Reliability & Qualification Report
for
MEMS Based Variable Optical Attenuators

P/N: MMVOA-1-1550-S-9/125-XX-0.25-1

Revision History			
Rev	Approval Date	ECM/ECR	Description of Change
00	10/18/2008		Initial release
01	02/09/2009		Add shock & vibration data

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1 PURPOSE

This document presents the qualification data for Micro-Electro-Mechanical System (MEMS) based Variable Optical Attenuator (VOA) device family. The MEMS based VOA products are used to attenuate the optical power in the transmitted optical path. This VOA' attenuation is controlled by the applied DC voltage over the device. These VOA devices exhibit superior optical performance including low insertion loss, low Wavelength Dependent Loss (WDL), low Polarization Dependent Loss (PDL), low Polarization Mode Dispersion (PMD) and low Temperature Dependent Loss (TDL) across both C and L bands.

2 REFERENCE

1. Telcordia GR-910-CORE "Generic Requirements for Fiber Optic Attenuators".
2. Telcordia GR-1221-CORE "Generic Reliability Assurance for Fiber Optic Components"
3. Telcordia GR-1209-CORE "Generic Requirements for Fiber Optic Branching Components Performance Criteria"

3 PRODUCT DESCRIPTION

The MEMS device is packaged in a hermetically sealed standard TO-can. The collimator is aligned with the MEMS through the hermetic glass window on the TO-can and laser-welded to the package. TO-cans are 100% tested for hermeticity and the passed ones have less than 1×10^{-8} std cc/sec leak rates. Figure 3 shows the VOA mechanical drawing.

