UL 60947-7-4

STANDARD FOR SAFETY

Low-Voltage Switchgear and Controlgear – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors

UL Standard for Safety for Low-Voltage Switchgear and Controlgear – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors, UL 60947-7-4

First Edition, Dated April 27, 2018

Summary of Topics

This First Edition of ANSI/UL 60947-7-4 specifies requirements for PCB terminal blocks primarily intended for industrial or similar use.

As noted in the Commitment for Amendments statement located on the back side of the title page, UL, CSA, and ANCE are committed to updating this harmonized standard jointly.

The new requirements are substantially in accordance with Proposal(s) on this subject dated May 19, 2017 and December 22, 2017.

No Text on This Page

Association of Standardization and Certification
NMX-J-538/7-4-ANCE
First Edition

CSA Group
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First Edition
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First Edition

Low-Voltage Switchgear and Controlgear – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors

April 27, 2018

This national standard is based on publication IEC 60947-7-4, first edition (2013).

ANSI/UL 60947-7-4-2018

Commitment for Amendments

This standard is issued jointly by the Association of Standardization and Certification (ANCE), the Canadian Standards Association (operating as "CSA Group"), and Underwriters Laboratories Inc. (UL). Comments or proposals for revisions on any part of the standard may be submitted to ANCE, CSA Group, or UL at anytime. Revisions to this standard will be made only after processing according to the standards development procedures of ANCE, CSA Group, and UL. CSA Group and UL will issue revisions to this standard by means of a new edition or revised or additional pages bearing their date of issue. ANCE will incorporate the same revisions into a new edition of the standard bearing the same date of issue as the CSA Group and UL pages.

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This Standard is subject to review within five years from the date of publication, and suggestions for its improvement will be referred to the appropriate committee. The technical content of IEC and ISO publications is kept under constant review by IEC and ISO. To submit a proposal for change, please send the following information to inquires@csagroup.org and include "Proposal for change" in the subject line: Standard designation (number); relevant clause, table, and/or figure number; wording of the proposed change; and rationale for the change.

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This ANSI/UL Standard for Safety consists of the First Edition. The most recent designation of ANSI/UL 60947-7-4 as an American National Standard (ANSI) occurred on April 27, 2018. ANSI approval for a standard does not include the Cover Page, Transmittal Pages, Title Page (front and back), or the Preface. The National Difference Page and IEC Foreword are also excluded from the ANSI approval of IEC-based standards.

Comments or proposals for revisions on any part of the Standard may be submitted to UL at any time. Proposals should be submitted via a Proposal Request in UL's On-Line Collaborative Standards Development System (CSDS) at https://csds.ul.com.

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PREFACE

This is the harmonized ANCE, CSA Group, and UL standard for Low-Voltage Switchgear and Controlgear - Part 7-4: Ancillary Equipment - PCB Terminal Blocks for Copper Conductors. It is the First edition of NMX-J-538/7-4-ANCE, CAN/CSA-C22.2 No. 60947-7-4, and UL 60947-7-4.

This harmonized standard is based on IEC Publication 60947-7-4: Edition 1 (2013), Low-voltage switchgear and controlgear - Part 7-4: Ancillary equipment - PCB terminal blocks for copper conductors, issued August 2013. IEC 60947-7-4 is copyrighted by the IEC.

This harmonized standard was prepared by the Association of Standardization and Certification (ANCE), CSA Group, and Underwriters Laboratories Inc. (UL). The efforts and support of the Technical Harmonization Subcommittee, THSC 121A WG5, of the Council on the Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA), are gratefully acknowledged.

This standard is considered suitable for use for conformity assessment within the stated scope of the standard.

The Mexican Standard was developed by the CT PIE-A from the Comite de Normalizacion de la Asociacion de Normalizacion y Certificacion, A.C., CONANCE, with the collaboration of the manufacturers and users.

This standard was reviewed by the CSA Subcommittee on Terminal Assemblies, under the jurisdiction of the CSA Technical Committee on Industrial Products and the CSA Strategic Steering Committee on Requirements for Electrical Safety, and has been formally approved by the CSA Technical Committee. This standard has been developed in compliance with Standards Council of Canada requirements for National Standards of Canada. It has been published as a National Standard of Canada by CSA Group.

This standard has been approved by the American National Standards Institute (ANSI) as an American National Standard.

Application of Standard

Where reference is made to a specific number of samples to be tested, the specified number is to be considered a minimum quantity.

Note: Although the intended primary application of this standard is stated in its scope, it is important to note that it remains the responsibility of the users of the standard to judge its suitability for their particular purpose.

This is the NMX-J-538/7-4-ANCE standard for Low-Voltage Switchgear and Controlgear - Part 7-4: Ancillary Equipment - PCB Terminal Blocks for Copper Conductors. This NMX-J-538/7-4-ANCE Part 4 is to be used in conjunction with the first edition of NMX-J-538/7-1-ANCE. The requirements for Ancillary Equipment - PCB Terminal Blocks for Copper Conductors are contained in this Part 4 Standard and NMX-J-538/7-1-ANCE. Requirements of this Part 4 Standard, where stated, amend the requirements of NMX-J-538/7-1-ANCE. Where a particular subclause of NMX-J-538/7-1-ANCE is not mentioned in NMX-J-538/7-4-ANCE, the NMX-J-538/7-1-ANCE subclause applies.

This is the CAN/CSA-C22.2 No. 60947-7-4 Standard for Low-Voltage Switchgear and Controlgear — Part 7-4: Ancillary Equipment — PCB Terminal Blocks for Copper Conductors. This CSA Group Part 4 is to be used in conjunction with the first edition of CAN/CSA-C22.2 No. 60947-7-1. The requirements for Ancillary Equipment — PCB Terminal Blocks for Copper Conductors are contained in this Part 4 Standard and CAN/CSA-C22.2 No. 60947-7-1. Requirements of this Part 4 Standard, where stated, amend the

requirements of CAN/CSA-C22.2 No. 60947-7-1. Where a particular subclause of CAN/CSA-C22.2 No. 60947-7-1 is not mentioned in CAN/CSA-C22.2 No. 60947-7-4, the CAN/CSA-C22.2 No. 60947-7-1 subclause applies.

This is the UL standard for Low-Voltage Switchgear and Controlgear - Part 7-4: Ancillary Equipment - PCB Terminal Blocks for Copper Conductors. This UL 60947-7-4, Low-Voltage Switchgear and Controlgear - Part 7-4: Ancillary Equipment - PCB Terminal Blocks for Copper Conductors, is to be used in conjunction with the fourth edition of UL 60947-7-1. The requirements for Ancillary Equipment - PCB Terminal Blocks for Copper Conductors are contained in this Part 4 Standard and UL 60947-7-1. Requirements of this Part 4 Standard, where stated, amend the requirements of UL 60947-7-1. Where a particular subclause of UL 60947-7-1 is not mentioned in UL 60947-7-4, the UL 60947-7-1 subclause applies.

Level of Harmonization

This standard adopts the IEC text with national differences.

This standard is published as an equivalent standard for ANCE, CSA Group and UL.

An equivalent standard is a standard that is substantially the same in technical content, except as follows: Technical national differences are allowed for codes and governmental regulations as well as those recognized as being in accordance with NAFTA Article 905, for example, because of fundamental climatic, geographical, technological, or infrastructural factors, scientific justification, or the level of protection that the country considers appropriate. Presentation is word for word except for editorial changes.

All national differences from the IEC text are included in the ANCE, CSA Group, and UL versions of the standard. While the technical content is the same in each organization's version, the format and presentation may differ.

Reasons for Differences From IEC

National Differences from the IEC are being added in order to address safety and regulatory situations present in the US, Canada, and Mexico.

Interpretations

The interpretation by the standards development organization of an identical or equivalent standard is based on the literal text to determine compliance with the standard in accordance with the procedural rules of the standards development organization. If more than one interpretation of the literal text has been identified, a revision is to be proposed as soon as possible to each of the standards development organizations to more accurately reflect the intent.

IEC Copyright

For ANCE, the text, figures, and tables of International Electrotechnical Commission Publication 60947-7-4, Low-voltage switchgear and controlgear — Part 7-4: Ancillary equipment — PCB terminal blocks for copper conductors, copyright 2013, are used in this standard according to the guidelines provided in the ISO/IEC/POCOSA.

For CSA Group, the text, figures, and tables of International Electrotechnical Commission Publication 60947-7-4, Low-voltage switchgear and controlgear — Part 7-4: Ancillary equipment — PCB terminal blocks for copper conductors, copyright 2013, are used in this standard with the consent of the International Electrotechnical Commission. The IEC Foreword and Introduction are not a part of the requirements of this standard but are included for information purposes only.

NATIONAL DIFFERENCES

National Differences from the text of International Electrotechnical Commission (IEC) Publication 60947-7-4, Low-Voltage Switchgear and Controlgear – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors, copyright 2013, are indicated by notations (differences) and are presented in bold text. The national difference type is included in the body.

There are five types of National Differences as noted below. The difference type is noted on the first line of the National Difference in the standard. The standard may not include all types of these National Differences.

DR – These are National Differences based on the **national regulatory requirements**.

D1 – These are National Differences which are based on **basic safety principles and requirements**, elimination of which would compromise safety for consumers and users of products.

D2 – These are National Differences from IEC requirements based on existing **safety practices**. These requirements reflect national safety practices, where empirical substantiation (for the IEC or national requirement) is not available or the text has not been included in the IEC standard.

DC – These are National Differences based on the **component standards** and will not be deleted until a particular component standard is harmonized with the IEC component standard.

DE – These are National Differences based on **editorial comments or corrections**.

