



# EPON ONU Optical Transceiver SFF Module

## ***RTXM169-514***

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### Features

- *Integrated Single fiber bi-directional optical subassembly*
- *SC receptacle optical interface*
- *1310nm FP laser Burst-mode Transmitter and 1490nm PIN Continuous receiver (with WDM)*
- *SFF 2x10 metallic package*
- *+3.3V single power supply*
- *Low power consumption*
- *0 to 70°C operating case temperature*
- *LVPECL compatible data input*
- *CML compatible data output*
- *LVTTL transmitter burst mode control*
- *Burst Enable: L-active*
- *LVTTL receiver signal-detected indication*
- *Class 1 Laser eye safety*
- *Excellent EMI and EMC characteristics*
- *DDM Function implemented*
- *Compliant with RoHs&WEEE*

## Application

- *Optical transceiver for Gigabit Ethernet Passive Optical Networks (EPON) ONU side*

## Standard

- *IEEE802.3ah 1000BASE-PX20*
- *Small Form Factor Transceiver Multisource Agreement July 5,2000*
- *Compliant with SFF-8472 v9.5*

## Description

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

The transmitter section uses a 1310nm FP laser and an integrated BM laser driver which is designed to perform very small burst enable/disable delay time. The laser driver also includes digital APC and temperature compensation circuit, which are used for keeping the launch optical power and extinction ratio constant over temperature and aging.

The receiver section uses an integrated 1490nm InGaAs PIN photodiode and preamplifier mounted together. It has the function that indicates receiver signal-detected status (active high).

An integrated WDM coupler can separate 1490nm input light and 1310nm output light.

## Absolute Maximum Ratings

Parameter	Symbol	Unit	Min	Max
Operating Case Temperature Range	T <sub>c</sub>	°C	0	70
Storage Temperature Range	T <sub>s</sub>	°C	-40	85
Relative Humidity	RH	%	5	95
Power Supply Voltage	V <sub>cc</sub>	V	0	4.6
Pin Input Voltage		V	GND	V <sub>cc</sub>
Receiver Damage Threshold		dBm	+4	-
Lead Solder Temperature		°C	-	260
Lead Solder Duration		S	-	10
Fiber Yield Strength		kgf	-	0.5
Fiber Bend Radius		mm	30	-

## Recommended operating conditions

Parameter	Symbol	Unit	Min	Typ	Max
Operating Voltage	V <sub>cc</sub>	V	3.13	3.3	3.47
Operating Case Temperature Range	T <sub>c</sub>	°C	0	-	70

## Specifications (0°C<T<sub>c</sub><70°C and 3.13V<V<sub>cc</sub><3.47V)

Parameter	Symbol	Unit	Min	Typ	Max	Notes
<b>Electrical Characteristics</b>						
Supply Current	I <sub>cc</sub>	mA	–	–	300	
LVPECL Single Ended Data Input Swing		mV	100	–	800	1
CML Single Ended Data Output Swing		mV	300	–	500	2
Differential Data input impedance		Ω	–	100	–	1
Signal Level(LVTTL H)		V	2.4	–	V <sub>cc</sub>	
Signal Level(LVTTL L)		V	0	–	0.8	
<b>Optical transmitter Characteristics</b>						
Data Rate		Mbps	–	1250	–	
Center Wavelength Range	λ <sub>c</sub>	nm	1280	1310	1350	
Spectral Width(@RMS)	Δλ	nm	–	–	3	
Launch Optical Power	P <sub>o</sub>	dBm	0	–	+4	3
Off level light		dBm	–	–	-45	
Extinction Ratio	EX	dB	10	–	–	4
Burst turn on/off time	Ton/Toff	Bit	–	–	16	5
Rise/Fall time (20%~80%)	Tr/Tf	ps	–	–	260	6
RIN <sub>15</sub> OMA		dB/Hz	–	–	-113	
Optical Return Loss Tolerance		dB	–	–	15	
Maximum reflectance		dB	–	–	-12	λ=1.31μm
Transmitter dispersion penalty	TDP	dB	–	–	1.8	7
TX_SD delay	Ttx_sd_delay	ns			1000	10
TX_SD response error		ns			100	11
Eye Diagram	Compliant with IEEE Std 802.3ah					8
<b>Optical receive Characteristics</b>						
Data Rate		Mbps	–	1250	–	
Receiver Sensitivity	S	dBm	–	–	-27	9
Overload Input Optical Power	P <sub>in</sub>	dBm	-3	–	–	9
Center Wavelength Range	λ <sub>c</sub>	nm	1480	1490	1500	
Receiver reflectance		dB	–	–	-12	λ=1.49μm
SD(LVTTL)	Optical Dessert	dBm	-44	–	–	
	Optical Assert		–	–	-28	
SD Hysteresis		dB	0.5	–	6	

