Проектирование сетей,
поставка оборудования, оптимизация и
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NS-QSFP28-100G-CWDM4

100Gb/s QSFP28 CLR4 Single Mode Optical Transceiver

Features

- 4 independent full-duplex channels
- Up to 28Gb/s data rate per channel
- QSFP28 MSA compliant
- Compliant to 100G CLR4
- Up to 2km reach for G.652 SMF
- Maximum power consumption 3.5W
- Single +3.3V power supply
- Operating case temperature: 0 to 70 C
- RoHS-6 compliant

Applications

- 100G Ethernet links
- Infiniband QDR and DDR interconnects
- Datacenter and Enterprise networking

1. General Description

This product is a transceiver module designed for 2km optical communication applications. The design is compliant to IEEE802.3ba and 100G-CLR4 standard. The module converts 4 inputs channels of 25Gb/s electrical data to 4 CWDM optical signals, and multiplexes them into a single channel for 100Gb/s optical transmission. Reversely, on the receiver side, the module optically de-multiplexes a 100Gb/s input into 4 CWDM channels signals, and converts them to 4 channel output electrical data.

The central wavelengths of the 4 CWDM channels are 1271, 1291, 1311 and 1331 nm as members of the CWDM wavelength grid defined in ITUT-T G.694.2 and are spaced at 20 nm. It contains a duplex LC connector for the optical interface and a 38-pin connector for electrical interface. Its electrical interface is based on IEEE802.3 CAUI-4 to module retimed interface.

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP28 Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference. The module can be managed through the I2C two-wire serial interface.

2. Functional Description

This product converts the 4-channel 25Gb/s electrical input data into CWDM optical signals, by a driven 4-wavelength Distributed Feedback Laser (DFB) array. The light is combined by the MUX parts as a 100Gb/s data, propagating out of the transmitter module from the SMF. The receiver module accepts the 100Gb/s CWDM optical signals input, and de-multiplexes it into 4 individual 25Gb/s channels with different wavelength. Each wavelength light is collected by a discrete photo diode, and then outputted as electrical data after amplified by a TIA and a post amplifier. Figure 1 shows the functional block diagram of this product.

A single +3.3V power supply is required to power up the module. Both power supply pins VccTx and VccRx are internally connected and should be applied concurrently. Per MSA the module offers 7 low speed hardware control pins (including the 2-wire serial interface): ModSelL, SCL, SDA, ResetL, LPMode, ModPrsL and IntL.

Module Select (ModSelL) is an input pin. When held low by the host, the module responds to 2-wire serial communication commands. The ModSelL allows the use of multiple QSFP28 modules on a single 2-wire interface bus – individual ModSelL lines for each QSFP28 module must be used.

Serial Clock (SCL) and Serial Data (SDA) are required for the 2-wire serial bus communication interface and enable the host to access the QSFP28 memory map.

The ResetL pin enables a complete module reset, returning module settings to their default state, when a low level on the ResetL pin is held for longer than the minimum pulse length. During the execution of a reset the host shall disregard all status bits until the module indicates a completion of the reset interrupt. The module indicates this by posting an IntL (Interrupt) signal with the Data_Not_Ready bit negated in the memory map. Note that on power up (including hot insertion) the module should post this completion of reset interrupt without requiring a reset.

Low Power Mode (LPMode) pin is used to set the maximum power consumption for the module in order to protect hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

Module Present (ModPrsL) is a signal local to the host board which, in the absence of a module, is normally pulled up to the host Vcc. When a module is inserted into the connector, it completes the path to ground through a resistor on the host board and asserts the signal. ModPrsL then indicates a module is present by setting ModPrsL to a “Low” state.

Interrupt (IntL) is an output pin. Low indicates a possible module operational fault or a status critical to the host system. The host identifies the source of the interrupt using the 2-wire serial interface. The IntL pin is an open collector output and must be pulled to the Host Vcc voltage on the Host board.

