SLOVENSKI STANDARD
SIST EN 50123-5:1998

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Railway applications - Fixed installations - D.C. switchgear - Part 5: Surge arresters and low-voltage limiters for specific use in d.c. systems

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Bahnanwendungen - Ortsfeste Anlagen - Gleichstromschalteinrichtungen -- Teil 5: Überspannungsableiter und Niederspannungsbegrenzer für spezielle Verwendung in Gleichstromsystemen

Applications ferroviaires - Installations fixes - Appareillage à courant continu -- Partie 5: Parafoudres et limiteurs de tension pour usage spécifique dans les systèmes à courant continu

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English version

Railway applications - Fixed installations - D.C. switchgear Part 5: Surge arresters and low-voltage limiters for specific use in d.c. systems

Applications ferroviaires - Installations fixes - Appareillage à courant continu Partie 5: Parafoudres et limiteurs de tension pour usage spécifique dans les systèmes à courant continu

Bahnanwendungen - Ortsfeste Anlagen Gleichstrom-Schalteinrichtungen Teil 5: Überspannungsableiter und Spannungsbegrenzer für spezielle Verwendung in Gleichstromsystemen

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CENELEC

European Committee for Electrotechnical Standardization
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Foreword

This European Standard was prepared by SC 9XC, Electric supply and earthing systems for public transport equipment and ancillary apparatus (fixed installations) of Technical Committee CENELEC TC 9X, Electrical and electronic applications for railways.

The text of the draft was submitted to the formal vote and was approved by CENELEC as EN 50123-5 on 1996-10-01.

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) 1997-12-01

- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 1997-12-01

This part 5 is to be used in conjunction with the standards of the EN 60099 series.

Annexes designated "informative" are given for information only.
In this standard, annex A is informative.

INTRODUCTION

This EN 50123-5 is divided into five divisions as follows:

1 Common matters;
2 Non-linear resistor type gapped surge arresters: based on EN 60099-1:1994 (IEC 99-1:1991);
3 Artificial pollution testing of surge arresters: under consideration;
4 Metal-oxide surge arresters without gaps; based on EN 60099-4:1993 (IEC 99-4:1991);
5 Low-voltage limiters.

Divisions 2 and 4 of this standard shall be read in conjunction with the above mentioned documents.

In particular Sections 4 to 8 and annexes B, D and E of EN 60099-1:1994 (IEC 99-1:1991) are referred to in division 2 of EN 50123-5, unless explicitly otherwise indicated in this European Standard.

For gapless surge arresters the appropriate portions of EN 60099-4:1993 (IEC 99-4:1991) are quoted in division 4 of EN 50123-5, and apply.

NOTE 1: Only those clauses and sub-clauses which are modified in respect to the above-mentioned CENELEC and IEC Publications are mentioned in this document. The National Committees may copy the unchanged portions of the IEC 99 Publications referred altering the type face as necessary.

NOTE 2: The numbering of this EN 50123-5 follows the following criteria:
- the first number identifies the five divisions of this standard;
- the remaining numbers, for divisions 2 and 4, are taken unchanged from EN 60099-1 and EN 60099-4 respectively.

1 COMMON MATTERS

1.1 Scope

Divisions 1, 2, 3 and 4 of EN 50123-5 cover particular requirements for surge arresters for specific use in fixed installations of d.c. traction systems. These are surge arresters consisting of one or more non-linear resistors which may be in series with single or multiple spark gaps.

Low-voltage limiters are covered under division 5 of EN 50123-5. These are protective devices mainly used in fixed installations of d.c. traction systems to connect certain portions of the circuit, when, owing to an abnormal situation, the voltage across the device exceeds a predetermined limited value. They are not used in general to provide surge protection.

In particular the following main uses of low-voltage limiters (LVL) are envisaged:

- connection to the rail of metallic masses;
- protection of rail circuits;
- earthing of rails in the substation;
- protection of cathodic circuits;
- protection of cable shields.

1.2 Normative references

This European Standard incorporates by dated or undated reference, provisions from other documents. These normative references are cited at the appropriate places in the text and the publications are listed thereafter. 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.