**Note1:** LVPECL input, AC coupled internally (see the recommended circuit below).

**Note2:** CML output, AC coupled internally (see the recommended circuit below).

**Note3:** Coupled into 9/125 SMF

**Note4:** Measured with PRBS 2<sup>7</sup>-1 test pattern @1.25Gbps.

**Note5:** See Figure 1.

**Note6:** Measured with the Bessel-Thompson filter OFF.

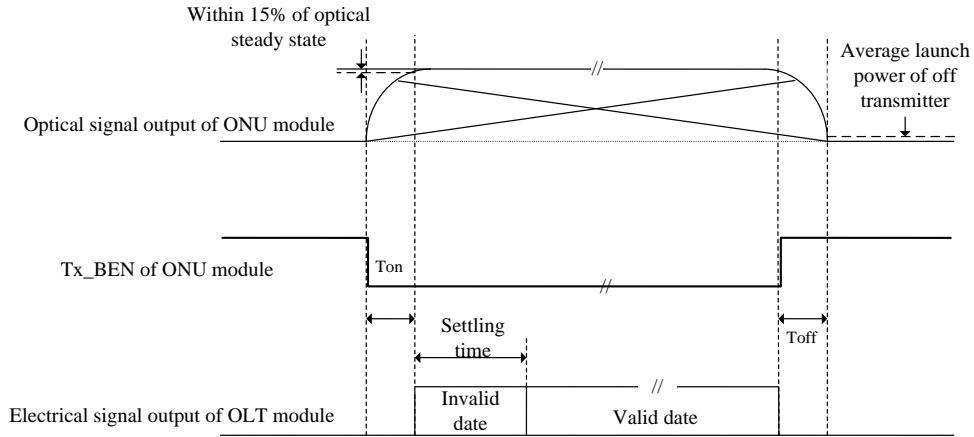
**Note7:** Transmit on 20km SMF.

**Note8:** See Figure 2.

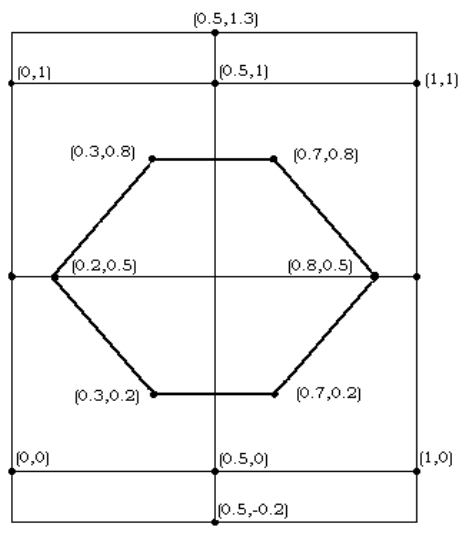
**Note9:** Measured with PRBS 2<sup>7</sup>-1 test pattern @1.25Gbps with Tx on, ER=10dB, BER=10E-12.

