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METRIC UNITS

**SPECIFICATION FOR
FIXED RESISTORS OF
ASSESSED QUALITY: GENERIC
DATA AND METHODS OF TEST**

BRITISH STANDARDS INSTITUTION

BS 9110 : 1969
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BRITISH STANDARDS INSTITUTION

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THIS BRITISH STANDARD, having been approved by the Telecommunication Industry Standards Committee, was published under the authority of the Executive Board on 27th October, 1969.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 9000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue. The BSI Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the British Standards quoted in 1.1.2.

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CO-OPERATING ORGANIZATIONS

The Telecommunication Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- | | |
|--|--|
| *British Broadcasting Corporation | Electronic Valve and Semiconductor |
| British Electrical and Allied Manufacturers' Association | Manufacturers' Association |
| *British Radio Equipment Manufacturers' Association | *Institution of Electrical Engineers |
| British Radio Valve Manufacturers' Association | *Institution of Electronic and Radio Engineers |
| British Railways Board | Institution of Production Engineers |
| Cable and Wireless Ltd. | Ministry of Defence |
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| Department of Employment and Productivity | *Ministry of Defence, Navy Department |
| Electrical Contractors' Association (Incorporated) | *Ministry of Technology |
| *Electrical Research Association | *Post Office |
| *Electricity Council, the Generating Board and the Area Boards, in England and Wales | *Radio and Electronic Component Manufacturers' Federation |
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| | *Society of British Aerospace Companies |
| | *Telecommunication Engineering and Manufacturing Association |

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

Radio Society of Great Britain

United Kingdom Atomic Energy Authority

The following BSI references relate to the work on this standard:
Committee references TLE/4 and TLE/4/6

Draft for comment 66/29323



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BRITISH STANDARD SPECIFICATION FOR FIXED RESISTORS OF ASSESSED QUALITY: GENERIC DATA AND METHODS OF TEST

FOREWORD

This British Standard which has been prepared under the Authority of the Telecommunications Industry Standards Committee, is the generic specification for fixed resistors in the system of standards for electronic components of assessed quality. It has been issued in the United Kingdom, where it is urgently required, but if a similar procedure is adopted in other countries changes in the specification will be considered for the purposes of harmonization.

SPECIFICATION

1. PRINCIPLES AND MANDATORY PROCEDURES

1.1 GENERAL MATTERS

1.1.1 Scope. This British Standard gives details of the essential test procedures and other general requirements and information relating to fixed resistors of assessed quality. General rules for the preparation of detail specifications for use by BSI Technical Committees or components manufacturers are given in Section 2. The specific rules for each sub-family are listed in the BS Yearbook.

1.1.2 Related documents

- BS 1852. (IEC 62) Marking codes for values and tolerances of resistors and capacitors.
- BS 1991. (IEC 27) Letter symbols, signs and abbreviations.
- BS 2011. (IEC 68) Methods for the environmental testing of electronic components and electronic equipment.
- BS 2488. (IEC 63) Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment.
- BS 3939. Graphical symbols for electrical power, telecommunications and electronics diagrams.
- BS 4000. (ISO R216) Sizes of paper and board.
- BS 4119. (IEC 195) Method of measurement of current noise generated in fixed resistors.
- BS 4727. (IEC 50). Glossary of electrotechnical, power, telecommunications, electronics, lighting and colour terms.
- BS 6001. (IEC 410) Sampling procedures and tables for inspection by attributes. (Or BS 9001 which has the same technical content.)
- BS 9000. General requirements for electronic components of assessed quality.

When reference to an IEC Publication or an ISO Recommendation is given in parentheses the British Standard is identical in technical content with the IEC Publication or ISO Recommendation except where deviations are indicated in the British Standard.

1.1.3 Terminology. For the purposes of this British Standard the following definitions apply in addition to those covered in BS 4727:

- (1) *Style.* A variation, within a sub-family, of fixed resistors having a specific rating and/or characteristic.

NOTE. Where a detail specification covers a range of styles, the limits of the range will be prescribed in the detail specification.

