

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

Generic specification: Fixed capacitors

The European Standard EN 130000:1993, together with its amendments A1 to A10, has the status of a British Standard

ICS 31.060.10

Cooperating organizations

The European Committee for Electrotechnical Standardization (CENELEC), under whose supervision this European Standard was prepared, comprises the national committees of the following countries:

Austria	Italy
Belgium	Luxembourg
Denmark	Netherlands
Finland	Norway
France	Portugal
Germany	Spain
Greece	Sweden
Iceland	Switzerland
Ireland	United Kingdom

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 October 1994

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The following BSI references relate to the work on this standard:
Committee reference ECL/4
Special announcement in *BSI News* July 1994

ISBN 0 580 23449 5

Amendments issued since publication

Amd. No.	Date	Comments
9114	December 1996	
9692	November 1997	Indicated by a sideline in the margin

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National foreword

This British Standard has been prepared under the direction of Technical Committee EPL/40 (formerly ECL/4), Capacitors and resistors for electronic equipment, and is the English language version of EN 130000:1993 *Generic specification: Fixed capacitors*, including Amendments A1 to A5:1993, Amendment A8:1995 (which includes Amendments A6 and A7), Amendment A9:1995 and Amendment A10:1997, published by the Electronic Components Committee (CECC) of the European Committee for Electrotechnical Standardization (CENELEC).

This British Standard supersedes BS CECC 30000:1992. Any references elsewhere to BS CECC 30000 should be read as references to BS EN 130000:1994.

The foreword of EN 130000 makes reference to the “date of withdrawal” (dow) of the relevant national standard. In this case the relevant national standard was BS CECC 30000 which was withdrawn on 30 July 1995.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, the EN title page, pages 2 to 52, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

Descriptors: Quality, electronic components, capacitors

English version

Genetic specification: Fixed capacitors

(includes amendments A1 to A5:1993, amendment A8:1995, amendment A9:1995 and amendment A10:1997)

Spécification générique: Condensateurs fixes
(inclut les amendements A1 à A5:1993,
l'amendement A8:1995, l'amendement A9:1995
et l'amendement A10:1997)

Fachgrundspezifikation: Festkondensatoren
(enthält Änderungen A1 bis A5:1993, Änderung
A8:1995, Änderung A9:1995 und Änderung
A10:1997)

This European Standard was approved by the CENELEC Electronic Components Committee (CECC) on 14 October 1991. 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

European Committee for Electrotechnical Standardization
Comité Européen de Normalisation Electrotechnique
Europäisches Komitee für Elektrotechnische Normung

Central Secretariat: rue de Stassart 35, B-1050 Brussels

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 European Standard was prepared by CECC WG 3, Capacitors.

The text of the draft based on document CECC 30000 Issue 3:1983, including amendment proposals, was submitted to the formal vote for conversion to a European Standard; together with the voting report, circulated as document CECC (Secretariat) 2871 it was approved by CECC as EN 130000 on 14 October 1991.

The text of EN 130000 consists of:

CECC 30000 Issue 3 (with A1 to A6),
CECC(Sec)2517/01.90 [RV CECC(Sec)2871/09.91],
CECC(Sec)2396/04.89 [RV CECC(Sec)2593/05.90],
CECC(Sec)2409/04.89 [RV CECC(Sec)2578/09.90],
CECC(Sec)2657/09.90 [RV CECC(Sec)2867/09.91],
CECC(Sec)2658/09.90 [RV CECC(Sec)2868/09.91],
CECC(Sec)2683/10.90 [RV CECC(Sec)2952/11.91],
CECC(Sec)2684/10.90 [RV CECC(Sec)2872/09.90].

