LC, Multimode, One-Piece Housing, Fiber Optic Connector

1. INTRODUCTION

1.1. Purpose

Testing was performed on Tyco Electronics LC multimode, one-piece housing, fiber optic connectors to determine their conformance to the requirements of the Optical Fiber Cabling Components Standard, TIA/EIA-568-B.3.

1.2. Scope

This report covers the optical, environmental, and mechanical performance of LC multimode, one-piece housing, fiber optic connectors terminated to 2.0 mm jacketed 50/125 μm cable. Cable assemblies were manufactured by Tyco Electronics, Fiber Optics Business Unit. Testing was performed between 31Jan06 and 21Feb06. The test file number for this testing is B066497-006.

1.3. Conclusion

LC multimode, one-piece housing, fiber optic connectors, terminated to 2.0 mm jacketed cable (as described in paragraph 1.5), meet the optical, environmental, and mechanical performance requirements of the Optical Fiber Cabling Components Standard, TIA/EIA-568-B.3 when two simplex connectors are fastened together to form a duplex connector.

LC connectors terminated to cable with 62.5/125 μm fiber size are assumed to be qualified by similarity to performance of LC connectors terminated to cable with 50/125 μm fiber size.

1.4. Product Description

The Tyco Electronics LC fiber optic cable assemblies consist of two simplex, epoxy, LC connectors fastened together to form a duplex connector on one end of 2.0 mm jacketed, OFNP zipcord cable, and dual FC connectors on the other end for attachment to optical measurement equipment. LC fiber optic cable assemblies are used in data communication and telecommunications networks and equipment.

1.5. Test Specimens

Test specimens were manufactured using normal production means. Specimens consisted of two duplex cable assemblies mated to form an LC duplex connector pair, and the following supplies outlined below.

Component Description	Test Group		
	1	2	3
Fiber size (microns/microns)	50/125		
Cable Type	2.0 mm OFNP Zipcord		
Cable Assembly PN (See Note (a))	1918191-5		
Connector Type (See Note (b))	Simplex LC		
Coupling Receptacle PN	1754683-1		
Test Specimens Required (See Note (c))	8 (duplex)	8 (duplex)	8 (duplex)
Control Cable Required	Yes	No	No

NOTE

(a) Cable assembly consists of two simplex LC connectors, PN 1918267-1, terminated to cable PN 6457471-2.
(b) Two simplex LC connectors are fastened together with LC duplex clip PN 1754371-1 to form a duplex specimen.
(c) Two duplex cable assemblies and one duplex adapter were used to form one mated connector pair (test specimen).

1.6. Qualification Test Sequence

Test or Examination	Test Groups (a)		
	1	2	3
	Test Sequence (b)		
Visual and mechanical inspection	1	1	1
Attenuation (insertion loss)	2	2	2
Return loss	3	3	3
Low temperature	4		
Temperature life	5		
Humidity, steady state	6		
Strength of coupling mechanism		4	
Cable retention, 0 degrees		5	
Cable retention, 90 degrees		6	
Flex		7	
Twist		8	
Impact			4
Durability			5

NOTE

(a) See paragraph 1.5.
(b) Numbers indicate sequence in which tests are performed.

2. SUMMARY OF TESTING

2.1. Visual and Mechanical Inspection - All Test Groups

All specimens submitted for testing were manufactured by Tyco Electronics, and were inspected and accepted by the Product Assurance Department of the Fiber Optics Business Unit. Specimens are assumed to be compliant with FOCIS dimensions from Tyco Electronics First Article approval, which included verification of product drawings per the dimensions specified in TIA/EIA-604-10A.

2.2. Initial Optical Performance - All Test Groups

All attenuation and return loss measurements met the specification requirements. Attenuation and return loss were measured at 850 nm and 1300 nm wavelengths for all test groups.

