# PROLABS – DS-SFP-FC4G-SW-C

**4GBd SFP (Small Form Pluggable) Short Wavelength (850nm) Transceiver**

## DS-SFP-FC4G-SW-C Overview

ProLabs's DS-SFP-FC4G-SW-C SFP optical transceivers are compatible with Fiber Channel as defined in FC-PI-2 Rev7, and provide a quick and reliable interface for the 4FC/2FC/FC application. The Digital diagnostics functions are available via 2-wire serial bus specified in the SFP MSA. In addition, they comply with the Small Form Factor Pluggable Multi Sourcing Agreement (MSA) and SFF-8472.

### Product Features

- Up to 4.25 GBd bi-directional data links
- Compliant with Fiber Channel, 2X Fiber Channel and 4X Fiber Channel
- Compliant with SFP MSA
- Hot-pluggable SFP footprint
- 850nm VCSEL laser transmitter
- Duplex LC connector
- Built-in digital diagnostic functions
- Up to 500m on 50/125um MMF
- Up to 300m on 62.5/125um MMF
- Single power supply 3.3V
- RoHS Compliance
- Class 1 laser product complies with EN 60825-1
- Operating temperature range: 0℃ to 70℃.

### Applications

- 1.25 GBd Gigabit Ethernet (Rate Selectable Version)
- 1.063 GBd Fiber Channel
- 2.125 GBd Fiber Channel
- 4.25 GBd Fiber Channel

### Ordering Information

| Part Number | Description |
|---|---|
| DS-SFP-FC4G-SW-C | 4FC/2FC/FC SFP 850nm LC Connectors 500m on MMF, with DOM function. |

### General Specifications

| Parameter | Symbol | Min | Typ | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Data Rate | $DR$ | | 1.062 | | GBd | Fiber Channel |
| | | | 2.125 | | | 2X Fiber Channel |
| | | | 4.25 | | | 4X Fiber Channel |
| Bit Error Rate | $BER$ | | $10^{-12}$ | | | |
| Operating Temperature | $T_{OP}$ | 0 | | 70 | ℃ | Case temperature |
| Storage Temperature | $T_{STO}$ | $-40$ | | 85 | ℃ | Ambient temperature |
| Supply Current | $I_S$ | | 180 | 240 | mA | For electrical power interface |
| Input Voltage | $V_{CC}$ | 3 | 3.3 | 3.6 | V | |
| Maximum Voltage | $V_{MAX}$ | $-0.5$ | | 4 | V | For electrical power interface |

## Optical Characteristics – Transmitter
$V_{CC}$=3V to 3.6V, $T_C$=0℃ to 70℃

| Parameter | Symbol | Min | Typ | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Output Optical Power 50/125um fiber, NA=0.2 62.5/125um fiber, NA-0.275 | $P_{TX}$ | $-9$ | | $-2.5$ | dBm | Class 1 Product |
| Optical Center Wavelength | $\lambda_C$ | 830 | | 860 | nm | |
| Optical Modulation Amplitude(<=2.125G) | OMA | 190 | | | uW | Equivalent extinction ratio specification for FC |
| Optical Modulation Amplitude(4.25GBd) | OMA | 250 | | | uW | Equivalent extinction ratio specification for FC |
| Spectral Width (RMS) | $\Delta\lambda$ | | | 0.85 | nm | |
| Optical Rise/Fall Time (<=2.125G) | $T_{RF\_IN}$ | | 100 | 150 | ps | |
| Optical Rise/Fall Time (4.25G) | $T_{RF\_IN}$ | | | 90 | ps | |
| Relative Intensity Noise | RIN | | | $-120$ | dB/Hz | |
| Deterministic Jitter Contribution(4.25G) | $TX\_\Delta DJ$ | | | 30 | ps | |
| Total Jitter Contribution(4.25G) | $TX\_\Delta TJ$ | | | 60 | ps | |

