

# QSFP28 100GB/s Single-mode 10km DDM Transceiver

## Key Features

- Support line rates from 103.125 Gbps to 111.81 Gbps
- Transmission data rate up to 25.78 and 27.95 Gbps (NRZ) per channel
- Up to 10km transmission on single mode fiber
- High speed I/O electrical interface (CAUI-4)
- I2C interface with integrated Digital Diagnostic monitoring
- QSFP28 MSA package with duplex LC connector
- Single +3.3V power supply; Dissipation
- Commercial (0~70): < 4W
- Complies with EU Directive 2015/863/EU

## Applications

- 100GBASE-LR4 Ethernet
- 100G Datacom & Telecom connections
- ITU-T OTU4

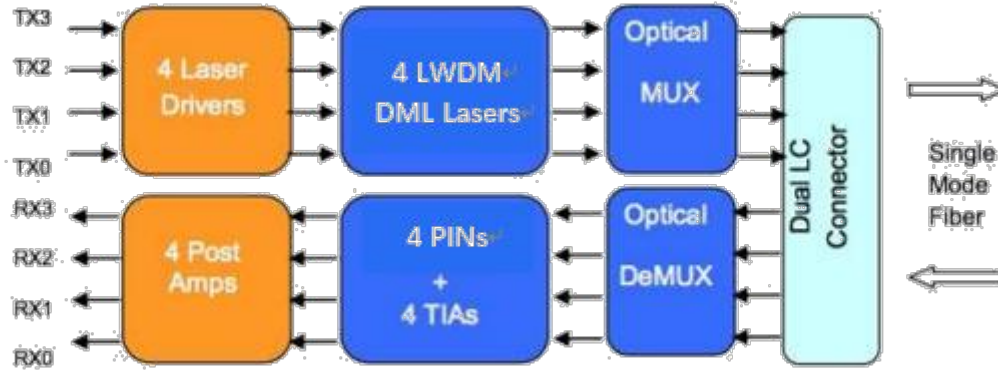
## Ordering Information

| Part No.                   | Wavelength | Distance | Connector Type | Fiber Type | Temp Range |
|----------------------------|------------|----------|----------------|------------|------------|
| <b>100GBASE-LR4 QSFP28</b> |            |          |                |            |            |
| LLQ0-SLR04LC               | LWDM       | 10km     | LC             | SMF        | C TEMP     |

## Description

The 100G QSFP LR4 Transceiver is designed for 10 km optical communication applications. This module contains a 4-lane optical transmitter, a 4-lane optical receiver, and a module management block, including a 2-wire serial interface. The optical signals are multiplexed to a single-mode fiber through an industry standard LC connector.

## Module Block Diagram



## Absolute Maximum Ratings

| Parameter                   | Symbol | Min. | Max. | Unit |
|-----------------------------|--------|------|------|------|
| Storage Temperature         | TS     | -40  | +85  | °C   |
| Maximum Supply Voltage      | VCC    | -0.5 | 3.6  | V    |
| Operating Relative Humidity | RH     |      | 85   | %    |

## Recommended Operating Conditions

| Parameter                  | Symbol            | Min. | Typical            | Max. | Unit | Notes       |
|----------------------------|-------------------|------|--------------------|------|------|-------------|
| Operating Case Temperature | Top               | 0    |                    | +70  | °C   |             |
| Power Supply Voltage       | VCC               | 3.13 | 3.3                | 3.47 | V    |             |
| Power Supply Current       | ICC               |      |                    | 1.21 | A    |             |
| Maximum Power Dissipation  | P <sub>D</sub>    |      |                    | 4    | W    |             |
| Aggregate Bit Rate         | BRAVE             |      | 103.125/<br>111.81 |      | Gb/s |             |
| Lane Bit Rate              | BRLANE            |      | 25.7812<br>5/27.95 |      | Gb/s |             |
| Transmission Distance      | TD                |      |                    | 10   | km   |             |
| Coupled fiber              | Single mode fiber |      |                    |      |      | 9/125um SMF |

