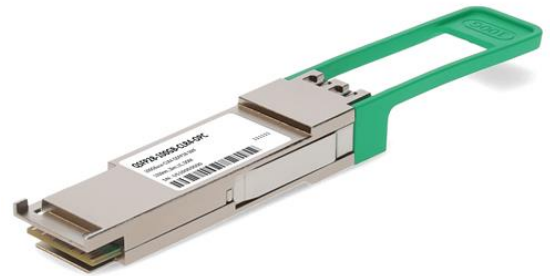


## **QSFP28-100GB-CLR4-OPC**

MSA and TAA 100GBase-CLR4 QSFP28 Transceiver (SMF, 1310nm, 2km, LC, DOM)

### **Features**

- Compliant with QSFP28 MSA
- Supports 100Gbps
- Single 3.3V Power Supply
- Power Dissipation is
- 4\*25Gbps DFB-based CWDM transmitter
- PIN and TIA array on the receiver side
- 4x25G Electrical Interface
- Duplex LC Connector
- Single-mode Fiber
- Commercial Temperature 0 to 70 Celsius
- RoHS Compliant and Lead Free



### **Applications:**

- 100G CLR4 applications with or without FEC

### **Product Description**

This MSA compliant QSFP28 transceiver provides 100GBase-CLR4 throughput up to 2km over single-mode fiber (SMF) using a wavelength of 1310nm via an LC connector. It can operate at temperatures between 0 and 70C. All of our transceivers are built to comply with Multi-Source Agreement (MSA) standards and are uniquely serialized and tested for data-traffic and application to ensure seamless network integration. Additional product features include Digital Optical Monitoring (DOM) support which allows access to real-time operating parameters. This transceiver is Trade Agreements Act (TAA) compliant. We stand behind the quality of our products and proudly offer a limited lifetime warranty.

## Absolute Maximum Ratings

| Parameter                          |              | Symbol            | Min.  | Typ. | Max.                 | Unit  | Notes |
|------------------------------------|--------------|-------------------|-------|------|----------------------|-------|-------|
| Power Supply Voltage               |              | V <sub>CC</sub>   | -0.5  | 3.3  | 3.6                  | V     |       |
| Power Supply Voltage               |              | V <sub>CC</sub>   | 3.135 | 3.3  | 3.465                | V     |       |
| Power Supply Noise                 |              |                   |       |      | 66                   | mVp-p | 1     |
| Power Dissipation                  |              | P <sub>DISS</sub> |       |      | 3.5                  | W     |       |
| Storage Temperature                |              | T <sub>stg</sub>  | -40   |      | 85                   | °C    |       |
| Operating Case Temperature         |              | T <sub>c</sub>    | 0     | 25   | 70                   | °C    | 2     |
| Relative Humidity                  |              | RH                | 5     |      | 85                   | %     |       |
| Data Input Voltage                 | Single-Ended |                   | -0.5  |      | V <sub>CC</sub> +0.5 | V     |       |
|                                    | Differential |                   |       |      | 0.8                  | V     | 3     |
| Receiver Damage Threshold Per Lane |              | Rxdmg             | 3.3   |      |                      | dBm   |       |

### Notes:

1. Power Supply Noise is defined as the peak-to-peak noise amplitude over the frequency range at the host supply side of the recommended power supply filter with the module and recommended filter in place. Voltage levels including peak-to-peak noise are limited to the recommended operating range of the associated power supply. See below for the recommended power supply filter.
2. The position of the case temperature measurement is shown below. Continuous operation at the maximum Recommended Operating Case Temperature should be avoided in order to not degrade reliability.
3. This is the maximum voltage that can be applied across the differential inputs without damaging the input circuitry. The damage threshold of the module input shall be at least 1600mV peak-to-peak differential.
4. Exposure to current surges and overvoltage events can cause immediate damage to the transceiver module. Observe the precautions for normal operation of electrostatic discharge sensitive equipment. Attention shall also be paid to limiting transceiver module exposure to conditions beyond those specified in the absolute maximum ratings.
5. Optical connectors include female connectors. These elements will be exposed as long as the cable or port plug is not inserted. At this time, always pay attention to protection.
6. Each module is equipped with a port guard plug to protect the optical port. The protective plug shall always be in place whenever the optical fiber is not inserted. Before inserting the optical fiber, it is recommended to clean the end of the optical fiber connector to avoid contamination of the module optical port due to a dirty connector. If contamination occurs, use standard LC port cleaning methods.
7. Exceeding the Absolute Maximum Ratings table may cause permanent damage to the device. This is just an emphasized rating and does not involve the functional operation of the device that exceeds the specifications of this technical specification under these or other conditions. Long-term operation under Absolute Maximum Ratings will affect the reliability of the device.

