

Transformers and inductors for use in electronic and telecommunication equipment — Measuring methods and test procedures

The European Standard EN 61007 : 1997 has the status of a
British Standard

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National foreword

This British Standard is the English language version of EN 61007 : 1997. It was derived by CENELEC from IEC 1007 : 1994.

The CENELEC common modifications have been implemented at the appropriate places in the text and are indicated by a side line in the margin.

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Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 62, an inside back cover and a back cover.

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Transformers and inductors for use in electronic and telecommunication equipment - Measuring methods and test procedures
(IEC 1007:1994, modified)

Transformateurs et inductances utilisés dans les équipements électroniques et de télécommunications - Méthodes de mesure et procédures d'essais
(CEI 1007:1994, modifiée)

Transformatoren und Drosseln für die Anwendung in elektronischen und nachrichtentechnischen Einrichtungen. Meßmethoden und Prüfverfahren
(IEC 1007:1994, modifiziert)

This European Standard was approved by CENELEC on 1997-03-11. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Central Secretariat or to any CENELEC member.

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CENELEC

European Committee for Electrotechnical Standardization
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Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Foreword

The text of the International Standard IEC 1007:1994, prepared by IEC TC 51, Magnetic components and ferrite materials, together with common modifications prepared by Reporting Secretariat SR 51, was submitted to the formal vote and was approved by CENELEC as EN 61007 on 1997-03-11.

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with the EN have to be withdrawn (dow) 1998-03-01

Annexes designated "normative" are part of the body of the standard.

In this standard, annex ZA is informative.

Annex ZA has been added by CENELEC.

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TRANSFORMERS AND INDUCTORS FOR USE IN ELECTRONIC AND TELECOMMUNICATION EQUIPMENT – MEASURING METHODS AND TEST PROCEDURES

1 Scope

This standard describes measuring methods and test procedures for inductors and transformers for use in electronic and telecommunication equipment that may be involved in any specifications for such components, in particular those forming part of the IEC Quality Assessment System for Electronic Components (IECQ scheme).

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of IEC 1007. At the time of publication, the editions indicated were valid. All normative documents are subject to revision, and parties to agreements based on IEC 1007 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 27: *Letter symbols to be used in electrical technology*

IEC 44-4: 1980, *Instrument transformers – Part 4: Measurement of partial discharges*

IEC 50, *International Electrotechnical Vocabulary (IEV)*

IEC 68-1: 1988, *Environmental testing – Part 1: General and guidance*
Amendment 1 (1992)

IEC 68-2: *Environmental testing – Part 2: Tests*

IEC 68-2-1: 1990, *Environmental testing – Part 2: Tests – Tests A: Cold*
Amendment 1 (1993)

IEC 68-2-2: 1974, *Environmental testing – Part 2: Tests – Tests B: Dry heat*
Amendment 1 (1993)

IEC 68-2-3: 1969, *Environmental testing – Part 2: Tests – Test Ca: Damp heat, steady state*

IEC 68-2-6: 1982, *Environmental testing – Part 2: Tests – Test Fc and guidance: Vibration (sinusoidal)*

IEC 68-2-7: 1983, *Environmental testing – Part 2: Tests – Test Ga and guidance: Acceleration, steady state*
Amendment 1 (1986)

IEC 68-2-10: 1988, *Environmental testing – Part 2: Tests – Test J and guidance: Mould growth*

IEC 68-2-13: 1983, *Environmental testing – Part 2: Tests – Test M: Low air pressure*

IEC 68-2-14: 1984, *Environmental testing – Part 2: Tests – Test N: Change of temperature*
Amendment 1 (1986)

IEC 68-2-17: 1978, *Environmental testing – Part 2: Tests – Test Q: Sealing*
Amendment 4 (1991)

IEC 68-2-20: 1979, *Environmental testing – Part 2: Tests – Test T: Soldering*
Amendment 2 (1989)

IEC 68-2-21: 1983, *Environmental testing – Part 2: Tests – Test U: Robustness of terminations and integral mounting devices*
Amendment 2 (1991), Amendment 3 (1992)

IEC 68-2-27: 1987, *Environmental testing – Part 2: Tests – Test Ea and guidance: Shock*

