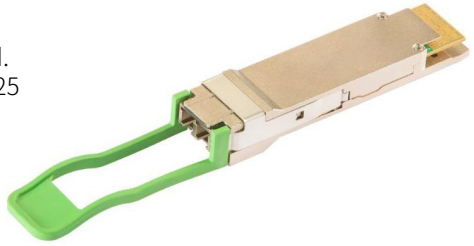
QSFP-DD 400GE FR4 2 km Optical Transceiver Module

OM3660FX102

ETSC's OM3660FX102 is a transceiver module designed for 2 km optical communication applications, and it is compliant with 100G Lambda MSA standard. This module can convert 8-channel 53.125 Gbit/s electrical data to 4-channel 106.25 Gbit/s optical signals, and multiplex them into a single channel for 425 Gbit/s optical transmission. Similarly, it optically de-multiplexes a 425 Gbit/s input into 4-channel signals, and converts them to 8-channel output electrical data on the receiver side. It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference. The module offers very high functionality and feature integration, accessible via a two-wire serial interface.



FEATURES

- QSFP-DD MSA rev5.0 compliant
- 100G Lambda MSA compliant
- 802.3cu compliant
- 400GE FR4 specification compliant
- QSFP-DD CMIS4.0 Management interface compliant
- Non-hermetic package design
- 4 CWDM lanes MUX/DEMUX design
- 8 x 53.125 Gbit/s PAM4 electrical interface (400GAUI-8)
- Maximum power consumption 12 W
- LC duplex connector
- 425 Gbit/s aggregate bit rate
- Up to 2 km transmission on single mode fiber with FEC
- Single 3.3 V power supply
- RoHS-2 compliant

