

TS-EP-OLT-P+



SFP SC Receptacle 20km EPON OLT Transceiver

Features

- ◆ Small form-factor pluggable(SFP) with Multi-Source Agreement(MSA) compliant
- ◆ Single Fiber Bi-Directional SC Receptacle Optical Interface, Up to 20km Reach
- ◆ Single Power Supply +3.3V DC, Low Power Consumption
- ◆ Digital Diagnostic Monitor(DDM) Function
- ◆ Continuous-Mode DFB Transmitter, operation wavelength at 1490nm, 1250Mbps
- ◆ Burst-Mode high sensitivity APD Receiver, operation wavelength at 1310nm, 1250Mbps
- ◆ LVPECL compatible data input&output
- ◆ Other Optional Function: LVTTL for TX_Disable input &TX_Fault output
- ◆ Compliant with IEC60825 Class I
- ◆ Compliant with IEEE802.3 ah™ - 2004 1000BASE-PX20

- ◆ Compliant with SFF-8472 v11.0
- ◆ RoHS6 Compliance
- ◆ Optional Operating temperature range: Commercial: 0°C ~ +70°C

Applications

- ◆ Gigabit Ethernet Passive Optical Network(EPON) OLT
- ◆ Other Optical Links

Specification

Absolute Maximum Ratings					
Parameter	Symbol	Min.	Max.	Unit	Note
Storage Ambient Temperature	T _{STG}	-40	85	°C	
Operating Case Temperature	T _{OPR}	0	70	°C	
Storage Humidity	H _S	5	90	%	
Operating Humidity	H _O	5	85	%	
Power Supply Voltage	V _{CC}	0	+3.6	V	
Input Voltage		GND	V _{CC}	V	
Receiver Damaged Threshold		+4		dBm	

Recommended Operating Conditions						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply Voltage	V _{CC}	3.135	3.3	3.465	V	3.3V±5%
Operating Case Temperature	T _{OPR}	0		70	°C	
Operating Humidity Range	H _{OPR}	5		95	%	
Data Rate			1250		Mbps	
Power Supply Current	I _{CC}			300	mA	

Transmitter Optical and Electrical Characteristics						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Average Launch Power (BOL, 25°C)	P _{OUT}	+3.5		+7	dBm	1
Average Launch Power (EOL, 0-70°C)	P _{OUT}	+2.5		+7	dBm	1
Average Launch Power-OFF Transmitter	P _{OFF}			-39	dBm	1
Extinction Ratio	ER	9			dB	2
Optical Center Wavelength	λ _C	1480	1490	1500	nm	
Optical Spectrum Width (-20dB)	Δλ			1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Rise/Fall Time (20%-80%)	T _R /T _F			260	ps	3
Transmitter Reflectance				-10	dB	λ=1490nm
Optical Return Loss Tolerance				15	dB	
RIN _{15OMA}				-115	dB/Hz	

Transmitter and Dispersion Penalty	TDP			2.3	dB	
Optical Eye Diagram	Compliant With IEEE Std 802.3ah™ - 2004 1000BASE-PX20					2,4
Data Input Differential Swing	V _{IN}	300		2400	mV	5
Input Differential Impedance	Z _{IN}	90	100	110	Ω	
Transmitter Disable Voltage - Low		0		0.8	V	
Transmitter Disable Voltage - High		2.0			V	
Transmitter Disable Assert / Deassert Time				1	ms	
Transmitter Fault Voltage - Low		0		0.4	V	
Transmitter Fault Voltage - High		2.4			V	
Transmitter Fault Assert / Deassert Time				10	us	
Total Jitter	T _j			0.28	UI	6

Note 1: Launched into 9/125um SMF

Note 2: Measured with PRBS 2⁷-1 test pattern @1250Mbit/s, and the Bessel-Thompson filter is turned on.

Note 3: Measured with PRBS 2⁷-1 test pattern @1250Mbit/s, and the Bessel-Thompson filter is turned off.

Note 4: Transmitter eye mask definition in IEEE Std 802.3 ah™ - 2004 1000BASE-PX20.

Note 5: Compatible with LVPECL input.

Note 6: IEEE Std 802.3 ah™ - 2004 1000BASE-PX20 Compliant

Note 7: All test at full operating temperature.

Receiver Optical and Electrical Characteristics						
Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Wavelength		1260	1310	1360	nm	
Receiver Sensitivity	P _{SEN}			-30.0	dBm	1
Overload Input Optical Power	P _{SAT}	-6			dBm	
LOS De-assert Level	H-L			-30.0	dBm	2
LOS Assert Level	L-H	-45			dBm	3
LOS Hysteresis		0.5	2.5	6	dBm	
LOS Assert time	T _{assert}			100	us	4
LOS Deassert time	T _{deassert}			100	us	4
Receiver Reflectance				-12	dB	λ =1310nm
1490nm Tx to 1310nm Rx Crosstalk				-45	dB	
Data Output Differential Swing	V _{OUT}	400		1600	mV	5
LOS Voltage - Low				0.8	V	
LOS Voltage - High		2.0			V	

Note 1: Measured with PRBS 2⁷-1 @1250Mbit/s, ER=10dB, BER =10⁻¹².

