



# Qualification Test Report

## **Fiber Optical Switch**

**Per**

**Telcordia GR-1221-CORE**

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## I. Introduction

This report presents the qualification test results of MESU fiber optical switch products. The products chosen to performance the qualification testing are 1X2 SM fiber optical switch by following requirement of Telcordia GR-1221-CORE.

As the similarity between the manufacturing process and material used for other type of Switch type, the result of this qualification should also be applicable to other similar devices.

## II. Product Description and Specification

MESU all-optical miniature opto-mechanical (MOM) fiber optic switch is an ideal component for OADM, OXC, system monitoring and protection. The MOM switch's specially design offer excellent performance characteristics, which its low insertion loss, high repeatability and compact dimension. MESU's innovative prism design improves the switch repeatability and stability. Directly mountable on PCB, it can be easy to integrate into a high density optical communication system.

Main applications include: 1). Network Switching, 2). Configurable optical Add/Drop multiplexing, 3). Network Protection and Monitoring, 4). Instrumentation, Testing and Measurement

The main specifications of products, Switch, are shown below, and our qualification samples were chosen among qualified products meeting our listed specifications.

Parameters	Unit	1×2 Optical Switch	
Wavelength Range	nm	1260~1650	850±40 / 1300±40
Test Wavelength	nm	1310 / 1550	850 / 1300
Insertion Loss <sup>1,2</sup>	dB	≤ 0.8 ( typical: 0.5)	≤ 1.2 ( typical: 0.8)
Fiber Type		9/125 SM fiber	50/125 or 62.5/125 MM fiber
Return Loss <sup>1</sup>	dB	≥ 50 (typical: 55)	≥ 30
Crosstalk	dB	≥ 55(typical: 60)	≥ 35
Wavelength Dependent Loss	dB	≤0.25	
Polarization Dependent Loss	dB	≤0.05(typical: 0.03)	
Temperature Dependent Loss	dB	≤0.2	
Repeatability	dB	≤±0.02	
Operating Voltage	VDC	3 or 5	
Durability	Cycles	≥ 10 Million	
Switching Time	ms	≤8	
Optical Power	mW	≤500	
Operating Temperature	℃	-20 ~ +75	
Storage Temperature	℃	-40 ~ +85	
Relative Humidity	%	≤95	
Dimension	mm	(L)21.0×(W)11.5×(H)8.0 ±0.2	

### III. Telcordia GR-1221 Qualification Test

**1. Sample flow chart and number of allowed failures:** The following table shows the qualification flow chart used to evaluate planar splitters according to Telcordia GR-1221. The sample sizes have been divided in 6 groups to perform the tests in parallel.

Group	Sample Number	Test Condition	Number of Allowed Failures
A	11	Mechanical tests (Shock, Vibration, Cable Retention, Side Pull)	0
B	11	Damp Heat	0
C	11	Temperature Cycling	0
D	11	High Temperature Storage	0
E	11	Low Temperature Storage	0
F	11	Thermal Shock	0

**2. Optical parameters:** The following optical performances will be tested and monitored during the tests: Insertion Loss, Polarization Dependent Loss, Return Loss (monitoring)

#### 3. Pass/ Fail criteria

Parameter	Pass/Fail Criteria
Insertion Loss change ( $\Delta IL$ )	$\leq 0.5\text{dB}$
Polarization Dependent Loss change ( $\Delta PDL$ )	$\leq 0.1\text{dB}$
Return Loss change ( $\Delta RL$ )	$\leq 5\text{dB}$ – Monitoring
Physical Damage	None

#### 4. Telcordia GR-1221 qualification summary

Heading	Test	Condition	Reference
<b>Mechanical Integrity</b>	Mechanical Shock	5 times/direction, 6 directions, 500G, 1 ms	GR1221, section 6.2.1
	Vibration	20G, 20-2000 Hz min/cy, 4 min/cy, 4 cy/axis	GR1221, section 6.2.2
	Side Pull	230-450g, 90° angle	GR1209, section 5.1.3.3
	Fiber Pull Test (Cable Retention)	450-500g, 1min., 3 times	GR1209, section 5.1.3.4
	Thermal Shock	$\Delta T=100^{\circ}\text{C}$ , 20 cycles, Transfer time $\leq 10\text{s}$ , Dwell time $\geq 5\text{min}$	GR1221, section 6.2.3
<b>Endurance</b>	Damp Heat	$85^{\circ}\text{C}/85\% \text{RH}$ , 2000 hours	GR1221, section 6.2.5
	Temperature Cycling	$40^{\circ}\text{C}$ to $85^{\circ}\text{C}$ , 100 cycles for pass/fail, 500 cycles for info.	GR1221, section 6.2.7
	High Temperature	$85^{\circ}\text{C}$ or max. storage T, 2000 hrs	GR1221, section 6.2.4
	Low Temperature	$-40^{\circ}\text{C}$ or min. storage T, 2000 hrs	GR1221, section 6.2.6

#### 5. Test definitions

- **Mechanical Shock:** 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: 1ms.

