

## **CSMQDDQGS31S5**

### **400 Gbps QSFP-DD DR4 500 m Optical Transceiver Module**

#### **Description**

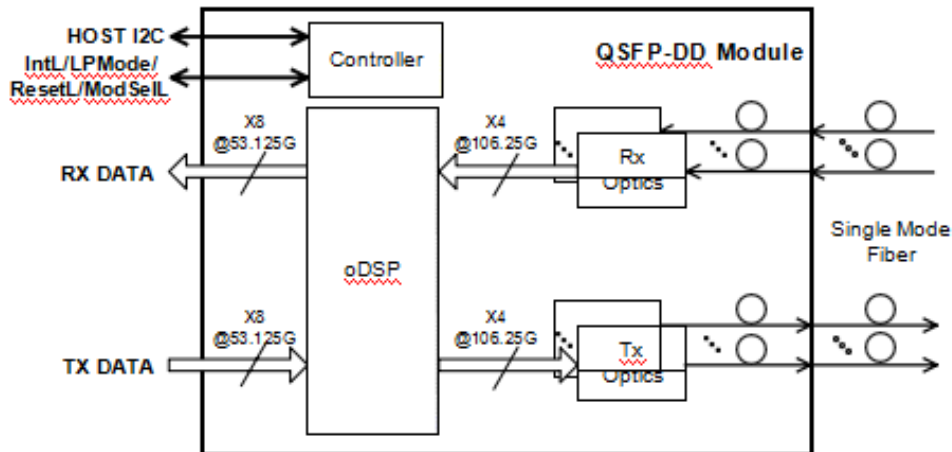
The CSMQDDQGS31S5 is a transceiver module designed for 500 m optical communication applications and is compliant with QSFP-DD MSA, IEEE 802.3-2018 400GBASE-DR4, and 400GAUI-8 standards. The 425 Gbps signal is carried over four parallel lanes with one wavelength per lane. This module converts 8-channel 53.125 Gbit/s electrical data into four parallel channels of optical signals, each supporting 106.25 Gbit/s data transmission. On the receiver side, it converts four channels of 106.25 Gbit/s optical signals into 8-channel electrical output data. It is designed to meet harsh external operating conditions, including temperature, humidity, and EMI interference. The module provides high functionality and feature integration accessible via the I<sup>2</sup>C interface. A block diagram is shown in Figure 1.

#### **Features**

- Compliant with QSFP-DD MSA Rev. 5.1
- Compliant with IEEE 802.3-2018 400GBASE-DR4
- Compliant with QSFP-DD CMIS 4.0 Management Interface
- Compliant with 400GE DR4 Specification
- 8 × 53.125 Gbit/s PAM4 Electrical Interface (400GAUI-8)
- Non-Hermetic Package Design
- Maximum power consumption 12 W
- MPO Connector
- 425 Gbit/s Aggregate Bit Rate
- Up to 500 m Transmission over Single-Mode Fiber with FEC
- Single 3.3 V power supply
- RoHS 2 Compliant
- Operating Case Temperature: 0 °C to +70 °C

#### **Applications**

- 400G Ethernet
- Data center network



**Figure 1. Transceiver Block Diagram**

## Absolute Maximum Ratings

Operation beyond any individual absolute maximum rating may cause permanent damage to this module.

| Parameter                   | Symbol          | Min. | Typ. | Max. | Unit | Notes          |
|-----------------------------|-----------------|------|------|------|------|----------------|
| Maximum Supply Voltage      | V <sub>CC</sub> | -0.3 | 3.3  | 3.6  | V    |                |
| Storage Temperature         | T <sub>s</sub>  | -40  |      | 85   | °C   |                |
| Relative Humidity           | RH              | 0    |      | 85   | %    | Non-condensing |
| Damage Threshold, Each Lane | THd             | 5    |      |      | dBm  |                |

## Recommended Operating Conditions

The following electrical and optical characteristics are defined under the recommended operating conditions unless otherwise specified.

| Parameter                | Min.  | Typ.   | Max.  | Unit   | Notes |
|--------------------------|-------|--------|-------|--------|-------|
| Supply Voltage           | 3.135 | 3.3    | 3.465 | V      |       |
| Case Temperature         | 0     |        | 70    | °C     |       |
| Data Rate, Each Lane     |       | 106.25 |       | Gbit/s |       |
| Data Rate Accuracy       | -100  |        | 100   | ppm    |       |
| Link Distance with G.652 | 2     |        | 500   | m      |       |

