

Product Specification

10km Multi-rate 100G QSFP28 Optical Transceiver Module FTLC1154SDPL

PRODUCT FEATURES

- Hot-pluggable QSFP28 form factor
- Supports 103.1Gb/s and 112Gb/s aggregate bit rates
- Power dissipation < 3.5W
- RoHS-6 compliant
- Commercial case temperature range of 0°C to 70°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 4I1-9D1F
- 100GBASE-LR4 100G Ethernet

Finisar's FTLC1154SDPL QSFP28 transceiver modules are designed for use in 100 Gigabit Ethernet and 4x28G OTN client interface links on up to 10km of single mode fiber. They are compliant with the QSFP28 MSA¹, IEEE 802.3ba 100GBASE-LR4², IEEE 802.3bm CAUI-4³ and OTU4 4I1-9D1F requirements specified in ITU-T Recommendations G.959.1/G.709 and Supplement 39 (G.sup39). 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/EU⁶. See Finisar Application Note AN-2038⁷ for more details.

PRODUCT SELECTION

FTLC1154SDPL

- 4: Gen 2
- S: OTU4 maximum bit rate (112 Gb/s)
- D: 4x28G LAN-WDM 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 | |
| 29 | Vcc Tx | +3.3 V Power supply transmitter | |

| | | | |
|----|--------|-------------------------------------|---|
| 30 | Vcc1 | +3.3 V Power Supply | |
| 31 | LPMODE | Low Power Mode | |
| 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.

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 _{CC} | -0.5 | | 3.6 | V | |
| Storage Temperature | T _S | -40 | | +85 | °C | |
| Case Operating Temperature | T _{OP} | 0 | | +70 | °C | |
| Relative Humidity | RH | 15 | | 85 | % | 1 |
| Receiver Damage Threshold, per Lane | P _{Rdmg} | 5.5 | | | dBm | |

Notes:

1. Non-condensing.

III. Electrical Characteristics (EOL, T_{OP} = 0 to +70 °C, V_{CC} = 3.135 to 3.465 Volts)

| Parameter | Symbol | Min | Typ | Max | Unit | Ref. |
|--|----------------------|---|------|-------|------|------|
| Supply Voltage | V _{CC} | 3.135 | | 3.465 | V | |
| Supply Current | I _{CC} | | | 1.12 | A | |
| Module total power | P | | | 3.5 | W | 1 |
| Transmitter | | | | | | |
| Signaling rate per lane | | 25.78 | | 27.95 | Gb/s | |
| Differential data input swing per lane | V _{in,pp} | | | 900 | mV | |
| Differential input return loss (min) at LR4 | RL _d (f) | 9.5 – 0.37f, 0.01 ≤ f < 8 4.75 – 7.4log ₁₀ (f/14), 8 ≤ f < 19 | | | dB | |
| Differential to common mode input return loss (min) at LR4 | RL _{dc} (f) | 22-20(f/25.78), 0.01 ≤ f < 12.89 15-6(f/25.78), 12.89 ≤ f < 19 | | | dB | |
| Differential input return loss (min) at OTU4 | SDD11 | -11, 0.05 < f < fb -6.0+9.2log ₁₀ (2f/fb), fb/7 < f < fb | | | dB | 2 |
| Different to common mode input return loss (min) at OTU4 | SDC11 SCD11 | -22+14(f/fb), 0.05 < f < fb/2 -18+6f/fb, fb/2 < f < fb | | | dB | 2 |
| 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 | |

| Receiver | | | | | | |
|--|---------------------------------|---|--|---------|------|---|
| Signaling rate per lane | | 25.78125 | | 27.9525 | GBd | |
| Differential data output swing | Vout,pp | 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 | RLd(f) | 9.5 – 0.37f, 0.01 ≤ f < 8 4.75 – 7.4log ₁₀ (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 15-6(f/25.78), 12.89 ≤ f < 19 | | | dB | |
| Differential output return loss (min) at OTU4 | SDD22 | -11, 0.05 < f < fb -6.0+9.2log ₁₀ (2f/fb), fb/7 < f < fb | | | dB | 2 |
| Common to differential mode conversion return loss (min) at OTU4 | SDC22 SCD22 | -25+20(f/fb), 0.05 < f < fb/2 -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 | t _r , t _f | 12 | | | ps | |
| Transition time, 20% to 80% at OTU4 | t _r , t _f | 9.5 | | | ps | |

Notes:

1. Maximum total power value is specified across the full temperature and voltage range.
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.