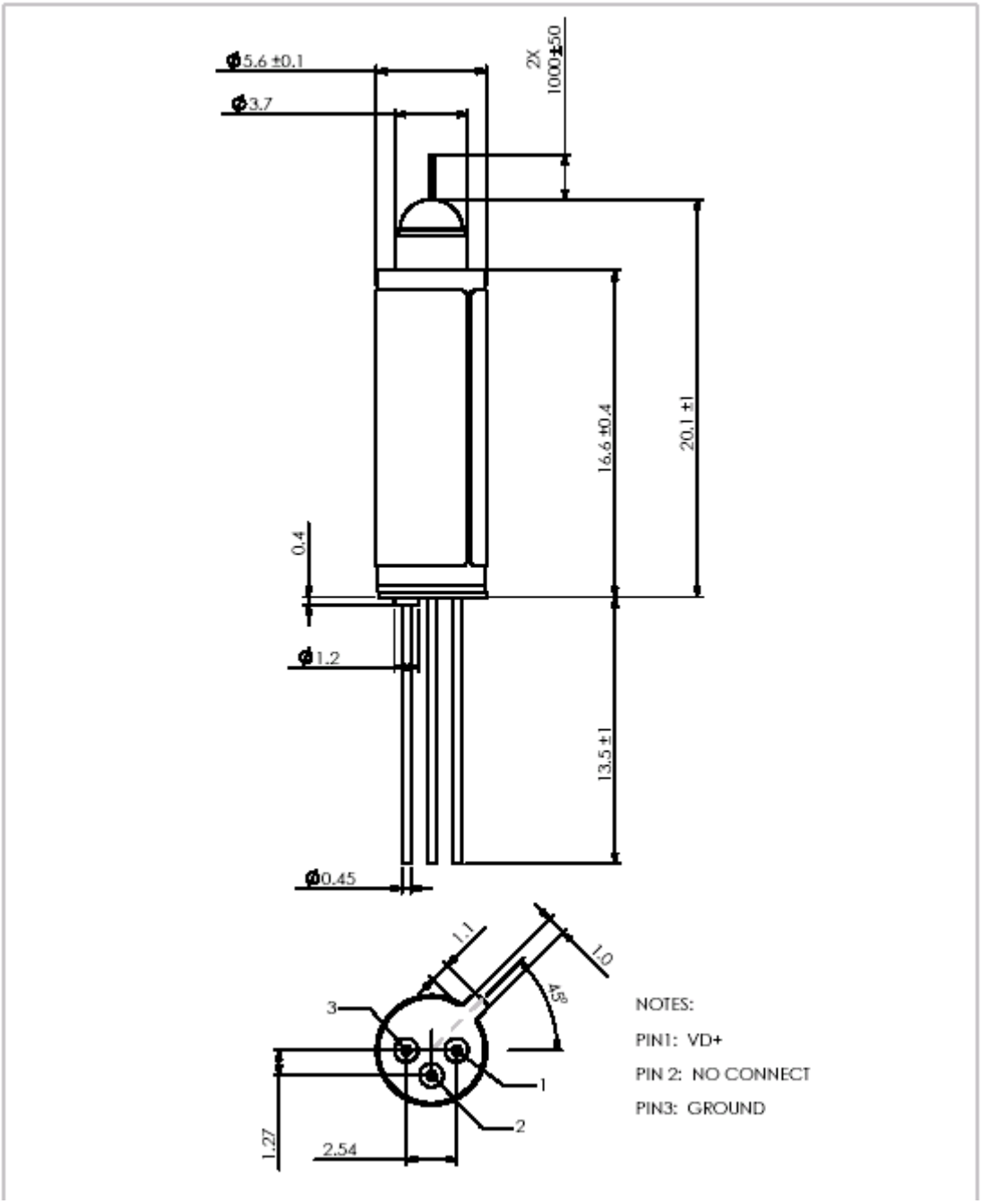


Figure 3: VOA Mechanical Specification Drawing

4 QUALIFICATION TEST DESCRIPTION

4.1 TEST PROCEDURE

Table 4.1 shows the sample size and test sequence for VOA devices per Telcordia GR-910-CORE/GR-1221-CORE requirements. The tested samples have been divided into 4 groups to progress in parallel.

Table 4.1: VOA Testing Group List

GROUP	Sample Size	TEST
A	11	Mechanical – Vibration, Shock, Fiber Pull
B	11	Damp Heat and Temperature Cycling
C	11	High Temperature Storage
D	11	Low Temperature Storage

4.2 PASS/FAIL CRITERIA

The following Table 4.2 shows our general the pass/fail criteria for the qualification.

Table 4.2: General Qualification Pass/Fail Criteria

Attenuation at 1545nm	**Before and after test**			**Change**		
	At 0 dB	At 10 dB	At 20 dB	At 0 dB	At 10 dB	At 20 dB
IL (dB)	≤ 1	NA	NA	≤ 0.2	≤ 1.5	≤ 2.0
PDL (dB)	≤ 0.2	≤ 0.3	≤ 0.8	≤ 0.1	≤ 0.15	≤ 0.2
RL (dB)	≥ 50			NA		

Parameter Definitions:

Before the stress test, the voltage required to produce 0, 10 and 20dB attenuation (where attenuation in this case is defined as the loss in excess of the minimum insertion loss) at 1545 nm should be recorded. After the stress test, the same voltage should be applied to the device.

1) The IL is measured at 1550nm and room temperature only
2) The change in PDL is the largest change in PDL at any wavelength in the wavelength range from 1528nm to 1570nm. The PDL value is measured at 0, 10 and 20dB attenuation.
3) The RL is measured with power off state.

4.3 TEST DEFINITIONS

The following is the description of the VOA qualification item.

1. High Temperature storage (Dry Heat)
   The high temperature storage (Dry Heat) test is based on the procedures stated in EIA/TIA -455-4A. VOA test samples are subjected to a temperature resistance test at a modified test temperature of +85°C with a relative humidity less than 40%, and a test length duration of 2000 hrs for qualification and 5000 for information. Optical parameters are measured before and after the test.

2. Low Temperature storage
   The low temperature storage test is based on the procedures stated in EIA/TIA-455-4A. VOA test samples are subjected to a temperature resistance test at a modified test temperature of -40°C, and test length duration of 2000 hrs for qualification and 5000 for information. Optical parameters are measured before and after the test.

3. Damp Heat:
   VOA test samples are subjected to a temperature test at a test temperature of +85C with a Relative Humidity of 85% and test duration of 100 hrs and 500 hrs. The test is in compliance with GR-468-CORE. Optical parameter measurements are made at the before and after the test.

4. Temperature Cycling:
   VOA test samples are subjected to a temperature cycle between +85°C and –40°C for 500 cycles. Temperature rises from –40^{o}C to +85^{o} C within 25min. The temperature falls from +85^{o} C to - 40^{o}C in 25 min. The dwell time at specified temperature is 20min. The operating humidity condition is uncontrolled. The optical power measurements are made before and after the test.

5. Mechanical shock (Impact test)
   The above test method described in GR-1221-CORE is based on MIL-STD-883, Method 2002, with the following conditions:
   - Number of Shocks: 5 times per direction for 6 directions (on 3 axes)
   - Shock Level: 500G
   - Duration: 1 ms

   The VOA must not incur physical damage according to GR-1209-CORE § 5.1.8 recommendations. Optical parameters are measured before and after the test.

