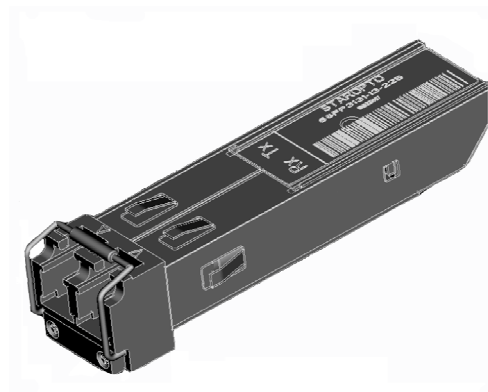


**Product Features**

- Transceiver unit with independent
  - 850nm Oxide VCSEL laser transmitter
  - InGaAs PIN photodiode receiver
- Multi-sourced SFP package style with duplex LC receptacle
- Hot-pluggable
- Metal enclosure for lower EMI
- +3.3V single power supply.
- Content of FC-PI-2 Rev. 7.0<sup>2</sup> protocol transmission
- Extended operating temperature range: 0°C to +70°C
- Compliant ROHS and lead free



**Product Applications**

- Tri-Rate 1.25/2.5/4.25 Gb/s  
Fiber Channel

**Product Descriptions**

The optical transceiver is compliant with the Small Form Factor Pluggable (SFP) transceivers are compatible with the Small Form Factor Pluggable Multi-Sourcing Agreement (MSA)<sup>1</sup>. They are compatible with Fibre Channel FC-PI-2 Rev. 7.0<sup>2</sup>. They are ROHS compliant and lead-free per Directive 2002/95/EC<sup>4</sup>. Digital diagnostics functions are available via the 2-wire serial bus specified in the SFP MSA.

**Transmitter Section**

Transmitter is designed for Multi mode fiber and operates at a nominal wavelength of 850nm. The transmitter module uses a VCSEL laser diode and full IEC825 and CDRH class 1 eye safety. The output power can be disabled via the single TXDIS pin. Logic LVTTTL HIGH level disables the transmitter. It contains APC function, temperature compensation circuit, CML data inputs, LVTTTL TXDIS input and TX fault Output interface, as shown in figure 1.

