Verizon NEBS™ Compliance: Generic Reliability Assurance Requirements for Passive Optical Components

Verizon Technical Purchasing Requirements

VZ.TPR.9405

Issue 7, June 2012

CHANGE CONTROL RECORD:

Version	Date	Action*	Reason for Revision
1	*08/21/2007*	New	New Document
2	*10/04/2007*	Add	Stress screening requirements for PLC splitters, Full optical characterization for sample Group-A
3	*10/28/07*	Change Add	Changed the During test measurement requirement Added note for providing additional test data
4	*2/1/2008*	Change	Modified pass criteria from 5% to 5% dB
	2/1/2008	Change	Added only after 23°C note for final characterization
5	*08/242011*	Change	Plug and Play Splitter Qualification – Added Clarification
	08/24/2011	Change	Splitter and splitter Module Re-Qual Guidelines – Added Clarification
	08/24/2011	Change	Extended Thermal Cycle Test Conditions – Listed 100, 168 hr measurements as optional
	08/24/2011	Add	Added Proven Technology and Product Family Qualification Test Program description and criteria.
6	09/13/2011	Change	Modified Proven Technology and Product Family Qualification Test Program description and criteria.
	09/13/2011	Add	Defined ports tested for 1x64, 2x64 splitters
7	06/18/2012	Add	Added Bidirectional IL test requirements.

*** New, Add, Delete, Change, Reissue**

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1.0 PURPOSE

The purpose of this Verizon Technical Purchasing Requirement document is to provide FOC testing Reliability Assurance Requirements for Passive Optical Components.

2.0 SCOPE

FOC Products

3.0 REFERENCES

Verizon FOC Memo #27, Rev 1; July 27, 2005	GRs: 1209 and 1221 Splitters and other Passive Optical Components, Complete Program Test Punch Lists and Modified Test Programs/Punch Lists for Specific Scenarios
Verizon FOC Memo #26, June 30 2005	Notes and Information – Various GR's
Verizon FOC Memo #40, June 26, 2006	Summary Notes
Verizon FOC Memo # 43, October 3, 2006	GR-326, 3120, 1435, 3152, 3128, 1081 Extended Thermal Cycling (Reliability) Test
Verizon FOC Memo # 45; November 3, 2006	Reinforcing the need of completing Factory audit requirements in a timely manner.
Verizon April 2007 FOC Conference	Day 2 - Critical FOC Memos for April 2007 Meeting
Verizon April 2005 FOC Conference	Requirements Checklists Analysis for Verizon Approved Test Plans
GR-1209-CORE, Issue 3, March 2001	Generic Requirements for Passive Optical Components
GR-1221-CORE; Issue 2, January 1999	Generic Reliability Assurance Requirements for Passive Optical Components

4.0 ACRONYMS

A	After
B	Before
D	During
FDH	Fiber Distribution Hub
FOC	Fiber Optic Components
IL	Insertion Loss
ITL	Independent Testing Laboratory
N/A	Not Applicable
nm	Nanometer
RL	Return Loss

5.0 RELIABILITY ASSURANCE REQUIREMENTS FOR PASSIVE OPTICAL COMPONENTS

Verizon is considering using Passive Optical Components for all applications as required. The following are the test requirements for qualifying Passive Optical Components. All the testing must be performed by a Verizon approved ITL.

MxN Splitter Module FOC TPR.9405 (GR-1221) Qualification Test Program				
Task Name	**Sample Groups**	**Number of Samples**	**Optical Monitoring**	**Test Conditions**
Prepare Test Samples & Materials				Room Temp unless noted otherwise.
3.0 Basic Reliability Assurance Program Requirements				**Manufacturing Quality & Operations Audit**
3.1 Vendor and Device Qualification				Factory Audit Per TPR.9404
3.2 Lot-To-Lot Quality and Reliability Controls				Factory Audit Per TPR.9404
3.3 Standardized Test Procedures				Factory Audit Per TPR.9404
3.4 Feedback and Corrective Action				Factory Audit Per TPR.9404
3.5 Device Storage and Handling				Factory Audit Per

