MMS4X50-NM 800Gbps Twin-port OSFP 2xFR4, 2x400Gb/s Single Mode, 2km

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Introduction

The NVIDIA MMS4X50-NM is an 800Gb/s 2x400Gb/s Twin-port OSFP, 2xFR4 single mode, 8-channel electrical transceiver. This transceiver uses two, 2-fiber, LC Duplex optical connectors each carrying 4-channels of 100G-PAM4. The dual Far Reach 8-channel (2xFR4) design uses 100G-PAM4 electrical and optical modulation based on the CWDM4 serial, multiplexed 1310nm wavelength grid.

It has a maximum fiber reach of 2,000-meters which assumes two optical patch panels in the link. The transceiver firmware supports both InfiniBand and Ethernet and is automatically enabled depending on the protocol of the switch.

The Twin-port 2xFR4 transceiver has two internal transceiver engines enabling 64-ports of 400Gb/s in a 32-OSFP cage Quantum-2 switch. Spectrum-4 switches have 32 or 64 cages and enable 64-128 400G ports.

The main application for MMS4X50-NM is linking two switches together up to 2,000-meter. A bright green marking on transceiver body indicates 2k-meter maximum reach.

The transceiver combinations guarantee optimal operation in NVIDIA end-to-end InfiniBand systems and a rigorous production tested to ensure the best out-of-the-box installation experience, performance, and durability.

⚠ Images are for illustration purposes only. Product labels, colors, and lengths may vary.

Key Features

- 800G 2xFR4 single mode
- 8-channels of 100G-PAM4 electrical modulation
- Two Duplex LC ports of 4-channel 100G-PAM4 optical modulation
- Supports two single mode fiber cables with duplex LC optical connectors
- 8x 1330nm EML lasers
- 2km Max reach
- 17-Watts max power
- Single 3.3V power supply
- Class 1 laser safety
- Hot pluggable, RoHS compliant
- OSFPmsa.org compliant
- CMIS 5.0 compliant

Fibers not supplied by NIVDIA

Applications

- Used to link Quantum-2 or Spectrum-4 air-cooled switches together.

Application Overview

The Twin-port transceiver is a key innovation for expanding the 400G NDR InfiniBand Quantum-2 and 400GbE Spectrum-4 Ethernet (400G IB/EN) switch capabilities. The line rate is 400Gb/s for both 400GbE Ethernet and NDR InfiniBand based on the 100G-PAM4 modulation. The switches use Twin port OSFP cages supporting two transceiver engines in a single OSFP form-factor plug creating 800Gb/s electrical to the switch and 2x400G multiplexed optics using duplex LC optical connectors. Each LC-based fiber cable can link to another 2xFR4 transceiver transferring 800Gb/s or to two separate 2xFR4s in separate switches at 400Gb/s for a total of three switches linked. Additionally, since the LC fiber cables send 4x100G-PAM4 CWDM4 signals, they can also link to 400G FR4 QSFP-DD transceivers there by enabling bridging 50G-PAM4 Spectrum-3 to 100G-PAM4 Spectrum-4 Ethernet systems.

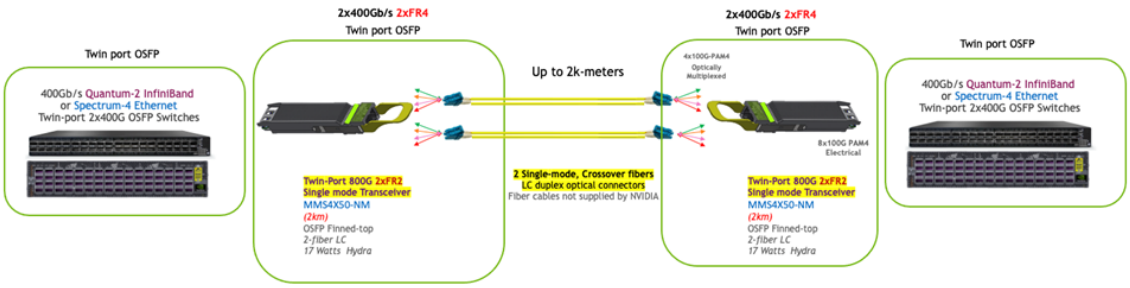
Connectivity Scenarios

The primary use case for the MMS4X50-NM transceiver is to link multiple switches together up to 2km reaches.

