

400 Gb/s QSFP-DD LR4 10 km Transceiver

QSFP-DD Series



- **Compliant to IEEE 802.3cu**
- **4 duplex channels transmitters and PIN receivers**
- **4 CWDM lanes MUX/DEMUX design**
- **Up to 10km transmission on single mode fiber**
- **Maximum power consumption 9W**
- **QSFP-DD MSA compliant**

Ascent's QSFP-DD-LR4-10 is a 400Gb/s Quad Small Form Factor Pluggable-double density (QSFP-DD) optical module designed for 10km optical communication applications. The module converts 8 channels of 50Gb/s (PAM4) electrical input data to 4 channels of CWDM optical signals, and multiplexes them into a single channel for 400Gb/s optical transmission. Conversely, on the receiver side, the module optically de-multiplexes a 400Gb/s optical input into 4 channels of CWDM optical signals, and converts them to 8 channels of 50Gb/s (PAM4) electrical output 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 ITU-T G.694.2. It contains a duplex LC connector for the optical interface and a 76-pin connector for the electrical interface. To minimize the optical dispersion in the long-haul system, single-mode fiber (SMF) has to be applied in this module. Host FEC is required to support up to 10km fiber transmission

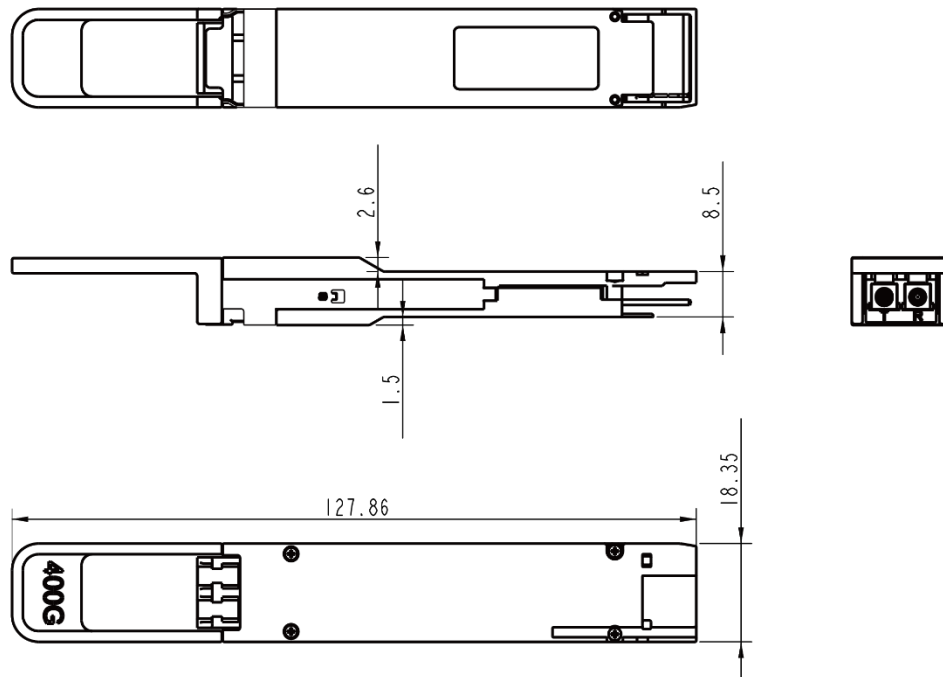
The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP-DD Multi-Source Agreement (MSA) Type 2. It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

The module is designed for 10 km optical communication applications, and it is compliant with 100G Lambda MSA standard. This module can convert 8-channel 53.125 Gbps electrical data to 4-channel 106.25 Gbps optical signals, and multiplex them into a single channel for 425 Gbps optical transmission. Similarly, it optically de-multiplexes a 425 Gbps input into 4-channel signals, and converts them to 8-channel output electrical data on the receiver side.

