

OP-QSFP-DD-LR4

400G QSFP-DD LR4 Optical Transceiver

This product is a 400Gb/s QSFP-DD optical module designed for 10km optical communication applications. The module converts 8 channels of 50Gb/s (PAM4) electrical input data to 4 channels of CWDM optical signals and multiplexes them into a single channel for 400Gb/s optical transmission.

On the receiver side, the module optically de-multiplexes a 400Gb/s optical input into 4 channels of CWDM optical signals and converts them to 8 channels of 50Gb/s (PAM4) electrical output data.

The central wavelengths of the 4 CWDM channels are 1271, 1291, 1311 and 1331 nm. Host FEC is required to support up to 10km fiber transmission.



Applications

- 400G BASE-LR4 Ethernet
- Data Center Interconnect
- Infiniband Interconnect
- Enterprise Networking

Features

- Compliant to QSFP-DD MSA
- 4 CWDM lanes MUX/DEMUX design
- 100G Lambda MSA 400G-LR4 Specification compliant
- Maximum power consumption 10W

1. General Description

- Compliant with 400G-LR4-10 Technical Specification
- Compliant with QSFP-DD MSA
- Compliant with CMIS4.0 Management interface specifications
- 8x53.125Gb/s electrical interface (400GAUI-8)
- Up to 10km transmission on single mode fiber (SMF) with FEC
- Single +3.3V power supply
- Case temperature range: 0 ~ +70°C
- Maximum power consumption 10W
- Duplex LC connector
- RoHS complaint

2. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Storage Temperature Range	T _{STG}	-40	+85	°C
Supply Voltage	V _{CC}	-0.5	3.6	V
Relative Humidity	RH	10% to 90% non-condensing		

3. Operating Conditions

Parameter	Symbol	Min	Max	Unit
Case Temperature- Operating	T _{CASE}	0	70	°C
Supply Voltage	V _{CC}	3.135	3.465	V
Power Consumption	P _{DISS}		10	W
Pre-FEC Bit Error Ratio			2.4x10 ⁻⁴	
Link Distance over SMF			10	KM

4. Transmitter Optical Specifications

Transmitter Parameter	Lane	Min	Typical	Max	Units
Lane Wavelength Range	Lane 0	1264.5	1271	1277.5	nm
	Lane 1	1284.5	1291	1297.5	nm
	Lane 2	1304.5	1311	1317.5	nm
	Lane 3	1324.5	1331	1337.5	nm
Average launch Power per lane		-2.7		5.1	dBm
Total Average launch power				11.1	dBm
Outer Optical Modulation Amplitude (OMA _{outer}), each lane, for TDECQ < 1.4 Db for 1.4 dB ≤ TDECQ ≤ 3.4 dB		0.3 -1.1 + TDECQ		4.4	dBm
Difference in launch power between any two lanes (OMA _{outer})				4	dB
Average Launch Power per Lane @ TX Off State				-16	dBm
Transmitter and Dispersion Eye Closure for PAM4, each Lane				3.4	dB
Extinction Ratio		3.5			dB
Relative Intensity Noise (OMA)				-136	dB/Hz
Side-Mode Suppression Ration (SMSR)		30			dB
Optical Return Loss Tolerance				15.6	dB
Transmitter Reflectance				-26	dB
Transmitter Output Power Monitoring Accuracy		-3		3	dB
TDECQ – 10*log ₁₀ (Ceq), each Lane				3.4	dB
Transmitter transition time				17	ps

5. Receiver Optical Specifications

Receiver Parameter	Lane	Min	Typical	Max	Units
Lane Wavelength Range	Lane 0	1264.5	1271	1277.5	nm
	Lane 1	1284.5	1291	1297.5	nm
	Lane 2	1304.5	1311	1317.5	nm
	Lane 3	1324.5	1331	1337.5	nm
Damage Threshold		6.1			dBm
Average Receive Power, each lane		-9.0		5.1	dBm
Receiver Power, each lane (OMA)				4.4	dBm
Receiver Reflectance				-26.0	dB
Difference in receive Power between any Two Lanes(OMA_{outer})				4.3	dBm
Receiver Sensitivity each lane (OMA_{outer}) for TDECQ <1.4 dB for 1.4 dB ≤ TDECQ ≤ 3.4 dB				max(-6.8, TECQ-8.2)	dBm
Stressed Receiver Sensitivity (OMA_{outer}), each				-4.8	dBm
Stressed Conditions for Stress Receiver Sensitivity					
Stressed Eye Closure for PAM4 (SECQ), Lane under Test			3.4		dB
SECQ – $10 \cdot \log_{10}(Ceq)$, lane under test			3.4		dB
OMA _{outer} of each Aggressor Lane			-0.4		dBm

