

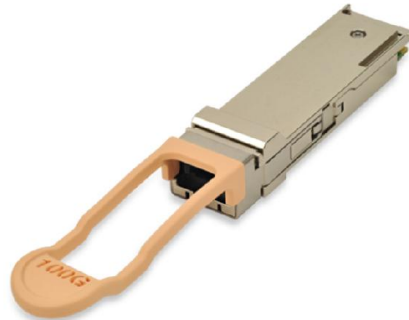
## Product Specification

### 128G Fibre Channel Parallel 100m MMF QSFP28 Optical Transceiver

#### FTLC9555FEPM

#### PRODUCT FEATURES

- Hot-pluggable QSFP28 form factor
- Supports up to 112.2Gb/s aggregate bit rates
- Power dissipation < 2.5W
- RoHS-6 compliant
- Commercial case temperature range of 0°C to 70°C
- Single 3.3V power supply
- Maximum link length of 100m on OM4 Multimode Fiber (MMF)
- 4x28Gb/s 850nm VCSEL-based transmitter
- 4x25G electrical interface
- Single MPO12 receptacle
- I2C management interface



#### APPLICATIONS

- 8/16/32/128G Fibre Channel\*

Finisar's FTLC9555FEPM 128G QSFP28 transceiver modules are designed for use in 16/32/128G Fibre Channel links over multimode fiber. They are compliant with the QSFP28 MSA<sup>1</sup>, 128GFC<sup>2</sup> and IEEE 802.3bm CAUI-4<sup>3</sup>. Digital diagnostics functions are available via the I2C interface, as specified by the QSFP28 MSA<sup>1</sup> and Finisar Application Note AN-2041<sup>4</sup>. The transceiver is RoHS-6 compliant per Directive 2011/65/EU<sup>5</sup> and Finisar Application Note AN-2038<sup>6</sup>.

**\*See section V for compliance information.**

#### PRODUCT SELECTION

#### FTLC9555FEPM

F: 128G FC maximum bit rate (112.2 Gb/s)  
E: 4x28G parallel optics  
P: Pull tab release  
M: MPO receptacle

## I. Pin Descriptions

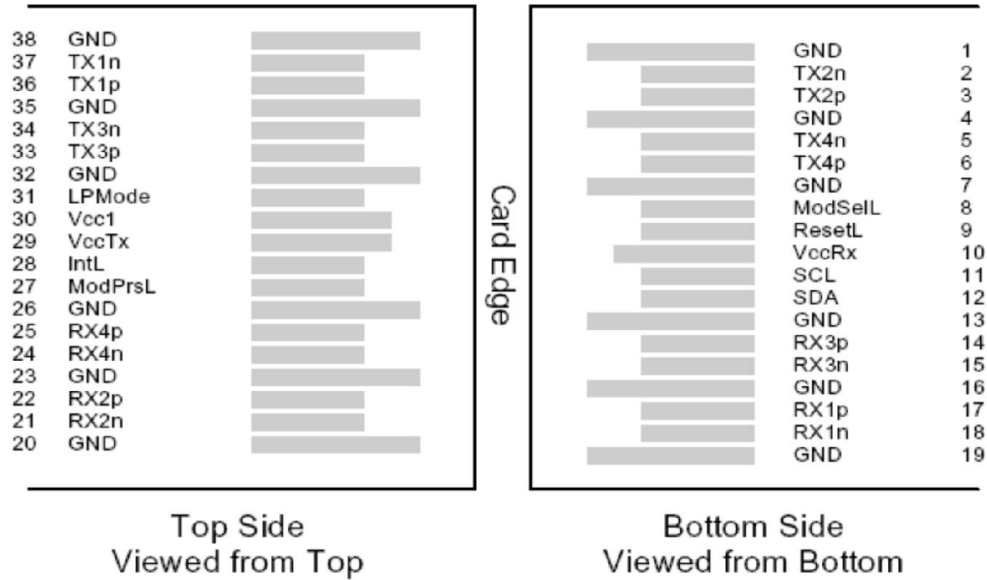


Figure 1 – QSFP28-compliant 38-pin connector (per SFF-8679)

