



SLOVENSKI STANDARD SIST EN 62423:2009

01-december-2009

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[cgdcX]b`g_c`]b`dcXcVbc`fUvc`fhjd`6`F776g`]b`hd`6`F76CgLf197`*`&`&`\$\$+ž
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Type B residual current operated circuit-breakers with and without integral overcurrent protection for household and similar uses (Type B RCCBs and Type B RCBOs) (IEC 62423:2007, modified)

STANDARD PREVIEW

Typ B Fehlerstrom-/Differenzstrom-Schutzschalter mit und ohne eingebautem Überstromschutz für Hausinstallationen und für ähnliche Anwendungen (Typ B RCCBs und Typ B RCBOs) (IEC 62423:2007, modifiziert)

[SIST EN 62423:2009](https://standards.iteh.ai/catalog/standards/sist/f8625fd7-a94f-4e7b-b033-100000000000)

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Interrupteurs automatiques à courant différentiel résiduel de Type B avec et sans protection contre les surintensités incorporée pour usages domestiques et analogues (ID et DD de Type B) (CEI 62423:2007, modifiée)

Ta slovenski standard je istoveten z: EN 62423:2009

ICS:

29.120.50 Xæ[çæ\ ^Á Ái` * æ Fuses and other overcurrent protection devices
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SIST EN 62423:2009

en,fr

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EUROPEAN STANDARD
NORME EUROPÉENNE
EUROPÄISCHE NORM

EN 62423

October 2009

ICS 29.120; 29.120.50

English version

**Type B residual current operated circuit-breakers
with and without integral overcurrent protection
for household and similar uses
(Type B RCCBs and Type B RCBOs)
(IEC 62423:2007, modified)**

Interrupteurs automatiques
à courant différentiel résiduel de Type B
avec et sans protection contre
les surintensités incorporée
pour usages domestiques et analogues
(ID et DD de Type B)
(CEI 62423:2007, modifiée)

Typ B Fehlerstrom-/Differenzstrom-
Schutzschalter mit und ohne eingebautem
Überstromschutz für Hausinstallationen
und für ähnliche Anwendungen
(Typ B RCCBs und Typ B RCBOs)
(IEC 62423:2007, modifiziert)

STANDARD PREVIEW
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SIST EN 62423:2009

<https://standards.iteh.ai/catalog/standards/sist/f8625fd7-a94f-4e7b-b033-1946b0c0e209/EN-62423-2009>

This European Standard was approved by CENELEC on 2009-07-01. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard 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 European Standard 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.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Bulgaria, Cyprus, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and the United Kingdom.

CENELEC

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

Central Secretariat: Avenue Marnix 17, B - 1000 Brussels

Foreword

The text of the International Standard IEC 62423:2007, prepared by SC 23E, Circuit-breakers and similar equipment for household use, of IEC TC 23, Electrical accessories, together with the common modifications prepared by the Technical Committee CENELEC TC 23E, Circuit breakers and similar devices for household and similar applications, was submitted to the Unique Acceptance Procedure and was approved by CENELEC as EN 62423 on 2009-07-01.

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) 2010-07-01
- latest date by which the national standards conflicting with the EN have to be withdrawn (dow) 2012-07-01

This European Standard has been prepared under a mandate given to CENELEC by the European Commission and the European Free Trade Association and covers essential requirements of EC Directive 2004/108/EC. See Annex ZZ.

Clauses, subclauses, notes, tables and figures which are additional to those in IEC 62423 are prefixed “Z”.

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Annexes ZA, ZB and ZZ have been added by CENELEC.
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SIST EN 62423:2009

<https://standards.iteh.ai/catalog/standards/sist/f8625fd7-a94f-4e7b-b033-b9415d3bb9e2/sist-en-62423-2009>

Endorsement notice

The text of the International Standard IEC 62423:2007 was approved by CENELEC as a European Standard with agreed common modifications as given below.

