



LTD1533 Gigabit Ethernet Optical Transceiver

2x10 SFP 40 km 1550 nm DFB / PIN

The LTD1533 SFP Gigabit Ethernet LC duplex transceiver is intended for 40 km reach service in 1250 Mb/s 1550 nm single mode high-speed LAN and SAN data communications equipment where low-cost, extraordinary performance and reliability are essential. It meets the requirements of IEEE802.3z 1000 BASE-LX, consumes low power, operates from a 3.3 volt DC power supply. 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 assembly 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 and the SFF-8472 Rev 9.3 compliant digital diagnostic monitor feature which is accessed via the I²C 2-wire serial ID interface. 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

- 1250 Mb/s Gigabit Ethernet data links
- Channel extenders
- Bus extenders
- High speed I/O file servers
- Data storage networks
 - LAN
 - SAN
 - RSAN
- Host adapters
- Switch-to-switch interfaces
- Mass storage system interconnects
- Hub interconnects
- Router interconnects
- Distributed multi processing
- Telecom switches

FEATURES

- LC Duplex optical interface
- 40 km reach
- 1250 Mb/s data rate
- +3.3 V power supply
- Low DC power consumption
- 2x10 SFP MSA compliant package
- Bail or pull latch option
- Hot swappable
- High performance 1550 nm DFB laser
- High sensitivity PIN/TIA optical receiver:
- Single Mode operation
- BER < 1X10⁻¹² (2⁷ - 1 NRZ PRBS)
- IEEE 802.3z 1000 BASE-LX compliant
- Operating temperature ranges:
 - Commercial: 0 to 70°C
 - Extended: -10 to 80°C
 - Industrial: -40 to 85°C

ELECTRICAL INTERFACE

- LVPECL Tx Data differential input
AC-coupled and terminated
100 Ohms differential (line to line)
50 Ohms single ended (line to ground)
- LVPECL Rx Data Differential Output
AC-coupled
100 Ohms differential (line to line)
50 Ohms single ended (line to ground)
- LVTTTL Tx Disable logic input
- LVTTTL Tx Fault logic output
- LVTTTL Rx Loss of Signal logic output
- LVTTTL 8472 digital diagnostics

ORDERING INFORMATION

Part Number	Latch Option (X)		Temperature Option (Y)	
	LTD1533 XY	B	Bail	C
P		Pull	E	-10 to 80°C
			H	-40 to 85°C



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

Parameter	Symbol	Minimum	Maximum	Units
Storage Temperature	T _{stg}	-40	+85	°C
Relative Humidity - Storage	RH _s	0	95	%
Relative Humidity - Operating	RH _o	0	85	%
DC Supply Voltage	V _{CC}	0	3.6	V
Soldering Temperature	T _{slid}	0	260	°C
Soldering Time Duration	t _{slid}	0	10	seconds
Tx DATA DC Input Voltage	V _{in}	0	V _{CC} + 0.5	V

Optical and Electrical Signal Absolute Maximum Ratings

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

Logic State Absolute Maximum Ratings

Tx_DISABLE Logic HIGH State	Tx_DIS	-	V _{CC} +0.5	V
Tx_FAULT Logic HIGH State	Tx_FAULT	-	V _{CC} +0.5	V
Rx_LOS Logic HIGH State	Rx_LOS	-	V _{CC} +0.5	V
8472 MOD-DEF2	MOD_DEF2	-	V _{CC} +0.5	V

Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units	Notes
Ambient Operating Temperature	T _{amb}	0	25	+70	°C	Temperature Range = C
		-10	25	+80	°C	Temperature Range = E
		-40	25	+85	°C	Temperature Range = H
DC Supply Voltage	V _{CC}	3.14	3.30	3.46	Volts	
Module Supply Current	I _{IN}	-	150	200	mA	
Power Dissipation	P _D	-	500	700	mW	



