BS EN 60358-2:2013

BSI Standards Publication

Coupling capacitors and capacitor dividers

Part 2: AC or DC single-phase coupling capacitor connected between line and ground for power line carrier-frequency (PLC) application

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National foreword

This British Standard is the UK implementation of EN 60358-2:2013. It is identical to IEC 60358-2:2013. Together with BS EN 60358-1:2012, BS EN 60358-3 and BS EN 60358-4 it supersedes BS 7578:1992 (dual numbered as IEC 60358:1990), which will be withdrawn on publication of all parts of the BS EN 60358 series.

The UK participation in its preparation was entrusted to Technical Committee PEL/33, Power capacitors.

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

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Supersedes HD 597 S1:1992 (partially)

English version

Coupling capacitors and capacitor dividers - Part 2: AC or DC single-phase coupling capacitor connected between line and ground for power line carrier-frequency (PLC) application (IEC 60358-2:2013)

Condensateurs de couplage et diviseurs capacitifs -
Partie 2: Condensateur de couplage monophasé à courant alternatif ou à courant continu connecté entre la ligne et la terre pour application aux liaisons à courant porteur sur lignes d'énergie (CPL)
(CEI 60358-2:2013)

Kopplungskondensatoren und kapazitive Teiler -
Teil 2: Einphasen-Kopplungskondensatoren für Wechsel- oder Gleichstrom, die für Trägerfrequenzübertragungen auf Hochspannungsleitungen (TFH-Übertragung) zwischen Außenleiter und Erde geschaltet sind
(IEC 60358-2:2013)

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Foreword

The text of document 33/531/FDIS, future edition 1 of IEC 60358-2, prepared by IEC/TC 33, "Power capacitors and their applications" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60358-2:2013.

The following dates are fixed:

• latest date by which the document has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2014-06-16
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2016-09-16

This document supersedes HD 597 S1:1992 (partially).

This European Standard is to be used in conjunction with the latest edition of EN 60358-1 and its amendments. It was established on the basis of the first edition (2012) of that standard.

This Part 2 supplements or modifies the corresponding clauses in EN 60358-1.

When a particular subclause of Part 1 is not mentioned in this Part 2, that subclause applies as far as is reasonable. Where this Part 2 states “addition” or “replacement”, the relevant text in Part 1 is to be adapted accordingly.

For additional clauses, subclauses, figures, tables or annexes, the following numbering system is used:
– subclauses, tables and figures which are additional to those in Part 1 are numbered starting from 200;
– additional annexes are lettered AA, BB etc.
– as the notes are integrated into the clauses, their numbering starts from 1 as usual.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CENELEC [and/or CEN] shall not be held responsible for identifying any or all such patent rights.

Endorsement notice

The text of the International Standard IEC 60358-2:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following notes have to be added for the standards indicated:

IEC 60085	NOTE	Harmonized as EN 60085.
IEC 60721 Series	NOTE	Harmonized in EN 60721 series.
IEC 61462	NOTE	Harmonized as EN 61462.
CISPR 16-1-1	NOTE	Harmonized as EN 55016-1-1.

Annex ZA
(normative)

Normative references to international publications with their corresponding European publications

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.

NOTE When an international publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

Publication	Year	Title	EN/HD	Year
IEC 60060-1		High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	
IEC 60060-2		High-voltage test techniques - Part 2: Measuring systems	EN 60060-2	
IEC 60358-1 + corr. July	2012 2013	Coupling capacitors and capacitor dividers - Part 1: General rules	EN 60358-1 + AC:2013	2012 2013
IEC 60481		Coupling devices for power line carrier systems	-	-
IEC 61869-5		Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers		

CONTENTS

INTRODUCTION

This series consists of the following parts:

IEC 60358-1, Coupling capacitors and capacitor dividers – Part 1: General rules

IEC 60358-2, Coupling capacitors and capacitor dividers – Part 2: AC or DC single-phase coupling capacitor connected between line and ground for power line carrier-frequency (PLC) application

IEC 60358-3[1], Coupling capacitors and capacitor dividers – Part 3: AC or DC single-phase coupling capacitor connected between line and ground for harmonic-filters applications

IEC 60358-4[2], Coupling capacitors and capacitor dividers – Part 4: AC or DC single-phase capacitor-divider and RC-divider connected between line and ground (except for CVT's which belong to IEC 61869 series)

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1 Under consideration.

