CRYSTAL CONTROLLED OSCILLATORS

ESCC Generic Specification No. 3503

Issue 2	December 2016

Document Custodian: European Space Agency – see https://escies.org

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DCR No.	CHANGE DESCRIPTION
1037	Specification upissued to incorporate editorial change per DCR.

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1 INTRODUCTION

1.1 SCOPE

This specification defines the general requirements for the qualification, qualification maintenance, procurement, and delivery of Crystal Controlled Oscillator types XO, VCXO, TCXO, or a mix of these types (e.g. VCTCXO etc.), for space applications. This specification contains the appropriate inspection and test schedules and also specifies the data documentation requirements.

Both Oscillator Classes 1 and 2 as defined in Para. 3 are covered by this specification.

1.2 APPLICABILITY

This specification is primarily applicable to the granting of qualification approval to Oscillators qualified in accordance with ESCC Basic Specification No. 20100.

It is also primarily applicable to the procurement of Oscillators so qualified.

This specification may also be applied to the procurement of unqualified Oscillators, recommendations for which are given in ESCC Basic Specification No. 23100.

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 starting qualification or placing the Purchase Order.

2.1 ESCC SPECIFICATIONS

- No. 3501, Generic Specification for Quartz Crystal Units.
- No. 5000, Generic Specification for Discrete Semiconductor Components.
- No. 9000, Generic Specification for Integrated Circuits Monolithic.
- 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 Dispatch of ESCC Components.
- No. 20900, Radiographic Inspection of Electronic Components.
- No. 2093501, Radiographic Inspection of Quartz Crystal Units
- No. 21300, Terms, Definitions, Abbreviations, Symbols and Units.
- No. 21400, Scanning Electron Microscope Inspection of Semiconductor Dice.
- No. 2043501, Internal Visual Inspection of Quartz Crystal Units
- No. 21700, General Requirements for the Marking of ESCC Components.
- No. 22600, Requirements for the Evaluation of Standard Electronic Components for Space Application.
- No. 22800, ESCC Non-Conformance Control System.
- No. 22900, Total Dose Steady-State Irradiation Test Method.
- No. 23100, Recommendations on the use of the ESCC Specification System for the Evaluation and Procurement of Unqualified Components.
- No. 23500, Lead Materials and Finishes for Components for Space Application.
- No. 24200, Electrical Test Methods for Crystal Controlled Oscillators.
- No. 24600, Minimum Quality System Requirements.
- No. 24800, Resistance to Solvents of Marking, Materials and Finishes.

For qualification and qualification maintenance or procurement of qualified Oscillators, with the exception of ESCC Basic Specifications Nos. 20100, 21700, 22800 and 24600, where Manufacturers' specifications are equivalent to, or more stringent than, the ESCC Basic Specifications listed above, they may be used in place of the latter, subject to the approval of the ESCC Executive. Such replacements shall be clearly identified in the applicable Process Identification Document (PID).

For procurement of unqualified Oscillators, where Manufacturers' specifications are equivalent to or more stringent than the applicable ESCC Basic Specifications listed above, they may be used in place of the latter subject to the approval of the Orderer.

Such replacements may be listed in an appendix to the appropriate Detail Specification at the request of the Manufacturer or Orderer, subject to the approval of the ESCC Executive.

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

2.2 OTHER APPLICABLE DOCUMENTS

- ECSS-Q-ST-60,Electrical, Electronic and Electromechanical (EEE) Components.
- ECSS-Q-ST-60-15,Radiation Hardness Assurance - EEE Components.
- ECSS-Q-ST-70,Materials, Mechanical Parts and Processes.
- ECSS-Q-ST-70-08, The Manual Soldering of High-Reliability Electrical Connections.
- ECSS-Q-ST-70-10, Qualification of Printed Circuit Boards
- ECSS-Q-ST-70-11,Procurement of Printed Circuit Boards.
- ECSS-Q-ST-70-38, High-Reliability Soldering for Surface Mount and Mixed Technology.
- MIL-STD-883,Test Methods Standard, Microcircuits.
- MIL-STD-202, Test Methods Standard, Electronic and Electrical Component Parts.
- MIL-STD-1580, Destructive Physical Analysis for Electronic, Electromagnetic, and Electromechanical Parts.
- IEC 60758,Synthetic Quartz Crystal Specifications and Guide to the Use.

2.3 OTHER (REFERENCE) DOCUMENTS

- REP005, ESCC Qualified Parts List.
- REP006, ESCC Qualified Manufacturers List.
- IEC 60410,Sampling plans and procedures for inspection by attributes.

2.4 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) ESCC Detail Specification.
(b) ESCC Generic Specification.
(c) ESCC Basic Specification.
(d) Other documents, if referenced herein.

3 TERMS, DEFINITIONS, ABBREVIATIONS, SYMBOLS AND UNITS

The terms, definitions, abbreviations, symbols and units specified in ESCC Basic Specification No. 21300 shall apply. In addition following definitions apply:

Supplier: Manufacturer of add-on components or materials.

Material: "Materials" refer to non-electronic piece parts as: attachment, wires, cables, ribbons, carriers, mechanical parts, packages, substrate and PCBs.

Add-on components: Add-on components are the individual active or passive piece parts for Oscillator assembly such as:

- Microcircuits and Semiconductors in die form
- Discrete Active Components (encapsulated)
- Passive Components (in die form or packaged)
- Crystal Units (in blank form or packaged)

Swept Crystal: Swept crystals are crystals that have undergone a solid-state electro-diffusion purification process. Swept crystals have increased resistance to radiation.

Production Lot: A production lot consists of a single oscillator type manufactured on the same production line by the same production techniques according to the same oscillator design and with the same add-on components and materials incoming inspection lots during one uninterrupted period.

XO: The simplest and most general-purpose-type of crystal oscillator where the principal control element is the crystal unit. Because the XO employs no means of temperature control or compensation, it exhibits a frequency-temperature characteristic determined mainly by the crystal unit employed.

VCXO: Voltage controlled oscillator: A crystal oscillator whose output frequency can be offset or modulated by application of an external control voltage. Similar to the XO, the frequency-temperature characteristic of a VCXO is determined mainly by the crystal unit employed.

TCXO: Temperature controlled oscillator: A crystal oscillator whose frequency-temperature deviation is reduced from that of the crystal unit by an electronic (analog or digital) means of compensation within the device. TCXO-type devices are crystal oscillators in which compensation is achieved by a temperature-dependent variation of the crystal load reactance in a manner that compensates for the crystal unit's frequency-temperature characteristic.

Oscillators covered by this specification are identified in the technology classes as follows:

Class 1: Oscillators using discrete technology. This technology uses exclusively discrete (encapsulated) type electronic components (including surface mount devices) assembled and interconnected on a printed circuit board or an insulating substrate.

Class 2: Oscillators using microelectronic (hybrid) technology. This technology uses microelectronic circuit elements electrically and mechanically interconnected on an insulating substrate upon which resistors, capacitors, or conductors have been deposited, and used in hermetic package that will be backfilled with an inert gas.

4 REQUIREMENTS

4.1 GENERAL

The requirements for the qualification of an Oscillator shall be in accordance with ESCC Basic Specification No. 20100.

The test requirements for procurement of both qualified and unqualified Oscillators (see Chart F1) shall comprise:

- Production Control:
  - Requirements for add-on components and materials
  - Special In-Process Controls
- Screening Tests.
- Periodic Testing (for qualified Oscillators only).
- Lot Validation Testing if stipulated in the Purchase Order.

4.1.1 Specifications

For qualification, qualification maintenance, procurement and delivery of Oscillators in conformity with this specification, the applicable 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 ESCC 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 Oscillators unless it is agreed by the ESCC Executive (for qualification, qualification maintenance, or procurement of qualified Oscillators) or the Orderer (for procurement of unqualified Oscillators), to use an approved external facility.

4.1.4 Inspection Rights

The ESCC Executive (for qualification, qualification maintenance, or procurement of qualified Oscillators), or the Orderer (for procurement of unqualified Oscillators if stipulated in the Purchase Order), reserves the right to monitor any of the tests and inspections scheduled in the applicable specifications.

4.1.5 Pre-Encapsulation Customer Source Inspection

If stipulated in the Purchase Order, the Orderer may perform a source inspection at the Manufacturer's facility prior to encapsulation (including, for example, performance of Internal Visual Inspection, witness of Bond Strength and Shear). Details of the inspections to be performed or witnessed and the required period of notification shall be as stipulated in the Purchase Order.

Depending of the Oscillator class (Class 1 or 2), two source inspections, before and after crystal assembly, may be necessary.

