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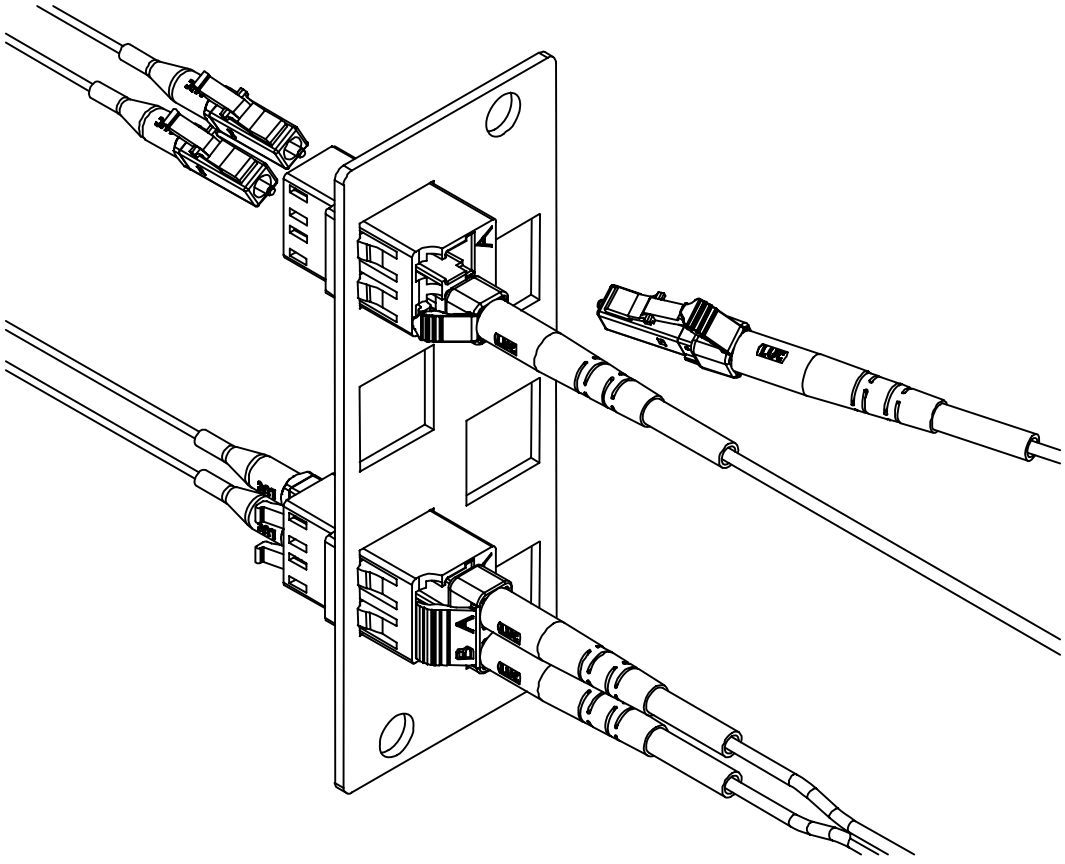
Leading Optical Innovations



LC Product Specification

640-252-056
D02AK0036
Issue 5
June 30, 2006

LC Product Specification

General Definition:

The LC Connector Product is a robust optical connector designed to support Telecom and Datacom networks. The connector family includes but not limited to jumper connectors, Behind-the-Wall connectors (BTW), adapters, attenuators, modular adapters, device receptacles, jumpers, an assortment of connector modules and panels, and installation tool kits and consumable kits. The connector is defined as a small form factor connector (SFFC) with significant size reduction relative to traditional connectors, typically 50% smaller than standard SC and ST®fiber products. The square connector housing uses unique trigger and latch structures and a tunable cylindrical ferrule. The LC Connector family was designed to provide a high performance SFFC incorporating traditional technology, advances in latching systems, and versatility for both singlemode and multimode fiber applications.

Terms of Specification:

The specification document is intended to provide users of OFS LC Connector products a level of confidence and means of understanding the characteristics of purchased product. The product is designed and should be manufactured according to the specification document. The product specification serves as a guideline to the features and performance of the product, and is subject to change without notice.

Definition of Products:

LC Jumper Connectors: Robust family of connectors designed to mount on 1.6 mm fiber cordage and intended to meet the Telcordia GR-326-CORE, Issue 3, for Type I Media (typically 3.0mm cordage). Note: Telcordia GR-326-CORE, Issue 3 exceptions for smaller size and future changes for SFF connectors.

LC BTW Connectors: Shorter LC connectors designed for 900 micron buffered fiber. This product is intended to meet Telcordia GR-326-CORE, Issue 3 for Type II Media (900 micron buffered fiber).

LC Jumpers: Connectorized 1.6mm cordage in various lengths and fiber counts. Jumpers are produced in a vast array of hybrid configurations allowing interconnection between LC based product and other connector styles. These products are intended to meet Telcordia GR-326-CORE, Issue 3 for Type I Media.

LC Adapters: Two port configuration for joining two LC connectors. The adapter contains the alignment sleeve for the precise alignment of the connector ferrules. Available in simplex, duplex and higher density configurations based on application needs. See also 0dB Modular Adapters.

LC Attenuators & Modular Adapters: Attenuator products are configured as a Build-On style or a Modular Adapter. Build-On Attenuators are one-piece designs that combine an LC Connector and adapter and are available in several attenuation values. The Modular Adapters are Customer assembled from two separate single port adapters, a base and a cap. The cap is available in 0-dB and attenuated values. Each attenuator product reduces optical power internally.

LC Device Receptacles: Device ports provide a mechanism for interfacing connectors to electronic subpackages (typically T.O. Cans). LC device receptacles are available in simplex and duplex configurations.

Product Identification:

LC products are easy to identify in accordance with industry standards:

- Blue represents singlemode
- Beige represents multimode
- Green represents singlemode APC (Angled Physical Contact)
- A & B port identification is on duplex adapters in accordance with TIA 568

Safety Precautions:

Optical fibers may emit radiation if the far end is connected to a working laser or LED. Never view the fiber end of a cable, patchcord, or plug with the naked eye or any optical instrument until absolute verification is established that the fiber is disconnected from any laser or LED source.

* ST® is a registered trademark of OFS, Inc.

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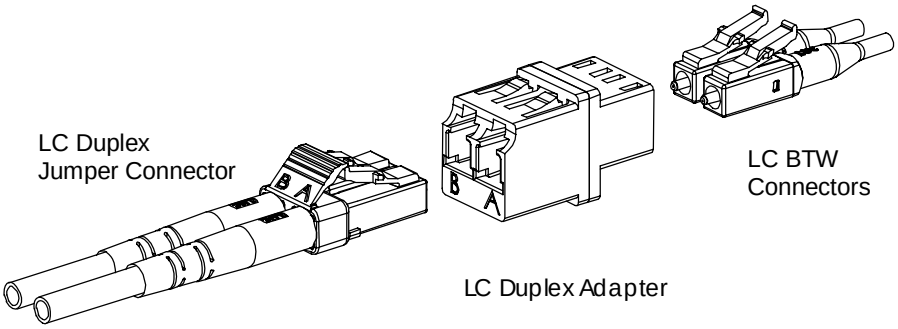
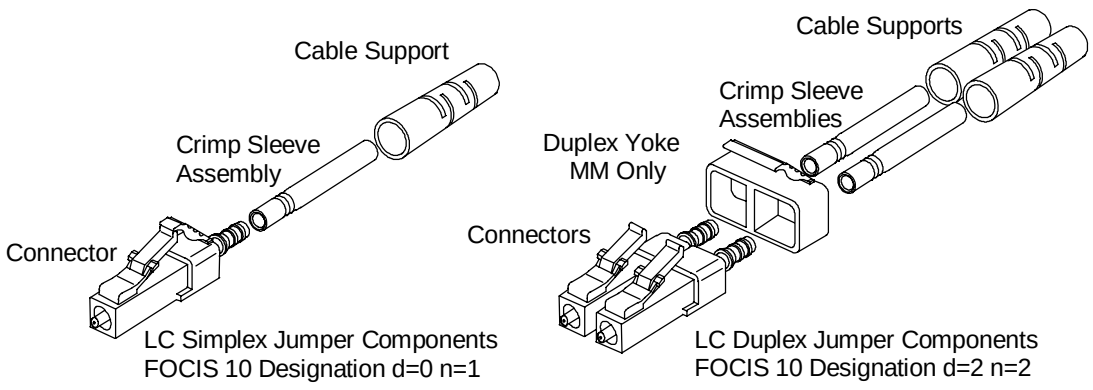
1.0 LC Connector Specification

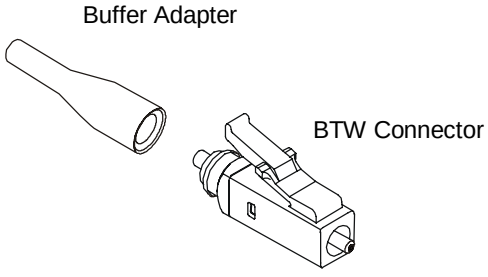
1.0 - LC Connector Specification



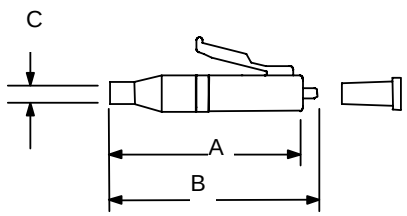
1.1 - LC Connector Application



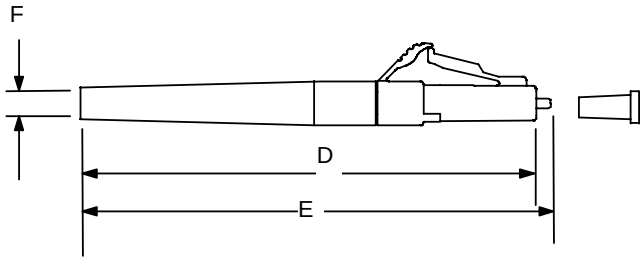
1.2a - LC Jumper Connectors: Exploded View



1.2b - LC BTW (Behind the Wall) Connector: Exploded View



BTW Connector



Jumper Connector

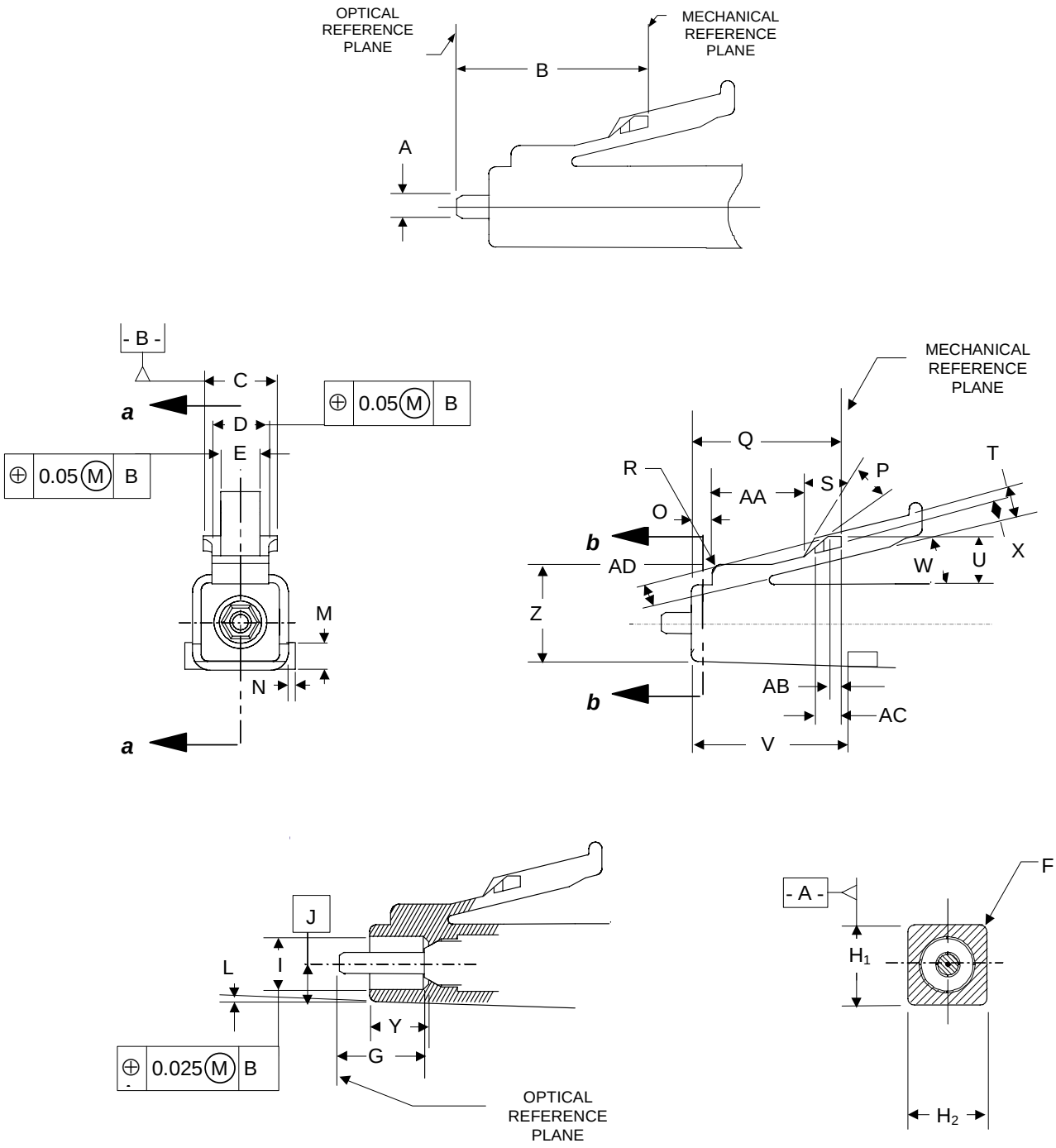
1.3 - LC Connector Footprint Dimensions

REF.	DIMENSIONS mm	
	Minimum	Maximum
A	-	30
B	-	32
C	0.7	1.4
D	-	49
E	-	51
F	1.8	3.4

1.4 - LC Connector Materials

Connector Part	Material	UL 94 Rating	Oxygen Index
Unibody Housing	Engineering Plastic	V-0	38%
BTW Housing	Engineering Plastic	V-0	47%
BTW Extender Cap	Engineering Plastic	V-0	38%
Cable Support	Thermoplastic Elastomer	V-0	30%
Heat Shrink Tubing	Polyolefin (flame retardant)	UL/CSA Recognized [2]	-
Buffer Adapter	PVC	V-0	28%
Simplex Trigger/Duplex Yoke	Nylon	V-0	31%
Spring	Metal	-	-
Ferrule	Zirconia	-	-
Crimp Sleeve	Metal	-	-
Jumper Ext. Cap Insert	Metal	-	-
Ferrule Flange	Metal	-	-
Ferrule Flange Tubing	Teflon® PTFE [1]	V-0	95%
Dust Cap	Engineering Plastic	V-0	30%