APPLICATIONS

- Data center interconnect

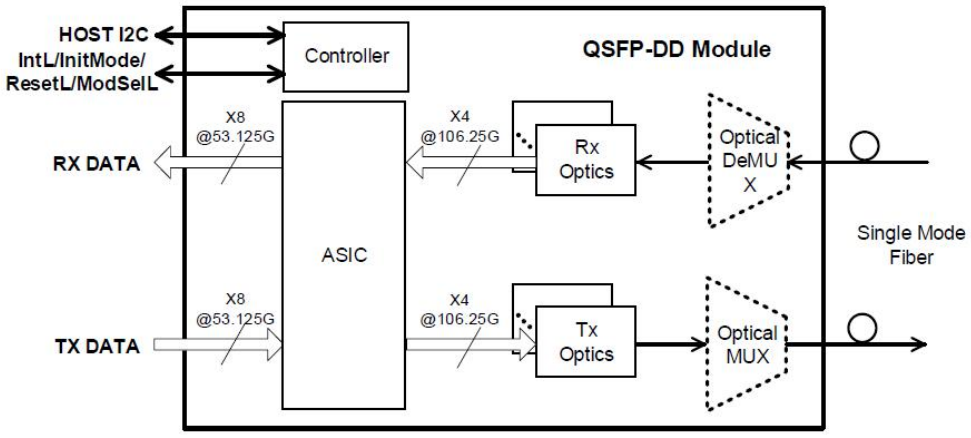


Figure 1. Transceiver Block Diagram

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Pin Descriptions

Figure 2 QSFP-DD MSA compliant connector

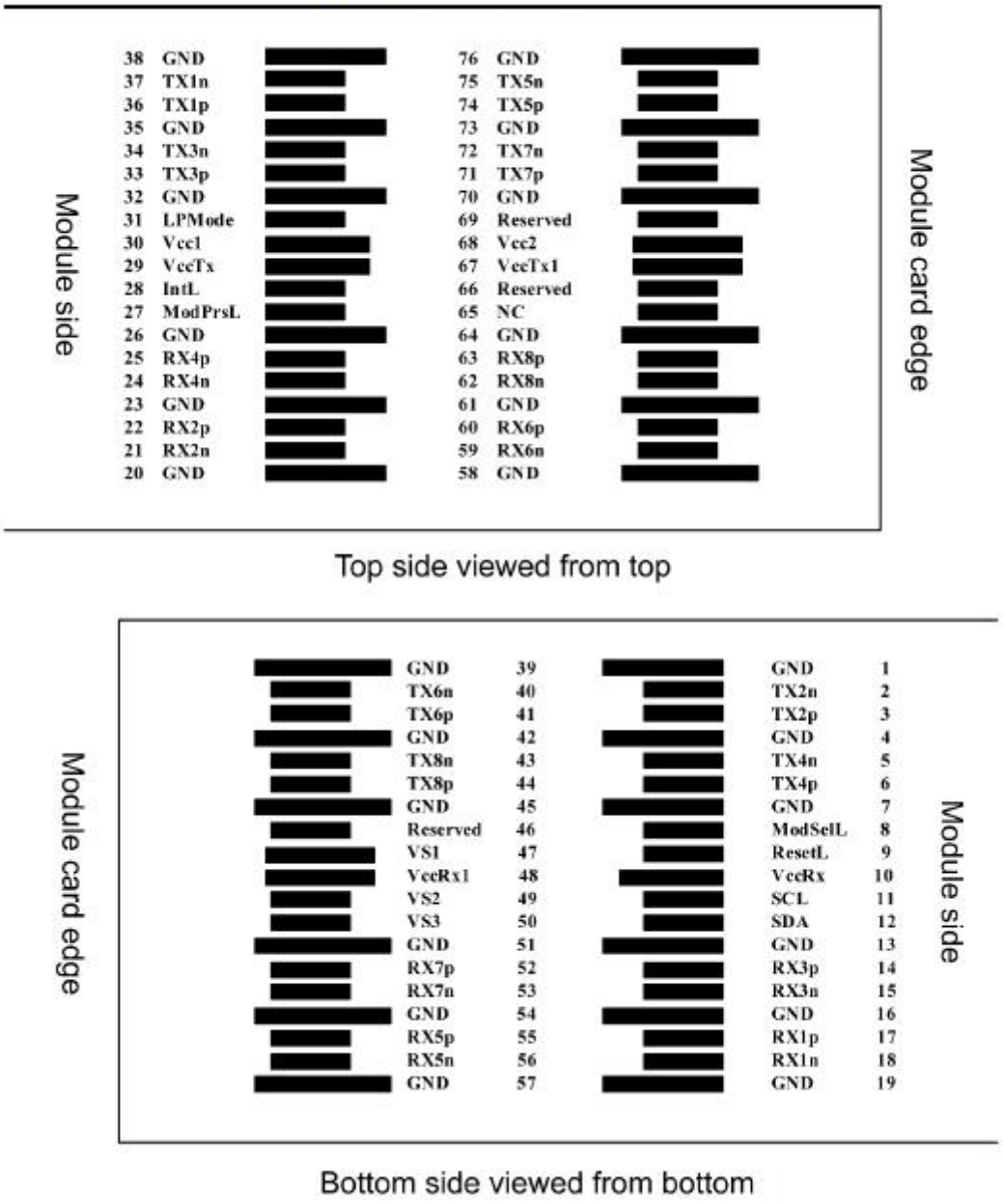

Figure 2. QSFP-DD MSA compliant connector

Pin	Logic	Symbol	Description	Plug sequence	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	LVCMOS-I/O	SCL	2-wire serial interface clock	3B	
12	LVCMOS-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 Non-Inverted Data Output	3B	
25	CML-O	Rx4p	Receiver Inverted Data Output	3B	
26		GND	Ground	1B	1
27	LVTTL-I	ModPrsL	Module Present	3B	
28	LVTTL-I	IntL	Interrupt	3B	
29		VccTx	+3.3 V Power supply transmitter	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

Pin	Logic	Symbol	Description	Plug sequence	Notes
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 Non-Inverted Data Output	3A	
60	CML-O	Rx6p	Receiver Inverted Data Output	3A	
61		GND	Ground	1A	1
62	CML-O	Rx8n	Receiver Non-Inverted Data Output	3A	
63	CML-O	Rx8p	Receiver 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. Requirements defined for the host side of the Host Card Edge Connector are listed in the table. VccRx, VccRx1, Vcc1, Vcc2, VccTx and VccTx1 may be internally connected within the module in any combination. The connector Vcc pins are each rated for a maximum current of 1000 mA.
3. All Vendor Specific, Reserved and No Connect pins may be terminated with 50 Ω to ground on the host. Pad 65 (No Connect) shall be left unconnected within the module. Vendor specific and Reserved pads shall have an impedance to GND that is greater than 10 kΩ and less than 100 pF.
4. Plug Sequence specifies the mating sequence of the host connector and module.

