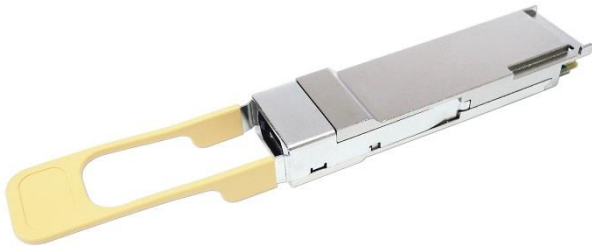




## 100G QSFP28 eSR4 Transceiver

Hot Pluggable, MPO / MTP, 850nm VCSEL, OM3 200M / OM4 300M, DDM

**Part Number: FQ28-K9-M85-X3D**



### Overview

FQ28-K9-M85-X3D is a parallel fiber optical transceiver module for 103.1Gbps data transmission applications at 850nm. It is ideally suited for datacom & storage area network (SAN/NAS) applications based on IEEE 802.3ba 100GBASE-SR4 standard. Designed for short range multi-lane data communication, The QSFP28 full-duplex optical module with MPO-12 receptacle integrates four independent transmitter and receiver channels. Each capable 25.78125 operation for an aggregate data rate of 103.1Gbps up to MMF OM3 200m / OM4 300m optical links.

### Applications

- 100GBASE-SR4 Ethernet @103.1G
- Breakout to 4 x 25GBASE-SR Ethernet
- Data Centers Switch Interconnect
- Server and Storage Area Network Interconnect

### Features

- Compliant with IEEE802.3bm 100GBASE-SR4
- Compliant with SFF-8665 QSFP28 MSA
- Compliant with IEEE 802.3bm CAUI-4 Interface
- 4 independent full-duplex channels
- Data Rate 25.78125Gbps per Lane
- Built in quad Tx CDR and Rx CDR
- Hot Pluggable QSFP28 footprint
- 4CH 850nm VCSEL array transmitter
- 4CH PIN array receiver
- MPO-12 receptacle connector
- 2-wire interface for management and diagnostic monitor compliant with SFF-8636
- Single 3.3V power supply
- Link distance 200m over OM3 and 300m over OM4 MM fiber with Host FEC
- Maximum power consumption 2.5W
- RoHS compliant



## Laser Safety

- This is a Class 1 Laser Product complies with 21 CFR 1040.10 and 1040.11 except for conformance with IEC 60825-1 Ed. 3., as described in Laser Notice No. 56, dated May 8, 2019.
- Caution: Use of control or adjustments or performance of procedure other than those specified herein may result in hazardous radiation exposure.

## Absolute Maximum Ratings

| Parameters                | Symbol           | Min. | Max. | Unit |
|---------------------------|------------------|------|------|------|
| Storage Temperature       | T <sub>ST</sub>  | -40  | +85  | °C   |
| Storage Relative Humidity | RH               | 0    | 95   | %    |
| Supply Voltage            | V <sub>CC3</sub> | -0.5 | +4.0 | V    |

## Recommended Operating Conditions

| Parameters                               | Symbol          | Min.  | Typ.     | Max.               | Unit |
|------------------------------------------|-----------------|-------|----------|--------------------|------|
| Case Operating Temperature               | T <sub>OP</sub> | 0     | -        | +70                | °C   |
| Supply Voltage                           | V <sub>CC</sub> | +3.13 | +3.3     | +3.47              | V    |
| Data Rate, per Lane                      | DR              |       | 25.78125 |                    | Gb/s |
| Data Rate Accuracy                       | ΔDR             | -100  |          | +100               | ppm  |
| Bit Error Rate                           | BER             |       |          | 5x10 <sup>-5</sup> |      |
| Supply Current                           | I <sub>CC</sub> |       |          | 750                | mA   |
| Power Consumption                        | P               |       |          | 2.5                | W    |
| Transceiver Power-on Initialization Time |                 |       |          | 2000               | ms   |
| Control Input Voltage High               | V <sub>IH</sub> | 2.0   |          | V <sub>CC</sub>    | V    |
| Control Input Voltage Low                | V <sub>IL</sub> | GND   |          | 0.8                | V    |
| Control Output Voltage High              | V <sub>OH</sub> | 2.0   |          | V <sub>CC</sub>    | V    |
| Control Output Voltage Low               | V <sub>OL</sub> | GND   |          | 0.8                | V    |



