VOA Array Rack System

(350-2400nm, high precision, 70dB, high speed, SM, PM, MM, Bidirectional)

(US patent 8,666,218 and other patents pending)

The VOA Array Rack System is a highly versatile platform designed to meet performance requirements across all application scenarios. It integrates monitoring power taps for precision power feedback and high-accuracy laser output control. Multiple VOA types are available: MEMS VOAs offer low cost and up to 70 dB attenuation; Electro-Optical NanoSpeed™ VOAs provide 800 ns response for high-speed power stabilization that eliminates fluctuations; and Fiber-Fiber™ VOAs deliver ultra-broadband performance from 200 to 2500 nm with ultra-low insertion loss across all fiber types. The modular pluggable design supports any number of channels within a single rack, with corresponding system heights. Each standard plug-in module accommodates up to eight channels via compact LC connectors, allowing a 1U rack to host up to 24 channels. VOAs within the same module can be controlled simultaneously, while inter-module control introduces a short delay; special configurations are available for simultaneous control of all channels. The same system can integrate additional optical modules such as switches, power monitors, and dispersion compensators. Control is provided via Ethernet or RS232, with a standard web-based GUI and command list. Optional custom control interfaces are available with extra cost.

Features

- Very Low Loss
- Highly Repeatable
- Latching
- High Resolution
- Large Attenuation

Applications

- Power Control
- Power Regulation
- Channel Balance
- Instrumentation

RoHS COMPLIANT

Rev 06/11/26

Specifications

Parameters	Min	Typical	Max	Unit
Operation Wavelength	300		2500	nm
Insertion Loss		0.3	0.5 [1]	dB
		1	1.5 [2]	dB
Polarization Dependent Loss		0.15	0.5	dB
Wavelength Dependence Loss		0.1	0.2	dB
Attenuation Range [4]	20	60	78 [3]	dB
Attenuation Resolution/Setting Repeatability			0.05	dB
Extinction Ratio (PM version only)	18	23	25	dB
Polarization Mode Dispersion (SM version only)		0.01	0.05	ps
Return Loss	45			dB
Response Time [5]			100	ms
Optical Power handling (CW)		0.3	20 [6]	W
Operating Temperature [7]	-5		45	°C
Storage Temperature	-40		85	°C
Electrical Power Input	100		230	VAC
Communication Interface (Ethernet)	SNMP	Telnet		

Notes:

[1]. Uses an ultra-broadband Precision MEMS VOA with a built-in position sensor. Loss values exclude connector loss; each connector typically adds 0.1–0.3 dB depending on mating condition.

[2]. Conventional MEMS VOAs include a tap monitor and have a limited wavelength range due to coating constraints. Loss values exclude connector loss; each connector adds 0.1–0.3 dB depending on mating condition.

[3]. The 60 dB and 78 dB attenuation ranges use special MEMS VOAs and Precision MEMS VOAs.

[4]. For SM and PM, for MM the value is related to the mold fill ratio.

[5]. Response time is based on stored internal process sequences; substantial delays may occur due to computer and Ethernet communication latency.

[6]. 1 W single-mode and 3 W multimode versions are only available with the Precision MEMS VOA.

[7]. The VOA can be operated in a wider temperature range from as -10 to 70°C, but some performances such as the maximum attenuation will be degraded.

