

Asterfusion 400G QSFP56-DD SR4.2 MPO-12 BiDi MMF 150m Optical Transceiver

Features

- 8x53.125Gb/s electrical interface
- 2x4x53.125Gb/s bi-directional optical lanes
- Maximum 150m on OM5 MMF
- Power consumption <12W
- Hot Pluggable QSFP56-DD form factor
- MPO-12 BiDi connector receptacle
- 4 channels 850nm plus 4 channels 908nm VCSEL array
- 8 channels PIN photo detector array
- Marvell DSP
- Internal CDR circuits on both receiver and transmitter channels
- I2C interface is supported to read and control the status of this product
- Built-in digital diagnostic functions
- Compliant with CMIS
- Operating case temperature 0°C to +70°C
- 3.3V power supply voltage
- Class 1M laser safety
- RoHS-6 compliant

Overview

The Asterfusion QSFP56-DD 400G SR4.2 optical transceiver supports bit rates of up to 425 Gb/s and is designed for 400 Gigabit Ethernet applications. This low-power, high-density module is a Bi-Directional (BiDi) optical

transceiver that utilizes a QSFP56-DD form factor. It enables optical communication over multi-mode fiber with two groups of optical bi-directional lanes, each containing four pairs of optical lanes.

The transmitter uses 850nm VCSEL for the first group and 908nm VCSEL for the second group. On the receiver side, the module accepts eight optical input signals and converts them to eight electrical data channels, outputting signals that are voltage-compatible with Common Mode Logic (CML) levels.

With a data rate of 53.125 Gbps per lane, the module can support distances of up to 150 meters over OM5 multi-mode fiber. The optical interface uses 12-fiber MTP (MPO) connectors. It supports digital diagnostics, fully complying with the Common Management Interface Specification (CMIS).

Product Applications

- AI Training Fabric
- AI Inference Fabric
- Data Center Fabric
- Ethernet Storage Fabric
- HPC (High Performance Computing)
- Supercomputer
- Telecom Backbone