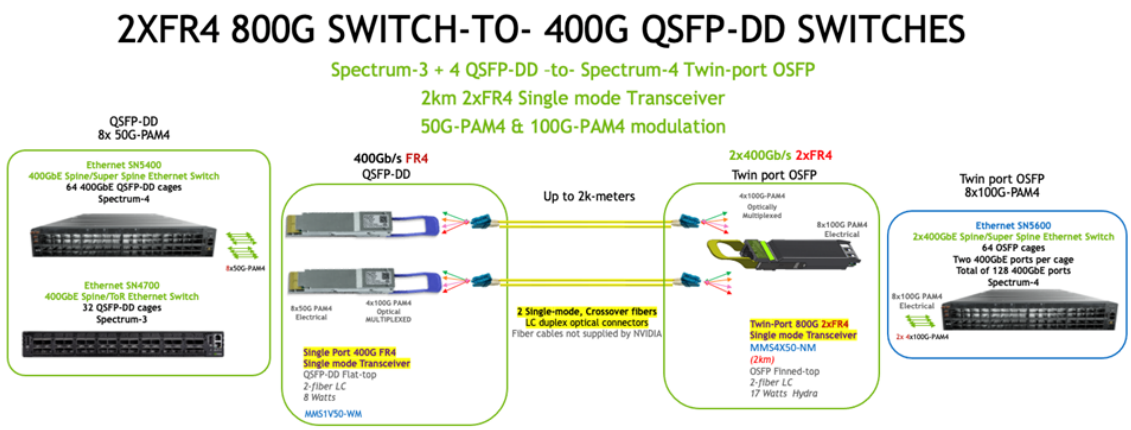
- FR4 CWDM4 multiplexing combines 4 different wavelength laser data signals into a single fiber which is filtered back to 4 in the receiving transceiver.
- Used for long fiber runs and in complex fiber infrastructures to save fiber costs.
- Linking two transceivers directly together, the LC fibers must be crossed over to align transmit lasers with receive photodetectors.
- Twin-Port transceivers require ordering two fibers at specific lengths. NVIDIA does not supply these fibers.
- Fiber splitters cannot be used with CWDM4 transceivers, as the wavelengths are multiplexed together into one fiber.
- Both fibers should be the approximately same length to avoid inducing different latency delays in the fibers (4.5ns/meter).

The use cases include:

1. Switch-to-switch at 800Gb/s
   This configuration enables transferring 800Gb/s between two switches using a single transceiver in each switch. The 2xFR4 supports both InfiniBand and Ethernet and can link two InfiniBand Quantum-2 switches or two Ethernet SN5600 switches together using only 4 fibers in total. Additionally, one 800G switch can link two switches at 400G using separate fiber to each 2xFR4 in the switches.



2. 800G switch-to-two QSFP-DD switches at 400Gb/s
   A 2xFR4 Twin port OSFP transceiver can have each 400G fiber cable sent to two QSFP-DD FR4 transceivers as both operate optically at 100G-PAM4. This enables 8x50G-PAM4 electrical Spectrum-3 Ethernet SN4700 QSFP-DD switches to link to a 64-port Ethernet SN5600 Spectrum-4 Twin port OSFP switch. Additionally, each 400G FR4 could be inserted into two different QSFP-DD switches.
   The 400G FR4 QSFP-DD transceiver employs an 8x50G-PAM4 electrical side and uses an internal “gearbox” IC to translate to 4x100G-PAM4 optical which can link to the 2xFR4 Twin port OSFP..