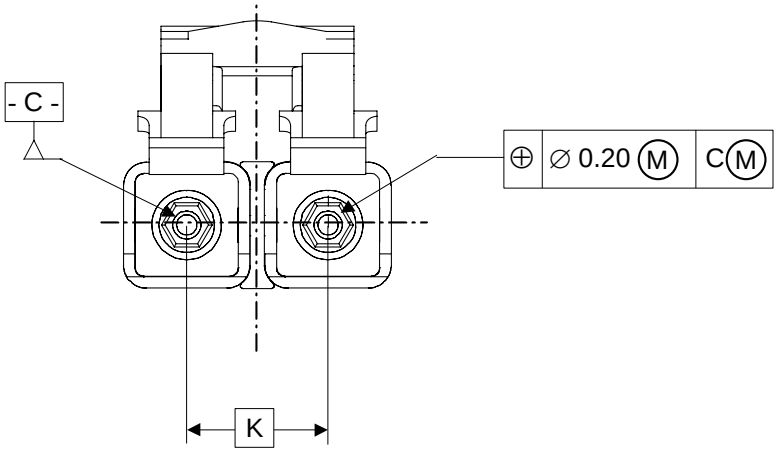
Notes:
1. Teflon is a registered trademark of Dupont
2. UL 224, 125 C, 600V, VW-1



Section *a-a*

Section *b-b*

1.5a – LC Simplex Connector Illustrations



1.5b - LC Duplex Connector Illustration

1.5c – LC Connector Specifications for Intermateability			
Dim.	Min. (mm)	Max. (mm)	Notes
A	1.2485	1.2495	diameter
B	10.3	10.5	1
C	4.2	4.4	
D	3.2	3.35	
E	2.2	2.4	
F	0.3	0.5	radius
G	4.88	4.98	ferrule extension
H_1	4.42	4.52	
H_2	4.42	4.52	
I	3.0	3.2	diameter
J	H/2	H/2	
K	6.25		basic dimension, 6
L	0.0	0.2	degrees, 5
M	1.07	-	
N	0.56	-	
O	1.1	1.3	
P	21	-	degrees, typical
Q	8.5	8.7	
R	0.4	0.6	radius
S	30	-	degrees, typical
T	1.4	1.6	
U	2.7	2.9	
V	12.2	-	
W	14	-	degrees, typical
X	0.5	0.7	

Y	3.3	3.5	
Z	5.6	5.7	
AA	5.2	5.4	
AB	0.3	0.5	
AC	1.3	1.5	
AD	1.2	1.4	

NOTE 1. Dimensions B and G are given for a plug endface when not mated. The ferrule is movable by a certain axial compression force, with direct contacting endface, and therefore dimensions B and G are variable. Ferrule compression force shall be 5.0 N to 6.0 N when the position of the optical datum target is moved to the range 9.6 mm to 10.2 mm.

NOTE 2. Dome eccentricity of the spherically polished endface shall be less than 50 μm.

NOTE 3. A Chamfer or Radius is allowed to a maximum depth of 0.5 mm from the ferrule endface.

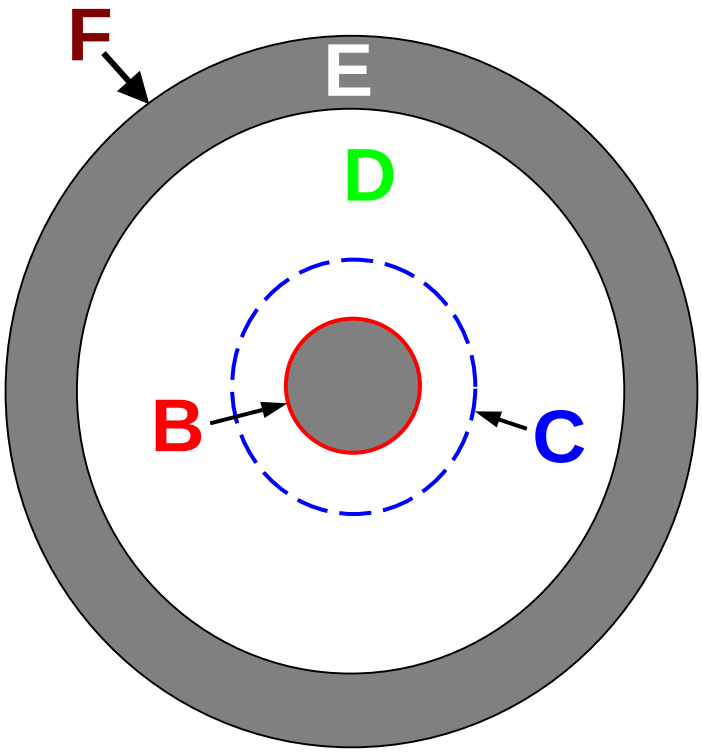
NOTE 4. These dimensional requirements apply to the finished ferrule, after all polishing procedures have been completed.

NOTE 5. Taper, dimension L, is applied to the surfaces associated with dimension/feature H_1 and H_2

NOTE 6. Each of the units in the duplex connector shall comply with all of the dimensions of Figures 1.5a and 1.5b

1.6 – Ferrule Surface Requirements
(SM only)
Issued June 1, 2000

Definition of Regions of Ferrule End



B = FIBER HOLE

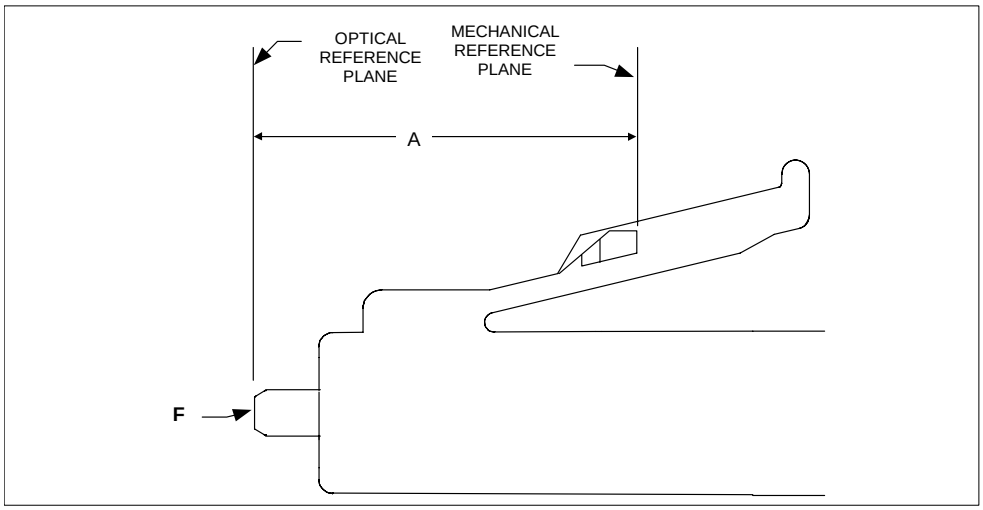
C = FERRULE SURFACE
FERRULE END SURFACE COVERING AREA FROM FIBER HOLE TO 250 MICRON DIAMETER

D = FERRULE PEDESTAL
ALL REMAINING FERRULE END SURFACE FROM 250 MICRON DIAMETER TO CHAMFER

E = CHAMFER

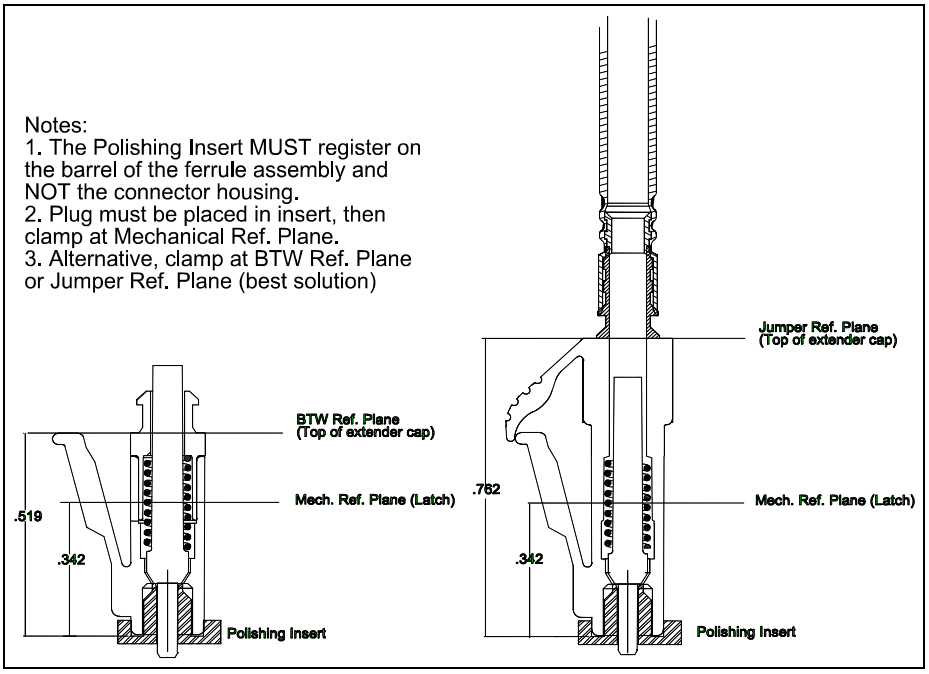
F = OUTSIDE CYLINDERICAL SURFACE

DEFECT	C	D	F
VOIDS and BLACK SPOTS - SINGLEMODE	➢ Voids and black spots < 2.0 μm do not count. ➢ Maximum diameter < 10 μm. Cannot touch the fiber hole ➢ Sum of diameters of voids and black spots < 30 μm.	➢ Voids and black spots < 2.0 μm do not count. ➢ Maximum diameter voids < 25um. ➢ Maximum diameter black spots < 100 μm ➢ Sum of diameters of voids and black spots < 100 μm.	➢ Voids and black spots <10 μm dia. do not count. ➢ Maximum diameter voids < 50 μm. Sum of all void diameters < 150 μm. ➢ Maximum diameter black spots < 150 μm. Sum of all black spot diameters < 500 μm. ➢
VOIDS and BLACK SPOTS - MULTIMODE	Maximum allowable diameter of: ➢ Voids < 10 μm ➢ Black spots < 10 μm	Max. allowable diameter of: ➢ Voids < 25 μm ➢ Black Spots < 100 μm	Max. allowable diameter of: ➢ Voids < 50 μm ➢ Black Spots < 150 μm
CHIP – Fiber Hole	Maximum length of chip < 40 μm Maximum width of chip < 3 μm		
CHIP – Pedestal Edge		Max. length of chip < 100 μm Max. width of chip < 50 μm Max. depth of chip < 20 μm	
SCRATCHES	Maximum width < 3 μm.		
SURFACE ROUGHNESS	0.1 μm R_a (arithmetic avg.) Max.	0.1 μm R_a (arithmetic avg.) Max.	
CRACKS	None allowed in ferrule	None allowed in ferrule	None allowed in ferrule
CHAMFER	Chamfer around fiber hole < 1 μm depth		



1.7 - LC Connector Ferrule Extension and Contact Force		
Requirements for ferrule travel and contact force:		
	IF	**THEN**
1	$F = 0$	$A \geq 10.45$ mm
2	$A \leq 10.2$ mm	$F \geq$ 5 N (510 gf)
3	$A \geq 9.6$ mm	$F \leq$ 6 N (612 gf)

Note: Dimension A is for finished ends after all polishing has been completed



1.8 - LC Reference Dimensions (inches) for Polishing Fixturing

1.9 - LC Connector Coding (or equivalent)

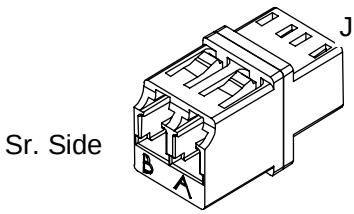
P	1	2	00	A	-	Z	-	125
Plug	**Series**	**Type** 0-MM 1-SM 2-APC	**Style** 00-Jumper Plug 01-BTW Plug	**Version**		**Ferrule** Z-Zirconia		**Hole Size**

1.10 - LC Connector Color Coding

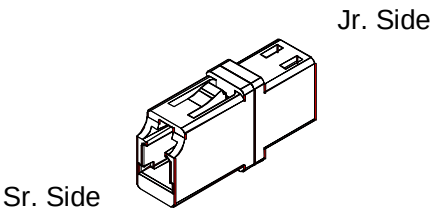
Connector	Housing Color	Cable Support Color
SM	Blue	White
MM	Beige	White
APC	Green	White

