



DPC: 24/30501865 DC

**BSI Group Headquarters**

389 Chiswick High Road London W4 4AL

Tel: +44 (0)20 8996 9000

Fax: +44 (0)20 8996 7400

www.bsigroup.com

Date: 04 October 2024

Origin: International

**Latest date for receipt of comments: 27 November 2024**

Project No. 2018/03897

Responsible committee: W/- Consumer Products and Services Sector Policy and Strategy Committee

Interested committees:

Title: Draft BS EN IEC 60115-2 Fixed resistors for use in electronic equipment. Part 2: Sectional specification: Low-power film resistors with leads for throughhole assembly on circuit boards (THT).

Please notify [admin.start@bsigroup.com](mailto:admin.start@bsigroup.com) if you are aware of any keywords that might assist in clarifying or identifying the standard or of the content of this standard:

- i) has any issues related to 3rd party IPR, patent or copyright
- ii) affects other national standard(s)
- iii) requires additional national guidance or information

**WARNING: THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND 27 November 2024**

This draft is issued to allow comments from interested parties; all comments will be given consideration prior to publication. No acknowledgement will normally be sent. **See overleaf for information on the submission of comments.**

No copying is allowed, in any form, without prior written permission from BSI except as permitted under the Copyright, Designs and Patent Act 1988 or for circulation within a nominating organization for briefing purposes. Electronic circulation is limited to dissemination by e-mail within such an organization by committee members.

Further copies of this draft may be purchased from BSI Shop <http://shop.bsigroup.com> or from BSI Customer Services, Tel: +44(0) 20 8996 9001 or email [cservices@bsigroup.com](mailto:cservices@bsigroup.com). British, International and foreign standards are also available from BSI Customer Services.

Information on the co-operating organizations represented on the committees referenced above may be obtained from <https://standardsdevelopment.bsigroup.com/>.

## Introduction

This draft standard is based on national and international discussions. Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international standards, comments will be reviewed by the relevant UK national committee before sending the consensus UK vote and comments to the international committee, which will then decide appropriate action. If the international standard is approved, it is usual for the text to be published as a British Standard.

For national standards, comments will be reviewed by the relevant UK national committee and the resulting standards published as a British Standard.

## UK Vote

Please indicate whether you consider the UK should submit a negative (with supporting technical reasons) or positive vote on this draft. Please indicate if you are aware of any reason why this draft standard should not be published as a British Standard.

## Submission of Comments

- **Annotated drafts are not acceptable and will be rejected.**
- All comments should be submitted online at <https://standardsdevelopment.bsigroup.com/>. You will need to register in order to comment.

## Template for comments and secretariat observations

|                  |                        |
|------------------|------------------------|
| Date: xx/xx/20xx | Document: ISO/DIS xxxx |
|------------------|------------------------|

| 1  | 2                                          | (3)                          | 4               | 5                                                                                                                                  | (6)                                                                      | 7                                                  |
|----|--------------------------------------------|------------------------------|-----------------|------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------|
| MB | Clause No./ Subclause No./Annex (e.g. 3.1) | Paragraph/ Figure/Table/Note | Type of comment | Comment (justification for change) by the MB                                                                                       | Proposed change by the MB                                                | Secretariat observations on each comment submitted |
|    | 3.1                                        | Definition 1                 | ed              | Definition is ambiguous and needs clarifying.                                                                                      | Amend to read '...so that the mains connector to which no connection...' |                                                    |
|    | 6.4                                        | Paragraph 2                  | te              | The use of the UV photometer as an alternative cannot be supported as serious problems have been encountered in its use in the UK. | Delete reference to UV photometer.                                       |                                                    |



**40/2690/CD**

COMMITTEE DRAFT (CD)

PROJECT NUMBER:

**IEC 60115-2 ED4**

DATE OF CIRCULATION:

**2019-08-02**

CLOSING DATE FOR COMMENTS:

**2019-10-25**

SUPERSEDES DOCUMENTS:

**40/2653/RR**

IEC TC 40 : CAPACITORS AND RESISTORS FOR ELECTRONIC EQUIPMENT

SECRETARIAT:

Netherlands

SECRETARY:

Mr Ronald Drenthen

OF INTEREST TO THE FOLLOWING COMMITTEES:

PROPOSED HORIZONTAL STANDARD:

☐

Other TC/SCs are requested to indicate their interest, if any, in this CD to the secretary.

FUNCTIONS CONCERNED:

☐ EMC

☐ ENVIRONMENT

☐ QUALITY ASSURANCE

☐ SAFETY

This document is still under study and subject to change. It should not be used for reference purposes.

Recipients of this document are invited to submit, with their comments, notification of any relevant patent rights of which they are aware and to provide supporting documentation.

TITLE:

**Fixed resistors for use in electronic equipment - Part 2: Sectional specification: Leaded fixed low power film resistors**

NOTE FROM TC/SC OFFICERS:

Copyright © 2019 International Electrotechnical Commission, IEC. All rights reserved. It is permitted to download this electronic file, to make a copy and to print out the content for the sole purpose of preparing National Committee positions. You may not copy or "mirror" the file or printed version of the document, or any part of it, for any other purpose without permission in writing from IEC.

# CONTENTS

|    |                                                                      |    |
|----|----------------------------------------------------------------------|----|
| 1  | FOREWORD .....                                                       | 6  |
| 2  | 1 Scope .....                                                        | 8  |
| 3  | 2 Normative references .....                                         | 8  |
| 4  | 3 Terms and definitions .....                                        | 9  |
| 5  | 3.1 Terms .....                                                      | 9  |
| 6  | 3.2 Product technologies .....                                       | 9  |
| 7  | 3.3 Product classification .....                                     | 10 |
| 8  | 4 Preferred characteristics .....                                    | 10 |
| 9  | 4.1 General .....                                                    | 10 |
| 10 | 4.2 Style and dimensions .....                                       | 10 |
| 11 | 4.3 Preferred climatic categories .....                              | 13 |
| 12 | 4.4 Resistance .....                                                 | 13 |
| 13 | 4.5 Tolerances on resistance .....                                   | 13 |
| 14 | 4.6 Rated dissipation $P_{70}$ .....                                 | 13 |
| 15 | 4.7 Limiting element voltage $U_{\max}$ .....                        | 14 |
| 16 | 4.8 Insulation voltage $U_{\text{ins}}$ .....                        | 14 |
| 17 | 4.9 Insulation resistance $R_{\text{ins}}$ .....                     | 14 |
| 18 | 5 Tests and test severities .....                                    | 15 |
| 19 | 5.1 General provisions for tests invoked by this specification ..... | 15 |
| 20 | 5.2 Preparation of specimens .....                                   | 15 |
| 21 | 5.3 Tests .....                                                      | 20 |
| 22 | 5.4 Optional and/or additional tests .....                           | 29 |
| 23 | 6 Performance requirements .....                                     | 31 |
| 24 | 6.1 General .....                                                    | 31 |
| 25 | 6.2 Limits for change of resistance at tests .....                   | 31 |
| 26 | 6.3 Temperature coefficient of resistance .....                      | 34 |
| 27 | 6.4 Temperature rise .....                                           | 34 |
| 28 | 6.5 Visual inspection .....                                          | 35 |
| 29 | 6.6 Solderability .....                                              | 35 |
| 30 | 6.7 Insulation resistance .....                                      | 36 |
| 31 | 6.8 Flammability .....                                               | 36 |
| 32 | 7 Marking, packaging and ordering information .....                  | 36 |
| 33 | 7.1 Marking of the component .....                                   | 36 |
| 34 | 7.2 Packaging .....                                                  | 36 |
| 35 | 7.3 Marking of the packaging .....                                   | 36 |
| 36 | 7.4 Ordering information .....                                       | 37 |
| 37 | 8 Detail specifications .....                                        | 37 |
| 38 | 8.1 General .....                                                    | 37 |
| 39 | 8.2 Information to be specified in a detail specification .....      | 37 |
| 40 | 9 Quality assessment procedures .....                                | 40 |
| 41 | 9.1 General .....                                                    | 40 |
| 42 | 9.2 Definitions .....                                                | 40 |
| 43 | 9.3 Formation of inspection lots .....                               | 40 |
| 44 | 9.4 Approved component (IECQ AC) procedures .....                    | 41 |
| 45 | 9.5 Qualification approval (QA) procedures .....                     | 41 |
| 46 | 9.6 Capability certification (IECQ AC-C) procedures .....            | 42 |

