

**LC Multimode Fiber Optic Connectors Terminated To 1.6 mm  
Simplex Cable With 50/125  $\mu$ m Fiber****1. INTRODUCTION****1.1. Purpose**

Testing was performed on LC multimode fiber optic connectors terminated to 1.6 mm simplex cable with 50/125  $\mu$ m fiber to determine their conformance to the requirements stated in this document.

**1.2. Scope**

This report covers the optical, environmental, and mechanical performance of cable assemblies, which consist of LC multimode connectors with 1.6 mm simplex cable and 50/125  $\mu$ m fiber, manufactured by the Fiber Optic Business Unit of Tyco Electronics. Testing was performed between September 11, 2002 and October 29, 2002.

**1.3. Conclusion**

LC simplex fiber optic cable assemblies, listed in section 1.5, meet the optical, environmental, and mechanical performance requirements stated in this document.

**1.4. Product Description**

Tyco Electronics LC multimode fiber optic connectors and cable assemblies are used in telephone company central offices, CATV headends, interbuilding backbones and customer premise applications. In particular, the small form factor of the LC connector is ideal for applications that require high-density utilization of space.

**1.5. Test Samples**

Samples were constructed using normal manufacturing means. Multimode 50/125  $\mu$ m optical fiber was used in the following tests. The following sample quantities were used for the test group.

Test Group	1
Connector Type	Simplex LC Multimode
Connector Part Number	1588705-1
Fiber Type	Multimode 50/125
Cable Type	1.6 mm Simplex Riser Rated
Cable PN	1374394-2
Coupling Receptacle PN	1457567-1
Test Cable Length (m)	5
Test Samples Required	8
Source Wavelength	850 nm

## 1.6. Design Verification Test Sequence

Test or Examination	Test Sequence
Examination of Product	1
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**NOTE** Numbers indicate sequence in which tests are performed.

## 2. SUMMARY OF TESTING

### 2.1. Examination of Product

Tyco Electronics Fiber Optic Business Unit, using normal manufacturing processes, built all samples submitted for testing. The samples were inspected for conformance to the applicable production drawings.

### 2.2. End Face Geometry

All measurements met the stated performance goal. As a criterion, the geometry requirements of Telcordia GR-326-CORE, Issue 3 was used.

### 2.3. Random Mating Loss Characteristics

All measurements met the stated performance goal. The maximum permitted loss, for any given mated pair, is 0.75 dB. The minimum permitted Return Loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below, with histograms located in the Appendix.

Test Group (N = 224)	Attenuation (dB)				Return Loss (dB)			
	Average	Minimum	Maximum	Std Dev	Average	Minimum	Maximum	Std Dev
1	0.09	0.01	0.25	0.06	47.1	41.8	48.4	0.6

## 2.4. Initial Optical Performance

All measurements met the stated performance goal. The maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below.

Test Group (N = 8)	Initial Attenuation (dB)			Initial Return Loss (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.05	0.00	0.11	47.2	46.7	48.2

## 2.5. Low Temperature

All measurements met the stated performance goal. The maximum allowable change in transmission during the test is 0.3 dB. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below. The Change in Transmission graph is located in the Appendix.

Test Group (N = 8)	Change In Transmission During Test (dB)			Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
1	-0.02	-0.07	0.00	0.07	0.00	0.14	48.1	44.4	57.2

## 2.6. Temperature Life

All measurements met the stated performance goal. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below. In addition, the Change in Transmission graph is located in the Appendix.

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.08	0.01	0.16	50.5	42.6	54.4

## 2.7. Humidity

All measurements met the stated performance goal. The maximum allowable change in transmission during the test is 0.4 dB. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below. In addition, the Change in Transmission is characterized in the Appendix.

Test Group (N = 8)	Change In Transmission During Test (dB)			Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.00	-0.01	0.03	0.08	0.01	0.18	49.7	41.7	52.7

## 2.8. Flex

All measurements met the stated performance goal. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below with graphs located in the Appendix.

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.04	0.01	0.06	50.6	45.4	55.1

## 2.9. Twist

All measurements met the stated performance goal. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below with graphs located in the Appendix.

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.06	0.00	0.10	50.7	45.3	55.3

## 2.10. Cable Retention

All measurements met the stated performance goal. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below with graphs located in the Appendix.

### A. Axial Pull

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.03	0.00	0.06	50.1	47.4	53.4

### B. Right Angle Pull

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.05	0.01	0.13	50.3	47.5	53.4

## 2.11. Impact

All measurements met the stated performance goal. For the initial and final measurements, the maximum permitted loss is 0.75 dB. The minimum permitted return loss is 20 dB. Attenuation and return loss were measured at 850 nm. The test results are tabularized below with graphs located in the Appendix.

Test Group (N = 8)	Attenuation After Test (dB)			Return Loss After Test (dB)		
	Average	Minimum	Maximum	Average	Minimum	Maximum
1	0.03	0.00	0.06	51.2	47.7	55.0

### 3. TEST METHODS

All optical measurements were performed with the utilization of a multimode test system. This measurement facility is compliant with TIA/EIA 568 B-3, Annex A. Loss and reflectance is measured at 850 nm. Following the installation of the samples, sequential testing was performed. Changes in transmission were calculated from the difference in optical power. A negative change in transmission value indicates a decrease in optical power.