## Transmitter Electro-optical Characteristics

V<sub>CC</sub> = 3.13V to 3.47V, T<sub>OP</sub> = 0 °C to 70 °C

| Parameters                                                             | Symbol               | Min.                             | Typ.     | Max. | Unit | Note |
|------------------------------------------------------------------------|----------------------|----------------------------------|----------|------|------|------|
| Operating Data Rate, per Lane                                          | DR                   |                                  | 25.78125 |      | Gb/s |      |
| Average Launch Power, per Lane                                         | P <sub>AVG</sub>     | -8.4                             |          | +2.4 | dBm  |      |
| Optical Modulation Amplitude (OMA), per Lane                           | P <sub>OMA</sub>     | -6.4                             |          | +3.0 | dBm  | 1    |
| Difference in Launch Power between any two Lanes (OMA)                 | P <sub>TX-DIFF</sub> |                                  |          | 4.0  | dB   |      |
| Transmitter Dispersion Penalty, per Lane                               | TDP                  |                                  |          | 4.3  | dBm  |      |
| Launch Power in OMA minus Transmitter and Dispersion Penalty, per Lane | OMA-TDP              | -7.3                             |          |      | dB   | 1    |
| Optical Wavelength, each Lane                                          | λ <sub>c</sub>       | 840                              | 850      | 860  | nm   | 1    |
| Spectral Width (RMS)                                                   | Δλ                   |                                  |          | 0.6  | nm   |      |
| Optical Extinction Ratio                                               | ER                   | 2                                |          |      | dB   |      |
| Optical Eye Mask { X1, X2, X3, Y1, Y2, Y3 }                            |                      | { 0.28,0.34,0.43,0.36,0.44,0.4 } |          |      |      | 2    |
| Average Launch Power OFF, per Lane                                     | P <sub>OFF</sub>     |                                  |          | -30  | dBm  |      |
| Optical Return Loss Tolerance                                          | ORLT                 |                                  |          | 12   | dB   |      |
| Input Differential Impedance                                           | Z <sub>IN</sub>      | 90                               | 100      | 110  | Ω    |      |
| Differential Data Input Voltage                                        | V <sub>IN-PP</sub>   | 180                              |          | 900  | mVpp |      |

**Note1:** Transmitter wavelength, RMS spectral width and launch power need to meet the OMA minus TDP specs to guarantee link performance.

**Note2:** Hit ratio 5x10<sup>-5</sup> hits per sample.

## Receiver Electro-optical Characteristics

$V_{CC} = 3.13V$  to  $3.47V$ ,  $T_{OP} = 0\text{ }^{\circ}C$  to  $70\text{ }^{\circ}C$

