

## Palo Alto Compatible PAN-QSFP28-100GBASE-LR4 Quick Spec

|                       |   |
|-----------------------|---|
| Part Number:          | PAN-QSFP28-100GBASE-LR4<br>PAN-QSFP28-100GBASE-LR4-EXT<br>PAN-QSFP28-100GBASE-LR4-IND |
| Form Factor:          | QSFP28  |
| TX Wavelength:        | 1310nm  |
| Reach:                | 10km  |
| Cable Type:           | SMF   |
| Rate Category:        | 100GBase  |
| Interface Type:       | LR4   |
| DDM:                  | Yes   |
| Connector Type:       | Dual-LC   |
| Optical Power Budget: | 7.3 dB  |
| TX Power Min/Max:     | -1.3 to 4.5 dBm   |
| RX Power Min/Max:     | -8.6 to 4.5 dBm   |



## Palo Alto Compatible PAN-QSFP28-100GBASE-LR4 Features:

- Hot pluggable QSFP28 MSA form factor
- Supports 103 Gbps and 112 Gbps
- Up to 10km reach for G.652 SMF
- Single +3.3V power supply
- Transmitter: cooled 4x25 Gbps LAN WDM EML TOSA (1295.56, 1300.05, 1304.58, 1309.14nm)
- Receiver: 4x25/28 Gbps PIN ROSA
- 4x28G Electrical Serial Interface (CEI-28GVSR)
- Maximum power consumption 4.5W
- RoHS-6 compliant (lead-free)
- Duplex LC receptacle
- I<sup>2</sup>C interface with integrated Digital Diagnostic Monitoring
- Operating Case Temperature
  - Standard 0 to +70 °C
  - Extended -40 to +70 °C
  - Industrial -40 to +85 °C

## Palo Alto Compatible PAN-QSFP28-100GBASE-LR4 Applications:

- 100GBASE-LR4 Ethernet links
- Infiniband QDR and DDR interconnects
- Client-side 100G telecom connections
- OTU4 4I1-9D1F

## Palo Alto Compatible PAN-QSFP28-100GBASE-LR4 Overview

The QSFP28-100GBaseLR4 is a 103/112 Gbps transceiver module designed for optical communication applications compliant to 100GBASE-LR4 of the IEEE P802.3ba standard and OUT-4. The module converts 4 input channels of 25/28 Gbps electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 103/112 Gbps optical transmission. Reversely on the receiver side, the module de-multiplexes a 103/112 Gbps optical input into 4 channels of LAN WDM optical signals and then converts them to 4 output channels of electrical data. The central wavelengths of the 4 LAN WDM channels are 1295.56, 1300.05, 1304.58 and 1309.14 nm as members of the LAN WDM wavelength grid defined in IEEE 802.3ba. The high-performance cooled LAN WDM EA-DFB transmitters and high sensitivity PIN receivers provide superior performance for 100G applications up to 10km links and compliant to optical interface with IEEE802.3ba Clause 88 100GBASE-LR4 and OUT-4I1-9D1F requirements. The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP+ Multi-Source Agreement (MSA).

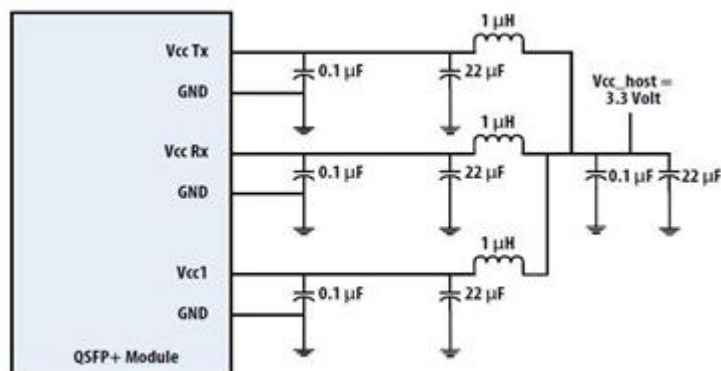
## Absolute Maximum Ratings

| Parameter                            | Symbol | Min  | Max | Unit |
|--------------------------------------|--------|------|-----|------|
| Storage Temperature                  | $T_s$  | -40  | +85 | °C   |
| Operating Case Temp (Standard)       | TOP    | 0    | 70  | °C   |
| Operating Case Temp (Extended)       | TOP    | -40  | 70  | °C   |
| Operating Case Temp (Industrial)     | TOP    | -40  | 85  | °C   |
| Power Supply Voltage                 | Vcc    | -0.5 | 3.6 | V    |
| Relative Humidity (non-condensation) | RH     | 5    | 85  | %    |