**Note10:** TX\_SD delay is the edge between TX\_SD and TX\_Burst\_EN, See Figure 3.

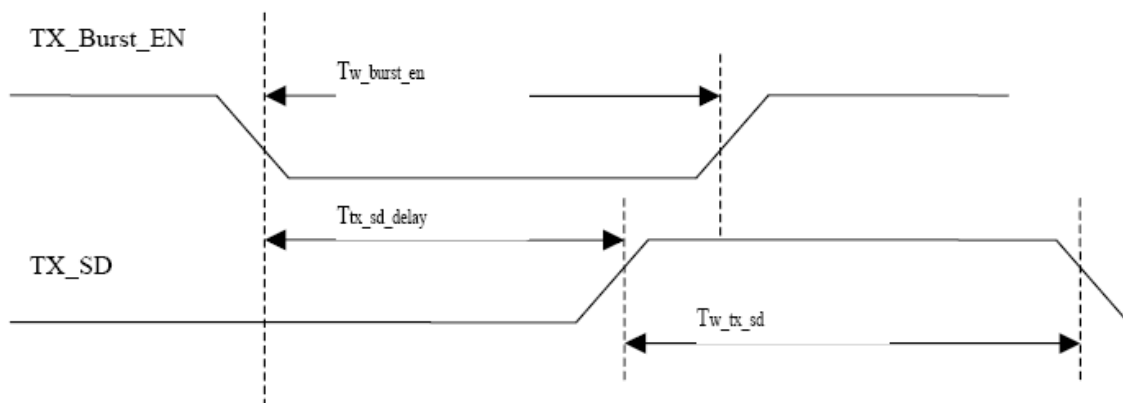
**Note11:** TX\_SD response error is the difference between TX\_SD and TX\_Burst\_EN, defined by  $|Tw_{burst\_en} - Tw_{tx\_sd}|$ , See Figure 3.



**Figure1 Burst\_mode Receiver Dynamic range in EPON system**

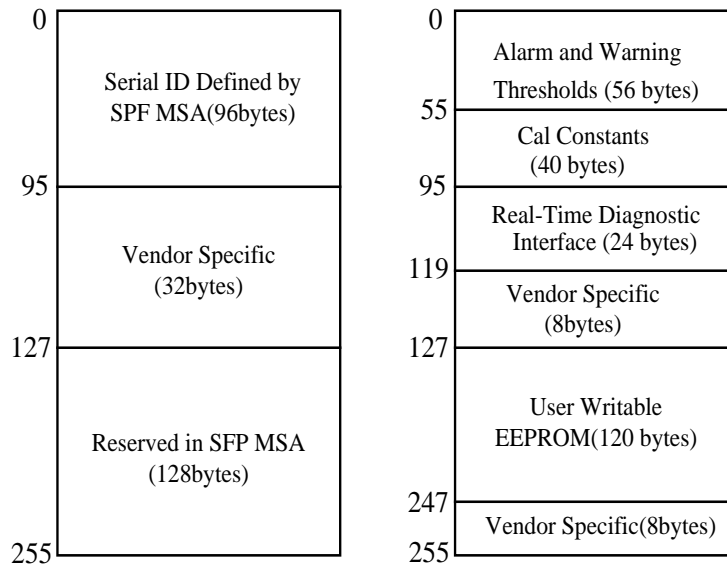


**Figure2 Mask of diagram**



**Figure3 Timing diagram of TX\_SD**

## Digital Diagnostic Memory Map



## EEPROM Serial ID Memory Contents

Accessing Serial ID Memory uses the 2 wire address 1010000X (A0). Memory Contents of Serial ID are shown in the Table 1.

**Table 1 Serial ID Memory Contents**

Data Address	Size (Bytes)	Name of Field	Contents(Hex)	Description
<b>BASE ID FIELDS</b>				
0	1	Identifier	02	Module/connector soldered to motherboard
1	1	Extended Identifier	04	SFF
2	1	Connector	01	SC
3-10	8	Transceiver	00 00 00 80 00 00 00 00	1000BASE-PX20
11	1	Encoding	01	8B10B
12	1	BR, Nominal	0D	1.25Gbit/sec
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	"WTD"(ASCII)
36	1	Reserved	00	
37-39	3	Vendor OUI	00 1C AD	

