Technical Note:

Measuring Wide or Thick Resistors Vol.4

Resistance Meter Series

When measuring wide or thick objects, for example sheets or blocks, or current sensing resistors (shunt resistors) with a resistance of less than 1 Ω, it can be difficult to obtain accurate results with clip-type or pin-type leads. This Technical Note describes methods for achieving stable measurement of objects such as these.

1. Current Distribution

Applying a current to a measurement target such as that shown in Figure 1 gives rise to equipotential lines such as those illustrated in Figure 2. Just as in the relationship between wind and the pressure distribution charts used in weather forecasting, small gaps between equipotential lines indicate areas of high current density, while a lack of lines indicates areas of low current density. This figure illustrates how the potential gradient increases near the point at which the current is applied. This increase reflects the fact that the current is in the process of expanding out into the measurement target, and the current density is still high.

Consequently, when the voltage detection terminals are placed near the points at which the current is applied, small differences in the position of the points of contact lead to significant differences in measured values.

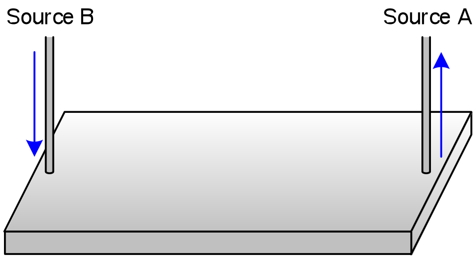

Figure 1. A Measurement Target

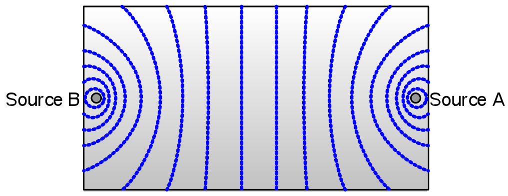

Figure 2. Equipotential Lines on the Measurement Target

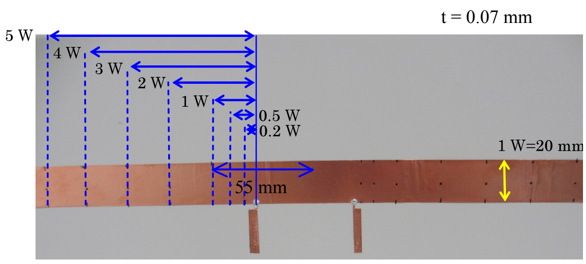

Figure 3. Pattern Used in Measurement

This phenomenon can be confirmed by means of the pattern shown in Figure 3. Assume that an L2104 Four-terminal Lead has been connected to an RM3545 Resistance Meter, and that the resistance value of a pattern with a length of 55 mm will be measured. The positions of the L2104's voltage detection terminals will be fixed, while the positions of the current application terminals will be varied (see Figures 4 through 6).

*RM3545 settings: 10 mΩ range, SLOW1 speed, OVC on

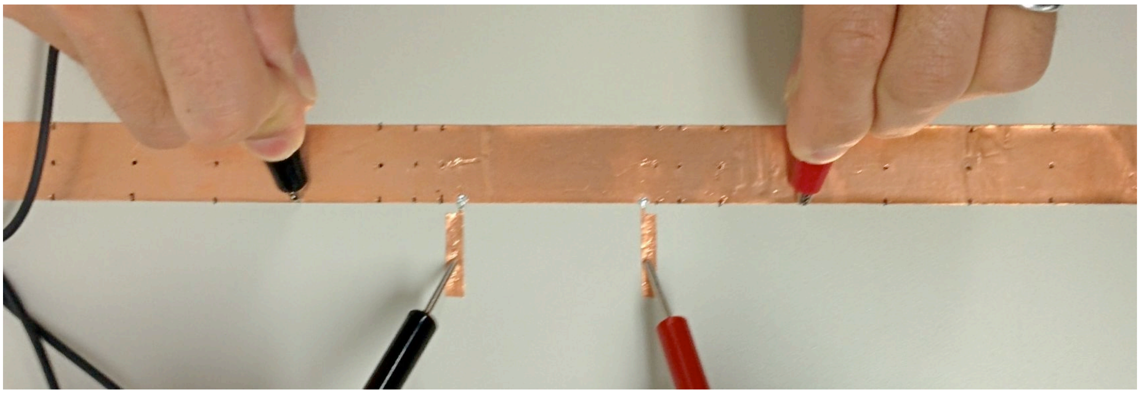

Figure 4. Measurement Positions (Current Application Terminal Positions [Lower Edge])