## Electrical Specifications

| Parameter                                           | Min.                                       | Typ. | Max.            | Unit | Notes                  |
|-----------------------------------------------------|--------------------------------------------|------|-----------------|------|------------------------|
| Power Dissipation                                   |                                            |      | 12              | W    |                        |
| Supply Current                                      |                                            |      | 3.64            | A    |                        |
| Receiver (Module Input)                             |                                            |      |                 |      |                        |
| Data Rate, Each Lane                                | 26.5625 ± 100 ppm                          |      |                 | GBd  |                        |
| Overload differential voltage pk-pk                 | 900                                        |      |                 | mV   |                        |
| Common-Mode Voltage                                 | -350                                       |      | 2850            | mV   |                        |
| Differential Termination Resistance Mismatch        |                                            |      | 10              | %    | At 1 MHz               |
| Differential Return Loss (SDD11)                    |                                            |      | Equation (16-1) | dB   | OIF-CEI-56G-VSR-PAM4   |
| Common-Mode to Differential-Mode Conversion (SCD11) |                                            |      | Equation (16-2) | dB   | OIF-CEI-56G- VSR-PAM4  |
| Stressed Input Test                                 | See OIF-CEI-56G-VSR-PAM4 Section 16.3.10.3 |      |                 |      |                        |
| Transmitter (Module Output)                         |                                            |      |                 |      |                        |
| Data rate, each lane                                | 26.5625 ± 100 ppm                          |      |                 | GBd  |                        |
| Differential voltage, pk-pk                         |                                            |      | 900             | mV   |                        |
| Common mode voltage (Vcm)                           | -350                                       |      | 2850            | mV   |                        |
| Common mode noise, RMS                              |                                            |      | 17.5            | mV   |                        |
| Differential Termination Resistance Mismatch        |                                            |      | 10              | %    | At 1 MHz               |
| Differential Return Loss (SDD22)                    |                                            |      | Equation (16-1) |      |                        |
| Common-Mode to Differential-Mode Conversion (SCD22) |                                            |      | Equation (16-3) | dB   |                        |
| Common mode return loss (SCC22)                     |                                            |      | -2              | dB   | From 250 MHz to fb GHz |
| Transition Time                                     | 9.5                                        |      |                 | ps   |                        |

| Parameter                                     | Min.  | Typ. | Max. | Unit | Notes |
|-----------------------------------------------|-------|------|------|------|-------|
| Near-End Eye Width at 10-6 Probability (EW6)  | 0.265 |      |      | UI   |       |
| Near-End Eye Height at 10-6 Probability (EH6) | 70    |      |      | mV   |       |
| Far-End Eye Width at 10-6 Probability (EW6)   | 0.2   |      |      | UI   |       |
| Far-End Eye Height at 10-6 Probability (EH6)  | 30    |      |      | mV   |       |
| Near-End Eye Linearity                        | 0.85  |      |      |      |       |

