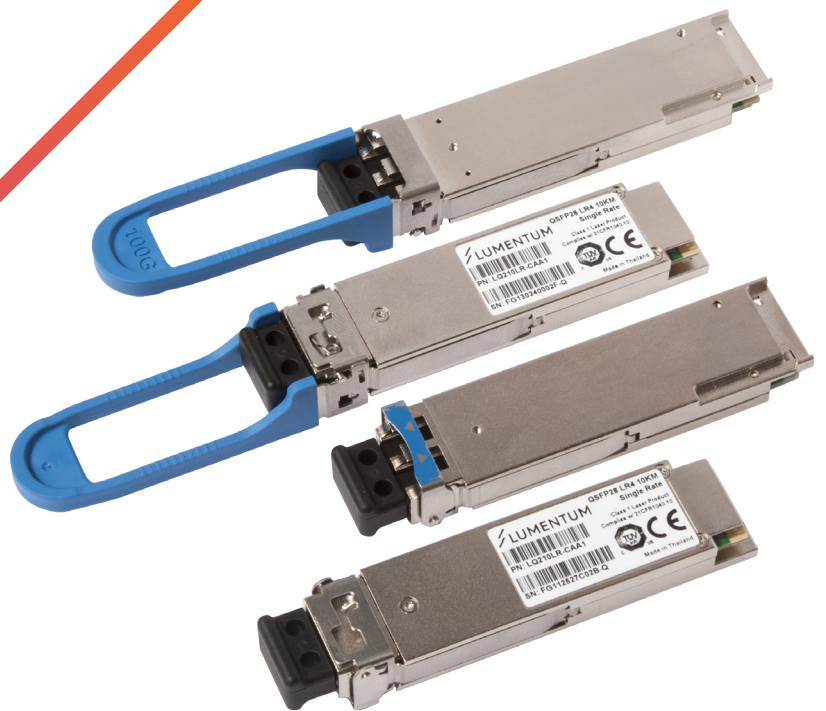


# QSFP28 Optical Transceiver -100 Gigabit Ethernet for up to 10 km Reach

LQ2 Series



The Lumentum 100G QSFP28 LR4 Optical Transceiver is a full duplex, photonic-integrated optical transceiver that provides a high-speed link at aggregated data rate of either 103.125 Gbps or 111.81 Gbps over up to 10 km of SMF28. The module complies with IEEE 802.3-2015 Clause 88 and 83E standard and ITU-T G.959.1-2016-04.

The transceiver integrates the receive and transmit path on one module. On the transmit side, four lanes of serial data are recovered by a programmable continuous time linear equalizer (CTLE), retimed and passed to four laser drivers, which control four lasers with center wavelengths of 1296 nm, 1300 nm, 1305 nm and 1309 nm. The optical signals are multiplexed to a single-mode fiber through an industry standard LC connector. On the receive side, four lanes of optical data streams are optically de-multiplexed by an integrated optical demultiplexer. Each data stream is recovered by a PIN photodetector transimpedance amplifier, retimed and passed to a CAUI-4 compliant output driver.

This module features a hot-pluggable electrical interface, low power consumption and 2-wire I2C management interface.

#### **Key Features**

- Supports 100GBASE-LR4 for line rate of 103.125 Gbps and OTU4 for line rate of 111.81 Gbps
- Integrated LAN WDM TOSA/ROSA for up to 10 km reach over SMF28
- Duplex single mode LC optical receptacle
- Operating temperature range from 0°C to 70°C
- Low power dissipation < 4 W
- RoHS 6/6 compliant
- Single 3.3 V power supply
- External reference clock is not required
- Compliant with CEI-28G-VSR/CAUI-4 electrical interface
- Digital diagnostic monitoring support
- Tx and Rx re-timers
- Hot pluggable 38 pin electrical interface
- 2-wire I2C management interface
- Blue handle

#### **Applications**

- Local area network (LAN)
- Wide area network (WAN)
- Ethernet switches and router applications

#### **Compliance**

- IEEE 802.3-2015 Clause 88 standard
- IEEE 802.3-2015 Clause 83E standard
- ITU-T G.959.1-2016-04 standard
- OIF-CEI-03.1 CEI-28G-VSR standard
- SFF-8661 Rev 2.3 QSFP28 module mechanical
- SFF-8679 Rev 1.7 QSFP28 Base Electrical
- SFF-8636 Rev 2.7 Common Management Interface
- Class 1 laser safety
- Tested in accordance with Telcordia GR-468

## Section 1 Functional Description

The 100G QSFP28 LR4 optical transceiver is a fully duplex device with both transmit and receive functions contained in a single module. The optical signals are multiplexed to a single-mode fiber through an industry standard LC connector.

The module provides a high speed link at an aggregated signaling rate of 103.125 Gbps or 111.81 Gbps. It is compliant with IEEE 802.3-2015 Clause 88 100GBASE-LR4 and ITU-T G.959.1-2016-04 OTL4.4 (OTU4 striped across four physical lanes) 411-9D1F for up to 10 km reach over SMF28 fiber. The two-wire management interface complies with SFF-8636. The transceiver mechanical design complies with SFF-8661 and the base electrical design complies with SFF-8679. A block diagram is shown in Figure 1.

