




Page i

RESISTORS, FIXED FILM
ESCC Generic Specification No. 4001

ISSUE 1
October 2002



Document Custodian: European Space Agency - see <https://escies.org>

	ESCC Generic Specification		PAGE ii ISSUE 1
---	----------------------------	--	--------------------

LEGAL DISCLAIMER AND COPYRIGHT

European Space Agency, Copyright © 2002. All rights reserved.

The European Space Agency disclaims any liability or responsibility, to any person or entity, with respect to any loss or damage caused, or alleged to be caused, directly or indirectly by the use and application of this ESCC publication.

This publication, without the prior permission of the European Space Agency and provided that it is not used for a commercial purpose, may be:

- copied in whole in any medium without alteration or modification.
- copied in part, in any medium, provided that the ESCC document identification, comprising the ESCC symbol, document number and document issue, is removed.



europaean space agency
agence spatiale européenne

Pages 1 to 34

RESISTORS, FIXED FILM

ESA/SCC Generic Specification No. 4001



**space components
coordination group**

Issue/Rev.	Date	Approved by	
		SCCG Chairman	ESA Director General or his Deputy
Issue 7	April 1999	<i>San Mill</i>	<i>Joan</i>

**SCC**ESA/SCC Generic Specification
No. 4001

PAGE 2

ISSUE 7

DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	Reference	CHANGE Item	Approved DCR No.
		This Issue supersedes Issue 6 and incorporates all modifications defined in Revisions 'A', 'B' and 'C' to Issue 6 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**

	<u>Page</u>
1. <u>INTRODUCTION</u>	6
1.1 Scope	6
1.2 Applicability	6
2. <u>APPLICABLE DOCUMENTS</u>	6
2.1 ESA/SCC Specifications	6
2.2 Other (Reference) Documents	7
2.3 Order of Precedence	7
3. <u>TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS</u>	7
4. <u>REQUIREMENTS</u>	7
4.1 General	7
4.1.1 Specifications	7
4.1.2 Conditions and Methods of Test	7
4.1.3 Manufacturer's Responsibility for Performance of Tests and Inspections	7
4.1.4 Inspection Rights	8
4.1.5 Pre-encapsulation Inspection	8
4.2 Qualification Approval Requirements on a Manufacturer	8
4.3 Deliverable Components	8
4.3.1 Lot Failure	8
4.3.2 Testing and Lot Acceptance Levels	9
4.4 Marking	9
4.5 Materials and Finishes	9
5. <u>PRODUCTION CONTROL</u>	9
5.1 General	9
5.2 Special In-process Controls	9
6. <u>FINAL PRODUCTION TESTS</u>	11
6.1 General	11
6.2 Test Methods and Conditions	11
6.3 Documentation	11
7. <u>BURN-IN AND ELECTRICAL MEASUREMENTS</u>	11
7.1 General	11
7.1.1 Conditions of Test	11
7.1.2 Data Points	11
7.2 Failure Criteria	12
7.2.1 Parameter Drift Failure	12
7.2.2 Parameter Limit Failure	12
7.2.3 Other Failures	12
7.3 Failed Components	12
7.4 Lot Failure	12
7.4.1 Lot Failure during 100% Testing	12
7.4.2 Lot Failure during Sample Testing	12
7.5 Documentation	12
8. <u>QUALIFICATION APPROVAL AND LOT ACCEPTANCE TESTS</u>	13
8.1 Qualification Testing	13
8.1.1 General	13



	<u>Page</u>	
8.1.2	Distribution within the Qualification Test Lot	13
8.2	Lot Acceptance Testing	13
8.2.1	General	13
8.2.2	Distribution within the Sample for Lot Acceptance Testing	14
8.2.3	Lot Acceptance Level 3 Testing	14
8.2.4	Lot Acceptance Level 2 Testing	14
8.2.5	Lot Acceptance Level 1 Testing	14
8.3	Failure Criteria	15
8.3.1	Environmental and Mechanical Test Failures	15
8.3.2	Electrical Failures	15
8.3.3	Other Failures	15
8.4	Failed Components	15
8.5	Lot Failure	15
8.6	Documentation	15
9.	<u>TEST METHODS AND PROCEDURES</u>	20
9.1	Overload	20
9.1.1	Mounting	20
9.1.2	Initial Measurements	20
9.1.3	Procedure	20
9.1.4	Recovery and Visual Examination	20
9.1.5	Final Measurement	20
9.2	Third Harmonic Control and Current Noise	20
9.2.1	Third Harmonic Control	20
9.2.2	Current Noise	21
9.3	Seal Test	21
9.4	Dimension Check	21
9.5	Electrical Measurements	21
9.5.1	Resistance	21
9.5.2	Parameter Drift Value Measurements	22
9.5.3	Electrical Measurements at High and Low Temperatures	22
9.5.4	Electrical Measurements at Room Temperature	22
9.5.5	Electrical Measurements during Endurance Testing	22
9.6	Insulation Resistance	22
9.6.1	Leaded Resistors	22
9.6.2	Surface Mount Resistors	23
9.7	Temperature Coefficient	23
9.7.1	Procedure I	23
9.7.2	Procedure II	23
9.7.3	Test Procedure	23
9.8	Voltage Proof	24
9.8.1	Leaded Resistors	24
9.8.2	Surface Mount Resistors	25
9.9	Solderability	25
9.9.1	Initial Measurement	25
9.9.2	Procedure	25
9.9.3	Final Measurement	25
9.10	Robustness of Terminations	25
9.10.1	Leaded Resistors	25
9.10.2	Surface Mount Resistors	26
9.11	Resistance to Soldering Heat	27
9.12	Rapid Change of Temperature	27
9.12.1	Initial Measurement	27
9.12.2	Procedure and Recovery	27
9.12.3	Final Measurement	27
9.13	Vibration	27



