BS EN 50065-4-1:2002

Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz —

Part 4-1: Low voltage decoupling filters — Generic specification

The European Standard EN 50065-4-1:2001 has the status of a British Standard

ICS 33.040.30; 31.160; 29.240.20

National foreword

This British Standard is the official English language version of EN 50065-4-1:2001. It supersedes DD 158:1987 which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee PEL/205, Mains signalling, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the BSI Standards Catalogue under the section entitled "International Standards Correspondence Index", or by using the "Find" facility of the BSI Standards Electronic Catalogue.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

This British Standard, having been prepared under the direction of the Electrotechnical Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 24 January 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN title page, pages 2 to 17 and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

Amendments issued since publication

Amd. No.	Date	Comments

ISBN 0 580 38880 8

EUROPEAN STANDARD **EN 50065-4-1**

NORME EUROPÉENNE

EUROPÄISCHE NORM July 2001

ICS 31.160; 33.040.30

English version

Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz Part 4-1: Low voltage decoupling filters - Generic specification

Transmission de signaux sur les réseaux électriques basse tension dans la bande de fréquences de 3 kHz à 148,5 kHz Partie 4-1: Filtres basse tension de découplage - Spécification générique

Signalübertragung auf elektrischen Niederspannungsnetzen im Frequenzbereich 3 kHz bis 148,5 kHz Teil 4-1: Niederspannungs-Entkopplungsfilter - Fachgrundspezifikation

This European Standard was approved by CENELEC on 2000-08-01. 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.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the Central Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

CENELEC

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B - 1050 Brussels

Ref. No. EN 50065-4-1:2001 E

Foreword

This draft European Standard was prepared by SC 205A, Mains communicating systems, of Technical Committee CENELEC TC 205, Home and Building Electronic Systems (HBES).

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 50065-4-1 on 2000-08-01.

The following dates were fixed:

– latest date by which the EN has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2002-02-01
– latest date by which the national standards conflicting with the EN have to be withdrawn	(dow)	2003-04-01

Annexes designated "normative" are part of the body of the standard.
Annexes designated "informative" are given for information only.
In this standard, annexes A and B are informative.

EN 50065 consists of the following parts, under the general title: Signalling on low voltage electrical installations in the frequency range 3 kHz to 148,5 kHz

Part 1	General requirements, frequency bands and electromagnetic disturbances
Part 2-1	Immunity requirements for mains communications equipment and systems operating in the range of frequencies 95 kHz to 148,5 kHz and intended for use in residential, commercial and light industrial environments
Part 2-2	Immunity requirements for mains communications equipment and systems operating in the range of frequencies 95 kHz to 148,5 kHz and intended for use in industrial environments
Part 2-3	Immunity requirements for mains communications equipment and systems operating in the range of frequencies 3 kHz to 95 kHz and intended for use by electricity suppliers and distributors
Part 4-1	Low voltage decoupling filters – Generic specification
Part 4-2	Low voltage decoupling filters – Safety requirements
Part 4-3	Low voltage decoupling filters – Incoming filter
Part 4-4	Low voltage decoupling filters – Impedance filter
Part 4-5	Low voltage decoupling filters – Segmentation filter
Part 4-6	Low voltage decoupling filters – Phase coupler
Part 7	Equipment impedance

Contents

Introduction

Electrical networks, in spite of being a difficult medium for data communication due to signal attenuation, noise level and coupling side impedance, are considered as a potentially important transmission medium for supporting Distribution Automation and Home and Building Electronic Systems (HBES).

In order to avoid unwanted interference among mains communication equipment transmitting on low voltage networks, a suitable device called "decoupling filter" may be installed either on the public supply network or within installations in consumers' premises.

Decoupling filter is a generic name given, for example, to incoming filter, impedance filter, segmentation filter.

This decoupling filter may be incorporated in a more complex device where optional coupling functions are included (ref. Figure 1) according to signal propagation methods described in the informative annex A.

The decoupling filter may be used:

a) to limit the transmission area of wanted signals to the area in which the mains communication system operates.

