TITLE **400G QSFP-DD LR4 10Km Transceiver**	**DOC No. RFD-20230616005-001**	
	REVISION：01	**AUTHORIZED BY：Mike Sun**
	DATE：2023/06/21	**CLASSIFICATION：Optical Transceiver**

1. SCOPE

This product is a 400Gb/s Quad Small Form Factor Pluggable-double density (QSFP-DD) optical module designed for 10km optical communication applications. The module converts 8 channels of 50Gb/s (PAM4) electrical input data to 4 channels of CWDM optical signals and multiplexes them into a single channel for 400Gb/s optical transmission. Reversely, on the receiver side, the module optically de-multiplexes a 400Gb/s optical input into 4 channels of CWDM optical signals, and converts them to 8 channels of 50Gb/s (PAM4) electrical output data.

The central wavelengths of the 4 CWDM channels are 1271, 1291, 1311 and 1331 nm as members of the CWDM wavelength grid defined in ITU-T G.694.2. It contains a duplex LC connector for the optical interface and a 76-pin connector for the electrical interface. To minimize the optical dispersion in the long-haul system, single-mode fiber (SMF) has to be applied in this module. Host FEC is required to support up to 10km fiber transmission

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP-DD Multi-Source Agreement (MSA) Type 2. It has been designed to meet the harshest external operating conditions including temperature humidity and EMI interference.

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2. PRODUCT FEATURES

- QSFP-DD MSA compliant
- 4 CWDM lanes MUX/DEMUX design
- 100G Lambda MSA 400G-LR4 Specification compliant
- Up to 10km transmission on single mode fiber (SMF) with FEC
- Operating case temperature: 0 to 70^{o}C
- 8x53.125Gb/s electrical interface (400GAUI-8)
- Data Rate 106.25Gbps (PAM4) per channel.
- Maximum power consumption 12W
- Duplex LC connector
- RoHS compliant

3. PRODUCT DESCRIPTION

3.1 PRODUCT NAME AND SERIES NUMBER(S)

QSFPDD 400G LR4 Transceiver

Part Number	Data Rate	Wavelength (nm)	Distance	Media	Power (dBm)	Sen. (dBm)	Connector	Tem.
P66000GGCB10-1	400G	CWDM	10 km	SMF	-2.8~4.0	-26	LC	**C**

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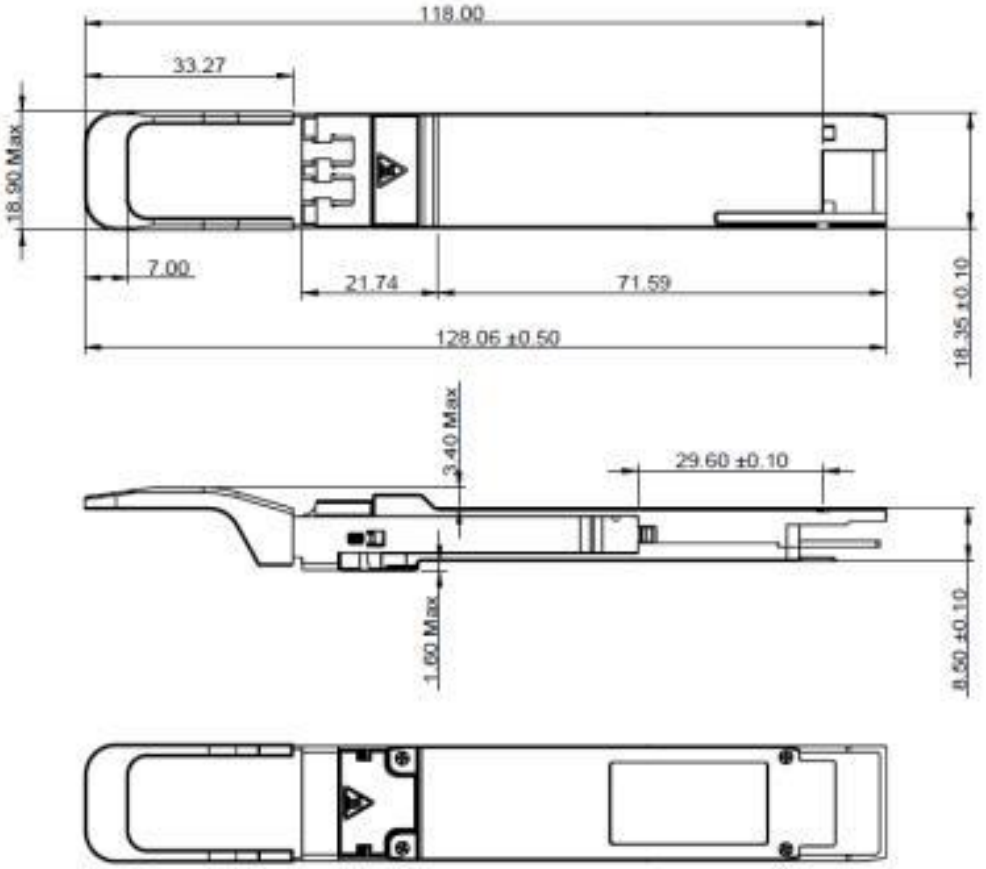
3.2 DIMENSIONS, MATERIALS, PLATINGS AND MARKING



