DATA SHEET

MODULETEK: SFP-25G-BIDI-Txxxx/Rxxxx-10KM-x-E16

- 25Gb/s SFP28 Tx1270nm/Rx1330nm 10km Bi-directional Transceiver
- 25Gb/s SFP28 Tx1330nm/Rx1270nm 10km Bi-directional Transceiver

Overview

ModuleTek's SFP-25G-BIDI-Txxxx/Rxxxx-10KM-x-E16 optical transceiver is based on 25 Gb/s Ethernet IEEE 802.3 standard and SFF-8402 standard, providing a high-speed and reliable interface for 25 Gb/s Ethernet applications. The product supports digital diagnostics via a 2-wire serial bus, compliant with the SFF-8472 standard.

Product Features

- Compliant with IEEE 802.3
- Compliant with SFF-8402
- Internal CDR on both Transmitter and Receiver channel
- Hot-pluggable SFP28 footprint
- DFB laser transmitter and PIN PD Receiver
- Simplex LC connector
- Built-in digital diagnostic functions
- Up to 10km on SMF
- Single power supply 3.3V
- RoHS Compliant
- Operating temperature range (Case Temperature): Commercial Level: 0°C to 70°C
  Industrial Level: −40°C to 85°C

Applications

- 25GBASE-LR Ethernet

Ordering Information

Part Number	Product ID	Description	Color on Clasp
SFP-25G-BIDI-T1270/R1330-10KM-C-E16	M009928	25GBASE SFP28 BIDI, TX1270nm/RX1330nm LC Connector 10km on SMF, Commercial Temperature	Yellow
SFP-25G-BIDI-T1330/R1270-10KM-C-E16	M009929	25GBASE SFP28 BIDI, TX1330nm/RX1270nm LC Connector 10km on SMF, Commercial Temperature	Blue
SFP-25G-BIDI-T1270/R1330-10KM-I-E16	M009930	25GBASE SFP28 BIDI, TX1270nm/RX1330nm LC Connector 10km on SMF, Industrial Temperature	Yellow
SFP-25G-BIDI-T1330/R1270-10KM-I-E16	M009931	25GBASE SFP28 BIDI, TX1330nm/RX1270nm LC Connector 10km on SMF, Industrial Temperature	Blue

For more information or to order the above product, please contact:

Email: sales@moduletek.com

ModuleTek Web: www.moduletek.com

General Specifications

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Line Rate	BR		25.78		Gb/s	1
Bit Error Rate	BER			5×10^{-5}		2
Operating Temperature	T_C	0		70	°C	3
		-40		85	°C	3
Storage Temperature	T_{STO}	-40		85	°C	4
Input Voltage	V_{CC}	3.14	3.3	3.46	V	
Power Dissipation (Commercial Temperature)	P_C		0.9	1.3	W	
Power Dissipation (Industrial Temperature)	P_I		0.9	1.4	W	
Maximum Voltage	V_{MAX}	-0.5		4	V	5

Notes:
1. IEEE 802.3
2. Measured with line rate at 25.78Gb/s, PRBS $2^{31}-1$
3. Case temperature
4. Ambient temperature
5. For electrical power interface

Link Distances

Line Rate	Fiber Type	Distance Range (km)	Remarks
25.78 Gb/s	9/125 um SMF	10	1

Notes:
1. This module requires RS-FEC on the host ports for operation at 25G

Optical Characteristics – Transmitter

V_{CC} = 3.13 V to 3.46 V, T_C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Output Optical Power	P_{TX}	-7		2	dBm	1
Optical Center Wavelength (T1270/R1330)	λ_{C1}	1260	1270	1280	nm	
Optical Center Wavelength (T1330/R1270)	λ_{C2}	1320	1330	1340	nm	
Transmitter Dispersion Penalty	TDP			2.7	dB	
Extinction Ratio	ER	3.5			dB	
Spectral Width (-20 dB)	$\Delta\lambda$			1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Launch Power of OFF Transmitter	P_{OUT_OFF}			-30	dBm	1

