

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

---

**Residual direct current detecting device (RDC-DD) to be used for mode 3  
charging of electric vehicles**

**Dispositif de détection à courant différentiel résiduel continu (DD-CDC) à utiliser  
pour la charge en mode 3 des véhicules électriques**



**THIS PUBLICATION IS COPYRIGHT PROTECTED**  
**Copyright © 2018 IEC, Geneva, Switzerland**

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

Droits de reproduction réservés. Sauf indication contraire, aucune partie de cette publication ne peut être reproduite ni utilisée sous quelque forme que ce soit et par aucun procédé, électronique ou mécanique, y compris la photocopie et les microfilms, sans l'accord écrit de l'IEC ou du Comité national de l'IEC du pays du demandeur. Si vous avez des questions sur le copyright de l'IEC ou si vous désirez obtenir des droits supplémentaires sur cette publication, utilisez les coordonnées ci-après ou contactez le Comité national de l'IEC de votre pays de résidence.

IEC Central Office  
3, rue de Varembe  
CH-1211 Geneva 20  
Switzerland

Tel.: +41 22 919 02 11  
[info@iec.ch](mailto:info@iec.ch)  
[www.iec.ch](http://www.iec.ch)

#### **About the IEC**

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

#### **About IEC publications**

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigenda or an amendment might have been published.

#### **IEC Catalogue - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)**

The stand-alone application for consulting the entire bibliographical information on IEC International Standards, Technical Specifications, Technical Reports and other documents. Available for PC, Mac OS, Android Tablets and iPad.

#### **IEC publications search - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee,...). It also gives information on projects, replaced and withdrawn publications.

#### **IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Stay up to date on all new IEC publications. Just Published details all new publications released. Available online and also once a month by email.

#### **Electropedia - [www.electropedia.org](http://www.electropedia.org)**

The world's leading online dictionary of electronic and electrical terms containing 21 000 terms and definitions in English and French, with equivalent terms in 16 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

#### **IEC Glossary - [std.iec.ch/glossary](http://std.iec.ch/glossary)**

67 000 electrotechnical terminology entries in English and French extracted from the Terms and Definitions clause of IEC publications issued since 2002. Some entries have been collected from earlier publications of IEC TC 37, 77, 86 and CISPR.

#### **IEC Customer Service Centre - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: [sales@iec.ch](mailto:sales@iec.ch).

---

#### **A propos de l'IEC**

La Commission Electrotechnique Internationale (IEC) est la première organisation mondiale qui élabore et publie des Normes internationales pour tout ce qui a trait à l'électricité, à l'électronique et aux technologies apparentées.

#### **A propos des publications IEC**

Le contenu technique des publications IEC est constamment revu. Veuillez vous assurer que vous possédez l'édition la plus récente, un corrigendum ou amendement peut avoir été publié.

#### **Catalogue IEC - [webstore.iec.ch/catalogue](http://webstore.iec.ch/catalogue)**

Application autonome pour consulter tous les renseignements bibliographiques sur les Normes internationales, Spécifications techniques, Rapports techniques et autres documents de l'IEC. Disponible pour PC, Mac OS, tablettes Android et iPad.

#### **Recherche de publications IEC - [webstore.iec.ch/advsearchform](http://webstore.iec.ch/advsearchform)**

La recherche avancée permet de trouver des publications IEC en utilisant différents critères (numéro de référence, texte, comité d'études,...). Elle donne aussi des informations sur les projets et les publications remplacées ou retirées.

#### **IEC Just Published - [webstore.iec.ch/justpublished](http://webstore.iec.ch/justpublished)**

Restez informé sur les nouvelles publications IEC. Just Published détaille les nouvelles publications parues. Disponible en ligne et aussi une fois par mois par email.

#### **Electropedia - [www.electropedia.org](http://www.electropedia.org)**

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 21 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 16 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

#### **Glossaire IEC - [std.iec.ch/glossary](http://std.iec.ch/glossary)**

67 000 entrées terminologiques électrotechniques, en anglais et en français, extraites des articles Termes et Définitions des publications IEC parues depuis 2002. Plus certaines entrées antérieures extraites des publications des CE 37, 77, 86 et CISPR de l'IEC.

#### **Service Clients - [webstore.iec.ch/csc](http://webstore.iec.ch/csc)**

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: [sales@iec.ch](mailto:sales@iec.ch).