|    |      |                                                                                          |    |
|----|------|------------------------------------------------------------------------------------------|----|
| 47 | 9.7  | Technology certification (IECQ-AC-TC) procedures .....                                   | 42 |
| 48 | 9.8  | Periodical evaluation of termination platings .....                                      | 42 |
| 49 | 9.9  | Delayed delivery .....                                                                   | 42 |
| 50 | 9.10 | Certified test records .....                                                             | 42 |
| 51 | 9.11 | Certificate of conformity (CoC) .....                                                    | 42 |
| 52 |      | Annex A (normative) Symbols and abbreviated terms .....                                  | 53 |
| 53 | A.1  | Symbols .....                                                                            | 53 |
| 54 | A.2  | Abbreviated terms .....                                                                  | 56 |
| 55 |      | Annex B (normative) Visual inspection acceptance criteria .....                          | 58 |
| 56 | B.1  | General .....                                                                            | 58 |
| 57 | B.2  | Criteria for ... ..                                                                      | 58 |
| 58 | B.3  | Criteria for ... ..                                                                      | 58 |
| 59 | B.4  | Criteria for ... ..                                                                      | 58 |
| 60 |      | Annex C (normative) Workmanship requirements for the assembly of leaded film             |    |
| 61 |      | resistors .....                                                                          | 59 |
| 62 | C.1  | General .....                                                                            | 59 |
| 63 | C.2  | Lead forming .....                                                                       | 59 |
| 64 | C.3  | Mounting .....                                                                           | 61 |
| 65 | C.4  | Lead trimming .....                                                                      | 63 |
| 66 |      | Annex D (normative) 0 $\Omega$ Resistors (Jumper) .....                                  | 65 |
| 67 | D.1  | General .....                                                                            | 65 |
| 68 | D.2  | Preferred characteristics .....                                                          | 65 |
| 69 | D.3  | Tests and test severities .....                                                          | 65 |
| 70 | D.4  | Performance requirements .....                                                           | 66 |
| 71 | D.5  | Marking, packaging and ordering information .....                                        | 66 |
| 72 | D.6  | Detail specification .....                                                               | 66 |
| 73 | D.7  | Quality assessment procedures .....                                                      | 67 |
| 74 |      | Annex E (informative) Guide on the application of optional and/or additional tests ..... | 68 |
| 75 | E.1  | General .....                                                                            | 68 |
| 76 | E.2  | Endurance at room temperature .....                                                      | 68 |
| 77 | E.3  | Single-pulse high-voltage overload test .....                                            | 69 |
| 78 | E.4  | Periodic- pulse overload test .....                                                      | 70 |
| 79 | E.5  | Operation at low temperature .....                                                       | 70 |
| 80 | E.6  | Damp heat, steady state, accelerated .....                                               | 71 |
| 81 |      | Annex F (informative) Radial formed types .....                                          | 73 |
| 82 | F.1  | General .....                                                                            | 73 |
| 83 | F.2  | Radial formed types for through-hole assembly .....                                      | 75 |
| 84 | F.3  | Radial formed types for surface-mount assembly .....                                     | 79 |
| 85 | F.4  | Packaging .....                                                                          | 80 |
| 86 | F.5  | Quality assessment .....                                                                 | 80 |
| 87 |      | Annex X (informative) Cross reference for the prior revision of this specification ..... | 83 |
| 88 |      | Bibliography .....                                                                       | 86 |

|     |                                                                                             |    |
|-----|---------------------------------------------------------------------------------------------|----|
| 89  | Figure 1 – Illustration of a typical axial leaded resistor .....                            | 9  |
| 90  | Figure 2 – Illustrations of typical radial leaded resistors .....                           | 9  |
| 91  | Figure 3 – Shape and dimension of axial leaded resistors .....                              | 11 |
| 92  | Figure 4 – Alternative methods for specification of the length of excessive protective      |    |
| 93  | coating on axial leaded resistors .....                                                     | 11 |
| 94  | Figure 5 – Lead-wire spacing of axial leaded resistors with bent leads .....                | 12 |
| 95  | Figure 6 – Specification of the lead eccentricity of axial leaded resistors .....           | 12 |
| 96  | Figure 7 – Derating curve .....                                                             | 14 |
| 97  | Figure 8 – Basic layout for mechanical, environmental and electrical tests .....            | 17 |
| 98  | Figure 9 – Assembly of specimen to the test board .....                                     | 18 |
| 99  | Figure 10 – Mounting of axial leaded specimens on a rack, top view .....                    | 19 |
| 100 | Figure 11 – Examples of specimen lead fixation devices .....                                | 20 |
| 101 | Figure C.1 – Lead forming dimensions .....                                                  | 59 |
| 102 | Figure C.2 – Examples of mounting height support .....                                      | 60 |
| 103 | Figure C.3 – Clearance between coating and solder .....                                     | 61 |
| 104 | Figure C.4 – Lateral mounting .....                                                         | 62 |
| 105 | Figure C.5 – Upright mounting .....                                                         | 63 |
| 106 | Figure C.6 – Lead protrusion .....                                                          | 64 |
| 107 | Figure C.7 – Lead end distortion .....                                                      | 64 |
| 108 | Figure F.1 – Shape and dimensions of radial formed resistor for lateral body position ..... | 75 |
| 109 | Figure F.2 – Shape and dimensions of radial formed resistor for lateral body position       |    |
| 110 | with kinked lead wires .....                                                                | 75 |
| 111 | Figure F.3 – Shape and dimensions of radial formed resistor for upright body position ..... | 76 |
| 112 | Figure F.4 – Shape and dimensions of radial formed resistor for upright body position       |    |
| 113 | and wide spacing .....                                                                      | 77 |
| 114 | Figure F.5 – Shape and dimensions of radial formed resistor for upright body position       |    |
| 115 | and wide spacing, with kinked lead wire .....                                               | 77 |
| 116 | Figure F.6 – Shape and dimensions of radial formed resistor for surface-mount               |    |
| 117 | assembly (Z-bend) .....                                                                     | 79 |
| 118 | Figure F.7 – Land pattern dimensions for surface-mount assembly .....                       | 79 |
| 119 |                                                                                             |    |
| 120 | Table 1 – Preferred styles of axial leaded resistors .....                                  | 10 |
| 121 | Table 2 – Test board dimensions .....                                                       | 16 |
| 122 | Table 3 – Preferred aggravated overload conditions .....                                    | 23 |
| 123 | Table 4 – Limits for the change of resistance at tests .....                                | 33 |
| 124 | Table 5 – Permitted change of resistance due to the variation of temperature .....          | 34 |
| 125 | Table 6 – Test schedule for the qualification approval .....                                | 43 |
| 126 | Table 7 – Test schedule for the quality conformance inspections .....                       | 48 |
| 127 | Table C.1 – Lead bend radius .....                                                          | 60 |
| 128 | Table C.2 – Recommended circuit board bore diameters .....                                  | 61 |
| 129 | Table C.3 – Clearance of lateral mounted resistors .....                                    | 62 |
| 130 | Table E.1 – Implementation of the test endurance at room temperature .....                  | 68 |
| 131 | Table E.2 – Implementation of the single-pulse high-voltage overload test .....             | 69 |
| 132 | Table E.3 – Implementation of the periodic-pulse overload test .....                        | 70 |
| 133 | Table E.4 – Implementation of the operation at low temperature test .....                   | 71 |

|     |                                                                                  |    |
|-----|----------------------------------------------------------------------------------|----|
| 134 | Table E.5 – Implementation of the test damp heat, steady state, accelerated..... | 72 |
| 135 | Table F.1 – Feasible lead-wire spacing of radial formed resistor for             |    |
| 136 | lateral body position.....                                                       | 76 |
| 137 | Table F.2 – Feasible lead-wire spacing of radial formed resistor for             |    |
| 138 | upright body position.....                                                       | 78 |
| 139 | Table X.1 – Cross reference for references to clauses .....                      | 83 |
| 140 | Table X.2 – Cross reference for references to figures .....                      | 85 |
| 141 | Table X.3 – Cross reference for references to table .....                        | 85 |
| 142 |                                                                                  |    |

## INTERNATIONAL ELECTROTECHNICAL COMMISSION

## FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

**Part 2: Sectional specification:  
Leaded fixed low power film resistors**

## FOREWORD

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

International Standard IEC 60115-2 has been prepared by IEC technical committee 40: Capacitors and resistors for electronic equipment.

This fourth edition cancels and replaces the third edition, published in 2014, and it constitutes a technical revision.