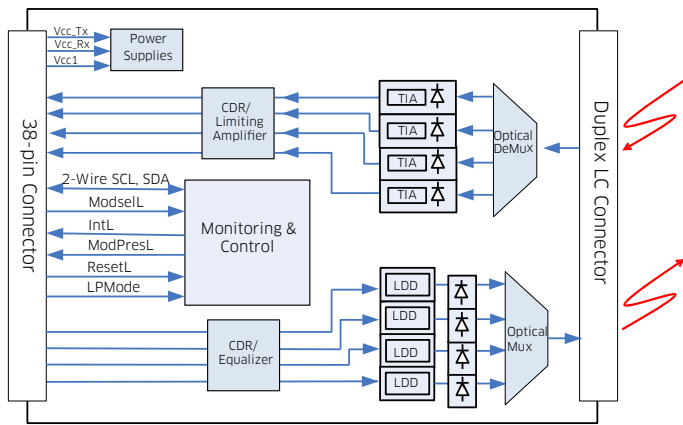


Figure 1 Functional block diagram

### Transmitter

The transmitter path converts four lanes of serial NRZ electrical data from line rate of 25.78 Gbps to 27.95Gbps to a standard compliant optical signal. Each signal path, accepts a 100 Ω differential 100 mV peak-to-peak to 900 mV peak-to-peak electrical signal on TDxn and TDxp pins.

Inside the module, each differential pair of electric signals is input to a CDR (clock-data recovery) chip. The recovered and retimed signals are then passed to a laser driver which transforms the small swing voltage to an output modulation that drives a cooled EML laser. The laser drivers control four EMLs with center wavelengths of 1296 nm, 1300 nm, 1305 nm and 1309 nm, respectively. The control of transmitted laser power and modulation swing over temperature and voltage variations is provided on each laser. The optical signals from the four lasers are multiplexed together optically. The combined optical signals are coupled to single-mode optical fiber through an industry standard LC optical connector. The optical signals are engineered to meet the 100 Gigabit Ethernet or OTU4 specifications.

### Receiver

The receiver takes incoming combined four lanes of DC balanced LAN-WDM NRZ optical data from line rate of 25.78 Gbps to 27.95 Gbps through an industry standard LC optical connector. The four incoming wavelengths are separated by an optical demultiplexer into four separated channels. Each output is coupled to a PIN photodetector. The electrical currents from each PIN photodetector are converted to a voltage in a high-gain transimpedance amplifier. The electrical output is recovered and retimed by the CDR chip. The four lanes of reshaped electrical signals are output on the RDxp and RDxn pins as a 100 Ω differential CEI signals.

### Low-Speed Signaling

The Lumentum 100G QSFP28 LR4 Optical Transceiver has several low-speed interface connections including a 2-wire serial interface (SCL and SDA). These connections include; Low Power Mode (LPMode), Module Select (ModSelL), Interrupt (IntL), Module Present (ModPrsL) and Reset (ResetL) as shown in Figure 1.

**ModSelL:** The ModSelL is an input pin. When held low by the host, the module responds to 2-wire serial communication commands. The ModSelL allows the use of multiple QSFP28 modules on a single 2-wire interface bus. When the ModSelL is “High”, the module does not respond to or acknowledge any 2-wire interface communication from the host.

In order to avoid conflicts, the host system shall not attempt 2-wire interface communications within the ModSelL de-assert time after any QSFP28 modules are deselected. Similarly the host must wait at least for the period of the ModSelL assert time before communicating with the newly selected module. The assertion and de-assertion periods of different modules may overlap as long as the above timing requirements are met.

**ResetL:** The ResetL pin is pulled up to Vcc inside the QSFP28 module. A low level on the ResetL pin for longer than the minimum pulse length ( $t_{Reset\_init}$ ) initiates a complete module reset, returning all user module settings to their default state. Module Reset Assert Time ( $t_{init}$ ) starts upon the rising edge after the low level on the ResetL pin is released. During the execution of a reset ( $t_{init}$ ) the host shall disregard all status bits until the module indicates a completion of the reset interrupt. The module indicates this by posting an IntL signal with the Data\_Not\_Ready bit negated. Note that on power up (including hot insertion) the module will post this completion of reset interrupt without requiring a reset.

**LPMode:** The LPMode pin is pulled up to Vcc inside the QSFP28 module. This function is affected by the LPMode pin and the combination of the Power\_override and Power\_set software control bits (Address A0h, byte 93, bits 0,1).

The module has three modes: a low power mode, a limit power mode and a high power mode. The high power mode operates in one of the four power classes.

When the module is in a low power mode it has a maximum power consumption of 1.5W. The maximum power consumption of a limit power mode is 3.5W. This protects hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

The module's 2-wire serial interface and all laser safety functions are fully operational in this low power mode. The module still supports the completion of reset interrupt in this low power mode.

The Extended Identifier bits (Page 00h, byte 129 bits 6-7) indicate that our module has power consumption greater than 1.5W. When the module is in low power mode, the module will reduce its power consumption to less than 1.5W while still maintaining the functionality above. However, the Tx or Rx may not be operational in this state.

