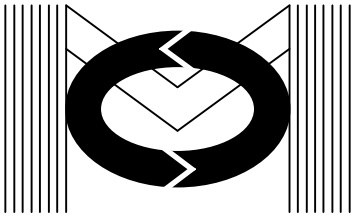
FFP-TF2
Fiber Fabry-Perot Tunable Filter
GR-2883 Test Report



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November 18, 2004

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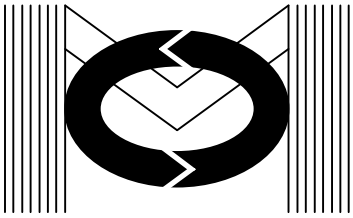

Micron Optics, Inc.

FFP-TF2 Fiber Fabry-Perot Tunable Filter

GR-2883 Test Report

I. Telcordia GR-2883-CORE Testing Overview

November 18, 2004

Overview

The tests described in this document were performed as described in Telcordia Generic Requirements GR-2883-CORE (Issue 1, December 1995). “Generic Requirements for Fiber Optic Filters.” The objective of the testing was to certify conformance of the component under test to the requirements of the aforementioned specification.

Fiber Fabry-Perot Tunable Filters (FFP-TF2) were selected from September, 2003 production. All filters were manufactured by Micron Optics, Inc.

References

GR-2883-CORE		Generic Requirements for Fiber Optic Filters, Issue1, December 1995
GR-63-CORE		Network Equipment-Building System (NEBS) Requirements: Physical Protection, Issue 1, October 1995, Issue 2, April 2002
EIA/TIA-455-B		Standard Test Procedures for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components
FOTP-1	TIA/EIA-455-1-B	Cable Flexing for Fiber Optic Interconnecting Devices, October 1998
FOTP-2	TIA/EIA-455-2-C	Impact Test Measurements for Fiber Optic Devices, July 1998
FOTP-3	TIA/EIA-455-3-A	Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components, May 1989
FOTP-4	TIA/EIA-455-4-C	Fiber Optic Component Temperature Life Test, June 2002
FOTP-5	TIA/EIA-455-5-C	Humidity Test Procedure for Fiber Optic Components, June 2002
FOTP-6	TIA/EIA-455-6-B	Cable Retention Test Procedure for Fiber Optic Cable Interconnecting Devices, March 1992
FOTP-11	TIA/EIA-455-11-C	Vibration Test Procedure for Fiber Optic Components and Cables, June 2002
FOTP-71	TIA/EIA-455-71-A	Procedure to Measure Temperature-Shock Effects on Fiber Optic Components, October 1999

Description of Test Sample

The Fiber Fabry-Perot Tunable Filter II, referred to as Device Under Test (DUT), is an all-fiber optical device constructed with partially transmitting mirrors forming a

resonance cavity that is variable in length to enable tuning the filter to a desired wavelength.

Method of Monitoring DUT

All DUT were optically characterized prior to testing, upon completion of each test, and if required, monitored during test. For tests that require active monitoring throughout the test, optical loss and locking voltage were recorded. The optical characterization setup is configured as follows:

Optical Characterization Test-Set:

The DUT is connected to FFP-C PZT Controller and a triangular ramp voltage is applied to the PZT so that the filter scans across the spectrum. A tunable, narrow band laser is passed through the filter to a log-amp detector. As the filter is swept across the laser line, the filter profile is detected. Through an optical switch, the filter input and output are alternately detected to determine optical loss. The laser is stepped across the spectrum as the filter scans. Insertion loss and bandwidth are recorded as a function of wavelength.

For one reliability test (Temperature Cycling), the Glitch Free Dynamic Range was also recorded; although this is not a GR2883 requirement it illustrates the lifetime performance of an important filter characteristic for some high performance applications. The Glitch Free Dynamic Range is measured by the use of a Log Amp with a narrow line laser and measures the depth of the Filter shape following the Airy function without a glitch of a specific size in dB.

Equipment:

Ando AQ8201A Rack Main Frame
Ando AQ8201-13B ECL Module (1500nm-1620nm)
Ando AQ8201-13 ECL Module (1460nm-1580nm)
Ando AQ8201-21 OPM Module
Ando AQ8201-43 1X12 OSW
Micron Optics FFP-C PZT Controller
Log Amp
ASE Source

Test Site

Test were performed at the following locations:

- Optical Criteria, Operating Environment, Non-Operating Environment, and Reliability Tests:
  Test performed by Micron Optics, Inc.

- Shock Criteria, Vibration Test:
  Test performed by Engent AAT, Inc., 3140 Northwoods Parkway, Suite 300A, Norcross, Georgia 30071

- Flex Test, Twist Test, Side Pull, and Cable Retention:
  Test performed by Micromotion Engineering, Inc. Marietta, GA 30066, at Micron Optics facility.

II. Performance Criteria Summary
(GR-2883-CORE, Section 4)

Characteristic	Criteria	Date Completed	Sample Size	Number Failures	Test Passed?
Optical Criteria					
Optical Bandwidth and Center WL	1290 à 1330nm or 1520 à 1570nm	4/1/2004	36	0	Yes
Insertion Loss	3.5dB	4/1/2004	36	0	Yes
Flatness	N/A	N/A	N/A	N/A	N/A
Wavelength Isolation	25dB	4/1/2004	36	0	Yes
Reflectance	40dB	N/A	N/A	N/A	N/A
Polarization-Dependent Loss	0.2dB	4/1/2004	36	0	Yes
Environmental Criteria					
Operating Environment	-5 to 50°C, 5 to 90% RH	11/12/2004	1	0	Yes
Non-Operating Environment	-40 to 70°C, 0 to 95% RH	11/5/2004	2	0	Yes
Shock Criteria	30” Drop Packaged, 4” Drop Unpackaged	3/31/2004	1	0	Yes
Vibration Test	1-500Hz, 1.5g along each axis	3/26/2004	1	0	Yes
Airborne Contaminants	N/A	N/A	N/A	N/A	N/A
Flex Test	1 lb Load, 100 cycles	3/31/2004	1	0	Yes
Twist Test	1 lb Load, 10 cycles	3/31/2004	1	0	Yes
Side Pull	0.5-1 lb load, 90°angle	3/31/2004	1	0	Yes
Cable Retention	1.0-2.2 lb load, for 1 minute	3/31/2004	1	0	Yes

Optical Bandwidth and Center Wavelength (GR-2883-CORE, Section 4.1.1)
All DUT used for the reliability portion of the test were fully optically characterized and meet Requirement CR4-4 of GR-2883-CORE.

Insertion Loss (GR-2883-CORE, Section 4.1.2)
All DUT used for the reliability portion of the test were fully optically characterized and meet Requirement CR4-6 of GR-2883-CORE.

Wavelength Isolation (GR-2883-CORE, Section 4.1.4)
All DUT used for the reliability portion of the test were fully optically characterized and meet Requirement CR4-8 of GR-2883-CORE.

Reflectance (GR-2883-CORE, Section 4.1.5)
Requirement R4-11 of GR-2883-CORE does not apply to reflective type filters such as Fabry-Perot.

Polarization-Dependent Loss (GR-2883-CORE, Section 4.1.6)
All DUT used for the reliability portion of the test were fully optically characterized and meet Requirement R4-14 of GR-2883-CORE.

Operating Environment (GR-2883-CORE, Section 4.2.1)
The DUT was subjected to a cyclic temperature and humidity of –5 to 55°C, t to 90%RH for a duration of ≈185 hours. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with Requirement R4-20 of GR-2883-CORE.

Non-Operating Environment (GR-2883-CORE, Section 4.2.2)

Low Temperature Exposure and Thermal Shock:
The DUT was subjected to a temperature of -40°C and held for a period of 72 hours. The chamber temperature was then increased to ambient in less than 5 minutes. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of the test. The DUT conforms with requirement R4-22 of GR-2883-CORE.

High Temperature Exposure and Thermal Shock:
The DUT was subjected to a temperature of 70°C and held for a period of 72 hours. The chamber temperature was then decreased to ambient in less than 5 minutes. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of the test. The DUT conforms with requirement R4-22 of GR-2883-CORE.

High Relative Humidity Exposure:
The DUT was subjected to a temperature of 40°C, 95%RH for a period of 96 hours. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of the test. The DUT conforms with requirement R4-22 of GR-2883-CORE.

Shock Criteria (GR-2883-CORE, Section 4.2.3)

Shipment from Manufacturer:
The DUT as packaged for shipment was subjected to a drop from a height of 30 inches onto concrete floor on all six sides and all eight corners. The visual inspection of the DUT revealed no anomalies. No deterioration in performance

was noted as a result of the test. The DUT conforms with requirement R4-23 of GR-2883-CORE.

During Use:
The DUT was subjected to a drop from a height of 4 inches onto a cast aluminum plate. The DUT was dropped flat on 3 sides (one side on each axis). The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-25 of GR-2883-CORE.

Vibration Test (GR-2883-CORE, Section 4.2.4)
The DUT was subjected to a 1g vibration on each of 3 axis for 90 minutes each. The frequency was swept from 5 to 100 Hz at 0.25 octaves/minute. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-26 of GR-2883-CORE.

Flex Test (GR-2883-CORE, Section 4.2.6)
The DUT was subjected to 100 cable flex cycles with a 1 pound load attached to the buffer tube while the filter is being rotated through ±90°. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-29 of GR-2883-CORE.

Twist Test (GR-2883-CORE, Section 4.2.7)
The DUT was subjected to 10 ± 180° twist cycles with a 1-pound load attached to the buffer tube. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-30 of GR-2883-CORE.

Side Pull (GR-2883-CORE, Section 4.2.8)
The DUT buffer tube was subjected to 1-pound tensile load applied at an angle of 90° to the filter. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-31 of GR-2883-CORE.

Cable Retention (GR-2883-CORE, Section 4.2.9)
The DUT buffer tube was subjected to 2.2-pound tensile load for a minimum period of one minute. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted during or as a result of the test. The DUT conforms with requirement R4-32 of GR-2883-CORE.

Characterization (GR-2883-CORE, Section 6.3.1)
All DUT were fully characterized for optical performance. The DUT conforms with requirement R6-2 of GR-2883-CORE.

III. Reliability Test Summary
(GR-2883-CORE, Section 6.3.2)

Test	Test Conditions	Date Completed	Sample Size	Number Failures	Test Passed?
Mechanical Shock	1.8 meters, 5 cycles	N/A	N/A	N/A	N/A
Vibration	20G, 10-2,000 Hz	N/A	N/A	N/A	N/A
Thermal Shock	ΔT=100°C, 20 cycles	N/A	N/A	N/A	N/A
High Temp. Aging (Dry)	85°C, <40%RH, 5000 hrs	9/6/2004	18	0	Yes
High Temp. Storage (Damp)	75°C, 90%RH, 2000 hrs	9/6/2004	18	0	Yes
Low Temp. Storage	Only Required for Uncontrolled Environments	N/A	N/A	N/A	N/A
Temp. Cycling	-40 to 75°C, 500 cycles	4/1/2004	18	0	Yes
Temp./Humidity Cycling	Only Required for Uncontrolled Environments	N/A	N/A	N/A	N/A
Salt Spray	Only Required for Uncontrolled Environments	N/A	N/A	N/A	N/A
Water Immersion	Only Required for Uncontrolled Environments	N/A	N/A	N/A	N/A
Airborne Contaminants	Only Required for Uncontrolled Environments	N/A	N/A	N/A	N/A
Internal Moisture	Hermetic Packages Only	N/A	N/A	N/A	N/A
ESD	Not Applicable	N/A	N/A	N/A	N/A

Thermal Shock (EIA/TIA-455-71)
Not required for components with non-hermetic packages.

High Temperature Aging (Dry) (Mil-STD-883-D)
The DUT was subjected to 85°C with RH < 40% for 5000 hours. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of

the test. The DUT conforms with high temperature dry aging requirement R6-4 of GR-2883-CORE.

High Temperature Storage (Damp) (EIA/TIA-455-5A)
The DUT was subjected to 75°C, 90% RH for 2000 hours. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of the test. The DUT conforms with high temperature damp storage requirement R6-4 of GR-2883-CORE.

Temperature Cycling (EIA/TIA-455-3A)
The DUT was subjected to 500 temperature cycles of -40°C to 75°C. The visual inspection of the DUT revealed no anomalies. No deterioration in performance was noted as a result of the test. The DUT conforms with temperature cycling requirement R6-4 of GR-2883-CORE.

IV. Optical Performance Criteria (GR-2883-CORE, Section 4.1)

General Requirement: DUT was stressed by subjecting it to the operating environment conditions of GR-2883-Core Section 4.2.1. The optical criteria were then verified after completion of the environmental tests using the optical characterization test set described in section I. Optical bandwidth, insertion loss, wavelength isolation, and polarization dependent loss were measured across the spectrum. The reflectance criteria does not apply to reflective type filters and was not recorded. An example data sheet from the optical characterization test set is shown below.

