APPLICATION NOTE

Product Family: Networking Hardware

Number: AN-NH-002

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Subject: Connecting Fiber Devices

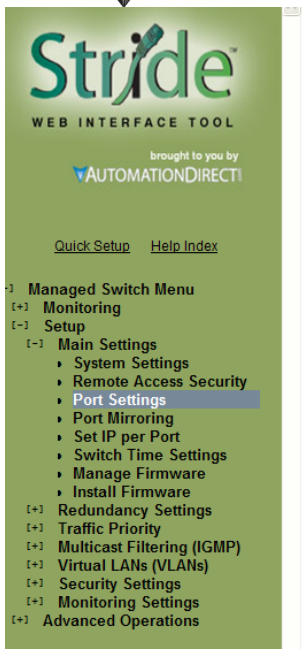
Revision: Original

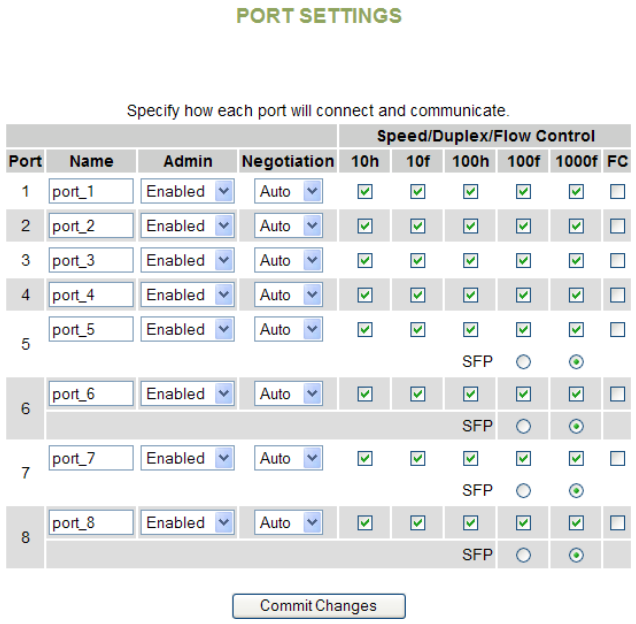
This guide provides an end-to-end overview of the process, troubleshooting common connectivity issues, and answers to frequently asked questions.

1. Troubleshooting an end-to-end fiber connection
2. Introduction to Transceivers and connectors
3. Fiber Transceiver Performance Specifications – Reference Tables
4. Calculating Fiber Optic Distances

Section 1: Troubleshooting an End-to-End Fiber Connection

1. Ensure that the cable type you are using matches the transceiver type. That is, **Multimode cable requires Multimode transceivers, and Singlemode cable requires Singlemode transceivers.**
2. Additionally, it is important that 62.5um is used with 62.5um and 50um used with 50um. If the fiber cores are not aligned correctly significant attenuation will occur.
3. Make sure that the **speeds** of both ends of a link match: a 100Mbps SFP on one switch must connect to a 100Mbps connection on the other switch or end device. Fiber ports do not negotiate speed.
4. If you are using a 100Mbps SFP in a Stride switch, you must **manually change the port speed on the Port Settings page** of the Switch Setup interface:





5. Make sure that all of your connectors are clean. Even a little bit of dust, dirt or grease on a connector face can significantly degrade a fiber signal. This includes the main fiber optic link as well as any patch cables that you may be using. When cleaning, it is important to use lint-free swabs or wipes, preferably of a clean room quality. These can be used dry or wet (with 99% isopropyl alcohol solutions).
    - Make certain that you are not cleaning an active fiber, as the laser can cause permanent damage to your eyes should you look into the end face.
    - Additionally, it is not necessary to scrub the end face, rather to just gently wipe it clean and then double-check the link. If additional cleaning is required simply repeat this process.
6. Make sure that all connectors are plugged completely into their proper ports. Again, if end faces are not lined up correctly with transceivers and/or mated fiber ends, the system may fail due to excess attenuation.
7. Make sure that the transmit cable at the near end is the receive cable at the far end. There needs to be a crossover for a fiber link to work correctly. Be sure to factor in all patch cords that may be used.

Note that the physical connectors on the ends of a fiber cable do NOT need to match: a link may use an LC connector on one end and an SC connector on the other end.

