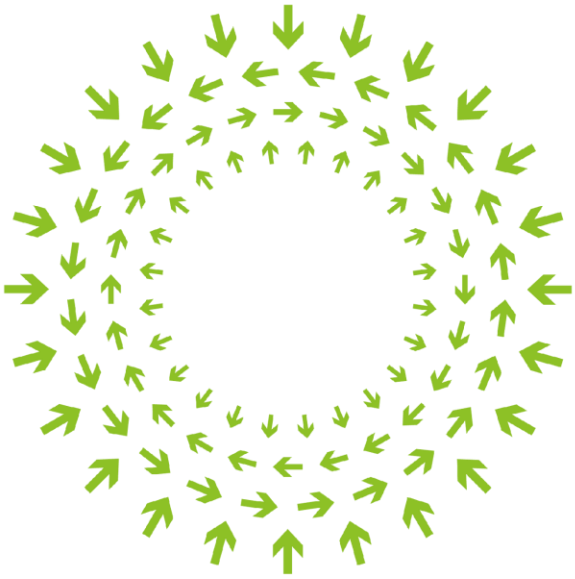


OPEN Compute Project

Optical Transceiver

100G QSFP28 DR1

OCP Immersion Active Optical Cable (iAOC)

Specification V0.1

Product Specification
Effective August 19th, 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.

Table of Contents

1 License 4
1.1 Scope 6
1.2 Overview 6
2 Common Terms 7
2.1 Parameter related 7
2.2 Product related 7
2.3 Fiber 8
2.4 Standard 8
3 Operating Conditions 9
4 Specifications 9
4.1 Electrical Transmitter Characteristic 9
4.2 Electrical Receiver Characteristic 10
4.3 High-Speed Signal 10
4.4 Optical Fiber Link Model 10
5 Form Factor 11
5.1 Mechanical Drawing 11
6 Management Interface 12
7 Immersion Cooling Requirements 13
8 Reference 13
9 Revisions 14

1 License

THE UPDATED DEFAULT CONTRIBUTOR LICENSE AGREEMENT (CLA) IS **OWFa 0.9**. PLEASE VERIFY THE CORRECT CLA/FSA IS USED AND EXECUTED FOR THIS CONTRIBUTION.

1.1. Open Web Foundation (OWF) CLA

Contributions to this Specification are made under the terms and conditions set forth in **Modified Open Web Foundation Agreement 0.9 (OWFa 0.9)**. (As of October 16, 2024) ("Contribution License") by:

Formerica Optoelectronics Inc

Usage of this Specification is governed by the terms and conditions set forth in **Modified OWFa 0.9 Final Specification Agreement (FSA)** (As of October 16, 2024) **("Specification License").**

You can review the applicable Specification License(s) referenced above by the contributors to this Specification on the OCP website at https://www.opencompute.org/contributions/templates-agreements.

For actual executed copies of either agreement, please contact OCP directly.

Notes:

The above license does not apply to the Appendix or Appendices. The information in the Appendix or Appendices is for reference only and non-normative in nature.

NOTWITHSTANDING THE FOREGOING LICENSES, THIS SPECIFICATION IS PROVIDED BY OCP "AS IS" AND OCP EXPRESSLY DISCLAIMS ANY WARRANTIES (EXPRESS, IMPLIED, OR OTHERWISE), INCLUDING IMPLIED WARRANTIES OF MERCHANTABILITY, NON-INFRINGEMENT, FITNESS FOR A PARTICULAR PURPOSE, OR TITLE, RELATED TO THE SPECIFICATION. NOTICE IS HEREBY GIVEN, THAT OTHER RIGHTS NOT GRANTED AS SET FORTH ABOVE, INCLUDING WITHOUT LIMITATION, RIGHTS OF THIRD PARTIES WHO DID NOT EXECUTE THE ABOVE LICENSES, MAY BE IMPLICATED BY THE IMPLEMENTATION OF OR COMPLIANCE WITH THIS SPECIFICATION. OCP IS NOT RESPONSIBLE FOR IDENTIFYING RIGHTS FOR WHICH A LICENSE MAY BE REQUIRED IN ORDER TO IMPLEMENT THIS SPECIFICATION. THE ENTIRE RISK AS TO IMPLEMENTING OR OTHERWISE USING THE SPECIFICATION IS ASSUMED BY YOU. IN NO EVENT WILL OCP BE LIABLE TO YOU FOR ANY MONETARY DAMAGES WITH RESPECT TO ANY CLAIMS RELATED TO, OR ARISING OUT OF YOUR USE OF THIS SPECIFICATION, INCLUDING BUT NOT LIMITED TO ANY LIABILITY FOR LOST PROFITS OR ANY CONSEQUENTIAL,