4. APPLICABLE DOCUMENTS AND SPECIFICATIONS

- 400G Ethernet
- Data Center Interconnect
- Infiniband Interconnect
- Enterprise Networking

TITLE	DOC No. RFD-20230616005-001	
400G QSFP-DD LR4 10Km Transceiver	REVISION：01	AUTHORIZED BY：Mike Sun
	DATE：2023/06/21	CLASSIFICATION：Optical Transceiver

5. Absolute Maximum Ratings & Recommended Operating Conditions

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit
Storage Temperature	TS	-40	85	℃
Operating Case Temperature	TOP	0	70	℃
Power Supply Voltage	VCC	-0.5	3.6	V
Relative Humidity (non-condensation)	RH	0	85	%
Damage Threshold, each Lane	THd	5.0		dBm

Recommended Operating Conditions

Parameter	Symbol	Min.	Typical	Max.	Unit
Case Temperature Operating	Tcase	0	-	70	℃
Supply Voltage	Vcc	3.14	-	3.46	V
Power Consumption	P	-	-	12	W
Supply Current	Icc	-	-	3.64	A
Pre-FEC Bit Error Ratio	-	-	-	$2.4x10^{-4}$	-
Post-FEC Bit Error Ratio	-	-	-	$1x10^{-12}$	-
Link Distance	D	0.002	-	10	km
Data Rate Accuracy	-	-100	-	100	ppm

TITLE **400G QSFP-DD LR4 10Km Transceiver**	**DOC No. RFD-20230616005-001**	
	REVISION：01	**AUTHORIZED BY：Mike Sun**
	DATE：2023/06/21	**CLASSIFICATION：Optical Transceiver**

Transmitter Operating Characteristic-Optical

Parameter	Symbol	Min.	Typical	Max.	Unit	Note
Line wavelengths Range	Lane 1	1264.5	1271	1277.5	nm	
	Lane 2	1284.5	1291	1297.5	nm	
	Lane 3	1304.5	1311	1317.5	nm	
	Lane 4	1324.5	1331	1337.5	nm	
Signal Rate per Lane	-	-	53.125	-	Gbd	
Modulation Format	-	PAM4				
Side- mode Suppression Ratio	SMSR	30	-	-	dB	
Total Average Launch Power	PT	-	-	10.0	dBm	
Average Launch Power, each Lane	PAVG	-2.8	-	4.0	dBm	1
Outer Optical Modulation Amplitude (OMA_{outer}), each Lane	POMA	0.2	-	4.2	dBm	2
Launch Power in OMA_{outer} minus TDECQ, each Lane for ER ≥ 4.5dB for ER < 4.5dB	-	 -1.2 -1.1	-	-	dB	
Transmitter and Dispersion Eye Closure for PAM4, each Lane	TDECQ	-	-	3.9	dB	
TDECQ – 10*log10(Ceq), each Lane	-	-	-	3.9	dB	3
Extinction Ratio	ER	3.5	-	-	dB	
Difference in Launch Power Between Any Two Lanes (OMA_{outer})	-	-	-	-4	dB	
$RIN_{15.6OMA}$	RIN	-	-	-136	dB/Hz	
Optical Return Loss Tolerance	TOL	-	-	15.6	dB	
Transmitter Reflectance	RT	-	-	-26	dB	
Transmitter Transition Time	-	-	-	17	ps	
Average Launch Power of OFF Transmitter, each Lane	Poff	-	-	-20	dBm	

