



# How to Determine the Right Fiber Optic Network Backup Switch For Your Application

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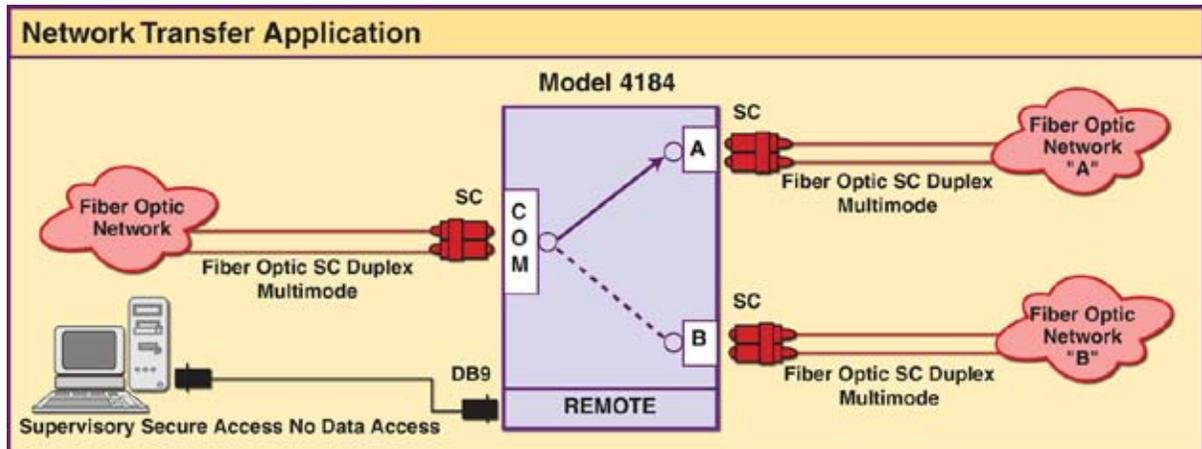
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**Abstract:** Fiber optic network backup switches allow the users the capability of sharing a device/s connected to the COMMON port/s among devices connected to the (A, B, C, etc.) lettered or (1, 2, 3, etc.) numbered ports. The number of switch positions required will be related to how many devices or networks to which you want to send your data. This paper will evaluate the elements required to design a fiber optic network backup switch.

## 1. Questions to Consider in the Design of Your Switch.

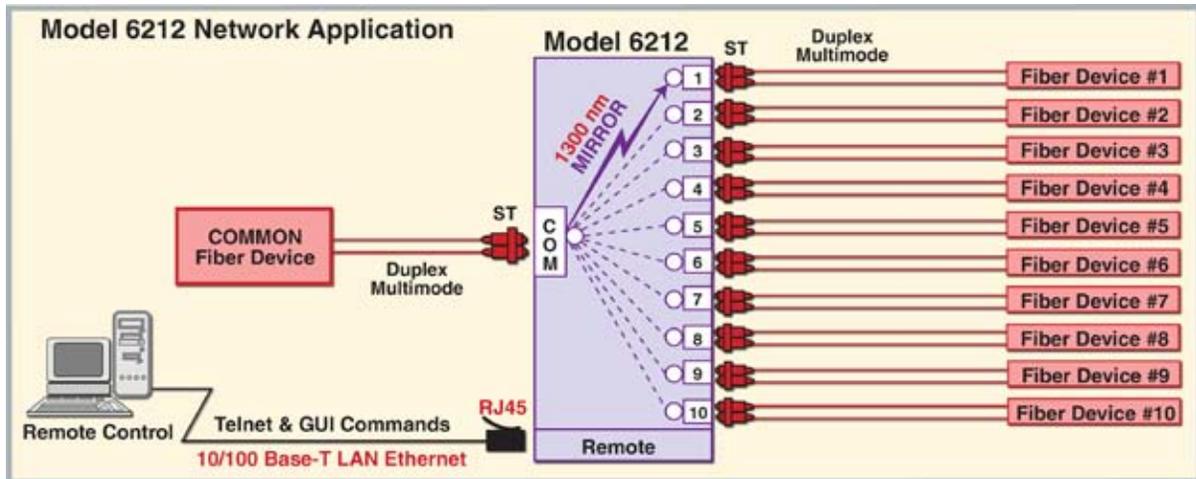
### A. How many positions does your application require?

- i. Two-position and three-position switches are very common. Complex multi-position switches are also required. Block diagrams 1 and 2 illustrate the differences between an A/B and a 10-position switch.



**Block Diagram 1: Example of an A/B switch.**

The **QuickSwitch**® Model 4184 Fiber Optic SC Duplex A/B Switch with Remote Port enables the user to push a button for local control, or utilize the RS232 serial security enhanced Supervisory Remote Port for remote control.



**Block Diagram 2: Example of a 10-Position switch.**

The **QuickSwitch®** Model 6212 ST Duplex All-Optic 10-Position Switch with Remote Ethernet Port and Graphical User Interface affords the user more options. One ST duplex fiber port is able to access any one of ten ST duplex ports. The Remote Ethernet Port allows for both Telnet and GUI remote control. Control the switch via a 10/100-Base-T LAN Ethernet environment or via pushbuttons. This is a simple point and click operation.