Pin Description

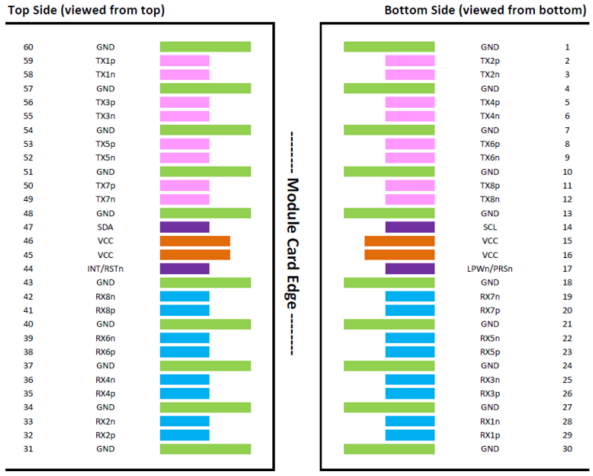
The device is OSFP MSA Specification for OSFP Octal Small Form Factor Pluggable Module Rev. 1.12 compliant, see www.osfpmsa.org.

OSFP Pin Description

Pin	Symbol	Description	Pin	Symbol	Description
1	GND	Ground	31	GND	Ground
2	Tx2p	Transmitter Non-Inverted Data Input	32	Rx2p	Receiver Non-Inverted Data Output
3	Tx2n	Transmitter Inverted Data Input	33	Rx2n	Receiver Inverted Data Output
4	GND	Ground	34	GND	Grounds
5	Tx4p	Transmitter Non-Inverted Data Input	35	Rx4p	Receiver Non-Inverted Data Output
6	Tx4n	Transmitter Inverted Data Input	36	Rx4n	Receiver Inverted Data Output
7	GND	Ground	37	GND	Ground
8	Tx6p	Transmitter Non-Inverted Data Input	38	Rx6p	Receiver Non-Inverted Data Output
9	Tx6n	Transmitter Inverted Data Input	39	Rx6n	Receiver Inverted Data Output
10	GND	Ground	40	GND	Ground
11	Tx8p	Transmitter Non-Inverted Data input	41	Rx8p	Receiver Non-Inverted Data Output
12	Tx8n	Transmitter Inverted Data Input	42	Rx8n	Receiver Inverted Data Output
13	GND	Ground	43	GND	Ground
14	SCL	2-wire serial interface clock	44	INT / RSTn	Module Interrupt / Module Reset
15	VCC	+3.3V Power	45	VCC	+3.3V Power
16	VCC	+3.3V Power	46	VCC	+3.3V Power
17	LPWn / PRSn	Low-Power Mode / Module Present	47	SDA	2-wire Serial interface data
18	GND	Ground	48	GND	Ground
19	Rx7n	Receiver Inverted Data Output	49	Tx7n	Transmitter Inverted Data Input
20	Rx7p	Receiver Non-Inverted Data Output	50	Tx7p	Transmitter Non-Inverted Data Input
21	GND	Ground	51	GND	Ground
22	Rx5n	Receiver Inverted Data Output	52	Tx5n	Transmitter Inverted Data Input
23	Rx5p	Receiver Non-Inverted Data Output	53	Tx5p	Transmitter Non-Inverted Data Input
24	GND	Ground	54	GND	Ground

Pin	Symbol	Description	Pin	Symbol	Description
25	Rx3n	Receiver Inverted Data Output	55	Tx3n	Transmitter Inverted Data Input
26	Rx3p	Receiver Non-Inverted Data Output	56	Tx3p	Transmitter Non-Inverted Data Input
27	GND	Ground	57	GND	Ground
28	Rx1n	Receiver Inverted Data Output	58	Tx1n	Transmitter Inverted Data Input
29	Rx1p	Receiver Non-Inverted Data Output	59	Tx1p	Transmitter Non-Inverted Data Input
30	GND	Ground	60	GND	Ground

OSFP Module Pad Layout



The Active Optical Cable (AOC) pin assignment is SFF-8679 compliant.

