

Product Specification

**GEPON OLT Optical SFP Module
20km with SC Receptacle**

ESFP-GE-T2

ePHOTON

Preliminary**ESFP-GE-T2**
*GEAPON OLT PX20 SC Receptacle SFP Transceiver***1 Features**

- 1.1 Single fiber bi-directional data links with symmetric 1.25Gbps upstream and 1.25Gbps downstream
- 1.2 Integrated with micro-optics WDM filter for dual wavelength Tx/Rx operation at 1490/ 1310nm
- 1.3 Continuous 1490nm DFB laser transmitter
- 1.4 1310nm burst-mode receiver with APD-TIA
- 1.5 Support more than 24dB dynamic range
- 1.6 Burst mode received signal strength indication (RSSI) output
- 1.7 Digital Diagnostic Monitoring (DDM) with external calibration
- 1.8 0 to 70°C operating temperature
- 1.9 SFP package with SC receptacle
- 1.10 Single 3.3V power supply
- 1.11 LVPECL compatible data input/output interface
- 1.12 LVTTL transmitter disable control
- 1.13 LVTTL transmitter laser failure alarm
- 1.14 LVTTL receiver signal-detected indication
- 1.15 Low EMI and excellent ESD protection
- 1.16 RoHS Compliance
- 1.17 Compliant with SFF MSA and SFF-8472

**2 Applications**

- 2.1 Gigabit Ethernet Passive Optical Networks (GE-PON) – OLT side

3 General

ESFP-GE-T2 is Optical Line Terminal (OLT) compliant with 1000BASE-PX20 application.

The transceiver is the high performance module for 1.25Gbps data link in single fiber by using 1490nm continuous-mode transmitter and 1310nm burst-mode receiver. It provides digital diagnostic information of its operating conditions and status, including transmitting power, laser bias current, module temperature, and supply voltage. Calibration and alarm/warning threshold data are written and stored in the internal memory (EEPROM). The memory map is compatible with SFF-8472.

The transmitter section uses a multiple quantum well 1490nm DFB laser and is Class I laser compliant product according to international safety standard IEC-60825.

The receiver has a hermetically packaged APD-TIA (trans-impedance amplifier) pre-amplifier and a limiting amplifier with LVPECL compatible differential outputs. It features a Loss of Signal (LOS) output which is LVTTL compatible.

The receiver offers burst-mode RSSI outputs, which is I2C accessible digitized data stored in the internal flash memory.

The optical output can be disabled by a LVTTL logic high-level input of TX_DIS. LAS_FAIL is provided to indicate that degradation of the laser.

4 Performance Specifications

4.1 Absolute Maximum Ratings

Absolute Maximum Ratings are those values, beyond which, some damages may occur to the devices. Exposure to conditions above the Absolute Maximum Ratings listed in Table 1 may negatively impact the reliability of the products.

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Temperature (Non-Operating)	Tstg	-40	+85	°C	
Humidity (Operating)	Hop	5	90	%	
Input Voltage	-	GND	Vcc	V	
Power Supply Voltage	Vcc-Vee	0	+4	V	

4.2 Operating Environment

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply Voltage	Vcc	+3.1	+3.3	+3.5	V	-
Case Temperature (Operating)	Tc	0	-	70	°C	-
Data Rate			1.25/1.25		Gb/s	-
Data Rate Drift	-	-100	-	100	PPM	-

4.3 Transmitter Specifications

(Over Operating Case Temperature Range, Vcc = 3.135V to 3.465V)

Electrical Characteristics						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Differential Data Input Swing	Vin,pp	200	-	1600	mV	5
Differential Input Impedance	Rin	90	100	110	ohm	
Transmitter Disable Voltage-Low	VTDIS_L	0		0.8	V	6
Transmitter Disable Voltage-High	VTDIS_H	2		VCC	V	
Laser Failure Alarm Voltage-Low	VLFA_L	0		0.8	V	7
Laser Failure Alarm Voltage-High	VLFA_H	2.4		VCC	V	
Power Supply Current	ICC_TX			180	Ma	
Optical Characteristics						
Average Launch Optical Power(BOL)	Peout	+2	-	+7	dBm	1
Average Launch Optical Power-OFF	Peoff			-45	dBm	
Optical Extinction Ratio	ER	9		-	dB	2
Optical Wavelength	λ	1480		1500	nm	
Spectral Width (-20dB)	σ	-	-	1	nm	
Optical Rise/Fall Time	Tr/Tf	-		260	ps	3
Side Mode Suppression Ratio	SMSR	30			dB	
Optical Return Loss Tolerance		-		12	dB	
Transmitter Reflection				-10	dB	
Optical Eye Diagram	Compliant with IEEE Std 802.3ah™-2004					4

Note :

1. Launched into 9/125um Single Mode Fiber.
2. Measured with PRBS 27-1 test pattern @1.25 Gbit/s.
3. Measured with the Bessel-Thompson filter OFF.
4. Transmitter eye mask definition {0.22UI, 0.375UI, 0.20UI, 0.20UI, 0.30UI}.

