400 Gbps QSFP-DD ZR+ Transceiver

Model Name: ECPO-QDDZRP400G
Part Number: M0OECECPO016Z

This document is a specification for a 100-400G flexible line rate digital coherent optical transceiver module based on QSFP-DD MSA and 400ZR/Open ZR+ standards.

Key Features and Benefits

- For DCI/Metro WDM applications
- Compliant with QSFP-DD MSA
- Supports 400ZR/Open ZR+ interoperability
- Modulation: 400G DP-16QAM, 200G DP-QPSK, 100G DP-QPSK
- 400 GbE, 200 GbE, and 100 GbE applicable
- CEI-56G-VSR-PAM4, CEI-28G-VSR(SR)-NRZ
- C-band tunable wavelength
- Compliant with CMIS (Common Management Interface) version 5.0
- Compliant with OIF Coherent CMIS
- Power Supply Voltage: +3.3V
- Control Interface: TWI (Two-Wire-Interface)
- Class 1 Laser Product

Ordering Information

Edgecore Model Name	Edgecore Part Number	Case Operating Temperature	Wavelength	Type
ECPO-QDDZRP400G	M0OECECPO016Z	0°C to +70°C	Tunable: ITU 75/100GHz Grids ITU ± (nx25) GHz (n=0,1,2, etc)	100G/200G/400G QSFP-DD Open ZR+

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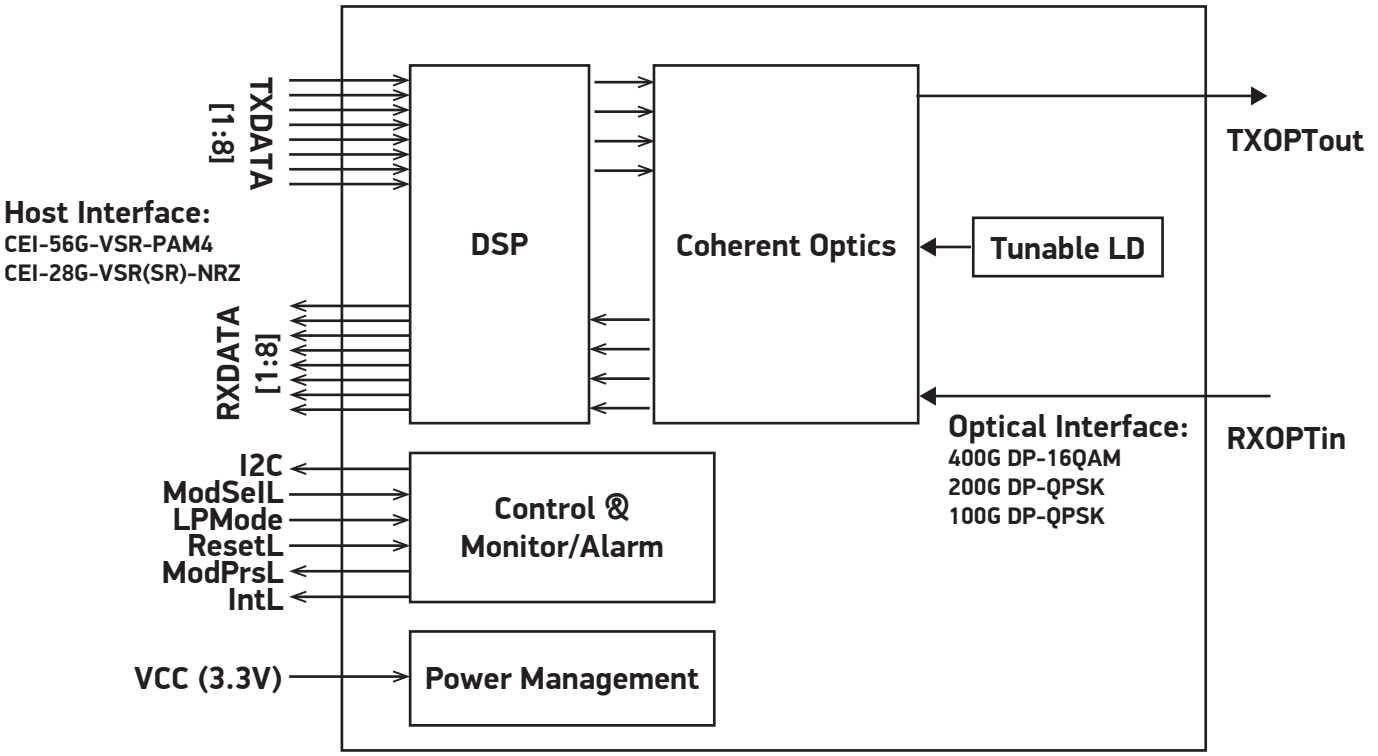
Function Block Diagram

