

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

**Passive filter units for electromagnetic interference suppression –  
Part 2: Sectional specification – Passive filter units for which safety tests are  
appropriate – Test methods and general requirements**

**Filtres passifs d'antiparasitage –  
Partie 2: Spécification intermédiaire – Filtres passifs pour lesquels des essais de  
sécurité sont appropriés – Méthodes d'essai et exigences générales**

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

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

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## INTERNATIONAL ELECTROTECHNICAL COMMISSION

**PASSIVE FILTER UNITS FOR ELECTROMAGNETIC  
INTERFERENCE SUPPRESSION –****Part 2: Sectional specification –  
Passive filter units for which safety tests are appropriate –  
Test methods and general requirements**

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International Standard IEC 60939-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This second edition cancels and replaces the first edition published in 1988. This second edition constitutes a technical revision.

The major changes that have been made between the first and the second edition are :

- Capacitance and  $\tan \delta$  measurements, d.c. line resistance or voltage drop at rated current, impulse voltage, passive flammability, current overload, solvent resistance of marking, component solvent resistance and active flammability have been added to Clause 4, test and measurement procedures.

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

FDIS	Report on voting
40/1510/FDIS	40/1537/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.

IEC 60939 consists of the following parts, under the general title *Passive filter units for electromagnetic interference suppression*

- Part 1: Generic specification
- Part 2: Sectional specification: Test methods and general requirements
- Part 2-1: Blank detail specification – Passive filter units for electromagnetic interference suppression – Filters for which safety tests are required (Assessment level D / DZ)
- Part 2-2: Blank detail specification – Passive filter units for electromagnetic interference suppression – Filters for which safety tests are required (Safety tests only)

The committee has decided that the contents of this publication will remain unchanged until the maintenance result 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

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## PASSIVE FILTER UNITS FOR ELECTROMAGNETIC INTERFERENCE SUPPRESSION –

### Part 2: Sectional specification – Passive filter units for which safety tests are appropriate – Test methods and general requirements

#### 1 General

##### 1.1 Scope

This Sectional specification applies to passive filter units for electromagnetic interference suppression which fall within the scope of the Generic Specification IEC 60939-1.

The scope of this Sectional specification is restricted to passive filter units for which safety tests are appropriate. This implies that filters specified according to this Sectional specification will either be connected to mains supplies, when compliance with the mandatory tests of Table 3 is necessary, or used in other circuit positions where the equipment specification prescribes that some or all of these safety tests are required.

This Sectional specification applies to passive filter units which will be connected to an a.c. mains or other supply with a nominal voltage not exceeding 1 000 V a.c., with a nominal frequency not exceeding 400 Hz, or 1 000 V d.c.

##### 1.2 Normative references

The following referenced documents are indispensable for the application 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.

NOTE Components other than inductors and capacitors in the filter unit should fulfil requirements in the relevant IEC Standard.

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

IEC 60062, *Marking codes for resistors and capacitors*

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

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

IEC 60085, *Thermal evaluation and classification of electrical insulation*

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

IEC 60384-9, *Fixed capacitors for use in electronic equipment – Part 9: Sectional specification: Fixed capacitors of ceramic dielectric, Class 2*

IEC 60384-14, *Fixed capacitors for use in electronic equipment – Part 14: Sectional specification: Fixed capacitors for electromagnetic interference suppression and connection to the supply mains*



IEC 60664 (all parts), *Insulation coordination for equipment within low-voltage systems*

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

IEC 60939-1, *Passive filter units for electromagnetic interference suppression – Part 1: Generic specification*

IEC 60940, *Guidance information on the application of capacitors, resistors, inductors and complete filter units for radio interference suppression*

IEC 61140, *Protection against electric shock – Common aspects for installation and equipment*

### **1.3 Information to be given in a detail specification**

#### **1.3.1 General**

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

Detail specifications shall not specify requirements inferior to those of the generic, sectional or blank detail specification. When more severe requirements are included, they shall be listed in 1.9 of the detail specification, and indicated in the test schedules, for example by an asterisk.

NOTE The information given in 1.3.2 may, for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from the appropriate clause of this sectional specification.

#### **1.3.2 Outline drawing and dimensions**

There shall be an illustration of the filter as an aid to easy recognition and for comparison of the filter with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres.

Normally, the numerical values shall be given for the length of the body, the width and height of the body and the wire spacing, or for cylindrical types, the body diameter and the length and diameter of the terminations. When necessary, for example when a range of filters is covered by a single detail specification, their dimensions and their associated tolerances shall be placed in a table following the drawing.

In addition, the detail specification shall state such other dimensional information as will adequately describe the filter outline.

#### **1.3.3 Mounting**

The detail specification shall specify the method of mounting recommended for normal use and the method which is mandatory for the application of the vibration, bump, shock and endurance tests. The design of the filter may be such that special mounting fixtures or heat sinks 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 vibration, bump or shock tests. The specified heat sink shall be used in the application of the endurance test.