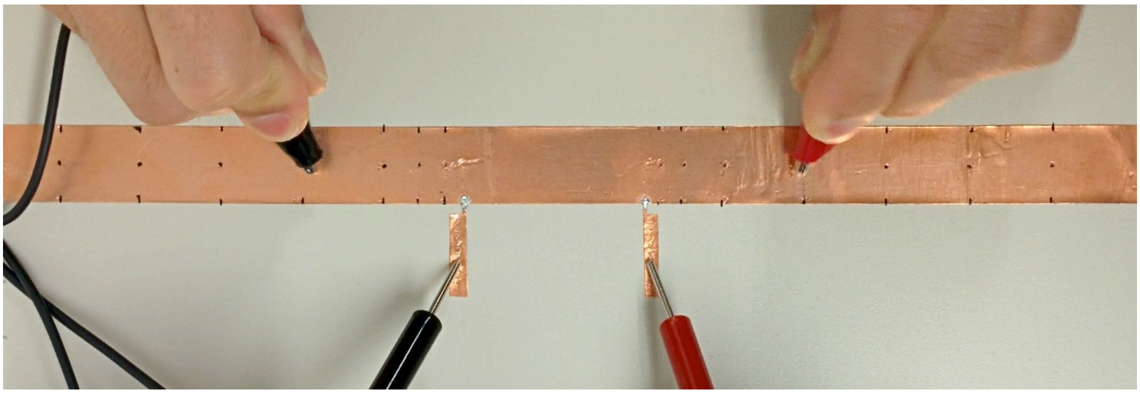

Figure 5. Measurement Positions (Current Application Terminal Positions [Center])

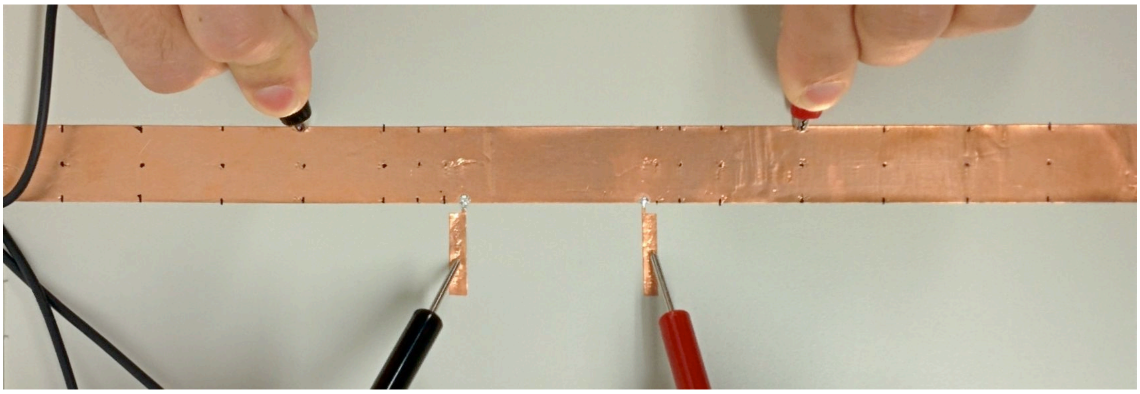

Figure 6. Measurement Positions (Current Application Terminal Positions [Top Edge])

Table 1 and Figure 7 list and illustrate the measurement results, respectively. By separating the current application terminals and the voltage detection terminals by at least 3 W, the resistance value was stabilized. When the current application terminals and voltage detection terminals are placed close together, there is a significant amount of variation in the resistance values detected at the top and bottom edges, but roughly the same values are obtained once the terminals are separated by an adequate distance.

Unit: mΩ

Distance between	Current application terminal position		
	Center	**Bottom edge**	**Top edge**
0.2	1.218 32	1.423 89	1.099 13
0.5	1.234 30	1.287 91	1.176 15
1.0	1.232 06	1.240 40	1.217 95
2.0	1.229 17	1.229 81	1.229 38
3.0	1.229 10	1.229 27	1.229 70
4.0	1.228 90	1.229 25	1.229 80
5.0	1.229 02	1.229 31	1.230 07

[1] 1 W = 20 mm

Table 1. Distances between Current Application Terminals and Voltage Detection Terminals and Associated Resistance Values