We will perform this test to EIA/TIA-455-2A procedures as following: switch ( $\leq 125$  gm mass) are to withstand 8 impacts, in each of three mutually perpendicular axes (6 directions), when dropped from a height of 1.8 meters (6 feet) onto a concrete floor or when subjected to shock intensities of 500 g, half-sine pulse, 1 ms duration. Samples are mounted rigidly so that the shock is transmitted to the internal components and not absorbed or cushioned by the leads. A suggested method for performing this test is to place the test sample inside a container filled with a rigid packing material (such as sand or small glass beads) so that the sample does not shift or bounce around when the container is dropped. In this way, the impact shock is not absorbed by an elastic packing material or by the sample's leads, but is fully transmitted to the internal components. The sample leads may be protected from breakage if they are coiled and tied. After dropping, each switch is to be carefully examined for evidence of any physical damage and also measure the optical performance.

- **Vibration:** The variable frequency vibration test is performed to evaluate the mechanical integrity of the switch and is based on MIL-STD-883, Method 2007, with the following conditions:  
Acceleration: 20 G maximum acceleration  
Frequency: 20-2,000 Hz  
Duration: 4 min per cycle and 4 cycles per axis

This test subjects the samples to a simple harmonic motion having amplitude of 1.52 mm maximum total excursion. The frequency is to vary uniformly between 20 Hz and 2000 Hz and return to 20 Hz in approximately 20 minutes.

After Vibration, each switch is to be carefully examined for evidence of any physical damage and also measure the optical performance.

- **Thermal Shock Test:** The thermal shock test is based on MIL-STD-883 Method 1011 with the following conditions:  
Temperature Range:  $\Delta T = 100^{\circ}\text{C}$  ( $0^{\circ}\text{C}$  to  $100^{\circ}\text{C}$ ), liquid-to-liquid  
Dwell Times:  $\geq 5$  minutes at temperature extremes (typical 20min.)  
Transfer Time:  $\leq 10$  seconds  
Number of Cycles: 15

After test, each switch is to be carefully examined for evidence of any physical damage and also measure the optical performance. The optical test is made after the components are stabilized at room conditions for at least 2 hours.

- **Damp Heat:** The high temperature storage (damp heat) test is based on the procedure stated in MIL-STD-883 Method 103 or EIA/TIA-455-5A, test type 1, with the following conditions:  
Temperature:  $85^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ )  
Humidity: 85% ( $\pm 5\%$ ) RH

The test samples are subjected to a temperature resistance test at a modified test temperature of  $+85^{\circ}\text{C}$  with a relative humidity of 85%, and shall be taken initially and at the end, as well as interim measurements, at 100, 168, 500, 1000, 2000, and 5000 hour intervals, 2000 hrs for qualification and 5000 for information. The optical test is made after the components are stabilized at room conditions

for at least 2 hours.

- **Temperature cycling:** The temperature cycling test is based on the procedures stated in MIL-STD-883, Method 1010, with the following conditions or EIA/TIA-455-3A, with the following conditions:  
Temperature:  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ) for RT/UNC  
Dwell Time at Extremes:  $\geq 15$  minutes  
Temperature Ramp Rate:  $\geq 1^{\circ}\text{C}$  per minute.  
Number of Cycles: 100 pass/fail, 500 for information for RT/UNC

Samples will be put into the chamber to a temperature cycle from  $+85 \pm 2^{\circ}\text{C}$  to  $-40 \pm 2^{\circ}\text{C}$ . The test was started with the high temperature. The temperature rate of change was kept constant at  $3^{\circ}\text{C}$  per minute; the dwell time at highest and lowest temperature is 30 minutes. Samples will be taken initially and at the end, as well as interim measurements, at 20, 50, 100, 200, and 500 intervals, 100 cycles for qualification and 500 for information. The optical test is made after the components are stabilized at room conditions for at least 2 hours.

