

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Arc welding equipment –
Part 1: Welding power sources**

**Matériel de soudage à l'arc –
Partie 1: Sources de courant de soudage**



THIS PUBLICATION IS COPYRIGHT PROTECTED
Copyright © 2017 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 It also gives information on projects, replaced and withdrawn publications.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 16 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 16 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



**Arc welding equipment –
Part 1: Welding power sources**

**Matériel de soudage à l'arc –
Partie 1: Sources de courant de soudage**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 25.160.30

ISBN 978-2-8322-3854-7

**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.....	9
1 Scope.....	11
2 Normative references	11
3 Terms and definitions	12
3.1 General terms.....	12
3.2 Terms related to battery systems	21
4 Environmental conditions.....	24
5 Tests.....	25
5.1 Test conditions	25
5.2 Measuring instruments.....	25
5.3 Conformity of components	25
5.4 Type tests.....	26
5.5 Routine tests.....	26
6 Protection against electric shock	27
6.1 Insulation.....	27
6.1.1 General	27
6.1.2 Clearances	28
6.1.3 Creepage distances.....	30
6.1.4 Insulation resistance.....	32
6.1.5 Dielectric strength.....	32
6.2 Protection against electric shock in normal service (direct contact).....	34
6.2.1 Protection provided by the enclosure.....	34
6.2.2 Capacitors.....	34
6.2.3 Automatic discharge of supply circuit capacitors	35
6.2.4 Isolation of the welding circuit.....	35
6.2.5 Welding circuit touch current	35
6.2.6 Touch current in normal condition.....	36
6.3 Protection against electric shock in case of a fault condition (indirect contact).....	37
6.3.1 Protective provisions	37
6.3.2 Isolation between windings of the supply circuit and the welding circuit.....	37
6.3.3 Internal conductors and connections.....	37
6.3.4 Additional requirements for plasma cutting systems.....	38
6.3.5 Movable coils and cores	38
6.3.6 Touch current in fault condition.....	38
7 Thermal requirements.....	39
7.1 Heating test	39
7.1.1 Test conditions	39
7.1.2 Tolerances of the test parameters	39
7.1.3 Duration of test.....	40
7.2 Temperature measurement	40
7.2.1 Measurement 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 air temperature	41

7.2.6	Recording of temperatures	41
7.3	Limits of temperature rise	41
7.3.1	Windings, commutators and slip-rings.....	41
7.3.2	External surfaces.....	42
7.3.3	Other components	43
7.4	Loading test.....	43
7.5	Commutators and slip-rings	44
8	Thermal protection.....	44
8.1	General requirements	44
8.2	Construction	44
8.3	Location.....	44
8.4	Operating capacity.....	44
8.5	Operation.....	45
8.6	Resetting	45
8.7	Indication.....	45
9	Abnormal operation	45
9.1	General requirements	45
9.2	Stalled fan test.....	46
9.3	Short circuit test.....	46
9.4	Overload test	47
10	Connection to the supply network	47
10.1	Supply voltage	47
10.2	Multi-supply voltage	47
10.3	Means of connection to the supply circuit.....	47
10.4	Marking of terminals	48
10.5	Protective circuit.....	48
10.5.1	Continuity requirement.....	48
10.5.2	Type test	49
10.5.3	Routine test.....	49
10.6	Cable anchorage.....	50
10.7	Inlet openings.....	51
10.8	Supply circuit on/off switching device.....	51
10.9	Supply cables	52
10.10	Supply coupling device (attachment plug)	52
11	Output.....	53
11.1	Rated no-load voltage.....	53
11.1.1	Rated no-load voltage for use in environments with increased risk of electric shock	53
11.1.2	Rated no-load voltage for use in environments without increased risk of electric shock	53
11.1.3	Rated no-load voltage for the use with mechanically held torches with increased protection for the operator	53
11.1.4	Rated no-load voltage for special processes for example plasma cutting	53
11.1.5	Additional requirements	54
11.1.6	Measuring circuits	55
11.2	Type test values of the conventional load voltage	56
11.2.1	Manual metal arc welding with covered electrodes.....	56
11.2.2	Tungsten inert gas.....	56
11.2.3	Metal inert/active gas and flux cored arc welding	56

