Opticonnect
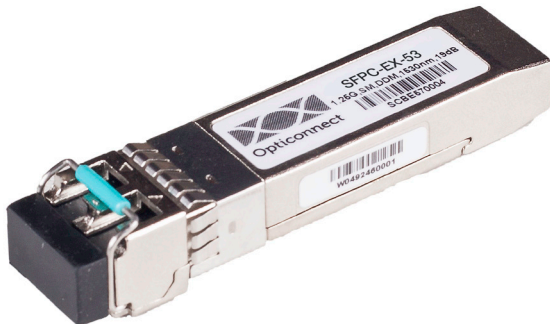
SFPC-EX Series

SFP Single-Mode, Dual Fiber transceiver
for CWDM application up to 1.25Gbps
with Digital Diagnostic function

Features

- Data Rate 1.25 Gbps
- Up to 41 DB link budget
- 8-Wavelengths CWDM
- 1470nm to 1610nm,
- 20nm Spacing
- Hot Pluggable
- Duplex LC Connector
- MSA Compliant
- Digital Diagnostics

Applications

- Fiber Channel Links
- Gigabit Ethernet Links
- Fast Ethernet Links
- Other Optical Links

Product description

The SFPC-EX series single-mode transceiver is small form factor pluggable module for serial optical data communications such as Gigabit Ethernet 1000BASE-ZX and Fiber Channel 1x SM-LC-L FC-PI. It is with the SFP 20-pin connector to allow hot plug capability. This module is designed for single mode fiber and operates at a nominal CWDM wavelength. A guaranteed minimum optical link budget of 41dB is offered. The transmitter section uses a multiple quantum well CWDM DFB laser and is a class 1 laser compliant according to International Safety Standard IEC-60825. The receiver section uses an integrated InGaAs Avalanche photodetector preamplifier mounted in an optical header and a limiting post-amplifier IC. The SFP-EX series are designed to be compliant with SFF-8472 Multi-Source Agreement (MSA).

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All product specifications are subject to change without notice to improve reliability, function or design or otherwise.

Ordering information

Part No.	Data Rate	Fiber	Link Budget	Interface	Temperature	DDMI
SFPC-EX-xx*Note1	1.25Gbps	SMF	19dB	LC	Standard	YES
SFPC-ZX-xx	1.25Gbps	SMF	24dB	LC	Standard	YES
SFPC-EZX-xx	1.25Gbps	SMF	34dB	LC	Standard	YES
SFPC-XZX-xx	1.25Gbps	SMF	41dB	LC	Standard	YES

Note1: xx refers to CWDM Wavelength range 1470nm to 1610nm;

CWDM* Wavelength (0~70°C)

Band	Nomenclature	Wavelength(nm)		
		Min.	Typ.	Max.
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

Regulatory compliance

Feature	Standard	Performance
Electrostatic discharge (ESD) to the electrical pins	MIL-STD-883G Method 3015.7	Class 1C (>1000V)
Electrostatic discharge to the enclosure	EN 55024:1998+A1+A2 IEC-61000-4-2 GR-1089-CORE	Compliant with standards
Electromagnetic interference (EMI)	FCC Part 15 Class B EN55022:2006 CISPR 22B :2006 VCCI Class B	Compliant with standards Noise frequency range: 30MHz to 6GHz. Good system EMI design practice required to achieve Class B margins. System margins are dependent on customer host board and chassis design.
Immunity	EN 55024:1998+A1+A2 IEC 61000-4-3	Compliant with standards. 1KHz sine-wave, 80% AM, from 80MHz to 1GHz. No effect on transmitter/receiver performance is detectable between these limits.
Laser eye safety	FDA 21CFR 1040.10 and 1040.11 EN (IEC) 60825-1:2007 EN (IEC) 60825-2:2004+A1	CDRH compliant and Class I laser product. TüV Certificate No. 50135086

Feature	Standard	Performance
Component recognition	UL and CUL EN60950-1:2006	UL file E317337 TüV Certificate No. 50135086 (CB scheme)
RoHS6	2002/95/EC 4.1&4.2 2005/747/EC 5&7&13	Compliant with standards*[note2]

Note 2: For update of the equipments and strict control of raw materials, Opticonnect has the ability to supply the customized products since Jan 1st, 2007, which meet the requirements of RoHS6 (Restrictions on use of certain Hazardous Substances) of European Union.

