- ✧ Single +3.3V power supply
- ✧ Supports 103.125Gb/s and 111.81Gb/s aggregate bit rate
- ✧ Operating case temperature: 0~70℃
- ✧ Transmitter: cooled 4x28Gb/s LAN WDM TOSA (1295.56, 1300.05, 1304.58, 1309.14nm)
- ✧ Receiver: 4x28Gb/s SOA+PIN ROSA
- ✧ Maximum power consumption 6W
- ✧ Duplex LC receptacle
- ✧ RoHS compliant

## Features:

- ✧ Hot pluggable QSFP28 MSA form factor
- ✧ Compliant to IEEE 802.3ba 100GBASE-ER4
- ✧ Up to 40km transmission on single mode fiber

## Applications:

- ✧ 100GBASE-ER4 Ethernet Links
- ✧ Telecom networking
- ✧ Data Center Connect

**Part Number Ordering Information**

| | |
|---|---|
| OPQE40-A | 100G QSFP28 ER4 40km dual rate optical transceiver with full real-time digital diagnostic monitoring and pull tab. |

### 1. General Description

This product is a 100Gb/s transceiver module designed for optical communication applications compliant to 100GBASE-ER4 standard. The module converts 4 input channels of 25Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 100Gb/s optical transmission. Reversely on the receiver side, the module de-multiplexes a 100Gb/s optical input into 4 channels of LAN WDM optical signals and then converts them to 4 output channels of electrical data.

The central wavelengths of the 4 LAN WDM channels are 1295.56, 1300.05, 1304.58 and 1309.14 nm as members of the LAN WDM wavelength grid defined in IEEE 802.3ba. The high performance cooled LAN WDM transmitters and SOA+PIN receivers provide superior performance for 100Gigabit Ethernet applications up to 40km without FEC.

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

## 2. Functional Description

The transceiver module receives 4 channels of 28Gb/s electrical data, which are processed by a 4- channel Clock and Data Recovery (CDR) IC that reshapes and reduces the jitter of each electrical signal. Subsequently, each of 4 laser driver IC's converts one of the 4 channels of electrical signals to an optical signal that is transmitted from one of the 4 cooled lasers which are packaged in the Transmitter Optical Sub-Assembly (TOSA). Each laser launches the optical signal in specific wavelength specified in IEEE802.3ba 100GBASE-ER4 requirements. These 4-lane optical signals will be optically multiplexed into a single fiber by a 4-to-1 optical WDM MUX. The transmitter output can be turned off by TX_DIS hardware signal and/or 2-wire serial interface.

The receiver receives 4-lane LAN WDM optical signals. The optical signals are first amplified by semiconductor optical amplifier (SOA) and then de-multiplexed by a 1-to-4 optical DEMUX. Each of the resulting 4 channels of optical signals is fed into one of the 4 receivers that are packaged into the Receiver Optical Sub-Assembly (ROSA). Each receiver converts the optical signal to an electrical signal. The regenerated electrical signals are retimed and de-jittered and amplified by the RX portion of the 4-channel CDR. The retimed 4-lane output electrical signals are compliant with CEI-28G-VSR interface requirements. In addition, each received optical signal is monitored by the DOM section. The monitored value is reported through the 2-wire serial interface. If one or more received optical signal is weaker than the threshold level, RX_LOS hardware alarm will be triggered.

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 its 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.

