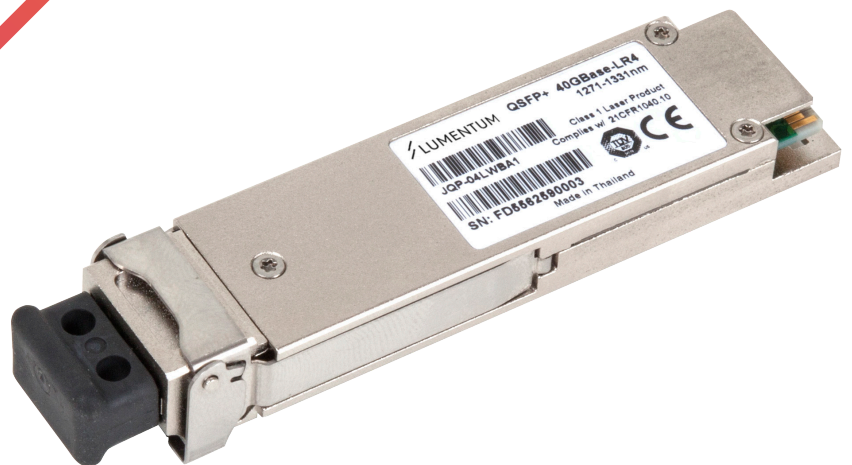


# QSFP+ 40G LR4 Optical Transceiver – 1310 nm CWDM for up to 10 km Reach

JQP Series



The Lumentum 40G 1310 nm QSFP+ optical transceiver is a full-duplex, photonic-integrated optic transceiver that provides a high-speed link at a signaling rate of up to 43.02 Gbps over up to 10 km of single-mode fiber.

The transceiver integrates the receive and transmit path on one module. In the transmit side, four 10 Gbps serial data streams are passed to laser drivers. The laser drivers control directly modulated lasers (DMLs) with wavelengths of 1271, 1291, 1311 and 1331 nm; the output of the four DMLs are optically multiplexed to a single-mode fiber through an industry-standard LC connector.

In the receive side, the four 10 Gbps optical data streams are optically de-multiplexed by the integrated optical demultiplexer; then, each data stream is recovered by a PIN photodetector/transimpedance amplifier and passed to an output driver. This module features a hot-pluggable electrical interface, low power consumption, and 2-wire management interface.

#### Key Features

- Integrated CWDM TOSA/ROSA
- Duplex LC optical receptacle
- Operating case temperature range from -5°C to 70°C
- Low power consumption (<3.5 W max)
- Hot-pluggable to 38-pin electrical interface
- 2-wire management interface
- Supports 40GE and OTU3 applications

#### Applications

- Wide area networks
- Local area networks
- Storage area networks
- 40G Ethernet switches and routers

#### Compliance

- IEEE 802.3-2012 Clause 87, Annex 86A XLPP1
- ITU-T G.695 OTL3.4
- QSFP+ MSA SFF-8436 Rev. 4.7
- RoHS 6/6
- Class 1 laser safety
- Tested in accordance with Telcordia GR-468

## Section 1 Functional Description

The transceiver is a fully duplex, parallel electric and optical device with both transmit and receive functions contained in a single module. It is designed to be compliant with IEEE 802.3-2012 Clause 87, 40GBase-LR4 at an aggregated signaling rate of 41.25 Gbps, and ITU-T G.695-201010 OTL3.4 (OTU3 striped across four physical lanes) C4S1-2D1 at an aggregated signaling rate of 43.02 Gbps for 10 km reach over single-mode fiber. The transceiver is also fully compliant with the QSFP+ MSA specification SFF-8436 Rev. 4.7. A block diagram is shown in Figure 1.

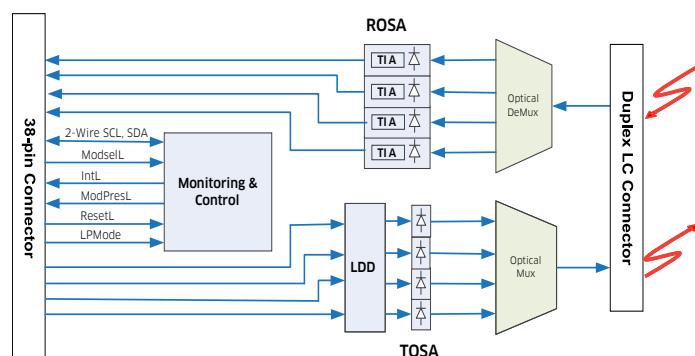


Figure 1. Transceiver functional block diagram

### 1.1 Transmitter

The transmitter path converts four lanes of serial NRZ electrical data from a line rate of 10 Gbps to a standard compliant optical signal. The transmitter accepts a 100  $\Omega$  differential 190 mV peak-to-peak to 700 mV peak-to-peak 10 Gbps CML electrical signal on the TXnp and TXnn pins.

