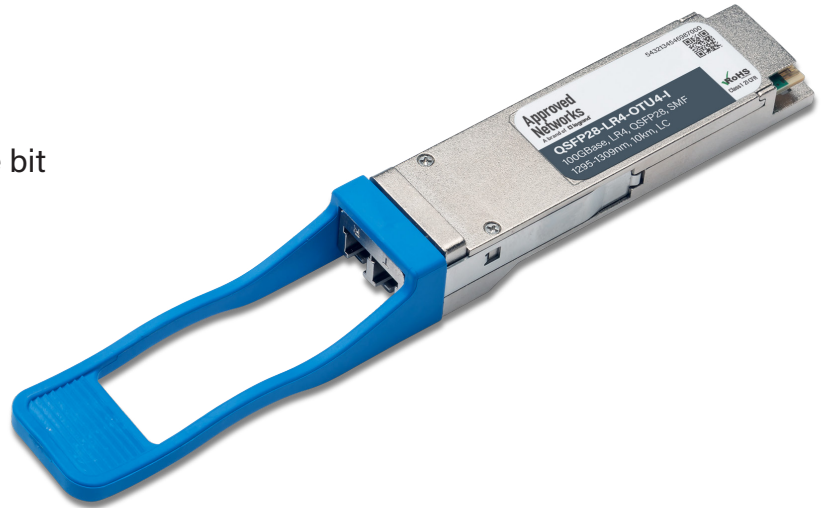


## Features

- Hot-pluggable QSFP28 form factor
- Supports 103.1Gb/s and 112Gb/s aggregate bit rates
- Power dissipation < 4.5W
- RoHS-6 compliant
- Industrial case temperature range of -40°C to 85°C
- Single 3.3V power supply
- Maximum link length of 10km on Single Mode Fiber (SMF)
- 4x28Gb/s DFB-based LAN-WDM transmitter
- 4x28G retimed electrical interface
- Duplex LC receptacles
- I2C management interface



## Applications

- OTN OTU4 411-9D1F
- 100GBASE-LR4 100G Ethernet
- Outside plant
- Reduced air flow central office

## 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 | Units | Notes |
|-------------------------------------|--------|------|-----|-------|-------|
| Maximum Supply Voltage              | Vcc    | -0.5 | 3.6 | V     |       |
| Storage Temperature                 | TS     | -40  | 85  | °C    |       |
| Case Operating Temperature          | TOP    | -40  | 85  | °C    |       |
| Relative Humidity                   | RH     | 15   | 85  | %     | 1     |
| Receiver Damage Threshold, per Lane | PRdmg  | 5.5  |     | dBm   |       |

Notes

1. Non-condensing.

## 2. Environmental Specifications

| Parameter                  | Symbol | Min | Typ | Max | Units |
|----------------------------|--------|-----|-----|-----|-------|
| Case Operating Temperature | Top    | -40 |     | 85  | °C    |
| Storage Temperature        | Tsto   | -40 |     | 85  | °C    |

### 3. Electrical Characteristics

(EOL, TOP = -40 to +85 °C, VCC = 3.135 to 3.465 Volts)

