IEC TS 60947-7-5

Edition 1.0 2021-11

TECHNICAL SPECIFICATION

SPECIFICATION TECHNIQUE

colour inside

Low-voltage switchgear and controlgear –
Part 7-5: Ancillary equipment – Terminal blocks for aluminium conductors

Appareillage à basse tension –
Partie 7-5: Matériels accessoires – Blocs de jonction pour conducteurs en aluminium

IEC TS 60947-7-5:2021-11(en-fr)

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LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

**Part 7-5: Ancillary equipment –
Terminal blocks for aluminium conductors**

FOREWORD

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IEC TS 60947-7-5 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. It is a Technical Specification.

This publication shall be read in conjunction with the sixth edition of IEC 60947-1:2020 and the third edition of IEC 60947-7-1:2009. The provisions of the general rules dealt with in IEC 60947-1:2020 and the requirements for terminal blocks of IEC 60947-7-1:2009 are applicable to this publication, where specifically called for. Clauses and subclauses, tables, figures and annexes thus applicable are identified by reference to IEC 60947-1:2020 or IEC 60947-7-1:2009.

The text of this Technical Specification is based on the following documents:

Draft	Report on voting
121A/418/DTS	121A/428A/RVDTS

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

The language used for the development of this Technical Specification is English.

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.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/standardsdev/publications.

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

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- withdrawn,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

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INTRODUCTION

The connection of aluminium conductors, as defined in IEC 60228, and suitable terminations for such conductors has been deemed relevant such that a specific test program for aluminium-suited terminals and the development of a new publication under the scope of IEC SC121A are appropriate.

Additional tests were deemed necessary due to experience showing that reliable electrical connections for aluminium conductors require more consideration than those with copper mainly due to different oxidative behaviour and mechanical characteristics of the materials.

It is well known that when two different metals come into contact; galvanic corrosion is likely to occur. This is an electrochemical process where electrons will flow from the less noble metal to the more noble metal. This effect will be sped up by additional DC current flow and the presence of an electrolyte. In an electrical contact situation this process shall be considered, as it may result in contamination of the contact area with corrosion products and reduction of contact pressure and contact area when the termination is affected.

This document is based on the well-known test program for copper conductors as defined in IEC 60947-7-1. However, further tests have been modified and added to those for copper conductors. These additional tests were derived from those already defined in IEC 61545, IEC 60269-2, IEC 60947-7-1 and IEC 60947-1.

There is a new current-cycling ageing test which includes pre-conditioning of the specimens by storage in a cold environment followed by dry heat with AC for AC terminal blocks or damp heat with DC for AC and/or DC terminal blocks, inspired by tests of Annex Q of IEC 60947-1:2020.

The current-cycling ageing test comprises a total of 768 on-off cycles. For testing the reference value I_{al} is established from Table 2 becoming the base test current with an additional safety margin of 1,25. The manufacturer is required to provide the I_{al} value to the user in his documentation.

Therefore, in contrast to IEC 60947-7-1, it was necessary to introduce additional marking, which is similar that of IEC 61545.

LOW-VOLTAGE SWITCHGEAR AND CONTROLGEAR –

Part 7-5: Ancillary equipment – Terminal blocks for aluminium conductors

1 Scope

This part of IEC 60947 specifies requirements for terminal blocks with screw-type or screwless-type clamping units primarily intended for industrial or similar use and to be fixed to a support to provide electrical and mechanical connection. This document can be used for terminal blocks for connection between aluminium conductors or aluminium to copper conductors. It applies to terminal blocks intended to connect round conductors, with or without special preparation, having a cross-section between 2,5 mm^2 and 300 mm^2 (AWG 12 to 600 kcmil), intended to be used in circuits of a rated voltage not exceeding 1 000 V AC (up to 1 000 Hz) or 1 500 V DC.

This document can be used as a guide to qualify terminal blocks for conductors out of aluminium not complying with IEC 60228 (e.g. smaller than 10 mm^2, flexible or other materials). This document can also be used as a guide to qualify other types of terminal blocks for conductors out of aluminium other than feed through terminal blocks (e.g. partially insulated terminal blocks).

NOTE 1 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 document does not apply to clamping units:

– dedicated to any other types of switchgear and controlgear;
– for connection by crimping, brazing, soldering or welding;
– for data and signalling circuits;
– for flat quick-connect terminations, insulation-piercing connecting devices and twist-on connecting devices, for which separate parts are under consideration.

NOTE 2 In case of use of special types of conductors (e.g. cladded conductors) which require a special preparation, this document can be used as a guide.

NOTE 3 In some countries, national regulation for installation rules can allow different cross-sections. For internal wiring (inside enclosures), other rules or product standards can be applicable.

