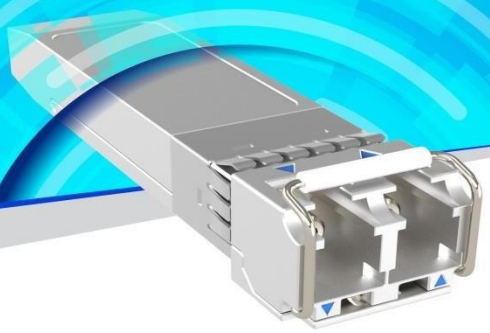
PRODUCT DETAILS

25G SFP28 ZR Optical Transceiver

QD1310-SFP-LC.S80 Series

Single-Mode, 25G SFP28
With DDMI and Dual CDR



Product Description

The QD1310-SFP-LC.S80 optical supports high speed serial links over single-mode optical fiber at signal rates up to 25.78Gb/s. The product is compliant with Small Form Plug-gable industry agreements SFP and SFP28 for mechanical and low speed electrical specifications.

The transmitter side of the module incorporates one 1300nm EML and CDR integrated with EML driver, and the receiver side integrated with SOA and PIN-TIA followed by Rx CDR.

Digital diagnostic monitoring information (DDMI) is present in this module per the requirements of SFF-8472, providing real time monitoring information of transceiver laser, receiver and environment conditions over a SFF-8419 2-wire serial interface.

Features

- Operating Data Rate Support 25.78Gbps
- 1300nm EML laser on transmitter side
- Integrated SOA and PIN TIA on receiver side
- Single 3.3V Power Supply
- Distance up to 80km over SMF
- Duplex LC Connector Interface, Hot Pluggable
- Built-in Dual CDR
- Compliant with MSA SFP+ Specification SFF-8472
- Power Dissipation:
  - Commercial temperature < 2.5W
  - Industrial temperature < 3W
- Operating Case Temperature：
  - Commercial：0℃~70℃
  - Industrial: -40℃~85℃
- Safety Certification: TUV/UL/FDA*1

Applications

- 25GbE applications with FEC on host side
- Other Optical Link

Ordering Information

Part No.	Data Rate	Fiber	Distance*3	CDR	Interface	Temp.	DDMI
QD1310-SFP-LC.S80*2	25.78Gbps	SMF	80km	YES	LC	0℃~70℃	YES
QD1310-SFP-LC.S80(WT)*4	25.78Gbps	SMF	80km	YES	LC	-40℃~85℃	YES

*1: For the latest certification information, please check with Data Controls.

*2: 80km applications with FEC on host side.

*3: Over SMF.

*4: Industrial version.

*The product image is only for reference purpose.