#### 3.1. Examination of Product

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

#### 3.2. End Face Geometry

Using interferometric techniques, the radius of curvature, apex offset and fiber height of each sample was measured.

#### 3.3. Random Mating Loss Characteristics

Initial optical power, through the selected launch connector fiber, was measured. The connector assembly was then mated and final optical power measured from the receive-side cable assembly. Cable assembly loss was calculated by taking the difference between the initial measurement and the final measurement. Return loss was performed using optical time domain reflectometry. The launch cable and the receive cable were varied until measurements of each connector, on either end of the cable assemblies, were taken.

#### 3.4. Initial Optical Performance

Initial optical power, through the selected launch connector fiber, was measured. The connector assembly was then mated and final optical power measured from the receive-side cable assembly. Cable assembly attenuation was calculated by taking the difference between the initial measurement and the final measurement. Return loss was performed using optical time domain reflectometry.

#### 3.5. Low Temperature

The mated cable assembly pairs were preconditioned for 24 hours at 23°C and 20-70% relative humidity for 24 hours, then subjected to 96 hours of 0°C. Attenuation measurements were taken before, during, and after the test; return loss was measured before and after the test.

#### 3.6. Temperature Life

The mated pairs were subjected to 96 hours of 60°C after being preconditioned for 2 hours at 23°C and 20-70% relative humidity. Attenuation measurements were taken before and after the test; return loss was measured before and after the test.

#### 3.7. Humidity

The test samples were preconditioned for 24 hours at 50°C and a maximum of 33% RH before being exposed to 90-90% RH at 40°C for 96 hours. Attenuation measurements were taken before, during, and after this test, and return loss was measured after.

**3.8. Flex**

Using a 7.6 cm [3 in] mandrel, the receive sides of the mated pairs were wrapped 22 to 28 cm [10 in] behind the strain relief. A 4.9 N [1.1 lbf] tensile load was applied to the cable. The receive side of each mated pair was then flexed  $\pm 90$  degrees for 100 cycles. Attenuation and return loss were measured before and after the test.

**3.9. Twist**

Using a 7.6 cm [3 in] mandrel, the receive sides of the mated pairs were wrapped 22 to 28 cm [10 in] behind the strain relief. A 15 N [3.4 lbf] tensile load was applied to the cable. Each sample was twisted 2.5 revolutions in one direction followed by 5 revolutions in the opposite direction and then returned back to the starting position. This procedure was repeated for 9 cycles. Attenuation and return loss were measured before and after the test.

**3.10. Cable Retention****A. Axial Pull**

Using a 7.6 cm [3 in] mandrel, the receive sides of the mated pairs were wrapped 22 to 28 cm [10 in] behind the strain relief. With a load application rate of 25.4 mm [1 in] per minute, the mated pairs were subjected to a 50 N [11.24 lbf] axial load for a minimum of 5 seconds. Attenuation and return loss were measured before and after the load application.

**B. Right Angle Pull**

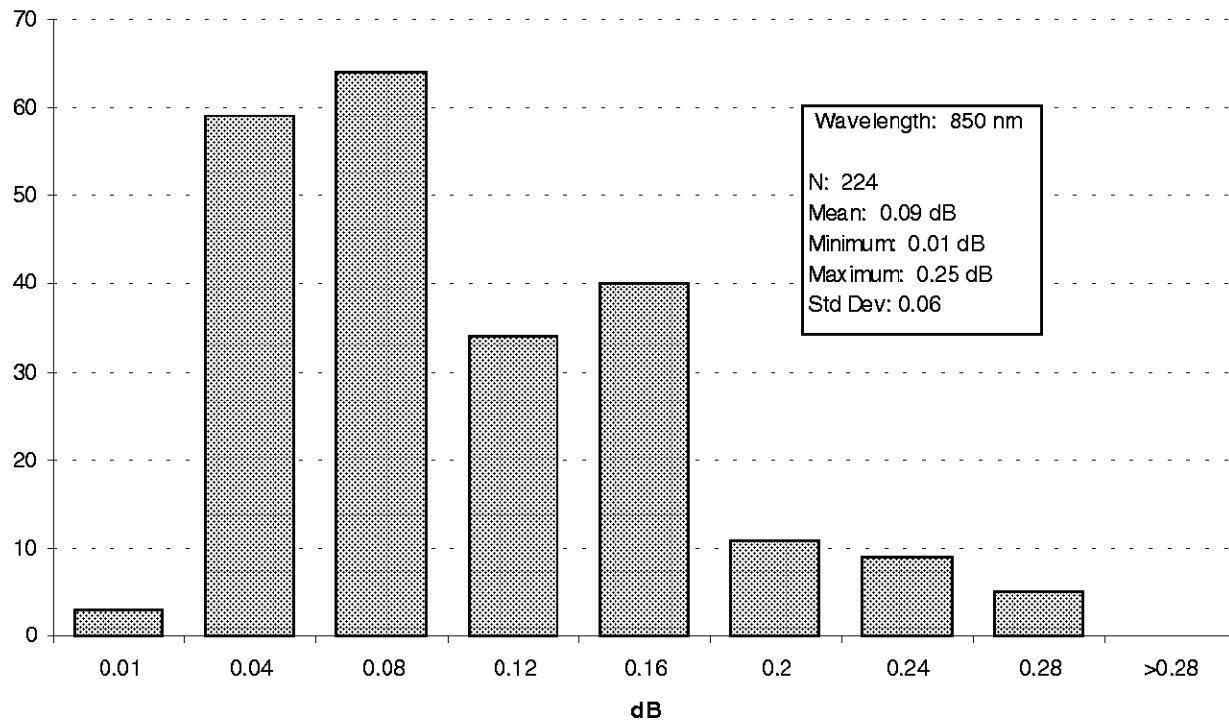
Using a 7.6 cm [3 in] mandrel, the receive sides of the mated pairs were wrapped 22 to 28 cm [10 in] behind the strain relief. Each mated pair was randomly clocked to one of eight positions (0, 45, 90, 135, 180, 225, 270, and 315 degrees). With a load application rate of 25.4 mm [1 in] per minute, the mated pairs were subjected to a 19.4 N [4.4 lbf] side load for a minimum of 5 seconds. Attenuation and return loss were measured before and after the load application.

