

Railway applications — Fixed installations — Particular requirements for a.c. switchgear —

Part 1: Single-phase circuit-breakers
with U_n above 1 kV

ICS 29.120.40; 29.130.99; 29.280

National foreword

This British Standard is the UK implementation of EN 50152-1:2007. It supersedes BS EN 50152-1:1999 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee GEL/9, Railway electrotechnical applications, to Subcommittee GEL/9/3, Fixed equipment.

A list of organizations represented on this committee can be obtained on request to its secretary.

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 30 April 2008

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ISBN 978 0 580 56842 8

Amendments/corrigenda issued since publication

Date	Comments

English version

**Railway applications -
Fixed installations -
Particular requirements for a.c. switchgear -
Part 1: Single-phase circuit-breakers with U_n above 1 kV**

Applications ferroviaires -
Installations fixes -
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appareillage à courant alternatif -
Partie 1: Disjoncteurs monophasés
avec U_n supérieur à 1 kV

Bahnanwendungen -
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Besondere Anforderungen an
Wechselstrom-Schaltanlagen -
Teil 1: Einphasen-Leistungsschalter
mit U_n über 1 kV

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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

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, Electric and electronic applications for railways.

This European Standard supersedes EN 50152-1:1997 and has been prepared taking into account the changes that have been made in the high voltage switchgear and controlgear Standards of IEC TC 17 and in EN 50124-1/A2:2005.

This document is technically equivalent to EN 50152-1:1997 except for the normative references which have changed and the revised classification of rated insulation voltages according to Table A.2 of EN 50124-1/A2:2005.

The text of the draft was submitted to the unique acceptance procedure and was approved by CENELEC as EN 50152-1 on 2007-07-01.

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) | 2008-07-01 |
| – | latest date by which the national Standards conflicting with the EN have to be withdrawn | (dow) | 2010-07-01 |

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Introduction

The European Standard series EN 50152 is divided as follows.

Part 1: Single-phase circuit-breakers with U_n above 1 kV.

Part 2: Single-phase disconnectors, earthing switches and switches with U_n above 1 kV.

Part 3-1: Measurement, control and protection devices for specific use in a.c. traction systems – Application guide

Part 3-2: Measurement, control and protection devices for specific use in a.c. traction systems – Single-phase current transformers

Part 3-3: Measurement, control and protection devices for specific use in a.c. traction systems – Single-phase voltage transformers

EN 50152-1 has to be used in conjunction with EN 62271-100.

The essential requirements of EN 62271-100 have been transcribed in this European Standard. Other complementary clauses of EN 62271-100 are mentioned in this European Standard. Where a particular clause of EN 62271-100 is not mentioned, but is not referred as "not applicable" in this Standard, that clause applies as far as reasonable. Where this Standard states "addition" or "replacement", the relevant text of EN 62271-100 is to be adapted accordingly.

The numbering of clauses in EN 60694 and the EN 62271 series is not used in this European Standard. The numbering in square brackets refers to the numbering of clauses in EN 60694 and EN 62271.

NOTE 1 Where terms defined in EN 62271-100 conflict with definitions of the same terms as given in IEC 60050-811:1991 or of the other railway applications documents listed in the normative references, the definitions used in EN 62271-100 are to be used.

NOTE 2 The suffix N which appears in this Standard for rated values is not present in EN 62271-100.

1 Scope

This EN 50152-1 is applicable to single-phase a.c. one-pole circuit-breakers designed for indoor or outdoor fixed installations for operation at frequencies of 16,7 Hz and 50 Hz on traction systems having an U_{Nm} above 1 kV up to 52 kV.

This EN 50152-1 is also applicable to two-pole circuit-breakers when connected in the following manner: one pole supplying the connection to the contact line of the track, the second pole supplying the connection to the feeder cable which runs alongside the same track and which is used to boost the track voltage at regular intervals in combination with autotransformers. The centre of this circuit is connected to earth.

This European Standard is also applicable to the operating devices of circuit-breakers and to their auxiliary equipment.

This European Standard does not address circuit-breakers with dependent manual operating mechanism.