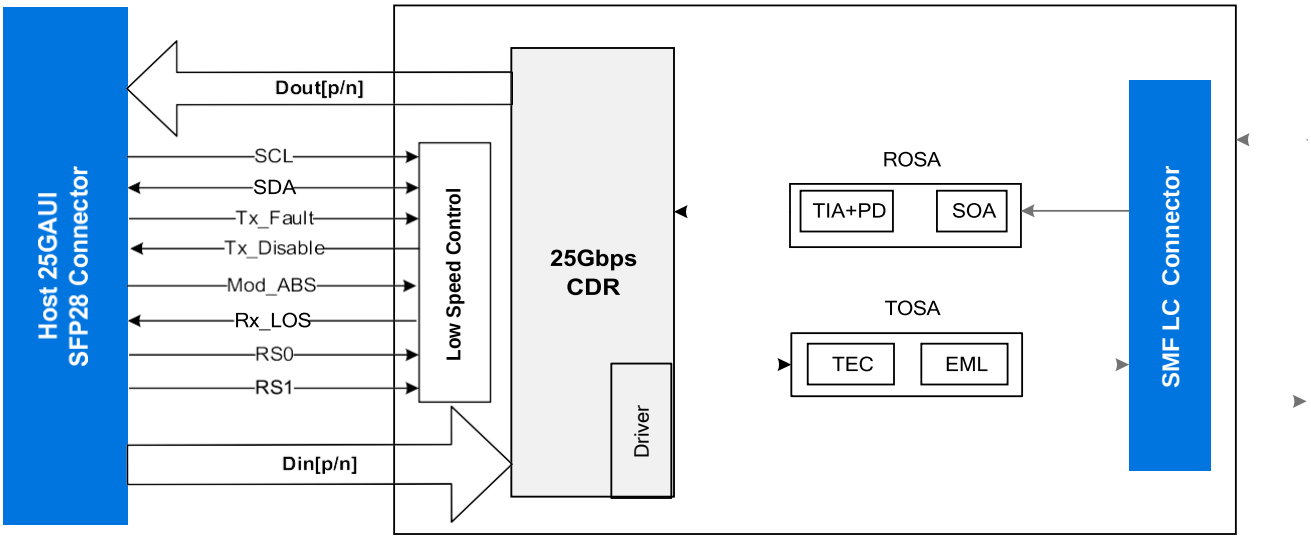


Figure 1: Transceiver Block Diagram

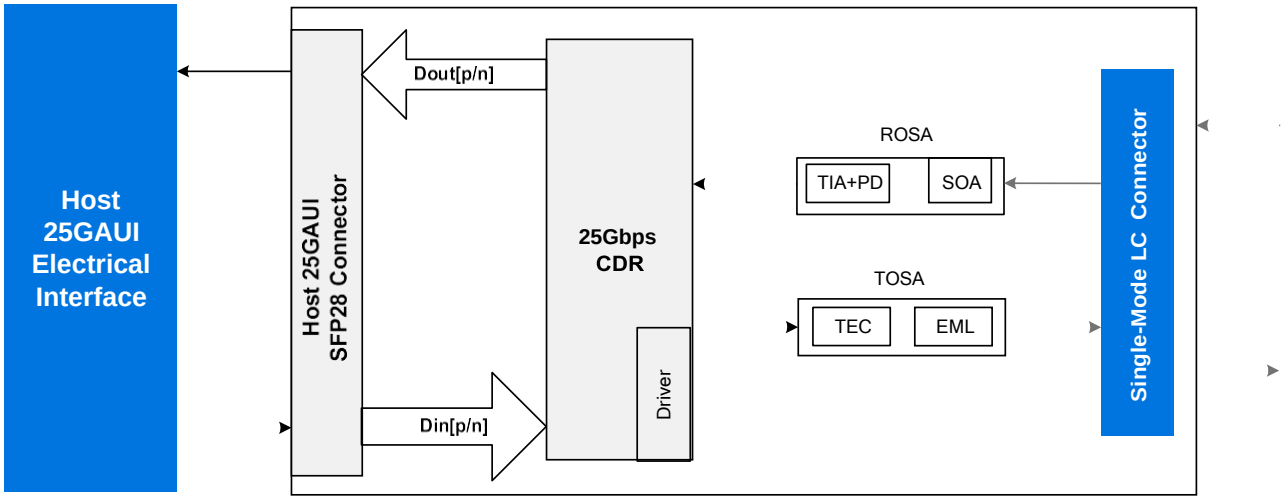


Figure 2: Application Reference Diagram

Transmitter

As shown in Figure 1, the transmitter path of the transceiver contains a 25GAUI electrical input with equalization (EQ) block, integrated EML driver, EML laser and diagnostic monitor.
The transmitter section uses a wavelength of 1300nm EML, it's a class 1 laser compliant according to International Safety Standard IEC 60825.

Receiver

As shown in Figure 1, the receiver path of the transceiver contains an SOA, PIN photodiode, trans-impedance amplifier (TIA), 25GAUI compliant electrical output block.
The receiver section is integrated with SOA and PIN-TIA which enable the high sensitivity capability for the Rx side.

High Speed Electrical Signal Interface

The interface between SFP28 module and ASIC/SerDes is shown in Figure 2. The high speed signal lines are internally AC-coupled and the electrical inputs are internally terminated to 100 Ohms differential. All transmitter and receiver electrical channels are compliant to 25GAUI specifications per IEEE 802.3cc.

Low Speed Electrical Signal Interface

The module has the following low speed signals for control and status: TX_Fault, TX_Disable, MOD-ABS, RX LOS, RS0, RS1. In addition, there is an industry standard two wire serial interface scaled for 3.3V LVCMOS. It is implemented as a slave device. Signal and timing characteristics are further defined in the Control Characteristics and Control Interface.

Handling and Cleaning

Exposure to current surges and overvoltage events can cause immediate damage to the transceiver module. Observe the precautions for normal operation of electrostatic discharge sensitive equipment; Attention shall also be paid to limiting transceiver module exposure to conditions beyond those specified in the absolute maximum ratings.
Optical connectors include female connectors. These elements will be exposed as long as the cable or port plug is not inserted. At this time, always pay attention to protection.
Each module is equipped with a port guard plug to protect the optical port. The protective plug shall always be in place whenever the optical fiber is not inserted. Before inserting the optical fiber, it is recommended to clean the end of the optical fiber connector to avoid contamination of the module opticalport due to dirty connector. If contamination occurs, use standard LC port cleaning methods.

Absolute Maximum Ratings

Exceeding the absolute maximum ratings table may cause permanent damage to the device. This is just an emphasized rating, and does not involve the functional operation of the device that exceeds the specifications of this technical specification under these or other conditions. Long-term operation under absolute maximum ratings will affect the reliability of the device.