IEC 68-2-29: 1987, *Environmental testing – Part 2: Tests – Test Eb and guidance: Bump*

IEC 68-2-30: 1980, *Environmental testing – Part 2: Tests – Test Db and guidance: Damp heat, cyclic (12 + 12-hour cycle)*
Amendment 1 (1985)

IEC 68-2-42: 1982, *Environmental testing – Part 2: Tests – Test Kc: Sulphur dioxide test for contacts and connections*

IEC 68-2-45: 1980, *Environmental testing – Part 2: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 68-2-52: 1984, *Environmental testing – Part 2: Tests – Test Kb: Salt mist, cyclic (sodium chloride solution)*

IEC 68-2-58: 1989, *Environmental testing – Part 2: Tests – Test Td: Solderability, resistance to dissolution of metallization and to soldering heat of Surface Mounting Devices (SMD)*

IEC 270: 1981, *Partial discharge measurements*

IEC 367-1: 1982, *Cores for inductors and transformers for telecommunications – Part 1: Measuring methods*
Amendment 1 (1984), Amendment 2 (1992)

IEC 551: 1987, *Determination of transformer and reactor sound levels*

IEC 617, *Graphical symbols for diagrams*

IEC 651: 1979, *Sound level meters*
Amendment 1 (1993)

IEC 695-2: *Fire hazard testing – Part 2: Test methods*

IEC 695-2-2: 1991, *Fire hazard testing – Part 2: Test methods – Section 2: Needle-flame test*

IEC 695-2-4/0: 1991, *Fire hazard testing – Part 2: Test methods – Section 4/Sheet 0: Diffusion type and pre-mixed type flame test methods*

IEC 695-2-4/1: 1991, *Fire hazard testing – Part 2: Test methods – Section 4/Sheet 1: 1 kW nominal pre-mixed test flame and guidance*

ISO 3: 1973, *Preferred numbers – Series of preferred numbers*

ISO 497: 1973, *Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers*

ISO 1000: 1992, *SI units and recommendations for the use of their multiples and of certain other units*

3 Terminology

For the purpose of this standard the following definitions apply in addition to those of IEC 50:

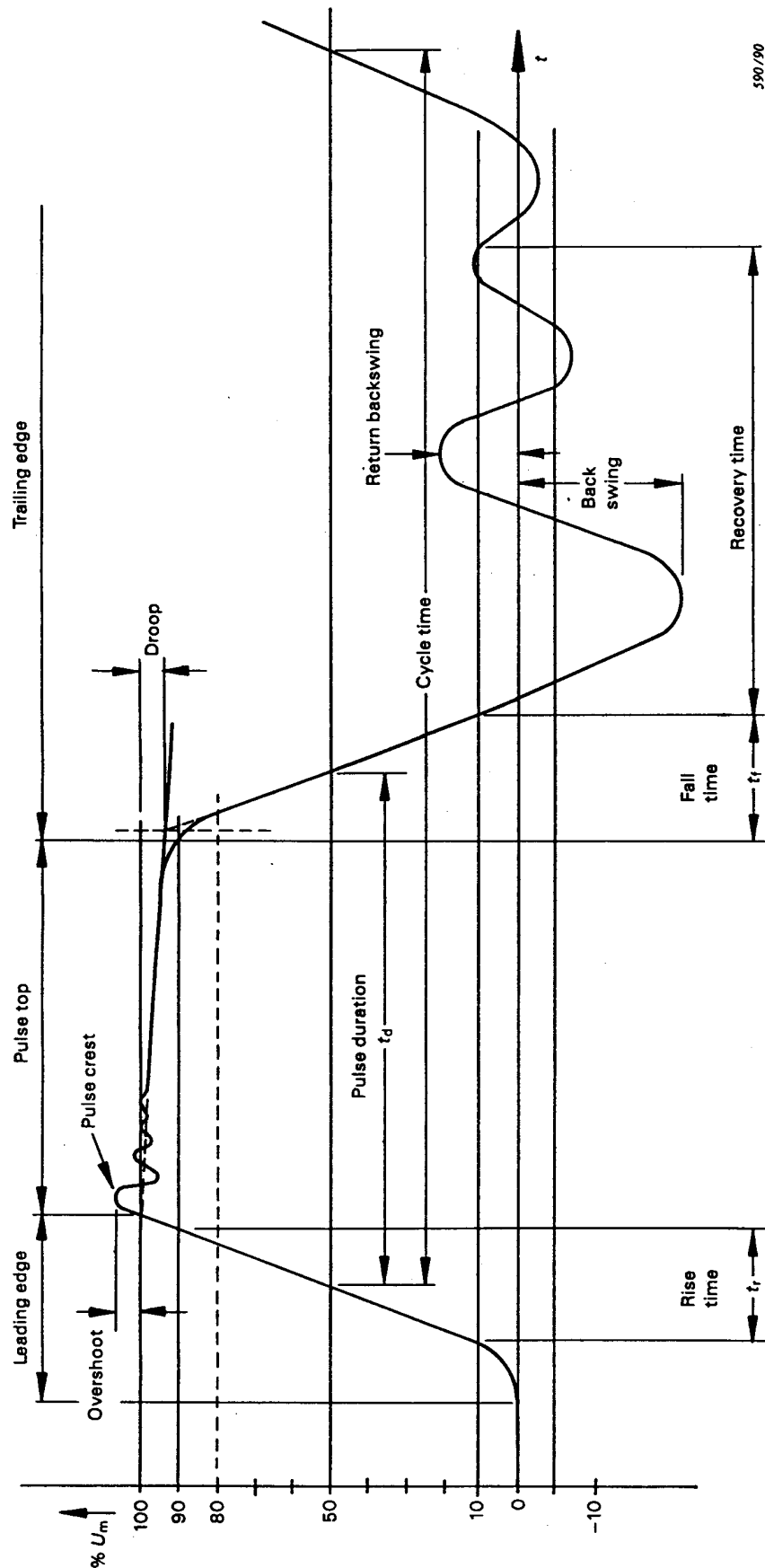
3.1 **component:** A transformer or an inductor.

