

# 400G QSFP-DD 4X100G LR1 Optical Transceiver

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## QSFP-DD Series

- Breakout Mode
- Aggregation Mode
- QSFP-DD MSA compliant
- MPO-12 / APC connector with 8° angled end-face
- Power consumption < 8W
- CMIS 4.0 management interface

The ACT QSFP56-DD 400Gb/s 4x100G LR1 optical module is designed for 10 km single-mode fiber (SMF) data-center and telecom interconnect applications. The module supports an aggregate data rate of 400 Gb/s by converting eight 53.125 Gb/s PAM4 electrical lanes into four parallel 100 Gb/s optical lanes, each operating in the 1310 nm wavelength range. On the receive side, the module converts four 100 Gb/s optical signals back into eight 53.125 Gb/s PAM4 electrical output lanes, enabling high-capacity bidirectional transmission.

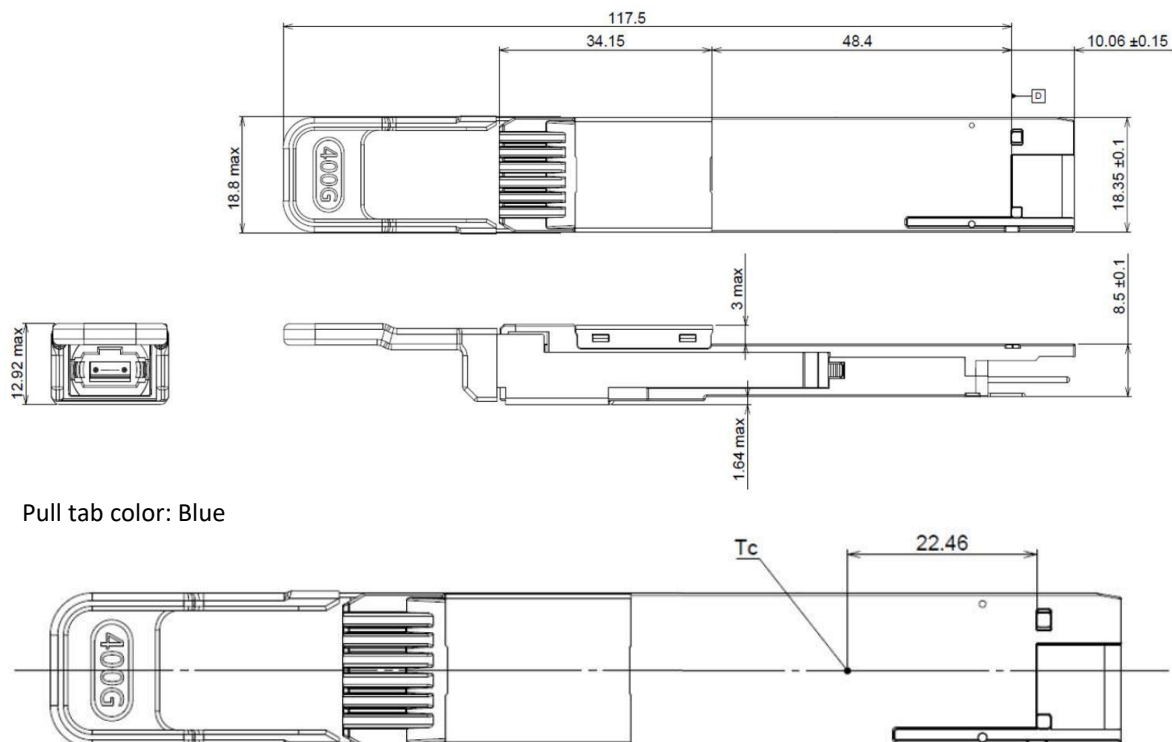
The optical interface uses a standard MPO-12 APC connector, with dedicated transmit and receive fiber lanes to support 4x100GBASE-LR1 operation. Accurate optical alignment is ensured by integrated guide pins within the receptacle. The electrical interface is compliant with the QSFP56-DD MSA edge connector, allowing seamless integration with QSFP-DD-based 400G network platforms.