**B. What type of connector or port preference? The selection of connectors include ST, SC, LC, ESCON and others.**

- i. ST connectors** use a plug and socket that is locked in place with a half-twist bayonet lock.
- ii. SC connectors** feature a push-pull latching system providing speedy insertion and removal along with a positive connection.
- iii. LC connectors** are smaller versions of the SC connectors.
- iv. ESCON** connectors have two 2.55 mm ceramic ferrules and a robust strain relief design.



**Figure 1.**The above images are examples of ST, SC, LC and ESCON fiber optic connectors.

### C. Fiber Requirement: Simplex or Duplex?

- i. In configuring your backup switch, a determination on the fiber type, simplex or duplex needs to be made.
  1. **Simplex fiber optic cable** consists of a single fiber, and is primarily used in applications that only require one-way data transmission. Simplex fiber is available in both singlemode and multimode. Simplex means the cable has only one thread of fiber optic glass inside the single core and one single outer jacket.
  2. **Duplex cable** consists of two fibers, usually in a zipcord (side-by-side) style. Duplex multimode or single mode fiber optic cables are used for applications that require simultaneous, bidirectional data transfer. Workstations, fiber switches and servers, fiber modems, and similar hardware usually require duplex cable. Duplex fiber is available in singlemode and multimode. Duplex fiber cable can be regarded as two simplex cables having their jackets joined by a jacket material. Some duplex fiber optic cables have clips on the two fiber optic connectors at each side of the cable to combine the two connectors together.

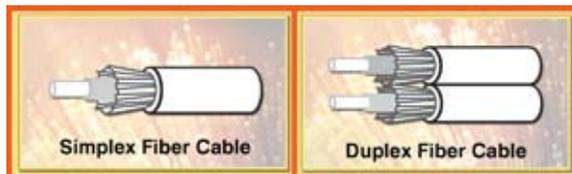


Figure 2. Demonstrates the difference between simplex and duplex fiber optic cables.

### D. Mode: Multimode or Singlemode?

- i. **Multimode fiber optic cable** has a large diameter core that is much larger than the wavelength of light transmitted, and therefore has multiple pathways of light. Several wavelengths of light may be used in the fiber core. Multimode optical cable is most commonly used for shorter distances, such as a building or a campus. Typical multimode links have data rates of 10 Mbit/s to 10 Gbit/s over link lengths of up to 600 meters.
- ii. **Singlemode fiber optic cable** has a small core and only one pathway of light. With only a single wavelength of light passing through its core, singlemode realigns the light toward the center of the core instead of simply bouncing it off the edge of the core as with multimode. The glass fiber diameter is usually 8.3 to 10 microns. Single mode fiber provides a higher transmission rate and up to 50 times more distance than multimode.



Figure 3A.  
Top row: demonstrates ST, SC, and LC multimode fiber optic cables. (orange jackets)

Figure 3B.  
Bottom Row: demonstrates ST, SC, and LC single-mode fiber optic cables. (yellow jackets)

**E. Switch Specifications: Wavelength, Speed, Fiber Size, Simplex, Duplex, Interface Conversion will be unique to your network. Examples of two switches with very different specs follow.**

- i. The **QuickSwitch®** Model 4181 SC Duplex 100Base-FX Auto Fallback Switch and the **QuickSwitch®** Model 4189 4-Way Fiber Optic Switch/Converter have some specs in common, both switches feature full duplex transmission and 62.5/125μ fiber size. However, their function and interfaces require significant differences.



**Figure 4A. QuickSwitch® Model 4181**



**Figure 4B. QuickSwitch® Model 4189**

Connectors:	A, B, and COMMON are SC Duplex.	Ports 1, 2 are 10BaseFX Fiber Optic, ST duplex. Ports 3, 4 are 100BaseFX Fiber Optic ST duplex. COMMON port is 10/100Base-TX, RJ45.
Wavelength:	1300nm.	Ports 1, 2 are 850nm. Ports 3, 4 are 1300nm.
Speed:	100 Mbps.	Ports 1, 2 are 10 Mbps. Ports 3, 4 are 100 Mbps.
Front Panel Control:	Via pushbutton.	(4) Pushbuttons to select network port.
Remote Control:	(1) DB9 Female rear-panel connector accepts ASCII RS232 Serial Data for Remote Control Operation.	No remote control.
Function:	Fiber-to-Fiber A/B Switch.	Copper-to-Fiber A/B/C/D Switch/Converter.

**F. Technology Preference: All Optic, Optic/Electronic/Optic, No Preference?**

- i. **All-Optic (O-O-O)** — Fiber optic network switches designed with scalable all-optical, O-O-O, MEMS (Micro-Electromechanical System) technology employ control mechanisms to tilt mirrors or direct prisms in multiple directions to manage light signals without converting the signals to electrical and back to optical. This increased level of control minimizes insertion loss and keeps the features of high data rate and protocol transparency.
- ii. **Optic/Electronic/Optic (O-E-O) Technology** — Optic/Electronic/Optic technology is both economical and reliable, however such an architecture prevents the switch from performing with the same speed as an all-optical scheme and is not transparent to network protocols used.