	<u>Page</u>
9.13.1 Initial Measurement	27
9.13.2 Procedure	28
9.13.3 Final Measurement	28
9.14 Climatic Sequence	28
9.14.1 Initial Measurement	28
9.14.2 Dry Heat	28
9.14.3 Damp Heat (Accelerated) First Cycle	28
9.14.4 Cold Test	28
9.14.5 Low Air Pressure	28
9.14.6 Damp Heat (Accelerated) Remaining Cycles	29
9.14.7 d.c. Load	29
9.14.8 Final Measurement	29
9.15 Operating Life	29
9.15.1 Initial Measurement	29
9.15.2 Mounting	29
9.15.3 Procedure	29
9.15.4 Intermediate and Final Measurements	30
9.16 High Temperature Storage	30
9.16.1 Initial, Intermediate and Final Measurements	30
9.16.2 Procedure	30
9.17 External Visual Inspection	30
9.18 Burn-in	30
9.19 Permanence of Marking	30
9.20 Surface Mount Resistor Mounting	30
10. <u>DATA DOCUMENTATION</u>	31
10.1 General	31
10.1.1 Qualification Approval	31
10.1.2 Testing Level 'B'	31
10.1.3 Testing Level 'C'	32
10.1.4 Data Retention/Data Access	32
10.2 Cover Sheet(s)	32
10.3 List of Equipment Used	32
10.4 List of Test References	32
10.5 Special In-process Control Data	33
10.6 Final Production Test Data	33
10.7 Burn-in and Electrical Measurement Data	33
10.7.1 Testing Level 'B'	33
10.7.2 Testing Level 'C'	33
10.8 Qualification Test Data	33
10.9 Lot Acceptance Test Data	34
10.9.1 Testing Level 'B'	34
10.9.2 Testing Level 'C'	34
10.10 Failed Components List and Failure Analysis Report	34
10.11 Certificate of Conformity	34
11. <u>DELIVERY</u>	34
12. <u>PACKAGING AND DESPATCH</u>	34
<u>CHARTS</u>	
I TESTING LEVELS	10
II FINAL PRODUCTION TESTS	16
III BURN-IN AND ELECTRICAL MEASUREMENTS	17
IV QUALIFICATION TESTS	18
V LOT ACCEPTANCE TESTS	19

**1. INTRODUCTION****1.1 SCOPE**

This specification defines the general requirements for the qualification approval, procurement, including lot acceptance testing, and delivery of Resistors, Fixed Film, 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. 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. 23500, Requirements for Lead Materials and Finishes for Components for Space Application.


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.

	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>	<p>PAGE 7 ISSUE 7</p>
---	---	---------------------------

2.2 OTHER (REFERENCE) DOCUMENTS

IEC Publication No. 68, Basic Environmental Testing Procedures.

IEC Publication No. 115, Fixed Resistors for Use in Electronic Equipment.

IEC Publication No. 195, Method of Measurement of Current Noise generated in Fixed Resistors.

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

IEC Publication No. 440, Method of Measurement of Non-linearity in Resistors.

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

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

Not applicable.

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.

	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>	<p>PAGE 9 ISSUE 7</p>
---	---	---------------------------

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

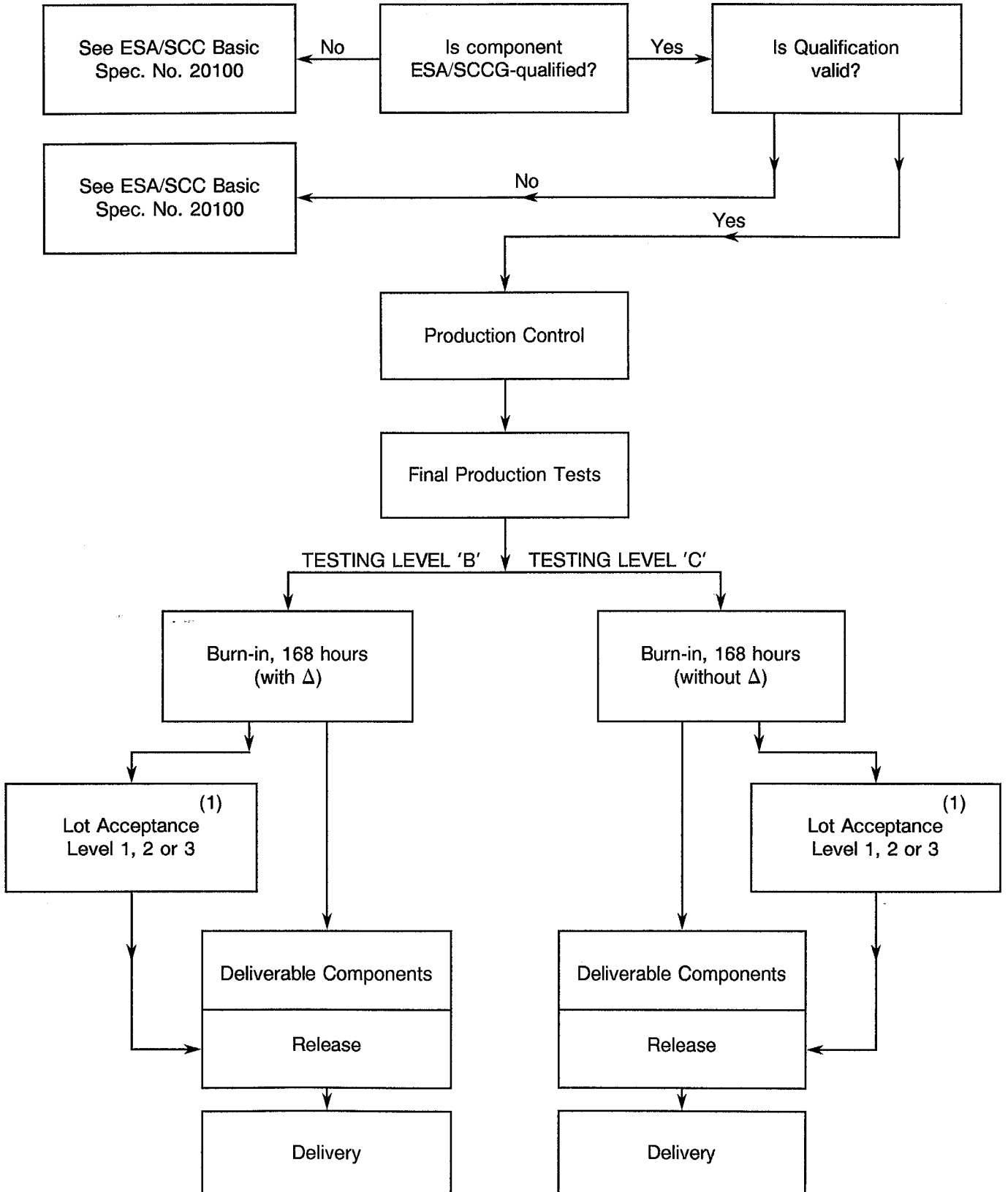
The minimum requirements for production control, which are equally applicable to procurement, are defined in ESA/SCC Basic Specification No. 20100, Paras. 5.1 and 5.2.

5.2 SPECIAL IN-PROCESS CONTROLS

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





CHART I - TESTING LEVELS



NOTES

1. When applicable.

 	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>		<p>PAGE 11 ISSUE 7</p>
---	---	--	----------------------------

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. For the applicable test methods and procedures, see Para. 9.18.