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

OTU4 4I1-9D1F Operation

| Parameter | Symbol | Min | Typ | Max | Unit | Ref. |
|--|-------------------|--|-----|------|------|------|
| Transmitter | | | | | | |
| Signaling Speed per Channel | | 27.9525 ± 20 ppm | | | Gb/s | 1 |
| Channel center wavelengths (range) | | 1294.53 – 1296.59 1299.02 – 1301.09 1303.54 – 1305.63 1308.09 – 1310.19 | | | nm | |
| Total Average Launch Power | P _{OUT} | | | 10 | dBm | |
| Average Launch Power per Channel | TXP _x | -0.6 | | 4.0 | dBm | 5 |
| Optical Channel Extinction Ratio | ER | 4.0 | | 6.5 | dB | |
| Channel Power Difference | ΔP _{OUT} | | | 5 | dB | |
| Optical Return Loss | ORL | | | 20 | dB | |
| Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} | | {0.25, 0.4, 0.45, 0.25, 0.28, 0.4} | | | | 2 |
| Receiver | | | | | | |
| Signaling Speed per Channel | | 27.9525 ± 20 ppm | | | GBd | 3 |
| Channel center wavelengths (range) | | 1294.53 – 1296.59 1299.02 – 1301.09 1303.54 – 1305.63 1308.09 – 1310.19 | | | nm | |
| Average Input Power per Channel | RXP _x | -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 | P_{IN} | | | 10.0 | dBm | |
| Channel Power Difference | ΔP_{IN} | | | 5.5 | dB | |
| LOS De-Assert | LOS_D | | | -11.6 | dBm | |
| LOS Assert | LOS_A | -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 5×10^{-5} .
3. Receiver consists of 4 photodetectors operating at 27.95Gb/s each.
4. Specified at a BER of 10^{-6} (pre-FEC), per ITU-T G.sup39.
5. Power value and power accuracy are with all channels on.

100GBASE-LR4 Operation

| Parameter | Symbol | Min | Typ | Max | Unit | Ref. |
|--|-------------|--|-----|-------|-------|------|
| Transmitter | | | | | | |
| Signaling Speed per Lane | | 25.78125 ± 100 ppm | | | Gb/s | 1 |
| Lane center wavelengths (range) | | 1294.53 – 1296.59 1299.02 – 1301.09 1303.54 – 1305.63 1308.09 – 1310.19 | | | nm | |
| Total Average Launch Power | P_{OUT} | | | 10.5 | dBm | |
| Transmit OMA per Lane | $TxOMA$ | -1.3 | | 4.5 | dBm | |
| Average Launch Power per Lane | TXP_x | -4.3 | | 4.5 | dBm | 2,7 |
| Optical Extinction Ratio | ER | 4 | | | dB | |
| Sidemode Suppression ratio | SSR_{min} | 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 1299.02 – 1301.09 1303.54 – 1305.63 1308.09 – 1310.19 | | | nm | |
| Receive Power (OMA) per Lane | $RxOMA$ | | | 4.5 | dBm | |
| Average Receive Power per Lane | RXP_x | -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_D | | | -11.6 | dBm | |
| LOS Assert | LOS_A | -24 | | -13.6 | dBm | |
| LOS Hysteresis | | | 1.5 | | dBm | |

Notes:

1. Transmitter consists of 4 lasers operating at 25.78Gb/s each. Power consumption < 3.5W when stabilized, but may be > 3.5W during acquisition.
2. Minimum value is informative.
3. Hit ratio 5×10^{-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 | Min | Typ | Max | Units | Ref. |
|-------------------------------------|--------|-------|-----|------------|-------|------|
| Bit Rate (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:

- Supports OTU4 4I1-9D1F per ITU-T G.959.1 and 100GBASE-LR4 per IEEE 802.3ba.
- Tested with a $2^{31} - 1$ PRBS.
- Tested with a $2^{31} - 1$ 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.

VI. Environmental Specifications

Finisar FTLC1154SDPL 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 _{op} | 0 | | +70 | °C | |
| Storage Temperature | T _{sto} | -40 | | +85 | °C | |

VII. Regulatory Compliance

Finisar FTLC1154SDPL 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

FTLC1154SDPL QSFP28 transceivers support the I2C-based diagnostics interface specified by the SFF Committee¹. See also Finisar Application Notes AN-2152⁴ and AN-2153⁵.