If recommendations for mounting for "normal" use are made, they shall be included in the detail specification under 1.8 "Additional information (not for inspection purposes)". If they are included, a warning can be given that the full vibration, bump and shock performance may not be available if mounting methods other than those specified in 1.1 of the detail specification are used.

### 1.3.4 Ratings and characteristics

#### 1.3.4.1 General

The ratings and characteristics shall be in accordance with the relevant clauses of this specification.

#### 1.3.4.2 Particular characteristics

Additional characteristics may be listed when they are considered necessary to specify adequately the filter for design or application purposes.

#### 1.3.5 Marking

The detail specification shall specify the content of the marking on the filter and the package.

### 1.4 Terms and definitions

For the purposes of this Sectional specification, the terms and definitions given in 2.2 of IEC 60939-1, as well as the following apply.

#### 1.4.1

##### a.c. mains filter (or mains filter)

passive filter unit designed essentially for application with a power-frequency alternating voltage supplied from the mains

#### 1.4.2

##### class X capacitor

capacitor of a type suitable for use in situations where failure of the capacitor would not lead to danger of electric shock but could result in a risk of fire.

Class X capacitors are divided into three subclasses (see Table 1) according to the peak voltage of the impulses superimposed on the mains voltage to which they may be subjected in service. Such impulses may arise from lightning strikes on outside lines, from switching in neighbouring equipment, or switching in the equipment in which the capacitor is used.

**Table 1 – Classification of class X capacitors**

Subclass	Peak pulse voltage in service	IEC 60664 insulation category	Application	Peak impulse voltage $U_p$ applied before endurance test
X1	> 2,5 kV ≤ 4,0 kV	III	High pulse application	when $C_R \leq 1,0 \mu\text{F}$ : $U_p = 4,0 \text{ kV}$ when $C_R > 1,0 \mu\text{F}$ : $U_p = \frac{4}{\sqrt{C_R \times 10^6}} \text{ kV}$
X2	≤ 2,5 kV	II	General purpose	when $C_R \leq 1,0 \mu\text{F}$ : $U_p = 2,5 \text{ kV}$ when $C_R > 1,0 \mu\text{F}$ : $U_p = \frac{2,5}{\sqrt{C_R \times 10^6}} \text{ kV}$
X3	≤ 1,2 kV	-	General purpose	none

**1.4.3****class Y capacitor**

capacitor or RC-unit of a type suitable for use in situations where failure of the capacitor could lead to danger of electric shock.

Class Y capacitors are further divided into four subclasses Y1, Y2, Y3 and Y4, as shown in Table 2.

(IEC 60384-14, 1.5.4)

**Table 2 – Classification of class Y capacitors**

Subclass	Type of insulation bridged	Range of rated voltages	Peak impulse voltage before endurance test
Y1	Double insulation or reinforced insulation	≤ 500 V	8,0 kV
Y2	Basic insulation or supplementary insulation	≥ 150 V ≤ 300 V	5,0 kV
Y3		≥ 150 V ≤ 250 V	none
Y4		< 150 V	2,5 kV

NOTE For definitions of basic, supplementary, double and reinforced insulation, see IEC 61140.

One Y-capacitor may bridge basic insulation. One Y-capacitor may bridge supplementary insulation. If combined basic and supplementary insulations are bridged by two Y2-, Y3- or Y4-capacitors in series, they must have the same nominal value.

For guidance on the application of capacitors bridging basic insulation, see 6.1 of IEC 60940.

**1.4.4****earth inductor**

inductor that forms part of the earth lead of a filter

**1.5 Marking**

**1.5.1** See 2.4 of IEC 60939-1 with the following details:

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:

- a) manufacturer's name or trademark;
- b) manufacturer's type designation or the type designation given in the detail specification;
- c) recognised approval mark;
- d) rated voltage and rated frequency;
- e) identification of terminations and/or circuit diagram;
- f) rated current;
- g) rated temperature;
- h) climatic category;
- i) year and month (or week) of manufacture (if the indication is in code, it shall be the code given in IEC 60062);
- j) reference to the detail specification.

**1.5.2** The filter shall be clearly marked with the information in 1.5.1 a), b), c), d) and f), and also e) if this is not implied by b).

**1.5.3** The package containing the filter(s) shall be clearly marked with all the information listed in 1.5.1.

National approvals may be indicated by lettering as an alternative to the approval mark.

**1.5.4** Any additional marking shall be so applied that no confusion can arise.

## **2 Preferred ratings and characteristics**

### **2.1 Preferred characteristics**

#### **2.1.1 General**

The values given in detail specifications should preferably be selected from the following:

#### **2.1.2 Preferred climatic categories**

The filters covered by this specification are classified into climatic categories according to the general rules given in IEC 60068-1.

The lower and upper category temperature and the duration of the damp heat, steady state test should be chosen from the following:

Lower category temperature: –65 °C, –55 °C, –40 °C, –25 °C or –10 °C;

Upper category temperature: +70 °C, +85 °C, +100 °C, +125 °C or +155 °C;

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

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

For guidance on the application of the categories described above, see IEC 60940.

