IEC 62024-1

Edition 4.0 2024-07

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: Bobine d'inductance pastille de l'ordre du nanohenry

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HIGH FREQUENCY INDUCTIVE COMPONENTS – ELECTRICAL CHARACTERISTICS AND MEASURING METHODS –

Part 1: Nanohenry range chip inductor

FOREWORD

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

This fourth edition cancels and replaces the third edition published in 2017. This edition constitutes a technical revision.

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

a) addition of S parameter measurement;
b) addition of the inductance, Q-factor and impedance of an inductor which are measured by the reflection coefficient method with a network analyzer;

c) addition of the resonance frequency of an inductor which is measured by a two-port network analyzer;

d) addition of the mounting method for a surface mounting inductor with Pb-free solder.

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

Draft	Report on voting
51/1500/FDIS	51/1511/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

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- withdrawn, or
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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 the electrical characteristics and measuring methods for the nanohenry range chip inductor that is normally used in the 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 60068-2-58, *Environmental testing – Part 2-58: Tests – Test Td: Test methods for solderability, resistance to dissolution of metallization and to soldering heat of surface mounting devices (SMD)*

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 terminology databases for use in standardization at the following addresses:

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

4 Inductance, Q-factor and impedance

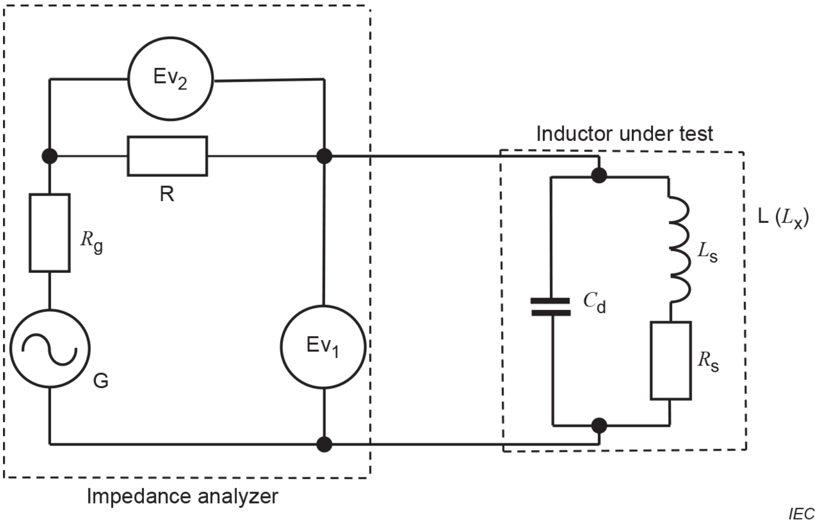
4.1 Inductance

4.1.1 Measuring method

The inductance of an inductor is measured by either the vector voltage/current method (impedance analyzer) or the reflection coefficient method (network analyzer).

4.1.2 Measuring circuit

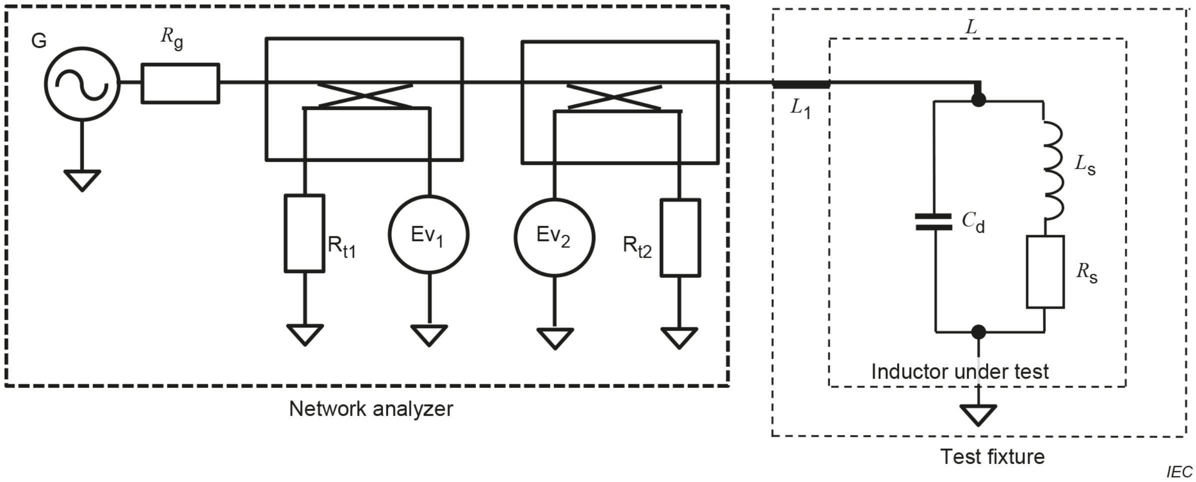
An example of the circuit for the vector voltage/current method is shown in Figure 1 and an example of the circuit for the reflection coefficient method is shown in Figure 2.