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

- a) the definitions of product technologies and product classification levels of the generic specification, IEC 60115-1:201X, have been adopted;
- b) a basis for the optional specification of the lead eccentricity of axial leaded resistors has been amended in 4.2;
- c) the 'period-pulse high-voltage overload test' of IEC 60115-1:201X, 8.3 has been adopted as default test method in 5.3.8, thereby replacing the legacy test 'periodic-pulse overload test' if IEC 60115-1:201X, 8.4;

- d) the revised solderability test of IEC 60115-1:201X, 11.1 has been adopted in 5.3.19 and 5.3.20;
- e) the combined solvent resistance test of IEC 60115-1:201X, 11.3 has been adopted in 5.3.22;
- f) the 'endurance at room temperature test' of IEC 60115-1:201X, 7.2 (prior Annex C of IEC 60115-2:2014) has been adopted as an optional test in 5.4.1;
- g) the 'single-pulse high-voltage overload test' of IEC 60115-1:201X, 8.2, applied with the pulse shape 10/700 in 5.3.7, is complemented with the optional alternative provided by the pulse shape 1,2/50 in 5.4.2;
- h) climatic tests for 'operation at low temperature' of IEC 60115-1:201X, 10.2, and for 'damp heat, steady state, accelerated' of IEC 60115-1:201X, 10.4, have been adopted as optional tests in 5.4.4. and 5.4.5, respectively;
- i) new guidance is provided in 6.2 on the presentation of stability requirements with their permissible absolute and relative deviations;
- j) acceptance criteria for the visual inspection have been added in 6.5 and in Annex B;
- k) visual inspection for the primary and proximity packaging has been added in 6.5.2 and in 7.2
- l) the periodical evaluation of termination platings has been added as a new topic of quality assessment in 9.8;
- m) the revised test clause numbering of IEC 60115-1:201X has been applied;
- n) a new Annex C has been added to summarize workmanship requirements for the assembly of leaded film resistors, e.g. as given in the prior IEC 61192 series of standards;
- o) the informative Annex F (prior Annex B) on radial formed styles has been amended with details on a formed Z-bend style for surface-mount assembly.

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

| FDIS       | Report on voting |
|------------|------------------|
| 40/XX/FDIS | 40/XX/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.

A list of all parts in the IEC 60115 series, published under the general title *Fixed resistors for use in electronic equipment*, can be found on the IEC website.

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

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

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

## FIXED RESISTORS FOR USE IN ELECTRONIC EQUIPMENT –

### Part 2: Sectional specification: Leaded fixed low-power film resistors

#### 1 Scope

This part of IEC 60115 is applicable to leaded fixed low-power film resistors for use in electronic equipment.

These resistors are typically described according to types (different geometric shapes) and styles (different dimensions) and product technology. The resistive element of these resistors is typically protected by a conformal lacquer coating. These resistors have wire terminations and are primarily intended to be mounted on a circuit board in through-hole technique.

The object of this standard is to prescribe preferred ratings and characteristics and to select from IEC 60115-1, the appropriate quality assessment procedures, tests and measuring methods and to give general performance requirements for this type of resistor.

#### 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 60062:2016, *Marking codes for resistors and capacitors*

IEC 60068-1:2013, *Environmental testing – Part 1: General and guidance*

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

IEC 60068-2-2, *Basic environmental testing procedures – Part 2-2: Tests - Tests B: Dry heat*

IEC 60068-2-6:2007, *Environmental testing – Part 2-6: Tests - Test Fc: Vibration (sinusoidal)*

IEC 60068-2-20:2008, *Environmental testing – Part 2-20: Tests – Test T – Test methods for solderability and resistance to soldering heat of leaded devices*

IEC 60115-1:201X, *Fixed resistors for use in electronic equipment - Part 1: Generic specification*

IEC 60286-1, *Packaging of components for automatic handling - Part 1: Tape packaging of components with axial leads on continuous tapes*

IEC 60294:2012, *Measurement of the dimensions of a cylindrical component having two axial terminations*

IEC 60301, *Preferred diameters of wire terminations of capacitors and resistors*

IEC 61193-2:2007, *Quality assessment systems – Part 2: Selection and use of sampling plans for inspection of electronic components and packages*

IEC 61760-1:2006, *Surface mounting technology – Part 1: Standard method for the specification of surface mounting components (SMDs)*

### 3 Terms and definitions

#### 3.1 Terms

For the purpose of this document, the terms and definitions given in IEC 60115-1:201X, 3.1, as well as the following, apply.

##### 3.1.1

##### axial type

physical design of a component with leads extending to both sides along the longitudinal axis of the components body

Example: Figure 1 shows an illustration of a typical axial leaded resistor.

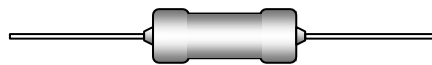


Figure 1 – Illustration of a typical axial leaded resistor

##### 3.1.2

##### radial type

physical design of a component with leads extending to one side along the longitudinal or along the diagonal axis of the component body

Note 1 to entry: The single direction of the leads may originate from inside the component body or by forming one or both leads outside of the component body.

Example: Figure 2 shows illustration of typical radial leaded resistors.

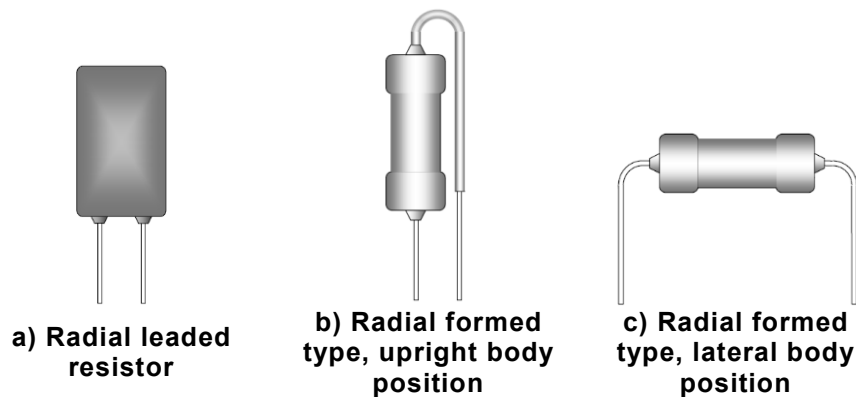


Figure 2 – Illustrations of typical radial leaded resistors

#### 3.2 Product technologies

The definitions of product technologies intend to provide the reader with a guidance on the variety of technologies used for the making of resistors, and to aid their identification

For the purpose of this document, the following product technologies as described in IEC 60115-1:201X, Clause 3.2 apply:

- Metal film technology
- Metal glaze technology
- Metal oxide technology
- Carbon film technology

### 3.3 Product classification

The introduction of a product classification permits the user to select performance requirements according to the conditions of the intended end-use application.

For the purpose of this document, the following product classification levels as defined in IEC 60115-1:201X, Clause 3.4 apply:

- Level G – General electronic equipment
- Level P – High-performance electronic equipment
- Level R – High-performance and high-reliable electronic equipment

## 4 Preferred characteristics

### 4.1 General

The values given in detail specifications shall preferably be selected from the following:

### 4.2 Style and dimensions

#### 4.2.1 Preferred styles and outline dimensions

The shape and dimensions of axial leaded resistors is shown in Figure 3, with preferred styles and their respective dimensions given in Table 1. Style designators of axial leaded film resistors begin with RA.

**Table 1 – Preferred styles of axial leaded resistors**

| Style <sup>a</sup> | Dimensions                |                         |                           |                                |
|--------------------|---------------------------|-------------------------|---------------------------|--------------------------------|
|                    | Body diameter $D^c$<br>mm | Body length $L^b$<br>mm | Lead diameter $d^d$<br>mm | Lead length $l_{\min}^e$<br>mm |
| RA_0204            | $2^{+0}_{-0,7}$           | $4^{+1,0}_{-1,0}$       | 0,5                       | 21                             |
| RA_0207            | $2^{+0,5}_0$              | $7^{+0,2}_{-2,0}$       | 0,6                       | 21                             |
| RA_0309            | $3^{+0}_{-0,5}$           | $9^{+0,2}_{-2,5}$       | 0,7                       | 21                             |
| RA_0411            | $4^{+0}_{-1,0}$           | $11^{+0,2}_{-3,5}$      | 0,7                       | 21                             |
| RA_0414            | $4^{+0,2}_{-0,5}$         | $14^{+0,2}_{-4,0}$      | 0,8                       | 21                             |
| RA_0617            | $6^{+0,5}_{-1,0}$         | $17^{+0,2}_{-4,0}$      | 0,8                       | 21                             |
| RA_0922            | $9^{+0,5}_{-3,0}$         | $22^{+0,2}_{-5,0}$      | 0,8                       | 21                             |

<sup>a</sup> The style reference is completed by a third character for the product technology, as given in 3.2:

M = metal film; G = metal glaze; C = carbon film; X = metal oxide.

Examples for complete style references are RAM0204, RAX0414.

<sup>b</sup> The body length of the resistor  $L$  shall be measured according to IEC 60294, see 5.2.1.

<sup>c</sup> The body diameter of the resistor  $D$  shall be gauged as prescribed in IEC 60294.

<sup>d</sup> Nominal diameter of the lead wires  $d$ , with permissible tolerances according to IEC 60301.

