



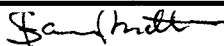
**european space agency
agence spatiale européenne**

Pages 1 to 34

**RELAYS ELECTROMAGNETIC,
RF COAXIAL SWITCH, LATCHING
ESA/SCC Generic Specification No. 3603**



**space components
coordination group**

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		SCCG Chairman	ESA Director General or his Deputy
Issue 1	August 1999		

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DOCUMENTATION CHANGE NOTICE

Rev. Letter	Rev. Date	Reference	CHANGE Item	Approved DCR No.

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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 Relays Electromagnetic, RF Coaxial Switch, Latching, 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 from qualified Manufacturers.

2. APPLICABLE DOCUMENTS

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

2.1 ESA/SCC SPECIFICATIONS

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

No. 20400, Internal Visual Inspection.

No. 20500, External Visual Inspection.

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

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

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

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

No. 23500, 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.

No. 3401, Connectors, Electrical, Non-filtered, Circular and Rectangular.

No. 3402, Connectors, RF Coaxial.

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.

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2.2 OTHER (REFERENCE) DOCUMENTS

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

MIL-STD-1344, Test Methods for Electrical Connectors.

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

ESA PSS-01-736, Material Selection for Controlling Stress Corrosion Cracking.

IEC Publication No. 68, Basic Environmental Test Procedures.

IEC Publication No. 255-5, Specification for the Insulation Testing of Electrical Relays.

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

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), screening 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), screening and electrical measurements to testing level 'B' (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 delivery of 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.

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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.

4.1.6 Add-on Components

Add-on components for the switches covered by this specification are encapsulated components and/or those components which are completed to such a stage that they may be subjected fully to the requirements of Tables 2 and 3 of an approved ESA/SCC Detail Specification. All add-on components shall be selected using the following preferences:-

- (a) Components qualified by ESA/SCC (see ESA/SCC QPL).
- (b) All other components.

Components selected under (b) because of the non-availability of suitably qualified components, shall be qualified separately in accordance with an ESA/SCC Generic Specification representative of the type of component selected and an approved ESA/SCC Detail Specification for the component selected. If an approved ESA/SCC Detail Specification does not exist for the selected component, a specification shall be written and approved prior to the commencement of this qualification.

The procurement of add-on components shall be in accordance with the appropriate ESA/SCC Generic and Detail Specifications at Level 'B'.

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.

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4.3.1 Lot Failure

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

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

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

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

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

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

4.3.2 Testing and Lot Acceptance Levels

This specification defines 1 level of testing severity which is designated by the letter 'B' (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) - None.

Level 2 (LA2) - Endurance Subgroup

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

The required lot acceptance level shall 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**.

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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.

All metallic materials shall be selected from Table I of ESA PSS-01-736.

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

5. PRODUCTION CONTROL

5.1 GENERAL

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

5.2 SPECIAL IN-PROCESS CONTROLS

5.2.1 Low Level Test (Miss Test)

RF and indicator contacts of each relay shall be submitted to a low level test in accordance with MIL-STD-202, Method 311. The following details and exceptions shall apply:-

(a) **Ambient temperature**

1 temperature cycle +25, +85, -40, +25 °C, 1 hour at each temperature extreme. The rate of temperature change shall not exceed 2°C/minute.

(b) **Number of misses allowed:** 0.

(c) **Maximum contact resistance:** 3.0Ω.

(d) **Cycling rate:** 1 position per second maximum.

(e) **Number of operations:** 5 000.

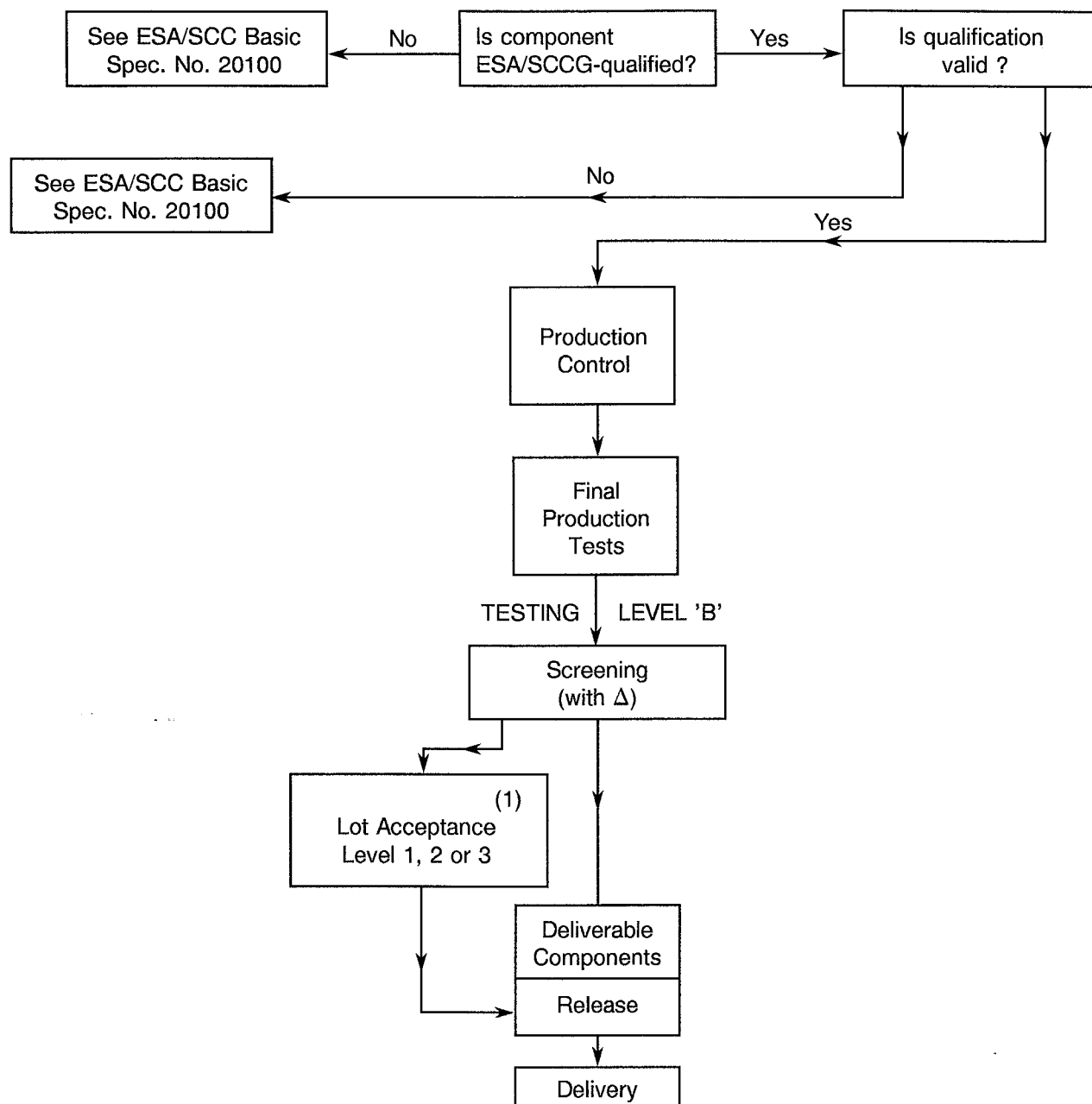
(f) **Coil energising voltage:** Minimum coil voltage (Table 1(b) of the Detail Specification).