All the normative references listed in EN 50123-1 and especially:

EN 50125-2	1997	Railway applications - Environmental conditions for equipment Part 2: Equipment in fixed installations
EN 60099-1	1994	Surge arresters -- Part 1: Non-linear resistor type gapped surge arresters for a.c. systems. (IEC 99-1:1991)
EN 60099-4	1993	Surge arresters -- Part 4: Metal-oxide surge arresters without gaps for a.c. systems (IEC 99-4:1991)

2 NON-LINEAR RESISTOR TYPE GAPPED SURGE ARRESTERS

2.1 General

See 1, Common matters.

2.2 Definitions

The definitions given in clause 3 of EN 50123-1, as well as the definitions in Section 2 of EN 60099-1:1994 apply except for the following:

2.2.8 rated voltages:

2.2.8.1 rated voltage of a gapped arrester (U_r): The maximum d.c. voltage value between terminals at which the surge arrester is designated to withstand continuously.

NOTE: Preferred values taken from table 2.1A are recommended.

2.2.8.2 protective voltage level of a gapped arrester (U_p): Crest value, declared by the supplier, higher than the maximum of the three voltage values between the surge arrester terminals: residual voltage at I_n, maximum standard lightning impulse sparkover voltage, maximum front of wave impulse sparkover voltage, the latter divided by 1,15.

NOTE 1: Preferred values taken from table 2.1B are recommended.

NOTE 2: The definition of the protective voltage level is due to the fact that, according EN 50124-1, a wide choice of impulse levels may be associated to a single rated voltage. The choice of Up shall be co-ordinated with the impulse withstand level of the equipment/section protected, taking into account a margin selected by the purchaser.

2.2.9 Not applicable.

2.2.33 nominal discharge current of a gapped arrester (I_n): The peak value of discharge current, having an 8/20 waveshape, which is used to classify an arrester. It is also the discharge current which is used to initiate follow-through current in the operating duty test.

2.3 Marking

Gapped surge arresters shall be identified by the following minimum information which shall appear on the rating plate (nameplate):

- compliance with EN 50123-5;
- type: gapped - suitable for d.c. traction systems;
- rated voltage U_r;
- protective voltage level U_p;
- nominal discharge current I_n;
- pressure relief class in kA (if any);
- manufacturer's name or trademark, type and identification;
- year of manufacture;
- serial number.

NOTE: Information to be given by enquiry or tender may be guided by Annex A of this standard or by Annex B of EN 60099-1.

2.4 Preferred ratings

A document giving a guidance in the selection of proper rated characteristics to ensure the required protection to the circuit is under preparation (see also note 2 under 2.2.8.2 above).

2.4.1 Preferred voltage ratings

Preferred values of rated voltages for gapped arresters (U_r) shall be as listed in table 2.1A.

Table 2.1A - Preferred voltage ratings (kV)

0,750	1	2	4

2.4.2 Preferred protective voltage levels

Preferred protective voltage levels for gapped arresters (U_p) shall be as listed in table 2.1B.

Table 2.1B - Preferred protective voltage levels (kV_{cr})

3,0	4,5	5,0	6,0	8,0	10	12	15	18
20	25	30	35	40				

2.4.3 Preferred nominal discharge currents

The preferred nominal discharge currents (I_n), are as listed in table 2.1C:

Table 2.1C - Preferred nominal discharge currents (kA)

20	10	5	2,5

2.4.4 Service conditions

Where service conditions differ from those defined as "normal" either in clause 4 and annex B of EN 50123-1:1995 (indoor arresters) or in EN 60099 series (outdoor arresters), the purchaser shall state this fact in the tender specification. Where a d.c. arrester is suitable for use in service conditions different from those defined as "normal" in the above mentioned documents, the manufacturer shall state this fact.

2.5 Requirements

See Section 5 of EN 60099-1:1994 except for the following:

2.5.4 Switching impulse sparkover voltage

No limits for the maximum switching impulse sparkover voltage have been specified. The test under 2.8.3.5 is considered an investigation test, i.e. a test carried out by agreement between parties for gaining experience, without reference to the contractual obligations.

NOTE: The switching phenomena on d.c. systems are under consideration.