## Electrical Characteristics

| Parameter                                                     | Test Point | Min.              | Typ. | Max. | Unit | Notes |
|---------------------------------------------------------------|------------|-------------------|------|------|------|-------|
| Transceiver Power Consumption                                 |            |                   |      | 3.5  | W    |       |
| Transceiver Power Supply Total Current                        |            |                   |      | 1120 | mA   |       |
| AC Coupling Capacitors (Internal)                             |            |                   | 0.1  |      | μF   |       |
| Input Characteristics                                         |            |                   |      |      |      |       |
| Signaling Rate Per Lane                                       | TP1        | 25.78125 ± 100ppm |      |      | GBd  | 1     |
| Differential pk-pk Input Voltage Tolerance                    | TP1a       | 900               |      |      | mV   |       |
| Single-Ended Voltage Tolerance Range                          | TP1a       | -0.4              |      | 3.3  | V    |       |
| DC Common-Mode Output Voltage                                 | TP1        | -350              |      | 2850 | mV   | 2     |
| Differential Input Return Loss (Minimum)                      | TP1        | Equation (83E-5)  |      |      | dB   | 3     |
| Differential- to Common-Mode Input Return Loss (Minimum)      | TP1        | Equation (83E-6)  |      |      | dB   | 3     |
| Differential Termination Mismatch                             | TP1        |                   |      | 10   | %    |       |
| Module Stressed Input Test                                    | TP1a       |                   |      |      |      | 4     |
| Eye Width                                                     |            |                   | 0.46 |      | UI   |       |
| Applied pk-pk Sinusoidal Jitter                               |            | Table 88-13       |      |      |      | 3     |
| Eye Height                                                    |            |                   | 95   |      | mV   |       |
| Output Characteristics                                        |            |                   |      |      |      |       |
| Signaling Speed Per Lane                                      | TP4        | 25.78125 ± 100ppm |      |      | GBd  | 1     |
| AC Common-Mode Output Voltage (RMS)                           | TP4        |                   | 17.5 |      | mV   |       |
| DC Common-Mode Voltage                                        | TP4        | -350              |      | 2850 | mV   | 5     |
| Differential Output Voltage                                   | TP4        |                   |      | 900  | mV   |       |
| Differential Output Return Loss (Minimum)                     | TP4        | Equation (83E-2)  |      |      | dB   |       |
| Common- to Differential-Mode Conversion Return Loss (Minimum) | TP4        | Equation (83E-3)  |      |      | dB   |       |
| Differential Termination Mismatch                             | TP4        |                   |      | 10   | %    |       |
| Transition Time (20-80%)                                      | TP4        | 12                |      |      | ps   |       |
| Eye Width                                                     | TP4        | 0.57              |      |      | UI   |       |
| Eye Height Differential                                       | TP4        | 228               |      |      | mV   |       |
| Vertical Eye Closure                                          | TP4        |                   |      | 5.5  | dB   |       |

### Notes:

1. CAUI-4 operation with host-generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.
2. DC common-mode voltage is generated by the host. Specification includes the effects of ground offset voltage.
3. 802.3bm.
4. Module stressed input tolerance is measured using the procedure defined in 83E.3.4.1.1.

5. DC common-mode voltage is generated by the host. Specification includes the effects of ground offset voltage.
6. Unless otherwise stated, the above characteristics are defined under recommended operating conditions.
7. For control signal timing, including ModSelL, ResetL, LPMode/TxDis, ModPrsL, IntL/RxLOSL, SCL, and SDA, see Control Interface Section.

