

INTERNATIONAL STANDARD

Inductive components – Reliability management





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Inductive components – Reliability management

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INDUCTIVE COMPONENTS – RELIABILITY MANAGEMENT**FOREWORD**

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International Standard IEC 62211 has been prepared by IEC technical committee 51: Magnetic components, ferrite and magnetic powder materials.

This second edition cancels and replaces the first edition published in 2003. This edition constitutes a technical revision.

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

- a) continuous shock and mechanical shock are integrated in the test conditions;
- b) the normative references in Table 3 are changed.

The text of this standard is based on the following documents:

FDIS	Report on voting
51/1150/FDIS	51/1158/RVD

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

This publication has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this publication will remain unchanged until the stability date indicated on the IEC web site under "<http://webstore.iec.ch>" in the data related to the specific publication. At this date, the publication will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

A bilingual version of this publication may be issued at a later date.

INDUCTIVE COMPONENTS – RELIABILITY MANAGEMENT

1 Scope

This document is applicable to inductive components (chokes and transformers) based on magnetically soft materials. These are components based especially on laminated iron sheets, iron powder materials (including alloys), as well as ferrites and amorphous or crystalline metal band cores.

Winding assemblies mean wire winding assemblies as well as multilayer and stacking technologies of planar technology including coils based on non-magnetic materials. Discrete type components and the different types of surface mount inductive components (SMD) are also considered in this document.

The reliability of assemblies of inductive components based on several technologies such as glued types, types with clamps (clips), impregnated (varnished) types as well as (vacuum) potted types can also be checked with this document.

The subsequent determinations can be applied either for the primary qualification of inductive components or for all manners of requalification examinations (design, process, change of production facility). They can also be applied for the monitoring of products out of actual manufacturing processes.

This document sets up a broad basis of electric and mechanical criteria of failure test procedures.

If manufacturers advertise compliance with this standard in their data sheets, customers can request data to demonstrate compliance with this standard. The customers can also request the product to be in compliance with this standard by a recognised body.

Customers and manufacturers can elect to perform additional testing and acceptance criteria different than those defined in this standard.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-6, *Environmental testing – Part 2-6: Tests – Test Fc: Vibration (sinusoidal)*

IEC 60068-2-14, *Environmental testing – Part 2-14: Tests – Test N: Change of temperature*

IEC 60068-2-27, *Environmental testing – Part 2-27: Tests – Test Ea and guidance: Shock*

IEC 60068-2-30, *Environmental testing – Part 2-30: Tests – Test Db: Damp heat, cyclic (12 h + 12 h cycle)*

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 60068-2-78, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60424 (all parts), *Ferrite cores – Guidelines on the limits of surface irregularities*

IEC 61007:1994, *Transformers and inductors for use in electronic and telecommunication equipment – Measuring methods and test procedures*

IEC 61248 (all parts), *Transformers and inductors for use in electronic and telecommunication equipment*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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>

3.1

reliability

<inductive component> component level reliability of the inductive component in the customer's electrical circuit application

3.2

reliability tests

<component level> sequence of tests performed on an individual component, each specific test being designed to represent conditions under which the component is expected to operate in end applications

Note 1 to entry: Categories of test levels are organised to be consistent for typical applications.

3.3

reliability tests

<system level> sequence of tests performed on a collection of components as arranged in a specific end application under working conditions

3.4

component family

group of components characterised by the same common features, for example the same magnetic base material, the same core size and the same winding type

4 Component families

In a similar way to the qualification rules contained in IEC 61248 (all parts), reliability tests can be performed on typical samples representing families of inductive components.

A family of inductive components is defined on the basis of:

- the same application class as specified in IEC 61248 (all parts);

- the same magnetic base material group (for example ferrite, metal powder, etc.);
- the same core shape (for example E-type, RM, ring core, etc.);
- the same winding type (for example wire-wound, multilayer, stack, etc.);
- the same termination configuration (PTH, SMD etc.);
- comparable accessories and insulating materials (bobbin, clamps, insulating tapes, etc.);
- the same insulation principle (encapsulation, impregnation, potting).

This means that reliability tests for a family of unencapsulated, wire-wound PTH transformers on RM ferrite cores, for instance, can be carried out representatively on small and large size models (for example RM4 and RM14).

Similar conclusions applied to the other sizes regarding reliability can be made, as long as one can prove that all materials used are the same in terms of their load characteristics.

NOTE This applies in particular to the properties of the magnetic materials (NiZn-ferrite cannot be handled in the same way as, for example, MnZn-ferrite), the bobbin (plastic/shape), as well as other materials such as clips, bonding agents, spacers and insulating tapes.