Key

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

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



Key

R_g	source resistance (50 Ω)
R_{t1}, R_{t2}	termination resistor (50 Ω)
L	inductor under test
C_d	parallel capacitance of inductor under test
L_s	series inductance of inductor under test
R_s	series resistance of inductor under test
Ev_1, Ev_2	vector voltmeter
G	signal generator
L_1	50 Ω micro-strip line or equivalent transmission line

Figure 2 – Example of circuit for reflection coefficient method

4.1.3 Mounting the inductor for the test

4.1.3.1 General

The inductor shall be mounted in a test fixture as specified in the relevant standard. If no fixture is specified, one of the following test fixtures A, B or C 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 3 and Table 1.

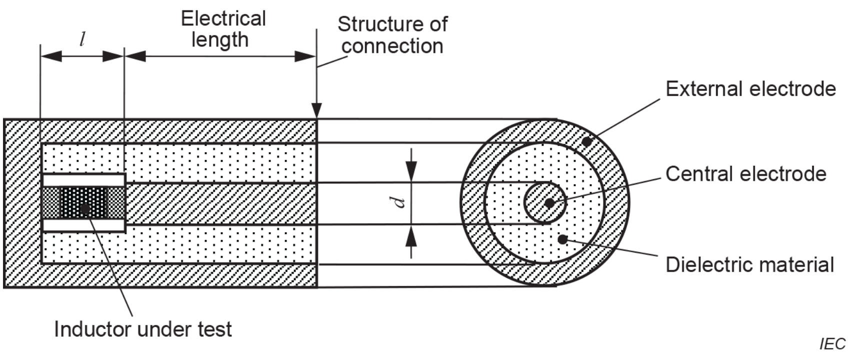


Figure 3 – Fixture A

Table 1 – Dimensions of *l* and *d*

Size of inductor under test[a]	*l* mm	*d* mm
1608	1,6	0,95
1005	1,0	0,60
0603	0,6	0,36
0402	0,4	0,26
0201	0,2	0,12

[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 mechanical force shall be specified. A characteristic impedance of the structure between the measurement circuit and the test fixture shall maintain a characteristic impedance as close as possible to 50 Ω.

4.1.3.3 Fixture B

The test fixture B as shown in Figure 4 shall be used.

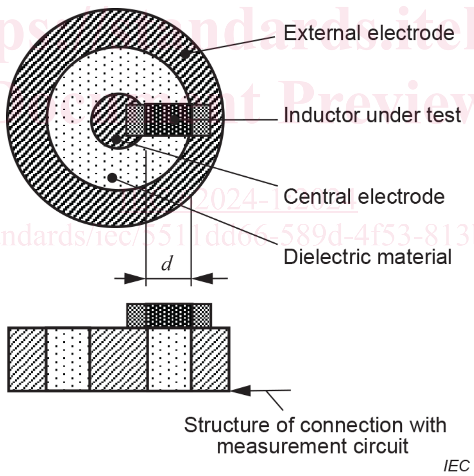


Figure 4 – Fixture B

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 mechanical force shall be specified. A characteristic impedance of the structure between the measurement circuit and the test fixture shall maintain a characteristic impedance as close as possible to 50 Ω. Dimension *d* shall be specified between the parties concerned.

4.1.3.4 Fixture C

The test fixture C as shown in Figure 5 shall be used.

