MMA4Z00-NS400 400Gb/s Single-port OSFP 400Gb/s Multimode SR4 50m

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1 Introduction

The NVIDIA MMA4Z00-NS400 is an InfiniBand (IB) and Ethernet (ETH) 400Gb/s, Single-port, OSFP, SR4 multimode parallel transceiver using a single, 4-channel MPO-12/APC optical connector. The Short Reach 4-channel (SR4) design uses 100G-PAM4 modulation and has a maximum fiber reach of 50-meters using OM4 multimode fiber and assumes two optical patch panels in the link. It has identical design and internals as the QSFP112 version, only with different connector shells.

The transceiver firmware supports both InfiniBand and Ethernet and is automatically enabled depending on the protocol of the switch attached to. 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.

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

NVIDIA's Single-port and Twin-port transceiver combinations guarantee optimal operation in NVIDIA end-to-end systems and customer networking solutions. Rigorous production testing ensures 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 SR4 multimode
- 4-channels of 100G-PAM4 electrical and optical modulation
- Flat top OSFP connector shell
- 850nm VCSEL
- Maximum reach:
  - 30m using OM3 fiber
  - 50m using OM4 fiber
- Single MPO-12/APC optical connector
- Operates as a 200Gb/s NDR200 transceiver with 2-fiber splitter ends

- 8.5 Watts (max) using 4-channels
- 5.5 Watts (max) using 2-channels
- Single 3.3V power supply
- Class 1 laser safety
- Hot pluggable, RoHS compliant
- OSFPmsa.org compliant
- CMIS 4.0 compliant
- Case temperature range 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 Connectivity Scenarios

The transceiver is inserted into 400Gb/s ConnectX-7/OSFP-based, PCIe-bus network cards. Typically, the transceiver is linked to a single 800Gb/s Twin-port 2x400G OSFP transceiver (MMA4Z00-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:

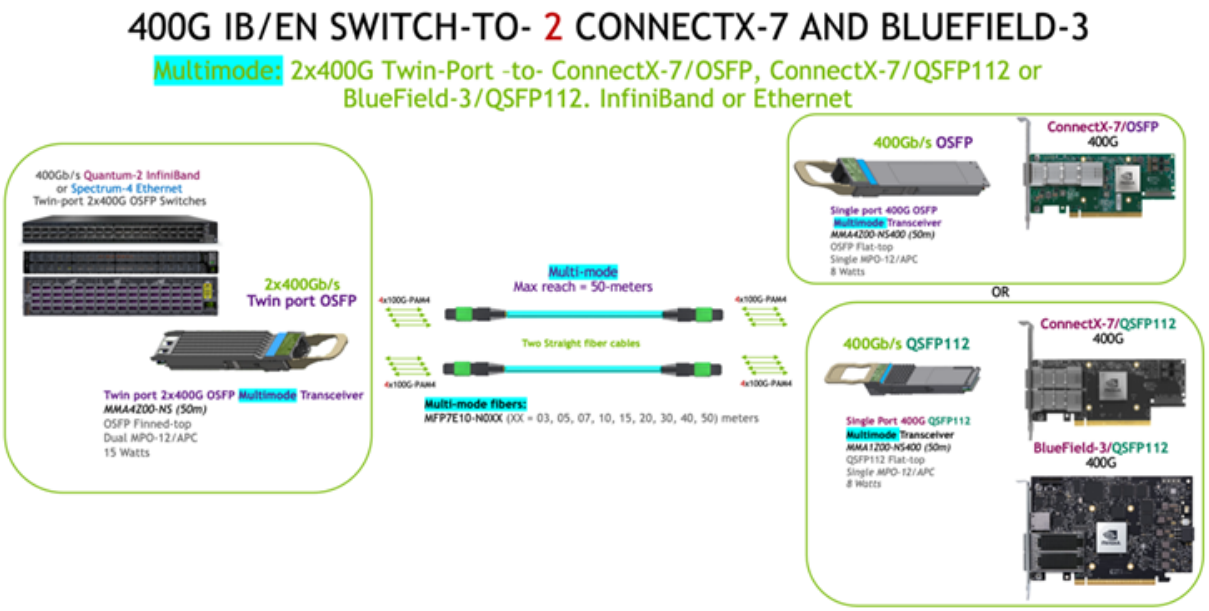
1. 400Gb/s mode: Using 4-channels straight 50-meter crossover fiber cables (MFP7E10), the transceiver draws 9 Watts maximum or 8 Watts typical. In this case, the Twin-port 2x400G transceiver supports two 400G transceivers and two ConnectX-7/OSFP adapter cards.
2. 200Gb/s mode: Using 2-channels and 1:2 splitter 50-meter crossover fiber cables fiber cables (MFP7E20), the transceiver operates at 200Gb/s (200GbE, NDR200) rate and draws 5 Watts typical and 6.5 Watts maximum automatically reducing power as only 2 channels are activated. This case creates links to four 200Gb/s ConnectX-7/OSFP adapter cards.