## Optical Characteristics – Receiver
$V_{CC}$=3V to 3.6V, $T_C$=0℃ to 70℃

| Parameter | Symbol | Min | Typ | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Optical Receiver Power | $P_{RX}$ | | | 0 | dBm | Average |
| Optical Center Wavelength | $\lambda_C$ | 770 | | 860 | nm | |
| Receiver Sensitivity @ 1.063GBd | $R_{X\_SEN1}$ | | | $-20$ | dBm | BER < $10^{-12}$w / PRBS $2^7-1$ test pattern |
| Receiver Sensitivity @ 2.125GBd | $R_{X\_SEN3}$ | | | $-18$ | dBm | |
| Receiver Sensitivity @ 4.25GBd | $R_{X\_SEN4}$ | | | $-15$ | dBm | |
| Optical Return Loss | ORL | 12 | | | dB | |
| Receiver Electrical 3dB Upper cutoff frequency | | | | 1500 | MHz | |
| Loss of Signal-Asserted | $P_{LOS\_A}$ | $-30$ | | | dBm | |
| Loss of Signal-Deasserted | $P_{LOS\_D}$ | | | $-20$ | dBm | |
| Loss of Signal-Hysteresis | | | 0.5 | | dB | |

## Electrical Characteristics – Transmitter
$V_{CC}$=3V to 3.6V, $T_C$=0℃ to 70℃

| Parameter | Symbol | Min | Typ | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Input differential impedance | $R_{IN}$ | | 100 | | Ω | Non condensing |
| Single ended data input swing | $V_{IN\_PP}$ | 250 | | 1200 | mV | |
| Transmit disable voltage | $V_D$ | 2 | | $V_{CC}$ | V | |
| Transmit enable voltage | $V_{EN}$ | $V_{EE}$ | | $V_{EE}$+0.8 | V | |

## Electrical Characteristics – Receiver
$V_{CC}$=3V to 3.6V, $T_C$=0℃ to 70℃

| Parameter | Symbol | Min | Typ | Max | Unit | Remarks |
|---|---|---|---|---|---|---|
| Single ended data output swing | $V_{OUT\_PP}$ | 250 | 450 | 550 | mV | |
| Data output rise time (20%-80%) | $T_R$ | | 90 | 175 | ps | |
| Data output fall time (20%-80%) | $T_F$ | | 90 | 175 | ps | |
| LOS Fault | $V_{LOS\_Fault}$ | 2 | | $V_{CC\_HOST}$ | V | |
| LOS Normal | $V_{LOS\_normal}$ | $V_{EE}$ | | $V_{EE}$+0.5 | V | |

**Digital Diagnostic Functions**

DS-SFP-FC4G-SW-C support the 2-wire serial communication protocol as defined in the SFP MSA. Digital diagnostic information are accessible over the 2-wire interface at the address 0xA2. Digital Diagnostics for DS-SFP-FC4G-SW-C are internally calibrated by default. A micro controller unit inside the transceiver gathers the monitoring information and reports the status of transceiver.

**Transceiver Temperature**, internally measured, represented as a 16 bit signed twos complement value in increments of 1/256 degrees Celsius, Temperature accuracy is better than ±3 degrees Celsius over specified operating temperature and voltage.

**Transceiver Supply Power,** internally measured, represented as a 16 bit unsigned integer with the voltage defined as the full 16 bit value (0 – 65535) with LSB equal to 100 µVolt, yielding a total range of 0 to +6.55 Volts.

**Transceiver TX bias current,** internally measured, represented as a 16 bit unsigned integer with the current defined as the full 16 bit value (0 – 65535) with LSB equal to 2 µA, yielding a total range of 0 to 131mA. Accuracy is better than ±10% over specified operating temperature and voltage.

**Transceiver TX output power,** internally measured, represented as a 16 bit unsigned integer with the power defined as the full 16 bit value (0 – 65535) with LSB equal to 0.1 µW. Data is assumed to be based on measurement of laser monitor photodiode current. Accuracy is better than ±3dB over specified temperature and voltage. Data is not valid when the transmitter is disabled.