## Optical Specifications

| Parameter                                                              | Min.             | Typ. | Max.                | Unit |
|------------------------------------------------------------------------|------------------|------|---------------------|------|
| <b>Transmitter</b>                                                     |                  |      |                     |      |
| Data Rate, Each Lane                                                   | 53.125 ± 100 ppm |      |                     | GBd  |
| Modulation Format                                                      | PAM4             |      |                     |      |
| Lane Wavelengths                                                       | 1304.5           | 1311 | 1317.5              | nm   |
| Average Launch Power, Each Lane                                        | -2.9             |      | 4                   | dBm  |
| Optical Modulation Amplitude (OMA), Each Lane                          | -0.8             |      | 4.2                 | dBm  |
| Extinction Ratio (ER)                                                  | 3.5              |      |                     | dB   |
| Side-Mode Suppression Ratio (SMSR)                                     | 30               |      |                     | dB   |
| Launch Power in OMA Minus TDECQ, Each Lane                             | -2.2             |      |                     | dBm  |
| Transmitter and Dispersion Eye Closure for PAM4, Each Lane (TDECQ)     |                  |      | 3.4                 | dB   |
| Optical Return Loss Tolerance                                          |                  |      | 21.4                | dB   |
| Transmitter Reflectance                                                |                  |      | -26                 | dB   |
| Average Launch Power of OFF Transmitter, Each Lane                     |                  |      | -15                 | dBm  |
| <b>Receiver</b>                                                        |                  |      |                     |      |
| Data Rate, Each Lane                                                   | 53.125 ± 100 ppm |      |                     | GBd  |
| Modulation Format                                                      | PAM4             |      |                     |      |
| Damage Threshold, Each Lane                                            | 5                |      |                     | dBm  |
| Lane Wavelengths                                                       | 1304.5           |      | 1317.5              | nm   |
| Average Receiver Power, Each Lane                                      | -5.9             |      | 4                   | dBm  |
| Receiver Power, Each Lane (OMA)                                        |                  |      | 4.2                 | dBm  |
| Receiver Sensitivity (OMOuter), Each Lane <sup>1</sup> (Max.)          |                  |      | max(-3.9, SECQ-5.3) | dBm  |
| Stressed Receiver Sensitivity (OMOuter), Each Lane <sup>2</sup> (Max.) |                  |      | -1.9                | dBm  |
| LOS Assert                                                             | -15              |      |                     | dBm  |
| LOS De-Assert                                                          |                  |      | -8.4                | dBm  |
| LOS Hysteresis                                                         | 0.5              |      |                     | dB   |
| Receiver Reflectance                                                   |                  |      | -26                 | dB   |
| <b>Conditions of Stressed Receiver Sensitivity<sup>3</sup></b>         |                  |      |                     |      |
| Stressed Eye Closure for PAM4 (SECQ), Lane under Test                  | 3.4              |      |                     | dB   |
| OMOuter of Each Aggressor Lane                                         | 4.2              |      |                     | dBm  |

**Notes:**

1. Receiver sensitivity (OMOuter), each lane (max) is informative and is defined for a transmitter with a value of SECQ up to 3.4 dB.
2. Measured with a conformance test signal at BER =  $2.4 \times 10^{-4}$ .
3. These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

## EEPROM Definitions

Refer to CMIS Rev. 4.0.

