



**Features**

- Compliant with QSFP28 Standard: SFF-8665 Revision 1.9, SFF-8636 Revision 2.6
- Compliant with 100G 4WDM-40 MSA technical specification rev 1.0
- High speed I/O electrical interface (CAUI-4) compliant with IEEE 802.3bm
- Single 3.3V Supply Voltage
- Maximum power consumption 4.5W
- 0-70 °C Case Operating Temperature
- LAN WDM EML laser and APD Receiver
- QSFP28 MSA package with duplex LC connector
- Two Wire Serial Interface with Digital Diagnostic Monitoring
- Complies with EU Directive 2011/65/EU (RoHS compliant)
- Class 1 Laser

**Absolute Maximum Ratings**

**Table 1 – Absolute Maximum Ratings**

| Parameter                          | Symbol                                | Min. | Typical | Max.                 | Unit | Notes |
|------------------------------------|---------------------------------------|------|---------|----------------------|------|-------|
| Storage Temperature                | T <sub>s</sub>                        | -40  | -       | +85                  | °C   |       |
| Supply Voltage                     | V <sub>CC</sub>                       | -0.5 | -       | 3.6                  | V    |       |
| Relative Humidity (non-condensing) | RH                                    | 5    | -       | 95                   | %    |       |
| Data Input Voltage – Differential  | IV <sub>DIP</sub> -V <sub>DIN</sub> I | -    | -       | 1.0                  | V    |       |
| Control Input Voltage              | V <sub>I</sub>                        | -0.3 | -       | V <sub>CC</sub> +0.5 | V    |       |
| Control Output Current             | I <sub>o</sub>                        | -20  | -       | 20                   | mA   |       |

## Recommended Operating Conditions

**Table 2 – Recommended Operating Conditions**

| Parameter                                    | Symbol       | Min.               | Typical | Max.               | Unit | Notes         |
|--|--------------|--------------------|---------|--------------------|------|---------------|
| Operating Case Temperature                   | $T_{OPR}$    | 0                  | -       | 70                 | °C   |               |
| Power Supply Voltage                         | $V_{CC}$     | 3.135              | 3.3     | 3.465              | V    |               |
| Instantaneous peak current at hot plug       | $I_{CC\_IP}$ | -                  | -       | 1800               | mA   |               |
| Sustained peak current at hot plug           | $I_{CC\_SP}$ | -                  | -       | 1485               | mA   |               |
| Maximum Power Dissipation                    | $P_D$        | -                  | -       | 4.5                | W    |               |
| Maximum Power Dissipation,<br>Low Power Mode | $P_{DLP}$    | -                  | -       | 1.5                | W    |               |
| Aggregate Bit Rate                           | ABR          | -                  | 103.125 | -                  | Gb/s |               |
| Data Rate per Lane                           | DRL          | -                  | 25.78   | -                  | Gb/s |               |
| Control Input Voltage High                   | $V_{IH}$     | $V_{CC} \cdot 0.7$ | -       | $V_{CC} + 0.3$     | V    |               |
| Control Input Voltage Low                    | $V_{IL}$     | -0.3               | -       | $V_{CC} \cdot 0.3$ | V    |               |
| Two Wire Serial Interface Clock Rate         | -            | -                  | -       | 400                | kHz  |               |
| Power Supply Noise Tolerance                 | -            | -                  | -       | 66                 | mVpp | 10 Hz -10 MHz |
| Rx Differential Data Output Load             | -            | -                  | 100     | -                  | ohms |               |
| Operating Distance                           | -            | 2                  | -       | 40,000             | m    | With FEC      |