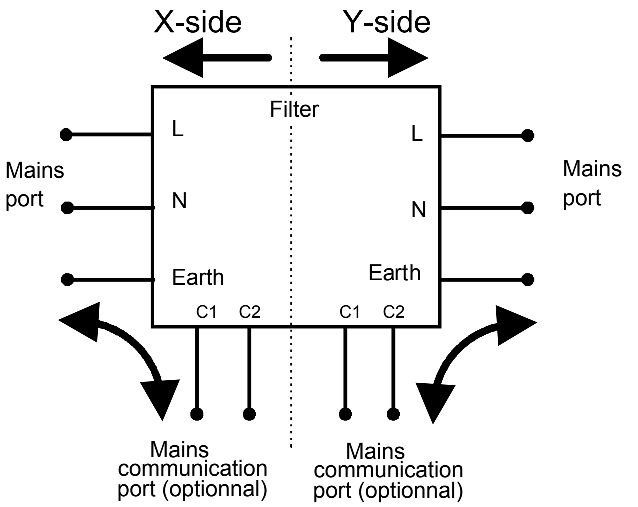
b) to reduce unwanted signals coming from the other side of the mains port.

c) to allow simultaneous communication on both sides of the filter.

d) to set a suitable impedance to the mains power ports at the signalling frequency.

e) to provide a return path for the signal when needed (e.g. common mode propagation).

A decoupling filter may perform all the functions listed above or some of them.



X	Y
Utility	Consumer
Utility	Utility (*)
Consumer	Consumer (*)
(*) in this case the filter may be reversed	

Figure 1 - Filter combined with other functions

1 Scope

This standard applies to decoupling filters installed on the low voltage mains network and operating in the frequency range 3 kHz to 148,5 kHz on low voltage mains network.

It does not apply to general purpose filters for EMI suppression.

It does not apply to protocol dependant devices except physical layer (frequency).

It does not apply to filters incorporated in household equipment for example: washing machines and coffee machines.

It specifies the impedance and the transfer function definitions, requirements and test methods of the decoupling filter and some other requirements for example Voltage Drop, Leakage Current and Form Factor.

The impedance and the transfer function are referred to the decoupling filter mains power ports (ref. Figure 1).

The use of the decoupling filter is considered optional; additional rules or obligations may exist that are outside the scope of this standard.

The safety requirements related to decoupling filters are not covered in this standard. They are covered in an other part of the EN 50065 set of standards

2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

EN 50065-1	Signalling on low-voltage electrical installations in the frequency range 3 kHz to 148,5 kHz -- Part 1: General requirements, frequency bands and electromagnetic disturbances
EN 50065-4-2	Signalling on low voltage electrical installations in the frequency range 3 kHz to 148,5 kHz -- Part 4-2: Low voltage decoupling filters - Safety requirements
EN 60068-2-27	Basic environmental testing procedures -- Part 2: Tests - Test Ea and guidance: Shock (IEC 60068-2-27)
EN 60417-1	Graphical symbols for use on equipment -- Part 1: Overview and application (IEC 60417-1)
EN 60417-2	Graphical symbols for use on equipment -- Part 2: Symbol originals (IEC 60417-2)
EN 60617	Graphical symbols for diagrams (IEC 60617 series)

EN 60898	Circuit-breakers for overcurrent protection for household and similar installations (IEC 60898, modified)
EN 60947-5-1	Low-voltage switchgear and controlgear -- Part 5-1: Control circuit devices and switching elements - Electromechanical control circuit devices (IEC 60947-5-1)
EN 60950:2000	Safety of information technology equipment (IEC 60950:1999, modified)
EN 61140	Protection against electric shock - Common aspects for installation and equipment (IEC 61140)
IEC 60027	Letter symbols to be used in electrical technology (harmonized in HD 245 series)
IEC 60038:1983 A1:1994	IEC standard voltages
IEC 60050-161	International Electrotechnical Vocabulary (IEV) -- Chapter 161: Electromagnetic compatibility
IEC 80416	General principles for the formulation of graphical symbols
ISO 3744	Acoustical noise

3 Definitions

For the purposes of this standard the following definitions apply. Furthermore, the definitions of the International Electrotechnical Vocabulary IEC 60050-161 and EN 50065-1 apply.

3.1
decoupling filter
device installed in an electrical installation in order to make possible reliable data transmission over the low voltage mains network

3.2
nominal current of the decoupling filter
the maximum power frequency continuous current for which the decoupling filter is declared by the manufacturer to be suitable in defined conditions

3.3
nominal voltage of the decoupling filter
the maximum voltage (for three-phase supply, the voltage between phases) for which the decoupling filters is operated

NOTE The definition of IEC 60038/A1:1994 has been the basis for the present definition.

3.4
operating frequency range (fmin, fmax)
decoupling filters may operate in either of the frequency bands;

- utility band 3 to 95 kHz,
- consumer band 95 to 148,5 kHz.

