# 100Gb/s QSFP28 ER4 Optical Transceiver Module AISQ-104S-DDM

## Features

- Compliant to Ethernet 100GBASE-ER4 Lite
- Supports 103.1Gb/s aggregate bit rate
- Transmitter: cooled 4x25Gb/s LAN WDM EML TOSA (1295.56, 1300.05, 1304.58, 1309.14nm)
- Receiver: 4x25Gb/s APD ROSA
- Up to 30km reach for G.652 SMF without FEC
- Up to 40km reach for G.652 SMF with FEC
- Duplex LC optical receptacle
- 4x25G electrical interface (OIF CEI-28G-VSR)
- RoHS-6 compliant and lead-free
- Single +3.3V power supply
- Maximum power consumption 4.5W
- Case operating temperature

  Commercial: 0 ~ +70$^{o}$C

## Applications

- 100GBASE-ER4 Ethernet Links
- Infiniband QDR and DDR interconnects
- Client-side 100G

  Telecom connections

## Part Number Ordering Information

| Part Number | Data Rate (Gb/s) | Wavelength (nm) | Transmission Distance(km) | Temperature ($_{o}$C) (Operating Case) |
|---|---|---|---|---|
| AISQ-104S-DDM | 103.1 | 1295.56, 1300.05, 1304.58, 1309.14 | 40km SMF | 0~70 commercial |

## 1. 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 | $T_S$ | -40 | 85 | $^0C$ | |
| Power Supply Voltage | $V_{CC}$ | -0.3 | 4.0 | V | |
| Relative Humidity (non-condensation) | RH | 0 | 85 | % | |
| Damage Threshold | $TH_d$ | -3.0 | | dBm | |

## 2. Recommended Operating Conditions and Power Supply Requirements

| Parameter | Symbol | Min | Typical | Max | Unit | Notes |
|---|---|---|---|---|---|---|
| Operating Case Temperature | $T_{OP}$ | 0 | | 70 | $^0C$ | commercial |
| Power Supply Voltage | $V_{CC}$ | 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 | |
| Link Distance with G.652 (without FEC) | D1 | | | 30 | km | 1 |
| Link Distance with G.652 (with FEC) | D2 | | | 40 | km | 1 |

Notes:

1. Depending on actual fiber loss/km (link distance specified is for fiber insertion loss of 0.4dB/km)

## 3. General Description

This product is a 100Gb/s transceiver module designed for optical communication applications compliant to Ethernet 100GBASE-ER4 Lite 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 EA-DFB transmitters and high sensitivity APD receivers provide superior performance for 100Gigabit Ethernet applications up to 30km links without FEC and 40km links with FEC.

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.

## 4. Functional Description

The transceiver module receives 4 channels of 25Gb/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, EML laser driver IC converts each one of the 4 channels of electrical signals to an optical signal that is transmitted from one of the 4 cooled EML lasers which are packaged in the Transmitter Optical Sub-Assembly (TOSA). Each laser launches the optical signal in specific wavelength specified in IEEE 802.3ba 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 optical output power of each channel is maintained constant by an automatic power control (APC) circuit. 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 de-multiplexed by a 1-to-4 optical DEMUX and 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.

