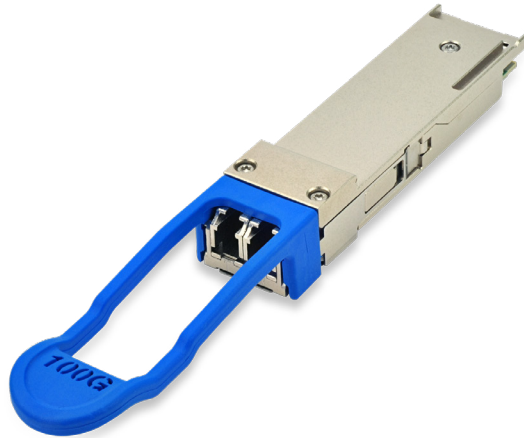


# FTLC1154RDPL4

## 10km 100GBASE-LR4 QSFP28 Optical Transceiver Module

FTLC1154RDPL4 QSFP28 transceiver modules are designed for use in 100 Gigabit Ethernet links on up to 10km of single mode fiber. Designed for outside plant applications with an industrial temperature range (-40°C to +85°C), they are compliant with the QSFP28 MSA<sup>1</sup>, IEEE 802.3ba 100GBASE-LR4<sup>2</sup> and IEEE 802.3bm CAUI-4<sup>3</sup>. Digital diagnostic functions are available via the I2C interface, as specified by the QSFP28 MSA and Finisar Application Notes AN-21524 and AN-21535. The optical transceiver is compliant per the RoHS-6 Directive 2011/65/EU<sup>6</sup>. See Finisar Application Note AN\_x005F\_xFFFE\_2038<sup>7</sup> for more details.



### FEATURES

- Hot-pluggable QSFP28 form factor
- Supports 103.1Gb/s aggregate bit rate
- Power dissipation < 4.5W
- RoHS-6 compliant
- Industrial case temperature range of -40°C to 85°C
- Adaptive CTLE
- Single 3.3V power supply
- Maximum link length of 10km on Single Mode Fiber (SMF)
- 4x25Gb/s DFB-based LAN-WDM transmitter
- 4x25G retimed electrical interface
- Duplex LC receptacles
- I2C management interface

### APPLICATIONS

- 100GBASE-LR4 100G Ethernet
- Outside Plant
- Reduced Air Flow Central Office

Product Selection

**FTLC1154RDPL4**

- 4: Gen 2
- R: 100GE-LR4 maximum bit rate (103.1 Gb/s)
- D: 4x25G LAN-WDM optical architecture
- P: Pull-tab release
- L: LC straight receptacles
- 4: Industrial temperature range

1. Pin Descriptions

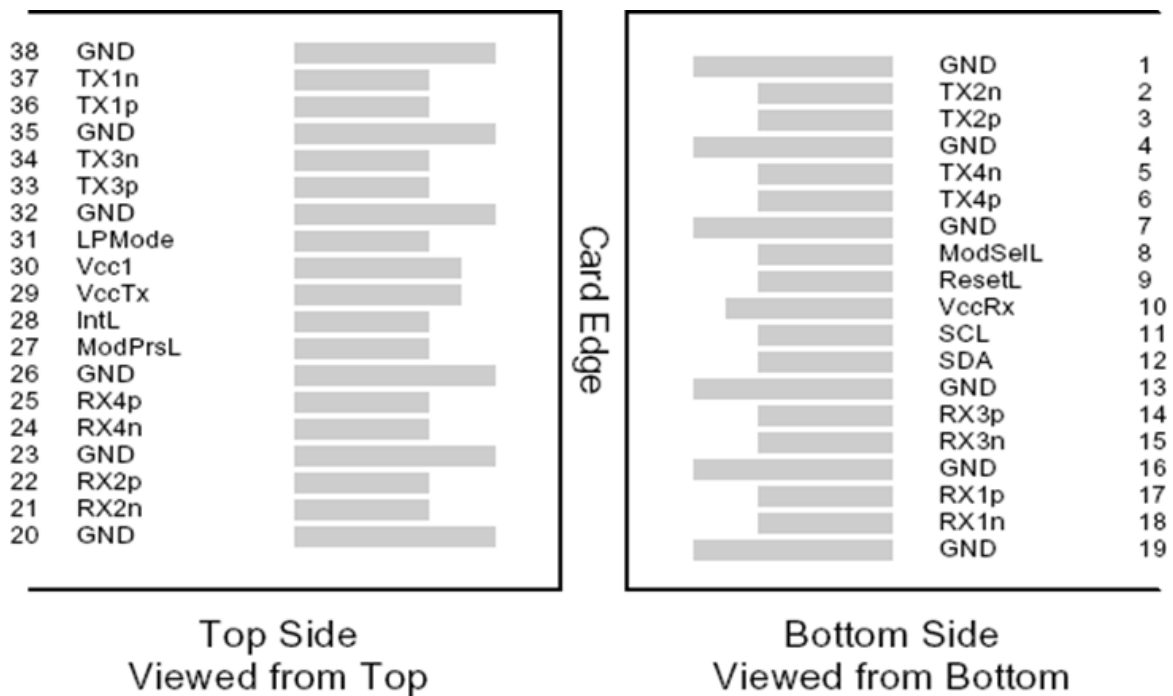


Figure 1 – QSFP28-compliant 38-pin connector (per SFF-8679)