- **High Temperature storage:** The high temperature storage (dry heat) test is based on the procedures stated in EIA/TIA-455-4A, with the following conditions:  
Temperature:  $85^{\circ}\text{C}$  ( $\pm 2^{\circ}\text{C}$ ) or the maximum storage temperature  
Humidity:  $< 40\%$  RH  
Test Duration: 2,000 hrs for qualification and 5,000 hrs for information

Test samples are subjected to a temperature resistance test at a modified test temperature of  $+85^{\circ}\text{C}$  with a relative humidity less than 40%, and data shall be taken initially and at the end, as well as interim measurements, at 168, 500, 1000, 2000, and 5000 hours intervals, 2000 hrs for qualification and 5000 for information. The optical test is made after the components are stabilized at room conditions for at least 2 hours.

- **Low Temperature storage:** The low temperature storage test is based on the procedures stated in EIA/TIA-455-4A with the following conditions:  
Temperature:  $-40^{\circ}\text{C}$  ( $\pm 5^{\circ}\text{C}$ )  
Humidity: Uncontrolled  
Test Duration: 2,000 hrs for qualification and 5000 hrs for information

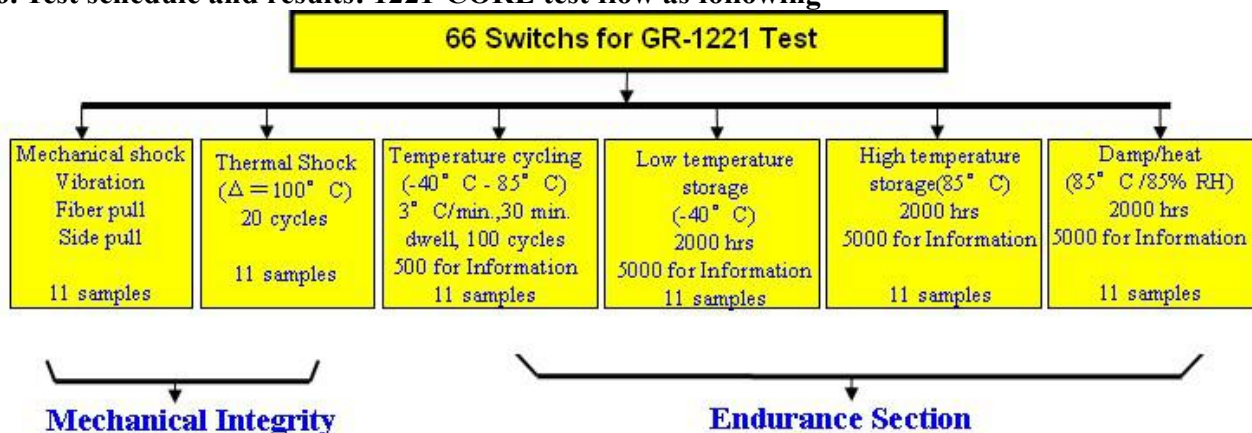
The test samples are subjected to a temperature resistance test at a modified test temperature of  $-40^{\circ}\text{C}$ , and data shall be taken initially and at the end, as well as interim measurements, at 168, 500, 1000, 2000, and 5000 hour intervals as minimum, 2000 hrs for qualification and 5000 for information. The optical test is made after the components are stabilized at room conditions for at least 2 hours.

- **Fiber side pull:** Test samples are to be subjected to the required tensile side load, with the load applied at an angle of  $90^{\circ}$ . The 230g load is to be applied at a distance of 22-28 cm from the component housing (see GR-326-CORE for more details). The switch may not incur physical damage. Measure the optical performance after the load is applied for at least 5 seconds, 2 directions and 3 times. Remove the load, and after 10 seconds re-measure the optical performance.
- **Fiber and cable retention (straight pull):** The load is applied during 1 min on each fiber of the switch. The switch may not incur physical damage, including: 1). Fiber Breakage; 2). Package Cracks; 3). Fiber Pullout; 4). Fiber Jacket Damage; 5). Failure of the Fiber-terminus Joint; 6). Seal

Damage.

The load is applied to the fiber at a minimum distance of 10 cm from the fiber end, at a rate of 400μm/sec. until attaining the max load, and maintain for 1 minute.