## 5. Pin Assignment and Pin Description

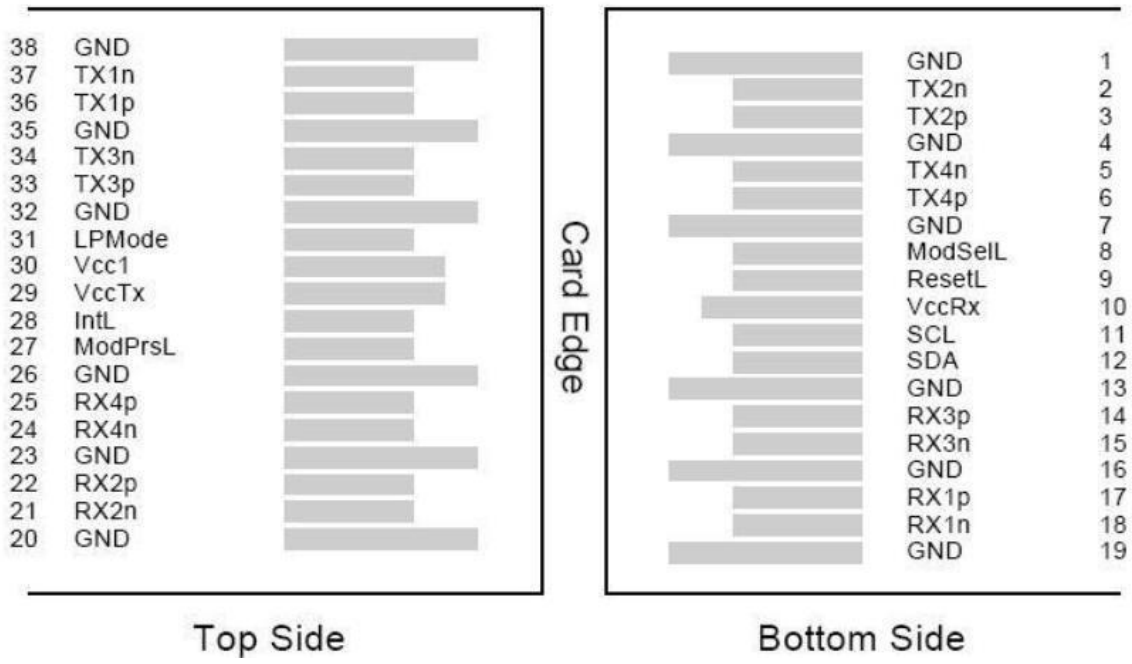


**Figure1. Diagram of host board connector block pin numbers and names**

| Pin | Symbol | Name/Description | Notes |
|---|---|---|---|
| 1 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 2 | Tx2n | Transmitter Inverted Data Input | |
| 3 | Tx2p | Transmitter Non-Inverted Data output | |
| 4 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 5 | Tx4n | Transmitter Inverted Data Input | |
| 6 | Tx4p | Transmitter Non-Inverted Data output | |
| 7 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 8 | ModSelL | Module Select | |
| 9 | ResetL | Module Reset | |
| 10 | VccRx | 3.3V Power Supply Receiver | 2 |
| 11 | SCL | 2-Wire serial Interface Clock | |
| 12 | SDA | 2-Wire serial Interface Data | |
| 13 | GND | Transmitter Ground (Common with Receiver Ground) | |
| 14 | Rx3p | Receiver Non-Inverted Data Output | |
| 15 | Rx3n | Receiver Inverted Data Output | |
| 16 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 17 | Rx1p | Receiver Non-Inverted Data Output | |
| 18 | Rx1n | Receiver Inverted Data Output | |
| 19 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 20 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 21 | Rx2n | Receiver Inverted Data Output | |
| 22 | Rx2p | Receiver Non-Inverted Data Output | |
| 23 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 24 | Rx4n | Receiver Inverted Data Output | 1 |
| 25 | Rx4p | Receiver Non-Inverted Data Output | |

| | | | |
|---|---|---|---|
| 26 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 27 | ModPrsl | Module Present | |
| 28 | IntL | Interrupt | |
| 29 | VccTx | 3.3V power supply transmitter | 2 |
| 30 | Vcc1 | 3.3V power supply | 2 |
| 31 | LPMode | Low Power Mode | |
| 32 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 33 | Tx3p | Transmitter Non-Inverted Data Input | |
| 34 | Tx3n | Transmitter Inverted Data Output | |
| 35 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |
| 36 | Tx1p | Transmitter Non-Inverted Data Input | |
| 37 | Tx1n | Transmitter Inverted Data Output | |
| 38 | GND | Transmitter Ground (Common with Receiver Ground) | 1 |

Notes:

1. GND is the symbol for signal and supply (power) common for QSFP28 modules. 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. VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown 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.

