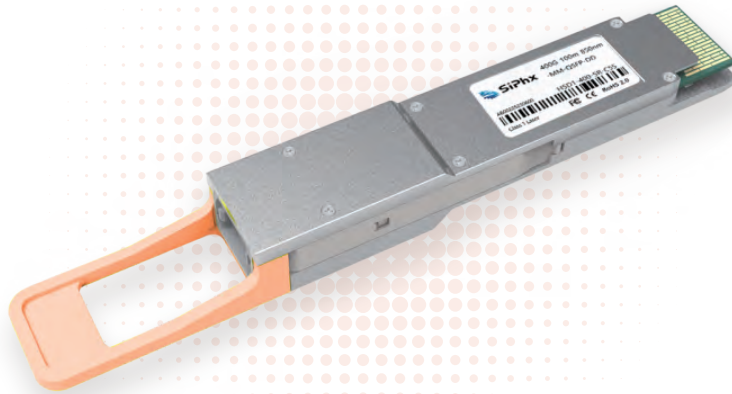# 400G BASE-SR8 QSFP-DD PAM4 850nm
100m DOM MTP/MPO MMF Optical Transceiver Module
P/N HSD1-400-SR-C5S

Product Features

- Hot pluggable QSFP-DD form factor
- Supports 400Gb/s aggregate bit rate
- Up to 53.125Gbps data rate per channel
- Maximum link length of 70m on OM3 and 100m on OM4
- MPO connector receptacle
- Case temperature range: 0 ~ +70℃
- Power dissipation: <10W
- Single 3.3V power supply
- Compliant to QSFP-DD MSA
- Compliant with IEEE 802.3cd
- RoHS complaint

Applications

- 400GBASE-SR8 400G Ethernet
- Data Center

Product Description

This is a hot-pluggable QSFP-DD transceiver for 400G links over multimode fiber. It is a high-performance module for short-range data communication and interconnect applications, operating at 400Gbps up to 70m using OM3 multimode fiber or 100m using OM4 multimode fiber. This module is designed to operate over multimode fiber systems using a nominal wavelength of 850nm. The electrical interface uses a 76-pin connector, while the optical interface employs an MPO connector.
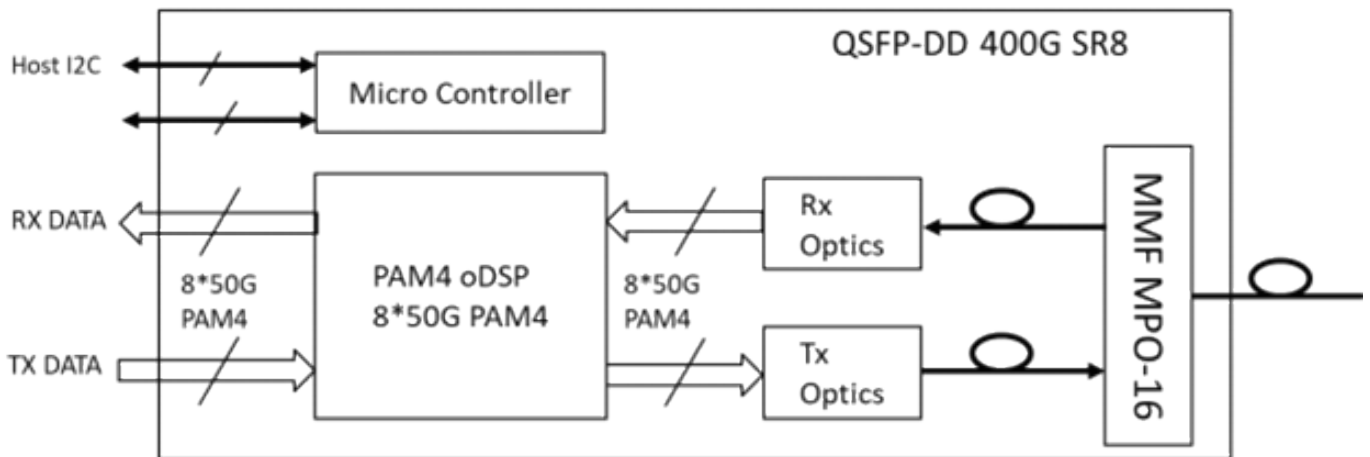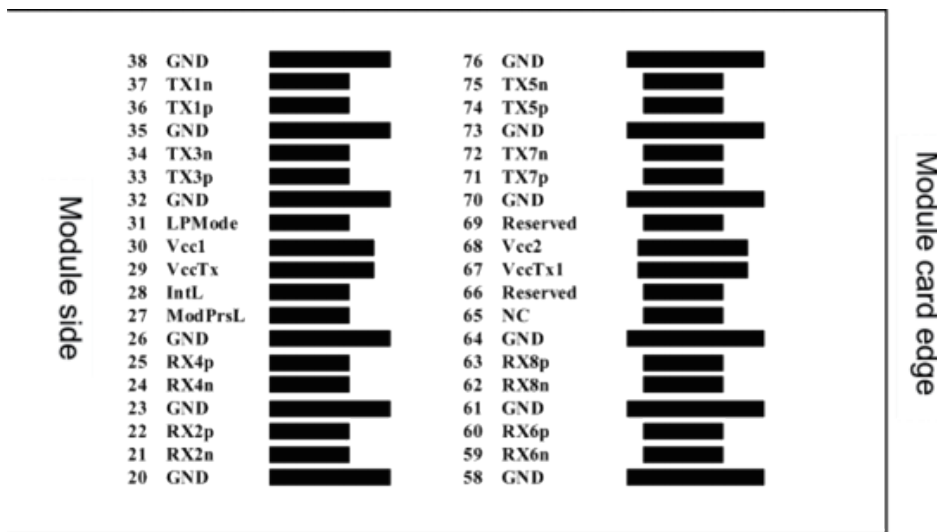
Figure 1 Transceiver block diagram