- Single port OSFP 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.

2.1.1 Use cases

1. Switch-to-switch at 800Gb/s or to two switches at 400Gb/s
A Twin port OSFP transceiver using two, straight fiber cables can support up to two ConnectX-7/OSFP adapters. Each of the two, 4-channel fiber cables (MFP7E10) can link to the 400G OSFP MMA4Z00-NS400 transceiver up to 50-meters.

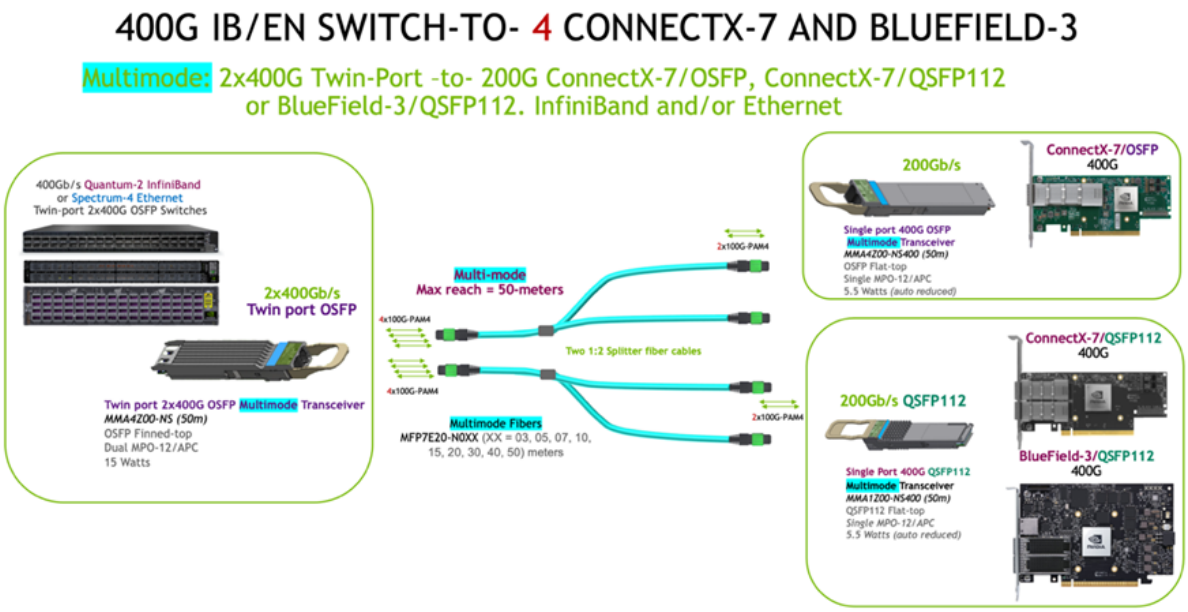
- ConnectX-7 adapters are offered on both OSFP and QSFP112
- BlueField-3 adapters only accept QSFP112 devices.



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

A Twin port OSFP transceiver using two, 1:2 fiber splitter cables can support up to four ConnectX-7 adapters. Each of the two, 4-channel 1:2 fiber splitter cables (MFP7E20) can link to a 400G OSFP MMA4Z00-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 15 Watts.



