

**Harmonized system of quality assessment
for electronic components**

**Fixed film resistor networks
for use in electronic
equipment.**

**Sectional specification for film
resistor networks of assessed
quality on the basis of the
capability approval procedure**

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electronic Components Standards Policy Committee (ECL/-) to Technical Committee ECL/4, upon which the following bodies were represented:

- EEA (the Association of the Electronics, Telecommunications and Business Equipment Industries)
- Electronic Components Industry Federation
- Ministry of Defence
- National Supervising Inspectorate

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

- BEAMA Ltd.
- ERA Technology Ltd.

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National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committree. It is identical with IEC 1045-2 : 1991 *Fixed film resistor networks for use in electronic equipment Part 2 : Sectional specification for film resistor networks of assessed quality on the basis of the capability approval procedure*. IEC 1045-2 also designated QC 390100 is a harmonized specification within the IECQ system for electronic components of assessed quality.

The standard is to be used in conjunction with BS QC 390000 : 1992 *Harmonized system of quality assessment for electronic components. Fixed film resistor networks for use in electronic equipment: generic specification*.

Cross-references

International standard	Corresponding British Standard
IEC 63 : 1963	BS 2488 : 1966 <i>Schedule of preferred numbers for the resistance of resistors and the capacitance of capacitors for telecommunication equipment</i> (Technically equivalent)
IEC 68	BS 2011 <i>Environmental testing</i> (All parts are identical or technically equivalent)
IEC 115-1 : 1982 (QC 400000)	BS QC 400000 : 1990 <i>Harmonized system of quality assessment for electronic components. Fixed resistors for use in electronic equipment: generic specification</i> (Identical)
IEC 115-6 : 1983 (QC 400400)	BS 9940 : Part 04.0 : 1984 <i>Sectional specification: fixed resistor networks with individually measurable resistors</i> (Identical)
IEC 115-7 : 1984	BS 9940 : Part 05.00 : 1985 <i>Sectional specification: fixed resistor networks in which not all resistors are individually measurable</i> (Identical)
IEC 410 : 1973	BS 6001 <i>Sampling procedures for inspection by attributes</i> Part 1 : 1991 <i>Specification for sampling plans indexed by acceptable quality levels (AQL) for lot-by-lot inspection</i> (Technically equivalent)
IEC 440 : 1973	BS 5694 : 1979 <i>Method for measurement of non-linearity in resistors</i> (Identical)
IEC 1045-1 : 1990	BS QC 390000 : 1992 <i>Harmonized system of quality assessment for electronic components. Fixed film resistor networks for use in electronic equipment: generic specification</i> (Identical)
QC 001002 : 1986	BS QC 001002 : 1991 <i>Rules of Procedure of the IEC Quality Assessment System for electronic components (IECQ)</i> (Identical)

The British Standard which implements the IECQ Rules of Procedure is BS 9000 *General requirements for a system for electronic components of assessed quality* Part 3 : 1991 *Specification for the national implementation of the IECQ system*.

The Technical Committee has reviewed the provisions of QC 001001 to which reference is made in the text and has decided that they are acceptable for use in conjunction with this standard.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

FIXED FILM RESISTOR NETWORKS FOR USE IN ELECTRONIC EQUIPMENT

PART 2: SECTIONAL SPECIFICATION FOR FILM RESISTOR NETWORKS OF ASSESSED
QUALITY ON THE BASIS OF THE CAPABILITY APPROVAL PROCEDURE

SECTION ONE - GENERAL1. General1.1 Scope

This standard is applicable to fixed film resistor networks.
The resistor elements may be individually isolated or interconnected
in any circuit configuration.

1.2 Object

The object of this standard is to prescribe preferred ratings and
characteristics and to select from IEC Publication 1045-1, appropriate
Capability Approval procedures, tests and measuring methods and to give
performance requirements for this type of resistor networks.

The concept of preferred values is directly applicable to catalogue
products but does not necessarily apply to custom built products.