The transmitter inputs are connected to four laser driver circuits, each of which transforms the small swing digital voltage to an output modulation that drives a direct feedback (DFB) laser. The four laser optical output signals are combined using a CWDM optical multiplexer and coupled into a single mode fiber through an industry standard LC optical connector. Control of the transmitted power and modulation swing over temperature and voltage variations is provided.

### 1.2 Receiver

The receiver converts the incoming four lanes of NRZ optical data into four lanes of XLPPi electrical data. The four incoming wavelengths are separated by a CWDM optical demultiplexer with each output coupled to a PIN photodetector. The electrical currents from each PIN photodetector are converted to a voltage in a high-gain transimpedance amplifier.

The amplified signals are passed to the RXnp and RXnn pins as a 100  $\Omega$ , 300 mV peak-to-peak to 850 mV peak-to-peak CML signal. The output signal meets IEEE 802.3-2012 Annex 86A XLPPi requirements.

### 1.3 Low-Speed Signaling

The 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 QSFP+ 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.

To avoid conflicts, the host system shall not attempt 2-wire interface communications within the ModSelL de-assert time after any QSFP+ 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 QSFP+ module. A low level on the ResetL pin for longer than the minimum pulse length ( $t_{\text{Reset\_init}}$ ) initiates a complete module reset, returning all user module settings to their default state. Module reset assert time ( $t_{\text{init}}$ ) starts upon the rising edge after the low level on the ResetL pin is released. During the execution of a reset ( $t_{\text{init}}$ ), 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 QSFP+ module. This function is affected by the LPMODE pin and the combination of the Power\_over-ride and Power\_set software control bits (Address A0h, byte 93, bits 0, 1).

The module has two modes: a low-power mode and a high-power mode. The high-power mode operates in power class 4.

When the module is in a low power mode, it has a maximum power consumption of 1.5 W. 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 power consumption greater than 1.5 W. If the module is in low-power mode, then the module reduces its power consumption to less than 1.5 W while still maintaining the functionality above. The Tx and Rx are not 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 is in the high state and the power-set bit is also high. The module will be in high-power mode if the LPMODE pin is in the low state, or if the power-override bit is 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 bits are shown in Table 1.

Table 1. Power-mode truth table

| LPMODE | Power-Override Bit | Power-Set Bit | Module Power Allowed |
|--------|--------------------|---------------|----------------------|
| 1      | 0                  | X             | Low power            |
| 0      | 0                  | X             | High power           |
| X      | 1                  | 1             | Low power            |
| X      | 1                  | 0             | High power           |

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 asserted Low when the module is inserted and deasserted High when the module is physically absent from the host connector.

**IntL** – IntL is an output pin. Low 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.

Section 2 Application Schematics

Recommended MSA connections to the transceiver are shown in Figure 2.

Power supply filtering is recommended for the transceiver. Power-supply noise including ripple should be no more than 50 mV from 1 kHz to frequency of operation, measured at Vcc Host.