4.2 QUALIFICATION AND QUALIFICATION MAINTENANCE REQUIREMENTS ON A MANUFACTURER

To obtain and maintain the qualification of an Oscillator, or family of Oscillators, a Manufacturer shall satisfy the requirements of ESCC Basic Specification No. 20100.

4.3 DELIVERABLE COMPONENTS

4.3.1 ESCC Qualified Oscillators

Oscillators delivered to this specification shall be processed and inspected in accordance with the relevant Process Identification Document (PID).

4.3.2 ESCC Oscillators

Each Oscillator, irrespective of qualification status, identified with an ESCC Component Number and delivered to this specification shall:

- be traceable to its production lot. All add-on components, process and materials used shall be traced to their respective production lot allowing a bidirectional and unequivocal relationship between add-on components, materials, processes and Oscillators.
- have satisfactorily completed all the tests required by the relevant issues of the applicable specifications.
- be produced from lots that are considered by the Manufacturer to be capable of passing all applicable tests, and sequences of tests, that are defined in Chart F4. The Manufacturer shall not knowingly supply Oscillators that cannot meet this requirement. In the event that, subsequent to delivery and prior to operational use, an Oscillator is found to be in a condition such that, demonstrably, it could not have passed these tests at the time of manufacture, this shall be grounds for rejection of the delivered lot.

4.3.3 Lot Failure

Lot failure may occur during Special In-Process Controls (Chart F2), Screening Tests (Chart F3), or Qualification and Periodic Tests (Chart F4).

Should such failure occur during qualification, qualification maintenance or procurement of qualified Oscillators, the Manufacturer shall initiate the non-conformance procedure in accordance with ESCC Basic Specification No. 22800. The Manufacturer shall notify the Orderer and the ESCC Executive by any appropriate written means, within 5 working days, giving details of the number and mode of failure and the suspected cause. No further testing or analysis shall be performed on the failed Oscillators until so instructed by the ESCC Executive.

Should such failure occur during procurement of unqualified Oscillators, the Manufacturer shall notify the Orderer by any appropriate written means within 5 working days, giving details of the number and mode of failure and the suspected cause. No further testing or analysis shall be performed on the failed Oscillators until so instructed by the Orderer. The Orderer shall inform the Manufacturer within 5 working days of receipt of notification what action shall be taken.

4.4 MARKING

All Oscillators procured and delivered to this specification shall be marked in accordance with ESCC Basic Specification No. 21700.

4.5 MATERIALS AND FINISHES

Specific requirements for materials and finishes are specified in the Detail Specification. Where a definite material or finish is not specified a material or finish shall be used so as to ensure that the Oscillator meets the performance requirements of this specification and the Detail Specification. Acceptance or approval of any constituent material or finish does not guarantee acceptance of the finished product.

Unless otherwise specified in the Detail Specification, the Oscillator shall be hermetically sealed and shall have a metal body with hard glass seal or a ceramic body. The Oscillator case lid shall be welded, brazed, preform soldered or glass frit sealed.

All materials and finishes of the Oscillators specified in the Detail specification shall comply with the restrictions on materials specified in ESCC Basic Specification No. 22600.

4.6 RADIATION TESTING

For qualification or qualification maintenance, total dose radiation testing shall be performed when specified in the Detail Specification to the specified total dose level, in accordance with ESCC Basic Specification No. 22900, unless relevant data are available for the applicable add-on components. In this respect, the criteria for acceptance of data intended to substitute actual total dose radiation testing shall be defined in the PID and will be subjected to review and approval by the ESCC Executive.

For procurement, as stipulated in the Purchase Order, total dose radiation testing shall be performed to the total dose level specified in the Detail Specification or to an alternative radiation test plan if so stipulated in the Purchase Order.

4.7 ADD-ON COMPONENTS AND MATERIALS

Add-on components and materials used in Oscillators supplied to this specification shall meet the requirements of Para. 5.2 and the relevant procurement specifications.

For qualified Oscillators, the requirements for add-on components and materials shall also be defined in the PID.

5 PRODUCTION CONTROL

5.1 GENERAL

Unless otherwise specified herein or in the Detail Specification, all lots of Oscillators used for qualification and qualification maintenance, Lot Validation Testing and for delivery shall be subject to tests and inspections in accordance with Chart F2 in the sequence shown. Any Oscillators which do not meet these requirements shall be removed from the lot and at no future time be resubmitted to the requirements of this specification.

The applicable test requirements are detailed in the paragraphs referenced in Chart F2.

For qualified Oscillators the full production control provisions are defined in the PID.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.3.

5.2 REQUIREMENTS FOR ADD-ON COMPONENTS AND MATERIALS

5.2.1 Selection of Add-On Components And Materials

The selection of add-on components and materials shall be made in accordance with the requirements of ECSS-Q-ST-60 and ECSS-Q-ST-70 respectively. For qualified Oscillators, the selection criteria shall also be defined in the PID.

All add-on components and materials shall be procured as traceable homogeneous lots.

For add-on components and materials, the same restrictions apply as defined in Para. 4.5 herein.

For qualified Oscillators, the PID shall include a list of add-on components and materials which have been successfully procured and tested in accordance with this specification and approved for their inclusion in the PID by the ESCC Executive

Printed circuit boards shall be procured in according with ECSS-Q-ST-70-11 from a Manufacturer qualified by ESA in accordance with ECSS-Q-ST-70-10.

For qualified Oscillators, add-on components shall be shall be ESCC Qualified as evidenced by a listing in the current ESCC Qualified Parts List REP005 or ESCC Qualified Manufacturers List REP006, with the exception of naked semiconductor dice add-on components selected in accordance with Para. 5.2.2.4 herein. If the required component types are not available, ECSS-Q-ST-60 requirements for Class 1 components shall be applied,

Pure Tin (≥ 97 %) shall not be used on any internal and external elements of the Oscillator; this includes under plating.

5.2.2 Specifications and Test Requirements For Add-On Components

Each add-on component shall be controlled by a procurement specification.

The procurement specification of ESCC Qualified add-on components listed in REP005 or REP006 shall be the relevant listed ESCC Detail Specification.

For qualified Oscillators, where add-on components which are not ESCC Qualified are used, these procurement specifications shall:

(a) be approved by the ESCC Executive
(b) be subject to configuration control as defined in the PID
(c) include requirements for procurement, storage and relife as defined in PID.

The minimum screening test requirements applicable to add-on components shall be those of the applicable ESCC Detail Specifications or equivalent to those of the nearest ESCC Detail Specification plus as detailed in the following subparagraphs.

All testing of add-on components shall be performed at the Oscillator Manufacturer’s facility or at a source approved by the ESCC Executive for qualified Oscillators, or by the Orderer for unqualified Oscillators.

5.2.2.1 Crystals and Crystal Units

The Crystals used in the Oscillators specified herein shall be swept synthetic quartz meeting the infrared quality requirements of grade A or B of IEC 60758.

For discrete (encapsulated) crystal units, the requirements of ESCC No. 3501 shall apply.

Crystals shall be assembled with at least a three-point mount.

5.2.2.2 Passive Encapsulated Chips

Each lot shall undergo a bondability test prior to use in Oscillator production. 10 samples selected at random from each procured lot shall be assembled into suitable packages that simulate the assembly methods, processes and materials to be used in production. The so assembled test vehicle(s) shall be submitted to the following tests:

(a) High Temperature Stabilization Bake in accordance with MIL-STD-883, Test Method 1008 condition C as a minimum.

(b) Temperature Cycling in accordance with MIL-STD-883 test method 1010, Test Condition B, 100 Cycles, 10°C/minute maximum.

(c) Bond Pull and Shear tests:
If wire bonding is used, a minimum of 22 bond wires shall be tested.
A Shear test shall then be performed on all the chips.
Results shall conform to MIL-STD-883, Test Method 2011 for bond pull strength if wire bonding is used, and MIL-STD-883, Test Method 2019 for die shear strength, with no failures allowed. Individual separation forces and categories shall be recorded.

5.2.2.3 Bare Passive Chips

Each lot shall undergo a bondability test prior to use in Oscillator production. 10 samples selected at random from each procured lot shall be assembled into suitable packages that simulate the assembly methods, processes and materials to be used in production. The so assembled test vehicle(s) shall be submitted to the following tests:

(a) Thermal Ageing: storage at T_{amb} = +300°C for 1 hour.

(b) Bond Pull and Shear tests:
If wire bonding is used, a minimum of 22 bond wires shall be tested.
A shear test shall then be performed on all the chips.
Results shall conform to MIL-STD-883, Test Method 2011 for bond pull strength if wire bonding is used, and MIL-STD-883, Test Method 2019 for die shear strength, with no failures allowed. Individual separation forces and categories shall be recorded.