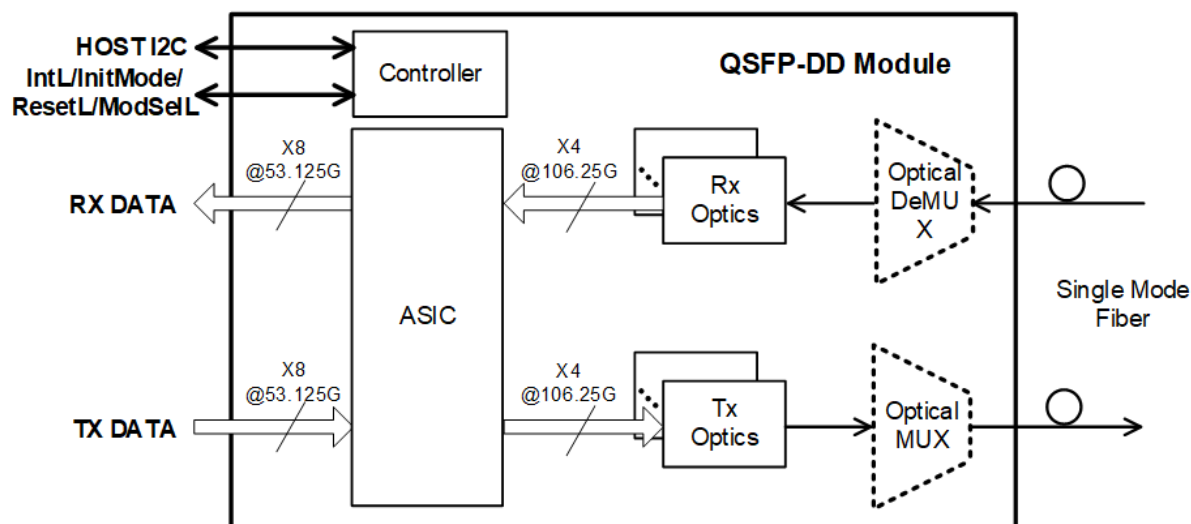
Key Features

- 4x106.25Gbps PAM4 parallel lanes
- 8x53.125Gbps PAM4 electrical interface(400GAUI-8)
- 4 duplex channels transmitters and PIN receivers
- 4 CWDM lanes MUX/DEMUX design
- Maximum power consumption 9W
- LC duplex connector
- Up to 10km transmission on single mode fiber
- Operating case temperature: 0°C to 70°C
- Single 3.3V power supply
- QSFP-DD MSA compliant rev5.0 compliant
- Compliant to IEEE 802.3cu

Outline Dimensions



Transceiver Block Diagram



Digital Diagnostic Monitoring Functions

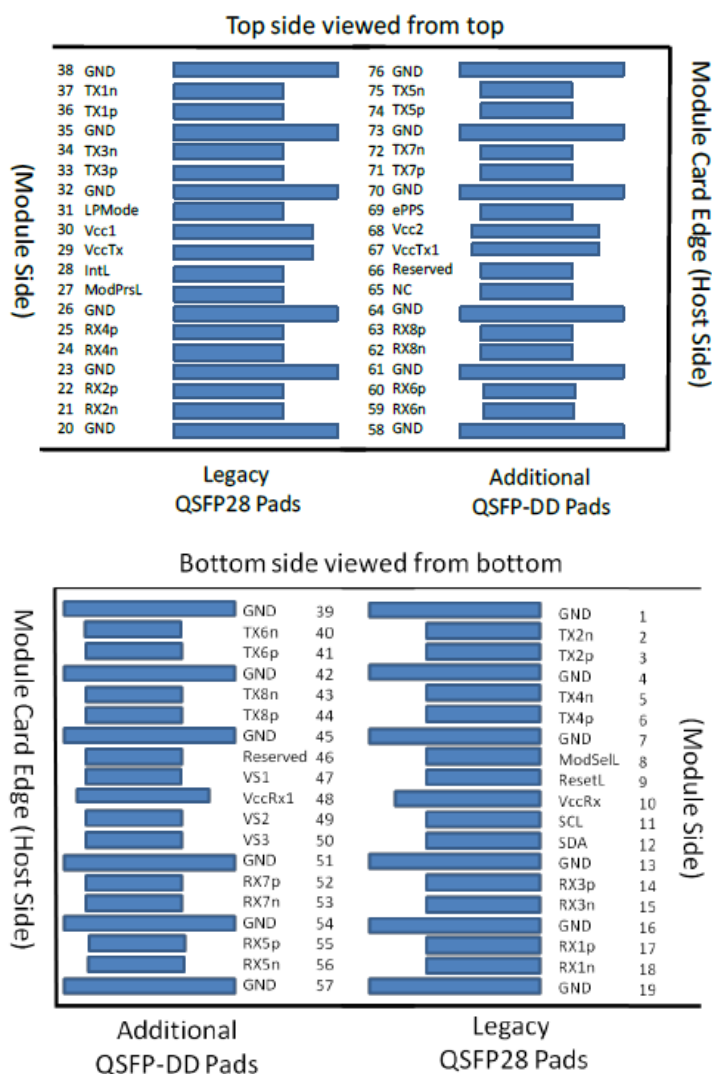
Digital diagnostic management interface (DDMI) is realized by I2C interface in compliance with CMIS 4.0. diagnostic management functions are realized, and the data addresses are listed in the form below.