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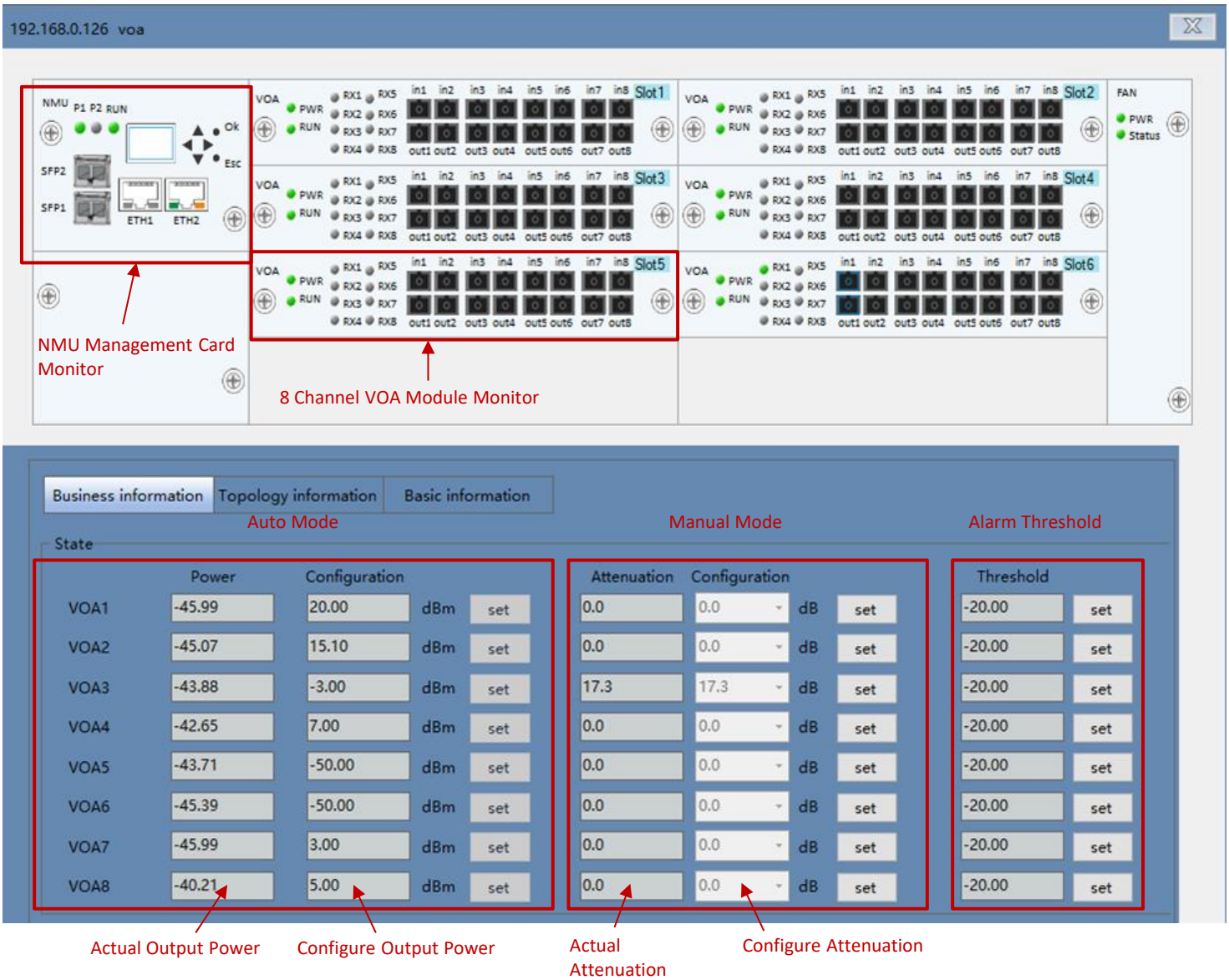
GUI Software

- The system contains tap monitor on each channel output providing attenuation and power control function.