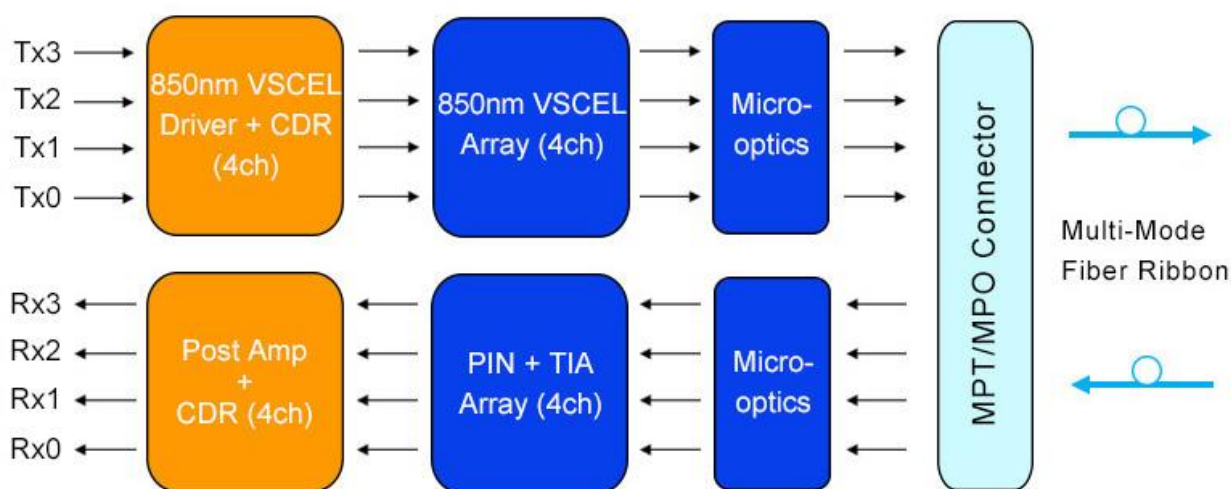
| Parameters                                    | Symbol                   | Min. | Typ.     | Max.  | Unit     | Note |
|-----------------------------------------------|--------------------------|------|----------|-------|----------|------|
| Operating Data Rate, per Lane                 | DR                       |      | 25.78125 |       | Gb/s     |      |
| Damage Threshold, per Lane                    | D <sub>TH</sub>          | +3.4 |          |       | dBm      | 1    |
| Average Receive Power, per Lane               | P <sub>RX-AVG</sub>      |      |          | +2.5  | dBm      |      |
| Receive Sensitivity (OMA), per Lane           | SEN <sub>OMA</sub>       |      |          | -10.3 | dBm      | 2    |
| Stressed Receiver Sensitivity (OMA), per Lane | SEN <sub>SOMA</sub><br>A |      |          | -5.2  | dBm      | 3    |
| Optical Wavelength, each Lane                 | $\lambda_c$              | 840  | 850      | 860   | nm       |      |
| Receiver Reflectance                          | R <sub>RX</sub>          |      |          | -12   | dB       |      |
| LOS De-Assert                                 | LOS <sub>D</sub>         |      |          | -11   | dBm      |      |
| LOS Assert                                    | LOS <sub>A</sub>         | -30  |          |       | dBm      |      |
| LOS Hysteresis                                | LOS <sub>HY</sub>        | 0.5  |          | 5     | dB       |      |
| Output Differential Impedance                 | Z <sub>OUT</sub>         | 90   | 100      | 110   | $\Omega$ |      |
| Differential Data Output Voltage              | V <sub>OUT-PP</sub>      | 300  |          | 850   | mVpp     |      |