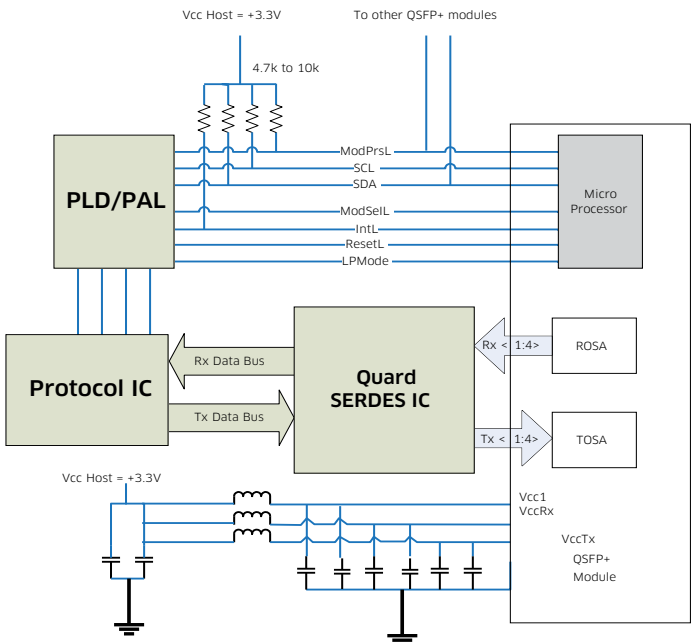


Figure 2. Application schematics

Note:  
Decoupling capacitor values vary depending on the application.

## Section 3 Specifications

Technical specifications include:

- Section 3.1 Absolute Maximum Ratings
- Section 3.2 Operating Conditions
- Section 3.3 Electrical Pin Function Definitions
- Section 3.4 QSFP+ XLPI Reference Model Compliance Points
- Section 3.5 Electrical Characteristics
- Section 3.6 Jitter and Eye-Mask Specifications
- Section 3.7 Timing Requirement of Control and Status I/O
- Section 3.8 QSFP+ 2-wire Interface Protocol and Management Interface
- Section 3.9 Optical Transmitter Characteristics
- Section 3.10 Optical Receiver Characteristics
- Section 3.11 Regulatory Compliance
- Section 3.12 PCB Layout
- Section 3.13 Module Outline
- Section 3.14 Connectors

### 3.1 Absolute Maximum Ratings

| Parameter                                                   | Symbol         | Ratings                  | Unit |
|-------------------------------------------------------------|----------------|--------------------------|------|
| Storage temperature                                         | $T_{ST}$       | -40 to +85               | °C   |
| Operating case temperature                                  | $T_{OP}$       | -5 to +70                | °C   |
| Relative humidity                                           | RH             | 5 to 85 (non-condensing) | %    |
| Static electrical discharge (high speed) (human body model) | ESD            | 1000                     | V    |
| Power supply voltages                                       | $V_{CC3, max}$ | -0.3 to 3.63             | V    |
| Receive input optical power (per lane) (damage threshold)   | Prdth          | 3.3                      | dBm  |

Note:

Absolute maximum ratings represent the damage threshold of the device. Damage may occur if the device is operated above the limits stated here except for brief excursions.

Performance is not guaranteed and reliability is not implied for operation at any condition outside the recommended operating limits.

### 3.2 Operating Conditions

| Part Number | 40GBase-LR4 (41.25 Gbps) | OTL3.4 (OTU3) (43.02 Gbps) | Operating Case Temperature (-5°C - 70°C) |
|-------------|--------------------------|----------------------------|------------------------------------------|
| JQP-04LWBAX | X                        |                            | X                                        |
| JQP-04LMBAX | X                        | X                          | X                                        |

Note:

Performance is not guaranteed and reliability is not implied for operation at any condition outside the recommended operating limits.

### 3.3 Electrical Pin Function Definitions

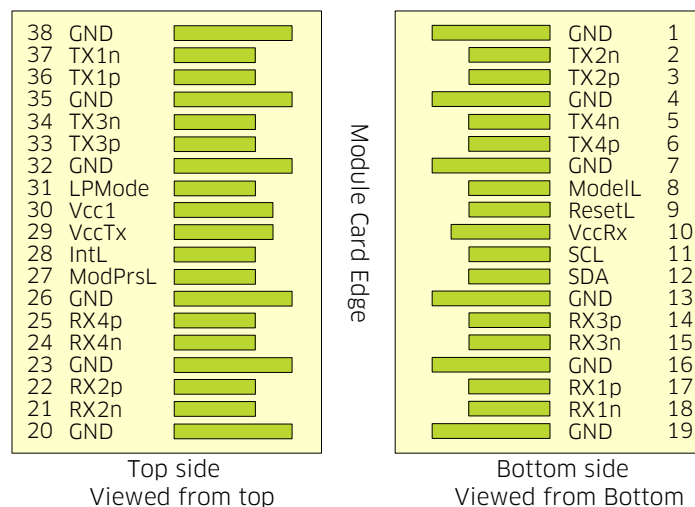


Figure 3. Module pin pad layout

**Table 2. Electrical 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  | +3.3 V 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     | 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  | +3.3 V power supply transmitter     |
| 30         |             | Vcc1    | +3.3 V power supply                 |
| 31         | LVTTL-I     | LPMode  | Low-power mode                      |
| 32         |             | GND     | Module ground                       |

