EPON OLT Optical Transceiver SFP Module

SFP-GEPON-LH20

Features

- Integrated Single fiber bi-directional optical subassembly
- 1310nm Burst-mode APD/TIA receiver and 1490nm Continuous DFB laser Transmitter (with WDM)
- SFP metallic package
- 0 to 70^{o}C operating ambient temperature
- Single SC receptacle optical interface compliant
- Hot-pluggable
- +3.3V single power supply
- Low power consumption
- Resetless burst-mode receiver
- Wide dynamic range over 20dB
- Settling time less than 400ns
- Digitalized burst mode optical power monitoring
- LVPECL compatible AC coupled data input interface
- LVPECL compatible DC coupled data output interface
- LVTTL transmitter laser shutdown
- LVTTL receiver burst-power-detect indication
- Class 1 Laser eye safety standard
- Excellent EMI and EMC characteristics
- ESD protection function

Applications

Optical transceiver for 20km Gigabit Ethernet Passive Optical Networks (EPON) OLT side

Standard

IEEE802.3ah 1000BASE-PX20-D

Description

The EPON OLT Transceiver module is designed for Gigabit Ethernet Passive Optical Network（EPON） 20km transmission. The module incorporates 1490nm continuous-mode transmitter and 1310nm burst-mode receiver.

The transmitter section uses a 1490nm DFB laser and an integrated laser driver which is desigened to be class-1 eye safe under any single fault. The laser driver includes APC and temperature compensation functions, which are used for keeping the launch optical power and extinction ratio constant over temperature and aging.

The receiver section uses an integrated APD and BM-preamplifier mounted together. The burst-mode receiver is resetless and wide dynamic range over 20dB can be obtained under whole operating conditions. The module has the function that indicates receiver burst-power-detect signal (active HIGH).

The receiver includes digitalized burst mode optical power monitoring function, which converses any of a received ONU optical power directly in digital, with a Trigger input from system. When rising edge of Trigger detected, the DDM processor starts a burst optical power conversion, the digital result is available via DDM interface after Burst Optical Power Conversion Time. Trigger pulse width should be more than Burst Optical Power Conversion Holding Time.

An integrated WDM coupler can distinguish 1310nm input light from 1490nm output light.

The metallic package guarantees excellent EMI and EMC characteristics.

Absolute Maximum Ratings

Parameter	Symbol	Unit	Min	Max
Operating Temperature Range	T_c	^oC	0	70
Storage Temperature Range	T_s	^oC	-40	85
Relative Humidity	RH	%	5	95
Power Supply Voltage	V_{cc}	V	0	4.6
Pin Input Voltage		V	GND	Vcc
Reciever Damage Threshold		dBm	+4	–

Recommended operating conditions

Parameter	Symbol	Unit	Min	Typ	Max
Operating Voltage	V_{cc}	V	3.135	3.3	3.465
Operating Temperature Range	T_{op}	℃	0	–	70
Operating Data Rate		Gbps	–	1.25±100ppm	–

Specifications(0°C<T_{op}<70°C and 3.135V<V_{cc}<3.465V)

Parameter	Symbol	Unit	Min	Typ	Max	Test condition
Electrical Characteristics						
Operating Voltage	V_{op}	V	3.135	3.3	3.465	
Supply Current	I_{cc}	mA	200	–	300	
LVPECL Single Ended Data Input Swing		mV	300	–	1600	Note7
LVPECL Differential Data Output Swing		mV		1500		Note10
Differential Data input impedance		Ω	–	100	–	Note7
Signal Level(LVTTL H)		V	2.0	–	Vcc	
Signal Level(LVTTL L)		V	0	–	0.8	
Optical transmiter Characteristics						
Data Rate		Mbps	–	1250	–	
Center Wavelength Range	λ_c	nm	1480	1490	1500	DFB-LD
Spectral Width(@-20dB)	Δλ	nm	–	–	1	
Side Mode Suppression Ratio	SMSR	dB	30	–	–	
Launch Optical Power	P_o	dBm	+2	–	+7	Note1
Off level light		dBm	–	–	-39	Note2
Extinction Ratio	EX	dB	9.0	–	–	Note3
Total Jitter	J_{total}	UI	–	–	0.44	
Rise/Fall time(20～80%)	Tr/Tf	ps	–	–	350	Note4
$RIN_{15}OMA$		dB/Hz	–	–	-115	
Optical Return Loss Tolerance		dB	–	–	15	
Maximum reflectance		dB	–	–	-12	λ=1.49μm
Eye Diagram	Compliant with IEEE Std 802.3ah					Note3 Note5

