

Features

- ◎ Supports 10Gb/s serial optical interface
- ◎ Up to 10km transmission on SMF
- ◎ 1310nm DFB laser and PIN receiver
- ◎ Hot-pluggable SFP+ footprint
- ◎ SFI high speed electrical interface
- ◎ Built-in digital diagnostic functions
- ◎ Single +3.3V power supply
- ◎ Power consumption less than 1.0 W
- ◎ Operating case temperature: -5~+70°C
- ◎ SFP+ MSA package with duplex LC connector



Applications

- ◎ 10GBASE-LR/LW 10G Ethernet
- ◎ Other optical links

Standard

- ◎ Compliant with SFF-8472 and SFP+ MSA
- ◎ Compliant to SFF-8431 and SFF-8432
- ◎ Compliant with IEEE 802.3ae 10GBASE-LR/LW
- ◎ Compliant with FCC 47 CFR Part 15, Class B
- ◎ Compliant with Telcordia GR-468-CORE
- ◎ RoHS Compliant

Table 1. Regulatory Compliance

Feature	Standard	Performance
Electrostatic Discharge(ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class 1(>1000V for SFI pins, >2000V for other pins.)
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	IEC 61000-4-2 GR-1089-CORE	Compatible with standards

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Electromagnetic nterference (EMI)	FCC Part 15 Class B EN55022 Class B (CISPR 22B) VCCI Class B	Compatible with standards
Immunity	IEC 61000-4-3	Compatible with standards
Laser Eye Safety	FDA 21CFR 1040.10 and 1040.11	Compatible with Class I laser product
RoHS	2002/95/EC 4.1&4.2 2011/65/EU	Compatible with standards

Product Description

The SFP+ transceivers are high performance, cost effective modules supporting data rate of 10Gbps and 10km transmission distance with SMF.

The transceiver consists of three sections: a Un-cooled 1310nm DFB laser transmitter, a PIN photodiode integrated with a trans-impedance preamplifier (TIA) and MCU control unit. All modules satisfy class I laser safety requirements.

The transceivers are compatible with SFP Multi-Source Agreement and SFF-8472 digital diagnostics functions.

