

10G EPON ONU PRX30 SFP+ Transceiver

PNES1-02A

Features

- SFP+ Package.
- Single Power Supply +3.3 Voltage.
- Sleep Mode compliance
- Single Fiber Bi-Directional SC/UPC receptacle.
- Burst-Mode Transmitter, operation wavelength at 1310nm, 1.25Gbps
- Continuous-Mode Receiver, operation wavelength at 1577nm, 10.3125Gbps
- SFP electrical interface
- 2-wire interface for integrated Digital Diagnostic monitoring
- Operating temperature range: -40 °C ~+85 °C

Applications

- 10 Gigabit PON ONU for P2MP application

Compliance

- Compliant with IEEE 802.3av PRX30
- RoHS compliance



Description

The HG Genuine PNES1-02A transceiver consists of a 1310nm DFB laser, 1577nm APD photodiode WDM filter and Preamplifier in a high-integrated optical sub-assembly for 1.25G upstream and 10G downstream EPON applications up to 20km. The optical interface is SC/UPC receptacle. It adopts SFP+ Package. Power supply is single +3.3 Voltage.

Specification

Absolute Maximum Ratings

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Storage Temperature	T _{STG}	-40		85	°C	
Operating Relative Humidity		5		95	%	
Supply Voltage	V _{CC}	-0.5		4	V	

Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Case Operation Temperature	T _a	-40		85	°C	
Supply Voltage	V _{CC}	3.135	3.3	3.465	V	
Module Power Dissipation	P			1.3	W	

Tested under recommended operating conditions, unless otherwise noted

Transmitter Operating Characteristic-Optical, Electrical

Parameter	Symbol	Min	Typical	Max	Units	Notes
Data Rate	BR		1.25		Gb/s	
Transmitter differential input voltage		200	-	1600	mV	
Tx burst input	V _{OH}	2.0	-	V _{CC}	V	LVTTL
	V _{OL}	0	-	0.8		LVTTL
Tx _SD Voltage	V _{OH}	2.4	-	V _{CC}	V	LVTTL
	V _{OL}	0	-	0.4		LVTTL
Center Wavelength	λ _c	1260	1310	1360	nm	
Optical Power Output	BOL	P _o	1.62	5.62	dBm	
	EOL			0.62		
Spectral Width@-20dB	Δλ			1	nm	
Side Mode Suppression Ratio	SMSR	30	-	-	dB	
Extinction Ratio	ER	6			dB	
Transmitter and Dispersion Penalty	TDP	-	-	1.4	dB	1
Output Optical Eye	Compliant with IEEE 802.3av					
Average launch power of OFF transmitter	P _{off}			-45	dBm	
Optical Burst On Time	T _{on}			30	ns	
Optical Burst Off Time	T _{off}			30	ns	
Tx_indication assert	T _{indi-on}			1000	ns	
Tx_indication deassert	T _{indi-off}			1000	ns	

Receiver Operating Characteristic-Optical, Electrical							
Parameter	Symbol	Min	Typical	Max	Units	Notes	
Data Rate	BR		10.3125		Gb/s		
Receiver differential output voltage		300	-	850	mV		
Rx_LOS Voltage	V _{OH}	2.4	-	V _{cc}	V	LVTTTL	
	V _{OL}	0	-	0.4		LVTTTL	
Sensitivity	BOL	RX _{sens}	-	-	-29	dBm	2
	EOL		-	-	-28.5		
Maximum Overload Power	RX _{OVERLOAD}	-8	-	-	dBm		
Maximum Input Power	RX _{max}	0			dBm		
Input Operating Wavelength	λ _{RX}	1575	1577	1580	nm		
Optical reflectance	R _{RX}	-	-	-12	dB	λ =1577nm	
Rx_LOS Assert	P _A	-45	-	-	dBm		
Rx_LOS Deassert	P _D	-	-	-29.5	dBm		
Hysteresis	P _A - P _D	0.5	2.5	6	dB		

Notes:

[1] Transmit on 20km SMF.

[2] Measured with PRBS 2³¹-1 test pattern @10.3125Gbps with Tx on, ER=8dB, BER=10⁻³.