NOTE A rated short-circuit making current cannot be specified for these circuit-breakers and the use of these mechanisms may give reasons for the objection based on their safety in operation.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 50124-1:2001 + amendment A2:2005, *Railway applications - Insulation coordination - Part 1: Basic requirements - Clearances and creepage distances for all electrical and electronic equipment*.

EN 50163:2004, *Railway applications - Supply voltages of traction systems*.

EN 60044-1:1999, *Instrument transformers – Part 1: Current transformers (IEC 60044-1:1996, modified)*.

EN 60507:1993, *Artificial pollution tests on high-voltage insulators to be used on a.c. systems (IEC 60507:1991)*.

EN 60694:1996, *Common specifications for high-voltage switchgear and controlgear standards (IEC 60694:1996)*.

EN 60721 (all parts), *Classification of environmental conditions (IEC 60721 all parts)*.

EN 62271-100:2001, *High-voltage switchgear and controlgear – Part 100: High-voltage alternating-current circuit-breakers (IEC 62271-100:2001)*.

EN 62271-102:2002, *High-voltage switchgear and controlgear – Part 102: Alternating-current disconnectors and earthing switches (IEC 62271-102:2001)*.

3 Definitions

For the purpose of this document, the terms and definitions given in EN 60694 and EN 62271-100 and the following apply:

3.1

single-pole circuit-breaker

a circuit-breaker with one electrically separated conducting path for the main circuit suitable for use in a single phase circuit

NOTE The construction arrangement of this device is in principle identical to one phase of a three-phase circuit-breaker.

3.2

two-pole circuit-breaker

a circuit-breaker with two independent electrically separated conducting paths for the main circuit

NOTE 1 The two paths may be connected in series for use in a single phase circuit where the establishment and the separation of the two paths is simultaneous.

NOTE 2 The construction arrangement of this device is in principle identical to two phases of a three phase circuit-breaker.

3.3

index of definitions

same as in 3.8 of EN 62271-100, but amended according to the definitions above

4 Service conditions

Clause 2 of EN 60694:1996 is applicable except as follows:

Addition:

The equipment covered by this Standard shall be suitable for installation in trackside locations subject to vibrations from passing trains, airborne iron dust contamination from train brakes and shall meet the electromagnetic compatibility (EMC) requirements.

For special service conditions, agreement is necessary between purchaser and supplier.

5 Rating

5.1 General

A circuit-breaker in correct condition of maintenance and adjustment shall be able to withstand all stresses that occur in service provided that these do not exceed its rated characteristics.

The characteristics of a circuit-breaker, including its operating devices and auxiliary equipment, that shall be used to determine the rating are the following:

Rated characteristics to be given for all circuit-breakers:

- a) rated voltage;
- b) rated insulation level;
- c) rated frequency;
- d) rated normal current;
- e) rated short-time withstand current;
- f) rated peak withstand current;
- g) rated duration of short circuit, for circuit-breakers not fitted with direct over-current release;
- h) rated supply voltage of closing and opening devices and of auxiliary circuits;
- i) rated supply frequency of closing and opening devices and of auxiliary circuits;
- j) rated pressures of compressed gas supply for operation and for interruption, if applicable;

- k) rated gas pressure for sealed gas pressure devices;
- l) rated short-circuit breaking current;
- m) rated transient recovery voltage for terminal faults;
- n) rated short-circuit making current;
- o) rated operating sequence.

5.2 Rated voltage (U_{Ne})

The rated voltage U_{Ne} shall be chosen taking into consideration the maximum voltage level suitable to be permanently applied to the circuit-breaker (i.e. highest permanent voltage U_{max1} as defined in EN 50163).

NOTE This standard makes reference to the values U_{max1} and U_{max2} , taken from EN 50163. These values are used to express the values of U_{Ne} , which are expected to be equal or higher than U_{max1} . The insulation characteristics are also expected to be suitable to allow, when required in Clause 5 and Clause 7, the highest non-permanent voltage U_{max2} .

5.3 Nominal voltage (U_n)

The nominal voltage U_n shall be one of the voltages listed in Table 1 of EN 50163.

5.4 Rated insulation voltage (U_{Nm})

[4.2]

The value of the rated insulation voltage U_{Nm} , of the rated impulse withstand voltage U_{Ni} and of the power-frequency withstand voltage U_a shall be as given in Table 1, taken from the values listed in EN 50124-1.