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Transmitter Logic						
Parameter	Function	Logic State	Logic Type	Min	Max	Units
Tx_DIS and Tx_FAULT	DISABLE	HIGH	LVTTL	2.4	V _{CC} +0.3	V
Tx_DIS and Tx_FAULT	ENABLE	LOW	LVTTL	0	0.8	V
Tx_DIS	Assert Time	-	LVTTL	-	10	µs
Receiver Logic						
Parameter	Function	Logic State	Logic Type	Min	Max	Units
Rx_LOS	LOSS OF SIGNAL	HIGH	LVTTL	2.4	V _{CC} +0.3	V
Rx_LOS	NORMAL	LOW	LVTTL	0	0.8	V
I ² 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	LVTTL	2.4	V _{CC} +0.3	V
		LOW	LVTTL	0	0.8	V
MOD_DEF 2	Serial Data	HIGH	LVTTL	2.4	V _{CC} +0.3	V
		LOW	LVTTL	0	0.8	V

Transmitter Electro-Optical Characteristics						
Parameter	Symbol	LTD1533			Units	Notes
		Min	Typ	Max		
Laser Type		1550 nm DFB				
Optical Output Power	P _o	0	-	5.2	dBm	Average Optical Output
Center Wavelength	λ		1550		nm	
Spectral Line Width @ -20dB	Δλ	-	-	1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Extinction Ratio	ER	9	-	-	dB	
Optical Rise and Fall Time	t _r , t _f	-	150	260	ps	20% - 80%
Relative Intensity Noise	RIN	-	-	-120	dB/Hz	
Deterministic Jitter	DJ	-	-	0.2	UI	
Transmitter Generated RMS Jitter	J _{RMS}	-	0.03	-	UI	
Output Eye		IEEE 802.3z 1000 BASE-LX compliant				
Tx Differential Input Impedance	Z _{in}	-	100	-	Ohms	
Tx Differential Input Voltage	V _{IN}	300	-	2400	mV p-p	LVPECL Tx DATA (Note 1)
Note 1: Internally AC coupled and terminated						



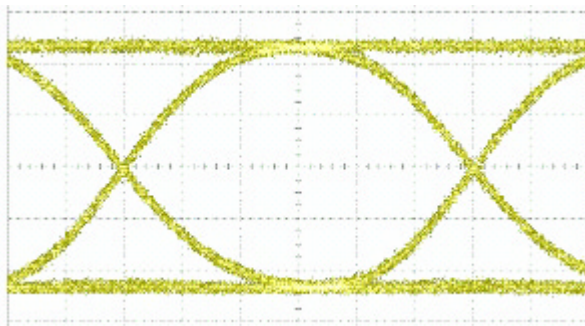
Receiver Electro-Optical Characteristics

Parameter	Symbol	LTD1533			Units	Notes
		Min	Typ	Max		
Receiver Type		PIN / TIA				
Receiver Optical Sensitivity	P_{IN}	-	-	-24	dBm	Average Received Power (Note 1)
Receiver Optical Overload	$P_{IN MAX}$	-	-	-3	dBm	
Center Wavelength	λ		1550		nm	
Optical Return Loss	RL	12	-	-	dB	
Rx Upper 3 dB Cut off Frequency	f_c	-	-	1500	MHz	
Signal Loss - Assert	P_{SLA}	-36	-	-24.5	dBm	
Signal Loss - Deassert	P_{SLD}	-35.5	-	-24	dBm	
Signal Loss - Hysteresis	P_H	0.5	2	5	dB	
Data Output Rise / Fall Time	t_r / t_f		150	-	ps	20 - 80 %
Rx Differential Load Impedance	Z_{LOAD}	-	100	-	Ohms	
Rx Differential Output Voltage	V_{OUT}	400	-	1200	mV p-p	LVPECL Rx DATA (Note 2)

Note 1: Average received power where the BER = 10^{-12} , measured with a 2^7-1 NRZ test pattern

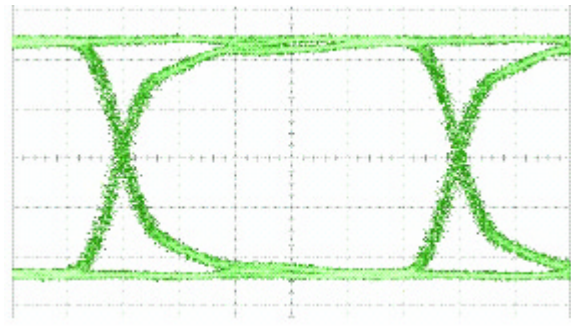
Note 2: Internally AC coupled and terminated

