

## EOLS-BI1648-11X 16X 24X Series

Single-Mode for 4X2X1 FC and GBE application  
 SC/LC Single-Fiber SFP Transceiver  
 RoHS6 Compliant

### Features

- ◆ Up to 4.25Gbps Data Links
- ◆ 18-Wavelength CWDM DFB LD Transmitter from 1270nm to 1610nm, with step 20nm
- ◆ Single 3.3V Power supply and TTL Logic Interface
- ◆ Hot-Pluggable SFP Footprint Simplex SC/LC Connector Interface
- ◆ Class 1 FDA and IEC60825-1 Laser Safety Compliant
- ◆ Operating Case Temperature  
 Standard: 0°C~+70°C  
 Extended:-20°C~+85°C
- ◆ Compliant with SFP MSA Specification
- ◆ Compliant with Digital Diagnostic Monitor Interface SFF-8472
- ◆ Compliant with Fiber Channel FC-PI 400/200/100
- ◆ Compliant with IEEE 802.3ah-2004 1000BASE-BX



### Applications

- ◆ Fiber Channel Links
- ◆ WDM Gigabit Ethernet Links
- ◆ Other Optical Links

### Ordering Information

Part No.	Data Rate	Power budget	Interface	Temp.	DDMI
EOLS-BI1648-11X <sup>*(note1)</sup>	4.25Gbps	≥11dB	SC	Standard	NO
EOLS-BI1648-11XI	4.25Gbps	≥11dB	SC	Extended	NO
EOLS-BI1648-11XD	4.25Gbps	≥11dB	SC	Standard	YES
EOLS-BI1648-11XDI	4.25Gbps	≥11dB	SC	Extended	YES
EOLS-BI1648-11XL <sup>*(note1)</sup>	4.25Gbps	≥11dB	LC	Standard	NO
EOLS-BI1648-11XIL	4.25Gbps	≥11dB	LC	Extended	NO
EOLS-BI1648-11XDL	4.25Gbps	≥11dB	LC	Standard	YES
EOLS-BI1648-11XDIL	4.25Gbps	≥11dB	LC	Extended	YES

EOLS-BI1648-16X <sup>*(note1)</sup>	4.25Gbps	≥16dB	SC	Standard	NO
EOLS-BI1648-16XI	4.25Gbps	≥16dB	SC	Extended	NO
EOLS-BI1648-16XD	4.25Gbps	≥16dB	SC	Standard	YES
EOLS-BI1648-16XDI	4.25Gbps	≥16dB	SC	Extended	YES
EOLS-BI1648-16XL <sup>*(note1)</sup>	4.25Gbps	≥16dB	LC	Standard	NO
EOLS-BI1648-16XIL	4.25Gbps	≥16dB	LC	Extended	NO
EOLS-BI1648-16XDL	4.25Gbps	≥16dB	LC	Standard	YES
EOLS-BI1648-16XDIL	4.25Gbps	≥16dB	LC	Extended	YES
EOLS-BI1648-24X <sup>*(note1)</sup>	4.25Gbps	≥24dB	SC	Standard	NO
EOLS-BI1648-24XI	4.25Gbps	≥24dB	SC	Extended	NO
EOLS-BI1648-24XD	4.25Gbps	≥24dB	SC	Standard	YES
EOLS-BI1648-24XDI	4.25Gbps	≥24dB	SC	Extended	YES
EOLS-BI1648-24XL <sup>*(note1)</sup>	4.25Gbps	≥24dB	LC	Standard	NO
EOLS-BI1648-24XIL	4.25Gbps	≥24dB	LC	Extended	NO
EOLS-BI1648-24XDL	4.25Gbps	≥24dB	LC	Standard	YES
EOLS-BI1648-24XDIL	4.25Gbps	≥24dB	LC	Extended	YES

Note1: Standard version, X refer to CWDM Wavelength range 1270nm to 1610nm, A=1270, B=1290...Q=1590, R=1610. TX and RX wavelength spacing must ≥60nm. Typical transmitter and receiver wavelength combinations are L/O, M/Q, M/P and etc.

