SLOVENSKI STANDARD
SIST EN 50329:2003/A1:2010

01-november-2010

Železniške naprave - Stabilne naprave električne vleke - Transformatorji vlečnih tokokrogov

Railway applications - Fixed installations - Traction transformers

Bahnanwendungen - Ortsfeste Anlagen - Bahn-Transformatoren

Applications ferroviaires - Installations fixes - Transformateurs de traction

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ICS:

29.180	Transformatorji. Dušilke	Transformers. Reactors
29.280	Električna vlečna oprema	Electric traction equipment

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EUROPEAN STANDARD

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ICS 29.180; 29.280

English version

Railway applications - Fixed installations - Traction transformers

Applications ferroviaires - Installations fixes - Transformateurs de traction

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This amendment A1 modifies the European Standard EN 50329:2003; it was approved by CENELEC on 2010-05-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this amendment 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 amendment 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.

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CENELEC

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

Management Centre: Avenue Marnix 17, B - 1000 Brussels

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Foreword

This amendment to the European Standard EN 50329:2003 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. It was submitted to the formal vote and was approved by CENELEC as A1 to EN 50329:2003 on 2010-05-01.

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

The following dates were fixed:

– latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement	(dop)	2011-05-01
– latest date by which the national standards conflicting with the amendment have to be withdrawn	(dow)	2013-05-01

1 General

1.2 Normative references

Delete the following normative references:

HD 464 S1 + A2 + A3 + A4	1988 1991 1992 1995	Dry-type power transformers (IEC 60726:1982 + A1:1986, mod.)
IEC 60354	1991	Loading guide for oil-immersed power transformers

Add the following normative references:

EN 60076-11	2004	Power transformers – Part 11: Dry-type transformers (IEC 60076-11:2004)
IEC 60076-7	2005	Power transformers – Part 7: Loading guide for oil-immersed power transformers

2 General requirements for a traction transformer

Replace Subclause 2.2 by the following:

2.2 Checking of the capability of the transformer to sustain the stipulated load cycle

2.2.1 General

The temperature rise test shall be carried out in accordance with either EN 60076-2 or EN 60076-11 as applicable.

Basis for determining the temperature rises shall be the rated service current (the approximate relationship between the rated current and the rated service current is given in Table C.3).

The resulting temperature rises after long-time overloads shall be within the limits of the temperature rises prescribed in EN 60076-2 and EN 60076-11 under the stipulated ambient conditions and altitude.

The winding temperature rise after short-time overload conditions may exceed by 15 K the applicable temperature rise limits according to EN 60076-2 and EN 60076-11.

When determining the temperature rises the effect of the harmonics should be considered according to 2.2.2, 2.2.3 and 2.2.4.

2.2.2 Temperature rise measurement for liquid immersed transformers

The procedure of 5.2.2 of EN 60076-2 shall be applied with the exceptions mentioned here below. The specified duty class or load cycle shall be taken into account. For transformers designed according to a duty class the test cycles given in Figure A.1 to Figure A.3 shall apply.

The transformer in short circuit conditions shall be injected with a current causing the total losses. In case of a traction converter transformer, the total losses are intended as the sum of the no-load loss and of the total load losses determined according to Annex C.

Total losses calculated on the service current in basic load condition (I_{BG}) are injected until it reaches temperature steady-state conditions and then the long-term overload current is injected, for the specified duration of said overload according to the duty class or load cycle. The final top oil temperature rise shall be recorded.

For determining the temperature rises of windings, the transformer shall be subsequently loaded by service currents representing the basic load (including the effect of harmonics), for the time necessary to reach steady temperatures of the windings, and, for the respective durations, the service currents corresponding to long-time overloads, and, when practicable and agreed between purchaser and supplier, service currents corresponding to short-time overloads.

Measurements shall be taken at the end of the long-time overload duration and, when applicable, at the end of the short-time overload duration. When actual measurements are not possible, it may be agreed to carry out calculations on temperature variations along the short-time load duration, performed according to conventional methods.

IEC 60076-7 gives some guidance for such a calculation.

2.2.3 Temperature rise measurement for dry-type transformers

The requirements given in Clause 23 of EN 60076-11 apply taking into account that in the second part of the test the losses attributable to the various stages of the current demand shall be calculated and successively applied and the overloads for the respective duration. Annex C allows determining total load losses.

Measurements shall be taken at the end of the long-time overload duration and, when applicable, at the end of the short-time overload duration. For transformers designed according to a duty class, the test cycles given in Figure A.1 to Figure A.3 apply.

When actual measurements are not possible, it may be agreed to carry out calculations on temperature variations along the short-time load duration, performed according to conventional methods.

IEC 60905 gives some guidance for such a calculation.

2.2.4 Alternative criteria for determining temperature rise limits

On agreement between purchaser and manufacturer temperature limits and thermal ageing according to IEC 60076-7 and IEC 60905 may be applied.

If the purchaser is able to define the load cycle in an extensive way as current demand, the capability of the transformer to sustain this current demand shall be checked as follows:

- temperature rise and loss measurements shall be performed at sinusoidal load with rated service current;
- based on these measurements, the top-oil temperature, the hot-spot temperatures of the windings and the relative loss of life for the given current demand shall be calculated. The loss of life calculation procedure of IEC 60076-7 may be used;
- the temperatures at the beginning of the load-cycle shall be set equal to those at the end of the load cycle to consider a steady state condition; the maximum service temperature shall be taken into account;
- the calculated relative loss of life for the load cycle shall be lower than 1;
- for oil immersed transformers, the maximum occasional hot-spot- temperature shall be lower than 140 °C and the maximum top oil temperature shall be lower than 115 °C during the load cycle;
- the influence of harmonics shall be considered as described in Annex C.