## Electrical Characteristics

| Parameter                                    | Symbol          | Min. | Typical  | Max. | Unit | Notes |
|----------------------------------------------|-----------------|------|----------|------|------|-------|
| Transmitter (Module Input)                   |                 |      |          |      |      |       |
| Data Rate, each lane                         |                 |      | 25.78125 |      | Gbps |       |
| Differential Voltage pk-pk                   | Vpp             |      |          | 900  | mV   | 1     |
| Common Mode Voltage                          | Vcm             | -350 |          | 2850 | mV   |       |
| Transition time                              | Trise/<br>Tfall | 10   |          |      | ps   | 2     |
| Receiver (Module Output)                     |                 |      |          |      |      |       |
| Data Rate, each lane                         |                 |      | 25.78125 |      | Gbps |       |
| Common Mode Noise, RMS                       | Vrms            |      |          | 17.5 | mV   |       |
| Differential output voltage swing            | Vout, pp        |      |          | 900  | mV   |       |
| Eye width                                    | EW15            | 0.57 |          |      | UI   |       |
| Eye height                                   | EH15            | 228  |          |      | mV   |       |
| Differential Termination Resistance Mismatch |                 |      |          | 10   | %    | 1     |
| Transition time                              | Trise/<br>Tfall | 12   |          |      | ps   |       |

## Optical and Characteristics

### Specifications for 100Gbase-LR4

| Parameter                      | Symbol         | Min.    | Typical  | Max.    | Unit | Notes |
|--------------------------------|----------------|---------|----------|---------|------|-------|
| Transmitter                    |                |         |          |         |      |       |
| Signaling Speed per Lane       |                |         | 25.78125 |         | Gbps |       |
| Lane Wavelength                | L0             | 1294.53 | 1295.56  | 1296.59 | nm   |       |
|                                | L1             | 1299.02 | 1300.05  | 1301.09 | nm   |       |
|                                | L2             | 1303.54 | 1304.58  | 1305.63 | nm   |       |
|                                | L3             | 1308.09 | 1309.14  | 1310.19 | nm   |       |
| Total Average Launch Power     | P <sub>T</sub> |         |          | 10.5    | dBm  | 1     |
| Average Launch Power per Lane, | Pavg           | -4.3    |          | 4.5     | dBm  | 1     |

|                                                                                               |                                   |         |          |         |       |   |
|-----------------------------------------------------------------------------------------------|-----------------------------------|---------|----------|---------|-------|---|
| OMA, each Lane                                                                                | P <sub>OMA</sub>                  | -1.3    |          | 4.5     | dBm   | 1 |
| Difference in launch power between any two lanes(Average and OMA) between any Two Lanes (OMA) | P <sub>tx,diff</sub>              |         |          | 3       | dB    |   |
| Average Output Power (Laser Turn off)                                                         | P <sub>off</sub>                  |         |          | -30     | dBm   |   |
| Side Mode Suppression Ratio                                                                   | SMSR                              | 30      |          |         | dB    |   |
| Extinction Ratio                                                                              | ER                                | 4       |          |         | dB    |   |
| RIN <sub>20OMA</sub>                                                                          | RIN                               |         |          | -130    | dB/Hz |   |
| Optical Return Loss Tolerance                                                                 | TOL                               |         |          | 20      | dB    |   |
| Transmitter Reflectance                                                                       | R <sub>T</sub>                    |         |          | -12     | dB    |   |
| Optical Eye Mask                                                                              | {0.25,0.4, 0.45, 0.25, 0.28, 0.4} |         |          |         | %     | 2 |
| Receiver                                                                                      |                                   |         |          |         |       |   |
| Signaling rate, each lane                                                                     |                                   |         | 25.78125 |         | Gbps  |   |
| Center Wavelength Lane 0                                                                      | λ <sub>0</sub>                    | 1294.53 | 1295.56  | 1296.59 | nm    |   |
| Center Wavelength Lane 1                                                                      | λ <sub>1</sub>                    | 1299.02 | 1300.05  | 1301.09 | nm    |   |
| Center Wavelength Lane 2                                                                      | λ <sub>2</sub>                    | 1303.54 | 1304.58  | 1305.63 | nm    |   |
| Center Wavelength Lane 3                                                                      | λ <sub>3</sub>                    | 1308.09 | 1309.14  | 1310.19 | nm    |   |
| Damage threshold , each lane                                                                  | P <sub>damage</sub>               | 5.5     |          |         | dBm   |   |
| Average Receive Power, each lane                                                              |                                   | -10.6   |          | 4.5     | dBm   |   |
| Receiver Sensitivity (OMA) per Lane                                                           | SEN                               |         |          | -8.6    | dBm   | 3 |
| Los Assert                                                                                    | LosA                              | -30     |          |         | dBm   |   |
| Los De-assert                                                                                 | LosDA                             |         |          | -12     | dBm   |   |
| Los Hysteresis                                                                                | LosH                              | 0.5     |          |         | dB    |   |

