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IS 9333 : 2009
IEC 60732 : 1982

भारतीय मानक

चुम्बकीय सामग्री की सिलिंडर कोर, ट्यूब कोर और पैंच कोर की मापन पद्धतियाँ

(पहला पुनरीक्षण)

Indian Standard

MEASURING METHODS FOR CYLINDER CORES, TUBE CORES AND SCREW CORES OF MAGNETIC OXIDES

(First Revision)

ICS 29.100.10

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

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NATIONAL FOREWORD

This Indian Standard (First Revision) which is identical with IEC 60732 : 1982 'Measuring methods for cylinder cores, tube cores and screw cores of magnetic oxides' issued by the International Electrotechnical Commission (IEC) was adopted by the Bureau of Indian Standards on the recommendation of the Semiconductor and Other Electronic Components and Devices Sectional Committee and approval of the Electronics and Information Technology Division Council.

This standard was originally published in 1979 and has now been revised to align it with the latest IEC Publication.

The text of IEC Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker in the International Standard while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

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MEASURING METHODS FOR CYLINDER CORES, TUBE CORES AND SCREW CORES OF MAGNETIC OXIDES

(First Revision)

1. Scope

This standard describes methods of measuring the magnetic properties of cylinder, tube and screw cores in terms of the inductance L and quality factor Q of a specified coil containing the test core in a specified position relative to it.

For test purposes, cores are normally assessed by means of comparative measurements against a standard core.

This standard covers cores up to 45 mm in length and up to 8.5 mm in diameter at frequencies up to 100 MHz. The dimensional characteristics of such cores are the subject of IEC Publication 220: Dimensions of Tubes, Pins and Rods of Ferromagnetic Oxides, and IEC Publication 221: Dimensions of Screw Cores made of Ferromagnetic Oxides.

The determination of the magnetic properties of ferrite rod aerials forms the subject of IEC Publication 492: Measuring Methods for Aerial Rods.

2. Definitions

For the purpose of this standard, the following definitions apply:

2.1 *Inductance*

The inductance L is the inductance of a specified measuring coil placed on the core:

$$L = \mu_{app} \cdot L_0$$

where:

μ_{app} = apparent permeability of the core
L_0 = inductance of the measuring coil without core

2.2 *Quality factor*

The quality factor Q is the ratio of the reactance ωL_s to the loss resistance R_s, when the impedance of the coil is represented by a series combination of a reactance and a resistance, or the ratio of the total loss resistance R_p to the reactance ωL_p, when represented by a parallel combination, i.e.:

$$Q = \frac{\omega L_s}{R_s} = \frac{R_p}{\omega L_p} = \frac{1}{\tan \delta}$$

where:

ω = angular frequency = $2\pi f$
δ = corresponding loss angle

Notes 1. — The reactance and resistance refer to a specified measuring coil placed on the core and to a specified measuring frequency f.

The relations between the characteristic quantities are:

$$R_p = R_s (1 + Q^2)$$

$$L_p = L_s (1 + 1/Q^2)$$

If $Q > 10$, these expressions approximate to:

$$R_p \approx R_s Q^2$$

$$L_p \approx L_s = L$$

$$Q \approx \frac{\omega L}{R_s} \approx \frac{R_p}{\omega L}$$

2. — The quality factor of the measuring coil without core is designated Q_o (see Tables III to VI).

3. Measuring frequency

3.1 *Inductance L*

The measuring coils specified in Table II have been designed to allow the cores to be measured at a frequency between 10 kHz and 100 kHz. It is permissible to use the coil specified in Table III to measure the inductance at 0.5 MHz or 1.5 MHz in combination with a measurement of Q, if desired, although the resultant accuracy may not be as great.

3.2 *Quality factor Q*

For the measurement of the quality factor Q of the core in the coil up to 100 MHz, the measuring frequency shall be chosen from the series 0.5 MHz, 1.5 MHz, 10 MHz, 40 MHz and 100 MHz. The number of turns shall be chosen so that the tuning capacitance lies within the range from 10 pF to 400 pF.

