

## VC-QSFP56-200G-SR4

200Gb/s QSFP56 SR4 70m OM3 Optical Transceiver

### Features

- ✓ QSFP56 MSA compliant
- ✓ 4 parallel lanes on 850nm center wavelength
- ✓ Compliant to IEEE 802.3bs Specification
- ✓ Up to 100m transmission on multi-mode fiber (MMF) OM3 with FEC
- ✓ Operating case temperature: 0 to 70°C
- ✓ 4x53.125Gb/s electrical interface (200GAUI-4)
- ✓ Data Rate 53.125Gbps (PAM4) per channel.
- ✓ Maximum power consumption 5W
- ✓ MPO-12 APC connector
- ✓ RoHS compliant



### Application

- ✓ Data Center Interconnect
- ✓ 200G Ethernet
- ✓ InfiniBand interconnects
- ✓ Enterprise networking

### General Description

This product is a parallel 200Gb/s Quad Small Form Factor Pluggable (QSFP56) optical module. It provides increased port density and total system cost savings. The design is compliant to IEEE802.3bs Annex120E (200GAUI-4 C2M). The QSFP56 full-duplex optical module offers 4 independent transmit and receive channels, each capable of 53.125Gb/s operation for an aggregate data rate of 200Gb/s on 70 meters of OM3 multi-mode fiber.

An optical fiber cable with an MTP/MPO-12 APC connector can be plugged into the QSFP56 SR4 module receptacle. Proper alignment is ensured by the guide pins inside the receptacle. The cable

usually cannot be twisted for proper channel to channel alignment. Electrical connection is achieved through a QSFP56 MSA-compliant edge type connector.

The central wavelengths of all the 4 parallel lanes are 850nm. It contains an optical MPO-12 APC connector for the optical interface and a 38-pin connector for the electrical interface. Host FEC is required to support up to 70m OM3 multi-mode fiber transmission.

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP56 Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

### Functional Description

The module incorporates 4 parallel channels, on 850nm Center Wavelength, operating at 50G per channel. The transmitter path incorporates a 4-channel CDR retimer, a quad channel VCSEL drivers together with a VCSEL array. On the receiver path, a photodiode array optics are coupled with an 4-channel CDR retimer. The electrical interface is compliant with IEEE 802.3bs and QSFP56 MSA in the transmitting and receiving directions, and the optical interface is compliant to QSFP56 MSA with MPO-12 APC Optical Connector. Figure 1 shows the functional block diagram of this product.

A single +3.3V power supply is required to power up this product. All the power supply pins are internally connected and should be applied concurrently. As per MSA specifications the module offers seven low speed hardware control pins (including the 2-wire serial interface): ModSelL, SCL, SDA, ResetL, InitMode, 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 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.

Initialize Mode (InitMode) is an input signal. It is pulled up to Vcc in the QSFP56 module. The InitMode signal allows the host to define whether the QSFP56 module will initialize under host

software control (InitMode asserted High) or module hardware control (InitMode deasserted Low). Under host software control, the module shall remain in Low Power Mode until software enables the transition to High Power Mode, as defined in the QSFP56 Management Interface Specification. Under hardware control (InitMode de-asserted Low), the module may immediately transition to High Power Mode after the management interface is initialized. The host shall not change the state of this signal while the module is present. In legacy QSFP applications, this signal is named LPMode. See SFF-8679 for LPMode signal description.

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.

### 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 | Notes |
|--------------------------------------|--------|------|-----|-------|-------|
| Storage Temperature                  | TS     | -40  | 85  | degC  |       |
| Operating Temperature Case           | TOP    | 0    | 70  | degC  |       |
| Power Supply Voltage                 | VCC    | -0.5 | 3.6 | V     |       |
| Relative Humidity (non-condensation) | RH     | 0    | 85  | %     |       |

### Recommended Operating Conditions

| Parameter                  | Symbol | Min   | Typical | Max   | Units | Notes |
|----------------------------|--------|-------|---------|-------|-------|-------|
| Operating Temperature Case | TOP    | 0     |         | 70    | deg C |       |
| Power Supply Voltage       | VCC    | 3.135 | 3.3     | 3.465 | V     |       |

|                          |   |      |         |                      |     |      |
|--------------------------|---|------|---------|----------------------|-----|------|
| Data Rate, each Lane     |   |      | 26.5625 |                      | GBd | PAM4 |
| Data Rate Accuracy       |   | -100 |         | 100                  | ppm |      |
| Pre-FEC Bit Error Ratio  |   |      |         | 2.4x10 <sup>-4</sup> |     |      |
| Post-FEC Bit Error Ratio |   |      |         | 1x10 <sup>-1</sup>   |     | 1    |
| Link Distance with OM3   | D | 0.5  |         | 100                  | m   | 2    |

