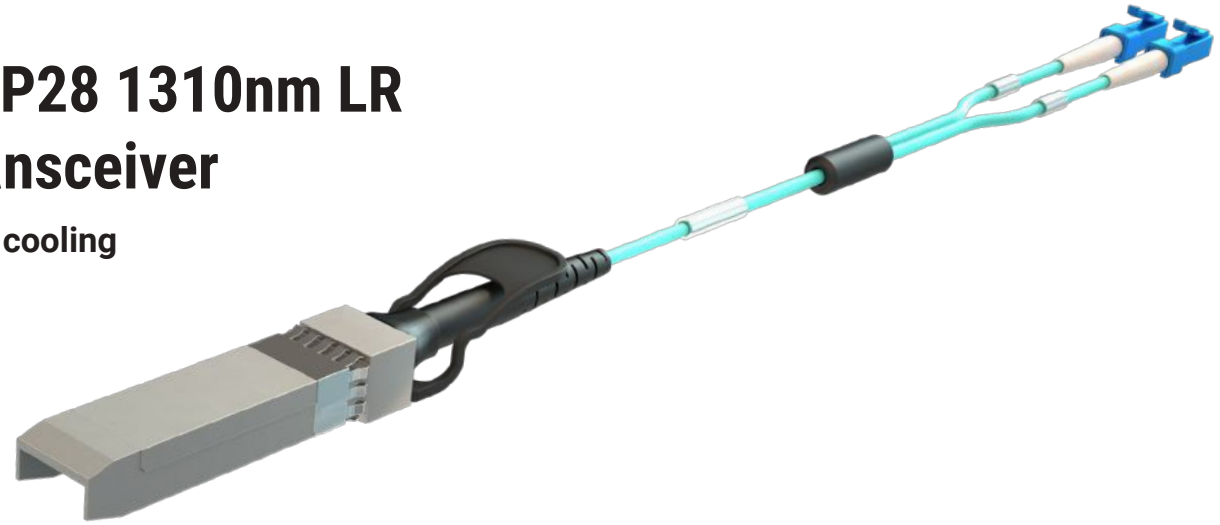
25Gbps SFP28 1310nm LR Optical Transceiver

Module for liquid cooling



Key Feature

- Hot-pluggable SFP28 form factor
- Supports 25Gbps data rate
- Maximum link length of 10km
- Uncooled 1310nm DML transmitter and PIN receiver
- Internal CDR on both Transmitter and Receiver channel
- Optional pigtail type and length
- Single 3.3V power supply
- Power dissipation < 1.5W
- RoHS compliant (2011/65/EU, lead free)
- Operating case temperature range: 0°C to 60°C

Applications

- 25GBASE-LR Ethernet
- CPRI Option 10
- Support 10G CPRI option 8 by CDR bypass
- Especially design for liquid immersion environment

Ordering Information - 25Gbps SFP28 LR Optical Transceiver

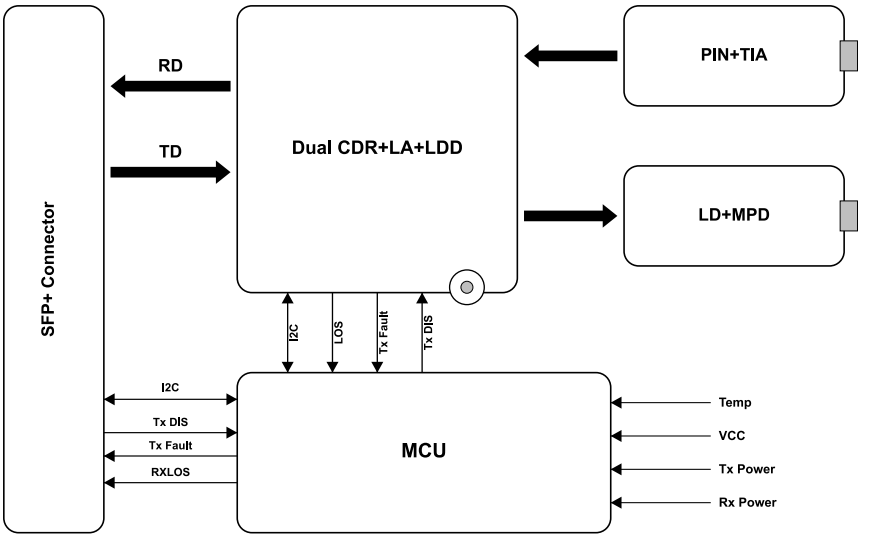
Part No.	Data Rate	Distance	Wavelength	Media	Connector	Temp.
LIPX-UULxxxC	25G	~10Km	1310nm	SMF	LC/FC/MPO Pigtail	C