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 the 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 5% (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.

If a lot is composed of groups of components of one family defined in one ESA/SCC Detail Specification, but separately identifiable for any reason, then the lot failure criteria shall apply separately to each identifiable group.


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.

If a lot failure occurs, 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.

	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>		<p>PAGE 13 ISSUE 7</p>
---	---	--	----------------------------

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

A sample of 102 components shall be submitted to qualification testing (Chart IV). The distribution within the sample shall be as follows:-

First case

If the critical resistance is within the range to be qualified:

- 1/3 of the lot with the critical resistance value.
- 1/3 of the lot with the lowest resistance value.
- 1/3 of the lot with the highest resistance value.

Second case

If the critical resistance is outside the range to be qualified:

- 1/3 of the lot with the lowest resistance value.
- 1/3 of the lot with the highest resistance value.
- 1/3 of the lot with the resistance value in the middle of the range.

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) If the tests can be performed without mounting the components, 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 shall 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, resistance to solvents, robustness of terminations, 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

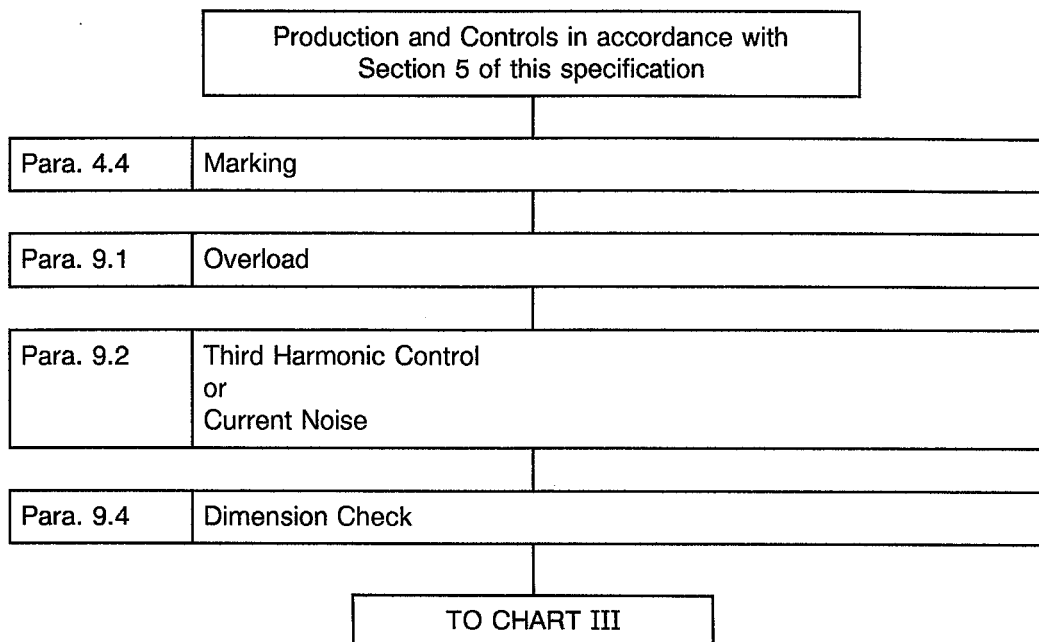
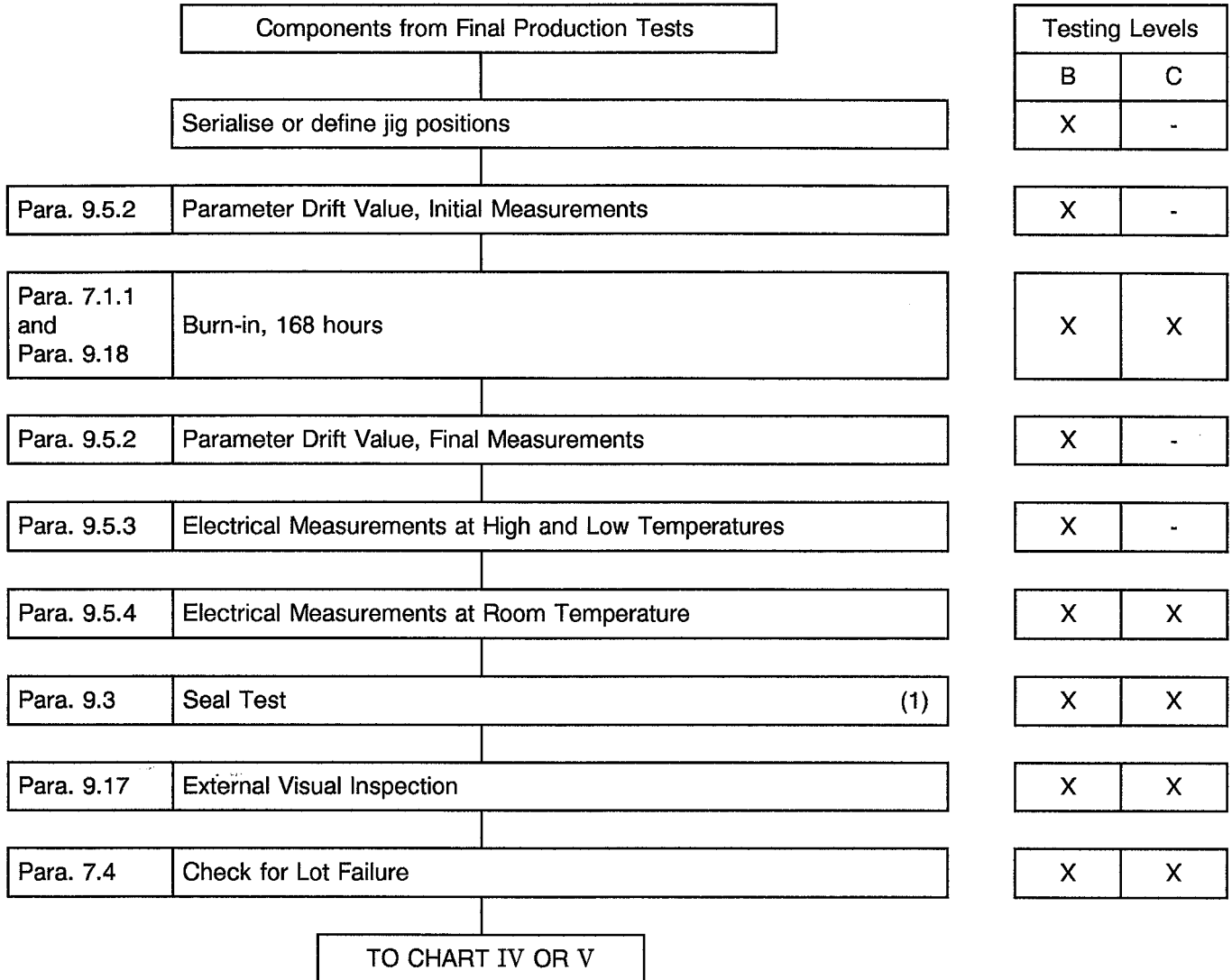