- 5. Compatible with LVPECL input, AC coupled internally.
- 6. TX_DISABLE (See Pin Function Definitions)
- 7. TX Fault (See Pin Function Definitions)

4.4 Receiver Specifications

(Over Operating Case Temperature Range, Vcc = 3.135V to 3.465V)

Electrical Characteristics						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Power Supply Current	I _{CC_RX}			120	mA	
Data Output Differential Swing	V _{OUT}	400		1000	mV	5
Los Voltage-Low	V _{SD L}	0		0.8	V	
Los Voltage-High	V _{SD H}	2.4		V _{cc}	V	
Los Assert Time	T _{ASS}			500	nS	
Los De-assert Time	T _{DAS}			500	nS	
Optical Characteristics						
Operating Wavelength		1270	1310	1350	nM	
Sensitivity	P _{SEN}		-	-30	dBm	1
Saturation	P _{OV}	-6			dBm	
Receiver Threshold Setting Time	T _{set}			400	nS	
Dynamic Range		24			dB	2
Los Assert Level	P _{LOSA}			-32	dBm	3
Los De-assert Level	P _{LOSD}	-45			dBm	4
Los Hysteresis	P _{LOSA-PL OSD}	0.5		5	dB	
Receiver Reflectance				-12	dB	

Note :

- 1. Measured with a PRBS 2⁷⁻¹ test pattern @1.25Gbit/s and ER=10dB, BER =10⁻¹².
- 2. See Figure 3.
- 3. An increase in optical power above the specified level will cause Loss of Single (LOS) output to switch from a high state to a low state.
- 4. A decrease in optical power below the specified level will cause Loss of Single (LOS) output to switch from a low state to a high state.
- 5. LVPECL output, DC coupled internally, guaranteed in the full range of input optical power (-6dBm to -30dBm) (See Recommended Interface Circuit)

4.5 Digital Diagnostic Monitor Accuracy

Parameter	Unit	Accuracy	Range	Calibration
Tx Optical Power	dB	±3	Full Temperature Range	External
		±2	Room Temperature	
Rx Optical Power	dB	±3	-6dBm to -30dBm	External
Bias Current	%	±10	Id: 1-100mA, Recommended Operating Conditions	External
Power Supply Voltage	%	±3	V _{cc} :3.0-3.6V, Recommended Operating Conditions	External
Internal Temperature	°C	±3	Recommended Operating Conditions	External

1.6 Timing Parameter Definition in Burst Mode Sequence

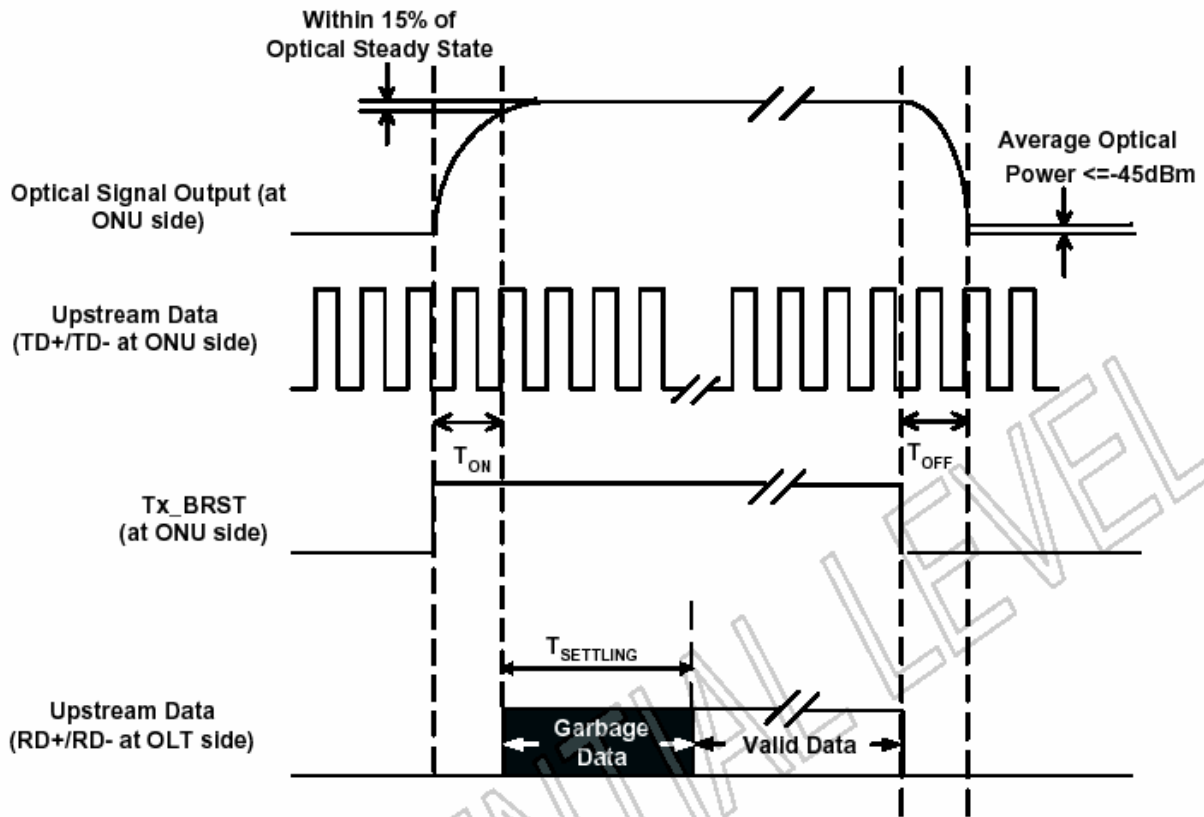


Figure 1 Timing Parameter Definition in Burst Mode Sequence (only one)