- (2) *Pattern*. A pattern usually describes a single value within a style.
- (3) *Rated resistance*. The resistance value which is indicated upon it.
- (4) *Critical resistance*. That resistance above which the rated voltage may not be applied to the resistor (see 1.1.3(11)).
- (5) *Category temperature range*. The range of ambient temperatures for which the resistor is designed to operate continuously (see 1.1.12(6)).
- (6) *Upper category temperature*. The maximum ambient temperature at which a resistor has been designed to operate continuously.
- (7) *Lower category temperature*. The minimum ambient temperature at which a resistor has been designed to operate continuously.
- (8) *Rated dissipation*. The maximum allowable dissipation at an ambient temperature of 70 °C under the conditions of the endurance test and which will result in a change in resistance not greater than that specified for the endurance test of 1000 h duration.



- (9) *Category dissipation*. That portion of the rated dissipation applicable at the upper category temperature taking account of the derating curve in the relevant detail specification.
- (10) *A.c. r.m.s. voltage*. Where the term a.c. r.m.s. voltage is used in this specification the maximum peak voltage is 1.4 times the r.m.s. value.
- (11) *Rated voltage*. That d.c. or a.c. r.m.s. voltage calculated from the square root of the product of the rated resistance and the rated dissipation.

NOTE. At high values of resistance the rated voltage may not be applicable (see 1.1.3(12)).

- (12) *Limiting element voltage*. The maximum d.c. or a.c. r.m.s. voltage which may be applied between the terminations of a resistor.
- (13) *Isolation voltage* (applicable only to insulated resistors). The maximum peak voltage under continuous operating conditions which may be applied between the resistor terminations and any conducting mounting surface as determined by the tests for insulation resistance and voltage proof (see 1.1.12(4)).
- (14) *Wirewound resistor IEC Type 1*. A type especially suitable for applications in circuits where high stability and low tolerances of resistance value are of major importance.
- (15) *Wirewound resistor IEC Type 2*. A resistor essentially suitable for applications where low tolerances and high stability of resistance value at maximum rated dissipation are not of major importance.
- (16) *Non-wirewound resistor IEC Type 1*. A resistor especially suitable for application in circuits where its high stability properties are essential.
- (17) *Non-wirewound resistor IEC Type 2*. A resistor of a type suitable for application in circuits where high stability of the resistance is not of major importance.

1.1.4 Letter symbols, signs and abbreviations. Any letter symbols, signs and abbreviations which are employed shall be in conformity with BS 1991* or shall be derived in accordance with the principles of that standard.

1.1.5 Graphical symbols. Any graphical symbols which are employed shall be in conformity with BS 3939† or shall be derived in accordance with the principles of that standard.

* BS 1991, 'Letter symbols, signs and abbreviations'.

† BS 3939, 'Graphical symbols for electrical power, telecommunications and electronics diagrams'.

1.1.6 Marking of the part and package

1.1.6.1 Each resistor shall be marked with (1) and (2) and with as many of the remaining items in the order given below as is practical.

- (1) Rated resistance. {Where practicable, values and tolerances are to be coded using one of the
- (2) Selection tolerance. {methods in BS 1852* (IEC Publication 62).
- (3) Date code. See 2.6.8 of BS 9000†.



- (4) Manufacturer's name or trade mark.
- (5) The number of the detail specification and style designation



1.1.6.2 All the information required by 1.1.6.1 shall be marked on the package of the resistor(s).

NOTE. Where a transparent package is used, the information may be marked on a label which can be read without opening the package.

1.1.7 Eligibility for qualification approval. For the purposes of this specification the first stage of factory processing is defined as:

- (1) For film types: the deposition of the resistive film.
- (2) For carbon composition types: the process which produces the greatest change in polymerization of the binder.
- (3) For wirewound types: the winding of the resistance wire (or ribbon) on the former.

1.1.8 Structurally similar parts. Structurally similar parts are a range of styles as defined in 1.1.3(1) and are usually covered by a single detail specification. The detail specification shall state whether results of tests are to be recorded separately for CTR purposes.

