Qualification Test Report

PLC Splitters
(Planar Lightwave Circuit Splitters)

Per

Telcordia GR-1221-CORE

Prepared by: Fang Huang

Approved by: Jinhe Qiu

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I. Introduction

This report presents the qualification test results of MESU Planar Lightwave Circuit Splitter (PLCS) products. The products chosen to performance the qualification testing are 1x8 PLC splitters by following requirement of Telcordia GR-1221-CORE.

II. Product Description and Specification

The single-mode Planar Lightwave Circuit Splitter (PLCS) are developed based on unique silica glass waveguide process with reliable precision aligned fiber pigtail in a miniature package case, it provides a low cost light distribution solution with broad wavelength range from 1260 nm to 1650 nm, small form factor and high reliability. The PLCS devices have high performance in terms of low insertion loss, low PDL, high return loss and excellent uniformity over a wide wavelength range from 1260 nm to 1650 nm and working in temperature from -40ºC to +85ºC. The PLCS devices have standard configurations of 1x4, 1x8, 1x16 and 1x32 configurations, as well as customized structures of 2x16, 2x32, and 2x64. These products meet or exceed GR-1221-CORE reliability qualification requirement.

Main applications include: 1). FTTX Systems, 2). LAN, WAN and Metro Networks, 3). Analog/Digital Passive Optical Networks, 3). CATV Networks, 4). Other applications in fiberoptic systems

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

Port Configuration		1×2	1×4	1×8	1×16	1×32	1×64
Operating Wavelength (nm)		1260-1650					
Fiber Type		G657A1					
Insertion Loss (dB) (P/S Grade)	Max	3.6/3.9	6.9/7.2	10.0/10.3	13.2/13.5	16.3/16.8	19.8/20.1
Loss Uniformity (dB)	Max	0.4	0.6	0.8	1.2	1.5	2.5
Polarization Dependent Loss(dB)	Max	0.20	0.20	0.20	0.20	0.25	0.30
Return Loss (dB)	Min	55	55	55	55	55	55
Directivity (dB)	Min	55	55	55	55	55	55
Wavelength Dependent Loss(dB)	Max	0.3	0.3	0.3	0.4	0.5	0.5
Temperature Stability(-40~85 ℃)(dB)	Max	0.5	0.5	0.5	0.5	0.5	0.5
Operating Temperature (℃)			-40~85				
Storage Temperature (℃)			-40~85				

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 (ΔIL)	≤ 0.5dB
Polarization Dependent Loss change (ΔPDL)	≤ 0.1dB
Return Loss change (ΔRL)	≤ 5dB – Monitoring

4. Telcordia GR-1221 qualification summary

Heading	Test	Condition	Reference
Mechanical Integrity	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	ΔT=100°C, 20 cycles, Transfer time ≤10s, Dwell time≥5min	GR1221, section 6.2.3
Endurance	Damp Heat	85°C/85% RH, 2000 hours	GR1221, section 6.2.5
	Temperature Cycling	40°C to 85°C, 100 cycles for pass/fail, 500 cycles for info.	GR1221, section 6.2.7
	High Temperature	85°C or max. storage T, 2000 hrs	GR1221, section 6.2.4
	Low Temperature	-40°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: PLCS (≤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 PLCS 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 splitter 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 (0.060") 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 PLCS 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: ΔT = 100°C (0°C to 100°C), liquid-to-liquid
  Dwell Times: ≥5 minutes at temperature extremes (typical 20min.)
  Transfer Time: ≤ 10 seconds
  Number of Cycles: 15

After test, each PLCS 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°C (±2°C)
  Humidity: 85% (±5%) RH

The test samples are subjected to a temperature resistance test at a modified test temperature of +85°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°C to 85°C (±2°C) for RT/UNC
Dwell Time at Extremes: ≥15 minutes
Temperature Ramp Rate: ≥1°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±2℃ to -40±2℃. The test was started with the high temperature. The temperature rate of change was kept constant at 3°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°C (±2°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°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°C (±5°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°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.