3. Transceiver Block Diagram

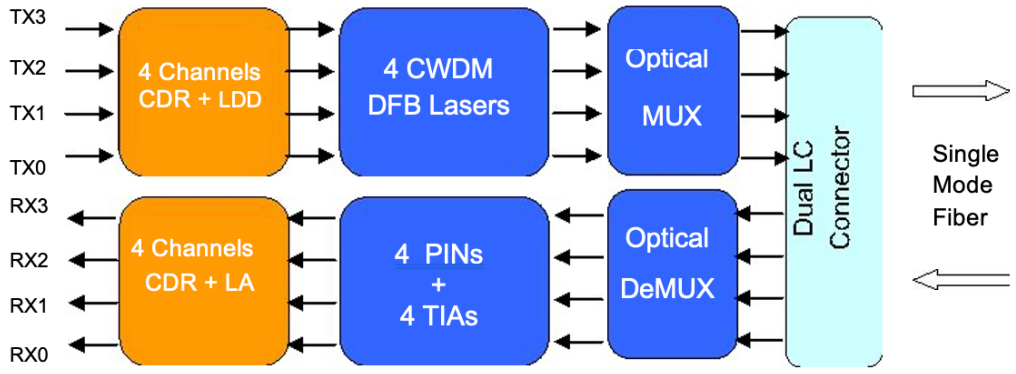

Figure 1. Transceiver Block Diagram

4. Pin Assignment and Description

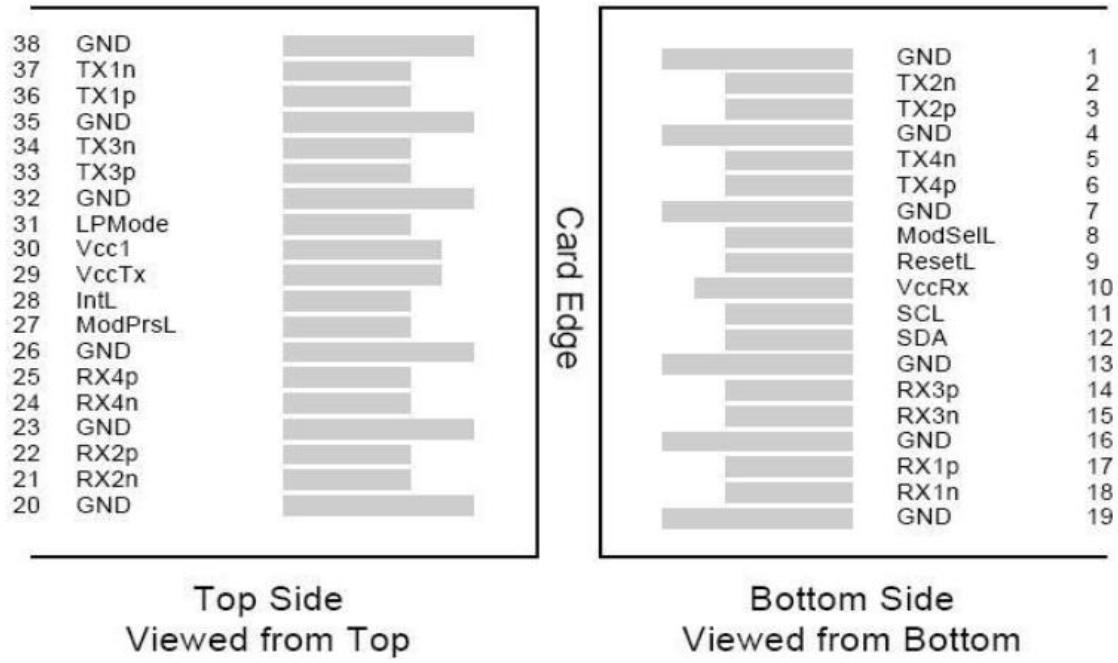

Figure 2. QSFP28 Transceiver Electrical Connector Layout

PIN	Logic	Symbol	Name/Description	Notes
1		GND	Ground	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	
3	CML-I	Tx2p	Transmitter Non-Inverted Data output	
4		GND	Ground	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	
6	CML-I	Tx4p	Transmitter Non-Inverted Data output	
7		GND	Ground	1
8	LVTLL-I	ModSelL	Module Select	
9	LVTLL-I	ResetL	Module Reset	
10		VccRx	+3.3V Power Supply Receiver	2
11	LVCMOS-I/O	SCL	2-Wire Serial Interface Clock	
12	LVCMOS-I/O	SDA	2-Wire Serial Interface Data	
13		GND	Ground	
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	
15	CML-O	Rx3n	Receiver Inverted Data Output	
16		GND	Ground	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	
18	CML-O	Rx1n	Receiver Inverted Data Output	
19		GND	Ground	1