Test severities and requirements prescribed in detail specifications
referring to this sectional specification shall be of equal or higher
performance level, because lower performance levels are not permitted.

1.3 Related documentsIEC Publications:

Publication 63 (1963):	Preferred Number Series for Resistors and Capacitors. Amendment No. 1 (1967) Amendment No. 2 (1977)
Publication 68:	Basic Environmental Testing Procedures.
Publication 1045-1 (1990):	Fixed Resistor Networks for Use in Electronic Equipment. Part 1: Generic Specification.
Publication 115-1 (1982):	Generic Specification.
Publication 115-6 (1983):	Sectional Specification: Fixed Resistor Networks with Individually Measurable Resistors.
Publication 115-7 (1984):	Sectional Specification: Fixed Resistor Networks in which not all Resistors are Individually Measurable.

Publication 410 (1973):	Sampling Plans and Procedures for Inspection by Attributes.
Publication 440 (1973):	Method of Measurement of Non-linearity in Resistors.
Publication QC 001001(1986):	Basic Rules of the IEC Quality Assessment System for Electronic Components (IECQ).
Publication QC 001002 (1986):	Rules of Procedure of the IEC Quality Assessment System for Electronic Components (IECQ).

Note. -The above references apply to the current editions except for IEC 68, for which the referenced edition in the applicable test clauses of the generic specification shall be used.

1.4 Information to be given in a detail specification

Detail specifications shall be derived from the relevant blank detail specification.

If possible, a short description of the function of the network shall be given.

Detail specifications shall not specify requirements inferior to those of the Generic or Sectional specification. When more severe requirements are included, they shall be listed in Sub-clause 1.8 of the detail specification and indicated in the test schedules, for example by an asterisk.

Note. -The information given in Sub-clauses 1.4.1 and 1.4.3 may, for convenience, be presented in tabular form.

The following information shall be given in each detail specification and the values quoted shall preferably be selected from those given in the appropriate clause of this sectional specification.

Each detail specification shall state all tests and measurements required for lot-by-lot inspection. This shall, as a minimum, include the relevant tests given in this specification, with methods and severities.

Environmental tests, measurements, severities and end points limits for periodic tests shall be included in the detail specification(s) for the CQC(s). They shall be in accordance with the applicable parts of the generic specification and this specification.

1.4.1 Outline drawing and dimensions

There shall be an illustration of the network as an aid to easy recognition and for comparison of the network with others. Dimensions and their associated tolerances, which affect interchangeability and mounting, shall be given in the detail specification. All dimensions shall preferably be stated in millimetres, however when the original dimensions are given in inches, the converted metric dimensions in millimetres shall be added.

Numerical values shall normally be given for the length, width and height of the body and the termination spacing. For cylindrical types the body diameter, and the length and diameter of the terminations shall be given.

If necessary, for example when in a detail specification more than one package is covered, the dimensions and their associated tolerances shall be placed in a table below the drawing.

If the configuration is other than described above the detail specification shall state such dimensional information as will adequately describe the resistor network.

1.4.2 Mounting

The detail specification shall specify the method of mounting to be applied for normal use and for the application of the vibration and the bump or shock tests. The resistor networks shall be mounted by their normal means. The design of the resistor network may be such that special mounting fixtures are required in its use. In this case the detail specification shall describe the mounting fixtures and they shall be used in the application of the vibration and bump or shock tests.

1.4.3 Style (IEC Publication 115-1, Sub-clause 2.2.3)

For the purpose of this standard the style may be represented by a code which is arbitrarily chosen per detail specification and is generally based on dimensional factors. The style designation, therefore, has no meaning unless the number of the detail specification is also given.

1.4.4 Ratings and characteristics

The ratings and characteristics shall be in accordance with the relevant clauses of this specification together with the following:

1.4.4.1 Rated resistance range

See Sub-clause 2.3.1. The preferred values are those of the E-series of IEC Publication 63.