**Table 2. Electrical Pin Descriptions (continued)**

| Pin Number | Type  | Name | Description                          |
|------------|-------|------|--------------------------------------|
| 33         | CML-I | Tx3p | Transmitter non-inverted data output |
| 34         | CML-I | Tx3n | Transmitter inverted data output     |
| 35         |       | GND  | Module ground                        |
| 36         | CML-I | Tx1p | Transmitter non-inverted data output |
| 37         | CML-I | Tx1n | Transmitter inverted data output     |
| 38         |       | GND  | Module ground                        |

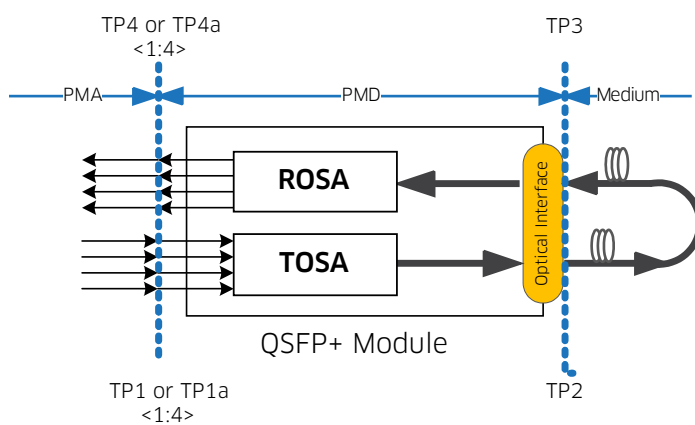
**3.4 QSFP+ XLPI Reference Model Compliance Points**

Figure 4. Transmitter and receiver reference points

**Table 3. Test Point Directions**

| Test Point | Direction                                        |
|------------|--------------------------------------------------|
| TP1        | Looking downstream into PMD transmitter input    |
| TP1a       | Looking upstream into PMA transmitter output     |
| TP2        | Looking upstream into optical transmitter output |
| TP3        | Looking upstream into medium output              |
| TP4        | Looking upstream into PMD receiver output        |
| TP4a       | Looking downstream into PMA receiver input       |

### 3.5 Electrical Characteristics

| Parameter                                                                                               | Symbol   | Minimum        | Typical | Maximum        | Unit     | Notes                                                                                              |
|---------------------------------------------------------------------------------------------------------|----------|----------------|---------|----------------|----------|----------------------------------------------------------------------------------------------------|
| <b>Supply Currents and Voltages</b>                                                                     |          |                |         |                |          |                                                                                                    |
| Voltage                                                                                                 | $V_{CC}$ | 3.13           | 3.3     | 3.47           | V        | With respect to GND                                                                                |
| Supply Current                                                                                          | $I_{CC}$ |                |         | 1000           | mA       |                                                                                                    |
| Power dissipation                                                                                       | Pwr      |                |         | 3.5            | W        |                                                                                                    |
| <b>Low-Speed Control and Sense Signals (detailed specification in SFF-8436 Rev 4.7)</b>                 |          |                |         |                |          |                                                                                                    |
| Outputs<br>(Interrupt, ModPrsL)                                                                         | $V_{OL}$ | 0              |         | 0.4            | V        | $R_{pullup}$ pulled to host_Vcc, measured at host side of connector<br>$I_{OL(max)} = 2\text{ mA}$ |
|                                                                                                         | $V_{OH}$ | host_Vcc - 0.5 |         | host_Vcc + 0.3 | V        | $R_{pullup}$ pulled to host_Vcc, measured at host side of connector                                |
| Inputs (ModSelL, ResetL, LPMode)                                                                        | $V_{IL}$ | -0.3           |         | 0.8            | V        | Pulled up in module to Vcc                                                                         |
|                                                                                                         | $V_{IH}$ | 2              |         | Vcc3 + 0.3     | V        | Pulled up in module to Vcc                                                                         |
| SCL and SDA inputs                                                                                      | $V_{IL}$ | -0.3           |         | Vcc3 * 0.3     | V        | $R_{pullup}$ pulled to host_Vcc, measured at QSFP+ side of connector                               |
|                                                                                                         | $V_{IH}$ | Vcc3 * 0.7     |         | Vcc3 + 0.5     | V        | $R_{pullup}$ pulled to host_Vcc, measured at QSFP+ side of connector                               |
| <b>Transmitter Inputs per Lane (detailed specification in IEEE802.3-2012 Annex 86A and ITU-T G.695)</b> |          |                |         |                |          |                                                                                                    |
| Data input baud rate nominal                                                                            |          | 10.3125        |         | 10.7546        | Gbps     |                                                                                                    |
| Data input bit rate tolerance (40GE)                                                                    |          | -100           |         | +100           | ppm      |                                                                                                    |
| Data input bit rate tolerance (OTU3)                                                                    |          | -20            |         | +20            | ppm      |                                                                                                    |
| Data input differential impedance                                                                       | $R_i$    | 90             | 100     | 110            | $\Omega$ |                                                                                                    |
| <b>Receiver Outputs per Lane (detailed specification in IEEE802.3-2012 Annex 86A and ITU-T G.695)</b>   |          |                |         |                |          |                                                                                                    |
| Data output baud rate nominal                                                                           |          | 10.3125        |         | 10.7546        | Gbps     |                                                                                                    |
| Data output bit rate tolerance (40GE)                                                                   |          | -100           |         | +100           | ppm      |                                                                                                    |
| Data output bit rate tolerance (OTU3)                                                                   |          | -20            |         | +20            | ppm      |                                                                                                    |

