BS EN 60358-3:2014

BSI Standards Publication

Coupling capacitors and capacitor dividers

Part 3: AC or DC coupling capacitors for harmonic-filters applications

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National foreword

This British Standard is the UK implementation of EN 60358-3:2014. It is identical to IEC 60358-3:2013. Together with BS EN 60358-1:2012, BS EN 60358-2:2013 and BS EN 60358-4 it supersedes BS 7578:1992 (dual numbered as IEC 60358:1990), which will be withdrawn upon publication of all parts of the BS EN 60358 series.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.

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Coupling capacitors and capacitor dividers - Part 3: AC or DC coupling capacitors for harmonic-filters applications

(IEC 60358-3:2013)

Condensateurs de couplage et diviseurs capacitifs - Partie 3: Condensateur de couplage à courant alternatif ou à courant continu pour des applications à filtres harmoniques
(CEI 60358-3:2013)

Kopplungskondensatoren und kapazitive Teiler – Teil 3: Kopplungskondensatoren für Wechsel- oder Gleichstrom als Oberwellenfilter
(IEC 60358-3:2013)

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Europäisches Komitee für Elektrotechnische Normung

CEN-CENELEC Management Centre: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of document 33/510/CDV, future edition 1 of IEC 60358-3, prepared by IEC/TC 33, "Power capacitors and their applications" was submitted to the IEC-CENELEC parallel vote and approved by CENELEC as EN 60358-3:2014.

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)	2014-10-01
• latest date by which the national standards conflicting with the document have to be withdrawn	(dow)	2017-01-01

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

This European Standard is to be used in conjunction with EN 60358-1:2012 and its amendments.

This Part 3 supplements or modifies the corresponding clauses in EN 60358-1:2012.

When a particular subclause of Part 1 is not mentioned in this Part 3, that subclause applies as far as is reasonable. Where this standard states “addition”, "modification" 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 300;
– additional tables or 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 60358-3:2013 was approved by CENELEC as a European Standard without any modification.

In the official version, for Bibliography, the following note has to be added for the standard indicated:

IEC 60633	NOTE Harmonized as EN 60633.

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.

Replace Annex ZA of EN 60358-1:2012 with the following:

Publication	Year	Title	EN/HD	Year
IEC 60060-1	2010	High-voltage test techniques - Part 1: General definitions and test requirements	EN 60060-1	2010
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 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	EN 60358-2	-
IEC 60481	-	Coupling devices for power line carrier systems	-	-
IEC 61869-5	-	Instrument transformers - Part 5: Additional requirements for capacitor voltage transformers	EN 61869-5	-

CONTENTS

INTRODUCTION

This series consists of the following parts:

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

IEC 60358-2:2013, *Coupling capacitor 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 60358-3:2013[1], *Coupling capacitor and capacitor dividers – Part 3: AC or DC coupling capacitor for harmonic-filters applications*

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

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1 To be published.

2 Under consideration.

COUPLING CAPACITORS AND CAPACITOR DIVIDERS –

Part 3: AC or DC coupling capacitor for harmonic-filters applications

1 Scope

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

This part of IEC 60358 applies to AC or DC single-phase coupling capacitor, with rated voltage higher than 1 000 V, connected line to ground with the low voltage terminal either permanently earthed or connected to a tuning device for harmonic-filters applications.

NOTE Diagrams of coupling capacitors to which this standard applies are given in Figures AA.1 and AA.2.

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 60060-1:2012, *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 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 60481, *Coupling devices for power line carrier systems*

IEC 61869-5, *Instrument transformers – Part 5: Additional requirements for capacitive 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 IEC 60358-1:2012, as well as the following, apply.

3.300 Definition for harmonic filters

3.1.1
filter capacitor
power capacitor intended to form part of a circuit designed to reduce one or more harmonic currents present in a network

[SOURCE: IEC 60050-436:1990, 436-02-06]

3.1.2
tuning device
accessory to the capacitor to improve filtering harmonics on the network. It consists of passive components adjusted to the filter capacitor and the frequencies to be filtered.