20		GND	Ground	1
21	CML-O	Rx2n	Receiver Inverted Data Output	
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	
23		GND	Ground	1
24	CML-O	Rx4n	Receiver Inverted Data Output	1
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	
26		GND	Ground	1
27	LVTTL-O	ModPrsL	Module Present	
28	LVTTL-O	IntL	Interrupt	
29		VccTx	+3.3 V Power Supply transmitter	2
30		Vcc1	+3.3 V Power Supply	2
31	LVTTL-I	LPMode	Low Power Mode	
32		GND	Ground	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	
34	CML-I	Tx3n	Transmitter Inverted Data Output	
35		GND	Ground	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	
37	CML-I	Tx1n	Transmitter Inverted Data Output	
38		GND	Ground	1

Notes:

1. GND is the symbol for signal and supply (power) common for QSFP28 modules. All are common within the QSFP28 module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal common ground plane.

2. VccRx, Vcc1 and VccTx are the receiver and transmitter power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown in Figure 3 below. Vcc Rx, Vcc1 and VccTx may be internally connected within the QSFP28 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

5. Recommended Power Supply Filter

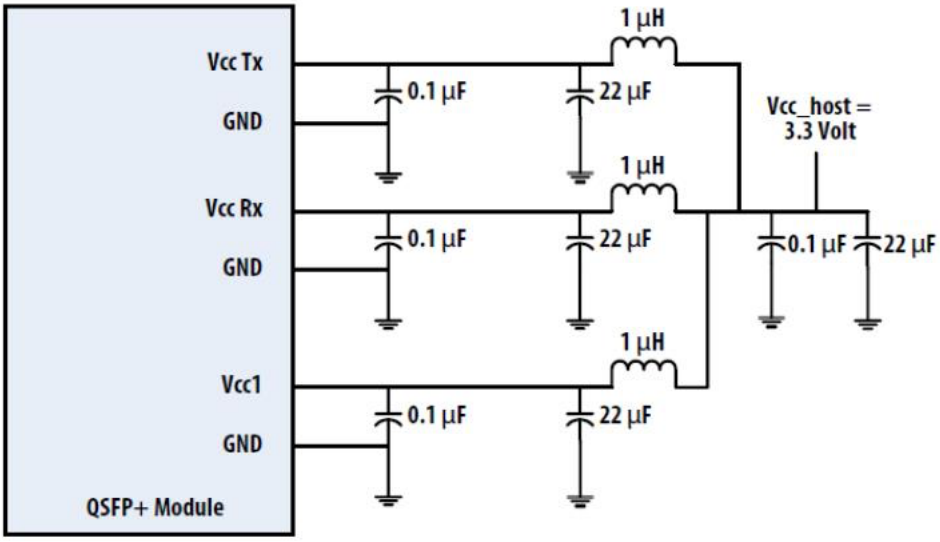

Figure 3. Recommended Power Supply Filter

6. Absolute Maximum Ratings

It has to be noted that the operation in excess of any absolute maximum ratings might cause permanent damage to this module.

Parameter	Symbol	Min	Max	Units	Notes
Storage Temperature	Ts	-40	85	degC	
Operating Case Temperature	Top	0	70	degC	
Power Supply Voltage	Vcc	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	0	85	%	
Damage Threshold, each Lane	THd	3.5		dBm	

7. Recommended Operating Conditions and Power Supply Requirements

Parameter	Symbol	Min	Max	Units	Notes
Operating Case Temperature	Top	0		70	degC
Power Supply Voltage	Vcc	3.135	3.3	3.465	V
Data Rate, each Lane			25.78125		Gb/s
Control Input Voltage High		2		Vcc	V
Control Input Voltage Low Link Distance with G.652	 D	0 0.002		0.8 2	V km