Parameter	Symbol	Min.	Typical	Max.	Unit
Storage Temperature	Ts	-40		+85	°C
3.3 V Power Supply Voltage	Vcc	-0.5	3.3	3.6	V
Relative Humidity	RH	5		85	%

Recommended Operating Conditions

For operations beyond the recommended operating conditions, optical and electrical characteristics are not defined, reliability is not implied, and such operations for a long time may damage the module.

Parameter	Symbol	Min.	Typical	Max.	Unit
Storage Temperature	Ts	-40		+85	°C
Operating Case Temperature*6	T_C-C Temp	0		70	°C
	T_C-I Temp	-40		85	°C
Operating Relative Humidity	RH			65	%
Power Supply Voltage	Vcc	3.135	3.3	3.465	V
Power Supply Noise*7				25	mVpp
Power Dissipation	P_D-C Temp			2.5	W
	P_D-I Temp			3	W
Electrical Signal Rate *8			25.78125		GBd
Optical Signal Rate *9			25.78125		GBd
Receiver Differential Data Output Load		90	100	110	Ohm
Fiber Length *10				80	km

*5: Power Supply specifications, Instantaneous, sustained and steady state current compliant with SFP28 MSA Power Classification.

*6: The position of case temperature measurement is shown in Figure 8.

*7: Power Supply Noise is defined as the peak-to-peak noise amplitude over the frequency range at the host supply side of the recommended power supply filter with the module and recommended filter in place. Voltage levels including peak-to-peak noise are limited to the recommended operating range of the associated power supply. See Figure 6 for recommended power supply filter.

*8: 25GAUI operation with Host generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.

*9: 25G ZR operation with Host generated FEC. The transmitter must receive pre-coded FEC signals from the host ASIC.

*10: 9μm SMF. The maximum link distance is based on an allocation of 27dB of attenuation and 3dB total connection and splice loss. The loss of a single connection shall not exceed 0.5dB.

General Electrical Characteristics*11

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Symbol	Min.	Typical	Max.	Unit
Transceiver Power Consumption	P_D-C Temp			2.5	W
	P_D-I Temp			3	W
Transceiver Power Supply Total Current	I_{CC}-C Temp			722	mA
	I_{CC}-I Temp			865	mA
AC Coupling Internal Capacitor			0.1		uF

*11: For control signal timing including TX_Fault, TX_Disable, MOD-ABS, RX LOS, RS0, RS1, SCL and SDA see Control Interface Section.

Reference Points*12

The PMD block diagram is shown in Figure3. For purposes of system conformance, the PMD sublayer is standardized at the points described in this subclause. The optical transmit signal is defined at the output end of a single-mode fiber patch cord (TP2), between 2 m and 5 m in length. Unless specified otherwise, all transmitter measurements and tests defined in IEEE 802.3 114.7 are made at TP2. The optical receive signal is defined at the output of the fiber optic cabling (TP3) at the MDI (see IEEE 802.3 88.11.3). Unless specified otherwise, all receiver measurements and tests defined in IEEE 802.3 114.7 are made at TP3.