Each national difference contains a description of what the national difference entails. Typically one of the following words is used to explain how the text of the national difference is to be applied to the base IEC text:

Addition / Add - An addition entails adding a complete new numbered clause, subclause, table, figure, or annex. Addition is not meant to include adding select words to the base IEC text.

Modification / Modify - A modification is an altering of the existing base IEC text such as the addition, replacement or deletion of certain words or the replacement of an entire clause, subclause, table, figure, or annex of the base IEC text.

Deletion / Delete - A deletion entails complete deletion of an entire numbered clause, subclause, table, figure, or annex without any replacement text.

INTERNATIONAL ELECTROTECHNICAL COMMISSION

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors

FOREWORD

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International Standard IEC 60947-7-4 has been prepared by subcommittee 17B: Low-voltage switchgear and controlgear, of IEC technical committee 17: Switchgear and controlgear.

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

FDIS	Report on voting
17B/1822/FDIS	17B/1827/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.

A list of all parts in the IEC 60947 series, published under the general title *Low-voltage switchgear and controlgear*, 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 web site 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.

DV.1 DE *Add the following paragraph to the IEC Foreword:*

The numbering system in the standard uses a space instead of a comma to indicate thousands and uses a comma instead of a period to indicate a decimal point. For example, 1 000 means 1,000 and 1,01 means 1.01.

INTRODUCTION

This standard IEC 60947-7-4 for PCB terminal blocks covers not only the terminal block requirements according to IEC 60947-7 series but also takes into account the specifications of connectors according to IEC 61984 as the requirements for both components are highly similar due to equivalent applications.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR – Part 7-4: Ancillary equipment – PCB terminal blocks for copper conductors

DV.2 DC *Modification to Standard Title:*

Replace "PCB terminal blocks for copper conductors" with "PCB terminal blocks for copper and aluminum conductors".

1 General

1.1 Scope

This part of IEC 60947 specifies requirements for PCB terminal blocks primarily intended for industrial or similar use.

Mounting and fixing on the printed circuit board is made by soldering, press-in or equivalent methods to provide electrical and mechanical connection between copper conductors and the printed circuit board.

This standard applies to PCB terminal blocks intended to connect copper conductors, with or without special preparation, having a cross-section between 0,05 mm^2 and 300 mm^2 (AWG 30/600 kcmil), intended to be used in circuits of a rated voltage not exceeding 1 000 V a.c. up to 1 000 Hz or 1 500 V d.c.

NOTE 1 Large cross section terminal blocks are dedicated to specific design of high current PCBs. The range up to 300 mm^2 is kept to cover any possible application. Examples of high current PCBs and PCB terminal blocks are shown in Annex C.

NOTE 2 AWG is the abbreviation of "American Wire Gage" (Gage (US) = Gauge (UK));

kcmil = 1 000 cmil;

1 cmil = 1 circular mil = surface of a circle having a diameter of 1 mil;

1 mil = 1/1 000 inch.

This standard may be used as a guide for special types of PCB terminal blocks with components, such as disconnect units, integrated cartridge fuse-links and the like.

If applicable, in this standard the term "clamping unit" is used instead of "terminal". This is taken into account in case of references to IEC 60947-1.

1.1DV D2 *Modification by adding the following:*

1.1DV.1 This standard also applies to terminal blocks that have insulation piercing or displacement clamping units.

1.1DV.2 The wire range for terminal blocks covered by this standard include 0,051 mm^2 to 300 mm^2 (30 AWG to 600 kcmil) copper conductors and 3,31 mm^2 to 300 mm^2 (12 AWG to 600 kcmil) aluminum conductors. See Annex DVA for aluminum requirements.

In Mexico, 3,31 mm^2 (12 AWG), 5,26 mm^2 (10 AWG), and 8,37 mm^2 (8 AWG) aluminum conductors are not allowed.

1.1DV.3 The voltage range includes up to 1500 Vac and 1500 Vdc.

1.2 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 60068-2-20, *Environmental testing – Part 2-20: Tests – Test T: Test methods for solderability and resistance to soldering heat of devices with leads*

IEC 60352-1, *Solderless connections – Part 1: Wrapped connections – General requirements, test methods and practical guidance*

IEC 60352-2, *Solderless connections – Part 2: Crimped connections – General requirements, test methods and practical guidance*

IEC 60352-3, *Solderless connections – Part 3: Solderless accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-4, *Solderless connections – Part 4: Solderless non-accessible insulation displacement connections – General requirements, test methods and practical guidance*

IEC 60352-5, *Solderless connections – Part 5: Press-in connections – General requirements, test methods and practical guidance*

IEC 60352-6, *Solderless connections – Part 6: Insulation piercing connections – General requirements, test methods and practical guidance*

IEC 60352-7, *Solderless connections – Part 7: Spring clamp connections – General requirements, test methods and practical guidance*

IEC 60512-2-1, *Connectors for electronic equipment – Tests and measurements – Part 2-1: Electrical continuity and contact resistance tests – Test 2a: Contact resistance – Millivolt level method*

IEC 60512-4-1, *Connectors for electronic equipment – Tests and measurements – Part 4-1: Voltage stress tests – Test 4a: Voltage proof*

IEC 60512-5-2, *Connectors for electronic equipment – Tests and measurements – Part 5-2: Current-carrying capacity tests – Test 5b: Current-temperature derating*

IEC 60512-11-7, *Connectors for electronic equipment – Tests and measurements – Part 11-7: Climatic tests – Test 11g: Flowing mixed gas corrosion test*

IEC 60512-11-9, *Connectors for electronic equipment – Tests and measurements – Part 11-9: Climatic tests – Test 11i: Dry heat*

IEC 60512-11-10, *Connectors for electronic equipment – Tests and measurements – Part 11- 10: Climatic tests – Test 11j: Cold*

IEC 60695-2-11, *Fire hazard testing – Part 2-11: Glowing/hot-wire based test methods – Glow-wire flammability test method for end-products*

IEC 60695-2-12, *Fire hazard testing – Part 2-12: Glowing/hot-wire based test methods – Glow-wire flammability index (GWFI) test method for materials*

IEC 60695-2-13, *Fire hazard testing – Part 2-13: Glowing/hot-wire based test methods – Glow-wire ignition temperature (GWIT) test method for materials*

IEC 60947-1:2007, *Low-voltage switchgear and controlgear – Part 1: General rules*; Amendment 1: 2010

IEC 60998-2-3, *Connecting devices for low-voltage circuits for household and similar purposes – Part 2-3: Particular requirements for connecting devices as separate entities with insulation-piercing clamping units*

IEC 60999-1, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 1: General requirements and particular requirements for clamping units for conductors from 0,2 mm^2 up to 35 mm^2 (included)*

IEC 60999-2, *Connecting devices – Electrical copper conductors – Safety requirements for screw-type and screwless-type clamping units – Part 2: Particular requirements for clamping units for conductors above 35 mm^2 up to 300 mm^2 (included)*

IEC 61210, *Connecting devices – Flat quick-connect terminations for electrical copper conductors – Safety requirements*

ISO 6988, *Metallic and other non-organic coatings – Sulfur dioxide test with general condensation of moisture*

1.2DV D1 *Modification to add the following:*

See Annex DVB for standard references.

2 Terms and definitions

For the purposes of this document, the terms and definitions given in IEC 60947-1, as well as the following, apply.

2.1
printed circuit board
PCB
piece of insulating material with fixed metal traces to connect electronic components

Note 1 to entry: Printed circuit boards are typically subdivided according to:

– their structure (e.g. single- and double-sided, multilayers);

– the nature of the base material (e.g. rigid, flexible).

2.2
PCB terminal block
part intended to be mounted on a printed circuit board and carrying one or more mutually insulated contact units and which provides an electrical and mechanical connection between copper conductor and printed circuit board

2.3
rated current
current value assigned by the manufacturer which the PCB terminal block can carry continuously (without interruption) and simultaneously through all its poles connected with the maximum cross-section, preferably at an ambient temperature of 40 °C, without the upper limiting temperature being exceeded

2.4
contact unit
conductive part establishing the connection between printed circuit board and connectable conductor(s)

Note 1 to entry: See Annex A.

2.5
upper limiting temperature
ULT
maximum temperature in the PCB terminal block as outcome (sum) of the ambient temperature and the temperature rise due to current flow, at which the PCB terminal block is intended to be still operable

Note 1 to entry: At ambient temperature = ULT the available temperature rise due to current flow is zero, thus the current carrying capacity of the PCB terminal block is zero.

2.6
lower limiting temperature
LLT
minimum temperature of a PCB terminal block assigned by the manufacturer, at which a PCB terminal block is intended to operate

2.7DV D2 *Add the following definitions to Clause 2:*

2.7DV.1
special preparation (of conductor end)
alteration of the manufactured shape or surface of the conductor to enable it to be connected to the terminal.

2.7DV.2
factory wiring terminal
a terminal intended in the end application to be connected under controlled conditions, usually at a manufacturer's location. Such terminations use prepared or unprepared conductors. Applicable for the United States. In Canada and Mexico, this definition does not apply.

2.7DV.3
insulation piercing or displacement clamping unit
a clamping unit for the connection and possible disconnection of one conductor or the interconnection of two or more conductors, the connection being made by piercing, boring through, cutting through, removing, displacing, or making ineffective in some other manner the insulation of the conductor or conductors without previous stripping.

2.7DV.4
post connector
a connector utilizing a post onto which one or more conductors are secured by means of a tool.

2.7DV.5
SMD
a surface mount device

2.7DV.6
stud-and-nut type connector
a connector in which a conductor can be looped around a stud and retained by a nut or a connector that can retain a conductor that is first terminated in a wire connector.

