



**VALIDATION AND LOT ACCEPTANCE TESTING
GUIDELINES FOR LASER DIODES**

ESCC Basic Specification No. 23202

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this guideline document is to recommend an approach and pertinent requirements for the validation and lot acceptance testing of laser diode modules for use in space applications.

1.2 SCOPE

This Validation and Lot Acceptance Testing Guideline defines the general requirements for the validation, lot acceptance testing, procurement, and delivery of laser diode submounts, packaged laser diodes and integrated laser modules for space applications. This guideline contains the appropriate inspection and test schedules and also specifies the data documentation requirements.

This document does not include nor enable the qualification of laser diode submounts, packaged laser diodes, integrated laser modules and does not cover the qualification and lot control of add-on components that are addressed by separate documents.

1.3 APPLICABILITY

This specification is applicable to laser diode modules with hermetic and non-hermetic packages. It is also applicable to any optical fibres, fibre-optic cables or optical connectors which form part of the laser diode module's fibre/cable attachment.

2 RELATED 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 the Purchase Order.

2.1 APPLICABLE DOCUMENTS

The following ESCC documents form part of, and shall be read in conjunction with, this specification:

- No. [23201](#), Evaluation Test Programme Guidelines for Laser Diode Modules.
- No. [20400](#), Internal Visual Inspection.
- No. [20500](#), External Visual Inspection.
- No. [20900](#), Radiographic Inspection of Electronic Components.
- No. [21300](#), Terms, Definitions, Abbreviations, Symbols and Units.
- No. [21400](#), Scanning Electron Microscope Inspection of Semiconductor Dice.
- 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. [20600](#), Preservation, Packaging and Despatch of ESCC Components.
- No. [23500](#), Lead Materials and Finishes for Components for Space Application.
- No. [24600](#), Minimum Quality System Requirements
- No. [23800](#), Electrostatic Discharge Sensitivity Test Method.
- No. [24800](#), Resistance to Solvents of Marking, Materials and Finishes.
- No. [25000](#), Electro-Optical Test Methods for Charge Coupled Devices.
- No. [25100](#), Single Event Effects Test Method and Guidelines.
- No. [2263010](#), Evaluation Test Programme for Optical Fibre Connector Sets.

For qualification and qualification maintenance or procurement of qualified components, with the exception of ESCC Basic Specifications Nos. [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. Such replacements shall be clearly identified in the applicable Process Identification Document (PID).

For procurement of unqualified components, 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 Orderer. Such replacements may be listed in an appendix to the appropriate Detail Specification at the request of the Manufacturer or Orderer.

2.2 REFERENCE DOCUMENTS

- ESCC No. [22700](#), Requirements and Guidelines for the Process Identification Document (PID).
- No. [21700](#), General Requirements for the Marking of ESCC Components.
- ECSS-Q-ST-60, Space product assurance electrical, electronic and electromechanical (EEE) components.
- ECSS-Q-ST-70, Materials, mechanical parts and processes.
- ECSS-Q-ST-70-02, Thermal vacuum outgassing test for the screening of space materials.
- ECSS-Q-ST-70-21, Flammability testing for the screening of space materials.
- ECSS-Q-ST-70-29, Determination of offgassing products from materials and assembled articles to be used in a manned space vehicle crew compartment.
- ECSS-Q-ST-60-05, Generic procurement requirements for hybrids.
- [MIL-STD-883](#), Test Methods and Procedures for Micro-electronics.
- Telcordia-GR-468, Generic Reliability Assurance Requirements for Optoelectronic Devices Used in Telecommunications Equipment.
- Telcordia-GR-1221, Generic Reliability Assurance Requirements for Passive Optical Components.
- Telcordia-GR-20, Generic Requirements for Optical Fibre and Optical Fibre Cable.
- GR-326-CORE, Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies.
- GR-2882-CORE, Generic Requirements for Optical Isolators and Circulators.

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) ESCC Detail Specification.
- (b) ESCC Basic Specification, Validation and Lot Acceptance Testing Guidelines (this specification).
- (c) ESCC Basic Specification No. [23201](#).
- (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 the following definitions shall apply:

- Laser diode submount: laser die attached on a submount.
- Packaged laser diode: small packaged assemblies containing the laser diode submount with no other components.
- Laser modules: small packaged assemblies containing several components (add-on elements) in addition to the laser diode submount.
- Add-on elements: consist of all optical and electro-optical elements taking part in the control of the laser diode operation (resistor, photodiode, drivers, isolators, thermoelectric-cooler (TEC), thermistor, fibre pig-tail, optical connector, etc.).
- Hermetic module/package: a package/module package which by design or construction is able to pass a seal test ([MIL-STD-883 Test Method 1014](#)).

4 **DEVICES COVERED**

The requirements described in the following sections are applicable to:

- laser diode submounts.
- packaged laser diodes.
- laser modules.

It is the manufacturer's responsibility to demonstrate that the procured materials and piece parts have no impact on the reliability of the add-on parts in the laser diode environment.

For add-on elements the generic procurement requirements for hybrids given in ECSS-Q-ST-60-05 (applicable document for the procurement and the qualification of active and passive chips), ESCC [2263010](#), and the Telcordia standards listed below could be used as guidelines.

- Telcordia-GR-468 Generic Reliability Assurance Requirements for Optoelectronic Devices Used in Telecommunications Equipment.
- Telcordia-GR-1221 Generic Reliability Assurance Requirements for Passive Optical Components.
- Telcordia-GR-20 Generic Requirements for Optical Fibre and Optical Fibre Cable.
- GR-326-CORE, Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies.
- GR-2882-CORE, Generic Requirements for Optical Isolators and Circulators.
- Basic Specification ESCC [2263010](#), ETP for Simplex Optical Fibre Connector Sets.

5 REQUIREMENTS

5.1 GENERAL

The test requirements for procurement (see Chart F1) shall comprise:

- Wafer Lot Acceptance.
- Mirror Passivation Lot Acceptance
- Special In-Process Controls.
- Screening Tests.
- Lot Acceptance Testing, if stipulated in the Purchase Order.

5.1.1 Specifications

For validation and delivery of laser diode submounts, packaged laser diodes, and laser modules in conformity with this Basic Specification the applicable specifications listed in Section 2 of this document shall apply in total, unless otherwise specified herein or in the Detail Specification.

5.1.2 Conditions and Methods of Test

The conditions and methods of test shall be in accordance with this Basic Specification, ESCC Basic Specification No. [23201](#) and the Detail Specification.

5.1.3 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 Orderer to use an approved external facility.

5.1.4 Inspection Rights

The Orderer reserves the right to monitor any of the tests and inspections scheduled in the applicable specifications.

5.1.5 Customer Source Inspection

5.1.5.1 *Pre or Post Encapsulation Customer Source Inspection*

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

5.1.5.2 *Final Customer Source Inspection*

If stipulated in the Purchase Order, the Orderer may perform a source inspection at the Manufacturer's facility at the end of Screening or during Lot Acceptance Testing, if applicable, (including, for example, witness of final Reference Temperature Electro-Optical Measurements, performance of External Visual Inspection and Physical Dimension Check, review of the data documentation package). Details of the inspections to be performed or witnessed and the required period of notification shall be as stipulated in the Purchase Order.