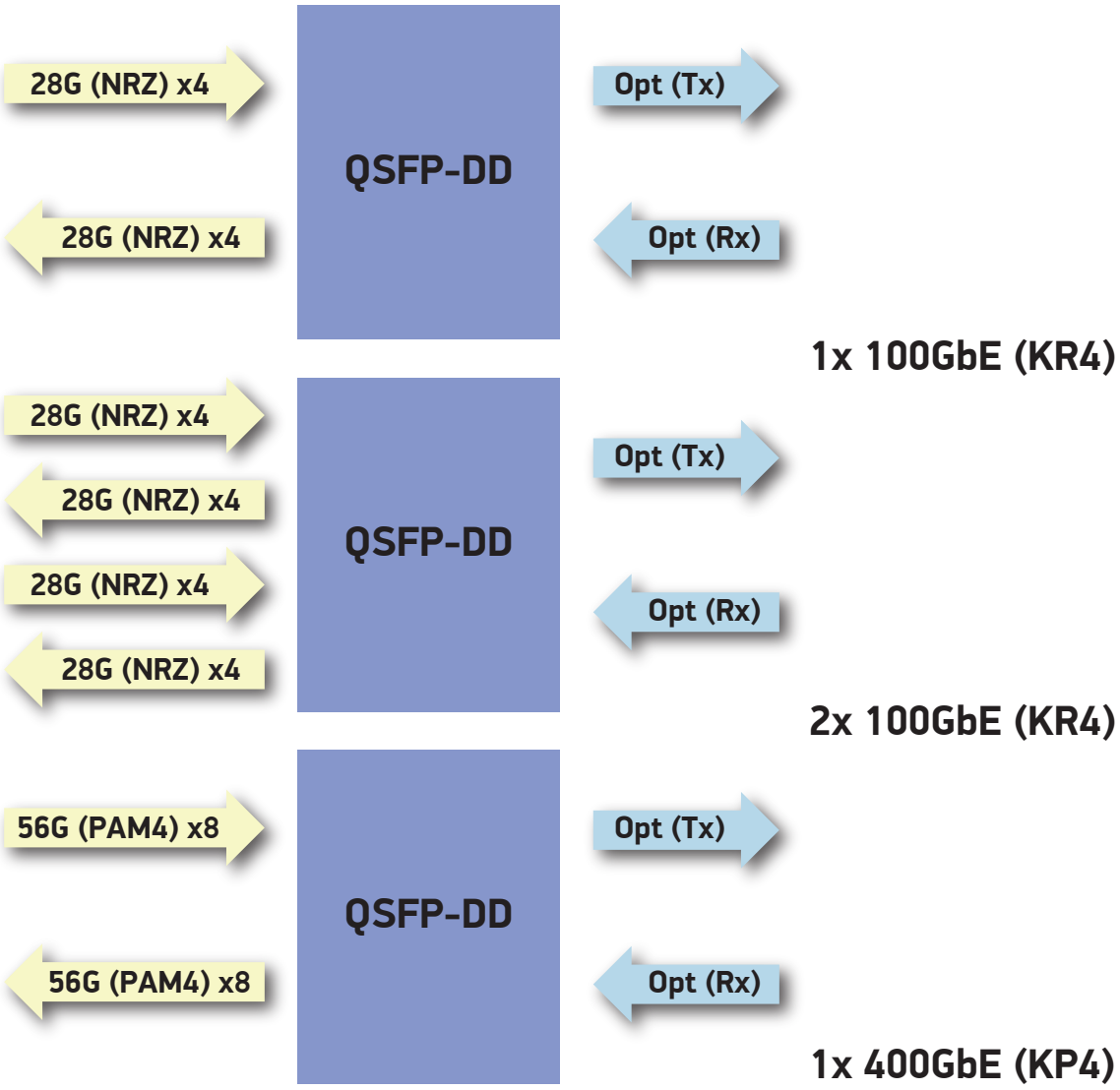


Absolute Maximum Ratings

Parameter	Min	Typ	Max	Unit	Note
Storage Temperature	-40		85	°C	
Storage Humidity			85	%	
Power Supply Voltage (VccT, VccR)	-0.3		3.6	V	
Voltage on LVTTL Input	-0.3		Vcc+0.3	V	
Rx Input Optical Power			15	dBm	
Static Discharge Voltage HBM per ANSI/ESDA/JEDEC JS-001	-1000		1000	V	

Operation Modes

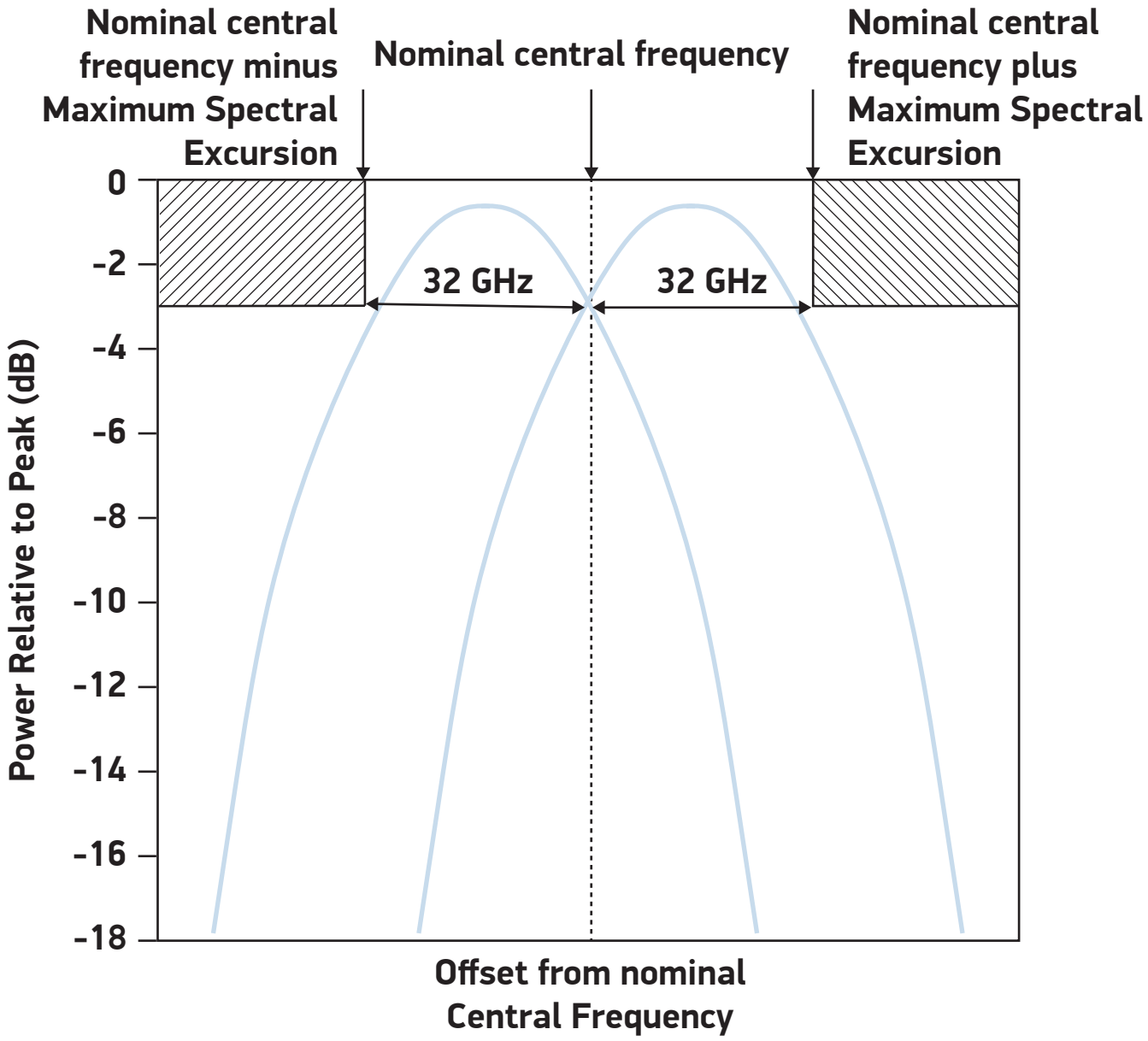
Operation Mode		Client Capacity	Host Lane Interfaces		Modulation Format	FEC	Symbol Baud Rate [Gbaud]	bit/symbol
			400GBASE-R	100GBASE-R				
400ZR		400G	1		DP-16QAM	CFEC	59.84375	8
OpenZR+	400ZR+	400G	1		DP-16QAM	OFEC	60.138546798	8
	200ZR+	200G		2	DP-QPSK		60.138546798	4
	100ZR+	100G		1	DP-QPSK		30.069273399	4