5.2.2.4 Naked Semiconductor Dice

Each wafer lot shall be subjected to testing in accordance with the requirements of Para. 5.2.2.4.1 prior to use in Oscillator production in order to verify:

- The ability of the dice to be bonded / wire-bonded
- The reliability of the dice after assembly and screening.

Successful completion of those tests allows the procured lot to be used in production

5.2.2.4.1 Naked Semiconductor Dice Testing

Each wafer lot shall be subjected to tests and inspections in accordance with Chart F5 and as follows, in the sequence shown:

(a) Wafer Lot Acceptance in accordance with ESCC 5000 or 9000, as applicable.

(b) Wafer Screening in accordance with the following:

i. Electrical Measurements at Room Temperature:
100% DC probe electrical measurements with traceability and wafer mapping, shall be performed on all the procured wafers at room temperature in accordance with Room Temperature Electrical Measurements of the applicable procurement specification. All values obtained shall be recorded by location.
All failed dice shall be clearly identified and rejected.
As an alternative to on-wafer measurements, all dice may be measured after dice separation, in accordance with Room Temperature Electrical Measurements of the applicable procurement specification provided that full traceability to the wafer is maintained.

ii. Electrical Measurements at High and Low Temperatures:
DC probe electrical measurements with traceability and wafer mapping, shall be performed on all the procured wafers at high and low temperatures in accordance with High and Low Temperatures Electrical Measurements of the applicable procurement specification. The measurements shall be performed on 5 sample dice selected at random from each wafer. All values obtained shall be recorded.
All failed dice shall be clearly identified and rejected.
As an alternative to on-wafer measurements, the 5 dice may be measured after dice separation, in accordance with High And Low Temperatures Electrical Measurements of the applicable procurement specification provided that full traceability to the wafer is maintained.
A wafer shall be counted as a limit failure if one or more parameters on any of the probed 5 sample dice exceeds the limits specified in High and Low Temperatures Electrical Measurements of the applicable procurement specification.
If a limit failure occurs, further electrical measurements shall be performed to General Inspection Level I, AQL 1.0 of IEC 60410 on the remaining dice of the wafer containing the failed dice. If a further failure occurs, the wafer shall be rejected.

iii. Wafer dicing: in accordance with the PID

iv. 100% die visual inspection: in accordance with ESCC 20400 and the relevant paragraphs of the appropriate ESCC ancillary basic specification.

(c) Bondability
5 sample dice selected at random from each lot shall be assembled into suitable packages that simulate the assembly methods, processes and materials to be used in Oscillator production. The so assembled test vehicle(s) shall be submitted to the following tests:

i. Thermal Ageing: storage at T_{amb} = +300°C for 1 hour.

ii. Bond Pull and Shear tests:
For Bond Pull, a minimum of 20 bond wires shall be tested.
A shear test shall then be performed on all the dice.
Results shall conform to MIL-STD-883 Test Method 2011 for bond pull strength, and MIL-STD-883 Test Method 2019 for die shear strength, with no failures allowed. Individual separation forces and categories shall be recorded.

(d) Packaged Test Sublot Testing
Sample dice shall be selected at random and assembled into suitable packages that simulate the assembly methods, processes and materials to be used in Oscillator production.
The quantities to be selected and assembled are 18 dice per wafer.
For qualified Oscillators, the packages shall be as specified in the PID.
The so assembled test vehicles shall be submitted to tests similar to Screening Tests and Lot Validation Testing (LVT) in accordance with the requirements of ESCC Generic Specification No. 5000 or 9000 (as applicable), as follows:

i. 'Screening'
- Encapsulation and serialisation.
- High temperature storage: T_{amb} = +125°C for 72 hours
- Temperature cycling: in accordance with MIL-STD-883, Test Method 1010, Test Condition B, 10 cycles, 30°C/minute.
- Constant acceleration: in accordance with MIL-STD-883, Test Method 2001, Test Condition B, Y1 axis
- Initial electrical test at room, high and low temperatures. Read and record.
- Burn-In: 240 hours at T_{amb} = +125°C
- Final electrical test at room temperatures. Read and record.
- Parameter drift calculation. Read and record.

ii. 'LVT'
Split of the Packaged Test Sublot: 7 per wafer for Life Test and 11 per wafer for Radiation Testing (if required):
- Endurance Testing (on 7 test vehicles per wafer):
  1) Life test: 1000 hours at T_{amb} = +125°C
  2) Final electrical test at room temperatures. Read and record.
  3) Bond Pull (on 22 bond wires minimum) in accordance with MIL-STD-883, Test Method 2011, Test Condition C. Individual separation forces and categories shall be recorded.
  4) Shear test (5 dice minimum) in accordance with MIL-STD-883, Test Method 2019. Individual separation forces and categories shall be recorded.
- Radiation Testing (on 11 test vehicles per wafer, if required):
  Total dose radiation testing shall be performed in accordance with ESCC Basic Specification No. 22900 and the applicable procurement specification. All electrical measurement values obtained shall be recorded.

iii. Check for wafer lot failure according to the below table:

Samples Number (per wafer)	Number of defects allowed after				Accumulated defects	
	'Screening': Electrical Tests	'Screening': Burn-In	'LVT': Endurance Testing	'LVT': Radiation Testing	Wafer Lot Rejection	Wafer Lot Acceptance
18	0/18	0/18	0/7	0/11	1	0

5.2.3 Traceability Requirements For Add-On Components And Materials

All add-on components and materials used shall be traceable to their Oscillator production lot and their individual incoming inspection lots.

Records shall be maintained for a minimum of 10 years to provide traceability from each Oscillator serial number to the add-on components' production lots.

In case of materials with limited shelf life, appropriate means to verify the validity of the relevant material shall be in place. The verification and re-certification shall be in compliance with the Manufacturer's QM plan and, for qualified Oscillators, the PID.

5.2.4 Changes in Add-On Components And Materials

The Manufacturer shall be responsible for controlling all add-on components and materials.

Any change must be controlled, evaluated and documented by the Manufacturer and finally notified to and approved by the ESCC Executive for qualified Oscillators or the Orderer for unqualified Oscillators. This is also applicable to any additional testing of add-on components due to any change.

5.2.5 Documentation of Add-On Components

Documentation applicable to add-on components shall be in accordance with Para. 9.5.

5.3 SPECIAL IN-PROCESS CONTROLS

5.3.1 Internal Visual Inspection

Internal Visual Inspection shall be performed in accordance with Para. 8.1.

5.3.2 Bond Strength, And Shear (Class 2 Oscillators Only)

Bond Strength and Shear tests shall be performed on test samples in accordance with Para. 8.2.1. A single failure shall be cause for lot failure. These tests are considered as destructive and therefore Oscillators so tested shall not form part of the delivery lot.

5.3.3 High Temperature Stabilisation Bake (Pre-Encapsulation)

A High Temperature Stabilisation Bake shall be performed prior to encapsulation in accordance with Para. 8.4.

5.3.4 Dimension Check

Dimension Check shall be performed in accordance with Para. 8.9 on 3 samples only. In the event of any failure a 100% Dimension Check shall be performed.

5.3.5 Weight

The maximum weight of the Oscillator specified in the Detail Specification shall be guaranteed but not tested.

5.3.6 Internal Water Vapour Content (Class 2 Oscillators Only)

Internal Water Vapour content shall be performed in accordance with Para. 8.20 on 1 sample minimum per production lot. A single failure shall be cause for lot failure. This test is considered destructive and therefore Oscillators so tested shall not form part of the delivery lot.

5.3.7 Documentation

Documentation of Special In-Process Controls shall be in accordance with Para. 9.6.

6 SCREENING TESTS

6.1 GENERAL

Unless otherwise specified herein or in the Detail Specification, all lots of Oscillators used for qualification and qualification maintenance, Lot Validation Testing, and for delivery, shall be subjected to tests and inspections in accordance with Chart F3 in the sequence shown. All Oscillators shall be serialised prior to the tests and inspections.

Any Oscillators which do not meet these requirements shall be removed from the lot and at no future time be resubmitted to the requirements of this specification.

The applicable test methods and conditions are specified in the paragraphs referenced in Chart F3.

6.2 FAILURE CRITERIA

6.2.1 Environmental And Mechanical Test Failure

The following shall be counted as failures:

- Oscillators which fail during tests for which the pass/fail criteria are inherent in the test method, i.e. Constant Acceleration, PIND, Radiographic Inspection, Seal, External Visual Inspection and Solderability

6.2.2 Parameter Drift Failure

The acceptable change limits are shown in Parameter Drift Values in the Detail Specification. An Oscillator shall be counted as a parameter drift failure if the changes during Burn-in are larger than the drift values (Δ) specified.