**Notes:**

1. FEC provided by host system.
2. FEC required on host system to support maximum distance.

**Electrical Characteristics**

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

| Parameter                                  | Test Point      | Min               | Typical | Max  | Units            | Notes |
|--------------------------------------------|-----------------|-------------------|---------|------|------------------|-------|
| Power Consumption                          |                 |                   |         | 5    | W                |       |
| Supply Current                             | I <sub>cc</sub> |                   |         | 1.52 | A                |       |
| <b>Transmitter (each Lane)</b>             |                 |                   |         |      |                  |       |
| Signaling Rate, each Lane                  | TP1             | 26.5625 ± 100 ppm |         |      | GBd              |       |
| Differential pk-pk Input Voltage Tolerance | TP1a            | 900               |         |      | mV <sub>pp</sub> | 1     |

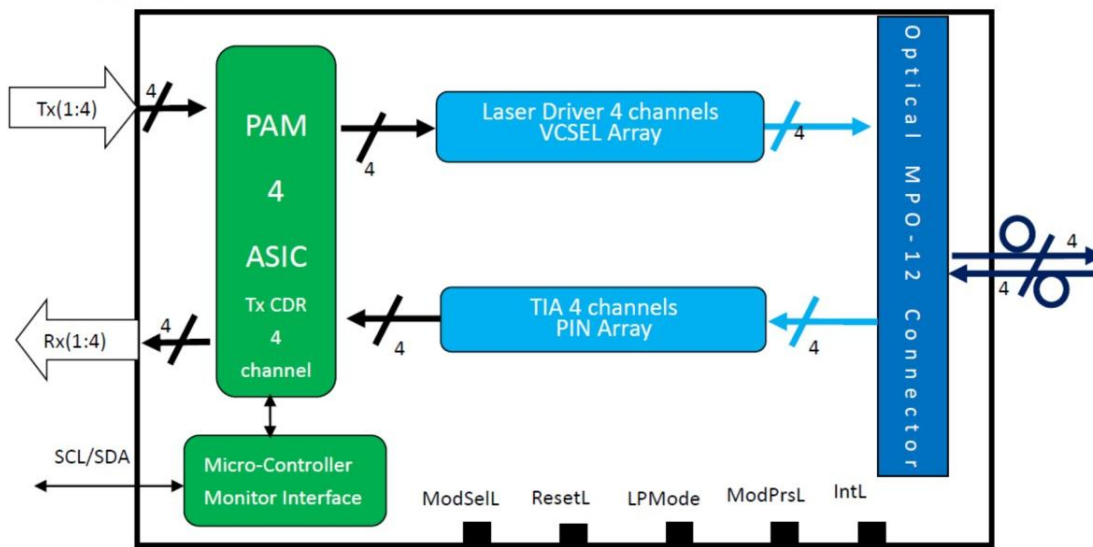
|                                               |      |                                  |  |    |    |   |
|-----------------------------------------------|------|----------------------------------|--|----|----|---|
| Differential Termination Mismatch             | TP1  |                                  |  | 10 | %  |   |
| Differential Input Return Loss                | TP1  | IEEE 802.3-2015 Equation (83E-5) |  |    | dB |   |
| Differential to Common Mode Input Return Loss | TP1  | IEEE 802.3-2015 Equation (83E-6) |  |    | dB |   |
| Module Stressed Input Test                    | TP1a | See IEEE 802.3bs 120E.3.4.1      |  |    |    | 2 |
| Single-ended Voltage Tolerance Range (Min)    | TP1a | -0.4 to 3.3                      |  |    | V  |   |

