

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Low-voltage switchgear and controlgear –
Part 1: General rules

ITeH STANDARD PREVIEW
(standards.iteh.ai)

Appareillage à basse tension –
Partie 1: Règles générales

[IEC 60947-1:2020](#)

<https://standards.iteh.ai/catalog/standards/sist/2c788cc6-9ab2-45c9-8aef-9541344a529d/iec-60947-1-2020>



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2020 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
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 corrigendum or an amendment might have been published.

IEC publications search - 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 It also gives information on projects, replaced and withdrawn publications.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

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

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: sales@iec.ch.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22,000 terminological entries 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

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.

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.

Recherche de publications IEC -

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

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

Service Clients - 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.

Electropedia - www.electropedia.org

Le premier dictionnaire d'électrotechnologie en ligne au monde, avec plus de 22 000 articles terminologiques 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

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.

INTERNATIONAL STANDARD

NORME INTERNATIONALE



Low-voltage switchgear and controlgear –
Part 1: General rules

STANDARD PREVIEW
(standards.iteh.ai)

Appareillage à basse tension – IEC 60947-1:2020

Partie 1: Règles générales
<https://standards.iteh.ai/catalog/standards/sist/2c788cc6-9ab2-45c9-8aef-9541344a529d/iec-60947-1-2020>

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 29.130.20

ISBN 978-2-8322-8026-3

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.....	13
INTRODUCTION.....	16
1 Scope.....	17
2 Normative references	17
3 Terms, definitions, symbols and reference clauses	21
3.1 General.....	21
3.2 Alphabetical index of definitions.....	21
3.3 General terms and definitions	26
3.4 Switching devices	30
3.5 Parts of switching devices.....	33
3.6 Operation of switching devices.....	39
3.7 Characteristic quantities	44
3.8 Tests	54
3.9 Ports.....	54
3.10 Symbols and references clauses for characteristics described in this document.....	54
4 Classification.....	55
5 Characteristics	55
5.1 Summary of the characteristics.....	55
5.2 Type of equipment	56
5.3 Rated and limiting values for the main circuit	56
5.3.1 Rated voltages.....	56
5.3.2 Currents	57
5.3.3 Rated frequency	58
5.3.4 Rated duties	58
5.3.5 Characteristics under normal load and overload conditions (see 8.2.4).....	60
5.3.6 Short-circuit characteristics	61
5.3.7 Pole impedance of the switching device (Z)	62
5.4 Utilization category	62
5.5 Control circuits.....	62
5.5.1 Electrically or electronically controlled circuits	62
5.5.2 Air-supply control circuits (pneumatic or electro-pneumatic)	63
5.6 Auxiliary circuits.....	63
5.7 Relays and releases	63
5.8 Co-ordination with short-circuit protective devices (SCPD).....	63
6 Product information	63
6.1 Nature of information	63
6.2 Marking.....	64
6.3 Instructions for installation, operation and maintenance, decommissioning and dismantling.....	65
6.4 Environmental information	66
7 Normal service, mounting and transport conditions.....	66
7.1 Normal service conditions	66
7.1.1 Ambient air temperature	66
7.1.2 Altitude	67
7.1.3 Atmospheric conditions.....	67

7.1.4	Shock and vibration	68
7.2	Conditions during transport and storage.....	68
7.3	Mounting.....	68
8	Constructional and performance requirements	68
8.1	Constructional requirements	68
8.1.1	General	68
8.1.2	Materials	69
8.1.3	Current-carrying parts and their connections	70
8.1.4	Clearances and creepage distances	70
8.1.5	Actuator.....	70
8.1.6	Indication of the contact position	71
8.1.7	Additional requirements for equipment suitable for isolation.....	71
8.1.8	Terminals	73
8.1.9	Additional requirements for equipment provided with a neutral pole	74
8.1.10	Provisions for protective earthing.....	74
8.1.11	Dedicated enclosures for equipment.....	76
8.1.12	Degrees of protection of enclosed equipment	76
8.1.13	Conduit pull-out, torque and bending with metallic conduits	76
8.2	Performance requirements.....	77
8.2.1	Operating conditions.....	77
8.2.2	Temperature rise.....	78
8.2.3	Dielectric properties.....	79
8.2.4	Ability to make, carry and break currents under no-load, normal load and overload conditions.....	82
8.2.5	Ability to make, carry and break short-circuit currents.....	83
8.2.6	Pole impedance.....	83
8.2.7	Leakage currents of equipment suitable for isolation.....	84
8.3	Electromagnetic compatibility (EMC).....	84
8.3.1	General	84
8.3.2	Immunity.....	84
8.3.3	Emission.....	85
9	Tests	85
9.1	Kinds of test.....	85
9.1.1	General	85
9.1.2	Type tests.....	85
9.1.3	Routine tests	86
9.1.4	Sampling tests.....	86
9.1.5	Special tests.....	86
9.2	Compliance with constructional requirements.....	87
9.2.1	General	87
9.2.2	Test of materials to abnormal heat and fire	87
9.2.3	Equipment	87
9.2.4	Enclosures for equipment	87
9.2.5	Mechanical and electrical properties of terminals.....	88
9.2.6	Verification of the effectiveness of indication of the main contact position of equipment suitable for isolation	90
9.2.7	Vacant.....	93
9.2.8	Conduit pull-out test, torque test and bending test with metallic conduits	93
9.2.9	Test of earth continuity for protective earth.....	94

