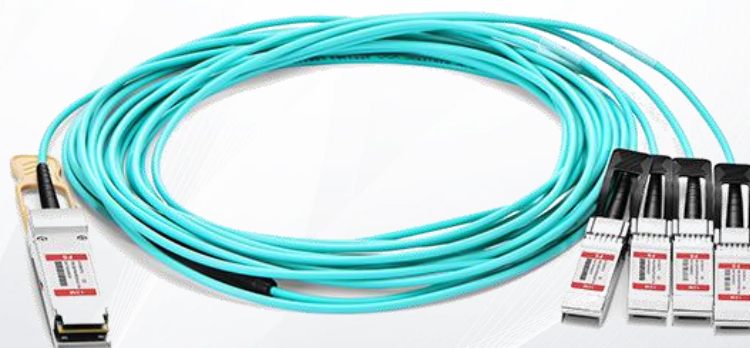


# 100G QSFP28 to 4x25G SFP28 Breakout Active Optical Cable (AOC)



## Application

- 100GEthernet
- Infiniband EDR

## Features

- 4 independent full-duplex channels
- Up to 25.78Gb/s data rate perchannel
- QSFP28 and SFP28 MSA compliant
- Up to 100m OM4 MMF transmission
- Maximum power consumption of 3.5W for QSFP28 terminal and 1.0W for each SFP28 terminal
- Operating case temperature: 0 to70oC
- Single 3.3V power supply
- RoHS-6compliant

## General Description

This product is a high data rate parallel active optical cable (AOC), to overcome the bandwidth limitation of traditional copper cable. The AOC is terminated with a QSFP28 module at one end and four SFP28 modules at the other. With the QSFP28 terminal, it offers 4 independent data transmission channels and 4 data receiving channels via multimode ribbon fibers, each capable of 25Gb/s operation. The fiber ribbon then fans out to four fiber cables, each of which is terminated with an SFP28 module. Consequently, an aggregate data rate of 100Gb/s over up to 100m transmission can be achieved by this product, to support the ultra-fast computing data exchange.

The product is designed with form factor, optical/electrical connection according to the QSFP28 and SFP28 Multi-Source Agreements (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

## Functional Description

The QSFP28 module converts the parallel electrical input signals into parallel optical signals by a driven Vertical Cavity Surface Emitting Laser (VCSEL) array inside the QSFP28 module on its transmitter side. The optical signals propagate first through 4 optical data transmission lanes in the multimode ribbon fibers and then through those of the 4 separate dual-core fiber cables. They are then captured by the photo diodes inside the receivers of the 4 SFP28 modules at the other end. The optical signals are converted into electrical signals, which are outputted by the receivers of the 4 SFP28 modules individually.

In the reverse direction, each of the 4 SFP28 modules converts the electrical input signal into an optical signal by a driven VCSEL inside the module on its transmitter side. The 4 optical signals propagate first through the other transmission lanes of the 4 separate dual-core fiber cables and then through those in the multimode ribbon fibers. They are captured by the photo diode array inside the QSFP28 on its receiver side. The optical signals are converted into parallel electrical signals and outputted. Consequently, the QSFP28 terminal of the cable has 8 ports, 4 for data transmission and 4 for data receiving, to provide a total of 100Gb/s data exchange rate while each of the 4 SFP28 terminals at the other end has 2 ports, 1 for data transmission and 1 for receiving, to provide 25Gb/s data exchangerate.

## I. QSFP28 Terminal

A single +3.3V power supply is required to power up this product. Both power supply pins VccTx and VccRx are internally connected and should be applied concurrently. As per MSA specifications the module offers 7 low speed hardware control pins (including the 2-wire serial interface): ModSelL, SCL, SDA, ResetL, LPMode, ModPrsL and IntL.

Module Select (ModSelL) is an input pin. When held low by the host, this product responds to 2-wire serial communication commands. The ModSelL allows the use of this product on a single 2-wire interface bus – individual ModSelL lines must be used.

Serial Clock (SCL) and Serial Data (SDA) are required for the 2-wire serial bus communication interface and enable the host to access the QSFP28 memory map.