COMMON MODIFICATIONS

Contents Add:

9.Z1 Electromagnetic compatibility (EMC)

Annex ZA Normative references to international publications with their corresponding European publications

Annex ZB Special national conditions

Annex ZZ Coverage of Essential Requirements of EC Directives

Table Z1 Tests to be applied for EMC

Table A.Z1

Table A.Z2 Number of samples for full test procedure

Table A.Z3 Number of samples for simplified test procedure

Table B.Z1

Table B.Z2 Number of samples for full test procedure

Table B.Z3 Number of samples for simplified test procedure

1 Scope

Replace the first two paragraphs by the following new paragraphs:
<https://standards.iteh.ai/catalog/standards/sist/8625f17-a94f-4e7b-b033-b9415d3bb9e2/sist-en-62423-2009>

The scope of EN 61008-1 and EN 61008-2-1 or EN 61009-1 and EN 61009-2-1 applies.

This standard specifies requirements and tests for type B RCDs. Requirements and tests given in this standard are in addition to the requirements of type A residual current devices according to EN 61008-2-1 or EN 61009-2-1. Type B RCCBs and type B RCBOs are able to provide protection in case of alternating residual sinusoidal currents up to 1 000 Hz, pulsating direct residual currents and smooth direct residual currents in case of three phase supply.

Delete the fifth paragraph.

Replace note 2 by the following new note:

NOTE 2 Requirements for 2 poles devices are under consideration.

5 Characteristics

5.3 Delete the value "60 Hz" three times: in the title of 5.3, in the title of Table 2 and in note 4 of Table 2.

9 Tests

9.2 Delete the third paragraph.

9.Z1 Add the new following subclause:

9.Z1 Electromagnetic compatibility (EMC)

EMC tests shall be performed according to EN 61543 as follows:

- *Tests listed in the following table are covered by EN 61008-1 or EN 61009-1 as applicable and have not to be repeated:*

Table Z1 – Tests to be applied for EMC

Reference to Tables 4 and 5 of EN 61543	Electromagnetic phenomena	Tests of EN 61008-1	Tests of EN 61009-1
T 1.3	Voltage amplitude variations	9.9.5 and 9.17	9.9.1.5 and 9.17
T 1.4	Voltage unbalance	9.9.5 and 9.17	9.9.1.5 and 9.17
T 1.5	Power frequency variations	9.2	9.2
T 1.8	Magnetic fields	9.11 and 9.18	9.12 and 9.18
T 2.4	Current oscillatory transients	9.19	9.19

- *The remaining tests in Tables 4, 5 and 6 of EN 61543 shall be done according to the test sequences Z1, Z2 and Z3 listed in Annex A or B of this standard.*

For devices containing a continuously operating oscillator, the test of EN 55014 (series) shall be carried out on the samples prior to the tests of EN 61543.

Annex A Number of samples to be submitted and test sequences to be applied for verification of conformity for type B RCCBs

Modify the note before A.1 into a requirement.

Table A.1 **Replace** the second column heading by the following:

Tests according to EN 61008-1 and EN 61008-2-1

Delete in sequence D₁ the row referred to 9.17.

Modify footnote reference ^a into *.

Add the following new test sequences D₂ and H:

D ₂	9.11.2.3 c)		Verification of the suitability in IT system
H	9.24		Verification of correct operation at low ambient air temperature of RCCBs for use in the range of -25 °C to +40 °C

Replace footnote ^a by the following new footnote *:

- * An additional test according to 9.21.1.1 shall be made with a supply voltage of 1,1 U_n. Only the lower limits of the tripping currents are verified.

Delete the last sentence after Table A.1.

Add the following new Tables A.Z1, A.Z2 and A.Z3.