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

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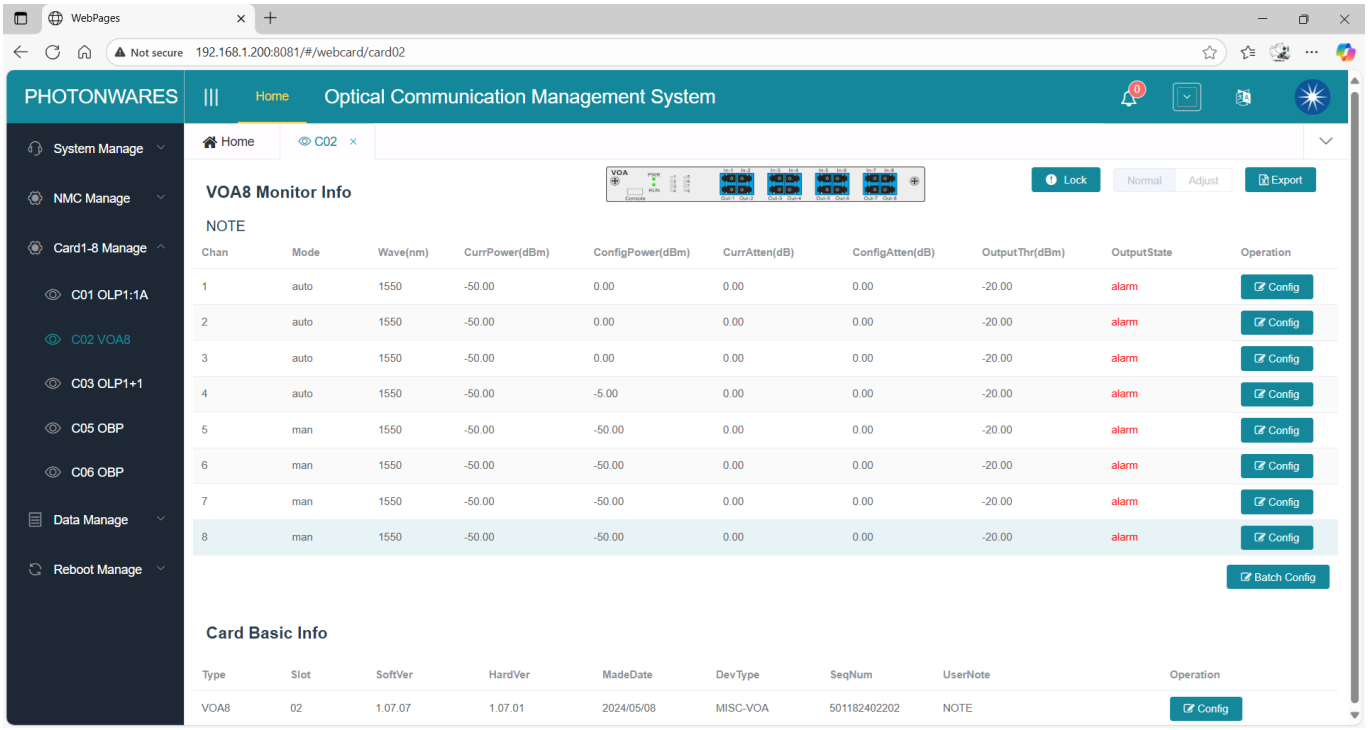

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Mechanical Footprint Dimensions (mm)

19" rack. The unit will select the minimum height to accommodate the channel count and connector type
For 1U chassis

- Choose LC connectors up to 32 Channels; 4 pluggable cards
- Choose FC, SC, or ST connectors for up to 16 Channels; 2 pluggable cards

Ordering Information (Part Number)

- ❑ The system includes a rack-mount box of from 1U up to 6U with multiple plug-in modules
- ❑ Pluggable module order information below, each module accommodate up to 8 channels power control with LC connectors

	☐☐	☐	☐	☐	☐☐	☐	☐	☐	☐☐	☐
Prefix	**Channel**	**Speed[0]**	**Configuration [1]**	**Test Wavelength**	**Fiber Type**	**Attenuation [2]**	**Connector [3][7]**	**Interface [4]**	**Output Power [5]**	**Code**
VOAS-	8 = A8 16 = 16 24 = 24 32 = 32 ... 96 = 96 120 = A2 220 = B2 Special = 00	MEMS 2ms = S MEMS 100ms = 1 NS 10μs/18dB = 2 NS 10μs/35dB = 3 NS 10μs/50dB = 5 NS 1μs/18dB = 6 NS 1μs/35dB = 7 NS 1μs/50dB = 8 Latching 100ms =L	MEMS Transparent Calibrated [6] = C Transparent Auto Attenuation Control = 2 Transparent Auto Output Power Control =1 Opaque Auto Output Control = 7 Opaque Auto Attenuation Control = 5 5W NS Auto Output Control = H Special = 0	1260-1620 = C 488 = 4 532 = 5 630 = 6 780 = 7 850 = 8 980 = 9 1060 = 1 1310 = 3 1550 = A 2000 = 2 Special = 0	***Pick from the below table***	35 dB = 1 60 dB = 2 65 dB = 3 70 dB = 4	FC/PC = 2 FC/APC = 3 SC/PC = 4 SC/APC = 5 ST/PC = 6 LC/PC = 7 MTP = 9 LC/APC = A LC/UPC = U Special = 0	Ethernet = E RS232 = R 0-5V = A UART = U GPIB = G	N/A = NA 0.001W = A1 0.002W = A2 ... 0.01W = B1 0.02W = B2 ... 0.1W = C1 0.2W = C2 ... 1W = D1 2W = D2 ... 9W = D9 10W = 10 ... 20W = 20	Non = N Python = P LabVIEW = L

[0]. For auto attenuation, the speed is for running stored process since computer and internet introduce substantial delay. Calibrated version is direct fast control.