4. Measuring voltage

The cores shall be measured at low flux density (within the Rayleigh region). The r.m.s. values of voltage U applied to the measuring coil shall therefore not exceed the following values:

f (MHz)	0.01	0.1	0.5	1.5	10	40	100
U (V)	0.02	0.2	1.0	3	20	80	80

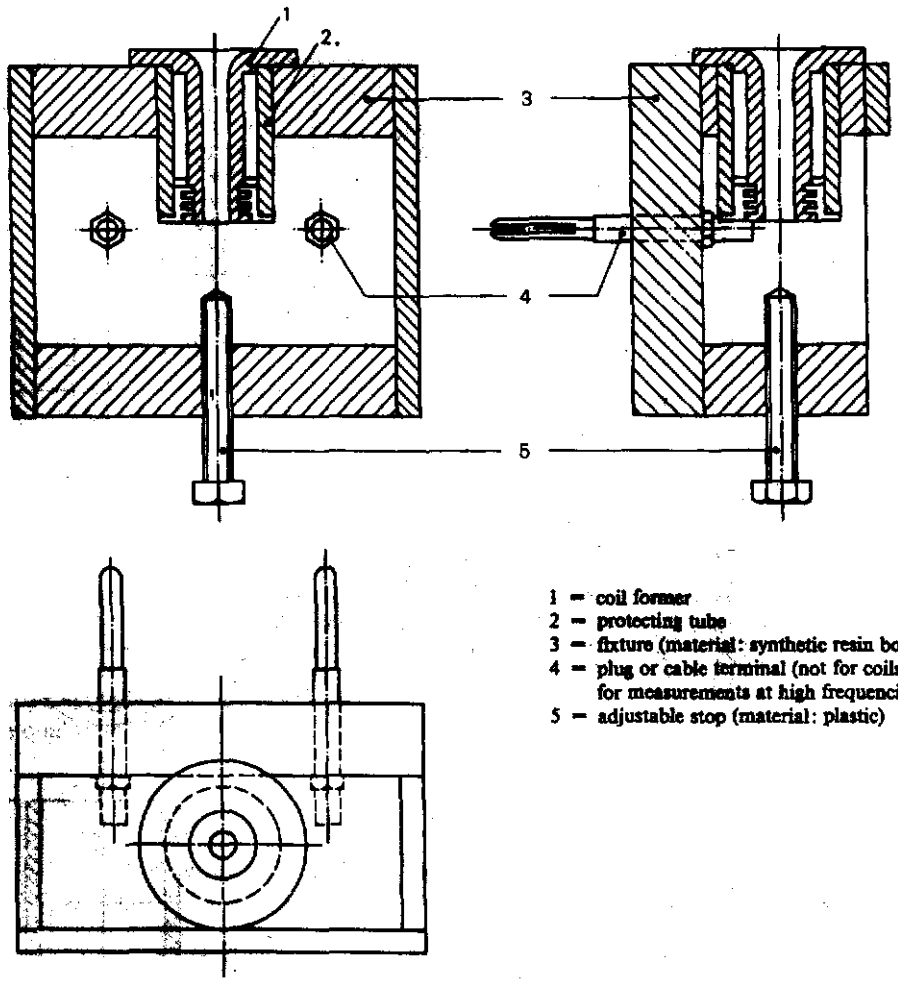
Note. — At the higher frequencies, it may be preferable to specify voltages much lower than those shown in this table.

5. Measuring coils

5.1 Two series of measuring coils are specified: one series for the measurement of the inductance L, the other for the measurement of the quality factor Q. The latter may also be used for the measurement of the inductance L.

Each individual coil consists of a winding made on a former protected by a tube and mounted in a fixture.

An example of a possible construction is given in Figure 1.



1 — coil former
2 — protecting tube
3 — fixture (material: synthetic resin bonded fabric)
4 — plug or cable terminal (not for coils for measurements at high frequencies)
5 — adjustable stop (material: plastic)

FIG. 1. — Example of the construction of a measuring coil.

5.2 The coil former shall be of a low-loss material* which is resistant to abrasion and has a Vicat softening point not less than 90 °C (in accordance with ISO Standard 306, measured in air), for example of polycarbonate. The dimensions of coil formers (for both inductance and quality factor measurements) shall conform to the values given in Table I.

Note. — The material of the protecting tube may be either acrylic resin or bonded fabric.

* For the purpose of this standard, a material with a tan δ not exceeding 150×10^{-4} measured at 1 MHz (according to IEC Publication 250: Recommended Methods for the Determination of the Permittivity and Dielectric Dissipation Factor of Electrical Insulating Materials at Power, Audio and Radio Frequencies including Metre Wavelengths), can be considered to be a low-loss material.