MxN Splitter Module FOC TPR.9405 (GR-1221) Qualification Test Program				
Task Name	**Sample Groups**	**Number of Samples**	**Optical Monitoring**	**Test Conditions**
				TPR.9404
3.6 Documentation and Test Data				Factory Audit Per TPR.9404
3.7 Availability of Devices				Factory Audit Per TPR.9404
4.0 Specific Reliability and Quality Criteria				**Manufacturing Quality & Operations Audit**
4.1 Qualification of Passive Optical Devices				Factory Audit Per TPR.9404
4.2 Qualification of Integrated Passive Optical Module				Factory Audit Per TPR.9404
4.3 Quality Assurance and Lot Controls				Factory Audit Per TPR.9404
4.4 Reliability and Quality of Optical Adhesives				Factory Audit Per TPR.9404
Initial Optical Performance Measurements	A		Complete set of initial optical characterization measurements at four wavelengths @-40°C, 23°C, 85°C	1310 nm, 1490 nm, 1550 nm, and 1625 nm, All ports unless otherwise stated.
6.0 Reliability Test Procedures				
6.2.4 High Temperature Storage Test (Dry Heat)	A	7 & 7 or 11	Complete initial optical characterization at four wavelengths @ -40°C, 23°C, and 85°C. Before & After IL	85°C (±5°C), < 40% RH, 2,000 hrs. for qualification and ≥ 5000 hrs (optional) for information. IL measurements initially, and then at 168- (optional), 500-, 1000-, and 2000-hour intervals.

MxN Splitter Module FOC TPR.9405 (GR-1221) Qualification Test Program				
Task Name	**Sample Groups**	**Number of Samples**	**Optical Monitoring**	**Test Conditions**
			and RL (Input Port) measurements	
6.2.5 High Temperature Storage Test (Damp Heat)	B	7 & 7 or 11	Complete initial optical characterization at four wavelengths @ 23°C. B & A IL and RL (Input Port) measurements.	75°C (±5°C), 90% (± 5%) RH, 2,000 hrs. For qualification and ≥ 5000 hrs (optional) for information. IL measurements initially, and then at 168- (optional) 500-, 1000-, 2000-hour intervals.
6.2.6 Low Temperature Storage Test	C	7 & 7 or 11	Complete initial optical characterization at four wavelengths @ 23°C. B & A IL and RL (Input Port) measurements.	-40°C (±5°C), uncontrolled humidity, 2,000 hrs. For qualification and ≥ 5000 hrs (optional) for information. IL measurements initially, and then at 168- (optional), 500-, 1000-, 2000-hour intervals.
6.2.1 Mechanical Shock (Impact Test)	D	7 & 7 or 11	B & A IL and RL (Input port).	50 G (based on module mass), 5 times per direction for 6 directions (on 3 axes), 1 ms. B &A IL and RL (Input port) measurements only at four wavelengths at 23 □C.

MxN Splitter Module FOC TPR.9405 (GR-1221) Qualification Test Program				
Task Name	**Sample Groups**	**Number of Samples**	**Optical Monitoring**	**Test Conditions**
6.2.2 Variable Frequency Vibration Test	D	7 & 7 or 11	B & A IL and RL (Input port).	20 G maximum acceleration, 20-2,000 Hz, 4 min per cycle and 4 cycles per axis. IL and RL (Input port) measurements only at four wavelengths at 23°C.
6.2.8 Cyclic Moisture Resistance Test	E	7 & 7 or 11	B & A IL and RL (Input port).	85-95% at 75°C; uncontrolled at 25°C & -40°C, 3 to 16 Hours dwell time at extremes, 5 complete cycles (each complete cycle has 5 sub-cycles). B & A IL and RL (Input port) measurements only at four wavelengths at 23°C.
6.2.7 Temperature Cycling Test Final Optical measurements	E	7 & 7 or 11	B & A IL and RL (Input port).	- 40°C to 70°C (± 2°C) for CO, 40°C to 85°C (± 2°C) for RT/UNC, ≥ 15 minutes dwell time at extremes, 100 cycles pass/fail, 500 cycles (optional) for information for CO, 500 cycles pass/fail, 1000 cycles (optional) for information for RT/UNC. Only Two tests are sequenced tests. (Vibration/Impact) therefore, the final optical measurements will be the IL/RL measurements taken after each specific test. However, for any IL/RL non-compliances during or after a specific test, a full after optical characterization is