Note 2: An increase in optical power above the specified level will cause the Loss of signal output to switch from a high state to a low state.

Note 3: A decrease in optical power below the specified level will cause the Loss of signal output to switch from a low state to a high state.

Note 4: Measured with single burst packet@1.25Gb/s, EX=10dB, BER=1X10⁻¹²

Note 5: LVPECL output, DC coupled internally, guaranteed in the full range of input optical power.

Note 6: All test at full operating temperature.

Timing Characteristics for Digital RSSI

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
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Trigger delay	Td			20	ns	
Trigger time	Tw	300	500		ns	
Sample/Setting time	Ts	2300	2500		ns	
Measure time	Tm	80		120	us	
I2C Rate				100	Kbps	

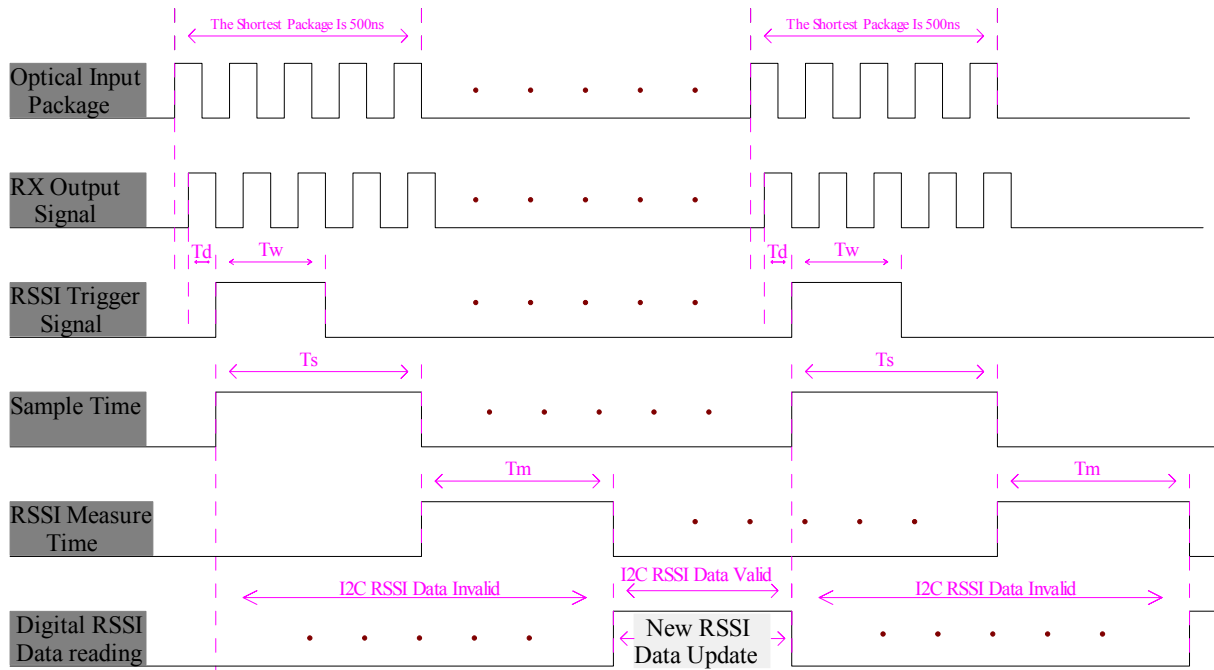


Figure1

EEPROM Serial ID Memory Contents

The optical transceiver contains a MCU. It provides access to sophisticated identification information that describes the transceiver's capabilities, standard interfaces, manufacturer, and other information. The serial interface uses the MCU. 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 MCU that are not writing protected within the EPON OLT transceiver. The negative edge clocks data from the EPON OLT 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.

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. The diagnostic data are raw A/D values and must be converted to real world units using calibration constants stored in MCU locations 56 – 95 at wire serial bus address A2h. The digital diagnostic memory map specific data fields define as following.