(g) **Contact load:** Shall not be switched.

5.3 DOCUMENTATION

Documentation of special in-process controls shall be in accordance with the requirements of Para. 10.5 of this specification.

CHART I - TESTING LEVELS



NOTES

1. When applicable.

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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.

For components which fail to meet the requirements of Chart II, rework down to sub-assembly (add-on component) level is permitted provided that the extent of the rework and the reworking procedures have been approved by the Orderer for each individual failure. Reworked components shall be resubmitted to the full requirements of Chart II and any further failure shall be cause for rejection.

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. SCREENING 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 shall be serialised prior to the tests and inspections.

7.2. FAILURE CRITERIA

7.2.1 Parameter Drift Failure

The applicable delta limits are shown in Table 4 of the Detail Specification. A component shall be counted as a parameter drift failure if the changes during the thermal test 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 screening sequence shall be rejected and not counted when determining lot rejection.

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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 10% (rounded upwards to the nearest whole number) of the number of components submitted to screening 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 I 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 screening and electrical measurements shall be in accordance with Para. 10.7 of this specification.

8. QUALIFICATION APPROVAL AND LOT ACCEPTANCE TESTS

8.1 QUALIFICATION TESTING

8.1.1 General

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

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8.1.2 Distribution within the Qualification Test Lot

A minimum sample of 8 components (single pole double throw) shall be submitted to qualification testing. When a component comprises more than 1 single pole double throw (2 RF blades), the minimum number of RF blades to be submitted to qualification testing shall be 16, with a minimum of 3 components.

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

The selected 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 2 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

A minimum sample of 4 components (single pole double throw) shall be submitted to lot acceptance testing. When a component comprises more than 1 single pole double throw (2 RF blades), the minimum number of RF blades to be submitted to lot acceptance testing shall be 8, with a minimum of 2 components.

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)

No tests or inspections are required for this level.

8.2.4 Lot Acceptance Level 2 Testing (LA2)

Lot acceptance level 2 testing shall comprise the tests on an endurance subgroup. For the endurance subgroup, the following shall apply:-

- (a) The tests in this subgroup are considered to be destructive and therefore components 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 LA2 (endurance subgroup) plus tests on an environmental and mechanical subgroup. For the endurance subgroup, the requirements and conditions for LA2 (see Para. 8.2.4) shall apply.

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For the environmental and mechanical subgroup, the following shall apply:-

- (a) The tests in this subgroup are considered to be destructive and therefore components so tested shall not form part of the delivery lot.

8.3 FAILURE CRITERIA

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

8.3.1 Environmental and Mechanical Test Failures

The following shall be counted as component failures:

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

8.3.2 Electrical Failures

The following shall be counted as component failures:-

- (a) Components which, when subjected to electrical measurements on completion of environmental tests, in accordance with either Table 2 or Table 6, as specified in the Detail Specification, fail one or more of the applicable limits.
- (b) Components which, when subjected to electrical measurements at intermediate and end-points during endurance testing, in accordance with Table 6 of the Detail Specification, fail one or more of the applicable limits.
- (c) Components which, when subjected to measurement of electrical characteristics, in accordance with Tables 2 and 3 of the Detail Specification, fail one or more of the applicable limits.

8.3.3 Other Failures

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

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

8.4 FAILED COMPONENTS

A component shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 8.3 of this specification.

The allowable number of failed components per subgroup, the aggregate failure constraints and the permitted distribution of such failures are shown at the foot of Charts IV and V of this specification.

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

Failed components from successful lots shall be marked as such 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.

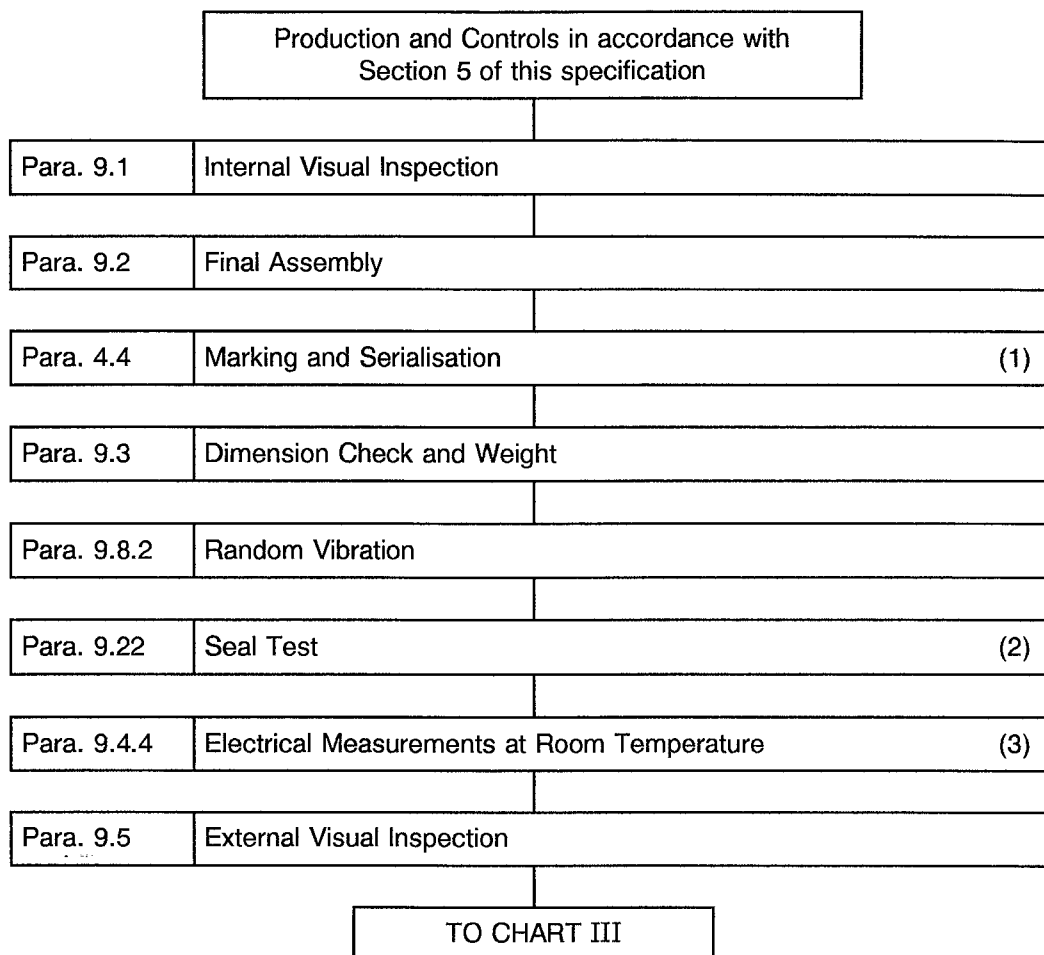
In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.1 of this specification.

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.