Notes:
1. Average optical power

Optical – Characteristics – Receiver

V_{CC} = 3.13 V to 3.46 V, T_C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Optical Center Wavelength (T1270/R1330)	λ_{C1}	1310	1330	1350	nm	
Optical Center Wavelengt (T1330/R1270)	λ_{C2}	1250	1270	1290	nm	
Receiver Power	P_{RX}	-13.3		2	dBm	1
LOS Assert	LOS_A	-30			dBm	
LOS De-Assert	LOS_D			-17	dBm	
LOS Hysteresis	LOS_H	0.5			dB	

Notes:
1. Average optical power, measured with test signal at 25.78 Gbps and PRBS 2^{31}-1 for BER = $5x10^{-5}$, and without fiber

Electrical Characteristics – Transmitter

V_{CC} = 3.13 V to 3.46 V, T_C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Input differential impedance	R_{IN}		100		Ω	
Differential data input swing	V_{IN_PP}	250		900	mV	
Transmit Disable Voltage	V_D	2		V_{CC}	V	
Transmit Enable Voltage	V_{EN}	V_{EE}		V_{EE}+0.8	V	

Electrical – Characteristics – Receiver

V_{CC} = 3.13 V to 3.46 V, T_C

Parameter	Symbol	Min	Typ	Max	Unit	Remarks
Differential data output swing	V_{OUT_PP}	370	600	850	mV	
LOS Assert	V_{LOS_A}	2		V_{CC_HOST}	V	
LOS De-Assert	V_{LOS_D}	V_{EE}		V_{EE}+0.8	V	

Digital Diagnostic Functions

SFP-25G-BIDI-Txxxx/Rxxxx-10KM-x-E16 supports the 2-wire serial communication protocol as defined in SFF-8472. Digital diagnostic information is accessible over the 2-wire interface at the address 0xA2. Digital diagnostics for the tranceiver are internally calibrated by default. A micro controller unit inside the transceiver gathers the monitoring information and reports the status of transceiver, such as Transceiver Temperature, Supply Power, TX bias current, TX output power and RX received optical power.

Digital Diagnostic Threshold Range					
Parameter		**High Alarm**	**High Warning**	**Low Warning**	**Low Alarm**
Temperature (°C)	C	75.00 (4B00h)	70.00 (4600h)	0.00 (0000h)	-5.00 (FB00h)
	I	90.00(5A00h)	85.00 (5500h)	-40.00 (D800h)	-45.00 (D300h)
Voltage (V)		3.63(8DCCh)	3.46 (875Ah)	3.13 (7A76h)	2.97 (7404h)
Bias Current (mA)		90.00 (AFC8h)	80.00 (9C40h)	8.00 (0FA0h)	6.50 (0CB2h)
Tx Power (dBm)		5.00 (7B87h)	2.00 (3DE9h)	-7.00 (07CBh)	-11.00 (031Ah)
Rx Power (dBm)		5.00 (7B87h)	2.00 (3DE9h)	-13.30 (01D4h)	-17.30 (00BAh)

A0h/A2h Write Protection

Security Level 1 Password (Factory Value)		
Password Entry Bytes	**Size**	**Value (hex)**
A2h, 7Bh-7Eh	4	00 00 10 11

SFP-25G-BIDI-Txxxx/Rxxxx-10KM-x-E16 has the function of A0h and A2h write-protection. Transceiver need enter the security level 1 working state to write the device address A0h as well as page 00h and page 01h of device address A2h. The method to enter the security level 1 working state is to write the security level 1 password sequentially to bytes 7Bh-7Eh of the device address A2h. After entering the security level 1, the user can either write directly to device address A0h or write to page 00h and page 01h of device address A2h by modifying 7Fh page select byte of the device address A2h.

A0h Memory Map

Byte	Size	Name	Description	Initial Value (hex)
0	1	Identifier	SFP	03
1	1	Extended Identifier	Two-wire interface	04
2	1	Connector	Connector Type = LC	07
3-10	8	Transceiver	25GBASE-LR	00 00 00 00 00 00 00 00
11	1	Encoding	Encoding Type = NRZ	03
12	1	BR, Nominal	Nominal Bit Rate 25.78 Gb/s	FF
13	1	Rate Identifier	No rate selection function	00
14	1	Length (9 μm)-km	9 μm SMF Link Length = 10 km	0A
15	1	Length (9 μm)-100 m	9 μm SMF Link Length = 10 km	64
16	1	Length (50 μm, OM2)-10 m	50 μm OM2 MMF Link Length = N/A	00
17	1	Length (62.5 μm, OM1)-10 m	62.5 μm OM1 MMF Link Length = N/A	00
18	1	Length (50 μm, OM4)-10 m	50 μm OM4 MMF Link Length = N/A	00
19	1	Length (50 μm, OM3)-10 m	50 μm OM3 MMF Link Length = N/A	00
20-35	16	Vendor name	MODULETEK	4D 4F 44 55 4C 45 54 45 4B 20 20 20 20 20 20 20