| 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; These changes require customization. See Finisar Application Note AN-2174<sup>3</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>   | -40  |     | +85 | °C   |      |
| Relative Humidity                   | RH                | 15   |     | 85  | %    | 1    |
| Receiver Damage Threshold, per Lane | P <sub>Rdmg</sub> | 5.5  |     |     | dBm  |      |

Notes:

1. Non-condensing.

### III. Electrical Characteristics (EOL, TOP = -20 to 85 °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>                 |   |      | 1.6   | A    |      |
| Module total power                                       | P                               |   |      | 4.5   | 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 ± 100ppm   |      |       | Gb/s |      |
| 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)                    | 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) | 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    | %    |      |
| Transition time, 20% to 80%                              | t <sub>r</sub> , t <sub>f</sub> | 12  |      |       | ps   |      |

## Notes:

- 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.
- Output voltage is settable in 4 discrete ranges via I2C. Default range is 400 – 800 mV.

IV. Optical Characteristics (EOL,  $T_{OP} = -40$  to  $85$  °C,  $V_{CC} = 3.135$  to  $3.465$  Volts)

| Parameter  | Symbol             | Min   | Typ  | Max   | Unit  | Ref. |
|--|--------------------|-------|--|-------|-------|------|
| Transmitter  |                    |       |  |       |       |      |
| Signaling Speed per Lane                                 |                    |       | 25.78125 ± 100ppm  |       | Gb/s  | 1    |
| Lane center wavelengths (range)                          |                    |       | 1294.53 – 1296.59<br>1299.02 – 1301.09<br>1303.54 – 1305.63<br>1308.09 – 1310.19 |       | nm    |      |
| 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                               | SSR <sub>min</sub> | 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 {X1, X2, X3, Y1, Y2, Y3} |                    |       | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4}   |       |       | 3    |
| Receiver   |                    |       |  |       |       |      |
| Signaling Speed per Lane                                 |                    |       | 25.78125 ± 100 ppm   |       | GBd   | 4    |
| Lane center wavelengths (range)                          |                    |       | 1294.53 – 1296.59<br>1299.02 – 1301.09<br>1303.54 – 1305.63<br>1308.09 – 1310.19 |       | nm    |      |
| 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  | LOS <sub>D</sub>   |       |  | -11.6 | dBm   |      |
| LOS Assert   | LOSA               | -24   |  | -13.6 | dBm   |      |
| LOS Hysteresis   |                    |       | 1.5  |       | dB    |      |

## Notes:

1. Transmitter consists of 4 lasers operating at 25.78Gb/s each.
2. Minimum value is informative.
3. Hit ratio  $5 \times 10^{-5}$ .
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.

## V. General Specifications

| Parameter                           | Symbol | Typ | Max               | Units | Ref. |
|-------------------------------------|--------|-----|-------------------|-------|------|
| Bit Rate (all wavelengths combined) | BR     |     | 103.1             | Gb/s  | 1    |
| Bit Error Ratio @25.78Gb/s          | BER    |     | 10 <sup>-12</sup> |       | 2    |
| Maximum Supported Distances         |        |     |                   |       |      |
| Fiber Type                          |        |     |                   |       |      |
| SMF per G.652                       | Lmax   |     | 10                | km    |      |

Notes:

1. Supports 100GBASE-LR4 per IEEE 802.3ba.
2. Tested with a 2<sup>31</sup> - 1 PRBS.

## VI. Environmental Specifications

Finisar FTLC1154RDPL4 QSFP28 transceivers have an operating case temperature range of -40°C to +85°C.

| Environmental Specifications | Symbol | Min | Typ | Max | Units | Ref. |
|------------------------------|--------|-----|-----|-----|-------|------|
| Case Operating Temperature   | Top    | -40 |     | +85 | °C    |      |
| Storage Temperature          | Tsto   | -40 |     | +85 | °C    |      |

## VII. Regulatory Compliance

Finisar FTLC1154RDPL4 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      | EN 60825-1:2014<br>EN 60825-2:2004+A1+A2                           |
| Electrical Safety | CSA      | IEC60950-1:2005+A1+A2  |
|                   | TÜV      | EN 60950-1:2006+A11+A1+A12+A2                                      |
|                   | UL/CSA   | CAN/CSA-C22.2 No. 60950-1-07+A2:2014 ANSI/UL Std. No. 60950-1:2014 |

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

## VIII. Digital Diagnostics Functions

FTLC1154RDPL4 QSFP28 transceivers support the I2C-based diagnostics interface specified by the SFF Committee<sup>1</sup>. See also Finisar Application Notes AN-2152<sup>4</sup> and AN- 2153<sup>5</sup>.