## Optical Characteristics

| Parameter                                               | Symbol                             | Min.   | Typ.     | Max.   | Unit  | Notes |
|---------------------------------------------------------|------------------------------------|--------|----------|--------|-------|-------|
| Transmitter                                             |                                    |        |          |        |       |       |
| Signaling Speed Per Lane                                | BRAVE                              |        | 25.78125 |        | Gbps  | 1     |
| Data Rate Variation                                     |                                    | -100   |          | 100    | ppm   |       |
| Modulation Format                                       |                                    |        | NRZ      |        |       |       |
| Lane 0 Center Wavelength                                | λC0                                | 1264.5 |          | 1277.5 | nm    |       |
| Lane 1 Center Wavelength                                | λC1                                | 1284.5 |          | 1297.5 | nm    |       |
| Lane 2 Center Wavelength                                | λC2                                | 1304.5 |          | 1317.5 | nm    |       |
| Lane 3 Center Wavelength                                | λC3                                | 1324.5 |          | 1337.5 | nm    |       |
| Total Average Output Power                              | Po                                 |        |          | 8.3    | dBm   |       |
| Average Launch Power Per Lane                           | Peach                              | -6.5   |          | 2.3    | dBm   | 2     |
| Transmit OMA Per Lane                                   | TxOMA                              | -4.0   |          | 2.5    | dBm   | 3     |
| Launch Power in OMA Minus TDP Per Lane                  | OMA-TDP                            | -5.0   |          |        | dBm   |       |
| Average Launch Power of Off Transmitter Per Lane        | Poff                               |        |          | -30    | dBm   |       |
| Transmitter and Dispersion Penalty Per Lane             | TDP                                |        |          | 3      | dB    | 4     |
| Side-Mode Suppression Ratio                             | SMSR                               | 30     |          |        | dB    |       |
| Optical Return Loss Tolerance                           | ORLT                               |        |          | 20     | dB    |       |
| Transmitter Reflectance                                 |                                    |        |          | -12    | dB    | 5     |
| Extinction Ratio                                        | ER                                 | 3.5    |          |        | dB    |       |
| RIN OMA                                                 | RIN                                |        |          | -130   | dB/Hz |       |
| Transmitter Eye Mask Definition: X1, X2, X3, Y1, Y2, Y3 | (0.25, 0.4, 0.45, 0.25, 0.28, 0.4) |        |          |        |       | 6     |
| Receiver                                                |                                    |        |          |        |       |       |
| Signaling Speed Per Lane                                | BRAVE                              |        | 25.78125 |        | Gbps  | 1     |
| Data Rate Variation                                     |                                    | -100   |          | 100    | ppm   |       |
| Receiver Differential Data Output Load                  |                                    | 100    |          |        | Ω     |       |
| Damage Threshold                                        | Rxdmg                              | 3.3    |          |        | dBm   |       |
| Lane 0 Center Wavelength                                | λC0                                | 1264.5 |          | 1277.5 | nm    |       |
| Lane 1 Center Wavelength                                | λC1                                | 1284.5 |          | 1297.5 | nm    |       |

|                                                            |                |        |  |        |     |    |
|------------------------------------------------------------|----------------|--------|--|--------|-----|----|
| Lane 2 Center Wavelength                                   | $\lambda_{C2}$ | 1304.5 |  | 1317.5 | nm  |    |
| Lane 3 Center Wavelength                                   | $\lambda_{C3}$ | 1324.5 |  | 1337.5 | nm  |    |
| Average Receive Power Per Lane                             | Rxpow          | -10    |  | 2.3    | dBm | 7  |
| Receive Power (OMA) Per Lane                               | RxOMA          |        |  | 2.5    | dBm |    |
| Unstressed Receive Sensitivity (OMA) With FEC Per Lane     | Rxsens_FEC     |        |  | -11    | dBm | 8  |
| Unstressed Receiver Sensitivity (OMA) Without FEC Per Lane | Rxsens         |        |  | -8.5   | dBm | 8  |
| Stressed Receiver Sensitivity (OMA) With FEC Per Lane      | RxSRS_FEC      |        |  | -8.5   | dBm | 9  |
| Stressed Receiver Sensitivity (OMA) Without FEC Per Lane   | RxSRS          |        |  | -6     | dBm | 9  |
| Receiver Reflectance                                       |                |        |  | -26    | dB  |    |
| Conditions of Stressed Receiver Sensitivity Test           |                |        |  |        |     |    |
| Vertical Eye Closure Penalty                               | VECP           |        |  | 2.5    | dB  | 10 |
| Stressed J2 Jitter With FEC                                | J2             |        |  | TBD    | UI  | 10 |
| Stressed J4 Jitter With FEC                                | J4             |        |  | TBD    | UI  | 10 |
| Stressed J2 Jitter Without FEC                             | J2             |        |  | 0.3    | UI  | 11 |
| Stressed J9 Jitter Without FEC                             | J9             |        |  | 0.47   | UI  | 11 |
| LOS Assert                                                 | LOSA           | -25    |  |        | dBm |    |
| LOS De-Assert                                              | LOSD           |        |  | -12    | dBm |    |
| LOS Hysteresis                                             | LOSH           | 0.5    |  |        | dB  |    |