TITLE	DOC No. RFD-20230616005-001	
400G QSFP-DD LR4 10Km Transceiver	REVISION：01	AUTHORIZED BY：Mike Sun
	DATE：2023/06/21	CLASSIFICATION：Optical Transceiver

Differential pk-pk Input Voltage Tolerance	TP1a	900	-	-	mVpp	4
Differential Termination Mismatch	TP1	-	-	10	%	
Differential Input Return Loss	TP1	IEEE 802.3-2015 Equation(83E-5)			dB	
Differential to Common Mode Input Return Loss	TP1	IEEE 802.3-2015 Equation(83E-6)			dB	
Module Stressed Input Test	TP1a	See IEEE 802.3bs 120E.3.4. 1			-	5
Single-ended Voltage Tolerance Range	TP1a	-0.4 to 3.3			V	
DC Common Mode Input Voltage	TP1	-350	-	2850	mV	6

Notes:

1. Average launch power, each lane (min) is informative and not the principal indicator of signal strength. A transmitter with launch power below this value cannot be compliant; however, a value above this does not ensure compliance.

2. Even if the TDECQ < 1.4 dB for an extinction ratio of ≥ 4.5 dB or TDECQ < 1.3 dB for an extinction ratio of < 4.5 dB, the OMAouter (min) must exceed the minimum value specified here.

3. Ceq is a coefficient defined in IEEE Std 802.3-2018 clause 121.8.5.3 which accounts for reference equalizer noise enhancement.

4. With the exception to IEEE 802.3bs 120E.3. 1.2 that the pattern is PRBS31Q or scrambled idle.

5. Meets BER specified in IEEE 802.3bs 120E. 1.1.

6. DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.

Receiver Operating Characteristic-Optical, Electrical

Parameter	Symbol	Min.	Typical	Max.	Unit	Note
Line wavelengths Range	Lane 1	1264.5	1271	1277.5	nm	
	Lane 2	1284.5	1291	1297.5	nm	
	Lane 3	1304.5	1311	1317.5	nm	
	Lane 4	1324.5	1331	1337.5	nm	
Modulation Format	-	PAM4				
Signal Rate per Lane	-	-	53.125	-	Gbd	
Damage Threshold, each Lane	THd	5.0	-	-	dBm	1
Average Receive Power, each Lane	-	-9.1	-	4.0	dBm	2
Receive Power (OMAouter), each Lane	-	-	-	4.2	dBm	

TITLE **400G QSFP-DD LR4 10Km Transceiver**	**DOC No. RFD-20230616005-001**	
	REVISION：01	**AUTHORIZED BY：Mike Sun**
	DATE：2023/06/21	**CLASSIFICATION：Optical Transceiver**