A recommended scheme for the inspection of structurally similar parts is given in Appendix B.

1.1.9 Delayed delivery. Fixed resistors held by the manufacturer for a period exceeding twelve months following acceptance inspection shall be re-examined for visual examination and resistance as specified in Group A of the relevant detail specification.

Where fixed resistors held by a stockist have to be re-examined as prescribed by BS 9000† they shall be tested as stated above and shall meet the specified requirements.

1.1.10 Supplementary procedure for qualification approval. Not applicable.

(Information concerning the standard qualification approval procedure is given in BS 9000†.)

1.1.11 Certified test records (CTR's). Certified test records shall be prepared by the manufacturer, as specified in BS 9000†, for fixed resistors in the special and general application categories. Certified test records are not required for fixed resistors in the commercial application category.

Certified test records shall be printed on international size A4 paper to BS 4000‡ (ISO/R 216) in the style shown in Appendix E.

When the relevant detail specification requires that attributes information shall be recorded, the following procedures shall be used.

- (1) Where a sub-group comprises a single conditioning test, the total number of rejected resistors shall be recorded without reference to the parameter for which the rejection was made.
- (2) Where a sub-group comprises a number of conditioning tests, the relevant detail specification shall state whether the results shall be recorded for the individual conditioning tests or for a number of them as a group. For the purposes of this specification, the climatic sequence shall be deemed to form a single conditioning test.

The relevant detail specification shall state which tests are to be reported on in the certified test record as measurements information. It shall also state whether results may be aggregated, e.g. by rated dissipation, ranges of rated resistance, etc.

As a minimum, the results of all electrical endurance tests shall be presented as measurements information. To ensure a standard presentation, measurements information for endurance tests and current noise shall be given in the following manner:

- * BS 1852, 'Marking codes for values and tolerances of resistors and capacitors'.
- † BS 9000, 'General requirements for electronic parts of assessed quality'.
- ‡ BS 4000, 'Sizes of paper and board'.

For the endurance tests, the intervals for the parametric change shall be $\% \Delta R$: 0.05, 0.1, 0.2, 0.5, 1.0, 2.0, 3.0, 5.0, 10.0, 15.0 and 20.0 and the time intervals shall be 168 h, 500 h and 1000 h.

Where the duration of an endurance test exceeds 1000 h the additional time intervals of 2000 h, 4000 h and 8000 h shall be used.

If the number of results to be presented is 20 or less, the actual values shall be stated but the identity of the measurements need not be retained. See BS 9000. Where the number of results exceeds 20, the results shall be presented as follows:

Percentage change in resistance	Duration (in hours)								
	168	500	1000	168	500	1000	168	500	1000
	Resistance range			Resistance range			Resistance range		
Positive									
> 20									
> 15 to 20									
> 10 to 15									
> 5 to 10									
> 3 to 5									
> 2 to 3									
> 1.0 to 2									
> 0.5 to 1.0									
> 0.2 to 0.5									
> 0.1 to 0.2									
> 0.05 to 0.1									
+ 0.05 to - 0.05									
Negative									
> 0.05 to 0.1									
> 0.1 to 0.2									
> 0.2 to 0.5									
> 0.5 to 1.0									
> 1.0 to 2.0									
> 2 to 3									
> 3 to 5									
> 5 to 10									
> 10 to 15									
> 15 to 20									
> 20									

The results of the measurement of current noise shall be presented in the following manner:

Noise in μV per volt per decade	Quantity
> 6.4	
> 3.2 but ≤ 6.4	
> 1.6 but ≤ 3.2	
> 0.8 but ≤ 1.6	
> 0.4 but ≤ 0.8	
> 0.2 but ≤ 0.4	
> 0.1 but ≤ 0.2	
> 0.05 but ≤ 0.1	
≤ 0.05	

1.1.12 Standard values of ratings and characteristics. Ratings and characteristics should, wherever possible, be taken from the following list. If additional items are included in a detail specification, the values and conditions under which they apply shall be stated. Any interdependence of ratings and characteristics and any limiting conditions of use shall be stated.