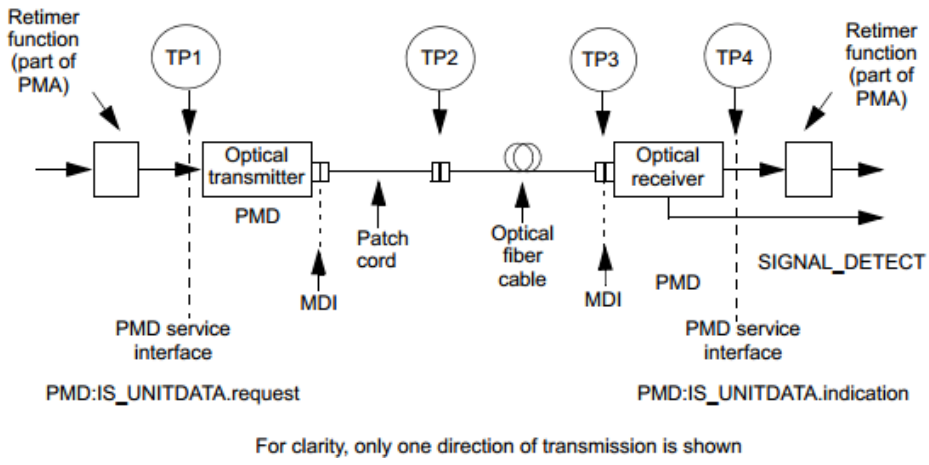


Figure 3: Block diagram for 25GBASE-LR and 25GBASE-ER transmit/receive paths

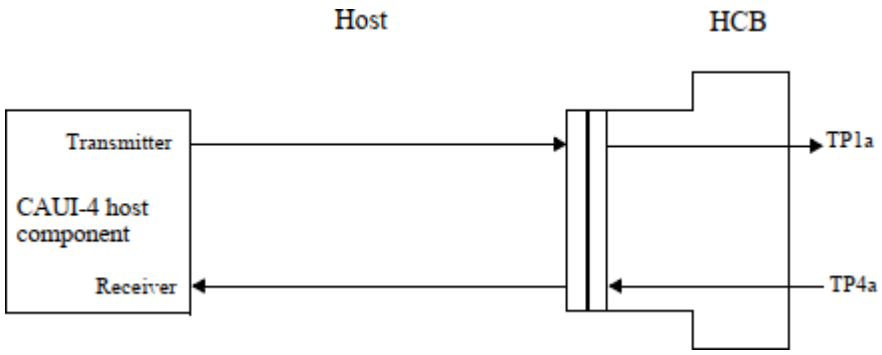


Figure 4: Host CAUI-4 compliance pointsTP1a, TP4a

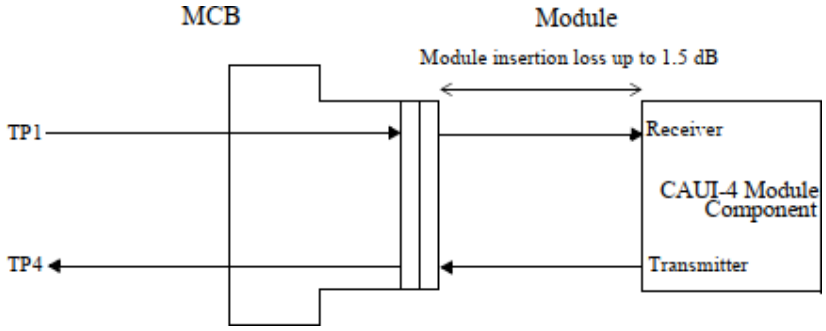


Figure 5: Module CAUI-4 compliance pointsTP1, TP4

*12: 25GAUI C2M compliance points are defined in 83E.2. The HCB and MCB for a four-lane connector (e.g., QSFP28) are described and specified in 92.11.2. The HCB and MCB for a single-lane connector (e.g., SFP28) are described and specified in Annex 110B.

High Speed Electrical Input Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Test Point	Min.	Typical	Max.	Unit	Standards
Signaling Rate Per Lane	TP1		25.78125+/- 100 ppm		GBd	
DC Common-Mode Output Voltage*13	TP1	-350		2850	mV	
Differential peak-peak Input Voltage Tolerance	TP1a	900			mV	
Single-Ended Voltage Tolerance Range	TP1a	-400		3300	mV	
Differential Input Return Loss (Min)	TP1		Equation (83E-2)		dB	802.3ba
Common To Differential Mode Conversion Return Loss (Min)	TP1		Equation (83E-3)		dB	802.3ba
Differential Termination Mismatch	TP1		10		%	
Module Stressed Input			83E.3.4.1			

Test*14				
Eye Width	TP1a	0.46	UI	
Eye Height	TP1a	95	mV	
Applied peak-peak Sinusoidal Jitter	TP1a	Table 88-13		802.3ba

*13: DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.

*14 Module stressed input tolerance is measured using the procedure defined in 83E.3.4.1.

High Speed Electrical Output Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Parameter	Test Point	Min.	Typical	Max.	Unit
Signaling Rate Per Lane (Range)	TP4a		25.78125 ± 100 ppm		GBd
Common Mode Voltage	TP4a	-0.3		2.8	V
Differential peak-peak Input Voltage Tolerance	TP4	900			mV
Differential Input Return Loss (Min)	TP4a		Equation (83E-2)		dB
Differential To Common Mode Input Return Loss (Min)	TP4a		Equation (83E-3)		dB
Differential Termination Mismatch	TP4a		10		%
Host Stressed Input Test			83E3.3.2		
Eye Width	TP4		0.57		UI
Eye Height	TP4		228		mV
Applied peak-peak Sinusoidal Jitter	TP4		Table 88-13		

High Speed Optical Transmitter Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions

Optical Characteristics @TP2 Test Point

Parameter	Symbol	Min	Typical	Max	Unit
Signaling Speed			25.78		Gbps
Modulation Format			NRZ		
Center Wavelength	λ_C	1299.02	1300.05	1301.09	nm
Side-mode suppression ratio	SMSR	30			dB
Spectral Width (20dB)	$\Delta\lambda$			1	nm
Extinction Ratio	ER	8			dB

Average Launch Power *15	P_{avg}	2	7	dBm
Optical Modulation Amplitude (OMA) *16	P_{OMA}	3.7	8.6	dBm
Average launch power of OFF transmitter	P_{off}		-30	dBm
Transmitter dispersion penalty*17	TDP		3	dB
Optical Return Loss Tolerance			20	dB
Transmitter reflectance*18			-26	dB
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}*19		{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		

*15: Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

*16: Even if the TDP < 1.0dB, the OMA (min) must exceed 0.5dB.