5.2 DELIVERABLE COMPONENTS

Each component, delivered to this Basic Specification, shall be processed and inspected in accordance with the relevant Process Identification Document (PID) and shall:

- be traceable to its production lot (including Wafer Lot, Mirror Passivation Lot, Assembly Lot and Sealing lot).
- 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 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, demonstrably, it could not have passed these tests at the time of manufacture, this shall be grounds for rejection of the delivered lot.

5.2.1 Lot Failure

Lot failure may occur during Wafer Lot Acceptance (Chart F2), Mirror Passivation Lot Acceptance (Chart F2), Special In-Process Controls (Chart F2), Screening Tests (Chart F3), or Validation and Lot Acceptance Testing (Chart F4).

Should such failure occur during procurement of components 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 components 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.

5.2.2 MARKING

All components procured and delivered to this specification should be marked in accordance with ESCC Basic Specification No. [21700](#).

5.3 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 component meets the performance requirements of this Basic Specification and the Detail Specification. Acceptance or approval of any constituent material or finish does not guarantee acceptance of the finished product.

All non-metallic materials and finishes, which are not within a hermetically sealed enclosure, of the components specified in the Detail Specification shall meet the outgassing requirements as outlined in ECSS-Q-ST-70-02.

The use of epoxies and other organic compounds in an enclosed package could potentially cause reliability problems.

6 PRODUCTION CONTROL

6.1 GENERAL

Unless otherwise specified herein or in the Detail Specification, all lots of components used for validation and Lot Acceptance Testing shall be subject to tests and inspections in accordance with Chart F2 in the sequence shown.

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

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

In the case of lot failure the Manufacturer shall act in accordance with Para. 5.2.1.

6.2 REBONDING

The rebonding of wires during assembly shall be in accordance with ECSS-Q-ST-60-05, Para. 10.5.3.

6.3 WAFER LOT ACCEPTANCE

6.3.1 Process Monitoring Review

Process monitoring review shall be done in compliance with the Manufacturer's SPC rules described in the PID.

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

6.3.2 Wafer Inspection

The Wafer inspection shall be in compliance with criteria specified in the Detail Specification.

6.3.3 Documentation

Documentation of Wafer Lot Acceptance shall be in accordance with Para. 10.5.

6.4 MIRROR PASSIVATION LOT ACCEPTANCE

6.4.1 Catastrophic Optical Mirror Damage

Components supplied to this Basic Specification shall be produced from a mirror passivation batch that has been subjected to, and successfully met, the Catastrophic Optical Mirror Damage test requirements specified in the Detail Specification.

6.4.2 Documentation

Documentation of Mirror Passivation Lot Acceptance shall be in accordance with Para. 10.5.

6.5 SPECIAL IN-PROCESS CONTROLS

6.5.1 Internal Visual Inspection

Internal Visual Inspection shall be performed in accordance with Para. 9.1.

- 6.5.2 External Visual Inspection
External Visual Inspection shall be performed in accordance with Para. 9.3.
- 6.5.3 Bond Strength, and Die Shear or Substrate Attach Strength
Bond Strength and either Die Shear or Substrate Attach Strength tests shall be performed on test samples of laser diode chips, and add-on devices, in accordance with Para. 9.2. A single failure shall be cause for lot failure.
- 6.5.4 Fibre Pull (for Pig-tailed Packages)
Fibre Pull test shall be performed on pig-tailed packages in accordance Para. 9.12.
- 6.5.5 Radiographic Inspection
Radiographic Inspection shall be performed in accordance Para. 9.13.
- 6.5.6 Internal Gas Analysis
Internal Gas Analysis test shall be performed on pig-tailed packages in accordance with Para. 9.10.
- 6.5.7 Physical Dimension Check
Physical Dimension Check shall be performed in accordance with Para. 9.3.1 on 3 samples only. In the event of any failure a 100% Physical Dimension Check shall be performed.
- 6.5.8 Geometrical Dimension Check
Geometrical Dimension Check shall be performed in accordance with Para. 9.3.2.
- 6.5.9 Weight
Unless otherwise specified the maximum weight of the component specified in the Detail Specification shall be guaranteed but not tested.
- 6.5.10 Documentation
Documentation of Special In-Process Controls shall be in accordance with Para. 10.6.

7 SCREENING TESTS

7.1 GENERAL

Unless otherwise specified in the Detail Specification all lots of components used for delivery, validation and Lot Acceptance Testing, if applicable, shall be subjected to tests and inspections in accordance with Chart F3A (laser diode submounts) or Chart F3B (packaged laser diodes and laser modules) in the sequence shown.

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

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

7.2 FAILURE CRITERIA

7.2.1 Environmental and Mechanical Test Failure

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, i.e. Particle Impact Noise Detection, Seal and External Visual Inspection.

7.2.2 Parameter Drift Failure

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

7.2.3 Parameter Limit Failure

A component shall be counted as a limit failure if one or more parameters exceed the limits shown in High, Reference and Low Temperatures Electro-Optical Measurements in the Detail Specification.

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

7.2.4 Other Failures

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

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

7.3 FAILED COMPONENTS

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

7.4 LOT FAILURE

In the case of lot failure, the Manufacturer shall act in accordance with Para. 5.2.1.

7.4.1 Lot Failure during 100% Testing

If the number of components which fail, on the basis of the failure criteria specified in Paras. 7.2.2 and 7.2.3, exceeds 5% (rounded upwards to the nearest whole number) of the components submitted to Burn-in of Chart F3, the lot shall be considered as failed.

If a lot is composed of groups of components of one family defined in one ESCC 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 which occur during sample testing, as specified herein or in the Detail Specification, is exceeded.

Unless otherwise specified, if lot failure has occurred, 100% testing may be performed. The cumulative percent defective shall not exceed that specified in Para. 7.4.1.

7.5 DOCUMENTATION

Documentation of Screening Tests shall be in accordance with Para. 10.7.

8 VALIDATION AND LOT ACCEPTANCE TESTING

When Validation and Lot Acceptance Testing is required, it shall consist of the performance of the tests of Chart F4. The tests of Chart F4 shall be performed on the specified sample chosen at random from components which have successfully passed the tests in Charts F3. This sample constitutes the Validation Test Lot. The Validation 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 F4.

For procurement of components the need for Lot Acceptance Testing shall be determined by the Orderer (ref. ESCC Basic Specification No. [23100](#)). The testing to be performed and the sample size shall be as stipulated in the Purchase Order.

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

8.1 FAILURE CRITERIA

The following criteria shall apply to Validation and Lot Acceptance Testing.

8.1.1 Environmental and Mechanical Test Failures

The following shall be counted as component failures: Components which fail during tests for which the pass/fail criteria are inherent in the test method, e.g. Seal, Terminal Strength, etc.

8.1.2 Electro-Optical Failures

The following shall be counted as component failures:

- Components 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 Electro-Optical Measurements in the Detail Specification.

8.1.3 Other Failures

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

- Visual failure
- Mechanical failure
- Handling failure
- Lost component

8.2 **FAILED COMPONENTS**

A component shall be considered a failed component if it exhibits one or more of the failure modes detailed in Para. 8.1.

When requested by the Orderer, failure analysis of failed components shall be performed under the responsibility of the Manufacturer and the results provided.