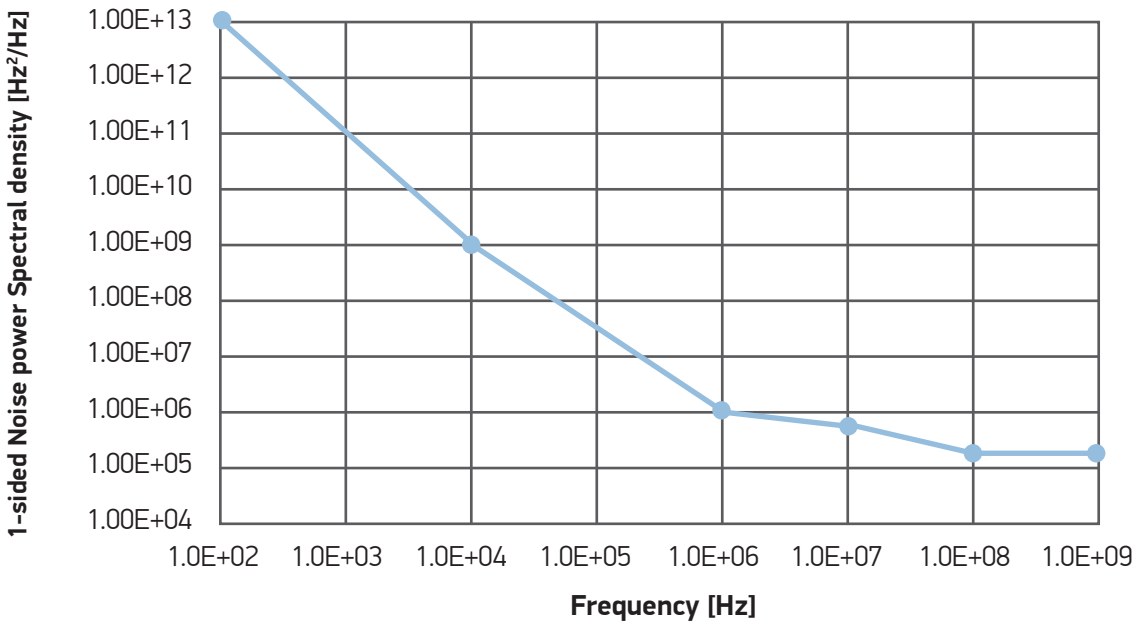
Transmitter Specifications

Parameter	400ZR			OpenZR+			Unit	Note
	Min	Typ	Max	Min	Typ	Max		
Modulation Format		DP-16QAM			DP-16QAM			400G
					DP-QPSK			200G
					DP-QPSK			100G
Baud Rate	59.84375± 100ppm			60.138547 ± 20ppm			Gbaud	400G
				60.138547 ± 20ppm				200G
				30.069274 ± 20ppm				100G
Channel Frequency	191.3	193.7	196.1	191.3		196.1	THz	
Channel Spacing	100			100			GHz	
	75*			75			GHz	64ch (*optional)
Laser Frequency Accuracy	-1.8		1.8	-1.8		1.8	GHz	
Tx Spectral Excursion			32	-32		32	GHz	Note 1
Laser Frequency Noise		See MASK			See MASK		Hz2/Hz	Note 2
Laser RIN(AVG)			-145			-145	dB/Hz	0.2G ≦ f ≦ 10GHz
Laser RIN(Peak)			-140			-140	dB/Hz	0.2G ≦ f ≦ 10GHz
Excess Bandwidth	12.5			12.5			%	Note 3
Tx Output Signal Power (Pout)	-10		-6	-10		-6	dBm	400G
				-9		-5	dBm	200G
				-8		-4	dBm	100G
Total Output Power with Tx Disabled			-20			-20	dBm	
Total Output Power During Wavelength Switching			-20			-20	dBm	
Inband OSNR	34			34			dB/0.1nm	
Out-of-band OSNR	23			23			dB/0.1nm	
Transmitter Reflectance			-20			-20	dBm	
Transmitter Back Reflection Tolerance			-24			-24	dBm	
Transmitter Polarization Dependent Power			2.0			2.0	dB	
X-Y Skew			5			5	ps	
Mean I-Q Amplitude Imbalance			1			1	dB	
I-Q Phase Imbalance	-5		5	-5		5	degrees	
I-Q Skew			0.75			0.75	ps	

Tx Spectral Excursion



Laser Frequency Noise



Frequency [Hz]	1-sided Noise power Spectral density [Hz²/Hz]
1.0e+02	1.0e+13
1.0e+04	1.0e+09
1.0e+06	1.0e+06
1.0e+07	6.0e+05
1.0e+08	1.0e+05
1.0e+09	1.0e+05

Mask does not apply to spurs.

Excess Bandwidth

The baseband Tx spectral shape in this excess bandwidth shall meet or exceed the following conditions:
The magnitude of the spectrum in the frequency range:

$$\frac{1}{2T} \leqq f \leqq \frac{9}{16T}$$

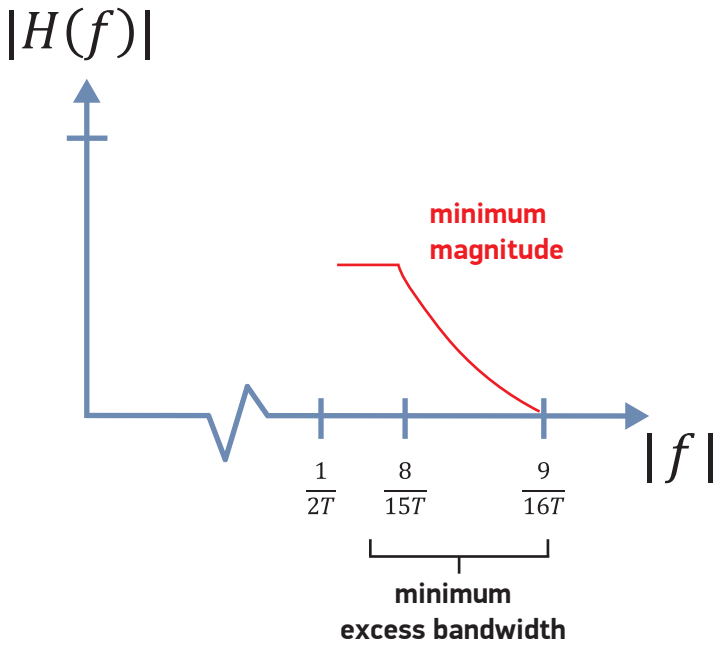
shall meet

$$|H(f)| \geq H(o)\sqrt{\frac{1}{2}\left\{1+cos\left[8\pi T\left(\left(\frac{8}{15T}\right)-\frac{7}{16T}\right)\right]\right\}}$$

