



10G/1G EPON ONU Optical Transceiver SFP+ Module

RTXM166-401

Features

- *Integrated Single fiber bi-directional optical subassembly*
- *1310nm DFB laser Burst-mode Transmitter and 1577nm APD Continuous receiver(with WDM)*
- *Asymmetric 1.25Gb/s upstream and 10.3125 Gb/s downstream bitrate*
- *SFP+ metallic package, SC connector*
- *+3.3V single power supply*
- *Low power consumption*
- *0 to 70°C operating ambient temperature*
- *LVPECL data input*
- *CML data output*
- *LVTTL transmitter burst mode control*
- *Burst Enable: L-active*
- *LVTTL transmitter signal-detected indication*
- *LVTTL receiver LOS signal indication*
- *Class 1 Laser eye safety*
- *Excellent EMI and EMC characteristics*
- *Compliant with RoHS&WEEE*

Applications

- *20Km Asymmetric 10 Gigabit Ethernet Access over PON Networks*

Standard

- *IEEE802.3av, 2009*
- *10G/1GBASE-PRX-U3*
- *SFF-8432 Specification for*
- *Improved Pluggable Formfactor, Revision 4.3: 2007.5*
- *Compliant with SFF-8472 v9.5*

Description

The EPON ONU Transceiver is designed for 10G EPON transmission. The module incorporates 1Gb/s 1310nm burst-mode transmitter and 10Gb/s 1577nm continuous-mode receiver.

The transmitter section uses a 1310nm DFB laser and an integrated BM laser driver which 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 1577nm APD photodiode and preamplifier mounted together. It has the function that indicates receiver los status (active high).

An integrated WDM coupler can separate 1577nm input light and 1310nm output light.

The metallic package guarantees excellent EMI and EMC characteristics, which totally comply with international relevant standards.

Absolute Maximum Ratings

Parameter	Symbol	Unit	Min	Max
Operating Temperature Range	T _c	°C	0	70
Storage Temperature Range	T _s	°C	-40	85
Relative Humidity	RH	%	5	95
Power Supply Voltage	V _{cc}	V	0	4.6
Pin Input Voltage		V	GND	V _{cc}
Receiver Damage Threshold		dBm	-9	–

Recommended operating conditions

Parameter	Symbol	Unit	Min	Typ	Max
Operating Voltage	V _{cc}	V	3.13	3.3	3.47
Operating Temperature Range	T _{op}	°C	0	–	70

Specifications *(0°C < T_{op} < 70°C and 3.13V < V_{cc} < 3.47V)*

Parameter	Symbol	Unit	Min	Typ	Max	Notes
Electrical Characteristics						
Power Consumption		W	–	–	1.0	
LVPECL Single Ended Data Input Swing		mV	100	–	800	1
CML Single Ended Data Output Swing		mV	350	–	500	23
Differential Data input impedance		Ω	–	100	–	1
Signal Level(LVTTL H)		V	2.4	–	V _{cc}	
Signal Level(LVTTL L)		V	0	–	0.8	
Optical transmitter Characteristics						
Data Rate		Mbps	–	1250	–	
Center Wavelength Range	λ_c	nm	1260	–	1360	
Spectral Width(@-20dB)	$\Delta\lambda$	nm	–	–	1	
Launch Optical Power	P _o	dBm	0.62	–	+5.62	3
Off level light		dBm	–	–	-45	
Extinction Ratio	EX	dB	9	–	–	4
Burst turn on/off time	Ton/Toff	ns	–	–	512	5
RIN ₁₅ OMA		dB/Hz	–	–	-115	
Optical Return Loss Tolerance		dB	–	–	15	
Maximum reflectance		dB	–	–	-10	$\lambda=1.31\mu\text{m}$
Transmitter dispersion penalty	TDP	dB	–	–	1.4	6
Eye Diagram	Compliant with 802.3ah					7
Optical receive Characteristics						
Data Rate		Mbps	–	103125	–	
Receiver Sensitivity	S	dBm	–	–	-28.5	8
Overload Input Optical Power	P _{in}	dBm	-10	–	–	8
Center Wavelength Range	λ_c	nm	1574	1577	1580	
Receiver reflectance		dB	–	–	-12	$\lambda=1.577\mu\text{m}$
LOS(LVTTL)	Optical Dessert	dBm	–	–	-29	
	Optical Assert		-44	–		
LOS Hysteresis		dB	0.5	–	6	

Note1: AC coupled internally and terminated externally (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 2⁷-1 test pattern @1.25Gbps.