## Optical and Electrical Characteristics

**Table 3 – Transmitter Optical Specifications**

| Parameter  | Symbol         | Min.                               | Typical | Max.    | Unit | Notes |
|--|----------------|------------------------------------|---------|---------|------|-------|
| Wavelength L0  | $\lambda_{C0}$ | 1294.53                            | 1295.56 | 1296.59 | nm   |       |
| Wavelength L1  | $\lambda_{C1}$ | 1299.02                            | 1300.05 | 1301.09 | nm   |       |
| Wavelength L2  | $\lambda_{C2}$ | 1303.54                            | 1304.58 | 1305.63 | nm   |       |
| Wavelength L3  | $\lambda_{C3}$ | 1308.09                            | 1309.14 | 1310.19 | nm   |       |
| Side-mode suppression ratio  | SMSR           | 30                                 |         |         | dB   |       |
| Total Average Optical Launch Power                                 | $P_{OUT}$      | -                                  | -       | 12.5    | dBm  |       |
| Average Launch Power Tx_Off (Each Lane)                            | $P_{OUT\_OFF}$ | -                                  | -       | -30     | dBm  |       |
| Average Optical Launch Power (Each Lane)                           | $P_{OUTL}$     | -2.5                               | -       | 6.5     | dBm  |       |
| Extinction Ratio   | ER             | 4.5                                | -       | -       | dB   |       |
| Optical Modulation Amplitude (OMA), (Each Lane)                    | OMA            | 0.5                                | -       | 6.5     | dBm  |       |
| Launch Power in OMA minus TDP (Each Lane)                          | OMA-TDP        | -0.5                               | -       | -       | dBm  |       |
| Difference in launch power between any two lanes (Average and OMA) | DT_OMA         | -                                  | -       | 4       | dB   |       |
| Transmitter and Dispersion Penalty (Each Lane)                     | TDP            | -                                  | -       | 3       | dB   |       |
| Optical Return Loss Tolerance                                      | ORLT           | 20                                 | -       | -       | dB   |       |
| Transmitter Eye Mask Definition                                    | -              | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} |         |         |      |       |
| Transmitter Reflectance  | TR             | -                                  | -       | -26     | dB   |       |

**Table 4 – Receiver Optical Specifications**

| Parameter   | Symbol           | Min.                              | Typical | Max.    | Unit | Notes |
|---|------------------|-----------------------------------|---------|---------|------|-------|
| Wavelength L0   | $\lambda_{C0}$   | 1294.53                           | 1295.56 | 1296.59 | nm   |       |
| Wavelength L1   | $\lambda_{C1}$   | 1299.02                           | 1300.05 | 1301.09 | nm   |       |
| Wavelength L2   | $\lambda_{C2}$   | 1303.54                           | 1304.58 | 1305.63 | nm   |       |
| Wavelength L3   | $\lambda_{C3}$   | 1308.09                           | 1309.14 | 1310.19 | nm   |       |
| Receiver sensitivity (OMA), each lane at $5 \times 10^{-5}$ BER |                  | -                                 | -       | -18.5   | dBm  |       |
| Stressed receiver sensitivity (OMA), each lane                  | -                | -                                 | -       | -16     | dBm  |       |
| Stressed Receiver Sensitivity Test Conditions:                  |                  |                                   |         |         |      |       |
| Stressed Eye J2 Jitter (Each Lane)                              | -                | -                                 | 0.33    | -       | UI   |       |
| Stressed Eye J4 Jitter (Each Lane)                              | -                | -                                 | 0.48    | -       | UI   |       |
| Vertical Eye Closure Penalty                                    | -                | -                                 | 2.5     | -       | dB   |       |
| SRS eye mask definition { X1, X2, X3, Y1, Y2, Y3}               |                  | {0.39, 0.5, 0.5, 0.39, 0.39, 0.4} |         |         |      |       |
| Damage threshold, each lane                                     | $P_{in, damage}$ | -2.5                              | -       | -       | dBm  |       |
| Average Receive Power (Each Lane)                               | -                | -20.5                             | -       | -3.5    | dBm  |       |
| Receive Power in OMA (Each Lane), Overload                      | OMA              | -                                 | -       | -3.5    | dBm  |       |
| Receiver Reflectance  | $RX_R$           | -                                 | -       | -26     | dB   |       |

**Table 5 – Electrical Specifications**

**High-Speed Signal:** Compliant to CAUI-4 (IEEE 802.3bm)

**Low-Speed Signal:** Compliant to SFF-8679

| Transmitter (Module Input)         |               |              |         |              |      |               |
|------------------------------------|---------------|--------------|---------|--------------|------|---------------|
| Parameter                          | Symbol        | Min.         | Typical | Max.         | Unit | Notes         |
| Differential Data Input Amplitude  | $V_{IN,P-P}$  | 95           | -       | 900          | mVpp | Note 1        |
| Differential Termination Mismatch  |               | -            | -       | 10           | %    |               |
| LPMode, Reset and ModSelL          | $V_{IL}$      | -0.3         | -       | 0.8          | V    |               |
|                                    | $V_{IH}$      | 2            | -       | $V_{CC}+0.3$ | V    |               |
| Receiver (Module Output)           |               |              |         |              |      |               |
| Differential Data Output Amplitude | $V_{OUT,P-P}$ | 250          | -       | 900          | mVpp | Note 1        |
| Differential Termination Mismatch  |               | -            | -       | 10           | %    |               |
| Output Rise/Fall Time, 20%~80%     | $T_R$         | 9.5          | -       | -            | ps   |               |
| ModPrsL and IntL                   | $V_{OL}$      | 0            | -       | 0.4          | V    | $I_{OL}=4mA$  |
|                                    | $V_{OH}$      | $V_{CC}-0.5$ | -       | $V_{CC}+0.3$ | V    | $I_{OL}=-4mA$ |