36	1	Transceiver	25GBASE-LR	03
37-39	3	Vendor OUI	Without vendor OUI	00 00 00
40-55	16	Vendor PN	Vendor Part Number	Defined by vendor
56-59	4	Vendor Revision Number	Manufacturer product version number	00 00 00 00
60-61	2	Wavelength	Laser wavelength 1270/1330 nm	04 F6/05 32
62	1	Reserved	Reserved	00
63	1	CC_BASE	Check sum of bytes 0-62	Defined by vendor
64	1	Transceiver Options	BIT7:6 = 0 Reserved BIT5 = 0 Power Level 2, < 1.5 W BIT4 = 1 Paging function is implemented BIT3 = 1 With retimer or CDR indicator BIT2 = 0 Uncooled laser transmitter BIT1 = 1 Power Level 2, < 1.5 W BIT0 = 0 Receiver output is conventional limiting	1A
65	1	Transceiver Options	BIT7 = 0 Receiver decision threshold is not implemented BIT6 = 0 The transmitter wavelength is not tunable BIT5 = 0 RATE_SELECT functionality is not implemented BIT4 = 1 Tx_Disable is implemented BIT3 = 1 Tx_Fault is implemented BIT2 = 0 Signal Detect is not implemented BIT1 = 1 Rx_LOS is implemented BIT0 = 0 Reserved	1A
66	1	BR, nominal	BR, nominal	67
67	1	BR, deviation	BR, deviation	00
68-83	16	Vendor SN	Manufacturer serial number	Defined by vendor
84-91	8	Date code	Date	Defined by vendor

92	1	Monitoring Type	BIT7 = 0 Compatible with SFF-8472 requirements BIT6 = 1 Digital diagnostic function is implemented BIT5 = 1 Internal calibration is implemented BIT4 = 0 Externally calibration is not implemented BIT3 = 1 Received power measurement type is average power BIT2 = 0 No address change required BIT1:0 = 0 Reserved	68
93	1	Enhanced Options	BIT7 = 1 Optional Alarm/Warning flags are implemented for all monitored quantities BIT6 = 1 Optional soft Tx_Disable control and monitoring are implemented BIT5 = 1 Optional soft Tx_Fault monitoring is implemented BIT4 = 1 Optional soft Rx_LOS monitoring is implemented BIT3 = 0 Optional soft RATE_SELECT control and monitoring are not implemented BIT2 = 0 Optional Application Select control is not implemented per SFF-8079 BIT1 = 0 Optional soft Rate Select control is not implemented per SFF-8431 BIT0 = 0 Reserved	F0
94	1	Compliance	Includes functionality described in Rev 12.3 of SFF-8472	08
95	1	CC_EXT	Check sum of bytes 64-94	Defined by vendor
96-127	32	Vendor Specific	Vendor specific memory addresses	Defined by vendor
128-255	128	Vendor Specific	Vendor specific memory addresses	Defined by vendor