INCIDENTAL, INDIRECT, SPECIAL OR PUNITIVE DAMAGES OF ANY CHARACTER FROM ANY CAUSES OF ACTION OF ANY KIND WITH RESPECT TO THIS SPECIFICATION, WHETHER BASED ON BREACH OF CONTRACT, TORT (INCLUDING NEGLIGENCE), OR OTHERWISE, AND EVEN IF OCP HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGE.

Scope and Overview

1.1 Scope

This document defines the technical specifications for the 100G QSFP28 DR1 iAOC, optical transceivers used in large-scale data center applications.

1.2 Overview

The 100G QSFP28 DR1 iAOC OCP optical specification is based on 100GBASE as defined in IEEE 802.3 cd.

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 100G operation, the module shall be compliant to the IEEE 802.3 cd.

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)	4.5	W
Data Rate per Channel (Typical)	26.5625 +/- 100ppm	Gb/s

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 (Typical)	100	Ohm
Differential Data Input Amplitude	80~900	mVpp
Differential termination mismatch (Max)	10	%
DC common-mode input voltage	-0.3~2.8	V
Transition time (20%~80%) (Min)	10	ps
LPMode, Reset and ModSelL / Tx dis	-0.3~0.8	V
LPMode, Reset and ModSelL / Tx dis	2.0~VCC+0.3	V

4.2 Electrical Receiver Characteristic

Electrical Receiver Characteristics		
Parameters	**Value**	**Unit**
Output Differential Impedance (Typical)	100	Ohm
Differential Data Output Amplitude (Max)	900	mVpp
Differential termination mismatch (max)	10	%
Transition time, 20% to 80% (Min)	12	ps
ModPrsL and IntL/ Rx los	0~0.4	V
ModPrsL and IntL/ Rx los	VCC-0.5~VCC+0.3	V

4.3 High-Speed Signal

Compliant to CAUI-4 (IEEE 802.3 cd)

4.4 Optical Fiber Link Model

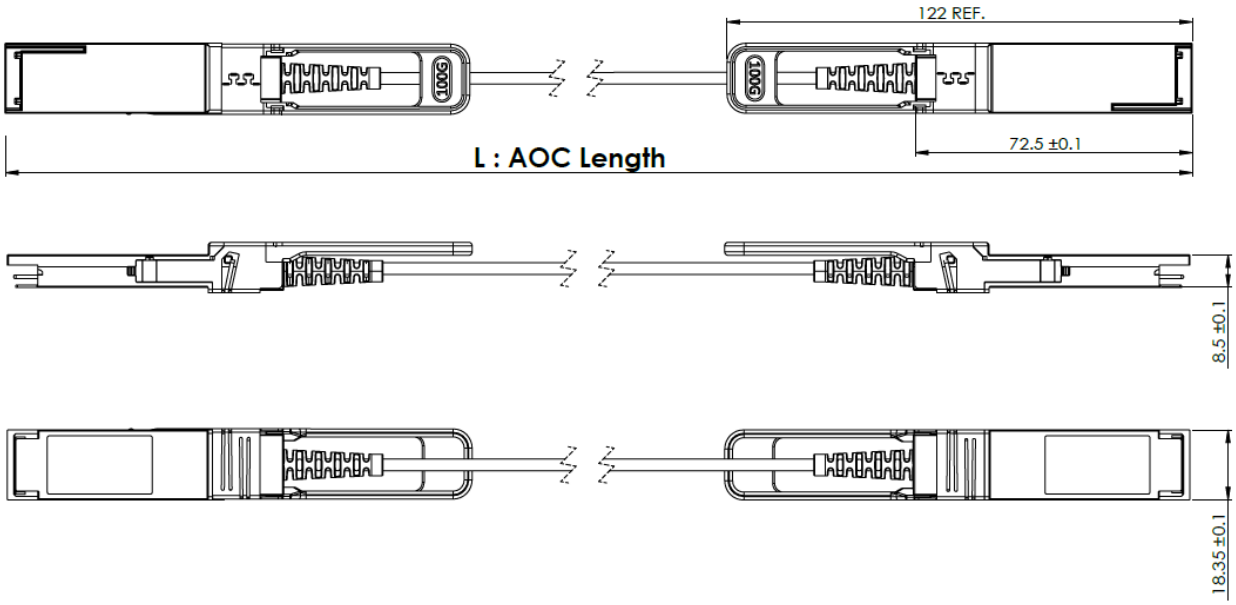
The reference optical fiber link model is based on SMF fiber. The distance. Refer to IEEE 802.3 cd.