3.1.3
voltage limitation device
element connected between low voltage terminal of the filter capacitor and earth to limit the overvoltages which appear across the tuning device 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

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:

6.2.300 Tuning device

The purchaser defines:

- The values and ratings of the components and its electrical circuit.
- The test voltages of the tuning device, however
  - The 50 Hz insulation test voltage shall not be lower than 3 kV.
  - The BIL test voltage shall not be lower than 10 kV.

7 Test conditions

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

8 Classification of tests

Clause 8 of IEC 60358-1:2012 is applicable with the following additions:

8.2 Routine tests

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

8.2.300 Routine test for tuning device

a) AC frequency voltage test (9.300.2.1)

b) Impedance measurement (9.300.2.2)

c) Routine voltage test for voltage limitation device (9.300.2.3)

8.3 Type tests

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

8.3.300 Type tests for filter capacitor and tuning device

8.3.300.1 Type tests for filter capacitor

a) High frequency capacitance and equivalent series resistance (10.300.1)

b) Measurement of the stray capacitance and stray conductance of the low voltage terminal (10.300.2)

8.3.300.2 Type tests for tuning device

a) Impulse voltage test (10.301.1)

9 Routine tests

Clause 9 of IEC 60358-1:2012 is applicable with the following additions:

9.300 Electrical tests for coupling capacitor and tuning device

9.300.1 Routine tests for coupling capacitor

The routine tests on the capacitor part are specified in 60358-1:2012, Subclause 8.1. No supplementary test is specified for filter capacitors.

9.300.2 Routine tests for tuning device

9.300.2.1 AC frequency voltage test

The AC-voltage is applied between protective earth and terminal (short-circuited) of the tuning device during one minute according to Figure 300. The voltage level is defined in 6.2.300.

If the voltage limitation device is connected on protective earth, it shall be disconnected during the test.

Neither breakdown nor flashover shall occur during the test.