5 Test samples

5.1 Classification by application

With regard to their application in accordance with the rules of IEC 61248 (all parts), the inductive components to be specified here are classified into the following classes:

- signal transformers (ST);
- power transformers (PT);
- power transformers for switched mode power supplies (PTS);
- pulse transformers (IT);
- inductors (chokes) (C);
- RF inductors (RF);
- intermediate frequency transformers (HF).

This classification as well as a further classification with regard to the core shape and the magnetic material shall be documented. In a short technical description the materials used as well as the construction of the inductive component shall be presented, and a data sheet as well as a test specification for this shall be enclosed. It is necessary to specify for entirely encapsulated inductive components the dimensions with their tolerances and a sectional view of the construction.

All test samples shall be manufactured in the actual production environment with the same tools and materials as used during regular production.

5.2 Numbering of samples and content of test report

All test samples shall be numbered. All test reports shall contain the following information:

- part number;
- date code;
- location of manufacture.

5.3 Pre-treatment of test samples

5.3.1 Magnetic pre-treatment

It is essential to ensure that the test samples are in a magnetically neutral state, i.e. if necessary they should undergo a demagnetisation cycle before the tests are conducted (in accordance with IEC 61007).

5.3.2 Mechanical pre-treatment

For all tests, the test samples should be mounted on carrier boards that allow easy contacts, for example printed circuit boards with plated-through holes (reflow soldering, wave soldering, screw-mounting, etc.). The carrier board may not be necessary for very large components.

5.3.3 Exposure to reflow temperature profile

Multiple exposures to a reflow cycle before testing shall be a pre-requisite to performing the test of Table 2. The suggested temperature profile for solder reflow components is in accordance with IEC 60068-2-58.

The number of cycles and the temperature should be specified in the detail specification.

6 Failure criteria

Failure criteria are mechanical properties and electrical characteristics that guarantee that the inductive components will work as specified, with serious impairments in performance as a result if they are not met.

The mechanical failure criteria given in Table 1 are all designated as “general” failure criteria, which means that they shall be checked at every stage of the test sequence in which measurements shall be made or the failure criteria checked. In the electrical tests as specified in Table 2, the general failure criteria should be treated in the same way as the mechanical failure criteria.

The other electrical criteria can be considered as a list of suggestions which may, but do not necessarily have to be, tested, depending on their relevance to the application. They shall be specified explicitly in a qualification according to this document.

Extra criteria may be added to both the mechanical and the electrical failure criteria according to customer requirements. In agreement with the customer, these can be used as additional criteria for a general family release (where at least one other component size is being tested), in order to achieve qualification for the whole component family.

A component family may be specified on the data sheet as being “in accordance with IEC 62211” if the “general” failure criteria given in the “test evaluation” (see Clause 9) are met. The rider “for the following application classes ...” can only be given if the corresponding failure criteria have been explicitly listed on the data sheet.

If only certain failure criteria given in this document are investigated during a reliability test, then the manufacturer of the inductive component is entitled to include a reference in a table or footnote to all “tests with failure criteria as given in IEC 62211”. Full compliance, however, cannot be claimed.

The mechanical failure criteria listed in Table 1 are general failure criteria (apart from solvent resistance) which are checked before and after the tests within the framework of the component analysis.

If for special properties a trend of change caused by the tests is expected, this trend should be fixed as part of the relevant failure criteria. Supplier data sheets which refer to IEC 62211 should contain this trend as part of the property. Trends can be agreed upon between interested parties.

Table 1 – General mechanical failure criteria

Parameter	Failure definition	Measuring method ^a /test criterion
Glue joint	Cracks in the joint Breakage of the joint Glue comes off	<u>Visual inspection (10× magnification)</u> Cracks, breakage of the glue or glue coming off are generally not admissible
Wire	Wire breakage Damaged insulating varnish	<u>Visual inspection (10× magnification)</u> Damaged insulating varnish Max. of test wire diameter: wire diameter < 0,5 mm 0,5 mm max.: wire diameter > 0,5 mm NOTE This wire damage is the one caused by the reliability test in addition to the damage by pre-soldering prior to the test.
Coil former	a) Deforming b) Cracks c) Breakage Mobility of the pins	<u>Visual inspection (10× magnification) for items a), b), and c)</u> <u>Mobility of pins in manual test not admissible</u> Terminal retention test shall be specified between parties concerned
Mounting parts	Snap and damage of mounting parts (clamps, covers, insulating tape)	<u>Visual inspection on presence of part and on correct functioning</u> An insulating tape is considered as detached if the winding under the tape is visible
Encapsulation	Splinters Cracks Flaking, delamination, bulging	<u>Visual inspection (10× magnification)</u> Not admissible
	Molding resin comes off the case (housing)	<u>Visual inspection (10× magnification)</u> . Generally not admissible for components working at operating voltage > 100 V For components working at operating voltage < 100 V, only admissible if conducting contact between case and transformer can be excluded (to be proved by constructional drawing showing sectional view)
	Bubble formation in vacuum potting	Bubbles are not permitted
Solvent resistance (optional)	Chemical reaction with ambient substances	(Definitions of failure criteria and measuring methods according to customer specifications only)
Magnetic components (ferrite cores, iron powder cores, alloy power cores, metal band cores)	Chips Cracks Breakage	Testing and failure criteria according to IEC 60424 (all parts)
Solder joint at inductive component (not solder joints at carrier board)	Modifications of the solder joints (compared to the state when supplied)	<u>Visual inspection (10× magnification)</u> Evaluation according to IEC 61007:1994, 4.2.2
NOTE The measuring method is underlined.		

