

# SO-QSFP28-4xSFP28-AOCxM

QSFP28 to 4xSFP28, 100G, AOC, xm

## OVERVIEW

The SO-QSFP28-4xSFP28-AOCxM is a parallel active optical cable (AOC) which overcomes the bandwidth limitation of traditional copper cables. The AOC is terminated with four SFP28 modules at one end and one QSFP28 module at the other. With the QSFP28 terminal, the cable offers four independent data transmission channels and four data receiving channels via multimode ribbon fibers. The fiber ribbon is then fanned out to four fiber cables, each terminated with an SFP28 module. Each fiber cable operates at up to 25Gbps, resulting in an aggregate data rate of 100Gbps. The AOC can be used for distances up to 100m, achieving the ultrafast data exchange. The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP28 Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

## PRODUCT FEATURES

- QSFP28 and SFP28 MSA form factor
- 4 independent full-duplex channels
- Up to 100m reach for OM4 MMF transmission
- Single +3.3V power supply
- Operating case temperature: 0~70oC
- Up to 28Gbps data rate per channel
- Maximum power consumption for QSFP28 terminal 3.5W
- Maximum power consumption for each SFP28 terminal 1.0W
- RoHS-6 compliant

## APPLICATIONS

- 100G Ethernet
- Infiniband EDR

## ORDERING INFORMATION

Part Number	Description
SO-QSFP28-4xSFP28-AOCxM	AOC,100Gbps, QSFP28 to 4x SFP28 fan-out, xm*
	* x=5, 7, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100m

## 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

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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 exchange rate.

#### 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 a reset. 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.

#### SFP28 TERMINAL:

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 k $\Omega$ , 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.

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.

This is a Class 1 Laser Product according to EN 60825-1:2014. This product complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated (June 24, 2007).

## ABSOLUTE MAXIMUM RATINGS

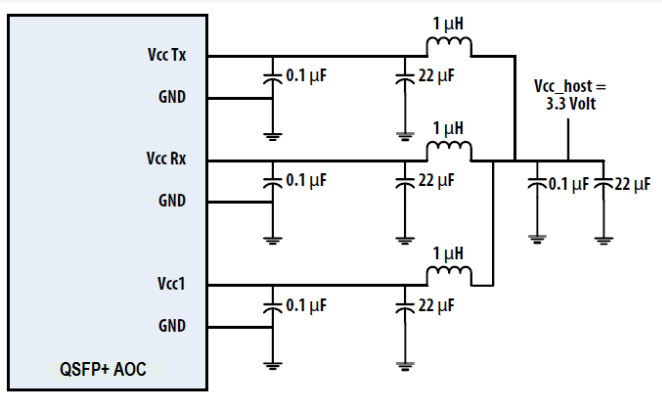
Parameter	Symbol	Min	Max	Unit
Storage temperature	$T_s$	-40	+85	degC
Operating case temperature	TOP	0	70	degC
Power supply voltage	Vcc	-0.5	3.6	V
Relative humidity (non-condensation)	RH	0	85	%

## RECOMMENDED OPERATING CONDITIONS

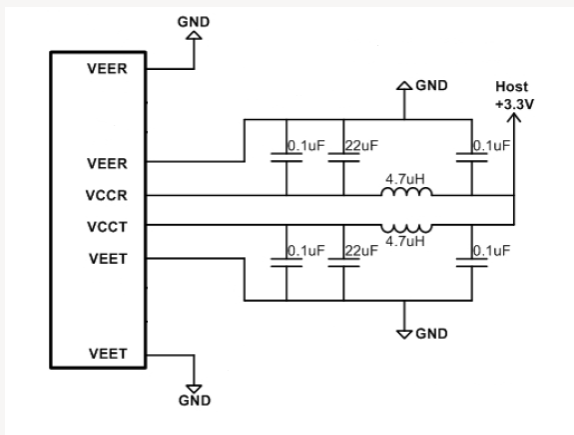
Parameter	Symbol	Min	Typ	Max	Unit
Operating case temperature	TOP	0		70	degC
Power supply voltage	Vcc	3.135	3.3	3.465	V
Data rate, each lane (QSFP28)			25.78125	28.05	Gb/s
Data rate, (each SFP28)			25.78125	28.05	Gb/s
Control input voltage high		2		Vcc	V
Control input voltage low		0		0.8	V

