

## PROLABS – EX-SFP-10GE-LR-C

10GBd SFP+ LR Transceiver

### EX-SFP-10GE-LR-C Overview

PROLABS's EX-SFP-10GE-LR-C SFP+ optical transceivers are based on 10G Ethernet IEEE 802.3ae standard and SFF 8431 standard, and provide a quick and reliable interface for the 10G Ethernet application. The Digital diagnostics functions are available via 2-wire serial bus specified in the SFF 8472.

#### Product Features

- Up to 10.5 GBd bi-directional data links
- Compliant with IEEE 802.3ae 10GBASE-LR/LW
- Compliant with SFF8431
- Hot-pluggable SFP+ footprint
- 1310nm DFB laser transmitter
- Duplex LC connector
- Built-in digital diagnostic functions
- Up to 10km on SMF
- Single power supply 3.3V
- RoHS Compliance
- Operating temperature range: 0°C to 70°C.

#### Applications

- 10GBASE-LR/LW Ethernet

#### Ordering Information

| Part Number      | Description   |
|------------------|---|
| EX-SFP-10GE-LR-C | 10G SFP+ 1310nm LC Connectors 10km on SMF, with DOM function. |

#### General Specifications

| Parameter             | Symbol    | Min   | Typ     | Max        | Unit | Remarks                        |
|-----------------------|-----------|-------|---------|------------|------|--------------------------------|
| Data Rate             | DR        |       | 10.3125 |            | GBd  | IEEE 802.3ae                   |
| Bit Error Rate        | BER       |       |         | $10^{-12}$ |      |                                |
| Operating Temperature | $T_{OP}$  | 0     |         | 70         | °C   | Case temperature               |
| Storage Temperature   | $T_{STO}$ | - 40  |         | 85         | °C   | Ambient temperature            |
| Supply Current        | $I_S$     |       | 230     | 260        | 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 |

#### Link Distances

| Parameter   | Fiber Type  | Distance Range (Km) |
|-------------|-------------|---------------------|
| 10.3125 GBd | 9/125um SMF | 10                  |

## Optical Characteristics – Transmitter

$V_{CC}=3V$  to  $3.6V$ ,  $T_C=0^{\circ}C$  to  $70^{\circ}C$

| Parameter                       | Symbol          | Min                                   | Typ | Max   | Unit  | Remarks          |
|---------------------------------|-----------------|---------------------------------------|-----|-------|-------|------------------|
| Output Optical Power            | $P_{TX}$        | - 8.2                                 |     | 0.5   | dBm   | Average          |
| Optical Center Wavelength       | $\lambda_C$     | 1260                                  |     | 1355  | nm    |                  |
| Optical Modulation Amplitude    | OMA             | - 5.2                                 |     |       |       | Per IEEE 802.3ae |
| Extinction Ratio                | ER              | 3                                     | 5.5 |       | dB    |                  |
| Spectral Width (- 20 dB)        | $\Delta\lambda$ |                                       |     | 0.6   | nm    |                  |
| Side Mode Suppression Ratio     | SMSR            | 30                                    |     |       | dB    |                  |
| Relative Intensity Noise        | RIN             |                                       |     | - 128 | dB/Hz |                  |
| Transmitter Dispersion Penalty  | TDP             |                                       |     | 3.2   | dB    |                  |
| Transmitter Jitter              |                 | According to IEEE 802.3ae requirement |     |       |       |                  |
| Launch Power of OFF Transmitter | $P_{OUT\_OFF}$  |                                       |     | - 30  | dBm   | Average          |

## Optical Characteristics – Receiver

$V_{CC}=3V$  to  $3.6V$ ,  $T_C=0^{\circ}C$  to  $70^{\circ}C$

| Parameter                                       | Symbol        | Min   | Typ | Max    | Unit | Remarks  |
|---|---------------|-------|-----|--------|------|--|
| Optical Center Wavelength                       | $\lambda_C$   | 1260  |     | 1600   | nm   |  |
| Optical Input Power                             | $P_{IN}$      | -14.4 |     | 0.5    | dBm  | Average, Informative   |
| Receiver Sensitivity (OMA)@ 10.3GBd             | $R_{X\_SEN1}$ |       |     | - 12.6 | dBm  | Measured with worst ER:<br>BER<10 <sup>-12</sup> 2 <sup>31</sup> -1 PRBS |
| Stressed Receiver Sensitivity in OMA @ 10.3Gb/s | $P_{SENS2}$   |       |     | - 10.3 | dBm  | IEEE 802.3ae   |
| Receiver Reflectance                            | $TR_{RX}$     |       |     | - 12   | dB   |  |
| LOS Assert                                      | $LOS_A$       | - 25  |     |        | dBm  |  |
| LOS De-Assert                                   | $LOS_D$       |       |     | - 16   | dBm  |  |
| LOS Hysteresis                                  |               | 0.5   |     |        | dB   |  |