8. Electrical Characteristics

The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

Parameter	Symbol	Min	Typical	Max	Units	Notes
Power Consumption				3.5	W	
Supply Current	Icc			1.1	A	
Transceiver Power-on Initialization Time				2000	ms	1
Module input characteristics (each Lane)						
Parameter	**Test Point**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Signal Rate, each Lane	TP1	25.78125±100ppm			Gb/s	
Differential pk-pk Input Voltage Tolerance	TP1a	900			mV	
Differential Input Return Loss	TP1	IEEE802.3bm Equation 83E-5			dB	
Differential to Common Mode Input Return Loss	TP1	IEEE802.3bm Equation 83E-6			dB	
Differential Termination Mismatch	TP1			10	%	
Module Stressed Input Test	TP1a	IEEE802.3bm 83E.3.4.1				2
Single End Voltage Tolerance Range	TP1a	-0.4		3.3	V	
DC Common Mode Voltage	TP1	-350		2850	mV	3
Receiver (each Lane)						
Parameter	**Test Point**	**Min**	**Typical**	**Max**	**Units**	**Notes**
Signaling Rate, each Lane	TP4	25.78125±100ppm			Gb/s	
AC Common Mode Output Voltage (RMS)	TP4			17.5	mV	
Differential Output Voltage	TP4			900	mV	

Eye Width	TP4	0.57			UI	
Eye Height, Differential	TP4	228			mV	
Vertical Eye Closure	TP4			5.5	dB	
Differential Output Return Loss	TP4	IEEE802.3bm Equation 83E-2			dB	
Common to Differential Mode Conversion Return Loss	TP4	IEEE802.3bm Equation 83E-3			dB	
Differential Termination Mismatch	TP4			10	%	
Transition Time (20% to 80%)	TP4	12			ps	
DC Common Mode Voltage	TP4	-350		2850	mV	3

Notes:

1. Power-on Initialization Time is the time from when the power supply voltages reach and remain above the minimum recommended operating supply voltages to the time when the module is fully functional.

2. Meets BER specified in IEEE802.3bm 83E.1.1.

3. DC common mode voltage is generated by the host. Specification includes effects of ground offset voltage.

9. Electrical Characteristics

9.1 Optical Characteristics without FEC

Parameter	Symbol	Min	Typical	Max	Units	Notes
Transmitter						
Signaling Rate, each Lane		25.78125±100ppm			Gb/s	
BER		$1x10^{-12}$				
Lane Wavelength	L0	1264.5	1271	1277.5	nm	
	L1	1284.5	1291	1297.5		
	L2	1304.5	1311	1317.5		
	L3	1324.5	1331	1337.5		
Side Mode Suppression Ratio	SMSR	30			dB	
Total Average Launch Power	P_T			8.5	dBm	
Average Launch Power, each Lane	P_{AVG}	-6.5		2.5	dBm	
Optical Modulation Amplitude (OMA), each Lane	P_{OMA}	-4.0		2.5	dBm	1
Launch Power in OMA minus Transmitter and Dispersion Penalty (TDP), each Lane		-5.0			dBm	2
TDP, each Lane	TDP			3.3	dB	
Extinction Ratio	ER	3.5			dB	
Relative Intensity Noise	RIN_{20} OMA			-130	dB/Hz	
Optical Return Loss Tolerance	TOL			20	dB	
Transmitter Reflectance	R_T			-20	dB	
Average Launch Power OFF Transmitter, each Lane	Poff			-30	dBm	
Transmitter Eye Mask Definition {X1, X2, X3, Y1, Y2, Y3}		{0.25, 0.42, 0.46, 0.28, 0.3, 0.4}				