**3.11. Impact**

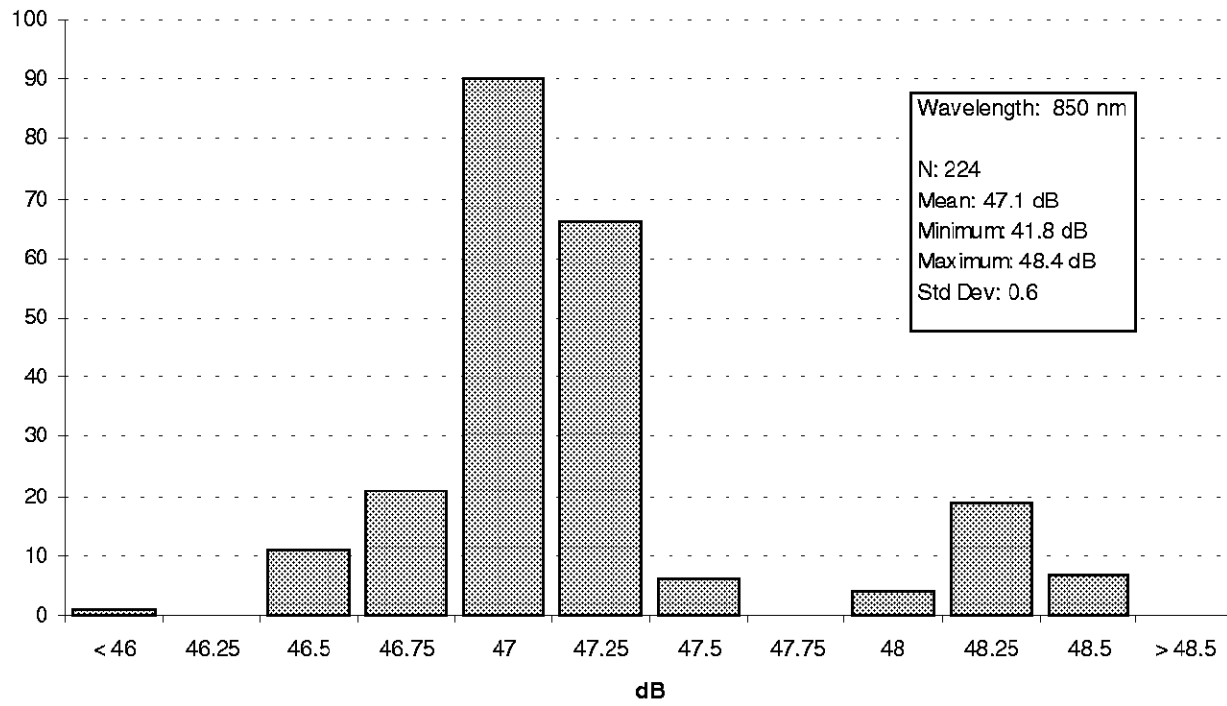
Initial attenuation and return loss measurements were taken. The receive cable was then removed and a dust cover was installed. Using a test setup compliant with TIA/EIA FOTP-2, Service Class Method B, the connector assembly was subjected to eight drops from a height of 1.8 m [5.9 ft]. The connector under test was reinstalled and final loss measurements were recorded.