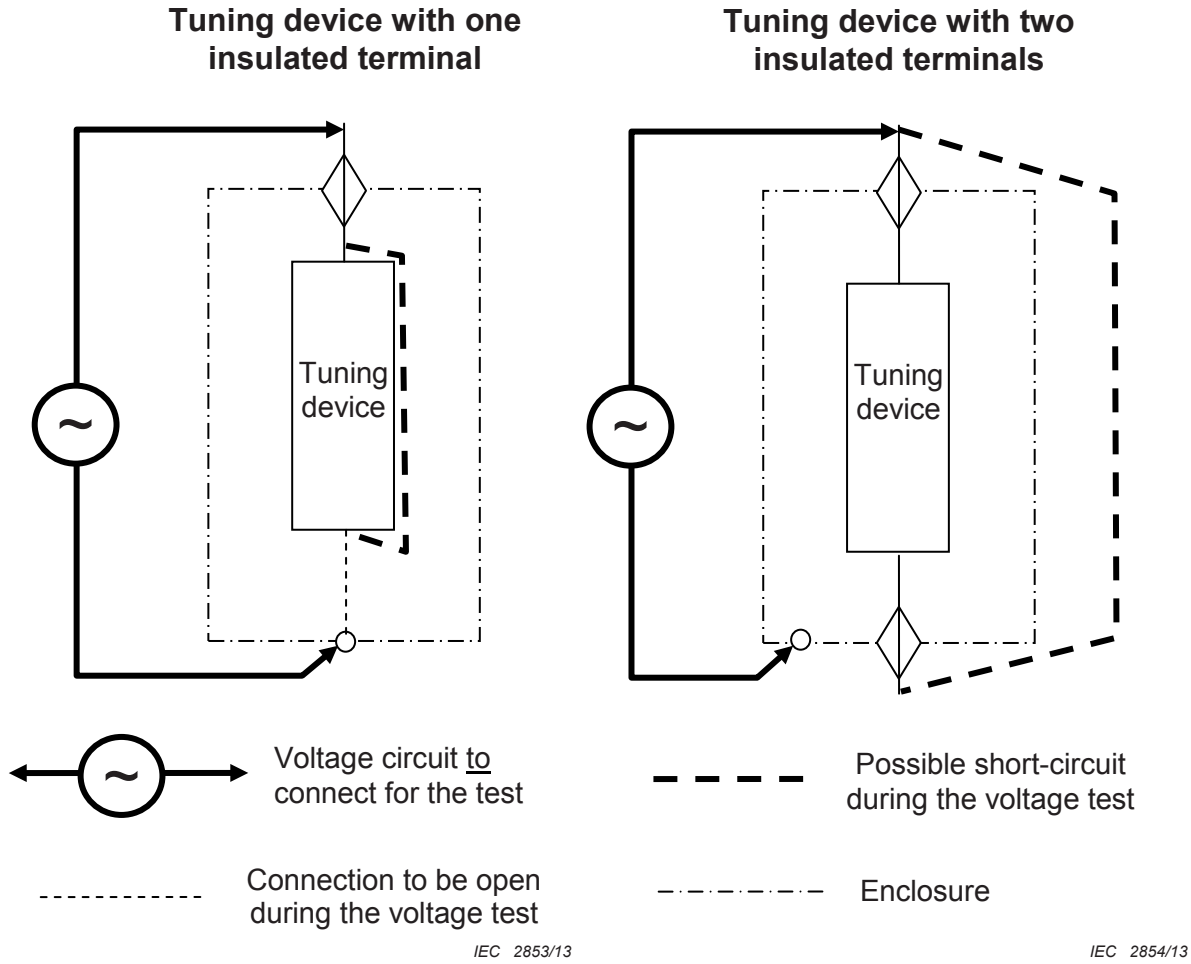


Figure 300 – Connection for voltage test of tuning device

9.300.2.2 Impedance measurement

A measurement of impedance at specified frequencies has to be performed; the filter capacitor can be replaced by a capacitor model.

As acceptance criteria the purchaser shall define the maximum impedance at specified frequencies.

Limitation device to be tested either by subsupplier or by manufacturer

9.300.2.3 Routine voltage test for voltage limitation device

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 1mA rms, 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:

10.300 Test on capacitor

10.300.1 High frequency capacitance and equivalent series resistance

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

The capacitance and the equivalent series resistance 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 frequencies specified from the purchaser.

The purchaser specifies the measuring frequencies and the acceptance criteria in terms of capacitance variation in function of the filter capability

The equivalent series resistance has an influence on the quality of the filter and on the thermal withstand of the capacitor; the acceptance criteria will then be defined between purchaser and manufacturer.

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

NOTE 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.

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

The measurements shall be carried out either on a bottom 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 frequencies specified from the purchaser, shall not exceed 200 pF and 20 μS respectively.

NOTE By low capacitance value of the filter capacitor and by different frequency range, the purchaser can ask for lower values.

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, Subclause 6.2.7.

10.301 Test on tuning device

10.301.1 Impulse voltage test

Five positive and five negative lightning impulses 1,2/50 μs with the test value according to 6.2.300 shall be applied on the high voltage terminal. If this, due to low resistance, is not possible to obtain, the best possible curve with the test equipment may be accepted. In this case, preference shall be given to retaining the front time. The tail time should however, if possible, not be shorter than 5 μs. The other end of the tuning network shall be earthed. The

protective device shall be disconnected. This test verifies the voltage withstand of the tuning network components.

No insulation breakdown is permitted.

No significant changes in the impedance measurement (8.2.300) made before and after the impulse test shall occur.

11 Special tests – Mechanical strength test

Clause 11 of IEC 60358-1:2012 is applicable.

