

Silicon Photonics

200Gbps QSFP56 FR4

Optical Transceiver

Data Sheet

Intel Confidential



Important Note: All specifications, technical data, and other information contained in this document are preliminary in nature. All information is subject to change.
Please contact Intel for more information



Contents

1. Features	4
2. Applications.....	4
3. Absolute Maximum Ratings	5
4. Recommended Operating Conditions	5
5. Optical Transmitter	6
5.1. Optical Transmitter Input Electrical Specifications	6
5.2. Optical Transmitter Output Optical Specifications.....	7
6. Optical Receiver	8
6.1. Optical Receiver Input Optical Specifications	8
6.2. Optical Receiver Output Electrical Specifications	9
7. Electrical Connector Pin Assignment	10
8. Power Supply Provisioning.....	12
8.1. Power Supply Filtering.....	12
8.2. Power Supply Sequencing.....	13
9. Control and Monitoring Interface.....	13
9.1. Low Speed Electrical Hardware Interface	13
9.1.1. ResetL.....	13
9.1.2. ModPrsL	13
9.1.3. IntL.....	13
9.1.4. ModSelL.....	14
9.1.5. LPMode.....	14
9.1.6. SCL.....	14
9.1.7. SDA.....	14
9.2. Management Interface	15
9.2.1. General Functionality.....	15
9.2.2. Timing Requirements for Control and Status	15
9.2.3. Monitor Accuracy.....	16



Datasheet – 200 Gbps QSFP56 FR4 Optical Transceiver

Intel® Silicon Photonics

10.	Mechanical Specifications	16
11.	Regulatory and Compliance.....	17
12.	Part Number Ordering Information	19
13.	Revision History	19



General Description

The Intel® Silicon Photonics 200 Gbps QSFP56 FR4 Optical Transceiver is a small form-factor, high speed, and low power consumption product targeted for use in optical interconnects for data communications applications. The high bandwidth module supports 100G/200G Ethernet connection over single mode fiber links up to 3km.

1. Features

- Compliant to FR4 MSA optical interface specification with range of 3km
- Electrical interface compliant with IEEE 802.3bs 200GAUI-4 (CAUI-4) standard
- Compatibility with SMF connectors and cable infrastructures
- Compact QSFP-56 form factor for high faceplate density in network equipment
- Power dissipation of 6.5W maximum
- Operating temperature range: 15 to 65°C
- CMIS-compliant management interface with full module diagnostics and control through I²C.

2. Applications

- 200GbE Connectivity for large-scale cloud and enterprise data centers
- Ethernet switch, router, and client-side telecom interfaces



3. Absolute Maximum Ratings

Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Temperature	Ts	-40	85	°C	
Case Temperature (Powered)	Tc	15	65	°C	
Relative Humidity	RH	5	85	%	non-condensing
Power Supplies	V _{CC}	-0.3	3.6	V	
ESD (HBM)	V _{ESD}	-1k	1k	V	
Receiver Damage Threshold	P _{max_rx}		5.7	dBm	

4. Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Operating Case Temperature	Tc	15		65	°C	
Power Supply Voltage	V _{CC}	3.135	3.3	3.465	V	
Power Supply consumption (200G Mode)	P			6.5	W	
Power Supply consumption (100G Mode)	P			6.0	W	
Power consumption, low power mode	P _{LP}			1.5	W	
Steady state current	I _{cc}			2.0	A	
In-rush, instantaneous peak current	I _{peak}			2.6	A	
In-rush current, dI/dt	I _{Inrush}			200	mA/us	
Relative humidity	RH	5		85		
Module power supply noise tolerance, peak to peak	PSNR			66	mV	
Bit Rate	BR	53.12	53.125	53.13	Gbps	



5. Optical Transmitter

200G FR4 optical transceiver electric interface is based on IEEE 802.3 200G GAUI-4 host to module retimed interface. The 200G FR4 Optical transmitter is compliant with IEEE 802.3bs 200GBASE-FR4 specification based on duplex SMF with optical ach of 3km.

5.1. Optical Transmitter Input Electrical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Data Modulation Type		PAM4				
Signaling Rate		53.119	53.125	53.130	Gbs	
Signaling Rate		26.559	26.562	26.565	Gbd	
Input DC Common Mode Voltage	Vin(cm)	-0.35	-	+2.85	V	
Differential termination mismatch		-	-	10	%	
Differential input return loss		Minimum per IEEE802.3bm Annex 83E.				
Different to common mode input return loss		Minimum per IEEE802.3bm Annex 83E.				



