Qualification – VITA87 Optical Connector with LMT and PCMT Ferrules

1. INTRODUCTION

1.1 Purpose

Qualification testing of the VITA87 Optical Connector product with Lensed MT (LMT) and Physical Contact MT (PCMT) ferrules by subjecting multiple groups of samples to mechanical and environmental stress.

The qualification was conducted to verify the optical performance of 12 fiber LMT and 24F PCMT housed within the VITA87, Size 15, 4-position plug and receptacle housings with requirements provided by 108-32269, Rev 6.

1.2 Scope

This report covers the environmental and mechanical performance of the VITA87 Connector. Testing was performed at the Harrisburg Electrical Components Test Laboratory (HECTL/2900 FMR) between September 2020 and April, 2023.

1.3 Product Requirements

Performance	Value	Units
Optical Attenuation, LMT, New Product, Max	1.25	dB
Optical Attenuation, LMT, After Exposure, Max	1.50	dB
Optical Attenuation, PCMT, New Product, Max	0.75	dB
Optical Attenuation, PCMT, After Exposure, Max	1.05	dB
Optical Return Loss, LMT and PCMT, Min	20	dB
Mating Durability LMT / PCMT	500/250	cycles

1.4 Test Methods

Description	Procedure / Method
Optical Insertion Loss	TIA/EIA-455-171
Optical Return Loss	TIA/EIA-455-107
Vibration – Random (LMT)	MIL-STD-1678-3, Condition C, 5.3c (35Grms)
Vibration, Random (PCMT)	TIA/EIA-455-11, Condition VI-D, 11.95Grms, 1 hr. per axis
Mechanical Shock (LMT & PCMT)	MIL-S-901 Gr A, type B, Class I, 100Grms, 6ms half sine, 3 shocks per axis
Mechanical Shock (PCMT)	TIA/EIA-455-14 Condition E, 50Grms, 11ms Sawtooth, 3 shocks per axis
Mating Durability	TIA/EIA-455-21, 250 cycles (PCMT), 500 cycles (LMT)
Humidity Exposure	TIA/EIA-455-5, steady state, 75C and 95%RH
Thermal Cycle	TIA/EIA-455-3 Condition, C-4, 21 cycles, -40C to +85C

1.5 Conclusion

The VITA87 LMT samples successfully met the environmental (Thermal Cycling and Steady State Humidity) and mechanical (Random Vibration, Mechanical Shock and Mating Durability) optical and inspection performance criteria specified by 108-32269, Rev 6.

The VITA87 PCMT samples successfully met environmental (Thermal Cycling and Steady State Humidity) and mechanical (Random Vibration, Mechanical Shock and Mating Durability) optical performance and visual inspection criteria specified by 108-32269, Rev 6 with one anomaly related to t-cycle noted in section 5.3.

The optical performance compliance for Insertion Loss, Return Loss and Change in Transmittance was fully met at 850nm transmission wavelength.

2.0 Test Specimens for LMT Samples

See Table 1 for the allocation and attributes of the specimens submitted for testing. The listing is as identified by the submitted request.

Table 1 – Specimen Identification

Test Set	Quantity	Part Number	Description
1	2	2382992-1	Fiber Optic Assembly VITA87, Receptacle, Size 15, 4-position, w/4 x 12F LMT to 4 MPO
	2	2382993-1	Fiber Optic Assembly VITA87, Plug, Size 15, 4-position, w/4 x 12F LMT to 4 MPO
2	2	2382992-1	Fiber Optic Assembly VITA87, Receptacle, Size 15, 4-position, w/4 x 12F LMT to 4 MPO
	2	2382993-1	Fiber Optic Assembly VITA87, Plug, Size 15, 4-position, w/4 x 12F LMT to 4 MPO

2.1 Test Sequence for LMT Samples

Refer to Table 2 for the testing sequence performed on the specimens listed in Table 1.

Table 2- Test Sequence for LMT Samples

Test or Examination	Test Set 1	Test Set 2
	Test Sequence *(a)*	
Examination of Product	1, 9	1, 7
Insertion Loss and Return Loss	2, 4, 6, 8	2, 4, 6
Thermal Cycling, -40°C, 85°C 21 Cycles	3	-
Humidity, 75°C & 95 %RH	5	-
Random Vibration, 35 Grms, 50-2000Hz @ 8 Hrs. per axis.	-	3
Mech. Shock, Half-Sine 100G & 6ms, 3 shocks per axis.	-	5
Mating Durability, 500 Cycle	7	-

(a) Numbers indicate the sequence in which tests were performed.

2.2 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 21.0°C to 24.4°C
Relative Humidity: 45.6% to 58.9%

3. SUMMARY OF TESTING FOR LMT

Project testing results are summarized in order by project test condition as defined by Table 2. The test results when applicable provide statistical optical performance summaries by test group and test sample. Note, the expression “Test Set” and “Test Group” are used interchangeably throughout the test report.

Two forms of the presented Change in Transmittance (CIT) performance are presented. A change in optical transmittance based on the New Product (Initial Sequence) baseline and a baseline formed at the start of each specified test.

Additionally, the Design Objectives (108-32269, Rev 6) define the optical wavelength of interest of 850nm.

3.1 Examination of Product (Test Sets 1,2)

Visual inspection of the samples in the mated state was the most typical inspection performed during project testing. In most cases the specimens remained mated from production and undisturbed (un-coupled) throughout the test plan. The primary exceptions include Test Set 1 (Mating Durability) and Test Set 2 (Post Project). Environmental or mechanical testing minimum sample inspection required external visual review of the product workmanship condition. In all cases no noted evidence of change which would cause non-compliant effects to the product performance or finish.

The samples were inspected throughout the project sequential testing as part of product qualification. The tally below provides a few visual inspection findings noted during the project:

- Visual / Mechanical Inspection - Initial Examination – The unaided eye and supplemental imaging/photos were taken of the plug and receptacle connector assemblies. No observed defects were noted.
- End-face Geometry & Other Dimensional Inspection – No formal review or examination related to product dimensional criteria was performed. Production acquired data is expected to provide the information needed for formal dimensional compliance.
- Product Workmanship Inspection – Visual inspections when required during Test Set 1 (Mating Durability) & Test Set 2 (Supplemental Post Project) found no evidence of non-compliant conditions as specified by 108-32269. Review of the LMT end-face & external condition of the samples found no unacceptable defects such as: scratches, pits, debris, marks, chips, or shell wear affecting the product performance or finish. Typical end-face inspections acquired during event are found in Figure 1.

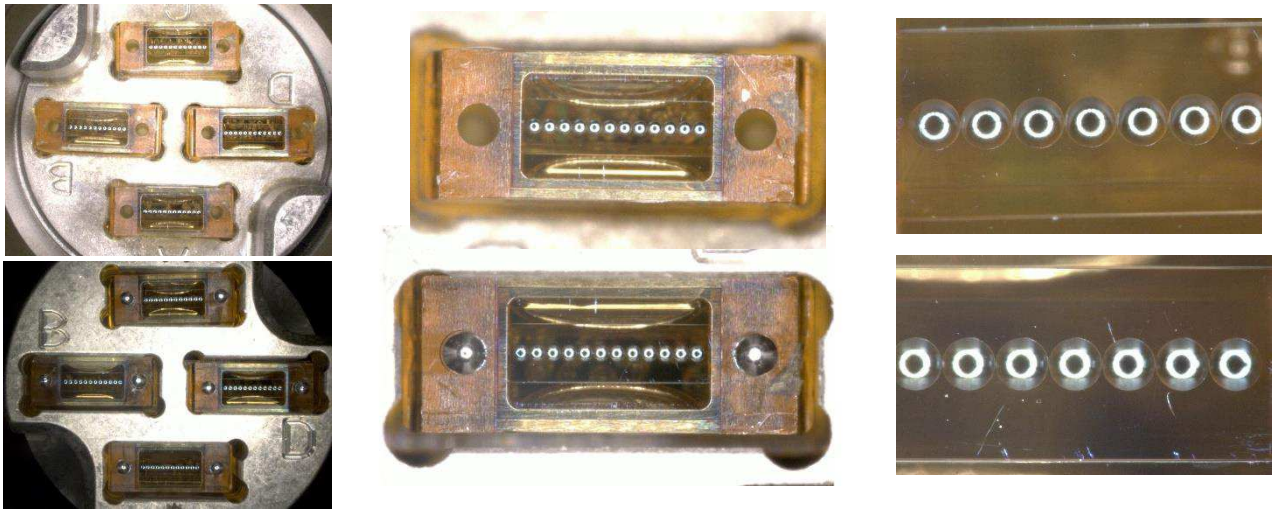

Figure 1 – Sample Inspection – Test Set 3 (After 100 Mating Cycles) – Typical Inspection

3.2 Insertion Loss & Return Loss / Sequence Evaluations (Test Sets 1,2)

A statistical summary of Test Set 1 and 2, New Product, Insertion & Return Loss by group and individual sample is found in Table 3 and Table 4 below. A review of the results finds full compliance to the 108-32269, at the primary 850nm wavelength. Measured 850 Return Loss was found fully compliant (≥ 20 dB).

The following is a brief set of New Product summary results providing a of each sample found within the Test Record for Cavity worst case optical performance:

- Test Set 1 - New Product Optical Performance Summary – A brief review summary of the worst-case optical performance (IL & RL) by sample:

  Sample S1-1 – worst case (850nm) - IL = 1.16 dB, RL = 22 dB
  Sample S1-2 – worst case (850nm) - IL = 1.06 dB, RL = 22 dB

- Test Set 2 - New Product Optical Performance Summary – A brief review summary of the worst-case optical performance (IL & RL) by sample:

  Sample S2-1 – worst case (850nm) - IL = 0.78 dB, RL = 22 dB
  Sample S2-2 – worst case (850nm) - IL = 0.85 dB, RL = 22 dB

A statistical summary of Test Set 1, test set sequential, Insertion & Return Loss is found below. Review of the results finds Insertion Loss compliance (≤ 1.25 dB) to the product print at the 850nm wavelength and full Return Loss compliance (≥ 20dB) at 850nm.