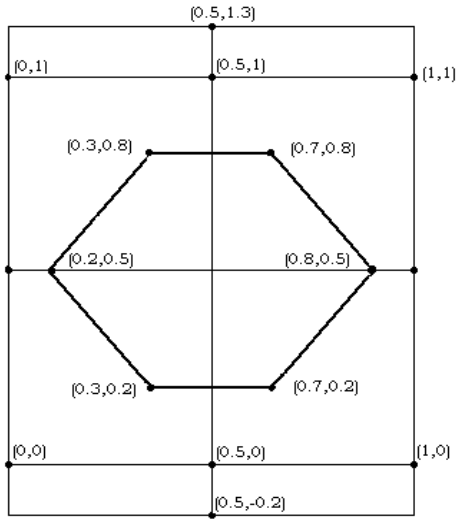
Note1:Coupled into 9/125 SMF

Note2:Measured without data input

Note3:Measured with PRBS 2^7-1 test pattern @1.25Gbps

Note4:Measured with the Bessel-Thompson filter ON

Note5:Mask of diagram



Mask of diagram

Optical receive Characteristics							
Data Rate			Mbps	–	1250	–	
Receiver Sensitivity		S	dBm	–	–	-28	Note6
Overload Input Optical Power		P_{in}	dBm	-6	–	–	Note6
Center Wavelength Range		λ_c	nm	1260	1310	1360	
Reciever Settling Time		$T_{settling}$	ns	–	–	400	Note8
Reciever Dynamic range			dB	20	–	–	Note9
Receiver reflectance			dB	–	–	-12	λ=1.31μm
BPD(LVTTL)	Optical Dessert		dBm	-45	–	–	Note11
	Optical Assert			–	–	-31	
BPD Hysteresis			dB	0.5	–	6	Note11
Measurement Accuracy of received burst optical power, range from -10dBm to -30dBm			dB	-1		+1	
Burst optical power conversion settling time		BOPCS Time	ns			250	Figure 1
Burst optical power conversion holding time		Holding Time	ns	400			Figure 1
Burst optical power conversion time			us			500	result can be read out since trigger is High
Burst optical power conversion interval time			ms	1.0			means 1000 conversions/s max.

Note6:Measured with PRBS 2^7-1 test pattern @1.25Gbps with Tx on,ER=10dB,BER<=10E-12.
Note7:AC coupled internal(see the recommended circuit below).

Note8:Define $T_{settling}$ as the time from the Tx_BEN assertion,minus the Ton time,to the time the electrical signal the Reciever output reaches within 15% of its steady state conditions.It is shown in the Figure 1.

Note9:See Figure 2.

Note10:LVPECL output, DC coupled internal（see the recommended circuit on page 14).

Note11:Burst optical Power received Detect.

