

BRITISH STANDARD

**BS QC 390000 :
1992
IEC 1045-1 :
1991**

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

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

Generic specification

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.

This British Standard, having been prepared under the direction of the Electronic Components Standards Policy Committee, was published under the authority of the Standards Board and comes into effect on 15 July 1992

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National foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Policy Committee. It is identical with IEC 1045-1 : 1991 *Fixed film resistor networks for use in electronic equipment Part 1 : Generic specification*. IEC 1045-1 also designated QC 390000 is a harmonized specification within the IECQ system for electronic components of assessed quality.

Cross-references

International standard	Corresponding British Standard
ISO 3 : 1973	BS 2045 : 1965 <i>Preferred numbers</i>
ISO 497 : 1973	(Technically equivalent)
ISO 1000 : 1981	BS 5555 : 1981 <i>Specification for SI units and recommendations for the use of their multiples and of certain other units</i>
	(Identical)
IEC 62 : 1974	BS 1852 : 1975 <i>Specification for marking codes for resistors and capacitors</i>
	(Identical)
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)
	BS 2011 <i>Environmental testing</i>
IEC 68-1 : 1988	Part 1.1 : 1989 <i>General and guidance</i>
	(Identical)
IEC 68-2-1 : 1990	Part 2.1A : 1990 <i>Tests A. Cold</i>
	(Identical)
IEC 68-2-2 : 1974	Part 2.1B : 1977 <i>Tests B. Dry heat</i>
	(Identical)
IEC 68-2-3 : 1969	Part 2.1Ca : 1977 <i>Test Ca. Damp heat, steady state</i>
	(Identical)
IEC 68-2-6 : 1982	Part 2.1Fc : 1983 <i>Test Fc. Vibration (sinusoidal)</i>
	(Identical)
IEC 68-2-13 : 1983	Part 2.1M : 1984 <i>Test M. Low air pressure</i>
	(Identical)
IEC 68-2-14 : 1974	Part 2.1N : 1985 <i>Test N. Change of temperature</i>
	(Identical)
IEC 68-2-20 : 1979	Part 2.1T : 1981 <i>Test T. Soldering</i>
	(Identical)
IEC 68-2-21 : 1983	Part 2.1U : 1984 <i>Test U. Robustness of terminations and integral mounting devices</i>
	(Identical)
IEC 68-2-27 : 1987	Part 2.1Ea : 1977 <i>Test Ea. Shock</i>
	(Identical)
IEC 68-2-30 : 1969	Part 2.1Db : 1981 <i>Test Db and guidance: Damp heat, cyclic (12 + 12 hour cycle)</i>
	(Identical)
IEC 68-2-45 : 1980	Part 2.1XA : 1981 <i>Test XA and guidance. Immersion in cleaning solvents</i>
	(Identical)
IEC 191-2 : 1966	BS 3934 : <i>Mechanical standardization of semiconductor devices</i>
	Part 2 : 1992 <i>Schedule of international drawings giving dimensions</i>
	(Identical)

IEC 195 : 1965	BS 4119 : 1967 <i>Method of measurement of current noise generated in fixed resistors</i> (Technically equivalent)
IEC 294 : 1969	BS 5692 : 1979 <i>Method for measurement of the dimensions of a cylindrical electronic component having two axial terminations</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 617	BS 3939 <i>Guide for graphic symbols for electrical power, telecommunications and electronic diagrams</i> (All parts are identical)
IEC 717 : 1981	BS 6303 : 1982 <i>Method for determination of the space required by capacitors and resistors with unidirectional terminations</i> (Identical)
IEC 748-20 : 1988	BS QC 763000 : 1990 <i>Harmonized system of quality assessment for electronic components. Film and hybrid film integrated circuits. Generic specification</i> (Identical)
QC 001002 : 1986	BS QC 001002 : 1991 <i>Rules of Procedure for 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 IEC 27-1, IEC 50, IEC 102 and 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 1: GENERIC SPECIFICATION

SECTION ONE - SCOPE

1. Scope

This standard is applicable to fixed film resistor networks for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of test for use in sectional and detail specifications for Qualification Approval and Capability Approval of fixed film resistor networks.