Note 1: Amplitude customization beyond these specs is dependent on validation in customer system

**Table 6 –I/O Timing for Squelch & Disable**

| Parameter                       | Symbol     | Min. | Typical | Max. | Unit | Notes |
|---------------------------------|------------|------|---------|------|------|-------|
| Rx Squelch Assert Time          | ton_Rxsq   |      |         | 80   | μs   |       |
| Rx Squelch Deassert Time        | toff_Rxsq  |      |         | 80   | μs   |       |
| Tx Squelch Assert Time          | ton_Txsq   |      |         | 400  | ms   |       |
| Tx Squelch Deassert Time        | toff_Txsq  |      |         | 400  | ms   |       |
| Tx Disable Assert Time          | ton_txdis  |      |         | 100  | ms   |       |
| Tx Disable Deassert Time        | toff_txdis |      |         | 400  | ms   |       |
| Rx Output Disable Assert Time   | ton_rxdis  |      |         | 100  | ms   |       |
| Rx Output Disable Deassert Time | toff_rxdis |      |         | 100  | ms   |       |
| Squelch Disable Assert Time     | ton_sqdis  |      |         | 100  | ms   |       |
| Squelch Disable Deassert Time   | toff_sqdis |      |         | 100  | ms   |       |

**Table 7 – Digital Diagnostics**

| Parameter                   | Range                | Accuracy | Unit | Calibration |
|-----------------------------|----------------------|----------|------|-------------|
| Temperature                 | 0 to 70              | ±3       | °C   | Internal    |
| Voltage                     | 0 to V <sub>cc</sub> | 0.1      | V    | Internal    |
| Tx Bias Current (Each Lane) | 0 to 100             | 10%      | mA   | Internal    |
| Tx Output Power (Each Lane) | -2.5 to 6.5          | ±3       | dB   | Internal    |
| Rx Power (Each Lane)        | -20.5 to -3.5        | ±3       | dB   | Internal    |