This EN also includes the following amendments:

A1 CECC(Sec)2798/04.91
[RV CECC(Sec)2948/11.91], approved on 06.01.92
A2 CECC(Sec)3086/03.92
[RV CECC(Sec)3198/09.92], approved on 14.10.92
CECC(Sec)3087/03.92
[RV CECC(Sec)3198/09.92], approved on 14.10.92
A3 CECC(Sec)3318/03.93
[RV CECC(Sec)3429/09.93], approved on 10.10.93
A4 CECC(Sec)3330/03.93
[RV CECC(Sec)3426/09.93], approved on 10.10.93
A5 CECC(Sec)3331/03.93
[RV CECC(Sec)3430/09.93], approved on 10.10.93

The dates fixed hereunder are based on the last amendments (A3 to A5) included in this EN, covering the whole document:

- latest date of announcement
of the EN at national level (doa) 1994-01-30
- latest date of publication of
an identical national
standard^a (dop) 1994-07-30
- latest date of withdrawal of
conflicting national
standards^a (dow) 1995-07-30

^a National standard (excluding national implementation of IECQ specifications).

Foreword of amendment A8

This amendment to the European Standard EN 130000 was prepared by CLC/TC CECC/WG 3.

The text of the draft based on document CECC (Secretariat) 3497 was submitted to the formal vote; together with the voting report, circulated as document CECC (Secretariat) 3597, it was approved as amendment A6 to EN 130000:1993 on 1994-08-22.

The text of the draft based on document CECC (Secretariat) 3498 was submitted to the formal vote; together with the voting report, circulated as document CECC (Secretariat) 3598, it was approved as amendment A7 to EN 130000:1993 on 1994-08-22.

The text of the draft based on document CECC (Secretariat) 3540 was submitted to the formal vote; together with the voting report, circulated as document CECC (Secretariat) 3619, it was approved as amendment A8 to EN 130000:1993 on 1994-10-16.

This amendment A8 includes amendments A6 and A7.

The following dates were fixed:

- latest date by which the
amendment has to be
implemented at national
level by publication of an
identical national standard
or by endorsement (dop) 1995-08-08
- latest date by which
national standards
conflicting with the
amendment have to be
withdrawn (dow) 1996-08-08

Foreword of amendment A9

This amendment was prepared by CLC/TC CECC/WG 3.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A9 to EN 130000:1993 on 1995-09-20.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1996-10-01
- latest date by which national standards conflicting with the amendment have to be withdrawn (dow) 1996-10-01

Foreword of amendment A10

This amendment was prepared by the Technical Committee CENELEC/TC CECC/SC 40XA, Capacitors.

The text of the draft was submitted to the Unique Acceptance Procedure and was approved by CENELEC as amendment A10 to EN 130000:1993 on 1996-12-09.

The following dates were fixed:

- latest date by which the amendment has to be implemented at national level by publication of an identical national standard or by endorsement (dop) 1997-12-01
- latest date by which the national standards conflicting with the amendment have to be withdrawn (dow) 1997-12-01

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1 Scope

This generic specification is applicable to fixed capacitors for use in electronic equipment.

It establishes standard terms, inspection procedures and methods of tests for use in sectional and detail specifications within the CECC System for electronic components.

