
British Standard Specification for
**Capability approval of light emitting and
infra-red diode arrays of assessed quality:
Generic data and methods of test**

Homologation des matrices de diodes luminescentes et infra-rouges de qualité définie :
données génériques et méthodes d'essai

Fähigkeitsgenehmigung gütebestätigter lichtemittierender und Infrarot-Diodenanordnungen :
Fachgrunddaten und Prüfverfahren

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Foreword

This British Standard has been prepared under the direction of the Electronic Components Standards Committee. It is the generic specification for capability approval of light emitting diode (LED) arrays in the system of standards for electronic components of assessed quality.

This standard calls for the use of substances and/or test procedures that may be injurious to health if adequate

precautions are not taken. It refers only to technical suitability and in no way absolves either the supplier or the user from statutory obligations relating to health and safety at any stage of manufacture or use.

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

British Standard Specification for

Capability approval of light emitting and infra-red diode arrays of assessed quality: Generic data and methods of test

Section one. Principles and mandatory procedures

0. Introduction

This is a generic specification for light emitting diode (LED) arrays that are not suitable for inclusion under the Qualification Approval System for one or more of the following reasons.

- (a) Each is designed for a particular customer requirement.
- (b) Each requires an individual specification to satisfy the particular customer's needs.
- (c) The customer requirement cannot be satisfied from a standard range capable of qualification approval.

Light emitting diode arrays in these categories are termed custom-built, although standard items are not precluded. Examples of custom-built light emitting diode arrays are those having design criteria, package and/or fixing and termination arrangements or requiring a specialized process peculiar to a customer's need (see clause 15 of BS 9000 : Part 1 : 1981).

1. Scope

This British Standard specifies the capability approval procedures for light emitting and infra-red diode arrays of assessed quality.

NOTE. The titles of the publications referred to in this standard are listed on the inside back cover.

2. Related documents

This specification is to be read in conjunction with the standards in the BS 9000 series. Such general details and definitions given in those standards as are appropriate to this specification shall be held to be part of this specification unless otherwise stated herein.

The Technical Committee has reviewed the provisions of IEC 147-5, to which reference is made in the text, and has decided that it is acceptable for use in conjunction with this standard. A related British Standard is BS 9300 'Semiconductor devices of assessed quality: generic data and methods of test'.

3. Terminology

For the purposes of this British Standard the following definitions apply in addition to those defined in BS 4727, BS 9300, BS 9400, BS 9450 and the BS CECC series.

3.1 light emitting diode (LED). A semiconductor device comprising a pn junction designed to emit light when forward biased.

3.2 infra-red emitting diode. A semiconductor device comprising a pn junction designed to emit infra-red radiation when forward biased.

3.3 single-path metallization. Single-path metallization exists where the device current for the circuit element is supplied by a single path.

3.4 multiple-path metallization. Multiple-path metallization exists where the device current for the circuit is supplied by multiple paths.

3.5 photopic. The standardized spectral sensitivity of the eye adapted for 'daylight vision' when the luminance on the field of view is $> 10 \text{ cd/m}^2$. (See CIE Publication 18 1970, 'Principles of light measurements'.)

3.6 scotopic. The standardized spectral sensitivity of the eye adapted for 'night vision' when the luminance on the field of view is $< 10^{-3} \text{ cd/m}^2$. (See CIE Publication 18 1970, 'Principles of light measurements'.)

4. Letter symbols, signs and abbreviations

Letter symbols, signs and abbreviations shall be in accordance with BS 1991.

5. Graphical symbols

Graphical symbols shall be in accordance with BS 3939.

6. Marking of the component and package

The symbols or codes shall be clearly marked on the component in the following order of preference as far as is practicable:

- (a) terminal identification;
- (b) part number (including manufacturer's code and issue number);
- (c) customer's reference (where specified by the contract or order);
- (d) date code.

All codes and symbols, except marking of terminations, shall also appear on the primary package. Where a transparent package is used, the information may be marked on a label that can be read without opening the package.

7. Eligibility for release of products using the capability approval procedures

For a product to be eligible for release using the capability approval procedure, the following requirements shall be satisfied, as appropriate, on all items used in the product construction.

Light emitting diode arrays may be manufactured using integral monolithic semiconductor arrays or as an assembly of discrete semiconductor diode chips mounted on sub-carriers comprised of thin or thick film circuits as defined in BS 9450 or printed circuit boards, as defined in BS 9760 and associated sectional specifications.

The LED arrays shall be eligible for submission for capability approval to this specification if the primary stages of manufacture and subsequent processing are carried out at an approved manufacturing facility.

The primary stage of manufacture for a light emitting diode is the first stage that converts the wholly n-type material to n-type and p-type. The primary stage of manufacture for thick and thin film circuits is as defined in BS 9450.

The primary stage of manufacture for printed circuit boards is as defined in BS 9760.

The primary stage and/or any subsequent stage up to and including the finished product may be carried out at any approved manufacturing facility.

The supervising inspectorate shall have access to the data on which the manufacturer's chief inspector has based his acceptance of any items under 14.3 of BS 9000 : Part 1 : 1981 and shall be satisfied that the quality of the final product is not reduced by the use of these items.

If the approved manufacturer wishes to sub-contract operations corresponding to the primary stage of processing or any subsequent stages to an unapproved manufacturer he shall, in addition to the requirements of 14.3.2 of BS 9000 : Part 1 : 1981, ensure the following conditions are satisfied.

(a) The sub-contracted manufacturing processes may be the manufacture of the LED or the assembly of the device. Sub-carriers shall be manufactured or procured in accordance with BS 9450 or BS 9760, as applicable. Sub-carriers manufactured by the approved LED array manufacturer for incorporation into the array shall comply with all of the requirements, both of initial capability approval and of subsequent maintenance, of BS 9450 or BS 9760 with the exception that formal application to BSI, payment of the application fee and the subsequent production of a certificate of approval in accordance with BS 9450 or BS 9760 is not mandatory. Add-on components shall be procured in accordance with 1.3.1 of BS 9450 : 1975.