Performance item	Data address		
	Alarm & Warning	Alarm & Warning Thresholds	Monitor
Module Temperature	Lower page 9	Page2h (128-135)	Lower page (14-15)
Module Voltage	Lower page 9	Page2h (136-143)	Lower page (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)

Regulatory Compliance

Feature	Agency	Standard	Performance
Safety	NRTL	UL 62368-1 CAN/CSA C22.2 No. 62368-1 IEC 60825-1	NRTL recognized component for US and CAN
	TUV	IEC 60825-2 EN 62368-1 EN 60825-1 EN 60825-2	
	FDA	U.S. 21 CFR 1040.10 & 1040.11	FDA/CDRH certified with accession 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 –6 dB margin to the limit when tested with a metal enclosure. Final margin may vary depending on system application, good system EMI design practice, ie: suitable metal enclosure and well-bonding, is required to achieve Class B margins at the system level. Tested frequency range: 30 MHz to 40 GHz or 5th harmonic (5 times the highest frequency), whichever is less. Withstands discharges of ± 8 kV contact, ± 15 kV air.
	ESD	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-2	
	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 Substances	RoHS	EU RoHS (2011/65/EU & (EU) 2015/863) & UK RoHS EN IEC 63000:2018 & BS EN IEC 63000:2018	

Pin Assignment



Pin	Symbol	Description	Notes
1	GND	Ground	1
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data Input	
4	GND	Ground	1
5	Tx4n	Transmitter Inverted Data Input	
6	Tx4p	Transmitter Non-Inverted Data Input	
7	GND	Ground	1
8	ModSelL	Module Select	
9	ResetL	Module Reset	
10	VccRx	+3.3 V Power Supply Receiver	2
11	SCL	2-wire Serial Interface Clock	
12	SDA	2-wire Serial Interface Data	
13	GND	Ground	1