# INTERNATIONAL STANDARD

# NORME INTERNATIONALE

---

**Residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles**

**Dispositif de détection à courant différentiel résiduel continu (DD-CDC) à utiliser pour la charge en mode 3 des véhicules électriques**

INTERNATIONAL  
ELECTROTECHNICAL  
COMMISSION

COMMISSION  
ELECTROTECHNIQUE  
INTERNATIONALE

---

ICS 29.120.50

ISBN 978-2-8322-5424-0

**Warning! Make sure that you obtained this publication from an authorized distributor.  
Attention! Veuillez vous assurer que vous avez obtenu cette publication via un distributeur agréé.**

## CONTENTS

FOREWORD.....	11
INTRODUCTION.....	13
1 Scope.....	14
2 Normative references .....	15
3 Terms, definitions and symbols .....	15
3.1 Definitions relating to RDC-DD design .....	16
3.2 Symbols.....	16
4 Classification RDC-DD (RDC-MD, RDC-PD).....	16
4.1 RDC-DDs are classified according to the type of construction .....	16
4.1.1 RDC-MD .....	17
4.1.2 RDC-PD .....	18
4.2 According to the number of poles.....	18
4.3 According to the method of connection .....	18
4.4 According to the type of terminals.....	18
4.5 According to range of ambient air temperature.....	18
5 Characteristics of RDC-DDs .....	18
5.1 Summary of characteristics.....	18
5.2 Rated quantities and other characteristics.....	19
5.2.1 Rated voltage ( $U_n$ ) .....	19
5.2.2 Rated current ( $I_n$ ) .....	19
5.2.3 Rated DC residual operating current ( $I_{\Delta dc}$ ) .....	19
5.2.4 Rated DC residual non-operating current ( $I_{\Delta ndc}$ ) .....	19
5.2.5 Rated frequency .....	19
5.2.6 Rated making and breaking capacity ( $I_m$ ) .....	19
5.3 Standard and preferred values.....	20
5.3.1 Preferred values of rated voltage ( $U_n$ ) .....	20
5.3.2 Preferred values of rated current ( $I_n$ ).....	20
5.3.3 Standard value of rated DC residual operating current ( $I_{\Delta dc}$ ) .....	20
5.3.4 Standard value of DC residual non-operating current ( $I_{\Delta ndc}$ ) .....	20
5.3.5 Preferred values of rated frequency .....	20
5.3.6 Minimum value of the rated making and breaking capacity ( $I_m$ ) .....	20
5.3.7 Minimum value of the rated residual making and breaking capacity ( $I_{\Delta m}$ ) .....	21
5.3.8 Standard and preferred values of the rated conditional short-circuit current ( $I_{nc}$ ) .....	21
5.3.9 Standard values of the rated conditional residual short-circuit current ( $I_{\Delta c}$ ) .....	21
5.3.10 Limiting values of break time .....	21
5.3.11 Standard value of rated impulse withstand voltage ( $U_{imp}$ ) .....	22
5.4 Coordination with short-circuit protective devices (SCPDs) .....	22
5.4.1 General .....	22
5.4.2 Rated conditional short-circuit current ( $I_{nc}$ ) .....	23
5.4.3 Rated conditional residual short-circuit current ( $I_{\Delta c}$ ).....	23
6 Marking and other product information.....	23
7 Standard conditions for operation in service and for installation.....	25
7.1 Standard conditions .....	25
7.2 Conditions of installation.....	25