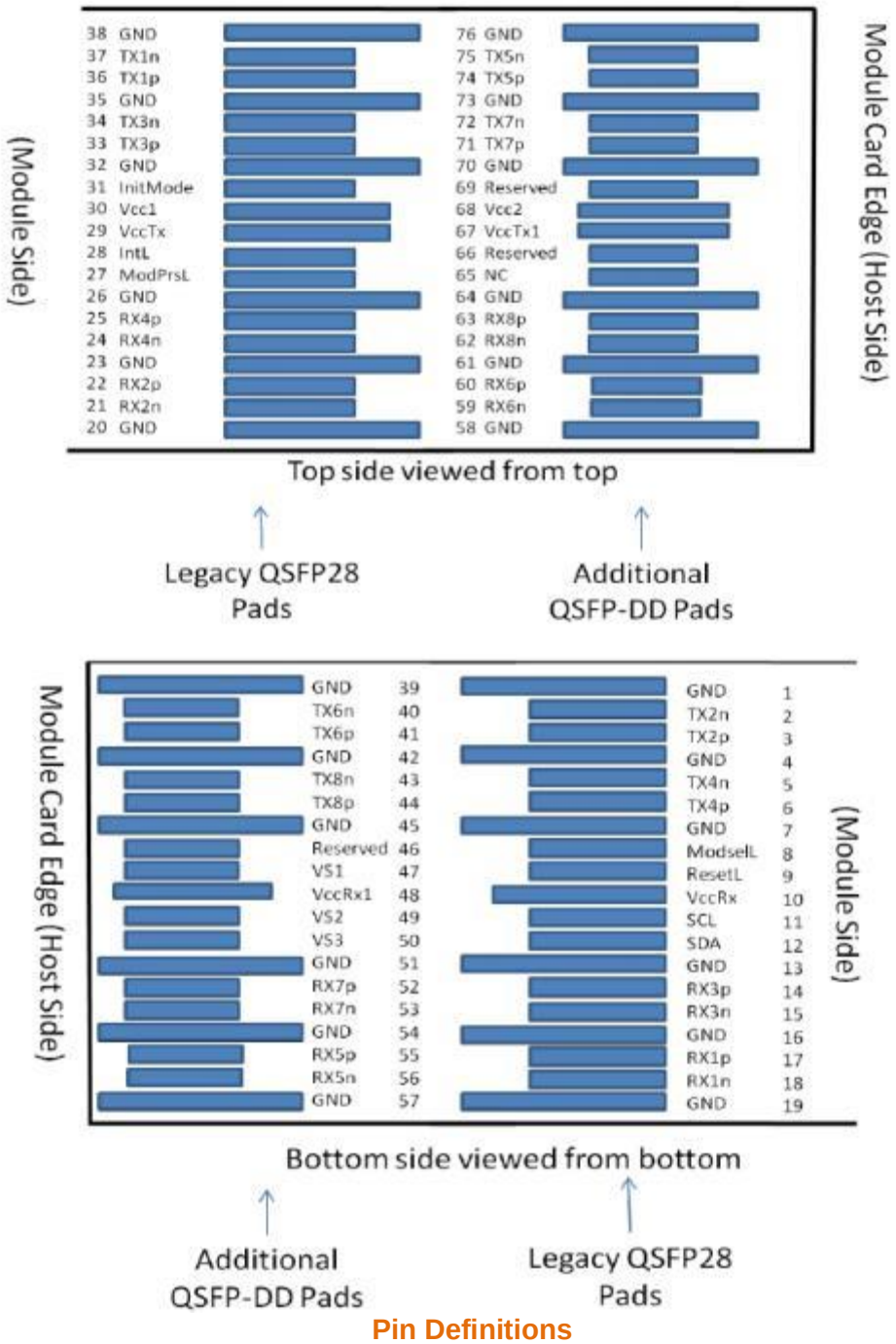
Difference in Receiver Power between any Two Lanes (OMAouter)	-	-	-	4.6	dB	
Receiver Sensitivity (OMAouter), each Lane	SEN	-	-	Equation (1)	dBm	
Stressed Receiver Sensitivity (OMAouter) Each Lane	SRS	-	-	-4.1	dBm	3
Receiver Reflectance	RR	-	-	-26	dB	
LOS Assert	LOSA	-20	-	-	dBm	
LOS De-assert	LOSD	-	-	-12.1	dBm	
LOS Hysteresis	LOSH	0.5	-	-	dB	
Differential Peak-to-Peak Output Voltage	TP4	-	-	900	mVpp	
AC Common Mode Output Voltage, RMS	TP4	-	-	17.5	mV	
Differential Termination Mismatch	TP4	-	-	10	%	
Differential Output Return Loss	TP4	IEEE 802.3-2015 Equation(83E-2)			-	
Common to Differential Mode Conversion Return Loss	TP4	IEEE 802.3-2015 Equation(83E-3)			-	
Transition Time, 20% to 80%	TP4	9.5	-	-	ps	
Near-end Eye Symmetry Mask Width	TP4	-	0.265	-	UI	
Near-end Eye Height Differential	TP4	70	-	-	mV	
Far-end Eye Symmetry Mask Width	TP4	-	0.2	-	UI	
Far-end Eye Height Differential	TP4	30	-	-	mV	
Far-end Pre-cursor ISI Ratio	TP4	-4.5	-	2.5	%	
Common Mode Output Voltage	TP4	-350	-	2850	mV	