A2h Memory Map

Byte	Size	Name	Description	Initial Value (hex)
Lower Memory Map(A2h)				
00-01	2	Temp High Alarm	Temperature high alarm threshold	See Table of Threshold Ranges
02-03	2	Temp Low Alarm	Temperature low alarm threshold	See Table of Threshold Ranges
04-05	2	Temp High Warning	Temperature high warning threshold	See Table of Threshold Ranges
06-07	2	Temp Low Warning	Temperature low warning threshold	See Table of Threshold Ranges
08-09	2	Voltage High Alarm	Voltage high alarm threshold	See Table of Threshold Ranges
10-11	2	Voltage Low Alarm	Voltage low alarm threshold	See Table of Threshold Ranges
12-13	2	Voltage High Warning	Voltage high warning threshold	See Table of Threshold Ranges
14-15	2	Voltage Low Warning	Voltage low warning threshold	See Table of Threshold Ranges
16-17	2	Bias High Alarm	Bias current high alarm threshold	See Table of Threshold Ranges
18-19	2	Bias Low Alarm	Bias current low alarm threshold	See Table of Threshold Ranges
20-21	2	Bias High Warning	Bias current high warning threshold	See Table of Threshold Ranges
22-23	2	Bias Low Warning	Bias current low warning threshold	See Table of Threshold Ranges
24-25	2	TX Power High Alarm	TX power high alarm threshold	See Table of Threshold Ranges

26-27	2	TX Power Low Alarm	TX power low alarm threshold	See Table of Threshold Ranges
28-29	2	TX Power High Warning	TX power high warning threshold	See Table of Threshold Ranges
30-31	2	TX Power Low Warning	TX power low warning threshold	See Table of Threshold Ranges
32-33	2	RX Power High Alarm	RX power high alarm threshold	See Table of Threshold Ranges
34-35	2	RX Power Low Alarm	RX power low alarm threshold	See Table of Threshold Ranges
36-37	2	RX Power High Warning	RX power high warning threshold	See Table of Threshold Ranges
38-39	2	RX Power Low Warning	RX power low warning threshold	See Table of Threshold Ranges
40-41	2	Optional Laser Temp High Alarm	This function is not implemented	00 00
42-43	2	Optional Laser Temp Low Alarm	This function is not implemented	00 00
44-45	2	Optional Laser Temp High Warning	This function is not implemented	00 00
46-47	2	Optional Laser Temp Low Warning	This function is not implemented	00 00
48-49	2	Optional TEC Current High Alarm	This function is not implemented	00 00
50-51	2	Optional TEC Current Low Alarm	This function is not implemented	00 00
52-53	2	Optional TEC Current High Warning	This function is not implemented	00 00
54-55	2	Optional TEC Current Low Warning	This function is not implemented	00 00

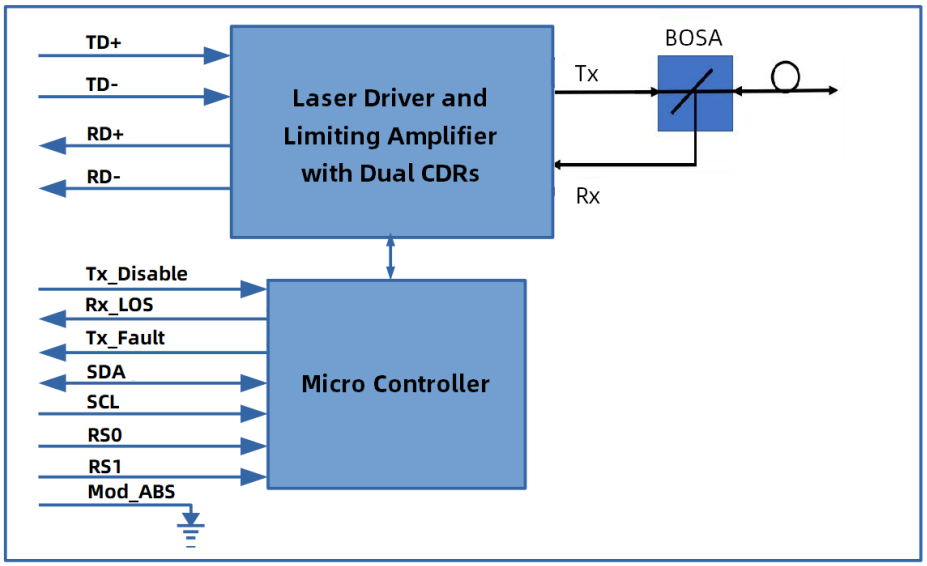
56-59	4	RX_PWR(4)	External calibration data for RX optical power, the module only implements an internally calibrated function	00 00 00 00
60-63	4	RX_PWR(3)	External calibration data for RX optical power, the module only implements an internally calibrated function	00 00 00 00
64-67	4	RX_PWR(2)	External calibration data for RX optical power, the module only implements an internally calibrated function	00 00 00 00
68-71	4	RX_PWR(1)	External calibration data for RX optical power, the module only implements an internally calibrated function	3F 80 00 00
72-75	4	RX_PWR(0)	External calibration data for RX optical power, the module only implements an internally calibrated function	00 00 00 00
76-77	2	TX_I(Slope)	External calibration data for laser bias current, the module only implements an internally calibrated function	01 00
78-79	2	TX_I(Offset)	External calibration data for laser bias current, the module only implements an internally calibrated function	00 00
80-81	2	TX_PWR(Slope)	External calibration data for TX optical power, the module only implements an internally calibrated function	01 00
82-83	2	TX_PWR(Offset)	External calibration data for TX optical power, the module only implements an internally calibrated function	00 00
84-85	2	T(Slope)	External calibration data for internal module temperature, the module only implements an internally calibrated function	01 00
86-87	2	T(Offset)	External calibration data for internal module temperature, the module only implements an internally calibrated function	00 00
88-89	2	V(Slope)	External calibration data for internal module supply voltage, the module only implements an internally calibrated function	01 00
90-91	2	V(Offset)	External calibration data for internal module supply voltage, the module only implements an internally calibrated function	00 00
92-94	3	Reserved	Reserved	00 00 00
95	1	Checksum	Check sum of bytes 0-94	Defined by vendor