| 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              | Vcc               | -0.5 |     | 4.0 | V    |      |
| Storage Temperature                 | T <sub>S</sub>    | -40  |     | 85  | °C   |      |
| Case Operating Temperature          | T <sub>OP</sub>   | 0    |     | 70  | °C   | 1    |
| Relative Humidity                   | RH                | 15   |     | 85  | %    | 2    |
| Receiver Damage Threshold, per Lane | P <sub>Rdmg</sub> | 3.4  |     |     | dBm  |      |

Notes:

1. Can support temporary excursions of case operating temperature from -5 to -75 °C not exceeding 72 hours.
2. 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                           | Vcc         | 3.135                                       |     | 3.465 | V    |      |
| Supply Current                           | Icc         |                                             |     | 1.5   | A    |      |
| Module total power                       | P           |                                             |     | 2.5   | W    | 1    |
| Transmitter                              |             |                                             |     |       |      |      |
| Signaling rate per lane                  |             | 25.78                                       |     | 28.05 | Gb/s | 2    |
| Differential data input voltage per lane | Vin,pp,diff |                                             |     | 900   | mV   |      |
| Single-ended voltage tolerance           | Vin,pp      | -0.35                                       |     | +3.3  | V    |      |
| Module stress input test                 |             | Per Section 13.3.11.2.1, OIF<br>CEI-28G-VSR |     |       |      |      |
| Receiver                                 |             |                                             |     |       |      |      |
| Signaling rate per lane                  |             | 25.78                                       |     | 28.05 | Gb/s | 2    |
| Differential data output swing           | Vout,pp     | 100                                         |     | 400   | mVpp | 3    |
|                                          |             | 300                                         |     | 600   |      |      |
|                                          |             | 400                                         | 600 | 800   |      |      |
|                                          |             | 600                                         |     | 1200  |      |      |
| Eye width                                |             | 0.57                                        |     |       | UI   |      |
| Eye height, differential                 |             | 228                                         |     |       | mV   |      |
| Vertical eye closure                     | VEC         | 5.5                                         |     |       | dB   |      |
| Transition time (20% to 80%)             | tr, tr      | 12                                          |     |       | ps   |      |

Notes:

- Maximum total power value is specified across the full operational temperature and voltage range when CDRs are locked or a lack of input signal results in squelch being activated. If incorrect frequencies cause the CDRs to continuously attempt to lock, maximum power dissipation may reach 3.5 W.
- $\pm 100\text{ppm}$
- Output voltage is settable in 4 discrete ranges via I2C. Default range is 400 – 800 mV.

