Document Number	EDCS-214870 Rev 5
Based on Template	EDCS-206507 Rev 7
Created By	Rick Manderscheid

1st Level Qualification for Optical Devices

This document contains detailed descriptions of 1st level qualification experiments that must be executed as part of the overall qualification process for all optical components used by Cisco.

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Modification History

Revision	Date	Originator	Comments
1	19 Jul 2001	Jay Bhagat	Qual Spec Doc #703861-0000 initial
2	24 Jul 200s	Phil Adell	Initial Release of EDCS-214870
3	31 Jul 2006	Phil Adell	General update and inclusion of changes made to GR-468
4	19 Jun 2009	Rick Manderscheid	Reformatted and included new findings from Optics Quality initiative analysis. Combined with L2 Doucment.
5	1 Feb 2010	Rick Manderscheid	Separated from L2 document.

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1 Overview

Cisco is deeply committed to the long-term reliability of all products. Traditional qualification tests look at the device by itself, however the optical and electrical interconnects also play a major role in overall product reliability. This document contains required experiments that must be executed and critical information that must be provided by all suppliers who deliver optical components (both active and passive) to Cisco. Devices qualified to this document are designated Cisco Carrier Class Components, and are known as Reliability Grade S. This document will use the term "device" to refer to either an optical module or a discrete optical component.

The experiments described in this document must be executed for all new packages and new devices in previously qualified packages. Additionally, all information required from suppliers must be provided before any package may be used in production runs of Cisco products. If material, construction and/or processing information is proprietary then Non-Disclosure Agreements must be developed so that this information may be shared with Cisco. Testing should be done with production quality parts unless otherwise approved by Cisco.

Any and all changes to a device/module, its internal components, or to its manufacturing process must be communicated to Cisco through the PCN process described in EDCS-226406, "Product Change Notification and EOL Notification Requirements", and emailed to: component-pcn@cisco.com . Notices that are sent to that email alias should not be deemed received by Cisco until an acknowledgment is sent by the Cisco Component Engineering Department.

1.1 Terms and Definitions

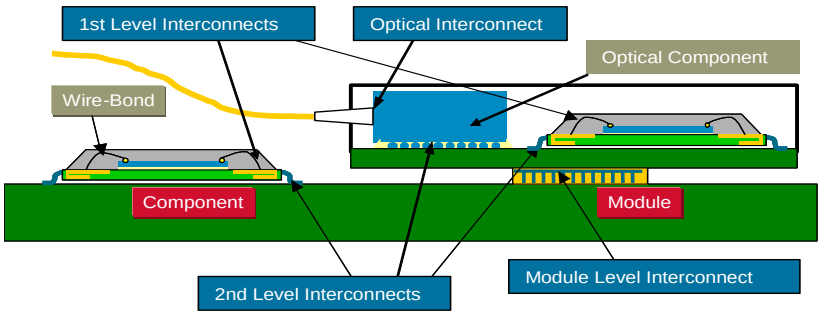
AOC	Active Optical Cable
BGA	Ball Grid Array
CM	Contract Manufacturer
Depanelization	process of separating individual PCBs from a larger panel that contains multiple individual PCB's.
EDVT	Electrical Design Verification Testing
EMI	Electro-Magnetic Interference
EOL	End of Life, 9 months notice is to be given before a product's Last Time Buy
ESD	Electro-Static Discharge
Fiber Pigtail	single-fiber or multi-fiber cable that typically has an optical connector on one end and a length of exposed fiber at the other end that is spliced into an optical device.
FIT	Failures In Time
FOCIS	Fiber Optic Cable Intermateability Standard.
Hermetic	Sealed to prevent moisture or contaminants from entering the package.
HFE	HydroFluoroEther – a optical cleaning solvent.
In-Situ	As it would be in use.
LTPD	Lot Tolerant Percent Defective.
MEMS	Micro-ElectroMechanical Systems.
MSL	Moisture Sensitivity Level
MSA	Multi Source Agreement
MTTF	Mean Time To Failure
OSA	Optical Sub-Assembly
Outgassing	process by which materials expel or release gasses over time.
OFA	Optical Fiber Amplifier
OQA	Outgoing Quality Assurance
ORT	Ongoing Reliability Testing
Pb-free	Per Cisco's Definition, Lead Free (Pb-free) is defined as a product which does not need to make use of RoHS Exemption 7b (Pb in Solder for

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	Networks, AKA NIE Exemption). These products are not entirely without Pb but rather do not use the Pb-solder exemption.
PCB	Printed Circuit Boart
PCN	Part Change Notice, 90 Days notice before change will be implemented
RGA	Residual Gas Analysis
ROADM	Reconfigurable Optical Add/Drop Multiplexer
RoHS	Restriction of Hazardous Substances, mainly legislation out of the European Union, though other countries and groups are following suit, such as China and Norway
TEC	Thermo Electric Cooler.
Tg	Glass Transition Temperature
WSS	Wavelength Selectable Switch.
Heat Deflection Temp/ Deflection Temp Under Load (HDT/DTUL)	the temperature at which a standard test bar deflects a specified distance under a load

1.2 Definition of Different Levels of Interconnect

The figure below is an illustration of different levels of interconnects. When looking at electronics, the 1st level interconnect is generally the die to package interconnect. The 2nd level interconnect refers to the mounting of a package to a PCB for electronic devices.



There are 4 levels to optoelectronic packaging as defined in IPC-0040 and listed below.

- OPTO Level 0: Uncased device (e.g., lenses. Isolator, laser diode, waveguide beam splitters etc.)
- OPTO Level 1: Single device or multiple devices in a package (MCM package integrating optical, optoelectronic components and IC components)
- OPTO Level 2: Modules and product boards (Transponder on a daughter card)
- OPTO Level 3: Mother board with product boards or cabling (Transponder mounted on a mother board)

Cisco uses "1st Level Qualification" to refer to the qualification and reliability assessment of all components, attachments, and manufacturing processes used internal to a component or module, primarily at OPTO Level 0 and Level 1 packaging level (may be referenced as "L1 Qual").