The ResetL pin enables a complete reset, returning the settings to their default state, when a low level on the ResetL pin is held for longer than the minimum pulse length. During the execution of a reset the host shall disregard all status bits until it indicates a completion of the reset interrupt. The product indicates this by posting an IntL (Interrupt) signal with the Data\_Not\_Ready bit negated in the memory map. Note that on power up (including hot insertion) the module should post this completion of reset interrupt without requiring areset.

Low Power Mode (LPMode) pin is used to set the maximum power consumption for the product in order to protect hosts that are not capable of cooling higher power modules, should such modules be accidentally inserted.

Module Present (ModPrsL) is a signal local to the host board which, in the absence of a product, is normally pulled up to the host Vcc. When the product is inserted into the connector, it completes the path to ground through a resistor on the host board and asserts the signal. ModPrsL then indicates it is present by setting ModPrsL to a “Low” state.

Interrupt (IntL) is an output pin. “Low” indicates a possible operational fault or a status critical to the host system. The host identifies the source of the interrupt using the 2-wire serial interface. The IntL pin is an open collector output and must be pulled to the Host Vcc voltage on the Host board.

## II. SFP28 Terminals

The SFP28 module electrical interface is compliant to SFI electrical specifications. The transmitter input and receiver output impedance is 100 Ohms differential. Data lines are internally AC coupled. The module provides differential termination and reduce differential to common mode conversion for quality signal termination and low EMI. SFI typically operates over 200 mm of improved FR4 material or up to about 150mm of standard FR4 with one connector.

The transmitter converts 25Gbit/s serial PECL or CML electrical data into serial optical data. An open collector compatible Transmit Disable (Tx\_Dis) is provided. Logic “1” or no connection on this pin will disable the laser from transmitting. Logic “0” on this pin provides normal operation. The transmitter has an internal automatic power control loop (APC) to ensure constant optical power output across supply voltage and temperature variations. An open collector compatible Transmit Fault (Tx\_Fault) is provided. TX\_Fault is module output contact that when high, indicates that the module transmitter has detected a fault condition related to laser operation or safety. The TX\_Fault output contact is an open drain/collector and shall be pulled up to the Vcc\_Host in the host with a resistor in the range 4.7-10 kΩ. TX\_Disable is a module input contact. When TX\_Disable is asserted high or left open, the SFP28 module transmitter output shall be turned off. This contact shall be pulled up to VccT with a 4.7 kΩ to 10 kΩ resistor.

The receiver converts 25Gbit/s serial optical data into serial PECL/CML electrical data. An open collector compatible Loss of Signal is provided. Rx\_LOS when high indicates an optical signal level below that specified in the relevant standard. The Rx\_LOS contact is an open drain/collector output and shall be pulled up to Vcc\_Host in the host with a resistor in the range 4.7-10 kΩ, or with an active termination. Power supply filtering is recommended for both the transmitter and receiver. The Rx\_LOS signal is intended as a preliminary indication to the system in which the SFP28 is installed that the received signal strength is below the specified range. Such an indication typically points to non-installed cables, broken cables, or a disabled, failing or a powered off transmitter at the far end of the cable.

## Product Specifications

### I. 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	Ref.
<b>Storage Temperature</b>	T <sub>S</sub>	-40		85	°C	
<b>Operating Case Temperature</b>	T <sub>OP</sub>	0		70	°C	
<b>Power Supply Voltage</b>	V <sub>CC</sub>	-0.5		3.6	V	
<b>Relative Humidity (non-condensation)</b>	RH	0		85	%	

## II. Recommended Operating Environment

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Operating Case Temperature</b>	$T_{OP}$	0		70	°C	
<b>Power Supply Voltage</b>	$V_{CC}$	3.135	3.3	3.465	V	
<b>Data Rate, each Lane (QSFP28)</b>			25.78125		Gb/s	
<b>Data Rate (each SFP28)</b>			25.78125		Gb/s	
<b>Control Input Voltage High</b>		2		$V_{CC}$	V	
<b>Control Input Voltage Low</b>		0		0.8	V	

## III. Electrical Characteristics

The following electrical characteristics are defined over the Recommended Operating temperature and supply voltage unless otherwise specified.