2 Under consideration.

COUPLING CAPACITORS AND CAPACITOR DIVIDERS –

Part 2: AC or DC single-phase coupling capacitor connected between line and ground for power line carrier-frequency (PLC) application

1 Scope

Clause 1 of IEC 60358-1:2012 is applicable with the following additions:

This part of the IEC 60358 series applies to AC or DC single-phase coupling capacitors, with rated voltage > 1 000 V, connected between line and ground with a low voltage terminal either permanently earthed or connected to a device for power line carrier-frequency (PLC) applications at frequencies from 30 kHz to 500 kHz or similar applications (DC or AC) at power frequencies from 15 Hz to 60 Hz.

The transmission requirements for coupling devices for power line carrier (PLC) systems are defined in IEC 60481.

NOTE Diagrams of coupling capacitors to which this standard applies are given in Figure A.1.

2 Normative references

Clause 2 of IEC 60358-1:2012 is replaced by the following:

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

IEC 60060-2, High-voltage test techniques – Part 2: Measuring systems

IEC 60358-1:2012, Coupling capacitors and capacitor dividers. – Part 1: General rules

IEC 60481, Coupling devices for power line carrier systems

IEC 61869-5, Instrument transformers – Part 5: Additional requirements for capacitor voltage transformers

3 Terms and definitions

Clause 3 of IEC 60358-1:2012 is applicable with the following additions:

For the purposes of this document, the terms and definitions given in Clause 3 of IEC 60358-1:2012, as well as the following apply.

3.200 Carrier-frequency accessories definitions

3.200.1
coupling device
arrangement of elements which contribute to ensure, together with one or more associated coupling capacitors, the transmission, under prescribed conditions, of carrier-frequency signals between one or more conductors of the power line and the carrier-frequency connection

3.200.2
carrier-frequency accessories
circuit element intended to permit the injection of carrier frequency signal and which is connected between the low voltage terminal of a coupling capacitor unit and earth, and having an impedance which is insignificant at the power frequency, but appreciable at carrier frequency

Note 1 to entry: See Figure A.1.

3.200.3
drain coil
inductance which is connected between the low voltage terminal of a coupling capacitor and earth, and whose impedance is insignificant at the power frequency, but has a high value at the carrier frequency

3.200.4
voltage limitation device
element connected between the coupling capacitor and earth to limit the overvoltages which appear across the coupling device.

Note 1 to entry: Overvoltages appear in case of:

a) a short circuit between the high-voltage terminal and earth;

b) where an impulse voltage is applied between the high voltage terminal and earth.

3.200.5
carrier earthing switch
switch for earthing the low voltage terminal

4 Service conditions

Clause 4 of IEC 60358-1:2012 is applicable.

5 Ratings

Clause 5 of IEC 60358-1:2012 is applicable.

6 Design requirements

Clause 6 of IEC 60358-1:2012 is applicable with the following additions:

6.200 Design requirements for coupling capacitor and carrier-frequency accessories

6.200.1 Design requirements for coupling capacitor

Coupling capacitors shall be designed to withstand an additional steady high frequency current of at least 1 A (r.m.s. value of current equivalent to a power of 400 W for a terminal resistance of 400 Ω), without any damage or deterioration.

6.200.2 Design requirements for carrier-frequency accessories

6.200.2.1 General

The carrier-frequency accessories, comprising a drain coil and a protective device, shall be connected between the low voltage terminal of the coupling capacitor and the earth terminal. The connections are typically as shown in Figure A.1.

The requirements for the complete coupling device are specified in IEC 60481.

6.200.2.2 Drain coil

The drain coil shall be designed in such a way, that:

a) for an AC application, the impedance should be as low as possible and in no case exceed 20 Ω at power frequency;

   for a DC application, no standard value is defined; manufacturer and purchaser shall define the impedance value;

b) the current-carrying capability at power frequency is as follows:

   – continuous operation: rated current of capacitor, but not less than 1 A r.m.s.;

   – short-time current: 30 A r.m.s. for 0,2 s;

c) the drain coil shall be able to withstand a 1,2/50 µs impulse voltage whose peak value is twice the value of the impulse spark voltage of the voltage limitation device, but the minimum value should be 10 kV peak (see 10.201.2.2)

d) for a drain coil with iron core, the insulation between winding and iron core shall support 3 kV for 60 s (see 9.2.200.2.1.3).

e) If the maximum fundamental frequency current of the capacitor is higher than 1 A, the continuous operation current for the drain coil should be increased accordingly

f) for a DC application, the grading current of the coupling capacitor shall not saturate the drain coil.

