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Generic specification: Fixed resistors

Generic Specification: Fixed resistors

Fachgrundspezifikation: Festwiderstände

Spécification générique: Résistances fixes

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STANDARD PREVIEW
This European Standard was approved by the CENELEC Electronic Components Committee (CECC) on 13 February 1993. CENELEC members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration.

Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the General Secretariat of the CECC or to any CENELEC member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CENELEC member into its own language and notified to the CECC General Secretariat has the same status as the official versions.

CENELEC members are the national electrotechnical committees of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom. The membership of the CECC is identical, with the exception of the national electrotechnical committees of Greece, Iceland and Luxembourg.

CECC

CENELEC Electronic Components Committee
Comité des Composants Electroniques du CENELEC
CENELEC-Komitee für Bauelemente der Elektronik

General Secretariat: Gartenstr. 179, D-60596 Frankfurt am Main

Foreword

The CENELEC Electronic Components Committee (CECC) is composed of those member countries of the European Committee for Electrotechnical Standardization (CENELEC) who wish to take part in a harmonized system for electronic components of assessed quality.

The object of the system is to facilitate international trade by the harmonization of the specifications and quality assessment procedures for electronic components, and by the grant of an internationally recognized mark, or certificate, of conformity. The components produced under the system are thereby acceptable in all member countries without further testing.

This specification was prepared by CECC WG 4A, Fixed resistors.

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Contents

	Page		Page
Foreword	2	3.2 Primary stage of manufacture	11
Section 1. Scope	5	3.3 Subcontracting	12
1 Scope	5	3.4 Structurally similar components	12
Section 2. General	6	3.5 Qualification approval procedures	12
2 General	6	3.6 Capability approval procedures	12
2.1 Related documents	6	3.7 Rework and repair work	13
2.2 Units, symbols and terminology	7	3.8 Release for delivery	13
2.3 Preferred values	9	3.9 Certified test records	13
2.4 Marking	10	3.10 Delayed delivery	14
2.5 ESD sensitivity	10	3.11 Alternative test methods	14
Section 3. Quality assessment procedures	11	3.12 Assessed process average procedures	15
3 Quality assessment procedures	11	3.13 Manufacture outside the geographical limits of CECC supervising inspectorates	15
3.1 General	11	Section 4. Test and measurement procedures	16
		4 Test and measurement procedures	16
		4.1 General	16
		4.2 Standard atmospheric conditions	16
		4.3 Drying	17
		4.4 Visual examination and check of dimensions	17
		4.5 Resistance	17
		4.6 Insulation resistance	18
		4.7 Voltage proof	19
		4.8 Variation of resistance with temperature	19
		4.9 Reactance	21
		4.10 Non-linear properties	22
		4.11 Voltage coefficient	22
		4.12 Noise	22
		4.13 Overload	22
		4.14 Temperature rise	23
		4.15 Robustness of the resistor body	23
		4.16 Robustness of terminations	24
		4.17 Solderability	25
		4.18 Resistance to soldering heat	25
		4.19 Rapid change of temperature	26
		4.20 Bump	26
		4.21 Shock	26
		4.22 Vibration	26
		4.23 Climatic sequence	27
		4.24 Damp heat, steady state	28
		4.25 Endurance	29
		4.26 Accidental overload test (for low power non-wirewound resistors only)	33
		4.27 Single-pulse high-voltage overload test	35
		4.28 Periodic pulse high-voltage overload test	37