(b) The supervising inspectorate shall be satisfied that the chief inspector of the certifying manufacturer has been provided with the full quality assurance and inspection documentation from the non-approved facility, and that he has the responsibility for inspection of the work and the inspection arrangements there. Such documentation shall include the inspection records for each sample of the product that undergoes inspection.

(c) The chief inspector shall be provided with the production line process charts, the defined inspection points, the inspection requirements at each stage and the quality control requirements, together with the procedures for the transfer of the parts from the place of manufacture to the certifying manufacturer. The supervising inspectorate shall be informed and have access to this documentation and be able to verify the application of these requirements.

(d) Any changes in inspection requirements and manufacturing procedures shall be reported back to the

approved manufacturer's chief inspector who is certifying the components. These changes shall be declared on the document accompanying the transferred parts. The significant changes shall be reported by the approved manufacturer's chief inspector to the supervising inspectorate.

(e) The approved manufacturer shall perform the acceptance tests required by the detail specification for the component he is certifying. He can perform the acceptance tests in a non-approved facility, provided that this facility is supervised by the supervising inspectorate. Acceptance tests can be sub-contracted to approved test laboratories.

8. Structurally similar components

The requirements of 19.1 of BS 9000 : Part 1 : 1981 are replaced by the details of the capability approval procedure included in section two of this specification. See section two.

9. Delayed delivery

Components held for a period exceeding 2 years after acceptance testing shall be re-examined prior to despatch and shall satisfy the group A inspection requirements as specified in the relevant schedule.

10. Supplementary procedure for qualification approval

Not applicable.

11. Certified test records

The information to be present in certified test records shall be as stated in table 1 of this standard.

Manufacturers are free, but not obliged, to give additional CTR information beyond that required in table 1, but where this additional information is derived from sources other than acceptance procedures, this shall be stated.

12. Standard ratings and characteristics

The custom-built LED arrays covered by this standard are classified into temperature categories in accordance with the general rules given in appendix A of BS 2011 : Part 1 : 1980 and reference should be made to 1.2.6 of BS 9300 : 1969. Temperatures should be selected from values within the following preferred temperature ranges.

Lower category temperature: -65°C to -25°C .

Upper category temperature: 75°C to 125°C .

13. Unchecked parameters

Not applicable.

14. Procedure to be followed in the event of failure at group C or D inspection

The procedure given in 20.1(b) of BS 9000 : Part 1 : 1981 shall be applied, with the following proviso.

If more than one type of CQC is used to demonstrate the capability, it is possible that failure of any one of those types may not reflect upon the whole capability.

If investigation shows that the features that caused failure of group C test are present in only certain types of an approved range, the disciplines of 20.1(b) of BS 9000 : Part 1 : 1981 should be limited to that part of the approved capability.

15. Ordering information

See customer detail specification. See appendix A.

16. Release prior to completion of group B tests

Not applicable.

17. Supplementary procedures for reduced inspection

Not applicable.

18. Approval of capability

Capability approval may be granted on the satisfactory completion of the first 1000 h of the endurance test. See 14.1 of BS 9000 : Part 1 : 1981.

19. Rework

Rework shall only be permitted within the procedures declared in the manufacturer's approved capability manual. Such procedures shall demonstrate, to the satisfaction of the supervising inspectorate, that the subsequent reliability of the component as supplied to the customer is not thereby impaired.

Section two. Test procedures and methods

20. Test procedures

The test and measurement methods and procedures given in 20.1 to 20.11 inclusive of this section shall be applied as follows:

- (a) when they are required to verify facilities or assessment tests included as a part of a manufacturer's capability assessment programme; *or*
- (b) when they are required to perform tests or measurements contained in a customer's detail specification.

A manufacturer is free to specify those tests that he offers as part of his declared production capability, and that will be specified in his capability manual.

Tests and measurement procedures shall be applied in accordance with the inspection requirements of BS 9000.

20.1 Test methods. Test methods shall be selected from the BS 9000 series or BS CECC 50 000 specifications, where applicable.

If no test method is available, the manufacturer shall declare his test methods in his capability manual and they shall be included in the manufacturer's guidance to customers document, if one is produced.

20.2 Test and measurement conditions. Unless otherwise specified, all tests shall be carried out under standard atmospheric conditions for test as specified in clause 5 of BS 2011 : Part 1.1 : 1980 (see also IEC 68-2). Where there is a requirement for components to attain thermal stability, this shall be in accordance with 4.8 of BS 2011 : Part 1.1 : 1980.

20.3 External visual inspection. Unless otherwise specified, visual inspection shall be performed under approved factory lighting conditions and under normal visual conditions.

Inspection shall include the following items:

- (a) correctness of marking;
- (b) correctness of terminal identification;

- (c) correct encapsulation;
- (d) unbroken body.

20.4 Dimensioning and gauging procedures. The dimensions shall be verified as required by the detail specification but this does not preclude dimensional checks as part of the maintenance of capability approval.

These tests shall be made in accordance with the specified drawing and a given in table 1. The dimensions, which shall be checked as part of the group B, C and D inspection requirements, are indicated by the standardized letter references in IEC Publication 191-1, which are also used in the drawings in BS 3934.

20.5 Electrical test procedures. Electrical test procedures shall be as specified in BS 9300, BS 9400 and relevant BS CECC 50 000 specifications, where applicable.

20.6 Environmental test procedures. This clause covers the requirements for environmental tests to be used in accordance with the general requirements of BS 9000. The conditions given in each procedure are those from which the manufacturer chooses in order to establish his capability approval. Other conditions may be prescribed by a customer for particular applications. These conditions shall be included in the detail specification. They should be taken from those included in BS 2011.

Unless otherwise specified, all tests shall be performed under the standard atmospheric conditions for testing as specified in BS 2011.