6. Mechanical Vibration Test:
   The variable frequency vibration test is performed to evaluate the mechanical integrity of the VOA. Test samples are subjected to a sinusoidal vibration with amplitude of 1.52 mm maximum total excursion (20G at 55 Hz). Test samples are to withstand vibrations from 20Hz to 2000Hz. Each cycle has 4 min duration. This test is performed with 4cycles per axis, total three perpendicular axes. The vibration test is to be performed according to EIA/TIA-455-11A, test condition IV. Optical parameters are measured before and after the test.

7. Fiber Side pull:
   Our collimator supplier performs this test according to GR-1209-CORE and GR-326-CORE.

8. Fiber and Cable retention:
   Our collimator supplier performs this test according to GR-1209-CORE § 5.4.3.4.

5 TEST RESULTS

The following qualification items are tested and passed the required criteria. The results are summarized as below in Table 5. Detailed data provided in Section 6.

Table 5: SUMMARY OF QUALIFICATION TEST RESULTS

	Test and conditions	SS	Sample Group	Test results	Section
Environmental Tests	High temperature storage: 85 °C, 2000 hrs	11	C	PASS	6.1
	Low temperature storage: -40 °C, 2000 hrs	11	D	PASS	6.2
	Damp heat: 85 °C/ 85 %RH, 500 hrs	11	B	PASS	6.3
	Temperature cycling: -40 °C to 85 °C, 500 cycles	11	B	PASS	6.4
Mechanical Tests	Mechanical shock: 5 times/direction, 6 directions, 500 G acceleration, 1ms duration	11	A	PASS	6.5
	Mechanical vibration: 20 G, 20 – 2000 Hz 4 min/cycle 4 cycles/axis	11	A	PASS	6.6
Fiber Integrity Tests (250□m)	Side pull: 0.23 kgmf load, 90° 5 sec, 2 directions	11	NA	PASS	Qualified by collimator supplier
	Cable retention: 0.45 kgmf load 5 sec, 3 times	11	NA	PASS	Qualified by collimator supplier
High Temperature Operating Life	Temperature: 70°C Duration: 2346 hours	11	NA	PASS	6.7
Operational Vibration Test	10-55 Hz, 1.5 mm-pp, any axis	2	NA	PASS	6.8

6 TEST DATA

6.1 HIGH TEMPERATURE STORAGE TEST DATA

6.1.1 TEST CONDITIONS

Storage Temperature: 85 °C.
Humidity: uncontrolled.
Duration: 2000 hours.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: Minimum IL, RL, WDL and PDL
Test Result: Pass

6.1.2 TEST RESULT

Table 6.1.1: Minimum Insertion Loss Measurement (in dB)

Samples	Before	After	Change
1	0.60	0.68	**0.08**
2	0.60	0.75	**0.15**
3	0.60	0.75	**0.15**
4	0.60	0.69	**0.09**
5	0.60	0.55	**-0.05**
6	0.66	0.63	**-0.03**
7	0.68	0.62	**-0.06**
8	0.69	0.60	**-0.09**
9	0.68	0.79	**0.11**
10	0.68	0.70	**0.02**
11	0.50	0.59	**0.09**

Table 6.1.2: Return Loss Measurement (in dB)

Samples	Before	After	Change
1	57	59	**2**
2	57	57	**0**
3	59	58	**-1**
4	57	58	**1**
5	60	58	**-2**
6	58	59	**1**
7	59	57	**-2**
8	61	59	**-2**
9	60	59	**-1**
10	62	62	**0**
11	59	60	**1**

Table 6.1.3: Polarization Dependent Loss Measurement (in dB)

Samples	At 0 dB attenuation			At 10 dB attenuation			At 20 dB attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.16	0.09	**-0.07**	0.17	0.18	**0.01**	0.37	0.17	**-0.20**
2	0.15	0.15	**0.00**	0.21	0.19	**-0.02**	0.71	0.64	**-0.07**
3	0.11	0.07	**-0.04**	0.10	0.08	**-0.02**	0.19	0.33	**0.14**
4	0.09	0.05	**-0.04**	0.15	0.14	**-0.01**	0.3	0.18	**-0.12**
5	0.20	0.19	**-0.01**	0.23	0.17	**-0.06**	0.37	0.38	**0.01**
6	0.19	0.11	**-0.08**	0.20	0.10	**-0.10**	0.21	0.04	**-0.17**
7	0.15	0.09	**-0.06**	0.22	0.20	**-0.02**	0.3	0.32	**0.02**
8	0.13	0.06	**-0.07**	0.21	0.07	**-0.14**	0.19	0.1	**-0.09**
9	0.10	0.06	**-0.04**	0.19	0.07	**-0.12**	0.22	0.1	**-0.12**
10	0.10	0.09	**-0.01**	0.25	0.12	**-0.13**	0.43	0.23	**-0.20**
11	0.18	0.15	**-0.03**	0.18	0.11	**-0.07**	0.21	0.14	**-0.07**