The module will be in low power mode if the LPMode pin is in the high state, or if the Power\_override bit (Page 00h, byte 93 bit 0) is in the high state and the Power\_set bit (Page 00h, byte 93 bit 1) is also high. The module will be in high power mode if the LPMode pin is in the low state and High\_Power\_Class\_Enable bit (Page 00h, byte 93 bit 2) is in high state, or both the Power\_override bit and the High\_Power\_Class\_Enable bit are high and the Power\_Set bit is low. Note that the default state for the Power\_override bit is low.

A truth table for the relevant configurations of the LPMode and the Power\_override and Power\_set are shown in Table 1.

LPMode	Power Over-ride Bit (93.0)	Power_set Bit (93.1)	High Power Class Enable Bit (93.2)	Module Power Allowed
1	0	X	X	Low Power (1.5 W)
0	0	X	0	Limit Power (3.5 W)
0	0	X	1	High Power (4.0 W)
X	1	1	X	Low Power (1.5 W)
X	1	0	0	Limit Power (3.5 W)
X	1	0	1	High Power (4.0 W)

Table 1 Power mode truth

The module supports a feature to ignore High\_Power\_Class\_Enable bit. This feature is disabled by default. Please contact Lumentum if this feature is preferred.

At power up, the Power\_override and Power\_set bits are set to 0.

**ModPrsL:** ModPrsL is pulled up to Vcc\_Host on the host board and grounded in the module. The ModPrsL is "Low" when the module is inserted and "High" when the module is physically absent from the host connector.

**IntL:** IntL is an output pin. When "Low", it indicates a possible module operational fault or a status critical to the host system. The host identifies the source of the interrupt using the 2-wire serial interface. The IntL pin is an open collector output and must be pulled to host supply voltage on the host board.

### Application Schematics

An example application schematic (reference SFF 8679) showing connections from a host IC and host power supply to the Lumentum 100G QSFP28 LR4 optical transceiver is shown in Figure 2.

QSFP28 LR4 modules are hot pluggable and active connections are powered by individual power connection at 3.3 V nominal voltage. Multiple modules can share a single 3.3 V power supply with individual filtering. To limit wide band noise power, the host system and module shall each meet a maximum of 2% peak-to-peak noise when measured with a 1 MHz low pass filter. In addition, the host system and the module shall each meet a maximum of 3% peak-to-peak noise when measured with a filter from 1 MHz - 10 MHz.

A module will meet all electrical requirements and remain fully operational in the presence of noise on the 3.3V power supply. Power supply filtering components should be placed as close to the Vcc pins of the host connector as possible for optimal performance. Note: Decoupling Capacitor values vary depending on the application.

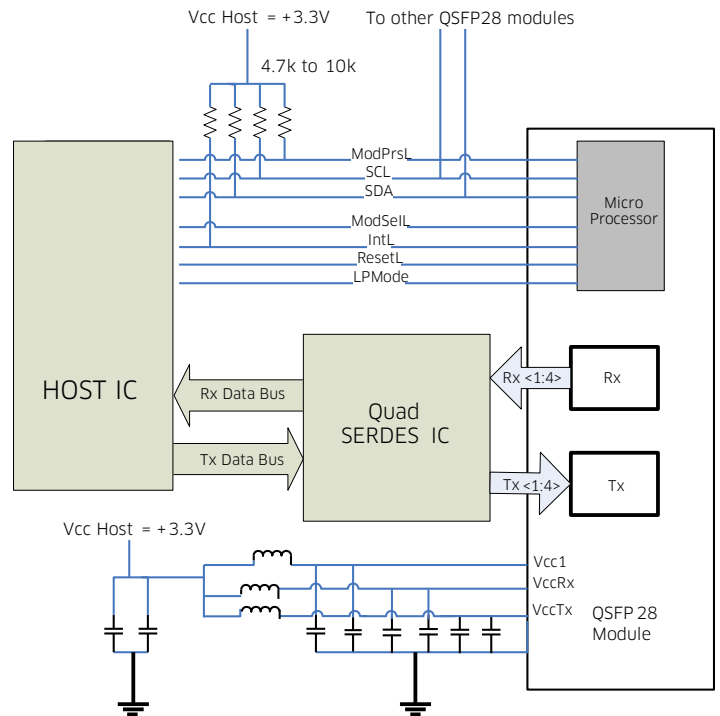


Figure 2. Typical application schematics

## Section 2 Specifications

Technical specifications include:

- Section 2.1 Pin Function Definitions
- Section 2.2 QSFP28 LR4 Lane Assignment
- Section 2.3 Absolute Maximum Ratings
- Section 2.4 Recommended Operating Condition
- Section 2.5 Low Speed Electrical Characteristics
- Section 2.6 Timing Requirement of Control and Status I/O
- Section 2.7 Optical Transmitter Characteristics
- Section 2.8 Optical Receiver Characteristics
- Section 2.9 Electrical Input and Output Squelch Behavior
- Section 2.10 Module CTLE Behavior
- Section 2.11 Regulatory Compliance
- Section 2.12 Module Outline
- Section 2.13 Connectors