When testing is performed by the device manufacturer, more severe test conditions than those specified are permitted. In this case, temperatures may be higher than those specified when the specified temperatures are 25 °C and above, and lower than those specified when the specified temperatures are below 25 °C. In all other cases the prescribed limits of test conditions shall be used.

Wherever possible, the tests given in 20.6.1 to 20.6.20 inclusive are taken from BS 2011 : Part 2.1. However, some tests are additional to those in BS 2011 (e.g. rapid change of temperature, flammability test for material(s)), and in these cases the test procedures are given in full.

20.6.1 Test Aa : Cold for non-heat dissipating specimen with sudden change of temperature. (This test is non-destructive.) The air in the chamber need not be agitated. Unless otherwise specified, there shall be no upper limit requirements for the time of recovery or the relative humidity during the recovery period.

The following specified conditions will be given in the detail specification:

- (a) temperature of conditioning;
- (b) duration of conditioning;
- (c) association with other tests in a sequence;
- (d) electrical and mechanical tests to be made prior to conditioning and after recovery, as appropriate.

20.6.2 Test Ba : Dry heat for non-heat dissipating specimen with sudden change of temperature. (This test is non-destructive.)

NOTE. The atmosphere should be of inert gas if the devices are for subsequent delivery or subject to solderability tests.

The air in the chamber need not be agitated and there shall be no requirement for the control of relative humidity during the conditioning period.

The duration of the recovery period shall be not less than

Table 1. Dimensions

Configuration of devices	Group B	Group C	Group D
(a) Wire mounted single ended, e.g. SO-3 (BSI), C4 (IEC) with base SB8-1A(BSI), B7A(IEC)	ϕD A	ϕB_2 L	All*
(b) Flatpack, e.g. SO-92 type 1	H Number of leads Seated height (maximum)	$L_{(min)}$ $b_{(max)}$ e $Z_{(max)}$	All*
(c) In-line (body width does not overhang terminals), e.g. Dual-in-line, SO-87 type 1	$D_{(max)}$ Seated height (maximum)	$b_{(max)}$ $c_{(max)}$ $L_{(min)}$ Stand off height (minimum)	All*
(d) In-line (body overhangs terminals)	$D_{(max)}$ $Z_{(max)}$ Package width (maximum) $Z_{1(max)}$ Seated height (maximum)	$\phi b_{(max)}$ $L_{(min)}$ Stand off height (minimum)	All*

* All dimensions included on the BS 3934 drawing called up in the specification or the drawing in the specification and prepared in accordance with BS 3934 except those covered in groups B and C.

1 h nor more than 6 h and there shall be no requirements for the control of relative humidity during that period.

The following specified conditions will be given in the detail specification:

- (a) temperature of conditioning;
- (b) duration of conditioning;
- (c) association with other tests in sequence;
- (d) electrical and mechanical tests to be made prior to conditioning and after recovery, as appropriate.

20.6.3 High temperature storage. (This test is non-destructive.)

20.6.3.1 Purpose. The purpose of this test is to determine the effect on the devices of storage at elevated temperatures without electrical stress being applied. This method may also be used in a screening sequence or as a pre-conditioning treatment prior to the conduct of other tests. This test shall not be used to determine device failure rates for other than storage conditions.

20.6.3.2 Apparatus. The apparatus required for this test shall consist of a controlled temperature chamber capable of maintaining the specified temperature and suitable electrical equipment to make the specified end point measurements.

20.6.3.3 Procedure. The device shall be stored at the specified ambient conditions for the specified time. End-point measurements shall be made at 0 h and after the specified duration of test $\pm 72_0$ h. End-point measurements shall be made at standard conditions and sample units shall be removed from the test ambient and allowed to reach standard conditions before final end-point measurements. Additional measurements may be made at intermediate points. It may be desirable to make end-point and, where applicable, intermediate measurements on a serialized device basis or on the basis of a histogram distribution by total

sample in order to increase the sensitivity of the test to parameter degradation or the progression of specific failure mechanisms with time and temperature.

20.6.3.4 Test condition. The ambient test temperature shall be in accordance with one of the following test temperatures or as specified.

Temperature

70 $\pm$ 5 °C
85 $\pm$ 5 °C
100 $\pm$ 5 °C
125 $\pm$ 5 °C
150 $\pm$ 5 °C
175 $\pm$ 5 °C
200 $\pm$ 5 °C

20.6.3.5 Specified conditions. The following test conditions will be obtained from the detail specification:

- (a) whether or not device has been screened;
- (b) test temperature;
- (c) test duration, if other than 1000 h;
- (d) end-point measurements;
- (e) intermediate measurements, if applicable;
- (f) device number or special data reporting requirements, if applicable.

20.6.4 Test Ca : Damp heat, steady state. (Unless otherwise specified, this test is non-destructive. The detail specification shall specify when the test is destructive). Unless excluded by the detail specification, devices subjected to the test shall be checked for corrosion as follows.

- (a) The marking shall remain legible.
- (b) Where appropriate, the lead wires shall be subjected to one bending cycle as in 20.6.16.2 and fracture of a lead shall constitute a failure.

The following specified conditions will be given in the detail specification:

- (1) severity of test (4 days, 21 days or 56 days);
- (2) loading conditions;
- (3) electrical and mechanical tests to be made prior to conditioning and after recovery, as appropriate.

20.6.5 Test Db : Damp heat, cyclic. (Unless otherwise specified, this test is non-destructive. The detail specification shall state when the test is destructive). This test may be applied to the device in its mounted condition of use if the rapid change of temperature test, see **20.6.13**, specifies that it shall be so mounted.

After removal from the chamber, surface water may be removed by shaking or by a blast of air at laboratory temperature.

Unless otherwise specified, the sample shall remain under standard atmospheric conditions for recovery for not less than 1 h nor more than 2 h. Where the test is performed as a group B test, the number of cycles shall be six. Where it is performed as a group C test, the number of cycles shall be 28.

