

### 56-Gbps QSFP+ Active Optical Cable

#### Feature

- 4-channel bi-directional AOC with aggregate bandwidth of 56-Gbps (Electrical Interface Only)
- Compliant to SFF-8436 QSFP+ Specification Revision 4.1
- Supports 56-Gbps aggregate data-rate links up to 100-m
- Low power consumption of max 1.5 W (Compliant to Power Level 1)
- Full Digital Diagnostics Monitor Interface
- Hot pluggable electrical interface
- 0 to 70°C case temperature operating range
- RoHS Compliance and Lead-Free

#### Applications

- InfiniBand FDR, QDR, DDR, and SDR
- 40GBASE-SR4 Ethernet links
- 4G/8G/10G Fiber Channel
- SATA/SAS Storage
- HPC Interconnects
- Proprietary Interconnections



#### Purpose

This document validates solely for the product of T-TECH, 56-Gbps Active Optical Cable (AOC). However, this document is not fully complete yet, therefore, this datasheet only provides basic information and electronic characteristics. This document is for customer's reference only, and it subjects to change without notice.

#### General Description

Quad Small Form-Factor Pluggable Plus (QSFP+) active optical cables (AOC) are high-performance active optical cable with bi-directional signal transmission and aggregate 56-Gbps bandwidth for InfiniBand FDR (4-Channel × 14-Gbps); also backwards compatible with InfiniBand QDR and Ethernet 40GBase-SR4 expands. Compared to conventional copper cables, longer and lighter optical cables enable the ease of complicated data-center cabling. The AOCs utilize multimode fiber with 850-nm VCSELs and PIN PDs. The certificated cables have superior signal integrity and bit-error-rate, which enables reliable operation performance.

#### Absolute Maximum Rating

Not necessarily applied together. Exceeding these values may cause permanent damage. Functional operation under these conditions is not implied.

Parameter	Min	Max	Unit	Note
Storage Temperature	-10	70	℃	1
3.3V Power Supply Voltage	-0.5	3.6	V	
Data Input Voltage- Single Ended	-0.5		V <sub>cc</sub> +0.5	
Control Input Voltage	-0.5	3.6	V	
Relative Humidity	5	85	%	2

Notes:

1.Limited by the fiber cable jacket, not the active ends.

2.Non-condensing.

### Recommended Operating Conditions

Parameter	Min	Typical	Max	Unit	Note
Case Operating Temperature	0	40	70	℃	
Power Supply Voltage	3.135	3.3	3.465	V	
Date Rate per Channel	2.5		14.0625	Gbps	1
Power Supply Noise Ripple Susceptibility (PSNR)			50	mV	2
Bit Error Ratio		10-12			3
Data Pattern	Both compatible with 8b/10b and 64b/66b coding				
Control Input Voltage High	2		V <sub>cc</sub> +0.3	V	
Control Input Voltage Low	-0.3		0.8	V	
Two Wire Serial (TWS) Interface Clock Rate		100		kHz	
Differential Data Input / Output Load		100		Ohms	
Standard Cable Lengths	3		100	m	

Notes:

1.Lane speed up to 12.5-Gbps is available upon customer requests.

2. Power supply noise is defined as peak-to-peak noise amplitude over 1K to 15 MHz frequency range at host supply side by the recommended power supply filter for module. See Section 10 for the recommended power supply filter.

3.Bit-Error-Rate (BER) is tested with PRBS 231-1 pattern.

## Electrical Characteristics

Parameter	Min	Typical	Max	Unit	Note
<b>Transceiver</b>					
Transceiver Power Consumption			1.5	W	
Transceiver Power-On Initialization Time			2000	ms	1
<b>Transmitter</b>					
Data Input Differential Peak-to-Peak Voltage Swing		1000*		mVpp	
SDD11 Differential Input Return Loss	Up to 15.0 GHz			dB	2
J2 Jitter Tolerance			0.17*	UI	
J9 Jitter Tolerance			0.29*	UI	
<b>Receiver</b>					
Data Output Differential Peak-to-Peak Voltage Swing	300		800*	mVpp	4
Output Transition Time 20% to 80%	24			ps	
SDD22 Differential Output Return Loss	Up to 15.0 GHz			dB	3
J2 Jitter Output			0.42	UI	
J9 Jitter Output			0.65*	UI	

\* FDR specification target and subject to change.