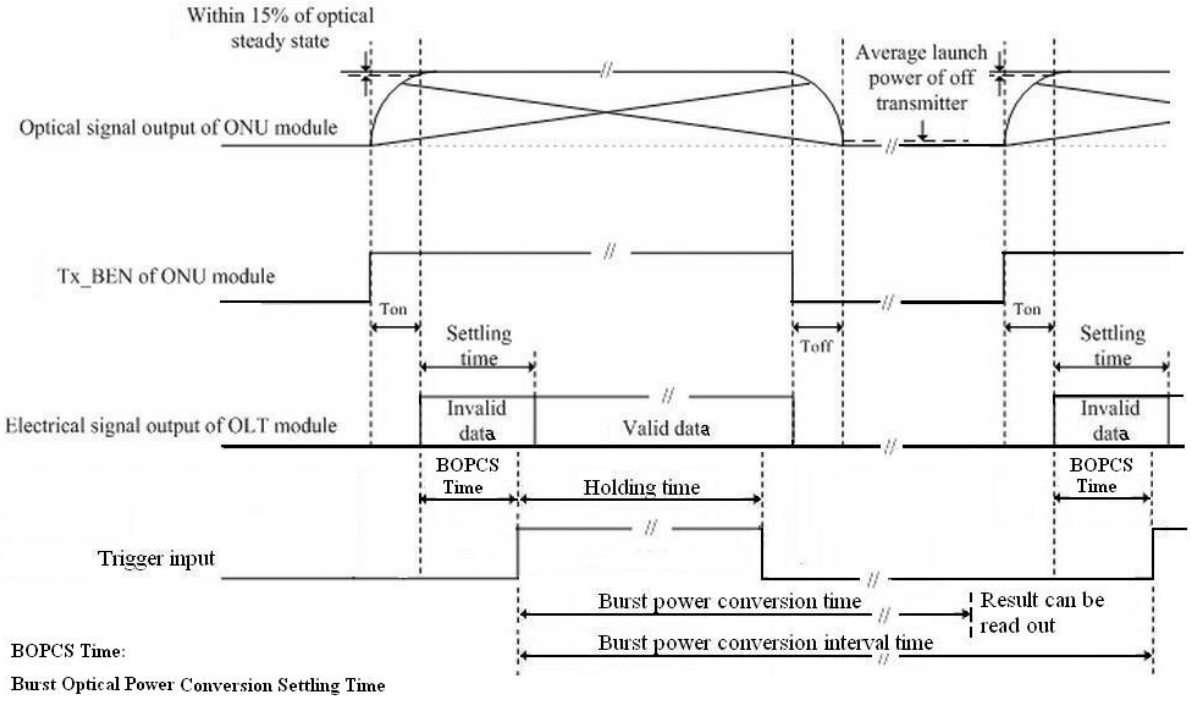


Figure1 Time parameter definition in EPON system

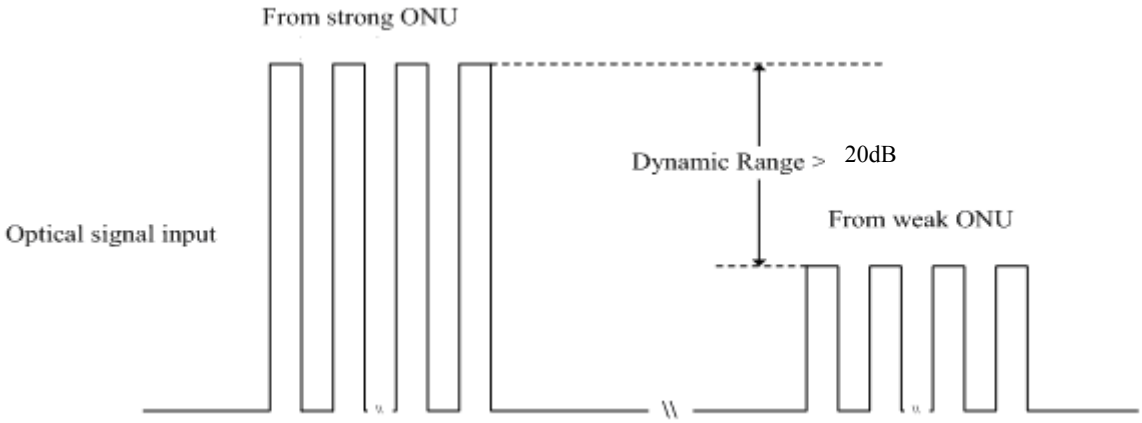
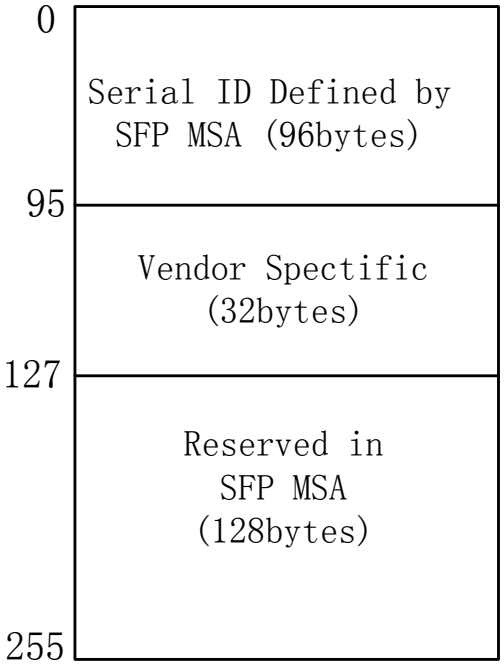


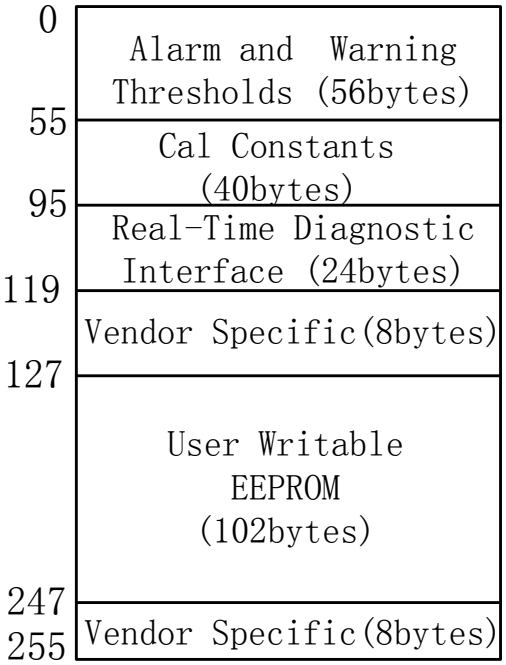
Figure2 Burst_mode Reciever Dynamic range in EPON system

Memory Map

2 wire address 1010000X (A0)



2 wire address 1010001X(A2)



EEPROM Serial ID Memory Contents

Accessing Serial ID Memory uses the 2 wire address 1010000X (A0). Memory Contents of Serial ID are shown in Table below.