### 3. Transceiver Block Diagram

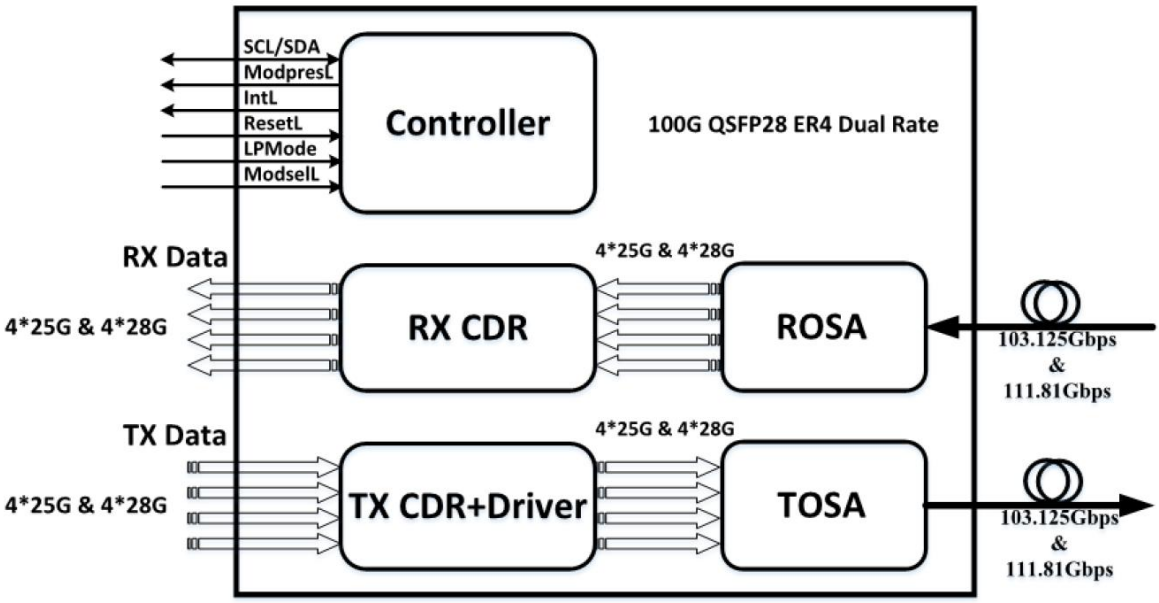


**Figure 1. Transceiver Block Diagram**

### 4. Pin Assignment and Description

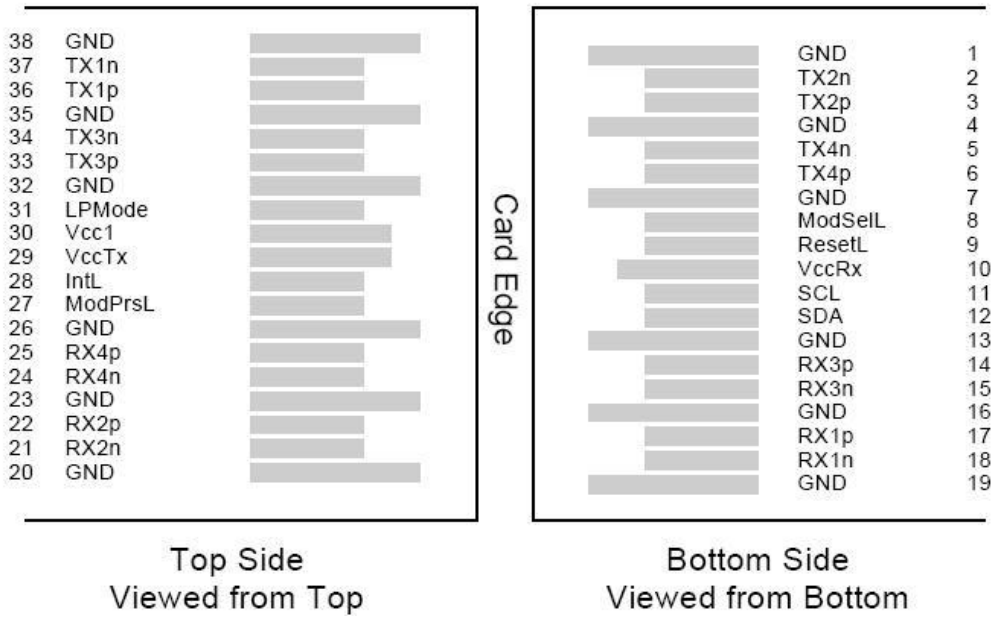


**Figure 2. MSA Compliant Connector**

## Pin Definition

| PIN | Logic | Symbol | Name/Description | Notes |
|---|---|---|---|---|
| 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 | LVCMOS-I/O | SCL | 2-Wire Serial Interface Clock | |
| 12 | LVCMOS-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 module in any combination.

