

TECHNICAL REPORT

Overhead electrical conductors – Calculation methods for stranded bare conductors



THIS PUBLICATION IS COPYRIGHT PROTECTED

Copyright © 2021 IEC, Geneva, Switzerland

All rights reserved. Unless otherwise specified, no part of this publication may be reproduced or utilized in any form or by any means, electronic or mechanical, including photocopying and microfilm, without permission in writing from either IEC or IEC's member National Committee in the country of the requester. If you have any questions about IEC copyright or have an enquiry about obtaining additional rights to this publication, please contact the address below or your local IEC member National Committee for further information.

IEC Central Office
3, rue de Varembe
CH-1211 Geneva 20
Switzerland

Tel.: +41 22 919 02 11
info@iec.ch
www.iec.ch

About the IEC

The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes International Standards for all electrical, electronic and related technologies.

About IEC publications

The technical content of IEC publications is kept under constant review by the IEC. Please make sure that you have the latest edition, a corrigendum or an amendment might have been published.

IEC publications search - webstore.iec.ch/advsearchform

The advanced search enables to find IEC publications by a variety of criteria (reference number, text, technical committee, ...). It also gives information on projects, replaced and withdrawn publications.

IEC Just Published - webstore.iec.ch/justpublished

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

IEC Customer Service Centre - webstore.iec.ch/csc

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

IEC online collection - oc.iec.ch

Discover our powerful search engine and read freely all the publications previews. With a subscription you will always have access to up to date content tailored to your needs.

Electropedia - www.electropedia.org

The world's leading online dictionary on electrotechnology, containing more than 22 000 terminological entries in English and French, with equivalent terms in 18 additional languages. Also known as the International Electrotechnical Vocabulary (IEV) online.

Preview generated by EVS

TECHNICAL REPORT

Overhead electrical conductors – Calculation methods for stranded bare conductors

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

ICS 29.240.20

ISBN 978-2-8322-9938-8

Warning! Make sure that you obtained this publication from an authorized distributor.

CONTENTS

FOREWORD.....	4
1 Scope.....	6
2 Normative references	6
3 Terms and definitions	6
4 Symbols, units and abbreviated terms	7
4.1 Symbols and units.....	7
4.2 Abbreviated terms.....	8
5 Current carrying capacity.....	8
5.1 General.....	8
5.2 Heat balance equation	8
5.3 Calculation method	9
5.4 Joule effect.....	9
5.5 Solar heat gain	9
5.6 Radiated heat loss	9
5.7 Convection heat loss.....	10
5.8 Method to calculate current carrying capacity (CCC).....	10
5.9 Determination of the maximum permissible aluminium temperature.....	10
5.10 Calculated values of current carrying capacity	11
6 Alternating current resistance, Inductive and capacitive reactances.....	11
6.1 General.....	11
6.2 Alternating current (AC) resistance	11
6.3 Inductive reactance.....	12
6.4 Capacitive reactance	14
7 Elongation of stranded conductors.....	14
7.1 General.....	14
7.2 Thermal elongation	15
7.3 Stress-strain properties.....	18
7.4 Assessment of final elastic modulus.....	20
8 Conductor creep	22
8.1 General.....	22
8.2 Creep of single wires	23
8.3 Total conductor creep	24
8.4 Prediction of conductor creep	24
8.5 Creep values	24
9 Loss of strength.....	25
Annex A (informative) A practical example of CCC calculation	27
A.1 Basic Assumptions.....	27
A.2 CCC calculation	27
Annex B (informative) Indicative conditions for CCC calculation.....	29
Bibliography.....	30
Figure 1 – Typical creep curve.....	23
Figure 2 – Loss of strength of aluminium A1 as a function of temperature.....	26
Figure 3 – Loss of strength of aluminium A2	26

Table 1 – Values of K_g for inductive reactance calculations	13
Table 2 – Coefficient of linear expansion β of inhomogeneous conductors designated Ax/Sxy	17
Table 3 – Coefficient of linear expansion β of inhomogeneous conductors designated Ax/20SA	18
Table 4 – Typical stress-strain data of stranded conductors based on published test results	21
Table 5 – Final modulus of elasticity calculated with $E_a = 55000$ MPa and $E_s = 190000$ MPa	22
Table 6 – Final modulus of elasticity calculated with $E_a = 55000$ MPa and $E_s = 159000$ MPa (20SA).....	22
Table 7 – Indicative creep values of stranded conductors(25 %RTS, 20 °C)	25
Table B.1 – Indicative conditions for CCC calculation	29

INTERNATIONAL ELECTROTECHNICAL COMMISSION

**OVERHEAD ELECTRICAL CONDUCTORS – CALCULATION
METHODS FOR STRANDED BARE CONDUCTORS**

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as “IEC Publication(s)”). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

IEC TR 61597 has been prepared by IEC technical committee 7: Overhead electrical conductors. It is a Technical Report.

This second edition cancels and replaces the first edition published in 1995. This edition constitutes a technical revision.

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

- a) Addition of Clause 2 and Clause 3 since the “Normative references” and “Terms and definitions” clauses are mandatory elements of the text according to the new IEC template.
- b) In Clause 6, addition of new kinds of aluminium alloy and aluminium clad steel and their values of temperature coefficients of resistance.
- c) In Clause 6, addition of guidelines for the calculation of AC resistance taken into account hysteresis and eddy current losses.

- d) In Clause 7, addition of the values of coefficient of linear expansion of aluminium alloy conductor aluminium-clad steel reinforced series.
- e) Deletion of Clause 8 “Calculation of maximum conductor length on drums” in the last version.
- f) Annex A, replaced by “A practical example of CCC calculation”.
- g) Annex B, replaced by “Indicative conditions for CCC calculation”.

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

Draft	Report on voting
7/704/DTR	7/707/RVDTR

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 Report is English.

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.

OVERHEAD ELECTRICAL CONDUCTORS – CALCULATION METHODS FOR STRANDED BARE CONDUCTORS

1 Scope

This document, which is a Technical Report, provides information with regard to conductors specified in IEC 61089 and other aluminium and aluminium steel conductors. Such information includes properties of conductors and useful methods of calculation. The following chapters are included in this document.

- current carrying capacity of conductors: Calculation method and typical example
- alternating current resistance, inductive and capacitive reactances
- elongation of conductors: Thermal and stress-strain data
- conductor creep
- loss of strength of aluminium wires due to high temperatures

It is noted that this document does not discuss all theories and available methods for calculating conductor properties, but provides users with simple methods that provide acceptable accuracies.

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 TR 60943:1998, *Guidance concerning the permissible temperature rise for parts of electrical equipment, in particular for terminals*
IEC TR 60943:1998/AMD1:2008

IEC 61089:1991, *Round wire concentric lay overhead electrical stranded conductors*
IEC 61089:1991/AMD1:1997

IEC 60104:1987, *Aluminium-magnesium-silicon alloy wire for overhead line conductors*

IEC 60889:1987, *Hard-drawn aluminium wire for overhead line conductors*

IEC 61232:1993, *Aluminium-clad steel wires for electrical purposes*

IEC 61395:1998, *Overhead electrical conductors – Creep test procedures for stranded conductors*

IEC 62004:2007, *Thermal-resistant aluminium alloy wire for overhead line conductor*

3 Terms and definitions

No terms and definitions are listed in this document.

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