

INTERNATIONAL STANDARD

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**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**

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CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Inductance, Q-factor and impedance	6
4.1 Inductance	6
4.1.1 Measuring method	6
4.1.2 Measuring circuit	6
4.1.3 Mounting the inductor for the test	7
4.1.4 Measuring method and calculation formula	8
4.1.5 Notes on measurement.....	9
4.2 Quality factor	10
4.2.1 Measuring method	10
4.2.2 Measuring circuit	10
4.2.3 Mounting the inductor for test	10
4.2.4 Measuring methods and calculation formula	10
4.2.5 Notes on measurement.....	11
4.3 Impedance	11
4.3.1 Measuring method	11
4.3.2 Measuring circuit	11
4.3.3 Mounting the inductor for test	11
4.3.4 Measuring method and calculation	11
4.3.5 Notes on measurement.....	11
5 Resonance frequency.....	12
5.1 Self-resonance frequency.....	12
5.2 Minimum output method.....	12
5.2.1 General	12
5.2.2 Measuring circuit	12
5.2.3 Mounting the inductor for test	12
5.2.4 Measuring method and calculation formula	13
5.2.5 Note on measurement	13
5.3 Reflection method.....	13
5.3.1 General	13
5.3.2 Measuring circuit	14
5.3.3 Mounting the inductor for test	14
5.3.4 Measuring method	15
5.3.5 Notes on measurement.....	15
5.4 Measurement by analyser	16
5.4.1 Measurement by impedance analyser	16
5.4.2 Measurement by network analyser.....	16
6 DC resistance.....	16
6.1 Voltage-drop method.....	16
6.1.1 Measuring circuit	16
6.1.2 Measuring method and calculation formula	17
6.2 Bridge method	17
6.2.1 Measuring circuit	17

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6.2.2	Measuring method and calculation formula	17
6.3	Notes on measurement	18
6.4	Measuring temperature	18
Annex A	(normative) Mounting method for a surface mounting coil	19
A.1	Overview	19
A.2	Mounting printed-circuit board and mounting land	19
A.3	Solder	19
A.4	Preparation	19
A.5	Pre-heating	19
A.6	Soldering	19
A.7	Cleaning	19
Figure 1	– Example of circuit for vector voltage/current method	7
Figure 2	– Fixture A	7
Figure 3	– Fixture B	8
Figure 4	– Short device shape	10
Figure 5	– Example of test circuit for the minimum output method	12
Figure 6	– Self-resonance frequency test board (minimum output method)	13
Figure 7	– Example of test circuit for the reflection method	14
Figure 8	– Self-resonance frequency test board (reflection method)	15
Figure 9	– Suitable test fixture for measuring self-resonance frequency	16
Figure 10	– Example of test circuit for voltage-drop method	17
Figure 11	– Example of test circuit for bridge method	18
Table 1	– Dimensions of l and d	8
Table 2	– Short device dimensions and inductances	10

IEC 62024-1:2017

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

**HIGH FREQUENCY INDUCTIVE COMPONENTS –
ELECTRICAL CHARACTERISTICS AND MEASURING METHODS –****Part 1: Nanohenry range chip inductor**

FOREWORD

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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.

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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*

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ISO 9453, *Soft solder alloys – Chemical compositions and forms-1-2017*

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

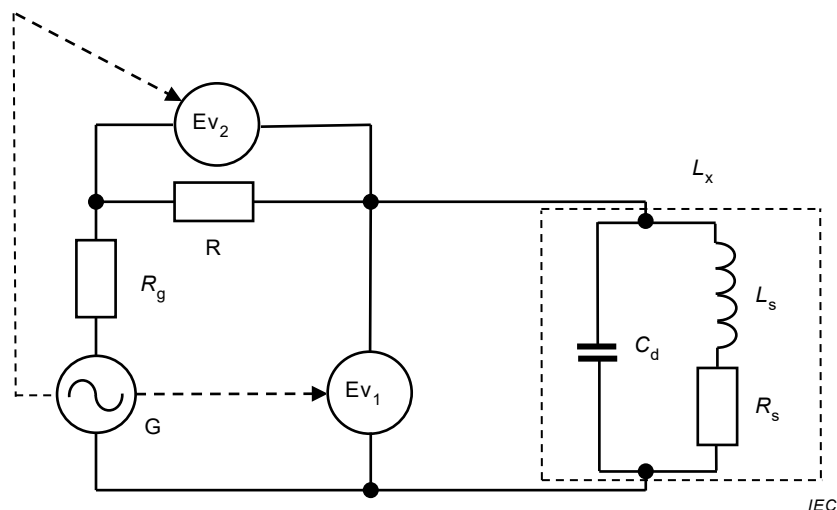
4.1 Inductance

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- - \rightarrow phase reference signalEv₁, Ev₂ 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.