**Transceiver RX received optical power,** internally measured, represented as a 16 bit unsigned integer with the power defined as the full 16 bit 35 value (0 – 65535) with LSB equal to 0.1 µW. Accuracy is better than ±3dB over specified temperature and voltage.

| Parameter | Symbol | Accuracy | Units | Report Range | | Unit | Remarks |
|---|---|---|---|---|---|---|---|
| | | | *Internal Calibration* | | | | |
| Temperature | $T_{MON}$ | ±3 | ℃ | − 40 | 95 | ℃ | |
| Voltage | $V_{MON}$ | ±0.1 | V | 2.7 | 3.9 | V | |
| Bias Current | $I_{MON}$ | ±10 | % | 1 | 15 | mA | |
| Tx Power | $P_{MON}$ | ±3 | dB | − 12 | 1 | dBm | |
| Rx Power | $P_{MON}$ | ±3 | dB | − 20 | 1 | dBm | |

**Block Diagram of Transceiver**
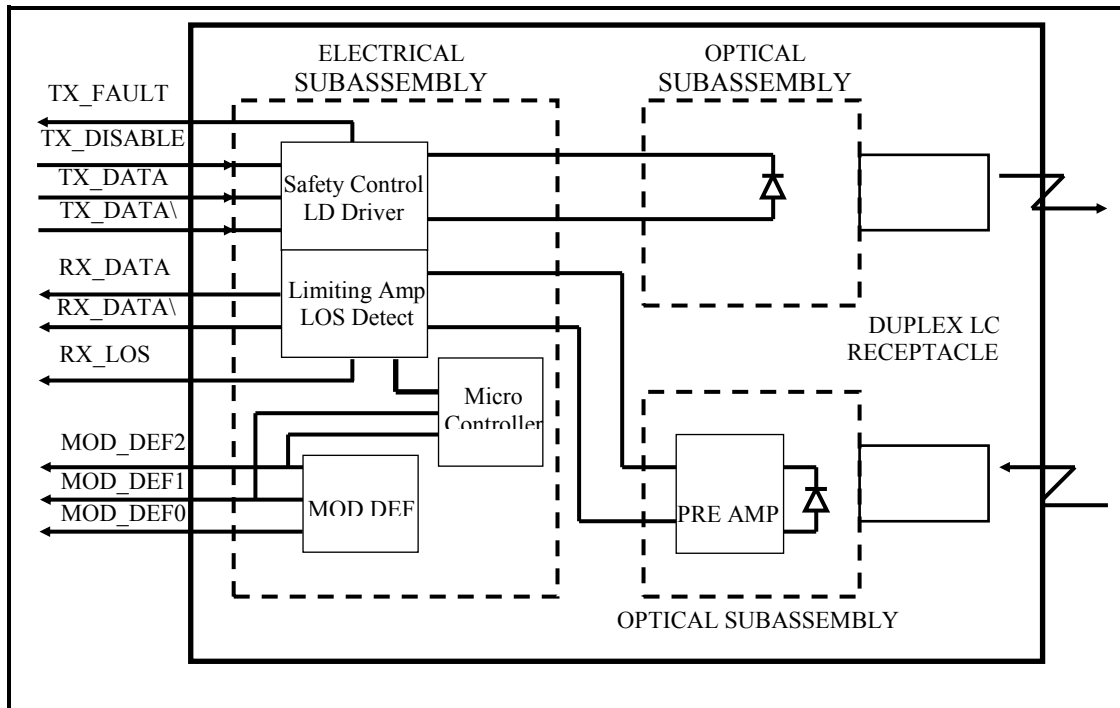


**Transmitter Section**

The VCSEL driver accept differential input data and provide bias and modulation currents for driving a laser. An automatic power-control (APC) feedback loop is incorporated to maintain a constant average optical power. 850 nm VCSEL in an eye safe optical subassembly (OSA) mates to the fiber cable.