	Page	Page
4.29 Component solvent resistance	40	Figure C.8 49
4.30 Solvent resistance of marking	41	Figure C.9 50
4.31 Shear test and substrate bending test (for surface mounting resistors only)	41	Figure C.10 Figure C.11 50 50
4.32 Corrosion	41	Figure D.1 51
4.33 Flammability	41	Figure D.2 52
4.34 Seal test (Hermetically sealed resistors only)	41	Figure D.3 52
Annex A Example of a certified test record (RCE)	42	Table 1 — Noise measurement results Table 2 — Voltages for referee purposes 14 17
Annex B Internal visual examination of fixed resistors	44	Table 3 — Values of R and ΔR Table 4 — Value of $\Delta\theta$ 20 20
Annex C External visual examination of fixed resistors with enhanced assessment quality	46	Table 5 — Tensile force for wire terminations Table 6 — Torque figures 24 25
Annex D Radiographic inspection of fixed resistors	50	Table 7 — Cycles per climatic category Table 8 — Reference heat sink data (see Figure 8) 27 31
Annex E Blank detail specifications	52	Table 9 — Test severities Table 10 — List of preferred severities 37 40
Figure 1 — Insulation resistance and voltage proof test jig for rectangular surface mounting resistors	18	
Figure 2 — Insulation resistance and voltage proof test jig for cylindrical type chip resistors	19	
Figure 3 — Test circuit	21	
Figure 4 — Oscilloscope trace	22	
Figure 5 — Testing of resistor body robustness	24	
Figure 6 — Mounting straps	28	
Figure 7 — A suitable test jig for ten resistors	29	
Figure 8 — Reference heat sink	32	
Figure 9 — Gauze cylinder fixture	34	
Figure 10 — Pulse generator 1,2/50 Values in μF and in Ω	36	
Figure 11 — Pulse generator 10/700 Values in μF and in Ω	36	
Figure 12 — Block diagram of a test equipment	38	
Figure 13 — Tolerances on the pulse shape	39	
Figure B.1	45	
Figure B.2	46	
Figure B.3	46	
Figure C.1	48	
Figure C.2	48	
Figure C.3	49	
Figure C.4	49	
Figure C.5	49	
Figure C.6	49	
Figure C.7	49	

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Section 1. Scope

1 Scope

This document relates to fixed discrete resistors with the exception of those whose prime usage requires that resistance is temperature or voltage dependent, for example, NTC resistors. It establishes standard terms, inspection procedures and test methods for use in sectional and detail specifications for capability and qualification approval.

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Section 2. General

2 General

2.1 Related documents

- ISO 3:(1973-04-01), *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:—, *SI units and recommendations for the use of their multiples and of certain other units.*
- IEC 27:—, *Letter symbols to be used in electrical technology.*
- IEC 50:—, *International Electrotechnical Vocabulary.*
- IEC 60:—, *High voltage test techniques.*
- IEC 62:(1974), *Marking codes for resistors and capacitors.*
- IEC 63:(1963), *Preferred number series for resistors and capacitors. (1967).*
- Amendment 1 (1967)
- Amendment 2 (1977)
- IEC 68:—, *Basic environmental testing procedures.*
- IEC 68-1:(1988), *Part 1: General.*
- IEC 68-2-1:(1974), *Tests A: Cold.*
- IEC 68-2-1A:(1976), *First supplement.*
- IEC 68-2-2:(1974), *Tests B: Dry heat.*
- IEC 68-2-2A:(1976), *First supplement.*
- IEC 68-2-3:(1969), *Test Ca: Damp Heat, Steady state.*
- IEC 68-2-6:(1982), *Test Fc: Vibration (Sinusoidal).*
- Amendment No. 1:1983
- Amendment No. 2:1985
- IEC 68-2-11:(1981), *Test Ka: Salt mist.*
- IEC 68-2-13:(1983), *Test M: Low Air pressure.*
- IEC 68-2-14:(1984), *Test N: Change of Temperature. Amendment No. 1 (1986)*
- IEC 68-2-20:(1979), *Test T: Soldering.*
- IEC 68-2-20A:(1970), *First Supplement: Test TB: Resistance to Soldering Heat, Method 1.*
- IEC 68-2-21:(1983), *Test U: Robustness of Terminations and Integral Mounting Devices.*
- Amendment No. 1 (1985)
- Amendment No. 2 (1991)
- IEC 68-2-27:(1987), *Test Ea: Shock.*
- IEC 68-2-29:(1987), *Test Eb: Bump.*
- IEC 68-2-30:(1980), *Test Db: Damp Heat, Cyclic (12 + 12 hour Cycle).*
- IEC 68-2-45:(1980), *Test XA and guidance: Immersion in cleaning solvents.*
- IEC 117:—, *Recommended graphical symbols.*
- IEC 195:(1965), *Method of measurement of current noise generated in fixed resistors.*
- IEC 294:(1969), *Measurement of the dimensions of a cylindrical component having two axial terminations.*
- IEC 410:(1973), *Sampling procedures and tables for inspection by attributes (See CECC 00 007).*
- IEC 440:(1973), *Method of measurement of non-linearity in resistors.*
- IEC 695-2-2, *Needle flame test.*
- CECC 00 100:(1974), *Basic Rules.*
- CECC 00 114:(1990), *Quality assessment procedures.*
- CECC 00 109:(1974), *Certified Test Records.*
- CECC 00 111:(1974), *Specifications and their harmonization.*
- CECC 00 006:(1973), *Harmonization document for IEC 68: Basic environmental testing procedures.*