### 3.6 Jitter and Eye-Mask Specifications

| Parameter                                                 | Test Point   | Minimum       | Typical | Maximum     | Unit     | Notes                               |
|-----------------------------------------------------------|--------------|---------------|---------|-------------|----------|-------------------------------------|
| <b>Electrical Interface and Jitter Specifications</b>     |              |               |         |             |          |                                     |
| Differential input return loss                            | TP1          | See 86A.4.1.1 |         |             | dB       | 10 MHz to 11.1 GHz                  |
| Differential to common-mode input return loss             | TP1          | 10            |         | —           | dB       | 10 MHz to 11.1 GHz                  |
| Single ended output voltage tolerance                     | TP4          | −0.3          |         | 4           | V        | Referred to signal common           |
| AC common-mode output voltage (RMS)                       | TP4          | —             |         | 7.5         | mV       |                                     |
| Termination mismatch at 1 MHz                             | TP4          | —             |         | 5           | %        |                                     |
| Differential output return loss                           | TP4          | See 86A.4.2.1 |         | —           | dB       | 10 MHz to 11.1 GHz                  |
| Common-mode output return loss                            | TP4          | See 86A.4.2.1 |         | —           | dB       | 10 MHz to 11.1 GHz                  |
| Output transition time, 20% to 80%                        | TP4          | 28            |         | —           | ps       |                                     |
| J2 jitter output                                          | TP4          | —             |         | 0.42        | UI       |                                     |
| J9 jitter output                                          | TP4          | —             |         | 0.65        | UI       |                                     |
| <b>Eye-Mask Specification</b>                             |              |               |         |             |          |                                     |
| Eye mask coordinates<br>X1, X2<br>Y1, Y2                  | TP1a<br>TP1a | 0.11<br>95    |         | 0.31<br>350 | UI<br>mV | Hit ratio: $5 \times 10^{-5}$       |
| Crosstalk source VMA, each lane                           | TP1a         |               | 700     |             | mV       |                                     |
| Crosstalk source transition times, 20% to 80%             | TP1a         |               | 37      |             | pps      |                                     |
| Eye mask coordinates<br>X1, X2<br>Y1, Y2                  | TP4<br>TP4   | 0.29<br>150   |         | 0.5<br>425  | UI<br>mV | Hit ratio: $5 \times 10^{-5}$       |
| Crosstalk calibration signal VMA                          | TP4          |               | 850     |             | mV       |                                     |
| Crosstalk calibration signal transition times, 20% to 80% | TP4          |               | 34      |             | pps      | While calibrating compliance signal |