|                                                    |     |                                  |       |      |      |   |
|----------------------------------------------------|-----|----------------------------------|-------|------|------|---|
| DC Common Mode Input Voltage                       | TP1 | -350                             |       | 2850 | mV   | 3 |
| <b>Receiver (each Lane)</b>                        |     |                                  |       |      |      |   |
| Signaling Rate, each lane                          | TP4 | 26.5625 ± 100 ppm                |       |      | GBd  |   |
| Differential Peak-to-Peak Output Voltage           | TP4 |                                  |       | 900  | mVpp |   |
| Common Mode vOLTAGE                                |     | -350                             |       | 2850 | mV   |   |
| AC Common Mode Output Voltage, RMS                 | TP4 |                                  |       | 17.5 | mV   |   |
| Differential Termination Mismatch                  | TP4 |                                  |       | 10   | %    |   |
| Differential Output Return Loss                    | TP4 | IEEE 802.3-2015 Equation (83E-2) |       |      |      |   |
| Common to Differential Mode Conversion Return Loss | TP4 | IEEE 802.3-2015 Equation (83E-3) |       |      |      |   |
| Transition Time, 20% to 80%                        | TP4 | 9.5                              |       |      | ps   |   |
| Near-end Eye Symmetry Mask Width (ESMW)            | TP4 |                                  | 0.265 |      | UI   |   |
| Near-end Eye Height, Differential                  | TP4 | 70                               |       |      | mV   |   |
| Far-end Eye Symmetry Mask Width (ESMW)             | TP4 |                                  | 0.2   |      | UI   |   |
| Far-end Eye Height, Differential                   | TP4 | 30                               |       |      | mV   |   |
| Far-end Pre-cursor ISI Ratio                       | TP4 | -4.5                             |       | 2.5  | %    |   |
| Common Mode Output Voltage (Vcm)                   | TP4 | -350                             |       | 2850 | mV   | 3 |

#### Notes:

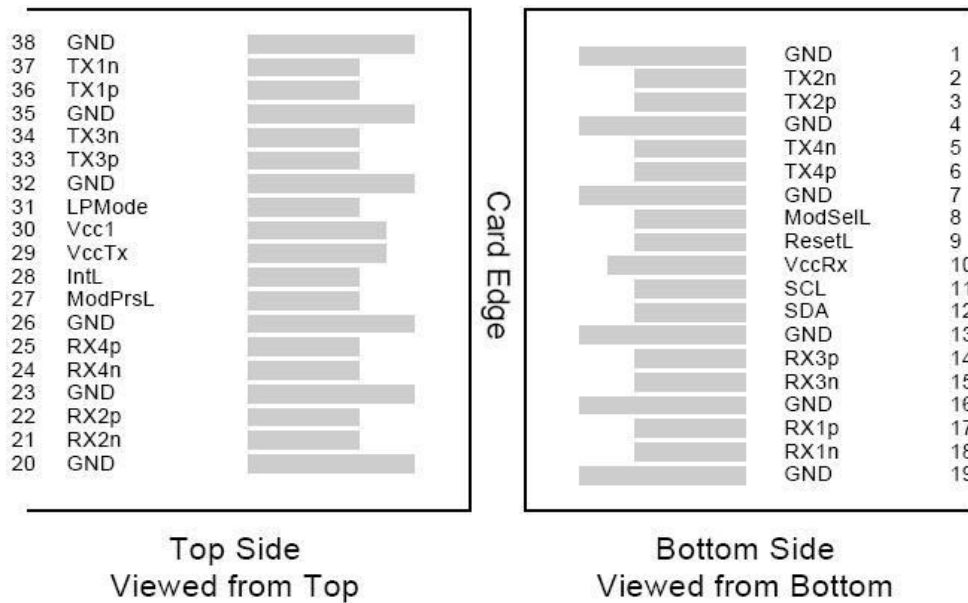
1. With the exception to IEEE 802.3bs 120E.3.1.2 that the pattern is PRBS31Q or scrambled idle.
2. Meets BER specified in IEEE 802.3bs 120E.1.1.
3. DC common mode voltage generated by the host. Specification includes effects of ground offset voltage