### 2.1 Pin Function Definitions

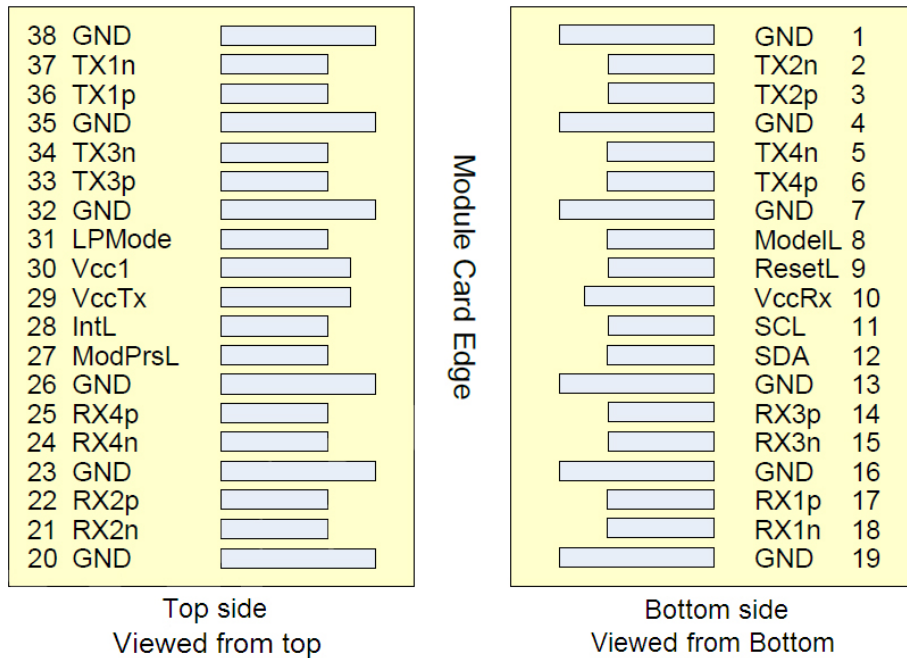


Figure 3 QSFP28 optical transceiver pin-out

**Table 2 QSFP28 optical transceiver pin descriptions**

Pin Number	Type	Name	Description
1		GND	Module Ground
2	CML-I	Tx2n	Transmitter Inverted Data Input
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input
4		GND	Module Ground
5	CML-I	Tx4n	Transmitter Inverted Data Input
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input
7		GND	Module Ground
8	LVTTL-I	ModSelL	Module Select
9	LVTTL-I	ResetL	Module Reset
10		Vcc Rx	+3.3V Power Supply
11	LVCNOS-I/O	SCL	2-Wire Serial Interface Clock
12	LVCNOS-I/O	SDA	2-Wire Serial Interface Data
13		GND	Module Ground
14	CML-O	Rx3p	Receiver Non-Inverted Data Output
15	CML-O	Rx3n	Receiver Inverted Data Output
16		GND	Module Ground
17	CML-O	Rx1p	Receiver Non-Inverted Data Output
18	CML-O	Rx1n	Receiver Inverted Data Output
19		GND	Module Ground
20		GND	Module Ground
21	CML-O	Rx2n	Receiver Non-Inverted Data Output
22	CML-O	Rx2p	Receiver Inverted Data Output
23		GND	Module Ground
24	CML-O	Rx4n	Receiver Non-Inverted Data Output
25	CML-O	Rx4p	Receiver Inverted Data Output
26		GND	Module Ground
27	LVTTL-O	ModPrsL	Module Present
28	LVTTL-O	IntL	Interrupt
29		Vcc Tx	+3.3V Power Supply
30		Vcc1	+3.3V Power Supply
31	LVTTL-I	LPMode	Low Power Mode
32		GND	Module Ground
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input
34	CML-I	Tx3n	Transmitter Inverted Data Input
35		GND	Module Ground
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input
37	CML-I	Tx1n	Transmitter Inverted Data Input
38		GND	Module Ground

## 2.2 QSFP28CLR4 Lane Assignment

Lane	Center Frequency	Center Wavelength	Wavelength Range	Module electrical lane per SFF8679
L0	231.4 THz	1295.56 nm	1294.53 to 1296.59 nm	Tx1, Rx1
L1	230.6 THz	1300.05 nm	1299.02 to 1301.09 nm	Tx2, Rx2
L2	229.8 THz	1304.58 nm	1303.54 to 1305.63 nm	Tx3, Rx3
L3	229.0 THz	1309.14 nm	1308.09 to 1310.19 nm	Tx4, Rx4

## 2.3 Absolute Maximum Ratings

Absolute maximum ratings represent the damage threshold of the device. Damage may occur if the device is operated outside the limits stated. Performance is not guaranteed and reliability is not implied for operation at any condition outside the recommended operating limits.