Receiver						
BER		1x10				
Lane Wavelength	L0	1264.5	1271[12]	1277.5	nm	
	L1	1284.5	1291	1297.5		
	L2	1304.5	1311	1317.5		
	L3	1324.5	1331	1337.5		
Damage Threshold, each Lane	TH_d	3.5			dBm	3
Average Receive Power, each Lane		-10		2.5	dBm	4
Receiver Reflectance	R_R			-26	dB	
Receive Power (OMA), each Lane	SEN			2.5	dBm	5
Receiver Sensitivity (OMA), each Lane				-8.1	dBm	
Stressed Receiver Sensitivity (OMA), each Lane				-5.6	dBm	
Difference in Receive Power between any Two Lanes (OMA)	Prx,diff			5.5	dB	
LOS Assert	LOSA	-30		-16	dBm	
LOS Deassert	LOSD			-12	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Receiver Electrical 3 dB upper Cutoff Frequency, each Lane	Fc			31	GHz	
Conditions of Stress Receiver Sensitivity Test (Note 6)						
Vertical Eye Closure Penalty, each Lane				1.95	dB	
Stress Eye J2 Jitter, each Lane	J2			0.3	UI	
Stress Eye J9 Jitter, each Lane	J9			0.5	UI	

Notes:

1. Even if the TDP < 1 dB, the OMA min must exceed the minimum value specified here.

2. A tradeoff regarding the transmitter launch power can be made.

3. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.

4. Average receiver 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 thie does not ensure compliance.

5. Receiver sensitivity (OMA), each lane(max) is informative.

6. Vertical eye closure penalty, stress eye J2 jitter, and stressed eye J9 jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver. A max TDP of 3.3dB is assumed.

9.2 Optical Characteristics with FEC

Parameter	Symbol	Min	Typical	Max	Units	Notes
Transmitter						
Signaling Rate, each Lane		25.78125±100ppm			Gb/s	
Pre-FEC BER						
Lane Wavelength	L0	1264.5	1271	1277.5	nm	
	L1	1284.5	1291	1297.5		
	L2	1304.5	1311	1317.5		
	L3	1324.5	1331	1337.5		
Side Mode Suppression Ratio	SMSR	30			dB	
Total Average Launch Power	P_T			8.5	dBm	
Average Launch Power, each Lane	P_{AVG}	-6.5		2.5	dBm	
Optical Modulation Amplitude (OMA), each Lane	P_{OMA}	-4.0		2.5	dBm	1

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Launch Power in OMA minus Transmitter and Dispersion Penalty (TDP), each Lane		-5.0			dBm	
TDP, each Lane	TDP			2.7	dB	2
Extinction Ratio	ER	3.5			dB	
Relative Intensity Noise	RIN_{20} OMA			-130	dB/Hz	
Optical Return Loss Tolerance	TOL			20	dB	
Transmitter Reflectance	R_T			-20	dB	
Average Launch Power OFF Transmitter, each Lane	Poff			-30	dBm	
Transmitter Eye Mask Definition {X1, X2, X3, Y1, Y2, Y3}		{0.31, 0.4, 0.45, 0.34, 0.38, 0.4}				
Receiver						
Pre-FEC BER		$2.1x10^{-5}$				
Lane Wavelength	L0	1264.5	1271	1277.5	nm	
	L1	1284.5	1291	1297.5		
	L2	1304.5	1311	1317.5		
	L3	1324.5	1331	1337.5		
Damage Threshold, each Lane	TH_d	3.5			dBm	3
Average Receive Power, each Lane		-12.5			dBm	4
Receiver Reflectance	R_R			-26	dB	
Receive Power (OMA), each Lane				2.5	dBm	
Receiver Sensitivity (OMA), each Lane	SEN			-10.9	dBm	5
Stressed Receiver Sensitivity (OMA), each Lane				-8.5	dBm	
Difference in Receive Power between any Two Lanes (OMA)	Prx,diff			5.5	dB	

LOS Assert	LOSA	-30		-16	dBm	
LOS Deassert	LOSD			-12	dBm	
LOS Hysteresis	LOSH				dB	
Receiver Electrical 3 dB upper Cutoff Frequency, each Lane	Fc			31	GHz	
Conditions of Stress Receiver Sensitivity Test (Note 6)						
Vertical Eye Closure Penalty, each Lane				1.95	dB	
Stress Eye J2 Jitter, each Lane	J2			0.33	UI	
Stress Eye J9 Jitter, each Lane	J9			0.48	UI	

Notes:

1. Even if the TDP < 1 dB, the OMA min must exceed the minimum value specified here.

2. A tradeoff regarding the transmitter launch power can be made.

3. The receiver shall be able to tolerate, without damage, continuous exposure to a modulated optical input signal having this power level on one lane. The receiver does not have to operate correctly at this input power.