7.3	Pollution degree.....	25
8	Requirements for construction and operation.....	26
8.1	Mechanical design .....	26
8.1.1	General .....	26
8.1.2	Mechanism .....	26
8.1.3	Clearances and creepage distances .....	27
8.1.4	Screws, current-carrying parts and connections.....	32
8.1.5	Terminals for external conductors .....	33
8.2	Protection against electric shock.....	35
8.3	Dielectric properties .....	36
8.4	Temperature rise .....	36
8.4.1	Temperature rise limits .....	36
8.4.2	Ambient air temperature .....	36
8.5	Operating characteristic .....	36
8.6	Electrical endurance .....	36
8.7	Performance at short-circuit currents .....	37
8.8	Resistance to mechanical shock and impact .....	37
8.9	Resistance to heat .....	37
8.10	Resistance to abnormal heat and to fire .....	37
8.11	Test device .....	37
8.12	Behaviour of RDC-DDs in the case of current surges caused by impulse voltages .....	38
8.13	Reliability.....	38
8.14	Electromagnetic compatibility (EMC).....	38
8.15	Behaviour of the correct operation for three- and four- pole RDC-DD powered on two poles only.....	38
9	Tests .....	38
9.1	General.....	38
9.2	Test conditions .....	39
9.3	Test of indelibility of marking .....	40
9.4	Test of reliability of screws, current-carrying parts and connections .....	41
9.5	Tests of reliability of screw-type terminals for external copper conductors .....	42
9.6	Verification of protection against electric shock.....	43
9.7	Test of dielectric properties.....	44
9.7.1	Resistance to humidity.....	44
9.7.2	Insulation resistance of the main circuit .....	44
9.7.3	Dielectric strength of the main circuit .....	45
9.7.4	Insulation resistance and dielectric strength of auxiliary circuits .....	46
9.7.5	Secondary circuit of detection transformers .....	46
9.7.6	Capability of control circuits connected to the main circuit withstanding high DC voltages due to insulation measurements.....	47
9.7.7	Verification of impulse withstand voltages (across clearances and across solid insulation) .....	47
9.8	Test of temperature-rise.....	50
9.8.1	Ambient air temperature .....	50
9.8.2	Test procedure .....	51
9.8.3	Measurement of the temperature of parts .....	51
9.8.4	Temperature rise of a part .....	51
9.9	Verification of the operating characteristics.....	51
9.9.1	Test circuit and test procedure.....	51

9.9.2	Verification of correct operation of RDC-DDs with smooth DC residual current.....	52
9.9.3	Verification of non-operating time for alternating residual currents.....	54
9.10	Verification of mechanical and electrical endurance .....	54
9.10.1	General test conditions .....	54
9.10.2	Test procedure .....	55
9.10.3	Condition of the RDC-DD after test.....	55
9.11	Verification of the behaviour of the RDC-DD under short-circuit conditions .....	55
9.11.1	List of the short-circuit tests.....	55
9.11.2	Short-circuit tests .....	56
9.12	Verification of resistance to mechanical shock and impact .....	63
9.12.1	Mechanical shock .....	63
9.12.2	Mechanical impact.....	63
9.13	Test of resistance to heat.....	66
9.14	Test of resistance to abnormal heat and to fire .....	67
9.15	Verification of the trip-free mechanism .....	67
9.15.1	General test conditions .....	67
9.15.2	Test procedure .....	68
9.16	Verification of the operation of the test device at the limits of rated voltage.....	68
9.17	Verification of the correct operation in case of three- and four- pole RDC-DDs powered on two poles only .....	68
9.18	Verification of behaviour of RDC-DDs in case of current surges caused by impulse voltages .....	68
9.18.1	Current surge test for all RDC-DDs (0,5 µs/100 kHz ring wave test).....	68
9.18.2	Verification of behaviour at surge currents up to 3 000 A (8/20 µs surge current test).....	69
9.19	Verification of reliability.....	69
9.19.1	General .....	69
9.19.2	Climatic test .....	70
9.19.3	Test with temperature of 40 °C .....	71
9.20	Verification of ageing of electronic components .....	72
9.21	Electromagnetic compatibility (EMC).....	72
9.21.1	Tests covered by the present document.....	72
9.21.2	Additional tests.....	72
9.22	Test of resistance to rusting.....	73
Annex A (normative) Test sequence and number of samples to be submitted for testing purposes .....		95
A.1	Test sequences .....	95
A.2	Number of samples to be submitted for full test procedure .....	96
A.3	Number of samples to be submitted for simplified test procedures in case of submitting simultaneously a range of RDC-DDs of the same fundamental design.....	97
Annex B (normative) Determination of clearances and creepage distances .....		100
B.1	General.....	100
B.2	Orientation and location of a creepage distance.....	100
B.3	Creepage distances where more than one material is used.....	100
B.4	Creepage distances split by floating conductive part .....	100
B.5	Measurement of creepage distances and clearances .....	100
Annex C (normative) Arrangement for the detection of the emission of ionized gases during short-circuit tests .....		105