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

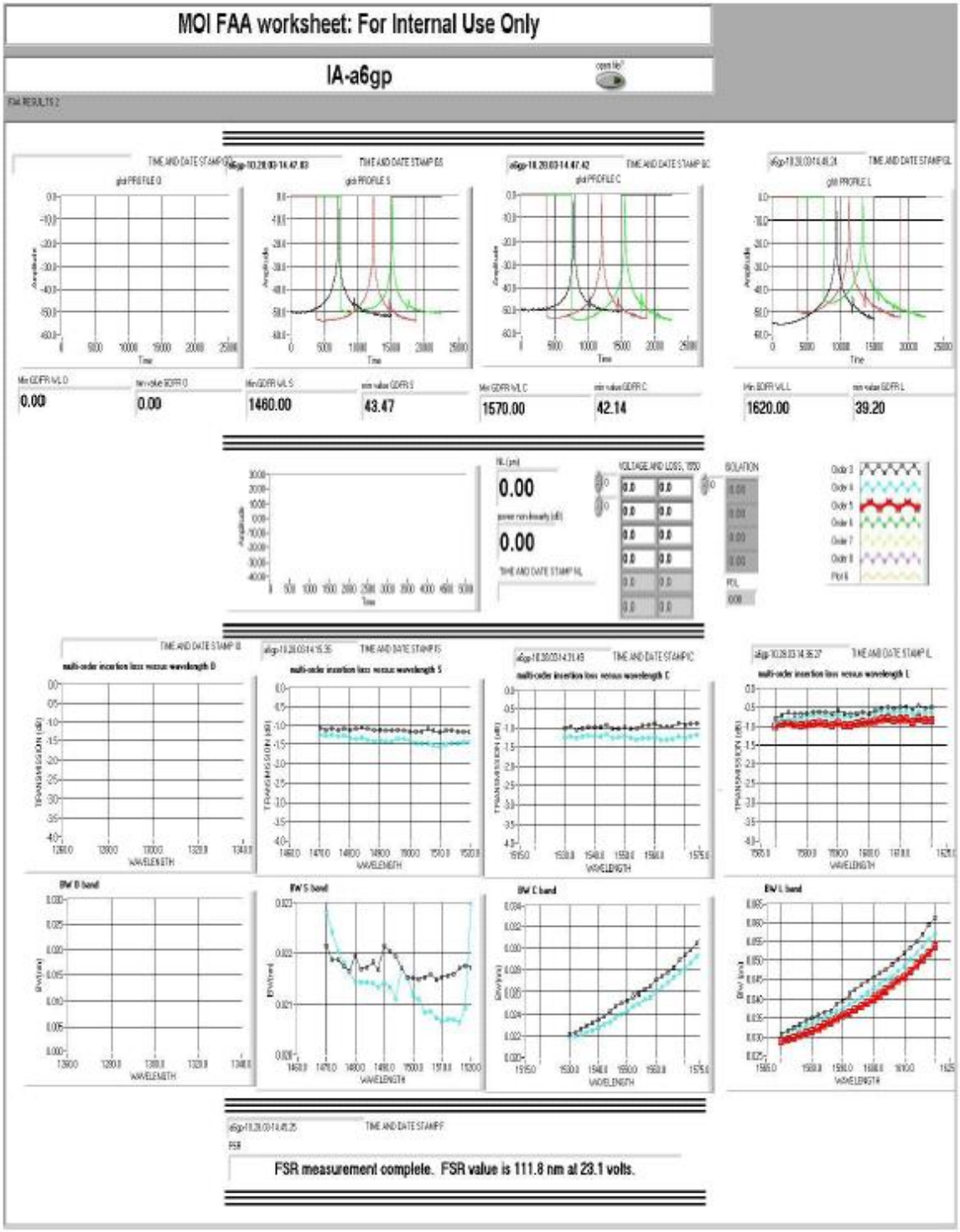

Figure 1: Optical Characterization Worksheet

V. Environmental Testing: Operating Environment (GR-2883-CORE, Section 4.2.1)

General Requirement: DUT is subjected to a prescribed temperature/humidity profile and monitored throughout the test period. Conformance is based on the ability of the DUT to operate throughout the test period. See GR-2883-Core, Section 5.1.2 for a description of temperature/humidity profile.

Test Equipment:
Chamber - Espec LHU-113 Environmental Chamber, S/N 3012000693
Micron Optics FFP-C Filter Controller S/N 1123
Fluke 2620A Data Acquisition Unit S/N 5893500
Photonetics 3612HE1560 Tunable External Cavity Laser S/N 104184

Test Set-Up: The DUT was placed in temperature/humidity chamber under computer control. The laser was enabled and tuned to 1550nm. The filter controller was locked onto the laser, and the voltage from the detector of the controller as measured by the Data Acquisition Unit was recorded as the reference level. The chamber was programmed to follow the temperature/humidity profile described in GR-2883-Core, Section 5.1.2. During the course of the test the data that was recorded was: Temperature and humidity as reported by the chamber, locking voltage as measured by the 2620A, insertion loss change as calculated by converting the detector voltage change reported by the 2620A into dB change, and time elapsed in seconds.

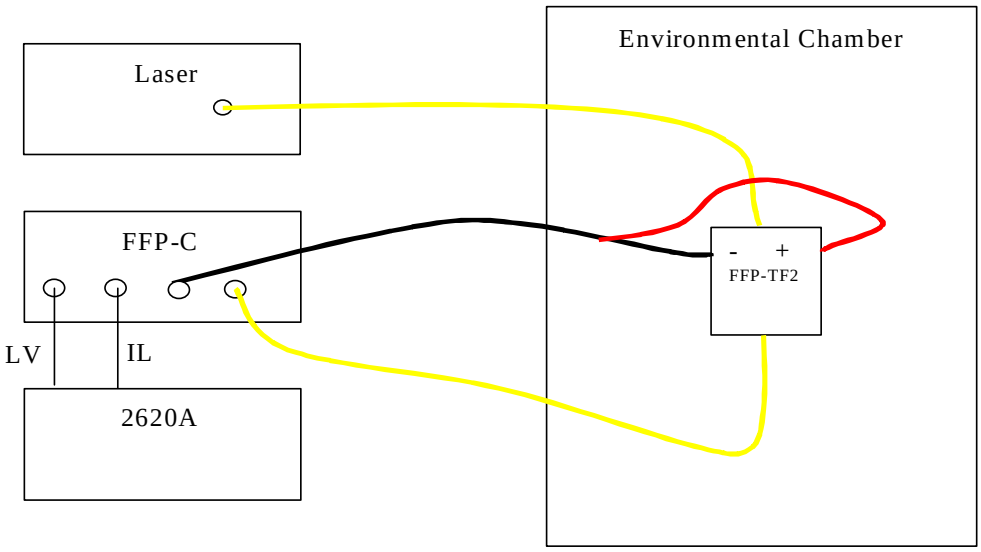

Figure 2: Test Setup

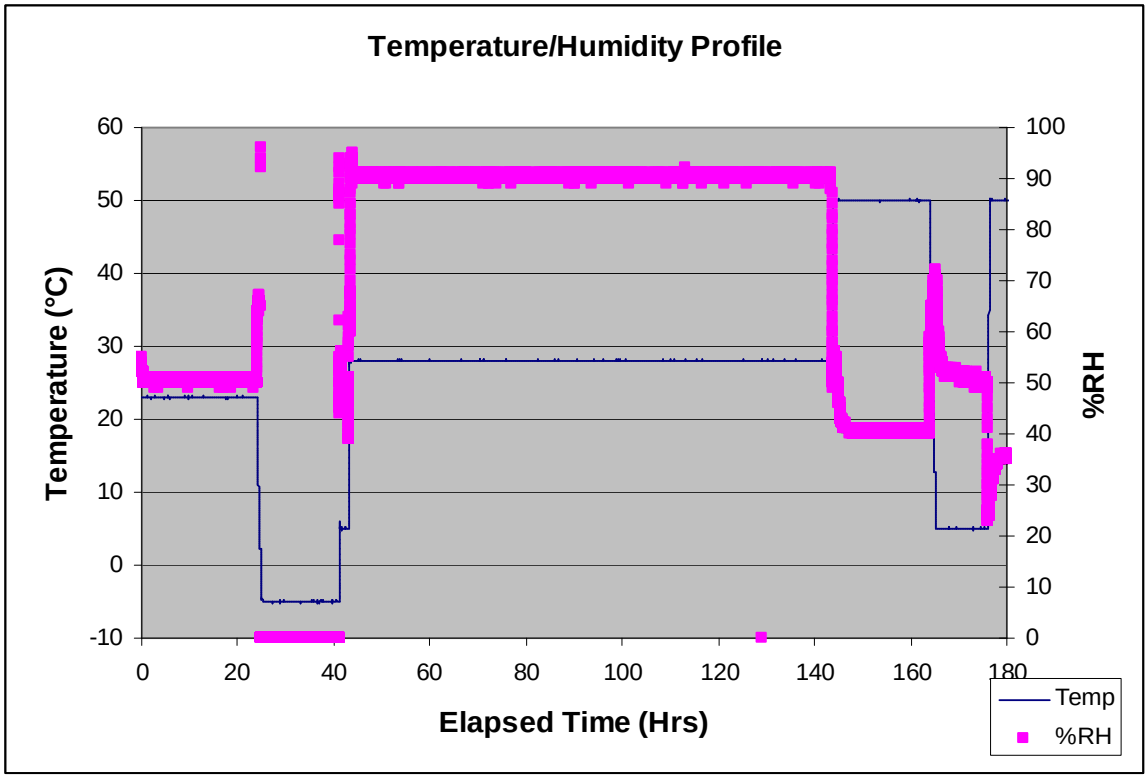

Figure 3: Temperature / RH Profile

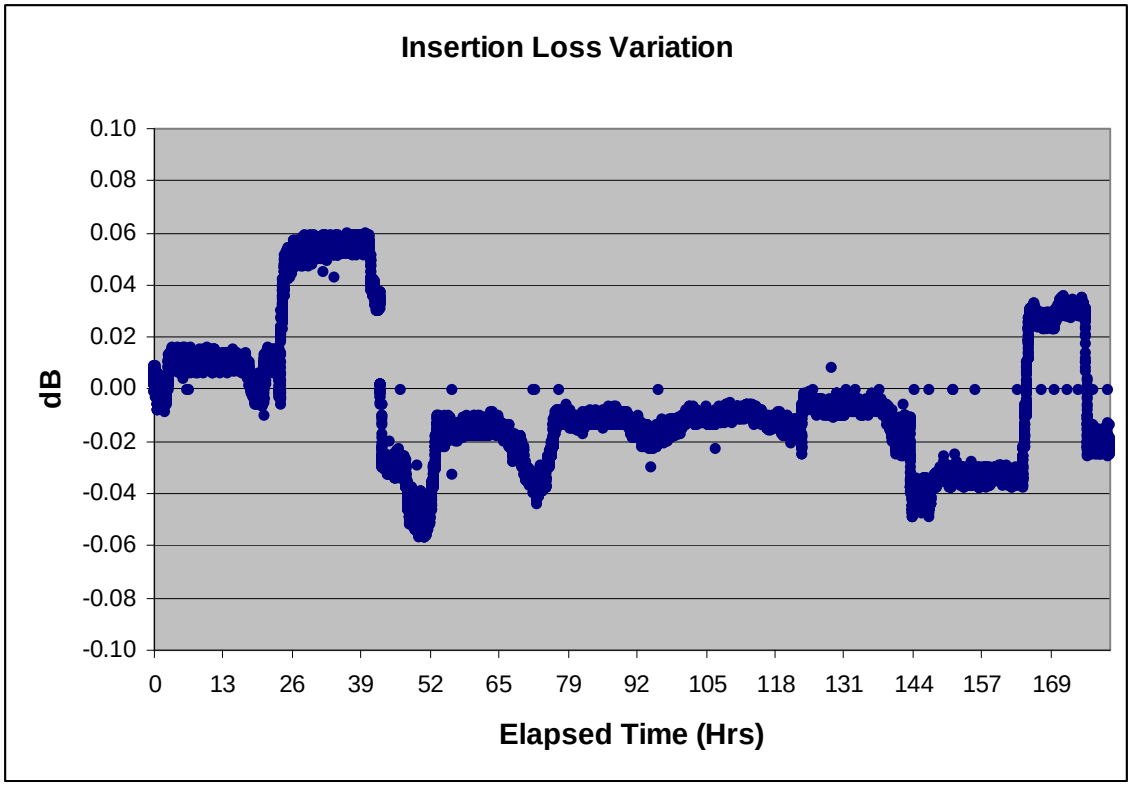

Figure 4: Insertion Loss Variation

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

VI. Environmental Testing: Non-Operating
(GR-2883-CORE, Section 4.2.2)

Equipment:
Chamber – Tenney Environmental
Optical Characterization Test-Set

Low-Temperature Exposure and Thermal Shock:

General Requirement: The temperature of DUT is decreased from ambient to –40°C at a rate of about 30°C/hr. The device is maintained at a temperature of –40°C for a period of 72 hours. The DUT temperature is rapidly increased to ambient in less than 5 minutes. The DUT must meet test criteria after stabilizing at ambient temperature.

Filter: A6HA	Insertion Loss	Voltage	FSR	Voltage Change	Insertion Loss Change
Initial	1.6	23.3	109.5		
Low Temp Shock	1.9	27.8	109.6	4.5	0.3

High-Temperature Exposure and Thermal Shock:

General Requirement: The temperature of DUT is increased from ambient to 70°C at a rate of about 30°C/hr. The device is maintained at a temperature of 70°C for a period of 72 hours. The DUT temperature is rapidly decreased to ambient in less than 5 minutes. The DUT must meet test criteria after stabilizing at ambient temperature.

Filter: A6HA	Insertion Loss	Voltage	FSR	Voltage Change	Insertion Loss Change
Initial	1.6	23.3	109.5		
High Temp Shock	2	32.6	108.9	9.3	0.4

High Relative Humidity Exposure:

General Requirement: The temperature of DUT is increased from ambient to 40°C at a rate of about 30°C/hr. While maintaining temperature at 40°C, increase RH to 95% in less than 4 hours. The device is maintained at temperature of 40°C and RH of 95% for a period of 96 hours. The DUT temperature is then returned to ambient at a rate of 30°C/hr. The DUT must meet test criteria after stabilizing at ambient temperature.

Filter: A729	Insertion Loss	Voltage	FSR	Voltage Change	Insertion Loss Change
Initial	0.7	24.1	125.2		
High Rel Humidity - 1	0.6	22.5	126.9	-1.6	-0.1

Filter: A71W	Insertion Loss	Voltage	FSR	Voltage Change	Insertion Loss Change
Initial	0.5	24.5	126.3		
High Rel Humidity - 2	0.5	28.9	125.7	4.4	0

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

VII. Environmental Testing: Shock Test
(GR-2883-CORE, Section 4.2.3)

Shock – Shipment from Manufacturer:

General Requirement: Drop packaged device from a height of 30 inches onto a hard, smooth, and unyielding surface. Drop on all 6 sides and all eight corners. The DUT must meet test criteria and show no visible damage.

Test Set-Up: The DUT was packaged for shipment and supported at a height of 30 inches above concrete floor. The package was oriented so that it would fall in the prescribed orientation. The package was released and allowed to fall to the floor. This process was repeated for each of the 6 sides and eight corners.

