

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Resistance welding equipment –
Part 1: Safety requirements for design, manufacture and installation**

**Matériels de soudage par résistance –
Partie 1: Exigences de sécurité pour la conception, la fabrication et l'installation**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2015 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
Fax: +41 22 919 03 00
info@iec.ch
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

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 - www.iec.ch/searchpub

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

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

The world's leading online dictionary of electronic and electrical terms containing 20 000 terms and definitions in English and French, with equivalent terms in 15 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

IEC Glossary - std.iec.ch/glossary

65 000 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

If you wish to give us your feedback on this publication or need further assistance, please contact the Customer Service Centre: csc@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

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 - www.iec.ch/searchpub

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

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

Le premier dictionnaire en ligne de termes électroniques et électriques. Il contient 20 000 termes et définitions en anglais et en français, ainsi que les termes équivalents dans 15 langues additionnelles. Egalement appelé Vocabulaire Electrotechnique International (IEV) en ligne.

Glossaire IEC - std.iec.ch/glossary

65 000 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

Si vous désirez nous donner des commentaires sur cette publication ou si vous avez des questions contactez-nous: csc@iec.ch.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



**Resistance welding equipment –
Part 1: Safety requirements for design, manufacture and installation**

**Matériels de soudage par résistance –
Partie 1: Exigences de sécurité pour la conception, la fabrication et l'installation**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 25.160

ISBN 978-2-8322-3084-8

**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

CONTENTS	2
FOREWORD	6
1 Scope	8
2 Normative references	8
3 Terms and definitions	9
4 Environmental conditions	11
5 Tests	11
5.1 Test condition	11
5.2 Measuring instruments	11
5.3 Type tests	12
5.4 Routine tests	12
6 Protection against electric shock	12
6.1 General	12
6.2 Insulation	13
6.2.1 General	13
6.2.2 Clearances	13
6.2.3 Creepage distances	14
6.2.4 Insulation resistance	16
6.2.5 Dielectric strength	16
6.2.6 Welding circuit touch current	18
6.2.7 Liquid cooling	18
6.3 Protection against electric shock in normal service (direct contact)	19
6.3.1 General	19
6.3.2 Rated no-load voltage at the output	19
6.3.3 Protection provided by barriers or the enclosure	20
6.3.4 Capacitors	21
6.3.5 Automatic discharge of input capacitors	21
6.3.6 Protective conductor current under normal condition	22
6.3.7 Touch current in normal condition	22
6.4 Protection against electric shock in case of a fault condition (indirect contact)	22
6.4.1 General	22
6.4.2 Protective provisions for welding circuit	24
6.4.3 Internal conductors and connections	36
6.4.4 Touch current in fault condition	36
6.4.5 DC resistance welding equipment operating at mains frequency	37
6.4.6 DC resistance welding equipment operating at medium frequency	37
6.4.7 Continuity of the protective bonding circuit	37
6.5 Additional user requirements	38
6.6 Supply voltage	38
6.7 Conductors of the welding circuit	38
7 Thermal requirements	38
7.1 Heating test	38
7.1.1 Test conditions	38
7.1.2 Tolerances of the test parameters	39
7.1.3 Beginning of the heating test	40