Note5: see Figure 1.

Note6: Transmit on 20km SMF.

Note7: See Figure 2. {X1, X2, Y1, Y2, Y3} = {0.22, 0.375, 0.20, 0.20, 0.30}

Note8: Measured with PRBS 2³¹-1 test pattern @10.3125Gbps with Tx on, ER=6dB, BER=10⁻³.

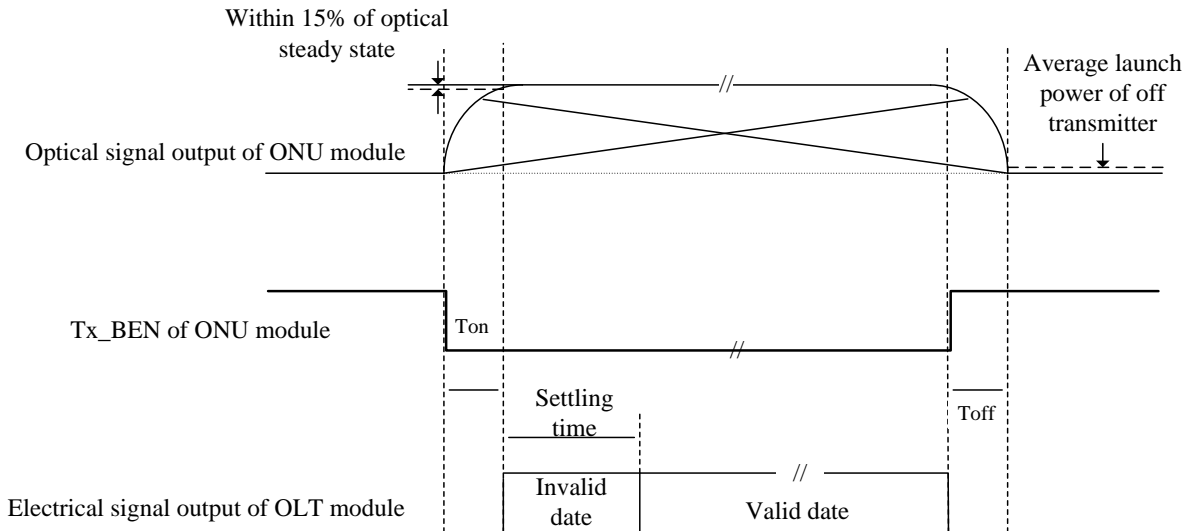


Figure1 Burst_mode Receiver Dynamic range in 10G EPON system

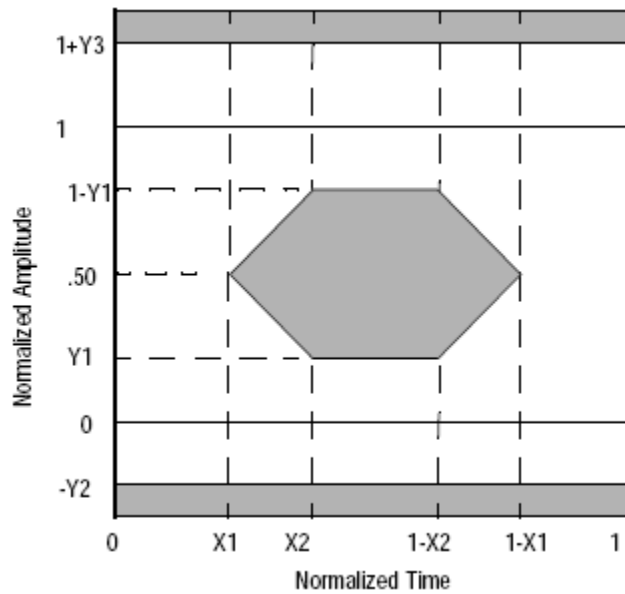
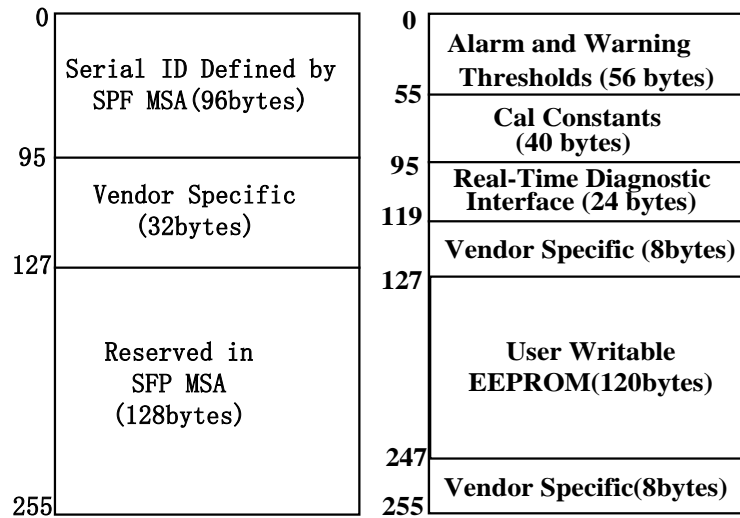


