IEC 60938-2

Edition 3.0 2021-07

INTERNATIONAL STANDARD

NORME INTERNATIONALE

Fixed inductors for electromagnetic interference suppression –
Part 2: Sectional specification on power line chokes

Inductances fixes d'antiparasitage –
Partie 2: Spécification intermédiaire sur les bobines d'arrêt pour ligne électrique

IEC 60938-2:2021-07(en-fr)

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INTERNATIONAL
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COMMISSION

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FOREWORD

1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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IEC 60938-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This third edition cancels and replaces the second edition published in 1999 and its Amendment 1:2006. This edition constitutes a technical revision.

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

a) the test plan for performance testing has been removed; mandatory safety tests and optional performance tests are listed in one test plan in Annex B;
b) requirements for Thyristor-Chokes have been withdrawn;
c) material requirements are harmonized with IEC 60939-3 and UL 60939-3;
d) AC chokes up to 1 000 V and DC chokes up to 1 500 V are now in the Scope.

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

FDIS	Report on voting
40/2846/FDIS	40/2862/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 detail at www.iec.ch/standardsdev/publications.

A list of all parts in the IEC 60938 series, published under the general title *Fixed inductors for electromagnetic interference suppression*, 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.

FIXED INDUCTORS FOR ELECTROMAGNETIC INTERFERENCE SUPPRESSION –

Part 2: Sectional specification on power line chokes

1 Scope

This part of IEC 60938 applies to fixed inductors designed for electromagnetic interference suppression, which will be connected to an AC mains or other supply with a nominal voltage not exceeding 1 000 V AC RMS or 1 500 V DC with a nominal frequency not exceeding 400 Hz.

This sectional specification is restricted to fixed inductors for which safety tests are appropriate. This implies that inductors specified according to this specification will either be connected to mains supplies, when compliance with the mandatory tests of Annex A is necessary, or used in other circuit positions where the equipment specification prescribes that some or all of these safety tests are required.

The object of this document is to prescribe standard requirements for safety tests, preferred ratings and characteristics, to select from IEC 60938-1 the appropriate methods of test and to give general performance requirements for suppression inductors.

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 applies, including any amendments.

IEC 60027 (all parts), *Letter symbols to be used in electrical technology*

IEC 60050 (all parts), *International Electrotechnical Vocabulary (IEV)*

IEC 60060-1, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60068-1, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-13, *Environmental testing – Part 2-13: Tests – Test M: Low air pressure*

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

IEC 60068-2-17, *Basic environmental testing procedures – Part 2-17: Tests – Test Q: Sealing*

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

IEC 60068-2-45, *Basic environmental testing procedures – Part 2-45: Tests – Test XA and guidance: Immersion in cleaning solvents*

IEC 60317-0-7, *Specifications for particular types of winding wires – Part 0-7: General requirements – Fully insulated (FIW) zero-defect enamelled round copper wire*

IEC 60317-56, *Specifications for particular types of winding wires – Part 56: Solderable fully insulated (FIW) zero-defect polyurethane enamelled round copper wire, class 180*

IEC 60335-1, *Household and similar electrical appliances – Safety – Part 1: General requirements*

IEC 60617, *Graphical symbols for diagrams* (available at http://std.iec.ch/iec60617)

IEC 60664-1, *Insulation coordination for equipment within low-voltage supply systems – Part 1: Principles, requirements and tests*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products (GWEPT)*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 60695-10-2, *Fire hazard testing – Part 10-2: Abnormal heat – Ball pressure test method*

IEC 60695-11-10, *Fire hazard testing – Part 11-10: Test flames – 50 W horizontal and vertical flame test methods*

IEC 60695-11-20, *Fire hazard testing – Part 11-20: Test flames – 500 W flame test method*

IEC 60851-5, *Winding wires – Test methods – Part 5: Electrical properties*

IEC 60938-1:2021, *Fixed inductors for electromagnetic interference suppression – Part 1: Generic specification*

IEC 60938-2-2, *Fixed inductors for electromagnetic interference suppression – Part 2-2: Blank detail specification – Inductors for which safety tests are required (only)*

CISPR 17, *Methods of measurement of the suppression characteristics of passive EMC filtering devices*

ISO 80000-6, *Quantities and units – Part 6: Electromagnetism*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60938-1 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

4 General requirements

4.1 General

Units, graphical symbols, letter symbols and terminology shall be taken from the following publications whenever possible:

– IEC 60027 (all parts),
– IEC 60050 (all parts),
– IEC 60617,
– ISO 80000-6.

When further items are required, they shall be derived in accordance with the principles of the documents listed above.

4.2 Preferred values of ratings and characteristics

4.2.1 Climatic categories

Electromagnetic interference suppression inductors covered by this specification are classified into climatic categories according to the general rules given in IEC 60068-1. The lower and upper category temperatures and the duration of the damp heat, steady state test shall be selected from the following:

Lower category temperature: −65 °C, −55 °C, −40 °C, −25 °C and −10 °C.