96-97	2	Temperature	Internally measured module temperature, unit is 1/256 °C	Variable
98-99	2	Vcc	Internally measured supply voltage in module, unit is 100 uV	Variable
100-101	2	TX Bias	Internally measured TX Bias Current, unit is 2 uA	Variable
102-103	2	TX Power	Internally measured TX output power, unit is 0.1 uW	Variable
104-105	2	RX Power	Internally measured RX input power, unit is 0.1 uW	Variable
106-107	2	Optional Laser Temp	This function is not implemented	00 00
108-109	2	Optional TEC current	This function is not implemented	00 00
110	1	Status/Control	BIT7 Tx_Disable Input Pin State BIT6 = 0 Laser disable control bit. Writing '1' disables laser BIT5 RS1 Pin State BIT4 RS0 Pin State BIT3 = 0 Soft RS0 control bit. Soft Rate Select is not implemented BIT2 Tx_Fault Pin State BIT1 Rx_LOS Pin State BIT0 Data_Ready_Bar State. Zero/low indicates that the module data is ready	Variable
111	1	Reserved	Reserved for SFF-8079	00
112	1	Alarm Flags	BIT7 Temp High Alarm Flag, active high BIT6 Temp Low AlarmFlag, active high BIT5 Vcc High Alarm Flag, active high BIT4 Vcc Low Alarm Flag, active high BIT3 TX Bias High Alarm Flag, active high BIT2 TX Bias Low Alarm Flag, active high BIT1 TX Power High Alarm Flag, active high BIT0 TX Power Low Alarm, active high	Variable

113	1	Alarm Flags	BIT7 RX Power High Alarm Flag, active high BIT6 RX Power Low Alarm Flag, active high BIT5 Optional Laser Temp High Alarm Flag, this alarm flag is not implemented BIT4 Optional Laser Temp Low Alarm Flag, this alarm flag is not implemented BIT3 Optional TEC current High Alarm Flag, this alarm flag is not implemented BIT2 Optional TEC current Low Alarm Flag, this alarm flag is not implemented BIT1:0 Reserved Alarm Flag	Variable
114	1	Tx input equalization control	BIT7:4 Hight-speed mode input equalization level control BIT3:0 Low-speed mode input equalization level control, it is not used	00
115	1	Rx out emphasis Control	BIT7:4 Hight-speed mode output emphasis level control BIT3:0 Low-speed mode output emphasis level control, it is not used	00
116	1	Warning Flags	BIT7 Temp High Warning Flag, active high BIT6 Temp Low Warning Flag, active high BIT5 Vcc High Warning Flag, active high BIT4 Vcc Low Warning Flag, active high BIT3 TX Bias High Warning Flag, active high BIT2 TX Bias Low Warning Flag, active high BIT1 TX Power High Warning Flag, active high BIT0 TX Power Low Warning Flag, active high	Variable

