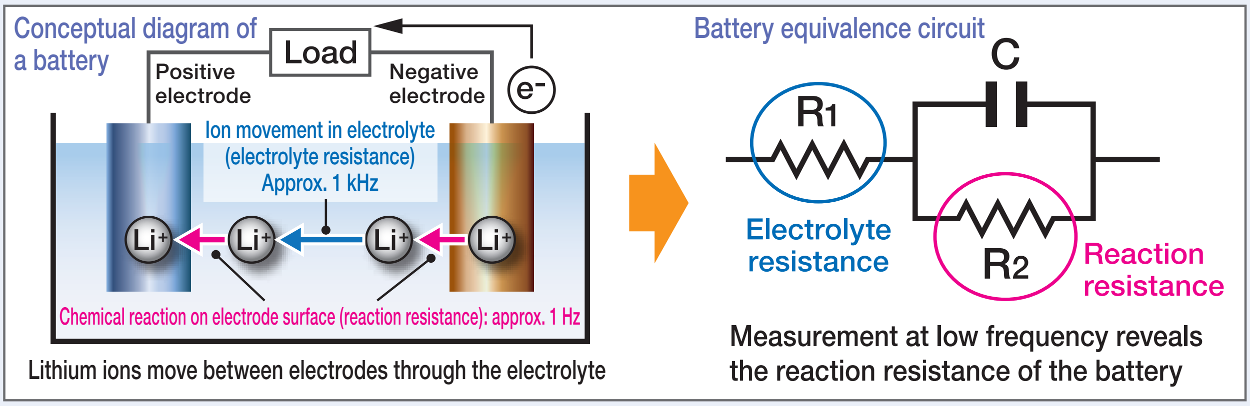
* Contact your local Hioki distributor for details of the probe tip shapes.

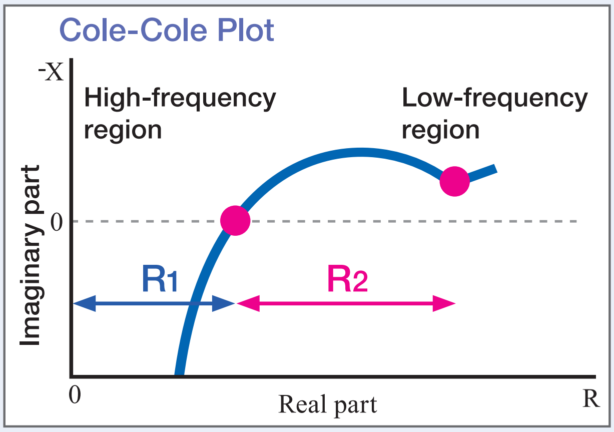
Technical Analysis

An alternative measurement method for inspecting charging/discharging output characteristics (DC-IR) [Low-frequency AC-IR measurement]

Information obtained by low-frequency measurement

Electrochemical characteristics of a battery and Cole-Cole plot



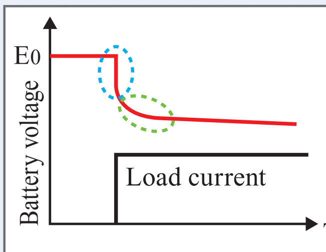


Two-point measurement at high and low frequencies

Traditional battery testers only record the electrolyte resistance of the battery by measuring it at a frequency of 1 kHz. Measurement at a low frequency of around 1 Hz, however, enables the tester to also observe the reaction resistance on the surface of the electrodes.
The **BT4560** assures the quality of battery cells by investigating both electrolyte resistance and reaction resistance with a two-point measurement at high and low frequencies. In this way, it helps to improve quality and extend the service life of lithium ion battery modules.

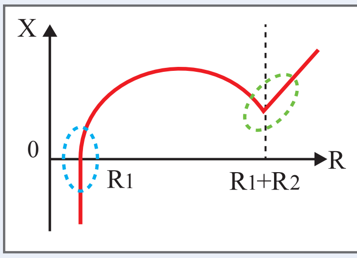
Correlation between DC-IR measurement and low-frequency AC-IR measurement

DC-IR measurement



Method whereby a DC load is put through the battery, and the resistance is calculated from the voltage variation that occurs.