Digital Diagnostic Memory Map

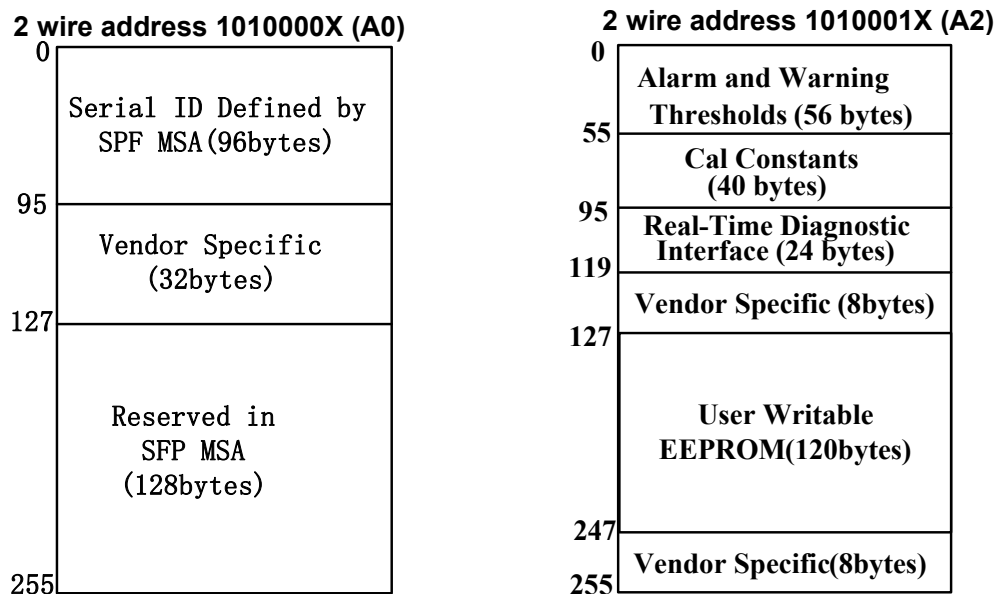


Figure1

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 1

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	SC Connector
3-10	8	Transceiver	0x00 0x00 0x00 0x00 0x00 0x00 0x00 0x00	
11	1	Encoding	01	8B/10B
12	1	BR, Nominal	0D	1250bps
13	1	Reserved	00	
14	1	Length (9μm) km	14	20km
15	1	Length (9μm) 100m	C8	20km
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	48 47 20 47 45 4E 55 49 4E 45 20 20 20 20 20 20	"HG GENUINE" (ASCII)
36	1	Reserved	00	
37-39	3	Vendor OUI	00 00 00	
40-55	16	Vendor PN	50 4E 45 53 31 2D 30 32 41 20 20 20 20 20 20 20	"PNES1-02A" (ASCII)
56-59	4	Vendor rev	00 00 00 00	
60-61	2	Wavelength	05 1E	Transceiver 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 0C	Soft TX_FAULT,RX_LOS,implemented
66	1	BR, max	00	
67	1	BR, min	00	
68-83	16	Vendor SN	30 30 34 39 34 39 30 35 20 20 20 20 20 20 20 20	Serial Number of transceiver (ASCII). For example "00494905".

84-91	8	Date code	31 36 30 35 30 35 20 20	Manufacture date code. For example "160505".
92	1	Diagnostic Monitoring Type	68	Digital diagnostic monitoring implemented, "internally calibrated" is implemented. RX measurement type is "Average Power".
93	1	Enhanced Options	B0	Optional Alarm/Warning flags implemented for all monitored quantities, Optional Soft TX_FAULT monitoring implemented, Optional Soft RX_LOS monitoring implemented.
94	1	SFF_8472 Compliance	03	Includes functionality described in Rev 10.2 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

Diagnostic Monitor Functions

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

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	MSB at low address, 90°C
02-03	2	Temperature Low Alarm	MSB at low address, -45°C
04-05	2	Temperature High Warning	MSB at low address, 85°C
06-07	2	Temperature Low Warning	MSB at low address, - 40°C
08-09	2	Vcc High Alarm	MSB at low address, 3.63V
10-11	2	Vcc Low Alarm	MSB at low address, 2.97V
12-13	2	Vcc High Warning	MSB at low address, 3.47V
14-15	2	Vcc Low Warning	MSB at low address, 3.13V
16-17	2	Bias High Alarm	MSB at low address
18-19	2	Bias Low Alarm	MSB at low address
20-21	2	Bias High Warning	MSB at low address
22-23	2	Bias Low Warning	MSB at low address
24-25	2	TX Power High Alarm	MSB at low address, 6.62dBm
26-27	2	TX Power Low Alarm	MSB at low address, -0.48dBm
28-29	2	TX Power High Warning	MSB at low address, 5.62dBm
30-31	2	TX Power Low Warning	MSB at low address, 0.62dBm
32-33	2	RX Power High Alarm	MSB at low address, -9.0dBm