Table 1 Serial ID Memory Contents

Data Address	Size (Bytes)	Name of Field	Contents(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	01	Connector
3-10	8	Transceiver	00 00 00 80 00 00 00 00	1000BASE-PX
11	1	Encoding	01	8B10B
12	1	BR, Nominal	0D	1250Mbps
13	1	Reserved	00	
14	1	Length (9μm) km	14	Transceiver transmit distance 20km
15	1	Length (9μm) 100m	C8	
16	1	Length (50μm) 10m	00	
17	1	Length(62.5μm)10m	00	
18	1	Length (Copper)	00	Not compliant
19	1	Reserved	00	
20-35	16	Vendor name	57 54 44 20 20 20 20 20 20 20 20 20 20 20 20 20	GCOM
36	1	Reserved	00	
37-39	3	Vendor OUI	00 00 00	
40-55	16	Vendor PN	52 54 58 4D 31 36 38 2D 34 31 35 20 20 20 20 20	“RTXM168-415” Transceiver part number
56-59	4	Vendor rev	20 20 20 20	
60-61	2	Wavelength	05 D2	1490nm downstream TX
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 1C	TX_DISABLE, TX_FAULT and Burst Power Detect implemented.
66	1	BR,max	00	
67	1	BR,min	00	
68-83	16	Vendor SN	42 30 30 39 38 32 32 20 20 20 20 20 20 20 20 20	Serial Number of transceiver (ASCII). For example “B009822”.
84-91	8	Date code	30 32 31 30 30 35 20 20	Manufactory date code. For example “021005”.

92	1	Diagnostic Monitoring Type	60	DDM implemented, internal calibration
93	1	Enhanced Options	80	Alarm/warning flags implemented.
94	1	SFF-8472 compliance	02	Rev 9.5 of SFF-8472
95	1	CC_EXT	Check Sum (Variable)	Check sum for Extended ID Field.
VENDOR SPECIFIC ID FIELDS				
96-127	32	Vendor Specific	Read only	Depends on customer information
128-255	128	Reserved	Read only	Filled by zero

Diagnostic Monitor Functions

Diagnostic Monitor Functions interface uses the 2 wire address 1010001X (A2). Memory contents of Diagnostic Monitor Functions are shown in Table below

Table 2 Memory contents of Diagnostic Monitor Function

Data Address	Field Size (bytes)	Name	Contents and Description
Alarm and Warning Thresholds			
00-01	2	Temperature High Alarm	Set to 85 °C
02-03	2	Temperature Low Alarm	Set to -5 °C
04-05	2	Temperature High Warning	Set to 75 °C
06-07	2	Temperature Low Warning	Set to 0 °C
08-09	2	Vcc High Alarm	Set to 3.6 V
10-11	2	Vcc Low Alarm	Set to 3.0 V
12-13	2	Vcc High Warning	Set to 3.5 V
14-15	2	Vcc Low Warning	Set to 3.1 V
16-17	2	Bias High Alarm	50mA
18-19	2	Bias Low Alarm	3.75mA
20-21	2	Bias High Warning	40mA
22-23	2	Bias Low Warning	7.5mA
24-25	2	TX Power High Alarm	+6dBm
26-27	2	TX Power Low Alarm	+2dBm
28-29	2	TX Power High Warning	+5dBm
30-31	2	TX Power Low Warning	+3dBm
32-33	2	RX Power High Alarm	-6dBm
34-35	2	RX Power Low Alarm	-30dBm
36-37	2	RX Power High Warning	-9dBm
38-39	2	RX Power Low Warning	-27dBm
40-55	16	Reserved	

Calibration Constants			
56-59	4	RX Power Calibration Data4	Single precision floating-point numbers (various values at each device)
60-63	4	RX Power Calibration Data3	
64-67	4	RX Power Calibration Data2	Single precision floating-point numbers (various values at each device)
68-71	4	RX Power Calibration Data1	
72-75	4	RX Power Calibration Data0	
76-77	2	Bias Calibration Data1	00 01 (fixed)
78-79	2	Bias Calibration Data0	00 00 (fixed)
80-81	2	TX Power Calibration Data1	00 01 (fixed)
82-83	2	TX Power Calibration Data0	00 00 (fixed)
84-85	2	Temperature Calibration Data1	00 01 (fixed)
86-87	2	Temperature Calibration Data0	00 00 (fixed)
88-89	2	Vcc Calibration Data1	00 01 (fixed)
90-91	2	Vcc Calibration Data0	00 00 (fixed)
92-94	3	Reserved	00 00 00 (fixed)
95	1	Check Sum	Checksum of bytes 0-94
Real Time Diagnostic Monitor Interface			
96-97	2	Measured Temperature	Yield to a 16-bit A/D value (see Table 2.1)
98-99	2	Measured Vcc	Yield a 16-bit A/D value (see Table 2.1)
100-101	2	Measured Bias	Yield a 16-bit A/D value (see Table 2.1)
102-103	2	Measured TX Power	Yield a 16-bit A/D value (see Table 2.1)
104-105	2	Measured RX Power	Yield a 16-bit A/D value (see Table 2.1)
106-109	4	Reserved	
110	1	Logic Status	See Table 2.2
111	1	AD Conversion Updates	See Table 2.2
112-119	8	Alarm and Warning Flags	See Table 2.3
Vendor Specific			
120-127	8	Vendor Specific	Don’t Access
128-247	120	User writable EEPROM	
248-255	8	Vendor Specific	Don’t Access