5.2. Optical Transmitter Output Optical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit
Signaling Rate, each lane (range)		26.5625			Gbd
		+/-100ppm			
Lane wavelength range		1265.25 to 1276.75 1271 center wavelength			nm
		1285.25 to 1296.75 1291 center wavelength			
		1305.25 to 1316.75 1311 center wavelength			
		1325.25 to 1336.75 1331 center wavelength			
Single-Mode Suppression Ratio	SMSR	30			dB
Total Ave Launch Power	AOP_total			10.7	dBm
Average Optical Output Power, each lane ¹	AOP	-5.2		4.7	dBm
Outer Optical Modulation Amplitude, each lane	OMAouter	-2.2		4.5	dBm
Difference in launch power between any two lanes (OMAouter)	dOMAouter			4	dB
Transmitter dispersion and eye closure penalty, each lane	TDECQ			3.3	dB
Launch power in OMA minus TDECQ each lane ²	OMAouter-TDECQ	-3.5			dBm
Extinction Ratio	ER	3.5			dB
Average Launch Power of OFF Transmitter, each lane	Toff			-30	dBm
Transmitter Reflectance ⁵	Tx_Ref			-26	dB
RIN20 OMA ⁴	RIN			-132	dB/Hz
Optical Return Loss Tolerance	ORLT			17.1	dB
Rise and Fall Time ³	Tr/Tf			24	ps
Operating link reach		3		3000	m

¹Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

²Even if the TDECQ < 1.4 dB for an extinction ratio of ≥ 4.5 dB or TDECQ < 1.3 dB for an extinction ratio of < 4.5 dB, the OMAouter must exceed this value.

³Between 20% and 80%.

⁴RIN on OMA measured with 17.1dB return loss.

⁵Transmitter reflectance is defined looking into the transmitter.

6. Optical Receiver

6.1. Optical Receiver Input Optical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit
Signaling Rate, each lane (range)		26.5625			Gbd
		+/-100ppm			
Lane Wavelengths range		1265.25 to 1276.75 1271 center wavelength			nm
		1285.25 to 1296.75 1291 center wavelength			nm
		1305.25 to 1316.75 1311 center wavelength			nm
		1325.25 to 1336.75 1331 center wavelength			nm
Bit Error Rate Floor ⁴	BER_FL	3.4e-6			
Average Receive Power, each lane ¹	AOP	-9.2		4.7	dBm
Difference in receive power between any two lanes (OMA _{outer})	dOMA _{outer}			4.1	dB
Outer optical modulation amplitude, each lane	OMA _{outer}	-7		4.5	dBm
Stressed Receiver Sensitivity (OMA _{outer}), each lane ³	SRS			-4.6	dBm
Loss of signal assert, AOP on each lane	LOS_A	-16	-13	-10.0	dBm
Loss of signal hysteresis	LOS_H	1	2	3	dB
Stressed eye closure for PAM4 (SECQ), lane under test		3.3			dB
OMA _{outer} of each aggressor lane		0.5			dBm

¹Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

²Receiver sensitivity (OMA_{outer}), each lane is informative and is defined for a transmitter with SECQ of 0.9 dB.

³Measured with conformance test signal at TP3 for the BER = 2.4E-4. The stressed conditions are: a). Stressed eye closure for PAM4 (SECQ), lane under test = 3.3 and b). OMA_{outer} of each aggressor lane = 0.5

⁴Measured with a reference transmitter to produce SECQ greater than or equal to 2dB. The BER at receiver must stay within the specified limit over an OMA range of -5.9dBm to 4.5dBm



6.2. Optical Receiver Output Electrical Specifications

Parameter	Symbol	Min.	Typ.	Max.	Unit
Data modulation Type		PAM4			
Signaling Rate	BR	53.119	53.125	53.130	Gbs
Signaling Rate	BR	26.559	26.562	26.565	Gbd
DC Common Mode Voltage	V_{out_AC-CM}	-350	-	2850	mV
AC Common Mode Voltage	V_{out_DC-CM}	-	-	17.5	mV (rms)
Differential Peak-to-peak output voltage	V_{out_pp}			900	mV _{pp}
Near-end ESMW (eye symmetry mask width)	$ESMW_{near}$	0.265			UI
Near-end eye height differential	EH_{near}	70	-	-	mV
Far-end ESMW (eye symmetry mask width)	$ESMW_{far}$	0.2			UI
Far-end eye height differential	EH_{far}	30	-	-	mV
Far-end pre-cursor ISI ratio		-4.5	-	2.5	%
Differential output return loss	SDD22	Minimum per IEEE802.3bm Annex 83E.			
Common to differential mode conversion return loss	SDC22	Minimum per IEEE802.3bm Annex 83E.			
Differential termination mismatch			-	10	%
Transition time (20-80%)	T_{rf}	24	-	-	ps

7. Electrical Connector Pin Assignment

The optical transceiver pinout for QSFP56 200G FR4 is the same as QSFP28 and is compliant with SFF-8679 specifications. Figure 1 below shows the module connector pad layout, and Table 7 below lists and describes all of the electrical pins of the module.