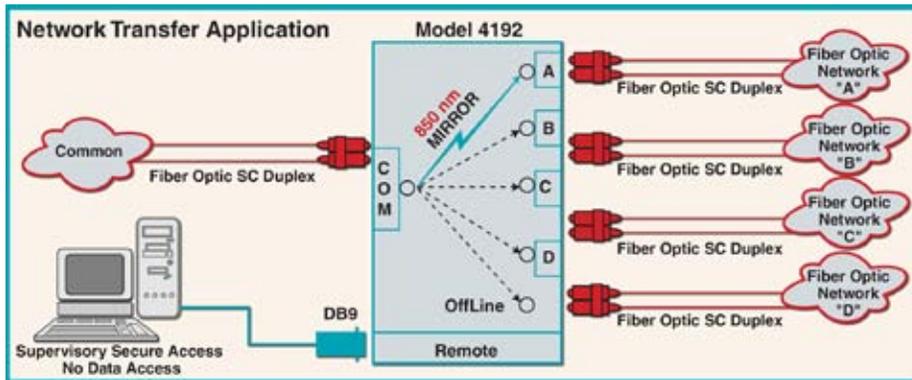
**G. Chassis Type: Rackmount or Desktop? — This table lists a variety of switches built to fit equipment racks and desktops.**

Network Switch	Description	Dimensions	Weight
	Model 4192 SC Duplex A/B/C/D/Off-Line Switch with Remote, Rackmount.	19" W x 3.5" H x 8" D Height is 2U (3.5") Installs in a standard 19" rack. Rackmount unit.	5 lbs.
	Model 4294 4-Way All-Optic Simplex Fiber Switch with Threaded FC Connectors, 100/140 Graded Index Fiber, UPC, Rackmount.	19" W x 1.75" H x 8" D Height is 1U (1.75") Installs in a standard 19" rack. Rackmount unit.	3 lbs.
	Model 6259 16-Channel ST Simplex Fiber Optic A/B/OFFLINE Switch, Rackmount.	19" W x 3.5" H x 12" D Height is 2U (3.5") Installs in a standard 19" rack. Rackmount unit.	6.5 lbs.
	Model 6190 A/B Switch, ST Duplex, Dual Wavelength with Remote Serial Control and Optional Graphical User Interface, Desktop.	8" W x 2.7" H x 7.25" D Desktop Unit.	3 lbs.
	Model 5191 4-Way Fiber Optic Switch / Converter with Remote Control, Desktop.	11" W x 2.75" H x 8.5" D Desktop Unit.	3 lbs.
	Model 6212 ST Duplex Fiber Optic 10-Position Switch with Remote Ethernet Port and Graphical User Interface, Desktop	16.49" W x 3.5" H x 8" D Desktop Unit	6 lbs.

## H. Security Concerns can be addressed in a variety of ways.

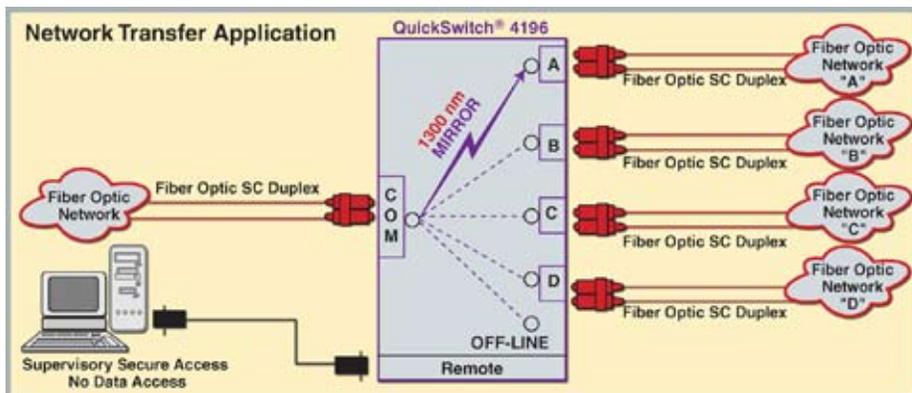
### i. Off-line positions.

- 1. External Off-line Position** — The block diagram of the Model 4192 Fiber Optic SC Duplex A/B/C/D/Off-Line Switch illustrates a fiber optic switch with an external off-line position. This switch enables a fiber optic device connected to the SC Duplex COMMON connector of the unit to access any of the four fiber optic networks connected to the A, B, C, or D ports, or to disconnect completely from all output ports. The switch position can be changed via a pushbutton or via a device connected to the Remote port. Applying the appropriate voltage to the designated pins of the Remote connector will cause the switch to change position.