Block Diagram

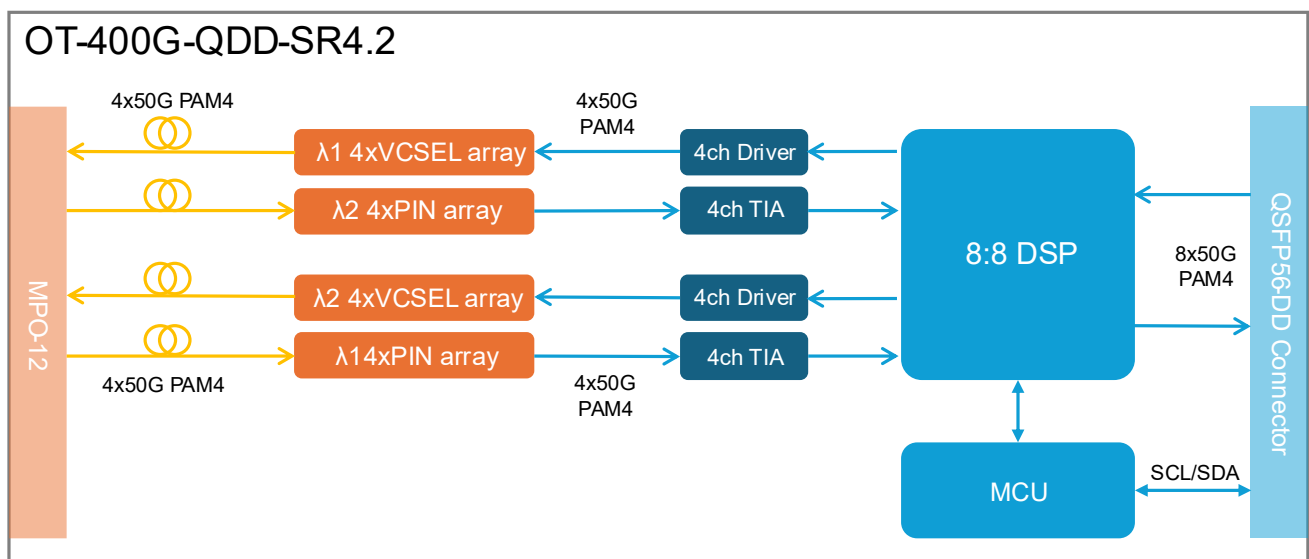


Figure 1 The 400G QSFP56-DD SR4.2 Optical Transceiver Block Diagram

Networking

This product is allowed for two typical applications: The first application is QSFP-DD SR4.2 to QSFP-DD SR4.2 point to point communication.

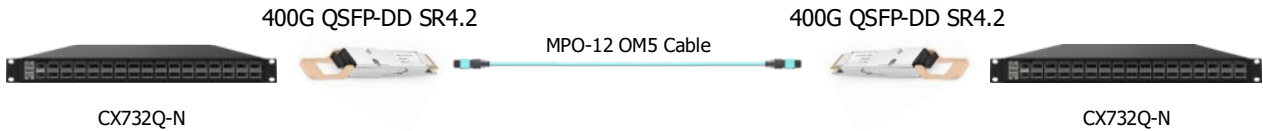


Figure 2 Connect two 400G-port switches

The second application is QSFP-DD SR4.2 to 4 x QSFP28 SR1.2 breakout communication.

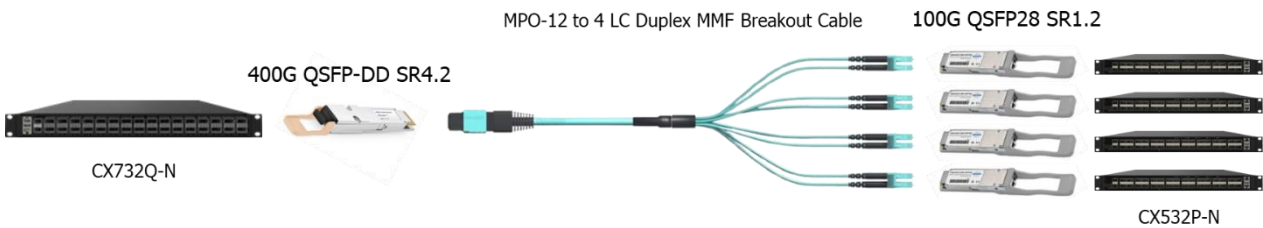


Figure 3 Connect 1 x 400G-port switch to 4 x 100G-port switches

Specifications

Electrical Specifications

Parameter	Test Point	Min	Typical	Max	Units	Notes
Power Consumption				12	W	
Supply Current	Icc			3.63	A	
Pre-FEC Bit Error Ratio				2.4×10^{-4}		
Post-FEC Bit Error Ratio				1×10^{-12}		
Data Rate Accuracy		-100		100	ppm	
Transmitter (each Lane)						
Signaling Rate, each Lane	TP1	26.5625 ± 100 ppm			GBd	PAM4
Differential pk-pk 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 120E.3.4.1				[2]
Single-ended Voltage Tolerance Range (Min)	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	PAM4
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)				
Common to Differential Mode Conversion Return Loss	TP4	IEEE 802.3-2015 Equation (83E-3)				
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 120E.3.1.2 that the pattern is PRBS31Q or scrambled idle.
2. Meets BER specified in IEEE 802.3bs 120E.1.1.
3. DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.