6. Receiver Thresholds for Loss of Signal (LOS)

Parameter	Min	Typical	Max	Unit
RX_LOS_Assert Min/Max	-24.0			dBm
RX_LOS_De-Assert Min/Max			-13	dBm
RX_LOS_Hysteresis	0.5			dB

7. Digital Diagnostic Monitoring Specifications

Parameter	Unit	Specification
Temperature Monitor absolute error	°C	± 3
Supply Voltage Monitor absolute error	%	± 5
I _{bias} Monitor absolute error	%	± 10
Received Power (Rx) Monitor absolute error	dB	± 3.0
Transmit Power (Tx) Monitor absolute error	dB	± 3.0

8. Low Speed Electrical signal

Parameter	Symbol	Min	Max	Unit	Condition
SCL and SDA	VOL	0	0.4	V	IOL(max)=3.0mA for fast mode, 20mA for Fast-mode plus
	VOH	V _{cc} -0.5	V _{cc} +0.3	V	
SCL and SDA	VIL	-0.3	V _{cc} *0.3	V	
	VIH	V _{cc} *0.7	V _{cc} +0.5	V	
Capacitance for SCL and SDA I/O pin	Ci		14	pF	
Total bus capacitive load for SCL and SDA	Cb		100	pF	3.0k Ohms Pull up resistor, max
			200	pF	1.6k Ohms Pull up resistor, max
LPMoDe/TxDis, Reset and ModeSelL	VIL	-0.3	0.8	V	I _{lin} <= 125uA for Vin < V _{cc}
	VIH	2	V _{cc} + 0.3	V	
IntL/RxLOS	VOL	0	0.4	V	IOL=2.0mA
	VOH	V _{CC} - 0.5	V _{CC} + 0.3	V	10k ohms pull-up to Host V _{cc}
ModPrsL	VOL	0	0.4	%	IOL=2.0mA
	VOH			dB	ModPrsL can be implemented as a short-circuit to GND on the module

High Speed Electrical Specifications

Parameter	Min	Typical	Max	Units	Notes
Receiver electrical output characteristics at TP4					
Signaling rate per lane		26.5625		GBd	
AC common-mode output voltage(RMS)		-	17.5	mV	
Differential peak-to-peak output voltage			900	mV	
Near-end ESMW (Eye symmetry mask width)		0.265		UI	
Near-end Eye height, differential	70			mV	
Far-end ESMW (Eye symmetry mask width)		0.2		UI	
Far-end Eye height, differential	30			mV	
Far-end pre-cursor ISI ratio	-4.5		2.5	%	
Differential output return loss	9.5 - 0.37f			dB	0.01 - 8 GHz
	4.75 - 7.4log ₁₀ (f/14)			dB	8 - 19 GHz
Common to differential mode conversion return loss	22-20(f/25.78)			dB	0.01 - 12.89GHz
	15 - 6log ₁₀ (f/25.78)			dB	12.89 - 19 GHz
Differential termination mismatch			10	%	
Transition time (min, 20% to 80%)	9.5			ps	
DC common mode voltage	-350		2850	mV	
Transmitter electrical input characteristics at TP1					
Signaling rate, per lane		26.5625		GBd	
Differential pk-pk input voltage tolerance	900			mV	
Differential input return loss	9.5 - 0.37f			dB	0.01 - 8 GHz
	4.75 - 7.4log ₁₀ (f/14)			dB	8 - 19 GHz
Differential to common mode input return loss	22-20(f/25.78)			dB	0.01 - 12.89GHz
	15 - 6log ₁₀ (f/25.78)			dB	12.89 - 19 GHz
Differential termination mismatch			10	%	
Module stressed input test	Per Section 120E.3.4.1, IEEE802.3bs				
Single-ended voltage tolerance range	-0.4		3.3	V	
Common-mode voltage	-350		2850	mV	

10. QSFP-DD Edge Connector and Pinout Description

The electrical pinout of the QSFP-DD module is shown in Figure 2 below.

