

**Specification**  
**100Gb/s QSFP28 to 4x SFP28 Fanout**  
**Optical Transceiver Module**



**Ordering Information**

**TQS-214H8-X82xx**

**Distance**

| Part Number     | Discription                                        |
|-----------------|----------------------------------------------------|
| TQS-214H8-X8201 | QSFP-28 to SFP28 Breakout Active Optical Cable 1m  |
| TQS-214H8-X8203 | QSFP-28 to SFP28 Breakout Active Optical Cable 3m  |
| TQS-214H8-X8205 | QSFP-28 to SFP28 Breakout Active Optical Cable 5m  |
| TQS-214H8-X8207 | QSFP-28 to SFP28 Breakout Active Optical Cable 7m  |
| TQS-214H8-X8210 | QSFP-28 to SFP28 Breakout Active Optical Cable 10m |
| TQS-214H8-X8220 | QSFP-28 to SFP28 Breakout Active Optical Cable 20m |
| TQS-214H8-X8230 | QSFP-28 to SFP28 Breakout Active Optical Cable 30m |

| Model Name      | Voltage | Category  | Device type | Interface | Temperature | Distance | Latch Color |       |
|-----------------|---------|-----------|-------------|-----------|-------------|----------|-------------|-------|
| TQS-214H8-X82xx | 3.3V    | With DDMI | VCSEL       | CML/CML   | 0 ~+70°C    | NA       | SFP28       | Black |
|                 |         |           |             |           |             |          | QSFP28      | Beige |

## Features

- 4 independent full-duplex channels
- Up to 28Gb/s data rate per channel
- QSFP28 and SFP28 MSA compliant
- Up to 10m OM4 MMF transmission
- Single +3.3V power supply
- Operating case temperature: 0 to 70°C
- Maximum power consumption of 3.5W for QSFP28 terminal and 1.0W for each SFP28 terminal
- RoHS compliant

## Applications

- 100GBASE Ethernet Links
- Infiniband EDR interconnects

## General Description

This product is a high data rate parallel active optical cable (AOC), to overcome the bandwidth limitation of traditional copper cable. The AOC is terminated with a QSFP28 module at one end and four SFP28 modules at the other. With the QSFP28 terminal, it offers 4 independent data transmission channels and 4 data receiving channels via multimode ribbon fibers, each capable of 25Gb/s operation. The fiber ribbon then fans out to four fiber cables, each of which is terminated with an SFP28 module.

The product is designed with form factor, optical/electrical connection according to the QSFP28 and SFP28 Multi-Source Agreements (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

## Functional Description

The QSFP28 module converts the parallel electrical input signals into parallel optical signals by a driven Vertical Cavity Surface Emitting Laser (VCSEL) array inside the QSFP28 module on its transmitter side. The optical signals propagate first through 4 optical data transmission lanes in the multimode ribbon fibers and then through those of the 4 separate dual-core fiber cables. They are then captured by the photo diodes inside the receivers of the 4 SFP28 modules at the other end. The optical signals are

---

converted into electrical signals, which are outputted by the receivers of the 4 SFP28 modules individually.

In the reverse direction, each of the 4 SFP28 modules converts the electrical input signal into an optical signal by a driven VCSEL inside the module on its transmitter side. The 4 optical signals propagate first through the other transmission lanes of the 4 separate dual-core fiber cables and then through those in the multimode ribbon fibers. They are captured by the photo diode array inside the QSFP28 on its receiver side. The optical signals are converted into parallel electrical signals and outputted. Consequently, the QSFP28 terminal of the cable has 8 ports, 4 for data transmission and 4 for data receiving, to provide a total of 100Gb/s data exchange rate while each of the 4 SFP28 terminals at the other end has 2 ports, 1 for data transmission and 1 for receiving, to provide 25Gb/s data exchange rate.

For QSFP28 terminal, a single +3.3V power supply is required to power up this product. Both power supply pins VccTx and VccRx are internally connected and should be applied concurrently. As per MSA specifications the module offers 7 low speed hardware control pins (including the 2-wire serial interface): ModSelL, SCL, SDA, ResetL, LPMode, ModPrsL and IntL.

