“Rear Pivot Latch”
LC Connector

A Robust SFF Fiber Optic Connector for High-Density Network Applications

White Paper – 11/2003

PANDUIT®

Executive Summary

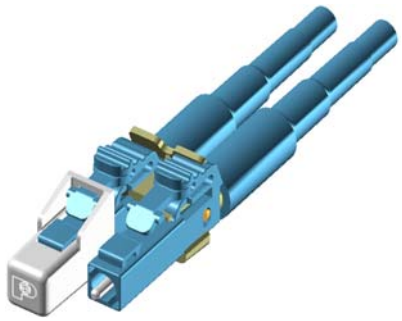
PANDUIT has designed established and broadly accepted technologies into a “Rear Pivot Latch” LC Connector that provides a superior performing, easily deployable Small Form Factor (SFF) interconnection system. This paper provides information on the “Rear Pivot Latch” LC Connector System -- a best in class, FOCIS-10 compatible LC connector with superior optical and mechanical performance, competitive installation time for low installed cost, and greater durability for longer life.

Introduction

Primary in system upgrades is the desire to boost fiber termination count within existing and currently available space, or conversely, to shrink the total interconnection envelope for a given number of terminations. The LC connector is the ideal solution for Enterprise applications, where space is usually constrained and expensive. With this connector system, users effectively double interconnect density, without the added expense of additional fiber management systems (shelves, patch bays, and panels). To further ease system upgrades, the LC mini duplex adapter was designed to fit SC simplex adapter panel openings. The LC interface was designed to solve issues that equipment vendors had with established fiber interconnect. This connector system provides these OEM’s with a small footprint, that frees up costly equipment/board space.

The LC connector is the natural progression/replacement for the SC, but is also securing applications traditionally held by other connector systems such as the MT-RJ. The LC will be popular as a 10 Gbps Ethernet connector and is also the standard fiber interface for 1394B S800 (Firewire/iLink Home and Commercial Video) and for the InfiniBand Trade Association (Agilent, Nortel, etc.).

The “Rear Pivot Latch” LC Connector is an industry standard FOCIS-10 compatible plug interface that provides a dependable, repeatable means of mating the precision ceramic ferrule used to align and secure the fiber.



This connector has a practical connector duplexing clip that can be installed after the connector termination step. This affords the opportunity for channel change after termination. Several competitive designs have duplexing clips that necessitate re-termination if channel assignment is incorrect.

Innovative features include an intrinsically snag-proof latch and an enhanced protective cap, which provide protection against connector damage in installation and channel move processes.

Design Considerations

A significant portion of the market for the LC is dominated by RBOCs, IXCs, ILECs (Service Provider) and Data Center (Enterprise) applications. LC connector usage in the Service Provider market is being driven by switching and WDM applications, and in the Enterprise market by the widespread deployment of Gbps Ethernet. The requirements for high-density interconnections and superior performance to support these applications make the LC a logical choice. Not only is the LC smaller than most other traditional connectors, it exhibits superior optical performance as well. The LC footprint and performance has bolstered its acceptance in all markets.

The LC supports both singlemode and multimode fiber, which are finding use in the backbone and FTTX applications. The connector also suits the storage area networking (SAN) market, where many vendors are producing LC-based transceivers for the Fiber Channel protocol commonly used in SANs.

Typical concerns in these types of high-density applications are:

- **Single/Multiple Fiber Interconnect** – Simplex LC connectors can be duplexed in two-fiber applications with a duplexing clip that provides centerline spacing and polarity information. The separate connector channels of the LC mitigate risk in the remedy of polarity problems. Separate, simplex connectors can simply be unplugged and re-inserted with the correct polarity, thereby reducing the TCO (Total Cost of Ownership).

- **Fiber Compatibility** - The use of proprietary fiber solutions in fiber cable assemblies is recommended by some cable assembly manufacturers. Specifying interconnection components that do not require specialty fibers is the most sensible and cost effective long-term choice.