The measured values located at bytes 96-105(in the 2 wire address 0xA2) are raw A/D values (16-bit integers) of transceiver temperature, supply voltage, laser bias current, laser optical output power and received power. All the measured values are “Internally Calibrated”, and then it is necessary to convert raw A/D values to real world units by the manner as shown in Table 2.1

Table 2.1 Real Time Diagnostic Monitor Values

Byte	Name	Description
96	Temperature MSB	Internally measured transceiver temperature. Comply with Internal Calibration of SFF-8472.
97	Temperature LSB	
98	Vcc MSB	Internally measured supply voltage. Comply with Internal Calibration of SFF-8472.
99	Vcc LSB	
100	Laser Bias MSB	Measured Laser bias current. Comply with Internal Calibration of SFF-8472.
101	Laser Bias LSB	
102	Tx Power MSB	Measured Tx power. Comply with Internal Calibration of SFF-8472.
103	Tx Power LSB	
104	Rx Power MSB	Measured Rx power. Comply with Internal Calibration of SFF-8472.
105	Rx Power LSB	

This transceiver implements two optional status bytes, "Logic States" at byte 110(0xA2)" and "A/D Updated" at byte 111(0xA2) as shown in Table 2.2. "A/D Updated" status bits allow the user to verify if an update from the analog-digital conversion has occurred of the measured values, temperature, Vcc, laser bias, Tx power and Rx power. The user writes the byte to 0x00. Once a conversion is completed for a given value, its bit will change to '1'.

Table 2.2 Logic Status and AD Conversion Updates

Byte	Bit	Name	Description
110	7	Tx Disable State	Optional digital State of the Tx Disable input pin.
110	6	Soft Tx Disable Control	Not supported (set to 0).
110	5	Reserved	Set to 0.
110	4	Rx Rate Select State	Not supported (set to 1).
110	3	Soft Rate Select Control	Not supported (set to 0).
110	2	Tx Fault	Optional digital state of the Tx Fault output pin.
110	1	LOS	Not supported.
110	0	Power on Logic	Bit will be 0 when the analog monitoring is active.
111	7	Temp A/D Valid	Indicates A/D value in Bytes 96/97 is valid.
111	6	Vcc A/D Valid	Indicates A/D value in Bytes 98/99 is valid.
111	5	Laser Bias A/D Valid	Indicates A/D value in Bytes 100/101 is valid.
111	4	Tx Power A/D Valid	Indicates A/D value in Bytes 102/103 is valid.
111	3	Rx Power A/D Valid	Indicates A/D value in Bytes 104/105 is valid.
111	2	Reserved	Set to 0.
111	1	Reserved	Set to 0.
111	0	Reserved	Set to 0.

Each of the measured values has a corresponding high alarm, low alarm, high warning and low warning threshold level at location 00-39(0xA2) written as the data format of a corresponding valued shown in Table 3.3.Alarm and warning flags at bytes 112-119(0xA2) are defined as follows.

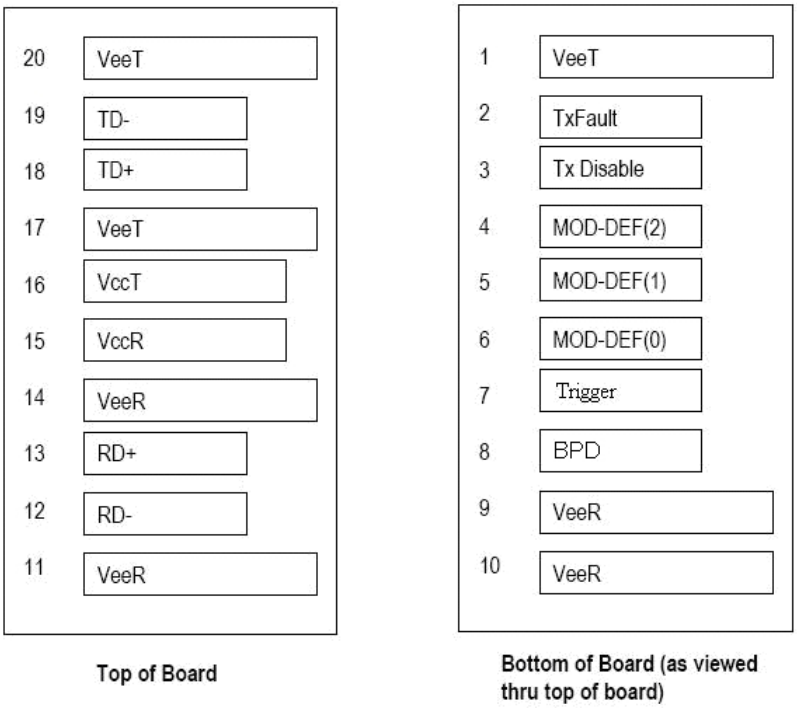
(1) Alarm flags indicate conditions likely to result (or have resulted) in link failure and cause for immediate action.