Note. -If products approved to the detail specification have different ranges, the following statement should be added:
"The range of values available in each style is given in the qualified products list".

1.4.5 Marking

The detail specification shall specify the content of the marking on the network and on the primary package. Deviations from Sub-clause 2.4 of the Generic Specification, shall be specifically stated.

1.4.6 Ordering information

The detail specification shall state that the following information is required when ordering resistor networks:

- 1) Circuit type (e.g. thick film resistor network).
- 2) Number of the detail specification and issue reference and if appropriate, style reference and assessment level.
- 3) Function of the circuit, if appropriate.
- 4) Basic functional characteristics with tolerances, if appropriate.

1.4.7 Additional information (not for inspection purposes)

The detail specification may include information (which is not required to be verified by the inspection procedure), such as circuit diagrams, curves, drawings and notes needed for the clarification of the detail specification.

SECTION TWO - PREFERRED RATINGS, CHARACTERISTICS AND TEST SEVERITIES2. Preferred ratings, characteristics and test severities2.1 Preferred characteristics

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

2.1.1 Preferred climatic categories

The resistor networks covered by this document are classified into climatic categories according to the general rules given in IEC Publication 68-1.

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: -55 °C, -40 °C and -25 °C.

Upper category temperature: +85 °C, +100 °C, +125 °C and +155 °C.

Duration of the damp heat, steady state test: 4, 10, 21 and 56 days.

The severities for the cold and dry heat tests are the lower and upper category temperatures respectively. Because of the construction of some resistor networks these temperatures will occur between two of the preferred temperatures given in IEC Publication 68-2. In this event the nearest preferred temperature within the actual range of the resistor network shall be chosen for this severity.

2.1.2 Temperature coefficients and temperature characteristics of resistance

The preferred limits of change in resistance for the temperature characteristic of resistance test are given in Table I.

Each line in the table gives the preferred temperature coefficient and corresponding temperature characteristic for 20 °C to 70 °C and limits of change in resistance for the measurement of the temperature characteristic of resistance (see IEC Publication 1045-1, Sub-clause 4.10) on the basis of the category temperature ranges of Sub-clause 2.1.1 of this sectional specification.

TABLE I

Temperature coefficient	Temperature characteristic of resistance 20/70 °C	Temperature characteristic of resistance (limits of percentage change in resistance)							
		Reference temperature/ lower category temperature				Reference temperature/ upper category temperature			
10 ⁻⁶ /°C	%	+20/-55	+20/-40	+20/-25	+20/+85	+20/+100	+20/+125	+20/+155	
- 150/ - 1500	- 0,75/ - 7,5	+ 1,13/ +11,3	+ 0,9/ + 9	+ 0,68/ + 6,8	- 0,98/ - 9,8	- 1,2/ -12	- 1,58/ -15,8	- 2,03/ -20,3	
± 250	± 1,25	± 1,88	± 1,5	± 1,13	± 1,62	± 2	± 2,62	± 3,38	
± 100	± 0,5	± 0,75	± 0,6	± 0,45	± 0,65	± 0,8	± 1,05	± 1,35	
± 50	± 0,25	± 0,375	± 0,3	± 0,23	± 0,325	± 0,4	± 0,525	± 0,675	
± 25	± 0,125	± 0,188	± 0,15	± 0,113	± 0,162	± 0,2	± 0,262	± 0,338	
± 15	± 0,075	± 0,113	± 0,09	± 0,068	± 0,098	± 0,12	± 0,158	± 0,203	

2.1.2.a Differential resistance/temperature characteristics and temperature coefficients

The preferred limits are given by the table below:

TABLE Ia

Differential temperature coefficient	Differential resistance/temperature characteristics 20/70 °C	Differential resistance/temperature characteristics in %									
		Reference temperature/ lower category temperature					Reference temperature/ upper category temperature				
10 ⁻⁶ /°C	%	+20/-55	+20/-40	+20/-25	+20/+85	+20/+100	+20/+125	+20/+155			
± 5	± 0,025	± 0,038	± 0,03	± 0,023	± 0,033	± 0,04	± 0,052	± 0,068			
± 10	± 0,05	± 0,075	± 0,06	± 0,045	± 0,065	± 0,08	± 0,104	± 0,135			
± 25	± 0,13	± 0,188	± 0,15	± 0,113	± 0,162	± 0,2	± 0,262	± 0,338			
± 50	± 0,25	± 0,37	± 0,3	± 0,23	± 0,325	± 0,4	± 0,525	± 0,675			
± 100	± 0,5	± 0,75	± 0,6	± 0,45	± 0,65	± 0,8	± 1,05	± 1,35			
± 200	± 1	± 1,5	± 1,2	± 0,9	± 1,3	± 1,6	± 2,1	± 2,7			

2.1.3 Limits for change in resistance

For each stability class the preferred limits of change in resistance of any individual resistor element for each of the tests listed in the heading of Table II are as indicated.

Note. -The clause numbers in the heading of Table II refer to IEC Publication 1045-1.

TABLE II

Stability class in %	<u>LONG-TERM TESTS</u>	<u>SHORT-TERM TESTS</u>
	4.19 Climatic sequence 4.20 Damp heat, steady state 4.21.1 Endurance at 70 °C 4.21.2 Endurance at upper category temperature	4.12 Overload 4.13 Robustness of terminations 4.15 Resistance to soldering heat 4.16 Rapid change of temperature 4.17 Shock 4.18 Vibration
10	$\pm (10\% + 0,5 \Omega)$	$\pm (2\% + 0,1 \Omega)$
5	$\pm (5\% + 0,1 \Omega)$	$\pm (1\% + 0,05 \Omega)$
2	$\pm (2\% + 0,1 \Omega)$	$\pm (0,5\% + 0,05 \Omega)$
1	$\pm (1\% + 0,05 \Omega)$	$\pm (0,25\% + 0,05 \Omega)$
0,5	$\pm (0,5\% + 0,05 \Omega)$	$\pm (0,1\% + 0,01 \Omega)$
0,25	$\pm (0,25\% + 0,05 \Omega)$	$\pm (0,05\% + 0,01 \Omega)$
0,1	$\pm (0,1\% + 0,01 \Omega)$	$\pm (0,02\% + 0,01 \Omega)$

2.1.3a Differential resistance change

The preferred limits of differential resistance changes are:
 $\pm 0,1\%$; $\pm 0,25\%$; $\pm 0,5\%$; $\pm 1\%$.

2.2 Functional characteristics

Depending on the function, the characteristics to be prescribed are different. Details related to function characteristics e.g. voltage division ratio, characteristic impedance, attenuation etc, shall be given in the relevant detail specification.

2.3 Preferred values of ratings2.3.1 Rated resistance

See IEC Publication 1045-1, Sub-clause 2.2.15.

2.3.2 Tolerances on rated resistance

$\pm 10\%$, $\pm 5\%$, $\pm 2\%$, $\pm 1\%$, $\pm 0,5\%$, $\pm 0,25\%$ and $\pm 0,05\%$.

2.3.2a Tolerances on resistance ratio

The preferred tolerances on rated resistance ratio are:
 $\pm 0,05\%$; $\pm 0,1\%$; $\pm 0,25\%$; $\pm 0,5\%$; $\pm 1\%$.