EYE DIAGRAM



Transmitter Test Conditions

- Optical Output Power = **-2 dBm**
- Test Pattern = 2^7-1 NRZ PRBS



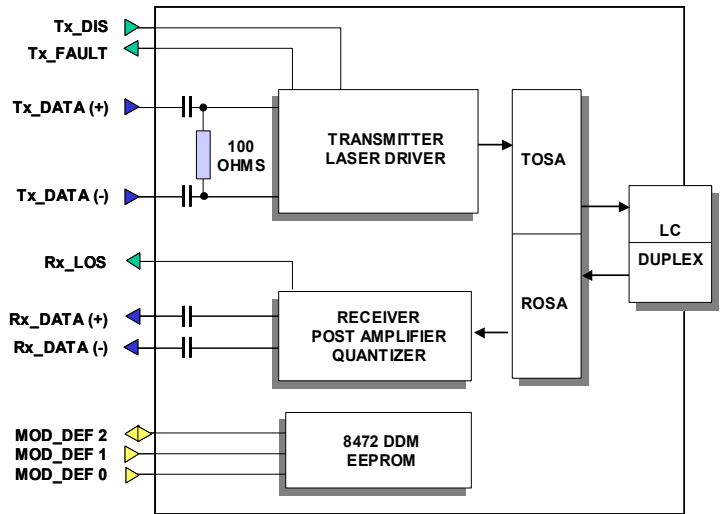
Receiver Test Conditions

- Optical Input Power = **-17 dBm**
- Test Pattern = 2^7-1 NRZ PRBS

TRANSCEIVER BLOCK DIAGRAM

Transmitter Section

The transmitter section consists of a high reliability 1550 nm 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 I²C data bus.



Receiver Section

The receiver section consists of a high-speed PIN/TIA photodiode 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.

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.

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 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 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 REVISION 9.3 DIGITAL DIAGNOSTICS

This device incorporates the SFF-8472 Revision 9.3 digital diagnostic monitoring and control functions, which provide backward compatibility with the SFP-MSA digital diagnostic interface.

This device incorporates two 128-bytes data tables:

1. Table A0 (HEX) contains 128-bytes of information relating to the type of device as shown in the table below. The data is programmed into memory at the time the device is manufactured and is normally WRITE PROTECTED.
2. Table A2 (HEX) contains 128-bytes of real-time dynamic data from the internal calibration of the device, which includes the module temperature, the transmit output power, the receiver input power, the module DC operating current and the DC oper-

ating voltage. At the time the device is manufactured upper and lower WARNING and ALARM limits are stored in the EEPROM and WRITE PROTECTED. During operation, the stored values are compared with the real time data generated by the transceiver and a FLAG is SET if the WARNING or ALARM values are exceeded.

The SFF-8472 Revision 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.

Code Table for 8472 Digital Diagnostics - Page A0 HEX

Data Address	No of Bytes	Name of Field	Field Description
0	1	ID Field	SFP transceiver
1	1	Extended ID Field	SFP function is defined by serial ID only
2	1	Connector ID Field	LC optical connector
6	1	Transceiver ID Field	1000BASE-LX
11	1	Transceiver Encoding	8B/10B
12	1	Nominal Bit Rate	1300 Mb/s
14	1	Link Length	40 km
15	1	Link Length > 25.4 km	GBIC compatibility requirement
20 to 35	16	Vendor Name	Ligent Photonics
37 to 39	3	Vendor IEEE ID	TBD
40 to 55	16	Ligent Part Number	LTD1533
56 to 59	4	Ligent Rev Number	1.0
60 to 61	2	Wavelength	1550 nm
65	1	SFP Codes	Rx LOS, Tx DIS, Tx FAULT
66, 67	1	Bit Rate Max Tolerance	20 percent
68 to 83	16	Ligent Serial Number	Loaded at time of manufacture
84 to 91	8	Ligent Date Code	Loaded at time of manufacture
92	1	Type of Diagnostics	Average Power, Internal Calibration, DDM
93	1	Enhanced Options	Alarm / Warning Flags, Soft Fault, LOS
94	1	8472 Compatibility	Compatible with 8472 Rev 9.3



