Qualification Test Report

MIDU-22B121131

Ultra Mini MEMS Dual 2x2 Latching Switch

Prepared by Photonwares Corp.

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1 Report Approval and Revision History

Report Name and Release Number

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Revision History

Rev	Description	Prepared By	Date
-	Preliminary Release	Jeanne Hladky	11/28/2023

2 Overview

This document summarizes the reliability test results for the MEMS Series Ultra mini switch. These tests were based on prescribed tests within the Telcordia reliability assurance requirement and standards GR-1221-CORE and GR-1073-CORE.

For this report 1260-1620nm MEMS Ultra Mini Dual 2x2 latching switches were used (part number MIDU-22B121131). However the results qualify the entire family of MEMS switches that use a similar actuation. This family includes both latching and non-latching versions as well as different port configurations. A functional diagram of the switch is shown below in *Figure 1*.

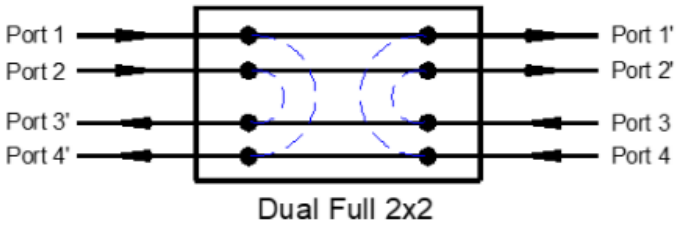

Figure 1: Functional diagram for the switch

3 Telcordia GR-1221-CORE/GR-1073-CORE Reliability Test

The following environmental and stress tests have been completed and their results reported herein:

- Temperature cycling
- Damp heat
- Mechanical vibration
- Mechanical shock

3.1 Performance testing methods

Performance tests are performed before, during and after the environmental and mechanical stress tests, in accordance with the requirements of Telcordia and the defined testing process in the production line to make this product.

3.2 Summary of Environmental and Stress Test Conditions

Test conditions employed are summarized in the following Table I.

Table I: Summary of Environmental Test Conditions

Tests	References	Test Conditions
Temperature Cycling Test	Telcordia GR-1073-CORE 6.6.2.4	Temperature: -40°C to 85°C Dwell Time at Extremes: 20min Duration Time: 100cls for qualification
High Temperature Storage Test (Damp Heat)	Telcordia GR-1221-CORE 6.2.5	Temperature: 85°C(+/- 2°C) Humidity: 85%RH (+/- 5%) Duration Time:500h for qualification
Variable Frequency Vibration Test	Telcordia GR-1073-CORE 6.6.1.1	Type: Sinusoidal Acceleration: 20G Frequency: 20 to 2000HZ Duration: 4 min/cycle, 4 cycles/axis
Mechanical Shock (Impact)	Telcordia GR-1073-CORE 5.2.1.4	500 G, 2 shocks/direction/axis, 3 axes (12 shocks total), 1 ms pulse

3.3 Definitions

BOL: Beginning of life

Insertion Loss: the fraction of power transferred from input port i to output port j expressed in units of dB. It's measured on 1550nm wavelength.

3.4 Pass/Fail Criteria

The following criteria for performance or performance changes are used to determine whether a device passes or fails the environmental test, as proposed in the Telcordia specifications. Any device with performance not meeting the stated criteria is considered a failure, during or after the environmental tests.

Table 1: Pass and Fail Criteria

Parameters	Criteria	Reference
IL_{max}	≤ 1.00 dB (BOL)	Photonwares criteria
∆ Insertion Loss	≤ 0.50 dB	GR-1221-CORE

3.5 Summary of Test Results

The test results are summarized in the Table 2, which shows that all the sampled devices passed the requirements of GR-1221-CORE and GR-1073-CORE. The detailed data are appended to this report in Section 3.9.

Table 2: Summary on Reliability Test Results

Test Item	Sample Size	Group	Date Complete	Number of Failures	Test Passed
Temperature Cycling Test	11	A	6/2023	0	Passed
Variable Frequency Vibration Test	9(1)	A	9/2023	0	Passed
Mechanical Shock	8(2)	A	10/2023	0	Passed
High Temperature Storage Test (Damp Heat)	8	B	9/2023	0	Passed

Notes

(1): 2 switches were damaged by fixturing, resulting in a sample size of 9.

(2): Fibers damaged on 1 switch resulting in a sample size of 8.