Digital Diagnostic Memory Map

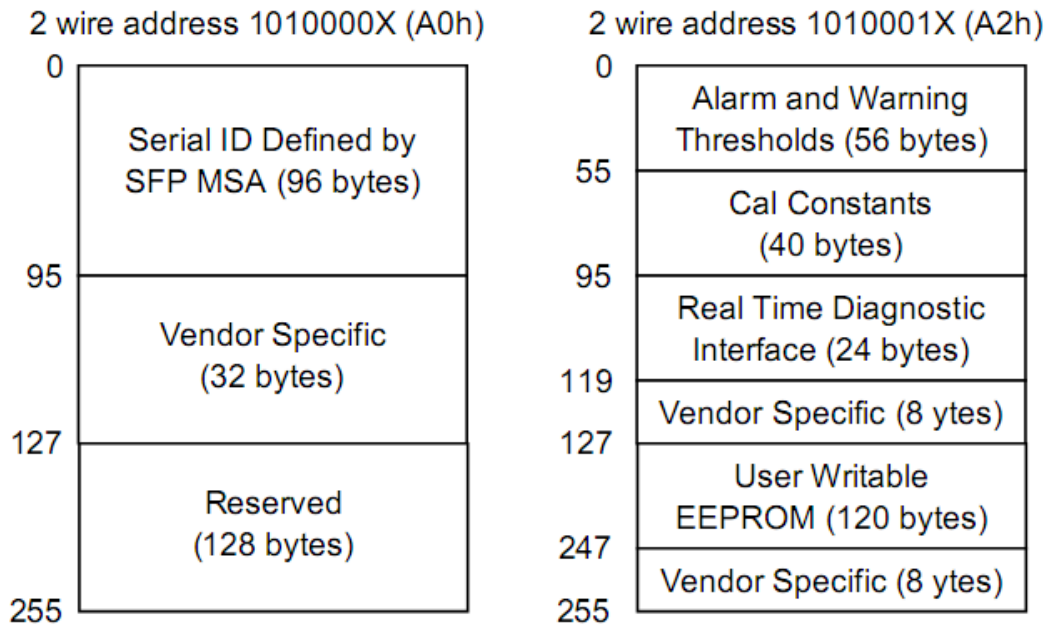


Figure2

EEPROM Serial ID Memory Contents(2-Wire Address A0h)

Address	Name of field	Hex	Description
BASE ID Fields			
00	Identifier	03	SFP transceiver
01	Ext.Identifier	04	Serial ID module supported for SFP
02	Connector	01	SC
03-05	Transceiver Codes	00 00 00	Not defined
06	Transceiver Codes	80	BASE-PX
07-10	Transceiver Codes	00 00 00	Not defined
11	Encoding	01	8B10B
12	BR,Nominal	0C	Nominal 1250Mbps transmitter
13	Rate Identifier	00	Not defined
14	Length(9um)-km	14	20Km@9/125um SM fiber
15	Length(9um)-m	C8	20000m@9/125um SM fiber
16	Length(50um)	00	Not support MMF
17	Length(62.5um)	00	Not support MMF
18	Length(cable)	00	Not support cable
19	Length(OM3)	00	Not support OM3
20-35	Vendor Name	4D 45 4E 54 45 43 48 4F 50 54 4F...	(ASCII character)

36	Reserved	00	Not defined
37-39	Vendor OUI	20 20 20	Not defined
40-55	Vendor P/N	53 4C 45 32 33 2D 44 36	(ASCII character)
56-59	Vendor P/N Rev.	56 31 2E 30	“V1.0” (ASCII character)
60-61	Laser Wavelength	05 D2	1490nm in Hex byte
62	Reserved	00	Not defined
63	CC_BASE	XX	Check sum of bytes 0-62
Extended ID Fields			
64-65	Options	00 1A	RX_LOS 、 TX_Fault 、 TX_Disable are implemented
66	BR, max	00	Not defined
67	BR, min	00	Not defined
68-83	Vendor SN	MA....xx	Vendor Serial Number in ASCII character
84-91	Date Code	Data Code	Vendor Date Code in ASCII character
92	Diagnostic Monitoring Type	58	Digital Diagnostic monitoring implemented “Externally calibrated ” is implemented, RX measurement type is “Average Power”
93	Enhanced options	F0	Optional Alarm/warning flags, soft Tx_Fault monitoring, soft LOS monitoring are implemented
94	SFF-8472 compliant	05	SFF-8472 compliant with revision 11.0
95	CC-EXT	XX	Check sum of bytes 64-94
Vendor Specific ID Field			
96-127	Vendor Specific	00	Vendor specific EEPROM
128-255	Reserved	00	Reserved for future use

Digital Diagnostic Monitoring Interface (2-Wire Address A2h)

Alarm and Warning Thresholds (2 Wire Address A2h)

Address	#Bytes	Name	Hex	Real Value	Unit	Note
00-01	2	Temp High Alarm	5F 00	95	°C	
02-03	2	Temp Low Alarm	EC 00	-20	°C	
04-05	2	Temp High Warning	55 00	85	°C	
06-07	2	Temp Low Warning	F6 00	-10	°C	
08-09	2	Voltage High Alarm	94 70	3.8	V	
10-11	2	Voltage Low Alarm	6D 60	2.8	V	
12-13	2	Voltage High Warning	87 8C	3.47	V	
14-15	2	Voltage Low Warning	7A 44	3.13	V	
16-17	2	Bias High Alarm	88 B8	70	mA	
18-19	2	Bias Low Alarm	01 F4	1	mA	
20-21	2	Bias High Warning	75 30	60	mA	
22-23	2	Bias Low Warning	01 F4	1	mA	
24-25	2	TX Power High Alarm	F6 78	8	dBm	
26-27	2	TX Power Low Alarm	1F 07	-1	dBm	
28-29	2	TX Power High Warning	C3 C7	7	dBm	
30-31	2	TX Power Low Warning	3D E9	2	dBm	