Optical Characteristics

Parameter	Symbol	Min	Typical	Max	Units	Notes
Transmitter						
Signaling rate, each lane		26.5625± 100ppm			Gbd	PAM4
Center Wavelength	$\lambda 1$	844		863	nm	
Center Wavelength	$\lambda 2$	900		918	nm	
RMS Spectral Width	$\Delta\lambda$ rms			$\lambda 1:0.6 \lambda 2: 0.65$	nm	
Average Launch Power, each Lane	P _{AVG}	-6.2		4	dBm	[1]
Optical Modulation Amplitude (OMA), each Lane	P _{OMA}	-4.2		3	dBm	[2]
Launch power in OMA minus TDECQ, each lane		-5.6			dBm	
Transmitter Dispersion Penalty, each lane	TDECQ			4.5	dB	[3]

TDECQ – $10\log_{10}(C_{eq})$, each lane				4.5		[4]
Extinction Ratio	ER	3.0			dB	
RIN12 OMA				-128	dB/Hz	
Optical Return Loss Tolerance	TOL			12	dB	
Average Launch Power OFF Transmitter, each Lane	Poff			-30	dBm	
Encircled Flux		$\geq 86\%$ at $19\ \mu\text{m}$ $\leq 30\%$ at $4.5\ \mu\text{m}$				[5]
Receiver						
Signaling rate, each lane		$26.5625 \pm 100\text{ppm}$	Gbd	PAM4		
Center Wavelength Lane0	$\lambda 1$	844		863	nm	
Center Wavelength Lane1	$\lambda 2$	900		918	nm	
Damage Threshold, each Lane	TH _d	5			dBm	[6]
Average Receive Power, each Lane		-8.2		4	dBm	[7]
Receive Power (OMA), each Lane				3.0	dBm	
Receiver Sensitivity (OMA), each Lane	SEN			Max (-6.6, SECQ - 8)	dBm	[9]
Receiver Reflectance	RR			-12	dB	
Stressed receiver sensitivity in OMA, each lane				-3.5	dBm	[8]

Note:

1. Average launch power, r, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

2. Even if the TDECQ < 1.4 dB, the OMA_{outer} (min) must exceed this value.
3. TDECq is specified and measured as per IEEE802.3.cm Clause 150.8.5.
4. Ceq is a coefficient defined in IEEE 802.3-2018 Clause 121.8.5.8, which accounts for the reference equalizer noise enhancement.
5. If measured into type A1a.2, or type A1a.3, or type A1a.4, 50 um fibers in accordance with IEC 61280- 1-4.
6. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level on one lane. The receiver does not have to operate correctly at this input power.
7. Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.
8. Measured with a conformance test signal at TP3 (see IEEE 802.3 Cl 150) for the BER specified. They are not characteristics of the receiver. The conditions for measuring stressed receiver sensitivity are the following:

Stressed eye closure (SECQ), lane under test		
SECQ – 10log10(Ceq) lane under test (max)	4.5	dBm
OMA _{outer} of each aggressor lane	3.0	dBm

These test conditions are for measuring stressed receiver sensitivity.

9. Receiver sensitivity is considered a normative requirement. RX sensitivity is defined for a transmitter with a value of SECQ up to 4.5dB. For transmitter with SECQ different from 4.5dB, limit is reported as per figure 4.

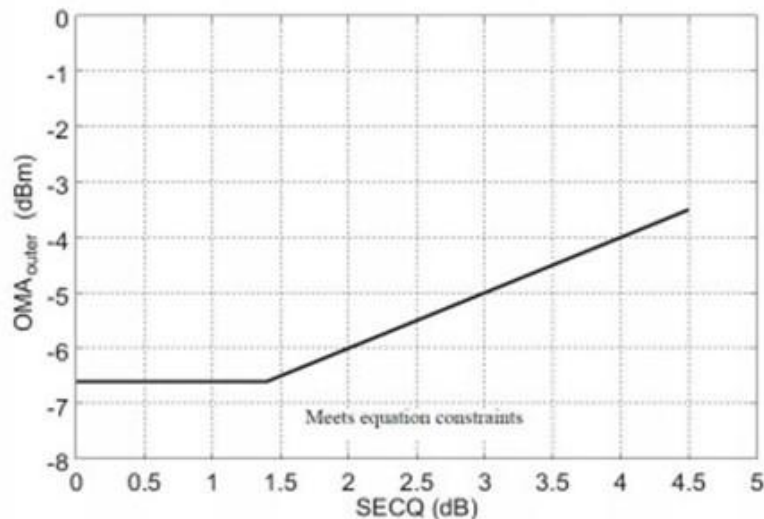


Figure 4 Illustration of Receiver Sensitivity

Optical Interface Lanes and Assignment

The optical interface port is an MPO-12 BiDi receptacle. The transmit and receive optical lanes shall occupy

the positions depicted in Figure 5.