2.0 - LC Adapter Specification

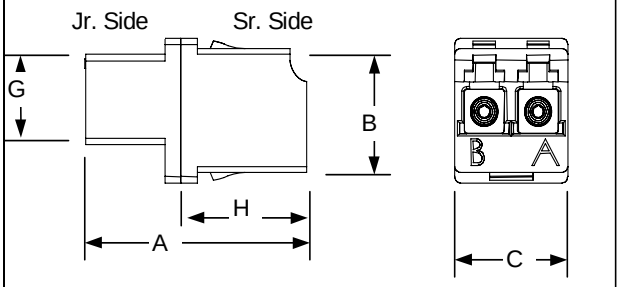
2.0 - LC Adapter Specification



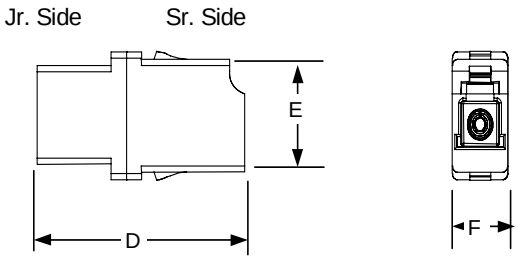
2.1a - LC Duplex Adapter



2.1b - LC Simplex Adapter

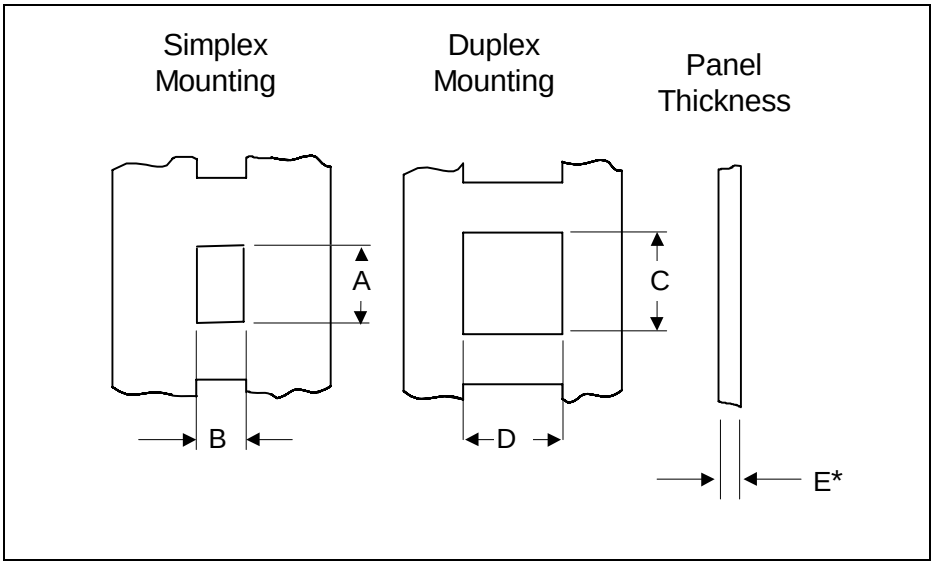


2.2a - LC Duplex Adapter Footprint Dimensions



2.2b - LC Simplex Adapter Footprint Dimensions

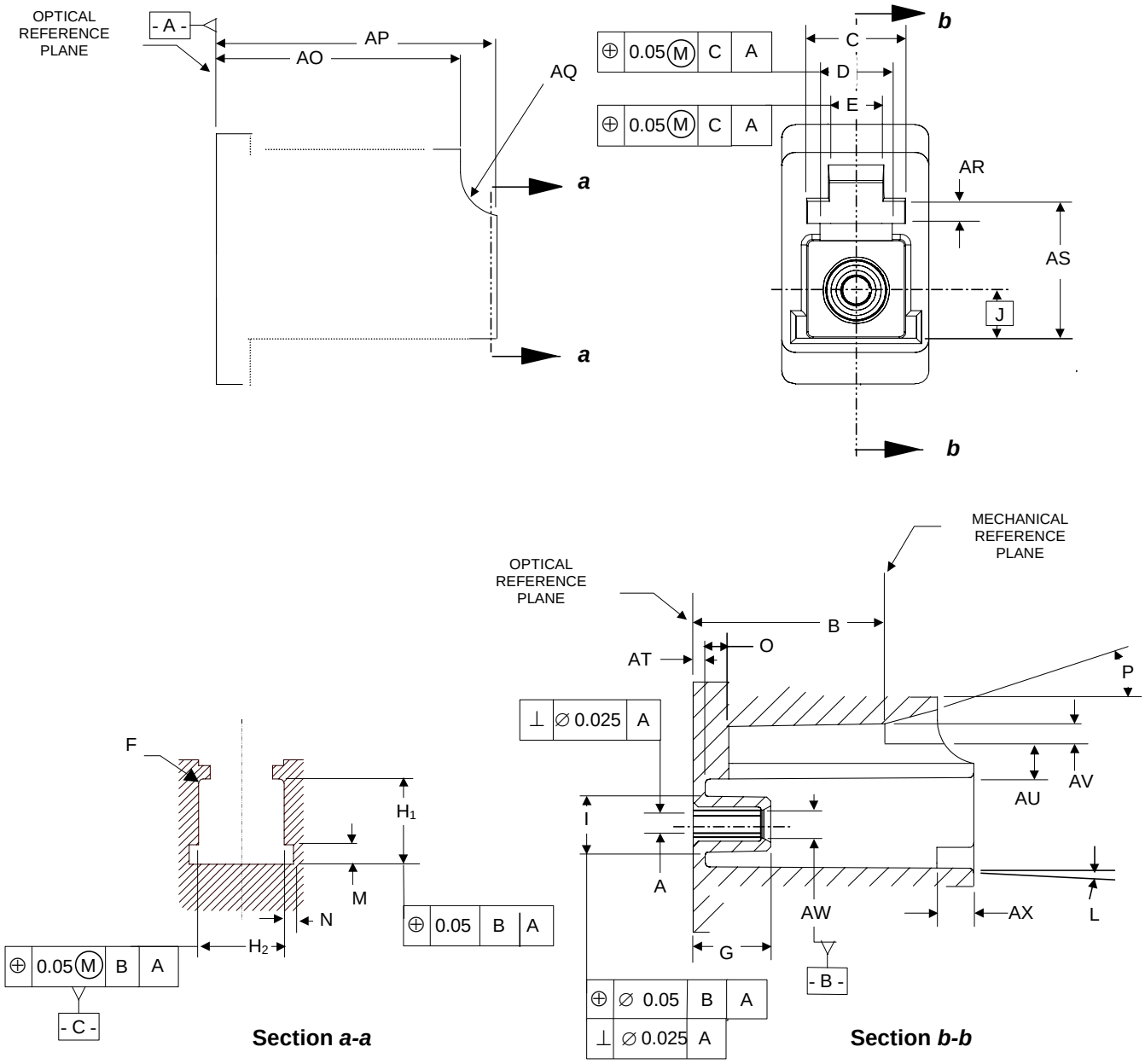
REF.	DIMENSIONS		
	Minimum	mm	Maximum
A	25.0		30.0
B	13.0		13.1
C	13.0		13.1
D	25.0		30.0
E	11.5		11.6
F	6.9		7.0
G	10		10.1
H	14.55		14.65



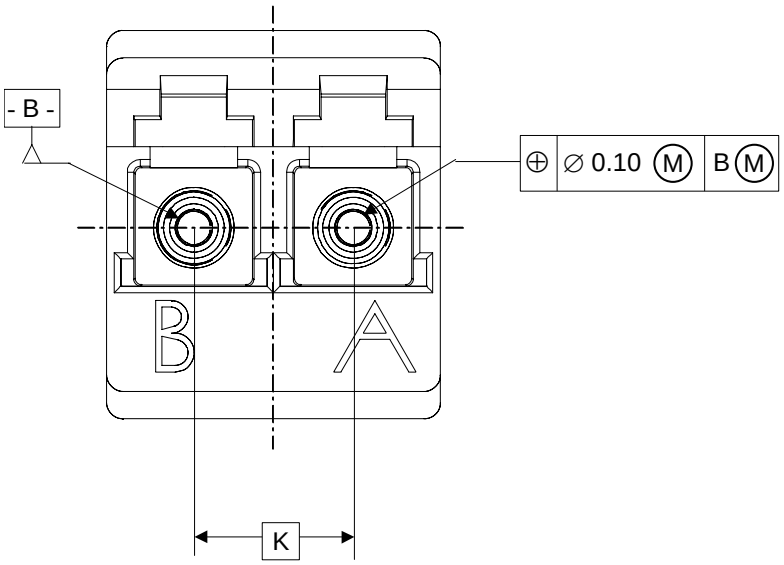
2.3 - Panel Cutout Dimensions for Mounting LC Adapters		
Dimension	Minimum (mm)	Maximum (mm)
A	11.7	11.8
B	7.1	7.2
C	13.2	13.4
D	13.2	13.4
E*	1.2	1.7

* Panel thickness “E” applies after surface preparation i.e. painting, etc.

2.4 - LC Adapter Materials			
Connector Part	**Material**	**UL 94 Rating**	**Oxygen Index**
Adapter Housing	Engineering Plastic	V-0	47
SM Sleeve	Zirconia	-	-
MM Sleeve	Metal	-	-



2.5a - LC Simplex Adapter Illustrations



2.5b - LC Duplex Adapter Illustrations

2.5c – LC Adapter Specifications for Intermateability			
Dim.	Min. (mm)	Max. (mm)	Notes
A	-	-	diameter 1, 2, 3
B	9.9	10.0	
C	4.5	-	
D	3.4	3.5	
E	2.6	2.7	
F	0.2	0.3	radius
G	4.0	4.1	
H_1	4.65	4.75	
H_2	4.65	4.75	
I	2.87	2.97	diameter
J	2.29		basic dimension
K	6.25		basic dimension
L	0.0	0.2	degrees, 5
M	1.0	1.1	
N	0.5	0.6	
O	-	1.2	
P	15	-	degrees, typical
AO	11.1	12.8	
AP	14.5	14.7	
AQ	2.2	2.4	radius
AR	1.1	1.2	
AS	6.6	6.8	
AT	0.6	0.7	

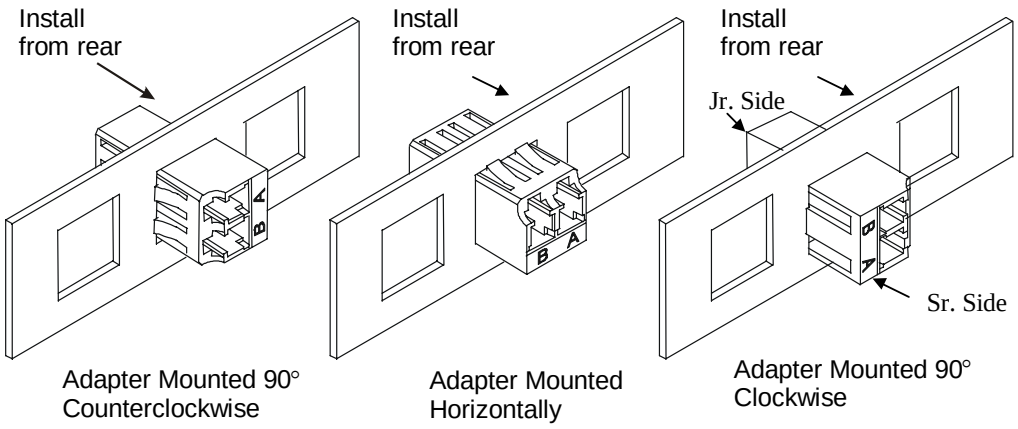
AU	1.8	2.0	
AV	1.0	1.1	
AW	1.4	1.5	diameter
AX	1.9	-	

NOTE 1. The connector alignment feature is a resilient (split) alignment sleeve, and the sleeve may be either fixed or floating. For a fixed sleeve the positional tolerance of dimension I applies to both A and I dimensions. For a floating sleeve, a gauge pin inserted in the sleeve must be capable to move freely into a position such that it is coincident with datum B. Dimension A defines the inner diameter of the alignment feature.

NOTE 2. The connector alignment feature is an alignment sleeve. The feature must accept a pin gauge to the center of the adapter with a force of 1.0 N to 2.5 N under the condition that another pin gauge is inserted into the feature from the other side until both pin gauges butt against each other. The pin gauge shall be 1.2490 mm. The center of the adapter is defined by the left side position of dimension B.

NOTE 3. Each of the units in the duplex adapter shall comply with all of dimensions of Figures 2.5a and 2.5b.

NOTE 4. Taper, dimension L, is applied to the surfaces associated with dimension/feature H_1 and H_2.



2.6 - LC Duplex Adapter Mounting Options

2.7 - LC Adapter Coding (or equivalent)

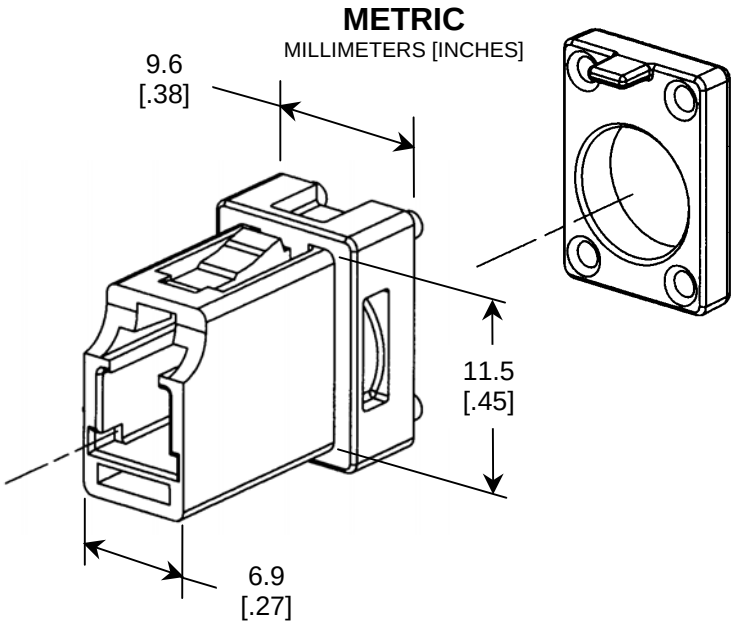
C	1	2	0	0	B	-	1
Adapter	**Series**	**Type** 0-MM 1-SM 2-APC	**Style** 0-LC to LC	**Version** 0-Flanged 1-Flanged with Sr. and Jr. Profiles	**Sleeve** A-Zirconia B-Metal		**Ports** 1-Simplex 2-Duplex

2.8 - LC Adapter Color Coding

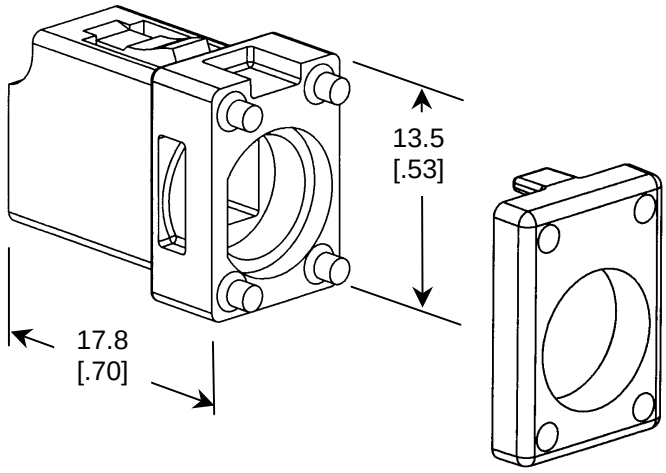
Adapter	Housing Color
SM	Blue
MM	Beige
APC	Green

3.0 – LC Device Receptacle Specification

3.0 - LC Device Receptacle Specification



3.1a - LC Simplex Device Receptacle - Front View



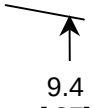
3.1b - LC Simplex Device Receptacle – Rear View

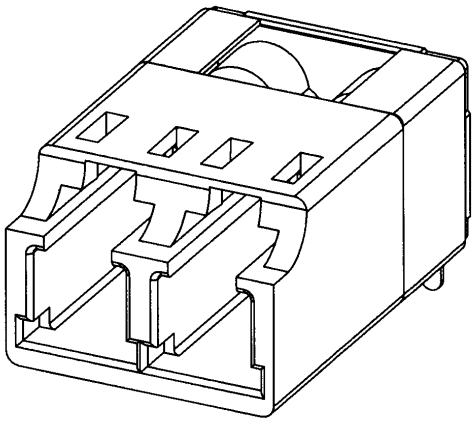
SPECIFICATIONS

- Compliant with FOCIS 10 Connector Standard (to be TIA/EIA-604-10).
- Housing material is an engineered thermoplastic.
- Non-keyed connector adapter housing.
- Housing accepts a ferrule alignment and device insert.
- Insert provides LC ferrule stop and known optical reference plane.
- Device insert bore is cylindrical, with non-rotation flat in outer diameter.
- Two-piece design aids in device installation.
- The assembled adapter is mounted using the molded-in cantilever latching arms.
- Includes one simplex LC bore dust cover.

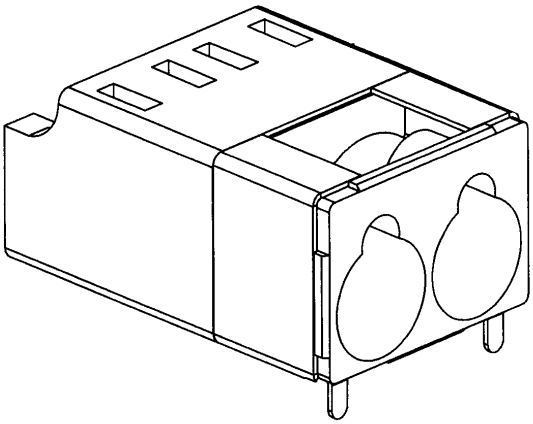
FEATURES

This device adapter couples one singlemode LC connector to customer supplied transmitting or receiving device. The simplex LC half of this device follows the small form-factor LC adapter standard. Two-piece design allows customers to install a ferrule alignment and device insert inside the housing. Once the device is mounted in the insert, and the insert assembly is installed into the device adapter housing, the rear-housing unit is pressed onto the retaining pins.





