

MEMS 1xN Fiber Optical Switch

(N Up to 196 Ports, Non-Blocking, Bidirectional, Passive, 70dB on/off)

The MEMS FIBER Optical switches establish optical signal paths passively in milliseconds supporting all data rates, ideally suited to manage and monitor large optical networks intelligently and remotely. The MEMS switches are reliable with longevity suited for continuous operation. The control is net-based GUI that is compatible with standard network management protocols. The box height is depended on connector choice and fiber port count. The 1U box front panel can house approximately 40 LC connectors (1x36).

The order table includes a list of standard control interfaces. Additionally, we provide a list of commands to assist customer engineers in coding. For those who require it, we offer a code-writing service for customer interfaces at an additional charge.

To minimize the delay between issuing a switching command and the actuation of switches caused by a standard window-based computer, it's essential to use a dedicated computer with a real-time operating system, such as a single-board computer running real-time Linux.



Features

- Low Cost
- High Reliability
- Low Insertion Loss
- Broad Band
- Up To 500 Port
- 750, 850, 1550, 200nm

Applications

- Optical Signal Routing
- Network Protection
- Wavelength Management
- Signal Monitoring
- Instrumentation

Specifications ^[1]

Parameters	Min	Typical	Max	Unit	
Operation Wavelength	750	1270~1630	2400	nm	
Insertion Loss ^[1] (SM)	1x8	0.5	0.7	0.8	dB
	1x24	0.5	0.8	1.0	
	1x32	0.7	0.9	1.2	
	1x64	0.8	1	1.5	
	1x128	1.1	1.5	1.8	
Insertion Loss ^[2] (MM)	0.5	1	4.3	dB	
Crosstalk, On/Off Ratio (SM) ^[3]	45	50	70	dB	
Extinction Ratio (PM)	18		26	dB	
Switch Speed (Rise, Fall) ^[4]		5	20	ms	
Durability	10 ⁹			cycle	
Polarization Dependent Loss		0.04	0.2	dB	
Wavelength Dependence Loss ^[5]		0.1	0.3	dB	
Return Loss ^[3]	50			dB	
Repeatability		0.05	0.1	dB	
Operating Temperature	-5		65	°C	
Port to Port Time Delay Difference			0.5	ns	
Optical Power Handling (CW)		300	500	mW	
Storage Temperature	-40		85	°C	
Electrical Power Consumption			50 ^[6]	W	
Package Dimension	1RU / 2RU / 4RU				

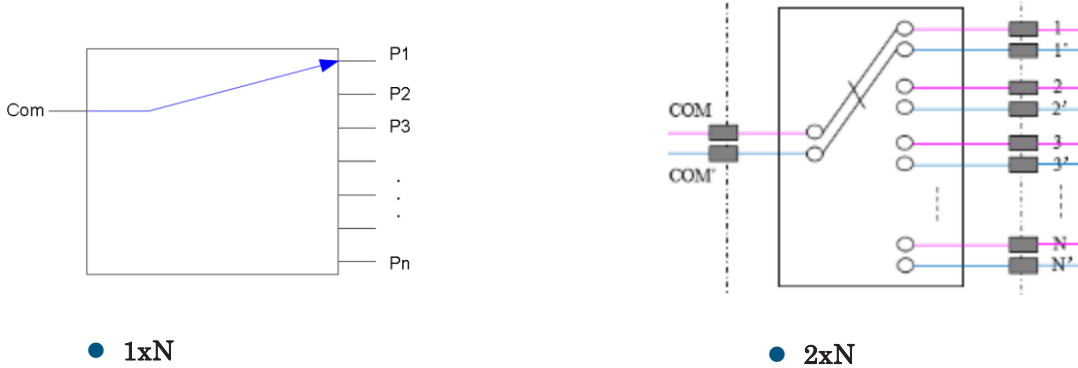
Notes:

- [1]. Measurement Conditions: Losses are measured at 1550 nm without connectors for SM28 fiber. Each connector adds 0.2-0.3 dB of loss. Loss increases for shorter or longer wavelengths.
- [2]. Multimode Switch Performance: The optical performance of a multimode switch depends on the mode fill ratio across the core (CPR). Small Fill Ratio: using a single-mode laser, results in lower loss. Large Fill Ratio: using an LED, results in higher loss. The difference can be 50X.
- [3]. Fiber Type Considerations: Multimode (MM) fiber typically exhibits lower performance values compared to single-mode (SM) fiber in similar conditions.
- [4]. Intrinsic Switch Performance: The performance values provided reflect the intrinsic switch component capabilities. Remote control introduces additional delay, with Ethernet having the longest delay. Using a Linux-based computer can reduce CPU-induced delay.
- [5]. Bandwidth Range: Performance specifications are valid within a 50 nm bandwidth around the central wavelength.