#### Notes:

- 100G FR4 operation with the host-generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.1.
- Average launch power, per lane (minimum), is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.
- Even if the TDP<1.0dB, the OMA (minimum) must exceed this value.
- TDP does not include a penalty for multi-path interference (MPI).
- Transmitter reflectance is defined looking into the transmitter.
- With FEC hit ratio of  $5 \times 10^{-5}$ . Without FEC hit ratio of  $1 \times 10^{-12}$ .
- Average receive power, per lane (minimum), is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
- With FEC sensitivity is specified at  $5 \times 10^{-5}$  BER. Without FEC sensitivity is specified at  $1 \times 10^{-12}$  BER.
- With FEC measured with conformance test signal at TP3 for BER= $5 \times 10^{-5}$ . Without FEC measured with conformance test signal at TP3 for BER= $1 \times 10^{-12}$ .
- Vertical eye closure penalty, stressed eye J2 Jitter, stressed eye J4 Jitter, and SRS eye mask definition are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.
- Vertical eye closure penalty, stressed eye J2 Jitter, stressed eye J9 Jitter, and SRS eye mask definition are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

12. Unless otherwise stated, the above characteristics are defined under recommended operating conditions.
13. Power supply specifications, instantaneous, sustained, and steady state current compliant with QSFP28 MSA Power Classification.