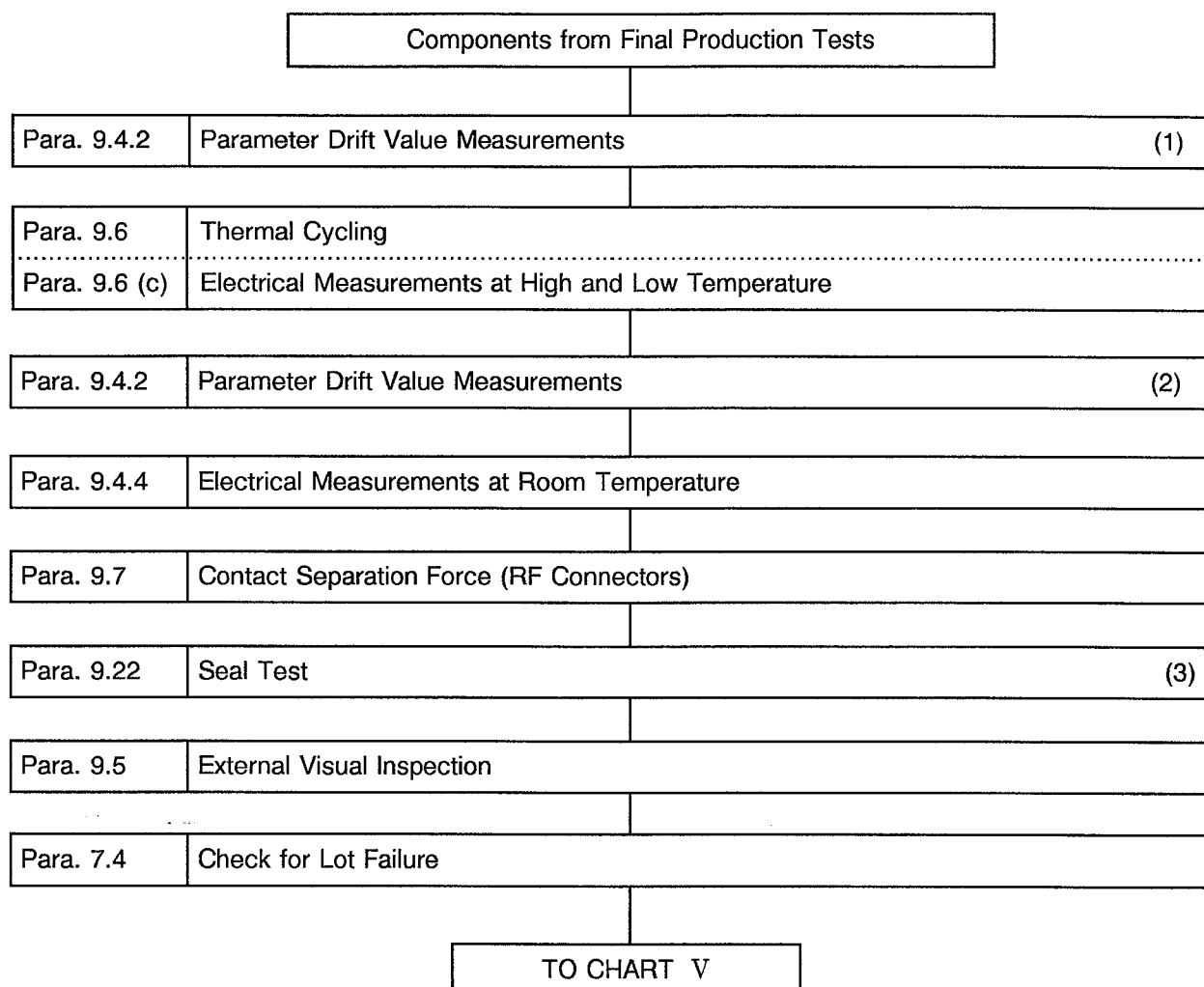
CHART II - FINAL PRODUCTION TESTS



NOTES

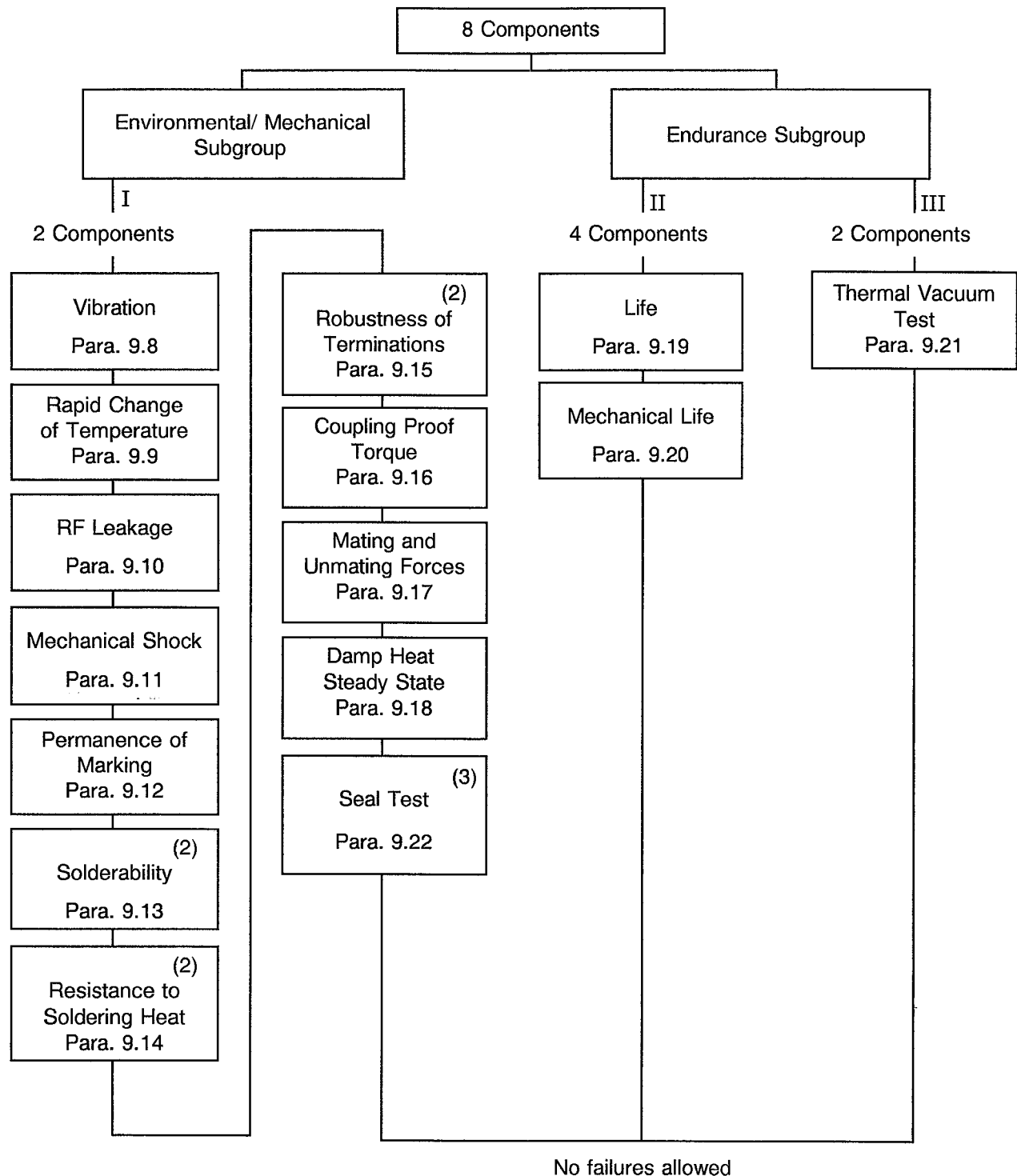
1. Marking and serialisation may take place at a different stage of the sequence.
2. Applicable to non-vented devices only.
3. Electrical measurements shall first be performed without connector savers. Then, savers shall be mounted on RF and DC (if applicable) connectors. Savers shall be kept on the relays during Chart III. RF electrical measurements need not be performed with savers.