Attenuation (Insertion Loss) and Return Loss - Requirements for New Product (dB)

Performance Requirements	Test Groups (1-3)	
	850 nm	1300 nm
Maximum allowed attenuation for any individual specimen	0.75	0.75
Minimum allowed return loss for any individual specimen	20	20

Attenuation (Insertion Loss) and Return Loss - Actual for New Product (dB)

Test Group	Maximum and Median Attenuation Values		Minimum and Median Return Loss Values	
	850 nm	1300 nm	850 nm	1300 nm
1	0.23 Max 0.10 Med	0.16 Max 0.06 Med	28.7 Min 30.4 Med	31.3 Min 32.9 Med
2	0.34 Max 0.18 Med	0.26 Max 0.12 Med	26.5 Min 27.3 Med	30.8 Min 32.3 Med
3	0.60 Max 0.21 Med	0.43 Max 0.16 Med	26.5 Min 28.7 Med	31.4 Min 36.5 Med

2.3. Attenuation, Change in Attenuation, Attenuation Increase and Return Loss - All Test Groups

All attenuation, change in attenuation, attenuation increase and return loss measurements met the specification requirements. All measurements were recorded at 850 nm and 1300 nm for 50/125 µm fiber size. Values shown in the table below represent maximum attenuation, maximum change in attenuation, maximum attenuation increase and minimum return loss.

Attenuation, Change in Attenuation, Attenuation Increase and Return Loss Results (dB)

Test Group	Condition	Requirements (850 and 1300 nm)			Actual (850 nm)			Actual (1300 nm)		
		Before	During	After	Before	During	After	Before	During	After
		IL	ΔIL	IL,RL,IL↑	IL	ΔIL	IL,RL,IL↑	IL	ΔIL	IL,RL,IL↑
1	Low temperature	0.75	0.3	0.75(IL) 20(RL)	0.23	0.07	0.22(IL) 28.8 (RL)	0.16	0.04	0.15(IL) 31.7 (RL)
	Temperature life		NA		0.22	NA	0.23(IL) 29.1(RL)	0.15	NA	0.16(IL) 32.1(RL)
	Humidity, steady state		0.4		0.24	0.14	0.17(IL) 29.1(RL)	0.16	0.11	0.10(IL) 32.1(RL)
2	Strength of coupling mechanism	0.75	NA	0.75IL 20(RL)	0.32	NA	0.32(IL) 26.5(RL)	0.24	NA	0.23(IL) 31.4(RL)
	Cable retention, 0 degrees			0.75(IL) 20(RL) 0.5(IL↑)	0.42		0.42(IL) 26.5(RL) 0.02(IL↑)	0.31		0.31(IL) 31.2(RL) 0.01(IL↑)
	Cable retention, 90 degrees				0.40		0.39(IL) 26.5(RL) 0.01IL↑)	0.33		0.33(IL) 31.3(RL) 0.01(IL↑)
	Cable flexing			0.75(IL) 20(RL)	0.40		0.41(IL) 26.5(RL)	0.31		0.31(IL) 31.4(RL)
	Twist				0.47		0.47(IL) 26.5(RL)	0.36		0.37(IL) 31.3(RL)
3	Impact	0.75	NA	0.75(IL) 20(RL)	0.60	NA	0.59(IL) 26.6(RL)	0.43	NA	0.42(IL) 31.3(RL)
	Durability				0.61		0.62(IL) 27.2(RL)	0.43		0.45(IL) 32.6(RL)

NOTE *(IL) - Insertion Loss (Attenuation)*
(ΔIL) - Change in Insertion Loss (Attenuation)
(IL↑) - Insertion Loss (Attenuation) Increase
(RL) - Return Loss

2.4. Low Temperature - Test Group 1

There was no evidence of physical damage to the connector or cable and no change in optical performance beyond the specified limit during low temperature exposure. All attenuation and return loss measurements met requirements before and after test. Optical performance was measured at 850 and 1300 nm.