- (1) *Rated resistances.* As specified in BS 2488 (IEC Publication 63).
The resistance range shall be stated.
- (2) *Selection tolerances*
 ± 0.05 , ± 0.1 , ± 0.25 , ± 0.5 , ± 1 , ± 2 , ± 5 , ± 10 and $\pm 20\%$.
- (3) *Limiting element voltage*
100, 150, 200, 250, 350, 500 and 750 V.
- (4) *Isolation voltage.* The value of the isolation voltage shall be not less than 1.4 times the limiting element voltage, rounded off to the nearest 10 V.
- (5) *Rated dissipation*
0.06, 0.125, 0.25, 0.50, 1, 2, 3, 5, 8, 10, 16, 25, 40, 63, 100, 160 and 250 W at 70 °C.
- (6) *Preferred groupings of environmental categories.* (See BS 2111 : Part 1 : Appendix A.)

55/200/56	55/100/21
55/155/56	40/200/56
55/155/21	40/200/21
55/155/04	40/200/04
55/125/56	40/155/56
55/125/21	40/155/21
55/125/04	40/125/21
55/100/56	10/125/04

(7) *Preferred severities for environmental tests*

Vibration:	Range 10 Hz to 500 Hz 0.75 mm or 98 m/s ² (whichever is the less severe)
Bump:	390 m/s ² : 4000 $\pm$ 10 bumps Sweep endurance 6 h
Low air pressure:	85 mbar

(8) *Temperature characteristic*

Standard values of temperature characteristic over the range 20°C to 70°C	Temperature coefficient
%	p.p.m./°C
+0.025 to -0.025	± 5
+0.050 to -0.050	± 10
+0.075 to -0.075	± 15
+0.100 to -0.100	± 20
+0.125 to -0.125	± 25
+0.150 to -0.150	± 30
+0.250 to -0.250	± 50
+0.45 to -0.45	± 90
+0.50 to -0.50	± 100
+0.625 to -0.625	± 125
+0.75 to -0.75	± 150
+1.000 to -1.000	± 200
+2.000 to -1.000	+400 to -200
+2.000 to -5.000	+400 to -1000
+2.50 to -2.50	± 500
+2.75 to -2.75	± 550
+3.5 to -3.5	± 700
+4.0 to -4.0	± 800
+5.0 to -5.0	± 1000
+6.5 to -6.5	± 1300
+11.5 to -11.5	± 2300
+14.0 to -14.0	± 2800



For other ranges of temperature, the characteristic shall be calculated using the following formulae:

70°C to upper category temperature:

$$\text{Characteristic} = \left(\frac{A - 70}{50} \right) \times \text{value selected from the table,}$$

where *A* is the highest temperature reached, i.e. the upper category temperature.

20°C to lower category temperature

$$\text{Characteristic} = \left(\frac{B - 20}{50} \right) \times \text{value selected from the table,}$$

where *B* is the numerical value of the lowest temperature reached, i.e. the lower category temperature.

(9) *Permissible drift after endurance test*

±0.01, 0.05, 0.25, 0.1, 0.5, 1.0, 1.5, 2.0, 3.0, 5.0 and 10.0 %.

Where more than one rating is applied, each with an associated stability, an endurance test at laboratory temperature or at 70°C, as appropriate, shall be carried out for each individual rating.

(10) *Diameters of wire terminations*

Minimum	Nominal	Maximum
mm	mm	mm
0.45	0.50	0.55
0.55	0.60	0.66
0.75	0.80	0.88
0.95	1.00	1.10

1.1.13 Unchecked parameters. Detail specifications prepared by BSI Technical Committees give no information on the operation of resistors under special conditions, e.g. at radio-frequencies or under pulse conditions. Consistent performance under such conditions cannot be relied upon.

Where a requirement exists for operation under such conditions, it may be given in a detail specification prepared by a manufacturer. The additional test method(s) used shall be fully described and appropriate limits, AQLs and inspection levels specified.