3.2a - LC Duplex Device Receptacle – Front View



3.2b - LC Duplex Device Receptacle – Rear View

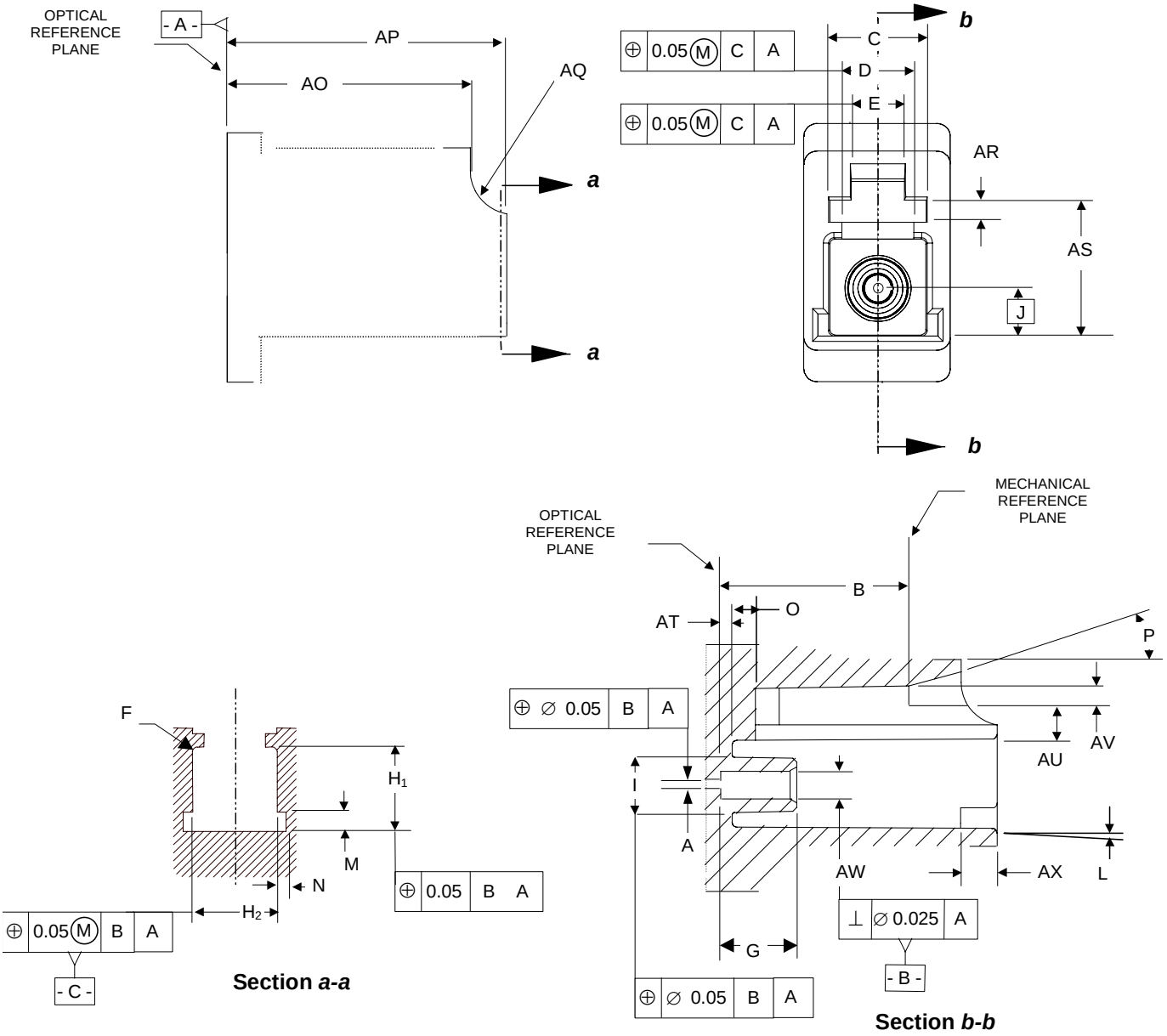
SPECIFICATIONS

- Compliant with FOCIS 10 Connector Standard (to be TIA/EIA-604-10).
- Housing material is a glass filled thermoplastic.
- Non-keyed connector adapter housing.
- Positive LC ferrule stop, provides known optical reference plane.
- Single piece design, with mounting clip.
- Clip has solder-able mounting tabs. Tab widths are 0.040 in. and spaced 0.400 in.
- Single cylindrical device bore, with non-rotation tab notch.
- Vented device bores.
- Includes two simplex LC bore dust covers.

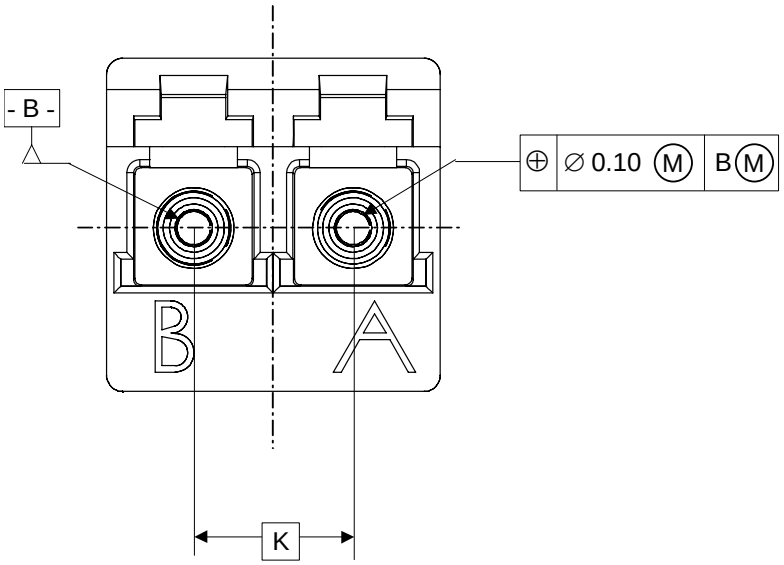
FEATURES

This device adapter will couple one or two simplex, or a duplex multimode LC connector to customer supplied transmitting and receiving devices. The duplex LC half of this device follows the small form-factor LC adapter standards. Single piece design, with mounting clip, allows customers to install devices and mount the adapter to electronic wiring boards. Securing the device adapter will be done by means of solder-able tabs on the retaining clip.

3.3 - LC Device Receptacle Materials			
Connector Part	**Material**	**UL 94 Rating**	**Oxygen Index**
Receptacle Housing	Engineering Plastic	V-1	28
Receptacle Back Plate	Engineering Plastic	V-1	28
Receptacle Insert	Metal	-	-



3.4a – LC Simplex Device Receptacle Illustrations



3.4b - LC Duplex Device Receptacle Illustrations

3.4 – LC Device Receptacle Specifications for Intermateability			
Dim.	Min. (mm)	Max. (mm)	Notes
A	0.5	0.8	See Grade Table 3b
B	9.9	10.0	
C	4.5	-	
D	3.4	3.5	
E	2.6	2.7	
F	0.2	0.3	radius
G	4.0	4.1	
H_1	4.65	4.75	
H_2	4.65	4.75	
I	2.87	2.97	diameter
J	2.29		basic dimension
K	6.25		basic dimension, 3
L	0.2	0.0	degrees, 4
M	1.0	1.1	
N	0.5	0.6	
O	-	1.2	
P	15	-	degrees, typical
AO	12.6	12.8	
AP	14.5	14.7	
AQ	2.2	2.4	radius
AR	1.1	1.2	
AS	6.6	6.8	
AT	0.6	0.7	

AU	1.8	2.0	
AV	1.0	1.1	
AW	-	-	See GRADE TABLE 3b
AX	1.9	-	

NOTE 1. The connector alignment feature is a rigid bore sleeve or a resilient alignment sleeve. Dimension AW defines the inner diameter of the alignment feature.

NOTE 2. The sleeve may be fixed or floating. For a fixed sleeve, the positional tolerance applies. For a floating sleeve, a gauge pin inserted in the sleeve must be capable to move freely into a position such that it is coincident with datum B.

NOTE 3. Each of the units in the duplex receptacle shall comply with all of dimensions of Figures 3.4a and 3.4b.

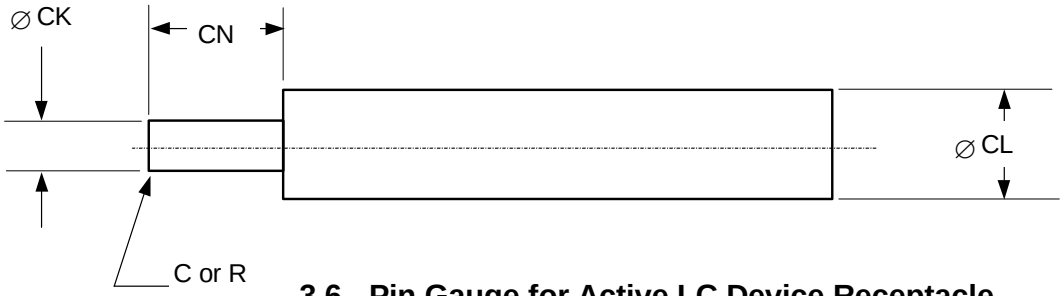
NOTE 4. Taper, dimension L, is applied to the surfaces associated with dimension/feature H_1 and H_2

3.5 - Active Device Receptacle Interface - Alignment Sleeve Grade

GRADE	N (mm)		NOTES
	MIN	MAX	
1	1.251	1.252	rigid bore sleeve, 1, 3
2	1.251	1.254	
3	1.251	1.257	
4			resilient alignment sleeve, 2, 3

NOTE 1. The connector alignment feature is a rigid bore sleeve. The dimension A shall be tested using two pin gauges. One pin gauge has the pin gauge grade number 1 μm larger than the maximum value of dimension A, the other pin gauge has the number pin gauge grade number 1 μm smaller than the minimum value of dimension A. The appropriate pin gauge shall be selected from the pin gauge grade table.

NOTE 2. The connector alignment feature is a resilient (split) alignment sleeve. The feature must accept a pin gauge completely to the left side of dimension G with a force of 1.0 N to 2.5 N. Insert the pin gauge completely, from only one side, the connector side of the active device receptacle interface. The pin gauge is defined in Table 4.



3.6 - Pin Gauge for Active LC Device Receptacle

3.7 – Pin Gauge Grade							
PIN GAUGE GRADE	CK (mm)		CL (mm)		CN (mm)		NOTES
	MIN	MAX	MIN	MAX	MIN	MAX	
1.249	1.2485	1.2495	2.6	4.4	4.2	15	resilient sleeve, 1
1.250	1.2495	1.2505					rigid bore sleeve, 1
1.253	1.2525	1.2535					
1.255	1.2545	1.2555					
1.258	1.2575	1.2585					
NOTE 1. Surface roughness should be 0,2 μm Ra and cylindricity is less than 0,5 μm.							

3.8 - LC Device Receptacle Coding (or equivalent)

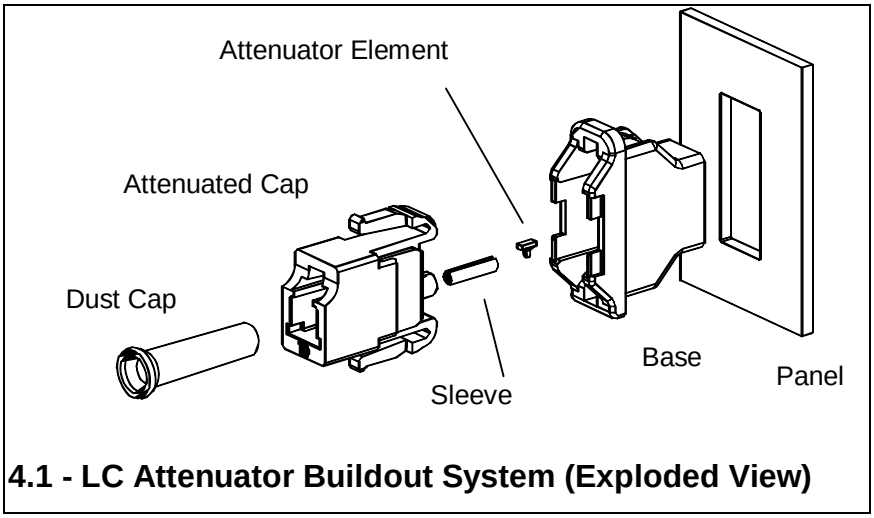
R	**1**	**1**	**0**	**1**	**B**	**-**	**3**
Receptacle	**Ports** 1-Simplex 2-Duplex	**Performance** 0-Standard 1-High Perf.	**Style** 0- No Pin 1-Pin 2- Threaded 3-Clip 4-Cover	0-No Latch 1-Latch	**Interface** A-Std. Ferrule Stop B-Bushing C-Lens Cavity		**Device Side** 1-Stepped Bore 2-Full Bore 3-Type “A” Bushing 4-Type “B” Bushing

3.9 - LC Device Receptacle Color Code

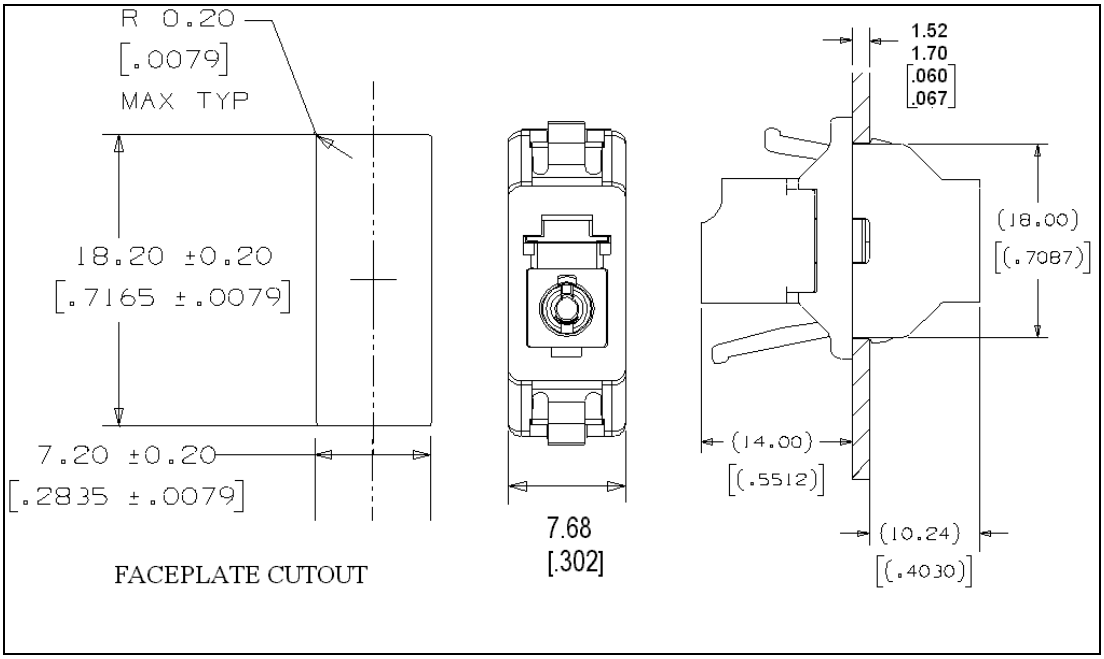
Device Receptacle	Housing Color
SM	Blue
MM	Black

4.0 – LC Attenuator Specification

4.0 - LC Attenuator Specification



4.1 - LC Attenuator Buildout System (Exploded View)