Cisco uses "2nd Level Qualification" to refer to the qualification and reliability assessment of the external interconnects (i.e. electrical and optical), primarily at the OPTO Level 2 packaging level (may be referenced as "L2 Qual"). There are also times when we look at OPTO Level 0 and Level 3.General Requirements

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1.3 Documentation Requirements

1.3.1 L1 Qualification Plan and Checklist

EDCS-463021 should be used to show completion of all L1 qualification requirements. Reliability test reports and other applicable documents may either be inserted into this checklist as an embedded file or provided separately in a zipfile. If providing in a separate zipfile, please list each filename in the applicable sections of the checklist with the appropriate file links. The GSM Technologist Qqualification Stress Matrix (QSM) is an additional set of Cisco requirements not detailed in this document.

The overall L1 qualification plan and expected completion schedule is expected to be determined early in the overall design / qualification cycle. EDCS-595097 is a high-level checklist that *may* be used to help track milestones in the L1/L2 qualification process for key test requirements. It is an optional format that can be used as a tool for communicating with the Optic CE team prior to starting L1/L2 testing. It is not intended to replace the Optic L1 Qual Checklist or the QSM.

1.3.2 Data Sheet

A released revision of the Data Sheet in PDF format must be provided along with detailed CAD drawings of the entire packaged module. Any gaps to Cisco's product specifications need to be highlighted and formal agreement by Cisco to any specification changes must be obtained. The revision of Cisco's product specification should be noted in the specification and checklist.

1.3.3 MTTF & FIT Considerations

Please provide the MTTF and FIT calculations in a separate document, that is appropriately titled for ease of review by Cisco's quality organization following qualification approval. These documents should include the assumptions around temperature and confidence level for at least two different temperature (35^{o}C and 50^{o}C case temperatures are preferred) and two different confidence level (60% & 90% are preferred) combinations.

1.3.4 Characterization Reports for Optical Components/Modules

The purpose of electrical/optical characterization is to determine if a component will meet the specifications called out in the data sheet as technology drifts from one process corner to another. This would demonstrate that the design is robust and has enough margin to provide good devices as the technology varies within its defined window.

The supplier shall specify **all** data sheet parameters and whether the particular parameter is 100% tested, guaranteed by design, sample tested, tested over full temperature range or room temperature only, and tested over full electrical range or nominal only. Sample size selected should be statistically meaningful.

1.4 Materials & Tg ratings

For ALL polymeric and plastic materials within the module the following should be provided: Tg, curing process details, % polymerization and solids, lot and line qualification procedures, and use/storage limitations, as applicable. For any polymeric materials used in an optical path describe in detail the impact of optical power densities, thermal, and hygroscopic properties over time.

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1.4.1 Device Assembly Process

A flow chart must be provided which clearly identifies all in-line inspection test points, rework points, and tuning points. Also indicate manual, semi-automated, and fully automated processes for each electrical and optical assembly step. Process for subassemblies (including TOSAs & ROSAs) shall be included as well.

1.5 Failure Analysis Requirements

When failures are seen, Cisco requires that a complete Failure Analysis Report be completed. Such a report should follow the "8D" methodology of defining the problem, containing the problem, identifying and verifying root cause, implementing corrective actions, and verifying the effectiveness of those corrective actions.

A failure mode prediction report is highly recommended to highlight the potential and observed failure modes. This report should be used to highlight the design criticalities of the assembly and justify the criteria identified by the supplier for the accelerated life test.

Cisco's desired FA response times are listed below. Refer to the Master Purchase Agreement between the supplier and Cisco for specific details.

Table 1 Desired Failure Analysis Response Times

Failure Analysis type	Normal	Urgent	Deliverables
Initial response	5 days	24 hours	Functional status If fail, outline of analysis steps and timeline If pass, return parts to Cisco via overnight carrier
Preliminary failure analysis	10 days	48 hours	Preliminary identification of root cause Recommendations for containment of problem
Completed failure analysis	15 days	5 days	Completed failure analysis summary If appropriate, corrective action plan and timeline
Update schedule	weekly	daily	Progress report on work completed Projection on next actions Updated timelines

1.6 Use of TEC

For modules containing TEC controlled lasers, if the laser has not been qualified independently of the TEC, then the accelerated aging tests must be performed twice – once with the TEC enabled and once with the TEC disabled. If the laser has been independently qualified through high temperature operating life stress without TEC then only TEC controlled module aging must be carried out. However, Cisco recommends that accelerated aging should be verified with both TEC controller ON and OFF independently for all TEC controlled modules.

If a passive component is controlled via TEC, e.g. temperature controlled fiber, then both accelerated aging and high temperature storage is required. For passive components without a TEC the accelerated aging and high temperature storage tests will be required if the operating temperature is lower than the maximum storage temperature.

1.7 Physical Samples

The supplier shall provide a minimum of 1 mechanical sample for evaluation by Cisco's Optical Component Engineer Qualification Team. This sample(s) may be non-functional, but should be

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mechanically complete and suitable for testing the mechanical fit and the functionality of the optical and electrical interconnects. The sample should also be suitable for evaluating various inspection and cleaning processes.

1.8 RoHS Compliance

Cisco is comitted to compliance to EU regulations regarding Cadmium (Cd), Mercury (Hg), Hexavalent Chromium (Hex-Cr), Polybrominated biphenyls (PBB), Polybrominated diphenyl ethers (PBDE), and lead (Pb).

All Pb-free optic devices and/or Pb-free components used in optic devices need to be evaluated and qualified with specific attention to Pb-free components and assembly process. Guidelines for Cisco Pb-free qualification are contained in Cisco's Lead-free Requirements for Optical Suppliers (EDCS-491485) for modules and Cisco Pb-free Qualification Specification (EDCS-281405) for individual components. The following areas are covered in these documents and should be considered as part of Pb-free qualification process: Moisture & Temperature Resistance, Solderability, Tin Whiskers, and Solder Joint Reliability.

All suppliers to Cisco for all components must submit a Certificate of Compliance stating the regulated content. A standard format for this certificate is included in Cisco's Lead-free Requiements for Optical Suppliers (EDCS-491485).

2 General Reliability Requirements

The purpose of the Reliability tests is to demonstrate the long-term reliability and quality of Active and Passive Optical components, both as a discrete device or module, and when used in a system.

When optical devices are contained in a module with significant amounts of additional electronic circuitry, the complete module must be tested to the standards defined in this document. If the supplier can show that each of the additional electronic components has been qualified according to Telcordia GR-357, *Generic Requirements for Assuring the Reliability of Components Used in Telecommunications Equipment,* and the applicable Cisco 1st Level Qualification document, then it is only necessary for the optical device itself to be tested to the standards defined in this document.

