

The GigaTech Products **ET5402-LR-GT** is programmed to be fully compatible and functional with all intended EDGE-CORE switching devices. This SFP module is based on the 10G Ethernet IEEE 802.3ae standard and is designed to be compliant with the SFF-8431 SFP Multi-source Agreement (MSA). This module is designed for single mode fiber and operates at a nominal wavelength of 1310nm up to 10KM.

## Features:

- Up to 10.7GBd bi-directional data links
- Hot-pluggable SFP+ footprint
- 1310nm VCSEL laser transmitter
- Duplex LC connector
- Built-in digital diagnostic function
- Up to 10km over single mode fiber
- Single power supply 3.3V
- Operating temperature range  
C-Temp: 0°C to 70°C



## Compliance:

- IEEE 802.3ae 10GBase-LR/LW
- MSA SFF8431
- SFP 10G FC
- RoHS Compliant

## Applications:

- 10GBASE-LR/LW Ethernet
- 10GB Fiber Channel

## Warranty:

GigaTech Branded Optical Transceivers- Lifetime Warranty

### General Specifications

| <i>Parameter</i>    | <i>Symbol</i>          | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> | <i>Remarks</i>           |
|---------------------|------------------------|------------|------------|------------|-------------|--------------------------|
| Data Rate           | <i>DR</i>              |            | 10.3125    |            | GBd         | IEEE 802.3ae             |
| Bit Error Rate      | <i>BER</i>             |            |            | $10^{-12}$ |             |                          |
| Input Voltage       | <i>V<sub>CC3</sub></i> | 3          | 3.3        | 3.6        | V           |                          |
| Maximum Voltage     | <i>V<sub>max</sub></i> | -0.5       |            | 4          | V           | Electric Power Interface |
| Supply Current      | <i>I<sub>s</sub></i>   |            | 230        | 260        | mA          | Electric Power Interface |
| Storage Temperature | <i>T<sub>sto</sub></i> | -40        |            | 85         | °C          | Ambient Temperature      |

### Link Distances

| <i>Parameter</i> | <i>Fiber Type</i> | <i>Distance Range (km)</i> |
|------------------|-------------------|----------------------------|
| 10.3125 GBd      | 9/125 SMF         | 10km                       |

### Optical Characteristics - Transmitter

| <i>Parameter</i>                | <i>Symbol</i>                         | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> | <i>Remarks</i>   |
|---------------------------------|---------------------------------------|------------|------------|------------|-------------|------------------|
| Optical Center Wavelength       | $\lambda$                             | 1260       |            | 1355       | nm          |                  |
| Output Optical Power            | <i>P<sub>tx</sub></i>                 | -8.2       |            | 0.5        | dBm         | Average          |
| Optical Modulation Amp          | <i>OMA</i>                            | -5.2       |            |            |             | Per IEEE 802.3ae |
| Extinction Ratio                | <i>ER</i>                             | 3          | 5.5        |            | dB          |                  |
| Spectral Width (-20 dB)         | $\Delta\lambda$                       |            |            | 0.6        | nm          |                  |
| Relative Intensity Noise        | <i>RIN</i>                            |            |            | -128       | dB/Hz       |                  |
| Transmitter Dispersion Penalty  | <i>TDP</i>                            |            |            | 3.2        | dB          |                  |
| Launch Power of OFF Transmitter | <i>P<sub>OUT_OFF</sub></i>            |            |            | -30        | dBm         | Average          |
| Transmitter Jitter              | According to IEEE 802.3ae requirement |            |            |            |             |                  |