MxN Splitter Module FOC TPR.9405 (GR-1221) Qualification Test Program				
Task Name	**Sample Groups**	**Number of Samples**	**Optical Monitoring**	**Test Conditions**
				required for that test.

Optical Measurements:		
Characterization	100% of devices and channels, unless otherwise specified in this TPR	
B & A - Before and After	IL Testing @ (1310, 1490, 1550 and 1625nm) - 100% of channels, unless otherwise specified in this TPR	
D - During	IL Testing @ (1310, 1490, 1550 and 1625nm) - 100% of channels, unless otherwise specified in this TPR	
Sample Configurations:		
1 product	11 samples / 3 hot spares	
2 or more products	7samples/7samples/x…. 2 hot spares/2 hot spares/x….	
Number of Ports Tested	Sample ports tested. For all full evaluations of 1x64 or higher count splitter modules (including 2x64), the number of ports tested is reduced to 50%. Ports are selected for testing in the following manner: Sample 1 – All even numbered ports Sample 2- All odd numbered ports Sample 3 – All even numbered ports Sample 4- All odd numbered ports • • •	
Bi-Directional Testing	Due to their inherent nature, some specific types of splitter technologies may not exhibit symmetrical Insertion Loss (upstream and downstream) behavior. Therefore for the environmental and mechanical tests the measurement direction for IL shall be split evenly between "upstream" and "downstream" directions. The difference between the upstream and downstream IL on each sample shall not exceed 0.5 dB.	

***Plug and Play Splitters:**

Plug and Play Splitters must be tested in a configuration that uses the actual complete FDH or a fixture that simulates the FDH receptacle shelf for the splitter. When performing the GR-1209 Temperature and Humidity Cycle the following procedural steps are required:

At 23 C, perform 10 insert/remove cycles of the plug/play splitter modules. Measure IL/RL, then subject the samples to 42 cycles of Temp/Hum per GR-1209. At the conclusion of the 42 cycles measure, IL/RL. Raise the chamber temperature to 40 C and allow the temperature to stabilize. Subject the samples to 25 insert/remove cycles, measure IL/RL. Lower the chamber temperature to -18 C and allow the temperature to stabilize. Subject the samples to 25 insert/remove cycles. Measure IL/RL. Raise the chamber temperature to 23 C. Perform 10 insert/remove cycles and measure IL/RL.

Splitter & Splitter Module Re-Qualification Guidelines (Due to Design Changes):

Note: Test results for all the requirements that need testing per Section 3 of GR-1209 and Section 3 & 4 of GR-1221 must be provided with option A & B below.

- Option A – Splitter component new or redesigned has not been FOC Qualified. Module previously FOC qualified (with old splitter component) However, there are no design changes to the Module. :
    - Qualify the splitter component to both TPR.9427 (GR-1209) and TPr.9405 (GR-1221).
    - Perform a complete set of initial optical characterization measurements for Group-A at four wavelengths @-40°C, 23°C, 85°C, as specified in the TPR.
    - The fiber integrity tests are not required, since the module has already been qualified.
    - No module level testing required
    - Complete set of final optical characterization measurements for Group-A at four wavelengths @ 23°C (only), as specified in the TPR.

