DISCRETE MICROWAVE SEMICONDUCTOR COMPONENTS

ESCC Generic Specification No. 5010

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DISCRETE MICROWAVE SEMICONDUCTOR COMPONENTS

ESA/SCC Generic Specification No. 5010

space components
coordination group

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		SCCG Chairman	ESA Director General or his Deputy
Issue 5	March 1998		
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Revision 'B'	December 2000		
Revision 'C'	June 2001		

DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	Reference	CHANGE Item	Approved DCR No.
'A'	Apr. '99		This Issue supersedes Issue 4 and incorporates all modifications defined in Revisions 'A' and 'B' to Issue 4 and the changes agreed in DCRs 21086, 21107, 221434, 221450 and 23731.	221461
		P1.	Cover page	None
		P2.	DCN	None
		P4. T of C	: Paras. 8.2.4 and 8.2.5 page reference amended to "18A"	None
		P18. Para. 8.2.1	: New penultimate paragraph added	21134
			: New second sentence added to the last paragraph	21111
		Paras. 8.2.4 and 8.2.5	: Moved to Page 18A	None
		P18A.	: Page added	None
		Paras. 8.2.4 and 8.2.5	: Added from Page 18	None
		P22. Chart III(a)	: Para. 9.9.1 Boxes amended	23892
		P23. Chart III(b)	: Para. 9.9.1 Boxes amended	23892
		P26. Chart V	: "(5)" added to "No failures allowed"	21134
			: Note 5 added	21134
		P31. Para. 9.21	: In Duration, first sentence amended	21114
		P32. Para. 9.21	: In Data Points, text amended	21114
		Para. 9.22	: In Duration, first sentence amended	21114
			: In Data Points, text amended	21114
		P33. Para. 10.1.2.1:	Item (b), "PDA figure and " deleted from text	21119
			: Item (c) rewritten	21119
			: New Item (e) added	21119
		P34. Para. 10.1.3.1:	Item (a), "(including PDA figure)" deleted	21119
		Para. 10.1.4	: Item (e) rewriiten	21119
			: Item (f), "(including PDA figure)" deleted	21119
		P37. Para. 10.11	: New Item (e) added	21134
'B'	Dec. '00	P1.	Cover page	None
		P2.	DCN	None
		P31. Para. 9.17	: Text added	221584
'C'	June '01	P1.	Cover page	None
		P2.	DCN	None
		P32. Para 9.21	: For duration add: For Category 2 of Chart III(a): A minimum of 48 hours for both testing levels.	23936
			For Chart III(b): A minimum of 48 hours for both testing levels.	23936

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1. INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification approval, procurement, including lot acceptance testing, and delivery of discrete microwave semiconductor components or naked dice for space applications.

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 or naked dice 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. 20900, Radiographic Inspection

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

No. 21400, Scanning Electron Microscope (SEM) Inspection of Semiconductor Dice.

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

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

No. 22900, Total Dose Steady-State Irradiation Test Method.

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.

2.2 OTHER (REFERENCE) DOCUMENTS

MIL-STD-105, Sampling Procedures and Tables for Inspection by Attributes.

MIL-STD-202, Test Method for Electronic and Electrical Component Parts.

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

MIL-STD-750, Test Methods for Semiconductor Devices.

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. In addition, the following shall apply:-

Component - Items which are to be delivered after encapsulation.
Naked dice - Items which are to be delivered without encapsulation.
Wafer Lot - A batch of wafers which is limited to the capacity of the metalisation deposition equipment and to which a unique identification has been allocated from the commencement of processing.

4. REQUIREMENTS

4.1 GENERAL

The test requirements for the qualification approval of a component shall comprise wafer lot acceptance (see Para. 5.2), final production tests (see Chart II(b)), 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 wafer lot acceptance (see Para. 5.2) with radiation tests (see Para. 5.2.3) if specified by the Orderer, final production tests (Chart II(b)), 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.

The test requirements for procurement of naked dice of a qualified component type shall comprise wafer lot acceptance (see Para. 5.2) and wafer screening (see Chart II(a)); additionally a sample of components (see Para. 6.2) shall be submitted to final production tests (see Chart II(b)), burn-in and electrical measurements (see Chart III) and lot acceptance level 2 testing (Endurance Subgroup only)(see Chart V).

Chart I(b) summarises the requirements for procurement of both components and naked dice.

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 or naked dice that meet all of the performance, quality and reliability requirements defined in this specification and the Detail Specification.

The qualification status of the procured components shall not be impaired by variations in the level of radiation testing called for in the purchase order.

4.1.1 Specifications

For qualification approval, procurement (including lot acceptance testing) and delivery of components or naked dice 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 AND NAKED DICE

Components and naked dice delivered to this specification shall be processed and inspected in accordance with the relevant Process Identification Document (P.I.D.).

ESA/SCC qualified components or naked dice 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 or naked dice that cannot meet this requirement. In the event that, subsequent to delivery and prior to operational use, a component or naked dice 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.

Each delivered component or naked dice shall be traceable to its production lot. Components and naked dice 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).

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

Components or naked dice produced from lots where samples have failed the specified level of radiation testing shall not be delivered against orders requiring a lower level of radiation testing, unless data is available to demonstrate that the samples passed that lower level. Should such data not be available, components or naked dice shall not be delivered against orders requiring a lower level of radiation testing unless a sample is first retested to that lower level.

4.3.1 Lot Failure

Lot failure may occur during wafer screening (Chart II(a)), final production tests (Chart II(b)), burn-in and electrical measurements (Charts III(a) and III(b)), 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 or naked dice 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 6 levels of radiation testing (see ESA/SCC Basic Specification No. 22900), 2 levels of testing severity which are designated by the letters 'B' and 'C' (see Chart I (a)) 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 level of radiation testing, testing level and lot acceptance level shall be specified in the purchase order.

4.4 MARKING

All components and the packaging of naked dice 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 and naked dice 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 the Process Identification Document (P.I.D.).

5.2 WAFER LOT ACCEPTANCE

5.2.1 Process Monitoring Review

For all wafers, a review of the statistical process control (SPC) data shall be performed against the statistical limits and sigmas specified in the P.I.D.

5.2.1.1 Process Control Failure

A wafer shall be rejected if one or more process control data parameters exceed the allowed distribution as specified in the P.I.D.

5.2.2 Scanning Electron Microscope (SEM) Inspection

Components and naked dice supplied to this specification shall be produced from the wafer lots that have been subjected to, and successfully met, the scanning electron microscope inspection requirements in accordance with ESA/SCC Basic Specification No. 21400.

5.2.3 Total Dose Radiation Testing

During qualification and maintenance of qualification:

- If specified in the Detail Specification, components and naked dice shall be produced from a wafer lot which has been subjected to and successfully met the radiation requirements contained in ESA/SCC Basic Specification No. 22900.

During procurement:

- When required by the purchase order, components and naked dice shall be produced from a wafer lot which has been subjected to and successfully met the radiation requirements contained in ESA/SCC Basic Specification No. 22900.

Device Dependent Irradiation Requirements for Microwave Diodes

Device Type	Radiation Source	Parameter(s) in Detail Specification (Table 7)	Bias Conditions	Annealing Test
Gunn	Electrons	RF Output Power	dc forward	No
PIN	Electrons	Minority Carrier Lifetime	dc reverse	No
Schottky/ Varactor	Electrons	Reverse Current	dc reverse	No

5.2.4 Documentation

Documentation of wafer lot acceptance shall be in accordance with the requirements of Para. 10.5 of this specification and shall only be supplied if specified in the purchase order.

5.3 WAFER SCREENING (CHART II(a))

5.3.1 General

All dice to be used for component qualification, or for delivery shall be subjected to the wafer screening tests specified in Chart II(a) of this specification.