### Optical Characteristics - Receiver

| <i>Parameter</i>                               | <i>Symbol</i>            | <i>Min</i> | <i>Typ</i> | <i>Max</i> | <i>Unit</i> | <i>Remarks</i>                                       |
|------------------------------------------------|--------------------------|------------|------------|------------|-------------|------------------------------------------------------|
| Optical Center Wavelength                      | $\lambda_c$              | 1260       |            | 1600       | nm          |                                                      |
| Optical Input Power                            | <i>P<sub>IN</sub></i>    | -14.4      |            | 0.5        | dBm         | Average                                              |
| Receiver Sensitivity in OMA @ 10.3GBd          | <i>P<sub>SENS1</sub></i> |            |            | -12.6      | dBm         | Worst ER: BER< $10^{-12}$<br>2 <sup>31</sup> -1 PRBS |
| Stressed Receiver Sensitivity in OMA @ 10.3GBd | <i>P<sub>SENS2</sub></i> |            |            | -10.3      | dBm         | IEEE 802.3ae                                         |
| Receiver Reflectance                           | <i>TR<sub>RX</sub></i>   |            |            | -12        | dB          |                                                      |
| LOS Assert                                     | <i>LOS<sub>A</sub></i>   | -25        |            |            | dBm         |                                                      |
| LOS De-Assert                                  | <i>LOS<sub>D</sub></i>   |            |            | -16        | dBm         |                                                      |
| LOS Hysteresis                                 |                          | 0.5        |            |            | dB          |                                                      |

### Electrical Characteristics – Transmitter

| <i>Parameter</i>              | <i>Symbol</i> | <i>Min</i> | <i>Typ</i> | <i>Max</i>     | <i>Unit</i> | <i>Remarks</i> |
|-------------------------------|---------------|------------|------------|----------------|-------------|----------------|
| 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

| <i>Parameter</i>               | <i>Symbol</i> | <i>Min</i>     | <i>Typ</i> | <i>Max</i>     | <i>Unit</i> | <i>Remarks</i> |
|--------------------------------|---------------|----------------|------------|----------------|-------------|----------------|
| Differential data output swing | $V_{OUT\_PP}$ | 600            | 650        | 800            | mV          |                |
| Data output rise time          | $T_R$         |                |            | 40             | ps          | 20%-80%        |
| Data output fall time          | $T_F$         |                |            | 40             | ps          | 20%-80%        |
| LOS Fault                      | $V_{LOS\_F}$  | $V_{CC} - 0.5$ |            | $V_{CC\_HOST}$ | V           |                |
| LOS Normal                     | $V_{LOS\_N}$  | GND            |            | GND + 0.5      | V           |                |

### Digital Diagnostic Functions

The SFP 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 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.