QSFP28 Terminal						
Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
<b>Power Consumption, each Terminal</b>				3.5	W	
<b>Supply Current, each Terminal</b>	$I_{CC}$			1060	mA	
<b>Transceiver Power-on Initialization Time</b>				2000	ms	1
Transmitter (each Lane)						
<b>Single Ended Input Voltage Tolerance (Note 2)</b>		-0.3		3.6	V	
<b>AC Common Mode Input Voltage Tolerance</b>		15			mV	RMS
<b>Differential Input Voltage Swing Threshold</b>		50			mVpp	LOSA Threshold
<b>Differential Input Voltage Swing</b>	$V_{in,pp}$	180		1000	mVpp	

<b>Differential Input Impedance</b>	Zin	90	100	110	Ohm	
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<b>Total Jitter</b>				0.40	UI	
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<b>Deterministic Jitter</b>				0.15	UI	
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### Receiver (each Lane)

<b>Single Ended Output Voltage</b>		-0.3		4	V	
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<b>AC Common Mode Output Voltage</b>				7.5	mV	RMS
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<b>Differential Output Voltage Swing</b>	Vout,pp	300		1000	mVpp	
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<b>Differential Output Impedance</b>	Zout	90	100	110	Ohm	
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<b>Total Jitter</b>				0.3	UI	
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<b>Deterministic Jitter</b>				0.15	UI	
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### SFP28 Terminal

Parameter	Symbol	Min	Typ.	Max	Unit	Ref.
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<b>Power Consumption</b>				1000	mW	
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<b>Supply Current, each SFP28</b>	Icc			300	mA	
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<b>Transceiver Power-on Initialization Time</b>				300	ms	1
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### Transmitter

<b>Single Ended Input Voltage Tolerance</b>		-0.3		4	V	
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<b>AC Common Mode Voltage Tolerance</b>		15			mV	RMS
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<b>Differential Input Voltage Swing</b>	Vin,pp	180		700	mV	
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<b>Differential Input Impedance</b>	Zin	90	100	110	Ohm	
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<b>Data Dependent Input Jitter</b>	DDJ			0.40	UI	
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<b>Data Input Total Jitter</b>	TJ			0.15	UI	
<b>Receiver</b>						
<b>Single Ended Output Voltage</b>		-0.3		4	V	
<b>AC Common Mode Voltage</b>				7.5	mV	RMS
<b>Differential Output Voltage Swing</b>	Vout,pp	300		850	mVpp	
<b>Differential Output Impedance</b>	Zout	90	100	110	Ohm	
<b>Rx Output Rise and Fall Time</b>	Tr/Tf	30			ps	20% to 80%
<b>Total Jitter</b>	TJ			0.3	UI	
<b>Deterministic Jitter</b>	DJ			0.15	UI	