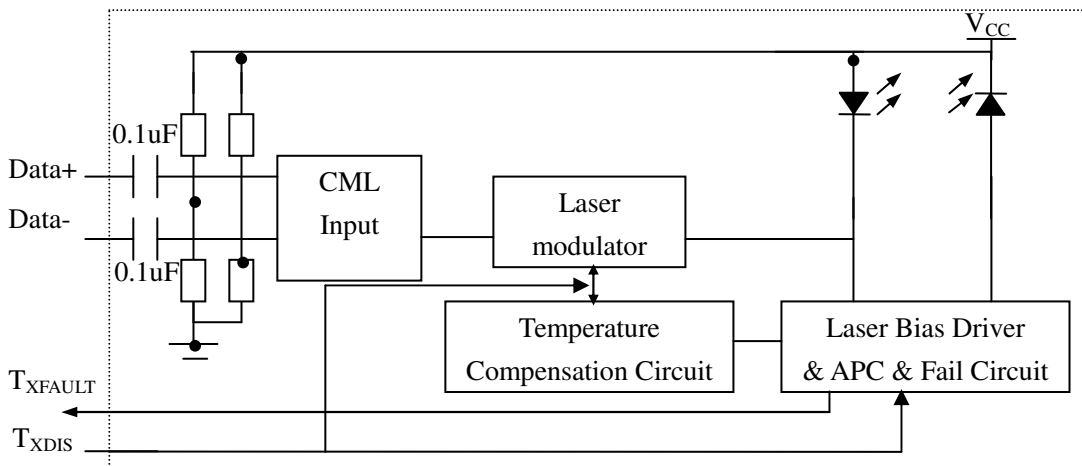


Figure1. Transmitter Block Diagram

### Receiver Section

The receiver section uses a hermetic packaged front end receiver (InGaAs PIN and preamplifier). The post-amplifier is AC coupled to preamplifier through a capacitor and a low pass filter. The capacitor and LPF are enough to pass the signal from 1000Mb/s to 4250Mb/s without significant distortion or performance penalty. The LPF limits the preamplifier bandwidth to improve receiver sensitivity. Figure 2 shows the receiver section which provides CML logic differential outputs and a signal detect output. As the input optical is decreased, Signal Detect will switch from low to high. As the input optical power is increased from very low levels, Signal Detect will switch back from high to low.

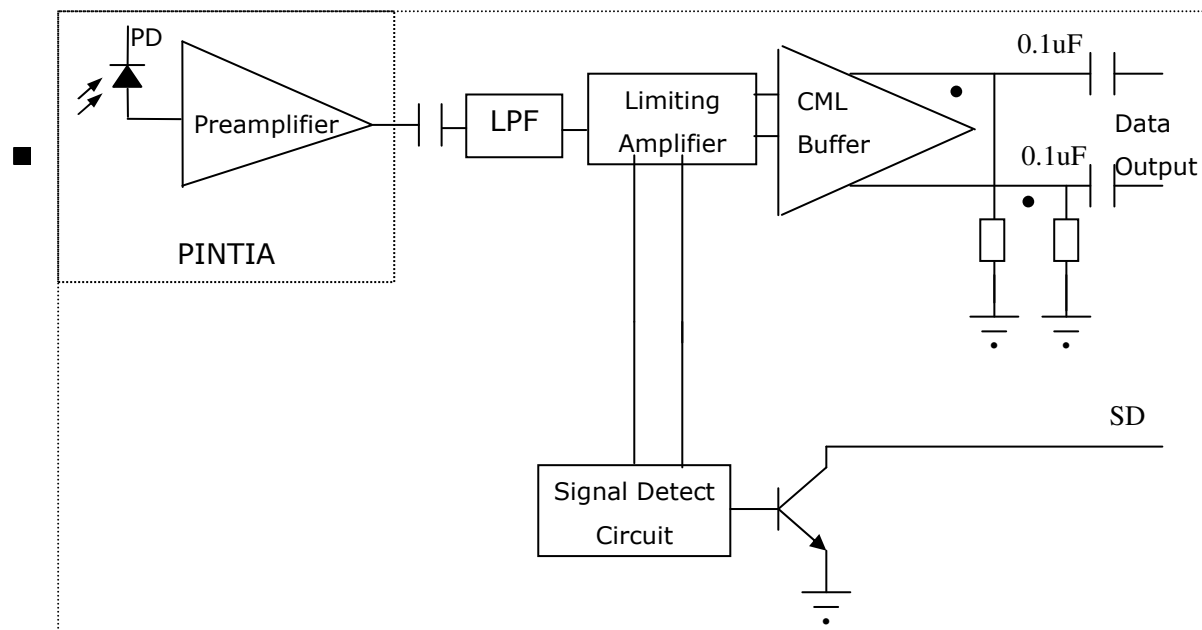


Figure 2. Receiver Block Diagram

### EEPROM Section

The module contains an EEPROM. It provides access to sophisticated identification information that describes the transceiver’s capabilities, standard interfaces, manufacturer, and other information. The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C01A/02/04 family of components. When the serial protocol is activated, the host generates the serial clock signal (SCL, Mod Def 1). The positive edge clocks data into those segments of the EEPROM that are not writing protected within the SFP transceiver. The negative edge clocks data from the SFP transceiver. The serial data signal (SDA, Mod Def 2) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

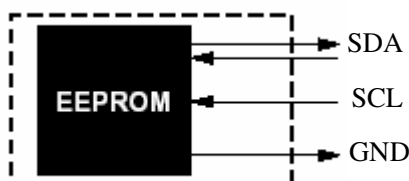


Figure 3. EEPROM Block Diagram

## Performance Specifications

### Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Storage Temperature	TST	-40	+85	°C
Operating Temperature	To	-20	+70	°C
Input Voltage	-	GND	VCC	V
Power Supply Voltage	VCC-VEE	-0.5	+4.0	V