## CWDM\* Wavelength

Band	Nomenclature	Wavelength(nm)		
		Min.	Typ.	Max.
O-band Original	A	1264	1270	1277.5
	B	1294	1290	1297.5
	C	1304	1310	1317.5
	D	1324	1330	1337.5
	E	1344	1350	1357.5
E-band Extended	F	1364	1370	1377.5
	G	1384	1390	1397.5
	H	1404	1410	1417.5
	I	1424	1430	1437.5
	J	1444	1450	1457.5
S-band Short Wavelength	K	1464	1470	1477.5
	L	1484	1490	1497.5
	M	1504	1510	1517.5
	N	1524	1530	1537.5
C-band Conventional	O	1544	1550	1557.5
L-band Long Wavelength	P	1564	1570	1577.5
	Q	1584	1590	1597.5
	R	1604	1610	1617.5

CWDM\*: 18 Wavelengths from 1270nm to 1610nm, each step 20nm.

## Regulatory Compliance

Product Certificate	Certificate Number	Applicable Standard
TUV	R50135086	EN 60950-1:2006+A11+A1+A12
		EN 60825-1:2007
		EN 60825-2:2004+A1+A2
UL	E317337	UL 60950-1
		CSA C22.2 No. 60950-1-07
EMC CE	AE 50135430 0001	EN 55022:2006
		EN 55024:1998+A1+A2
CB	JPTUV-024038-M1	IEC 60825-2
		IEC 60950-1
FCC	WTF13F0503735E	47 CFR PART 15 OCT., 2010
	WTF13F0503732E	47 CFR PART 15 OCT., 2010
FDA	1230816-000	CDRH 1040.10
ROHS	RLSZF00163462	2011/65/EU

## Product Description

The EOLS-BI1X48-X series is small form factor pluggable module for Gigabit Ethernet 1000BASE-BX and Fiber Channel single fiber applications. It is with the SFP 20-pin connector to allow hot plug capability.

The transmitter section uses a distributed feedback laser and is a class 1 laser compliant according to International Safety Standard IEC 60825. The receiver section uses an integrated B type / A type detector preamplifier (IDP) mounted in an optical header and a limiting post-amplifier IC.

The EOLS-BI1X48-X-D series are designed to be compliant with SFF-8472 MSA.

## Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Storage Temperature	T <sub>s</sub>	-40	+85	°C
Supply Voltage	V <sub>cc</sub>	0.5	3.6	V
Operating Relative Humidity		-	95	%

\*Exceeding any one of these values may destroy the device immediately.

## Recommended Operating Conditions

Parameter	Symbol	Min.	Typical	Max.	Unit	
Operating Case Temperature	T <sub>c</sub>	EOLS-BI1X48-X	0		+70	°C
		EOLS-BI1X48-XI	-20		+85	
Power Supply Voltage	V <sub>cc</sub>	3.15	3.3	3.45	V	
Power Supply Current	I <sub>cc</sub>		200	300	mA	
Data Rate		1		4.25	Gbps	

**Performance Specifications - Electrical**

Parameter	Symbol	Min.	Typ.	Max	Unit	Notes
<b>Transmitter</b>						
LVPECL Compatible Inputs(Differential)	Vin	400		2000	mVpp	AC coupled inputs <sup>*(Note4)</sup>
Input Impedance (Differential)	Zin	85	100	115	ohm	Rin > 100 kohm @ DC
TX_Dis	Disable	2		Vcc+0.3	V	
	Enable	0		0.8		
TX_FAULT	Fault	2		Vcc+0.3	V	
	Normal	0		0.5		
<b>Receiver</b>						
CML Outputs (Differential)	Vout	400	800	2000	mVpp	AC coupled outputs <sup>*(Note4)</sup>
Output Impedance (Differential)	Zout	85	100	115	ohm	
RX_LOS	LOS	2		Vcc+0.3	V	
	Normal	0		0.8	V	
MOD_DEF ( 0:2 )	VoH	2.5			V	With Serial ID
	VoL	0		0.5	V	