1.1.14 Procedure to be followed in the event of failures at Group C inspection. Where failures occur on long term Group C tests, the following procedure shall apply:

(1) *Endurance tests.* A test of 48 h duration under the conditions of the endurance test during which failures have occurred shall be carried out on a lot-by-lot basis. The detail specification shall indicate an appropriate Group B test in accordance with the provisions of BS 9000.

(2) *Damp heat tests.* Any damp heat, cyclic test already included in Group B shall be carried out at the next tighter acceptable quality level, in accordance with the provisions of BS 9000. Where there is no damp heat, cyclic test already in Group B, the detail specification shall give details of an appropriate test.

1.1.15 Ordering information. When ordering resistors, the following information shall be given:

- (1) Value of rated resistance.
- (2) Tolerance on rated resistance.
- (3) Temperature characteristic of resistance, unless implicit in the style.
- (4) The BS number of the detail specification and style.

Example: 220 kΩ ± 1 %, BS 9111 N001 Issue 1, Style 1C56-0.50.

This describes a fixed metal film insulated resistor (IEC Type 1) with a temperature characteristic of resistance better than ±0.25 % change in resistance over the range +20°C to +70°C and a climatic category



of 55/155/56. The rated dissipation is 0.5 W and the value of rated resistance 220 000 Ω . The tolerance on the rated resistance is $\pm 1\%$.

1.1.16 Release for delivery before the completion of Group B tests. When the conditions of BS 6001 (or BS 9001) for reduced inspection have been satisfied for all Group B tests, the manufacturer is permitted to release components before the completion of such tests.

1.2 TEST PROCEDURES

This section comprises a schedule of tests. Not all tests are applicable in all cases.

1.2.1 Measuring conditions. Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for testing as specified in BS 2111 (IEC Publication 68).

Before the measurements are made, the resistor shall be stored at the measuring temperature for a time sufficient to allow the entire resistor to reach this temperature. The recovery period called for after conditioning is sufficient for this purpose.

When measurements are made at a temperature other than the specified temperature, the results shall, where necessary, be corrected to the specified temperature. In this case the temperature during the measurements shall be stated in the test report.

During measurements the resistor shall not be exposed to draughts, direct sun-rays or other influences likely to cause error. All values in this British Standard shall be considered as true values, and accuracy of test equipment shall be taken into account when assessing the results.

1.2.2 Visual inspection. The condition, workmanship, marking and finish shall be satisfactory as determined by visual examination without magnification.

1.2.3 Dimensioning and gauging procedure. The dimensions shall be checked and shall comply with those given in the detail specification. Where applicable the methods given below shall be used.

1.2.3.1 Measurement of the dimensions of a cylindrical component having two axial wire terminations

(1) *Length.* The length of the body shall be measured by inserting the terminations into slots (or holes) of two gauge plates and by moving these plates parallel to each other until the component body is clamped without deforming the body or the termination. The plates shall be considered sufficiently close to parallel if, allowing for the size of plate and the distance between the component and the measuring device, the error in measurement due to this cause does not exceed 0.2 mm.

Alternative methods of measurement are given in Methods 1 and 2 (see Figs. 1 and 2).

(2) *Maximum length of the termination covered by coating material.* When the terminations are inserted in the gauge plates and the component is clamped as prescribed in 1.2.3.1(1) no coating material shall extend beyond the gauge plates.

The thickness T of the gauge plate shall be specified in the relevant detail specification.

NOTE. Recommended values are 1.5 ± 0.05 mm for components for use on single sided printed wiring board and 4 ± 0.05 mm for components for other applications.