CHART III - BURN-IN AND ELECTRICAL MEASUREMENTS

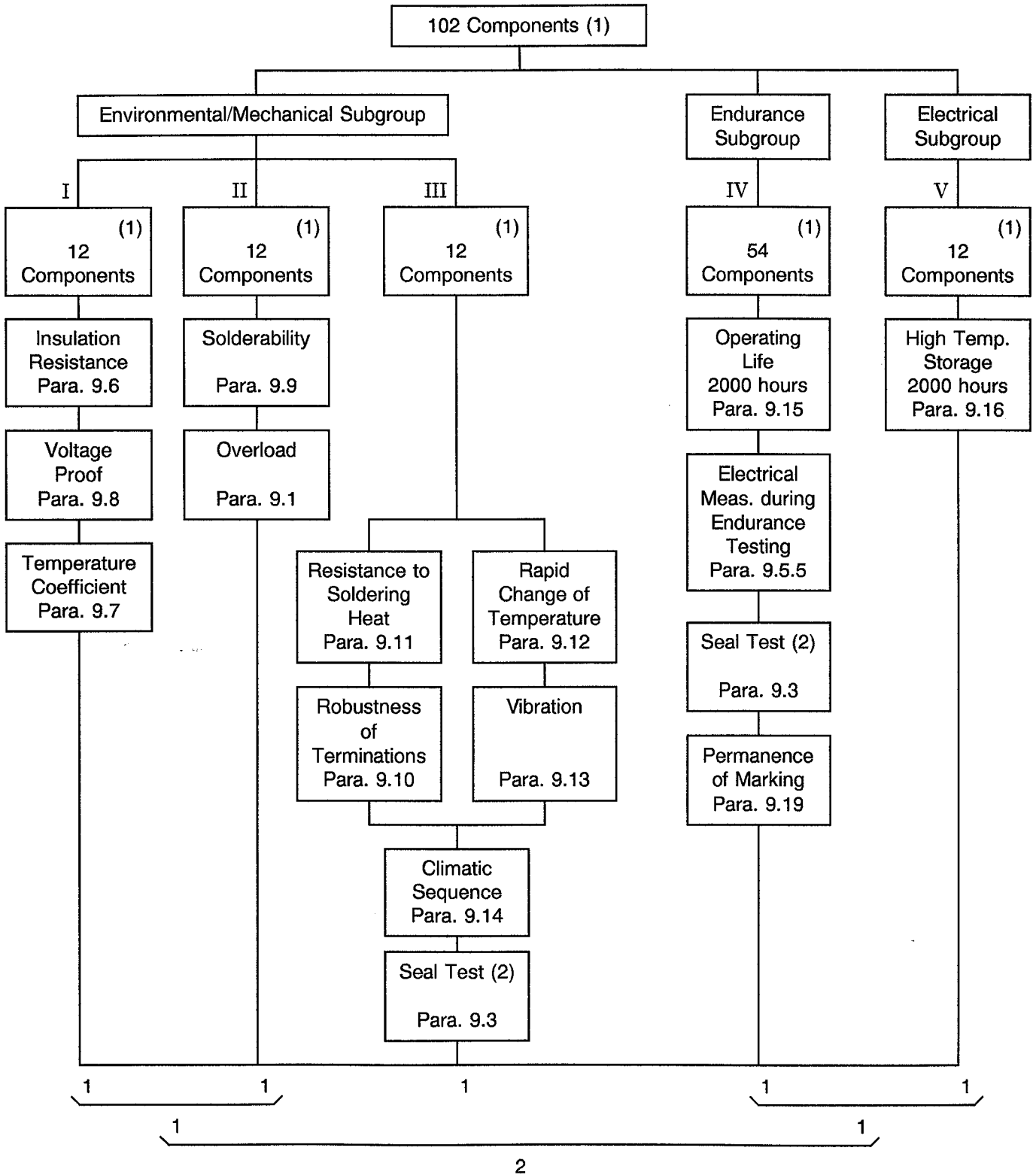


NOTES

1. For hermetically sealed resistors only.



CHART IV - QUALIFICATION TESTS



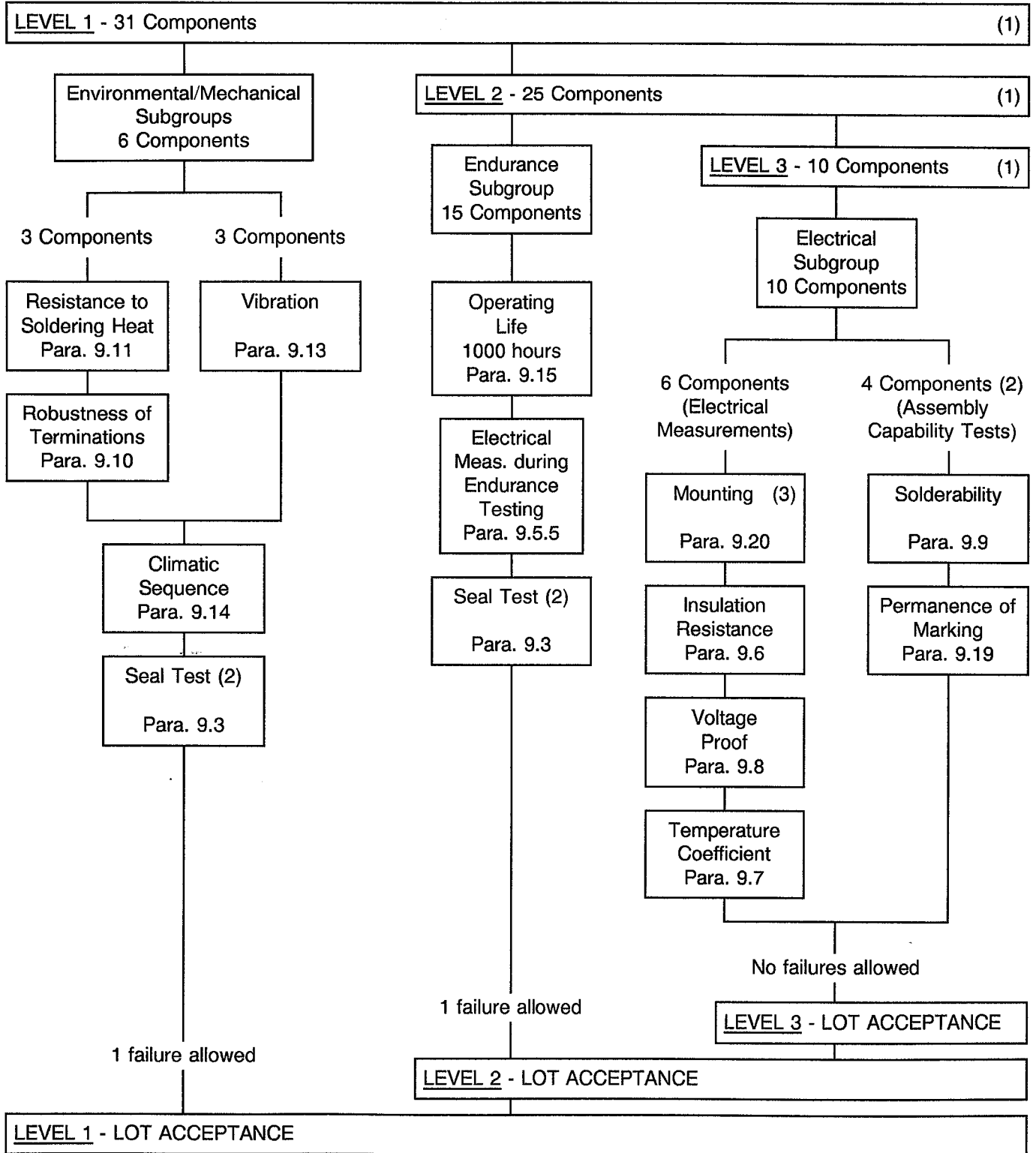
Total allowable number of failed components = 2.

NOTES

- 1. For distribution within the subgroups, see Para. 8.1.2.
- 2. For hermetically sealed resistors only.



CHART V - LOT ACCEPTANCE TESTS



NOTES

1. For distribution within the subgroups, see Para. 8.2.2.
2. For hermetically sealed resistors only.
3. This operation is at the discretion of the Manufacturer, see Para. 8.2.3(c). If mounted, the components are not deliverable.

**9. TEST METHODS AND PROCEDURES**

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 OVERLOAD**9.1.1 Mounting**

Resistors shall be mounted horizontally in free space with no object closer than 70mm to the resistor case, except the mounting base, which shall be not closer than 50mm below the resistors. The surface mount resistors shall be mounted on a suitable test substrate with an end-cap contact system, in such a way that their temperature does not effect the adjoining resistors. They shall be mounted in still air with no circulation other than that caused by the heat of the resistors being operated. The ambient temperature shall be between +15 and +35 °C.

9.1.2 Initial Measurement**DURING CHART IV**

The resistance shall be measured as specified in Para. 9.5.1.

9.1.3 Procedure

A voltage shall be applied to the terminations of the resistors. Its duration and the maximum voltage which may be applied to the resistor type are given in the Detail Specification.

9.1.4 Recovery and Visual Examination

After a recovery period of not less than 1 hour, nor more than 2 hours, the resistors shall be visually examined. There shall be no evidence of damage and the marking shall be legible.

9.1.5 Final Measurement**DURING CHART II**

The resistance shall be measured as specified in Para. 9.5.1. The value shall not exceed the limits specified in Table 2 of the Detail Specification.

DURING CHART IV

The resistance shall again be measured. The change in resistance compared to the value measured according to Para. 9.1.2 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

9.2 THIRD HARMONIC CONTROL AND CURRENT NOISE

The Manufacturer and the Orderer shall jointly agree which of these tests is to be performed.