3.2 **peak working voltage:** The maximum instantaneous voltage for which the winding insulation is rated under working circuit conditions.

3.3 **pulse waveform parameters** (see figure 1)

a) **peak pulse amplitude, U_m :** The maximum value of an extrapolated smooth curve through the top of the pulse, excluding any initial "spike" or "overshoot", the duration of which is less than 10 % of the pulse duration.

b) **pulse duration, t_d :** The time interval between the first and last instants at which the pulse amplitude equals 50 % of the peak pulse amplitude.



NOTE - For clarity in illustrating droop, the 80% and 10% points have been used in constructing the line which determines the border between the pulse top and the trailing edge.

Figure 1 - Pulse waveform parameters

c) **pulse rise time, t_r** : The interval between the first instant at which the pulse amplitude reaches 10 % of the peak pulse amplitude and the first instant at which the pulse amplitude reaches 90 % of the peak pulse amplitude, excluding any unwanted or irrelevant portion of the waveform.

d) **pulse fall time, t_f** : The interval between the last instant at which the pulse amplitude reaches 90 % of the peak pulse amplitude and the next instant at which the pulse amplitude reaches 10 % of the peak pulse amplitude, excluding any unwanted or irrelevant portion of the waveform.

NOTE – Where the value of the droop approaches 10 % of the peak pulse amplitude, the upper point defining fall time may be replaced by the last instant at which the pulse amplitude reaches 80 % of the peak pulse amplitude.

e) **droop**: The difference between the peak pulse amplitude and the amplitude of the extrapolated smooth curve through the top of the pulse, excluding any initial "spike" or "overshoot", at its intersection with the straight line through the points defining the pulse fall time, expressed as a percentage of the peak pulse amplitude.

f) **pulse crest**: The maximum amplitude of the pulse.

g) **overshoot**: The amount by which the pulse crest exceeds the peak pulse amplitude. Overshoot is expressed as a percentage of the peak pulse amplitude.

h) **backswing**: The maximum amplitude of the reverse pulse, i.e. the portion of the pulse after the zero-crossing, expressed as a percentage of the peak pulse amplitude.

i) **return backswing**: The maximum amplitude of the swing that follows the backswing, expressed as a percentage of the peak pulse amplitude.

j) **recovery time**: The time interval between the end of the pulse fall time and the time at which the pulse amplitude last reaches +10 % of the peak pulse amplitude. Exceptionally, a figure less than 10 % may be used, in which case the interval is termed "the X % recovery time".

k) **pulse repetition frequency (prf)**: The average number of pulses in unit time when this is independent of the period over which it is measured.