- **Singlemode/Multimode Capability** – Most system designers and installers are apt to specify dual use interconnection products (those that support both singlemode and multimode applications).

- **Insertion/Return Loss** - Power budget requirements for networks are becoming increasingly more stringent. Gigabit Ethernet allows for only 20% of the power loss allowable for 100 Mbps Ethernet. In general, low loss interconnections assure longer practical life in both Enterprise and Service Provider environments.

- **Field Installation** - Many installers choose quick-mounting anaerobic adhesive based connectors because they are using them in quantity and no supplementary training is required. Most anaerobic connector installation tools are common between connector families, making universal installation kits the wise choice to reduce capital investment.

- **Installation Features** - With increasing density of fiber interconnect, fiber optic jumper assemblies can easily become snagged during use and installation. Connectors with intrinsic snagless designs minimize the TCO in fiber networks. Some LC connectors offer a visual check of polarity through the use of A/B markings.

- **Handling/Contamination** – Design features that protect the ceramic tip of the LC are paramount to reducing TCO.

- **Operation** - The modular RJ45 plug/jack is now universal in private data networks because of its small footprint, low cost and intuitive operation. An audible “click” upon mating is an essential feature of the LC connector and has been fundamental to the RJ45 design. Standardized color-coding helps to distinguish between multimode (beige or black) and singlemode (blue) connectors. System designers/installers should use LC connectors that provide polarity indication, color-coding and an audible “click” to signal successful mating.

- **Intermatability/Compatibility** – It is good engineering practice to standardize on products that demonstrate extended service life through the support of functional intermatability. Products that offer design adherence to the FOCIS-10 standard will assure multiple interconnection configurations and backward compatible design.

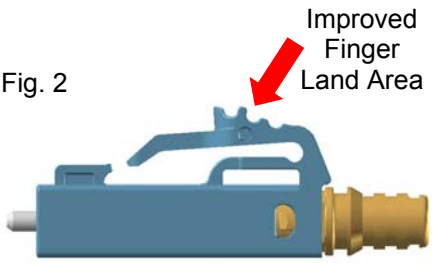
LC Connector Design

The LC connector footprint is approximately half the size of an SC connector. The LC has a back shell designed to accommodate standard 1.6mm or 2.0mm diameter cable designs. The standard construction of the LC connector consists of a spring loaded, 1.25mm diameter zirconia ceramic ferrule housed in a thermoplastic connector back shell.

The latch configuration depicted (Figure 1) is a front pivot design. The drawback with this design, especially in simplex (buffered) cross-connect applications, is that the latch is open on the back and can easily snag on rack components, other connectors or conduit. In duplex applications it is less of a problem because the design of most duplexing clips incorporates a feature that allows the connector set to become “snagless”. Unfortunately, some of these designs necessitate the installation of the duplexing clip during the connector installation process. Installers performing behind the wall or behind the rack applications sometimes pull multiple channel pre-terminated cables through conduit and perform the duplexing at the outlet or rack port. The design of the “Rear Pivot Latch” LC Connector (Figure 2) is intrinsically snagless in simplex form (no clip is required to render the connector snagless) and minimizes risk in both applications mentioned above. The increased finger landing area on the rear pivot latch connector (Figure 2) also provides ergonomic latch access in high-density applications.

Fig. 1

Fig. 2



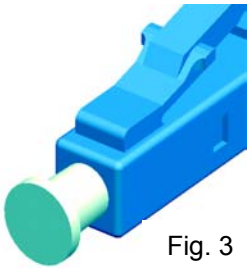


Fig. 3

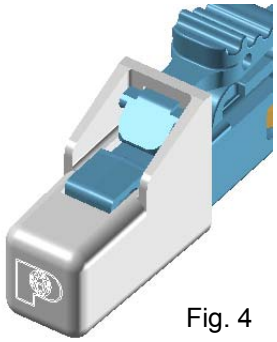


Fig. 4

Another area of design differentiation among LC connectors is the protective cap included with the connector. Some LC designs include a cap that fits snuggly to the outside diameter of the ceramic ferrule nose of the connector (Figure 3). If an LC connector utilizing this type of cap is subject to a sudden impacting load to the front area of the connector that houses the ferrule, the possibility of breakage exists. The Rear Pivot Latch LC Connector includes an innovative protective dust cap. The cap installs on the connector with an audible “click”, and it does not directly bear on the sensitive ferrule end face (Figure 4).