9.2.1 Third Harmonic Control

The resistors shall be submitted to the measurement of the third harmonic voltage according to IEC Publication No. 440. Acceptance of the units shall be determined by statistical method. Limits are the mean \pm twice the standard deviation unless otherwise agreed between the Manufacturer and the Orderer.



9.2.2 Current Noise

The resistors shall be submitted to the measurement of current noise according to IEC Publication No. 195. Test equipment, procedure and performance shall be stated by mutual agreement between the Manufacturer and the Orderer.

9.3 SEAL TEST

For the purposes of this specification, a hermetically sealed resistor is a resistor whose resistance element is contained within a sealed enclosure of ceramic glass or metal, or combinations thereof, the sealing being accomplished by material fusion, welding, brazing or soldering. Hermetically sealed resistors shall be submitted to Test Q1 of IEC Publication No. 68-2-17.

The devices shall be placed in a dye solution such as Rhodamine B, Fluorescein, Dy-check, Zylglow, FL50 or equivalent, and the chamber pressurised at 620kPa minimum for 3 hours minimum. The devices shall then be removed and carefully washed, using a suitable solvent for the dye used. The devices shall then be examined under a magnification of $\times 7$ to $\times 20$, using an ultraviolet light source of appropriate frequency to determine that all dye has been removed from the exterior. Devices shall then be placed in a vacuum chamber and evacuated to less than 650Pa for 30 ± 5 minutes.

The devices shall then be removed and examined under magnification of $\times 7$ to $\times 20$, using an ultraviolet source of appropriate frequency. After removal from the dye solution, clear glass devices may be examined for dye in the cavity.

In the case of non-transparent envelopes, the resistors shall be thoroughly cleansed of external dye and then rotated about their longitudinal axis for a minimum of 2 minutes at a minimum ambient temperature of $+80^{\circ}\text{C}$. Following rotation, the resistors shall be examined for evidence of dye leakage. Any evidence of dye in the cavity, or of dye effusion, shall constitute a failure.

9.4 DIMENSION CHECK

In accordance with ESA/SCC Basic Specification No. 20500 and the Detail Specification. To be performed on 5 samples only.



If 1 failure occurs, the complete lot shall be checked.