[1]. MEMS Transparent Calibrated: This version features a fast response time of 0.3 to 5 ms, high precision, and low cost. It is factory-calibrated so that the control voltage maps directly to attenuation.

Transparent: The device passes light without an applied electrical voltage.

Opaque: The device blacks light without an applied electrical voltage.

Auto Output Power Control: Uses an output tap for feedback control of the output power at a desired attenuation setpoint.

Auto Attenuation Control: Uses two output taps for feedback control to maintain the optical output power at a desired attenuation setpoint.

[2]. Single mode fiber @1550nm

[3]. Regular fiber connector has PER ~22dB. Connector with PER >27 dB is available using special process

[4]. A and U are choice for NS type fast VOA only. Each channel has a dedicated connection on the front panel. UART is a digital control format that can also be converted into USB interface. A GUI is provided.

[5]. For the selection of auto output power control only. Since the VOA has a limited dynamic range, a maximum output power needs to be selected and the minimum controllable output power = max output setting – dynamic range-insertion loss.

[7]. The default connector configuration uses fiber with 0.9 mm buffer protection. The connector cannot be installed directly onto bare fiber because the bare fiber is prone to damage during shipping. However, the connector can be assembled on bare fiber if a 3 cm protective loose tube is added for reinforcement. The customer may remove this protective tube after testing. The optical power handling of a standard connector is less than 0.5 W for SMF-28 fiber and decreases further for smaller-core fibers.

Fiber Type Selection Table:

01	**SMF-28**	34	**PM1550**	67	**OM1 (MMF 62.5/125μm)**
02	**SMF-28e**	35	**PM1950**	68	**OM2 (MMF 50/125μm)**
03	**Corning XB**	36	**PM1310**	69	**OM3 (MMF 50/125μm)**
04	**SM450**	37	**PM400**	70	**OM4 (MMF 50/125μm)**
05	**SM1950**	38	**PM480**	71	**GIF50 (GIF 50/125μm)**
06	**SM600**	39	**PM630**	72	**GIF625 (GIF 62.5/125μm)**
07	**Hi780**	40	**PM850**	73	**105/125um**
08	**SM800**	41	**PM980**	74	
09	**Hi980**	42		75	
10	**Hi1060**	43	**PM780**	76	
11		44		77	
12		45		78	

