



OPEN

Compute Project

Optical Transceiver

400G QSFP-DD SR8

OCP Immersion Active Optical Pigtail (iAOP)

Specification V0.1

Product Specification

Effective July 15th, 2025

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Compliance with OCP Tenants

Openness

By migrating the Immersion Active Optical Cable & Pigtail Specifications to the Open Compute foundation, they become open to all to review and implement. In addition, the broad membership of the OCP is able to contribute to the future development of the specification.

Efficiency

The purpose of the Immersion Active Optical Cable Specification is to drive commonality in implementations of iAOCs/iAOPs in order to reduce friction in adoption users. This directly reduces opex in the form of qualifications and firmware work to adapt to different iAOC/iAOP implementations.

Impact

Immersion Active Optical Cables or Pigtails have proven to be essential components of hyperscale and service provider networks in order to enable high speed, low cost, low power and highly reliable networks. Migrating this specification to OCP drives commonality in these implementations and a broader membership base to widen impact.

Scale

Multiple hyperscalers have deployed or are planning to deploy Active Optical Cables. Soon they will be deployed in immersion cooling.

Similarly to optical connectors in Air/DLC, the CMIS/DDMI monitoring functions ensure the Data Center Fabric is performing at its optimal.

Sustainability

Active Optical Cables & Pigtails ease fabric connection complexity. Immersion Active Optical Cables & Pigtails allows the fabric to function in immersion cooling, which lowers PUE of data centers for AI/ML/HPC.

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Scope and Overview

1.1 Scope

This document defines the technical specifications for the 400G QSFP-DD SR8 OCP Immersion Active Optical Pigtail (iAOP) used in large-scale data center applications.

1.2 Overview

The 400G QSFP-DD SR8 iAOP OCP optical specification is based on 400GBASE-SR8 as defined in IEEE 802.3 cm.

This optimization mainly considers the use of the product in an immersion environment. Considering the characteristics of liquid cooling oil and the operation mode of the cooling system, we have relaxed the temperature specifications of the product.

The temperature range will be relaxed from 0-70°C to RT-70°C. (Note, the RT value depends on dew point of the air).

While this specification is focused on 400G operation, the module shall be compliant to the IEEE 802.3 cm.

2 Common Terms

The following terms are used in this document

2.1 Parameter related

AOP - Average Optical Power

OMA - Optical Modulation Amplitude

TDECQ - Transmitter Dispersion Eye Closure Quaternary

ER - Extinction Ratio

SMSR - Side Mode Suppression Ratio

BER - Bit Error Rate

FEC - Forward Error Correction

PAM4 - 4-level Pulse Amplitude Modulation

Gbps - Gigabit per second

GBd - Gigabaud

2.2 Product related

iAOP - Immersion Active Optical Pigtail

iAOC - Immersion Active Optical Cable

AOC - Active Optical Cable

CT - Commercial Temperature

IT - Industrial Temperature

LPMode - Low Power Mode

I2C - Inter-Integrated Circuit

SR - Short reach

LR - Long reach

2.3 Fiber

MMF - Multi-Mode Fiber

SMF - Single-Mode Fiber

OM3 - Optical Multimode 3

PC - Physical Contact

APC - Angled Physical Contact

MPO - Multiple-Fiber Push-On

2.4 Standard

CWDM - Coarse Wavelength Division Multiplex

IEEE - Institute for Electrical and Electronics Engineers

MSA - Multi-Source Agreement

SFF - Small Form Factor

QSFP - Quad Small Form Factor Pluggable

QSFP112 - Quad Small Form Factor Pluggable Module 112

QSFP-DD - QSFP–Double Density

OSFP - Octal Small Form Factor Pluggable Module

OSFP-RHS - OSFP-Riding Heat Sink

CMIS - Common Management Interface Specification

3 Operating Conditions

Recommended Operating Conditions		
Parameters	Value	Unit
Case Operating Temperature	RT ~ 70 Note1	°C
Power Supply Voltage (Typical)	3.3	V
Power Consumption (Max)	10	W
Data Rate per Channel (Typical)	26.5625	GBd

Note1: RT (Room Temp) value depends on dew point of the air

4 Specifications

4.1 Electrical Transmitter Characteristic

Electrical Transmitter Characteristics		
Parameters	Value	Unit
Input differential impedance	90 ~ 110	Ohm
Differential data input swing	400 ~ 900	mV