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Optical Path Illustration

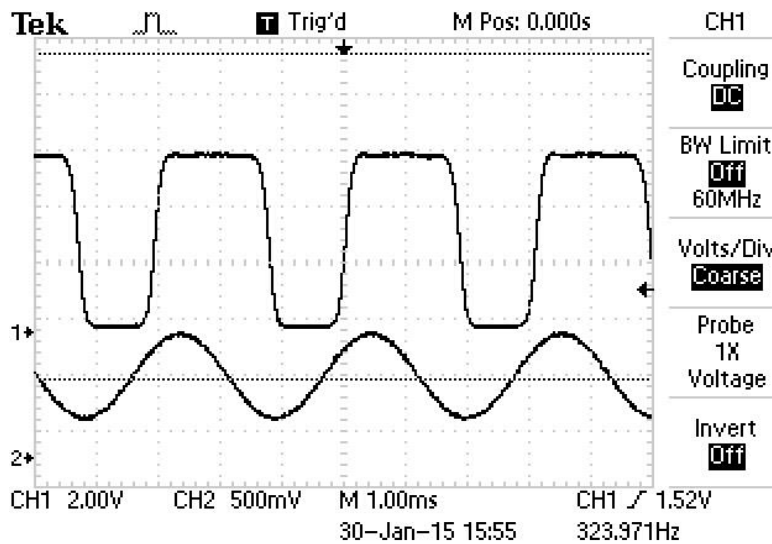


● 1xN

● 2xN

10⁹ Switching Cycle Test

We have tested MEMS 1x2 switch at the resonant frequency ~300Hz for more than 40 days, as shown in the attachment, which corresponds over 10⁹ switching cycles. The measurements show little changes in Insertion loss, Cross Talk, Return loss, etc, all parameters are within our specs.



Control & Electric Interface

The switch default control is Ethernet with a GUI.

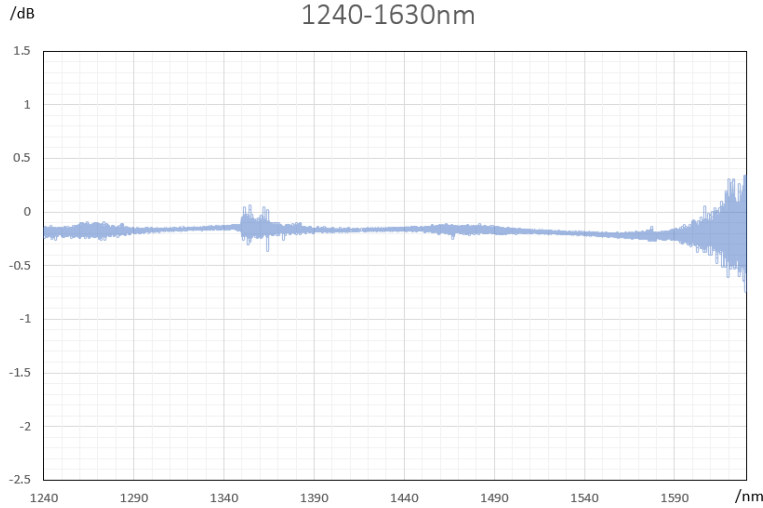
- Physical Layer: 10/100Base-T
- Data Link Layer: Ethernet Protocol per IEEE 802.3
- Network Layer: IPv4
- Transport Layer: UDP
- Application Protocol: SNMP
- Connector Type: RJ-45
- Dual 48V/110-220V Power Input

We provide a command list for customers to write their control code, such as Python

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Typical Insertion Loss vs Wavelength (1240-1630nm)



