NVIDIA MMS4X00-NS400 400Gb/s Single-port OSFP Single Mode DR4 Transceivers Product Specifications

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1 Introduction

The NVIDIA MMS4X00-NS400 is an InfiniBand (IB) and Ethernet (ETH) 400Gb/s, Single-port, OSFP, DR4 single mode parallel transceiver using a single, 4-channel MPO-12/APC optical connector. The Datacenter Reach 4-channel (DR4) design uses 100G-PAM4 modulation and has a maximum fiber reach of 100-meters and assumes two optical patch panels in the link. It has identical design and internals as the QSFP112 version with different connector shells.

The transceiver firmware supports both InfiniBand and Ethernet and is automatically enabled depending on the protocol of the connected switch. The OSFP shell has a flat-top and utilizes the riding heat sink (cooling fins) on the ConnectX-7 connector cage.

When linked to 1:2 splitter fiber cable split end has only 2 channels and will activate only 2-channels in the 400G transceiver automatically creating a 200G speed and reducing power consumption.

Single mode optics is denoted by a yellow-colored pull tab and optical fiber. Green plastic shell on the MPO-12/APC optical connector denotes Angled Polish Connector (APC) and is not compatible with the aqua colored Ultra-flat Polished Connectors (UPC).

NVIDIA's Single-port and Twin-port 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.

Flat Top Transceiver

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

1.1 Key Features

- IB and ETH support
- 400G DR4 single mode transceiver
- 4-channels of 100G-PAM4 electrical and optical modulation
- OSFP connector shell
- 1310nm EML single mode laser
- Single MPO-12/APC optical connector
- 100m max reach
- 9W max (4-channels)
- 5W max (2-channels)
- Single 3.3V power supply
- Class 1 laser safety
- Hot pluggable, RoHS compliant

- Adaptive Tx input equalizer
- http://OSFPmsa.org compliant
- CMIS 4.0 compliant
- Case temperature range of 0°C to +70°C

1.2 Applications

- Used in ConnectX-7/OSFP adapters linked to Twin-port transceivers in 2x400G IB/EN switches

2 Overview

2.1 Transceiver Connectivity Scenarios

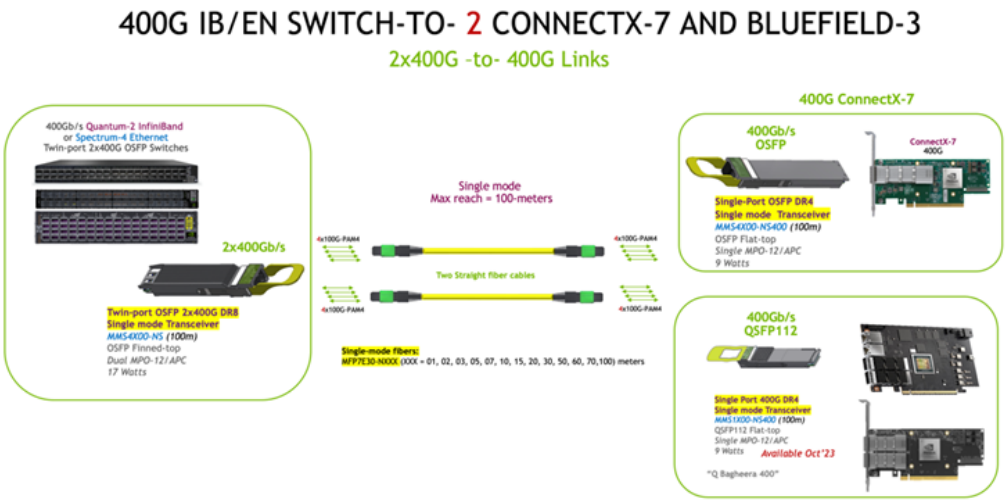
The transceiver is used for connecting 400G and 200Gb/s ConnectX-7/OSFP-based, PCIe-bus network cards. Typically, the transceiver is linked to a single 800Gb/s Twin-port 2x400G OSFP transceiver (MMS4X00-NS) in a Quantum-2 InfiniBand or Spectrum-4 Ethernet switch. The 400Gb/s transceiver has two speeds depending on the number of fibers attached:

1. 400Gb/s mode: Using 4-channels and straight 100-meter crossover fiber cables (MFP7E30), the transceiver draws 9 Watts maximum or 9 Watts typical. In this case, the Twin-port 2x400G transceiver supports 400G transceivers in two ConnectX-7/OSFP.
2. 200Gb/s mode: Using 2-channels and 1:2 splitter fiber cables (MFP7E40), the transceiver operates at 200Gb/s NDR200 rate and draws 5 Watts maximum. It automatically reduces power from 9 Watts as only 2 channels are activated. This case creates links to four 200Gb/s ConnectX-7/OSFP cards.