6.2 LOW TEMPERATURE STORAGE TEST DATA

6.2.1 TEST CONDITIONS

Storage Temperature: -47 °C.
Humidity: uncontrolled.
Duration: 2000 hours.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: Minimum IL, RL, WDL and PDL
Test Result: Pass

6.2.2 TEST RESULT

Table 6.2.1: Minimum Insertion Loss Measurement (in dB)

Samples	Before	After	Change
1	0.68	0.69	**0.01**
2	0.61	0.70	**0.09**
3	0.64	0.69	**0.05**
4	0.63	0.66	**0.03**
5	0.58	0.54	**-0.04**
6	0.67	0.63	**-0.04**
7	0.55	0.69	**0.14**
8	0.55	0.64	**0.09**
9	0.60	0.65	**0.05**
10	0.68	0.77	**0.09**
11	0.67	0.67	**0.00**

Table 6.2.2: Return Loss Measurement (in dB)

Samples	Before	After	Change
1	61	60	**-1**
2	60	60	**0**
3	60	61	**1**
4	59	59	**0**
5	60	58	**-2**
6	62	60	**-2**
7	59	60	**1**
8	61	59	**-2**
9	59	61	**2**
10	58	59	**1**
11	61	61	**0**

Table 6.2.3: Polarization Dependent Loss Measurement (in dB)

Samples	At 0 dB attenuation			At 10 dB attenuation			At 20 dB attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.09	0.03	**-0.06**	0.14	0.12	**-0.02**	0.17	0.37	**0.20**
2	0.08	0.05	**-0.03**	0.12	0.24	**0.12**	0.15	0.3	**0.15**
3	0.12	0.03	**-0.09**	0.23	0.14	**-0.09**	0.36	0.52	**0.16**
4	0.11	0.05	**-0.06**	0.2	0.13	**-0.07**	0.21	0.15	**-0.06**
5	0.15	0.12	**-0.03**	0.2	0.26	**0.06**	0.53	0.39	**-0.14**
6	0.13	0.04	**-0.09**	0.16	0.13	**-0.03**	0.27	0.23	**-0.04**
7	0.15	0.05	**-0.10**	0.25	0.1	**-0.15**	0.53	0.33	**-0.20**
8	0.15	0.05	**-0.10**	0.18	0.14	**-0.04**	0.26	0.38	**0.12**
9	0.03	0.03	**0.00**	0.2	0.1	**-0.10**	0.51	0.31	**-0.20**
10	0.08	0.03	**-0.05**	0.13	0.12	**-0.01**	0.59	0.39	**-0.20**
11	0.1	0.02	**-0.08**	0.08	0.17	**0.09**	0.21	0.34	**0.13**

6.3 DAMP HEAT TEST DATA

6.3.1 TEST CONDITIONS

Temperature: 85 °C.
Humidity: 85 %.
Duration: 500 hours.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: IL, RL, WDL and PDL
Test Result: Pass

6.3.2 TEST RESULT

Table 6.3.1: Insertion Loss at Different Attenuation Measurement (in dB)

Sample	0dB Attenuation			10dB Attenuation			20dB Attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.58	0.59	0.01	10.4	8.99	-1.4	20.1	18.5	-1.65
2	0.66	0.54	-0.12	9.01	8.1	-0.91	19.6	18.1	-1.51
3	0.68	0.67	-0.01	10.5	11.3	0.84	20.2	20.6	0.37
4	0.77	0.68	-0.09	9.57	10.1	0.55	20.2	22	1.73
5	0.79	0.67	-0.12	8.93	9.31	0.38	18.9	19.5	0.59
6	0.3	0.26	-0.04	9.69	8.95	-0.74	18.3	17.6	-0.69
7	0.3	0.23	-0.07	10.3	9.45	-0.81	20.1	19.7	-0.46
8	0.3	0.28	-0.02	9.1	8.52	-0.58	18.5	17.9	-0.65
9	0.35	0.26	-0.09	9.81	9.2	-0.61	20.2	18.6	-1.62
10	0.3	0.25	-0.05	10.6	9.42	-1.13	20.8	19.9	-0.92
11	0.4	0.33	-0.07	9.39	10.3	0.86	19.4	20.2	0.87

Table 6.3.2: Return Loss Measurement (in dB)

Samples	Before	After	Change
1	57	59	**-2**
2	57	59	**-2**
3	58	59	**-1**
4	58	59	**-1**
5	57	59	**-2**
6	61	62	**1**
7	61	62	**1**
8	61	62	**1**
9	61	62	**1**
10	61	62	**1**
11	61	62	**1**