3.4 **Q factor (quality factor)**: The ratio of the energy stored to the energy dissipated during one cycle at a particular frequency in a specified winding. It is expressed in terms of either the series or the parallel components of reactance and loss resistance.

3.5 **harmonic distortion**: The square root of the sum of the square of all harmonic voltages up to and including the seventh harmonic (excluding the fundamental) expressed as a percentage or as a ratio in decibels of the fundamental.

3.6 **maximum winding temperature**: The mean temperature rise of any winding of the component under full load, when thermal stability has been achieved, added to the specified maximum ambient temperature.

3.7 **voltage-time product rating**: The voltage pulse amplitude multiplied by the time elapsed from the start of the pulse within which the non-linearity of the magnetizing current does not exceed a specified value.

3.8 **background (acoustic) noise**: The noise measured at a measuring point with the exclusion of that produced by the component under test.

3.9 compass safe distance: The distance from the pivot of the test magnetometer or compass to the nearest point on the surface of the component under test, at which the magnetic deviation is limited to a stated value.

3.10 duty ratio; duty factor: The ratio of pulse duration t_d to the cycle time.

3.11 current transformer parameters

a) **burden:** That property of the circuit connected to the secondary winding of a current transformer which determines the real and reactive power at the secondary terminals. It is expressed as total impedance with effective resistive and reactive components or as the total volt-amperes and power factor at the specified values of current and frequency.

b) **current transformation ratio, k :** The ratio of the r.m.s. value of the primary current to the r.m.s. value of the secondary current under specified conditions.

c) **phase angle:** The angular displacement between the vectors representing the primary and secondary currents of the transformer. The phase angle is positive when the secondary current leads the primary current.

d) **ratio error:** The difference between the measured current transformation ratio k and its nominal value k_n , divided by the measured value, and expressed as a percentage.

$$\text{ratio error} = \frac{k_n - k}{k} \times 100 \text{ (per cent)}$$

3.12 electrostatic screen: A conducting screen inserted between windings that, when it is connected to earth, considerably reduces the transference of unwanted signals from one winding to the other via interwinding capacitance.

3.13 protective screen: A conducting screen inserted between windings that, when it is connected to earth, effectively prevents fault currents flowing between those windings, in the event of an insulation failure.

NOTE: "protective" is often replaced by "safety", "isolating", or "earth".

3.14 polarity (applicable to single-phase windings): A property of a single-phase winding such that a terminal on one winding has the same polarity as a terminal on another winding if, when the other ends of the windings are connected to form a common terminal and the transformer/inductor is energized with a sinusoidal voltage, the induced voltage appearing between each of the two terminals and the common terminal is rising positively through zero at the same instant of time.

3.15 uniformly-insulated winding: A winding in which the insulation to earth is, at all points, designed to withstand an electric strength test of a value appropriate to the insulation of the high-voltage end.

3.16 graded-insulated winding: A winding in which insulation to earth is graded from the amount at the high-voltage end to a smaller amount at the low-voltage end.

NOTE – Such a winding should withstand an electric strength test of a value appropriate to the insulation of the low-voltage end.

4 Test procedures

4.1 Test and measurement conditions

Unless otherwise specified all tests shall be carried out under standard atmospheric conditions for testing as specified in IEC 68-1. Where there is a requirement for components to attain temperature stability this shall be in accordance with 4.8 of IEC 68-1.

Unless otherwise stated in the detail specification, all voltages and currents shall be sinusoidal; values shall be taken as r.m.s. and polyphase supplies shall be assumed to be balanced.

The "information to be stated" that is required to complete the descriptions of test methods in this clause shall be specified in the relevant detail specification for the component. The detail specification shall also specify the test fixture to be used in association with a component, where this is intended for use at frequencies high enough for the length of test leads to become significant.

4.1.1 Measurement uncertainty

The limits quoted in detail specifications shall be absolute. The tolerance values applying to the actual measurement system shall be taken into account when the measurements are assessed against specification limits. Where tolerances in respect of set conditions or instrument error have been prescribed these shall be regarded as additional minimum requirements.