PAGE A2 (HEX) SFF 8472 REVISION 9.3 DIGITAL DIAGNOSTICS

Page A2 (HEX) contains the ALARM, WARNING and ACTUAL data for 5 different transceiver parameters. The information is stored in the "two's-complement" format with the MSB occupying the lower byte and the LSB occupying the higher byte as shown in the table below. For each of the 5 parameters there are 10 memory locations:

1. High ALARM Value
2. Low ALARM Value
3. High WARNING Value
4. Low WARNING Values
5. Real Time Data

When an ALARM or WARNING value is reached, a FLAG is set that can be read by the I²C serial interface. The FLAG is a single bit in a specific 8-bit memory location. It is possible to have several ALARM and WARNING FLAGS set within a single 8-bit byte. In the table below, bytes 112, 113, 116 and 117 are the FLAG memory locations and the number in the parenthesis is the bit location with the 8-bit byte.

SFF-8472 Rev 9.3 A2 (HEX) Address Table for Alarm and Warning Data

8472 Parameter	Alarm Threshold Data				Warning Threshold Data				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)

REGULATORY INFORMATION

Eye Safety

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

ments including UL1950, CSA 22.2, and IEC 60950-1, and has been designed to meets the flammability requirements of UL94.

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 610004-3. 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 require-

Notice

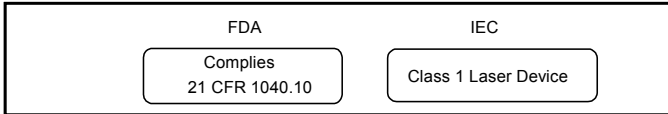
The factory has made all adjustments to this device prior to shipment. No adjustments or modifications to the device are required or permitted. Any adjustment, modification or tampering of the device voids the product warranty. The US Food and Drug Administration may consider that any adjustment or modification 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.