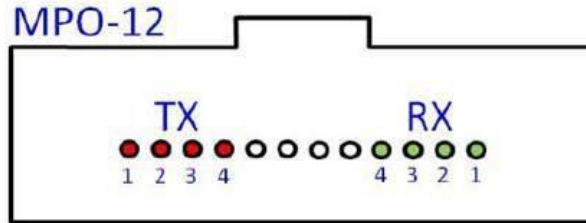
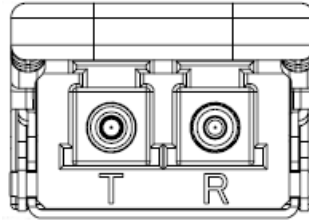
The module is fully compliant with the QSFP56-DD Multi-Source Agreement (MSA) Type 2 and supports CMIS 4.0 digital diagnostic monitoring, enabling real-time access to key operating parameters. Designed for reliable operation in data-center and telecom environments, the module meets stringent requirements for performance, signal integrity, and electromagnetic compatibility, ensuring stable operation across the specified commercial temperature range.

## Key Features

- Breakout Mode
  - 4x100GBASE-LR1 compliant  
106.25Gb/s with PAM4
  - 4x100GAUI-2 compliant  
2x53.125Gb/s with PAM4
- Or Aggregation Mode
  - 400 Gb/s Ethernet Protocol  
4x106.25Gb/s with PAM4
  - 400GAUI-8 compliant  
8x53.125Gb/s with PAM4
- QSFP-DD MSA compliant
- MPO-12 / APC connector with 8° angled end-face
- Power consumption < 8W
- Operating case temperature 0 to 70°C
- CMIS 4.0 management interface