$$\frac{1}{2T} \leq |f| \leq \frac{8}{15T}$$

$$|H(f)| \geq H(o)\sqrt{\frac{1}{2}\left\{1+cos\left[8\pi T\left(|f|-\frac{7}{16T}\right)\right]\right\}}$$

$$\frac{8}{15T} \leq |f| \leq \frac{9}{16T}$$



where T denotes the symbol period of the signal.

Receiver Specifications

Parameter	400ZR			OpenZR+			Unit	Note
	Min	Typ	Max	Min	Typ	Max		
Modulation Format		DP-16QAM			DP-16QAM			400G
					DP-QPSK			200G
					DP-QPSK			100G
Baud Rate	59.84375± 100ppm			60.138547 ± 20ppm			Gbaud	400G
				60.138547 ± 20ppm				200G
				30.069274 ± 20ppm				100G
Post FEC BER			1E-15			1E-15		
Channel Frequency	191.3	193.7	196.1	191.3		196.1	THz	
Channel Spacing	100			100			GHz	
	75*			75			GHz	64ch (optional*)
Frequency Offset Between Received carrier and LO	-3.6		3.6	-3.6		3.6	GHz	
Input Power range (Pin)	-12		0	-12		0	dBm	400G
				-18		0	dBm	200G
				-18		0	dBm	100G
Input Sensitivity	-12			-12			dBm	400G
				-18			dBm	200G
				-18			dBm	100G
OSNR Tolerance			26			24	dB/0.1nm	400G
						16	dB/0.1nm	200G
						12.5	dB/0.1nm	100G
Optical Return Loss	20			20			dB	
CD Tolerance	2,400			20,000			ps/nm	400G
				50,000			ps/nm	200G
				100,000			ps/nm	100G
Optical path OSNR Penalty Tolerance			0.5			0.5	dB	
PMD Tolerance	10			20			ps	400G
				25			ps	200G
				30			ps	100G
Peak PDL Tolerance	3.5			3.5			dB	
Tolerance to change in SOP	50			50			krad/s	
Optical Input Power Transient Tolerance	-2		2	-2		2	dB	Condition: Rise/fall time of power change defined by 20-80% of 50 us or slower

Electrical Power Supply and Power Dissipation

Parameter	Min	Typ	Max	Unit	Note
Case Temperature	0		70	°C	
Operating Humidity	5		85	%	Non-condensing
Power Supply Voltage (VccT, VccR)			3.465	V	
Power Supply Current			6.86	A	OpenZR+400G (1)
			6.42		OpenZR+200G (1)
			5.20		OpenZR+100G (1)
			6.10		400ZR (1)
Power Consumption			21.5	W	OpenZR+400G
			20.1		OpenZR+200G
			16.3		OpenZR+100G
			19.1		400ZR
Power Consumption@Low Power Mode			1.5	W	

Transmitter Electrical Interface

Characteristics of 28G SERDES Interface (TXI)

Parameter	Min	Typ	Max	Unit	Note
Baud Rate		25.78125		Gbaud	100GE(KR4)
Baud Rate Tolerance	-100		100	ppm	100GE
Differential Input Voltage	0.9			Vppd	
Differential Termination Resistance	80	100	120	Ohm	

Characteristics of 56G SERDES Interface (TXI)

Parameter	Min	Typ	Max	Unit	Note
Baud Rate		26.5625		Gbaud	400GE
Baud Rate Tolerance	-100		100	ppm	400GE
Differential Input Voltage	0.9			Vppd	
Differential Termination Resistance	80	100	120	Ohm	

Receiver Electrical Interface

Characteristics of 28G SERDES Interface (RXO)

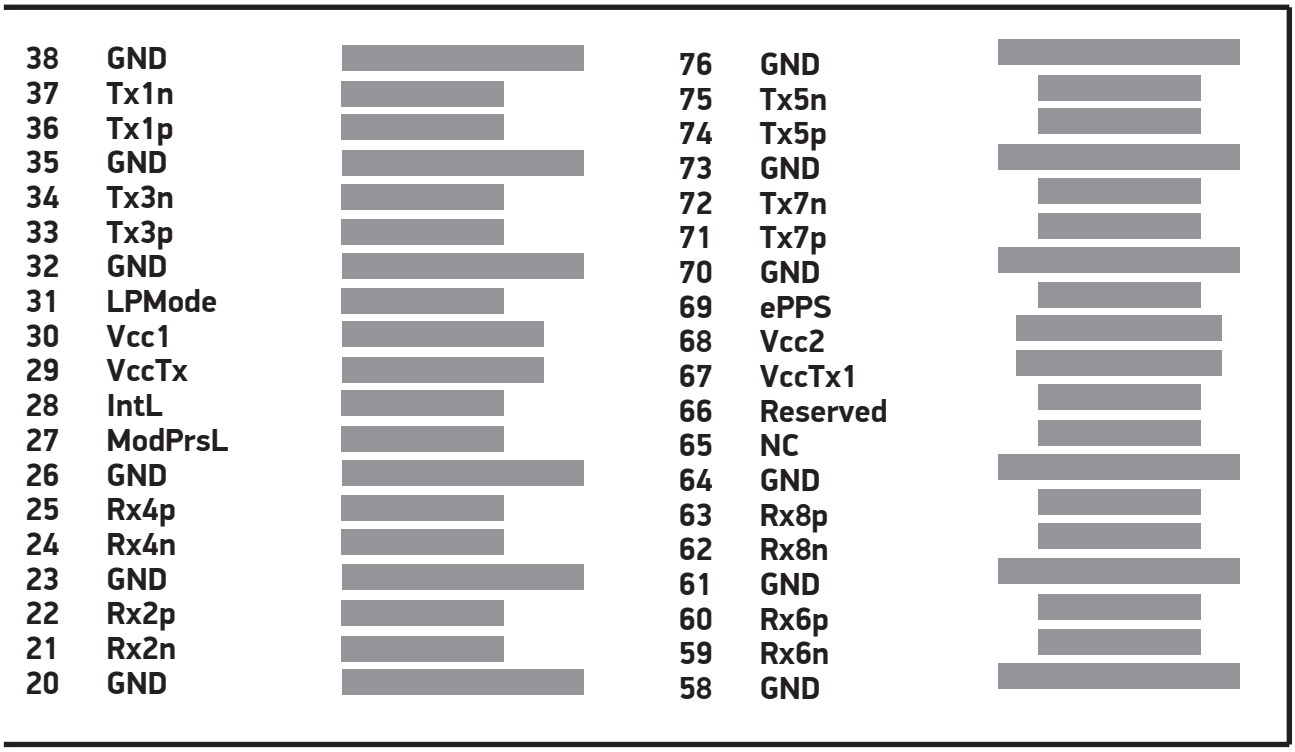
Parameter	Min	Typ	Max	Unit	Note
Baud Rate		25.78125		Gbaud	100GE(KR4)
Baud Rate Tolerance	-100		100	ppm	100GE
Maximum Differential Output Voltage			0.9	Vppd	
Rise and Fall Time (20% to 80%)	8			ps	
Differential Termination Resistance	70	85	110	Ohm	

