



#### Product Description

The LTD1505 SFP SONET/SDH LC duplex transceiver is intended for 40 km reach service in 622 Mb/s 1550 nm single mode high-speed telecommunications equipment where low-cost, extraordinary performance and reliability are essential. It meets the requirements of Telcordia SONET OC-12/LR-1 and ITU-T G.957 SDH STM-4/L4.1, consumes low power, operates from a 3.3 volt DC power supply and is offered in the 0 to 70°C commercial temperature range. The industry standard 2x10 small form pluggable (SFP) package is fabricated with a rugged die cast metal housing and cage assembly. The low jitter and low bit error rate optical assemblies features a 1550 nm DFB laser transmitter and PIN/TIA receiver. It incorporates the SFP MSA LVTTTL Loss of Signal (Rx\_LOS), Tx Fault (Tx\_FAULT) and Tx Disable (Tx\_DIS) monitor and control functions. The SFF-8472 Rev 9.3 compliant digital diagnostic monitor feature which is accessed via the I<sup>2</sup>C 2-wire serial ID interface is an available option. The differential AC coupled Tx and Rx data interfaces (50 ohms to ground, 100 ohms line to line) are LVPECL compatible. The device is Class I laser safety compliant.



#### Applications

- 622 Mb/s SONET/SDH telecom equipment
- Hub interconnects
- Mass storage system interconnects
- Rack to rack system interconnects
- Bus extenders
- Telecom switches
- Metro / Access Networks
- Channel extenders
- Router interconnects
- Switch to switch interfaces
- Host adapter interconnects

#### Features

- LC Duplex optical interface
- Single Mode operation
- Tx Fault (Tx\_FAULT), LVTTTL
- 40 km reach
- BER < 1X10<sup>-10</sup>
- 2-wire I<sup>2</sup>C data bus
- 622 Mb/s data rate
- (2<sup>23</sup> - 1 NRZ PRBS test pattern)
- SFF-8472 Rev 9.3 MSA compliant
- +3.3 V power supply
- Telcordia SONET OC-12/LR-1 compliant
- Internally AC coupled and terminated
- Low DC power consumption
- ITU-T G.957 SDH STM-4/L4.1 compliant
- LVPECL Rx and Tx data interface
- 2x10 SFP MSA compliant package
- Operating temperature range:
- 100 Ohms differential (line to line)
- 50 Ohms single ended (line to ground)
- Bail or pull latch option
- Commercial: 0 to 70°C
- Hot swappable
- Monitor and Control Functions
- High performance 1550 nm DFB laser
- Loss of Signal (Rx\_LOS), LVTTTL
- High sensitivity PIN/TIA optical receiver:
- Tx Disable (Tx\_DIS), LVTTTL



**Absolute Maximum Ratings (EXCEEDING THESE RATINGS MAY CAUSE IRREVERSIBLE DAMAGE TO THE DEVICE)**

Parameter	Symbol	Minimum	Maximum	Units
Storage Temperature	T <sub>stg</sub>	-40	+85	°C
Relative Humidity - Storage	RH <sub>S</sub>	0	95	%
Relative Humidity - Operating	RH <sub>O</sub>	0	85	%
DC Supply Voltage	V <sub>CC</sub>	0	3.6	V
Soldering Temperature	T <sub>slid</sub>	0	260	°C
Soldering Time Duration	t <sub>slid</sub>	0	10	seconds
Tx DATA	V <sub>in</sub>	0	V <sub>CC</sub> + 0.5	V

**Optical and Electrical Signal Absolute Maximum Ratings**

Signal / Data Input Voltage (Tx_DATA )	V <sub>IN PK-PK</sub>	-	2.4	V
8472 Clock Signal (Standard Mode)	I <sub>CLOCK</sub>	100	-	kHz
8472 Clock Signal (Fast Mode)	I <sub>CLOCK</sub>	-	400	kHz
Rx Optical Input Power	P <sub>IN-MAX</sub>		3	dBm

**Logic State Absolute Maximum Ratings**

Tx_DISABLE Logic HIGH State	Tx_DIS	-	V <sub>CC</sub> +0.5	V
Tx_FAULT Logic HIGH State	Tx_FAULT	-	V <sub>CC</sub> +0.5	V
Rx_LOS Logic HIGH State	Rx_LOS	-	V <sub>CC</sub> +0.5	V
8472 MOD-DEF2	MOD_DEF2	-	V <sub>CC</sub> +0.5	V

**Recommended Operating Conditions**

Parameter	Symbol	Min	Typ	Max	Units	Notes
Ambient Operating Temperature	T <sub>amb</sub>	0	25	+70	°C	Temperature Range = C
DC Supply Voltage	V <sub>CC</sub>	3.1	3.3	3.5	Volts	
Module Supply Current	I <sub>IN</sub>	-	138	180	mA	
Power Dissipation	P <sub>D</sub>	-	450	700	mW	