Operating frequency range (fmin, fmax) for each side is a sub range of either of the frequency bands:

– for utility side : $f_{min} \geq 3$ kHz, $f_{max} \leq 95$ kHz;
– for consumer side : $f_{min} \geq 95$ kHz, $f_{max} \leq 148,5$ kHz;

3.5
decoupling filter impedance
the impedance of the decoupling filter, considered as a two port device, is defined as the impedance which can be measured on either side of the filter. The termination shall be specified R_{Load}

3.6
transfer function
the ratio between the output signal and the input signal, depending on the frequency with given load conditions

3.7
leakage current
an electric current which, under normal operating conditions, flows in an unwanted conducting path

3.8
voltage drop at 50 Hz
the difference between the RMS value of the input voltage and the RMS value of the output voltage at nominal current at 50 Hz

3.9
total harmonic distortion (THD)
the THD added by the filter, at the nominal supply frequency and current, due to non linear effects

3.10
power dissipation
power dissipation at the nominal current

3.11
overcurrent
current exceeding nominal current that can occur during fault condition until protective devices (e.g. circuit-breakers) operate

3.12.1
overvoltage
voltage exceeding nominal voltage that can occur during normal operation.

3.12.2
surge
surge voltage that can occur during normal operation due to lightning effects or opening/closing line equipment

3.13
mechanical shocks
Refers to EN 60068-2-27

3.14
acoustical noise
Refers to ISO 3744

4 Symbols and abbreviations

Letter symbols, signs, abbreviations and graphical symbols shall comply with IEC 60027, EN 60417, EN 60617/IEC 60617 or IEC 80416, as appropriate.

5 Requirements

5.1 Marking

5.1.1 General information

See EN 50065-4-2.

5.1.2 Instruction sheet

An instruction sheet shall be supplied by the manufacturer with the filter unit showing:

a) its installation circuit diagram;

b) the precautions to be observed during the installation;

c) the transmission characteristics: operating frequency range, attenuation, impedance;

d) ambient operating condition such as operating temperature range;

e) electrical operating conditions such as current derating curve;

f) safety conditions.

5.2 Requirements of decoupling filter

5.2.1 Nominal current

Selected from : 1, 3, 6, 10, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125 A.

5.2.2 Nominal voltage

Selected from 230 V single phase and 400 V three phase system.

5.2.3 Decoupling filter impedance

The impedance curve shall not show resonance phenomena with a Q factor higher than 6 with the opposite side mains ports open or short-circuit.

For values refer to relevant parts of the standard.

In Annex B, general information is given about network impedance.

5.2.4 Transfer function

For values refer to relevant parts of the standard.

The typical figures and relative tolerances shall be detailed in the instruction sheet issued by the manufacturer.

5.2.5 Leakage current

When tested in accordance with 6.3 the maximum leakage current from any pole shall not exceed 3,5 mA for class I filters at 50 Hz (or values according to EN 60950:2000, subclause 5.1 and IEC 61140, subclause 7.5).

5.2.6 Voltage drop at 50 Hz

When measured at nominal current and frequency of the supply network, the modulus of the voltage drop shall not exceed 1 V rms.

5.2.7 Total harmonic distortion (THD)

Void.

5.2.8 Power dissipation

Requirements for DIN distribution board mounted filters: dissipated power shall not exceed 7 W/18 mm wide at nominal current.

Requirements for other types of filters: Void

5.2.9 Overcurrent

According to the relevant part of the product standard EN 50065-4-X.

5.2.10 Overvoltage / surges

According to the relevant part of the product standard EN 50065-4-X.

5.2.11 Mechanical shocks

According to EN 60068-2-27.

5.2.12 Acoustical noise

Void

5.2.13 Environmental conditions

Void

6 Test method

In the following figures the box "Network analyser" represents either a network analyser or other suitable measuring equipment e.g. measuring equipment described in "Equipment Impedance".

When the 125 µH coil is connected in parallel with the filter, its impedance shall be to taken into account when relevant. The value of this coil can be adapted when the measuring set-up is used only in the consumer band.

6.1 Decoupling filter impedance

- Frequency range:

  1 For utility side the test is made from 3 kHz to 95 kHz;

  2 For consumer side the test is made from 95 kHz to 148,5 kHz.

- Signal level : the maximum output levels of the signal are defined in EN 50065-1.

- Test conditions and set up : the test is performed in accordance with:

  Figure 2 measuring set up for open circuit, impedance measurement;

  Figure 3 measuring set up for nominal current, impedance measurement;

  Figure 4 measuring set up for nominal load, impedance measurement;

  Figure 5 measuring set up for nominal current on nominal load, impedance measurement.