Ordering Information

Prefix	Type ^[1]	Wavelength ^[2]	Control Interface ^[3]	Package ^[4]	Fiber Type	Power Supply	Connector	On/Off	PER ^[5]	Monitor ^[6]
MEMS-	1x8 = AA8	1240-1640nm = 1	Ethernet = 2	1RU = 1	SMF-28 = 1	110-220V = 4	FC/PC = 2	Regular = 1	Non = N	Non = 1
	1x12 = A12	1310 = 3	RS232 = 3	1.5U = 5	50/125 = 2	48V = 5	FC/APC = 3	SM70dB = 2	>18 = 1	Output = 2
	1x16 = A16	1410 = 4	Button/Ethernet = 4	2RU = 2	Hi1060 = 3	Dual110-220V = 6	SC/PC = 4	MM50dB = 3	23 = 2	Input/Output = 3
	1x32 = A32	1550 = 5	Button/RS232 = 5	4RU = 4	PM1550 = 5	Dual48V = 7	SC/APC = 5	PM70dB = 5	29 = 3	Input = 4
	1x64 = A64	1310/1550nm = 2	Special = 0	Special = 0	780HP = 8	Special = 0	ST/PC = 6	Special = 0	Special = 0	Port Display = D
	1x96 = A96	1060nm = 6			PM980 = 9		LC/PC = 7			Special = 0
	1x128 = 128	850nm = 8			62.5/125 = 6		Duplex LC/PC = 8			
	1x192 = 192	750nm = 7			SM800 = A		LC/APC = A			
	1x256 = 256	Special = 0			PM850 = B		LC/UPC = U			
	Dual1x8 = DA8				PM780 = C		MTP 12 = M			
	Dual1x12 = D12				PM1310 = D		MTP 24 = P			
	Dual1x16 = D16				Special = 0		DuplexSC/PC = Q			
	Dual1x32 = D32						DuplexSC/APC = R			
	Duplex1x8 = PA8						Special = 0			
	Duplex1x12 = P12									
Duplex1x16 = P16										
Duplex1x32 = P32										
Special = 000										

[1]. Duplex Mode: Both switches operate simultaneously, designed for Tx/Rx pairs in communication fiber link applications.

[2]. Wavelength Coverage: The device supports a wide range of wavelengths. Devices labeled 1, 2, 3, 4, and 5 are the same model but measured at different wavelengths. Customers can request measurements at additional wavelengths for an extra cost.

[3]. Manual Switching: A button located on the front panel allows for manual switching, which overrides remote control functionality when activated.

[4]. Rack Size: The rack size depends on the connector selection; the smallest size will be chosen whenever possible. Rack Mount Depth ~ 430mm.

[5]. PER Definition: PER refers to the polarization extinction ratio for PM (polarization-maintaining) fiber.

[6]. Input and Output Monitoring: The output monitor function uses an external detector to tap a portion of the passing light and measure its intensity. Input and output monitor uses two external detectors that is more expensive. Port Display Option: A front panel LCD displays the selected channel, designed to function alongside the manual push-button control.

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Example of RS232 Control GUI
(one can create a running receipt, pause, repeat loop)



Running Status

Current Step	Step Duration (ms)	Loop Count
<input type="text"/>	<input type="text"/>	<input type="text"/>

Action Buttons

of Loops:

Loop Activate:

Programmable Running Sheet

Steps	Duration(ms)	Status (Click to Set to Light Path/Double Click to Reset The Light Paths)
1	1000	I1-O1
2	1000	I1-O2
3	1000	I1-O3
4	1000	I1-O4
5	1000	I1-O5
6	1000	I1-O6
7	1000	I1-O7
8	1000	I1-O8