3.6 Conclusions

Environmental and stress testing of the MEMSLatch™ switch has been completed.

No failures other than fixturing errors were observed during or after any of these tests.

3.7 Reference Documents

(1) GR-1221-CORE, Issue 2, January 1999. General Reliability Assurance Requirement for Passive Optical Components.
(2) GR-1073-CORE, Issue 1, January 2001, General Requirement for Single Mode Fiber Optic Switch.

3.8 Reliability Tests – List of Tables

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3.9 Reliability Test Results – Data for Group A (Temperature Cycling, Vibration and Mechanical Shock)

Table 3: Port 1 – 1' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.94	0.87	0.65	N/A(2)	-0.29	Pass
135	0.37	0.55	0.46	0.83	0.46	Pass
1034	0.40	0.32	0.39	0.40	0.00	Pass
949	0.44	0.49	0.45	0.42	-0.02	Pass
298	0.67	0.68	0.70	0.64	-0.03	Pass
844	0.81	0.89	0.80	0.81	0.00	Pass
321	0.51	0.47	0.45	0.49	-0.02	Pass
263	0.50	0.38	0.46	0.33	-0.17	Pass
767	0.34	0.30	N/A(1)	N/A(1)	-0.04	Pass
764	0.54	0.44	N/A(1)	N/A(1)	-0.10	Pass
717	0.51	0.41	0.49	0.47	-0.04	Pass
Max	**0.94**	**0.89**	**0.80**	**0.83**	**0.46**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 4: Port 2 – 2' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.75	0.65	0.44	N/A(2)	-0.31	Pass
135	0.50	0.56	0.49	0.61	0.11	Pass
1034	0.41	0.44	0.38	0.38	-0.03	Pass
949	0.47	0.41	0.44	0.40	-0.07	Pass
298	0.35	0.31	0.41	0.14	-0.21	Pass
844	0.40	0.35	0.35	0.49	0.09	Pass
321	0.69	0.68	0.67	0.79	0.10	Pass
263	1.00	0.90	0.92	0.86	-0.14	Pass
767	0.61	0.53	N/A(1)	N/A(1)	-0.08	Pass
764	0.68	0.60	N/A(1)	N/A(1)	-0.08	Pass
717	0.71	0.74	0.45	0.70	-0.01	Pass
Max	**1.00**	**0.90**	**0.92**	**0.86**	**0.11**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 5: Port 3 – 3' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.56	0.45	0.59	N/A(2)	0.03	Pass
135	0.58	0.65	0.60	0.80	0.22	Pass
1034	0.35	0.38	0.29	0.20	-0.15	Pass
949	0.50	0.47	0.48	0.54	0.04	Pass
298	0.34	0.30	0.32	0.32	-0.02	Pass
844	0.80	0.73	0.79	0.86	0.06	Pass
321	0.40	0.35	0.31	0.38	-0.02	Pass
263	0.75	0.72	0.74	0.79	0.04	Pass
767	0.37	0.26	N/A(1)	N/A(1)	-0.11	Pass
764	0.63	0.55	N/A(1)	N/A(1)	-0.08	Pass
717	0.49	0.53	0.69	0.63	0.14	Pass
Max	**0.80**	**0.73**	**0.79**	**0.86**	**0.22**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 6: Port 4 – 4' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.74	0.75	0.76	N/A(2)	0.02	Pass
135	0.36	0.29	0.27	0.54	0.18	Pass
1034	0.72	0.82	0.73	0.73	0.01	Pass
949	0.26	0.26	0.21	0.37	0.11	Pass
298	0.30	0.32	0.34	0.31	0.01	Pass
844	0.71	0.63	0.60	0.80	0.09	Pass
321	0.31	0.27	0.28	0.47	0.16	Pass
263	0.44	0.52	0.42	0.41	-0.03	Pass
767	0.42	0.39	N/A(1)	N/A(1)	-0.03	Pass
764	0.60	0.54	N/A(1)	N/A(1)	-0.06	Pass
717	0.64	0.68	0.62	0.80	0.16	Pass
Max	**0.74**	**0.82**	**0.76**	**0.80**	**0.18**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 7: Port 1 – 4' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.99	0.91	0.90	0.99(2)	0.00	Pass
135	0.72	0.79	0.66	0.71	-0.01	Pass
1034	0.55	0.62	0.68	0.63	0.08	Pass
949	0.55	0.66	0.56	0.68	0.13	Pass
298	0.57	0.58	0.59	0.46	-0.11	Pass
844	0.80	0.85	0.76	0.93	0.13	Pass
321	0.55	0.52	0.48	0.61	0.06	Pass
263	0.55	0.44	0.48	0.35	-0.20	Pass
767	0.55	0.56	N/A(1)	N/A(1)	0.01	Pass
764	1.00	1.00	N/A(1)	N/A(1)	0.00	Pass
717	0.43	0.39	0.36	0.59	0.16	Pass
Max	**1.00**	**1.00**	**0.90**	**0.99**	**0.16**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 8: Port 2 - 3' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.62	0.51	0.47	0.32(2)	-0.30	Pass
135	0.83	0.88	0.77	0.36	-0.47	Pass
1034	0.42	0.53	0.44	0.32	-0.10	Pass
949	0.61	0.65	0.60	0.51	-0.10	Pass
298	0.38	0.35	0.43	0.34	-0.04	Pass
844	0.59	0.59	0.59	0.70	0.11	Pass
321	0.51	0.48	0.41	0.47	-0.04	Pass
263	0.68	0.71	0.68	0.73	0.05	Pass
767	0.58	0.56	N/A(1)	N/A(1)	-0.02	Pass
764	0.85	0.85	N/A(1)	N/A(1)	0.00	Pass
717	0.59	0.57	0.38	0.70	0.11	Pass
Max	**0.85**	**0.88**	**0.77**	**0.73**	**0.11**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 9: Port 3 - 2' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.58	0.49	0.43	N/A(2)	-0.15	Pass
135	0.74	0.78	0.78	0.74	0.00	Pass
1034	0.78	0.71	0.68	0.64	-0.14	Pass
949	0.53	0.48	0.51	0.51	-0.02	Pass
298	0.73	0.74	0.78	0.50	-0.23	Pass
844	0.76	0.62	0.66	0.75	-0.01	Pass
321	0.59	0.55	0.54	0.75	0.16	Pass
263	0.96	0.76	0.84	0.77	-0.19	Pass
767	0.96	0.74	N/A(1)	N/A(1)	-0.22	Pass
764	0.74	0.62	N/A(1)	N/A(1)	-0.12	Pass
717	0.54	0.65	0.66	0.71	0.17	Pass
Max	**0.96**	**0.78**	**0.84**	**0.77**	**0.17**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