**6. Test schedule and results: 1221-CORE test flow as following**



**1). Damp/heat testing results of GR1221:**

**85% RH and 85°C and 11 samples ( 1x2 Switch devices, all device has no fiber connector)**

Telcordia GR-1221 Damp/Heat Testing Result Summary										
Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	IL	PDL	ΔIL	ΔPDL	ΔIL	ΔPDL	ΔIL	ΔPDL	ΔIL	ΔPDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
SW12DH01	0.67	0.02	0.11	0.01	0.15	0.02	0.21	0.03	0.25	0.03
SW12DH02	0.57	0.02	0.08	0.02	0.13	0.02	0.18	0.02	0.23	0.03
SW12DH03	0.36	0.01	0.07	0.01	0.1	0.02	0.19	0.02	0.27	0.02
SW12DH04	0.44	0.01	0.1	0.02	0.12	0.03	0.23	0.03	0.31	0.02
SW12DH05	0.47	0.01	0.12	0.01	0.17	0.01	0.21	0.01	0.28	0.01
SW12DH06	0.63	0.02	0.05	0.02	0.09	0.02	0.16	0.02	0.17	0.02
SW12DH07	0.55	0.02	0.11	0.01	0.18	0.02	0.25	0.03	0.29	0.02
SW12DH08	0.68	0.02	0.11	0.02	0.13	0.03	<b>0.28</b>	0.03	<b>0.34</b>	0.03
SW12DH09	0.38	0.01	0.06	0	0.12	0.01	0.14	0.01	0.21	0.01
SW12DH10	0.46	0.01	0.1	0.01	<b>0.19</b>	0.01	0.24	0.02	0.29	0.02
SW12DH11	0.58	0.02	<b>0.13</b>	0.01	0.17	0.02	0.19	0.02	0.2	0.02

**2). Mechanical integrity testing results of GR1221:**

**Mechanical integrity testing results of 11 samples in cascaded method according to GR1221. The samples selected for the test were 1x2 Switch devices.**

Telcordia GR-1221 Mechanical Integrity Testing Result Summary										
Device No.	Initial		Vibration		Shock		Side pull		Straight Pull	
	IL	PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
SW12MI01	0.32	0.01	0.12	0.01	0.25	0.01	0.28	0.01	0.29	0.01
SW12MI02	0.56	0.02	0.15	0.01	0.27	0.01	0.29	0.02	0.31	0.02
SW12MI03	0.55	0.01	0.17	0	0.23	0	0.25	0.01	0.27	0.02
SW12MI04	0.41	0.01	0.09	0.01	0.15	0.01	0.18	0.01	0.18	0.01
SW12MI05	0.51	0.02	0.1	0.01	0.18	0.01	0.2	0.01	0.23	0.01
SW12MI06	0.63	0.02	0.18	0.01	0.31	0.02	0.37	0.02	0.4	0.02
SW12MI07	0.68	0.02	<b>0.21</b>	0.02	<b>0.35</b>	0.02	<b>0.38</b>	0.02	<b>0.43</b>	0.02
SW12MI08	0.67	0.02	0.16	0.01	0.28	0.01	0.33	0.02	0.37	0.02
SW12MI09	0.41	0.01	0.11	0.01	0.19	0.01	0.24	0.01	0.26	0.01
SW12MI10	0.47	0.02	0.12	0	0.22	0.01	0.28	0.01	0.28	0.01
SW12MI11	0.56	0.02	0.14	0.01	0.27	0.02	0.31	0.02	0.33	0.01

### 3). High temperature storage testing results of GR1221:

High temperature +85°C storage testing results of 11 samples according to GR1221. The samples selected for the test were 1x2 Switch devices.

Telcordia GR-1221 High Temperature Storage Testing Result Summary										
Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	IL	PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
SW12HT01	0.67	0.03	0.05	0.01	0.08	0.01	0.12	0.01	0.13	0.02
SW12HT02	0.55	0.02	0.08	0.01	0.09	0.01	0.1	0.02	0.12	0.01
SW12HT03	0.51	0.01	0.07	0	0.09	0.01	0.11	0.01	0.14	0.01
SW12HT04	0.48	0.01	0.09	0.01	0.12	0.01	<b>0.15</b>	0.01	0.16	0
SW12HT05	0.39	0.01	0.06	0.01	0.09	0.02	0.09	0.01	0.11	0.01
SW12HT06	0.37	0.02	0.05	0.01	0.07	0.01	0.1	0.01	0.1	0.01
SW12HT07	0.52	0.02	0.08	0.02	0.11	0.02	0.12	0.02	0.13	0.01
SW12HT08	0.55	0.02	0.07	0	0.1	0	0.14	0.01	0.13	0.01
SW12HT09	0.43	0.01	0.07	0.01	0.12	0.01	0.15	0.01	<b>0.17</b>	0
SW12HT10	0.48	0.02	<b>0.1</b>	0	<b>0.13</b>	0.01	0.13	0.02	0.15	0.02
SW12HT11	0.46	0.02	0.06	0.01	0.09	0.01	0.12	0.01	0.13	0.01

### 4). Low temperature storage testing results of GR1221:

Low temperature -40°C storage testing results of 11 samples according to GR1221. The samples selected for the test were 1x2 Switch devices.