<sup>e</sup> The minimum lead length  $l_{\min}$  applies only to the free lead length in tape packaging according to IEC 60286-1.

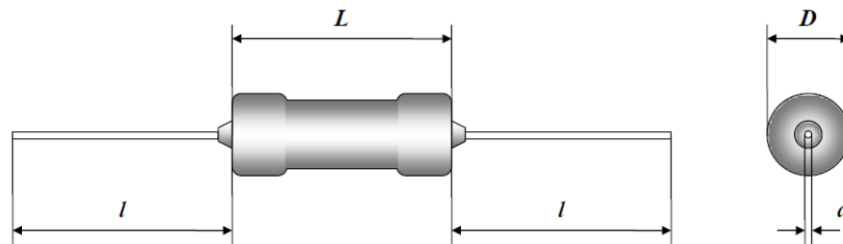


**Figure 3 – Shape and dimension of axial leaded resistors**

The detail specification shall present a realistic outline illustration of the resistors covered therein, which shall contain all relevant dimensions.

For the specification of any unsolderable area on the lead wires, e.g. due to excessive coating or due to extended welding beads, if required, the considerations of 4.2.2 shall be applied.

For the specification of any eccentricity of the lead wires, if required, the considerations of 4.2.4 shall be applied.

#### 4.2.2 Length of excessive coating or welding bead

As an optional element, the detail specification may specify the permissible length of excessive protective coating extending onto the leads of the resistor, using one of the alternative methods given in Figure 4.

The length of excessive protective coating, dimension  $c$  as shown in Figure 4a, shall be gauged as prescribed in IEC 60294:2012, Clause 4, using a gauge plate of a thickness corresponding to the maximum permissible length of excessive protective coating. A method for measuring or gauging the length between clean leads, dimension  $L_c$ , as shown in Figure 4b, shall be prescribed by the detail specification, if required.



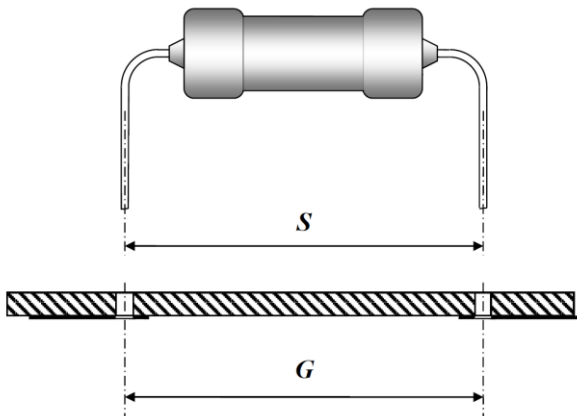
**a) Length of excessive coating,  $c$**

**b) Length between clean leads,  $L_c$**

**Figure 4 – Alternative methods for specification of the length of excessive protective coating on axial leaded resistors**

#### 4.2.3 Lead wire spacing

Associated with a style and the actual dimensions of the respective products is the shortest possible standard distance of the centre line of the lead wires bent to  $90^\circ$  from the direct axis of the resistor body, the lead-wire spacing  $S$ , as shown in Figure 5. The spacing  $S$  also defines the minimum grid dimension  $G$  of PCB bores into which the resistor can be assembled with its body located lateral on the PCB surface, when the required forming is done in the assembly process.



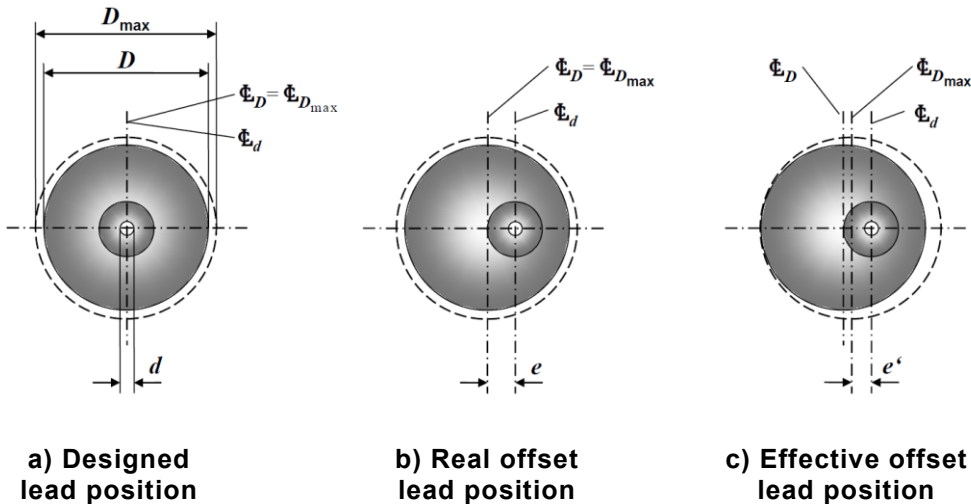
Key:  
 $S$  Resistor lead-wire spacing, distance of the centre lines of the bent leads.  
 $G$  Grid of the bores in the circuit board intended for assembly of the resistor  
NOTE The drawing of the resistor with formed leads is not intended to suggest the availability of ready formed resistors under this specification.

Figure 5 – Lead-wire spacing of axial leaded resistors with bent leads

If the component type is other than described above, e.g. for radial leaded resistors, the detail specification shall state such dimensional information as will adequately describe the resistor. See the considerations on radial formed types of resistors in Annex F.

4.2.4 Lead eccentricity

Axial leaded resistors are typically designed with centric leads emerging from both faces of the resistor body, unless specifically declared and specified otherwise. A significant offset lead position may jeopardize an automated assembly process and is likely to infringe upon designed distances within the assembled circuit and thereby adversely affect safety requirements.



Key  
 $d, D$  nominal diameters, see Table 1  
 $D_{max}$  maximum permissible diameter D, including the permissible tolerance given in Table 1  
 $\Phi$  centre line  
 $e$  real eccentricity, distance between centre lines of  $D$  and  $d$   
 $e'$  effective eccentricity, distance between centre lines of  $D_{max}$  and  $d$

Figure 6 – Specification of the lead eccentricity of axial leaded resistors

As an optional element, the detail specification may specify the permissible eccentricity of the leads of a resistor, by means of the real eccentricity  $e$ , or of the effective eccentricity  $e'$  as shown in Figure 6. The eccentricity shall be assessed on the straight part of each lead nearest to the resistor body.

The detail specification shall prescribe a suitable method for measuring or gauging the lead eccentricity, if required.

#### 4.3 Preferred climatic categories

The leaded film resistors covered by this specification are classified into climatic categories according to the general rules given in IEC 60068-1:2013, Annex A.

The lower and upper category temperature and the duration of the damp heat, steady state test shall be chosen from the following:

|                                  |                                            |
|----------------------------------|--------------------------------------------|
| Lower category temperature (LCT) | –65 °C; –55 °C; –40 °C; –25 °C and –10 °C. |
|----------------------------------|--------------------------------------------|

|                                  |                                                   |
|----------------------------------|---------------------------------------------------|
| Upper category temperature (UCT) | 85 °C; 100 °C; 125 °C; 155 °C; 175 °C and 200 °C. |
|----------------------------------|---------------------------------------------------|

|                                           |                 |
|-------------------------------------------|-----------------|
| Duration of damp heat, steady state test: | 21 and 56 days. |
|-------------------------------------------|-----------------|

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively.

#### 4.4 Resistance

See IEC 60115-1:201X, 4.2.2.

#### 4.5 Tolerances on resistance

The preferred tolerances on resistance are:

±10 %; ±5 %; ±2 %; ±1 %; ±0,5 %; ±0,25 %; ±0,1 %; ±0,05 %; ±0,02 % and ±0,01 %.

#### 4.6 Rated dissipation $P_{70}$

The preferred values of rated dissipation  $P_{70}$  for mounted resistors at 70 °C ambient temperature are taken on from every third value of the R10 series of preferred numbers of ISO 3: 0,063 W; 0,125 W; 0,25 W; 0,5 W; 1 W and 2 W.

The detail specification shall specify the conditions under which the rated dissipation applies.

Figure 7 shows the format of a typical derating curve, suitable for providing information on the required derating of the permissible dissipation for any ambient temperature above the rated temperature.

