

## Product Specification

### 2km 100G CWDM4 QSFP28 Optical Transceiver Module FTLC1155RGPL

#### PRODUCT FEATURES

- Hot-pluggable QSFP28 form factor
- Supports 103.1Gb/s aggregate bit rate
- Power dissipation < 3.5W
- RoHS-6 compliant
- Commercial case temperature range of 0°C to +70°C
- Adaptive CTLE
- Single 3.3V power supply
- Loss budget of 5 dB on up to 2 km of Single Mode Fiber (SMF) [with KR4 FEC]
- 4x25Gb/s CWDM transmitter
- 4x25G retimed electrical interface
- Duplex LC receptacles
- I2C management interface



#### APPLICATIONS

- 100G CWDM4 applications with FEC

Finisar's FTLC1155RGPL QSFP28 transceiver modules are designed for use in 100 Gigabit Ethernet links on up to 2 km of single mode fiber. They are compliant with the QSFP28 MSA<sup>1</sup>, CWDM4 MSA<sup>2</sup> and portions of IEEE P802.3bm<sup>3</sup>. Digital diagnostic functions are available via the I2C interface, as specified by the QSFP28 MSA and Finisar Application Notes AN-2153<sup>4</sup> and AN-2154<sup>5</sup>. The optical transceiver is compliant per the RoHS-6 Directive 2011/65/EU<sup>6</sup>. See Finisar Application Note AN-2038<sup>7</sup> for more details.

#### PRODUCT SELECTION

### FTLC1155RGPL

- 5: Gen 2
- R: Ethernet maximum bit rate (103.1 Gb/s)
- G: 4x25G CWDM optical architecture
- P: Pull-tab release
- L: LC straight receptacles

## I. Pin Descriptions

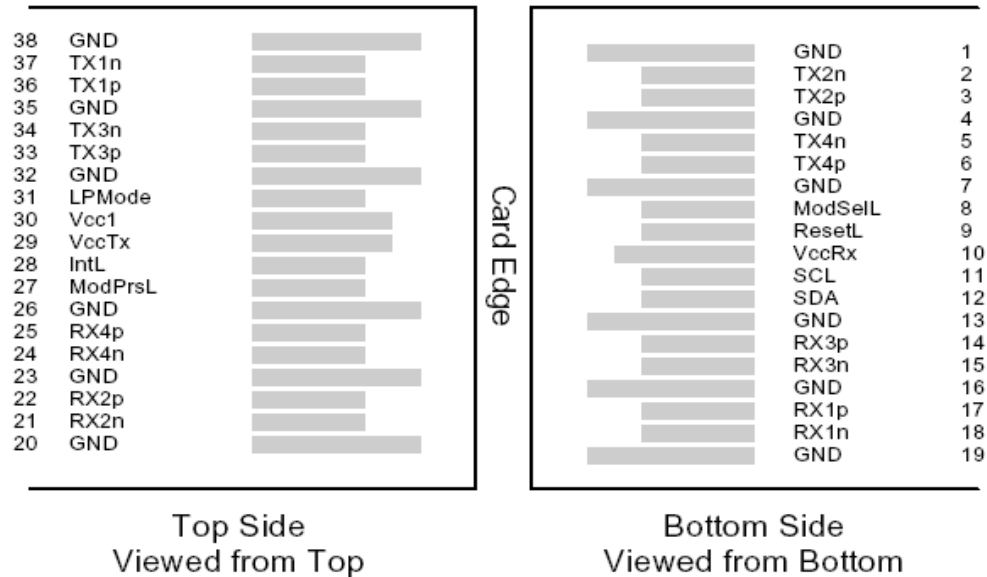


Figure 1 – QSFP28-compliant 38-pin connector (per SFF-8679)