(2) Warning flags indicate conditions outside the guaranteed operating specification of transceiver but not necessarily causes of immediate link failures.

Table 2.3 Alarm and Warning Flags

Byte	Bit(s)	Name	Description
112	7	Temperature High Alarm	Set when temperature monitor value exceeds high alarm level.
112	6	Temperature Low Alarm	Set when temperature monitor value exceeds low alarm level.
112	5	Vcc High Alarm	Set when Vcc monitor value exceeds high alarm level.
112	4	Vcc Low Alarm	Set when Vcc monitor value exceeds Low alarm level.
112	3	Laser Bias High Alarm	Set when laser bias monitor value exceeds high alarm level.
112	2	Laser Bias Low Alarm	Set when laser bias monitor value exceeds low alarm level.
112	1	Tx Power High Alarm	Set when Tx power monitor value exceeds high alarm level
112	0	Tx Power Low Alarm	Set when Tx power monitor value exceeds low alarm level.
113	7	Rx Power High Alarm	Set when Rx power monitor value exceeds high alarm level
113	6	Rx Power Low Alarm	Set when Rx power monitor value exceeds low alarm level
113	5-0	Reserved	All bits set to 0.
114	7-0	Reserved	All bits set to 0.
115	7-0	Reserved	All bits set to 0.
116	7	Temperature High warning	Set when temperature monitor value exceeds high warning level.
116	6	Temperature Low warning	Set when temperature monitor value exceeds low warning level.
116	5	Vcc High warning	Set when Vcc monitor value exceeds high warning level.
116	4	Vcc Low warning	Set when Vcc monitor value exceeds Low warning level.
116	3	Laser Bias High warning	Set when laser bias monitor value exceeds high warning level.
116	2	Laser Bias Low warning	Set when laser bias monitor value exceeds low warning level.
116	1	Tx Power High warning	Set when Tx power monitor value exceeds high warning level
116	0	Tx Power Low warning	Set when Tx power monitor value exceeds low warning level.
117	7	Rx Power High warning	Set when Rx power monitor value exceeds high warning level
117	6	Rx Power Low warning	Set when Rx power monitor value exceeds low warning level
117	5-0	Reserved	All bits set to 0.
118	7-0	Reserved	All bits set to 0.
119	7-0	Reserved	All bits set to 0.

Pin Descirption



Pin	Name	Function/Description	Engagement order	Notes
1	VeeT	Transmitter Ground	1	
2	TX Fault	Transmitter Fault Indication	3	1
3	TX Disable	Transmitter Disable-Module disables on high or open	3	2
4	MOD-DEF2	Module Definition 2-Two wire serial ID interface	3	3
5	MOD-DEF1	Module Definition 1-Two wire serial ID interface	3	3
6	MOD-DEF0	Module Definition 0-Two wire serial ID interface	3	3
7	Trigger	Trigger input of burst signal packet received	3	
8	BPD	Burst Power Detect (active HIGH)	3	4
9	VeeR	Receiver Ground	1	
10	VeeR	Receiver Ground	1	
11	VeeR	Receiver Ground	1	
12	RD-	Inverse Received Data out	3	5
13	RD+	Received Data out	3	5
14	VeeR	Receiver Ground	1	
15	VccR	Receiver Power —— +3.3V±5%	2	6
16	VccT	Transmitter Power —— +3.3 V±5%	2	6
17	VeeT	Transmitter Ground	1	
18	TD+	Transmitter Data In	3	7
19	TD-	Inverse Transmitter Data In	3	7
20	VeeT	Transmitter Ground	1	

Note1. TX Fault is open collector/drain output which should be pulled up externally with a 4.7K – 10KΩ resistor on the host

board to supply <VccT+0.3V or VccR+0.3V. When high, this output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to <0.8V.

Note2. TX Disable input is used to shut down the laser output per the state table below. It is pulled up within the module with a 4.7 – 10K resistor.

