IEC 62024-1

Edition 3.0 2017-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

High frequency inductive components – Electrical characteristics and measuring methods –
Part 1: Nanohenry range chip inductor

Composants inductifs à haute fréquence – Caractéristiques électriques et méthodes de mesure –
Partie 1: Inductance pastille de l'ordre du nanohenry

IEC 62024-1:2017-12(en-fr)

IEC Secretariat
3, rue de Varembé
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

IEC 62024-1

Edition 3.0 2017-12

INTERNATIONAL STANDARD

NORME INTERNATIONALE

High frequency inductive components – Electrical characteristics and measuring methods – Part 1: Nanohenry range chip inductor

Composants inductifs à haute fréquence – Caractéristiques électriques et méthodes de mesure – Partie 1: Inductance pastille de l'ordre du nanohenry

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.100.10

ISBN 978-2-8322-1088-0

Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.

CONTENTS

INTERNATIONAL ELECTROTECHNICAL COMMISSION

HIGH FREQUENCY INDUCTIVE COMPONENTS – ELECTRICAL CHARACTERISTICS AND MEASURING METHODS –

Part 1: Nanohenry range chip inductor

FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
6) All users should ensure that they have the latest edition of this publication.
7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62024-1 has been prepared by IEC technical committee 51: Magnetic components, ferrite and magnetic powder materials.

This third edition cancels and replaces the second edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) addition of voltage-drop method of DC resistance measuring;
b) unification of technical terms.

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

CDV	Report on voting
51/1187/CDV	51/1202/RVC

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.

A list of all parts of the IEC 62024 series, published under the general title *High frequency inductive components – Electrical characteristics and measuring methods,* can be found on the IEC website.

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.

HIGH FREQUENCY INDUCTIVE COMPONENTS – ELECTRICAL CHARACTERISTICS AND MEASURING METHODS –

Part 1: Nanohenry range chip inductor

1 Scope

This part of IEC 62024 specifies electrical characteristics and measuring methods for the nanohenry range chip inductor that is normally used in high frequency (over 100 kHz) range.

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 61249-2-7, *Materials for printed boards and other interconnecting structures – Part 2-7: Reinforced base materials clad and unclad – Epoxide woven E-glass laminated sheet of defined flammability (vertical burning test) copper-clad*

IEC 62025-1, *High frequency inductive components – Non-electrical characteristics and measuring methods – Part 1: Fixed, surface mounted inductors for use in electronic and telecommunication equipment*

ISO 6353-3, *Reagents for chemical analysis – Part 3: Specifications – Second series*

ISO 9453, *Soft solder alloys – Chemical compositions and forms*

3 Terms and definitions

No terms and definitions are listed in this document.

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

4 Inductance, Q-factor and impedance

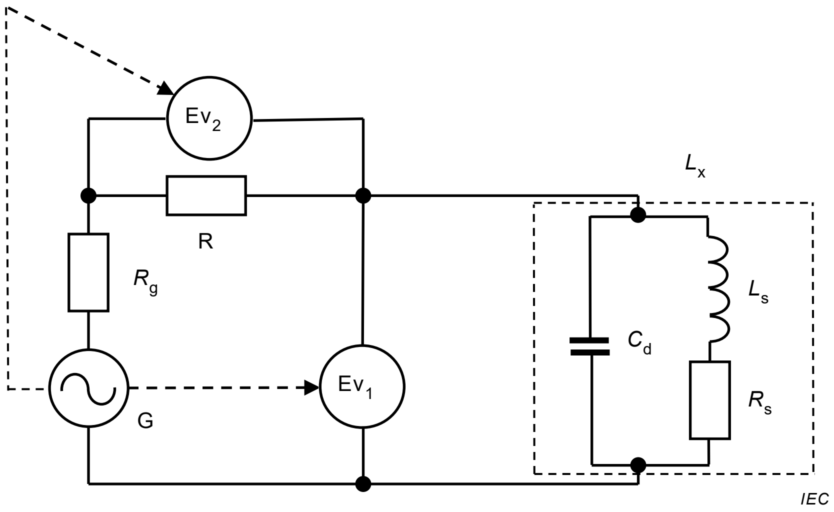
4.1 Inductance

4.1.1 Measuring method

The inductance of an inductor is measured by the vector voltage/current method.

4.1.2 Measuring circuit

An example of the circuit for the vector voltage/current method is shown in Figure 1.



Key

R_g	source resistance (50 Ω)
R	resistor
L_x	inductance of inductor under test
C_d	distributed capacitance of inductor under test
L_s	series inductance of inductor under test
R_s	series resistance of inductor under test
- - ▶	phase reference signal
Ev_1, Ev_2	vector voltmeter
G	signal generator

Figure 1 – Example of circuit for vector voltage/current method

4.1.3 Mounting the inductor for the test

4.1.3.1 General

The inductor shall be measured in a test fixture as specified in the relevant standard. If no fixture is specified, one of the following test fixtures A or B shall be used. The fixture used shall be reported.