**Optical and Electrical Characteristics**
**(CWDM DFB and PIN-TIA with 11dB Power Budget)**

Parameter	Symbol	Min.	Typical	Max.	Unit
Power budget		11			dB
Data Rate				4250	Mbps
<b>Transmitter</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda_C - 6$	$\lambda_C$	$\lambda_C + 7.5$	nm
Spectral Width (-20dB)	$\Delta\lambda$			1	nm
Side Mode Suppression Ratio	SMSR	30			dB
Average Output Power <sup>*(Note2)</sup>	Pout	-5		0	dBm
Extinction Ratio <sup>*(Note3)</sup>	ER	5			dB
Rise/Fall Time(20%~80%)	tr/tf			175	ps
Output Optical Eye <sup>*(Note3)</sup>	IUT-T G.957 Compliant <sup>*(Note6)</sup>				
TX_Disable Assert Time	t_off			10	Us
<b>Receiver</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda - 20$	$\lambda$	$\lambda + 20$	nm
Receiver Sensitivity <sup>*(Note5)</sup>	Pmin			-16	dBm
Receiver Overload	Pmax	0			dBm
Return Loss		12			dB
Optical Path Penalty				1	dB

LOS De-Assert	LOSD			-17	dBm
LOS Assert	LOSA	-30			dBm
LOS Hysteresis <sup>*(Note7)</sup>		0.5			dB

### (CWDM DFB and PIN-TIA with 16dB Power Budget)

Parameter	Symbol	Min.	Typical	Max.	Unit
Power budget		16			dB
Data Rate				4250	Mbps
<b>Transmitter</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda_C-6$	$\lambda_C$	$\lambda_C+7.5$	nm
Spectral Width (-20dB)	$\Delta\lambda$			1	nm
Side Mode Suppression Ratio	SMSR	30			dB
Average Output Power <sup>*(Note2)</sup>	Pout	0		+5	dBm
Extinction Ratio <sup>*(Note3)</sup>	ER	5			dB
Rise/Fall Time(20%~80%)	tr/tf			175	ps
Output Optical Eye <sup>*(Note3)</sup>	IUT-T G.957 Compliant <sup>*(Note6)</sup>				
TX_Disable Assert Time	t_off			10	Us
<b>Receiver</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda-20$	$\lambda$	$\lambda+20$	nm
Receiver Sensitivity <sup>*(Note5)</sup>	Pmin			-16	dBm
Receiver Overload	Pmax	0			dBm
Return Loss		12			dB
Optical Path Penalty				1	dB
LOS De-Assert	LOSD			-17	dBm
LOS Assert	LOSA	-30			dBm
LOS Hysteresis <sup>*(Note7)</sup>		0.5			dB

### (CWDM DFB and APD-TIA with 24dB Power Budget)

Parameter	Symbol	Min.	Typical	Max.	Unit
Power budget		24			dB
Data Rate				4250	Mbps
<b>Transmitter</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda_C-6$	$\lambda_C$	$\lambda_C+7.5$	nm
Spectral Width (-20dB)	$\Delta\lambda$			1	nm
Side Mode Suppression Ratio	SMSR	30			dB
Average Output Power <sup>*(Note2)</sup>	Pout	0		+5	dBm
Extinction Ratio <sup>*(Note3)</sup>	ER	5			dB
Rise/Fall Time(20%~80%)	tr/tf			175	ps
Output Optical Eye <sup>*(Note3)</sup>	IUT-T G.957 Compliant <sup>*(Note6)</sup>				
TX_Disable Assert Time	t_off			10	Us
<b>Receiver</b>					
Channel Centre Wavelength <sup>*(Note8)</sup>		$\lambda-20$	$\lambda$	$\lambda+20$	nm
Receiver Sensitivity <sup>*(Note5)</sup>	Pmin			-24	dBm

Receiver Overload	Pmax	-8			dBm
Return Loss		12			dB
Optical Path Penalty				1	dB
LOS De-Assert	LOSD			-25	dBm
LOS Assert	LOSA	-45			dBm
LOS Hysteresis*(Note7)		0.5			dB

Note2: Output is coupled into a 9/125µm single-mode fiber.