7.1.4	Duration of the test	40
7.2	Temperature measurement	40
7.2.1	Measurements conditions	40
7.2.2	Surface temperature sensor.....	40
7.2.3	Resistance	40
7.2.4	Embedded temperature sensor	41
7.2.5	Determination of the ambient temperature (t_a)	41
7.2.6	Determination of cooling liquid temperature (t_a).....	41
7.2.7	Recording of temperatures	41
7.3	Limits of temperature rise	42
7.3.1	Windings	42
7.3.2	External surfaces.....	42
7.3.3	Other components	44
7.4	Protection from thermal hazards in normal service (direct contact).....	44
7.4.1	General	44
7.4.2	Identification of hot surfaces	44
7.4.3	Protection provided by insulation or other barriers	45
7.4.4	Protection provided by supplemental cooling	45
8	Abnormal operation	45
8.1	General requirements	45
8.2	Stalled fan test.....	45
8.3	Cooling system failure.....	45
8.4	Overload test	46
9	Provisions against mechanical hazards	46
9.1	General.....	46
9.2	Risk analysis.....	46
9.2.1	General	46
9.2.2	Ready-to-use equipment as in delivery state.....	46
9.2.3	Equipment not ready to use as in delivery state	46
9.2.4	Equipment not ready for use and designed to be incorporated in more complex equipment.....	47
9.3	Measures	47
9.3.1	Minimum measures.....	47
9.3.2	Additional measures	47
9.4	Conformity of components	48
9.5	Starting for manual operated equipment.....	48
10	Instructions and markings.....	49
10.1	Instructions	49
10.2	Markings	49
10.3	Marking of terminals	49
Annex A (informative)	Nominal voltages of supply networks.....	51
Annex B (normative)	Construction of supply circuit terminals	52
B.1	Size of terminals	52
B.2	Spacings between supply circuit terminals	52
B.3	Connections at the terminals.....	53
B.4	Construction of the terminals	53
B.5	Fixing of the terminals.....	53
Annex C (normative)	Touch current measurement in fault condition	54

Annex D (informative) Extrapolation of temperature to time of shutdown	56
Annex E (informative) Example of risk analysis and safety level requirement	57
E.1 General.....	57
E.2 Monitored hazards	57
E.3 General measures	57
E.4 Typical hazards by type of equipment	57
E.4.1 General	57
E.4.2 Spot welding.....	58
E.4.3 Projection welding	59
E.4.4 Seam welding	60
E.4.5 Butt welding.....	60
Annex F (informative) Indirect contact protection in resistance welding equipment.....	61
F.1 Protection against indirect contact by automatic disconnection of the supply	61
F.1.1 General	61
F.1.2 TN system	61
F.1.3 TT systems.....	62
F.2 Automatic disconnection of supply in single phase a.c. current equipment	63
F.2.1 TN system	63
F.2.2 TT systems.....	64
F.3 Automatic disconnection of supply in d.c. current equipment operating at medium frequency (inverter equipment)	64
F.3.1 TN system	64
F.3.2 TT systems.....	65
Bibliography.....	68
Figure 1 – Measurement of welding circuit touch current.....	18
Figure 2 – Measurement of rms values	19
Figure 3 – Example of metal screen between windings of the supply circuit and the welding circuit.....	26
Figure 4 – Example of protective conductor connected directly to the welding circuit (single-spot, a.c. current equipment).....	27
Figure 5 – Example of protective conductor connected directly to welding circuits (multi-spot, a.c. current equipment)	27
Figure 6 – Example of protective conductor connected directly to welding circuits (medium-frequency equipment).....	28
Figure 7 – Example of protective conductor connected to welding circuits through impedances	29
Figure 8 – Example of protective conductor connected to welding circuits through auto-inductances	30
Figure 9 – Example of protective conductor connected to welding circuits through auto-inductances	30
Figure 10 – Example of current operated RCD (a.c. current equipment).....	31
Figure 11 – Example of current operated RCD (medium-frequency equipment).....	32
Figure 12 – Example of current operated residual current device and voltage relay	33
Figure 13 – Example of current operated residual current device and safety-voltage relay	34
Figure 14 – Example of safety voltage relay.....	35
Figure C.1 – Measuring network for weighted touch current	54