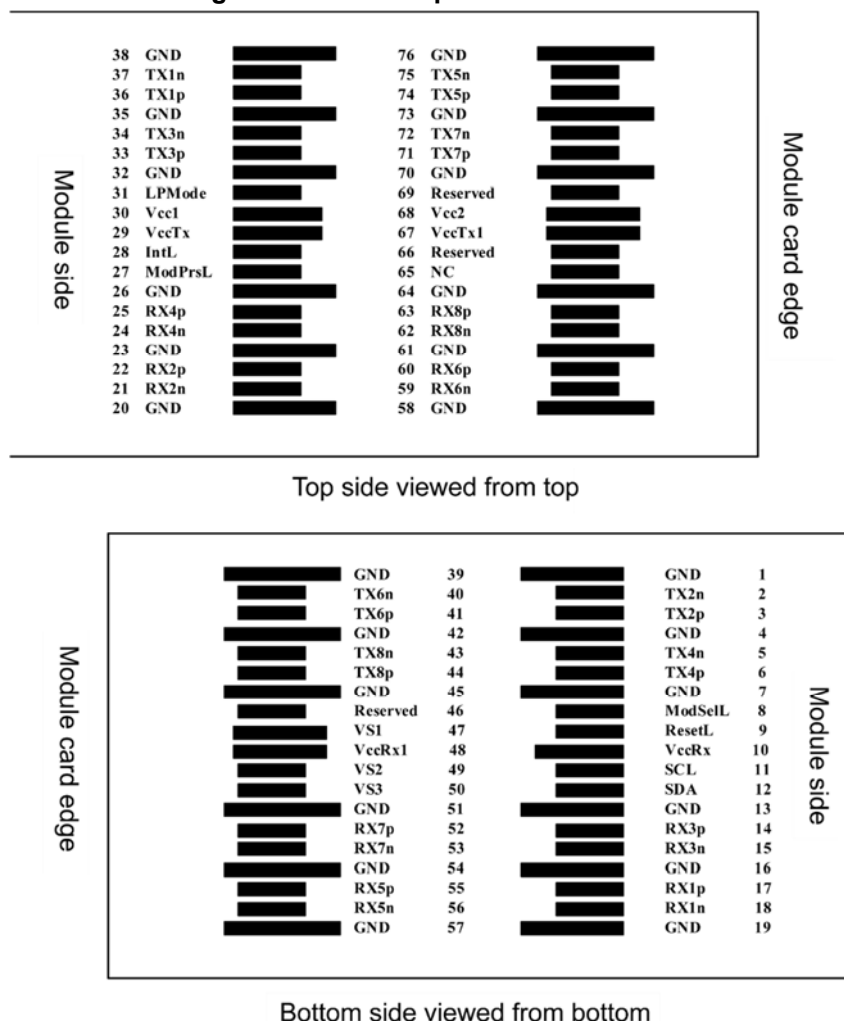
## Digital Diagnostic Memory Map

The CSMQDDQGS31S5 supports the I<sup>2</sup>C-based Diagnostic Monitoring Interface (DMI) defined in QSFP-DD CMIS Rev. 4.0. The host can access real-time performance data, including transmitter and receiver optical power, temperature, supply voltage, and bias current.

| Performance Item          | Data Address      |                            |                    |
|---------------------------|-------------------|----------------------------|--------------------|
|                           | Alarm & Warning   | Alarm & Warning Thresholds | Monitor            |
| Module temperature        | Lower page 9      | Page2h (128-135)           | Lower page (14-15) |
| Module voltage            | Lower page 9      | Page2h (136-143)           | Lower page (16-17) |
| Bias current              | Page11h (143-146) | Page2h (184-191)           | Page11h (170-177)  |
| Transmitter optical power | Page11h (139-142) | Page2h (176-183)           | Page11h (154-161)  |
| Receiver optical power    | Page11h (149-152) | Page2h (192-199)           | Page11h (186-193)  |