A brief worst-case summary of the final examination (end of sequence / EOS) for each Test Set is presented below:

- End of Sequence Optical Performance Summary – worst-case optical performance (IL & RL) by test set:

  Test Set 1 (Sample S1-1 & S1-2) – worst case (850nm) - IL = 1.05 dB, RL = 22 dB
  Test Set 2 (Sample S2-1 & S2-2) – worst case (850nm) - IL = 0.87 dB, RL = 22 dB

Table 3 - Test Set 1 / 2 – New Product - Attenuation / by Sample & Group

Sample Cavity Statistic ↓ Wavelength	**Sample 1 (S1-1)**	**Sample 2 (S1-2)**	**Sample 1 (S2-1)**	**Sample 2 (S2-2)**
	850nm	**850nm**	**850nm**	**850nm**
Maximum =	1.16	1.06	0.78	0.85
Minimum =	0.39	0.30	0.33	0.28
Average =	0.55	0.46	0.47	0.49
Std Dev. =	0.14	0.13	0.10	0.12
Median	0.52	0.44	0.44	0.47
Count =	48	48	48	48
Requirement (Max.)	≤ 1.25	≤ 1.25	≤ 1.25	≤ 1.25
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Pathway)	48 / 0	48 / 0	48 / 0	48 / 0

Units = dB

Table 4 – Test Set 1 / 2- New Product - Return Loss / by Sample & Group

Sample Cavity Statistic ↓ Wavelength	Sample 1 (S1-1)	Sample 2 (S1-2)	Sample 1 (S2-1)	Sample 2 (S2-2)
	850nm	850nm	850nm	850nm
Maximum =	26	25	26	26
Minimum =	22	22	22	22
Average =	24	24	24	24
Std Dev. =	1	1	1	1
Median	24	24	24	24
Count =	48	48	48	48
Requirement (Min.)	≥ 20	≥ 20	≥ 20	≥ 20
Pass / Fail (Pathway)	48 / 0	48 / 0	48 / 0	48 / 0

Units = dB

Table 5 - Test Set 1 – Sequential Test Examination - Attenuation / by Group

	New Product	After Temp Cyc.	After Hum. Age	After Durability
	850nm	850nm	850nm	850nm
Maximum =	1.16	1.19	1.11	0.90
Minimum =	0.30	0.28	0.28	0.27
Average =	0.51	0.50	0.50	0.44
Standard Deviation =	0.14	0.14	0.13	0.10
Median	0.48	0.46	0.46	0.43
Count (Path) =	96	96	96	48
Requirement (Max.)	≤ 1.25	≤ 1.50	≤ 1.50	≤ 1.50
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Sample)	2 / 0	2 / 0	2 / 0	2 / 0

Units = dB

Table 6 – Test Set 1 - Sequential Test Examination - Return Loss / by Group

	New Product	After Temp Cyc.	After Hum. Age	After Durability
	850nm	850nm	850nm	850nm
Maximum =	22	27	27	25
Minimum =	26	22	22	22
Average =	24	24	24	24
Standard Deviation =	1	1	1	1
Median	24	24	24	24
Count (Path) =	96	96	96	48
Objective (Min.)	≥ 20	≥ 20	≥ 20	≥ 20
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Sample)	2 / 0	2 / 0	2 / 0	2 / 0

Units = dB

Table 7 - Test Set 2 – Sequential Test Examination - Attenuation / by Group

	New Product	After Random Vibe	After Mech. Shock
	850nm	850nm	850nm
Maximum =	0.85	0.87	0.87
Minimum =	0.28	0.29	0.30
Average =	0.48	0.48	0.48
Standard Deviation =	0.11	0.11	0.11
Median	0.46	0.46	0.45
Count (Path) =	96	72	72
Requirement (Max.)	≤ 1.25	≤ 1.50	≤ 1.50
Requirement (Avg.)	NA	NA	NA
Pass / Fail (Sample)	2 / 0	2 / 0	2 / 0

Units = dB

Table 8 – Test Set 2 - Sequential Test Examination - Return Loss / by Group

	New Product	After Random Vibe	After Mech. Shock
	850nm	850nm	850nm
Maximum =	26	27	27
Minimum =	22	22	22
Average =	24	24	24
Standard Deviation =	1	1	1
Median	24	24	24
Count (Path) =	96	72	72
Objective (Min.)	≥ 20	≥ 20	≥ 20
Requirement (Avg.)	NA	NA	NA
Pass / Fail (Sample)	2 / 0	2 / 0	2 / 0

Units = dB

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3.3 Thermal Cycling, -40°C to +85°C @ 21 Cycles (Test Set 1)

A statistical summary of Test Set 1, optical performance with the applied environmental exposure, Thermal Cycling is found in Tables 9-14 below. The two Test Set 1 samples met the specified Change in Transmittance (CIT ≤ ± 0.4 dB) requirements as detailed in the 108-32269. The CIT results are fully compliant at 850nm wavelength.

No external physical change detrimental to product performance was noted following the specified exposure. Following completion of the test, samples were exposed to the next sequential test, Humidity.

Table 9 – Thermal Cycling – Change in Transmittance Summary – During

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	0.20	0.18
Minimum =	-0.15	-0.11
Average =	0.01	0.01
Std Dev. =	0.05	0.04
Median	0.01	0.01
Count =	25200	25200
Requirement (Max. / Min.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 10 – Thermal Cycling – Change in Transmittance Summary – Final

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	0.17	0.14
Minimum =	-0.05	-0.03
Average =	0.01	0.02
Std Dev. =	0.04	0.03
Median	0.00	0.02
Count =	48	48
Requirement (Max. / Min.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 11 – Thermal Cycling – Insertion Loss Summary – During

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	1.22	1.11
Minimum =	0.31	0.27
Average =	0.56	0.46
Std Dev. =	0.14	0.12
Median	0.53	0.44
Count =	25200	25200
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 12 – Thermal Cycling – Insertion Loss Summary – Final

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	1.19	0.98
Minimum =	0.33	0.28
Average =	0.55	0.45
Std Dev. =	0.15	0.11
Median	0.54	0.43
Count =	48	48
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Units = dB

Table 13 – Thermal Cycling – Return Loss Summary – During

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	27	25
Minimum =	22	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	25200	25200
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Units = dB

Table 14 – Thermal Cycling – Return Loss Summary – Final

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	27	25
Minimum =	22	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	48	48
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Units = dB

3.4 Humidity, 75°C & 95% RH @ 168 Hours (Test Set 1)

A statistical summary of Test Set 1, optical performance with the applied environmental exposure, Steady-State Humidity is found in Tables 15-20 below. Test Set 1 samples met the specified Change in Transmittance (CIT ≤ ± 0.4 dB) requirements as detailed in the 108-32269.

Further review of the results finds Insertion Loss compliance (≤ 1.50 dB) and Return Loss compliance (≥ 20dB) to the 108-32269 at 850nm wavelength

No external physical change detrimental to product performance was noted following the specified exposure.

Table 15 – Steady-State Humidity – Change in Transmittance Summary – During

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	0.15	0.15
Minimum =	-0.10	-0.13
Average =	0.00	0.04
Std Dev. =	0.04	0.04
Median	0.00	0.04
Count =	17424	17424
Requirement (Max. / Min.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 16 – Steady-State Humidity – Change in Transmittance Summary – Final

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	0.08	0.07
Minimum =	-0.08	-0.06
Average =	0.00	0.00
Std Dev. =	0.04	0.03
Median	0.01	0.00
Count =	48	48
Requirement (Max. / Min.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 17 – Steady-State Humidity – Insertion Loss Summary – During

	Test Set 1 Sample 1 (S1-1)	**Test Set 1 Sample 2 (S1-2)**
	850nm	**850nm**
Maximum =	1.20	1.09
Minimum =	0.28	0.25
Average =	0.55	0.41
Std Dev. =	0.15	0.11
Median	0.52	0.39
Count =	17424	17424
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 18 – Steady-State Humidity – Insertion Loss Summary – Final

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	1.11	0.90
Minimum =	0.36	0.28
Average =	0.55	0.45
Std Dev. =	0.14	0.10
Median	0.52	0.43
Count =	48	48
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 19 – Steady-State Humidity – Return Loss Summary – During

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	27	26
Minimum =	22	22
Average =	25	24
Std Dev. =	1	1
Median	25	24
Count =	17424	17424
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 20 – Steady-State Humidity – Return Loss Summary – Final

	Test Set 1 Sample 1 (S1-1)	Test Set 1 Sample 2 (S1-2)
	850nm	850nm
Maximum =	27	25
Minimum =	22	22
Average =	25	24
Std Dev. =	1	1
Median	24	24
Count =	48	48
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

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3.5 Mating Durability, 500 Cycles (Test Set 1)

A statistical summary of Test Set 1, optical performance before, during and after the Mating Durability exposure is found in Tables 21 below. The Test Set 1, sample met the specified Change in Transmittance (CIT ≤ ± 0.5 dB)) requirements during and after the exposure as detailed in the 108-32269. The CIT results are fully compliant at 850nm wavelength. 108-32269 indicates product requirement of 100 cycles. It was determined after completion of 100 cycles to extend the test to 500 cycles per FOTP-21.

Further review of the results of Table 21 finds full Insertion Loss compliance (≤ 1.50 dB) to the 108-32269 at 850nm wavelength during and after the test and Return Loss compliance (≥ 20dB) throughout.

Measurements were acquired every 10 cycles, inspection every 25 cycles through cycle 100. Thereafter measurements were acquired every 100 cycles through 500 cycles. Visual inspection and sample cleaning performed prior to optical measurement.
No external physical change detrimental to product performance was noted following the specified exposure and no formal cleaning beyond compressed air was utilized to provide the compliant optical and mechanical performance.

