

Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V —

**Part 1: Specification for performance,
testing and use —**

**(Implementation of CENELEC
HD 525.1 S1:1989, including amendment
A1:1991)**

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Committees responsible for this British Standard

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- Association of Consulting Engineers
- British (AC) Capacitor Manufacturers Association (BEAMA Ltd.)
- Department of the Environment (Property Services Agency)
- ERA Technology Ltd.
- Electricity Supply Industry in England and Wales
- Rotating Electrical Machines Association (BEAMA Ltd.)

This British Standard, having been prepared under the direction of the Power Electrical Engineering Standards Policy Committee, was published under the authority of the Board of BSI and comes into effect on 30 April 1990

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National foreword

This British Standard has been prepared under the direction of the Power Electrical Engineering Standards Policy Committee. It is identical with IEC Publication 871-1:1987 “*Shunt capacitors for a.c. power systems having a rated voltage above 1 000 V. Part 1: General. Performance, testing and rating — Safety requirements — Guide for installation and operation*” published by the International Electrotechnical Commission (IEC).

This standard implements CENELEC Harmonization Document (HD) 525.1 S1:1989, including amendment A1:1991.

Special attention. Where reference is made to things subject to agreement between manufacturer and purchaser, e.g. in the second paragraph of 6.3, this should be taken to indicate that the subject matter concerned is not inherently part of the requirements of the standard, but should be included in the purchase contract. Similarly, where a choice of values is allowed, e.g. paragraph 3 of 4.1 c), suitable provision should be made in the purchase contract. Furthermore “otherwise specified” is taken to mean specified in the purchase contract.

In cases where the prescriptive “shall” is used in a note, e.g. in note 1 of 7.1, the statement is to be regarded as a British Standard requirement.

Section 7 of the IEC standard contains guidance material which would normally form an appendix to a British Standard.

In subclause 25.1 item 12, “Reference to IEC Publication 871 (plus year of issue)” is to be taken to mean reference to the corresponding Part of this British Standard, i.e., BS 7264: Part 199 ...

Cross-references

International Standard	Corresponding British Standard
IEC 60	BS 923: <i>Guide on high-voltage testing techniques</i> (All Parts identical)
IEC 71	BS 5622: <i>Guide for insulation co-ordination</i>
IEC 71-1:1976	Part 1:1979 <i>Terms, definitions, principles and rules</i> (Identical)
IEC 71-2:1976	Part 2:1979 <i>Application guide</i> (Identical)
IEC 566:1977	BS 4017:1979 <i>Specification for capacitors for use in tubular fluorescent, high pressure mercury and low pressure sodium vapour discharge lamp circuits</i> (Identical)
IEC 50[436]	BS 4727 <i>Glossary of electrotechnical, power, telecommunication, electronics lighting and colour terms.</i> Part 2. <i>Terms particular to power engineering</i> Group 14:1991 <i>Power capacitors</i> (Identical)

Note 5 to the scope of the IEC standard makes reference to IEC Publications 110, 143, 252 and 358 for which there are no corresponding British Standards. The references are informative only, relating to exclusions from the standard, and the absence of corresponding standards does not adversely affect the validity of this standard.

The Technical Committee has reviewed the provisions of IEC 99, IEC 549 and IEC 593 to which normative references are made in the text, and for which there are no corresponding British Standards, and has decided they are acceptable for use in conjunction with this standard. Related British Standards for IEC 99 and IEC 549 are BS 2914:1972 “*Specification for surge diverters for alternating current power circuits*”, and BS 5564:1978 “*Specification for high-voltage fuses for the external protection of shunt power capacitors*”.

Additional information. With regard to references in clause 23, subclause 25.3 and Appendix B to materials which may pollute the environment, attention is drawn to Statutory Instrument 1986 No. 902, The Control of Pollution (Supply and Use of Injurious Substances) Regulations 1986.