Table 1 - Nominal voltages (U_n), rated impulse voltages (U_{Ni}) and short-duration power-frequency (A.C.) test levels U_a for circuits connected to the contact line

U_n kV	U_{Nm} kV	U^a kV	OV	U_{Ni} (1,2/50 μ s) kV	U_a kV
EN 50163	EN 50124	(EN 60694)	EN 50124-1		
15	17,25	(24,0)	3	95	38 or 50 ^b
			4	125	50
		(36,0)	3	145	70
			4	170	70 or 95 ^b
25	27,5 ^c	N/A	3	170	70 or 95 ^b
			4	200 ^c	95
		(52,0)	3	200 ^c	95
			4	250	95
see Note 3	52,0	(72,5)	3	250	95
			4	300	140
NOTE 1 The choice of the different values of U_{Ni} given for the same U_n , depends upon the highest non-permanent voltages (such as U_{max2} of EN 50163) actually appearing in the system.					
NOTE 2 OV3 and OV4 are overvoltage categories depending on the system configuration and degree of overvoltage control (inherent control or protective control) as given in EN 50124-1.					
NOTE 3 Take care that in those cases in which for circuit reasons it may happen that a higher voltage is applied to the device terminals in transient conditions a higher rated insulation voltage between contacts might be necessary (e. g. U_{Nm} = 52 kV for U_n = 25 kV).					
^a The values in brackets give the rated voltages according to Table 1a of EN 60694 having the nearest equivalence in test withstand voltages with the test values for single-phase voltages given in this Table.					
^b At purchaser's choice or by agreement.					
^c These values are used in railway application only and are not of wide industrial use.					

5.5 Rated frequency

[4.3]

Subclause 4.3 of EN 60694 is applicable.

5.6 Rated normal current and temperature rise

[4.4]

Subclauses 4.4.1 and 4.4.2 of EN 60694 are applicable with the following additions:

The values of rated currents shall be selected from the following standard values:

400 A; 630 A; 800 A; 1 250 A; 1 600 A; 2 000 A; 2 500 A; 4 000 A.

NOTE The above values are selected from the R 10 series, and, if required, higher values than those shown should also be selected from this series.

If the circuit-breaker is fitted with a series connected accessory, such as a direct over-current release, the rated normal current of the accessory is the r.m.s. value of the current which the accessory shall be able to carry continuously without deterioration at its rated frequency, with a temperature rise not exceeding the values specified in Table 3 of EN 60694.

Current transformers shall comply with EN 60044-1.

5.7 Rated short-time withstand current [4.5]

Subclause 4.5 of EN 60694 is applicable with the following addition:

The rated short-time withstand current is equal to the rated short-circuit breaking current (see 5.13).

5.8 Rated peak withstand current [4.6]

Subclause 4.6 of EN 60694 is applicable with the following addition:

The rated peak withstand current is equal to the rated short-circuit making current (see 5.16).

5.9 Rated duration of short-circuit [4.7]

Subclause 4.7 of EN 60694 is applicable with the following addition:

A rated duration of a short-circuit need not be assigned to a circuit-breaker fitted with a direct over-current release provided that, when connected in a circuit the prospective breaking current of which is equal to its rated short-circuit breaking current, the circuit-breaker shall be capable of carrying the resulting current for the break-time required by the circuit-breaker with the over-current release set for the maximum setting and maximum time delay if adjustable, when operating in accordance with its rated operating sequence (see 7.6.1).

5.10 Rated supply voltage of closing and opening devices and auxiliary circuit [4.8]

Subclause 4.8 of EN 60694 is applicable with the following addition:

The specified upper limit of the supply voltage for a closing solenoid shall be 105 % of the rated supply voltage.

5.11 Rated supply frequency of closing and opening devices and auxiliary circuits [4.9]

Subclause 4.9 of EN 60694 is applicable.

5.12 Rated pressures of compressed gas supply for operation and for interruption [4.10]

The value of the pressures to which the circuit-breaker is filled.

Subclause 4.10 of EN 60694 is applicable to the pressure of the compressed gas supply for operation.