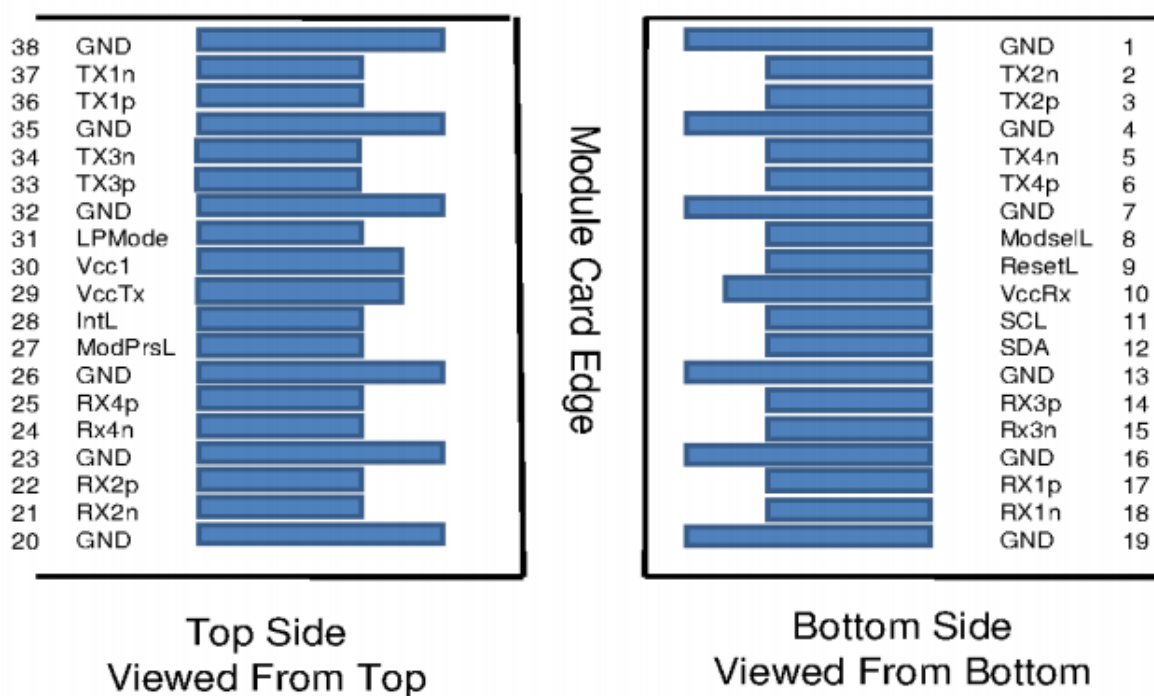


Figure 1: Pin Connectors

Datasheet – 200 Gbps QSFP56 FR4 Optical Transceiver

Intel® Silicon Photonics



Pin	Logic	Signal	Description
1		GND	Ground
2	CML-I	Tx2n	Transmitter Inverted Data Input
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input
4		GND	Ground
5	CML-I	Tx4n	Transmitter Inverted Data Input
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input
7		GND	Not connected, leaving floating
8	LVTTL-I	ModSelL	Module Select
9	LVTTL-I	ResetL	Module Reset
10		Vcc Rx	+3.3V Power supply, receiver
11	LVC MOS-I/O	SCL	2-wire serial interface clock
12	LVC MOS-I/O	SDA	2-wire serial interface data
13		GND	Ground
14	CML-O	Rx3p	Receiver Non-Inverted Data Output
15	CML-O	Rx3n	Receiver Inverted Data Output
16		GND	Ground
17	CML-O	Rx1p	Receiver Non-Inverted Data Output
18	CML-O	Rx1n	Receiver Inverted Data Output
19		GND	Ground
20		GND	Ground
21	CML-O	Rx2n	Receiver Inverted Data Output
22	CML-O	Rx2p	Receiver Non-Inverted Data Output
23		GND	Ground
24	CML-O	Rx4n	Receiver Inverted Data Output
25	CML-O	Rx4p	Receiver Non-Inverted Data Output
26		GND	Ground
27	LVTTL-O	ModPrsL	Module Present
28	LVTTL-O	IntL	Interrupt
29		Vcc Tx	+3.3V Power supply, transmitter
30		Vcc1	+3.3V Power supply
31	LVTTL-I	LPMode	Low Power Mode
32		GND	Ground
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input
34	CML-I	Tx3n	Transmitter Inverted Data Input
35		GND	Ground
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input
37	CML-I	Tx1n	Transmitter Inverted Data Input