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.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, the HD title page, pages 2 to 30, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

UDC 621.319.4.0266.6:620.1:614.8

Descriptors: Shunt capacitor, performance, testing, installation, operation

English version

Shunt capacitors for a.c. power systems
having a rated voltage above 600 V
Part 1: General — performance, testing and rating safety
requirements — guide for installation and operation

(include amendment A1:1991)

Condensateurs shunt destinés à être installés
sur des réseaux à courant alternatif de tension
assignée supérieure à 660 V

Première partie: Généralités Caractéristiques
fonctionnelles, essais et valeurs assignées

Règles de sécurité — Guide d'installation et
d'exploitation

(inclut l'amendement A1:1991)

Parallelkondensatoren für

Wechselspannungs-Starkstromanlagen mit
einer Nennspannung über 660 V

Teil 1: Allgemeines Ausführung, Prüfung und
Bemessung Sicherheitsanforderungen

Anleitung für Errichtung und Betrieb

(enthält Änderungen A1:1991)

This Harmonization Document was approved by CENELEC on 1989-06-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for implementation of this Harmonization Document on a national level.

Up-to-date lists and bibliographical references concerning national implementation may be obtained on application to the Central Secretariat or to any CENELEC member.

This Harmonization Document exists in three official versions (English, French, German).

CENELEC members are the national electrotechnical committees of Austria, Belgium, 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

Foreword

According to the CENELEC Internal Regulations the CENELEC member National Committees are bound:

- to announce the existence of this Harmonization Document at national level by or before 1989-12-01
- to publish their new harmonized national standard by or before 1990-06-01
- to withdraw all conflicting national standards by or before 1990-06-01.

Foreword to HD 525.1 S1:1989/A1:1991

A proposal to amend HD 525.1:1989 (IEC 871-1:1987), based on IEC document 33(C.O.)93, March 1989, was submitted to the CENELEC members for formal vote.

Its object was to increase the rated voltage limit between low voltage and high voltage shunt power capacitors from 660 V to 1 000 V.

The text of the draft was approved by CENELEC as A1 to HD 525.1 S1 on 11 June 1990.

The following dates were fixed:

- latest date of announcement of the HD at national level (doa) 1990-12-15
- latest date of publication of a new harmonized national standard (dop) 1992-03-15
- latest date of withdrawal of conflicting national standards (dow) 1992-03-15

Annexes designated “normative” are part of the body of the standard. In this standard, Annex ZA is normative.

Cover page + In the title, replace “660 V” by “1 000 V”

Pages 1,7 and 9

1 Scope

In the first sentence, replace “660 V” by “1 000 V”

In note 4, modify last line as follows:

“capacitors will be found in IEC Publication 831-1”

In note 5, first dash, replace the existing words with the following:

“Shunt power capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V (IEC Publication 931-1).”

Section 1. General

1 Scope

This standard is applicable to capacitor units and capacitor banks intended to be used in particular for power-factor correction of a.c. power systems having a rated voltage above 1 000 V and a frequency of 15 Hz to 60 Hz.

It is also applicable to capacitors intended for use in power filter circuits.

NOTE 1 Additional definitions, requirements and test for filter capacitors are given in Appendix C.

NOTE 2 Additional requirements for capacitors to be protected by internal fuses, as well as requirements for the internal fuses, are given in IEC Publication 593.

NOTE 3 Requirements for capacitors to be protected by external fuses, as well as requirements for the external fuses, are given in Appendix D.

NOTE 4 This standard is not applicable to high-voltage capacitors composed of low-voltage capacitors of the self-healing metallized dielectric type. Additional definitions, requirements and tests for self-healing capacitors will be found in IEC Publication 831-1.

NOTE 5 The following are also excluded from this standard:

- Shunt capacitors of the non-self-healing type for a.c. systems having a rated voltage up to and including 1 000 V (IEC Publication 931-1).
- Capacitors for induction heat-generating plants, operating at frequencies between 40 Hz and 24 000 Hz (IEC Publication 110).
- Series capacitors (IEC Publication 143).
- Capacitors for motor applications and the like (IEC Publication 252).
- Coupling capacitors and capacitor dividers (IEC Publication 358).
- Capacitors to be used in power electronics circuits [IEC Publication YYY (under consideration)].
- Small a.c. capacitors to be used for fluorescent and discharge lamps (IEC Publication 566).
- Capacitors for suppression of radio interference [IEC Publication ZZZ (under consideration)].
- Capacitors intended to be used in various types of electrical equipment and thus considered as components.
- Capacitors intended for use with d.c. voltage superimposed on the a.c. voltage.