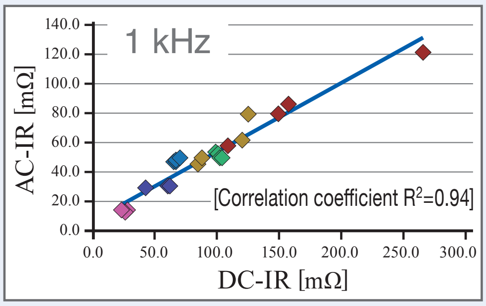
AC-IR measurement

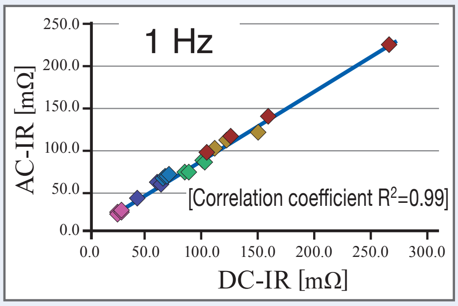


Method whereby an AC signal is applied to the battery to measure its impedance.

* Response derived from fast reactions   Response derived from slow reactions

When the correlation between DC-IR and AC-IR measurements is plotted using multiple Li-ion batteries ....





A **strong correlation** is found between the measured values of DC-IR and low-frequency AC-IR. ➡ Useful as an alternative to DC-IR testing

Characteristics and features of BT4560

All-in-one compact unit

The BT4560 requires no loading devices and provides measurements simply as a stand-alone unit, without having to establish a complicated measurement system.

Simultaneous measurement of impedance and voltage

Reduce tact time by simultaneously providing impedance measurement and highly accurate DC voltage measurement.

Self-calibration

Correct any offset voltage and gain drift that may be present in the circuit to improve the accuracy of voltage measurement.

Sample delay*

Specify a delay between AC voltage being applied and sampling being started so that measurement can start after the response stabilizes.

Prevent charging or discharging when AC voltage is applied*

To prevent the battery that is being measured from charging or discharging, the battery impedance meter terminates the applied measurement signal when zero is crossed.

Slope correction function*

If measurement signals drift due to the battery characteristics or the input impedance of measurement instrument, the tester applies correction to the linear drift.

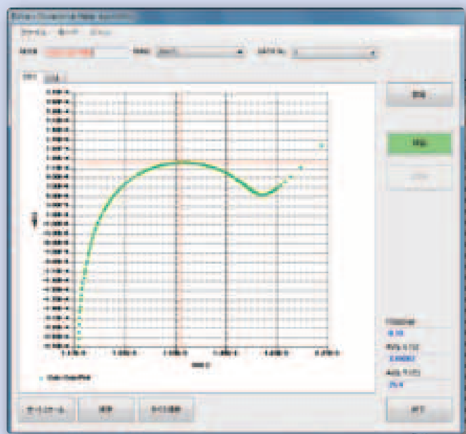
Temperature measurement

Reaction resistance measured at low frequency is sensitive to temperature.
An optional temperature sensor measures the temperature around the battery and associates the results with data, thereby improving the reliability of the measurements.

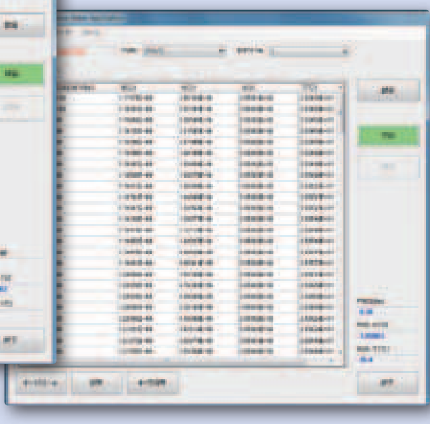
*Functions available during impedance measurement

Create Cole-Cole plots using bundled software

The BT4560 comes with a free PC application that can be used for measurement and drawing Cole-Cole plots. You can also select the desired measurement frequency or export the measured values in text format.



