SIST

SLOVENSKI STANDARD
SIST EN IEC 62812:2019

01-oktober-2019

Meritve nizke upornosti - Metode in navodila (IEC 62812:2019)

Low resistance measurements - Methods and guidance (IEC 62812:2019)

Messung niederohmiger Widerstände - Verfahren und Leitfaden (IEC 62812:2019)

Mesures de faibles résistances - Méthodes et recommandations (IEC 62812:2019)

Ta slovenski standard je istoveten z: EN IEC 62812:2019

ICS:

31.040.01 Upori splošno Resistors in general

SIST EN IEC 62812:2019 en

EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN IEC 62812

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English Version

Low resistance measurements - Methods and guidance (IEC 62812:2019)

Mesures de faibles résistances - Méthodes et recommandations (IEC 62812:2019)

Messung niederohmiger Widerstände - Verfahren und Leitfaden (IEC 62812:2019)

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European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European foreword

The text of document 40/2665/FDIS, future edition 1 of IEC 62812, prepared by IEC/TC 40 "Capacitors and resistors for electronic equipment" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN IEC 62812:2019.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2020-03-06
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2022-06-06

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 62812:2019 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60115-2	NOTE	Harmonized as EN 60115-2
IEC 60115-8	NOTE	Harmonized as EN 60115-8
IEC 60301	NOTE	Harmonized as EN 60301
IEC 61249-5-1	NOTE	Harmonized as EN 61249-5-1

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

NOTE 1 Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

NOTE 2 Up-to-date information on the latest versions of the European Standards listed in this annex is available here: www.cenelec.eu.

Publication	Year	Title	EN/HD	Year
IEC 60068-1	-	Environmental testing - Part 1: General and guidance	EN 60068-1	-
IEC 60115-1 (mod)	2008	Fixed resistors for use in electronic equipment - Part 1: Generic specification	EN 60115-1	2011
-	-		+ A11	2015
IEC 60294	-	Measurement of the dimensions of a cylindrical component with axial terminations	EN 60294	-

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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Low resistance measurements – Methods and guidance

Mesures de faibles résistances – Méthodes et recommandations

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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LOW RESISTANCE MEASUREMENTS – METHODS AND GUIDANCE

FOREWORD

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International Standard IEC 62812 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
40/2665/FDIS	40/2671/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

LOW RESISTANCE MEASUREMENTS – METHODS AND GUIDANCE

1 Scope

Resistance measurements are typically compromised by a variety of phenomena, for example serial resistance in the measurement path, self-heating or non-ohmic properties. Whether the effect of such phenomena on a resistance measurement is acceptable or not depends on the magnitude of each effect in comparison to the resistance and to the required accuracy. Hence, the risk of erroneous resistance measurements increases with decreasing resistance and with a tightening of the permissible tolerance.

This document specifies methods of measurement and associated test conditions that eliminate or reduce the influence of adverse phenomena in order to improve the attainable accuracy of low-resistance measurements.

The methods described in this document are applicable for the individual measurements of the resistance of individual resistors, and also for resistance measurements as part of a test sequence. They are applied if prescribed by a relevant component specification, or if agreed between a customer and a manufacturer.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60115-1:2008, *Fixed resistors for use in electronic equipment – Part 1: Generic specification*

IEC 60294, *Measurement of the dimensions of a cylindrical component with axial terminations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60115-1 and the following apply.

A list of used letter symbols and abbreviated terms is provided in Annex A.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
electromotive force
e.m.f.
difference in potential that gives rise to an electric current

3.2
thermoelectric e.m.f.
E_T
potential difference occurring at the junctions of dissimilar conductors when a temperature difference exists between the junctions

3.3
low resistance
resistance for which the predictable error when measured with a conventional two-wire sensing method is significant in comparison to the required precision or to the stated tolerance

3.4
four-wire sensing
Kelvin sensing
four-terminal sensing
four-point sensing
electrical impedance measuring technique using separate pairs of wires for carrying the measuring current and for sensing the potential difference in order to eliminate the impedance contribution of wiring and contact resistances

3.5
two-wire sensing
conventional electrical impedance measuring technique using one pair of wires for carrying the measuring current and for sensing the potential difference on the same wires

4 Resistance measurement phenomena

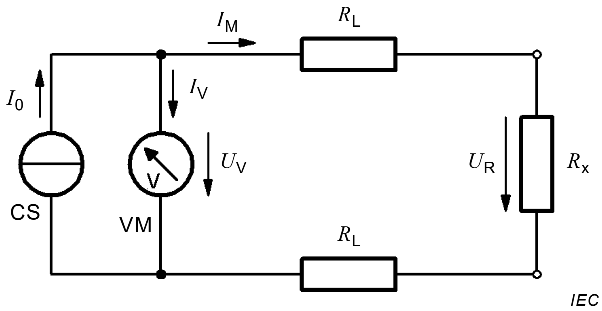
4.1 General

The measurement of a low resistance usually relies on the measurement of a low voltage, which requires a number of precautions against typical detrimental phenomena such as offset voltages, radio frequency interference, electromagnetic interference, electrical noise, or non-ohmic contacts. However, these phenomena are not discussed here as they are not specifically related to the measurement of resistance.