2.5. Temperature Life - Test Group 1

There was no evidence of physical damage to the connector or cable after temperature life. All attenuation and return loss measurements met specified limits before and after test. Optical performance was measured at 850 and 1300 nm.

2.6. Humidity, Steady State - Test Group 1

There was no evidence of physical damage to the connector or cable and no change in optical performance beyond the specified limits during steady state humidity. All attenuation and return loss measurements met requirements before and after test. Optical performance was measured at 850 and 1300 nm.

2.7. Strength of Coupling Mechanism - Test Group 2

There was no evidence of physical damage to the connector. Attenuation and return loss measurements met the specified limits before and after strength of coupling mechanism test. Optical performance was measured at 850 and 1300 nm.

2.8. Cable Retention, 0 Degrees - Test Group 2

There was no evidence of jacket pullout, or other damage to the connector or cable and no change in optical performance beyond the specified limits after cable retention test. Optical performance was measured at 850 and 1300 nm.

2.9. Cable Retention, 90 Degrees - Test Group 2

There was no evidence of jacket pullout, or other damage to the connector or cable and no change in optical performance beyond the specified limits after side pull test. Optical performance was measured at 850 and 1300 nm.

2.10. Flex - Test Group 2

There was no evidence of physical damage to the connector or cable. Attenuation and return loss measurements met the specified limits before and after flex test. Optical performance was measured at 850 and 1300 nm.

2.11. Twist - Test Group 2

There was no evidence of physical damage to the connector or cable. Attenuation and return loss measurements met the specified limits before and after twist test. Optical performance was measured at 850 and 1300 nm.

2.12. Impact - Test Group 3

There was no evidence of physical damage to the connector or cable. Attenuation and return loss measurements met the specified limits before and after impact test. Optical performance was measured at 850 and 1300 nm.

2.13. Durability - Test Group 3

There was no evidence of physical damage to the connectors or adapter. Attenuation and return loss measurements met the specified limits before and after durability test. Optical performance was measured at 850 and 1300 nm.

3. TEST METHODS

The multimode environmental facility is an automated, FOTP-20 compliant test system with initial specimen installation performed according to FOTP-171 procedures. Following the installation of the specimens, the sequential testing was performed.

For mechanical tests, optical measurements were obtained using manually operated FOTP-20 compliant test equipment. Initial specimen installation was performed according to FOTP-171 procedures. Following the installation of the specimens, the sequential testing was performed.

3.1. Visual and Mechanical Inspection

Product drawings and inspection plans were used to examine the specimens. They were examined visually and functionally.

3.2. Attenuation (Insertion Loss)

All multimode attenuation was measured in accordance with FOTP-171, method D1 processes, except that the launch was part of the specimen under test and was not reference quality. The initial optical power through each launch connector fiber path was measured. The connector assembly was then mated and optical power measured from the receive side cable assembly. Attenuation was calculated by taking the difference between these two measurements. The receive side cable assembly was then connected to the optical test equipment. Optical power was recorded as a reference to calculate change in attenuation during/after subsequent tests. Optical power readings were compensated by changes in a source monitor cable. In cases where a control cable was also used and exceeded limits stated in the specification, the change in the control cable was also factored into the loss.

3.3. Change in Attenuation

The initial optical power (dBm) through the specimens was recorded before the test using an optical source and detector. Relative optical power (dB) through the fiber was measured during and after each test as applicable. Change in attenuation was calculated by taking the difference between the initial measurement and the during/after measurements and recording the maximum range of all values for a specimen. Optical power readings were compensated by changes in the source monitor cable. In cases where a control cable was also used and exceeded limits stated in the specification, the change in the control cable was also factored into the loss.

3.4. Attenuation Increase

Increase in attenuation was calculated by taking the difference between the initial measurement and the measurement after each test. Attenuation increase represents a change in attenuation that results from a decrease in optical power (degraded performance). Optical power readings were compensated by changes in the source monitor cable.