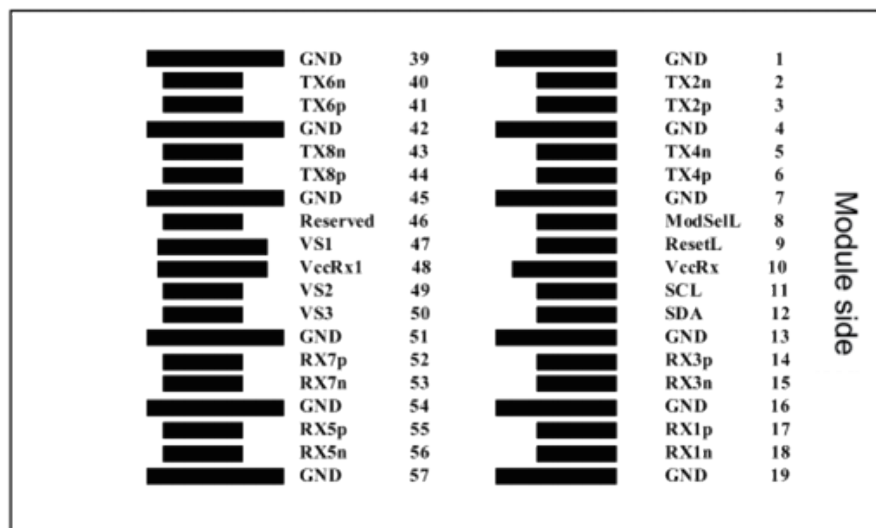| P/N	HSD1-400-SR-C5S
Form Factor	QSFP-DD
Wavelength	840, 860nm
Connector	MTP/MPO-16
Max Cable Distance	70m@OM3, 100m@OM4
Commercial Temperature Range	0°C~70°C

Pin Descriptions

The edge connector for the QSFP-DD SR8 module consists of a single paddle card featuring 38 pads on the top and an additional 38 pads on the bottom, totaling 76 pads. These pads are designed in such a way that they can accommodate the insertion of a QSFP module into a QSFP-DD receptacle.