Product Description

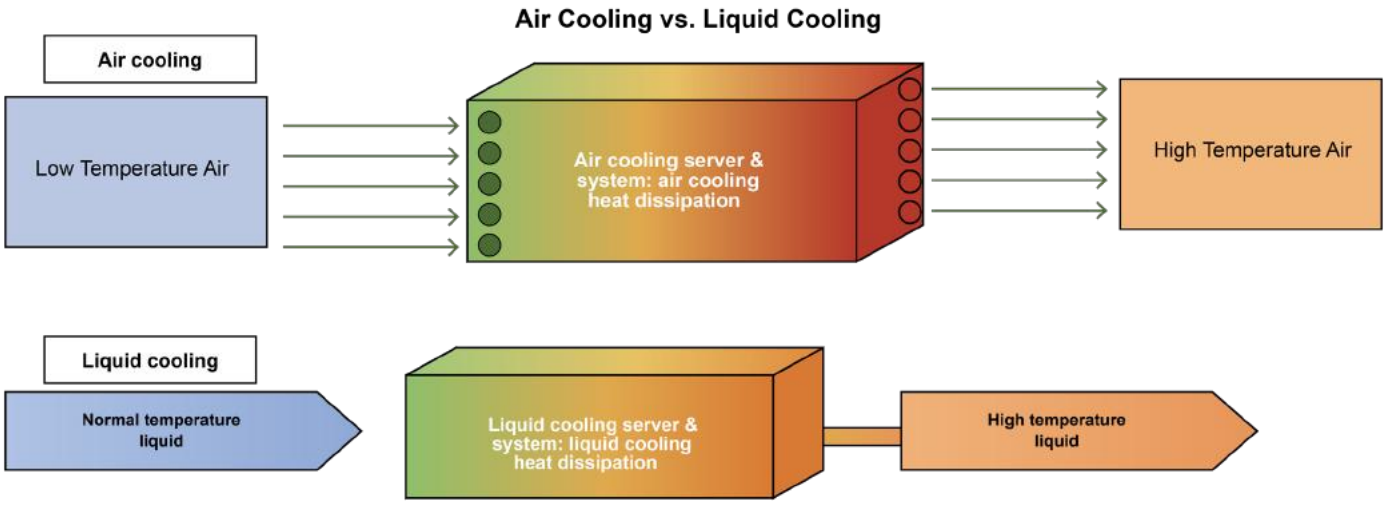
The Lumulus Immersion SFP28 transceiver is a single-channel, pluggable fiber optic module designed for 25 Gigabit Ethernet and CPRI Option 10 applications. Engineered specifically for reliable operation in liquid immersion environments, it delivers high performance for data communication and interconnect applications at data rates up to 25.78125 Gbps over distances of up to 10 km.

The module operates over single-mode fiber using a nominal wavelength of 1310 nm and features a standard 20-contact edge connector electrical interface. An optional pigtail optical interface is also available to support specific deployment requirements. Designed with high-quality components and proven engineering, the module provides long-term reliability, consistent performance, and dependable operation in demanding data center environments.