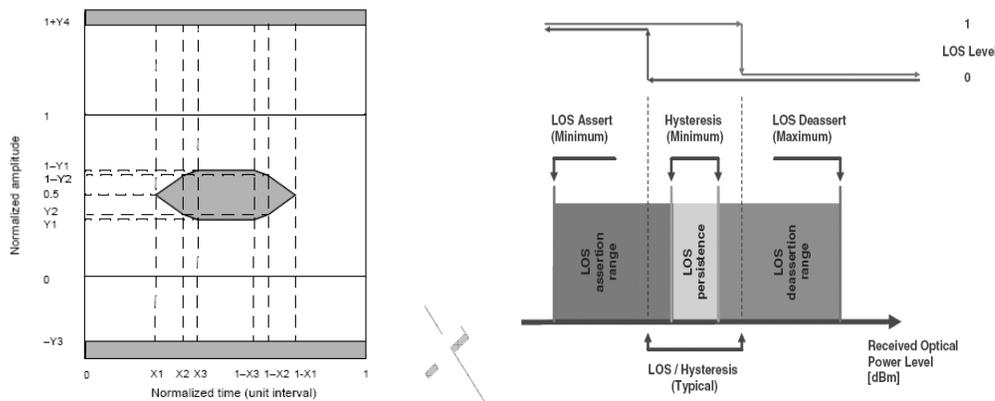
Note3: Filtered, measured with a PRBS 2<sup>7</sup>-1.

Note4: CML logic, internally AC coupled.

Note5: Measured at all data rates specified in Data Rate table with ER>5 dB, 2<sup>7</sup>-1 PRBS data pattern, BER <1E-12.