Characteristics of 56G SERDES Interface (RXO)

Parameter	Min	Typ	Max	Unit	Note
Baud Rate		26.5625		Gbaud	400GE
Baud Rate Tolerance	-100		100	ppm	400GE
Maximum Differential Output Voltage			0.9	Vppd	
Rise and Fall Time (20% to 80%)	9.5			ps	
Differential Termination Resistance	70	85	110	Ohm	

Electrical Pin Layout and Function Definition

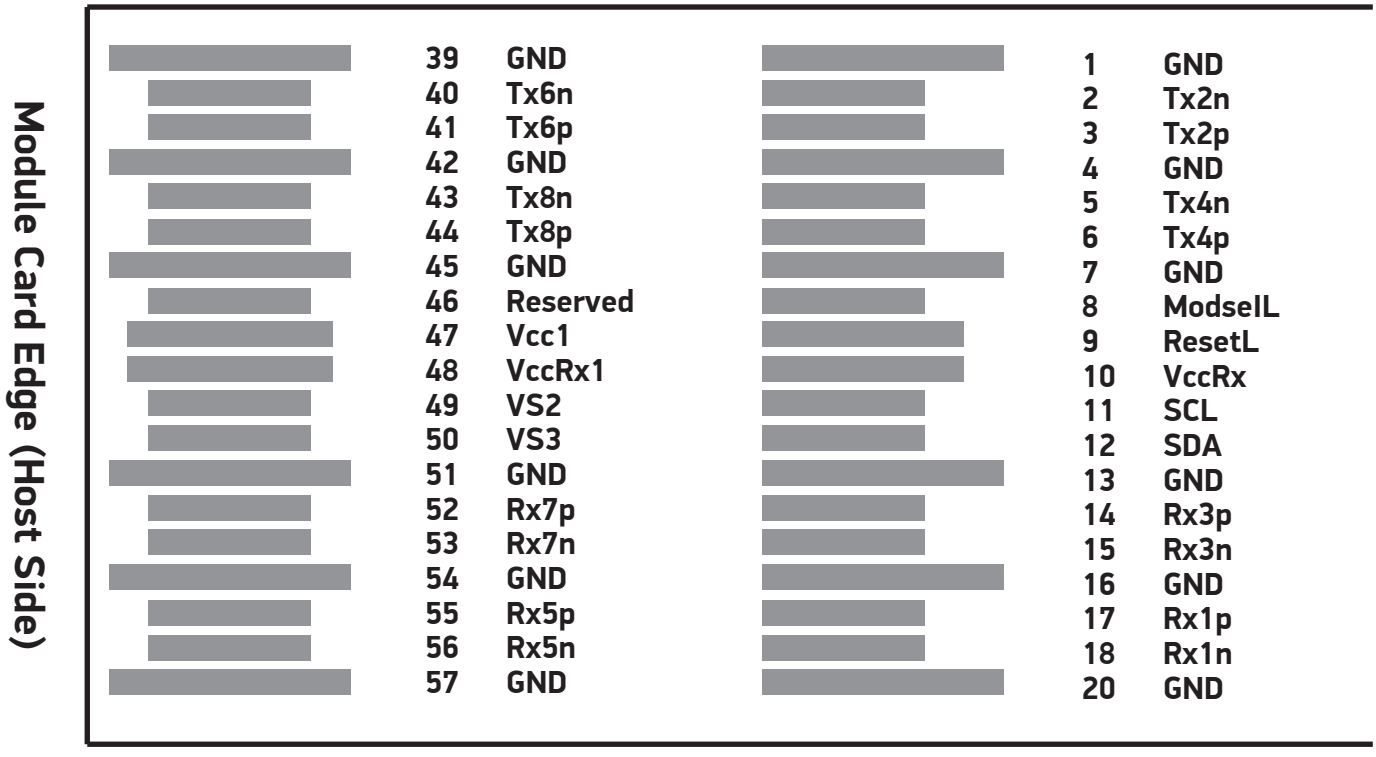
Top side (viewed from top)



Legacy QSFP28 Pads

Additional QSFP-DD Pads

Bottom side (viewed from top)



Additional QSFP-DD Pads

Legacy QSFP28 Pads

Pad Function Definition

Pad	Logic	Symbol	Description	Note
1		GND	Ground	
2	CML-I	TX2n	Tx inverted data input	
3	CML-I	TX2p	Tx non-inverted data input	
4		GND	Ground	
5	CML-I	TX4n	Tx inverted data input	
6	CML-I	TX4p	Tx non-inverted data input	
7		GND	Ground	
8	LVTTL-I	ModselL	Module Select	Internal 3.3VPU (10kΩ)
9	LVTTL-I	ResetL	Module Reset	Internal 3.3VPU (10kΩ)
10		VccRx	+3.3V power supply	
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	Rx non-inverted data output	
15	CML-O	RX3n	Rx inverted data output	
16		GND	Ground	
17	CML-O	RX1p	Rx non-inverted data output	
18	CML-O	RX1n	Rx inverted data output	
19		GND	Ground	
20		GND	Ground	
21	CML-O	RX2n	Rx inverted data output	
22	CML-O	RX2p	Rx non-inverted data output	
23		GND	Ground	
24	CML-O	RX4n	Rx inverted data output	
25	CML-O	RX4p	Rx non-inverted data output	
26		GND	Ground	
27	LVTTL-O	ModPrsL	Module Present	
28	LVTTL-O	IntL	Interrupt	
29		VccTx	+3.3V power supply	
30		Vcc1	+3.3V power supply	
31	LVTTL-I	LPMode	Low Power Mode	Internal 3.3VPU (10kΩ)
32		GND	Ground	
33	CML-I	TX3p	Tx non-inverted data input	
34	CML-I	TX3n	Tx inverted data input	
35		GND	Ground	
36	CML-I	TX1p	Tx non-inverted data input	
37	CML-I	TX1n	Tx inverted data input	
38		GND	Ground	