Absolute Maximum Ratings

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

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Maximum Supply Voltage	Vcc	-0.3	3.3	3.6	V	
Storage Temperature	Ts	-40		85	°C	
Relative Humidity	RH	0		85	%	

Operating Environments

Electrical and optical characteristics below are defined under this operating environment, unless otherwise specified.

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	Vcc	3.135	3.3	3.465	V
Case Temperature	T	0		70	°C
Data Rate Accuracy		-100		100	ppm
Link Distance		0.5		2000	m

Notes

1. G.652 Single-mode optical fiber.

Electrical Characteristics

Parameter	Min	Typ	Max	Unit	Note
Power dissipation			12	W	
Supply current			3.63	A	
Receiver (module input)					
Data Rate, each lane	26.5625 ± 100 ppm			GBd	
Overload Differential Voltage pk-pk	900			mV	
Common Mode Voltage	-350		2850	mV	
Differential Termination Resistance Mismatch			10	%	At 1 MHz
Differential Return Loss (SDD11)	Equation (16-1)			dB	OIF-CEI-56G-VSR-PAM4

Parameter	Min	Typ	Max	Unit	Note
Common Mode to Differential Mode Conversion (SCD11)	Equation (16-3)			dB	OIF-CEI-56G-VSR-PAM4
Stressed Input Test	See OIF-CEI-56G-VSR-PAM4 Section 16.3.10.3				
Transmitter (module output)					
Data Rate, each lane	26.5625 ± 100 ppm			GBd	
Differential Voltage, pk-pk			900	mV	
Common Mode Voltage (Vcm)	-350		2850	mV	
Common Mode Noise, RMS			17.5	mV	
Differential Termination Resistance Mismatch			10	%	At 1 MHz
Differential Return Loss (SDD22)			Equation (16-1)	dB	
Common Mode to Differential Mode Conversion (SDC22)			Equation (16-3)	dB	
Common Mode Return Loss (SCC22)			-2	dB	From 250 MHz to fb GHz
Transition Time	9.5			ps	
Near-end Eye Width at 10-6 proba- bility (EW6)	0.265			UI	
Near-end Eye Height at 10-6 prob- ability (EH6)	70			mV	
Far-end Eye Width at 10-6 proba- bility (EW6)	0.20			UI	
Far-end Eye Height at 10-6 proba- bility (EH6)	30			mV	
Near-end Eye Linearity	0.85				

Optical Characteristics

Parameters	Unit	min.	type.	max
Transmitter				
Data Rate, each Lane	GBd	53.125 ± 100 ppm		
Modulation Format		PAM4		
Line wavelengths	nm	1264.5	1271	1277.5
		1284.5	1291	1297.5
		1304.5	1311	1317.5
		1324.5	1331	1337.5
Total Average Launch Power	dBm			9.5
Average Launch Power, each lane	dBm	-3.3		3.5
Optical Modulation Amplitude (OMA), each lane	dBm	-0.2		3.7
Extinction Ratio (ER)	dB	3.5		
Side-Mode Suppression Ratio (SMSR)	dB	30		
Launch power in OMA minus TDECQ, each lane, for ER≥4.5 dB	dB	-1.7		
Launch power in OMA minus TDECQ, each lane, for ER <4.5 dB	dBm	-1.6		

Parameters	Unit	min.	type.	max
Transmitter and Dispersion Eye Clo- sure for PAM4, each Lane (TDECQ)	dB			3.4
Difference in Launch Power between any Two Lanes (OMA outer)	dB			4
RIN17.1OMA	dB/Hz			-136
Optical Return Loss Tolerance	dB			17.1
Transmitter Reflectance	dB			-26
Average Launch Power of OFF Transmitter, each Lane	dBm			-20
Receiver				
Data Rate, each Lane	GBd	53.125 ± 100 ppm		
Modulation Format		PAM4		
Damage Threshold, each lane	dBm	4.5		
Line wavelengths	nm	1264.5	1271	1277.5
		1284.5	1291	1297.5
		1304.5	1311	1317.5
		1324.5	1331	1337.5
Average receiver power, each lane	dBm	-7.3		3.5
Receiver power, each lane (OMA)	dBm			3.7
Difference in Receiver Power be- tween any Two Lanes (OMA)	dB			4.1
Receiver Sensitivity (OMA outer) , each lane (max)	dBm	See Note		
LOS Assert	dBm	-20		
LOS Deassert	dBm			-8.6
LOS Hysteresis	dB	0.5		
Receiver reflectance	dB			-26
Conditions of stressed receiver sensitivity				
Stressed eye closure for PAM4 (SECQ), lane under test	dB	0.9		3.4
OMA outer of each aggressor lane	dBm		1.5	
Long term performance test				
BER FLOOR		1E - 6 @ -3.1 ~ 2 dBm		

Notes

1. Measured with conformance test signal for BER = 2.4 x 10 - 4. A compliant receiver shall have stressed receiver sensitivity (OMA outer), each lane values below the mask of Figure 3, for SECQ values between 0.9 and 3.4 dB.