TABLE I

Dimensions of the coil formers shown in Figure 2 (in millimetres)

Coil reference	d_1	d_2	d_3	d_4
1.7	1.7	2.5	8	4.5
2.2	2.2	3	8	5
2.7	2.7	3.5	8.5	5.5
3.2	3.2	4	8.5	6
3.7	3.7	4.5	9	6.5
4.2	4.2	5	9	7
4.7	4.7	5.5	9.5	7.5
5.2	5.2	6	10	8
5.7	5.7	6.5	10.5	8.5
6.2	6.2	7	11	9
6.7	6.7	7.5	11.5	9.5
7.7	7.7	8.5	12.5	10.5
8.7	8.7	9.5	13.5	11.5
Tolerance:	$^{+0.1}_{0}$	$^{+0.1}_{0}$	$^{-0}_{0.1}$	±0.1

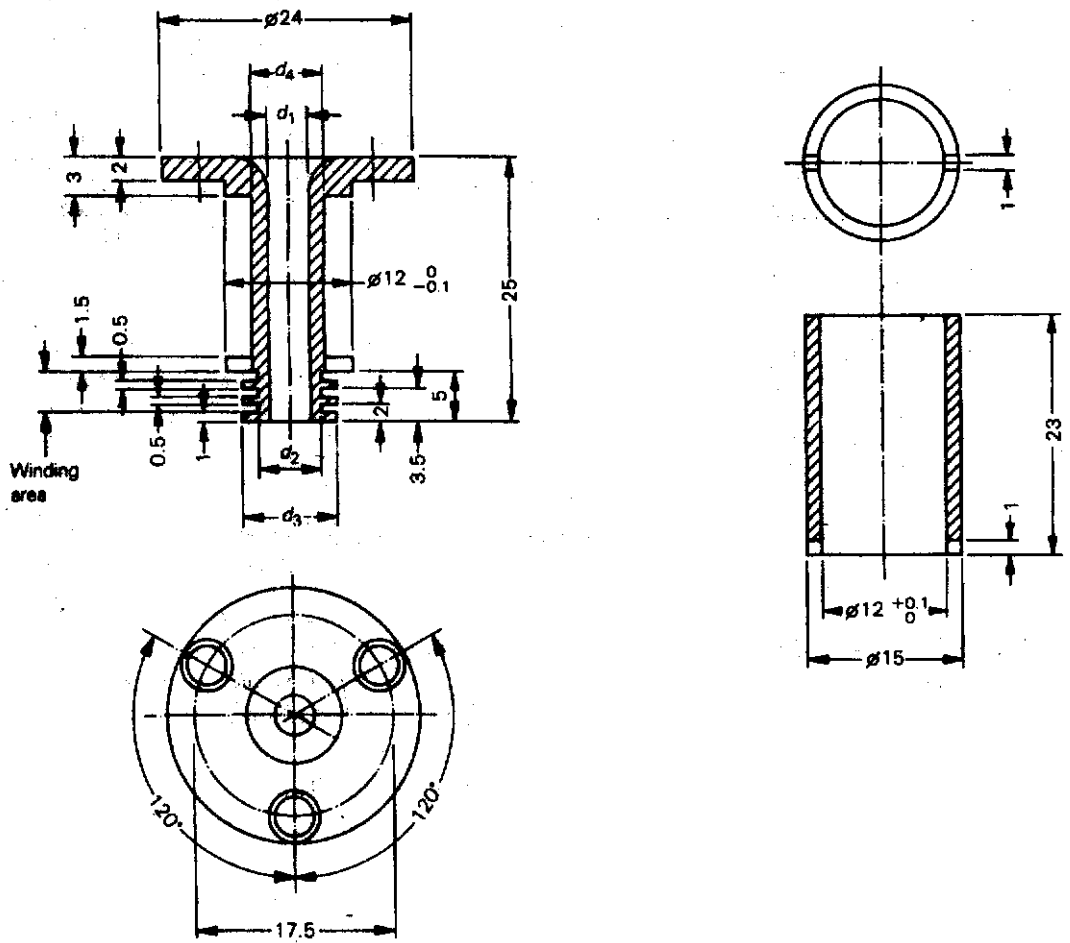


FIG. 2. — Coil former and protecting tube (dimensions in millimetres).