Module Select (ModSelL) is an input pin. When held low by the host, this product responds to 2-wire serial communication commands. The ModSelL allows the use of this product on a single 2-wire interface bus – individual ModSelL lines must be used.

Serial Clock (SCL) and Serial Data (SDA) are required for the 2-wire serial bus communication interface and enable the host to access the QSFP28 memory map.

The ResetL pin enables a complete reset, returning the settings to their default state, when a low level on the ResetL pin is held for longer than the minimum pulse length. During the execution of a reset the host shall disregard all status bits until it indicates a completion of the reset interrupt. The product indicates this by posting an IntL (Interrupt) signal with the Data\_Not\_Ready bit negated in the memory map. Note that on power up (including hot insertion) the module should post this completion of reset interrupt without requiring a reset.

Low Power Mode (LPMode) pin is used to set the maximum power consumption for the product in order to protect hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

Module Present (ModPrsL) is a signal local to the host board which, in the absence of a product, is normally pulled up to the host Vcc. When the product is inserted into the connector, it completes the path to ground through a resistor on the host board and asserts the signal. ModPrsL then indicates it is present by setting ModPrsL to a “Low” state.

Interrupt (IntL) is an output pin. “Low” indicates a possible 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 the Host Vcc voltage on the Host board.

The SFP28 module electrical interface is compliant to SFI electrical specifications. The transmitter input and receiver output impedance is 100 Ohms differential. Data lines are internally AC coupled. The module provides differential termination and reduce differential to common mode conversion for quality signal termination and low EMI. SFI typically operates over 200 mm of improved FR4 material or up to about 150mm of standard FR4 with one connector.

The transmitter converts 25Gbit/s serial PECL or CML electrical data into serial optical data. An open collector compatible Transmit Disable (Tx\_Dis) is provided. Logic "1" or no connection on this pin will disable the laser from transmitting. Logic "0" on this pin provides normal operation. The transmitter has an internal automatic power control loop (APC) to ensure constant optical power output across supply voltage and temperature variations. An open collector compatible Transmit Fault (Tx\_Fault) is provided. TX\_Fault is module output contact that when high, indicates that the module transmitter has detected a fault condition related to laser operation or safety. The TX\_Fault output contact is an open drain/collector and shall be pulled up to the Vcc\_Host in the host with a resistor in the range 4.7-10 kΩ. TX\_Disable is a module input contact. When TX\_Disable is asserted high or left open, the SFP28 module transmitter output shall be turned off. This contact shall be pulled up to VccT with a 4.7 kΩ to 10 kΩ resistor.

The receiver converts 25Gbit/s serial optical data into serial PECL/CML electrical data. An open collector compatible Loss of Signal is provided. Rx\_LOS when high indicates an optical signal level below that specified in the relevant standard. The Rx\_LOS contact is an open drain/collector output and shall be pulled up to Vcc\_Host in the host with a resistor in the range 4.7-10 kΩ, or with an active termination. Power supply filtering is recommended for both the transmitter and receiver. The Rx\_LOS signal is intended as a preliminary indication to the system in which the SFP28 is installed that the received signal

strength is below the specified range. Such an indication typically points to non-installed cables, broken cables, or a disabled, failing or a powered off transmitter at the far end of the cable.