4.1.3.2 Fixture A

The shape and dimensions of fixture A shall be as shown in Figure 2 and Table 1.

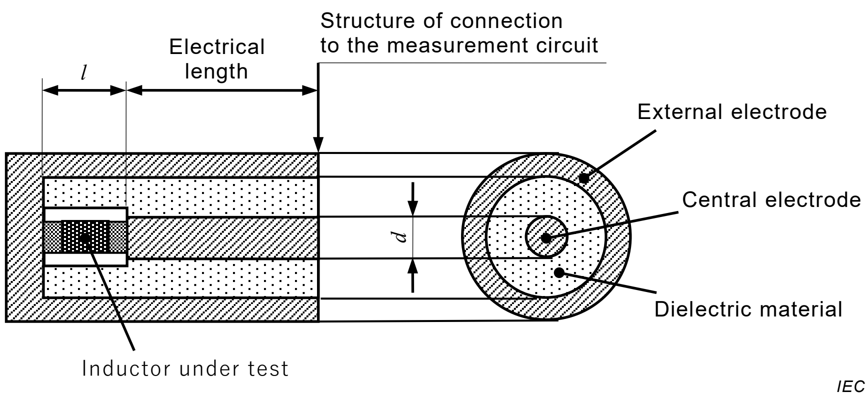


Figure 2 – Fixture A

Table 1 – Dimensions of *l* and *d*

Size of inductor under test[a]	l mm	d mm
1 608	1,6	0,95
1 005	1,0	0,60
0 603	0,6	0,36
0 402	0,4	0,26

[a] The outline dimensions of the surface mounted inductor shall be indicated by a four-digit number based on two significant figures for each dimension L, and W (or H) (refer to IEC 62025-1).

The electrodes of the test fixture shall contact the electrodes of the inductor under test by mechanical force provided by an appropriate method. This force shall be chosen so as to provide satisfactory measurement stability without influencing the characteristics of the inductor. The electrode force shall be specified. The structure between the measurement circuit and the test fixture shall maintain a characteristic impedance as near as possible to 50 Ω.

4.1.3.3 Fixture B

The test fixture B as shown in Figure 3 shall be used.

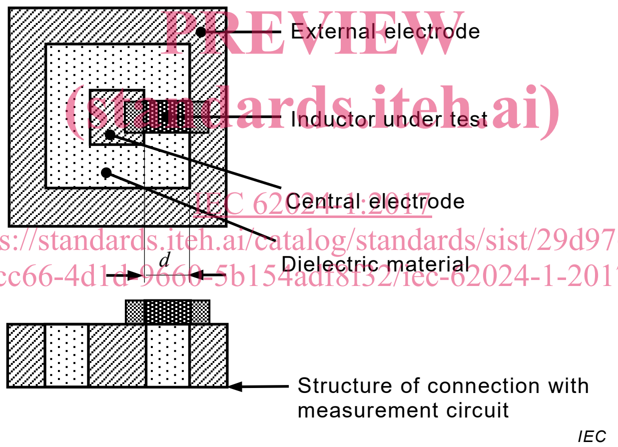


Figure 3 – Fixture B

The electrodes of the test fixture shall be in contact with the electrodes of the inductor under test by mechanical force provided by an appropriate method. This force shall be chosen so as to provide satisfactory measurement stability without influencing the characteristics of the inductor. The electrode force shall be specified.

The structure between the measurement circuit and the test fixture shall maintain a characteristic impedance as near as possible to 50 Ω.

Dimension d shall be specified between parties concerned.

4.1.4 Measuring method and calculation formula

Inductance L_x of the inductor L_x is defined by the vector sum of reactance caused by L_s and C_d (see Figure 1). The frequency f of the signal generator output signal shall be set to a frequency as separately specified. The inductor under test shall be connected to the measurement circuit by using the test fixture as described above. Vector voltage E_1 and E_2

shall be measured by vector voltage meters Ev_1 and Ev_2, respectively. The inductance L_x shall be calculated by the following formula:

$$L_x = \frac{\mathrm{Im}\left[R\frac{E_1}{E_2}\right]}{\omega} \tag{1}$$

where

L_x is the inductance of the inductor under test;

Im is the imaginary part of the complex value;

R is the resistance of the resistor;

E_1 is the value indicated on vector voltmeter Ev_1;

E_2 is the value indicated on vector voltmeter Ev_2;

ω is the angular frequency: $2\pi f$.