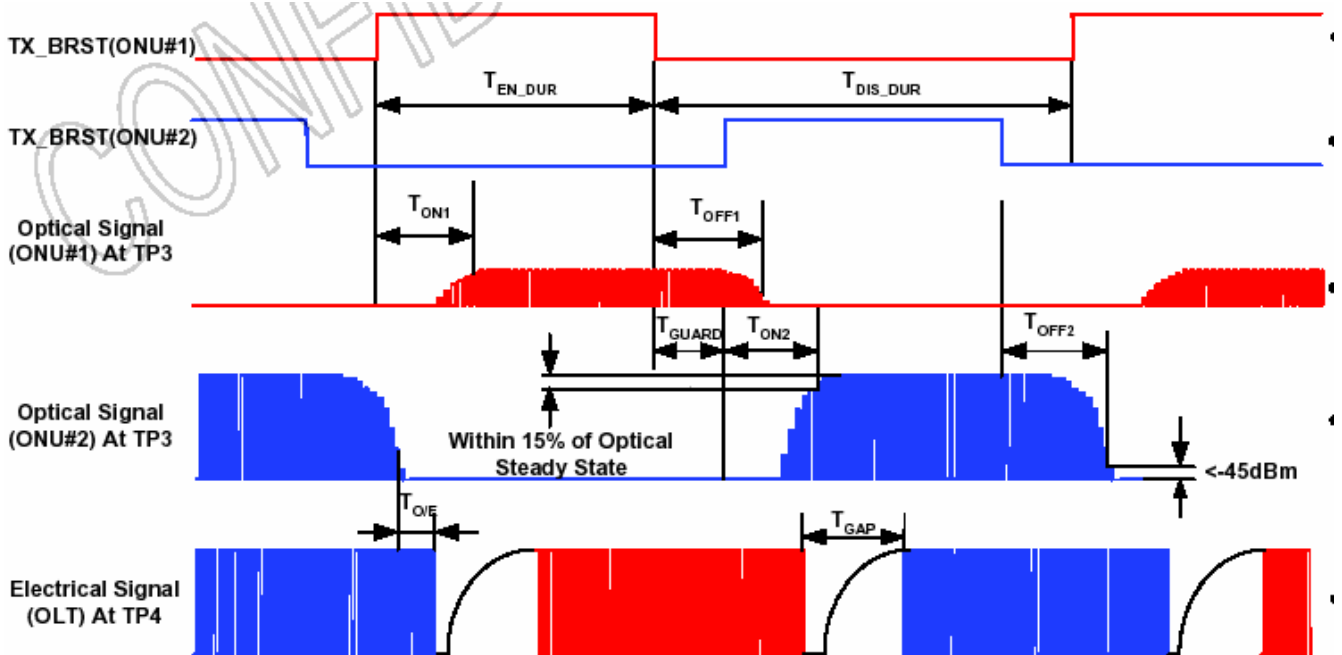


Figure 2 Timing Parameter Definitions in Burst Mode Sequence (Dual ONUs)

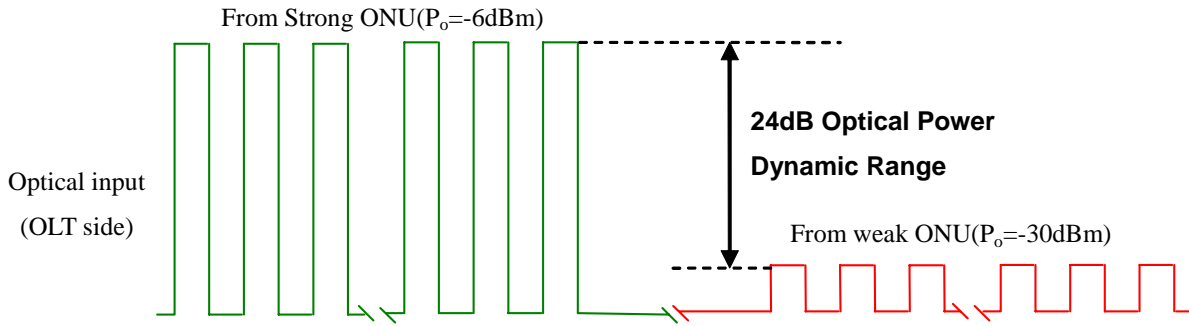


Figure 3 Burst Mode Receiver Dynamic Range in GEAPON System

Timing Characteristics for Digital RSSI

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Trigger delay	T_d	2	-	-	US
Trigger width	T_w	2	4	-	US
Sample time	T_s	6	-	-	US
I2C read time	T_{I2C}	150	200	-	US