Control Signals (OSFP)

The transceivers are CMIS 4.0 compliant, management interface and OSFP 4.1 compliant form factor and interfaces. The control signals shown in the pad layout are implemented with the following functions:

Name	Function	Description
LPWn/PRSn	Input/output	Multi-level signal for low power control from host to module and module presence indication from module to host. This signal requires the circuit as described in the OSFP Specification.
INT/RSTn	Input,/output	Multi-level signal for interrupt request from module to host and reset control from host to module. This signal requires the circuit as described in the OSFP Specification.

Name	Function	Description
SCL	BiDir	2-wire serial clock signal. Requires pull-up resistor to 3.3V on host.
SDA	Bidir	2-wire serial data signal. Requires pull-up resistor to 3.3V on host.

Diagnostics and Other Features

The transceiver has a microcontroller with functions for monitoring supply voltage, temperature, laser bias current, optical transmit and receive levels with associated warning and alarm thresholds that can be read by the switch software and viewed remotely.
The transceiver supports the OSFP MSA specification and has the following key features:
Physical layer link optimization:

- Adaptive Tx input equalization
- Programmable Rx output amplitude
- Programmable Rx output pre-cursor
- Programmable Rx output post-cursor

Digital Diagnostic Monitoring (DDM):

- Rx receive optical power monitor for each lane
- Tx transmit optical power monitor for each lane
- Tx bias current monitor for each lane
- Supply voltage monitor
- Transceiver case temperature monitor
- Warning and Alarm thresholds for each DDM function (not user programmable)

Page 13h and 14h Module Diagnostics

- Host side and line side loopback
- PRBS generator and checker on host and line interfaces

Interrupt indications:

- Tx & Rx LOS indication
- Tx & Rx LOL indication
- Tx fault indication

Other CMIS 4.0 functions

- FW upgrade supported via CDB commands.

Specifications

Absolute Maximum Specifications

Absolute maximum ratings are those beyond which damage to the device may occur.

Prolonged operation between the operational specifications and absolute maximum ratings is not intended and may cause permanent device degradation.

Parameter	Symbol	Min	Max	Units
Storage Temperature	T_S	-40	85	°C
Operating Case Temperature	T_{OP}	0	70	°C
Supply Voltage	Vcc	-0.5	3.6	V
Relative Humidity (non-condensing)	RH - Option 1	5	65	%
Control Input Voltage	V_I	-0.3	Vcc+0.5	V

⚠ Maximum switch ambient temperature for reverse (front to back) airflow on QM9700 is 40°C with all fans, and 35°C in case of fan failure.

Recommended Operating Conditions and Power Supply Requirements

Parameter	**Symbol**	**Min**	**Typ**	**Max**	**Units**
Power Supply Voltage	VCC	3.135	3.3	3.465	V
Instantaneous peak current at hot plug	ICC_IP	-	-	6800	mA
Sustained peak current at hot plug	ICC_SP	-	-	5670	mA
Maximum Power Dissipation	PD	-	16	17	W
Maximum Power Dissipation, Low Power Mode	PDLP	-	-	1.5	W
Signaling Rate per Lane	SRL	-	53.125	-	GBd
Two Wire Serial Interface Clock Rate	-	100	-	1000	kHz
Power Supply Noise Tolerance (10Hz - 10MHz)	-	-	-	25	mV
Rx Differential Data Output Load	-	-	100	-	Ohm
Operating Distance	-	2	-	(OPN dependent)	m