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

| Parameter                                                | Symbol           | Min             | Typ | Max   | Unit    | Ref. |
|----------------------------------------------------------|------------------|-----------------|-----|-------|---------|------|
| Transmitter                                              |                  |                 |     |       |         |      |
| Signaling Speed per Lane                                 |                  | 8.5             |     | 28.05 | Gb/s    | 1    |
| Center wavelength                                        |                  | 840             |     | 860   | nm      |      |
| RMS Spectral Width                                       | SW               | 128GFC per T.11 |     |       | nm      |      |
| Average Launch Power per Lane                            | TXP <sub>x</sub> |                 |     |       | dBm     |      |
| Transmit OMA per Lane                                    | TxOMA            |                 |     |       | dBm     |      |
| Difference in Power between any two lanes [OMA]          | DP <sub>x</sub>  |                 |     |       | dB      |      |
| Peak Power per Lane                                      | PP <sub>x</sub>  |                 |     |       | dBm     |      |
| Launch Power [OMA] minus TDP per Lane                    | P-TDP            |                 |     |       | dBm     |      |
| TDP per Lane                                             | TDP              |                 |     |       | dBm     |      |
| Optical Extinction Ratio                                 | ER               |                 |     |       | dB      |      |
| Optical Return Loss Tolerance                            | ORL              |                 |     |       | dB      |      |
| Encircled Flux                                           | FLX              |                 |     |       | dBm     |      |
| Average launch power of OFF transmitter, per lane        |                  |                 |     |       | dBm     |      |
| Relative Intensity Noise                                 | RIN              |                 |     |       | dB/Hz   |      |
| Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3} |                  |                 |     |       |         |      |
| Receiver                                                 |                  |                 |     |       |         |      |
| Signaling Speed per Lane                                 |                  | 8.5             |     | 28.05 | GBd     | 2    |
| Center wavelength                                        |                  | 840             |     | 860   | nm      |      |
| Damage Threshold                                         | DT               | 128GFC per T.11 |     |       | dBm     |      |
| Average Receive Power per Lane                           | RXP <sub>x</sub> |                 |     |       | dBm     |      |
| Receive Power (OMA) per Lane                             | RxOM<br>A        |                 |     |       | dBm     |      |
| Stressed Receiver Sensitivity (OMA) per Lane             | SRS              |                 |     |       | dBm     |      |
| Back to Back Receiver Sensitivity (OMA) per Lane         | RxSens           |                 |     |       | dBm     |      |
| Peak Power, per lane                                     | PP <sub>x</sub>  |                 |     |       | dBm     |      |
| Receiver Reflectance                                     | Rfl              |                 |     |       | dB      |      |
| Vertical eye closure penalty, per lane                   |                  |                 |     |       | dB      |      |
| Stressed eye J2 jitter, per Lane                         |                  |                 |     |       | UI      |      |
| Stressed eye J9 jitter, per Lane                         |                  |                 |     |       | UI      |      |
| OMA of each aggressor lane                               |                  |                 |     |       | dBm     |      |
| Receiver jitter tolerance [OMA], per Lane                |                  |                 |     |       | dBm     |      |
| Rx jitter tolerance: Jitter frequency and p-p amplitude  |                  |                 |     |       | kHz, UI |      |
|                                                          |                  |                 |     |       | kHz, UI |      |
| LOS De-Assert                                            | LOS <sub>D</sub> |                 |     | -13   | dBm     |      |
| LOS Assert                                               | LOS <sub>A</sub> | -30             |     |       | dBm     |      |
| LOS Hysteresis                                           |                  | 0.5             | 2   |       | dB      |      |

Notes:

- Transmitter consists of 4 lasers operating at a maximum speed of 28.05Gb/s each.

2. Receiver consists of 4 photodetectors operating at a maximum speed of 28.05Gb/s each.

## V. Data Rate and Reach Specifications

Finisar FTLC9555F QSFP28 Fibre Channel transceivers are compliant with 128G Fibre Channel (32GFC per lane), and compatible with 8GFC and 16GFC (per lane).

| Parameter                           | Symbol | Min | Typ | Max                | Units | Ref. |
|-------------------------------------|--------|-----|-----|--------------------|-------|------|
| Bit Rate (all wavelengths combined) | BR     |     |     | 112.2              | Gb/s  | 1    |
| Bit Error Ratio @28.05Gb/s          | BER2   |     |     | $5 \times 10^{-5}$ |       | 2    |
| <b>Maximum Supported Distances</b>  |        |     |     |                    |       |      |
| Fiber Type                          |        |     |     |                    |       |      |
| OM3 MMF                             | Lmax1  |     |     | 70                 | m     | 3    |
| OM4 MMF                             | Lmax2  |     |     | 100                | m     | 3    |

### Notes:

1. Supports 8/16/32/128G FC per T11.
2. Tested with a  $2^{31} - 1$  PRBS.
3. Requires FEC on the host to support maximum distance.

