

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Passive filter units for electromagnetic interference suppression –
Part 3: Passive filter units for which safety tests are appropriate**

**Filtres passifs d'antiparasitage –
Partie 3: Filtres passifs pour lesquels des essais de sécurité sont appropriés**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2024 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Secretariat
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and once a month by email.

IEC Customer Service Centre - webstore.iec.ch/csc

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Discover our powerful search engine and read freely all the publications provided, graphical symbols and the glossary. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 500 terminological entries in English and French, with equivalent terms in 25 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

A propos de l'IEC

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

A propos des publications IEC

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

Recherche de publications IEC -

webstore.iec.ch/advsearchform

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études, ...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

IEC Just Published - webstore.iec.ch/justpublished

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et une fois par mois par email.

Service Clients - webstore.iec.ch/csc

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: sales@iec.ch.

IEC Products & Services Portal - products.iec.ch

Découvrez notre puissant moteur de recherche et consultez gratuitement tous les aperçus des publications, symboles graphiques et le glossaire. Avec un abonnement, vous aurez toujours accès à un contenu à jour adapté à vos besoins.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 500 articles terminologiques en anglais et en français, ainsi que les termes équivalents dans 25 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Passive filter units for electromagnetic interference suppression –
Part 3: Passive filter units for which safety tests are appropriate**

**Filtres passifs d'antiparasitage –
Partie 3: Filtres passifs pour lesquels des essais de sécurité sont appropriés**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 31.160

ISBN 978-2-8322-8175-8

**Warning! Make sure that you obtained this publication from an authorized distributor.
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

CONTENTS

FOREWORD.....	8
1 Scope.....	10
2 Normative references	10
3 Terms and definitions	12
4 General requirements	16
4.1 Classification and usage of class X and Y capacitors	16
4.1.1 General	16
4.1.2 Class X capacitors	16
4.1.3 Class Y capacitors	16
4.2 Information to be given in a detail specification	17
4.2.1 General	17
4.2.2 Outline drawing and dimensions	18
4.2.3 Mounting	18
4.2.4 Ratings and characteristics	18
4.3 Marking.....	19
4.3.1 General	19
4.3.2 Coding.....	19
4.3.3 Marking details	19
4.3.4 Marking of filters	19
4.3.5 Marking of packaging.....	19
4.3.6 Additional marking	19
4.4 Components	20
4.5 Overcurrent protective devices.....	20
4.6 Wiring and Insulation	20
4.6.1 General	20
4.6.2 Sleeving, tubing and wire insulation.....	20
4.6.3 Properties of insulation material.....	20
4.7 Protective Bonding Conductors	21
4.8 Corrosion.....	21
5 Preferred ratings and characteristics	21
5.1 Preferred characteristics	21
5.1.1 General	21
5.1.2 Preferred climatic categories	21
5.2 Preferred values of ratings	22
5.2.1 Rated voltage (U_R).....	22
5.2.2 Rated temperature.....	22
5.2.3 Passive flammability	22
6 Test plan for safety tests	22
6.1 Structurally similar filters.....	22
6.2 Safety approval procedure	23
6.2.1 General	23
6.2.2 Sampling	23
6.2.3 Tests	23
6.3 Requalification tests.....	24
7 Test and measurement procedures.....	24
7.1 Measurement conditions	24