117	1	Warning Flags	BIT7 RX Power High Warning Flag, active high BIT6 RX Power Low Warning Flag, active high BIT5 Optional Laser Temp High Warning Flag, this warning flag is not implemented BIT4 Optional Laser Temp Low Warning Flag, this warning flag is not implemented BIT3 Optional TEC current High Warning Flag, this warning flag is not implemented BIT2 Optional TEC current Low Warning Flag, this warning flag is not implemented BIT1:0 Reserved Warning Flag	Variable
118	1	Ext Status/Control	BIT7:4 = 0 Reserved BIT3 = 0 Soft RS1 control bit. Soft Rate Select is not implemented BIT2 = 0 Reserved BIT1 = 1 Power Level State = Level 2, < 1.5 W BIT0 = 1 Power Level Select = Level 2, < 1.5 W	03
119	1	Ext Status/Control	BIT7:5 = 0 Reserved BIT4 = 0 64GFC Mode Tx Configured, this function is not implemented BIT3 = 0 64GFC Mode Rx Configured, this function is not implemented BIT2 = 0 64GFC Mode Configured, this function is not implemented BIT1 TX CDR state, 0 = CDR is locked, 1 = CDR loss of lock BIT0 RX CDR state, 0 = CDR is locked, 1 = CDR loss of lock	Variable
120-122	3	Reserved	Reserved	00 00 00
123-126	4	Security Level Password	Security level password entry. The written value can be read back and the default value on power-up is 00 00 00 00(hex)	00 00 00 00
127	1	Page selection byte	Page selection, select A2h high 128 bytes page	00
Upper Memory Map Page 00/01h				
128-255	128	User Writable EEPROM	User defined, readable and writeable under security level 1	Defined by vendor