32-39	8	RX Power Alarm/ Warning	No implement for burst receiver		
40-55	16	Reserved	00...00	Reserved	

Calibration Constants(2 Wire Address A2h)

Address	#Bytes	Name	Hex	Description
56-59	4	Rx_PWR(4)	xx xx xx xx	External calibration
60-63	4	Rx_PWR(3)	xx xx xx xx	External calibration
64-67	4	Rx_PWR(2)	xx xx xx xx	External calibration
68-71	4	Rx_PWR(1)	xx xx xx xx	External calibration
72-75	4	Rx_PWR(0)	xx xx xx xx	External calibration
76-77	2	Tx_I(slope)	xx xx	External calibration
78-79	2	Tx_I(offset)	xx xx	External calibration
80-81	2	Tx_PWR(slope)	xx xx	External calibration
82-83	2	Tx_PWR(offset)	xx xx	External calibration
84-85	2	T(slope)	xx xx	External calibration
86-87	2	T(offset)	xx xx	External calibration
88-89	2	V(slope)	xx xx	External calibration
90-91	2	V(offset)	xx xx	External calibration
92-94	3	Reserved	00 00 00	Not Defined
95	1	Checksum	xx	Byte 95 contains the low order 8 bits of the sum of bytes 0 – 94.

A/D Value(2 Wire Address A2h)

Address	#Bytes	Name	Description
96-97	2	Temperature(MSB,LSB)	Internal measured module temperature
98-99	2	Supply Voltage(MSB,LSB)	Internal measured module supply voltage
100-101	2	Tx Bias Current(MSB,LSB)	Internal measured module Tx bias current
102-103	2	Tx Optical Power (MSB,LSB)	measured Tx output optical power
104-105	2	Rx Received power (MSB,LSB)	Measured Rx input optical power
106-109	4	Reserved	Not defined

Notes: Temperature(Signed twos complement value)

A2h Byte 96(Temperature MSB)								A2h Byte 97(Temperature LSB)							
S	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰	2 ⁻¹	2 ⁻²	2 ⁻³	2 ⁻⁴	2 ⁻⁵	2 ⁻⁶	2 ⁻⁷	2 ⁻⁸

Supply Voltage, Tx Bias Current, Tx Optical Power, Rx Received Power

A2h Byte 98(Vcc MSB)								A2h Byte 99(Vcc LSB)							
A2h Byte 100(Tx Bias MSB)								A2h Byte 101(Tx Bias LSB)							
A2h Byte 102(Tx Power MSB)								A2h Byte 103(Tx Power LSB)							
A2h Byte 104(Rx Power MSB)								A2h Byte 105(Rx Power LSB)							
2 ¹⁵	2 ¹⁴	2 ¹³	2 ¹²	2 ¹¹	2 ¹⁰	2 ⁹	2 ⁸	2 ⁷	2 ⁶	2 ⁵	2 ⁴	2 ³	2 ²	2 ¹	2 ⁰

The digital value conversions are updated every 13ms (nominal) or 20ms (max) in rotation. After getting digital value, each measurement could be obtained by multiplying digital value and plus offset value by corresponding LSB value:

$$\text{Temperature} = \text{Temp}(\text{digital value}) \times T_{\text{Slope}} + T_{\text{Offset}}$$

$$V_{CC} = V_{CC}(\text{digital value}) \times V_{\text{slope}} + V_{\text{offset}}$$

$$\text{Tx Bias Current} = \text{Tx Bias Current}(\text{digital value}) \times \text{Tx_I}_{\text{slope}} + \text{Tx_I}_{\text{offset}}$$

$$\text{Tx Power} = \text{Tx Power}(\text{digital value}) \times \text{Tx_PWR}_{\text{slope}} + \text{Tx_PWR}_{\text{offset}}$$

$$\begin{aligned} \text{Rx Power} = & \text{Rx_PWR}(4) \times \text{Rx Power}^4(\text{digital value}) + \\ & \text{Rx_PWR}(3) \times \text{Rx Power}^3(\text{digital value}) + \\ & \text{Rx_PWR}(2) \times \text{Rx Power}^2(\text{digital value}) + \\ & \text{Rx_PWR}(1) \times \text{Rx Power}^1(\text{digital value}) + \\ & \text{Rx_PWR}(0) \end{aligned}$$

Optional Status/Control Bits(2 Wire Address A2h)