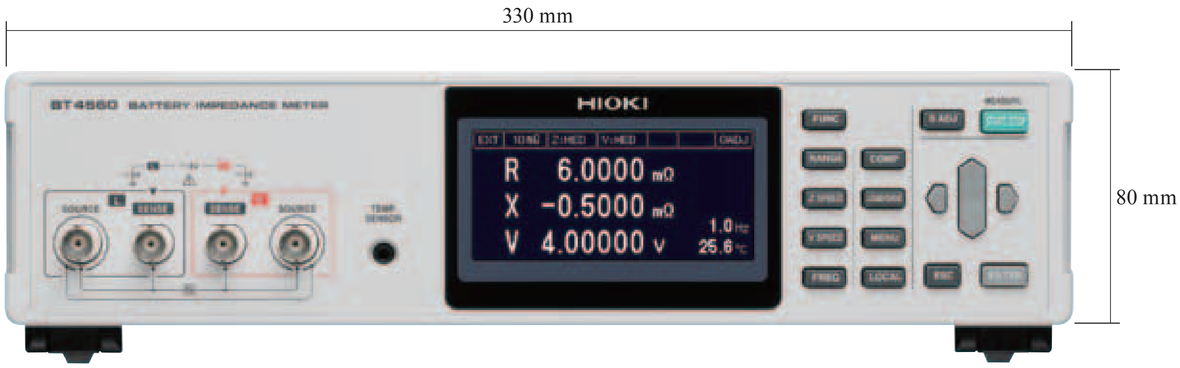
Cole-Cole plot drawing screen

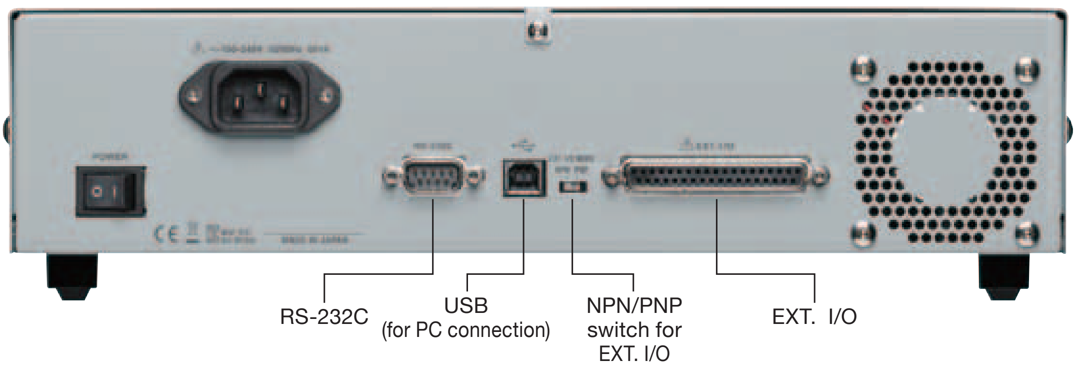


Cole-Cole plot data

Measurement screen

Embed in automated machines and production lines

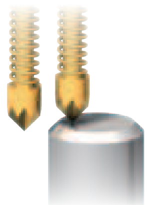




Functions suitable for automated machines

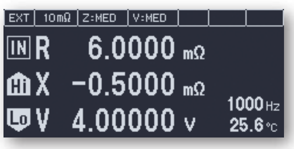
Contact check

Monitor the contact resistance of the probe before and after measurement so that the measurement will only start when the measuring electrode on the probe is in contact with the object to be measured.



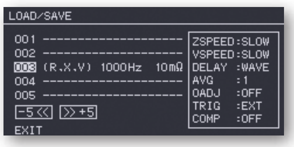
Comparator

- Simultaneously measure impedance and voltage
- Output overall determination results
- Use the two-tone buzzer to indicate determination results



Panel saving and loading

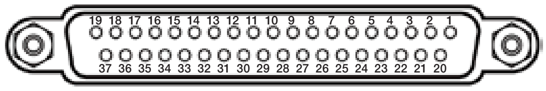
Store up to 126 sets of measurement conditions in internal memory so that they can be called through EXT. I/O for future measurements.