#### IV. Pin Assignment

##### QSFP28 Terminal:

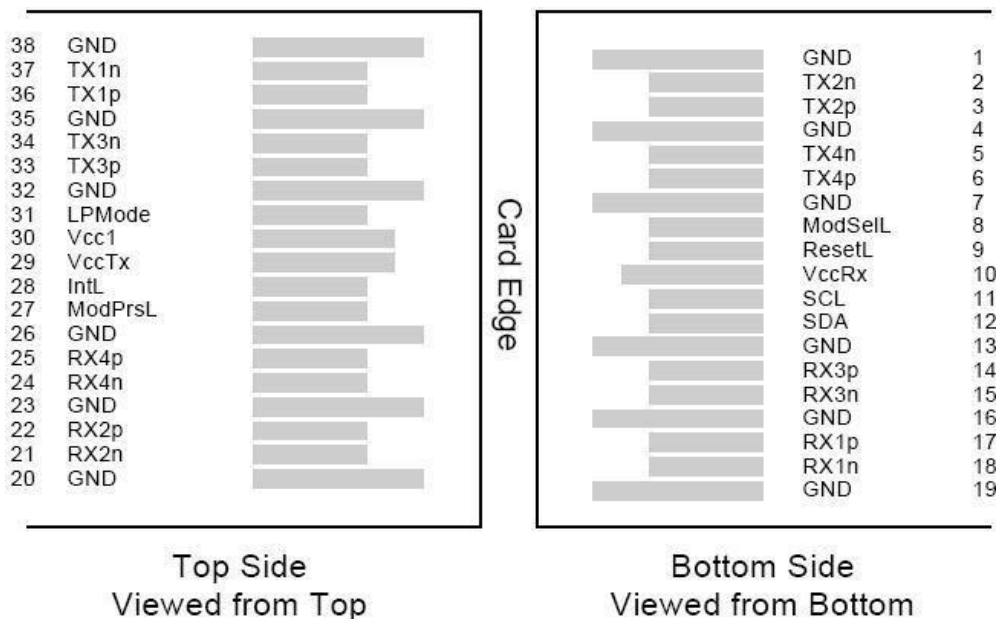


Figure 1 – MSA compliant QSFP28 Connector

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

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

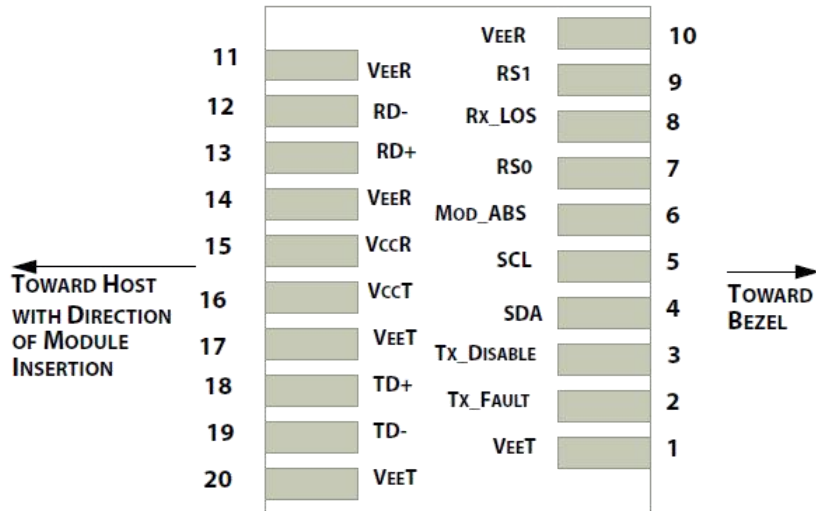
**Notes:**

- 1.GND is the symbol for signal and supply (power) common for QSFP28 modules. All are common within the QSFP28 module and all module voltages are referenced to this potential unless otherwise noted.Connectthesedirectlytothehostboardsignalcommongroundplane.
- 2.VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. Recommended host board power supply filtering is shown in Figure 4 below. Vcc Rx, Vcc1 and VccTx may be internally connected within the QSFP28 transceiver module in any combination. The connector pins are each rated for a maximum current of 1000mA.

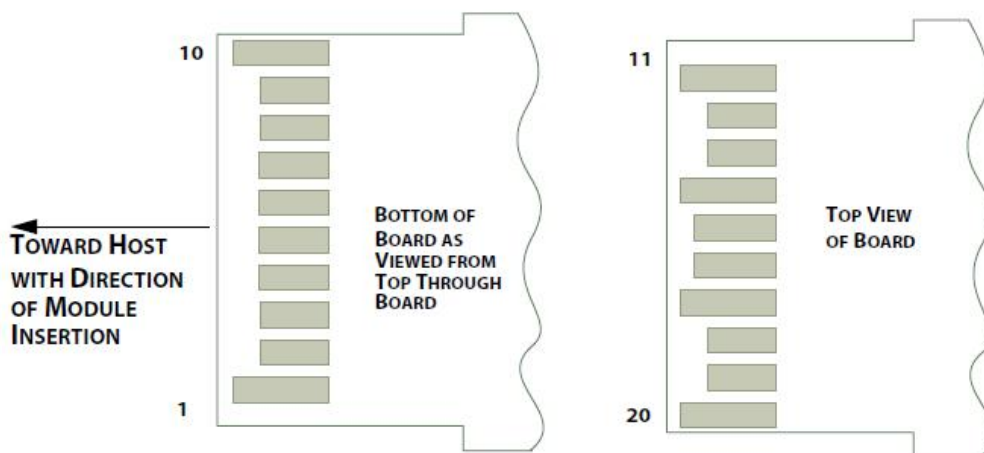


**SFP28 Terminal:**

The SFP28 modules are hot-pluggable. Hot pluggable refers to plugging in or unplugging a module while the host board is powered. The SFP28 host connector is a 0.8 mm pitch 20 position right angle improved connector specified by SFF-8083, or stacked connector with equivalent electrical performance. Host PCB contact assignment is shown in Figure 2 and contact definitions are given in the PIN description table. SFP28 module contacts mates with the host in the order of ground, power, followed by signal as illustrated by Figure 3 and the contact sequence order listed in the PIN description table.