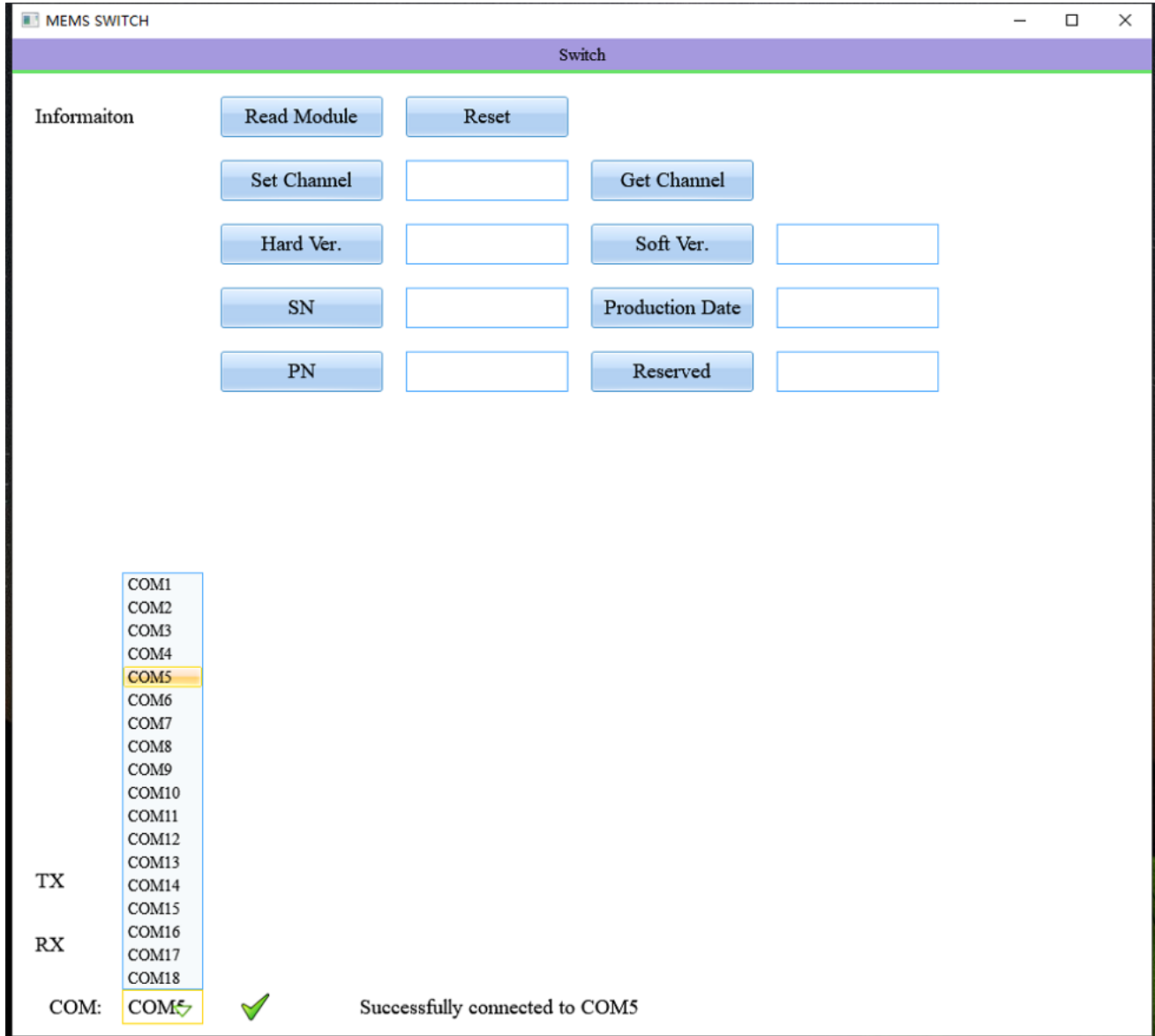
Light Path Status

Input 1 ● Output 1
 Output 2
 Output 3
 Output 4
 Output 5
 Output 6
 Output 7
 Output 8

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Example of RS232 Remote Control GUI



RS232 Command List (1x196 example) (start)

```
##### COM SET #####
UART Control Setting
Baud Rate: 115200
Start Bits: 1
Data Bits: 8
Parity: None
Stop Bits: 1
Flow Control: None
```



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RS232 Command List (1x196 example) (ending)