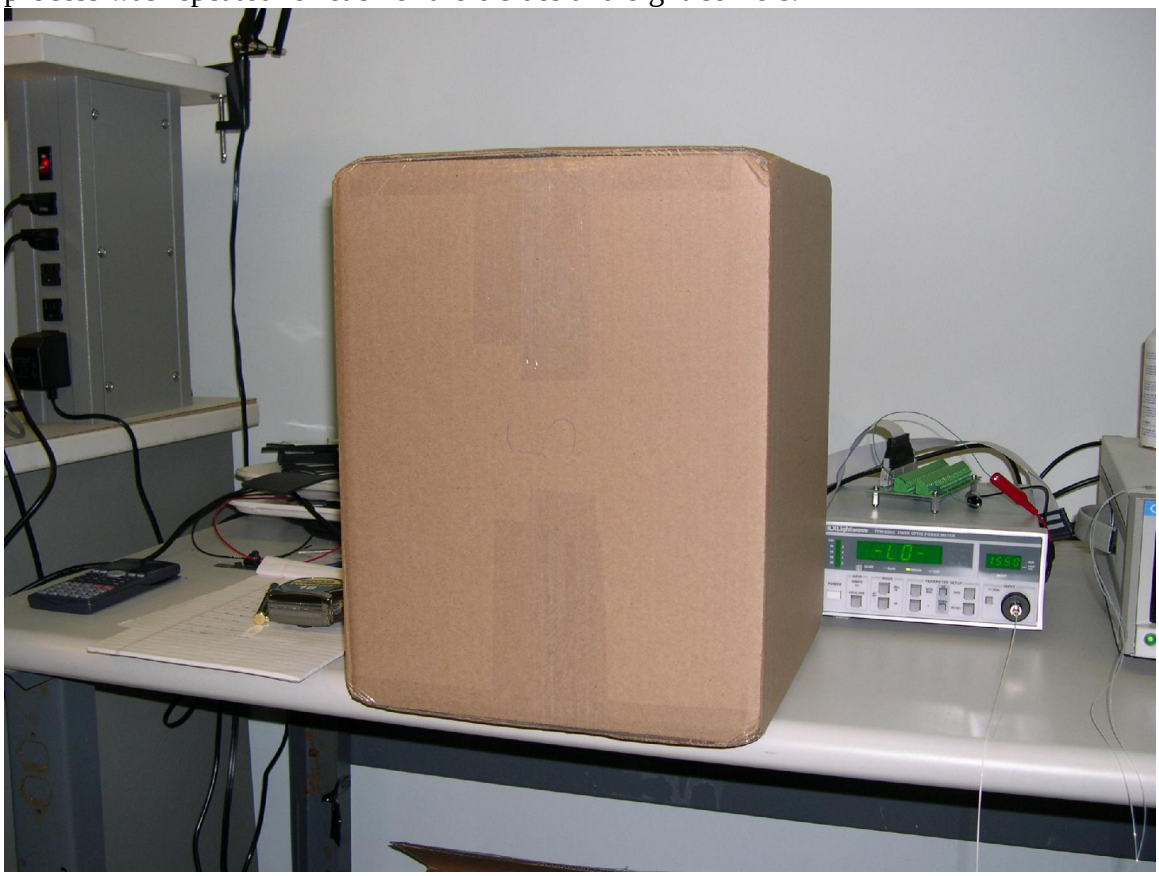

Figure 5: Shipping Container

Test Results: Passed
6 Sides – No evidence of damage to carton
8 Corners – minor deformation of each corner

Change in filter loss - .006 dB

Shock - In Use:

General Requirement: Flat-drop unpackaged device on its base from a height of 4 inches onto a hard, smooth, and unyielding surface. The DUT must meet test criteria and show no visible damage.

Test Set-Up: The DUT was held by hand 4 inches above drop surface using scale for reference. A 12”x15”x.5” cast aluminum plate was used for the drop surface.

Power Level before drop – 345.8µw

Drop #	Power Level	Condition
1	345.5µw	Drop on top surface
2	345.4µw	Drop on side
3	346.3µw	Drop on end (end of buffer tube 4” above surface)
4	346.1µw	Drop on bottom side (pins down)
5	346.0µw	Drop on top surface

Based on above data there was no loss increase. The reference level of the filter was 1.15 dB loss. There was no physical damage to the dip pins or the buffer tube assembly and fiber when dropped such that those components made contact first.

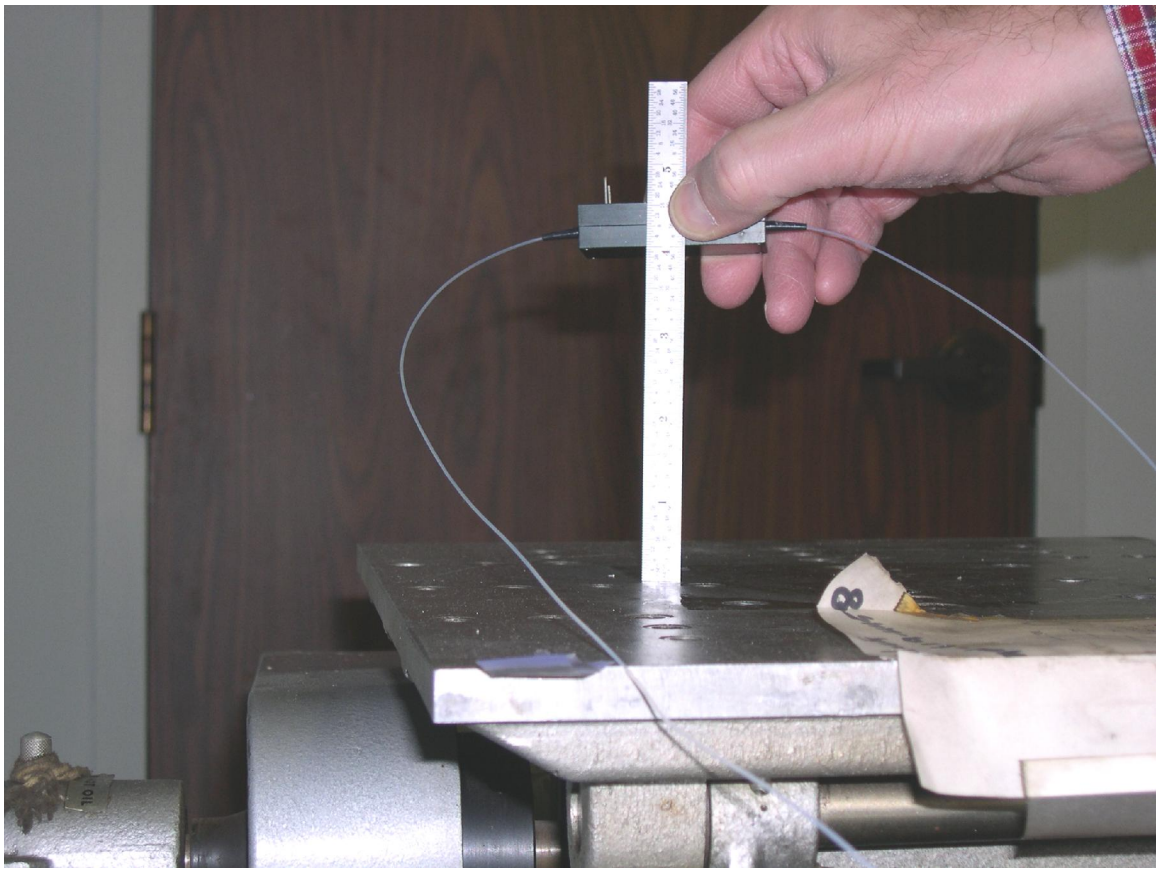

Figure 6: Drop Test

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

VIII. Environmental Testing: Vibration Test (GR-2883-CORE, Section 4.2.4)

Vibration – Office:

General Requirement: Loss shall not exceed maximum allowable loss of 3.5 dB while being monitored throughout the test. It shall be tested on each of three axes for 90 minutes each. The frequency shall be swept from 5 to 100 Hz at 0.25 octaves/minute. The force shall be held constant at 1 g.

Test Set-Up: The set-up for the test is as described below:
Data sample rate – 4 Hz.

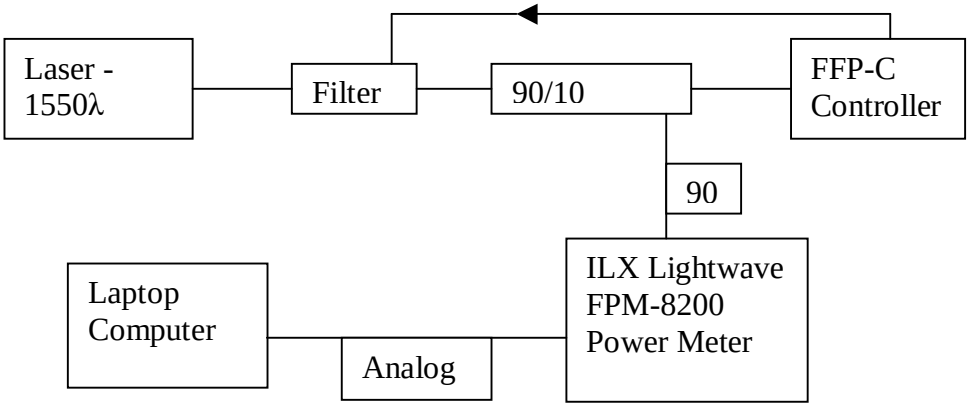

Figure 7: Office Vibration Test Setup

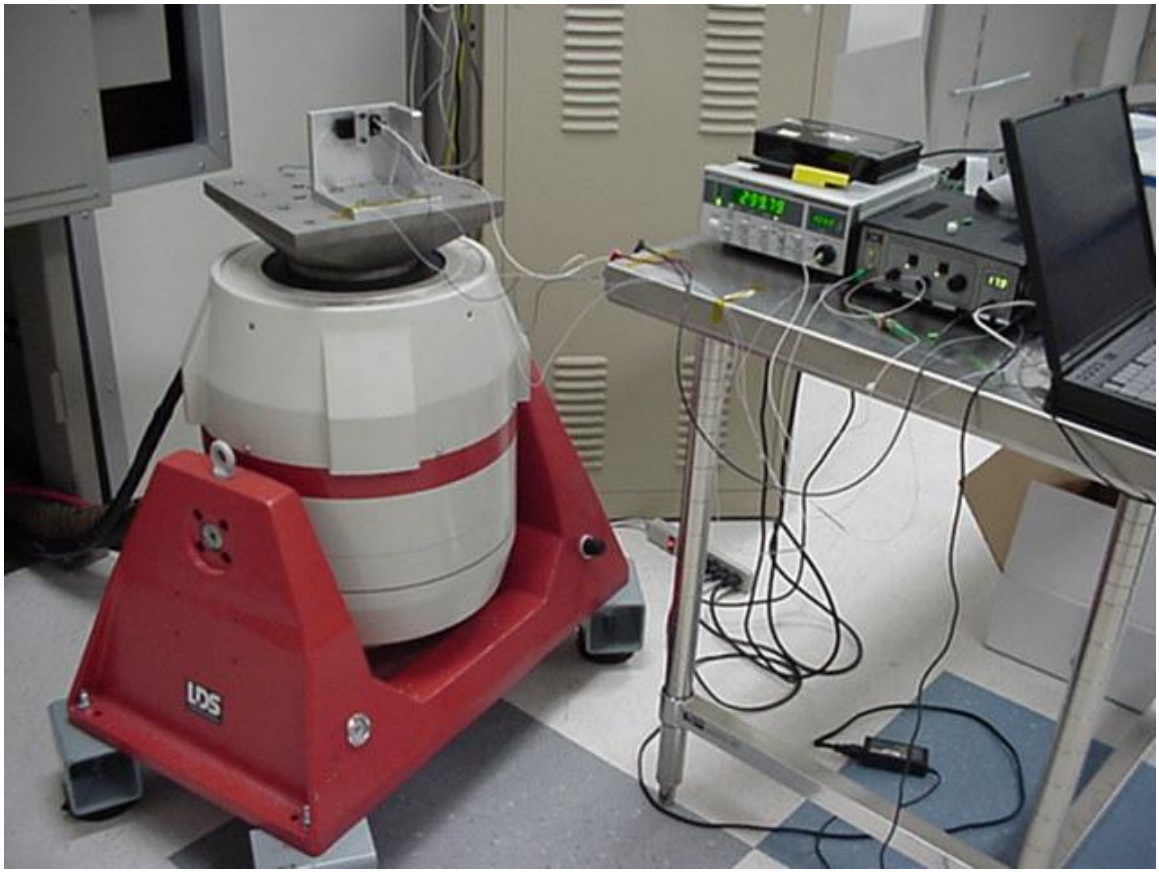

Figure 8: Vibration Table Setup

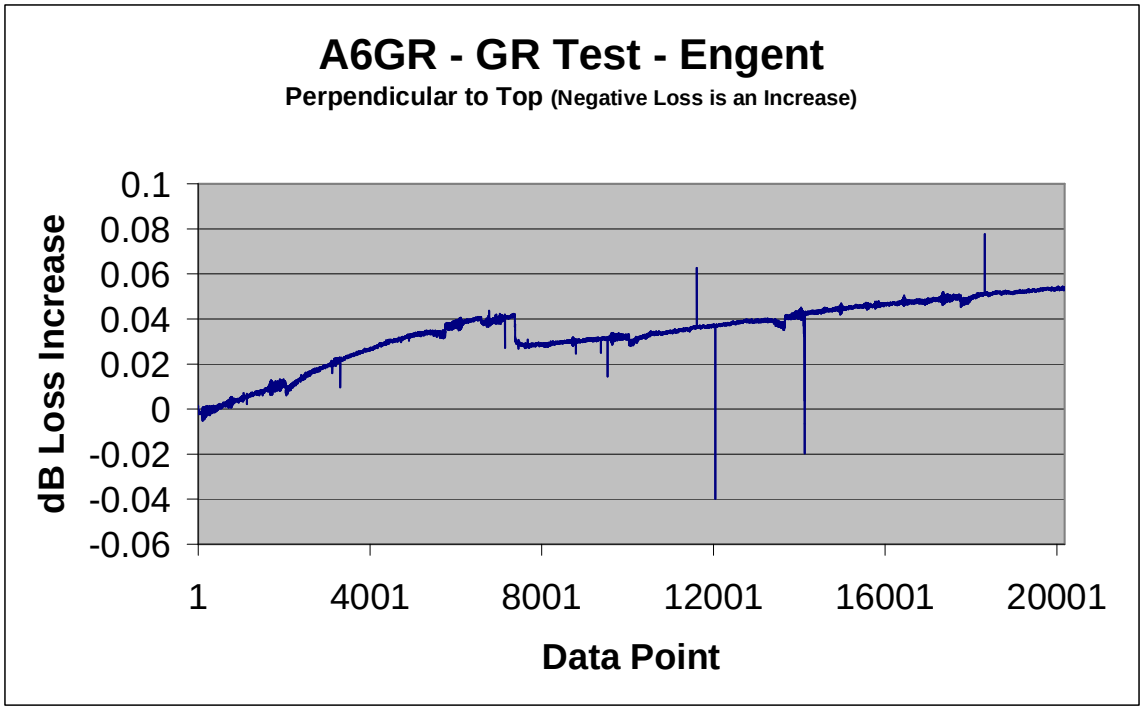

Figure 9: Office Vibration Results (Perpendicular to Top)