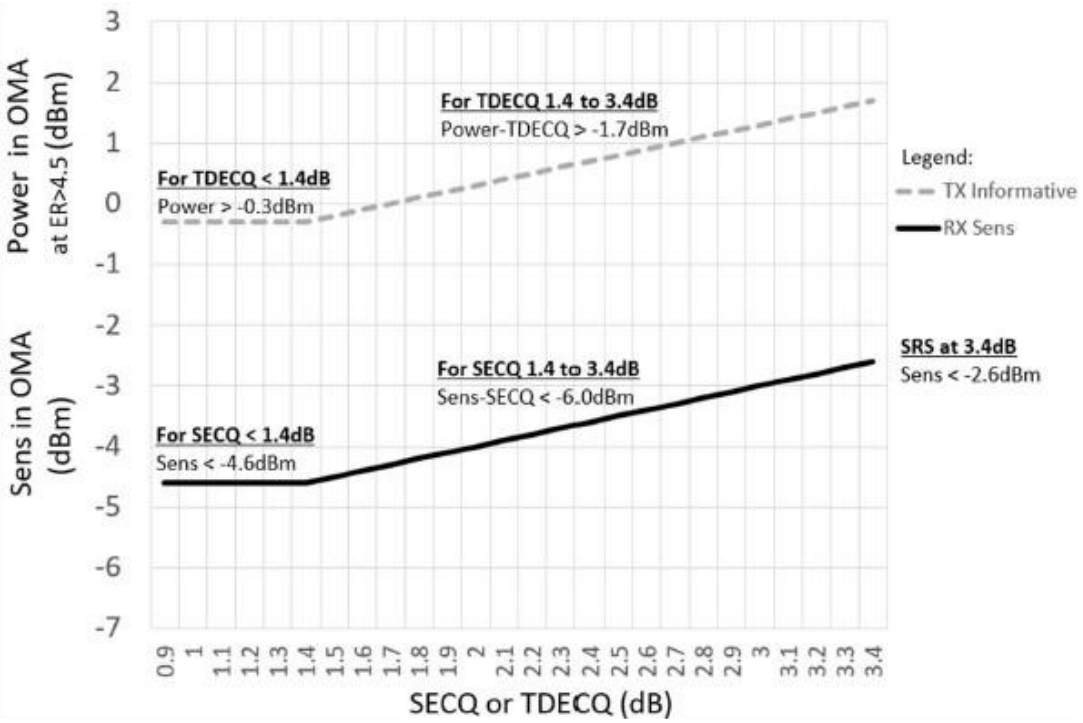

Figure 3. Stressed receiver sensitivity mask for 400GE-FR4

Digital Diagnostic Monitoring Functions

Digital diagnostic management interface (DDMI) is realized by I2C interface in compliance with CMIS 4.0. Diagnostic management functions are realized, and the data addresses are listed in the form below.

Performance Item	Data address		
	Alarm & Warning	Alarm & Warning thresholds	Monitor
Module temperature	Lowpage 9	Page2h (128-135)	Lowpage (14-15)
Module voltage	Lowpage 9	Page2h (136-143)	Lowpage (16-17)
Bias current	Page11h (143-146)	Page2h (184-191)	Page11h (170-177)
Transmitter optical power	Page11h (139-142)	Page2h (176-183)	Page11h (154-161)
Receiver optical power	Page11h (149-152)	Page2h (192-199)	Page11h (186-193)