4.1.2 Alternative test methods

The test and measurement methods given in the relevant specification shall not be regarded as the only methods to be used. Special test equipment and automatic test sets are available, which may also be used. However, the tester shall satisfy the customer or relevant authority (see Note 1) that any alternative methods which he may use will give results equivalent (see Note 2) to those obtained by standard methods. In the case of dispute, for referee and reference purposes the specified methods only shall be used. Alternative test methods shall not be shown in detail specifications.

NOTES

1 Such as a National Supervising Inspectorate within the IECQ scheme.

2 By "equivalent" it is meant that the value of the characteristic established by such other method and deemed acceptable in accordance with the limits ascribed to such other method will fall within the specified limits when measured by the specified method.

4.2 Visual inspection

Visual inspection shall be performed under normal factory lighting without visual aids. The condition, workmanship, marking and finish shall be satisfactory.

NOTE – If special lighting and/or visual aids are necessary for the acceptance of particular components (e.g. very small components), these may be specified as additional tests in the relevant detail specification.

4.2.1 *Protective screen position*

NOTE: "protective" is often replaced by "safety", "isolating", or "earth".

Purpose: To determine the position of a protective screen in relation to adjacent windings.

Procedure: The fitted and positioned protective screen shall be inspected before being obscured by subsequent windings. The protective screen shall:

- a) totally cover the winding around which it is wrapped such that the "finish" end overlaps the "start" end by no less than the amount specified in the detail specification;
- b) be adequately insulated so as not to comprise a short-circuited winding;
- c) have edges extending sufficiently along the winding being screened to prevent direct contact between windings.

NOTE – Screens fitted to toroidal transformers may consist of a number of turns of conductive strip provided that each turn overlaps the adjacent turn by not less than 5 % of the strip width.

Information to be stated:

- minimum overlap.

4.2.2 *Quality of solder joints*

NOTE – A good solder joint is one that has excellent electrical contact between the parts joined and good mechanical strength. Examples of good solder joints are shown in figure 2. Figure 3 illustrates defective joints.

Purpose: To determine the quality of all solder joints.

Procedure: All solder joints shall be inspected to ensure that the following requirements are complied with:

Requirements: Soldered joints shall:

- a) exhibit good tinning as evidenced by the free flowing of solder with wetting of the termination;
- b) be smooth with no spikes;
- c) be bright and shiny;
- d) be without rough patches;
- e) shall have a concave surface and the outline of the wire shall be visible under the surface of the solder;
- f) not have been moved during soldering (such joints exhibit an "orange peel" effect, as shown in figure 3a);
- g) not be "dry" (that is, shall not exhibit a distinct line where the solder fillet joins the wire or have a high contact angle between the solder and the wire (see figure 3b));
- h) be wired at terminals in such a way as to leave no residual stress (see figure 3c);
- i) not exhibit "wicking" (that is, the joining wire shall not be overheated, leading to the movement of solder into multi-stranded wires (see figure 3d)).