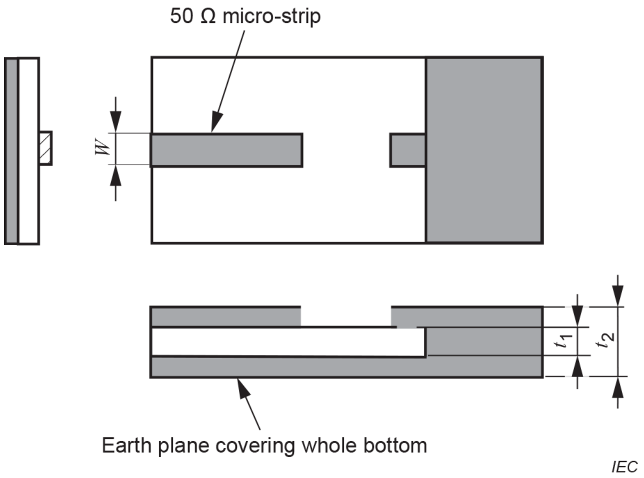


Figure 5 – Fixture C

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 mechanical force shall be specified. A characteristic impedance of the structure between the measurement circuit and the test fixture shall maintain a characteristic impedance as close as possible to 50 Ω. The dimensions of the patterns of the fixture and material of the fixture shall be specified between the parties concerned.

4.1.4 Measuring method and calculation formula

Inductance L_x of the inductor L is defined by the vector sum of the reactance caused by L_s and C_d (see Figure 1 or Figure 2). 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 in 4.1.3.2 to 4.1.3.4. Vector voltages 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 Formula (1) and Formula (2) for the vector voltage/current method, or Formula (3) to Formula (5) for the reflection coefficient method:

$$L_x = \frac{\mathrm{Im}[Z_x]}{\omega} \tag{1}$$

$$Z_x = R\frac{E_1}{E_2} \tag{2}$$

where

L_x is the inductance of the inductor under test;

Im is the imaginary part of the complex value;

Z_x is the impedance of the inductor under test;

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: $2\pi f$.

$$L_x = \frac{\mathrm{Im}[Z_x]}{\omega} \quad (3)$$

$$Z_x = R\frac{E_1}{E_2} \quad (4)$$

$$S_{11} = \frac{E_1}{E_2} \quad (5)$$

where

L_x is the inductance of the inductor under test;

Im is the imaginary part of the complex value;

Z_x is the impedance of the inductor under test;

R is the resistance of the resistor;

S_{11} is the reflection coefficient of the inductor under test;

Z_0 is the system impedance of the measurement system (50 Ω);

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 Annex B.

4.1.5.2 Short compensation

For test fixture A, the applicable short device dimension and shape are as shown in Figure 6 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.

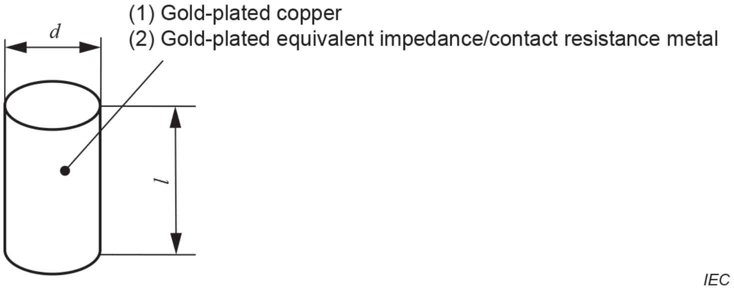


Figure 6 – Short device shape

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
0201	0,2	0,12	0,05

If an inductance value other than those defined in Table 2 and if a short device shape other than that defined in Figure 6, such as rectangular shape, are used for test fixture A, the employed value shall be specified. For test fixtures B and C, the 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 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 fixtures B and C 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 either the vector voltage/current method or the reflection coefficient method.

4.2.2 Measuring circuit

The measurement circuit is as shown in Figure 1 and Figure 2. The measurement equipment shall be suitably calibrated.

4.2.3 Mounting the inductor for test

Mounting of the inductor is as described in 4.1.3.

4.2.4 Measuring method and calculation formula

The frequency of the signal generator (Figure 1 or Figure 2) output signal shall be set to a frequency as separately specified. The inductor shall be connected to the measurement circuit by using the test fixtures as described in 4.1.3.2 to 4.1.3.4. Vector voltages 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:

$$Q = \frac{\mathrm{Im}[Z_{\mathrm{x}}]}{\mathrm{Re}[Z_{\mathrm{x}}]} \tag{6}$$