### 3.7 Timing for Soft Control and Status Functions

| Parameter                                 | Symbol       | Maximum | Unit | Conditions                                                                                                                                       |
|-------------------------------------------|--------------|---------|------|--------------------------------------------------------------------------------------------------------------------------------------------------|
| Initialization time                       | t_init       | 2000    | ms   | Time from power on, hot plug or rising edge of reset until the module is fully functional.                                                       |
| Reset init assert time                    | t_reset_init | 2       | μs   | A reset is generated by a low level longer than the minimum reset pulse time present on the ResetL pin <sup>1</sup> .                            |
| 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      | 2000    | ms   | Time from rising edge on the ResetL pin until the module is fully functional.                                                                    |
| LPMODE assert time                        | ton_LPMODE   | 100     | μs   | Time for assertion of LPMODE (Vin: LPMODE=Vin) until module power consumption reaches Power Level.                                               |
| 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     | μs   | 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.                                                                     |
| Power-override 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-override or power-set deassert time | toff_Pdown   | 300     | ms   | Time from P_Down bit set (Value = 0b) until module is fully functional.                                                                          |

1. If the host and the module are in the middle of a 2-wire interface communication with a reset pulse present, the minimum reset pulse time can be up to 5 μs.

3.8 2-Wire Interface Protocol and Management Interface

2-wire serial  
address,1010000x  
(A0h)"

|     |                                       |            |
|-----|---------------------------------------|------------|
| 0   |                                       |            |
| 2   | ID and status                         | (3 Bytes)  |
| 21  | Interrupt flags                       | (19 Bytes) |
| 33  | Module monitors                       | (12 Bytes) |
| 81  | Channel monitor                       | (48 Bytes) |
| 85  | Reserved                              | (4 Bytes)  |
| 97  | Control                               | (12 Bytes) |
| 99  | Reserved                              | (2 Bytes)  |
| 106 | Module and channel mask               | (7 Bytes)  |
| 118 | Reserved                              | (12 Bytes) |
| 122 | Password change entry area (optional) | (4 Bytes)  |
| 126 | Password entry area (optional)        | (4 Bytes)  |
| 127 | Page select byte                      | (1 Bytes)  |

Page 00

|     |                    |            |
|-----|--------------------|------------|
| 128 |                    |            |
| 191 | Base ID fields     | (64 Bytes) |
| 223 | Extended ID        | (32 Bytes) |
| 255 | Vendor-specific ID | (32 Bytes) |

Page 01 (Optional)

|     |                          |           |
|-----|--------------------------|-----------|
| 128 | CC APPS                  | (1 Bytes) |
| 129 | AST table length (TL)    | (1 Bytes) |
| 131 | Application code entry0  | (2 Bytes) |
| 133 | Application code entry1  | (2 Bytes) |
|     | Other entries            |           |
| 255 | Application code entryTL | (2 Bytes) |

Page 02 (Optional)

|     |                  |             |
|-----|------------------|-------------|
| 128 |                  |             |
| 255 | User EEPROM data | (128 Bytes) |

Page 03 (Optional for Direct Attach Cables)

|     |                                  |            |
|-----|----------------------------------|------------|
| 128 | Module threshold                 | (48 Bytes) |
| 223 | Channel threshold                | (48 Bytes) |
| 225 | Reserved                         | (2 Bytes)  |
| 241 | Vendor-specific channel controls | (16 Bytes) |
| 253 | Channel monitor mask             | (12 Bytes) |
| 255 | Reserved                         | (2 Bytes)  |