Annex D (normative) Routine tests.....	108
D.1 General.....	108
D.2 Tripping test.....	108
D.3 Electric strength test.....	108
D.4 Performance of the test device.....	108
Annex E (informative) Methods for determination of short-circuit power-factor .....	109
Annex F (informative) Examples of terminal designs .....	110
Annex G (informative) Correspondence between ISO and AWG copper conductors .....	113
Annex H (informative) SCPDs for short-circuit tests .....	114
H.1 Introductory remark.....	114
H.2 Silver wires .....	114
H.3 Fuses .....	114
H.4 Other means .....	114
Annex I (normative) Particular requirements for RDC-DDs with screwless type terminals for external copper conductors .....	115
I.1 Scope .....	115
I.2 Normative references.....	115
I.3 Definitions .....	115
I.4 Classification .....	116
I.5 Characteristics of RDC-DDs.....	116
I.6 Marking and other product information .....	116
I.7 Standard conditions for operation in service and for installation .....	116
I.8 Requirements for construction and operation .....	116
I.8.1 General .....	116
I.8.2 Connection or disconnection of conductors.....	117
I.8.3 Dimensions of connectable conductors .....	117
I.8.4 Connectable cross-sectional areas .....	117
I.8.5 Insertion and disconnection of conductors .....	118
I.8.6 Design and construction of terminals .....	118
I.8.7 Resistance to ageing .....	118
I.9 Tests .....	118
I.9.1 General .....	118
I.9.2 Test of reliability of screwless terminals.....	118
I.9.3 Tests of reliability of terminals for external conductors: mechanical strength .....	119
I.9.4 Cycling test .....	120
I.10 Reference documents .....	122
Annex J (normative) Particular requirements for RDC-DDs with flat quick-connect terminations.....	124
J.1 Scope .....	124
J.2 Normative references.....	124
J.3 Definitions .....	124
J.4 Classification .....	125
J.5 Characteristics of RDC-DDs.....	125
J.6 Marking and other product information .....	125
J.7 Standard conditions for operation in service and for installation .....	125
J.8 Requirements for construction and operation .....	125
J.8.1 General .....	125
J.8.2 Clearances and creepage distances (see Annex B) .....	125

J.8.3	Terminals for external conductors .....	126
J.9	Tests .....	126
J.9.1	General .....	126
J.9.2	Mechanical overload-force .....	126
J.10	Reference documents .....	130
Annex K (normative) Specific requirements for RDC-DDs with screw-type terminals for external untreated aluminium conductors and with aluminium screw-type terminals for use with copper or with aluminium conductors .....		131
K.1	Scope .....	131
K.2	Normative references.....	131
K.3	Definitions .....	131
K.4	Classification .....	132
K.5	Characteristics of RDC-DDs.....	132
K.6	Marking and other product information .....	132
K.7	Standard conditions for operation in service and for installation .....	132
K.8	Requirements for construction and operation .....	132
K.9	Tests .....	133
K.9.1	General .....	133
K.9.2	Test conditions .....	135
K.9.3	Current cycling test.....	135
Annex L (informative) Examples of RDC-DD according to classification 4.1 based on construction .....		141
Annex M (normative) Additional requirements and tests for RDC-MDs according to classification 4.1.1.2 consisting of an RDC-M-Unit designed to be assembled on site together to a separate switching protective device .....		143
M.1	Scope .....	143
M.2	Normative references.....	143
M.3	Terms and definitions.....	143
M.4	Classification .....	143
M.4.1	According to the type of construction .....	143
M.5	Characteristics.....	143
M.5.1	Summary of characteristics.....	143
M.6	Marking and other product information .....	144
M.6.1	Manufacturer's name or trademark .....	144
M.6.2	Marking .....	144
M.6.3	Instructions for assembly and operation.....	145
M.7	Constructional requirements .....	145
M.7.1	General .....	145
M.7.2	Degree of protection .....	145
M.7.3	Mechanical requirements .....	145
M.7.4	Electrical compatibility .....	145
M.8	Type tests and verifications .....	146
M.8.1	Tests on RDC-M-units .....	146
M.8.2	Tests on assembled RDC-MDs .....	146
M.8.3	Verification of marking and constructional requirements of RDC-MDs.....	146
M.9	Routine tests on the RDC-M-unit.....	146
Annex N (normative) Additional requirements and tests for RDC-MDs according to classification 4.1.1.3 consisting of an RDC-MD module electrically coupled to a separate switching device or a protective device.....		147
N.1	Scope .....	147