Unless excluded by the detail specification, devices subjected to 28 cycles test in group C inspection shall be checked for corrosion as follows.

- (a) The marking shall remain legible.
- (b) Where appropriate, the lead wires shall be subjected to one bending cycle as in **20.6.16.2** and fracture of a lead shall constitute a failure.

The following specified conditions will be given in the detail specification:

- (1) loading conditions;
- (2) association with other tests in a sequence;
- (3) electrical and mechanical tests to be made prior to conditioning and after recovery, as appropriate.

20.6.6 Test Ea : Shock. (This test is non-destructive.) The half-sine pulse shape shall be that normally used but the manufacturer may, at his discretion, use the trapezoidal pulse shape and exceed the upper tolerance boundary. The following specified conditions will be given in the detail specification.

- (a) Method of mounting.
- (b) The severity of test. One of the following conditions shall be selected:

Peak acceleration	Duration of pulse
m/s ²	ms
(1) 249	18
(2) 490	11
(3) 981	6
(4) 14 700	0.5

- (c) Association with other tests in a sequence.
- (d) Electrical and mechanical tests to be made prior to and after conditioning, as appropriate.

20.6.7 Test Eb : Bump. (This test is non-destructive.)

The preferred severities are:

- (a) 390 m/s² and a total of 4000 ± 10 bumps;
- (b) 390 m/s² and a total of 1000 ± 10 bumps;
- (c) 98 m/s² and a total of 1000 ± 10 bumps.

The following specified conditions will be given in the detail specification:

- (1) method of mounting;

- (2) association with other tests in a sequence;
- (3) electrical and mechanical tests to be made prior to and after conditioning, as appropriate;
- (4) severity of test.

20.6.8 Test Fc : Vibration, sinusoidal. (These tests are destructive unless their duration is restricted to a maximum of 5 minutes.) The sample shall be subjected to the procedure using one of the methods specified below.

NOTE. The IEC standard frequency range 10 Hz to 2000 Hz may be restricted to 150 Hz to 2000 Hz when testing devices of mass less than 10 g, as no useful additional information is provided by testing at low frequencies.

20.6.8.1 Vibration, swept frequency. The sample shall be subjected to procedure B4 of test Fc of BS 2011 using a stated combination of acceleration and frequency range selected from the following lists.

Frequency minimum	Frequency maximum	Acceleration
Hz	Hz	m/s ²
150	2000	196
55	500	98
20	150	49
		10

The sample shall be divided into three subsamples. The subsamples shall be vibrated for a minimum of 2 h or longer, as specified, in three mutually perpendicular axes, one subsample per axis. For this test, the three subsamples may be mounted on the three faces of a cubic mounting block.

20.6.8.2 Vibration, fixed frequency. Each device in the sample shall be vibrated along an axis perpendicular to the diameter of devices having cylindrical shapes and perpendicular to the major plane of devices having rectangular shapes. The vibration shall be applied at one frequency in the range 40 Hz to 200 Hz for a minimum duration of 20 h.

The acceleration shall be selected from the table in **20.6.8.1**.

The following specified conditions will be given in the detail specification:

- (a) method of mounting;
- (b) association with other tests in a sequence;
- (c) electrical and mechanical tests to be made prior to and after conditioning, as appropriate.

20.6.9 Test Ga : Acceleration steady state. (This test is non-destructive.) The manufacturer may, at his discretion, exceed the upper limits of acceleration tolerance. The appropriate severity shall be chosen from one of the following:

Acceleration
m/s ²
294 000
196 000
49 000
19 600
4 000
490
95

NOTE. The above applies to all forms of devices and the lower values have been added to cater for the larger devices.

The following specified conditions will be given in the detail specification:

- (a) method of mounting;
- (b) association with other tests in a sequence

(c) electrical and mechanical tests to be made prior to and after conditioning, as appropriate.

20.6.10 Test J : Mould growth. (This test is destructive.) The following specified conditions shall be given in the detail specification:

- (a) if inspection other than visual is required;
- (b) amount of mould growth allowable and any special requirements regarding etching of surfaces;
- (c) if performance deterioration is to be determined, pre-test and post-test measurements;
- (d) period of exposure;
- (e) any variation from the procedure of test J.

20.6.11 Corrosion. Under consideration.

20.6.12 Test M : Low air pressure. (This test is non-destructive.) The following specified conditions will be given in the detail specification:

- (a) severity of test;
- (b) association with other tests in a sequence;
- (c) electrical and mechanical tests to be made prior to conditioning and after recovery, as appropriate.

20.6.13 Tests Na and Nb : Rapid change of temperature. (These tests are non-destructive.)

20.6.13.1 Initial measurements. Each specimen shall be visually inspected and shall be electrically and mechanically checked as prescribed in the relevant detail specification.

20.6.13.2 Apparatus. Either a single chamber capable of being cycled between the temperature extremes or two chambers, one for the low temperature and one for the high temperature shall be provided. In the latter case, the position of the chambers shall be such as to allow a rapid transfer from one chamber to the other.

The single chamber for this test shall be so designed that, in any region where the specimen under test is placed, a temperature cycle can be performed in such a manner that:

- (a) the low temperature required for the test can be maintained;
- (b) the high temperature required for the test can be maintained;
- (c) the change-over from low temperature to high temperature or vice versa can be performed with the

rate of change of temperature required for the test.

20.6.13.3 Conditioning. Specimens shall be placed in such a position with respect to the air stream that there is substantially no obstruction to the flow of air across and around the specimen. When special mounting is required, it shall be specified. The specimen shall be subjected to the specified conditions for the specified number of cycles performed continuously. One cycle is as defined under **20.6.13.5**.

If two chambers are used, specimens shall not be subjected to forced circulating air while being transferred from one chamber to the other. Where single or multiple chambers are used, the effective total transfer time from the specified low ambient temperature to the specified high ambient temperature or the reverse shall not exceed 5 min. The devices under test shall be so arranged that the temperature changes take place only as a result of impinging or other gases.