**Figure 2 – SFP28 Module Interface to Host**



**Figure 3 – SFP28 Module Contact Assignment**

Pin	Logic	Symbol	Description	Notes
1		VeeT	Module Transmitter Ground	1
2	LVTTTL-O	TX_Fault	Module Transmitter Fault	
3	LVTTTL-I	TX_Dis	Transmitter Disable; Turns off transmitter laser output	
4	LVTTTL-I/O	SDA	2-Wire Serial Interface Data Line	2
5	LVTTTL-I	SCL	2-Wire Serial Interface Clock	2
6		MOD-DEFO	Module Definition, Grounded in the module	
7	LVTTTL-I	RS0	Receiver Rate Select	
8	LVTTTL-O	RX-LOS	Receiver Loss of Signal Indication Active LOW	
9	LVTTTL-I	RS1	Transmitter Rate Select (not used)	
10		VeeR	Module Receiver Ground	1
11		VeeR	Module Receiver Ground	1
12	CML-O	RD-	Receiver Inverted Data Output	
13	CML-O	RD+	Receiver Data Output	
14		VeeR	Module Receiver Ground	1
15		VccR	Module Receiver 3.3 V Supply	
16		VccT	Module Receiver 3.3 V Supply	
17		VeeT	Module Transmitter Ground	1
18	CML-I	TD+	Transmitter Non-Inverted Data Input	
19	CML-I	TD-	Transmitter Inverted Data Input	
20		VeeT	Module Transmitter Ground	1