Module Block Diagram



Liquid cooling advantage



Liquid Immersion Cooling Applications

As data traffic continues to grow and the heat generated by high-performance processors and AI accelerators increases, conventional air-cooling solutions are reaching their practical limits. Liquid cooling technologies provide a more efficient method of heat removal by using dielectric fluids with high thermal capacity, significantly improving cooling efficiency and reducing overall data center power consumption.
This optical transceiver is specifically designed for operation in liquid immersion cooling environments, providing reliable operation when fully immersed in dielectric cooling fluids at depths of up to 10 meters. It is ideally suited for liquid-cooled servers, switches, and high-performance computing systems. The module is compatible with a wide range of dielectric cooling fluids, including fluorinated fluids and mineral oils, ensuring long-term reliability and stable optical performance in demanding immersion cooling applications.

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Supply Voltage	Vcc	0	3.6	V
Storage Temperature	Ts	-40	85	ºC
Operating Humidity	Rh	5	85	%

Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Unit
Operating Case Temperature	Tc	0		+60	°C
Power Supply Voltage	Vcc	3.13	3.3	3.47	V
Power Supply Current	Icc			450	mA
Liquid immersion depth				10	m

Electrical Specifications

Parameter	Symbol	Min	Typical	Max	Unit
Differential Input Impedance	Zin	90	100	110	ohm
Differential Output Impedance	Zout	90	100	110	ohm
Differential Input Voltage Amplitude1	ΔVin	300		1100	mVp-p
Differential Output Voltage Amplitude2	ΔVout	500		800	mVp-p
Input Logic Level High	VIH	2.0		Vcc	V
Input Logic Level Low	VIL	0		0.8	V
Output Logic Level High	VOH	Vcc-0.5		Vcc	V
Output Logic Level Low	VOL	0		0.4	V

Notes:

1. Differential input voltage amplitude is measured between TxnP and TxnN.
2. Differential output voltage amplitude is measured between RxnP and RxnN.

Optical Characteristics

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Transmitter						
Data rate	BR		25.78		Gbps	
Centre Wavelength	λc	1295	1310	1325	nm	
Spectral Width (-20dB)	σ			1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Average Output Power	Pavg	-7		2	dBm	
Optical Modulation Amplitude	OMA	-4		2.2	dBm	
Extinction Ratio	ER	3.5			dB	
Eye Mask Coordinates			{0.31, 0.4, 0.45, 0.34, 0.38, 0.4}			
Receiver						
Data rate	BR		25.78		Gbps	
Centre Wavelength	λc	1295	1310	1325	nm	
Average Power at Receiver				2	dBm	
Receive reflectance(max)				-26	dB	
Receiver Sensitivity (OMA)	Psens			-12.0	dBm	1
Stressed receiver sensitivity(OMA)				-9.5	dBm	2
LOS De-Assert	LOSD			-12	dBm	
LOS Assert	LOSA	-30			dBm	
LOS Hysteresis		0.5			dB	

Notes:

1. For 25G-LR with FEC, receiver sensitivity is defined at $5E^{-5}$ BER level, not 10^{-12} BER level.
2. Measured with conformance test signal at TP3 for BER=5E-5.