## Pin Descriptions

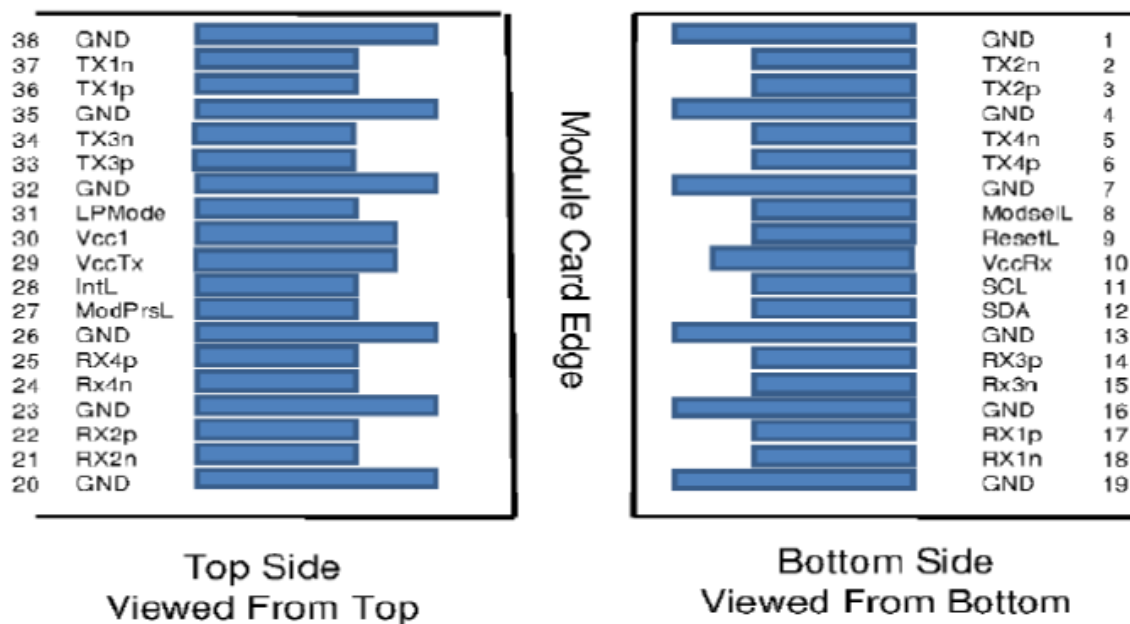
| Pin | Logic       | Symbol  | Name/Description                     | Plug Sequence | Note |
|-----|-------------|---------|--------------------------------------|---------------|------|
| 1   |             | GND     | Module Ground.                       | 1             | 1    |
| 2   | CML-I       | Tx2-    | Transmitter Inverted Data Input.     | 3             |      |
| 3   | CML-I       | Tx2+    | Transmitter Non-Inverted Data Input. | 3             |      |
| 4   |             | GND     | Module Ground.                       | 1             | 1    |
| 5   | CML-I       | Tx4-    | Transmitter Inverted Data Input.     | 3             |      |
| 6   | CML-I       | Tx4+    | Transmitter Non-Inverted Data Input. | 3             |      |
| 7   |             | GND     | Module Ground.                       | 1             | 1    |
| 8   | LVTTL-I     | ModSelL | Module Select.                       | 3             |      |
| 9   | LVTTL-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     | Module Ground.                       | 1             | 1    |
| 14  | CML-O       | Rx3+    | Receiver Non-Inverted Data Output.   | 3             |      |
| 15  | CML-O       | Rx3-    | Receiver Inverted Data Output.       | 3             |      |
| 16  |             | GND     | Module Ground.                       | 1             | 1    |
| 17  | CML-O       | Rx1+    | Receiver Non-Inverted Data Output.   | 3             |      |
| 18  | CML-O       | Rx1-    | Receiver Inverted Data Output.       | 3             |      |
| 19  |             | GND     | Module Ground.                       | 1             | 1    |
| 20  |             | GND     | Module Ground.                       | 1             | 1    |
| 21  | CML-O       | Rx2-    | Receiver Inverted Data Output.       | 3             |      |
| 22  | CML-O       | Rx2+    | Receiver Non-Inverted Data Output.   | 3             |      |
| 23  |             | GND     | Module Ground.                       | 1             | 1    |
| 24  | CML-O       | Rx4-    | Receiver Inverted Data Output.       | 3             |      |
| 25  | CML-O       | Rx4+    | Receiver Non-Inverted Data Output.   | 3             |      |
| 26  |             | GND     | Module Ground.                       | 1             | 1    |
| 27  | LVTTL-O     | ModPrsL | Module Present.                      | 3             |      |
| 28  | LVTTL-O     | IntL    | Interrupt.                           | 3             |      |
| 29  |             | VccTx   | +3.3V Transmitter Power Supply.      | 2             | 2    |
| 30  |             | Vcc1    | +3.3V Power Supply.                  | 2             | 2    |
| 31  | LVTTL-I     | LPMODE  | Low-Power Mode.                      | 3             |      |
| 32  |             | GND     | Module Ground.                       | 1             | 1    |

|    |       |      |                                      |   |   |
|----|-------|------|--------------------------------------|---|---|
| 33 | CML-I | Tx3+ | Transmitter Non-Inverted Data Input. | 3 |   |
| 34 | CML-I | Tx3- | Transmitter Inverted Data Input.     | 3 |   |
| 35 |       | GND  | Module Ground.                       | 1 | 1 |
| 36 | CML-I | Tx1+ | Transmitter Non-Inverted Data Input. | 3 |   |
| 37 | CML-I | Tx1- | Transmitter Inverted Data Input.     | 3 |   |
| 38 |       | GND  | Module Ground.                       | 1 | 1 |