3 Classification

A distinction is made between various types of PCB terminal blocks, if applicable, as follows:

a) type of clamping unit (see 7.1.1);

b) ability to accept prepared conductors (see 2.3.28 of IEC 60947-1:2007, Amendment 1 (2010));

c) type of electrical contact to the printed circuit board;

d) type of mechanical fastening to the printed circuit board;

e) number of poles;

f) pitch (center to center pin spacing);

g) contact unit with identical or dissimilar clamping units;

h) number of clamping units on each contact unit;

i) service conditions.

3DV.1 D2 *Modification by adding the item j) to the list of types of terminal blocks as follows:*

j) for field and factory wiring or for factory wiring only. In Canada and Mexico this does not apply.

3DV.2 D3 *Modification to add the following:*

In Canada, the general requirements applicable to this Standard are provided in CAN/CSA-C22.2 No. 0.

4 Characteristics

4.1 Summary of characteristics

The characteristics of a PCB terminal block are as follows:

– type of PCB terminal block (see 4.2);

– rated and limiting values (see 4.3).

4.2 Type of PCB terminal block

The following shall be stated:

– type of clamping units (see 7.1.1);

– type of contacting on the printed circuit board;

– number of clamping units.

4.3 Rated and limiting values

4.3.1 Rated voltages

Subclauses 4.3.1.2 and 4.3.1.3 of IEC 60947-1:2007 apply.

4.3.1DV D2 *Modification by adding the following:*

Clause 4.3.1.1 of Table DVB.2, Reference No. 9, applies.

4.3.2 Rated current

Verification of the rated current specified by the manufacturer is made according to 8.4.5.

If an ambient temperature other than 40 °C is used for the definition of the rated current, the manufacturer should state, in the technical documentation, the ambient temperature on which the rating is based, with reference, if appropriate, to the derating curve defined in IEC 60512-5-2, Test 5b.

The derating curve is obtained by applying a reduction factor of 0,8 according to IEC 60512-5-2, Test 5b. If another reduction factor is used, this shall be stated in the technical documentation.

4.3.3 Standard cross-sections

The standard values for cross-sections of copper conductors to be used are given in Table 1.

Table 1 – Standard cross-sections of copper conductors

Metric size ISO	Comparison between AWG/kcmil and metric sizes	
	Size	Equivalent metric area
mm^2	AWG/kcmil	mm^2
0,05	30	0,05
0,08	28	0,08
0,14	26	0,13
0,2	24	0,205
0,34	22	0,324
0,5	20	0,519
0,75	18	0,82
1	–	–
1,5	16	1,3
2,5	14	2,1
4	12	3,3
6	10	5,3
10	8	8,4
16	6	13,3
25	4	21,2
35	2	33,6
50	0	53,5
70	00	67,4
95	000	85
–	0000	107,2
120	250 (kcmil)	127
150	300 (kcmil)	152
185	350 (kcmil)	177
240	500 (kcmil)	253
300	600 (kcmil)	304

4.3.4 Maximum cross-section

The maximum cross-section shall be selected from the standard cross-sections given in Table 1.

4.3.5 Connecting capacity

For PCB terminal blocks with a maximum cross-section between 0,05 mm^2 and 35 mm^2 inclusive, the minimum range contained in Table 2 applies. The conductors may be rigid (solid or stranded) or flexible. The manufacturer shall state the types and the maximum and minimum cross-sections of conductors that can be connected and, if applicable, the number of conductors simultaneously connectable to each clamping unit. The manufacturer shall also state any necessary preparation of the end of the conductor.

4.3.5DV D2 *Modification by adding the following:*

The minimum wire range specified in Table 2 does not apply.

Table 2 – Relationship between maximum cross-section and connecting capacity of PCB terminal blocks

Maximum cross-section		Connecting capacity	
mm^2	AWG/kcmil	mm^2	AWG
0,05	30	0,05	30
0,08	28	0,05 – 0,08	30 – 28
0,14	26	0,05 – 0,08 – 0,14	30 – 28 – 26
0,2	24	0,08 – 0,14 – 0,2	28 – 26 – 24
0,34	22	0,14 – 0,2 – 0,34	26 – 24 – 22
0,5	20	0,2 – 0,34 – 0,5	24 – 22 – 20
0,75	18	0,34 – 0,5 – 0,75	22 – 20 – 18
1	–	0,5 – 0,75 – 1	–
1,5	16	0,75 – 1 – 1,5	20 – 18 – 16
2,5	14	1 – 1,5 – 2,5	18 – 16 – 14
4	12	1,5 – 2,5 – 4	16 – 14 – 12
6	10	2,5 – 4 – 6	14 – 12 – 10
10	8	4 – 6 – 10	12 – 10 – 8
16	6	6 – 10 – 16	10 – 8 – 6
25	4	10 – 16 – 25	8 – 6 – 4
35	2	16 – 25 – 35	6 – 4 –2
50	0	25 – 35 – 50	4 – 2 – 0
70	00	35 – 50 – 70	2 – 0 – 00
95	000	50 – 70 – 95	0 – 00 – 000
–	0000	–	00 – 000 – 0000
120	250	70 – 95 – 120	000 – 0000 – 250
150	300	95 – 120 – 150	0000 – 250 – 300
185	350	120 – 150 – 185	250 – 300 – 350
–	400	–	300 – 350 – 400
240	500	150 – 185 – 240	350 – 400 – 500
300	600	185 – 240 – 300	400 – 500 – 600

4.3.6DV D2 *Addition of Clauses 4.3.6DV.1 – 4.3.6DV.7 to Clause 4.3:*

4.3.6DV.1 Rated current – The manufacturer shall declare the maximum value of current per terminal assembly.

4.3.6DV.2 Rated torque – The tightening torque value or range shall be specified.

4.3.6DV.3 In the United States, a terminal block shall be rated for factory wiring only if applicable. In Canada and Mexico this requirement does not apply.

4.3.6DV.4 Any special wire types such as pre-bonded, pre-tinned, or double tinned wire shall be specified.

4.3.6DV.5 All terminal blocks shall be rated [Prime]Solid[Prime] or [Prime]Stranded[Prime] or both as appropriate.

4.3.6DV.6 A terminal block having insulation piercing or displacement connections shall be rated for specific insulation types.

4.3.6DV.7 A terminal block having screwless-type terminals shall be rated with a nominal strip length.

5 Product information

5.1 Marking

A PCB terminal block shall be marked in a durable and legible manner with the following:

a) the name of the manufacturer or a trade mark by which the manufacturer can be readily identified;

b) a type reference permitting its identification in order to obtain relevant information from the manufacturer or his catalogue.

Very small PCB terminal blocks with a surface which cannot be marked shall be marked only according to a). In those cases all specified information shall be marked on the smallest packing unit.

5.2 Additional information

The following information shall be stated by the manufacturer, if applicable, e.g. in the manufacturer's data sheet or his catalogue or on the packing unit:

a) IEC 60947-7-4, if the manufacturer claims compliance with this standard;

b) the maximum cross-section;

c) the connecting capacity, if different from Table 2, including the number of conductors simultaneously connectable;

d) the rated current and the reduction factor to determine the derating curve if different from 0,8;

NOTE Unless otherwise specified, the rated current is preferably determined on four-pole contact units.

e) the rated insulation voltage (U_i);

f) the rated impulse withstand voltage (U_{imp}), when determined;

g) service conditions, if different from those in Clause 6;

h) special preparation of the end of the conductor.

5.2DV.1 D2 *Modification by adding Clauses 5.2DV.1.1 and 5.2DV.1.2 after item (a):*

5.2DV.1.1 Item (a) does not apply in Canada and the United States.

5.2DV.1.2 In Mexico, replace item (a) with NMX-J-538/7-4-ANCE, if the manufacturer claims compliance with this standard;″

5.2DV.2 D2 *Modification by adding the following items to the list following item (h):*

i) the rated current. See Clause 4.3.6DV.1;

j) the tightening torque. See Clause 4.3.6DV.2. In Canada and Mexico, the tightening torque need not be marked unless the manufacturer specifies a tightening torque;

k) in Canada and the United States, factory wiring only when applicable. See Clause 4.3.6DV.3. In Mexico this does not apply;

l) ″CU″ or ″Copper″ if rated for copper wire only; also see Clause DVA.3.1 for aluminum conductors;

m) special conductor preparation or use of prepared conductors. See Clause 4.3.6DV.4;

n) specific insulation types (insulation displacement/piercing). See Clause 4.3.6DV.6;

o) solid conductors only or stranded conductors only as appropriate. See Clause 4.3.6DV.5;

p) special conductor types. See Clause 4.3.6DV.4;

q) instructions to clearly indicate any rearrangement or adjustment necessary to adapt to various sizes of wires;

r) instructions for proper installation of the wire where the wiring method is not obvious;

s) a nominal strip length for a terminal block having screwless-type terminals. See Clause 4.3.6DV.7;

t) rated operational voltage. See Clause 4.3.1DV.

6 Normal service, mounting and transport conditions

Clause 6 of IEC 60947-1:2007 applies.

6DV D2 *Modification by replacing with the following:*

Refer to standards in accordance with Table DVB.2, Reference No. 9.

7 Constructional and performance requirements

7.1 Constructional requirements

7.1.1 Clamping units

The clamping units shall allow the conductors to be connected by means ensuring that a reliable mechanical linkage and electrical contact is properly maintained.

No contact pressure shall be transmitted through insulating materials other than ceramic, or other material with characteristics not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage of the insulating material.

The corresponding test is under consideration.

Clamping units and connecting methods listed in Table 3 fulfil the requirements of this standard.