12 Marking of the equipment

Clause 12 of IEC 60358-1:2012 is applicable with the following additions:

12.300 Marking of the tuning device

For the tuning device, the rating plate shall include the information given in Table 300:

Table 300 – Marking of the rating plate

No.	Rating
1	Manufacturer's name or abbreviation
2	Indication: Tuning device
3	Type, designation
4	Year of manufacture
5	Serial number
6	Schema
7	Components values
8	Components corresponding tolerances
9	Voltage limitation device Type: (air-gap or varistor, ….)
10	Voltage limitation device Protection level voltage (1,2/50 μs or 8/20 μs or DC)

Annex AA

Typical diagram of a filter capacitor

Figures AA.1 and AA.2 give examples of diagrams for a filter capacitor with and without low voltage terminal, and with tuning device, respectively.

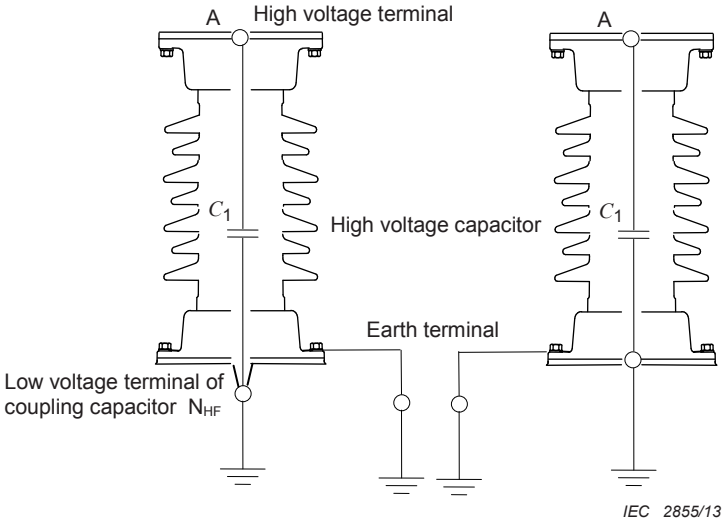


Figure AA.1 – Example of a diagram for a filter capacitor (with and without low voltage terminal)

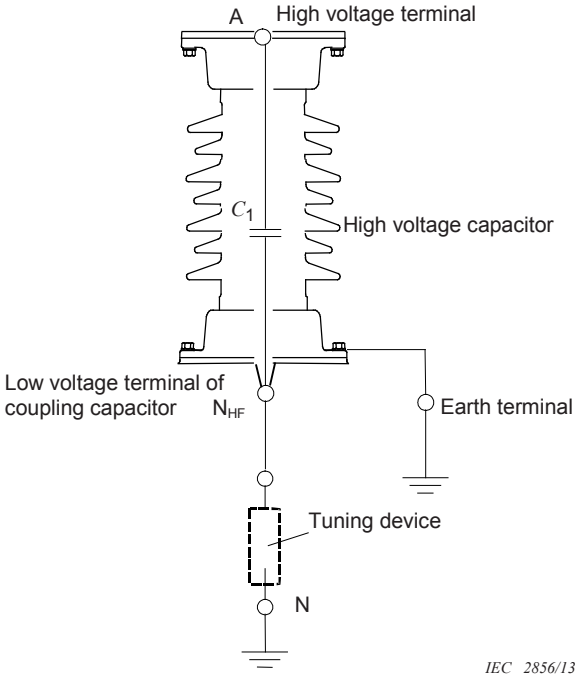


Figure AA.2 – Example of a diagram for a filter capacitor with tuning device

Annex BB
(informative)

High-frequency characteristics of filter capacitors

BB.1 High frequency capacitance and equivalent series resistance (10.300.1)

The frequency conditions are given from the purchaser according the design of the installation.

The fact should be considered that any change in the high frequency characteristics of the coupling capacitor, as, for instance, a change in the capacitance of the coupling capacitor itself or the introduction of stray quantities (capacitance, etc.) may affect the filter capability.

BB.2 Stray capacitance and conductance of the low voltage terminal (10.300.2)

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

NOTE Values higher than 20 μs and/or higher than 200 pF may have an appreciable effect on the bandwidth of the filter, at least for operation at frequencies lower than 100 kHz and for a low coupling capacitance.