The specimens shall be subjected to five complete cycles, unless otherwise prescribed in the detail specification.

20.6.13.4 Final measurements. The specimen shall be visually inspected and shall be electrically and mechanically checked as prescribed in the detail specification.

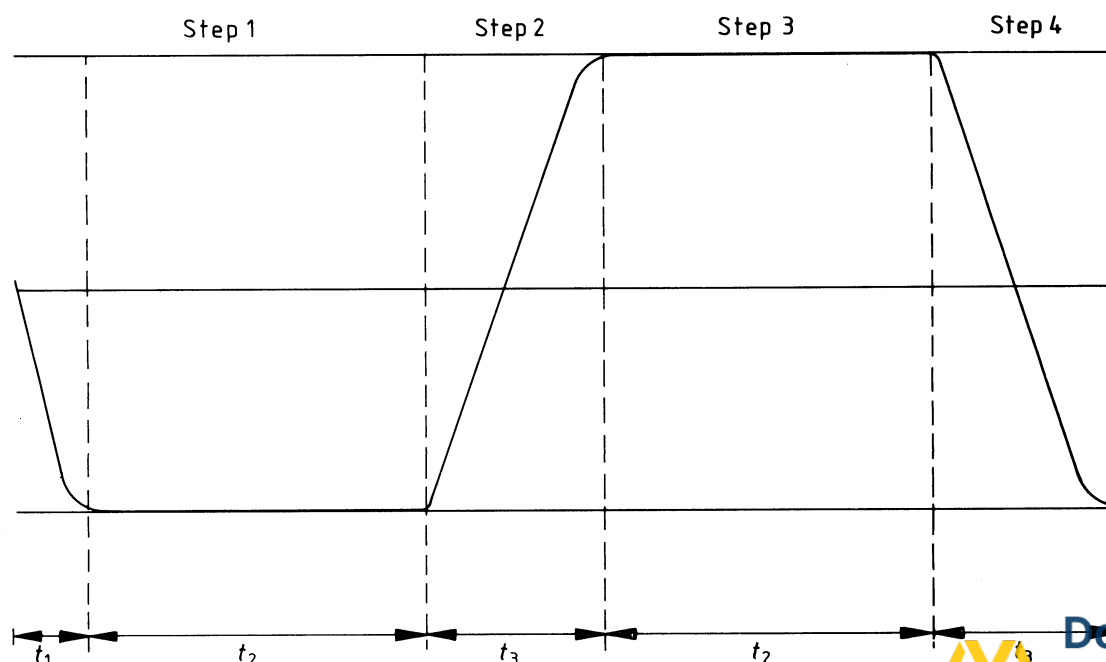
20.6.13.5 Test conditions. 'One cycle' consists of the following steps.

Step	Duration	Ambient temperature
	min	°C
1	10 minimum (see note 1)	-65 ± 5
2	5 maximum	See note 1
3	10 minimum (see note 1)	150 ± 5
4	5 maximum	See note 2

NOTE 1. The use of carriers, holders or other factors may make 10 min inadequate and where this is so, a greater duration will be prescribed in the detail specification.

NOTE 2. Total transfer time from one temperature to the other including any dwell time at an intermediate temperature prescribed in the detail specification.

The requirements for the ambient temperature where a single chamber is used may be illustrated as follows:



The time for ambient to reach extreme temperature from 25 °C (t_1) is ≤ 2 min.

The duration at extreme ambient temperature (t_2) is ≥ 10 min.

The total transfer time from one extreme ambient temperature to the other (t_3) ≤ 5 min.

20.6.13.6 Information to be included in the relevant specification. When this test is included in the relevant specification, the following details shall be given as far as they are applicable:

- (a) measurements and mechanical checks prior to conditioning;
- (b) low temperature, if other than - 65 °C;
- (c) high temperature, if other than 150 °C;
- (d) duration of the exposure at high and low temperature, if other than 10 min minimum;
- (e) maximum change-over time, if other than 5 min;
- (f) number of cycles, if other than five;
- (g) duration of recovery;
- (h) measurements and mechanical checks after recovery;
- (i) any deviations in procedure.

20.6.14 Sealing

20.6.14.1 Fine leak tests

20.6.14.1.1 Test Qk : Container sealing, tracer gas method, with mass spectrometer. (This test is non-destructive.)

The tracer gas shall be helium of a purity of not less than 90 % (V/V), or alternatively, helium with a purity of between 40 % (V/V) and 90 % (V/V), provided that either:

- (a) the pressure used in the pressure vessel is increased so that the partial pressure of the helium is not less than the standard pressure given below; or
- (b) the time for which the specimens are conditioned in the pressure vessel is not less than:

$$4 \left(\frac{90}{P} \right)^2 h$$

where

P is the percentage purity by volume of helium used (in % (V/V)).

The pressure in the pressure vessel shall be not less than 414 kPa* (4140 mbar).

The specimen shall remain under pressure for a minimum of 4 h. On removal from the pressure vessel, it shall be cleaned externally in an air stream to remove all adhering tracer gas. Within 2 h of removal from the pressure vessel, the specimen shall be placed in the detection chamber of a mass spectrometer and the preferred leak rate shall not exceed 5×10^{-8} Pa·m³/s (5×10^{-7} bar·cm³/s).

NOTE. The pressure may be varied within a range of 2 atmospheres to 8 atmospheres (absolute) if a compensated time is associated that maintains the product $P \times t$ constant at 414 kPa (4140 mbar) $\times$ 4 h.

20.6.14.1.2 Radioactive krypton method. (This test is non-destructive.)

The sample shall be subjected to the procedure of the test in 7.3 of IEC 147-5 : 1977.

This test is to determine the leak rate of a semiconductor device or integrated circuit by measuring the radiation level present within the device after having been pressurized in a chamber with suitable radioactive tracer gas.