7.1.1	General	24
7.1.2	Standard atmospheric conditions for testing	24
7.1.3	Recovery conditions	25
7.1.4	Referee conditions.....	25
7.1.5	Reference conditions	25
7.1.6	Drying.....	25
7.2	Visual examination and check of dimensions	26
7.2.1	Visual examination	26
7.2.2	Dimensions (gauging).....	26
7.2.3	Dimensions (detail).....	26
7.2.4	Creepage distances and clearances	26
7.3	Inductance measurement.....	29
7.3.1	General	29
7.3.2	Measuring conditions.....	29
7.4	Earth inductors incorporated in filters.....	29
7.5	Capacitance.....	29
7.5.1	General	29
7.5.2	Measuring conditions.....	29
7.6	Insertion loss	30
7.7	Insulation resistance	30
7.7.1	General	30
7.7.2	Measuring voltage	30
7.7.3	Application of measuring voltage	31
7.7.4	Mean time to measuring	32
7.7.5	Temperature correction factor.....	32
7.7.6	Information to be given in a detail specification.....	32
7.7.7	Requirements	34
7.8	Voltage proof	35
7.8.1	General	35
7.8.2	Test procedure	35
7.8.3	Applied voltage.....	35
7.8.4	Tests	36
7.8.5	Requirements	37
7.8.6	Repetition of the voltage proof test	37
7.8.7	Information to be given in a detail specification.....	37
7.8.8	Requirements	37
7.9	DC line resistance or voltage drop at rated current	37
7.9.1	General	37
7.9.2	DC line resistance	38
7.9.3	Voltage drop at rated current	38
7.10	Discharge resistance	38
7.10.1	General	38
7.10.2	Resistor Test.....	38
7.11	Capacitor discharge.....	39
7.11.1	General	39
7.11.2	Discharge measurement.....	39
7.12	Robustness of terminations.....	39
7.12.1	General	39
7.12.2	Test Ua1 – Tensile	39

7.12.3	Test Ub – Bending	40
7.12.4	Test Uc – Torsion	40
7.12.5	Test Ud – Torque	40
7.12.6	Visual examination	41
7.13	Resistance to soldering heat	41
7.13.1	Applicability of the test	41
7.13.2	Pre-measurement	41
7.13.3	Test conditions	41
7.13.4	Test severity	42
7.13.5	Intermediate inspection, measurements and requirements	42
7.14	Climatic sequence	42
7.14.1	General	42
7.14.2	Initial measurements	42
7.14.3	Dry heat	42
7.14.4	Damp heat, cyclic	42
7.14.5	Cold	43
7.14.6	Low air pressure	43
7.14.7	Damp heat, cyclic, remaining cycles	43
7.14.8	Final inspection, measurements and requirements	43
7.15	Damp heat, steady state	44
7.15.1	Pre-measurements	44
7.15.2	Test method	44
7.15.3	Test conditions	44
7.15.4	Final inspection, measurements and requirements	44
7.16	Temperature rise	44
7.16.1	General	44
7.16.2	Test method	45
7.16.3	Test description	45
7.16.4	Requirements	46
7.17	Current overload	47
7.17.1	Pre-measurements	47
7.17.2	Test method	47
7.17.3	Final inspection, measurements and requirements	48
7.18	Leakage current	48
7.19	Protective conductor resistance	48
7.20	Impulse voltage	48
7.20.1	General	48
7.20.2	Initial measurements	48
7.20.3	Test conditions	48
7.20.4	Requirements	49
7.21	Endurance	49
7.21.1	General	49
7.21.2	General test conditions	49
7.21.3	Test conditions – current test	50
7.21.4	Test conditions – voltage test, terminations/case	50
7.21.5	Test conditions – voltage test between terminations	51
7.21.6	Test conditions – combined voltage/current tests	51
7.21.7	Final inspection, measurements and requirements	51
7.22	Passive flammability	52