4.2 - LC Split Adapter/Attenuator Footprint Illustration

4.3 - LC Attenuator Materials and Specifications

Connector Part	Material	UL 94 Rating	Oxygen Index
Attenuator Cap	Engineering Plastic	V-0	48
Base	Engineering Plastic	V-0	48
Attenuator Element	Optical Plastic	H.B	T.B.D
Attenuator Sleeve	Zirconia	-	-

Specifications:	Units	Value
Physical		LC Split Adapter Type
Cap Color		0 dB = Blue, Attenuator = Yellow
Base Color		Black
Transmission		Singlemode
Nominal Attenuation @ 1550 nm and 0 dBm	dB	See Table-1 below
Attenuation Tolerance @ 1550 nm and 0 dBm	dB	See Table-1 below
Maximum Spectral Attenuation Variation (1300 to 1620 nm)	dB	See Note 1
Maximum Attenuation Variation Due to Incident Power	dB	See Note 2
Maximum Incident Optical Power Handling Capability	dBm	25
Reflectance	dB	Typically = –34, Maximum = -30
Operating Temperature	°C	-40 to 75
Matings over Life		200
Qualification Tests and Applicable Standards		See Table - 2

4.4 – SM Attenuation Levels and Performance

All numbers apply for 1550 nm and 0 dBm signals

PRODUCT CODE	ORDER COMCODE	NOMINAL* LOSS (dB)	TYPICAL STANDARD DEVIATION IN LOSS (dB)	NOMINAL LOSS TOLERANCE +/- (dB)
AALCS-00.5	108355363	0.5	.08	0.25
AALCS-01.0	108355371	1	.08	0.25
AALCS-01.5	108355389	1.5	.08	0.25
AALCS-02.0	108349457	2	.08	0.25
AALCS-02.5	108349440	2.5	.08	0.25
AALCS-03.0	108288481	3	.08	0.25
AALCS-03.5	108288440	3.5	.08	0.25
AALCS-04.0	108357963	4	.08	0.25
AALCS-04.5	108357971	4.5	.08	0.25
AALCS-05.0	108288473	5	.08	0.25
AALCS-05.5	108357989	5.5	.08	0.25
AALCS-06.0	108349432	6	.08	0.25
AALCS-06.5	108357997	6.5	.08	0.25
AALCS-07.0	108288465	7	.08	0.25
AALCS-07.5	108358003	7.5	.08	0.25
AALCS-08.0	108358011	8	.08	0.25
AALCS-08.5	108358029	8.5	.10	0.25
AALCS-09.0	108358037	9	.10	0.25
AALCS-09.5	108358045	9.5	.10	0.25
AALCS-10.0	108288457	10	.10	0.25
AALCS-11.0	108358078	11	.12	0.50
AALCS-12.0	108358094	12	.12	0.50
AALCS-13.0	108358128	13	.12	0.50
AALCS-14.0	108358144	14	.12	0.50
AALCS-15.0	108358169	15	.12	0.50
AALCS-18.0	108358193	18	.12	0.50
AALCS-19.0	108358201	19	.15	0.50
AALCS-20.0	108358219	20	.14	0.50

*The caps are laser marked with the nominal attenuation (dB)

4.5 - LC Attenuator Compliance to GR-910-CORE

Tests	Compliance	Notes
Baseline IL/RL	Yes	
Damage	Yes	
Thermal Aging	Yes	
Thermal Cycling	Yes	
Humidity/Condensation	Yes	
Dry Out-Thermal Cycle	Yes	
Vibration	Not Tested to GR-910-CORE	Tested to GR-63-CORE
Flex	Yes	
Twist	Yes	
Proof	Yes	
Transmission w/Applied Load	Yes	
Durability	Yes	
Impact	Yes	
End of Test	Yes	

4.6 - Spectral Flatness:

Attenuation increases at lower wavelengths. Attenuation for wavelengths other than 1550 nm is described by the following equations:

For $\lambda < 1550$ nm
$$\mathbf{L_S = A(1 + 3.88x10^{-4} (1550-\lambda))}$$

For $\lambda > 1550$ nm
$$\mathbf{L_S = A(1 - 3.88x10^{-4} (\lambda-1550))}$$

L_S = Predicted loss of a randomly selected attenuator in dB
A = Nominal Attenuation value in dB at 1550 nm and 0 dBm
λ = Wavelength in nm

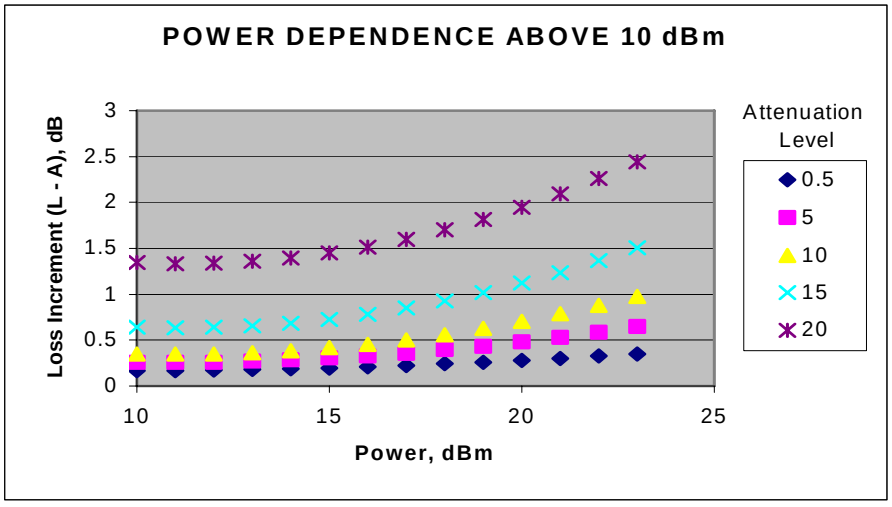
4.7 - Power Divergence:

Below 10 dBm the attenuation is not affected by the power level.
At 10dBm and above the loss depends on Power and Attenuation level and can be described by the following equation:

$$\mathbf{L_P = A + 0.213 - 0.0143\ P + 0.000806\ P^2 + 0.0826\ A - 0.00439\ A^2 + 0.000279\ A^3 - 0.00823\ AP + 0.000358\ AP^2}$$

L_P = Predicted loss of a randomly selected attenuator in dB
A = Nominal Attenuation value in dB at 1550 nm and 0 dBm
P = Power in dBm

This dependence is shown in plot.

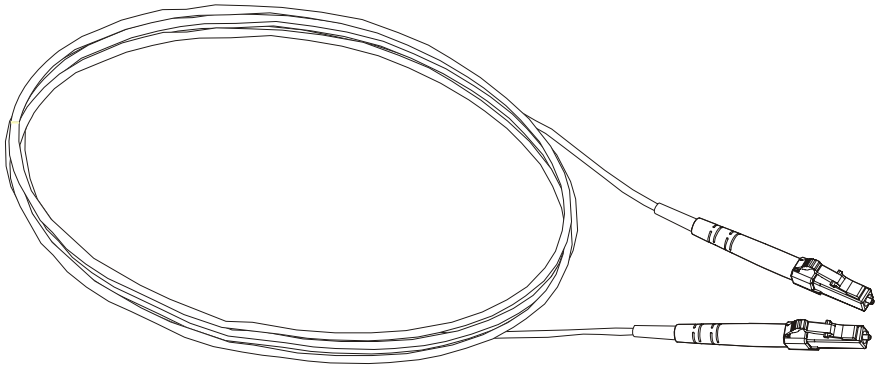


4.8 - LC Attenuator Coding (or equivalent)					
A	**A**	**LC**	**S**	**-**	**3.0**
|	|	|	|		|
Attenuator	**Type**	**Connector Type**	**Style**		**Attenuation**
	A – Buildout B - Buildon		S - Singlemode		# -IL of Attenuated Cap Cap-0 dB Cap Base-Base Assy-0 dB Cap/base Assembly

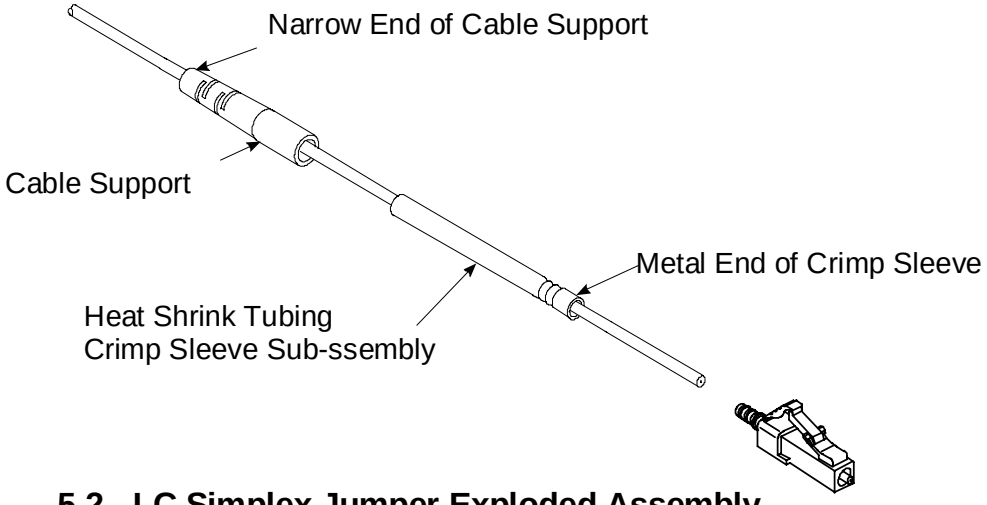
4.9 - LC Attenuator Color Code	
Attenuator	**Housing Color**
SM – Attenuated Cap	Yellow
0-dB Cap	Blue
Base	Black

5.0 – LC Jumper Specification

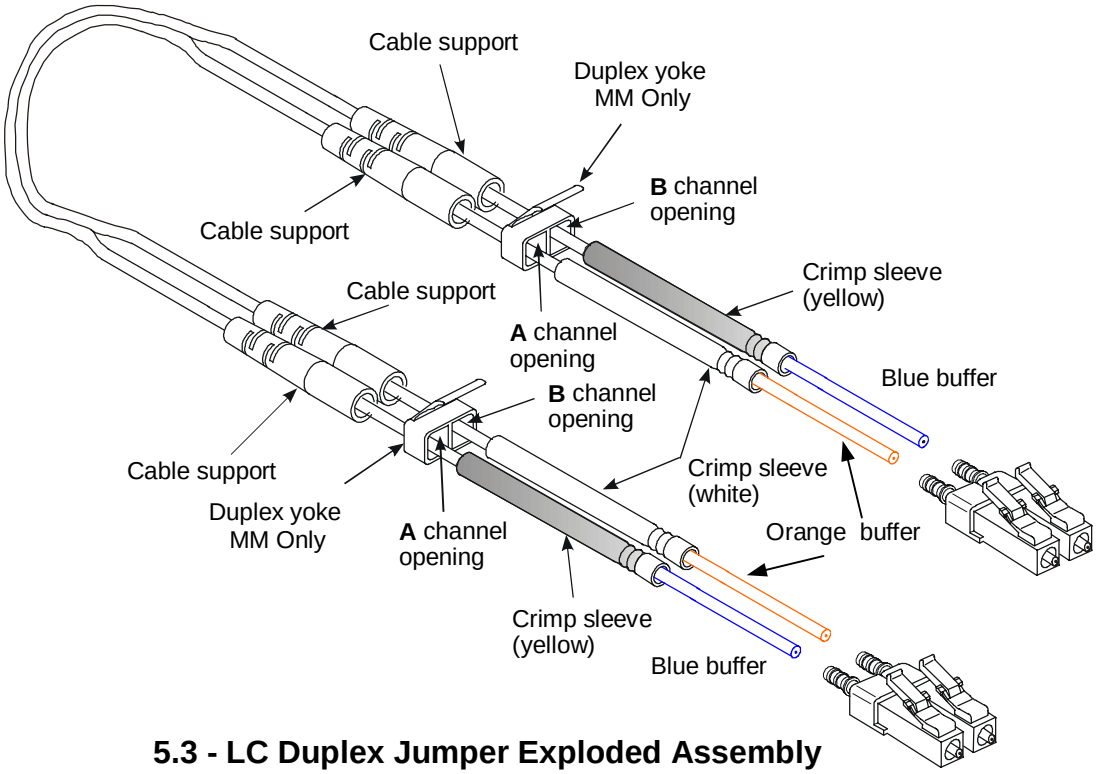
5.0 - LC Jumper Specification



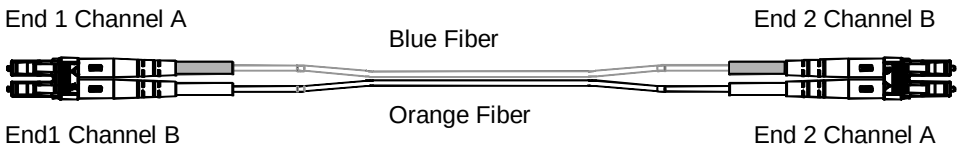
5.1 - LC Simplex Jumper on 1.6mm Cordage



5.2 - LC Simplex Jumper Exploded Assembly



5.3 - LC Duplex Jumper Exploded Assembly



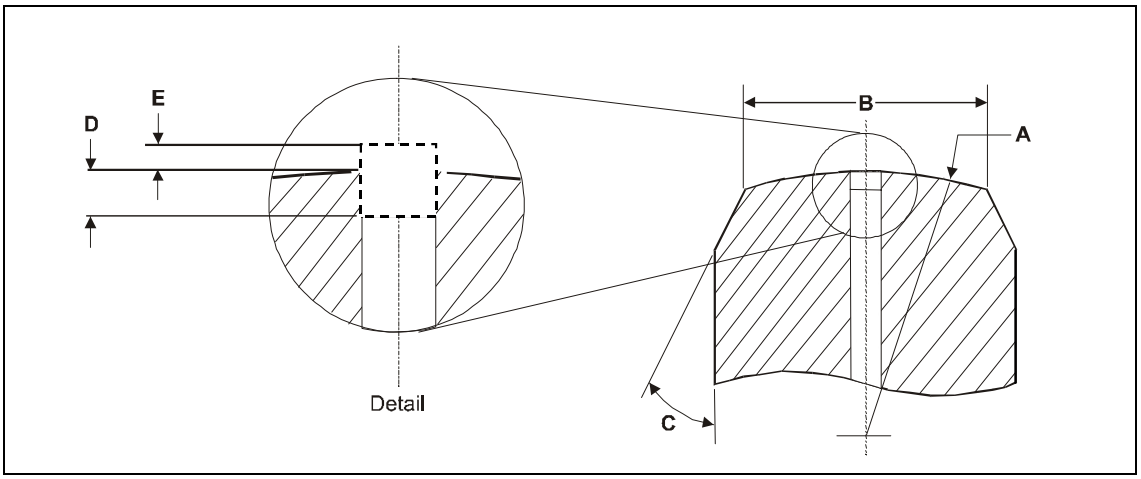
5.4 - LC Duplex MM Jumper as per TIA/EIA