**Ordering Information**

Latch Options	Bail and Pull Latches are compatible with the dimensions defined by the SFP MSA
Ambient Operating Temperature	Commercial

Part Number	Latch Option (X)		Temperature Option (Y)	
<b>LTD1505 XY</b>	B	Bail	C	0 to 70 °C
	P	Pull		



Transmitter Logic						
Parameter	Function	Logic State	Logic Type	Min	Max	Units
Tx_DIS and Tx_FAULT	DISABLE	HIGH	LVTTTL	2.4	V <sub>CC</sub> +0.3	V
Tx_DIS and Tx_FAULT	ENABLE	LOW	LVTTTL	0	0.8	V
Tx_DIS	Assert Time	-	LVTTTL	-	10	µs
Receiver Logic						
Parameter	Function	Logic State	Logic Type	Min	Max	Units
Rx_LOS	LOSS OF SIGNAL	HIGH	LVTTTL	2.4	V <sub>CC</sub> +0.3	V
Rx_LOS	NORMAL	LOW	LVTTTL	0	0.8	V
I <sup>2</sup> C Serial ID Logic						
Parameter	Function	Logic State	Logic Type	Min	Max	Units
MOD_DEF 0	Digital Ground	Ground	N/A	0	0	V
MOD_DEF 1	Clock Signal	HIGH	LVTTTL	2.4	V <sub>CC</sub> +0.3	V
		LOW	LVTTTL	0	0.8	V
MOD_DEF 2	Serial Data	HIGH	LVTTTL	2.4	V <sub>CC</sub> +0.3	V
		LOW	LVTTTL	0	0.8	V

Transmitter Electro-Optical Characteristics						
Parameter	Symbol	LTD1505			Units	Notes
		Min	Typ	Max		
Laser Type		1550 nm DFB				
Optical Output Power	P <sub>o</sub>	-5		0	dBm	Average Optical Output
Center Wavelength	λ		1550		nm	
Spectral Line Width @ -20dB	Δλ	-	-	1	nm	
Side Suppression Mode Ratio	30				dB	
Extinction Ratio	ER	TBD	-	-	dB	
Optical Rise and Fall Time	t <sub>r</sub> , t <sub>f</sub>	-	500	600	ps	20% - 80%
Relative Intensity Noise	RIN	-	-	-117	dB/Hz	
Transmitter Generated RMS Jitter	J <sub>RMS</sub>	-	-	0.007	UI	
Output Eye		ITU-T G.957 Compliant				
Tx Differential Input Impedance	Z <sub>in</sub>	-	100	-	Ohms	
Tx Differential Input Voltage	V <sub>IN</sub>	200	-	2400	mV p-p	LVPECL Tx DATA (Note 1)

Note 1: Internally AC coupled and terminated



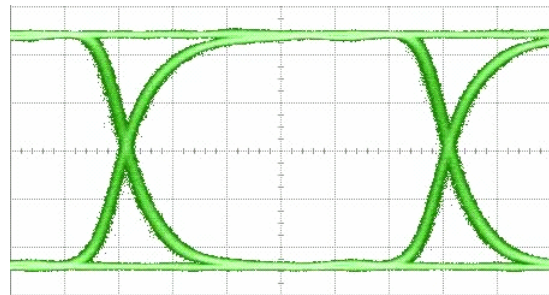
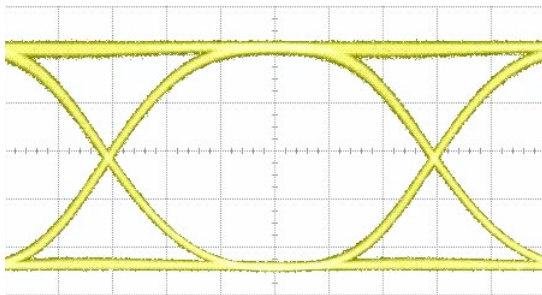
**Receiver Electro-Optical Characteristics**

Parameter	Symbol	LTD1505			Units	Notes
		Min	Typ	Max		
Package Type		SFP				
Signaling Rate		622			Mb/s	±100 ppm
Receiver Type		PIN / TIA				
Receiver Optical Sensitivity	P <sub>IN</sub>	-	-	-28	dBm	Average Received Power (Note 1)
Receiver Optical Overload	P <sub>IN MAX</sub>	-	-	-8	dBm	
Center Wavelength	λ		1550		nm	
Optical Return Loss	RL	14	-	-	dB	
Rx Upper 3 dB Cutoff Frequency	f <sub>c</sub>	-	-	900	MHz	
Signal Loss - Assert	P <sub>SLA</sub>	-42	-	-30.5	dBm	
Signal Loss - Deassert	P <sub>SLD</sub>	-41.5	-	-30	dBm	
Signal Loss - Hysteresis	P <sub>H</sub>	0.5	2	5	dB	
Data Output Rise / Fall Time	t <sub>r</sub> / t <sub>f</sub>		500	-	ps	20 - 80 %
Rx Differential Load Impedance	Z <sub>LOAD</sub>	-	100	-	Ohms	
Rx Differential Output Voltage	V <sub>OUT</sub>	300	-	1800	mV p-p	LVPECL Rx DATA (Note 2)