Fixed film resistor networks are classified according to their structure and technology of manufacture as shown in Table I below:

TABLE I

Film	1) Thick film 2) Thin film
Added components	0) None 1) All types of resistive devices.
Circuit encapsulation	0) None 1) Embedded

SECTION TWO - GENERAL2. General2.1 Related documentsIEC Publications:

Publication 27-1 (1971):	Letter Symbols to be Used in Electrical Technology: Part 1: General.
Publication 50:	International Electrotechnical Vocabulary (IEV)
Publication 62 (1974):	Marking Codes for Resistors and Capacitors.
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 68-1 (1988):	Part 1: General and guidance.
Publication 68-2-1 (1974):	Tests A: Cold Amendment No. 1 (1983)
68-2-1A (1976):	First supplement.
Publication 68-2-2 (1974):	Tests B: Dry Heat.
68-2-2A (1976):	First supplement.
Publication 68-2-3 (1969):	Test Ca: Damp Heat, Steady State. Amendment No. 1 (1984)
Publication 68-2-6 (1982):	Test Fc and guidance: Vibration (sinusoidal). Amendment No. 2 (1985)
Publication 68-2-13 (1966):	Test M: Low Air Pressure.
Publication 68-2-14 (1974):	Test N: Change of Temperature.
Publication 68-2-20 (1979):	Test T: Soldering.
Publication 68-2-21 (1983):	Test U: Robustness of Terminations and Integral Mounting Devices.
Publication 68-2-27 (1987):	Test Ea and guidance: Shock
Publication 68-2-30 (1969):	Test Db: Damp heat, Cyclic (12 + 12-hour Cycle).
Publication 68-2-45 (1980):	Test XA and Guidance: Immersion in Cleaning Solvents.
Guide 102 (1989):	Electronic Components. Specification Structures for Quality Assessment. (Qualification approval and capability approval).

Publication 191-2 (1966):	Dimensions.
Publication 195 (1965):	Method of Measurement of Current Noise Generated in fixed Resistors.
Publication 294 (1969):	Measurement of the Dimensions of a Cylindrical Component having Two Axial Terminations.
Publication 410 (1973):	Sampling Plans and Procedures for Inspection by Attributes.
Publication 440 (1973):	Method of Measurement of Non-linearity in Resistors.
Publication 617:	Graphical symbols for diagrams.
Publication 717 (1981):	Method for the Determination of the Space required by Capacitors and Resistors with Unidirectional Terminations.
Publication 748-20 (1988):	Generic Specification for Film Integrated Circuits and Hybrid Film Integrated Circuits.
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).

ISO publications

ISO 3 (1973):	Preferred Numbers - Series of Preferred Numbers.
ISO 497 (1973):	Guide to the Choice of Series of Preferred Numbers and of Series Containing more Rounded Values of Preferred Numbers.
ISO 1000 (1981):	SI Units and Recommendations for the Use of their Multiples and of Certain Other Units.

Note. -The above references apply to the current editions, except for IEC Publication 68 for which the referenced edition must be used.

2.2 Units, symbols and terminology

2.2.1 General

Units, graphical symbols, letter symbols and terminology shall, whenever possible be taken from the following publications:

- ISO 1000
- IEC 27
- IEC 617
- IEC 50

When further items are required they shall be derived in accordance with the principles of the documents listed above.

2.2.2 Type

A group of components having similar design features and the similarity of whose manufacturing techniques enables them to be grouped together either for qualification approval or for quality conformance inspection.

They are generally covered by a single detail specification.

Note. -Components described in several detail specifications may, in some cases, be considered as belonging to the same type and may therefore be grouped together for qualification approval and quality conformance inspection.

2.2.3 Style

A sub-division of a type, generally based on dimensional factors.

A style may include several variants, generally of a mechanical order.

2.2.4 Grade

A term to indicate additional general characteristics concerning the intended application e.g. long life applications.

The term "grade" may only be used in combination with one or more words (e.g. long life grade) and not by a single letter or number.

Figures to be added after the term "grade" should be arabic numerals.

2.2.5 Family (of electronic components)

A group of electronic components which predominantly displays a particular physical attribute and/or fulfils a defined function.

2.2.6 Sub-family (of electronic components)

A group of components within a family manufactured by similar technological methods.

2.2.7 Fixed resistor network

A network in which a number of resistive elements are physically inseparably associated, so that, in terms of specifications, tests, trade and maintenance, it is considered as indivisible.