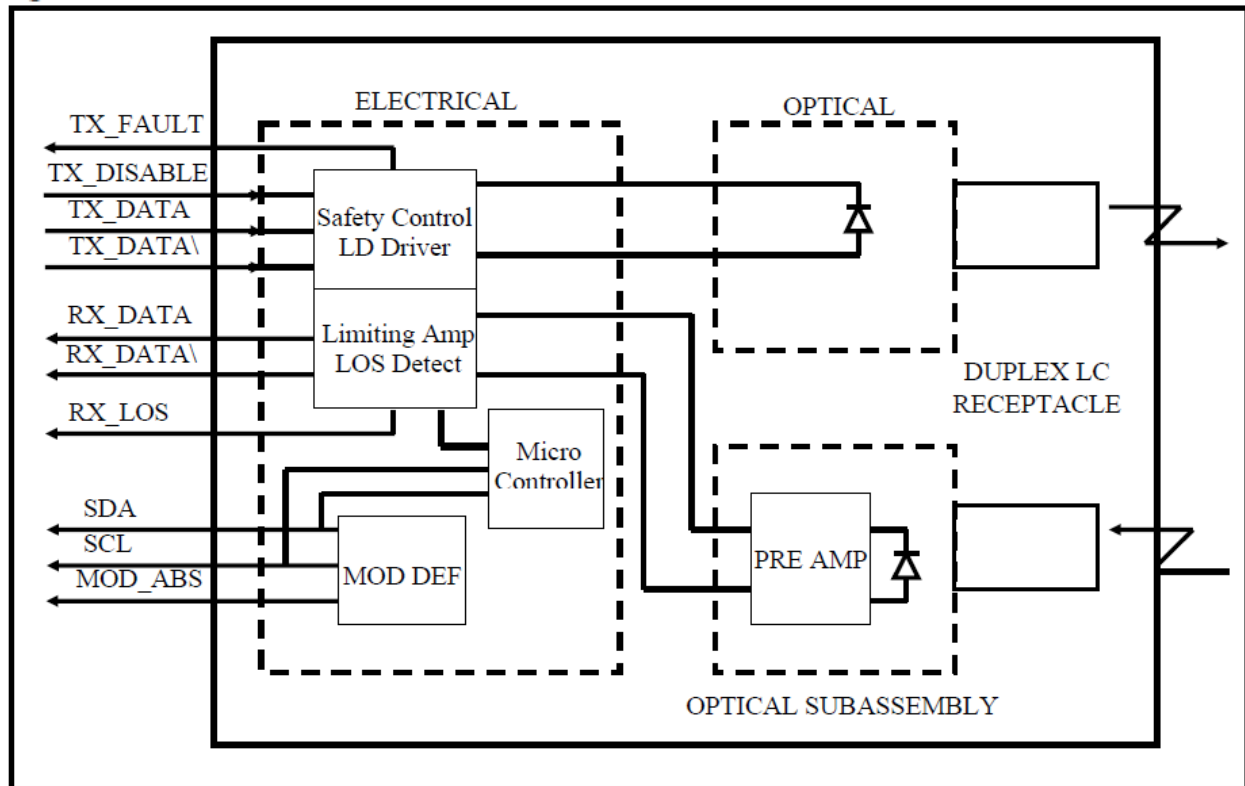
**Transceiver TX bias current-** Internally measured, represented as a 16 bit unsigned integer with the current defined as the full 16 bit value (0 – 65535) with LSB equal to 2  $\mu$ A, yielding a total range of 0 to 131mA. Accuracy is better than  $\pm 10\%$  over specified operating temperature and 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> |
|------------------|---------------|-----------------|--------------------|---------------------|--------------------|----------------|
| Temperature      | $T_{mon}$     | $\pm 3$         | $^{\circ}\text{C}$ | -10 - +85           | $^{\circ}\text{C}$ |                |
| Voltage          | $V_{mon}$     | $\pm 0.1$       | V                  | 2.9 - 3.7           | V                  |                |
| Bias Current     | $T_F$         | $\pm 10$        | %                  | 1 - 15              | mA                 |                |
| Tx Power         | $V_{LOS\_F}$  | $\pm 3$         | dB                 | -10 - 0             | dBm                |                |
| Rx Power         | $V_{LOS\_N}$  | $\pm 3$         | dB                 | -20 - 0             | dBm                |                |