Any change to identified test conditions requires justification and approval from Cisco.

2.1 Pass/Fail Criteria for Optical Components

Pass/Fail criteria for the reliability tests defined in this document should be supplied by the supplier and agreed upon by Cisco.

Cisco's desired definition of failure is based on the parametric changes in two ways – (a) parametric change > 10% or +/- 0.5 dB, and (b) parametric change that result in the product not meeting the data sheet over full operating conditions as result of stress.

For DWDM component and modules, wavelength stability demonstration is required for associated TOSA or OSA Module and final Integrated Product. Pass / fail criteria for DWDM components require (1) demonstration of saturation of changes in wavelength and (2) must meet BOL (beginning of life) and EOL (end of life) limits for these changes appropriate for particular application.

Any deviation from the above failure definition must be discussed and agreed upon with Cisco. It is recommended that the suppliers pay detailed attention to measurement errors in light of these tight requirements.

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2.2 Interval Testing

The supplier's reliability test plan **must** include periodic interval parametric tests of the product/component after application of stress. In-situ parametric monitoring during stress is allowed. Otherwise it is expected that the stress will be removed from the product/component and the product/component will be tested at room or elevated temperature, as appropriate.

It is recommended that during the first half of the stress duration (or cycle), interval testing should be more frequent, compared to the later half. The interval testing plan, along with the qualification plan, should be discussed with Cisco prior to starting stress testing to avoid any ambiguity or conflict.

DWDM Prouducts - For DWDM TOSA, OSA and Integrated Product, since wavelength changes rapidly during early part of endurance stress, frequent interval testing during the first 500 hrs is required. Supplier should discuss their interval test plan with Cisco prior to starting the endurance test for DWDM products. All data sheet parameters that are affected by wavelength change must be measured.

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2.3 Pre-Qualification Guidelines

It is our recommendation that the following items in Table 2 Pre-qualification Guidelines be in place at the supplier prior to the start of the qualification effort.

Table 2 Pre-qualification Guidelines

Item or Stress	Remarks
Wafer qualification process established and documented	Data available for review upon request.
Burn-in process established and effectiveness documented	Pre, Post BI, and extended stress – parametric test data
Reliability monitors in place	Wafer qual and burn-in effectiveness
Activation Energy and other acceleration factors determined	Data, analysis, and assumptions
MTTF, FIT (10^9 hrs) and time to 1 failure @ Ta=55ºC with 90% confidence level.	Data, assumptions, and analysis. Desired FIT is 50 @50ºC, as observed by Cisco.
Latch-up test for IC EIA/JESD78	Room and +70C; must meet or exceed latch-up current of 200mA
Resistance to solder thermal shock (popcorn test) JEDEC J-STD-020A	Only applicable to soldered packages, particularly IC's.
Accelerated moisture resistance unbiased autoclave JESD 22 A102B	Only applicable to packaged Ics.
Aqueous Wash	Typical wash conditions – 160ºF, 2PSI Pre and post-wash procedures must be provided (air bake or thermal method)
Label Retention	Ensure label cannot be "wiped out" during placement or handling. Label should be viewable with part assembled to a board.
Epoxies	Suppliers should verify that they are using epoxies within the temperature and other use conditions specified by the epoxy manufacturer.
Moisture Resistance 85ºC/85%RH, or conditions agreed upon with Cisco	Applicable to active and passive devices with non-hermetic packages.
Moisture/Reflow Sensitivity Classification for Non-Hermetic Solid State Surface Mount Devices – JSTD-020C	Revised Moisture Sensitivity Levels (MSL) for Pb-free soldering processes
Device manufacturing traceability	Supplier should indicate all assembly and test locations for all devices used in reliability testing, as well as provide indication on whether those locations are for prototype or production.
PCB Depanelization Process	Supplier should review and qualify their depanelization process per EDCS-686142
Port and Cable Intermateability concerns	Port design and prequalification testing should take into account the wide variety of cables used in the field that may or may not be FOCIS compliant. Optical devices are expected to work in the field under these conditions.
PCB Thermal Stress Test – Per IPC-TM-650, method 2.6.8	Should be performed on at least 3 finished PCB's from 3 different fabrication panels. Each sample should be stressed 6 times. Each type of interconnect structure (for example, Through Vias, Component Holes, Laser Blind Vias, Sub-Composite Buried Vias, Buried Via Core Vias) shall be cross-sectioned in each axis and evaluated. The thermal stress requirements for PCBs shall meet the requirements of Class 3 plated-through holes after thermal stress.

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3 Level 1 Reliability Test Requirements for Active Optical Components/Modules

Table 3 Device Reliability Test Requirements for Active Optical Components/Modules

	L1	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size Zero Failures
Mechanical Integrity	L1	O, E	Mechanical Shock [1]	GR-468 Issue 2	MIL-STD-883E Method 2002.4	5 times/axis, 6 axes; 1500g, 0.5ms, for units without a TEC. 5 times/axis, 6 axes, 500g, 1.0ms, for units with a TEC.	11
	L1	O, E	Vibration [1]	GR-468 Issue 2	MIL-STD-883E Method 2007.3	Cond. A, 20G, 20-2,000 Hz, 4 min/cyc, 4cyc/axis	11
	L1	O, E	Operational Vibration (optional) [3]	GR-63-CORE, Section 5.4.2	-	Swept sine wave at a level of 1.0 g, 3 mm max displacement, 5 Hz to 100 Hz, 0.1 octaves/minute, 3 axes	11
	L1	O, E	Thermal Shock ***(Appendix D.2)***	GR-468 Issue 2	MIL-STD-883E Method 1011.9	Cond. A, 0 and 100°C; OR Delta $T=T_{max,storage} - T_{min,storage}$ Dwell time >= 5 min at temp extremes, transfer time <= 10 sec, the device or module shall reach specified temperature within 5 minutes. This fixes the equilibration rate needed. **NOTE: To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Accel. Aging / High Temp. (HTOL)	GR-468 Issue 2, Section 3.4.1	-	Tmax,op; max operating current/voltage 2,000 hours required 5,000 hours for information **NOTE: to satisfy L2 requirements, at least five devices must be mated, and tested at operating extremes.**	11 5 mated
	L1	O,E	High Temp. Storage	GR-468 Issue 2, Section 3.3.2.1	-	Max. storage Temperature 2,000 hours **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Low Temp Storage (optional)	GR-468 Issue 2, Section 3.3.2.1	-	Min. storage Temperature 500 hours	11
	L1	O,E	Temperature Cycling ***(Appendix D.11)***	MIL-STD-883C Method 1010.7	-	Tmin,storage to Tmax,storage; Requires 10 C/min. ramp, minimum 100 cycles pass/fail; 500 cycles for info. Device may be powered or unpowered during this test, but powered is recommended in situations where the device can handle such conditions. **NOTE: to satisfy L2 requirements, at least five devices must be mated, and tested at operating extremes.**	11 5 mated