*17: Measured at 25.78125Gbps & BER = $5*10^{-5}$.

*18: Transmitter reflectance is defined looking into the transmitter.

*19: Vertical eye closure penalty, stressed eye J2 Jitter, stressed eye J4 Jitter, and SRS eye mask definition are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

High Speed Optical Receiver Characteristics

Unless otherwise stated, the following characteristics are defined under recommended operating conditions.

Optical Characteristics @TP3 Test Point

Parameter	Symbol	Min.	Typical	Max.	Unit
Signaling Speed			25.78125		Gbps
Center Wavelength	λ_C	1299.02	1300.05	1301.09	nm
Receiver overload	P_{sat}	-6			dBm
Average Receive Power *20	Rx_pow	-31		-6	dBm
Damage threshold (min) *21	P_{Damage}			-5	dBm
Receiver Sensitivity (OMA) *22	Rx_sens			-26.5	dBm
LOS Assert (Avg.)	LOSA	-40		-32.5	dBm
LOS De-Assert (Avg.)	LOSD			-29.5	dBm
LOS Hysteresis		0.5			dB
Receiver Reflectance	ORL			-26	dB

*20: Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.

*21: The receiver shall be able to tolerate, without damage, continuous exposure to an optical signal having this average power level.

*22: Receiver sensitivity (OMA), each lane (max) at $5*10^{-5}$ BER is a normative specification.

Regulatory Compliance Issues

Various standard and regulations apply to the QD1310-SFP-LC.S80 modules. These include eye-safety, Component Recognition, RoHS, ESD, EMC and Immunity. Please note the transmitter module is a Class 1 laser product. See Regulatory Compliance Table for details.

Regulatory Compliance Table

Feature	Test Method	Performance
Laser Eye Safety and Equipment Type Testing 	(IEC) EN 62368-1:2014+A11 (IEC) EN 60825-1:2014 (IEC) EN 60825-2:2004+A1+A2	CDRH Accession Number:2132182-000 TUV File: R 50457725 0001 CB File: JPTUV-100513
Component Recognition	Underwriters Laboratories (UL) and Canadian Standards Association (CSA) Joint Component Recognition for Information Technology Equipment including Electrical Business Equipment	UL File: E317337
RoHS Compliance	RoHS Directive 2011/65/EU&(EU)2015/863	Less than 100 ppm of cadmium. Less than 1000 ppm lead, mercury, hexavalent chromium, poly brominated biphenyls (PPB), poly brominated biphenyl ethers (PBDE), dibutyl phthalate, butyl benzyl phthalate, bis (2-ethylhexyl) phthalate and diisobutyl phthalates.
Electrostatic Discharge (ESD) to the Electrical Contacts	JEDEC Human Body Model (HBM)	High speed contacts shall withstand 1000V. All other contacts shall withstand 2000 V.
Electrostatic Discharge (ESD) to the Optical Connector Receptacle	IEC 61000-4-2:2008	When installed in a properly grounded housing and chassis the units are subjected to 15Kv air discharges during operation and 8Kv direct discharges to the case.
Electromagnetic Interference (EMI)	FCC Part 15 Class B; CISPR 32 (EN55032) 2015;	System margins are dependent on customer board and chassis design.
Immunity	IEC 61000-4-3:2010; EN55035:2017	Typically shows no measurable effect from a 10V/m field swept from 80 MHz to 6 GHz applied to the module without a chassis enclosure.

Electrostatic Discharge (ESD)

The QD1310-SFP-LC.S80 is complies with the ESD requirements described in the Regulatory Compliance Table. However, in the normal processing and operation of optical transceiver, the following two types of situations need special attention.

Case I: Before inserting the transceiver into the rack meeting the requirements of SFP28 MSA, ESD preventive measures must be taken to protect the equipment. For example, the grounding wrist strap, workbench and floor should be used wherever the transceiver is handled.

Case II: After the transceiver is installed, the electrostatic discharge outside the chassis of the host equipment shall be within the scope of system level ESD requirements. If the optical interface of the transceiver is exposed outside the host equipment cabinet, the transceiver may be subject to equipment system level ESD requirements.