Notes:

1. "Initialization Time" is the time from when the supply voltages reach and remain above the minimum "Recommended Operating Conditions" to the time when the module enables TWS access. The module at that point is fully functional.
2. Frequency dependent input return loss by the following formula  $SDD11(f) \approx -\min(10, 12-2 \cdot \sqrt{f/1.4}, 6.3-13 \cdot \log(f/7.7))$  dB, where  $0.01 \text{ GHz} \approx f \approx 15 \text{ GHz}$
3. Frequency dependent output return loss by the following formula  $SDD22(f) \approx -\min(10, 12-2 \cdot \sqrt{f/1.4}, 6.3-13 \cdot \log(f/7.7))$  dB, where  $0.01 \text{ GHz} \approx f \approx 15 \text{ GHz}$
4. AC-Coupled with 100Ω differential output impedance.

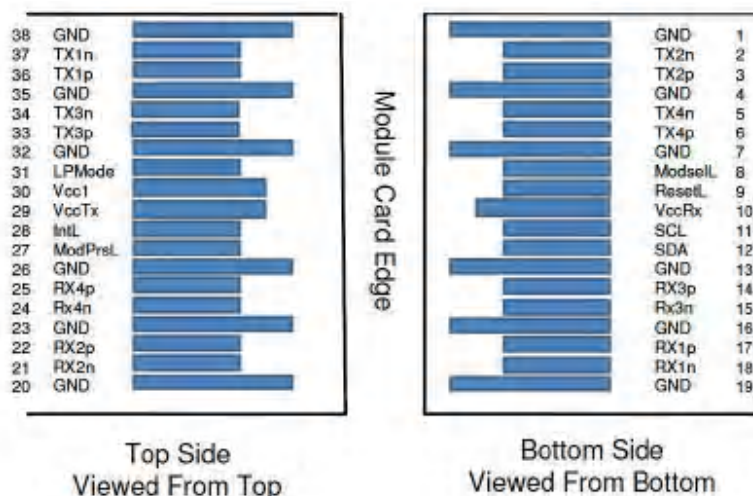
## Optical Cable Specification

Parameter	Specification	Notes
Minimum Cable Bending Radius	48 mm	IBTA Spec. Is 100-mm.
Cable Cross-Section Dimension	Ribbon Type Cable with Size of $4.7 \times 2.5 \text{ mm}^2$	
Cable Cover Type	LSZH	1
Standard Cable Length	10, 20, 30, 50, 100-m	
Cable Length Tolerance	+100/-0 cm	

Notes:

1. Cable cover type standard is LSZH. Other types can be available upon request.

## QSFP+ Module Pad Assignments and Descriptions



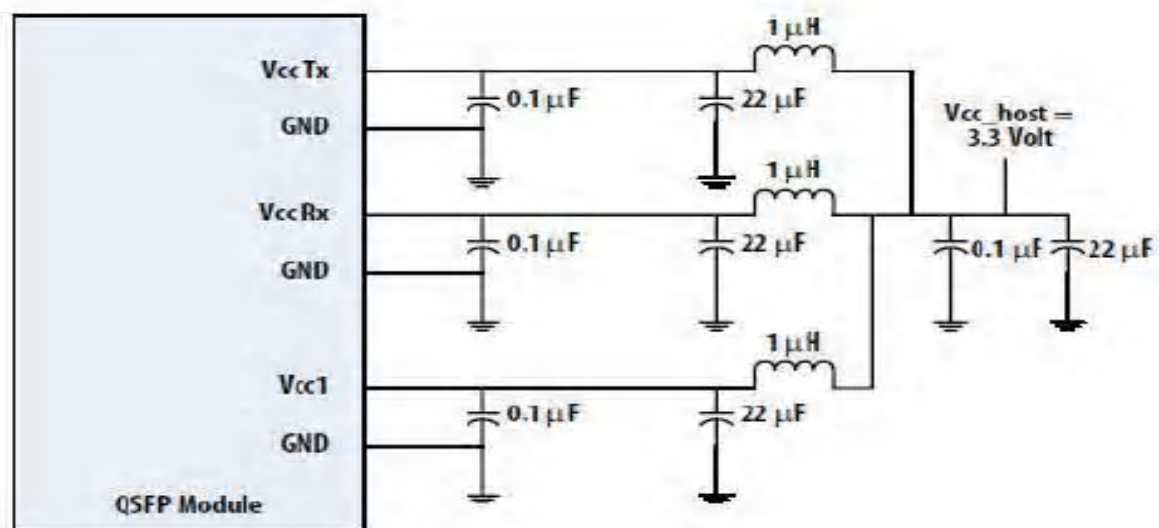
Pin	Logic	Symbol	Description	Plug Sequence	Notes
1		GND	Ground	1	1
2	CML-I	Tx2n	Transmitter Inverted Data Input	3	
3	CML-I	Tx2p	Transmitter Non-Inverted Data Input	3	
4		GND	Ground	1	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	3	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	3	
7		GND	Ground	1	1
8	LVTTL-I	ModSelL	Module Select	3	
9	LVTTL-I	ResetL	Module Reset	3	
10		Vcc Rx	+3.3V Power Supply Receiver	2	2
11	LVC MOS-I/O	SCL	2-wire serial interface clock	3	
12	LVC MOS-I/O	SDA	2-wire serial interface data	3	
13		GND	Ground	1	2
14	CML-O	Rx3p	Receiver Non-Inverted Data Output	3	
15	CML-O	Rx3n	Receiver Inverted Data Output	3	
16		GND	Ground	1	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Output	3	
18	CML-O	Rx1n	Receiver Inverted Data Output	3	
19		GND	Ground	1	1
20		GND	Ground	1	1
21	CML-O	Rx2n	Receiver Inverted Data Output	3	
22	CML-O	Rx2p	Receiver Non-Inverted Data Output	3	
23		GND	Ground	1	1
24	CML-O	Rx4n	Receiver Inverted Data Output	3	
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	3	

26		GND	Ground	1	1
27	LVTTL-O	ModPrsL	Module Present	3	
28	LVTTL-O	IntL	Interrupt	3	
29		Vcc Tx	+3.3V Power supply transmitter	2	2
30		Vcc1	+3.3V Power supply	2	2
31	LVTTL-I	LPMODE	Low Power Mode	3	
32		GND	Ground	1	1
33	CML-I	Tx3p	Transmitter Non-Inverted Data Input	3	
34	CML-I	Tx3n	Transmitter Inverted Data Input	3	
35		GND	Ground	1	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	3	
37	CML-I	Tx1n	Transmitter Inverted Data Input	3	
38		GND	Ground	1	1