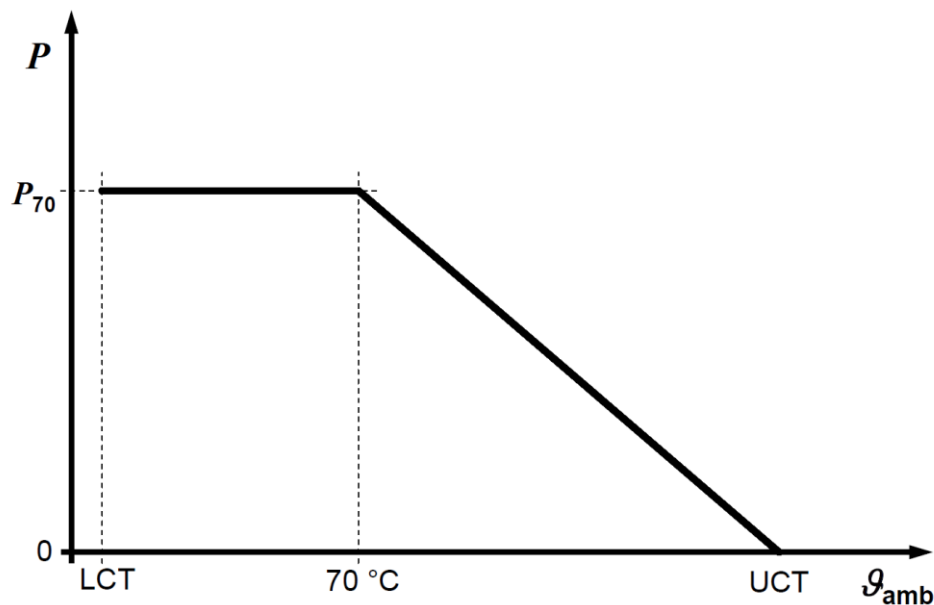


Figure 7 – Derating curve

The upper category temperature (UCT), which is used for test procedures, should be based on the maximum element temperature (MET).

All end points and break points on the derating curve shall be verified by test.

#### 4.7 Limiting element voltage $U_{\max}$

The preferred values of DC or AC RMS limiting element voltage  $U_{\max}$  are taken on from the R10 series of preferred numbers of ISO 3: 50 V; 63 V; 80 V; 100 V; 125 V; 160 V; 200 V; 250 V; 315 V; 400 V; 500 V; 630 V; 800 V and 1 000 V.

In addition, the following customary values are still in use:

- 300 V ( $2^{\text{nd}}$  more rounded R'10 value from ISO 497);
- 750 V (R40 value from ISO 3).

#### 4.8 Insulation voltage $U_{\text{ins}}$

For insulated resistors, the preferred values of DC or AC peak insulation voltage  $U_{\text{ins}}$  are taken on from the R10 series of preferred numbers of ISO 3: 80 V; 100 V; 125 V; 160 V; 200 V; 250 V; 315 V; 400 V; 500 V; 630 V; 800 V; 1 000 V; 1 250 V and 1 600 V.

In addition, the following customary values are still in use:

- 150 V; 300 V and 1 500 V ( $2^{\text{nd}}$  more rounded R'10 values from ISO 497);
- 1 100 V ( $1^{\text{st}}$  more rounded R'20 value from ISO 497);
- 75 V and 750 V (R40 values from ISO 3).

The insulation voltage  $U_{\text{ins}}$  shall not be specified lower than the AC voltage peak value that can be applied continuously and therefore shall not be rated less than  $U_{\text{ins}} = 1,42 \cdot U_{\max}$ .

#### 4.9 Insulation resistance $R_{\text{ins}}$

For insulated resistors, the insulation resistance  $R_{\text{ins}}$  shall preferably be not less than 1 GΩ.

NOTE See 6.7 for requirements to the insulation resistance  $R_{\text{ins}}$  after tests.

## 5 Tests and test severities

### 5.1 General provisions for tests invoked by this specification

Clause 5.2 provides detailed prescriptions related to the preparation of specimens for tests, particularly on a preferred variety of mounting methods. Any deviation from these prescriptions as may be required by the type of resistors covered by a particular detail specification under this sectional specification shall be clearly prescribed by such particular detail specification.

Clause 5.3 provides detailed prescriptions of all the tests applied by the test schedules for qualification approval and for quality conformance inspection. The amount of information given here clearly exceeds any short overview information fitted in to the conditions of test column of the respective test schedule and therefore shall take precedence over the overview information.

Clause 5.4 provides detailed prescriptions of additional tests which are not contained in the test schedules for qualification approval and for quality conformance inspection. These tests are intended to be used as an alternative to tests contained in the test schedules, or as additions to the prescribed number of tests, in the drafting of a detail specification aiming to cover special requirements. Any prescription of such additional test shall be accompanied by the prescription of suitable inspections, e.g. visual inspection or assessment of the change of resistance. Furthermore, the respective detail specification shall present suitable performance requirements for any applied additional test. See Annex E for recommendations on the suitable implementation of these optional and/or additional tests into the test schedules.

The specified tests shall be conducted under standard atmospheric conditions for testing as outlined in IEC 60115-1:201X, 5.2.3, unless prescribed otherwise.

Tolerances on specified test parameters shall be applied according to IEC 60115-1:201X, 5.3, unless prescribed otherwise.

### 5.2 Preparation of specimens

#### 5.2.1 Drying

Procedure 1 of IEC 60115-1:201X, 5.4 shall be used.

#### 5.2.2 Mounting of components on test boards

##### 5.2.2.1 General

If the relevant specification calls for mounting of the specimens on a test board, the axial leaded resistors, regardless of their product technology, shall be mounted on a board as specified in 5.2.2.2, with applying the assembly provisions of 5.2.2.3.

The provisions of IEC 60115-1:201X, 5.5.2 shall be applied.

##### 5.2.2.2 Specification of test boards

Unless specified otherwise, the test boards shall be an epoxide woven glass type with a thickness of  $(1,6 \pm 0,1)$  mm, with conductors made of un-tinned copper with a nominal thickness of 35  $\mu\text{m}$ .

Unless specified otherwise, the central area of tests boards shall comply with the basic layout as shown in Figure 8. Outside of the defined area, the conductor tracks should not be wider than prescribed inside. The total board size, connector style, use of solder mask, and number of specimens on each board are at the discretion of the executor of tests, and subject of approval of the responsible certification body.

The detail specification may provide a different material specification and basic layout, as technically required for the scope of components covered therein.

Test boards with Kelvin (4 point) connections according to Figure 8a, with the dimensions given in Table 2, shall be used for tests for a stability class 0,1 or below and if the resistance of the specimen is below 100  $\Omega$ .

Test boards according to Figure 8b, with the dimensions given in Table 2, may be used for tests for any stability class above 0,1, when the resistance of the specimen is 100  $\Omega$  or higher, or for tests not requiring a measurement of the resistance value.

**Table 2 – Test board dimensions**

| Style                                                                                                                                                                                                                                                                                                             | <i>b</i><br>mm | <i>G</i><br>mm | <i>C</i><br>mm | <i>P</i><br>mm | <i>M</i><br>mm |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|
| RA_0204                                                                                                                                                                                                                                                                                                           | 0,8 ± 0,1      | 7,5 ± 0,1      | 2,0 ± 0,1      | 15,0 ± 0,1     | 7,5 ± 0,1      |
| RA_0207                                                                                                                                                                                                                                                                                                           | 1,0 ± 0,1      | 10,0 ± 0,1     | 5,0 ± 0,1      | 20,0 ± 0,1     | 10,0 ± 0,1     |
| RA_0309                                                                                                                                                                                                                                                                                                           | 1,3 ± 0,1      | 12,5 ± 0,1     | 7,5 ± 0,1      | 25,0 ± 0,1     | 12,5 ± 0,1     |
| RA_0411                                                                                                                                                                                                                                                                                                           | 1,3 ± 0,1      | 15,0 ± 0,1     | 10,0 ± 0,1     | 30,0 ± 0,1     | 15,0 ± 0,1     |
| RA_0414                                                                                                                                                                                                                                                                                                           | 1,3 ± 0,1      | 17,5 ± 0,1     | 10,0 ± 0,1     | 30,0 ± 0,1     | 15,0 ± 0,1     |
| RA_0617                                                                                                                                                                                                                                                                                                           | 1,3 ± 0,1      | 22,5 ± 0,1     | 10,0 ± 0,1     | 45,0 ± 0,1     | 22,5 ± 0,1     |
| RA_0922                                                                                                                                                                                                                                                                                                           | 1,3 ± 0,1      | 27,5 ± 0,1     | 15,0 ± 0,1     | 45,0 ± 0,1     | 22,5 ± 0,1     |
| No metal area is permitted on the bottom side or on any inner layer under the defined area, except a single straight sense conductor with a maximum width of 0,3 mm for every Kelvin connection.<br>If applicable, the test board layout may also run both sense conductors to the same edge of the defined area. |                |                |                |                |                |