34-35	2	RX Power Low Alarm	MSB at low address,-29.5dBm
36-37	2	RX Power High Warning	MSB at low address,-10.0dBm
38-39	2	RX Power Low Warning	MSB at low address, -28.5dBm
40-55	16	Reserved	
Calibration Constants			
56-59	4	RX Power Calibration Data4	00 00 (fixed)
60-63	4	RX Power Calibration Data3	00 00 (fixed)
64-67	4	RX Power Calibration Data2	00 00 (fixed)
68-71	4	RX Power Calibration Data1	00 01 (fixed)
72-75	4	RX Power Calibration Data0	00 00 (fixed)
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 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	Reserved	
112-119	8	Alarm and Warning Flags	See Table 2.3
Vendor Specific			
120-127	8	Vendor Specific	Vendor Specific
128-247	120	User writable EEPROM	User writable EEPROM
248-255	8	Vendor Specific	Vendor Specific

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 “Externally 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. Compliant with External Calibration of SFF-8472.
97	Temperature LSB	
98	V _{CC} MSB	Internally measured supply voltage. Compliant with External Calibration of SFF-8472.
99	V _{CC} LSB	
100	Laser Bias MSB	Measured Laser bias current. Compliant with External Calibration of SFF-8472.
101	Laser Bias LSB	
102	Tx Power MSB	Measured Tx power. Compliant with External Calibration of SFF-8472.
103	Tx Power LSB	
104	Rx Power MSB	Measured Tx power. Compliant with External Calibration of SFF-8472.
105	Rx Power LSB	

This transceiver implements one optional status bytes, “Logic States” at byte 110(0xA2)” as shown in Table 2.2.

Table 2.2 Logic Status and AD Conversion Updates

Byte	Bit	Name	Description
110	7	Reserved	Reserved
110	6	Reserved	Reserved
110	5	Reserved	Reserved
110	4	Reserved	Reserved
110	3	Reserved	Reserved
110	2	Tx Fault	Optional digital state of the Tx Fault output pin.
110	1	RX_LOS	Optional digital state of the RX_LOS output pin.
110	0	Reserved	Reserved

Each of the measured values has a corresponding high alarm, low alarm, high warning and low warning threshold level at location 00-39(x0A2) written as the data format of a corresponding valued shown in Table 2.3. 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	V _{CC} High Alarm	Set when V _{CC} monitor value exceeds high alarm level.
112	4	V _{CC} Low Alarm	Set when V _{CC} 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.

Internal Calibration

Measurements stored in data address byte 96~ 105 are calibrated over transceiver operating temperature and supply voltage and are interpreted as defined in SFF-8472 Rev9.5. Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

External Calibration

Measurements are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at 2 wire serial bus address A2h. Calibration is valid over transceiver operating temperature and voltage.

Alarm and warning threshold values should be interpreted in the same manner as real time 16 bit data.

After calibration per the equations given below for each variable as described in SFF-8472 Rev9.5, the results are consistent with the accuracy and resolution goals for internally calibrated devices.

Internally measured transceiver temperature. Temperature, **T** (°C), is given by

$$T = \text{TSLOPE} * \text{TAD} + \text{TOFFSET}$$

Where **TAD** is 16-bit signed 2's complement A/D value at bytes 96-97, **TSLOPE** is unsigned fixed-point value at bytes 84-85 and **TOFFSET** is signed 2's complement value with LSB equal to 1/256 deg-C at bytes 86-87. The result, **T**, is 16-bit signed 2's complement value with LSB equal to 1/256 OC, yielding a total range of -128 OC to +128 OC.

Internally measured supply voltage: Voltage, **V** (μV), is given by

$$\mathbf{V = VSLOPE * VAD + VOFFSET}$$

Where **VAD** is 16-bit unsigned A/D value at bytes 98-99, **VSLOPE** is unsigned fixed-point value at bytes 88-89 and **VOFFSET** is signed 2's complement value with LSB equal to 100 μV at bytes 90-91. The result, **V**, is 16-bit unsigned value with LSB equal to 100 μV , yielding a total range of 0-6.55V.