6.200.2.3 Voltage limitation device

A lightning arrester shall be connected as directly as possible between the low voltage terminal of the coupling capacitor and the earth terminals and shall be capable of protecting the coupling device and the carrier-frequency connection.

For AC applications: The AC protection level voltage U_{PL} at power frequency shall be greater than 10 times the maximum AC voltage across the drain coil during rated operation conditions.

The voltage U_{PL} is given by the following formula:

$$U_{PL} \geq 10 \cdot \frac{F_V}{3} \cdot \frac{U_m}{\sqrt{2} \cdot (\pi f_R)^2 \cdot C_R \cdot L_D}$$

where

L_D is the value of the drain coil in henry;

F_V is the voltage factor according to IEC 60358-1:2012, Table 2.

NOTE 1 Arresters of the air-gap type or those of the non-linear resistor type are used.

Example:

a) power-frequency withstand test voltage:

   – air-gap arrester: 2 kV r.m.s.,

   – arrester with spark-gap: rated voltage: approx. 1 kV r.m.s.

b) impulse withstand voltage:

– air-gap arrester and arrester with spark-gap: at test impulse voltage of about 4 kV peak with a wave shape 8/20 µs the arrester are able to sustain the peak current of at least 5 kA.

NOTE 2 It is desirable that the arrester be capable of sustaining a power frequency current of at least 5 kA r.m.s. for a period of 0,2 s while ensuring, even if damaged, that the other parts of the coupling device remain adequately protected.

For DC applications:

The DC protection level voltage U_{PL} shall be:

$$U_{PL} \geq 3{,}5\,\text{kV}\quad \text{DC}$$

NOTE 3 3,5 kV coming from 2,5 kV AC × √2.

7 Test conditions

Clause 7 of IEC 60358-1:2012 is applicable.

8 Classification of tests

8.1 General

Subclause 8.1 of IEC 60358-1:2012 is applicable with the following addition:

The tests specified in this standard are classified as routine tests, type tests and special tests.

8.2 Routine tests

Subclause 8.2 of IEC 60358-1:2012 is applicable with the following additions:

8.2.200 General

The tests specified in 8.1 apply to coupling capacitors.

8.2.201 Routine tests for carrier frequency accessories

8.2.201.1 Routine test for drain coil

a) current carrying capability test (9.2.200.2.1.1);
b) measurement of the impedance at power frequency (9.2.200.2.1.2);
c) voltage test between winding and iron core (9.2.200.2.1.3).

8.2.201.2 Routine test for voltage limitation devise

AC or DC voltage test (9.2.200.2.2.1).

8.3 Type tests

Subclause 8.3 of IEC 60358-1:2012 is applicable with the following additions:

8.3.200 Type test for coupling capacitor and carrier-frequency accessories

8.3.200.1 Type test for coupling capacitors

a) high frequency capacitance and equivalent series resistance (10.200.1);

b) measurement of the stray capacitance and stray conductance of the low voltage terminal (10.200.2).

8.3.200.2 Type tests for carrier-frequency accessories

8.3.200.2.1 Type tests for drain coil

a) impedance measurement (10.201.2.1);

b) impulse voltage test (10.201.2.2);

c) current capability test (10.201.2.3);

d) short time current test (10.201.2.4).

8.3.200.2.2 Type test for voltage limitation device together with drain coil

a) impulse voltage test (10.201.2.2).

8.4 Special tests

Subclause 8.4 of IEC 60358-1:2012 is applicable.

9 Routine tests

9.1 Tightness of the liquid-filled equipment

Subclause 9.1 of IEC 60358-1:2012 is applicable.

9.2 Electrical routine tests

Subclause 9.2 of IEC 60358-1:2012 is applicable with the following additions:

9.2.200 Electrical tests for coupling capacitor and carrier frequency accessories

9.2.200.1 Routine tests for coupling capacitor

The routine tests on the coupling capacitor are specified in IEC 60358-12012, 8.1. No supplementary test is specified for PLC application for coupling capacitors.

9.2.200.2 Routine tests for carrier frequency accessories

9.2.200.2.1 Routine tests for drain coil

9.2.200.2.1.1 Current carrying capability test

The test shall be carried out, applying for 1 min a power frequency voltage between the terminals of the drain coil. The test voltage shall be adjusted to achieve a current twice the rated current of the capacitor, but not less than 1 A (r.m.s.). No damage shall occur.