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

8.3 **LOT FAILURE**

The lot shall be considered as failed if one component in any test specified for Lot Acceptance Testing is a failed component based on the criteria specified in Para. 8.1.

In the case of lot failure, the Manufacturer shall act in accordance with Para. 5.2.1.

8.4 **VALIDATION AND LOT ACCEPTANCE TESTING SAMPLES**

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

8.5 **DOCUMENTATION**

Documentation of Validation and Lot Acceptance Testing shall be in accordance with Para. 10.8.

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 Basic Specification and the Detail Specification.

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.

9.1 **INTERNAL VISUAL INSPECTION**

ESCC Basic Specification No. [20400](#).

9.2 BOND STRENGTH, AND DIE SHEAR OR SUBSTRATE ATTACH STRENGTH

9.2.1 Bond Strength

[MIL-STD-883 Test Method 2011](#)

- Test condition C or D for thermo-compression, ultrasonic or wedge bonding.
- Test condition F for flip-chip bonding.
- Test condition G or H for beam lead bonding.

2 test samples shall be selected at random from the lot of components accepted after Internal Visual Inspection. All bonds shall be tested.

If agreed by the Orderer, the test samples for Special In-Process Controls may have only passed the low magnification phase of the Internal Visual Inspection.

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

9.2.2 Die Shear or Substrate Attach Strength

[MIL-STD-883 Test Method 2019 or 2027](#).

The same test samples submitted to Bond Strength shall be used. Individual separation forces and categories shall be recorded. A single failure shall be cause for lot failure.

9.3 EXTERNAL VISUAL INSPECTION AND DIMENSION CHECK

External Visual Inspection shall be performed in accordance with ESCC Basic Specification No. [20500](#).

9.3.1 Physical Dimension Check

Physical 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 components. In the event of any failure a 100% Physical Dimension Check shall be performed.

9.3.2 Geometrical Dimension Check

Geometrical Dimension Check (during Special In-Process Controls only) shall be performed in accordance with ESCC Basic Specification No. [20500](#) and the Detail Specification on all components unless otherwise specified.

9.4 SCANNING ELECTRON MICROSCOPE INSPECTION

ESCC Basic Specification No. [21400](#).

9.5 CATASTROPHIC OPTICAL MIRROR DAMAGE

ESCC Basic Specification No. [23201](#).

For laser diode submounts the test shall be performed under an atmosphere fully representative of the application environment, in particular in terms of gas mixture and pressure.

9.6 RADIATION TESTING

9.6.1 Total Dose Radiation Testing

Total Dose (Total Ionizing Dose and Displacement Damage Dose) Radiation Testing shall be performed in accordance with ESCC Basic Specification No. [22900](#) to the total dose level specified in the Detail Specification or as stipulated in the Purchase Order.

9.6.2 Single Event Effects Testing

Single Event Effects Testing shall be performed in accordance with ESCC Basic Specification No. [25100](#).

This test shall be performed on laser modules only depending on the sensitivity of the active add-on devices (e.g. CMOS drivers) to Single Event Effects.

9.7 HIGH TEMPERATURE STABILISATION BAKE

[MIL-STD-883 Test Method 1008](#).

- Duration: 48 hours at maximum storage temperature rating specified in the Detail Specification.

9.8 TEMPERATURE CYCLING

Telcordia-GR-468.

- Low temperature = -40 °C.
- High temperature = +85 °C.

For Screening Tests: number of cycles = 10.

For Validation and Lot Acceptance Testing: number of cycles = 100.

9.9 PARTICLE IMPACT NOISE DETECTION

This test shall be performed on packaged components and modules only.

Components shall be subjected to a mechanical shock/vibration test as specified in [MIL-STD-883 Test Method 2020](#) Test Condition A or [MIL-STD-883 Test Method 2002](#) Test Condition A. The test method shall be as specified in the Detail Specification.

For pig-tailed devices the optical fibre has to be properly clamped during the test to avoid any damage.

9.10 INTERNAL GAS ANALYSIS

Hermetic packages only.

[MIL-STD-883 Test Method 1018.4](#).

Taking into account that carbon based compounds can have a dramatic effect on laser diode reliability (especially for high power devices operated in an oxygen free atmosphere), the tracking and the elimination of even low levels of organic contaminants is required.

9.11 ELECTROSTATIC DISCHARGE SENSITIVITY (ESD)

ESD testing shall be performed in accordance with either ESCC [23800](#) or [MIL-STD-883 Test Method 3015](#).

9.12 FIBRE PULL (FOR PIG-TAILED PACKAGES)

This test shall be performed on pig-tailed packages in accordance with Telcordia-GR-468.

After each pull, light-current-bias curves shall be performed at room temperature to verify the optical power drift.

9.13 RADIOGRAPHIC INSPECTION

ESCC Basic Specification No. [20900](#).

9.14 THERMAL RESISTANCE

Thermal Resistance shall be determined by using either the Manufacturer's test method or another relevant method and applying the limit given in the Detail Specification.

9.15 ELECTRO-OPTICAL MEASUREMENTS

9.15.1 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 serial numbers and the parameter drift calculated.

9.15.2 High, Reference and Low Temperatures Electro-Optical Measurements

High, Reference and Low Temperatures Electro-Optical Measurements shall be performed as specified in the Detail Specification. The minimum set of parameters that must be included is as follows:

TEST OR MEASUREMENT	PARAMETER
Optical Spectrum	Central or Peak Wavelength Spectral Width if applicable Side Mode Suppression Ratio
Beam Geometry	Vertical Far Field Parallel Far Field
Light-Current Curve	Threshold Current L-I Linearity/Kinks L-I Saturation Slope Efficiency P @ Inom and Pmax
Voltage-Current Curve	Forward Voltage Low Level I-V Curve
Modulated Output	Self Pulsations Modulation Depth Rise/Fall Times Turn-on Delay Cutoff Frequency
Monitor Operation	Dark Current Photocurrent @ Pmax, Pnom
Thermo-Electric Cooler (TEC) and Temperature Sensor	TEC Current TEC Voltage Sensor Resistance/Sensor Voltage
Component Alignment	Coupling Efficiency
Thermal Characteristics	Thermal Resistance (See Para. 9.14)

All values obtained shall be recorded against serial numbers.

9.15.3 Intermediate and End-Point Electro-Optical Measurements

At each of the relevant data points during Validation and Lot Acceptance Testing, Intermediate and End-Point Electro-Optical Measurements shall be performed as specified in the Detail Specification. All values obtained shall be recorded against serial numbers and the parameter drift calculated, if specified.

9.16 BURN-IN

- Duration
Unless otherwise specified in the Detail Specification components shall be subjected to a total Burn-in period of 240 (+24 -0) hours.
- Test Conditions
As specified in Burn-in in the Detail Specification.
The alternative temperature and time combinations per either Telcordia-GR-468 or [MIL-STD-883 Test Method 1015](#) are permissible provided that the maximum operating ratings for a component are not exceeded.
- Data Points
As specified in Parameter Drift Values in the Detail Specification at 0 hours (initial) and T (+24 -0) hours (where T is the specified duration). Drift shall be related to the initial measurement.

9.17 SEAL

Hermetic package components only.