### Operating Environment

Parameter	Symbol	Min	Max	Unit
Power Supply Voltage	VCC	+3.0	+3.6	V
Ambient Operating Temperature	TA	0	+70	°C

### Electrical characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Supply Voltage	Vcc	3.0	3.3	3.6	V	-
Supply Current	Icc	-	110	200	mA	-
<b>Transmitter</b>						
Input differential	Rin	-	100	-	Ω	1
Single ended data input swing	Vin,pp	150	-	1200	mV	2
Transmit Disable Voltage	VD	2	-	Vcc	V	3
Transmit Enable Voltage	VEN	Vee	-	Vee+ 0.8	V	-
<b>Receiver</b>						
Single ended data output	Vout,pp	300	350	550	mV	4
Data output rise time	tr	-	80	120	ps	5
Data output fall time	tf	-	80	120	ps	5
LOS Fault	VLOS	2	-	VccHOST	V	-
LOS Normal	VLOS	Vee	-	Vee+0.8	V	-
Power Supply Rejection	PSR	100	-	-	mVpp	-
Deterministic Jitter Contribution @ 2.5 Gb/s	RX Δ DJ	-	-	51.7	ps	-
Deterministic Jitter Contribution @ 4.25 Gb/s	-	-	-	23.5	ps	-
Total Jitter Contribution @ 2.5 Gb/s	RX Δ TJ	-	-	122	ps	-
Total Jitter Contribution @ 4.25 Gb/s	-	-	-	61	ps	-

#### Notes:

1. Connected directly to TX data input pins. AC coupling from pins into laser driver IC.
2. We recommend <600mV for best EMI performance.
3. Or open circuit.
4. Into 100 ohms differential termination.
5. Unfiltered, 20 – 80 %

### Optical Characteristic

Parameter	Symbol	Min	Typ	Max	Unit	Note
<b>Transmitter</b>						
Output Opt. Pwr: 50 or 62.5 MMF	POUT	-9	-	-3	dBm	-
Optical Wavelength	$\lambda$	830	850	860	nm	-
Spectral Width	$\sigma$	-	0.3	0.65	nm	-
Optical Modulation Amplitude @	OMA	247	-	-	$\mu$ W	-
Optical Modulation Amplitude @	OMA	196	-	-	$\mu$ W	1
Optical Modulation Amplitude @	OMA	156	-	-	$\mu$ W	-
Optical Rise/Fall Time	tr/ tf	-	80	90	ps	-
Relative Intensity Noise	RIN	-	-	-118	dB/Hz	-
Deterministic Jitter Contribution	RX $\Delta$ TJ	-	-	56.5	Ps	2
Deterministic Jitter Contribution	RX $\Delta$ TJ	-	-	28.2	Ps	-
Total Jitter Contribution @ 2.5	RX $\Delta$ TJ	-	-	119	ps	-
Total Jitter Contribution @ 4.25	RX $\Delta$ TJ	-	-	56.5	ps	-
Extinction Ratio @1.25 Gb/s	ER	9	-	-	dB	-
Extinction Ratio @2.5 Gb/s	ER	8.5	-	-	dB	-
Extinction Ratio @4.25 Gb/s	ER	7	-	-	dB	-
<b>Receiver</b>						
Receiver Sensitivity = 1.25 Gb/s	RxSENS	-	-	-20	dBm	-
Receiver Sensitivity = 2.5 Gb/s	RxSENS	-	-	-18	dBm	-
Receiver Sensitivity = 4.25 Gb/s	RxSENS	-	-	-15	dBm	-
Saturation Power	-	0	-	-	dBm	-
Receiver Elec. 3 dB cutoff	-	-	-	1500	MHz	1
Receiver Elec. 3 dB cutoff	-	-	-	2500	MHz	2
Optical Center Wavelength	$\lambda$ C	770	-	860	nm	-
Optical Return Loss	-	12	-	-	dB	-
LOS De-Assert	LOSD	-	-	-19	dBm	-
LOS Assert	LOSA	-30	-	-	dBm	-
LOS Hysteresis	-	0.5	-	-	dB	-