Table 6.3.3: Polarization Dependent Loss Measurement (in dB)

Samples	At 0 dB attenuation			At 10 dB attenuation			At 20 dB attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.10	0.10	**0.00**	0.15	0.11	**-0.04**	0.3	0.39	**0.09**
2	0.07	0.13	**0.06**	0.09	0.13	**0.04**	0.23	0.19	**-0.04**
3	0.10	0.13	**0.03**	0.17	0.10	**-0.07**	0.35	0.15	**-0.20**
4	0.14	0.15	**0.01**	0.23	0.17	**-0.06**	0.43	0.35	**-0.08**
5	0.11	0.13	**0.02**	0.12	0.21	**0.09**	0.13	0.27	**0.14**
6	0.05	0.05	**0.00**	0.08	0.21	**0.13**	0.5	0.49	**-0.01**
7	0.03	0.04	**0.01**	0.27	0.27	**0.00**	0.46	0.43	**-0.03**
8	0.14	0.11	**-0.03**	0.24	0.24	**0.00**	0.66	0.74	**0.08**
9	0.03	0.09	**0.06**	0.27	0.28	**0.01**	0.49	0.58	**0.09**
10	0.03	0.03	**0.00**	0.26	0.24	**-0.02**	0.51	0.53	**0.02**
11	0.07	0.02	**-0.05**	0.21	0.19	**-0.02**	0.51	0.31	**-0.20**

6.4 TEMPERATURE CYCLING TEST DATA

6.4.1 TEST CONDITIONS

Temperature range: -40 °C to 85 °C.
Dwell time at extreme temperatures: 20 minute.
Temperature rising rate: 25 minute from -40 °C to 85 °C.
Temperature falling rate: 25 minute from 85 °C to -40 °C.
Humidity: uncontrolled.
Numbers of cycles: 500 cycles.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: IL, RL, WDL and PDL
Test Result: Pass

6.4.2 TEST RESULT

Table 6.4.1: Insertion Loss at Different Attenuation Measurement (in dB)

Sample	0dB Attenuation			10dB Attenuation			20dB Attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.38	0.36	-0.02	10.3	10.4	0.1	20.1	20.1	0.08
2	0.5	0.35	-0.15	9.61	9.01	-0.6	20.3	19.6	-0.72
3	0.58	0.58	0	10.4	10.5	0.07	20	20.2	0.28
4	0.58	0.52	-0.06	9.95	9.57	-0.38	20.4	20.2	-0.18
5	0.55	0.56	0.01	10.2	9.69	-0.5	19.6	18.3	-1.37
6	0.69	0.63	-0.06	10.5	10.3	-0.21	20.2	20.1	-0.06
7	0.3	0.26	-0.04	9.7	9.29	-0.41	19.9	19.3	-0.62
8	0.33	0.3	-0.03	9.76	9.81	0.05	20	20.2	0.22
9	0.65	0.59	-0.06	10.2	10.6	0.32	20.6	20.8	0.2
10	0.5	0.45	-0.05	9.83	9.39	-0.44	20.4	19.4	-1.07
11	0.25	0.3	0.05	9.95	10.2	0.27	19.9	20.5	0.57

Table 6.4.2: Return Loss Measurement (in dB)

Samples	Before	After	Change
1	57	57	**0**
2	58	57	**-1**
3	55	57	**2**
4	55	57	**2**
5	56	58	**2**
6	58	57	**-1**
7	56	57	**1**
8	57	57	**0**
9	56	57	**1**
10	57	57	**0**
11	57	57	**0**

Table 6.4.3: Polarization Dependent Loss Measurement (in dB)

Samples	At 0 dB attenuation			At 10 dB attenuation			At 20 dB attenuation		
	Before	After	Change	Before	After	Change	Before	After	Change
1	0.05	0.07	**0.02**	0.19	0.22	**0.03**	0.33	0.48	**0.15**
2	0.14	0.10	**-0.04**	0.23	0.15	**-0.08**	0.36	0.3	**-0.06**
3	0.10	0.07	**-0.03**	0.17	0.09	**-0.08**	0.35	0.23	**-0.12**
4	0.08	0.10	**0.02**	0.11	0.13	**0.02**	0.32	0.12	**-0.20**
5	0.11	0.07	**-0.04**	0.18	0.12	**-0.06**	0.44	0.31	**-0.13**
6	0.04	0.10	**0.06**	0.15	0.17	**0.02**	0.41	0.45	**0.04**
7	0.15	0.10	**0.05**	0.27	0.23	**-0.04**	0.54	0.48	**-0.06**
8	0.17	0.09	**-0.08**	0.25	0.26	**0.01**	0.63	0.43	**-0.20**
9	0.15	0.10	**-0.05**	0.25	0.27	**0.02**	0.45	0.52	**0.07**
10	0.17	0.11	**-0.06**	0.25	0.12	**-0.13**	0.32	0.13	**-0.19**
11	0.13	0.13	**0.00**	0.24	0.26	**0.02**	0.43	0.45	**0.02**

