

Features

- Hot pluggable QSFP28 MSA form factor
- Compliant to IEEE 802.3ba 100GBASE-LR4, ITU G.959.1, and CFP-MSA- HW-Specification
- Supports 103.1Gb/s and 112Gb/s aggregate bit rates
- Up to 10km reach for G.652 SMF
- Single +3.3V power supply
- Operating case temperature: 0~70°C
- Transmitter: cooled 4x28Gb/s LAN WDM EML TOSA (1295.56, 1300.05, 1304.58, 1309.14nm)
- Receiver: 4x28Gb/s PIN ROSA
- 4x28G Electrical Interface (OIF CEI-28G-VSR)
- Maximum power consumption 4.5W
- Duplex LC receptacle
- RoHS-6 compliant



Applications

- 100GBASE-LR4 100G Ethernet
- OTN OTU4 4I1-9D1F

Absolute Maximum Ratings

<i>Parameter</i>	<i>Symbol</i>	<i>Min.</i>	<i>Max.</i>	<i>Units</i>	<i>Note</i>
Storage Temperature	T_s	-40	85	°C	
Operating Case Temperature	T_{op}	0	70	°C	
Supply Voltage	V_{cc}	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	0	85	%	
Damage Threshold, each Lane	TH_d	5.5		dBm	

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Units
Operating Case Temperature	T_{op}	0		70	°C
Power Supply Voltage	Vcc	3.135	3.3	3.465	V
Data Rate, each Lane (100GE)			25.78125		Gb/s
Data Rate Accuracy (100GE)		-100		100	ppm
Data Rate, each Lane (OTU4)			27.95249		Gb/s
Data Rate Accuracy (OTU4)		-20		20	ppm
Control Input Voltage High		2		Vcc	V
Control Input Voltage Low		0		0.8	V
Link Distance with G.652	D	0.002		10	km

Diagnostics Monitoring

Parameter	Symbol	Accuracy	Unit	Notes
Temperature monitor absolute error	DMI_Temp	± 3	°C	Over operating temperature range
Supply voltage monitor absolute error	DMI_VCC	± 0.1	V	Over full operating range
Channel RX power monitor absolute error	DMI_RX_Ch	± 2	dB	1
Channel Bias current monitor	DMI_Ibias_Ch	± 10%	mA	
Channel TX power monitor absolute error	DMI_TX_Ch	± 2	dB	1

Notes:

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

Transmitter Electrical Characteristics

<i>Parameter</i>	<i>Test Point</i>	<i>Min</i>	<i>Typ.</i>	<i>Max</i>	<i>Units</i>	<i>Notes</i>
Power Consumption				4.5	W	
Supply Current	<i>I_{cc}</i>			1.36	A	
Overload Differential Voltage pk-pk	<i>TP1a</i>	900			mV	
Common Mode Voltage (<i>V_{cm}</i>)	<i>TP1</i>	-350		2850	mV	1
Differential Termination Resistance Mismatch	<i>TP1</i>			10	%	At 1MHz
Differential Return Loss (SDD11)	<i>TP1</i>			See CEI-28G-VSR Equation 13-19	dB	
Common Mode to Differential conversion and Differential to Common Mode conversion (SDC11, SCD11)	<i>TP1</i>			See CEI-28G-VSR Equation 13-20	dB	
Stressed Input Test	<i>TP1a</i>		See CEI-28G-VSR Section 13.3.11.2.1			

Notes:

- V_{cm}* is generated by the host. Specification includes effects of ground offset voltage.

Transmitter Optical Characteristics for IEE802.3 100GBASE-LR4

Parameter	Symbol	Min	Typ.	Max	Units	Notes
Data Rate, each Lane			25.78125		Gb/s	
Data Rate Accuracy		-100		100	ppm	
Lane Wavelength	L0	1294.53	1295.56	1296.59	nm	
	L1	1299.02	1300.05	1301.09	nm	
	L2	1303.54	1304.58	1305.63	nm	
	L3	1308.09	1309.14	1310.19	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Total Average Launch Power	P _T			10.5	dBm	
Average Launch Power, each Lane	P _{AVG}	-4.3		4.5	dBm	
OMA, each Lane	P _{OMA}	-1.3		4.5	dBm	1
Difference in Launch Power between any Two Lanes (OMA)	P _{tx, diff}			5	dB	
Launch Power in OMA minus Transmitter and Dispersion Penalty (TDP), each Lane		-2.3			dBm	
TDP, each Lane	TDP			2.2	dB	
Extinction Ratio	ER	4.0			dB	
RIN _{20OMA}	RIN			-130	dB/Hz	
Optical Return Loss Tolerance	TOL			20	dB	
Transmitter Reflectance	R _T			-12	dB	
Average Launch Power OFF Transmitter, each Lane	P _{off}			-30	dBm	
Eye Mask {X1, X2, X3, Y1, Y2, Y3}		{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}				2