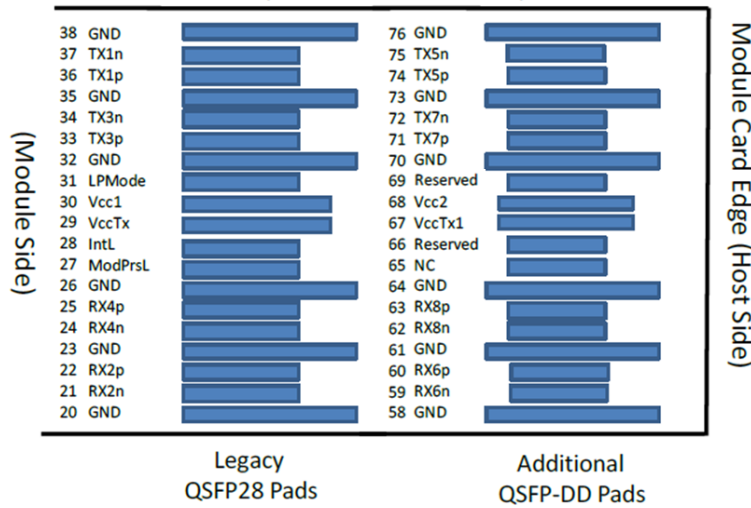
## Block Diagram



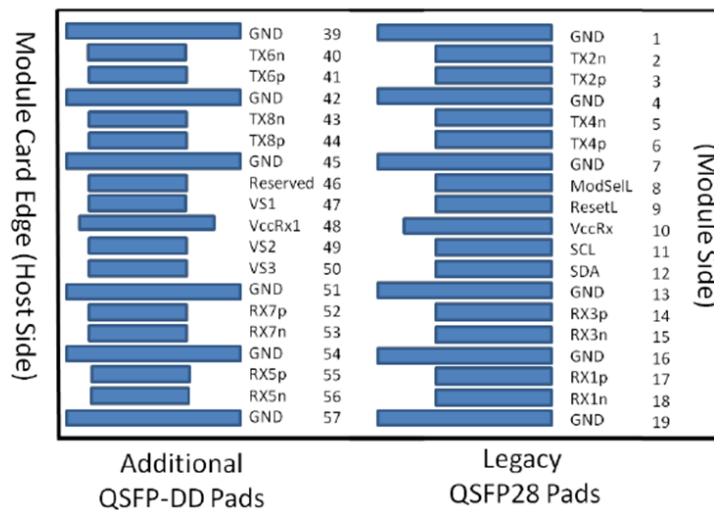


## Pin Assignment

Top side viewed from top



Bottom side viewed from bottom



Pin #	Logic	Symbol	Description	Plug Sequence <sup>4</sup>	Definition
1		GND	Ground	1B	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3B	
3	CML-I	Tx2p	Transmitter Non-Inverted Data output	3B	
4	CML-I	GND	Ground	1B	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3B	
6		Tx4p	Transmitter Non-Inverted Data output	3B	
7		GND	Ground	1B	1
8	LVTTTL-I	ModSelL	Module Select	3B	
9	LVTTTL-I	ResetL	Module Reset	3B	
10		VccRx	3.3V Power Supply Receiver	2B	2
11	LVCMS-I/O	SCL	2-Wire serial Interface Clock	3B	
12	LVCMS-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	LVTTTL-O	ModPrsL	Module Present	3B	
28	LVTTTL-O	IntL	Interrupt	3B	
29		VccTx	3.3V power supply transmitter	2B	2
30		Vcc1	3.3V power supply	2B	2
31	LVTTTL-I	Init Mode	Initialization mode	3B	
32		GND	Ground	1B	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	3B	
34	CML-I	Tx3n	Transmitter Inverted Data Output	3B	
35		GND	Ground	1B	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	3B	
37	CML-I	Tx1n	Transmitter Inverted Data Output	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 output	3A	
42		GND	Ground	1A	1
43	CML-I	Tx8n	Transmitter Inverted Data Input	3A	
44	CML-I	Tx8p	Transmitter Non-Inverted Data output	3A	
45		GND	Ground	1A	1
46		Reserved	For Future Use	3A	3

Pin #	Logic	Symbol	Description	Plug Sequence <sup>4</sup>	Definition
47		VS1	Module Vendor Specific 1	3A	3
48		VccRx1	3.3V 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	3.3V power supply	2A	2
68		Vcc2	3.3V power supply	2A	2
69	LVTTTL-I	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 Output	3A	
73		GND	Ground	1A	1
74	CML-I	Tx5p	Transmitter Non-Inverted Data Input	3A	
75	CML-I	Tx5n	Transmitter Inverted Data Output	3A	
76		GND	Ground	1A	1

**Note:**

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 above 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, no connect and ePPS (if not used) pins may be terminated within 50 Ohms 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 kOhms and less than 100 pF.
4. Plug sequence specifies the mating sequence of the host connector and module. The sequence is 1A, 2A, 3A, 1B, 2B, 3B (see above figure for pad locations). Contact sequence A will make, then break contact with additional QSFP-DD pads. Sequence 1A, 1B will then occur simultaneously, followed by 2A, 2B, followed by 3A, 3B.

## Specifications

### Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Notes
Supply Voltage	V <sub>CC</sub>	0	3.6	V	
Storage Temperature		-40	85	°C	
Optical Receiver Input		-	5.8	dBm	Average, each lane

### Operating Conditions

Parameter	Symbol	Min.	Typ	Max.	Unit	Notes
Supply Voltage	V <sub>CC</sub>	3.135	3.3	3.465	V	
Supply Voltage Noise Tolerance	PSNR <sub>mod</sub>	-	-	66	mV	10 Hz to 10 MHz
Power Consumption	P <sub>4</sub>	-	-	8	W	
Instantaneous Peak Current	I <sub>cc_ip_4</sub>			3200	mA	
Sustained Peak Current	I <sub>cc-sp_4</sub>			2640.3	mA	
Supply Current	I <sub>cc-4</sub>	-	-	2551.8	mA	Steady state
Case Temperature	T <sub>c</sub>	0	25	70	°C	