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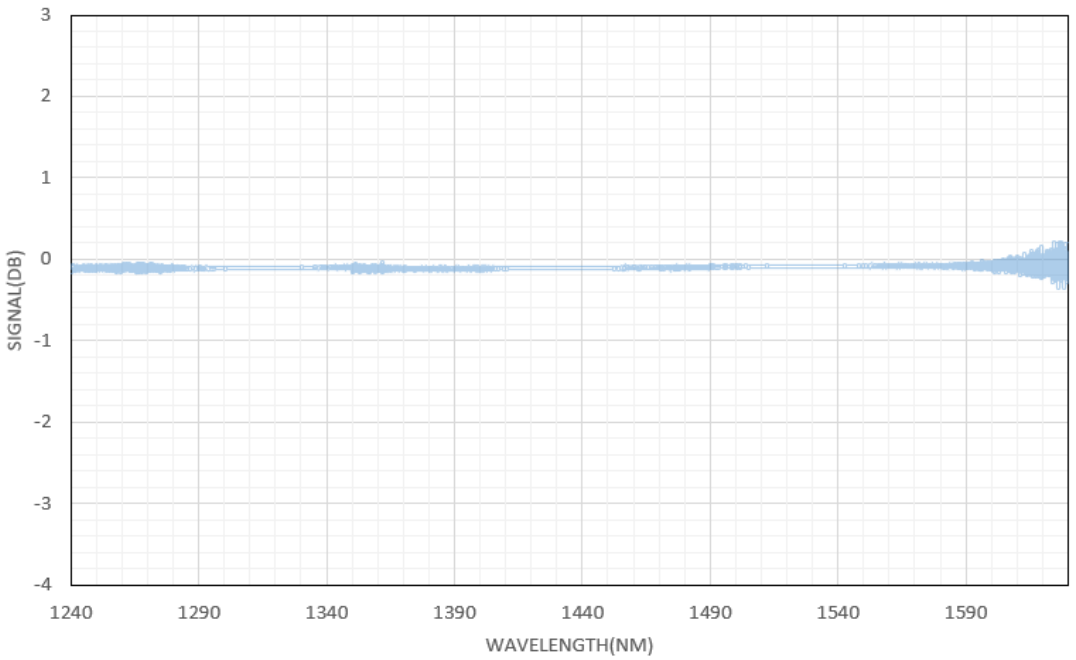
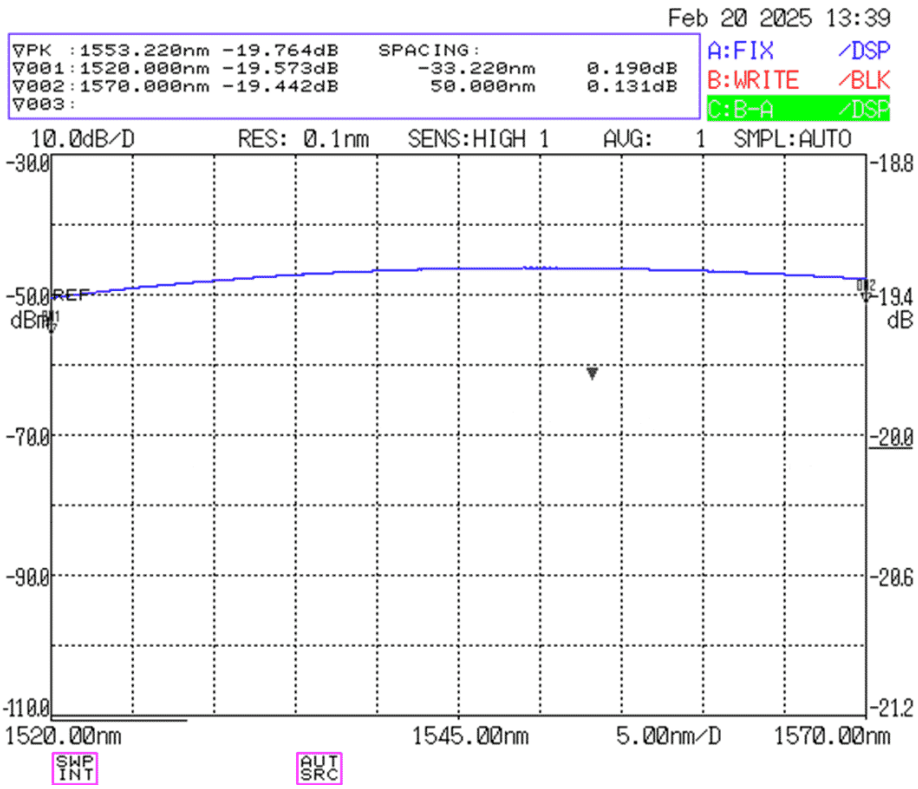
Typical Insertion Loss vs Wavelength (1240-1630nm)