## Block Diagram of Transceiver



**Transmitter Section-** The Laser 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").

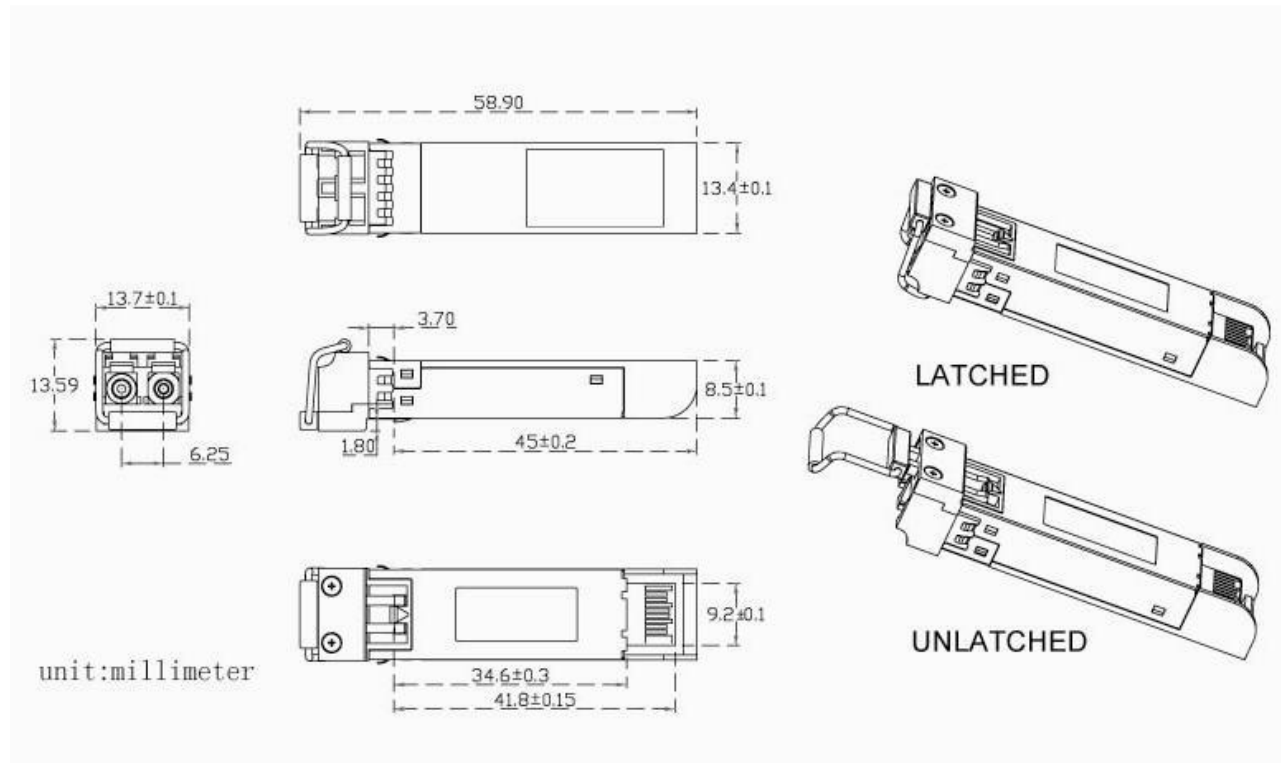
**TX\_FAULT-** When the TX\_FAULT signal is high, output indicates a laser fault of some kind. Low indicates normal operation.

**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.

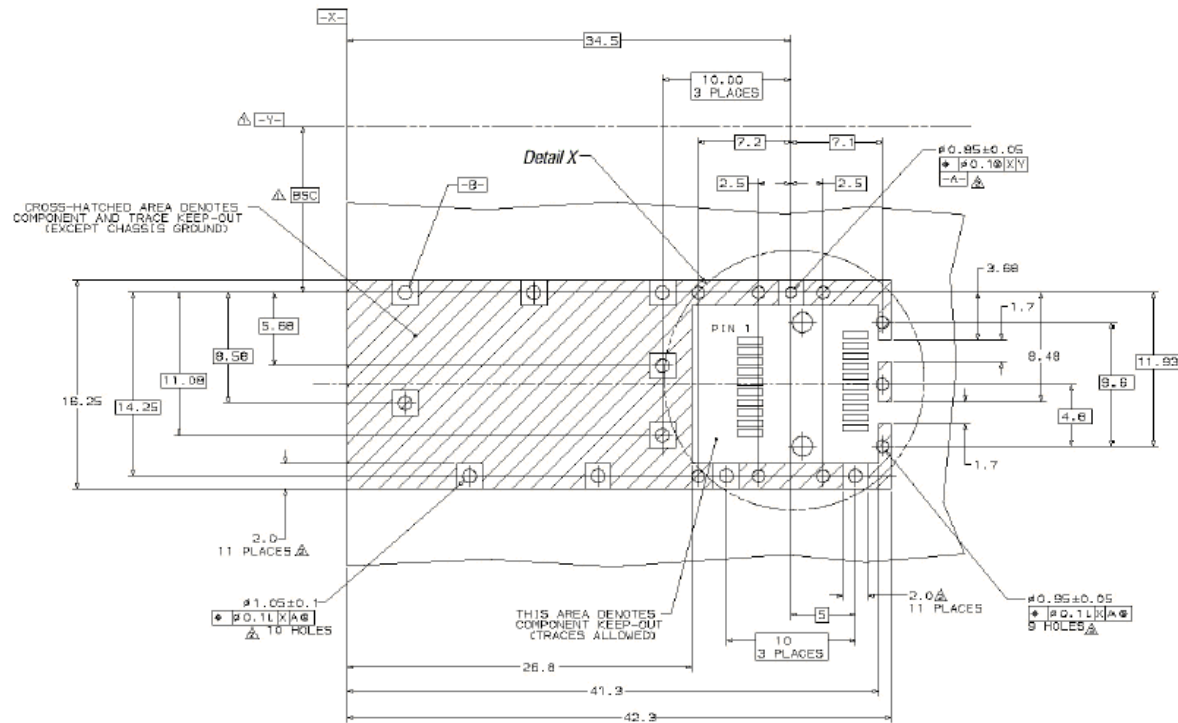
**Controller Section-** The micro controller unit monitors the operation information of LD driver and Limiting Amplifier and report these status to the customer.