## VI. Environmental Specifications

Finisar FTLC9555 QSFP28 transceivers have a commercial operating case temperature range of 0°C to +70°C. They can support temporary excursions to case temperatures of -5°C and +75°C without permanent damage (see Section II).

| 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 FTLC9555 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                                  |
| Laser Eye Safety  | TÜV      | EN 60825-1:2014<br>EN 60825-2:2004+A1+A2                              |
| Electrical Safety | TÜV      | EN 60950-1:2006+A11+A1+A12+A2                                         |
| Electrical Safety | UL/CSA   | CAN/CSA-C22.2 No. 60950-1-07+A2:2014<br>ANSI/UL Std. No. 60950-1:2014 |

Copies of the referenced certificates will be available at Finisar upon request. Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated June 24, 2007.

**CAUTION** – Use of Controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

## VIII. Digital Diagnostics Functions

FTLC9555 QSFP28 transceivers support the I2C-based diagnostics interface specified by the QSFP28 MSA<sup>1</sup>. See Finisar Application Note AN-2041<sup>4</sup>.

## IX. Memory Contents

Per the QSFP28 MSA<sup>1</sup>. See Finisar Application Note AN-2041<sup>4</sup>.

## XI. Mechanical Specifications

Finisar FTLC9555 QSFP28 transceivers are compatible with the MSA specification for QSFP28 pluggable form factor modules<sup>1</sup>.

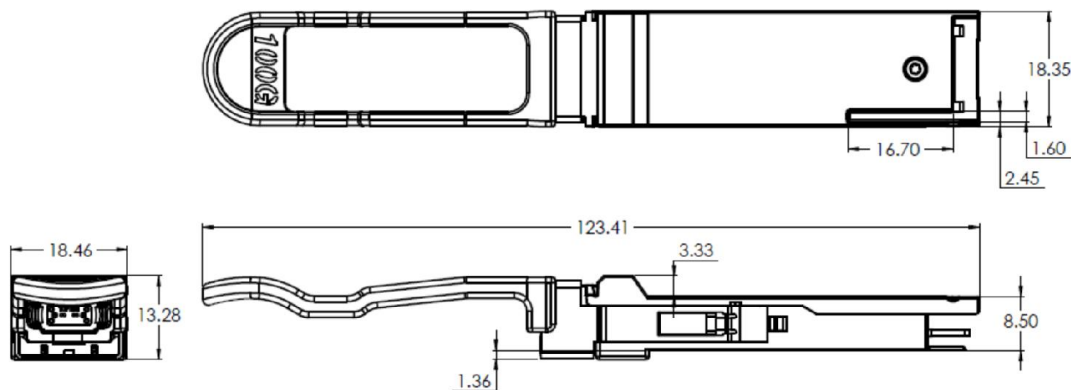


Figure 2. FTLC9555FEPM Mechanical Dimensions.

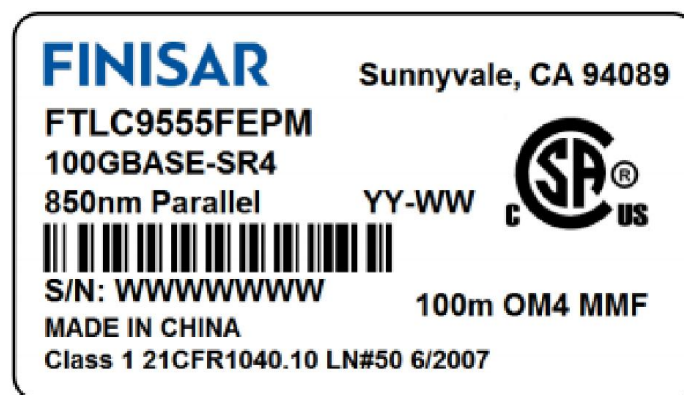


Figure 3. FTLC9555FEPM Product Label (not to scale)

## **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. 128G Fibre Channel Specification, per ANSI T.11.
3. IEEE 802.3bm CAUI-4.
4. Application Note AN-2041, Finisar Corporation.
5. 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.
6. “Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers”, Finisar Corporation, January 21, 2005.

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