Typical Wavelength Dependence @20dB Attenuation



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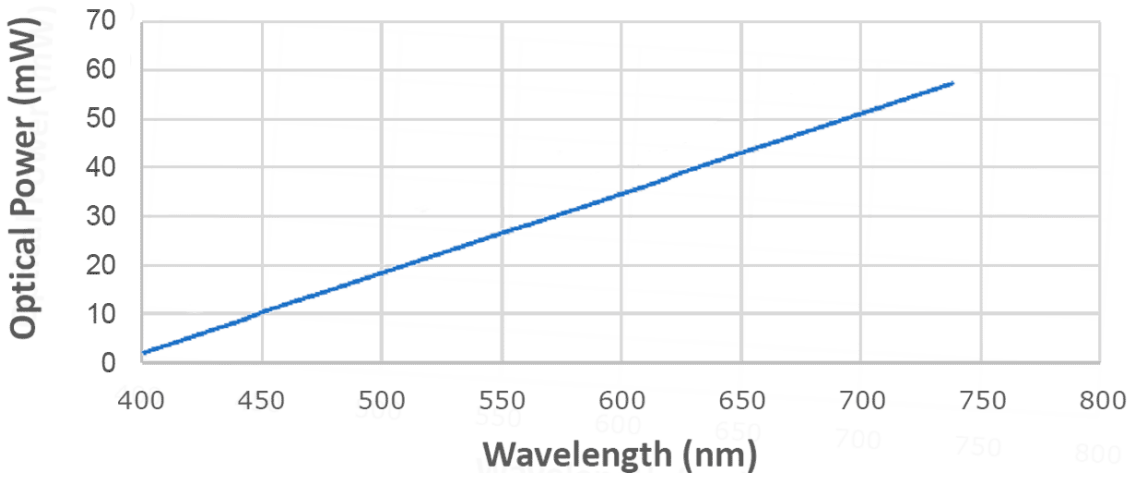
Optical Power Handling vs Wavelength for Standard SM Fibers



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.

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Operation Manual

1. Connect a control signal to the SMA connector on the PCB.
2. Attach the accompanied power supply (typically a wall-pluggable unit).
3. The device should then function properly.

Note: Do not alter device factory settings.

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? When power is restored, does the IN/OUT configuration before failure remain in place?
A: This depends, if one mirror fails, it only affects the light go through that mirror. Yes, when power back up it will go to the previous points

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 power to the device were shutoff, would the device continue to pass the fiber light as configured before failure?
A: This function is call latching. We uniquely offer MEMS latching switch 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, could this switch 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

Command List (page 1)

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 General information:

NMC B_?
Example:
[FAST@\h \W]# NMC B_?
Show NMC Info:
===== NMC Chassis Info =====
Name Power1Status Power2Status FanSwitch FanStatus DateTime
OTNS4443 open close open close 2021-07-15 08:28:13

===== NMC Basic Info =====
Type Slot SoftVer HardVer MadeDate DevType SeqNum
NMC 00 1.08.15 1.02.01 2021-01-01 OTNS-M4 1234567890AB

===== NMC Payload Info =====
Name Payload(%) PayloadThr(%) Status
CPU 2 80 normal
Memory 9 80 normal

===== NMC Database Info =====
Name AutoBackup(day) AutoRecord(hor) Capacity(row)
DBM 1 1 200

===== NMC Network Info =====
Version Switch NetAddress Netmask Gateway MacAddress
IPv4 open 192.168.001.200 255.255.255.000 192.168.001.001 70-b3-d5-46-04-29
IPv6 close fe80:0:0:0:1034:56 ff:fe78:9126/64 fe80:0:0:0:0:0:0:1 70-b3-d5-46-04-29

===== NMC SNMP Info =====
Version ReadCom WriteCom AuthPassword PrivPassword TrapIP TrapIP2
IPv4 public private 123456789 123456789 127.000.000.001 127.000.000.001
IPv6 public private 123456789 123456789 0:0:0:0:0:0:0:1

===== NMC RemoteLog Info =====
Version Switch NetAddress
IPv4 open 127.000.000.001
IPv6 close 0:0:0:0:0:0:0:1

2, Fan Operation:

2.1 Turn on the Fan

NMC FNC_1

2.2 Turn off the Fan

NMC FNC_0
Return Success or Fail
Example:
[FAST@\h \W]# NMC FNC_1
Send: FNC_1
Return: Operation Success
[FAST@\h \W]#
[FAST@\h \W]# NMC FNC_0
Send: FNC_0
Return: Operation Success
[FAST@\h \W]#

Command List (page 2)

3, Set System Time

NMC TIME_2021-07-05-14-02-02
Example:
[FAST@\h \W]# NMC TIME_2021-07-05-14-02-02
Send: TIME_2021-07-05-14-02-02
Return: Operation Success
[FAST@\h \W]#