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

5.3.2 Test Methods and Conditions

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

5.3.3 Acceptance Criteria

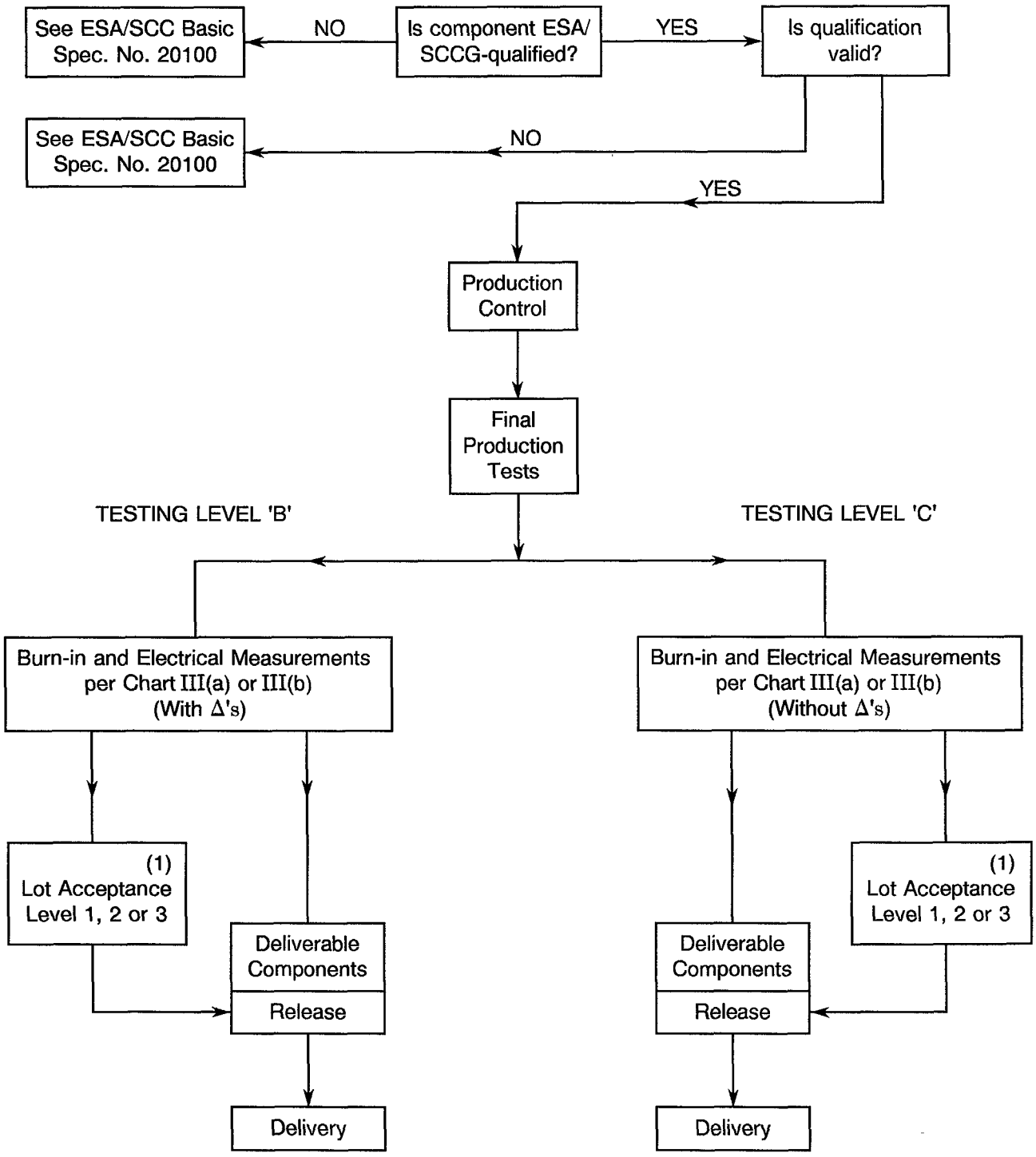
A wafer shall be counted as a limit failure if one or more parameters on any of the 5 sample dice probed exceeds the limits specified in Table 3 of the Detail Specification.

If a failure occurs, further measurements shall be performed to General Inspection Level I, AQL 1.0 of IEC Publication No. 410 on the remaining dice of the wafer containing the failed die. If a further failure occurs, the wafer shall be rejected.

5.3.4 Documentation

Documentation shall be supplied as specified in Para. 10.6 of this specification.

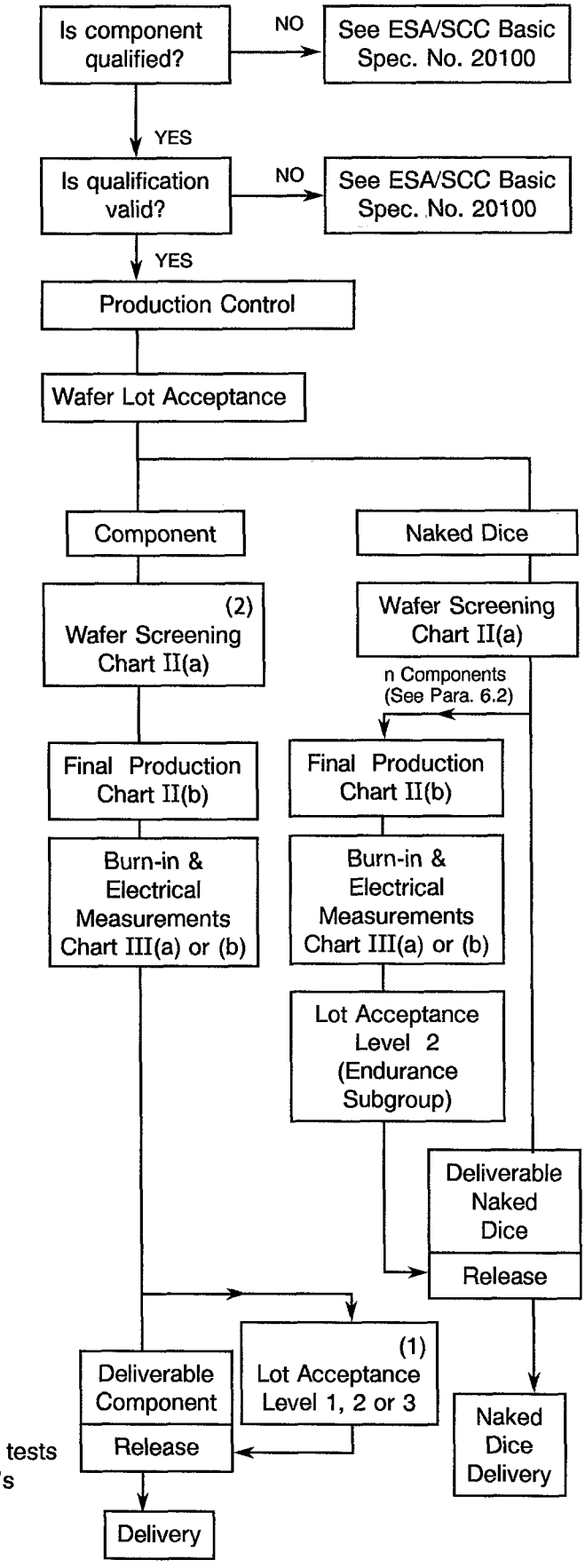
CHART I(a) - TESTING LEVELS



NOTES

1. When applicable.

CHART I(b) - PROCUREMENT PROCEDURES



NOTES

1. When applicable.
2. The performance of these tests is left to the Manufacturer's discretion.

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 or used for the acceptance of naked dice delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart II (b).

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 SAMPLING FOR NAKED DICE PROCUREMENT

For naked dice procurement, dice shall be selected for assembly into their approved packages, as specified in the P.I.D, for submission to further testing as test vehicles as specified in Para. 4.1.

The quantities to be selected are as follows:-

(a) **Group 1**: Chip area $\leq 0.3mm^2$: 24 parts per wafer.

(b) **Group 2**: Chip area $> 0.3 \leq 1.0mm^2$: 4 parts per wafer, with a minimum of 16 parts per Wafer Lot.

(c) **Group 3**: Chip area $> 1.0mm^2$: 3 parts per wafer with a minimum of 12 parts per Wafer Lot.

N.B
In addition to the sample quantities specified above, an additional 3 samples per wafer for Groups 1 and 2 and 2 samples per wafer for Group 3, shall be selected for use in bond-pull and die-shear testing in Chart II(b).

6.3 TEST METHODS AND CONDITIONS

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

For components undergoing burn-in tests in accordance with Category 1 of Chart III(a), it is recommended that pre-burn-in be performed in accordance with Para. 9.21 of this specification, under the conditions specified in Table 5 of the Detail Specification.

For all other components, it is recommended that pre-burn-in be performed in accordance with Para. 9.22 of this specification, under the conditions specified in Table 5 of the Detail Specification.