## RECOMMENDED POWER SUPPLY FILTERS

### QSFP28 TERMINAL



### SFP28 TERMINAL



## ELECTRICAL CHARACTERISTICS QSFP28 TERMINAL

Parameter	Symbol	Min	Typ	Max	Unit
Power consumption, each terminal		-		3.5	W
Supply current, each terminal	$I_{cc}$			1060	mA
Transceiver power-on initialization time (note 1)				2000	ms

## ELECTRICAL CHARACTERISTICS QSFP28 TERMINAL – TRANSMITTER (EACH LANE)

Parameter	Symbol	Min	Typ	Max	Unit
Single-ended input voltage tolerance (note 2)		-0.3		3.6	V
AC common mode input voltage tolerance		15			mV
Differential input voltage swing threshold		50			mVpp
Differential input voltage swing	$V_{in.pp}$	180		1000	mVpp
Differential input impedance	$Z_{in}$	90	100	110	$\Omega$
Total jitter				0.40	UI
Deterministic jitter				0.15	UI

## ELECTRICAL CHARACTERISTICS QSFP28 TERMINAL – RECEIVER (EACH LANE)

Parameter	Symbol	Min	Typ	Max	Unit
Single-ended output voltage		-0.3		4.0	V
AC common mode output voltage				7.5	mV
Differential output voltage swing	$V_{out.pp}$	300		1000	mVpp
Differential output impedance	$Z_{out}$	90	100	110	ohm
Total jitter				0.3	UI
Deterministic jitter				0.15	UI

## ELECTRICAL CHARACTERISTICS SFP28 TERMINAL

Parameter	Symbol	Min	Typ	Max	Unit
Power consumption		-		1000	mW
Supply current, each SFP28	<i>I<sub>cc</sub></i>			300	mA
Transceiver power-on initialization time (note 1)				300	ms

## ELECTRICAL CHARACTERISTICS SFP28 TERMINAL – TRANSMITTER

Parameter	Symbol	Min	Typ	Max	Unit
Single-ended input voltage tolerance (note 2)		-0.3		4	V
AC common mode voltage tolerance		15			mV
Differential input voltage swing	<i>V<sub>in,pp</sub></i>	180		700	mV
Differential input impedance	<i>Z<sub>in</sub></i>	90	100	110	Ω
Data dependent input jitter	<i>DDJ</i>			0.40	UI
Data input total jitter	<i>TJ</i>			0.15	UI