The presence of the pig-tail in pig-tailed packages can affect leak test results (gross leak as well as fine leak); this must be taken into consideration.

9.17.1 Seal, Fine Leak

9.17.1.1 *Packages without helium*

[MIL-STD-883 Test Method 1014](#) Condition A, unless otherwise specified.

For very low leak rate (critical for small packages) requirements leading to criteria lower than the minimum detection sensitivity capability of the mass spectrometer, [MIL-STD-883 Test Method 1014](#) Condition A is not applicable. In these conditions, a destructive leak rate assessment approach based on an Internal Gas Analysis could be used on a sampling basis. The main steps of the method are:

- Define the required helium leak rate for the application.
This assessment could be done theoretically, based on the quantity of gas or contaminants such as oxygen or water that are required/acceptable at both the start and end of life.
- Define the helium bombing conditions (pressure and duration) that lead to a quantity of helium inside the package that could be easily detected by Internal Gas Analysis.
- Carry out the helium bombing and Internal Gas Analysis test. If the measured helium content is greater than the detection limit, the leak rate is higher than the acceptable value.

9.17.1.2 *Packages pre-filled with helium*

Unless otherwise specified, all devices shall be submitted to fine leak testing, without pressurization (bombing) within one hour of removal from sealing atmosphere and prior to any other test. Devices may be sealed with any amount of helium tracer gas and shall pass the true helium leak rate criteria specified for the application. The true helium leak rate is defined by:

$$L_{\text{He}} = \frac{R_{\text{He}}}{\% \text{He}}$$

where R_{He} is the measured helium leak rate and %He the amount (in %) of helium within the package.

9.17.2 Seal, Gross Leak

[MIL-STD-883 Test Method 1014](#), Condition C or D.

Due to the presence of the optical fibre, the usual requirements for gross leak testing in terms of temperature could exceed the maximum temperature rating of the package devices; appropriate care must therefore be taken.

9.18 MECHANICAL SHOCK

[MIL-STD-883 Test Method 2002](#) Test Condition B.

9.19 RANDOM VIBRATION

[MIL-STD-883 Test Method 2026](#) Test Condition G.

9.20 MOISTURE STRESS

A moisture stress test shall be performed as follows depending on the package.

(a) For Hermetic Package Components

Components shall be subjected to a moisture resistance test followed by a temperature cycling test in accordance with the following conditions:

- Phase 1 Moisture resistance:
 - relative humidity: 85%
 - ambient temperature: +85 °C
 - no electro-optical bias
 - duration: 240 hours
- Phase 2 Temperature cycling around dew point:
 - cycling between -10 °C and +50 °C under a non-condensing atmosphere
 - rate: 3 °C/minute
 - low temperature and high temperature dwell time: 3 hours
 - number of cycles: 10
 - electro-optical bias shall be applied.

(b) For Non-Hermetic Package Components and Laser Diode Submounts

Components shall be subjected to a bake in accordance with the following conditions:

- relative humidity: 70%
- ambient temperature: +70 °C
- no electro-optical bias
- duration: 500 hours

9.21 HIGH TEMPERATURE STORAGE

[MIL-STD-883 Test Method 1008](#).

- Duration: 2000 hours at maximum storage temperature rating specified in the Detail Specification.

9.22 OPERATING LIFE

Telcordia-GR-468.

- Duration: 2000 hours minimum.
- Conditions: As specified in Operating Life in the Detail Specification.
- Data Points
In-situ monitoring of the emitted power and bias voltage is preferred unless otherwise specified in Intermediate and End-Point Electro-Optical Measurements in the Detail Specification. The drift shall be related to the 0-hour measurement.

For laser diode submounts the test shall be performed in an atmosphere which fully represents the application environment, particularly in terms of gas mixture and pressure.

9.23 THERMAL VACUUM

The samples shall be placed within the thermal vacuum chamber and connected to the optical measuring equipment, outside the chamber, via vacuum optical feedthroughs.

- Duration: 1000 hours minimum.
- Conditions: As specified in Operating Life in the Detail Specification.
- Pressure: $\leq 1\text{mPa}$.
- Data Points
In-situ monitoring of the emitted power and bias voltage shall be preferred unless otherwise specified in Intermediate and End-Point Electro-Optical Measurements in the Detail Specification. The drift shall be related to the 0-hour measurement.

9.24 PERMANENCE OF MARKING

ESCC Basic Specification No. [24800](#).

9.25 TERMINAL STRENGTH

[MIL-STD-883 Test Method 2004](#), Test Condition D for chip carrier packages or Test Condition B2 for all other packages. For Condition B2, 3 leads (excluding corner leads) or 10% of the leads (whichever is greater) shall be randomly selected on each component.

9.26 SOLDERABILITY

[MIL-STD-883 Test Method 2003](#). To be performed on all terminals.

Solderability testing shall be performed on packaged devices. 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 components with gold plated lead finish, activated fluxes (RMA, RA, and OA) may be used but shall be cleaned off with an acceptable solvent immediately after dipping.

9.27 CONSTRUCTIONAL ANALYSIS

A constructional analysis shall be performed as follows:

- External Visual Inspection in accordance with Para. 9.3.
- Radiographic Inspection in accordance with Para. 9.13 (for packaged laser diode and laser diode modules).
- Seal in accordance with Para. 9.17 (for packaged laser diode and laser diode modules).
- PIND in accordance with Para. 9.9 (for packaged laser diode and laser diode modules).
- Fibre Pull in accordance with Para. 9.12.
- Internal Gas Analysis in accordance with Para. 9.10 (for packaged laser diode and laser diode modules).
- Internal Visual Inspection in accordance with Para. 9.1.
- Die Shear or Substrate Attach Strength in accordance with Para. 9.2.2.
- Bond Strength in accordance with Para. 9.2.1.
- Microsection, at least on active devices.
- X-ray material analysis and dimensions (thickness and geometry).

As a minimum, the following photographs shall be taken:

- An overall photograph of an opened component.
- Photographs of any anomalies found, with magnification where appropriate.
- Microsection at both assembly and semiconductor level. All findings shall be photo documented.
- Scanning Electron Microscope Inspection in accordance with Para. 9.4. This shall include, but not be limited to, examination of the following:
 - Detailed examination of any anomalies identified by the internal visual inspection
 - Clearance of bond wires
 - Quality of wire bonds
 - Microsection inspection including assessment of coating and die attach quality

The steps above shall be photo documented.

Material Analysis shall be performed to confirm that the laser diode materials comply with the material specifications given in the Detail Specification. Prohibited materials are listed in ESCC-Q-ST-70.

Unless relevant data is available, outgassing shall be tested in accordance with ECSS-Q-ST-70-02 to verify all non-metallic materials and finishes of the laser diodes meet the outgassing requirements.

9.28 DESTRUCTIVE PHYSICAL ANALYSIS

A Destructive Physical Analysis shall be performed as follows:

- External Visual Inspection in accordance with Para. 9.3.
- Radiographic Inspection in accordance with Para. 9.13 (for packaged laser diode and laser diode modules).
- Seal in accordance with Para. 9.17 (for packaged laser diode and laser diode modules).
- PIND in accordance with 9.9 (for packaged laser diode and laser diode modules).
- Fibre Pull in accordance with Para. 9.12.
- Internal Gas Analysis in accordance with Para. 9.10 (for packaged laser diode and laser diode modules).
- Internal Visual Inspection in accordance with Para. 9.1.
- Die Shear or Substrate Attach Strength in accordance with Para. 9.2.2.
- Bond Strength in accordance with Para. 9.2.1.