CECC 00 007:(1978), *Harmonization document for IEC 410: Sampling procedures and tables for inspection by attributes for electronic components of assessed quality.*

CECC 00 015:(1992), *Basic specification: Protection of electrostatic sensitive devices.*

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 documents:

ISO 1000, *SI units and recommendations for the use of their multiples and of certain other units.*

IEC 27, *Letter symbols to be used in electrical technology.*

IEC 50, *International Electrotechnical Vocabulary.*

IEC 117, *Recommended graphical symbols.*

The following paragraphs contain additional terminology applicable to fixed resistors and shall be included in each national harmonized specification system. A reference to the appropriate IEC document is given against each term.

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

2.2.2 Type (IEC 115-1 clause 2.2.2)

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 1 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.

NOTE 2 Mounting accessories are ignored, provided they have no significant effect on the test results.

NOTE 3 Ratings cover the combination of:

— electrical ratings;

— sizes;

— environmental category.

NOTE 4 The limits of the range of ratings shall be given in the detail specification.

2.2.3 Style (IEC 115-1 clause 2.2.3)

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 (IEC 115-1 clause 2.2.4)

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

The term "grade" may be used only 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) (IEC 115-1 clause 2.2.5)

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) (IEC 115-1 clause 2.2.6)

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

2.2.7 Rated resistance (IEC 115-1 clause 2.2.7)

The resistance value for which the resistor has been designed, and which is generally indicated upon the resistor.

2.2.8 Critical resistance (IEC 115-1 clause 2.2.8)

The resistance value at which the rated voltage is equal to the limiting element voltage (see sub-clauses 2.2.15 and 2.2.16).

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 any voltage to be applied.

2.2.9 *Category temperature range* (IEC 115-1 clause 2.2.9)

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

2.2.10 *Upper category temperature* (IEC 115-1 clause 2.2.10)

The maximum ambient temperatures for which a resistor has been designed to operate continuously at that portion of the rated dissipation which is indicated in the category dissipation. (See 2.2.14).

2.2.11 *Lower category temperature* (IEC 115-1 clause 2.2.11)

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

2.2.12 *Maximum surface temperature* (IEC 115-1 clause 2.2.12)

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

2.2.13 *Rated dissipation*

The rated temperature of a resistor is the maximum ambient temperature at which the rated dissipation may be applied continuously under the conditions of the endurance test prescribed for this temperature. It has a value of 70 °C unless otherwise prescribed in the relevant sectional specification.

NOTE The maximum allowable dissipation at the rated temperature under the conditions of the endurance test at the rated temperature and for which the permitted change of resistance for this endurance test is not exceeded.

2.2.14 *Category dissipation* (IEC 115-1 clause 2.2.14)

A fraction of the rated 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.