Table 2 lists the electrical properties of the components, the respective standards and test conditions and special requirements.

Table 2 – Electrical failure criteria

Parameter	Application class ^a	Failure definition	Measuring method ^b
Inductance or impedance	General	Beyond the scope of the specification ^c	4.4.4.1
Conducting state of winding	General	No conduction	Same measurement as DC resistors (4.4.1.1)
High-voltage resistance	General	Beyond the scope of the specification	4.4.2.1
Polarity	General	Incorrect polarity	Same measurement as turns ratio (no standard criterion for single winding chokes) 4.4.17 or transformation ratio 4.4.7.1
Turns ratio	General	Incorrect turns ratio	(See polarity)
DC resistance	General	Beyond the scope of the specification ^c	4.4.1.1
Quality factor Q	C, ST	Beyond the scope of the specification ^c	4.4.3.3
Resonant frequency	C, PTS, RF, HF, ST, IT	Beyond the scope of the specification	4.4.8.1
Leakage inductance	PT, PTS, HF, ST, IT	Beyond the scope of the specification	4.4.4.2
No-load current	PT, PTS, ST	Beyond the scope of the specification	4.4.3.1
Magnetic shielding	PT, PTS, RF, HF, ST, IT	Beyond the scope of the specification	4.4.21.1
Insulation resistance (standard atmospheric conditions)	PT, PTS, HF, ST, IT	Beyond the scope of the specification	4.4.2.3
Capacitive test of shields	PT, C, PTS, ST, IT	Beyond the scope of the specification	4.4.18.1
Noise level	PT, C, PTS, ST, IT	Beyond the scope of the specification	4.4.19.1
Capacitance	PTS, HF, ST, IT	Beyond the scope of the specification	Self-capacitance 4.4.6.1 Interwinding capacitance 4.4.6.2
Magnetic flux leakage	PT, C, PTS	Beyond the scope of the specification	4.4.21.2
Temperature rise	PT, PTS, IT, C, RF, HF, ST	Beyond the scope of the specification	4.4.15
Short-term (operation under load)	PT, PTS, HF, ST, IT	Beyond the scope of the specification	4.6.1 (only applicable to special HF components)
Insertion loss	HF, ST	Beyond the scope of the specification	4.4.9.1
Return loss	HF, ST	Beyond the scope of the specification	4.4.9.2
Total harmonic distortion	HF, ST	Beyond the scope of the specification	4.4.13
Voltage-time loadability	PTS, IT	Beyond the scope of the specification	4.4.12
^a According to IEC 61248 (all parts).			
^b Subclause number according to IEC 61007:1994.			
^c Depending on the materials and assemblies used, shifts of parameters during the test may be allowed as far as specified or agreed upon.			

7 Test conditions and specification of the minimum requirements

Table 3 specifies the test conditions for the test specimen of reliability tests. There are two different types of test conditions:

All conditions which are designated as “optional” are based on application-specific requirements and cannot be specified in general terms. They are not binding for compliance with this document.

When all general conditions of this document are complied with, the manufacturer is allowed to state in a data sheet that the component series is also in accordance with the optional test conditions of IEC 62211 when all of their details are specified.

NOTE 1 Bending and solderability have not been considered in Table 3 but can be added and the tests performed according to IEC 60068-2-21, IEC 60068-2-20, IEC 60068-3-13, IEC 60068-2-54 and IEC 60068-2-58.

NOTE 2 Substrate bending according to IEC 60068-2-21 and solderability/resistance to soldering heat according to IEC 60068-2-20, IEC 60068-3-13, IEC 60068-2-54 and IEC 60068-2-58 have not been considered in Table 3, but if these tests are requested they could be performed according to these documents.