NOTE 4 For connections to copper conductors only, IEC 60947-7-1:2009 is applicable.

NOTE 5 In USA, UL 1059 applies and in Canada, CSA C22.2 No. 158 applies.

Where applicable in this document, the term “clamping unit” is used instead of the term “terminal”. This is taken into account in case of reference to IEC 60947-1:2020.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60068-2-1:2007, *Environmental testing – Part 2-1: Tests – Test A: Cold*

IEC 60068-2-2:2007, *Environmental testing – Part 2-2: Tests – Test B: Dry heat*

IEC 60068-2-78:2012, *Environmental testing – Part 2-78: Tests – Test Cab: Damp heat, steady state*

IEC 60228, *Conductors of insulated cables*

IEC 60364-5-52:2009, *Low-voltage electrical installations – Part 5-52: Selection and erection of electrical equipment – Wiring systems*

IEC 60695-11-5:2016, *Fire hazard testing – Part 11-5: Test flames – Needle-flame test method – Apparatus, confirmatory test arrangement and guidance*

IEC 60947-1:2020, *Low-voltage switchgear and controlgear – Part 1: General rules*

IEC 60947-7-1:2009, *Low-voltage switchgear and controlgear – Part 7-1: Ancillary equipment – Terminal blocks for copper conductors*

ISO 4046-4:2016, *Paper, board, pulps and related terms – Vocabulary – Part 4: Paper and board grades and converted products*

3 Terms and definitions

Clause 2 of IEC 60947-7-1:2009 applies with the following additions.

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
treated conductor
contact area of a conductor that has had its oxide layer on the outside strands scraped away and/or has had a compound added to improve connectability and/or prevent corrosion

Note 1 to entry: In the USA and Canada, treatment of the specimens and conductors to be tested is not acceptable.

[SOURCE: IEC 61545:1996, 3.13, modified – Insertion of Note 1 to entry.]

3.2
prefilled clamping unit
<terminal block> clamping unit of a terminal block that is prefilled by the manufacturer with an oxide-inhibiting compound

3.3
nominal cross-section for aluminium conductors
value of cross-section for a given type of conductor, solid, rigid stranded or flexible, stated by the manufacturer, and to which certain thermal, mechanical and electrical requirements are referred

Note 1 to entry: Terminal blocks may have several nominal cross-sections depending on the type of conductor.

3.4
nominal connection capacity for aluminium conductors
range of cross-sections, types of conductors and, if applicable, the number of connectable conductors, for which the terminal block is designed

3.5
corresponding copper conductors
cross-section value of the connectable types of conductors, rigid (solid and stranded) and flexible, stated by the manufacturer, and to which certain thermal, mechanical and electrical requirements are referred

3.6
nominal connection capacity for copper conductors
range of cross-sections and, if applicable, the number of connectable conductors, for which the terminal block is designed

3.7
nominal current
I_{al}
<terminal blocks for aluminium conductors> current, as declared by the manufacturer, based on the nominal cross-section of the aluminium conductors

4 Classification

Distinction is made between various type of terminal blocks as follows:

– method of fixing the terminal block to the support;
– number of poles;
– type of clamping units: screw-type clamping units or screwless-type clamping units;
– ability to receive different types of conductors, e.g, solid, rigid stranded or flexible conductors;
– ability to receive different types of conductors based on their treatment; treated, untreated, either treated or untreated;
– ability to receive either aluminium conductors or both aluminium and copper conductors;
– ability to receive prepared conductors (see 3.5.28 of IEC 60947-1:2020);
– terminal assemblies with identical or dissimilar clamping units;
– number of clamping units on each terminal assembly;
– service conditions;
– treatment of clamping units: filled (either prefilled or filled on site), unfilled;
– suitability for AC current and/or DC current.

5 Characteristics

5.1 Summary of characteristics

The characteristics of a terminal block are as follows:

– type of terminal block (see 5.2);
– rated and limiting values (see 5.3).

5.2 Type of terminal block

The following shall be stated:

– type of clamping units (e.g. screw-type, screwless-type);
– number of clamping units;
– treatment of conductors;
– treatment of clamping unit.

5.3 Rated and limiting values

5.3.1 Rated voltage

Subclause 5.3.1.2 and 5.3.1.3 of IEC 60947-1:2020 apply.

5.3.2 Short-time withstand current

A specified RMS value of current which a terminal block shall be able to withstand during a specified short-time under prescribed conditions of use and behaviour (see 8.2.4 and 9.4.6).

5.3.3 Standard cross-sections

The standard values of cross-sections of round aluminium conductors to be used are contained in Table 1.