2.2.15 *Rated voltage* (U_N or U_R) (IEC 115-1 clause 2.2.15)

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

NOTE At high values of resistance the rated voltage may not be applicable because of the size and the construction of the resistor (see sub-clause 2.2.16).

2.2.16 *Limiting element voltage*

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

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

NOTE 2 For testing under pulse load conditions see sub-clause 4.2.8.

2.2.17 *Insulation voltage (applicable only to insulated resistors)*

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

2.2.18 *Insulated resistor* (IEC 115-1 clause 2.2.18)

A resistor 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.

2.2.19 *Insulation resistance*

The resistance of the encapsulation of the insulated resistor measured between the resistor terminations connected together and any conducting mounting surface.

2.2.20 Variation of resistance with temperature (IEC 115-1 clause 2.2.20)

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

2.2.20.1 Temperature characteristic of resistance (IEC 115-1 clause 2.2.20.1)

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.

$$\text{Temperature characteristic of resistance} = \frac{\Delta R}{R}$$

where:

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

R is the resistance value at the reference temperature.

2.2.20.2 Temperature coefficient of resistance (α) (IEC 115-1 clause 2.2.20.2)

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

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

Where:

$\Delta\theta$ is the algebraic difference, in degrees Celsius, between the specified ambient temperature and the reference temperature (for calculation see subclause 4.8.4).

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.

2.2.21 Visible damage (IEC 115-1 clause 2.2.21)

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

2.2.22 Surface mounting resistor (IEC 115-1 clause 2.2.22)

A fixed resistor whose small dimensions and the nature or the shape of the terminations make it suitable for use in hybrid circuits and on printed boards.

2.2.23 Heat sink resistor

A resistor type designed for mounting on a separate heatsink.

2.2.24 Derating curve

The derating curve is a curve which shows the maximum allowable dissipation at ambient temperatures between the upper and lower category temperatures.

2.2.25 Voltage coefficient of resistance

The voltage coefficient of resistance is defined as the reversible change in resistance caused by the applied voltage. It is expressed as a percentage change in resistance per applied volt.

2.2.26 Maximum element temperature

The maximum stated temperature at any point on or within the resistor under any permissible operating condition.

When subjected to the conditions of the endurance test at the maximum element temperature, the resulting change in resistance will not exceed that specified for this endurance test.

2.3 Preferred values**2.3.1 General** (IEC 115-1 clause 2.3.1)

Each sectional specification shall prescribe the preferred values appropriate to the sub-family; for rated resistance see also sub-clause 2.3.2.

2.3.2 Preferred values of rated resistance (IEC 115-1 clause 2.3.2)

The preferred values of rated resistance shall be taken from the series specified in IEC 63.

2.4 Marking

2.4.1 General

2.4.1.1 The information given in the marking is normally selected from the following list; the relative importance of each item is indicated by its position in the list:

- a) rated resistance;
- b) tolerance on rated resistance;
- c) temperature coefficient (when necessary);
- d) year and month (or week) of manufacture;
- e) number of the detail specification and style reference;
- f) manufacturer's name or trade mark.

2.4.1.2 The resistor shall be clearly marked with a) and b) above and with as many of the remaining items as is practicable. Any duplication of information in the marking on the resistor should be avoided.

2.4.1.3 The package containing the resistor(s) shall be clearly marked with all the information listed above.

2.4.1.4 Any additional marking shall be so applied that no confusion can arise.

2.4.2 Coding (IEC 115-1 clause 2.4.2)

When coding is used for resistance value, tolerance or date of manufacture, the method shall be selected from those given in IEC 62.

2.5 ESD sensitivity

Sensitivity against electrostatic discharge shall be stated in the blank detail specifications.

For protection of electrostatic sensitive devices the requirements of CECC 00 015 shall be applied.

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Section 3. Quality assessment procedures

3 Quality assessment procedures

3.1 General

Before resistors are qualified according to the procedures of this section the manufacturer shall have obtained approval of his organization following the provisions of CECC 00 114-I.