6.2.3 Parameter Limit Failure

An Oscillator shall be counted as a limit failure if one or more parameters exceed the limits shown in Room Temperature Electrical Measurements or High and Low Temperatures Electrical Measurements in the Detail Specification.

Any Oscillator which exhibits a limit failure prior to the submission to Burn-in shall be rejected and not counted when determining lot rejection.

6.2.4 Other Failures

An Oscillator shall be counted as a failure in any of the following cases:

- Visual failure.
- Mechanical failure.
- Handling failure.
- Lost Oscillator.

6.3 FAILED OSCILLATORS

An Oscillator shall be considered as a failed Oscillator if it exhibits one or more of the failure modes described in Para. 6.2.

6.4 LOT FAILURE

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.3.

6.4.1 Lot Failure During 100% Testing

If the number of Oscillators failed on the basis of the failure criteria specified in Paras. 6.2.2 and 6.2.3 exceeds 5% (rounded upwards to the nearest whole number) of the Oscillators submitted to Burn-in of Chart F3, the lot shall be considered as failed.

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

6.4.2 Lot Failure During Sample Testing

A lot shall be considered as failed if the number of allowable failures during sample testing as specified herein or in the Detail Specification, is exceeded.

Unless otherwise specified, if a lot failure occurs, a 100% testing may be performed but the cumulative percent defective shall not exceed that specified in Para. 6.4.1.

No failures are allowed for the Solderability test.

6.5 DOCUMENTATION

Documentation of Screening Tests shall be in accordance with Para. 9.7.

7 QUALIFICATION, QUALIFICATION MAINTENANCE AND LOT VALIDATION TESTING

The requirements of this paragraph are applicable to the tests performed on Oscillators as part of qualification or qualification maintenance in accordance with ESCC Basic Specification No. 20100. They are also applicable to Lot Validation Testing as part of the procurement of qualified or unqualified Oscillators.

7.1 QUALIFICATION TESTING

7.1.1 General

Qualification testing shall be in accordance with the requirements specified in Chart F4. The tests of Chart F4 shall be performed on the specified sample, chosen at random from Oscillators which have successfully passed the tests in Chart F3. This sample constitutes the Qualification Test Lot.

The Qualification Test Lot is divided into subgroups of tests and all Oscillators 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 F4.

The conditions governing qualification testing are specified in ESCC Basic Specification No. 20100.

7.1.2 Distribution Within The Qualification Test Lot

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

The distribution shall be as specified by, or agreed with, the ESCC Executive.

7.2 QUALIFICATION MAINTENANCE (PERIODIC TESTING)

Qualification is maintained through periodic testing and the test requirements of Para. 7.1 shall apply. For each subgroup, the sample size and the period between successive subgroup testing shall be as specified in Chart F4. The conditions governing qualification maintenance are specified in ESCC Basic Specification No. 20100.

7.3 LOT VALIDATION TESTING

For procurement of qualified Oscillators, Lot Validation Testing is not required and shall only be performed if specifically stipulated in the Purchase Order.

For procurement of unqualified Oscillators, the need for Lot Validation Testing shall be determined by the Orderer (ref. ESCC Basic Specification No. 23100).

When Lot Validation Testing is required, it shall consist of the performance of one or more of the tests or subgroup test sequences of Chart F4. The testing to be performed and the sample size shall be as stipulated in the Purchase Order.

When procurement of more than one Oscillator type is involved from a family, range or series, the selection of representative samples shall also be stipulated in the Purchase Order.

7.4 FAILURE CRITERIA

The following criteria shall apply to qualification, qualification maintenance and Lot Validation Testing.

7.4.1 Environmental And Mechanical Test Failures

The following shall be counted as failures:

- Oscillators which fail during tests for which the pass/fail criteria are inherent in the test method, e.g. Seal, Lead Integrity, etc.

7.4.2 Electrical Failures

The following shall be counted as failures:

- Oscillators which fail one or more of the applicable limits at each of the relevant data points specified for environmental, mechanical and endurance testing in Intermediate and End-Point Electrical Measurements in the Detail Specification.

7.4.3 Other Failures

An Oscillator shall be counted as a failure in any of the following cases:

- Visual failure
- Mechanical failure
- Handling failure
- Lost Oscillator

7.5 FAILED OSCILLATORS

An Oscillator shall be considered as failed if it exhibits one or more of the failure modes detailed in Para. 7.4.

When requested by the ESCC Executive (for qualification, qualification maintenance or procurement of qualified Oscillators) or the Orderer (for procurement of qualified or unqualified Oscillators), failure analysis of failed Oscillators shall be performed under the responsibility of the Manufacturer and the results provided.

Failed Oscillators shall be retained at the Manufacturer's plant until the final disposition has been agreed and certified.

7.6 LOT FAILURE

For qualification and qualification maintenance, the lot shall be considered as failed if one Oscillator in any subgroup of Chart F4 is a failed Oscillator based on the criteria specified in Para. 7.4.

For procurement, the lot shall be considered as failed if one Oscillator in any test specified for Lot Validation Testing is a failed Oscillator based on the criteria specified in Para. 7.4.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 4.3.3.

7.7 QUALIFICATION, QUALIFICATION MAINTENANCE AND LOT VALIDATION TESTING SAMPLES

All tests of Chart F4 are considered to be destructive and therefore Oscillators so tested shall not form part of the delivery lot.

7.8 DOCUMENTATION

Documentation of qualification, qualification maintenance and Lot Validation Testing shall be in accordance with Para. 9.8.

8 TEST METHODS AND PROCEDURES

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

For a qualified Oscillator, documentation supporting the change shall be approved by the ESCC Executive and retained by the Manufacturer. It shall be copied, when requested, to the ESCC Executive. The change shall be specified in an appendix to the Detail Specification and in the PID.

For an unqualified Oscillator, the change shall be approved by the Orderer. The change may be specified in an appendix to the Detail Specification at the request of the Manufacturer or Orderer, subject to the approval of the ESCC Executive.

8.1 INTERNAL VISUAL INSPECTION

8.1.1 Class 1 Oscillators
Oscillators shall be inspected in accordance with ECSS-Q-ST-70-08 and ECSS-Q-ST-70-38.

8.1.2 Class 2 Oscillators
Oscillators shall be inspected in accordance with ESCC Basic Specification No. 20400 and the following specifications:

- MIL-STD-883, Test Method 2017, Class K requirements, to the extent applicable to the hybrid part of the Oscillator.
- ESCC Basic Specification No. 2043501 to the extent applicable to the crystal inside the Oscillator.

8.2 BOND STRENGTH, AND SHEAR

8.2.1 Bond Strength During Special In-Process Controls (Class 2 Oscillators only)
MIL-STD-883, Test Method 2011.

- Test Condition: D for thermo-compression, ultrasonic or wedge bonding.
- Test Samples:
  The required test samples shall be selected at random from the lot of Oscillators accepted after Internal Visual Inspection.
  - Quantity of internal bond wires ≤ 25: Test samples = 2, Test all bond wires
  - Quantity of internal bond wires > 25: Test samples = 1, Test all bond wires

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

8.2.2 Bond Strength During Qualification And Periodic Tests (DPA) (Class 2 Oscillators only
MIL-STD-883, Test Method 2011.

- Test Condition: D for thermo-compression, ultrasonic or wedge bonding.
- Test Samples:
  All bond wires of one sample Oscillator selected from the Oscillators submitted to DPA of Chart F4 shall be tested.

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

8.2.3 Shear (Class 2 Oscillators only
MIL-STD-883, Test Method 2019.

The same test samples submitted to Bond Strength shall be used. All dice, chips and crystal studs shall be tested. Individual separation forces and categories shall be recorded. A single failure shall be cause for lot failure.

8.3 RADIATION TESTING
ESCC Basic Specification No. 22900 to the total dose level specified in the Detail Specification or as stipulated in the Purchase Order.

8.4 HIGH TEMPERATURE STABILISATION BAKE
MIL-STD-883, Test Method 1008.

- Duration: 24 hours at maximum storage temperature rating specified in the Detail Specification.

8.5 TEMPERATURE CYCLING
MIL-STD-883, Test Method 1010, Test Condition B. The temperature extremes shall not exceed the maximum storage temperature rating specified in the Detail Specification.

8.6 PARTICLE IMPACT NOISE DETECTION (PIND) (CLASS 2 OSCILATORS ONLY)
MIL-STD-883, Test Method 2020, Test Condition A.

8.7 SEAL

8.7.1 Seal, Fine Leak
MIL-STD-883, Test Method 1014, Condition A2.

8.7.2 Seal, Gross Leak
MIL-STD-883, Test Method 1014, Condition C.

8.8 ELECTRICAL MEASUREMENTS

8.8.1 General
When measured, the Oscillator shall meet the electrical measurements requirements as specified in the Detail Specification. As a minimum the following parameters shall be tested:

- Input Current-Power.
- Output Waveform, Frequency and Frequency Accuracy.
- Output Voltage.