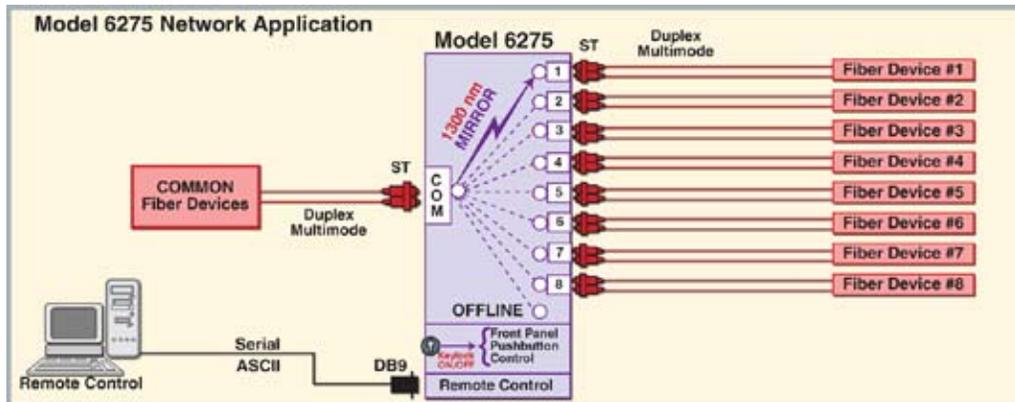
**Block Diagram 3: Example of a fiber optic switch with an external Off-Line position.**

- 2. External Off-Line Position with Switch Position Memory** — The Model 4196 4-Way All-Optic Fiber Switch, Multimode, 62.5/125 Microns with a Fully Decoupled Off-Line Capability allows a fiber optic device connected to the unit's SC Duplex COMMON connector to access any of the four fiber optic networks connected to the A, B, C, or D ports, or to disconnect completely from all output ports. Switch position can be changed via front-panel pushbuttons or by a device connected to the rear panel Remote port. Applying appropriate voltage to designated pins of the Remote connector also changes the switch position. The Off-Line pushbutton uncouples all fiber ports from each other. The Model 4196 has Switch Position Memory. When power is lost, the Model 4196 automatically changes to the Off-Line position and decouples all fiber connection in and out of the unit. When power returns, the Model 4196 automatically reads the voltages on the Remote port and looks to the pushbutton activity to select its switch position.



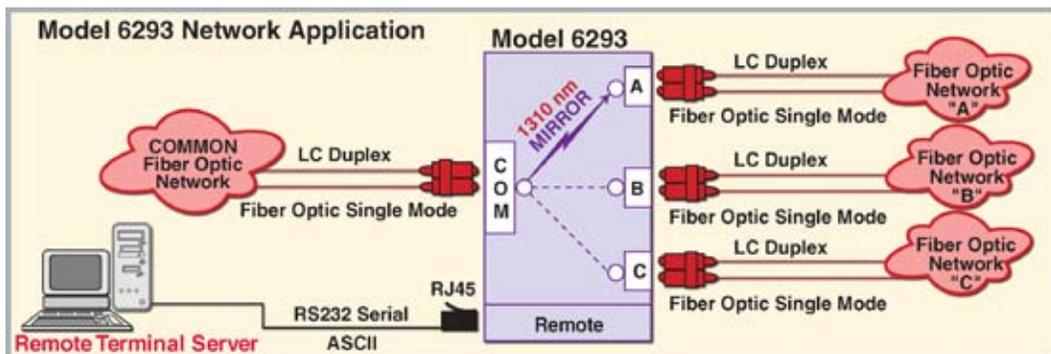
**Block Diagram 4: Example of a fiber optic switch with an external Off-Line position with switch position memory.**

- 3. Internal Off-Line Position with Options** – The Model 6275 ST Duplex Fiber Optic 8-Position Switch with Off-Line Position and Remote Serial Control provides both an Off-Line position and a keylock to lock out the front panel pushbutton controls. The Model 6275 features both local and remote control. The Off-Line position is a valid state to preserve network and data isolation. The user can configure the switch to either maintain its position and data pathways on power failure or to revert to the Off-Line position during power failure. A key is provided to lockout the front-panel pushbutton controls.



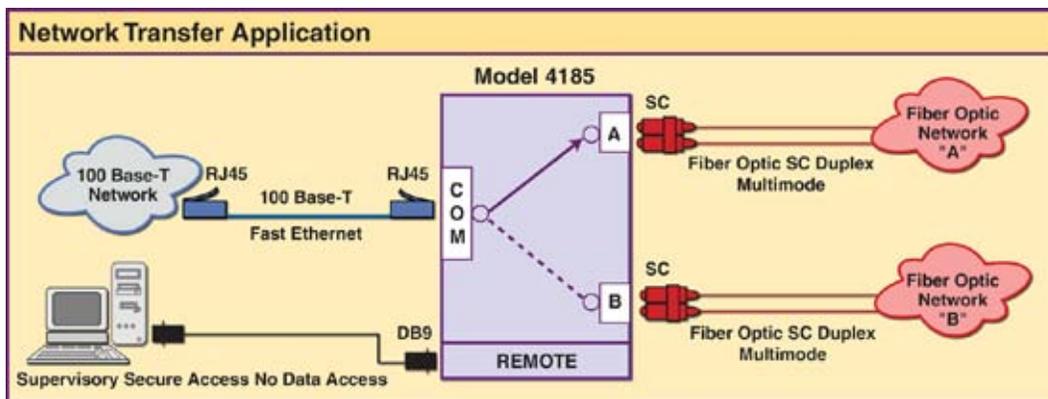
**Block Diagram 5: Example of a fiber optic switch with an internal Off-Line position and a keylock to lock out the front panels pushbutton controls.**

- ii. Front Panel Lockout** - The Model 6293 Fiber Optic Mirror A/B/C Switch, Single Mode LC Duplex with Remote Serial Access allows sharing a fiber optic LC duplex pair connected to the COMMON port among three other sets of LC duplex pairs connected to the A, B, and C ports with local and remote access functionality. The front-panel pushbutton can be locked out using remote ASCII commands.