Parameter	Symbol	Ratings	Unit	Note
Storage temperature	$T_{ST}$	-40 to +85	°C	
Relative humidity	RH	5 to 85	%	Non-condensing
Static electrical discharge (human body model)	ESD	500	V	All pins withstand HBM of 1kV per JEDEC JESD22-A114-D
Power supply voltages	$V_{CC, max}$	-0.3 to 3.6	V	
Receive damage threshold	$P_{dmg}$	+3.5	dBm	Per lane

## 2.4 Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit
Power supply voltage	$V_{CC}$	3.135	3.3	3.465	V
Operating case temperature	$T_{OP}$	0		+70	°C
Signal rate (per channel)	fD		25.78125 27.9525		Gbps
Operating range	m	2		10000	m

## 2.5 Low Speed Electrical Characteristics

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
<b>Supply Currents and Voltages</b>						
Voltage	$V_{CC}$	3.135	3.3	3.465	V	With Respect to GND
Supply current	$I_{CC}$			1154.4	mA	Voltage 3.465V
Power dissipation	$P_{wr}$			4	W	
Power dissipation (low power mode)	$P_{lp}$			1.5	W	
<b>Low speed control and sense signals (detailed specification in SFF-8679 Rev 1.7)</b>						
Outputs (Interrupt, ModPrsL)	$V_{OL}$	0		0.4	V	$R_{pullup}$ pulled to host $V_{CC}$ , measured at host side of connector. $I_{OL}(max)=2mA$
	$V_{OH}$	host $V_{CC}-0.5$		host $V_{CC}+0.3$	V	$R_{pullup}$ pulled to host $V_{CC}$ , measured at host side of connector
Inputs (ModSelL, ResetL, LPMode)	$V_{IL}$	-0.3		0.8	V	Pulled up in module to $V_{CC3}$
	$V_{IH}$	2		$V_{CC}+0.3$	V	Pulled up in module to $V_{CC3}$
SCL and SDA inputs	$V_{IL}$	-0.3		$V_{CC3}+0.3$	V	$R_{pullup}$ pulled to host $V_{CC}$ , measured at QSFP+ side of connector
	$V_{IH}$	$V_{CC3}+0.7$		$V_{CC3}+0.5$	V	$R_{pullup}$ pulled to host $V_{CC}$ , measured at QSFP+ side of connector

## 2.6 Timing Requirement of Control and Status I/O

Parameter	Symbol	Max	Unit	Notes
Initialization time	t_init	60	s	Time from power on, hot plug or rising edge of reset until the module is fully functional. This time does not apply to non-power level 0 modules in low power state
Reset initialization assert time	t_reset_init	10	us	A reset is generated by a low level longer than the minimum reset pulse time present on the ResetL pin
Serial bus hardware ready time	t_serial	2000	ms	Time from power on until the module responds to data transmission over the 2-wire serial bus
Monitor data ready time	t_data	2000	ms	Time from power on to data not ready, bit 0 of Byte 2, deasserted and IntL asserted
Reset assert time	t_reset_init	60	s	Time from rising edge on the ResetL pin until the module is fully functional
LPMODE assert time	ton_LPMODE	100	us	Time for assertion of LPMODE (Vin: LPMODE=Vin) until module power consumption reaches power level 1
LPMODE deassert time	Toff_LPMODE	300	ms	Time for deassertion of LPMODE (Vin:LPMODE=Vil) until module is fully functional
IntL assert time	ton_IntL	200	ms	Time from occurrence of condition triggering IntL until Vout:IntL=Vol
IntL deassert time	toff_IntL	500	us	Time from clear on read operation of associated flag until Vout:IntL=Voh. This includes deassert times for Rx Los, Tx fault and other flag bits
Rx LOS assert time	ton_los	100	ms	Time from Rx LOS state to Rx LOS bit set (Value = 1b) and IntL asserted.
Tx fault assert time	ton_Txfault	200	ms	Time from Tx fault state to Tx fault bit set (value = 1b) and IntL asserted
Flag assert time	ton_flag	200	ms	Time from occurrence of condition triggering flag to associated flag bit set (value=1b) and IntL asserted.
Mask assert time	ton_mask	100	ms	Time from mask bit set (Value = 1b) until associated IntL assertion is inhibited
Mask deassert time	toff_mask	100	ms	Time from mask bit set (Value = 0b) until associated IntL operation resumes
Application or rate select change time	t_ratesel	100	ms	Time from change of state of application or rate select bit until transmitter or receiver bandwidth is in conformance with appropriate specification
Power_over-ride or power-set assert time	ton_Pdown	100	ms	Time from P_Down bit set (Value = 1b) until module power consumption reaches power level 1
Power_over-ride or power-set deassert time	toff_Pdown	300	ms	Time from P_Down bit set (Value = 0b) until module is fully functional



## 2.7 Optical Transmitter Characteristics

The following specifications are applicable within the operating case temperature range

Parameter	Symbol	Min	Typ.	Max	Unit	Notes
Signaling rate, each lane		25.78125 ± 100 ppm 27.9525 ± 20 ppm			GBd GBd	100GBASE-LR4 OTU4
Side-mode suppression ratio	SMSR	30			dB	
Total launch power				10.5 10.0	dBm dBm	100GBASE-LR4 OTU4
Average launch power, each lane	Pavg	-4.3 <sup>a</sup> -0.6		4.5 4.0	dBm dBm	100GBASE-LR4 OTU4
Extinction ratio	ER	4 4		7	dB dB	100GBASE-LR4 OTU4
Optical modulation amplitude, each lane (OMA)	OMA	-1.3 <sup>b</sup>		4.5	dBm	100GBASE-LR4
Difference in launch power between any two lanes (OMA)				5	dB	100GBASE-LR4 OTU4
Transmitter and dispersion penalty, each lane	TDP			2.2	dB	100GBASE-LR4
OMA minus TDP, each lane	OMA-TDP	-2.3			dBm	100GBASE-LR4
Average launch power of OFF transmitter, each lane				-30	dBm	100GBASE-LR4
Optical return loss tolerance				20	dB	100GBASE-LR4
Optical return loss at MPI-S <sub>M</sub>		20			dB	OTU4
Relative Intensity Noise	RIN <sub>OMA</sub>			-130	dB/Hz	100GBASE-LR4
Transmitter reflectance				-12 <sup>c</sup>	dB	100GBASE-LR4
Transmitter eye mask {X1, X2, X3, Y1, Y2, Y3}		{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}				100GBASE-LR4

a. Average launch power, each lane (min) is informative for 100GBASE-LR4, not the principal indicator of signal strength.

b. Even if the TDP < 1 dB, the OMA (min) must exceed this value.

c. Transmitter reflectance is defined looking into the transmitter.