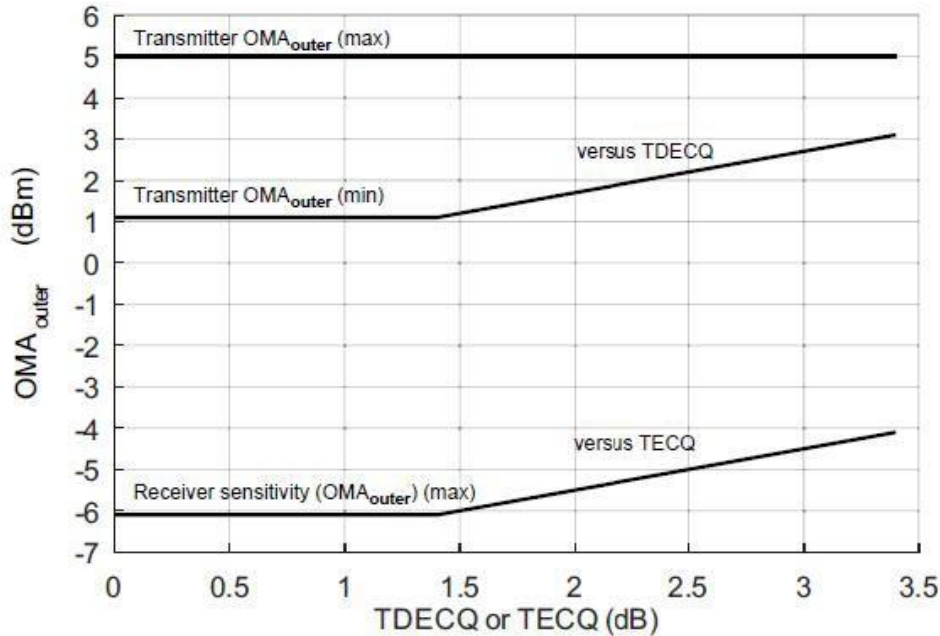
### Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Channel Data Rate	f <sub>DC</sub>	106.25			Gb/s	
Signaling Rate	f <sub>SG</sub>	106.25			Gb/s	PAM4
Signal Speed Variation from Nominal	Δf <sub>SG</sub>	-100		+100	ppm	
Wavelength (Range)	C	1304.5		1317.5	nm	
Side-Mode Suppression Ratio	SMSR	30			dB	
Average Launch Power		-1.9		4.8	dBm	Note 1
Outer Optical Modulation Amplitude (OMA <sub>outer</sub> )		1.1		5.0	dBm	for TDECQ < 1.4 dB
		-0.3		5.0	dBm	for 1.4 dB ≤ TDECQ ≤ 3.4 dB
				+ TDECQ		
Transmitter and Dispersion Eye Closure for PAM4	TDECQ			3.4	dB	
Transmitter Eye Closure for PAM4   TDECQ – TECQ	TECQ			3.4	dB	
Over/Under-Shoot				2.5	dB	
Transmitter Power Excursion				22	%	
Extinction Ratio	ER	3.5		2.8	dBm	
Transmitter Transition Time				17	ps	
Average Optical Output Power of Off Transmitter	P <sub>off</sub>			-15	dBm	
RIN <sub>15.6OMA</sub>				-136	dB/Hz	
Optical Return Loss Tolerance				15.6	dB	
Transmitter Reflectance				-26	dB	Note 2
Average Receive Power		-8.2		4.8	dBm	Note 3
Receive Power (OMA <sub>outer</sub> )				5.0	dBm	
Receiver Reflectance				-26	dB	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Receiver Sensitivity (OMA <sub>outer</sub> )		Max -6.1				for TECQ<1.4 dB, Note 4
		Max (-7.5 + TECQ)				for 1.4 dB ≤ TECQ ≤ 3.4 dB, Note 4
Stressed Receiver Sensitivity (OMA <sub>outer</sub> )				-4.1	dBm	Note 4, 5
<b>Conditions of Stressed Receiver Sensitivity Test (Note 6)</b>						
Stressed Eye Closure for PAM4 (SECQ), Lane under Test	SECQ	3.4			dB	

**Notes:**

1. Average launch power, 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. Transmitter reflectance is defined looking into the transmitter.
3. 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.
4. For when Pre-FEC BER is  $2.4 \times 10^{-4}$ .
5. Measured with conformance test signal at TP3 (see IEEE Std 802.3-2022 clause 140.7.10) for the BER specified in IEEE Std 802.3-2022 clause 140.1.1.
6. These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.