Note 1: Average received power where the BER = 10<sup>-10</sup>, measured with a 2<sup>23</sup>-1 NRZ test pattern

Note 2: Internally AC coupled and terminated

**Eye Diagram**



**Transmitter Test Conditions**

- Optical Output Power = **-2 dBm**
- Test Pattern = 2<sup>23</sup>-1 NRZ PRBS

**Receiver Test Conditions**

- Optical Input Power = **-17 dBm**
- Test Pattern = 2<sup>23</sup>-1 NRZ PRBS



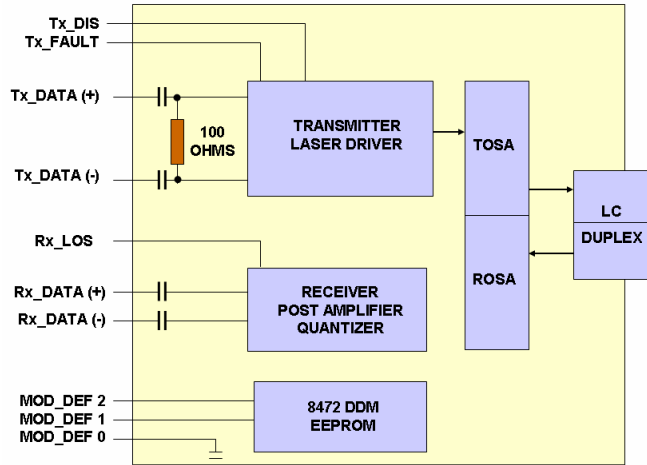
### Transceiver Block Diagram

#### Transmitter Section

The transmitter section consists of a high reliability 1550nm DFB laser diode (LD) with back facet monitor photo detector (PD) in an eye safe optical sub-assembly (TOSA), which is mated to the Tx port of the fiber optic LC duplex receptacle. A driver IC converts LVPECL differential input data signals into an analog current source that drives the LD. The transmitter is provided with the Tx\_Disable and Tx\_FAULT control and monitoring functions. SFF-8472 Rev 9.3 MSA digital diagnostics are enabled via the 2-wire I<sup>2</sup>C data bus.

#### Receiver Section

The receiver section consists of a high-speed InGaAs PIN photo-diode and transimpedance preamplifier mounted in an optical subassembly (ROSA), which is mated to the Rx port of the fiber optic LC duplex receptacle. The output of the PD drives the post-amplification, quantizing, and optical signal detection circuits. The receiver is equipped with the Rx\_LOS (Loss of Signal) monitoring function.



### Transceiver Monitor and Control Functions

#### Rx Signal Loss (Rx\_LOS) Description

The Rx\_LOS (Loss of Signal) is an open collector LVTTTL monitor port. It switches state based on the received optical input signal level that passes through the photo detector (PD), post amplifier and quantizer. If the received signal is above the Rx threshold, then Rx\_LOS is set LOW indicating normal operation. If the received signal is below the Rx threshold, then Rx\_LOS is set HIGH indicating a possible broken fiber, unplugged connector or low Tx signal from the host. The Rx\_LOS pin requires an external 4.7K to 10 K Ohm pull-up resistor.

#### Tx Disable (Tx\_DIS) Description

The Tx\_DIS (Transmit Disable) is an open collector LVTTTL control port that is controlled by a logic signal on the host (system) printed circuit board. If the system is ready to send data then the Tx\_DIS line is set LOW to enable the laser driver and the laser transmitter. If the system is not ready to send data, then the Tx\_DIS line is set HIGH to disable the transmitter.

#### Tx Fault (Tx\_FAULT) Description

The Tx\_FAULT (Transmit Fault) is an open collector LVTTTL monitor port. It switches states based on the condition of the laser driver and the laser including the end of life condition of the laser. If the parameters of the laser driver and laser are within specifications then the Tx\_FAULT is set LOW indicating normal transceiver operation. If a fault occurs, including excess optical output power then Tx\_FAULT is set HIGH which disables the transmitter. The Tx\_FAULT can be reset to normal operation by toggling Tx\_DIS or switching the power supply. The Tx\_FAULT pin requires an external 4.7K to 10K Ohm pull-up resistor.