CHART III - SCREENING AND ELECTRICAL MEASUREMENTS

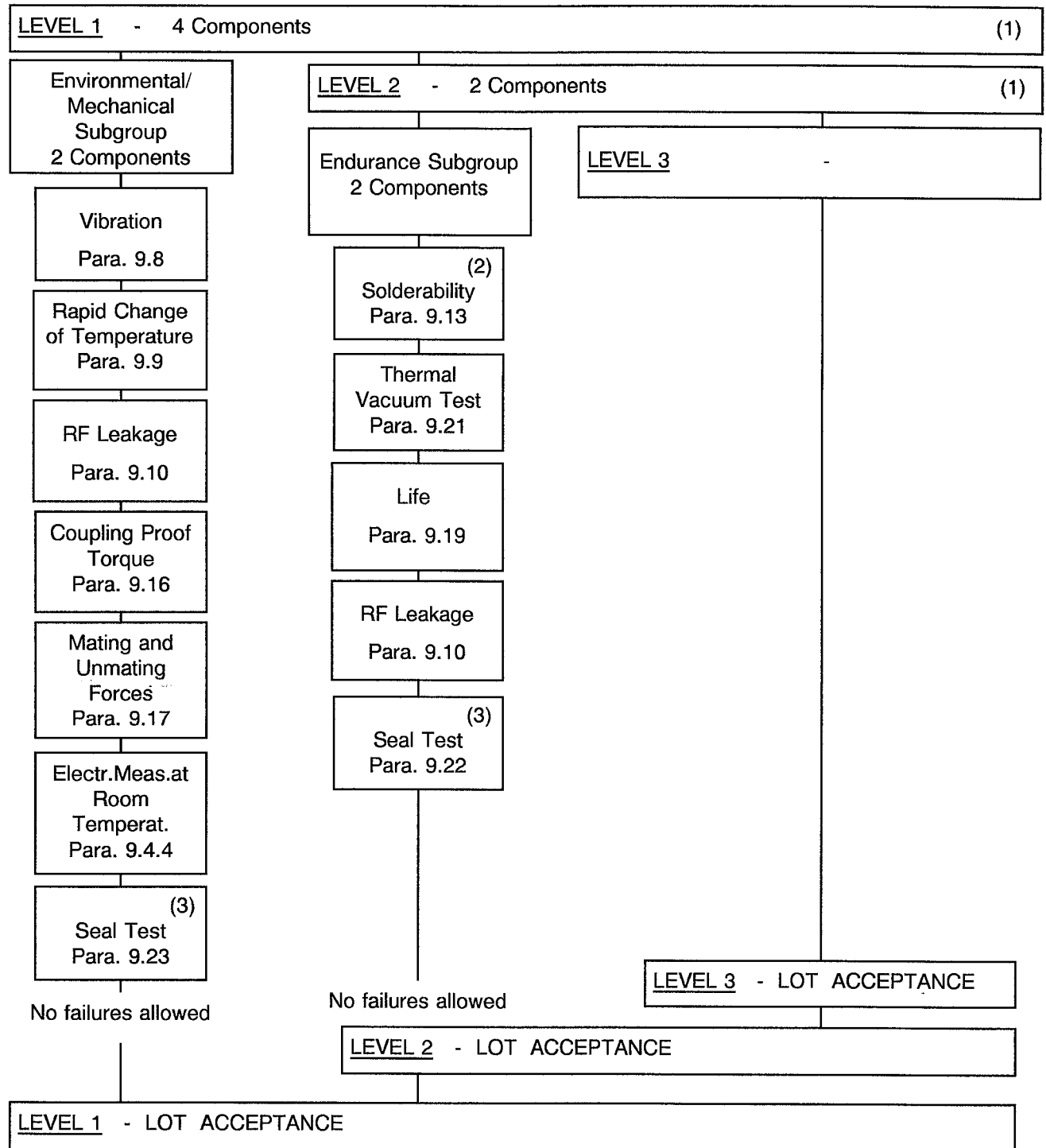


NOTES

1. Values from Chart II may be used for initial Parameter Drift Value measurements.
2. Parameter Drift Value measurements may be performed during Electrical Measurements at Room Temperature.
3. Applicable to non-vented devices only.

**CHART IV - QUALIFICATION TESTS****NOTES**

1. For distribution within the subgroups, see Para. 8.1.2.
2. Not applicable to connectors.
3. Applicable to non-vented devices only.

**CHART V - LOT ACCEPTANCE TESTS****NOTES**

1. For distribution within the subgroups, see Para. 8.2.2.
2. Not applicable to connectors.
3. Applicable to non-vented devices only.

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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 INTERNAL VISUAL INSPECTION

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

9.2 FINAL ASSEMBLY

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

9.3 DIMENSION CHECK AND WEIGHT

The dimension check shall be performed in accordance with ESA/SCC Basic Specification No. 20500 and the Detail Specification. To be performed on 3 samples only.

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

1 component shall be weighed and meet the requirements of the Detail Specification.

9.4 ELECTRICAL MEASUREMENTS

9.4.1 General

Electrical measurements and methods shall be as follows. In case of dispute for RF measurements, a suitable network analyser may be used as a reference.

9.4.1.1 Pick-up Voltage

The voltage applied to the coil shall be gradually increased until the relay operates. The pick-up voltage shall be read when all contacts have transferred. Suitable means shall be provided for the monitoring of make and break of contacts. When pick-up voltage has been read, the voltage shall be increased to the rated coil voltage before any other measurement is made. Repeat this measurement for each RF position of the relay.

9.4.1.2 Operate and Bounce Times

These times shall be measured using an oscilloscope or automatic test bench. The trace shall show contact switching at "operate". A square wave pulse of a voltage equal to the minimum coil voltage specified in Table 1(b) of the Detail Specification and of a duration equal to the maximum operate time plus the maximum bounce time shall be applied to the coil for each RF contact position. Suitable means shall be provided to monitor contact positions. Contacts shall be loaded with 6.0V d.c. maximum at 10mA maximum. The operate times shall be exclusive of contact bounce. Timing measurements shall be made on all contact sets.

9.4.1.3 Insulation Resistance

The relays shall be measured in accordance with IEC Publication No. 255-5. The following details shall apply:-

(a) **Test condition**

- 100V for relays with coil and contact voltage ratings less than 60V.
- 500V for all other relays.

(b) **Points of measurements:** See Para 9.4.1.4 (d).

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9.4.1.4 Voltage Proof

The relays shall be tested in accordance with IEC Publication 255-5. The following details shall apply:-

- (a) **Test voltage:** As specified in the Detail Specification.
- (b) **Maximum leakage current:** 1.0mA.
- (c) **Duration of application:** 5 seconds.
- (d) **Points of application:**
 - Between terminals (except coil) and case for each contact position.
 - Between open contacts for each contact position.
 - Between coil(s) and case.
 - Between coil(s) and indicator circuit terminals.
 - Between open indicator circuit contacts for each circuit position.
 - Between each pair of open RF connector centre contacts.
 - Between the centre contact and the shell of each RF connector.