2.5.6 Not applicable

2.5.8 Long-duration current withstand

Arresters shall withstand the long-duration current impulse test according to 2.8.5.3 and table 6 of EN 60099-1. The average dry power-frequency sparkover voltage of 2.8.2 recorded before and after this test shall not have changed by more than 10 %.

NOTE: The switching phenomena on d.c. systems are under consideration.

2.6 General testing procedure

See Section 6 of EN 60099-1:1994.

2.7 Routine and acceptance tests

NOTE: The term "acceptance test" is under revision.

2.7.1 Routine tests

The minimum requirement for routine test to be made by the manufacturer shall be the dry power-frequency sparkover test (see 2.8.2).

2.7.2 Acceptance tests

When the purchaser specifies acceptance tests in the purchase agreement, the following tests shall be made on the nearest higher whole number to the cube root of the number of arresters to be supplied:

a) dry power-frequency voltage sparkover test on the complete arrester (see 2.8.2).

b) standard lightning impulse sparkover test on the complete arrester (see 2.8.3.2).

c) only when specifically agreed between the manufacturer and the purchaser, residual voltage shall be determined on the complete arrester at a discharge current of not less than 0,25 times the nominal discharge current (see 2.8.4).

Any alteration in the number of samples or type of tests shall be specifically negotiated between the manufacturer and the purchaser.

2.8 Type tests

See Section 8 of EN 60099-1:1994 except for the following:

2.8.1 General

Same as in clause 8.1 of EN 60099-1:1994, except for table 3 which shall be substituted by the following table 2.3 applicable for any standard discharge current:

Table 2.3 - Arrester test requirements

Power-frequency voltage sparkover test	2.8.2
Standard lightning voltage sparkover test	2.8.3.2
Front-of-wave-voltage sparkover test	2.8.3.4
Residual voltage test	2.8.4
Current impulse withstand: - High-current - Long-duration	 2.8.5.2 2.8.5.3
Operating duty test	2.8.6
Pressure relief test	2.8.7
Arrester disconnector (when fitted)	2.8.8
NOTE: The numbers in column 2 refer to subclauses in this standard.	

2.8.2 Power-frequency voltage sparkover test

Dry and wet tests shall be made in accordance with 6.1, 6.2 and 6.3 of EN 60099-1:1994 and 2.8.1 on three complete arresters of each voltage rating tested. The performance for other voltage ratings of the same design (as defined in 2.8.1) within ± 25 % of a test sample rating can be determined by adjusting the voltage level in proportion to the voltage ratings. The voltage applied to the arrester shall be switched on at a value low enough to avoid sparkover of arrester by resulting switching surge and risen rapidly at a uniform rate until sparkover of the series gap occurs. The time during which the voltage is allowed to exceed the rated voltage of the arrester shall be in the range of 2 s to 5 s when testing arresters using grading resistors which are subject to damages by overheating if the applied voltage exceeds the rated voltage for too long. After sparkover, the test voltage shall be switched off as rapidly as possible, preferably by automatic tripping and in any case within 0,5 s. If it is difficult to measure the rapidly increasing voltage with an indicating type of instrument, a high speed recorder or an oscillograph shall be used. The manufacturer shall be consulted about the permissible test procedure.

The load imposed on the testing circuit by a surge arrester having non-linear grading resistors of high conductivity gives rise to harmonics, and the test-circuit shall have a sufficiently low impedance to maintain the waveform of the voltage across the arrester within the limits specified in the current edition of HD 588.

The voltage shall be applied not less than 5 times, with an interval of about 10 s between successive applications.

The average sparkover value of the five tests is adopted as the power-frequency sparkover voltage for purposes of a comparison of tests made before and after other type tests.

NOTE 1: By agreement between purchaser and supplier an additional test may be carried out by applying a d.c. voltage, with the same procedures. The rate of increase of the voltage shall be approximately 10 V/s. The d.c. voltage value shall have the same peak value as the peak value of a sinusoidal power frequency test level as required in EN 50124-1.

NOTE 2: When the arrester is provided with an enclosure, the test shall be carried out with such enclosure.