Table 21 – Mating Durability – Test Set 1 / Sample S1-2 Only – Sample Performance Summary

	CIT (dB) Base Line = Test Set 1 Sequence	CIT (dB) Base Line = Mating Durability Test	Insertion Loss (dB)	Return Loss (dB)
	850nm	850nm	850nm	850nm
INITIAL:				
Maximum =	0.15	0.00	0.93	25
Minimum =	-0.06	0.00	0.27	22
Average =	0.03	0.00	0.44	24
Standard Deviation =	0.04	0.00	0.10	1
Median =	0.03	0.00	0.42	24
Count (Path) =	48	48	48	48
DURING:				
Maximum =	0.18	0.04	0.93	25
Minimum =	-0.08	-0.08	0.26	22
Average =	0.02	-0.01	0.45	24
Standard Deviation =	0.05	0.01	0.10	1
Median =	0.02	-0.01	0.44	24
Count (Path x Meas.) =	1008	1008	1008	1008
FINAL:				
Maximum =	0.18	0.03	0.90	25
Minimum =	-0.07	-0.06	0.27	22
Average =	0.03	-0.01	0.44	24
Standard Deviation =	0.05	0.01	0.10	1
Median =	0.01	-0.01	0.43	24
Count (Path) =	48	48	48	48
Requirement (Min.)	NA	NA	NA	≥ 20
Requirement: Max. >> Initial/Final	≤ ±0.30	≤ ±0.30	≤ 1.50	NA
Requirement: Max. >> During	≤ ±0.40	≤ ±0.40	≤ 1.50	NA
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Sample)	1 / 0	1 / 0	1 / 0	1 / 0

3.6 Vibration, Random 35 Grms (Test Set 2)

A statistical summary of Test Set 2, optical performance with the applied Vibration exposures is found in Table 22 thru 27 below and Figure 2, provides a graphical summary of the mechanical exposure applied during the test. The two Test Set 2 samples met the specified Change in Transmittance (CIT ≤ ± 0.5 dB) requirements before, during and after the exposure at 850nm transmission as detailed in the 108-32269. Additionally, active transient monitoring of CIT during the random vibration exposure created no optical discontinuities among any of the fiber pathways (both samples) monitored throughout the exposure. Optical discontinuity is defined as 1dB or greater reduction in optical power for a period of 1 microsecond or longer. Table 28 provides a manual collection of Optical Discontinuity Monitor (ODM) voltage indicator observations before and after each vibration exposure. As indicated no optical change (CIT) on any pathway among any cavity greater than ± 0.02 dB was noted during the setup or exposure.

Further review of the results finds full compliance for Insertion Loss (≤ 1.50 dB) and Return Loss (≥ 20dB) at 850nm during and after the exposure. Following completion of the test no observed physical change was noted including damage, breaks or loose coupling of either sample.

Following completion of the test, samples were exposed to the next sequential test, Mechanical Shock (100G, Half-Sine, 6 ms.).

Table 22 – Random Vibration – Change in Transmittance Summary - During

	Test Set 2 Sample 1 (S2-1)	**Test Set 2 Sample 2 (S2-2)**
	850nm	**850nm**
Maximum =	0.01	0.02
Minimum =	-0.04	-0.03
Average =	0.00	0.00
Std Dev. =	0.01	0.01
Median	0.00	0.00
Count =	144	144
Requirement (Max.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 23 – Random Vibration – Change in Transmittance Summary – Final

	Test Set 2 Sample 1 (S2-1)	**Test Set 2 Sample 2 (S2-2)**
	850nm	**850nm**
Maximum =	0.01	0.02
Minimum =	-0.04	-0.03
Average =	-0.01	-0.01
Std Dev. =	0.01	0.01
Median	0.00	-0.01
Count =	36	36
Requirement (Max.)	± 0.5	± 0.5
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 24 – Random Vibration – Insertion Loss Summary – During

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	0.73	0.87
Minimum =	0.33	0.29
Average =	0.46	0.49
Std Dev. =	0.09	0.13
Median	0.44	0.47
Count =	144	144
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 25 – Random Vibration – Insertion Loss Summary – Final

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	0.73	0.87
Minimum =	0.34	0.29
Average =	0.47	0.50
Std Dev. =	0.10	0.13
Median	0.45	0.48
Count =	36	36
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 26 – Random Vibration – Return Loss Summary – During

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	26	27
Minimum =	23	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	144	144
Requirement (Min.)	**≥ 20**	**≥ 20**
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

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Table 27 – Random Vibration – Return Loss Summary – Final

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	26	27
Minimum =	23	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	36	36
Requirement (Max.)	**≥ 20**	**≥ 20**
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 28 – Random Vibration – Sample Exposure Summary – Manually recorded ODM Information

ID	Date	ODM Ch.1	ODM Ch.2	ODM Ch.3	ODM Ch.4	ODM Ch.5	ODM Ch.6	COMMENTS OBSERVATIONS
1	10/13/2021	-23.95	NA	NA	-23.85	-24.02	-24.1	**Initial ODM Setup Power (1300nm)**
2	10/13/2021	1.000	-	-	1.000	1.000	1.000	Initial Setup In Vibration Room - S2-1 & S2-2
3	10/13/2021	0.991	-	-	1.003	1.000	1.025	Vibration Initial Setup Stability (+2 hrs.)
4	10/13/2021	1.000	-	-	1.000	1.000	1.000	Vibration Initial Setup Stability (Reset)
5	10/14/2021	1.014	-	-	1.016	1.006	**1.066**	Vibration Initial Setup Stability (+13 hrs.)
6	10/14/2021	1.000	-	-	1.000	1.000	1.000	Reset Initial Monitor Voltage (V) - S1 & S2 (Longitudinal)
7	10/14/2021	1.050	-	-	1.023	1.018	0.989	Final Monitor Voltage (V) - S1 & S2 (Longitudinal)
8	10/14/2021	1.000	-	-	1.000	1.000	1.000	Reset Before Move to Radial Voltage (V) - S1 & S2
9	10/14/2021	0.989	-	-	0.997	0.995	0.994	After Move to Radial Voltage (V) - S1 & S2
10	10/14/2021	1.000	-	-	1.000	1.000	1.000	Reset Initial Monitor Voltage (V) - S1 & S2 (Radial)
11	10/15/2021	1.069	-	-	0.998	1.014	0.944	Final Monitor Voltage (V) - S1 & S2 (Radial)
12	10/19/2021	0.988	-	-	1.100	1.150	1.000	After Return from long test delay Voltage - S1 & S2
13	10/19/2021	1.000	-	-	1.000	1.000	1.000	Reset Before Move to Mech Shock Monitor Voltage (V) - S1 & S2
14	10/20/2021	0.995	-	-	0.992	0.989	1.000	Before Move to Mech Shock (Sys-Sample Prepped) Monitor Voltage (V) - S1 & S2
15	10/20/2021	1.046	-	-	1.011	0.997	1.036	Immediately After Move (Still Prepped & Power On) Monitor Voltage (V) - S1 & S2
16	10/20/2021	1.000	-	-	1.000	1.000	1.000	Before Mech Install - Reset Monitor Voltage (V) - S1 & S2
-								
Summary – Includes all above data								
	Min. (V) =	0.988			0.992	0.989	0.944	Listed ODM Voltage (V Min.)
	Max. (V) =	1.069			1.100	1.150	1.066	Listed ODM Voltage (V Max.)
	Max.(-dB) =	-0.05			-0.03	-0.05	-0.25	Maximum Before/After Change in -dB
	Max.(+dB) =	0.29			0.41	0.61	0.28	Maximum Before/After Change in +dB

NOTE: ODM pathway monitoring includes 3 fibers per sample fiber array (12 fiber ribbon) for each test sample = (3 x 4) = 12 monitored pathways = Effectively 25% of Test Set 1 pathways. Fibers 1, 6 & 7 among each array was part of the monitored selection of fiber pathways, See Test Methods, Figure 3.

NOTE: No ODM events / transients were observed during applied vibration are indicated in comments above. ODM Exposure Summary above provides IDs = step by step processing of Test Set 2 samples.

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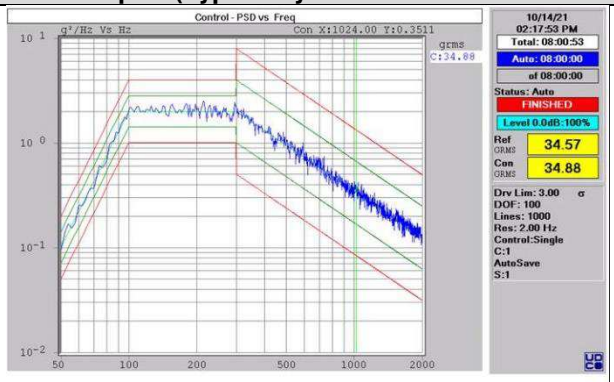
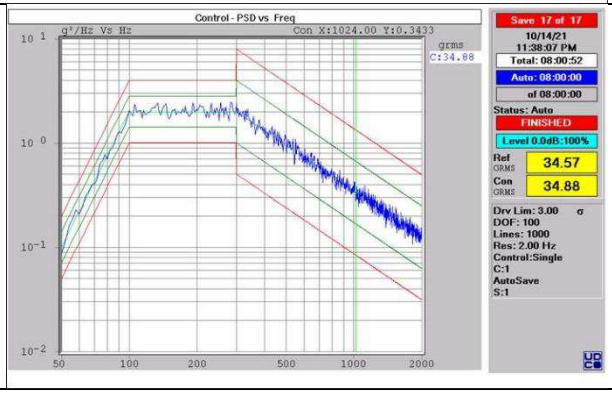
Exposure Specifics:	Exposure Report (Typical System Generated Information)
Test Date: TS2 - 10/14/2021 **Sample Direction:** Both samples: Longitudinal **Raw Vibration Sys. Test Report:** Portion of Typical System Report Shown **Transient Monitoring Results:** S2-1 & S2-2 – No ODM events	
Test Date: TS2 - 10/14/2021 **Sample Direction:** Both samples: Radial **Raw Vibration Sys. Test Report:** Portion of Typical System Report Shown **Transient Monitoring Results:** S2-1 & S2-2 – No ODM events	

Figure 2 – Random Vibration – Sample Exposure Summary

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3.7 Mechanical Shock, Half-Sine 100G & 6 ms (Test Set 2)

A statistical summary of Test Set 2, optical performance with the applied Mechanical Shock exposures is found in Table 29 thru 34 below and Figure 3, provide a graphical summary of the typical mechanical shock pulses applied during the test exposures. The two Test Set 2 samples met the specified Change in Transmittance (CIT ≤ ± 0.3 dB), Insertion Loss (IL ≤ ± 1.50 dB), and Return Loss (RL ≥ ± 20 dB) requirements during and after the exposure at 850nm transmission as detailed in the 108-32269. Additionally, active transient monitoring of CIT during the mechanical shock exposure created no optical discontinuities among any of the fiber pathways (both samples) monitored throughout the exposure. Optical discontinuity is defined as 1dB or greater reduction in optical power for a period of 1 microsecond or longer. Table 35 provides a manual collection of Optical Discontinuity Monitor (ODM) voltage indicator observations before and after each vibration exposure.