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 Input	
4		GND	Ground	1
5	CML-I	Tx4n	Transmitter Inverted Data Input	
6	CML-I	Tx4p	Transmitter Non-Inverted Data Input	
7		GND	Ground	1
8	LVTTL-I	ModSelL	Module Select	
9	LVTTL-I	ResetL	Module Reset	
10		VccRx	+3.3 V Power Supply	2
11	LVCMOS-I/O	SCL	2-wire Serial Interface Clock	
12	LVCMOS-I/O	SDA	2-wire Serial Interface Data	
13		GND	Ground	1
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	
25	CML-O	Rx4p	Receiver Non-Inverted Data Output	
26		GND	Ground	1
27	LVTTL-O	ModPrsL	Module Present	
28	LVTTL-O	IntL	Interrupt	
29		VccTx	+3.3 V Power Supply	2
30		Vcc1	+3.3 V Power Supply	2
31	LVTTL-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 Input	
35		GND	Ground	1
36	CML-I	Tx1p	Transmitter Non-Inverted Data Input	
37	CML-I	Tx1n	Transmitter Inverted Data Input	
38		GND	Ground	1

Pin	Logic	Symbol	Description	Notes
39		GND	Ground	1
40	CML-I	Tx6n	Transmitter Inverted Data Input	
41	CML-I	Tx6p	Transmitter Non-Inverted Data Input	
42		GND	Ground	1
43	CML-I	Tx8n	Transmitter Inverted Data Input	
44	CML-I	Tx8p	Transmitter Non-Inverted Data Input	
45		GND	Ground	1
46		Reserved	For Future Use, No Connect	
47		VS1	Module Vendor Specific 1, No Connect	
48		VccRx1	+3.3 V Power Supply	2
49		VS2	Module Vendor Specific 2	
50		VS3	Module Vendor Specific 3	
51		GND	Ground	1
52	CML-O	Rx7p	Receiver Non-Inverted Data Output	
53	CML-O	Rx7n	Receiver Inverted Data Output	
54		GND	Ground	1
55	CML-O	Rx5p	Receiver Non-Inverted Data Output	
56	CML-O	Rx5n	Receiver Inverted Data Output	
57		GND	Ground	1
58		GND	Ground	1
59	CML-O	Rx6n	Receiver Inverted Data Output	
60	CML-O	Rx6p	Receiver Non-Inverted Data Output	
61		GND	Ground	1
62	CML-O	Rx8n	Receiver Inverted Data Output	
63	CML-O	Rx8p	Receiver Non-Inverted Data Output	
64		GND	Ground	1
65		NC	No Connect	
66		Reserved	For Future Use, No Connect	
67		VccTx1	+3.3 V Power Supply	2
68		Vcc2	+3.3 V Power Supply	2
69		Reserved	For Future Use, No Connect	
70		GND	Ground	1
71	CML-I	Tx7p	Transmitter Non-Inverted Data Input	
72	CML-I	Tx7n	Transmitter Inverted Data Input	
73		GND	Ground	1
74	CML-I	Tx5p	Transmitter Non-Inverted Data Input	
75	CML-I	Tx5n	Transmitter Inverted Data Input	
76		GND	Ground	1

Notes:

1.QSFP-DD uses a common ground (GND) for all signals and power supply. All these aspects are common within the QSFP-DD module, and all module voltages are referenced to this potential unless otherwise noted. Please connect these directly to the host board's signal-common ground plane.

2.VccRx, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 should be applied concurrently. VccRx, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 may be internally connected within the module in any combination. Each Vcc pin on the connector is rated for a maximum current of 1000 mA.

Module side		Module card edge
38 GND	76 GND	
37 TX1n	75 TX5n	
36 TX1p	74 TX5p	
35 GND	73 GND	
34 TX3n	72 TX7n	
33 TX3p	71 TX7p	
32 GND	70 GND	
31 LPMode	69 Reserved	
30 Vcc1	68 Vcc2	
29 VccTx	67 VccTx1	
28 IntL	66 Reserved	
27 ModPrsL	65 NC	
26 GND	64 GND	
25 RX4p	63 RX8p	
24 RX4n	62 RX8n	
23 GND	61 GND	
22 RX2p	60 RX6p	
21 RX2n	59 RX6n	
20 GND	58 GND	

Top side viewed from top

Module card edge		Module side
GND	39	GND	1
TX6n	40	TX2n	2
TX6p	41	TX2p	3
GND	42	GND	4
TX8n	43	TX4n	5
TX8p	44	TX4p	6
GND	45	GND	7
Reserved	46	ModSelL	8
VS1	47	ResetL	9
VccRx1	48	VccRx	10
VS2	49	SCL	11
VS3	50	SDA	12
GND	51	GND	13
RX7p	52	RX3p	14
RX7n	53	RX3n	15
GND	54	GND	16
RX5p	55	RX1p	17
RX5n	56	RX1n	18
GND	57	GND	19

