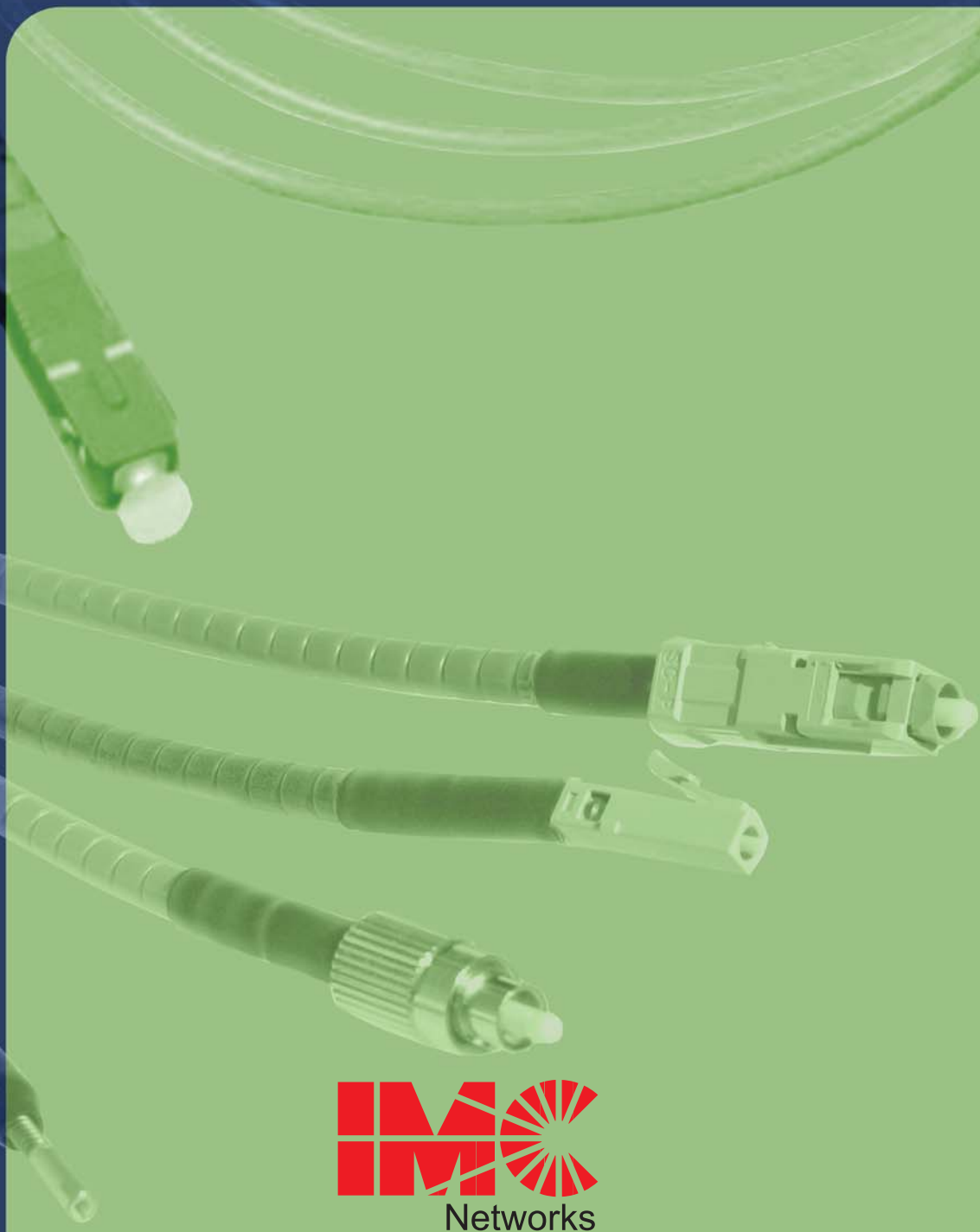
Benefits of Single-Strand Fiber Technology

Single-Strand Fiber



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Making Your Net Work Better

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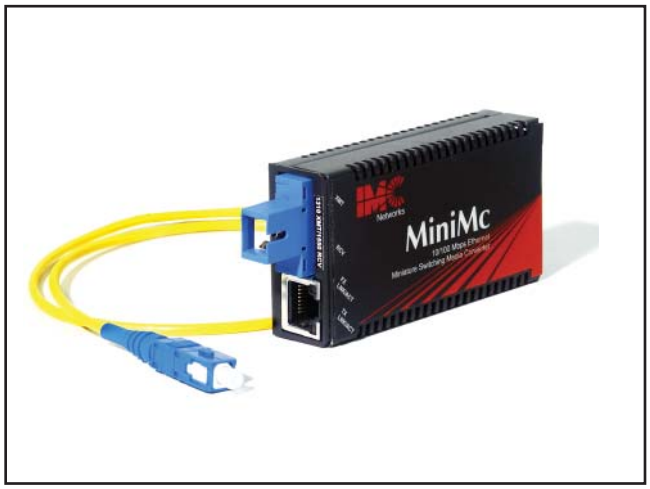