Test methods and conditions shall be as specified in ESCC Basic Specification No. 24200. The details of the measurements set-up shall be as specified in the Manufacturer's documentation and shall be agreed by the ESCC Executive for qualified components, and by the Orderer for unqualified components.

All values obtained shall be recorded against Oscillator serial numbers.

8.8.2 Parameter Drift Values
At each of the relevant data points during Screening Tests, Parameter Drift Values shall be measured as specified in the Detail Specification. All values obtained shall be recorded against Oscillator serial numbers and the parameter drift calculated.

8.8.3 High And Low Temperatures Electrical Measurements
High and Low Temperatures Electrical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against Oscillator serial numbers.

8.8.4 Room Temperature Electrical Measurements
Room Temperature Electrical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against Oscillator serial numbers.

8.8.5 Intermediate And End-Point Electrical Measurements
At each of the relevant data points during Qualification and Periodic Tests, Intermediate and End-Point Electrical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against Oscillator serial numbers and the parameter drift calculated, if specified.

8.9 EXTERNAL VISUAL INSPECTION AND DIMENSION CHECK
External Visual Inspection shall be performed in accordance with ESCC Basic Specification No. 20500.

Dimension Check (during Special In-Process Controls only) shall be performed in accordance with ESCC Basic Specification No. 20500 and the Detail Specification on a sample of 3 Oscillators. In the event of any failure a 100% Dimension Check shall be performed.

8.10 RADIOGRAPHIC INSPECTION

8.10.1 Class 1 Oscillators
Oscillators shall be inspected in accordance with MIL-STD-883, Test Method 2012, views in X, Y and Z axes.

8.10.2 Class 2 Oscillators
Oscillators shall be inspected in accordance with ESCC Basic Specification No. 20900 and the following specifications:

- MIL-STD-883, Test Method 2012, views in X, Y and Z axes, to the extent applicable to the hybrid part of the Oscillator.
- ESCC Basic specification No. 2093501 to the extent applicable to the crystal inside the Oscillator.

NOTE: the performance of the test depends on the technology. The opacity of the construction materials, and the use of Aluminium bond wires and epoxy bonding for chips may effectively prevent radiographic identification of certain types of defects or materials from some or all possible viewing angles.

8.11 MECHANICAL SHOCK
MIL-STD-202, Test Method 213, Test Condition F (1500g, 0.5ms, half-sine).

8.12 RANDOM VIBRATION

8.12.1 Screening Tests (Class 1 Oscillators Only)
MIL-STD-202, Test Method 214, Test Condition I-B (7.56grms overall), 3 minutes per axis.

8.12.2 Qualification And Periodic Tests (Class 1 and 2 Oscillators)
MIL-STD-202, Test Method 214, Test Condition I-F (20.71grms overall), 3 minutes per axis.

8.13 CONSTANT ACCELERATION

8.13.1 Screening Tests (Class 2 Oscillators only)
MIL-STD-883, Test Method 2001, Test Condition A (5000g), Y1 axis only.

8.13.2 Qualification And Periodic Tests (Class 2 Oscillators only)
MIL-STD-883, Test Method 2001, Test Condition B (10000g), Y1 axis only.

8.14 THERMAL SHOCK
MIL-STD-883. Test Method 1011, Test Condition B. The temperature extremes shall not exceed the maximum storage temperature rating specified in the Detail Specification.

8.15 MOISTURE RESISTANCE
MIL-STD-883, Test Method 1004.

8.16 SOLDERABILITY
For procurement lots: 3 samples. A single failure shall be cause for lot failure.

MIL-STD-883, Test Method 2003, to be performed on all terminals.

Solderability testing may be performed on empty packages or electrical rejects. The test samples used must be of the same package type and must have been manufactured using the same process, at the same time and have been subjected to the same screening as the packages of the delivery lot with which they are associated.

For Oscillators with gold plated lead finish, a de-golding operation in accordance with ECSS-Q-ST-70-08 shall be performed prior the solderability test. Activated fluxes (RMA) may be used but shall be immediately cleaned off after dipping using an acceptable solvent.

Solderability testing is classed as destructive and therefore Oscillators so tested shall not form part of the delivery lot.

8.17 PERMANENCE OF MARKING
ESCC Basic Specification No. 24800.

8.18 LEAD INTEGRITY
MIL-STD-883, Test Method 2004, Test Condition B2, on 3 leads (excluding corner leads) or 10% of the leads (whichever is greater) randomly selected on each oscillator.

8.19 OPERATING LIFE

MIL-STD-883, Test Method 1005, Test Condition B. Unless otherwise specified, the following conditions shall apply:

- Duration: 2000 hours.
- Test Conditions:
  - Temperature: Maximum operating temperature rating as specified in the Detail Specification.
  - Supply Voltage: Nominal supply voltage as specified in the Detail Specification.
  - Output Load: as specified in the Detail Specification.
- Data Points: As specified in Intermediate and End-Point Electrical Measurements in the Detail Specification at 0 hour, 1000 ±48 hours and 2000 ±48 hours. If drift values are specified, the drift shall always be related to the 0 hour measurement.

8.20 INTERNAL WATER VAPOUR CONTENT (CLASS 2 OSCILLATORS ONLY)

MIL-STD-883, Test Method 1018, Procedure 1.

The internal water vapour content shall not exceed 5000ppm at T_{amb} = +100°C when tested. The value shall be recorded.

8.21 FREQUENCY AGEING

Oscillators shall be subjected to Frequency Ageing in accordance with the following requirements, unless otherwise specified:

- Duration: 30 days minimum.
- Test Conditions:
  - Ageing Temperature: T_{amb} = +70°C or maximum operating temperature as specified in the Detail Specification, whichever is lower.
  - Ageing Temperature Tolerance: ±3°C.
  - Ageing Temperature Measurement Tolerance (stability): ±0.2°C.
  - Supply Voltage: Nominal supply voltage as specified in the Detail Specification.
  - Output Load: as specified in the Detail Specification.
- Data Points:
  After insertion into the oven, the Oscillators shall be stabilised at the ageing temperature for 48 hours prior to beginning the measurement acquisition. Frequency shall be measured immediately after the stabilisation period, and then a minimum of four times per week at regular intervals for a minimum of 30 days. All measurements obtained shall be recorded against Oscillator serial numbers.

- Ageing Analysis:
  The measurements obtained shall be fit using the method of least squares to the function:
  $f(t) = A \times ln(B \times t + 1) + f_0$
  where f(t) is the frequency of the Oscillator, t days after the start of the ageing cycle (the time origin for measurements analysis shall be the beginning of the stabilisation period), and A, B and f_0 are constants determined from the least squares fit.

  For monotonic ageing, all the measurements shall be used for the curve fitting. If the ageing trend is not monotonic, the measurement period shall be extended to 40 days or longer after the extremum in the ageing trend, and the measurements from 12 days after the extremum is reached to the end of the ageing measurement period shall be fit to the above function.

  The total frequency change and/or the ageing rate at the end of the specified period shall be determined from the above equation using the constants determined from the least squares fit, as specified in Room Temperature Electrical Measurements in the Detail Specification. The square root of the least squares fit variance of the measurements from the curve-fit function shall not exceed 5% of the total ageing change allowed during the test period.

  If a projected total frequency change for a particular period (such as 1 year) is specified in the Detail Specification, it shall be determined by means of a linear extrapolation from the end of the ageing measurement period using the coefficients determined from the least squares fit.
  Example: The frequency change over a period of 1 year (365 days) for a total ageing measurement period of T_a, in days (where T_a is 30 days or longer), is given by:

$$\Delta f(1yr) = \frac{A \times B}{B \times T_a + 1} \times (365 - T_a) + \Delta f_{T_a}$$

  where $\Delta f_{T_a} = A \times \ln(B \times T_a + 1)$, and A and B are the constants determined from the least squares fit.

8.22 DESTRUCTIVE PHYSICAL ANALYSIS (DPA)

8.22.1 DPA for Class 1 Oscillators

Destructive Physical Analysis shall be performed in accordance with the following requirements:

1. External Visual Inspection: Para. 8.9.
2. Radiographic Inspection: Para. 8.10.1.
3. Seal (Fine and Gross Leak): Para. 8.7.
4. Decapsulation
5. Internal Visual Inspection: Para. 8.1.1
6. Microsections:

   At least one microsection shall be made on each type of add-on component. Each microsection shall be made on the add-on component having the worst solder joint appearance identified during the Internal Visual Inspection. No cracked solder joints or damaged components shall be observed.