NOTE 6 Accessories, such as insulators, switches, instrument transformers, external fuses, etc., shall comply with the relevant IEC standards.

2 Object

The object of this standard is:

- a) to formulate uniform rules regarding performance, testing and rating;
- b) to formulate specific safety rules;
- c) to provide a guide for installation and operation.

3 Definitions

For the purpose of this standard, the following definitions apply:

3.1

capacitor element (or element¹⁾)

a device consisting essentially of two electrodes separated by a dielectric (IEV 436-01-03¹⁾)

3.2

capacitor unit (or unit)

an assembly of one or more capacitor elements in the same container with terminals brought out (IEV 436-01-04)

3.3

capacitor bank (or bank)

a number of capacitor units connected so as to act together (IEV 436-01-06)

3.4

capacitor

in this standard, the word “capacitor” is used when it is not necessary to lay particular stress upon the different meanings of the word “capacitor unit” or “capacitor bank”

¹⁾ IEC Publication 50(436). (In preparation.)

3.5**capacitor installation**

a capacitor bank and its accessories (IEV 436-01-07)

3.6**discharge device of a capacitor**

a device, which may be incorporated in a capacitor, capable of reducing the voltage between the terminals effectively to zero within a given time, after the capacitor has been disconnected from a network (IEV 436-03-15)

3.7**internal fuse of a capacitor**

a fuse connected inside a capacitor unit, in series with an element or a group of elements (IEV 436-03-16)

3.8**line terminals**

terminals to be connected to the lines (IEV 436-03-01)

NOTE In polyphase capacitors, a terminal intended to be connected to the neutral conductor is not considered to be a line terminal.

3.9**rated capacitance of a capacitor (C_N)**

the capacitance value for which the capacitor has been designed (IEV 436-01-12)

3.10**rated output of a capacitor (Q_N)**

the reactive power derived from the rated values of capacitance, frequency and voltage (or current) (IEV 436-01-15)

3.11**rated voltage of a capacitor (U_N)**

the r.m.s. value of the alternating voltage for which the capacitor has been designed (IEV 436-01-16)

NOTE In the case of capacitors consisting of one or more separate circuits (for example single-phase units intended for use in polyphase connection, or polyphase units with separate circuits), U_N refers to the rated voltage of each circuit.

For polyphase capacitors with internal electrical connections between the phases, and polyphase capacitor banks, U_N refers to the phase-to-phase voltage.

3.12**rated frequency of a capacitor (f_N)**

the frequency for which the capacitor has been designed (IEV 436-01-14)

3.13**rated current of a capacitor (I_N)**

the r.m.s. value of the alternating current for which the capacitor has been designed (IEV 436-01-13)

3.14**capacitor losses**

the active power dissipated by a capacitor (IEV 436-04-10)

NOTE 1 All loss-producing components should be included:

- for example for a unit, losses from dielectric, internal fuses, discharge device(s), connections, etc.;
- for example for a bank, losses from units, external fuses, busbars, discharge and damping reactors, etc.

NOTE 2 The capacitor losses may be recalculated as an equivalent series resistor to the unit and/or bank.

3.15**tangent of the loss angle ($\tan \delta$) of a capacitor**

the ratio between the equivalent series resistance and the capacitive reactance of a capacitor at specified sinusoidal alternating voltage and frequency (IEV 436-04-11)

3.16**maximum permissible voltage of a capacitor**

the maximum r.m.s. alternating voltage which a capacitor can withstand for a given time in specified conditions (IEV 436-04-07)

3.17**maximum permissible current of a capacitor**

the maximum r.m.s. alternating current which a capacitor can carry for a given time in specified conditions (IEV 436-04-09)

3.18**ambient air temperature**

the temperature of the air at the proposed location of the capacitor

3.19**cooling air temperature**

the temperature of the cooling air measured at the hottest position in the bank, under steady-state conditions, midway between two units. If only one unit is involved, it is the temperature measured at a point approximately 0.1 m away from the capacitor container and at two thirds of the height measured from its base

3.20**steady-state condition**

thermal equilibrium attained by the capacitor at constant output and at constant ambient air temperature

3.21**residual voltage**

the voltage remaining on the terminals of a capacitor at a certain time following disconnection

4 Service conditions**4.1 Normal service conditions**

This standard gives requirements for capacitors intended for use in the following conditions:

a) Residual voltage at energization.