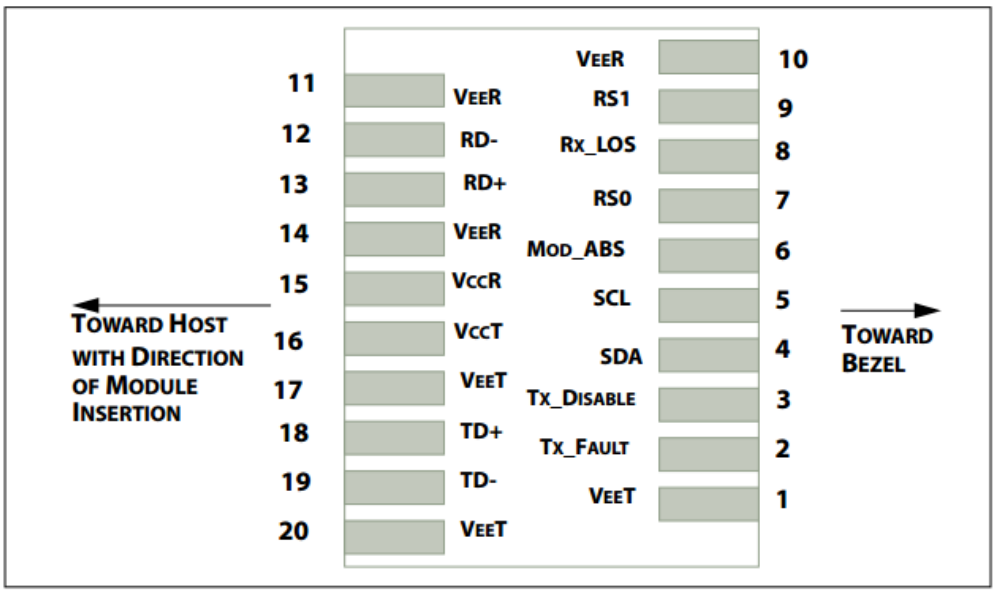
Electromagnetic Interference (EMI)

Communication equipment with optical transceivers is usually regulated by FCC in the United States and CENELEC EN55032 (CISPR 32) in Europe. The compliance of QD1310-SFP-LC.S80 with these standards is detailed in the regulatory compliance table. The metal shell and shielding design of QD1310-SFP-LC.S80 will help equipment designers minimize the equipment level EMI challenges they face.

Flammability

QD1310-SFP-LC.S80 optical transceiver meets UL certification requirements, its constituent materials have heat and corrosion resistance, and the plastic parts meet UL94V-0 requirements.

SFP28 Transceiver Electrical Pad Layout



Pin Arrangement and Definition

Pin	Logic	Symbol	Description	Plug Sequence	Notes
1		VeeT	Transmitter Ground	1	3
2	LVTTL-O	Tx_Fault	Transmitter Fault Indication	3	4
3	LVTTL-I	Tx_Disable	Transmitter Disable	3	5
4	LVTTL-I/O	SDA	2-Wire Serial Interface Data Line	3	6
5	LVTTL-I/O	SCL	2-Wire Serial Interface Clock	3	6
6		Mod_ABS	Module Absent	3	7
7	LVTTL-I	RS0	Rate Select 0	3	8
8	LVTTL-I/O	Rx_LOS	Receiver Loss of Signal Indication	3	4
9	LVTTL-I	RS1	Rate Select 1	3	8
10		VeeR	Receiver Ground	1	3
11		VeeR	Receiver Ground	1	3
12	CML-O	RD-	Receiver Inverted Data Output	3	
13	CML-O	RD+	Receiver Non-Inverted Data Output	3	
14		VeeR	Receiver Ground	1	3
15		VccR	Receiver 3.3V Supply	2	
16		VccT	Transmitter 3.3V Supply	2	
17		VeeT	Transmitter Ground	1	3
18	CML-I	TD+	Transmitter Data Input	3	
19	CML-I	TD-	Transmitter Inverted Data Input	3	
20		VeeT	Transmitter Ground	1	3

1. Labeling as inputs (I) and outputs (O) are from the perspective of the module
2. The case makes electrical contact to the cage before any of the board edge contacts are made.
3. The module signal ground contacts, VeeR and VeeT, should be isolated from the module case.
4. This contact is an open collector/drain output contact and shall be pulled up on the host see 2.4.1 and 2.4.6. Pull ups can be connected to one of several power supplies, however the host board design shall ensure that no module contact has voltage exceeding module VccT/R +0.5 V.
5. Tx_Disable is an input contact with a 4.7 KΩ to 10 KΩ pullup to VccT inside the module.
6. See SFF-8431 4.2.
7. See SFF-8431 2.4.4.
8. For SFF-8431 rate select definition see section 2.4.3 and 2.5. (If implementing SFF-8079 contact 7 and in SFF-8431 are used for AS0 and AS1 respectively).