## Pin Diagram

**Figure 2. MSA-Compliant Connector**



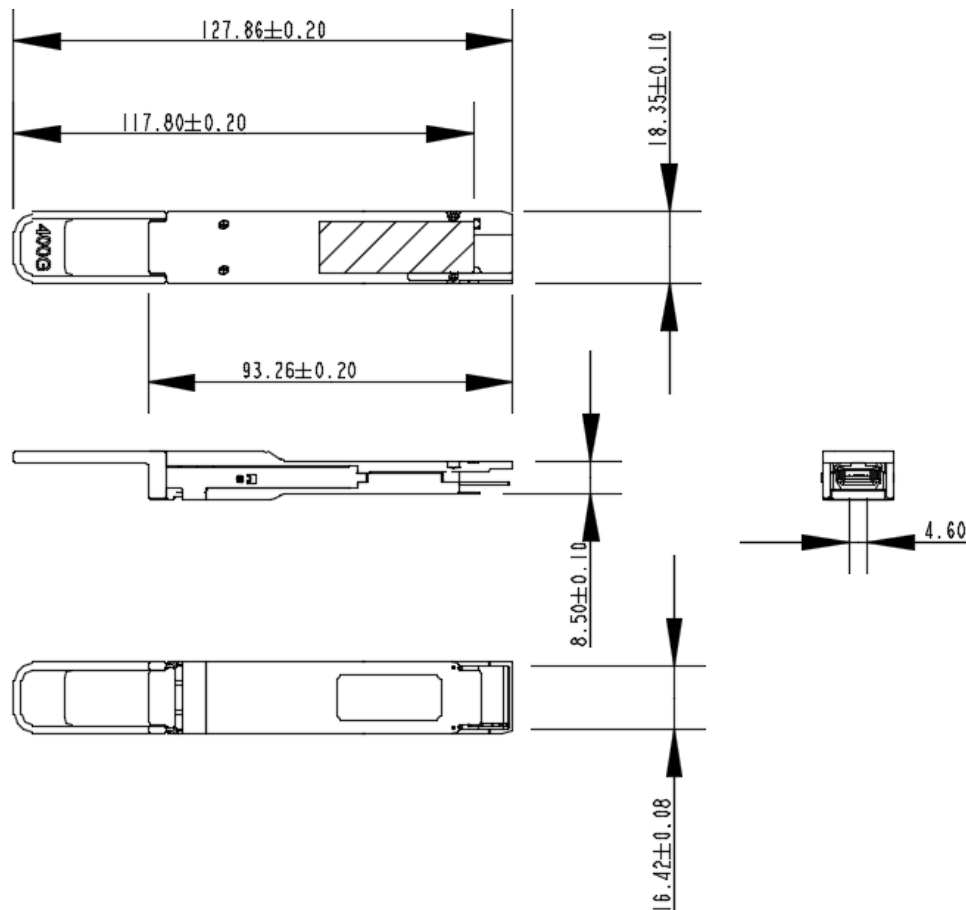
**Pin Definitions**

| Pin | Logic       | Symbol  | Description                         | Plug Seq. | Notes |
|-----|-------------|---------|-------------------------------------|-----------|-------|
| 1   |             | GND     | Ground                              | 1B        | 1     |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input     | 3B        |       |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data Input | 3B        |       |
| 4   |             | GND     | Ground                              | 1B        | 1     |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input     | 3B        |       |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data Input | 3B        |       |
| 7   |             | GND     | Ground                              | 1B        | 1     |
| 8   | LVTTL-I     | ModSelL | Module Select                       | 3B        |       |
| 9   | LVTTL-I     | ResetL  | Module Reset                        | 3B        |       |
| 10  |             | VccRx   | +3.3 V Receiver Power Supply        | 2B        | 2     |
| 11  | LVC MOS-I/O | SCL     | 2-Wire Serial Interface Clock       | 3B        |       |
| 12  | LVC MOS-I/O | SDA     | 2-Wire Serial Interface Data        | 3B        |       |
| 13  |             | GND     | Ground                              | 1B        | 1     |
| 14  | CML-O       | Rx3p    | Receiver Non-Inverted Data Output   | 3B        |       |
| 15  | CML-O       | Rx3n    | Receiver Inverted Data Output       | 3B        |       |
| 16  |             | GND     | Ground                              | 1B        | 1     |
| 17  | CML-O       | Rx1p    | Receiver Non-Inverted Data Output   | 3B        |       |
| 18  | CML-O       | Rx1n    | Receiver Inverted Data Output       | 3B        |       |
| 19  |             | GND     | Ground                              | 1B        | 1     |
| 20  |             | GND     | Ground                              | 1B        | 1     |
| 21  | CML-O       | Rx2n    | Receiver Inverted Data Output       | 3B        |       |
| 22  | CML-O       | Rx2p    | Receiver Non-Inverted Data Output   | 3B        |       |
| 23  |             | GND     | Ground                              | 1B        | 1     |
| 24  | CML-O       | Rx4n    | Receiver Inverted Data Output       | 3B        |       |
| 25  | CML-O       | Rx4p    | Receiver Non-Inverted Data Output   | 3B        |       |
| 26  |             | GND     | Ground                              | 1B        | 1     |
| 27  | LVTTL-O     | ModPrsL | Module Present                      | 3B        |       |
| 28  | LVTTL-O     | IntL    | Interrupt                           | 3B        |       |
| 29  |             | VccTx   | +3.3 V Transmitter Power Supply     | 2B        | 2     |
| 30  |             | Vcc1    | +3.3 V Power Supply                 | 2B        | 2     |
| 31  | LVTTL-I     | LPMode  | Low Power Mode                      | 3B        |       |
| 32  |             | GND     | Ground                              | 1B        | 1     |
| 33  | CML-I       | Tx3p    | Transmitter Non-Inverted Data Input | 3B        |       |
| 34  | CML-I       | Tx3n    | Transmitter Inverted Data Input     | 3B        |       |
| 35  |             | GND     | Ground                              | 1B        | 1     |
| 36  | CML-I       | Tx1p    | Transmitter Non-Inverted Data Input | 3B        |       |
| 37  | CML-I       | Tx1n    | Transmitter Inverted Data Input     | 3B        |       |
| 38  |             | GND     | Ground                              | 1B        | 1     |