9.3	Performance	94
9.3.1	Test sequences	94
9.3.2	General test conditions	94
9.3.3	Performance under no-load, normal load and overload conditions	96
9.3.4	Performance under short-circuit conditions	109
9.4	Tests for EMC	114
9.4.1	General	114
9.4.2	Immunity	114
9.4.3	Emission	115
Annex A (informative) Harmonisation of utilization categories for low-voltage switchgear and controlgear		146
Annex B (Vacant)		149
Annex C (normative) Degrees of protection of enclosed equipment		150
C.1	General	150
C.2	Object	150
C.3	Definitions	150
C.4	Designation	150
C.5	Degrees of protection against access to hazardous parts and against ingress of solid foreign objects indicated by the first characteristic numeral	150
C.6	Degrees of protection against ingress of water indicated by the second characteristic numeral	150
C.7	Degrees of protection against access to hazardous parts indicated by the additional letter	151
C.8	Supplementary letters	151
C.9	Examples of designations with IP Code	151
C.10	Marking	151
C.11	General requirements for tests	151
C.12	Tests for protection against access to hazardous parts indicated by the first characteristic numeral	152
C.13	Tests for protection against ingress of solid foreign objects indicated by the first characteristic numeral	152
C.14	Tests for protection against water indicated by second characteristic numeral	153
C.14.1	Test means	153
C.14.2	Test conditions	153
C.14.3	Acceptance conditions	153
C.15	Tests for protection against access to hazardous parts indicated by additional letter	153
C.16	Summary of responsibilities of relevant technical committees	153
Annex D (informative) Examples of clamping units and relationship between clamping unit and connecting device		157
D.1	Clamping unit in a connecting device	157
D.2	Examples of clamping units	158
Annex E (informative) Description of a method for adjusting the load circuit		165
Annex F (informative) Determination of short-circuit power-factor or time-constant		167
F.1	Determination of short-circuit power-factor	167
F.1.1	Method I – Determination from DC component	167
F.1.2	Method II – Determination with pilot generator	167
F.2	Determination of short-circuit time-constant (oscillographic method)	168
Annex G (informative) Measurement of creepage distances and clearances		169

G.1	Basic principles.....	169
G.2	Use of ribs	169
Annex H (informative)	Correlation between the nominal voltage of the supply system and the rated impulse withstand voltage of equipment	176
Annex J (informative)	Items subject to agreement between manufacturer and user.....	178
Annex K (normative)	Procedure to determine reliability data for electromechanical devices used in functional safety applications	179
K.1	General.....	179
K.1.1	Overview	179
K.1.2	Object.....	179
K.1.3	General requirements	179
K.2	Terms, definitions and symbols	180
K.2.1	Terms and definitions	180
K.2.2	Symbols	181
K.3	Method based on durability test results	181
K.3.1	General method.....	181
K.3.2	Test requirements.....	181
K.3.3	Number of samples.....	181
K.3.4	Characterization of a failure mode	181
K.3.5	Weibull modelling	182
K.3.6	Useful life and upper limit of failure rate.....	184
K.3.7	Reliability data.....	185
K.4	Data information	185
K.5	Example.....	186
K.5.1	Test results.....	186
K.5.2	Weibull distribution and median rank regression	186
K.5.3	Useful life and failure rate.....	187
Annex L (normative)	Terminal marking and distinctive number	189
L.1	General.....	189
L.2	Terminal marking of impedances (alphanumeric).....	189
L.2.1	Coils	189
L.2.2	Electromagnetic releases.....	190
L.2.3	Interlocking electromagnets	190
L.2.4	Indicating light devices	191
L.3	Terminal marking of contact elements for switching devices with two positions (numerical).....	191
L.3.1	Contact elements for main circuits (main contact elements).....	191
L.3.2	Contact elements for auxiliary circuit (auxiliary contact elements).....	191
L.4	Terminal marking of overload protection devices.....	193
L.5	Distinctive number	194
L.6	Marking of terminals for external associated electronic circuit components, contacts and complete devices	194
L.6.1	Marking of terminals for external associated electronic circuit components and contacts	194
L.6.2	Marking of terminals for external complete devices.....	197
Annex M (normative)	Flammability test	200
M.1	Hot wire ignition test (HWI)	200
M.1.1	Test sample.....	200
M.1.2	Description of test apparatus	200