**Block Diagram 6: Example of a fiber optic switch with a Remote port which can be used to lock-out the front-panel pushbuttons with ASCII commands.**

**iii. Password Protection** - Password protection is another method of providing network security. The Model 4185 Fiber Optic SC Duplex, Multimode Switch/Converter allows accessing two separate fiber optic 100 Base FX ports (ports A and B) from a 100 Base TX Fast Ethernet port (COMMON port). The fiber optic/twisted pair copper conversion is built in. This unit includes an RS232 serial security enhanced Supervisory Remote Port. Upon proper authentication, a terminal or computer in terminal mode connected to this port can communicate with the unit, determine its status, change the switch position as desired, and/or lock out the front panel switching capability. A modem can also be connected to this port to remotely access the switch. Access to the Supervisory Remote Port feature is password protected.



**Block Diagram 7: QuickSwitch® 4185 is an example of a password protected Supervisory Remote. Access can be obtained with the proper authentication.**

**i. Power Loss – How should your switch function during a power loss?**

- i. Should the switch continue to pass data?
- ii. If passing data during a power loss, should data pass through the last selected switch position or go to the default position?
- iii. Upon power up, should the switch remain in the last position or start up in default mode?
  1. Examples of Power Loss Design Protocols.
    - a. The **QuickSwitch®** Model 4187 ST Duplex 100BaseFX A/B Switch with Remote Access: In the event of a temporary power failure, the switch will return to the last ordered position when power is restored. Data will not pass through the unit during the power loss.
    - b. The **QuickSwitch®** Model 4196 4-Way All-Optic Fiber Switch, Multimode, 62.5/125 Microns with a Fully Decoupled Off-Line Capability: When power is lost, the **QuickSwitch®** Model 4196 automatically changes to the OFF-LINE position and decouples all fiber connections in and out of the unit. When power returns, the Model 4196 automatically



reads the voltages on the Remote port and looks to the pushbutton activity to select its switch position.

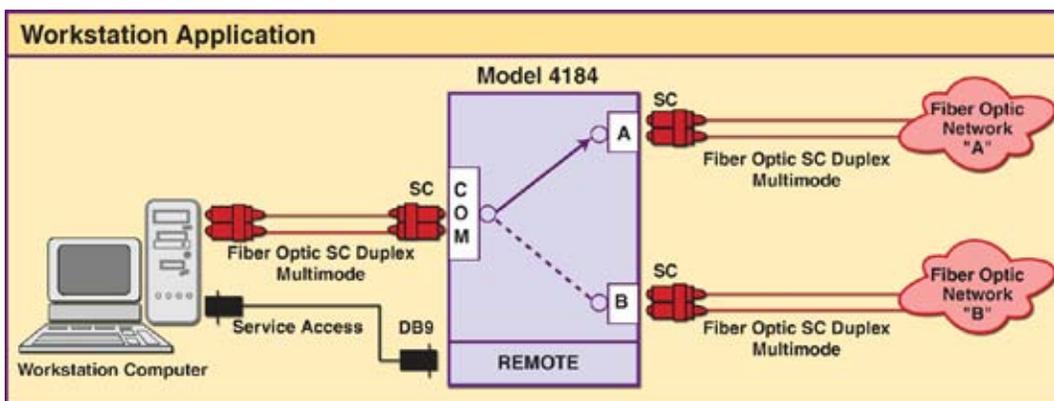
- c. The **QuickSwitch**® Model 4294 4-Way All-Optic Simplex Fiber Switch with Threaded FC Connectors, 100/140 Graded Index Fiber, UPC: When power is lost, the **QuickSwitch**® Model 4294 automatically changes to its default position and will continue to pass data.
  - d. The Model 5528 Single Channel 3-State SVCN/GPCN/OFFLINE RJ45 Cat5e Keylock Switch: The Model 5528 will revert to the OFFLINE status regardless of the keylock position. When power is restored, the unit will automatically read and match the switch position indicated by the keylock actuator.
  - e. The **QuickSwitch**® Model 6190 Fiber Optic A/B Switch, ST Duplex, Dual Wavelength with Remote Serial Control and Optional Graphical User Interface will always revert to A and continue to pass data when power to the unit is lost.
  - f. The **QuickSwitch**® Model 6212 ST Duplex Fiber Optic 10-Position Switch with Remote Ethernet Port and Graphical User Interface is a latching switch and will maintain its position and continue to pass data in the event of a power failure.
  - g. The **QuickSwitch**® Model 6259 16-Channel ST Simplex Fiber Optic A/B/OFFLINE Switch goes offline on power loss and stops passing data.
  - h. The **QuickSwitch**® Model 6275 ST Duplex Fiber Optic 8-Position Switch with OFFLINE Position and Remote Serial Control can be configured to either maintain its position and data pathways on power failure or to revert to the OFFLINE position during power failure.
- j. Number of Channels per Chassis** - Electro Standards manufactures fiber optic backup switches ranging from Single-Channel to 16-Channel Switches.
- k. Multiple channel switch control: Simultaneous or Individual.**  
Examples of how these switches function follow:
- i. Simultaneous Channel Switching:** The **QuickSwitch**® Model 6257 Quad-Channel All-Optic A/B Switch Multimode ST Duplex 62.5 Micron with Remote Control Port switches all channels simultaneously. The Model 6257 is controlled locally by manually operating the front panel pushbutton or remotely from the DB9 custom Remote Control port. The DB9 Remote port provides control by signal transition logic and allows the user to both control and monitor the switch.
  - ii. Individual Channel Switching:** All channels are switched individually with the **QuickSwitch**® Model 6258 Six-Channel All-Optic Online/Offline Switch, LC Duplex with 10/100 Base-T LAN TELNET Access. Switching may be accomplished via front-panel control or remotely using an Ethernet 10/100 Base-T connection and TELNET commands. Front panel LEDs display switch position, status, and power.