7.1.1DV.1 D2 *Modification by replacing with the following: (U.S. and Canada only)*

Refer to standards in accordance with Table DVB.2, Reference No. 9.

Table 3 – Standards for clamping units and connecting methods

Ref.	Clamping units and connecting methods	Reference standards
a)	Screw-type clamping unit	IEC 60999-1 or IEC 60999-2
b)	Screwless-type clamping unit	IEC 60999-1 or IEC 60999-2 or IEC 60352-7
c)	Wrapped connection	IEC 60352-1
d)	Crimped connection	IEC 60352-2
e)	Insulation displacement connection (accessible)	IEC 60352-3 or IEC 60998-2-3
f)	Insulation displacement connection (non accessible)	IEC 60352-4 or IEC 60998-2-3
g)	Press-in connection	IEC 60352-5
h)	Insulation piercing connection	IEC 60352-6 or IEC 60998-2-3
i)	Flat quick-connect termination	IEC 61210
j)	Soldered connection	IEC 60068-2-20 [a]
[a] The test method selected shall be stated in the test report.		
NOTE The relevant standard applies for the preconditioning of prepared conductors.		

7.1.1DV.1A D2 *Addition of the following: (U.S. only)*

In the U.S. for clamping units rated only for factory wiring, only Clause 8.3.3.1 of Part 7-1 is applicable.

In Mexico, all of Clause 7.1.1 applies.

7.1.1DV.2 D2 *Addition of Clauses 7.1.1DV.2.1 through 7.1.1DV.2.2.3:*

7.1.1DV.2.1 Current-carrying parts and their connections

7.1.1DV.2.1.1 A current-carrying part intended for use with copper wire shall be of copper, a copper alloy, or other material suitable for the purpose.

7.1.1DV.2.2 Wiring terminals

7.1.1DV.2.2.1 A wire-binding screw or stud-and-nut type terminal for field wiring may be employed for conductors not larger than 5,3 mm^2 (10 AWG), provided that the application of normal clamping action as intended will not impair the integrity of the joint. See Solid-Wire Tightening Test, Clause 8.3.3.6dv.2 of Part 7-1.

7.1.1DV.2.2.2 A field wiring connector employing a wire-binding screw or stud-and-nut terminal shall be capable of accommodating a three-quarter loop.

7.1.1DV.2.2.3 To determine compliance with 7.1.1DV.2.2, the conditions in (a) and (b) shall be met or, for a solid conductor, the test described in 8.3.3.6dv.2 of Part 7-1 shall be conducted. A terminal for a stranded conductor shall meet conditions described in (a) and (b).

a) The threaded screw or stud shall not have more than 12,6 threads per centimeter and shall not be smaller than 4,2 mm diameter for wire larger than 2,1 mm^2 (14 AWG) and not smaller than 3,5 mm diameter for 14 AWG and smaller wire. A wire-binding screw or stud-and-nut type terminal shall be provided with upturned lugs, a cupped washer, barriers, or other equivalent means to hold the wires in position even if the screw or nut becomes slightly loose.

b) The tapped terminal plate shall not have less than two full threads, and shall be of metal not less than 1,3 mm thick for a wire larger than 14 AWG and not less than 0,76 mm thick 14 AWG or smaller wire. Threads provided by extruding a hole before tapping shall be counted if the thickness of the unextruded metal is not less than the pitch of the thread.

7.1.2 Mounting and installation

PCB terminal blocks shall be so designed that safe mounting on a printed circuit board is possible by means of soldering, pressing-in, screwing, etc. The connection to the printed circuit board shall not be damaged by connecting the conductors.

Tests shall be made in accordance with 8.3.2.

7.1.3 Clearances and creepage distances

For PCB terminal blocks for which the manufacturer has stated values of rated impulse withstand voltage (U_{imp}) and rated insulation voltage (U_i), minimum values of clearances and creepage distances are given in Tables 13 and 15 of IEC 60947-1:2007, Amendment 1 (2010).

For PCB terminal blocks for which the manufacturer has not declared a value of rated impulse withstand voltage (U_{imp}), guidance for minimum values is given in Annex H of IEC 60947-1:2007.

Electrical requirements are given in 7.2.2.

7.1.3DV D2 *Modification by adding the following:*

The spacings on a terminal block shall be as specified in Table 7.1.3DV. Alternately, the creepage and clearance distances given in Tables 13 and 15 of the standards contained in Table DVB.2, Reference No. 9, may be used.

Note 1DV: For information regarding verification of clearances and creepage distances by measurement, see the standards contained in Table DVB.2, Reference No. 9, Annex G.

Table 7.1.3DV D2 *Add the following table:*

Table 7.1.3DV – Minimum acceptable clearances and creepage distances

Application	Potential involved in volts (rms or d.c.)	Minimum clearances and creepage distances, mm, between uninsulated live parts of opposite polarity and between an uninsulated live part and a grounded part including any mounting surface	
		Clearance through air	Creepage over surface
A. Service – including dead-front switchboards, panelboards, service equipment, and the like	51 – 150 151 – 300 301 – 600	12,7 19,1 25,4	19,1 31,8 50,8
B. Commercial appliances, including business equipment, electronic data processing equipment, and the like	51 – 150 151 – 300 301 – 600	1,6[a] 2,4[a] 9,5	1,6[a] 2,4[a] 12,7
C. Industrial, general	51 – 150 151 – 300 301 – 600	3,2[a] 6,4 9,5	6,4 9,5 12,7
D. Industrial, devices having limited ratings[b]	51 – 300 301 – 600	1,6[a] 4,8	3,2[a] 9,5
E. Terminal blocks rated 601 – 1 500 V	601 – 1 000 1 001 – 1 500	14,0 17,8	21,6 30,5
NOTES – 1) A slot, groove, or similar spacing, 0,33 mm wide or less, in the contour of insulating material, shall be disregarded. 2) An air space of 0,33 mm or less between a live part and an insulating surface shall be disregarded for the purpose of measuring over surface spacings.			

Table 7.1.3DV – Minimum acceptable clearances and creepage distances Continued on Next Page

Table 7.1.3DV – Minimum acceptable clearances and creepage distances (Continued)

Application	Potential involved in volts (rms or d.c.)	Minimum clearances and creepage distances, mm, between uninsulated live parts of opposite polarity and between an uninsulated live part and a grounded part including any mounting surface	
		Clearance through air	Creepage over surface
[a] The spacing between field wiring terminals of opposite polarity and the spacing between a field wiring terminal and a grounded dead metal part shall not be less than 6,4 mm if short-circuiting or grounding of such terminals can result from projecting strands of wire. Examples of means that prevent stray wire strand contact include rating the terminal block for solid wire only, and design features such as recessed terminal pockets. [b] The clearances and creepage distances specified in item D are applicable to a terminal block for use only in or with industrial control equipment where the load on any single circuit of the terminal block does not exceed 15 amperes at 51 – 150 volts, 10 amperes at 151 – 300 volts, 5 amperes at 301 – 600 volts, or the maximum ampere rating, whichever is less.			

7.1.4 Terminal identification and marking

Subclause 7.1.8.4 of IEC 60947-1:2007 applies with the following addition:

A PCB terminal block shall have provision, or at least space, for identification marks or numbers for each clamping unit or contact unit related to the circuit of which it forms a part except when such marking is not physically possible.

If such marking is not possible the information shall be stated by the manufacturer, e.g. in the manufacturer's data sheet or his catalogue or on the packing unit.

Such provision may consist of separate marking items, such as marking tags, identification labels, etc.

7.1.4DV D2 *Modification to add the following:*

Refer to standards in accordance with Table DVB.2, Reference No. 9.

7.1.5 Resistance to abnormal heat and fire

The insulation materials of PCB terminal blocks shall not be adversely affected by abnormal heat and fire.

Compliance is checked by:

a) the glow-wire test on the complete product according to 8.5 or

b) verification of the insulating material in accordance with

1) IEC 60695-2-12, method GWFI at a temperature of 850 °C or

2) IEC 60695-2-13, method GWIT at a temperature of 775 °C.

This verification is not necessary for small parts (see IEC 60695-2-11).

NOTE 1 The relevant test method is specified by the manufacturer.

NOTE 2 For some applications it may be mandatory to check compliance by the glow-wire test on the complete product according to 8.5 only. The need is either defined in the end-product standard or by agreement between manufacturer and users. See B.1.

7.1.5DV D2 *Addition of Clauses 7.1.5DV.1 – 7.1.5DV.1.8 and Table 7.1.5DV.1: (Canada and the United States Only)*

7.1.5DV.1 Insulation

7.1.5DV.1.1 Insulation material shall not have less than the minimum values specified in Table 7.1.5DV.1 and shall be subjected to the Thermoplastic Insulator Stress Relief Test, 8.7DV, for the United States and the Accelerated Aging Test, 8.8DV, for Canada. The relative thermal index used shall be the lesser, published value from Electrical or Mechanical without Impact. For the purpose of this Standard, an insulation material is defined as a material which is in contact with or within 0,8 mm of either uninsulated live parts of opposite polarity, or uninsulated live parts and either metal parts that are capable of being grounded in service or any surface exposed to contact.

In Canada, insulating materials in contact with current-carrying parts of devices shall have a flammability classification of V-2 or better, in accordance with the standards contained in Table DVB.2, Reference No. 1, in a thickness of 1,6 mm or in the minimum thickness in contact with that current-carrying part.

7.1.5DV.1.2 An insulation material having values less than any of those contained in Table 7.1.5DV.1 may be used, when based on end-product performance tests. See Table DVB.2, Reference No. 6 or 7, and footnotes c, d, and e of Table 7.1.5DV.1.

7.1.5DV.1.3 The thermoplastic insulator stress relief test is not required for rigid thermosetting materials, such as phenolic.