2 General

2.1 Related documents

CECC 00100:1974	<i>Basic Rules</i>
CECC 00014:1986	<i>CECC Assessed Process Average Procedure (APA)</i>
CECC 00114-I:1990	<i>Approval of manufacturers and other organizations</i>
CECC 00114-II:1991	<i>Qualification approval of electronic components</i>
CECC 00114-III:1989	<i>Capability approval of an electronic component manufacturing activity</i>
CECC 00802 Issue 2	<i>Guidance document: CECC standard method for the specification of surface mounting components (SMDs) of assessed quality</i>
ECQAC 1220:1992	<i>ECQAC Policy on Uncertainty of Measurement</i>
ISO 3:1973	<i>Preferred numbers — Series of preferred numbers</i>
ISO 497:1973	<i>Guide to the choice of series of preferred numbers and of series containing more rounded values of preferred numbers</i>
ISO 1000:1981	<i>SI units and recommendations for the use of their multiples and of certain other units</i>
IEC 27-1:1971	<i>Letter symbols to be used in electrical technology — Part 1: General</i>
Amendment 4:1983	
IEC 50	<i>International Electrotechnical Vocabulary</i>
IEC 62:1974	<i>Marking codes for resistors and capacitors</i>
IEC 63:1963	<i>Preferred number series for resistors and capacitors</i>
Amendment 1:1967	
Amendment 2:1977	
IEC 68	<i>Basic environmental testing procedures</i>
IEC 68-1:1988	<i>General</i>
IEC 68-2-1:1990	<i>Test A: Cold</i>
IEC 68-2-2:1974	<i>Test B: Dry heat</i>
IEC 68-2-2A:1976	<i>First supplement</i>
IEC 68-2-3:1969	<i>Test Ca: Damp heat, steady state</i>
IEC 68-2-6:1982	<i>Test Fc: Vibration (sinusoidal)</i>
Amendment 1:1983	
Amendment 2:1985	
IEC 68-2-13:1983	<i>Test M: Low air pressure</i>
IEC 68-2-14:1984	<i>Test N: Change of temperature</i>
Amendment 1:1986	
IEC 68-2-17:1978	<i>Test Q: Sealing</i>
Amendment 3:1989	
IEC 68-2-20:1979	<i>Test T: Soldering</i>
Amendment 1:1986	
Amendment 2:1987	
IEC 68-2-21:1983	<i>Test U: Robustness of terminations and integral mounting devices</i>
Amendment 1:1985	
IEC 68-2-27:1987	<i>Test Ea: Shock</i>
IEC 68-2-29:1987	<i>Test Eb: Bump</i>

IEC 68-2-30:1980 Amendment 1:1985	<i>Test Db: Damp heat, cyclic [(12 + 12) hour cycle]</i>
IEC 68-2-45:1980 Amendment 1:1993	<i>Test XA and guidance: Immersion in cleaning solvents</i>
IEC 68-2-47:1982	<i>Mounting of components, equipment and other articles for dynamic tests, including shock (Ea), bump (Eb), vibration (Fc and Fd) and steady-state acceleration (Ga) and guidance</i>
IEC 117	<i>Recommended graphical symbols</i>
IEC 286-1:1980	<i>Tape packaging of components with axial leads on continuous tapes</i>
IEC 286-2:1985	<i>Tape packaging of components with unidirectional leads on continuous tapes</i>
IEC 286-3:1991	<i>Packaging of leadless components on continuous tapes</i>
IEC 294:1969	<i>Measurement of the dimensions of a cylindrical component having two axial terminations</i>
IEC 410:1973	<i>Sampling plans and procedures for inspection by attributes</i>
IEC 469-1:1987	<i>Pulse techniques and apparatus; part 1; pulse terms and definitions</i>
IEC 469-2:1987	<i>Pulse techniques and apparatus; pulse measurement and analysis; general considerations</i>
IEC 695-2-2:1980	<i>Fire hazard testing; part 2: Test methods needle flame test</i>

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 50, IEC 117.

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 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.

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, for example long-life application

the term "Grade" may only be used in combination with one or more words (for example 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**D.C. capacitor**

a capacitor designed essentially to be used with direct voltage

NOTE A d.c. capacitor may not be suitable for use on a.c. supplies.

2.2.8**polar capacitor** (for electrolytic capacitors)

a capacitor intended for use with an unidirectional voltage connected according to the polarity indication

2.2.9**bipolar capacitor** (for electrolytic capacitors)

an electrolytic capacitor designed to withstand an alternating voltage and/or reversal of the applied direct voltage

2.2.10**A.C. capacitor**

a capacitor designed essentially for application with alternating voltages

2.2.11**pulse capacitor**

a capacitor for use with pulses of current or voltage

NOTE The definitions of IEC 469-1 and IEC 469-2 apply.

