Industry: Material, chemical, pharmaceutical, battery material

Application: Evaluation of material characteristics and properties, R&D, experimentation

Measuring volume resistivity and surface resistivity of conductive materials using the 4-point probe method

The 4-point probe method can be used to measure volume resistivity, surface resistivity, and conductivity.

The "4-point probe method," is a method in which measurement is made in the "Kelvin 4-wire method" (1 each of source send/receive probes and 2 sense probes), using a 4-point array probe (which has a very precise pin pitch and placement).

With this specific probing, RCF calculation (Resistivity Correction Factor) is used to calculate volume resistivity and surface resistivity (sheet resistance), and conductivity. This 4-point probe resistivity measurement is made possible by Hioki's Resistance Meter RM3545, 4-point array probe, and PC application software.

Highlights

・ Hioki provides 4-point array probes in two variants with probe spacing of 5.0 mm and 1.5 mm. Both can be used in the normal measurement mode.[1]

・ Hioki provides two types of PC application software: for cuboid DUTs and for disk-shaped/solid-cylindrical DUTs.

・ Measurement parameters include volume resistivity ($\Omega \cdot$ m), surface resistivity (Ω/sq), conductivity (S/cm), and resistance (Ω).

・ The application software displays the values calculated based on the user-input DUT dimensions and measurement position coordinates.

・ The application software provides convenient functions of a probing position guide, a measurement history, and outputting measurement results as a CSV file.

・ Low resistance values are measured with basic accuracy of 0.006% and a maximum resolution of 0.01 μΩ (as per the RM3545's specifications), allowing for volume resistivity to be calculated with a high degree of precision.

[1]
When using the JIS K 7194-compliant measurement mode, the probes that can be used are limited to those with a pin spacing of 5.0 mm.
JIS K 7194-1994 "Testing method for resistivity of conductive plastics with a 4-point probe array" is a Japanese industrial standard established by the Japanese Standards Association Group and specifies that the distance between adjacent probe pins should be 5.0 mm.

System components

PC software that come with the probes
(for cuboid DUTs or disk-shapes/solid cylindrical DUTs)

OS: Windows 10 Pro
*Users are responsible for providing a PC

USB connection

Four-point array probe
Model: RM9010-01/RM9010-02

Resistance Meter RM3545
(RM3545, RM3545-01, RM3545-02)

Model: RM9010-01
Four-point array probe with 5.0 mm
spacing between adjacent probe pins

Model: RM9010-02
Four-point array probe with 1.5 mm
spacing between adjacent probe pins
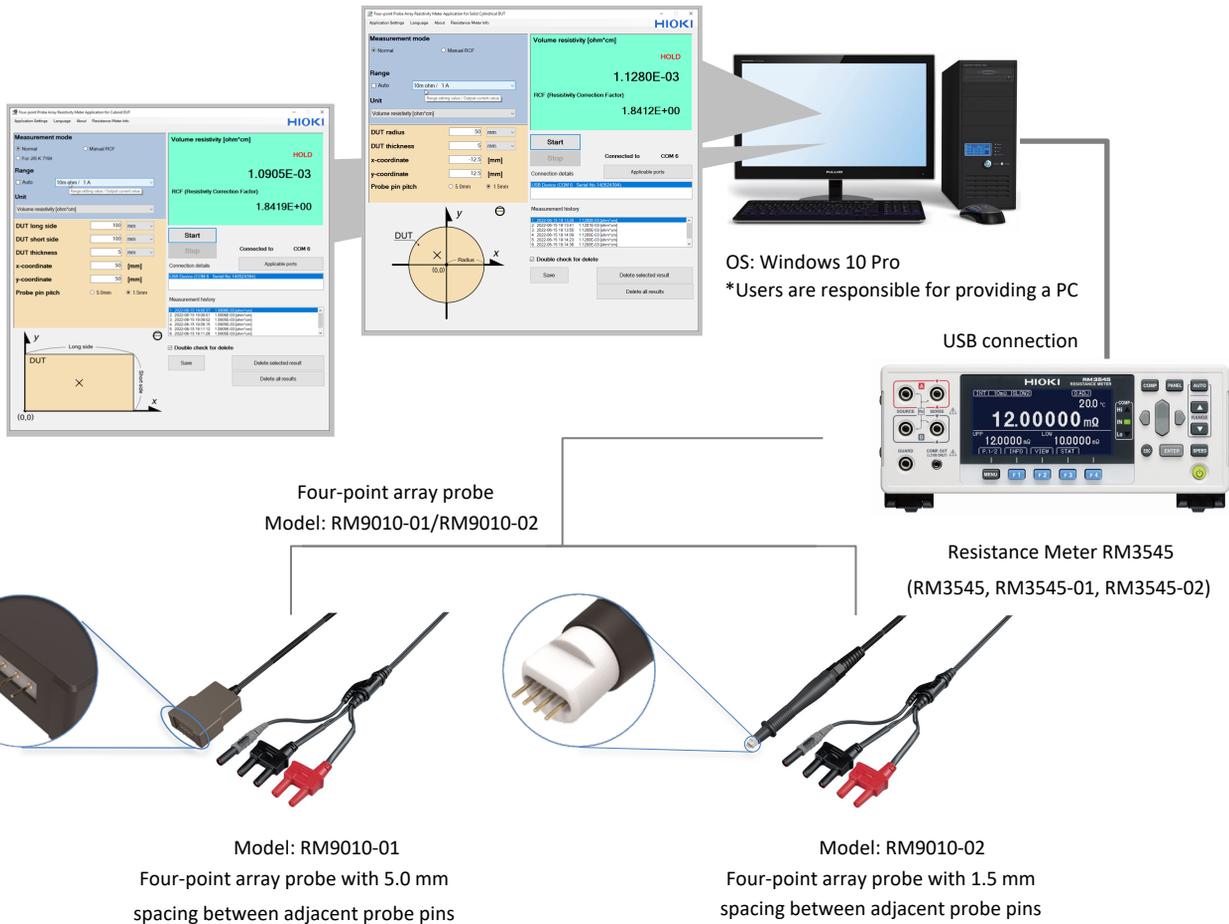
Measurement run-time/environment:
.NET Framework 4.6.1 or one of the versions compatible with. NET Framework 4.6.1
Note: Download and install. NET Framework from Microsoft's support website.