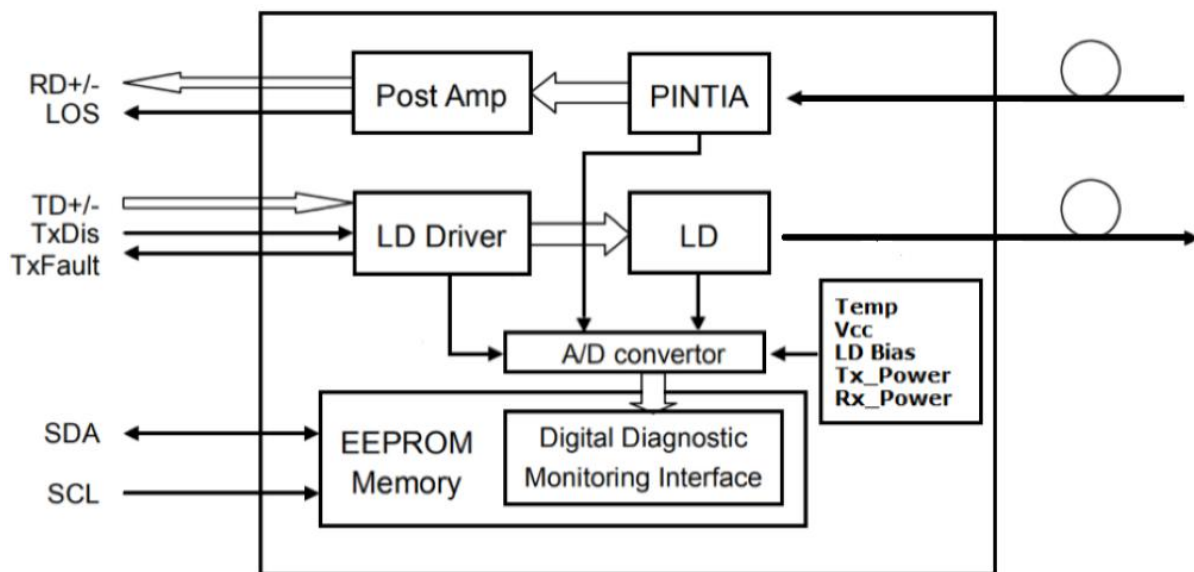


Figure 1. Transceiver functional Block Diagram

Absolute Maximum Ratings

Table 2. Absolute Maximum Ratings

(Exceeding the limits below may damage the transceiver module permanently)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
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Maximum Supply Voltage	V _{CC}	-0.5	-	+4.0	V	
Storage Temperature	T _S	-40	-	+85	°C	
Case Operating Temperature	T _A	-10	-	+75	°C	
Relative Humidity	RH	5	-	85	%	1

Notes:

1. Non-condensing.

Recommend Operation Environment

Table 3. Recommend Operation Environment

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Data Rate	BR	9.9528	10.3125	11.3168	Gbps	
Power Supply Voltage	V _{CC}	3.13	3.3	3.47	V	
Power Supply Current	I _{CC}	-	-	300	mA	
Power Dissipation	P _D	-	-	1.0	W	
Case Operating Temperature	T _A	-5	-	+70	°C	
Transmission Distance	T _D	-	-	10	km	1

Notes:

1. Measured with ITU-T G.652 SMF

Optical Characteristics

Table 4. Optical Characteristics(T_{OP} = -5 to +70 °C, V_{CC} = 3.13 to 3.47 V)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Transmitter						
Optical Center Wavelength	λ _c	1290	1310	1330	nm	
Data Rate	BR	9.9528	10.3125	11.3168	Gbps	
Average Output Power	P _O	-8.2	-	+0.5	dBm	1
Optical Modulation Amplitude	P _{OMA}	-5.2	-	-	dBm	1
Optical Extinction Ratio	ER	3.5	5.0	-	dB	2
RMS Spectral Width (-20dB)	Δλ	-	-	1	nm	
Side Mode Suppression Ratio	SMSR	30	-	-	dB	
Optical Rise/Fall time 20%~80%	T _r /T _f	-	-	26	ps	

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Data Dependent Jitter	DDJ	-	-	0.10	UI	
Total Jitter	TJ	-	-	0.28	UI	
Transmitter and Dispersion Penalty	TDP	-	-	3.2	dB	
Average Launch power of Tx OFF	P _{OFF}	-	-	-30	dBm	
Optical Eye Mask	Compliant with IEEE 802.3ae-2005 and ITU-T G.691					
Receiver						
Center Wavelength Range	λ_c	1260	-	1620	nm	
Data Rate	BR	9.9528	10.3125	11.3168	Gbps	
Receiver Sensitivity	R _{SEN}	-	-	-14.4	dBm	3
Stressed Receiver Sensitivity (OMA)	R _{SENS}	-	-	-12.6	dBm	
Maximum Input Power	P _{MAX}	0.5	-	-	dB	3
LOS Assert	LOS _A	-28	-	-	dBm	
LOS De-Assert	LOS _D	-	-	-16	dBm	
LOS Hysteresis	LOS _H	0.5	-	5	dB	
Receiver Reflectance	R _R	-	-	-12	dB	

Notes:

1. The optical power is launched into SMF.
2. Measured with worst ER=3.5dB, RPBS 2³¹-1 test pattern @10.3125Gbs.
3. Measured with worst ER=3.5dB, RPBS 2³¹-1 test pattern @10.3125Gbs BER=<10⁻¹².

Electrical/Optical Characteristics

Table 5. Electrical Characteristics(T_{OP} = -5 to +70 °C, V_{CC} = 3.13 to 3.47 V)

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Transmitter						
Differential Data Input Amplitude	V _{IN,P-P}	180	-	850	mVpp	1
Input Differential Impedance	Z _{IN}	80	100	120	Ω	
Transmitter Fault Output-High	V _{OH}	2.4	-	V _{CC}	V	
Transmitter Fault Output-Low	V _{OL}	-0.3	-	0.4	V	
Transmitter Disable Voltage- High	V _{IH}	2.0	-	V _{CC}	V	
Transmitter Disable Voltage- low	V _{IL}	0	-	0.8	V	
Receiver						
Differential output voltage swing	V _{OUT,P-P}	300	-	850	mVpp	1
Output Differential Impedance	Z _{OUT}	80	100	120	Ω	
Data Output Rise/Fall time 20%~80%	T _r /T _f	-	-	28	ps	2