Measured transmitter laser bias current: Current (μA), **I**, is given by

$$\mathbf{I = ISLOPE * IAD + IOFFSET}$$

Where **IAD** is 16-bit unsigned A/D value at bytes 100-101, **ISLOPE** is unsigned fixed-point value at bytes 76-77 and **IOFFSET** is signed 2's complement value with LSB equal to 2 μA at bytes 78-79. The result, **I**, is 16-bit unsigned value with LSB equal to 2 μA , yielding a total range of 0-131mA.

Measured coupled TX optical output power: Power, **TX_P** (μW), is given by

$$\mathbf{TX_P = TX_PSLOPE * TX_PAD + TX_POFFSET}$$

Where **TX_PAD** is 16-bit unsigned A/D value at bytes 102-103, **TX_PSLOPE** is unsigned fixed-point value at bytes 80-81 and **TX_POFFSET** is signed 2's complement value with LSB equal to 0.1 μW at bytes 82-83. The result, **TX_P**, is 16-bit unsigned value with LSB equal to 0.1 μW , yielding a total range of 0-6.5mW.

Measured received optical power: Power, **RX_P** (μW), is given by

$$\mathbf{RX_P = R4 * RX_PAD^4 + R3 * RX_PAD^3 + R2 * RX_PAD^2 + R1 * RX_PAD + R0}$$

Where **RAD** is 16-bit unsigned A/D value at bytes 104-105 and **R4**, **R3**, **R2**, **R1** and **R0** are single precision floating-point values at bytes 56-75. The maximum value for **R4**, **R3**, **R2**, **R1** and **R0** is 1e8. The result, **RX_P**, is 16-bit unsigned value with LSB equal to 0.1 μW , yielding a total range of 0-6.5mW.

Digital Diagnostic Monitor Accuracy

Parameter	Range	Actual Value	Calibration Option	Note
Transceiver Temperature	-40~85°C	±3°C	Internal calibration	Recommended Operating Conditions
Power Supply Voltage	3.0-3.6V	±3%	Internal calibration	Recommended Operating Conditions
Tx Bias Current	0~100mA	±10%	Internal calibration	Recommended Operating Conditions
Tx BM Optical Power	0.62~5.62dBm	±3dB	Internal calibration	Recommended Operating Conditions
Rx Optical Power	-29~-8dBm	±3dB	Internal calibration	Recommended Operating Conditions