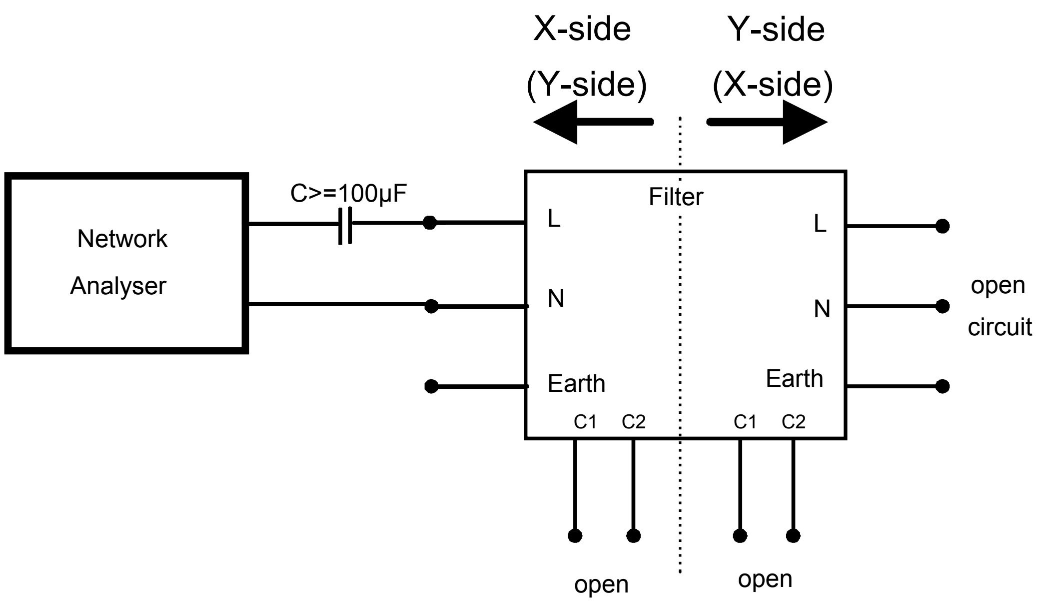


Figure 2 - Open circuit measuring set-up

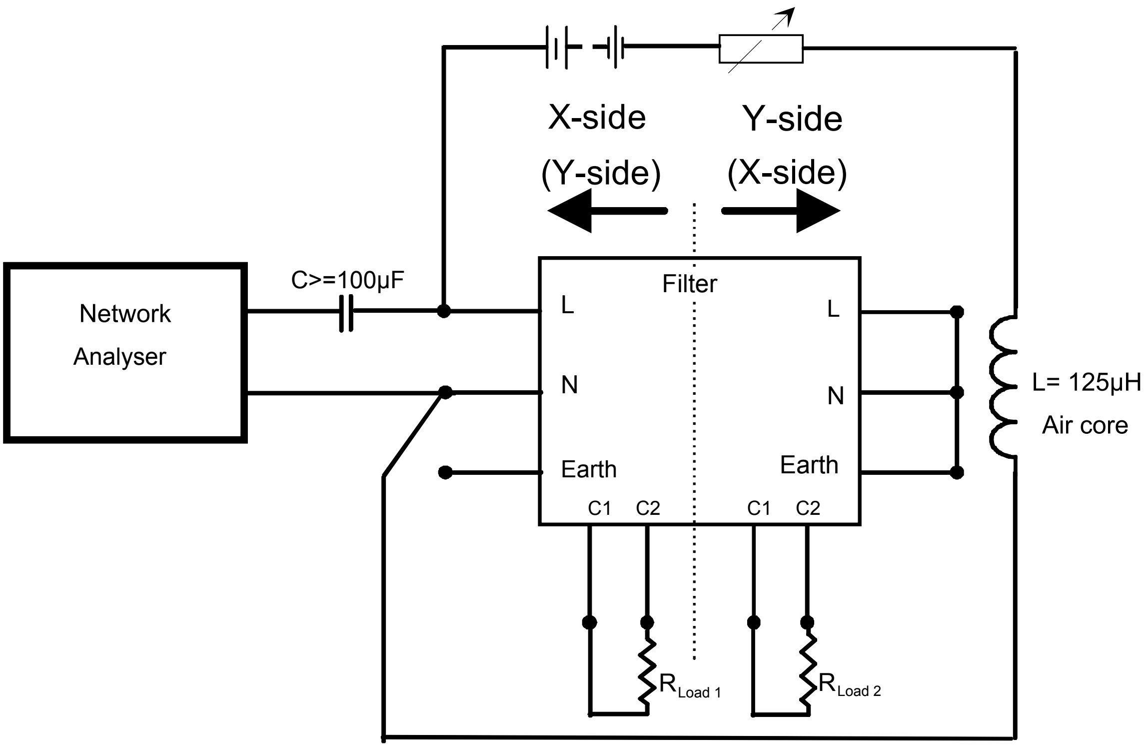


Figure 3 - Short-circuit measuring set-up

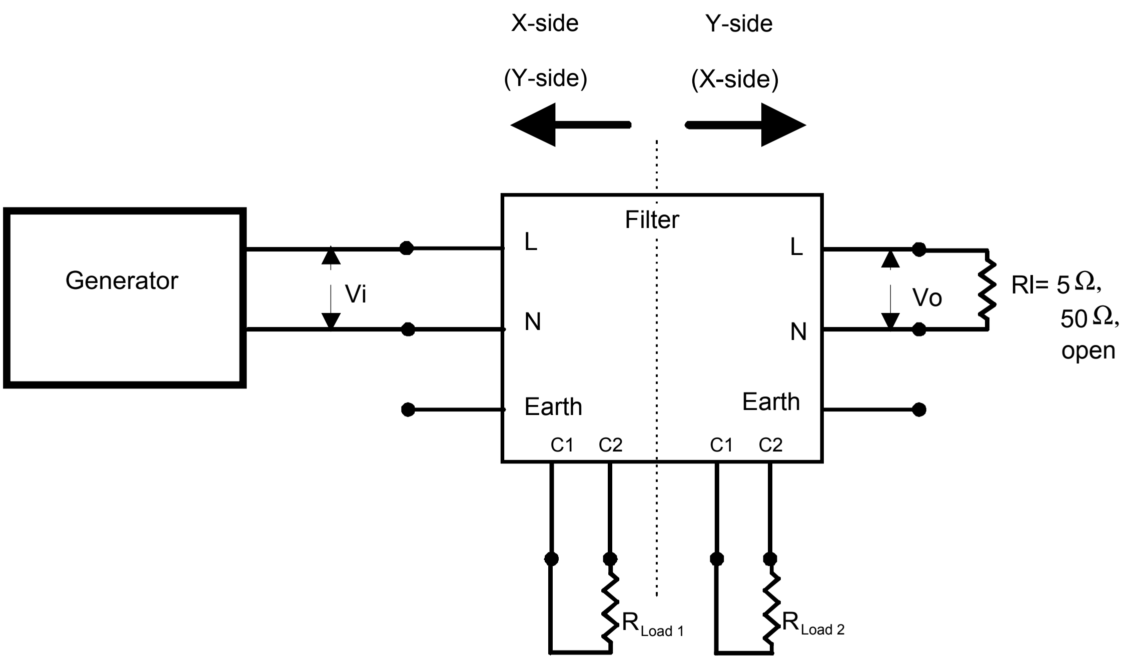


Figure 4 - Loaded measuring set-up

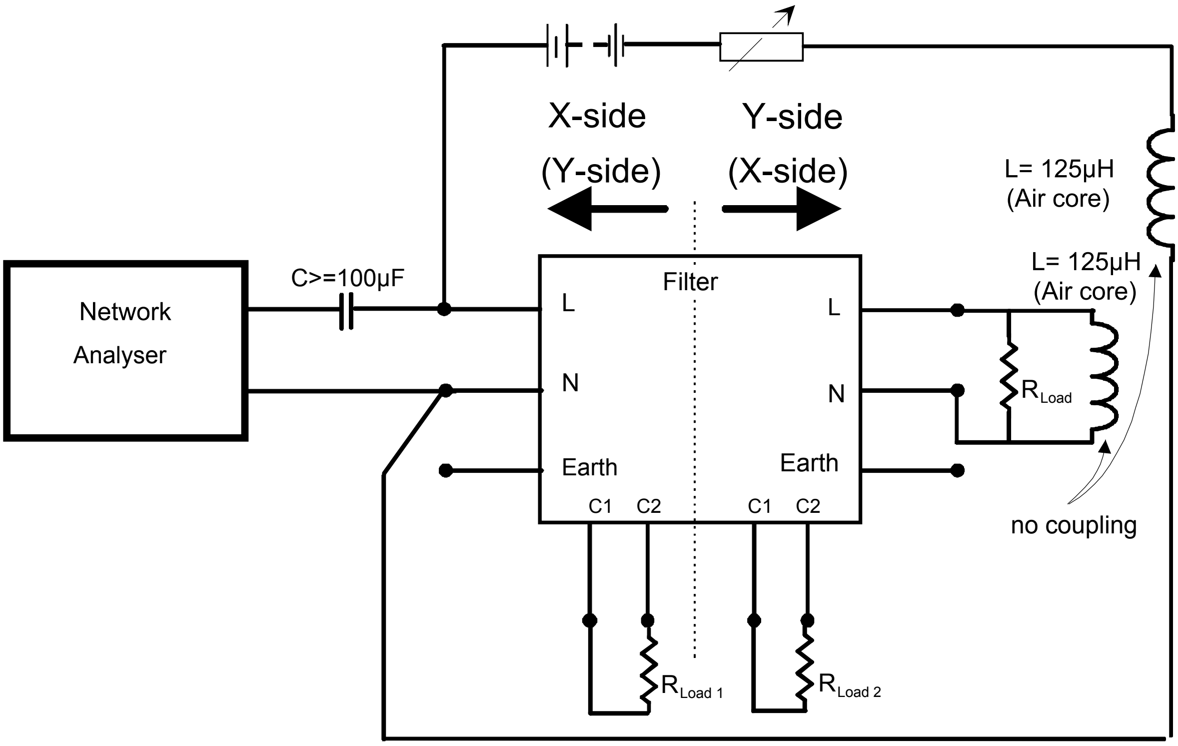


Figure 5 - Loaded measuring set-up at nominal current

6.2 Transfer function

- Frequency range:

  1 For utility side (when relevant) the test is made from 3 kHz to 95 kHz;

  2 For consumer side (when relevant) the test is made from 95 kHz to 148,5 kHz.