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Deterministic Jitter	DJ	-	-	0.42	UI	
Total Jitte	TJ	-	-	0.70	UI	
LOS Output Voltage-High	V _{LOSH}	2.0	-	V _{cc}	V	3
LOS Output Voltage-Low	V _{LOSL}	-	-	0.8	V	3

Notes:

1. CML input/output, internally AC-coupled and terminated.
2. Measured with Module Compliance Test Board and OMA test pattern.
3. LOS is an open collector output. Should be pulled up with 4.7kΩ to 10kΩ on the host board.
Normal operation is logic 0; loss of signal is logic 1.

Table 6. Timing and Electrical

Parameter	Symbol	Min	Typ	Max	Unit
Tx Disable Negate Time	t _{on}	-	-	1	ms
Tx Disable Assert Time	t _{off}	-	-	10	μs
Time To Initialize, including Reset of Tx Fault	t _{init}	-	-	300	ms
Tx Fault Assert Time	t _{fault}	-	-	100	μs
Tx Fault To Reset	t _{reset}	10	-	-	μs
LOS Assert Time	t _{loss_on}	-	-	100	μs
LOS De-assert Time	t _{loss_off}	-	-	100	μs
Serial ID Clock Rate	f _{serial_clock}	-	-	400	KHz
SDA, SCL, MOD_ABS High Level	V _H	2	-	V _{cc}	V
SDA, SCL, MOD_ABS Low Level	V _L	-	-	0.8	V

Pin Assignment

Table 7. Pin Descriptions

Pin	Symbol	Name/Description	Notes
1	VEET	Module Transmitter Ground	
2	Tx_Fault	Module Transmitter Fault	1
3	Tx_Disable	Transmitter Disable, Turns off transmitter laser output	2
4	SDA	2 wire serial interface data input/output (SDA)	1
5	SCL	2 wire serial interface clock input (SCL)	1
6	MOD_ABS	Module Absent, connected to VeeT or VeeR in the module	1
7	RS0	Receiver Rate Select	
8	Rx_LOS	Loss of Signal indication, Logic 0 indicates normal operation	3
9	RS1	Transmitter Rate Select, Not Used for this product	
10	VEER	Module Receiver Ground	
11	VEER	Module Receiver Ground	
12	RD-	Receiver Inverted Data Output, AC Coupled	4
13	RD+	Receiver Non-Inverted Data Output, AC Coupled	4
14	VEER	Module Receiver Ground	
15	VccR	Module Receiver 3.3 V Supply	
16	VccT	Module Transmitter 3.3 V Supply	
17	VEET	Module Transmitter Ground	
18	TD+	Transmitter Non-Inverted Data Input, AC Coupled	5
19	TD-	Transmitter Inverted Data Input, AC Coupled	5
20	VEET	Module Transmitter Ground	

Notes:

1. Open collector/drain output, which should be pulled up with a 4.7k Ω to 10k Ω resistor on the host board if intended for use. Pull up voltage should be between 2.0V to 3.6V. A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
2. Laser output disabled on Tx_Disable >2.0V or open, enabled on Tx_Disable <0.8V.
3. LOS is open collector output. Should be pulled up with 4.7k Ω to 10k Ω on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.
4. RD-/+ : These are the differential receiver outputs. They are internally AC-coupled 100 Ω differential lines which should be terminated with 100 Ω (differential) at the user SERDES.
5. TD-/+ : These are the differential transmitter inputs. They are internally AC-coupled, differential lines with 100 Ω differential termination inside the module.