| Parameter  | Symbol               | Min   | Typ  | Max     | Units | Notes |
|--|----------------------|---|------|---------|-------|-------|
| Supply Voltage   | Vcc                  | 3.135   |      | 3.465   | V     |       |
| Supply Current   | Icc                  |   |      | 1.6     | A     |       |
| Module total power   | P                    |   |      | 4.5     | W     | 1     |
| <b>Transmitter</b>   |                      |   |      |         |       |       |
| Signaling rate per lane                                    |                      | 25.78   |      | 27.95   | Gb/s  |       |
| Differential data input swing per lane                     | V <sub>in,pp</sub>   |   |      | 900     | mV    |       |
| Differential input return loss (min) at LR4                | RL <sub>d</sub> (f)  | 9.5 - 0.37f, 0.01 ≤ f < 8<br>4.75 - 7.4log <sub>10</sub> (f/14), 8 ≤ f < 19 |      |         | dB    |       |
| Differential to common mode input return loss (min) at LR4 | RL <sub>dc</sub> (f) | 22-20(f/25.78), 0.01 ≤ f < 12.89<br>15-6(f/25.78), 12.89 ≤ f < 19           |      |         | dB    |       |
| Differential input return loss (min) at OTU4               | SDD11                | -11, 0.05 < f < fb<br>-6.0+9.2log <sub>10</sub> (2f/fb), fb/7 < f < fb      |      |         | dB    | 2     |
| Different to common mode input return loss (min) at OTU4   | SDC11<br>SCD11       | -22+14(f/fb), 0.05 < f < fb/2<br>-18+6f/fb, fb/2 < f < fb                   |      |         | dB    | 2     |
| Differential termination mismatch                          |                      |   |      | 10      | %     |       |
| <b>Stressed input parameters</b>                           |                      |   |      |         |       |       |
| Eye width  |                      |   | 0.46 |         | UI    |       |
| Applied pk-pk sinusoidal jitter                            |                      | Per IEEE 802.3bm Table 88-13  |      |         |       |       |
| Eye height   |                      |   | 95   |         | mV    |       |
| DC common mode voltage                                     |                      | -350  |      | 2850    | mV    |       |
| <b>Receiver</b>  |                      |   |      |         |       |       |
| Signaling rate per lane                                    |                      | 25.78125  |      | 27.9525 | GBd   |       |
| Differential data output swing                             | V <sub>out,pp</sub>  | 100   |      | 400     | mVpp  | 3     |
|  |                      | 300   |      | 600     |       |       |
|  |                      | 400   |      | 800     |       |       |
|  |                      | 600   |      | 1200    |       |       |
| Eye width  | EW15                 | 0.57  |      |         | UI    | 4     |
| Eye height   | EH15                 | 228   |      |         | mV    | 4     |
| Vertical eye closure                                       |                      |   |      | 5.5     | dB    |       |
| Differential output return loss (min) at LR4               | RL <sub>d</sub> (f)  | 9.5 - 0.37f, 0.01 ≤ f < 8<br>4.75 - 7.4log <sub>10</sub> (f/14), 8 ≤ f < 19 |      |         | dB    |       |
| Common to differential mode                                |                      |   |      |         |       |       |

|  |                |   |  |      |    |   |
|--|----------------|---|--|------|----|---|
| conversion return loss (min) at LR4                              | RLdc(f)        | 22-20(f/25.78), 0.01≤f<12.89<br>15-6(f/25.78), 12.89≤f<19 |  |      | dB |   |
| Differential output return loss (min) at OTU4                    | SDD22          | -11, 0.05<f<fb<br>-6.0+9.2log10(2f/fb), fb/7<f<fb         |  |      | dB | 2 |
| Common to differential mode conversion return loss (min) at OTU4 | SDC22<br>SCD22 | -25+20(f/fb), 0.05<f<fb/2<br>-18+6f/fb, fb/2<f<fb         |  |      | dB | 2 |
| Common mode return loss at OTU4                                  | SCC22          |   |  | -2   | dB | 5 |
| Common mode noise, RMS   |                |   |  | 17.5 | mV |   |
| Differential termination mismatch                                |                |   |  | 10   | %  |   |
| Transition time, 20% to 80% at LR4                               | tr tf          | 12  |  |      | ps |   |
| Transition time, 20% to 80% at OTU4                              | tr tf          | 9.5   |  |      | ps |   |

Notes:

1. Maximum total power value is specified across the full temperature and voltage range. Power consumption ≤ 4.5W when stabilized (both Tx and Rx CDR locked), but may be ≤ 5W during locking acquisition.
2. fb is the data rate per lane in Gb/s
3. Output voltage is settable in 4 discrete ranges via I2C. Default range is 400 – 800 mV.
4. Defined at 10-15 probability.
5. From 250 MHz to 30 GHz.