5.3 Specifications and characteristics at 25 ± 5 °C of measuring coils (without core) for the measurement of inductance L are given in Table II.

TABLE II

Measuring coils for measurement of L

Coil reference	Number of turns	Wire*	D.C. resistance R_o		Inductance L_o	
		(mm)	(Ω)	Tolerance	(μH)	Tolerance
1.7	27 + 27 + 27 = 81	0.16	0.90	±0.1 Ω	11.0	±0.5 μH
2.2	27 + 27 + 27 = 81		1.00		14.3	
2.7	27 + 27 + 27 = 81		1.12		17.6	
3.2	23 + 23 + 23 = 69		1.12		16.0	
3.7	21 + 21 + 21 = 63		1.06		15.5	
4.2	21 + 21 + 21 = 63		1.11		17.0	
4.7	17 + 17 + 17 = 51		0.99		13.4	
5.2	17 + 17 + 17 = 51		1.02		14.2	
5.7	17 + 17 + 17 = 51		1.09		15.8	
6.2	17 + 17 + 17 = 51		1.17		17.7	
6.7	15 + 15 + 15 = 45		1.14		15.2	
7.7	13 + 13 + 13 = 39		1.14		14.0	
8.7	11 + 11 + 11 = 33		1.12		11.8	

* Grade 1 enamelled copper wire, whose nominal conductor diameter is of the value shown, in accordance with IEC Publication 317-4: Specifications for Particular Types of Winding Wires, Part 4: Self-fluxing Enamelled Round Copper Wires.

5.4 Specifications and characteristics at 25 ± 5 °C of measuring coils (without core) for the measurement of the quality factor Q are given in Tables III to VI.

TABLE III

Measuring coils for measurement of Q at 0.5 MHz and 1.5 MHz

Coil reference	Number of turns	Wire**	D.C. resistance R_o		Inductance L_o		Q_o at 1.5 MHz	
		(mm)	(Ω)	Tolerance	(μH)	Tolerance		Tolerance
1.7	40 + 40 + 40 = 120	8×0.04	3.43	±0.3 Ω	32.4	±1.0 μH	68	±5
2.2	38 + 38 + 38 = 114		3.51		35.0		73	
2.7	36 + 36 + 36 = 108		4.12		36.2		67	
3.2	34 + 34 + 34 = 102		3.87		41.5		79	
3.7	32 + 32 + 32 = 96		3.81		41.0		81	
4.2	30 + 30 + 30 = 90		4.84		38.1		81	
4.7	28 + 28 + 28 = 84		3.88		40.0		82	
5.2	26 + 26 + 26 = 78		3.50		35.3		78	
5.7	24 + 24 + 24 = 72		3.43		33.0		76	
6.2	22 + 22 + 22 = 66		3.28		30.7		76	
6.7	20 + 20 + 20 = 60		3.06		27.2		75	
7.7	16 + 16 + 16 = 48		2.69		21.2		67	
8.7	12 + 12 + 12 = 36		2.20		14.2		52	

** Eight bunched enamelled copper wires with silk covering, of nominal conductor diameter 0.04 mm, in accordance with IEC Publication 317-11: Specifications for Particular Types of Winding Wires, Part 11: Bunched Enamelled Copper Wires with Silk Covering.

Note. — Further variance on the measured Q_o (approximately ±15%) can be expected due to the variations between commercially available Q meters.

TABLE IV

Measuring coils for measurement of Q at 10 MHz

Coil reference	Number of turns	Wire*	D.C. resistance R_o		Inductance L_o		Q_o	
		(mm)	(Ω)	Tolerance	(μH)	Tolerance		Tolerance
1.7	7 + 7 + 7 = 21	0.25	0.13	±0.02 Ω	0.60	±0.1 μH	36	±5
2.2	7 + 7 + 7 = 21		0.15		0.95		40	
2.7	6 + 6 + 6 = 18		0.15		0.89		47	
3.2	6 + 6 + 6 = 18		0.16		1.12		50	
3.7	5 + 5 + 5 = 15		0.15		0.96		68	
4.2	5 + 5 + 5 = 15		0.16		1.08		62	
4.7	5 + 5 + 5 = 15		0.17		1.25		65	
5.2	4 + 4 + 4 = 12		0.16		0.94		68	
5.7	4 + 4 + 4 = 12		0.17		1.03		75	
6.2	4 + 4 + 4 = 12		0.18		1.17		80	
6.7	Not yet specified							
7.7								
8.7								

* Grade 1 enamelled copper wire, whose nominal conductor diameter is of the value shown, in accordance with IEC Publication 317-4.