In light of item 5 in RoHS exemption list of RoHS Directive 2002/95/EC, Item 5: Lead in glass of cathode ray tubes, electronic components and fluorescent tubes.

In light of item 13 in RoHS exemption list of RoHS Directive 2005/747/EC, Item 13: Lead and cadmium in optical and filter glass.

The three exemptions are being concerned for Opticonnect's transceivers, because Opticonnect's transceivers use glass, which may contain Pb, for components such as lenses, windows, isolators, and other electronic components.

Absolute maximum ratings

Parameter	Symbol	Min.	Max.	Unit
Storage temperature	T_S	-40	+85	°C
Supply voltage	V_{CC}	-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_C	SFPC-EX Series	0	-	+70	°C
Power supply voltage	V_{CC}		3.15	3.3	3.45	V
Power supply current	I_{CC}		-	-	300	mA
Date Rate	GbE		-	1.25	-	Gbps
	1GFC		-	1.063	-	

Performance specifications - Electrical

Parameter		Symbol	Min.	Typ.	Max	Unit	Notes
Transmitter							
LVPECL inputs(Differential)		Vin	400	-	2000	mVpp	AC coupled inputs*[note5]
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	-	0.8		

Parameter		Symbol	Min.	Typ.	Max	Unit	Notes
Receiver							
LVPECL outputs (Differential)		Vout	400	-	2000	mVpp	AC coupled outputs*[note5]
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
SFPC-EX-xx, 19dB

Parameter	Symbol	Min.	Typical	Max.	Unit
Link budget		19	-	-	dB
Data rate		-	1.063/1.25	-	Gbps
Transmitter					
Center wavelength	λc	λc–6	λc	λc+7.5	nm
Spectral width (-20dB)	Δλ	-	-	1	nm
Average output power*[note3]	Pout	-5	-	0	dBm
Side mode suppression ratio	SMSR	30	-	-	dB
Extinction ratio*[note4]	ER	8.2	-	-	dB
Rise/Fall time(20%～80%)	tr/tf	-	-	0.26	ns
Total jitter	TJ	-	-	56.5	ps
Output optical eye*[note4]	Compatible with IEEE 802.3ah-2004*[note8]				
TX_Disable assert time	t_off	-	-	10	μs
P_{out}@TX Disable asserted	Pout	-	-	-45	dBm
Receiver					
Center wavelength	λc	1260	-	1600	nm
Receiver sensitivity*[note6]	Pmin	-	-	-24	dBm
Receiver overload	Pmax	-3	-		dBm
Return loss		12	-	-	dB
Optical path penalty*[note7]		-	-	1	dB
LOS De-Assert	LOSD	-	-	-25	dBm
LOS assert	LOSA	-42	-	-	dBm
LOS hysteresis*[note9]		0.5	-	-	dB

SFPC-ZX-xx, 24dB

Parameter	Symbol	Min.	Typical	Max.	Unit
Link budget		24	-	-	dB
Data rate		-	1.063/1.25	-	Gbps
Transmitter					
Center wavelength	λc	λc–6	λc	λc+7.5	nm
Spectral width (-20dB)	$\Delta \lambda$	-	-	1	nm
Average output power*(note3)	Pout	0	-	5	dBm
Side mode suppression ratio	SMSR	30	-	-	dB
Extinction ratio*(note4)	ER	8.2	-	-	dB
Rise/Fall time (20%～80%)	tr/tf	-	-	0.26	ns
Total jitter	TJ	-	-	56.5	ps
Output optical eye*(note4)	Compatible with IEEE 802.3ah-2004*(note8)				
TX_Disable assert time	t_off	-	-	10	μs
P_{out}@TX Disable asserted	Pout	-	-	-45	dBm
Receiver					
Center wavelength	λc	1260	-	1600	nm
Receiver sensitivity*(note6)	Pmin	-	-	-24	dBm
Receiver overload	Pmax	-3	-	-	dBm
Return loss		12	-	-	dB
Optical path penalty*(note7)		-	-	1	dB
LOS De-assert	LOSD	-	-	-25	dBm
LOS assert	LOSA	-42	-	-	dBm
LOS hysteresis*(note9)		0.5	-	-	dB