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Required Label

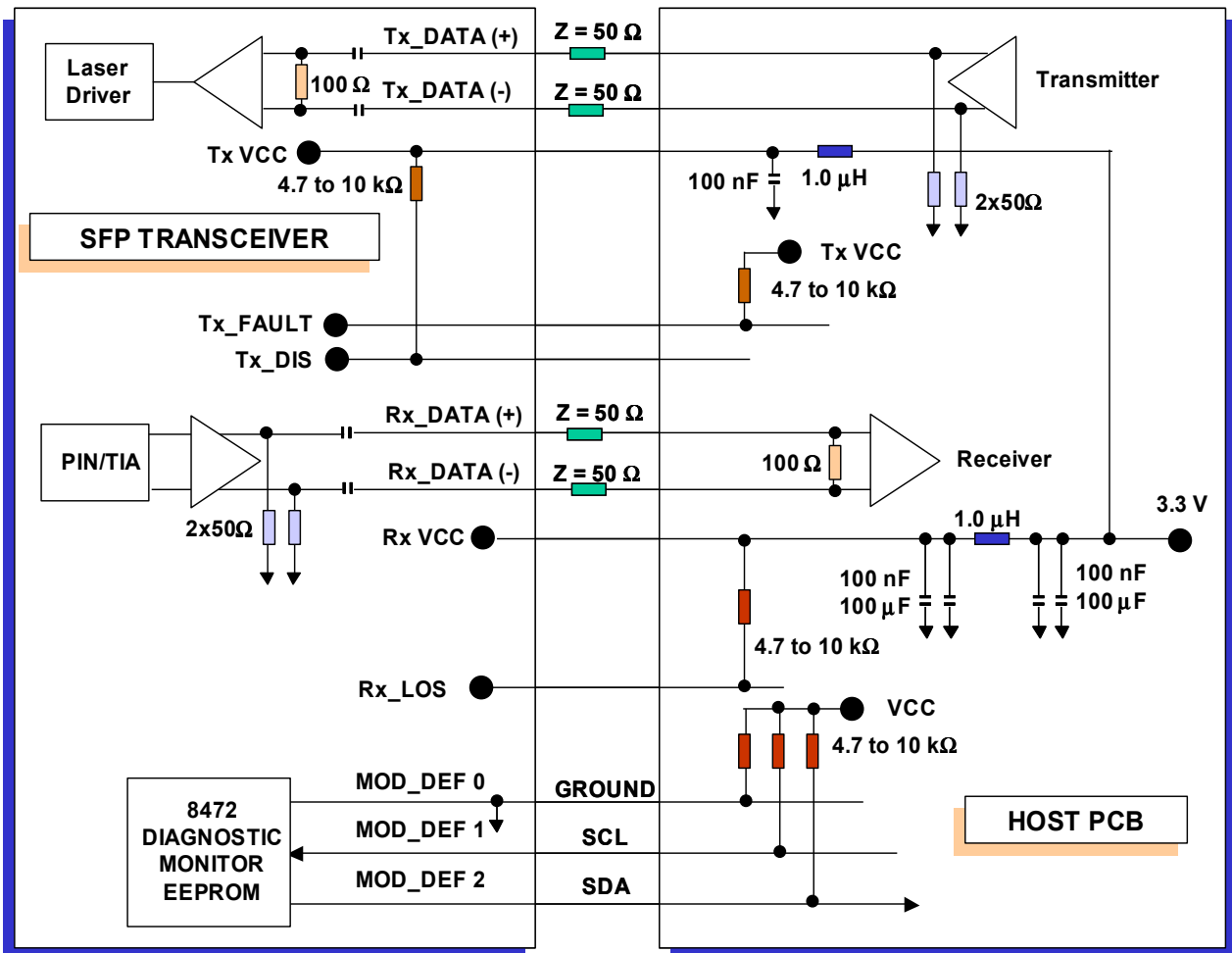


Laser Emission



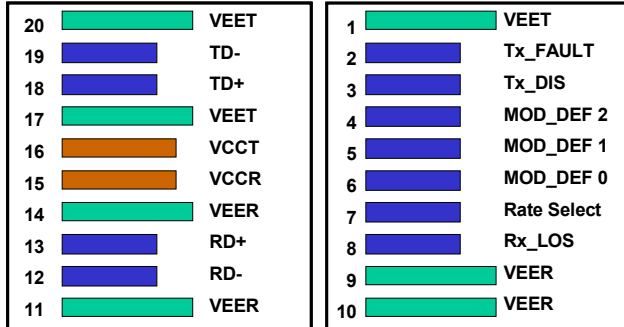
Laser Radiation Information	
Wavelength	1550 nm
FDA Total Pout: 7 mm aperture at 20 cm distance	< 790 microwatts
IEC Total Pout : 7 mm aperture at 10 cm distance	< 10,000 microwatts
Beam Divergence	17.25°