9.2.200.2.1.2 Measurement of the impedance at power frequency

The measured value shall be within the range specified by the manufacturer. This test shall be performed after the current carrying capability test.

9.2.200.2.1.3 Voltage test between winding and iron core

The test shall be carried out, applying a 3 kV power frequency voltage between the terminals of the winding and the iron core for 1 min.

9.2.200.2.2 Routine test for voltage limitation devices

The following routine test is specified according to the cases below:

a) air-gap arrester;

measurement of the protection level voltage;

the voltage AC or DC is increased until breakdown. The breakdown voltage must be within the range specified by the manufacturer;

b) arrester;

measurement of the reference voltage of arrester;

the AC voltage is increased on the arrester until the current reach 1 mA r.m.s, the measured reference voltage must be within the range specified by the manufacturer.

10 Type tests

Clause 10 of IEC 60358-1:2012 is applicable with the following additions:

10.200 Test on capacitor

10.200.1 High frequency capacitance and equivalent series resistance

The measurements shall be carried out on a complete capacitor or on a capacitor unit.

The capacitances and the equivalent series resistances shall be measured at the two temperatures equal to the limits of the temperature category and at a temperature within the standard range for testing (IEC 60358-1:2012, Clause 7), at several frequencies over the whole frequency range specified in Clause 1.

The measured values of the capacitance between the line and low voltage terminals shall not deviate by more than –20 % to +50 % from the rated capacitance.

For very high capacitance value and higher rated voltage values, the self-inductance of the capacitor (typical 1 µH/m) will not permit to cover the complete PLC frequency range given in Clause 1. In that case the usable frequency range shall be agreed between manufacturer and purchaser (see Annex AA).

The measured values of the equivalent series resistance between the line and low voltage terminals of the complete equipment shall not exceed 40 Ω at any frequency and temperature.

For the lower measuring frequencies (for instance 30 kHz to 100 kHz) with a temperature equal to the lower limit of the category, or for capacitor stacks with a capacitance equal to or less than 2 000 pF, or for U_m greater than 420 kV, the equivalent series resistance may be higher than 40 Ω. In this case, the value shall be agreed between manufacturer and purchaser.

For high frequency characteristics and measuring methods, see Annex AA.

In the case of practical difficulties in carrying out the measurements at the limits of the temperature category, the purchaser and the manufacturer may agree on measurements over a smaller temperature range, or on measurements performed on a model capacitor containing a limited number of elements.

10.200.2 Measurement of the stray capacitance and stray conductance of the low voltage terminal

The measurements shall be carried out either on a unit or on a model representative of the bottom part of the capacitor under consideration.

This model shall include the earth terminal, the metal parts (e.g. flanges) permanently connected to it, and the low voltage terminal with at least one element connected to it and

placed in its proper position. If a model is used, it shall be filled with the insulating liquid used for the capacitor.

The values of the stray capacitance and the stray conductance, measured at any frequency in the carrier frequency range, shall not exceed 200 pF and 20 µs respectively.

To avoid a harmful increase of the stray conductance in polluted ambient conditions, the low voltage terminal should have a creepage distance in accordance with IEC 60358-1:2012, 6.2.7.

10.201 Type test on carrier frequency accessories

10.201.1 General

The routine tests according to 9.2.200.2 shall be repeated after the type tests.

10.201.2 Type tests for drain coil

10.201.2.1 Impedance measurement

The impedance shall be measured within the carrier-frequency range. The proposed frequency steps are 30, 50, 100, 200, 300, 400 and 500 kHz.

The value of impedance shall be within the specified limit.

10.201.2.2 Impulse voltage test

The impulse voltage test shall be performed between the terminals of the drain coil installed in its enclosure after disconnecting the voltage limitation device.

The peak value shall be twice the value of the impulse spark voltage of the voltage limitation device, but the minimum value should be 10 kV peak.

Ten 1,2 / 50 µs voltage impulses shall be applied in sequence, five negative and five positive (see IEC 60060-1).

10.201.2.3 Current carrying capability test

The current carrying capability test shall be carried out, by applying a power frequency voltage between the terminals of the drain coil. The test voltage shall be adjusted to achieve the rated current that shall not be less than 1 A (r.m.s). During this test the temperature rise ΔT shall be measured and the test shall be continued until the temperature has reached a steady state ($\Delta T < 1$ K/h). The temperature rise shall not exceed the appropriate value given in Table 200.