2.2.8 Film hybrid network

A film network on which at least one component, encapsulated or unencapsulated, has been mounted.

2.2.9 Passive film hybrid network

A film hybrid network in which all elements are passive.

2.2.10 Substrate

A piece of material forming a supporting base for film circuit elements and/or added components.

2.2.11 Multilayer film network

A network of more than one layer of film interconnection, separated by at least one insulating film or gap.

2.2.12 Passive element

An element primarily contributing resistance, capacitance or inductance or a combination of these to a circuit function.

Note. -Examples are resistors, capacitors, inductors, filters, inter-connecting tracks.

2.2.13 Thin-film network

A film network whose films are formed either completely by vacuum deposition techniques or by vacuum deposition techniques and then thickened by other deposition techniques.

2.2.14 Thick-film network

A film network whose films are usually formed by screen printing techniques.

2.2.15 Rated resistance

The resistance value for which each resistive element in the network has been designed.

2.2.16 Critical resistance

The resistance value at which the rated voltage is equal to the limiting element voltage (See Sub-clauses 2.2.17 and 2.2.28).

At an ambient temperature of 70 °C the maximum voltage which may be applied across the terminations of a resistor is either the calculated rated voltage if the resistance is less than the critical resistance, or the limiting element voltage if the resistance is equal to or greater than the critical resistance. At temperatures other than 70 °C, account shall be taken of the derating curve and the limiting element voltage in the calculation of the voltage to be applied.

2.2.17 Category temperature range

The range of ambient temperatures for which the resistor network is designed to operate continuously; this is defined by the temperature limits of its appropriate category.

2.2.18 Upper category temperature

The maximum ambient temperature for which a resistor network has been designed to operate continuously at that portion of the rated dissipation which is indicated in the category dissipation.

2.2.19 Lower category temperature

The minimum ambient temperature at which a resistor network has been designed to operate continuously.

2.2.20 Maximum surface temperature

The maximum temperature permitted on the surface for any resistor network of that type when operated continuously at rated network dissipation at an ambient temperature of 70 °C.

2.2.21 Rated resistor element dissipation

The maximum allowable dissipation which a resistor element is capable of dissipating in continuous operation at the ambient temperature of 70 °C.

2.2.22 Rated network dissipation

The maximum allowable dissipation which the resistor network is capable of dissipating in continuous operation at the ambient temperature of 70 °C.

2.2.23 Category dissipation

A fraction of the rated network dissipation exactly defined in the detail specification, applicable at the upper category temperature, taking account of the derating curve prescribed in the detail specification.

Note. -The category dissipation may be zero.

2.2.24 Rated voltage (U_R)

The d.c. or a.c. r.m.s. voltage of each resistive element calculated from the square root of the product of the rated resistance and the rated element dissipation.

Note. -At high values of resistance the rated voltage may not be applicable because of the size and the construction of the resistor (see Sub-clause 2.2.28).

2.2.25 Isolation voltage (applicable only to insulated resistor networks)

The maximum peak voltage which may be applied under continuous operating conditions between the resistor network terminations and any conducting mounting surface.

2.2.26 Insulated resistor network

A resistor network which fulfils the voltage proof and insulation resistance test requirements and the damp heat steady state test with a polarizing voltage applied when mounted on a metal plate.

2.2.27 Insulation resistance

Under consideration.

2.2.28 Variation of resistance with temperature

Variation of resistance with temperature can be expressed either as temperature characteristic or as temperature coefficient as defined below:

2.2.28.1 Temperature characteristic of resistance

The maximum reversible variation of resistance produced over a given temperature range within the category temperatures. It is normally expressed as a percentage of the resistance related to a reference temperature of 20 °C.

Temperature characteristic of resistance = $\frac{\Delta R}{R}$, where:

ΔR is the change in resistance between the two specified ambient temperatures.

R is the resistance value at the reference temperature.

2.2.28.2 Temperature coefficient of resistance (α)

The relative variation of resistance between two given temperatures (mean coefficient), divided by the difference in temperature producing it. It shall preferably be expressed in parts per million per °C ($10^{-6}/^{\circ}\text{C}$).

$$\alpha = \frac{R_2 - R_1}{R_1 \times \Delta\theta},$$

where:

$\Delta\theta$ (for calculation see Sub-clause 4.10.4) is the algebraic difference, in degree Celsius, between the reference temperature and the specified ambient temperature.

