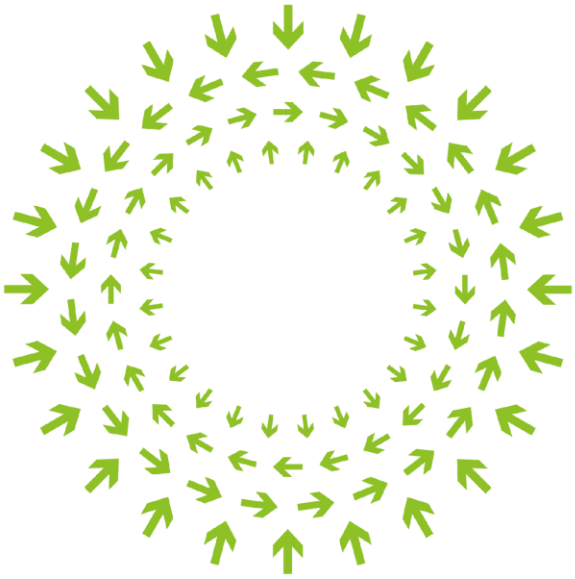


OPEN
Compute Project

Optical Transceiver

400G QSFP56-DD SR8 (Air) to 2x200G QSFP56 SR4 (Immersion)

OCP Immersion Active Optical Cable (iAOC)

Specification V0.1

Product Specification
Effective July 15th, 2025

Author: Eric Chen, FormericaOE

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 shall 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 QSFP56-DD SR8 (Air) to 2x200G QSFP56 SR4 (Immersion) OCP Immersion Active Optical Cable (iAOC) used in large-scale data center applications.

1.2 Overview

The 400G QSFP56-DD SR8 (Air) to 2x200G QSFP56 SR4 (Immersion) iAOC OCP optical specification is based on 400GBASE-SR8 as defined in IEEE 802.3 cd and IEEE 802.3 cm.

This optimization involves the adoption of coolant-compatible materials, preservation of optical path integrity, and validated thermal performance to ensure reliable operation in immersion liquid-cooling environments. Considering the characteristics of liquid cooling fluid and the operation mode of the cooling system, temperature specifications of the product have been relaxed. The temperature range shall 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 cd and 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	Air = 0 ~ 70	℃
	Immersion = RT ~ 70 Note1	
Power Supply Voltage (Typical)	3.3	V
Power Consumption (Max)	Air = 9	W
	Immersion = 5	
Data Rate per Channel (Typical)	26.5625	GBd

Note:1, RT (Room Temp) value depends on dew point of the air

4 Specifications

4.1 Electrical Transmitter Characteristic (Air side)

Parameter	Value	Unit
Input differential impedance	90~110	Ω
Differential data input swing(max)	880	mVpp

4.2 Electrical Receiver Characteristic (Air side)

Parameter	Value	Unit
Differential data output swing(max)	900	mVpp
Bit Error Rate(max)	2.4E-4	

4.3 Electrical Transmitter Characteristic (Immersion side)

Parameter	Value	Unit
Input differential impedance	90~110	Ω
Differential pk-pk input Voltage Tolerance (min)	900	mVpp

4.4 Electrical Receiver Characteristic (Immersion side)

Parameter	Value	Unit
Differential data output swing(max)	900	mVpp
Bit Error Rate Pre-FEC(max)	2.4E-4	