This method is intended to be specified for devices that are designed to be hermetically sealed in glass, metal or ceramic (or combinations thereof) encapsulations and is suitable for leak rates smaller than 10^{-6} Pa·m³/s (10^{-5} bar·cm³/s).

The numerical values given are applicable for krypton-85 tracer gas and for a leak rate limit close to 5×10^{-9} Pa·m³/s (5×10^{-8} bar·cm³/s). The use of other tracer gases would require other numerical values.

20.6.14.1.2.1 Apparatus. The apparatus required for this test consists of a radioactive tracer activation tank and a counting station with sufficient sensitivity to determine the radiation level of the tracer gas inside the device.

The apparatus operates with a tracer gas mixture of krypton-85 and dry nitrogen with a specific activity of 37 MBq/Pa·m³ (minimum) (100 μ Ci/cm³ under standard atmospheric conditions).

Instructions for the use of the leak testing equipment, as supplied by the manufacturer of the equipment, shall be followed in calibrating and operating the equipment. Test results obtained under non-preferred conditions can be compared with those under preferred conditions by conversion through the appropriate formula given in these instructions.

The activation pressure and soak time shall be determined in accordance with the following equation (see note below):

$$Q_s = \frac{R}{3600 s k \bar{P} T}$$

where

Q_s is the maximum leak rate allowable for the device to be tested (in Pa·m³/s);

R is 1200 counts per minute above the ambient background after activation if the device leak rate were exactly equal to Q_s ; this is the reject count above the background of both the counting equipment and the component if it has been through previous radioactive leak tests;

s is the specific activity of the krypton-85 gas in the activation system (in MBq/Pa·m³);

k is the overall counting efficiency of the scintillation crystal in counts per minute per MBq of krypton-85 in the internal cavity of the specific component being evaluated: this factor depends upon component configuration and dimensions of the scintillation crystal and the counting efficiency shall be determined in accordance with 7.3.2.4 of IEC Publication 147-5 : 1977;

T is the soak time that the devices are to be activated (in h);

$$\bar{P} = P_e^2 - P_i^2$$

where

P_e is the absolute activation pressure (in Pa);

P_i is the original absolute internal pressure of the devices (in Pa):

the activation pressure (P_e) may be established by specification, or if a convenient soak time (T) has been established, the activation pressure (P_e) can be adjusted to satisfy the equation.

NOTE. The complete version of the equation contains a factor $P_o^2 - (\Delta P)^2$ in the numerator which is a correction factor for elevation above sea level. P_o is the pressure at sea level (in Pa)

* 1 Pa = 10^{-5} bar = 1 N/m².

† 1 MBq/Pa·m³ $\approx$ 2.7 μ Ci/atm·cm³.

and ΔP is the difference in pressures (in Pa) between the actual pressure at the test station and sea level pressure.

If $P_0 = 840 \times 10^2$ Pa; $\Delta P = 140 \times 10^2$ Pa at 2200 m.

The counting efficiency (k) of the equation shall be determined as follows.

(a) A representative unit of the device type to be tested shall be provided with a tube to its internal cavity and the cavity shall be backfilled through the tube with a known volume and specific activity of krypton-85 tracer gas and the tabulation should be sealed off.

(b) The counts per minute in the shielded scintillation crystal of the counting station in which the devices are tested shall be directly read.

For each type of encapsulation to be tested, the coatings and the external sealants shall be evaluated for surface sorption of krypton-85 before establishing the leak test parameters. Representative samples of the devices shall be subjected to the predetermined pressure and time conditions established for the device configuration as specified in 7.3.2.2 and 7.3.2.3 of IEC Publication 147-5 : 1977. The count rate of the samples shall then be noted every 10 min, until it becomes constant. The elapsed time shall be noted and is the 'wait time' as specified in 7.3.4 of IEC Publication 147-5 : 1977.

20.6.14.1.2.2 Procedure. The devices shall be placed in a radioactive tracer gas activation tank. The tank shall be evacuated to at least 50 Pa. The actual pressure and soak time shall be determined in accordance with 7.3.2.3 of IEC Publication 147-5 : 1977.

The devices shall be subjected to a minimum of 2×10^5 Pa absolute pressure of krypton-85/dry nitrogen mixture for a minimum of 12 min. The krypton-85/dry nitrogen gas mixture shall be evacuated until a pressure less than 50 Pa exists in the activation tank. The evacuation shall be complete in 5 min maximum.

The activation tank shall then be backfilled with air (air wash). The devices shall then be removed from the activation tank, and leak tested within 2 h after gas exposure.

The wait time determined by 7.3.2.5 of IEC Publication 147-5 : 1977 shall be observed, but in no case shall the time between removal from the activation chamber and test exceed 2 h.

If the test is to be repeated on the same specimen(s), then they shall be first decontaminated in vacuum for 8 h, prior to representation.

The actual leak rate of the component shall be calculated using the following equation:

$$Q = \frac{(\text{actual readout in net counts per minute}) \times Q_s}{R}$$

where

Q is the actual leak rate (in $\text{Pa} \cdot \text{m}^3/\text{s}$).

20.6.14.1.2.3 Specified condition. The limit of the leak rate shall be specified.

20.6.14.2 Gross leak tests

20.6.14.2.1 Test Q_c : Bubble test. (This test is non-destructive.) This method consists of placing the prescribed sample of devices in a bath containing a suitable non-corrosive high boiling point liquid* maintained at a temperature of $125 \pm 5^\circ \text{C}$ and checking for the emanation of bubbles that are indicative of gas leakage.

The bath shall contain a sufficient volume of liquid to ensure that the insertion of the specimen does not have a significant effect upon the temperature.

Specimens shall be completely immersed to a depth of not less than 10 mm above the uppermost part of the enclosure or seal to be tested.

