CAPACITORS, VARIABLE,

CONCENTRIC TRIMMER

ESCC Generic Specification No. 3010

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Pages 1 to 31

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ESA/SCC Generic Specification No. 3010

space components
coordination group

Issue/Rev.	Date	Approved by	
		SCCG Chairman	ESA Director General or his Deputy
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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	CHANGE Reference	Item	Approved DCR No.
		This Issue supersedes Issue 2 and incorporates all modifications defined in Revisions 'A', 'B' and 'C' to Issue 2 and the changes agreed in the following DCR's:-		
		Cover Page		None
		DCN		None
		Para. 8.2.1	: New second sentence added to last paragraph	21111
		Para. 10.1.2.1	: Item (b), "PDA figure and" deleted from text	21119
			: Item (c) rewritten	21119
		Para. 10.1.3.1	: Item (a), "(including PDA figure)" deleted	21119

TABLE OF CONTENTS

1. INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification approval, procurement, including lot acceptance testing, and delivery of Capacitors, Variable, Concentric Trimmer, for space application.

This specification contains the appropriate inspection and test schedules and also specifies the data documentation requirements.

1.2 APPLICABILITY

This specification is primarily applicable to the granting of qualification approval to a component in accordance with ESA/SCC Basic Specification No. 20100 and the procurement of such components from qualified Manufacturers.

2. APPLICABLE DOCUMENTS

The following documents form part of, and shall be read in conjunction with, this specification. The relevant issues shall be those in effect on the date of placing the purchase order.

2.1 ESA/SCC SPECIFICATIONS

No. 20100, Requirements for the Qualification of Standard Electronic Components for Space Application.

No. 20400, Internal Visual Inspection.

No. 20500, External Visual Inspection.

No. 20600, Preservation, Packaging and Despatch of SCC Electronic Components.

No. 21300, Terms, Definitions, Abbreviations, Symbols and Units.

No. 21700, General Requirements for the Marking of SCC Components.

No. 22800, ESA/SCC Non-conformance Control System.

No. 24600, Minimum Quality System Requirements.

No. 24800, Resistance to Solvents of Marking, Materials and Finishes.

With the exception of ESA/SCC Basic Specifications Nos. 20100, 21700, 22800 and 24600, where Manufacturers' specifications are equivalent to, or more stringent than, the ESA/SCC Basic Specifications listed above, they may be used in place of the latter, subject to the approval of the appropriate Qualifying Space Agency.

Such replacements shall be clearly identified in the applicable Process Identification Document (P.I.D.) and listed in an Appendix to the appropriate Detail Specification.

Unless otherwise stated herein, references within the text of this specification to "the Detail Specification" shall mean the relevant ESA/SCC Detail Specification.

2.2 OTHER (REFERENCE) DOCUMENTS

IEC Publication No. 410, Sampling Plans and Procedures for Inspection by Attributes.

IEC Publication No. 68, Basic Environmental Testing Procedures.

ESA PSS-01-702, A Thermal Vacuum Test for the Screening of Space Materials.

MIL-STD-414, Sampling Procedures and Tables for Inspection by Variables for Per Cent Defective.

2.3 ORDER OF PRECEDENCE

For the purpose of interpretation and in case of conflict with regard to documentation, the following order of precedence shall apply:-

(a) ESA/SCC Detail Specification.

(b) ESA/SCC Generic Specification.

(c) ESA/SCC Basic Specification.

(d) Other documents, if referenced herein.

3. TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

The terms, definitions, abbreviations, symbols and units specified in ESA/SCC Basic Specification No. 21300 shall apply.

4. REQUIREMENTS

4.1 GENERAL

The test requirements for qualification approval of a component shall comprise final production tests (see Chart II), burn-in and electrical measurements to testing level "B" (see Chart III) and qualification testing (see Chart IV).

The test requirements for procurement of components shall comprise final production tests (Chart II), burn-in and electrical measurements to testing level "B" or "C" as required (Chart III) together with, when applicable, a level of lot acceptance testing (see Chart V) to be specified by the Orderer.

If a Manufacturer elects to eliminate a final production test by substituting an in-process control or statistical process control procedure, the Manufacturer is still responsible for delivering components that meet all of the performance, quality and reliability requirements defined in this specification and the Detail Specification.

4.1.1 Specifications

For qualification approval, procurement (including lot acceptance testing) and delivery of components in conformity with this specification, the specifications listed in Section 2 of this document shall apply in total unless otherwise specified herein or in the Detail Specification.

4.1.2 Conditions and Methods of Test

The conditions and methods of test shall be in accordance with this specification, the ESA/SCC Basic Specifications referenced herein and the Detail Specification.

4.1.3 Manufacturer's Responsibility for Performance of Tests and Inspections

The Manufacturer shall be responsible for the performance of tests and inspections required by the applicable specifications. These tests and inspections shall be performed at the plant of the Manufacturer of the components unless it is agreed by the Qualifying Space Agency prior to commencing qualification testing, or procurement, to use an approved external facility.

4.1.4 Inspection Rights

The Qualifying Space Agency (for qualification approval or for a procurement) reserves the right to monitor any of the tests and inspections scheduled in the applicable specifications.

4.1.5 Pre-encapsulation Inspection

The Manufacturer shall notify the Orderer at least 2 working weeks before the commencement of pre-encapsulation inspection. The Orderer shall indicate immediately whether or not he intends to witness the inspection.

4.2 QUALIFICATION APPROVAL REQUIREMENTS ON A MANUFACTURER

To obtain and maintain the qualification approval of a component, or family of components, a Manufacturer shall satisfy the requirements of ESA/SCC Basic Specification No. 20100.

4.3 DELIVERABLE COMPONENTS

Components delivered to this specification shall be processed and inspected in accordance with the relevant Process Identification Document (P.I.D.). Each delivered component shall be traceable to its production lot. Components delivered to this specification shall have completed satisfactorily all tests to the testing level and lot acceptance level specified in the purchase order (see Para. 4.3.2).

ESA/SCC qualified components delivered to this specification shall be produced from lots that are capable of passing all tests, and sequences of tests, that are defined in Charts IV and V. The Manufacturer shall not knowingly supply components that cannot meet this requirement. In the event that, subsequent to delivery and prior to operational use, a component is found to be in a condition such that it could not have passed these tests at the time of manufacture, this shall be grounds for rejection of the delivered lot.

Components failing inspections and tests of the higher testing level (i.e level "B") shall not be supplied against any order for components of the lower testing level.

4.3.1 Lot Failure

Lot failure may occur during final production tests (Chart II), burn-in and electrical measurements (Chart III), qualification testing (Chart IV) or lot acceptance testing (Chart V).

Should such failure occur, the non-conformance procedure shall be initiated in accordance with ESA/SCC Basic Specification No. 22800.

Should such failure occur during procurement, the Manufacturer shall notify the Orderer by telex within 2 working days, giving details of the number and mode of failure and the suspected cause.

In the case where qualification approval has been granted to the component, he shall, at the same time by the same means, inform the Qualifying Space Agency in order that the latter may consider its implications.

