

CSMQDDQGL3140

400 Gbps QSFP-DD ER4 40 km Optical Transceiver Module

Description

The CSMQDDQGL3140 is a 400 Gbps Quad Small Form Factor Pluggable Double-Density (QSFP-DD) optical module designed for optical communication applications. The module converts eight channels of 50 Gbps PAM4 electrical input data into four channels of LAN-WDM optical signals and multiplexes them into a single channel for 400 Gbps optical transmission. On the receiver side, the module optically demultiplexes a 400 Gbps optical input into four channels of WDM optical signals and converts them into eight channels of 50 Gbps PAM4 electrical output data.

The central wavelengths of the four 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. It contains a duplex LC connector for the optical interface and a 76-pin connector for the electrical interface. To minimize optical dispersion in long-haul systems, single-mode fiber (SMF) is used with this module. It supports up to 30 km with 400G KP4 FEC and 40 km with built-in PFEC.

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

Features

- Compliant with QSFP-DD MSA
- 4-Lane LWDM MUX/DEMUX Design
- Up to 40 km Transmission over Single-Mode Fiber (SMF) with Built-In PFEC
- 8 × 53.125 Gbps Electrical Interface (400GAUI-8)
- Data Rate of 106.25 Gbps PAM4 per Channel
- Maximum Power Consumption 12 W
- Duplex LC connector
- Single 3.3 V power supply
- RoHS compliant
- Operating Case Temperature: Standard, 0 °C to +70 °C

Applications

- Data Center Interconnect
- 400G Ethernet
- InfiniBand Interconnects
- Enterprise Networking

Functional Description

The module incorporates four independent LAN-WDM channels at center wavelengths of 1295.56, 1300.05, 1304.58, and 1309.14 nm, operating at 100 Gbps per channel. The transmitter path incorporates a DSP-integrated quad-channel EML driver, EML lasers, and an optical multiplexer. On the receiver path, an optical demultiplexer is coupled to a 4-channel APD array. A DSP-based gearbox converts eight channels of 25 GBaud PAM4 signals into four channels of 50 GBaud PAM4 signals, and an 8-channel retimer and FEC block are also integrated in the DSP.

The electrical interface is compliant with IEEE 802.3bs and QSFP-DD MSA, and the optical interface is compliant with IEEE 802.3bs through a duplex LC connector. A single +3.3 V power supply is required. All power supply pins are internally connected and should be applied concurrently. The module provides low-speed hardware control pins and a 2-wire serial interface, including ModSelL, SCL, SDA, ResetL, InitMode, ModPrsL, and IntL, in accordance with QSFP-DD MSA requirements.