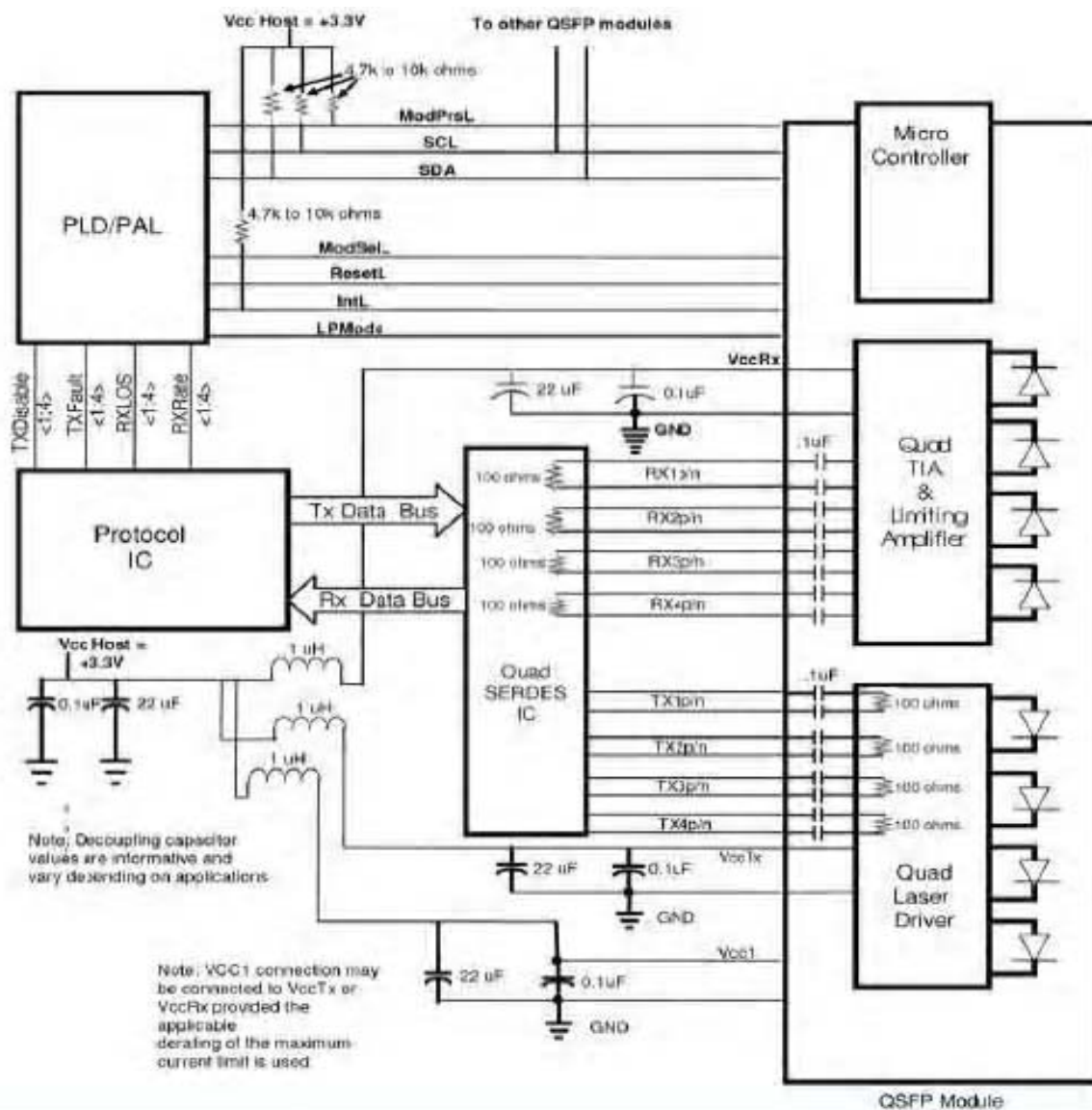
**Notes:**

1. GND is the symbol for signal and supply (power) common for the QSFP+ module. All are common within the QSFP+ 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. Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently. requirements defined for the host side of the Host Edge Card Connector are listed in Table 6. Recommended host board power supply filtering is shown in Figure 4. Vcc Rx Vcc1 and Vcc Tx may be internally connected within the QSFP+ module in any combination. The connector pins are each rated for a maximum current of 500 mA.