In duplexing connectors together, a feature that enhances the ease of installation and minimizes TCO is a duplex clip that has the ability to be installed after connector termination. This type of clip snaps into place (Figure 5), providing the correct center-to-center spacing for the duplex application and the required A-B polarization markings. Some LC duplex designs require that these clips be mounted onto the connector pair in the course of fiber termination. If polarity changes are required, connectors must be re-terminated. Still, other LC duplex designs require tools to install or remove the clip. The design shown in Figure 5, requires no tools and can be easily installed and removed to facilitate connector changes.

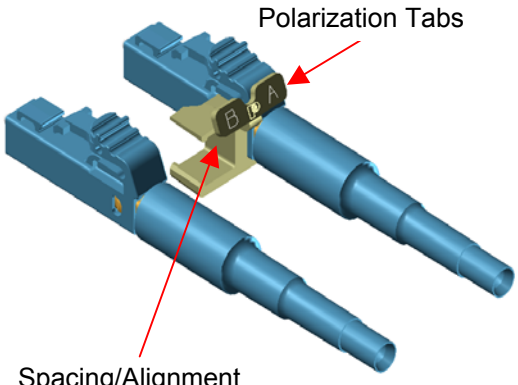


Fig. 5

The “Rear Pivot Latch” LC Connector design (Figure 6) incorporates design features that satisfy all of the design concerns mentioned earlier.

The snagless rear pivot latch assures easy installation by reducing the chance that the connector body will become snagged. The large, ergonomically shaped finger land area on the latch provides efficient moves, adds and changes. The duplexing clip can be installed after termination to assure rapid polarity changes. The unique protective dust cap with audible “click” serves to reduce the chance that the ceramic ferrule broken (during install or adds/changes). All of these things directly impact the TCO of the interconnect solution.

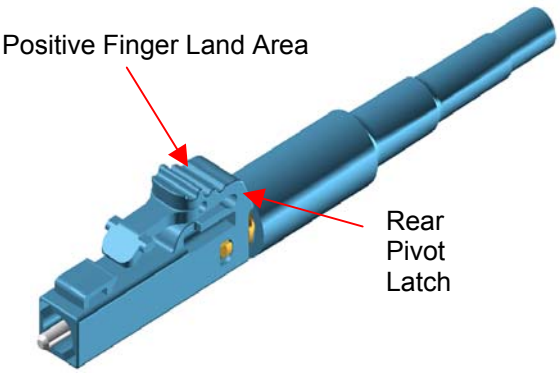
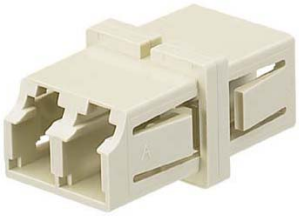


Fig. 6

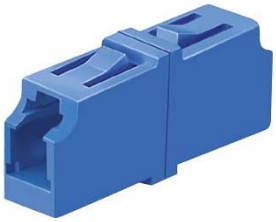
LC System Solution Components

LC connector adapters and modules for outlets support the LC System Solution for both multimode and singlemode applications. High performance adapters are offered in simplex and duplex configurations with highly toleranced phosphor bronze or zirconia ceramic split alignment sleeves, to assure consistently low loss and repeatable connections.