M.1.3	Conditioning	201
M.1.4	Test procedure	201
M.2	Arc ignition test (AI)	201
M.2.1	Test sample	201
M.2.2	Description of test apparatus	201
M.2.3	Conditioning	202
M.2.4	Test procedure	202
M.3	HWI and AI requirements	203
Annex N (normative)	Requirements and tests for equipment with protective separation	204
N.1	General	204
N.2	Terms and definitions	204
N.3	Requirements	206
N.3.1	General	206
N.3.2	Dielectric requirements	206
N.3.3	Construction requirements	206
N.4	Tests	207
N.4.1	General	207
N.4.2	Dielectric tests	207
N.4.3	Examples of constructional measures	207
Annex O (informative)	Environmentally conscious design	209
O.1	General	209
O.2	Object	209
O.3	Terms and definitions	210
O.4	General considerations	212
O.5	Fundamentals requirements of environmentally conscious design (ECD)	215
O.6	Environmentally conscious design process (ECD process)	216
O.6.1	General	216
O.6.2	Process steps of ECD	216
O.7	Tools for including ECD in product design and development	217
O.8	Relevant ISO technical committees	217
Annex P (informative)	Terminal lugs for low voltage switchgear and controlgear connected to copper conductors	218
Annex Q (normative)	Special tests – Tests for environmental categories	219
Q.1	General	219
Q.2	Classification of equipment	219
Q.3	Tests	220
Q.3.1	General test conditions	220
Q.3.2	Test sequences	220
Annex R (normative)	Application of the metal foil for dielectric testing on accessible parts during operation or adjustment	225
R.1	General	225
R.2	Object	225
R.3	Definition of zones	226
R.3.1	General	226
R.3.2	Application of metal foil on accessible parts during normal operation or adjustment	226
Annex S (normative)	Digital inputs and outputs	233
S.1	General	233
S.2	Terms and definitions	233

S.3	Functional requirements.....	233
S.3.1	Rated values and operating ranges	233
S.3.2	Digital I/Os	234
S.4	Verification of input/output requirements	242
S.4.1	General	242
S.4.2	Verification of digital inputs.....	243
S.4.3	Verification of digital outputs.....	243
S.4.4	Behaviour of the equipment	244
S.5	General information to be provided by the manufacturer	245
S.5.1	Information on digital inputs (current sinking).....	245
S.5.2	Information on digital outputs for alternating currents (current sourcing)	245
S.5.3	Information on digital outputs for direct current (current sourcing).....	246
S.6	Digital input standard operating range equations.....	246
Annex T (normative)	Extended functions within electronic overload relays	248
T.1	Object.....	248
T.1.1	General	248
T.1.2	Ground/earth fault detection function	248
T.2	Terms and definitions.....	248
T.3	Classification of electronic overload relays.....	249
T.4	Types of relays with ground/earth fault detection function	249
T.5	Performance requirements.....	249
T.5.1	Limits of operation of ground/earth fault electronic overload relays	249
T.5.2	Limits of operation of ground/earth fault current sensing electronic relays Type CII(-A and -B)	250
T.5.3	Limits of operation of voltage asymmetry relays.....	250
T.5.4	Limits of operation of phase reversal relays	250
T.5.5	Limits of operation of current imbalance relays	250
T.5.6	Limits of operation of over-voltage relays and releases.....	250
T.6	Tests	251
T.6.1	Limits of operation of ground/earth fault current sensing electronic relays Types CI and CII (-A and -B)	251
T.6.2	Verification of inhibit function of ground/earth fault current sensing electronic relays Type CII (-A and -B)	251
T.6.3	Current asymmetry relays.....	251
T.6.4	Voltage asymmetry relays.....	251
T.6.5	Phase reversal relays	251
T.6.6	Over-voltage relays	252
T.7	Routine and sampling tests	252
Annex U (informative)	Examples of control circuit configurations	253
U.1	External control device.....	253
U.1.1	Definition	253
U.1.2	Diagrammatic representation of an external control device	253
U.1.3	Parameters of an external control device	253
U.2	Control circuit configurations.....	254
U.2.1	Equipment with external control supply	254
U.2.2	Equipment with several external control supplies	254
U.2.3	Equipment with bus interface (may be combined with other circuit configurations).....	255
Annex V (informative)	Power management with switchgear and controlgear for electrical energy efficiency.....	256