4, Set the Payload

4.1 CPU payload

NMC CPULIM_xx
Note: xx is the payload of CPU, from 1~99
Example: Set the CPU payload to 80%
[FAST@\h \W]# NMC CPULIM_80
Send: CPULIM_80
Return: Operation Success
[FAST@\h \W]#

4.2 Memory Payload

NMC MEMLIM_xx
Note: xx is the payload of system memory, from 1~99
Example: Set the memory payload to 80%
[FAST@\h \W]# NMC MEMLIM_80
Send: MEMLIM_80
Return: Operation Success
[FAST@\h \W]#

5, Network Operations

5.1 IP address

NMC IP_192.168.1.200
Example:
[FAST@\h \W]# NMC IP_192.168.1.200
Send: IP_192.168.1.200
Return: Operation Success
[FAST@\h \W]#

5.2 Subnet Mask

NMC MSK_255.255.255.000
Example:
[FAST@\h \W]# NMC MSK_255.255.255.000
Send: MSK_255.255.255.000
Return: Operation Success
[FAST@\h \W]#

5.3 Gateway

NMC GW_192.168.1.1
Example:
[FAST@\h \W]# NMC GW_192.168.1.1
Send: GW_192.168.1.1
Return: Operation Success
[FAST@\h \W]#

Command List (page 3)

6, Card information

CARD -c xx B_?
xx is the card slot number, 2~16
Example:
[FAST@\h \W]# CARD -c 16 B_?
Show Card Info:

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

Chan	Mode	Wave(nm)	CurrPower(dBm)	ConfigPower(dBm)	CurrAtten(dB)	ConfigAtten(dB)	OutputThr(dBm)	OutputState
1	auto	1550	-50	-63.15	36	36	-69	normal
2	auto	1550	-50	-63.1	40	40	-19	alarm
3	auto	1550	-50	-63.1	40	40	-19	alarm
4	auto	1550	-50	-63.15	0	0	-19	alarm
5	auto	1550	-50	-63.1	0	0	-19	alarm
6	man	1550	-50	-63.13	9	9	-19	alarm
7	auto	1550	-50	-63.13	0	0	-18	alarm
8	man	1550	-50	-63.18	0	0	-70	normal

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

Type	Slot	SoftVer	HardVer	MadeDate	DevType	SeqNum
VOA8	16	1.05.01	1.01.02	2021-03-16	VOA8-2table	123456789012

7, VOA Operations

7.1 Single Channel working mode setup

CARD -c xx My_z
Note:
xx is the slot number of the card, from 2~16
y is the Channel number on the card, from 1~8
z is the mode, 1 is auto mode, 0 is manual mode
Example of setting the channel 1 on Card 16 to auto mode:
[FAST@\h \W]# CARD -c 16 M1_1
Send: M1_1
Return: Operation Success
[FAST@\h \W]#
Example of setting the channel 1 on Card 16 to manual mode:
[FAST@\h \W]# CARD -c 16 M1_0
Send: M1_0
Return: Operation Success
[FAST@\h \W]#

7.2 All Channels working mode setup

CARD -c xx MTOT_z_z_z_z_z_z_z_z
Note:
xx is the slot number of the card, from 2~16
z is the mode, 1 is auto mode, 0 is manual mode
Example to set the channel 1 and 2 on card 16 to auto mode, the rest channels are set to manual mode:
[FAST@\h \W]# CARD -c 16 MTOT_1_1_0_0_0_0_0_0
Send: MTOT_1_1_0_0_0_0_0_0
Return: Operation Success
[FAST@\h \W]#

Command List (page 4)

7.3 Single Channel wavelength setup

```
CARD -c xx Wy_z
Note:
   xx is the slot number of the card, from 2~16
   y is the Channel number on the card, from 1~8
   z is the wavelength code, 1 is 1550nm, 0 is 1310nm
Example of setting the wavelength of channel 1 on card 16 to 1550nm:
[FAST@\h \W]# CARD -c 16 W1_1
Send: W1_1
Return: Operation Success
[FAST@\h \W]#
Example of setting the wavelength of channel 1 on card 16 to 1310nm:
[FAST@\h \W]# CARD -c 16 W1_0
Send: W1_0
Return: Operation Success
[FAST@\h \W]#
```