# APPENDIX

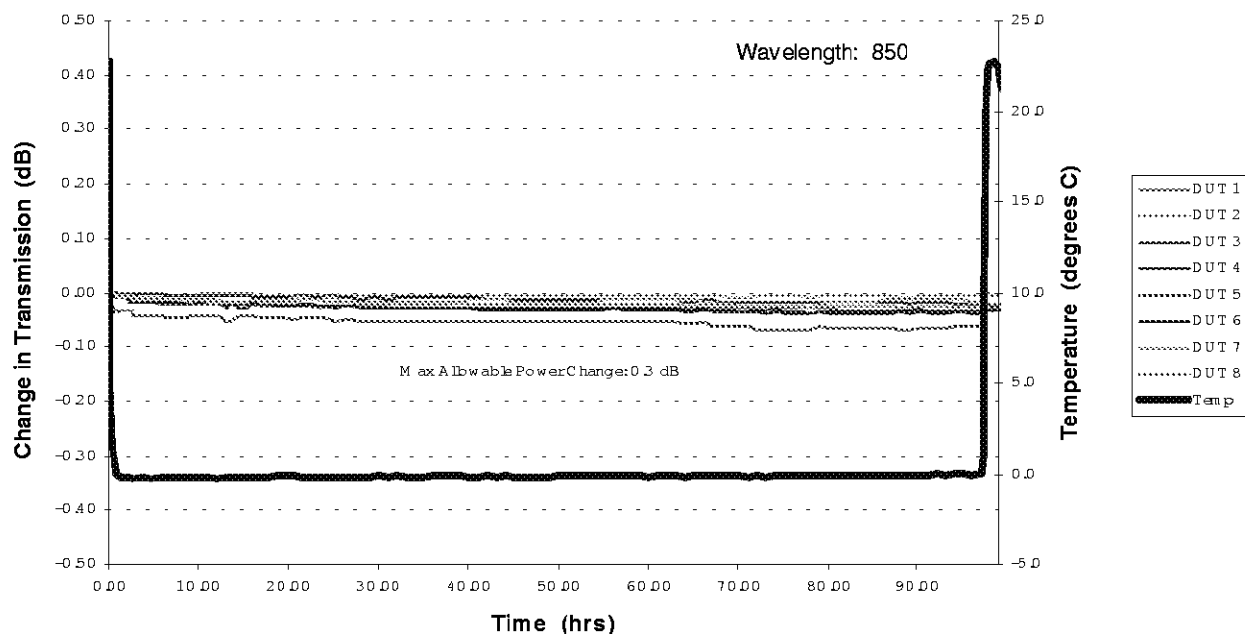
INSERTION LOSS CHARACTERISTICS FOR RANDOM MATE TEST



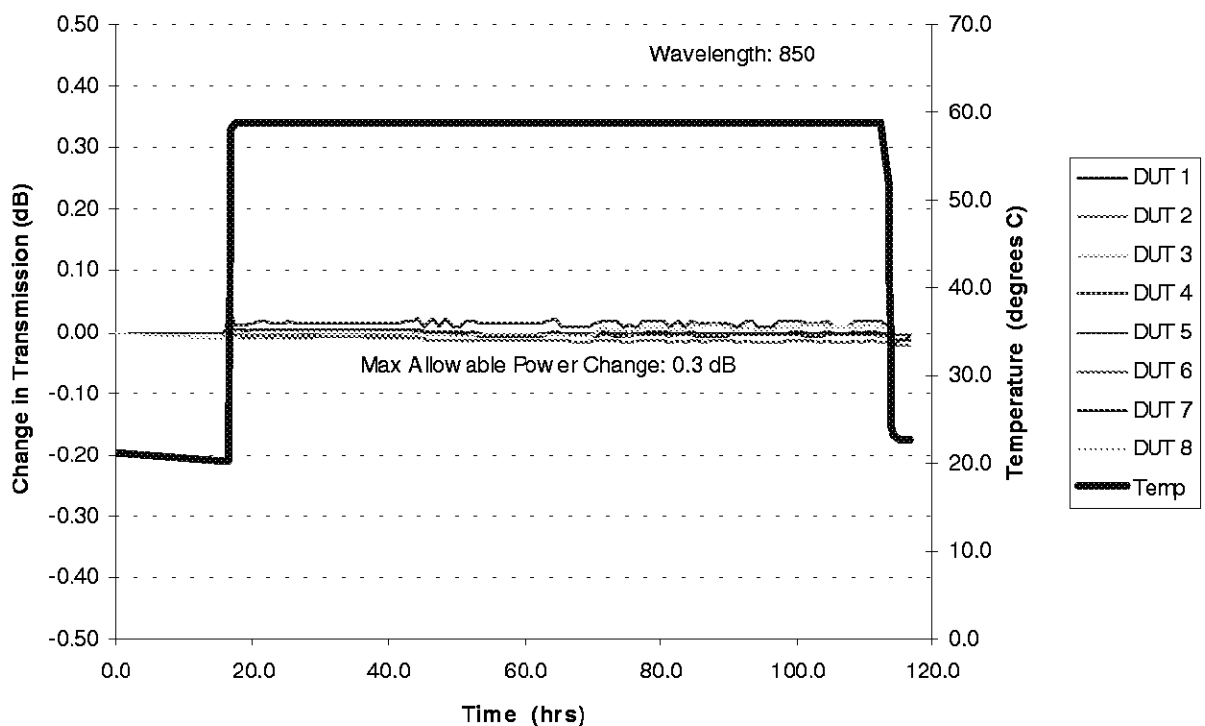
RETURN LOSS CHARACTERISTICS FOR RANDOM MATE TEST



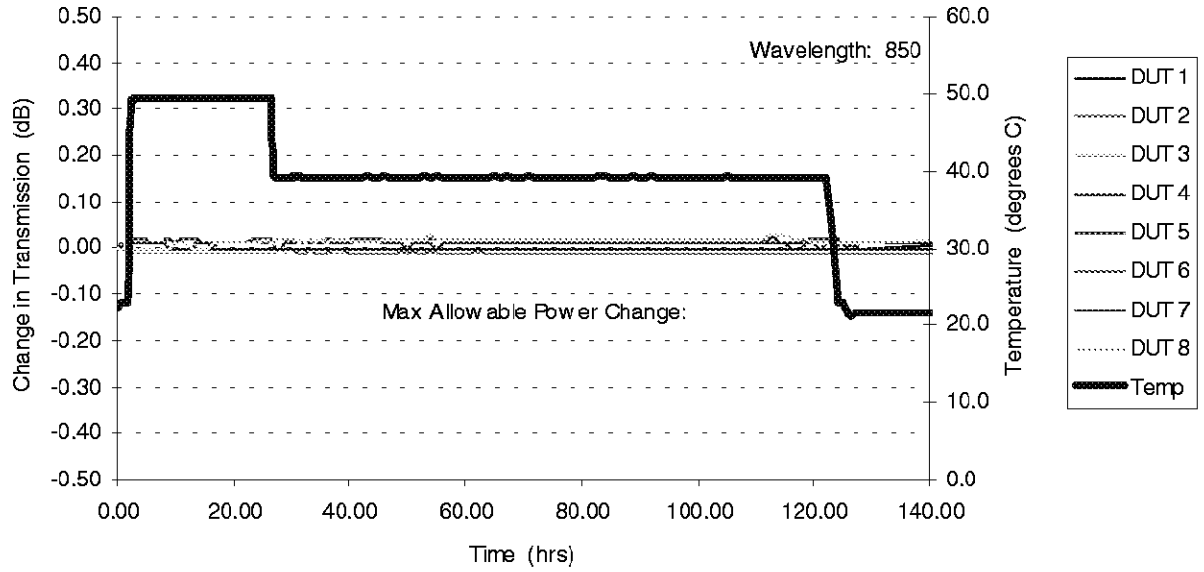