Pin	Symbol	Description	Notes
14	Rx3p	Receiver Non-Inverted Data Output	
15	Rx3n	Receiver Inverted Data Output	
16	GND	Ground	1
17	Rx1p	Receiver Non-Inverted Data Output	
18	Rx1n	Receiver Inverted Data Output	
19	GND	Ground	1
20	GND	Ground	1
21	Rx2n	Receiver Inverted Data Output	
22	Rx2p	Receiver Non-Inverted Data Output	
23	GND	Ground	1
24	Rx4n	Receiver Inverted Data Output	
25	Rx4p	Receiver Non-Inverted Data Output	
26	GND	Ground	1
27	ModPrsL	Module Present	
28	IntL	Interrupt	
29	VccTx	+3.3 V Power supply transmitter	2
30	Vcc1	+3.3 V Power supply	2
31	LPMode	Low Power mode	
32	GND	Ground	1
33	Tx3p	Transmitter Non-Inverted Data Input	
34	Tx3n	Transmitter Inverted Data Input	
35	GND	Ground	1
36	Tx1p	Transmitter Non-Inverted Data Input	
37	Tx1n	Transmitter Inverted Data Input	
38	GND	Ground	1
39	GND	Ground	1
40	Tx6n	Transmitter Inverted Data Input	
41	Tx6p	Transmitter Non-Inverted Data Input	
42	GND	Ground	1
43	Tx8n	Transmitter Inverted Data Input	
44	Tx8p	Transmitter Non-Inverted Data Input	
45	GND	Ground	1
46	Reserved	For Future Use	3
47	VS1	Module Vendor Specific 1	3
48	VccRx1	3.3 V Power Supply	2
49	VS2	Module Vendor Specific 2	3
50	VS3	Module Vendor Specific 3	3
51	GND	Ground	1
52	Rx7p	Receiver Non-Inverted Data Output	

Pin	Symbol	Description	Notes
53	Rx7n	Receiver Inverted Data Output	
54	GND	Ground	1
55	Rx5p	Receiver Non-Inverted Data Output	
56	Rx5n	Receiver Inverted Data Output	
57	GND	Ground	1
58	GND	Ground	1
59	Rx6n	Receiver Inverted Data Output	
60	Rx6p	Receiver Non-Inverted Data Output	
61	GND	Ground	1
62	Rx8n	Receiver Inverted Data Output	
63	Rx8p	Receiver Non-Inverted Data Output	
64	GND	Ground	1
65	NC	No Connect	3
66	Reserved	For Future Use	3
67	VccTx1	3.3 V Power Supply	2
68	Vcc2	3.3 V Power Supply	2
69	ePPS	Precision Time Protocol (PTP) reference clock input. It is not used.	3
70	GND	Ground	1
71	Tx7p	Transmitter Non-Inverted Data Input	
72	Tx7n	Transmitter Inverted Data Input	
73	GND	Ground	1
74	Tx5p	Transmitter Non-Inverted Data Input	
75	Tx5n	Transmitter Inverted Data Input	
76	GND	Ground	1

Notes:

- 1.QSFP-DD uses common ground (GND) for all signals and supply (power). All are comon within the QSFP-DD module and all module voltages are referenced to this po-te-nial 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. 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 50ohms 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 10K ohms and less than 100pF.

Specifications

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	Note
Maximum Supply Voltage	V _{CC}	-0.5	3.3	3.6	V	
Storage Temperature	T _s	-40		85	°C	
Relative Humidity	RH	10		85	%	Non-condensing
Damage Threshold, each Lane	THd	4.5			dBm	

Recommended Operating Conditions

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

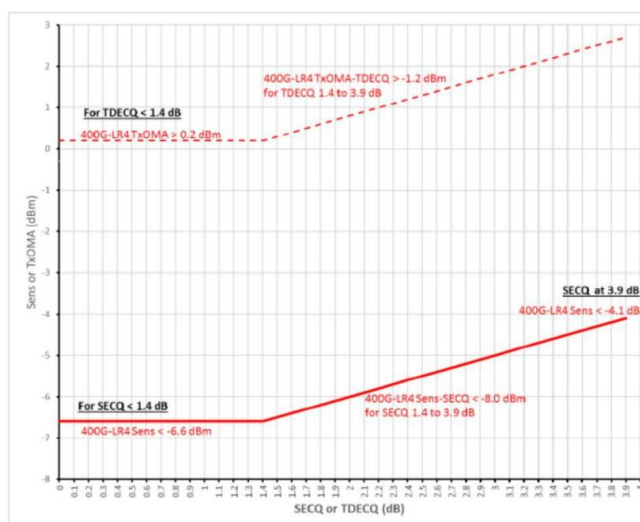
Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Supply Voltage	V _{CC}	3.135	3.3	3.465	V	
Case Temperature	T _{op}	0		70	°C	
Link Distance with G.652		0		10	km	