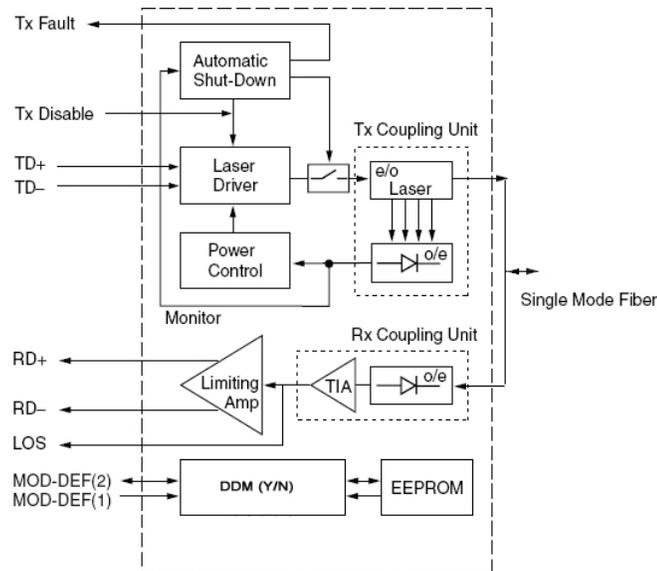
Note6: Eye Pattern Mask

Note7: LOS Hysteresis

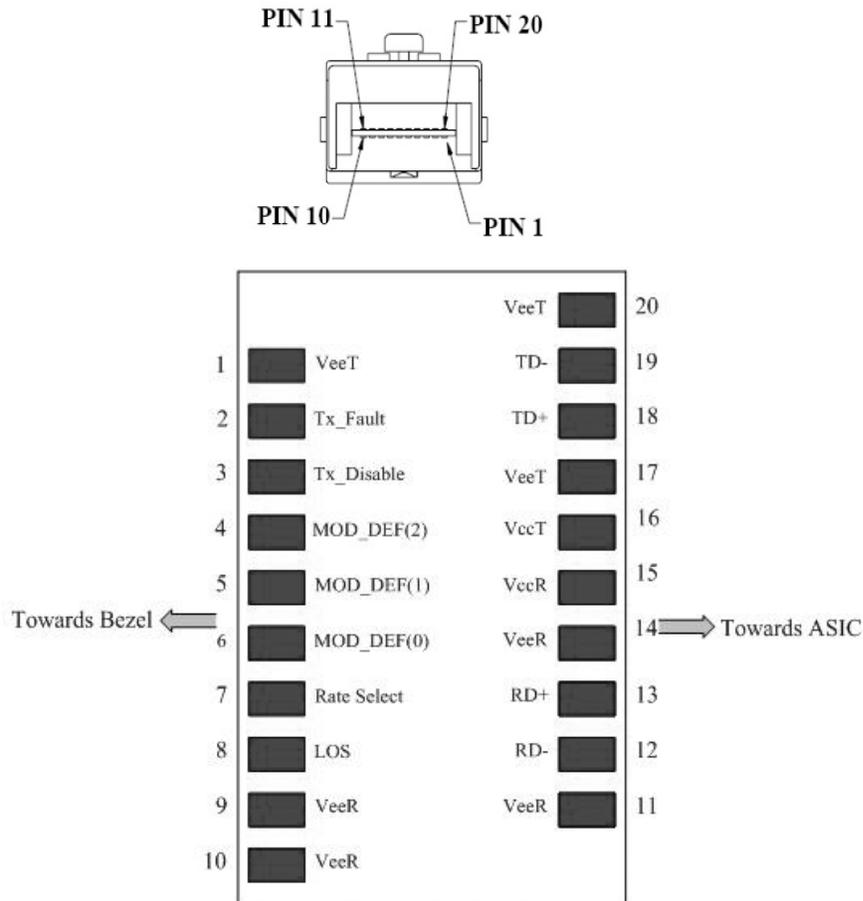


Note8: The channel center wavelength of transmitter side is compliant with table <CWDM\* Wavelength >, and the channel center wavelength of receiver side is the typical wavelength of CWDM channel ±20nm.

## Functional Description of Transceiver



## SFP Transceiver Electrical Pad Layout



### Pin Function Definitions

Pin NO.	Name	Function	Plug Seq.	Notes
1	VeeT	Transmitter Ground	1	5)
2	TX Fault	Transmitter Fault Indication	3	1)
3	TX Disable	Transmitter Disable	3	2) Module disables on high or open
4	MOD-DEF2	Module Definition 2	3	3) Data line for Serial ID.
5	MOD-DEF1	Module Definition 1	3	3) Clock line for Serial ID.
6	MOD-DEF0	Module Definition 0	3	3) Grounded within the module.
7	Rate Select	Not Connect	3	Function not available
8	LOS	Loss of Signal	3	4)
9	VeeR	Receiver Ground	1	5)
10	VeeR	Receiver Ground	1	5)
11	VeeR	Receiver Ground	1	5)
12	RD-	Inv. Received Data Out	3	6)
13	RD+	Received Data Out	3	6)

14	VeeR	Receiver Ground	1	5)
15	VccR	Receiver Power	2	7) 3.3 ± 5%
16	VccT	Transmitter Power	2	7) 3.3 ± 5%
17	VeeT	Transmitter Ground	1	5)
18	TD+	Transmit Data In	3	8)
19	TD-	Inv. Transmit Data In	3	8)
20	VeeT	Transmitter Ground	1	5)

## Notes:

1) 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.

2) 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. It's states are:

Low (0 – 0.8V): Transmitter on

(>0.8, < 2.0V): Undefined

High (2.0 – 3.465V): Transmitter Disabled

Open: Transmitter Disabled

3) 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.