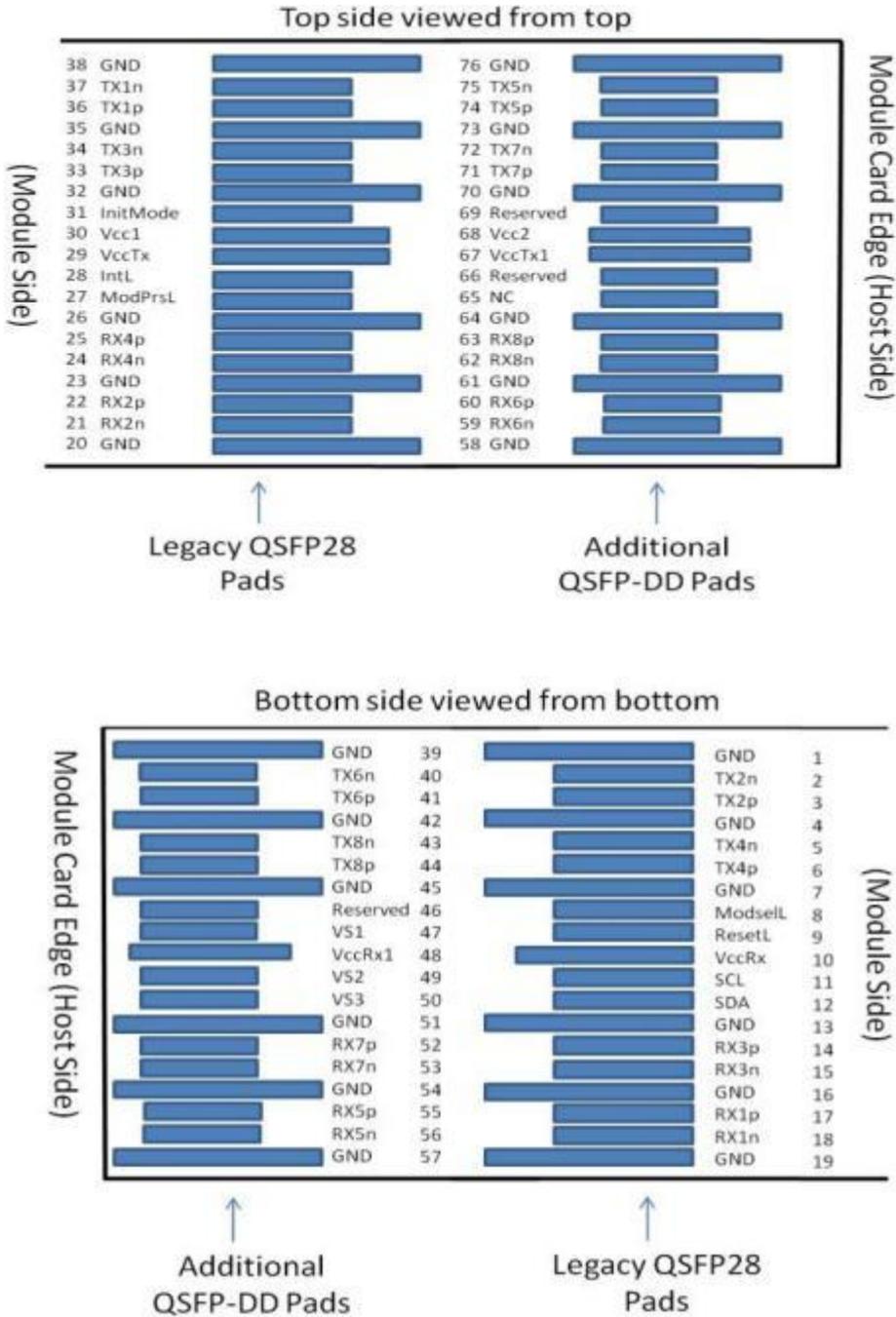


Figure 1. Host PCB QSFP-DD pad assignment top view

Pin No.	Symbol	Description	Note
1	GND	Ground	1
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data output	
4	GND	Ground	1
5	Tx4n	Transmitter Inverted Data Input	
6	Tx4p	Transmitter Non-Inverted Data output	
7	GND	Ground	1
8	ModSelL	Module Select	
9	ResetL	Module Reset	
10	VccRx	3.3V Power Supply Receiver	2
11	SCL	2-Wire serial Interface Clock	
12	SDA	2-Wire serial Interface Data	
13	GND	Ground	1
14	Rx3p	Receiver Non-Inverted Data Output	
15	Rx3n	Receiver Inverted Data Output	
16	GND	Ground	1
17	Rx1p	Receiver Non-Inverted Data Output	
18	Rx1n	Receiver Inverted Data Output	
19	GND	Ground	1
20	GND	Ground	1
21	Rx2n	Receiver Inverted Data Output	
22	Rx2p	Receiver Non-Inverted Data Output	
23	GND	Ground	1
24	Rx4n	Receiver Inverted Data Output	
25	Rx4p	Receiver Non-Inverted Data Output	
26	GND	Ground	1
27	ModPrsL	Module Present	
28	IntL	Interrupt	
29	VccTx	3.3V power supply transmitter	2
30	Vcc1	3.3V power supply	2
31	Init Mode	Initialization mode	
32	GND	Ground	1
33	Tx3p	Transmitter Non-Inverted Data Input	
34	Tx3n	Transmitter Inverted Data Output	
35	GND	Ground	1
36	Tx1p	Transmitter Non-Inverted Data Input	