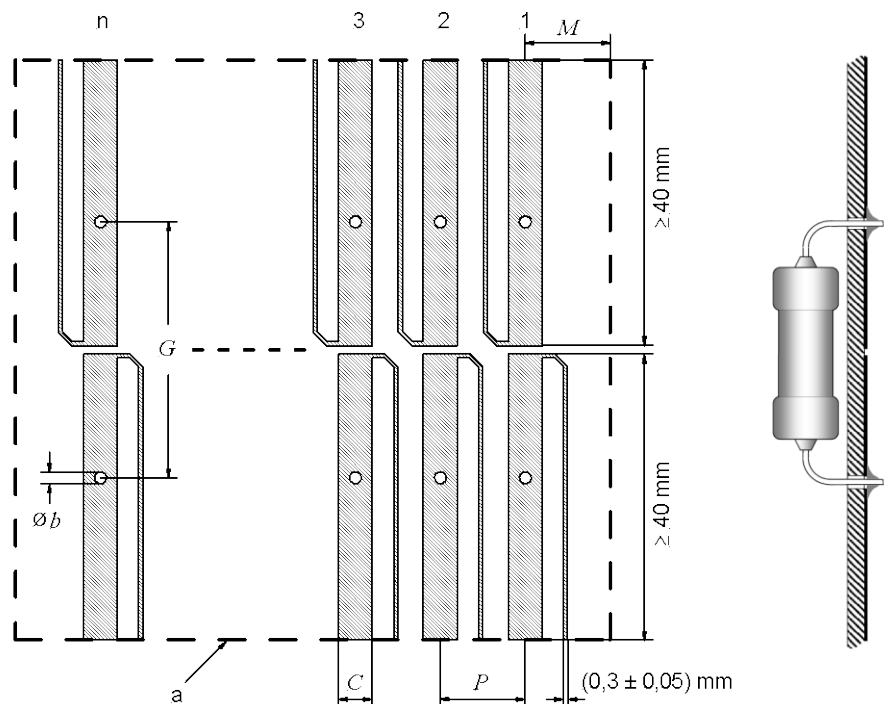


**Figure 8a - Basic layout with Kelvin (4 point) connections**

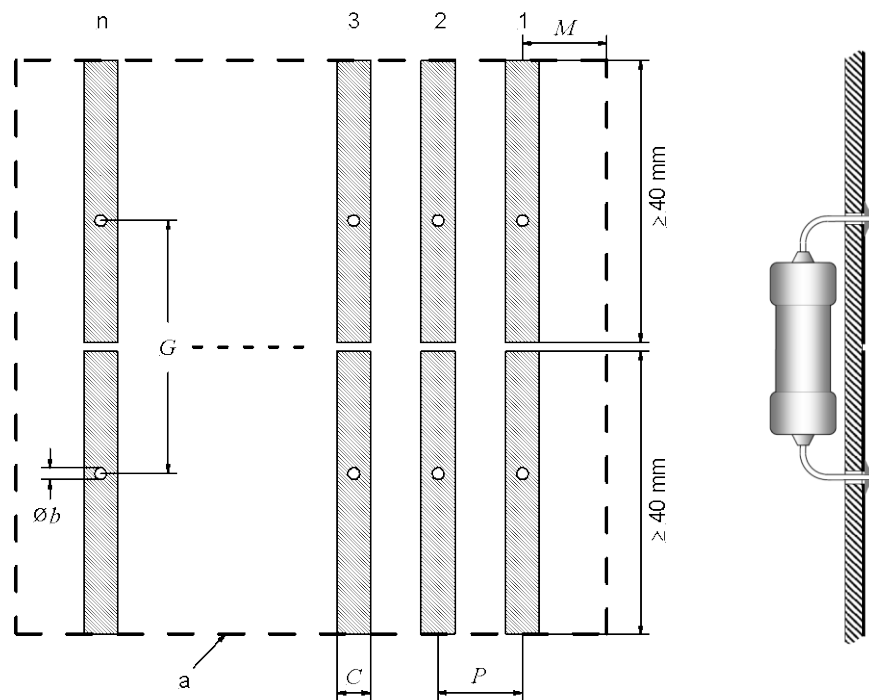


**Figure 8b - Basic layout with standard connections**

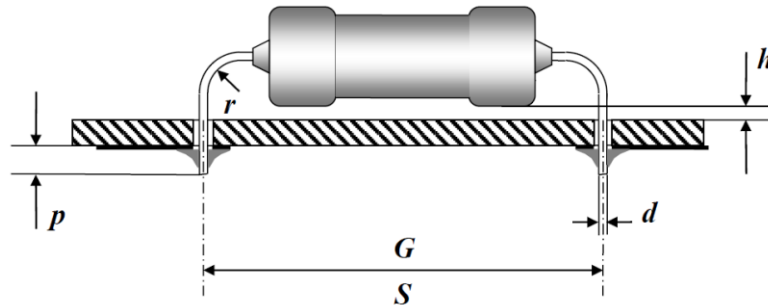
### Key

- |                                                                                     |                                                                                             |
|-------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| a                                                                                   | limit of the defined area, where dimensions apply as given in Table 2                       |
| C                                                                                   | width of the force copper conductor                                                         |
| P                                                                                   | centre line pitch of any two adjacent force conductors                                      |
| M                                                                                   | distance from any first or last force conductor's centre line of to the defined area's edge |
| G                                                                                   | centre distance of the holes for specimen assembly                                          |
| b                                                                                   | bore diameter of the holes for specimen assembly                                            |
|  | copper layer                                                                                |

NOTE The test board may also run both sense conductors to the same edge of the defined area.

### 5.2.2.3 Assembly on test boards

The resistor specimens shall be mounted lateral to the component side (primary side) of the test board, with the axial leads bent each to 90° in order to fit into the appropriate bores, as shown in Figure 9.



Key:

- $S$  resistors lead-wire spacing
- $d$  nominal diameter of the lead-wire
- $r$  lead-wire bending radius, measured on the inside of the wire
- $h$  clearance of the resistor body above the circuit board
- $p$  protrusion length of the cropped lead-wire below the circuit board
- $G$  Grid of bores in the circuit board intended for assembly of the resistor

NOTE Plated via holes may be required for the vibration test, the bump test or the shock test in order to build a stronger solder joint.

**Figure 9 – Assembly of specimen to the test board**

The workmanship requirements of Annex C shall be observed, particularly

- C.2.1 for details concerning the straight length and the radius of the lead forming;
- C.3.2 for details concerning the lateral mounting position of the resistor;
- C.4 for details concerning the cropping of the protruding lead ends.

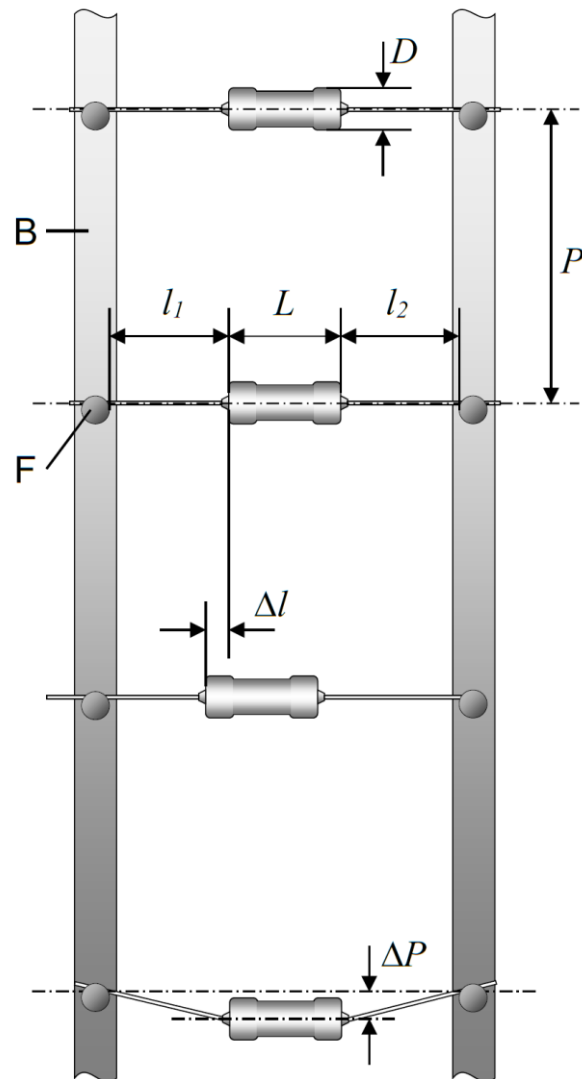
Special considerations may be required on a minimum clearance of resistors specified for a high limiting element voltage. Such considerations and/or constraints are subject to the relevant detail specification.

### 5.2.3 Mounting of components on a test rack

As the default mounting method, or if the relevant specification calls for mounting of the specimens on a test rack, the resistors shall be connected by their terminations (e.g. lead wires) to suitable fixation devices on the rack. The relevant provisions of IEC 60115-1:201X, 5.5 shall be applied.