No further testing shall be performed on the failed components except on instruction from the Orderer. The Orderer shall inform the Manufacturer and the Qualifying Space Agency within 2 working days of receipt of the telex, by the same means, what action shall be taken.

In the case when lot failure occurs during qualification testing, the Manufacturer shall immediately notify the appropriate Qualifying Space Agency who will define a course of action to be followed. No further testing shall be performed on the failed components.

4.3.2 Testing and Lot Acceptance Levels

This specification defines 2 levels of testing severity which are designated by the letters "B" and "C" (see Chart I) and 3 levels of lot acceptance testing (see Chart V).

The lot acceptance levels are designated 1, 2 and 3 and are comprised of tests as follows:-

Level 3 (LA3) - Electrical Subgroup.

Level 2 (LA2) - Endurance Subgroup
plus Electrical Subgroup.

Level 1 (LA1) - Environmental and Mechanical Subgroup
plus Endurance Subgroup
plus Electrical Subgroup.

The required testing level and lot acceptance level shall both be specified in a purchase order.

4.4 MARKING

All components procured and delivered to this specification from a source qualified according to ESA/SCC Basic Specification No. 20100 shall be marked in accordance with ESA/SCC Basic Specification No. 21700. Thus, they shall bear the ESA symbol to signify their conformance to the ESA/SCC qualification approval requirements and full compliance with the requirements of this specification and the Detail Specification.

Components procured from sources which are not ESA/SCC qualified, provided that they fully comply with the procurement requirements of this specification and the Detail Specification, may bear the SCC marking **with the exception of the ESA symbol**.

4.5 MATERIALS AND FINISHES

All non-metallic materials and finishes that are not within a hermetically sealed enclosure, of the components specified herein shall meet the outgassing requirements as outlined in ESA PSS-01-702.

Specific requirements for materials and finishes are specified in the Detail Specification.

5. PRODUCTION CONTROL

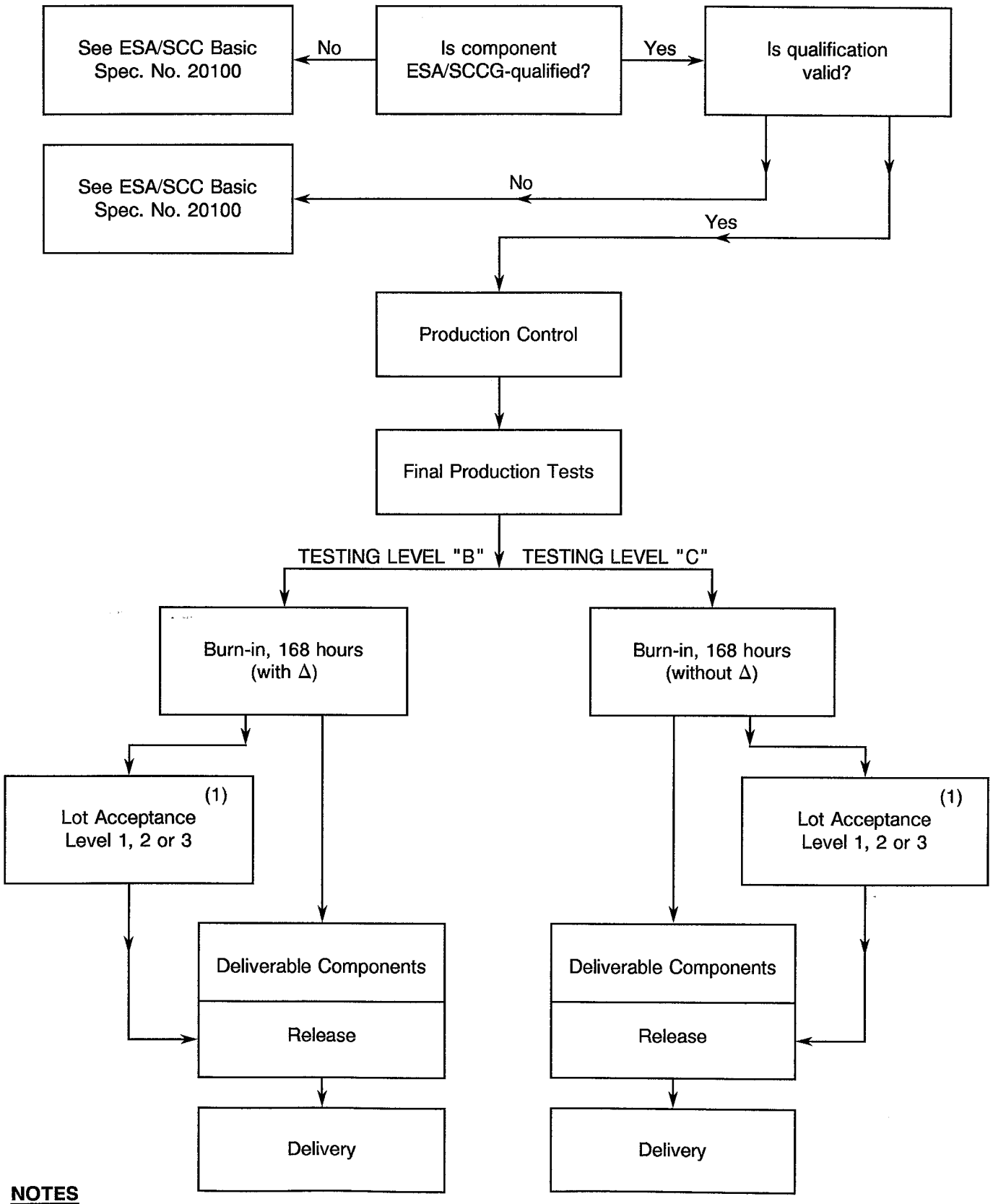
5.1 GENERAL

The minimum requirements for production control, which are equally applicable to procurement, are defined in ESA/SCC Basic Specification No. 20100, Para's 5.1 and 5.2.

5.2 SPECIAL IN-PROCESS CONTROLS

Where applicable, special in-process controls shall apply as specified in the relevant Detail Specification.

CHART I - TESTING LEVELS



NOTES

1. When applicable.

6. FINAL PRODUCTION TESTS

6.1 GENERAL

Unless otherwise specified in the Detail Specification, all components used for qualification testing and all components for delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart II.

Unless otherwise specified in the Detail Specification, the tests shall be performed in the order shown.

Any components that do not meet these requirements shall be removed from the lot and at no future time be re-submitted to the requirements of this specification.

6.2 TEST METHODS AND CONDITIONS

The applicable test methods and conditions are specified in the paragraphs referenced in Chart II of this specification.

6.3 DOCUMENTATION

Documentation of final production test data shall be in accordance with the requirements of Para. 10.6 of this specification.

7. BURN-IN AND ELECTRICAL MEASUREMENTS

7.1 GENERAL

Unless otherwise specified in the Detail Specification, all components used for qualification testing and all components for delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart III.

Unless otherwise specified in the Detail Specification, the tests shall be performed in the order shown.

The applicable test methods and conditions are specified in the paragraphs referenced in Chart III.

Components of testing level "B" shall be serialised prior to the tests and inspections.

7.1.1 Conditions of Test

The conditions for burn-in shall be as shown in Table 5 of the Detail Specification.