Upper category temperature: +85 °C, +100 °C, +125 °C and +155 °C.

Duration of the damp heat, steady state test: 21 days and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

4.2.2 Nominal inductance and tolerance

Preferred values of nominal inductance are values chosen from the E6 series of preferred values given in IEC 60063.

The preferred tolerances on inductance are as follows:

±30 %; −30 % / +50 %

4.2.3 Rated voltage U_R

Preferred values for rated voltages are:

- for AC inductors:
  50 V, 125 V, 250 V, 300 V, 400 V, 440 V, 480 V, 600 V, 760 V, 800 V and 1 000 V.
- for DC inductors:
  60 V, 160 V, 250 V, 500 V, 1 000 V and 1 500 V.

Electromagnetic interference suppression inductors are normally chosen to have their rated voltage equal to or greater than the nominal voltage of the supply system to which they are to be connected. It should, however, be borne in mind that the voltage of the system may rise up to 10 % above the nominal voltage.

4.2.4 Rated temperature T_r

The rated temperature shall be given in the detail specification. It shall not be lower than +40 °C.

4.2.5 Rated current I_r

The preferred values of rated current are selected from the R10 series of ISO 3.

The following Figure 1 shows the relation between applied current and ambient temperature.

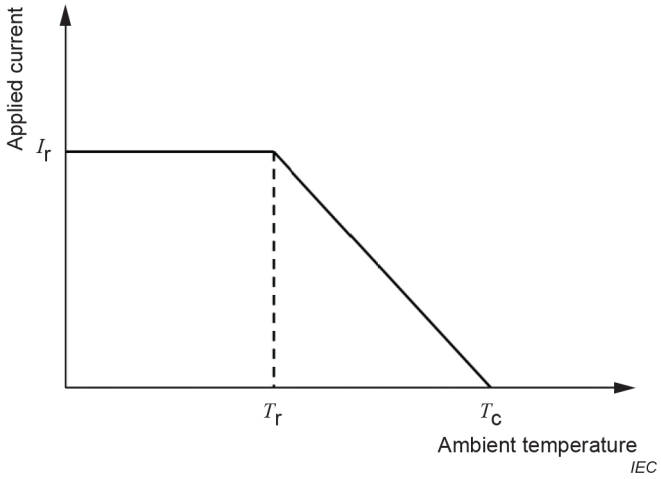

Figure 1 – Relation between ambient temperature and applied current

If not stated otherwise in the detail specification, a linear derating of applied current over ambient temperature is assumed up to zero current at the upper category temperature T_C.

4.3 Information to be given in a detail specification

4.3.1 General

Detail specifications shall be derived from the relevant blank detail specification.

Detail specifications shall not specify requirements inferior to those of the generic or sectional specification. When more severe requirements are included, they shall be listed separately.

4.3.2 Outline drawing and dimensions

There shall be an illustration of the inductor as an aid to easy recognition and for comparison of the inductor with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be indicated upon the drawing. All dimensions shall be stated in millimetres.

The numerical values shall be given for the length of the body, the width and height of the body or for cylindrical types, the body diameter, and the length and diameter of the terminations. When necessary, for example when a number of items (inductance values/ voltage ranges) are covered by a detail specification, the dimensions and their associated tolerances shall be placed in a table below the drawing.

When the configuration is other than described above, the detail specification shall state such dimensional information to describe the inductor adequately. When the inductor is not designed for use on printed boards, this shall be clearly stated in the detail specification.

4.3.3 Mounting

The detail specification shall specify the method of mounting to be recommended for normal use and the method, which is mandatory for the application of the vibration and shock tests. The design of the inductor may be such that special mounting fixtures are required in its use. In this case, the detail specification shall describe the mounting fixtures and they shall be used in the application of the bump, shock and vibration tests. The specified heat sink shall be used in the application of the endurance test.

4.3.4 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this sectional specification. Additional characteristics may be listed, when they are considered necessary to specify adequately the inductor for design and application purposes.

4.4 Insulated inductors for power line applications

Insulated inductors may be built either with housing or with isolated wires where the isolation provides basic or reinforced insulation, e.g. TIW, FIW-wires, PVC-isolated wires, wires in insulation sleeves or the like. The isolated wires or the insulating materials used shall be in accordance with relevant IEC standards.

Fully insulated winding wires (FIW) shall comply by certificate with IEC 60851-5, IEC 60317-0-7 and IEC 60317-56. They may be applied maximum for insulation class F. FIW wires are chosen from Table F.1 to have a minimum dielectric test voltage to withstand the voltage test B or C with the test voltage defined in Table 1.

Insulation materials used between terminals and windings, for housing or potting, shall be certified to a minimum rating of V-2, VTM-2 or HF-2 according to IEC 60695-11-10, IEC 60695-11-20 (or UL 94) at the appropriate minimum thickness, which is determined by the smallest thickness of insulation in direct contact with a conductor.