5.5 - LC Jumper/Connector Materials			
Connector Part	**Material**	**UL 94 Rating**	**Oxygen Index**
Unibody Housing	Engineering Plastic	V-0	38%
BTW Housing	Engineering Plastic	V-0	47%
BTW Extender Cap	Engineering Plastic	V-0	38%
Strain Relief Boot	Thermoplastic Elastomer	V-0	30%
Heat Shrink Tubing	Polyolefin (flame retardant)	UL/CSA Recognized [2]	-
Buffer Adapter	PVC	V-0	28%
Simplex Trigger/Duplex Clip	Nylon	V-0	31%
Spring	Metal	-	-
Ferrule	Zirconia	-	-
Crimp Sleeve	Metal	-	-
Jumper Ext. Cap Insert	Metal	-	-
Ferrule Flange	Metal	-	-
Ferrule Flange Tubing	Teflon PTFE [1]	V-0	95%
Dust Cap	Engineering Plastic	V-0	34%
1.6mm Minicord		UL 1666	
Jacket	PVC		
Buffer	Nylon		
Strength Material	Arimid Yarn		

Notes:

1. Teflon is a registered trademark of Dupont
2. UL 224, 125 C, 600V, VW-1

5.6 - Minicord® Technical Specifications	
Multimode Fiber, Core/Cladding	62.5/125 microns
Singlemode Fiber, Core/Cladding	8.3/125 microns
Fiber Coating	250 micron
Buffer Diameter	0.9 mm
Jacket Diameter	1.6 mm
Fiber Proof Test	100 CPIs (689 N/mm^2)
Cordage Proof Test	20 lb. (88.9 N)

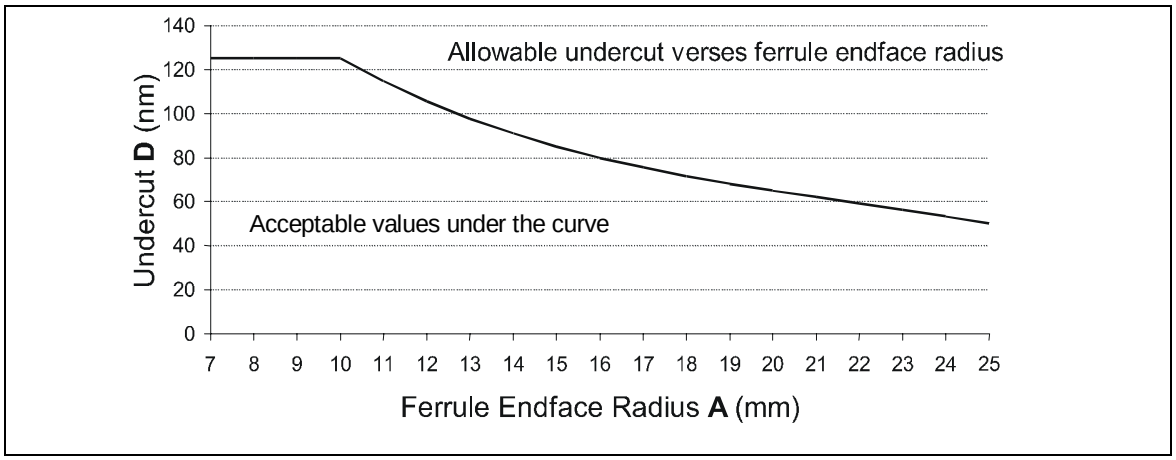


Note: The dimensions in table below are for reference only and apply after polishing procedures have been completed.

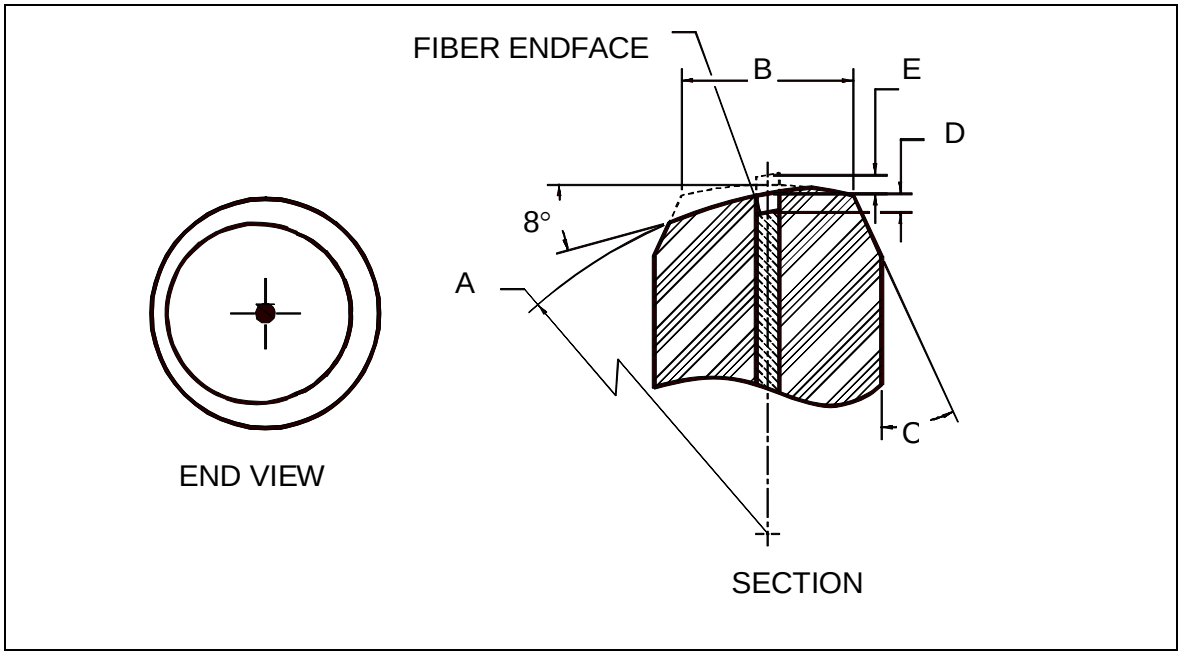
5.7 - LC Singlemode Ferrule Endface Geometry

Item	Reference	Minimum	Nominal	Maximum	Dimensions
Radius	A	7	12	25	mm
Pedestal*	B	0.6	---	0.85	mm
Dome ECC.	—	0	—	0.070	mm
Chamfer	C	25	30	35	degrees
Undercut	D	—	—	See Graph A	nm
Protrusion	E	—	—	50	nm

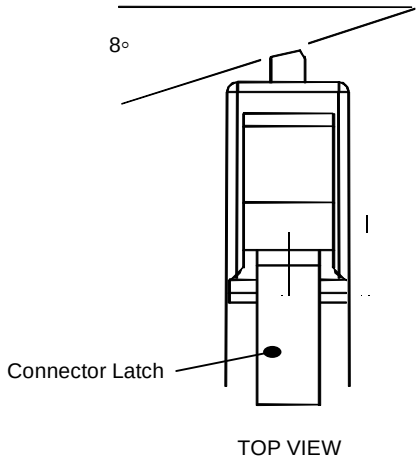
* - Pedestal diameter after polishing.



Graph A. Recommended Fiber Undercut (Table Reference D)



5.8 - LC APC Ferrule Endface Geometry					
Item	**Reference**	**Minimum**	**Nominal**	**Maximum**	**Dimensions**
Radius	A	5	-	12	mm
Pedestal	B	0.6	-	0.85	mm
Dome ECC.	-	0	-	0.070	mm
Chamfer	C	25	-	35	degrees
Undercut	D	-	-	100	nm
Protrusion	E	-	-	50	nm



5.9 - LC APC Ferrule/Angle Orientation

5.10 - LC Factory Made PC Patch Cord – Specifications

Fiber Type	Singlemode PC	APC	Multimode
Loss[1]: Avg./Std. Dev.	0.08 dB/0.07 dB (Tuned)*	0.08 dB/0.06 dB	0.10 dB/0.10 dB
Loss[1]: Maximum	0.25 dB[3] 0.15 dB (BT)[4]	0.30 dB 0.15 dB (BT)[4]	0.5
Return Loss Minimum	55 dB	65 dB	20 dB
Cable Retention[2] (1.6mm) 0° Axial Pull	10 lbs./44.5 N	10 lbs./44.5 N	10 lbs./44.5 N
Mating Durability (500 Reconnects) Insertion Loss Change	< 0.2 dB	< 0.2 dB	< 0.2 dB
Temp. Stability (-40 °C to 75 °C) Insertion Loss Change	< 0.3 dB	< 0.3 dB	< 0.3 dB

1 Complete connection concatenated statistics 8.8/125 fiber, 62.5/125 fiber. Dry connection.
2 Values represent axial force on connector with axial pull on cordage. See cordage requirements in Section 5.6. Cable dependent to cause permanent light transmission failure. Figures representative of use with OFS jumper cordage or equivalent.
3 ** The performance is representative of all LC factory patchcords herein. $X_{max} + 2\sigma = 0.22$ dB, $X_{max} + 3\sigma = 0.30$ dB. Performance representative of product - to - product or product - to - OFS "Golden Reference Jumper" (Part No. 108513045).*
4 BT = Blue Tiger Patchcord

5.11 - Visual Inspection Criteria for Fiber Optic Connectors with Fiber

Issued: February 2000

Figure 2- Definition of regions and defects

A = RESTRICTED AREA
A=(fiber OD+d)/2

Fiber OD=125 microns
d- is the core diameter of the fiber
d for SM = 8 microns
d for MM is 62 microns
A=66 microns for SM fiber
A=95 microns for MM fiber

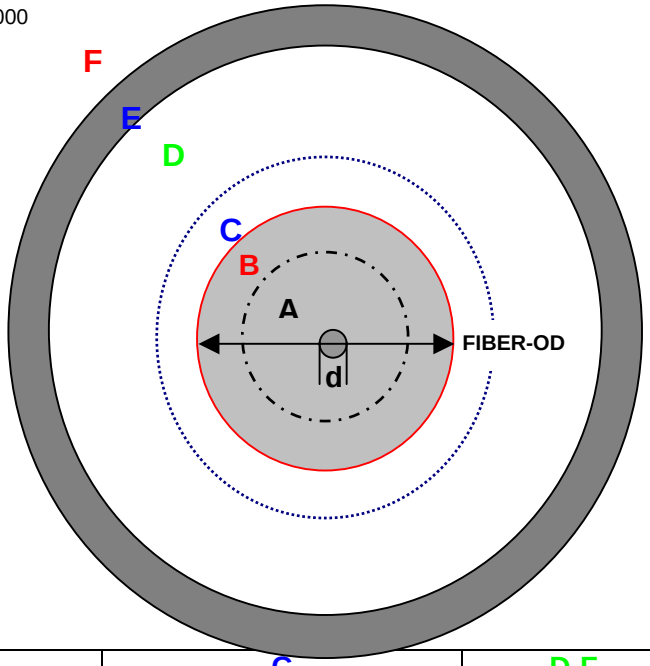
B = FIBER SURFACE
AREA OUTSIDE RESTRICTED **"A"** TO EDGE OF FIBER(125 UM)

C = FERRULE SURFACE
FERRULE AREA COVERING AREA FROM 125 TO 250 MICRONS

D = FERRULE PEDESTAL

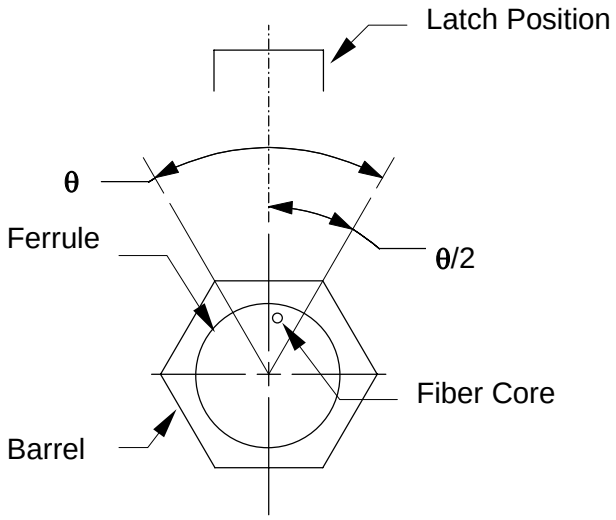
E = CHAMFER

F=OUTSIDE CYLINDRICAL SURFACE



DEFECT	A	B	C	D-F
CRACK	not acceptable	**No Cracks when extended can intersect the core**		**N/A polished end See Ferrule Spec**
CHIP	not acceptable	One defect up to 10um in diameter is acceptable Defect <2.0 um don't count	Multiple defects <10um each are acceptable (can't touch fiber edge) Defects <2.0 um do not count **Sum of all defect types<30um**	**N/A for polished end See Ferrule Spec**
PIN HOLES/VOIDS			Multiple defects <10um each are acceptable (can't touch fiber edge) Defects <2.0 um do not count **Sum of all defect types<30um**	**N/A for polished end See Ferrule Spec**
SCRATCHES (SM)	No scratches in core Tangent to core acceptable if less than 2 um width	**Scratches are acceptable if they do not exceed 2um width**		
SCRATCHES (MM And APC connectors)	Scratches in the core are acceptable if transmission requirements are met	**Scratches are acceptable if they do not exceed 2um width**		
FERRULE SCRATCHES			**No scratches > 2 um**	**acceptable**
EPOXY RING		Epoxy ring is acceptable if the width is less than 5 um		
FIXED CONTAMINATION BLACK SPOTS	not acceptable	One defect up to 10um in diameter is acceptable Defect <2.0 um don't count	Multiple defects <10um each are acceptable (can't touch fiber edge) Defects <2.0 um do not count **Sum of all defect types<30um**	**acceptable**
RAISED CONTAMINATION	not acceptable	not acceptable	not acceptable	**acceptable**
LOOSE CONTAMINATION	not acceptable	not acceptable	not acceptable	**acceptable**

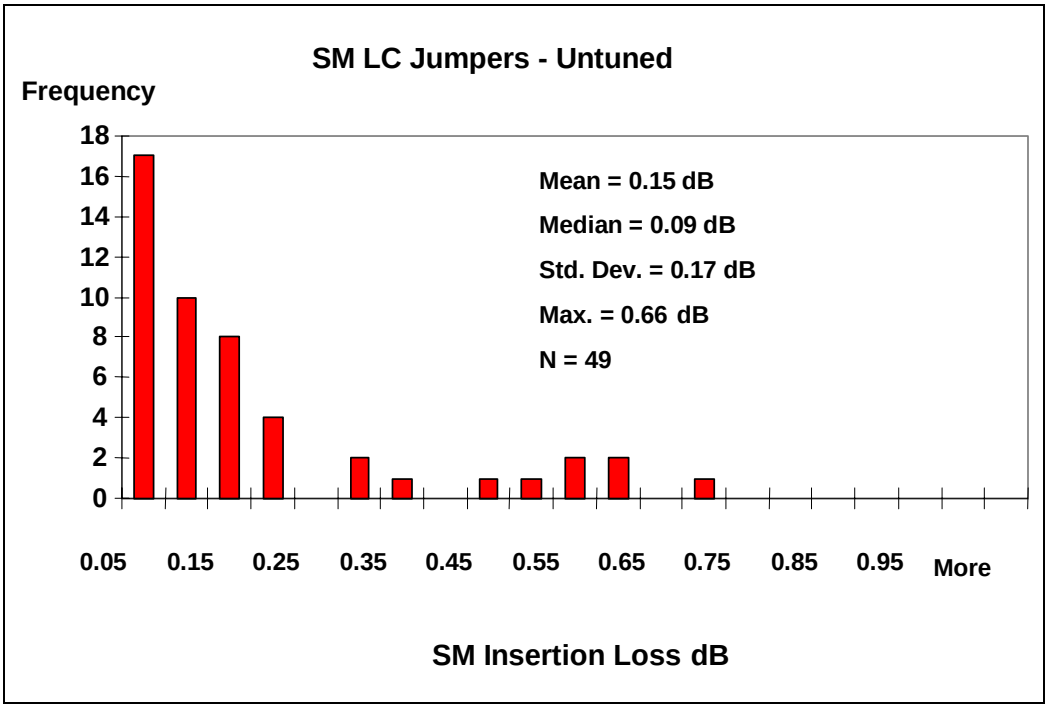
5.12 – LC SM Jumper Tuning Configuration