Table 29 – Mechanical Shock – Change in Transmittance Summary – During

	Test Set 2 Sample 1 (S2-1)	**Test Set 2 Sample 2 (S2-2)**
	850nm	**850nm**
Maximum =	0.03	0.02
Minimum =	-0.01	-0.02
Average =	0.00	0.00
Std Dev. =	0.00	0.01
Median	0.00	0.00
Count =	648	648
Requirement (Max./ Min.)	± ≤ 0.30	± ≤ 0.30
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 30 – Mechanical Shock – Change in Transmittance Summary – Final

	Test Set 2 Sample 1 (S2-1)	**Test Set 2 Sample 2 (S2-2)**
	850nm	**850nm**
Maximum =	0.03	0.01
Minimum =	-0.01	-0.02
Average =	0.00	0.00
Std Dev. =	0.01	0.01
Median	0.00	0.00
Count =	36	36
Requirement (Max.)	± ≤ 0.30	± ≤ 0.30
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

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Table 31 – Mechanical Shock – Insertion Loss Summary – During

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	0.73	0.88
Minimum =	0.34	0.29
Average =	0.46	0.50
Std Dev. =	0.09	0.13
Median	0.45	0.48
Count =	648	648
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 32 – Mechanical Shock – Insertion Loss Summary – Final

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	0.73	0.87
Minimum =	0.35	0.30
Average =	0.47	0.50
Std Dev. =	0.09	0.13
Median	0.45	0.47
Count =	36	36
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 33 – Mechanical Shock – Return Loss Summary – During

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	26	27
Minimum =	23	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	648	648
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

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Table 34 – Mechanical Shock – Return Loss Summary – Final

	Test Set 2 Sample 1 (S2-1)	Test Set 2 Sample 2 (S2-2)
	850nm	850nm
Maximum =	26	27
Minimum =	23	22
Average =	24	24
Std Dev. =	1	1
Median	24	24
Count =	36	36
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	48 / 0	48 / 0

Table 35 – Mechanical Shock – ODM Transient System Exposure Summary

ID	Date	ODM Ch.1	ODM Ch.2	ODM Ch.3	ODM Ch.4	ODM Ch.5	ODM Ch.6	COMMENTS OBSERVATIONS
1	10/13/2021	-23.95			-23.85	-24.02	-24.1	**Initial ODM Setup Power (1300nm)**
13	10/19/2021	1.000			1.000	1.000	1.000	Reset Before Move to Mech Shock Monitor Voltage (V) - S1 & S2
14	10/20/2021	0.995			0.992	0.989	1.000	Before Move to Mech Shock (Sys-Sample Prepped) Monitor Voltage (V) - S1 & S2
15	10/20/2021	1.046			1.011	0.997	1.036	Immediately After Move (Still Prepped & Power On) Monitor Voltage (V) - S1 & S2
16	10/20/2021	1.000			1.000	1.000	1.000	Before Mech Install - Reset Monitor Voltage (V) - S1 & S2
17	10/20/2021	0.999			1.002	1.010	1.001	Mech Shock Initial Setup Stability (+2 hrs)
18	10/20/2021	0.988			1.004	1.023	1.001	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (Y1)
19	10/20/2021	1.000			1.000	1.000	1.000	Overnight Stability Reset Monitor Voltage (V) - S1 & S2 (Y1)
20	10/21/2021	1.071			0.992	0.982	1.040	Mech Shock Initial Setup Stability (+12 hrs)
21	10/21/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (Y1)
22	**10/21/2021**	**1.000**			**1.006**	**1.000**	**1.000**	After Mech Shock Voltage (V) - S1 & S2 (Y1)
23	10/21/2021	0.991			0.999	0.977	0.990	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (Y2)
24	10/21/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (Y2)
25	**10/21/2021**	**1.002**			**1.012**	**1.005**	**1.002**	After Mech Shock Voltage (V) - S1 & S2 (Y2)
26	10/21/2021	1.005			1.000	1.006	1.005	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (X1)
27	10/21/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (X1)
28	**10/21/2021**	**1.002**			**1.006**	**1.000**	**1.000**	After Mech Shock Voltage (V) - S1 & S2 (X1)
29	10/21/2021	0.999			1.001	1.002	0.998	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (X2)
30	10/21/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (X2)
31	**10/21/2021**	**1.003**			**0.995**	**1.001**	**1.002**	After Mech Shock Voltage (V) - S1 & S2 (X2)
32	10/21/2021	1.006			0.990	1.000	1.005	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (Z1)
33	10/21/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (Z1)
34	**10/21/2021**	**1.001**			**1.003**	**1.004**	**1.001**	After Mech Shock Voltage (V) - S1 & S2 (Z1)
35	10/22/2021	1.014			0.966	1.029	1.017	Overnight Stability Monitor Voltage (V) - S1 & S2
36	10/22/2021	1.013			0.965	1.027	1.014	Mech Shock Samples Mounted Monitor Voltage (V) - S1 & S2 (Z2)
37	10/22/2021	1.000			1.000	1.000	1.000	Reset Before Mech Shock Voltage (V) - S1 & S2 (Z2)
38	**10/22/2021**	**1.000**			**0.996**	**1.002**	**1.002**	After Mech Shock Voltage (V) - S1 & S2 (Z2)
39	10/22/2021	1.000			1.000	1.000	1.000	ODM Issue Retest - Reset Before Mech Shock Voltage (V) - S1 & S2 (Z2). ODM Indictor required reset (DM-600-10) after overnight
40	**10/22/2021**	**1.000**			**0.999**	**1.001**	**1.001**	After Mech Shock Voltage (V) - S1 & S2 (Z2)
Summary – Includes all above data								
	Min. (V) =	0.988			0.965	0.977	0.990	Listed ODM Voltage (V Min.)
	Max. (V) =	1.071			1.012	1.029	1.040	Listed ODM Voltage (V Max.)
	Max.(-dB) =	-0.05			-0.15	-0.10	-0.04	Maximum Before/After Change in -dB
	Max.(+dB) =	0.30			0.05	0.12	0.17	Maximum Before/After Change in +dB

NOTE: ODM pathway monitoring includes 3 fibers per sample cavity for each test sample = (2 x 4) x 3 = 24 monitored pathways = Effectively 25% of Test Set 2 pathways. Observed 0.1us event was noted ODM Ch. 1, 5 & 6 immediately after start of some exposures. The system was reset with no other observed events occurring. It is noted the HECTL, ODM is not formally calibrated at this low duration indicator level.

NOTE: No discontinuity events observed at the specified 0.5 dB & 1us level

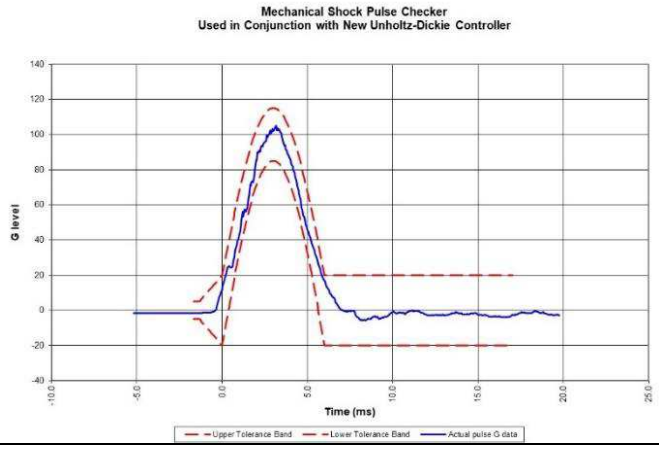
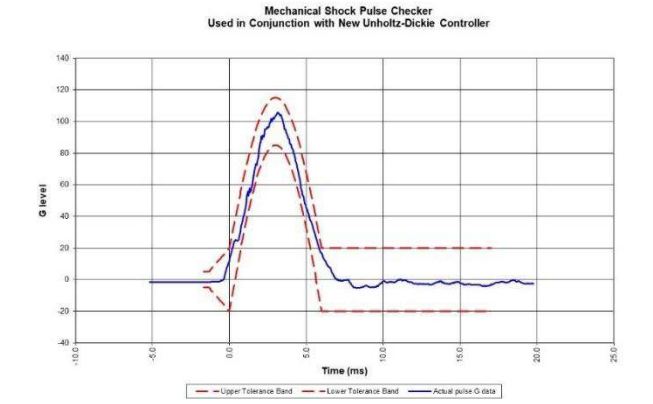
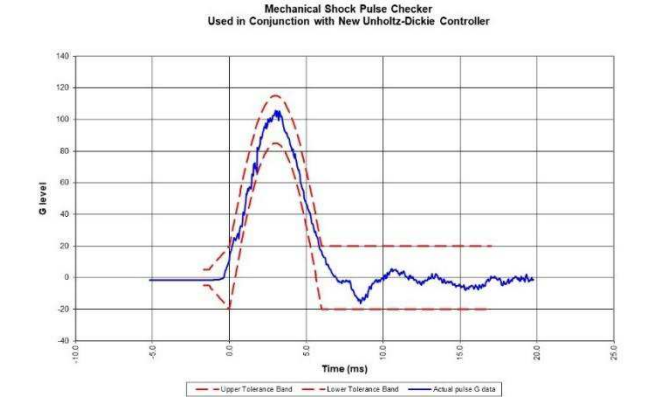
Exposure Specifics:	Exposure Report (Force Profile Information)
Test Date: 10/21/2021 **Sample Direction:** Y1 & Y2 - Axis **Raw Sys Test Report:** "Y2 Shock-3" **Test Results:** The presented plot is a snap-shot shock application event. After completing Y1 & Y2 shock events = 3 x 2 = 6th exposure	
Test Date: 10/21/2021 **Sample Direction:** X1 & X2 - Axis **Raw Sys Test Report:** "X2 Shock-3" **Test Results:** The presented plot is a snap-shot shock application event. After completing X1 & X2 shock events = 3 x 2 = 6th exposure	
Test Date: 10/21/2021 thru 10/22/2021 **Sample Direction:** Z1 & Z2 - Axis **Raw Sys Test Report:** "Z2 Shock-3 re-test" **Test Results:** The presented plot is a snap-shot shock application event. After completing Z1 & Z2 shock events plus re-test Z2 due to ODM reset. See Procedures = (3 x 2) +3 = 9th exposures*	