- Signal level: the maximum input level of the signal is defined in EN 50065-1.

- Test condition and set up: the test is performed in accordance with

  Figure 4 measuring set up for open circuit;

  Figure 5 measuring set up for nominal current.

- The respective transfer function (attenuation) is calculated in the following way :

$$|H(f)|_{(dB)} = 20 \lg (Vo/Vi).$$

6.3 Leakage current

The leakage current is measured between each terminal of the mains supply and the earth (ground) terminal.

The measuring circuit is shown in Figure 6; the test voltage is the nominal 50 Hz supply voltage.

The resistance of the voltage source is 2 000 Ω ± 100 Ω; the measuring instrument has an accuracy class of at least 5 at 50 Hz.

NOTE It is recommended that the decoupling filter is either supplied through an isolating transformer or insulated from ground.

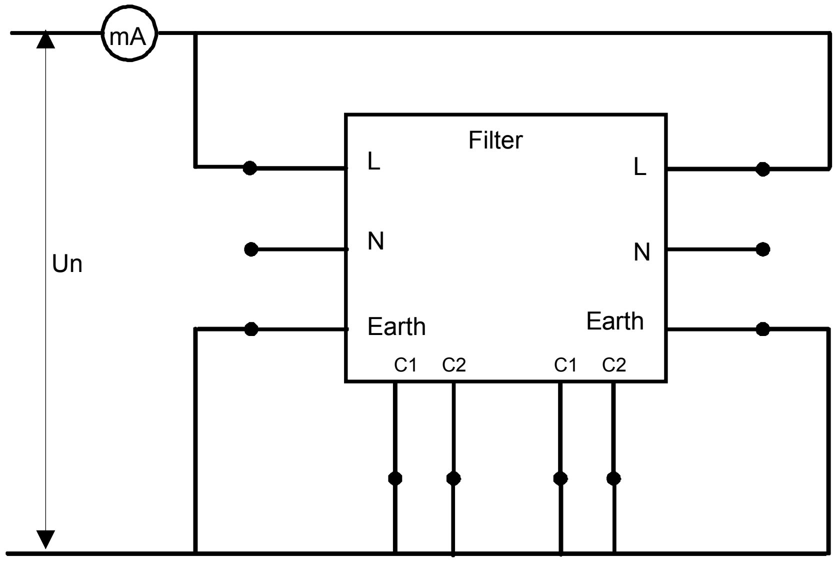


Figure 6 - Leakage current measurement

6.4 Voltage drop at 50 Hz

In practice, the voltage drop shall be measured at the nominal current of the filter (see Figure 7). Table 1 shows the copper conductors to be used in the test.