9.5 ELECTRICAL MEASUREMENTS

9.5.1 Resistance

Measurements of resistance shall be made by using a direct voltage of small magnitude for as short a time as practicable so that the temperature does not rise appreciably during measurement. In the event of conflicting results, attributable to such test voltages, the voltage specified in the following table shall be used for reference purposes:-

Rated Resistance (R_n) (Ω)	Measuring Voltage V (+0 - 10) %
< 10	0.1 (see Note)
10 to 99	0.3
100 to 999	1.0
1 000 to 9 999	3.0
10 000 to 99 999	10
100 000 to 999 999	22
$\geq 1.0\text{M}\Omega$	50

		<p>ESA/SCC Generic Specification No. 4001</p>	<p>PAGE 22 ISSUE 7</p>
---	---	---	----------------------------

The accuracy of the measuring equipment shall be such that the error does not exceed 10% of the tolerance. Where the measurement forms part of a test sequence, it shall be possible to measure a change in resistance with an error not exceeding 10% of the maximum change permitted for that test. The resistance limits at $+22 \pm 3$ °C are given in Table 2 of the Detail Specification.

N.B.

The measuring voltage shall be chosen such that the resistor dissipates less than 10% of its rated dissipation without exceeding 0.1W.

9.5.2 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.

9.5.3 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. Where sample testing is applied, note the requirements of Para. 8.2.3(b). For Testing Level 'B', all values obtained shall be recorded against serial numbers.

9.5.4 Electrical Measurements at Room Temperature

For components of Testing Levels 'B' and 'C', the measurements of electrical characteristics shall be made in accordance with Table 2 of the Detail Specification. Where sample testing is applied, note the requirements of Para. 8.2.3(b). For Testing Level 'B', all values obtained shall be recorded against serial numbers.

9.5.5 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.

9.6 INSULATION RESISTANCE

This test applies only to insulated resistors.

9.6.1 Leaded Resistors

9.6.1.1 Mounting

For types having axial terminations, a V-block method can be used. For other types, a metal foil shall be wrapped closely around the whole body of the resistor. A space of 1.0 to 1.5 mm shall be left between the edge of the foil and each termination

V-block Method

The resistor shall be clamped in the trough of a 90° metallic V-block of such size that the resistor body does not extend beyond the extremities of the block. The clamping force shall be such that adequate contact between the resistor and the block is guaranteed. The terminations shall be so positioned that the distance between them and any point of the V-block is not less than:-

For cylindrical resistors:

- The radius of the resistor body minus the radius of the circumscribed circle of the terminations (the larger circle in the case that the two terminations have different dimensions).



For rectangular resistors:

- Half the smaller side of the resistor body minus the radius of the circumscribed circle of the terminations (the larger circle in the case that the two terminations have different dimensions).

Any out-of-centre positioning of the termination at its emergence from the resistor body shall be ignored.

9.6.1.2 Procedure

The insulation resistance shall be measured with a direct voltage of either $100 \pm 15V$ for resistors with an isolation voltage of less than 500V, or $500 \pm 50V$ for resistors with an isolation voltage of equal to or above 500V, between both terminations of the resistor connected together as one pole and the metal foil, or the mounting devices (i.e. V-block) as the other pole. The voltage shall be applied for 1 minute or such shorter time as is necessary to obtain a stable reading. The insulation resistance shall be read at the end of that period and be not less than prescribed in the Detail Specification.

9.6.2 Surface Mount Resistors

The insulation resistance shall be measured with a voltage as specified in Para. 9.6.1.2 between test points A and B as shown in Figure 7a or 7b of IEC Publication No. 115-1, Clauses 4.6.1.4 and 4.6.1.5.

The voltage shall be applied for 1 minute or the time necessary to obtain a stable reading. The insulation resistance shall be not less than that prescribed in the Detail Specification.

9.7 TEMPERATURE COEFFICIENT

N.B.

Surface mounted resistors may be mounted as prescribed in Para. 9.20.

The resistors shall be dried as prescribed in the Detail Specification by applying either Procedure I or II as follows:-

9.7.1 Procedure I

For 24 ± 4 hours in an oven at a temperature of $+55 \pm 2$ °C and with a relative humidity not exceeding 20%.

9.7.2 Procedure II

For 96 ± 4 hours in an oven at $+100 \pm 5$ °C. The resistors shall then be allowed to cool in a desiccator, using a suitable desiccant such as activated alumina or silica gel, and be kept therein from the time of removal from the oven until the beginning of the test.

9.7.3 Test Procedure

The resistors shall be maintained at each of the following temperatures in turn:-

- $+22 \pm 3$ °C.
 - Lower category ± 3 °C.
 - $+22 \pm 3$ °C.
 - Upper category ± 2 °C.
- $+22 \pm 3$ °C.



10 to 15 minutes after the resistors have reached thermal stability, resistance measurements shall be made at each of the above mentioned temperatures, using the method specified in Para. 9.5. The temperature of the resistors at the time of measurement shall be recorded. The error of temperature measurement shall not exceed 1.0°C.

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

$$\text{Temperature coefficient of resistance (in } 10^{-6}/^{\circ}\text{C)} = 10^6 \frac{\Delta R}{R\Delta T} \times K, \text{ where}$$

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

'ΔT' = difference between recorded temperatures and where, if the resistances recorded above are designated Ra, Rb, Rc, Rd and Re, 'R' and 'ΔR' are given as shown in the table below.

	Lower Category Temperature	Upper Category Temperature
R	1/2 (Ra + Rc)	1/2 (Rc + Re)
ΔR	Rb - R	Rd - R

The temperature coefficient, determined as described above, shall not exceed the value prescribed in the Detail Specification for the appropriate category temperature. Where the resistance value is greater than 5.0Ω but less than 10Ω, the temperature coefficient shall not exceed twice the value prescribed in the Detail Specification.

N.B.

The temperature coefficient is not specified for resistance values of less than 5.0Ω due to difficulty of accurate measurement.

9.8 VOLTAGE PROOF

9.8.1 Leaded Resistors

9.8.1.1 Mounting

For types without mounting devices, a metal foil shall be wrapped closely around the whole body of the resistor. For types with axial terminations, a space of 1.0 to 1.5 mm shall be left between the edge of the foil and each termination.

For types with axial terminations, the foil shall be wrapped around the whole body of the resistor and protrude at least 5.0mm from each end provided the minimum space of 1.0mm between foil and termination can be maintained. The ends of the foil shall not be folded over the ends of the resistor. A V-block mounting method can also be used. For types with mounting devices, the resistor shall be mounted in the normal manner on a metal plate (or between two metal plates) extending in all directions at least 12.5mm beyond the mounting face of the resistor.

**9.8.1.2 Procedure**

An alternating voltage of 40 to 60Hz with a peak value of 1.4 times the insulation voltage shall be applied for a period of 60 ± 5 seconds between the terminations of the resistor, connected together as one pole, and the metal foil or mounting plate(s) as the other pole. The voltage shall be applied gradually at a rate of approximately 100V/second. When tested as specified, using one of the above mentioned mounting methods, there shall be no breakdown or flash-over.