#### **SFP MSA and SFF 8472 Rev 9.3 Digital Diagnostics**

This device incorporates digital diagnostic monitoring and control functions that are compliant with the SFF-8472 Rev 9.3 Specifications that provides backward compatibility with the digital diagnostic interface defined by the SFP-MSA. The data entry point A0 (hex) is the entry point for the legacy information including Serial ID and Vendor specific information such as the part number, date code, vendor identification, product serial number, type of transceiver and the transceiver parameters. The data entry point A2 (hex) is the entry point for the advanced diagnostic feature sets outlined in the SFF-8472 Rev 9.3 specification. The device is internally calibrated at the time of manufacture and the parameter sets corresponding to the Alarm and Warning functions are programmed into memory. The SFF-8472 Rev 9.3 digital diagnostic interface enables the system host to discover the transceiver's parametric and data functions via a 2-wire system with one wire providing the clock and timing information and the other wire providing two-way communications with the transceiver. Additional information can be found in the SFF-8472 Rev 9.3 documentation.

#### **A0 (hex) Table - Summary of Parameters in the A0 (hex) Parametric Table**

SFP Optical transceiver with LC Duplex connector

Type of transceiver by application

Encoding - 8B10B

The maximum reach of this transceiver over a specified length of fiber type

Vendor Name - Ligent Photonics

Vendor OUI - None

Vendor Part Number - the Ligent Photonics part number on this data sheet

Vendor Revision - the Ligent revision number

Laser Operating Wavelength - the wavelength specified on this data sheet

Options Supported by this Transceiver (LVTTTL digital interface)

Tx\_DISABLE

Tx\_FAULT

Rx\_LOS

Bit Rate MIN and MAX Limits - the limits determined by the Bit Rate tolerances specified on this data sheet

Vendor Serial Number - the Ligent serial number in ASCII format

Diagnostic Monitoring Type - Internally Calibrated

Enhanced Monitoring Features for Software Control are Enabled in this device

Alarm and Warning Flags are enabled

Software support for monitoring and control of Tx\_DISABLE is enabled

Software support for monitoring and control of Tx\_FAULT is enabled

Software support for monitoring and control of Rx\_LOS is enabled

Software support for monitoring and control of RATE\_SELECT is not supported on this device



#### A2 (hex) 8472 Digital Diagnostic Table - Summary of Parameters in the A2 (hex) Parametric Table

The data in the parameter tables are compared with the data in the measured data tables in order to create a warning or alarm status bit

Parameters stored in memory are the reference data for this device. There are two tables for each parameter (Warning and Alarm):

Case Temperature	High and Low Values for Alarm and Warning
Operating Voltage	High and Low Values for Alarm and Warning
Laser Bias Current	High and Low Values for Alarm and Warning
Tx Optical Output Power	High and Low Values for Alarm and Warning
Rx Optical Input Power	High and Low Values for Alarm and Warning

The following parameters return the value of zero because this device is internally calibrated

- Rx\_PWR(4), Rx\_PWR(3), Rx\_PWR(2), Rx\_PWR(1), Rx\_PWR(0)
- Tx\_I(SLOPE), Tx\_I(OFFSET), Tx\_PWR(SLOPE), Tx\_PWR(OFFSET)
- T(SLOPE), T(OFFSET)
- V(SLOPE, V(OFFSET))

Measured A/D values are stored in two bytes corresponding to the MSB and LSB data

Case Temperature	Signed integer, LSB equal to 1/256C
Operating Voltage	Unsigned integer, LSB equal to 100 $\mu$ Volt
Laser Bias Current	Unsigned integer, LSB equal to 2 $\mu$ A
Tx Optical Output Power	Unsigned integer, LSB equal to 0.1 $\mu$ W
Rx Optical Input Power	Unsigned integer, LSB equal to 0.1 $\mu$ W

Software status bits for software control of this device

Tx_DISABLE	Set or cleared status bit indicates the state of the Tx_DISABLE control function
Tx_DISABLE	Read/Write bit for software control of Tx_DISABLE
Rx_RATE_SELECT	Not used on this device
Tx_FAULT	Set or cleared status bit indicates the state of the Tx_FAULT monitor function
Rx_LOS	Set or cleared status bit indicates the state of the Rx_LOS control function
Data_Ready_Bar	Bit is set at power up and remains set to indicate data is ready to be read
Data_Ready_Bar	Bits is set low when reading data from the transceiver