Table 200 – Limits of temperature rise of windings

Class of insulation (in accordance with IEC 60085)	Maximum temperature rise ΔT K
All classes, immersed in oil. When the drain coil is not so fitted or arranged, the temperature rise ΔT of the oil at the top of the housing shall not exceed 50 K.	60
All classes, immersed in oil and hermetically sealed. When the drain coil has an inert gas above the oil, or is hermetically sealed, the temperature rise ΔT of the oil at the top of the housing shall not exceed 55 K.	65
All classes, immersed in bituminous compound.	50
Classes not immersed in oil or bituminous compound: Y A E B F H The temperature rise ΔT measured on the external surface of the core and other metallic parts which are in contact with, or adjacent to, insulation shall not exceed the appropriate values.	 45 60 75 85 110 135

For some materials (e.g. resin) the manufacturer should specify the relevant insulation class.

10.201.2.4 Short time current test

The test shall be carried out, by applying a power frequency voltage between the terminals of the drain coil. The test voltage shall be adjusted to achieve a current of 30 A (r.m.s.) for 0.2 s. The measurement of impedance has to be performed before and after the test (coil at room temperature). The measured value has to be within the specified tolerance.

10.201.3 Type test for voltage limitation device together with drain coil: Impulse voltage test

The test shall be performed between the terminals of the voltage limitation device together with the drain coil installed in their enclosure.

The impulse voltage is increased step by step until the protection level voltage of the voltage limitation device is reached.

The value of the protection level voltage has to be at maximum 50 % of the impulse voltage withstand capability of the drain coil.

For air-gap arresters and arresters: 8/20 µs protection level voltage impulse shall be applied in sequence, five negative and five positive.

NOTE 1 The test can be done with a 1,2/50 µs.

NOTE 2 Additional tests, such as composite loss and return loss tests, concerning complete coupling devices for PLC systems are covered by IEC 60481.

11 Special tests

Clause 11 of IEC 60358-1:2012 is applicable with the following addition:

The special tests are specified in IEC 60358-1:2012, 8.4. No supplementary test is specified for PLC application for coupling capacitors.

12 Marking

12.1 General

Subclause 12.1 of IEC 60358-1:2012 is applicable.

12.2 Marking of capacitor

Subclause 12.2 of IEC 60358-1:2012 is applicable with the following addition:

12.200 Marking of the carrier-frequency accessories

For the carrier-frequency accessories, the rating plate shall include the following information

Carrier–frequency accessories	
Drain coil L D mH	
Voltage limitation device	Type: Protection level voltage (1,2/50 µs or 8/20 µs or DC)

Annexes

The annexes of IEC 60358-1:2012 apply except as follows:

Annex A
(informative)

Typical diagram of an equipment

Annex A of IEC 60358-1:2012 is applicable with the following addition:

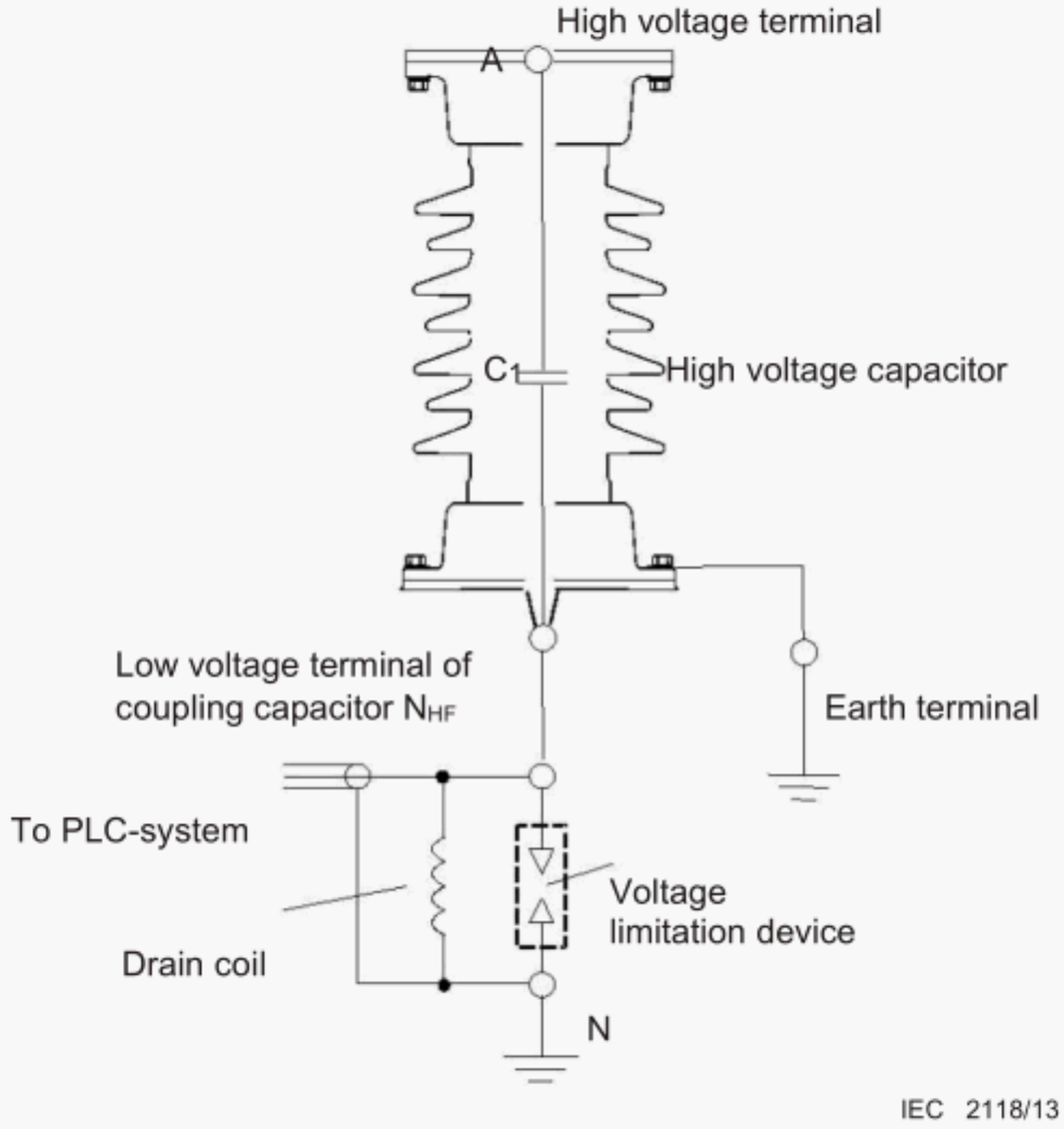


Figure A.200.1 – Example of a diagram for a coupling capacitor with carrier-frequency accessories (see IEC 60481)

Annex AA
(informative)

High-frequency characteristics of coupling capacitors for power line carrier circuits

AA.1 High-frequency capacitance and equivalent series resistance (10.200.1)

The frequency conditions mentioned in Clause 1 are those occurring in the great majority of cases. For different conditions that may occur in certain countries for frequencies above 500 kHz or below 30 kHz, the recommendations may differ, if necessary, from the values indicated for the type test (Clause 10).

The fact should be considered that any change in the high-frequency characteristics of the coupling capacitor, such as, for instance, a change in the capacitance of the coupling capacitor itself or the introduction of stray quantities (capacitance, etc.) may affect the transmission bandwidth (useful frequency band), shift this band and produce an additional coupling attenuation.

AA.2 Stray capacitance and conductance of the low voltage terminal (10.200.2)

Stray capacitance and conductance of the low voltage terminal, with respect to the earth terminal, should be as low as possible.

Terminal design and arrangement should be chosen so that the effect of adverse atmospheric conditions (humidity, snow, frost, dust, etc.) does not involve stray capacitance and conductance values appreciably higher than those stated above and in Clause 10.

NOTE 1 Values higher than 20 µs may have an appreciable effect on the bandwidth of the coupling equipment, at least for operation at frequencies lower than 100 kHz and for a low coupling capacitance.

NOTE 2 The values given in Clause 10 cannot generally be obtained when testing a complete capacitor voltage transformer, owing to the capacitance and the additional losses of the electromagnetic unit. In the case of a capacitor voltage transformer, the following limiting values can generally be assumed:

– for stray capacitance: $(300 + 0{,}05) \times C_R$ (in pF), where C_R represents the rated capacitance, expressed in picofarads;

– for stray conductance: 50 µs.