6.4 DOCUMENTATION

Documentation of final production test data shall be in accordance with the requirements of Para. 10.7 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 the acceptance of naked dice, and all components for delivery, including those submitted to lot acceptance tests, shall be subjected to tests and inspections in accordance with Chart III(a) or III(b).

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(a) or III(b).

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

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 high temperature reverse bias or power burn-in are larger than 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 any of the individual PDA's specified in Chart III(a) or III(b), or exceeds 10% of the number of components submitted to all of the tests defined in the burn-in and electrical measurements (Chart III(a) or III(b)), the lot shall be considered as failed.

N.B.
All PDA's shall be rounded upwards to the nearest whole number with respect to the original quantity submitted to Chart III tests. The individual PDA's for each power burn-in or HTRB shall be maximum values for that particular test.

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 MIL-STD-105 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 Detail Specification, a lot shall be considered as failed if the number of failures allowed is exceeded (see Annex I for LTPD Sampling Plan).

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. 10.8 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(b) 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 Para's 6.3 and 6.4.

8.1.2 Distribution within the Qualification Test Lot

Where an ESA/SCC Detail Specification covers a range or series of components that are considered to be similar, the qualification test lot shall be constituted of components so selected that they adequately represent all of the various mechanical, structural and electrical peculiarities of that range or series (i.e. covered by the Detail Specification).

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 for each 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, whenever possible, shall have been chosen 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.

For a qualified Manufacturer, the failure of 1 component shall be permitted when this is completely attributable to a handling or other human error and can be demonstrated to have no bearing on the inherent quality or reliability of the lot. The Manufacturer shall prepare a report justifying this assessment for inclusion in the lot data documentation. The Manufacturer shall also ensure that appropriate measures are taken to prevent a reoccurrence of the error and make objective evidence of these preventative measures available to the relevant Qualifying Space Agency, when requested.

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 to be similar, it may be necessary that the sample for lot acceptance testing be constituted 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 of the component types will normally vary from procurement to procurement and shall be as specified by the Orderer.

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, 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 and terminal strength tests are 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 these tests.

(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. seal, 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. 10.9 of this specification.

In the case of lot acceptance testing, the data shall be documented in accordance with the requirements of Para. 10.10 of this specification.

CHART II(a) - WAFER SCREENING

Manufacture	
Para. 9.9.3.1	Electrical Measurements at Room Temperature
Para. 9.9.2.1	Electrical Measurements at High and Low Temperatures
Para. 9.24	Wafer Dicing
Para. 9.25	Dice Visual Inspection

CHART II(b) - FINAL PRODUCTION TESTS

Production Control in accordance with Section 5 of this specification		
Production up to encapsulation stage		
Para 9.1	100% Internal (pre-encapsulation) Visual Inspection	
Para 9.2.1	Bond Strength Test	(1)
Para 9.2.2	Die-Shear Test	(1)
Para 9.3	Encapsulation	
Para 9.4	High Temperature Stabilisation Bake (Optional)	(2)
Para 9.9.3	Electrical Measurements at Room Temperature (Optional)	(2)
Para 9.5	Thermal Shock	
Para 9.7	Particle Impact Noise Detection (PIND) Test	(3) (4)
Para. 9.8.1 Para. 9.8.2	Seal Test, Fine Leak Seal Test, Gross Leak (Optional)	(2)
Para 9.9.3	Electrical Measurements at Room Temperature	
Para. 6.3	Pre-burn-in (240 hrs max.) (Optional)	(2)
Para 9.9.3	Electrical Measurements at Room Temperature	(5)
Para 9.9.2	Electrical Measurements at High and Low Temperatures (Optional)	(2)
Para 4.4	Marking (plus Serialisation for Level 'B' only)	(6)
Para 9.10	External Visual Inspection; Sampling AQL 1%, Level II	
Para 9.11	Dimension Check	(4)
To Chart III		

NOTES

1. If read and record data is available for the same wafer (lot) from production, this may replace the tests.
2. The performance of this test is left to the Manufacturer's discretion.
3. For all cavity devices of Testing Level 'B', except Diodes with transparent packages.
4. This test shall not be performed on packaged dice during naked dice procurement.
5. This test shall not be performed if pre-burn-in is omitted.
6. Marking may be performed at any time during Chart II(b) or III. Traceability requirements shall be met.

CHART III(a) - BURN-IN AND ELECTRICAL MEASUREMENTS FOR MICROWAVE DIODES

Components from Final Production Tests

Category 1 (1) (Power Burn-in & HTRB)	Category 2 (1) (HTRB & Power Burn-in)	Testing Levels B	Testing Levels C
Para. 9.9.1 - Initial Parameter Drift Value (Initial Measurements for Power Burn-in) (2)	Para. 9.9.1 - Initial Parameter Drift Value (Initial Measurements for H.T.R.B.) (2)	X	-
Para. 9.22 Power Burn-in PDA = 5%	Para. 9.21 HTRB PDA = 5%	X	X
Para. 9.9.1 - Δ1 Parameter Drift Value (Final Measurements for Power Burn-in; Initial Measurements for H.T.R.B)	Para. 9.9.1 - Δ1 Parameter Drift Value (Final Measurements for H.T.R.B; Initial Measurements for Power Burn-in)	X	-
Para. 9.21 HTRB PDA = 5%	Para. 9.22 Power Burn-in PDA = 5%	X	X
Para. 9.9.1 - Δ2 Parameter Drift Value (Final Measurements for H.T.R.B.)	Para. 9.9.1 - Δ2 Parameter Drift Value (Final Measurements for Power Burn-in)	X	-

Para. 9.9.3	Electrical Measurements at Room Temperature (5)	X	X
Para. 9.9.2	Electrical Measurements at High and Low Temperatures (6)	X	X
Para. 9.12	Radiographic Inspection (3) (4) (6) (7)	X	-
Para. 9.8.1 Para. 9.8.2	Seal Test, Fine Leak Seal Test, Gross Leak (3) (6)	X	X
Para. 9.10	External Visual Inspection (3) (6)	X	X
Para. 7.4	Check for Lot Failure	X	X

To Chart IV or V

NOTES: See Page 24.

CHART III(b) - BURN-IN AND ELECTRICAL MEASUREMENTS FOR MICROWAVE TRANSISTORS

Components from Final Production Tests

		Testing Levels B	Testing Levels C
Para 9.9.1	Parameter Drift Value (Initial Measurements for H.T.R.B.) (2)	X	-
Para. 9.21	High Temperature Reverse Bias, Burn-in, PDA = 5%	X	X
Para 9.9.1	Δ1 Parameter Drift Value (Final Measurements for H.T.R.B; Initial Measurements for Power Burn-in)	X	-
Para. 9.22	Power Burn-in, PDA = 5%	X	X
Para. 9.9.1	Δ2 Parameter Drift Value (Final Measurements for Power Burn-in)	X	-
Para. 9.9.3	Electrical Measurements at Room Temperature (5)	X	X
Para. 9.9.2	Electrical Measurements at High and Low Temperatures (6)	X	X
Para. 9.12	Radiographic Inspection (3) (4) (6)	X	-
Para. 9.8.1 Para. 9.8.2	Seal Test, Fine Leak Seal Test, Gross Leak (3) (6)	X	X
Para. 9.10	External Visual Inspection (3) (6)	X	X
Para. 7.4	Check for Lot Failure	X	X

To Chart IV or V

NOTES: See Page 24.