## 6. Electrical Characteristics

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

| Parameter | Symbol | Min. | Typ. | Max | Unit | Notes |
|---|---|---|---|---|---|---|
| Power Consumption | P | | | 4.5 | W | |
| Supply Current | Icc | | | 1360 | mA | |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Transmitter (each Lane)** | | | | | | |
| Overload Differential Voltage pk-Pk | TP1a | 900 | | | mV | |
| Common Mode Voltage (Vcm) | TP1 | -350 | | 2850 | mV | 1 |
| Differential Termination Resistance Mismatch | TP1 | | | 10 | % | At 1MHz |
| Differential Return Loss (SDD11) | TP1 | | | See CEI-28G-VSR Equation 13-19 | dB | |
| Common Mode to Differential conversion and Differential to Common Mode conversion (SDC11, SCD11) | TP1 | | | See CEI-28G-VSR Equation 13-20 | dB | |
| Stressed Input Test | TP1a | See CEI-28G-VSR Section 13.3.11. 2.1 | | | | |
| **Receiver** | | | | | | |
| Differential Voltage, pk-pk | TP4 | | | 900 | mV | |
| Common Mode Voltage (Vcm) | TP4 | -350 | | 2850 | mV | 1 |
| Common Mode Noise, RMS | TP4 | | | 10 | % | At 1MHz |

| | | | | | | |
|---|---|---|---|---|---|---|
| Differential Return Loss (SDD22) | TP4 | | | See CEI-28G-VSR Equation 13-19 | dB | |
| Common Mode to Differential conversion and Differential to Common Mode conversion (SDC22, SCD22) | TP4 | | | See CEI-28G-VSR Equation 13-21 | dB | |
| Common Mode Return Loss (SCC22) | TP4 | | | -2 | dB | 2 |
| Transition Time, 20 to 80% | TP4 | 9.5 | | | ps | |
| Vertical Eye Closure (VEC) | TP4 | | | 5.5 | dB | |
| Eye Width at 10-15 probability (EW15) | TP4 | 0.57 | | | UI | |
| Eye Height at 10-15 probability (EH15) | TP4 | 228 | | | mV | |

Notes:

1. Vcm is generated by the host. Specification includes effects of ground offset voltage.
2. From 250MHz to 30GHz.

## 7. Optical Characteristics

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

| Parameter | Symbol | Min. | Typical | Max | Unit | Notes |
|---|---|---|---|---|---|---|
| **Transmitter** | | | | | | |
| Lane wavelength (range) | 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 | 1310.09 | nm | |
| Signaling rate, each lane | | | 25.78125 | | GBd | |
| Side-mode suppression ratio | SMSR | 30 | | | | |
| Total launch power | $P_T$ | | | 10.5 | dBm | |
| Average launch power, each lane | Pavg | -2.9 | | 4.5 | dBm | 1 |
| OMA, each Lane | $P_{OMA}$ | 0.1 | | 4.5 | dBm | 2 |
| Extinction Ratio | ER | 7 | | | dB | |
| Difference in Launch Power between any Two Lanes (OMA) | Ptx,diff | | | 3.6 | dB | |
| Transmitter and Dispersion Penalty, each lane | TDP | | | 2.5 | dB | |
| OMA minus TDP, each lane | OMA-TDP | -0.65 | | | dBm | |
| Average launch power of OFF transmitter, each lane | Poff | | | -30 | dBm | |
| Transmitter reflectance | $R_T$ | | | -12 | dB | |
| $RIN_{20}OMA$ | RIN | | | -130 | dB/Hz | |
| Optical Return Loss Tolerance | TOL | | | 20 | dB | |
| Transmitter eye mask {X1, X2,X3, Y1, Y2, Y3} | | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} | | | | |
| **Receiver** | | | | | | |
| Signaling rate, each lane | | | 25.78125 | | GBd | |
| Average Receive Power, each Lane | | 16.9 | | -4.9 | dBm | For 30km Link Distance |

| | | | | | | |
|---|---|---|---|---|---|---|
| Average Receive Power, each Lane | | -20.9 | | -4.9 | dBm | For 40km Link Distance |
| Receive Power (OMA), each Lane | | | | -1.9 | dBm | |
| Receiver Sensitivity (OMA), each Lane | SEN1 | | | -14.65 | dBm | for BER = $1x10^{-12}$ |
| Stressed Receiver Sensitivity (OMA), each Lane | | | | -12.65 | dBm | for BER = $1x10^{-12}$ |
| Receiver Sensitivity (OMA), each Lane | SEN2 | | | -18.65 | dBm | for BER = $5x10^{-5}$ |
| Receiver Sensitivity (OMA), each Lane | | | | -16.65 | dBm | for BER = $5x10^{-5}$ |
| Receiver reflectance | | | | -26 | dB | |
| Difference in Receive Power between any Two Lanes (Average and OMA) | Ptx,diff | | | 3.6 | dB | |
| LOS Assert | LOSA | | -26 | | dBm | |
| LOS Deassert | LOSD | | -24 | | dBm | |
| LOS Hysteresis | LOSH | 0.5 | | | dB | |
| Receiver Electrical 3 dB Upper | $F_C$ | | | 31 | GHz | |