2.3.3 Rated dissipation

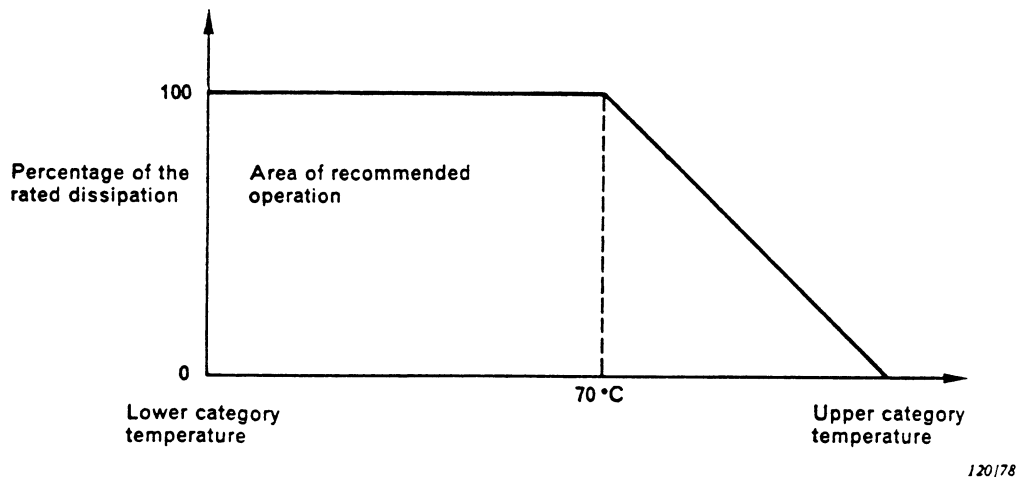
The preferred values of rated dissipation, at 70°C, are:

For the network: 0,125 W, 0,25 W, 0,5 W, 1 W, 1,5 W, 2 W and 4 W.

For the resistor element: 0,05 W, 0,10 W, 0,25 W, 0,5 W and 1 W.

The detail specification shall prescribe the applicable value of rated dissipation for each resistor element in the network and also the maximum allowable total dissipation for the network.

The derated values of dissipation at temperatures in excess of 70 °C shall be as indicated by the following curve:



A larger area of operation may be given in the detail specification, provided it includes all the area given above. In this event the detail specification shall state the maximum allowable dissipation at temperatures other than 70 °C. All break points on the curve shall be verified by test.

2.3.4 Limiting element voltage

The preferred values of limiting element voltage are:

10 V, 15 V, 25 V, 35 V, 50 V, 100 V and 500 V d.c. or a.c. r.m.s.

2.3.5 Isolation voltage between individual resistor elements (if applicable)

The value of the isolation voltage between the individual resistor elements shall be given in the detail specification.

2.3.6 Insulation resistance between individual resistor elements (if applicable)

Unless otherwise prescribed in the detail specification, the minimum value for insulation resistance between resistor elements shall be 1 GΩ.

2.4 Preferred test severities

Test severities given in detail specifications shall preferably be selected from the following:

2.4.1 Drying

Procedure I of IEC Publication 1045-1, Sub-clause 4.3 shall be used.

2.4.2 Vibration

Sub-clause 4.18 of IEC Publication 1045-1 with the following details:

Frequency range: 10 to 500 Hz.

Amplitude: 0,75 mm or 98 m/s² (whichever is the less severe).

Sweep endurance: Total duration: 6 h.

The detail specification shall prescribe the mounting method to be used (see Sub-clause 1.4.2).

The detail specification shall prescribe the electrical measurements to be made during vibration to check intermittant contacts or open or short circuits.

2.4.3 Low air pressure

Sub-clause 4.19.5 of IEC Publication 1045-1 with the following details:

Air pressure: 8,5 kPa (85 mbar).

2.4.4 Overload

Sub-clause 4.12 of IEC Publication 1045-1 with the following details:

The detail specification shall specify the terminals between which the overload shall be applied and the magnitude of the load to be applied between such terminals.

2.4.5 Endurance at 70 °C

Sub-clause 4.21.1 of IEC Publication 1045-1, with the following details:

If required, the detail specification shall specify how the load shall be applied to the network.

2.4.6 Insulation resistance between adjacent resistor elements (if applicable)

Sub-clause 4.8 of IEC Publication 1045-1.