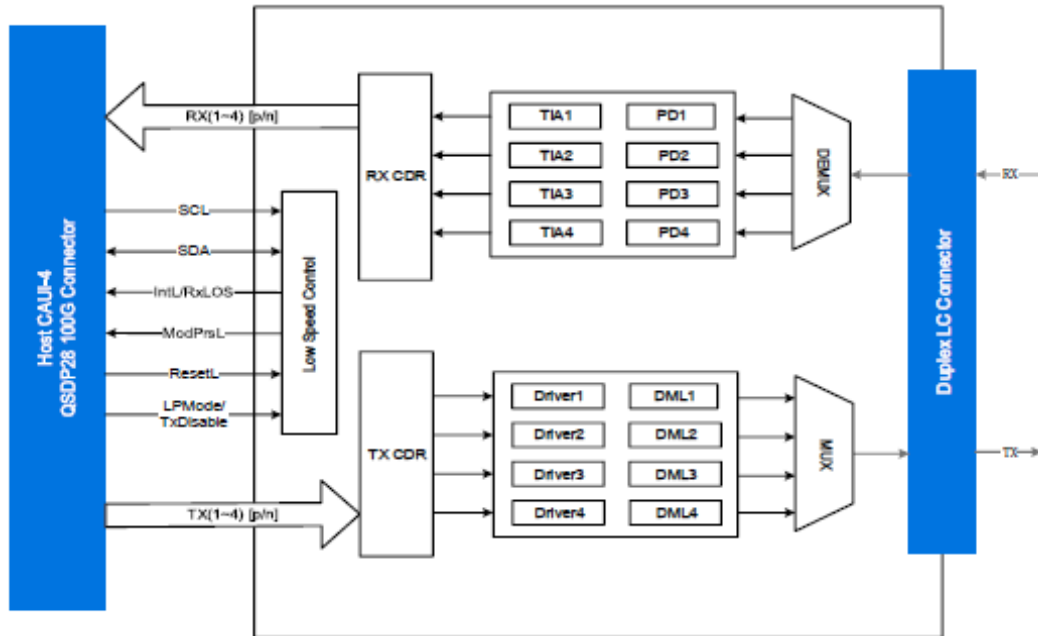
#### Notes:

1. GND is the symbol for signal and supply (power) common for the module. All are common within the 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. VccRx, Vcc1, and VccTx are applied concurrently and may be internally connected within the module in any combination. Vcc contacts in SFF-8662 and SFF-8672 each have a steady state current rating of 1A.
3. The control signal interface is compliant with QSFP28 MSA. The following pins are provided to control the module or display the module's status: ModSelL, ResetL, LPMode/TxDis, ModPrsL, and IntL/RxLOSL. In addition, there is an industry standard 2-wire serial interface scaled for 3.3V LVTTTL. The definition of the control signal interface and the registers of the serial interface memory are defined in the Control Interface Electrical Specifications section.