Unless otherwise specified in the Detail Specification, components of both Levels "B" and "C" shall be subjected to a total burn-in period of 168 hours.

7.1.2 Data Points

For components of testing level "B", undergoing a total burn-in period of 168 hours, the data points for parameter drift measurement shall be 0 hours (initial) and 168 (+24 − 0) hours (final).

For components of testing level "C", undergoing a total burn-in period of 168 hours, the data point for post-burn-in electrical measurements shall be 168 (+24 − 0) hours.

7.2 FAILURE CRITERIA

7.2.1 Parameter Drift Failure

The acceptable delta limits are shown in Table 4 of the Detail Specification. A component of testing level "B" shall be counted as a parameter drift failure if the changes during burn-in are larger than the delta (Δ) values specified.

7.2.2 Parameter Limit Failure

A component shall be counted as a limit failure if one or more parameters exceed the limits shown in Tables 2 or 3 of the Detail Specification.

Any component which exhibits a limit failure prior to the burn-in sequence shall be rejected and not counted when determining lot rejection.

7.2.3 Other Failures

A component shall be counted as a failure in any of the following cases:

- Mechanical failure.
- Handling failure.
- Lost component.

7.3 FAILED COMPONENTS

A component shall be considered as a failed component if it exhibits one or more of the failure modes described in Para. 7.2 of this specification.

7.4 LOT FAILURE

In case of lot failure, the Manufacturer shall act in accordance with the requirements of Para. 4.3.1 of this specification.

7.4.1 Lot Failure during 100% Testing

If the number of components failed on the basis of the failure criteria described in Para. 7.2, exceeds 10% (rounded upwards to the nearest whole number) of the number of components submitted to burn-in and electrical measurements, the lot shall be considered as failed.

7.4.2 Lot Failure during Sample Testing

A lot shall be considered as failed if the number of allowable failures during sample testing, in accordance with General Inspection Level II of IEC Publication No. 410 and the applicable AQL, as specified in the Detail Specification, is exceeded.

In the case where an LTPD to MIL-STD-414 is specified in the relevant Detail Specification, a lot shall be considered failed if the number of failures allowed is exceeded.

If a lot failure occurs in either case, a 100% testing may be performed with the lot failure criteria given in Para. 7.4.1.

7.5 DOCUMENTATION

Data documentation of burn-in and electrical measurements shall be in accordance with Para. 10.7 of this specification.

8. QUALIFICATION APPROVAL AND LOT ACCEPTANCE TESTS

8.1 QUALIFICATION TESTING

8.1.1 General

Qualification testing shall be in accordance with the requirements of Chart IV of this specification. The tests to Chart IV shall be performed on the specified sample, chosen at random from components which have successfully passed the tests in Charts II and III for testing level "B". This sample constitutes the qualification test lot.

The qualification test lot is divided into subgroups of tests and all components assigned to a subgroup shall be subjected to all of the tests in that subgroup, in the sequence shown.

The applicable test requirements are detailed in the paragraphs referenced in Chart IV.

The conditions governing qualification testing are given in ESA/SCC Basic Specification No. 20100, Para. 5.3 and, for the extension or renewal of qualification approval, in Paras. 6.3 and 6.4.

8.1.2 Distribution within the Qualification Test Lot

Where a Detail Specification covers a range, or series of components that are considered similar, then the qualification test lot shall be comprised of component types so selected that they adequately represent all of the various mechanical, structural and electrical peculiarities of that range or series.

The distribution shall be as specified by, or agreed with, the Qualifying Space Agency.

8.2 LOT ACCEPTANCE TESTING

8.2.1 General

The sample sizes of the 3 lot acceptance levels are specified in Chart V. All components assigned to a subgroup shall be subjected to all of the tests of that subgroup in the sequence shown.

The tests to Chart V shall be performed on the specified sample which shall have been chosen, whenever possible, at random from the proposed delivery lot (but see Para. 8.2.3(b)).

The applicable test requirements are detailed in the paragraphs referenced in Chart V.

As a minimum for procurement of non-qualified components, lot acceptance level 3 tests shall apply. For procurement of qualified components, lot acceptance testing shall be performed if specified in a purchase order. Procurement lots ordered with a lot acceptance test level shall be delivered only after successful completion of lot acceptance testing.

8.2.2 Distribution within the Sample for Lot Acceptance Testing

Where a Detail Specification covers a range or series of components that are considered similar, then it may be necessary that the sample for lot acceptance testing be comprised of component types so selected that they adequately represent all of the various mechanical, structural and electrical peculiarities of the procured range or series.

The distribution of the component types will normally vary from procurement to procurement and shall be as specified by the Orderer, following as closely as possible the requirements prescribed in Para. 8.1.2. of this specification.

8.2.3 Lot Acceptance Level 3 Testing (LA3)

Lot acceptance level 3 tests are designated as the electrical subgroup and comprise electrical measurements of characteristics and tests to prove the assembly capability of the component. For LA3 testing, the following requirements and conditions shall apply:-

(a) LA3 testing shall be performed by the Manufacturer's quality assurance personnel using dedicated quality assurance equipment whenever possible. LA3 testing shall not be a repetition of routine measurements made by production personnel during final production tests and burn-in and electrical measurements.

(b) When tests to Tables 2 and 3 of the Detail Specification have been performed on a sample basis, then the components for LA3 testing shall be selected from this sample.

(c) The electrical measurements for LA3 are considered to be non-destructive and therefore components so tested may form part of the delivery lot.

(d) The solderability test is considered to be destructive and therefore components so tested may not form part of the delivery lot. Post-burn-in electrical rejects may be used for this test.

(e) When required in the purchase order, the Manufacturer shall notify the Orderer at least 2 working weeks before the commencement of LA3 testing. The Orderer shall indicate immediately whether or not he intends to witness the tests.

8.2.4 Lot Acceptance Level 2 Testing (LA2)

Lot acceptance level 2 testing shall comprise the tests for LA3 (electrical subgroup) plus tests on an endurance subgroup. For the electrical subgroup, the requirements and conditions as for LA3 (see Para. 8.2.3) shall apply.

For the endurance subgroup, the following shall apply:-

(a) Components of testing level "C", selected for the endurance subgroup, shall be serialised prior to the tests.

(b) The tests in this subgroup are considered to be destructive and therefore components (of testing level "B" or "C") so tested shall not form part of the delivery lot.

8.2.5 Lot Acceptance Level 1 Testing (LA1)

Lot acceptance level 1 testing shall comprise the tests for LA3 (electrical subgroup) and LA2 (endurance subgroup) plus tests on an environmental and mechanical subgroup. For the electrical and endurance subgroups, the requirements and conditions for LA3 (see Para. 8.2.3) and LA2 (see Para. 8.2.4) respectively shall apply.

For the environmental subgroup, the following shall apply:-

(a) Components of testing level "C", selected for the environmental subgroup, shall be serialised prior to the tests.

(b) The tests in this subgroup are considered to be destructive and therefore components (of testing level "B" or "C") so tested shall not form part of the delivery lot.

8.3 FAILURE CRITERIA

The following criteria shall apply to qualification testing and to lot acceptance testing.