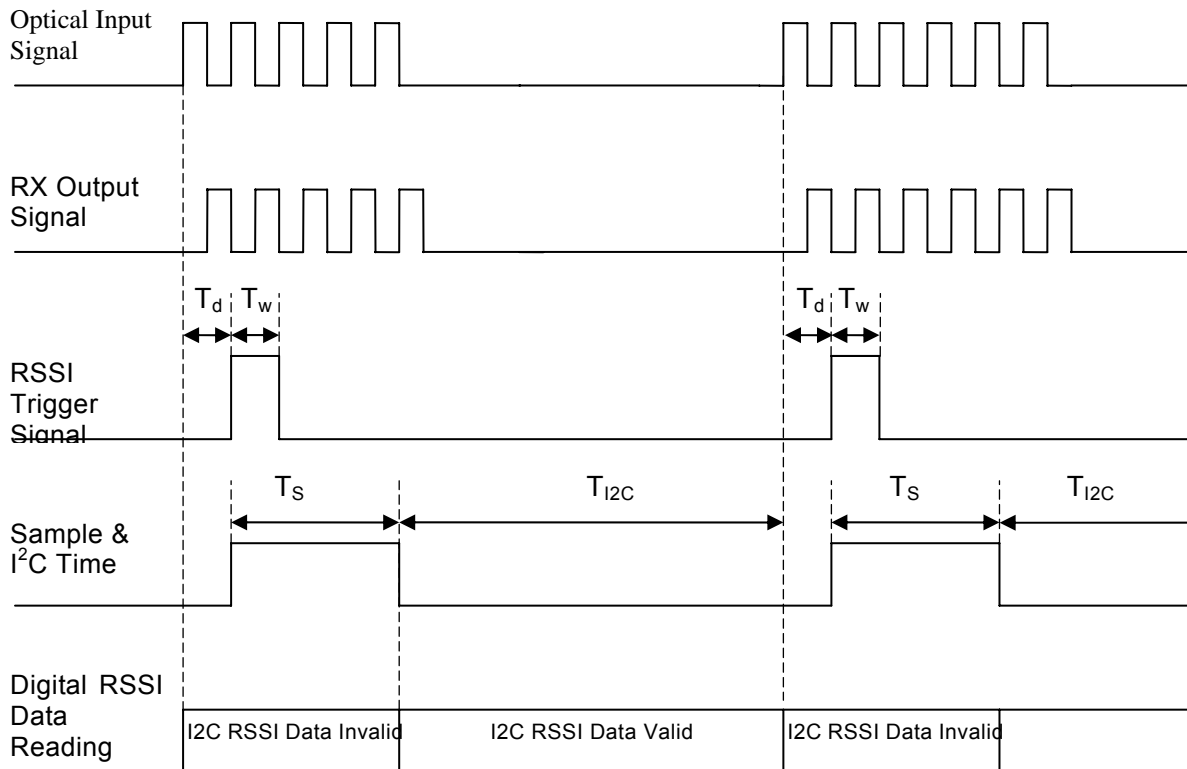


Figure 4 RSSI timing Characteristics

5 Pin Definitions

5.1 Pin Diagram

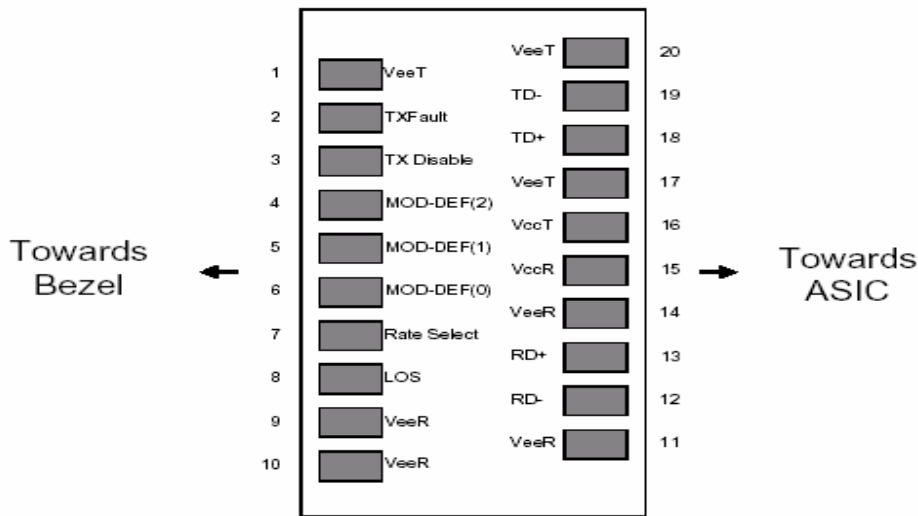


Figure 5 SFP Outline

5.2 Pin Descriptions

Pin#	Name	Function	Notes
1	VeeT	Transmitter Ground	-
2	TX Fault	Transmitter Fault Indication	Note 1
3	TX Disable	Transmitter Disable	Note 2, Module disables on high or
4	MOD-DEF2	Module Definition 2	Note 3, 2 wire serial ID interface
5	MOD-DEF1	Module Definition 1	Note 3, 2 wire serial ID interface
6	MOD-DEF0	Module Definition 0	Note 3, Grounded in Module
7	RSSI_Trigger		
8	LOS	Loss of Signal	Note 4
9	VeeR	Receiver Ground	Note 5
10	VeeR	Receiver Ground	Note 5
11	VeeR	Receiver Ground	Note 5
12	RD-	Inv. Received Data Out	Note 6
13	RD+	Received Data Out	Note 6
14	VeeR	Receiver Ground	Note 5
15	VccR	Receiver Power	Note 7, 3.3V± 5%
16	VccT	Transmitter Power	Note 7, 3.3V± 5%
17	VeeT	Transmitter Ground	Note 5
18	TD+	Transmit Data In	Note 8
19	TD-	Inv. Transmit Data In	Note 8
20	VeeT	Transmitter Ground	Note 5

Notes:

- 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 K Ω 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 – 10K Ω 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 – 10K Ω 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 DC coupled 100 Ω differential lines which should be terminated with 100 Ω (differential) at the user SERDES.
7. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V \pm 5% at the SFP connector pin. Maximum supply current is 400mA. Recommended host board power supply filtering is shown below. Inductors with DC resistance of less than 1 Ω 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 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 100 Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board.