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

3 Pin Description

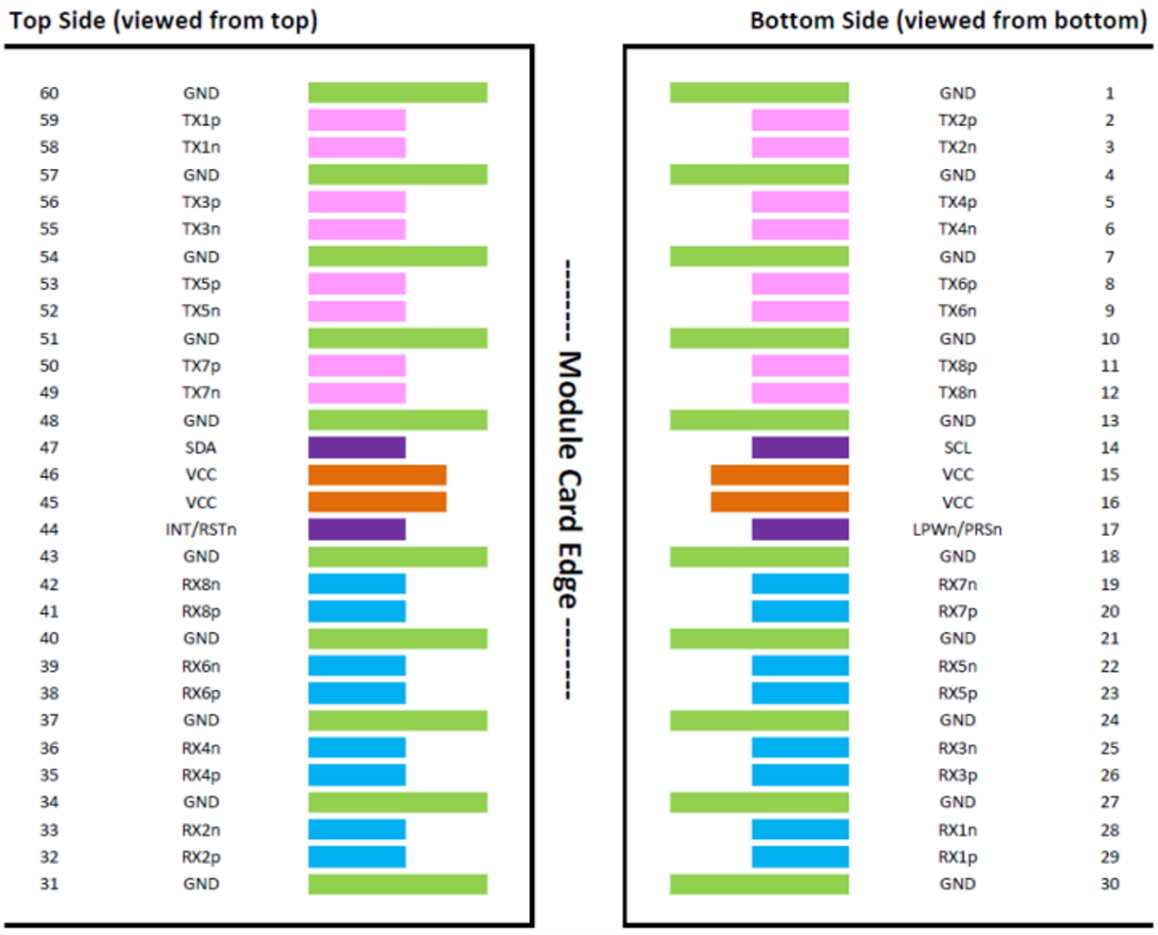
The device is OSFP MSA Specification for OSFP Octal Small Form Factor Pluggable Module Rev. 1.12 compliant, see www.osfpmsa.org.

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

Pin	Symbol	Description	Pin	Symbol	Description
23	Rx5p	Receiver Non-Inverted Data Output	53	Tx5p	Transmitter Non-Inverted Data Input
24	GND	Ground	54	GND	Ground
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 [ ].
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

Firmware upgrade is 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 75°C 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	-	-	8.5	W
Maximum Power consumption, Low Power Mode (400G)	PDLP	-	-	2	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	-	-	2	W
Signaling Rate per Lane	SRL	-	53.125	-	GBd
Two Wire Serial Interface Clock Rate	-	-	-	400	kHz

Parameter	Symbol	Min	Typ	Max	Units
Power Supply Noise Tolerance (10Hz - 10MHz)	-	66	-		mV
Rx Differential Data Output Load	-	-	100	-	Ohm
Operating distance (OM3)		2		30	m
Operating distance (OM4)		2		50	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