- QSFP112 are not for use in switches. BlueField-3 only accepts QSFP112s
- Both fibers in the Twin-port 2x400G transceiver linked to the QSFP112s must be the same type – straight or splitter and cannot be mixed

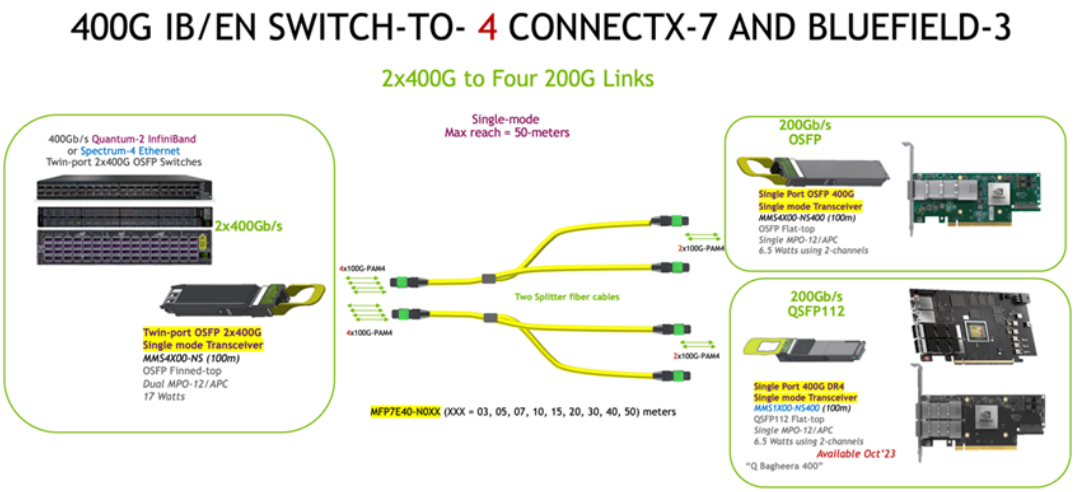
2.2 Use cases

1. Switch-to-two 400G ConnectX-7/OSFP
   A Twin port QSFP transceiver using two, straight fiber cables can support up to two ConnectX-7 adapters. Each of the two, 4-channel fiber cables (MFP7E30) can link to the 400G OSFP MMS4X00-NS400 transceiver up to 100-meters.
   - ConnectX-7 adapters are offered on both OSFP and QSFP112
   - BlueField-3 adapters only accept QSFP112 devices



2. Switch-to-two 200G ConnectX-7/OSFP

   A Twin port OSFP transceiver using two, 1:2 fiber splitter cables can support up any combination of four ConnectX-7/OSFPs. Each of the two, 4-channel 1:2 fiber splitter cables (MFP7E40) can link to a 400G OSFP MMS1X00-NS400 transceiver up to 50-meters.
   The two-fiber channel ends only activate two of the lanes in the 400G transceiver creating a 200G device and automatically reduces the power consumption of only the 400G transceivers from 8 Watts typical to 5.5 Watts typical. Twin port OSFP power consumption remains at 17 Watts.



> ⚠ OSFP is not for use in BlueField-3 DPUs.

3 Pin Description

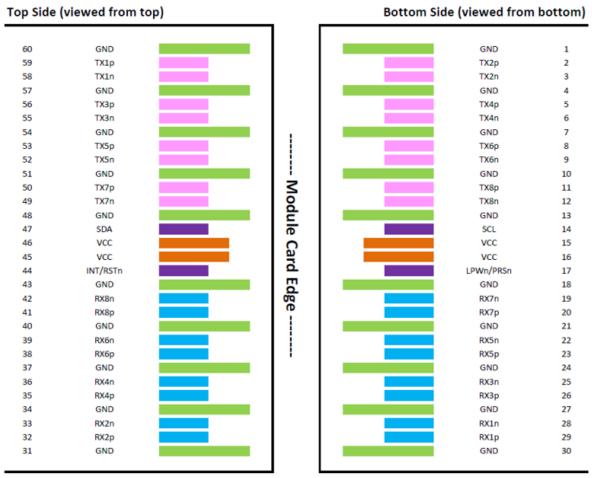
The device is OSFP MSA Specification for OSFP Octal Small Form Factor Pluggable Module Rev. 1.12 compliant, see www.osfpmsa.org.

3.1 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

3.1.1 OSFP Module Pad Layout



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

3.2 Control Signals (OSFP)

This device supports CMIS 4.0 (check for update, e.g. to CMIS 5) compliant management interface and OSFP MSA compliant form factor and interfaces. This implies that 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.

3.3 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.