6. Serial interface memory map

Module identification and diagnostic information is accessible through the address map shown in the following tables.

6.1 EEPROM serial ID memory contents (A0h)

Addr	Hex	ASCII	Description	Addr	Hex	ASCII	Description	Addr	Hex	ASCII	Description	
0	03		SFP	32	20		Vendor name	64	00		(001Ah=LOS, TX_FAULT, all supported)	
1	04		SFP function is defined by serial ID only	33	20			65	1A			
2	01		SC connector	34	20			66	00			BR, Max
3	00		Not defined	35	20			67	00			BR, Min.
4	00		Not defined	36	XX		Reserved	68	XX		Vendor Serial number	
5	00		Not defined	37	00		Vendor OUI	69	XX			
6	80		EPON	38	00			70	XX			
7	00		Not defined	39	00			71	XX			
8	00		Not defined	40	45	E	Vendor part number	72	XX			
9	00		Not defined	41	53	S		73	XX			
10	00		Not defined	42	46	F		74	XX			
11	01		8B10B	43	50	P		75	XX			
12	0C	1.25G bps	BR in 100Mbps	44	2D	-		76	XX			
13	00		Reserved	45	47	G		77	XX			
14	14	20	Length(9u)*km	46	45	E		78	XX			
15	C8	200	Length(9u)*100m	47	2D	-		79	XX			
16	00		Length(50u)*10m	48	54	T		80	XX			
17	00		Length(62.5u)*10m	49	31	1		81	XX			
18	00		Length(Copper)	50	20			82	XX			
19	XX		Reserved	51	20			83	XX			
20	65	e	Vendor name	52	20			84	XX		Vendor data code: Year	
21	50	P		53	20			85	XX		Vendor data code: Month	
22	48	H		54	20			86	XX			
23	4F	O		55	20		Vendor PN reversion 1.0	87	XX		Vendor data code: Day	
24	54	T		56	31			88	XX			
25	4F	O		57	2E	.		89	XX		Blank	
26	4E	N		58	30		90	20				
27	20			59	20		91	20				
28	20			60	XX		Reserved	92	XX		Reserved	
29	20			61	XX		Reserved	93	XX		Reserved	
30	20		62	XX		Reserved	94	XX		Reserved		
31	20		63	XX		CC_BASE(0-62)	95	XX		CC_EXT(64-94)		

96-127: 00, Vendor specific
 128-255: 00, Reserved
 XX: denotes hex values which varies from module to module