Table 3 – Test conditions (1 of 2)

Items		Level S ^a	Level A ^a	Level B ^a	Level C ^a	Level D ^a
Temperature cycle according to IEC 60068-2-14 Test Na	No. of cycles	1 000 ^b	1 000 ^b	100 ^c	100	10
	High temperature	150 °C	125 °C	125 °C ^d 105 °C ^d 85 °C ^d	85 °C	70 °C
	Low temperature	–55 °C	–40 °C	–40 °C	–40 °C	–25 °C
	Transit period $m < 15$ g	30 s	30 s	30 s	3 min	3 min
	Transit period 500 g $> m \geq 15$ g	3 min	3 min	3 min	3 min	3 min
	Transit period $m \geq 500$ g	55 min	55 min	55 min	55 min	55 min
	Dwell time	30 min	30 min	30 min	30 min	30 min
Humidity test according to IEC 60068-2-78	Condition	85 °C/85 % RH	85 °C/85 % RH	40 °C/90 % RH ^e 60 °C/90 % RH ^e 85 °C/85 % RH ^e	40 °C/90 % RH	40 °C/90 % RH
	Period	1 000 h	1 000 h	1 000 h	96 h	96 h
Storage test according to IEC 60068-2-2 Test Bb	Storage temperature	150 °C	125 °C	125 °C ^d 105 °C ^d 85 °C ^d	85 °C	70 °C
	Duration	1 000 h	1 000 h	1 000 h	500 h	96 h
Non-repetitive shock according to IEC 60068-2-27		2 000 m/s ² 6 ms, 3 axes	1 000 m/s ² 6 ms, 3 axes	1 000 m/s ² 6 ms, 3 axes	1 000 m/s ² 6 ms, 3 axes	Not specified
Vibration-sinusoidal according to IEC 60068-2-6		(10 to 2 000) Hz $A = 1,5$ mm or 200 m/s ² max. 10 cycle/axis 1 oct/min	(10 to 2 000) Hz $A = 1,5$ mm or 200 m/s ² max. 10 cycle/axis 1 oct/min	(10 to 500) Hz $A = 0,75$ mm or 100 m/s ² 10 cycle/axis 1 oct/min	(10 to 55) Hz $A = 1,5$ mm or sweep 1 min 3 axes, 2 h/axis 6 h	Not specified
Repetitive shock according to IEC 60068-2-27		Condition to be specified between parties concerned				Not specified
Vibration-random (optional)		Condition to be specified between parties concerned				Not specified

8 Test sequence

As already specified in Clause 4, the first step is to define the units under test.

These are parts taken from mass production, or parts manufactured with series production equipment under mass production conditions.

A separate test group of 30 test units should be provided for each test conditioning procedure as specified in Clause 7.

The number of test units for a separate test group can be reduced to 5 for very large and expensive components. This document has deliberately avoided linking together a series of test conditioning procedures, as the complexity of the components means that there shall be a clear assignment of conditioning procedure to the failure criterion.

All test units shall be numbered and tested against all the general failure criteria specified in Clause 6, and the results documented (additional criteria are possible as an option, see Clause 6). The test units shall then be divided into the test groups and mounted on the carrier boards. After they are attached to the carrier boards, a visual inspection should be performed for all mechanical failure criteria if possible.

NOTE For SMD, this is a test of the thermal stability of the device as specified in IEC 60068-2-20.

All electrical failure criteria specified are also checked at this point.

This is followed by the load condition tests specified in Clause 7.

After the tests and after a minimum of 2 h and a maximum of 48 h out of operation at room temperature, the test units shall once again be checked against all general failure criteria, and against any optional failure criteria if applicable, with the results documented in the test report.

9 Test evaluation

The general rule for all test groups is that after the test load condition procedures, no failures are admissible against any of the general failure criteria or any optional failure criteria that may apply. If one or more components fail in one test group, then a one-off requalification process is possible. This means that the test cycle of the failure group is repeated once more on the additional reserve batch of 30 components. This process can be carried out for a maximum of 2 groups (general load condition procedures).

If the requalification test is completed successfully without failures, then the reliability test specified according to this document can be considered as passed. For optional qualifications, these may also be specified explicitly for this component.

If failures still arise in the requalification test for general load conditions, the reliability test specified according to this document cannot be considered as passed. The cause of the failures shall then be eliminated by the manufacturer in a redesign process (with proof), and the resulting redesigned parts shall undergo another full reliability test as specified in this document.

If failure occurs in optional test requalifications, then although general fulfilment of the reliability requirements given in this document is confirmed, it is not permitted to specify the optional qualifications as given in this document in the data sheet.

Bibliography

IEC 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60068-2-21, *Environmental testing – Part 2-21: Tests – Test U: Robustness of terminations and integral mounting devices*

IEC 60068-2-54, *Environmental testing – Part 2-54: Tests – Test Ta: Solderability testing of electronic components by the wetting balance method*

IEC 60068-3-13, *Environmental testing – Part 3-13: Supporting documentation and guidance on Test T – Soldering*

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