### **2.2 Preferred values of ratings**

#### **2.2.1 Rated voltage ( $U_R$ )**

The preferred values of rated voltage are:

115 V, 125 V, 250 V, 400 V, 440 V, 500 V and 760 V.

Electromagnetic interference suppression filters shall be chosen to have a rated voltage equal to or greater than the nominal voltage of the supply system to which they are connected. The design of the filters shall take into account the possibility that the voltage of the system may rise by up to 10 % above its nominal voltage.

NOTE X-capacitors can be used in a star connect.

#### **2.2.2 Category voltage ( $U_C$ )**

The category voltage is equal to the rated voltage unless otherwise stated in the detail specification.

### 2.2.3 Rated temperature

The rated temperature shall not be less than +40 °C.

### 2.2.4 Passive flammability

When specified, the minimum category of passive flammability permitted is category C.

## 3 Quality assessment procedures

### 3.1 Primary stage of manufacture

See 3.2 of IEC 60939-1.

### 3.2 Structurally similar filters

See 3.4 of IEC 60939-1.

In addition to these provisions, filters may be considered as structurally similar only when for their range of component values they have the same capacitor, inductor and resistor technologies and corresponding capacitive elements are of the same subclass.

### 3.3 Certified records of released lots

The information required in 3.5.1 of IEC 60939-1 shall be made available when prescribed in the detail specification and when requested by a customer. After the endurance test, the parameters for which variables information is required are insertion loss change and insulation resistance.

### 3.4 Approval testing

#### 3.4.1 Safety tests only approval [IEC 60939-2:2005](https://standards.iteh.ai/catalog/standards/iec/12d4eb8f-5b2e-458f-9934-25695c6054b6/iec-60939-2-2005)

Table 3 and Annex B form a schedule limited to tests concerning safety only requirements. The schedule to be used for safety only approval will be on the basis of fixed sample sizes according to 3.4 of IEC 60939-1 as given in 3.4.3 and Table 3 of this Sectional specification. Prior to the approval testing being carried out, it is necessary to submit to the certification body a declaration of design (Annex E) registering essential data and basic design details of the passive filters for which approval is sought.

If subsequent to the granting of approval, any component is changed, the certification body shall be informed (see Annex E). Extension of approval to include changed component(s) is at the discretion of the certification body.

#### 3.4.2 Qualification approval

Tables 4, 5, 6 and 7 are to be used when qualification approval is sought.

The procedures for qualification approval testing are given in 3.5 of IEC 60939-1. The schedule to be used for qualification approval testing on the basis of lot-by-lot and periodic tests is given in 3.5 and Tables 5, 6 and 7 of this Sectional specification. The procedure using a fixed sample size schedule is given in 3.4.3 and Table 4. For the two procedures, the sample sizes and the number of non-conforming items shall be of comparable order. The test conditions and requirements shall be the same. Qualification approval according to the fixed sample sizes of Table 4 is preferred.

### 3.4.3 Sampling

Filter types to be qualified together shall have the same rated voltage, and combination of component technologies; in addition, the corresponding capacitive elements shall be of the same subclass. The numbers of filters required for each qualification in each group are given in Tables 3 and 4.

For each qualification, the sample shall contain equal numbers of specimens of the highest and lowest total capacitance values in the range to be qualified. Where only one total capacitance value is involved, the total number of filters as stated in Tables 3 and 4 shall be tested.

If, for a given value of total capacitance, there is more than one rated current available in the range, then filters with the highest rated current shall be chosen. If at this rated current more than one inductance value is available in the range, then filters with the highest inductance value shall be chosen.

NOTE "Total capacitance" in the paragraph above means the capacitance between the input terminations of the filter.

Spare specimens are permitted as follows:

- a) one per value which may be used to replace the non-conforming item in group 0;
- b) one per value which may be used as replacements for non-conforming specimens because of incidents not attributable to the manufacturer;
- c) sufficient specimens to enable the repeat test of Note 8 to Tables 7 to be carried out.

The numbers given in Group 0 assume that all further groups are applicable. If this is not so, the numbers may be reduced accordingly. The numbers given in Group 0 may also be reduced if, for example for expensive filters, the manufacturer chooses to carry out the tests of a number of groups in sequence on the same specimens. The numbers given for Group 0 do not include the specimens required for Groups 7 and 8.

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.

Table 3 or 4 gives the number of specimens to be tested in each group together with the permissible number of non-conforming for qualification approval tests.

### 3.4.4 Tests

Before submission to qualification approval testing, an appropriate 100 % voltage proof test between terminations according to Table 9 shall be made. The details of this test are the prerogative of the manufacturer, but the time shall not be less than 1 s. If a d.c. test voltage is used instead of a.c. for filters containing class Y capacitors and the time is less than 2 s, it shall not be less than 1,8 times the a.c. test voltage in Table 9. All non-conforming items shall be removed from the lot prior to qualification approval testing.

One or more of the complete series of tests indicated in Table 3 or Table 4 may be required for the approval of filters covered by one detail specification. The tests of each group shall be carried out in the order given.

The whole sample with the exception of those specimens to be submitted to the tests of Groups 7 and 8 shall be subjected to the tests of Group 0 and then subdivided for the other groups.