   The microsections shall be stored for a period of at least ten years.

   For qualified Oscillators, the ESCC Executive shall have access to the microsections.

8.22.2 DPA for Class 2 Oscillators

Destructive Physical Analysis shall be performed in accordance with the following requirements:

NOTE: DPA test sequence depends on the technology and shall be performed in conformance with the requirements of MIL-STD-1580 with deviations when specified in the Detail Specification.

1. External Visual Inspection: Para. 8.9.
2. Radiographic Inspection: Para. 8.10.2.
3. Seal (Fine and Gross Leak): Para. 8.7.
4. PIND: Para. 8.6.
5. Internal Water Vapour Content: Para. 8.20.
6. Decapsulation.
7. Internal Visual Inspection: Para. 8.1.2.
8. SEM Inspection: MIL-STD-883, Test Method 2018
9. Bond Strength: Para. 8.2.2 (performed on all bond wires on one sample Oscillator).
10. Shear: Para. 8.2.3 (performed on one sample Oscillator).

8.23 BURN-IN

Unless otherwise specified, Oscillators shall be subjected to Burn-in in accordance with the following requirements:

- Duration: 240 hours minimum.
- Test Conditions:
  - Temperature: Maximum operating temperature rating as specified in the Detail Specification.
  - Supply Voltage: Nominal supply voltage as specified in the Detail Specification.
  - Output Load: as specified in the Detail Specification.
- Data Points: As specified in Parameter Drift Values in the Detail Specification at 0 and 240 (+24 -0) hours.

9 DATA DOCUMENTATION

9.1 GENERAL

For the qualification, qualification maintenance and procurement for each lot a data documentation package shall exist in a printed or electronic form.

This package shall be compiled from:

(a) Cover sheet (or sheets).
(b) List of equipment (testing and measuring).
(c) List of test references.
(d) Add-on Components Procurement and Testing Documentation (Chart F5).
(e) Special In-Process Controls data (Chart F2).
(f) Screening Tests data (Chart F3).
(g) Qualification and Periodic Tests data including Lot Validation Testing data (when applicable) (Chart F4).
(h) Failed Oscillators list and failure analysis report (when applicable).
(i) Certificate of Conformity.

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

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

Whenever possible, documentation should preferably be available in electronic format suitable for reading using a compatible PC. The format supplied shall be legible, durable and indexed. The preferred storage medium is CD-ROM and the preferred file format is PDF.

9.1.1 Qualification And Qualification Maintenance

In the case of qualification or qualification maintenance, the items listed in Para. 9.1(a) to (i) are required.

9.1.2 Oscillator Procurement And Delivery

For all deliveries of Oscillators procured to this specification, 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 Oscillator serial numbers).

9.1.3 Additional Documentation

The Manufacturer shall deliver additional documentation containing data and reports to the Orderer, if stipulated in the Purchase Order.

9.1.4 Data Retention/Data Access

If not delivered, all data shall be retained by the Manufacturer for a minimum of 10 years during which time it shall be available for review, if requested, by the Orderer or the ESCC Executive (for qualified Oscillators).

9.2 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 ESCC Generic Specification, including issue and date.
(c) ESCC Component Number and the Manufacturer's part type number.
(d) Lot identification.
(e) Range of delivered Oscillator serial numbers.
(f) Number of the Purchase Order.
(g) Radiation testing level (if applicable).
(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 Oscillator assembly and test).
(k) Signature on behalf of Manufacturer.
(l) Total number of pages of the data package.

9.3 LIST OF EQUIPMENT USED

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. This list shall indicate for which tests such equipment was used.

9.4 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.

9.5 ADD-ON COMPONENTS PROCUREMENT AND TESTING DOCUMENTATION (CHART F5)

For each lot of Oscillators, a summary of the procurement details applicable to all add-on components shall be compiled including:

- Procurement specification(s) number and quality level
- Manufacturer's name and location
- Lot identification
- Certificate of Conformity
- Traceability information against Oscillator serial number

For add-on component testing in accordance with Para. 5.2.2, a test result summary shall be compiled showing the total number of each add-on component submitted to and the total number rejected after each of the tests. For each test requiring electrical measurements, the results shall be recorded. Where a drift value is specified during a test the drift calculation shall be recorded. For all Bond Strength and Shear tests, the separation forces and categories shall be recorded.

9.6 SPECIAL IN-PROCESS CONTROLS DATA (CHART F2)

A test result summary shall be compiled showing the total number of Oscillators submitted to, and the total number rejected after each of the tests. For the Bond Strength and Shear tests, the separation forces and categories shall be recorded. For the Internal Water Vapour Contents test, the value shall be recorded.

9.7 SCREENING TESTS DATA (CHART F3)

A test result summary shall be compiled showing the total number of Oscillators submitted to and the total number rejected after each of the tests. For each test requiring electrical measurements, the results shall be recorded against Oscillator serial number. Drift calculations shall be recorded for each specified test against Oscillator serial number. For Radiographic Inspection, photographic results shall be recorded against Oscillator serial number. For Frequency Ageing, all measurements and Ageing Analysis results shall be recorded against Oscillator serial number.

9.8 QUALIFICATION AND PERIODIC TESTS DATA (CHART F4)

9.8.1 Qualification Testing

A test result summary shall be compiled showing the Oscillators submitted to, and the number rejected after each test in each subgroup. Oscillator serial numbers for each subgroup shall be identified. For each test requiring electrical measurements, the results shall be recorded against Oscillator serial number. Where a drift value is specified during a test the drift calculation shall be recorded against Oscillator serial number.

9.8.2 Periodic Testing For Qualification Maintenance

A test result summary shall be compiled showing the Oscillators submitted to and the number rejected after each test in each subgroup. Oscillator serial numbers for each subgroup shall be identified. For each test requiring electrical measurements, the results shall be recorded against Oscillator serial number. Where a drift value is specified during a test the drift calculation shall be recorded against Oscillator serial number.

In addition to the full test data a report shall be compiled for each subgroup of Chart F4 to act as the most recent Periodic Testing summary. These reports shall include a list of all tests performed in each subgroup, the ESCC Component Numbers and quantities of Oscillators tested, a statement confirming all the results were satisfactory, the date the tests were performed and a reference to the full test data.

9.8.3 Lot Validation Testing

A test result summary shall be compiled showing the Oscillators submitted to and the number rejected after each test in each subgroup (as applicable). Oscillator serial numbers for each subgroup shall be identified. For each test requiring electrical measurements, the results shall be recorded against Oscillator serial number. Where a drift value is specified during a test the drift calculation shall be recorded against Oscillator serial number.

9.8.4 DPA Report

When Destructive Physical Analysis has been performed for qualification, qualification maintenance or procurement, a DPA test report shall be compiled showing the total number of Oscillators submitted to and the total number rejected after each of the tests. For Radiographic Inspection, photographic results shall be recorded against Oscillator serial number. For the Internal Water Vapour Contents test, the value shall be recorded against Oscillator serial number. For Microsection (as applicable), photographic results shall be recorded against Oscillator serial number. For SEM Inspection (as applicable), photographic results shall be recorded against Oscillator serial number. For the Bond Strength and Shear tests (as applicable), the separation forces and categories shall be recorded against Oscillator serial number.

Photographs of typical assemblies and possible anomalies shall be provided in the report.

9.9 FAILED OSCILLATORS LIST AND FAILURE ANALYSIS REPORT

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

(a) The reference and description of the test or measurement performed as defined in this specification and/or the Detail Specification during Special In-Process Controls, Screening Tests and Qualification and Periodic Tests.
(b) Traceability information including serial number (if applicable) of the failed Oscillator.
(c) The failed parameter and the failure mode of the Oscillator.
(d) Detailed failure analysis (if requested by the ESCC Executive or Orderer).

9.10 CERTIFICATE OF CONFORMITY

A Certificate of Conformity shall be established in accordance with the requirements of ESCC Basic Specification No. 20100.

10 DELIVERY

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

(a) The delivery lot.
(b) The Oscillators used for Lot Validation Testing (as applicable), but not forming part of the delivery lot, if stipulated in the Purchase Order.
(c) The relevant documentation in accordance with the requirements of Paras. 9.1.2 and 9.1.3.

In the case of an Oscillator for which a valid qualification is in force, all data of all Oscillators submitted to Lot Validation Testing shall also be copied, when requested, to the ESCC Executive.