### 5. Recommended Power Supply Filter

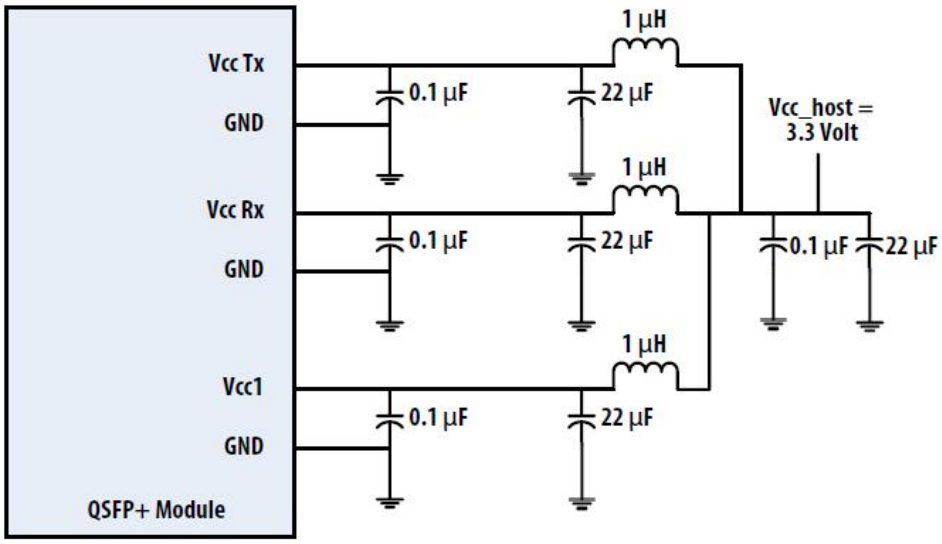


**Figure 3. Recommended Power Supply Filter**

### 6. 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 | Units | Note |
|---|---|---|---|---|---|
| Storage Temperature | TS | -40 | 85 | ℃ | |
| Operating Case Temperature | TOP | 0 | 70 | ℃ | |
| Power Supply Voltage | VCC | -0.5 | 3.6 | V | |
| Relative Humidity (non-condensation) | RH | 0 | 85 | % | |
| Damage Threshold, each Lane | THd | -6.0 | | dBm | |

### 7. Recommended Operating Conditions and Power Supply Requirements

| Parameter | Symbol | Min | Typical | Max | Units |
|---|---|---|---|---|---|
| Operating Case Temperature | TOP | 0 | | 70 | ℃ |
| Power Supply Voltage | VCC | 3.135 | 3.3 | 3.465 | V |
| Data Rate, each Lane | | | 25.78125 | | Gb/s |
| Control Input Voltage High | | 2 | | Vcc | V |
| Control Input Voltage Low | | 0 | | 0.8 | V |

## 8. Electrical Characteristics

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

| Parameter | Symbol | Min | Typical | Max | Units | Notes |
|---|---|---|---|---|---|---|
| Power Consumption | | | | 6.0 | W | |
| Supply Current | Icc | | | 1.8 | A | |
| **Transmitter (each Lane)** | | | | | | |
| Data Rate, each lane | | | 25.78125 | | Gbps | |
| Differential Voltage pk-pk | Vpp | | | 900 | mV | |
| Common Mode Voltage | Vcm | -350 | | 2850 | mV | At 1MHz |
| Differential Termination Resistance Mismatch | | | | 10 | % | |
| Transition time ,20 to 80% | Trise/Tfall | 10 | | | ps | |
| Eye width | EW15 | 0.46 | | | | |
| Eye height | EH15 | 95 | | | | |
| **Receiver (each Lane)** | | | | | | |
| Data Rate, each lane | | | 25.78125 | | Gbps | |
| Differential Voltage, pk-pk | Vpp | | | 900 | mV | |
| Common Mode Voltage | Vcm | -350 | | 2850 | mV | 2 |
| Common Mode Noise, RMS | Vrms | | | 17.5 | mV | |
| Differential Termination Resistance Mismatch | | | | 10 | % | At 1MHz |
| Transition Time, 20 to 80% | | 12 | | | ps | |
| Eye Width at 10-15 probability (EW15) | | 0.57 | | | UI | |
| Eye Height at 10-15 probability (EH15) | | 228 | | | mV | |

## 9. Optical Characteristics

| Ethernet 100GBASE-ER4 | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typical** | **Max** | **Unit** | **Notes** |
| 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 | |
| **Transmitter** | | | | | | |
| SMSR | SMSR | 30 | | | dB | |
| Total Average Launch Power | PT | | | 8.9 | dBm | |
| Average Launch Power, each Lane | $P_{AVG}$ | -2.9 | | 2.9 | dBm | |
| Extinction Ratio | ER | 8 | | | dB | |
| $RIN_{20}OMA$ | RIN | | | -130 | dB/Hz | |
| Output Eye Mask definition {X1，X2，X3，Y1，Y2，Y3} | {0.25， 0.4， 0.45， 0.25， 0.28， 0.4} | | | | | |
| **Receiver** | | | | | | |
| Damage Threshold, each Lane | THd | 5.5 | | | dBm | 1 |
| Average Receive Power,each Lane | | -20.9 | | -3.5 | dBm | |
| Receiver OMA Sensitivity, each Lane | SEN | | | -21.4 | dBm | 2 |
| LOS Assert | LOSA | -33 | | | dBm | |
| LOS Deassert | LOSD | | | -24 | dBm | |
| LOS Hysteresis | LOSH | 0.5 | | 5 | dB | |