## Recommended Operating Conditions

| Parameter                   | Symbol | Min   | Typ      | Max   | Unit |
|-----------------------------|--------|-------|----------|-------|------|
| Power Supply Voltage        | Vcc    | 3.135 | 3.3      | 3.465 | V    |
| Data Rate, each Lane        |        |       | 25.78125 |       | Gb/s |
| Control Input Voltage High) |        | 2     |          | Vcc   | V    |
| Control Input Voltage Low   |        | 0     |          | 0.8   | V    |
| Link Distance with G.652    | D      |       |          | 10    | km   |

## Recommended Power Supply Filter



## Electrical Characteristics

| Parameter         | Symbol                | Min | Typ | Max  | Unit |
|-------------------|-----------------------|-----|-----|------|------|
| Power Consumption |                       | -   |     | 4.5  | W    |
| Supply Current    | <i>I<sub>cc</sub></i> |     |     | 1.21 | A    |

## Electrical Characteristics-Transmitter (each lane)

| Parameter                        | Symbol                   | Min | Typ | Max  | Unit |
|----------------------------------|--------------------------|-----|-----|------|------|
| Differential Input Voltage Swing | <i>V<sub>in.pp</sub></i> | 150 |     | 1200 | mVpp |
| Differential Input Impedance     | <i>Z<sub>in</sub></i>    | 85  | 100 | 115  | Ω    |

## Electrical Characteristics-Receiver

| Parameter                         | Symbol                    | Min | Typ | Max  | Unit |
|-----------------------------------|---------------------------|-----|-----|------|------|
| Differential Output Voltage Swing | <i>V<sub>out.pp</sub></i> | 200 |     | 1100 | mVpp |
| Differential Output Impedance     | <i>Z<sub>out</sub></i>    | 85  | 100 | 115  | ohm  |

## Optical Characteristics

| Parameter       | Symbol    | Min     | Typ     | Max     | Unit |
|-----------------|-----------|---------|---------|---------|------|
| Lane Wavelength | <i>L0</i> | 1294.53 | 1295.56 | 1296.59 | nm   |
|                 | <i>L1</i> | 1299.02 | 1300.05 | 1301.09 |      |
|                 | <i>L2</i> | 1303.54 | 1304.58 | 1305.63 |      |
|                 | <i>L3</i> | 1308.09 | 1309.1  | 1310.19 |      |

### Optical Characteristics-Transmitter (100GBase-LR4 operation)

| Parameter                                | Symbol      | Min                                  | Typ   | Max  | Unit | Notes |
|--|-------------|--------------------------------------|-------|------|------|-------|
| Signaling Speed per Lane                 | <i>BR</i>   |                                      | 25.78 |      | Gbps |       |
| Side-mode Suppression Ratio              | <i>SMSR</i> | 30                                   |       |      | dB   |       |
| Total Average Launch Power               | <i>PT</i>   |                                      |       | 10.5 | dBm  |       |
| Average Launch Power (each Lane)         | <i>PAVG</i> | -4.3                                 |       | 4.5  | dBm  |       |
| Optical Modulation Amplitude (each Lane) | <i>POMA</i> | -1.3                                 |       | 4.5  | dBm  | 1     |
| Extinction Ratio                         | <i>ER</i>   | 4                                    |       |      | dB   |       |
| Optical Return Loss Tolerance            | <i>TOL</i>  |                                      |       | 20   | dB   |       |
| Eye Mask {X1, X2, X3, Y1, Y2, Y3}        |             | IEEE 802.3 Clause 88<br>100GBase-LR4 |       |      |      |       |
| Average Launch Power OFF (each Lane)     | <i>Poff</i> |                                      |       | -30  | dBm  |       |