The specimens, which shall be at a temperature of between 15°C and 35°C at the beginning of the test, shall be immersed in a test liquid with the seals uppermost for a period of $30 \pm 5, -0$ s.

Specimens with seals on more than one surface shall be reorientated in turn to bring the respective seals uppermost. The sample will be rejected if, during the period of the test, any of the following conditions are observed:

- (a) a continuous stream of bubbles;
- (b) more than two large bubbles;
- (c) an attached bubble that increases in size.

Should the specimens require to be cleaned† after the test, use a suitable solvent rinse procedure and dry in a stream of warm air.

The detail specification shall state which measurements are to be undertaken prior to conditioning and after recovery, as appropriate.

20.6.14.2.2 Test Q_l : Bomb pressure test. (This test is destructive.) The test liquid shall be water or industrial spirit‡ to which a minimum of 2 % (V/V) of wetting agent has been added.

The pressure in the pressure vessel shall be raised to 345 kPa (3450 mbar).

After removal from the pressure vessel, the sample shall be allowed to remain under standard atmospheric conditions for recovery for a period of not less than 2 h or more than 24 h.

20.6.14.2.3 Fluorocarbon gross leak test. (This test is non-destructive.) This test is to determine the effectiveness of the seals using a fluorocarbon liquid.

This method, which is conducted in two stages as described below, involves the impregnation under vacuum and pressure of a device using low boiling point fluorocarbon liquid.

The effectiveness of the seals is checked by subsequent immersion of the specimen in a bath containing a high temperature liquid and checking for the emanation of gas bubbles.

* For test temperatures above 90°C suitable liquids should have a kinematic viscosity of the order of 0.3 cSt at the test temperature. Commonly used liquids are fluorocarbon, e.g. perfluorotributylamine or perfluoro (1 - methyldecane).

† This process will not be required when fluorocarbon liquid is used, as the liquid drains away to leave a clean dry surface. When using hydrocarbon or siliconeous, or similar liquids for the immersion bath, cleaning will be necessary.

‡ Complying with BS 3591. It should be noted that the use of industrial methylated spirits is governed by the Methylated Spirits Regulations, 1952 (SI 1952, No. 2230).

The purpose of the method is to detect gross leak rates equal to or greater than 10^{-6} Pa·m³/s (10^{-5} bar·cm³/s) in electronic components and is of particular application in screening tests on components with internal cavities of small volume.

(a) *Stage one : impregnation* (carried out at room temperature). The specimen shall be enclosed in a vacuum/pressure vessel and the pressure reduced to about 100 Pa for 1 h. After this period, and without breaking the vacuum, an impregnating fluid* shall be drawn into the vessel until the specimen is completely immersed.

The vessel shall then be pressurized under the following conditions.

Internal cavity volume cm ³	Minimum pressure (absolute) kPa	Minimum duration h
< 0.1	600	1
> 0.1	300	2

At the end of the impregnation period the pressure shall be removed, the specimens being retained in the liquid until required for the next stage of testing.

(b) *Stage two : immersion*. Prior to the commencement of stage two testing, the specimen shall be removed from the stage one liquid and allowed to dry in air at room temperature for 3 ± 1 min.

Stage two (immersion) testing shall be conducted in accordance with the bubble test of 20.6.14.2.1 and employ the same rejection criteria for observed leakage from the specimens.

The specimens shall be observed from the instant of immersion for a period of 30 s or such other period defined in the detail specification.

In the observation for leakage, it should be noted that a defective specimen, being filled with a volatile fluorocarbon material, will produce a copious stream of bubbles of fluorocarbon vapour.

20.6.15 Test T : Soldering. (These tests are destructive, except where the lead finish is not materially altered by the solderability tests. Use of electrical rejects is permitted.) When considered necessary, accelerated ageing may be specified prior to the test.

20.6.15.1 Test Ta : Solderability

20.6.15.1.1 Solder globule method. The terminations shall be immersed into a flux consisting of 25 % (m/m) of colophony with 75 % (m/m) of isopropyl alcohol for a minimum time of 5 s.

The point of application shall be 5 ± 1 mm from the body. When applicable, two leads on each specimen comprising the sample shall be tested. The leads shall be selected in a cyclic manner, leads numbers 1 and 2 on the first specimen, numbers 2 and 3 on the second specimen and so on.

The solder shall wet the lead within 2.5 s.

When observed under $\times 10$ magnification, the dipped surface shall be covered with a smooth and bright solder

* The liquid used for impregnation in stage 1 should have a kinematic viscosity of the order of 0.4 cSt at room temperature, a boiling point of approximately 60 °C and a low heat of vaporization to facilitate rapid generation of vapour within the specimen when stage two tests are conducted.

Commonly used materials are fluorocarbons, e.g. cyclic-perfluorodipropyl ether or perfluoro-N-hexane, which shall be compatible with the liquid utilized in stage two.

coating with no more than traces (approximately 5 %) of scattered imperfections such as pin holes or unwetted or de-wetted areas. These imperfections shall not be concentrated in one area.

The detail specification shall prescribe the final measurements.

20.6.15.1.2 Solder bath method. Prior to the test, the terminations shall first be immersed into a flux consisting of 25 % (m/m) of colophony with 75 % (m/m) of isopropyl alcohol for a minimum time of 5 s to the depth as given below.

The terminations shall be immersed to a point 1.5 ± 0.75 mm from the body, unless otherwise specified, or to half the length of the tag or termination, as appropriate. For flexible leads having no tag or termination, the last 12.5 mm shall be immersed. The temperature of the solder bath shall be 230 ± 5 °C. The duration of the immersion shall be 2.0 ± 0.5 s.

When observed under $\times 10$ magnification, the dipped surface shall be covered with a smooth and bright solder coating with no more than traces (approximately 5 %) of scattered imperfections such as pin holes or unwetted or de-wetted areas. These imperfections shall not be concentrated in one area.

The detail specification shall prescribe the ageing, if applicable.