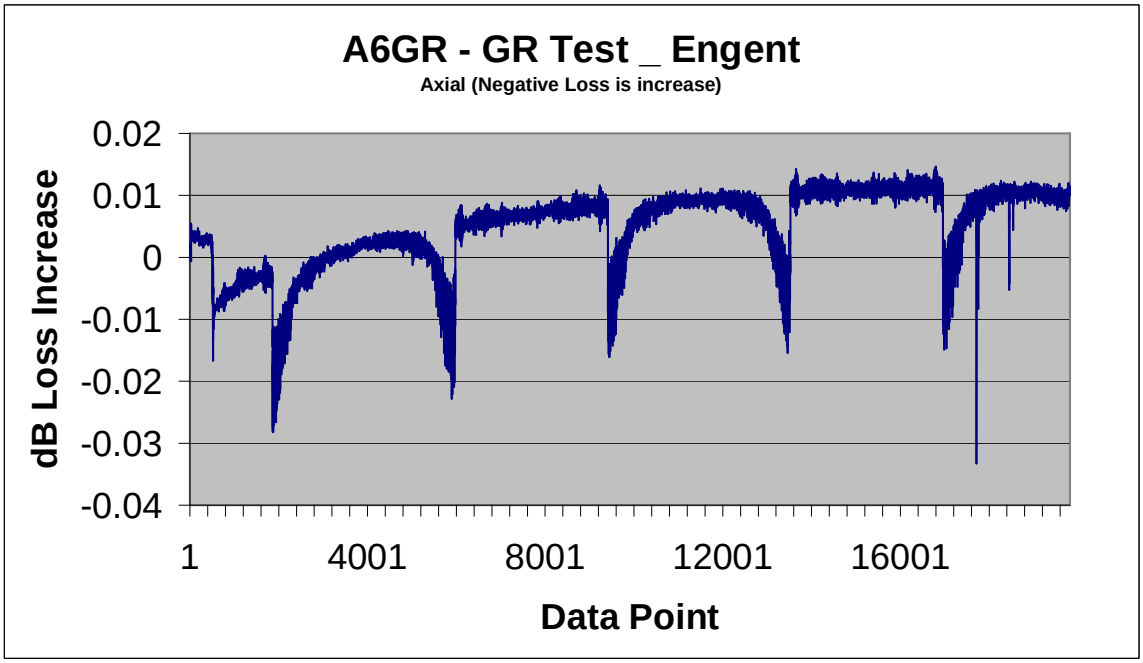

Figure 10: Office Vibration Results (Axial)

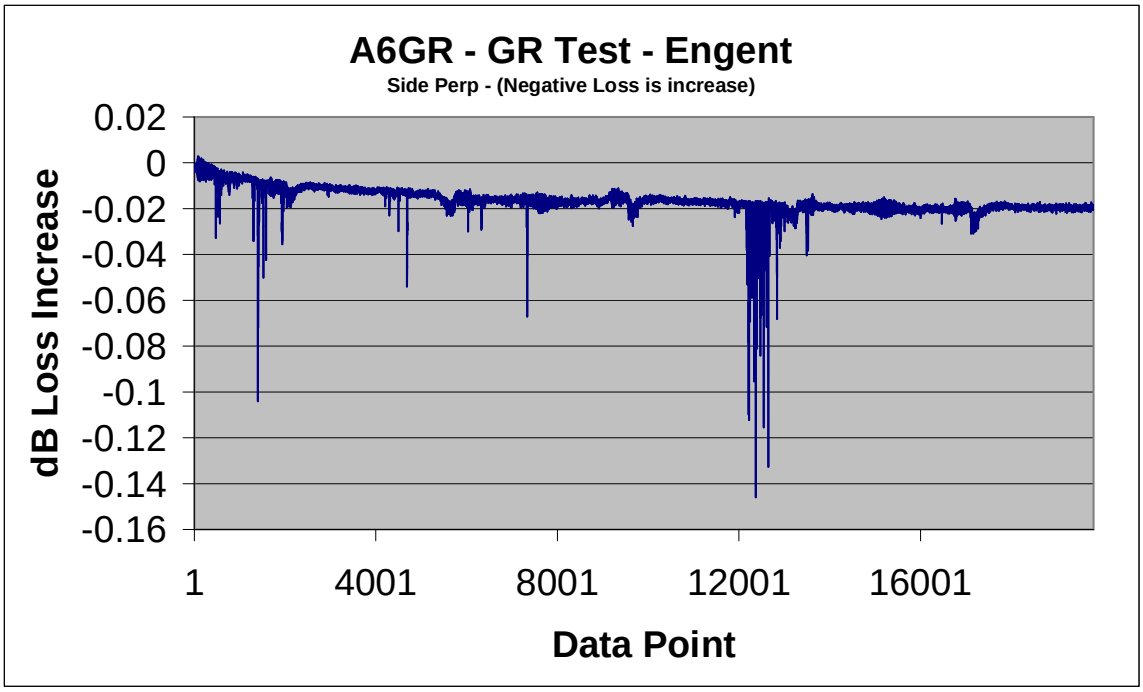

Figure 11: Office Vibration Results (Perpendicular to Side)

Initial Loss – 1.76 dB
Maximum loss increase - .15dB

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

Vibration – Transportation:

General Requirement: Loss shall not exceed maximum allowable loss of 3.5 dB after being subjected to vibration in the shipping container per the table below.

Part	Frequency	Force	Time
1	5 - 100 Hz @ .1 octaves/min.	.5g	90 minutes
2	100 – 500 Hz @ .25 octaves/min	1.5g	90 minutes

Two filters were tested with the initial and final test results shown in the graphs below.

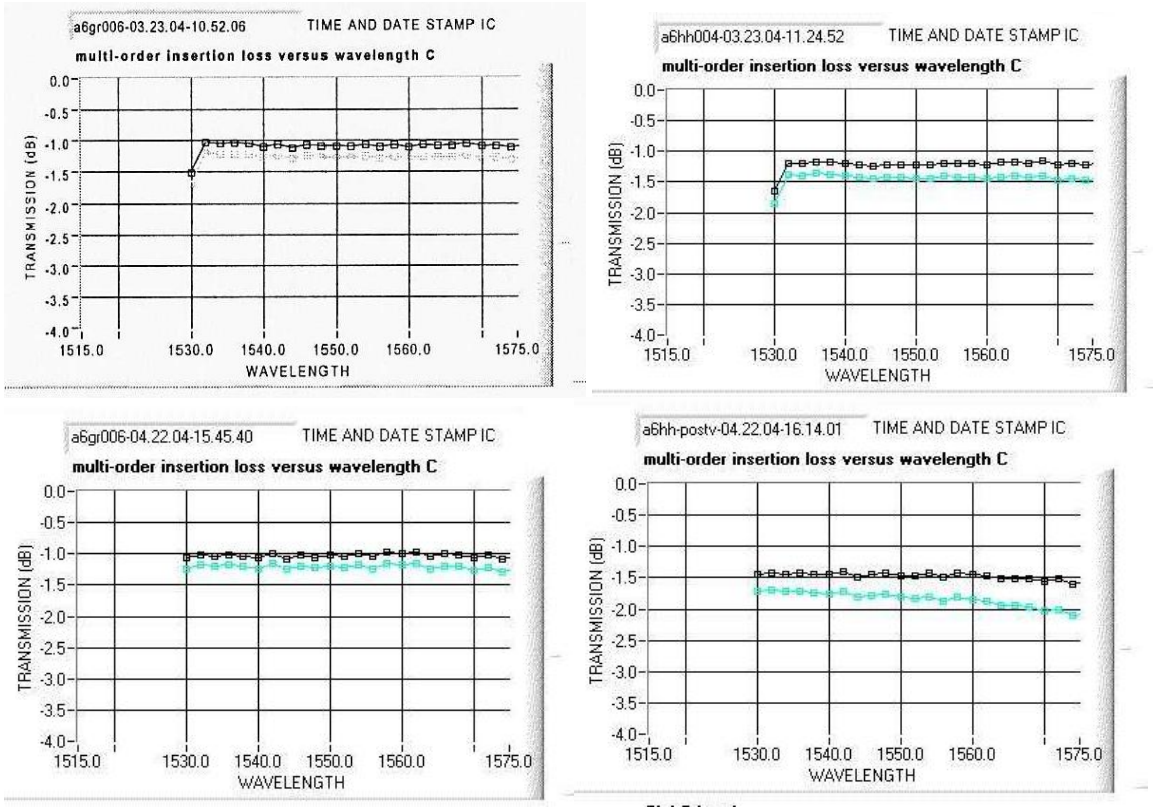

Figure 12: Transportation Vibration Results

The first two graphs show the loss prior to vibration testing and the last two graphs show the loss after transportation vibration testing.

Test Results: Passed. DUT did not sustain any damage or deterioration of performance during the test.

IX. Environmental Testing: Flex Test (GR-2883-CORE, Section 4.2.6)

Test Requirements: The insertion loss shall not exceed the maximum of 3.5dB with no physical damage when the component to fiber interfaces is subject to 100 cycles (±90°) with a one-pound weight attached to the buffer. Ten cycles shall be run at a maximum rate of 30 cycles/min (cpm). The loss requirement applies after completion of the test.

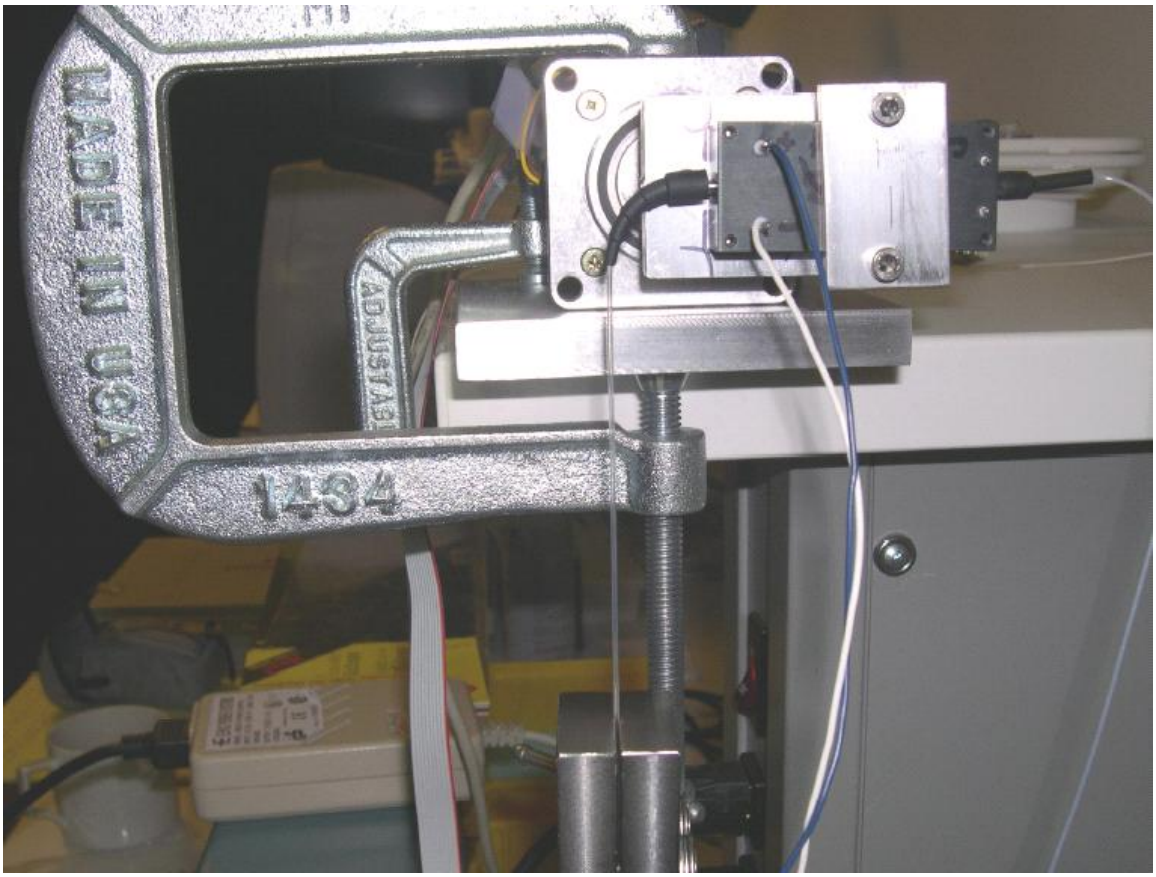

Figure 13: Flex Test Setup

Test Procedure: A one-pound weight was clamped to the buffer tube at 22 cm from the filter. A stepper motor was used to rotate the filter through a ±90° arc at a rate of 16 cpm for 90 cycles. The rate was changed to 30 cpm and run again for 10 cycles. Loss was monitored throughout the test and the change in loss is recorded below. Note the initial loss before starting the test, the loss during flexing at 16 cpm, the loss around data point 1300 with no flexing. The loss is higher during flexing at 30 cpm but comes back to the original loss level at data point 1400.

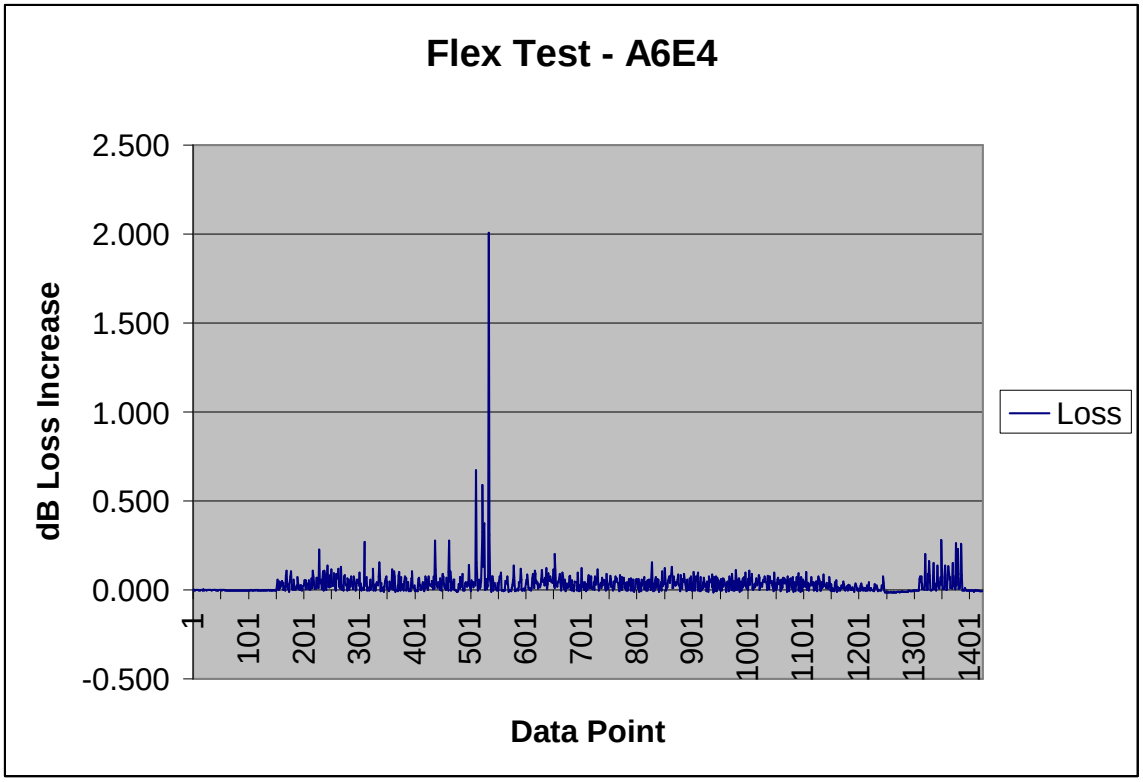

Figure 14: Flex Test Results

Test Results: Passed. No physical damage of DUT was observed during the test and there was no measurable increase in loss after the test.