Telcordia GR-1221 Low Temperature Storage Testing Result Summary										
Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	IL	PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
SW12LT01	0.48	0.01	0.11	0.01	0.13	0.01	0.15	0.01	0.19	0.01
SW12LT02	0.53	0.02	0.09	0.01	0.13	0.01	0.16	0.01	0.21	0.02
SW12LT03	0.54	0.02	0.12	0.01	0.15	0.01	0.18	0.01	<b>0.25</b>	0.02
SW12LT04	0.49	0.01	0.08	0	0.09	0	0.12	0.01	0.2	0.01
SW12LT05	0.62	0.03	<b>0.13</b>	0.01	<b>0.14</b>	0.01	<b>0.23</b>	0.02	0.22	0.02
SW12LT06	0.61	0.02	0.12	0.02	0.12	0.02	0.21	0.02	0.21	0.02
SW12LT07	0.58	0.02	0.09	0.01	0.12	0.01	0.19	0.02	0.23	0.02
SW12LT08	0.47	0.02	0.07	0.02	0.09	0.01	0.12	0.01	0.19	0.01
SW12LT09	0.44	0.01	0.06	0	0.07	0.01	0.1	0.01	0.13	0.02
SW12LT10	0.47	0.01	0.1	0.01	0.11	0.01	0.15	0.01	0.17	0.02
SW12LT11	0.48	0.02	0.13	0.01	0.14	0.01	0.16	0.02	0.18	0.02

**5). Temperature cycling and thermal shock testing results of GR1221:**

11 samples of 1x2 Switch devices temperature cycling from -40°C to +85°C testing results, and 11 samples of 1x2 Switch samples thermal shock of temperature from -40°C to +85°C testing results according to GR1221.

GR-1221 Temperature Cycle Testing Result Summary						
Device No.	Initial		100 cycles		500 cycles	
	IL	PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL
	dB	dB	dB	dB	dB	dB
SW12TC01	0.38	0.01	0.17	0.02	0.25	0.02
SW12TC02	0.45	0.02	0.21	0.02	0.28	0.02
SW12TC03	0.65	0.02	0.28	0.02	0.37	0.03
SW12TC04	0.51	0.01	0.15	0.01	0.28	0.01
SW12TC05	0.53	0.02	0.1	0.01	0.21	0.02
SW12TC06	0.67	0.02	<b>0.29</b>	0.01	<b>0.42</b>	0.01
SW12TC07	0.59	0.02	0.09	0.02	0.19	0.02
SW12TC08	0.47	0.01	0.08	0.01	0.13	0.01
SW12TC09	0.51	0.01	0.11	0.01	0.23	0.02
SW12TC10	0.57	0.02	0.13	0.01	0.27	0.02
SW12TC11	0.46	0.01	0.16	0.02	0.31	0.03

GR-1221 Thermal Shock Testing Result Summary						
Device No.	Initial		Thermal Shock			
	IL	PDL	$\Delta$ IL	$\Delta$ PDL	$\Delta$ IL	$\Delta$ PDL
	dB	dB	dB	dB	dB	dB
SW12TS01	0.4	0.01	0.14	0.01		
SW12TS02	0.46	0.02	0.22	0.01		
SW12TS03	0.62	0.02	0.31	0		
SW12TS04	0.68	0.02	<b>0.37</b>	0.02		
SW12TS05	0.53	0.02	0.3	0.01		
SW12TS06	0.43	0.01	0.28	0.01		
SW12TS07	0.48	0.02	0.15	0.01		
SW12TS08	0.56	0.02	0.19	0.02		
SW12TS09	0.51	0.01	0.18	0.01		
SW12TS10	0.38	0.01	0.1	0		
SW12TS11	0.42	0.01	0.12	0.01		

**IV. Test Conclusions**

1. Fiber optical switch products can meet the Telcordia standards and the products specification.
2. Visual inspection shows no physical abnormal after the test.

**V. References**

GR-1221-CORE, “Generic Reliability Assurance Requirements for Passive Optical Components”, Issue 2, January 1999.