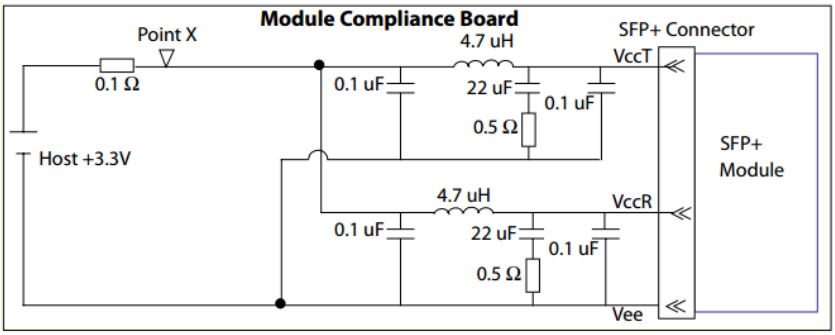


Figure 6: Recommended Host Board Power Supply Filter. (SFF-8431_figure 56)

During power transient events, the host should ensure that any neighboring modules sharing the same

supply stay within their specified supply voltage limits. The host should also ensure that the intrinsic noise of the power rail is filtered in order to guarantee the correct operation of the optical modules. The reference power supply filter is shown in Figure 6.

Package Outline

The module is designed to meet the package outline defined in the SFP28 MSA specification. See the package outline for details.

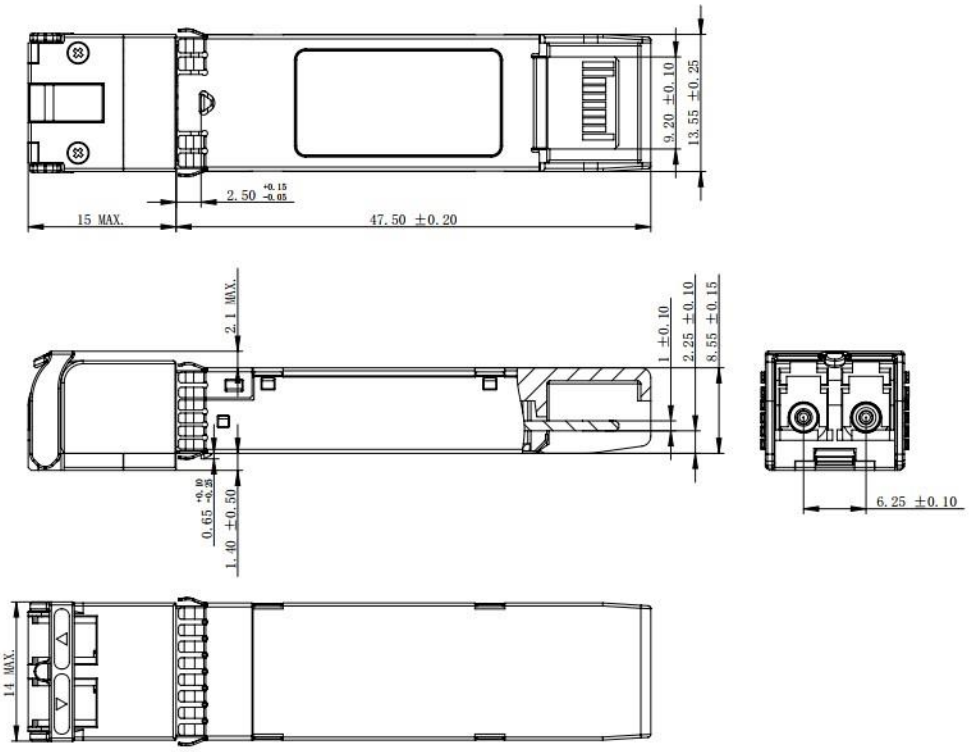


Figure 7: Mechanical Package Outline (All dimensions in mm)

*This 2D drawing is only for reference, please check with Data Controls before ordering.

The bellow picture shows the location of the hottest spot for measuring module case temperature. In addition, the digital diagnostic monitors (DDM) temperature is also calibrated to this spot.

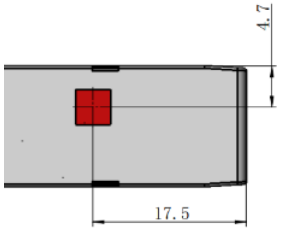


Figure 8: Case Temperature Measurement Point

The optical interface port is a LC connector as specified in SFF-8432.

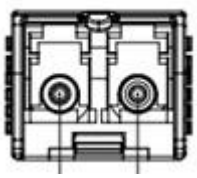


Figure 9: Module Optical Interface (looking into the optical port)

Control Interface & Memory Map

The control interface combines dedicated signal lines for TX Fault, TX Disable, MOD-ABS, RX LOS, RS0, RS1 with two-wire serial (TWS), interface clock (SCL) and data (SDA), signals to provide users rich functionality over an efficient and easily used interface.