#### Transceiver Block Diagram For 200GAUI-8



**Figure 1. Transceiver Block Diagram**

### Optical interface and Pin Assignment



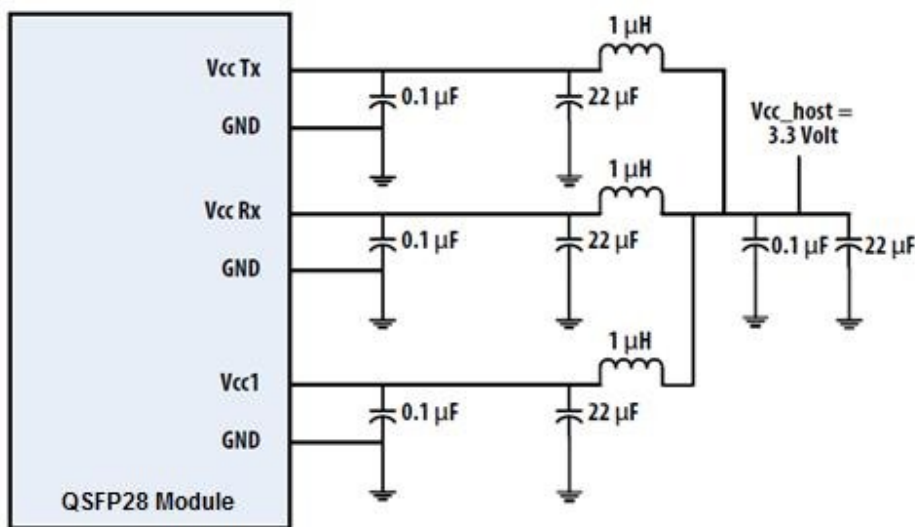
**Figure 2. MSA Compliant Connector**

## Pin Definition 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  | 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 QSFP56 modules. All are common within the QSFP56 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 QSFP56 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

**Recommended Power Supply Filter****Figure 3. Recommended Power Supply Filter**

## Optical Characteristics

| Parameter                                                             | Symbol                | Min                                                     | Typical | Max | Units | Notes     |
|-----------------------------------------------------------------------|-----------------------|---------------------------------------------------------|---------|-----|-------|-----------|
| Transmitter                                                           |                       |                                                         |         |     |       |           |
| Center Wavelength                                                     | $\lambda_C$           | 840                                                     | 850     | 860 | nm    |           |
| Data Rate, each Lane                                                  |                       | 26.5625 $\pm$ 100 ppm                                   |         |     | GBd   |           |
| Modulation Format                                                     |                       | PAM4                                                    |         |     |       |           |
| RMS Spectral Width                                                    | $\Delta\lambda_{rms}$ |                                                         |         | 0.6 | nm    | Modulated |
| Average Launch Power, each Lane                                       | PAVG                  | -6.5                                                    |         | 4   | dBm   | 1         |
| Outer Optical Modulation Amplitude (OMA <sub>outer</sub> ), each Lane | POMA                  | -4.5                                                    |         | 3   | dBm   | 2         |
| Launch Power in OMA <sub>outer</sub> minus TDECQ, each Lane           |                       | -5.9                                                    |         |     | dB    |           |
| Transmitter and Dispersion Eye Clouser for PAM4, each Lane            | TDECQ                 |                                                         |         | 4.5 | dB    |           |
| Extinction Ratio                                                      | ER                    | 3                                                       |         |     | dB    |           |
| Optical Return Loss Tolerance                                         | TOL                   |                                                         |         | 12  | dB    |           |
| Average Launch Power of OFF Transmitter, each Lane                    | Poff                  |                                                         |         | -30 | dBm   |           |
| Encircled Flux                                                        |                       | $\geq 86\%$ at 19 $\mu m$<br>$\leq 30\%$ at 4.5 $\mu m$ |         |     |       |           |
| Receiver                                                              |                       |                                                         |         |     |       |           |
| Center Wavelength                                                     | $\lambda_C$           | 840                                                     | 850     | 860 | nm    |           |
| Data Rate, each Lane                                                  |                       | 26.5625 $\pm$ 100 ppm                                   |         |     | GBd   |           |
| Modulation Format                                                     |                       | PAM4                                                    |         |     |       |           |
| Damage Threshold, each Lane                                           | THd                   | 5                                                       |         |     | dBm   | 3         |

|                                                                     |      |      |     |            |     |   |
|---------------------------------------------------------------------|------|------|-----|------------|-----|---|
| Average Receive Power, each Lane                                    |      | -8.4 |     | 4          | dBm | 4 |
| Receive Power (OMAouter), each Lane                                 |      |      |     | 3          | dBm |   |
| Receiver Sensitivity (OMAouter), each Lane                          | SEN  |      |     | Equation 1 | dBm | 7 |
| Stressed Receiver Sensitivity (OMAouter), each Lane                 | SRS  |      |     | -3.4       | dBm | 5 |
| Receiver Reflectance                                                | RR   |      |     | -12        | dB  |   |
| LOS Assert                                                          | LOSA | -30  |     |            | dBm |   |
| LOS De-assert                                                       | LOSD |      |     | -12        | dBm |   |
| LOS Hysteresis                                                      | LOSH | 0.5  |     |            | dB  |   |
| <b>Stressed Conditions for Stress Receiver Sensitivity (Note 7)</b> |      |      |     |            |     |   |
| Stressed Eye Closure for PAM4 (SECQ), Lane under Test               |      |      | 4.5 |            | dB  |   |
| SECQ – $10\log_{10}(C_{eq})f$ (max), lane under test                |      |      | 4.5 |            | dB  |   |
| OMAouter of each Aggressor Lane                                     |      |      | 3   |            | dBm |   |