| Pin | Symbol  | Name/Description                    | Notes |
|-----|---------|-------------------------------------|-------|
| 1   | GND     | Ground                              | 1     |
| 2   | Tx2n    | Transmitter Inverted Data Input     |       |
| 3   | Tx2p    | Transmitter Non-Inverted Data Input |       |
| 4   | GND     | Ground                              | 1     |
| 5   | Tx4n    | Transmitter Inverted Data Input     |       |
| 6   | Tx4p    | Transmitter Non-Inverted Data Input |       |
| 7   | GND     | Ground                              | 1     |
| 8   | ModSelL | Module Select                       |       |
| 9   | ResetL  | Module Reset                        |       |
| 10  | Vcc Rx  | +3.3 V Power supply receiver        |       |
| 11  | SCL     | 2-wire serial interface clock       |       |
| 12  | SDA     | 2-wire serial interface data        |       |
| 13  | GND     | Ground                              | 1     |
| 14  | Rx3p    | Receiver Non-Inverted Data Output   |       |
| 15  | Rx3n    | Receiver Inverted Data Output       |       |
| 16  | GND     | Ground                              | 1     |
| 17  | Rx1p    | Receiver Non-Inverted Data Output   |       |
| 18  | Rx1n    | Receiver Inverted Data Output       |       |
| 19  | GND     | Ground                              | 1     |
| 20  | GND     | Ground                              | 1     |
| 21  | Rx2n    | Receiver Inverted Data Output       |       |
| 22  | Rx2p    | Receiver Non-Inverted Data Output   |       |
| 23  | GND     | Ground                              | 1     |
| 24  | Rx4n    | Receiver Inverted Data Output       |       |
| 25  | Rx4p    | Receiver Non-Inverted Data Output   |       |
| 26  | GND     | Ground                              | 1     |
| 27  | ModPrsL | Module Present                      |       |
| 28  | IntL    | Interrupt                           | 2     |
| 29  | Vcc Tx  | +3.3 V Power supply transmitter     |       |
| 30  | Vcc1    | +3.3 V Power Supply                 |       |

|    |        |                                     |   |
|----|--------|-------------------------------------|---|
| 31 | LPMODE | Low Power Mode                      | 2 |
| 32 | GND    | Ground                              | 1 |
| 33 | Tx3p   | Transmitter Non-Inverted Data Input |   |
| 34 | Tx3n   | Transmitter Inverted Data Input     |   |
| 35 | GND    | Ground                              | 1 |
| 36 | Tx1p   | Transmitter Non-Inverted Data Input |   |
| 37 | Tx1n   | Transmitter Inverted Data Input     |   |
| 38 | GND    | Ground                              | 1 |

**Notes**

1. Circuit ground is internally isolated from chassis ground.
2. The IntL pin (“Interrupt Low”, pin 28) can be configured to act as an Rx\_LOS output;  
The LPMODE pin (“Low Power Mode”, pin 31) can be configured to act as an input for Tx\_Disable;  
See Finisar Application Note AN-2038<sup>8</sup> for more details.

**II. Absolute Maximum Ratings**

Module performance is not guaranteed beyond the operating range (see Section VI).  
Exceeding the limits below may damage the transceiver module permanently.

| Parameter                           | Symbol            | Min  | Typ | Max | Unit | Ref. |
|-------------------------------------|-------------------|------|-----|-----|------|------|
| Maximum Supply Voltage              | V <sub>CC</sub>   | -0.5 |     | 3.6 | V    |      |
| Storage Temperature                 | T <sub>S</sub>    | -40  |     | +85 | °C   |      |
| Case Operating Temperature          | T <sub>OP</sub>   | 0    |     | +70 | °C   |      |
| Relative Humidity                   | RH                | 15   |     | 85  | %    | 1    |
| Receiver Damage Threshold, per Lane | P <sub>Rdmg</sub> | 3.5  |     |     | dBm  |      |

**Notes:**

1. Non-condensing.

**III. Electrical Characteristics (EOL, T<sub>OP</sub> = 0 to +70 °C, V<sub>CC</sub> = 3.135 to 3.465 Volts)**

| Parameter                                           | Symbol               | Min                                                                         | Typ  | Max   | Unit | Ref. |
|-----------------------------------------------------|----------------------|-----------------------------------------------------------------------------|------|-------|------|------|
| Supply Voltage                                      | V <sub>CC</sub>      | 3.135                                                                       |      | 3.465 | V    |      |
| Supply Current                                      | I <sub>CC</sub>      |                                                                             |      | 1.12  | A    |      |
| Module total power                                  | P                    |                                                                             |      | 3.5   | W    | 1    |
| <b>Transmitter</b>                                  |                      |                                                                             |      |       |      |      |
| Signaling rate per lane                             |                      | 25.78125 ± 100 ppm                                                          |      |       | GBd  |      |
| Differential data input swing per lane              | V <sub>in,pp</sub>   |                                                                             |      | 900   | mV   |      |
| Differential input return loss (min)                | 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) | 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 termination mismatch                   |                      |                                                                             |      | 10    | %    |      |
| Stressed input parameters                           |                      |                                                                             |      |       |      |      |
| 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 ± 100 ppm                                                          |      |       | GBd  |      |
| Differential data output swing                      | V <sub>out,pp</sub>  | 100                                                                         |      | 400   | mVpp | 2    |
|                                                     |                      | 300                                                                         |      | 600   |      |      |
|                                                     |                      | 400                                                                         |      | 800   |      |      |
|                                                     |                      | 600                                                                         |      | 1200  |      |      |
| Eye width                                           |                      | 0.57                                                                        |      |       | UI   |      |