Notes:

1. Even if TDP < 1 dB, the OMA min must exceed the minimum value specified here.
2. Hit ratio 5x10⁻⁵.

Transmitter Optical Characteristics for ITU G.959.1 OTU4 4I1-9D1F

Parameter	Symbol	Min	Typ.	Max	Units	Notes
Data Rate, each Lane			27.95249		Gb/s	
Data Rate Accuracy		-20		20	ppm	
Lane Wavelength	L0	1294.53	1295.56	1296.59	nm	
	L1	1299.02	1300.05	1301.09	nm	
	L2	1303.54	1304.58	1305.63	nm	
	L3	1308.09	1309.14	1310.19	nm	
Side Mode Suppression Ratio	SMSR	30			dB	

Transmitter parameters for an optical output with ER > 4dB

Total Average Launch Power	P_T			10	dBm	
Average Launch Power, each Lane	P_{AVG}	-0.6		4	dBm	
Extinction Ratio	ER	4.0		6.5	dB	

Transmitter parameters for an optical output with ER > 7dB

Total Average Launch Power	P_T			8.9	dBm	
Average Launch Power, each Lane	P_{AVG}	-2.5		2.9	dBm	
Extinction Ratio	ER	7			dB	
Difference in Launch Power between any Two Lanes (OMA)	$P_{tx, diff}$			5	dB	
Optical Return Loss	ORL	20			dB	
Average Launch Power OFF Transmitter, each Lane	P_{off}			-30	dBm	
Eye Mask {X1, X2, X3, Y1, Y2, Y3}				{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}		1

Notes:

1. Hit ratio 5×10^{-5} .

Receiver Electrical Characteristics

Parameter	Test Point	Min	Typ.	Max	Units	Notes
Differential Voltage, pk-pk	TP4			900	mV	
Common Mode Voltage (Vcm)	TP4	-350		2850	mV	1
Common Mode Noise, RMS	TP4			17.5	mV	
Differential Termination Resistance Mismatch	TP4			10	%	At 1MHz
Differential Return Loss (SDD22)	TP4			See CEI-28G-VSR Equation 13-19	dB	
Common Mode to Differential conversion and Differential to Common Mode conversion (SDC22, SCD22)	TP4			See CEI-28G-VSR Equation 13-21	dB	
Common Mode Return Loss (SCC22)	TP4			-2	dB	2
Transition Time, 20 to 80%	TP4	9.5			ps	
Vertical Eye Closure (VEC)	TP4			5.5	dB	
Eye Width at 10 ⁻¹⁵ probability (EW15)	TP4	0.57			UI	
Eye Height at 10 ⁻¹⁵ probability (EH15)	TP4	228			mV	

Notes:

1. Vcm is generated by the host. Specification includes effects of ground offset voltage.
2. From 250MHz to 30GHz.

Receiver Optical Characteristics for IEE802.3 100GBASE-LR4

Parameter	Test Point	Min	Typ.	Max	Units	Notes
Damage Threshold, each Lane	TH _d	5.5			dBm	
Average Receive Power, each Lane		-10.6		4.5	dBm	
Receive Power (OMA), each Lane				4.5	dBm	
Receive Sensitivity (OMA), each Lane	SEN			-8.6	dBm	
Stressed Receiver Sensitivity (OMA), each Lane				-6.8	dBm	1
Receiver Reflectance	R _R			-26	dB	
Difference in Receive Power between any Two Lanes (OMA)	Prx,diff			5.5	dB	
LOS Assert	LOSA	-30			dBm	
LOS Deassert	LOSD			-13	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Receiver Electrical 3 dB upper Cutoff Frequency, each Lane	F _c			31	GHz	

Conditions of Stress Receiver Sensitivity Test (Note 2)

Vertical Eye Closure Penalty, each Lane			1.8		dB	
Stressed Eye J2 Jitter, each Lane			0.3		UI	
Stressed Eye J9 Jitter, each Lane			0.47		UI	

Notes:

1. Measured with conformance test signal at receiver input for BER = 1x10⁻¹².
2. Vertical eye closure penalty, stressed eye J2 jitter, and stressed eye J9 jitter are test conditions for measuring stressed receiver sensitivity. They are not characteristics of the receiver.