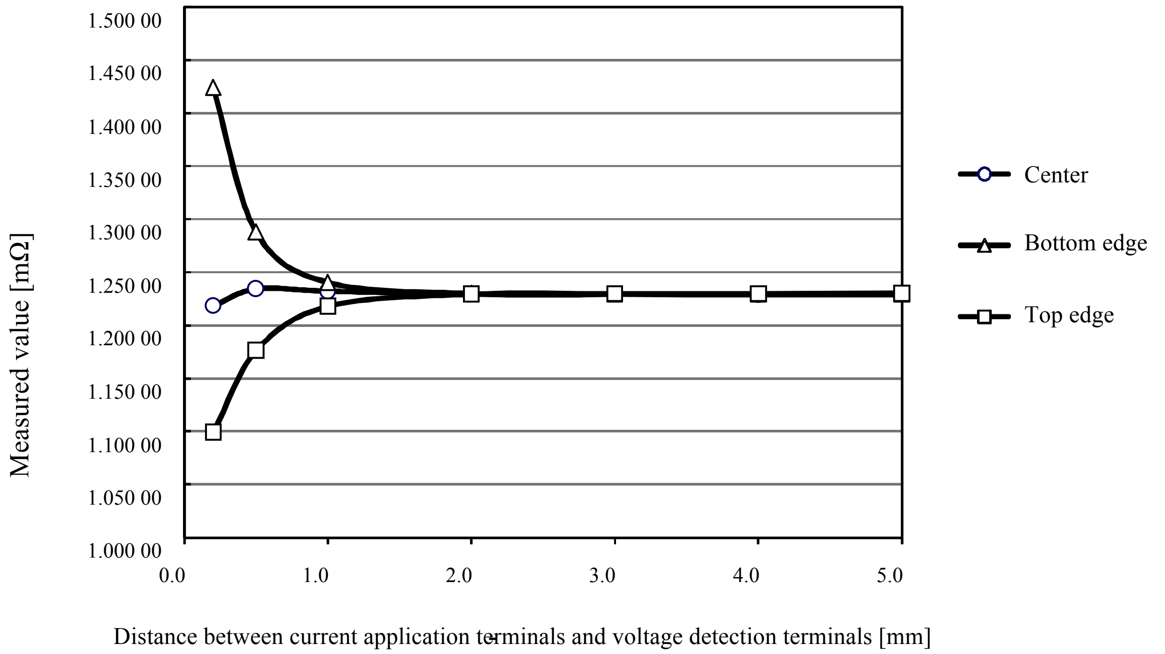

Figure 7. Distances between Current Application Terminals and Voltage Detection Terminals and Associated Resistance Values

2. Differences in Measured Values due to Measurement Leads

The previous section examined differences in measured values caused by differences in current distribution. This section looks at differences in measured values caused by the use of various measurement leads. Assume that a 9772 Pin Type Lead (with a pin pitch of 2.5 mm; see Figure 8) and an L2103 Pin Type Lead (with a pin pitch of 0.2 mm; see Figure 9) have been connected to an

RM3545 Resistance Meter to measure the resistance value (at the center) of a pattern with a length of 55 mm (see Figure 3).

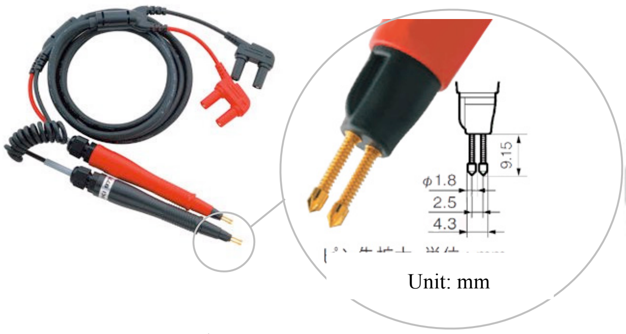

Figure 8. 9772

Figure 9. L2103

Table 2 lists the measurement results for this setup. Compared to the measured value obtained when the current application terminals and voltage detection terminals are separated by at least 3 W when using the L2104, the measured values obtained with the 9772 and L2103, which feature closer spacing, are higher. Additionally, the measured value obtained with the L2103, which has a shorter distance between the current application terminals and the voltage detection terminals, is higher than that obtained with the 9772.

Unit: mΩ

Distance between terminals[1]	**9772**	**L210**	**L210**
0.0	1.32698	1.66638	-
3.0	-	-	1.229 02

[1]1 W = 20

Table 2. Measurement Leads and Resistance Values

3. Summary

In order to accomplish stable measurement of a wide or thick resistive element, it is important to detect the voltage at a location characterized by uniform current distribution and a low voltage gradient. To accomplish this, it is necessary to leave adequate space between the current application terminals and the voltage detection terminals. Note that pin-type leads such as the L2102 and L2103, which combine current application terminals and voltage detection terminals, tend to yield higher measured values.

Technical Notes explore measurement topics from a more in-depth perspective than conventional user guides. They are intended to be used in combination with product operating manuals, user guides, and other documentation.