Transceiver Block Diagram

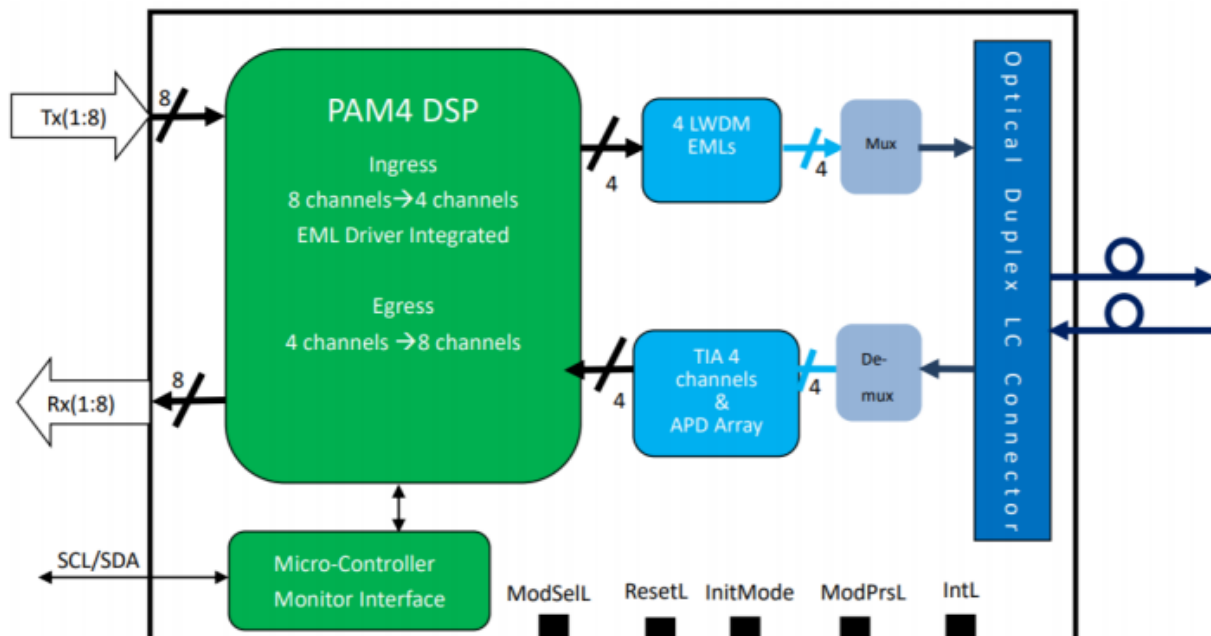


Figure 1. Transceiver Block Diagram

Absolute Maximum Ratings

Operation beyond any individual absolute maximum rating may cause permanent damage to this module.

Parameter	Symbol	Min	Max	Unit	Notes
Storage Temperature	T _S	-40	+85	°C	
Operating Case Temperature	T _{OP}	0	+70	°C	
Power Supply Voltage	V _{CC}	-0.5	+3.6	V	
Relative Humidity (Non-Condensing)	RH	0	85	%	
Damage Threshold, Each Lane	THd	-5		dBm	

Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Operating Case Temperature	T _{OP}	0		+70	°C	
Power Supply Voltage	V _{CC}	3.135	3.3	3.465	V	
Data Rate, each Lane			26.5625		GBd	PAM4
Data Rate Accuracy		-100		100	ppm	
Pre-FEC Bit Error Ratio				2.4 x 10 ⁻⁴		
Post-FEC Bit Error Ratio				1 x 10 ⁻¹³		1
Link Distance	D	0.002		30	km	2
Link Distance	D	0.002		40	km	3

Notes:

1. FEC is provided by the host system.
2. FEC is required on the host system to support the maximum distance.
3. Built-in PFEC is required to support up to 40 km.

Electrical Specifications

The following electrical specifications are defined over the Recommended Operating Conditions unless otherwise specified.

Parameter	Test Point	Min	Typical	Max	Unit	Notes
Power Consumption				12	W	
Supply Current	I _{cc}			3.64	A	
Transmitter (Each Lane)						
Signaling Rate, Each Lane	TP1	26.5625 ± 100 ppm			GBd	
Differential Peak-to-Peak Input Voltage Tolerance	TP1a	900			mVpp	1
Differential Termination Mismatch	TP1			10	%	
Differential Input Return Loss	TP1	IEEE 802.3-2015 Equation (83E-5)			dB	
Differential to Common-Mode Input Return Loss	TP1	IEEE 802.3-2015 Equation (83E-6)			dB	
Module Stressed Input Test	TP1a	See IEEE 802.3bs Section 120E.3.4.1				2
Single-Ended Voltage Tolerance Range	TP1a	-0.4 to +3.3			V	
DC Common-Mode Input Voltage	TP1	-350		2850	mV	3
Receiver (Each Lane)						
Signaling Rate, Each Lane	TP4	26.5625 ± 100 ppm			GBd	
Differential Peak-to-Peak Output Voltage	TP4			900	mVpp	
AC Common Mode Output Voltage, RMS	TP4			17.5	mV	
Differential Termination Mismatch	TP4			10	%	
Differential Output Return Loss	TP4	IEEE 802.3-2015 Equation (83E-2)			dB	
Common-Mode to Differential-Mode Conversion Return Loss	TP4	IEEE 802.3-2015 Equation (83E-3)			dB	
Transition Time, 20% to 80%	TP4	9.5			ps	
Near-end Eye Symmetry Mask Width (ESMW)	TP4		0.265		UI	
Near-end Eye Height, Differential	TP4	70			mV	
Far-end Eye Symmetry Mask Width (ESMW)	TP4		0.2		UI	
Far-end Eye Height, Differential	TP4	30			mV	
Far-end Pre-cursor ISI Ratio	TP4	-4.5		2.5	%	
Common-Mode Output Voltage (VCM)	TP4	-350		2850	mV	3

