SLOVENSKI STANDARD

SIST EN 50327:2003/A1:2005

december 2005

Železniške naprave – Stabilne naprave električne vleke – Harmoniziranje vrednosti razredov pretvorniških skupin in preskušanje pretvorniških skupin

Railway applications - Fixed installations - Harmonization of the rated values for converter groups and tests on converter groups

ICS 29.200; 29.280

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English version

Railway applications – Fixed installations – Harmonisation of the rated values for converter groups and tests on converter groups

Applications ferroviaires –
Installations fixes –
Harmonisation des valeurs assignées et des essais sur les groupes convertisseurs

Bahnanwendungen –
Ortsfeste Anlagen –
Harmonisierung der Bemessungswerte von Stromrichtergruppen und Prüfungen von Stromrichtergruppen

This amendment A1 modifies the European Standard EN 50327:2003; it was approved by CENELEC on 2005-03-01. 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.

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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

Ref. No. EN 50327:2003/A1:2005 E

Foreword

This amendment to the European Standard EN 50327:2003 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.

The text of the drat was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A1 to EN 50327:2003 on 2005-03-01.

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)	2006-03-01
– latest date by which the national standards conflicting with the amendment have to be withdrawn	(dow)	2008-03-01

3.2 Symbols

Add the following symbols:

d_{rB} resistive direct voltage drop of the converter group in percent of U_{di}

d_{xB} inductive direct voltage drop of the converter group in percent of U_{di}

e_{rB} resistive component of the relative short-circuit voltage of the converter transformer

e_{xB} inductive component of the relative short-circuit voltage of the converter transformer

e_{xL} inductive component of the relative impedance of the feeding grid

f_N rated frequency

$I_{dlinmax}$ maximum current value of the range of linear voltage drop

I_{SS} sustained d.c. short-circuit current

I_{SSmax} theoretical maximum value of the steady state d.c. short-circuit current at $L_d = \infty$

$\hat{I}_{SS}$ transient peak value of the d.c. short-circuit current

L_s inductance of the secondary windings of the converter transformer

L_d inductance on the load side (i.e.traction side)

R_d resistance on the load side (i.e.traction side)

T_c circuit time constant of the load circuit

T_s time constant of the grid on the supply side of the converter group

V_D resistive direct voltage drop on the load side (i.e.traction side) in percent of U_{di}

V_{Dt} total relative resistive direct voltage drop in percent of U_{di}

Annex A

Replace by the following new Annex A:

Annex A
(informative)

Determination of the voltage drop and the short-circuit currents of converter groups

A.1 General

The usual connections of non-controlled traction converter groups are the connections no. 8, 9 and 12 (see Table 2).

This Annex gives a simplified method for the determination of the d.c. output characteristics of converter groups having one of the above mentioned connections.

The characteristics of non-controlled converters can be shown as a curve between the no-load voltage U_{d0} and the short-circuit point (see Figure A.1). This curve gives only the steady state values of the current but not the transient values.

The method described in Table A.1 gives the possibility to determine the voltage characteristics, the steady state currents and the transient currents.

The values of main interest for traction converters are:

– the conventional no-load voltage U_{d0} ($U_{d0} \approx U_{di}$);

– the rated direct voltage U_{Nd} at basic current I_{Bd};

– the direct voltage U_d at specified overload currents;

– the sustained value I_{SS} and the peak value $\hat{I}_{SS}$ of the short-circuit current at the output terminals of the rectifier and at other locations in the substation and the d.c. supply system.