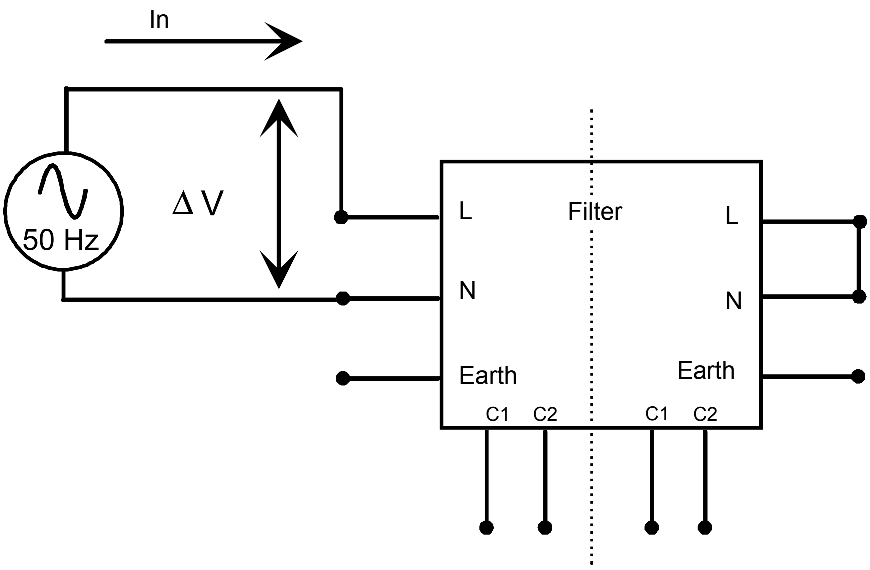


Figure 7 - Voltage drop measurement

Table 1 - Cross-sectional area(s) of test copper conductors corresponding to the current (In)

S (mm^2)	In (A)
1	In ≤ 6
1,5	6 < In ≤ 13
2,5	13 < In ≤ 20
4	20 < In ≤ 25
6	25 < In ≤ 32
10	32 < In ≤ 50
16	50 < In ≤ 63
25	63 < In ≤ 80
35	80 < In ≤ 100
50	100 < In ≤ 125

6.5 Total Harmonic Distortion (THD)

Void

6.6 Power dissipation

In practice, the power dissipation shall be measured at the nominal current of the filter (see Figure 8). Table 1 shows the copper conductors to be used in the test.

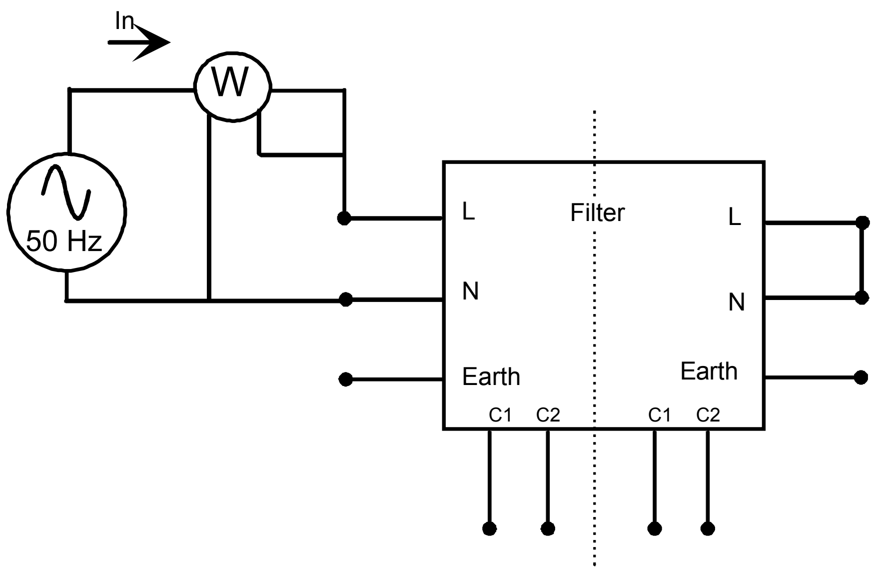


Figure 8 - Power dissipation measurement

6.7 Overcurrent,

Test and set up according to EN 60947-5-1.

6.8 Overvoltage / surges

Void

6.9 Mechanical shocks

Test and set up according to EN 60898 (subclause 8.13, mechanical shocks).