X. Environmental Testing: Twist Test (GR-2883-CORE, Section 4.2.7)

Test Requirements: The insertion loss shall not exceed the maximum, 3.5dB with no physical damage when the component to fiber interfaces are subject to 10 ± 180° twists with a one pound weight attached to the buffer 1.2 inches below the device. The loss requirement applies after completion of the test.

Test Procedure: Compression filter A6E4.

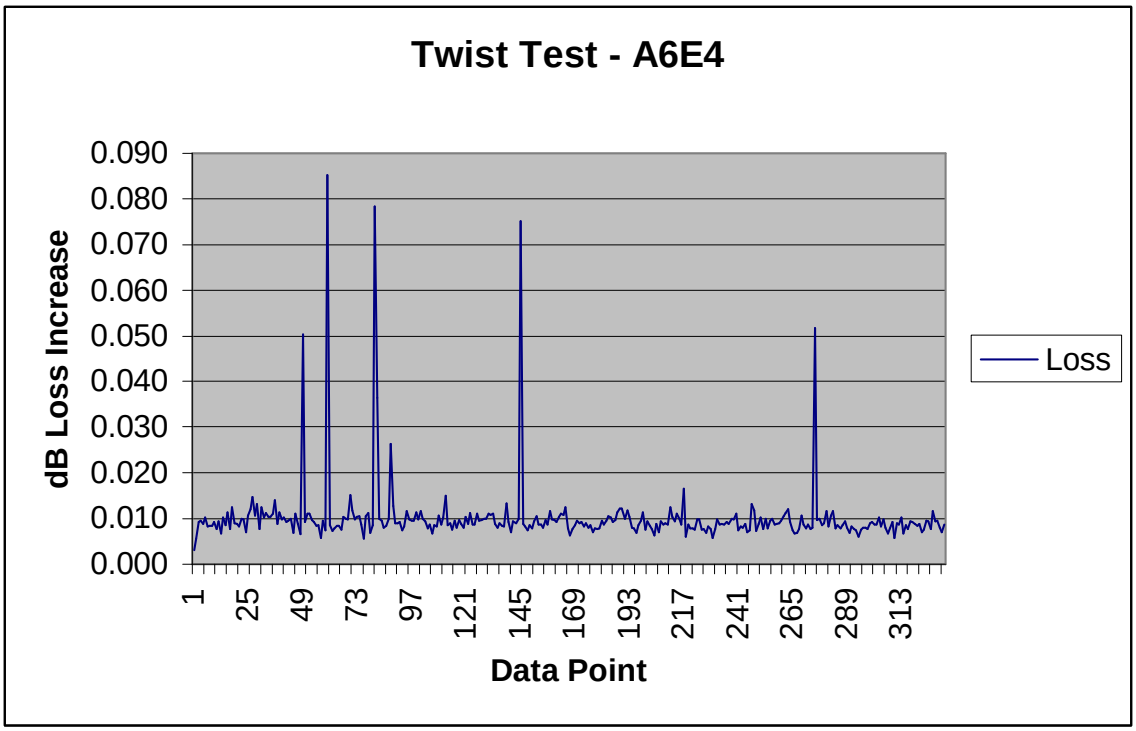

Figure 15: Twist Test Results

Test Results: Passed. No physical damage of DUT was observed. No increase in loss measured after testing and removal of weight. Data is shown in graph for before, during and after completion of test.

XI. Environmental Testing: Side Pull (GR-2883-CORE, Section 4.2.8)

Test Requirements: The insertion loss shall not exceed the maximum, 3.5dB with no physical damage when the component to fiber interfaces are subject to a one pound weight attached to the buffer 22 – 28 cm from the device and applied at an angle of 90° to the device. The loss requirement applies 5 seconds after application of the load and 10 seconds after completion of the test.

Test Procedure: A one-pound weight was clamped to the buffer tubing 22 cm from the filter box. The filter was rotated to 90° in 10° steps, held at 90° for 8 seconds and then rotated back to 0° in 10° steps. Loss was monitored throughout the test and change in loss is shown in the graph below.

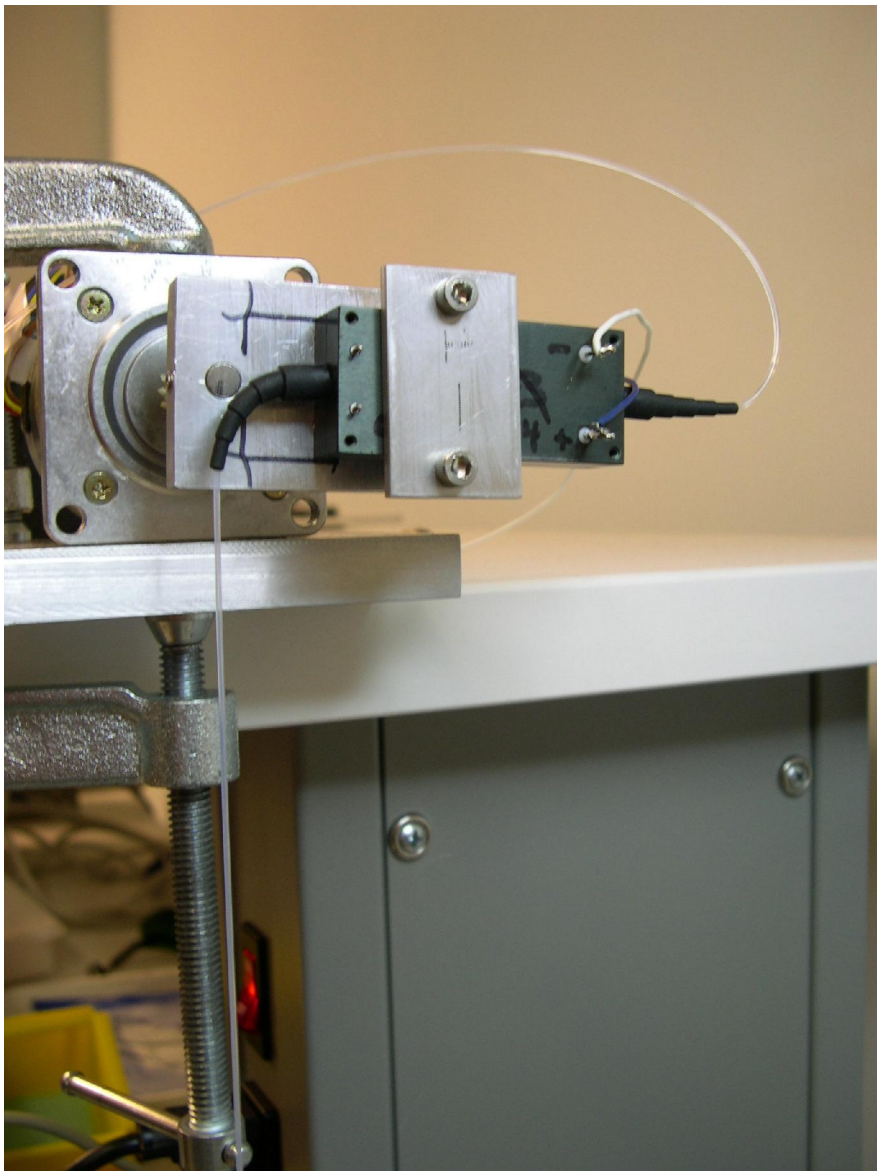

Figure 16: Side Pull Setup

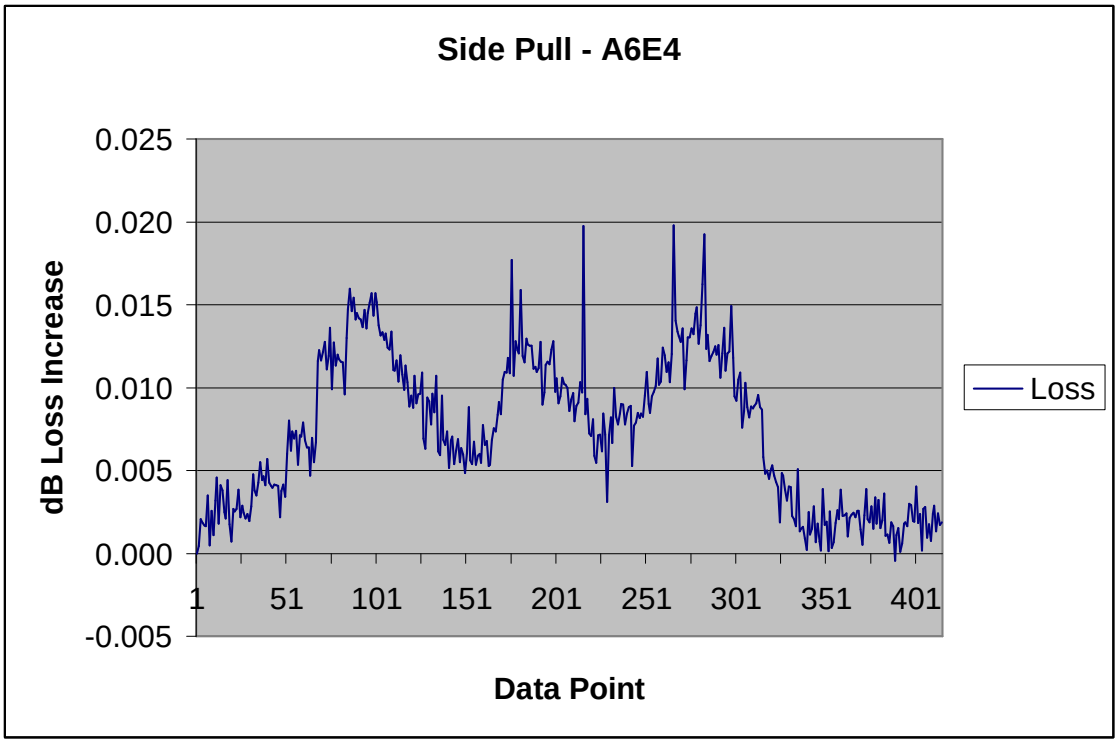

Figure 17: Side Pull Test Results

Test Results: Passed. No physical damage of DUT was observed. Maximum loss increase was .02dB.

XII. Environmental Testing: Cable Retention (GR-2883-CORE, Section 4.2.9)

Test Requirements: The insertion loss shall not exceed the maximum, 3.5dB with no physical damage when the loose tube buffer is subject to the application of a 2.2 lb load for a period of one minute. The loss requirement applies after completion of the test.

Test Conditions: Compression filter A6E4 with 28 AWG PTFE tubing with a .012" nominal wall thickness.

Test Procedure: Filter A6E4 was clamped in the vertical plane to a rack and pinion mechanism to provide controlled vertical lift. A one-pound weight was clamped to the buffer tube and a 1.2 lb weight was attached to the one lb weight via extension spring to allow the gradual loading between 1 and 2.2 lbs. The load was increased from 1.0 to 2.2 lbs over a period of 15 seconds. The 2.2 lbs of weight was suspended for a total of 10

minutes and no appreciable stretching of the buffer tube was observed. Filter loss was not monitored during the test.

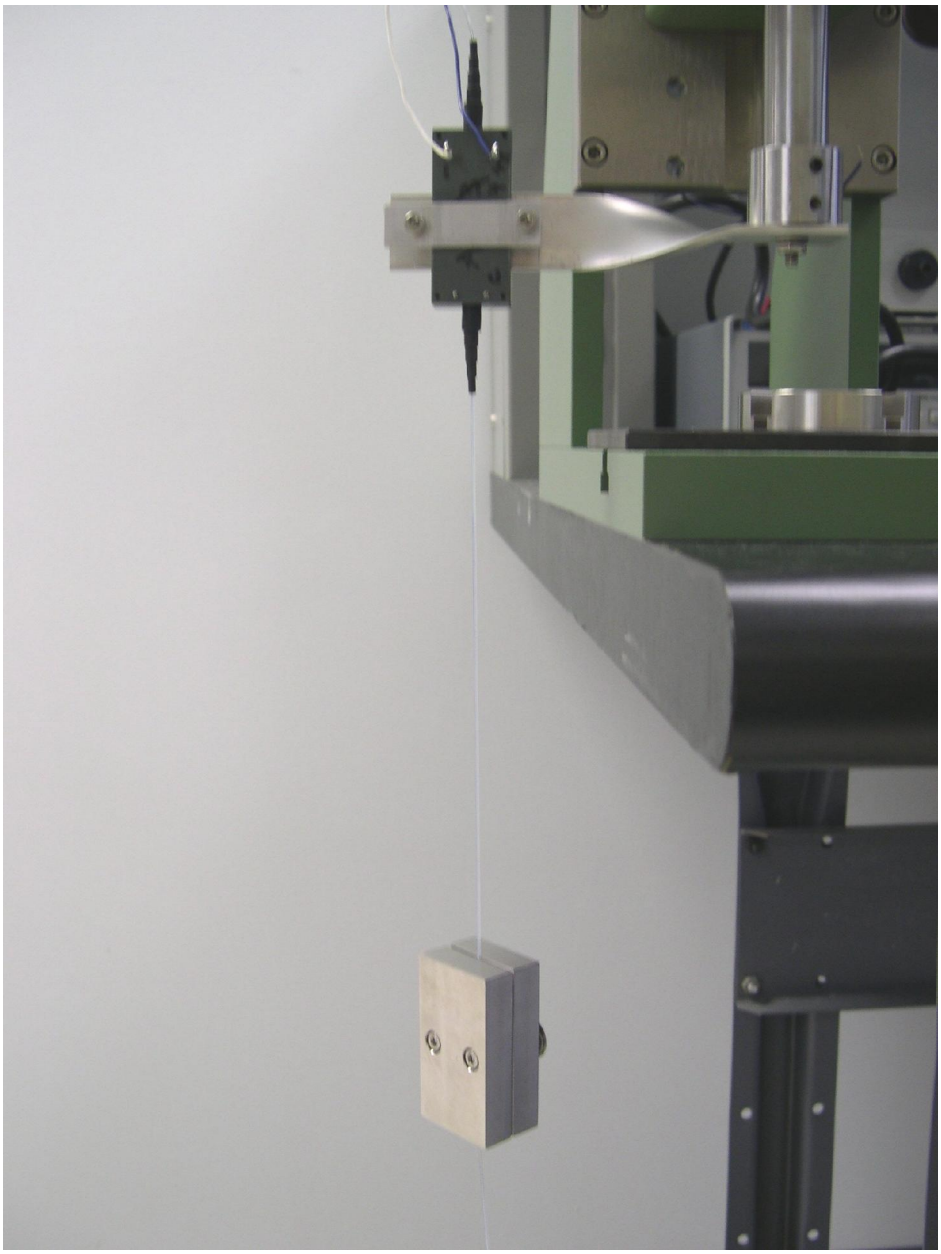

Figure 18: Cable Retention Test Setup

Test Results: Passed. No physical damage of DUT was observed. Total filter loss measured 1.48 dB after the test.