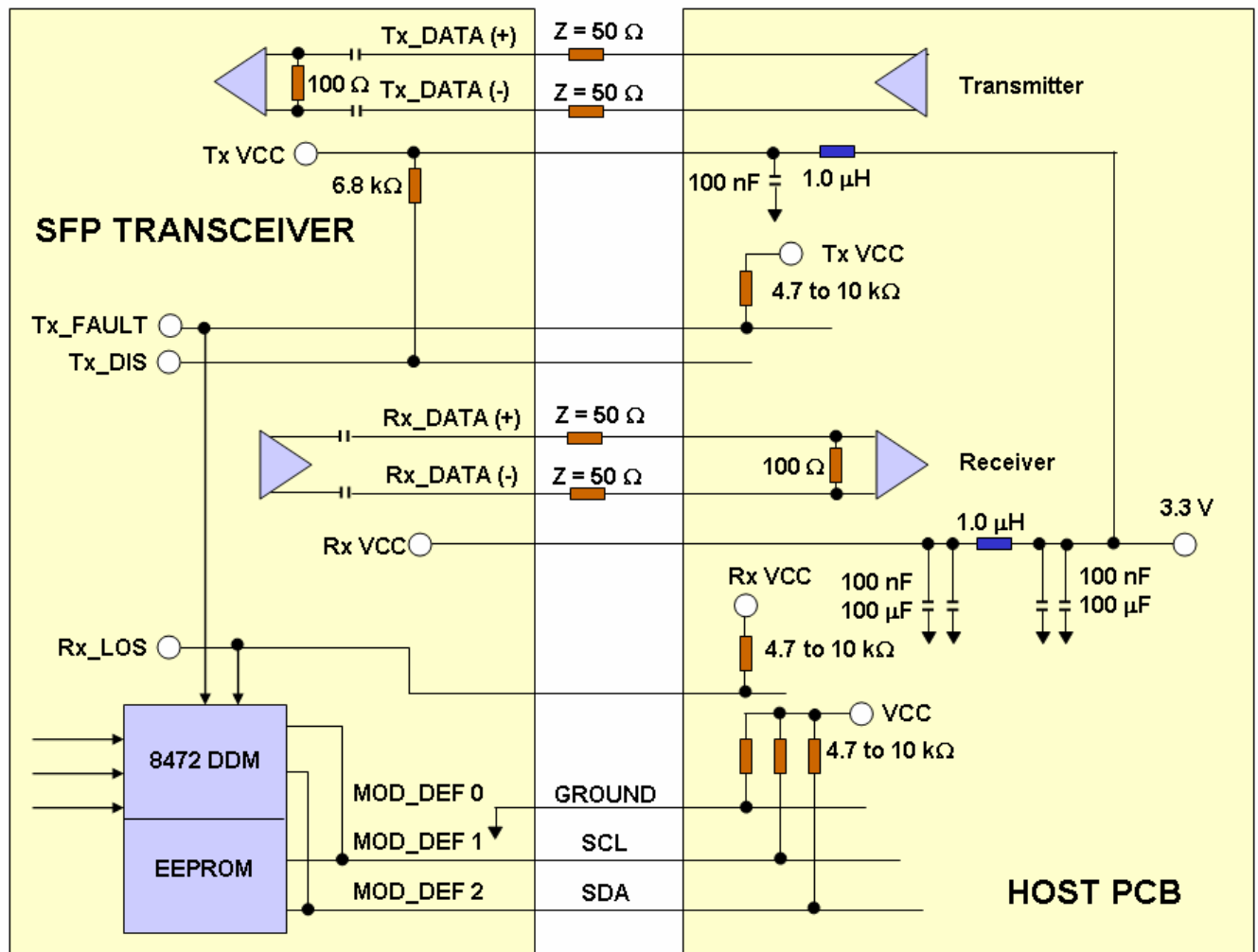
The Warning or Alarm bit is set when the parameter drops below or exceeds the Low or High values stored in memory. The parametric values are such the Warning bit is set before the Alarm bit:

- Case Temperature
- Operating Voltage
- Laser Bias Current
- Tx Optical Output Power
- Rx Optical Input Power



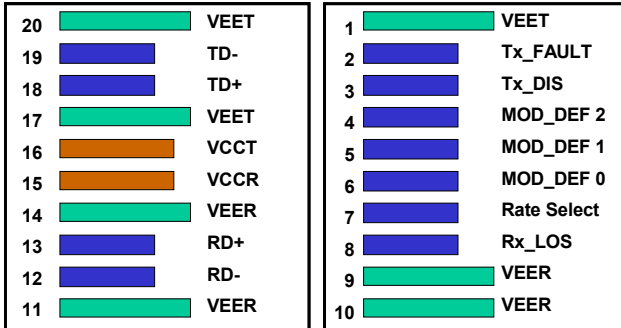
SFF-8472 Rev 9.3 A2 (HEX) Address Table for Alarm and Warning Data														
8472 Parameter	Alarm Threshold Data				Warning Threshold Data				Internally Measured Values		Alarm Bit (Set) Address + Position		Warning Bit (Set) Address + Position	
	High Value		Low Value		High Value		Low Value				High	Low	High	Low
	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	MSB	LSB	High	Low	High	Low
Temperature	00	01	02	03	04	05	06	07	96	97	112(7)	112(6)	116(7)	116(6)
Vcc	08	09	10	11	12	13	14	15	98	99	112(5)	112(4)	116(5)	116(4)
Tx Bias	16	17	18	19	20	21	22	23	100	101	112(3)	112(2)	116(3)	116(2)
Tx Out	24	25	26	27	28	29	30	31	102	103	112(1)	112(0)	116(1)	116(0)
Rx Input	32	33	34	35	36	37	38	39	104	105	113(7)	113(8)	117(7)	117(6)