Bottom side viewed from bottom

Absolute Maximum Ratings

Please note that operating this module beyond any individual absolute maximum ratings might cause permanent damage.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Maximum supply voltage	Vcc	-0.3	3.3	3.6	V	
Storage temperature	Ts	-40		85	℃	
Relative humidity	RH	5		85	%	1
Damage threshold, each lane	THd	5			dBm	

Operating Environments

The electrical and optical characteristics listed below are defined under these operating conditions, unless otherwise specified.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply voltage	Vcc	3.135	3.3	3.465	V	
Case temperature	Tc	0		70	℃	
Data rate, each lane			26.5625		GBd	
Data rate accuracy		-100		100	ppm	
Modulation format			PAM4			
Link distance with OM3 MMF				70	m	
Link distance with OM4 MMF				100	m	
Link distance with OM5 MMF				100	m	

Note：

Initialization Flows: We recommend following the Host Initialization Flows outlined in

Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Power dissipation			9	10	W	
Steady state current	Icc			3189	mA	1
Instantaneous peak current				4000	mA	
Sustained peak current				3300	mA	
Module-to-Host electrical specifications at TP4 (module output)						
Differential voltage pk-pk	Vpp			900	mV	
Common mode voltage	Vcm	-350		2850	mV	2
AC common-mode output voltage (RMS)				17.5	mV	
Transition time	Trise/Tfall	9.5			ps	20%~80%
Differential termination resistance mismatch				10	%	
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			IEEE 802.3-2018 Equation (83E-2)		dB	
Common to differential mode con- version return loss			IEEE 802.3-2018 Equation (83E-3)		dB	
Host-to-Module electrical specifications (module input)						
Differential termination resistance mismatch				10	%	
Overload differential voltage pk-pk	Vpp	900			mV	TP1a
DC common mode voltage	Vcm	-350		2850	mV	TP1
Parameter	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**	**Notes**
Single-ended voltage tolerance		-0.4		3.3	V	TP1a
Module stressed input test			IEEE 802.3bs 120E.3.4.1			TP1a
Differential input return loss			IEEE 802.3-2018 Equation (83E-5)		dB	TP1
Differential to common mode input return loss			IEEE 802.3-2018 Equation (83E-6)		dB	TP1

Notes：

1.The module must operate within its declared power class.

2.The host generates the DC common mode voltage. This specification includes the effects of ground offset voltage.

Optical Characteristics

Parameters	Symbol	Min.	Typ.	Max.	Unit	Notes
Center wavelength	λ_c	840		868	nm	
Transmitter						
RMS spectral width				0.65	nm	
Average launch power, each lane	P_{AVG}	-6.5		4	dBm	
Outer optical modulation amplitude (OMA$_{outer}$), each lane	P_{OMA}	-4.5		3	dBm	
Launch power in OMA $_{outer}$ minus TDECQ, each lane		-5.9			dBm	
Transmitter and dispersion eye closure for PAM4, each lane	TDECQ			4.5	dB	
TDECQ – $10\log_{10}(C_{eq})$, each lane				4.5	dB	
Extinction ratio, each lane	ER	3			dB	
Transmitter transition time, each lane				34	ps	
Average launch power of OFF transmitter, each lane	P_{OFF}			-30	dBm	
RIN$_{12}$OMA				-128	dB/Hz	
Optical return loss tolerance				12	dB	
Parameters	**Symbol**	**Min.**	**Typ.**	**Max.**	**Unit**	**Notes**
Encircled flux		≥ 86% at 19 um				
		≤ 30% at 4.5 um				
Receiver						
Average receiver power, each lane		-8.4		4	dBm	
Receiver power, each lane (OMA)				3	dBm	
Damage threshold, each lane	THd	5			dBm	
Receiver reflectance				-12	dB	
LOS assert	LosA	-24.6			dBm	
LOS de-assert	LosD			-8	dBm	
LOS hysteresis	LosH	0.5			dB	
Receiver sensitivity (OMA $_{outer}$), each lane	Sen			Max (−6.5, SECQ −7.9)	dB	
Stressed receiver sensitivity (OMA), each lane	SRS			-3.4	dBm	
Conditions of stressed receiver sensitivity test						
Stressed eye closure for PAM4, lane under test	SECQ			4.5	dB	
SECQ – $10\log_{10}(C_{eq})$, lane under test				4.5	dB	
OMA $_{outer}$ of each aggressor lane				3	dBm	

EEPROM Definitions

Refer to the CMIS Rev4.0 used for QSFP-DD.