Pad Function Definition

Pad	Logic	Symbol	Description	Note
39		GND	Ground	
40	CML-I	TX6n	Tx inverted data input	
41	CML-I	TX6p	Tx non-inverted data input	
42		GND	Ground	
43	CML-I	TX8n	Tx inverted data input	
44	CML-I	TX8p	Tx non-inverted data input	
45		GND	Ground	
46		Reserved	For Future Use	Open
47		VS1	Module Vendor Specific 1	Internal PD (1kΩ)
48		VccRx1	+3.3V power supply	
49		VS2	Module Vendor Specific 2	Internal PD (1kΩ)
50		VS3	Module Vendor Specific 3	Internal PD (10kΩ),(1)
51		GND	Ground	
52	CML-O	RX7p	Rx non-inverted data output	
53	CML-O	RX7n	Rx inverted data output	
54		GND	Ground	
55	CML-O	RX5p	Rx non-inverted data output	
56	CML-O	RX5n	Rx inverted data output	
57		GND	Ground	
58		GND	Ground	
59	CML-O	RX6n	Rx inverted data output	
60	CML-O	RX6p	Rx non-inverted data output	
61		GND	Ground	
62	CML-O	RX8n	Rx inverted data output	
63	CML-O	RX8p	Rx non-inverted data output	
64		GND	Ground	
65		NC	No connection	Open
66		Reserved	For Future Use	Internal PD (10kΩ)
67		VccTx1	+3.3V power supply	
68		Vcc2	+3.3V power supply	
69	LVTTL-I	ePPS	Precision Time Protocol (PTP) reference clock input	Internal PD (20kΩ)
70		GND	Ground	
71	CML-I	TX7p	Tx non-inverted data input	
72	CML-I	TX7n	Tx inverted data input	
73		GND	Ground	
74	CML-I	TX5p	Tx non-inverted data input	
75	CML-I	TX5n	Tx inverted data input	
76		GND	Ground	

(1) Shall be unconnected or be terminated to GND.

Low Speed Control and Sense Signals

Parameters	Symbol	Min	Max	Unit	Note
SCL and SDA	VOL	0	0.4	V	IOL=3mA
SCL and SDA	VIL	-0.3	Vcc*0.3	V	
	VIH	VCC*0.7	VCC+0.5	V	
Capacitance for SCL and SDA I/O Signal	Ci		14	pF	
Total bus capacitive load for SCL and SDA	Cb		100	pF	@3kΩPU
			200		@1.6kΩPU
LPMode,ResetL,ModSelL and ePPS	VIL	-0.3	0.8	V	
	VIH	2	VCC+0.3	V	
LPMode,ResetL,ModSelL	|Iin|		360	uA	0<Vin<Vcc
ePPS	|Iin|		6.5	mA	0<Vin<Vcc
IntL	VOL	0	0.4	V	IOL=2mA
	VOH	VCC-0.5	VCC+0.3	V	@10kΩPU to HostVcc
ModPrsL	VOL	0	0.4	V	IOL=2mA
				V	As a short-circuit to GND on the module