4-point Array Probe Resistivity Meter Application Software

Recommended operating environment:

Supported Operating system	Windows 10 Pro (32 or 64 bits)
CPU	Intel(R) Core(TM) i7, 2.4 GHz, 4 threads or better
Memory	8 GB or more (4 GB or more of available RAM)
Display	1050 × 1050 pixels or more, 32768 colors or more
Hard disk	Free capacity 2 GB or more
Communication interface	USB 2.0 (virtual COM port)
Run-time execution environment	.NET Framework 4.6.1 or one of the versions compatible with .NET Framework 4.6.1 Note: Download and install .NET Framework from Microsoft's support website.

Measurement conditions for cuboid DUT applications (measurement mode: Normal)
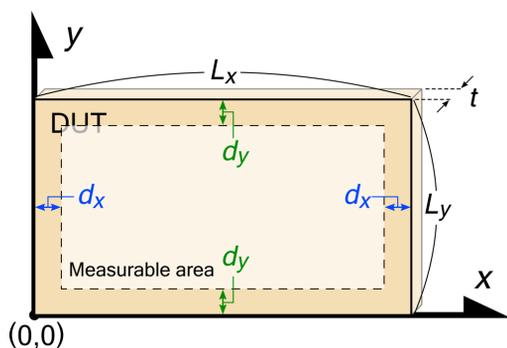
Probe Head Orientation

Place the probe head on the sample so that the four tips are aligned on a straight line parallel to the x-axis.

The measurable area is calculated/shown with the contact point as the center of the probe head.

L_x	:	18 mm — 2000 mm
L_y	:	2.0 mm — L_x
t	:	10^{-9} mm — 30 mm
d_x	:	8.5 mm — more
d_y	:	1.0 mm — more

Model RM9010-01: 4-point array probe with 5.0 mm spacing pins

L_x	:	6.0 mm — 2000 mm
L_y	:	1.5 mm — L_x
t	:	10^{-9} mm — 30 mm
d_x	:	3.0 mm — more
d_y	:	0.75 mm — more

Model RM9010-02: 4-point array probe with 1.5 mm spacing pins

Set the DUT dimensions and probe conditions. The values for the probe settings can accept 5 significant digits and up to 2 decimal places.