## Dimensions



ALL DIMENSIONS ARE  $\pm 0.2\text{mm}$  UNLESS OTHERWISE SPECIFIED UNIT: mm

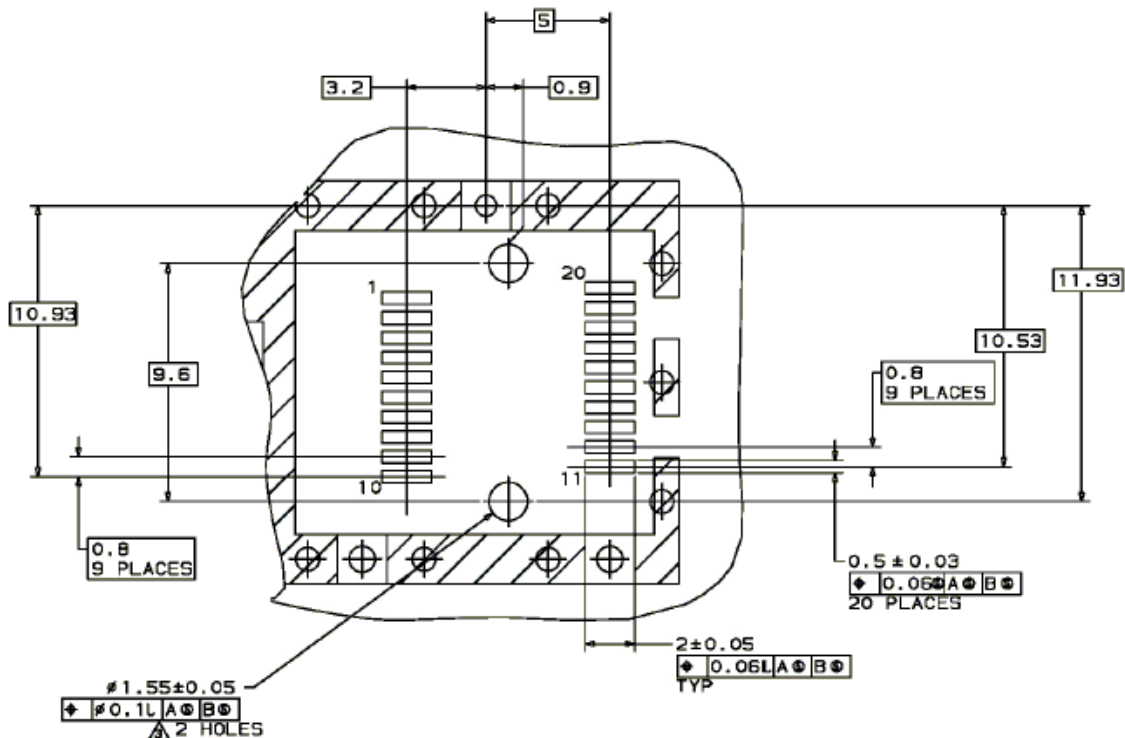