Address	Bit	Name	Description
110	7	Tx Disable	Not implement
110	6	Soft Tx Disable	Digital state of the Tx Disable
110	5	RS(1) State	Not implement
110	4	Rate_Select State(RS0)	Not implement
110	3	Soft Rate_Select State(RS0)	Not implement
110	2	Tx_Fault State	Digital state of the Tx_Fault output pin
110	1	LOS	Digital state of the LOS output pin
110	0	Date_Ready_Bar	Indicates transceiver has achieved power up and data is ready
111	7-0	Reserved	Not defined

Alarm/Warning Flag Bits (2 Wire Address A2h)

Address	Bit	Name	Description
112	7	Temp High Alarm	Set when internal temperature exceeds the high alarm level
112	6	Temp Low Alarm	Set when internal temperature exceeds the low alarm level
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level
112	4	Vcc Low Alarm	Set when internal supply voltage exceeds low alarm level
112	3	Tx Bias High Alarm	Set when Tx Bias current exceeds the high alarm level
112	2	Tx Bias Low Alarm	Set when Tx Bias current exceeds the low alarm level
112	1	Tx Power High Alarm	Set when Tx output power exceeds the high alarm level
112	0	Tx Power Low Alarm	Set when Tx output power exceeds the low alarm level
113	7	Rx Power High Alarm	Not implement in burst receiver
113	6	Rx Power Low Alarm	Not implement in burst receiver
113	5-0	Reserved Alarm	Reserved Alarm
114-115	All	Reserved	Not defined
116	7	Temp High Warning	Set when internal temperature exceeds the high warning level
116	6	Temp Low Warning	Set when internal temperature exceeds the low warning level
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level
116	4	Vcc Low Warning	Set when internal supply voltage exceeds low warning level
116	3	Tx Bias High Warning	Set when Tx Bias current exceeds the high warning level
116	2	Tx Bias Low Warning	Set when Tx Bias current exceeds the low warning level
116	1	Tx Power High Warning	Set when Tx output power exceeds the high warning level
116	0	Tx Power Low Warning	Set when Tx output power exceeds the low warning level
117	7	Rx Power High Warning	Not implement in burst receiver
117	6	Rx Power Low Warning	Not implement in burst receiver

117	5-0	Reserved Warning	Reserved Warning
118-119	All	Reserved	Not defined

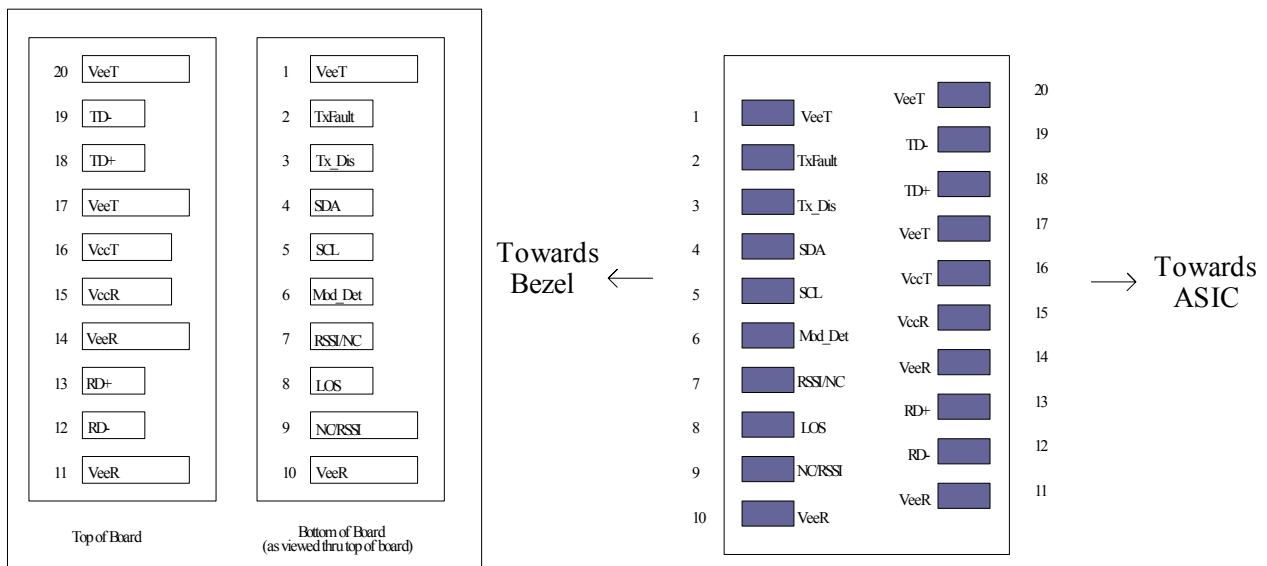
Vendor specific and User Accessible EEPROM(2 Wire Address A2h)

Address	#Bytes	Name	Description
120-127	8	Vendor specific	Vendor specific memory addresses
128-247	120	User EEPROM	User writable EEPROM
248-255	8	Vendor specific	Vendor specific control functions