**TX_DISABLE**

The TX_DISABLE signal is high (TTL logic "1") to turn off the laser output. The laser will turn on within 1ms when TX_DISABLE is low (TTL logic "0").

**TX_FAULT**

When the TX_FAULT signal is high, output indicates a laser fault of some kind. Low indicates normal operation.

**Receiver Section**

The receiver utilizes a PIN detector integrated with a trans-impedance preamplifier in an OSA. This OSA is connected to a Limiting Amplifier which providing post-amplification quantization, and optical signal detection. The limiting Amplifier is AC-coupled to the transimpedance amplifier, with internal 100Ω differential termination.
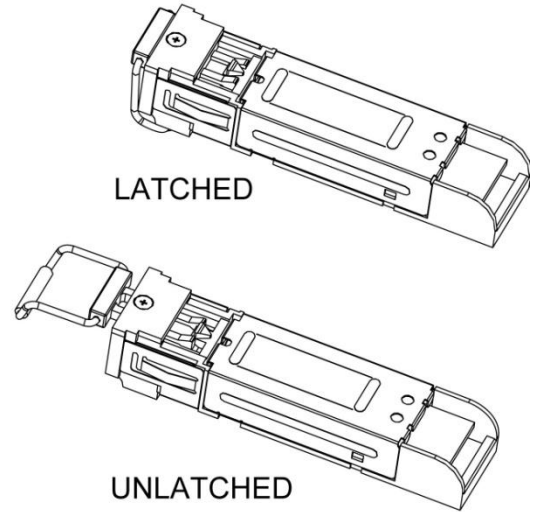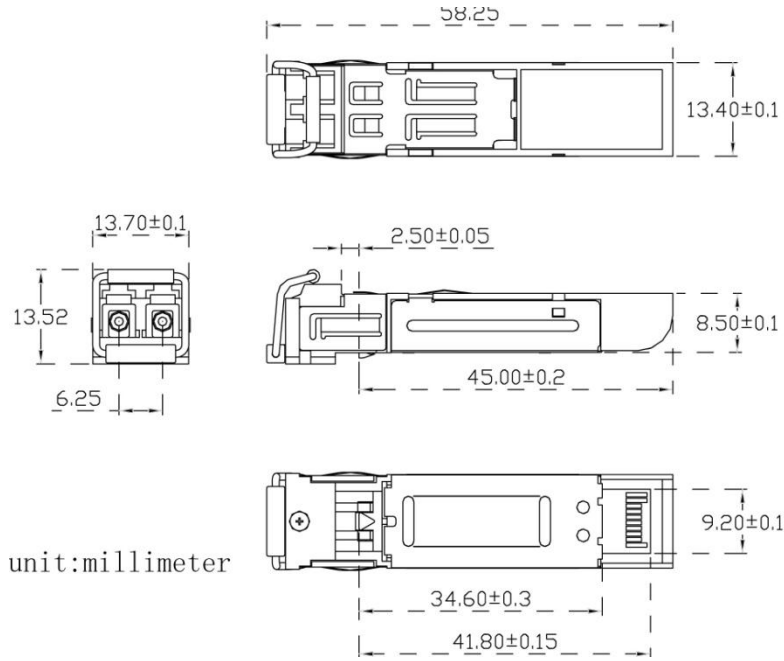
**Receive Loss (RX_LOS)**

The RX_LOS is high (logic "1") when there is no incoming light from the companion transceiver. This signal is normally used by the system for the diagnostic purpose. The signal is operated in TTL level.

**Controller Section**

The micro controller unit monitors the operation information of LD driver and Limiting Amplifier. And report these status to the customer.