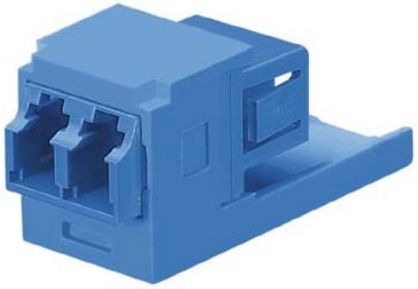
LC Sr./Jr. (Junior) Mini Duplex Multimode Adapter

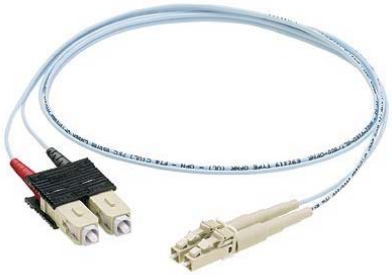


LC Sr./Sr. (Senior) Simplex Singlemode Adapter



LC Sr./Jr. (Junior) Duplex Singlemode Adapter Module





LC Cable Assemblies constructed with the “Rear Pivot Latch” LC Connector design provide high-density optical interconnections with snagless cable management for high performance and long-term reliability, especially in Enterprise/Data Center applications. The footprint of the LC connector provides as much as 50% reduction in space over SC, FC and ST connectors. The stepped design of the boot directs the cable in any direction so that the cable is managed with a controlled bend and easier routing.

EIA/TIA-568 Testing

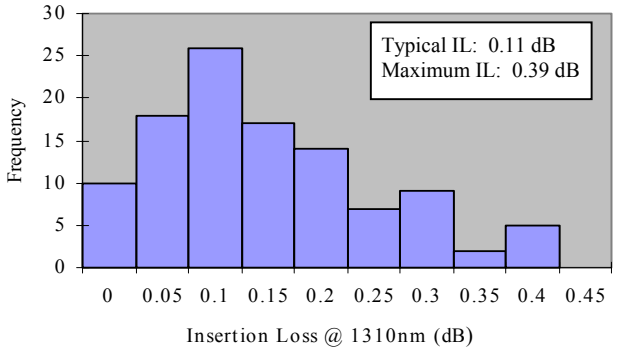
The Rear Pivot LC connector was tested to TIA/EIA-568-A specifications for multimode and singlemode connector performance (Table 1).

Table 1 - Performance Testing to TIA/EIA-568-A

TEST	REQUIREMENT	METHOD	RESULT	
			Multimode	Singlemode
Insertion Loss	Maximum IL: 0.75dB. Maximum IL: 0.60dB (10Gbps)	EIA/TIA-455-171 (FOTP-171); Method D	Exceeds Requirement	Exceeds Requirement (See Figure7 on Page 6)
Return Loss	Minimum RL: 20dB (MM) Minimum RL: 26dB (SM)	EIA/TIA-455-107 (FOTP-107)	Exceeds Requirement	Exceeds Requirement (See Figure 7 on Page 6)
Cable Retention	> 11.24 pounds for each jacketed cable channel > 0.5 lbs. for each buffered fiber	EIA/TIA-455-6B (FOTP-6)	Exceeds Requirement	Exceeds Requirement
Low Temperature	0°C temperature for 4 days (mated connector pair)	EIA/TIA-455-188 (FOTP-188)	Complies	Complies
Temperature Life	60°C for 4 days (mated connector pair)	EIA/TIA-455-4 (FOTP-4)	Complies	Complies
Impact Test	Drop of 1.8 meters (mated connector pair)	EIA/TIA-455-2 (FOTP-2)	Complies	Complies
Cable Flexing	Flex cycles (90 to -90 degrees for 100 cycles) Mated connectors weighted with: a) 1.1 pounds for jacketed cable b) 0.5 lbs. for buffered fiber	EIA/TIA-455-1 (FOTP-1)	Exceeds Requirement	Exceeds Requirement
Strength of Coupling	7.4 lbs of force at a 0°angle applied at a rate of 1 inch/minute; must remain mated for 5 seconds (mated connector pair)	EIA/TIA-455-185 (FOTP-185)	Exceeds Requirement	Exceeds Requirement
Durability	500 mating cycles	EIA/TIA-455-21 (FOTP-21)	Exceeds Requirement >1000 cycles	Exceeds Requirement >1000 cycles
Humidity	4 days at 90-95% humidity at 40°C. (mated connector pair)	EIA/TIA-455-5 (FOTP-5)	Complies	Complies
Jacket Cable Twist	5 twist rotations in both clockwise and counterclockwise directions for 10 cycles: a) 3.5 lbs. for jacketed cable b) 5 lbs. for buffered fiber (mated connector pair)	EIA/TIA-455-36 (FOTP-36)	Exceeds Requirement	Exceeds Requirement