Table A.Z1

Test sequence	Tests according to EN 61543		Test (or Inspection)
Z1 ^a	EN 61543 Table 4 – T1.1 EN 61543 Table 4 – T1.2 EN 61543 Table 5 – T2.3		Harmonics, interharmonics Signalling voltage Conducted unidirectional transients of the ms and μ s time scale
Z2	EN 61543 Table 5 – T2.1 and T2.5 EN 61543 Table 5 – T2.2		Conducted oscillatory voltages or currents Conducted unidirectional transients of the ns time scale (burst)
Z3	EN 61543 Table 5 – T2.6 EN 61543 Table 6 – T3.1		Conducted common mode disturbances in the frequency range lower than 150 kHz Electrostatic discharges

^a For devices containing a continuously operating oscillator, the test of EN 55014 series shall be carried out on the samples prior to the tests of this sequence.

Table A.Z2 – Number of samples for full test procedure

Test sequence	Number of samples	Minimum number of samples which shall pass the tests ^{a,b}	Maximum number of samples for repeated tests ^c
A	1	1	–
B	3	2	3
C	3	2 ^d	3
D	3	2 ^d	3
D ₂	3	2	3
E	3	2 ^d	3
F ₀	3	2 ^d	3
F ₁	3	2 ^d	3
G	3	2	3
H	3	2	3
Z1 ^e	3	2	3
Z2 ^e	3	2	3
Z3 ^e	3	2	3

^a In total a maximum of three test sequences may be repeated.

^b It is assumed that a sample which has not passed a test has not met the requirements due to workmanship or assembly defects which are not representative of the design.

^c In the case of repeated tests, all test results must be acceptable.

^d Except for tests of 9.12.10, 9.12.11.2, 9.12.11.3, 9.12.11.4, and 9.12.13, as appropriate, which all samples shall pass.

^e On request of the manufacturer the same set of samples may be subjected to more than one of these test sequences.

Table A.Z3 – Number of samples for simplified test procedure

Test sequence	Number of samples according to number of poles ^a					
	2 poles ^b		3 poles ^c		4 poles	
A	1	max. rating I_n min. rating $I_{\Delta n}$	1	max. rating I_n min. rating $I_{\Delta n}$	1	max. rating I_n min. rating $I_{\Delta n}$
B	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
C	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
D ₀ + D ₁	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
D ₀	1	for all other ratings of $I_{\Delta n}$				
D ₂	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
E	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
F	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$
G	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$
H	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$	3 ^d	min. rating I_n max. rating $I_{\Delta n}$
Z1 ^e	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$
Z2 ^e	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$
Z3 ^e	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$

^a If a test is to be repeated according to the minimum performance criteria of A.2, a new set of samples is used for the relevant test. In the repeated test all test results must be acceptable.

^b If only 3-pole or 4-pole RCCBs are submitted, this column shall also apply to a set of samples with the smallest number of poles.

^c This column is omitted when 4-pole RCCBs have been tested.

^d If only one value of $I_{\Delta n}$ is submitted, these sets of samples are not required.

^e If a range of RCCBs of the same fundamental design are submitted, only the samples with the maximum number of poles need to be tested.

Annex B Number of samples to be submitted and test sequences to be applied for verification of conformity for type B RCCOs

Modify the note before B.1 into a requirement.

Table B.1 Replace the second column heading by the following:

Tests according to EN 61009-1 and EN 61009-2-1

Replace the test sequences C₁ and C₂ by the following:

C ₁	9.10		Mechanical and electrical endurance
	--	9.3	Verification of the RCD after test sequence
	9.12.11.2.Z1 (and 9.12.12)		Performance at reduced short-circuit currents (Verification of the RCBO after short-circuit tests)
C ₂	9.12.11.2.Z2 (and 9.12.12)		Short-circuit test for verifying the suitability of RCBOs for use in IT systems (Verification of the RCBO after short-circuit tests)

Delete in sequence D₁ the rows referred to 9.17 and 9.12.13.

Modify footnote reference ^a into *.

Replace footnote ^a by the following new footnote *.

