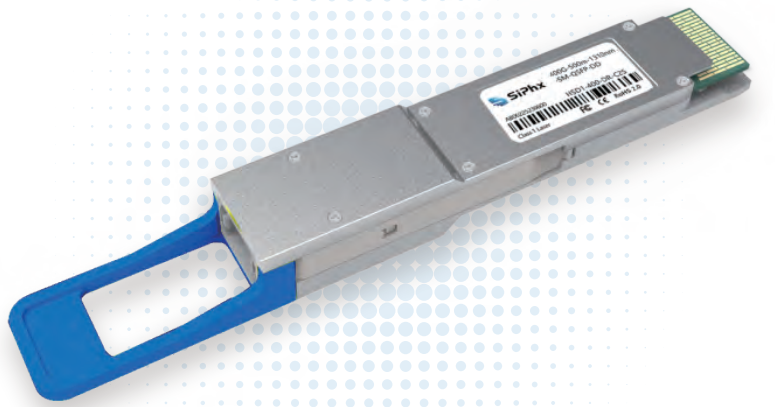
400G DR4 QSFP-DD PAM4 1310nm 500m DOM MTP/MPO SMF SiPh Optical Transceiver Module Hyper Silicon™ PAM4 Technology P/N HSD1-400-DR-C4S



Product Features

- QSFP-DD MSA 5.1 and CMIS 4.0 compliant
- MPO-12 APC connector
- 8x53.125Gbps PAM4 400GAUI-8 host interface
- 4x106.25Gbps (53.125GBd PAM4) optical signal
- Up to 500m over single-mode fiber (SMF) with KP-FEC
- Power dissipation ≤ 10W
- Operating case temperature: 0°C to 70°C
- IEEE 802.3bs 400GBASE-DR4 compliant
- Built-in digital diagnostic functions
- 3.3V power supply voltage
- RoHS compliant

Applications

- 400GBASE-DR4 Ethernet
- Data center networks

Product Description

The SiPhx HSD1-400-DR-C2S transceiver is designed for 500m optical communication applications, and is compliant with QSFP-DD MSA, CMIS 4.0, IEEE 802.3bs, and 400GAUI-8 standards. The 425 Gigabit signal is carried over four parallel lanes at 1310nm. The module's transmitter converts 8-channel 53.125 Gbps electrical data to 4 parallel optical output signals, each supporting 106.25 Gbps. The receiver converts 4-channel 106.25 Gbps optical input data to 8-channel electrical output data.

Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{cc}	-0.5	-	3.6	V
Storage Temperature	T_{sto}	-40		85	°C
Relative Humidity (Non-condensing)	RH	5		95	%
Control Input Voltage	V_i	-0.3		V_{cc}+0.5	

Specified Operations Conditions

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Voltage	V_{cc}	3.135	3.3	3.465	V
Case Operating Temperature	T_{op}	0	-	70	°C
Relative Humidity (Non-condensing)	RH	15		85	%
I2C Clock Frequency			100	400	kHz

Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit
Power Supply Current	I_{cc}			3820	mA
Power On Initialization Time	T_{init}			2000	ms
Transmitter					
Signaling Speed, each lane			25.5625		GBd
Signaling Speed Tolerance		-100		+100	ppm
Differential Input Voltage, pk-pk	$V_{in,pp}$			900	mV
Differential Input Impedance	Z_{in}	90	100	110	Ohms
DC Common Mode Voltage		-350		2850	mV
Receiver					
Signaling Speed, each lane			25.5625		GBd
Signaling Speed Tolerance		-100		+100	ppm
Differential Input Voltage, pk-pk	$V_{out,pp}$			900	mV
Differential Output Impedance	Z_{out}	90	100	110	Ohms
Transition Time, 20% to 80%	T_r, T_f	9.5			ps
DC Common Mode Voltage		-350		2850	mV
AC Common Mode Voltage (RMS)				17.5	mV