6.10 Acoustical noise

Void

Annex A
(informative)

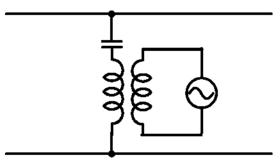
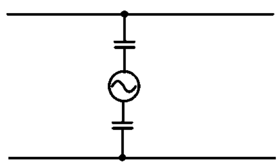
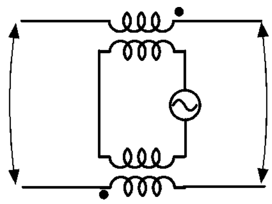
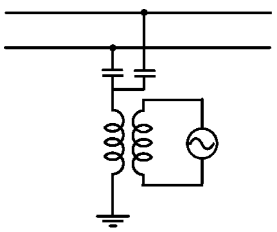
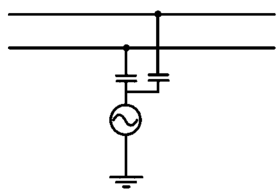
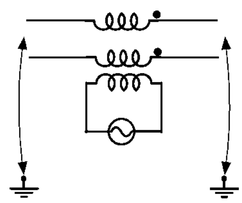
Coupling and propagation methods

The coupling methods to inject signals on low voltage power lines, taking into account both differential and common mode propagation are shown in Table A.1.

Parallel coupling injects signals on the power lines by using either phase-to-neutral injection (differential propagation mode) or phase and/or neutral-to-earth coupling (common mode propagation).

Serial coupling allows the injection of signals at the operating frequency on the power line, using a magnetic coupling circuit between phase and a primary winding suitable for maximum power transfer at the operating frequency.

Table A.1 - Coupling and propagation modes

Propagation mode	Coupling		
	Parallel		Serial
Differential			
Common mode (can be single phase)			

Common mode injection shall not be used unless otherwise explicitly allowed by local regulation (see EN 50065-1).

Annex B
(informative)

Characteristics of consumer networks

A limited programme of network impedance measurements was carried out in three European countries (Italy, France and Germany). These results are considered to be representative of similar networks.

In particular the statistical distribution of the impedance values, measured on consumers' networks in the frequency range 3 kHz to 148,5 kHz, shows that the impedance has the following characteristics :

- it is rarely greater than 20 Ω,
- 90% of the values lie in the range 0,5 Ω to 10 Ω,
- the most frequent values are around 5 Ω,
- the impedance depends on the measuring point,
- the reactive part of the impedance often dominates the resistive part,

The reasons for this behaviour are as follows :

- the consumers' power network has, in general, a complex "tree" structure having lines or cables with three conductors (phase, neutral and earth), with the power supply point situated on the "root" and the loads distributed on the "branch ends";
- the layout of the network and the loads differs between consumers;
- some consumer loads (that is, household and professional equipment) have a very low impedance (in the range 0,1 Ω to 10 Ω), mainly due to the radio-interference suppression filters installed in them (upstream of the apparatus switch);
- the impedance of the lines or cables is not negligible in relation to that of the loads.

BSI — British Standards Institution

BSI is the independent national body responsible for preparing British Standards. It presents the UK view on standards in Europe and at the international level. It is incorporated by Royal Charter.

Revisions

British Standards are updated by amendment or revision. Users of British Standards should make sure that they possess the latest amendments or editions.

It is the constant aim of BSI to improve the quality of our products and services. We would be grateful if anyone finding an inaccuracy or ambiguity while using this British Standard would inform the Secretary of the technical committee responsible, the identity of which can be found on the inside front cover. Tel: +44 (0)20 8996 9000. Fax: +44 (0)20 8996 7400.

BSI offers members an individual updating service called PLUS which ensures that subscribers automatically receive the latest editions of standards.

Buying standards

Orders for all BSI, international and foreign standards publications should be addressed to Customer Services. Tel: +44 (0)20 8996 9001. Fax: +44 (0)20 8996 7001. Email: orders@bsi-global.com. Standards are also available from the BSI website at http://www.bsi-global.com.

In response to orders for international standards, it is BSI policy to supply the BSI implementation of those that have been published as British Standards, unless otherwise requested.

Information on standards

BSI provides a wide range of information on national, European and international standards through its Library and its Technical Help to Exporters Service. Various BSI electronic information services are also available which give details on all its products and services. Contact the Information Centre. Tel: +44 (0)20 8996 7111. Fax: +44 (0)20 8996 7048. Email: info@bsi-global.com.

Subscribing members of BSI are kept up to date with standards developments and receive substantial discounts on the purchase price of standards. For details of these and other benefits contact Membership Administration. Tel: +44 (0)20 8996 7002. Fax: +44 (0)20 8996 7001. Email: membership@bsi-global.com.

Information regarding online access to British Standards via British Standards Online can be found at http://www.bsi-global.com/bsonline.

Further information about BSI is available on the BSI website at http://www.bsi-global.com.

Copyright

BSI
389 Chiswick High Road
London
W4 4AL