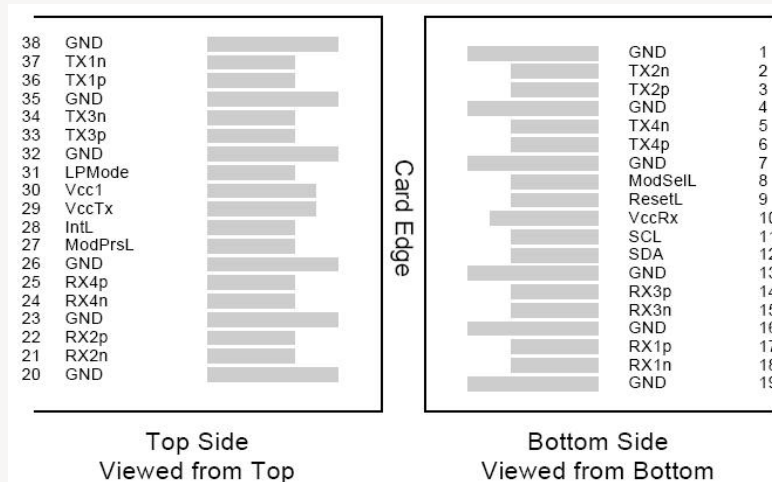
## ELECTRICAL CHARACTERISTICS SFP28 TERMINAL – RECEIVER

Parameter	Symbol	Min	Typ	Max	Unit
Single-ended output voltage		-0.3		4	V
AC common mode voltage				7.5	mV
Differential output voltage swing	<i>V<sub>out,pp</sub></i>	300		850	mV
Differential output impedance	<i>Z<sub>out</sub></i>	90	100	110	ohm
Rx output rise and fall time	<i>T<sub>r</sub>/T<sub>f</sub></i>	30			ps
Total jitter	<i>TJ</i>			0.3	UI
Deterministic jitter	<i>DJ</i>			0.15	UI

## Notes:

1. Power-on Initialization Time is the time from when the power supply voltages reach and remain above the minimum recommended operating supply voltages to the time when the module is fully functional.
2. The single ended input voltage tolerance is the allowable range of the instantaneous input signals.

**PIN ASSIGNMENT AND FUNCTION DEFINITIONS QSFP28 TERMINAL**



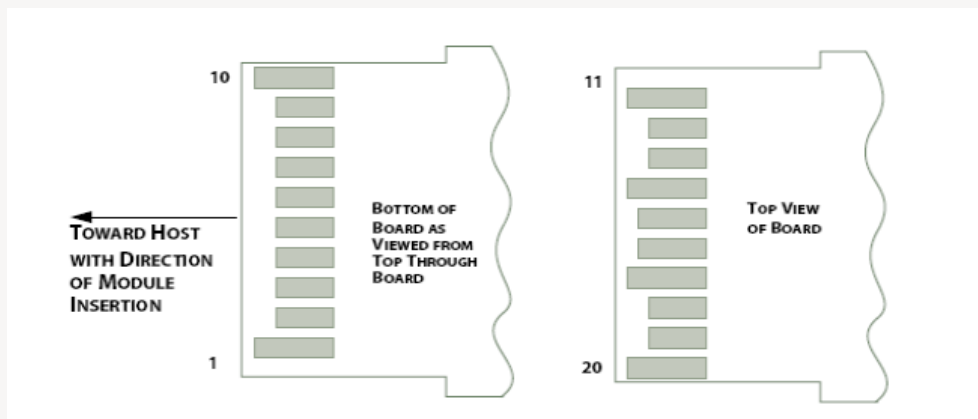
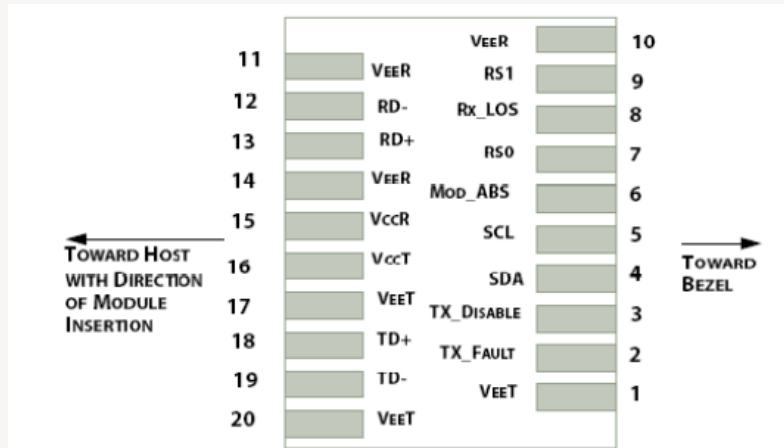
**PIN DEFINITION**