## 2.8 Optical Receiver Characteristics

The following characteristics are applicable within the operating case temperature and supply voltage ranges.

Parameter	Symbol	Min	Typ.	Max	Unit	Notes
Signaling rate, each lane		25.78125 ± 100 ppm 27.9525 ± 20 ppm			GBd GBd	100GBASE-LR4 OTU4
Average receive power, each lane, <sup>1</sup>	Pavg	-10.6		4.5	dBm dBm	100GBASE-LR4
Average launch power, each lane. <sup>2</sup>	Pavg	-6.9 -8.8		4 2.9	dBm dBm	OTU4 with Tx ER of 4 to 7dB OTU4 with Tx ER > 7dB
Receive power, each lane (OMA)				4.5	dBm	100GBASE-LR4
Difference in launch power between any two lanes				5.5	dB	100GBASE-LR4 (OMA) OTU4 (Avg Power)
Mean total input power				10	dBm	OTU4
Optical path penalty				1.5	dB	OTU4
Receiver sensitivity (OMA), each lane <sup>1</sup> @BER= 1x10 <sup>-12</sup>	Rsen			-8.6	dBm	100GBASE-LR4,
Equivalent receiver sensitivity <sup>2</sup> @ BER=1.8x10 <sup>-4</sup>				-8.4 -10.3	dBm	OTU4 with Tx ER of 4 to 7dB OTU4 with Tx ER > 7dB
Stressed receiver sensitivity (OMA), each lane	SRS			-6.8	dBm	100GBASE-LR4, at TP3 for BER= 1x10 <sup>-12</sup>
Stressed receiver sensitivity test conditions						
Vertical eye closure penalty, each lane <sup>3</sup>	VECP		1.8		dB	100GBASE-LR4
Stressed sys J2 jitter, each lane <sup>3</sup>	J2		0.3		UI	100GBASE-LR4
Stressed sys J9 jitter, each lane <sup>3</sup>	J9		0.47		UI	100GBASE-LR4
Receiver reflectance				-26	dB	100GBASE-LR4 OTU4
LOS assert <sup>4</sup>	Plos_on			-15	dBm	
LOS hysteresis <sup>4</sup>		0.5			dB	

1. Minimum average receive power and Maximum Receiver sensitivity (OMA), each lane, is informative for 100GBASE-LR4.

2. For OTU4, 411-9D1F defines two sets of specification based on two options of Transmitter ER. The Minimum Average Receive Power represents Rx\_Sensitivity (OMA) of -7.55 dBm at worst case ER over all condition with 10 km fiber link at Post GFEC of BER 1x10<sup>-12</sup>. The Maximum Receiver Sensitivity is informative and representing Rx\_Sensitivity (OMA) of -9.05 dBm at worst case ER over all condition at Pre GFEC of BER 1.8x10<sup>-4</sup>.

3. Vertical eye closure penalty, stressed eye J2 Jitter, and stressed eye J9 Jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

4. LOS function is implemented per modulated input signal.

## 2.9 Electrical Input and Output Squelch Behavior

The Lumentum 100G QSFP28 Optical Transceiver is compliant to the Rx squelch behavior described in SFF-8636 section 6.6.2.

Rx(n)(p/n) are QS Lumentum QSFP28 transceiver. In the event of the optical signal on any channel becoming equal to or less than the level required to assert LOS, then the receiver data output for that channel shall be squelched or disabled. In the squelched or disabled state output impedance levels are maintained while the differential voltage swing shall be less than 50 mVpp.

In normal operation the default case has Rx Squelch active. Rx Squelch can be deactivated using Rx Squelch Disable through the 2-wire serial interface. For the Lumentum 100G QSFP28 Optical Transceiver, squelch and output disable is controlled for each channel using bytes 240 and 241 of page 03h. Writing a '1' in the Squelch Disable register (byte 240, page 03h) disables the squelch for the associated channel. Writing a '1' in the Output Disable register (byte 241, page 03h) squelches the output of the associated channel. When a '1' is written in both registers for a channel, the associated output is disabled. The registers read all '0's upon power-up. All other squelch functionality details are outside the scope of this document.

The Lumentum 100G QSFP28 Optical Transceiver also support Tx Squelch Function.

## 2.10 Module CTLE Behavior

The Lumentum 100G QSFP28 Optical Transceiver supports continuously manual (programmable) equalization with non-readable CTLE gain. Please contact Lumentum if adaptive equalization is preferred.