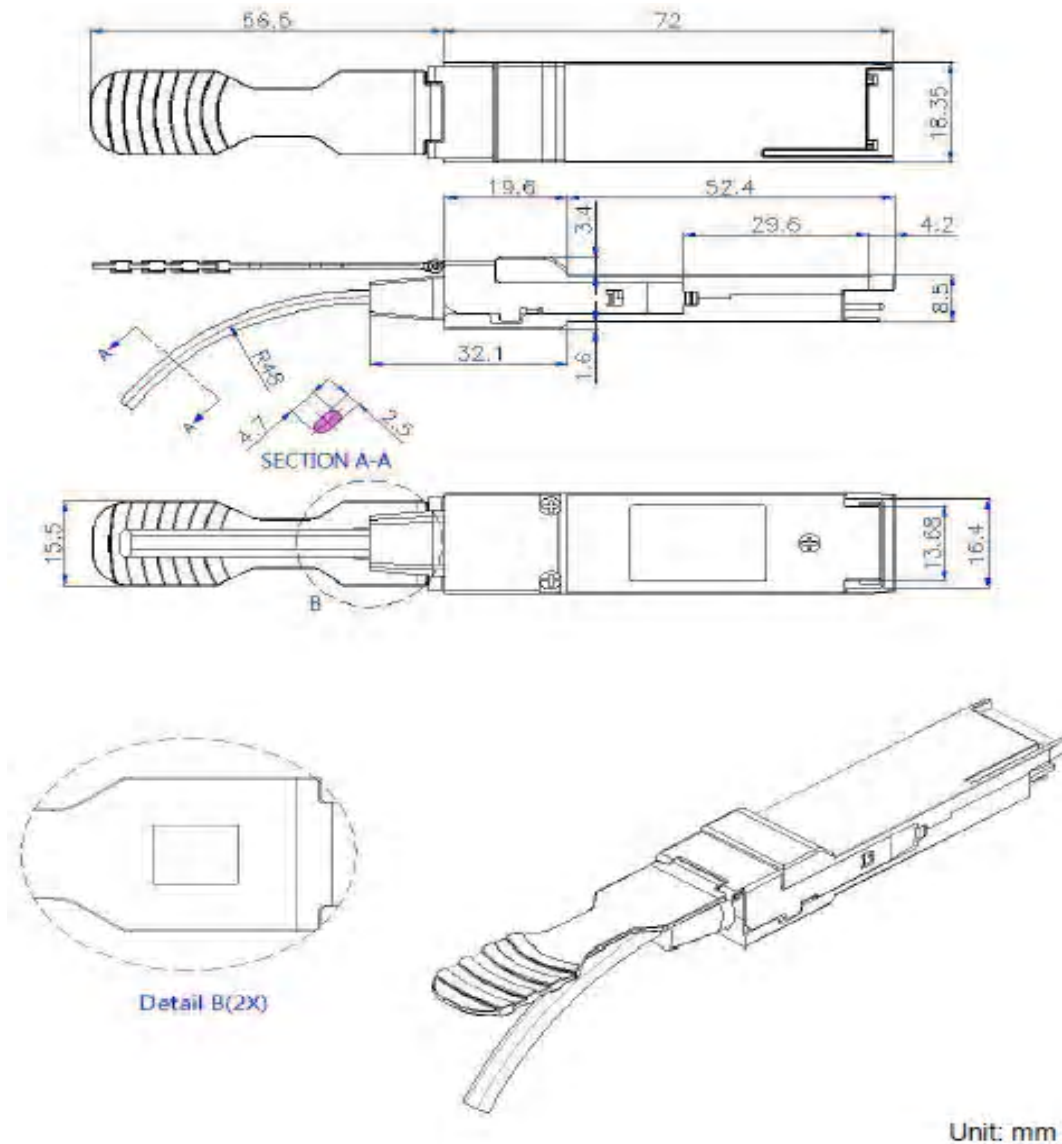
## Recommended Host Board Power Supply Circuit