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	L1 L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Environmental Stress / Endurance	L1	O,E	Damp Heat – Operating Non-Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	**Non-Hermetic OSA's** - Tmax,op (or 85 C)/85% RH 2,000 hrs required. **Non-Hermetic Modules** - Tmax,op (or 85 C)/85% RH 1,000 hrs required; 2,000 hrs for information. **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Damp Heat –Non-Operating Non-Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	**All Non-Hermetic Products** - Tmax,storage (or 85 C)/85% RH 1,000 hrs **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Damp Heat – Operating Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	**Hermetic OSA's (Recommended) -** Tmax,op (or 85 C)/85% RH, 1,000 hrs required; 2,000 hrs for information. Allows verification of long term hermeticity and moisture resistance. **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Damp Heat –Non-Operating Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	**Hermetic Products -** (1) Tmax,storage (or 85 C)/85% RH for 1,000 hrs, 2,000 hrs for information, or, if Epoxy is used, (2) 50 C/85% RH 3,500 hrs. The test is used to determine if the hermetic package remains hermetic or moisture proof on a long term basis. **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O,E	Cyc. Moist Res.	GR-468 Issue 2, Section 3.3.3.2	MIL-STD-883E, Method 1004.7	20 cycles, w/ 5 subcycles. **NOTE: to satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O	Internal Moisture	MIL-STD-883E, Method 1018.3	-	<5000 ppm moisture content in hermetic modules. This test must be done only **after** thermal shock test on the sample to stress the joints prior to conducting internal moisture or hermiticity test. Full RGA analysis is required to detect moisture or other inorganic or organic residue levels inside the hermetic package.	5
	L1	E,O	ESD Threshold	IEC61000-4-2 IEC61000-4-2	- -	DIRECT: Contact discharge– 8kV Air Discharge – 15kV Units must be passing traffic during test. Device shall not lose data during test. INDIRECT: Horizontal and vertical coupling planes – 15kV Units must be passing traffic during test. Device shall not lose data during test.	

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Special Tests	L1	O	Eye Safety	FDA CDRH21-CFR 1040 and EN60825-1/A11	-	Provide Laser Hazard classification.	
	L1 L1	E E	Electro-magnetic Interference Electro-magnetic Immunity	FCC Class B; (CISPR22: 1997 /EN55022: 1998)	-	Frequency range as applicable. Cisco recommends a 6dB margin, but, depending on the density of modules on Cisco's boards, specific applications may require additional margin against these requirements.	
				IEC61000-4-3	-	80-1000MHz and 1.4-2GHz at Test Level 3=10V/m, or applicable frequency range and field strength.	
	L1	O	HTOL – Special Case	-	-	10,000 HTOL with 100+ TOSAs if LD facet coating is new and never used in other product	100
	L1	-	Flammability	-	-	Supplier must provide a statement or report showing that the module meets the specific UL94-V0 flammability rating at the module level.	
	L1 L2 Requirement	**Optical / Electrical**	**Test**	**Ref Doc**	**Test Methodology**	**Conditions**	**Sample Size / Failures**

Notes:

1. The same sample of devices must be used for the Mechanical Shock and Vibration tests.

2. GR-468-Core, Issue 2, includes additional fiber and receptacle reliability tests which, for Cisco's purposes, are covered in the optical 2nd level qual specification, EDCS-181527. These tests include fiber twist, fiber side pull, cable retention, mating durability, wiggle, and connector pull test.

3. Operational shock and Vibration testing is sometimes performed at the product level in various Cisco BU's specializing in "Switching Products". Please contact the BU representative for confirmation on whether these tests will be required by the BU.

DWDM Components and Products - Endurance stress such as Temperature Cycling (T/C), bb*High Temperature Storage (HTS), and High Temperature Operating Life (HTOL) are required stresses for demonstrating wavelength stability. Wavelength stability is implied if "changes" in the wavelength due to stress show asymptotic saturation. Plots of wavelength change against time or stress cycles are required to show saturation in wavelength changes.

Note that wavelength stability demonstration may require longer stress duration beyond standard requirement for L-1 qualification for T/C, HTS and HTOL as listed in table above. Supplier may use combination of T/C and HTS to demonstrate wavelength stability.

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4 L1 Device Reliability Test Requirements for Highly Integrated OFAs, ROADMs, WSS, etc.

Highly integrated OFA, ROADM, WSS, and similar modules must be qualified against Telcordia GR-1312-CORE, Issue 3. Mandatory Test Conditions are summarized in Table 4 Device Reliability Test Requirements for Highly Integrated OFAs, ROADMs, WSS, etc.. Due to the variety and complexity of modules covered under this section, the module manufacturer MUST communicate, and receive buy-off on, their qualification plan from Cisco BEFORE beginning that qualification effort.

For reverse engineering purposes, for the module itself, as well as for all critical components, the supplier should provide:

1. detailed description of the component, highlighting criticalities
2. failure mode analysis (deduced from above point)
3. operation flow chart (assembly sequence and production tests at sub-assembly and at final test), to assess process reliability

In addition, the critical components must be qualified at the component level to the criteria identified in the appropriate sections of this document. Incoming inspection criteria for these critical components should be provided.

Table 4 Device Reliability Test Requirements for Highly Integrated OFAs, ROADMs, WSS, etc.

