

# 40GBASE-LR4 and OTU3 QSFP+ 1310nm 10km LC DOM Transceiver

X2-10GB-ER-LL



## Application

- 40GBASE-LR4 40G Ethernet
- OTN OTU3 C4S1-2D1
- OTU3e1 and OTU3e2

## Features

- Hot-pluggable QSFP+ form factor
- Supports 39.8 Gb/s to 44.6 Gb/s aggregate bit rates
- Power dissipation < 3.5W
- RoHS-6 compliant
- Commercial case temperature range 0° C to 70° C
- Single 3.3V power supply
- Maximum link length of 10km on Single Mode Fiber (SMF)
- Uncooled 4x10Gb/s CWDM transmitter
- XLPP electrical interface
- Duplex LC receptacles
- Built-in digital diagnostic functions, including Tx/Rx power monitoring

## Description

QSFP+ transceiver modules are designed for use in 40 Gigabit Ethernet links and 4x10G OTN client interfaces over single mode fiber. They are compliant with the QSFP+ MSA, IEEE 802.3ba 40GBASE-LR4 and OTU3 C4S1-2D1 requirements specified in ITU-T Recommendation G.695. Digital diagnostics functions are available via an I2C interface, as specified by the QSFP+ MSA. The optical transceiver is compliant per the RoHS Directive 2011/65/EU.

## Product Specifications

### I. General Specifications

Parameter	Value	Unit	Notes			
<b>Module Form Factor</b>	QSFP+					
<b>Number of Lanes</b>	4 Tx and 4 Rx					
<b>Maximum Aggregate Data Rate</b>	44.6	Gb/s				
<b>Maximum Data Rate per Lane</b>	11.2	Gb/s				
<b>Protocols Supported</b>	Typical applications include OTN OTU3, 40G Ethernet, Fiber Channel, SATA/SAS3					
<b>Electrical Interface and Pin-out</b>	38-pin edge connector		Pin-out as defined by the QSFP+ MSA			
<b>Maximum Power Consumption</b>	3.5	Watts				
<b>Management Interface</b>	Serial, I2C-based, 400 kHz maximum frequency		As defined by the QSFP+ MSA			
Data Rate Specifications	Symbol	Min	Typ.	Max	Units	Ref.
<b>Bit Rate per Lane</b>	BR			11,200	Mb/sec	1
<b>Bit Error Ratio</b>	BER			10 <sup>-12</sup>		2
<b>Link distance on SMF-28</b>	d			10	kilometers	3

#### Notes:

- Compliant with 40GBASE-LR4 and XLPP1 per IEEE 802.3ba, OTU3 C4S1-2D1 per ITU-T Rec. G.695 and OTU3e1/OTU3e2 per ITU-T G-Series Rec. Supplement 43. Compatible with 1/10 Gigabit Ethernet and 1/2/4/8/10G Fibre Channel.
- Tested with a PRBS 2-1 test pattern.
- Per 40GBASE-LR4, IEEE 802.3ba.

## II. Absolute Maximum Ratings

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Maximum Supply Voltage</b>	V <sub>CC1</sub> , V <sub>CCTx</sub> , V <sub>CCRx</sub>	-0.5		3.6	V	
<b>Storage Temperature</b>	T <sub>s</sub>	-40		85	° C	
<b>Case Operating Temperature</b>	T <sub>op</sub>	0		70	° C	
<b>Relative Humidity</b>	RH	0		85	%	1
<b>Damage Threshold, per Lane</b>	DT	3.4			dBm	

**Note:**

Non-condensing.

## III. Electrical Characteristics (TOP = 0 to 70°C, VCC = 3.1 to 3.47 Volts)

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Supply Voltage</b>	V <sub>CC1</sub> , V <sub>CCTx</sub> , V <sub>CCRx</sub>	3.1		3.47	V	
<b>Supply Current</b>	I <sub>CC</sub>			1.13	A	
<b>Transmit turn-on time</b>				2000	ms	1
<b>Transmitter (per Lane)</b>						
<b>Single ended input voltage tolerance</b>	V <sub>inT</sub>	-0.3		4.0	V	
<b>Differential data input swing</b>	V <sub>in,pp</sub>	120		1200	mV <sub>pp</sub>	2
<b>Differential input threshold</b>			50		mV	
<b>AC common mode input voltage tolerance (RMS)</b>		15			mV	
<b>Differential input return loss</b>		Per IEEE P802.3ba, Section 86A.4.1.1			dB	3