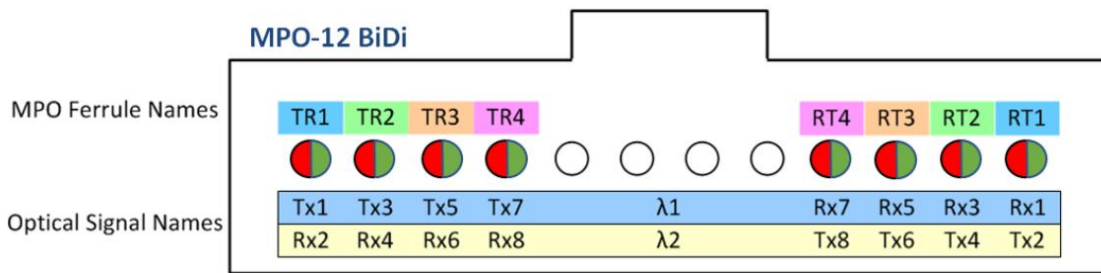
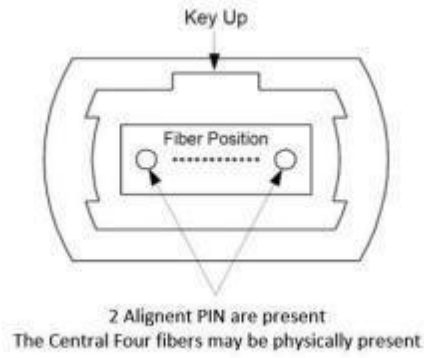


Figure 5 Optical Receptacle and Channel Orientation

Mechanical Dimensions

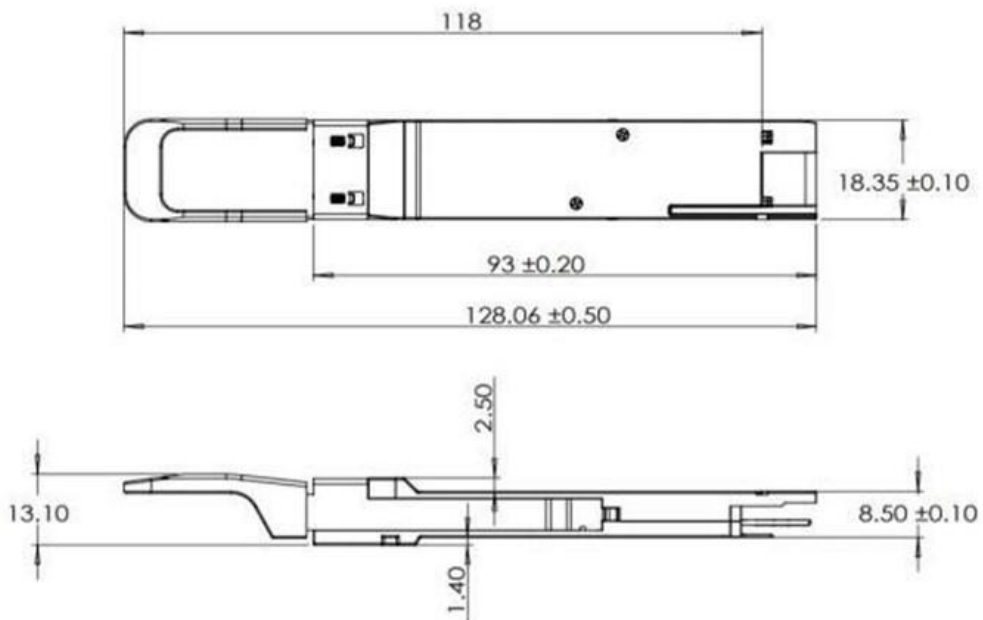


Figure 6 Mechanical Specifications (mm)

Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Units	Note
Storage Temperature	TS	-40	85	°C	
Operating Case Temperature	TOP	0	70	°C	
Power Supply Voltage	VCC	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	0	85	%	
Damage Threshold, each Lane	TH _d	3.4		dBm	

Recommended Operating Conditions

Parameter	Symbol	Min	Typical	Max	Units	Notes
Operating Case Temperature	TOP	0		70	°C	
Power Supply Voltage	VCC	3.135	3.3	3.465	V	
Data Rate, each Lane			26.5625		GBd	PAM4
Link Distance with OM3	D	0.5		70	m	
Link Distance with OM5	D	0.5		150	m	

PIN Description

The electrical interface of QSFP56-DD module consists of 76 contacts edge connectors. It complies with the QSFP-DD MSA Specification, see <http://www.qsfp-dd.com> .

QSFP56-DD Pin Description

Pin #	Logic	Symbol	Description	Plug Sequence
1		GND	Ground	1B
2	CML-I	Tx2n	Transmitter Inverted Data Input	3B
3	CML-I	Tx2p	Transmitter Non- Inverted Data Input	3B
4		GND	Ground	1B
5	CML-I	Tx4n	Transmitter Inverted Data Input	3B
6	CML-I	Tx4p	Transmitter Non- Inverted Data Input	3B
7		GND	Ground	1B
8	LVTTL-I	ModSelL	Module Select	3B
9	LVTTL-I	ResetL	Module Reset	3B
10		VccRx	+3.3V Power Supply Receiver	2B
11	LVCOS-I/O	SCL	2-wire serial interface clock	3B



12	LVCOS-I/O	SDA	2-wire serial interface data	3B
13		GND	Ground	1B
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	3B
15	CML-O	Rx3n	Receiver Inverted Data Output	3B
16	GND	Ground	1B	
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	3B
18	CML-O	Rx1n	Receiver Inverted Data Output	3B
19		GND	Ground	1B
20		GND	Ground	1B
21	CML-O	Rx2n	Receiver Inverted Data Output	3B
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	3B
23		GND	Ground	1B
24	CML-O	Rx4n	Receiver Inverted Data Output	3B
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	3B
26		GND	Ground	1B
27	LVTTTL-O	ModPrsL	Module Present	3B
28	LVTTTL-O	IntL	Interrupt	3B
29		VccTx	+3.3V Power supply transmitter	2B
30		Vcc1	+3.3V Power supply	2B
31	LVTTTL-I	InitMode	Initialization mode; In legacy QSFP applications, the InitMode pad is called LPMODE	3B
32		GND	Ground	1B
33	CML-I	Tx3p	Transmitter Non- Inverted Data Input	3B
34	CML-I	Tx3n	Transmitter Inverted Data Input	3B
35		GND	Ground	1B
36	CML-I	Tx1p	Transmitter Non- Inverted Data Input	3B
37	CML-I	Tx1n	Transmitter Inverted Data Input	3B
38		GND	Ground	1B
39		GND	Ground	1A
40	CML-I	Tx6n	Transmitter Inverted Data Input	3A
41	CML-I	Tx6p	Transmitter Non- Inverted Data Input	3A
42		GND	Ground	1A
43	CML-I	Tx8n	Transmitter Inverted Data Input	3A
44	CML-I	Tx8p	Transmitter Non- Inverted Data Input	3A
45		GND	Ground	1A
46		Reserved	For future use	3A
47		VS1	Module Vendor Specific 1	3A
48		VccRx1	3.3V Power Supply	2A
49		VS2	Module Vendor Specific 2	3A
50		VS3	Module Vendor Specific 3	3A
51		GND	Ground	1A
52	CML-O	Rx7p	Receiver Non-Inverted Data Output	3A
53	CML-O	Rx7n	Receiver Inverted Data Output	3A
54		GND	Ground	1A