38		GND	Ground
----	--	-----	--------

Table 1: Pin Definitions for Electrical Connectors

8. Power Supply Provisioning

The maximum and typical power supply specifications are described in tables 4 and Table 5 respectively. Here we describe the power supply filtering requirements and the power supply sequencing requirements.

8.1. Power Supply Filtering

The power supply filtering requirements for the 200 Gbps QSFP56 FR4 Optical Transceiver have been designed to be consistent with those required for QSFP modules. A representative power supply filtering circuit is shown below in Figure 2.

One filtering circuit is recommended for each power supply rail.

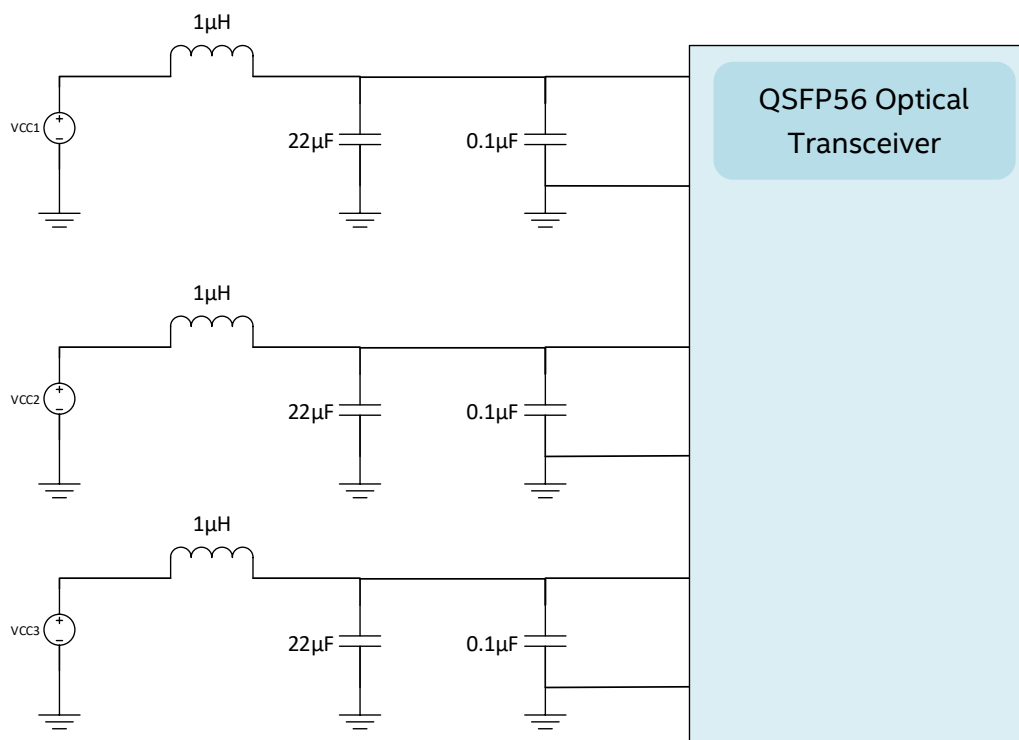


Figure 2 : Recommended Power Supply Filtering Circuit

8.2. Power Supply Sequencing

No power supply sequencing is required.

9. Control and Monitoring Interface

The 200 Gbps QSFP56 FR4 Optical Transceiver supports a full Hardware Pins support a full FR4 compliant set of control, alarm, and monitoring features through a standard I²C management interface as well as low speed control pins which support additional module control and interrupt features.

9.1. Low Speed Electrical Hardware Interface

In addition to the I²C interface described below in Section 9.2, the optical transceiver also supports low speed control pins which provide immediate easy access to key module functions and provide additional user interface signals to support the management interface.