- Option B – The Splitter component has been previously FOC Qualified, but the module is new or redesigned and is not Qualified.
    - Perform a complete set of initial optical characterization measurements for Group-A at four wavelengths @-40°C, 23°C, 85°C, as specified in this TPR.
    - Perform a complete TPR.9427 qualification program
    - Substitute the module vibration and physical shock test in 1209 with the module vibration and physical shock test from 1221.
    - Complete set of final optical characterization measurements for Group-A at four wavelengths @ 23°C (only)

Extended Thermal Cycle Test Conditions (modified GR-1221 requirement)

Temperature:	Cycle in Figure 1 (-40°C to 85°C).
	All ramp times are 1.4°C per minute. All plateaus are 30 minutes.
Humidity:	Uncontrolled

Duration: 500 cycles in 2000 hours

Measurement of Insertion Loss and Reflectance: Data shall be taken initially, and then at (100 optional), (168 optional), 500, 1000, and 2000-hour intervals.

The test conditions for the Extended Thermal Cycle Test are shown in Figure 1 below.

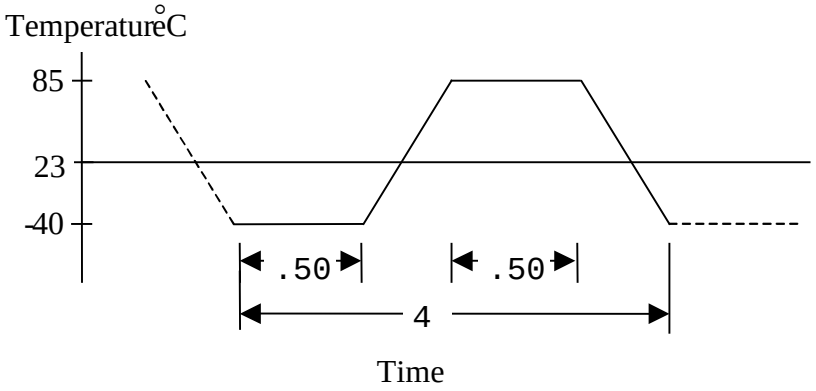

Figure 1: Temperature Profile for Extended Thermal Cycle Test

Stress Screening Requirements[1]:

Splitter Components:

- Temperature cycling: Temperature cycling testing is performed for all PLC splitters. The testing condition is as follows.
  - Number of cycle: 10
  - Temperature limits: -40 and 85 degree C

- Measurement before Temp cycling
  - Insertion loss at 1310 nm and 1550 nm

- Measurement after Temp cycling

[1] Stress screening for splitter components is performed as part of the manufacturing quality control program. Stress Screening is not required for any of the test samples intended for FOC qualification.

- Insertion loss at 1310 nm and 1550 nm
- Insertion loss change by Temp cycling at 1310 nm and 1550 nm (Pass criteria 5%[2] of dB change)
- Uniformity at 1310 nm and 1550 nm
- PDL at 1310 nm and 1550 nm
- Return loss at 1310 nm and 1550 nm
- Bandpass
- Directivity (adjacent channels only @ 1310 nm and 1550 nm)

If a supplier is buying splitters from some other manufacturer, it is the responsibility of the supplier to Verizon to ensure that above listed conditions are followed by the PLC manufacturer.

Splitter Modules:

No Stress Screening is required for the Splitter Modules; however, a Lot-to-Lot reliability test program is required. Manufacturer of Splitter Modules can decide on the number of samples to be tested for reliability per lot.

[2] The 5% pass/fail criteria may not be appropriate for some optical parameters.

Splitter Proven Technology Product Family Qualification Test Program

This section defines a "Proven Technology Product Family Qualification Test Program" that is intended to provide necessary performance criteria for qualifying new splitter products using a reduced set of TPR.9405 and TPR.9427 criteria based on proven technology and the existence of previously qualified high splitter count Splitter products. The set of criteria is intended to provide sufficient assurance of product performance and quality while reducing substantially the product qualification testing cycle.