The voltage to be measured increases with an increase of the measuring current, which may also result in effects which are adverse to the measurement. Such phenomena are discussed in Clause 4.

4.2 Lead and contact resistance

A conventional method for measuring a resistance is to use a constant current source with a known (or measured) output current and a voltmeter for measuring the voltage across the unknown resistor, while the connection is built with a single pair of test leads, as shown in Figure 1.



Key

CS current source

VM voltmeter, measuring voltage U_V

R_L lead resistance, including contact resistance to the specimen

R_x resistance to be measured

I_O supply current from current source

I_V current passing through the voltmeter

I_M current passing through the unknown resistor

Figure 1 – Resistance measurement using two-wire sensing

In this circuit, the source current I_0 splits up into the current I_M passing through the path with the unknown resistor and the current I_V passing through the voltmeter, where I_V depends on the measured voltage U_V and the voltmeter's impedance R_V.

$$I_0 = I_M + I_V \quad (1)$$

$$I_V = \frac{U_V}{R_V} \quad (2)$$

The voltmeter measures the following voltage drop of current I_M along both lead and contact resistances R_L, plus along the unknown resistor R_x:

$$U_V = I_M \cdot (2R_L + R_x) \quad (3)$$

This leads to the apparent result of the resistance measurement, R', based on the measured voltage U_V and the known sourced current I_0:

$$R' = \frac{U_V}{I_0} = \frac{I_M}{I_M + I_V} \cdot (2R_L + R_x) = \frac{2R_L + R_x}{1 + \frac{2R_L + R_x}{R_V}} \quad (4)$$

With $I_V \rightarrow 0$, which is the case if $R_V >> (2R_L + R_x)$, the apparent result tends towards:

$$R' = \frac{U_V}{I_0} = \frac{I_M}{I_M + 0} \cdot (2R_L + R_x) = 2R_L + R_x \quad (5)$$

This final apparent result still bears the error ΔR of

$$\Delta R = R' - R_x = 2R_L \tag{6}$$

This error will only be negligible if ($2R_L$) << R_x, where the negligibility depends on the required accuracy for the measurement of R_x.

EXAMPLE 1 A 1 m copper wire with a cross section of 0,5 mm² has a resistance of 35 mΩ. Using a pair of these wires for two-wire sensing for measuring a 100 mΩ resistor results in an unacceptable error of 70 %. The current passing through the voltmeter due to its limited impedance is not likely to gain any significance on the error figure.

EXAMPLE 2 Using the same circuit for measuring a 10 Ω resistor results in 0,7 % error, while first assuming the current through the voltmeter to be zero. This 0,7 % error may be acceptable if the relative tolerance of the resistance is given as ±10 %, but not if it is only ±1 %.

Using a voltmeter in this circuit with an impedance of 1 MΩ results in only a −0,001 % additional error, which is not significant compared to the error caused by the lead wires. If the voltmeter, however, has an impedance of only 10 kΩ, the additional error is −0,1 % and thus may no longer be negligible.

EXAMPLE 3 For a resistor of 1 kΩ, measured as above, even the seemingly small error of only 0,007 % renders the described circuit useless, if it is a high precision type with, for example, a relative tolerance of ±0,01 %.

Using a voltmeter in this circuit with an impedance of 1 MΩ results in the additional error of −0,1 %. Comparing the absolute error contributions, this influence is even larger than the error caused by the lead wires.

4.3 Self-heating

The measuring current I_M passing through the unknown resistor with its resistance R_x causes dissipation of the power P_R

$$P_R = I_M^2 \cdot R_x \tag{7}$$

The dissipation P_R produces a temperature rise on the unknown resistor, which depends on the ability of the test assembly or fixture to dissipate heat to the environment, expressed as the thermal resistance R_{th}. The steady-state temperature rise $\Delta\vartheta_{R\infty}$ on the unknown resistor is

$$\Delta\vartheta_{R\infty} = R_{th} \cdot P_R \tag{8}$$

which adds to the ambient temperature next to the specimen, ϑ_{amb}, and thereby leads to the steady-state temperature $\vartheta_{R\infty}$ on the unknown resistor of

$$\vartheta_{R\infty} = \vartheta_{amb} + \Delta\vartheta_{R\infty} = \vartheta_{amb} + R_{th} \cdot P_R \tag{9}$$

NOTE The heat conduction out of the unknown resistor is considered to be a linear system for the purpose of this specification. This is based on the general observation that radiation and convection from the body of most low-power resistors only have a minor share in the total heat dissipation. A more complex consideration can be suitable for large resistors where radiation and convection from the body's surface prevail over conduction through the terminals or lead wires.

The temporal rise of the temperature $\vartheta_R(t)$ on the unknown resistor before reaching the steady state is determined by the thermal time constant τ_{th} of the unknown resistor in its test assembly or fixture:

$$\vartheta_x(t) = \vartheta_{amb} + \Delta\vartheta_{R\infty} \cdot (1 - e^{-t/\tau_{th}}) \tag{10}$$

Knowledge of the thermal time constant τ_{th} is necessary for measurements aiming at the steady state and for determination of the timing of switched measurements alike.