As a minimum, the following photographs shall be taken:

- An overall photograph of an opened component.
- Photographs of any anomalies found, with magnification where appropriate.
- Scanning Electron Microscope Inspection in accordance with Para. 9.4. This shall include, but not be limited to, examination of the following:
 - Detailed examination of any anomalies identified by the internal visual inspection
 - Clearance of bond wires
 - Quality of wire bonds

The steps above shall be photo documented.

10 DATA DOCUMENTATION

10.1 GENERAL

For the Validation and Lot Acceptance Testing 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) Wafer Lot and Mirror Passivation Lot Acceptance data (Chart F2).
- (e) Special In-Process Controls data (Chart F2).
- (f) Screening Tests data (Chart F3).
- (g) Lot Acceptance Testing data (when applicable) (Chart F4).
- (h) Failed components list and failure analysis report (when applicable).
- (i) Add-on parts procurement and qualification status.
- (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:

- 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.

10.1.1 Component Procurement and Delivery

For all deliveries of components procured to this Basic 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 serial numbers).

10.1.2 Additional Documentation

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

10.1.3 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 for review, if requested, by the Orderer.

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 this ESCC Basic Specification, including issue and date.
- (c) Manufacturer's part type number.
- (d) Lot identification.
- (e) Add-on parts lot identification.
- (f) Range of delivered serial numbers.
- (g) Number of the Purchase Order.
- (h) Information relative to any additions to this Basic Specification and/or the Detail Specification.
- (i) Manufacturer's name and address.
- (j) Location of the manufacturing plant (specify place of diffusion, assembly and test).
- (k) Signature on behalf of Manufacturer.
- (l) Total number of pages of the data package.

10.3 LIST OF EQUIPMENT USED

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.

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 Detail Specification.

10.5 WAFER LOT AND MIRROR PASSIVATION LOT ACCEPTANCE DATA (CHART F2)

Wafer Inspection data shall be prepared in accordance with the requirements given in the Detail Specification.

Catastrophic Optical Mirror Damage test data shall be prepared in accordance with the requirements given in the Detail Specification.

10.6 SPECIAL IN-PROCESS CONTROLS DATA (CHART F2)

A test result summary shall be compiled showing the total number of components submitted to, and the total number rejected after each of the tests. For the Bond Strength and either Die Shear or Substrate Attach Strength tests, the separation forces and categories shall be recorded.

For Chart F2B, a record of the results, recorded against component serial number, shall be provided for Fibre Pull, Internal Gas Analysis, Radiographic Inspection (including photographic results), Physical and Geometric Dimensions.

10.7 SCREENING TESTS DATA (CHART F3)

A test result summary shall be compiled showing the total number of components submitted to, and the total number rejected after each of the tests. For each test requiring electro-optical measurements the results shall be recorded against component serial number. Component drift calculations shall be recorded for each specified test against component serial number.

10.8 VALIDATION AND LOT ACCEPTANCE TESTING DATA (CHART F4)

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

A record of the results, recorded against component serial number, shall be provided for Geometric Dimensions, Destructive Physical Analysis, Catastrophic Optical Mirror Damage, Constructional Analysis and Radiation Testing.

10.9 FAILED COMPONENTS LIST AND FAILURE ANALYSIS REPORT

The failed components 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 Basic Specification and/or the Detail Specification during Wafer Lot Acceptance, Mirror Passivation Lot Acceptance, Special In-Process Controls, Screening Tests, Validation and Lot Acceptance Testing.
- (b) Traceability information including serial number (if applicable) of the failed component.
- (c) The failed parameter and the failure mode of the component.
- (d) Detailed failure analysis.

10.10 ADD-ON PARTS PROCUREMENT AND QUALIFICATION STATUS

A Certificate of Conformity shall be established for each add-on part in accordance with the relevant specification.

11 DELIVERY

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

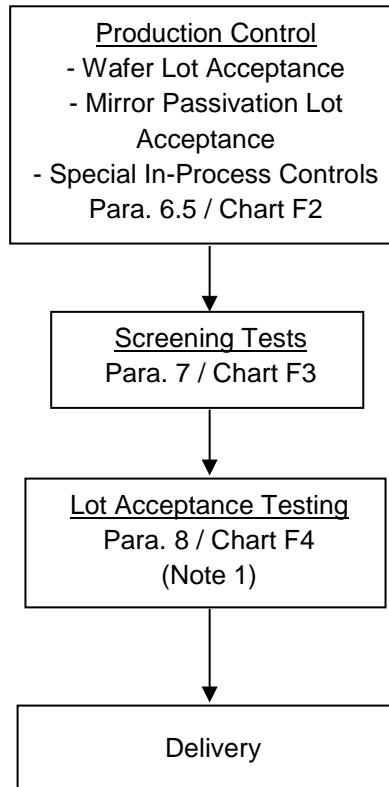
- (a) The delivery lot.
- (b) If stipulated in the Purchase Order, the components used for Lot Acceptance Testing (as applicable) but not forming part of the delivery lot.

12 PACKAGING AND DESPATCH

The packaging and despatch of components to this Basic Specification shall be in accordance with the requirements of ESCC Basic Specification No. 20600. Each component's primary package shall be hermetically sealed in a dry nitrogen atmosphere.