8.3.1 Environmental and Mechanical Test Failures

The following shall be counted as component failures:

- Components which fail during tests for which the pass/fail criteria are inherent in the test method, e.g. solderability, terminal strength, etc.

8.3.2 Electrical Failures

The following shall be counted as component failures:-

(a) Components which, when subjected to electrical measurements on completion of environmental tests, in accordance with either Table 2 or Table 6, as specified in the Detail Specification, fail one or more of the applicable limits.

(b) Components which, when subjected to electrical measurements at intermediate and end-points during endurance testing, in accordance with Table 6 of the Detail Specification, fail one or more of the applicable limits.

(c) Components which, when subjected to measurement of electrical characteristics, in accordance with Tables 2 and 3 of the Detail Specification, fail one or more of the applicable limits.

8.3.3 Other Failures

The following additional failures may also occur during qualification testing or lot acceptance testing:-

(a) Components failing to comply with the requirements of ESA/SCC Basic Specification No. 20500.

(b) Lost components.

8.4 FAILED COMPONENTS

A component shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 8.3 of this specification. The allowable number of failed components per subgroup, the aggregate failure constraints and the permitted distribution of such failures are shown at the foot of Charts IV and V of this specification.

When requested by the Qualifying Space Agency or the Orderer, failure analysis of failed components shall be performed by the Manufacturer and the results provided.

Failed components from successful lots shall be marked as such and be stored at the Manufacturer's plant for 24 months.

8.5 LOT FAILURE

A lot shall be considered as failed if the allowable number of failures according to Chart IV or V of this specification, as relevant, has been exceeded.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.1 of this specification.

8.6 DOCUMENTATION

For qualification testing, the qualification test data shall be documented in accordance with the requirements of Para. 10.8 of this specification.

In the case of lot acceptance testing, the data shall be documented in accordance with the requirements of Para. 10.9 of this specification.

CHART II - FINAL PRODUCTION TESTS

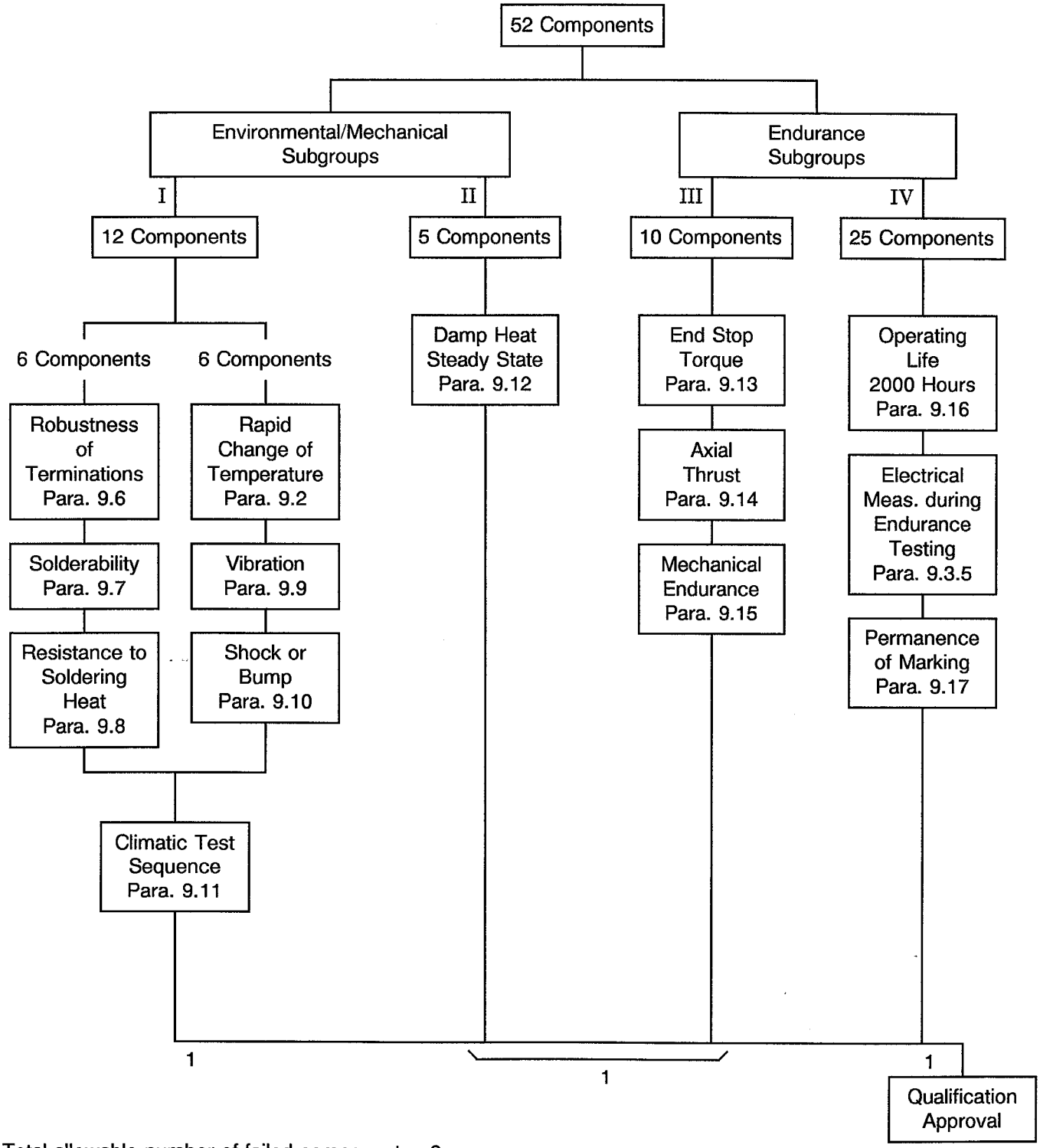
	Production and Controls in accordance with Section 5 of this specification
Para. 9.1	Internal Visual Inspection
	Final Assembly
Para. 4.4	Marking and Serialisation (Level 'B' only)
Para. 9.2	Rapid Change of Temperature
Para. 9.3.4	Electrical and Mechanical Measurements at Room Temperature
Para. 9.4	External Visual Inspection
Para. 9.5	Dimension Check
	TO CHART III

CHART III - BURN-IN AND ELECTRICAL MEASUREMENTS

Components from Final Production Tests		Testing Levels	
		B	C
Para. 9.3.2	Parameter Drift Value Measurements	X	-
Para. 7.1	Burn-in, 168 hours	X	X
Para. 9.3.2	Parameter Drift Value Measurements	X	-
Para. 9.3.3	Electrical Measurements at High and Low Temperatures	X	X
Para. 9.3.4	Electrical and Mechanical Measurements at Room Temperature	X	X
Para. 9.4	External Visual Inspection	X	X
Para. 7.4	Check for Lot Failure	X	X