SFPC-EZX-xx, 34dB

Parameter	Symbol	Min.	Typical	Max.	Unit
Link budget		34	-	-	dB
Data rate		-	1.063/1.25	-	Gbps
Transmitter					
Center wavelength	λc	λc–6	λc	λc+7.5	nm
Spectral width (-20dB)	$\Delta \lambda$	-	-	1	nm
Average output power*(note3)	Pout	2	-	7	dBm
Side mode suppression ratio	SMSR	30	-	-	dB
Extinction ratio*(note4)	ER	8.2	-	-	dB
Rise/Fall time(20%～80%)	tr/tf	-	-	0.26	ns
Total jitter	TJ	-	-	56.5	ps
Output optical eye*(note4)	Compatible with IEEE 802.3ah-2004*(note8)				

Parameter	Symbol	Min.	Typical	Max.	Unit
TX_Disable assert time	t_off	-	-	10	µs
P_{out}@TX Disable asserted	Pout	-	-	-45	dBm
Receiver					
Center wavelength	λc	1260	-	1600	nm
Receiver sensitivity*[note6]	Pmin	-	-	-32	dBm
Receiver overload	Pmax	-10	-	-	dBm
Return loss		12	-	-	dB
Optical path penalty*[note7]		-	-	1	dB
LOS De-assert	LOSD	-	-	-33	dBm
LOS assert	LOSA	-42	-	-	dBm
LOS hysteresis*[note9]		0.5	-	-	dB

SFPC-XZX-xx, 41dB

Parameter	Symbol	Min.	Typical	Max.	Unit
Link budget		41	-	-	dB
Data rate		-	1.063/1.25	-	Gbps
Transmitter					
Center wavelength	λc	λc–6	λc	λc+7.5	nm
Spectral width (-20dB)	Δλ	-	-	1	nm
Average output power*[note3]	Pout	4	-	7	dBm
Side mode suppression ratio	SMSR	30	-	-	dB
Extinction ratio*[note4]	ER	8.2	-	-	dB
Rise/Fall time(20%~80%)	tr/tf	-	-	0.26	ns
Total jitter	TJ	-	-	56.5	ps
Output optical eye*[note4]	Compatible with IEEE 802.3ah-2004*[note8]				
TX_Disable assert time	t_off	-	-	10	µs
P_{out}@TX Disable asserted	Pout	-	-	-45	dBm
Receiver					
Center wavelength	λc	1260	-	1600	nm
Receiver sensitivity*[note6]	Pmin	-	-	-37	dBm
Receiver overload	Pmax	-10	-	-	dBm
Return loss		12	-	-	dB
Optical path penalty*[note7]		-	-	1	dB
LOS De-assert	LOSD	-	-	-38	dBm
LOS assert	LOSA	-45	-	-	dBm
LOS hysteresis*[note9]		0.5	-	-	dB

Note3: Output is coupled into a 9/125µm single-mode fiber.

Note4: Filtered, measured with a PRBS 2^7-1 test pattern @1.25Gbps
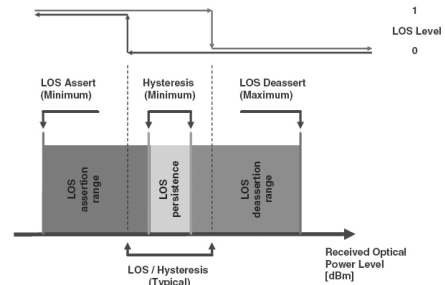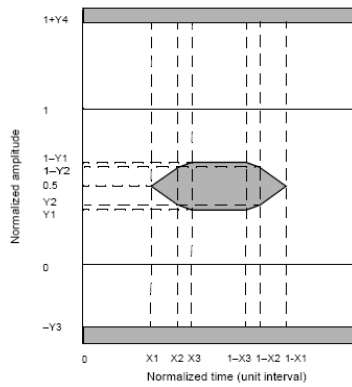
Note5: LVPECL logic, internally AC coupled.

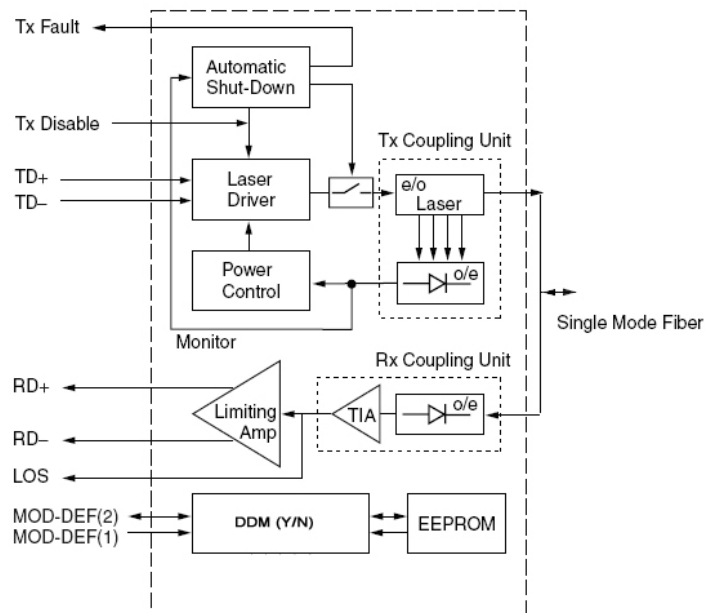Note6: Minimum average optical power measured at BER less than 1E-12, with a 2^7-1 PRBS and ER=9dB.