## 4. Optical Characteristics

(EOL, TOP = -40 to +85 °C, VCC = 3.135 to 3.465 Volts)

| OTU4 4I1-9D1F Operation            |        |                   |         |     |      |       |
|------------------------------------|--------|-------------------|---------|-----|------|-------|
| Parameter                          | Symbol | Min               | Typical | Max | Unit | Notes |
| <b>Transmitter</b>                 |        |                   |         |     |      |       |
| Signaling Speed per Channel        |        | 27.9525± 20 ppm   |         |     | Gb/s | 1     |
| Channel center wavelengths (range) |        | 1294.53 – 1296.59 |         |     | nm   |       |
|                                    |        | 1299.02 – 1301.09 |         |     |      |       |
|                                    |        | 1303.54 – 1305.63 |         |     |      |       |
|                                    |        | 1308.09 – 1310.19 |         |     |      |       |
| Total Average Launch Power         | POUT   |                   |         | 10  | dBm  |       |
| Average Launch Power per Channel   | TXPx   | -0.6              |         | 4.0 | dBm  | 5     |
| Optical Channel Extinction Ratio   | ER     | 4.0               |         | 6.5 | dB   |       |
| Channel Power Difference           | ΔPOUT  |                   |         | 5   | dB   |       |

|   |        |                                    |     |       |     |     |
|---|--------|------------------------------------|-----|-------|-----|-----|
| Optical Return Loss   | ORL    |                                    |     | 20    | dB  |     |
| Transmitter eye mask definition<br>{X1, X2, X3, Y1, Y2, Y3} |        | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} |     |       |     |     |
| <b>Receiver</b>   |        |                                    |     |       |     |     |
| Signaling Speed per Channel                                 |        | 27.9525 ± 20 ppm                   |     |       | GBd | 3   |
| Channel center wavelengths (range)                          |        | 1294.53 – 1296.59                  |     |       | nm  |     |
|   |        | 1299.02 – 1301.09                  |     |       |     |     |
|   |        | 1303.54 – 1305.63                  |     |       |     |     |
|   |        | 1308.09 – 1310.19                  |     |       |     |     |
| Average Input Power per Channel                             | RXPx   | -6.9                               |     | 4.0   | dBm | 4,5 |
| Optical Path Penalty  | OPP    |                                    |     | 1.5   | dB  |     |
| Equivalent Sensitivity per Channel                          | Rxsens |                                    |     | -8.4  | dBm | 4   |
| Total Average Input Power                                   | PIN    |                                    |     | 10.0  | dBm |     |
| Channel Power Difference                                    | ΔPIN   |                                    |     | 5.5   | dB  |     |
| LOS De-Assert   | LOSD   |                                    |     | -11.6 | dBm |     |
| LOS Assert  | LOSA   | -24                                |     | -13.6 | dBm |     |
| LOS Hysteresis  |        |                                    | 1.5 |       | dBm |     |

Notes:

1. Transmitter consists of 4 lasers operating at 27.95Gb/s each.
2. Hit ratio 5x10<sup>-5</sup>.
3. Receiver consists of 4 photodetectors operating at 27.95Gb/s each.
4. Specified at a BER of 10<sup>-6</sup> (pre-FEC), per ITU-T G.sup39.
5. Power value and power accuracy are with all channels on.

| OTU4 4I1-9D1F Operation         |        |                    |         |      |      |       |
|---------------------------------|--------|--------------------|---------|------|------|-------|
| Parameter                       | Symbol | Min                | Typical | Max  | Unit | Notes |
| <b>Transmitter</b>              |        |                    |         |      |      |       |
| Signaling Speed per Lane        |        | 25.78125 ± 100 ppm |         |      | Gb/s | 1     |
| Lane center wavelengths (range) |        | 1294.53 – 1296.59  |         |      | nm   |       |
|                                 |        | 1299.02 – 1301.09  |         |      |      |       |
|                                 |        | 1303.54 – 1305.63  |         |      |      |       |
|                                 |        | 1308.09 – 1310.19  |         |      |      |       |
| Total Average Launch Power      | POUT   |                    |         | 10.5 | dBm  |       |
| Transmit OMA per Lane           | TxOMA  | -1.3               |         | 4.5  | dBm  |       |