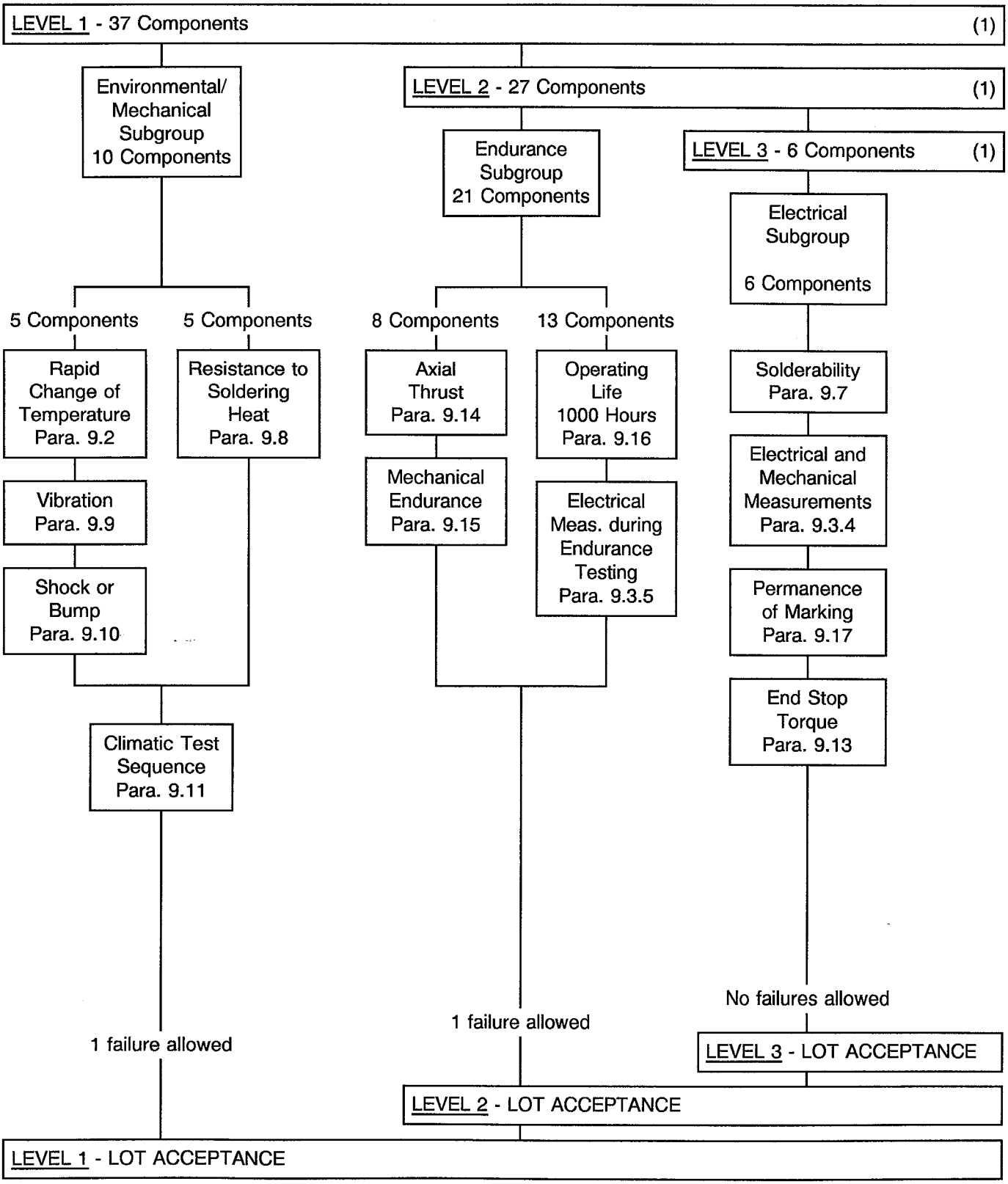
TO CHART IV OR V

CHART IV - QUALIFICATION TESTS



Total allowable number of failed components: 2.

CHART V - LOT ACCEPTANCE TESTS



NOTES

1. For distribution within the subgroups, see Para. 8.2.2.

9. TEST METHODS AND PROCEDURES

Unless otherwise specified, the capacitors shall be submitted to tests set at 75% of the capacitance range specified in the Detail Specification.

If a Manufacturer elects to eliminate or modify a test method or procedure, the Manufacturer is still responsible for delivering components that meet all of the performance, quality and reliability requirements defined in this specification and the Detail Specification.

Documentation supporting the change shall be approved by the Qualifying Space Agency and retained by the Manufacturer. It shall be copied, when requested, to the Qualifying Space Agency.

The change shall be specified in the Detail Specification and in the P.I.D.

9.1 VISUAL INSPECTION

In accordance with ESA/SCC Basic Specification No. 20400.

9.2 RAPID CHANGE OF TEMPERATURE

9.2.1 Procedure for Final Production Tests (Chart II)

The capacitors shall be tested in accordance with IEC Publication No. 68-2-14, Test 'Na'. The following details shall apply:-

T_{amb} = −55°C.
T_B = +125°C.
t_1 = 30 minutes.
t_2 = 1.0 minute.
Recovery time: 4 hours minimum.

For qualification and lot acceptance tests, the initial and final measurements shall be made of minimum and maximum rated capacitance. The drifts shall be calculated and shall not exceed the limits prescribed in Table 6 of the Detail Specification.

9.3 ELECTRICAL AND MECHANICAL MEASUREMENTS

9.3.1 General

Unless otherwise specified in the Detail Specification, the following measurements shall be made under standard conditions in accordance with Table 2 of the Detail Specification.

9.3.1.1 Capacitance

Capacitors shall be tested using a test jig incorporating a guard provision. The following details and exception shall apply:

- Test frequency: Minimum and maximum rated capacitance shall be measured at a frequency of 1.0MHz ± 100kHz.
- Limit of accuracy: Within ±0.1% or 0.02pF, whichever is greater.

9.3.1.2 Change in Capacitance

The rate of change in capacitance shall be monitored by any suitable method while capacitance is adjusted from the minimum rated value to the maximum rated value and back to the minimum rated value. The rate of change in capacitance as a function of the change in adjustment shall not change sign over the entire range of adjustment.

9.3.1.3 Insulation Resistance

For this test, the measurement shall be made with the rotor set at the minimum and maximum capacitance positions between terminals.

Test voltage applied: 500V.

The reading shall be made after 5.0 seconds of application of the test voltage for final production tests and burn-in and, for qualification and lot acceptance tests, after 60 seconds.

9.3.1.4 Voltage Proof

Capacitors shall be set at maximum rated capacitance and 200% of d.c. rated voltage shall be applied between terminals. The test voltage shall be maintained during 5.0 seconds for final production tests and burn-in and during 60 seconds for qualification and lot acceptance tests.

9.3.1.5 Quality Factor

Capacitors shall be tested as follows:-

- Capacitors shall be set at maximum rated capacitance and quality factor shall be measured at a frequency of 100MHz ± 1.0MHz unless otherwise specified in the Detail Specification.
- The mounting means shall be snugly fitted against the capacitor when making measurements.
- Measurements shall be made using a test jig designed for a minimum stray capacitance effect with an accuracy sufficient to guarantee the minimum quality factor specified.
- The quality factor test shall be performed by sampling.

9.3.1.6 Operating Torque

The torque required to start and maintain rotation of the rotor shall be measured by a gradually applied force sufficient to turn the rotor through at least 50% of the total number of rotations.