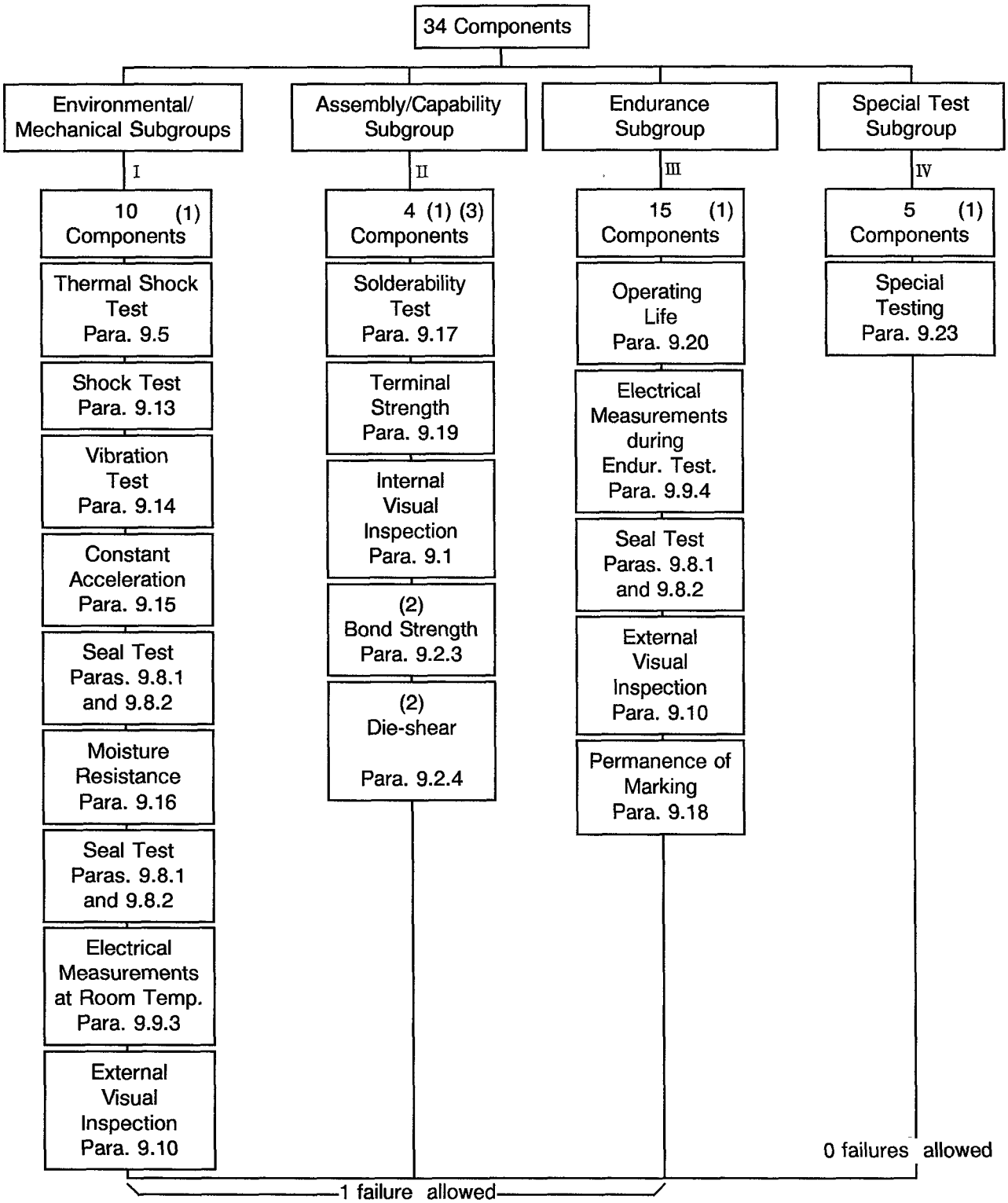
NOTES FOR CHARTS III(a) AND III(b)

1. The category of burn-in to be used shall be based on technology, type of application and Manufacturer's experience and shall be defined in the Detail Specification. As a guidance:
   Category 1 - Devices which are designed to be used normally in reverse-bias operation e.g. Varactor and Impatt diodes.
   Category 2 - Devices which are designed to be used normally in forward-bias operation e.g. Detector, Gunn and all Multiplier diodes or devices which may be used with biasing in either direction e.g. PIN diodes.

N.B.
The inclusion of a component into a specific Category may be varied at the request of the Manufacturer with the agreement of the Q.S.A.

2. Measurements of parameters need not be repeated if data is available from the last Electrical Measurements at Room Temperature.
3. This test shall not be performed on packaged dice during naked dice procurement.
4. Radiographic Inspection may be performed at any point during the test sequence shown in this Chart.
5. The measurement of parameters for the purpose of drift value measurements need not be repeated for electrical measurements at room temperature.
6. Electrical measurements at High and Low Temperatures, Radiographic Inspection, Seal Test and External Visual Inspection rejects shall not be counted for PDA.
7. Except Diodes with transparent packages.

CHART IV - QUALIFICATION TESTS

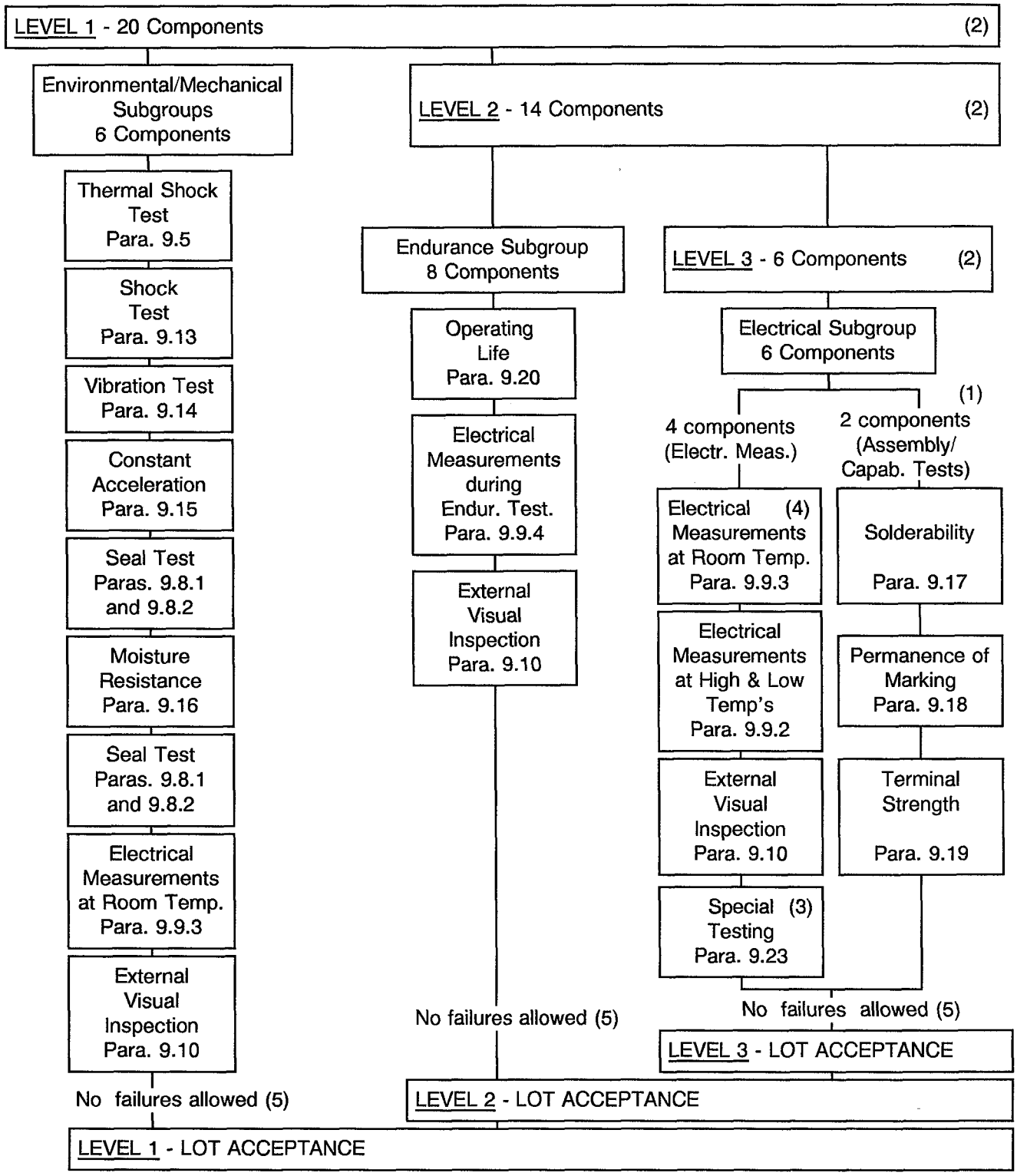


Total allowable number of failed components = 1.

NOTES

1. For distribution within the subgroups, see Para. 8.1.2.
2. No failures allowed for these tests.
3. These parts may be electrical rejects that should be capable of passing internal Visual Inspection, Bond Strength and Die-Shear tests after delidding.