Block-Diagram-of-Transceiver



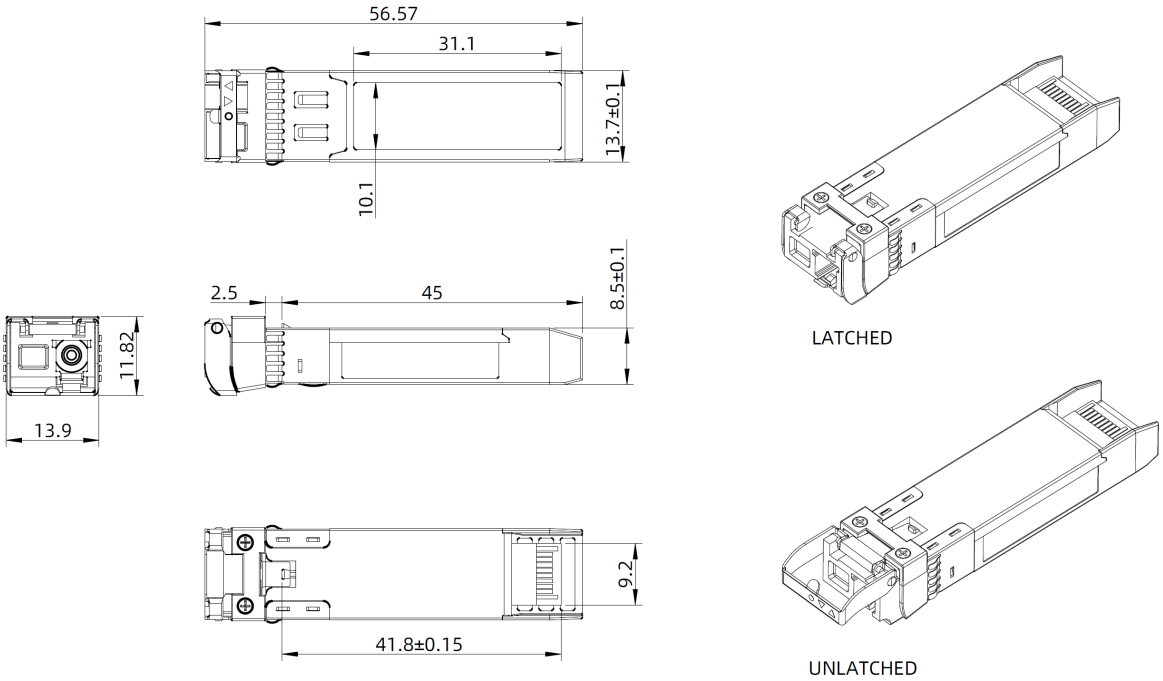
Functions Description

The transmitter consists of a laser driver (LD) chip with integrated clock data recovery function (CDR) and a BOSA (Bidirectional Optical Sub-Assembly). The BOSA integrates a 1310 nm DFB laser diode and a monitor photodiode (MPD). During operation, the input signal is routed to the laser driver chip, which provides both bias current and modulation current and retimes the input signal. The laser driver chip employs an Automatic Power Control (APC) feedback loop to maintain constant average optical output power of the laser, compensating for temperature drift and laser aging effects. When the transmitter disable pin (Tx_Disable) is high (logic "1"), the laser output is turned off. When Tx_Disable is low (logic "0"), the laser is turned on within 1 ms. When the transmitter fault signal (Tx_Fault) is reported as high, it indicates that a fault has occurred on the transmitter side. A low level indicates normal operation. The transmitter output power remains constant regardless of whether an input signal is present. The transmitter output remains active even during input signal loss, and is not squelched.

The receiver consists of a limiting amplifier (LA) chip with integrated clock data recovery function (CDR) and the same BOSA. The BOSA integrates a PIN photodiode and a transimpedance amplifier (TIA) chip. During operation, the light signal is converted into a photo-generated current by the photodetector. The photo-generated current is converted into an electrical signal after passing through the transimpedance amplifier. The electrical signal is further amplified and retimed by the limiting amplifier, and then sent to the host at a fixed amplitude. The receiver detects and reports the Rx_LOS status based on optical modulation amplitude (OMA). When the amplitude of the electrical signal from the photodetector is lower than the preset threshold, the module reports signal loss and sets the Rx_LOS pin to high level (logic "1"). During input signal loss, the receiver output is squelched and the oscilloscope shows that the waveform of the output electrical signal is a straight line.