9.3.2 Parameter Drift Value Measurements

At each of the relevant data points for components of testing level "B", measurements shall be made of all parameters listed in Table 4 of the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated.

9.3.3 Electrical Measurements at High and Low Temperatures

For components of testing levels "B" and "C", the electrical measurements at high and low temperatures shall be made in accordance with Table 3 of the Detail Specification. For testing level "B", all values obtained shall be recorded against serial numbers.

9.3.4 Electrical and Mechanical Measurements at Room Temperature

The measurements of electrical and mechanical characteristics shall be made in accordance with Table 2 of the Detail Specification.

9.3.5 Electrical Measurements during Endurance Testing

At each of the relevant data points specified for endurance testing, measurements shall be made of all parameters listed in Table 6 of the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated, if required.

9.4 EXTERNAL VISUAL INSPECTION

In accordance with ESA/SCC Basic Specification No. 20500.

9.5 DIMENSION CHECK

In accordance with ESA/SCC Basic Specification No. 20500 and Figure 2 of the Detail Specification. The dimension check shall be performed by sampling.

9.6 ROBUSTNESS OF TERMINATIONS

Capacitors shall be tested in accordance with IEC Publication No. 68-2-21, Test 'Ub', Clause 4.5.2.2 (Bending-Tag Termination), Method 1. The terminations shall be bent at the mid-point of their total length. The Detail Specification shall indicate to which capacitor variants the test applies or otherwise (e.g. non-tag termination, leadless types - test not applicable.)

9.7 SOLDERABILITY

Capacitors shall be tested in accordance with IEC Publication No. 68-2-20, Test 'Ta', Method 1.

All solderable terminations of each part shall be tested. The dipped surface of the leads shall be covered by at least 95% with a new, smooth, solder coating. The remaining 5% of the lead surface shall show only small pin-holes or rough spots; these shall not be concentrated in one area. Bare base metal and areas where the solder dip failed to cover the original coating are indications of poor solderability and shall be cause for rejection. In case of dispute, the percentage of areas covered with pin-holes or rough spots shall be determined by actual measurement.

9.8 RESISTANCE TO SOLDERING HEAT.

Capacitors shall be tested in accordance with IEC Publication No. 68-2-20, Test 'Tb', Method 1A. The following details and exceptions shall apply:

- Leads shall be immersed in molten solder to the depth specified in the Detail Specification.
- Immersion time shall be as specified in the Detail Specification.
- Cooling time prior to measurement after test shall be sufficient to allow the capacitor temperature to return to $+22 \pm 3$ °C.
- After test: Capacitance, voltage proof and quality factor shall be measured as specified in Para. 9.3 of this specification.

The limits shall be as specified in Table 6 of the Detail Specification. This test is only applicable to those capacitor variants with tag terminations.

9.9 VIBRATION (SINUSOIDAL)

Capacitors shall be tested in accordance with IEC Publication No. 68-2-6, Test 'Fc', Endurance by Sweeping. The following details and exceptions shall apply:

- Capacitors shall be mounted by their normal mounting means. Lead-mounted capacitors, designed for printed circuit mounting, shall be seated firmly against a printed circuit board or comparable support to withstand forces occurring in service. Leads shall pass through mounting holes in the board and be soldered onto the reverse side of the printed circuit board.
- Prior to test, capacitors shall be set at approximately 75% of maximum rated capacitance and capacitance shall then be measured as specified in Para. 9.3.1.1 of this specification.
- Frequency range: 10 to 2 000 Hz.
- Vibration amplitude: Displacement below the cross-over frequency of 57 to 62 Hz shall be 2.0mm and then acceleration of 294m/s^2 (30gn) above this frequency
- Duration: 10 sweep cycles in each of the 3 mutually perpendicular planes unless otherwise specified in the Detail Specification.
- During vibration, a potential of 125% of the d.c. rated voltage shall be applied between rotor and stator. Observation shall be made for momentary arcing or short circuiting of 0.5ms or greater duration.

9.10 SHOCK OR BUMP

9.10.1 Shock

Capacitors shall be tested in accordance with IEC Publication No. 68-2-27, Test 'Ea'. The following details and exceptions shall apply:

- Capacitors shall be mounted by their normal mounting means. Lead-mounted capacitors, designed for printed circuit mounting, shall be seated firmly against a printed circuit board or comparable support to withstand forces occurring in service. Leads shall pass through mounting holes in the board and be soldered onto the reverse side of the printed circuit board.
- Prior to test, capacitors shall be set at approximately 75% of maximum rated capacitance and capacitance shall then be measured as specified in Para. 9.3.1.1 of this specification.
- Acceleration: 100g.
- Duration: 6.0ms.
- Waveform: 1/2 sine pulse.
- 10 shocks shall be applied in each of the 3 mutually perpendicular planes unless otherwise specified in the Detail Specification.
- During shock, a potential of 125% of the d.c. rated voltage shall be applied between rotor and stator. Observation shall be made for momentary arcing or short circuiting of 0.5ms or greater duration.

9.10.2 Bump

Capacitors shall be tested in accordance with IEC Publication No. 68-2-29, Test 'Eb'. The following details and exceptions shall apply:

- Capacitors shall be mounted by their normal mounting means. Lead-mounted capacitors, designed for printed circuit mounting, shall be seated firmly against a printed circuit board or comparable support to withstand forces occurring in service. Leads shall pass through mounting holes in the board and be soldered onto the reverse side of the printed circuit board.
- Prior to test, capacitors shall be set at approximately 75% of maximum rated capacitance and capacitance shall then be measured as specified in Para. 9.3.1.1 of this specification.
- Acceleration: 40g.
- Pulse duration: 6.0ms.
- Number of bumps: 4 000 $\pm$ 10 in total.
- The bumps shall be applied in each of the 3 mutually perpendicular planes unless otherwise specified in the Detail Specification.
- During bumps, a potential of 125% of the d.c. rated voltage shall be applied between rotor and stator. Observation shall be made for momentary arcing or short circuiting of 0.5ms or greater duration.

9.10.3 Final Measurements

After shock or bump, capacitors shall be measured for capacitance and the calculated drift shall meet the requirements of Table 6 of the applicable ESA/SCC Detail Specification. Capacitors shall also be examined visually for evidence of breakdown, arcing, cracks, loosening of parts or other visible damage (capacitors shall not be dissembled).

9.11 CLIMATIC TEST SEQUENCE

Prior to the test, capacitors shall be set at approximately 75% of maximum rated capacitance and capacitance shall then be measured as specified in Para. 9.3.1.1 of this specification.

9.11.1 Dry Heat

The capacitors shall be subjected to Test 'Ba' of IEC Publication No. 68-2-2. Duration: 2 hours. Maximum storage temperature as specified in the Detail Specification (Table 1(b)). The capacitors shall be visually examined for evidence of mechanical damage.

9.11.2 Damp Heat, Cyclic

Unless otherwise specified in the Detail Specification, the capacitors shall be subjected to Test 'Db' of IEC Publication No. 68-2-30, upper temperature severity of +55°C, Variant 1 for 1 cycle. After recovery, the capacitors shall be subjected immediately to the cold test.