No standard values are given for rated pressure of compressed gas supply for interruption.

5.13 Rated short-circuit breaking current (I_{Nss}) [4.101]

5.13.1 General [4.101]

The rated short-circuit breaking current (I_{Nss}) is the highest short-circuit current which the circuit-breaker shall be capable of breaking under the conditions of use and behaviour prescribed in this standard in a circuit having a power-frequency recovery voltage corresponding to the rated voltage of the circuit-breaker and having a transient recovery voltage equal to the rated value specified in 5.14.1.

Short-line fault interruption is not a requirement for circuit-breakers to this standard. Such a requirement shall be deemed to be special and subject to agreement between purchaser and supplier.

The rated short-circuit breaking current is characterized by two values:

- the r.m.s. value of its a.c. component, termed "rated short-circuit current" for shortness, and
- the percentage d.c. component.

NOTE 1 If the d.c. component does not exceed 20 %, the rated short-circuit breaking current is characterized only by the r.m.s. value of its a.c. component.

For determination of the a.c. and d.c. components, see Figure 8 of EN 62271-100.

The circuit-breaker shall be capable of breaking any short-circuit current up to its rated short-circuit breaking current containing any a.c. component up to the rated value and associated with it any percentage d.c. component up to that specified, under the conditions mentioned above.

The following applies to a standard circuit-breaker:

- a) At voltages below the rated voltage, it will be capable of breaking its rated short-circuit breaking current.

NOTE 2 For circuit-breakers having proved rated short-circuit breaking currents I_{Nss} at two different rated voltages U_{Ne} , intermediate characteristics may be assigned from the straight line drawn between the two proved rating points on a plot of $\log U$ versus $\log I$. In case of doubt, tests should be carried out to check the validity of the interpolation.

- b) At voltages above the rated voltage, no short-circuit breaking current is guaranteed except to the extent provided for in 5.18.

5.13.2 A.C. component of the rated short-circuit breaking current

[4.101.1]

The r.m.s. value of the a.c. component of the rated short-circuit breaking current shall be selected from the values shown in Table 6.

NOTE The values in Table 6 are selected from the R 10 series, and, if required, higher values than those shown should also be selected from this series.

5.13.3 D.C. component of the rated short-circuit breaking current

[4.101.2]

The value of the percentage d.c. component shall be determined as follows:

- a) For a circuit-breaker which can be tripped by a short-circuit current without the aid of any form of auxiliary power, the percentage d.c. component shall correspond to a time interval τ equal to the minimum opening time of the circuit-breaker.
- b) For a circuit-breaker which can be tripped solely by a form of auxiliary power, the percentage d.c. component shall correspond to a time interval τ equal to the minimum opening time of the circuit-breaker plus one-half cycle of rated frequency.

The minimum opening time mentioned above is the shortest opening time of the circuit-breaker obtainable under any service conditions whether in a breaking operation or a make-break operating cycle.

The percentage value of the d.c. component is dependent on the time interval τ . Standard values and special case values are given in Figure 9 of EN 62271-100.

5.14 Rated transient recovery voltage for terminal faults

[4.102]

5.14.1 General

The rated transient recovery voltage (TRV) for terminal faults, relating to the rated short-circuit breaking current in accordance with 5.13.1, is the reference voltage which constitutes the limit of the prospective transient recovery voltage of circuits which the circuit-breaker shall be capable of breaking in the event of a short-circuit at its terminals.

5.14.2 Representation of transient recovery voltage waves

[4.102.1]

The wave form of transient recovery voltages varies according to the arrangement of actual circuits.

NOTE 1 The transient recovery voltage approximates to a damped single frequency oscillation. This wave form is adequately represented by an envelope consisting of two line segments defined by means of two parameters. Methods of drawing TRV envelopes are given in EN 62271-100, Annex F.

The influence of local capacitance on the source side of the circuit-breaker produces a slower rate of rise of the voltage during the first few microseconds of the TRV. This is taken into account by introducing a time delay.

It appears that every part of the TRV wave may influence the interrupting capability of a circuit-breaker. The very beginning of the TRV may be of importance for some types of circuit-breakers.