13 CHARTS

13.1 CHART F1 - GENERAL FLOW FOR PROCUREMENT

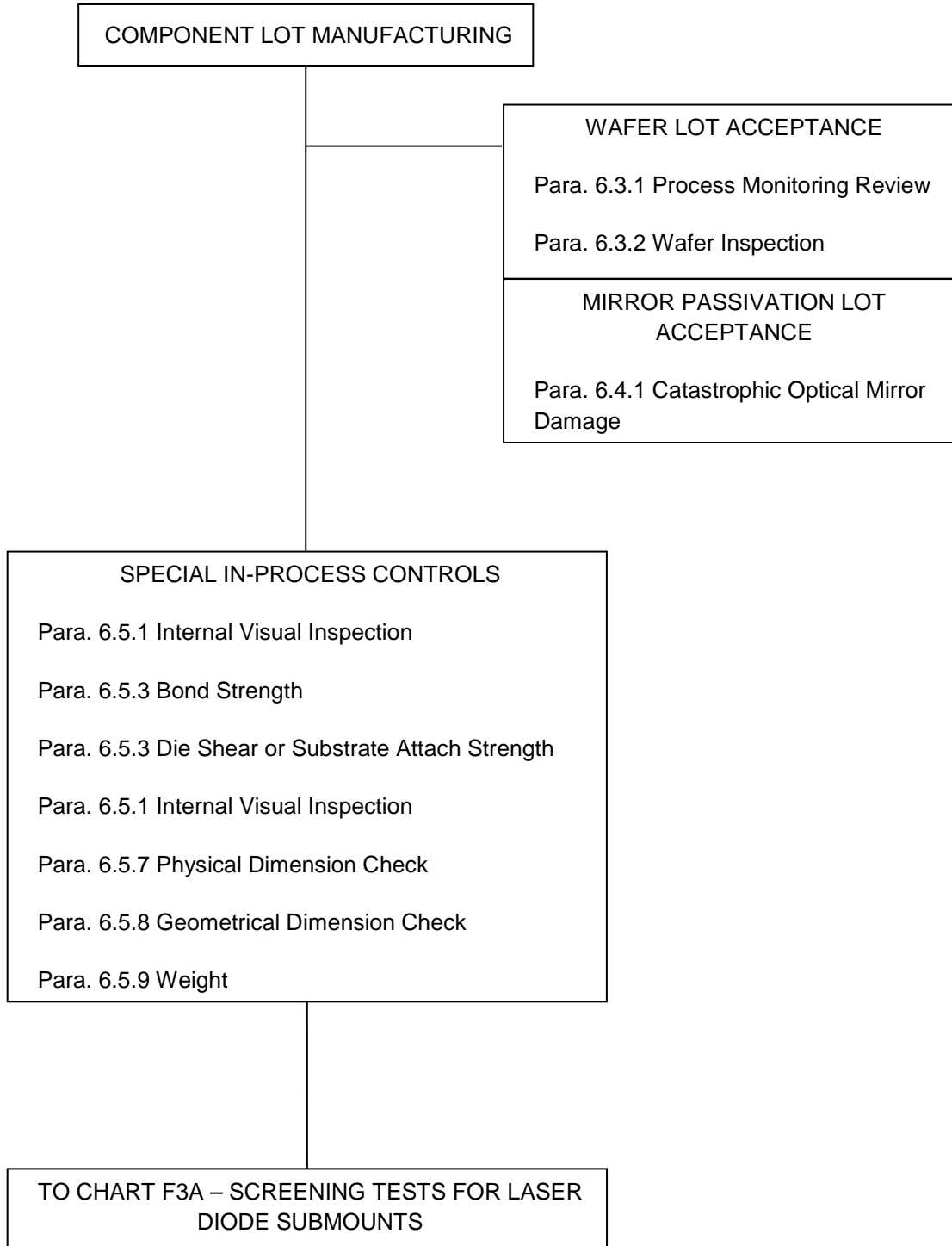


NOTES:

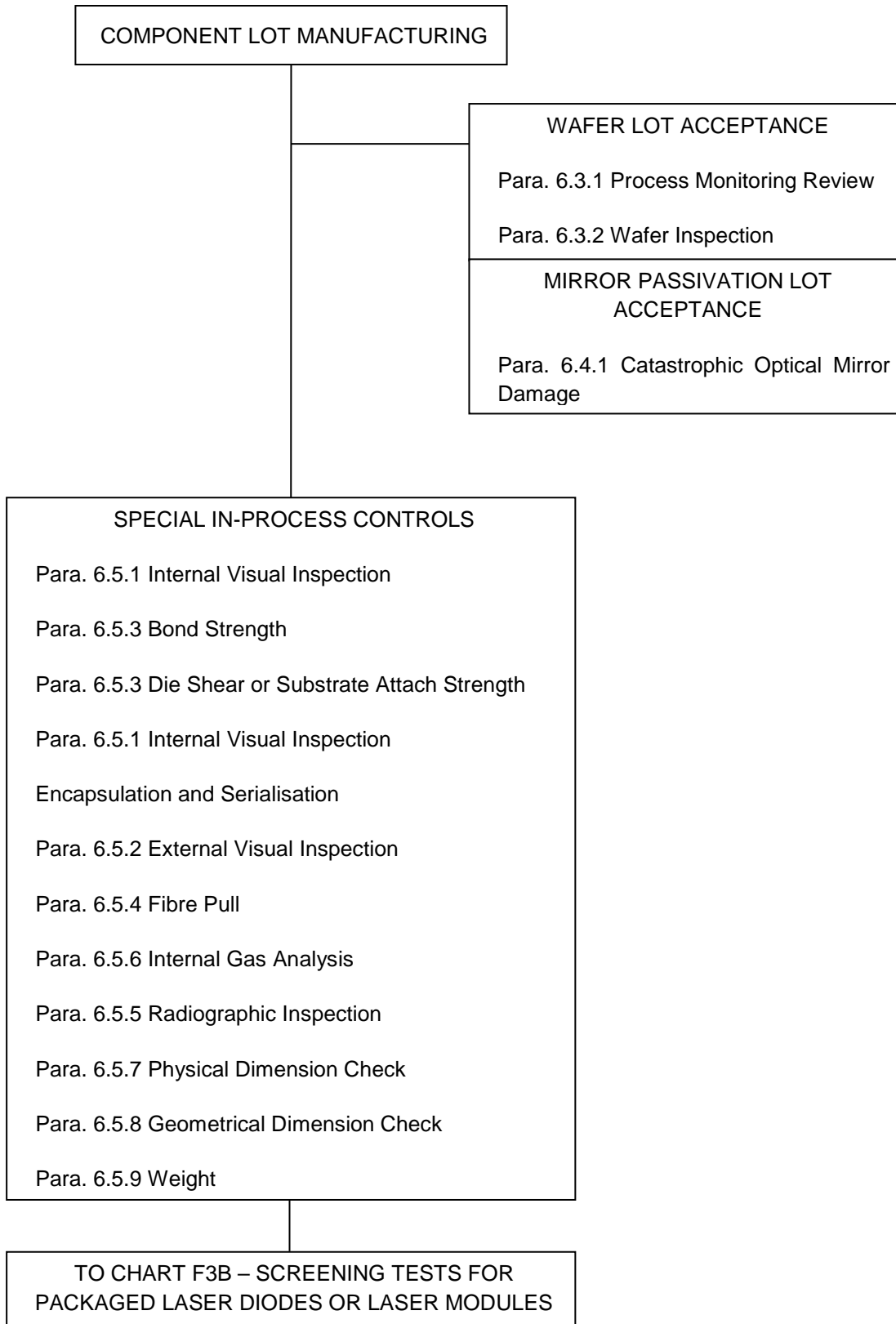
1. Lot Acceptance Testing is only required if stipulated in the Purchase Order.