40-55	16	Vendor PN	52 54 58 4D 31 36 39 2D 35 31 34 20 20 20 20 20	"RTXM169-514"
56-59	4	Vendor rev	31 2E 30 20	1.0
60-61	2	Wavelength	05 1E	Transceiver wavelength: 1310nm
62	1	Reserved	00	
63	1	CC_BASE	Check Sum (Variable)	Check code for Base ID Fields
<b>EXTENDED ID FIELDS</b>				
64-65	2	Options	00 0C	TX_FAULT and RX-SD is implemented.
66	1	BR,max	0A	10%
67	1	BR,min	0A	10%
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	68	Digital diagnostic monitoring implemented, "internally calibrated" is implemented, RX measurement type is "Average Power".
93	1	Enhanced Options	C0	Optional Alarm/Warning flags implemented for all monitored quantities, Optional Soft TX_Disable monitoring implemented.
94	1	SFF_8472 Compliance	02	Includes functionality described in Rev9.5 SFF-8472.
95	1	CC_EXT	Check Sum (Variable)	Check sum for Extended ID Field.
<b>VENDOR SPECIFIC ID FIELDS</b>				
96-127	32	Vendor Specific	Read only	Depends on customer information
128-255	128	Reserved	Read only	

**Table 3 Memory contents of Diagnostic Monitor Function**

Data Address	Field Size (Bytes)	Name	Contents and Description
<b>Alarm and Warning Thresholds</b>			
00-01	2	Temperature High Alarm	Set to 80°C
02-03	2	Temperature Low Alarm	Set to -10°C
04-05	2	Temperature High Warning	Set to 70°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	70mA
18-19	2	Bias Low Alarm	2 mA

20-21	2	Bias High Warning	60 mA
22-23	2	Bias Low Warning	4 mA
24-25	2	TX Power High Alarm	6.0dBm
26-27	2	TX Power Low Alarm	-2.0dBm
28-29	2	TX Power High Warning	4.0dBm
30-31	2	TX Power Low Warning	0dBm
32-33	2	RX Power High Alarm	0dBm
34-35	2	RX Power Low Alarm	-30.0dBm
36-37	2	RX Power High Warning	-3.0dBm
38-39	2	RX Power Low Warning	-27.0dBm
40-55	16	Reserved	
<b>Calibration Constants</b>			
56-59	4	RX Power Calibration Data4	00 00 00 00 (fixed)
60-63	4	RX Power Calibration Data3	00 00 00 00 (fixed)
64-67	4	RX Power Calibration Data2	00 00 00 00 (fixed)
68-71	4	RX Power Calibration Data1	3F 80 00 00 (fixed)
72-75	4	RX Power Calibration Data0	00 00 00 00 (fixed)
76-77	2	Bias Calibration Data1	01 00 (fixed)
78-79	2	Bias Calibration Data0	00 00 (fixed)
80-81	2	TX Power Calibration Data1	01 00 (fixed)
82-83	2	TX Power Calibration Data0	00 00 (fixed)
84-85	2	Temperature Calibration Data1	01 00 (fixed)
86-87	2	Temperature Calibration Data0	00 00 (fixed)
88-89	2	Vcc Calibration Data1	01 00 (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
<b>Real Time Diagnostic Monitor Interface</b>			
96-97	2	Measured Temperature	Yield a 16-bit A/D value (see Table 3.1)
98-99	2	Measured Vcc	Yield a 16-bit A/D value (see Table 3.1)
100-101	2	Measured Bias	Yield a 16-bit A/D value (see Table 3.1)
102-103	2	Measured TX Power	Yield a 16-bit A/D value (see Table 3.1)
104-105	2	Measured RX Power	Yield a 16-bit A/D value (see Table 3.1)
106-109	4	Reserved	
110	1	Logic Status	See Table 3.2
111	1	AD Conversion Updates	See Table 3.2
112-119	8	Alarm and Warning Flags	See Table 3.3
<b>Vendor Specific</b>			
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 “Externally Calibrated”, and then it is necessary to convert raw A/D values to real world units by the manner as shown in Table 3.1.