2.4.7 Voltage proof between adjacent resistor elements (if applicable)

Sub-clause 4.9 of IEC Publication 1045-1 with the following details:

The voltage proof shall be made by testing between each isolated element and all other elements connected together.

2.4.8 Robustness of terminations

Sub-clause 4.13 of IEC Publication 1045-1 with the following details:

Test U_{a1} shall be applied.

SECTION THREE - CAPABILITY APPROVAL PROCEDURES3. Capability Approval Procedures

Sub-clause 3.7 of IEC Publication 1045-1 with the following details:

3.1 Selection of Capability Qualifying Circuits (CQCs)

3.1.1 The CQCs for approval testing shall be taken from the following sources:

- a) Special circuits designed to qualify the design rules, processes and products. Terminations of film elements and added components shall be individually accessible for electrical measurement without influence from other circuit elements,

and/or

- b) Circuits intended for shipment to customers.

Any or all of these CQCs in combination with process test vehicles shall be adequate to assess the complete design rules, material and manufacturing processes, including any subcontracted process.

3.1.2 The CQCs shall be used to carry out the tests prescribed for initial capability approval and for periodic testing and hence to demonstrate to the NSI that:

- a) Performance limits claimed for individual film element types are achieved;
- b) Environmental limits claimed for structures intended for shipment are met,

and

- c) The electrical function performances claimed in the Capability Manual (see Appendix B) and the detail specifications are met.

3.1.3 Circuits which have received Qualification Approval according to the sectional specifications IEC Publications 115-6 and 115-7, may be counted as CQCs for the purposes of Capability Approval subject to NSI agreement on relevant structural similarity claims.

3.1.4 A manufacturer who has received Capability Approval may obtain a separate Qualification Approval for any circuit he makes, provided all appropriate testing in the sectional specifications, IEC Publications 115-6 and 115-7, has been completed successfully.

3.1.5 A manufacturer using customer circuits among those selected as CQCs may vary the types tested according to his production plan. In this case the CQCs need not necessarily assess all the claimed boundaries of his Capability all of the time, but they shall be representative of those released and assess all their important features.

His CQC selection shall be made available to the NSI every three months.

- 3.1.6 When production material divides into separate procedures or processes after a common process, e.g. encapsulation, the common process can be assessed by a single sample.

3.2 Structural Similarity

- a) The CQCs shall be selected by the manufacturer's Chief Inspector and agreed by the NSI before commencing the initial approval programme.
- b) Rules for Structural Similarity applicable to the grouping of completed networks for electrical, dimensional and environmental (including mechanical) tests are given in Appendix A of this specification.
- c) These rules shall be used to establish the basis of selection for initial approval. They shall also be used to determine whether new networks are within the existing approved Capability, or require its extension to enable their release.
- d) If CQCs are structurally similar for a test sequence, they may be grouped to form the number of samples required in the test tables. Each test sequence has its own structural similarity rules and criteria as defined in Appendix A.

3.3 Capability Approval Procedures

- 3.3.1 The procedures for Capability Approval are given in Sub-clause 3.7 of the Generic Specification, IEC Publication 1045-1.

The test tables for initial Capability Approval by CQCs, release of networks (lot-by-lot tests) and for periodic tests collectively prescribe the minimum test programme on completed networks.

The manufacturer may select which assessment level D, E, F or G he wishes to include, but a manufacturer with approved Capability may only release products as follows

<u>Approval assessment level</u>	<u>Release assessment levels</u>
D	D, E, F or G
E	E, F or G
F	F or G
G	G

A manufacturer may upgrade the assessment level of his approval by following the procedures given in the Generic Specification, IEC Publication 1045-1 and he may downgrade without further periodic testing until current test interval dates expire. In either case the NSI shall be notified.

Any additional tests required for specific applications shall be given in the detail specification and be subject to agreement between the customer and manufacturer.

The post-test electrical limits for the relevant environmental tests shall be given in the detail specification.