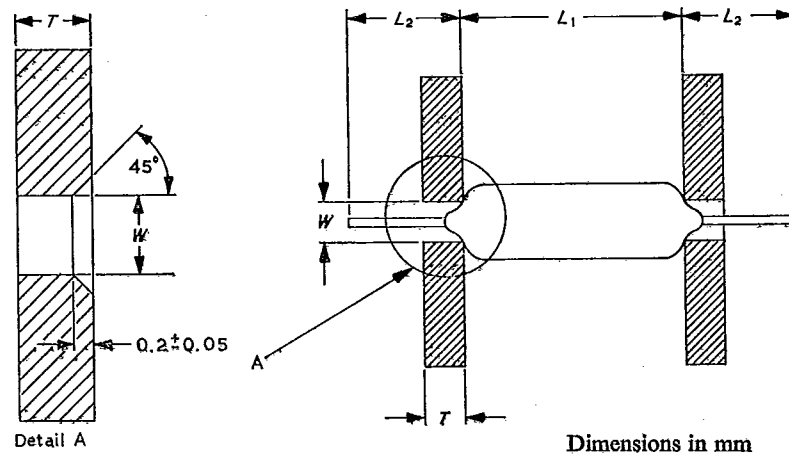
(3) *Method for checking the overall diameter.* For a given diameter the component shall pass through a straight tube, having an internal diameter equal to the maximum prescribed body diameter $+0.1$ mm with a tolerance of $+0.05$ mm and a length equal to the maximum prescribed body length for that component. The component shall pass through the gauge by its own weight.

The maximum diameter of the component as given in the detail specification shall take into account the irregularities in the shape of the body such as bow, caps on resistors and wire wrapping as part of the terminations.

1.2.3.2 Measurement of the dimensions of a component having radial terminations. Under consideration.



Method 1



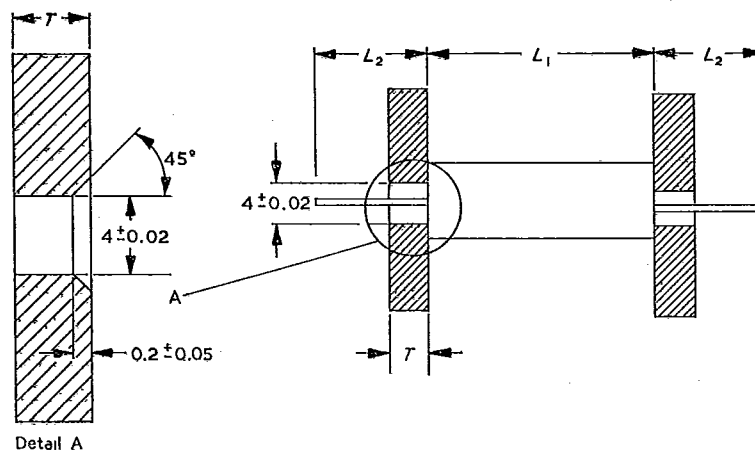
The length of the body is equal to the measured length L_1 , the length of the termination is equal to L_2 .
The width of the slot, W (or the diameter of the hole) in the gauge plate shall depend on the diameter of the wire termination in the manner given in the following table.

Nominal diameter of wire terminations	Width of slots in gauge plates (W)
mm	mm
Up to and including 0.45	$0.8 \pm 0.02^*$
0.45 up to and including 0.7	$1.0 \pm 0.02^*$
0.7 up to and including 0.9	$1.2 \pm 0.02^*$
0.9 up to and including 1.15	$1.5 \pm 0.02^*$
1.15 up to and including 1.32	$1.8 \pm 0.02^*$
1.32 up to and including 2.0	$3.0 \pm 0.02^*$

* This tolerance need only be maintained in the locality of the point where the termination will lie during measurement.

Fig. 1. Gauge plate for components having axial wire terminations (except components mentioned in Method 2)

Method 2



If there is a discontinuity in the wire termination, e.g. on components with welded terminations outside the case and on components provided with glass seals, the thickness of the gauge has no significance in the measurement of length. The length of the component shall be taken as the distance between the inside faces of the gauge plates (L_1), the length of the terminations is equal to L_2 .

The width of the slot (or the diameter of the hole) in the gauge plate shall be 4 ± 0.02 mm.

NOTE. This tolerance need only be maintained in the locality of the point where the termination will lie during measurement.

Fig. 2. Gauge plate for components with a diameter of 5 mm and over having axial terminations and with glass metal seals or with discontinuities in the wire terminations