4 Specifications

4.1 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	95	%
Control Input Voltage	V_I	-0.3	Vcc+0.5	V

Module temperature per DDMI readout of up to 80C is allowed

4.2 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 (400G)	ICC_IP	-	-	3600	mA
Sustained peak current at hot plug (400G)	ICC_SP	-	-	3000	mA
Maximum Power consumption (400G)	PD	-	-	9	W
Maximum Power consumption, Low Power Mode (400G)	PDLP	-	-	tbd	W
Instantaneous peak current at hot plug (200G)	ICC_IP	-	-	2200	mA
Sustained peak current at hot plug (200G)	ICC_SP	-	-	1840	mA
Maximum Power consumption (200G)	PD	-	-	5.5	W
Maximum Power consumption, Low Power Mode (200G)	PDLP	-	-	1.5	W
Signaling Rate per Lane	SRL	-	53.125	-	GBd
Two Wire Serial Interface Clock Rate	-	-	-	400	kHz
Power Supply Noise Tolerance (10Hz - 10MHz)	-	-	-	66	mV
Rx Differential Data Output Load	-	-	100	-	Ohm
Operating Distance	-	2	-	100	m

4.3 Electrical Specifications

Parameter	Min	Typ	Max	Units
Receiver (Module Input)				
AC common-mode output Voltage (RMS)	-	-	25	mV
Differential output Voltage (Long mode)	-	-	845	mV
Differential output Voltage (Short mode)	-	-	600	mV
Near-end Eye height, differential	70	-	-	mV
Far-end Eye height, differential	30	-	-	mV
Far end pre-cursor ratio	-4.5	-	2.5	%
Differential Termination Mismatch	-	-	10	%
Transition Time (min, 20% to 80%)	9.5	-	-	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.

4.3.1 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

4.4 Optical Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Transmitter						
Wavelength	λC	1304.5	1311	1317.5	nm	
Side Mode Suppression Ratio	SMSR	30	-	-	dB	
Average Launch Power, each lane	AOPL	-1.0	-	3.0	dBm	1

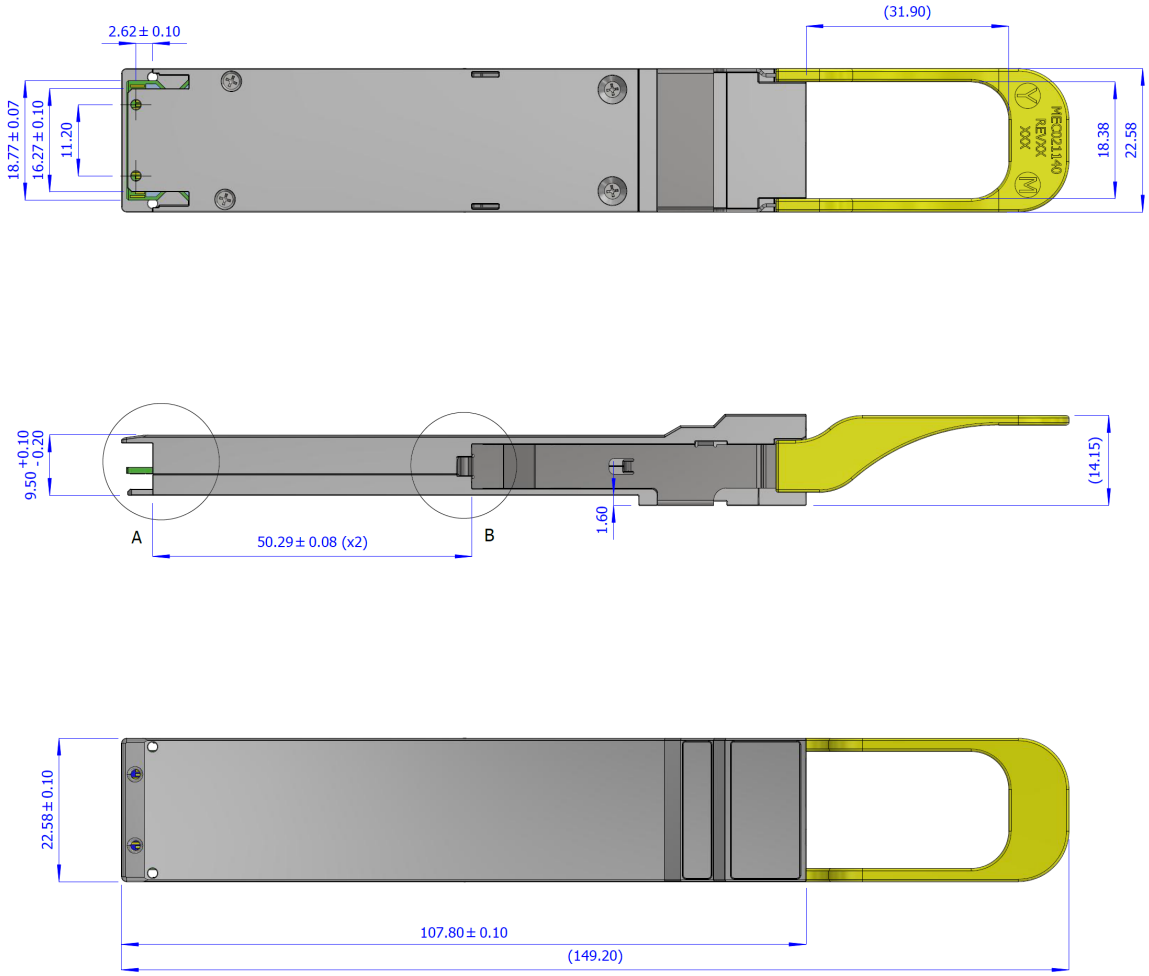
Outer Optical Modulation Amplitude (OMAouter), each lane	TOMA	-1.0	-	3.0	dBm	2
Launch Power in OMAouter minus TDECQ, each lane	TOMA-TDECQ	-2.2	-	-	dBm	
Transmitter and Dispersion Eye Closure for PAM4 (TDECQ), each lane	TDECQ	-	-	3.4	dB	
Average Launch Power of OFF Transmitter, each lane	TOFF	-	-	-15	dBm	
Extinction Ratio, each lane	ER	3.5	5.0	7.0	dB	
RIN21.4OMA	RIN	-	-	-136	dB/Hz	
Optical Return Loss Tolerance	ORL	-	-	21.4	dB	
Transmitter Reflectance	TR	-	-	-26	dB	3
Receiver						
Wavelength	λC	1304.5	1311	1317.5	nm	
Damage Threshold, each lane	AOPD	5	-	-	dBm	
Average Receive Power, each lane	AOPR	-5.9	-	4.0	dBm	
Receive Power (OMAouter), each lane	OMA-R	-	-	4.2	dBm	
Receiver Reflectance	RR	-	-	-26	dB	
Receiver Sensitivity (OMAouter), each lane	SOMA	-	-	-4.4	dBm	4
Stressed Receiver Sensitivity (OMAouter), each lane	SRS	-	-	-1.9	dBm	5
Conditions of stressed receiver sensitivity test						
Stressed eye closure for PAM4 (SECQ)			3.4		dB	
OMAouter of each aggressor lane			4.2		dBm	