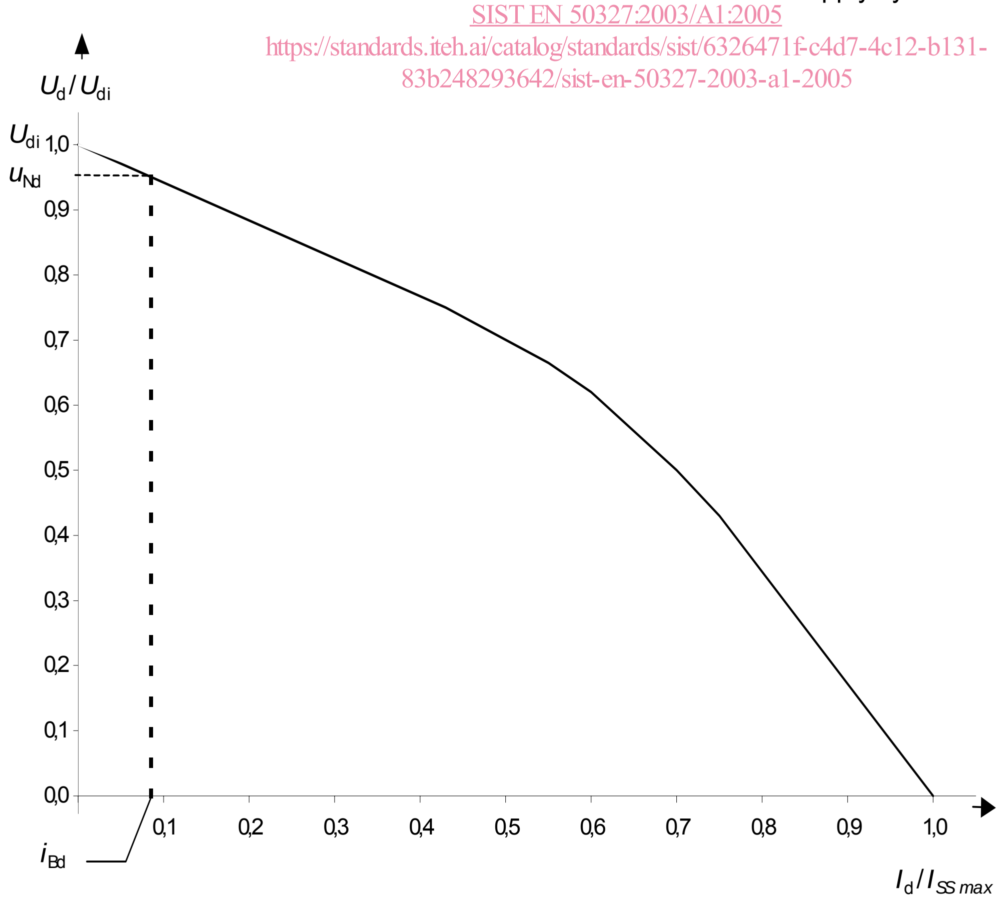

Figure A.1 - Typical characteristic of a rectifier group

For six-pulse rectifier groups Table A.1 is used together with Figure A.2.

The characteristics of twelve-pulse rectifier groups depend on the coupling factor between the secondary windings of the converter transformer. When the secondary windings are uncoupled, the characteristics are the same as for the six-pulse three-phase bridge connection (connection no. 8).

For twelve-pulse rectifier groups with coupling factor K ≈ 0, Table A.1 is used together with Figure A.2.

For twelve-pulse rectifier groups with closely coupled secondary windings (coupling factor K ≈ 1) Table A.1 is used together with Figure A.3.

A.2 Description of the method

The determination of the voltage characteristics and the short-circuit current calculation of the steady state values and the transient peak values for a fault at the rectifier output terminals are given in step 1 to step 5 of Table A.1.

For given load impedances the determination of the characteristics and the short-circuit calculation of the steady state values as well as the transient peak values is described in step 6 to step 10. Such load impedances are e.g. the resistance of d.c. cables to the d.c. switchgear or to the trackside feeding point or the inductance of smoothing reactors or current rise limiting reactors.

The determination of the initial current rise $di/dt_{t=0}$ of the short-circuit current is described in step 11.

The determination of the range of linear voltage drop is described in step 12.

Data required for the calculation:

– basic direct current I_{Bd} of the rectifier;
– no-load direct voltage U_{di};
– inductive component of the short-circuit voltage of the transformer e_{xB};
– resistive component of the short-circuit voltage of the transformer e_{rB} (see Note 1 below) ;
– coupling factor K (for twelve-pulse rectifiers only, see Note 5 below and EN 50329, 1.3.16).

Table A.1 – Method of use of the charts in Figure A.2 and Figure A.3

Step	Action	Formulae
1	Calculate d_{xB} and d_{rB}. Calculate the ratio I_{Bd} / I_{Ssmax}. Draw a vertical line at I_{Bd} / I_{SSmax}. Calculate I_{SSmax}.	d_{xB} = 0,5 x e_{xB} (for Figure A.2) d_{xB} = 0,26 x e_{xB} (for Figure A.3) d_{rB} = e_{rB} $\frac{I_{Bd}}{I_{SS\max}} = (1+K)\times\sqrt{3}\times d_x$
2	Mark d_{rB} on the vertical line drawn in step 1. To increase the accuracy it is recommended to draw a vertical line at 10 x I_{Bd} / I_{SSmax} and to mark the point 10 x d_{rB} on this line.	