N.2	Normative references.....	147
N.3	Terms and definitions.....	147
N.4	Classification .....	147
N.4.1	According to the type of construction .....	147
N.5	Characteristics.....	147
N.5.1	Summary of characteristics.....	147
N.6	Marking and other product information .....	148
N.6.1	Marking of the RDC-M Module.....	148
N.6.2	Instructions for assembly and operation.....	148
N.7	Constructional requirements .....	149
N.7.1	Degree of protection .....	149
N.7.2	Electrical compatibility .....	149
N.8	Type tests and verifications .....	149
N.8.1	Tests on RDC-M-module .....	149
N.8.2	Verification of marking and constructional requirements of RDC-M-module .....	150
N.8.3	Verification of behaviour in case of disconnection of the external detection module .....	150
N.9	Routine tests on the RDC-M-module .....	150
Annex O (normative) RDC-PDs with integrated DC, pulsating DC (type A) and 6 mA DC detection, evaluation and mechanical switching in one unit according to classification 4.1.2 .....		151
O.1	Scope .....	151
O.2	Normative references.....	151
O.3	Terms and definitions.....	151
O.4	Classification .....	151
O.4.1	According to the type of construction .....	151
O.5	Characteristics.....	151
O.6	Marking and other product information .....	151
O.7	Requirements for construction and operation .....	152
O.7.1	General .....	152
O.7.2	Operating characteristic.....	152
O.8	Tests .....	152
O.8.1	Testing according to the RCD standard .....	152
O.8.2	Testing according to this document.....	152
O.9	Routine tests on the RDC-PD.....	153
Bibliography.....		154
Figure 1 – Standard test finger (9.6) .....		75
Figure 2 – Test circuit for the verification of operating characteristics (9.9.3) .....		75
Figure 3 – Test circuit for the verification of the correct operation in case of smooth direct current .....		76
Figure 4 – Test circuit for 2-pole RDC-DD to verify the correct operation in case of residual pulsating direct currents which may result from rectifying circuits supplied from two phases .....		77
Figure 5 – Tests circuit for 3-pole and 4-pole RDC-DD to verify the correct operation in case of residual pulsating direct currents which may result from rectifying circuits supplied from three phases.....		77
Figure 6 – Typical diagram for all short circuit tests .....		78
Figure 7 – Detail of impedances $Z$ , $Z_1$ and $Z_2$ .....		78

Figure 8 – Test circuit for endurance test according to 9.10 .....	79
Figure 9 – Informative wave shape of inrush current for tests according to 9.10.....	80
Figure 10 – Test apparatus for the verification of the minimum $I^2t$ and $I_p$ values to be withstood by the RDC-DD (9.11.2.1 a)) .....	82
Figure 11 – Mechanical shock test apparatus (9.12.1) .....	83
Figure 12 – Mechanical impact test apparatus (9.12.2.1) .....	84
Figure 13 – Striking element for pendulum impact test apparatus (9.12.2.1) .....	85
Figure 14 – Mounting support for sample for mechanical impact test (9.12.2.1) .....	86
Figure 15 – Example of mounting and unenclosed RDC-DD for mechanical impact test (9.12.2.1).....	87
Figure 16 – Example of mounting of panel mounting type RDC-DD for the mechanical impact test (9.12.2.1) .....	88
Figure 17 – Application of force for mechanical test of rail mounted RDC-DD (9.12.2.2) .....	89
Figure 18 – Ball-pressure test apparatus (9.13.2) .....	89
Figure 19 – Current ring wave 0,5 $\mu$ s/100 kHz .....	90
Figure 20 – Test circuit for the ring wave test at RDC-DDs .....	90
Figure 21 – Stabilizing period for reliability test (9.19.1.3).....	91
Figure 22 – Reliability test cycle (9.19.1.3) .....	92
Figure 23 – Example for test circuit for verification of ageing of electronic components (9.20).....	93
Figure 24 – Surge current impulse 8/20 $\mu$ s.....	93
Figure 25 – Test circuit for the surge current test at RDC-DDs.....	94
Figure 26 – Example of calibration record for short-circuit test (9.11.2.1 j) ii)).....	94
Figure B.1 – Examples of methods of measuring creepage distances and clearances.....	104
Figure C.1 – Test arrangement .....	106
Figure C.2 – Grid.....	107
Figure C.3 – Grid circuit.....	107
Figure F.1 – Examples of pillar terminals .....	110
Figure F.2 – Examples of screw terminals.....	111
Figure F.3 – Examples of stud terminals .....	111
Figure F.4 – Examples of saddle terminals .....	112
Figure F.5 – Examples of lug terminals .....	112
Figure I.1 – Connecting samples.....	120
Figure I.2 – Examples of screwless-type terminals.....	122
Figure J.1 – Example of position of the thermocouple for measurement of the temperature-rise .....	127
Figure J.2 – Dimensions of male tabs .....	128
Figure J.3 – Dimensions of round dimple detents.....	129
Figure J.4 – Dimensions of rectangular dimple detents .....	129
Figure J.5 – Dimensions of hole detents .....	129
Figure J.6 – Dimensions of female connectors .....	130
Figure K.1 – General arrangement for the test .....	139
Figure K.2 – Detail of Figure K.1.....	139
Figure K.3 – Detail of Figure K.1.....	140
Figure K.4 – Detail of Figure K.1.....	140