## Specifications for OUT4 4I1-9D1F

| Parameter                                                                                     | Symbol                            | Min.    | Typical | Max.    | Unit | Notes |
|-----------------------------------------------------------------------------------------------|-----------------------------------|---------|---------|---------|------|-------|
| Transmitter                                                                                   |                                   |         |         |         |      |       |
| Signaling Speed per Lane                                                                      |                                   |         | 27.9525 |         | Gbps |       |
| Lane Wavelength                                                                               | L0                                | 1294.53 | 1295.56 | 1296.59 | nm   |       |
|                                                                                               | L1                                | 1299.02 | 1300.05 | 1301.09 | nm   |       |
|                                                                                               | L2                                | 1303.54 | 1304.58 | 1305.63 | nm   |       |
|                                                                                               | L3                                | 1308.09 | 1309.14 | 1310.19 | nm   |       |
| Total Average Launch Power                                                                    | P <sub>T</sub>                    |         |         | 10      | dBm  | 1     |
| Average Launch Power per Lane,                                                                | Pavg                              | -0.6    |         | 4       | dBm  | 1     |
| Difference in launch power between any two lanes(Average and OMA) between any Two Lanes (OMA) | Ptx,diff                          |         |         | 3       | dB   |       |
| Average Output Power (Laser Turn off)                                                         | P <sub>off</sub>                  |         |         | -30     | dBm  |       |
| Side Mode Suppression Ratio                                                                   | SMSR                              | 30      |         |         | dB   |       |
| Extinction Ratio                                                                              | ER                                | 4       |         | 7       | dB   |       |
| Optical Eye Mask                                                                              | {0.25,0.4, 0.45, 0.25, 0.28, 0.4} |         |         |         | %    | 2     |
| Receiver                                                                                      |                                   |         |         |         |      |       |
| Signaling rate, each lane                                                                     |                                   |         | 27.9525 |         | Gbps |       |
| Center Wavelength Lane 0                                                                      | λ0                                | 1294.53 | 1295.56 | 1296.59 | nm   |       |
| Center Wavelength Lane 1                                                                      | λ1                                | 1299.02 | 1300.05 | 1301.09 | nm   |       |
| Center Wavelength Lane 2                                                                      | λ2                                | 1303.54 | 1304.58 | 1305.63 | nm   |       |
| Center Wavelength Lane 3                                                                      | λ3                                | 1308.09 | 1309.14 | 1310.19 | nm   |       |
| Damage threshold , each lane                                                                  | Pdamage                           | 5.5     |         |         | dBm  |       |
| Average Receive Power, each lane                                                              |                                   | -6.9    |         | 4       | dBm  |       |
| Receiver sensitivity, each lane                                                               | SEN                               |         |         | -8.4    | dBm  | 4     |
| Los Assert                                                                                    | LosA                              | -30     |         |         | dBm  |       |
| Los De-assert                                                                                 | LosDA                             |         |         | -12     | dBm  |       |

|                |      |     |  |  |    |  |
|----------------|------|-----|--|--|----|--|
| Los Hysteresis | LosH | 0.5 |  |  | dB |  |
|----------------|------|-----|--|--|----|--|