CHART V - LOT ACCEPTANCE TESTS



NOTES

1. These parts may be electrical rejects.
2. For distribution within the sample, see Para. 8.2.2.
3. If no special testing is specified in the Detail Specification, these parts are deliverable.
4. If the a.c. measurements of Chart III(a) or III(b) are witnessed by the Orderer, then they need not be repeated here. d.c. measurements shall be performed.
5. See Para. 8.2.1.

9. TEST METHODS AND CONDITIONS

If a Manufacturer elects to eliminate or modify a test method or procedure, the Manufacturer is still responsible for delivering components and naked dice 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 Process Identification Document (P.I.D.)

9.1 INTERNAL VISUAL INSPECTION

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

9.2 BOND STRENGTH AND DIE-SHEAR TESTS

N.B. These tests are destructive.

When the die-shear test is impracticable, the components shall be subjected to 100% measurements of thermal resistance/conductivity in accordance with the test method and acceptance conditions prescribed in the Detail Specification.

9.2.1 Bond Strength Test during Final Production Tests

(a) **Test Conditions:**

- MIL-STD-750, Test Method 2037, Test Condition 'A' or 'B'.

(b) **Test Procedures:**

Test all bonds on 3 components selected at random from the lot accepted after internal visual inspection.

If agreed by the Q.S.A. (for qualification approval) or the Orderer (for a procurement) the components used for this test may have passed the low magnification phase only of the Internal Visual Inspection (Para. 9.1).

N.B.
The low magnification phase of the Internal Visual Inspection is that part of the inspection (at a magnification of <100) that addresses the bonds, bond wires and die mount.

(c) **Accept/Reject Criteria:**

Individual separation forces and categories shall be recorded. A single failure shall be cause for rejection of the lot.

9.2.2 Die-Shear Test during Final Production Tests

(a) **Test Conditions:**

- MIL-STD-750, Test Method 2017.

(b) **Test Procedures:**

Test on the 3 devices previously submitted to the Bond Strength test where this is performed. When no Bond Strength test is performed, test 3 components selected at random from the lot accepted after Internal Visual Inspection.

(c) **Accept/Reject Criteria:**

Individual separation forces and categories shall be recorded. A single failure shall be cause for rejection of the lot.

9.2.3 Bond Strength Test during Qualification Testing

(a) **Test Conditions:**

As per Para. 9.2.1(a).

(b) **Test Procedures:**

As per Para. 9.2.1(b), but components to be selected from those in Subgroup III of Chart IV.

(c) **Accept/Reject Criteria:**

As per Para. 9.2.1(c).

9.2.4 Die-Shear Test during Qualification Testing

(a) **Test Conditions:**

As per Para. 9.2.2(a).

(b) **Test Procedures:**

Perform the test on the components in Subgroup III of Chart IV previously submitted to the Bond Strength Test.

(c) **Accept/Reject Criteria:**

As per Para. 9.2.2(c).

9.3 ENCAPSULATION

In accordance with the Process Identification Document (P.I.D.).

9.4 HIGH TEMPERATURE STABILISATION BAKE

MIL-STD-750, Test Method 1032.

Duration: 48 hours at the maximum storage temperature specified in Table 1(b) of the Detail Specification.

9.5 THERMAL SHOCK

9.5.1 Final Production Tests

(a) Glass Encapsulation: MIL-STD-202, Test Method 107, Test Condition 'C'.

(b) Other Encapsulations: MIL-STD-202, Test Method 107, Test Condition 'B', 20 cycles.

9.5.2 Qualification and Lot Acceptance Tests

(a) Glass Encapsulation: MIL-STD-750, Test Method 1056, Test Condition 'A'.

(b) Other Encapsulations: MIL-STD-202, Test Method 107, Test Condition 'B', 10 cycles.

9.6 NOT USED.

9.7 PARTICLE IMPACT NOISE DETECTION (PIND)

MIL-STD-750, Test Method 2052, Test Condition 'A'. The use of the same attachment medium for the Sensivity Test Unit (S.T.U.) and for the components under test (D.U.T.) is not mandatory.

PIND prescreening shall not be performed.

The test frequency shall be selected based on the average internal package height from the graph of Figure 2052-2 of the test method. The average internal package height shall be the distance measured from the floor of the package cavity, excluding the thickness of the die mounted inside the package, to the underside of the package lid. For heights of less than 10mils the test frequency shall be 250Hz and for heights greater than 400mils the test frequency shall be 40Hz.

The lot shall be submitted to the PIND test procedure a maximum of 5 times.

After each PIND test procedure, defective devices shall be removed from the lot.

If the cumulative defective devices exceed 25% of the lot, the lot shall be rejected.

After any of the 5 PIND test procedures, if the number of defective devices does not exceed 1 or is less than 1% of the number of devices submitted to the procedure the lot shall be accepted.

9.8 SEAL TEST

9.8.1 Fine Leak

MIL-STD-750, Test Method 1071, Condition 'H_1' or 'H_2'. For devices with an internal cavity volume of 1×10^{-3} cm^3 or less, test condition 'H_2' shall be used with the addition that devices shall not be accepted if the equivalent standard leak rate (ℓ) exceeds 1×10^{-8} atm x cm^3 x S^{-1}.

9.8.2 Gross Leak

MIL-STD-750, Test Method 1071, Condition 'C' or 'K'.

9.9 ELECTRICAL MEASUREMENTS

9.9.1 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.

9.9.2 Electrical Measurements at High and Low Temperatures

9.9.2.1 Wafers

DC and RF probe measurements, with traceability and wafer mapping, shall be performed on all processed wafers at high and low temperatures in accordance with Table 3 of the Detail Specification. The measurements shall be performed on 5 sample dice from each wafer chosen at random and all failed dice shall be identified.

As an alternative to on-wafer measurements, 5 dice may be measured after dice separation, in accordance with Table 3 of the Detail Specification, provided that full traceability to the wafer is maintained.

If a failure occurs, further measurements shall be performed as specified in Para. 5.3.3 of this specification.

9.9.2.2 Components

For components of testing levels 'B' or '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. The measurements shall be performed on 5 samples at random from the complete lot. If a failure occurs, the measurements shall be performed on the complete lot.

9.9.3 Electrical Measurements at Room Temperature

9.9.3.1 Wafers

DC and RF probe measurements, with traceability and wafer mapping, shall be performed on all processed wafers at room temperature in accordance with Table 2 of the Detail Specification. All values obtained shall be recorded by location and all failed dice shall be clearly identified.

As an alternative to on-wafer measurements, all dice may be measured after dice separation, in accordance with Table 2 of the Detail Specification, provided that full traceability to the wafer is maintained.

As an alternative for procurement of components, the measurements may be performed go-no-go.

9.9.3.2 Components

For components of testing levels 'B' or 'C', the electrical measurements at room temperature 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, except during Final Production Tests (Chart II(b)).

For the Chart II(b) measurements performed immediately after the High Temperature Stabilisation Bake and immediately prior to Pre-Burn-in, where applicable, the Table 4 parameters of the Detail Specification shall be measured. No drift limits shall be applied.

For the Chart II(b) measurements performed after Pre-Burn-in, where applicable, the full characteristics specified in Table 2 of the Detail Specification shall be measured.

9.9.4 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.

9.10 EXTERNAL VISUAL INSPECTION

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

9.11 DIMENSION CHECK

In accordance with ESA/SCC Basic Specification No. 20500 and the Detail Specification. To be performed on 3 samples only.

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

9.12 RADIOGRAPHIC INSPECTION

In accordance with ESA/SCC Basic Specification No. 20900.

9.13 SHOCK TEST

MIL-STD-750, Test Method 2016, 1 500g, 0.5 milliseconds duration, 5 shocks, planes X1, Y1 and Z1.

9.14 VIBRATION, VARIABLE FREQUENCY

MIL-STD-750, Test Method 2056, 20g, 10-2000Hz, cross-over at 50Hz.

9.15 CONSTANT ACCELERATION

MIL-STD-750, Test Method 2006, 20 000g, planes X1, Y1 and Y2.

9.16 MOISTURE RESISTANCE

MIL-STD-750, Test Method 1021.

9.17 SOLDERABILITY

MIL-STD-750, Test Method 2026, to be performed on all terminals.

The use of activated fluxes (RMA and RA or OA) shall be allowed on all leadless devices with gold finished terminals. All activated fluxes must be immediately cleaned off after dipping using an acceptable solvent in accordance with Para. 4.3 of ESA/SCC Basic Specification No. 23500.