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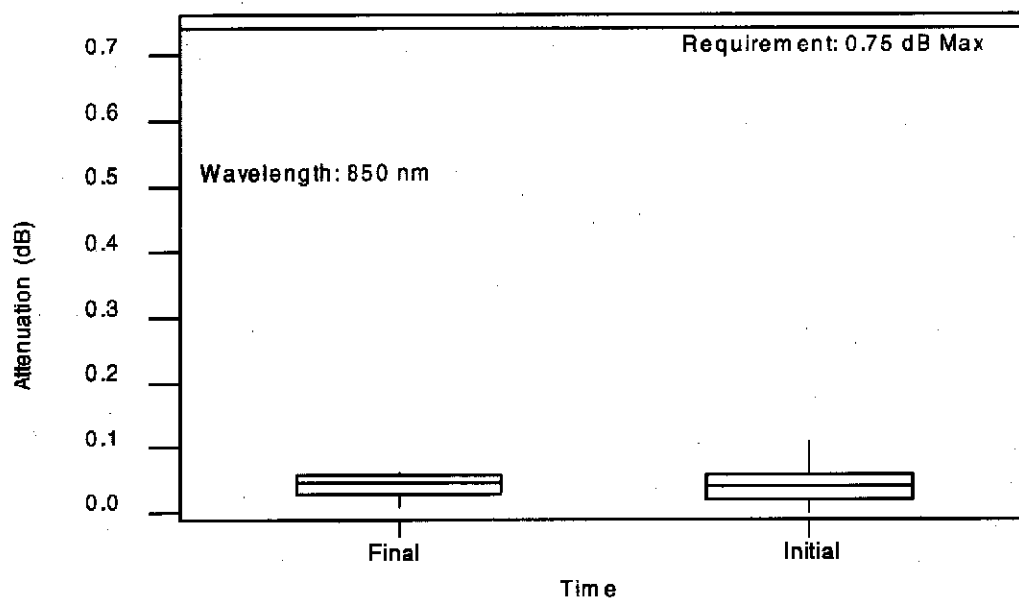
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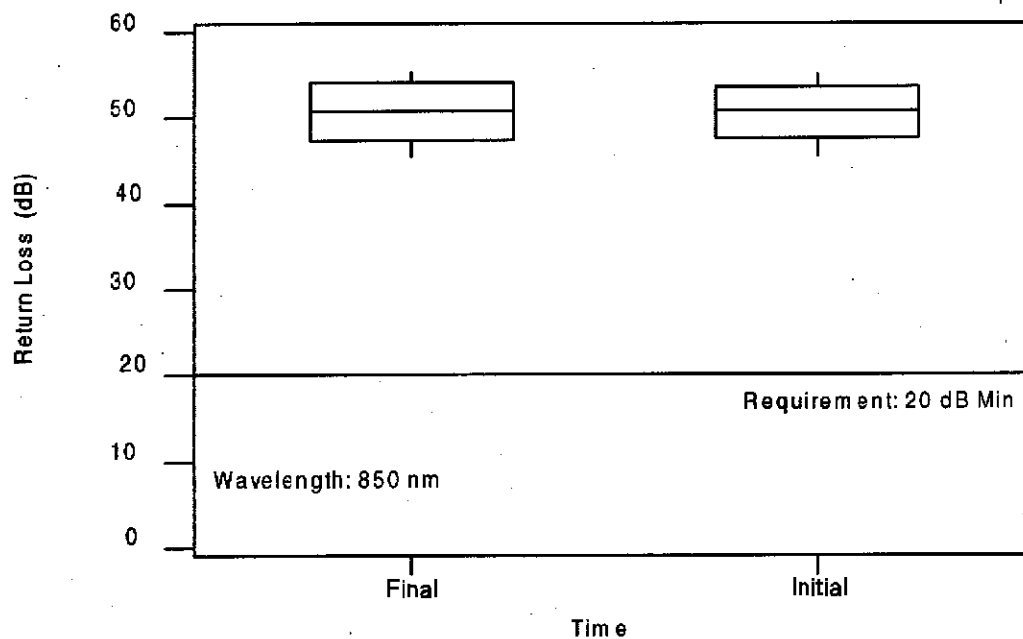
**CHANGE IN TRANSMISSION DURING THE 96 HOUR HUMIDITY TEST**