Fiber optic networking has traditionally required two strands of fiber to accomplish full duplex communications. Full duplex means transmitting and receiving signals can occur simultaneously; with standard fiber transceivers, one strand is reserved for transmitting, the other for receiving. However, with recent technical advancements it is now possible to accomplish full duplex communications over just one strand of fiber by using two separate optical wavelengths, one to receive and the other to transmit the signal. Subsequent cost reductions in bi-directional, dual wavelength transceivers have now made it possible to use this new technology in LAN and MAN access networks with only a minimum cost increase over equivalent dual strand fiber equipment.

The benefits and overall savings of a single-strand versus dual strand fiber implementation can be considerable, including not just the cost of the fiber optic cabling itself but also the labor and material involved in terminating the end-points, cross-connect rack space, reduced points-of-failure, and other direct and indirect costs.

IMC Networks offers a wide variety of Ethernet optical access products with single strand fiber interfaces, helping LAN managers and service providers alike to achieve cost savings and rapid return on the investment in fiber optic networks. The following technical overview discusses the benefits of single-strand fiber in more detail.

Single-Strand Fiber Technology — How it Works

Fiber optic communications connections have typically been point-to-point, full duplex links requiring two strands of fiber, one for transmitting and the other for receiving.

Each end device on a link would simultaneously transmit data on one fiber and receive data on the other. For a single-mode Ethernet connection, the transmitters have generally been inexpensive Fabry-Perot (FP) lasers operating at around 1310 nm, although for distances up to 80 km and even further, more costly Distributed Feedback (DFB) lasers operating at around 1550 nm have been required.

Multiple wavelengths, or colors, of light can share the same optical fiber without interference. Long haul SONET telecommunications systems use expensive, tightly tuned lasers with output wavelengths distributed across a range from 1530 to 1565 nm to multiplex, or share, the fiber among up to 100 channels. This is known as Dense Wavelength Division Multiplexing (DWDM).

IMC Networks' Single-Strand Fiber (SSFX) products use a simplified version known as Coarse Wavelength Division Multiplexing (CWDM), employing just 1310 and 1550 nm wavelengths. For one-way communication of two data channels, a special coupler combines the two wavelengths into one fiber output. On the receiving side, the one fiber carrying the two wavelengths is fed into a filter which separates out the 1310 and 1550 channels for use by the receivers.

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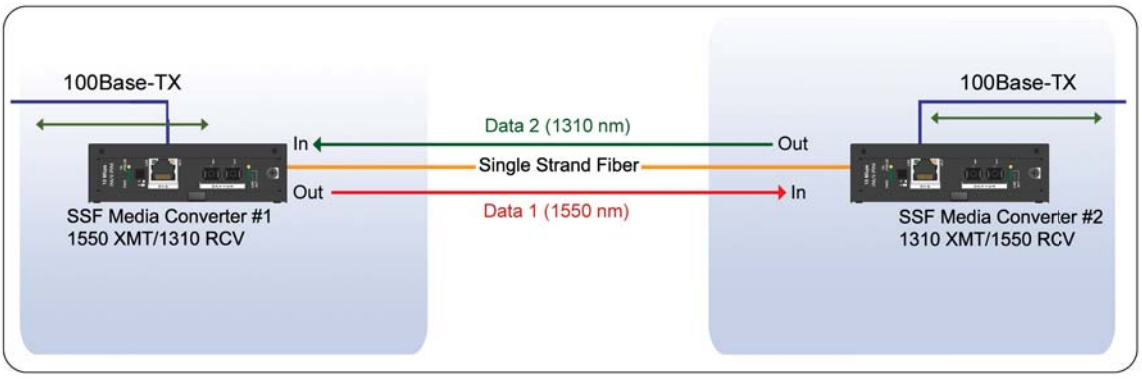
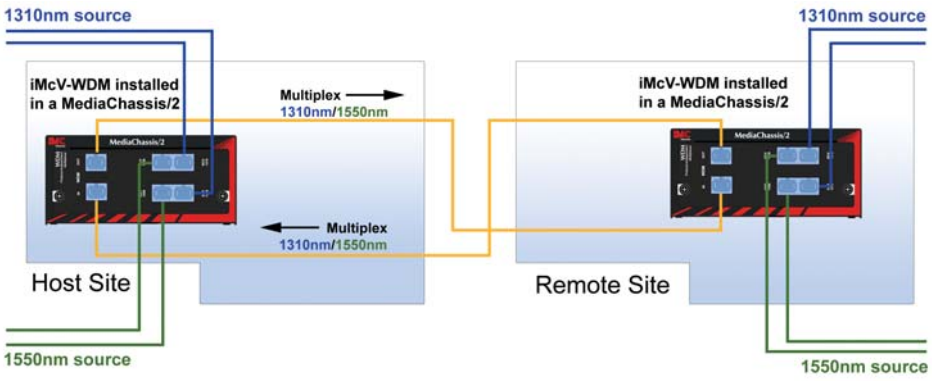
At one end of a link, the module contains a 1310 nm transmitter and 1550 nm receiver; the other end has a 1550 nm transmitter and 1310 nm receiver (technically speaking, the receivers are wavelength-independent but the internal filter ensures only the appropriate wavelength reaches the receiver). A single strand of fiber then connects the two end devices. As the left-to-right transmit channel operates at one wavelength and the right-to-left channel operates at another, both sides can be simultaneously transmitting and receiving so that full duplex communication occurs over only one fiber strand, not two.