Two methods are available for the approval of resistors of assessed quality. These are Qualification Approval according to the provisions of CECC 00 114-II and Capability Approval according to the provisions of CECC 00 114-III. For a given sub-family of resistors separate sectional specifications for Qualification Approval and Capability Approval are necessary, and Capability Approval is therefore available only when a relevant sectional specification has been published.

3.1.1 *Applicability of qualification approval*

Qualification Approval is appropriate for resistors in a standard range of sizes and values manufactured to similar design and production processes and conforming to a published detail specification.

The programme of tests defined in the detail specification for the appropriate assessment and performance levels applies directly to the resistor range to be qualified, as prescribed in 3.5 and the relevant sectional specification.

3.1.2 *Applicability of Capability Approval*

Capability Approval is appropriate when resistors based on common design rules are fabricated by a group of common processes. It is particularly appropriate when resistors are manufactured to a user's specific requirements.

Under Capability Approval detail specifications fall into the following three categories:

1) **Capability Qualifying Components (CQCs), including process validation test vehicles**

Documentation shall be prepared for each CQC as agreed with the ONS. The purpose of each CQC is to define the boundaries as declared by manufacturers and shall include all relevant requirements for tests, severities and limits. This document need not be published within the system.

2) **Components for listing in the Register of Approvals (Standard Catalogue items)**

When the manufacturer desires that a resistor covered by the Capability Approval procedure should be listed in CECC 00 200, a detail specification complying with the blank detail specification shall be written. Such specifications shall be registered by the CECC and the component may be listed in CECC 00 200: Register of Approvals. See 4.3 of CECC 00 114-III.

3) **Customer specified resistors**

The content of the detail specification (often known as a Customer Detail Specification CDS) shall be by agreement between the manufacturer and customer in accordance with 4.3 of CECC 00 114-III.

Further information on these detail specifications is given in the relevant blank detail specification.

Approval is given to a manufacturing facility on the basis of validated design rules, processes and quality control procedures and the results of tests on capability qualifying components, including any process validation test vehicles. See 3.6 and the relevant sectional specification for further information.

3.2 Primary stage of manufacture

Unless otherwise specified in the sectional specification, for resistor specifications, the primary stage of manufacture is:

- for film types:
the deposition of the resistive film on the substrate.
- for carbon composition types:
the process which produces the greatest change in polymerization of the binder.
- for wire-wound types:
the winding of the resistance wire (or ribbon) on the former.
- for metal foil types:
the fixing of the resistive foil on the substrate.
- for bulk metal types:
the fabrication of the element.

3.3 Subcontracting

If subcontracting of the primary stage of manufacture or subsequent stages is employed it shall be in accordance with 1.2 of CECC 00 114-II or 2.2 of CECC 00 114-III.

The sectional specification may restrict subcontracting in accordance with 1.2.2 of CECC 00 114-II or 2.2.2 of CECC 00 114-III.

3.4 Structurally similar components

The grouping of structurally similar components for qualification approval testing or for quality conformance testing under qualification approval or capability approval shall be prescribed in the relevant sectional specification.

3.5 Qualification approval procedures

3.5.1 Eligibility for qualification approval

The manufacturer shall comply with 1.1 of CECC 00 114-II.

3.5.2 Application for qualification approval

The manufacturer shall comply with 1.3 of CECC 00 114-II.

3.5.3 Test procedure for qualification approval

One of the two following procedures shall be followed:

a) The manufacturer shall produce test evidence of conformance to the specification requirements on three inspection lots for lot-by-lot inspection taken in as short a time as possible and one lot for periodic inspection. No major changes in the manufacturing process shall be made in the period during which the inspection lots are taken.

Samples shall be taken from the lots in accordance with IEC 410. Normal inspection shall be used, but when the sample size would give acceptance on zero defectives, additional specimens shall be taken to meet the sample size requirements to give acceptance on one defective.

b) The manufacturer shall produce test evidence to show conformance to the specification requirements on the fixed sample size test schedule given in the sectional specification.