Figure 5. Memory map

### 3.9 Optical Transmitter Characteristics

| Parameter                                                                                                                                                                            | Symbol                                                   | Minimum                              | Typical            | Maximum                              | Unit                 |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------------------------------|--------------------|--------------------------------------|----------------------|
| Signaling rate, each lane<br>10GBase <sup>1</sup><br>OTU2 <sup>2</sup>                                                                                                               |                                                          |                                      | 10.3125<br>10.7546 |                                      | Gbps<br>Gbps         |
| Data rate, total<br>40GBase <sup>1</sup><br>OTU3 <sup>2</sup>                                                                                                                        |                                                          |                                      | 41.25<br>43.02     |                                      | Gbps<br>Gbps         |
| Lane wavelengths (range)                                                                                                                                                             | $\lambda_0$<br>$\lambda_1$<br>$\lambda_2$<br>$\lambda_3$ | 1264.5<br>1284.5<br>1304.5<br>1324.5 |                    | 1277.5<br>1297.5<br>1317.5<br>1337.5 | nm<br>nm<br>nm<br>nm |
| Side-mode suppression ratio                                                                                                                                                          | SMSR                                                     | 30                                   |                    |                                      | dB                   |
| Total average optical power                                                                                                                                                          | $P_{tot}$                                                |                                      |                    | 8.3                                  | dBm                  |
| Average optical power, each lane<br>(measured using an external wavelength demultiplexer with all four channels enabled)<br>@10.3125 Gbps <sup>1</sup><br>@10.7546 Gbps <sup>2</sup> | $P_{ave}$<br>$P_{ave}$                                   | -7<br>-2.3                           |                    | 2.3<br>2.3                           | dBm<br>dBm           |
| Optical modulation amplitude, each lane                                                                                                                                              | OMA                                                      | -4                                   |                    | 3.5                                  | dBm                  |
| Difference in optical power between any two lanes                                                                                                                                    | $DP_{OMA}$                                               |                                      |                    | 6.5                                  | dB                   |
| Average optical power of OFF transmitter, each lane                                                                                                                                  | $P_{off}$                                                |                                      |                    | -30                                  | dBm                  |
| Extinction ratio<br>@10.3125 Gbps <sup>1</sup><br>@10.7546 Gbps <sup>2</sup>                                                                                                         | ER<br>ER                                                 | 3.5<br>4.5                           |                    |                                      | dB<br>dB             |
| Relative intensity noise                                                                                                                                                             | $RIN_{20\text{OMA}}$                                     |                                      |                    | -128                                 | dB/Hz                |
| Optical return loss tolerance                                                                                                                                                        | RL                                                       |                                      |                    | 20                                   | dB                   |

1. Part Number: JQP-04LWBAX

2. Part Number: JQP-04LMBAX

**3.10 Optical Receiver Characteristics**

| Parameter                                                                                    | Symbol                                                   | Minimum                              | Typical            | Maximum                              | Unit                 |
|----------------------------------------------------------------------------------------------|----------------------------------------------------------|--------------------------------------|--------------------|--------------------------------------|----------------------|
| Signaling rate, each lane<br>10GBase <sup>1</sup><br>OTU2 <sup>2</sup>                       |                                                          |                                      | 10.3125<br>10.7546 |                                      | Gbps<br>Gbps         |
| Data rate, total<br>40GBase <sup>1</sup><br>OTU3 <sup>2</sup>                                |                                                          |                                      | 41.25<br>43.02     |                                      | Gbps<br>Gbps         |
| Lane wavelengths (range)                                                                     | $\lambda_0$<br>$\lambda_1$<br>$\lambda_2$<br>$\lambda_3$ | 1264.5<br>1284.5<br>1304.5<br>1324.5 |                    | 1277.5<br>1297.5<br>1317.5<br>1337.5 | nm<br>nm<br>nm<br>nm |
| Average receive power, each lane<br>@10.3125 Gbps <sup>1</sup><br>@10.7546 Gbps <sup>2</sup> | $P_{rec}$<br>$P_{rec}$                                   | -13.7<br>-9                          |                    | 2.3<br>2.3                           | dBm<br>dBm           |
| Receiver power, each lane in OMA                                                             | $P_{r\_OMA}$                                             |                                      |                    | 3.5                                  | dBm                  |
| Receiver sensitivity (OMA), each lane<br>@10.3125 Gbps <sup>1</sup>                          | $R_{sen}$                                                |                                      |                    | -11.5                                | dBm                  |
| Receiver sensitivity (average power), each lane<br>@10.7546 Gbps <sup>2</sup>                | $R_{sen}$                                                |                                      |                    | -10.8                                | dBm                  |
| Stressed receiver sensitivity, each lane<br>@10.3125 Gbps <sup>1</sup>                       | SRS                                                      |                                      |                    | -9.6                                 | dBm                  |
| Optical path penalty<br>@10.7546 Gbps <sup>2</sup>                                           |                                                          |                                      |                    | 1.8                                  | dB                   |
| Receiver reflectance                                                                         | $R_{rx}$                                                 |                                      |                    | -26                                  | dB                   |

1. Part Number: JQP-04LWBAX

2. Part Number: JQP-04LMBAX

### 3.11 Regulatory Compliance

The Lumentum QSFP+ 40G LR4 Optical Transceiver is RoHS 6/6 compliant and complies with international electromagnetic compatibility (EMC) and product safety requirements and standards.