<b>J2 Jitter Tolerance</b>	Jt2	0.17			UI	
<b>J9 Jitter Tolerance</b>	Jt9	0.29			UI	
<b>Data Dependent Pulse Width Shrinkage</b>	DDPWS	0.07			UI	
<b>Eye mask coordinates {X1, X2, Y1, Y2}</b>			0.11, 0.31 95, 350		UI mV	4
<b>Receiver (per Lane)</b>						
<b>Single-ended output voltage</b>		-0.3		4.0	V	
<b>Differential data output swing</b>	Vout,pp	200		400	mVpp	5,6
		300		600		
		400	500	800		
		600		1200		
<b>AC common mode output voltage (RMS)</b>				7.5	mV	
<b>Termination mismatch at 1 MHz</b>				5	%	
<b>Differential output return loss</b>			Per IEEE P802.3ba, Section 86A.4.2.1		dB	3
<b>Common mode output return loss</b>			Per IEEE P802.3ba, Section 86A.4.2.2		dB	3
<b>Output transition time, 20% to 80%</b>		28			ps	
<b>J2 Jitter output</b>	Jo2			0.42	UI	
<b>J9 Jitter output</b>	Jo9			0.65	UI	
<b>Eye mask coordinates #1 {X1, X2, Y1, Y2}</b>			0.29, 0.5 150, 425		UI mV	4
<b>Power Supply Ripple Tolerance</b>	PSR	50			mVpp	

**Notes:**

1. From power-on and end of any fault conditions.
2. After internal AC coupling. Self-biasing 100Ω differential input.
3. 10 MHz to 11.1 GHz range
4. Hit ratio =  $5 \times 10^{-5}$ .
5. AC coupled with 100Ω differential output impedance.
6. Output voltage is settable in 4 discrete steps via the I2C. Default is 400-800 mV.

#### IV. Optical Characteristics (TOP = 0 to 70°C, VCC = 3.1 to 3.47 Volts)

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Transmitter</b>						
<b>Signaling Speed per Lane</b>				11.2	GBd	1
<b>Lane centerwavelengths (range)</b>			1264.5 – 1277.5 1284.5 – 1297.5 1304.5 – 1317.5 1324.5 – 1337.5		nm	
<b>Total Average Launch Power</b>	$P_{OUT}$			8.3	dBm	
<b>Transmit OMA per Lane</b>	$TxOMA$	-4.0		3.5	dBm	
<b>Average launch power per Lane</b>	$TXP_x$	-7.0		2.3	dBm	2
<b>Average launch power of OFF transmitter, per Lane</b>				-30	dBm	
<b>Relative Intensity Noise</b>	RIN			-128	dB/Hz	3
<b>Sidemode Suppression ratio</b>	SSRmin	30			dB	
<b>Optical Extinction Ratio</b>	ER	4.5			dB	
<b>Optical Return Loss Tolerance</b>				20	dB	
<b>Transmitter Reflectance</b>				-12	dB	
<b>Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}</b>			0.25, 0.4, 0.45, 0.25, 0.28, 0.4			
Parameter	Symbol	Min	Typ.	Max	Unit	Ref.

#### Receiver (per Lane)

<b>Signaling Speed per Lane</b>				11.2	GBd	4
<b>Lane Center wavelengths (range)</b>			1264.5-1277.5 1284.5-1297.5 1304.5-1317.5 1324.5-1337.5		nm	
<b>Total Average Receive Power</b>	$P_{IN}$			8.3	dBm	
<b>Receive Power (OMA) per Lane</b>	$RxOMA$			3.5	dBm	
<b>Average Receive power per Lane</b>	$RXP_x$	-11.5		2.3	dBm	5