Figure2 Mask of diagram

Digital Diagnostic 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 the 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	Extended. Identifier	04	GBIC/SFP function is defined by serial ID only
2	1	Connector	01	SC
3-10	8	Transceiver	00 00 00 00 00 00 00 00	Transceiver Codes
11	1	Encoding	01	8B10B
12	1	BR, Nominal	0C	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 FF FF FF FF FF 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 36 2D 34 30 31 20 20 20 20 20	"RTXM166-401"
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
EXTENDED ID FIELDS				
64-65	2	Options	00 0A	TX_FAULT and Loss of Signal are 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	E0	Optional Alarm/Warning flags implemented for all monitored quantities Optional Soft TX_DISABLE control and monitoring implemented, Optional Soft TX_FAULT 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.
VENDOR SPECIFIC ID FIELDS				
96-127	32	Vendor Specific	Read only	Depends on customer information
128-255	128	Reserved	Read only	Filled by zero

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 80 °C
02-03	2	Temperature Low Alarm	Set to -5°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	75mA
18-19	2	Bias Low Alarm	2 mA
20-21	2	Bias High Warning	60 mA
22-23	2	Bias Low Warning	5 mA
24-25	2	TX Power High Alarm	6.0dbm
26-27	2	TX Power Low Alarm	-1.0dbm
28-29	2	TX Power High Warning	5.0dbm
30-31	2	TX Power Low Warning	0dbm
32-33	2	RX Power High Alarm	-9.0dbm
34-35	2	RX Power Low Alarm	-29.5dbm
36-37	2	RX Power High Warning	-10.0dbm
38-39	2	RX Power Low Warning	-28.5.dbm
40-55	16	Reserved	
Calibration Constants			
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
Real Time Diagnostic Monitor Interface¹			
96-97	2	Measured Temperature	Internally measured module temperature
98-99	2	Measured Vcc	Internally measured supply voltage in module
100-101	2	Measured Bias	Internally measured Tx Bias current
102-103	2	Measured TX Power	Internally measured Tx Optical Power
104-105	2	Measured RX Power	Measured Rx input power
106-109	4	Reserved	
110	1	Logic Status	See Table 2.1
111	1	AD Conversion Updates	See Table 2.1
112-119	8	Alarm and Warning Flags	See Table 2.2
Vendor Specific			
120-127	8	Vendor Specific	Don't Access
128-247	120	User writable EEPROM	

248-255 8 Vendor Specific Don't Access

Note1: 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 (Unsigned values)															
A2h Byte 98 (Vcc MSB)								A2h Byte 99 (Vcc LSB)							
A2h Byte 98 (Vcc MSB)								A2h Byte 99 (Vcc 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

All the measured values are "Internally Calibrated", Each measurement could be obtained by multiplying digital value by corresponding LSB value:

Temperature = Temp (Digital Value) × (1/256); when Temperature < 128

Temperature = [Temp (Digital Value) × (1/256)] - 256; when Temperature ≥ 128

V_{CC} = V_{CC}(Digital Value) × 100μV

TX Bias Current = TX Bias Current (Digital Value) × 2μA

TX Power = TX Power (Digital Value) × 0.1μW

RX Power = RX Power (Digital Value) × 0.1μW

Table 2.1 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 Tx Continuously light indicate	Set to 1 , when the module emit continuous light more than 20ms
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	1= FAULT 0=NORMAL
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 2.2. 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 2.2 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