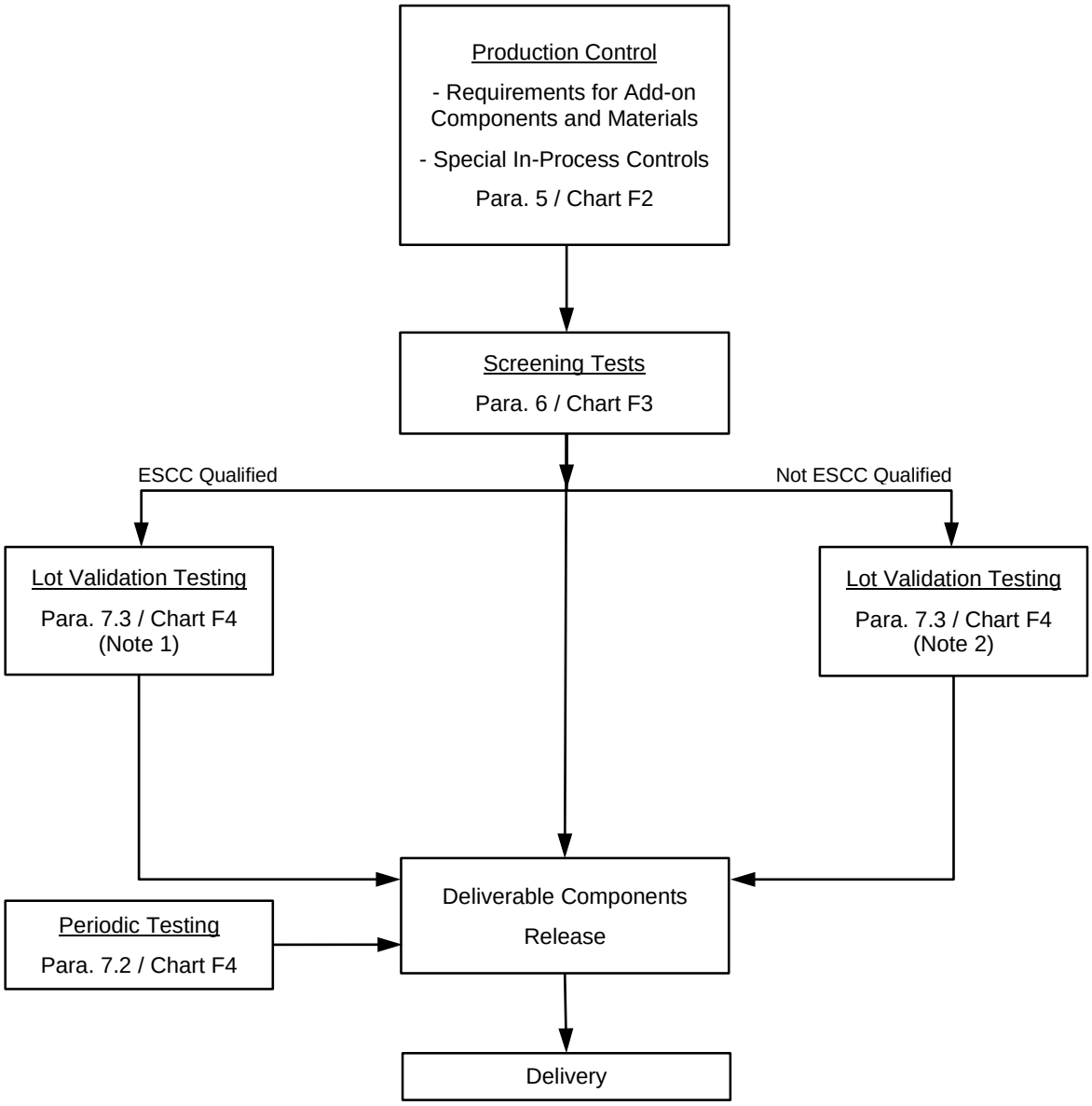
For qualification or qualification maintenance, the disposition of the Qualification Test Lot and its related documentation shall be as specified in ESCC Basic Specification No. 20100 and the relevant paragraphs of Section 9 of this specification.

11 PACKAGING AND DISPATCH

The packaging and dispatch of Oscillators to this specification shall be in accordance with the requirements of ESCC Basic Specification No. 20600.

12 CHARTS

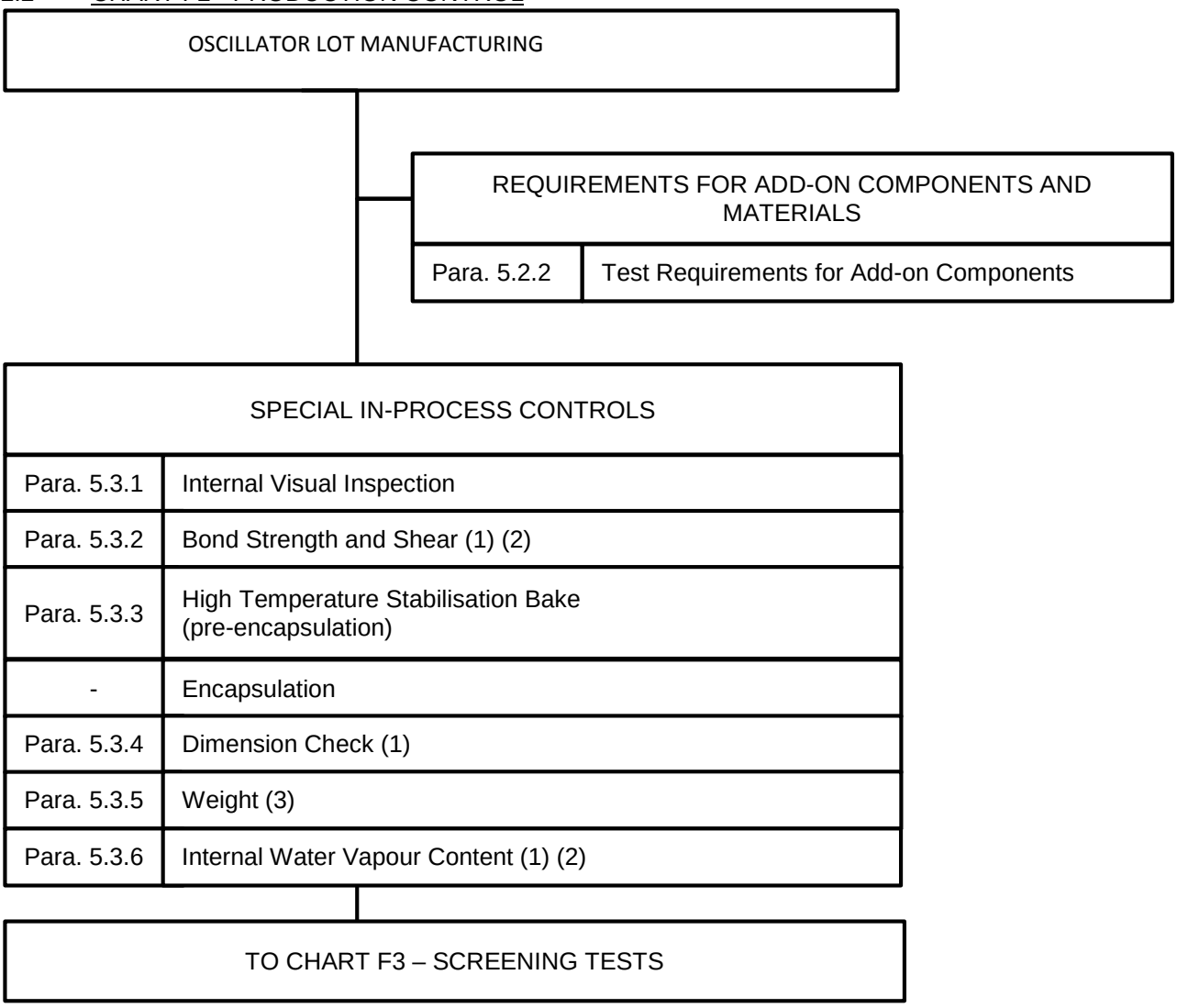
12.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT



NOTES:

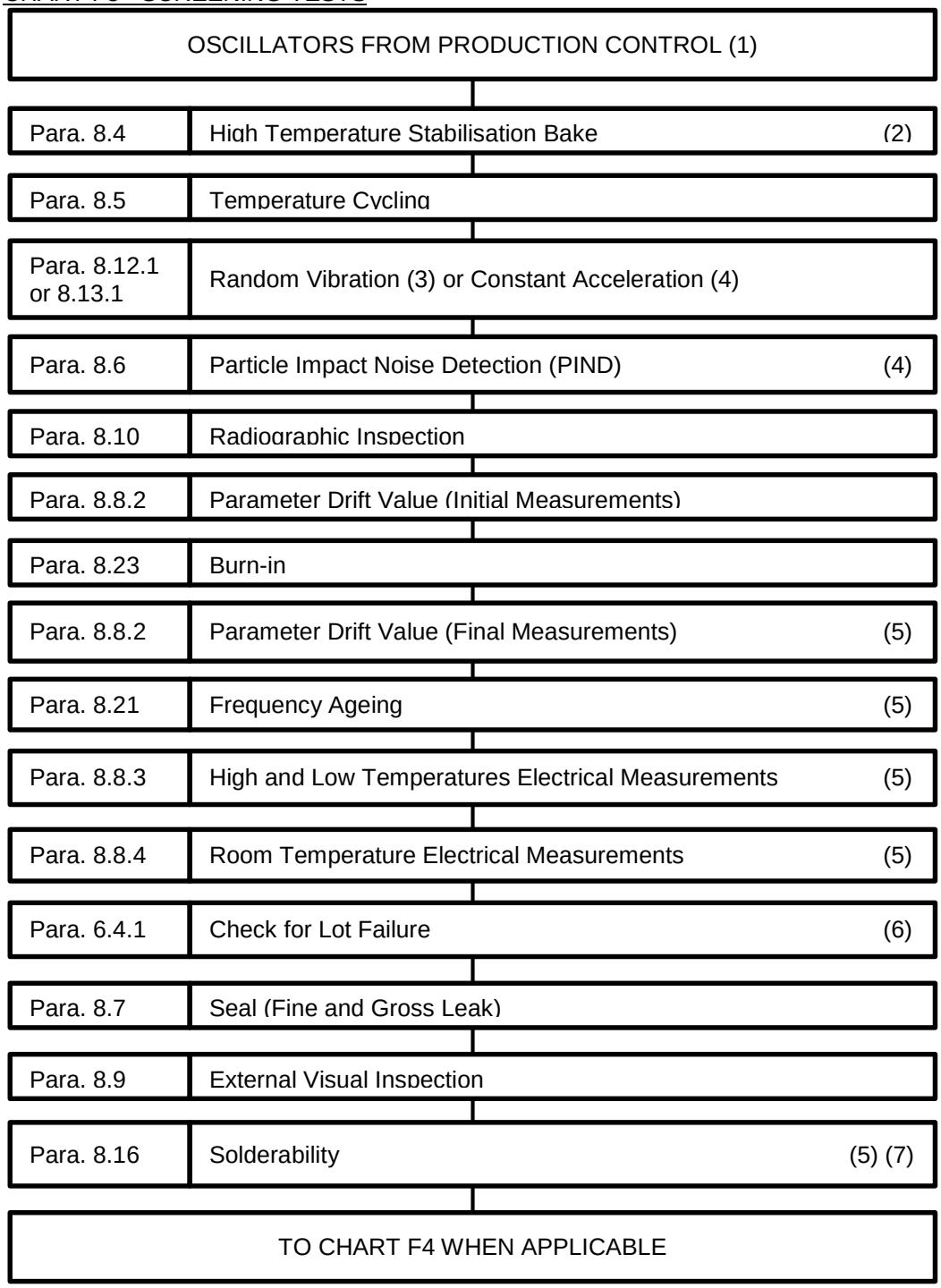
1. Lot Validation Testing is not required for qualified Oscillators unless specifically stipulated in the Purchase Order.
2. For unqualified Oscillators the need for Lot Validation Testing shall be determined by the Orderer and the required testing shall be as stipulated in the Purchase Order (ref. ESCC Basic Specification No. 23100).

12.2 CHART F2 - PRODUCTION CONTROL



NOTES:
1. Performed on a sample basis.
2. Class 2 Oscillators only.
3. Guaranteed but not tested.

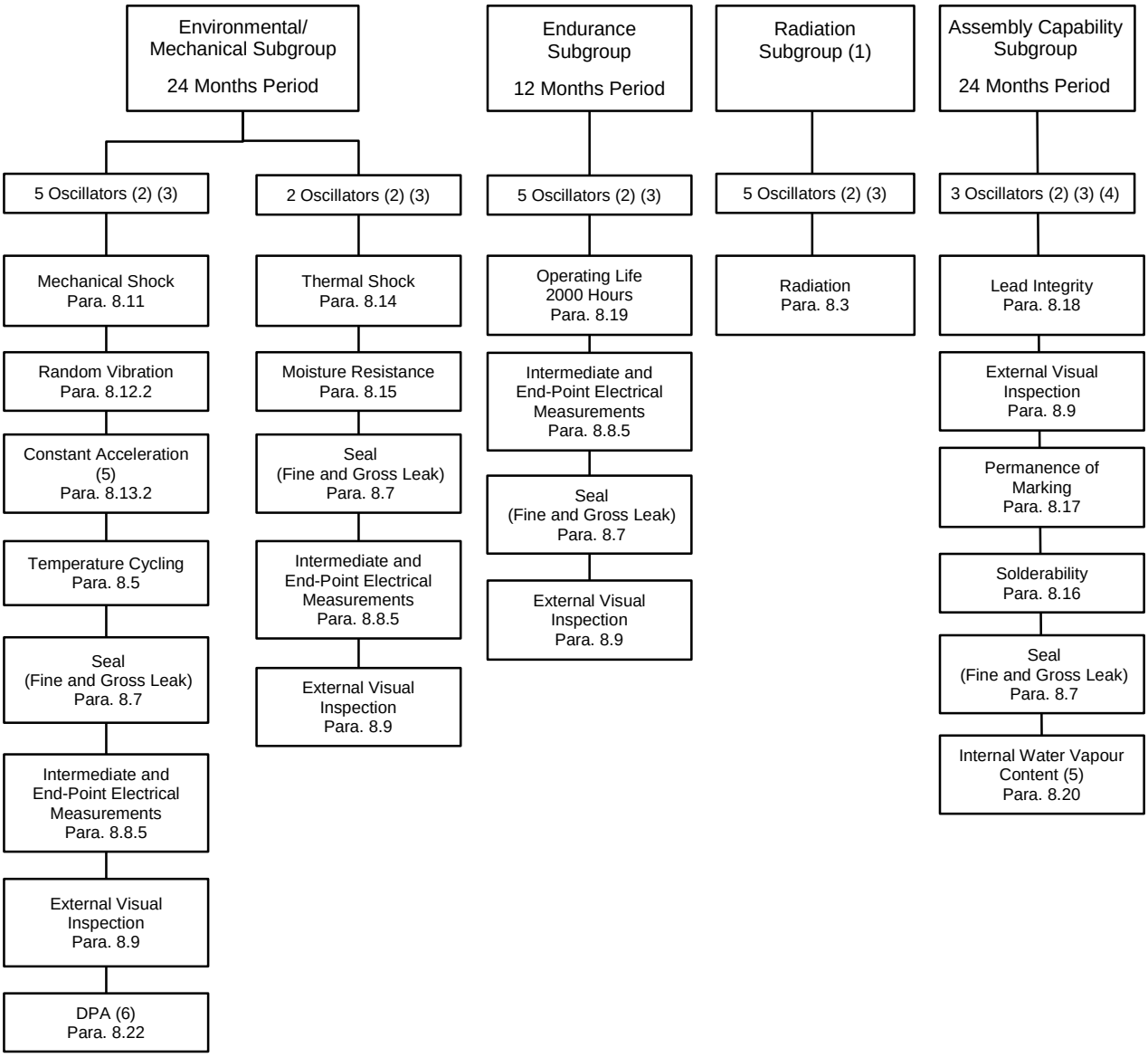
12.3 CHART F3 - SCREENING TESTS



NOTES:

1. All Oscillators shall be serialised prior to Screening Tests.
2. Performance of this test is optional at the Manufacturer's discretion.
3. Class 1 Oscillators only.
4. Class 2 Oscillators only.
5. The lot failure criteria of Para. 6.4 apply to this test.
6. Check for Lot Failure shall take into account all electrical parameter failures that may occur during Screening Tests in accordance with Para. 8.8.2, 8.8.3, 8.8.4, 8.21 subsequent to Burn-in.
7. Performed on a sample basis.

12.4 CHART F4 - QUALIFICATION AND PERIODIC TESTS



NOTES:

1. Only applicable to qualification and maintenance of qualification if and as specified in the PID (see Para. 4.6). Only applicable to Lot Validation Testing if specified in the Detail Specification and stipulated in the Purchase Order.
2. For distribution within the subgroups, see Para. 7.1.2 for qualification and qualification maintenance, and Para. 7.3 for Lot Validation Testing.
3. No failures are permitted.
4. Samples that have successfully completed the Endurance Subgroup tests may be used for the Assembly Capability Subgroup tests.
5. Class 2 Oscillators only.
6. DPA shall be performed on 3 Oscillators selected from the 5 Mechanical Subgroup samples

12.5 CHART F5 - NAKED SEMICONDUCTOR DICE ADD-ON COMPONENT TESTING