Note:

1. *Average receive power, each lane (min) is informative and not the principal indicator of signal strength. A received power below this value cannot be compliant; however, a value above this does not ensure compliance.*
2. *The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.*
3. *Measured with conformance test signal at TP3 for the BER equal to $2.4x10^{-4}$.*
4. *DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.*

TITLE	DOC No. RFD-20230616005-001	
400G QSFP-DD LR4 10Km Transceiver	REVISION：01	AUTHORIZED BY：Mike Sun
	DATE：2023/06/21	CLASSIFICATION：Optical Transceiver

6. Pin-out Definition:



Pin Definitions

TITLE	DOC No. RFD-20230616005-001	
400G QSFP-DD LR4 10Km Transceiver	REVISION：01	AUTHORIZED BY：Mike Sun
	DATE：2023/06/21	CLASSIFICATION：Optical Transceiver

Pin Assignment

Pin	Symbol	Name/Description	Note
1	GND	Ground	
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data Input	
4	GND	Ground	
5	Tx4n	Transmitter Inverted Data Input	
6	Tx4p	Transmitter Non-Inverted Data Input	
7	GND	Ground	
8	ModSelL	Module Select	
9	ResetL	Module Reset	
10	VccRx	+3.3V Power Supply Receiver	
11	SCL	2-wire serial interface clock	
12	SDA	2-wire serial interface data	
13	GND	Ground	
14	Rx3p	Receiver Non-Inverted Data Output	
15	Rx3n	Receiver Inverted Data Output	
16	Ground	1B	
17	Rx1p	Receiver Non-Inverted Data Output	
18	Rx1n	Receiver Inverted Data Output	
19	GND	Ground	
20	GND	Ground	
21	Rx2n	Receiver Inverted Data Output	
22	Rx2p	Receiver Non-Inverted Data Output	
23	GND	Ground	
24	Rx4n	Receiver Inverted Data Output	
25	Rx4p	Receiver Non-Inverted Data Output	
26	GND	Ground	
27	ModPrsL	Module Present	
28	IntL	Interrupt	

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	REVISION：01	**AUTHORIZED BY：Mike Sun**
	DATE：2023/06/21	**CLASSIFICATION：Optical Transceiver**