|                                                          |               |                                                                                       |  |     |    |  |
|----------------------------------------------------------|---------------|---------------------------------------------------------------------------------------|--|-----|----|--|
| Vertical eye closure                                     |               |                                                                                       |  | 5.5 | dB |  |
| Differential output return loss (min)                    | RLd(f)        | $9.5 - 0.37f$ , $0.01 \leq f < 8$<br>$4.75 - 7.4 \log_{10}(f/14)$ , $8 \leq f < 19$   |  |     | dB |  |
| Common to differential mode conversion return loss (min) | RLdc(f)       | $22 - 20(f/25.78)$ , $0.01 \leq f < 12.89$<br>$15 - 6(f/25.78)$ , $12.89 \leq f < 19$ |  |     | dB |  |
| Differential termination mismatch                        |               |                                                                                       |  | 10  | %  |  |
| Transition time, 20% to 80%                              | $t_r$ , $t_f$ | 12                                                                                    |  |     | ps |  |

**Notes:**

- Maximum total power value is specified across the full temperature and voltage range. Power consumption  $\leq 3.5W$  when stabilized, but may be  $> 3.5W$  during locking acquisition.
- Output voltage is settable in 4 discrete ranges via I2C. Default range is Range 2 (400 – 800 mV).

**IV. Optical Characteristics (EOL,  $T_{OP} = 0$  to  $+70$  °C,  $V_{CC} = 3.135$  to  $3.465$  Volts)**

| Parameter                                                | Symbol             | Min                                                                      | Typ | Max   | Unit | Ref. |
|----------------------------------------------------------|--------------------|--------------------------------------------------------------------------|-----|-------|------|------|
| Transmitter                                              |                    |                                                                          |     |       |      |      |
| Signaling Speed per Lane                                 |                    | 25.78125 ± 100 ppm                                                       |     |       | GBd  | 1    |
| Lane center wavelengths (range)                          |                    | 1264.5 – 1277.5<br>1284.5 – 1297.5<br>1304.5 – 1317.5<br>1324.5 – 1337.5 |     |       | nm   |      |
| Transmit OMA per Lane                                    | TxOMA1             | -4                                                                       |     | 2.5   | dBm  |      |
| Transmit OMA per Lane @TDP max                           | TxOMA2             | -2                                                                       |     |       | dBm  | 2    |
| Transmit Average Power per Lane                          |                    |                                                                          |     | 2.5   | dBm  | 8    |
| Optical Extinction Ratio                                 | ER                 | 3.5                                                                      |     |       | dB   |      |
| Transmitter and Dispersion Penalty per Lane              | TDP                |                                                                          |     | 3     | dB   | 3    |
| Launch Power (OMA-TDP)                                   | OMA-TDP            | -5                                                                       |     |       | dBm  |      |
| Sidemode Suppression ratio                               | SSR <sub>min</sub> | 30                                                                       |     |       | dB   |      |
| Average launch power of OFF transmitter, per lane        |                    |                                                                          |     | -30   | dBm  |      |
| Transmitter Reflectance                                  |                    |                                                                          |     | -12   | dB   |      |
| Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} |                    | {0.31, 0.4, 0.45, 0.34, 0.38, 0.4}                                       |     |       |      | 4    |
| Receiver                                                 |                    |                                                                          |     |       |      |      |
| Signaling Speed per Lane                                 |                    | 25.78125 ± 100 ppm                                                       |     |       | GBd  | 5    |
| Lane center wavelengths (range)                          |                    | 1264.5 – 1277.5<br>1284.5 – 1297.5<br>1304.5 – 1317.5<br>1324.5 – 1337.5 |     |       | nm   |      |
| Receive Saturation (OMA) per Lane                        | Rmax               | 2.5                                                                      |     |       | dBm  |      |
| Damage threshold per Lane                                |                    | 3.5                                                                      |     |       | dBm  |      |
| Unstressed Receiver Sensitivity (OMA) per Lane           | Rxsens             |                                                                          |     | -10   | dBm  | 6    |
| Stressed Receiver Sensitivity (OMA) per Lane             | SRS                |                                                                          |     | -7.3  | dBm  | 7    |
| Conditions of stressed receiver sensitivity test:        |                    |                                                                          |     |       |      |      |
| Vertical Eye Closure Penalty                             | VECP               | 1.9                                                                      |     |       | dB   |      |
| Stressed J2 Jitter                                       | J2                 | 0.33                                                                     |     |       | UI   |      |
| Stressed J4 Jitter                                       | J4                 | 0.48                                                                     |     |       | UI   |      |
| SRS eye mask definition {X1, X2, X3, Y1, Y2, Y3}         |                    | {0.39, 0.5, 0.5, 0.39, 0.39, 0.4}                                        |     |       |      |      |
| LOS De-Assert                                            | LOS <sub>D</sub>   |                                                                          |     | -11.6 | dBm  |      |
| LOS Assert                                               | LOS <sub>A</sub>   | -24                                                                      |     | -13.6 | dBm  |      |
| LOS Hysteresis                                           |                    |                                                                          | 1.5 |       | dB   |      |