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Pin Assignment (continued)

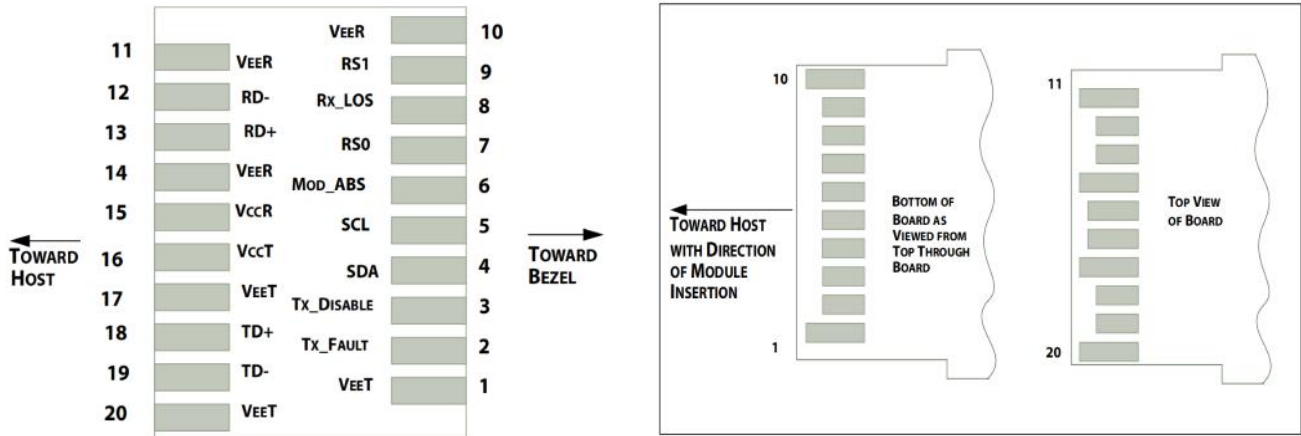


Figure 2. Host PCB SFP+ pad assignment top view and Names.

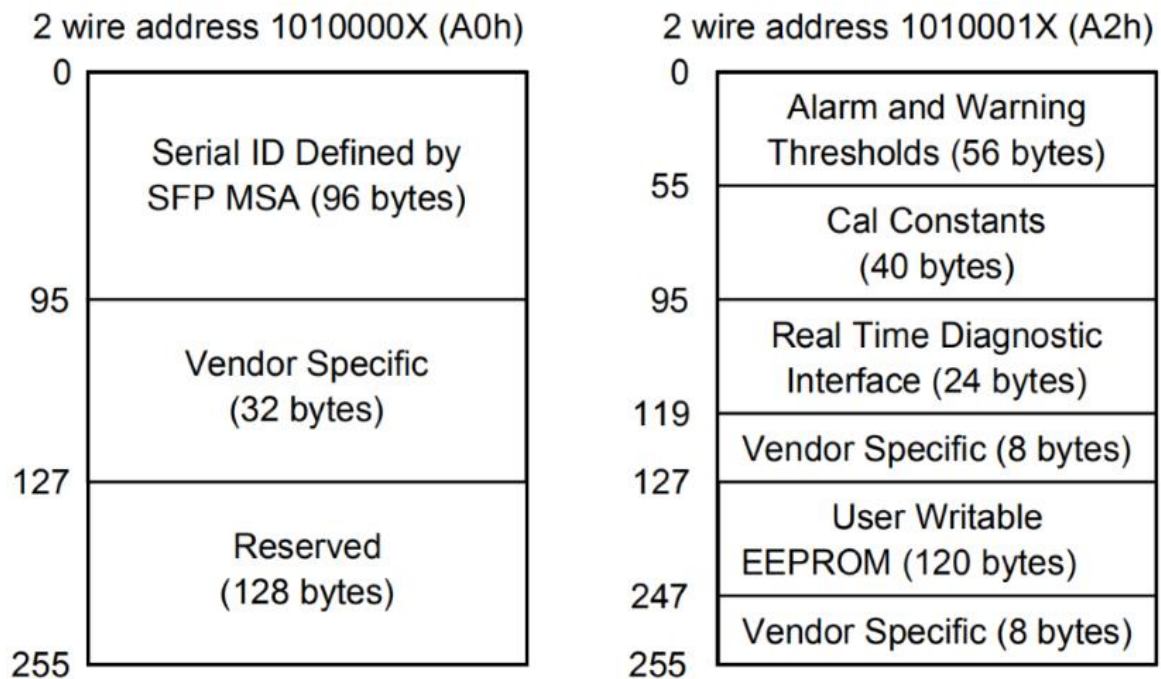
Digital Diagnostic Memory Map

The transceivers provide serial ID memory contents and diagnostic information about the present operating conditions by the 2-wire serial interface (SCL, SDA).