**Conditions of Stress Receiver Sensitivity Test (Note 4)**

| | | | | | | |
|---|---|---|---|---|---|---|
| Vertical Eye Closure Penalty, each Lane | | | 1.5 | | dB | |
| Stressed Eye J2 Jitter, each Lane | | | 0.3 | | UI | |
| Stressed Eye J9 Jitter, each Lane | | | 0.47 | | UI | |

Notes:

1. The minimum average launch power spec is based on ER not exceeding 9.5dB and transmitter OMA higher than

0. 1dBm.

2. Even if the TDP < 0.75 dB, the OMA min must exceed the minimum value specified here.

3. 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.

4. Vertical eye closure penalty, stressed eye J2 jitter, and stressed eye J9 jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

## 8. Digital Diagnostic Functions

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

| Parameter | Symbol | Min. | Max | Unit | Notes |
|---|---|---|---|---|---|
| Temperature monitor absolute error | DMI_ Temp | -3 | 3 | degC | Over operating temp |
| Supply voltage monitor absolute error | DMI _VCC | -0.15 | 0.15 | V | Full operating range |
| RX power monitor absolute error | DMI_RX | -2 | 2 | dB | |
| Bias current monitor | DMI_ bias | -10% | 10% | mA | |
| TX power monitor absolute error | DMI_TX | -2 | 2 | dB | |

## 9. Mechanical Dimensions

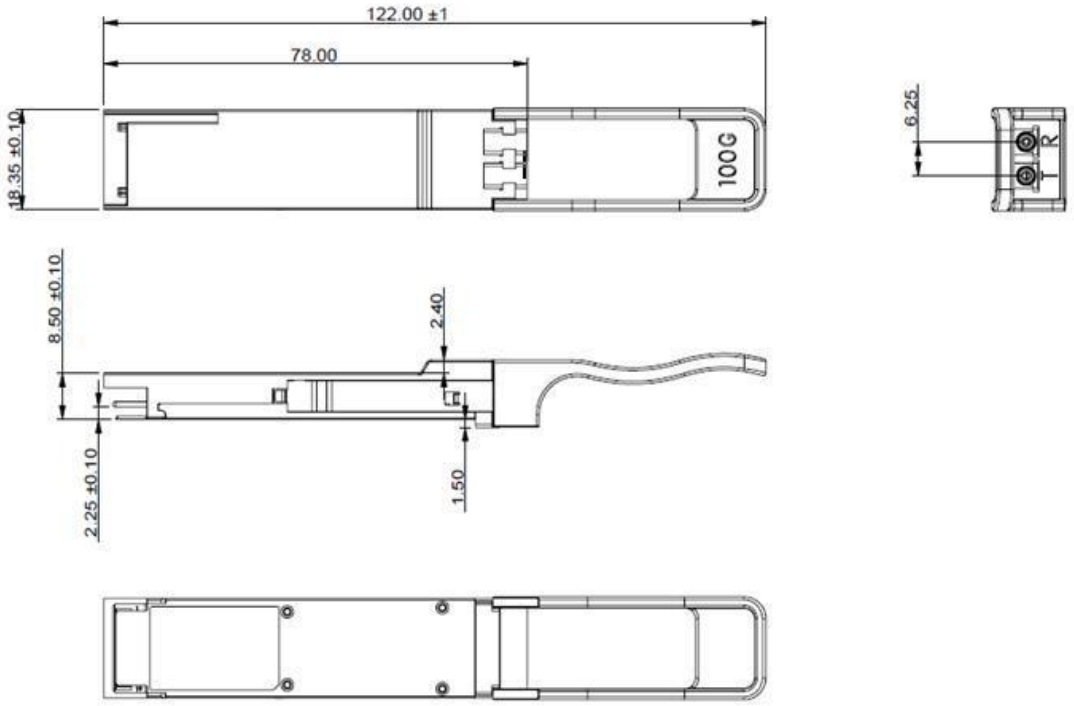


**Figure3. Mechanical Outline**