4.5 Optical Fiber Link Model

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

Optical Fiber Link Model	
400GBase-SR8	2m to 50m for OM3

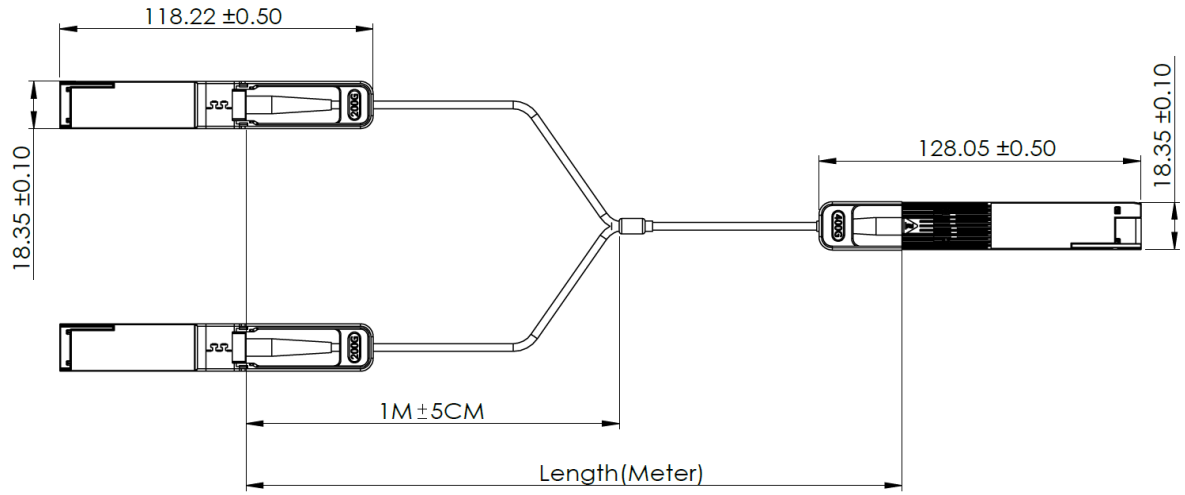
5 Form Factor

The QSFP56-DD and QSFP56 form factor described in QSFP-DD and QSFP MSA shall be used. This form factor is commonly referred to as QSFP-DD and QSFP MSA for 400G to 2x200G applications.

5.1 Mechanical Drawing

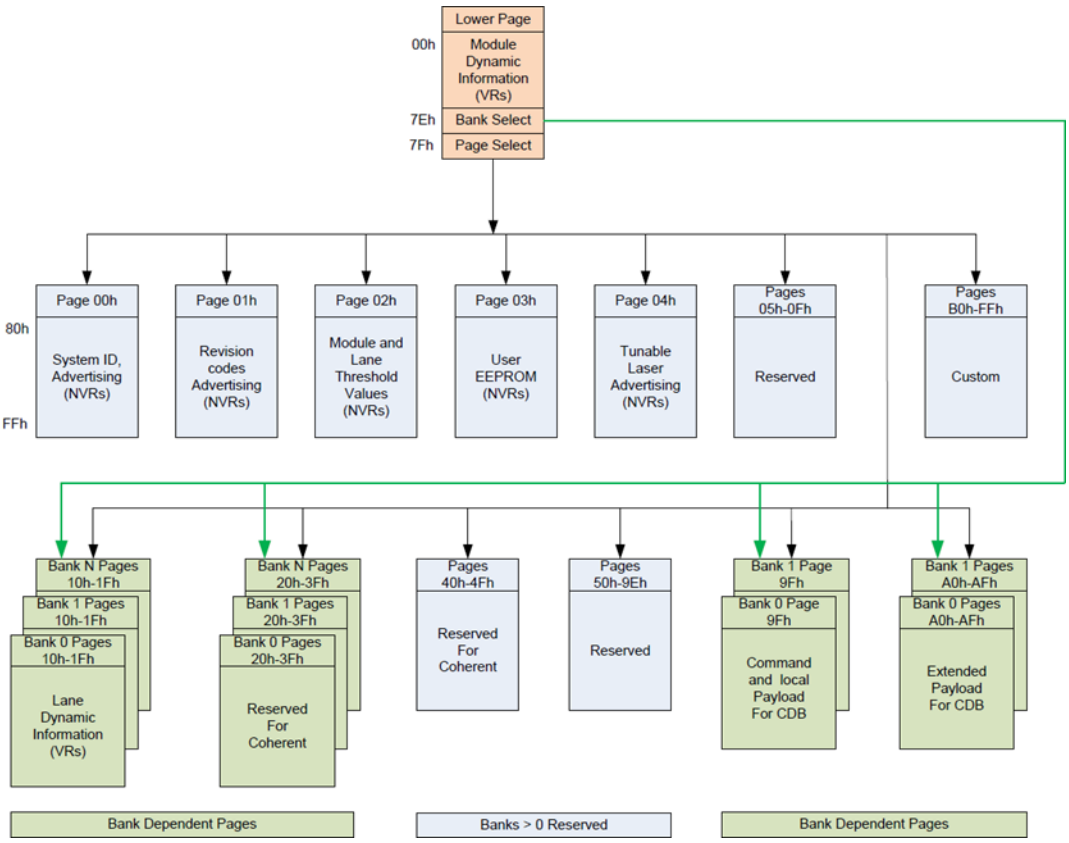
2x200G QSFP56 SR4 Flat Top (Immersion)

400G QSFPDD SR8 Flat Top/Type 2 (Air)



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 cd, IEEE 802.3 cm
CMIS
SFF-8665
SFF-8661
SFF-8662
SFF-8679
QSFP-DD MSA
QSFP MSA
OCP Material Compatibility in Immersion Cooling Rev 1.0
OCP Immersion Requirements Rev 2.1

9 Revisions

Rev	Date	Description
0.1	July 15th, 2025	Initial Release