## Electrical Characteristics – Transmitter

$V_{CC}=3V$  to  $3.6V$ ,  $T_C=0^{\circ}C$  to  $70^{\circ}C$

| Parameter                     | Symbol       | Min      | Typ | Max          | Unit     | Remarks        |
|-------------------------------|--------------|----------|-----|--------------|----------|----------------|
| Input differential impedance  | $R_{IN}$     |          | 100 |              | $\Omega$ | Non condensing |
| Single ended data input swing | $V_{IN\_PP}$ | 250      |     | 800          | 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  $3.6V$ ,  $T_C=0^{\circ}C$  to  $70^{\circ}C$

| Parameter                       | Symbol            | Min      | Typ | Max          | Unit | Remarks |
|---------------------------------|-------------------|----------|-----|--------------|------|---------|
| Single ended data output swing  | $V_{OUT\_PP}$     | 150      | 300 | 425          | mV   |         |
| Data output rise time (20%-80%) | $T_R$             |          | 30  |              | ps   |         |
| Data output fall time (20%-80%) | $T_F$             |          | 30  |              | ps   |         |
| LOS Fault                       | $V_{LOS\_Fault}$  | 2        |     | $V_{CC\_HO}$ | V    |         |
| LOS Normal                      | $V_{LOS\_normal}$ | $V_{EE}$ |     | $V_{EE}+0.5$ | V    |         |

## Digital Diagnostic Functions

EX-SFP-10GE-LR-C support the 2-wire serial communication protocol as defined in the SFF 8472. Digital diagnostic information are accessible over the 2-wire interface at the address 0xA2. Digital Diagnostics for EX-SFP-10GE-LR-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  $\pm 3$  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  $\mu$ Volt, yielding a total range of 0 to +6.55 Volts.

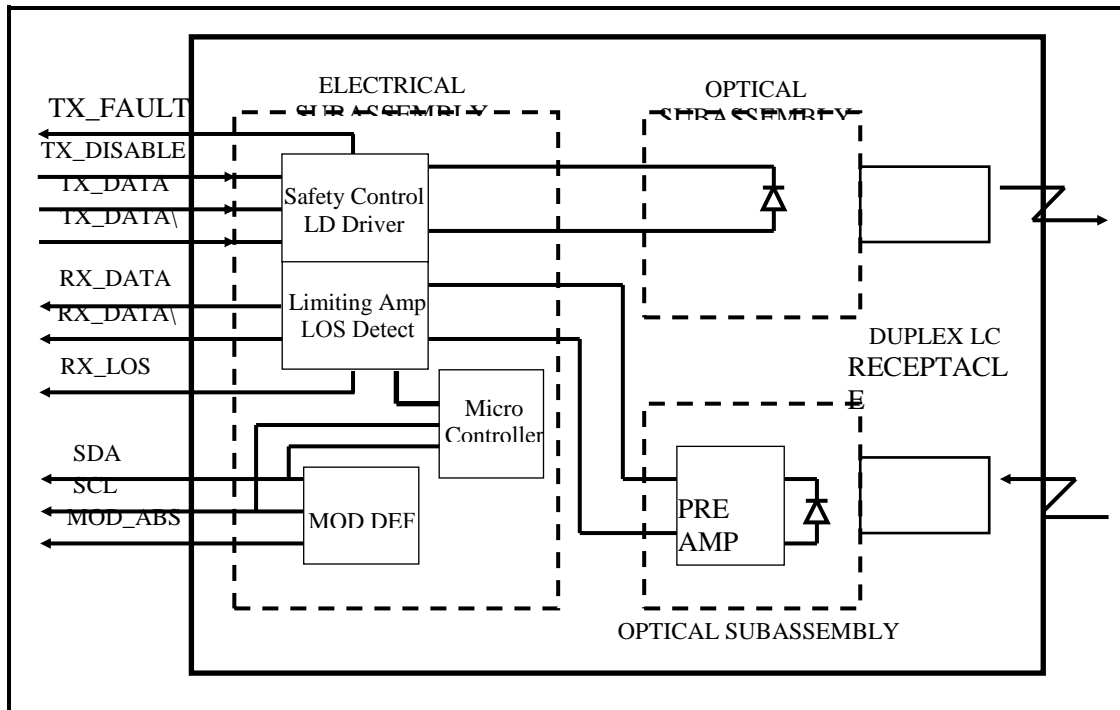
**Transceiver TX bias current**, internally measured, represented as a 16 bit unsigned integer with the current defined as the full 16 bit value (0 – 65535) with LSB equal to 2  $\mu$ A, yielding a total range of 0 to 131mA. Accuracy is better than  $\pm 10\%$  over specified operating temperature and 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  $\mu$ W. Data is assumed to be based on measurement of laser monitor photodiode current. Accuracy is better than  $\pm 3$ dB 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  $\mu$ W. Accuracy is better than  $\pm 3$ dB over specified temperature and voltage.