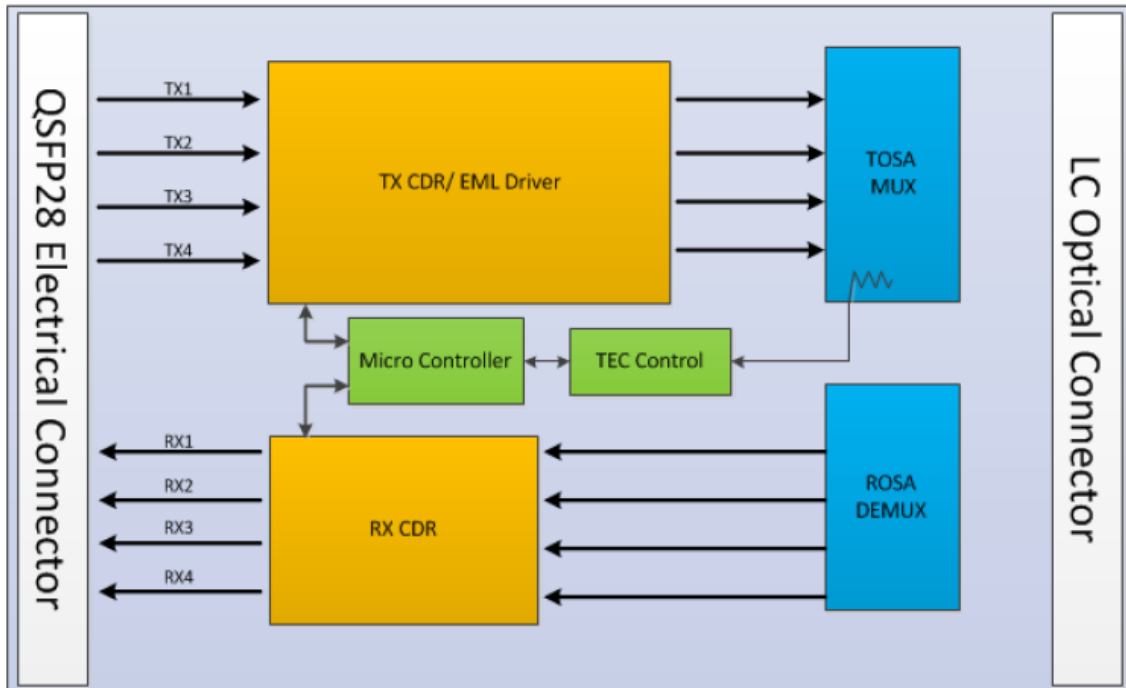
Receiver Optical Characteristics for ITU G.959.1 OTU4 4I1-9D1F

<i>Parameter</i>	<i>Test Point</i>	<i>Min</i>	<i>Typ.</i>	<i>Max</i>	<i>Units</i>	<i>Notes</i>
Damage Threshold, each Lane	TH _d	5.5			dBm	
Receiver parameters for an optical input with ER > 4dB						
Total Average Receive Power				10	dBm	
Average Receive Power, each Lane		-6.9		4	dBm	
Equivalent Sensitivity (Average), each Lane				-8.4	dBm	1
Receiver parameters for an optical input with ER > 7dB						
Total Average Receive Power				8.9	dBm	
Average Receive Power, each Lane		-8.8		2.9	dBm	
Equivalent Sensitivity (Average), each Lane				-10.3	dBm	1
Optical Path Penalty				1.5	dB	
Receiver Reflectance	R _R			-26	dB	
Difference in Receive Power between any Two Lanes (Average)	Prx,diff			5.5	dB	
LOS Assert	LOSA	-30			dBm	
LOS Deassert	LOSD			-13	dBm	
LOS Hysteresis	LOSH	0.5			dB	