**Notes:**

1. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.
2. Measured with PRBS $2^{31}$-1 test pattern, 25.78125Gb/s, BER 1*E-12.

| **OTN OTU4 4L1-9C1F** | | | | | | |
|---|---|---|---|---|---|---|
| **Parameter** | **Symbol** | **Min** | **Typical** | **Max** | **Unit** | **Notes** |
| 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 | |
| **Transmitter** | | | | | | |
| SMSR | SMSR | 30 | | | dB | |
| Total Average Launch Power | PT | | | 8.9 | dBm | |
| Average Launch Power, each Lane | $P_{AVG}$ | -2.7 | | 2.9 | dBm | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Extinction Ratio | ER | 8 | | | dB | |
| $RIN_{20}OMA$ | RIN | | | -130 | dB/Hz | |
| Output Eye Mask definition {X1，X2，X3，Y1，Y2，Y3} | {0.25， 0.4， 0.45， 0.25， 0.28， 0.4} | | | | | |
| **Receiver** | | | | | | |
| Damage Threshold, each Lane | THd | | | | dBm | 1 |
| Average Receive Power,each Lane | | -20.7 | | -3.5 | dBm | |
| Receiver average Sensitivity, each Lane | SEN | | | -23.2 | dBm | 2 |
| LOS Assert | LOSA | | | -28 | dBm | |
| LOS Deassert | LOSD | -35 | | | dBm | |
| LOS Hysteresis | LOSH | 0.5 | | 5 | dB | |

**Notes:**

1. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.
2. Measured with PRBS $2^{31}$-1 test pattern, 25.78125Gb/s, BER 5.0E-5.

## 10. Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

| Parameter | Symbol | Min | Max | Units | Notes |
|---|---|---|---|---|---|
| Temperature monitor absolute error | DMI_Temp | -3 | +3 | ℃ | Over operating temperature range |
| Supply voltage monitor absolute error | DMI _VCC | -0.1 | 0.1 | V | Over full operating range |
| Channel RX power monitor absolute error | DMI_RX_Ch | -3 | 3 | dB | |
| Channel Bias current monitor | DMI_Ibias_Ch | -10% | 10% | mA | |
| Channel TX power monitor absolute error | DMI_TX_Ch | -3 | 3 | dB | |

## 11.Mechanical Dimensions

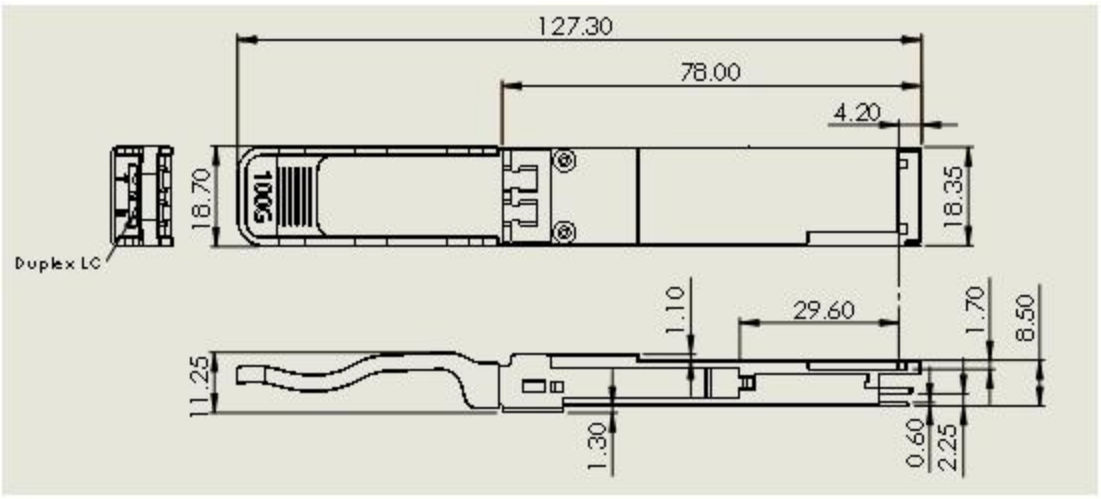


**Figure 4. Mechanical Outline**

## 12. ESD

This transceiver is specified as ESD threshold 1kV for SFI pins and 2kV for all other electrical input pins, tested per MIL-STD-883, Method 3015.4 /JESD22-A114-A (HBM). However, normal ESD precautions are still 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.

## 13. Laser Safety

This is a Class 1 Laser Product according to EN 60825-1:2014. 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.