Notes:

1. With the exception to IEEE 802.3bs Section 120E.3.1.2, the pattern is PRBS31Q or scrambled idle.
2. Meets the BER specified in IEEE 802.3bs Section 120E.1.1.
3. DC common-mode voltage is generated by the host. The specification includes the effects of ground offset voltage.

Optical Specifications

Parameter	Symbol	Min	Typical	Max	Unit	Notes
Wavelength Assignment	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	
Transmitter						
Data Rate, Each Lane		53.125 ± 100 ppm			GBd	
Modulation Format		PAM4				
Side-Mode Suppression Ratio	SMSR	30			dB	
Total Average Launch Power	PT			14.7	dBm	
Average Launch Power, Each Lane	PAVG	0.4		6.5	dBm	
Outer Optical Modulation Amplitude (OMA _{outer}), Each Lane	POMA	3.4		9	dBm	
Launch Power in OMA _{outer} Minus TDECQ, Each Lane		2			dB	
Transmitter and Dispersion Eye Closure for PAM4, Each Lane	TDECQ			3.9	dB	
Extinction Ratio	ER	6			dB	
Difference in Launch Power between Any Two Lanes (OMA _{outer})				4	dB	
RIN _{15.1OMA}	RIN	-132			dB/Hz	
Optical Return Loss Tolerance	TOL			15.6	dB	
Transmitter Reflectance	RT			-26	dB	
Average Launch Power of OFF Transmitter, Each Lane	P _{off}			-30	dBm	
Receiver						
Data Rate, Each Lane		53.125 ± 100 ppm			GBd	
Modulation Format		PAM4				
Damage Receiver Power, Each Lane		-2.4			dBm	
Receiver Saturation, Each Lane	overload	-3.4				
Sensitivity, Each Lane	Sen1	Max(-12.1, SECQ-13.5)			dBm	For 30 km
Sensitivity, Each Lane	Sen2	Max(-15.1, SECQ-16.5)			dBm	For 40 km
Stressed Conditions for Stress Receiver Sensitivity						
Stressed Eye Closure for PAM4 (SECQ), Lane under Test			3.4		dB	
SECQ - 10 × log ₁₀ (C _{eq}), Lane under Test					dB	
OMA _{outer} of Each Aggressor Lane			-8		dBm	

Digital Diagnostic Specifications

Parameter	Symbol	Min	Max	Unit	Notes
Temperature Monitor Absolute Error	DMI_Temp	-3	3	°C	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

Notes:

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

ESD

This transceiver is specified with an ESD threshold of 1 kV for high-speed data pins and 2 kV for all other 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.

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, adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Pin Diagram

The electrical pinout of the QSFP-DD module is shown in Figure 2.