**Electrical Interface**

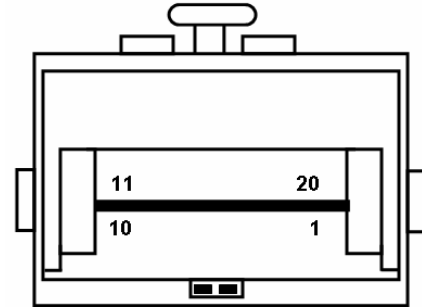




**Pin Assignment**



**Transceiver Electrical Pad Layout**  
Top View Bottom View



**Transceiver Pin Locations**

**SFP Pin Assignment**

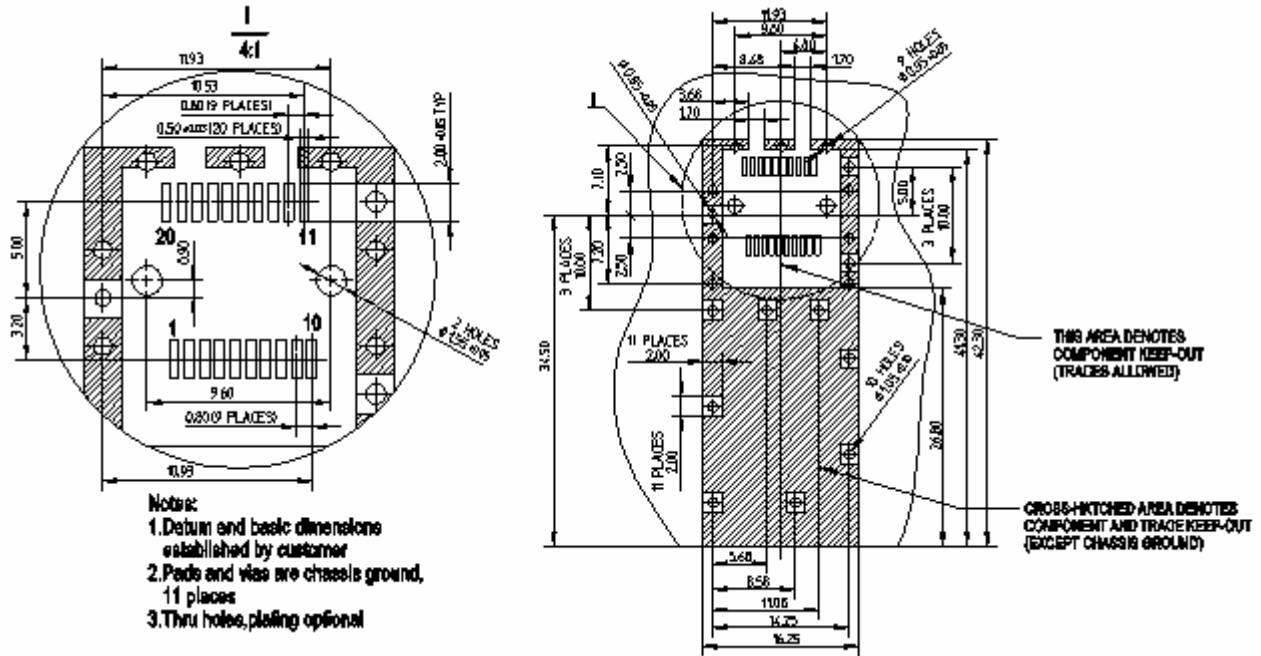
Pin	Symbol	Logic Type	Description	Notes
1	V <sub>EET</sub>	N/A	Transmitter Ground	
2	Tx_FAULT	LVTTTL	Transmitter Fault, LOW = Normal Operation, HIGH = Fault Indication	Note 1
3	Tx_DIS	LVTTTL	Transmit Disable, LOW = Normal Operation, HIGH = Disables Module	Note 1
4	MOD_DEF 2	LVTTTL	Module Definition 2 - Two-Wire Interface - Serial Data	Note 1
5	MOD_DEF 1	LVTTTL	Module Definition 1 - Two-Wire Interface - Clock Signal	Note 1
6	MOD_DEF 0	LVTTTL	Module Definition 0 - Two-Wire Interface Digital Ground	
7	Rate Select	N/A	Not Connected	
8	Rx_LOS	LVTTTL	Receiver Loss of Signal, LOW = Normal Operation, HIGH = Loss of Signal	Note 1
9	V <sub>EER</sub>	N/A	Receiver Ground	
10	V <sub>EER</sub>	N/A	Receiver Ground	
11	V <sub>EER</sub>	N/A	Receiver Ground	
12	RD-	LVPECL	Rx_Data Output (Inverted)	Note 2
13	RD+	LCPECL	Rx_Data Output (Non Inverted)	Note 2
14	V <sub>EER</sub>	N/A	Receiver Ground	
15	V <sub>CCR</sub>	N/A	Receiver DC Power	3.3 V +/- 5%
16	V <sub>CCT</sub>	N/A	Transmitter DC Power	3.3 V +/- 5%
17	V <sub>EET</sub>	N/A	Transmitter Ground	
18	TD+	LVPECL	Tx_Data Input (Non Inverted)	Note 3
19	TD-	LVPECL	Tx_Data Input (Inverted)	Note 3
20	V <sub>EET</sub>	N/A	Transmitter Ground	