Digital Diagnostic Monitoring Information

Parameter	Range	Accuracy	Calibration
Temperature	-40 to 80°C	±3°C	External
Voltage	3.0 to 3.6V	±3%	External
Bias Current	0 to 100mA	±10%	External
TX Power	-2 to +8dBm	±1dB	External
RX Power	-30 to -6dBm	±1dB	External

Pin Description



SFP Transceiver Electrical Pad Layout

Host Board Connector Pad Layout

Figure3

Pin Num.	Name	Function	Plug seq.	Note
1	VeeT	Transmitter Ground	1	1
2	Tx Fault	Transmitter Fault indication	3	2

3	Tx_Dis	Transmitter Disable	3	3
4	SDA	Module Definition 2, SDA Serial Data Signal	3	4
5	SCL	Module Definition 1, SCL Serial Clock Signal	3	4
6	MOD_Det	Module Definition 0	3	4
7	RSSI	RSSI Trigger Input	3	5
8	LOS	Loss of Signal, external pull up	3	6
9	VeeR	Receiver Ground	1	5
10	VeeR	Receiver Ground	1	1
11	VeeR	Receiver Ground	1	1
12	RD-	Inv. Received Data Out	3	7
13	RD+	Received Data Out	3	7
14	VeeR	Receiver Ground	1	1
15	VccR	Receiver Power	2	8
16	VccT	Transmitter Power	2	8
17	VeeT	Transmitter Ground	1	1
18	TD+	Transmit Data In	3	9
19	TD-	Inv. Transmit Data In	3	9
20	VeeT	Transmitter Ground	1	1

Plug Seq.: Pin engagement sequence during hot plugging.

Note 1: VeeR and VeeT internally connected within the SFP module.

Note 2: TX Fault indicates the status of module with 10 K Ω pull up 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.

Note 3: TX disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 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

Note 4: These are the module definition pins.

SDA is serial data signal with 10 K Ω pull up resistor on the host board.

SCL is serial clock signal with 10 K Ω pull up resistor on the host board.

MOD_Det is grounded internally and need 10 K Ω pull up resistor externally to indicate that the module is present.

Note 5: Optional RSSI(default) or NC, RSSI trigger input function can be changed between pin 7 and pin 9 depend on customer's requirement.

Note 6: LOS (Loss of Signal) indicates the status of received optical power with 10 K Ω pull up resistor on the host board. 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.

Note 7: RD -/+ : These are the differential receiver outputs. They are DC-coupled with LVPECL voltage level, and required 100ohm resistor to match the differential termination.

Note 8: 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 300 mA. 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.

Note 9: 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.

Function Description

The transceiver provides high-speed Bi-directional serial optical link for EPON OLT application up to 20km.

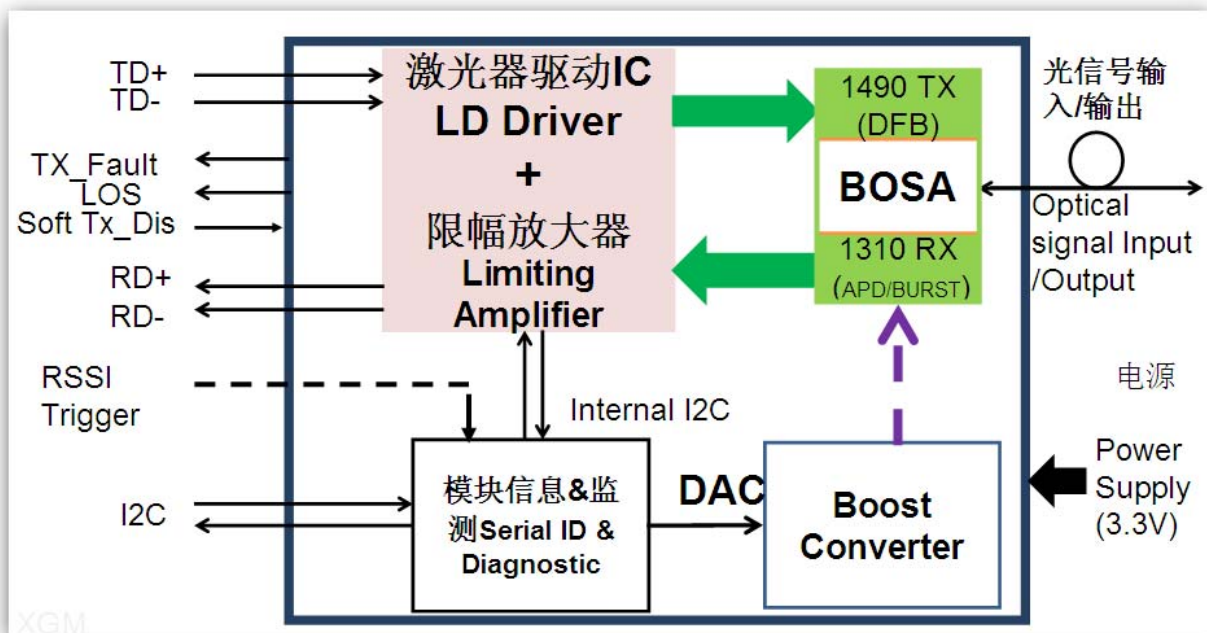


Figure4 Block diagram

The EPON OLT transmitter has a 1490nm DFB laser and a burst mode APD receiver. The transmitter part features AC-coupled differential data inputs and compatible LVPECL voltage level, the receiver part features DC-coupled differential data output and compatible with LVPECL /PECL voltage level.