Notes:

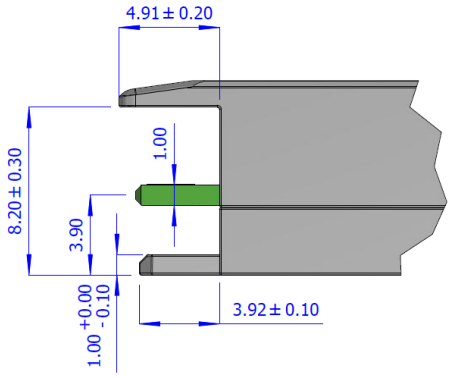
1. Average launch power, each lane (min) is informative and not the principal indicator of signal strength.
2. Even if TDECQ < 1.4dB, OMAouter (min) must exceed this value.
3. Transmitter reflectance is defined looking into the transmitter.
4. Receiver sensitivity (OMAouter), each lane (max) is informative 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

4.4.1 Mechanical Specifications

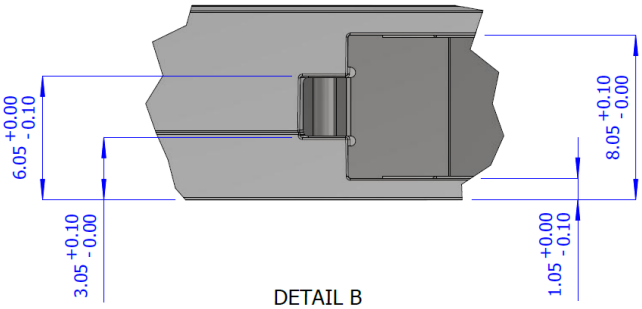
4.4.1.1 Option 1:



Enlarged view of detail A and B:

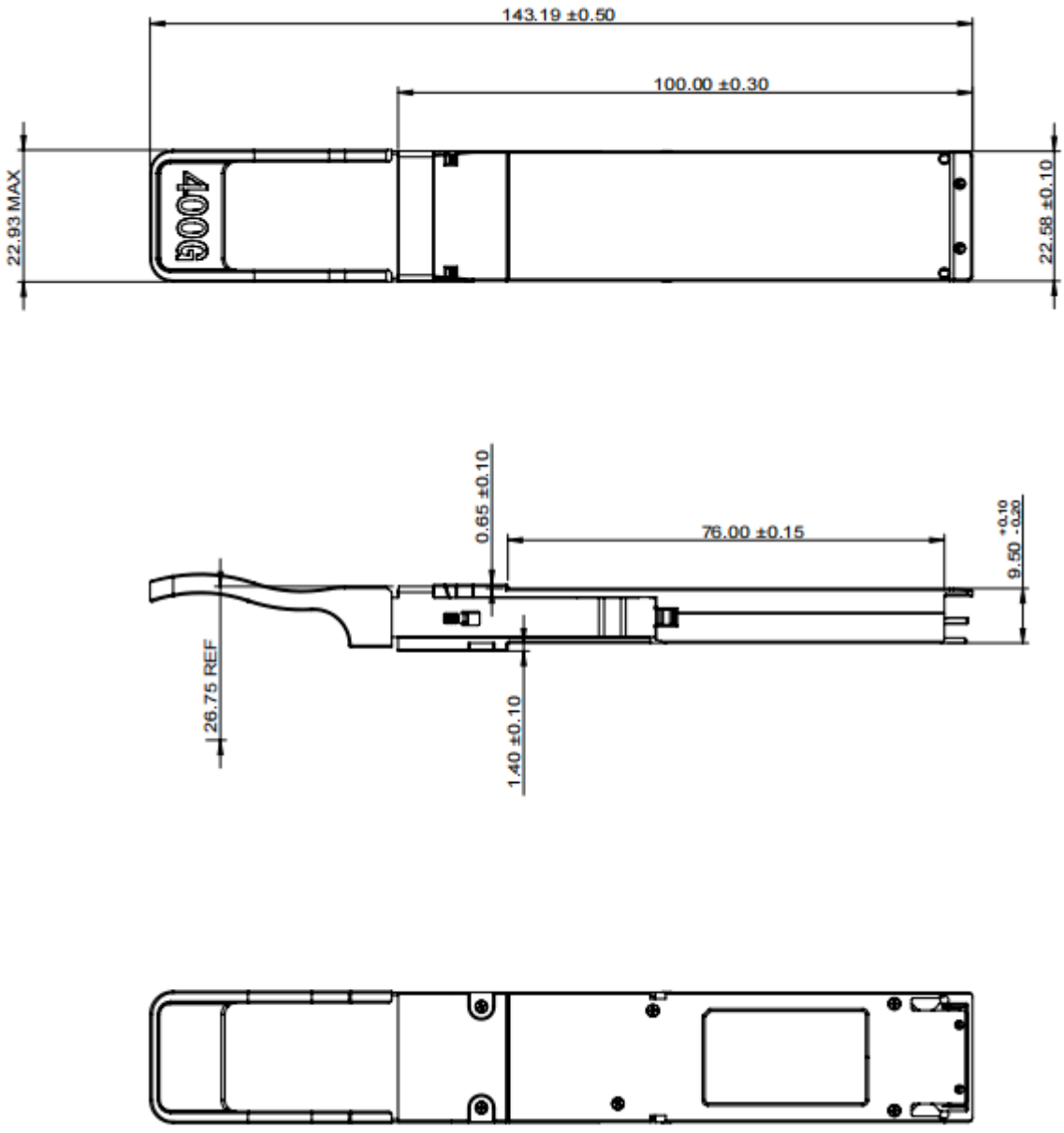


DETAIL A

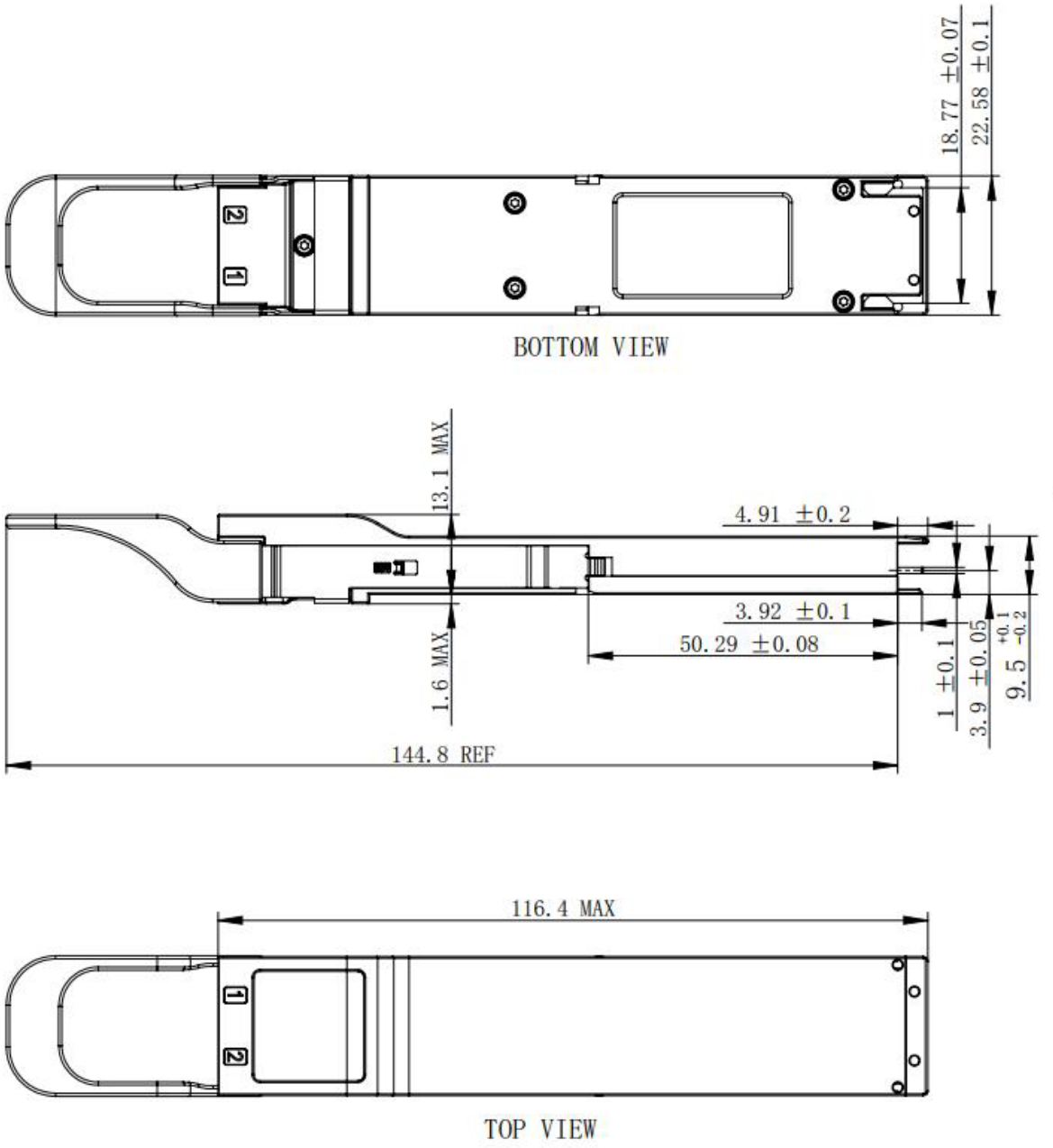


DETAIL B

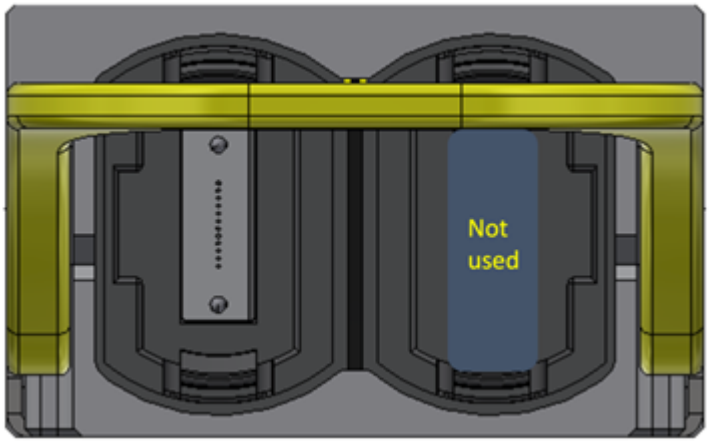
4.4.1.2 Option 2



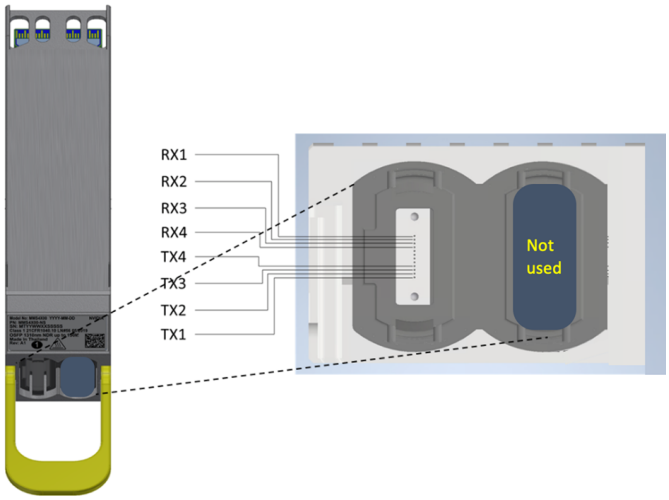
4.4.1.3 Option 3



MPO/APC end view:



This is the ‘head end’. The connectors in the ‘tails’ have same layout but only 2 transmit and 2 receive fibers with the middle 8 positions empty.



Module port labeling and lane routing. Txn/Rxn refers to the OSFP pin description

Single mode optics are denoted by a yellow-colored pull tab and yellow-colored optical fiber. The green plastic shell on the MPO-12/APC optical connector denotes Angled Polish Connector.

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

4.4.1.4 New Form-factors

The OSFP body has a flat-top to cool the NDR 9-Watt (400 Gb/s) or 6-Watt (200 Gb/s) transceiver in the ConnectX-7 HCA. Unlike the Twin-port transceiver, the heat sink is contained on the ConnectX-7 connector cage and there is no cooling package top difference for linking to either air or liquid-cooled systems.

OSFP is longer and wider than the traditionally used QSFP28/EDR or QSFP56/HDR form-factors.

4.5 Labels

4.5.1 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)

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

4.5.1.1 Transceiver Back-Shell Label Serial Number Legend

Symbol	Meaning	Notes
MT	Manufacturer name	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.