AA.3 Bridge method for measurement of the high-frequency capacitance and equivalent series resistance (10.200.1)

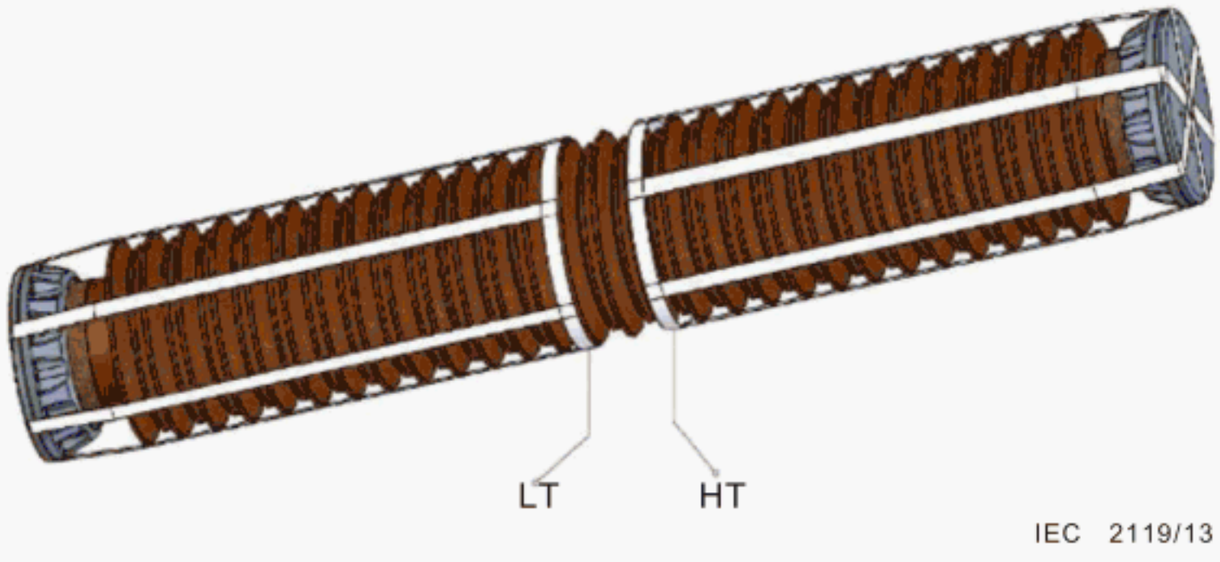
The measuring method giving the values of high-frequency capacitance and equivalent series resistance may be chosen, as convenient, from various high frequency procedures such as bridge methods, substitution methods, impedance analyser, etc.

It is recommended that capacitances and inductances due to the measurement connections should be reduced as far as possible (by minimizing the length thereof) and likewise the earth capacitances of the coupling capacitor. Particular care should be taken to screen the measuring equipment and, if necessary, the connections.

If the stray capacitance and inductance of the measuring arrangement produce an appreciable effect, this shall be allowed for in computing the results of the measurements.

The introduction of uncontrolled stray elements may give rise to serious errors in measuring the capacitance.

In order to reduce to insignificant values the inductances due to the measurement connections, it is suggested that two cages, insulated from one another, and each made with six or eight copper straps be used. These cages shall surround the capacitor under test and shall be in close contact with the insulating material throughout its length. One end of the upper cage should be connected to the line terminal, while one end of the lower cage should be connected to the low voltage terminal. The measuring bridge should be connected with two wires as short as possible, to the two other ends of the cages as shown in Figure AA.1.



Key

HT line terminal

LT low voltage terminal

Figure AA.1 – Wiring diagram of the measuring circuit for the high-frequency capacitance and equivalent series resistance of a coupling capacitor

AA.4PLC frequency range for high capacitance and long capacitor (10.200.1)

For very high capacitance values and long capacitors, the physical self-inductance of the capacitor (typically 1 µH/m) will reduce the 1st resonance frequency. If this is the case, the deviation of the capacitance between the line and low voltage terminals in the range of–20 % to +50 % from the rated capacitance cannot be obtained; in that case, the usable PLC frequency range shall be agreed between manufacturer and purchaser.

The graph presented in Figure AA.2 shows the cases where the relation between length and capacitance can fulfil the capacitive deviation –20 % to +50 % up to 500 kHz.