2.2.12**rated capacitance** (C_R)

the capacitance value for which the capacitor has been designed and which is usually indicated upon it

2.2.13**category temperature range**

the range of ambient temperatures for which the capacitor has been designed to operate continuously; this is defined by the temperature limits of the appropriate category

2.2.14**upper category temperature**

the maximum ambient temperature for which a capacitor has been designed to operate continuously

2.2.15**lower category temperature**

the minimum ambient temperature for which a capacitor has been designed to operate continuously

2.2.16**rated temperature**

the maximum ambient temperature at which the rated voltage may be continuously applied

2.2.17**rated voltage** (U_R)

the maximum direct voltage or peak value of pulse voltage which may be applied continuously to a capacitor at any temperature between the lower category temperature and the rated temperature (see 2.2.16)

2.2.18**category voltage** (U_C)

the maximum voltage which may be applied continuously to a capacitor at its upper category temperature (see 2.2.14)

2.2.19**temperature derated voltage**

for any temperature between the rated temperature and the upper category temperature, the temperature derated voltage is the maximum voltage that may be applied continuously to a capacitor

NOTE Information on the voltage/temperature dependence at temperatures between the rated temperature and the upper category temperature should, if applicable, be given in the sectional or the detail specification.

2.2.20**surge voltage ratio**

the quotient of the maximum instantaneous voltage which may be applied to the terminations of the capacitor for a specified time at any temperature within the category temperature range and the rated voltage or the temperature derated voltage as appropriate. The number of times per hour that this voltage may be applied shall be specified

2.2.21**rated ripple voltage**

the r.m.s. value of the maximum allowable alternating voltage of a specified frequency superimposed on the d.c. voltage at which the capacitor may be operated continuously at a specified temperature. The sum of the direct voltage and the peak value of the alternating voltage applied to the capacitor shall not exceed the rated voltage or temperature derated voltage as applicable

2.2.22**reverse voltage** (for polar capacitors only)

a voltage applied to the capacitor terminations in the reverse polarity direction

2.2.23**rated ripple current**

the r.m.s. value of the maximum allowable alternating current of a specified frequency, at which the capacitor may be operated continuously at a specified temperature

2.2.24**time constant**

the product of the insulation resistance and the capacitance. It is normally expressed in seconds

2.2.25**tangent of loss angle** ($\tan \delta$)

the power loss of the capacitor divided by the reactive power of the capacitor at a sinusoidal voltage of specified frequency

2.2.26**self-healing**

the process by which the electrical properties of the capacitor, after a local breakdown of the dielectric, are rapidly and essentially restored to the values before the breakdown

2.2.27**maximum temperature of a capacitor**

the temperature at the hottest point of its external surface

NOTE The terminations are considered to be part of the external surface.

2.2.28**minimum temperature of a capacitor**

the temperature at the coldest point of its external surface

NOTE The terminations are considered to be part of the external surface.

2.2.29**minimum storage temperature**

the minimum permissible ambient temperature which the capacitor shall withstand in the non-operating conditions without damage

NOTE The maximum permissible storage temperature is equal to the upper category temperature.

2.2.30 Variation of capacitance with temperature

The variation of capacitance with temperature can be expressed in two ways:

- 1) temperature characteristic of capacitance
- 2) temperature coefficient of capacitance.

2.2.30.1**temperature characteristic of capacitance**

the term characterizing this property applies mainly to capacitors of which the variations of capacitance as a function of temperature, linear or non-linear, cannot be expressed with precision and certainty. The temperature characteristic of capacitance is the maximum reversible variation of capacitance produced over a given temperature range within the category temperature range. It is expressed normally as a percentage of the capacitance related to a reference temperature of 20 °C

2.2.30.2**temperature coefficient of capacitance and temperature cyclic drift of capacitance**

the terms characterizing these two properties apply to capacitors of which the variations of capacitance as a function of temperature are linear or approximately linear and can be expressed with a certain precision for these capacitors, the variation of capacitance for any temperature, within the category temperature range, can be analysed into two components:

1) Temperature coefficient of capacitance (α)

The rate of change of capacitance with temperature measured over a specified range of temperature. It is normally expressed in parts per million per degree Celsius ($10^{-6}/^{\circ}\text{C}$)

2) Temperature cyclic drift of capacitance

The maximum irreversible variation of capacitance observed at room temperature during or after the completion of a number of specified temperature cycles. It is expressed normally as a percentage of the capacitance related to a reference temperature.