Figure K.5 – Detail of Figure K.1 .....	140
Figure K.6 – Detail of Figure K.1 .....	140
Figure L.1 – RDC-MD according to classifications 4.1.1.1 .....	141
Figure L.2 – RDC-MD according to classification 4.1.1.2 (mechanically coupled) .....	141
Figure L.3 – RDC-MD according to classification 4.1.1.3 (electrically coupled).....	142
Figure L.4 – RDC-PD according to classification 4.1.2 .....	142
Figure M.1 – Symbol to be marked.....	144
Table 1 – Preferred values of rated voltages .....	20
Table 2 – Maximum values of break times for residual direct currents .....	22
Table 3 – Minimum values of non-operating time for alternating residual currents (RMS values).....	22
Table 4 – Rated impulse withstand voltage as a function of the nominal voltage of the installation .....	22
Table 5 – Standard conditions for operation in service .....	25
Table 6 – Minimum clearances and creepage distances.....	29
Table 7 – Connectable cross-sections of copper conductors for screw-type terminals .....	33
Table 8 – Temperature rise values .....	36
Table 9 – List of type tests.....	39
Table 10 – Test copper conductors corresponding to the rated currents.....	40
Table 11 – Screw thread diameters and applied torques .....	41
Table 12 – Pulling forces .....	42
Table 13 – Test voltage of auxiliary circuits .....	46
Table 14 – Test voltage for verification of impulse withstand voltage .....	49
Table 15 – Tests to be made to verify the behaviour of RDC-DDs under short-circuit conditions .....	56
Table 16 – Minimum values of $I^2t$ and $I_p$ .....	57
Table 17 – Power factors for short-circuit tests .....	59
Table 18 – Tests covered by this document .....	72
Table 19 – Test to be carried out according to IEC 61543.....	73
Table 20 – Tripping current ranges for RDC-DDs in case of pulsating DC current .....	80
Table 21 – Key of letters symbols for all figures .....	81
Table A.1 – Test sequences.....	95
Table A.2 – Number of samples for full test procedure .....	97
Table A.3 – Number of samples for simplified test procedure .....	99
Table G.1 – Correspondence between ISO and AWG copper conductors.....	113
Table H.1 – Indication of silver wire diameters as a function of rated currents and short-circuit currents .....	114
Table I.1 – Connectable conductors .....	117
Table I.2 – Cross-sections of copper conductors connectable to screwless-type terminals.....	118
Table I.3 – Pull forces .....	119
Table J.1 – Informative table on colour code of female connectors in relationship with the cross section of the conductor.....	125
Table J.2 – Overload test forces .....	126