XIII. Reliability Tests: High Temperature Aging (dry)
(GR-2883-CORE, Section 6.3.2)

Test Requirements: 5000 hours, 85°C, <40%RH

Equipment:
Chamber - Fisher Scientific Model 825F, S/N 011N5003
Optical Characterization Test-Set

Test Procedure: Quantity 18 DUT were optically characterized prior to test. The DUT were placed on a tray with electrical leads shorted together and fiber pigtails coiled. The trays were placed in chamber at room temperature.

The chamber was set to maintain temperature at 85°C. Humidity was not controlled.

The temperature was reduced to room temperature at elapse time 500, 3500, and 5000 hours. At these points the DUT were removed from the chamber and optically characterized. After characterization all DUT were placed back in the chamber and the temperature was returned to 85°C.

FFP-TF-v2 GR - High Temperature Aging

A6FX	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	121	17.2	1.7	0	0	0
500 Hours	121.5	43.3	2.1	0.5	26.1	0.4
3500 Hours	121.7	44.5	2.5	0.7	27.3	0.8
5000 Hours	121.6	45.1	2	0.6	27.9	0.3

A6GJ	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	111.1	26.8	1.6	0	0	0
500 Hours	111.5	45.5	1.8	0.4	18.7	0.2
3500 Hours	110.3	48.8	1.6	-0.8	22	0
5000 Hours	110.3	48.8	1.6	-0.8	22	0

A6FY	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	103.8	22.8	1.6	0	0	0
500 Hours	103.3	39.8	1.8	-0.5	17	0.2
3500 Hours	103.4	37.4	1.9	-0.4	14.6	0.3
5000 Hours	104.9	32	1.8	1.1	9.2	0.2

A6HZ	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	113.9	23.1	2	0	0	0
500 Hours	112.1	40.6	2.5	-1.8	17.5	0.5
3500 Hours	111.9	46.5	2.2	-2	23.4	0.2
5000 Hours	111.8	48.9	2.5	-2.1	25.8	0.5

A6IG	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	121.4	27.7	1	0	0	0
500 Hours	122	45	1.1	0.6	17.3	0.1
3500 Hours	122	51.5	1.1	0.6	23.8	0.1
5000 Hours	122.6	53.1	1.2	1.2	25.4	0.2

A6GH	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	120.8	24	3	0	0	0
500 Hours	121.8	38.9	2.9	1	14.9	-0.1
3500 Hours	120.7	43.7	2.3	-0.1	19.7	-0.7
5000 Hours	121.7	45.4	2.4	0.9	21.4	-0.6

A6GI	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	112.9	21.3	2.8	0	0	0
500 Hours	112.1	30	3	-0.8	8.7	0.2
3500 Hours	111.4	34.7	2.9	-1.5	13.4	0.1
5000 Hours	113.5	28.7	3.2	0.6	7.4	0.4

A6I8	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	112.3	23.9	0.9	0	0	0
500 Hours	111.8	36.2	1	-0.5	12.3	0.1
3500 Hours	111.8	36.2	0.9	-0.5	12.3	0
5000 Hours	111.6	38.9	0.8	-0.7	15	-0.1

A6I1	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	118	22	1.2	0	0	0
500 Hours	122	47.3	1.5	4	25.3	0.3
3500 Hours	120.9	49	1.3	2.9	27	0.1
5000 Hours	120.2	50.9	1.2	2.2	28.9	0

A6I3	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	104.2	13.6	1.9	0	0	0
500 Hours	103.4	26.7	1.4	-0.8	13.1	-0.5
3500 Hours	103.4	33.3	1	-0.8	19.7	-0.9
5000 Hours	104.7	27	1	0.5	13.4	-0.9

A6FT	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	135.6	16.4	1.1	0	0	0
500 Hours	136.1	30.5	2	0.5	14.1	0.9
3500 Hours	136.1	30.7	1	0.5	14.3	-0.1
5000 Hours	135.8	31.3	1	0.2	14.9	-0.1

A6IC	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	97.1	12.7	1.7	0	0	0
500 Hours	111.4	43.9	1.2	14.3	31.2	-0.5
3500 Hours	111	41.8	1	13.9	29.1	-0.7
5000 Hours	112.4	46.7	1	15.3	34	-0.7

A6GM	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	103.9	17.3	1.35	0	0	0
500 Hours	112.3	39.6	1.1	8.4	22.3	-0.25
3500 Hours	104.1	29.9	1	0.2	12.6	-0.35
5000 Hours	104.1	30	1	0.2	12.7	-0.35

A6FS	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	123.9	14	2.2	0	0	0
500 Hours	122.2	26.4	2.1	-1.7	12.4	-0.1
3500 Hours	121.8	35	2	-2.1	21	-0.2
5000 Hours	122.7	32.6	1.8	-1.2	18.6	-0.4

A6GS	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	104	22.3	1.5	0	0	0
500 Hours	103.6	35.2	1.9	-0.4	12.9	0.4
3500 Hours	103.5	39.2	1.5	-0.5	16.9	0
5000 Hours	103.5	40.4	1.5	-0.5	18.1	0

A6FZ	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	108.6	15.9	1.1	0	0	0
500 Hours	111.4	39.6	1.3	2.8	23.7	0.2
3500 Hours	111.4	41.6	1.5	2.8	25.7	0.4
5000 Hours	111.9	44.2	1	3.3	28.3	-0.1

A6IE	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	103.5	17.2	1.8	0	0	0
500 Hours	103.9	17.7	2.1	0.4	0.5	0.3
3500 Hours	103.7	36.4	1	0.2	19.2	-0.8
5000 Hours	103.6	32.2	1	0.1	15	-0.8

A6FR	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	121.8	21.1	1.2	0	0	0
500 Hours	122.3	27	1.6	0.5	5.9	0.4
3500 Hours	122.4	33.6	1.2	0.6	12.5	0
5000 Hours	122.5	34.8	1.2	0.7	13.7	0

Test Results: Passed. The DUT did not sustain any damage or deterioration of functional performance during the test period while exposed to the required high temperature.

XIV. Reliability Tests: High Temperature Storage (damp) (GR-2883-CORE, Section 6.3.2)

Test Requirements: 2000 hours, 75°C, 90%RH

Equipment:
Chamber – ESPEC LHU-113 Humidity Cabinet, S/N 1012000693
Optical Characterization Test-Set

Test Procedure: Quantity 18 DUT were optically characterized prior to test. The DUT were placed on a tray with electrical leads shorted together and fiber pigtails coiled. The trays were placed in chamber at room temperature.

The chamber was set to maintain temperature and humidity of 75°C, 90%RH.

The temperature was reduced to room temperature and humidity at elapse time 500, 1000, and 2000 hours. At these points the DUT were removed from the chamber and optically characterized. After characterization all DUT were placed back in the chamber and the temperature and humidity returned to 75°C, 90%RH.

FFP-TF-v2 GR - High Temperature Storage

A72F	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.5	28.8	1	0	0	0
800 Hours	121.5	36.4	1.4	-7	7.6	0.4
2000 Hours	121.7	37.3	1.4	-6.8	8.5	0.4

A72C	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.7	25.9	1.5	0	0	0
800 Hours	128.8	32.1	1.9	0.1	6.2	0.4
2000 Hours	124.6	35	1.6	-4.1	9.1	0.1

A6GV	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	127.1	27.7	1	0	0	0
800 Hours	126.1	34.4	1.3	-1	6.7	0.3
2000 Hours	124	33.9	1	-3.1	6.2	0

A71S	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	127.9	27.4	1	0	0	0
800 Hours	124.3	33.7	1.5	-3.6	6.3	0.5
2000 Hours	124.1	35.2	1.4	-3.8	7.8	0.4

A71U	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.1	25.3	1.3	0	0	0
800 Hours	125.7	30.6	1.5	-2.4	5.3	0.2
2000 Hours	125	29.6	1.5	-3.1	4.3	0.2

A72D	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.4	20.1	0.4	0	0	0
800 Hours	129.1	26.7	1	0.7	6.6	0.6
2000 Hours	128.6	26.1	0.6	0.2	6	0.2

A725	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	129.1	21.7	0.5	0	0	0
800 Hours	128.9	28.9	0.6	-0.2	7.2	0.1
2000 Hours	124.5	30.6	1	-4.6	8.9	0.5

A72A	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	126.7	26.5	0.6	0	0	0
800 Hours	128.6	32.4	1	1.9	5.9	0.4
2000 Hours	125.2	33.7	1	-1.5	7.2	0.4

A72E	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	124.9	27.3	0.7	0	0	0
800 Hours	128.8	33.2	1	3.9	5.9	0.3
2000 Hours	125.7	34.8	0.9	0.8	7.5	0.2

A6H7	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	132.9	24	0.4	0	0	0
800 Hours	129.6	18.9	0.6	-3.3	-5.1	0.2
2000 Hours	124.9	27	0.4	-8	3	0

A6H8	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	133.2	36.1	0.4	0	0	0
800 Hours	129.1	35	0.5	-4.1	-1.1	0.1
2000 Hours	125.6	37.7	0.5	-7.6	1.6	0.1

A6H9	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	134	31.5	0.5	0	0	0
800 Hours	129	32.2	0.6	-5	0.7	0.1
2000 Hours	125.9	33.7	0.6	-8.1	2.2	0.1

A728	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	130.1	16.2	0.5	0	0	0
800 Hours	129.7	23.6	0.6	-0.4	7.4	0.1
2000 Hours	127.5	22.4	0.5	-2.6	6.2	0

A720	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.7	25.2	0.6	0	0	0
800 Hours	129	32.4	1	0.3	7.2	0.4
2000 Hours	123.7	33.1	1	-5	7.9	0.4

A71T	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	125.6	28.8	1.3	0	0	0
800 Hours	129.5	33	1.5	3.9	4.2	0.2
2000 Hours	125.9	33	1.5	0.3	4.2	0.2

A71V	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	128.7	22.7	1.5	0	0	0
800 Hours	128.8	31.6	1.8	0.1	8.9	0.3
2000 Hours	125	30.6	1.8	-3.7	7.9	0.3

A729	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	132.6	24.9	0.9	0	0	0
800 Hours	128.7	23	0.8	-3.9	-1.9	-0.1
2000 Hours	125.2	24.1	0.7	-7.4	-0.8	-0.2

A71W	FSR	Voltage	Loss (C-Band)	Δ FSR	Δ Voltage	Δ Loss
Initial	129.6	16.8	0.5	0	0	0
800 Hours	128.8	26.3	0.7	-0.8	9.5	0.2
2000 Hours	126.3	24.5	0.5	-3.3	7.7	0

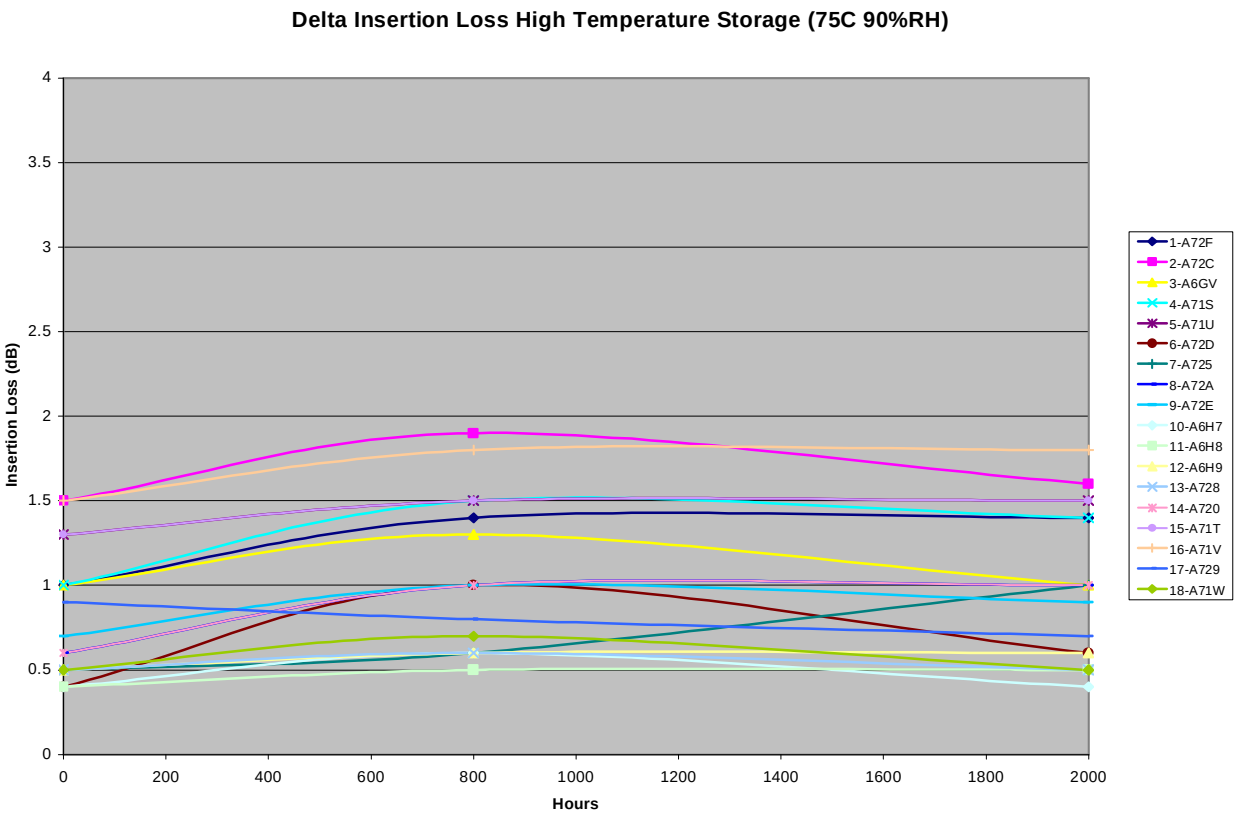

Figure 19: High Temperature Storage

Test Results: Passed. The DUT did not sustain any damage or deterioration of functional performance during the test period while exposed to the required damp heat.