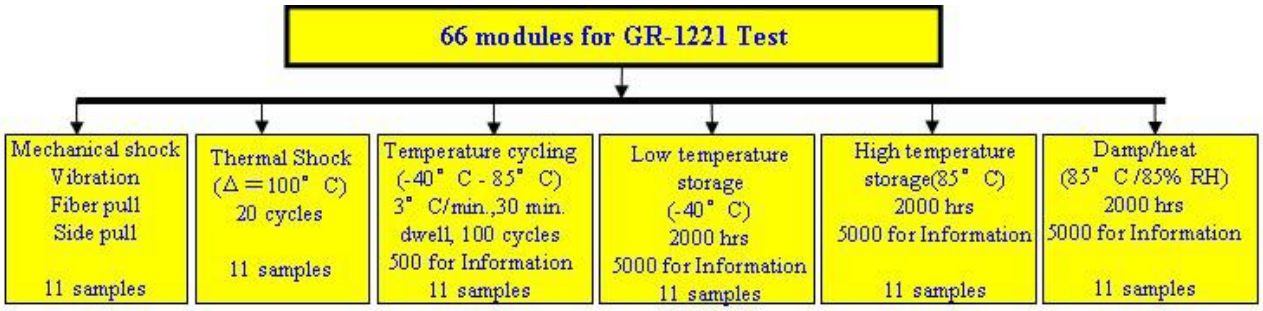
- **Fiber side pull:** Test samples are to be subjected to the required tensile side load, with the load applied at an angle of 90°. The 230g load is to be applied at a distance of 22-28 cm from the component housing (see GR-326-CORE for more details). The PLCS may not incur physical damage. Measure 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 side of the PLCS. The load is equal to 450g. The PLCS 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 and schedule as following



1). Damp/heat testing results of GR1221:
85% RH and 85C and 11 samples

Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
PLC18-DH01	10.21	0.08	0.11	0.02	0.13	0.03	**0.28**	0.03	**0.34**	0.03
PLC18-DH02	9.83	0.05	0.08	0.02	0.13	0.02	0.18	0.02	0.23	0.03
PLC18-DH03	9.88	0.06	0.07	0.01	0.1	0.02	0.19	0.02	0.27	0.02
PLC18-DH04	9.75	0.06	0.1	0.02	0.12	0.03	0.23	0.03	0.31	0.02
PLC18-DH05	10.04	0.07	0.12	0.01	0.17	0.01	0.21	0.01	0.28	0.01
PLC18-DH06	10.12	0.1	0.05	0.02	0.09	0.02	0.16	0.02	0.17	0.02
PLC18-DH07	10.55	0.09	0.11	0.01	0.18	0.02	0.25	0.03	0.29	0.02
PLC18-DH08	9.72	0.05	0.11	0.02	0.13	0.03	0.15	0.03	0.17	0.03
PLC18-DH09	9.87	0.03	0.06	0	0.12	0.01	0.14	0.01	0.21	0.01
PLC18-DH10	9.8	0.04	0.1	0.01	**0.19**	0.01	0.24	0.02	0.29	0.02
PLC18-DH11	9.92	0.04	**0.13**	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.

Device No.	Initial		Vibration		Shock		Side pull		Straight Pull	
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
PLC18-MI01	9.65	0.06	0.15	0.01	0.2	0.01	0.25	0.01	0.26	0.01
PLC18-MI02	9.83	0.05	0.15	0.01	0.27	0.01	0.29	0.02	0.31	0.02
PLC18-MI03	9.87	0.05	0.09	0.01	0.15	0.01	0.18	0.01	0.18	0.01
PLC18-MI04	10.05	0.07	0.12	0.01	0.15	0.01	0.19	0.01	0.18	0.01
PLC18-MI05	9.94	0.05	0.1	0.01	0.18	0.01	0.2	0.01	0.23	0.01
PLC18-MI06	9.84	0.06	0.18	0.01	0.31	0.02	0.37	0.02	0.4	0.02
PLC18-MI07	10.12	0.11	**0.2**	0.02	**0.25**	0.02	**0.32**	0.02	**0.44**	0.02
PLC18-MI08	10.25	0.12	0.16	0.01	0.28	0.01	0.33	0.02	0.3	0.02
PLC18-MI09	10.02	0.09	0.11	0.01	0.19	0.01	0.24	0.01	0.26	0.01
PLC18-MI10	9.93	0.07	0.12	0	0.22	0.01	0.28	0.01	0.28	0.01
PLC18-MI11	9.76	0.06	0.14	0.01	0.17	0.02	0.21	0.02	0.23	0.01

3). High temperature storage testing results of GR1221:

High temperature +85ºC storage testing results of 11 samples according to GR1221. The samples selected for the test were 1x8 PLCS devices.

Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
PLC18-HT01	9.58	0.05	0.07	0.02	0.09	0.01	0.12	0.01	0.19	0.01
PLC18-HT02	9.48	0.05	0.06	0	0.07	0.01	0.1	0.01	0.13	0.02
PLC18-HT03	10.11	0.08	**0.1**	0.01	0.11	0.01	0.15	0.01	0.17	0.02
PLC18-HT04	10.15	0.07	0.09	0.01	**0.12**	0.01	**0.15**	0.01	**0.23**	0
PLC18-HT05	9.86	0.04	0.06	0.01	0.09	0.02	0.09	0.01	0.11	0.01
PLC18-HT06	9.71	0.05	0.05	0.01	0.07	0.01	0.1	0.01	0.1	0.01
PLC18-HT07	9.68	0.04	0.07	0	0.09	0.01	0.11	0.01	0.14	0.01
PLC18-HT08	9.76	0.04	0.09	0.01	0.12	0.01	0.11	0.01	0.16	0
PLC18-HT09	10.08	0.06	0.06	0.01	0.09	0.02	0.09	0.01	0.11	0.01
PLC18-HT10	10.05	0.08	0.07	0.02	0.09	0.01	0.12	0.01	0.19	0.01
PLC18-HT11	9.87	0.06	0.06	0	0.07	0.01	0.1	0.01	0.13	0.02

4). Low temperature storage testing results of GR1221:

Low temperature -40ºC storage testing results of 11 samples according to GR1221. The samples selected for the test were 1x8 PLCS devices.

Device No.	Initial		168 Hrs		500 Hrs		1000 Hrs		2000 Hrs	
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB	dB	dB	dB	dB
PLC18-LT01	9.58	0.05	0.09	0.01	0.12	0.01	0.19	0.02	**0.23**	0.02
PLC18-LT02	9.94	0.06	0.07	0.02	0.09	0.01	0.12	0.01	0.19	0.01
PLC18-LT03	9.74	0.05	0.06	0	0.07	0.01	0.1	0.01	0.13	0.02
PLC18-LT04	10.08	0.07	0.1	0.01	0.11	0.01	0.15	0.01	0.17	0.02
PLC18-LT05	10.03	0.06	**0.13**	0.01	**0.14**	0.01	0.16	0.02	0.18	0.02
PLC18-LT06	9.68	0.04	0.12	0.02	0.12	0.02	**0.21**	0.02	0.21	0.02
PLC18-LT07	9.71	0.04	0.09	0.01	0.12	0.01	0.19	0.02	0.23	0.02
PLC18-LT08	10.11	0.06	0.07	0.02	0.09	0.01	0.12	0.01	0.19	0.01
PLC18-LT09	9.98	0.04	0.06	0	0.07	0.01	0.1	0.01	0.13	0.02
PLC18-LT10	9.86	0.05	0.1	0.01	0.11	0.01	0.15	0.01	0.17	0.02
PLC18-LT11	9.77	0.04	0.13	0.01	0.14	0.01	0.16	0.02	0.18	0.02

5). Temperature cycling testing results of GR1221:

11 samples of 1x8 PLCS devices temperature cycling from -40ºC to +85°C testing results.

Device No.	Initial		100 cycles		500 cycles	
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB
PLC18-TC01	10.06	0.07	**0.23**	0.02	**0.35**	0.03
PLC18-TC02	10.15	0.07	0.15	0.01	0.25	0.01
PLC18-TC03	10.11	0.06	0.1	0.01	0.21	0.02
PLC18-TC04	9.95	0.05	0.15	0.01	0.25	0.01
PLC18-TC05	9.87	0.04	0.1	0.01	0.21	0.02
PLC18-TC06	9.74	0.04	0.11	0.01	0.23	0.02
PLC18-TC07	9.79	0.05	0.13	0.01	0.21	0.02
PLC18-TC08	9.92	0.04	0.08	0.01	0.13	0.01
PLC18-TC09	10.02	0.06	0.11	0.01	0.23	0.02
PLC18-TC10	9.68	0.05	0.13	0.01	0.18	0.02
PLC18-TC11	9.76	0.04	0.16	0.02	0.26	0.03

6). Thermal shock testing results of GR1221:

11 samples of 1x8 PLCS samples thermal shock of temperature from -40°C to +85°C testing results according to GR1221.

Device No.	Initial		Thermal Shock			
	Max IL	Max PDL	Max △IL	Max △PDL	Max △IL	Max △PDL
	dB	dB	dB	dB	dB	dB
PLC18-TS01	9.87	0.05	0.25	0.02		
PLC18-TS02	9.68	0.05	0.16	0.01		
PLC18-TS03	9.72	0.06	0.16	0.01		
PLC18-TS04	10.07	0.08	0.23	0.02		
PLC18-TS05	10.16	0.08	0.32	0.03		
PLC18-TS06	9.93	0.06	0.18	0.01		
PLC18-TS07	9.84	0.05	0.14	0.01		
PLC18-TS08	9.87	0.05	0.16	0		
PLC18-TS09	10.02	0.06	0.12	0.01		
PLC18-TS10	9.69	0.04	0.1	0.01		
PLC18-TS11	9.76	0.05	0.12	0.02		

IV. Test Conclusions

1. PLC splitter 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.