SCL and SDA

The SCL and SDA is a hot plug interface that may support a bus topology. During module insertion or removal, the module may implement a pre- charge circuit which prevents corrupting data transfers from other modules that are already using the bus.

Tx_Fault

Tx_Fault is a module output that when high, indicates that the module transmitter has detected a fault condition related to laser operation or safety. If Tx_Fault is not implemented, the Tx_Fault contact signal shall be held low by the module and may be connected to Vee within the module.
The Tx_Fault output is an open drain/collector and shall be pulled up to the Vcc_Host in the host with a resistor in the range 4.7 KΩ to 10 KΩ, or with an active termination according to SFF-8431 Table 6.

Tx_Disable

When Tx_Disable is asserted high or left open, the SFP+ module transmitter output shall be turned off unless the module is a passive cable assembly (see Appendix E) in which case this signal may be ignored. This contact shall be pulled up to VccT with a 4.7 KΩ to 10 KΩ resistor in modules and cable assemblies.
Tx_Disable is a module input contact.
When Tx_Disable is asserted low or grounded the module transmitter is operating normally.

RS0/RS1

RS0 and RS1 are module inputs and are pulled low to VeeT with > 30 KΩ resistors in the module. RS0 optionally selects the optical receive signaling rate coverage. RS1 optionally selects the optical transmit signaling rate coverage. For logical definitions of RS0/RS1 see 2.5.
These contacts can also be used for AS0 and AS1 if implementing SFF8079.See SFF8079 for details.
RS1 is commonly connected to VeeT or VeeR in the classic SFP modules. The host needs to ensure that it will not be damaged if this contact is connected to VeeT or VeeR in the module.

Mod_ABS

Mod_ABS is connected to VeeT or VeeR in the SFP+ module. The host may pull this contact up to Vcc_Host with a resistor in the range 4.7 KΩ to10 KΩ.
Mod_ABS is asserted “High” when the SFP+ module is physically absent from a host slot. In the SFP MSA (INF-8074i) this contact has the same function but is called MOD_DEF0.

Rx_LOS

Rx_LOS when high indicates an optical signal level below that specified in the relevant standard. Rx_LOS is an open drain/collector output, but may also be used as an input by supervisory circuitry in the module. For a nominally 3.3 V Vcc_Host using a resistive pull up to Vcc_Host the resistor value shall be in the range 4.7 KΩ to 10 KΩ. For a nominally 2.5 V Vcc_Host using a resistive pull up to Vcc_Host the resistor value shall be in the range 4.7 KΩ to 7.2 KΩ. Alternatively, an active termination according to Table 6 maybe used.

Low Speed Control and Sense Signals

Parameter	Symbol	Min.	Typical	Max.	Unit
SCL and SDA	VOL	0		0.4	V
	VOH	V_{CC}-0.5		V_{CC}+0.3	V
SCL and SDA	VIL	-0.3		V_{CC}*0.3	V
	VIH	V_{CC}*0.7		V_{CC}+0.5	V
TX Disable, RS0, RS1	VIL	-0.3		0.8	V
	VIH	2		V_{CC}+0.3	V
LPMode, ResetL, ModSelL	|Iin|			360	Ma
TX Fault, RX LOS	VOL	0		0.4	V
	VOH	V_{CC}-0.5		V_{CC}+0.3	V
MOD-ABS	VOL	0		0.4	V

Memory Map

The Module provides diagnostic information about the present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture. Received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring all are implemented. The digital diagnostic memory map specific data field define as following. For detail EEPROM information, please refer to the related document of SFF 8472.

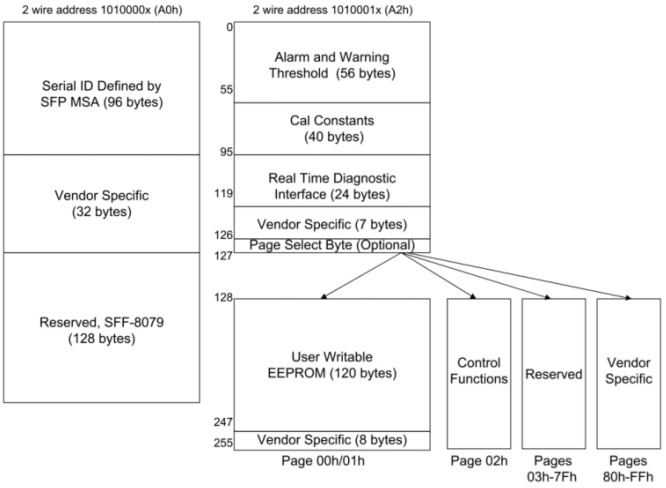


Figure 10: 2-wire Interface Fields

Notice

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