|   |        |                                    |     |       |       |     |
|---|--------|------------------------------------|-----|-------|-------|-----|
| Average Launch Power per Lane                               | TXPx   | -4.3                               |     | 4.5   | dBm   | 2,7 |
| Optical Extinction Ratio                                    | ER     | 4                                  |     |       | dB    |     |
| Sidemode Suppression ratio                                  | SSRmin | 30                                 |     |       | dB    |     |
| Average launch power of OFF transmitter, per lane           |        |                                    |     | -30   | dBm   |     |
| Relative Intensity Noise                                    | RIN    |                                    |     | -130  | dB/Hz |     |
| Optical Return Loss Tolerance                               |        |                                    |     | 20    | dB    |     |
| Transmitter Reflectance                                     |        |                                    |     | -12   | dB    |     |
| Transmitter eye mask definition<br>{X1, X2, X3, Y1, Y2, Y3} |        | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} |     |       |       | 3   |
| <b>Receiver</b>   |        |                                    |     |       |       |     |
| Signaling Speed per Lane                                    |        | 25.78125 ± 100 ppm                 |     |       | GBd   | 4   |
| Lane center wavelengths (range)                             |        | 1294.53 – 1296.59                  |     |       | nm    |     |
|   |        | 1299.02 – 1301.09                  |     |       |       |     |
|   |        | 1303.54 – 1305.63                  |     |       |       |     |
|   |        | 1308.09 – 1310.19                  |     |       |       |     |
| Receive Power (OMA) per Lane                                | RxOMA  |                                    |     | 4.5   | dBm   |     |
| Average Receive Power per Lane                              | RXPx   | -10.6                              |     | 4.5   | dBm   | 5,7 |
| Receiver Sensitivity (OMA) per Lane                         | Rxsens |                                    |     | -8.6  | dBm   |     |
| Return Loss   | RL     | -26                                |     |       | dB    |     |
| Stressed Receiver Sensitivity (OMA) per Lane                | SRS    |                                    |     | -6.8  | dBm   | 6   |
| Receive electrical 3 dB upper cutoff frequency, per lane    |        |                                    |     | 31    | GHz   |     |
| LOS De-Assert   | LOSD   |                                    |     | -11.6 | dBm   |     |
| LOS Assert  | LOSA   | -24                                |     | -13.6 | dBm   |     |
| LOS Hysteresis  |        |                                    | 1.5 |       | dBm   |     |

Notes:

1. Transmitter consists of 4 lasers operating at 25.78Gb/s each. Maximum total power value is specified across the full temperature and voltage range. Power consumption ≤ 4.5W when stabilized (both Tx and Rx CDR locked), but may be ≤ 5W during locking acquisition.
2. Minimum value is informative.
3. Hit ratio 5x10<sup>-5</sup>.
4. Receiver consists of 4 photodetectors operating at 25.78Gb/s each.

5. Minimum value is informative, equals min TxOMA with infinite ER and max channel insertion loss.
6. SRS is measured with vertical eye closure penalty of 1.8 dB max, J2 of 0.30 UI, and J9 of 0.47 UI.
7. Power value and power accuracy are with all channels on.