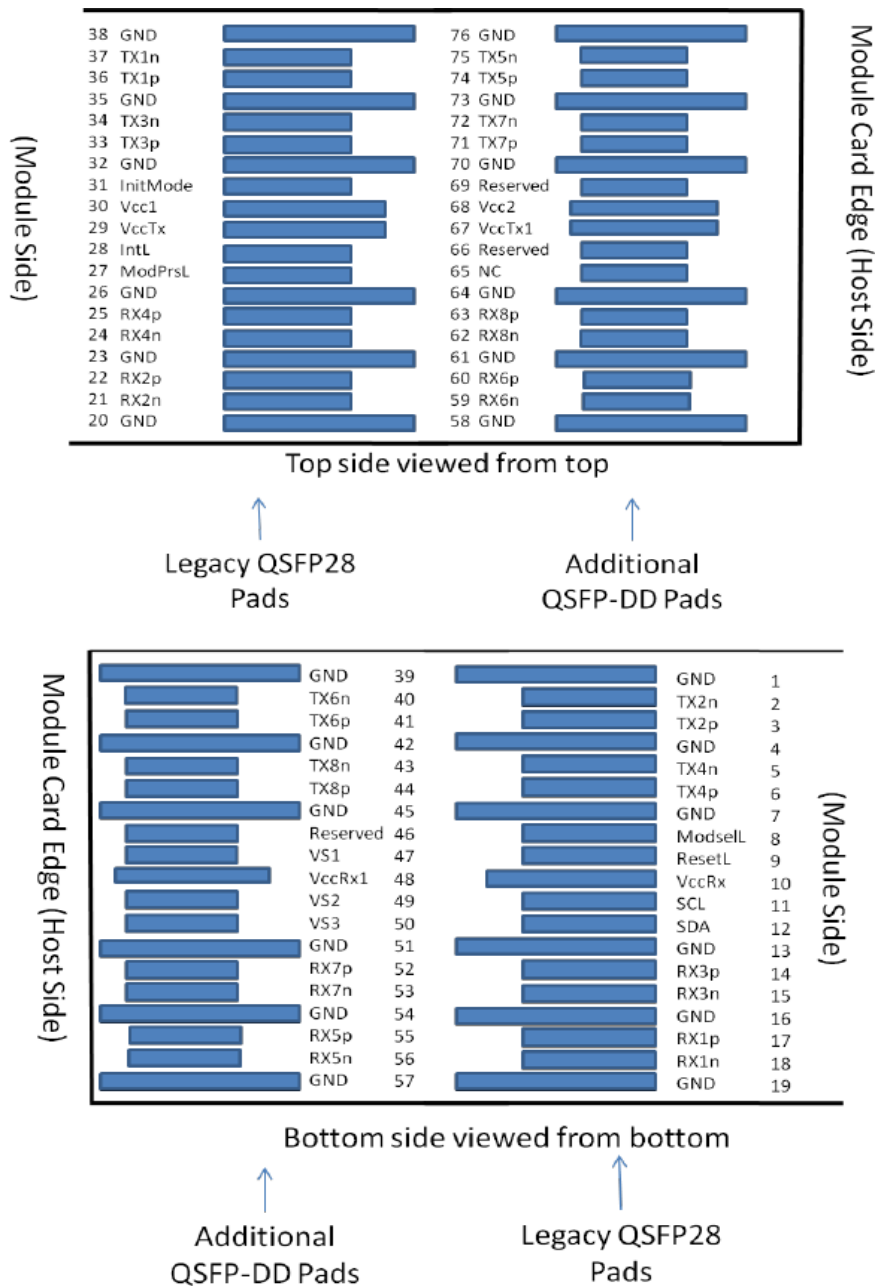


Figure 2. MSA-Compliant Connector

Pin Definitions

Pin	Logic	Symbol	Description	Plug Seq.	Notes
1		GND	Ground	1B	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3B	
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input	3B	
4		GND	Ground	1B	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3B	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	3B	
7		GND	Ground	1B	1
8	LVTTL-I	ModSelL	Module Select	3B	
9	LVTTL-I	ResetL	Module Reset	3B	
10		VccRx	+3.3 V Power Supply Receiver	2B	2
11	LVC MOS-I/O	SCL	2-Wire Serial Interface Clock	3B	
12	LVC MOS-I/O	SDA	2-Wire Serial Interface Data	3B	
13		GND	Ground	1B	1
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	3B	
15	CML-O	Rx3n	Receiver Inverted Data Output	3B	
16		GND	Ground	1B	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	3B	
18	CML-O	Rx1n	Receiver Inverted Data Output	3B	
19		GND	Ground	1B	1
20		GND	Ground	1B	1
21	CML-O	Rx2n	Receiver Inverted Data Output	3B	
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	3B	
23		GND	Ground	1B	1
24	CML-O	Rx4n	Receiver Inverted Data Output	3B	
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	3B	
26		GND	Ground	1B	1
27	LVTTL-O	ModPrsL	Module Present	3B	
28	LVTTL-O	IntL	Interrupt	3B	
29		VccTx	+3.3 V Transmitter Power Supply	2B	2
30		Vcc1	+3.3 V Power supply	2B	2
31	LVTTL-I	InitMode	Initialization Mode; in legacy QSFP applications, the InitMode pad is called LPMode.	3B	
32		GND	Ground	1B	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	3B	
34	CML-I	Tx3n	Transmitter Inverted Data Input	3B	
35		GND	Ground	1B	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	3B	

37	CML-I	Tx1n	Transmitter Inverted Data Input	3B	
38		GND	Ground	1B	1
39		GND	Ground	1A	1
40	CML-I	Tx6n	Transmitter Inverted Data Input	3A	
41	CML-I	Tx6p	Transmitter Non-Inverted Data Input	3A	