9.11.3 Cold Test

The capacitors shall be subjected to Test 'Aa' of IEC Publication No. 68-2-1. Duration: 2 hours. Minimum storage temperature as specified in the Detail Specification (Table 1(b)). At the end of the period of low temperature, the capacitors shall be visually examined for evidence of mechanical damage.

9.11.4 Low Air Pressure

The capacitors shall be subjected to Test 'M' of IEC Publication No. 68-2-13 under the following conditions:

- 5 minutes at 8kPA.
- Temperature: +15 to +35 °C.
- The voltage U_R shall be applied for 1 to 2 minutes immediately after the pressure of 8kPA has been attained.

9.11.5 Damp Heat, Cyclic

The capacitors shall be subjected to Test 'Db' of IEC Publication No. 68-2-30, upper temperature severity of +55°C, Variant 1 for 5 cycles.

9.11.6 Final Measurements

After a recovery period of 24 hours, the capacitors shall be visually examined for evidence of damage. Capacitance (drift calculation), quality factor, insulation resistance, voltage proof and operating torque shall be measured and shall meet the requirements of Table 6 of the Detail Specification.

9.12 DAMP HEAT, STEADY STATE

Prior to the test, the capacitance shall be measured as specified in Para. 9.3.1.1 of this specification and Table 6 of the Detail Specification. The capacitors shall be subjected to Test 'Ca' of IEC Publication No. 68-2-3 with no voltage applied unless otherwise prescribed in the Detail Specification. Duration shall be 56 days.

On completion of the final cycle, the capacitors shall be maintained at a temperature of +25(+10−5) °C and a relative humidity of 50±5% for a period of 12 to 24 hours. Capacitance (drift calculation), quality factor, insulation resistance, voltage proof and operating torque at ambient room temperature shall be measured as specified in Para. 9.3.1 of this specification. The limits shall be as specified in Table 6 of the Detail Specification.

9.13 END -STOP TORQUE

Capacitors shall be mounted by their normal mounting means. They shall withstand the torque applied to the rotor as specified in the Detail Specification. Following the test, there shall be no evidence of damage and the capacitors shall be electrically tested and visually examined as prescribed in Table 6 of the Detail Specification.

9.14 AXIAL THRUST

The capacitors shall be mounted by their normal mounting means. An axial thrust as specified in the Detail Specification shall be applied to the operating end of the actuating device and capacitance shall be measured under these conditions. The change in capacitance shall meet the requirements of Table 6 of the Detail Specification.

9.15 MECHANICAL ENDURANCE

Capacitors shall be mounted by their normal mounting means with the rotor screw set at approximately 20% of the maximum rated capacitance. The screw shall be rotated 4 complete revolutions in the direction of increasing capacitance and then be returned. This cycle shall be repeated 50 times at a rate of 5 cycles per minute. Following the final cycle, voltage proof shall be measured as specified in Para. 9.3.1.4 of this specification. The capacitors shall then be set at approximately 10% of the maximum rated capacitance value above the minimum rated capacitance value or 1.0pF, whichever is greater, and the rotor shall then be rotated in steps of 2 turns until 90% of maximum rated capacitance is reached. Capacitance measurements at a minimum of 3 steps shall be recorded. Capacitance shall be measured after each step at a frequency of 1.0MHz ± 10%, and shall be continuously monitored for reversals. The accuracy of the rotation shall be within ± 5° per revolution. Reproducibility of the measurements shall be within ± 0.1% or 0.01pF, whichever is greater. Following measurements of capacitance change versus rotation, the torque shall be measured at ambient room temperature as specified in Para. 9.3.1.6 of this specification.

Without further rotation after torque measurement, insulation resistance shall be measured between the rotor screw and mounting base. Dissembly may be necessary for this measurement. The quality factor shall then be measured. Capacitance change versus rotation of the rotor shall not deviate from a straight line by more than 10% and show no reversals in direction. Voltage proof, operating torque, insulation resistance and quality factor shall not exceed the values specified in Table 6 of the Detail Specification.

9.16 OPERATING LIFE

The initial capacitance is the maximum rated capacitance value measured after burn-in at room temperature.

Capacitors shall be submitted to an endurance test of 2 000 or 1 000 hours as required by Chart IV or V respectively at a voltage and ambient temperature as defined in Table 5 of the Detail Specification. After approximately 500, 1 000 and 2 000 hours for qualification, and 500 and 1 000 hours for lot acceptance, the maximum rated capacitance (drift calculation), insulation resistance, voltage proof, quality factor and operating torque shall be measured and shall not exceed the values specified in Table 6 of the Detail Specification. Before measurement, the recovery time shall be minimum 2, maximum 6 hours.

9.17 PERMANENCE OF MARKING

In accordance with ESA/SCC Basic Specification No. 24800.

9.18 TEMPERATURE COEFFICIENT

Unless otherwise specified in the Detail Specification for Final Production Tests (Chart II), the capacitors shall be dried for 1 hour at the maximum category temperature, followed by recovery for 24 hours. The capacitors shall then be maintained at each of the following temperatures in turn with the capacitance set to 75% of the rated maximum capacitance value:-

(a) +20 ± 2 °C (measured value Ca)

(b) Minimum operating temperature specified in Table 1(b) of the Detail Specification ±2°C (measured value Cb)

(c) +20 ± 2 °C (measured value Cc)

(d) Maximum operating temperature specified in Table 1(b) of the Detail Specification ±2°C (measured value Cd)

(e) +20 ± 2 °C (measured value Ce)

After the capacitors have reached thermal stability (10 to 15 minutes), the capacitance measurements shall be made at each of the temperatures specified above using the method specified in Para. 9.3.1.1. The temperature of the chamber at the time of each capacitance measurement shall be recorded. The error of temperature measurement shall not exceed 1°C.

The temperature coefficient of capacitance between +22°C and each of the other specified temperatures shall be calculated from the following formula:-

Temperature coefficient of capacitance in parts per million per °C = $(\Delta C/C\Delta T)106 \times K$

Where 'K' = $\frac{\text{difference between nominal specified}}{\text{difference between recorded temperatures}}$

ΔT = difference between recorded temperatures

C and ΔC are derived as shown in the table below:

Symbol	Lower Category Temperature	Upper Category Temperature
C	1/2 (Ca + Cc)	1/2 (Cc + Ce)
ΔC	Cb - C	Cd - C

The limit values specified in Tables 3 and 6 of the Detail Specification shall not be exceeded.

10. DATA DOCUMENTATION

10.1 GENERAL

For the qualification approval records and with each component delivery, a data documentation package is required. Depending on the testing level and lot acceptance level specified for the component, this package shall be compiled from:-

(a) Cover sheet (or sheets).

(b) List of equipment (testing and measuring).

(c) List of test references.

(d) Special in-process control test data.

(e) Final production test data (Chart II) (but see Para. 10.6).

(f) Burn-in and electrical measurement data (Chart III).

(g) Qualification test data (Chart IV).

(h) Lot acceptance test data (Chart V) (when applicable).

(i) Failed component list (see Para's 7.3 and 8.4) and failure analysis report (see Para. 8.4).

(j) Certificate of Conformity.