4.5.2 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

4.6 Connector and Cabling Details

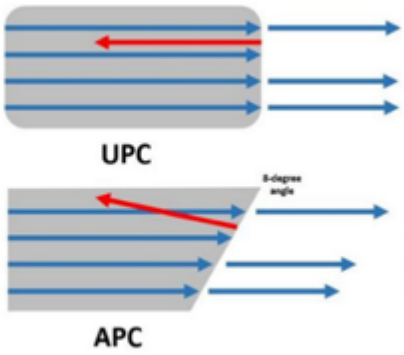
4.6.1 MPO-12/APC Optical Connector

The Twin-port NDR transceiver has a unique NVIDIA patented design enabling two, multiple-push-on/angled-polished-connector 12-fiber (MPO-12/APC) optical connectors per single OSFP form-factor by turning the optical connectors vertically in the twin-port transceiver end. This enables it to host two NDR transceivers inside, each with its own MPO-12/APC optical connector operating independently that can link to another Twin-port transceiver or to a single-port 400Gb/s NDR transceiver.
The MPO-12 has a 12-fiber ribbon but only 8-fibers are used – four transmit and four receive fibers for the 4-channels 100G-PAM4.

- The APC design minimizes back reflections and signal interference by diverting back reflected light from the fiber face to be absorbed into the fiber cladding.
- A positioning key on top of the connector together with the alignment pins define the fiber position numbering scheme to align pin 1 in the optical connector to pin 1 in the transceiver also called “polarity”
- Transceivers have alignment pins for precise positioning of the cable connector against the optical beams. The fiber cable has alignment holes matching the transceiver’s pins.
- Important to note that transceivers have pins. Optical connectors have holes used with transceivers have holes. Optical connectors with pins are not compatible with transceivers and used in trunk cabling to connect two fiber cables together.

The MPO-12/APC optical connector is used in both the 100G-PAM4 based single mode and multimode fiber cables.
Single mode optics is denoted by a yellow-colored pull tab and yellow-colored optical fiber. Green plastic shell on the MPO-12/APC connector denotes Angled Polish Connector and is not compatible with Ultra-flat Polished Connectors (UPC) used with slower line rate transceivers.

MPO-12/APC Showing 4-Transmit and 4-Receive Fibers and Angled Polish Connector End face

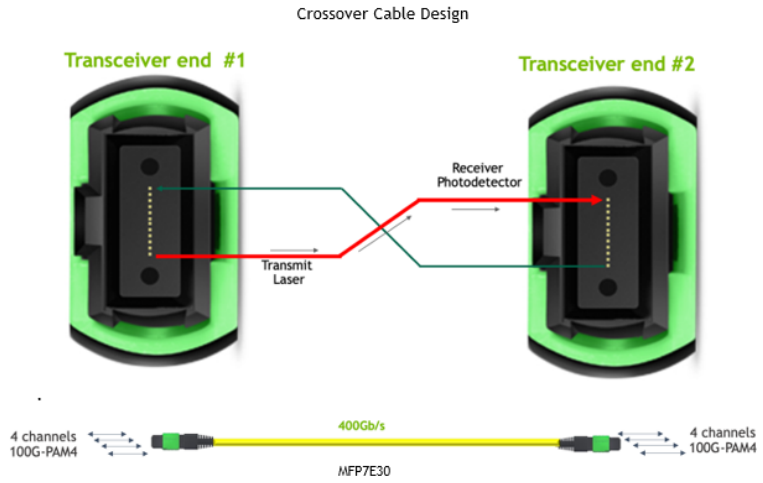


4.6.1.1 NVIDIA Supplied Crossover Type-B Fiber Cables

Linking two transceivers directly together requires aligning the transceiver laser sources with the correct photo detectors in the receive transceiver. Transmit and receive fibers are switched inside the cable enabling two transceivers to be directly connected to each other. This is called a Type-B crossover fiber.

Each of the two 4-channel NDR ports in the Twin-port transceiver has its own 4-channel optical cable that can link to two single-port 400Gb/s transceiver. Two fiber cables are needed for each Twin-port transceiver. Fiber cables are crossover cable Type-B that aligns the transmit laser with the opposite transceiver's receiver photodetector allowing to directly connect two transceivers together to maintain minimum optical losses, lowest back reflections, longest reach and increased reliability without the use of optical patch panels.

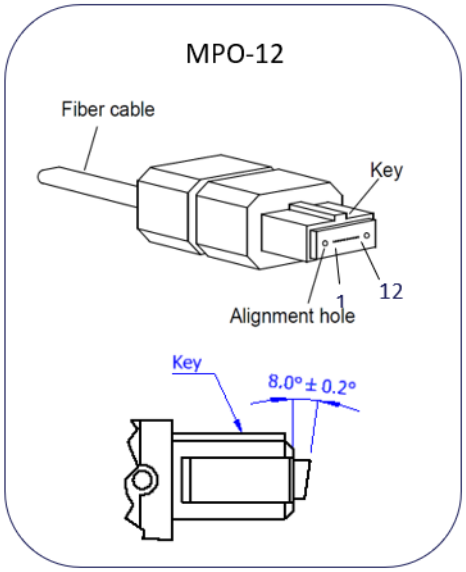
NVIDIA supplies crossover, single mode fiber cables up to 100-meters. For length from 100-to-500-meters, a crossover fiber segment must be implemented in the link to align transmit lasers with receiver photodetectors. This can be implemented by building the fiber cable as a crossover cable, or adding a NVIDIA crossover cable in the link, or via an optical patch panel with a crossover segment.