The specimens taken to form the sample shall be selected at random from current production or as agreed with the National Supervising Inspectorate.

For the two procedures the sample sizes and the number of permissible defectives shall be of comparable order. The test conditions and requirements shall be the same.

3.5.4 Granting of qualification approval

Qualification approval shall be granted when the procedures in accordance with 1.5 of CECC 00 114-II have been completed satisfactorily.

3.5.5 Maintenance of qualification approval

Qualification approval shall be maintained by regular demonstration of compliance with the requirements for Quality Conformance (see 3.5.6).

3.5.6 Quality conformance inspection

Blank detail specification(s) associated with the sectional specification shall prescribe the test schedule for quality conformance inspection. This schedule shall also specify the grouping, sampling and periodicity for the lot-by-lot and periodic inspection.

Operation of the switching rule for reduced inspection in group C given in 2.9 of CECC 00 114-II is permitted.

3.6 Capability approval procedures

3.6.1 Eligibility for capability approval

The manufacturer shall comply with 2.1 of CECC 00 114-III.

3.6.2 Application for capability approval

The manufacturer shall comply with 2.3 of CECC 00 114-III.

3.6.3 *Description of capability*

The description of the capability shall be made in a capability manual in accordance with 2.4 of CECC 00 114-III and the requirements of the relevant sectional specification.

The ONS shall treat the capability manual as a confidential document. The manufacturer may, if he so wishes, disclose part or all of it to a third party.

3.6.4 *Demonstration and verification of capability*

The manufacturer shall demonstrate and verify the capability in accordance with 2.5 of CECC 00 114-III and the requirements of the relevant sectional specification.

3.6.5 *Granting of capability approval*

Capability approval shall be granted when the procedures in accordance with 2.6 of CECC 00 114-III have been completed satisfactorily.

3.6.6 *Maintenance of capability approval*

Capability approval shall be maintained by complying with the requirements of 2.9 of CECC 00 114-III and the requirements declared in the capability manual, following the schedule of maintenance given in the relevant Sectional Specification.

3.6.7 *Quality conformance inspection*

The quality conformance test and requirements shall be given in the relevant detail specifications and shall be carried out in accordance with 3.1 of CECC 00 114-III.

3.7 *Rework and repair work*

3.7.1 *Rework*

Rework is the rectification of processing errors prior to the release of a resistor. See 1.4 and 7.1 of CECC 00 114-III.

It shall not be carried out if prohibited by the relevant sectional specification. The relevant sectional specification shall state if there is a restriction on the number of occasions that rework may take place on a specific component.

All rework shall be carried out prior to the formation of the inspection lot offered for inspection to the requirements of the detail specification.

Such rework procedures shall be fully described in the relevant documentation produced by the manufacturer and shall be carried out under the direct control of the Chief Inspector.

3.7.2 *Repair*

Repair is the making good of an approved resistor which has been damaged or become defective after release. See 1.5 and 7.2 of CECC 00 114-III.

Resistors which have been repaired shall not be released under the CECC system.

3.8 *Release for delivery*

Resistors shall be released for delivery according to 2 of CECC 00 114-II or 3 of CECC 00 114-III after the Quality Conformance inspection prescribed in the detail specification has been carried out.

3.8.1 *Release for delivery under qualification approval before the completion of group B tests*

When the conditions of IEC Publication 410 for changing to reduced inspection have been satisfied for all group B tests, the manufacturer is permitted to release components before the completion of such tests.

3.9 *Certified test records*

When certified test records are prescribed in the relevant specification and are requested by a purchaser, the information specified in 3.9.1 and 3.9.2 shall be given as a minimum. Attention is drawn to the fact that under Capability Approval the Certified Test Records will refer only to tests carried out on Capability Qualifying Components. See Annex A for example for a Certified Test Record.