2.8.3 Voltage impulse sparkover tests

2.8.3.2 *Standard lightning impulse sparkover test*

With the test sample arrester in the circuit, the impulse generator is adjusted to give a 1,2/50 voltage waveshape and a peak value of protective voltage level U_p. With this adjustment, five positive and five negative impulses shall be applied to the tested arrester and the series gaps of the arrester shall sparkover on every impulse. If in either series of five impulses, the gaps fail to sparkover once only, an additional ten impulses of that polarity shall be applied ant the gaps shall sparkover on all of these impulses.

The time interval between the start of the wave and instant of sparkover is immaterial in this test.

The tolerances on the adjustment of the testing equipment shall be such that the measured values lie within the following limits:

a) between 97 % and 100 % or the specified peak values;

b) from 0,85 µs to 1,6 µs for the virtual duration of the wavefront;

c) from 40 µs to 60 µs for the time to half value on the wavetail.

Oscillations on the first part of the wavefront (below 50 %) shall not exceed 10 % of the peak value. Small oscillations near the peak of the impulse are permissible provided that their amplitude is less than 5 % of the peak value. Measurement shall be made at the peak of the oscillations.

2.8.3.4 *Front-of-wave impulse sparkover test*

Using a voltage impulse with a virtual steepness of front equal to 10 kV/µs, five positive and five negative impulses shall be applied to the arrester and the sparkover voltage is determined from voltage-time oscillograms made during each test. On none of the impulses shall the sparkover voltage exceed 1,15 U_p.

It is permissible to use the point of intersection of the curve specified in 2.8.3.3 with a line representing the virtual steepness of front specified for determining the maximum front-of-wave sparkover voltage of the tested arrester provided there are at least five positive and five negative sparkover test points within ± 0,1 µs of the line representing the prescribed steepness. This is illustrated in figure 1 of EN 60099-1:1994.

2.8.3.5 *Switching impulse sparkover-voltage/time curve test*

As indicated in 2.5.4, this test may be agreed between purchaser and supplier to obtain information.

Test procedure and test values are subject to agreement, but subclause 8.3.5 of EN 60099-1:1994 may assist.

2.8.4 Measurement of residual voltage

2.8.4.1 *Lightning impulse residual voltage*

Add to the text of EN 60099-1:1994, 8.4.1:

The maximum residual voltage at nominal discharge current shall be U_p.

2.8.4.2 Not applicable

2.8.5 Current impulse withstand test

2.8.5.1 ***General***

Each of these tests shall be made in accordance 2.7.1 and 2.8.1 on three new complete arresters which have not been subjected to any test except those specified for evaluation purposes. If an arrester disconnector is built into the design of the arrester under consideration, these tests shall be made with the disconnector in operable condition.

2.8.5.2 ***High-current impulse test***

Same text as in EN 60099-1:1994, 8.5.2, but table 4 shall be modified as in following table 2.4.

Table 2.4 - High-current impulse test

Nominal discharge current I_n (8/20 µs) (kA)	2,5	5	10	20
Peak value of high-current (4/10 µs) (kA)	40	65	100	100

2.8.5.3 ***Long-duration current impulse test***

Subclause **8.5.3.1** of EN 60099-1:1994 is valid as far as applicable according to the following requirements.

Subclause **8.5.3.2** of EN 60099-1:1994 is not applicable in this European Standard.

In subclause **8.5.3.3** and in **table 6** of EN 60099-1:1994, mention of light-duty and to series A and B shall be omitted. The values given in table 6 for I_n = 10 kA are applicable also to I_n = 20 kA.

2.8.6 Operating-duty test

This is a test in which service conditions are simulated by the application to the arrester of 20 current impulses, in groups of 5, equal to the nominal discharge current I_n, while it is permanently energized by a d.c. power supply of a voltage corresponding to U_r. Annex E of EN 60099-1:1994 describes a typical test-circuit where an a.c. power source is used.

To simulate a d.c. source a capacitor bank can be used provided that the voltage shall be less than 95 % of U_r during the test. figure 1 shows a typical test circuit for this purpose.

The test shall be performed on a complete arrester.

In case of difficulties in arranging the test, the use of an a.c. voltage, having the same peak value as U_r is subject to agreement between purchaser and supplier.

It is not required that the tested arrester be energized between groups of impulses.

Second, fourth and following paragraphs of clause 8.6 of EN 60099-1:1994 apply, when consistent with the above requirements.