9.8.2 Surface Mount Resistors

The electrical conditions and alternating voltage shall be as specified in Para. 9.8.1.2 and applied between test points A and B as shown in Figure 7a or 7b of IEC Publication No. 115-1.

9.9 SOLDERABILITY

The resistors shall be dried as prescribed in the Detail Specification by application of either Procedure I or II (see Paras. 9.7.1 and 9.7.2 of this specification).

9.9.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.

9.9.2 Procedure

The resistors shall then be subjected to Test 'Ta' of IEC Publication No. 68-2-20, using Method 1 (solder bath) or Method 3 (solder globule).

9.9.3 Final Measurement

The resistance shall be measured 24 ± 4 hours after soldering unless it can be demonstrated that stability is reached earlier. The change in resistance compared to the value measured according to Para. 9.9.1 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

9.10 ROBUSTNESS OF TERMINATIONS**9.10.1 Leaded Resistors**

The resistors shall be subjected to Tests 'Ua', 'Ub', 'Uc' and 'Ud' of IEC Publication No. 68-2-21, as applicable.

N.B.

Tests 'Ub' and 'Uc' shall not be applied if the Detail Specification describes the terminations as rigid.

9.10.1.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.

9.10.1.2 Procedure

Test 'Ua': Tensile.

The force shall be:

- For terminations other than wire terminations: 20N.

- For wire terminations: See Table below.

Cross-sectional area of wire (mm ²)	Diameter of round wire (mm)	Force (N)
0.5 < S	0.8 < d	20
0.2 < S ≤ 0.5	0.5 < d ≤ 0.8	10
0.07 < S ≤ 0.2	0.3 < d ≤ 0.5	5.0
S ≤ 0.07	d ≤ 0.3	2.5

- Test 'Ub': Bending (half the number of terminations).
Two consecutive bends shall be applied.
- Test 'Uc': Torsion test (other half of terminations).
Method 'A', Severity 2 (two successive rotations of 180°) shall be applied.
- Test 'Ud': Torque test (for nuts, threaded terminations and fixing screws).

9.10.1.3 Final Measurement

- After each of these tests, the resistors shall be visually examined. There shall be no evidence of damage.
- The resistance shall then be measured. The change in resistance compared to the value measured according to Para. 9.10.1 shall not exceed the value prescribed in Table 6 of the Detail Specification.

9.10.2 Surface Mount Resistors

9.10.2.1 Mounting

Mounting shall be performed as specified in Para. 9.20.

9.10.2.2 Adhesion

9.10.2.2.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.

9.10.2.2.2 Procedure

Surface mount resistors shall be tested in accordance with IEC Publication No. 115-1, Clause 4.32.

9.10.2.2.3 Final Measurement



The resistance shall be measured in the mounted state. The change in resistance compared to the value measured in accordance with Para. 9.10.2.2.1 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

The resistors shall be visually examined (approximately 10X magnification). There shall be no signs of damage, cracking, lifting, or dry solder joints.

9.10.2.3 Bend Strength of the End Face Plating

9.10.2.3.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.

 	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>		<p>PAGE 27 ISSUE 7</p>
---	---	--	----------------------------

9.10.2.3.2 Procedure

Surface mount resistors shall be tested in accordance with IEC Publication No. 115-1, Clause 4.33.

9.10.2.3.3 Final Measurement

The resistance shall be measured, board in bent position. The change in resistance compared to the value measured in accordance with Para. 9.10.2.3.1 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

The resistors shall be visually examined (approximately 10X magnification). There shall be no signs of damage, cracking, lifting, or dry solder joints.

9.11 RESISTANCE TO SOLDERING HEAT

The resistors shall be dried by applying either Procedure I or II, specified in Paras. 9.7.1 and 9.7.2, as prescribed in the Detail Specification. The resistance shall then be measured as prescribed in Para. 9.5.1.

The resistors shall then be subjected to one of the procedures for resistance to soldering heat (see Test 'Tb' of IEC Publication No. 68-2-20A) as prescribed in the Detail Specification and remain under standard atmospheric conditions for recovery.

The resistors shall be visually examined. There shall be no evidence of damage and the marking shall be legible. The resistance shall be measured as specified in Para. 9.5.1, 24 ± 4 hours after soldering unless it can be demonstrated that the stability is reached earlier. The change in resistance compared to the value measured initially shall not exceed the limit prescribed in Table 6 of the Detail Specification.

For surface mount resistors, dissolution of the end-face plating (leaching) shall not exceed 25% of the length of the edge concerned.

9.12 RAPID CHANGE OF TEMPERATURE

9.12.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.

9.12.2 Procedure and Recovery

The resistors shall be submitted to Test 'Na' of IEC Publication No. 68-2-14 for 5 cycles. The duration of exposure at each of the temperature extremes given in Table 1(b) of the Detail Specification shall be 30 minutes.

The resistors shall then remain under standard atmospheric conditions for recovery for not less than 1 hour, nor more than 2 hours. After recovery, the resistors shall be visually examined. There shall be no evidence of damage.

9.12.3 Final Measurement

The resistance shall be measured. The change in resistance compared to the value measured according to Para. 9.12.1 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

9.13 VIBRATION

9.13.1 Initial Measurement

The resistance shall be measured as specified in Para. 9.5.1.



9.13.2 Procedure

The resistors shall be subjected to Test 'Fc', Procedure B4, of IEC Publication No. 68-2-6, taking into account the following details and exceptions:-

- Sweeping from 10 to 2 000 Hz.
- Amplitude: 1.5mm or 20g.
- Motion in each of the two mutually perpendicular directions: one perpendicular and the other parallel to the longitudinal axis of the resistor.
- Duration: 3 hours in each plane with total test time of 6 hours.
- If the component is provided with specific mounting means, these shall be used.

9.13.3 Final Measurement

After the test, the resistors shall be visually examined and there shall be no evidence of damage. The resistance shall be measured. The change in resistance compared to the value measured according to Para. 9.13.1 shall not exceed the limit prescribed in Table 6 of the Detail Specification.

9.14 CLIMATIC SEQUENCE

9.14.1 Initial Measurement

The resistors shall be dried, using either Procedure I or II specified in Paras. 9.7.1 and 9.7.2, as prescribed in the Detail Specification. The resistance shall then be measured as specified in Para. 9.5.1.

9.14.2 Dry Heat

The resistors shall be subjected to Test 'Ba' of IEC Publication No. 68-2-2 at the upper category temperature, taking into account the following deviation:-

- (a) The resistors shall be removed from the chamber and exposed to standard atmospheric conditions for recovery, for not less than 4 hours.