this is normally 20 °C. The conditions of measurement, during or after temperature cycling, a description of the temperature cycle and the number of cycles, shall be stated

2.2.31**visible damage**

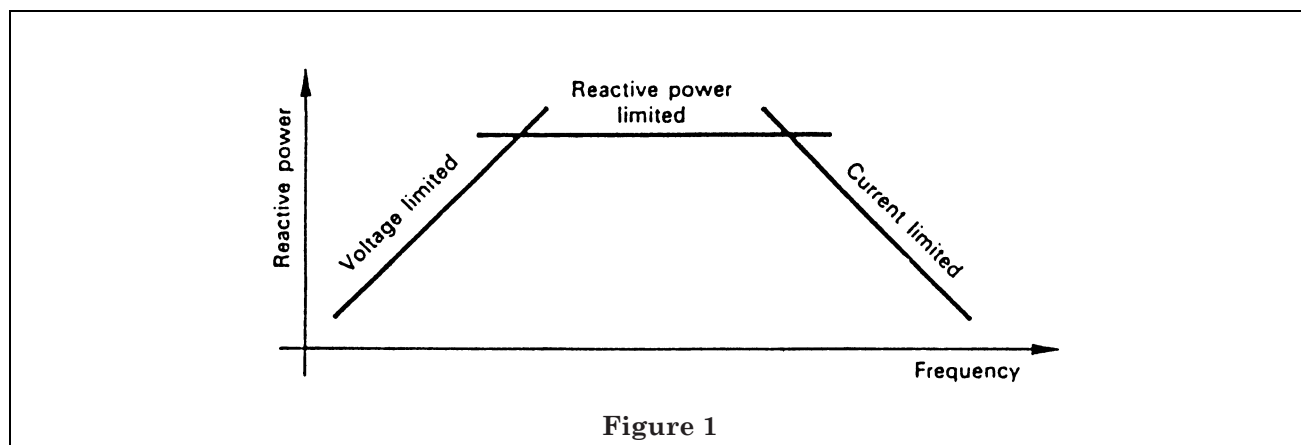
visible damage which reduces the usability of the capacitor for its intended purpose

2.2.32**rated a.c. load**

the rated load (a.c.) is the maximum sinusoidal a.c. load which may be applied continuously to the terminations of a capacitor at any temperature (see 2.2.16). It may be expressed:

- 1) at low frequencies as a rated a.c. voltage
- 2) at high frequencies as a rated a.c. current
- 3) at intermediate frequencies as a rated reactive power.

this is shown in Figure 1:



NOTE 1 For a particular type of capacitor it may be necessary to specify one or more of the above characteristics.

NOTE 2 Capacitors within the scope of this specification are normally less than 500 var at 50 to 60 Hz. Low frequencies may be 50 to 60 Hz, 100 to 120 Hz, or 400 Hz. Voltages may be up to 600 V r.m.s. at 50 to 60. However, capacitors for filters, transmitter or converter circuits may be required to operate under power over a wide range of frequencies and up to 10 kvar at the higher frequencies with voltages up to 1 000 V r.m.s.

2.2.33

rated pulse load

the rated pulse load is the maximum pulse load which may be applied at a certain pulse repetition frequency to the terminations of a capacitor at any temperature between the lower category temperature and the rated temperature (see **2.2.16**). It may be expressed as 1) and 2) and any of the remaining items:

- 1) peak current per μF or du/dt [$\text{V}/\mu\text{s}$]
- 2) relative duration of charge and discharge periods
- 3) r.m.s. current
- 4) peak voltage
- 5) peak reverse voltage
- 6) pulse repetition frequency (see note)
- 7) maximum active power.

these parameters are fixed for periodic pulses

NOTE In the case of intermittent pulses the duty cycle shall be specified. In the case of random pulses the total number expected over a given time period shall be stated.