⚠ 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	844	850	863	nm	
RMS spectral width	Dl			0.6		
Average Launch Power, each lane	AOPL	-4.6	-	4.0	dBm	1
Outer Optical Modulation Amplitude (OMAouter), each lane (min)	TOMA	-2.6		3.5	dBm	2
Transmitter and Dispersion Eye Closure for PAM4 (TDECQ), each lane	TDECQ	-	-	4.4	dB	
Average Launch Power of OFF Transmitter, each lane	TOFF	-	-	-30	dBm	
Extinction Ratio, each lane	ER	-	2.5		dB	
RIN21.4OMA	RIN	-	-	-132	dB/Hz	
Optical Return Loss Tolerance	ORL	-	-	12	dB	
Transmitter Reflectance	TR	-	-	-26	dB	3
Receiver						
Wavelength	λC	842	850	863	nm	
Damage Threshold, average optical power, each lane	AOPD	5	-	-	dBm	
Average Receive Power, each lane	AOPR	-6.3	-	4.0	dBm	6
Receive Power (OMAouter), each lane	OMA-R	-	-	3.5	dBm	
Receiver Reflectance	RR	-	-	-26	dB	
Receiver Sensitivity (OMAouter), each lane	SOMA	-	-	-4.4	dBm	4
Stressed Receiver Sensitivity (OMAouter), each lane	SRS	-	-	-1.8	dBm	5
Conditions of stressed receiver sensitivity test						
Stressed eye closure for PAM4	SECQ	4.4			dB	
OMAouter of each aggressor lane	OMAouter	3.5			dBm	

⚠

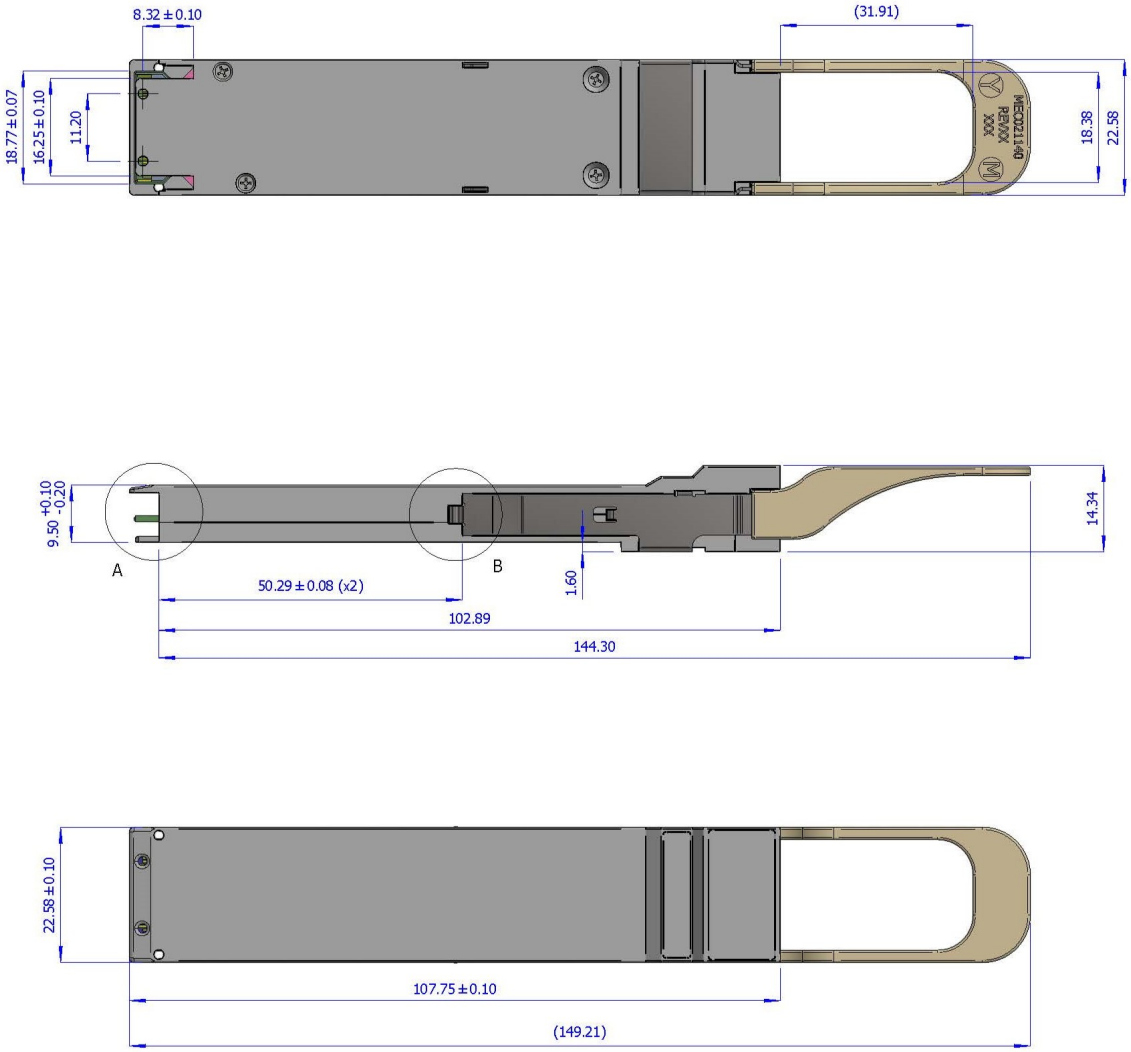
1. Average launch power, each lane (min) is informative and not the principal indicator of signal strength.
2. Even if max(TECQ,TDECQ) < 1.8dB, OMAouter (min) must exceed this value.