**Notes**

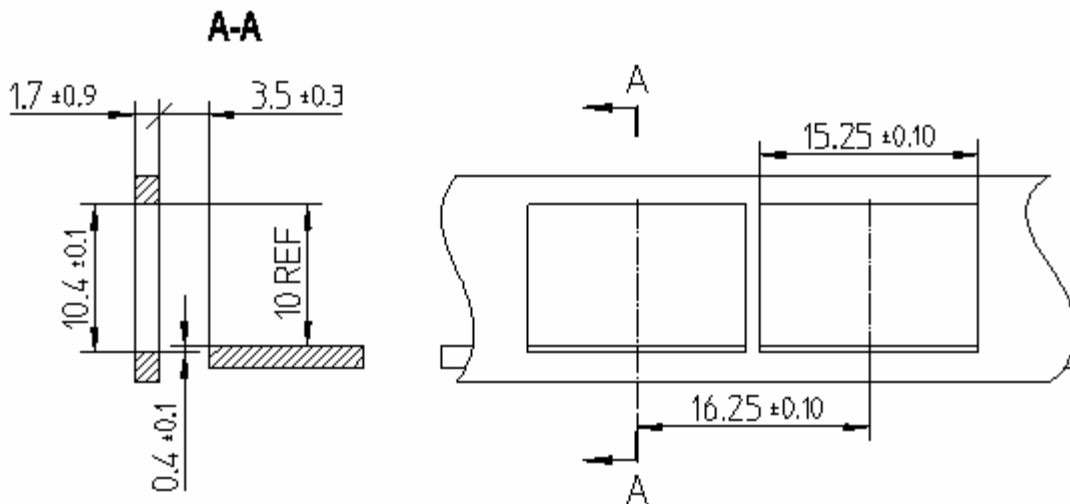
1	The uncommitted Tx_Fault, Rx_LOS, MOD_DEF 1 and MOD_DEF 2 LVTTTL monitor and control pins each require a pull up resistor of 4.7K to 10K Ohms.
2	The 100 Ohm differential Rx Data output is internally AC coupled and must be terminated with 100 Ohms at the differential user interface.
3	The 100 Ohm differential Tx Data input is internally AC coupled and terminated.



**Recommended PCB Layout**



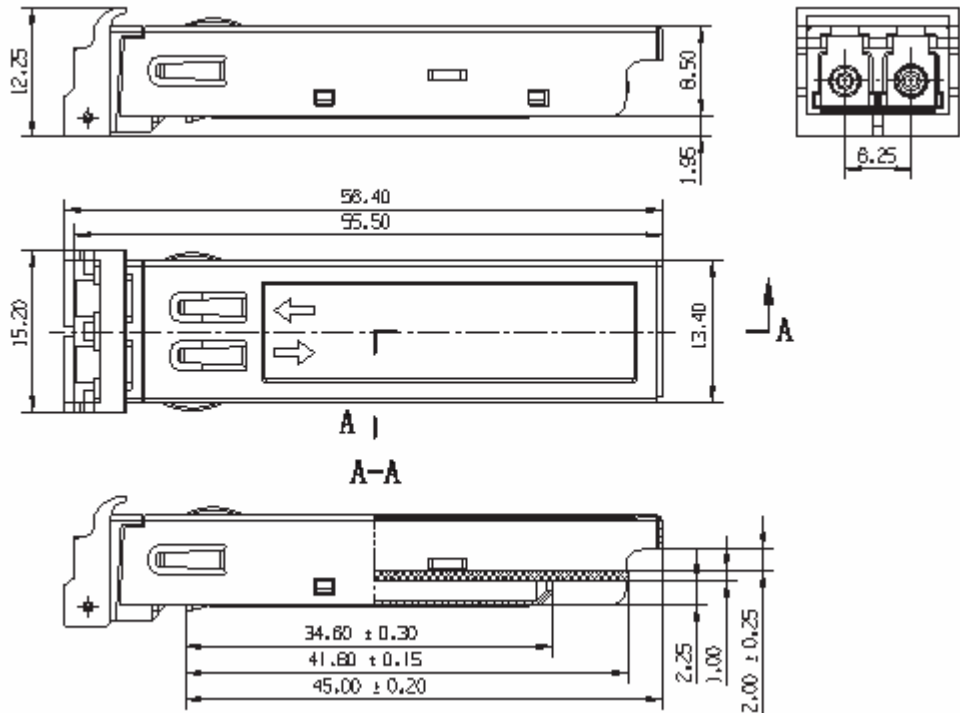
**Recommended Front Panel Layout Opening for LC**