7.1.5DV.1.4 In Canada, the accelerated aging test shall be conducted in accordance with Clause 8.8DV.

7.1.5DV.1.5 In the United States, the thermoplastic insulator stress relief test is not required for materials that have a published relative thermal index (Electrical and Mechanical without Impact) greater than 70 °C.

7.1.5DV.1.6 In the United States, the inclined plane tracking test, see Table DVB.2, Reference No. 6 or 7, shall be conducted at the application (rated) voltage for terminal blocks rated 601 – 1 500 Volts. In Canada and Mexico this requirement does not apply.

7.1.5DV.1.7 Insulation material bases that have been molded or fabricated from regrind materials, blending of materials, use of pigment, colorants, flame retardants, or similar means, shall comply with Table DVB.2, Reference No. 8.

7.1.5DV.1.8 A Proof Tracking Index (PTI) test shall be performed on the terminal block for those materials where no CTI rating exists.

Table 7.1.5DV.1 – Maximum performance level category (PLC) values for insulation materials

Flammability classification[b]	CTI[a,e]		HWI[a,c,f]		HAI[a,d,f]	
	Minimum value	Maximum PLC	Minimum value	Maximum PLC	Minimum value	Maximum PLC
V-0	175 V	3	7 s	4	15 arcs	3
V-1	175 V	3	15 s	3	30 arcs	2
V-2	175 V	3	30 s	2	30 arcs	2
HB	175 V	3	30 s	2	60 arcs	1

[a] See Table DVB.2, Reference No. 5.

[b] These flammability ratings are derived from Table DVB.2, Reference No. 1.

[c] A material with weaknesses in these values may be used provided abnormal overload or glow-wire end product tests are performed. See Table DVB.2, Reference No. 6.

[d] A material with weaknesses in these values may be used provided an end product arcing test is performed at 50% power factor and the amperage and voltage that the terminal block is rated for, to a maximum of 30A, 250V. For terminal blocks rated at greater than 30A, 250V, a minimum V-1 flammability rating and minimum CTI of 175 (PLC max of 3) are also required. See Table DVB.2, Reference No. 7, High Current Arc Resistance to Ignition (HAI).

[e] See 7.1.5DV.1.8.

[f] HB flammability rating, HWI, and HAI values do not apply in Canada.

7.1.6 Maximum cross-section and connecting capacity

PCB terminal blocks shall be so designed that conductors of the maximum cross-section and the connecting capacity, if applicable, can be accepted.

Compliance is checked by the test described in 8.3.4.

The verification of the maximum cross-section may be performed by the special test according to 8.3.5.

7.2 Performance requirements

7.2.1 Temperature rise

PCB terminal blocks shall be tested in accordance with 8.4.5. The sum of ambient temperature and temperature rise of the PCB terminal block shall not exceed the upper limiting temperature (ULT).

7.2.1DV D1 *Modification by adding the following:*

For Canada and the United States, the temperature rises on a terminal block shall not exceed the applicable values specified in Table 7.2.1DV. For Mexico, the temperature rises on a terminal block shall not exceed the applicable values specified in Table 7.2.1DV, except the wiring terminal of the terminal block shall not exceed 45K.

Table 7.2.1DV – Maximum acceptable temperature rises

Material and Components	°C
Insulation Base	**a**
Wiring terminal of terminal block	**30[b]**
Any bus, strap, or clip that mates with another similar bus, strap, or clip to facilitate a disconnection arrangement of a 2-piece terminal block (not a field wiring terminal)	**50**
NOTE – These limits do not apply to an insulated conductor or other material that has been investigated and found acceptable for a higher temperature.	
[a] Rated temperature limit of material minus test ambient temperature.	
[b] For Mexico, the maximum acceptable temperature rise is 45K.	

7.2.2 Dielectric properties

If the manufacturer has declared a value of the rated impulse withstand voltage (U_{imp}) (see 4.3.1.3 of IEC 60947-1:2007), the requirements of 7.2.3 and 7.2.3.1 of IEC 60947-1:2007, Amendment 1 (2010) apply. If applicable, the impulse withstand voltage test shall be carried out in accordance with 8.4.3 a).

For the verification of solid insulation the power-frequency withstand voltage test shall be carried out in accordance with 8.4.3 b).

The verification of sufficient clearances and creepage distances shall be made in accordance with 8.4.2. For PCB terminal blocks for which the manufacturer has not declared a value of rated impulse withstand voltage (U_{imp}), guidance for minimum values is given in Annex H of IEC 60947-1:2007.

7.2.2DV D2 *Modification of Clause 7.2.2 by replacing with the following:*

Immediately following the temperature-rise test and while still in a heated condition, a terminal block shall be capable of withstanding without breakdown for 1 minute the application of a 60-hertz essentially sinusoidal potential of 1 000 volts plus twice the rated voltage of the terminal block between:

a) Live parts that are not conductively interconnected; and

b) Live parts and the surface to which the terminal block is mounted.

Refer to standards in accordance with Table DVB.2, Reference No. 9.

7.2.3 Short-time withstand current

A PCB terminal block shall be capable of withstanding the short-time withstand current which corresponds to 120 A/mm^2 for 1 s, in accordance with 8.4.6.

The test shall be performed using the smallest cross-section in the current path of the contact unit as declared by the manufacturer.

7.2.3DV D2 *Modification by adding the following:*

Clause 7.2.3 does not apply in Canada and the U.S.

7.2.4 Contact resistance

When measured according to8.4.4, the change in contact resistance of a PCB terminal block caused by the conductor connection and the mounting on the printed circuit board shall not exceed the permissible deviations.

7.2.4DV D2 *Modification by adding the following:*

Clause 7.2.4 does not apply in Canada and the U.S.

7.2.5 Ageing test (climatic sequence and corrosion test)

For the verification of the resistance of connections against the influence of temperatures and corrosive atmospheres the climatic sequence test shall be carried out.

Compliance is checked by the test described in 8.4.7.

7.2.5DV D2 *Modification by adding the following (for Screwless-type terminal blocks only):*

In the U.S., for a screwless terminal block in accordance with Clause 8.4.7DV.1, the temperature rise for the last ″ON″ period shall not be more than 5°C higher than the first On period. In Mexico, either Clause 7.2.5 or Clause 7.2.5DV may be applied.

7.2.6DV D2 *Addition of Clauses 7.2.6DV.1 – 7.2.6DV.4:*

7.2.6DV.1 Test of mechanical strength of clamping units

7.2.6DV.1.1 The conductor ends shall not be cut off or damaged in any way that prevents their further use, and no damage shall have occurred to the terminal assemblies, the terminal block, or the mounting means, following the test in Clause 8.3.3.1 of Part 7-1.

7.2.6DV.2 Tab pull test

7.2.6DV.2.1 No damage shall have occurred to the terminal assembly, the terminal block, or the mounting means following the test in Clause 8.3.3.6dv.1 of Part 7-1.

7.2.6DV.3 Solid-wire tightening test

7.2.6DV.3.1 To determine that normal clamping action as intended does not impair the integrity of a joint as specified in 7.2.6DV.1, the binding member shall be tightened on a solid wire to the torque specified in Table 8.3.3.6dv.2 of Part 7-1, following the test in Clause 8.3.3.6dv.1 of Part 7-1, without causing:

a) The wire to be forced out of the joint; or

b) Damage to any part of the terminal block.

7.2.6DV.4 Thermoplastic insulation stress relief test

7.2.6DV.4.1 In the U.S. and Mexico, there shall be no shrinkage, warping, or other distortion resulting in the reduction of clearances or creepage distances below the specified values. In Canada, this requirement does not apply.

7.3 Electromagnetic compatibility (EMC)

Subclause 7.3 of IEC 60947-1:2007, Amendment 1 (2010) applies.

8 Tests

8.1 Kinds of test

Subclause 8.1.1 of IEC 60947-1:2007 applies with the following addition.

No routine tests are specified. The verification of the maximum cross-section according to 8.3.5 is a special test. All other tests are type tests.

8.1DV D2 *Modification to add the following:*

Refer to standards in accordance with Table DVB.2, Reference No. 9.

8.2 General

Unless otherwise specified, PCB terminal blocks are tested in new and in clean condition, and installed as for normal use (see 6.3 of IEC 60947-1:2007) at an ambient temperature of (25 ± 10) °C.

The tests are carried out in the order described in the subclauses.

8.2DV D2 *Modification by replacing the second paragraph with the following:*

In Canada and the U.S., the tests shall be performed as indicated in Table 8.2DV.1.

For Mexico, the tests shall either be carried out in the same order in which the subclauses describe them, or be performed as indicated in Table 8.2DV.1.

Each test is carried out on new individual specimens with at least four contact units (one set) where each multipole PCB terminal block may contain the required number of contact units.

For a PCB terminal block family with the same design and comparable form, tests need only be performed on specimens representing the most unfavourable case.

The surface of the conductors shall be free of contamination and corrosion which degrades performance.

Care shall be taken when stripping conductors to avoid cutting, nicking, scraping or otherwise damaging the conductors.

In cases where the manufacturer has stated that special preparation of the end of the conductor is necessary, the test report shall indicate the method of preparation used.

The tests are carried out with the type of conductors (rigid or flexible) as stated by the manufacturer.

If one of the PCB terminal blocks does not withstand one of the tests, this test shall be repeated on a second set of PCB terminal blocks, all of which shall then comply with the repeated test. If this test is part of a test sequence, the complete test sequence shall be repeated.