Note. — Further variance on the measured Q_o (approximately ±20%) can be expected due to the variations between commercially available Q meters.

TABLE V

Measuring coils for measurement of Q at 40 MHz

Coil reference	Number of turns	Wire*	Inductance L_o		Q_o	
		(mm)	(nH)	Tolerance		Tolerance
1.7	3 + 4 + 3 = 10	0.315	210	±30 nH	48	±10
2.2	3 + 3 + 3 = 9	0.315	210		60	
2.7	3 + 2 + 3 = 8	0.315	200		65	
3.2	2 + 3 + 2 = 7	0.45	230		75	
3.7	2 + 2 + 2 = 6	0.45	200		80	
4.2	2 + 2 + 2 = 6	0.45	210		93	
4.7	2 + 2 + 2 = 6	0.56	245		110	
5.2	2 + 1 + 2 = 5	0.56	195		110	
5.7	2 + 1 + 2 = 5	0.56	210		115	
6.2	2 + 1 + 2 = 5	0.56	235		130	
6.7	Not yet specified					
7.7						
8.7						

* Grade 1 enamelled copper wire, whose nominal conductor diameter is of the value shown, in accordance with IEC Publication 317-4.

Note. — Further variance on the measured Q_o (approximately ±20%) can be expected due to the variations between commercially available Q meters.

TABLE VI

Measuring coils for measurement of Q at 100 MHz

Coil Reference	Number of turns	Wire*	Inductance L_o		Q_o	
		(mm)	(nH)	Tolerance		Tolerance
1.7	6	0.56	90		125	
2.2	5	0.6	96		155	
2.7	4	0.8	84		170	
3.2	4	0.8	93		180	
3.7	4	0.8	104	±30 nH	200	±10
4.2	1 + 1 + 1 = 3	0.8	79		190	
4.7	1 + 1 + 1 = 3	0.8	87		205	
5.2	1 + 1 + 1 = 3	0.8	89		210	
5.7	1 + 1 + 1 = 3	0.8	97		230	
6.2	1 + 1 + 1 = 3	0.8	102		245	
6.7 7.7 8.7	Not yet specified					
For coils 1.7 to 3.7, the partition walls shall be removed and the turns uniformly spaced over the winding area						

* Grade 1 enamelled copper wire, whose nominal conductor diameter is of the value shown, in accordance with IEC Publication 317-4.

Note. – Further variance on the measured Q_o (approximately ±20%) can be expected due to the variations between commercially available Q meters.

6. Measurement procedure

6.1 *Position*

In order to obtain a satisfactory measurement accuracy, the adjustable stop shall be set so that a core of nominal length is centrally positioned in the measuring coil.

Magnetic parts and large metallic parts shall not be placed within a distance of 100 mm from the core to be measured.

6.2 *Choice of coil*

For each core measurement the smallest coil former, whose diameter d_1 exceeds that of the test core by at least 0.1 mm, shall be selected.

6.3 *Inductance L*

The inductance L shall be measured with one of the coils specified in Sub-clause 5.3 in accordance with the requirement given in Sub-clause 6.2. The inaccuracy of the measuring equipment used for the inductance measurement shall not exceed 1%.

The connecting cables between measuring coil and measuring apparatus shall be as short as possible; the use of low-loss flat cable is recommended.

6.4 *Quality factor Q*

The quality factor Q shall be measured with one of the coils specified in Sub-clause 5.4 in accordance with the requirement given in Sub-clause 6.2.

The connecting cables between measuring coils and measuring apparatus shall be as short as possible.

For measurements of Q at 100 MHz, the measuring coil is connected directly to the measuring apparatus; the length of the connecting wires shall not exceed 20 mm.

6.5 *Temperature*

Inductance L and quality factor Q shall be measured at 25 ± 5 °C. The cores to be tested shall be exposed to this temperature for at least 3 h immediately before the measurement.

6.5 *Temperature coefficient of inductance*

Not yet specified.

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Review of Indian Standards

Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard alongwith amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards: Monthly Additions'.

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Amendments Issued Since Publication

Amend No.	Date of Issue	Text Affected

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