	L1/L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Mechanical Integrity	L1	O	Straight-pull (for internal fiber cables)	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 3	EIA/TIA-455-6 (FOTP-6)	250mm: 0.5kg, 3 times, 5 sec. 900mm: 1.0kg, 3 times, 5 sec. >2mm ruggedised: 2.0kg, 3 times, 5 sec.	3
	L1	O	Side Pull (for internal fiber cables)	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 3	-	250mm: 0.25kg, 90°, 4 directions, 5 sec. 900mm: 0.5kg, 90°, 4 directions, 5 sec. >2mm ruggedised: 1.0kg, 90°, 4 directions, 5 sec	3
	L1	O	Flex (for internal fiber cables)	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 3	EIA/TIA-455-1 (FOTP-1)	>2mm ruggedised: 0.5kg, 300x, to FOTP-1A	3
	L1	O	Twist (for internal fiber cables)	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 3	EIA/TIA-455-36 (FOTP-36)	250mm: 0.25kg, +180°, -360°, +360°, -360°, +360°, -360°, 10cm from the end of strain relief. 900mm: 0. 5kg, +180°, -360°, +360°, -360°, +360°, -360°, °, 10cm from the end of strain relief. >2mm ruggedised: 1.36kg, 100x, -90°, +180°, -90°, to FOTP-36	3

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	L1/L2	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Mechanical Integrity	L1	O, E	Vibration	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 10-3	-	5-50Hz, 0.1 oct./min, 1.5G, then 50-500Hz, 0.25 oct/min., 3G Not packaged	3
	L1	O, E	Operating vibration test -sinusoidal	GR-1312-CORE, Iss. 3, Section 8.1.5.4	EIA/TIA-455-11A (FOTP-11)	10 - 55 Hz, per FOTP-11, Test Condition I: simple harmonic motion having a single amplitude of 0.76 mm (0.030 inches) or 1.52 mm (0.060 inch) maximum total excursion. The tolerance on vibration amplitude shall be ± 10%. From 10 to 55 Hz and return to 10 Hz within 1 minute; 120 times for each of the 3 mutually orthogonal directions	3
	L1	O, E	Office Vibration Test	GR-63-CORE, Section 5.4.2	-	5 to 100 to 5Hz, 0.1g, 0.1 oct/min.	3
	L1	O, E	Non operating vibration test-shocks	-	-	Half sine pulse, 6 directions, 500 times per direction, 40G peak acceleration, 6ms duration	3
	L1	O, E	Installation drop (unpackaged)	GR-63-CORE, Section 5.3.2	-	4 inch, 5 drops (1 surface, 2 edges, 2 corners)	3
	L1	O, E	Handling drop Packaged	GR-63-CORE, Section 5.3.1	-	29.5 inch, 10 drops (3 surface, 3 edges, 4 corners)	3
Environmental Stress / Endurance	L1	O, E	High temperature exposure and thermal shock test (Note 4)	GR-63-CORE, Section 5.1.1.2	-	70°C constant + Shock at room temperature 72 hrs at constant temperature For shock: ambient temp to 85°C, 30°C/hour, 85°C for 72 hours, 85°C to ambient, in less than 5min **NOTE: to satisfy L2 requirements, all three devices must be mated, and tested at operating extremes.**	3 mated
	L1	O, E	Low temperature exposure and thermal shock test (Note 4)	GR-63-CORE, Section 5.1.1.1	-	-40°C constant + Shock at room temperature 72 hrs at constant temperature For shock: ambient to –40°C, 30°C/hour, -40°C for 72 hours, -40°C to ambient in less than 5 min	3
	L1	O, E	Temperature Cycle – Non Operating	GR-418, Section 4.8	-	–40°C to +70°C, 100 cycles 90min transition, 30 min dwell **NOTE: to satisfy L2 requirements, all three devices must be mated, and tested at operating extremes.**	3 mated
	L1	O, E	Temperature Cycle – Operating	-	-	–5°C to +55°C+ΔT (note 3), 100 cycles 30min transition, 30 min dwell	3
	L1 L2	O, E	Damp Heat -Non-Operating	GR-1312-CORE, Iss. 3, Section 10.3.1, Table 1	-	85°C/85% RH, 1000 hrs, 2000hrs for information **To satisfy L2 requirements, all three devices must be mated, and tested at operating extremes.**	3 mated
	L1 L2	O, E	Accelerated Aging (High Temp) – (HTOL)	GR-63 GR-1217	EIA-364-1000 GR-326	Mated, Tmax; rated power, 2000hrs required	5

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	L1	O, E	High relative humidity exposure test (Note 4)	GR-63-CORE, Section 5.1.1.3	-	40°C 95%RH 96 hrs at constant temperature For shock: ambient temp to 40°C, 30°C/hour, RH to 95% (within 4 hours), 40°C 95%RH for 96 hours, 40°C to ambient, 30°C/hour	3
	L1	O, E	Operating temperature and relative humidity test	GR-63-CORE, Section 5.1.2	-	NEBS operating temperature and humidity profile, adding over-temperature	3

	L1/L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
	L1	E, O	ESD Threshold	IEC61000-4-2	-	DIRECT: Contact discharge– 8kV Air Discharge – 15kV Units must be passing traffic during test. Device shall not lose data during test.	
Special Tests	L1	E	Electro-magnetic Interference	FCC Class B; (CISPR22: 1997 /EN55022: 1998)	-	Frequency range as applicable. Cisco recommends a 6dB margin, but, depending on the density of modules on Cisco's boards, specific applications may require additional margin against these requirements.	
	L1	E	Electro-magnetic Immunity	IEC61000-4-3	-	80-1000MHz and 1.4-2GHz at Test Level 3=10V/m, or applicable frequency range and field strength.	
	L1	-	Flammability	-	-	Supplier must provide a statement or report showing that the module meets the specific UL94-V0 flammability rating at the module level.	

Notes:
1. It should be noted that the temperature ranges listed normally in reference standards are referring to the environmental temperature in which the system (Cisco), rather than the module (supplier), will have to operate; given that the module will operate inside Cisco System, its temperature ranges, both normal and exceptional ones, could significantly differ from those of the system itself (e.g. additional heating inside the shelf). This difference must be accounted for when defining, in the specification, the exact temperature under which the test needs being performed; this is accounted for by mentioning an over-temperature range (Delta T).
2. The over-temperature range should be considered to be, provisionally, -0°C / +15°C. It is intended that the temperature to which the module under test will be subjected is the case temperature.
3. The operating temperature/humidity range at system level is 5/40°C - 5/85%RH non-condensing, for long term (> 96hrs) conditions. For short term (24hrs), exceptional conditions of -5/55°C or 90%RH at 28°C must be withstood in specs. For this reason the temperature range that is considered for operating tests is –5/55°C.
4. To be performed w/o package.