Low (0 – 0.8V): Transmitter on

Between (0.8V and 2V): Undefined

High (2.0 – VccT): Transmitter Disabled

Open : Transmitter Disabled

Note3. Mod-Def 0, 1, 2. These are the module definition pins. They should be pulled up with a 4.7 - 10K resistor on the host board to supply less than VccT+0.3V or VccR+0.3V.

Mod-Def 0 is grounded by the module to indicate that the module is present.

Mod-Def 1 is clock line of two wire serial interface for optional serial ID.

Mod-Def 2 is data line of two wire serial interface for optional serial ID.

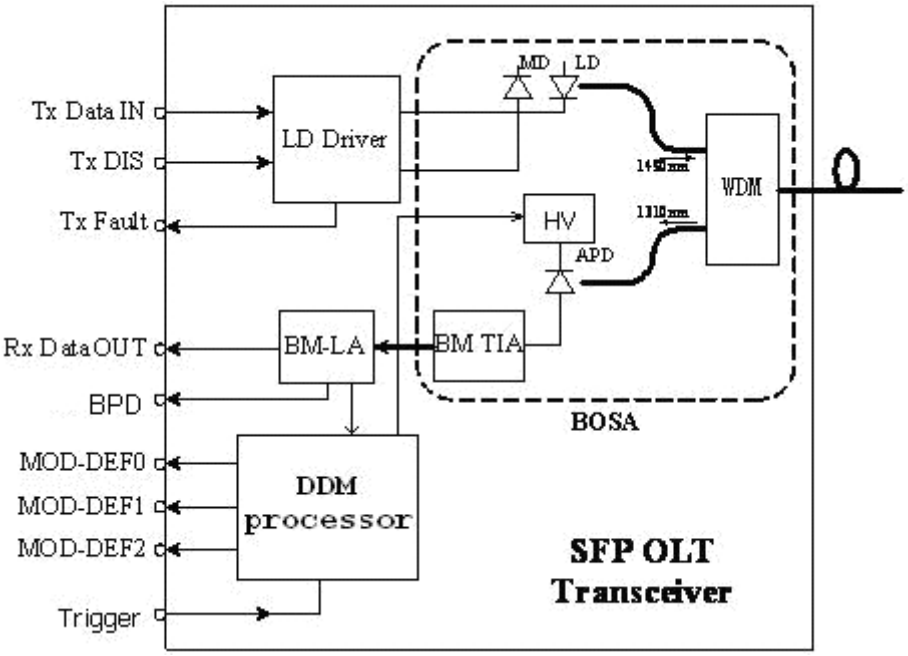
Note4. BPD (Burst Power Detect) is pulled up internally with a 10K resistor to VccR. When LOW, this output indicates the received optical power is below the worst case receiver sensitivity (as defined by the standard in use). HIGH indicates normal operation. In the low state, the output will be pulled to <0.8V.

Note5. RD-/+: These are the differential receiver outputs. They are DC coupled with Z0=100 OHM differential lines which should be terminated with LVPECL differential input at user SERDES. Please see recommended circuit on page 14