Table 8.2DV D2 *Add the following table:*

Table 8.2DV.1 – Test sequence

Sequence Number	Quantity	Test	Referenced Clause
1	2 of 5	Attachment of the terminal block on its support[a]	8.3.2
2	2 of 5	Mechanical properties of clamping units sequence	8.3.3
		Verification of voltage drop[a]	8.4.4
		Test of mechanical strength of clamping units	8.3.3.1
		Verification of voltage drop[a]	8.4.4
3	2	Test for damage and accidental loosening of conductors of a terminal block sequence	
		Flexion	8.3.3.2
		Pull-out	8.3.3.3

Table 8.2DV.1 – Test sequence Continued on Next Page

Table 8.2DV.1 – Test sequence (Continued)

Sequence Number	Quantity	Test	Referenced Clause
4	1	Verification of rated cross-section and rated connecting capacity[a]	8.3.3.4
5	1	Verification of rated cross-section (special test with gauges)[a]	8.3.3.5
6	6	Tab pull	8.3.3.6DV.1
7	1	Solid-wire tightening	8.3.3.6DV.2
8	2	Verification of clearances and creepage distances	8.4.2
9	5	Dielectric	8.4.3
10	3	Temperature rise sequence	
		Verification of the voltage drop[a]	8.4.4
		Temperature rise	8.4.5
		Verification of the voltage drop[a]	8.4.4
11	6	Conditioning	8.4.7DV.2.1
		Temperature rise	8.4.7DV.2.2
		Dielectric	8.4.3
12	1	Short time withstand current sequence	
		Verification of the voltage drop[a]	8.4.4
		Short time withstand current [a]	8.4.6
		Verification of the voltage drop[a]	8.4.4
13	2	Aging test sequence[b]	
		Verification of the voltage drop[a]	8.4.4
		Aging test for screwless-type terminal blocks	8.4.7
		Verification of the voltage drop[a]	8.4.4
		Pull-out [a]	8.3.3.3
14	3	Verification of thermal characteristics[a]	8.5
15	1	Thermoplastic insulation stress relief test[b]	8.7DV
16	1	Accelerated Aging Test[c]	8.8DV

[a] Not required in Canada and the United States.
[b] Not for Canada.
[c] Applies to Canada only.

8.3 Verification of mechanical characteristics

8.3.1 General

The verification of mechanical characteristics includes the following test:

– attachment of the PCB terminal block on its support (see 8.3.2);

– verification of the maximum cross-section and connecting capacity (see 8.3.4);

– verification of maximum cross-section (special test with gauges) (see 8.3.5).

8.3.2 Attachment of the PCB terminal block on its support

The tests shall be carried out on the smallest number of poles, preferably two poles, of a PCB terminal block, which is mounted on an appropriate support (printed circuit board) as in normal use according to the manufacturer's instructions. For PCB terminal blocks to be soldered on printed circuit boards, this test shall be carried out on printed circuit boards with plated-through holes.

The wiring of the PCB terminal blocks for this test shall be carried out as shown in Figure 1 with the maximum cross-section as specified by the manufacturer.

After the verification of the contact resistance according to 8.4.4 this conductor shall be connected and disconnected five times according to the manufacturer's instructions. For each connection a new end of the conductor shall be used.

The tightening torque for PCB terminal blocks with screw-type clamping units shall be in accordance with Table 4 of IEC 60947-1:2007 or alternatively with a higher value as specified by the manufacturer.

At the end of the test the PCB terminal blocks shall comply with the contact resistance test according to 8.4.4. After the test the terminal assembly shall be free from damage which may impair further use.

8.3.2DV D2 ***Modification by adding the following:***

Clause 8.3.2 does not apply in Canada and the U.S.

8.3.3 Vacant

8.3.4 Verification of the maximum cross-section and connecting capacity

The verification of the maximum cross-section and connecting capacity shall be carried out according to the standard for clamping units to be used (see 7.1.1).

NOTE The mechanical properties of clamping units are tested according to the applicable connecting methods listed in Table 3.

8.3.4DV D2 *Modification by adding the following:*

Clause 8.3.4 does not apply in Canada and the U.S.

8.3.5 Verification of maximum cross-section (special test with gauges)

Subclause 8.2.4.5 of IEC 60947-1:2007, Amendment 1 (2010) applies with the following addition.

The test shall be carried out on each clamping unit of one PCB terminal block.

8.3.5DV D2 *Modification by adding the following:*

8.3.5DV.1 Clause 8.3.5 does not apply in the U.S. and Canada.

8.4 Verification of electrical characteristics

8.4.1 General

The verification of electrical characteristics includes the following:

– verification of clearances and creepage distances (see 8.4.2);

– dielectric tests (see 8.4.3);

– verification of the contact resistance (see 8.4.4);

– temperature rise test (see 8.4.5);

– short-time withstand current test (see 8.4.6);

– ageing test (see 8.4.7).

8.4.2 Verification of clearances and creepage distances

8.4.2.1 General

The verification is made between two adjacent PCB terminal blocks or mutually insulated contact units of a multipole PCB terminal block and all live parts and accessible metal parts of a PCB terminal block.

The measurement of clearances and creepage distances shall be made under the following conditions:

a) the PCB terminal blocks shall be connected with the most unfavourable conductor type(s) and conductor cross-section(s) among those declared by the manufacturer or without a conductor, if this turns out to be the most unfavourable case;

b) the conductor ends shall be stripped, if required, to a length specified by the manufacturer.

The method of measuring clearances and creepage distances is described in annex G of IEC 60947-1:2007.

8.4.2.2 Clearances

The measured values of clearances shall be higher than the values given in Table 13 of IEC 60947-1:2007 for case B – homogeneous field (see 7.2.3.3 of IEC 60947-1:2007) based on the value of the rated impulse withstand voltage (U_{imp}) and the pollution degree stated by the manufacturer.

The impulse withstand voltage test shall be carried out in accordance with 8.4.3 a) unless the measured clearances are equal to or larger than the values given in Table 13 of IEC 60947-1:2007 for case A – inhomogeneous field (see 8.3.3.4.1, item 2), of IEC 60947-1:2007, Amendment 1 (2010)).

8.4.2.2DV D2 *Modification by adding the following:*

Refer to standards in accordance with Table DVB.2, Reference No. 9.

8.4.2.3 Creepage distances

The measured creepage distances shall be not less than the values given in Table 15 of IEC 60947-1:2007, Amendment 1 (2010) in connection with 7.2.3.4 a) and b) of IEC 60947-1:2007 based on the rated insulation voltage (U_i), the material group and the pollution degree as specified by the manufacturer.

8.4.2.3DV.1 D2 *Modification by replacing with Clauses 8.4.2.3DV.1.1 – 8.4.2.3DV.1.7: (Canada and the U.S. only)*

8.4.2.3DV.1.1 Spacings shall be measured through cracks or between sections of a sectional type terminal block. In applying Table 7.1.3DV, it shall be assumed that:

a) Adjacent poles are at opposite polarity; and

b) Any mounting surface is at ground potential.

8.4.2.3DV.1.2 Spacings shall be measured at all live parts of a terminal block, including factory terminations, e.g. printed circuit board solder pins. When soldered or wired in the actual end use application, these spacings shall be additionally evaluated in the end product.

8.4.2.3DV.1.3 A live screw head or nut on the underside of an insulating base shall be reliably prevented from loosening and shall be adequately insulated or spaced from the mounting surface. This can be accomplished by:

a) Countersinking such parts not less than 3,2 mm in the clear and then covering them with a waterproof, insulating sealing compound that does not melt at a temperature of 15°C higher than the normal operating temperature in the device, and not less than 100°C in any case, or

b) Reliably securing such parts and insulating them from the mounting surface by means of a barrier or the equivalent, or by means of through-air or oversurface spacings as specified in Table 7.1.3DV.

8.4.2.3DV.1.4 An insulating barrier or liner used as the sole separation between an uninsulated live part and a noncurrent-carrying metal part (including grounded metal part) or between uninsulated live parts of opposite polarity shall be of material that is acceptable for the mounting of an uninsulated live part and not less than 0,71 mm thick.

8.4.2.3DV.1.5 An insulating barrier or liner that is used in addition to an air space in place of the required spacing through air shall not be less and 0,8 mm thick. If the barrier or liner is of fiber, the air space shall not be less than 0,8 mm, and if that barrier or liner is of material of a type that is not suitable for the support of an uninsulated live metal part, the air space provided shall be such that, upon investigation, it is found to be adequate for the particular application.

8.4.2.3DV.1.6 A barrier or liner that is used in addition to at least one-half of the required spacing through air may be less than 0,8 mm, but not less than 0,33 mm thick, provided that the barrier or liner is of a material that is suitable for the mounting of an uninsulated live part, of adequate mechanical strength if exposed or otherwise likely to be subject to mechanical damage, and reliably held in place.

8.4.2.3DV.1.7 Insulating material having a thickness less than that indicated in Clauses 8.4.2.3DV.1.3 and 8.4.2.3DV.1.4 may be used if, upon investigation, it is found to be suitable and adequate for the particular application.

8.4.2.3DV.2 D2 *Modification by adding the following: (Mexico only)*

As an alternative to the IEC requirements, the Canadian, and U.S. requirements in Clauses 8.4.2.3DV.1.1 – 8.4.2.3DV.1.6 above may apply.

8.4.3 Dielectric test

a) If the manufacturer has declared a value for the rated impulse withstand voltage (U_{imp}), the impulse withstand voltage test shall be carried out in accordance with Table 4.

b) The power-frequency withstand verification of solid insulation according to IEC 60512-4-1 shall be made in accordance with the test voltages given in Table 5. For this test, the PCB terminal blocks are connected with the most unfavourable conductor (without a printed circuit board). The duration of the test is 1 min. The test voltage shall be applied between each of the poles which can assume different potentials in the application.