**Table 3.1 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 Vcc MSB	Internally measured supply voltage. Compliant with External Calibration of SFF-8472.
99 Vcc 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 two optional status bytes, “Logic States” at byte 110(0xA2)” and “A/D Updated” at byte 111(0xA2) as shown in Table 3.2. “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 3.2 Logic Status and AD Conversion Updates**

Byte	Bit	Name	Description
110	7	Tx Disable State	Not supported (set to 0).
110	6	Soft Tx Disable Control	1= disable, 0= enable.
110	5	Reserved	Set to 0.
110	4	Rx Rate Select State	Not supported (set to 0).
110	3	Soft Rate Select Control	Not supported (set to 0).
110	2	Tx Fault	Not supported (set to 0).
110	1	LOS	Not supported (set to 0).
110	0	Power on Logic	Bit will be 0 when the analog monitoring is active.
111	7-0	Temp A/D Valid	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(x0A2) 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 3.3 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 Description

Pin	Name	Description
1	NC	No function Definition
2	Rx GND	Receiver ground
3	Rx GND	Receiver ground
4	NC	No function Definition
5	NC	No function Definition
6	Rx GND	Receiver ground
7	Rx VCC	Receiver power supply
8	SD	LVTTTL Signal detect output, internally pull up. Asserts high when input optical power level is above threshold
9	RD-	Receiver data output-, AC coupled internally
10	RD+	Receiver data output+, AC coupled internally
11	Tx VCC	Transmitter power supply
12	Tx GND	Transmitter ground
13	Tx EN	LVTTTL Transmitter burst mode control, "L": Tx ON
14	TD+	LVPECL Data input+ ,AC coupled internally
15	TD-	LVPECL Data input- ,AC coupled internally

16	Tx_GND	Transmitter ground
17	SCL	I <sup>2</sup> C Serial Clock (LVTTTL)
18	SDA	I <sup>2</sup> C Serial Data (LVTTTL)
19	TX_FAULT	LVTTTL Transmitter Fault, internally pull up. Asserts high when the fault is detected by the laser driver.
20	Tx_SD	Tx Transmitter State Indication, TX_Indication Assert high When Transmitter ON