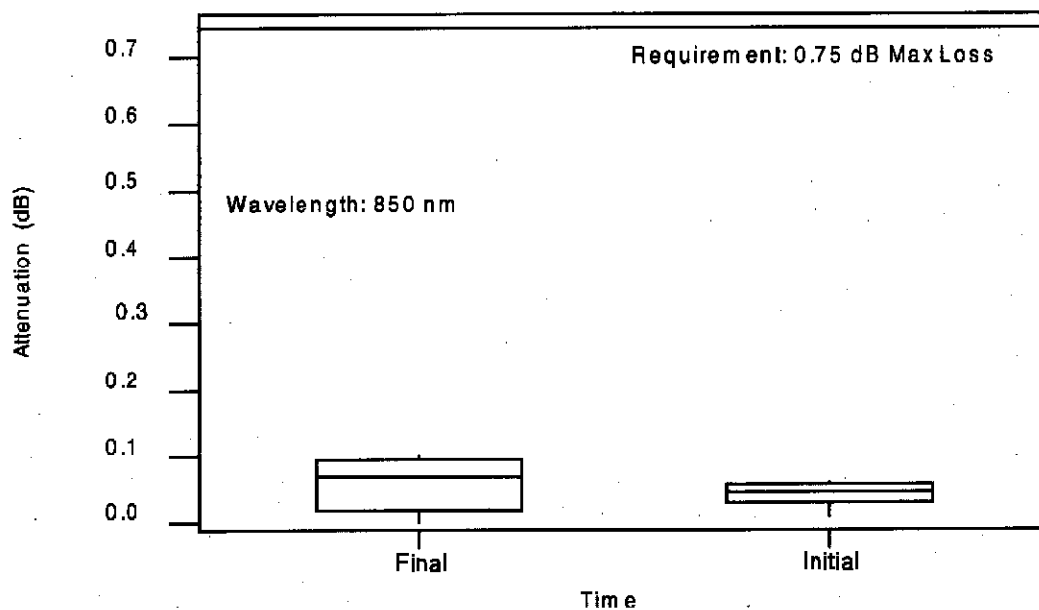
Transmission Characteristics Before and After Flex Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



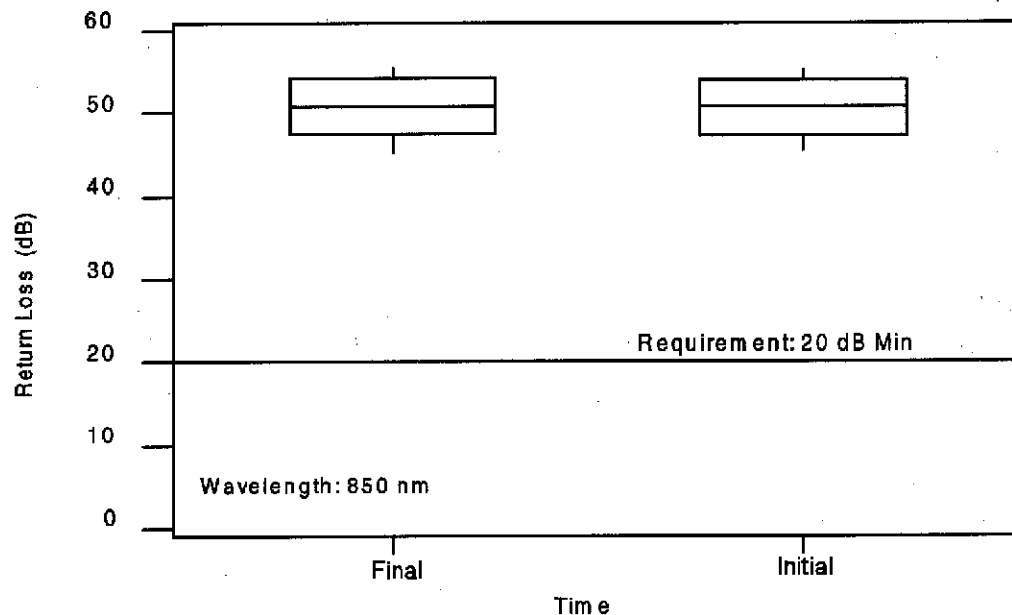
Return Loss Before and After Flex Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