NOTE The relationship between nominal voltages and of the rated impulse withstand voltage (U_{imp}) are given in Annex H of IEC 60947-1:2007 (see also 7.1.3).

A voltage dip of the test voltage or a disruptive discharge or flashover is not allowed.

Table 4 – Impulse withstand test voltages

Rated impulse voltage	Impulse withstand voltage[a]	
	for a height of 2 000 m above sea level	at sea level
kV	kV (1,2/50 µs)	kV (1,2/50 µs)
0,5	0,5	0,55
0,8	0,8	0,91
1,5	1,5	1,75
2,5	2,5	2,95
4	4	4,8
6	6	7,3
8	8	9,8
12	12	14,8
[a] If the testing laboratory is situated at a height between sea level and 2 000 m, interpolation of the impulse voltage is allowed.		

Table 5 – Dielectric test voltages corresponding to the rated insulation voltage

Rated insulation voltage	A.C. test voltage (r.m.s.)a	
U_i	Overvoltage category III	Overvoltage category II
V	kV	kV
$U_i \leq 63$	0,5	0,4
$63 < U_i \leq 100$	0,8	0,5
$100 < U_i \leq 160$	1,4	0,8
$160 < U_i \leq 320$	2,2	1,4
$320 < U_i \leq 500$	3,1	2,2
$500 < U_i \leq 1\,000$	4,2	3,1
[a] R.M.S. test voltages are based on 6.1.3.4 of IEC 60664-1:2007 and are higher than those of IEC 60947-1:2007, Table 12A in order to be in line with requirements of end-product standards.		

8.4.3DV D2 *Modification by adding the following:*

Table 5 does not apply in the U.S. and Canada.

Immediately following the temperature rise test in Clause 8.4.5DV and while still in a heated condition, terminal blocks having screwless-type terminals or insulation piercing or displacement connections shall be subjected to the dielectric test in Clause 7.2.2DV.

8.4.4 Verification of contact resistance

The contact resistance shall be verified:

a) before and after the test of attachment of the PCB terminal block on its support (see 8.3.2);

b) before and after the temperature rise test (see 8.4.5);

c) before and after the short-time withstand current test (see 8.4.6);

d) before, during and after the ageing test (see 8.4.7).

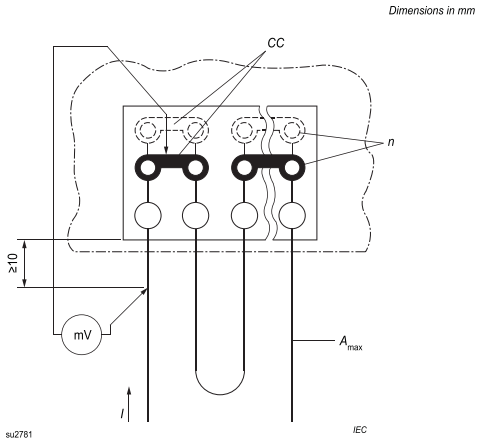
The verification is made as specified in 8.3.2, 8.4.5, 8.4.6 and 8.4.7.

The contact resistance shall be measured between the connected conductor and the interconnection on the printed circuit board at each contact unit of a PCB terminal block as shown in Figure 1. The measurement is carried out according to the procedure specified in IEC 60512-2-1. After the tests a), b), c) and d) the contact resistance shall not rise by more than 50 % of the initial measurement value.

If the measurement value exceeds 1,5 times the initial measurement value, the clamping units and the connecting methods may be evaluated separately.

8.4.4DV D2 ***Modification by adding the following:***

Subclause 8.4.4 does not apply in the U.S. and Canada.



Key

I Test current

mV Voltmeter

n Number of connections to the printed circuit board per contact unit

CC Trace on the printed circuit board for interconnection

A_{max} Maximum cross-section in mm^2

Figure 1 – Test assembly for the measurement of contact resistance and temperature rise

Figure 1DV D2 *Modification of Figure 1:*

Reduce the number of poles from 4 to 3 and remove the mV drop measurement locations.

8.4.5 Temperature rise test

This test serves to evaluate the ability of the PCB terminal block to carry the rated current permanently without exceeding the upper limiting temperature (ULT). Unless otherwise specified, the test shall be carried out according to IEC 60512-5-2 under the following test conditions.

The test is carried out on an assembly of PCB terminal blocks mounted next to each other with preferably four contact units per level as shown in Figure 1 and Figure 2. The PCB terminal block shall be mounted on a printed circuit board as in normal use and connected in series with insulated conductors of the maximum cross-section and conductors on the printed circuit board. The interconnections on the printed circuit board shall be made with solid bare conductors of equal cross-section or comparable means and as short as possible.

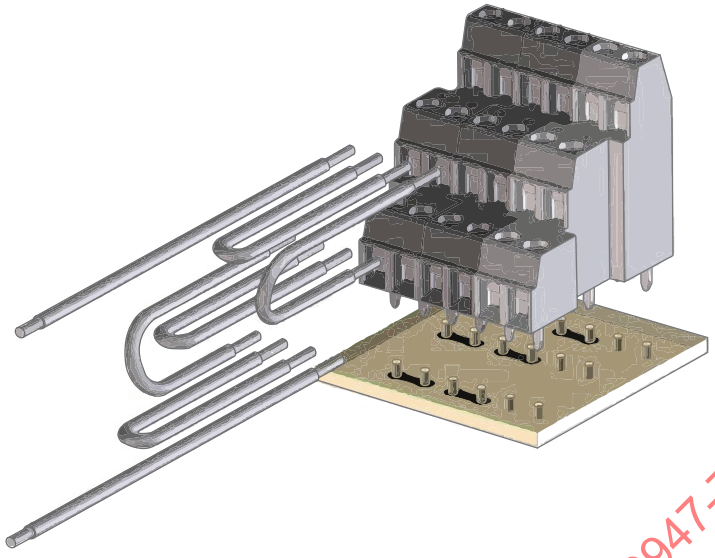


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Figure 2 – Example of wiring structure of a multi-tier PCB terminal block

The tightening torque for PCB terminal blocks with screw-type clamping units shall be in accordance with Table 4 of IEC 60947-1:2007 or alternatively with a higher value as specified by the manufacturer.

The length of connectable conductors and conductor loops shall be taken from Table 6.

Table 6 – Length of connectable conductors and conductor loops

Cross-section mm^2	Length mm
≤ 10	500 ± 50
16 to 35	1 000 ± 100
> 35	2 000 ± 200

For PCB terminal blocks having/providing several connections to the printed circuit board the cross-section of interconnections A_B shall be calculated according to the following equation:

$$A_B \leq (A_{max}/n)$$

where

A_B is the cross-section of interconnections in mm^2

A_{max} the maximum cross-section in mm^2 and

n the number of connections to the printed circuit board per contact unit.

The sum of cross-sections of interconnections ($A_B \times n$) shall not exceed the cross-section of the connectable conductor. Examples are given in Table 7.

Table 7 – Examples of cross-sectional distribution of interconnections on printed circuit boards

Maximum cross-section (A_{max})	Number of connections to printed circuit board (n)			
	1	2	3	4
	Cross-section of interconnections (A_B)			
mm²	mm²			
...	...	...	...	...
2,5	2,5	1	0,75	0,5
4	4	1,5	1	1
6	6	2,5	1,5	1,5
10	10	4	2,5	2,5
...	...	...	...	...

The test assembly shall be prepared and arranged for the test procedure as shown in Figure 1 according to the test conditions described in IEC 60512-5-2, Test 5b. Unless otherwise specified, the size of the printed circuit board shall be selected so that it protrudes over the base area of the PCB terminal block on all sides corresponding to five times the spacing of the PCB terminal block. The printed circuit board that is used shall be described in the test report.

After verification of the contact resistance as described in 8.4.4, the test shall be carried out with single-phase alternating or direct current as described in IEC 60512-5-2, Test 5b.

As described in IEC 60512-5-2, the measuring points for measuring the temperature shall be located on the hottest spot above the printed circuit board (component side).

Where applicable it may be necessary to determine the hottest spot by carrying out pre-tests.

The reduction factor to determine the derating curve is 0,8. If this is not adhered to, the derating factor used shall be indicated in the technical documentation.

At the end of the test and after cooling down to ambient temperature the PCB terminal block shall comply with the contact resistance test according to 8.4.4 without modification of the assembly.

8.4.5DV D2 *Modification by replacing with the following:*

8.4.5DV.1 Temperature-rise test

8.4.5DV.1.1 The terminal blocks shall be mounted on a horizontal nonmetallic surface and connected to an acceptable current source. Three adjacent terminal block poles shall be connected in series using the conductor size corresponding to the ampere rating in accordance with Table 8.4.5DV. If the ampere rating of a terminal block falls between two consecutive values in the table, the larger wire size shall be selected.

8.4.5DV.1.2 The conductors shall be tightened with a torque according to Table 4 of Table DVB.2, Reference No. 9, with respect to Table C.1 for screw-type clamping units with a diameter of threads up to and including 2,8 mm, or to the rated torque specified by the manufacturer. During the test, screws of clamping units shall not be retightened. The minimum length of each of the six conductors shall be 1 m for rated cross-sections up to and including 10 mm^2 (8 AWG), and 2 m for larger rated cross-sections.

8.4.5DV.1.3 Stranded conductors shall be used for 0,05 – 1,3 mm^2 (30 – 16 AWG) and 8,4 mm^2 (8 AWG) and larger conductor sizes. Solid conductors shall be used for 2,1 – 5,3 mm^2 (14 – 10 AWG) conductor sizes, unless the terminal block is rated for stranded wire only, in which case stranded wire shall be used. Also see Clause 4.3.6DV.5.