* An additional test according to 9.21.1.1 shall be made with a supply voltage of 1,1 U_n. Only the lower limits of the tripping currents are verified.

Delete the last sentence after Table B.1.

Add the following new Tables B.Z1, B.Z2 and B.Z3.

Table B.Z1

Test sequence	Tests according to EN 61543		Test (or inspection)
Z1 ^a	EN 61543 Table 4 – T1.1 EN 61543 Table 4 – T1.2 EN 61543 Table 5 – T2.3		Harmonics, interharmonics Signalling voltage Conducted unidirectional transients of the ms and µs time scale
Z2	EN 61543 Table 5 – T2.1 and T2.5 EN 61543 Table 5 – T2.2		Conducted oscillatory voltages or currents Conducted unidirectional transients of the ns time scale (burst)
Z3	EN 61543 Table 5 – T2.6 EN 61543 Table 6 – T3.1		Conducted common mode disturbances in the frequency range lower than 150 kHz Electrostatic discharges

^a For devices containing a continuously operating oscillator, the test of EN 55014 series shall be carried out on the samples prior to the tests of this sequence.

Table B.Z2 – Number of samples for full test procedure

Test sequence	Number of samples	Minimum number of samples which shall pass the tests ^{a b}	Maximum number of samples for repeated tests ^c
A	1	1	–
B	3	2	3
C ₁	3	2 ^d	3
C ₂	3	2 ^d	3
D ₀ + D ₁	3	2 ^d	3
E ₀ + E ₁	3	2 ^d	3
F ₀	3	2 ^d	3
F ₁	3	2 ^d	3
F ₂	3	2 ^d	3
G	3	2	3
H	3	2 ^d	3
Z1 ^e	3	2	3
Z2 ^e	3	2	3
Z3 ^e	3	2	3

^a In total a maximum of three test sequences may be repeated.

^b It is assumed that a sample which has not passed a test has not met the requirements due to workmanship or assembly defects which are not representative of the design.

^c In the case of repeated tests, all test results must be acceptable.

^d Except for tests of 9.12.10, 9.12.11.2, 9.12.11.3, 9.12.11.4, and 9.12.13, as appropriate, which all samples shall pass.

^e On request of the manufacturer the same set of samples may be subjected to more than one of these test sequences.

Table B.Z3 – Number of samples for simplified test procedure

Test sequence	Number of samples according to number of poles ^a					
	2 poles ^{b c}		3 poles ^d		4 poles	
A	1	max. rating I_n min. rating $I_{\Delta n}$	1	max. rating I_n min. rating $I_{\Delta n}$	1	max. rating I_n min. rating $I_{\Delta n}$
B	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
C ₁	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
C ₂	For 2 protected poles: 2 max. rating I_n min. rating $I_{\Delta n}$ For 1 protected pole: 3 max. rating I_n min. rating $I_{\Delta n}$		1	max. rating I_n min. rating $I_{\Delta n}$	1	max. rating I_n min. rating $I_{\Delta n}$
D ₀ + D ₁	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
D ₀	1	for all other ratings of $I_{\Delta n}$ with max. I_n				
E ₀ + E ₁	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
E ₀	1	for all other ratings of I_n with min. $I_{\Delta n}$				
F ₀	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$
F ₁	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$
F ₂	3 ^f	max. rating I_n min. rating $I_{\Delta n}$	3 ^f	max. rating I_n min. rating $I_{\Delta n}$	3 ^f	max. rating I_n min. rating $I_{\Delta n}$
G	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
H	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$	3	max. rating I_n min. rating $I_{\Delta n}$
	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$	3 ^e	min. rating I_n max. rating $I_{\Delta n}$
Z1 ^f	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$
Z2 ^f	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$
Z3 ^f	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$	3	any rating I_n min. rating $I_{\Delta n}$

^a If a test is to be repeated according to the minimum performance criteria of A.2, a new set of samples is used for the relevant test.

^b In the repeated test all test results must be acceptable.