7.4 All Channels wavelength setup

```
CARD -c xx WTOT_z_z_z_z_z_z_z_z
Note:
   xx is the slot number of the card, from 2~16
   z is the wavelength code, 1 is 1550nm, 0 is 1310nm
Example of setting the channel 1 and 2 on card 16 to 1550mm, the rest channels are set to 1310nm:
[FAST@\h \W]# CARD -c 16 WTOT_1_1_0_0_0_0_0_0
Send: WTOT_1_1_0_0_0_0_0_0
Return: Operation Success
[FAST@\h \W]#
```

7.5 Single Channel Output Power setup

```
CARD -c xx Py_z
Note:
   xx is the slot number of the card, from 2~16
   y is the Channel number on the card, from 1~8
   z is the power in dBm
Example of setting the output power of Channel 1 on card 16 to 2dBm:
[FAST@\h \W]# CARD -c 16 P1_2
Send: P1_1
Return: Operation Success
Example of setting the output power of Channel 1 on card 16 to -1dBm:
[FAST@\h \W]#
[FAST@\h \W]# CARD -c 16 P1_-1
Send: P1_-1
Return: Operation Success
[FAST@\h \W]#
```

```
7.6 All Channels Output Power setup
CARD -c xx PTOT_z_z_z_z_z_z_z_z
Note:
   xx is the slot number of the card, from 2~16
   z is the power in dBm
   Example of setting the output power of Channel 1 and 2 on card 16 to 1dBm, the rest channels to 2dBm:
[FAST@\h \W]# CARD -c 16 PTOT_1_1_2_2_2_2_2_2
Send: PTOT_1_1_2_2_2_2_2_2
Return: Operation Success
[FAST@\h \W]#
```

Command List (page 5)

7.7 Single Channel attenuation setup

```
CARD -c xx Ay_z
Note:
   xx is the slot number of the card, from 2~16
   y is the Channel number on the card, from 1~8
   z is the attenuation in dB
Example of setting the output power of Channel 1 on card 16 to 10dB:
[FAST@\h \W]# CARD -c 16 A1_10
Send: A1_10
Return: Operation Success
[FAST@\h \W]#
[FAST@\h \W]# CARD -c 16 A1_20
Send: A1_20
Return: Operation Success
[FAST@\h \W]#
```

7.8 All Channels attenuation setup

```
CARD -c xx ATOT_z_z_z_z_z_z_z_z
Note:
   xx is the slot number of the card, from 2~16
   z is the attenuation in dB
Example of setting the output power of Channel 1 and 2 on card 16 to 1dB, the rest channels to 2dB:
[FAST@\h \W]# CARD -c 16 CARD -c 16 ATOT_1_1_2_2_2_2_2_2
Send: ATOT_1_1_2_2_2_2_2_2
Return: Operation Success
[FAST@\h \W]#
```

7.9 Single Channel alarm level setup

```
CARD -c xx RXy_z
Note:
   xx is the slot number of the card, from 2~16
   y is the Channel number on the card, from 1~8
   z is the power level in dBm
Example of setting the alarm level of channel 1 on card 16 to -20dBm
[FAST@\h \W]# CARD -c 16 RX1_-20
Send: RX1_-20
Return: Operation Success
[FAST@\h \W]#
Example of setting the alarm level of channel 1 on card 16 to -21dBm
[FAST@\h \W]# CARD -c 16 RX1_-21
Send: RX1_-21
Return: Operation Success
[FAST@\h \W]#
```

7.10 All Channels alarm level setup

```
CARD -c xx RXTOT_z_z_z_z_z_z_z_z
Note:
   xx is the slot number of the card, from 2~16
   z is the power level in dBm
Example of setting the alarm level of Channel 1 and 2 on card 16 to -10dB, the rest channels to -20dB:
[FAST@\h \W]# CARD -c 16 RXTOT_-10_-10_-20_-20_-20_-20_-20_-20
Send: RXTOT_-10_-10_-20_-20_-20_-20_-20_-20
Return: Operation Success
[FAST@\h \W]#
```