#### Notes:

1. Rate Selectable version in low bandwidth mode.
2. Rate Selectable version in high bandwidth mode.

### General Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Note
Data Rate	BR	-	1.25 2.5 4.25	-	Gb/sec	1
Bit Error Rate	BER	-	-	$10^{-12}$	mA	5
Fiber Length on 50/125 $\mu$ m MMF	L	-	-	550 300 150	m	2 3 4
Fiber Length on 62.5/125 $\mu$ m MMF	L	-	-	300 150 70	m	2 3 4

**Notes:**

1. 1x, 2x,4x Fibre Channel compatible, per FC-P1-2 Rev. 7.0. Rate selectable version is also Gigabit Ethernet compatible per IEEE 802.3.
2. At 1.0625 Gb/s Fibre Channel data rate and, for rate selectable version, at 1.25 Gb/s Gigabit Ethernet data rate.
3. At 2.125 Gb/s Fibre Channel data rate.
4. At 4.25 Gb/s Fibre Channel data rate
5. 4.25Gb/s with PRBS 2<sup>7</sup>-1.

**SFP Module Control and Management****Serial Interface for ID and DDM**

The SFP modules implement the 2-wire serial communication protocol as defined in the SFP MSA. The serial ID information of the SFP modules and Digital Diagnostic Monitor parameters can be accessed through the I<sup>2</sup>C interface at address A0h and A2h. The memory is mapped in Table 1. Detailed ID information(A0h) is listed in Table 2. And the DDM specification(A2h) is described in Table 3. For more details of the memory map and byte definitions, please refer to the SFF-8472 (Rev 9.3, Aug. 2002), "Digital Diagnostic Monitoring Interface for Optical Transceivers".

The DDM parameters have been internally calibrated.

**Table 1. Digital Diagnostic Memory Map (Specific Data Field Descriptions)**

2 wire address 1010000X (A0h)		2 wire address 1010001X (A2h)	
Address	Information	Address	Information
0~95	Serial ID Defined by SFP MSA (96 bytes)	0~55	Alarm and Warning Thresholds (56 bytes)
		56~95	Calibration Constants (40 bytes)
96~127	Vendor Specific (32 bytes)	96~119	Real Time Diagnostic Interface (24 bytes)
		120~127	Vender Specific (8 bytes)
128~255	Reserved,SFF8079 (128 bytes)	128~247	User Writable EEPROM (120 bytes)
		248~255	Vender Specific (8 bytes)

**Table 2 - EEPROM Serial ID Memory Contents (A0h)**

Data Address	Size (Bytes)	Name of Field	Value(Hex)	Description of Field
BASE ID FIELDS				
0	1	Identifier	03	SFP
1	1	Ext. Identifier	04	SFP with serial ID
2	1	Connector	07	LC
3-10	8	Transceiver	00 00 00 01 40 40 08 10	
11	1	Encoding	03	NRZ
12	1	BR, Nominal	2A	
13	1	Reserved	00	
14	1	Length(9μm,km)	00	
15	1	Length (9μm)	00	
16	1	Length (50μm)	00	
17	1	Length (62.5μm)	1E	
18	1	Length (Copper)	00	
19	1	Reserved	00	
20-35	16	Vendor name	53 54 41 52 4F 50 54 4F 20 20 20 20 20 20 20 20	STAROPTO
36	1	Reserved	00	
37-39	3	Vendor OUI	000000	
40-55	16	Vendor PN	xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx	SMFP2391-13-155
56-59	4	Vendor rev	31 2E 30 20	1.0
60-61	2	Wavelength	03 52	850nm
62	1	Reserved	00	
63	1	CC_BASE	XX	Check code for Base ID Fields
EXTENDED ID FIELDS				
64-65	2	Options	001A	Los,Tx_falt, Tx_diabile
66	1	BR, max	00	Upper bit rate margin, units of %
67	1	BR, min	00	Lower bit rate margin, units of %
68-83	16	Vendor SN	xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx	Serial number(ASCII)
84-91	8	Date code	xx xx xx xx xx xx xx xx	Vendor's manufacturing date code (ASCII)
92	1	Diagnostic Monitoring Type	58	Digital diagnostics and internal calibration
93	1	Enhanced Options	F0	Alarm/Warning flags implemented
94	1	SFF-8472 Compliance	01	
95	1	CC_EXT	xx	Check code for the Extended ID Fields