9.14.3 Damp Heat (Accelerated) First Cycle

The resistors shall be subjected to Test 'Db' of IEC Publication No. 68-2-30, for one cycle of 24 hours. After recovery, the resistors shall be immediately subjected to the cold test.

9.14.4 Cold Test

The resistors shall be subjected to Test 'Aa' of IEC Publication No. 68-2-1 at the lower category temperature. After 1 hour of stabilisation at this temperature, full rated continuous voltage as specified in Table 1(b) of the Detail Specification shall be applied for 45 minutes. The resistors may be loaded individually or in parallel. The resistors shall be removed from the chamber and exposed to standard atmospheric conditions for recovery for not less than 4 hours.

9.14.5 Low Air Pressure

The resistors shall be subjected to Test 'M' of IEC Publication No. 68-2-13, using a pressure of 20 ± 1 mbar with full rated continuous voltage applied. The test shall be performed at a temperature between +15 and +35 °C.

The duration of the test shall be 1 hour.

**9.14.6 Damp Heat (Accelerated) Remaining Cycles**

The resistors shall be subjected to Test 'Db' of IEC Publication No. 68-2-30 for 5 cycles.

9.14.7 d.c. Load

At the end of the conditioning period, the resistors shall be subjected to the standard atmospheric conditions for recovery. The time of transfer shall be as brief as possible and in any case not exceed 5 minutes. At 30 ± 5 minutes after removal from the chamber for damp heat cyclic test, the resistors shall be subjected to a d.c. voltage for 1 minute. The voltage shall be the rated or limiting element voltage, whichever is the smaller. The resistors shall then be subjected to the standard atmospheric conditions for recovery for not less than 1 hour and not more than 2 hours.

9.14.8 Final Measurement

The resistors shall be visually examined; there shall be no evidence of damage and the marking shall be legible. The resistance and, for insulated types only, the insulation resistance shall then be measured as specified in Para. 9.5.1 and Para. 9.6 respectively. The change in resistance compared to the value measured according to Para. 9.14.1 shall not exceed the value prescribed in Table 6 of the Detail Specification. The insulation resistance shall be not less than that prescribed in Table 6 of the Detail Specification.

9.15 OPERATING LIFE**9.15.1 Initial Measurement**

The resistance shall be measured as specified in Para. 9.5.1.

9.15.2 Mounting

The resistors shall be connected by their terminations to suitable clips on a rack of insulating material. They shall be mounted in a horizontal position in 1 layer only. The distance between the axes of the resistors shall be not less than 7 times the diameter of the resistors. There shall be no undue draught over the resistors. Only natural convection resulting from the hot resistors may occur.

For surface mount resistors, when necessary, mounting shall be performed as specified in Para. 9.20.



9.15.3 Procedure

The resistors shall be subjected to an operating life test of 2 000 hours for qualification, or 1 000 hours for lot acceptance levels 1 and 2, at the ambient temperature defined in Table 5 of the Detail Specification.

They shall be tested with a direct voltage or full wave rectified a.c. voltage provide the ripple does not exceed 5.0%. The voltage shall be applied in cycles of 1.5 hour 'on' and 0.5 hour 'off' throughout the test. The 0.5 hour 'off' periods are included in the total test duration.

The voltage shall be either the rated or limiting element voltage, whichever is less. The applied voltage shall be within $\pm 5\%$ of this voltage. The size of the testing chamber and the number of resistors under test shall be such that when all resistors are fully loaded, the heat produced by them shall be less than that required to maintain the atmosphere in the chamber at the prescribed temperature, so that the temperature can still be controlled by the heating elements.

The temperature-controlling elements shall be suitably spaced from the resistors and shall be shielded so as not to be directly influenced by the radiation of the resistors. For the purpose of this test, it shall be assumed that the ambient temperature of the resistors is the prescribed temperature.

 	<p style="text-align: center;">ESA/SCC Generic Specification No. 4001</p>		<p>PAGE 30 ISSUE 7</p>
---	---	--	----------------------------

After approximately 1 000 and 2 000 hours for qualification testing and 1 000 hours for lot acceptance testing, the resistors shall be removed from the chamber and allowed to cool at room temperature for not less than 1 hour and not more than 2 hours. The removal from the chamber shall take place at the end of the 0.5 hour 'off' period.

9.15.4 Intermediate and Final Measurements

The resistors shall be visually examined and there shall be no evidence of damage. The resistance shall be measured as specified in Para. 9.5.1. For each subsequent measurement, the change in resistance compared to the value measured according to Para.9.15.1 shall not exceed the value prescribed in Table 6 of the Detail Specification.

After intermediate measurements, the resistors shall be returned to the test chamber. The interval between the removal of any resistor from the chamber and its return to the conditions of the test shall not exceed 12 hours.

At the end of the operating life test, the insulation resistance shall be measured as specified in Para. 9.6 and the value shall not be less than that prescribed in Table 6 of the Detail Specification.

9.16 HIGH TEMPERATURE STORAGE

9.16.1 Initial, Intermediate and Final Measurements

These measurements shall be performed as specified in Paras. 9.15.1 and 9.15.4.

9.16.2 Procedure

The resistors shall be subjected to an endurance test of 2 000 hours for qualification. The ambient temperature shall be as specified in Para. 4.8.6 of the Detail Specification. The test shall be performed at zero dissipation. After each removal from the chamber, the resistors shall be visually examined and there shall be no evidence of damage.

9.17 EXTERNAL VISUAL INSPECTION

See ESA/SCC Basic Specification No. 20500.

9.18 BURN-IN

The test shall be conducted in accordance with IEC Publication No. 115-1, Clause 4.25.

9.19 PERMANENCE OF MARKING

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

9.20 SURFACE MOUNT RESISTOR MOUNTING

Surface mount resistors may be mounted on a suitable substrate in accordance with IEC Publication No. 115-1, Clause 4.31.

**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) Final production test data (Chart II) (but see Para. 10.6).
- (e) Burn-in and electrical measurement data (Chart III).
- (f) Qualification test data (Chart IV).
- (g) Lot acceptance test data (Chart V) (when applicable).
- (h) Failed component list (see Paras. 7.3 and 8.4) and failure analysis report (see Para. 8.4), (when applicable).
- (i) Certificate of Conformity.

Items (a) to (i) 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 (i) less item (g) 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**

Not applicable.

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:

- Overload (Para. 9.1).
- Third harmonic control and current noise (Para. 9.2).
- External visual inspection (Para. 9.17).
- Dimension check (Para. 9.4).

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 of 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 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 3 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 Table 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 components 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.