9.18 PERMANENCE OF MARKING

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

9.19 TERMINAL STRENGTH

MIL-STD-750, Test Method 2036, Test Condition as specified in the Detail Specification.

9.20 OPERATING LIFE

9.20.1 Operating Life During Qualification Testing

MIL-STD-750, Test Method 1026.

(a) **Duration:** 3000 hours.

(b) **Test Conditions:**

As specified in Table 5 of the Detail Specification.

(c) **Data Points:**

Measurements at intermediate and end-points according Table 6 of the Detail Specification at 0, 1500 ± 48 hours and 3000 ± 48 hours.

In the case where Table 6 specifies "changes", the drift shall always be related to the 0-hour measurement.

9.20.2 Operating Life During Lot Acceptance Tests

MIL-STD-750, Test Method 1026.

(a) **Duration:** 1000 hours.

(b) **Test Conditions:**

As specified in Table 5 of the Detail Specification.

(c) **Data Points:**

Measurements at 0 hours and at 1000 ± 48 hours according to Table 6 of the Detail Specification.

9.21 HIGH TEMPERATURE REVERSE BIAS BURN-IN

(a) **For Diodes:**

MIL-STD-750, Test Method 1038, Test Condition 'A'.

(b) **For Transistors:**

MIL-STD-750, Test Method 1039, Test Condition 'A'.

Duration

Unless otherwise specified in Table 5(a) of the Detail Specification, the duration of high temperature reverse bias burn-in shall be as follows.

For Category 1 of Chart III(a) : A minimum of 240 hours for testing level 'B'.
: A minimum of 168 hours for testing level 'C'.

For Category 2 of Chart III(a) : A minimum of 48 hours for both testing levels.

For Chart III(b) : A minimum of 48 hours for both testing levels.

Test Conditions

As specified, where applicable, in Table 5(a) of the Detail Specification.

Data Points

For components of testing level 'B' undergoing the high temperature reverse bias test, the data points for parameter drift measurements shall be 0 hours (initial) and the burn-in end point as given in Duration above. When the duration is given in Table 5(a) of the Detail Specification, the end point shall be at the burn-in end point so specified.

9.22 POWER BURN-IN

(a) **For Diodes:**

MIL-STD-750, Test Method 1038, Test Condition 'B'.

(b) **For Transistors:**

MIL-STD-750, Test Method 1039, Test Condition 'B'.

Duration

Unless otherwise specified in Table 5(b) of the Detail Specification, the duration of power burn-in shall be as follows.

For Category 1 of Chart III(a) : A minimum of 48 hours.

For Category 2 of Chart III(a) : A minimum of 240 hours for testing level 'B'.
: A minimum of 168 hours for testing level 'C'.

For Chart III(b) : A minimum of 240 hours for testing level 'B'.
: A minimum of 168 hours for testing level 'C'.

Test Conditions

As specified in Table 5(b) of the Detail Specification.

Data Points

For components of testing level 'B' undergoing the power burn-in test, the data points for parameter drift measurements shall be 0 hours (initial) and the burn-in end point given in Duration above. When the duration is given in Table 5(b) of the Detail Specification, the end point shall be the burn-in end point so specified.

9.23 SPECIAL TESTING

The requirements for special testing shall be defined in the Detail Specification. The Detail Specification shall also state whether the test is destructive or not.

9.24 WAFER DICING

In accordance with the Process Identification Document (P.I.D.).

9.25 DICE VISUAL INSPECTION

In accordance with ESA/SCC Basic Specification No. 20400 and the relevant paragraphs of the appropriate ancillary specification.

10. DATA DOCUMENTATION

10.1 GENERAL

For the qualification approval records and with each component or naked chip 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) Wafer lot acceptance data (if specified in the purchase order).

(e) Wafer screening data (Chart II(a)) (when applicable).

(f) Final production test data (Chart II(b)) (but see Para. 10.8).

(g) Burn-in and electrical measurement data (Chart III(a) or III(b)).

(h) Qualification test data (Chart IV).

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

(j) Failed component list (see Paras. 7.3 and 8.4) and failure analysis report (see Para. 8.4).

(k) Certificate of Conformity.

(l) Radiographic inspection photographs.

Items (a) to (l) 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 (l) less item (i) 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(b), Charts III(a) and III(b) (including PDA figure) and Chart V (where applicable).

(d) Failed components list.

(e) Read and record data from Chart III(a) or III(b) (if specified in the purchase order).

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) Wafer lot acceptance data (if specified in the purchase order).

(b) Read and record data from Charts III(a) and III(b).

(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) Wafer lot acceptance data (if specified in the purchase order).

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

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

For components submitted to LA1 and LA2 testing, item (c) of Para. 10.1 shall also be provided (see Paras. 8.2.4(a) and 8.2.5(a)).

10.1.4 Dice Delivery

For deliveries of naked dice, the following documentation shall be supplied:-

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

(b) Wafer lot acceptance data (if specified in the Purchase Order).

(c) Attributes record of all measurements, tests and inspections performed in Chart II(a).

(d) Wafer screening read and record test data from Chart II(a), including data mapping, (if specified in the Purchase Order).

(e) Attributes record of all measurements, tests and inspections performed in Chart II(b), Chart III (including PDA figure) and Chart V for the test vehicles.

(f) Certificate of Conformity.

10.1.5 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 serial delivered numbers (for components of testing level 'B').

(f) Number of purchase order.

(g) Radiation testing level.

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

(i) Manufacturer's name and address.

(j) Location of the manufacturing plant (specify place of diffusion, assembly and test).

(k) Signature on behalf of Manufacturer.

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

10.3 LIST OF EQUIPMENT USED

If not in accordance with the data given in the Process Identification Document (P.I.D.), a list of equipment used for tests and measurements shall be prepared. Where applicable, this list shall contain inventory number, Manufacturer's type number, serial number, etc. and 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 WAFER LOT ACCEPTANCE TEST DATA

Statistical Process Control (SPC) data for each wafer lot shall be supplied if specified in the Purchase Order.

Data of SEM inspection shall be provided in accordance with the requirements of ESA/SCC Basic Specification No. 21400.

Radiation test report shall be provided in accordance with the requirements of ESA/SCC Basic Specification No. 22900 (if required).

10.6 WAFER SCREENING DATA (CHART II(a))

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

- Electrical measurements at room temperature (Para. 9.9.3.1).
- Electrical measurements at high and low temperatures (Para. 9.9.2.1).
- Wafer dicing (Para. 9.24).
- Dice visual inspection (Para. 9.25).

In the case of naked dice delivery, read and record data shall be supplied for the following (if specified in the Purchase Order):

- Electrical measurements at room temperature (Para. 9.9.3.1).
- Electrical measurements at high and low temperatures (Para. 9.9.2.1).

10.7 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:

- Pre-encapsulation internal visual inspection (Para. 9.1).
- Bond strength and die-shear tests (Para. 9.2).
- Seal Test (fine and gross leak). (Para. 9.8).
- Environmental Tests (Para. 9.4, 9.5, 9.6 and 9.7).
- Electrical measurements at room temperature (Para. 9.9.3).
- External visual inspection (Para. 9.10).
- Dimension check (Para. 9.11).

For the bond strength and die-shear tests, the separation forces and categories shall be recorded.

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.

10.8 BURN-IN AND ELECTRICAL MEASUREMENT DATA (CHARTS III(a) and III(b))

10.8.1 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) Initial Parameter Drift value measurements.

(b) $\Delta 1$ values after power burn-in or HTRB.

(c) $\Delta 2$ values after HTRB or power 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.

(h) Photographs from radiographic inspection, including those of reject components.

10.8.2 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 after, each of the tests and inspections) shall be prepared.

10.9 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 Tables 2 and 6 of the Detail Specification, as and where applicable.

10.10 LOT ACCEPTANCE TEST DATA (CHART V)

10.10.1 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 Tables 2, 3 and 6 of the Detail Specification, as and where applicable.

10.10.2 Testing Level 'C'

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

In the case of lot acceptance level 2 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. 8.2.4(a)).

In the case of lot acceptance level 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)).

10.11 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.

(e) In the case of an allowed failure during Chart V (see Para. 8.2.1), a report shall always be supplied.

10.12 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 Lot Acceptance 1 and Lot Acceptance 2 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.