55	CML-O	Rx5p	Receiver Non-Inverted Data Output	3A
56	CML-O	Rx5n	Receiver Inverted Data Output	3A
57		GND	Ground	1A
58		GND	Ground	1A
59	CML-O	Rx6n	Receiver Inverted Data Output	3A
60	CML-O	Rx6p	Receiver Non-Inverted Data Output	3A
61		GND	Ground	1A
62	CML-O	Rx8n	Receiver Inverted Data Output	3A
63	CML-O	Rx8p	Receiver Non-Inverted Data Output	3A
64		GND	Ground	1A
65		NC	No Connect	3A
66		Reserved	For future use	3A
67		VccTx1	3.3V Power Supply	2A
68		Vcc2	3.3V Power Supply	2A
69		Reserved	For Future Use	3A
70		GND	Ground	1A
71	CML-I	Tx7p	Transmitter Non- Inverted Data Input	3A
72	CML-I	Tx7n	Transmitter Inverted Data Input	3A
73		GND	Ground	1A
74	CML-I	Tx5p	Transmitter Non- Inverted Data Input	3A
75	CML-I	Tx5n	Transmitter Inverted Data Input	3A
76		GND	Ground	1A

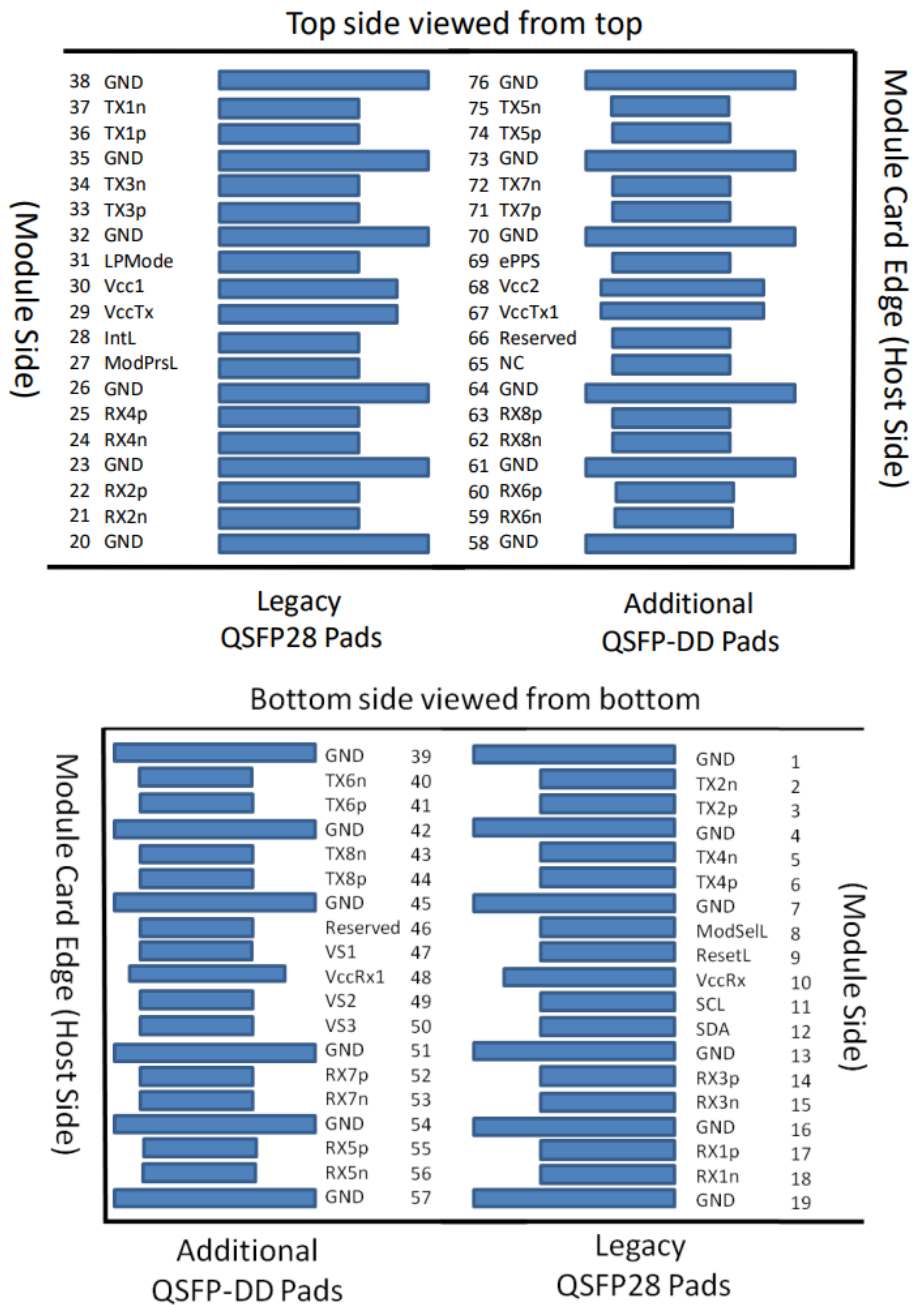


Figure 7 Electrical Pin-out Details

QSFP56-DD Control Signals

Name	Direction	Description
SCL	Bi-Directional	2-wire serial clock signal. Requires pull-up resistor to 3.3V on host.
SDA	Bi-Directional	2-wire serial data signal. Requires pull-up resistor to 3.3V on host.

ModSelL	Input	Input signal that be pulled to Vcc in modules . When held low by host, the module responds to TWI communication commands . When held high by host, the module shall not respond to TWI communication commands.
ResetL	Input	ResetL shall be pulled to Vcc in the module. A low level on it for longer than t_Reset_init initiates a complete module reset.
LPMoDe/TxDis	Input	Input signal from host with active high logic. Only support behaving as LPMoDe.