Optical Fiber Link Model	
100GBase-DR1	Length 0.5m~500m for SMF

5 Form Factor

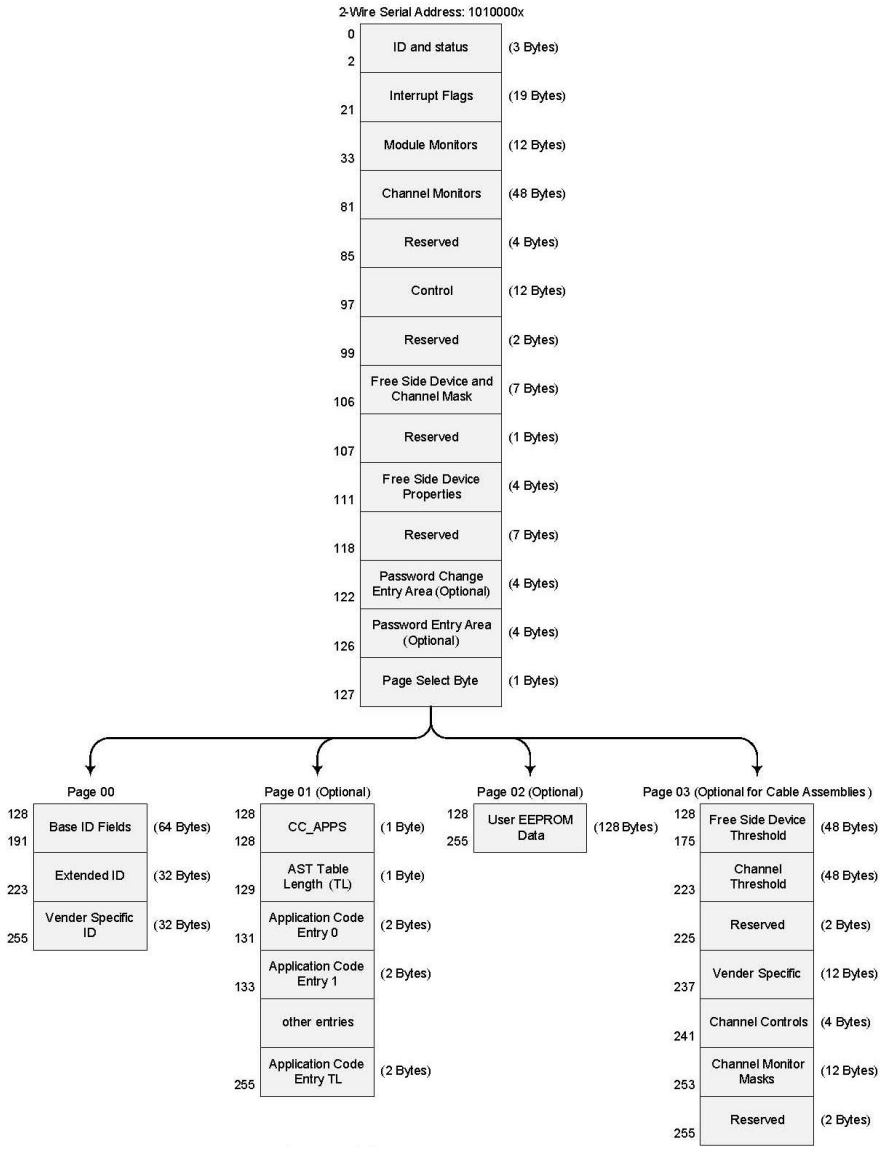
The QSFP28 form factor described in SFF-8636 shall be used. This form factor is commonly referred to as QSFP28 for 100G applications.

5.1 Mechanical Drawing



6 Management Interface

The module is compliant to SFF-8636.



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
SFF-8636
SFF-8665
SFF-8661
SFF-8662
SFF-8679
OCP Material Compatibility in Immersion Cooling Rev 1.0
OCP Immersion Requirements Rev 2.1

9 Revisions

Rev	Date	Description
0.1	August 19th, 2025	Initial Release