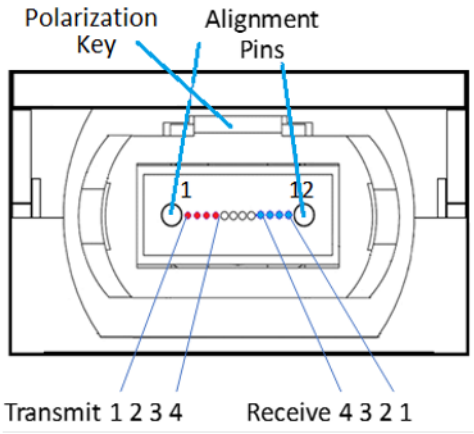


Note: Refer to the Recommended Fiber Cables table for more information.

Transceivers have alignment pins for precise positioning of the cable connector against the optical beams. The fiber cable has alignment holes matching the transceiver's pins.

MPO Connector with Alignment Holes and Positioning Key





NDR transceiver: MPO Receptacle, Lane Assignment, and Positioning Key (front view)

Reference: IEC specification IEC 61754-7

4.6.2 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.

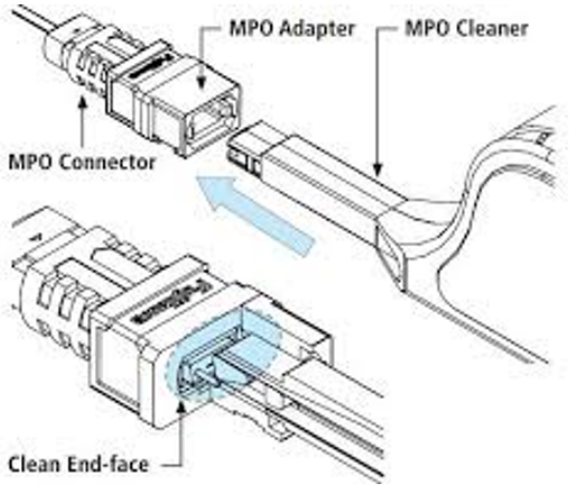
The transceiver is shipped with dust caps on both the electrical and the optical port. The cap on the optical port should always be in place when there is no fiber cable connected. The optical connector has a recessed connector surface which is exposed whenever it has no cable nor cap.

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*.



4.6.3 Cable Management Guidelines

For more information and general interconnect management and installation, see NVIDIA Cable Management Guidelines and FAQ Application Note.

5 Ordering Information

5.1 Part Numbers and Description

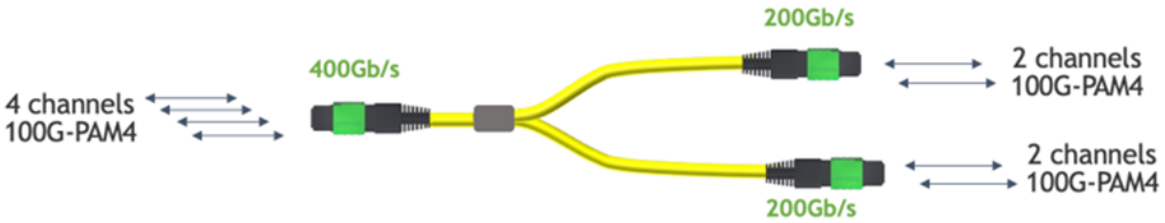
Legacy OPN	NVIDIA OPN	Description
MMS4X00-NS400	980-9I31N-00NM00	NVIDIA single port transceiver, 400Gbps, NDR, OSFP, MPO, 1310nm SMF, up to 100m, flat top

6 Recommended NVIDIA Supplied Crossover Fiber Cables Part Numbers

Single-mode, Straight Crossover Fibers

OPN	4-channel MPO/APC to 4-channel MPO/APC
MFP7E30-N001	1m
MFP7E30-N002	2m
MFP7E30-N003	3m
MFP7E30-N005	5m
MFP7E30-N007	7m
MFP7E30-N010	10m
MFP7E30-N015	15m
MFP7E30-N020	20m
MFP7E30-N030	30m
MFP7E30-N050	50m
MFP7E30-N060	60m
MFP7E30-N070	70m
MFP7E30-N100	100m

⚠ Lengths beyond 100-meters is not offered but available from third-party suppliers



Single-mode, 1:2 Splitter Crossover Fibers

OPN	4-channel MPO/APC to Two 2-channel MPO/APC
MFP7E40-N003	3m
MFP7E40-N005	5m
MFP7E40-N007	7m
MFP7E40-N010	10m
MFP7E40-N015	15m
MFP7E40-N020	20m
MFP7E40-N030	30m
MFP7E40-N050	50m

7 Document Revision History

Rev	Date	Description
1.3	Aug. 2026	Added alternate hardware mechanical drawings.
1.2	Nov. 2023	Updated mechanical drawings.
1.1	Apr. 2023	• Updated the document for Ethernet support. • Minor text edits
1.0	Dec. 2022	Initial release.

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