## IX. Memory Contents

Per SFF-8665 Specification<sup>1</sup>. See Finisar Application Note AN-2152<sup>4</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 FTLC1154RDPL4 transceivers are compatible with the QSFP28 Specification for pluggable form factor modules.

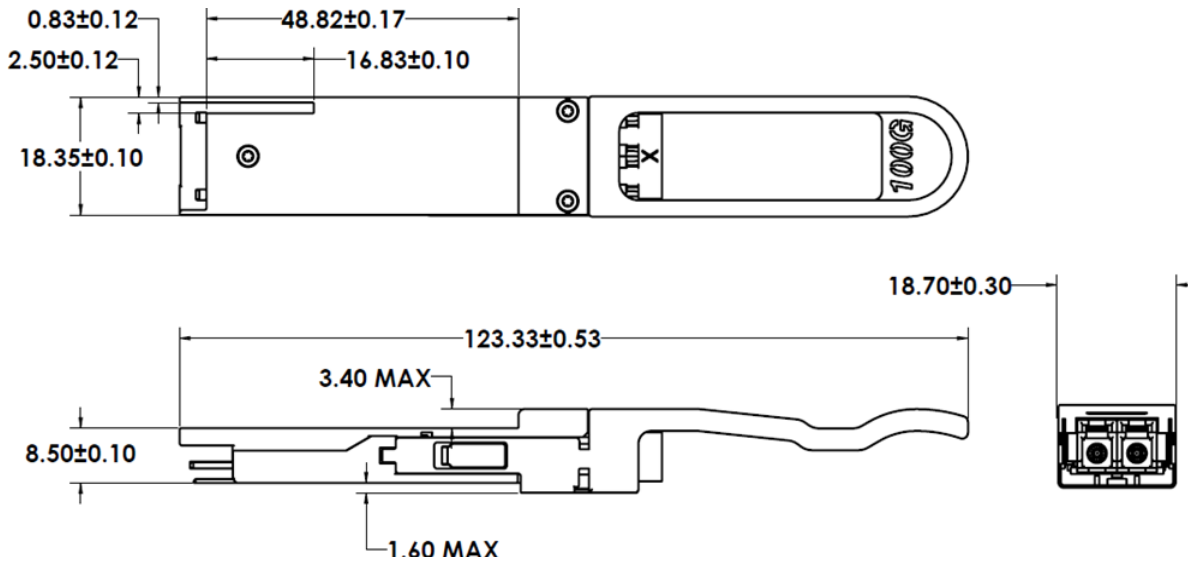


Figure 2. FTLC1154RDPL4 Mechanical Dimensions.

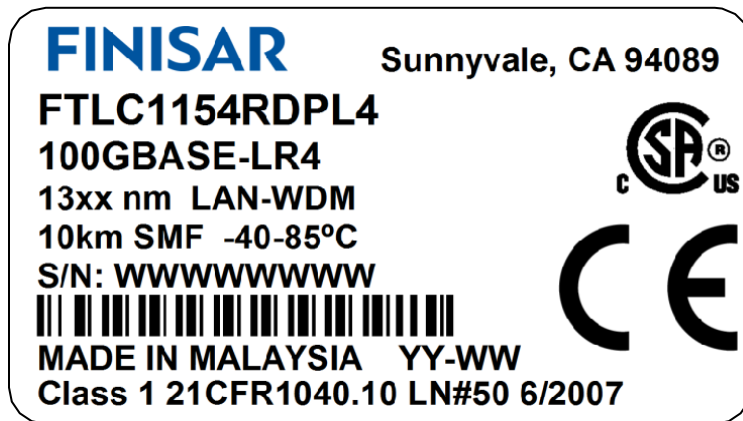


Figure 3. Product Label (Not to Scale)



## X. References

1. SFF-8665: "QSFP+ 28Gb/s 4X Pluggable Transceiver Solution (QSFP28)", Rev 1.9, June 29, 2015 (and associated SFF documents)
  - i. SFF-8661
  - ii. SFF-8679
  - iii. SFF-8636
  - iv. SFF-8662
  - v. SFF-8663
  - vi. SFF-8672
  - vii. SFF-8683
2. IEEE 802.3ba, PMD Type 100GBASE-LR4.
3. IEEE 802.3bm, Annex 83E, CAUI-4 Interface.
4. Application Note AN-2152: EEPROM Map, Finisar Corporation.
5. Application Note AN-2153: Initialization, 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.