All resistors shall be mounted in a horizontal position into the rack, and the rack shall be positioned horizontally and in a single layer only. See Figure 10 for the dimensions within a rack. Unless specified otherwise, the following constraints shall apply:

- a) the specimens mounting pitch shall at least be 7 times the body diameter,  $P \geq 7 \times D$ ;
- b) the specimens shall be approximately centred between the fixations on each bar,  $l_1 \approx l_2$ ;
- c) the length of lead wires shall not be shorter than 20 mm,  $l_1 \geq 20$  mm,  $l_2 \geq 20$  mm;
- d) the axial displacement shall not exceed 50 % of the specimens body length,  $\Delta l \leq 0,5 \times L$ ;
- e) the radial displacement shall not exceed the specimens body diameter,  $\Delta P \leq D$ ;

**Key**

|            |                                                 |
|------------|-------------------------------------------------|
| B          | conductive bar                                  |
| F          | specimen fixation device                        |
| $D$        | specimen body diameter                          |
| $L$        | specimen body length                            |
| $l_1, l_2$ | specimen lead length                            |
| $\Delta l$ | axial specimen displacement                     |
| $P$        | centre line pitch of any two adjacent specimens |
| $\Delta P$ | radial specimen displacement                    |

**Figure 10 – Mounting of axial leaded specimens on a rack, top view**

A rack normally consists of two parallel conductive strips or bars, which either are sufficiently rigid to support the specimens' mass themselves, or are supported by a suitable insulating substrate or construction. The strips or bars carry fixation devices (e.g. clips, clamps, screw terminals) at the appropriate places for the connection of the specimens' lead wires. See Figure 11 for examples of specimen lead fixation devices.

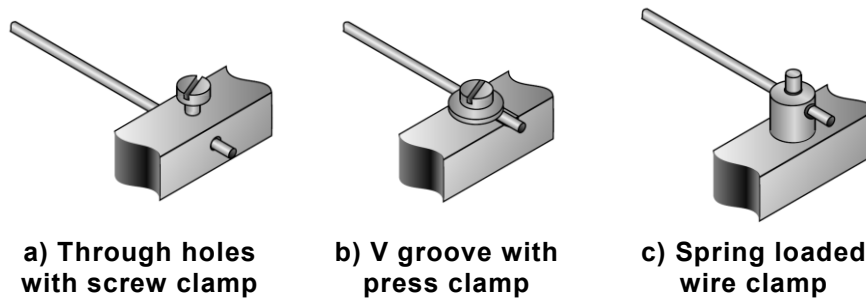


Figure 11 – Examples of specimen lead fixation devices

### 5.3 Tests

#### 5.3.1 Resistance

See IEC 60115-1:201X, 6.1 and IEC 60115-1:201X, 5.6.

Unless otherwise specified, the points of measurement on unmounted specimens shall be on the leads at a distance of  $l_{\text{meas}} = (6 \pm 1)$  mm from the resistor body. For specimens mounted on a test board according to 5.2.2, the points of measurement are determined by the solder joints.

#### 5.3.2 Temperature coefficient of resistance

See IEC 60115-1:201X, 6.2 and IEC 60115-1:201X, 5.6.

Unless otherwise specified, the points of measurement on unmounted specimens shall be on the leads at a distance of  $l_{\text{meas}} = (6 \pm 1)$  mm from the resistor body. For specimens mounted on a test board according to 5.2.2, the points of measurement are determined by the solder joints.

The sequence of temperatures, 20 °C / LCT / 20 ° / UCT / 20 °C, shall be applied consecutively.

#### 5.3.3 Temperature rise

See IEC 60115-1:201X, 6.7, with the following details:

The specimen shall be mounted on a test board according to 5.2.2, or mounted on a test rack according to 5.2.3, as prescribed by the detail specification. The test board or test rack shall be mounted horizontally and shall be in free air at the standard atmospheric conditions for testing as given in IEC 60115-1:201X, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

#### 5.3.4 Endurance at the rated temperature 70 °C

See IEC 60115-1:201X, 7.1, with the following details:

The specimen shall be mounted on a test board according to 5.2.2, or mounted on a test rack according to 5.2.3, as prescribed by the detail specification.

The test shall be performed with the rated voltage:

$$U_{\text{test}} = U_r = \sqrt{P_{70} \times R_n},$$

which shall be limited by

$$U_{\text{test}} \leq U_{\text{max}},$$

where

559  $U_r$  is the rated voltage;  
 560  $P_{70}$  is the rated dissipation;  
 561  $R_n$  is the nominal resistance;  
 562  $U_{\max}$  is the limiting element voltage.

563 The duration of the endurance test shall be  $t_{\text{test}} = 1000^{+24}_0$  h.

564 The extension of the endurance test to a total duration of  $t_{\text{test}} = 8\,000^{+48}_0$  h, is mandatory  
 565 only for resistors categorized as level P or R.

566 See 5.3.23 for the measurement of the insulation resistance of insulated resistors.

### 567 **5.3.5 Endurance at a maximum temperature: UCT**

568 See IEC 60115-1:201X, 7.3, with the following details:

569 The specimen shall be tested unmounted, or mounted on a test board according to 5.2.2, or  
 570 mounted on a test rack according to 5.2.3, as prescribed by the detail specification.

571 The duration of the endurance test shall be  $t_{\text{test}} = 1000^{+24}_0$  h.

572 See 5.3.23 for the measurement of the insulation resistance of insulated resistors.

### 573 **5.3.6 Short-term overload**

574 See IEC 60115-1:201X, 8.1, with the following details:

575 The specimen shall be mounted on a test board according to 5.2.2, or mounted on a test rack  
 576 according to 5.2.3, as prescribed by the detail specification. The test board or test rack shall  
 577 be mounted horizontally and shall be in free air at the standard atmospheric conditions for  
 578 testing as given in IEC 60115-1:201X, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

579 The preferred overload test voltage is

$$580 \quad U_{\text{test}} = 2,5 \times U_r = \sqrt{6,25 \times P_{70} \times R_n},$$

581 which shall be limited by

$$582 \quad U_{\text{test}} \leq 2 \times U_{\max},$$

583 where

584  $U_r$  is the rated voltage;  
 585  $P_{70}$  is the rated dissipation;  
 586  $R_n$  is the nominal resistance;  
 587  $U_{\max}$  is the limiting element voltage.

588 The overload duration is a function of the resistor style.

589 The detail specification shall prescribe the values for the overload duration  $t_{\text{load}}$ , preferably from  
 590 the following preferred values: 0,5 s; 1 s; 2 s; 5 s and 10 s. A relative tolerance of +5 % shall  
 591 apply to the overload duration.

### 592 **5.3.7 Single-pulse high-voltage overload test**

593 See IEC 60115-1:201X, 8.2.

594 The specimen shall be tested unmounted, or mounted on a test board according to 5.2.2, or  
 595 mounted on a test rack according to 5.2.3, as prescribed by the detail specification. If  
 596 unmounted, the specimen shall be placed in suitable fixture for the duration of the test.

597 The test shall be performed with pulses defined by:

598 Pulse shape: 10/700

599 Pulse peak voltage:  $\hat{U}_{\text{test}} = x \times \sqrt{P_{70} \times R_n}$ , with  $x \geq 10$ ,

600 which shall be limited by  $\hat{U}_{\text{test}} \leq y \times U_{\text{max}}$ , with  $y \geq 2$ .

601 The detail specification shall prescribe the values for  $x$  and  $y$ .

602 NOTE The given minimum values for multipliers,  $x = 10$  and  $y = 2$ , establish the lowest severity No.4 as defined  
603 for pulses of shape 10/700 in IEC 60115-1:201X, 8.2.

604 This test is mandatory only for resistors categorized as level P or R.

### 605 5.3.8 Periodic-pulse high-voltage overload test

606 See IEC 60115-1:201X, 8.3, with the following details:

607 The specimen shall be mounted on a test board according to 5.2.2, or mounted on a test rack  
608 according to 5.2.3, as prescribed by the detail specification. The test board or test rack shall  
609 be mounted horizontally and shall be in free air at the standard atmospheric conditions for  
610 testing as given in IEC 60115-1:201X, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C).

611 The preferred square pulse overload test voltage is, as prescribed as severity 3:

$$612 \hat{U}_{\text{test}} = \sqrt{25 \times P_{70} \times R_n},$$

613 which shall be limited by

$$614 \hat{U}_{\text{test}} \leq 3 \times U_{\text{max}}$$

615 where

616  $P_{70}$  is the rated dissipation;

617  $R_n$  is the nominal resistance;

618  $U_{\text{max}}$  is the limiting element voltage.