#### Notes:

1. Average launch power, each lane (min) 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.
2. Even if the TDECQ < 1 dB , the OMAouter (min) must exceed the minimum value specified here.
3. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.
4. Average receive power, each lane (min) 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.
5. Measured with conformance test signal at receiver input for the BER of  $2.4 \times 10^{-4}$ .
6. These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

7. Receiver sensitivity

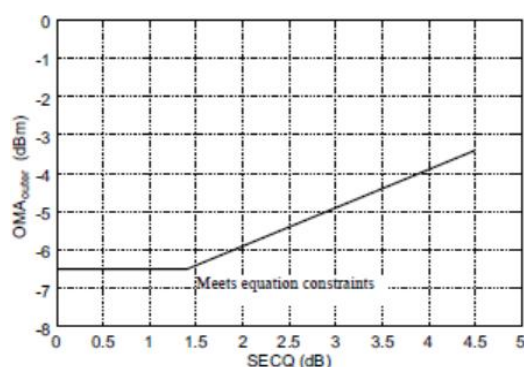
8. Receiver sensitivity is informative and is defined for a transmitter with a value of SECQ up to 4.5 dB. Receiver sensitivity should meet Equation (1), which is illustrated in Figure 1.

9.  $RS = \max(-6.5, SECQ - 7.9) \text{ (dBm)}$  (Equation 1) where

10. RS is the receiver sensitivity

11. SECQ is the SECQ of the transmitter used to measure the receiver sensitivity

12. The normative requirement for receivers is stressed receiver sensitivity.



**Figure 4. Illustration of receiver sensitivity**

## Digital Diagnostic Functions

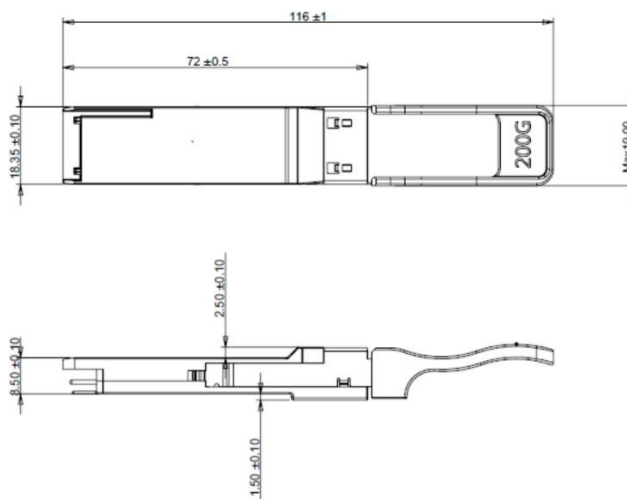
The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

| Parameter                               | Symbol       | Min  | Max | Units | Notes                            |
|-----------------------------------------|--------------|------|-----|-------|----------------------------------|
| Temperature monitor absolute error      | DMI_Temp     | -3   | 3   | degC  | 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    | -2   | 2   | dB    | 1                                |
| Channel Bias current monitor            | DMI_Ibias_Ch | -10% | 10% | mA    |                                  |
| Channel TX power monitor absolute error | DMI_TX_Ch    | -2   | 2   | dB    | 1                                |

### Notes:

Due to measurement accuracy of different fibers, there could be an additional  $\pm 1$  dB fluctuation, or a  $\pm 3$  dB total accuracy.

### Mechanical Dimensions



**Figure 5. Mechanical Outline**

### Ordering Information

| Part Number        | Product Description                                                                                                  |
|--------------------|----------------------------------------------------------------------------------------------------------------------|
| VC-QSFP56-200G-SR4 | 200G QSFP56 SR4 70m OM3 with FEC optical transceiver with full real- time digital diagnostic monitoring and pull tab |