42		GND	Ground	1A	1
43	CML-I	Tx8n	Transmitter Inverted Data Input	3A	
44	CML-I	Tx8p	Transmitter Non-Inverted Data Input	3A	
45		GND	Ground	1A	1
46		Reserved	For Future Use	3A	3
47		VS1	Module Vendor Specific 1	3A	3
48		VccRx1	+3.3 V Power Supply	2A	2
49		VS2	Module Vendor Specific 2	3A	3
50		VS3	Module Vendor Specific 3	3A	3
51		GND	Ground	1A	1
52	CML-O	Rx7p	Receiver Non-Inverted Data Output	3A	
53	CML-O	Rx7n	Receiver Inverted Data Output	3A	
54		GND	Ground	1A	1
55	CML-O	Rx5p	Receiver Non-Inverted Data Output	3A	
56	CML-O	Rx5n	Receiver Inverted Data Output	3A	
57		GND	Ground	1A	1
58		GND	Ground	1A	1
59	CML-O	Rx6n	Receiver Inverted Data Output	3A	
60	CML-O	Rx6p	Receiver Non-Inverted Data Output	3A	
61		GND	Ground	1A	1
62	CML-O	Rx8n	Receiver Inverted Data Output	3A	
63	CML-O	Rx8p	Receiver Non-Inverted Data Output	3A	
64		GND	Ground	1A	1
65		NC	No Connect	3A	3
66		Reserved	For Future Use	3A	3
67		VccTx1	+3.3 V Power Supply	2A	2
68		Vcc2	+3.3 V Power Supply	2A	2
69		Reserved	For Future Use	3A	3
70		GND	Ground	1A	1
71	CML-I	Tx7p	Transmitter Non-Inverted Data Input	3A	
72	CML-I	Tx7n	Transmitter Inverted Data Input	3A	
73		GND	Ground	1A	1
74	CML-I	Tx5p	Transmitter Non-Inverted Data Input	3A	
75	CML-I	Tx5n	Transmitter Inverted Data Input	3A	
76		GND	Ground	1A	1

Notes:

1. QSFP-DD uses common ground (GND) for all signals and supply (power). All are common within the QSFP-DD 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, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 shall be applied concurrently. Vcc contacts may be internally connected within the module in any combination. Each connector Vcc contact is rated for a steady-state current of 1000 mA.
3. Vendor Specific, Reserved, and No Connect pins are reserved for future use or vendor-specific functions. Pad 65 (No Connect) shall be left unconnected within the module.