11.2.4	Submerged arc welding	56
11.2.5	Plasma cutting	56
11.2.6	Plasma welding	56
11.2.7	Plasma gouging	56
11.2.8	Additional requirements	56
11.3	Mechanical switching devices used to adjust output	57
11.4	Welding circuit connections	57
11.4.1	Protection against unintentional contact	57
11.4.2	Location of coupling devices	57
11.4.3	Outlet openings	57
11.4.4	Three-phase multi-operator welding transformer	57
11.4.5	Marking	58
11.4.6	Connections for plasma cutting torches	58
11.5	Power supply to external devices connected to the welding circuit	58
11.6	Auxiliary power supply	58
11.7	Welding cables	59
12	Control circuits	59
12.1	General requirement	59
12.2	Isolation of control circuits	59
12.3	Working voltages of remote control circuits	59
13	Hazard reducing device	60
13.1	General requirements	60
13.2	Types of hazard reducing devices	60
13.2.1	Voltage reducing device	60
13.2.2	Switching device for AC to DC	60
13.3	Requirements for hazard reducing devices	60
13.3.1	Disabling the hazard reducing device	60
13.3.2	Interference with operation of a hazard reducing device	61
13.3.3	Indication of satisfactory operation	61
13.3.4	Fail to a safe condition	61
14	Mechanical provisions	61
14.1	General requirements	61
14.2	Enclosure	61
14.2.1	Enclosure materials	61
14.2.2	Enclosure strength	62
14.3	Handling means	62
14.3.1	Mechanised handling	62
14.3.2	Manual handling	62
14.4	Drop withstand	63
14.5	Tilting stability	63
15	Rating plate	63
15.1	General requirements	63
15.2	Description	64
15.3	Contents	65
15.4	Tolerances	68
15.5	Direction of rotation	68
16	Adjustment of the output	68
16.1	Type of adjustment	68

16.2	Marking of the adjusting device	69
16.3	Indication of current or voltage control	69
17	Instructions and markings	70
17.1	Instructions	70
17.2	Markings	71
Annex A (informative)	Nominal voltages of supply networks	72
Annex B (informative)	Example of a combined dielectric test	73
Annex C (normative)	Unbalanced load in case of AC tungsten inert-gas welding power sources	74
C.1	General	74
C.2	Unbalanced load	74
C.3	Example for an unbalanced load	75
Annex D (informative)	Extrapolation of temperature to time of shutdown	76
Annex E (normative)	Construction of supply circuit terminals	77
E.1	Size of terminals	77
E.2	Connections at the terminals	77
E.3	Construction of the terminals	78
E.4	Fixing of the terminals	78
Annex F (informative)	Cross-reference to non-SI units	79
Annex G (informative)	Suitability of supply network for the measurement of the true r.m.s. value of the supply current	80
Annex H (informative)	Plotting of static characteristics	81
H.1	General	81
H.2	Method	81
H.3	Analysis of the results	81
Annex I (normative)	Test methods for a 10 Nm impact	82
I.1	Pendulum impact hammer	82
I.2	Free fall spherical steel weight	83
Annex J (normative)	Thickness of sheet metal for enclosures	84
Annex K (informative)	Examples of rating plates	87
Annex L (informative)	Graphical symbols for arc welding equipment	94
L.1	General	94
L.2	Use of symbols	94
L.2.1	General	94
L.2.2	Selection of symbols	94
L.2.3	Size of symbols	94
L.2.4	Use of colour	94
L.3	Symbols	95
L.3.1	General	95
L.3.2	Letter symbols	95
L.3.3	Graphical symbols	96
L.4	Examples of combinations of symbols	116
L.5	Examples of control panels	118
Annex M (informative)	Efficiency and idle state power measurement	121
M.1	Measuring efficiency	121
M.2	Measuring idle state power	121
Annex N (normative)	Touch current measurement in fault condition	123

Annex O (normative) Battery-powered welding power sources	128
O.1 General.....	128
O.4 Environmental conditions	129
O.5 Tests	129
O.5.1 Test conditions	129
O.5.3 Conformity of components	130
O.6 Protection against electric shock.....	131
O.6.1 Insulation.....	131
O.6.2 Protection against electric shock in normal service	132
O.7 Thermal requirements	133
O.7.1 Heating test	133
O.7.2 Temperature measurement.....	134
O.7.4 Loading test.....	134
O.7.201 Normal charging of lithium-ion systems.....	134
O.8 Thermal protection	135
O.8.1 General requirements	135
O.8.4 Operating capacity.....	135
O.9 Abnormal operation.....	135
O.9.1 General requirements	135
O.9.2 Stalled fan test	136
O.9.3 Short circuit test	136
O.9.4 Overload test.....	136
O.9.201 Welding power source – abnormal conditions	136
O.9.202 Welding circuit components – abnormal conditions	137
O.9.203 Lithium-ion charging systems – abnormal conditions	137
O.9.204 Lithium-ion battery short circuit.....	138
O.9.205 Batteries other than lithium-ion – overcharging	139
O.9.206 Battery pack disconnection.....	139
O.9.207 General purpose batteries	139
O.10 Connection to the supply network	139
O.10.5 Protective circuit.....	140
O.10.8 Supply circuit on/off switching device.....	140
O.14 Mechanical provisions.....	141
O.14.1 General requirements	141
O.14.2 Enclosure	141
O.14.4 Drop withstand	141
O.15 Rating plate	142
O.15.3 Contents.....	142
O.17 Instructions and markings	144
O.17.1 Instructions.....	144
O.17.2 Markings.....	145
Bibliography.....	146