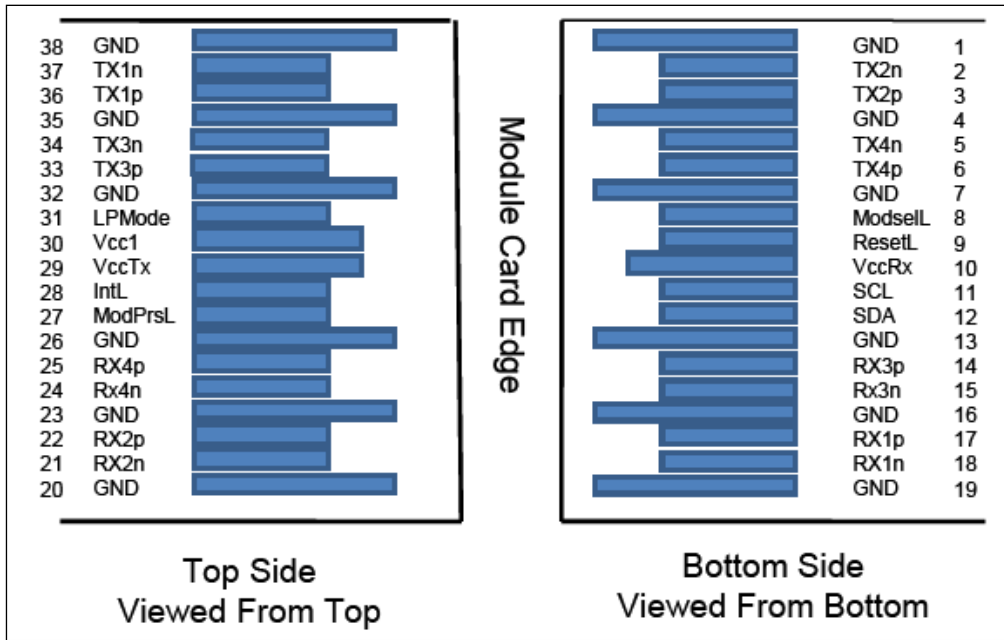
**Table 8 – Pin Definitions**

| Pin | Logic       | Symbol  | Description                         | Plug Sequence | Notes |
|-----|-------------|---------|-------------------------------------|---------------|-------|
| 1   |             | GND     | Ground                              | 1             | 1     |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input     | 3             |       |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data Input | 3             |       |
| 4   |             | GND     | Ground                              | 1             | 1     |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input     | 3             |       |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data Input | 3             |       |
| 7   |             | GND     | Ground                              | 1             | 1     |
| 8   | LVTTL-I     | ModSelL | Module Select                       | 3             |       |
| 9   | LVTTL-I     | ResetL  | Module Reset                        | 3             |       |
| 10  |             | Vcc Rx  | +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             | 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             |       |
| 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    | Interrupt                           | 3             |       |
| 29  |             | Vcc Tx  | +3.3V Power supply transmitter      | 2             | 2     |
| 30  |             | Vcc1    | +3.3V Power supply                  | 2             | 2     |
| 31  | LVTTL-I     | LPMODE  | Low Power Mode                      | 3             |       |
| 32  |             | GND     | Ground                              | 1             | 1     |
| 33  | CML-I       | Tx3p    | Transmitter Non-Inverted Data Input | 3             |       |
| 34  | CML-I       | Tx3n    | Transmitter Inverted Data Input     | 3             |       |
| 35  |             | GND     | Ground                              | 1             | 1     |
| 36  | CML-I       | Tx1p    | Transmitter Non-Inverted Data Input | 3             |       |
| 37  | CML-I       | Tx1n    | Transmitter Inverted Data Input     | 3             |       |
| 38  |             | GND     | Ground                              | 1             | 1     |

Note 1: GND is the symbol for signal and supply (power) common for the QSFP+ module. All are common within the QSFP+ module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal-common ground plane.

Note 2: Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently.

**QSFP+ Module Pad Layout**

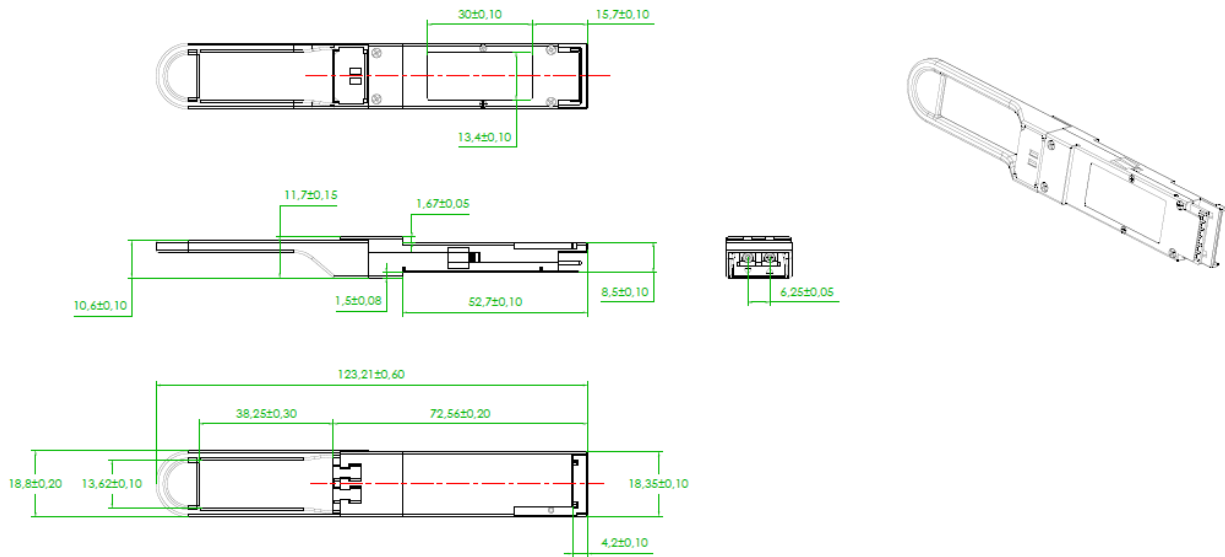


**Recommended Host Board Power Supply Filtering**

See SFF-8679



**Mechanical Diagram**



**Order Information**

**Table 9 – Order Information**

| Part No.       | Application  | Data Rate    | Laser Source | Fiber Type |
|----------------|--------------|--------------|--------------|------------|
| SPQ-CE-ER-CDFL | 100G 4WDM-40 | 103.125 Gb/s | LAN WDM EML  | SMF        |

## Warnings

**Handling Precautions:** This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.

**Laser Safety:** Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

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