| <i>Parameter</i>            | <i>Symbol</i>    | <i>Accuracy</i> | <i>Units</i> | <i>Report Range</i> | <i>Unit</i> | <i>Remarks</i> |
|-----------------------------|------------------|-----------------|--------------|---------------------|-------------|----------------|
| <i>Internal Calibration</i> |                  |                 |              |                     |             |                |
| Temperature                 | T <sub>MON</sub> | ±3              | °C           | – 10                | 85          | °C             |
| Voltage                     | V <sub>MON</sub> | ±0.1            | V            | 2.9                 | 3.7         | V              |
| Bias Current                | I <sub>MON</sub> | ±10             | %            | 1                   | 60          | mA             |
| Tx Power                    | P <sub>MON</sub> | ±3              | dB           | – 8                 | 0           | dBm            |
| Rx Power                    | P <sub>MON</sub> | ±3              | dB           | – 16                | 0           | 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. 1310 DFB 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.

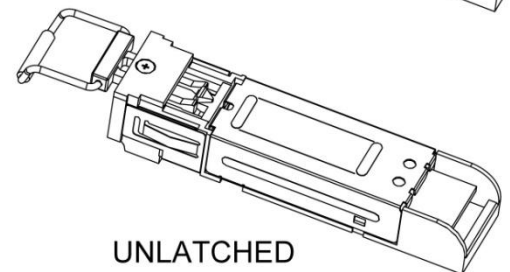
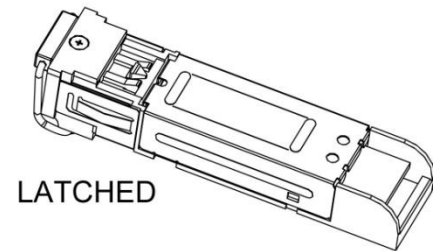
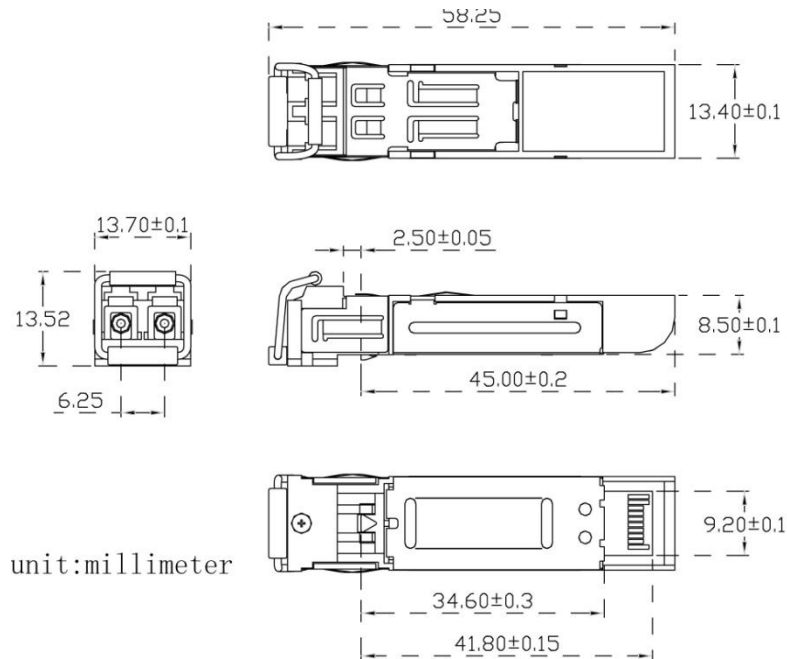
### Receive Loss (RX\_LOS)