Figure 3 – Mechanical Shock - Applied Shock Exposures

4.0 Test Specimens for PCMT Samples

See Table 36 for the allocation and attributes of the specimens submitted for testing. The listing is as identified by the submitted request.

Table 36 – Specimen Identification

Test Set	Quantity	Part Number	Description
4	2	2382992-3	Fiber Optic Assembly VITA87, Receptacle, Size 15, 4-position, w/4 x 24F PCMT to 4 MPO
	2	2382993-3	Fiber Optic Assembly VITA87, Plug, Size 15, 4-position, w/4 x 24F PCMT to 4 MPO
5	1	2382992-3	Fiber Optic Assembly VITA87, Receptacle, Size 15, 4-position, w/4 x 24F PCMT to 4 MPO
	1	2382993-3	Fiber Optic Assembly VITA87, Plug, Size 15, 4-position, w/4 x 24F PCMT to 4 MPO

4.1 Test Sequence for PCMT Samples

Refer to Table 37 for the testing sequence performed on the specimens listed in Table 1.

Table 37- Test Sequence for PCMT Samples

Test or Examination	Test Set 4	Test Set 5
	Test Sequence *(a)*	
Examination of Product	1, 9	1, 9
Insertion Loss and Return Loss	2, 4, 6, 8	2, 4, 6, 8
Thermal Cycling, -40°C, 85°C 21 Cycles	3	-
Humidity, 75°C & 95 %RH	5	-
Random Vibration, 11.95 Grms, 50Hz – 2000Hz, 1 Hrs. per axis.	-	3
Mech. Shock, 50G 11ms Sawtooth, 3 shocks per axis.		5
Mech. Shock, Half-Sine 100G & 6ms, 3 shocks per axis.	-	7
Mating Durability, 250 Cycle	7	-

(a) Numbers indicate the sequence in which tests were performed.

4.2 Environmental Conditions

Unless otherwise stated, the following environmental conditions prevailed during testing:

Temperature: 21.0°C to 24.4°C
Relative Humidity: 45.6% to 58.9%

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5.0 SUMMARY OF TESTING FOR PCMT

Project testing results are summarized in order by project test condition as defined by Table 37. The test results when applicable provide statistical optical performance summaries by test group and test sample. Note, the expression “Test Set” and “Test Group” are used interchangeably throughout the test report.

Two forms of the presented Change in Transmittance (CIT) performance are presented. A change in optical transmittance based on the New Product (Initial Sequence) baseline and a baseline formed at the start of each specified test.

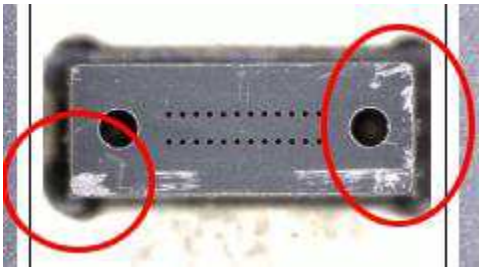
Additionally, the Design Objectives (108-32269, Rev 6) define the optical wavelength of interest of 850nm.

5.1 Examination of Product (Test Sets 4,5)

Visual inspection of the samples in the mated state was the most typical inspection performed during project testing. In most cases the specimens remained mated from production and undisturbed (un-coupled) throughout the test plan. The primary exceptions include Test Set 4 (Mating Durability) and Test Set 5 (Post Project). Environmental or mechanical testing minimum sample inspection required external visual review of the product workmanship condition. In all cases no noted evidence of change which would cause non-compliant effects to the product performance or finish.

The samples were inspected throughout the project sequential testing as part of product qualification. The tally below provides a few visual inspection findings noted during the project:

- Visual / Mechanical Inspection - Initial Examination – The unaided eye and supplemental imaging/photos were taken of the plug and receptacle connector assemblies. No observed defects were noted. Visual inspection with magnification was performed and identified blemishes on the corners of the ferrule endface in sample 4-2. It was determined that the ferrule guides were not used during ferrule insertion on this sample. Ferrule guides are designed to prevent this type of damage. Damage did not appear to influence the optical performance. The image below represents typical ferrule condition for this sample.



- End-face Geometry & Other Dimensional Inspection – No formal review or examination related to product dimensional criteria was performed. Production acquired data is expected to provide the information needed for formal dimensional compliance.

Product Workmanship Inspection – Visual inspections when required during Test Set 4 (Mating Durability) & Test Set 5 (Mechanical) found no evidence of non-compliant conditions as specified by 108-32269. Review of the MT end-face & external condition of the samples found no unacceptable defects such as: scratches, pits, debris, marks, chips or shell wear affecting the product performance or finish. Typical end-face inspections acquired are found in Figure 4

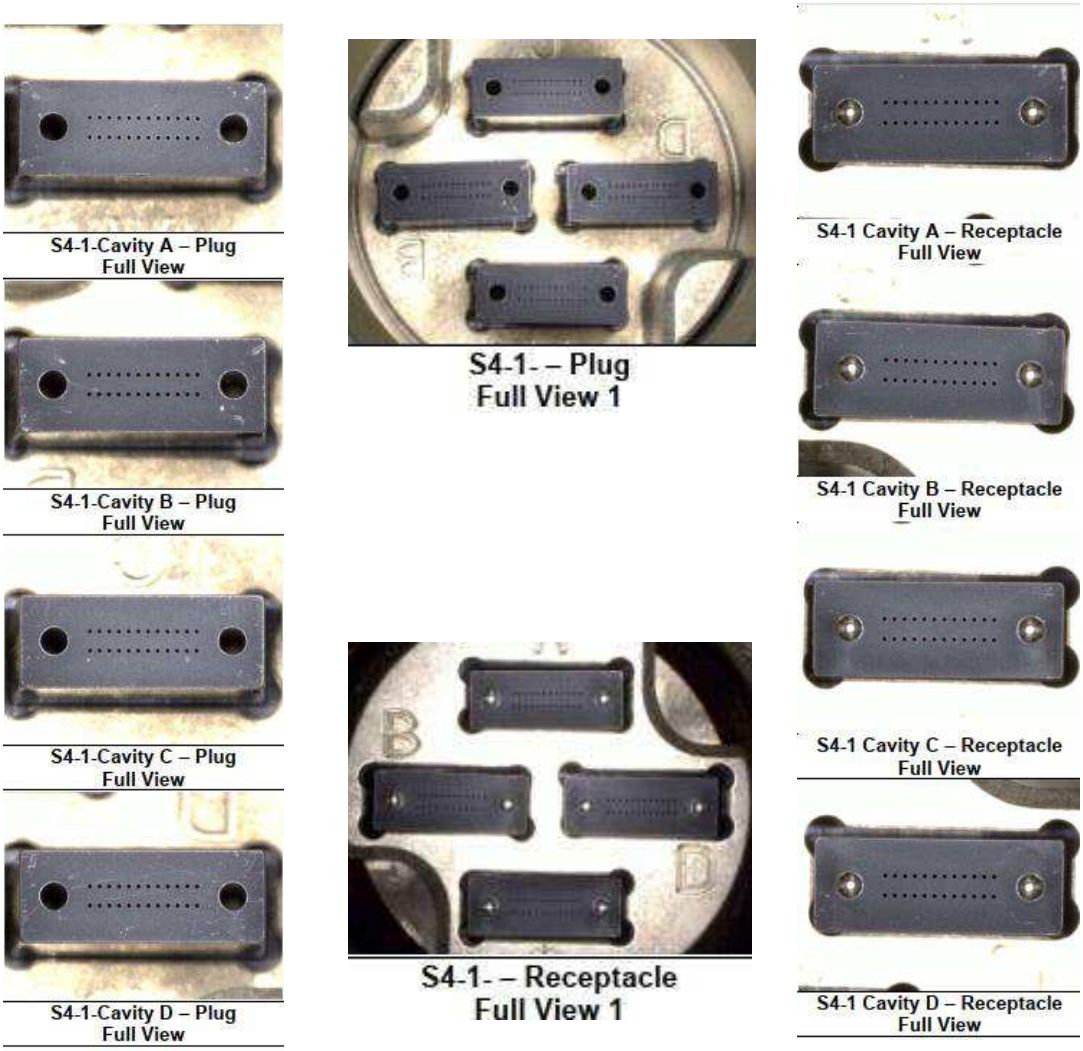


Figure 4 – Sample Inspection – Typical Pre/Post Test End Face Inspection

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5.2 Insertion Loss & Return Loss / Sequence Evaluations (Test Sets 4,5)

A statistical summary of Test Set 4 and 5, New Product, Insertion & Return Loss by group and individual sample is found in Table 38 thru 44 below. A review of the results finds full compliance to the 108-32269, at the primary 850nm wavelength. Measured 850 Return Loss was found fully compliant (≥ 20 dB).