VENDOR SPECIFIC ID FIELDS				
96-127	32	Vendor Specific		Vendor Specific EEPROM
128-255	128	Reserved		Reserved for SFF-8079.

**Note:**

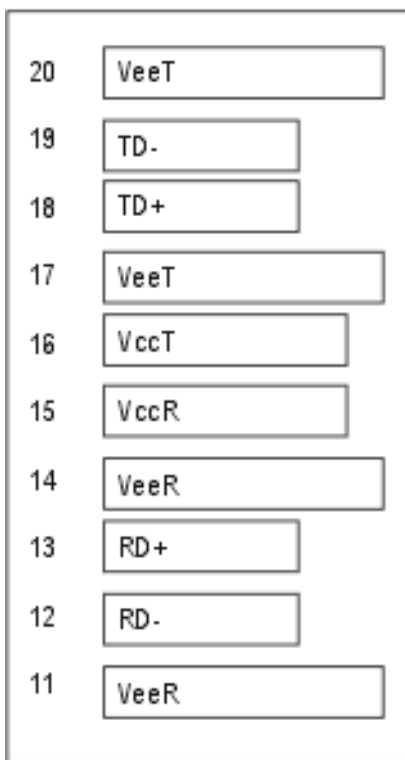
The "xx" byte should be filled in according to practical case. For more information, please refer to the related document of SFF-8472 Rev 9.4.

**Table 3 - DDM Specification**

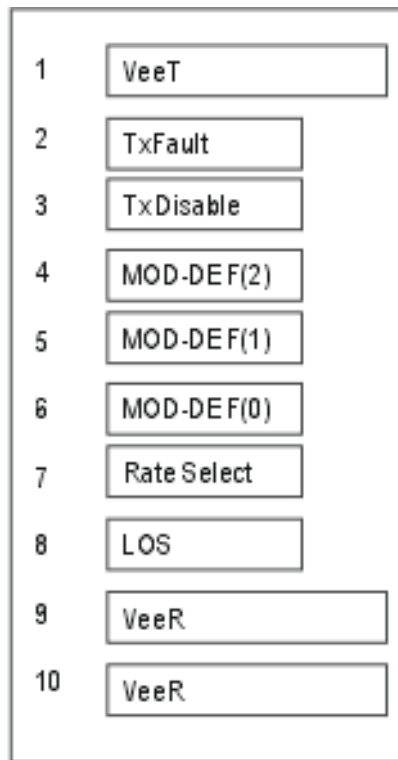
Parameter	Range	Accuracy	Calibration
Temperature	0 ~ +70°C	±3°C	Internal
Voltage	3.0 ~ 3.6V	±3%	Internal
Bias Current	0 ~ 15mA	±10% mA	Internal
TX Power	-9 ~ -3dBm	±2dBm	Internal
RX Power	-20 ~ 0dBm	±3dBm	Internal