Optical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Notes
Transmitter						
Signaling Speed			53.125		GBd	1
Signaling Speed Tolerance		-100		+100	ppm	
Modulation Format			PAM4			
Wavelength	λ	1304.5	1311	1317.5	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Average TX Power	P_{avg}	-2.9		4	dBm	1
Outer Optical Modulation Amplitude	OMA_{outer}	-0.8		4.2	dBm	1
Extinction Ratio	ER	3.5			dB	1
Avg Launch Power TX Off	P_{off}			-15	dBm	1
Launch Power in OMA_{outer} – TDECQ		-2.2			dBm	1
Transmitter & Dispersion Eye Closure	TDECQ			3.4	dB	1
Relative Intensity Noise	RIN			-136	dB/Hz	
Optical Return Loss	ORTL			21.4	dB	
Reflectance				-26	dB	
Receiver						
Signaling Speed			53.125		GBd	1
Signaling Speed Tolerance		-100		+100	ppm	
Modulation Format			PAM4			
Wavelength	λ	1304.5	1311	1317.5	nm	
Damage Threshold		5			dBm	1
Average RX Power		-5.9		4	dBm	1
RX Power (OMA_{outer})				4.2	dBm	2
RX Reflectance				-26	dBm	
RX Sensitivity (OMA_{outer})				-4.4	dBm	3
Stressed RX Sensitivity (OMA_{outer})				-1.9	dBm	1
Conditions of Stressed RX Sensitivity Test						
Stressed Eye Closure, lane under test	SECQ		3.4		dB	
OMA_{outer} of Each Agressor Lane			4.2			

1.Each lane.

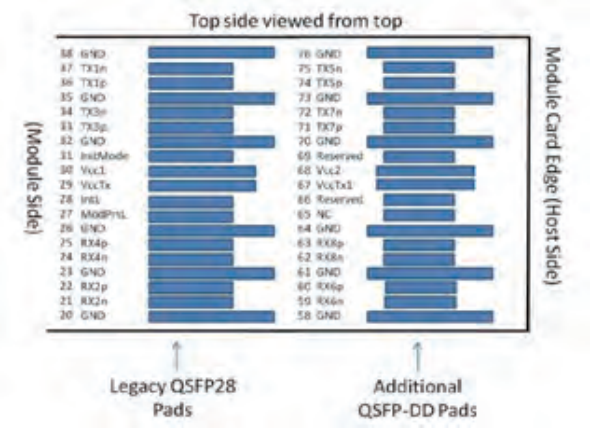
2.Receiver sensitivity (OMA outer) for each lane (max) is informative and is defined for a transmitter with SECQ of 0.9 dB.

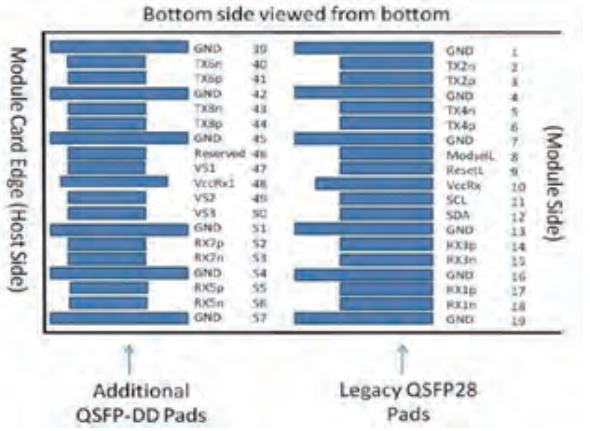
3.Measured using a conformance test signal at TP3 for BER of 2.4x10-4.

Electrical Input/Output

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	+3.3V Power Supply Receiver	2
11	LVCOMS-I/O	SCL	2-wire serial interface clock	
12	LVCOMS-I/O	SDA	2-wire serial interface data	
13		GND	Ground	1
14	CML-O	Rx3p	Receiver Non-Inverted Data Input	
15	CML-O	Rx3n	Receiver Inverted Data Input	
16		GND	Ground	1
17	CML-O	Rx1p	Receiver Non-Inverted Data Input	
18	CML-O	Rx1n	Receiver Inverted Data Input	
19		GND	Ground	1
20		GND	Ground	1
21	CML-O	Rx2n	Receiver Inverted Data Input	
22	CML-O	Rx2p	Receiver Non-Inverted Data Input	
23		GND	Ground	1
24	CML-O	Rx4n	Receiver Inverted Data Input	
25	CML-O	Rx4p	Receiver Non-Inverted Data Input	
26		GND	Ground	1
27	LVTTL-O	ModPrsL	Module Present	
28	LVTTL-O	IntL	Interrupt	
29		VccTx	+3.3V Power supply transmitter	2
30		Vcc1	+3.3V Power supply	2
31	LVTTL-I	InitMode	Initialization mode; In legacy QSFP applications, the InitMode pad is called LPMODE	
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
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	3
47		VS1	Module Vendor Specific 1	3
48		VccRx1	3.3V Power Supply	2
49		VS2	Module Vendor Specific 2	3
50		VS3	Module Vendor Specific 3	3
51		GND	Ground	1
52	CML-O	Rx7p	Receiver Non-Inverted Data Input	
53	CML-O	Rx7n	Receiver Inverted Data Input	
54		GND	Ground	1
55	CML-O	Rx5p	Receiver Non-Inverted Data Input	
56	CML-O	Rx5n	Receiver Inverted Data Input	
57		GND	Ground	1
58		GND	Ground	1
59	CML-O	Rx6n	Receiver Inverted Data Input	
60	CML-O	Rx6p	Receiver Non-Inverted Data Input	
61		GND	Ground	1
62	CML-O	Rx8n	Receiver Inverted Data Input	
63	CML-O	Rx8p	Receiver Non-Inverted Data Input	
64		GND	Ground	1
65		NC	No Connect	3
66		Reserved	For future use	3
67		VccTx1	3.3V Power Supply	2
68		Vcc2	3.3V Power Supply	2
69		Reserved	For future use	3
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