3.5. Return Loss

Return loss was measured in accordance with FOTP-107. A single measurement was recorded for return loss. Return loss was measured initially and after each test evaluation.

3.6. Low Temperature

Mated specimens were subjected to 0°C for a period of 96 hours (4 days). Optical performance for each specimen was recorded before and after exposure with the specimens in place in the test chamber and at 15-minute intervals throughout the exposure. Final optical performance was recorded after specimens returned to ambient conditions.

3.7. Temperature Life

Mated specimens were subjected to 60˚C for a period of 96 hours (4 days). Optical performance for each specimen was recorded before and after exposure with the specimens in place in the test chamber. Final optical performance was recorded after specimens returned to ambient conditions.

3.8. Humidity, Steady State

Mated specimens were subjected to 40 ± 2˚C at 90 to 95% RH for a period of 96 hours (4 days). Optical performance for each specimen was recorded before and after exposure with the specimens in place in the test chamber and at 15-minute intervals throughout the exposure. Final optical performance was recorded after specimens returned to ambient conditions.

3.9. Strength of Coupling Mechanism

A duplex connector was mated to a duplex adapter which was secured to the test fixture. A 33 N [7.4 lbf] tensile load was applied at a rate of approximately 25.4 mm [1 in] per minute to the coupling mechanism by using a nylon string wrapped around the duplex connector clip. The load was sustained for a minimum of 5 seconds. Optical performance was measured before and after test with the load removed.

3.10. Cable Retention, 0 Degrees

Duplex specimens were subjected to a sustained load of 50 N [11.24 lbf] for a minimum of 5 seconds. A nylon string wrapped around the duplex connector clip was used to secure the connector. The tensile load was manually applied by wrapping the jacketed cable around a 7.5 cm [3 in] diameter mandrel at a point 25.4 cm [10 in] from the connector. Optical performance was measured before and after test with the load removed.

3.11. Cable Retention, 90 Degrees

Duplex specimens were subjected to a sustained load of 19.4 N [4.4 lbf] for a minimum of 5 seconds. An adapter was secured to the test fixture. The load was manually applied at a 90 degree pull angle by wrapping the jacketed cable around a 7.5 cm [3 in] diameter mandrel at a point 25.4 cm [10 in] from the connector. Optical performance was measured before and after test with the load removed.

3.12. Cable Flexing

Duplex specimens were subjected to 100 cycles of fiber flexing. Specimens were tested at a rate of 25 cycles per minute. A brass block cable clamp was used to apply a tensile load of 0.5 Kg [1.1 lbf] to jacketed cable at a point approximately 25.4 cm [10 in] from the connector. The flex arc was ± 90 degrees from a vertical position. Optical performance was measured before and after test with the load removed.

3.13. Twist

Duplex specimens were subjected to 10 cycles of twist. Specimens were manually tested at a rate of approximately 3 cycles per minute. A 7.5 cm [3 in] diameter mandrel was used to apply a tensile load of 15 N [3.4 lbf] to jacketed cable at a point approximately 25.4 cm [10 in] from the connector. The twist motion for each cycle was ± 2.5 revolutions about the axis of the fiber. Optical performance was measured before and after test with the load removed.

3.14. Impact

An unmated duplex connector assembly, with protective cap over the ferrule, was dropped in random orientations from a height of 1.8 m [70.9 in] onto a concrete slab. The impact exposure was repeated 8 times. Initial optical performance was recorded before the specimen was unmated and exposed to testing. After completion of the 8 impacts, each connector was inspected, cleaned and re-mated before recording final optical measurements.

3.15. Durability

The duplex connector on one end of each mated specimen was subjected to 500 cycles of durability. Specimens were manually cycled at a rate not in excess of 300 cycles per hour. The connector and adapter were cleaned as specified every 25 cycles during test. Optical performance was measured before and after test. Specimens were unmated, cleaned, inspected, and re-mated before final optical measurements.