1, Command Format

1.1 Command

FLAG	LEN	RES	CMD	DATA	SUM
2 Byte	1 Byte	1 Byte	1 Byte	0-N Byte	1 Byte

FLAG: 0xEFEF or 0xAAAA

LEN: Total number of bytes from RES to SUM

RES: 0xFF

SUM: Checksum, SUM=FLAG+LEN+RES+CMD+DATA

1.2 Response

FLAG	LEN	RES	RESP	DATA	SUM
2 Byte	1 Byte	1 Byte	1 Byte	0-N Byte	1 Byte

FLAG: 0xEDFA

LEN: Total number of bytes from RES to SUM

RES: 0xFF

SUM: Checksum, SUM=FLAG+LEN+RES+ RESP+DATA

2, Command List

2.1 Set Channel

Command

FLAG1	LEN	RES	CMD	DATA	SUM
0xEFEF	0x04	0xFF	0x04	1 byte	SUM

DATA = Channel

Response

FLAG2	LEN	RES	RESP	DATA	SUM
0xEDFA	0x04	0xFF	0x04	1 byte	SUM

DATA = Result

Result = 0xEE Success

Result = 0xEF Fail

Example (Set Channel=180):

Command

EF EF 04 FF 04 B4 99

Response

ED FA 04 FF 04 EE DC

2.2 Get Channel

Command

FLAG1	LEN	RES	CMD	DATA	SUM
0xEFEF	0x03	0xFF	0x02	1 byte	SUM

Response

FLAG2	LEN	RES	RESP	DATA	SUM
0xEDFA	0x04	0xFF	0x02	1 byte	SUM

DATA = Channel

Example (Get Channel=0):

Command

EF EF 03 FF 02 E2

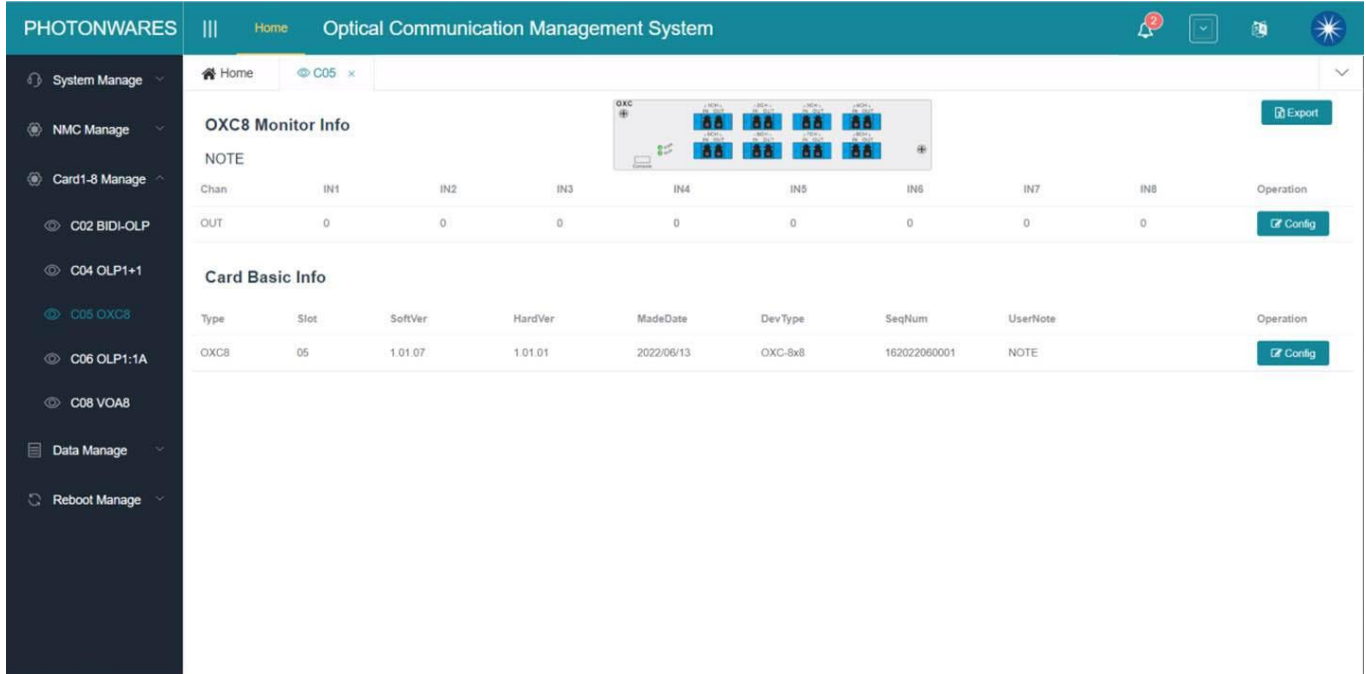
Response

ED FA 04 FF 02 00 EC

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Example of Ethernet Remote Control GUI