Digital Diagnostic Monitoring Functions

The Digital Diagnostic Management Interface (DDMI) is realized through an I2C interface in compliance with CMIS 4.0. The diagnostic management functions are implemented, and the data addresses are listed below.

Performance item	Related bytes	Monitor error	Notes
Module temperature	Lower Page (14 to 15)	≤ ± 3℃	1, 2
Module voltage	Lower Page (16 to 17)	≤ ± 3%	2
Transmitter optical power	Upper Page11h (154 to 169)	≤ ±3 dB	2
Bias current	Upper Page11h (170 to 185)	≤ ± 10%	2
Receiver optical power	Upper Page11h (186 to 201)	≤ ±3 dB	2

Note:

1.The actual temperature test point is located on the module case around the laser array.

2.The module operates within the full temperature range.

listed below.

Digital Diagnostic Monitoring Functions

HSD1-400-SR-C5S supports alarm functions, which are triggered when the values of the preceding basic performance measurements fall below or exceed the specified thresholds.

| Performance item	Alarm threshold bytes (Page02h memory)	Unit	Low threshold	High threshold
Temperature warning	132 to 135	℃	0	70
Voltage warning	140 to 143	V	3.135	3.465
Ibias warning	188 to 191	mA	5	8.5
Tx power warning	180 to 183	dBm	-6.5	5.5
Rx power warning	196 to 199	dBm	-7	5.5
Temperature alarm	128 to 131	℃	-10	80
Voltage alarm	136 to 139	V	2.97	3.63
Ibias alarm	184 to 187	mA	4	9.5
Tx power alarm	176 to 179	dBm	-9.5	7
Rx power alarm	192 to 195	dBm	-10	7

Mechanical Specifications
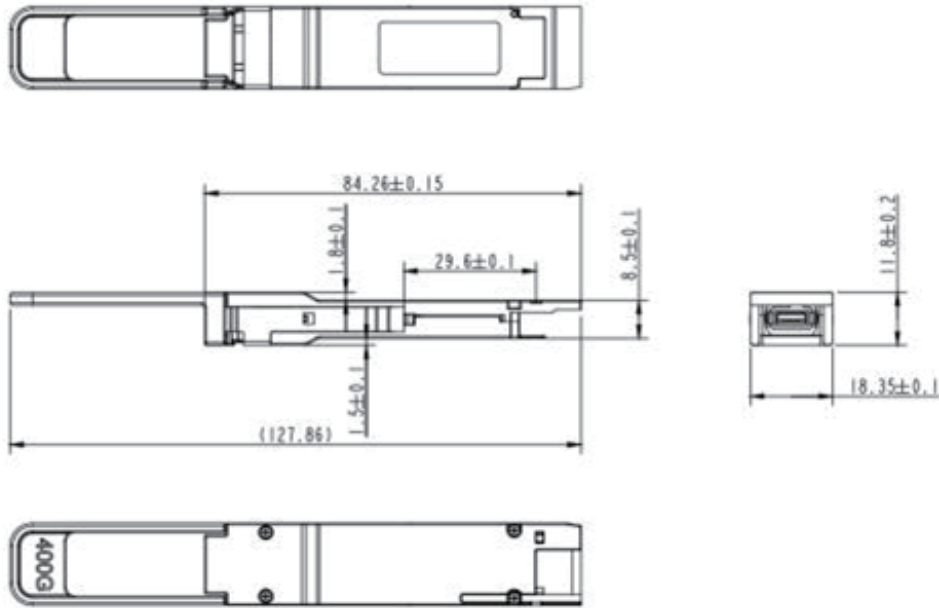
Figure 3 HSD1-400-SR-C5S mechanical dimensions