## 2. Putting the Switch All Together

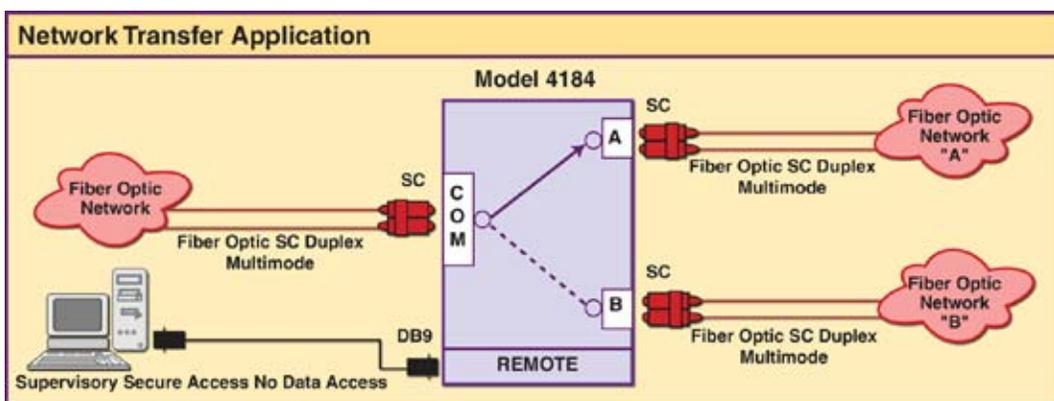
- i. The **QuickSwitch**® 4184 block diagram illustrates a Fiber Optic SC Duplex A/B Switch with a Supervisory Remote port that was designed for Fiber Optic Link Backup. The switch utilizes a multimode duplex fiber connector interface on the A, B, and COMMON ports. The multimode fiber optic full-duplex enables data to be sent in both directions simultaneously. This switch connects a workstation or devices between two other devices



or networks. The internal circuitry insures isolation between the A and B devices/networks. The isolation is necessary to prevent crosstalk where a signal transmitted on one channel of a transmission system creates an undesired effect in another channel. The **QuickSwitch®** Model 4184 also features an RS232 serial security enhanced Supervisory Remote Port. With proper authentication, a terminal or computer in terminal mode connected to this port can communicate with the switch, determine its status, change the switch position, and lockout the front-panel switching capability.

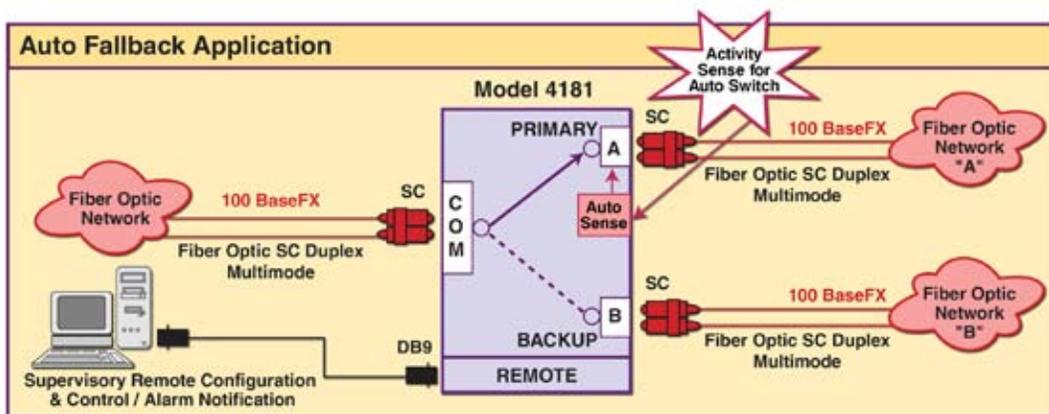


**Block Diagram 8a:** *QuickSwitch®* 4184 block diagram illustrates a Fiber Optic SC Duplex Switch for a workstation application showing fiber optic link backup.