Note7: Measured with a PRBS 2^7-1 test pattern @1.25Gbps, BER ≤1×10^{-12}.
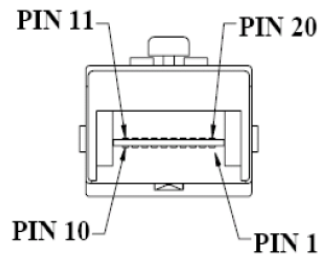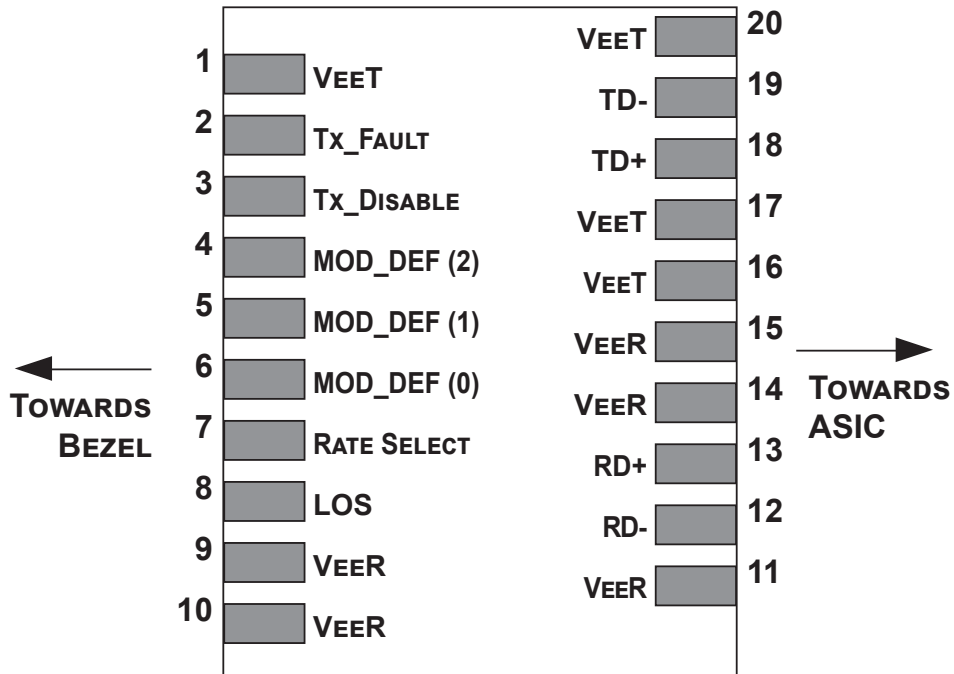
Note8: Eye Pattern Mask   Note9: LOS Hysteresis

Functional description of transceiver

SFP Transceiver electrical pad layout

Pin	Signal		Pin	Signal
1	VeeT		20	VeeT
2	Tx_Fault		19	TD-
3	Tx_Disable		18	TD+
4	MOD_DEF (2)		17	VeeT
5	MOD_DEF (1)		16	VeeT
6	MOD_DEF (0)		15	VeeR
7	Rate Select		14	VeeR
8	LOS		13	RD+
9	VeeR		12	RD-
10	VeeR		11	VeeR

← **Towards Bezel**

→ **Towards ASIC**

PIN 11 — PIN 20

PIN 10 — PIN 1

Pin function definitions

Pin Num.	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) 2 wire serial ID interface.
5	MOD-DEF1	Module Definition 1	3	3) 2 wire serial ID interface.
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. Its 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. The voltage swing on these lines will be between 400 and 2000mV differential (200 –1000mV single ended) when properly terminated.

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. The inputs will accept differential swings of 400 – 2000mV (200 – 1000mV single-ended).