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 TDECQ<=1.8 dB
5. Measured with conformance test signal at TP3 for the BER = 2.4x10-4

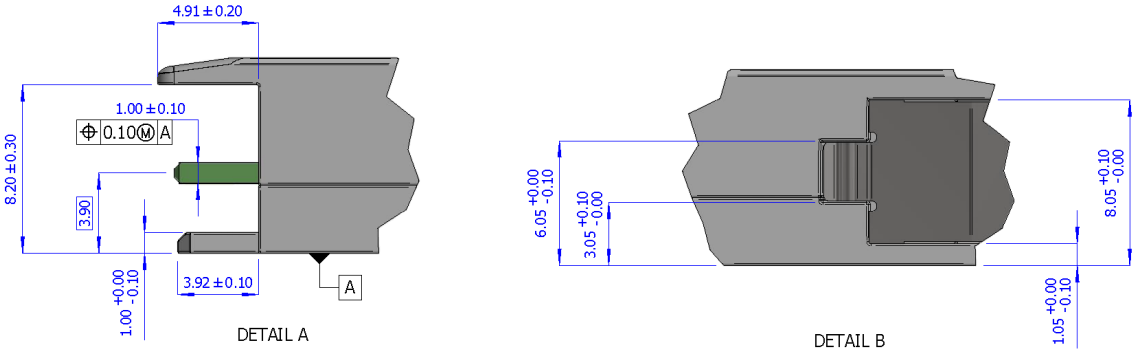
Minimum power is informative. AOP above the minimum does not ensure compliance

4.5 Mechanical Specifications

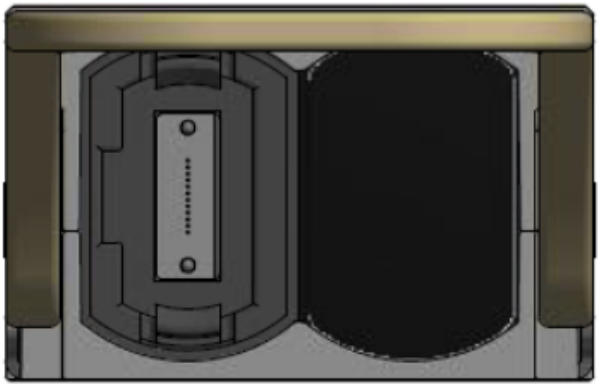
Finned-top twin-port for air-cooled 400G IB/EN Switches: Bottom, Side, and Top Views.



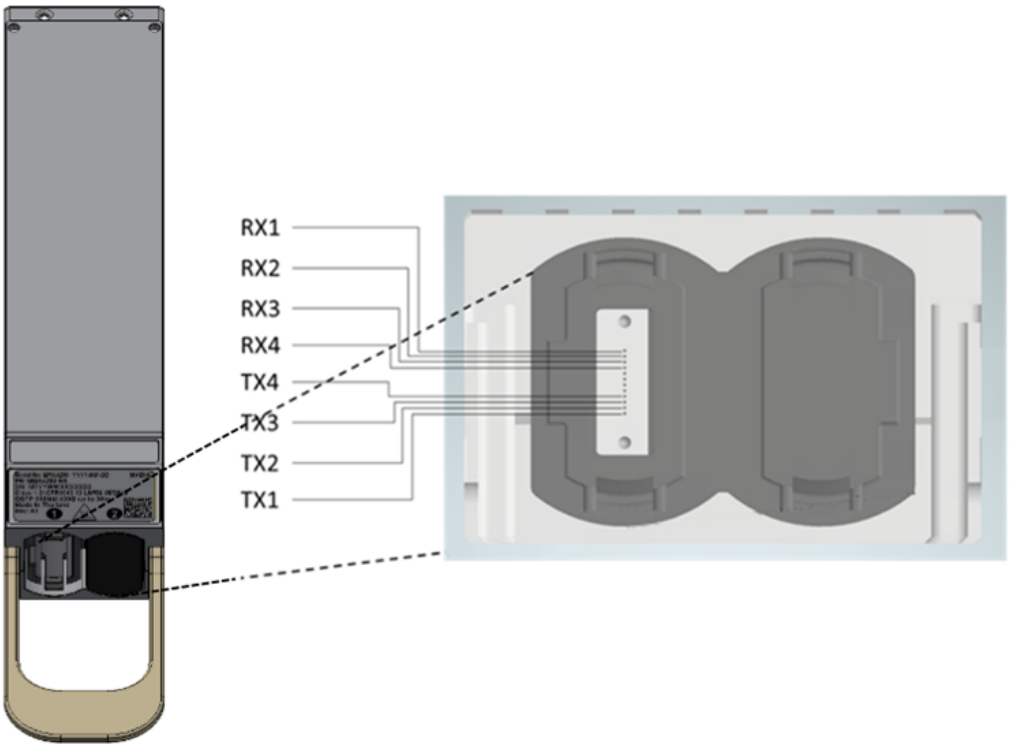
A and B expanded detail:



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

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

4.5.1 New Form-factors

The OSFP body has a flat-top to cool the 9-Watt NDR transceiver in the ConnectX-7 HCA. Unlike the Twin-port transceiver, the heat sink is contained on the ConnectX-7 card connector cage.

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

4.6 Labels

4.6.1 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.

4.6.1.1 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.

4.6.2 Regulatory Compliance

The transceiver is a Class 1M 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

Warning: Exposure to the laser light can cause damage to the eyes. Use protective face gear while handling this product and keep the laser light away from the eyes and face.

4.7 Connector and Cabling Details

4.7.1 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.

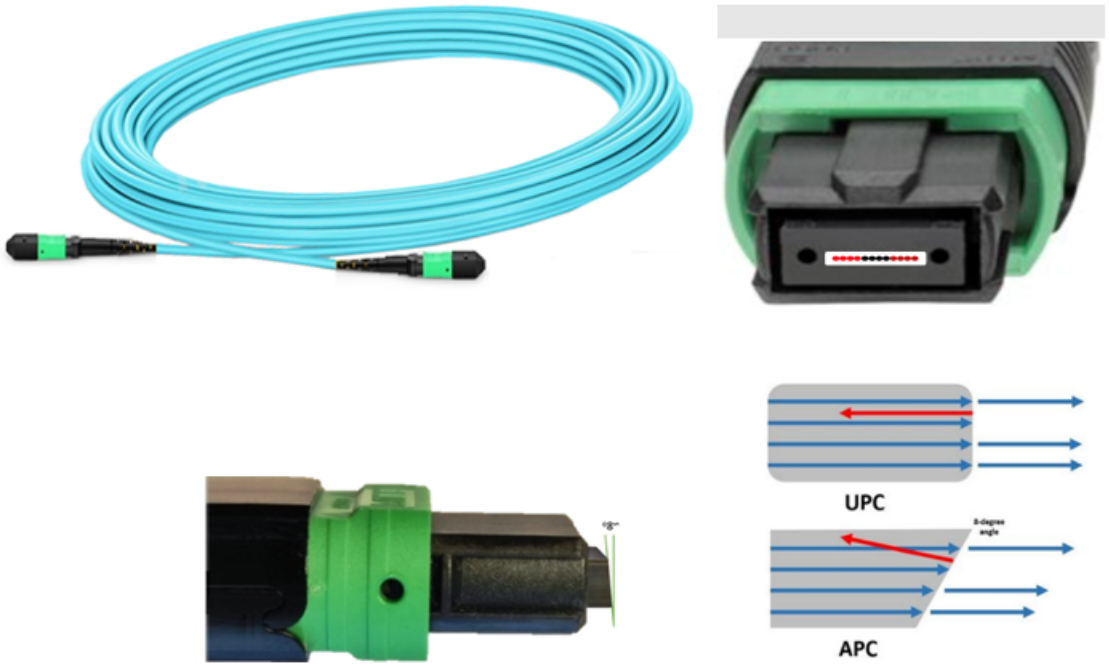
The MPO-12 has a 12-fiber ribbon but only 8-fibers are used – four transmit and four receive fibers for the 4-channels of 100G-PAM4 NDR.

- 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.
- It is important to note that transceivers have pins. Optical connectors have holes and are used with transceivers. Optical connectors with pins are not compatible with transceivers and are used in trunk cabling to connect two fiber cables together.

The MPO-12/APC optical connector is used in both the NDR single mode and multimode fiber cables.