4.2 Electrical Receiver Characteristic

Electrical Receiver Characteristics		
Parameters	Value	Unit
Differential data output swing (max)	900	mV
BER	2.4E-4	

4.3 Optical Transmitter Characteristic

Optical Transmitter Characteristics		
Parameters	Value	Unit
Center Wavelength (range)	840 ~ 860	nm
Spectral Width (max)	0.6	nm
Average Launch Optical Power, each lane	-6 ~ +4	dBm
Outer Optical Modulation Amplitude, each lane	-4 ~ +3	dBm
Launch power in OMA outer minus TDECQ (min)	-5.9	dBm
TDECQ (max)	4.9	dB
Average launch power of OFF transmitter, each lane (max)	-30	dBm
ER (min)	3	dB
Optical return loss tolerance (max)	12	dB

4.4 Optical Receiver Characteristics

Optical Receiver Characteristics		
Parameters	Value	Unit
Center Wavelength (range)	840 ~ 860	nm
Damage Threshold (min)	5	dBm
Average receiver power, each lane	-8.4 ~ +4	dBm
Receiver Power, each lane (max)	3	dBm
Receiver Reflectance (max)	-12	dB
Stressed receiver sensitivity, each lane (max)	-3.4	dBm
Receiver sensitivity (OMA outer), each lane (max)	RS = max (-6.5, SECQ -7.9)	dB

4.5 Optical Fiber Link Model

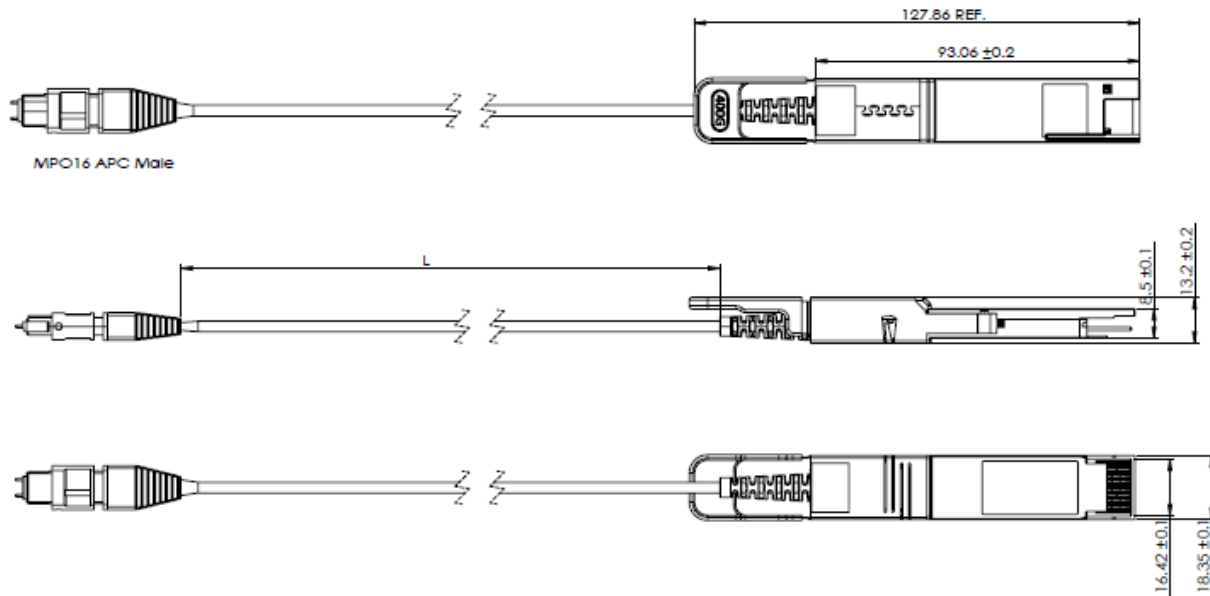
The reference optical fiber link model is based on MMF fiber. The distance. Refer to IEEE 802.3 cm.