<b>Receiver Sensitivity (OMA) per Lane</b>	Rxsens			-11.5	dBm	
<b>Stressed Receiver Sensitivity(OMA) per Lane</b>	SSRmin			-9.6	dBm	
<b>Damage Threshold per Lane</b>	P <sub>MAX</sub>			3.4	dBm	
<b>Return Loss</b>	RL			-26	dB	
<b>Vertical eye closure penalty, per lane</b>				1.9	dB	
<b>Receive electrical 3 dB upper cutoff frequency, per lane</b>				12.3	GHz	
<b>LOS De-Assert</b>	LOS <sub>D</sub>			-15	dBm	
<b>LOS Assert</b>	LOS <sub>A</sub>	-28			dBm	
<b>LOS Hysteresis</b>			1		dB	

**Notes:**

1. Transmitter consists of 4 lasers operating at up to 11.2 Gb/s each, +/- 20ppm
2. Minimum value is informative.
3. RIN is scaled by  $10 \cdot \log(10/4)$  to maintain SNR outside of transmitter.
4. Receiver consists of 4 photodetectors operating at up to 11.2 Gb/s each, +/-100ppm
5. Minimum value is informative, equals min TxOMA with infinite ER and max channel insertion loss.

## V. Pin Description

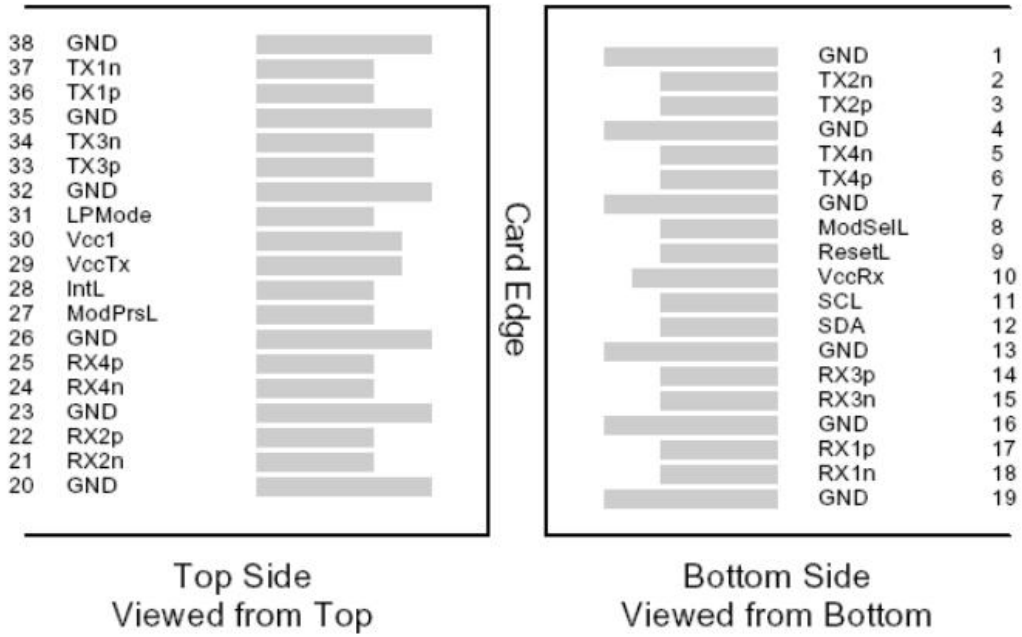


Figure 1 – QSFP+ MSA-compliant 38-pin connector

Pin	Symbol	Name/Description	Notes
1	GND	Ground	1
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data Input	
4	GND	Ground	1
5	Tx4n	Transmitter Inverted Data Input	
6	Tx4p	Transmitter Non-Inverted Data Input	
7	GND	Ground	1
8	ModSelL	Module Select	
9	ResetL	Module Reset	

10	Vcc Rx	+3.3 V Power supply receiver	
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	Vcc Tx	+3.3 V Power supply transmitter	
30	Vcc1	+3.3 V Power Supply	
31	LPMODE	Low Power Mode	
32	GND	Ground	1
33	Tx3p	Transmitter Non-Inverted Data Input	



34	Tx3n	Transmitter Inverted Data Input	
35	GND	Ground	1
36	Tx1p	Transmitter Non-Inverted Data Input	
37	Tx1n	Transmitter Inverted Data Input	
38	GND	Ground	1

**Note:**  
Circuit ground is internally isolated from chassis ground.

## VI. Mechanical Specifications

The mechanical specifications are compliant to the QSFP+ MSA transceiver module specifications.