Pin-out Description

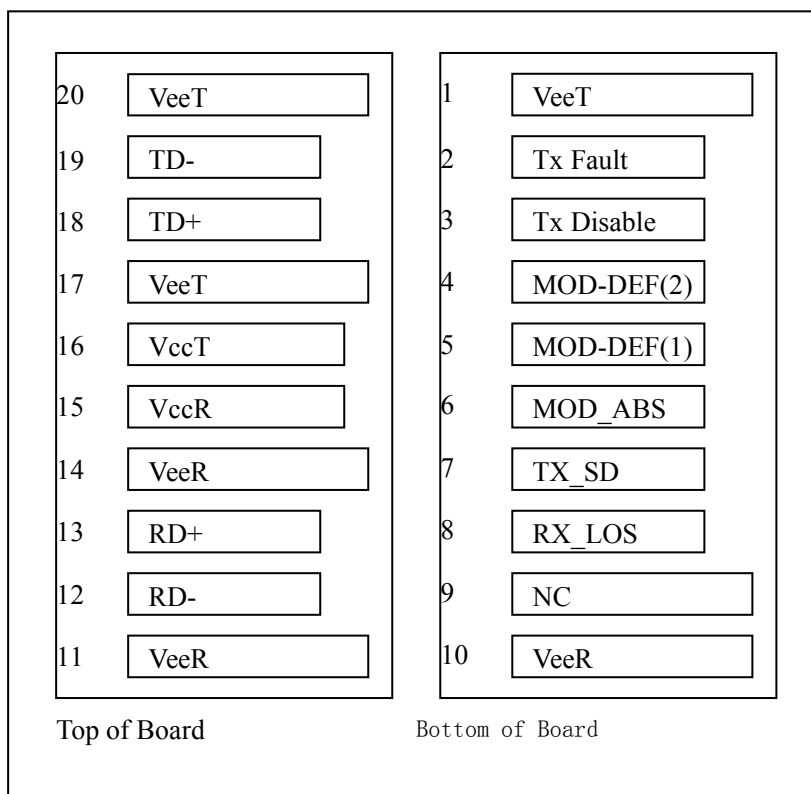


Figure2

Pin Assignment

Pin	Name	Description
1	VeeT	Transmitter Ground
2	TX Fault	Transmitter Fault Indication
3	TX Disable	Transmitter Disable
4	MOD-DEF2	2 wire serial ID interface, SDA
5	MOD-DEF1	2 wire serial ID interface, SCL
6	MOD_ABS	Module Absent, Grounded in Module
7	TX_SD	Tx Transmitter State Indication, TX_Indication Assert When Transmitter ON
8	RX_LOS	Loss of Signal
9	NC	NC
10	VeeR	Receiver Ground
11	VeeR	Receiver Ground
12	RD-	Inv. Received Data Out.AC couled.
13	RD+	Received Data Out. AC couled.
14	VeeR	Receiver Ground
15	VccR	Receiver Power
16	VccT	Transmitter Power
17	VeeT	Transmitter Ground
18	TD+	Transmit Data In. AC-coupled, differential lines with 100Ω differential termination inside the module
19	TD-	Inv. Transmit Data In. AC-coupled, differential lines with 100Ω differential termination inside the module
20	VeeT	Transmitter Ground

Function Description

The transceiver provides high-speed Bi-directional serial optical link for EPON 10G downstream and 1.25G upstream application up to 20km.

The burst-mode transmitter part has a 1310 nm DFB laser. It features ac-coupled differential data inputs. TX_BURST is a LVTTTL input for TX shut down control. Logic “1” disables the LD driver.

The 1577nm continuous-mode receiver part has a high performance photo detector. The preamplifier (TIA) and limiting amplifier amplify the incoming optical signal into the stable range and convert the signal to differential ac-coupled outputs. RX_LOS is LVTTTL output, which logic “1” indicates the input power is lower than the threshold, logic “0” indicates the input power is above the threshold.