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5 L1 & L2 Device Reliability Test Requirements for Passive Optical Components

Table 5 Device Reliability Test Requirements is adapted from Telcordia GR-1221-CORE, Issue 2. For all tests, a Lot Tolerant Percent Defective (LTPD) of 20% and a sample size of 11 is required. Any change to identified test conditions requires justification and must be approved by Cisco.

If a passive optical component has degradation mechanism that are accelerated by environmental conditions as well as applied forces (such as electrical or optical power), then these components must go through appropriate aging qualification that should be agreed upon with Cisco. Examples of such common components are electrically operated attenuators, and thermo-optic or electrically controlled switches. Hermetic components shall be tested and guaranteed to < 5000 ppm moisture content with manufacturing variation.

For passive optical components such as MEMS, suppliers must make sure that the vibration and / or shock stress on the component will include a harmonic (frequency) range that covers the natural vibration frequency of the component.

The supplier's reliability test plan must include periodic interval parametric tests of the product/component after application of stress. In-situ parametric monitoring during stress is allowed. Otherwise it is expected that the stress will be removed from the product/component and the product/component will be tested at room or elevated temperature, as appropriate.

Table 5 Device Reliability Test Requirements for Passive Optical Components (Couplers, Taps, Small Switches, et cetera)

	L1/L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Mechanical Integrity	L1	O E	Mechanical Shock	GR-1221-CORE, Issue 2	MIL-STD-883E Method 2002.4	5 times/axis, 6 axes; 1500g, 0.5ms, for units without a TEC. 5 times/axis, 6 axes, 500g, 1.0ms, for units with a TEC.	11
	L1	O E	Vibration Note1	-	MIL-STD-883E Method 2007.3	Cond. A, 20G, 20-2,000 Hz, 4 min/cyc, 4cyc/axis	11
	L1	O E	Thermal Shock Note 2 ***(Appendix D.2)***	GR-468 Issue 2	MIL-STD-883E Method 1011.9	Cond. A, 0 and 100°C; OR Delta $T=T_{max,storage} - T_{min,storage}$ Dwell time >= 5 min at temp extremes, transfer time <= 10 sec, the device or module shall reach specified temperature within 5 minutes. This fixes the equilibration rate needed. **To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11 2 mated
	L1	O	Fiber Integrity Note 3	-	-	In the absence of applicable standards use GR-468-CORE -- 1 kg, 3 times, 5 sec	11

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	L1/L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Environmental Stress / Endurance	L1	O E	High Temp. Storage	-	EIA/TIA-455-4A	Max. storage T 2,000 hours **To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11/ 0 2 mated / 0
	L1	O E	Low Temp. Storage	-	EIA/TIA-455-4A	Min. storage T 2,000 hours	11/ 0
	L1	O E	Temperature Cycling ***(Appendix D.11)***	GR-1221-CORE Section 6.2.7	MIL-STD-883 Method 1010	Tmin,storage to Tmax,storage; Requires 10 C/min. ramp, minimum 500 cycles pass/fail; 1000 cycles for info. **To satisfy L2 requirements, at least five devices must be mated, and tested at operating extremes.**	11/ 0 5 mated / 0
	L1	O E	Damp Heat - Non-Operating Non-Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	For controlled environments:Tmax,storage (or 85 C)/85% RH 1,000 Hrs 2,000 Hrs for info For uncontrolled environments, reference requirements in GR-1221. **To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11/ 0 2 mated / 0
	L1	O E	Damp Heat - Non-Operating Hermetic ***(Appendix D.12)***	MIL-STD-202G Method 103B or IEC 60068-2-3	-	Tmax,storage (or 85 C)/85%RH 1,000 Hrs 2,000 Hrs for info – with integrated Active components With Purely Passive Components: Tmax,storage(or 85 C)/85%RH 500 Hrs 1,000 Hrs for info **To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11/ 0 2 mated / 0
	L1	O E	Cyc. Moist Res.	GR-1221-CORE Section 6.2.8	MIL-STD-883E, Method 1004.7	85-95% RH at 75 C. Dwell time >= 3 hrs, 5 cycles each with 5 sub-cycles. **To satisfy L2 requirements, at least two devices must be mated, and tested at operating extremes.**	11/ 0 2 mated / 0

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	L1/L2 Requirement	Optical / Electrical	Test	Ref Doc	Test Methodology	Conditions	Sample Size / Failures
Special Tests	L1	O	Internal Moisture	MIL-STD-883E, Method 1018.3	-	<5000 ppm moisture content in hermetic modules. This test must be done only **after** thermal shock test on the sample to stress the joints prior to conducting internal moisture or hermiticity test. Full RGA analysis is required to detect moisture or other inorganic or organic residue levels inside the hermetic package.	5
	L1	O	ESD	HBM	MIL-STD-883, Method 3015.4 JESD22-A114-A	-	
	L1	O	Active Fiber - Fiber Strength	GR-1312 Section 10.2.6	R10-94 [598]	Five fibers of various lengths of fiber amplifiers (active fibers), from separate fiber draws, shall be coiled around a 10cm mandrel a minimum of 20 times.	
	L1	-	Flammability	-	-	Supplier must provide a statement or report showing that the module meets the specific UL94-V0 flammability rating at the module level.	

Notes:
1. GR-1312-Core OFA and Cisco specific -- 5 to 50 Hz, 0.1 oct/min, 1.5G, then 50-500 Hz, 0.25 oct/min, 3G
2. This is only required for Hermetic packages.
3. The component shall be tested to the criteria in the appropriate fiber integrity sections of the applicable documents (i.e. GR-1209-CORE for branching components (Section 5.1.8), GR-326-CORE for connectors and jumpers (Section 4.4.3.4), GR-1312-CORE for OFA's, GR-2854-CORE for dispersion compensators, GR-2882-CORE for isolators and circulators, and GR-2883-CORE for filters). In the absence of applicable reference, use GR-468-CORE (Section 5.2) -> 1Kg, 3 times, 5 sec.

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6 Lot Controls and Production Testing

The primary goal of instituting Lot Controls and Production Testing is to insure that all units are tested to meet the fault coverage requirements and critical performance requirements (speed, frequency, etc). Additional guard bands must be applied to increase product margins during production testing.