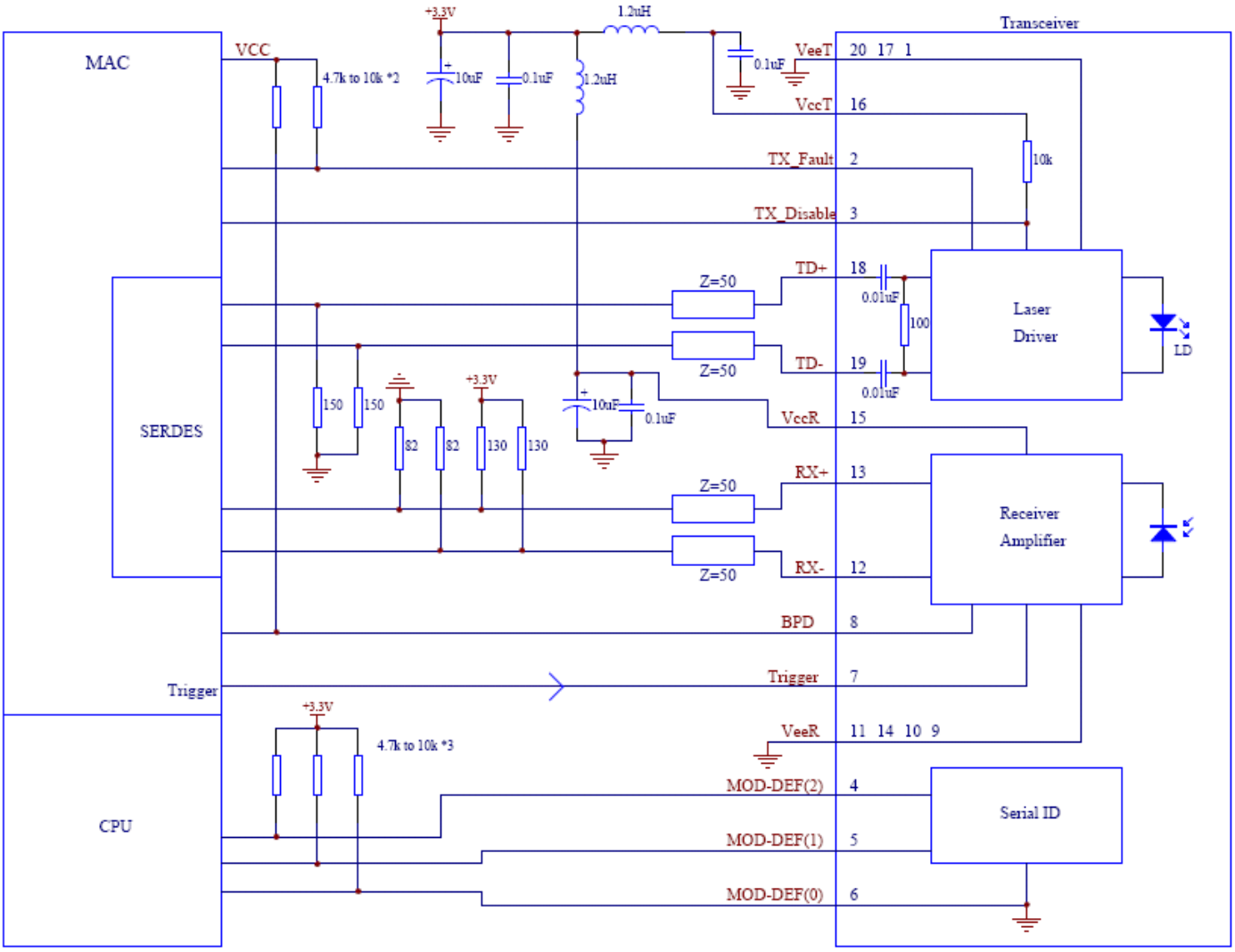
Note6. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V±5% at the SFP connector pin. The in-rush current will typically be no more than 30mA above steady state supply current after 500ns.

Note7. TD-/+: These are the differential transmitter inputs. They are AC coupled differential lines with 100 OHM differential termination inside the module. The AC coupling is done inside the module and is thus not required on host board.

Block diagram

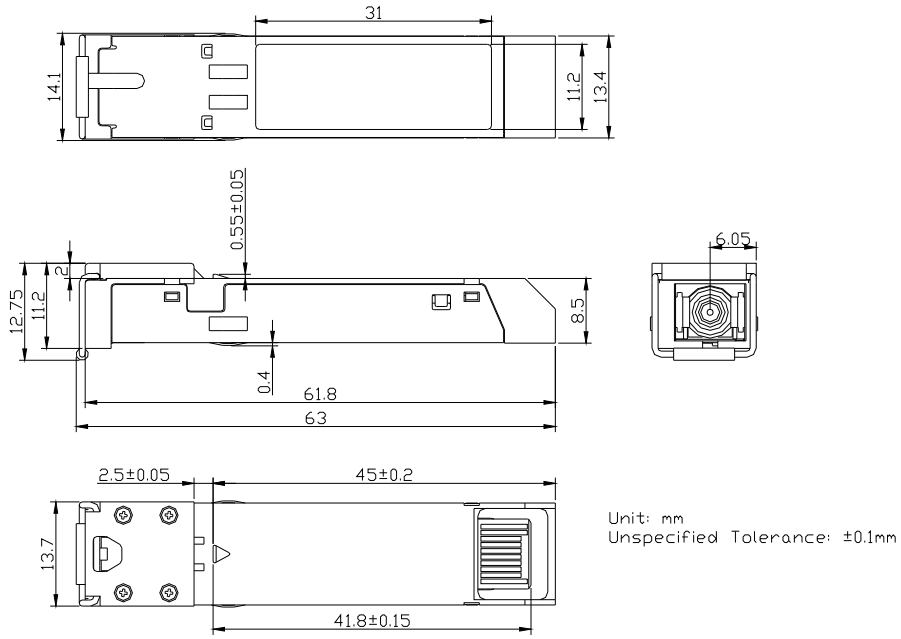


Typical application circuit



Package outline

Units in mm



Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class 1 (>1.5kV) – 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	Compliant with Class 1 laser product
	UL	
	TUV EN 60825-1	

	Package	Data Rate	Laser	Optical Power	Detector	Data Rate	Sensitivity	Temp	Standrad	Application Code
	SFP	1.25Gb/s	1490nm DFB	2 ~ 7dBm	APD	1.25Gb/s	<-28dBm	0~70°C	GEPON OLT 20km	