Table J.3 – Dimensions of tabs .....	127
Table J.4 – Dimensions of female connectors .....	130
Table K.1 – Marking for terminals .....	132
Table K.2 – Connectable cross-sections of aluminium conductors for screw-type terminals.....	133
Table K.3 – List of tests according to the material of conductors and terminals .....	134
Table K.4 – Connectable conductors and their theoretical diameters .....	134
Table K.5 – Cross sections ( $S$ ) of aluminium test conductors corresponding to the rated currents .....	135
Table K.6 – Test conductor length .....	136
Table K.7 – Equalizer and busbar dimensions.....	136
Table K.8 – Test current as a function of rated current.....	138
Table K.9 – Example of calculation for determining the average temperature deviation D ...	138
Table N.1 – List of required marking and other product information.....	148
Table O.1 – List of type tests according to this document and their applicability.....	153

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## RESIDUAL DIRECT CURRENT DETECTING DEVICE (RDC-DD) TO BE USED FOR MODE 3 CHARGING OF ELECTRIC VEHICLES

### FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

International Standard IEC 62955 has been prepared by subcommittee 23E: Circuit-breakers and similar equipment for household use, of IEC technical committee 23: Electrical accessories.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
23E/1042/FDIS	23E/1047/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The following differing practices of a less permanent nature exist in the countries indicated below.

Specific rules in several countries are introduced in:

- Clause 5.3.8.1, Table 4 and 8.1.2 Note 1,
- Annex I Note 1,
- Annex J Note 1,
- Annex J Note 1 and in Clause 8.3.2.

In this standard, the following print types are used:

- Requirements proper: in roman type.
- *Test specifications: in italic type.*
- Explanatory matter: in smaller roman type.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "<http://webstore.iec.ch>" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

## INTRODUCTION

According to IEC 60364-7-722, each connecting point is protected by its own RCD of at least type A, having a rated residual operating current not exceeding 30 mA.

Protective measures against DC fault currents need to be taken. The appropriate measures are:

- RCD type B, or
- RCD type A and appropriate equipment that ensures the switching of the supply in case of a DC fault current above 6 mA.

It is the purpose of this document to specify this type of detecting equipment to ensure that the proper functionality of RCDs type A or type F is not impaired by DC residual currents above 6 mA.

## **RESIDUAL DIRECT CURRENT DETECTING DEVICE (RDC-DD) TO BE USED FOR MODE 3 CHARGING OF ELECTRIC VEHICLES**

### **1 Scope**

This International Standard applies to residual direct current detecting devices (RDC-DD) for permanently connected AC electric vehicle charging stations (mode 3 charging of electric vehicles, according to IEC 61851-1 and IEC 60364-7-722), hereafter referred to as RDC-MD (residual direct current monitoring device) or RDC-PD (residual direct current protective device), for rated voltages not exceeding 440 V AC with rated frequencies of 50 Hz, 60 Hz or 50/60 Hz and rated currents not exceeding 125 A.

NOTE 1 This document can also be used as guidance for devices for voltages up to and including 690 V AC 50 Hz, 60 Hz or 50/60 Hz, at a rated current not exceeding 250 A.

RDC-DDs are intended to remove or initiate removal of the supply to the EV in cases where a smooth residual direct current equal to or above 6 mA is detected.

NOTE 2 The value of 6 mA for smooth residual direct current was chosen to prevent impairing the correct operation of an upstream type A or type F RCD.

This document covers two different classes of residual direct current detecting device (RDC-DD) to be used for mode 3 charging of electric vehicles (see classification in 4.1):

- RDC-MD (monitoring devices), and
- RDC-PD (protective devices).

This document applies to devices performing simultaneously the functions of detection of the residual direct current, of comparison of the value of this current with the residual operating value, and initiating the opening of the circuit when the residual direct current exceeds 6 mA.

RDC-PDs according to this document are suitable for isolation.

RDC-DDs are intended to be used for single-phase or multi-phase circuits in TN-, TT- and IT-systems.

RDC-DDs are intended to be used within the fixed installation.

RDC-DDs are intended to be used in AC circuits only. RDC-DDs according to this document are not intended for bilateral power flow between electric vehicle and fixed installation.

For RDC-DDs with integrated AC, pulsating DC and 6 mA DC detection, evaluation and mechanical switching in one unit, Annex O applies.

For RDC-MD consisting of a RDC-M-unit with a mechanical interface to a separate protective device (circuit breaker or RCD), Annex M applies.

For RDC-MD consisting of a RDC-M-module with separated residual current detection and evaluation with an electrical interface to a switching device (e.g. contactor) or a protective device (circuit breaker or RCD), Annex N applies.