6.2 EEPROM serial ID memory contents (A2h)

6.2.1 Alarm and Warning Thresholds, OM Output Calibration ID Fields

Addr. (DEC)	# Bytes	Name	Value
00-01	2	Temp high alarm	+80°C
02-03	2	Temp low alarm	-13°C
04-05	2	Temp high warning	+75°C
06-07	2	Temp low warning	-8°C
08-09	2	Supply voltage high alarm	+3.6V
10-11	2	Supply voltage low alarm	+3.0V
12-13	2	Supply voltage high warning	+3.47V
14-15	2	Supply voltage low warning	+3.14V
16-17	2	Bias high alarm	100mA
18-19	2	Bias low alarm	0mA
20-21	2	Bias high warning	80mA
22-23	2	Bias low warning	0mA
24-25	2	Tx power high alarm	+8dBm
26-27	2	Tx power low alarm	+1dBm
28-29	2	Tx power high warning	+7dBm
30-31	2	Tx power low warning	+2dBm
32-33	2	Rx power high alarm	-5dBm
34-35	2	Rx power low alarm	-31dBm
36-37	2	Rx power high warning	-6dBm
38-39	2	Rx power low warning	-30dBm
40-55	16	Reserved	Reserved for future monitored quantities
56-59	4	Rx_PWR(4)	Single precision floating point calibration data-Rx optical power. Bit7 of byte 56 is MSB, Bit 0 of byte 59 is LSB
60-63	4	Rx_PWR(3)	Single precision floating point calibration data-Rx optical power. Bit7 of byte 60 is MSB, Bit 0 of byte 63 is LSB
64-67	4	Rx_PWR(2)	Single precision floating point calibration data-Rx optical power. Bit7 of byte 64 is MSB, Bit 0 of byte 67 is LSB
68-71	4	Rx_PWR(1)	Single precision floating point calibration data-Rx optical power. Bit7 of byte 68 is MSB, Bit 0 of byte 71 is LSB
72-75	4	Rx_PWR(0)	Single precision floating point calibration data-Rx optical power. Bit7 of byte 72 is MSB, Bit 0 of byte 75 is LSB
76-77	2	Tx_I(Slope)	Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, Bit 0 of byte 77 is LSB.
78-79	2	Tx_I(Offset)	Fixed decimal (signed two's complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, Bit 0 of byte 79 is LSB
80-81	2	Tx_PWR(Slope)	Fixed decimal (unsigned) calibration data, transmitter coupled output power. Bit 7 of byte 80 is MSB, Bit 0 of byte 81 is LSB
82-83	2	Tx_PWR(Offset)	Fixed decimal (signed two's complement) calibration data, transmitter coupled output power. Bit 7 of byte 82 is MSB, Bit 0 of byte 83 is LSB.
84-85	2	T(Slope)	Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, Bit 0

			of byte 85 is LSB.
86-87	2	T(Offset)	Fixed decimal (signed two's complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, Bit 0 of byte 87 is LSB.
88-89	2	V(Slope)	Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, Bit 0 of byte 89 is LSB.
90-91	2	V(Offset)	Fixed decimal (signed two's complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB, Bit 0 of byte 91 is LSB.
92-95	4	Reserved	Reserved.

6.2.2 A/D Values and Status Bits

Addr. (DEC)	Bit	Name	Description
96	All	Temperature MSB	Internally measured module temperature
97	All	Temperature LSB	
98	All	Vcc MSB	Internal measured supply voltage
99	All	Vcc LSB	
100	All	Tx bias MSB	Internal measured Tx bias current
101	All	Tx bias LSB	
102	All	Tx power MSB	Measured TX output power
103	All	Tx power LSB	
104	All	Rx Power MSB	Measured RX input power
105	All	Rx Power LSB	
106	All	Reserved MSB	Reserved for 1 st future definition of digitized analog input
107	All	Reserved LSB	Reserved for 1 st future definition of digitized analog input
108	All	Reserved MSB	Reserved for 2 nd future definition of digitized analog input
109	All	Reserved LSB	Reserved for 2 nd future definition of digitized analog input
Optional status/control bits			
110	7	TX Disable State	Digital state of the TX Disable Input Pin. Not supported
110	6	Soft TX Disable	Read/Write bit that allows software disable of laser. Not supported
110	5	Reserved	
110	4	RX Rate Select State	Digital state of the SFP RX Rate Select Input Pin. Not supported
110	3	Soft RX Rate Select	Read/Write bit that allows software RX rate select, Not supported
110	2	TX fault	Digital state of the TX Fault Output Pin.
110	1	LOS	Digital state of the LOS Output Pin.
110	0	Data_Ready	Indicates transceiver has achieved power up and data is ready
111	7-0	Reserved	Reserved

6.2.3 Alarm and Warning Flags

Addr. (DEC)	Bit	Name	Description
112	7	Temp high alarm	Set when internal temperature exceeds high alarm level
	6	Temp low alarm	Set when internal temperature below low alarm level
	5	Vcc high alarm	Set when internal supply voltage exceeds high alarm level
	4	Vcc low alarm	Set when internal supply voltage below low alarm level
	3	Tx bias high alarm	Set when internal Tx bias current exceeds high alarm level
	2	Tx bias low alarm	Set when internal Tx bias current below low alarm level
	1	Tx power high alarm	Set when internal Tx output power exceeds high alarm level
	0	Tx power low alarm	Set when internal Tx output power below low alarm level
113	7	Rx power high alarm	Set when received power exceeds high alarm level
	6	Rx power low alarm	Set when received power is below low alarm level
	5-0	Reserved alarm	
114-115	All	Reserved	
116	7	Temp high warning	Set when internal temperature exceeds high warning level
	6	Temp low warning	Set when internal temperature below low warning level
	5	Vcc high warning	Set when internal supply voltage exceeds high warning level
	4	Vcc low warning	Set when internal supply voltage below low warning level
	3	Tx bias high warning	Set when internal Tx bias current exceeds high warning level
	2	Tx bias low warning	Set when internal Tx bias current below low warning level
	1	Tx power high warning	Set when internal Tx output power exceeds high warning level
	0	Tx power low warning	Set when internal Tx output power below low warning level
117	7	Rx power high warning	Set when received power exceeds high warning level
	6	Rx power low warning	Set when received power is below low warning level
	5-0	Reserved warning	
118-119	all	Reserved	