The following diagram illustrates two standalone copper to fiber media converters connecting two full-duplex 100Base-TX networks over a single fiber.



It is important to note that the media converters on either end of the connection are not identical; one transmits at 1550 nm and receives 1310 nm while the other end does the opposite. It is important to install them correctly, as the system clearly will not work if the same transmitters are used at either end of a connection.

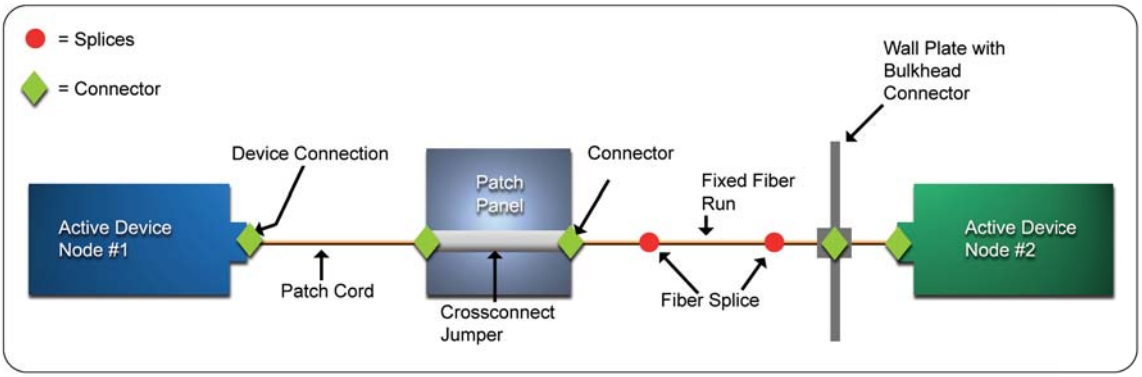
In this CWDM application example, the *iMcV-WDM* has inputs which can connect to any 1310 and 1550 nm sources regardless of the data rate, such as 100Mbps and Gigabit media converters. One *iMcV-WDM* has both output coupler and input filter packaged into one module, so that one duplex fiber pair can carry twice its normal capacity. As a completely passive device, the *iMcV-WDM* does not care whether the inputs are Ethernet or any other standard, such as OC-3, allowing different network types at varying data rates to share the fiber link.



Benefits of Single-Strand Fiber Technology

The first and most obvious benefit of using single-strand fiber (SSFX) technology is to double the capacity of an installed fiber link. As most fiber is already pulled in pairs, you can split the pair and connect to separate networks or to increase available bandwidth without incurring the cost of pulling a new fiber run.

However, the most significant savings of using single fibers comes with new installations. Consider the typical fiber connection shown below.



While this depicts an enterprise backbone or desktop application, the configuration is similar to that found in an optical access application. It is immediately evident that using a single strand fiber rather than the traditional fiber pair has cost implications well beyond that of just the cost per meter of the fiber run itself. Consider:

Half the Fiber End-Points

Whether or not patch cords are used, the fixed fiber run needs to be terminated and connected. Preparation, connection, polishing and testing of single-mode fiber is labor-intensive and costly. While a well-trained technician using quality tools and connectors is still necessary, half the fiber end-points means half the cost.

Patch Cords

On either end of a fiber link, patch cords are often used to provide flexibility when connected to active systems such as switches, media converters, or other optical access devices. An additional patch cord is frequently used for cross connection on a patch panel where multiple fiber runs are terminated. Patch cords are not cheap, mainly because of the number of connectors that have to be terminated to the fiber. And of course good quality single-mode patch cords are particularly expensive because of the precision connectors required (and poor quality single-mode patch cords are even more expensive in the long run).