## PCB Layout Recommendation



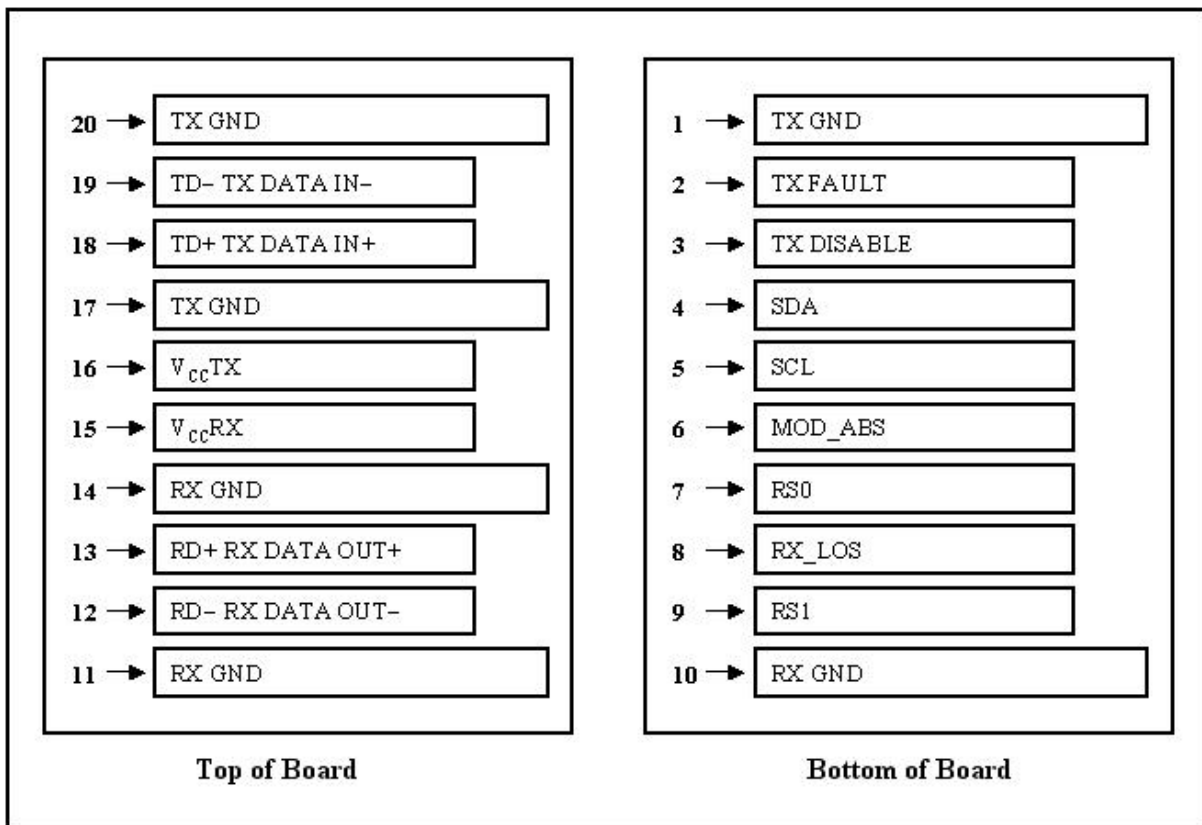
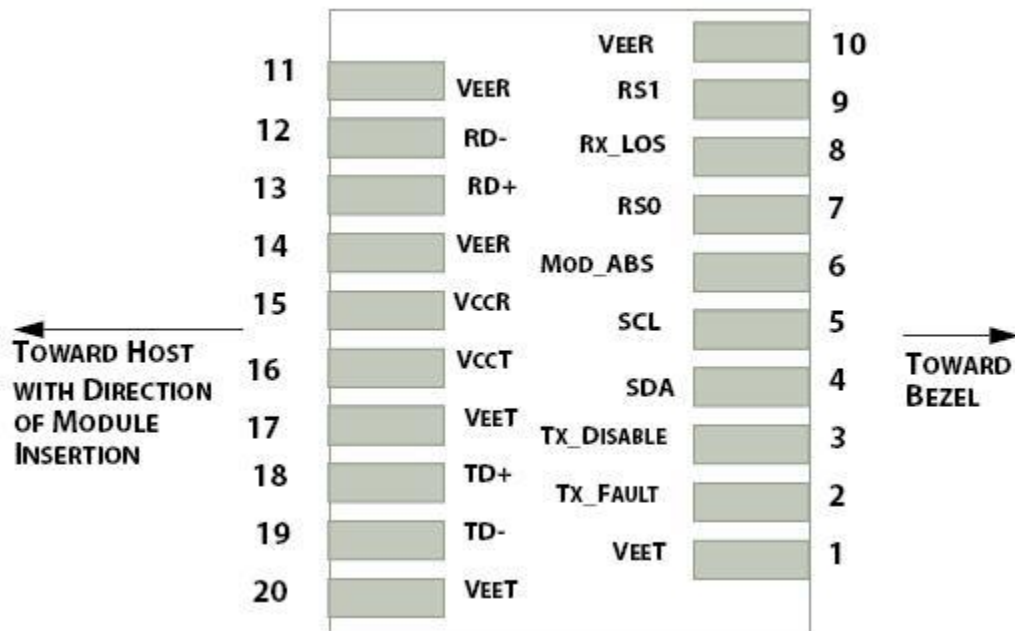
△ Datum and Basic Dimension Established by Customer