6.1 Visual Inspection

It is Cisco's expectation that all products go through at least some type of visual inspection as part of outgoing quality. Some inspection items may only be visually inspected on a sample basis. Package conditions, required documentation, product appearance/condition, key dimensions, product identification/marking, and connectors/adapters should all be reviewed for completeness. For devices with pigtails and optical ports, the connector endface or lens should be inspected per the guidelines in Cisco document EDCS-703683, Inspection Procedure for Fiber Optic Connectors.

Identify all visual inspection steps, and all items verified at each of those steps.

6.2 Production Screening

An effective Production Screening program is important to ensure the ongoing quality and reliability of shipped components.

The supplier shall specify all data sheet parameters and whether the particular parameter is 100% tested, guaranteed by design, sample tested, tested over full temperature range or room temperature only, and tested over full electrical range or nominal only.

Supplier shall document frequency of performance and reliability monitoring for product.

6.3 Burn-In and Temperature Cycling Requirements

Suppliers shall develop a burn-in and/or temperature cycling program at the module and sub component level that is designed to ensure there are no failures within the first two years of use and that ensures a life cycle consistent with a twenty-year lifetime. Sample size is 40 minimum. Cisco is motivated to have optical components that meet or exceed 100 FITS at 45-50^{o}C case under normal operating conditions. Burn-in matrix must be approved by Cisco before A0.

6.4 Ongoing Quality and Reliability Monitoring Program

Suppliers must provide proof of an ongoing quality assurance (OQA) and ongoing reliability testing (ORT) program. Samples used to demonstrate component integrity must be randomly selected and must be representative of the respective product family to insure proper coverage (such as package family, fab location, assembly location, etc.). All quality and reliability tests must be described in detail including sample size, frequency and pass/fail criteria.

In the case of failure of the optical component, Cisco will require history of the last 2 years, or more, of field returns and results of the implementation of corrective actions.

The supplier should provide a requalification schedule. Cisco generally expects that the frequency for this requalification will be at least every two years.

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7 Reference Documents

7.1 Industry Documents

Telcordia GR-468-CORE	Issue 2, Generic Reliability assurance Requirements for Optoelectronic Devices Used in Telecommunications Equipment
Telcordia GR-1221-CORE	Issue 2, Reliability Requirements for Passive Optical Components
Telcordia GR-1209-CORE	Issue 3, Generic Requirements for Passive Optical Components.
Telcordia GR-1312-CORE	Issue 3, Generic Requirements for OFAs and Proprietary DWDM Systems
Telcordia GR-1435	Generic Requirements for Multi-Fiber Optical Connectors Performance Testing
Telcordia GR-326	Generic Requirements for Single-Mode Optical Connectors and Jumper Assemblies
MIL-STD-883E	December 2000, Microcircuits
MIL-STD-810F	January 2000, Environmental Engineering Considerations and Laboratory Tests
EIA-604	Fiber Optic Connector Intermateability Standards (ANSI/TIA/EIA -604-93)(R2000)
EIA-364-31B, TP-31B	Humidity Test Procedure for Electrical Connectors and Sockets (ANSI/EIA-364-31B-00)
EIA-364-32B, TP-32B	Thermal Shock Test Procedure for Electrical Connectors (ANSI/EIA-364-32B-92)
EIA-541	Packaging Material Standards for ESD Sensitive Items (ANSI/EIA-541-88)
EIA-364-91, TP-91	Dust Test for Electrical Connectors and Sockets (ANSI/EIA-364-91-96)
EIA-455-35-A, FOTP-35 -	Fiber Optic Component Dust (Fine Sand) Test (ANSI/EIA/TIA-455-35A-90) (R95) (R99)
EIA-364-1000.01,	Environmental Test Methodology for Assessing the Performance of Electrical Connectors and Sockets Used in Business Office Apps.
IPC-9701	January 2002, Performance Test Methods and Qualification Requirements for Surface Mount Solder Attachments
IPC-7711	February 1998, Rework of Electronic Assemblies
IPC-0040	August 2002, Optoelectronic Assembly and Packaging Technology
Telcordia GR-20	Generic Requirements for Optical Fiber and Optical Fiber Cable
Telcordia GR-409	Generic Requirements for Premises Fiber Optic Cable
Telcordia GR-910	Generic Requirements for Fiber Optic Attenuators

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7.2 Cisco Documents

1st Level Qualification for Semiconductor Devices	(EDCS-191891)
Fiber Optic Connector and Cable Qualification	(EDCS-152890)
Qualification of Electrical Connectors	(EDCS-164608)
Inspection Procedure For Fiber Optic Connectors	(EDCS-703683)
2nd Level Qualification for Ball & Column Grid Array Packaged Devices	(EDCS-164125)
Cisco Pb-free Qualification Specification	(EDCS-281405)
Cisco Pb-free Required Qualification Information	(EDCS-407890).
Lead-free Requirements for Optical Suppliers	(EDCS-491485)
Fiber Optic Endcap Specification	(EDCS-218421)
Optical Power Variation Test Guidelines	(EDCS-274090)
Product Change Notification and EOL Notification Requirements	(EDCS-226406)
Optical Qualification Checklist	(EDCS-463021)
De-Panelization Guidelines for Optics and Power Supplies	(EDCS-686142)
Cisco Ongoing Reliability Test document	(not yet released)
Optics Test Review Process	(EDCS-675424)
Cisco Cosmetic Requirements	(EDCS-755658)
2nd Level Qualification for Optical Components	(EDCS-181527)

Appendicies

Appendix A Additional detail on reliability testing

D.1. Shock and Vibration Qualification Experiments (Cisco MDVT)

One of the key steps to product release at Cisco is Mechanical Design Verification Testing (MDVT). It is also an important requirement of 2nd Level Qualification to complete shock and vibration testing in a mated condition. If the applicable Cisco BU has committed to using a supplier's optical devices in MDVT, then the results can be used to satisfy the 2nd Level Qual requirements for shock and vibration.

MDVT includes shock and vibration experiments which are useful to simulate expected shipping conditions that post-attachment products will be exposed to in the field. Vibrations test are also expected

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to flag any poor interconnect to package solder joints that may exist due to attachment and/or package metallization issues. The vibration tests listed also meet the objective of GR-1435 and GR-326 vibration testing when tested with optical cables installed. Cisco MDVT is done at the linecard level with optical modules installed. Any optical modules that fail during Cisco MDVT will be returned to the supplier for failure analysis.