Table 10: Port 4 – 1' IL (dB)

S/N	Initial	100 TC	Vibration	Shock	Change	Pass/Fail
259	0.73	0.65	0.45	N/A(2)	-0.28	Pass
135	0.26	0.37	0.40	0.40	0.14	Pass
1034	0.80	0.74	0.66	0.66	-0.14	Pass
949	0.63	0.74	0.61	0.76	0.13	Pass
298	0.69	0.72	0.79	0.65	-0.04	Pass
844	0.91	0.81	0.80	0.77	-0.14	Pass
321	0.67	0.61	0.60	0.70	0.03	Pass
263	0.21	0.49	0.43	0.46	0.25	Pass
767	0.94	0.87	N/A(1)	N/A(1)	-0.07	Pass
764	0.52	0.40	N/A(1)	N/A(1)	-0.12	Pass
717	1.00	0.97	0.92	0.82	-0.18	Pass
Max	**1.00**	**0.97**	**0.92**	**0.82**	**0.25**	**Pass**

(1) Switch was damaged by fixturing during vibration test. We are unable to measure.
(2) Fibers damaged during shock test. Switch is functional, but only 1-4' and 2-3' could be measured.

3.10 Reliability Test Results – Data for Group B (Damp Heat)

Table 11: Port 1 – 1' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.35	0.52	0.34	-0.01	Pass
352	0.86	0.62	0.50	-0.36	Pass
143	0.46	0.70	0.41	-0.05	Pass
378	0.39	0.68	0.35	-0.04	Pass
284	0.75	0.52	0.49	-0.26	Pass
327	0.69	0.53	0.58	-0.11	Pass
523	0.83	0.94	0.89	0.06	Pass
666	0.28	0.45	0.40	0.12	Pass
Max	**0.86**	**0.94**	**0.89**	**0.12**	**Pass**