Optical Characteristics

Parameters	Min	Typ	Max	Unit	Note
Transmitter					
Data Rate, each Lane		53.125 ± 100 ppm		GBd	
Modulation Format	PAM4				
	1264.5	1271	1277.5		
	1284.5	1291	1297.5		
Line Wavelengths	1304.5	1311	1317.5	nm	
	1324.5	1331	1337.5		
Total Average Launch Power			9.5	dBm	
Average Launch Power, each Lane	-2.8		4	dBm	
Optical Modulation Amplitude (OMA), each Lane	0.2		4.2	dBm	
Extinction Ratio (ER)	3.5			dB	
Side-Mode Suppression Ratio (SMSR)	30			dB	
Launch Power in OMA Minus TDECQ, each Lane, for ER ≥ 4.5 dB	-1.2			dB	
Launch Power in OMA Minus TDECQ, each Lane, for ER < 4.5 dB	-1.1			dBm	
Transmitter and Dispersion Eye Closure for PAM4, each Lane (TDECQ)			3.9	dB	
Difference in Launch Power between Any Two Lanes (OMA Outer)			4	dB	
RIN17.1OMA			-136	dB/Hz	
Optical Return Loss Tolerance			17.1	dB	

Parameters	Min	Typ	Max	Unit	Note
Transmitter Reflectance			-26	dB	
Average Launch Power of OFF Transmitter, each Lane			-20	dBm	
Receiver					
Data Rate, each Lane		53.125 ± 100 ppm		GBd	
Modulation Format	PAM4				
Damage Threshold, each Lane	4.5			dBm	
Line Wavelengths	1264.5	1271	1277.5	nm	
	1284.5	1291	1297.5		
	1304.5	1311	1317.5		
	1324.5	1331	1337.5		
Average Receiver Power, each Lane	-9.1		4	dBm	
Receiver Power, each Lane (OMA)			4.2	dBm	
Difference in Receiver Power between Any Two Lanes (OMA)			4.1	dB	
Receiver Sensitivity (OMA Outer), each Lane (Max)	Max (-6.6, -8+ SECQ)			dBm	1
LOS Assert	-20			dBm	
LOS Deassert			-8.6	dBm	
LOS Hysteresis	0.5			dB	
Receiver Reflectance			-26	dB	
Conditions of Stressed Receiver Sensitivity					
Stressed Eye Closure for PAM4 (SECQ), Lane Under test	0.9		3.4	dB	
OMA Outer of Each Aggressor Lane		1.5		dBm	
Long Term Performance Test					
BER FLOOR		1E -6 @ -3.1 to 2 dBm			

Note: Measured with conformance test signal for BER = 2.4×10^{-4} . A compliant receiver shall have stressed receiver sensitivity (OMA outer), each lane values below the mask of below figure, for SECQ values between 0 and 3.9 dB.



Electrical Characteristics

Parameter	Min	Typ	Max	Unit	Note
Power Consumption			9	W	
Supply Current			2.86	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
Common Mode to Differential Mode Conversion (SCD11)	Equation (16-2)			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} Probability (EW6)	0.265			UI	
Near-End Eye Height at 10 ^{−6} Probability (EH6)	70			mV	
Far-End Eye Width at 10 ^{−6} Probability (EW6)	0.20			UI	
Far-End Eye Height at 10 ^{−6} Probability (EH6)	30			mV	
Near-End Eye Linearity	0.85				

Ordering Information

Product Name	Product Description
QSFP-DD-LR4-10	QSFP-DD 400G LR4 PAM4 CWDM4 lanes 10km Optical Transceiver Module, LC SMF DDM
JQ-DD-LR4-10	QSFP-DD 400G LR4 PAM4 CWDM4 lanes 10km Optical Transceiver Module, LC SMF DDM, Compatible with Juniper

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