Electrical Specifications

Parameter	Symbol	Min	Typ	Max	Units
Receiver (Module Output)					
Peak-peak AC common-mode voltage	VCMLF	17	-	32	mV
	VCMFB	-	-	80	
Differential output Voltage (Long mode)		-	-	900	mV
Differential output Voltage (Short mode)		-	-	600	mV
Eye height, differential		15	-	-	mV
Differential Termination Mismatch		-	-	10	%
Transition Time (min, 20% to 80%)		8.5	-	-	ps
DC common mode Voltage		-350	-	2850	mV
Transmitter (Module Input)					
Differential pk-pk input Voltage tolerance		750	-	-	mV
Differential termination mismatch		-	-	10	%
Single-ended voltage tolerance range		-0.4	-	3.3	V
DC common mode Voltage		-350	-	2850	mV

Notes:

Amplitude customization beyond these specs is dependent on validation in customer system.

Electrical Specification for Low Speed Signal

Parameter	Symbol	Min	Max	Units
Module output SCL and SDA	VOL	0	0.4	V
	VOH	VCC-0.5	VCC+0.3	V
Module Input SCL and SDA	VIL	-0.3	VCC*0.3	V
	VIH	VCC*0.7	VCC+0.5	V

Optical Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Transmitter						
Wavelength	λ1/λ5	1264.5	1271	1277.5	nm	
	λ2/λ6	1284.5	1291	1297.5		
	λ3/λ7	1304.5	1311	1317.5		
	λ4/λ8	1324.5	1331	1337.5		
Side Mode Suppression Ratio	SMSR	30	-	-	dB	

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Average Launch Power, each lane	AOPL	-3.2	-	4.4	dBm	1
Outer Optical Modulation Amplitude (OMAouter), each lane min: • for TDECQ < 1.4 dB • for 1.4 dB ≤ TDECQ ≤ 3.4 dB	TOMA	 -0.2 -1.6 + TDECQ	-	3.7	dBm	2
TDECQ minus TECQ, each lane	TDECQ-TECQ	-	-	2.5	dB	
Transmitter and Dispersion Eye Closure for PAM4 (TDECQ), each lane	TDECQ	-	-	3.4	dB	
Average Launch Power of OFF Transmitter, each lane	TOFF	-	-	-16	dBm	
Extinction Ratio, each lane	ER	3.5	-	-	dB	
RIN21.4OMA	RIN	-	-	-136	dB/Hz	
Optical Return Loss Tolerance	ORL	-	-	17.1	dB	
Transmitter Reflectance	TR	-	-	-26	dB	3
Receiver						
Wavelength	λ1/λ5	1264.5	1271	1277.5	nm	
	λ2/λ6	1284.5	1291	1297.5		
	λ3/λ7	1304.5	1311	1317.5		
	λ4/λ8	1324.5	1331	1337.5		
Damage Threshold, average optical power, each lane	AOPD	4.5	-	-	dBm	
Average Receive Power, each lane	AOPR	-7.2	-	4.4	dBm	
Receive Power (OMAouter), each lane	OMA-R	-	-	3.7	dBm	
Receiver Reflectance	RR	-	-	-26	dB	
Receiver Sensitivity (OMAouter), each lane	SOMA	-	-	-4.6	dBm	4
Stressed Receiver Sensitivity (OMAouter), each lane	SRS	-	-	-2.6	dBm	5
Conditions of stressed receiver sensitivity test						
Stressed eye closure for PAM4 (SECQ)			3.4		dB	
OMAouter of each aggressor lane			1.5		dBm	

Notes:

1. Average launch power, each lane (min) is informative and not the principal indicator of signal strength.
2. Even if TDECQ < 1.4dB, OMAouter (min) must exceed this value.