6.2.4 Vendor Specific Memory Addresses

Addr. (DEC)	# Bytes	Name	Description
120-127	8	Vendor specific	Vendor specific

6.2.5 User EEPROM

Addr. (DEC)	# Bytes	Name	Description
128-247	120	Vendor Writable Area	Vendor writable EEPROM
248-255	8	Vendor specific	Vendor specific control functions

7 Package Information

The mechanical design diagram of the SFP transceiver with SC receptacle (dimension in mm)

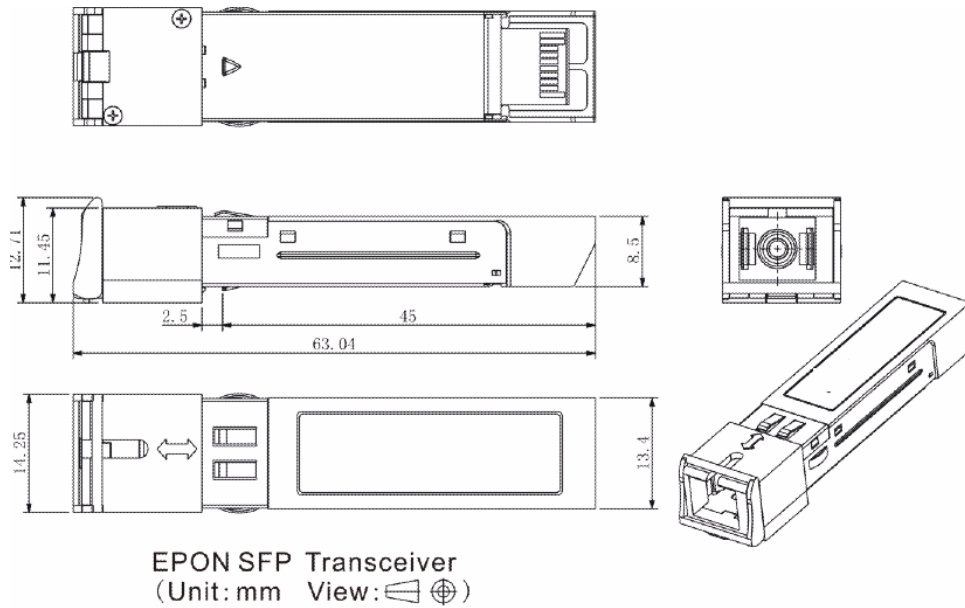


Figure 6: Mechanical Diagram

8 Recommended Circuit

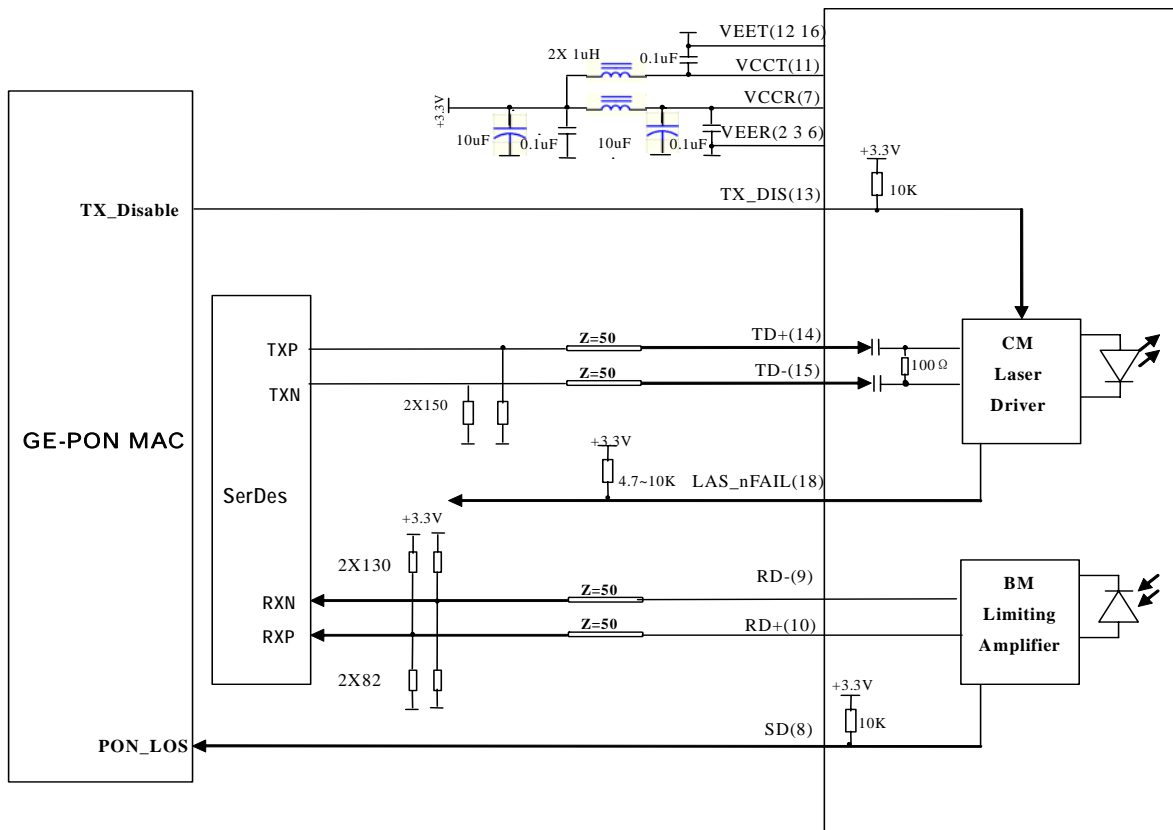
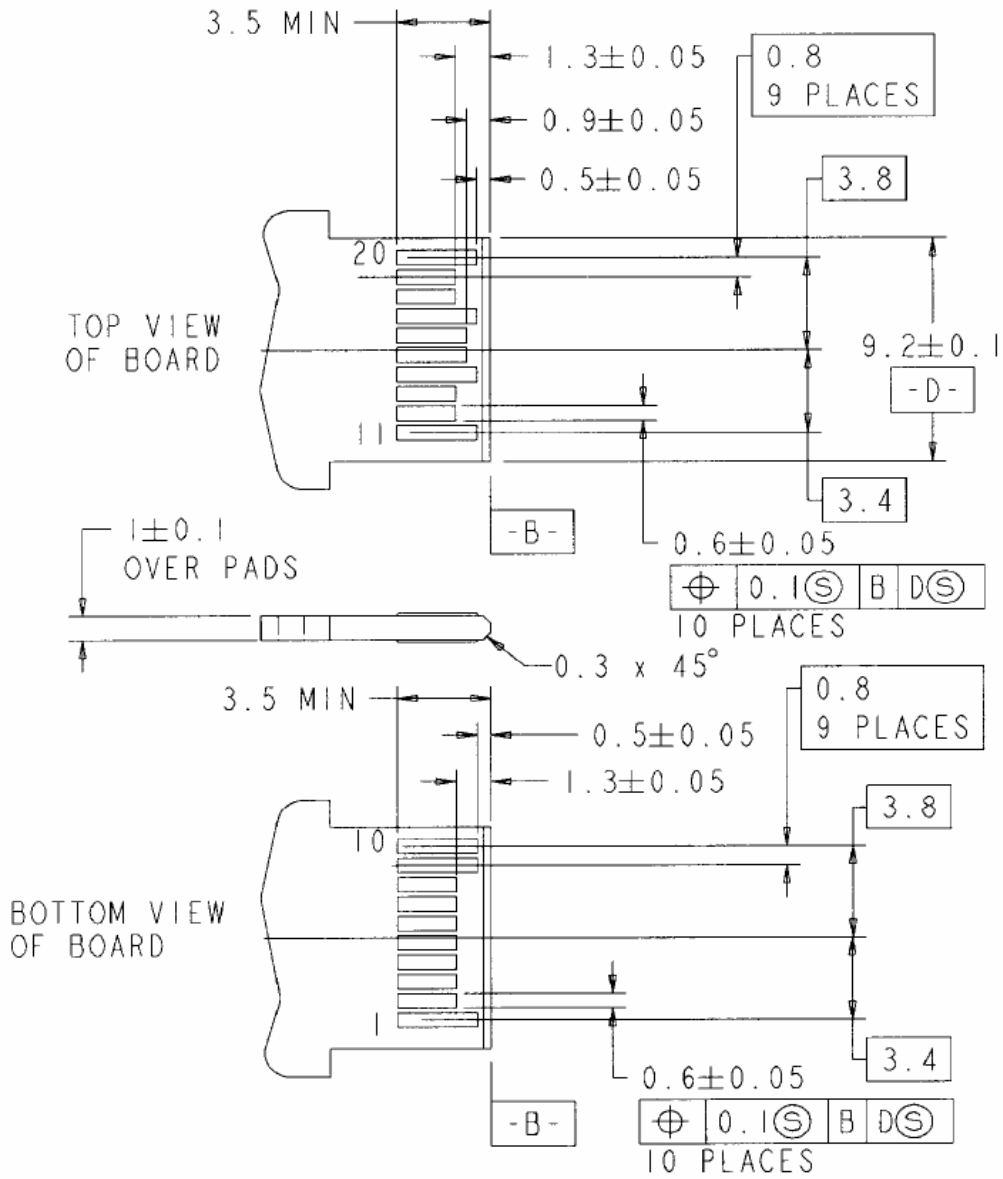


Figure 7: shows the recommended interface scheme

9 Pattern Layout of SFP Printed Circuit Board



(Unit: mm)