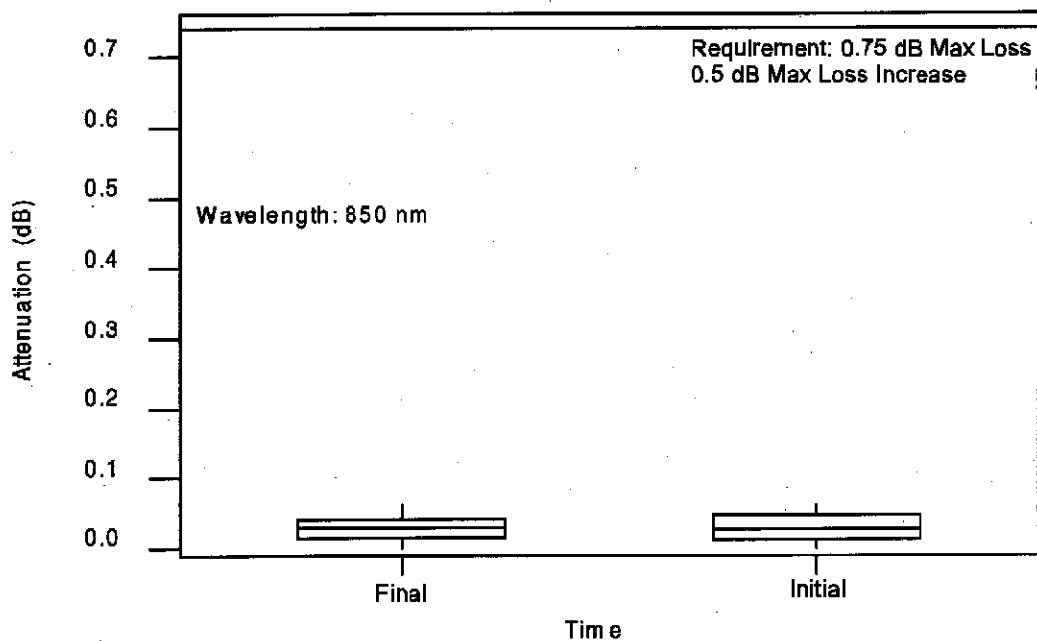
Transmission Characteristics Before and After Twist Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



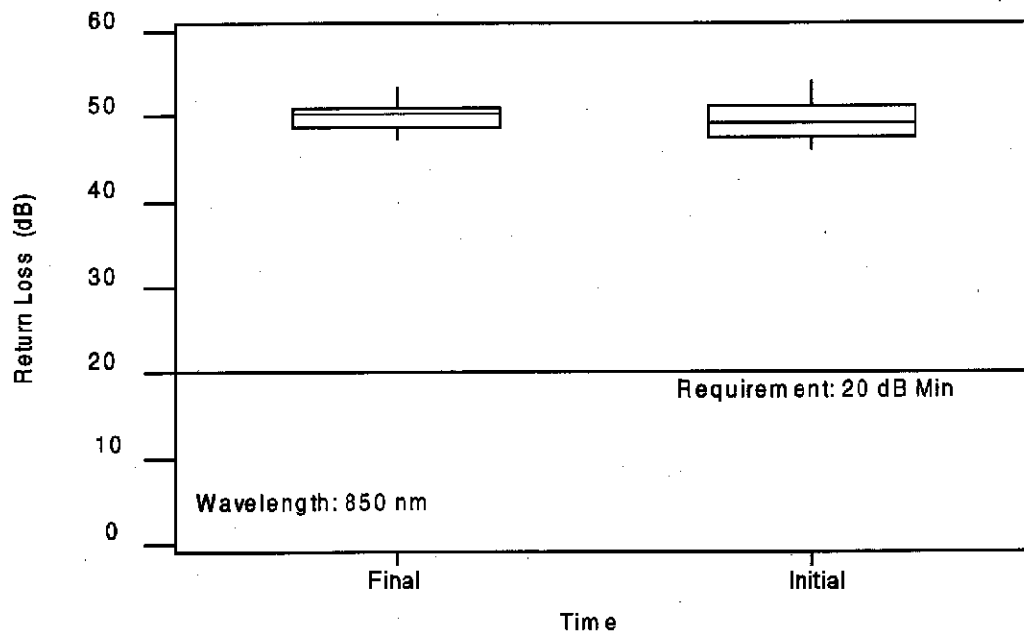
Return Loss Before and After Twist Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



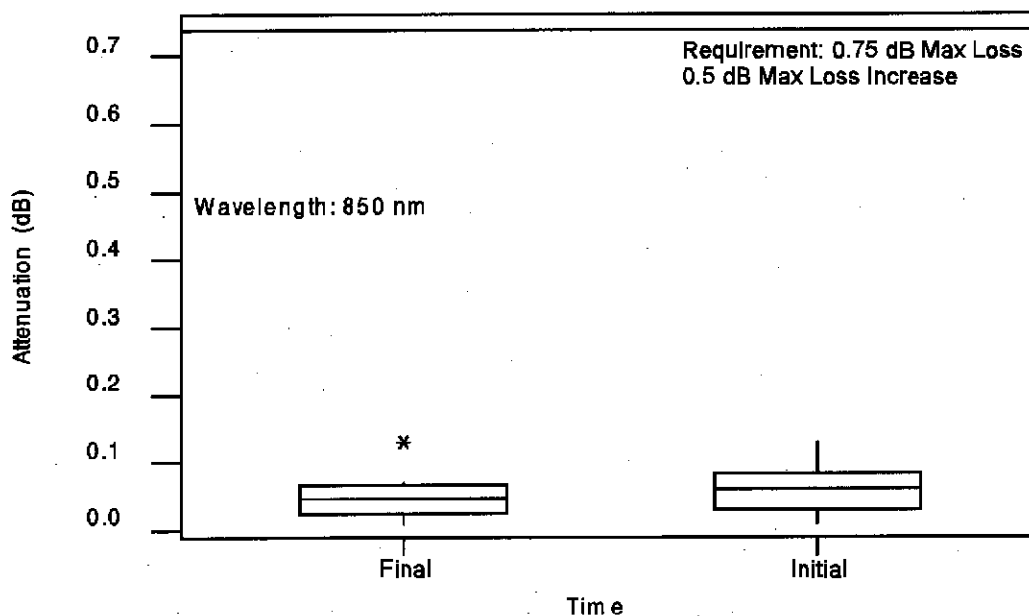
Transmission Characteristics Before and After Cable Retention - Axial Pull  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