Half the Number of Fibers

While the price of single-mode fiber has come down quite a bit due to manufacturer overcapacity, it is still by no means free. Though perhaps not a significant factor in short enterprise applications, using half the number of fibers can represent a significant savings in optical access applications. This is particularly true when the runs are of a length to require fusion splices, when plenum-rated or halogen-free cables are required by code, or when large numbers of fibers need to be aggregated into bundles with splice box sizes and support members proportional to the fiber count.

Reliability and Maintenance

Reliability and maintenance are also favorably impacted by the reduced number of points-of-failure. With traditional duplex fiber connections, it is unlikely but possible to have a break in one but not the other fiber; more common would be a failure due to a bad splice, dirty or bad connector, etc. that only affects one side of the connection but that nonetheless brings the whole link down. And of course having two connections presents the possibility of reversal, either at installation or when doing maintenance. In the simplest terms, half the number of fibers means half the number of potential problems.

Single-Strand Fiber Solutions from IMC Networks

IMC Networks started shipping single-strand fiber products early in 2001, and now has several thousand endpoints installed in live networks. IMC Networks offers the widest range of SSFX products in the industry, from unmanaged media converters, to SNMP manageable modules, to Optical Ethernet access devices. Below is a sampling of some of the product families wich use Single-Strand Fiber technology.

SFP Transceivers

SFPs are compact modular transceivers, which allow customers to change fiber types or from fiber to copper, without having to replace expensive network equipment.

Ethernet Media Converters

Ethernet copper-to-fiber media converters with single-strand fiber options include: **MiniMc** and **McBasic** low-cost standalone converters; **McLIM** modular unmanaged converters; and **iMcV-LIM** and the switching 10/100 **iMcV-MediaLinX** modular, managed converters.

All provide connection between two standard copper Ethernets over one fiber to distances up to 60 km.

Telco-Oriented TDM Extenders

Telco-oriented copper-to-fiber converters include: modular, managed **iMcV-T1/E1/J1** and **iMcV-DS3** which each connect two copper networks (T1/E1 at 1.5/2 Mbps or T3 at 45 Mbps, respectively) over single-strand fiber at distances up to 80 km.

Interface-Independent Applications

iMcV-WDM takes any two pairs of 1310 nm and 1550 nm sources, regardless of bit rate or protocol, and connects them over a standard fiber pair. The devices connected to *iMcV-WDM* determine distance.

Ethernet Optical Access Devices

iMcV-FiberLinX-II is an Ethernet optical access device that provides end-to-end managed, bandwidth-scalable Ethernet fiber connections at a low total system cost per customer. Deploy *iMcV-FiberLinX-II* either in pairs or as part of a mixed-configuration link partnered with media converters.

AccessEtherLinX is another Ethernet optical access device which provides a managed customer demarcation point with tagged VLAN and bandwidth management support.

iMcV-FiberLinX-II and *AccessEtherLinX* are available with single-strand fiber options ranging to 60km.

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A key advantage of having this broad product line of single-strand fiber products is that all the Ethernet products are compatible, allowing system integrators to mix-and-match end-points to meet their specific application requirements. For example, in a cost-sensitive enterprise fiber-to-the desktop application, *McLIM* modular media converters rack-mounted in the data center may interface over single strand fiber with desktop MiniMc standalone units.

An Optical Ethernet service provider may combine *iMcV-LIMs* at the central office location with *iMcV-FiberLinX-II* units at customer sites for a fully managed optical access network. And with 20 km, 40 km and 60 km range options for each product, the cost may be tailored to the specific application distance requirement.

Conclusion

CWDM and single-strand fiber technologies have brought about a major enhancement in fiber optics through the use of single-strand rather than paired fibers for full duplex communication. Service providers and network managers can use this increased fiber efficiency to double the capacity of an existing fiber plant. Or in new installations, single-strand fiber reduces the total number of end-points across the network by 50%, leading to substantial savings in labor and material.

IMC Networks offers the industry's broadest line of media conversion and optical access Ethernet products with single strand capability, allowing system integrators to tailor a system for their network architecture.

Contact IMC Networks Fiber Consulting Service free of charge at 800-624-1070 or fcs@imcnetworks. com for more information on how single strand fiber technology can lower your fiber connectivity costs.

About IMC Networks

IMC Networks is a leading ISO 9001 certified manufacturer of optical networking and LAN/WAN bandwidth management solutions for enterprise, telecommunications and service provider applications. The company provides the industry's widest variety of copper-to-fiber media converters, and fiber mode converters. In addition to physical layer products, IMC Networks offers remotely managed Customer Premises Equipment and Layer 3 and Layer 4 bandwidth control and packet classification solutions.

Fiber Consulting Services

IMC Networks' Fiber Consulting Services (FCS) assists network managers and system integrators with the design and development of fiber-based networks. Consulting services are free of charge. Please contact us at fcs@ imcnetworks. com or by calling 800-624-1070 in the USA or +1-949-465-3000 outside of USA.

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