## Pin Assignment and Pin Description

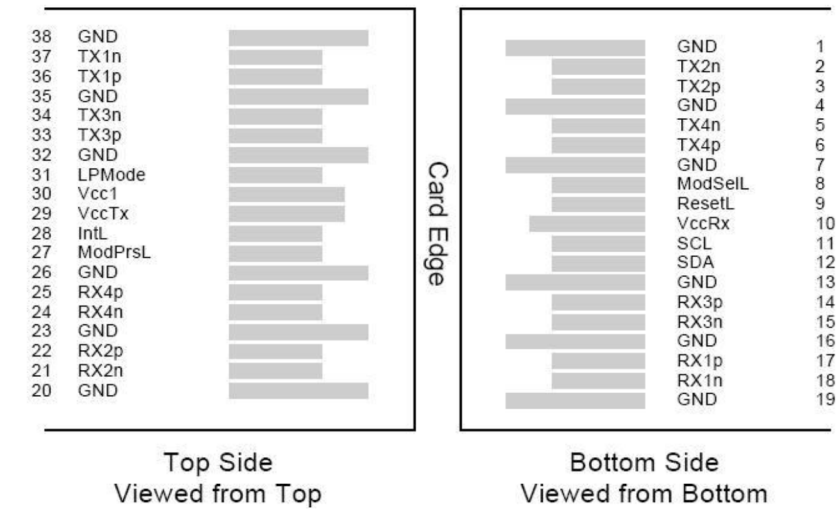


Figure 1. MSA compliant QSFP28 Connector

## Pin Definitions (QSFP28)

| PIN | Logic       | Symbol  | Name/Description                     | Note |
|-----|-------------|---------|--------------------------------------|------|
| 1   |             | GND     | Ground                               | 1    |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input      |      |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data output |      |
| 4   |             | GND     | Ground                               | 1    |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input      |      |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data output |      |
| 7   |             | GND     | Ground                               | 1    |
| 8   | LVTLL-I     | ModSelL | Module Select                        |      |
| 9   | LVTLL-I     | ResetL  | Module Reset                         |      |
| 10  |             | VccRx   | +3.3V Power Supply Receiver          | 2    |
| 11  | LVC MOS-I/O | SCL     | 2-Wire Serial Interface Clock        |      |
| 12  | LVC MOS-I/O | SDA     | 2-Wire Serial Interface Data         |      |
| 13  |             | GND     | Ground                               |      |
| 14  | CML-O       | Rx3p    | Receiver Non-Inverted Data Output    |      |
| 15  | CML-O       | Rx3n    | Receiver Inverted Data Output        |      |
| 16  |             | GND     | Ground                               | 1    |
| 17  | CML-O       | Rx1p    | Receiver Non-Inverted Data Output    |      |
| 18  | CML-O       | Rx1n    | Receiver Inverted Data Output        |      |
| 19  |             | GND     | Ground                               | 1    |
| 20  |             | GND     | Ground                               | 1    |
| 21  | CML-O       | Rx2n    | Receiver Inverted Data Output        |      |
| 22  | CML-O       | Rx2p    | Receiver Non-Inverted Data Output    |      |
| 23  |             | GND     | Ground                               | 1    |
| 24  | CML-O       | Rx4n    | Receiver Inverted Data Output        | 1    |
| 25  | CML-O       | Rx4p    | Receiver Non-Inverted Data Output    |      |
| 26  |             | GND     | Ground                               | 1    |
| 27  | LVTTL-O     | ModPrsL | Module Present                       |      |
| 28  | LVTTL-O     | IntL    | Interrupt                            |      |
| 29  |             | VccTx   | +3.3 V Power Supply transmitter      | 2    |
| 30  |             | Vcc1    | +3.3 V Power Supply                  | 2    |
| 31  | LVTTL-I     | LPMODE  | Low Power Mode                       |      |
| 32  |             | GND     | Ground                               | 1    |
| 33  | CML-I       | Tx3p    | Transmitter Non-Inverted Data Input  |      |
| 34  | CML-I       | Tx3n    | Transmitter Inverted Data Output     |      |

|    |       |      |                                     |   |
|----|-------|------|-------------------------------------|---|
| 35 |       | GND  | Ground                              | 1 |
| 36 | CML-I | Tx1p | Transmitter Non-Inverted Data Input |   |
| 37 | CML-I | Tx1n | Transmitter Inverted Data Output    |   |
| 38 |       | GND  | Ground                              | 1 |

**Notes:**

1. GND is the symbol for signal and supply (power) common for the QSFP28 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 the receiving and transmission power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown in Figure 3 below. Vcc Rx, Vcc1 and Vcc Tx may be internally connected within the QSFP28 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