The following is a brief set of New Product summary results providing a of each sample found within the Test Record for Cavity worst case optical performance:

- Test Set 4 - New Product Optical Performance Summary – A brief review summary of the worst-case optical performance (IL & RL) by sample:

  Sample S4-1 – worst case (850nm) - IL = 0.32 dB, RL = 24 dB
  Sample S4-2 – worst case (850nm) - IL = 0.33 dB, RL = 24 dB

- Test Set 5 - New Product Optical Performance Summary – A brief review summary of the worst-case optical performance (IL & RL) by sample:

  Sample S12-1 – worst case (850nm) - IL = 0.54 dB, RL = 29.7 dB

A statistical summary of Test Set 4, project sequential, Insertion & Return Loss by is found below. Review of the results finds Insertion Loss compliance (≤ 1.05 dB) to the product print at the 850nm wavelength and full Return Loss compliance (≥ 20dB) at 850nm.

A brief worst-case summary of the final examination (end of sequence / EOS) for each Test Set is presented below:

- End of Sequence Optical Performance Summary – worst-case optical performance (IL & RL) by test set:

  Test Set 4 (Sample S4-1 & S4-2) – worst case (850nm) - IL = 0.74 dB, RL = 24 dB
  Test Set 5 (Sample S12-1) – worst case (850nm) - IL = 0.25 dB, RL = 37.4 dB

Table 38 - Test A – Insertion Loss / New Product – D38999 w 24F MT

	Test Set 4 Sample 1 (S4-1)	**Test Set 4 Sample 2 (S4-2)**	**Test Set 5 Sample 1 (S12-1)**
	850nm	**850nm**	**850nm**
Maximum =	0.32	0.33	0.54
Minimum =	-0.04	0.00	-0.27
Average =	0.15	0.13	0.12
Std Dev. =	0.07	0.07	0.11
Median	0.15	0.12	NA
Count =	96	72	96
Requirement (Max.)	≤ 0.75	≤ 0.75	≤ 0.75
Requirement (Avg.)	NA	NA	NA
Pass / Fail (Pathway)	96 / 0	72 / 0	96 / 0

Units = dB

Table 39 – Return Loss / New Product – D38999 w 24F MT

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)	Test Set 5 Sample 1 (S12-1)
	850nm	850nm	850nm
Maximum =	38	38	37.6
Minimum =	24	24	29.7
Average =	37	36	37.0
Std Dev. =	2	2	1.0
Median	37	37	NA
Count =	96	72	96
Requirement (Min.)	≥ 20	≥ 20	≥ 20
Pass / Fail (Pathway)	96 / 0	72 / 0	96 / 0

Units = dB

Table 40 - Test Set Optical Performance Summary – D38999 w-24F MT

	Insertion Loss		Return Loss	
	Test Set 4	Test Set 5	Test Set 4	Test Set 5
	850nm	850nm	850nm	850nm
Maximum =	0.33	0.54	38	37.6
Minimum =	-0.04	-0.27	24	29.7
Average =	0.14	0.12	37	37.0
Standard Deviation =	0.08	0.11	2	1.0
Median =	0.13	NA	37	NA
Count =	168	96	168	96
Requirement (Max. / Min.)	≤ 0.75	≤ 0.75	≥ 20	≥ 20
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Sample)	2 / 0	1/ 0	2 / 0	1 / 0

Units = dB

Table 41 – Test Set 4 – Sequential Test Examination - Attenuation / by Group

	New Product	After Temp Cyc.	After Hum. Age	After Durability
	850nm	850nm	850nm	850nm
Maximum =	0.33	0.36	0.41	0.74
Minimum =	-0.04	-0.02	-0.03	-0.06
Average =	0.14	0.14	0.17	0.19
Standard Deviation =	0.08	0.08	0.08	0.13
Median	0.13	0.14	0.16	0.16
Count (Path) =	168	168	168	96
Requirement (Max.)	≤ 0.75	≤ 1.05	≤ 1.05	≤ 1.05
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Samples)	2 / 0	2 / 0	2 / 0	1 / 0

Units = dB

Table 42 – Test Set 4 - Sequential Test Examination - Return Loss / by Group

	New Product	After Temp Cyc.	After Hum. Age	After Durability
	850nm	850nm	850nm	850nm
Maximum =	38	38	38	38
Minimum =	24	22	24	24
Average =	37	37	37	37
Standard Deviation =	2	2	2	2
Median	37	37	37	37
Count (Path) =	168	168	168	96
Objective (Min.)	≥ 20	≥ 20	≥ 20	≥ 20
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Paths)	2 / 0	2 / 0	2 / 0	1 / 0

Units = dB

Table 43 – Test Set 5 – Sequential Test Examination - Attenuation / by Group

	New Product	After Vibration.	After 50G Sawtooth	After 100G Half Sine
	850nm	850nm	850nm	850nm
Maximum =	0.54	0.56	0.25	0.25
Minimum =	-0.27	-0.26	0.06	0.06
Average =	0.12	0.12	0.12	0.12
Standard Deviation =	0.11	0.10	0.04	0.04
Median	NA	NA	0.12	0.12
Count (Path) =	84	84	84	84
Requirement (Max.)	≤ 0.75	≤ 1.05	≤ 1.05	≤ 1.05
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Samples)	1 / 0	1 / 0	1 / 0	1 / 0

Units = dB

Table 44 – Test Set 5 – Sequential Test Examination – Return Loss / by Group

	New Product	After Vibration.	After 50G Sawtooth	After 100G Half Sine
	850nm	850nm	850nm	850nm
Maximum =	37.6	37.6	37.4	37.4
Minimum =	29.7	29.9	24.9	24.9
Average =	37.0	36.1	36.5	36.5
Standard Deviation =	1.0	1.4	1.5	1.5
Median	NA	NA	36.7	36.8
Count (Path) =	84	84	84	84
Requirement (Max.)	≥ 20	≥ 20	≥ 20	≥ 20
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Samples)	1 / 0	1 / 0	1 / 0	1 / 0

5.3 Thermal Cycling, -40°C to +85°C @ 21 Cycles (Test Set 4)

A statistical summary of Test Set 4, optical performance with the applied environmental exposure, Thermal Cycling is found in Tables 45 thru 50 below. The two Test Set 4 samples met the specified Change in Transmittance (CIT ≤ ± 0.4 dB) requirements as detailed in the 108-32269. The CIT results are fully compliant at 850nm wavelength.

No external physical change detrimental to product performance was noted following the specified exposure. Following completion of the test, samples were exposed to the next sequential tests, Humidity and Mating Durability.

2 Fibers in Cavity C of Sample S4-2 showed non-compliant CIT and RL for a brief period during thermal cycle exposure. Both channels recovered during thermal cycling test and met end of test requirements. Sample S4-2 then successfully met the during / after test requirements when subjected to Humidity Exposure, and 250 Mating Durability Cycles.

Table 45 – Thermal Cycling – Change in Transmittance Summary – During

	Test Set 4 Sample 1 (S4-1)	**Test Set 4 Sample 2 (S4-2)**
	850nm	**850nm**
Maximum =	0.13	0.07
Minimum =	-0.22	-0.51
Average =	0.00	-0.01
Std Dev. =	0.03	0.03
Median	0.00	-0.01
Count =	37152	27864
Requirement (Max. / Min.)	± 0.4	± 0.4
Requirement (Avg.)		-
Pass / Fail (Pathway)	96 / 0	70 / 2

Units = dB

Table 46 – Thermal Cycling – Change in Transmittance Summary – Final

	Test Set 4 Sample 1 (S4-1)	**Test Set 4 Sample 2 (S4-2)**
	850nm	**850nm**
Maximum =	0.10	0.05
Minimum =	-0.06	-0.08
Average =	0.00	0.00
Std Dev. =	0.03	0.02
Median	0.00	0.00
Count =	96	72
Requirement (Max. / Min.)	± 0.3	± 0.3
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

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Table 47 – Thermal Cycling – Insertion Loss Summary – During

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	0.41	0.69
Minimum =	*-0.04*	*-0.02*
Average =	0.15	0.14
Std Dev. =	0.07	0.08
Median	0.15	0.13
Count =	37152	27864
Requirement (Max.)	≤ 1.05	≤ 1.05
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 48 – Thermal Cycling – Insertion Loss Summary – Final

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	0.30	0.36
Minimum =	*-0.02*	0.00
Average =	0.15	0.14
Std Dev. =	0.07	0.08
Median	0.15	0.13
Count =	96	72
Requirement (Max.)	≤ 1.05	≤ 1.05
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 49 – Thermal Cycling – Return Loss Summary – During

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	38	38
Minimum =	14	9
Average =	37	37
Std Dev. =	2	2
Median	37	37
Count =	37152	27864
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	95 / 1	70 / 2

Units = dB

Table 50 – Thermal Cycling – Return Loss Summary – Final

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	**850nm**
Maximum =	38	38
Minimum =	24	22
Average =	37	37
Std Dev. =	2	2
Median	37	37
Count =	96	72
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

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5.4 Humidity, 75°C & 95% RH @ 168 Hours (Test Set 4)

A statistical summary of Test Set 4, optical performance with the applied environmental exposure, Steady-State Humidity is found in Tables 51 thru 56 below. Test Set 4 samples met the specified Change in Transmittance (CIT ≤ ± 0.4 dB) requirements as detailed in the 108-32269.