The diagnostic information with internal calibration or external calibration all are implemented, including received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring.

The digital diagnostic memory map specific data field defines as following.

Table 8. Digital Diagnostic Memory Map (Specific Data Field Descriptions)


Table 9. Digital Diagnostic Monitor Characteristics

Parameter	Calibration	Range	Accuracy	Unit
Transceiver Internal Temperature	Internal	-5 to +70°C	±3.0	°C
Vcc3 Internal Supply Voltage	Internal	3.0 to 3.6V	±3.0	%
Laser Bias Current	Internal	0 to 90mA	±10	%
Tx Output Power	Internal	-8.5 to +1dBm	±3.0	dBm
Rx Input Power	Internal	-15.5 to +0.5dBm	±3.0	dBm

Recommended Circuit

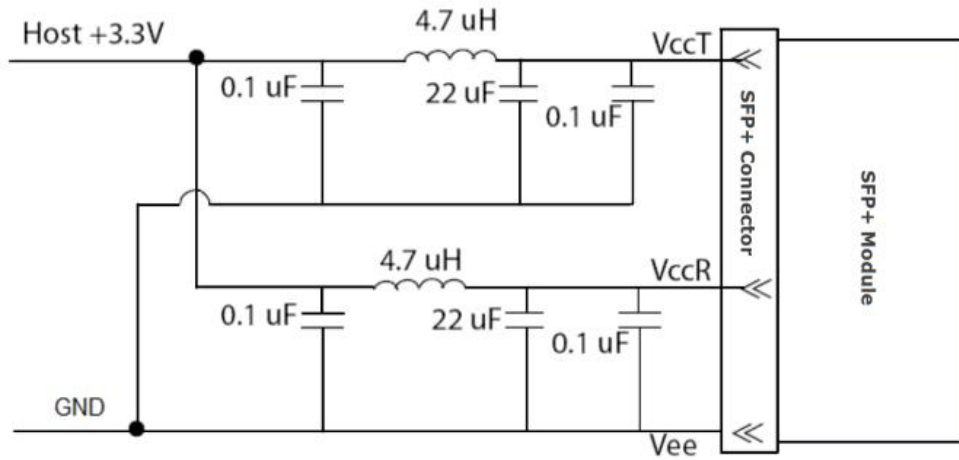