PIN	Signal Name	Description	PIN	Signal Name	Description
1	GND	Ground (1)	20	GND	Ground (1)
2	Tx2n	CML-I Transmitter 2 Inverted Data Input	21	Rx2n	CML-O Receiver 2 Inverted Data Output
3	Tx2p	CML-I Transmitter 2 Non-Inverted Data Input	22	Rx2p	CML-O Receiver 2 Non-Inverted Data Output
4	GND	Ground (1)	23	GND	Ground (1)
5	Tx4n	CML-I Transmitter 4 Inverted Data Input	24	Rx4n	CML-O Receiver 4 Inverted Data Output
6	Tx4p	CML-I Transmitter 4 Non-Inverted Data Input	25	Rx4p	CML-O Receiver 4 Non-Inverted Data Output
7	GND	Ground (1)	26	GND	Ground (1)
8	ModSelL	LVTTLL-I Module Select	27	ModPrsL	Module Present
9	ResetL	LVTTLL-I Module Reset	28	IntL	Interrupt
10	VccRx	+3.3V Power Supply Receiver (2)	29	VccTx	+3.3V Power Supply Transmitter (2)
11	SCL	LVC MOS-I/O 2-Wire Serial Interface Clock	30	Vcc1	+3.3V Power Supply
12	SDA	LVC MOS-I/O 2-Wire Serial Interface Data	31	LPMODE	LVTTLL-I Low Power Mode
13	GND	Ground (1)	32	GND	Ground (1)
14	Rx3p	CML-O Receiver 3 Non-Inverted Data Output	33	Tx3p	CML-I Transmitter 3 Non-Inverted Data Input
15	Rx3n	CML-O Receiver 3 Inverted Data Output	34	Tx3n	CML-I Transmitter 3 Inverted Data Input
16	GND	Ground (1)	35	GND	Ground (1)
17	Rx1p	CML-O Receiver 1 Non-Inverted Data Output	36	Tx1p	CML-I Transmitter 1 Non-Inverted Data Input
18	Rx1n	CML-O Receiver 1 Inverted Data Output	37	Tx1n	CML-I Transmitter 1 Inverted Data Input
19	GND	Ground (1)	38	GND	Ground (1)

**Notes:**

1. All Ground (GND) are common within the QSFP+ module and all module voltages are referenced to this potential unless noted otherwise. Connect these directly to the host board signal common ground plane.
2. VccRx, Vcc1 and VccTx are the receiving and transmission power suppliers and shall be applied concurrently. VccRx, 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.

PIN ASSIGNMENT AND FUNCTION DEFINITIONS SFP28 TERMINAL



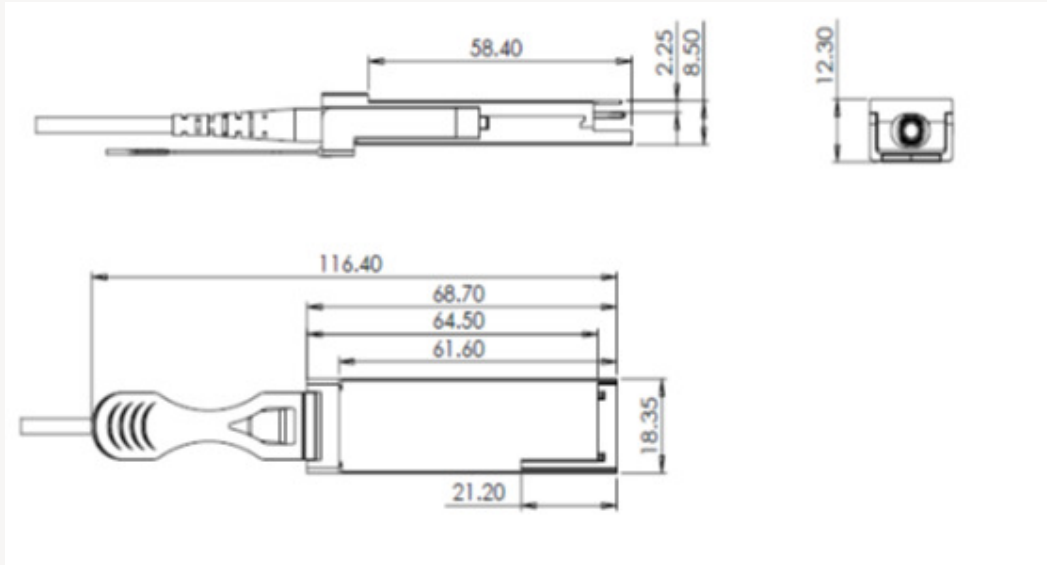
PIN	Signal Name	Description	PIN	Signal Name	Description
1	Veet	Module Transmitter Ground	11	Veer	Module Receiver Ground
2	TX Fault	LVTTTL-O Module Trasmmitter Fault	12	RD-	CML-O Receiver Inverted Data Output
3	TX Dis	LVTTTL-I Transmitter Disable; Turns off transmitter laser output	13	RD+	CML-O Receiver Data Output
4	SDA	LVTTTL-I/O 2-Wire Serial Interface Data Line	14	Veer	Module Receiver Ground
5	SCL	LVTTTL-I 2-Wire Serial Interface Clock	15	VccR	Module Receiver 3.3V Supply
6	MOD_DEF0	Module Definition, Grounded in the module	16	VccT	Module Receiver 3.3V Supply
7	RS0	LVTTTL-I Receiver Rate Select	17	Veet	Module Transmitter Ground
8	RX_LOS	LVTTTL-O Receiver Loss of Signal Indication Active LOW	18	TD+	CML-I Transmitter Non-Inverted Data Input
9	RS1	LVTTTL-I Transmitter Rate Select (not used)	19	TD-	CML-I Transmitter Inverted Data input
10	V <sub>eeR</sub>	Module Receiver Ground	20	V <sub>eeT</sub>	Module Transmitter Ground