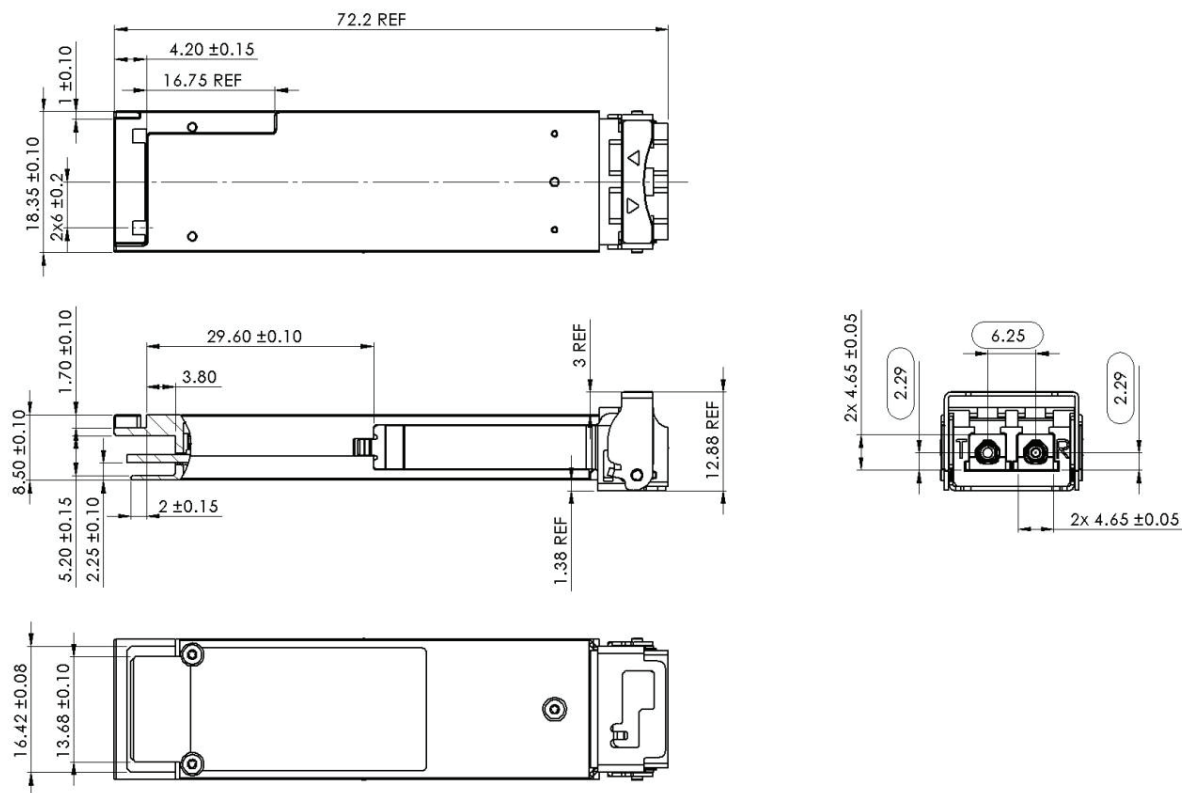
## 2.11 Regulatory Compliance

The Lumentum 100G QSFP28 Optical Transceiver is RoHS 6/6 compliant and complies with international electromagnetic compatibility (EMC) and product safety requirements and standards.

**Table 3 Regulatory Compliance**

Feature	Test Method	Performance
<b>Safety</b>		
Product safety	UL 60950-1	UL recognized component for US and CAN
	CSA C22.2 No. 60950-1	
	EN 60950-1	TUV certificate
	IEC 60950-1	CB certificate
	Flame class V-0	Passes Needle Flame Test for component flammability verification
	Low Voltage Directive 2014/35/EU	Certified to harmonized standards listed; Declaration of Conformity issued
Laser safety	EN 60825-1, EN 60825-2	TUV certificate
	IEC 60825-1, IEC 60825-2	CB certificate
	U.S. 21 CFR 1040.10	FDA/CDRH certified with accession number
<b>Electromagnetic compatibility</b>		
Radiated emissions	EMC Directive 2014/30/EU	Class B digital device with a minimum -6dB margin to the limit. Final margin may vary depending on system implementation. Tested frequency range: 30 MHz to 40 GHz or 5th harmonic (5 times the highest frequency), whichever is less. Good system EMI design practice is required to achieve Class B margins at the system level.
	FCC rules 47 CFR Part 15	
	CISPR 22, CISPR32	
	AS/NZS CISPR22, CISPR32	
	EN 55022, EN 55032	
	ICES-003, Issue 6	
	VCCI regulations	
Immunity	EMC Directive 2014/30/EU	Certified to harmonized standards listed; Declaration of Conformity issued
	CISPR 24	
	EN 55024	
ESD	IEC/EN 61000-4-2	Exceeds Requirements. Withstands discharges of ±8kV contact, ±15kV air
Radiated immunity	IEC/EN 61000-4-3	Exceeds Requirements. Field strength of 10V/m from 80 MHz to 6 GHz. No effect on transmitter / receiver performance is detectable between these limits.
<b>Restriction of hazardous substances (ROHS)</b>		
RoHS	EU Directive 2011/65/EU	Compliant per the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast). A RoHS Certificate of Compliance (C of C) is available upon request. The product may use certain RoHS exemptions..