**SFP28 Terminals**

The SFP28 modules are hot-pluggable. Hot pluggable refers to plugging in or unplugging a module while the host board is powered. The SFP28 host connector is a 0.8 mm pitch 20 position right angle improved connector specified by SFF-8083, or stacked connector with equivalent with equivalent electrical performance. Host PCB contact assignment is shown in Figure 2 and contact definitions are given in the PIN description table. SFP28 module contacts mates with the host in the order of ground, power, followed by signal as illustrated by Figure 3 and the contact sequence order listed in the PIN description table.

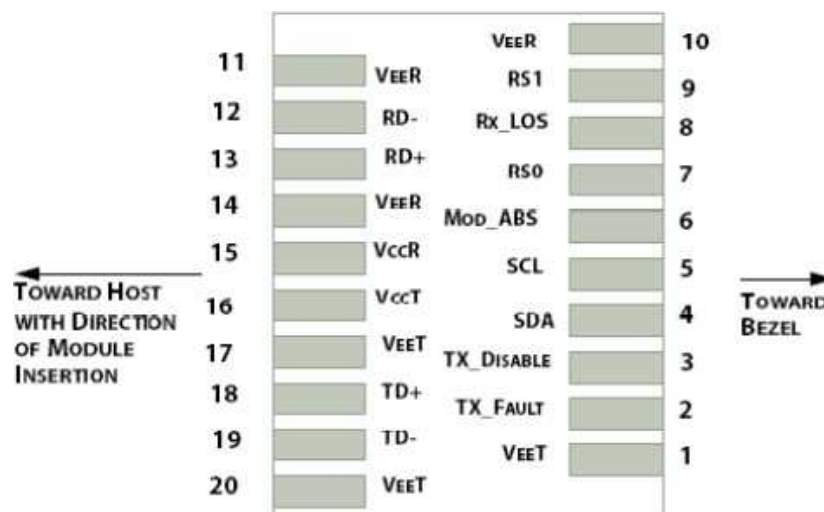


Figure 2. SFP28 Module Interface to Host





Figure 3. SFP28 Module Contact Assignment

### SFP28

| PIN | Logic     | Symbol   | Name / Description                                      | Notes |
|-----|-----------|----------|---------------------------------------------------------|-------|
| 1   |           | VeeT     | Module Transmitter Ground                               | 1     |
| 2   | LVTTL-O   | TX_Fault | Module Transmitter Fault                                |       |
| 3   | LVTTL-I   | TX_Dis   | Transmitter Disable; Turns off transmitter laser output |       |
| 4   | LVTTL-I/O | SDA      | 2-Wire Serial Interface Data Line                       | 2     |
| 5   | LVTTL-I   | SCL      | 2-Wire Serial Interface Clock                           | 2     |
| 6   |           | MOD_DEF0 | Module Definition, Grounded in the module               |       |
| 7   | LVTTL-I   | RS0      | Receiver Rate Select                                    |       |
| 8   | LVTTL-O   | RX_LOS   | Receiver Loss of Signal Indication Active LOW           |       |
| 9   | LVTTL-I   | RS1      | Transmitter Rate Select (not used)                      |       |
| 10  |           | VeeR     | Module Receiver Ground                                  | 1     |
| 11  |           | VeeR     | Module Receiver Ground                                  | 1     |
| 12  | CML-O     | RD-      | Receiver Inverted Data Output                           |       |
| 13  | CML-O     | RD+      | Receiver Data Output                                    |       |
| 14  |           | VeeR     | Module Receiver Ground                                  | 1     |
| 15  |           | VccR     | Module Receiver 3.3 V Supply                            |       |
| 16  |           | VccT     | Module Receiver 3.3 V Supply                            |       |
| 17  |           | VeeT     | Module Transmitter Ground                               | 1     |
| 18  | CML-I     | TD+      | Transmitter Non-Inverted Data Input                     |       |
| 19  | CML-I     | TD-      | Transmitter Inverted Data Input                         |       |
| 20  |           | VeeT     | Module Transmitter Ground                               | 1     |