13.2 CHART F2 – PRODUCTION CONTROL

13.2.1 Chart F2A – Production Control for Laser Diode Submounts

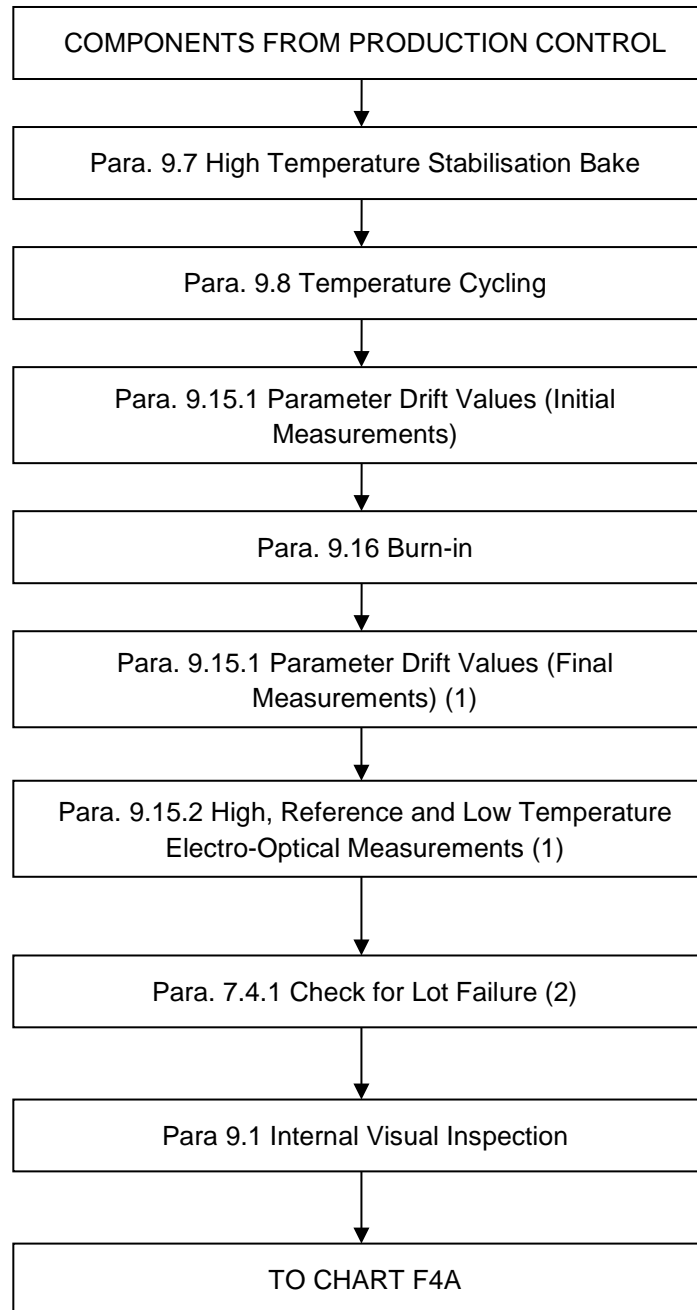


13.2.2 Chart F2B – Production Control for Packaged Laser Diodes or Laser Modules

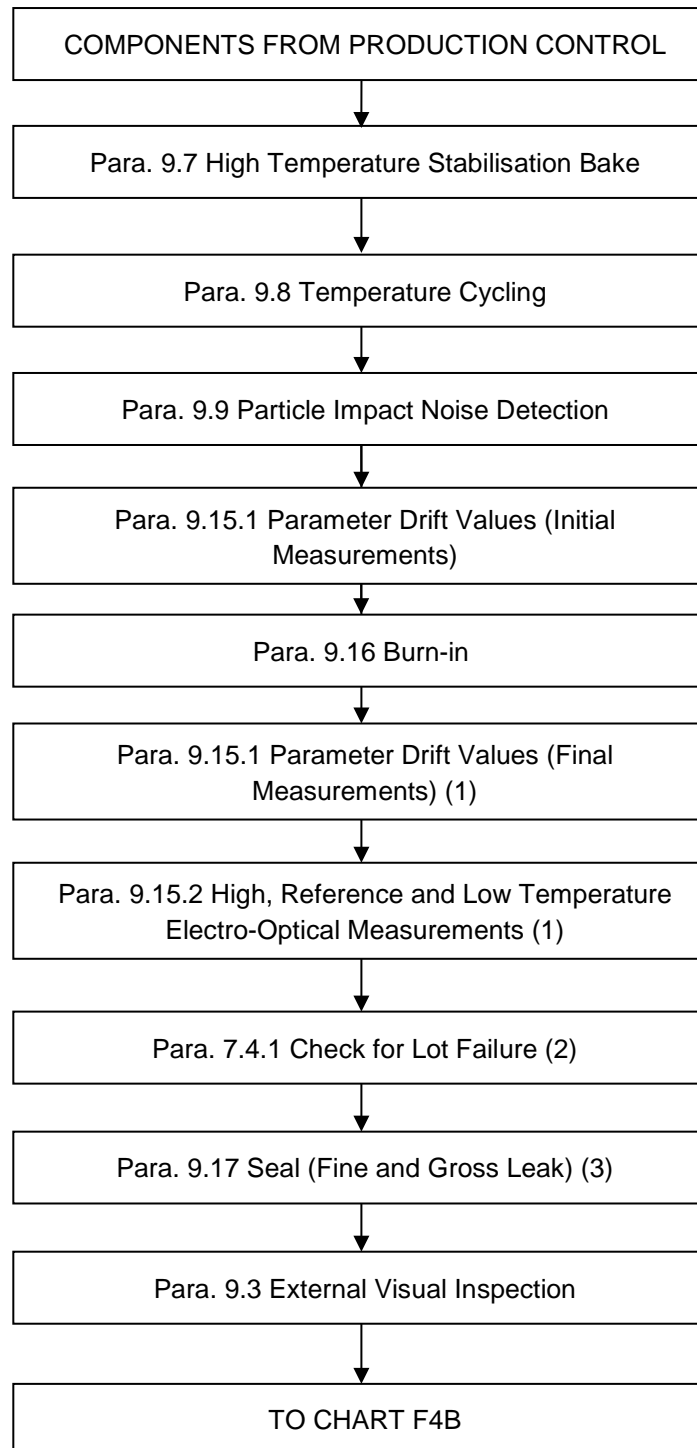


13.3 CHART F3 – SCREENING TESTS

13.3.1 Chart F3A – Screening Tests for Laser Diode Submounts



13.3.2 Chart F3B – Screening Tests for Packaged Laser Diodes or Laser Modules

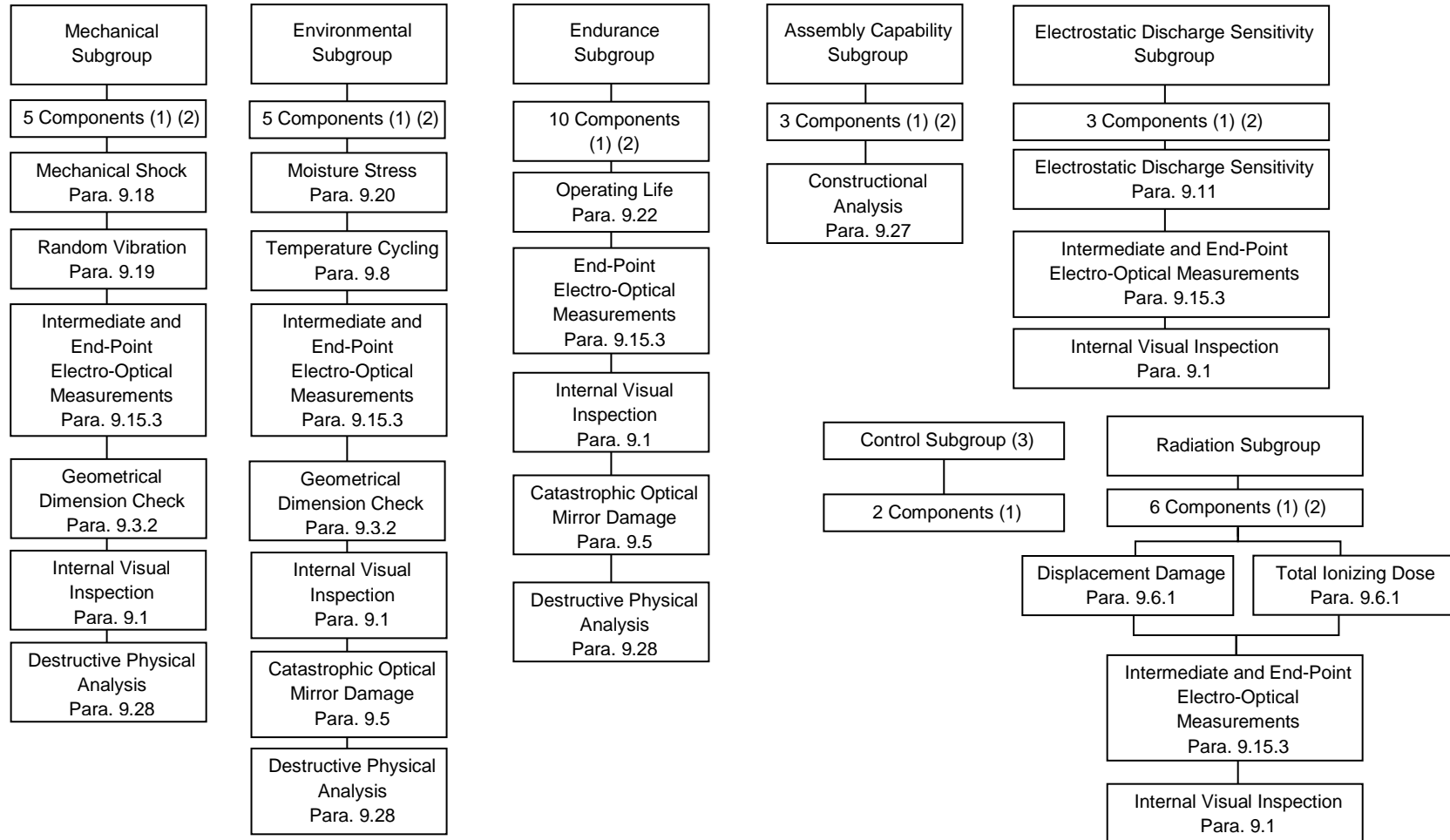


13.3.3 Consolidated Notes for Charts F3A and F3B

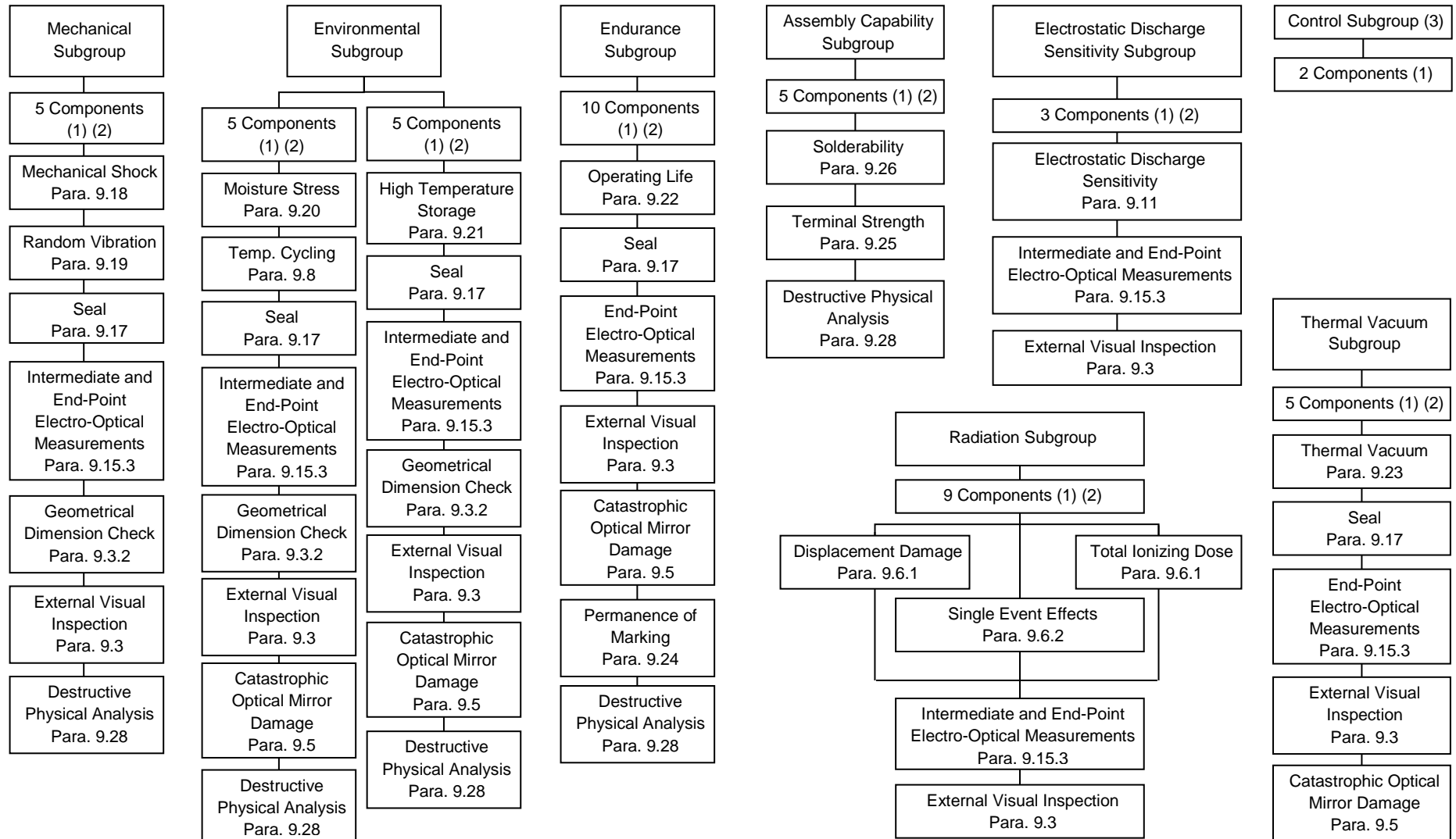
1. The lot failure criteria of Para. 7.4 apply to this test.
2. Check for Lot Failure shall take into account all electro-optical parameter failures that may occur during Screening Tests in accordance with Para. 9.15.1 and 9.15.2 subsequent to Burn-in.
3. For very low leak rate requirements, a destructive leak rate assessment approach based on an Internal Gas Analysis could be used but this shall be on a sampling basis only.

13.4 CHART F4 – VALIDATION AND LOT ACCEPTANCE TESTING

13.4.1 Chart F4A – Validation and Lot Acceptance Testing for Laser Diode Submounts



13.4.2 Chart F4B – Validation and Lot Acceptance Testing for Packaged Laser Diodes or Laser Modules



13.4.3 Consolidated Notes for Charts F4A and F4B

1. For distribution within the subgroup see Para. 8.
2. No failures are permitted.
3. This subgroup shall be performed for comparison purposes. Whenever electro-optical measurements are performed during any other subgroup testing, the components in the Control Component Subgroup shall also be subjected to the same electro-optical measurements.