9.4.1.5 Contact Resistance

The relays shall be tested in accordance with MIL-STD-202, Method 307. The following details shall apply:-

- (a) **Method of connection**

For relays with terminals, this measurement shall be made 3.0mm maximum from the emergence of the terminal from the relay.
- (b) **Test current:** 100mA maximum.
- (c) **Test voltage:** 6.0V d.c. max or a.c. rms.
- (d) **Points of measurement**

All contacts in their closed position; the coil shall be energised with the minimum coil voltage, if necessary, to close the contacts. Coils shall not be energised during measurement.
- (e) **Number of activations prior to measurements :** None
- (f) **Number of test activations:** 3.

No load shall be applied to the contacts during contact transfer.
- (g) **Number of measurements per activation:** 1 in each closed position.

9.4.1.6 Coil Resistance

The coils of the relays shall be measured in accordance with MIL-STD-202, Method 303.

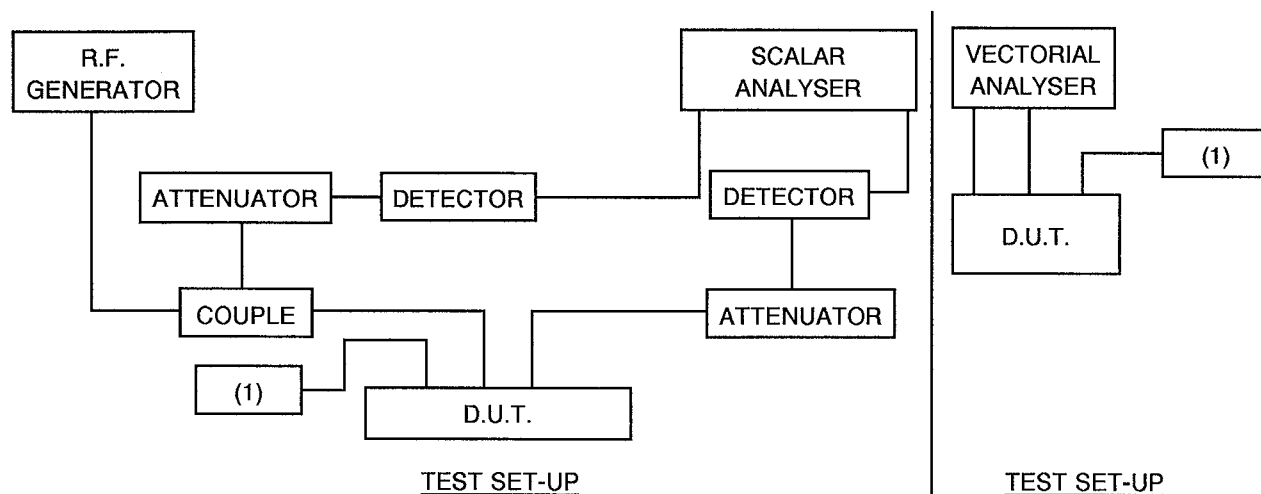
9.4.1.7 Insertion Loss

The insertion loss shall be measured for each RF path using swept frequency techniques and either test setup shown in Figure I . The insertion loss shall be measured over the frequency range defined in the Detail Specification. The insertion loss may also be measured at fixed frequencies, low, middle and high ends of the frequency range defined in the Detail Specification. The insertion loss shall not exceed the value of the Detail Specification over the frequency range.

9.4.1.8 Isolation

When relays are tested as specified, the ratio of the input power to the power from the isolated port shall be as specified over the specified frequency range. The isolation of each RF path shall be measured over the frequency range specified in the Detail Specification using swept frequency techniques and either test setup shown in Figure I. The isolation may also be measured at fixed frequencies, equally spaced points (seven points minimum) across the frequency range. The isolation shall not exceed the value of the Detail Specification over the specified frequency range.

FIGURE I - SWEPT FREQUENCY INSERTION LOSS AND ISOLATION MEASUREMENT TEST SETUP



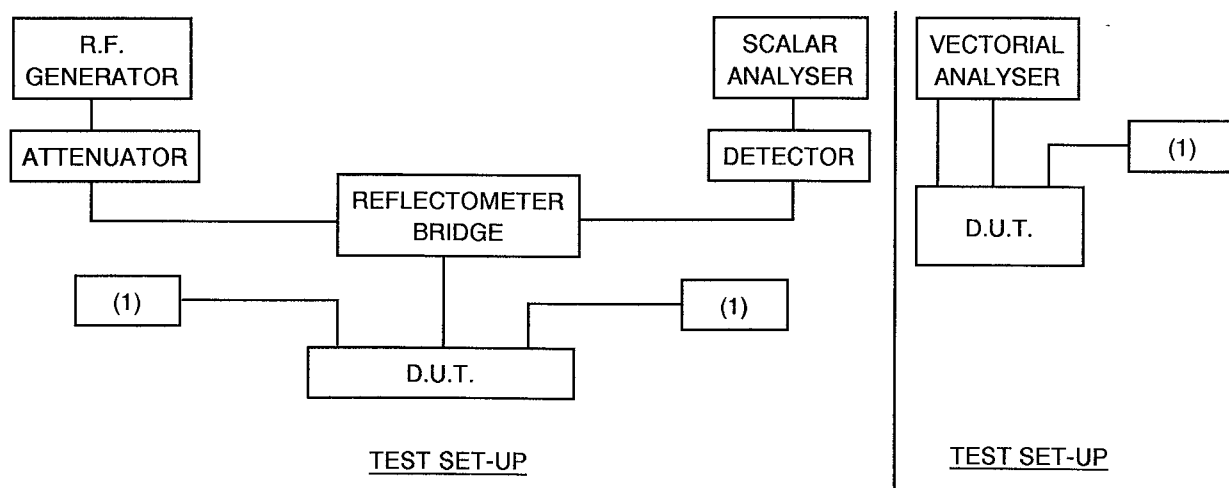
NOTES

1. Matched load according to relay configuration (example shown is SPDT relay).

9.4.1.9 Voltage Standing Wave Ratio

The VSWR of each port shall be measured across the full frequency range using swept frequency technique and either test setup shown in Figure II. Each unused port shall be terminated in a matched load. The VSWR may also be measured at fixed frequencies, equally spaced points (seven minimum) across the frequency range. The VSWR shall not exceed the value of the Detail Specification over the specified frequency range.

FIGURE II - SWEPT FREQUENCY VSWR TEST SETUP



NOTES

1. Matched load according to relay configuration (example shown is SPDT relay).

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9.4.2 Parameter Drift Value Measurements

At each of the relevant data points, 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.

9.4.3 Electrical Measurements at High and Low Temperatures

D.C. electrical measurements at high and low temperatures shall be made in accordance with Table 3 of the Detail Specification. All values obtained shall be recorded against serial numbers.

9.4.4 Electrical Measurements at Room Temperature

The measurement of electrical characteristics shall be made in accordance with Table 2 of the Detail Specification. All values obtained shall be recorded against serial numbers.

9.4.5 Electrical Measurements during Endurance Testing

Not applicable.

9.5 EXTERNAL VISUAL INSPECTION

In accordance with ESA/SCC Basic Specification No. 20500. During Final Production Tests (Chart II), shall be performed according to Inspection Level II, AQL 1% sampling of IEC Publication No. 410.