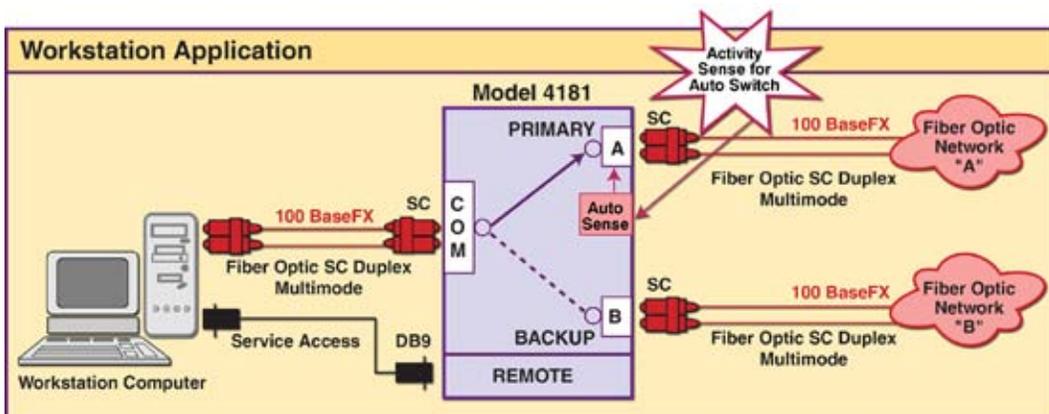
**Block Diagram 8b:** *QuickSwitch®* 4184 block diagram illustrates a Network Transfer application with an RS232 Serial security enhanced Supervisory Remote Port.

- ii. The **QuickSwitch**® 4181 SC Duplex 100BaseFX Automatic Fallback Switch provides that same backup function as the **QuickSwitch**® Model 4184, but with an added twist: Automatic Fallback based on monitoring its environment for SD (Signal Detect) to determine its switch position. In the fallback mode, the Model 4181 maintains connection from the Common port to port A while SD is present on the A port. If SD is absent or lost, the unit automatically switches to the fiber link connected to port B. Once SD has been restored and is sensed at port A, the switch automatically returns to the A position.



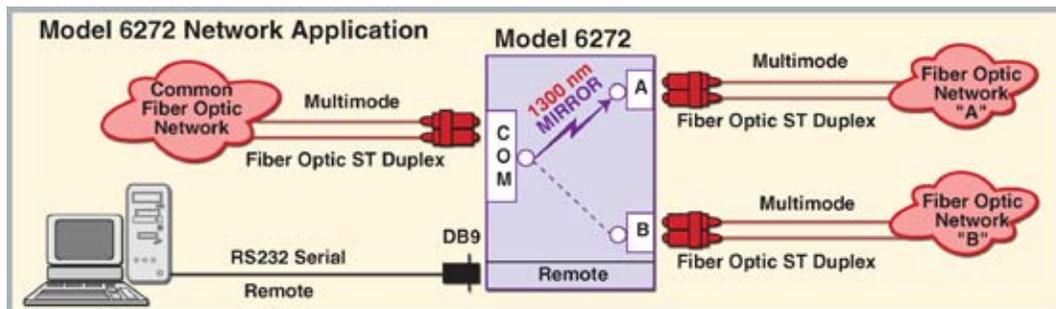
**Block Diagram 9a: QuickSwitch**® 4181 block diagram illustrates a Fiber Optic SC Duplex Switch for a workstation application showing Automatic Fallback based on SD.

- iii. The **QuickSwitch**® Model 4181 supports 100BaseFX fiber optic networks. 100BaseFX is also called "Fast Ethernet." It is a 100Mbps version of Ethernet (IEEE 802.3u standards). 100BaseFX transmits at 100 Mbps rather than 10 Mbps. Like regular Ethernet, Fast Ethernet is a shared media LAN. All modes share the 100 Mbps bandwidth. To guarantee proper signal timing, a 100BaseFX link cannot exceed 1312 feet (400 meters) in length.



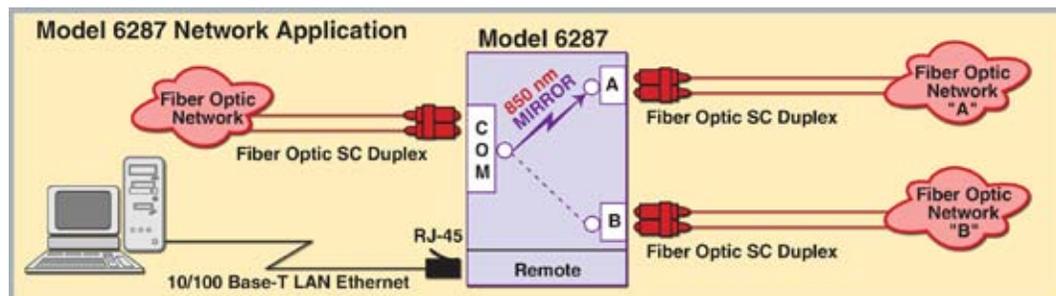
**Block Diagram 9b: QuickSwitch**® 4181 block diagram illustrates a Network Transfer application with a "FAST ETHERNET".