NOTE 2 This part of TRV, called initial TRV (ITRV), is caused by the initial oscillations of small amplitude due to reflections from the first major discontinuity along the busbar. The ITRV is a physical phenomenon which is very similar to the short-line fault. Compared with the short-line fault, the first voltage peak is rather low, but the time to the first peak is extremely short, that is within the first microseconds after current zero. Therefore the thermal mode of interruption may be influenced.

NOTE 3 Since the ITRV is proportional to the busbar surge impedance and to current, the ITRV requirement can be neglected for metal-enclosed switchgear and in most railway applications, because of the low surge impedance and for all switchgear with a rated short-circuit breaking current of less than 50 kA.

NOTE 4 If the circuit-breaker has a short-line fault rating the ITRV requirements are considered to be covered if the short-line fault tests are carried out using a line without time delay (see 7.10.5.2).

5.14.3 Representation of rated TRV

[4.102.2]

The following parameters are used for the representation of rated TRV:

- a) four-parameter reference line not applicable;
- b) two-parameter reference line (see Figure 11 of EN 62271-100):

u_c = reference voltage (TRV peak value), in kilovolts,
 t_3 = time to reach u_c , in microseconds;

- c) delay line of TRV (see Figure 11 of EN 62271-100):

t_d = time delay, in microseconds,
 u' = reference voltage, in kilovolts,
 t' = time to reach u' , in microseconds.

The delay line starts on the time axis at the rated time delay and runs parallel to the first section of the reference line of rated TRV and terminates at the voltage u' (time-coordinate t').

- d) not applicable.

5.14.4 Standard values of rated TRV

[4.102.3]

Standard values of rated TRV for single-phase circuit-breakers are given in Table 2.

Where the purchaser has requirements for higher severities of TRV than those in Table 2, these shall be identified in purchaser's specification.

Table 2 – Standard values of rated transient recovery voltage - Representation by two parameters - Single pole circuit-breaker

U_n	$U_{\max 2}$	U_c TRV peak value	t_3	t_d	u'	t'	U_c/t_3 rate of rise
kV	kV	kV	μs	μs	kV	μs	kV/ μs
15	18	36	108	16	12	52	0,33
25	29	57	132	20	19	64	0,43

with:

$$U_c = 1,4 \times \sqrt{2} \times U_{\max 2};$$

1,4 = amplitude factor (see EN 62271-100);

$$u' \approx \frac{U_c}{3};$$

$$t' = \frac{t_3}{3} + t_d;$$

$$t_d = 0,15 \times t_3.$$

NOTE 1 The values in Table 2 are minimum values. The values of Table 1a of EN 62271-100 may be adopted with $U(\text{EN 62271-100}) = \sqrt{3} \times U_{\max 2}$ and t_3 unchanged.

NOTE 2 The TRV figures are for a single-pole circuit-breaker. The equivalent three-phase circuit-breaker is tested with u_c and U_c/t_3 values equal to 1,5 times those shown in Table 2. Values for the time delay t_d are to be in accordance with Table 1a of EN 62271-100.

5.15 Standard values of initial transient recovery voltage [4.102.4]

Subclause 4.102.4 of EN 62271-100 is not applicable to single-phase circuit-breakers for railway applications.

5.16 Rated short-circuit making current [4.103]

The rated short-circuit making current (see Figure 8 of EN 62271-100) of a circuit-breaker is that which corresponds to the rated voltage, and shall be 2,5 times the r.m.s. value of the a.c. component of its rated short-circuit breaking current (see 5.13).

5.17 Rated operating sequence [4.104]

There are two alternative rated operating sequences as follows:

a) O - t - CO - t' - CO

Unless otherwise specified:

$t = 180$ s for circuit-breakers not intended for rapid auto-reclosing;

$t = 0,3$ s for circuit-breakers intended for rapid auto-reclosing (dead time);

$t' = 180$ s.

NOTE 1 Instead of $t' = 180$ s, other values: $t' = 15$ s (for rated voltages less than or equal to 52 kV) and $t' = 60$ s are also used for circuit-breakers intended for rapid auto-reclosing.

b) CO - t'' - CO

with:

$t'' = 15$ s, for circuit-breakers non intended for rapid auto-reclosing;

where:

O represents an opening operation;

CO represents a closing operation followed immediately (that is, without any intentional time-delay) by an opening operation;

t , t' and t'' are time-intervals between successive operations.