4. Average receiver 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 thie does not ensure compliance.

5. Receiver sensitivity (OMA), each lane (max) is informative.

6. Vertical eye closure penalty, stress eye J2 jitter, and stressed eye J9 jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver. A max TDP of 3.3dB is assumed.

7. With-FEC numbers provided for reference; each parameter is met if the equivalent CLR4 parameter without FEC is met.

10. Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

Parameter	Symbol	Min	Max	Units	Notes
Temperature monitor absolute error	DMI_Temp	-3	3	degC	Over operating temperature range
Supply voltage monitor absolute error	DMI _VCC	-0.1	0.1	V	Over full operating range
Channel RX power monitor absolute error	DMI_RX_Ch	-2	2	dB	1
Channel Bias current Monitor	DMI_Ibias_Ch	-10%	10%	mA	
Channel TX power monitor absolute error	DMI_TX_Ch	-2	2	dB	1

Note:

1. Due to measurement accuracy of different single mode fibers, there could be an additional +/-1 dB fluctuation, or a +/- 3 dB total accuracy.

11. Mechanical Dimensions

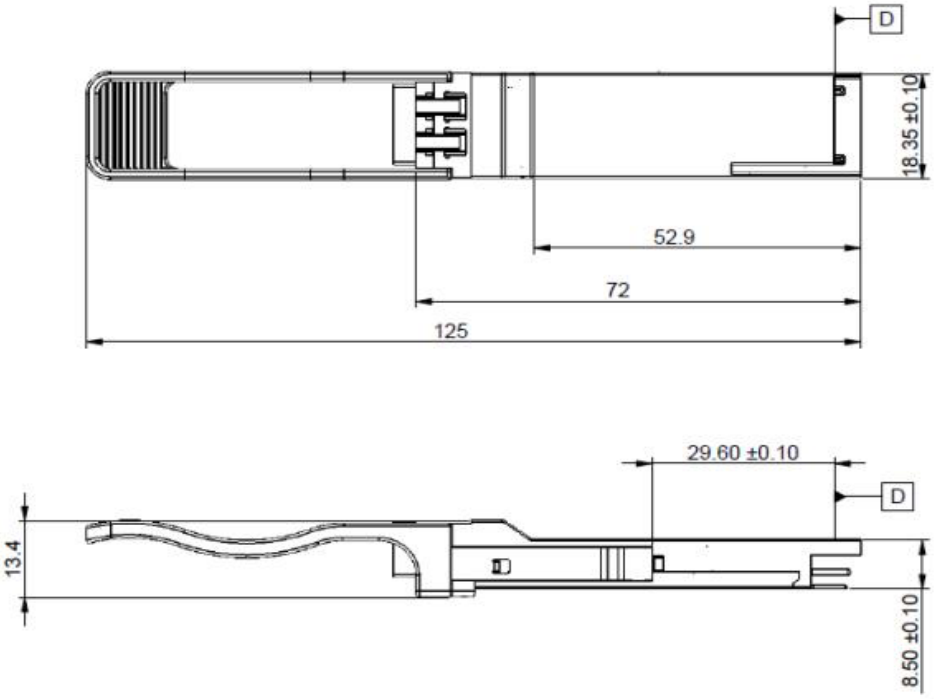

Figure 4. Mechanical Outline

12. ESD

This transceiver is specified as ESD threshold 1KV for high-speed data pins and 2KV for all others electrical input pins, tested per MIL-STD-883, Method 3015.4 /JESD22-A114-A (HBM). However, normal ESD precautions are still required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and handled only in an ESD protected environment.

13. Laser Safety

This is a Class 1 Laser Product according to EN 60825-1:2014. This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007).

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Part Number Ordering Information

NS-QSFP28-100G-CWDM4	QSFP28 CLR4 2km optical transceiver with full real-time digital diagnostic monitoring