7.22.1	General	52
7.22.2	Test method	52
7.23	Active flammability	53
7.24	Solvent resistance of the marking	53
7.24.1	General	53
7.24.2	Test description	53
7.24.3	Requirements after test	53
8	Optional tests (for performance only)	53
8.1	Solderability	53
8.1.1	General	53
8.1.2	Test method	53
8.1.3	Test conditions	53
8.1.4	Requirements	54
8.1.5	Final measurements and requirements	54
8.2	Rapid change of temperature	54
8.2.1	Pre-measurements	54
8.2.2	Test method	54
8.2.3	Final inspection	55
8.3	Vibration	55
8.3.1	Pre-measurements	55
8.3.2	Test method	55
8.3.3	Test conditions	55
8.3.4	Intermediate inspection	55
8.3.5	Final Inspection	55
8.4	Shock	55
8.4.1	Pre-measurements	55
8.4.2	Test method	55
8.4.3	Test conditions	55
8.4.4	Final Inspection	56
8.5	Container sealing	56
8.5.1	General	56
8.5.2	Test conditions	56
8.5.3	Requirements	56
8.6	Charge and discharge	56
8.6.1	General	56
8.6.2	Test circuits and wave forms	56
8.6.3	Information given in detail specification	58
8.6.4	Initial measurements	58
8.6.5	Test conditions	59
8.6.6	Final measurements and requirements	59
8.7	Component solvent resistance	59
8.7.1	General	59
8.7.2	Initial measurements	59
8.7.3	Test description	60
8.7.4	Final measurements	60
Annex A	(informative) Calculation of leakage current	61
A.1	General	61
A.2	Calculation of leakage current for 1-line filters	61
A.3	Calculation of leakage current for 2-line filters	62

A.4	Calculation of leakage current for 3-line filters	62
A.5	Calculation of leakage current for 4-line filters	64
Annex B (normative)	Sampling plan for safety requirements only	65
Annex C (normative)	Test schedule for safety requirements only	67
Annex D (normative)	Circuit for the impulse voltage test	70
Annex E (normative)	Circuit for the endurance test	72
Annex F (normative)	Declaration of design.....	73
Annex G (informative)	Safety and performance tests qualification approval – Assessment level DZ	74
Annex X (informative)	Cross reference for references to the previous edition of this document.....	77
Bibliography	79
Figure 1	– Asymmetrical and symmetrical test circuit	15
Figure 2	– Examples for the application of Tests A and B of Table 7	33
Figure 3	– Examples for the application of Test C of Table 7.....	34
Figure 4	– Impulse wave form	49
Figure 5	– Relay circuit	56
Figure 6	– Thyristor circuit	57
Figure 7	– Voltage and current waveforms	58
Figure A.1	– Leakage current for 1-line filters	61
Figure A.2	– Leakage current for 2-line filters	62
Figure A.3	– Leakage current for 3-line filters	63
Figure A.4	– Leakage current for 4-line filters	64
Figure D.1	– Impulse voltage test circuit	70
Figure E.1	– Endurance test circuit	72
Table 1	– Classification of Class X capacitors	16
Table 2	– Classification of Class Y capacitors	17
Table 3	– Standard atmospheric conditions.....	25
Table 4	– Creepage distances	28
Table 5	– Clearance.....	28
Table 6	– DC voltage for insulation resistance	31
Table 7	– Measuring points.....	33
Table 8	– Insulation resistance – Safety tests only.....	34
Table 9	– Insulation resistance – Safety and performance tests	35
Table 10	– Voltage proof (filter connected to mains)	36
Table 11	– Voltage proof (filter not connected to mains; e.g. DC filters).....	36
Table 12	– Force for wire terminations	40
Table 13	– Torque	40
Table 14	– Number of cycles.....	43
Table 15	– Maximum temperatures	47
Table 16	– Categories of flammability	52
Table 17	– Preferred severity	56

Table 18 – Measurements and requirements after charge and discharge	59
Table B.1 – Tests concerning safety requirements only.....	65
Table B.2 – Lot-by-lot test – Safety tests only approval.....	66
Table C.1 – Test schedule for safety requirements only	67
Table D.1 – Values of C_X , C_T , R_P , R_S , C_P	70
Table D.2 – Values and tolerances of C_X , t_r , t_d	71
Table G.1 – Sampling plan – Assessment level DZ	74
Table X.1 – Reference to IEC 60939-3 for clause/subclause or annex	76
Table X.2 – Reference to IEC 60939-3 for Figures/Tables.....	78

