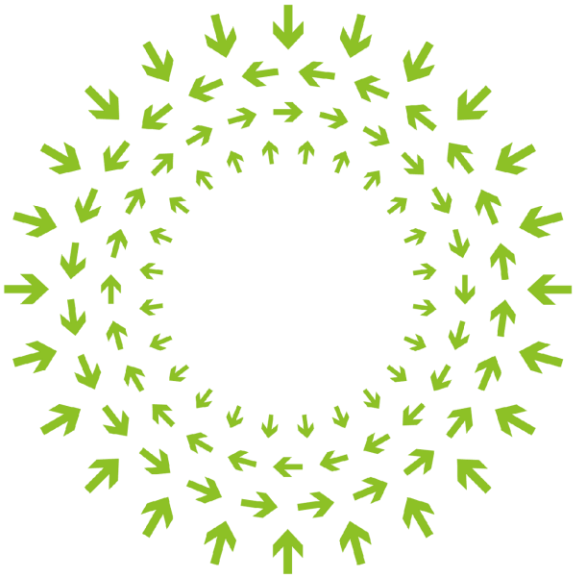


Optical Transceiver

400G OSFP112-RHS SR4

OCP Immersion Active Optical Pigtail (iAOP)

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 OSFP112-RHS SR4 OCP Immersion Active Optical Pigtail (iAOP) used in large-scale data center applications.

1.2 Overview

The 400G OSFP112-RHS SR4 iAOP OCP optical specification is based on 400GBASE-SR4 as defined in IEEE 802.3 db and IEEE 802.3 ck.

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 db and IEEE 802.3 ck.

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	℃
Power Supply Voltage (Typical)	3.3	V
Power Consumption (Max)	9	W
Data Rate per Channel (Typical)	53.125	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**
Differential pk-pk Input Voltage tolerance (min)	750	mV
Differential Termination Mismatch	10	%
Eye height (min)	10	mV
Common-mode to differential-mode return loss	IEEE 802.3 ck Equation (120G-1)	dB

4.2 Electrical Receiver Characteristic

Electrical Receiver Characteristics		
Parameters	**Value**	**Unit**
Pre FEC BER (max)	2.4E-4	
Post FEC BERT (max)	1E-12	
Differential data output swing	300 ~ 900	MVpp
Differential termination mismatch	10	%
Eye height (min)	15	mV
Vertical eye closure (max)	12	dB
Common-mode to differential-mode return loss	IEEE 802.3 ck Equation (120G-1)	

4.3 Optical Transmitter Characteristic

Optical Transmitter Characteristics		
Parameters	**Value**	**Unit**
Center Wavelength (range)	840 ~ 868	nm
RMS spectral width (max)	0.6	nm
Average Launch Optical Power, each lane	-1 ~ +4	dBm
Optical Power OMA, each lane (max)	3.5	dBm
TDECQ (max)	4.4	dB
ER (min)	2.5	dB

4.4 Optical Receiver Characteristics

Optical Receiver Characteristics		
Parameters	**Value**	**Unit**
Center Wavelength (range)	842 ~ 948	nm
Damage threshold (min)	5	dBm
Average receive power, each lane	-6.4 ~ +4.0	dBm
Receive power, each lane (OMA outer) (max)	3.5	dBm
Receiver reflectance (max)	-15	dB
Receiver sensitivity, each lane	RS = max (-4.6, TECQ -6.4)	dBm

4.5 Optical Fiber Link Model

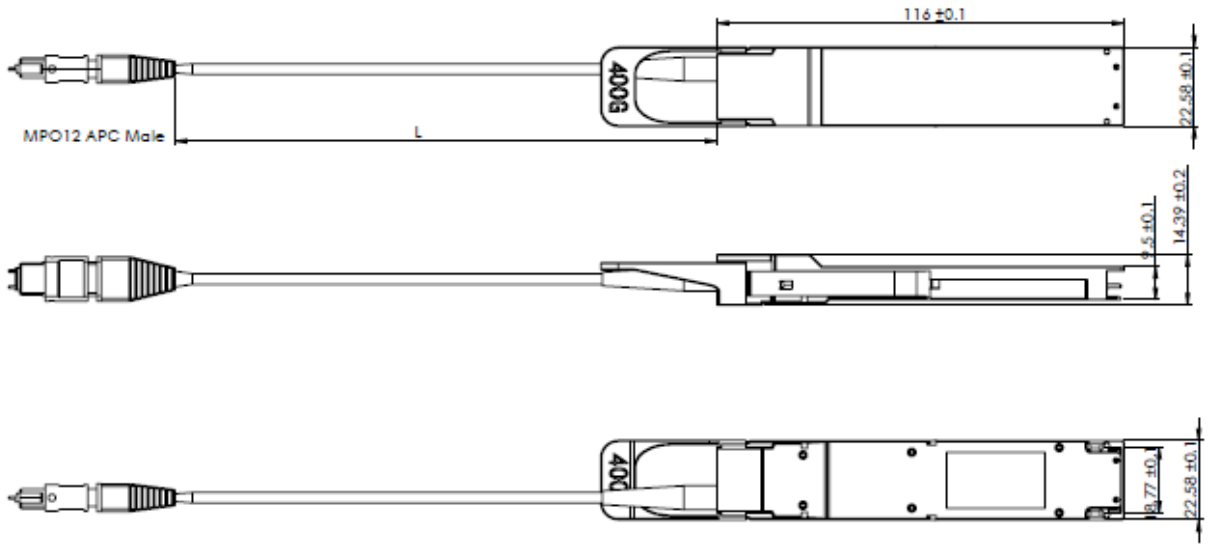
The reference optical fiber link model is based on MMF fiber. The distance. Refer to IEEE 802.3 db and IEEE 802.3 ck.