2.2.34

R.M.S. pulse current

this shall be calculated in accordance with sub-clause **2.5.2.4** of IEC 469-1. In the case of intermittent or random pulses the time interval shall be chosen to correspond with the maximum temperature rise

2.2.35

pulse equivalent circuit of a capacitor

the equivalent circuit of a capacitor consists of an ideal capacitor in series with the residual inductance and the equivalent series resistance (ESR)

NOTE For pulse operation the equivalent series resistance will be similar to but not identical with the ESR measured with a sinusoidal voltage. The pulse ESR shall take into account the series of harmonics in the pulse and the variation of the losses with frequency.

2.2.36

temperature rise

the temperature rise of the capacitor relative to the ambient temperature resulting from the losses in the capacitor due to operation under a.c. or pulse conditions

2.2.37

insulated capacitor

a capacitor in which all terminations of a section may be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use

2.2.38

uninsulated capacitor

a capacitor in which one or more of the terminations of a section cannot be raised to a potential different (but not less than the rated voltage) from that of any conducting surface with which the case is liable to come into contact in normal use

2.2.39

surface mounting capacitor

a capacitor whose small dimensions and nature of shape of terminations make it suitable for surface mounting in hybrid circuits and on printed boards

2.2.40

passive flammability

passive flammability is caused by external heating of the component (e.g. by flames)

2.2.41**active flammability**

active flammability (self-ignition) is caused by internal heating of the component (e.g. sparking due to insufficient internal contact)

2.2.42**category of passive flammability**

the category of passive flammability is given by the maximum burning time that is allowed after a specified time of flame application

2.3 Preferred values**2.3.1 General**

Each sectional specification shall prescribe the preferred values appropriate to the sub-family; for rated capacitance see **2.3.2**.

2.3.2 Preferred values of rated capacitance

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

2.4 Marking**2.4.1 General**

The sectional specification shall indicate the identification criteria and other information to be shown on the capacitor and/or packing. The order of priority for marking small capacitors shall be specified.

2.4.2 Coding

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

3 Quality assessment procedures**3.1 General**

Before capacitors are qualified according to the procedures of this section the manufacturer shall obtain approval of his organisation following the provisions of CECC 00114-I.

Two methods are available for the approval of capacitors of assessed quality. These are Qualification Approval according to the provisions of CECC 00114-II and Capability Approval according to the provisions of CECC 00114-III. For a given sub-family of capacitors separate 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 a standard range of capacitors 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 capacitor 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 capacitors based on common design rules are fabricated by a group of common processes. It is particularly appropriate when capacitors are manufactured to a user's specific requirements.

Under capability approval detail specifications fall into the following three categories for:

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

A detail specification shall be prepared for each CQC as agreed with the ONS. It shall identify the purpose of CQC and include all relevant test severities and limits.

3.1.2.2 Components for listing in the Register of Approvals (Standard catalogue items)

When the manufacturer desires that a capacitor covered by the capability approval procedure should be listed in the CECC Register of Approvals, a Capability Approval 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 00200: Register of Firms, Products and Services Approved under the CECC System (Register of Approvals). See § 4.3 of CECC 00114, Part III.

3.1.2.3 Customer specified capacitors

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 00114, Part III.

Further information on these detail specifications is given in the relevant sectional 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

The primary stage of manufacture shall be specified in the sectional specification.

3.3 Subcontracting

If subcontracting of the primary stage of manufacture and/or subsequent stages is employed it shall be in accordance with § 1.2 of CECC 00114-II or § 2.2 of CECC 00114-III.

The sectional specification may restrict subcontracting in accordance with § 1.2.2 of CECC 00114-II or § 2.2.2 of CECC 00114-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 00114-II.

3.5.2 Application for qualification approval

The manufacturer shall comply with § 1.3 of CECC 00114-II.

3.5.3 Test procedure for qualification approval

One of the two following procedures shall be followed:

- 1) 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 (see Annex A). The capacitance and voltage ranges for which approval is granted are defined by the sample taken in accordance with the sampling procedures prescribed by the sectional specification.

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.

- 2) 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 00114-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

The 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 00114-II is permitted in all sub-groups except endurance.

Inspection Levels and AQL's shall be selected from those given in IEC 410.