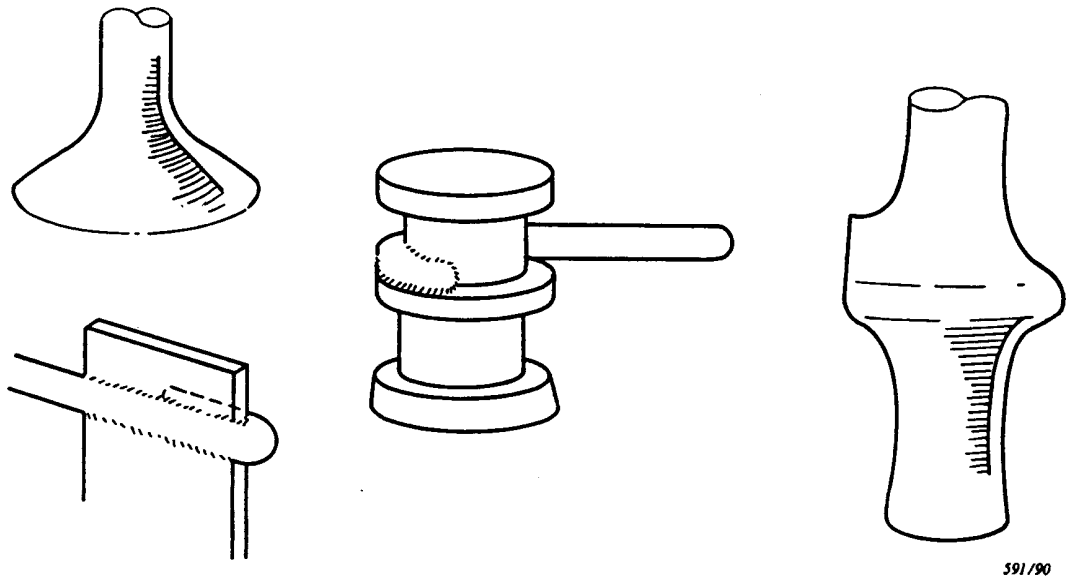


Figure 2 – Examples of good solder joints

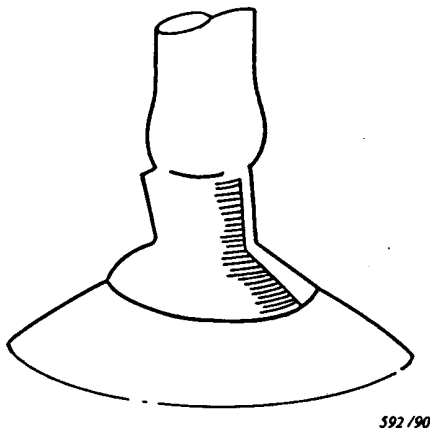


Figure 3a - Moved joint

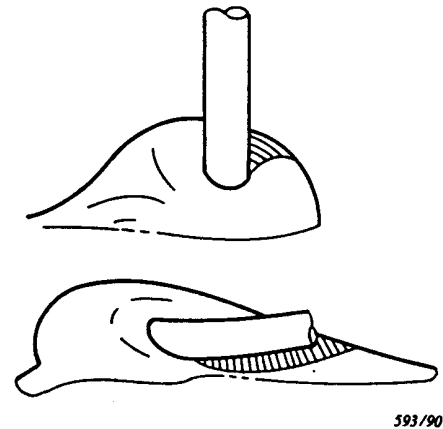


Figure 3b - Dry joints

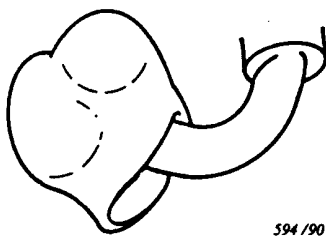


Figure 3c - Mechanically stressed joint

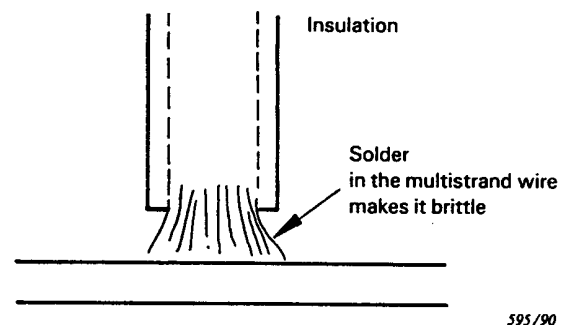


Figure 3d - Wicking

Figure 3 – Examples of defective joints

4.3 *Dimensioning and gauging procedure*

The dimensions shall be verified as being in accordance with the relevant specification.

4.4 *Electrical test procedures*

4.4.1 *Winding resistance*

4.4.1.1 *D.C. winding resistance*

Purpose: To determine the d.c. resistance of a winding or windings between specified terminations.

Procedure: The resistance shall be measured by a suitable method.

Where required by the detail specification, the ambient temperature θ (in °C) shall be measured and the result of the resistance measurement R_m (in Ω) corrected to the corresponding value at 20 °C, R_{20} (in Ω) by means of the following formula:

$$R_{20} = \frac{k + 20}{k + \theta} R_m$$

where k is a constant related to the thermal coefficient of resistivity. For the purposes of this standard, the value for copper shall be taken as 234,5 and for aluminium as 228,1.