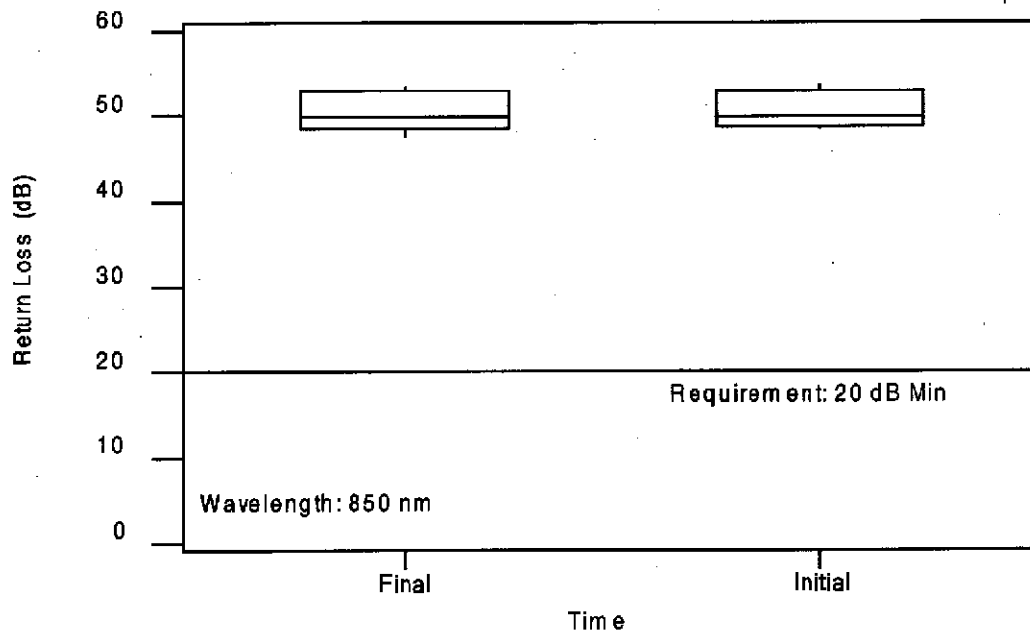
Return Loss Before and After Cable Retention - Axial Pull  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



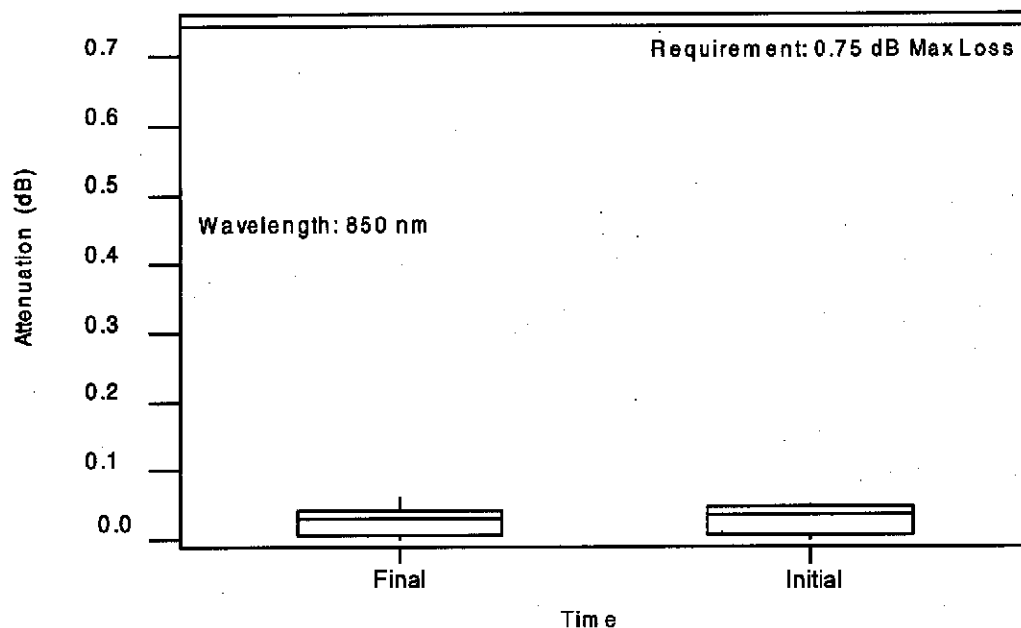
Transmission Characteristics Before and After Cable Retention - Right Angle Pull  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



Return Loss Before and After Cable Retention - Right Angle Pull  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



Transmission Characteristics Before and After Impact Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber



Return Loss Before and After Impact Test  
Tyco Electronics LC Cable Assemblies Made With 1.6 mm Riser Rated Cable and 50/125  $\mu$ m Fiber