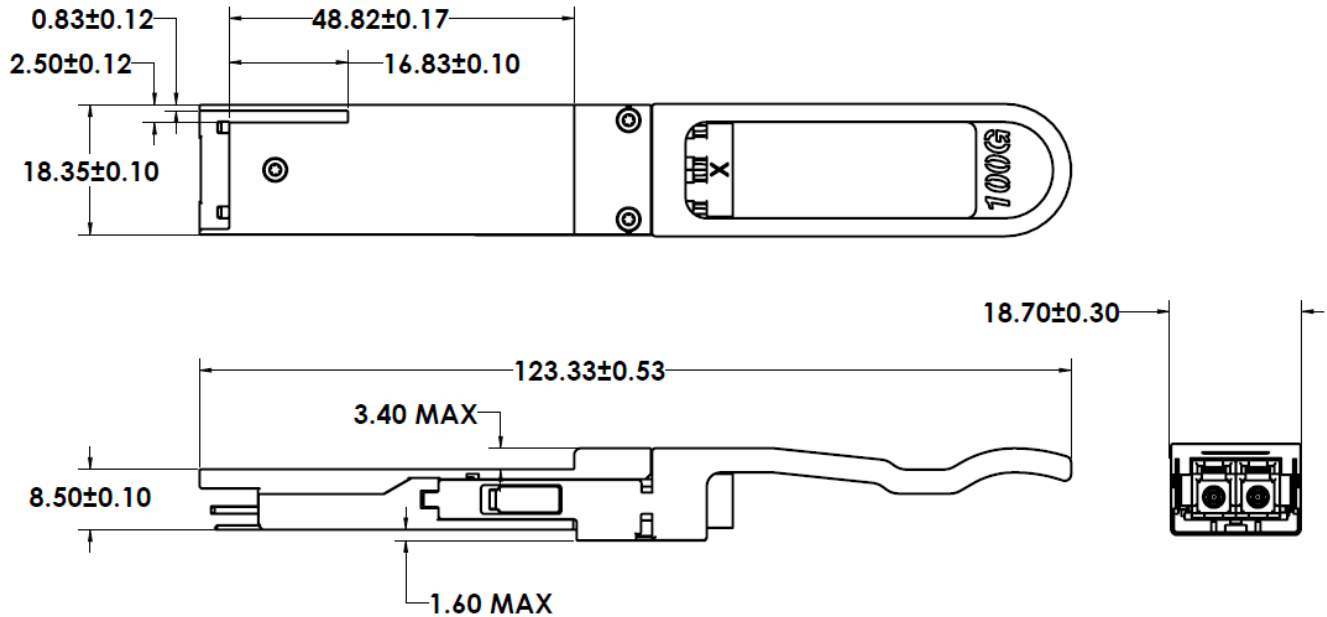
## 5. General Specifications

| Parameter                              | Symbol | Min   | Typ | Max   | Units | Notes |
|--|--------|-------|-----|-------|-------|-------|
| Bit Rate<br>(all wavelengths combined) | BR     | 103.1 |     | 112.0 | Gb/s  | 1     |
| Bit Error Ratio @25.78Gb/s             | BER1   |       |     | 10-12 |       | 2     |
| Bit Error Ratio @27.95Gb/s             | BER2   |       |     | 10-6  |       | 3     |
| Maximum Supported Distances            |        |       |     |       |       |       |
| Fiber Type                             |        |       |     |       |       |       |
| SMF per G.652                          |        | Lmax1 |     | 10    | km    |       |

Notes:

1. Supports OTU4 411-9D1F per ITU-T G.959.1 and 100GBASE-LR4 per IEEE 802.3ba.
2. Tested with a 231 – 1 PRBS.
3. Tested with a 231 – 1 PRBS. Per ITU-T G.959.1 and G.sup39, the BER of 10-12 for the OTU4 (112 Gb/s) application code is required to be met only after forward error correction has been applied. ITU-T G.sup39 defines the pre-FEC BER to be met as 10-6. The values for receiver sensitivity and optical path penalty measured at the receiver output at a BER of 10-6 will normally be conservative estimates of the values for receiver sensitivity and path penalty at the BER of 10-12 after the FEC decoder.

## 6. Mechanical Diagram



**Note:** External physical characteristics are subject to variation. This may include, but is not limited to, external case designs, pull tab colors and/or shapes, removal latch styles or colors, and label sizes and placement. These variations do not affect the function or characteristics of the transceivers.

## 7. Ordering Information

| OEM         | Part Number       | OEM2 | Part Number2      |
|-------------|-------------------|------|-------------------|
| MSA OnePort | OP-Q28-LR4-OTU4-I | MSA  | AN-Q28-LR4-OTU4-I |

## 8. Contact Information

Tel: 800.590.9535

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