**Notes:**

1. Module ground pins GND are isolated from the module case.
2. Shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.

### V. Recommended Power Supply Filters

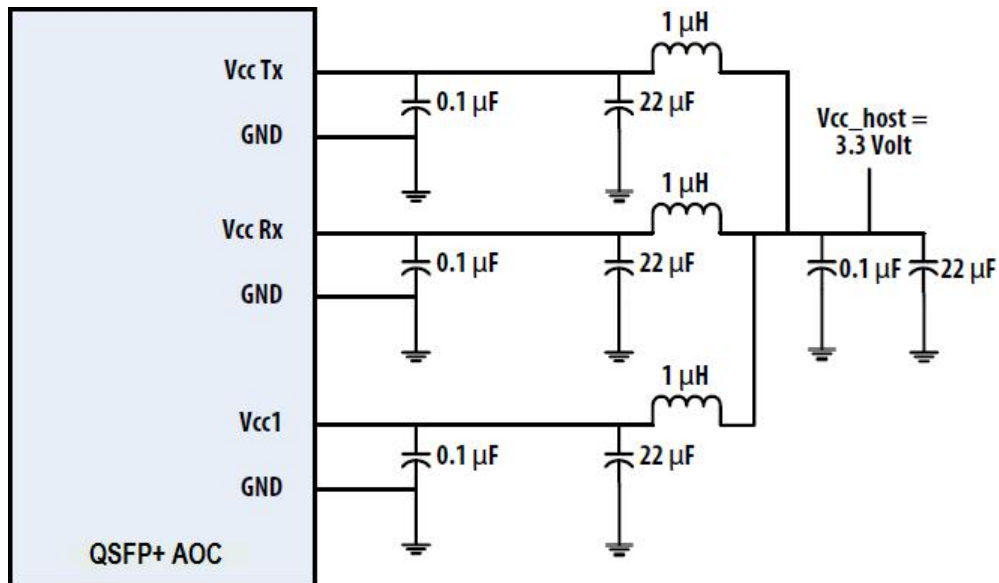


Figure 4 – Recommended Power Supply Filter for QSFP28 Terminal

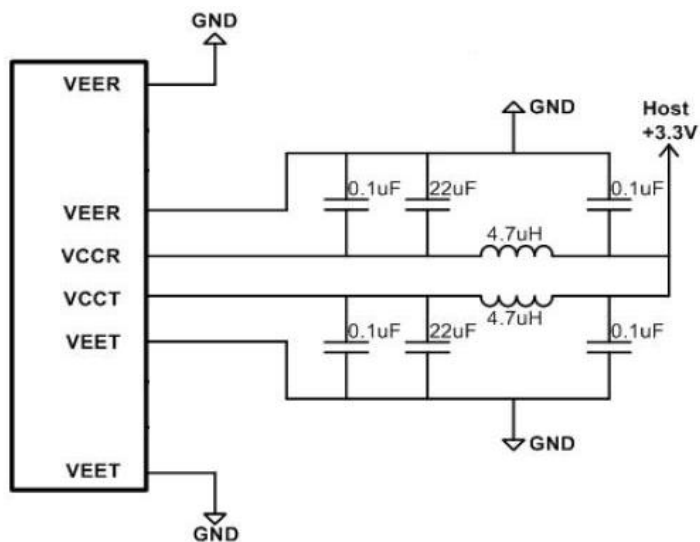
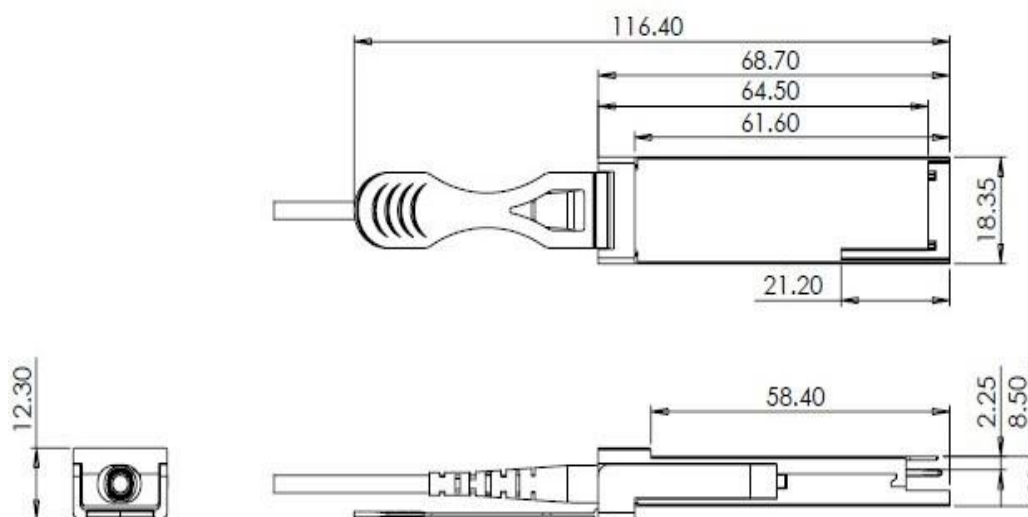
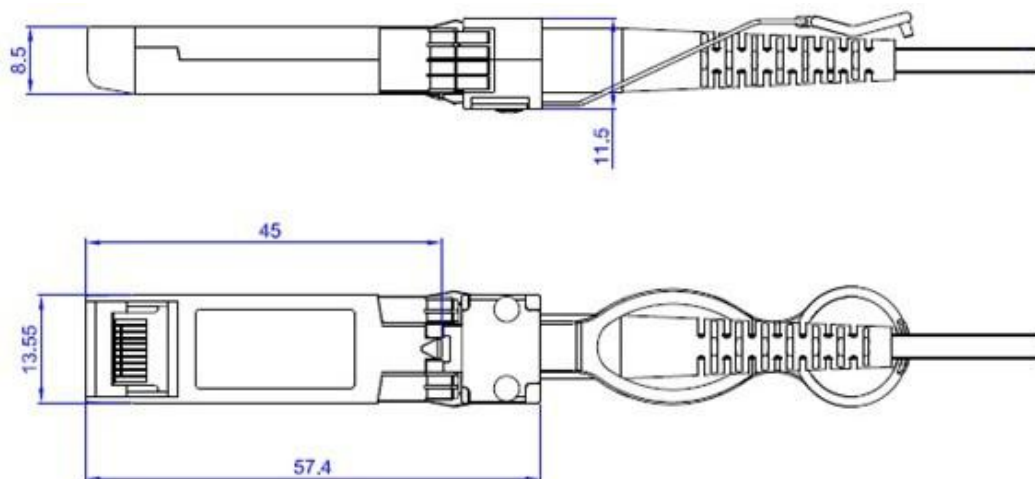