Optical device suppliers are highly encouraged to perform independent Shock and Vibration experiments with the device attached to a simulated motherboard using their proposed attachment method or MSA approved connectors and test boards.

D.2. Thermal Shock

Thermal shock testing is required to be completed in a mated condition (electrical and optical connections mated during test) for at least two modules, out of the total eleven. It is preferred that parametric testing be done while the devices are in the chamber. If this is not feasible, devices may be tested at operating temp extremes at the completion of thermal shock. Thermal shock report should include electrical connector used in testing.

D.3. Electrical Durability Testing

To meet Telcordia requirements, refer to the durability test requirements for the applicable design life. If the design life is not specified, assume a minimum of 10 year life. This is equivalent to System Quality (SQ) Requirement II as specified in GR-1217. Durability tests to meet this requirement shall ensure connector reliability over full design life. Qualification tests for SQ Requirement II for both reliability and durability shall simulate this requirement with a minimum of 200 wear cycles.

A design life of 25 years of service shall be assumed for SQ Requirement III. Unless otherwise specified, qualification tests for SQ Requirement III for both reliability and durability shall simulate this requirement with a minimum of 200 wear cycles, recommended is 300 wear cycles.

Pass requires no evidence of physical damage and LLCR for Noble metal less than 10 milliohms & Non-noble metals less than 20 milliohms delta, or, at module level, product must still function per datasheet.

D.4. Temperature Cycling

Temperature Cycling should be done in the mated condition for 5 out of the 11 samples. It is expected that a ramp rate of a minimum of 10 C/ min is used. Ramp rates less than 10 C / min require approval from Cisco and may require additional total cycles. Parametric Testing is required at operating temperature extremes after completion of the test if using the test method listed.

D.5. Damp Heat

Both operating and non-operating damp heat must be completed, unless the supplier can demonstrate, using test data from similar devices that have undergone both operating and non-operating testing, that they have used the worst case stress conditions. See GR-468-Core Revision 2, section 3.3.3.3.

D.6. Extended Temperature Cycling

This testing is required for devices having external BGA to flex circuit connections and external BGAs with less than 0.8 mm pitch. External BGAs are BGAs that may be stressed due to mechanical loading, mounting hardware, or installation of device to Cisco linecard. Examples of external BGAs are BGAs on

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FCI Meg-Array connectors which are used on SNAP-12 MSA products and 300 pin modules. Devices should be mated to an evaluation board with recommended mounting hardware if applicable.

D.7. Cisco Controlled Substances Specification

Cisco Controlled Substances Specification, EDCS-661823, controls the use of listed substances in the manufacture of Cisco Products. The controls apply to the products and /or manufacturing processes used in the fabrication of Cisco products, i.e. raw materials, parts, components, assemblies, and modules.

There are 3 categories of controlled substances -

Restricted - Substances reportable Maximum Concentration Values (MCV) at the homogeneous material level or intentional addition of such substance.

Reportable - Substances under certain laws, regulations or voluntary control programs must be reported.

Manufacturing Controlled - Substances that are restricted from use or must be reported and accompanied by a phase-out plan if used in manufacturing of Cisco parts, components, etc. These are Ozone Depleting Chemicals - ODC Class I and II.

Appendix B Aqueous Wash Guidelines

It is preferred that all devices be capable of withstanding an aqueous wash process at Cisco Contract Manufacturing locations. An aqueous wash process is frequently used during board rework and many board designs make it impractical to remove the optical devices. Moisture resistance capability must be stated and validation data should be provided to ensure an aqueous wash can be used (typical conditions listed below). Pre- and post-wash procedures must be provided (air bake or thermal method). Any handling procedure or requirements for removing fiber connectors should be stated. If a device is unable to meet aqueous wash requirements, this must be clearly stated in technical datasheets.

Typical Surface Mount Assembly Cleaning conditions (if using an aqueous solder paste flux)
Aqueous Wash:

- Water Pressure = 100 psi max
- Water Temperature = 65 C (150 F)
- Conveyor Speed = 3-4 feet/minute
- Dryer: Air Temperature = 93 C (200 F) to 121 C (250F)

Appendix F Qualification Checklist

Excel format checklist with active and passive test requirements tables is available from Cisco Component Engineering Team (Cisco Document # EDCS-463021).

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Appendix G Electronic Design Verification Testing (EDVT) – FOR INFORMATION ONLY

One of the key steps to product release at Cisco is Electronic Design Verification Testing (EDVT). It is important for a supplier to fully understand the stresses that are applied, **by Cisco**, to a device during this testing, so that their design can accommodate those stresses.

This type of testing is designed to stress the design of the system to verify that there are no component and noise margin issues that would affect production yield. Thus, the testing conditions are extended beyond the worst-case specifications.

The typically used stress vectors are:

- Voltage margining (minimum ±5 % of the nominal Power supply voltage)
- Frequency margining (minimum ±5 % of the nominal clock frequency)
- Environmental conditions: Extended Operating Temperature

All combinations of the extremes of frequencies, power supply and temperatures conditions define a test case, called CORNER. All the corners must be executed on three devices (or more) step-by-step applying the related conditions for a minimum time interval of 6 hours.

It is intended that the module, in all stress test corner conditions, shall perform according to specifications.

Voltage Margining Requirements

All power supplies used inside the module must have the possibility to be set at least at +/-5% from nominal (in some cases a lower tolerance is still acceptable).

When applicable, power supply output (slave) is derived from another (master) in such a way that a change in the master has a direct effect on the slave, the voltage margining shall be applied only on the master. Each voltage constitutes a power source under test: if the board has more than one power supply rail (e.g. 3V and 5V), each of them will constitute an additional parameter to put under stress, thus multiplying each time by 2 the number of corners.

It is intended that the module will operate with the internal power sources stressed as per above, while its inputs power levels are varied in a range that itself is suffering a similar deviation (at least +/-5%) from nominal.

The module must continue operating as specified when the stress conditions are applied.

Frequency margining of clocks

All equipment utilizing clocks should be able to tolerate a minimum variance in the frequency of +/-5% from the nominal frequency

An exception is that of reference clocks or microprocessor controllers on those circuit elements synchronized to the SONET/SDH network clock – these devices do not undergo this test. All other exceptions should be agreed upon on a case-by-case basis.

End of Document

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