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

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



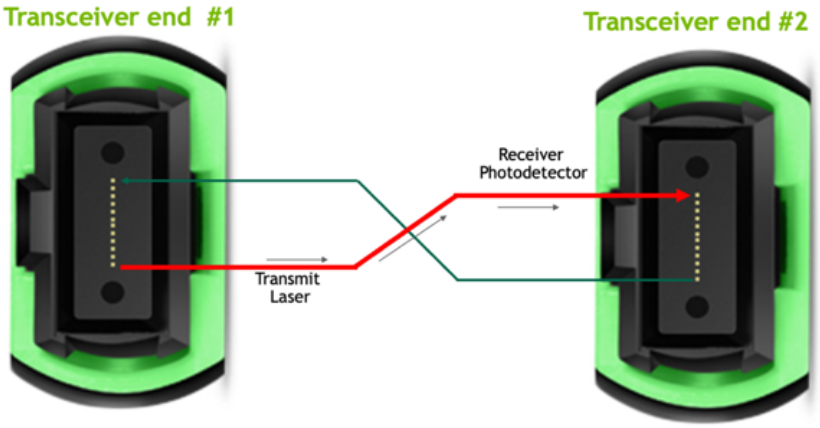
4.7.1.1 NVIDIA Supplied Crossover Type-B Fiber Cables

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 connector that can link to two single-port 400Gb/s NDR transceiver. Two fiber cables are needed for each Twin-port transceiver.

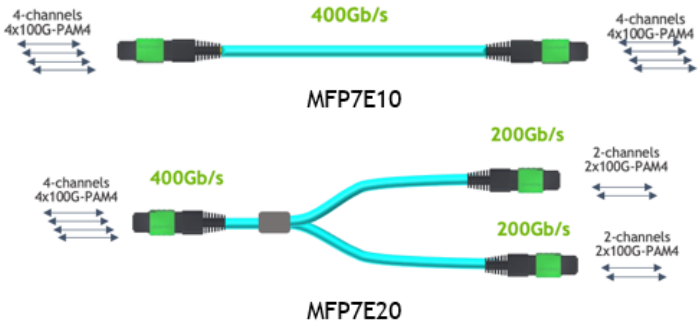
Fiber cables are crossover cable Type-B that aligns the transmit laser with the opposite transceiver's receiver photodetector allowing to directly connect two transceivers together to maintain minimum optical losses, lowest back reflections, longest reach and increased reliability without the use of optical patch panels. For Twin-port transceivers, both cables must be the same type (straight or 1:2 splitter) although different lengths are allowed.

Crossover Cable Design



Multimode Straight and Splitter Cables

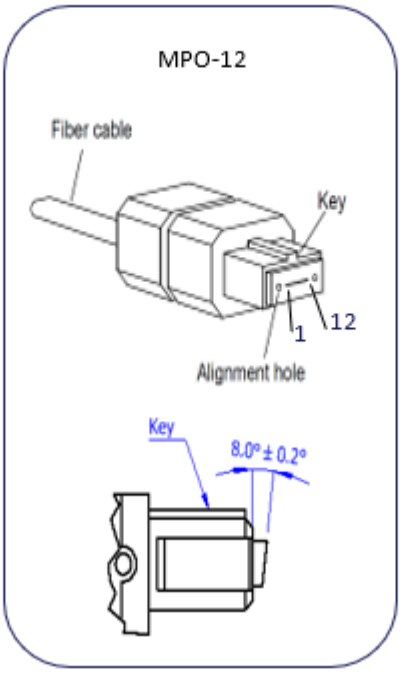
Twin-port transceiver side NDR or NDR200 HCA DPU side

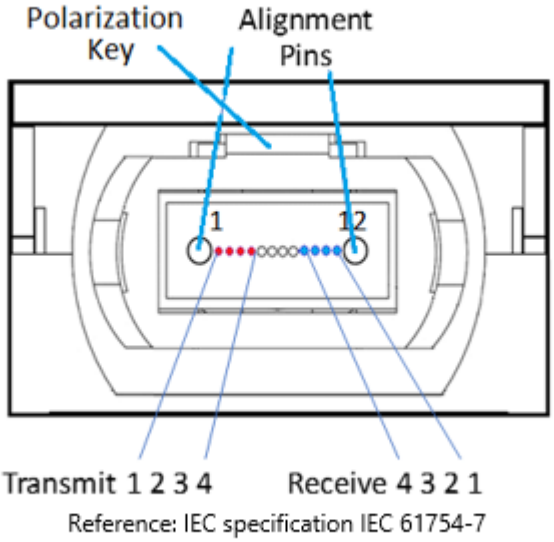


Note: Refer to the Recommended Fiber Cables table for more information.