**RX\_LOS Characteristics**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Receiver Loss of Signal Indicator Assert Level	RX_LOS	-15	-	-9.6	dBm	Average power
Receiver Loss of Signal Indicator De-assert Level	RX_LOS	-	-	-9.1	dBm	Average power
Hysteresis	RX_LOS	0.5	-	-	dB	



## Electrical Characteristics

Parameter	Min.	Typ.	Max.	Unit	Notes
<b>Module Output (each Lane, at TP4) [Note 1]</b>					
Signaling Rate per Lane (Range)	-100ppm	53.125	+100ppm	Gb/s	
AC Common-Mode Output Voltage(RMS)	-	-	17.5	mV	
Differential Peak-to-Peak Output Voltage	-	-	900	mV	
Near-End ESMW (Eye Symmetry Mask Width)	0.265	-	-	UI	
Near-End Eye Height, Differential	70	-	-	mV	
Far-End ESMW (Eye Symmetry Mask Width)	0.2	-	-	UI	
Far-End Eye Height, Differential	30	-	-	mV	
Far-End Pre-Cursor ISI Ratio	-4.5	-	2.5	%	
Differential Output Return Loss	Equation (83E-2)	-	-	dB	Note 2
Common to Differential Mode Conversion Return Loss	Equation (83E-3)	-	-	dB	Note 2
Differential Termination Mismatch	-	-	10	%	
Transition Time (Min, 20% to 80%)	9.5	-	-	ps	
DC Common Mode Voltage	-350	-	2850	mV	
<b>Module Input (each Lane)</b>					
Signaling Rate per Lane (Range)	-100ppm	53.125	+100ppm	Gb/s	
Differential Pk-Pk Input Voltage Tolerance	900	-	-	mV	at TP1a
Differential Input Return Loss	Equation (83E-5)	-	-	dB	at TP1, Note 2
Differential to Common Mode Input Return Loss	Equation (83E-6)	-	-	dB	at TP1, Note 2
Differential Termination Mismatch	-	-	10	%	at TP1
ESMW (Eye Symmetry Mask Width)	0.22	-	-	UI	at TP1a
Eye Width	0.22	-	-	UI	at TP1a
Applied Pk-Pk Sinusoidal Jitter	Table 120E-6			MHz, UI	at TP1a
Eye Height	32	-	-	mV	at TP1a
Single-ended input voltage tolerance range	-0.4	-	3.3	V	at TP1a
DC common mode voltage	-350	-	2850	mV	at TP1

### Notes:

1. Electrical module output is squelched for loss of optical input signal.
2. IEEE Std 802.3-2022 Section 6.

## Ordering Information

Product Name	Product Description
QSFP56-4X100G-LR1	QSFP56-DD 400GBASE PAM4 4X100G-LR1 1310nm 10km DOM MPO12, SMF Optical Module



## Contact Information

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### Ascent Communication Technology Ltd

#### AUSTRALIA

140 William Street, Melbourne  
Victoria 3000, AUSTRALIA  
Phone: +61-3-8691 2902

#### Hong Kong SAR

Room 1210, 12th Floor, Wing Tuck Commercial Centre  
181 Wing Lok Street, Sheung Wan , Hong Kong SAR  
Phone: +852-2851 4722

#### CHINA

Unit 1933, 600 Luban Road  
200023, Shanghai, CHINA  
Phone: +86-21-60232616

#### USA

2710 Thomes Ave  
Cheyenne, WY 82001, USA  
Phone: +1 203 350 9822

#### EUROPE

Pfarrer-Bensheimer-Strasse 7a  
55129 Mainz, GERMANY  
Phone: +49 (0) 6136 926 3246

#### VIETNAM

11th Floor, Hoa Binh Office Tower  
106 Hoang Quoc Viet Street, Nghia Do Ward  
Cau Giay District, Hanoi 10649, VIETNAM  
Phone: +84-24-37955917

**WEB:** [www.ascentcomtec.com](http://www.ascentcomtec.com)

**EMAIL:** [sales@ascentcomtec.com](mailto:sales@ascentcomtec.com)

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