Optical Fiber Link Model	
400GBase-SR4	0.5m to 60m for OM3
	0.5m to 100m for OM4

5 Form Factor

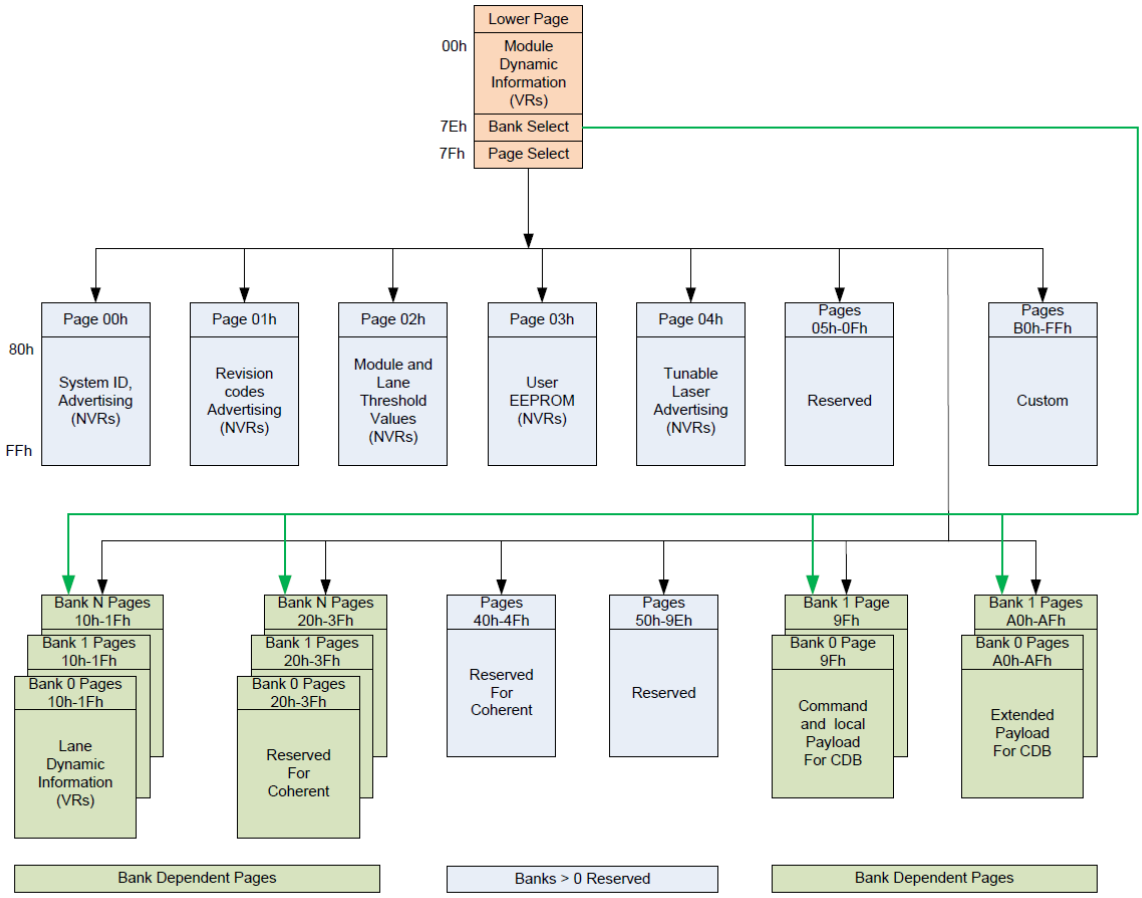
The OSFP112-RHS form factor described in OSFP MSA shall be used. This form factor is commonly referred to as OSFP MSA for 400G applications.

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:

CMIS
IEEE 802.3 db, IEEE 802.3 ck
OSFP 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