- iv. The **QuickSwitch**<sup>®</sup> Model 6272 ST Duplex Fiber Optic Mirror A/B Switch with Remote Serial Control is an ideal backup switch for high speed requirements. This switch features a Gigabit data rate and supports a fiber optic wavelength of 1300nm. This MEMS-based (Micro Electro Mechanical System) switch is designed with an all-optic (O-O-O) mirror/prism technology that insures insertion losses of less that 1.0 dB. The switching time is less than 1 msec for this switch. The Model 6272 offers front-panel pushbutton control or Remote ASCII Command access via the Remote serial port.



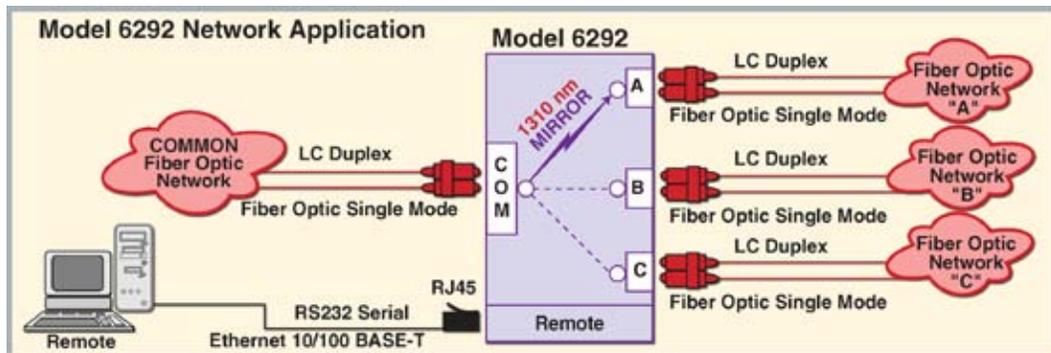
**Block Diagram 10: QuickSwitch<sup>®</sup> 6272 ST Duplex Fiber Optic Mirror A/B Switch with Remote Serial Control is an ideal backup switch for high speed requirements.**

- v. The **QuickSwitch**<sup>®</sup> Model 6287 is ideal for those who would like to control the switch via their 10/100 Base-T LAN network. This standard employs 8-position RJ45 connectors and can operate over distances of 100 meters. Switch position status may be attained via the front-panel LED display or the remote Graphical User Interface software via the rear-panel Remote LAN port. The switch can be controlled locally via pushbutton or remotely via File Transfer Protocol (FTP) communications over 10/100 Base-T. FTP is a standard Internet protocol and is an easy way to exchange files between computers on the Internet. In the event of a power loss to the **QuickSwitch**<sup>®</sup> Model 6287, the switch reverts to the default position and continues to allow data to pass. The A, B, and COMMON ports are all SC Duplex with bidirectional data flow. The SC connector offers an excellent packing density and its push-pull design resists fiber end face contact damage during connection. Ceramic connectors provide low signal loss, high reliability and a long life.



**Block Diagram 11: QuickSwitch<sup>®</sup> 6287 SC Duplex Fiber Optic Mirror A/B Switch with Remote Serial Control via a 10/100 Base-T network.**

- vi. The **QuickSwitch® 6292** Fiber Optic Mirror A/B/C Switch, Single Mode, LC Duplex with 10/100 Base-T LAN TELNET Access is IP Addressable for critical network alternate-path switching. The Model 6292 allows the user the capability of sharing a Fiber Optic LC Duplex pair connected to the COMMON port among three other sets of LC Duplex pairs connected to the A, B, and C ports with both local and remote access functionality. Remote access can be accomplished using an Ethernet 10/100-Base-T connection and Telnet commands. The Model 6292 supports single mode fiber (SMF 28), 9/125 micron fiber with a wavelength of 1310 nm. Single mode fiber is a type of fiber optic cable where only one light signal can travel at a time. Single-mode fiber is more resistant to attenuation than multi-mode fiber and therefore can be used for longer cable applications.



**Block Diagram 12: QuickSwitch® 6292 LC Single Mode Fiber Optic Mirror A/B/C Switch with 10/100 Base-T LAN TELNET Access Remote is an IP addressable switch.**

**3. Summary** - Fiber optic switches of various functions are available to add versatility, improve efficiency, and enhance scalability of data networks. They may be operated locally by pushbutton or remotely via a variety of common communication interfaces. The agility that they add to network operational performance is limited only by the innovation of the user and the design expertise of the switch product provider. Applications include switching to backup data lines, to test equipment, to monitoring equipment, or simply switching to off-line for security. Electro Standards Laboratories is available to provide an optimum switch solution for your application.

### Author's Background

Raymond B. Sepe, Sr., is the President of Electro Standards Laboratories, Cranston, Rhode Island. Mr. Sepe holds electrical engineering degrees from the University of Rhode Island. As the President of Electro Standards Laboratories, he has been involved with the design and manufacture of innovative network products for over 30 years, developing state-of-the-art fiber optic network backup switches, interface converters and cable assemblies.