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





Reference: IEC specification IEC 61754-7

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

4.7.2 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.

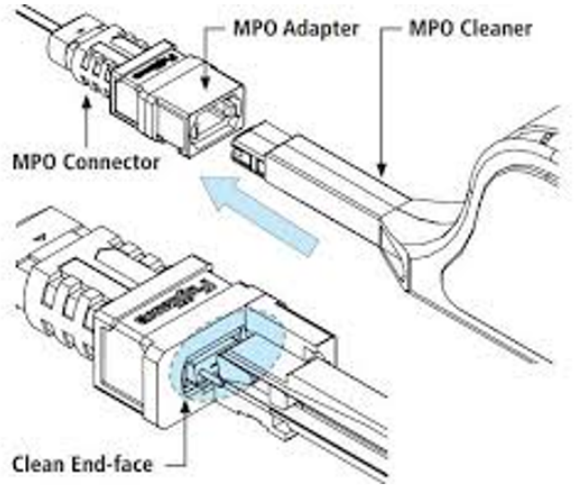
The transceiver is shipped with dust caps on both the electrical and the optical port. The cap on the optical port should always be in place when there is no fiber cable connected. The optical connector has a recessed connector surface which is exposed whenever it has no cable nor cap.

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*.



4.7.3 Cable Management Guidelines

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

5 Ordering Information

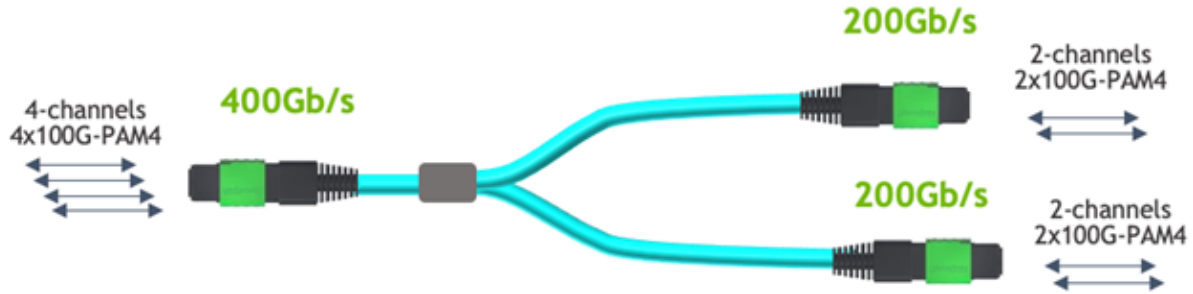
5.1 Part Numbers and Description

OPN	Description
MMA4Z00-NS400	NVIDIA single port Multimode SR4 transceiver, 400Gbps, NDR, OSFP, MPO12 APC, 850nm, up to 50m, flat top

6 Recommended NVIDIA Supplied Crossover Fiber Cables Part Numbers

Multimode, Straight Crossover Fibers

OPN	4-channel MPO/APC to 4-channel MPO/APC
MFP7E10-N003	3m
MFP7E10-N005	5m
MFP7E10-N007	7m
MFP7E10-N010	10m
MFP7E10-N015	15m
MFP7E10-N020	20m
MFP7E10-N030	30m
MFP7E10-N050	50m



Multimode, 1:2 Splitter Crossover Fibers

OPN	4-channel MPO/APC to Two 2-channel MPO/APC
MFP7E20-N003	3m
MFP7E20-N005	5m
MFP7E20-N007	7m
MFP7E20-N010	10m
MFP7E20-N015	15m
MFP7E20-N020	20m

OPN	4-channel MPO/APC to Two 2-channel MPO/APC
MFP7E20-N030	30m
MFP7E20-N050	50m

7 Document Revision History

Rev	Date	Description
1.7	May 2024	Corrected max power for 200G (2 channels) on front page to indicate 5.5W (was 6.5W) to match the number under Specifications section
1.6	Mar. 2024	Replaced mechanical drawings under Specifications section
1.5	Mar. 2024	Added DDMI note in the Specifications section.
1.4	Jan. 2024	Updated low power mode output.
1.3	Dec. 2023	Updated Regulatory Compliance section.
1.2	Aug. 2023	Updated maximum power consumption.
1.1	Apr. 2023	- Updated the document for Ethernet support. - Minor text edits.
1.0	Dec. 2022	Initial release.

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