NOTE – For safety reasons, consideration should be given to short-circuiting windings capable of producing high voltages at current interruption.

Information to be stated:

- a) terminations between which the measurement is to be made;
- b) whether the result of measurement should be corrected to 20 °C, and if so, the value of k to be used for materials other than copper or aluminium.

NOTES

- 1 The selected method should be determined by the ease of operating the test and the accuracy required. The accuracy of the equipment should be at least ten times better than the accuracy required of the test.
- 2 The measuring current should not be so large as to cause self-heating or to have a significant magnetizing effect on the component.

4.4.1.2 *Continuity*

Purpose: To verify the continuity of a specified winding.

Procedure: Continuity shall be established using a suitable d.c. or a.c. voltage or current source, and a suitable detector.

Information to be stated:

- winding to be tested.

NOTES

- 1 The current should not be so large as to have a significant magnetizing effect on the component.
- 2 Care should be taken in testing a winding with a high inductance value as a high voltage may be generated.
- 3 Where there are parallel paths, as with multiple windings or in polyphase components, a d.c. resistance check may be necessary to ensure that the path under examination is not being influenced by shunt paths.

4.4.2 Insulation tests

4.4.2.1 Electric strength test

Purpose: To ensure that the insulation of uniformly-insulated windings and the low-voltage end insulation of graded-insulated windings are adequate.

NOTES

- 1 This test is not suitable for the high-voltage end insulation of windings having graded insulation or designed to have one point earthed*. The high-voltage end insulation of such windings can be tested only by the application of an appropriate induced voltage test (see item b) of **special conditions of test of 4.4.2.2**).
- 2 In certain cases it may be appropriate to demonstrate the adequacy of the low-voltage end insulation of graded-insulated windings during the induced voltage test (see item b) of **special conditions of test of 4.4.2.2**).

Procedure: A test voltage whose value is selected from the table below, unless otherwise specified, shall be applied between specified pairs of isolated elements of the component. All windings shall be short-circuited. Windings and screens on one side of the insulation system shall be connected to frame, core and earth while windings and screens on the other side shall be connected together.

Electric strength test voltages

Peak working voltage V_{pk}	A.C. test voltage, 45 - 65 Hz (r.m.s.) $V_{r.m.s.}$	D.C. test voltage V
<25	50	71
>25 to 50	100	141
>50 to 100	300	424
>100 to 175	500	707
>175 to 700	2,8 x peak working voltage 1,4 x peak working voltage + 1 000	4 x peak working voltage 2 x peak working voltage + 1 400

The test voltage shall be increased at a convenient rate but not exceeding 2 kV per second, from zero to the specified value, maintained at this value for the specified time (unless breakdown occurs), then decreased to zero at the same rate.

* In the USA, "ground" is used in place of "earth" and "grounded" in place of "earthed".

For fluid-filled components, except for those designed for operation in one plane only and so marked, approximately half the test sample shall be tested with terminals uppermost and half with the terminals underneath.

If a specified environmental conditioning is required for this test the component shall be held for a minimum of 6 h unless otherwise specified in the specified conditions. (See IEC 68 for information on environmental testing.)

There shall be no evidence of heating, breakdown or deterioration. Ionization shall not be regarded as a criterion of breakdown. The leakage current shall not exceed the specified value.

Information to be stated:

- a) terminations between which the test is to be made;
- b) test voltage (for a winding having graded-insulation, values shall be given for both ends of the winding);
- c) frequency of a.c. test voltage (if different from the values shown in the table);
- d) test duration;
- e) maximum leakage current, if specified.

NOTES

3 If breakdown occurs during the test it can at first be detected by sporadic and intermittent increases in leakage current followed by a significant increase to a constant higher value which, on many electric strength test sets, is accompanied by a partial or complete collapse of the voltage. This type of breakdown may be caused by partial breakdown in ionized voids and weakened insulation which then avalanches to complete breakdown in the form of arc-over or arc-through.

4 Electric strength test voltages may be hazardous. Extreme care should be taken in performing this test.

4.4.2.2 Induced voltage test

Purpose: To verify the adequacy of inter-turn and inter-layer insulation of transformers and inductors, and to verify the adequacy of the high-voltage end insulation of windings having graded-insulation.