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.

BB.3 Bridge method for measurement of the high frequency capacitance and equivalent series resistance (10.300.1)

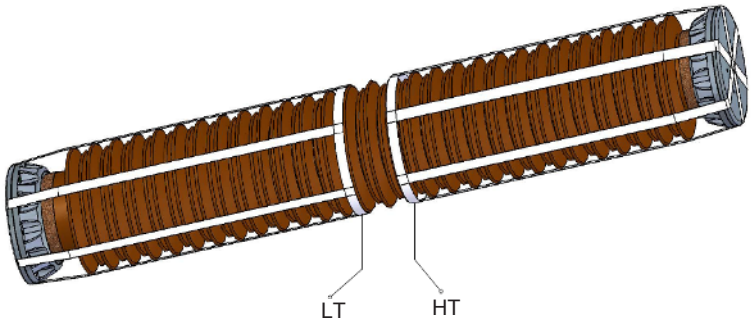
The measuring method giving the values of high-frequency capacitance and equivalent series resistance may be chosen, as convenient, from various high frequency procedures such as bridge methods, substitution methods, impedance analyser, etc.

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 one from the other, and each made with six or eight copper straps are 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 BB.1.



HT = Line terminal

LT = Low voltage terminal

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

BB.4 Filter frequency range by case of high capacitance and long capacitor (10.300.1)

For very high capacitance value and long capacitor, the physical self inductance of the capacitor (typical 1μH/m) will reduce the 1st resonance frequency; in that case, the deviation of the capacitance between the line and low voltage terminals in the specified range from the rated capacitance cannot be obtained; in that case, the usable filter frequency range shall be agreed between manufacturer and purchaser.

The graph presented in Figure BB.2 shows, as example, the cases where the relation between length and capacitance can fulfil the capacitive deviation -20/+50 % up to 500 kHz.

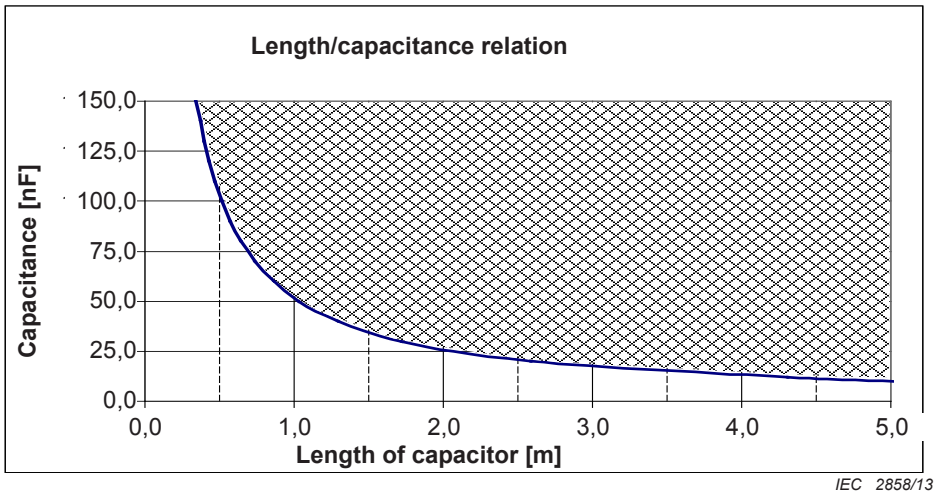


Figure BB.2 – Relation between length and capacitance where capacitive deviation –20/+50 % can be fulfilled up to 500 kHz

Bibliography

IEC 62001, *High-voltage direct current (HVDC) systems – Guidebook to the specification and design evaluation of AC filters*

IEC 60633, *Terminology for high-voltage direct current (HVDC) transmission*

IEC/TR 62543, *High-voltage direct current (HVDC) power transmission using voltage sourced converters (VSC)*

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