4.5 Marking

Necessary marking according to the relevant specifications shall be prescribed in the detail specification. Deviations from these requirements shall be listed separately and the reason for it stated specifically in the detail specification.

The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

1) manufacturer's name or trade mark;
2) manufacturer's type designation;
3) recognized approval mark;
4) nominal inductance and its tolerance;
5) rated voltage;
6) rated current;
7) identification of terminations or circuit diagram;
8) rated temperature;
9) climatic category;
10) year and month or week of manufacture, maybe in code form;
11) reference to the detail specification.

Marking of the inductor may be omitted when the manufacturer considers that there is insufficient space, and this fact is recorded in the detail specification. When present, the marking shall be sufficient to provide a clear identification of the inductor. Any duplication of information in the marking on the inductor should be avoided.

The packaging containing the inductors shall be clearly marked with all the information listed above except 7) identification of terminations or circuit diagram. Any additional marking shall be so applied that no confusion can arise.

The marking information may be applied as QR Code.

5 Safety tests for approval

5.1 General

5.1.1 Approval on the basis of the fixed sample size procedures

This document covers a procedure for qualification approval tests. A test procedure is given with mandatory safety tests and optional tests. Not all mandatory safety tests may be applicable on every type of inductors as prescribed by the detail specification. Optional performance tests shall be performed, if required in the detail specification.

Prior to the approval testing for safety tests only, it is necessary to submit to the certification body a declaration of design (see Annex C) registering essential data and basic design details of the inductors for which approval is sought. IEC 60938-2-2 provides a blank detail specification for safety tests only. IEC 60938-2-1 provides a blank detail specification including optional performance tests.

The complete series of tests is required for approval of a series of structurally similar inductors of one rated voltage.

The tests of each group shall be carried out in the order given. The whole sample shall be subjected to the tests of group 0 and then divided for the other groups. Non-conforming items found during the tests of group 0 shall not be used for the other groups.

"One non-conforming item" is counted when an inductor has not satisfied the whole or part of the tests of a group. The approval is granted when the number of non-conformances does not exceed the specified number of permissible non-conforming items for each group or subgroup and the total number of permissible non-conformances indicated in Annex A.

Annex A and Annex B together form the fixed sample size test schedule, for which Annex A describes the details for the sampling and permissible non-conforming items for the different tests or groups of tests. The conditions of tests and requirements for the fixed-sample-size test schedule shall be identical to those prescribed in the detail specification.

5.1.2 Structurally similar inductors

Inductors are structurally similar when for their range of inductance values they have the following common characteristics:

a) essentially the same materials;

b) similar design features and manufacturing techniques;

c) same rated voltage;

5.1.3 Sampling

Each rated voltage shall be separately qualified. The total number of inductors of each rated voltage to be tested in each group is given in Annex A. For each rated voltage, the sample shall contain equal numbers of specimens of the highest and lowest inductance and the highest and lowest rated current in the range to be qualified. Where only one inductance value or rated current value is involved, the total number of inductors shall be tested.

Spare specimens are permitted as follows:

a) one per inductance/rated current combination which may be used to replace the permitted non-conforming items in group 0;

b) one per inductance/rated current combination which may be used as replacements for specimens lost due to incidents not attributable to the manufacturer or the test sequence;

c) the remainder of the spares may be required if it is necessary to repeat any test solderability or resistance to soldering heat;

d) spares may be kept at the premises of the manufacturer instead of being sent to the testing station;

The numbers of samples given in group 0 assume that all groups are applicable. If this is not the case, numbers may be reduced accordingly.

When additional groups are introduced into the qualification approval test schedule, the number of specimens required for group 0 shall be increased by the same number as that required for the additional groups.

Re-qualification tests according to Annex B may be required by the certification body when a change of the design as given in Annex C is intended. The certification body will be informed about the intended change(s) and decide whether re-qualification tests have to be performed.

5.2 Standard atmospheric conditions

Refer to 5.2 of IEC 60938-1:2021 without changes.

5.3 Visual examination

5.3.1 Dimensions (gauging)

The condition, workmanship and finish shall be satisfactory as checked by visual examination. Marking shall be legible and shall conform to the requirements of the detail specification. The dimensions indicated in the detail specification and being suitable for gauging shall be checked. They shall comply with the values prescribed in the detail specification.

5.3.2 Dimensions (detail)

For mains inductors, creepage distances and clearances on the outside of the inductor between live parts of different polarity or between live parts and a metal case shall be not less than the appropriate values given in Annex D and Annex E.

Compliance shall be checked by measurement of clearance and creepage distances according to the rules laid down in IEC 60335-1 or IEC 60664-1. Additional requirements may be necessary for special-use inductors. Potting or sealing materials appear in lieu of clearance.

Instead of fulfilling requirements for clearance and creepage inside inductors, the windings may be insulated e.g. by potting or insulation sleeves or the windings might be built from insulated wires, e.g. TIW, FIW-wires, PVC-isolated wires, or the like.