SFP MSA RECOMMENDED ELECTRICAL INTERFACE

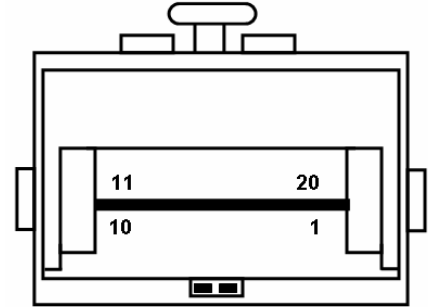




PIN



Transceiver Electrical Pad Layout
Top View Bottom View



Transceiver Pin Locations

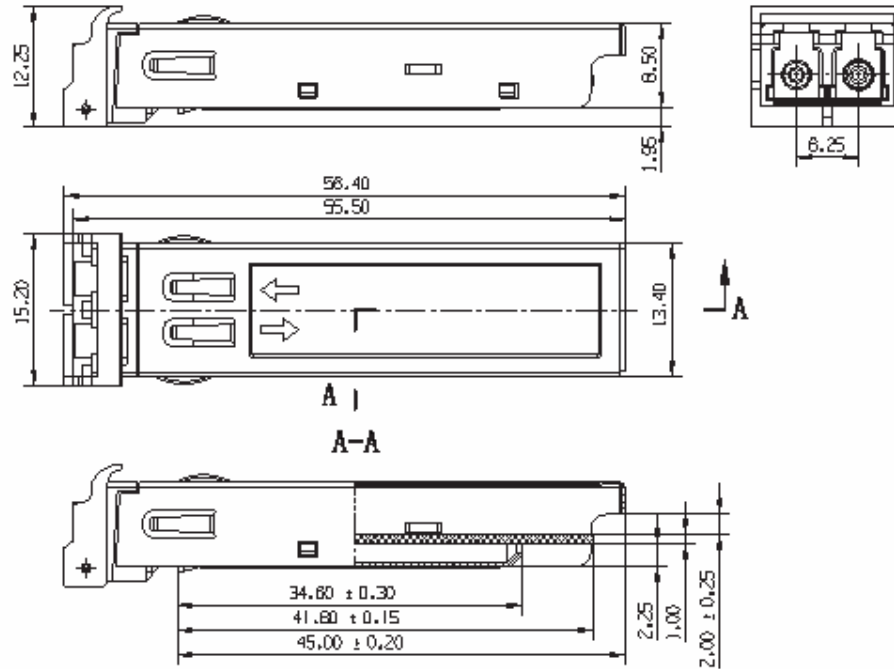
SFP Pin Assignment

Pin	Symbol	Logic Type	Description	Notes
1	V _{EET}	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 _{EER}	N/A	Receiver Ground	
10	V _{EER}	N/A	Receiver Ground	
11	V _{EER}	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 _{EER}	N/A	Receiver Ground	
15	V _{CCT}	N/A	Receiver DC Power	3.3 V +/- 5%
16	V _{CCT}	N/A	Transmitter DC Power	3.3 V +/- 5%
17	V _{EET}	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 _{EET}	N/A	Transmitter Ground	

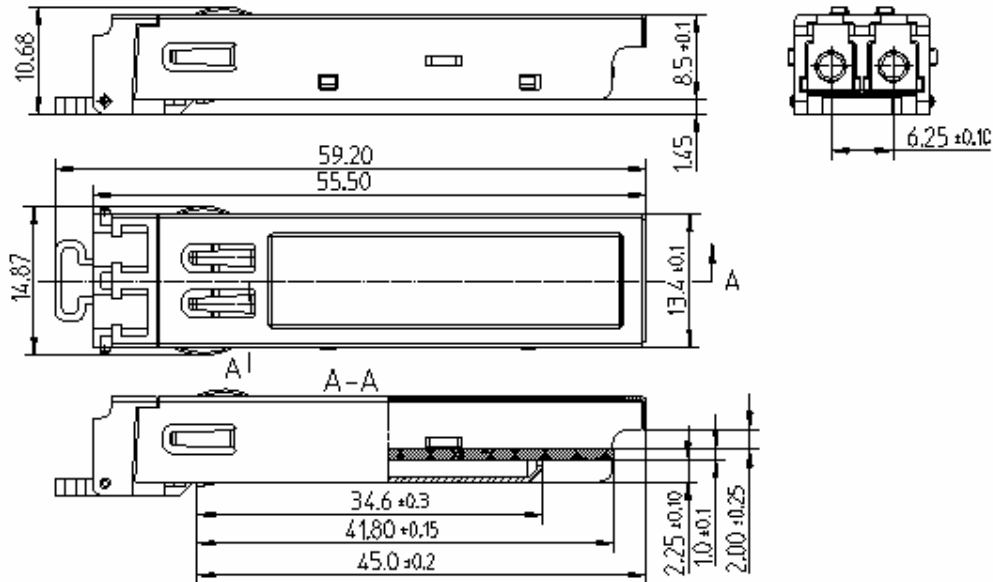
1. The uncommitted Tx_Fault, Rx_LOS, MOD_DEF 1 and MOD_DEF 2 LVTTTL monitor and control pins each require a pull up resistor of 4.7K to 10K Ohms.
2. The 100 Ohm differential Rx Data output is internally AC coupled and must be terminated with 100 Ohms at the differential user interface.
3. The 100 Ohm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



BAIL LATCH SFP MECHANICAL DIMENSIONS



PULL LATCH SFP MECHANICAL DIMENSIONS



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



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