**Note1:** 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.

**Note2:** Measured with conformance test signal at receiver input for BER=  $5 \times 10^{-5}$ .

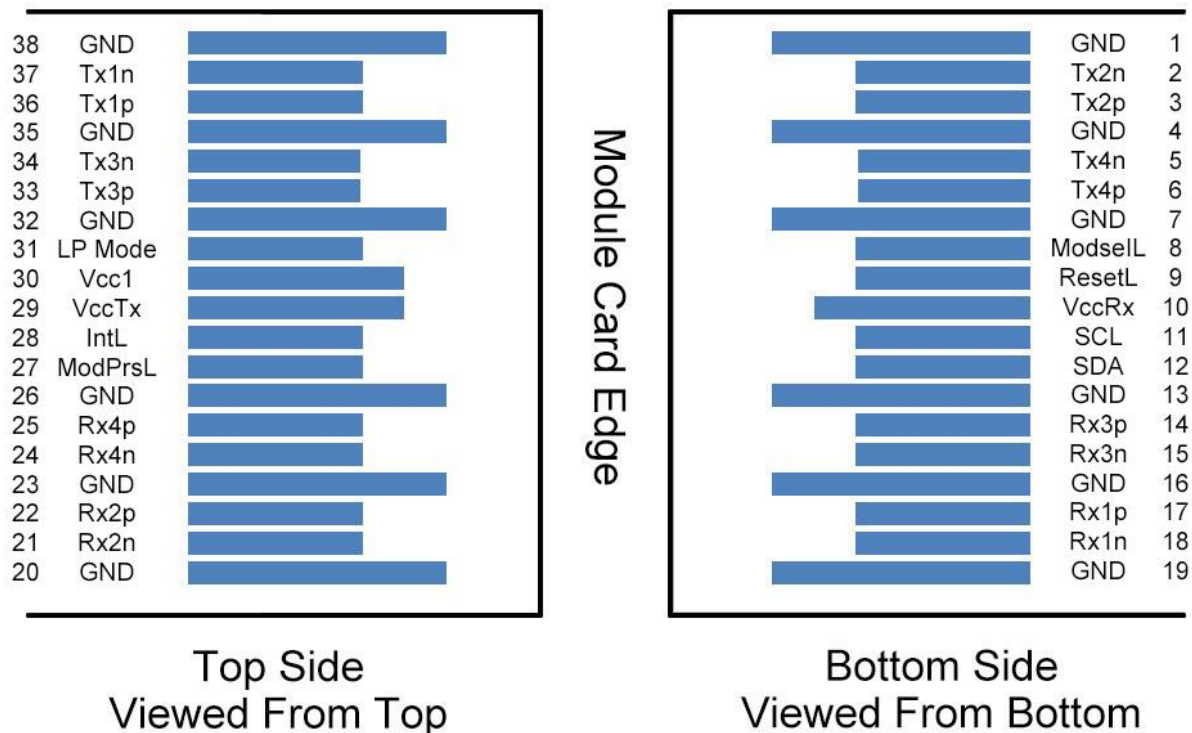
**Note3:** Measured with conformance test signal at receiver input for BER=  $1 \times 10^{-12}$ .

## Transceiver Block Diagram





## Pin Assignment



## Pin Description

| Pin | Logic       | Name    | Function / Description              |
|-----|-------------|---------|-------------------------------------|
| 1   |             | GND     | Module Ground                       |
| 2   | CML-I       | Tx2n    | Transmitter Inverted Data Input     |
| 3   | CML-I       | Tx2p    | Transmitter Non-Inverted Data Input |
| 4   |             | GND     | Module Ground                       |
| 5   | CML-I       | Tx4n    | Transmitter Inverted Data Input     |
| 6   | CML-I       | Tx4p    | Transmitter Non-Inverted Data Input |
| 7   |             | GND     | Module Ground                       |
| 8   | LVTLL-I     | ModSelL | Module Select                       |
| 9   | LVTLL-I     | ResetL  | Module Reset                        |
| 10  |             | VccRx   | +3.3V Power Supply Receiver         |
| 11  | LVC MOS-I/O | SCL     | 2-Wire Serial Interface Clock       |
| 12  | LVC MOS-I/O | SDA     | 2-Wire Serial Interface Data        |