**Notes:**

1. Transmitter consists of 4 lasers operating at 25.78Gb/s each.
2. At maximum TDP.
3. TDP value does not include MPI penalty.
4. Hit ratio of  $5 \times 10^{-5}$ , per IEEE.
5. Receiver consists of 4 photodetectors operating at 25.78Gb/s each.
6. Sensitivity is specified at  $5 \times 10^{-5}$  BER.
7. Measured with CWDM4 MSA<sup>2</sup> conformance test signal at TP3 for  $5 \times 10^{-5}$  BER.
8. Power value and power accuracy are with all channels on.

**V. General Specifications**

| Parameter                           | Symbol   | Min | Typ | Max                | Units | Ref. |
|-------------------------------------|----------|-----|-----|--------------------|-------|------|
| Bit Rate (all wavelengths combined) | BR       |     |     | 103.1              | Gb/s  |      |
| Bit Error Ratio @25.78Gb/s          | BER      |     |     | $5 \times 10^{-5}$ |       | 1    |
| <b>Maximum Supported Reach</b>      |          |     |     |                    |       |      |
| Fiber Type                          |          |     |     |                    |       |      |
| SMF per G.652                       | LossBdgt |     |     | 5                  | dB    | 2    |

**Notes:**

1. Tested with a  $2^{31} - 1$  PRBS.
2. This 5 dB loss budget includes 2.5dB optical coding gain from FEC on the host [RS-FEC (528,514) per Clause 91]. The maximum informative link length is 2km. The option to bypass RS-FEC is not supported. Loss budget may include up to 1dB MPI loss penalty with worse case Transmitter and worst case connector MPI.

**VI. Environmental Specifications**

Finisar FTLC1155RGPL QSFP28 transceivers have an operating case temperature range of 0°C to +70°C.

| Parameter                  | Symbol           | Min | Typ | Max | Units | Ref. |
|----------------------------|------------------|-----|-----|-----|-------|------|
| Case Operating Temperature | T <sub>op</sub>  | 0   |     | +70 | °C    |      |
| Storage Temperature        | T <sub>sto</sub> | -40 |     | +85 | °C    |      |

**VII. Regulatory Compliance**

Finisar FTLC1155RGPL QSFP28 transceivers are Class 1 Laser Products. They are certified per the following standards:

| Feature           | Agency   | Standard                              |
|-------------------|----------|---------------------------------------|
| Laser Eye Safety  | FDA/CDRH | CDRH 21 CFR 1040 and Laser Notice 50  |
|                   | CSA      | IEC60825-2:2004+A1+A2                 |
|                   | TüV      | EN60825-1:2014 & EN60825-2:2006+A1+A2 |
| Electrical Safety | CSA      | IEC60950-1:2005+A1+A2                 |
|                   | TüV      | EN60950-1:2006+A11+A1+A12+A2          |
|                   | UL/CSA   | CLASS 3862.13 & CLASS 3862.93         |

Copies of the referenced certificates are available at Finisar Corporation upon request.

## VIII. Digital Diagnostics Functions

FTLC1155RGPL QSFP28 transceivers support the I2C-based diagnostics interface specified by the SFF Committee<sup>1</sup>. See also Finisar Application Notes AN-2153<sup>4</sup> and AN-2154<sup>5</sup>.