### Notes:



1. Module ground pins GND are isolated from the module case.
2. Shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.

## Recommended Power Supply Filter

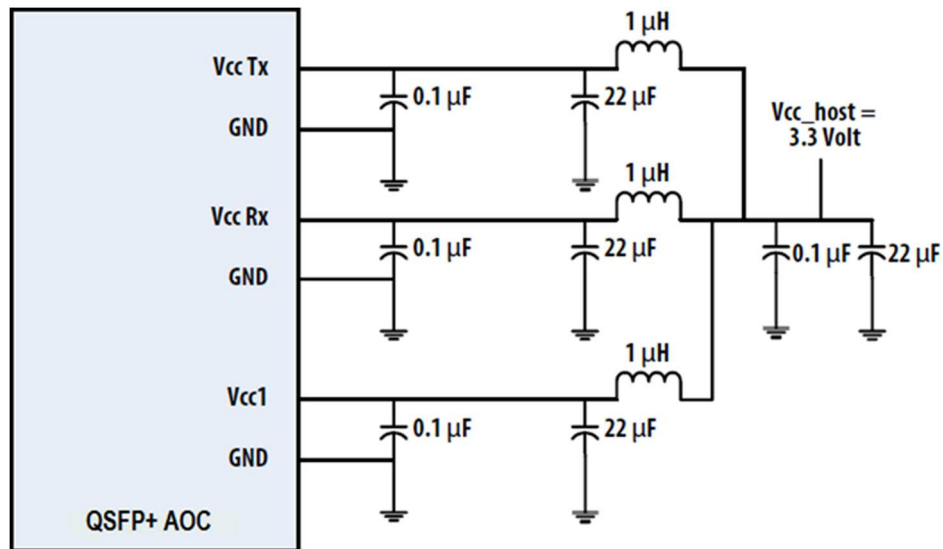


Figure 4. Recommended Power Supply Filter for QSFP28 Terminal

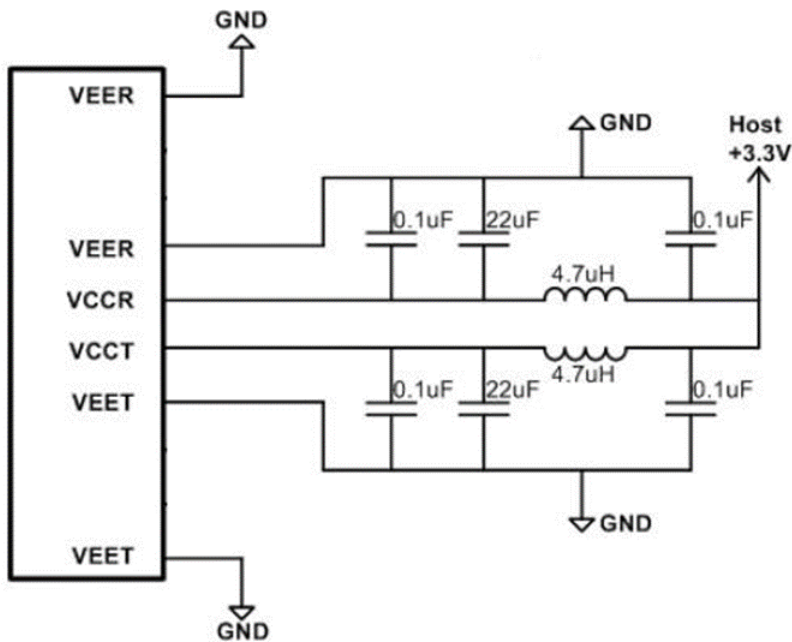


Figure 5. Recommended Power Supply Filter for SFP28 Terminals

## Absolute Maximum Ratings

It has to be noted that the operation in excess of any individual absolute maximum ratings might cause permanent damage to this module.