Figure 3, Recommended Host Board Power Supply Circuit

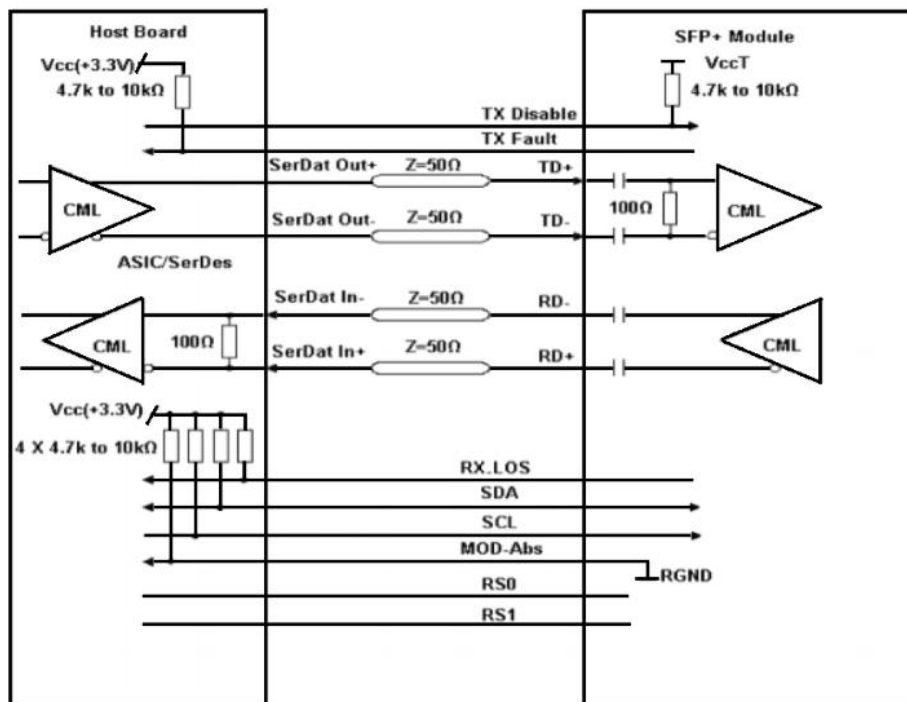


Figure 4, Recommended Interface Circuit

Mechanical Dimensions

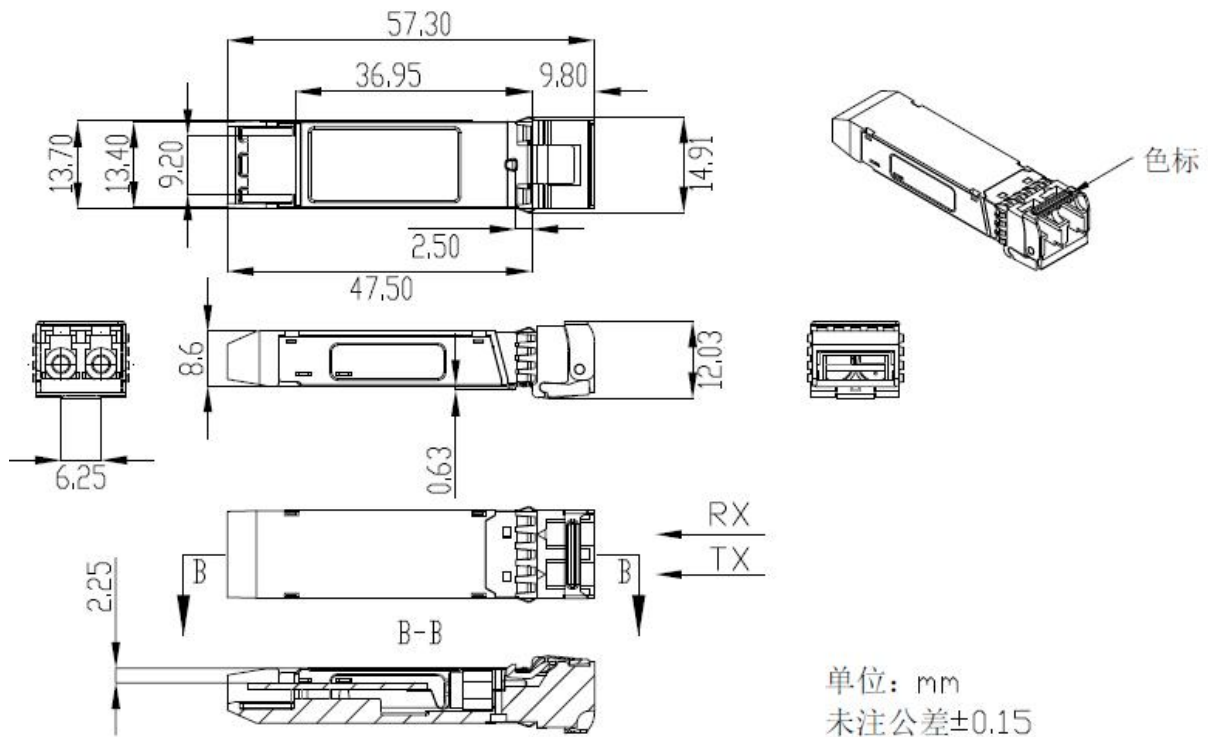


Figure 5, Mechanical Dimensions

Ordering information

Table 10. Ordering information

Part Number	Product Description
OTS-10G-LR	1310nm DFB, 10.3125Gbps, SMF 10km, -5°C ~ +70°C
OTS-10G-LR-E	1310nm DFB, 10.3125Gbps, SMF 10km, -20°C ~ +85°C
OTS-10G-LR-I	1310nm DFB, 10.3125Gbps, SMF 10km, -40°C ~ +85°C

Warnings

Handling Precautions: This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.

Laser Safety: Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

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