Special conditions of test

The following special conditions apply:

- a) Uniformly insulated windings are normally tested as in **Procedure 1, 2 or 3**, as appropriate. Any point of a winding may be earthed during the test as specified.
- b) Windings having graded-insulation are normally tested as in **Procedure 1, 2 or 3**, as appropriate. A point on such a winding may be earthed or raised to a specified voltage above earth during the test. The induced voltage shall be such that, when added vectorially to any applied voltage, the high-voltage end of the winding is raised to the appropriate peak test voltage given in 4.4.2.1, **Procedure**.

If the specified voltage above earth is alternating, then it shall be of the same frequency as the induced voltage.

NOTE 1 – In general, during the execution of the induced voltage test, no winding should be permitted to “float”, i.e. to remain unconnected at both ends.

Procedure 1: Applicable to transformers and inductors intended for energizing by sinusoidal waveforms.

A specified test voltage of not less than twice the rated supply voltage at a frequency of not less than twice the lowest rated frequency shall be applied across the specified winding. The duration and manner of application shall be as specified in the detail specification.

Procedure 2: Applicable to transformers and inductors intended for energizing by pulse waveforms.

Specified test voltage pulses of amplitude not less than twice the rated pulse amplitude, at a specified pulse repetition frequency of not less than 25 % of the maximum rated pulse repetition frequency and with a specified pulse duration not less than 25 % of the rated maximum pulse duration and normally* not greater than 50 % of the rated pulse duration shall be applied across the winding. The duration and manner of application shall be as specified in the detail specification.

Procedure 3: Applicable to transformers and inductors intended for energizing by non-sinusoidal periodic waveforms such as those in power supplies operating with semi-conductors in a switched mode.

A specified sinusoidal test voltage of peak value not less than twice the maximum rated peak value for the input voltage waveform and at a specified frequency, derived as follows, shall be applied across the specified winding. The duration and manner of application shall be as specified in the detail specification.

The test frequency shall be such that its cyclic period is normally** not greater than the effective shortest half-cycle period of the operative waveform for which the component is intended e.g. in the case of pulse width modulated symmetrical or asymmetrical waveforms the effective half-cycle shall be taken to be the effective minimum on-time of the electronic switch.

Duration for application of test voltage in Procedures 1, 2 and 3

The duration of application of the test voltage shall be specified as one of the following:

- a) The applied voltage shall be raised from one-third of the specified voltage to the full

* Pulse durations greater than 50 % of the rated maximum value may be specified provided that core flux saturation or other abnormalities are shown not to be incurred thereby.

** A lower test frequency may be specified provided that core flux saturation or other abnormalities are shown not to be incurred thereby.

value which shall then be maintained for $60\text{ s} \pm 5\text{ s}$ before reducing the voltage to one-third of its value and hence to zero.

b) 5 s to 10 s (value to be stated).

Requirements:

There shall be no evidence of heating, breakdown or deterioration. Ionization shall not be regarded as a criterion of breakdown.

Information to be stated in the detail specification:

- a) the test voltage (r.m.s. or peak as applicable);
- b) the winding(s) to be energized (see note 2);
- c) the winding point intended to be connected to a known potential and the value of this potential (if applicable);
- d) the duration of application of test voltage;
- e) the test frequency or pulse repetition frequency (as applicable);
- f) the pulse duration (applicable to Procedure 2).

NOTE 2 - A source of test voltage may be connected to windings other than the normal input winding in order to obtain the necessary voltages.

4.4.2.3 Insulation resistance

Purpose: To measure the resistance of the insulation between the various parts of the component.

Procedure: Unless otherwise specified the insulation resistance shall be measured with a d.c. voltage of either:

- 100 V $\pm$ 15 V for windings with peak working voltage < 500 V, or
- 500 V $\pm$ 50 V for windings with peak working voltage $\geq$ 500 V.

The test voltage shall be applied until a steady reading is obtained or, failing that, for $60\text{ s} \pm 5\text{ s}$.

If a specified environmental conditioning is required the component shall be held in the specified condition for a minimum of 6 h, unless otherwise specified. (See IEC 68 for information on environmental testing.)

Information to be stated:

- a) terminations between which the measurement is to be made;
- b) peak working voltage of each winding;
- c) environmental conditioning.