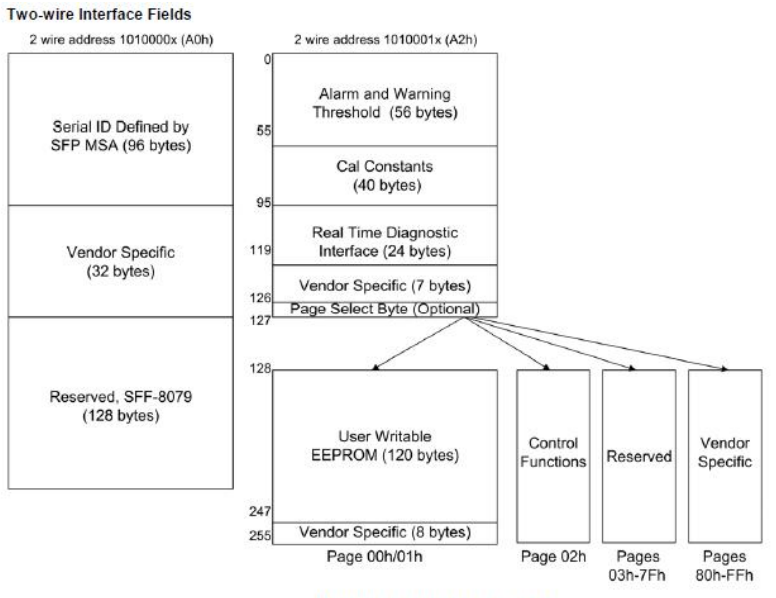
Timing and Electrical Specifications

Parameter	Symbol	Min.	Max.	Unit	Conditions
Tx_Disable assert time	t_off		100	μs	Rising edge of Tx_Disable to fall of output signal below 10% of nominal
Tx_Disable negate time	t_on		2	ms	Falling edge of Tx_Disable to rise of output signal above 90% of nominal. This only applies in normal operation, not during start up or fault recovery.
Time to initialize 2-wire interface	t_2w_start_up		300	ms	From power on or hot plug after the supply meeting Table 8.
Time to initialize	t_start_up		300	ms	From power supplies meeting Table 8 or hot plug or Tx disable negated during power up, or Tx_Fault recovery, until non-cooled power level I part (or non-cooled power level II part already enabled at power level II for Tx_Fault recovery) is fully operational.

Time to initialize cooled module and time to power up a cooled module to Power Level II	t_start_up_cooled	90	s	From power supplies meeting Table 8 or hot plug, or Tx disable negated during power up or Tx_Fault recovery, until cooled power level I part (or cooled power level II part during fault recovery) is fully operational. Also, from stop bit low-to-high SDA transition enabling Power Level II until cooled module is fully operational
Time to Power Up to Level II	t_power_level2	300	ms	From stop bit low-to-high SDA transition enabling power level II until non-cooled module is fully operational
Time to Power Down from Level II	t_power_down	300	ms	From stop bit low-to-high SDA transition disabling power level II until module is within power level I requirements
Tx_Fault assert	Tx_Fault_on	1	ms	From occurrence of fault to assertion of Tx_Fault
Tx_Fault assert for cooled module	Tx_Fault_on_cooled	50	ms	From occurrence of fault to assertion of Tx_Fault
Tx_Fault Reset	t_reset	10	µs	Time Tx_Disable must be held high to reset Tx_Fault
RS0, RS1 rate select timing for FC	t_RS0_FC, t_RS1_FC	500	µs	From assertion till stable output
RS0, RS1 rate select timing non FC	t_RS0, t_RS1	24	ms	From assertion till stable output
Rx_LOS assert delay	t_los_on	100	µs	From occurrence of loss of signal to assertion of Rx_LOS
Rx_LOS negate delay	t_los_off	100	µs	From occurrence of presence of signal to negation of Rx_LOS

Memory Organization

The transceiver provides serial ID memory contents and diagnostic information about its current operating conditions through a 2-wire serial interface (SCL and SDA). The memory map and its specific data fields are defined as follows.



TWO-WIRE INTERFACE FIELDS

CDR Rate Select control

The Soft RS0 Select bit (A2h, byte 110, bit 3) and Soft RS1 Select bit (A2h, byte 118, bit 3) are CDR control bits that enable CDR Rate Select through the 2-wire serial interface. These bits operate in conjunction with the corresponding hardware Rate Select pins (RS0 and RS1) through a logical OR function. As a result, the CDR Rate Select is enabled whenever either the corresponding software bit is set to “1” or the associated hardware pin is driven High.