V.1	General.....	256
V.2	Object.....	256
V.3	Terms and definitions.....	256
V.4	Electrical energy efficiency and safety	257
V.5	Principles on electrical energy efficiency (system approach).....	257
V.5.1	General	257
V.5.2	Strategy of energy management	257
V.5.3	Power management with automation and control	257
V.6	Energy efficiency application.....	258
V.6.1	Saving of semiconductor losses.....	258
V.6.2	Power factor correction.....	258
V.6.3	Load shedding.....	258
V.6.4	Motor control for fixed speed applications.....	258
Annex W (normative)	Procedure to establish material declaration	259
W.1	General.....	259
W.2	Object.....	259
W.3	Reference document.....	259
W.4	Terms and definitions.....	259
W.5	Material declaration requirements	260
W.5.1	General reporting requirements	260
W.5.2	Additional reporting requirements	261
W.6	Example of material declaration made according to W.5	261
Annex X (normative)	Co-ordination between circuit-breaker or CPS and another short-circuit protective device associated in the same circuit	267
X.1	General.....	267
X.2	Object.....	267
X.3	General requirements for the co-ordination of a circuit-breaker or CPS with another SCPD.....	268
X.3.1	General considerations	268
X.3.2	Take-over current (I_B)	268
X.3.3	Behaviour of C_1 in association with another SCPD	268
X.4	Type and characteristics of the associated SCPD	268
X.5	Verification of selectivity	269
X.5.1	General	269
X.5.2	Consideration of selectivity by desk study.....	269
X.5.3	Selectivity determined by test.....	270
X.6	Verification of back-up protection.....	271
X.6.1	Determination of the take-over current.....	271
X.6.2	Verification of back-up protection.....	271
X.6.3	Tests for verification of back-up protection	271
X.6.4	Results to be obtained	272
Bibliography.....		278
Figure 1 – Test equipment for flexion test (see 9.2.5.3 and Table 5)		131
Figure 2 – Gauges of form A and form B (see 9.2.5.5.2 and Table 7).....		131
Figure 3 – Diagram of the test circuit for the verification of making and breaking capacities of a single-pole equipment on single-phase AC or on direct current (see 9.3.3.5.2).....		132

Figure 4 – Diagram of the test circuit for the verification of making and breaking capacities of a two-pole equipment on single-phase AC or on direct current (see 9.3.3.5.2)	133
Figure 5 – Diagram of the test circuit for the verification of making and breaking capacities of a three-pole equipment (see 9.3.3.5.2)	134
Figure 6 – Diagram of the test circuit for the verification of making and breaking capacities of a four-pole equipment (see 9.3.3.5.2)	135
Figure 7 – Schematic illustration of the recovery voltage across contacts of the first phase to clear under ideal conditions (see 9.3.3.5.2, item e)).....	136
Figure 8 – Diagram of a load circuit adjustment method	137
Figure 9 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a single-pole equipment on single-phase AC or on direct current (see 9.3.4.1.2)	138
Figure 10 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a two-pole equipment on single-phase AC or on direct current (see 9.3.4.1.2)	139
Figure 11 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a three-pole equipment (see 9.3.4.1.2).....	140
Figure 12 – Diagram of the test circuit for the verification of short-circuit making and breaking capacities of a four-pole equipment (see 9.3.4.1.2)	141
Figure 13 – Example of short-circuit making and breaking test record in the case of a single-pole equipment on single-phase AC (see 9.3.4.1.8).....	142
Figure 14 – Verification of short-circuit making and breaking capacities on direct current (see 9.3.4.1.8)	143
Figure 15 – Determination of the prospective breaking current when the first calibration of the test circuit has been made at a current lower than the rated breaking capacity (see 9.3.4.1.8, item b)).....	144
Figure 16 – Actuator test force (see 9.2.6.2.1 and Table 17)	145
Figure D.1 – Clamping unit in a connecting device.....	157
Figure D.2 – Screw clamping units	158
Figure D.3 – Pillar clamping units	159
Figure D.4 – Stud clamping units	160
Figure D.5 – Saddle clamping units.....	161
Figure D.6 – Lug clamping units.....	162
Figure D.7 – Mantle clamping units	163
Figure D.8 – Screwless-type clamping units (sketches).....	164
Figure E.1 – Determination of the actual value of the factor γ	166
Figure G.1 – Measurement of ribs	170
Figure G.2 – Creepage distance across the fixed and moving insulation of contact carriers	170
Figure G.3 – Example 1	171
Figure G.4 – Example 2	171
Figure G.5 – Example 3	171
Figure G.6 – Example 4	172
Figure G.7 – Example 5	172
Figure G.8 – Example 6	172
Figure G.9 – Example 7	173
Figure G.10 – Example 8	173