Qualifications Requirements

Splitter Type and/or Manufacturer Experience	Qualification Program Required
New Manufacturer (no previously FOC qualified splitters)	Full TPR.9405 and Full TPR.9427 FOC test
New Splitter Technology (manufacturer has not qualified any identical technology type splitters)	Full TPR.9405 and Full TPR.9427 FOC test
New Family member (Supplier seeks to qualify a smaller port count splitter) (Large port count splitter previously qualified.)	TPR.9405 and TPR.9427 Waiver Program

Conditions for a PLC Based Optical Splitter and Modules Faimly Test Qualification Waiver

A Splitter component chip or module may qualify for a TPR.9405 and TPR.9427 test program waiver if the following conditions are met.

A. The highest port count (such as a 1x64 or 2x64) of the Vendor's splitter/module family has been FOC tested and qualified/certified via the Verizon FOC program.
B. Then the full FOC testing for any lower count modules can be waived (such as the 1x32 or 2x32) provided that the following criteria are met:

    a. A complete FOC test report (TPR.9405 and TPR.9427) for the highest count port exists and that the report shows that the highest port count splitters (for example, the 1x64 and 2x64) are compliant.
    b. The Vendor must provide proof that the lower port count splitter chip uses the same technology and that the chip component is manufactured by the same supplier utilizing the same manufacturing processes and acceptance criteria.

c. The splitter module design is exactly the same* as the originally qualified highest port count splitter

OR

In the lower count module, minor design changes have been made to improve the product. Vendor must supply change details and all applicable in-house test data showing that the changes have not resulted in a decrease in module performance. (Verizon will review the design changes and data and decide if the design changes are "minor" and if the data is sufficient to show that the changes are non-performance affecting.)

d. All Incoming lots of the splitter component are 100% screen tested and inspected. One hundred percent of all outgoing final products (including 100% of the ports) are tested for IL, RL, PDL, and Uniformity. Comprehensive records are kept of the testing results/activities. One hundred percent (100%) of shipped product must comply with the Verizon RFQ criteria.

e. The technical criteria of IL uniformity, RL and PDL for the smaller port count modules lower port spec on IL Uniformity, RL, and PDL are no worse than the higher end splitter/module,

f. A random sample selection and verification is required for the lower port count splitter/module. (See the following definition of the verification criteria).
   A. Factory Audit per Verizon TPR.9445 (Process audit only 1-2 day)
   B. Test Eleven (11) samples (from factory audit) to the complete set of optical characterization criteria Per TPR.9427 at 23C followed by;
   C. Seven (7) days of temperature-humidity aging per TPR.9427 section 5.4.1.1.
   D. Twenty One Cycles, Seven (7) days of temperature cycling per TPR.9427, section 5.4.2.2[3].
   E. Optical monitoring of IL/RL Before, IL during, and IL/RL after.

***A lower count splitter module is the same as the original higher count splitter module if the following conditions are met:**

Chip:

1. The lower port count splitter chip utilizes the same splitter technology and manufacturer as the high port count splitter chips.
2. The lower port count chip utilizes the same input fiber array and adhesive.
3. The lower port count chip utilizes the same output fiber array and adhesive
4. The lower port count chip uses the same component case style and materials (but case size may vary)
5. The lower port count chip uses the same fiber type

[3] Controlled Environment (section 5.4.2.1) Temperature Humidity cycling (with the modification of reducing testing to 168 hrs) is applicable for those splitters intended for controlled environment only.

Module:

1. The lower port count module chip meets the chip criteria 1 through 5 above.
2. The lower port count module utilizes the same materials and basic module physical design (shape, material thickness, component layout, etc.)
3. The lower port count module utilizes the same terminating method and parts (Including cables and connectors)
4. Basic manufacturing assembly procedures are the same as the larger port splitter module.
5. Module is assembled at the same factory location as the larger port splitter modules.