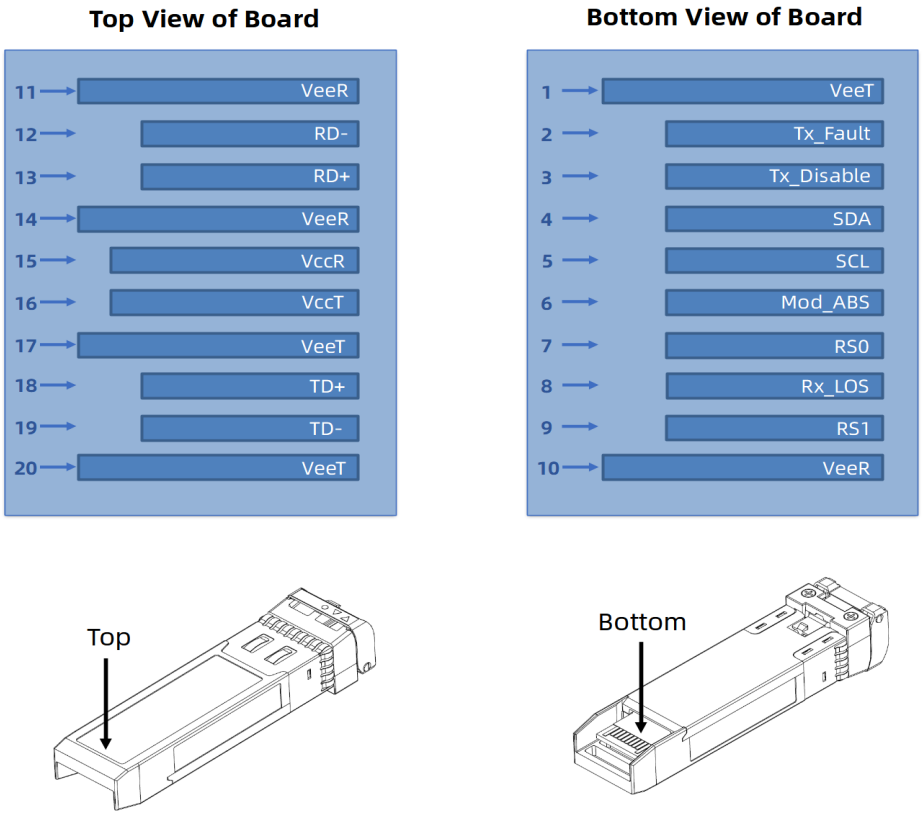
Dimensions

Module Weight: 20 g
Dust Cap Weight: 1 g

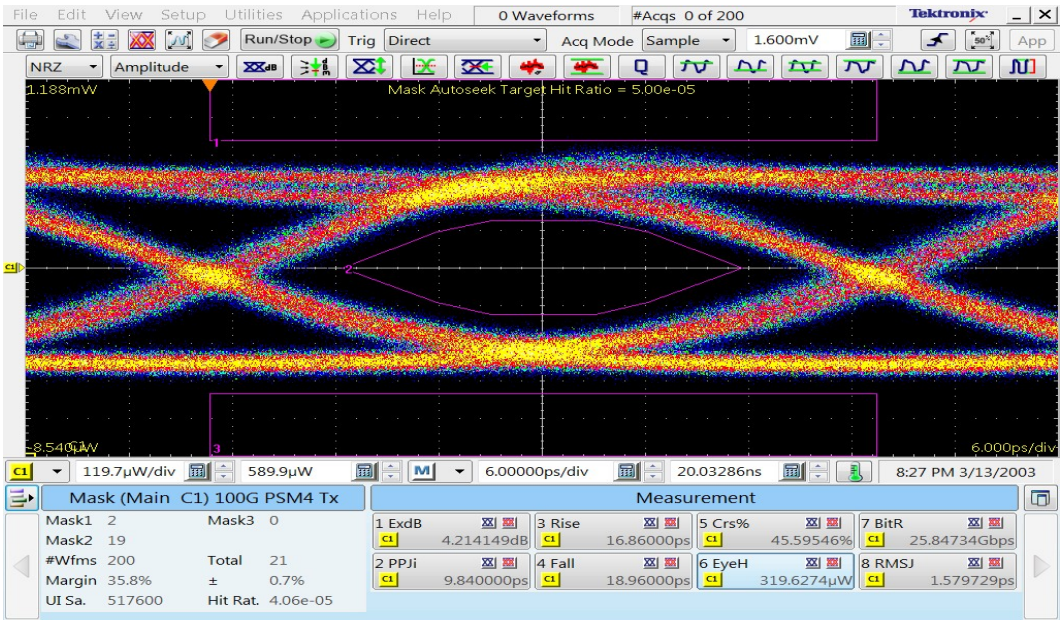


ALL DIMENSIONS ARE ± 0.2 mm UNLESS OTHERWISE SPECIFIED
UNIT: mm

Electrical Pad Layout



Typical Eye Diagram



Pin Assignment

PIN #	Symbol	Description	Remarks
1	VeeT	Transmitter ground (common with receiver ground)	1
2	Tx_Fault	Transmitter Fault	
3	Tx_Disable	Transmitter Disable. Laser output disabled on high or open	
4	SDA	2-wire Serial Interface Data Line	
5	SCL	2-wire Serial Interface Clock Line	
6	Mod_ABS	Module Absent. Grounded within the module	
7	RS0	No connection required	
8	Rx_LOS	Loss of Signal indication. Logic 0 indicates normal operation	
9	RS1	No connection required	
10	VeeR	Receiver ground (common with transmitter ground)	1
11	VeeR	Receiver ground (common with transmitter ground)	1
12	RD-	Receiver Inverted DATA out. AC coupled	
13	RD+	Receiver Non-inverted DATA out. AC coupled	
14	VeeR	Receiver ground (common with transmitter ground)	1
15	VccR	Receiver power supply	
16	VccT	Transmitter power supply	
17	VeeT	Transmitter ground (common with receiver ground)	1
18	TD+	Transmitter Non-Inverted DATA in. AC coupled	
19	TD-	Transmitter Inverted DATA in. AC coupled	
20	VeeT	Transmitter ground (common with receiver ground)	1

Notes:
1. Circuit ground is internally isolated from case

References

1. IEEE standard 802.3
2. SFF-8402 Specification for SFP+ 1X 28 Gb/s Pluggable Transceiver Solution (SFP28)
3. SFF-8472 Specification for Management Interface for SFP+