## 2.12 Module Outline



## 2.13 Connectors

### Fiber

The QSFP28 module has a duplex single mode LC receptacle connector.

### Electrical

The electrical connector is the 38 pin two row PCB edge connector

## Section 3 Related Information

- Section 3.1 Packing and Handling Instructions
- Section 3.2 Electrostatic Discharge (ESD)
- Section 3.3 Laser Safety
- Section 3.4 EMC Compliance

### 3.1 Package and Handling Instructions

#### Connector Covers

The Lumentum 100G QSFP28 Optical Transceiver is supplied with an LC duplex receptacle. The connector plug supplied protects the connector during standard manufacturing processes and handling by preventing contamination from dust, aqueous solutions, body oils, or airborne particles.

Note: It is recommended that the connector plug remain on whenever the transceiver optical fiber connector is not inserted.

#### Recommended Cleaning and De-Greasing Chemicals

Lumentum recommends the use of methyl, isopropyl and isobutyl alcohols for cleaning.

Do not use halogenated hydrocarbons (e.g. trichloroethane, ketones such as acetone, chloroform, ethyl acetate, MEK, methylene chloride, methylene dichloride, phenol, N-methylpyrrolidone).

This product is not designed for aqueous wash.

#### Housing

Lumentum QSFP28 Optical Transceiver housing is made from zinc.

### 3.2 ESD Discharge

#### Handling

Normal ESD precautions are required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and otherwise handled in an ESD protected environment utilizing standard grounded benches, floor mats, and wrist straps.

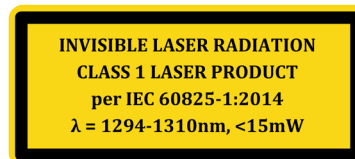
#### Test and Operation

In most applications, the optical connector will protrude through the system chassis and be subjected to the same ESD environment as the system. Once properly installed in the system, this transceiver should meet and exceed common ESD testing practices and fulfill system ESD requirements.

Typical of optical transceivers, this module's receiver contains a highly sensitive optical detector and amplifier which may become temporarily saturated during an ESD strike. This could result in a short burst of bit errors. Such an event might require that the application re-acquire synchronization at the higher layers (e.g. serializer/deserializer chip).

### 3.3 Laser Safety

The transceiver is certified as a Class 1 laser product per international standard IEC 60825-1:2014 3rd edition and is considered non-hazardous when operated within the limits of this specification. This device complies with 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50.



#### Caution

Operating this product in a manner inconsistent with intended usage and specifications may result in hazardous radiation exposure.

Use of controls or adjustments or performance of procedures other than these specified in this product datasheet may result in hazardous radiation exposure.

Tampering with this laser product or operating this product outside the limits of this specification may be considered an 'act of manufacturing' and may require recertification of the modified product.

Viewing the laser output with certain optical instruments (e.g., eye loupes, magnifiers, microscopes) within a distance of 100mm may pose an eye hazard.

### 3.4 EMC Compliance

The transceiver has been tested and found compliant with international electromagnetic compatibility (EMC) standards and regulations and is declared EMC compliant as stated below.

Note, EMC performance depends on the overall system design.

US	CAN	EU	AU/NZ	Japan
	CAN ICES-3 (B) NMB-3 (B)			

#### United States:

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation.

This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Caution: Any changes or modifications to the product not expressly approved by Lumentum Operations LLC could void the user's authority to operate this equipment.

**Canada:**  
ICES-3 (B) / NMB-3 (B)

This Class B digital apparatus complies with Canadian ICES-003. Cet appareil numérique de la classe B est conforme à la norme NMB-003 du Canada.

**European Union:**  
This product complies with the European Union's Low Voltage Directive 2014/35/EU and EMC Directive 2014/30/EU and is properly CE marked. This declaration is made by Lumentum Operations LLC who is solely responsible for the declared compliance.

**Japan:**

この装置は、クラスB情報技術装置です。この装置は、家庭環境で使用することを目的としていますが、この装置がラジオやテレビジョン受信機に近接して使用されると、受信障害を引き起こすことがあります。  
取扱説明書に従って正しい取り扱いをして下さい。 **VCCI-B**

Translation: This is a Class B product based on the standard of the Voluntary Control Council for Interference from Information Technology Equipment (VCCI). If this is used near a radio or television receiver in a domestic environment, it may cause radio interference. Install and use the equipment according to the instruction manual.

**Ordering Information**

For more information on this or other products and their availability, please contact your local Lumentum account manager or Lumentum directly at customer.service@lumentum.com.

Description	Product Code
100GE, 10 km reach, LR4, commercial temperature range, QSFP28 optical transceiver, bail latch	LQ210LR-CAA1
100GE, 10 km reach, LR4, commercial temperature range, QSFP28 optical transceiver, Pull Tab	LQ210LR-CAP1
100GE and OTU4, 10 km reach, LR4, commercial temperature range, QSFP28 optical transceiver, bail latch	LQ210LM-CAA1
100GE and OTU4, 10 km reach, LR4, commercial temperature range, QSFP28 optical transceiver, Pull Tab	LQ210LM-CAP1



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Outside North America  
Toll Free: 800 000 LITE (5483)

China  
Toll Free: 400 120 LITE (5483)

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