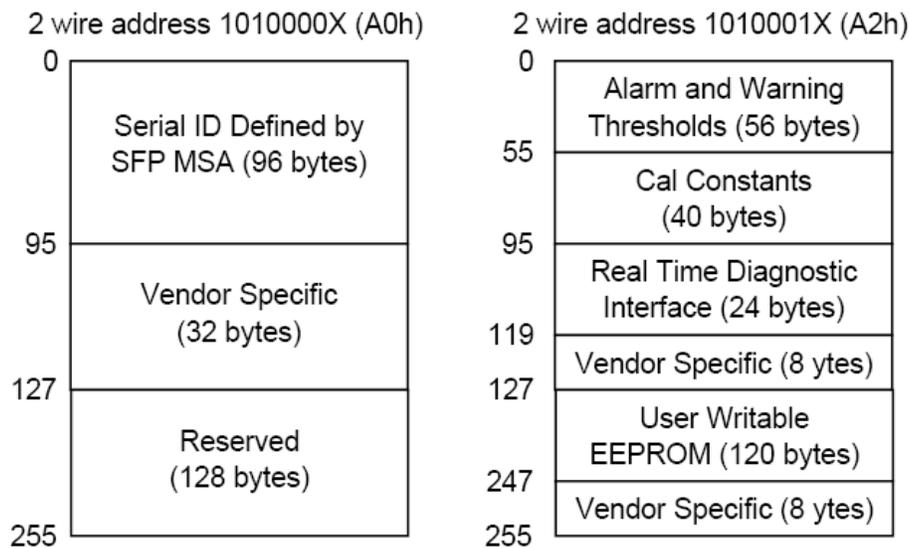
6) RD-/+ : These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω (differential) at the user SERDES. The AC coupling is done inside the module and is thus not required on the host board.

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 1 ohm 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, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30mA greater than the steady state value. VccR and VccT may be internally connected within the SFP transceiver module.

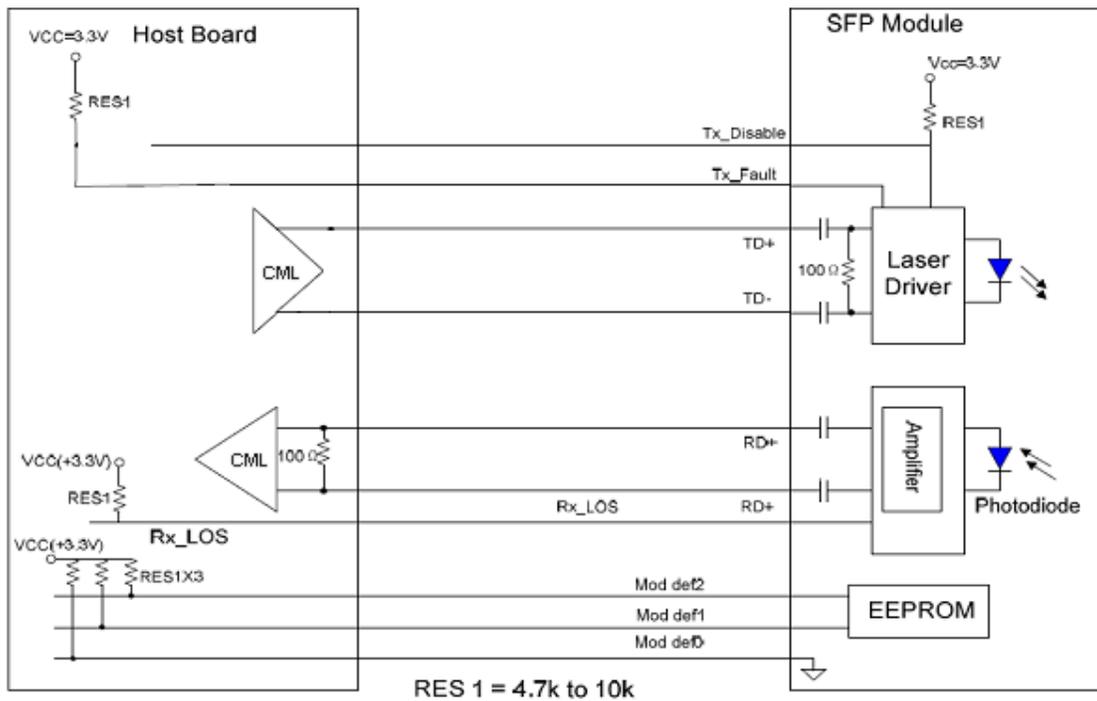
8) TD-/+: These are the differential transmitter inputs. They are AC-coupled, differential lines with 100Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board.