**Pin Description**

**Pin Out Diagram**



**Top of Board**



**Bottom of Board (as viewed thru top of board)**

Table 4.Pin Function Definitions

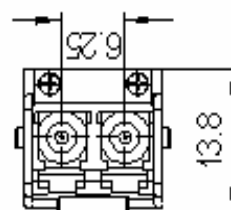
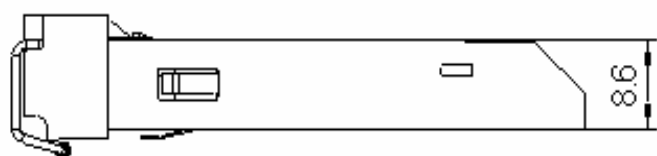
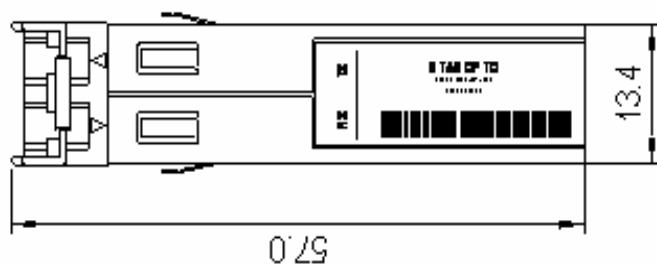
Pin#	Name	Function	Notes
1	VEET	Transmitter Ground	-
2	TX Fault	Transmitter Fault Indication	1
3	TX Disable	Transmitter Disable	2,Module disables on high or open
4	MOD-DEF2	Module Definition 2	3, 2 wire serial ID interface
5	MOD-DEF1	Module Definition 1	3, 2 wire serial ID interface
6	MOD-DEF0	Module Definition 0	3, Grounded in Module
7	Rate Select	No use	-
8	LOS	Loss of Signal	4
9	VEER	Receiver Ground	5
10	VEER	Receiver Ground	5
11	VEER	Receiver Ground	5
12	RD-	Inv. Received Data Out	6
13	RD+	Received Data Out	6
14	VEER	Receiver Ground	5
15	VCCR	Receiver Power	7,3.3V±5%
16	VCCT	Transmitter Power	7,3.3V±5%
17	VEET	Transmitter Ground	5
18	TD+	Transmit Data In	8
19	TD-	Inv. Transmit Data In	8
20	VEET	Transmitter Ground	5

**Note:**

- TX Fault is an open collector/drain output, which should be pulled up with a 4.7K–10KΩ resistor on the host board. Pull up voltage between 2.0V and VccT, R+0.3V. When high, output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
- TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7–10 KΩ resistor. Its states are:
  - Low (0 – 0.8V): Transmitter on
  - (>0.8, < 2.0V): Undefined
  - High (2.0 – 3.465V): Transmitter Disabled
  - Open: Transmitter Disabled
- Mod-Def 0,1,2. These are the module definition pins. They should be pulled up with a 4.7K – 10KΩ resistor on the host board. The pull-up voltage shall be VccT or VccR. Mod-Def 0 is grounded by the module to indicate that the module is present Mod-Def 1 is the clock line of two wire serial interface for serial ID Mod-Def 2 is the data line of two wire serial interface for serial ID