9.1.1. ResetL

ResetL (LVTTTL-I signal) is an input pin. The ResetL pin has a weak pull-up to Vcc. A low level on the ResetL pin for longer than the minimum pulse length ($t_{\text{Reset_init}} > 2\mu\text{s}$) initiates a complete module reset and returns all user module settings to their default state. Module Reset Assert Time (t_{init}) starts on the rising edge after the “Low” level signal on the ResetL pin is released.

9.1.2. ModPrsL

ModPrsL (LVTTTL-O signal) is pulled up to Vcc on the host board and grounded in the module. The ModPrsL pin is asserted “Low” when inserted and de-asserted “High” when the module is physically absent from the host connector.

9.1.3. IntL

IntL (LVTTTL-O signal) is an output signal. When IntL is asserted “Low”, it indicates a possible module operational fault, LOS condition or a status critical to the host system. The host identifies the source of the interrupt using the 2-wire serial interface.



9.1.4. ModSelL

The ModSelL (LVTTL-I signal) is an input pin. When held low by the host, the module responds to 2-wire serial communication commands, otherwise it does not. The ModSelL signal has weak pull-up on module connected to Vcc.

9.1.5. LPMode

LPMode (LVTTL-I signal) is an input signal. When LPMode is set “Low”, the module will boot into its standard default state. When LPMode is set “High”, the module will boot into ‘low power mode’ and only the management interface is active (high-speed TX and RX are shut down). The LPMode signal has a weak pull-up on the module connected to Vcc.

9.1.6. SCL

The SCL pin (LVCMOS-I/O open-drain signal) is the 2-wire serial interface clock for the module. The SCL signal requires a pull-up resistor on the host board, $\leq 3\text{ k}\Omega$ is recommended. Note that SCL and SDA timing specifications are defined in section 10.2.3, Management interface timing.

9.1.7. SDA

The SDA pin (LVCMOS-I/O open-drain signal) is the 2-wire serial interface data for the module. The SDA signal requires a pull-up resistor on the host board, $\leq 3\text{ k}\Omega$ is recommended. Note that SCL and SDA timing specifications are defined in section 10.2.3, Management interface timing.



9.2. Management Interface

9.2.1. General Functionality

An I²C interface shall be used for management interface between the optical transceiver and the respective host systems. The communication protocol shall follow the industry standard and parameters specified by Facebook's QSFP-56 CMIS requirements. Timing specification for control and status follows SFF-8679 and in addition to these timing requirements are as listed below in reference to QSFP-DD Hardware Specification.

9.2.2. Timing Requirements for Control and Status

Parameter	Symbol	Min	Max	Units
MgmtInit	t_init		2000	ms
Reset Init assert time	t_reset_init	12		us
Serial bus hardware ready time	t_serial		2000	ms
Monitor data ready time	t_data		2000	ms
Reset assert time	t_reset		3000	ms
LPMODE assert time	ton_LPMODE		15	ms
LPMODE de-assert time	toff_LPMODE		3000	ms
IntL assert time	ton_IntL		200	ms
IntL de-assert time	toff_IntL		7	ms
Rx LOS assert time	ton_LOS		100	ms
Tx fault assert time	ton_flag		200	ms
Flag assert time	toff_flag		200	ms
Mask assert time	ton_mask		100	ms
Mask de-assert time	toff_mask		100	ms
Application or rate select change time	t_ratesel		2000	ms
Power_override or power_set assert time	ton_Pdown		3000	ms
Power_override or power_set deassert time	toff_Pdown		2000	ms
Rx squelch assert time	ton_Rxsq		100	ms
Rx squelch de-assert time	toff_Rxsq		4000	ms
Tx squelch assert time	ton_Txsq		400	ms
Tx squelch de-assert time	toff_Txsq		2000	ms
Tx disable assert time	ton_txdis		3000	ms
Tx disable de-assert time	toff_txdis		400	ms

Rx output disable assert time	ton_rxdis		100	ms
Rx output disable de-assert time	toff_rxdis		100	ms
Squelch disable assert time	ton_sqdis		100	ms
Squelch disable de-assert time	toff_sqdis		100	ms

9.2.3. Monitor Accuracy

The analog monitors have an accuracy of:

Monitor	Accuracy
RX input power	+/- 2 dB
TX output power	+/- 2 dB
TX bias current	+/- 10%
Module temperature	+/- 3C
Module supply voltages	+/- 100mV

10. Mechanical Specifications

The module is compliant SFF-8661 specification. The module optical connector is a dual LC/UPC receptacle.