If required, more than one schedule may be specified.

3.6 Capability approval procedures

3.6.1 General

Capability approval in fixed capacitor technology covers:

- the complete design, material preparation and manufacturing techniques, including control procedures and tests;
- the performance limits claimed for the processes and products, that is, those specified for the Capability Qualifying Components (CQCs) and Process Control Parameters (PCPs);
- the range of mechanical structures for which approval is granted.

3.6.2 Eligibility for capability approval

The manufacturer shall comply with § 2.1 of CECC 00114-III.

3.6.3 Application for capability approval

The manufacturer shall comply with § 2.4 of CECC 00114-III.

3.6.4 Description of capability

The capability shall be described in a capability manual in accordance with § 2.5 of CECC 00114-III and the requirements of the relevant sectional specification with the following details:

The manufacturer shall prepare a manual to the satisfaction of the ONS, in accordance with Annex D and supplemented by the sectional specification describing his capability, in relation to the technologies involved.

The manual shall include or make reference to the following as a minimum:

- a general introduction and description of the technologies involved;
- aspects of customer liaison including provisions of design rules (if appropriate) and assistance to customers in the formulation of their requirements;
- a detailed description of the design rules to be used;
- the procedure for checking that the design rules are complied with for the relevant capacitor technology manufactured to a detail specification;
- a list of all materials used, with references to the corresponding purchasing specifications and goods inward inspection specifications;
- a flow chart for the total process, showing quality control points and permitted rework loops, and containing references to all process and quality control procedures;
- a declaration of processes for which approval has been sought in accordance with the requirements of the relevant sectional specification;
- a declaration of limits for which approval has been sought in accordance with the requirements of the relevant sectional specification;

- a list of CQCs used to assess the capability, with a general description of each, supported by a detailed table showing where the declared limits of capability are demonstrated by a particular CQC design;
- a detail specification for each CQC;
- a detailed control plan including PCPs used to control processes, with a general description of each PCP and showing the relation between a given PCP and the related properties and performance of the finished capacitor;
- guidance on the application of structural similarity in sampling for quality conformance testing.

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.

3.6.5 Demonstration and verification of capability

The manufacturer shall demonstrate and verify the capability in accordance with § 2.6 of CECC 00114-III and the requirements of the relevant sectional specification with the following details:

3.6.5.1 CQCs for demonstrating capability

The manufacturer shall agree with the ONS the process qualifying parameters and the range of capability qualifying components which are necessary to demonstrate the capability range specified in the capability manual.

The demonstration shall be made by testing the agreed range of CQCs which shall be designed, manufactured and the process parameters controlled in accordance with the capability manual. The CQCs shall comply with the following requirements:

- 1) the range of CQCs used shall represent all the limits of the declared capability. The CQCs shall be chosen to demonstrate mutually attainable combinations of limits.
- 2) the CQCs shall be one of the following:
 - capacitors specially designed to demonstrate a combination of limits of capability; or
 - capacitors of designs used in general production; or
 - a combination of both of these, provided the requirements of 1) are met.

When CQCs are designed and produced solely for capability approval, the manufacturer shall use the same design rules, materials and manufacturing processes as will be applied to released products.

A detail specification shall be prepared for each CQC and shall have a front page format in accordance with Annex D. The detail specification shall identify the purpose of the CQC and shall include all relevant stress levels and test limits. It may refer to internal control documentation which specifies production testing and recording in order to demonstrate control and maintenance of processes and limits of capability.

3.6.5.2 Limits of capability

The limits of capability shall be described in the relevant sectional specification.

3.6.6 Programme for capability approval

The manufacturer shall prepare a programme for the assessment of the declared capability. This programme shall be designed so that each declared limit of capability is verified by an appropriate CQC.

The programme shall include the following:

- a bar chart or other means of showing the proposed timetable for the approval exercise
- details of all the CQCs to be used with references to their detail specifications
- a chart showing the features to be demonstrated by each CQC
- reference to the control plans to be used for process control.

For a general overview of capability approval see Diagram 1.