## Recommended Interface Circuit

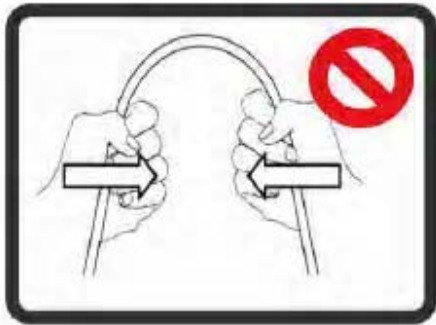


## Mechanical Design Diagram



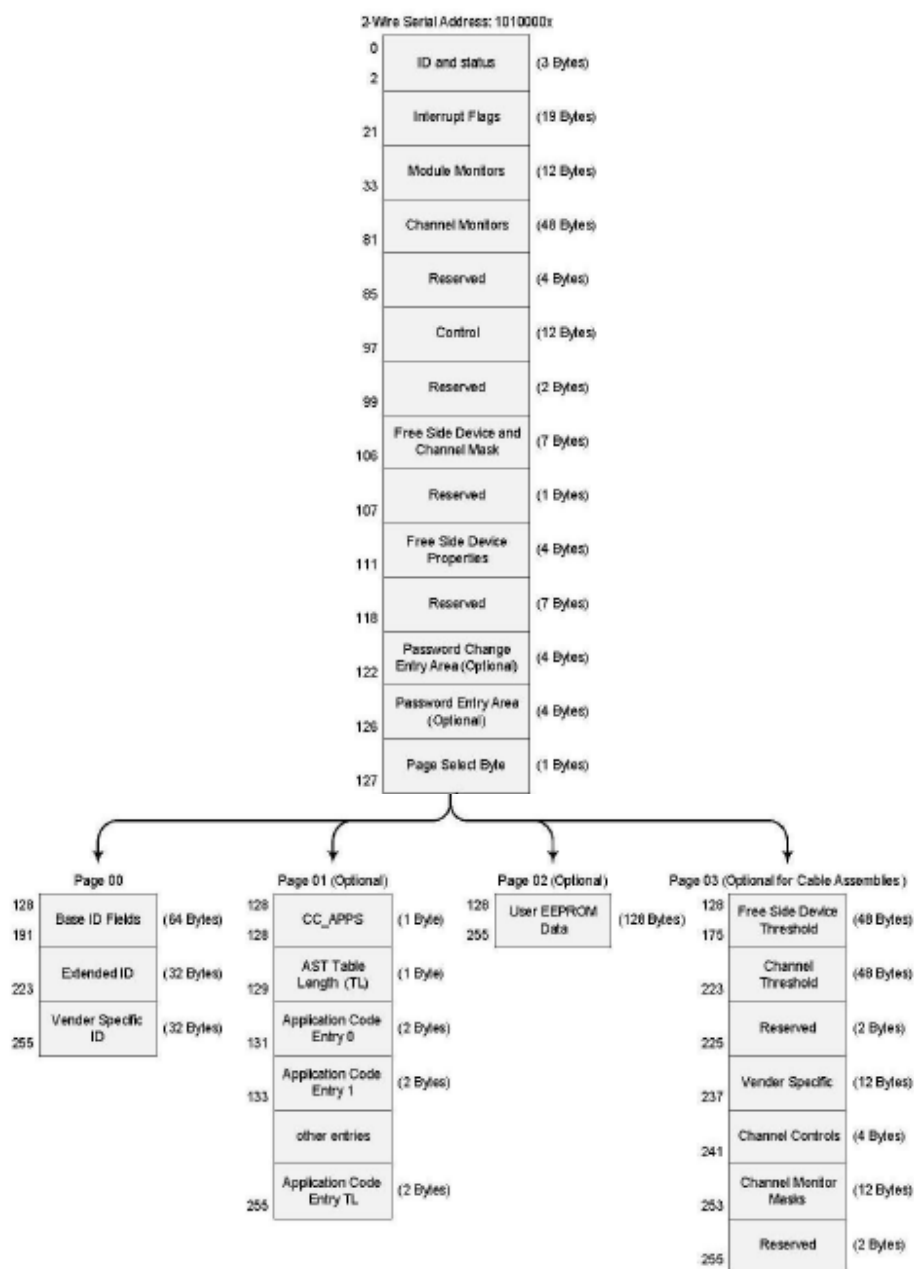
## Handling

Care should be taken to restrict exposure to the conditions defined in the Absolute Maximum Ratings. Put the product in an even and stable location. If the product falls down or drops, it may cause an injury or malfunction. The cable must not be subject to extreme bends during installation or while in operation. If you bend the cable at a radius less than the cable minimum bend radius, then the cable may get damaged. Don't twist or pull by force ends of the cable, which might cause malfunction. In addition, the bending direction should be perpendicular to the flat surface of the ribbon cable. Please do not bend or kink the cable in lateral directions of flat surface of the ribbon.



### Memory Map

The memory map is structured as a single address and multiple page approaches, according to the QSFP+ SFF-8436 MSA specification as shown in the below. For more detailed description of this memory map or lower pages, please see our Memory Map document with flexible customization settings.



**Ordering information**

56G-QSFP+-QSFP+-AOC3M	3 meter 56G QSFP+ to 56G QSFP+ Active Optical Cable
56G-QSFP+-QSFP+-AOC5M	5 meter 56G QSFP+ to 56G QSFP+ Active Optical Cable
56G-QSFP+-QSFP+-AOC7M	7 meter 56G QSFP+ to 56G QSFP+ Active Optical Cable
56G-QSFP+-QSFP+-AOC10M	10 meter 56G QSFP+ to 56G QSFP+ Active Optical Cable

**Notice:**

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