**Dimensions**



58.25

13.40±0.1

13.70±0.1

13.52

6.25

2.50±0.05

8.50±0.1

45.00±0.2

unit:millimeter

9.20±0.1

34.60±0.3

41.80±0.15

LATCHED

UNLATCHED

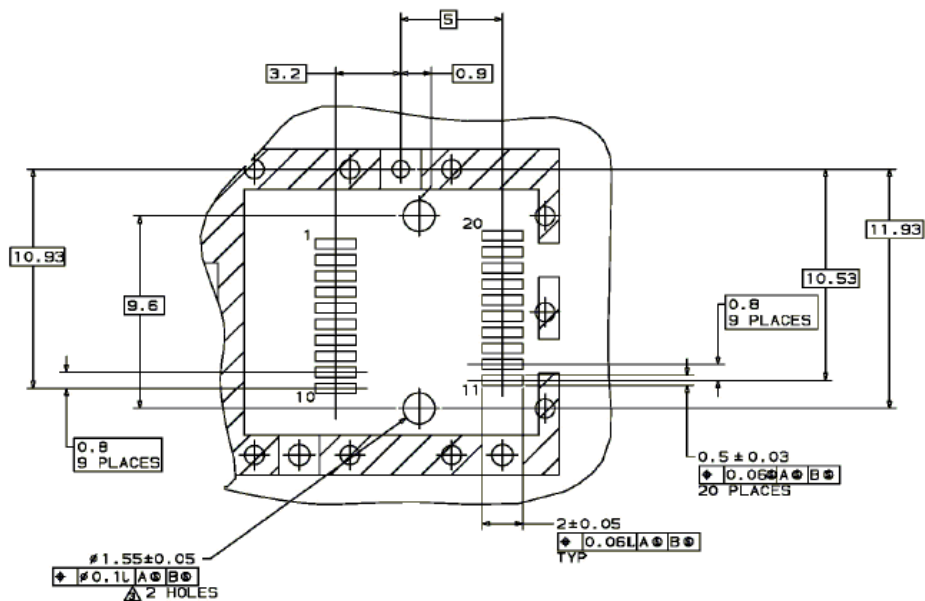**ALL DIMENSIONS ARE ±0.2mm UNLESS OTHERWISE SPECIFIED**
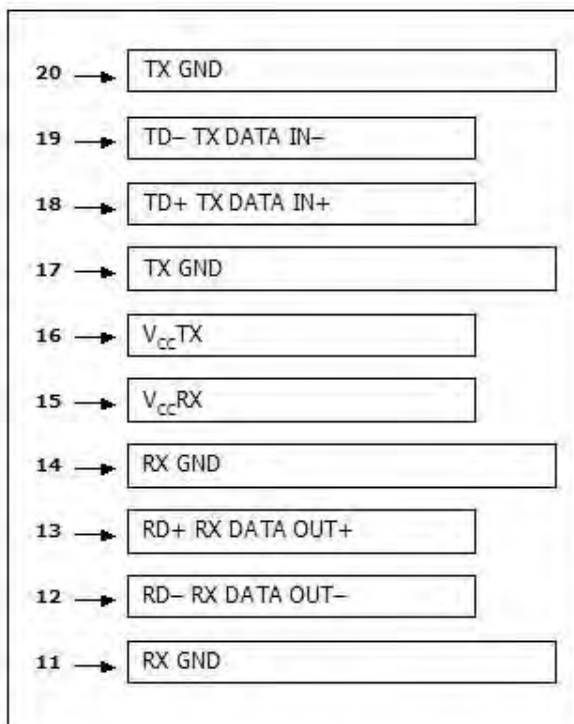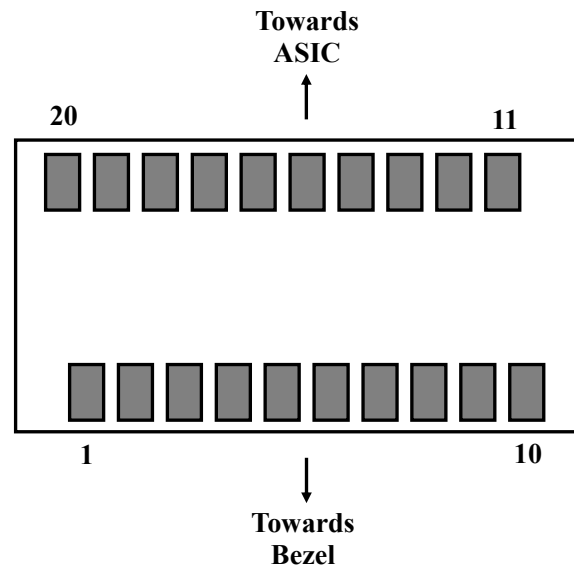**UNIT: mm**