△ Pads and Vias are Chassis Ground, 11 Places

△ Through Holes are Unplated



## Electrical Pad Layout



## Pin Assignment

| <i><b>PIN #</b></i> | <i><b>Symbol</b></i> | <i><b>Description</b></i>                                     | <i><b>Remarks</b></i>                                                                  |
|---------------------|----------------------|---------------------------------------------------------------|----------------------------------------------------------------------------------------|
| 1                   | VEET                 | Transmitter ground (common with receiver ground)              | Circuit ground is isolated from chassis ground                                         |
| 2                   | TFAULT               | Transmitter Fault                                             |                                                                                        |
| 3                   | TDIS                 | Transmitter Disable. Laser output disable on high or open     | Disabled: TDIS>2V or open<br>Enabled: TDIS<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. Ground 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                  | +3.3V Power Supply                                            | Circuit ground is isolated from chassis ground                                         |
| 10                  | VEER                 | Receiver ground (common with transmitter ground)              |                                                                                        |
| 11                  | VEER                 | Receiver ground (common with transmitter ground)              |                                                                                        |
| 12                  | RD-                  | Receiver Inverted DATA out. AC coupled                        |                                                                                        |
| 13                  | RD+                  | Receiver Non-inverted DATA out. AC coupled                    |                                                                                        |
| 14                  | VEER                 | Receiver ground (common with transmitter ground)              | Circuit ground is isolated from chassis ground                                         |
| 15                  | VCCR                 | Receiver power supply                                         |                                                                                        |
| 16                  | VCCT                 | Transmitter power supply                                      | Same as Pin# 1                                                                         |
| 17                  | VEET                 | Transmitter ground (common with receiver ground)              | Circuit ground is connected to chassis ground                                          |
| 18                  | TD+                  | Transmitter Non-inverted DATA out. AC coupled                 |                                                                                        |
| 19                  | TD-                  | Transmitter Inverted DATA out. AC coupled                     |                                                                                        |
| 20                  | VEET                 | 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.