| Parameter                               | Symbol          | Min  | Max | Unit | Notes |
|-----------------------------------------|-----------------|------|-----|------|-------|
| Storage Temperature                     | T <sub>s</sub>  | -40  | 85  | °C   |       |
| Operating Case Temperature              | T <sub>OP</sub> | 0    | 70  | °C   |       |
| Power Supply Voltage                    | V <sub>CC</sub> | -0.5 | 3.6 | V    |       |
| Relative Humidity<br>(non-condensation) | RH              | 0    | 85  | %    |       |

## Recommended Operating Conditions and Power Supply Requirements

| Parameter                     | Symbol          | Min   | Typ.     | Max             | Unit |
|-------------------------------|-----------------|-------|----------|-----------------|------|
| Operating Case Temperature    | T <sub>OP</sub> | 0     |          | 70              | °C   |
| Power Supply Voltage          | V <sub>CC</sub> | 3.135 | 3.30     | 3.465           | V    |
| Data Rate, each Lane (QSFP28) |                 |       | 25.78125 | 28.05           | Gb/s |
| Data Rate (each SFP28)        |                 |       | 25.78125 | 28.05           | Gb/s |
| Control Input Voltage High    |                 | 2     |          | V <sub>CC</sub> | V    |
| Control Input Voltage Low     |                 | 0     |          | 0.8             | V    |

## Electrical Characteristics

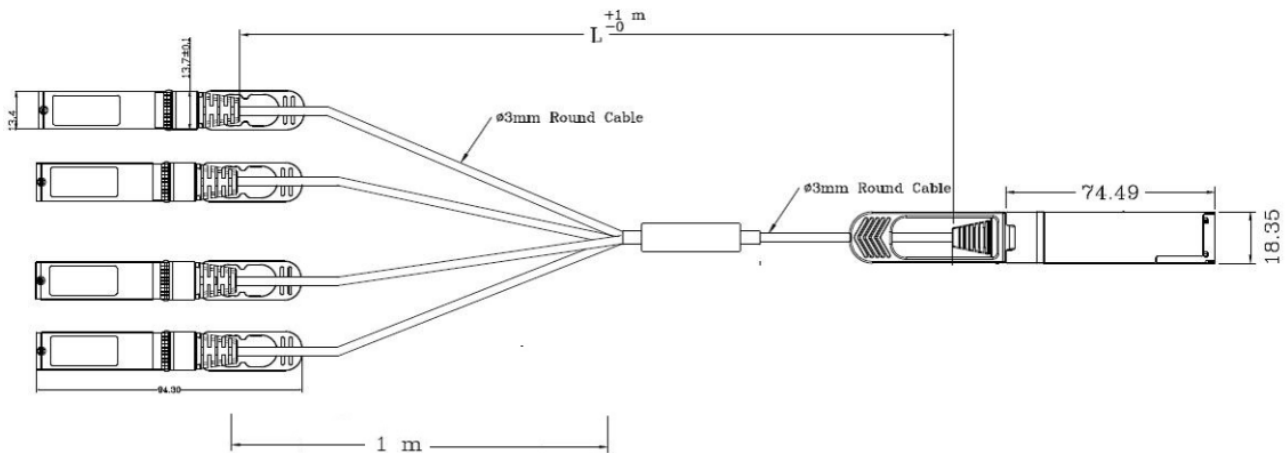
The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

(QSFP28 Terminal)