NPN/PNP switch

Switch the input/output circuits for EXT. I/O according to the type of output: current sink output (NPN) or current source output (PNP).

External control input/output terminal (EXT. I/O)



Pin	Signal name	I/O	Functionality
1	START (TRIG)	IN	Starts measurement (external trigger)
2	0 ADJ_ALL	IN	All-zero adjustment
3	STOP	IN	Stops measurement
4	LOAD 1	IN	Load number bit 1
5	LOAD 3	IN	Load number bit 3
6	LOAD 5	IN	Load number bit 5
7	Not used	–	–
8	ISO_5V	–	Isolated power supply +5 V (-5 V) output
9	ISO_COM	–	Isolated power supply common
10	ERR	OUT	Measurement error
11	RorZ_HI	OUT	Resistance determination result is Hi, impedance determination result is Hi
12	RorZ_LO	OUT	Resistance determination result is Lo, impedance determination result is Lo
13	V_IN	OUT	Voltage determination result is IN
14	Xorθ_HI	OUT	Reactance determination result is Hi, phase angle determination result is Hi
15	Xorθ_LO	OUT	Reactance determination result is Lo, phase angle determination result is Lo
16	Not used	–	–
17	Not used	–	–
18	PASS	OUT	The determination result passed
19	Not used	-	–
20	0 ADJ_SPOT	IN	Spot zero adjustment
21	CAL	IN	Self-calibration
22	LOAD 0	IN	Load number bit 0
23	LOAD 2	IN	Load number bit 2
24	LOAD 4	IN	Load number bit 4
25	LOAD 6	IN	Load number bit 6
26	Not used	–	–
27	ISO_COM	–	Isolated power supply common
28	EOM	OUT	End of measurement
29	INDEX	OUT	Measurement reference signal
30	RorZ_IN	OUT	Resistance determination result is IN, impedance determination result is IN
31	V_HI	OUT	Voltage determination result is Hi
32	V_LO	OUT	Voltage determination result is Lo
33	Xorθ_IN	OUT	Reactance determination result is IN, phase angle determination result is IN
34	Not used	–	–
35	Not used	–	–
36	Not used	–	–
37	FAIL	OUT	The determination result failed

Accuracy specifications

Impedance measurement accuracy

○ 3 mΩ range (0.1 Hz to 100 Hz), 10 mΩ range, 100 mΩ range

R accuracy $= \pm (0.004\,|R| + 0.0017\,|X|)\ [\mathrm{m\Omega}] \pm \alpha$

X accuracy $= \pm (0.004\,|X| + 0.0017\,|R|)\ [\mathrm{m\Omega}] \pm \alpha$

(The units of R and X are [mΩ]. α is as shown in the table below.)

Z accuracy $= \pm\ 0.4\%$ rdg. $\pm\ \alpha\ (|\sin\theta| + |\cos\theta|)$

θ accuracy $= \pm\ 0.1° \pm 57.3\frac{\alpha}{Z}\ (|\sin\theta| + |\cos\theta|)$

(α is as shown in the table below.)

○ 3 mΩ range (110 Hz to 1050 Hz)

R accuracy $= \pm (0.004\,|R| + 0.0052\,|X|)\ [\mathrm{m\Omega}] \pm \alpha$

X accuracy $= \pm (0.004\,|X| + 0.0052\,|R|)\ [\mathrm{m\Omega}] \pm \alpha$

(The units of R and X are [mΩ]. α is as shown in the table below.)

Z accuracy $= \pm\ 0.4\%$ rdg. $\pm\ \alpha\ (|\sin\theta| + |\cos\theta|)$

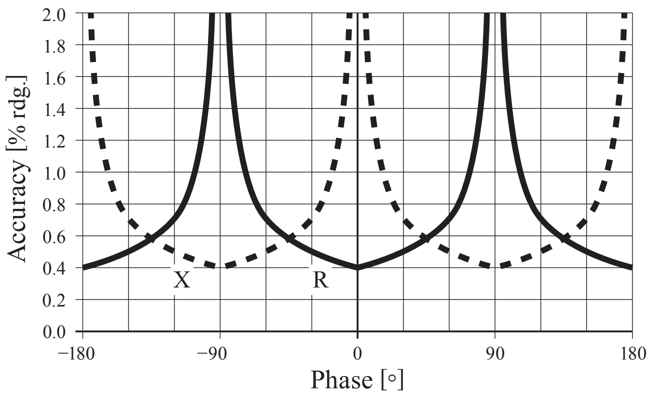
θ accuracy $= \pm\ 0.3° \pm 57.3\frac{\alpha}{Z}\ (|\sin\theta| + |\cos\theta|)$

(α is as shown in the table below.)