Items (a) to (j) inclusive shall be grouped, preferably as subpackages and, for identification purposes, each page shall include the following information:

- ESA/SCC Component Number.
- Manufacturer's name.
- Lot identification.
- Date of establishment of the document.
- Page number.

10.1.1 Qualification Approval

In the case of qualification approval, the items listed in Para. 10.1 (a) to (j) less item (h) are required.

10.1.2 Testing Level "B"

10.1.2.1 Qualified Components

For deliveries of qualified components, the following documentation shall be supplied:-

(a) Cover sheet (if all of the information is not included on the Certificate of Conformity).

(b) Certificate of Conformity (including range of delivered serial numbers).

(c) Attributes record of measurements, tests and inspections performed in Chart II, Chart III (including PDA figure) and Chart V (where applicable).

(d) Failed components list.

10.1.2.2 Unqualified Components

For deliveries of unqualified components, the documentation to be supplied shall be in accordance with Para. 10.1.2.1 plus the following:-

(a) Read and record data from Chart III.

(b) Special in-process control data (where applicable).

(c) Failure analysis report on failed components.

10.1.3 Testing Level "C"

10.1.3.1 Qualified Components

For deliveries of qualified components, the following documentation shall be supplied:-

(a) Certificate of Conformity.

10.1.3.2 Unqualified Components

For deliveries of unqualified components, the documentation to be supplied shall be in accordance with Para. 10.1.3.1 plus the following:-

(a) Cover sheet (if all of the information is not included on the Certificate of Conformity).

(b) Attributes record of all measurements, tests and inspections performed in Charts II, III and V (when applicable).

(c) Failed components list (including Failure Analysis Report).

(d) Special in-process control data (when applicable).

10.1.4 Data Retention/Data Access

If not delivered, all data shall be retained by the Manufacturer for a minimum of 5 years during which time it shall be available to the Qualifying Space Agency and the Orderer, if requested, for review. The Manufacturer shall deliver variables Data/Reports to the Orderer if required by the Purchase Order.

10.2 COVER SHEET(S)

The cover sheet(s) of the data documentation package shall include as a minimum:-

(a) Reference to the Detail Specification, including issue and date.

(b) Reference to the applicable ESA/SCC Generic Specification, including issue and date.

(c) Component type and number.

(d) Lot identification.

(e) Range of delivered serial numbers (for components of testing level "B").

(f) Number of purchase order.

(g) Information relative to any additions to this specification and/or the Detail Specification.

(h) Manufacturer's name and address.

(j) Location of the manufacturing plant.

(k) Signature on behalf of Manufacturer.

(l) Total number of pages of the data package.

10.3 LIST OF EQUIPMENT USED

A list of equipment used for tests and measurements shall be prepared, if not in accordance with the data given in the Process Identification Document (P.I.D.). Where applicable, this list shall contain inventory number, Manufacturer's type number, serial number, etc. This list shall indicate for which tests such equipment was used.

10.4 LIST OF TEST REFERENCES

This list shall include all Manufacturer's references or codes which are necessary to correlate the test data provided with the applicable tests specified in the tables of the Detail Specification.

10.5 SPECIAL IN-PROCESS CONTROL DATA

As specified in the Detail Specification

10.6 FINAL PRODUCTION TEST DATA (CHART II)

A test result summary shall be compiled showing the total number of components submitted to, and the total number rejected after, each of the following tests:

- Environmental tests (Para. 9.2).
- Electrical measurements at room temperature (Para. 9.3.4).
- External visual inspection (Para. 9.4).
- Dimension check (Para. 9.5).

The final production test data shall form an integral part of the data documentation package, but it is not a mandatory requirement that it be delivered with the qualification lot or delivery lot. However, the data package to be delivered shall contain the information as detailed in Paras. 10.1.2 and 10.1.3 or at least shall contain a list of final production tests actually performed and a certification that the data is available for review.

10.7 BURN-IN AND ELECTRICAL MEASUREMENT DATA (CHART III)

10.7.1 Testing Level "B"

For components of testing level "B", all data shall refer to the relevant serial numbers. Against these serial numbers, data shall be recorded for the following:-

(a) 0-hour measurement for burn-in.

(b) 168-hour measurement for burn-in.

(c) Delta values after burn-in.

(d) Values obtained during measurements at high and low temperatures (Table 3 of the Detail Specification).

(e) Values obtained during measurements of electrical characteristics (Table 2 of the Detail Specification).

(f) Failures during seal test.

(g) Failures during external visual inspection.

10.7.2 Testing Level "C"

For components of testing level "C", a test result summary (i.e. the total number of components subjected to, and the total number rejected from, each of the tests and inspections) shall be prepared.

10.8 QUALIFICATION TEST DATA (CHART IV)

All data shall be referenced to the relevant serial numbers. Detailed records shall be provided of the components submitted to each test in each of the subgroups and of those rejected. Detailed data shall be provided of all electrical measurements made in accordance with Table 6 of the Detail Specification, as and where applicable.

10.9 LOT ACCEPTANCE TEST DATA (CHART V)

10.9.1 Testing Level "B"

All data shall be referenced to the relevant serial numbers. Detailed records shall be provided of the components submitted to each test in each of the subgroups (as relevant to the lot acceptance level) and of those rejected.

Detailed data shall be provided of all electrical measurements made in accordance with Table 6 of the Detail Specification, as and where applicable.

10.9.2 Testing Level "C"

A test result summary (i.e. the total number of components submitted to, and and the total number rejected from, each of the tests and inspections) as relevant to the lot acceptance level shall be provided.

In the case of lot acceptance 2 testing, all data in respect of electrical measurements made in accordance with Table 6 of the Detail Specification shall be referenced to the relevant serial numbers (see Para. 8.2.4(a)).

In the case of lot acceptance 1 testing, all data in respect of electrical measurements made in accordance with Tables 2 and 6 of the Detail Specification shall be referenced to the relevant serial numbers (see Para. 8.2.5(a)).

10.10 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT

The failed component list and failure analysis report shall provide full details of:-

(a) The reference number and description of the test or measurement performed as defined in this specification and/or the Detail Specification.

(b) The serial number (if applicable) of the failed component.

(c) The failed parameter and the failure mode of the component.

(d) Detailed failure analysis, if requested.

10.11 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established as defined in ESA/SCC Basic Specification No. 20100.

11. DELIVERY

For qualification approval, the disposition of the qualification test lot and its related documentation shall be as specified in ESA/SCC Basic Specification No. 20100 and the relevant paragraphs of Section 10 of this specification.

For procurement, for each order, the items forming the delivery are:-

(a) The delivery lot.

(b) The components used for lot acceptance testing, (when applicable), but not forming part of the delivery lot (see Para's 8.2.3(d), 8.2.4(b) and 8.2.5(b)).

(c) The relevant documentation in accordance with the requirements of Section 10 of this specification.

In the case of a component for which a valid qualification approval is in force, all data of all components submitted to LA1 and LA2 testing shall also be copied, when requested, to the relevant Qualifying Space Agency.

12. PACKAGING AND DESPATCH

The packaging and despatch of components to this specification shall be in accordance with the requirements of ESA/SCC Basic Specification No. 20600.