Notes:

1. Specified at a BER of 10⁻⁶ (pre-FEC), per ITU-T G.sup39.

Block Diagram of Transceiver



This product is a 100Gb/s or 112Gb/s transceiver module designed for optical communication applications compliant to 100GBASE-LR4 requirements specified in IEEE 802.3ba and OTN OTU4 411-9D1F requirements specified in ITU-T Recommendations G.959.1 and Supplement 39 (G.sup39). The module converts 4 input channels of 25Gb/s or 28Gb/s electrical data to 4 channels of LAN WDM optical signals and then multiplexes them into a single channel for 100Gb/s or 112Gb/s optical transmission. Reversely on the receiver side, the module de-multiplexes a 100Gb/s or 112Gb/s optical input into 4 channels of LAN WDM optical signals and then converts them to 4 output channels of electrical data.

The central wavelengths of the 4 LAN WDM channels are 1295.56, 1300.05, 1304.58 and 1309.14 nm as members of the LAN WDM wavelength grid defined in IEEE 802.3ba. The high performance cooled LAN WDM EA-DFB transmitters and high sensitivity PIN receivers provide superior performance for 100Gigabit Ethernet and OTN OTU4 applications up to 10km links and compliant to optical interface with 100GBASE-LR4 requirements specified in IEEE 802.3ba Clause 88 and OTN OTU4 411-9D1F requirements specified in ITU-T Recommendations G.959.1.

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP+ Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

The transceiver module receives 4 channels of 25Gb/s or 28Gb/s electrical data, which are processed by a 4-channel Clock and Data Recovery (CDR) IC that reshapes and reduces the jitter of each electrical signal. Subsequently, EML laser driver IC converts each one of the 4 channels of electrical signals to an optical signal that is transmitted from one of the 4 cooled EML lasers which are packaged in the Transmitter Optical Sub-Assembly (TOSA). Each laser launches the optical signal in specific wavelength specified in IEEE 802.3ba 100GBASE-LR4 requirements. These 4-lane optical signals will be optically multiplexed into a single fiber by a 4-to-1 optical WDM MUX. The optical output power of each channel is maintained constant by an automatic power control (APC) circuit. The transmitter output can be turned off by TX_DIS hardware signal and/or 2-wire serial interface.

The receiver receives 4-lane LAN WDM optical signals. The optical signals are de-multiplexed by a 1-to-4 optical DEMUX and each of the resulting 4 channels of optical signals is fed into one of the 4 receivers that are packaged into the Receiver Optical Sub-Assembly (ROSA). Each receiver converts the optical signal to an electrical signal. The regenerated electrical signals are retimed and de-jittered and amplified by the RX portion of the 4-channel CDR. The retimed 4-lane output electrical signals are compliant with CEI-28G-VSR interface requirements. In addition, each received optical signal is monitored by the DOM section. The monitored value is reported through the 2-wire serial interface. If one or more received optical signal is weaker than the threshold level, RX_LOS hardware alarm will be triggered.

A single +3.3V power supply is required to power up this product. Both power supply pins VccTx and VccRx are internally connected and should be applied concurrently. As per MSA specifications 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, this product responds to 2-wire serial communication commands. The ModSelL allows the use of this product on a single 2-wire interface bus – individual ModSelL lines 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 reset, returning the 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 it indicates a completion of the reset interrupt. The product 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.