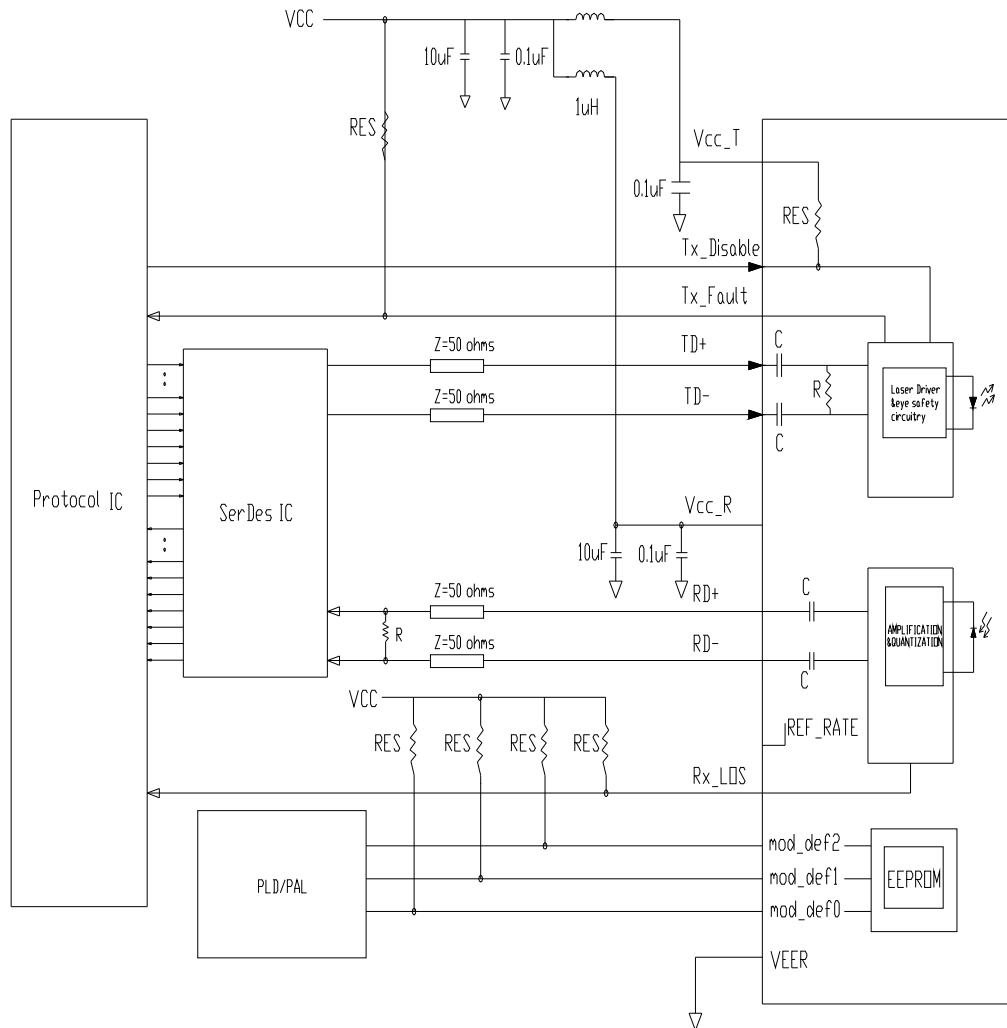
4. LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K – 10KΩ resistor. Pull up voltage between 2.0V and VccT, R+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity(as defined by the standard in use). Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
5. VeeR and VeeT may be internally connected within the SFP module.
6. RD-/+ : These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board.
7. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V ±5% at the SFP connector pin. Maximum supply current is 300mA. Recommended host board power supply filtering is shown below. Inductors with DC resistance of less than 1Ω should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply filtering network is used, hotplugging of the SFP transceiver module will result in an inrush current of no more than 30 mA greater than the steady state value. VccR and VccT may be internally connected within the SFP transceiver module.
8. TD-/+ : These are the differential transmitter inputs. They are AC-coupled, differential lines with 100Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board.