9.6 THERMAL CYCLING

The relays shall be submitted to a thermal test. The following conditions shall apply:-

(a) **Environment**

The relevant conditions are defined in Figure III. The temperature rate of change shall not exceed 5°C/minute.

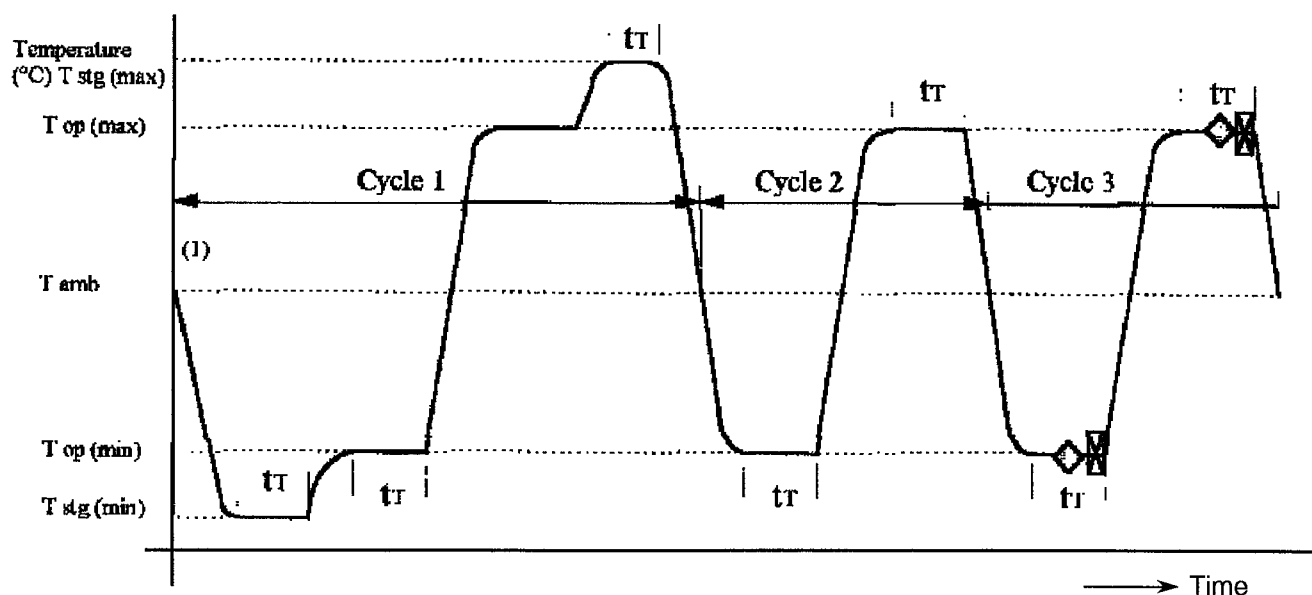
(b) **Duration**

The exposure to each temperature shall be 4 hours minimum. This 4 hour period shall start when the relay temperature does not vary more than $\pm 3^{\circ}\text{C}$ within a 15 minute period. The number of cycles shall be 3.

(c) **Measurements during test**

During the last cycle and at each temperature extreme, the relays shall be actuated 10 times, without contact load at the minimum coil voltage. Subsequently, electrical measurements shall be performed in accordance with Para. 9.4.3 of this specification.

FIGURE III - THERMAL CYCLING



NOTES

1.  = Relay actuation: 10 times.
2.  = Electrical measurements to Table 3 of the Detail Specification.
3. tr = Exposure time.

9.7 CONTACT SEPARATION FORCE

In accordance with ESA/SCC Generic Specification No. 3402, Para. 9.3.2.

9.8 VIBRATION

9.8.1 Sinusoidal Vibration

The test shall be performed in accordance with Test 'Fc' of IEC Publication No. 68-2-6. The following details and exceptions shall apply:-

(a) Method of mounting

The relays shall be mounted rigidly by their normal mounting means. Connections to the indicator circuit and coils shall be made by soldering flexible stranded wires to the relay terminals, or by the connector, as applicable. Connection to the RF path shall be made by coaxial connectors. The wires, from the relay or from the connectors, shall be clamped to a non-vibrating point which is at least 20cm away from the relay such that resonance of the wires is avoided.

(b) Test condition

Procedure B4 with a peak vibration of 20g, except that the frequency cycle shall be swept 3 times in each of 3 mutually perpendicular planes, one of which shall be parallel to the line of action of the RF switching mechanism (total duration of approximately 3 hours).

The relay shall be tested in 1 RF position.

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(c) **Measurements during vibration**

Normally closed contacts (RF and indicator) shall be monitored for any contact opening as specified in MIL-STD-202, Method 310, Condition 'A' (test circuit 'B' or equivalent).

(d) **Examination after vibration**

The relays shall be inspected for evidence of loosening of parts.

(e) **Final measurements**

The relays shall then be submitted to random vibration.

9.8.2 Random Vibration

The test shall be performed in accordance with IEC Publication No. 68-2-34. The following details and exceptions shall apply:-

(a) **Method of mounting**

See Para. 9.8.1(a).

(b) **Test conditions:**

- Final Production tests: 22.8gms.
- Qualification and Lot Acceptance tests: 26.4gms.

The test duration shall be 2 minutes in each axis. The relay shall be tested in 1 RF position.

(c) **Measurements during vibration**

See Para. 9.8.1(c).

(d) **Examination after vibration**

See Para. 9.8.1(d)

(e) **Final Measurements**

For final production tests, d.c. resistance shall be measured between:

- 1 device mounting hole and the shell of 1 RF connector.
- 1 devices mounting hole and the plate to which it is attached during the test.

The resistance measured shall not exceed 100mΩ.

For qualification and lot acceptance tests, pick-up voltages and operate and bounce times shall be measured and shall meet the requirements of Table 6 of the Detail Specification.

9.9 RAPID CHANGE OF TEMPERATURE

The test shall be performed in accordance with Test 'Na' of IEC Publication No. 68-2-14 for 10 cycles. The following details shall apply:-

During the last cycle, electrical measurements at the high and low temperatures shall be performed in accordance with Table 3 and shall meet the requirements of Table 6 of the Detail Specification.

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9.10 RF LEAKAGE

The relays shall be tested in accordance with MIL-STD-1344, Method 3008. The following details and exceptions shall apply:-

- (a) The decoupling value shall be as specified in Table 1(b) of the Detail Specification.
- (b) The RF frequency range shall be as specified in the Detail Specification.
- (c) Unused RF ports shall be terminated on matched shielded loads.

9.11 MECHANICAL SHOCK

The test shall be performed in accordance with Test 'Ea' of IEC Publication No. 68-2-27. The following details and exceptions shall apply:-

(a) **Method of mounting**

See Para. 9.8.1(a).

(b) **Test conditions**

$\frac{1}{2}$ sine, 6.0ms, 100g. In each direction of shock, the relay shall be subjected to 2 shocks. The relay shall be tested in 1 RF position.

(c) **Measurement during shock**

See Para. 9.8.1(c).

(d) **Examination after shock**

See Para. 9.8.1(d).

(e) **Final Measurements**

Electrical measurements as specified in Table 2 shall be performed and shall meet the requirements of Table 6 of the Detail Specification.

9.12 PERMANENCE OF MARKING

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

9.13 SOLDERABILITY

If applicable, terminal pins of indicator circuit and coils shall be tested in accordance with Test 'Ta', Method 1 (Solder Bath) of IEC Publication No. 68-2-20. The following details and exceptions shall apply:-

- (a) **Number of terminals to be tested:** All.