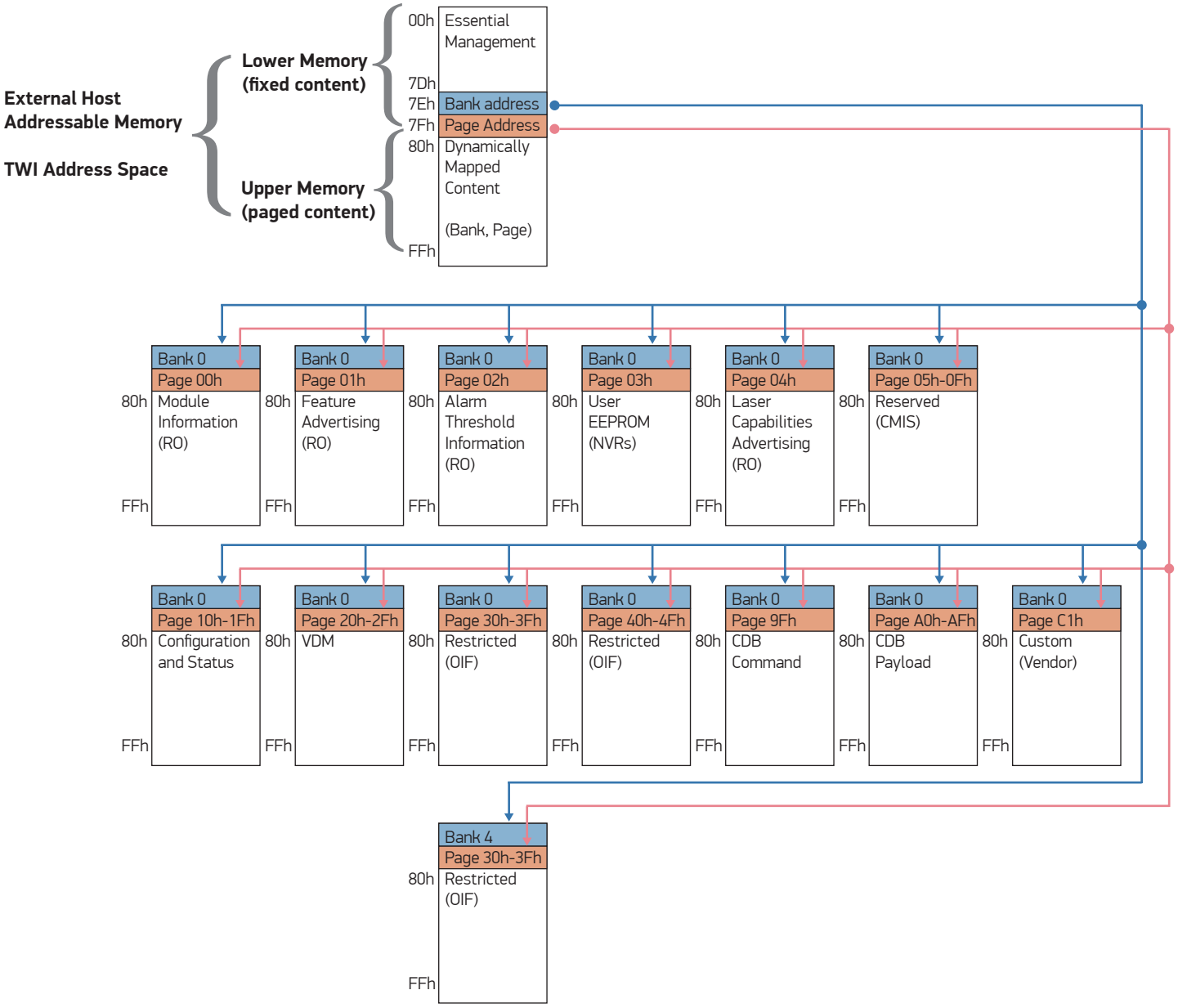
Module Digital Diagnostic Monitors

Parameters	Condition/Comment	Min	Typ	Max	Unit
Output Power Monitor, Accuracy	Total output power measurement including all ASE contribution. Measurement accuracy does not contribute to allowable output power signal window.	-2.0		2.0	dB
Input Total Power Monitor, Accuracy	Over the superset of input power range (From -12 dBm to 0 dBm), receiver sensitivity (>=-12dBm) and the optical Rx_LOS assert threshold range (From -20 to -16 dBm Channel Power)	-2.0		-2.0	dB
Input Channel Power Monitor, Accuracy	The module reports the channel power as received by the module.	-2.5		2.5	dB
VCC Voltage Monitor, Accuracy		-3.0		3.0	%
Case Temperature Monitor, Accuracy		-3.0		3.0	°C
CD: Chromatic Dispersion			supported		ps/nm
DGD: Differential Group Delay			supported		ps
OSNR: Optical Signal to Noise Ratio			supported		dB
CFO: Carrier Frequency Offset			supported		MHz
PDL: Polarization Dependent Loss			supported		dB

Digital Diagnostic Monitors Alarm Threshold Specification

Parameters	Threshold	Unit
Case Temperature Low Alarm	-3	°C
Case Temperature High Alarm	80	°C
Voltage Low Alarm	3.0	V
Voltage High Alarm	3.5	V
Tx Optical Power Low Alarm	-16	dBm
Tx Optical Power High Alarm	PoutMAX+2dB	dBm
Rx Optical Power Low Alarm	PinMIN-6dB	dBm
Rx Optical Power High Alarm	3	dBm

Memory Map


External Host Addressable Memory
TWI Address Space
Lower Memory (fixed content)
Upper Memory (paged content)
00h
Essential Management
7Dh
7Eh
Bank address
7Fh
Page Address
80h
Dynamically Mapped Content
(Bank, Page)
FFh
Bank 0 Page 00h
Module Information (RO)
Bank 0 Page 01h
Feature Advertising (RO)
Bank 0 Page 02h
Alarm Threshold Information (RO)
Bank 0 Page 03h
User EEPROM (NVRs)
Bank 0 Page 04h
Laser Capabilities Advertising (RO)
Bank 0 Page 05h-0Fh
Reserved (CMIS)
Bank 0 Page 10h-1Fh
Configuration and Status
Bank 0 Page 20h-2Fh
VDM
Bank 0 Page 30h-3Fh
Restricted (OIF)
Bank 0 Page 40h-4Fh
Restricted (OIF)
Bank 0 Page 9Fh
CDB Command
Bank 0 Page A0h-AFh
CDB Payload
Bank 0 Page C1h
Custom (Vendor)
Bank 4 Page 30h-3Fh
Restricted (OIF)

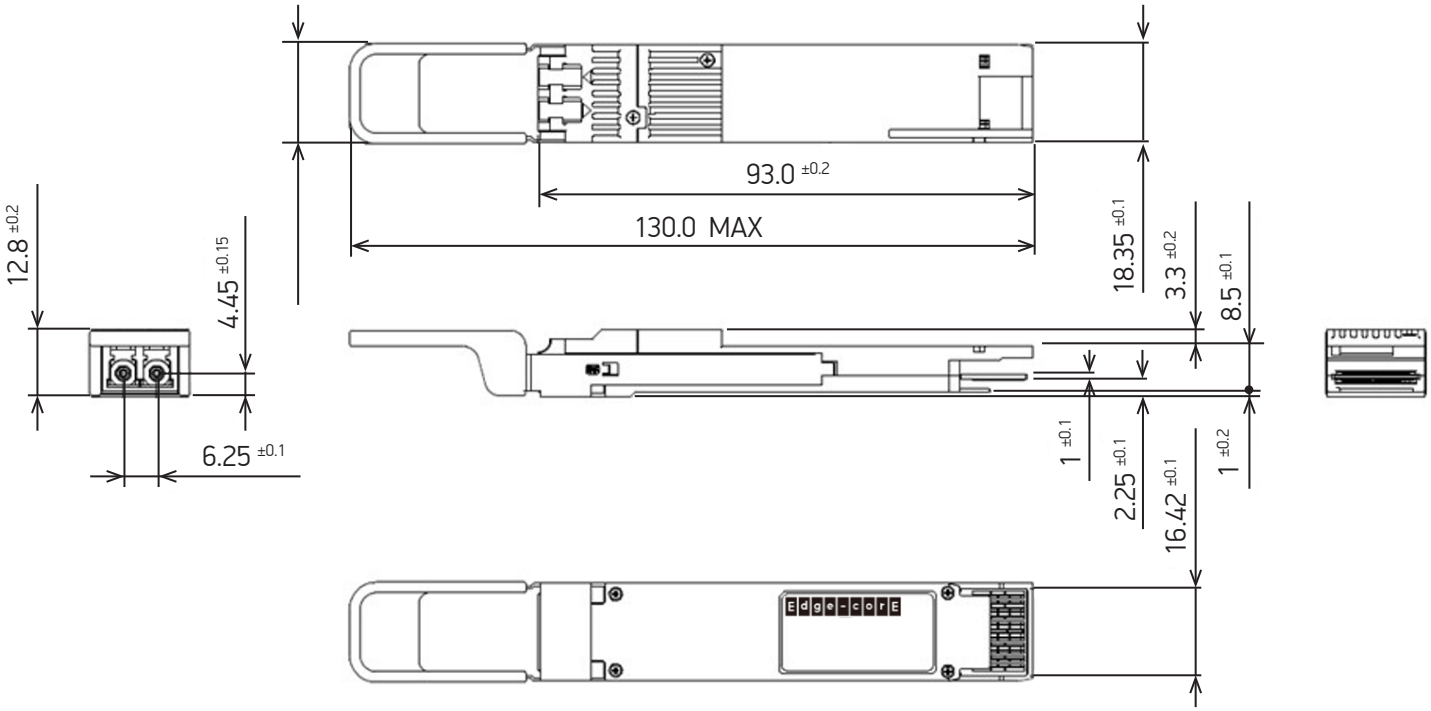
Memory Map Pages (Upper Memory: 80h-FFh)