Table A.1 – Method of use of the charts in Figure A.2 and Figure A.3 *(continued)*

Step	Action	Formulae
3	Draw a straight line from the zero point through the point marked in step 2. The distance between this line and the $L_d = \infty$ curve gives the external voltage characteristics of the rectifier group at the d.c. terminals; the distance below this line and the horizontal axis gives the resistive voltage drop; the distance between the $L_d = \infty$ curve and U_{di} gives the inductive voltage drop. Calculate U_{Nd} at I_{Bd}. The external voltage at any other current value within the range of linear voltage drop can be calculated in the same manner.	$U_{Nd} = [100\ \% - (d_{xB} + d_{rB})] \times U_{di}$
4	The intersection of the line drawn in step 3 with the $L_d = \infty$ (corresponding to $T_c = \infty$) curve gives the ratio of the sustained value of the short-circuit current I_{SS} / I_{SSmax} for a dead short at the rectifier output terminals.	
5	The intersection of the line drawn in step 3 with the $L_d = 0$ (corresponding to $T_c = 0$) curve gives the ratio of the transient value of the short-circuit current to I_{SSmax} for a dead fault at the rectifier output terminals. Due to the ripple of the direct current this value has to be multiplied by 1,05 to get the peak value of the short-circuit current $\hat{I}_{SS}$.	
6	Introduction of the load resistance R_d: Calculate the relative resistive voltage drop on the load side V_D at I_{Bd}. Calculate the total relative resistive voltage drop V_{Dt}. Multiply the value by 10 and mark it on the vertical line at 10 x I_{Bd} / I_{SSmax}.	$V_D = R_d \times I_{Bd} / U_{di}$ $V_{Dt} = d_{rB} + V_D$
7	Draw a straight line from the zero point to the point marked in step 6.	
8	The intersection of the line drawn in step 7 with the $L_d = \infty$ (corresponding to $T_c = \infty$) curve gives the ratio of the sustained value of the short-circuit current I_{SS} / I_{SSmax} for a fault with a d.c. side load resistance R_d.	
9	The intersection of the line drawn in step 7 with the $L_d = 0$ (corresponding to $T_c = 0$) curve gives the ratio of the transient value of the short-circuit current to I_{SSmax} for a fault with a d.c. side load resistance R_d. Due to the ripple of the direct current this value has to be multiplied by 1,05 to get the peak value of the short-circuit current $\hat{I}_{SS}$.	
10	Introduction of the time constant T_c of the load circuit. The intersection of the line drawn in step 7 with the T_c curve gives the ratio of the transient value of the short-circuit current for a given time constant to I_{SSmax} for a fault with a d.c. side load resistance R_d and a given time constant T_c. Due to the ripple of the direct current this value has to be multiplied by 1,05 to get the peak value of the short-circuit current $\hat{I}_{SS}$.	$T_c = L_d / R_d$

Table A.1 – Method of use of the charts in Figure A.2 and Figure A.3 *(continued)*

Step	Action	Formulae
11	The initial current rise ($di/dt_{t=0}$) of the short-circuit current may be calculated using the inductance of the transformer L_s and the inductance on the load side L_d.	$di/dt_{t=0} = U_{di} / (1{,}5 \times L_s + L_d)$ with: $L_S = \frac{U_{Bv} \times e_x}{I_{Bv} \times \varpi} = \frac{U_{di} \times e_x}{I_{Bd} \times f_N \times 12}$ $L_d = T_d \times R_d$
12	The range of linear voltage drop can be seen in the characteristic and the relating maximum current can be calculated.	$I_{dlinmax}$ = 0,45 x I_{SSmax} (for Figure A.2) $I_{dlinmax}$ = 0,35 x I_{SSmax} (for Figure A.3)

NOTE 1 e_{rB} can be calculated as ratio of the load losses over the rated power of the transformer, as a guidance e_{rB} can be assumed as approximately equal 0,1 x e_{xB}.

NOTE 2 The short-circuit power of the feeding grid can be introduced by adding the relative impedance voltage of the grid e_{xL} to the short-circuit voltage of the transformer e_{xB}.

NOTE 3 The voltage drop of the diodes can be introduced in the same manner as a load impedance.

NOTE 4 The resistance of a rectifier can be assumed as 1 mOhm, the electrical time constant of a rectifier group can be assumed as 10 ms.

NOTE 5 The value of the coupling factor K of transformers with closely coupled secondary windings is usually in the range between 0,90 and 0,93. Where the coupling factor K of the converter transformer is not known, the value K = 0,9 should be taken for calculation;

NOTE 6 The scale for the time constant T_s in the figures A.2 and A.3 depends on the rated frequency:

$$T_S = \frac{1}{\omega \cdot \frac{e_{rB}}{e_{xB}}}$$

For 50 Hz: $T_s = \frac{3{,}18 \cdot \times 10^{-3}}{\frac{e_{rB}}{e_{xB}}}$ [ms]