6.5 MECHANICAL SHOCK IL TEST DATA

6.5.1 TEST CONDITIONS

Acceleration: 500 G.
Numbers of shocks: 5 times per direction.
Numbers of directions: 6 directions.
Shock duration: 1ms.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: Minimum IL
Test Result: Pass

6.5.2 TEST RESULT

Table 6.5: Minimum Insertion Loss Measurement (in dB)

Samples	Before	After	Change
1	0.58	0.59	**0.01**
2	0.66	0.54	**-0.12**
3	0.68	0.67	**-0.01**
4	0.77	0.68	**-0.09**
5	0.80	0.67	**-0.13**
6	0.30	0.26	**-0.04**
7	0.30	0.23	**-0.07**
8	0.30	0.28	**-0.02**
9	0.35	0.26	**-0.09**
10	0.30	0.25	**-0.05**
11	0.40	0.33	**-0.07**

6.6 MECHANICAL VIBRATION IL TEST DATA

6.6.1 TEST CONDITIONS

Acceleration: 20 G.
Frequency: 20 – 2000 Hz.
Duration: 4 minutes per cycle.
Numbers of cycles: 4 cycles per axis.
Numbers of axis: 3 axes.
Sample Size: 11
Testing Temperature: Room Temperature
Tested Parameter for Pass/Fail: Minimum IL, RL, WDL and PDL
Test Result: Pass

6.6.2 TEST RESULT

Table 6.6: Insertion Loss Measurement (in dB)

Samples	Before	After	Change
1	0.66	0.68	**0.02**
2	0.63	0.70	**0.07**
3	0.65	0.76	**0.11**
4	0.60	0.72	**0.12**
5	0.72	0.62	**-0.10**
6	0.67	0.70	**0.03**
7	0.66	0.63	**-0.03**
8	0.66	0.60	**-0.06**
9	0.75	0.75	**0.00**
10	0.66	0.70	**0.03**
11	0.69	0.72	**0.03**

6.7 HIGH TEMPERATURE OPERATING LIFE

6.7.1 TEST CONDITION

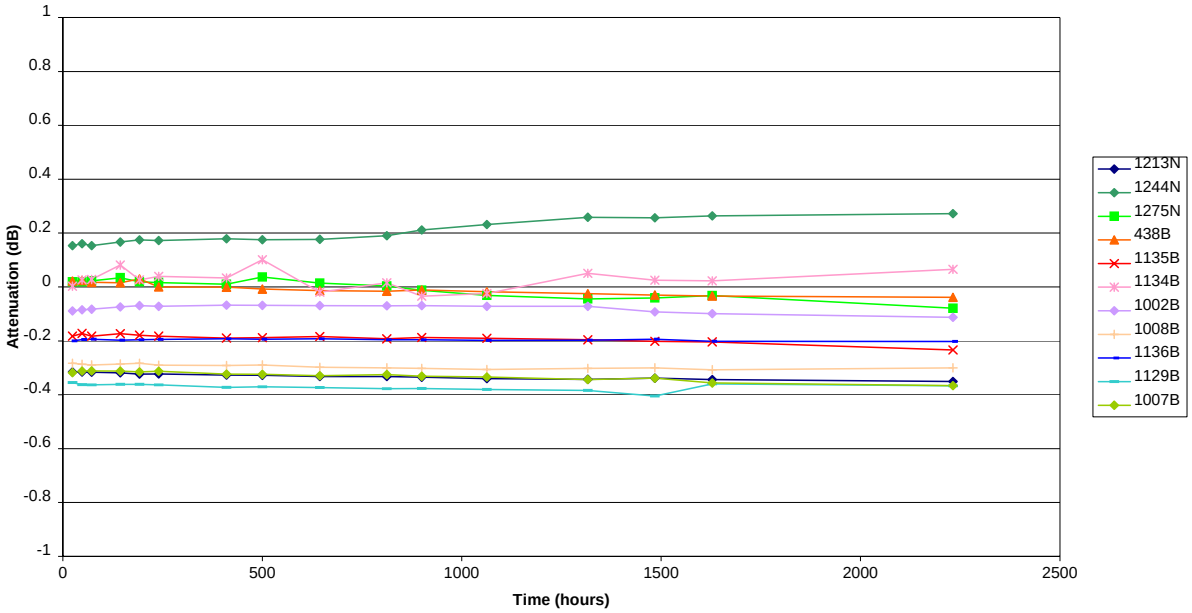
Temperature: 70°C.
Humidity: uncontrolled.
Duration: 2346 hours.
Sample Size: 11
During HTOL test, dark type VOA bias voltages are at minimum attenuation.
Wavelength range for PDL measurement is 1528 nm – 1570 nm.
Stability measurements were taken during the test at wavelength 1550 nm.
Test Result: Pass