3. Transmitter reflectance is defined looking into the transmitter.
4. Receiver sensitivity (OMAouter), each lane (max) is informative and is defined for a transmitter with SECQ of 0.9 dB.
5. Measured with conformance test signal at TP3 for the BER = 2.4x10-4

Connector Details

Single-mode Duplex LC PC to Duplex LC PC Optical Connector

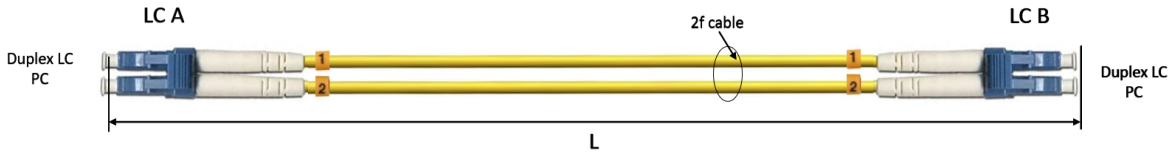
The fiber which connects connector A lane 1 must end at connector B lane 2 at the other end of the link.

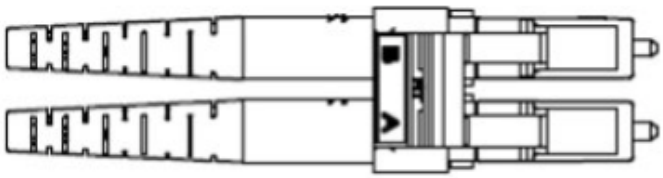
Duplex LC to Duplex LC Patch Cable Fiber Connections:

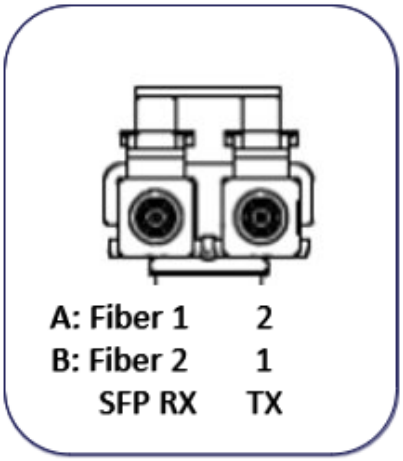
Connector A **Duplex LC**	**Connection**	**Connector B** **Duplex LC**
1	------>	2
2	<------	1

Multiple Duplex LC patch cables can be connected in series, but each added connector pair adds reflections in the link which impairs performance.

Typical Single Mode Duplex LC Fiber Patch Cable:

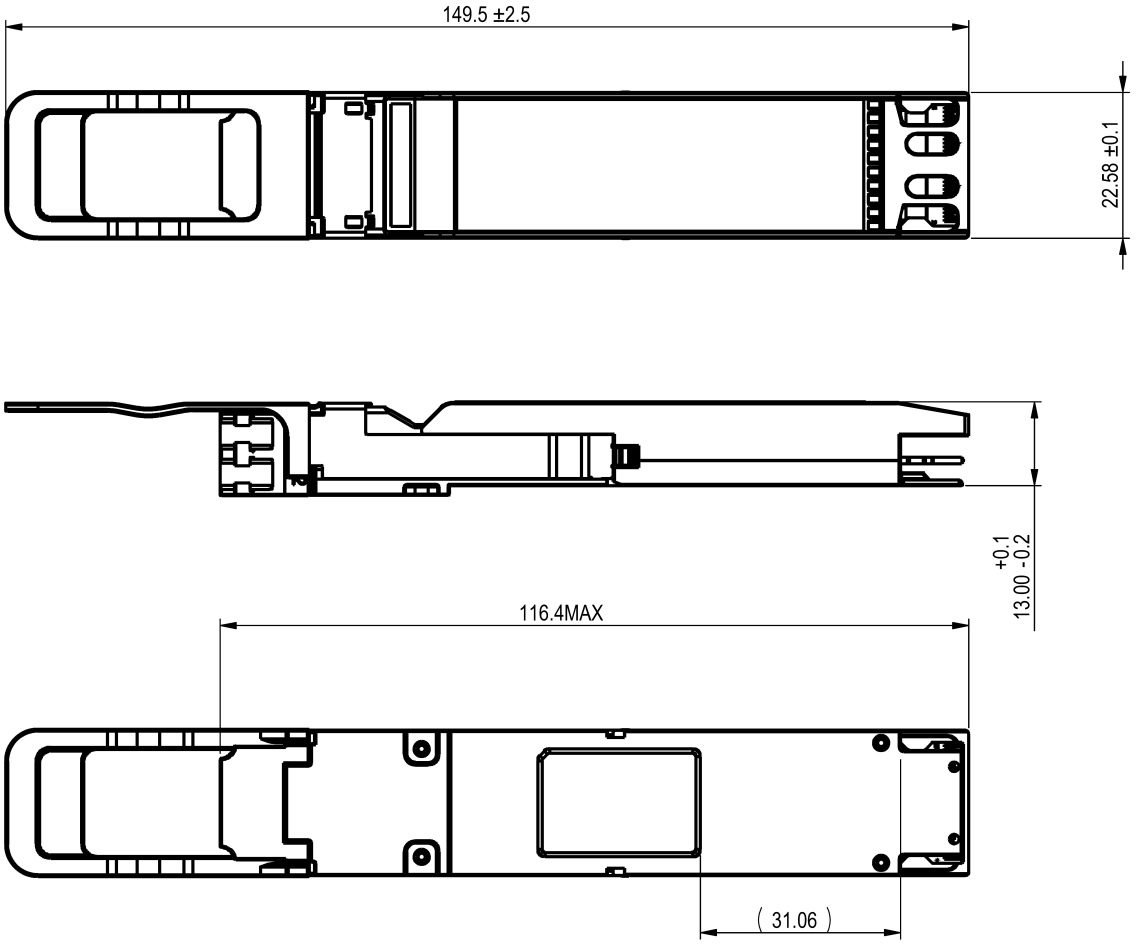




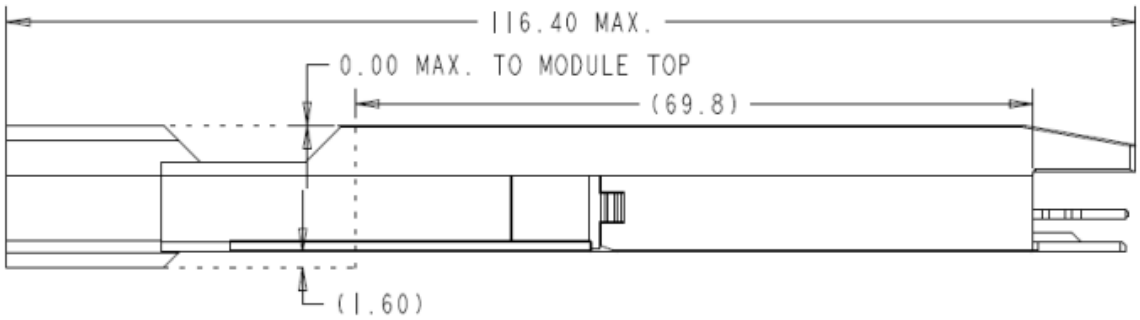


Mechanical Specifications

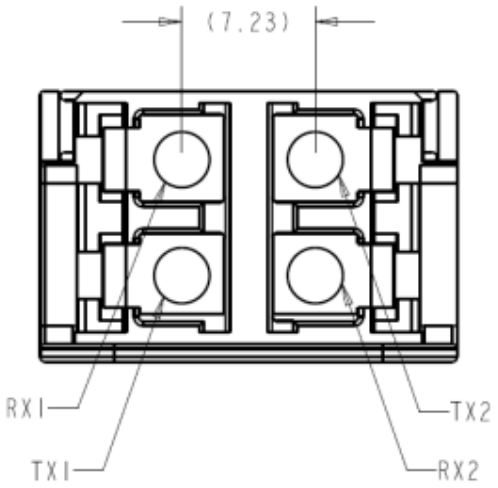
Option 1



Option 2



Connector



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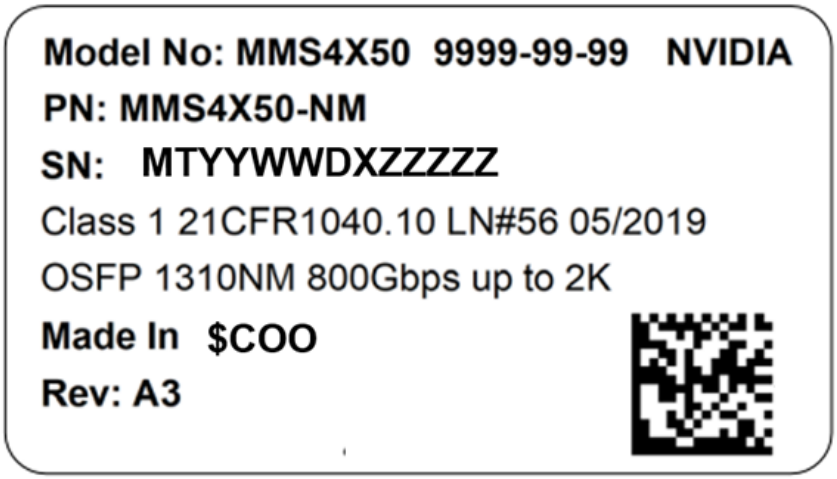
Labels

Back shell Label

The label applied on the transceiver's back-shell is illustrated below. Note that the Images are for illustration purposes only. Labels look and placement may vary.

Transceiver Label (Illustration)



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Transceiver Back-Shell Label Serial Number Legend

Symbol	Meaning	Notes
MT	Manufacturer name (Mellanox Technologies)	2 digits (alphanumeric)
YY	Year of manufacturing	2 last digits of the year (numeric)
WW	Week of manufacturing	2 digits (numeric)
JC *or* DM	Manufacturer Site: JC – Option 1 (China) DM – Option 2 (Malaysia)	Two characters
SSSSS	Serial number	5 digits (decimal numeric) for serial number, starting from 00001.

Regulatory Compliance

The transceiver is a Class 1 laser product. It is certified per the following standards:

Feature	Agency	Standard
Laser Eye Safety	FDA/CDRH	CDRH 21 CFR 1040 and Laser Notice 50
Electrical Safety	CB	IEC 62368
Electrical Safety	UL/CSA	UL 62368 and CAN/CSAN 62368

Handling and Cleaning