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

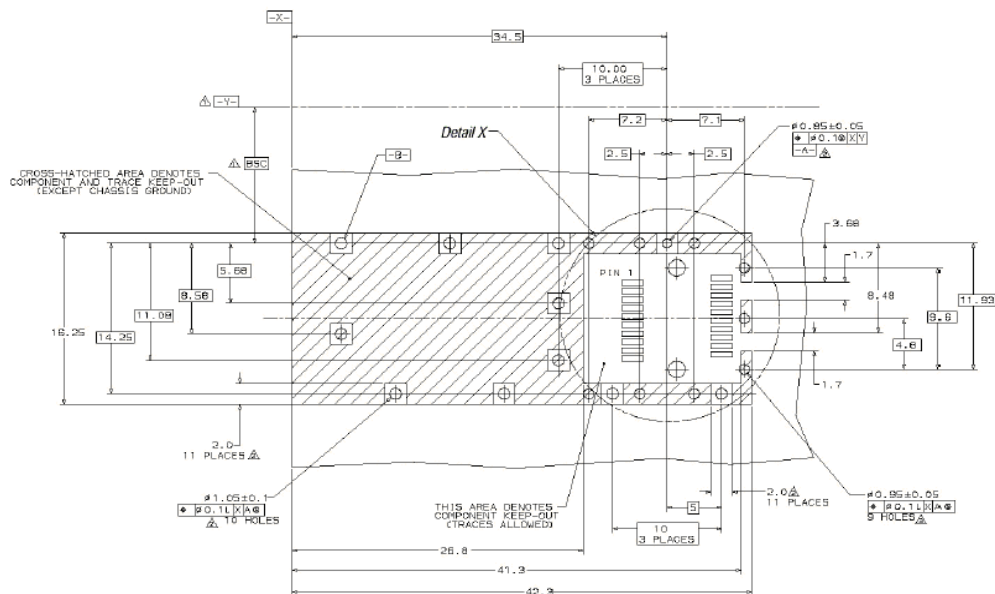
The micro controller unit monitors the operation information of LD driver and Limiting Amplifier. And report these status to the customer.