Category	Bank	Page	Page Description	Note
-	0	00h	Administrative Information	
		01h	Advertising	
		02h	Module and Lane Thresholds	
		03h	User EEPROM	
		04h	Laser Capabilities Advertising	
		05h-0Fh	Reserved (CMIS)	n/a
Configuration and Status	0	10h	Lane Control and Data Path Control	
		11h	Lane Status and Data Path Status	
		12h	Tunable Laser Control and Status	
		13h	Module Performance Diagnostics Control	
		14h	Module Performance Diagnostics Results	
		15h	Timing Characteristics	n/a
		16h-1Dh	Reserved	n/a
		1Eh-1Fh	Custom	n/a
VDM	0	20h	Descriptors for VDM Instances 1-64 (Group 1)	
		21h	Descriptors for VDM Instances 65-128 (Group 2)	n/a
		22h	Descriptors for VDM Instances 129-192 (Group 3)	
		23h	Descriptors for VDM Instances 193-256 (Group 4)	n/a
		24h	Samples of VDM Instances 1-64 (Group 1)	
		25h	Samples of VDM Instances 65-128 (Group 2)	n/a
		26h	Samples of VDM Instances 129-192 (Group 3)	
		27h	Samples of VDM Instances 193-256 (Group 4)	n/a
		28h	Thresholds 1-16 (Group 1)	
		29h	Thresholds 17-32 (Group 2)	n/a
		2Ah	Thresholds 33-48 (Group 3)	
		2Bh	Thresholds 49-64 (Group 4)	n/a
		2Ch	VDM Flags (Groups 1-4)	
		2Dh	VDM Masks (Groups 1-4)	
		2Eh	Reserved	n/a
		2Fh	Advertisement and Dynamic Controls	

Memory Map Pages (Upper Memory: 80h-FFh)

Category	Bank	Page	Page Description	Note
Restricted (OIF)	0	30h	Media Lane Configurable Thresholds	C-CMIS
		31h	Media Lane Provisioning	n/a
		32h	Media Lane Flag Masks	C-CMIS
		33h	Media Lane Flags and Status	C-CMIS
		34h	Media Lane FEC Performance Monitoring	C-CMIS
		35h	Media Lane Link Performance Monitoring	C-CMIS
		36h-37h	Reserved	n/a
	0,4	38h	Data Path Host Interface Configuration	C-CMIS
		39h	Reserved Datatpath Interface Future Use	n/a
		3Ah	Data Path Host Interface Performance Monitoring	C-CMIS
	0	3Bh	Data Path Host Interface Flags and Masks	C-CMIS
		3Ch-3Fh	Reserved	n/a
Restricted (OIF)	0	40h	Reserved for Applications Advertisement	n/a
		41h	Rx Signal Power Advertisement and Ranges for Configurable Thresholds	
		42h	Performance Monitoring Advertisement	
		43h	Media Lane Provisioning Advertisement	n/a
		44h	Alarm Advertisement	n/a
		45h-4Fh	Reserved	n/a
Reserved (CMIS)	0	50h-9Eh	Reserved (CMIS)	n/a
CDB Command	0	9Fh	CDB Message	
CDB Payload	0	A0h-AFh	CDB EPL Segments	
Custom (Vendor)	0	B0h-C0Fh		n/a
		C1h	Host Lane signal adjustment	
		C2h~FFh		n/a

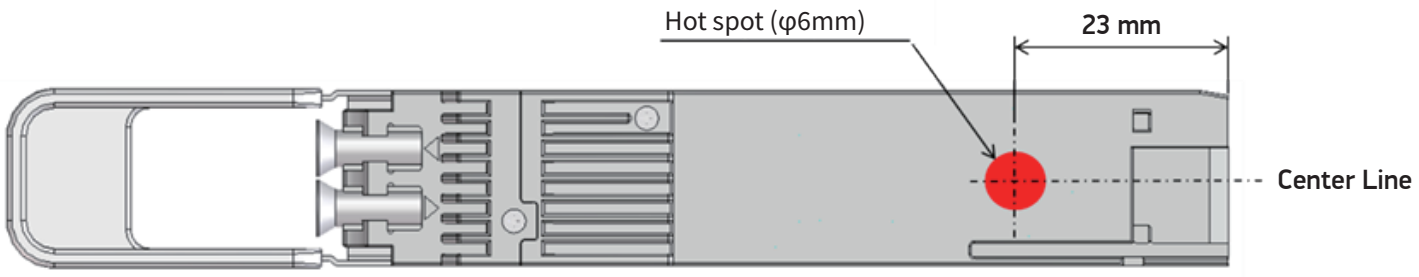
Mechanical Specifications



Thermal information

Hot Spot

The hottest location (hot spot) of this module is as follows. The case temperature is specified at the following location.



References

1. QSFP-DD MSA: QSFP-DD Hardware Specification for QSFP Double Density 8X Pluggable Transceiver, Revision 5.1, August 7, 2020
2. OIF-400ZR: Implementation Agreement 400ZR Revision 1.0, March 10, 2020
3. Open ZR+ MSA: Technical Specification Revision 1.0, September 4, 2020
4. QSFP-DD-CMIS: Common Management Interface Specification Revision 5.0, May 8, 2021
5. OIF-C-CMIS: Implementation Agreement for Coherent CMIS Revision 1.1, June 10, 2020

Warranty
Please check www.edge-core.com for the warranty terms in your country.

For More Information
To find out more about Edgecore Networks Corporation productsand solutions, visit www.edge-core.com.

About Edgecore Networks Corporation
Edgecore Networks Corporation is in the business of providing innovative network solutions. In the service provider network, in the data center or in the cloud, Edgecore Networks Corporation delivers the software and systems that transform the way the world connects. Edgecore Networks Corporation serves customers and partners worldwide. Additional information can be found at www.edge-core.com.

Edgecore Networks Corporation is a subsidiary of Accton Technology Corporation, the leading network ODM company. The Edgecore data center switches are developed and manufactured by Accton.

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