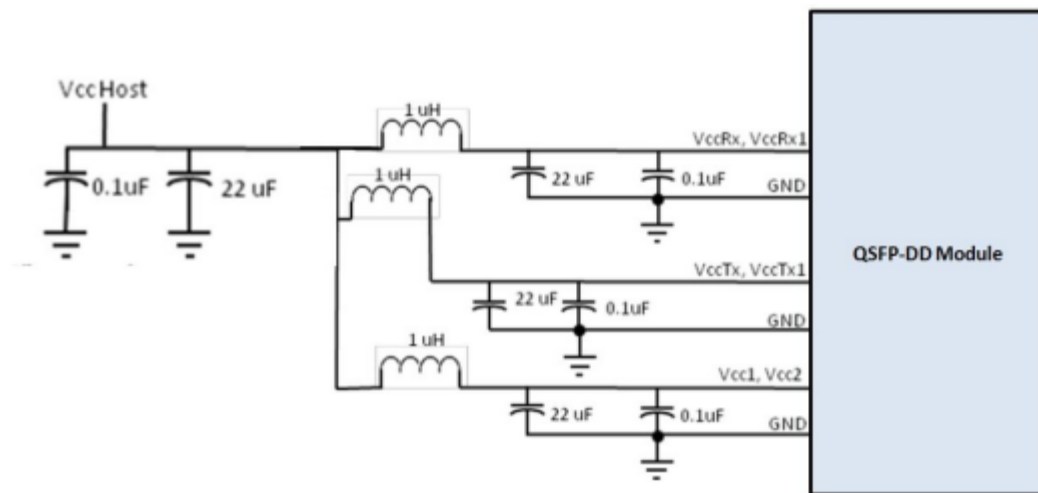
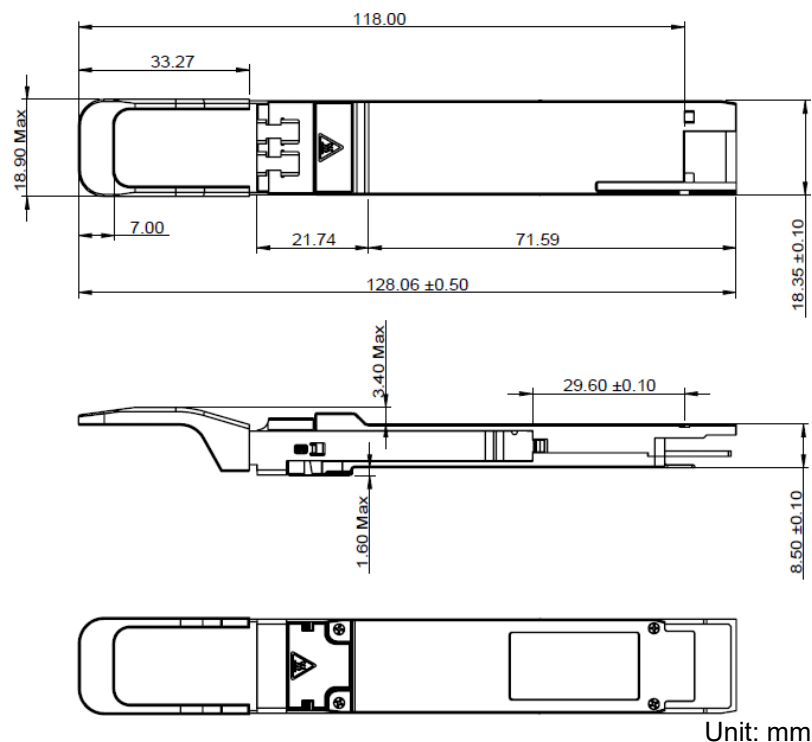
Recommended Power Supply Filter


Figure 3. Recommended Power Supply Filter

Mechanical Specifications


Ordering Information

Part Number	Product Description
CSMQDDQGL3140	QSFP-DD, 400G, ER4, 40 km, 0 °C to +70 °C

For More Information

Tel: +886-2-8227 1877

E-mail: sales@cosmo-ic.comWeb: <http://www.cosmo-ic.com>