Table 12: Port 2 – 2' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.71	0.68	0.41	-0.30	Pass
352	0.70	0.56	0.33	-0.37	Pass
143	0.85	0.80	0.83	-0.02	Pass
378	0.46	0.59	0.28	-0.18	Pass
284	0.56	0.55	0.45	-0.11	Pass
327	0.30	0.23	0.19	-0.11	Pass
523	0.28	0.23	0.26	-0.02	Pass
666	0.51	0.65	0.26	-0.25	Pass
Max	**0.85**	**0.80**	**0.83**	**-0.02**	**Pass**

Table 13: Port 3 – 3' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.23	0.25	0.29	0.06	Pass
352	0.50	0.34	0.30	-0.20	Pass
143	0.69	0.79	0.58	-0.11	Pass
378	0.84	0.76	0.32	-0.52	Pass
284	0.32	0.27	0.32	0.00	Pass
327	0.68	0.63	0.98	0.30	Pass
523	0.83	0.80	0.80	-0.03	Pass
666	0.36	0.29	0.21	-0.15	Pass
Max	**0.84**	**0.80**	**0.98**	**0.30**	**Pass**

Table 14: Port 4 – 4' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.66	0.65	0.47	-0.19	Pass
352	0.45	0.62	0.70	0.25	Pass
143	0.35	0.42	0.26	-0.09	Pass
378	0.59	0.61	0.38	-0.21	Pass
284	0.90	0.44	0.50	-0.40	Pass
327	0.44	0.22	0.50	0.06	Pass
523	0.46	0.42	0.28	-0.18	Pass
666	0.49	0.53	0.23	-0.26	Pass
Max	**0.90**	**0.65**	**0.70**	**0.25**	**Pass**

Table 15: Port 1 – 4' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.48	0.71	0.52	0.04	Pass
352	0.96	0.78	0.59	-0.37	Pass
143	0.83	0.93	0.67	-0.16	Pass
378	0.60	0.70	0.43	-0.17	Pass
284	0.94	0.94	0.94	0.00	Pass
327	0.69	0.27	0.42	-0.27	Pass
523	0.99	0.98	0.75	-0.22	Pass
666	0.45	0.55	0.43	-0.02	Pass
Max	**1.04**	**0.98**	**0.94**	**0.04**	**Pass**

Table 16: Port 2 - 3' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.51	0.55	0.48	-0.03	Pass
352	0.80	0.69	0.26	-0.54	Pass
143	0.58	0.50	0.39	-0.19	Pass
378	0.71	0.78	0.38	-0.33	Pass
284	0.44	0.26	0.21	-0.23	Pass
327	0.68	0.53	0.50	-0.18	Pass
523	0.69	0.57	0.56	-0.13	Pass
666	0.57	0.31	0.23	-0.34	Pass
Max	**0.80**	**0.78**	**0.56**	**-0.03**	**Pass**

Table 17: Port 3 - 2' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.46	0.52	0.36	-0.10	Pass
352	0.51	0.42	0.22	-0.29	Pass
143	0.68	0.89	0.94	0.26	Pass
378	0.90	0.92	0.40	-0.50	Pass
284	0.67	0.82	0.76	0.09	Pass
327	0.70	0.61	0.69	-0.01	Pass
523	0.49	0.61	0.47	-0.02	Pass
666	0.79	0.88	0.40	-0.39	Pass
Max	**0.90**	**0.92**	**0.94**	**0.26**	**Pass**

Table 18: Port 4 – 1' IL (dB)

S/N	Initial	500 Hours	1000 Hrs	Change	Pass/Fail
916	0.60	0.46	0.44	-0.16	Pass
352	0.49	0.74	0.78	0.29	Pass
143	0.55	0.67	0.59	0.04	Pass
378	0.52	0.58	0.46	-0.06	Pass
284	0.90	0.45	0.62	-0.28	Pass
327	0.74	0.27	0.78	0.04	Pass
523	0.64	0.55	0.55	-0.09	Pass
666	0.61	0.57	0.44	-0.17	Pass
Max	**0.90**	**0.74**	**0.78**	**0.29**	**Pass**

Table 19: Summary for MEMS Ultra Mini Dual 2x2 Latching Switch Qualification Testing

Parameter	Criteria	MAX	P/F
IL_{max}	≤ 1.00 dB (BOL)	1.00 dB	Pass
|Δ| Insertion Loss	≤ 0.50 dB	0.46 dB	Pass