^c Apply also to 2 pole RCBOs with 1 protected pole.

^d Also applicable to 4-pole RCBOs with 3 protected poles.

^e This column is omitted when 4-pole RCBOs have been tested. If only one value of $I_{\Delta n}$ is submitted, these samples are not required.

^f Only on the maximum number of poles.

Annex ZA (normative)

Normative references to international publications with their corresponding European publications

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.

NOTE Where an International Publication has been modified by common modifications, indicated by (mod), the relevant EN/HD applies.

<u>Publication</u>	<u>Year</u>	<u>Title</u>	<u>EN/HD</u>	<u>Year</u>
CISPR 14	series	Electromagnetic compatibility - Requirements for household appliances, electric tools and similar apparatus	EN 55014	series
IEC/TS 60479-1	- ¹⁾	Effects of current on human beings and livestock - Part 1: General aspects	-	-
IEC 60479-2	-	Effects of current passing through the human body - Part 2: Special aspects	-	-
IEC 61008-1 (mod) + A1 A2	1996 2002 2006	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) - Part 1: General rules	EN 61008-1 - A11 A12	2004 - 2007 2009
IEC 61008-2-1	1990	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCB's) - Part 2-1: Applicability of the general rules to RCCB's functionally independent of line voltage	EN 61008-2-1 A11 + corr. March	1994 1998 1999
IEC 61009-1 (mod) + A1 + corr. May A2	1996 2002 2003 2006	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) - Part 1: General rules	EN 61009-1 - + corr. July A11 A12 A13	2004 - 2006 2008 2009 2009
IEC 61009-2-1	1991	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBO's) - Part 2-1: Applicability of the general rules to RCBO's functionally independent of line voltage	EN 61009-2-1 + A11 + corr. March	1994 1998 1999
IEC 61543	1995	Residual current-operated protective devices (RCDs) for household and similar use - Electromagnetic compatibility	EN 61543 + corr. Dec. + A11 + corr. May + A12	1995 1997 2003 2004 2005

¹⁾ Undated reference.

Annex ZB (normative)

Special national conditions

Special national condition: National characteristic or practice that cannot be changed even over a long period, e.g. climatic conditions, electrical earthing conditions.

NOTE If it affects harmonization, it forms part of the European Standard.

For the countries in which the relevant special national conditions apply these provisions are normative, for other countries they are informative.

Clause Special national condition

Denmark

- 9.1 In accordance to the requirement of this standard multi-pole RCDs shall be able to operate down to a supply voltage of 85 V a.c. (phase – neutral).
In accordance to the requirement of this Standard multi-pole RCDs shall be able to operate when used for single phase circuits.

Germany

- 9.1 Multi-pole RCDs shall be able to operate down to a supply voltage of 50 V AC. This applies also to RCDs which are used for single phase circuits. Therefore the tests shall be carried out at 50 V instead of $0,85 U_n$.

Ireland, the Netherlands and the United Kingdom

- 1 Modify note 2 to read:

NOTE 2 Additional requirements for 1 pole devices for use in TN-S or TN-C-S systems and 2 pole devices (L-L) for use between phases are under consideration.

- 3.2 Replace 3.2 by:

3.2

type B residual current devices

residual current devices for which tripping is ensured as for type A according to IEC 61008-1 or IEC 61009-1, as applicable, and in addition for the following residual currents:

3.2.1

type B residual current device with 3 or 4 poles

residual current device for which tripping is ensured as for type A according to IEC 61008-1 or IEC 61009-1, as applicable, and in addition

- for residual sinusoidal alternating currents up to 1 000 Hz,
- for residual pulsating direct currents,
- for residual alternating currents superimposed on a smooth direct current,
- for residual pulsating direct currents superimposed on a smooth direct current,
- for residual pulsating rectified d.c. which results from two or more phases,
- for residual smooth direct currents,

independent of polarity and independent of whether the residual current appears suddenly or is slowly increased