RETIMER/CDR RATE SELECT LOGIC TABLE

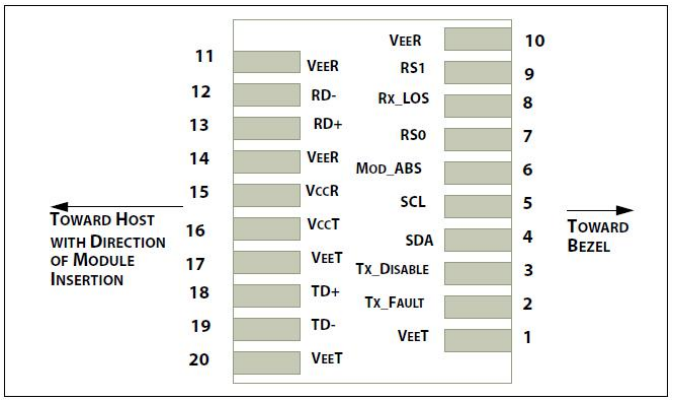
When byte 13d of A0h is set to 0Eh and bit 64.3 of A0h is set to 1

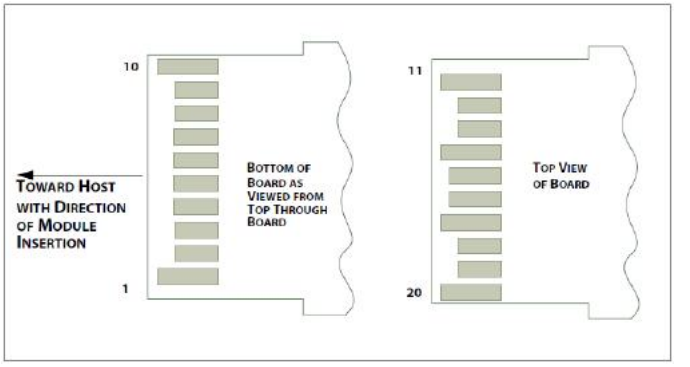
Logic OR of RS0 pin and RS0 bit	Logic OR of RS1 pin and RS1 bit	Receiver retimer/CDR	Transmitter retimer/CDR
Low/0	Low/0	Lock at low bit rate	Lock at low bit rate
Low/0	High/1	Lock at high bit rate	Bypass
High/1	Low/0	Bypass	Bypass
High/1	High/1	Lock at high bit rate	Lock at high bit rate

Note: Low and high bit rates are defined in byte 13d of A0h.

SFP28 Electrical Pad Layout

For detail mechanical information, please refer to the related document of SFP MSA.