ANNEXE I

LTPD SAMPLING PLAN LOT SIZES GREATER THAN 200 DEVICES

Minimum size of sample to be tested to assure with a 90% confidence that a lot whose Percent Defective equals the specified LTPD is not accepted (single sample).

Max. Percent Defective (LTPD) or λ	50	30	20	15	10	7	5	3	2	1.5	1	0.7	0.5	0.3	0.2	0.15	0.1
Acceptance Number (c) (r = c + 1)	MINIMUM SAMPLE SIZES (FOR DEVICE-HOURS REQUIRED FOR LIFE TEST, MULTIPLY BY 1000)																
0	5 (1.03)	8 (0.64)	11 (0.46)	15 (0.34)	22 (0.23)	32 (0.16)	45 (0.11)	76 (0.07)	116 (0.04)	153 (0.03)	231 (0.02)	328 (0.02)	461 (0.01)	767 (0.007)	1152 (0.005)	1534 (0.003)	2303 (0.002)
1	8 (4.4)	13 (2.7)	18 (2.0)	25 (1.4)	38 (0.94)	55 (0.65)	77 (0.46)	129 (0.28)	195 (0.18)	258 (0.14)	390 (0.09)	555 (0.06)	778 (0.045)	1296 (0.027)	1946 (0.018)	2592 (0.013)	3891 (0.009)
2	11 (7.4)	18 (4.5)	25 (3.4)	34 (2.24)	52 (1.6)	75 (1.1)	105 (0.78)	176 (0.47)	266 (0.31)	354 (0.23)	533 (0.15)	759 (0.11)	1065 (0.080)	1773 (0.045)	2662 (0.031)	3547 (0.022)	5323 (0.015)
3	13 (10.5)	22 (6.2)	32 (4.4)	43 (3.2)	65 (2.1)	94 (1.5)	132 (1.0)	221 (0.62)	333 (0.41)	444 (0.31)	668 (0.20)	953 (0.14)	1337 (0.10)	2226 (0.062)	3341 (0.041)	4452 (0.031)	6681 (0.018)
4	16 (12.3)	27 (7.3)	38 (5.3)	52 (3.9)	78 (2.6)	113 (1.8)	158 (1.3)	265 (0.75)	398 (0.50)	531 (0.37)	798 (0.25)	1140 (0.17)	1599 (0.12)	2663 (0.074)	3997 (0.049)	5327 (0.037)	7994 (0.025)
5	19 (13.8)	31 (8.4)	45 (6.0)	60 (4.4)	91 (2.9)	131 (2.0)	184 (1.4)	308 (0.85)	462 (0.57)	617 (0.42)	927 (0.28)	1323 (0.20)	1855 (0.14)	3090 (0.085)	4638 (0.056)	6181 (0.042)	9275 (0.028)
6	21 (15.6)	35 (9.4)	51 (6.6)	68 (4.9)	104 (3.2)	149 (2.2)	209 (1.6)	349 (0.94)	528 (0.62)	700 (0.47)	1054 (0.31)	1503 (0.22)	2107 (0.155)	3509 (0.093)	5267 (0.062)	7019 (0.047)	10533 (0.031)
7	24 (16.6)	39 (10.2)	57 (7.2)	77 (5.3)	116 (3.5)	166 (2.4)	234 (1.7)	390 (1.0)	589 (0.67)	783 (0.51)	1178 (0.34)	1680 (0.24)	2355 (0.17)	3922 (0.101)	5886 (0.067)	7845 (0.051)	11771 (0.034)
8	26 (18.1)	43 (10.9)	63 (7.7)	85 (5.6)	128 (3.7)	184 (2.6)	258 (1.8)	431 (1.1)	648 (0.72)	864 (0.54)	1300 (0.36)	1854 (0.25)	2599 (0.18)	4329 (0.108)	6498 (0.072)	8660 (0.054)	12995 (0.036)
9	28 (19.4)	47 (11.5)	69 (8.1)	93 (6.0)	140 (3.9)	201 (2.7)	282 (1.9)	471 (1.2)	709 (0.77)	945 (0.58)	1421 (0.38)	2027 (0.27)	2842 (0.19)	4733 (0.114)	7103 (0.077)	9468 (0.057)	14206 (0.038)
10	31 (19.9)	51 (12.1)	75 (8.4)	100 (6.3)	152 (4.1)	218 (2.9)	306 (2.0)	511 (1.2)	770 (0.80)	1025 (0.60)	1541 (0.40)	2199 (0.28)	3082 (0.20)	5133 (0.120)	7704 (0.080)	10268 (0.060)	15407 (0.040)
11	33 (21.0)	54 (12.8)	83 (8.3)	111 (6.2)	166 (4.2)	238 (2.9)	332 (2.1)	555 (1.2)	832 (0.83)	1109 (0.62)	1664 (0.42)	2378 (0.29)	3323 (0.21)	5546 (0.12)	8319 (0.083)	11092 (0.062)	16638 (0.042)
12	36 (21.4)	59 (13.0)	89 (8.6)	119 (6.5)	178 (4.3)	254 (3.0)	356 (2.2)	594 (1.3)	890 (0.86)	1187 (0.65)	1781 (0.43)	2544 (0.3)	3562 (0.22)	5936 (0.13)	8904 (0.086)	11872 (0.065)	17808 (0.043)
13	38 (22.3)	63 (13.4)	95 (8.9)	126 (6.7)	190 (4.5)	271 (3.1)	379 (2.26)	632 (1.3)	948 (0.89)	1264 (0.67)	1896 (0.44)	2709 (0.31)	3793 (0.22)	6321 (0.134)	9482 (0.089)	12643 (0.067)	18964 (0.045)
14	40 (23.1)	67 (13.8)	101 (9.2)	134 (6.9)	201 (4.6)	288 (3.2)	403 (2.3)	672 (1.4)	1007 (0.92)	1343 (0.69)	2015 (0.46)	2878 (0.32)	4029 (0.23)	6716 (0.138)	10073 (0.092)	13431 (0.069)	20146 (0.046)
15	43 (23.3)	71 (14.1)	107 (9.4)	142 (7.1)	213 (4.7)	305 (3.3)	426 (2.36)	711 (1.41)	1066 (0.94)	1422 (0.71)	2133 (0.47)	3046 (0.33)	4265 (0.235)	7108 (0.141)	10662 (0.094)	14216 (0.070)	21324 (0.047)
16	45 (24.1)	74 (14.0)	112 (9.7)	150 (7.2)	225 (4.8)	321 (3.37)	450 (2.41)	750 (1.44)	1124 (0.96)	1499 (0.72)	2249 (0.48)	3212 (0.337)	4497 (0.241)	7496 (0.144)	11244 (0.096)	14992 (0.072)	22487 (0.048)
17	47 (24.7)	79 (14.7)	118 (9.86)	158 (7.36)	236 (4.93)	338 (3.44)	473 (2.46)	788 (1.48)	1182 (0.98)	1576 (0.74)	2364 (0.49)	3377 (0.344)	4728 (0.246)	7880 (0.148)	11819 (0.098)	15759 (0.074)	23639 (0.049)
18	50 (24.9)	83 (15.0)	124 (10.0)	165 (7.54)	248 (5.02)	354 (3.51)	496 (2.51)	826 (1.51)	1239 (1.0)	1652 (0.75)	2478 (0.50)	3540 (0.351)	4956 (0.251)	8260 (0.151)	12390 (0.100)	16520 (0.075)	24780 (0.050)
19	52 (25.5)	86 (15.4)	130 (10.2)	173 (7.76)	259 (5.12)	370 (3.58)	518 (2.56)	864 (1.53)	1296 (1.02)	1728 (0.77)	2591 (0.52)	3702 (0.358)	5183 (0.256)	8638 (0.153)	12957 (0.102)	17276 (0.077)	25914 (0.051)
20	54 (26.1)	90 (15.6)	135 (10.4)	180 (7.82)	271 (5.19)	386 (3.65)	541 (2.60)	902 (1.56)	1353 (1.04)	1803 (0.78)	2705 (0.52)	3864 (0.364)	5410 (0.260)	9017 (0.156)	13526 (0.104)	18034 (0.078)	27051 (0.052)
26	65 (27.0)	109 (16.1)	163 (10.8)	217 (8.08)	326 (5.38)	466 (3.76)	652 (2.69)	1086 (1.61)	1629 (1.08)	2173 (0.807)	3259 (0.538)	4656 (0.376)	6518 (0.269)	10863 (0.161)	16295 (0.108)	21726 (0.081)	32589 (0.054)

NOTES

1. Sample sizes are based upon the Poisson exponential binomial limit.
2. The minimum quality (approximate AQL) required to accept (on the average) 19 of 20 lots is shown in parentheses for information only.