## EEPROM

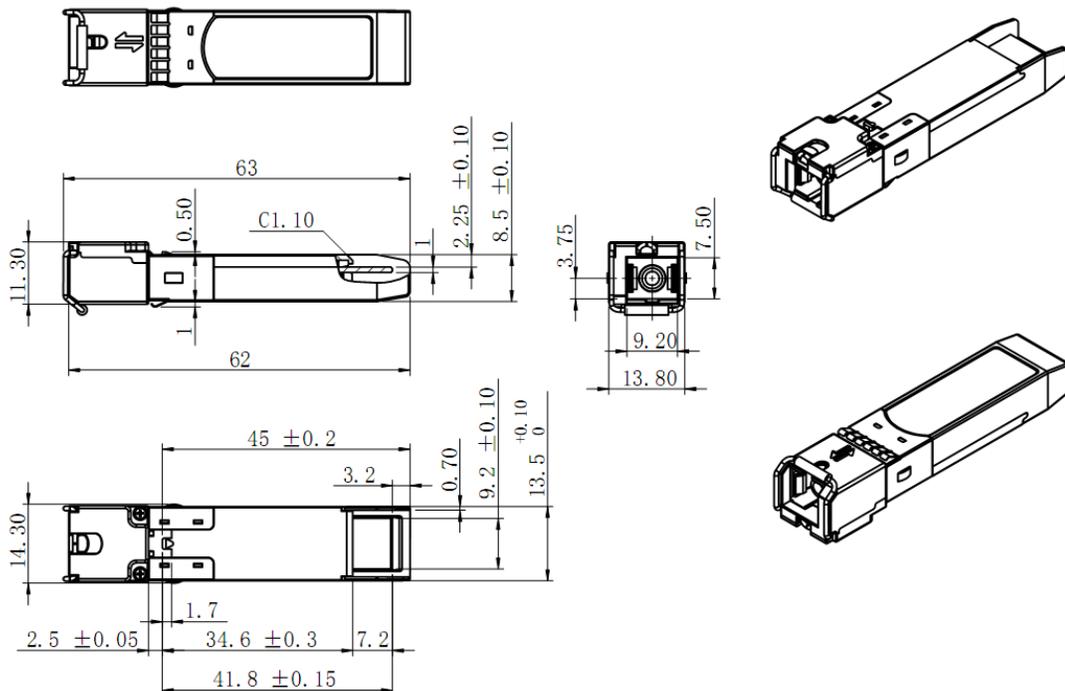
The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C02/04 family of components. When the serial protocol is activated, the host generates the serial clock signal (SCL). The positive edge clocks data into those segments of the EEPROM that are not write protected within the SFP transceiver. The negative edge clocks data from the SFP transceiver. The serial data signal (SDA) 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. The Module provides diagnostic information about the present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture. Received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring all are implemented. If the module is defined as external calibrated, the diagnostic data are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at wire serial bus address A2H. The digital diagnostic memory map specific data field define as following .For detail EEPROM information, please refer to the related document of SFF 8472 Rev 9.3.