Note. -It should be noted that use of the term does not imply any degree of linearity for this function, nor should any be assumed.

2.2.29 Differential resistance/temperature characteristic

The difference at a given temperature, between the resistance/temperature characteristics of any two specified resistors of the same network over a given temperature range.

Example of calculation:

$$\Delta(\text{R.T.C.}) = \left(100 \times \frac{\Delta R_1}{R_1} - 100 \times \frac{\Delta R_2}{R_2}\right) (\%)$$

where:

$\Delta(\text{R.T.C.})$ = the differential resistance/temperature characteristic between the two specified resistors expressed in %.

R_1 and R_2 = the resistance values of each of the two resistors at the reference ambient temperature (normally 20 °C).

ΔR_1 and ΔR_2 = the change in resistance between a given ambient temperature and the reference ambient temperature. This given ambient temperature shall be within the category temperature range.

2.2.30 Differential temperature coefficient

The difference between the temperature coefficients at a given ambient temperature of any two specified resistors in the same network over a given temperature range.

Example of calculation:

$$\Delta(\alpha) = \frac{10^6}{\Delta\theta} \times \left(\frac{\Delta R1}{R1} - \frac{\Delta R2}{R2} \right)$$

where:

$\Delta(\alpha)$ = the differential coefficient of temperature between the two specified resistors expressed in $10^{-6}/^{\circ}\text{C}$

$R1$ and $R2$ = the resistance value of each of the two resistors at the reference ambient temperature (normally 20°C)

$\Delta R1$ and $\Delta R2$ = the change in resistance value, between a given ambient temperature and the reference ambient temperature. This given ambient temperature shall be within a specified range included in the category temperature.

$\Delta\theta$ = the algebraic difference, in degrees Celsius, between the reference and the given ambient temperature.

2.2.31 Differential resistance change

The difference between the resistance change of any two specified resistors of the same network at the end of a test.

Note. -It is normally expressed in per cent.

2.2.32 Visible damage

Visible damage which reduces the usability of the resistor network for its intended purpose.

2.2.33 Resistance ratio

The ratio of the resistance values of any two specified resistors of the same network.

If applicable, the rated value of the ratio and its tolerance are given in the detail specification.

2.2.34 Functional characteristics

The functions for which the networks have been designed. These functions shall be defined when necessary by the detail specification which shall state the methods of measurement, the performance requirements and the tests before, during and after which these functions shall be measured.

2.2.35 Limiting element voltage

The maximum d.c. or a.c. r.m.s. voltage that may be continuously applied to the terminations of each resistor in the network (it is generally dependent upon size and manufacturing technology of the resistor network).

Where the term a.c. r.m.s. voltage is used in this standard the peak voltage shall not exceed 1,42 times the r.m.s. value.

Note. -This voltage shall only be applied to resistors when the resistance value is equal to or higher than the critical resistance value.

2.2.36 Vapour-phase deposition technique IEC Publication 748-20 (1),
Sub-clause 2.4.25

The deposition of conducting, insulating or semiconducting films onto solid substrates from a source material in the vapour phase by physical deposition or chemical reaction.

2.2.37 Screen printing technique

The deposition of films onto substrates by pressing pastes (inks) through screens.

2.2.38 Plated film IEC Publication 748-20 (1),
Sub-clause 2.4.27

Film obtained through chemical and/or electrochemical deposition.

2.2.39 Termination (Terminal) IEC Publication 748-20 (1),
Sub-clause 2.4.28

Conductor (pin, tab, pad, etc...) providing external electrical access to the network.

2.2.40 Package

Total or partial envelope of the network which provides:

- mechanical protection;
- environmental protection;
- outline dimensions.

The package may also contain or provide terminations. It may influence the thermal characteristics of the network.

2.2.41 Encapsulation IEC Publication 748-20 (1),
Sub-clause 2.4.30

Encapsulation is the general process of surrounding the network or components with a protective medium against mechanical and physical chemical stresses.

2.2.42 Protective coating IEC Publication 748-20 (1),
Sub-clause 2.4.31

A layer of insulating material applied over the circuit elements for the purpose of mechanical protection and prevention of contamination.