37	Tx1n	Transmitter Inverted Data Output	
38	GND	Ground	1

39	GND	Ground	1
40	Tx6n	Transmitter Inverted Data Input	
41	Tx6p	Transmitter Non-Inverted Data output	
42	GND	Ground	1
43	Tx8n	Transmitter Inverted Data Input	
44	Tx8p	Transmitter Non-Inverted Data output	
45	GND	Ground	1
46	Reserved	For Future Use	3
47	VS1	Module Vendor Specific 1	3
48	VccRx1	3.3V Power Supply	2
49	VS2	Module Vendor Specific 2	3
50	VS3	Module Vendor Specific 3	3
51	GND	Ground	1
52	Rx7p	Receiver Non-Inverted Data Output	
53	Rx7n	Receiver Inverted Data Output	
54	GND	Ground	1
55	Rx5p	Receiver Non-Inverted Data Output	
56	Rx5n	Receiver Inverted Data Output	
57	GND	Ground	1
58	GND	Ground	1
59	Rx6n	Receiver Inverted Data Output	
60	Rx6p	Receiver Non-Inverted Data Output	
61	GND	Ground	1
62	Rx8n	Receiver Inverted Data Output	
63	Rx8p	Receiver Non-Inverted Data Output	
64	GND	Ground	1
65	NC	No Connect	3
66	Reserved	For Future Use	3
67	VccTx1	3.3V power supply	2
68	Vcc2	3.3V power supply	2
69	Reserved	For Future Use	3
70	GND	Ground	1
71	Tx7p	Transmitter Non-Inverted Data Input	
72	Tx7n	Transmitter Inverted Data Output	
73	GND	Ground	1
74	Tx5p	Transmitter Non-Inverted Data Input	
75	Tx5n	Transmitter Inverted Data Output	
76	GND	Ground	1