Notes:

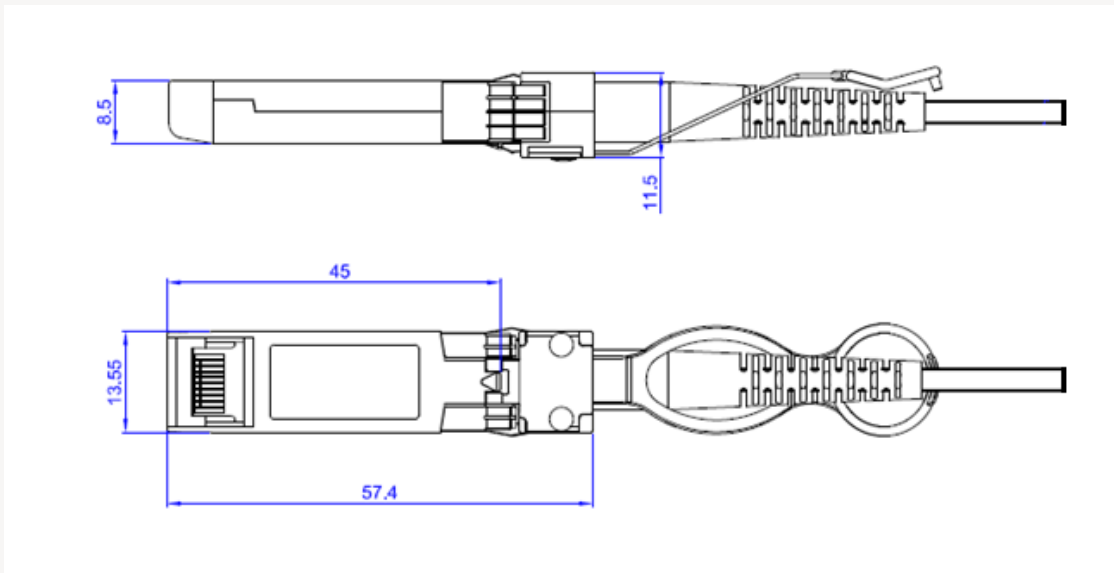
1. Module ground pins GND are isolated from the module case.
2. 2-Wire Serial Interface pins SDA and SCL shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.



MECHANICAL DRAWING QSFP28 TERMINAL



MECHANICAL DRAWING SFP28 TERMINAL



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