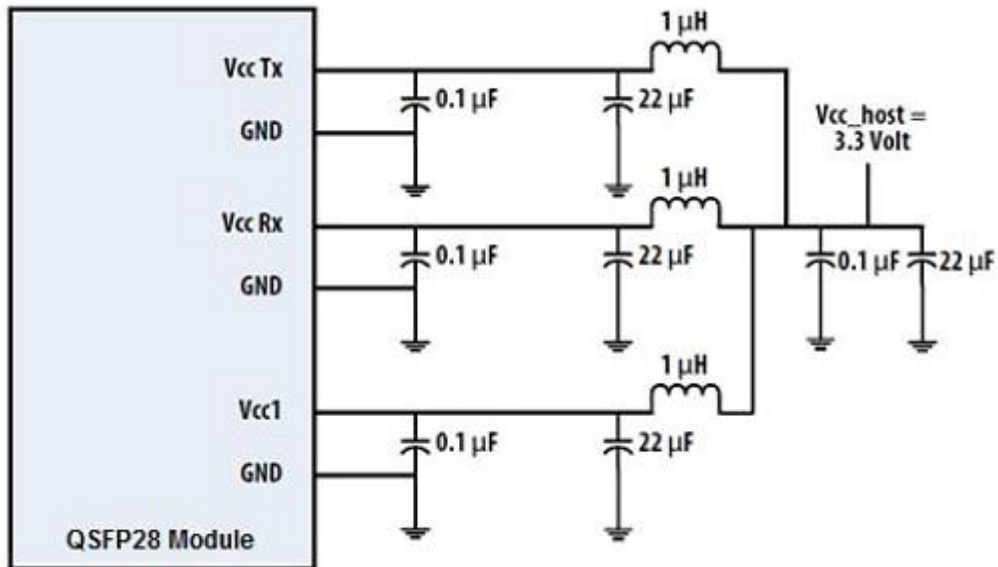
|    |         |         |                                     |
|----|---------|---------|-------------------------------------|
| 13 |         | GND     | Module Ground                       |
| 14 | CML-O   | Rx3p    | Receiver Non-Inverted Data Output   |
| 15 | CML-O   | Rx3n    | Receiver Inverted Data Output       |
| 16 |         | GND     | Module Ground                       |
| 17 | CML-O   | Rx1p    | Receiver Non-Inverted Data Output   |
| 18 | CML-O   | Rx1n    | Receiver Inverted Data Output       |
| 19 |         | GND     | Module Ground                       |
| 20 |         | GND     | Module Ground                       |
| 21 | CML-O   | Rx2n    | Receiver Inverted Data Output       |
| 22 | CML-O   | Rx2p    | Receiver Non-Inverted Data Output   |
| 23 |         | GND     | Module Ground                       |
| 24 | CML-O   | Rx4n    | Receiver Inverted Data Output       |
| 25 | CML-O   | Rx4p    | Receiver Non-Inverted Data Output   |
| 26 |         | GND     | Module Ground                       |
| 27 | LVTLL-O | ModPrsL | Module Present                      |
| 28 | LVTLL-O | IntL    | Interrupt                           |
| 29 |         | VccTx   | +3.3V Power Supply Transmitter      |
| 30 |         | Vcc1    | +3.3V Power Supply                  |
| 31 | LVTLL-I | LPMODE  | Low Power Mode                      |
| 32 |         | GND     | Module Ground                       |
| 33 | CML-I   | Tx3p    | Transmitter Non-Inverted Data Input |
| 34 | CML-I   | Tx3n    | Transmitter Inverted Data Input     |
| 35 |         | GND     | Module Ground                       |
| 36 | CML-I   | Tx1p    | Transmitter Non-Inverted Data Input |
| 37 | CML-I   | Tx1n    | Transmitter Inverted Data Input     |
| 38 |         | GND     | Module Ground                       |

**Note1:** 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 lane.

**Note2:** VccRx, Vcc1 and VccTx are the receiver and transmitter 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.



## Recommended Power Supply Filter





## Digital Diagnostic Functions

As defined by the QSFP28 MSA, Ficer's QSFP28 transceivers provide digital diagnostic functions via a 2-wire serial interface, which allows real-time access to the following operating parameters:

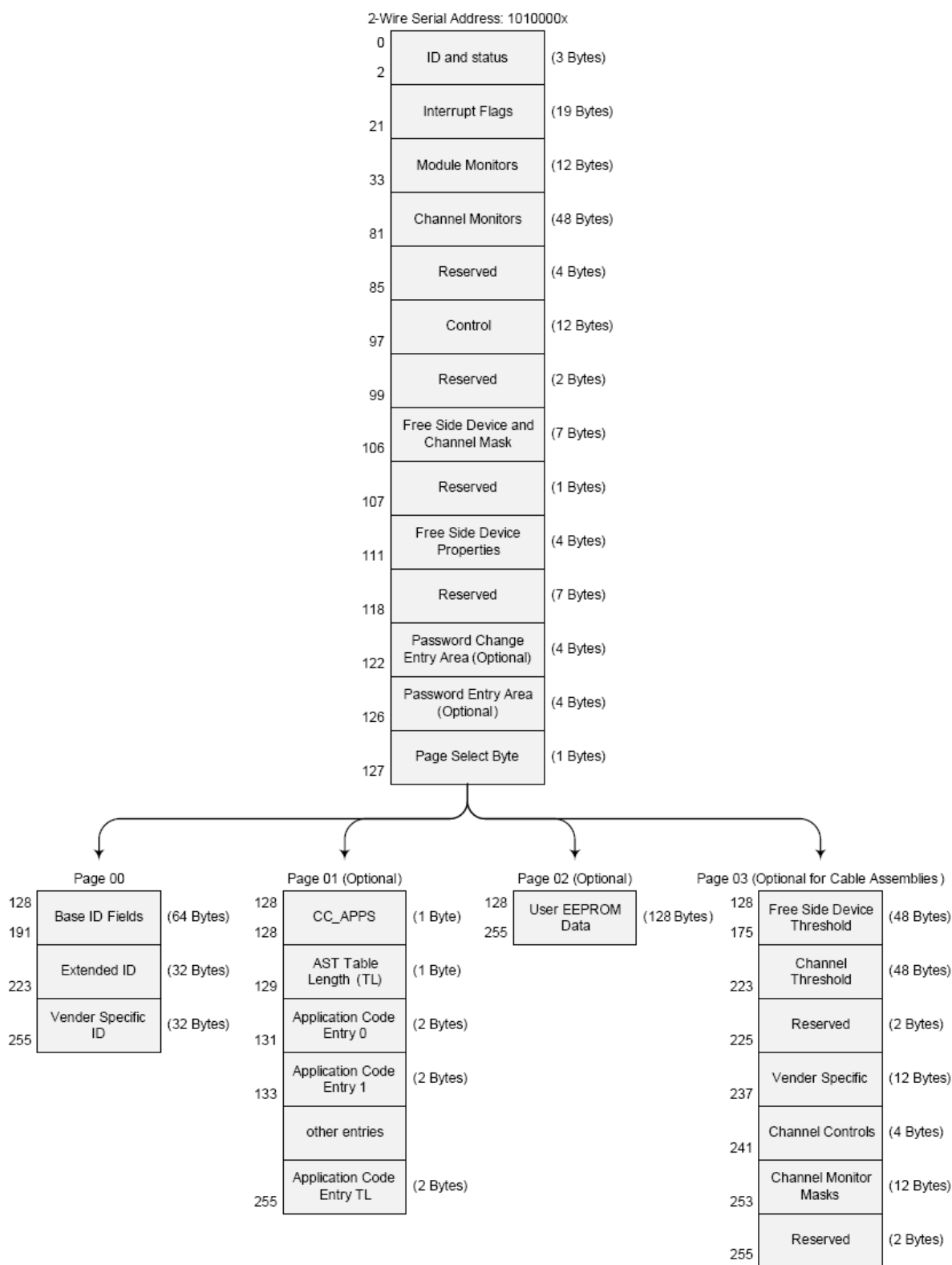
- Transceiver temperature
- Laser bias current (4-Channel)
- Transmitted optical power (4-Channel)
- Received optical power (4-Channel)
- Transceiver supply voltage

It also provides a sophisticated system of alarm and warning flags, which may be used to alert end-users when particular operating parameters are outside of a factory-set normal range.

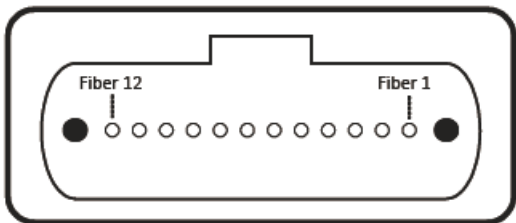
The operating and diagnostics information is monitored and reported by a Digital Diagnostics Controller (DDC) inside the transceiver, which is accessed through the 2-wire serial interface. When the serial protocol is activated, the serial clock signal (SCL pin) is generated by the host. The positive edge clocks data into the QSFP28 transceiver into those segments of its memory map that are not write-protected. The negative edge clocks data from the QSFP28 transceiver. The serial data signal (SDA pin) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially. The 2-wire serial interface provides sequential or random access to the 8 bit parameters, addressed from 000h to the maximum address of the memory.

For more detailed information including memory map definitions, please see the QSFP28 MSA Specification.