6.7.2 TEST RESULT

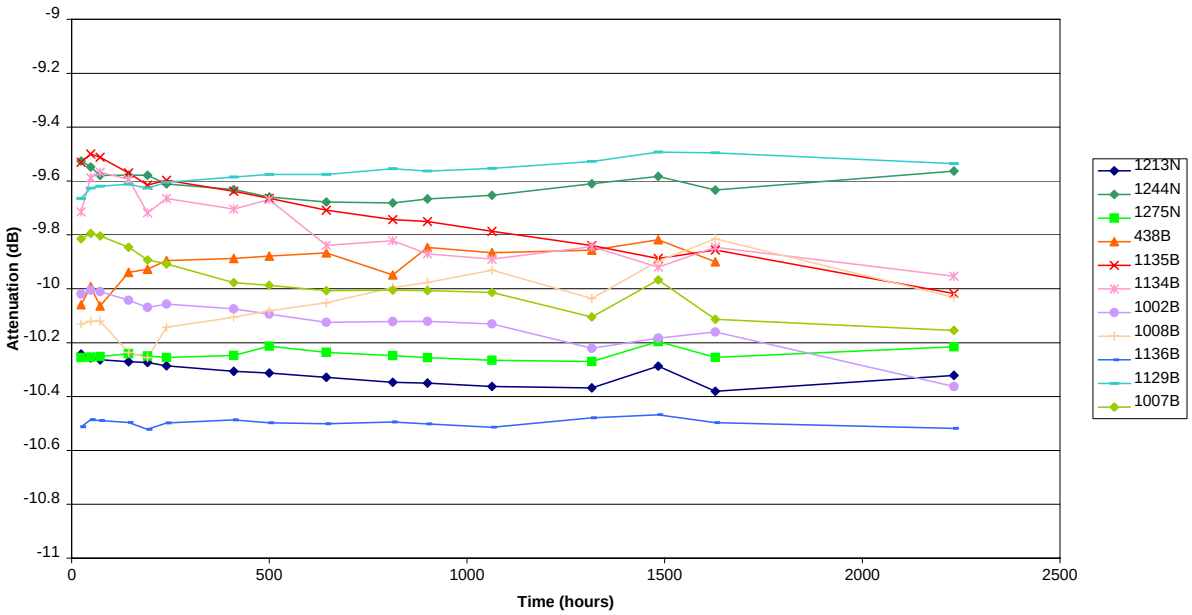
TABLE 6.7.1: PDL MEASUREMENT AND CHANGES