The 1310nm burst-mode receiver part has a high performance APD detector. The preamplifier (TIA) and limiting amplifier amplify the incoming optical signal into the stable range and convert the signal to differential DC-coupled LVPECL outputs. LOS is LVTTTL output, which logic"0" indicates the input power is lower than the threshold, logic"1" indicates the input power is above the threshold.

Interface Circuit

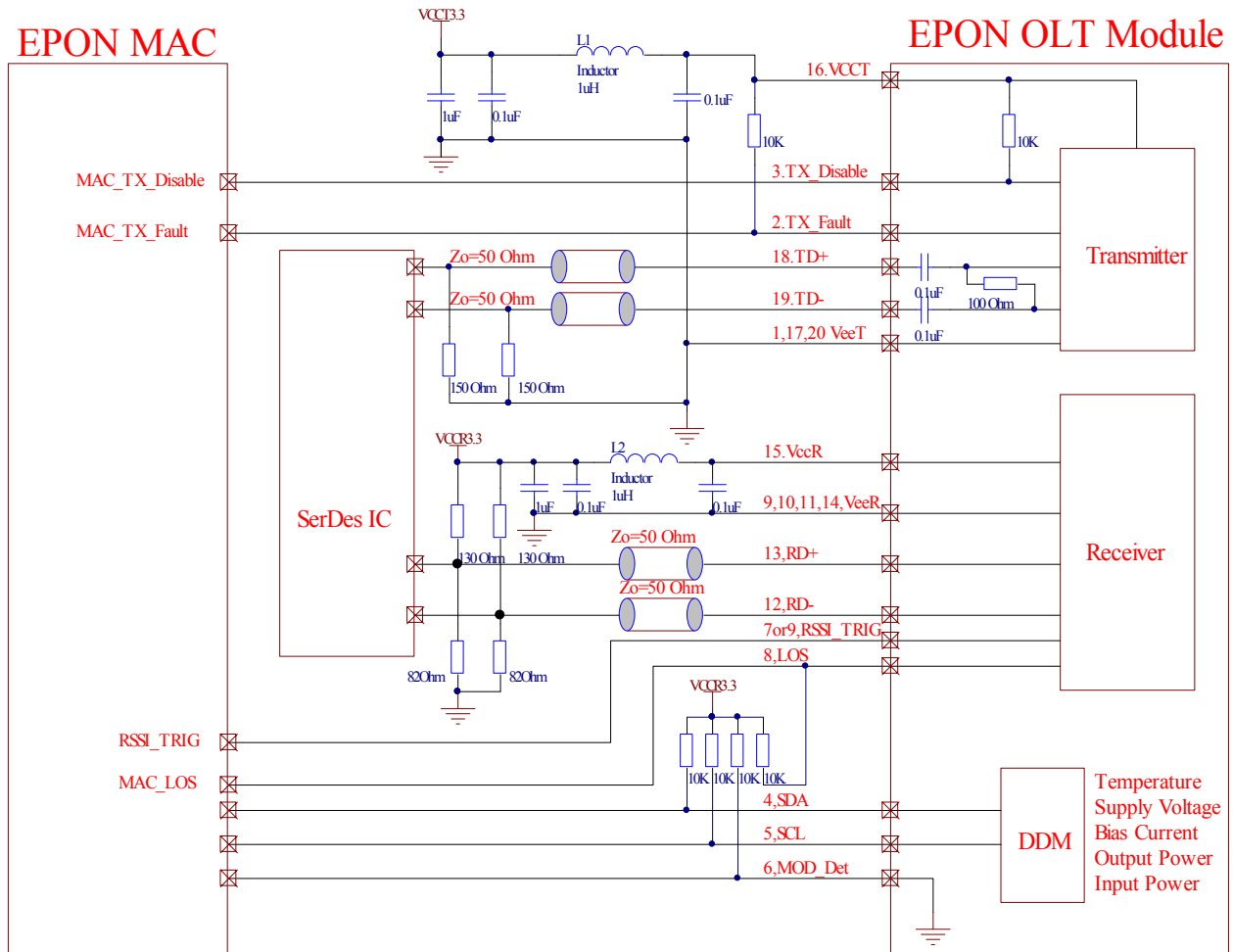


Figure5

Regulatory Compliance

Feature	Test	Method
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class 1 (>0.5kV) – Human Body Model
Electrostatic Discharge (ESD) Immunity	IEC61000-4-2	Class 2 (>4.0kV)
Electromagnetic Interference (EMI)	CISPR22 ITE Class B EN55022 Class B	Compliant with standards