Figure 1 – Example of insulation configuration for Class I equipment.....	28
Figure 2 – Measurement of welding circuit touch current.....	36
Figure 3 – Measurement of touch current in normal condition	36
Figure 4 – Measurement of r.m.s. values	55
Figure 5 – Measurement of peak values.....	55

Figure 6 – Principle of the rating plate	64
Figure B.1 – Combined high-voltage transformers	73
Figure C.1 – Voltage and current during AC tungsten inert-gas welding	74
Figure C.2 – Unbalanced voltage during AC tungsten inert-gas welding	75
Figure C.3 – AC welding power source with unbalanced load	75
Figure I.1 – Test set-up	82
Figure K.1 – Single-phase transformer	87
Figure K.2 – Three-phase rotating frequency converter	88
Figure K.3 – Subdivided rating plate: single-/three-phase transformer rectifier	89
Figure K.4 – Engine-generator-rectifier	90
Figure K.5 – Single-/three-phase inverter type	91
Figure K.6 – Battery powered welding power source with integral battery	92
Figure K.7 – Battery powered welding power source with detachable / separable battery	93
Figure L.1 – Input voltage power switch	119
Figure L.2 – Arc force control potentiometer	119
Figure L.3 – Remote receptacle and selector switches	119
Figure L.4 – Terminals with inductance selector for MIG/MAG welding	119
Figure L.5 – Process switch (MMA, TIG, MIG)	120
Figure L.6 – Selector switch on AC/DC equipment	120
Figure L.7 – Panel indicator lights (overheat, fault, arc striking, output voltage)	120
Figure L.8 – Setting pulsing parameters using digital display	120
Figure N.1 – Measuring network for weighted touch current	123
Figure N.2 – Diagram for touch current measurement on fault condition at operating temperature for single-phase connection of appliances other than those of class II	125
Figure N.3 – Diagram for touch current measurement on fault condition for three-phase four-wire system connection of appliances other than those of class II	127
Figure O.1 – Marking of battery voltage class B electric components	145
Table 1 – Minimum clearances for overvoltage category III	29
Table 2 – Minimum creepage distances	31
Table 3 – Insulation resistance	32
Table 4 – Dielectric test voltages	33
Table 5 – Minimum distance through insulation	37
Table 6 – Temperature limits for windings, commutators and slip-rings	42
Table 7 – Temperature limits for external surfaces	43
Table 8 – Cross-section of the output short-circuit conductor	46
Table 9 – Current and time requirements for protective circuits	49
Table 10 – Minimum cross-sectional area of the external protective copper conductor	49
Table 11 – Verification of continuity of the protective circuit	50
Table 12 – Pull	51
Table 13 – Summary of allowable rated no-load voltages	54
Table 14 – Hazard reducing device requirements	60

Table E.1 – Range of conductor dimensions to be accepted by the supply circuit terminals..... 77

Table F.1 – Cross-reference for mm² to American wire gauge (AWG)..... 79

Table I.1 – Angle of rotation θ to obtain 10 Nm impact 82

Table I.2 – Mass of the free fall weight and height of the free fall..... 83

Table J.1 – Minimum thickness of sheet metal for steel enclosures 85

Table J.2 – Minimum thickness of sheet metal for enclosures of aluminium, brass or copper 86

Table L.1 – Letters used as symbols 95

Withdrawn

INTERNATIONAL ELECTROTECHNICAL COMMISSION

ARC WELDING EQUIPMENT –**Part 1: Welding power sources**

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 60974-1 has been prepared by IEC technical committee 26: Electric welding.

This fifth edition cancels and replaces the fourth edition published in 2012 and constitutes a technical revision.

The significant changes with respect to the previous edition are the following:

- improvement of Figure 1 (6.1.1);
- modification of Table 3 (6.1.4);
- description of energy efficiency measurements in Annex M;
- inclusion of battery supplied welding power sources in the scope. Requirements therefore are described in Annex O.

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

FDIS	Report on voting
26/610/FDIS	26/613/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.

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

In this standard, the following print types are used:

- conformity statements: in *italic* type.
- terms defined in Clause 3: in **bold** type.

A list of all parts of the IEC 60974 series can be found, under the general title *Arc welding equipment*, 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.