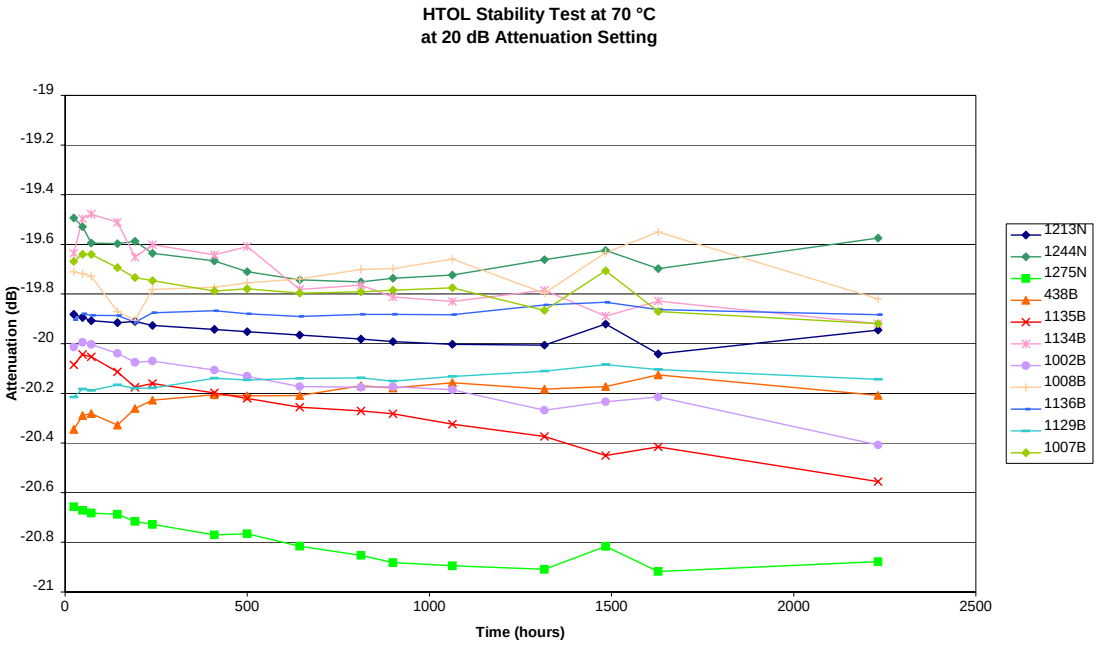
Sample SN:	At 0 dB attenuation			At 10 dB attenuation			At 20 dB attenuation		
	before	after	change	before	after	change	before	after	change
1213	0.02	0.03	0.01	0.16	0.19	0.03	0.43	0.53	0.10
1244	0.05	0.04	-0.01	0.10	0.10	0.00	0.13	0.29	0.16
1275	0.02	0.06	0.04	0.09	0.24	0.15	0.72	0.69	-0.03
438	0.03	0.03	0.00	0.18	0.22	0.04	0.49	0.55	0.06
1135	0.05	0.04	-0.01	0.11	0.12	0.01	0.14	0.13	-0.01
1134	0.04	0.01	-0.03	0.12	0.09	-0.03	0.34	0.27	-0.07
1002	0.04	0.02	-0.02	0.17	0.18	0.01	0.67	0.47	-0.20
1008	0.03	0.02	-0.01	0.17	0.15	-0.02	0.35	0.33	-0.02
1136	0.03	0.03	0.00	0.09	0.14	0.05	0.27	0.29	0.02
1129	0.04	0.04	0.00	0.09	0.10	0.01	0.22	0.26	0.04
1008	0.03	0.03	0.00	0.16	0.20	0.04	0.38	0.58	0.20

HTOL Stability Test at 70 °C
at 0 dB Attenuation Setting



HTOL Stability Test at 70 °C
at 10 dB Attenuation Setting




HTOL Stability Test at 70 °C
at 20 dB Attenuation Setting
Attenuation (dB)
-19
-19.2
-19.4
-19.6
-19.8
-20
-20.2
-20.4
-20.6
-20.8
-21
0
500
1000
1500
2000
2500
Time (hours)
1213N
1244N
1275N
438B
1135B
1134B
1002B
1008B
1136B
1129B
1007B

6.8 Operational (in situ) Shock & Vibration

Two units were tested for shock and vibration per the parameters in the table below:

Parameters	Conditions	Value			Unit
		Min	Typ	Max	
In situ Vibration Dependent Loss	10-55 Hz, 1.5 mm-pp, any axis			0.2	dBpp
In situ Shock Dependent Loss	With 50 g acceleration			1.0	dBpp

Both units passed the test along X, Y, and Z-axes. The results are tabulated below:

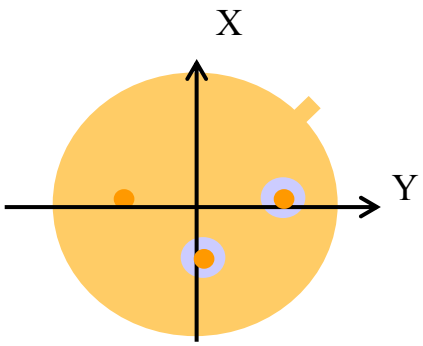


Figure 6.8.1: Bottom view of VOA
(X and Y directions are shown and Z direction is normal to this drawing)

Unit 1 S/N: 20064

Direction	DC optical[V]	Shock Peak (50g Impact) [dB] < 1 dB	Vibration Max Change of Power dPp-p [dB] < 0.2
Z+	5.1	0.4162487	0.0150
Z-	5.1	0.1670569	
Y+	5.1	0.1258913	0.0105
Y-	5.1	0.1258913	
X+	5.1	0.1506375	0.0229
X-	5.1	0.1258913	

Unit 2 S/N: 22905

Direction	DC optical[V]	Shock Peak (50g Impact) [dB] < 1 dB	Vibration Max Change of Power dPp-p [dB] < 0.2
Z+	2.63	0.0246993	0.0079
Z-	2.63	0.0246993	
Y+	2.63	0.2627065	0.0477
Y-	2.63	0.0817905	
X+	2.63	0.0492589	0.0101
X-	2.63	0.1140802	