1. DUT length
Enter the DUT length of the long side.
Settable range
RM9010-01: 18 mm to 2000 mm
RM9010-02: 6.0 mm to 2000 mm

2. DUT width
Enter the DUT width of the short side.
Settable range
RM9010-01: 2.0 mm to the length above
RM9010-02: 1.5 mm to the length above
3. DUT thickness
Enter the DUT thickness.
Settable range
RM9010-01: 10^{-9} mm to 30 mm
RM9010-02: 10^{-9} mm to 30 mm
4. X-coordinate
Enter the x-coordinate of the probing position. Enter the center coordinate of the probing head.
Settable range
RM9010-01: Enter a coordinate within the DUT and 8.5 mm or more inward from its short side.
RM9010-02: Enter a coordinate within the DUT and 3.0 mm or more inward from its short side.
5. Y-coordinate
Enter the y-coordinate of the probing position. Enter the center coordinate of the probing head.
Settable range
RM9010-01: Enter a coordinate within the DUT and 1.0 mm or more inward from its long side.
RM9010-02: Enter a coordinate within the DUT and 0.75 mm or more inward from its long side.

Measurement conditions for disk-shaped/solid cylindrical DUTs (measurement mode: Normal)
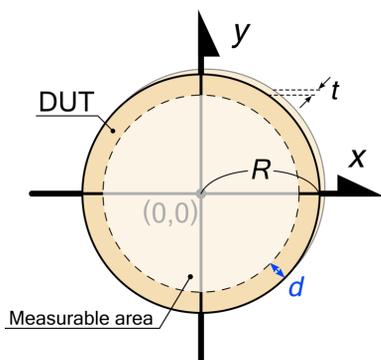
Probe Head Orientation
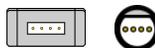
Place the probe head on the sample so that the four pins are aligned on a straight line parallel to the x-axis.

The measurable area is calculated/shown with the measurement point as the center of the probe head.

R	: 8.5 mm – 500 mm	R	: 3.0 mm – 500 mm
t	: 10^{-9} mm – 30 mm	t	: 10^{-9} mm – 30 mm
d	: 8.0 mm – more	d	: 3.0 mm – more

Model RM9010-01: 4-point array probe with 5.0 mm spacing pins	Model RM9010-02: 4-point array probe with 1.5 mm spacing pins

Set the DUT dimensions and probe conditions. The values for the probe settings can accept 5 significant digits and up to 2 decimal places.

1. DUT radius
Enter the DUT radius.
Settable range
RM9010-01: 8.5 mm to 500 mm
RM9010-02: 3.0 mm to 500 mm

2. DUT thickness
Enter the DUT thickness.
Settable range
RM9010-01: 10^{-9} mm to 30 mm
RM9010-02: 10^{-9} mm to 30 mm
3. (X-y) coordinates
Enter the (x-y) coordinates of the probing position. Enter the center coordinate of the probing head.
Settable range
RM9010-01: Enter (x-y) coordinates of 8.0 mm or more inward from the edge of the DUT.
RM9010-02: Enter (x-y) coordinates of 3.0 mm or more inward from the edge of the DUT.

Settable resistance range and applied current with the application software

10 MΩ, 1 µA	1000 kΩ, 10 µA	100 kΩ, 100 µA	10 kΩ, 1 mA	1000 Ω, 1 mA
100 Ω, 1 mA	10 Ω, 1 mA	1000 mΩ, 10 mA	100 mΩ, 100 mA	10 mΩ, 1 A

Four-point Array Probe model RM9010-01/RM9010-02

Model RM9010-01: Specifications

Probe material	Base material: Beryllium copper Plating: Gold (nickel undercoating)
Probe diameter	Approx. 0.77 mm
Probe pin tip shape	Spherical
Probe array	Collinear
Spacing between adjacent pins	5.0 mm ±0.1 mm (with every pin thrust against an object)
Insulation resistance between adjacent probes	10 GΩ or more for an applied voltage of 25 V at an ambient temperature of 23°C (73.4°F) and relative humidity of 35% RH
Pin spring force (per spring)	1.25 N ±0.25 N (with every pin thrust against an object)
Maximum rated terminal-to ground voltage	30 V AC RMS or less, 42.4 V AC peak or less, 60 V DC or less
Rated current	3 A AC/DC continuous
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Operating environment	Indoors, pollution degree 2, operating altitude: Up to 2000 m (6562 ft)
Length	About 1500 mm (59.06 in.)
Weight	About 200 g (7.1 oz.)