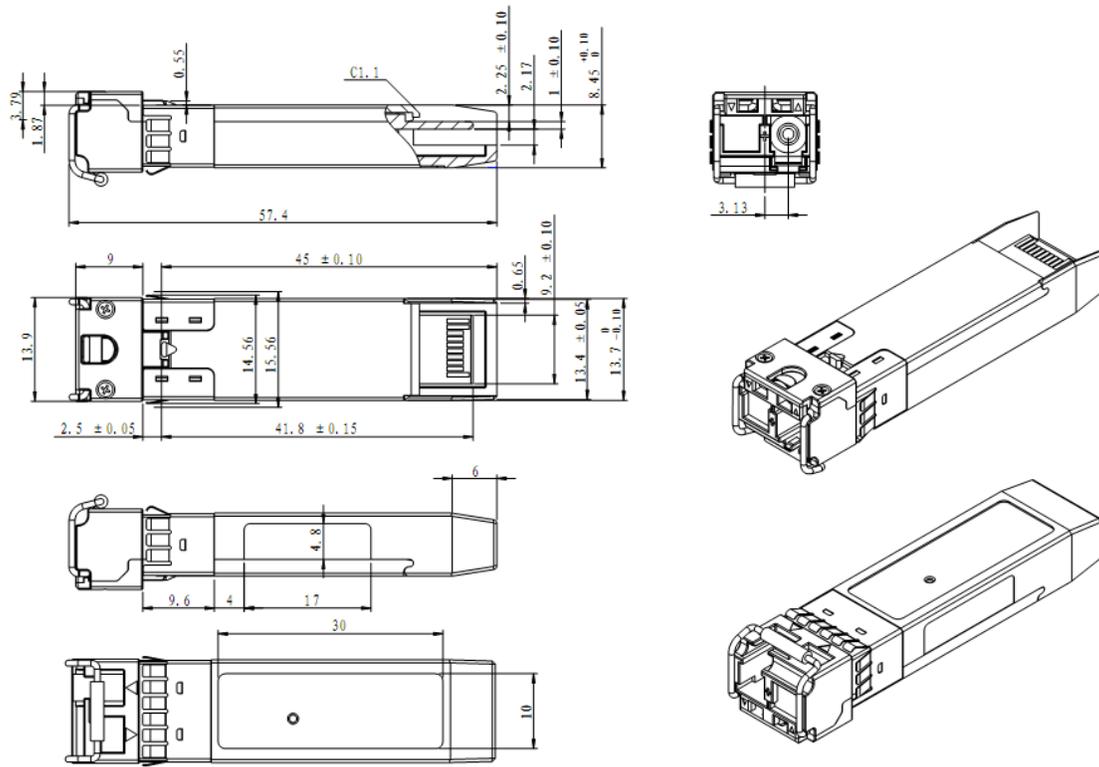
Recommended Circuit Schematic



Mechanical Specifications



SC



LC

**Laser Emission Data**

Wavelength	> 1460nm
Total output power (as defined by FDA: 7mm aperture at 20cm distance)	<0.79mW
Total output power (as defined by IEC: 7mm aperture at 10cm distance)	<10mW
Beam divergence	12.5°

**Laser Emission**



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## Revision History

Revision	Initiated	Reviewed	Approved	Revision History	Release Date
V2.a	Cathy	Kelly		Release	Mar 29, 2010
V2.b	Phlio	Kelly		Change Link Budget and Update recommend circuit	Aug. 22, 2011
V2.c	Kelly			Update photo.	Nov 4, 2011
V3.a	Arvin	Kelly/Phlio		Update the sensitivity.	2012-05-09
V3.b	Angela /Arvin	Jasson/Walt/ Lyn/Nygai	Alex	Update regulatory compliance and change the Industrial temperature range to Extended range. Correct Pin definition note3.	September 17, 2013

### Notice:

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### Contact:

Add: Floor 5, Building 2, No. 21 Gaopeng Avenue, High-Tech District, CHENGDU, SICHUAN  
610041 P.R. CHINA

Tel: (+86) 028-85122709 ext 816 & 809

Fax: (+86) 028-85121912

Postal: 610041

E-mail: sales@eoptolink.com

<http://www.eoptolink.com>