NOTE 2 t , t' and t'' should always be expressed in seconds.

If the dead time is adjustable, the limits of adjustment shall be specified.

5.18 Rated out-of-phase breaking current

[4.106]

If required by the purchaser, a single-pole circuit-breaker may be used in service in the open position with two different phases across its open terminals, such as a circuit-breaker used for supplying an alternative feed in emergency conditions. This test shall be performed at a rating specified by the purchaser based on the maximum fault current which can exist for this condition. This out-of-phase breaking current cannot exceed 50 % of the rated short-circuit current with two phases displaced by a maximum of 120 ° or 180 °. The purchaser shall identify if out-of-phase breaking current is applicable and which condition applies.

NOTE The 120° case occurs when voltage is derived from two different phases of a three-phase system. The 180 ° case typically occurs when the neutral is the central point of a single-phase system (currently indicated as $\pm U_n$ system).

The transient recovery voltage shall be as given in Tables 3 and 4.

Table 3 - Standard values of prospective transient recovery voltage for 120 ° out-of-phase breaking - Representation by two parameters - Single pole circuit-breaker

Nominal voltage U_n kV	U_{max2}^a kV	TRV peak value U_c kV	Time t_3 μs	Rate of rise U_c/t_3 kV/ μs
15	18	55	216	0,25
25	29	88	264	0,33
^a EN 50163				

with:

$$U_c = 1,25 \times \sqrt{2} \times \sqrt{3} \times U_{max2};$$

1,25 = corrected amplitude factor (see EN 62271-100);

$\sqrt{3}$ = factor of maximum phase-displacement;

$t_3 = 2 \times t_3$ (of Table 2).

Table 4 - Standard values of prospective transient recovery voltage for 180 ° out-of-phase breaking - Representation by two parameters - Single pole circuit-breaker

Nominal voltage U_n kV	U_{max2} kV	TRV peak value U_c kV	Time t_3 μs	Rate of rise U_c/t_3 kV/ μs
15	18	64	216	0,30
25	29	102	264	0,39

with:

$$U_c = 1,25 \times \sqrt{2} \times 2 \times U_{max2};$$

1,25 = corrected amplitude factor (see EN 62271-100);

2 = factor of phase opposition;

$t_3 = 2 \times t_3$ (of Table 2).

Where the purchaser has requirements for higher severities of TRV than those given in Tables 3 and 4, these shall be identified in purchaser's specification.

5.19 Rated line-charging breaking current

[4.107.1]

When specified by the purchaser the circuit-breaker shall be capable of breaking the capacitive current of the feeder cable or the catenary at a voltage value of not less than U_{max1} (see EN 50163), and with a current not exceeding 10 A.

5.20 Rated cable-charging breaking current

[4.107.2]

The rated cable-charging breaking current is the maximum cable-charging current that the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this Standard and without exceeding the appropriate maximum permissible switching overvoltages specified by the manufacturer. Suggested values are given in Table 5.

The specification of rated cable-charging breaking current to a circuit-breaker is not mandatory but is made on request, and is considered unnecessary for circuit-breakers of rated voltages equal to or less than 24 kV. If assigned, it is recommended that the rated cable-charging breaking current be 50 A for 15 kV systems and 80 A for 25 kV systems

5.21 Rated single capacitor bank breaking current

[4.107.3]

The rated single capacitor bank breaking current is the maximum capacitor current that the circuit-breaker shall be capable of breaking at its rated voltage under the conditions of use and behaviour prescribed in this standard and without exceeding the maximum permissible switching overvoltages specified by the manufacturer. Suggested values are given in Table 5, columns B.

NOTE 1 This breaking current refers to the switching of a shunt capacitor bank where no shunt capacitors are connected to the source side of the circuit-breaker.

The specification of a rated single capacitor bank breaking current is not mandatory.

NOTE 2 Values of rated single capacitor bank breaking current should be selected from the R 10 series and with a current not exceeding 200 A unless otherwise agreed between purchaser and supplier.