The transceiver can be damaged by exposure to current surges and over voltage events. Take care to restrict exposure to the conditions defined in Absolute Maximum Ratings. Observe normal handling precautions for electrostatic discharge-sensitive devices.

The transceiver is shipped with dust caps on both the electrical and the optical port. The cap on the optical port should always be in place when there is no fiber cable connected. The optical connector has a recessed connector surface which is exposed whenever it has no cable nor cap.

Important note 1: *Keep both the fiber and transceiver dust caps.*

Important note 2: *Clean both transceiver receptacle and cable connector* prior to insertion of the fiber cable, to prevent contamination from it.

The dust cap ensures that the optics remain clean during transportation. Standard cleaning tools and methods should be used during installation and service. Liquids must not be applied.

Important note 3: *80% of transceiver link problems are related to dirty optical connectors*.

Ordering Information

Part Numbers and Description

OPN	Description
MMS4X50-NM	NVIDIA twin port transceiver, 800Gbps, 2xFR4, 2xNDR, OSFP, 2xLC-LC, 1310nm SMF, up to 2km, finned

Document Revision History

Rev	Date	Description
1.2	Nov. 2023	Updated chapters: • Introduction • specifications • Labels • Ordering Part Numbers
1.1	Apr. 2023	▪ Updated the document for Ethernet support. ▪ Minor text edits
1.0	Dec. 2022	Initial release.

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