Figure G.11 – Example 9	174
Figure G.12 – Example 10	174
Figure G.13 – Example 11	175
Figure K.1 – Plot of Weibull median rank regression	188
Figure M.1 – Test fixture for hot wire ignition test.....	200
Figure M.2 – Circuit for arc ignition test	202
Figure N.1 – Example of application with component connected between separated circuits	208
Figure O.1 – Conceptual relationship between provisions in product standards and the environmental impacts associated with the product during its life cycle	214
Figure O.2 – Overview of ECD process	215
Figure P.1 – Dimensions	218
Figure R.1 – Operating mechanism outside the enclosure.....	227
Figure R.2 – Application of the metallic foil to operating areas around switch actuator	228
Figure R.3 – Example of finger protected location for hazardous-live-parts in push-button vicinity	229
Figure R.4 – Example I of application of the foil	229
Figure R.5 – Example II of application of the foil	230
Figure R.6 – Example III of application of the foil	230
Figure R.7 – Application of metal foil on holes and grooves	231
Figure R.8 – Operating space for actuation by rotary means	232
Figure S.1 – I/O parameters.....	235
Figure S.2 – <i>U-I</i> operation regions of current-sinking inputs	236
Figure S.3 – Temporary overload waveform for digital AC outputs	239
Figure S.4 – Temporary overload waveform for digital DC outputs	242
Figure T.1 – Test circuit for the verification of the operating characteristic of a ground/earth fault current sensing electronic relay	252
Figure U.1 – Diagrammatic representation of an external control device	253
Figure U.2 – Single supply and control input	254
Figure U.3 – Separate supply and control inputs	254
Figure U.4 – Equipment with several external control supplies	254
Figure U.5 – Equipment with bus interface	255
Figure W.1 – Example of Main and Business information, graphical representation of the XML code.....	263
Figure W.2 – Example of product information, graphical representation of the XML code	264
Figure W.3 – Example of declarable substances information, graphical representation of the XML code.....	265
Figure W.4 – Example of material classes information, graphical representation of the XML code	266
Figure X.1 – Overcurrent co-ordination between a circuit-breaker or CPS and a fuse or back-up protection by a fuse: operating characteristics	273
Figure X.2 – Total selectivity between two circuit-breakers or a circuit-breaker and a CPS	274
Figure X.3 – Back-up protection by a circuit-breaker or CPS – Operating characteristics	275

iteh STANDARD PREVIEW
(standards.iteh.ai)

IEC 60947-1:2020

<https://standards.iteh.ai/catalog/standards/sis/20788cc6-9ab2-45c9-8ac1-700000000000>