9.14 RESISTANCE TO SOLDERING HEAT

If applicable, terminal pins of indicator circuits and coils shall be tested in accordance with Test 'Tb', Method '1A' of IEC Publication No. 68-2-20. The following details and exceptions shall apply:-

- (a) **Depth of immersion of terminals in molten solder:** Within 2.0mm max. from the case.
- (b) **Final Measurements**

After stabilisation at room temperature, d.c. electrical measurements of Table 2 shall be performed and shall meet the requirements of Table 6 of the Detail Specification.

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9.15 ROBUSTNESS OF TERMINATIONS

If applicable, terminal pins of indicator circuits and coils shall be tested in accordance with Test 'Ua1' of IEC Publication No. 68-2-21. The following details and exceptions shall apply:-

- (a) **Number of terminals to be tested:** 2.
- (b) **Test condition:** The force shall be as specified in the Detail Specification.
- (c) **Examination after test**

Terminal pins shall not be dislodged from their position. There shall not be any undue play of the terminals.

9.16 COUPLING PROOF TORQUE

Coupling proof torque shall be performed on the RF coaxial connectors in accordance with ESA/SCC Generic Specification No. 3402, Para. 9.4.

9.17 MATING AND UNMATING FORCES

Mating and unmating forces shall be performed in accordance with ESA/SCC Generic Specification No. 3402, Para. 9.5 for RF connectors and No. 3401, Para. 9.2, as applicable, for d.c. connectors.

9.18 DAMP HEAT STEADY STATE (NOT APPLICABLE TO VENTED DEVICES)

The test shall be performed in accordance with Test 'Ca' of IEC Publication No. 68-2-3. The following details and exceptions shall apply:-

- (a) **Protective connector caps shall be used.**
- (b) **Polarisation voltage:** None.
- (c) **Special pre-conditioning procedure:** None.
- (d) **Initial measurements:** None.
- (e) **Duration:** 4 days.
- (f) **Electrical conditions**

No switching, no loading, no measurements.

- (g) **Final measurements**

After the specified drying period, electrical measurements as specified in Table 2 shall be performed and shall meet the requirements of Table 6 of the Detail Specification.

9.19 LIFE

The relays shall be submitted to a life test under the following conditions:-

- (a) **Ambient temperature**

Maximum high temperature as specified in Table 1(b) of the Detail Specification.

- (b) **Coil energising voltage**

The minimum coil voltage as specified in Table 1(b) of the Detail Specification shall only be applied to the coil(s) for the time necessary to change the status of the relay.

- (c) **Cycling rate**

1 operation per second maximum.

- (d) **Number of operations:** 100 000.

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(e) **Contact load conditions and monitoring**

Each “normally” closed contact shall be monitored for contact resistance during at least 50% of the closed time as follows:

- RF Contacts

RF contacts shall be tested as specified in Para. 5.2.1 and the contact resistance shall not exceed that specified in Para. 5.2.1. Contact sticking shall be monitored.

- Indicator Contacts

Indicator contacts shall switch the load as specified in Table 5 of the Detail Specification and the contact resistance shall not exceed the requirements of Table 6 of the Detail Specification.

(f) **Final Measurements**

Electrical measurements as specified in Table 2 shall be performed and shall meet the requirements of Table 6 of the Detail Specification.

9.20 MECHANICAL LIFE

The relays shall be tested as specified in Para. 9.19, Life with the following exceptions:-

(a) **Ambient temperature:** Room ambient temperature.

(d) **Number of operations:** 300 000.

(e) **Contact load conditions and monitoring:** No load. Indicator contacts only for closing.

(f) **Final measurements**

RF and indicator contacts shall be checked for contact resistance which shall not exceed the requirements of Table 6 of the Detail Specification.

9.21 THERMAL VACUUM

The relays shall be submitted to a thermal vacuum test. The following conditions shall apply:-

(a) **Environment**

The pressure shall be 1.10^{-5} Torr or less and the temperatures as specified in Figure IV.
The rate of change of the base plate temperature shall not exceed 2°C/minute.

(b) **Duration**

The number of thermal cycles shall be 6. The exposure at each temperature shall be 4 hours minimum. This 4 hour period shall start when the replay temperature does not vary by more than $\pm 3^{\circ}\text{C}$ within a 15 minute period.

(c) **Switching**

At each of the relevant data points in Figure IV, the relays under test shall be actuated 10 times without contact load at the minimum coil voltage.



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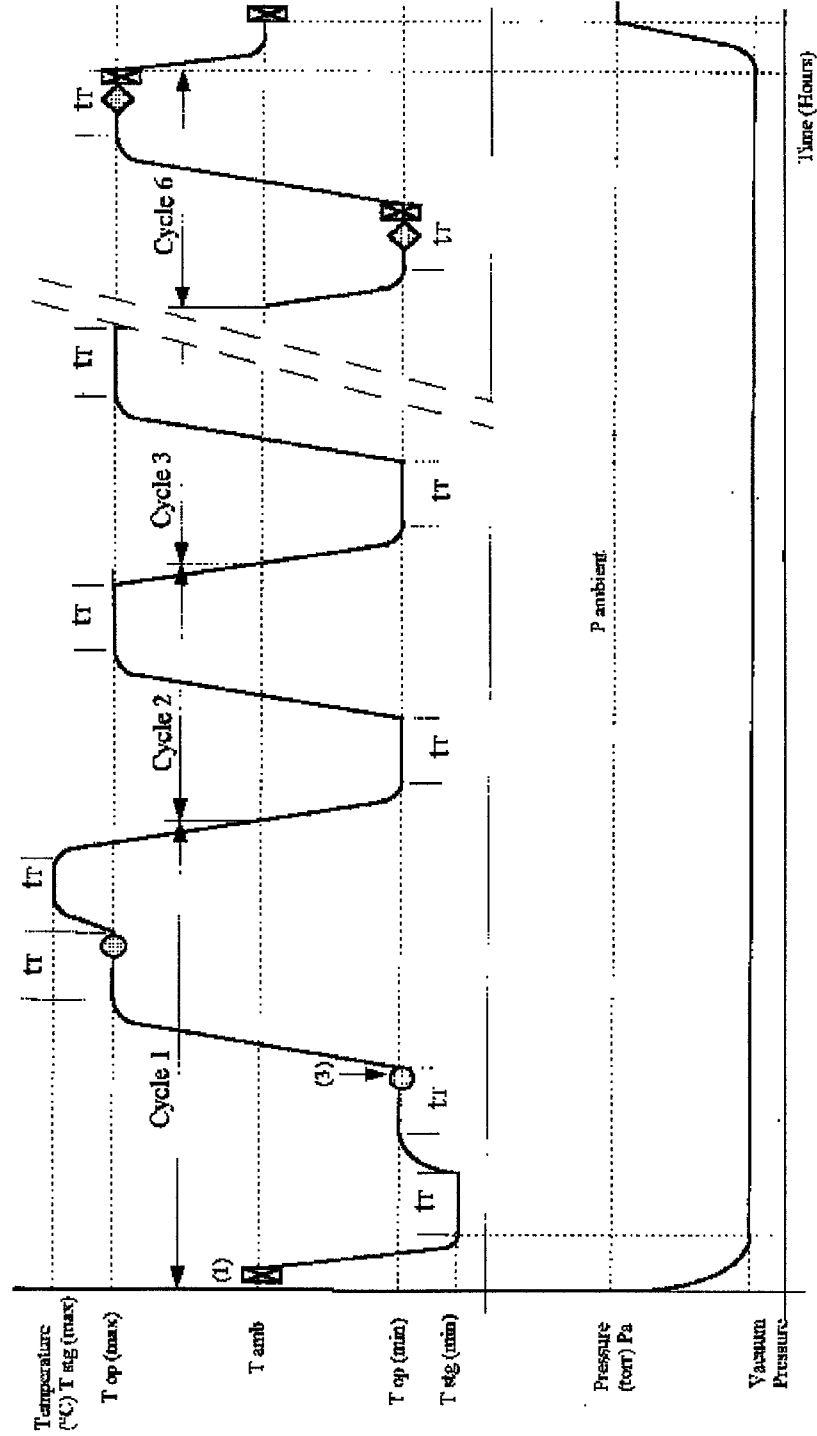
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FIGURE IV - THERMAL VACUUM TEST