XV. Reliability Tests: Temperature Cycling
(GR-2883-CORE, Section 6.3.2)

Test Requirements: 500 cycles, -40 to 75°C

Equipment:
Chamber – Tenney Environmental
Optical Characterization Test-Set

Test Procedure: Quantity 18 DUT were optically characterized prior to test. The DUT were placed on a tray with electrical leads shorted together and fiber pigtails coiled. The trays were placed in chamber at room temperature.

The chamber was programmed to repeatedly ramp to 75°C dwell, ramp down to –40°C, dwell, and repeat. Humidity was not controlled. The temperature cycle was paused as it reached room temperature on cycles 100, 250, and 500. At these points the DUT were removed from the chamber and optically characterized. After characterization all DUT were placed back in the chamber and the temperature cycle was resumed.

FFP-TF-v2 GR Temperature Cycling Data (-40 to 75C)

1)

A6DZ	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	115	25.2	1.3	40.93	39.8	36.15	0	0	0	0	0	0
100 Cycles@Current V	98	19.8	0.9	37.71	36.86	34.08	-17	-5.4	-0.4	-3.22	-2.94	-2.07
100 Cycles@Original V	113	39.4	0.8	40.29	41.94	37.92	-2	14.2	-0.5	-0.64	2.14	1.77
400 Cycles@Current V	112.4	48.1	1.3	40.19	42.76	37.59	-2.6	22.9	0	-0.74	2.96	1.44
400 Cycles@Original V	97.8	25.8	0.8	37.59	35.27	34.16	-0.2	6	-0.1	-0.12	-1.59	0.08
500 Cycles@Current V	112.2	47.2	1	40.53	39.89	37.7	-2.8	22	-0.3	-0.4	0.09	1.55
500 Cycles@Original V	97.6	25.5	1.3	37.58	34.83	34.23	-17.4	0.3	0	-3.35	-4.97	-1.92

2)

A6IB	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	113.1	17.2	1.2	n/a	n/a	n/a	0	0	0	0	0	0
100 Cycles@Current V	98.3	23.5	1.5	25.48	34.71	38.36	-14.8	6.3	0.3	n/a	n/a	n/a
100 Cycles@Original V	113.3	36.6	1.4	25.09	32.42	35.53	0.2	19.4	0.2	n/a	n/a	n/a
400 Cycles@Current V	112.1	48.5	1.1	25.09	32.06	35.37	-1	31.3	-0.1	n/a	n/a	n/a
400 Cycles@Original V	96.7	23.7	1.2	25.36	34.47	39.19	-16.4	6.5	0	n/a	n/a	n/a
500 Cycles@Current V	112.2	44.3	1.2	25.14	31.45	34.27	-0.9	27.1	0	n/a	n/a	n/a
500 Cycles@Original V	97.5	22.1	1.5	25.47	33.61	36.82	-15.6	4.9	0.3	n/a	n/a	n/a

3)

A6E8	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	114.3	21.3	1.5	36.29	35.97	33.6	0	0	0	0	0	0
100 Cycles@Current V	91.6	23.5	1.3	35.11	33.29	28.6	-22.7	2.2	-0.2	-1.18	-2.68	-5
100 Cycles@Original V	110.8	42.5	1	36.41	35.81	34.13	-3.5	21.2	-0.5	0.12	-0.16	0.53
400 Cycles@Current V	112.3	48.8	1.5	36.68	35.96	31.49	-2	27.5	0	0.39	-0.01	-2.11
400 Cycles@Original V	97.5	27.2		36.51	34.14	29.61	-16.8	5.9	-1.5	0.22	-1.83	-3.99
500 Cycles@Current V	113.4	47.9	1.5	38.07	36.34	32.04	-0.9	26.6	0	1.78	0.37	-1.56
500 Cycles@Original V	98.8	22.5	1.9	36.86	35.96	30.13	-15.5	1.2	0.4	0.57	-0.01	-3.47

4)

A6DY	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	115.1	24.8	1	39.71	40.55	41.3	0	0	0	0	0	0
100 Cycles@Current V	105	27.9	0.9	41.78	44.33	39.54	-10.1	3.1	-0.1	2.07	3.78	-1.76
100 Cycles@Original V	113.1	33.5	0.7	39.41	40.99	41.65	-2	8.7	-0.3	-0.3	0.44	0.35
400 Cycles@Current V	113.8	42.3	1.1	39.33	40.66	40.87	-1.3	17.5	0.1	-0.38	0.11	-0.43
400 Cycles@Original V	98.5	19.2		42.15	43.58	38.92	-16.6	-5.6	-1	2.44	3.03	-2.38
500 Cycles@Current V	113.2	32.9	1.5	41.13	41.8	39.25	-1.9	8.1	0.5	1.42	1.25	-2.05
500 Cycles@Original V	86.6	16.8	1.9	42.37	42.71	38.49	-28.5	-8	0.9	2.66	2.16	-2.81

5)

A6GO	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	113.6	24.4	0.9	37.87	36.15	31.03	0	0	0	0	0	0
100 Cycles@Current V	89.2	27.4	1.6	34.67	31.73	28.18	-24.4	3	0.7	-3.2	-4.42	-2.85
100 Cycles@Original V	112.6	43.2	1.4	37.38	36.26	30.5	-1	18.8	0.5	-0.49	0.11	-0.53
400 Cycles@Current V	113.4	49.8	1.6	38.79	36.02	31.07	-0.2	25.4	0.7	0.92	-0.13	0.04
400 Cycles@Original V	97.7	27.9	1.4	36.56	33.54	29.62	-15.9	3.5	0.5	-1.31	-2.61	-1.41
500 Cycles@Current V	112.8	50.9	1.8	38.13	36.99	31.8	-0.8	26.5	0.9	0.26	0.84	0.77
500 Cycles@Original V	97.8	28.6	2.4	37	33.91	30.15	-15.8	4.2	1.5	-0.87	-2.24	-0.88

6)

A6I5	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	112.6	14.6	1.4	38.92	40.47	40.04	0	0	0	0	0	0
100 Cycles@Current V	91.4	19.5	1.2	39.16	38.73	34.08	-21.2	4.9	-0.2	0.24	-1.74	-5.96
100 Cycles@Original V	112	40.5	0.7	40.63	40.08	40.56	-0.6	25.9	-0.7	1.71	-0.39	0.52
400 Cycles@Current V	113.1	45.7	1	39.34	40.53	40.6	0.5	31.1	-0.4	0.42	0.06	0.56
400 Cycles@Original V	97.3	25.3	1.4	43.93	7.15	33.87	-15.3	10.7	0	5.01	-33.32	-6.17
500 Cycles@Current V	112.2	45.9	1.2	42.79	43.93	40.73	-0.4	31.3	-0.2	3.87	3.46	0.69
500 Cycles@Original V	98	23.9	1.5	43.31	40.81	34.76	-14.6	9.3	0.1	4.39	0.34	-5.28

7)

A6IH	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	104.5	20.5	1	36.59	34.9	27.77	0	0	0	0	0	0
100 Cycles@Current V	98.2	18.9	1.2	35.38	33.5	26.48	-6.3	-1.6	0.2	-1.21	-1.4	-1.29
100 Cycles@Original V	104.4	33.2	1.2	37.43	35.29	28.64	-0.1	12.7	0.2	0.84	0.39	0.87
400 Cycles@Current V	103.3	47.5	1.6	34.07	31.79	24.7	-1.2	27	0.6	-2.52	-3.11	-3.07
400 Cycles@Original V	91.9	23.7	1.2	37.9	34.21	27.25	-12.6	3.2	0.2	1.31	-0.69	-0.52
500 Cycles@Current V	104.4	46.2	1.5	38.26	35.09	30.19	-0.1	25.7	0.5	1.67	0.19	2.42
500 Cycles@Original V	91.9	23.2	2.1	34.98	30.84	26.08	-12.6	2.7	1.1	-1.61	-4.06	-1.69

8)

A6I7	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	113.3	19.8	2	41.95	45.3	40.05	0	0	0	0	0	0
100 Cycles@Current V	91.3	22.8	1	40.63	38.96	33.24	-22	3	-1	-1.32	-6.34	-6.81
100 Cycles@Original V	113.1	37.1	n/a	43.46	44.06	40.23	-0.2	17.3	n/a	1.51	-1.24	0.18
400 Cycles@Current V	111.8	46.6	1	41.5	38.95	34.42	-1.5	26.8	-1	-0.45	-6.35	-5.63
400 Cycles@Original V	113.1	37.1	n/a	43.46	44.06	40.23	-0.2	17.3	n/a	1.51	-1.24	0.18
500 Cycles@Current V	111.9	45	1.4	42.95	44.65	39.66	-1.4	25.2	-0.6	1	-0.65	-0.39
500 Cycles@Original V	98.4	22.9	1.8	41.97	40.53	35.06	-14.9	3.1	-0.2	0.02	-4.77	-4.99

9)

A6I4	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	115.7	11.4	1	39.5	38.01	31.84	0	0	0	0	0	0
100 Cycles@Current V	104.8	27.2	0.9	38.2	35.04	30.51	-10.9	15.8	-0.1	-1.3	-2.97	-1.33
100 Cycles@Original V	113.5	31	n/a	39.93	38.66	32.56	-2.2	19.6	n/a	0.43	0.65	0.72
400 Cycles@Current V	113.3	38.7	1	40.49	37.36	33.16	-2.4	27.3	0	0.99	-0.65	1.32
400 Cycles@Original V	97.6	17.5	1	37.1	35.62	29.29	-18.1	6.1	0	-2.4	-2.39	-2.55
500 Cycles@Current V	112.6	44.1	1.2	40.95	39.38	33.64	-3.1	32.7	0.2	1.45	1.37	1.8
500 Cycles@Original V	97.9	18.4	2	37.66	36.22	30.22	-17.8	7	1	-1.84	-1.79	-1.62

10)

A6GQ	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	113.2	23.4	1.5	40.22	40.92	38.88	0	0	0	0	0	0
75 Cycles@Current V	112	41.3	1.1	37.49	40.74	38.88	1.2	17.9	-0.4	-2.73	-0.18	0
75 Cycles@Original V	106.1	20.4	n/a	n/a	n/a	n/a	-7.1	-3	n/a	n/a	n/a	n/a
400 Cycles@Current V	113.1	46	1.5	39.24	40.4	38.09	-0.1	22.6	0	-0.98	-0.52	-0.79
400 Cycles@Original V	97.6	24.4	1.8	40.08	41.34	38.76	-15.6	1	0.3	-0.14	0.42	-0.12
500 Cycles@Current V	112.1	47.1	1.4	40.9	40.2	38.33	-1.1	23.7	-0.1	0.68	-0.72	-0.55
500 Cycles@Original V	97.5	25.1	1.8	38.44	40.23	38.2	-15.7	1.7	0.3	-1.78	-0.69	-0.68

11)

A6GP	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	113.9	24	1.0	44.2	41.8	39.0	0	0	0	0	0	0
75 Cycles@Current V	113.2	43.5	0.8	42.1	40.8	39.2	0.7	19.5	-0.2	-2.1	-1.0	0.2
75 Cycles@Original V	106.1	20.4	n/a	n/a	n/a	n/a	-7.8	-3.6	n/a	n/a	n/a	n/a
400 Cycles@Current V	112.9	50.3	1.2	43.93	41.89	38.71	-1	26.3	0.2	-0.29	0.08	-0.29
400 Cycles@Original V	98	26.5	1.5	40.95	39.52	36.9	-15.9	2.5	0.5	-3.27	-2.29	-2.1
500 Cycles@Current V	112.2	49.1	1.1	43.52	41.62	38.58	-1.7	25.1	0.1	-0.7	-0.19	-0.42
500 Cycles@Original V	98.8	27.2	1.5	42.03	40.42	30.37	-15.1	3.2	0.5	-2.19	-1.39	-8.63

12)

A6E1	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	114.6	18.9	0.8	45.87	43.76	40.09	0	0	0	0	0	0
75Cycles@Current V	113.7	31.9	0.5	43.51	42.89	37.1	0.9	13	-0.25	-2.36	-0.87	-2.99
75 Cycles@Original V	106.1	20.4	0.5	45.27	42.9	37.94	-8.5	1.5	-0.25	-0.6	-0.86	-2.15
400 Cycles@Current V	112.8	44.4	0.9	42.16	43.86	38.09	-1.8	25.5	0.15	-3.71	0.1	-2
400 Cycles@Original V	98	18.7	1.0	43.15	42.07	36.6	-16.6	-0.2	0.25	-2.72	-1.69	-3.49
500 Cycles@Current V	113.7	36.1	0.7	44.85	42.77	38.01	-0.9	17.2	-0.05	-1.02	-0.99	-2.08
500 Cycles@Original V	97.9	14.3	0.9	43.44	42.31	36.7	-16.7	-4.6	0.15	-2.43	-1.45	-3.39

13)

A6GG	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	123.3	25.3	0.9	n/a	n/a	n/a	0	0	0	0	0	0
75 Cycles@Current V	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
75 Cycles@Original V	122.9	45.4	0.6	31.97	33.94	36.72	-0.4	20.1	-0.3	n/a	n/a	n/a
400 Cycles@Current V	121.5	53.7	0.9	27.04	36.78	37.64	-1.8	28.4	0	n/a	n/a	n/a
400 Cycles@Original V	97	20.6	1.2	34.04	39.04	44.39	-26.3	-4.7	0.3	n/a	n/a	n/a
500 Cycles@Current V	122.3	55	1.0	32.46	36.46	40.94	-1	29.7	0.1	n/a	n/a	n/a
500 Cycles@Original V	97.2	16.3	1.4	33.99	39.36	45.59	-26.1	-9	0.5	n/a	n/a	n/a