Currently in preview, click buy full version

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PASSIVE FILTER UNITS FOR ELECTROMAGNETIC
INTERFERENCE SUPPRESSION –****Part 3: Passive filter units for which safety tests are appropriate**

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 Publications”). 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.
- 2) The formal decisions or agreements of IEC on technical matters express, as far as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) IEC draws attention to the possibility that the implementation of this document may involve the use of (a) patent(s). IEC takes no position concerning the evidence, validity or applicability of any claimed patent rights in respect thereof. As of the date of publication of this document, IEC had not received notice of (a) patent(s), which may be required to implement this document. However, implementers are cautioned that this may not represent the latest information, which may be obtained from the patent database available at <https://patents.iec.ch> or www.iso.org/patents. IEC shall not be held responsible for identifying any or all such patent rights.

IEC 60939-3 has been prepared by of IEC technical committee 40: Capacitors and resistors for electronic equipment. It is an International Standard.

This second edition cancels and replaces the first edition published in 2015, Corrigendum 1:2016 and Corrigendum 2:2018. This edition constitutes a technical revision.

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

- a) Separated clauses for safety and performance tests;
- b) Added note for use of multiple X capacitors bridging basic insulation in 3 phase filters;
- c) Characteristics and conditions to substitute X and Y capacitors are now described in a separate Subclause 4.1;

- d) Creepage and clearance tables updated and in line with the latest editions of IEC 60938-2 and IEC 60664-1;
- e) Allowing voltage measurement for inductance measurements (7.3);
- f) Added requirements for marking depending on remaining energy after disconnection;
- g) Added content of CTL DSH 2044:2016 for temperature test of IEC filters;
- h) Added note about temperature rise required specimens for safety testing;
- i) Changed index of capacitors in Annex A to avoid confusion between index name and capacitor class;
- j) Moved tests from group 1A to 2. Now, samples in group 1A need to be submitted without potting;
- k) Revision of all parts of the document has taken place based on the ISO/IEC Directives, Part 2:2021, and harmonization with other similar kinds of documents. Annex X contains all cross-references of changes in clause/subclause numbers.

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

Draft	Report on voting
40/3102/FDIS	40/3118/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 in the IEC 60939 series, published under the general title *Passive filter units 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 webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn, or
- revised.

PASSIVE FILTER UNITS FOR ELECTROMAGNETIC INTERFERENCE SUPPRESSION –

Part 3: Passive filter units for which safety tests are appropriate

1 Scope

This part of IEC 60939 covers passive filters used to attenuate unwanted radio-frequency signals (such as noise or interference) generated from electromagnetic sources.

Both single and multi-channel filters within one enclosure or which are built on a printed circuit board forming a compact entity are included within the scope of this document.

Filters constructed of capacitive elements where the inductance is inherent in the construction of the filter are within the scope of this document. Similarly, filters constructed of inductive elements where the capacitance is inherent in the construction of the filter are also within the scope of this document. It is up to the manufacturer to state whether a given component is to be designed as a capacitor, an inductor or a filter. Filters can include also other components such as resistors and/or varistors or similar components.

This document applies to passive filter units for electromagnetic interference suppression for which safety tests are appropriate. This implies that filters specified according to this document will either be connected to mains supplies, when compliance with the mandatory tests of Table B.1 is necessary, or used in other circuit positions where the equipment specification specifies that some or all of these safety tests are required.

This document applies to passive filter units, which will be connected to an AC mains or other supply (DC or AC) with a nominal voltage not exceeding 1 000 V AC, with a nominal frequency not exceeding 400 Hz, or 1 500 V DC.

NOTE For AC use, IEC 60384-14 applies to capacitors which will be connected to AC mains with a nominal frequency not exceeding 100 Hz.

This document covers appliance filters (US) but does not cover facility filters, cord-connected filters or direct plug-in filters. These other filters will be covered by another sectional specification.

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 60060-1:2010, *High-voltage test techniques – Part 1: General definitions and test requirements*

IEC 60062:2016, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*