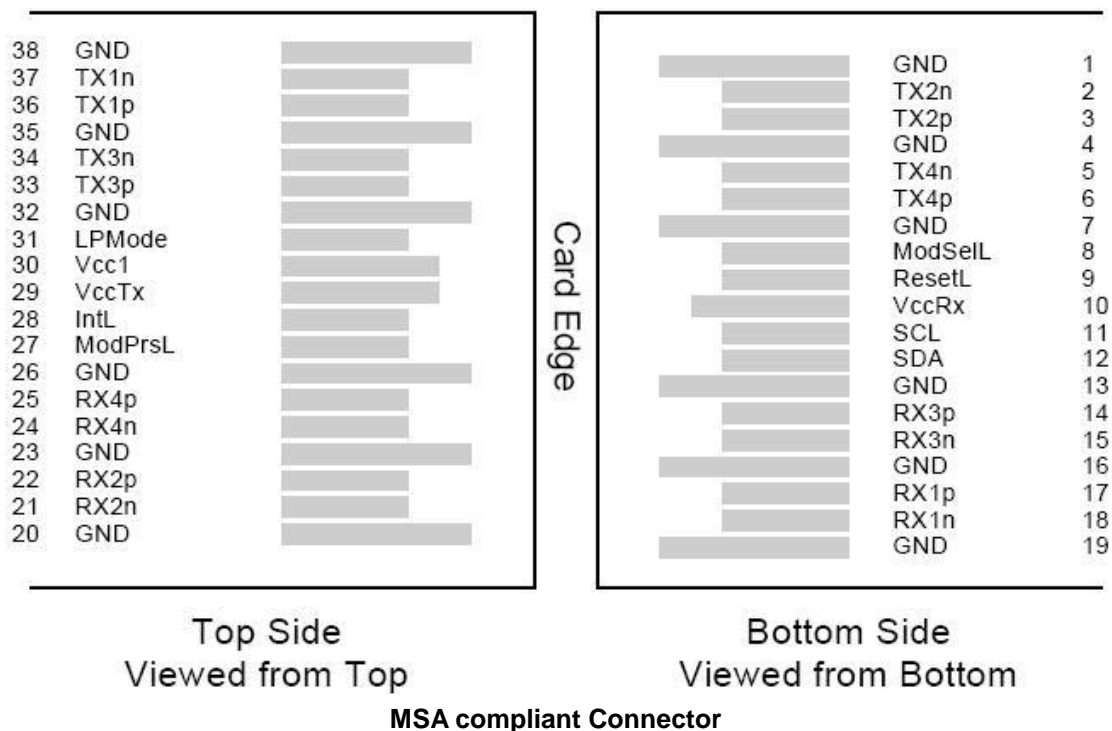
Low Power Mode (LPMode) pin is used to set the maximum power consumption for the product in order to protect hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

Module Present (ModPrsL) is a signal local to the host board which, in the absence of a product, is normally

pulled up to the host Vcc. When the product 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 its present by setting ModPrsL to a “Low” state.

Interrupt (IntL) is an output pin. “Low” indicates a possible 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.

Pin Assignment



Pin Description

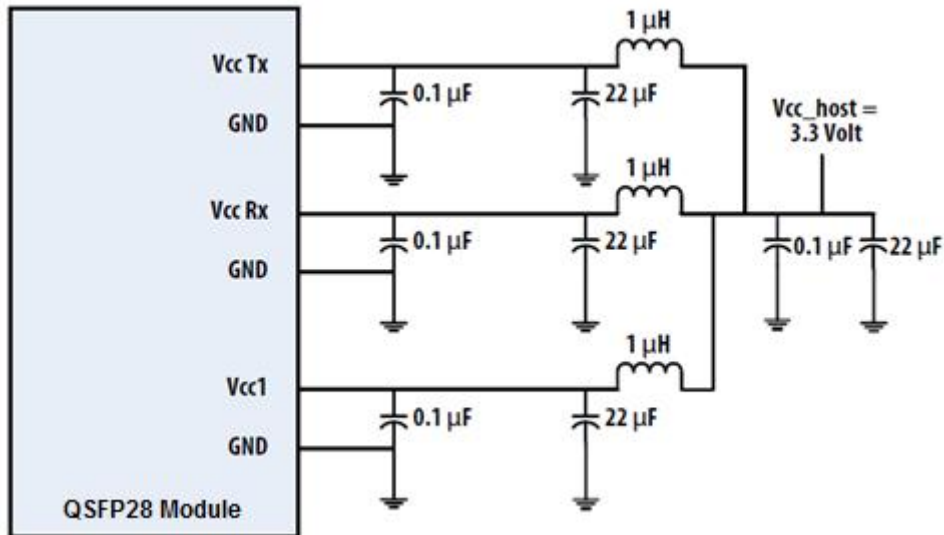
PIN	Logic	Symbol	Name/Description	Note
1		GND	Ground	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	
3	CML-I	Tx2p	Transmitter Non-Inverted Data output	
4		GND	Ground	1
5	CML-I	Tx4n	Transmitter inverted Data Input	
6	CML-I	Tx4p	Transmitter Non-Inverted Data output	
7		GND	Ground	1
8	LVTLL-I	ModSelL	Module Select	
9	LVTLL-I	ResetL	Module Reset	
10		VccRx	+3.3V Power Supply Receiver	2
11	LVC MOS-I/O	SCL	2-Wire Serial Interface Clock	
12	LVC MOS-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	