## Block Diagram

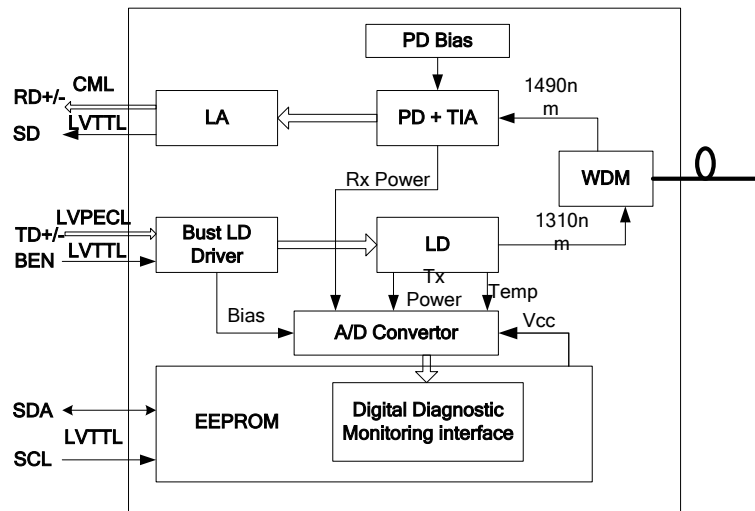


Figure4 Functional block diagram

## Typical Application Circuit

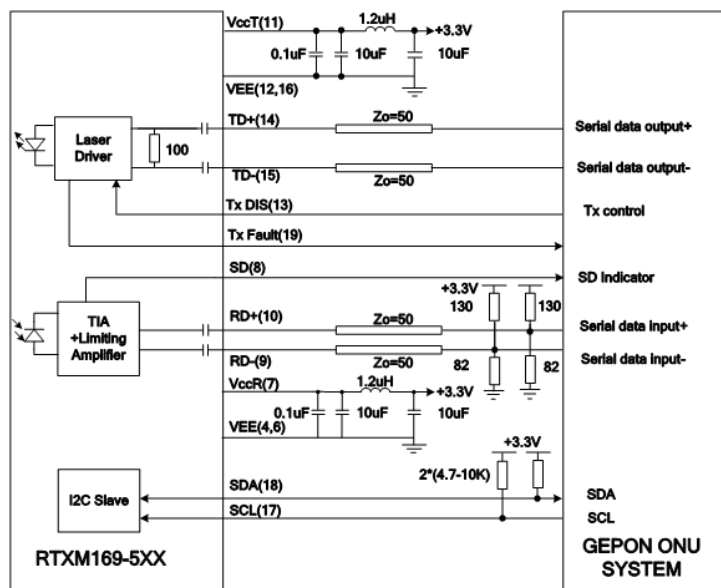


Figure5 Typical application circuit

## Package Outline

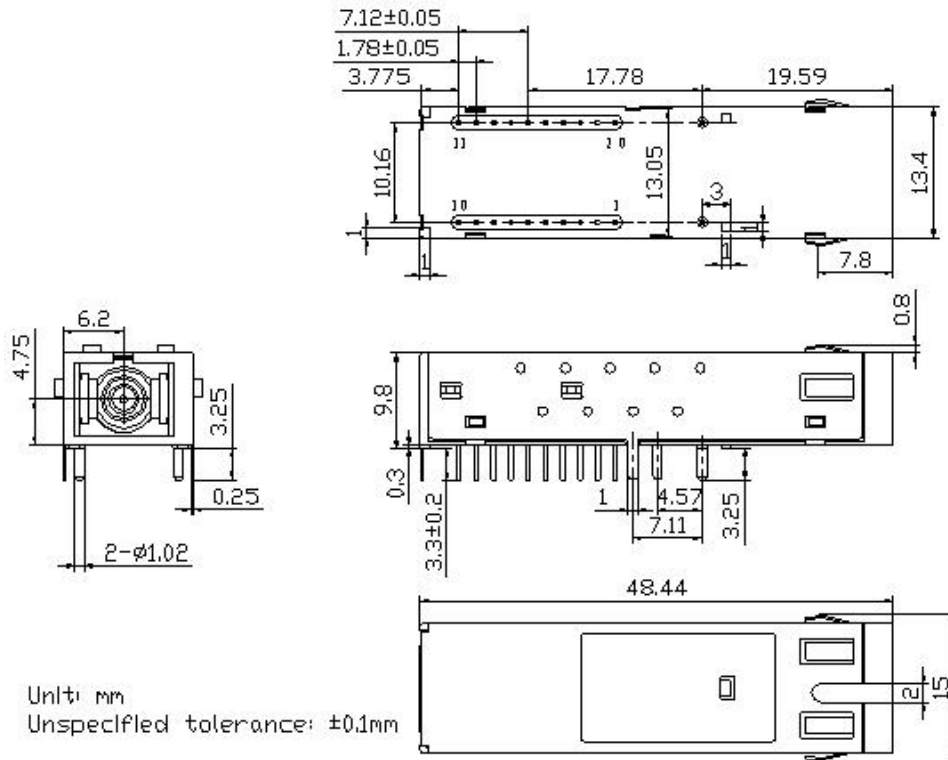


Figure6 Package outline

## 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 UL TUV EN 60825-1	Compliant with Class 1 laser product

## Update Information

## Ordering Information

Part No.	Specification									Application
	Package	Datarate	Laser	Optical Power	Detector	Sensitivity	Temp	Reach	BM control logic	Code
RTXM169-514	SFF/SC 2×10	1.25Gb/s	1310nm FP	0 ~ 4dBm	PIN	-27dBm	0~70°C	20km	L Enable	1000BASE-PX20

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