| Parameter                                        | Symbol              | Min  | Typ. | Max  | Units            | Notes             |
|--------------------------------------------------|---------------------|------|------|------|------------------|-------------------|
| Power Consumption<br>each Terminal               |                     |      |      | 3.5  | W                |                   |
| Supply Current<br>each Terminal                  | I <sub>cc</sub>     |      |      | 1060 | mA               |                   |
| Transceiver<br>Power-on Initialization Time      |                     |      |      | 2000 | ms               | 1                 |
| <b>Transmitter (each Lane)</b>                   |                     |      |      |      |                  |                   |
| Single Ended Input Voltage<br>Tolerance (Note 2) |                     | -0.3 |      | 3.6  | V                |                   |
| AC Common Mode Input Voltage<br>Tolerance        |                     | 15   |      |      | mV               | RMS               |
| Differential Input Voltage Swing<br>Threshold    |                     | 50   |      |      | mV <sub>pp</sub> | LOSA<br>Threshold |
| Differential Input Voltage Swing                 | V <sub>in,pp</sub>  | 180  |      | 1000 | mV <sub>pp</sub> |                   |
| Differential Input Impedance                     | Z <sub>in</sub>     | 90   | 100  | 110  | Ohm              |                   |
| Total Jitter                                     |                     |      |      | 0.40 | UI               |                   |
| Deterministic Jitter                             |                     |      |      | 0.15 | UI               |                   |
| <b>Receiver (each Lane)</b>                      |                     |      |      |      |                  |                   |
| Single Ended Output Voltage                      |                     | -0.3 |      | 4    | V                |                   |
| AC Common Mode Output<br>Voltage                 |                     |      |      | 7.5  | mV               | RMS               |
| Differential Output Voltage<br>Swing             | V <sub>out,pp</sub> | 300  |      | 1000 | mV <sub>pp</sub> |                   |
| Differential Output Impedance                    | Z <sub>out</sub>    | 90   | 100  | 110  | Ohm              |                   |
| Total Jitter                                     |                     |      |      | 0.3  | UI               |                   |
| Deterministic Jitter                             |                     |      |      | 0.15 | UI               |                   |

(SFP28 Terminals)

| Parameter                                | Symbol              | Min  | Typ. | Max  | Units | Notes      |
|------------------------------------------|---------------------|------|------|------|-------|------------|
| Power Consumption                        |                     |      |      | 1000 | mW    |            |
| Supply Current, each SFP28               | I <sub>cc</sub>     |      |      | 300  | mA    |            |
| Transceiver Power-on Initialization Time |                     |      |      | 300  | ms    |            |
| <b>Transmitter</b>                       |                     |      |      |      |       |            |
| Single Ended Input Voltage Tolerance     |                     | -0.3 |      | 4    | V     |            |
| AC Common Mode Voltage Tolerance         |                     | 15   |      |      | mV    | RMS        |
| Differential Input Voltage Swing         | V <sub>in,pp</sub>  | 180  |      | 700  | mV    |            |
| Differential Input Impedance             | Z <sub>in</sub>     | 90   | 100  | 110  | Ohm   |            |
| Data Dependent Input Jitter              | DDJ                 |      |      | 0.40 | UI    |            |
| Data Input Total Jitter                  | TJ                  |      |      | 0.15 | UI    |            |
| <b>Receiver</b>                          |                     |      |      |      |       |            |
| Single Ended Output Voltage              |                     | -0.3 |      | 4    | V     |            |
| AC Common Mode Voltage                   |                     |      |      | 7.5  | mV    | RMS        |
| Differential Output Voltage Swing        | V <sub>out,pp</sub> | 300  |      | 850  | mV    |            |
| Differential Output Impedance            | Z <sub>out</sub>    | 90   | 100  | 110  | Ohm   |            |
| Rx Output Rise and Fall Time             | Tr / Tf             | 30   |      |      | ps    | 20% to 80% |
| Total Jitter                             | TJ                  |      |      | 0.3  | UI    |            |
| Deterministic Jitter                     | DJ                  |      |      | 0.15 | UI    |            |

**Mechanical Dimensions (Unit: mm)****Figure 7. Mechanical Outline****ESD**

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 handled only in an ESD protected environment.

**Laser Safety**

This is a Class 1 Laser Product according to IEC / EN 60825-1: 2014 (Third Edition). This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007).

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

### Contact Information

**Formerica OptoElectronics Inc.**

5F-11, No.38, Taiyuan St., Zhubei City,  
Hsinchu County 30265, Taiwan

Tel: +886-3-5600286

Fax: +886-3-5600239

**San Diego, CA**

Tel: 1-949-466-8069

[inquiry@formericaoe.com](mailto:inquiry@formericaoe.com)

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