Section 2: Introduction to Transceivers and Connectors

Two distinct types of transceivers:

- 1x9 (SC or ST connectors) available on some models of 5 and 8 port managed switches as well as some models of 5 and 9 port unmanaged switches and unmanaged media converters.
- SFP (LC connectors) purchased separately for use in gigabit model managed switches, SE-SW8MG-4P and SE-SW10MG-2P

1x9 Transceivers with SC or ST Connectors

The 1x9 transceiver is offered on the fiber optic fast Ethernet (100 Mbps) ports. The notation "1x9" refers to the industry-standard pin-out of 1 row by 9 pins. These transceivers use multimode dual ST or SC style connectors.

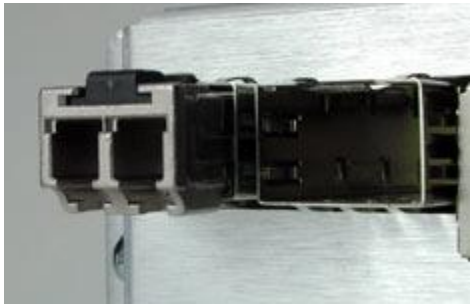
1x9 Transceiver with SC Connectors

1x9 Transceivers with ST Connectors

SFP (Small Form-factor Pluggable) Transceivers (aka Mini-Gbic) with LC Connectors

These transceivers are offered on the combo ports available on SE-SW8MG-4P and SE-SW10MG-2P. These transceivers plug into a cage assembly on the switch. They are more compact than 1x9-style transceivers. AutomationDirect offers six versions: 100Mbps (fast Ethernet) or 1000Mbps (Gigabit Ethernet,) and single-mode or multimode for distances from 550 meters to 30km.

SFP Transceiver out of cage



SFP Transceiver inserted in cage

Section 3: Fiber Transceiver Typical Performance Specifications – Reference Tables

Fiber Transceivers Performance Specifications

Ethernet Type	Mode	Wavelength (nm)	IEEE Standard	Cable size (core/cladding) um	Transceiver max rated distance	Power Budget (Power minus Sensitivity)	Transmitter Power*			Receiver Sensitivity*
						Worst case	Min dBm	Typ dBm	Max dBm	Max dBm
FastEthernet	Multi	1310	100BaseFX	62.5/125	4km	22 (-9 minus -31)	-9	--	0	-31
FastEthernet	Single	1310	100BaseLX	9/125	30km	19 (-15 minus -34)	-15	--	-8	-34
GigabitEthernet	Multi	850	1000BaseSX	50/125	550m	8 (-9 minus -17)	-9.5	--	-4	-17
GigabitEthernet	Multi	1310	1000BaseSX	50/125	2km	10 (-9 minus -19)	-9	--	-1	-19
GigabitEthernet	Single	1310	100BaseLX	9/125	10km	11 (-9 minus -20)	-9.5	--	-3	-20
GigabitEthernet	Single	1310	100BaseLX	9/125	30km	21 (-2 minus -23)	-2	-1	+3	-23

***** For transmitter power, a higher number is better. The opposite is true for receiver sensitivity, a lower number is better.

Fiber Cable Parameters (typical)

Cable Size (core/cladding) (µm)	Mode	Wavelength (nm)	Connector Losses (dB per connection)	Splice Losses (dB per splice)	Distance Losses (dB per km)	Multimode Modal Dispersion (MHz x km)	Singlemode Dispersion (ps /nm x km)
62.5/125 µm	Multi	850 nm	1 dB	0.2 dB	3.3 dB	300	--
50/125 µm	Multi	850 nm	1 dB	0.2 dB	2.7 dB	700	--
62.5/125 µm	Multi	1310 nm	1 dB	0.2 dB	1 dB	500	--
50/125 µm	Multi	1310 nm	1 dB	0.2 dB	0.8 dB	800	--
9/125 µm	Single	1310 nm	1 dB	0.2 dB	0.5 dB	--	3.5

NOTE: The parameters listed in this table are guideline numbers only. Refer to your cable specifications for more accurate values.

Section 4: Calculating Fiber Optic Distances

There are two primary ways to calculate how far you can go with your fiber optic links. To be safe, you should go by the shortest result from the two methods for Multimode fiber. Also, you should design for up to a 25% safety margin to be conservative and allow for degradation of the signal and cable over time.