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.

EEPROM Serial ID memory contents

Accessing Serial ID Memory uses the 2 wire address 1010000X(A0H). Memory Contents of Serial ID are shown in Table 1. The following information is according to SFPC-EX-Series.

Table 1 Serial ID memory contents

Addr.	Size (Bytes)	Name of Field	Hex	Description
BASE ID FIELDS				
0	1	Identifier	03	SFP
1	1	Ext. Identifier	04	SFP function is defined by serial ID only
2	1	Connector	07	LC Connector
3-10	8	Transceiver	XX XX XX XX XX XX XX XX[note10]	Transmitter Code
11	1	Encoding	01	8B10B
12	1	BR, Nominal	0D	1.25Gbps
13	1	Reserved	00	Transceiver transmit distance
14	1	Length (9µm)km	XX	
15	1	Length(9µm)100m	XX	
16	1	Length (50µm) 10m	XX	
17	1	Length(62.5µm)10m	XX	
18	1	Length (Copper)	00	Not compliant
19	1	Reserved	00	

Addr.	Size (Bytes)	Name of Field	Hex	Description
20-35	16	Vendor name	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX$^{(note10)}$	Vendor name
36	1	Reserved	00	
37-39	3	Vendor OUI	00 00 00	
40-55	16	Vendor PN	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX$^{(note10)}$	Transceiver part number
56-59	4	Vendor rev	XX XX XX XX$^{(note10)}$	
60-61	2	Wavelength	XX XX$^{(note10)}$	Wavelength
62	1	Reserved	00	
63	1	CC_BASE	Check Sum (Variable)	Check code for Base ID Fields
EXTENDED ID FIELDS				
64-65	2	Options	00 1A	TX_DISABLE, TX_FAULT and Loss of Signal implemented.
66	1	BR, max	00	
67	1	BR, min	00	
68-83	16	Vendor SN	XX XX XX XXXX XX XX XX 20 20 20 20 20 20 20 20$^{(Note10)}$	Serial Number of transceiver (ASCII). For example "B000822".
84-91	8	Date code	XX XX XX XX XX XX XX XX$^{(Note10)}$	Manufactory date code. For example "080405".
92	1	Diagnostic Monitoring Type	XX$^{(Note10)}$	Digital diagnostic monitoring implemented
93	1	Enhanced Options	XX$^{(Note10)}$	Optional flags
94	1	SFF_8472 Compliance	XX$^{(Note10)}$	01 for Rev9.3 SFF-8472.
95	1	CC_EXT	Check Sum (Variable)	Check sum for Extended ID Field.
VENDOR SPECIFIC ID FIELDS				
96-127	32	endor Specific	Read only	Depends on customer information
128-255	128	Reserved	Read only	

Note10: The "xx" byte should be filled in according to practical case. For more information, please refer to the related document of SFP Multi-Source Agreement (MSA).