Note – Testing using 2,1 – 5,3 mm2 (14 – 10 AWG) solid conductors is representative of testing with stranded conductors of the same size for the Temperature rise test.

8.4.5DV.1.4 The test shall be continued until steady temperature is reached. A variation of less than 1 K between any two out of three consecutive measurements made at an interval of 5 minutes is considered as steady temperature.

Table 8.4.5DV D2 *Add the following table:*

Table 8.4.5DV – Values of test current for temperature-rise test

Rated cross-section		Test Current
mm^2	(AWG or kcmil)	A
0,05	(30)	0,5
0,08	(28)	0,8
0,13	(26)	1
0,20	(24)	2
0,32	(22)	3
0,52	(20)	5
0,82	(18)	7
1,31	(16)	10
2,08	(14)	15
3,31	(12)	20
5,26	(10)	30
8,37	(8)	50
13,3	(6)	65
21,1	(4)	85
26,7	(3)	100
33,6	(2)	115
42,4	(1)	130
53,5	(1/0)	150
67,4	(2/0)	175
85,0	(3/0)	200
107	(4/0)	230
127	(250)	255
152	(300)	285

8.4.6 Short-time withstand current test

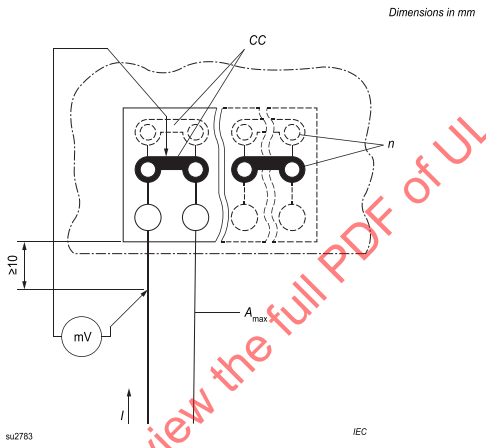
The purpose of this test is to verify the ability to withstand a thermal shock.

The test is carried out on two adjacent contact units with the longest and most unfavourable current paths of one PCB terminal block or two adjacent PCB terminal blocks. For this test, the PCB terminal block is mounted as in normal use according to the manufacturer's instructions and connected with conductors of maximum cross-section A_{max} and interconnections A_B as determined in 8.4.5 (see Figure 3).

The tightening torque for PCB terminal blocks with screw-type clamping units shall be in accordance with Table 4 of IEC 60947-1:2007 or alternatively with a higher value as specified by the manufacturer.

At the end of the test, the test (circuit) assembly shall show no interruptions and the PCB terminal blocks shall be free from cracks, ruptures or other critical damage.

After cooling down to room temperature the contact units shall comply with the contact resistance test according to 8.4.4.



Key

I Test current

mV Voltmeter

n Number of connections to the printed circuit board per contact unit

CC Trace on the printed circuit board for interconnection

A_{max} Maximum cross-section in mm^2

Figure 3 – Test assembly for the measurement of short-time withstand current

8.4.6DV D2 ***Modification by adding the following:***

Subclause 8.4.6 does not apply in Canada and the U.S.

8.4.7 Ageing test (climatic sequence and corrosion test)

The purpose of this test is to verify that clamping units and connections to the printed circuit board are able to withstand environmental conditions and ageing.

The test sequence is carried out on a set of PCB terminal blocks each connected with conductors of the minimum and maximum cross-section. Attachment of the terminal block to the PCB shall be made according to the manufacturer's instructions.

The tests are carried out on prepared specimens in the indicated test sequence (see Figure 4).

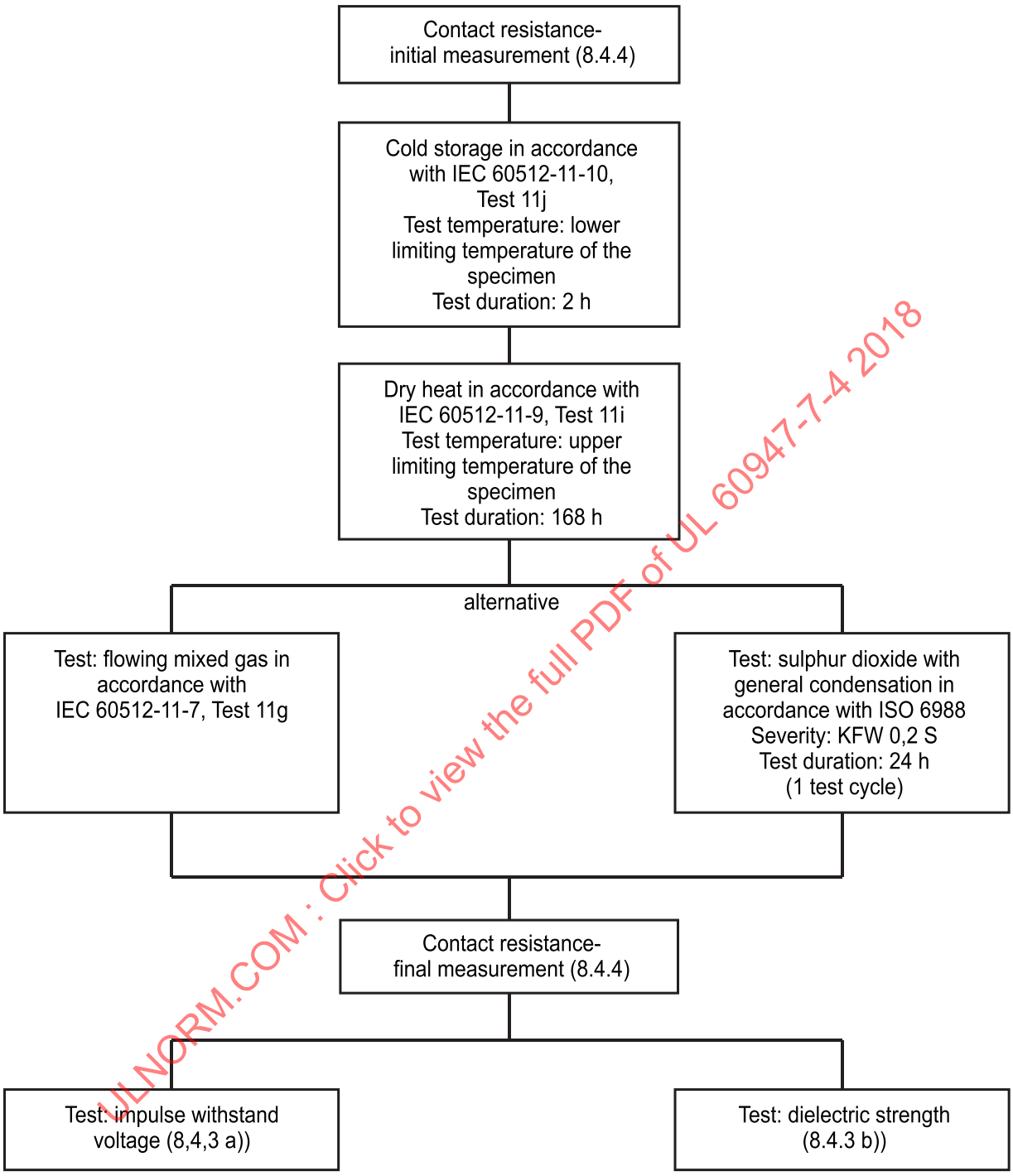


Figure 4 – Test sequence

After each test step, except after the contact resistance measurement, the specimens shall be subjected to visual inspection where the PCB terminal blocks shall be free from cracks, ruptures or other critical damage.

8.4.7DV D2 *Modification for Canada and the U.S. by adding the following:*

8.4.7DV.1 Two previously unused samples of the screwless-type terminal connection shall be connected to the maximum size and type conductor. The connections shall be connected in series as in 8.4.5DV.1.2. A current of 150 percent of rated current shall be passed through the connections for 84 on periods of 3-1/2 hours, each followed by a 1/2 hour off period. The temperature rise for each connection shall be determined at the end of the first on period and again at the end of the final on period.

8.4.7DV.2.1 Conditioning

8.4.7DV.2.1.1 Six previously unused connection points of terminal blocks having screwless-type terminals or insulation piercing or displacement connections shall be subjected to a conditioning of nine insertions and withdrawals of a conductor of the maximum size and type. A tenth insertion of a newly-stripped, previously unused length of wire shall be made and left in place for the temperature and dielectric tests. Types with release mechanisms or simultaneous twist and turn instructions are to be conditioned.

8.4.7DV.2.1.2 A terminal block that does not allow for reusability or requires the conductor to be cut for removal need not be conditioned.

8.4.7DV.2.2 Temperature test

8.4.7DV.2.2.1 The temperature rises on a terminal block having screwless-type terminals or insulation piercing or displacement connections shall not exceed the applicable values specified in Table 7.2.1DV while carrying its rated current. The test shall be conducted in a nominal 25°C ambient. Temperatures shall be taken on each of the six terminations assembled as indicated in Clause 8.4.5DV.1.2. The current shall be passed through the termination continuously for a period of 30 days. Temperatures shall be measured and recorded approximately every 24 hours.

8.4.7DV.2.3 Dielectric test

8.4.7DV.2.3.1 Following the temperature rise test in 8.4.7DV.2.2.1, the terminal blocks shall be subjected to the dielectric test in 8.4.3.

8.4.7DV.2.4 Aging test for insulation displacement terminal blocks

8.4.7DV.2.4.1 Requirements for the aging test for insulation displacement terminal blocks are covered by the Current Cycling tests contained in Table DVB.2, Reference Nos. 3 and 4.