Method 1: Modal Dispersion for Multimode Links Only

Maximum Distance = modal Dispersion / Signal rate

Speed	Mode	Wavelength (nm)	Cable Diameter (µm)	Modal Dispersion	Signal Rate (MHz)	Max. Distance Based on Modal Dispersion
FastEthernet	Multi	1310 nm	62.5/125	500	125	4 km
FastEthernet	Multi	1310 nm	50/125	800	125	6.4 km
GigabitEthernet	Multi	850 nm	62.5/125	300	1250	240 m
GigabitEthernet	Multi	850 nm	50/125	700	1250	560 m
GigabitEthernet	Multi	1310 nm	62.5/125	500	1250	400 m
GigabitEthernet	Multi	1310 nm	50/125	800	1250	640 m

Method 2: Based on Optical Budget

Power Budget = Transmitter Power - Receiver Sensitivity
Spare Optical Budget = Power Budget - Power Losses (splices and connectors)
Maximum Distance = Spare Optical Budget / Distance Losses

Speed	Mode	Cable Size	Wavelength	Power Budget (Worst case)	Typical Losses*	Spare Power	Distance Losses	Max Distance
FastEthernet	Multi	62.5/125 µm	1310 nm	22 dB	6 dB	16 dB	1 dB	16 km
FastEthernet	Single	9/125 µm	1310 nm	19 dB	6 dB	13 dB	0.5 dB	26 km
GigabitEthernet	Multi	50/125 µm	850 nm	8 dB	6 dB	2 dB	2.7 dB	0.7 km
GigabitEthernet	Multi	50/125 µm	1310 nm	10 dB	6 dB	4 dB	2.7 dB	1.4 km
GigabitEthernet	Single	9/125 µm	1310 nm	11 dB	6 dB	5 dB	0.5 dB	10 km
GigabitEthernet	Single	9/125 µm	1310 nm	21 dB	6 dB	15 dB	0.5 dB	30 km

*Typical losses include 2 dB (two connectors), 3 dB (safety margin) and 0.4 (two splices) = 6 dB (rounded up)

Example

An industrial user has a series of Ethernet devices operational at Location A. They are building a new facility 8km away. At this distance they must use single-mode fiber. They plan to transmit at Gigabit speeds. The SM fiber that they have decided to use attenuates at a rate of .3dB/km. There will be 3 splices along the route and then connectors at each end.

Cable attenuation = 8km x .3dB/km = 2.4dB

Splice loss = 3 splices x .2dB/splice = .6dB

Connector loss = 2 connectors x 1dB/connector = 2dB

Total loss along physical link = 5dB

Safety factor of 25% = 1.25dB

Total loss budget = 6.25dB

Looking at the Gigabit fiber transceiver performance specifications, we can see that the single mode Gigabit fiber transceiver has a worst-case power budget of 11dB so this should work satisfactorily in this proposed fiber link.

Fiber Optic Maximum Distance Summary

Speed	Mode	Cable Size	Wavelength	IEEE Recommended Distance	Max. Distance Based on Power Budget*	Max. Distance Based on Modal Dispersion*
FastEthernet	Multi	62.5/125 µm	1310 nm	2 km	16 km	4 km
FastEthernet	Multi	50/125 µm	1310 nm	2 km	--	6.4 km
FastEthernet	Single	9/125 µm	1310 nm	10 km	26 km	--
GigabitEthernet	Multi	62.5/125 µm	850 nm	220 m	--	240 m
GigabitEthernet	Multi	50/125 µm	850 nm	220 m	0.9 km	560 m
GigabitEthernet	Multi	62.5/125 µm	1310 nm	550 m	--	400 m
GigabitEthernet	Multi	50/125 µm	1310 nm	550 m	1.4 km	640 m
GigabitEthernet	Single	9/125 µm	1310 nm	5 km	10 km	--

GigabitEthernet	Single	9/125 µm	1310 nm	5 km	30 km	--

* The maximum distance numbers are guidelines only. They are highly dependent on your cable and transceiver specifications.

Technical Assistance: If you have questions regarding this Application Note, please contact us at 770-844-4200 for further assistance.