Further review of the results finds Insertion Loss compliance (≤ 1.05 dB) and Return Loss compliance (≥ 20dB) to the 108-32269 at 850nm wavelength

No external physical change detrimental to product performance was noted following the specified exposure

Table 51 – Steady-State Humidity – Change in Transmittance Summary – During

	Test Set 4 Sample 1 (S4-1)	**Test Set 4 Sample 2 (S4-2)**
	850nm	**850nm**
Maximum =	0.12	0.10
Minimum =	-0.24	-0.24
Average =	-0.04	-0.05
Std Dev. =	0.06	0.06
Median	-0.03	-0.04
Count =	17376	13032
Requirement (Max. / Min.)	± 0.4	± 0.4
Requirement (Avg.)		-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 52 – Steady-State Humidity – Change in Transmittance Summary – Final

	Test Set 4 Sample 1 (S4-1)	**Test Set 4 Sample 2 (S4-2)**
	850nm	**850nm**
Maximum =	0.08	0.09
Minimum =	-0.16	-0.15
Average =	-0.03	-0.03
Std Dev. =	0.04	0.05
Median	-0.03	-0.03
Count =	96	72
Requirement (Max. / Min.)	± 0.3	± 0.3
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

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Table 53 – Steady-State Humidity – Insertion Loss Summary – During

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	0.51	0.51
Minimum =	*-0.06*	*-0.02*
Average =	0.19	0.18
Std Dev. =	0.09	0.10
Median	0.18	0.17
Count =	17376	13032
Requirement (Max.)	≤ 1.05	≤ 1.05
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 54 – Steady-State Humidity – Insertion Loss Summary – Final

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	0.41	0.35
Minimum =	*-0.03*	0.03
Average =	0.18	0.17
Std Dev. =	0.08	0.08
Median	0.17	0.15
Count =	96	72
Requirement (Max.)	≤ 1.05	≤ 1.05
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 55 – Steady-State Humidity – Return Loss Summary – During

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	850nm
Maximum =	38	38
Minimum =	24	22
Average =	37	37
Std Dev. =	2	1
Median	37	37
Count =	17376	13032
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

Table 56 – Steady-State Humidity – Return Loss Summary – Final

	Test Set 4 Sample 1 (S4-1)	Test Set 4 Sample 2 (S4-2)
	850nm	**850nm**
Maximum =	38	38
Minimum =	24	28
Average =	37	37
Std Dev. =	2	1
Median	37	37
Count =	96	72
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	96 / 0	72 / 0

Units = dB

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5.5 Mating Durability, 250 Cycles (Test Set 4)

A statistical summary of Test Set 4, optical performance before, during and after the Mating Durability exposure is found in Table 57 below. The Test Set 4, sample met the specified Change in Transmittance (CIT ≤ ± 0.5 dB)) requirements during and after the exposure as detailed in the 108-32269. The CIT results are fully compliant at 850nm wavelength for product requirement of 250 cycles

Further review of the results of Table 57 finds full Insertion Loss compliance (≤ 1.05 dB) to the 108-32269 at 850nm wavelength during and after the test and Return Loss compliance (≥ 20dB) throughout.

Measurements were acquired every 10 cycles, inspection every 25 through cycle 150. Thereafter measurements were acquired every 25 cycles through 250 cycles. Visual inspection and sample cleaning performed prior to optical measurement.

No external physical change detrimental to product performance was noted following the specified exposure and no formal cleaning beyond compressed air was utilized to provide the compliant optical and mechanical performance.

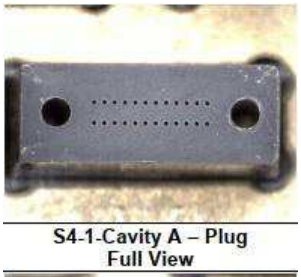
Table 57 – Mating Durability (250 Cycles) – Test Set 4 / Sample S4-1 Only – Sample Performance Summary

	CIT (dB) Baseline = Test Sequence	CIT (dB) Baseline = Durability Test	Insertion Loss (dB)	Return Loss (dB)
	850nm	850nm	850nm	850nm
INITIAL:				
Maximum =	0.14	0.00	0.39	38
Minimum =	-0.17	0.00	-0.04	24
Average =	-0.03	0.00	0.18	37
Standard Deviation =	0.06	0.00	0.09	2
Median =	-0.03	0.00	0.17	37
Count (Path) =	96	96	96	96
DURING:				
Maximum =	0.14	0.15	0.75	38
Minimum =	-0.59	-0.44	-0.07	23
Average =	-0.04	-0.01	0.19	37
Standard Deviation =	0.09	0.08	0.12	2
Median =	-0.01	0.00	0.17	37
Count (Path x Meas.) =	2208	2208	2208	2208
FINAL:				
Maximum =	0.12	0.15	0.74	38
Minimum =	-0.58	-0.43	-0.06	24
Average =	-0.04	-0.01	0.19	37
Standard Deviation =	0.11	0.10	0.13	2
Median =	0.00	0.02	0.16	37
Count (Path) =	96	96	96	96
Requirement (Min.)	NA	NA	NA	≥ 20
Requirement: Max. >> Initial/Final	NA	≤ ±0.50	≤ 1.05	≥ 20
Requirement: Max. >> During	NA	≤ ±0.50	≤ 1.05	≥ 20
Requirement (Avg.)	NA	NA	NA	NA
Pass / Fail (Sample)	NA	1 / 0	1 / 0	1 / 0

Units = dB

NOTE: Noted negative Change in Transmittance (-CIT) indicates degraded optical performance.

NOTE: Transmission (IL/CIT) compliance tolerance includes claimed measurement error, IL ± 0.10 dB, CIT ± 0.05 dB, RL ± 1 dB

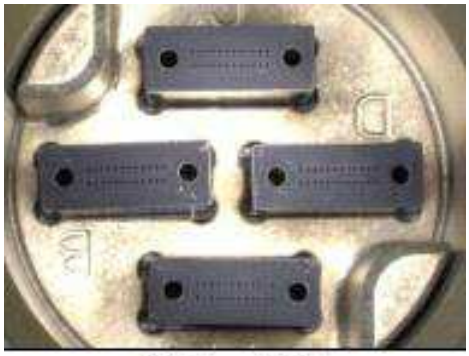


S4-1-Cavity A – Plug
Full View

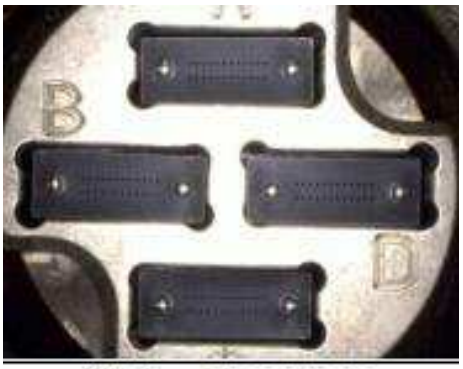
S4-1-Cavity B – Plug
Full View

S4-1-Cavity C – Plug
Full View

S4-1-Cavity D – Plug
Full View



S4-1- – Plug
Full View 1

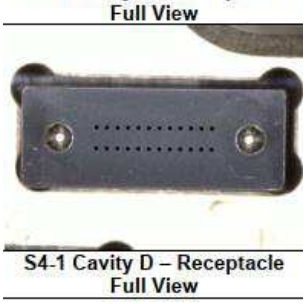


S4-1- – Receptacle
Full View 1

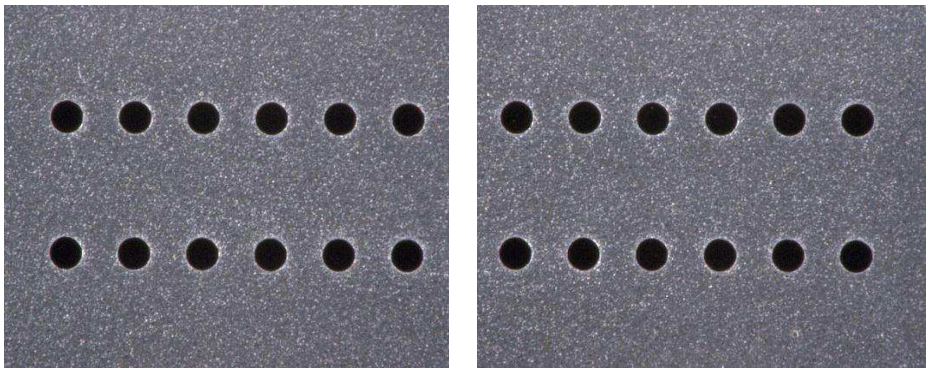
S4-1 Cavity A – Receptacle
Full View

S4-1 Cavity B – Receptacle
Full View

S4-1 Cavity C – Receptacle
Full View



S4-1 Cavity D – Receptacle
Full View



(Cavity C Ferrule -- Typical condition for all sample 12-1 ferrules)

Figure 5 – Sample Inspection – Test Sample 4-1 (After T-Cycle, Humidity, and 250 Mating Cycles)

5.6 Vibration, Random 11.95 Grms (Test Set 5)

A statistical summary of Test Set 5, optical performance with the applied Vibration exposures is found in Table 58 thru 63 below. The Test Set 5 samples met the specified Change in Transmittance (CIT ≤ ± 0.5 dB) requirements before, during and after the exposure at 850nm transmission as detailed in the 108-32269. Additionally, active transient monitoring of CIT during the random vibration exposure created no optical discontinuities among any of the fiber pathways monitored throughout the exposure. Optical discontinuity is defined as 0.5dB or greater reduction in optical power for a period of 1 microsecond or longer. As indicated no optical change (CIT) on any pathway among any cavity greater than ± 0.02 dB was noted during the setup or exposure.