Immunity	IEC61000-4-3 Class 2 EN55024	Typically show no measurable effect from a 3V/m field swept from 80 to 1000MHz applied to the transceiver without a chassis enclosure.
Eye Safety	FDA 21 CFR 1040.10 and 1040.11 Class 1, EN60950, UL TUV EN 60825-1	Compliant with Class 1 laser product
Component Recognition	UL and CSA	Compliant with standards
RoHS	2002/95/EC 4.1&4.2	Compliant with standards

Package Outline

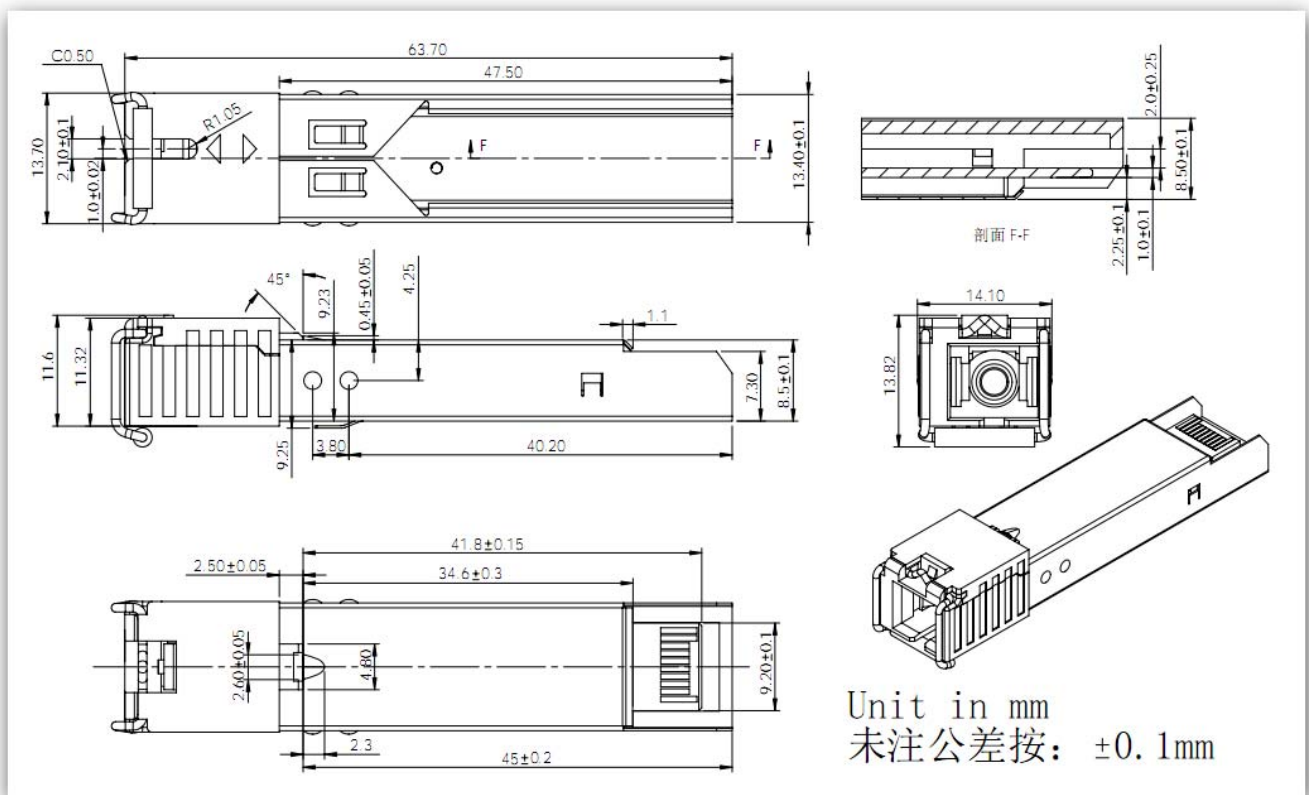


Figure6

Ordering information

PART NO.	Specifications									
	Type	Rate Tx/Rx	Tx (nm)	Po (dBm)	Rx (nm)	Sen (dBm)	Temp (°C)	Reach (km)	DDM	Others
TS-EP-OLT-P+	SFP	1.25/1.25G	1490 DFB	2.5~7	1310 APD	<-30	0~70	20	Y	SC Receptacle BIDI, LOS, TX_Fault,Soft_Tx_Dis

Appendix A. Document Revision

Version No.	Date	Description
V1.0	2014-12-18	Preliminary datasheet