Burst Mode Sequence

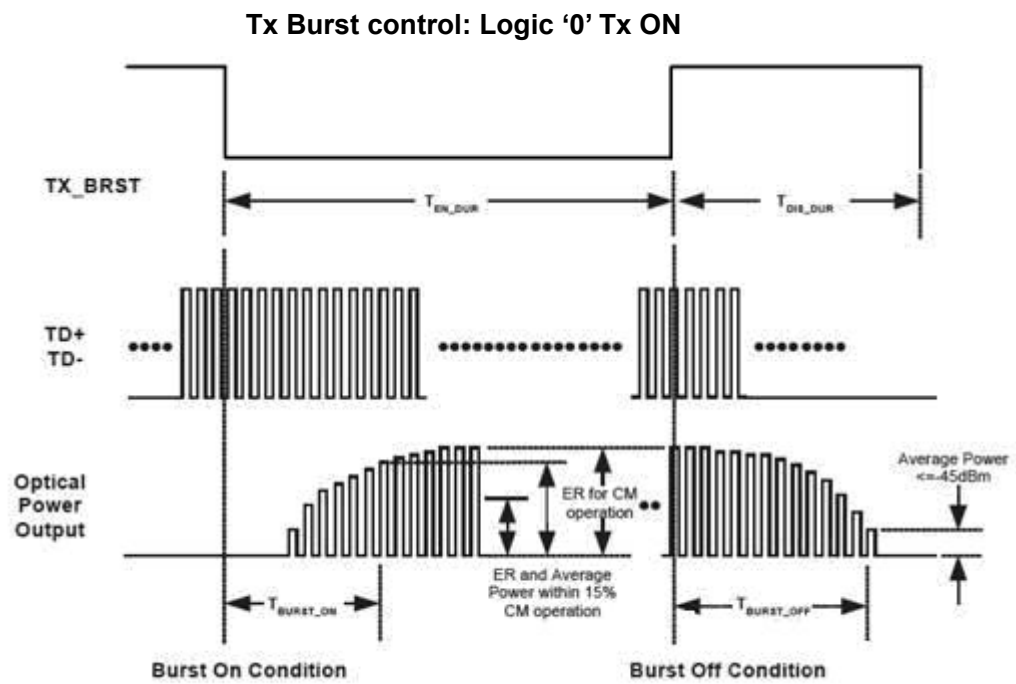


Figure3

Interface Circuit

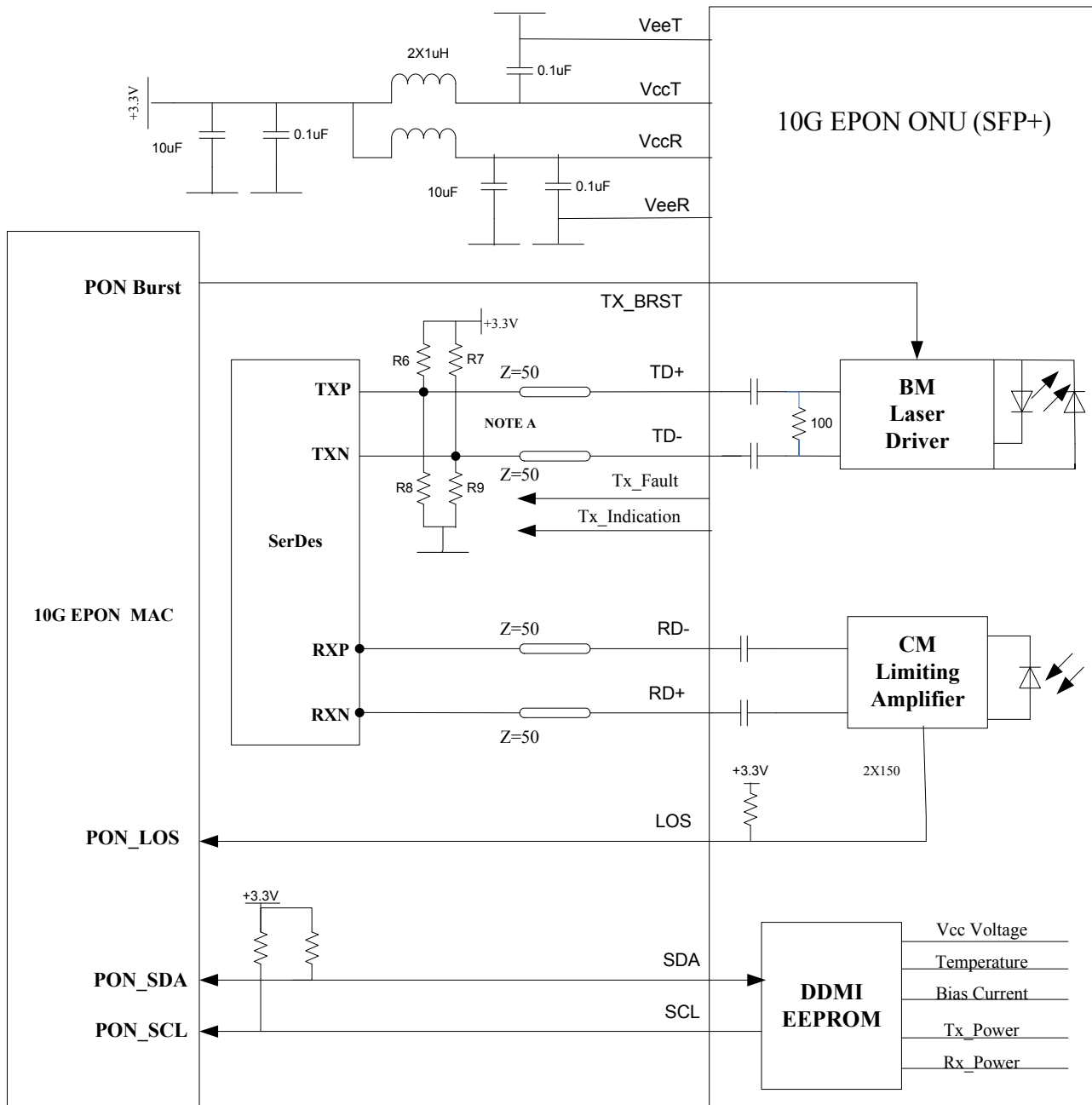


Figure3

Note A: AC coupled internally. R6=R7=N.C, R8=R9=150Ω.

Note B: CML output. AC coupled internally.