Mechanical Specifications

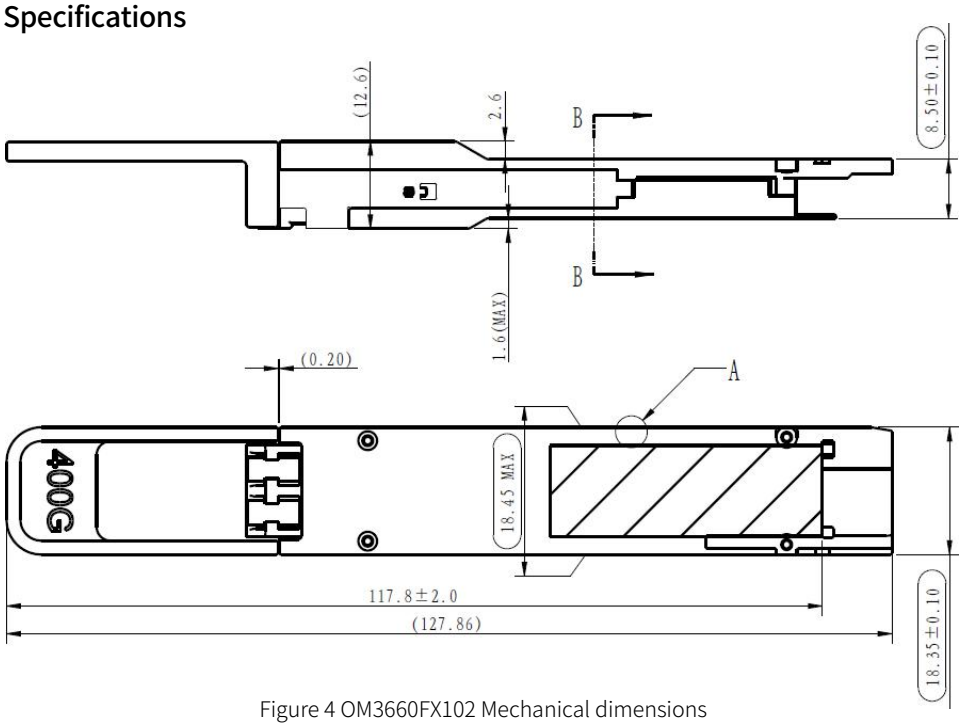

Figure 4 OM3660FX102 Mechanical dimensions

Regulatory Compliance

Feature	Agency	Standard	Performance
Safety	NRTL	UL 62368-1 CAN/CSA C22.2 No. 62368-1 IEC 60825-1 IEC 60825-2	NRTL recognized component for US and CAN
	TUV	EN 62368-1 EN 60825-1 EN 60825-2	TUV certificate
	FDA	U.S. 21 CFR 1040.10 & 1040.11	FDA/CDRH certified with ac-cession number according to Laser Notice 56
Electromagnetic Compatibility	Radiated emissions	EMC Directive 2014/30/EU EN 55032 CISPR 32 FCC rules 47 CFR Part 15 ICES-003 VCCI-CISPR 32 AS/NZS CISPR 32	Class B digital device with a minimum -6dB margin to the limit when tested with a metal enclosure. Final margin may vary depending on system ap-plication, good system EMI design practice, ie: suitable metal enclosure and well-bonding, is required to achieve Class B margins at the system level. Tested fre-quency range: 30 MHz to 40 GHz or 5th harmonic (5 times the highest frequency), which-ever is less.
	ESD	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-2	Withstands discharges of ± 8 kV contact, ± 15 kV air.
	Radiated immunity	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-3	Field strength of 10 V/m from 80 MHz to 6 GHz.
Restriction of Hazardous Sub-stances	RoHS	EU RoHS (2011/65/EU& (EU) 2015/863) & UK RoHS EN IEC 63000:2018 & BS EN IEC 63000:2018	

ESD Design

Normal ESD precautions are required during the handling of this module. This transceiver is shipped in ESD protective packaging. It should be removed from the packaging and otherwise handled in an ESD protected environment utilizing standard grounded benches, floor mats, and wrist straps.

Parameter	Threshold value	Notes
ESD of high-speed pins	1 KV	Human Body Model
ESD of low-speed pins	2 KV	Human Body Model
Air discharge during operation	15 KV	
Direct contact discharges to the case	8 KV	

Safety Specification Design

Cautions

Do not look into fiber end faces without eye protection using an optical meter (such as magnifier and microscope) within 100 mm, unless you ensure that the laser output is disabled. When operating an optical meter, observe the operation requirements.

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

Attention – L'utilisation des commandes ou réglages ou l'exécution des procédures autres que celles spécifiées dans les présentes exigences peuvent être la cause d'une exposition à un rayonnement dangereux.

Ordering Information

Part Number	Description
OM3660FX102	QSFP-DD-400GE-FR4

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