Model RM9010-01: Outline drawing

Unit: mm
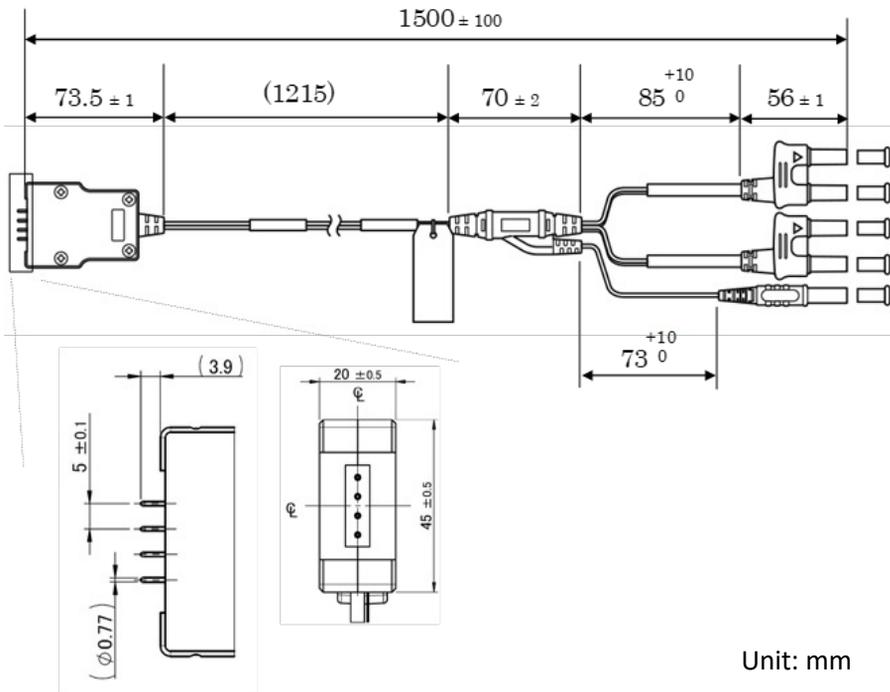
Model RM9010-02: Specifications

Probe material	Base material: Beryllium copper Plating: Gold (nickel undercoating)
Probe diameter	Approx. 0.5 mm
Probe pin tip shape	Spherical
Probe array	Collinear
Spacing between adjacent pins	1.5 mm ±0.1 mm (with every pin thrust against an object)
Insulation resistance between adjacent probes	10 GΩ or more for an applied voltage of 25 V at an ambient temperature of 23°C (73.4°F) and relative humidity of 35% RH
Pin spring force (per spring)	About 0.85 N (with every pin thrust against an object)
Maximum rated terminal-to ground voltage	30 V AC RMS or less, 42.4 V AC peak or less, 60 V DC or less
Rated current	1.5 A AC/DC continuous
Operating temperature and humidity range	0°C to 40°C (32°F to 104°F), 80% RH or less (non-condensing)
Storage temperature and humidity range	-10°C to 50°C (14°F to 122°F), 80% RH or less (non-condensing)
Operating environment	Indoors, pollution degree 2, operating altitude: Up to 2000 m (6562 ft)
Length	About 1500 mm (59.06 in.)
Weight	About 150 g (5.3 oz.)

Model RM9010-02: outline drawing

Unit: mm
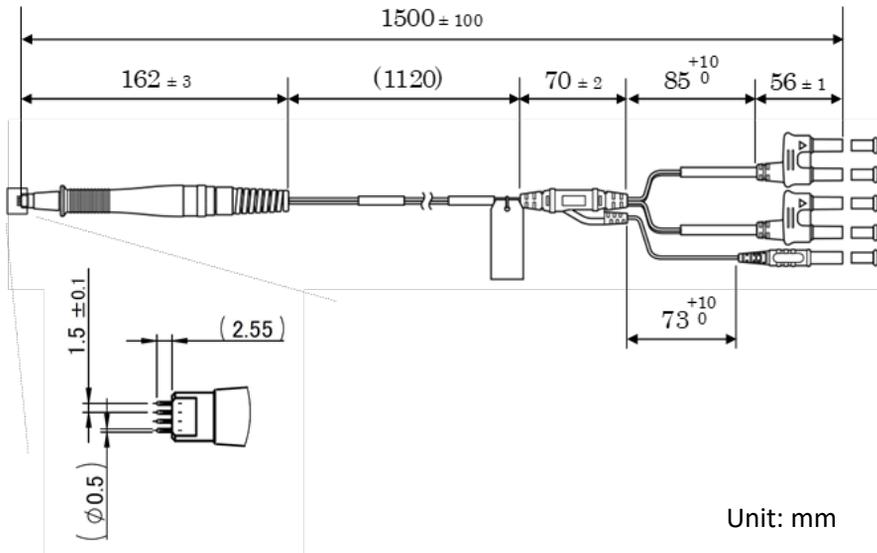
Please contact Hioki via the following web page:

HIOKI E. E. CORPORATION   https://www.hioki.com/contact