14)

A6G9	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	104.9	19.8	1.3	42.71	43.55	38.64	0	0	0	0	0	0
75 Cycles@Current V	91.4	16.9	1.2	41.98	40.16	36.81	-13.5	-2.9	-0.1	-0.73	-3.39	-1.83
75 Cycles@Original V	104.3	39.6	0.8	43.21	43.59	38.58	-0.6	19.8	-0.5	0.5	0.04	-0.06
400 Cycles@Current V	104.4	45.7	1.5	43.64	43.53	38.67	-0.5	25.9	0.2	0.93	-0.02	0.03
400 Cycles@Original V	91.3	25.1	1.8	42.16	41.65	37.04	-13.6	5.3	0.5	-0.55	-1.9	-1.6
500 Cycles@Current V	104.7	41.7	1.2	42.95	43.72	38.74	-0.2	21.9	-0.1	0.24	0.17	0.1
500 Cycles@Original V	91.8	21.4	1.5	42.28	41.73	37.04	-13.1	1.6	0.2	-0.43	-1.82	-1.6

15)

A6E9	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	106.8	21.6	1.0	44.59	42.69	39.04	0	0	0	0	0	0
75 Cycles@Current V	91.8	25.5	1.0	41.16	40.74	37.48	-15	3.9	0	-3.43	-1.95	-1.56
75 Cycles@Original V	104.9	45.4	0.7	43.93	43.76	39.95	-1.9	23.8	-0.3	-0.66	1.07	0.91
400 Cycles@Current V	104.4	51.5	1.0	43.41	43.95	39.97	-2.4	29.9	0	-1.18	1.26	0.93
400 Cycles@Original V	86.3	14.6	1.2	40.86	40.66	37.15	-20.5	-7	0.2	-3.73	-2.03	-1.89
500 Cycles@Current V	104.8	50.6	1.5	43.77	43.95	39.95	-2	29	0.5	-0.82	1.26	0.91
500 Cycles@Original V	88.2	15.3	1.7	40.78	40.32	38.01	-18.6	-6.3	0.7	-3.81	-2.37	-1.03

16)

A6E0	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	114.9	14.4	0.8	43.55	43.59	38.4	0	0	0	0	0	0
100 Cycles@Current V	105.2	18.4	0.7	41.52	32.9	25.36	-9.7	4	-0.1	-2.03	-10.69	-13.04
100 Cycles@Original V	113.9	28	0.8	43.08	41.38	28.07	-1	13.6	0	-0.47	-2.21	-10.33
400 Cycles@Current V	112.6	41.5	0.9	42.99	42.45	37.31	0.1	27.1	-1.14	-1.09	0.1	27.1
400 Cycles@Original V	98.2	15.2	1.0	42.55	34.09	29.19	-16.7	0.8	0.2	-1	-9.5	-9.21
500 Cycles@Current V	113.6	35.7	0.9	43.22	42.71	37.68	-1.3	21.3	0.1	-0.33	-0.88	-0.72
500 Cycles@Original V	97.8	14.6	1.1	41.59	34.9	27.92	-17.1	0.2	0.3	-1.96	-8.69	-10.48

17)

A6IF	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	123.5	19.5	1.2	41.61	43.29	41.76	0	0	0	0	0	0
100 Cycles@Current V	105.1	19.5	0.9	43.97	43.97	39.33	-18.4	0	-0.3	2.36	0.68	-2.43
100 Cycles@Original V	122.4	42.9	0.9	41.72	43.87	40.51	-1.1	23.4	-0.3	0.11	0.58	-1.25
400 Cycles@Current V	121.3	46.3	1.0	40.62	43.82	41.45	-2.2	26.8	-0.2	-0.99	0.53	-0.31
400 Cycles@Original V	104.6	23.7	1.1	43.39	45.41	40.3	-18.9	4.2	-0.1	1.78	2.12	-1.46
500 Cycles@Current V	122.6	46.1	1.1	41.33	44.55	41.25	-0.9	26.6	-0.1	-0.28	1.26	-0.51
500 Cycles@Original V	105.6	22.7	1.4	43.37	45.19	40.31	-17.9	3.2	0.2	1.76	1.9	-1.45

18)

A6FU	FSR	Voltage	Loss (C-Band)	GFDR Max S	GFDR Max C	GFDR Max L	Δ FSR	Δ Voltage	Δ Loss	Δ GFDR S	Δ GFDR C	Δ GFDR L
Initial	134.5	21.1	2.5	n/a	n/a	n/a	0	0	0	0	0	0
100 Cycles@Current V	109.4	24.4	2.7	n/a	n/a	n/a	-25.1	3.3	0.2	n/a	n/a	n/a
100 Cycles@Original V	124.9	46.6	2.7	35.14	40.53	40.08	-9.6	25.5	0.2	n/a	n/a	n/a
400 Cycles@Current V	125.1	52.8	2.7	28.3	36.28	35.22	-9.4	31.7	0.2	n/a	n/a	n/a
400 Cycles@Original V	100	21.9	2.5	34.81	39.41	39.48	-34.5	0.8	0	n/a	n/a	n/a
500 Cycles@Current V	138.6	58.4	2.7	35.45	39.52	38.31	4.1	37.3	0.2	n/a	n/a	n/a
500 Cycles@Original V	101	18.1	3.0	28.51	36.61	32.04	-33.5	-3	0.5	n/a	n/a	n/a

Test Results: Passed. The DUT did not sustain any damage or deterioration of functional performance during the test period while exposed to the required temperature cycle.

XVI. Appendix

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March 31, 2004

Report to Micron Optics

Subject: GR Tests on Compression Filter

GR testing was performed on samples of Compression Filters provided by Micron Optics Inc. The Generic Requirements included in the testing process were:

- Shock Test – During Use
- Shock Test – Shipment
- Office Vibration
- Transportation Vibration
- Cable Retention
- Twist Test
- Side Pull
- Flex Test

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Advanced Assembly Technology Vibration Test Summary

Micron Optics

Project Number: MCRO-031704-01

Date: April 14, 2004

Author

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Specification: The device supplied by Micron Optics was exposed to the customer specifications listed below:

90-minute test for each of three axes
Swept sine wave from 5 to 500 Hz and return
5-100Hz at 0.5g and a rate of 0.1 octaves/min
100-500Hz at 1.5g and a rate of .25 octaves/min

Procedure: The device under test (DUT) was placed in a shipping box and mounted directly to the vibration table as shown in the photograph below. The effects of this test were simulated by a single sine sweep of 0.5g from 5 to 100 Hz at a rate of 0.1 Octaves/min then 1.5g from 100 to 500 Hz at a rate of 0.25 Octaves/min and returning. The sweep was repeated for 90 min in each of three mutually perpendicular axes. The control accelerometer was fixed to the vibration table.

Figure 1: DUT in Shipping Box Strapped to Vibration Table

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Advanced Assembly Technology Vibration Test Summary

Micron Optics

Project Number: MCRO-031704-01

Date: March 30, 2004

Author

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Specification: The device supplied by Micron Optics was exposed to the customer specifications listed below:

- 90-minute test for each of three axes
- Acceleration level - 1.0 g - constant
- Swept sine wave from 5 to 100 Hz and return
- Sweep rate - .25 octaves/minute

Procedure: The device under test (DUT) was mounted to a fixture that allowed it to be secured in 3 perpendicular axes. The fixture was mounted directly to the vibration table as shown in the photograph below.

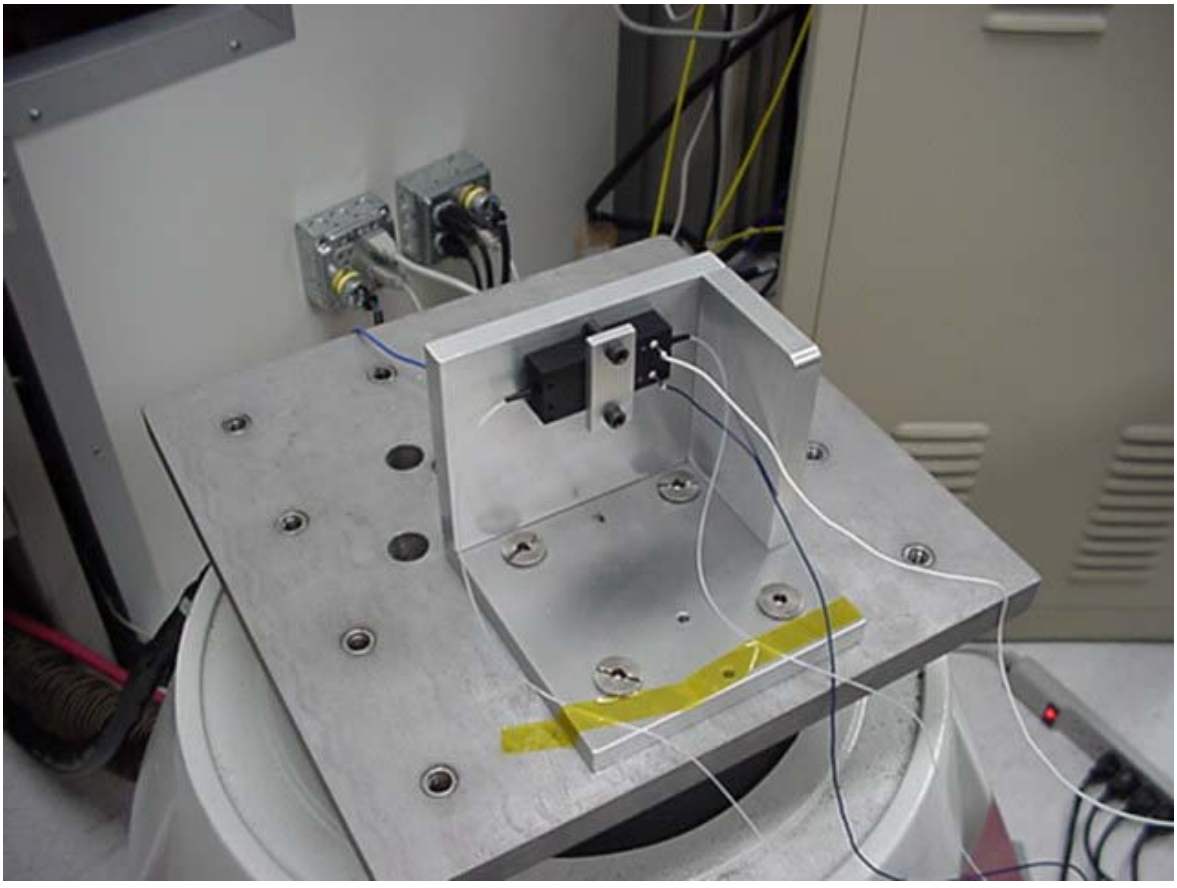

Figure 1: Device and Fixture mounted on vibration table

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Cables shown in the photo above were connected to the DUT for monitoring the performance of the device for the duration of the test.

The image below is a snapshot of the vibration controller screen. This snapshot shows the table vibration sweep from 5-100 Hz as it nears 100 Hz. The acceleration remains 1g as the profile sweeps at .25 octaves/min.

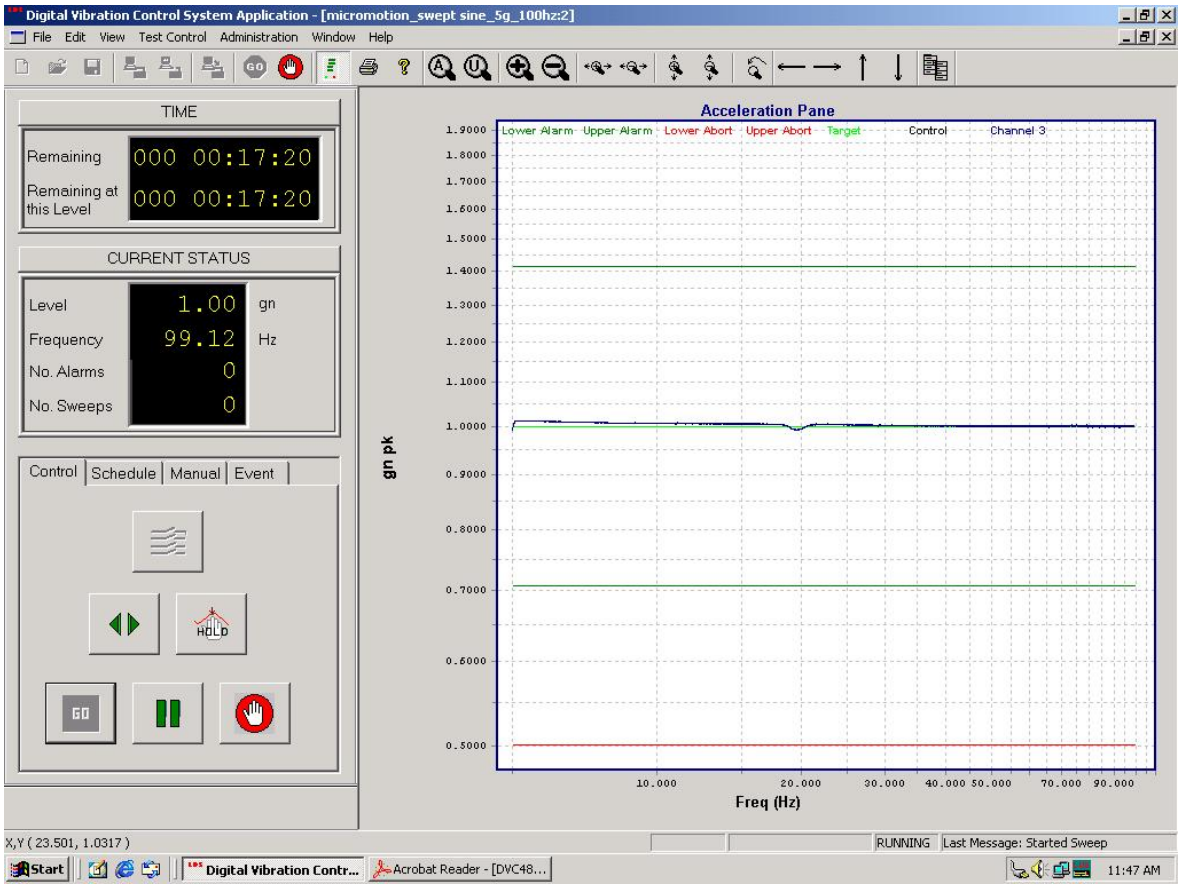

Figure 2: Snapshot of Vibration Controller screen