		3 mΩ range	10 mΩ range	100 mΩ range
α	FAST	25 dgt.	60 dgt.	60 dgt.
	MED	15 dgt.	30 dgt.	30 dgt.
	SLOW	8 dgt.	15 dgt.	15 dgt.
Temperature coefficient		R: ± R accuracy × 0.1 / °C, X: ± X accuracy × 0.1 / °C, Z: ± Z accuracy × 0.1 / °C, θ: ± θ accuracy × 0.1 / °C, (Applied in the ranges of 0 °C to 18°C and 28°C to 40 °C)		

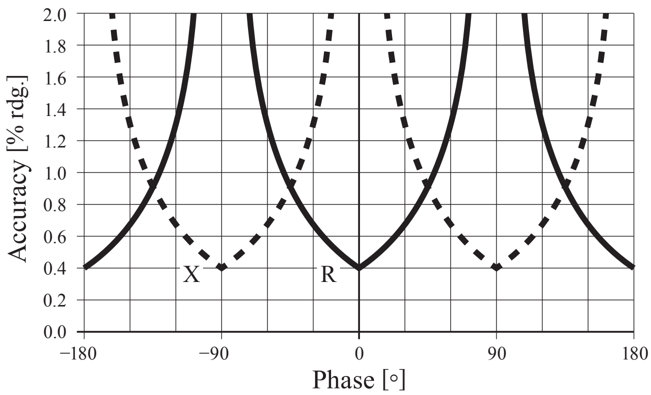
Accuracy graph

■ 3 mΩ range (0.1 Hz to 100 Hz), 10 mΩ range, 100 mΩ range



Impedance accuracy excluding α (0.004|R|+0.0017|X|, 0.004|X|+0.0017|R|)

■ 3 mΩ range (110 Hz to 1050 Hz)



Impedance accuracy excluding α (0.004|R|+0.0052|X|, 0.004|X|+0.0052|R|)

Voltage measurement accuracy (when self-calibration is performed)

V	Display range	−5.10000 V to 5.10000 V
	Resolution	10 µV
Voltage accuracy	FAST	±0.0035% rdg. ±5 dgt.
	MED	±0.0035% rdg. ±5 dgt.
	SLOW	±0.0035% rdg. ±5 dgt.
Temperature coefficient	±0.0005% rdg. ±1 dgt. /°C (applied in the ranges of 0°C to 18°C and 28°C to 40°C)	

Temperature measurement accuracy v

Accuracy	±0.5°C (measurement temperature: 10.0°C to 40.0°C) ±1.0°C (measurement temperature: -10.0°C to 9.9°C, 40.1°C to 60.0°C)
Temperature coefficient	Temperature coefficient: ±0.01°C/°C (applied in the ranges of 0°C to 18°C and 28°C to 40°C)

BT4560 specifications (Guaranteed accuracy period: 1 year)

Measured signals	Impedance, voltage, temperature

Impedance measurement

Measurement parameters	R resistance, X reactance, Z impedance, θ phase angle
Measurement frequency	0.1 Hz to 1050 Hz
Frequency setting resolution	0.10 Hz to 0.99 Hz in 0.01-Hz increments 1.0 Hz to 9.9 Hz in 0.1-Hz increments 10 Hz to 99 Hz in 1-Hz increments 100 Hz to 1050 Hz in 10-Hz increments
Measurement ranges	3.0000 mΩ, 10.0000 mΩ, 100.000 mΩ

Measurement current/DC load (DC load: offset current applied to measured object during impedance measurement)