20.6.15.2 Test Tb : Resistance to solder heat, method 1b. (This test is destructive.) No flux shall be used.

The terminations shall be immersed to a point $2 + 0.5, - 0$ mm from the seating plane.

The temperature of the solder bath shall be 350 ± 10 °C, unless otherwise specified.

The duration immersion shall be $3.0 + 1, - 0$ s.

The values of the following test conditions shall be prescribed in the detail specification:

- (a) temperature, if other than 350 °C;
- (b) final measurements.

20.6.16 Test U : Robustness of terminations. Use the appropriate procedures of test U or those additional procedures given below, as specified in the detail specification.

For multihead devices, the manufacturer may count a group of five leads as one specimen, i.e. a ten-lead device counts as two specimens: however, at least three devices shall be tested.

Where the number of terminations to be tested per specimen is less than the total number of terminations on the specimen, then the terminations shall be selected in a cyclic manner such that in the total sample each termination position is tested.

20.6.16.1 Test Ua : Tensile. (This test is destructive: electrical rejects may be used.) This test is applicable to flexible wire terminations that have not been performed for mounting.

The loading mass to be applied shall be as given in the table below.

Nominal diameter of round wire	Loading mass
mm	kg
< 0.3	0.25
> 0.3 to < 0.5	0.50
> 0.5 to < 0.8	1.00
> 0.8 to < 1.25	2.00
> 1.25	4.00

The loading mass shall be applied to one termination at a time. The number of terminations in excess of two to be tested per specimen shall be as specified in the detail specification. A broken termination shall constitute a failure.

20.6.16.2 Test *Ub* : Bending (wire or strip terminations). (This test is destructive: electrical rejects may be used.)

The test shall be applied to one termination at a time. The number of terminations in excess of two to be tested per specimen shall be as specified in the detail specification. For round wires, the load shall be half that stated in the table in 20.6.16.1. For strip terminations, the loads are under consideration.

Two consecutive bends shall be applied.

When specified for flat-pack and smaller encapsulations, the termination shall be restricted so that the bend starts 2.4 ± 0.8 mm from the body of the specimen. A broken termination shall constitute a failure.

20.6.16.3 Bending (row of terminations). (This test is destructive: electrical rejects may be used.) This test is applicable to rows of terminations that are:

- (a) not intended to be bent by the user; and/or
- (b) preformed for mounting.

It is also applicable to rows of terminations that have been separately subjected to the test specified in 20.6.16.2.

No tensile load is applied during the test. The body of the specimen and the row of terminations shall be held in a suitable jig. The ends of the terminations shall be simultaneously pushed through one cycle of bending to 45° and back to normal. The direction of bending shall be at right angles to the plane of the row of terminations.

For specimens having more than one row of terminations, the test shall be applied to each row in turn. A broken termination shall constitute a failure.

20.6.16.4 Push test. (This test is non-destructive.) This test is applicable to 'dual-in-line' packs and similar constructions designed to maintain an air gap under the body by means of specially shaped terminations.

A flat plate jig with holes at the nominal locations of the terminations is used. The diameters of the holes shall be as specified in the detail specification.

The specimen shall be inserted in the jig and a force applied to the body in a direction perpendicular to the plane of the jig. The force shall be as prescribed in the detail specification.

The following specified conditions will be given in the detail specification:

- (a) force to be applied;
- (b) association with other tests in a sequence;
- (c) electrical and mechanical tests to be made prior to and after conditioning, as appropriate.

20.6.17 Flammability. These tests are normally only applicable to solid encapsulation (plastics) types of devices. They are grouped into those applicable to encapsulated devices (20.6.17.1 and 20.6.17.2) and those applicable to materials (20.6.17.3).

20.6.17.1 Internal. (This test is destructive.) This test is to check that the device will not catch fire due to internal heating caused by excessive overloads.

The device shall be operated so that the internal electrical power is slowly increased from the maximum rated value until either:

- (a) the device becomes open circuit or its resistance increases to such a high value that further increase in power dissipation is impracticable;
- (b) the device ignites;
- (c) an internal power dissipation equal to five times the maximum rated power dissipation at 25°C is reached.

In the case of (c), the power shall then be maintained for a minimum duration of 1 min. A device shall be deemed a failure if it smoulders, ignites, or emits flammable or noxious vapours.

20.6.17.2 External. (This test is destructive: electrical rejects may be used.) This test is to check that the device will not support combustion arising from an external source.

(a) *Test equipment.* The test equipment shall consist of the following.

- (1) A three-sided metal screen, approximately 760 mm high, 460 mm wide, and 300 mm deep, with open front and closed top.
- (2) A suitable stand or support for the device.
- (3) A bunsen burner approximately 11.0 mm outside diameter and approximately 7.5 mm bore using town or similar gas.

(b) *Test procedure.* The test shall be carried out in a substantially draught free room.

(1) *Test flame.* The burner flame shall be adjusted by controlling the gas supply so that when a length of 0.71 mm diameter copper wire is held horizontally in the flame 6.5 mm above the tip of the inner cone, it melts in 8 s to 9 s. A flame with full air supply, adjusted to have inner cone height of approximately 38 mm and flame height of 200 mm, will usually be found suitable.

(2) *Mounting.* The device shall be mounted on the stand in the middle of the screen so that it will not be shielded from the flame by any support. The precise orientation relative to the flame, unless otherwise specified in the relevant detail specification, shall be either that judged to be most unfavourable, or that which presents maximum surface to the test flame. The height shall be adjusted so that the lowest point of the body of the device will be 6.5 mm above the tip of the inner cone of the flame.

(3) *Test.* The burner with flame adjusted as above shall be placed in position under the device until it ignites or for 15 s, whichever is the shorter time, and then withdrawn.

(c) *Requirements.* If ignition of the device has occurred, any visible flame shall disappear within 10 s of withdrawal from the burner flame. Failure of a device to meet this requirement will constitute a failure.