NOTES

1. = Electrical measurements.
2. = RF Power handling test.
3. = Relay actuation: 10 times.
4. tT = Test temperature.

(d) RF power handling (Figure V) (Qualification only)

During the first cycle, at each of the low and high temperatures, after thermal stabilisation, rated RF power as specified in Table 1(b) of the Detail Specification shall be applied to the input(s) of the relay for at least 1 hour. The frequency of the RF power shall be:

- 1 switch L or S band (0.9 - 4.0 GHz)
- 2 switches C band (4.0 - 8.0 GHz)
- 1 switch K band (12 - 18 GHz)

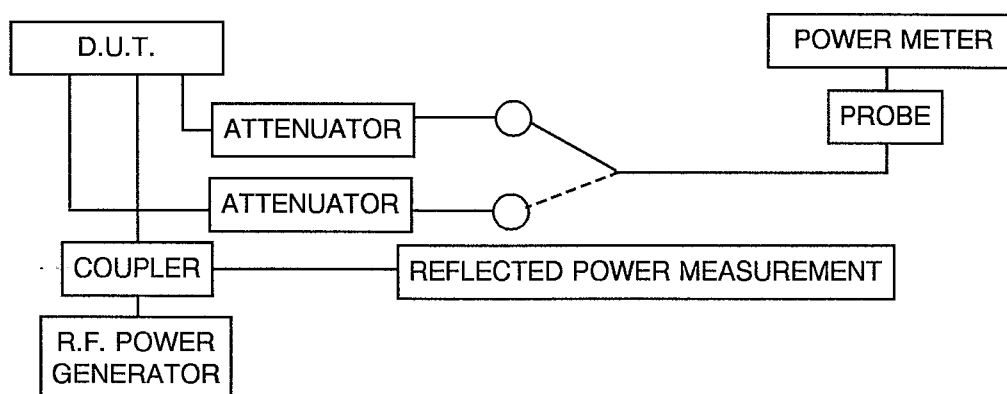
Each position of the switch shall be tested for 1/2 hour.

After each RF power handling, electrical measurements shall be performed as specified in Table 3 and shall meet the requirements of Table 6 of the Detail Specification.

(e) Final measurements

Upon completion of the test, electrical measurements shall be performed as specified in Table 2 and shall meet the requirements of Table 6 of the Detail Specification.

FIGURE V - RF POWER HANDLING TEST SETUP



N.B.

1 Attenuator per RF path according to the relay configuration. Example shown is an SPDT relay.

9.22 SEAL TEST (NON-VENTED DEVICES)

9.22.1 Gross Leak

The test shall be performed in accordance with Test 'Qc' of IEC Publication No. 68-2-17, Method 2 at +126 to +130 °C. There shall be no evidence of repetitive bubbling. De-ionised water may be used instead of mineral oil.

9.22.2 Fine Leak

The test shall be performed in accordance with Test 'Qk' of IEC Publication No. 68-2-17. The preferred tracer gas is helium and the permissible leakage rate is not greater than 10^{-8} m.bar dm³ /s air equivalent.

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10. DATA DOCUMENTATION

10.1 GENERAL

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

- (a) Cover sheet (or sheets).
- (b) List of equipment (testing and measuring).
- (c) List of test references.
- (d) Special in-process control test data.
- (e) Final production test data (Chart II) (but see Para. 10.6).
- (f) Screening and electrical measurement data (Chart III).
- (g) Qualification test data (Chart IV).
- (h) Lot acceptance test data (Chart V) (when applicable).
- (i) Failed component list (see Para's 7.3 and 8.4) and failure analysis report (see Para. 8.4).
- (j) Certificate of Conformity.

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

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

10.1.1 Qualification Approval

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

10.1.2 Testing Level 'B'

10.1.2.1 Qualified Components

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

- (a) Cover sheet (if all of the information is not included on the Certificate of Conformity).
- (b) Certificate of Conformity (including range of delivered serial numbers).
- (c) Attributes record of measurements, tests and inspections performed in Chart II, Chart III (including PDA figure) and Chart V (where applicable).
- (d) Failed components list.

10.1.2.2 Unqualified Components

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

- (a) Read and record data from Chart III.
- (b) Special in-process control data (where applicable).
- (c) Failure analysis report on failed components.

10.1.3 Testing Level 'C'

Not applicable.

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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.
- (f) Number of purchase order.
- (g) Information relative to any additions to this specification and/or the Detail Specification.
- (h) Manufacturer's name and address.
- (j) Location of the manufacturing plant.
- (k) Signature on behalf of Manufacturer.
- (l) Total number of pages of the data package.

10.3 LIST OF EQUIPMENT USED

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

10.4 LIST OF TEST REFERENCES

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

10.5 SPECIAL IN-PROCESS CONTROL DATA

As specified in the Detail Specification.

10.6 FINAL PRODUCTION TEST DATA (CHART II)

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

- Pre-encapsulation internal visual inspection (Para. 9.1).
- Dimension check and weight (Para. 9.6).
- Random vibration (Para. 9.8.2).
- Electrical measurements (Para. 9.4).
- External visual inspection (Para. 9.5).
- Seal Test (Para. 9.22) (if applicable).

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 Para. 10.1.2 or at least shall contain a list of final production tests actually performed and a certification that the data is available for review.

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10.7 SCREENING 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 provided of the following:-

- (a) Failures during vibration scan.
- (b) Failures during the low level test at each temperature and the number of misses.
- (c) Failures during internal moisture test. For each component, the lowest value of insulation resistance.
- (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.
- (g) Failures during seal test (if applicable).

10.7.2 Testing Level 'C'

Not applicable.

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

10.9 LOT ACCEPTANCE TEST DATA (CHART V)

10.9.1 Testing Level 'B'

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

Detailed data shall be provided of all electrical measurements made in accordance with Tables 2, 3 and 6 of the Detail Specification, as and where applicable.

10.9.2 Testing Level 'C'

Not applicable.

10.10 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT

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

- (a) The reference number and description of the test or measurement performed as defined in this specification and/or the Detail Specification.
- (b) The serial number (if applicable) of the failed component.
- (c) The failed parameter and the failure mode of the component.
- (d) Detailed failure analysis, if requested.

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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 8.2.4(a) and 8.2.5(a)).
- (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.