	3 mΩ range	10 mΩ range	100 mΩ range
Measurement current	1.5 Arms ±10%	500 mArms ±10%	50 mArms ±10%
DC load current	1 mA or less	0.35 mA or less	0.035 mA or less

Measurement wave number

	FAST	MED	SLOW
0.10 Hz to 66 Hz	1 wave	2 waves	8 waves
67 Hz to 250 Hz	2 waves	8 waves	32 waves
260 Hz to 1050 Hz	8 waves	32 waves	128 waves

Voltage measurement

Measurement range	5.00000 V (single range)
Resolution	10 μV
Measurement time	FAST : 0.1 s MED : 0.4 s SLOW : 1.0 s * When self-calibration is performed, 0.21 s is added to the measurement time.

Temperature measurement

Display range	-10.0 °C to 60.0 °C
Resolution	0.1 °C
Measurement time	2.3 s

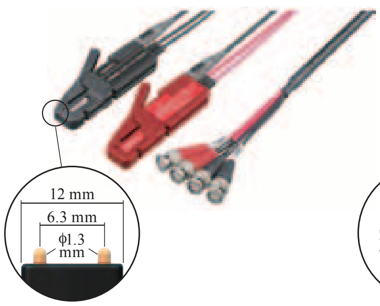
Measurement functions	(R,X,V,T)/(Z,θ,V,T)/(R,X,T)/(Z,θ,T)/(V,T)
Function	Comparator, self-calibration, sample delay, average, voltage limit, potential gradient compensation for impedance measurement, charge/discharge prevention during AC signal application, key lock, system test, panel saving and loading (up t o 126 condition sets)
Measurement error detection	Contact check, measurement current error, voltage drift on measured object, overvoltage input, voltage limit
Interface	RS-232C/USB (virtual COM port) * Cannot be used simultaneously Transmission speed: 9,600 bps/19,200 bps/38,400 bps
EXT. I/O	TRIG, LOAD, Hi, IN, Lo, and others (NPN/PNP can be switched)
Allowable input voltage	Up to 5 V
Operating temperature and humidity range	0 °C to 40 °C, 80% rh or less (no condensation)
Storage temperature and humidity range	-10 °C to 50 °C, 80% rh or less (no condensation)
Operating environment	Indoor, pollution degree 2, altitude up to 2,000 m
Power supplies	Rated supply voltage: 100 to 240 VAC Rated supply frequency: 50/60 Hz
Rated power	80 VA
Dielectric strength	1.62 kVAC, 1 min, cutoff current 10 mA (Between power supply terminal lump and protective ground)
Applicable standards	Safety: EN61010 EMC: EN61326, EN61000-3-2, EN61000-3-3
Dimensions and mass	Approx. 330W × 80H × 293D mm (12.99W × 3.15H × 11.54D in), Approx. 3.7 kg (130.5 oz)
Accessories	Power cord ×1, instruction manual ×1, zero-adjustment board ×1, USB cable (A-B type) ×1, CD-R (communication instruction manual, PC application software, USB driver) ×1

Instrument

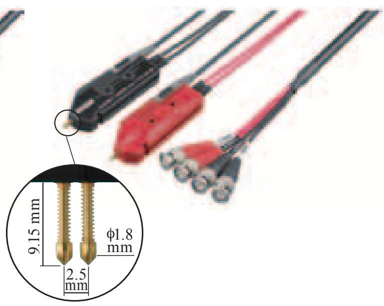
BATTERY IMPEDANCE METER BT4560

Standard accessories ········· Power cord, Instruction manual,
Zero-adjustment board, USB cable, CD-R

Options

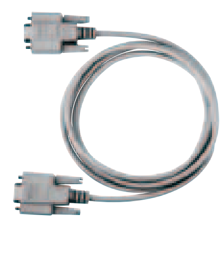


CLIP TYPE PROBE L2002
Cable length : 1.5 m



PIN TYPE PROBE L2003
Cable length : 1.5 m

TEMPERATURE SENSOR Z2005
Cable length : 1 m



RS-232C CABLE 9637
Cable length : 1.8 m

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