Not to exceed 10 % of rated voltage (Clause 21, Clause 31, Sub-clause 19.2 and Appendix A).

b) Altitude.

Not exceeding 1 000 m.

c) Ambient air temperature categories.

Capacitors are classified in temperature categories, each category being specified by a number followed by a letter. The number represents the lowest ambient air temperature at which the capacitor may operate. The letters represent upper limits of temperature variation ranges, having maximum values specified in Table I.

The temperature categories cover a total temperature range from $-50\text{ }^{\circ}\text{C}$ to $+55\text{ }^{\circ}\text{C}$.

The lowest ambient air temperature at which the capacitor may be operated should be chosen from the five preferred values $+5\text{ }^{\circ}\text{C}$, $-5\text{ }^{\circ}\text{C}$, $-25\text{ }^{\circ}\text{C}$, $-40\text{ }^{\circ}\text{C}$, $-50\text{ }^{\circ}\text{C}$.

NOTE With the agreement of the manufacturer, the capacitor may be used at a lower temperature than the limits above, provided that energization takes place at a temperature at or above these limits (Sub-clause 29.1).

Table I is based on service conditions in which the capacitor does not influence the ambient air temperature (for example outdoor installations).

Table I

Symbol	Ambient air temperature ($^{\circ}\text{C}$)		
	Maximum	Highest mean over any period of	
		24 h	1 year
A	40	30	20
B	45	35	25
C	50	40	30
D	55	45	35
NOTE The temperature values according to Table I can be found in the meteorological temperature tables covering the installation site.			

If the capacitor influences the air temperature, the ventilation and/or choice of capacitor shall be such that the cooling-air temperature in the installation does not exceed the temperature limits of Table I by more than 5 °C.

Any combination of minimum and maximum values can be chosen for the standard temperature category of a capacitor, for example – 40/A or – 5/C. Preferred standard temperature categories are: – 40/A, – 25/A, – 5/A and – 5/C.

4.2 Unusual service conditions

Unless otherwise agreed between manufacturer and purchaser, this standard does not apply to capacitors, the service conditions of which, in general, are incompatible with the requirements of the present standard.

Section 2. Quality requirements and tests

5 Test requirements

5.1 General

This section gives the test requirements for capacitor units.

Supporting insulators, switches, instrument transformers, external fuses, etc. shall be in accordance with relevant IEC standards.

5.2 Test conditions

Unless otherwise specified for a particular test or measurement, the temperature of the capacitor dielectric shall be in the range + 5 °C to + 35 °C.

When a correction has to be applied, the reference temperature to be used is + 20 °C, unless otherwise agreed between the manufacturer and the purchaser.

It may be assumed that the dielectric temperature of the capacitor unit is the same as the ambient temperature, provided that the capacitor has been left in an unenergized state at a constant ambient temperature for an adequate period.

The a.c. tests and measurements shall be carried out at a frequency of 50 Hz or 60 Hz independent of the rated frequency of the capacitor, if not otherwise specified.

6 Classification of tests

The tests are classified as routine tests, type tests and acceptance tests.

6.1 Routine tests

- a) Capacitance measurement (Clause 7).
- b) Capacitor loss tangent ($\tan \delta$) measurement (Clause 8).
- c) Voltage test between terminals (Clause 9).
- d) A.C. voltage test between terminals and container (Clause 10).
- e) Test of internal discharge device (Clause 11).
- f) Sealing test (Clause 12).

Routine tests shall be carried out by the manufacturer on every capacitor before delivery. On request, the purchaser shall be supplied with a test report.

The test sequence above is not mandatory.

NOTE If agreed between purchaser and manufacturer a short-circuit discharge test may be carried out as a routine test. The test parameters shall also be agreed upon.

6.2 Type tests

- a) Thermal stability test (Clause 13).
- b) Capacitor loss tangent ($\tan \delta$) measurement at elevated temperature (Clause 14).
- c) A.C. voltage test between terminals and container (Clause 15).
- d) Lightning impulse voltage test between terminals and container (Clause 16).
- e) Short-circuit discharge test (Clause 17).