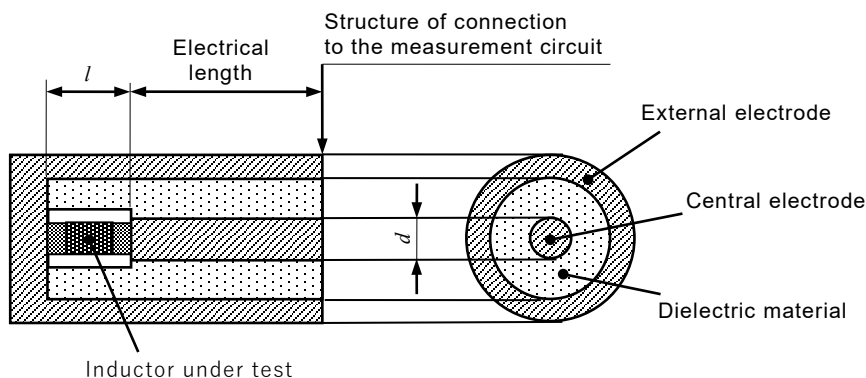
**Figure 2 – Fixture A**

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.

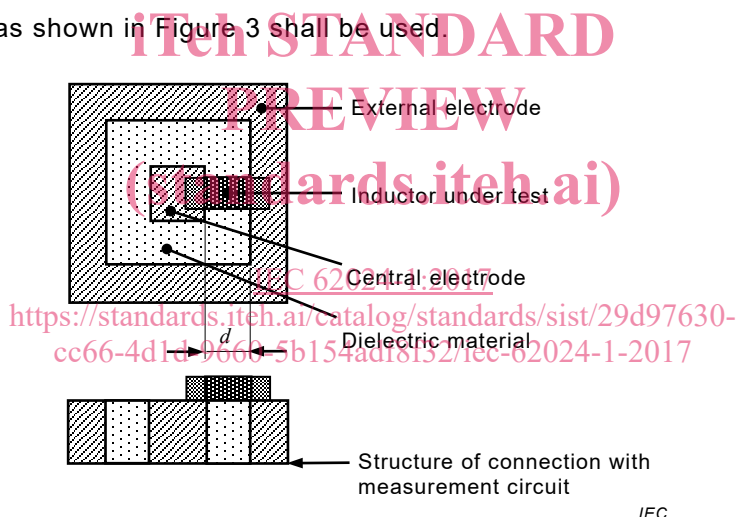


Figure 3 – Fixture B

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 E_{v1} and E_{v2} , respectively. The inductance L_x shall be calculated by the following formula:

$$L_x = \frac{\operatorname{Im} \left[R \frac{E_1}{E_2} \right]}{\omega} \quad (1)$$

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 E_{v1} ;

E_2 is the value indicated on vector voltmeter E_{v2} ;

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:

$$Z_x = A_c \frac{Z_m - B_c}{1 - Z_m C_c} \quad (2)$$

$$A_c = 1 + j0 \quad (3)$$

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

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

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.

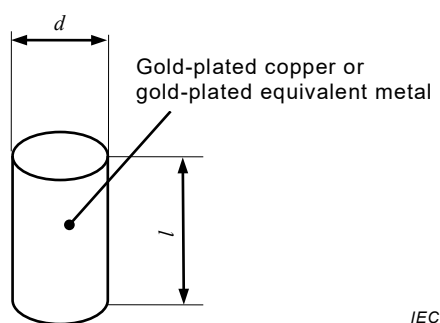


Figure 4 – Short device shape

Table 2 – Short device dimensions and inductances

Size of inductor under test	<i>l</i> mm	<i>d</i> 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:

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

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 iTeh STANDARD

The measurement circuit is as shown in Figure 1.

4.3.3 Mounting the inductor for test (standards.iteh.ai)

Mounting of the inductor is described in 4.1.3.

4.3.4 Measuring method and calculation IEC 62024-1:2017 https://standards.iteh.ai/catalog/standards/sist/29d97630-

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:

$$|Z| = R \frac{|E_1|}{|E_2|} \quad (7)$$

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.