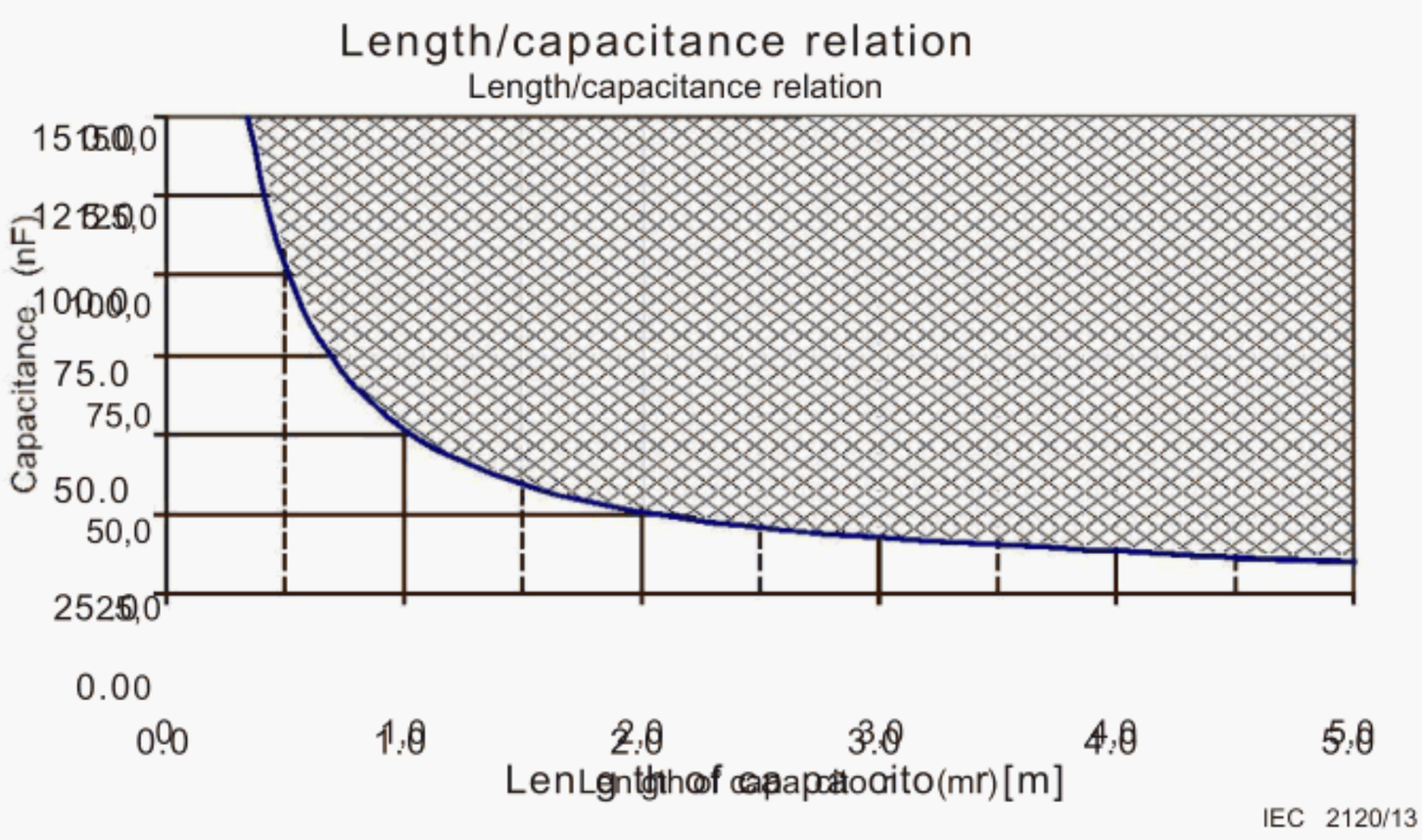


Figure AA.2 – Relation between length and capacitance where capacitive deviation –20 % to +50 % can be fulfilled up to 500 kHz

Bibliography

IEC 60085, Electrical insulation – Thermal evaluation and designation

IEC 60721 (all parts), Classification of environmental conditions

IEC 61462, Composite hollow insulators – Pressurized and unpressurized insulators for use in electrical equipment with rated voltage greater than 1 000 V – Definitions, test methods, acceptance criteria and design recommendations

CISPR 16-1-1, Specification for radio disturbance and immunity measuring apparatus and methods − Part 1-1: Radio disturbance and immunity measuring apparatus − Measuring apparatus

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