Recommend circuit schematic
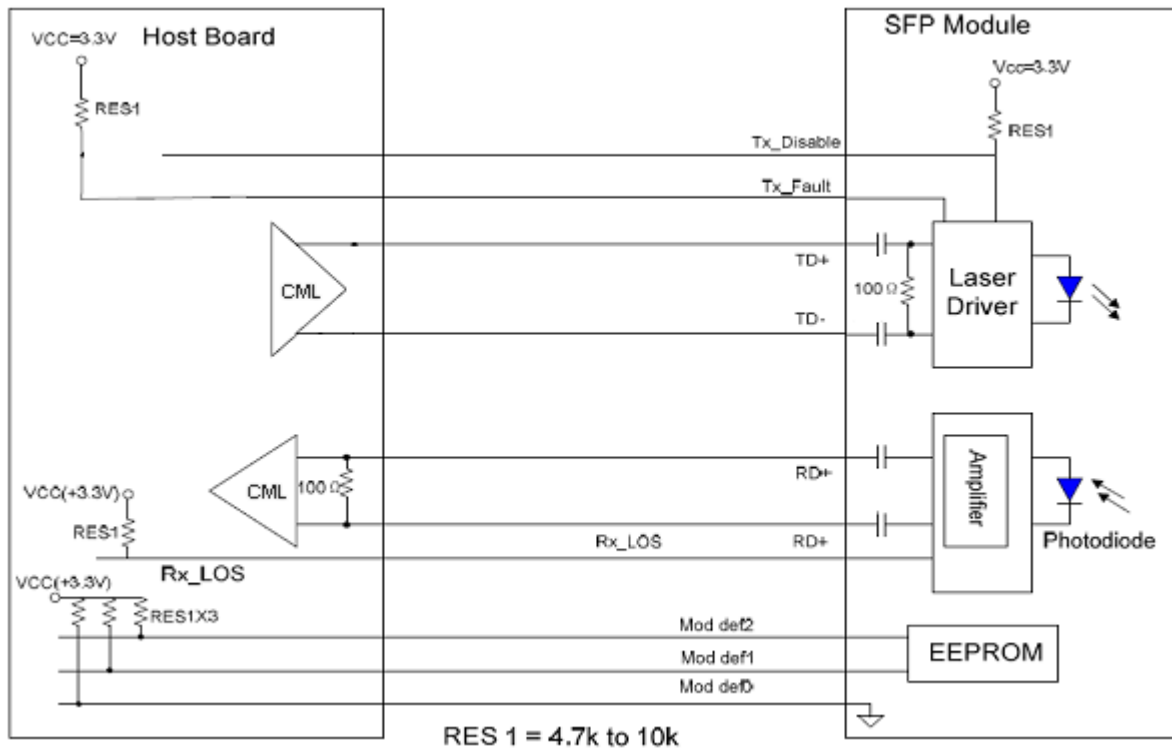
Mechanical specifications
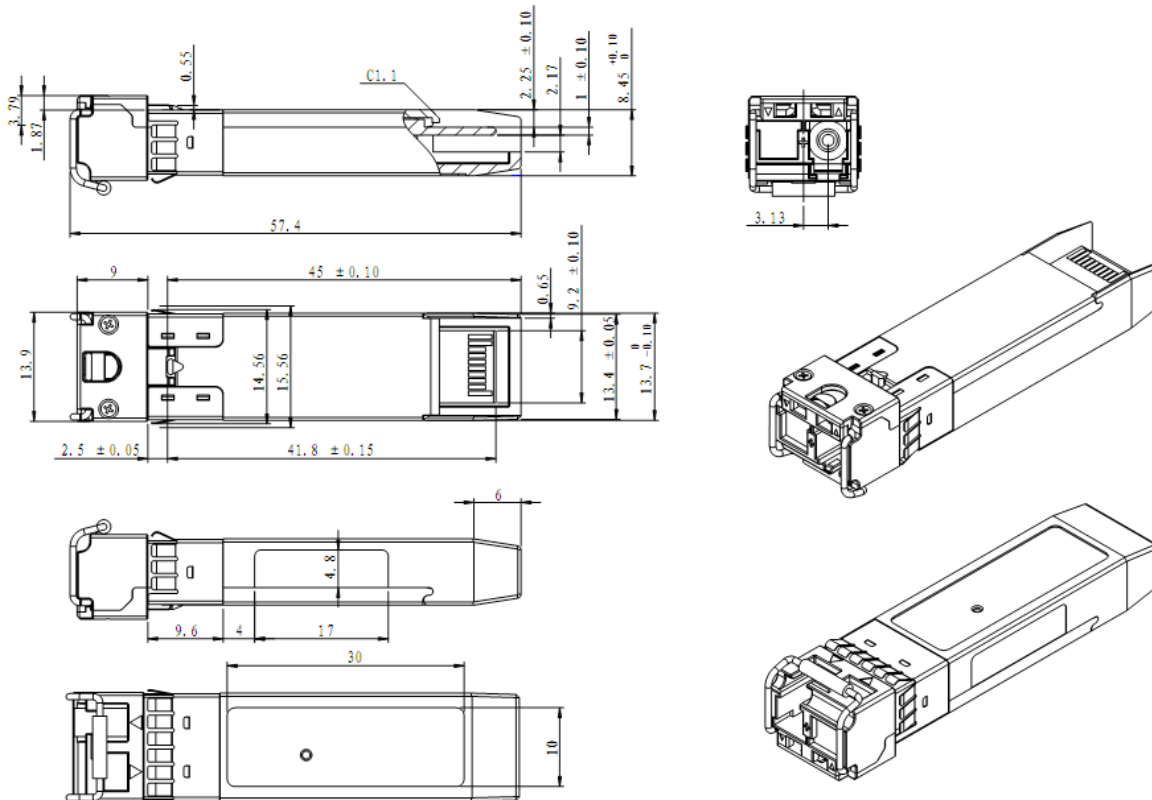
Laser emission data

Wavelength	>1260nm
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