Table 1 – Standard cross-section of conductors

Metric size ISO	Comparison between AWG/kcmil and metric size	
	Size	Equivalent metric area
mm^2	AWG/kcmil	mm^2
0,2 [a]	24 [a]	0,205
0,34 [a]	22 [a]	0,324
0,5 [a]	20 [a]	0,519
0,75 [a]	18 [a]	0,82
1 [a]	-	-
1,5 [a]	16 [a]	1,3
2,5	14 [a]	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

[a] For copper conductors only.

5.3.4 Nominal cross-section

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

5.3.5 Nominal connecting capacity

The manufacturer shall state for each clamping unit the material, 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, without intermixing of different conductor materials in one clamping unit. The manufacturer shall also state any necessary preparation of the end of the conductor.

5.3.6 Nominal current

The manufacturer shall state the nominal current for terminal blocks. This nominal current shall be based on the size of the aluminium conductors according to Table 2 and Table 3 and applies to the minimum corresponding copper conductor also, if any. To determine the corresponding copper conductor, refer to IEC 60364-5-52:2009, Table B.52.4, installation method C.

Terminal blocks for use with combination of aluminium and copper conductors have a nominal current based on the current for aluminium conductors.

6 Product information

6.1 Marking

A 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.

6.2 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, cross-medial reference is allowed:

a) IEC TS 60947-7-5 if the manufacturer claims compliance with this document;

b) the nominal cross-section for aluminium conductors and corresponding copper conductors, if applicable;

c) the nominal connecting capacities, including the number of conductors simultaneous connectable;

d) the rated insulation voltage (U_i);

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

f) service conditions, if different from those of Clause 7;

g) the following information, depending of the classification, shall be used:

- for clamping units declared for solid conductors "solid" or the abbreviations "s" or "sol";
- for clamping units declared for rigid stranded conductors "rigid stranded" or the abbreviation "r";
- for clamping units declared for flexible conductors "flexible" or the abbreviation "f";
- for clamping units declared for treated conductors "treated" or the abbreviation "t";
- for clamping units declared for aluminium conductors "aluminium" or the abbreviation "Al";
- for clamping units declared for copper conductors "copper" or the abbreviation "Cu";
- for clamping units declared for aluminium and copper conductors "aluminium and copper" or the abbreviation "Al-Cu".

In the case of combinations, the manufacturer shall use an appropriate combination of symbols.

In case of different classifications for different clamping units within a terminal block, the marking shall be unambiguous either on the terminal block or in the manufacturer´s documentation, for example with numbers.

EXAMPLE 1 Marking Al s-t Cu indicates a terminal block with clamping units suitable to connect both solid treated aluminium conductors and all types of copper conductors as well.

h) declared nominal current for terminal blocks with aluminium conductors dependent on nominal cross-section of conductor;

EXAMPLE 2 For one terminal block with three declared cross-sections and conductor types:

- at 16 mm^2: I_{al} = 45 A s-t/r-t;
- at 10 mm^2: I_{al} = 35 A s-t/f-t;
- at 6 mm^2: I_{al} = 32 A s-t.

i) the maintenance according to manufacturer´s instruction;

j) information about the inhibiting compound, if needed;

k) suitability to connect solid, rigid stranded and/ or flexible aluminium conductors, circular or e.g. sectoral;

l) the description of treatment of conductor and/or clamping unit by the user, including the application of inhibiting compound(s), if necessary;

m) suitability for AC current and/or DC current.

- Terminal blocks having passed Step 2 and Step 3 of 9.4.8 with DC current shall be marked DC and/or AC.
- Terminal blocks having passed Step 2 and Step 3 of 9.4.8 with AC current shall be marked AC only.

7 Normal service, mounting and transport conditions

Clause 7 of IEC 60947-1:2020 applies.

8 Constructional and performance requirements

8.1 Constructional requirements

8.1.1 Clamping units

Subclause 8.1.8.1 of IEC 60947-1:2020 applies with following additions.

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

NOTE Screw-type clamping units are not suitable for the connection of flexible connectors with tin-soldered ends.

The clamping units shall be able to withstand the force that can be applied through the connected conductors.

Compliance is checked by inspection and by the tests of 9.3.3.1, 9.3.3.2 and 9.3.3.3.

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.

8.1.2 Mounting

Terminal blocks shall be provided with means that allow them to be securely attached to a rail or a mounting surface.

Tests shall be made in accordance with 9.3.2.

NOTE Information on mounting on rails can be found in IEC 60715.

8.1.3 Clearances and creepage distances

For 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 Table 13 of IEC 60947-1:2020 and Table 15 of IEC 60947-1:2020.