## Digital Diagnostic Memory Map



Optical Interface Lanes and Assignment



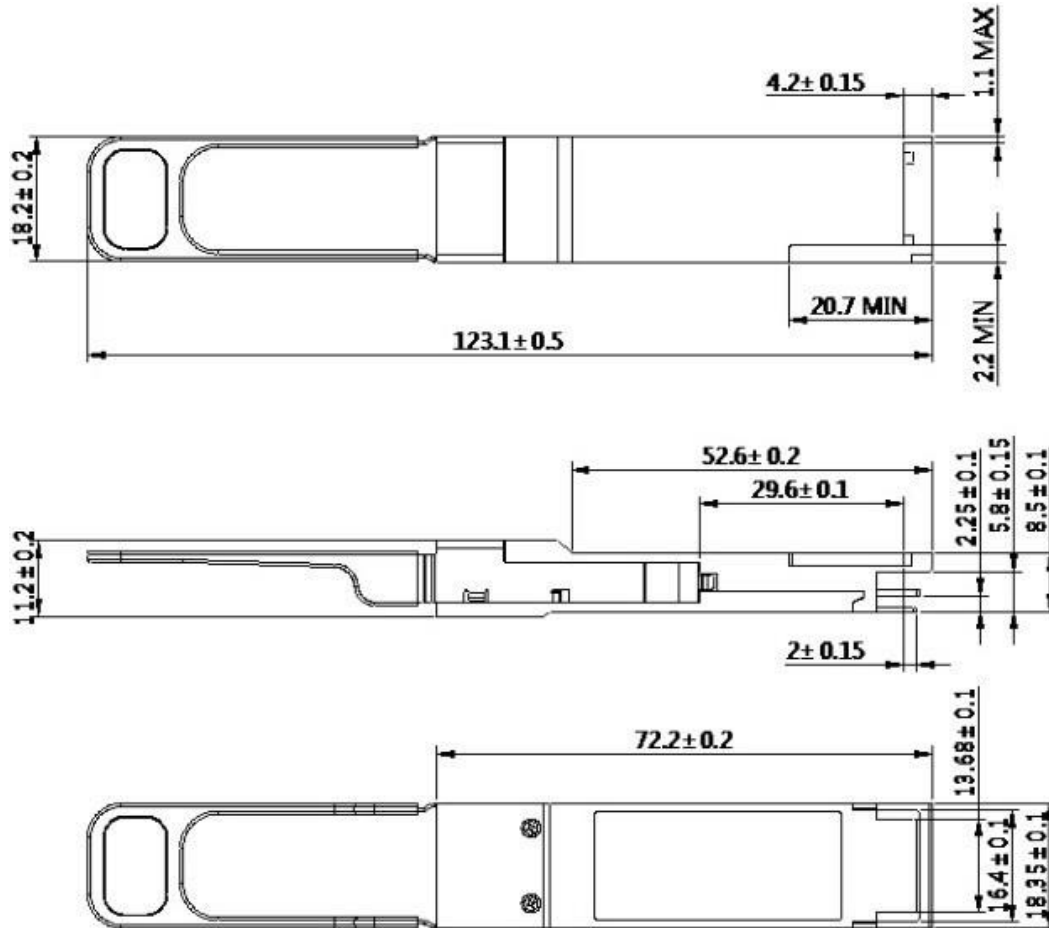
Outside View of the QSFP28 Module MPO

| Fiber # | Lane Assignment |
|---------|-----------------|
| 1       | Rx0             |
| 2       | Rx1             |
| 3       | Rx2             |
| 4       | Rx3             |
| 5,6,7,8 | Not used        |
| 9       | Tx3             |
| 10      | Tx2             |
| 11      | Tx1             |
| 12      | Tx0             |

lane assignment



## Mechanical Dimensions



(All Dimensions are ±0.20mm Unless Otherwise Specified, Unit: mm)

## Ordering Information

| Part No.        | Tx    | Rx    | Link                       | DDM | Temp.  |
|-----------------|-------|-------|----------------------------|-----|--------|
| FQ28-K9-M85-X3D | 850nm | 850nm | MM OM3 200m<br>MM OM4 300m | Yes | 0~70°C |

**Note:** Distances are indicative only. To calculate a more precise link budget based on specific conditions in your application, please refer to the optical characteristics.