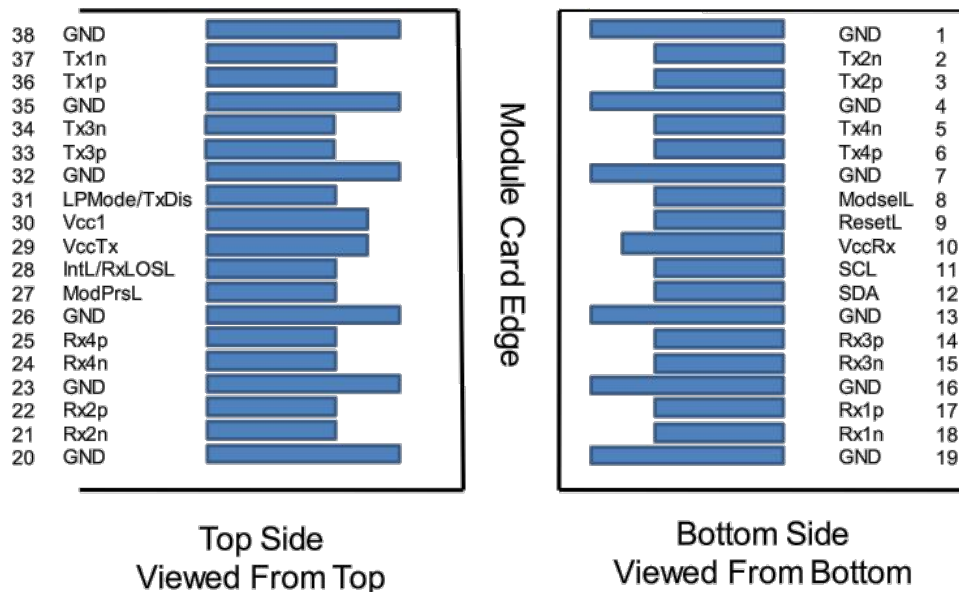
Note:

1. The optical power is launched into SMF.
2. Measured with a PRBS 231-1 test pattern @25.78125, Hit ratio  $\leq 5E^{-5}$ .
3. Measured with a PRBS 231-1 test pattern @25.78125 Gb/s, BER  $\leq 1E^{-12}$ .
4. The BER for these application codes is required to be met only after the error correction (if used) has been applied. The BER at the input of the FEC decoder can therefore be significantly higher than  $10^{-12}$ .

## Digital Diagnostics

| Parameter    | Range        | Unit | Accuracy                | Calibration         |
|--------------|--------------|------|-------------------------|---------------------|
| Temperature  | 0 to +70     | °C   | $\pm 3^{\circ}\text{C}$ | Internal / External |
| Voltage      | 3.0 to 3.6   | V    | $\pm 3\%$               | Internal / External |
| Bias Current | 30 to 100    | mA   | $\pm 10\%$              | Internal / External |
| TX Power     | -4.3 to 4.5  | dBm  | $\pm 3\text{dB}$        | Internal / External |
| RX Power     | -10.6 to 4.5 | dBm  | $\pm 3\text{dB}$        | Internal / External |