Ethernet Command List For Telnet/Python Control (start)

Login:

- 1, Use the Windows Command Prompt,
- 2, telnet 192.168.1.200 or the current IP address
- 3, Username: root
- 4, Password: fs19681086

Command List

- 1, Request Switch Status:

CARD -c xx B_?

xx is the slot number of card. For example, to show the status of the card in slot 2:

```
[FT@\h \w]# CARD -c 02 B_?
```

Show Card Info:

```
===== CARD Monitor Info =====
```

Chan	MaxRoute	CurrRoute
1	64	64

```
===== CARD Basic Info =====
```

Type	Slot	SoftVer	HardVer	MadeDate	DevType	SeqNum
OSW64	02	1.01.07	1.02.01	2021/10/22	MOSW64-DEV	333333333333

```
[FT@\h \w]#
```

- 2, Set Switch status:

CARD -c xx S01_y

xx is the slot number of the card.

01 is the input channel number of the switch, for 1xN products this is fixed.

y is the output channel number of the switch, for a 1x64 switch it's 1~64.

Return value: Success means operation succeed, Fail means operation failed.



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Ethernet Command List For Telnet/Python Control (ending)

For example, :

1> Set the input #1 to output #1:

```
[FT@\h \w]# CARD -c 02 S01_1  
Send: S01_1  
Return: Operation Success  
[FT@\h \w]#
```

2> Set the input #1 to output #64

```
[FT@\h \w]# CARD -c 02 S01_64  
Send: S01_64  
Return: Operation Success  
[FT@\h \w]#
```

3> Request the current status:

```
[FT@\h \w]# CARD -c 02 B_?
```

Show Card Info:

===== CARD Monitor Info =====

Chan	MaxRoute	CurrRoute
1	64	64

===== CARD Basic Info =====

Type	Slot	SoftVer	HardVer	MadeDate	DevType	SeqNum
OSW64	02	1.01.07	1.02.01	2021/10/22	MOSW64-DEV	333333333333

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Application Notes

Fiber Core Alignment

Note that the minimum attenuation for these devices depends on excellent core-to-core alignment when the connectors are mated. This is crucial for shorter wavelengths with smaller fiber core diameters that can increase the loss of many decibels above the specification if they are not perfectly aligned. Different vendors' connectors may not mate well with each other, especially for angled APC.

Fiber Cleanliness

Fibers with smaller core diameters (<5 μm) must be kept extremely clean, contamination at fiber-fiber interfaces, combined with the high optical power density, can lead to significant optical damage. This type of damage usually requires re-polishing or replacement of the connector.

Maximum Optical Input Power

Due to their small fiber core diameters for short wavelength and high photon energies, the damage thresholds for device is substantially reduced than the common 1550nm fiber. To avoid damage to the exposed fiber end faces and internal components, the optical input power should never exceed 20 mW for wavelengths shorter 650nm. We produce a special version to increase the how handling by expanding the core side at the fiber ends.

Questions and Answers

Q: If the device were to fail, would the switch continue to pass the fiber light through the switch as configured before failure?

A: This depends, if one mirror fails, it only affects the light going through that mirror.

Q: When power is restored, does the IN/OUT configuration before failure remain in place?

A: Yes, when power back up it will go to the previous flightpath

Q: If the power to the device were shut off, would the device continue to pass the fiber light as configured before failure?

A: This function is called latching. We uniquely offer MEMS latching switches but cost more.

Q: With the Ethernet Control Option, does the switch support SNMPv3

A: Yes. This internet standard protocol allows user to write their own control code

Q: With the Ethernet Control Option, what type of encryption does the SNMPv3 use?

A: MD5/DES

Q: With the Ethernet Control Option, could this device be controlled by multiple users at different locations and all users will also see the configuration updates?

A: Yes

Q: With the Ethernet Control Option, does the user need to install any software on their computer other than a web browser?

A: No