Figure X.4 – Example of test circuit for conditional short-circuit breaking capacity tests showing cable connections for a 3-pole circuit-breaker or CPS (C ₁)	276
Figure X.5 – Example of test circuit for the verification of selectivity	277
Table 1 – Nominal cross-sections of round copper conductors and approximate relationship between mm ² and AWG/kcmil sizes (see 8.1.8.2)	116
Table 2 – Temperature-rise limits of terminals (see 8.2.2.2 and 9.3.3.3.4)	117
Table 3 – Temperature-rise limits of accessible parts (see 8.2.2.3 and 9.3.3.3.4).....	117
Table 4 – Tightening torques for the verification of the mechanical strength of screw-type terminals (see 9.2.5.2 and 9.3.2.1)	118
Table 5 – Test values for flexion and pull-out tests for round copper conductors (see 9.2.5.4.1)	119
Table 6 – Test values for pull-out test for flat copper conductors (see 9.2.5.4.2)	119
Table 7 – Maximum conductor cross-sections and corresponding gauges (see 9.2.5.5.1)	120
Table 8 – Relationship between conductor cross-section and diameter	121
Table 9 – Test copper conductors for test currents up to 400 A inclusive (see 9.3.3.3.4).....	122
Table 10 – Test copper conductors for test currents above 400 A and up to 800 A inclusive (see 9.3.3.3.4)	123
Table 11 – Test copper bars for test currents above 400 A and up to 3 150 A inclusive (see 9.3.3.3.4)	123
Table 12 – Impulse withstand test voltages	124
Table 13 – Minimum clearances in air	124
Table 14 – Test voltages across the open contacts of equipment suitable for isolation	125
Table 15 – Minimum creepage distances	125
Table 16 – Values of power-factors and time-constants corresponding to test currents, and ratio <i>n</i> between peak and RMS values of current (see 9.3.4.3, item a)).....	126
Table 17 – Actuator test force (see 9.2.6.2.1)	127
Table 18 – Tolerances on test quantities (see 9.3.4.3, item a))	127
Table 19 – Dielectric test voltage corresponding to the rated insulation voltage	127
Table 20 – Test values for conduit pull-out test (see 9.2.8.2)	128
Table 21 – Test values for conduit bending test (see 9.2.8.3).....	128
Table 22 – Test values for conduit torque test (see 9.2.8.2 and 9.2.8.4)	128
Table 23 – Tests for EMC – Immunity (see 9.4.1).....	129
Table 24 – Acceptance criteria when EM disturbances are present	130
Table 25 – Cross-sectional area of a copper protective conductor.....	130
Table A.1 – Utilization categories used in the IEC 60947 series	146
Table C.1 – IP Codes (1 of 3)	154
Table G.1 – Minimum widths of grooves.....	169
Table H.1 – Correspondence between the nominal voltage of the supply system and the equipment rated impulse withstand voltage, in case of overvoltage protection by surge-arresters according to IEC 60099-1	177
Table K.1 – Failure modes of devices	182
Table K.2 – Example of 15 sorted ascending times to failure of contactors	186
Table K.3 – Example median rank calculation	187

Table M.1 – HWI and AI characteristics for materials necessary to retain current carrying parts in position.....	203
Table M.2 – HWI and AI characteristics for materials other than those covered by Table M.1	203
Table P.1 – Examples of terminal lugs for low voltage switchgear and controlgear connected to copper conductors	218
Table Q.1 – Test sequences (1 of 4)	221
Table S.1 – Rated values and operating ranges of incoming power supply.....	234
Table S.2 – Standard operating ranges for digital inputs (current sinking)	237
Table S.3 – Rated values and operating ranges for current sourcing digital AC outputs	238
Table S.4 – Rated values and operating ranges (direct current) for current-sourcing digital DC outputs	241
Table S.5 – Overload and short-circuit tests for digital outputs.....	244
Table T.1 – Tripping time of ground/earth fault electronic overload relays	249
Table W.1 – Example of main and business information in tabular form	262
Table W.2 – Example of product information in tabular form.....	263
Table W.3 – Example of declarable substances information in tabular form	264
Table W.4 – Example of material classes information in tabular form	266

iTeh STANDARD PREVIEW **(standards.iteh.ai)**

[IEC 60947-1:2020](https://standards.iteh.ai/catalog/standards/sist/2c788cc6-9ab2-45c9-8aef-9541344a529d/iec-60947-1-2020)

<https://standards.iteh.ai/catalog/standards/sist/2c788cc6-9ab2-45c9-8aef-9541344a529d/iec-60947-1-2020>

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –**Part 1: General rules****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.
<http://standards.iteh.ai/catalog/standards/sist/2e788ac6-9ab2-45e0-8a8f-3e33c3e30e0e/iec-60947-1-2020>
- 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 60947-1 has been prepared by subcommittee 121A: Low-voltage switchgear and controlgear, of IEC technical committee 121: Switchgear and controlgear and their assemblies for low voltage.

This sixth edition cancels and replaces the fifth edition published in 2007, Amendment 1:2010 and Amendment 2:2014. This edition constitutes a technical revision.

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

- DC values testing improvement;
- update of EMC tests;
- Annex B deletion;
- update of requirements for environmental tests (Table Q.1);
- improvement of Annex R (new examples);