## IX. Memory Contents

Per SFF-8665 Specification<sup>1</sup>. See Finisar Application Note AN-2154<sup>5</sup>. For CFP replacement applications, the transceiver module can be customized to enable Tx\_Disable and Rx\_LOS functions as alternate functions on LPMode and IntL pins. See Finisar Application Note AN-2174<sup>8</sup> for more details.

## XI. Mechanical Specifications

Finisar FTLC1155RGPL transceivers are compatible with the QSFP28 Specification for pluggable form factor modules.

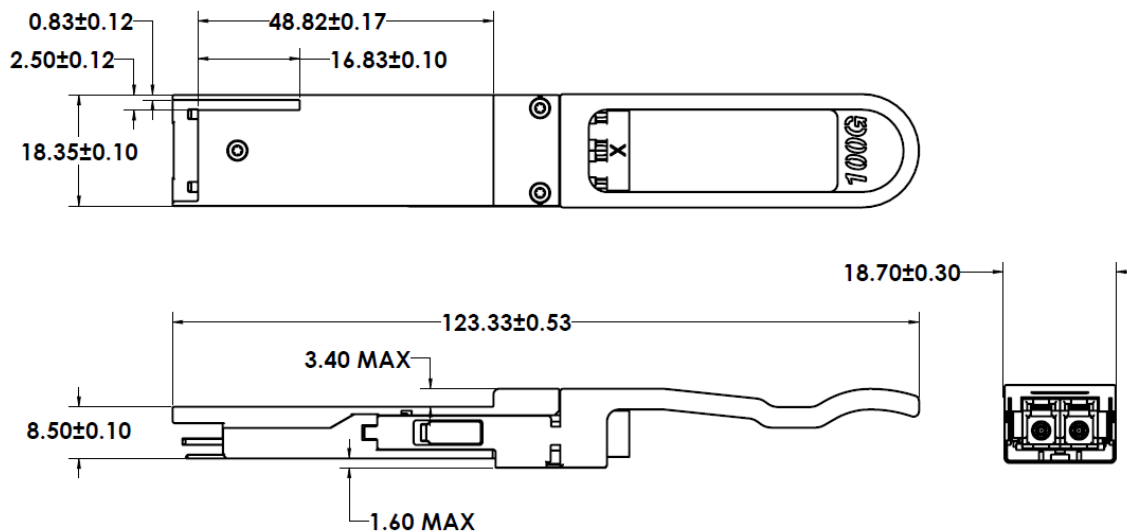


Figure 2. FTLC1155RGPL Mechanical Dimensions.

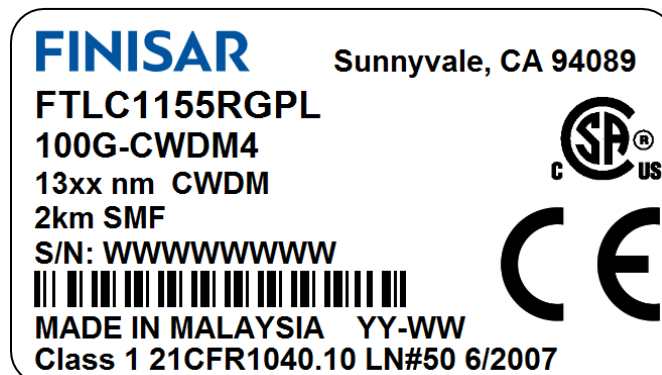


Figure 3. Product Label (Not to Scale)

## **XII. References**

1. SFF-8665: “QSFP+ 28Gb/s 4X Pluggable Transceiver Solution (QSFP28)”, Rev 1.9, June 29, 2015 and associated SFF documents referenced therein:
  - i. SFF-8661
  - ii. SFF-8679
  - iii. SFF-8636
  - iv. SFF-8662
  - v. SFF-8663
  - vi. SFF-8672
  - vii. SFF-8683
2. “100G CWDM4 MSA Technical Specifications: 2km Optical Specifications”, Rev. 1.1, November 23, 2015.
3. IEEE P802.3bm, CAUI-4 Interface.
4. Application Note AN-2153: Initialization, Finisar Corporation.
5. Application Note AN-2154: EEPROM Map, Finisar Corporation.
6. Directive 2011/65/EU of the European Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment,” July 1, 2011.
7. Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers, Finisar Corporation.
8. Application Note AN-2174: QSFP28 LR4 and QSFP28 CWDM4 – Tx\_Disable and Rx\_LOS Capability, Finisar Corporation.

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