Further review of the results finds full compliance for Insertion Loss (≤ 1.05 dB) and Return Loss (≥ 20dB) at 850nm during and after the exposure. Following completion of the test no observed physical change was noted including damage, breaks or loose coupling of either sample. No evidence of fiber or ferrule endface damage because of vibration exposure was recorded.

Following completion of the test, samples were exposed to the next sequential test, Mechanical Shock (50G, 11ms Sawtooth and Mechanical Shock 100G, Half-Sine, 6 ms.

Table 58 – Random Vibration – Change in Transmittance Summary - During

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	0.00
Minimum =	-0.01
Average =	0.00
Std Dev. =	0.00
Median	NA
Count =	96
Requirement (Max.)	± 0.5
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

Table 59 – Random Vibration – Change in Transmittance Summary – Final

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	0.03
Minimum =	-0.04
Average =	0.00
Std Dev. =	0.00
Median	NA
Count =	96
Requirement (Max.)	± 0.5
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

Table 60 – Random Vibration – Insertion Loss Summary – During

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	0.56
Minimum =	-0.26
Average =	0.12
Std Dev. =	0.10
Median	NA
Count =	96
Requirement (Max.)	≤ 1.05
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

Table 61 – Random Vibration – Insertion Loss Summary – Final

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	0.56
Minimum =	-0.26
Average =	0.12
Std Dev. =	0.10
Median	NA
Count =	96
Requirement (Max.)	≤ 1.05
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

Table 62 – Random Vibration – Return Loss Summary – During

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	37.7
Minimum =	32.6
Average =	37
Std Dev. =	0.8
Median	NA
Count =	96
Requirement (Min.)	≥ 20
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

Table 63 – Random Vibration – Return Loss Summary – Final

	Test Set 5 Sample 1 (S12-1)
	850nm
Maximum =	37.6
Minimum =	29.9
Average =	36.1
Std Dev. =	1.4
Median	NA
Count =	96
Requirement (Max.)	≥ 20
Requirement (Avg.)	-
Pass / Fail (Pathway)	96 / 0

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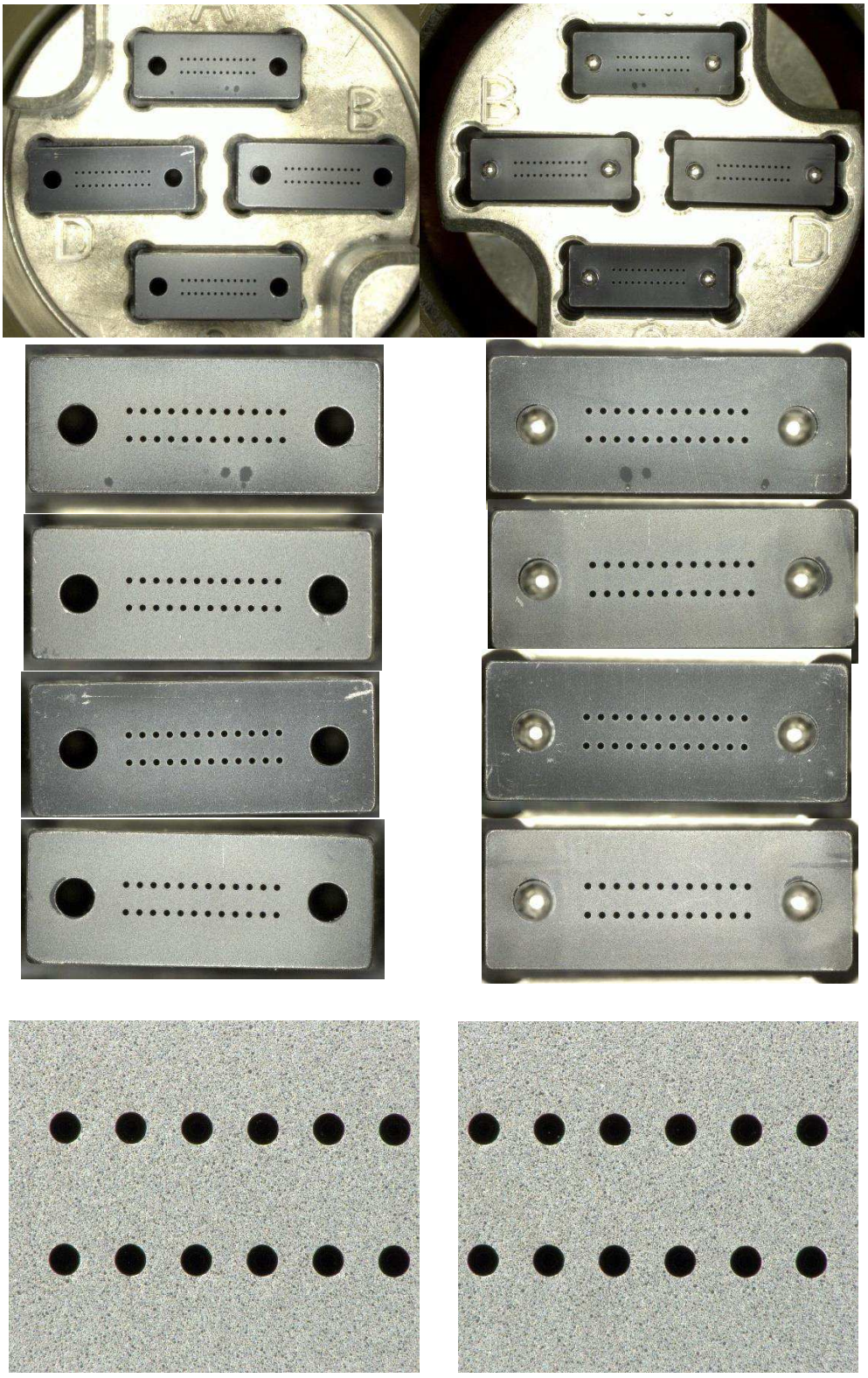

(Cavity C Ferrule -- Typical condition for all sample 12-1 ferrules)

Figure 6 – Sample Inspection – Test Group 5, Sample 12-1 (After 11.95Grms Random Vibration)

5.7 Mechanical Shock, 50G, 11ms Sawtooth and 100G, 6ms Half Sine (Test Set 2)

A statistical summary of Test Set 5, optical performance with the applied Mechanical Shock exposures is found in Table 65 thru 70. The test Set 5 sample met the specified Change in Transmittance (CIT ≤ ± 0.3 dB), Insertion Loss (IL ≤ ± 1.5 dB), and Return Loss (RL ≥ ± 20 dB) requirements during and after the exposure at 850nm transmission as detailed in the 108-32269. Additionally, active transient monitoring of CIT during the random vibration exposure created no optical discontinuities among any of the fiber pathways monitored throughout the exposure. Optical discontinuity is defined as 0.5dB or greater reduction in optical power for a period of 1 microsecond or longer. As indicated no optical change (CIT) on any pathway among any cavity greater than ± 0.02 dB was noted during the setup or exposure.

Further review of the results finds full compliance for Insertion Loss (≤ 1.05 dB) and Return Loss (≥ 20dB) at 850nm during and after the exposure. Following completion of the test no observed physical change was noted including damage, breaks or loose coupling of either sample. No evidence of fiber or ferrule endface damage because of vibration exposure was recorded.

Table 65 - Mechanical Shock – Change in Transmittance Summary – During

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	**Test Set 5 Sample 1 (S12-1) 100G Half Sine**
	850nm	**850nm**
Maximum =	0.01	0.01
Minimum =	-0.02	-0.02
Average =	0.00	0.00
Std Dev. =	0.00	0.00
Median	0.00	0.00
Count =	96	96
Requirement (Max.)	± ≤ 0.30	± ≤ 0.30
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0

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Table 66 – Mechanical Shock – Change in Transmittance Summary – Final

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	Test Set 5 Sample 1 (S12-1) 100G Half Sine
	850nm	850nm
Maximum =	0.01	0.01
Minimum =	-0.01	-0.02
Average =	0.00	0.00
Std Dev. =	0.00	0.01
Median	0.00	0.00
Count =	2364	1008
Requirement (Max./ Min.)	± ≤ 0.30	± ≤ 0.30
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0

Table 67 – Mechanical Shock – Insertion Loss Summary – During

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	Test Set 5 Sample 1 (S12-1) 100G Half Sine
	850nm	850nm
Maximum =	0.47	0.01
Minimum =	0.06	-0.02
Average =	0.12	0.00
Std Dev. =	0.04	0.01
Median	0.12	0.00
Count =	2364	1008
Requirement (Max./ Min.)	± ≤ 1.50	± ≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0

Table 68 – Mechanical Shock – Insertion Loss Summary – Final

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	Test Set 5 Sample 1 (S12-1) 100G Half Sine
	850nm	850nm
Maximum =	0.25	0.25
Minimum =	0.06	0.06
Average =	0.12	0.12
Std Dev. =	0.04	0.04
Median	0.12	0.12
Count =	84	84
Requirement (Max.)	≤ 1.50	≤ 1.50
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0

Table 69 – Mechanical Shock – Return Loss Summary – During

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	Test Set 5 Sample 1 (S12-1) 100G Half Sine
	850nm	850nm
Maximum =	37.4	37.4
Minimum =	24.9	24.9
Average =	36.5	36.5
Std Dev. =	1.5	1.5
Median	36.7	36.7
Count =	2364	1008
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0

Table 70 – Mechanical Shock – Return Loss Summary – Final

	Test Set 5 Sample 1 (S12-1) 50G Sawtooth	Test Set 5 Sample 1 (S12-1) 100G Half Sine
	850nm	850nm
Maximum =	37.4	37.4
Minimum =	24.9	24.9
Average =	36.5	36.5
Std Dev. =	1.5	1.5
Median	36.7	36.8
Count =	84	84
Requirement (Min.)	≥ 20	≥ 20
Requirement (Avg.)	-	-
Pass / Fail (Pathway)	84 / 0	84 / 0