**Package Information**



Unit:mm

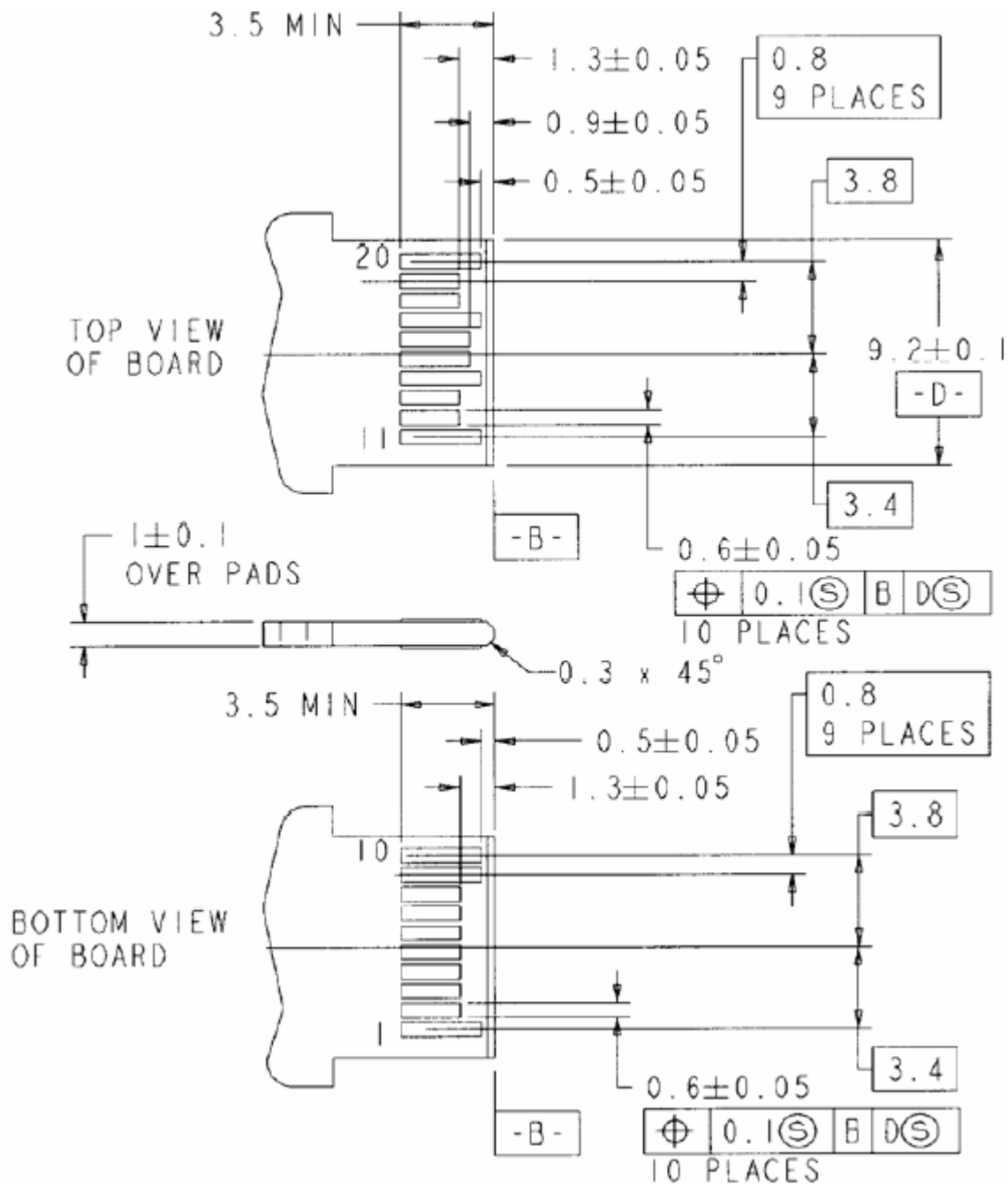
Recommended Circuit



NOTE:  $4.7K\ \text{ohms} < RES < 10K\ \text{ohms}$

Figure 5. Circuit of SFP Transceiver

Recommended Board Layout Hole Pattern



**Obtaining Document**

Please visit our website:

[Http://www.staropto.com](http://www.staropto.com)

**Ordering Information**

**SMFP 2 3 9 1 - 1 3 - 1 5 5**

Wave length (nm)	LD Type	Data Rate (Mb/s)	Package Type	Output power (dBm)	Operation Voltage (V)	Operation Temperature (°C)	Data/ Alarm Interface	Connector
2: 850	3: VCSEL	9: 4250	1: With DDM	1: -9~-3	3: 3.3	1: 0~70	5: Data: CML Alarm: TTL	5: LC/PC