## Pin Diagram



## Pin Definitions

| PIN | Logic       | Symbol  | Description                          | Plug Seq. | Notes |
|-----|-------------|---------|--------------------------------------|-----------|-------|
| 1   |             | GND     | Ground                               | 1         | 1     |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input      | 3         |       |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data output | 3         |       |
| 4   |             | GND     | Ground                               | 1         | 1     |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input      | 3         |       |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data output | 3         |       |
| 7   |             | GND     | Ground                               | 1         | 1     |
| 8   | LVTLL-I     | ModSelL | Module Select                        | 3         |       |
| 9   | LVTLL-I     | ResetL  | Module Reset                         | 3         |       |
| 10  |             | VccRx   | + 3.3V Power Supply Receiver         | 2         | 2     |
| 11  | LVC MOS-I/O | SCL     | 2-Wire Serial Interface Clock        | 3         |       |
| 12  | LVC MOS-I/O | SDA     | 2-Wire Serial Interface Data         | 3         |       |
| 13  |             | GND     | Ground                               | 1         |       |
| 14  | CML-O       | Rx3p    | Receiver Non-Inverted Data Output    | 3         |       |
| 15  | CML-O       | Rx3n    | Receiver Inverted Data Output        | 3         |       |
| 16  |             | GND     | Ground                               | 1         | 1     |
| 17  | CML-O       | Rx1p    | Receiver Non-Inverted Data Output    | 3         |       |
| 18  | CML-O       | Rx1n    | Receiver Inverted Data Output        | 3         |       |
| 19  |             | GND     | Ground                               | 1         | 1     |
| 20  |             | GND     | Ground                               | 1         | 1     |
| 21  | CML-O       | Rx2n    | Receiver Inverted Data Output        | 3         |       |
| 22  | CML-O       | Rx2p    | Receiver Non-Inverted Data Output    | 3         |       |
| 23  |             | GND     | Ground                               | 1         | 1     |

|    |         |                  |                                     |   |   |
|----|---------|------------------|-------------------------------------|---|---|
| 24 | CML-O   | Rx4n             | Receiver Inverted Data Output       | 3 | 1 |
| 25 | CML-O   | Rx4p             | Receiver Non-Inverted Data Output   | 3 |   |
| 26 |         | GND              | Ground                              | 1 | 1 |
| 27 | LVTTL-O | ModPrsL          | Module Present                      | 3 |   |
| 28 | LVTTL-O | IntL/Rx_LOS      | Interrupt/Rx_LOS                    | 3 |   |
| 29 |         | VccTx            | +3.3 V Power Supply transmitter     | 2 | 2 |
| 30 |         | Vcc1             | +3.3 V Power Supply                 | 2 | 2 |
| 31 | LVTTL-I | LPMode/<br>TxDIS | Low Power Mode/Tx_Disable           | 3 |   |
| 32 |         | GND              | Ground                              | 1 | 1 |
| 33 | CML-I   | Tx3p             | Transmitter Non-Inverted Data Input | 3 |   |
| 34 | CML-I   | Tx3n             | Transmitter Inverted Data Output    | 3 |   |
| 35 |         | GND              | Ground                              | 1 | 1 |
| 36 | CML-I   | Tx1p             | Transmitter Non-Inverted Data Input | 3 |   |
| 37 | CML-I   | Tx1n             | Transmitter Inverted Data Output    | 3 |   |
| 38 |         | GND              | Ground                              | 1 | 1 |

Notes:

1. GND is the symbol for signal and supply (power) common for the QSFP28 module. All are common within the QSFP28 module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal-common ground plane.
2. Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently. Requirements defined for the host side of the Host Edge Card Connector are listed in MSA. The connector pins are each rated for a maximum current of 1000 mA.

## Recommended Interface Circuit

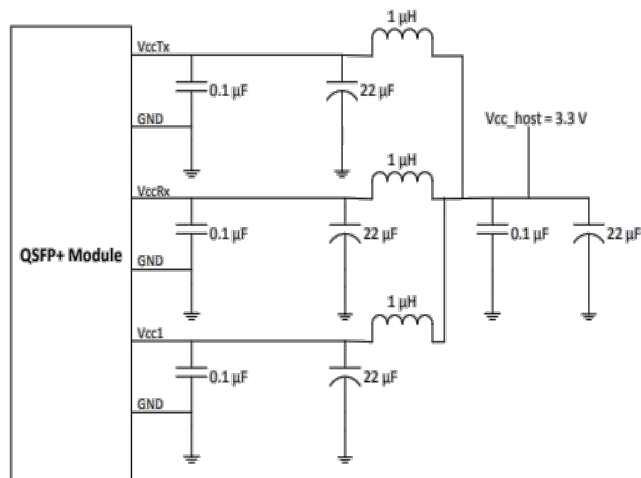


FIGURE 5-4 RECOMMENDED HOST BOARD POWER SUPPLY FILTERING

## Mechanical Diagram