|    |       |                 |                                                     |    |   |
|----|-------|-----------------|-----------------------------------------------------|----|---|
| 39 |       | GND             | Ground                                              | 1A | 1 |
| 40 | CML-I | Tx6n            | Transmitter Inverted Data Input                     | 3A |   |
| 41 | CML-I | Tx6p            | Transmitter Non-Inverted Data Input                 | 3A |   |
| 42 |       | GND             | Ground                                              | 1A | 1 |
| 43 | CML-I | Tx8n            | Transmitter Inverted Data Input                     | 3A |   |
| 44 | CML-I | Tx8p            | Transmitter Non-Inverted Data Input                 | 3A |   |
| 45 |       | GND             | Ground                                              | 1A | 1 |
| 46 |       | Reserved        | For Future Use                                      | 3A | 3 |
| 47 |       | VS1             | Module Vendor Specific 1                            | 3A | 3 |
| 48 |       | VccRx1          | +3.3 V Power Supply                                 | 2A | 2 |
| 49 |       | VS2             | Module Vendor Specific 2                            | 3A | 3 |
| 50 |       | VS3             | Module Vendor Specific 3                            | 3A | 3 |
| 51 |       | GND             | Ground                                              | 1A | 1 |
| 52 | CML-O | Rx7p            | Receiver Non-Inverted Data Output                   | 3A |   |
| 53 | CML-O | Rx7n            | Receiver Inverted Data Output                       | 3A |   |
| 54 |       | GND             | Ground                                              | 1A | 1 |
| 55 | CML-O | Rx5p            | Receiver Non-Inverted Data Output                   | 3A |   |
| 56 | CML-O | Rx5n            | Receiver Inverted Data Output                       | 3A |   |
| 57 |       | GND             | Ground                                              | 1A | 1 |
| 58 |       | GND             | Ground                                              | 1A | 1 |
| 59 | CML-O | Rx6n            | Receiver Inverted Data Output                       | 3A |   |
| 60 | CML-O | Rx6p            | Receiver Non-Inverted Data Output                   | 3A |   |
| 61 |       | GND             | Ground                                              | 1A | 1 |
| 62 | CML-O | Rx8n            | Receiver Inverted Data Output                       | 3A |   |
| 63 | CML-O | Rx8p            | Receiver Non-Inverted Data Output                   | 3A |   |
| 64 |       | GND             | Ground                                              | 1A | 1 |
| 65 |       | NC              | No Connect                                          | 3A | 3 |
| 66 |       | Reserved        | For Future Use                                      | 3A | 3 |
| 67 |       | VccTx1          | +3.3 V Power Supply                                 | 2A | 2 |
| 68 |       | Vcc2            | +3.3 V Power Supply                                 | 2A | 2 |
| 69 |       | Reserved/(ePPS) | Precision Time Protocol (PTP) Reference Clock Input | 3A | 3 |
| 70 |       | GND             | Ground                                              | 1A | 1 |
| 71 | CML-I | Tx7p            | Transmitter Non-Inverted Data Input                 | 3A |   |
| 72 | CML-I | Tx7n            | Transmitter Inverted Data Input                     | 3A |   |
| 73 |       | GND             | Ground                                              | 1A | 1 |
| 74 | CML-I | Tx5p            | Transmitter Non-Inverted Data Input                 | 3A |   |
| 75 | CML-I | Tx5n            | Transmitter Inverted Data Input                     | 3A |   |
| 76 |       | GND             | Ground                                              | 1A | 1 |

**Notes:**

1. QSFP-DD uses common ground (GND) for all signals and supply (power). All are common within the QSFP-DD 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, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 shall be applied concurrently. Requirements defined for the host side of the Host Card Edge Connector are listed in the table. VccRx, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 may be internally connected within the module in any combination. Each connector Vcc pin is rated for a maximum current of 1000 mA.
3. All Vendor Specific, Reserved, and No Connect pins may be terminated with 50 Ohm to ground on the host. Pad 65 (No Connect) shall be left unconnected within the module. Vendor Specific and Reserved pads shall have an impedance to GND that is greater than 10 kOhm and less than 100 pF.
4. Plug Sequence specifies the mating sequence of the host connector and module.

**Mechanical Specifications**


Unit: mm

**Ordering Information**

| Part Number   | Product Description                                              |
|---------------|------------------------------------------------------------------|
| CSMQDDQGS31S5 | QSFP-DD, 400GE, DR4, 500 m, 0 °C to +70 °C, with FEC, MPO-12 APC |

**For More Information**

Tel: +886-2-8227 1877

 E-mail: [sales@cosmo-ic.com](mailto:sales@cosmo-ic.com)

 Web: <http://www.cosmo-ic.com>