### Optical Characteristics-Receiver (100GBase-LR4 operation)

| Parameter                             | Symbol      | Min   | Typ   | Max  | Unit | Notes |
|---------------------------------------|-------------|-------|-------|------|------|-------|
| Signaling Speed per Lane              | <i>BR</i>   |       | 25.78 |      | Gbps |       |
| Total Average Receive Power           |             |       |       | 10.5 | dBm  |       |
| Average Power at Receiver, each Lane  |             | -10.6 |       | 4.5  | dBm  |       |
| Receive Power (OMA) (each Lane)       |             |       |       | 4.5  | dBm  |       |
| Receiver Sensitivity (OMA), each Lane | <i>SEN</i>  |       |       | -8.6 | dBm  |       |
| LOS Assert                            | <i>LOSA</i> |       | -26   |      | dBm  |       |
| LOS Deassert                          | <i>LOSD</i> |       | -11.6 |      | dBm  |       |
| LOS Hysteresis                        | <i>LOSH</i> | 0.5   |       |      | dB   |       |

### Optical Characteristics-Transmitter (OTU-4 operation)

| Parameter  | Symbol          | Min               | Typ   | Max  | Unit | Notes |
|--|-----------------|-------------------|-------|------|------|-------|
| Signaling Speed per Lane                               | <i>BR</i>       |                   | 27.95 |      | Gbps |       |
| Side-mode Suppression Ratio                            | <i>SMSR</i>     | 30                |       |      | dB   |       |
| Total Average Launch Power                             | <i>PT</i>       |                   |       | 10.5 | dBm  |       |
| Average Launch Power (each Lane)                       | <i>PAVG</i>     | -2.5              |       | 2.9  | dBm  |       |
| Difference in Launch Power between any two Lanes (OMA) | <i>Ptx,diff</i> |                   |       | 5    | dB   |       |
| Extinction Ratio                                       | <i>ER</i>       | 7                 |       |      | dB   |       |
| Optical Return Loss Tolerance                          | <i>TOL</i>      |                   |       | 20   | dB   |       |
| Transmitter Reflectance                                | <i>RT</i>       |                   |       | -12  | dB   |       |
| Eye Mask {X1, X2, X3, Y1, Y2, Y3}                      |                 | G.959.1 Compliant |       |      |      | 2     |
| Average Launch Power OFF (each Lane)                   | <i>Poff</i>     |                   |       | -30  | dBm  |       |

Note: Transmitter optical characteristics are measured with a single mode fiber.

### Optical Characteristics-Receiver (OTU4 operation)

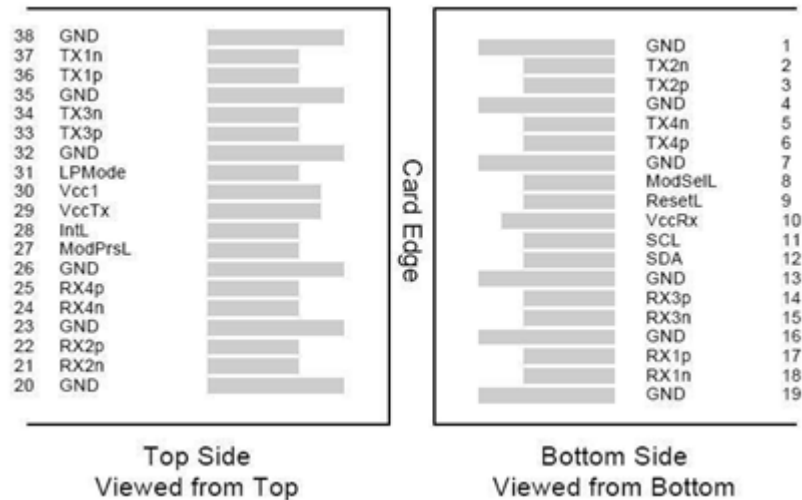
| Parameter   | Symbol          | Min  | Typ   | Max  | Unit | Notes |
|---|-----------------|------|-------|------|------|-------|
| Signaling Speed per Lane                          | <i>BR</i>       |      | 27.95 |      | Gbps |       |
| Damage Threshold (each Lane)                      | <i>THd</i>      | 4.5  |       |      | dBm  | 3     |
| Total Average Receive Power                       |                 |      |       | 10.5 | dBm  |       |
| Average Power at Receiver, each Lane              |                 | -8.6 |       | 2.9  | dBm  |       |
| Stressed Receiver Sensitivity, each Lane          |                 |      |       | -8.6 | dBm  | 4     |
| Difference in Receive Power between any two Lanes | <i>Prx,diff</i> |      |       | 5.5  | dB   |       |
| LOS Assert  | <i>LOSA</i>     |      | -25   |      | dBm  |       |
| LOS Deassert                                      | <i>LOSD</i>     |      | -11.6 |      | dBm  |       |
| LOS Hysteresis                                    | <i>LOSH</i>     | 0.5  |       |      | dB   |       |
| Optical Return Loss                               | <i>ORL</i>      |      |       | -26  | dB   |       |

## Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

| Parameter                               | Symbol             | Min  | Typ | Max | Unit   | Notes                            |
|---|--------------------|------|-----|-----|--------|----------------------------------|
| Temperature monitor absolute error      | <i>DMITEMP</i>     | -3   |     | 3   | deg. C | Over operating temperature range |
| Supply voltage monitor absolute error   | <i>DMIVCC</i>      | -0.1 |     | 0.1 | V      | Over Full operating range        |
| Channel RX power monitor absolute error | <i>DMIRX_CH</i>    | -2   |     | 2   | dB     | 1                                |
| Channel Bias current monitor            | <i>DMIibias_CH</i> | -10% |     | 10% | mA     |                                  |
| Channel TX power monitor absolute error | <i>DMITX_CH</i>    | -2   |     | 2   | dB     | 1                                |

## PIN Assignment and Function Definitions



## PIN Definition

| PIN | Signal Name | Description                                 |
|-----|-------------|---|
| 1   | GND         | Ground (1)                                  |
| 2   | Tx2n        | CML-I Transmitter 2 Inverted Data Input     |
| 3   | Tx2p        | CML-I Transmitter 2 Non-Inverted Data Input |
| 4   | GND         | Ground (1)                                  |
| 5   | Tx4n        | CML-I Transmitter 4 Inverted Data Input     |
| 6   | Tx4p        | CML-I Transmitter 4 Non-Inverted Data Input |
| 7   | GND         | Ground (1)                                  |
| 8   | ModSelL     | LVTTLL-I Module Select                      |
| 9   | ResetL      | LVTTLL-I Module Reset                       |
| 10  | VCCRx       | +3.3V Power Supply Receiver (2)             |
| 11  | SCL         | LVCNOS-I/O 2-Wire Serial Interface Clock    |
| 12  | SDA         | LVCNOS-I/O 2-Wire Serial Interface Data     |
| 13  | GND         | Ground (1)                                  |
| 14  | Rx3p        | CML-O Receiver 3 Non-Inverted Data Output   |
| 15  | Rx3n        | CML-O Receiver 3 Inverted Data Output       |
| 16  | GND         | Ground (1)                                  |
| 17  | Rx1p        | CML-O Receiver 1 Non-Inverted Data Output   |
| 18  | Rx1n        | CML-O Receiver 1 Inverted Data Output       |
| 19  | GND         | Ground (1)                                  |
| 20  | GND         | Ground (1)                                  |
| 21  | Rx2n        | CML-O Receiver 2 Inverted Data Output       |
| 22  | Rx2p        | CML-O Receiver 2 Non-Inverted Data Output   |
| 23  | GND         | Ground (1)                                  |
| 24  | Rx4n        | CML-O Receiver 4 Inverted Data Output       |
| 25  | Rx4p        | CML-O Receiver 4 Non-Inverted Data Output   |
| 26  | GND         | Ground (1)                                  |
| 27  | ModPrsL     | Module Present                              |
| 28  | IntL        | Interrupt                                   |
| 29  | VCCTx       | +3.3V Power Supply Transmitter (2)          |
| 30  | VCC1        | +3.3V Power Supply                          |
| 31  | LPMODE      | LVTTLL-I Low Power Mode                     |
| 32  | GND         | Ground (1)                                  |
| 33  | Tx3p        | CML-I Transmitter 3 Non-Inverted Data Input |
| 34  | Tx3n        | CML-I Transmitter 3 Inverted Data Input     |
| 35  | GND         | Ground (1)                                  |
| 36  | Tx1p        | CML-I Transmitter 1 Non-Inverted Data Input |
| 37  | Tx1n        | CML-I Transmitter 1 Inverted Data Input     |
| 38  | GND         | Ground (1)                                  |

### Notes:

1. All Ground (GND) are common within the QSFP+ module and all module voltages are referenced to this potential unless noted otherwise. Connect these directly to the host board signal common ground plane.
2. VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. The connector pins are each rated for a maximum current of 500mA.

## Licensing

The following U.S. patents are licensed by Palo Alto to FluxLight, Inc.:

U.S. Patent Nos: 7,184,668, 7,079,775, 6,957,021, 7,058,310, 6,952,531, 7,162,160, 7,050,720