Optical Fiber Link Model	
400GBase-SR8	0.5m to 70m for OM3
	0.5m to 100m for OM4

5 Form Factor

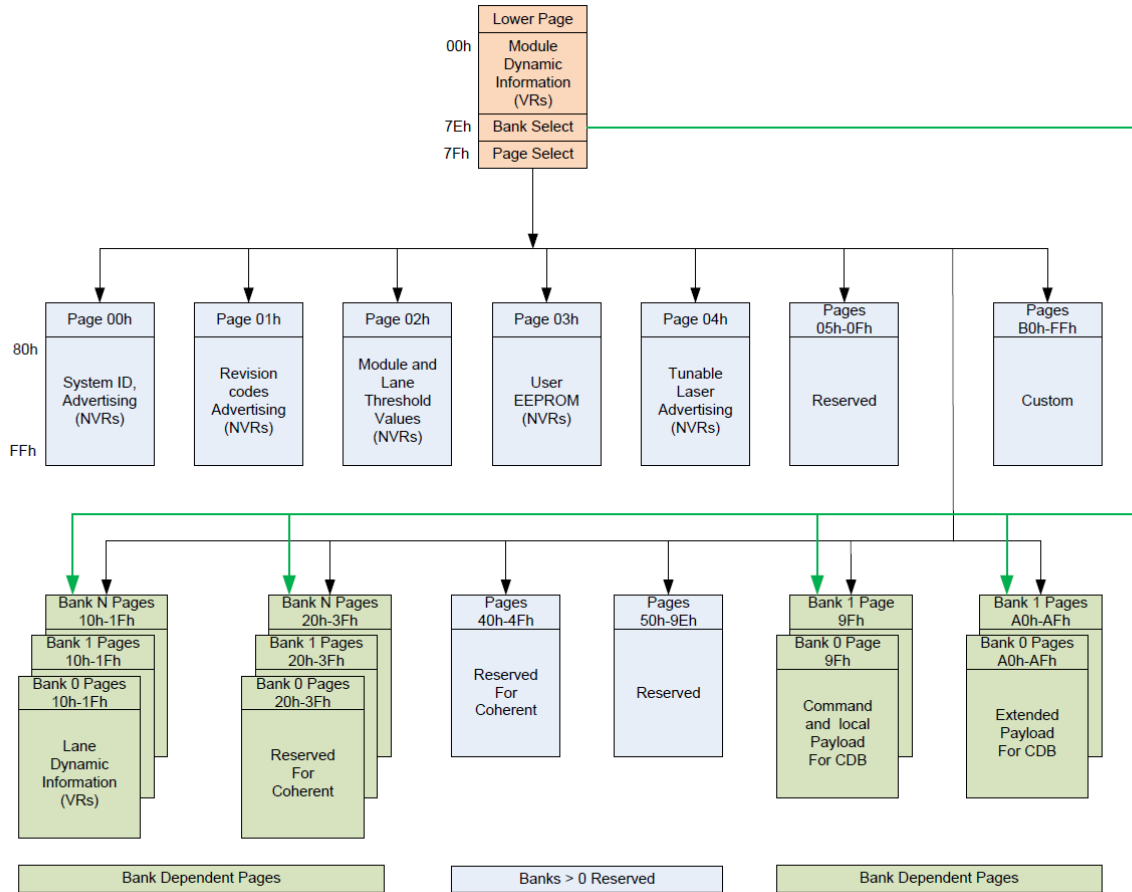
The QSFP-DD form factor described in QSFP-DD MSA will be used. This form factor is commonly referred to as QSFP-DD for 400G-SR8 applications.

5.1 Mechanical Drawing



6 Management Interface

The module is compliant to CMIS.



7 Immersion Cooling Requirements

Immersion products must be materially compatible with the immersion fluid and perform equal or better in the immersion fluid.

This involves utilizing the testing conditions specified in the OCP “Material Compatibility in Immersion Cooling” guideline (80°C, 0.8L, 336 hours) and adhering to the acceptance criteria to determine if the material is compatible (< 10% change in weight, length, diameter, etc. before and after test).

Only compatible materials should be used in immersion products.

8 Reference

The following documents are referenced in this specification:

- IEEE 802.3 cm
- CMIS
- QSFP-DD MSA
- OCP Material Compatibility in Immersion Cooling Rev 1.0
- OCP Immersion Requirements Rev 2.1

9 Revisions

Rev	Date	Description
0.1	July 15 th , 2025	Initial Release