619 Duration of the test:  $t_{\text{test}} = 100^{+5}_0 \text{ h}$ ;

620 Pulse duration:  $t_{\text{pulse}} = 100 \text{ } \mu\text{s}$ ;

621 Pulse frequency:  $f_{\text{pulse}} = 400 \text{ Hz}$ .

622 The detail specification may prescribe a higher overload factor than the 25 given in severity 3.  
623 In such case the test duration of 100 h and the pulse duration of 100  $\mu\text{s}$  shall be maintained  
624 and the pulse frequency be adjusted in order to establish a mean dissipation of the pulse  
625 sequence of 100 % of the rated dissipation  $P_{70}$ . See the preferred alternative overload  
626 conditions given in Table 3.

**Table 3 – Preferred aggravated overload conditions**

| Severity | Peak load<br>$\hat{P}$<br>W | Pulse voltage<br>$\hat{U}_{\text{test}}$<br>V | Pulse duration<br>$t_{\text{pulse}}$<br>µs | Pulse frequency<br>$f_{\text{pulse}}$<br>Hz |
|----------|-----------------------------|-----------------------------------------------|--------------------------------------------|---------------------------------------------|
| 3a       | $40 \times P_r$             | $\sqrt{40 \times P_r \times R_n}$             | 100                                        | 250                                         |
| 3b       | $63 \times P_r$             | $\sqrt{63 \times P_r \times R_n}$             | 100                                        | 160                                         |
| 3c       | $100 \times P_r$            | $\sqrt{100 \times P_r \times R_n}$            | 100                                        | 100                                         |
| 3d       | $160 \times P_r$            | $\sqrt{160 \times P_r \times R_n}$            | 100                                        | 63                                          |
| 3e       | $250 \times P_r$            | $\sqrt{250 \times P_r \times R_n}$            | 100                                        | 40                                          |
| 3f       | $400 \times P_r$            | $\sqrt{400 \times P_r \times R_n}$            | 100                                        | 25                                          |
| 3g       | $630 \times P_r$            | $\sqrt{630 \times P_r \times R_n}$            | 100                                        | 16                                          |
| 3h       | $1\,000 \times P_r$         | $\sqrt{1\,000 \times P_r \times R_n}$         | 100                                        | 10                                          |

This test is mandatory only for resistors categorized as level P or R.

### 5.3.9 Electrostatic discharge (ESD) test

See IEC 60115-1:201X, 8.5, with the following details:

The specimen shall be tested unmounted, or mounted on a test board according to 5.2.2, or mounted on a test rack according to 5.2.3, as prescribed by the detail specification. If unmounted, the specimen shall be placed in suitable fixture for the duration of the test.

The ESD test voltage is a function of the resistor style. The detail specification shall prescribe the values for the test voltage  $U_{\text{HBM}}$ , preferably from the preferred values given in IEC 60115-1:201X, 8.5.4. A relative tolerance of  $\pm 2\%$  shall apply to the test voltage.

An equal number of discharges with positive polarity,  $n_{\text{pos}}$ , and with negative polarity,  $n_{\text{neg}}$ , shall be applied to the specimens, where

$$n_{\text{pos}} = n_{\text{neg}} = 1 \quad \text{for resistors categorized as level G; or}$$

$$n_{\text{pos}} = n_{\text{neg}} = 3 \quad \text{for resistors categorized as level P or R.}$$

The minimum time between any two discharges shall be 1 s.

### 5.3.10 Visual inspection

See IEC 60115-1:201X, 9.1

The visual inspection shall be applied to the resistor body and to its terminations.

The visual inspection of the marking of marked resistors shall be applied to the required marking items according to 7.1.

### 5.3.11 Gauging of dimensions

See IEC 60115-1:201X, 9.2, with the following details:

The length and diameter (or height and width) of the resistor body and of the leads shall be gauged.

The length of the resistor body shall be assessed as prescribed in IEC 60294:2012, Clause 3.1.

The diameter of the resistor body shall be gauged according to IEC 60294:2012, Clause 5. A similar approach shall be used for a non-cylindrical resistor body.

If prescribed by the detail specification, the effective eccentricity  $e'$  as shown in Figure 4 shall be gauged as prescribed therein.

If prescribed by the detail specification, either the length of excessive protective coating, dimension  $c$  as shown in Figure 5a, shall be gauged as prescribed in IEC 60294:2012, Clause 4, or the length between clean leads, dimension  $L_c$ , as shown in Figure 5b shall be measured or gauged as prescribed by the detail specification.

### 5.3.12 Detail dimensions

See IEC 60115-1:201X, 9.3, with the following details:

All dimensions specified by the detail specification shall be measured.

For measurement of the length of the resistor body, a gauge plate according to IEC 60294:2012, 3.1 shall be used.

If prescribed by the detail specification, the real eccentricity  $e$  as shown in Figure 4 shall be gauged as prescribed therein.

If prescribed by the detail specification, either the length of excessive protective coating, dimension  $c$  as shown in Figure 3a, or the length between clean leads, dimension  $L_c$ , as shown in Figure 3b shall be measured as prescribed by the detail specification.

### 5.3.13 Robustness of terminations

See IEC 60115-1:201X, 9.5, with the following details:

The tests shall be carried out at the standard atmospheric conditions for testing as given in IEC 60115-1:201X, 5.2.3 (e.g. ambient temperature 15 °C to 35 °C). The specimen shall be kept in standard atmospheric conditions for at least 1 h prior to the tests.

The following tests shall be applied to the group of specimens subjected to this test:

- The whole specimens group shall be subjected to test  $U_{a1}$  – Tensile, as prescribed in IEC 60115-1:201X, 9.5.4.2.
- Then half of the specimens group shall be subjected to test  $U_b$  – Bending, as prescribed in IEC 60115-1:201X, 9.5.4.3, where each two successive bends shall be applied in alternate directions.
- The other half of the specimens group shall be subjected to test  $U_c$  – Torsion, as prescribed in IEC 60115-1:201X, 9.5.4.4, where method 1, severity 2 shall be applied.

### 5.3.14 Vibration

See IEC 60115-1:201X, 9.11, with the following details:

The method to be employed is endurance by sweeping according to IEC 60068-2-6:2007, 8.3.1, with the specimen mounted in such a way that they are not exposed to resonances, and with the following details:

Frequency range:  $f_1 = 10$  Hz to  
 $f_2 = 2\,000$  Hz;

692 Amplitude:  $\hat{a} = 200 \text{ m/s}^2$ , limited by  
693  $d = 1,5 \text{ mm}$ ;  
694 Duration:  $n = 10$  sweep cycles in each axis (x, y, z),  
695 resulting in a test duration  $t_{\text{load}} = 2,5 \text{ h}$  per axis.

### 696 5.3.15 Rapid change of temperature

697 See IEC 60115-1:201X, 10.1, with the following details:

698 Lower temperature:  $\vartheta_{\text{inf}} = \text{LCT}$ ;  
699 Upper temperature:  $\vartheta_{\text{sup}} = \text{UCT}$ ;  
700 Number of cycles:  $n = 5$ .

### 701 5.3.16 Rapid change of temperature, $\geq 100$ cycles

702 See IEC 60115-1:201X, 10.1, with the following details:

703 Lower temperature:  $\vartheta_{\text{inf}} = \text{LCT}$ ;  
704 Upper temperature:  $\vartheta_{\text{sup}} = \text{UCT}$ ;  
705 Number of cycles: preferred values for  $n$  are 100; 200; 500 and 1 000.

706 The detail specification may prescribe different values for  $n$  depending on the properties and  
707 capabilities of the individual style.

708 This test is mandatory only for resistors categorized as level P or R.

### 709 5.3.17 Climatic sequence

#### 710 5.3.17.1 General

711 See IEC 60115-1:201X, 10.3

712 The specimen shall be mounted on a test board according to 5.2.2, or mounted on a test rack  
713 according to 5.2.3, as prescribed by the detail specification.

#### 714 5.3.17.2 Dry heat

715 IEC 60115-1:201X, 10.3.3.3

716 The test specimens may be introduced directly into the heated chamber at any temperature  
717 from laboratory temperature to the upper category temperature, and withdrawn directly from it,  
718 since the effects of the sudden change of temperature are not known to be detrimental to the  
719 test specimen.

#### 720 5.3.17.3 Damp heat, cyclic, first cycle

721 See IEC 60115-1:201X, 10.3.3.4

#### 722 5.3.17.4 Cold

723 IEC 60115-1:201X, 10.3.3.5

724 The test specimens may be introduced directly into the cooled chamber at any temperature  
725 from the lower category temperature to laboratory temperature, and withdrawn directly from it,  
726 since the effects of the sudden change of temperature are not known to be detrimental to the  
727 test specimen.

728 Precaution against condensation of moisture on the test specimen is required if the  
729 specimens are inserted into the test chamber at a temperature below laboratory temperature.