Optical Interface

The optical interface port for the QSFP-DD 400GE SR8 shall be a male MPO-16 APC receptacle. Figure 4 shows the recommended location and numbering of the optical ports for each media-dependent interface. When looking into the MDI receptacle with the connector keyway feature on top, the transmitter and receiver optical lanes should occupy the positions depicted in Figure 4.
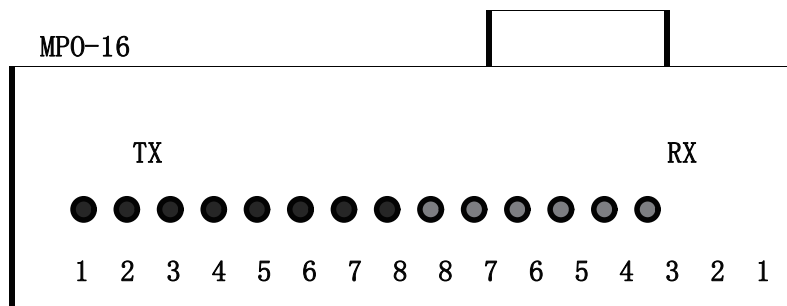

Figure 4 Optical media dependent interface port assignments

Regulatory Compliance

The QSFP-DD 400GE SR8 optical transceiver is RoHS 2.0 compliant and complies with international electromagnetic compatibility (EMC) and product safety requirements and standards.

Feature	Agency	Standard	Performance
Safety	NRTL	UL 62368-1 CAN/CSA C22.2 No. 62368-1	NRTL recognized component for US and Canada
	TUV	EN 62368-1 IEC 60825-1:2014 EN 60825-1:2014 IEC 60825-2:2004+A1:2006+A2:2010 EN 60825-2:2004+A1:2006+A2:2010	TUV certificate
	FDA	U.S. 21 CFR 1040.10	The QSFP-DD 400GE SR8 optical transceiver is FDA/CDRH certified and has been assigned an accession number in accordance with Laser Notice 56.
Electromagnetic Compatibility	Radiated emissions	EMC Directive 2014/30/EU EN 55032 CISPR 32 FCC rules 47 CFR Part 15 ICES-003 AS/NZS CISPR 32	The QSFP-DD 400GE SR8 optical transceiver is classified as a Class B digital device with a minimum -6dB margin to the limit when tested with a metal enclosure. The final margin may vary depending on the system application. To achieve Class B margins at the system level, it is essential to follow good system EMI design practices, such as using a suitable metal enclosure and ensuring proper bonding. The transceiver has been tested within a frequency range of 30 MHz to 40 GHz or the 5th harmonic (5 times the highest frequency), whichever is less.
	ESD	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-2	Withstands discharges of ± 8 kV contact, ± 15 kV air.
	Radiated immunity	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-3	Field strength of 10 V/m from 80 MHz to 6 GHz.
Restriction of Hazardous Substances	RoHS	EU Directive 2011/65/EU (EU) 2015/863	

产品满足中国 RoHS 的要求:

部件名称	产品中有害物质的名称及含量					
	镉	铅	汞	六价铬	多溴联苯	多溴二苯醚
机柜/插框	○	╳	○	○	○	○
PCBA	○	╳	○	○	○	○
辅料	○	╳	○	○	○	○
配套设备	○	╳	○	○	○	○

ESD Design

Standard ESD precautions must be taken while handling this module. The transceiver is shipped in ESD-protective packaging and should be removed from this packaging within an ESD-protected environment. This environment should include standard grounded benches, floor mats, and wrist straps.

Parameter	Value	Notes
ESD of all the QSFP-DD module pins	1 kV	Human body model
Air discharge during operation	15 kV	
Direct contact discharges to the case	8 kV	

Safety Specification Design

Do not look directly into the fiber end faces without using eye protection or an optical meter (such as a magnifier or microscope) within 100 mm, unless you have ensured that the laser output is disabled. When operating an optical meter, follow the operation requirements.

CAUTION - Use of controls, adjustments, or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Laser Safety

This is a Class 1 Laser Product as defined by IEC 60825-1:2014. When operated within the limits of this specification it is considered non-hazardous. Operating this product in a manner inconsistent with specifications and intended usage may result in hazardous radiation exposure.

CLASS 1
LASER PRODUCT

Product Label

Ordering Information

Part No.	Data Rate	Wavelength	Max Distance	Case Temperature Range
HSD1-400-SR-C5S	400Gbps	850nm	100m	0°C to 70°C

Notice

SiPhx reserves the right to change the specifications of the products identified in this datasheet without prior notice. The applications described herein are for illustrative purposes only, and SiPhx does not guarantee that the identified products will be suitable for the described applications without further testing and/or modification.

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