PIN	Logic	Symbol	Name/Description	Note
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	+3.3V Power Supply transmitter	2
30		Vcc1	+3.3V 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

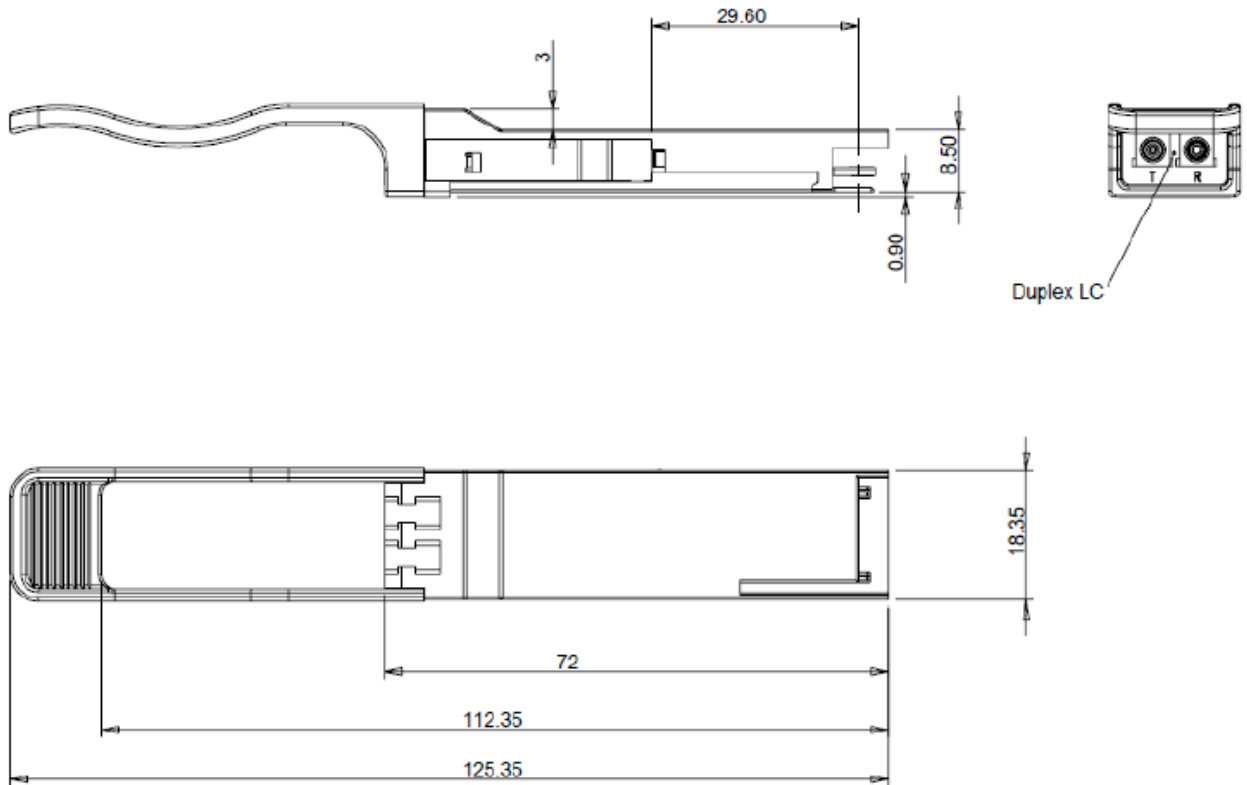
Note:

1. GND is the symbol for signal and supply (power) common for the QSFP28 module. All are common within the 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 receiving and transmission power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown in below Figure . Vcc Rx, Vcc1 and Vcc Tx may be internally connected within the module in any combination. The connector pins are each rated for a maximum current of 1000mA.