#### Electrical Pad Layout



## Transceiver Block Diagram

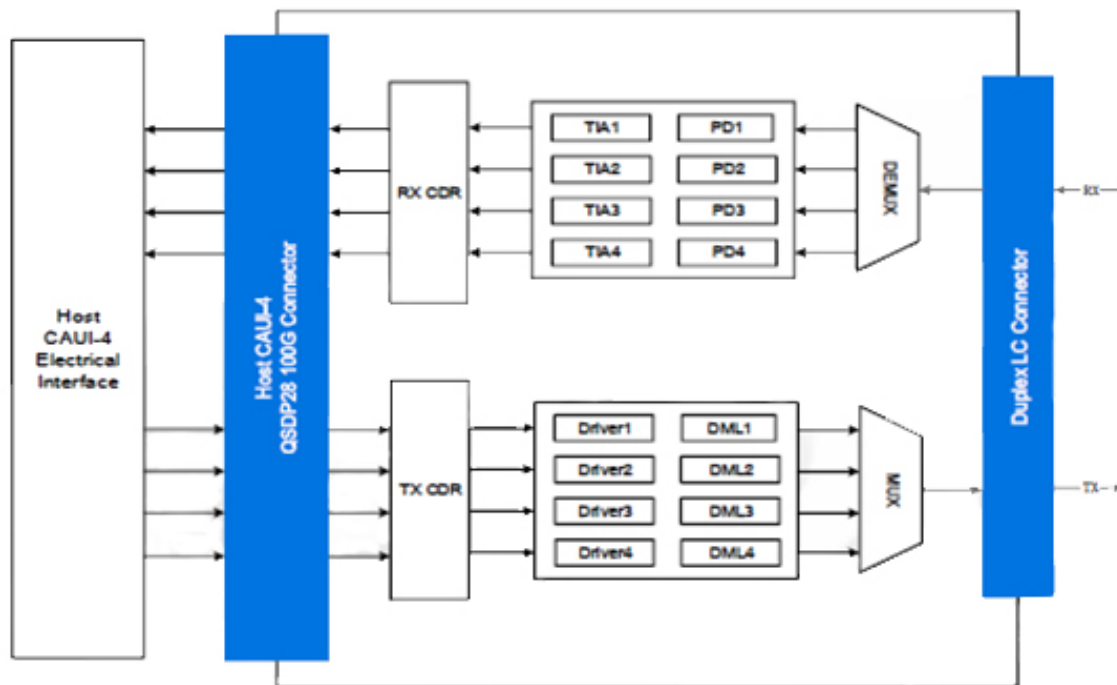


### Notes:

1. The transmitter path of the transceiver contains a 4x25Gbps, CAUI-4 electrical input with equalization (EQ) block, optical multiplexer, 4 channels directly modulated lasers (DML), laser driver, clock and recovery (CDR), and diagnostic monitoring. The transmitter converts 4 channels of 25Gbps electrical input data to 4 channels of 25Gbps CWDM optical signals. The optical multiplexer multiplexes them into a single channel for 100Gbps optical transmission.
2. The receiver path of the transceiver contains 4-channel PIN photodiodes (PD), trans-impedance amplifiers (TIA), de-multiplexer, clock and recovery (CDR), and 4x25G CAUI-4 compliant electrical output blocks. The receiver optically de-multiplexes a 100Gbps optical input into 4 channels of CWDM optical signals, converts 4 channels of 25Gbps CWDM optical signals to 4 channels of 25Gbps electrical output data.



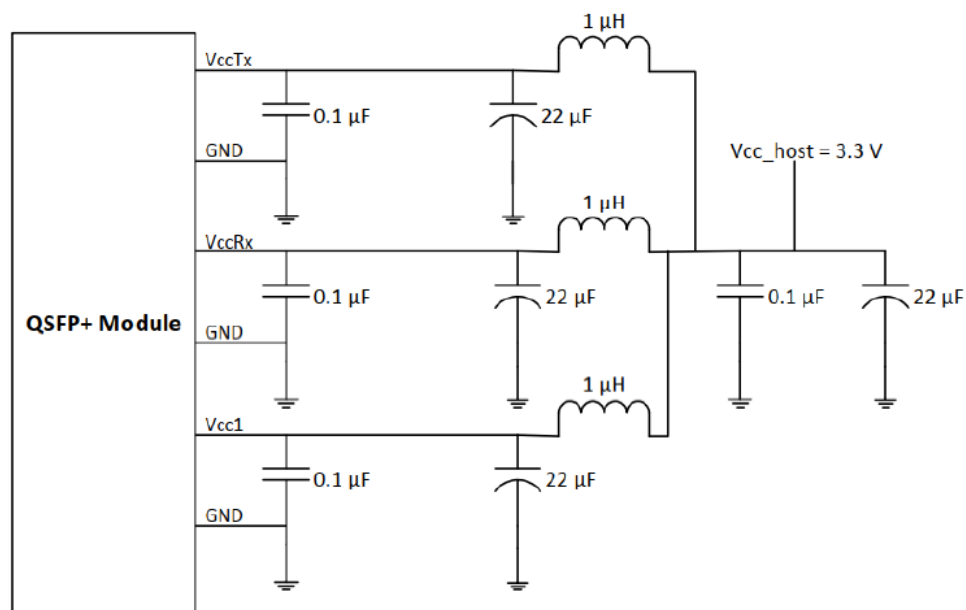
## Application Reference Diagram



### Notes:

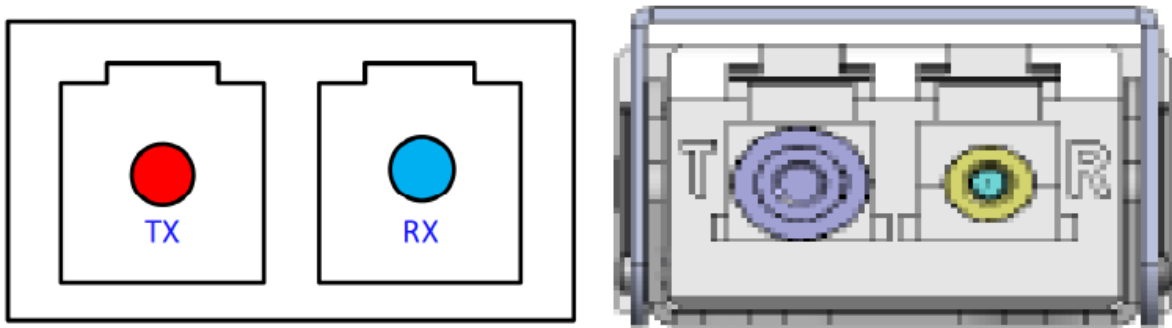
1. The interface between the QSFP28 module and ASIC/SerDes is shown above. The high-speed signal lines are internally AC coupled, and the electrical inputs are internally terminated to 100Ω differential. All transmitter and receiver electrical channels are compliant to module CAUI-4 specifications per IEEE 802.3bm.