**PCB Layout Recommendation**
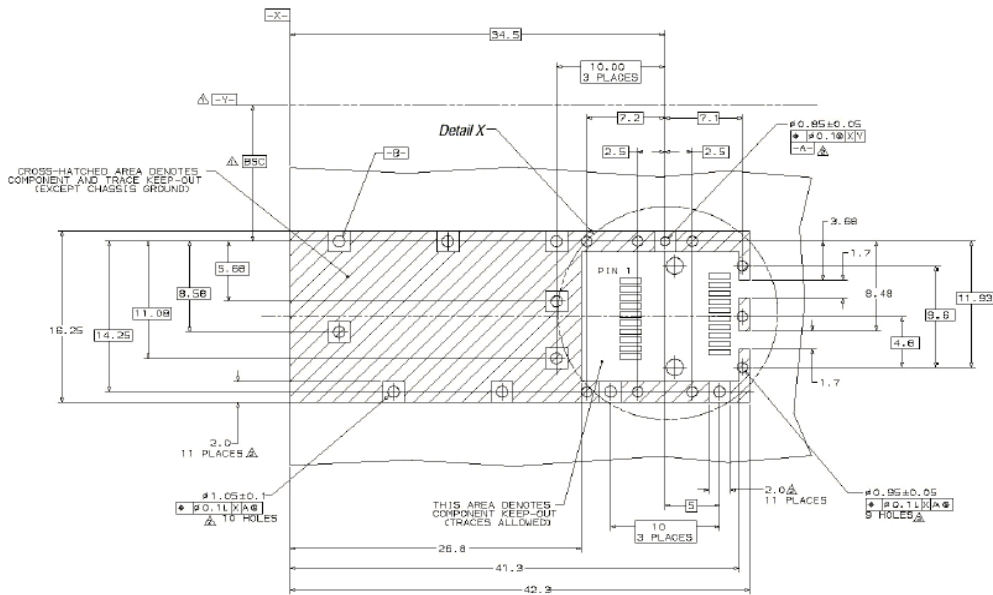


Datum and Basic Dimension Established by Customer

Pads and Vias are Chassis Ground, 11 Places

Through Holes are Unplated
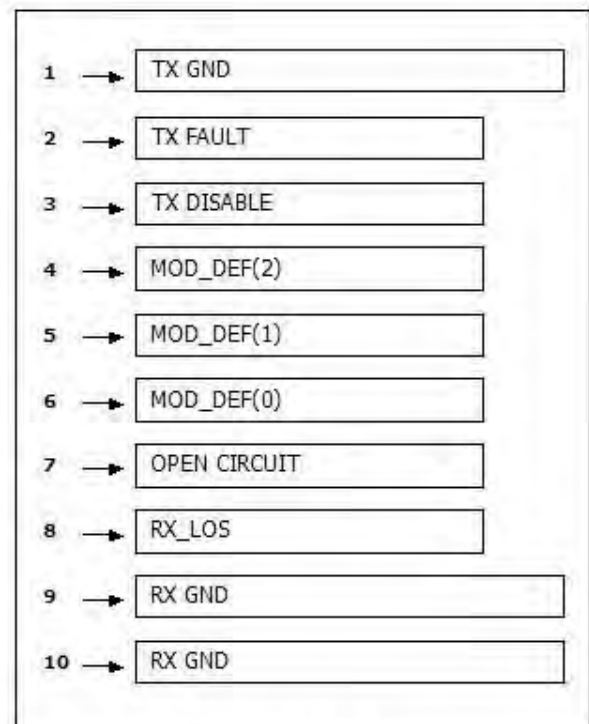
**Electrical Pad Layout**