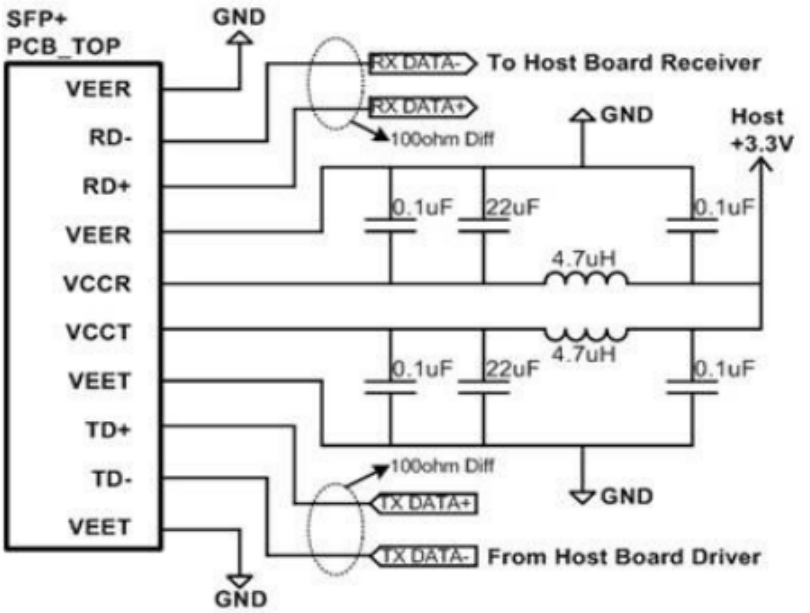


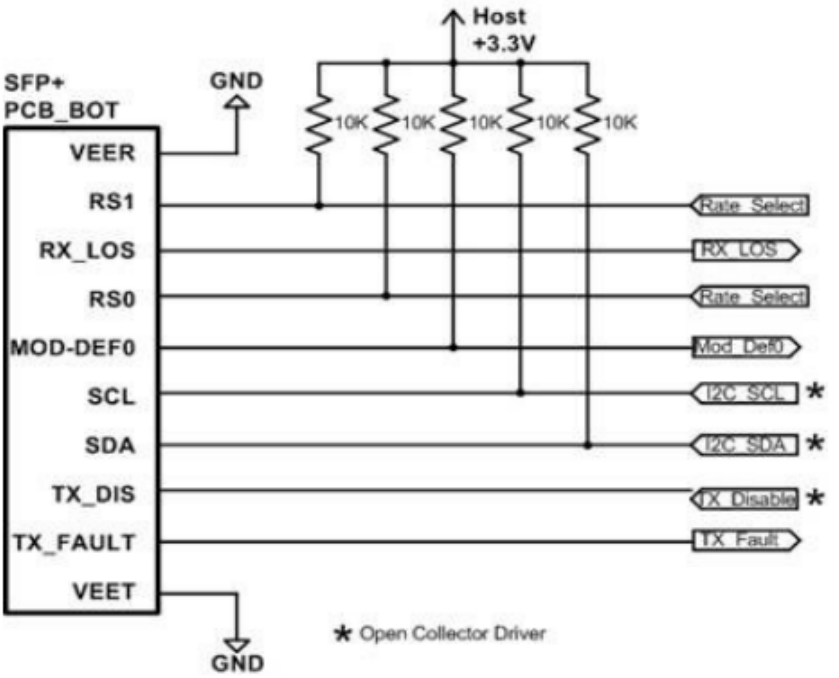


SFP28 PIN Function Definitions

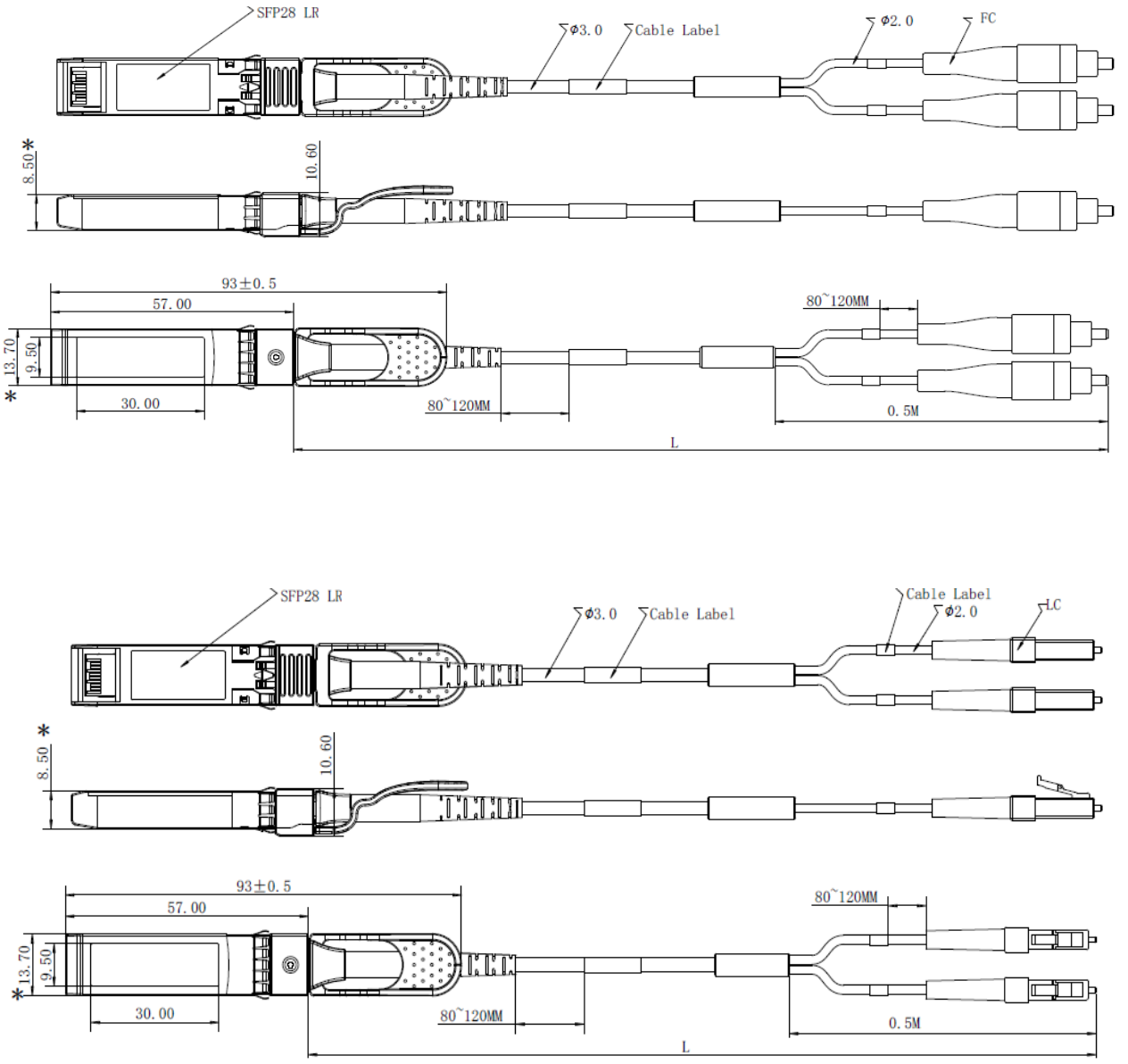
Pin	Logic	Symbol	Description
1		VeeT	Module Transmitter Ground
2	LVTTL-O	Tx_Fault	Module Transmitter Fault
3	LVTTL-I	Tx_DIS	Transmitter Disable; Active High Disable Transmitter Output
4	LVTTL-I/O	SDA	2-Wire Serial Interface Data
5	LVTTL-I/O	SCL	2-Wire Serial Interface Clock
6		Mod_ABS	Module Absent, connected to VeeT or VeeR in the module
7	LVTTL-I	RS0	Rate Select0, optionally controls SFP+ module receiver
8	LVTTL-O	RX_LOS	Receiver Loss of Signal Indication
9	LVTTL-I	RS1	Rate Select1,optionally controls SFP+ module transmitter
10		VeeR	Module Receiver Ground
11		VeeR	Module Receiver Ground
12	CML-O	RD-	Receiver Inverted Data Output
13	CML-O	RD+	Receiver Non-Inverted Data Output
14		VeeR	Module Receiver Ground
15		VccR	Module Receiver 3.3V Supply
16		VccT	Module Transmitter 3.3V Supply
17		VeeT	Module Transmitter Ground
18	CML-I	TD+	Transmitter Non-Inverted Data Input
19	CML-I	TD-	Transmitter Inverted Data Input
20		VeeT	Module Transmitter Ground

Recommended Interface Circuit





Mechanical Dimensions(FC/LC)



Regulatory Compliance

These optical transceivers are classified as Class 1 Laser Products and comply with the following laser safety standards:

Feature	Standard
Laser Safety	IEC 60825-1:2014 (3rd Edition) IEC 60825-2:2004/AMD2:2010 EN 60825-1-2014 EN 60825-2:2004+A1+A2
Electrical Safety	EN 62368-1: 2014 IEC 62368-1:2014 UL 62368-1:2014
Environmental protection	Directive 2011/65/EU with amendment(EU)2015/863
CE EMC	EN55032□2015 EN55035□2017 EN61000-3-2:2014 EN61000-3-3:2013
FCC	FCC Part 15, Subpart B ANSI C63.4-2014

References

• SFP28 MSA
• Ethernet IEEE802.3cc
• Directive 2011/65/EU of the European Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment,” July 1, 2011.

Laser Safety Warning

Caution: Use of optical instruments with this product will increase eye hazard. Do not view the laser beam directly with optical instruments or naked eyes.

Disclaimer

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