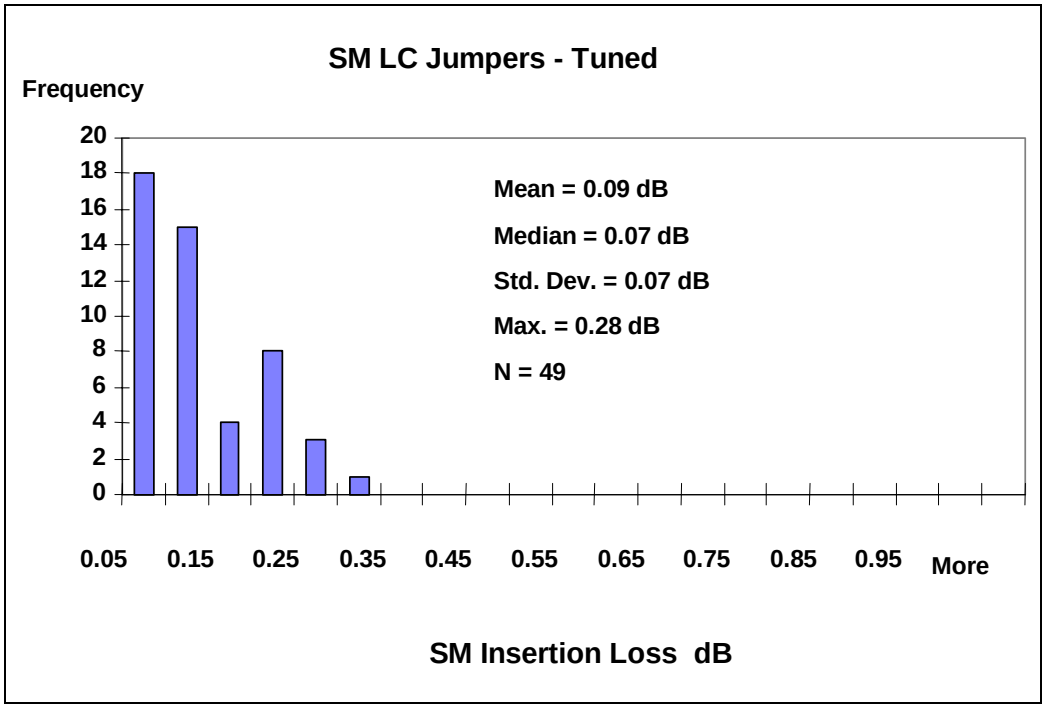


Notes:

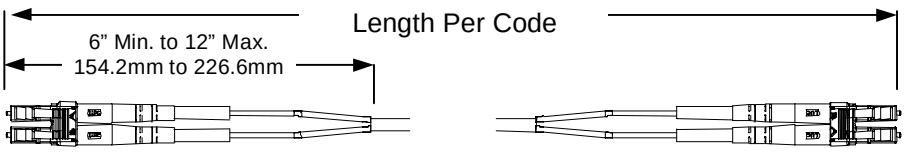
1. Tuning is required to minimize loss. The eccentricity of the fiber core is to be located relative to the connector latch within the angle θ as shown.
2. $\theta \leq 180°$

5.13 - LC SM Jumper Laboratory Performance, Untuned versus Tuned





Note: Data generated from the same laboratory samples in a laboratory environment



LC-LC Duplex Jumper on 1.6 mm Cordage Shown

5.14 - LC Jumpers - Available Configurations

LC-LC	LC-SC	LC-FC	LC-ST
SM & MM	SM & MM	SM & MM	SM & MM
Simlex & Duplex	Simplex & Duplex	Simplex & Duplex	Simplex & Duplex

Feet	Available Lengths and Tolerances	Meters
4 +0.5/-0		1.2 +0.15/-0
5 +0.5/-0		1.5 +0.15/-0
6 +0.5/-0		1.8 +0.15/-0
8 +0.5/-0		2.4 +0.15/-0
10 +0.5/-0		3.1 +0.15/-0
15 +1/-0		4.6 +0.3/-0
20 +1/-0		6.1 +0.3/-0
25 +1/-0		7.6 +0.3/-0
30 +1/-0		9.2 +0.3/-0
35 +1/-0		10.7 +0.3/-0
40 +1/-0		12.2 +0.3/-0
50 +1/-0		15.2 +0.3/-0
75 +1/-0		22.9 +0.3/-0
100 +1/-0		30.5 +0.3/-0

5.15 - LC Jumper Coding (or equivalent)

M	S	2	LC	-	LC	-	10
|	|	|	|				|
Cordage Type	**Fiber Type**	**Jumper Type**	**Connector Type (end 1)**		**Connector Type (end 2)**		Length (ft)
M - Minicord	S-SM	1-Simplex	LC for LC		LC for LC		
	L- MM (62.5)	2-Duplex	LCA for LC Angled		LCA for LC Angled		
B - SBJ	V-Matched Clad	4-Quad	LCB for LC Backlight		BCB for LC Backlight		
N - Nylon Buffer	W-Allwave				FC for FC		
	T-Truewave+						
	F-Truewave-				FCA for FC Angled		
	Z-Lazerspeed				D4 for D4		
					EP for STII+		
					SC for SC		

Variations: R- Red Jacket, S-Staggered Ends, G-Reference\Golden.
Note: Variation code specified in the third digit (MSB, MSR, MSY) or the forth digit (MS1G) or the (MS2LC-SLC)

5.16 - LC Jumper Color Coding

Jumper	Connector Color	Cordage Color
SM	Blue w/White Boot	Yellow
MM 62.5 μm	Beige w/White Boot	Slate (Gray)
APC	Green w/Green Boot	Yellow

6.0 – LC Product Specification – Data

6.0 - LC Product Specification Data

Fiber Optic Apparatus Qualification Laboratory
1997 Test Report – Singlemode LC Minicord™ Jumper.

- 15 SM jumpers randomly selected from Aug 97 production, manufactured by OFS Technology Atlanta Facility.

- Pass/fail determinations for each test: Telcordia GR-326 and OFS Product Specifications.

6.1 - Telcordia GR-326 Optical Performance Criteria (1997)

Insertion Loss (IL)	Requirement	Objective
Maximum IL	0.30 dB	0.20 dB
Mean IL	0.20 dB	0.15 dB

Return Loss (RL)	Requirement	Objective
Maximum RL	40 dB	50dB

OFS LC New Product Specification

Insertion Loss (IL)	Average	Std. Dev.
Factory Tuned	0.08 dB	0.07 dB
Field Installed	0.20 dB	0.10 dB

Return Loss (RL)	Minimum
Factory 1997	50 dB
Factory 1999	55 dB
Field 1999	50 dB

Notes:
1 Complete connection 8.8/125 fiber. Dry connection
2 Figures representative of use with OFS jumper cordage or equivalent.
3 The performance representative herein of LC factory patchcords that were produced and tested at OFS Atlanta Facility according toTelecordia 1997 GR-326

6.2 - Telcordia GR-326 1997 Test Descriptions

Test Description	Passing Requirement	Passing Objective	Test Protocol (15 Samples)
New Product Testing			
Insertion Loss	0.30 dB Max. 15/15	0.20 dB Max.	OFS in 1997 ≥ 50 dB RL
IL Increase	0.20 dB Max. Yes	0.15 dB Max.	OFS in 1999 ≥ 55 dB RL
Return Loss	40 dB Min. 15/15	55 dB Min.	
Thermal Aging			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Measurement every 6 hours
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	Post-test Criteria apply
Return Loss	40 dB Min. 15/15	55 dB Min.	
Humidity			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Measurement every 6 hours
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	Criteria listed apply both during and after test
Return Loss	40 dB Min. 15/15	55 dB Min.	
Thermal Cycle			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	1 hr hold points at –40C°, 23C°, and 75C°. Measurement following 30 min. at hold points.
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	Criteria listed apply both during and after test
Return Loss	40 dB Min. 15/15	55 dB Min.	

Note: Test samples were allowed to reach thermal equilibrium for at least 2 hr. at 23 C before IL and RL measurements were made at the start and finish of each test.

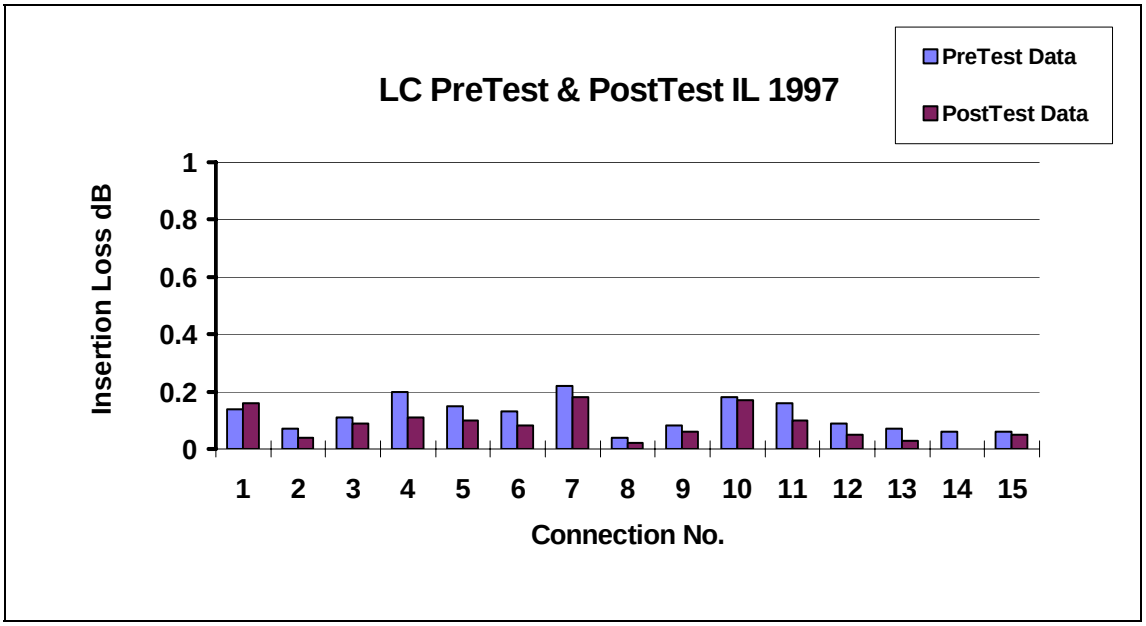
Test Description	Passing Requirement	Passing Objective	Test Protocol (15 Samples)
Vibration			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	3 principal axis's. 2 hr at 1.5mm amplitude, 10 and 55 Hz at a rate of 45 Hz/min. Criteria listed apply both during and after test.
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	
Return Loss	40 dB Min. 15/15	55 dB Min.	
Flex			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Mounted to test fixture with applied load of 2 lb. (0.9 kg). Rotate cycle 0°,90°, 0°, -90°,0 for 100 cycles. Criteria listed apply both during and after test.
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	
Return Loss	40 dB Min. 15/15	55 dB Min.	
Twist			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Mounted to test fixture with applied load of 3 lb. (1.36 kg). Capstan rotated 90° on fiber axis of fiber then reversed for 5 revolutions. Criteria listed apply both during and after test
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	
Return Loss	40 dB Min. 14/15	55 dB Min.	
Proof			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Mounted to test fixture with applied load of 10 lb. (4.5 kg) at 0° for a min 10 sec. Post-test criteria apply with load removed.
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	
Return Loss	40 dB Min. 14/15	55 dB Min.	
Transmission w/ Load 0.25 kg			
Insertion Loss	0.50 dB Max. 15/15	0.30 dB Max.	Mounted to test fixture with applied load of 0.55 lb. (.25 kg) at 0° for a min 10 sec. Increase angle to 90° &135° and repeat at each angle. Criteria listed apply both during and after test
Return Loss	40 dB Min. 14/15	55 dB Min.	

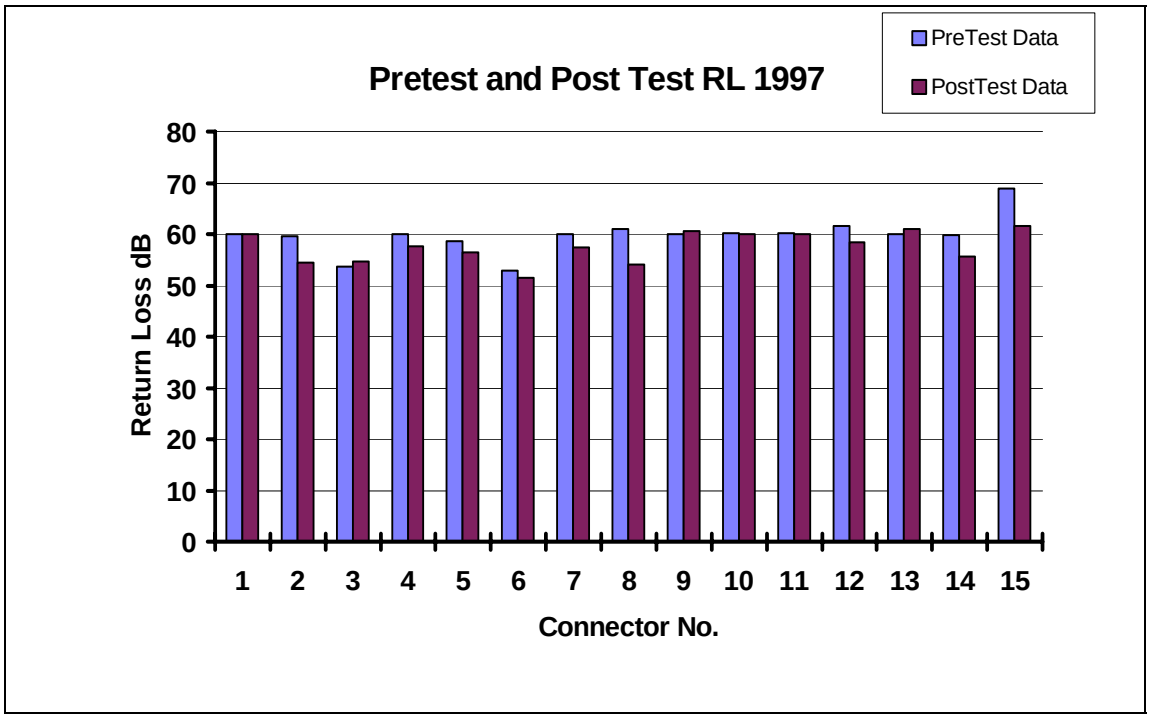
Test Description	Passing Requirement	Passing Objective	Test Protocol (15 Samples)
Transmission w/ Load 0.7 kg			
Insertion Loss	0.50 dB Max. 15/15	0.30 dB Max.	Increase load to 1.54 lb. (0.7 kg) repeat IL and RL measurements at 0° and 90°.
Return Loss	40 dB Min. 14/15	55 dB Min.	
Transmission w/ Load 1.5 kg			
Insertion Loss	0.50 dB Max. 15/15	0.30 dB Max.	Increase load to 3.3 lb. (1.5 kg) repeat IL and RL measurements at 0° and 90°.
Return Loss	40 dB Min. 14/15	55 dB Min.	
Transmission w/ Load 2.0 kg			
Insertion Loss	0.50 dB Max. 15/15	0.30 dB Max.	Increase load to 4.4 lb. (2 kg) repeat IL and RL measurements at 0° and 90°.
Return Loss	40 dB Min. 14/15	55 dB Min.	
Mating Durability			
Insertion Loss	0.40 dB Max. 15/15	0.30 dB Max.	Reconnect 200 times, both connectors cleaned after cycles 0, 50, 100, 150 and 200; mating connectors cleaned after 25, 50, 75, 125, and 175. Measurement on cycle immediately before and after each cleaning. Criteria listed apply for each measurement.
IL Increase	0.30 dB Max. 15/14	0.20 dB Max.	
Return Loss	40 dB Min. 14/15	55 dB Min.	
Impact			
Insertion Loss	0.50 dB Max. 15/15	0.30 dB Max.	Mount one connector (jumper) on fixture. Raise connector to Horizontal position, drop so connector impacts on block.
IL Increase	0.30 dB Max. 15/15	0.20 dB Max.	
Return Loss	40 dB Min. 14/15	55 dB Min.	Repeat 8 times. Post-test criteria apply
End of Test			
Insertion Loss	0.40 dB Max. 14/15	0.30 dB Max.	For this lot, Mean IL of 0.12 dB including fusion splices.
IL Increase	0.30 dB Max. Yes	0.20 dB Max.	Std. Dev. = 0.08 dB, for both 1310/1550 nm.
Return Loss	40 dB Min. 15/15	55 dB Min.	For this lot 56.6 dB RL, for both 1310/1550 nm.