Figure Dimensions

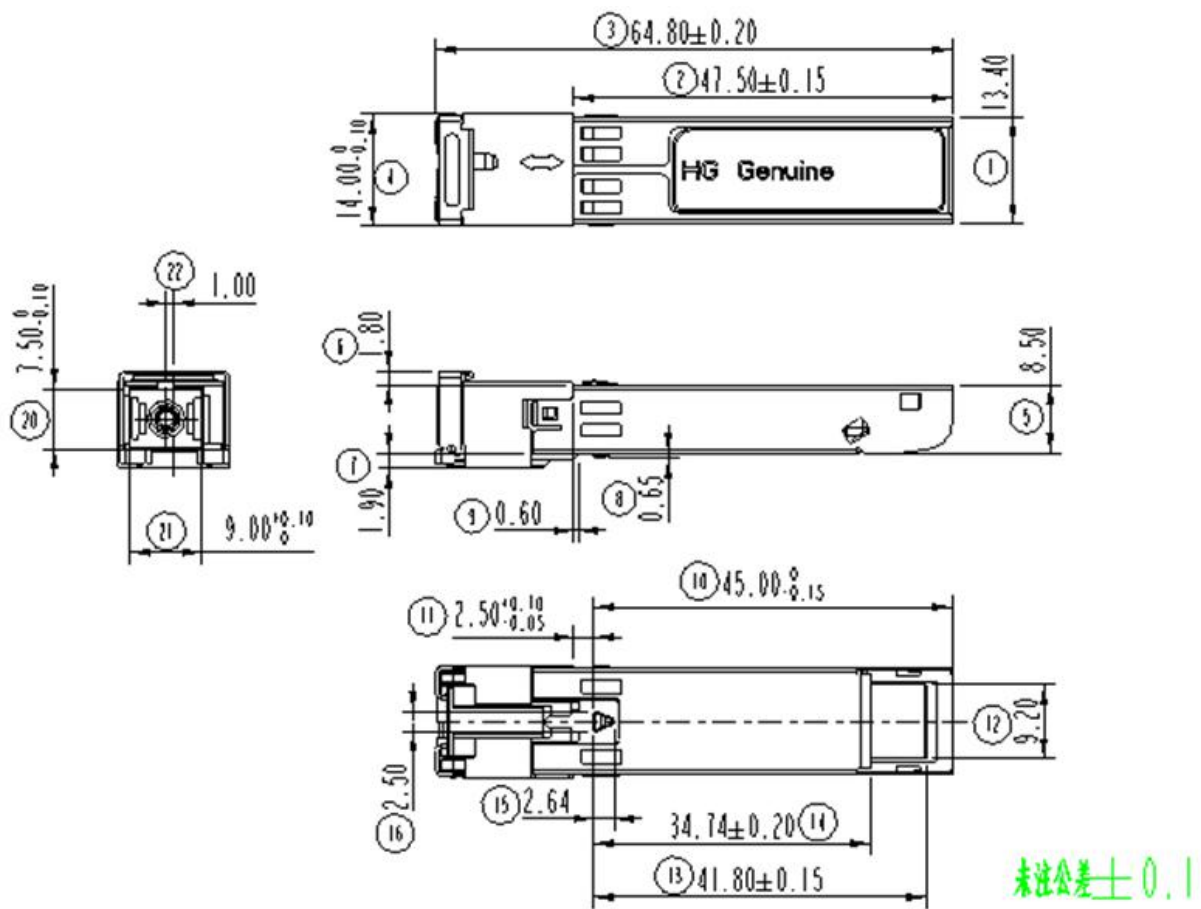


Figure4

Ordering Information

Part No.	Specification									Application
	Pack	Rate	Tx	Pout	Rx	S	Top	Reach	Others	
PNES1-02A	SFP+	1.25Gbps(U) 10.3125Gbs (D)	1310nm DFB	+0.62~+5.62dBm	APD	<-28.5dBm	-40~85℃	20km	"0"Tx ON	PRX30

Contact Information

Wuhan Huagong Genuine Optics Technology Co., Ltd

**Address: Science & Technology Region of HUST, Donghu High-Tech Zone
Wuhan, Hubei Province, 430223, China**

- **Tel: +86-27-87180102**
- **Fax: +86-27-87180220**

Email: market@genuine-opto.com

Website: <http://www.genuine-opto.com>

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