IX. Memory Contents

Per SFF-8665 Specification¹. See Finisar Application Note AN-2152⁴.

XI. Mechanical Specifications

Finisar FTLC1154SDPL transceivers are compatible with the QSFP28 Specification for pluggable form factor modules.

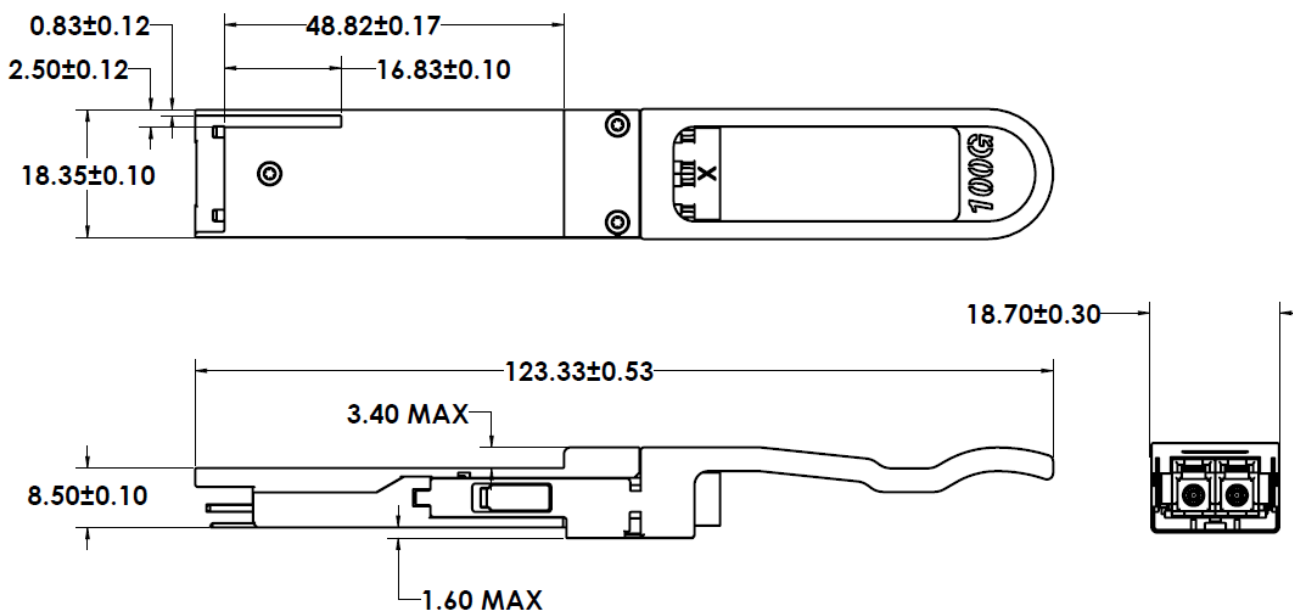


Figure 2. FTLC1154SDPL Mechanical Dimensions.

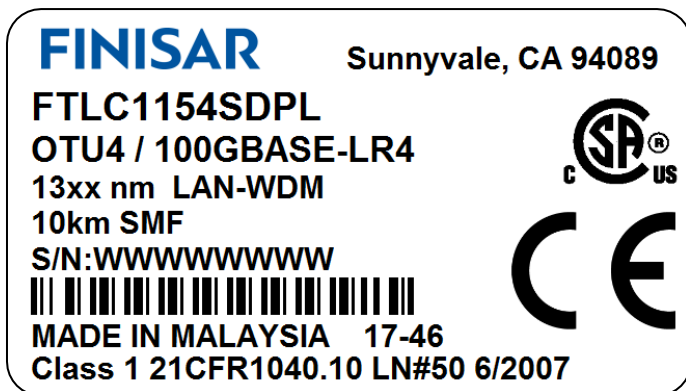


Figure 3. Product Label (Not to Scale)

XII. References

1. SFF-8665: “QSFP+ 28Gb/s 4X Pluggable Transceiver Solution (QSFP28)”, Rev 1.9, June 29, 2015 (and associated SFF documents)
 - 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.

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