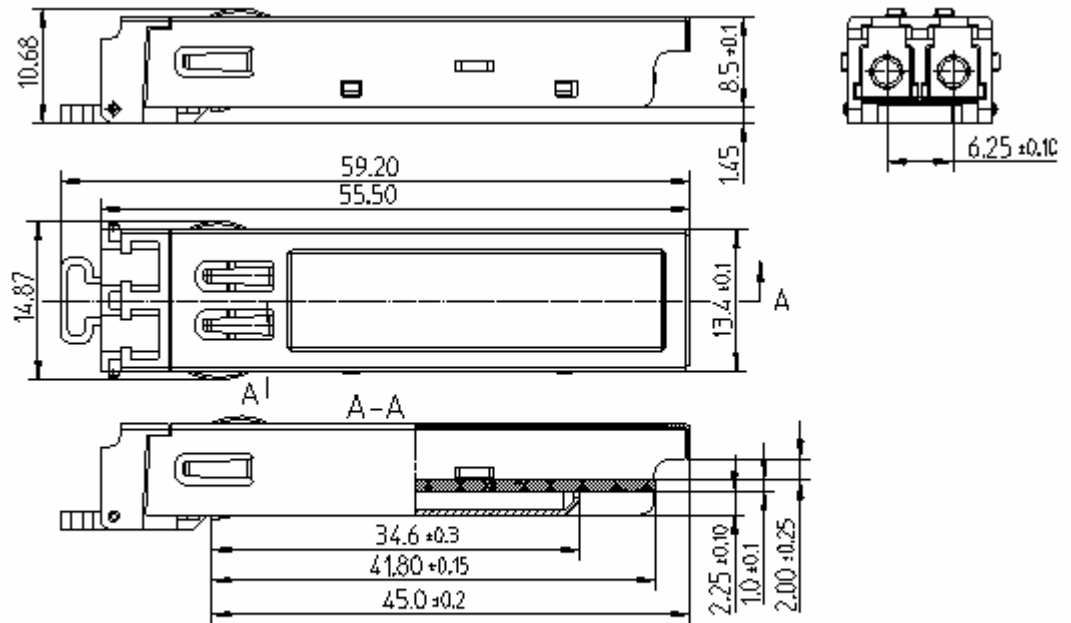


#### Mechanical Dimensions

##### Bail Latch



##### Pull Latch



Dimensions are in millimeters  
 Dimension tolerance is ± 0.1mm unless otherwise specified



### Regulatory Information

#### Eye Safety

The transceiver is a Class 1 eye-safe device according to FDA 21CFR1040.10 and IEC 60825-2.

#### Electromagnetic Interference (EMI), Immunity and Product Safety

The transceiver is ESD safe (electrical pins) when tested according to MIL-STD-883, Method 3015.7 and ESD safe (optical connector) when tested according to IEC 61000-4-2. The device is immune to strong RF fields when tested in accordance with IEC 61000-4-3. The device complies with (US) FCC, Part 15, Subpart J; (Europe) CENELEC EN 55022; (Canada) Class B (CISPR22A); and (Japan) VCCI Class 1. The device has been designed to conform to product safety requirements including UL1950, CSA 22.2, and IEC 60950-1, and has been designed to meet the flammability requirements of UL94.

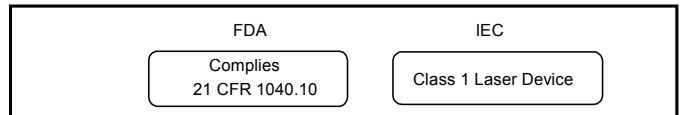
#### Notice

The factory has made all adjustments to this device prior to shipment. No adjustments or modifications to the device are required or permitted. Any adjustment, modification or tampering of the device voids the product warranty. The US Food and Drug Administration may consider that any adjustment or modification to this device is an act of manufacturing and therefore will require that the device be recertified in accordance with 21 CFR 1040.10 Subpart j.

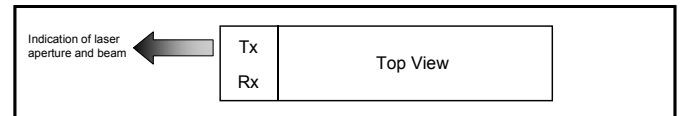
#### Laser Radiation Information

Wavelength	1550 nm
FDA Total Pout: 7 mm aperture at 20 cm distance	< 790 microwatts
IEC Total Pout : 7 mm aperture at 10 cm distance	< 10,000 microwatts
Beam Divergence	17.25°

#### Required Label



#### Laser Emission



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