## Dimensions



**ALL DIMENSIONS ARE  $\pm 0.2$ mm UNLESS OTHERWISE SPECIFIED**  
**UNIT: mm**

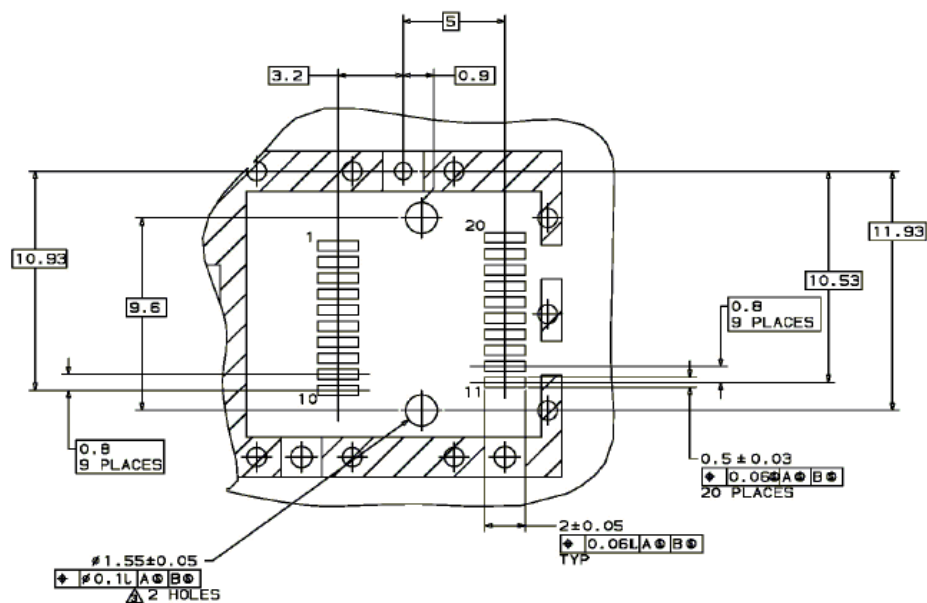
## PCB Layout Recommendation



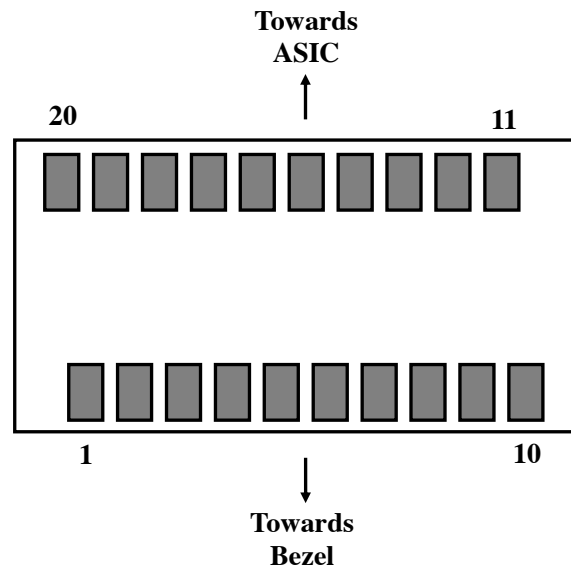
Datum and Basic Dimension Established by Customer

 Rads and Vias are Chassis Ground, 11 Places

 Through Holes are Unplated



## Electrical Pad Layout



|      |                    |
|------|--------------------|
| 20 → | TX GND             |
| 19 → | TD- TX DATA IN-    |
| 18 → | TD+ TX DATA IN+    |
| 17 → | TX GND             |
| 16 → | V <sub>CC</sub> TX |
| 15 → | V <sub>CC</sub> 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 →  | SDA        |
| 5 →  | SCL        |
| 6 →  | MOD_ABS    |
| 7 →  | RS0        |
| 8 →  | RX_LOS     |
| 9 →  | RS1        |
| 10 → | RX GND     |

Bottom of Board



## Pin Assignment

| PIN # | Symbol             | Description   | Remarks  |
|-------|--------------------|---|--|
| 1     | V <sub>EET</sub>   | Transmitter ground (common with receiver ground)              | Circuit ground is isolated from chassis ground   |
| 2     | T <sub>FAULT</sub> | Transmitter Fault.  |  |
| 3     | T <sub>DIS</sub>   | Transmitter Disable. Laser output disable on high or open     | Disabled: T <sub>DIS</sub> >2V or open<br>Enabled: T <sub>DIS</sub> <0.8V              |
| 4     | SDA                | Data line for serial ID                                       | Should Be pulled up with 4.7k – 10k ohm on host board to a voltage between 2V and 3.6V |
| 5     | SCL                | Clock line for serial ID                                      |  |
| 6     | MOD_ABS            | Module Absent. Grounded within the module                     |  |
| 7     | RS0                | No connection required  |  |
| 8     | LOS                | Loss of Signal indication. Logic 0 indicates normal operation | LOS is open collector output   |
| 9     | RS1                | No connection required  |  |
| 10    | V <sub>EER</sub>   | Receiver ground (common with transmitter ground)              | Circuit ground is isolated from chassis ground   |
| 11    | V <sub>EER</sub>   | Receiver ground (common with transmitter ground)              |  |
| 12    | RD–                | Receiver Inverted DATA out. AC coupled                        |  |
| 13    | RD+                | Receiver Non-inverted DATA out. AC coupled                    |  |
| 14    | V <sub>EER</sub>   | Receiver ground (common with transmitter ground)              | Circuit ground is isolated from chassis ground   |
| 15    | V <sub>CCR</sub>   | Receiver power supply   |  |
| 16    | V <sub>CCT</sub>   | Transmitter power supply                                      |  |
| 17    | V <sub>EET</sub>   | 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 <sub>EET</sub>   | Transmitter ground (common with receiver ground)              | Circuit ground is connected to chassis ground  |

## References

1. IEEE standard 802.3ae. IEEE Standard Department, 2005.
2. Enhanced 8.5 and 10 Gigabit Small Form Factor Pluggable Module “SFP+” – SFF-8431
3. Digital Diagnostics Monitoring Interface for Optical Transceivers – SFF-8472.