**Table 4. 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 $\pm 8$ kV contact, $\pm 15$ kV 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.. |

### 3.12 PCB Layout

Follow the guidelines given in SFF-8436 Rev. 4.7.

### 3.13 Module Outline

(Specifications are in mm unless otherwise noted.)

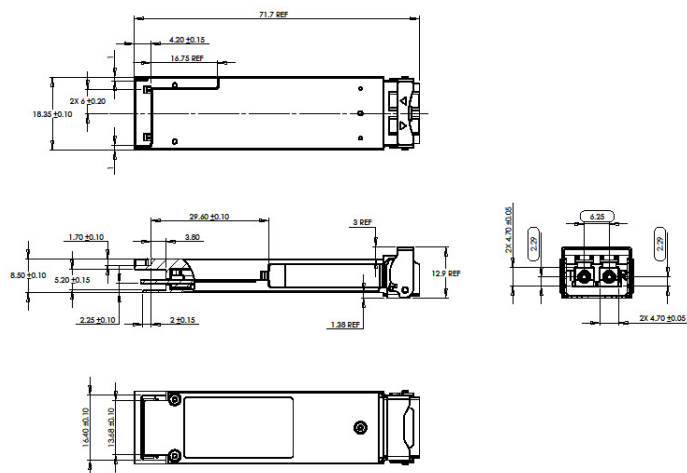


Figure 6. JQP-04LxBA1 bail-latch version

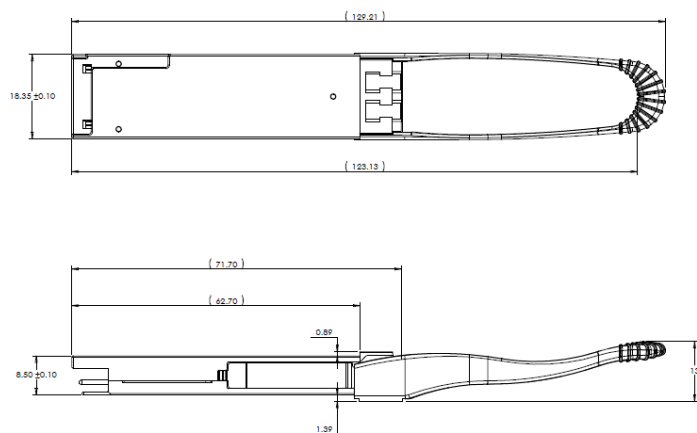


Figure 7. JQP-04LxBA2 pull-tab version

### 3.14 Connectors

**Optical** – Duplex LC receptacle

**Electrical** – 38-way, two-row PCB edge connector

## Section 4 Related Information

Other information related to the transceiver includes:

- Section 4.1 Packing and Handling Instructions
- Section 4.2 Electrostatic Discharge (ESD)
- Section 4.3 Laser Safety

### 4.1 Package and Handling Instructions

#### Connector Covers

The 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 (for example, 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

The transceiver housing is made of zinc.

### 4.2 Electrostatic Discharge (ESD)

#### 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 (for example, via a serializer/deserializer chip).

4.3 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 (for example, eye loupes, magnifiers, microscopes) within a distance of 100 mm may pose an eye hazard.

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](mailto:customer.service@lumentum.com).

Sample: JQP-04LWBA1

| Product Code | Description                                                                                                              |
|--------------|--------------------------------------------------------------------------------------------------------------------------|
| JQP-04LWBA1  | QSFP+ LR4, 40GBase-LR4, 1310 nm, commercial temperature range, 10 km optical transceiver, bail latch                     |
| JQP-04LMBA1  | QSFP+ LR4, 40GBase-LR4 and OTU3, dual rate, 1310 nm, commercial temperature range, 10 km optical transceiver, bail latch |
| JQP-04LWBA2  | QSFP+ LR4, 40GBase-LR4, 1310 nm, commercial temperature range, 10 km optical transceiver, pull tab                       |
| JQP-04LMBA2  | QSFP+ LR4, 40GBase-LR4 and OTU3, dual rate, 1310 nm, commercial temperature range, 10 km optical transceiver, pull tab   |

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North America  
Toll Free: 844 810 LITE (5483)

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

China  
Toll Free: 400 120 LITE (5483)

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Lumentum Operations LLC  
400 North McCarthy Boulevard  
Milpitas, CA 95035 USA

[www.lumentum.com](http://www.lumentum.com)