Electrical Input/Output



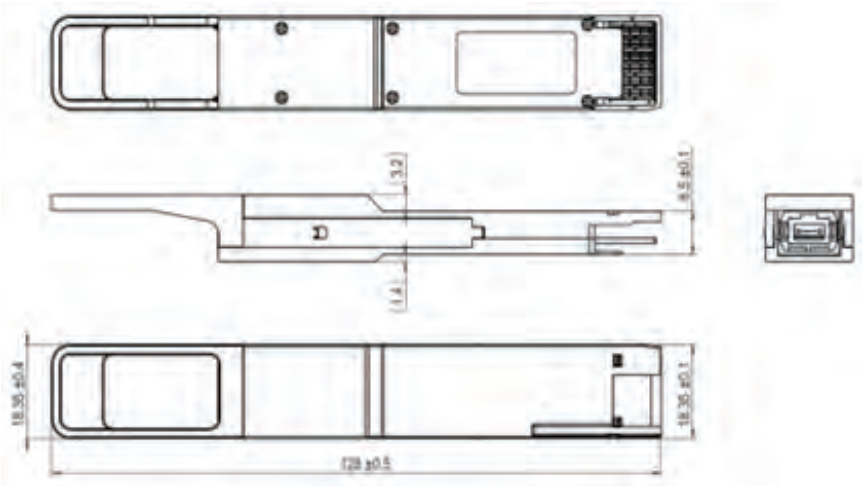


1.QSFP-DD uses a common ground (GND) for all signals and power supply. All connections within the QSFP-DD module share this common ground, and all module voltages are referenced to this potential unless otherwise specified. Connect these directly to the host board's signal-common ground plane.

2.VccRx, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 should be applied simultaneously. Requirements for the host side of the Host Card Edge Connector are listed in Table 6. VccRx, VccRx1, Vcc1, Vcc2, VccTx, and VccTx1 can be internally connected within the module in any combination. The connector Vcc pin is rated for a maximum current of 1000 mA.

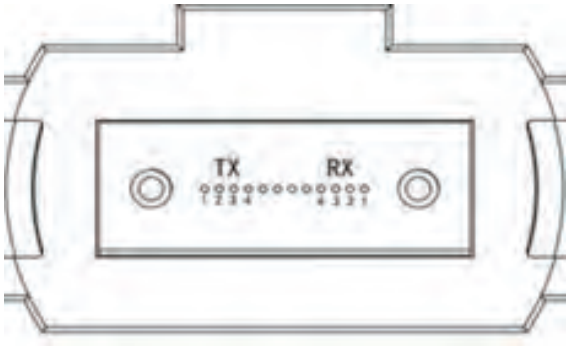
3.All Vendor Specific, Reserved, and No Connect pins can be terminated with 50 ohms to ground on the host. Pad 65 (No Connect) must be left unconnected within the module. Vendor-specific and Reserved pads should have an impedance to GND greater than 10 kohms and less than 100 pF.

Mechanical Specifications



The product should possess the design, construction, and physical dimensions specified in the relevant product drawing.

Optical Interface



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. Using this product in a manner inconsistent with the specifications and intended usage may result in hazardous radiation exposure.

Product Label

Regulatory Certifications

This product is certified in accordance with the following regulatory standards:

Category	Standard
Radiated Emissions	EMC Directive 2014/30/EU EN 55032 CISPR 32 FCC rules 47 CFR Part 15 ICES-003 VCCI-CISPR 32 AS/NZS CISPR 32
Radiated Immunity	EMC Directive 2014/30/EU EN 55035 CISPR 35 IEC/EN 61000-4-3
RoHS	EU RoHS (2011/65/EU & (EU) 2015/863) & UK RoHS EN IEC 63000:2018 & BS EN IEC 63000:2018
Flammability (PCB)	UL Class 94 V-0

Ordering Information

Part No.	Data Rate	Wavelength	Max Distance	Case Temperature Range
HSD1-400-DR-CS2	425Gbps	1310nm	500m	0°C to 70°C

Notice

SiPhx reserves the right to change product specifications 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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