4.1.5 Notes on measurement

4.1.5.1 General

The electrical length of the test fixture shall be compensated by an appropriate method followed by open-short compensation. If an electrical length that is not commonly accepted is used, it shall be specified. Open-short compensation shall be calculated by the following formulae:

$$Z_x = A_c \frac{Z_m - B_c}{1 - Z_m C_c} \tag{2}$$

$$A_c = 1 + j0 \tag{3}$$

$$B_c = \frac{Z_{sm} - (1 - Y_{om} Z_{sm}) Z_{ss} - Z_{sm} Y_{os} Z_{ss}}{1 - Y_{om} Z_{sm} Y_{os} Z_{ss}} \tag{4}$$

$$C_c = \frac{Y_{om} - (1 - Y_{om} Z_{sm}) Y_{os} - Y_{om} Y_{os} Z_{ss}}{1 - Y_{om} Z_{sm} Y_{os} Z_{ss}} \tag{5}$$

where

Z_x is the impedance measurement value after compensation;

Z_m is the impedance measurement value before compensation;

Z_{sm} is the impedance measurement value of the short device;

Z_{ss} is the short device inductance as defined in 4.1.5.2;

Y_{om} is the admittance measurement value of the fixture with test device absent;

Y_{os} is the admittance measurement value of the test fixture as defined in 4.1.5.3.

4.1.5.2 Short compensation

For test fixture A, the applicable short device dimension and shape are as shown in Figure 4 and Table 2. The appropriate short device inductance shall be selected from Table 2 depending on the dimension of the inductor under test. The inductance of the selected short device shall be used as a compensation value.

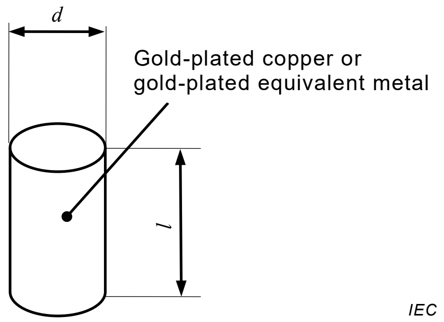


Figure 4 – Short device shape

Table 2 – Short device dimensions and inductances

Size of inductor under test	*l* mm	*d* mm	**Inductance value** nH
1608	1,6	0,95	0,43
1005	1,0	0,60	0,27
0603	0,6	0,36	0,16
0402	0,4	0,26	0,11

If an inductance value other than defined in Table 2 is used for test fixture A, the employed value shall be specified. For test fixture B, short device dimension, shape and inductance values shall be specified.

4.1.5.3 Open compensation

Open compensation for test fixture A shall be performed with test fixture electrodes at the same distance apart from each other as with the inductor under test mounted in the fixture. The admittance Y_{os} is defined as 0 S (zero Siemens) unless otherwise specified.

Open compensation for test fixture B shall be performed without mounting the inductor. The admittance Y_{os} is defined as 0 S (zero Siemens) unless otherwise specified.

4.2 Quality factor

4.2.1 Measuring method

The Q of the inductor shall be measured by the vector voltage/current method.

4.2.2 Measuring circuit

The measurement circuit is as shown in Figure 1.

4.2.3 Mounting the inductor for test

Mounting of the inductor is described in 4.1.3.

4.2.4 Measuring methods and calculation formula

The frequency of the signal generator (Figure 1) output signal shall be set to a frequency as separately specified. The inductor shall be connected to the measurement circuit by using the test fixture as described above. Vector voltage E_1 and E_2 shall be measured by vector voltage meters Ev_1 and Ev_2 respectively. The Q value shall be calculated by the following formula:

$$Q = \frac{\text{Im}[E_1 / E_2]}{\text{Re}[E_1 / E_2]} \tag{6}$$

where

Q is the Q of the inductor under test;

Re is the real part of the complex value;

Im is the imaginary part of the complex value;

E_1 is the value indicated on vector voltmeter Ev_1;

E_2 is the value indicated on vector voltmeter Ev_2.

4.2.5 Notes on measurement

Refer to 4.1.5.

4.3 Impedance

4.3.1 Measuring method

The impedance of an inductor shall be measured by the vector voltage/current method. The vector voltage/current method is as described in 4.3.2 to 4.3.5.

4.3.2 Measuring circuit

The measurement circuit is as shown in Figure 1.

4.3.3 Mounting the inductor for test

Mounting of the inductor is described in 4.1.3.

4.3.4 Measuring method and calculation

The frequency of the signal generator (Figure 1) output signal shall be set to a frequency f as separately specified. The inductor shall be connected to the measurement circuit by using the test fixture as described above. Vector voltage E_1 and E_2 shall be measured by vector voltage meters Ev_1 and Ev_2, respectively.

The impedance shall be calculated by the following formula:

$$|Z| = R\frac{|E_1|}{|E_2|} \tag{7}$$

where

$|Z|$ is the absolute value of the impedance;

R is the resistance;

$|E_1|$ is the absolute value of Ev_1;

$|E_2|$ is the absolute value of Ev_2.

4.3.5 Notes on measurement

Refer to 4.1.5.