Insertion/Return Loss Distributions

A quantity of 108 Singlemode "Rear Pivot Latch" LC connectorized ends were subject to Insertion/Return Loss testing per FOTP-171 & FOTP-107 respectively. A precision launch jumper was used in both cases. Results @ 1310nm are depicted below (Figure 7).



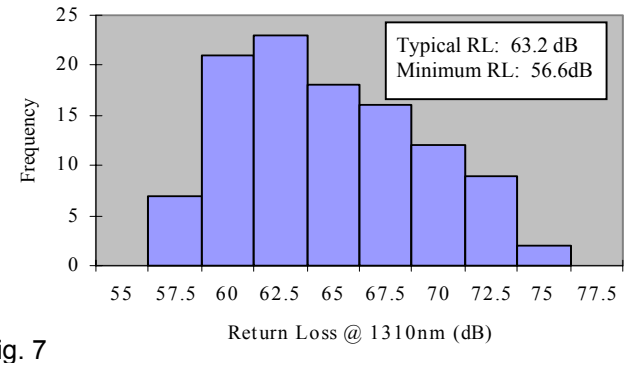


Fig. 7

Latch Cycling

In addition to the durability testing specified by the EIA/TIA-568 test sequence, a developmental test was performed to assess and optimize the cyclic fatigue properties of the Rear Pivot Latch design. Two competitive LC connector designs, along with the Rear Pivot Latch LC design were subjected to repetitive cycling of the connector latch to simulate dynamic fatigue of the latch as a function of mating and de-mating the connector multiple times (Table 2).

Table 2 – Cyclic Fatigue Testing of Latch

Design	Result Summary
Front Pivot LC (Vendor 'A')	1,000 cycles no stress marks or latch angle changes
Front Pivot LC (Vendor 'B')	@ 400 cycles stress marks (whitening) @ 700 cycles latch angle change @ 1,000 cycles no increase in stress marks or latch angle change
Rear Pivot LC	> 2,500 cycles no stress marks or latch angle changes

Conclusion

When comparing the design considerations and characteristics, performance and the Total Cost of Ownership advantages among the various LC connector designs, it is apparent that connector selection is a very important decision. The ideal LC fiber optic connector must be easily terminable and compatible with all standard fiber types. It must also have inherent robust characteristics across a variety of handling conditions/environments and should offer design adherence to the FOCIS-10 standard. The rear pivot latch design successfully fulfills these criteria.

PANDUIT® offers a fast-curing, adhesive-mounted, "Rear Pivot Latch" LC Connector that presents the best mix of performance, ease-of-use and cost for today's private networks, as well as for those network applications that are rapidly evolving.

When combined with standards-based, low-loss, high-bandwidth premise fiber cables, *PANDUIT* LC Connectors offer superior channel performance that ensures the long service life required by private network equipment for high-density infrastructure applications.

PANDUIT Corp. develops and manufactures fiber optic connectors, patch cords, optical component modules, enclosures, and cable management. Supplies connectors and patch cords that include FJ jack modules, FJ plugs, SC, LC, ST, and others. FJ jack modules, SC and ST connectors are also available for pre-polished crimp termination.