## Host Board Power Supply Filter



**Notes:**

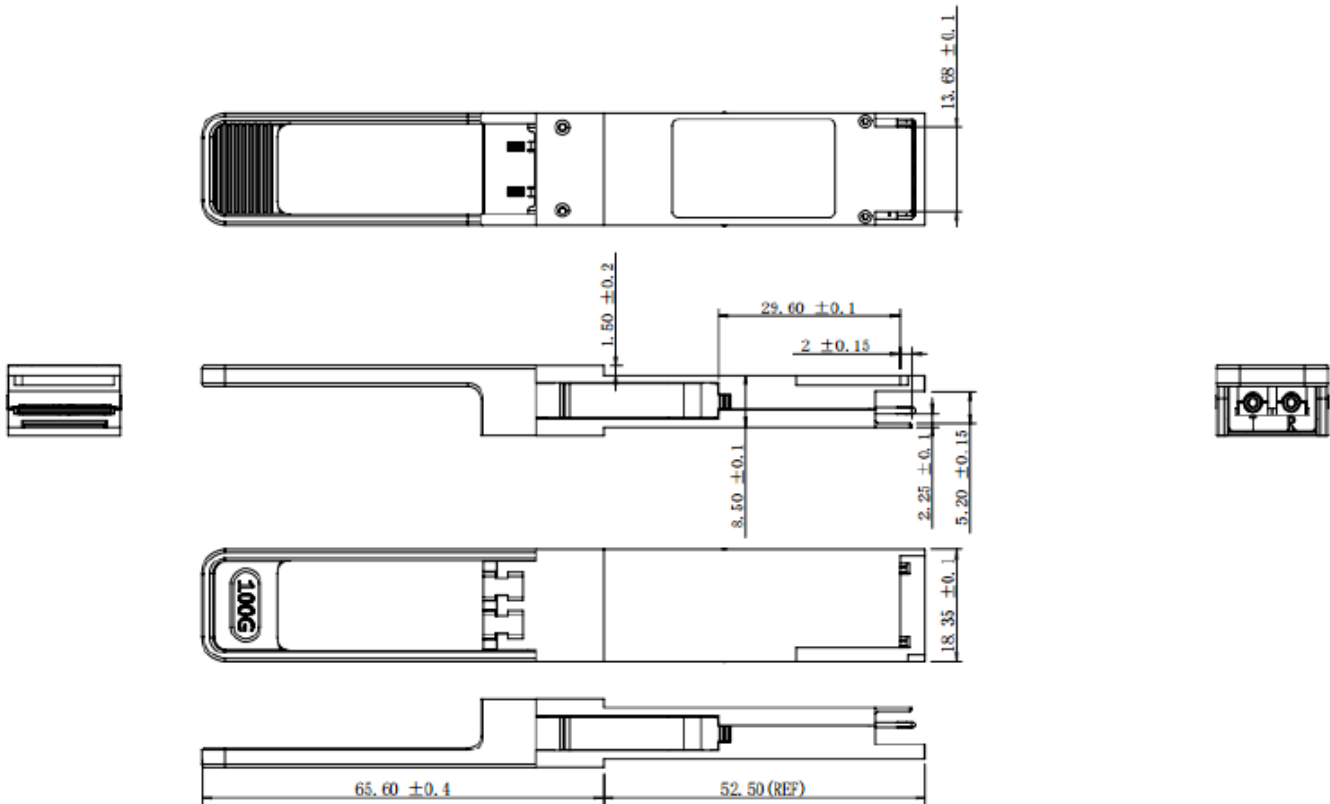
1. During power transient events, the host should ensure that any neighboring modules sharing the same supply stay within their specified supply voltage limits. The host should also ensure that the intrinsic noise of the power rail is filtered in order to guarantee the correct operation of the optical modules. The reference power supply filter is shown above.

**Module Optical Interface****Notes:**

1. Looking into the optical port. The optical interface port is a duplex LC connector as specified in IEC 61754-20.

**Mechanical Specifications**

The module is designed to meet the requirements defined by the QSFP28 MSA specifications.



All dimensions are in mm.