11. Module Block Diagram

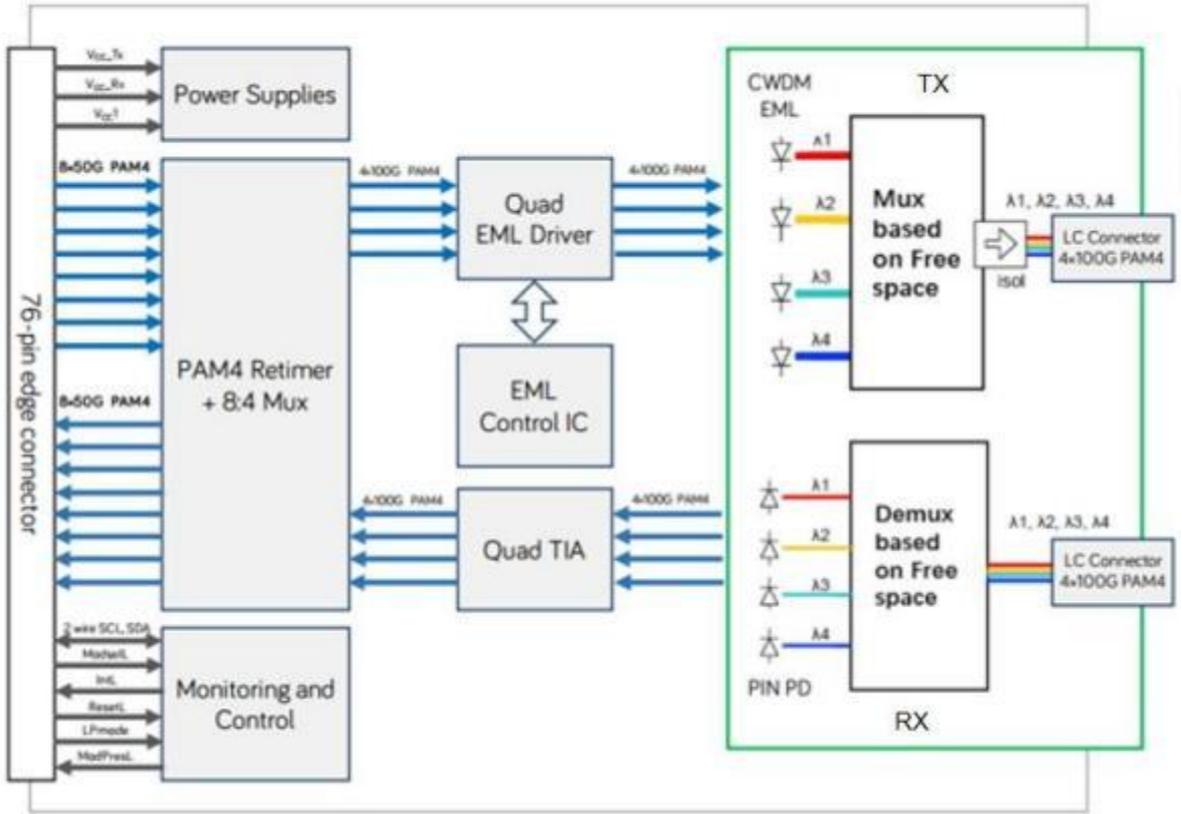
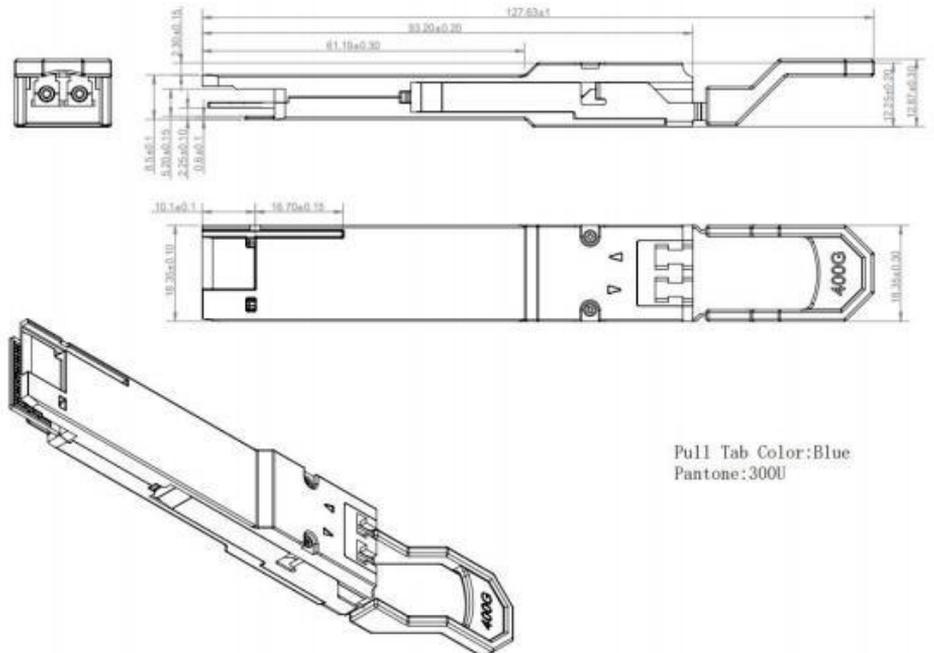


Figure 2. Module Block Diagram

12. Mechanical Specifications

Unit: mm





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13. Ordering Information

Part Number	Description
OP-QSFP-DD-LR4	400G QSFP-DD LR4 Optical Transceiver