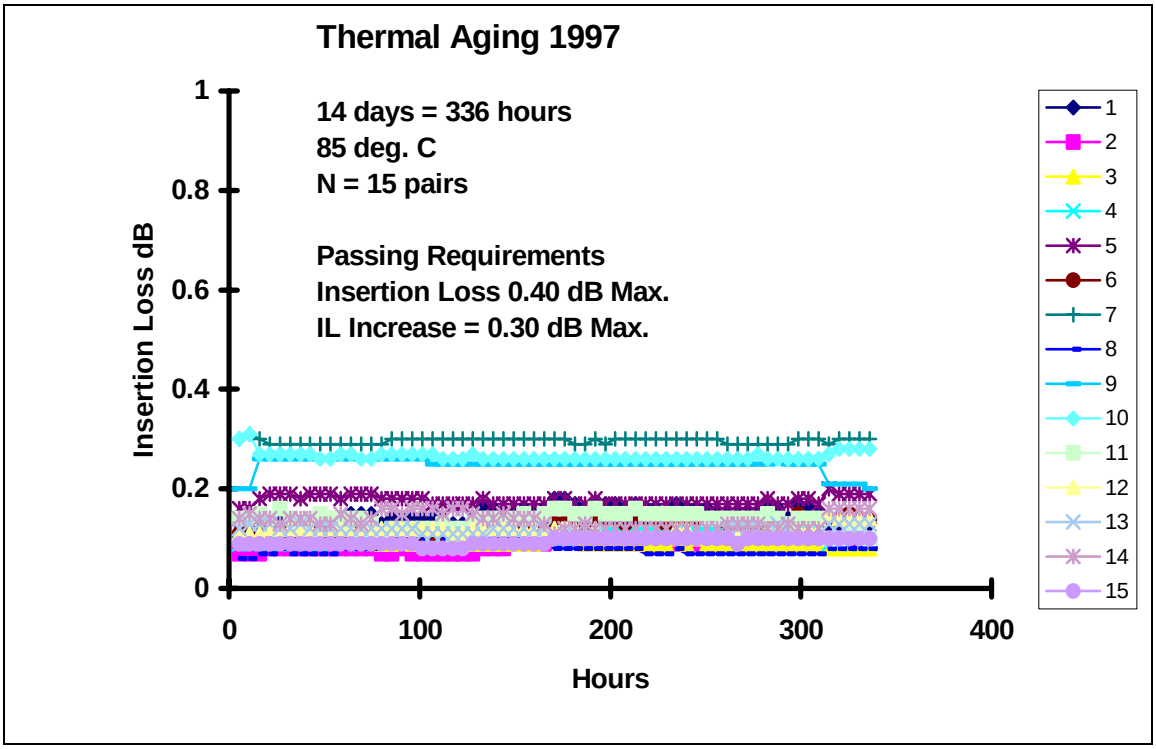
6.3 - Telcordia LC Test Results for 15 Samples

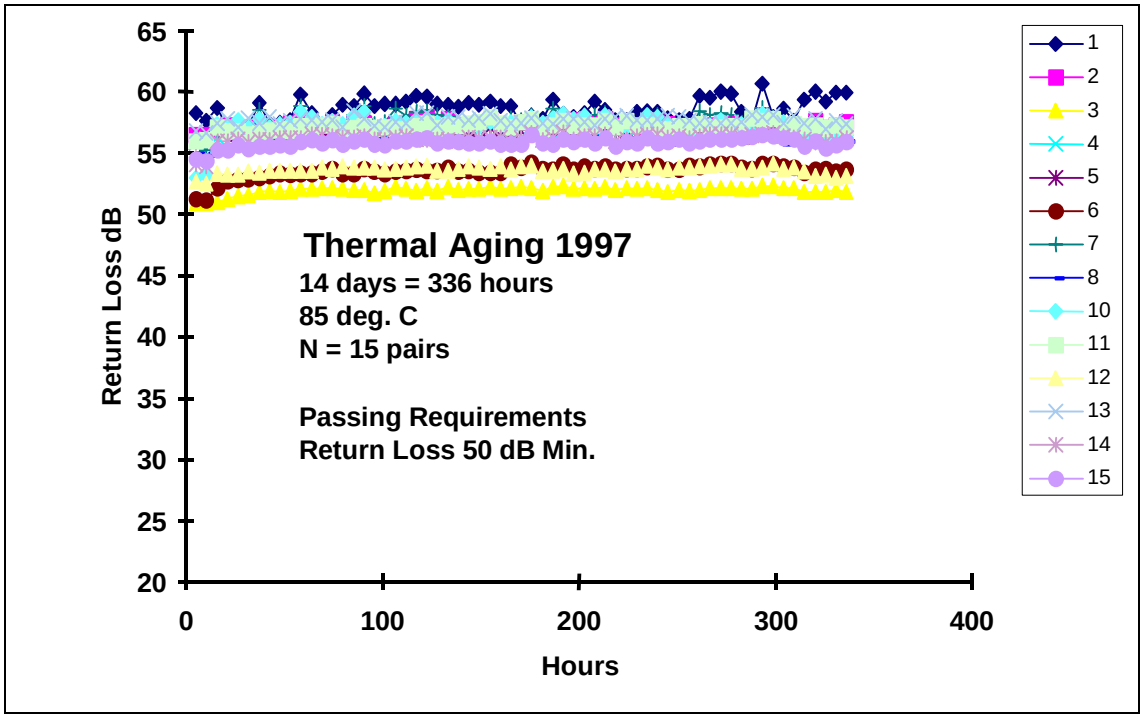
Tests	Requirements			Objectives		
	IL	IL+	RL	IL	IL+	RL
New Product Testing	15/15	Yes	15/15	15/15	Yes	15/15
Thermal Aging	15/15	15/15	15/15	15/15	15/15	14/15
Humidity	15/15	15/15	15/15	15/15	N/A	14/15
Thermal Cycle	15/15	15/15	15/15	15/15	15/15	13/15
Vibration	15/15	15/15	15/15	15/15	15/15	14/15
Flex	15/15	15/15	15/15	15/15	15/15	12/15
Twist	15/15	15/15	15/15	15/15	15/15	9/15
Proof	15/15	15/15	14/15	15/15	15/15	9/15
Transmission w/ Load 0.25 kg	15/15	N/A	14/15	15/15	N/A	9/15
Transmission w/ Load 0.7 kg	15/15	N/A	14/15	15/15	N/A	9/15
Transmission w/ Load 1.5 kg	15/15	N/A	14/15	15/15	N/A	9/15
Transmission w/ Load 2.0 kg	15/15	N/A	14/15	15/15	N/A	9/15
Mating Durability	15/15	15/15	14/15	15/15	15/15	12/15
Impact	15/15	15/15	14/15	14/15	15/15	12/15
End of Test	14/15	Yes	15/15	15/15	Yes	7/15

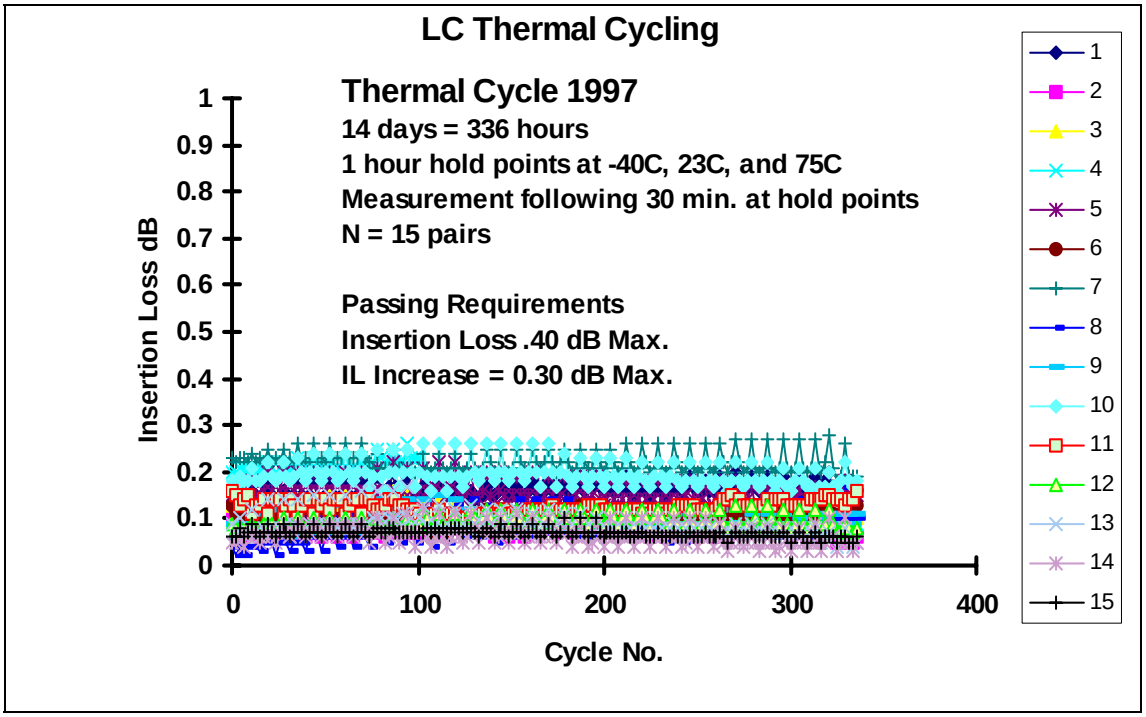
6.4 – Test Data

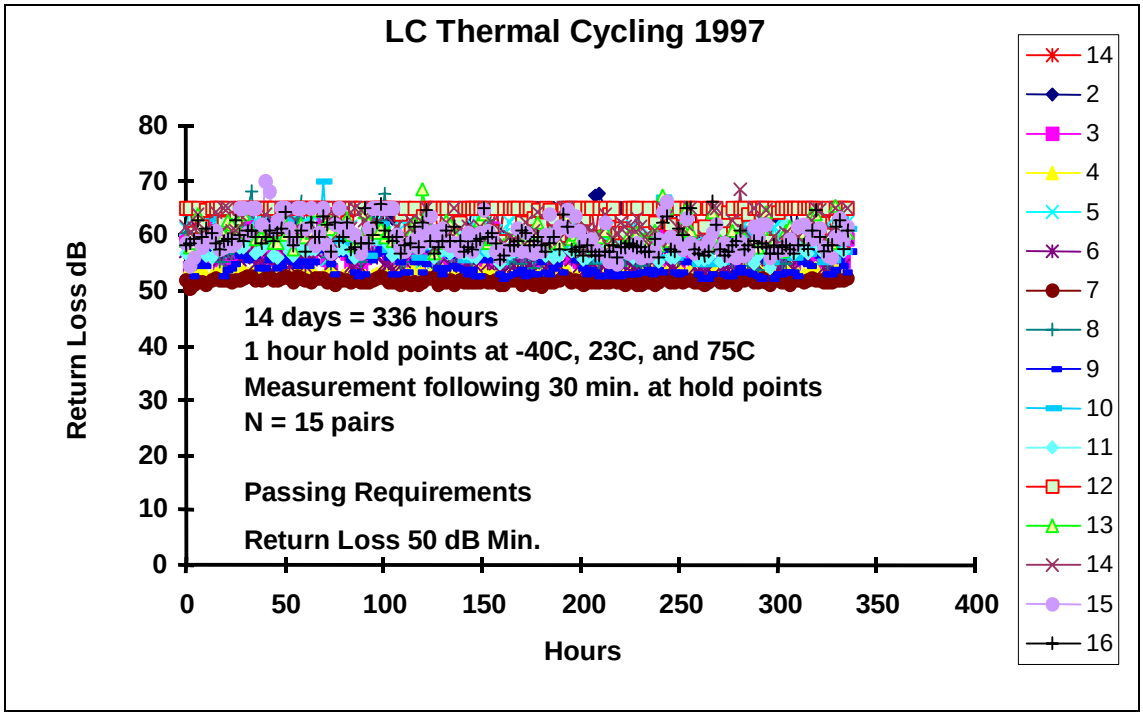

LC PreTest & PostTest IL 1997
PreTest Data
PostTest Data
Insertion Loss dB
1
0.8
0.6
0.4
0.2
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Connection No.


Pretest and Post Test RL 1997
PreTest Data
PostTest Data
Return Loss dB
80
70
60
50
40
30
20
10
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Connector No.


Thermal Aging 1997
14 days = 336 hours
85 deg. C
N = 15 pairs
Passing Requirements
Insertion Loss 0.40 dB Max.
IL Increase = 0.30 dB Max.
Insertion Loss dB
1
0.8
0.6
0.4
0.2
0
0
100
200
300
400
Hours
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


Return Loss dB
65
60
55
50
45
40
35
30
25
20
0
100
200
300
400
Hours
Thermal Aging 1997
14 days = 336 hours
85 deg. C
N = 15 pairs
Passing Requirements
Return Loss 50 dB Min.
1
2
3
4
5
6
7
8
10
11
12
13
14
15


LC Thermal Cycling
Thermal Cycle 1997
14 days = 336 hours
1 hour hold points at -40C, 23C, and 75C
Measurement following 30 min. at hold points
N = 15 pairs
Passing Requirements
Insertion Loss .40 dB Max.
IL Increase = 0.30 dB Max.
Insertion Loss dB
Cycle No.
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0
100
200
300
400
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15


LC Thermal Cycling 1997
14 days = 336 hours
1 hour hold points at -40C, 23C, and 75C
Measurement following 30 min. at hold points
N = 15 pairs
Passing Requirements
Return Loss 50 dB Min.
Return Loss dB
Hours
0
10
20
30
40
50
60
70
80
0
50
100
150
200
250
300
350
400
14
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16