Figure 5 – Recommended Power Supply Filter for SFP28 Terminals

## VI. Diagram Mechanical Drawing



**Figure 6 – Mechanical Outline of QSFP28 Terminal**



**Figure 7 – Mechanical Outline of SFP28 Terminal**

## **VII. ESD**

This transceiver is specified as ESD threshold 1kV for SFI pin 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.

## **VIII. Laser Safety**

This is a Class 1 Laser Product according to IEC 60825-1:2007. This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007).

## Test Center

FS.COM transceivers are tested to ensure connectivity and compatibility in our test center before shipped out. FS.COM test center is supported by a variety of mainstream original brand switches and groups of professional staff, helping our customers make the most efficient use of our products in their systems, network designs and deployments.

The original switches could be found nowhere but at FS.COM test center, eg: Juniper MX960 & EX 4300 series, Cisco Nexus 9396PX & Cisco ASR 9000 Series, HP 5900 Series & HP 5406R ZL2 V3(J9996A), Arista 7050S-64, Brocade ICX7750-26Q & ICX6610-48, Avaya VSP 7000 MDA 2, etc.



Cisco ASR 9000 Series(A9K-MPA-1X40GE)



ARISTA 7050S-64(DCS-7050S-64)



Juniper MX960



Brocade ICX 7750-26Q



Extreme Networks X670V VIM-40G4X



Mellanox M3601Q



Dell N4032F



HP 5406R ZL2 V3(J9996A)



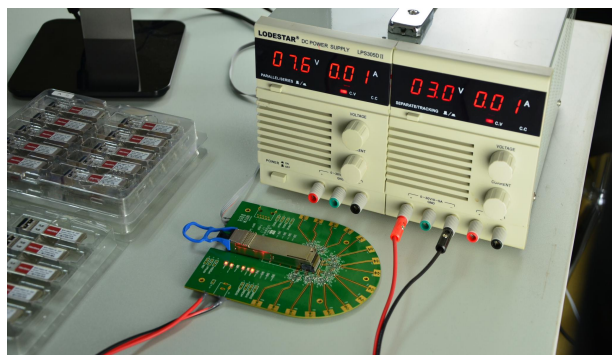
AVAYA 7024XLS(7002QQ-MDA)

## Test Assured Program

FS.COM truly understands the value of compatibility and interoperability to each optics. Every module FS.COM provides must run through programming and an extensive series of platform diagnostic tests to prove its performance and compatibility. In our test center, we care of every detail from staff to facilities—professionally trained staff, advanced test facilities and comprehensive original-brand switches, to ensure our customers to receive the optics with superior quality.



Our smart data system allows effective product management and quality control according to the unique serial number, properly tracing the order, shipment and every part.



Our in-house coding facility programs all of our parts to standard OEM specs for compatibility on all major vendors and systems such as Cisco, Juniper, Brocade, HP, Dell, Arista and so on.



With a comprehensive line of original-brand switches, we can recreate an environment and test each optics in practical application to ensure quality and distance.



The last test assured step to ensure our products to be shipped with perfect package.

## Order Information

Part Number	Data Rate	Length	Wire Gauge	Connector Type	Temp.Range	Cable Jacket
Q-4S28AO01	Up to 100G	1m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO02	Up to 100G	2m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO03	Up to 100G	3m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO05	Up to 100G	5m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO07	Up to 100G	7m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO10	Up to 100G	10m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO15	Up to 100G	15m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO20	Up to 100G	20m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO25	Up to 100G	25m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO30	Up to 100G	30m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP
Q-4S28AO50	Up to 100G	50m	QSFP28 to SFP28	AOC Cable	0-70°C	OFNP





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