ModPrsL	Output	ModPrsL shall be pulled up to Vcc host and pulled low in the module . When the module is inserted, it's asserted "Low" . When the module is absent, it's deasserted "High".
IntL/RxLOSL	Output	Active-low, open-collector output signal from module . Only support behaving as IntL . When IntL is asserted Low, it indicates a change in module state.

Digital Diagnostic Specification

Parameter	Symbol	Min	Max	Units	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:

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

Regulatory Compliance

Asterfusion OT-400G-QSFP56-DD-SR4.2 transceivers are Class 1M Laser Products. They are certified per the following standards:

Feature	Standard
Laser Safety	IEC/EN 60825-1:2014 (3 rd Edition) FDA 21 CFR 1040.10 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007)
Electrical Safety	EN 62368-1:2014 IEC 62368-1:2014 UL 62368-1:2014
Environmental protection	Directive 2011/65/EU with amendment (EU)2015/863
CE EMC	EN55032:2015 EN55035:2017 EN61000-3-2:2014 EN61000-3-3:2013
FCC	FCC Part 15, Subpart B ANSI C63.4-2014

References

1. QSFP-DD MSA Specification - Rev 5.1
2. CMIS
3. IEEE 802.3ck 400GBASE-SR4.2 Ethernet (PAM4)

ESD

This transceiver is specified as ESD threshold 1kV for high-speed data pins and 2kV for all others 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.

Order Information

Part Number	Description
OT-400G-QDD-SR4.2	400G, QSFP56-DD, SR4.2, MPO-12, BiDi MMF, 150m

Warranty and Service Support

Asterfusion optical transceivers come with 2-year Basic H/W service and warranty.

To acquire more info about company, products, and solutions: www.cloudswit.ch
Sales: bd@cloudswit.ch
Business Hotline: +86-0512-62982976