ANNEXE I

LTPD SAMPLING PLAN LOT SIZES LESS THAN, OR EQUAL TO, 200 DEVICES

C=0

N	10	20	30	40	50	60	80	100	120	150	160	200
n	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD
2	2 2 65	2 5 66	2 5 67	2.5 67	2.5 67	2 5 68	2 5 68	2.5 68	2.5 68	2 5 68	2 5 68	2 5 68
4	1 2 36	1 2 40	1 2 42	1 2 42	1.3 42	1 3 43	1 3 43	1 3 43	1 3 43	1.3 43	1 3 44	1 3 44
5	1.0 29	1 0 33	1 0 34	1.0 35	1 0 35	1 0 35	1 0 36	1 0 36	1 0 37	1 0 37	1 0 37	1 0 37
8	0 5 15	0 6 20	0.6 22	0.6 23	0 6 23	0.6 23	0.6 24	0.7 24	0.7 24	0.7 24	0 7 24	0 7 25
10		0.4 15	0.5 17	0.5 19	0.5 19	0.5 19	0.5 20	0.5 20	0.5 20	0 5 20	0.5 20	0.5 20
16		0 2 6 9	0 25 10	0.25 11	0 3 11	0.3 12	0 3 12	0 3 13	0 3 13	0 3 13	0 3 13	0 3 13
20			0 2 6 8	0 2 8 0	0 25 8 7	0 25 9 0	0 25 9 4	0.25 10	0 25 10	0 25 10	0 25 10	0 25 11
25			0.15 4.3	0.15 5 7	0 2 6.4	0 2 6 9	0 2 7 4	0 2 7 5	0 2 7 6	0 2 7 7	0 2 7 8	0 2 7 9
32				0 1 3 7	0.1 4.4	0 1 5.0	0.1 5 5	0.1 5 9	0.15 6 0	0 15 6 2	0.15 6.3	0 15 6 3
40					0 1 3.0	0 1 3.4	0 1 4.0	0.1 4.5	0 1 4.6	0.1 4 9	0.1 5 0	0 15 5.0
50						0 1 2 3	0 1 2 9	0 10 3 3	0 10 3.5	0 10 3 7	0 10 3 7	0 10 3 9
64							0 0 8 1.7	0 0 8 2 2	0 0 8 2 5	0 0 8 2.7	0 0 8 2 8	0 0 8 2 9
80								0 0 7 1 5	0.07 1 7	0.07 2 0	0.07 2 1	0.07 2.2
100									0 0 5 1.1	0 0 5 1.5	0 0 5 1 5	0 0 5 1 7
125										0 0 4 0.8	0 0 4 0 9	0 0 4 1 2
128										0.04 0 8	0 0 4 0 9	0 0 4 1 1
160												0.03 0.7

C=1

N	10	20	30	40	50	60	80	100	120	150	160	200
n	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD
2	27 95	24 95	24 95	23 95	23 95	23 95	23 95	23 95	23 95	22 95	22 95	22 95
4	15 62	12 66	12 66	11 67	11 67	10 67	10 67	10 67	10 67	9 8 67	9.7 67	9 7 68
5	13 51	10 55	8 8 56	8.5 57	8 4 57	8.1 58	7 9 58	7.6 58	7 5 58	7 5 58	7 5 58	7 5 58
8	11 28	7 2 35	6.2 38	5.8 38	5 4 39	5 0 39	4 7 39	4 5 39	4.3 39	4 3 40	4 2 40	4 2 40
10		6 2 30	5 0 30	4 6 31	4 2 32	4 2 32	4 2 32	3 9 33	3 5 33	3 3 33	3 3 33	3 3 33
16		5 6 15	4 2 18	3 8 18	3 4 20	3 0 20	2 9 21	2 6 21	2 5 21	2.3 21	2 3 22	2.2 22
20			4.0 13	3.2 15	2 8 16	2 5 16	2 4 16	2 3 16	2 1 17	2 0 17	2 0 17	2 0 18
25			3 8 9.2	3 1 11	2 5 12	2 2 13	2 0 13	1 8 13	1 7 13	1 6 14	1 6 14	1 6 14
32				3 1 7 4	2 4 8 2	2 1 9 0	1 8 9 9	1 6 10	1 5 10 5	1 4 11	1 3 11	1 3 11
40					2 4 5.9	2.1 6 8	1 6 7 6	1 4 7 8	1 3 8 2	1 2 8.3	1 2 8 4	1 2 8 6
50						1 7 4 6	1 4 5 6	1 2 6 1	1 2 6 4	1 0 65	0 9 6 7	0 9 6 7
64							1 3 3 8	1 1 4 4	1 0 4.7	0.8 5 0	0 8 5 0	0.7 5 2
80								1.1 3 0	1 0 3 4	0.8 3 7	0 7 3 8	0 6 4.0
100									0 9 2 5	0 7 2 8	0 7 2 8	0 6 3 0
125										0.7 1.9	0.7 2.0	0.5 2.2
128										0 7 1 7	0 7 1 9	0 5 2 2
160												0.5 1.5

C=2

N	10	20	30	40	50	60	80	100	120	150	160	200
n	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD	AQL LTPD
4	33 82	28 83	27 84	27 85	27 85	26 85	26 85	26 86	26 86	25 86	25 86	25 86
5	27 69	23 73	21 74	20 74	20 74	20 75	20 75	19 75	19 75	19 75	19 75	19 75
8	22 42	15 49	14 49	13 52	13 52	13 52	12 53	12 53	12 53	11 53	11 53	11 53
10		13 39	11 42	11 42	10 43	10 43	9 6 43	9 2 44	9.1 44	8.9 44	8 9 44	8.7 44
16		11 22	8.6 25	6 9 27	6 8 27	6 4 27	6 0 28	6 0 29	5 9 29	5 9 29	5 7 29	5.5 30
20			7 7 19	6.2 21	5.9 22	5 6 22	5 1 23	4 8 23	4 8 23	4 6 23	4 5 24	4 5 24
25			7.4 13	6.0 16	4 9 17	4.5 17	4 3 18	4 1 18	3 9 18	3 7 18	3 7 19	3 7 19
32				5 5 11	4 8 12	4.3 13	3 6 14	3 4 14	3 2 14	3 0 14 5	3 0 15	2 9 15
40					4.6 8.9	3.9 9 8	3.1 11	2.8 12	2.6 12	2.4 12	2.4 12	2.3 12
50						3 5 6 9	2.8 8 1	2.4 8 4	2 3 8 6	2 1 9 0	2 1 9 3	2.0 9 5
64							2 6 5.7	2 2 6.2	2.0 6 6	1.8 7 1	1 7 7 1	1 6 7 4
80								2 1 4 5	1 8 4 9	1 6 5 4	1 5 5 4	1 4 5 6
100									1 8 3 5	1 4 3 9	1.4 4 0	1 2 4 4
125										1.4 2.8	1.3 2 9	1.1 3.3
128										1 4 2 6	1 3 2 9	1 1 3 2
160												1.1 2.3

ANNEXE I

This table gives the AQL and LTPD values associated with certain single sampling plans (Acceptance Number "C", Sample Size "n" and Lot Size "N"). The table has the following features:-

(a) Calculations are based upon the hyper-geometric distribution (exact theory) for lot sizes of 200 devices or less.

(b) The AQL of a sampling plan is defined as the interpolated Percent Defective for which there is a 0.95 probability of acceptance under the plan. The AQL so defined need not be a realisable Lot Percent Defective for the lot size involved (e.g., 12 percent is not a realisable Percent Defective for a lot size of 20 devices).

(c) The LTPD of a sampling plan is defined as the interpolated Percent Defective for which there is a 0.10 probability of lot acceptance under the plan. The LTPD so defined need not be a realisable Lot Percent Defective for the lot size involved.

(d) The sequence of sample sizes and lot sizes are generated by taking products of preceding numbers in the respective sequences and the numbers 2 and 5.