Towards
ASIC

20                    11

1                      10

Towards
Bezel

| 20 → | TX GND |
| 19 → | TD– TX DATA IN– |
| 18 → | TD+ TX DATA IN+ |
| 17 → | TX GND |
| 16 → | $V_{cc}$TX |
| 15 → | $V_{cc}$RX |
| 14 → | RX GND |
| 13 → | RD+ RX DATA OUT+ |
| 12 → | RD– RX DATA OUT– |
| 11 → | RX GND |

**Top of Board**

| 1 → | TX GND |
| 2 → | TX FAULT |
| 3 → | TX DISABLE |
| 4 → | MOD_DEF(2) |
| 5 → | MOD_DEF(1) |
| 6 → | MOD_DEF(0) |
| 7 → | OPEN CIRCUIT |
| 8 → | RX_LOS |
| 9 → | RX GND |
| 10 → | RX GND |

**Bottom of Board**

**Pin Assignment**

| PIN # | Symbol | Description | Remarks |
|---|---|---|---|
| 1 | $V_{EET}$ | Transmitter ground (common with receiver ground) | Circuit ground is isolated from chassis ground |
| 2 | $T_{FAULT}$ | Transmitter Fault. Not supported | |
| 3 | $T_{DIS}$ | Transmitter Disable. Laser output disable on high or open | Disabled: $T_{DIS}$>2V or open |
| | | | Enabled: $T_{DIS}$<0.8V |
| 4 | MOD_DEF (2) | Module Definition 2. Data line for serial ID | Should Be pulled up with |
| 5 | MOD_DEF (1) | Module Definition 1. Clock line for serial ID | 4.7k – 10k ohm on host |
| 6 | MOD_DEF (0) | Module Definition 0. Grounded within the module | board to a voltage between 2V and 3.6V |
| 7 | Rate Select | No connection required | |
| 8 | LOS | Loss of Signal indication. Logic 0 indicates normal operation | LOS is open collector output |
| 9 | $V_{EER}$ | Receiver ground (common with transmitter ground) | Circuit ground is isolated from chassis ground |
| 10 | $V_{EER}$ | Receiver ground (common with transmitter ground) | |
| 11 | $V_{EER}$ | Receiver ground (common with transmitter ground) | |
| 12 | RD– | Receiver Inverted DATA out. AC coupled | |
| 13 | RD+ | Receiver Non-inverted DATA out. AC coupled | Circuit ground is isolated from chassis ground |
| 14 | $V_{EER}$ | Receiver ground (common with transmitter ground) | |
| 15 | $V_{CCR}$ | Receiver power supply | |
| 16 | $V_{CCT}$ | Transmitter power supply | |
| 17 | $V_{EET}$ | Transmitter ground (common with receiver ground) | Circuit ground is connected to chassis ground |
| 18 | TD+ | Transmitter Non-Inverted DATA in. AC coupled | |
| 19 | TD– | Transmitter Inverted DATA in. AC coupled | |
| 20 | $V_{EET}$ | Transmitter ground (common with receiver ground) | Circuit ground is connected to chassis ground |

**References**
1. IEEE standard 802.3. IEEE Standard Department, 2005.
2. Small Form Factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA), September 2000.
3. Fiber Channel Draft Physical Interface Specification (FC-PI-2 Rev7.0).
4. Digital Diagnostics Monitoring Interface for Optical Transceivers – SFF-8472.