For transformers designed according to a duty class, the text given in Figure A.1 to Figure A.3 applies.

Different temperature limits may be agreed between purchaser and supplier depending on the oil characteristics.

2.8 Rating plate

Replace the reference to HD 464 by a reference to EN 60076-11.

4 Traction converter transformers

Replace Clause 4 by the following:

4 Traction converter transformers

4.1 General

The EN 61378 series specifies requirements for converter transformers for industrial use. This clause specifies additional requirements for traction rectifier transformers of most common use in substations with semiconductor diode rectifiers. Traction converter transformers for controlled converters need additional considerations and shall be subject to special agreement between purchaser and supplier.

Transformers for 6-pulse three-phase bridge connections have one primary and one secondary winding.

Transformers for 12-pulse rectifier connections have one or two primary windings and two secondary windings with a 30° phase shift between the secondary windings. One secondary winding is commonly star connected and the other is delta connected. Three types of rectifier transformers are preferably used for 12-pulse traction rectifier groups:

a) three-windings transformer with one primary winding and two closely coupled secondary windings: coupling factor $K \geq 0{,}9$;

b) three-windings transformer with one primary winding and two loosely coupled secondary windings: coupling factor $0{,}2 \leq K < 0{,}9$;

c) four-windings transformer with two primary windings and two uncoupled secondary windings: coupling factor $K < 0{,}2$.

Three-windings transformers with closely coupled secondary windings are the preferred type for 12-pulse series connections and they are also used for 12-pulse parallel connections. The 12-pulse parallel connection needs an interphase transformer between the two rectifier bridges.

NOTE 1 At low secondary voltages as for example for series connected rectifier groups for nominal voltage 750 V d.c. it is practically impossible to reach a coupling factor $K \geq 0{,}9$ due to the inductance of busbars.

Three-windings transformers with loosely coupled secondary windings are used for 12-pulse parallel connections with interphase transformer where certain requirements regarding voltage characteristics and maximum short-circuit current exist.

Four-windings transformers are used for 12-pulse parallel connections without the need of an interphase transformer.

NOTE 2 It is recommended that 12-pulse rectifier groups with uncoupled rectifier transformers are not used with interphase transformers. The impedance of the uncoupled transformer secondary windings performs a function similar to an interphase transformer.

Other types of traction rectifier transformers are

– transformers using zigzag connections for 24-pulse rectifier connections,

– transformers with compensating windings.

These transformers need additional considerations and the particular requirements are subject to agreement between purchaser and supplier.

It is assumed in EN 60076 that transformers are tested in sinusoidal conditions of voltage and current, as applicable in the manufacturer's works or in a laboratory. The actual losses however are highly influenced by the harmonic contents of the current, which depends on the characteristics of the converter. To simplify the matter the only effect of the typical harmonics of each scheme are considered, without any reference to the voltage harmonics, due to external sources and to those harmonics, of negligible effect however, which appear in the actual operation of a converter. Refer to EN 61378-1 for testing methods to include such harmonic effects.

The neutral point of a secondary star winding feeding a converter shall not be earthed and normally needs not to be brought out.

4.2 Short-circuit impedance and load loss

4.2.1 Total load loss calculation

The losses shall be guaranteed at rated service current (see 10.4 of EN 60076-1). On purchaser's request, as an alternative, the losses at basic service current may be guaranteed.

The load loss, which appears under normal service conditions, is considered composed of the loss in the winding resistance as measured by d.c. and the additional loss caused by eddy currents, as well as by the stray flux in the windings and in the constructive parts.

The additional stray losses caused by the harmonics depend on the construction of the transformer, on the firing angle and the commutation reactance and may vary in a wide range.

The calculation of total load loss of the traction transformer in converter operation (P_T) may be obtained through alternative methods; the purchaser shall state which method he intends to be applied at the tender invitation stage, otherwise the method will be stated by the manufacturer.

In Annex C alternative methods for the calculation of load loss in transformers during converter operation are given.

4.2.2 Impedance

NOTE For the definition of impedance see 3.7 of EN 60076-1.

The short-circuit impedance shall be measured and recorded between each pair of windings. The impedance values shall be within the tolerances stated in 4.3.

For three-windings transformers the percent impedance shall be measured and recorded

– for the whole transformer with the terminals of both secondary windings short-circuited, at rated current flowing in the primary winding, $z_{P/S}$

– between the primary winding and either secondary winding with the terminals of one secondary winding short-circuited and the terminals of the other secondary left open, at 50 % rated current flowing in the primary winding, $z_{P/S1}$ and $z_{P/S2}$

– between the two secondary windings with the terminals of one secondary winding short circuited and rated current flowing in the other secondary winding. $z_{S1/S2}$

For four-windings transformers the percent impedance shall be measured and recorded

– for the whole transformer with the terminals of both secondary windings short-circuited, and rated current flowing in the primary windings, $z_{P/S}$

– between either one primary winding and the relating secondary winding with the terminals of the secondary winding short-circuited and the terminals of the other secondary left open, at rated current of each primary winding. $z_{P1/S1}$ and $z_{P2/S2}$

In case of additional windings (for example for auxiliary supply) care shall be taken to avoid adverse effect of these windings on the impedance of the secondary windings.

4.3 Tolerances

For no-load loss and load loss the tolerances stated in Clause 9 of EN 60076-1 apply.

The permissible tolerances for voltage ratio and short circuit impedance of traction converter transformers depend on the connection of the converter group and on the requirements regarding inherent voltage regulation, short-circuit current and parallel working of converter groups.

For voltage ratio and short-circuit impedance the tolerances according to Table 1 apply.

NOTE The required tolerance values for voltage ratio and short-circuit impedances can be significantly lower than for distribution transformers.