Recommended Power Supply Filter


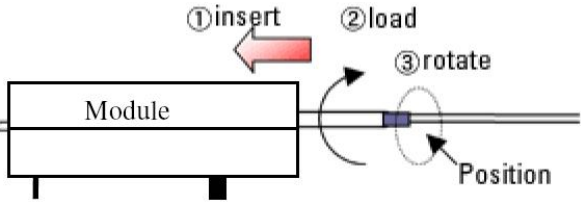


Dimensions



Optical Receptacle Cleaning Recommendations :

All fiber stubs inside the receptacle portions were cleaned before shipment. In the event of contamination of the optical ports, the recommended cleaning process is the use of forced nitrogen. If contamination is thought to have remained, the optical ports can be cleaned using a NTT international Cletop® stick type and HFE7100 cleaning fluid. Before the mating of patch-cord, the fiber end should be cleaned up by using Cletop® cleaning cassette.

<p>Cleaning of patch-cord</p> 	<p>Cleaning of fiber stub</p>  <ol style="list-style-type: none"> 1. Insert Ensure that stick is held straight when inserting into sleeve. 2. Load Apply sufficient pressure (approx 600-700g) to ensure ferrule a little depressed in sleeve. 3. Rotate Rotate stick clockwise 4-5 times, while ensuring direct contact with ferrule end-face is maintained. <p><i>Notice: Number of possible wipes: Maintenance (repair) ~1 use / piece Equipment construction: 4 uses / piece (max.)</i></p>
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Note: The pictures were extracted from NTT-ME website. And the Cletop® is a trademark registered by NTT-ME

Ordering Information

OP	C	W	S	10	13	C	B
	↑	↑	↑	↑	↑	↑	↑
Product Code:	Data Rate:	Type:	Reach:	Wavelength:	Operating Temperature:	Additional Feature:	
5=GBIC; 6=SFP-LC; 7=XFP; 8=XENPAK; 9=X2; A=SFP+ (SFP28); C=QSFP+ (QSFP28); F=CFP; G=CFP2; H=CFP4; P=SFP-SC; Q=SFP-MTRJ	A=155Mb/s; B=622Mb/s; C=1.25Gb/s; D=2.125Gb/s; E=2.5Gb/s; F=4.25Gb/s; G=3.1Gb/s; J=2.97G; P=6.144G; Q=7.37G; H=8.5Gb/s; K=10Gb/s; T=1/10Gb/s; L=16Gb/s; R=20Gb/s; X=25Gb/s; S=40Gb/s; W=100Gb/s (4x25G or 10x10G); M=100Base-X N=100/1000Base-X SGMII;	S=Single-mode; M=Multi-mode; W=BWDM; B=DUAL-BWDM; C=CWDM; D=DWDM; T=Copper-T (RJ-45) E=GEPON ONU; F=GEPON OLT; G=GPON ONU; H=GPON OLT X=MMF/SMF	Normal; X1=Under 150m; X2=220m; X3=300m; X5=550m; O2=2km, 10=10km; 70=70km; A0=100km; C0=120km CWDM: 20=20dB; 24=24dB; 28=28dB	Normal; 85=850nm; 13=1310nm; 15=1550nm; 00=Copper T (RJ-45) CWDM: 27=1270nm; 47=1470nm; 61=1610nm BWDM: B3=Tx1310/Rx1550; B5=Tx1550/Rx1310; B4=Tx1310/Rx1490; B9=Tx1490/Rx1310; 51=Tx1510/Rx1570; 57=Tx1570/Rx1510; 27=Tx1270/Rx1330; 33=Tx1330/Rx1270; B2=Tx1270/Rx1577; B7=Tx1577/Rx1270 T2=2TX1310nm; T3=TX1310nm; T5=TX1550nm DWDM: 17=Channel 17 34= Channel 34 00=Channel 17-61 Tunable	C=Commercial Purpose (0~70℃); I= Industrial Purpose (Extended Range)	M=Digital Optical Monitoring (DOM) (RX_LOS for Copper TX); F=with Fiber Stub; I=with Isolator; S=Customized Style	

Model Number	Part Number	Voltage	Temperature
QSFP28-LR4-OTN OTU4	OPCW-S10-13-CBT	3.3V	0°C to 70 °C

Note: All information contained in this document is subject to change without notice.