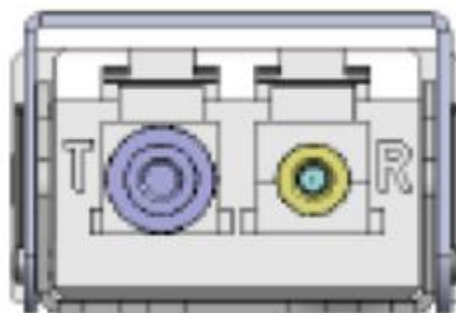


Figure 3 : QSFP56 Optical Receptacle and channel orientation for dual LC/UPC connector



11. Regulatory and Compliance

The Optical Transceiver will be compliant with the following regulations.

EMC-Immunity	• EN 55024 (EU) • IEC EN 61000-4-3 (International) • EMC Directive 89/336/EEC • IEC /CISPR/24
EMC - Emission	• CISPR 22, class B (Comité International Spécial des Perturbations Radioélectriques--CISPR; Special international committee on radio interference. International). • AS/NZS CISPR22 (Australia/New Zealand) • VCCI-03 (Japan) • FCC 47 CFR Part 15, class B (US) • ICES-003, Issue 4 (Canada) • EN 55022 (EU) • EMC Directive 2004/108/EEC (EU)
ESD Threshold	• Per MIL-STD 883C Method 3015.4 or ANSI/ESDA/JEDEC JS-001-2012 (component level). • IEC EN 61000-4-2; +/- 8kV contact, +/- 15kV air.
Product Safety	• UL Recognized Component: UL 60950-1 (2nd Ed.) Information Technology Equipment; CAN/CSA-C22.2 No. 60950-1 (2007) Information Technology Equipment; UL94-V0 flammability. • TUV Bauart Certificate: EN 60950-1 (2006+ A12:2012) Information Technology Equipment. • CB Certificate: IEC 60950-1 (2005 +A1:2009) Information Technology Equipment.
Fire Safety	• PCB material must be fully compliant to UL796; Temperature class B (IEC 60085); flammability class V-0- UL94). • Cables and connectors must have a flammability ratings of V0- UL94; Service temp.≥90 C. • Label materials must have a flammability ratings of V0- UL94; Service temp.≥90 C. • Optical fibers must have a flammability ratings of V0- UL94; Service temp.≥85 C.



Datasheet – 200 Gbps QSFP56 FR4 Optical Transceiver

Intel® Silicon Photonics

Optical Safety	• FDA/CDRH certified with accession number, Class 1 laser product: ○ U.S. 21 CFR 1040; ○ UL mark • TUV Certificate: ○ EN 60825-1 (2007) Safety of Laser Products ○ IEC 60825-1
RoHS	• 2002/95/EC and the revised and recast Directive 2011/65/EC (RoHS) Restriction on Hazardous Substances. • 2006/1907/EC (REACH) Registration, Evaluation, Authorization of Chemicals. • JIG 101-A, JIG 101-B Joint Industry Guide Japanese Material Composition Declaration. • CAITEC SJ/T 11363-2006 Requirements for Concentration Limits for Certain Hazardous Substances in Electronic Information Products (China RoHS)Complies with RoHS II Directive 2011/65/EU.



12. Part Number Ordering Information

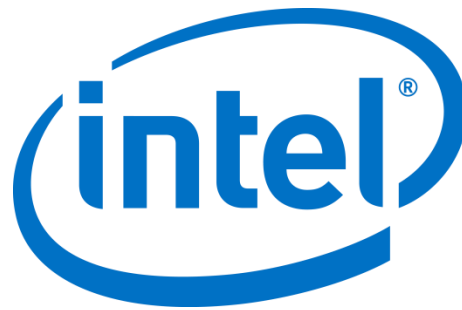
Part Number	Description
SPTSMP3CLCXX	200 Gbps QSFP56 FR4 Optical Transceiver, LC receptacle connector, 15-65°C operation, 3km

Table 2: Part Numbers and Descriptions

13. Revision History

Revision No.	Change Description	Date
1.0	New release	July 2021

Table 3: Specification Revisions



For more information on this or other Intel® Silicon Photonics Technology products:
Contact Intel® at www.intel.com

*Other names and brands may be claimed as the property of others.

This datasheet, including pictures and drawings, contains information about a new product. The information contained herein is given to describe certain components and shall not be considered as a guarantee of characteristics. Intel reserves the right to change the design of the product or specifications at any time without notice. The material is provided as is and without any warranties, including but not limited to warranties of non-infringement, description and fitness for a particular purpose.