Figure C.2 – Diagram for touch current measurement on fault condition at operating temperature for single-phase connection of appliances other than those of class II	55
Figure C.3 – Diagram for touch current measurement on fault condition for three-phase four-wire system connection of appliances other than those of class II	55
Figure E.1 – Structure of a mounted machine	58
Figure E.2 – Structure of a hand-held welding gun	58
Figure E.3 – Structure of projection welding machinery	59
Figure E.4 – Structure of seam welding machinery	60
Figure E.5 – Structure of butt welding machinery	60
Figure F.1 – Principle illustration of insulation fault	61
Figure F.2 – Illustrations of TN systems	62
Figure F.3 – Illustrations of TT systems	63
Figure F.4 – Typical fault current	65
Figure F.5 – Time-to-voltage reference curve	67
Table 1 – Minimum clearances for overvoltage category III	13
Table 2 – Minimum creepage distances	15
Table 3 – Insulation resistance	16
Table 4 – Dielectric test voltages	17
Table 5 – Minimum distance through insulation	25
Table 6 – Continuity of the protective bonding circuit	37
Table 7 – Limits of temperature rise for windings	42
Table 8 – Limits of temperature rise for external surfaces of hand-held equipment	43
Table 9 – Limits of temperature rise for external surfaces of hand-guided equipment	43
Table 10 – Limits of temperature rise for external surfaces of fixed equipment	43
Table B.1 – Range of conductor dimensions to be accepted by the supply circuit terminals	52
Table B.2 – Spacing between supply circuit terminals	53

INTERNATIONAL ELECTROTECHNICAL COMMISSION

RESISTANCE WELDING EQUIPMENT –

Part 1: Safety requirements for design, manufacture and installation

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 62135-1 has been prepared by IEC technical committee 26: Electric welding.

This second edition cancels and replaces the first edition published in 2008. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

- creepage distances for pollution degree 4 are no longer valid (see Table 2);
- insulation requirements for Class II equipment are defined (see Table 3);
- dielectric test voltage interpolation restriction lower limit is changed to 220 V and interpolation for control and welding circuit is clarified (see Table 4);
- maximum temperature for insulation systems are reviewed in accordance with current edition of IEC 60085 (see Table 7);

- marking of terminals is defined (see 10.3);
- table for nominal voltages of supply networks is changed adopting Table B.2 of IEC 60664-1:2007 in place of the Table B.1 values referenced in the previous edition to provide for equipment to be connected to both earthed and unearthed systems. The change impacts the creepage and clearance distance requirements for some supply voltage ratings (see Annex A);
- touch current in fault condition are measurement procedures are clarified (see 6.4.4 and Annex C).
- welding circuit touch current is defined (see 6.2.6);
- touch current in normal condition are clarified and moved in protection against electric shock in normal service (see 6.3.7);
- heating test conditions are clarified (see 7.1.1);
- external surface temperature rise limitation is changed (see 7.3.2).

This bilingual version (2016-01) corresponds to the monolingual English version, published in 2015-05.

The text of this standard is based on the following documents:

FDIS	Report on voting
26/558/FDIS	26/570/RVD

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

The French version of this standard has not been voted upon.

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

The list of all the parts of the IEC 62135 series, under the general title *Resistance welding equipment*, can be found on the IEC website.

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

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

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

RESISTANCE WELDING EQUIPMENT –

Part 1: Safety requirements for design, manufacture and installation

1 Scope

This part of IEC 62135 applies to equipment for resistance welding and allied processes and includes single and multiple welding stations which may be manually or automatically loaded and/or started.

This part of IEC 62135 covers stationary and portable equipment.

This part of IEC 62135 specifies electrical safety requirements for design, manufacture and installation. It does not cover all non-electrical safety requirements (e.g. noise, vibration).

This part of IEC 62135 does not include electromagnetic compatibility (EMC) requirements, which are included in IEC 62135-2.

To comply with this standard, all safety risks involved in loading, feeding, operating and unloading the equipment, where applicable, should be assessed and the requirements of related standards should be observed.

2 Normative references

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

IEC 60204-1:2005, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

IEC 60364-4-41:2005, *Low-voltage electrical installations – Part 4-41: Protection for safety – Protection against electric shock*

IEC 60364-6, *Low-voltage electrical installations – Part 6: Verification*

IEC 60417-DB:2011¹, *Graphical symbols for use on equipment*

IEC 60445, *Basic and safety principles for man-machine interface, marking and identification – Identification of equipment terminals, conductor terminations and conductors*

IEC 60529, *Degrees of protection provided by enclosures (IP Code)*

IEC 60664-1:2007, *Insulation coordination for equipment within low-voltage systems – Part 1: Principles, requirements and tests*

¹ “DB” refers to the IEC on-line database.