10G/1G EPON ONU SFP+					
Pin	Name	Description	Pin	Name	Description
1	GND_T	Transmitter ground	20	GND_T	Transmitter ground
2	TX_FAULT	LVTTTL Signal detect output, internally pull up	19	TD-(1G)	LVPECL Data input- (AC coupled and internal terminated)
3	TX_BRST	LVTTTL Transmitter burst mode control, "L": Tx ON	18	TD+(1G)	LVPECL Data input+ (AC coupled and internal terminated)
4	SDA	I ² C Serial Data (LVTTTL)	17	GND_T	Transmitter ground
5	SCL	I ² C Serial Clock (LVTTTL)	16	VCC_T	Transmitter power supply
6	MOS_ABS	Internally connected GND	15	VCC_R	Receiver power supply
7	TX-SD	LVTTTL Signal detect output, internally pull up	14	GND_R	Receiver ground
8	RX_LOS	LVTTTL Signal detect output, internally pull up	13	RD+(10G)	CML data output+ (AC coupled internally)
9	NC		12	RD-(10G)	CML data output- (AC coupled internally)
10	GND_R	Receiver ground	11	GND_R	Receiver ground

Block Diagram

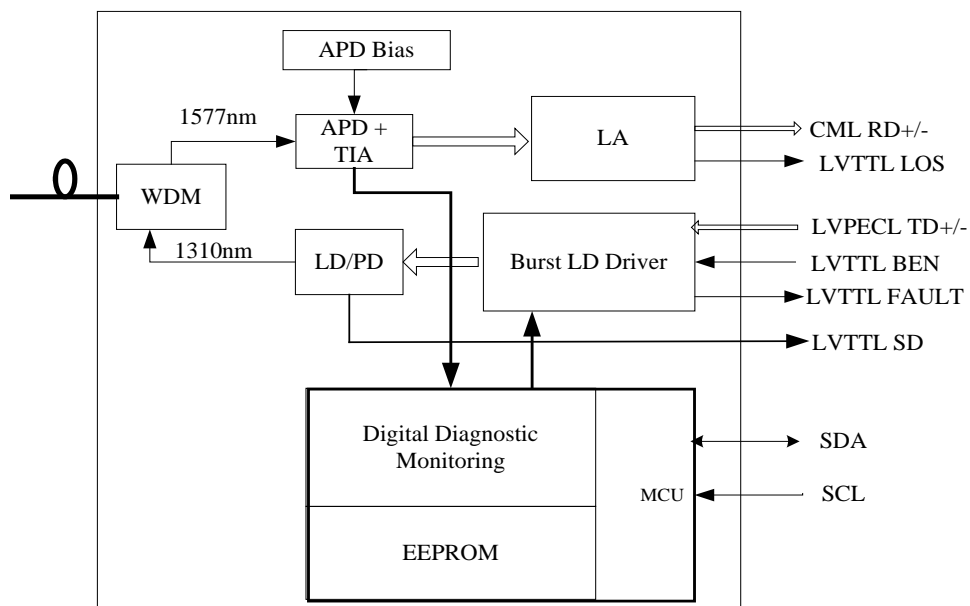


Figure3 Functional block diagram

Typical Application Circuit

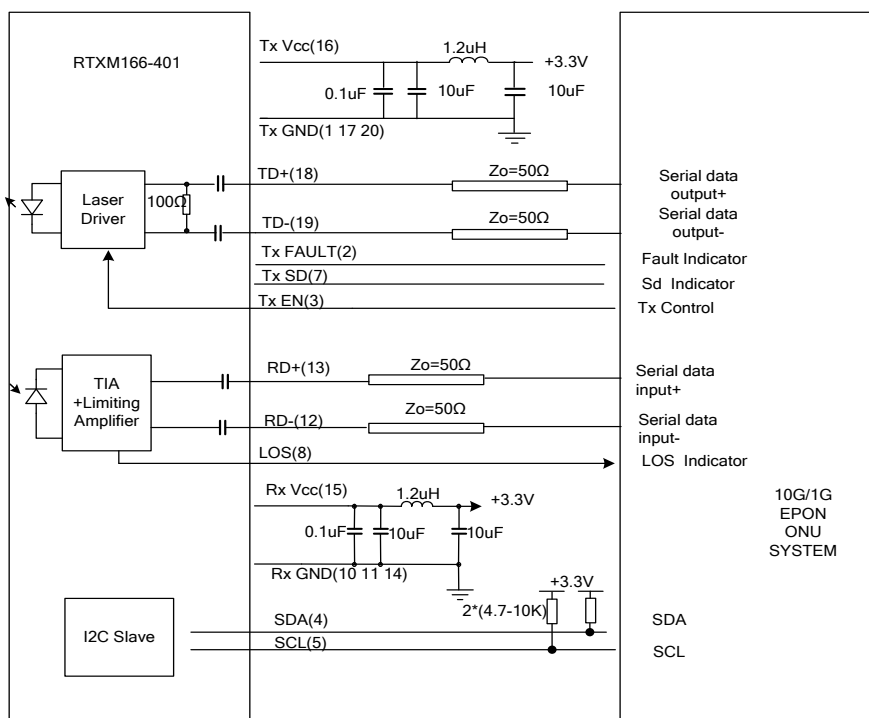


Figure4 Typical application circuit

Package Outline

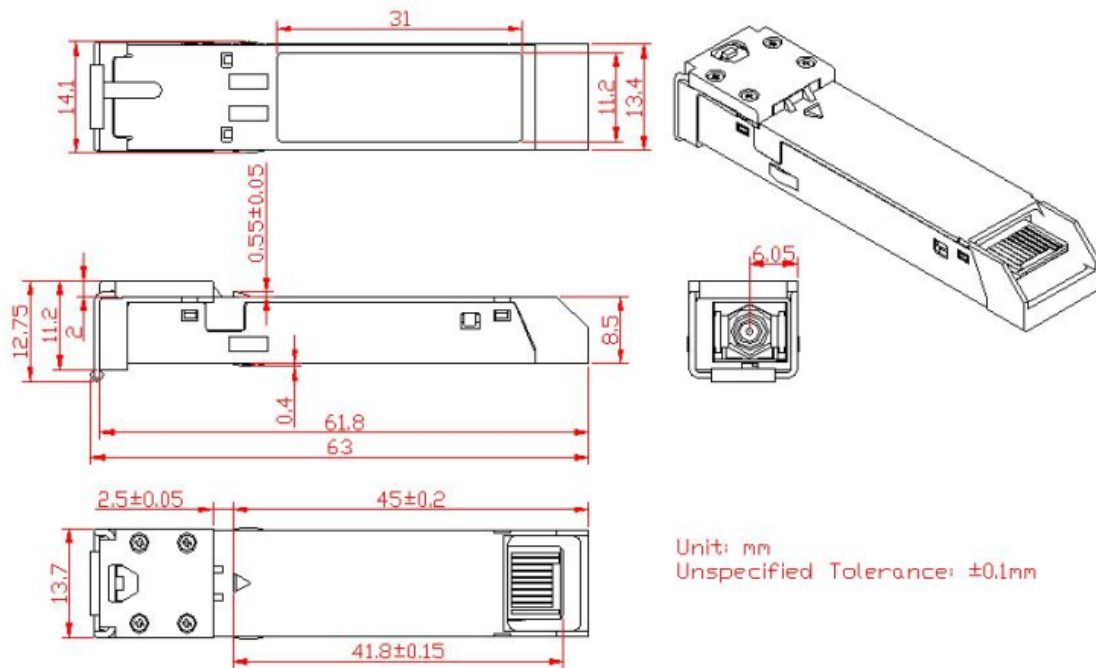


Figure5 Package outline

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

Ordering Information

Part No.	Specification							Application Code
	Package	Datarate	Laser	Optical Power	Detector Sensitivity	Temp	BM control logic	
RTXM166-401	SFP+	1.25Gb/s						10G/1G EPON
		US	1310nm	+0.62~	APD	-28.5dBm	0~70°C	
		10Gb/s	DFB	+5.62dBm				
		DS						

Note1: SC connector.

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