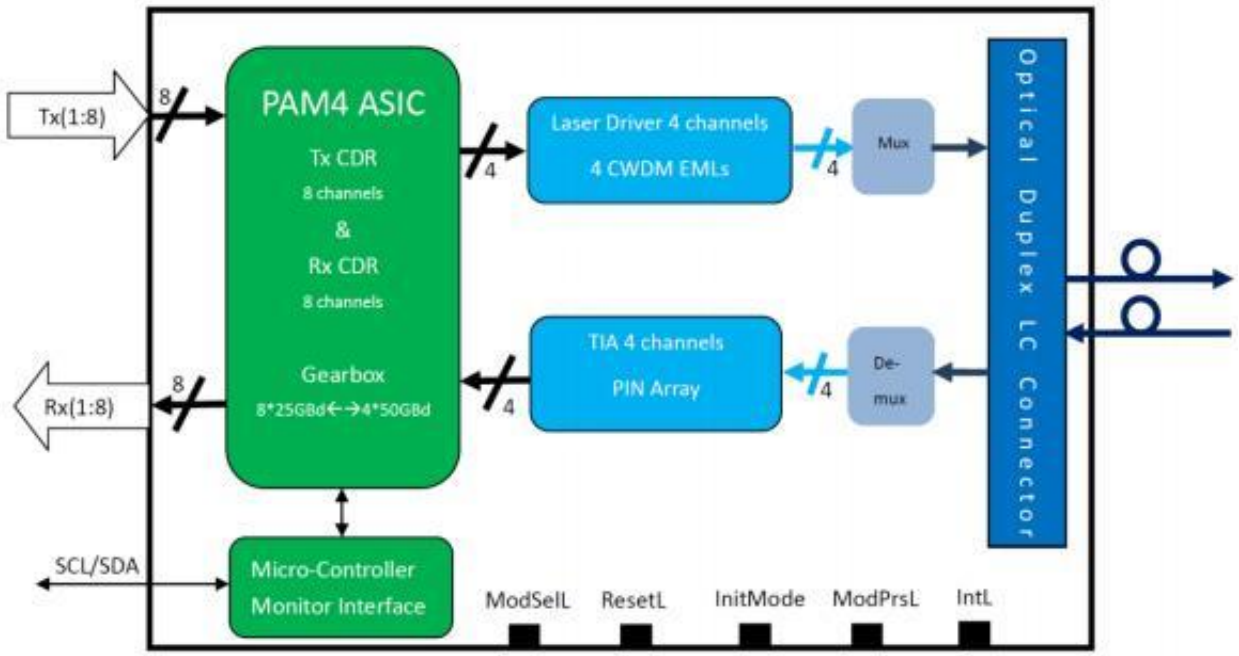
29	VccTx	+3.3V Power supply transmitter	
30	Vcc1	+3.3V Power supply	
31	InitMode	Initialization mode; In legacy QSFP applications, the InitMode pad is called LPMODE	
32	GND	Ground	
33	Tx3p	Transmitter Non-Inverted Data Input	
34	Tx3n	Transmitter Inverted Data Input	
35	GND	Ground	
36	Tx1p	Transmitter Non-Inverted Data Input	
37	Tx1n	Transmitter Inverted Data Input	
38	GND	Ground	
39	GND	Ground	
40	Tx6n	Transmitter Inverted Data Input	
41	Tx6p	Transmitter Non-Inverted Data Input	
42	GND	Ground	
43	Tx8n	Transmitter Inverted Data Input	
44	Tx8p	Transmitter Non-Inverted Data Input	
45	GND	Ground	
46	Reserved	For future use	
47	VS1	Module Vendor Specific 1	
48	VccRx1	3.3V Power Supply	
49	VS2	Module Vendor Specific 2	
50	VS3	Module Vendor Specific 3	
51	GND	Ground	
52	Rx7p	Receiver Non-Inverted Data Output	
53	Rx7n	Receiver Inverted Data Output	
54	GND	Ground	
55	Rx5p	Receiver Non-Inverted Data Output	
56	Rx5n	Receiver Inverted Data Output	
57	GND	Ground	
58	GND	Ground	

TITLE **400G QSFP-DD LR4 10Km Transceiver**	**DOC No. RFD-20230616005-001**	
	REVISION：01	**AUTHORIZED BY：Mike Sun**
	DATE：2023/06/21	**CLASSIFICATION：Optical Transceiver**

59	Rx6n	Receiver Inverted Data Output	
60	Rx6p	Receiver Non-Inverted Data Output	
61	GND	Ground	
62	Rx8n	Receiver Inverted Data Output	
63	Rx8p	Receiver Non-Inverted Data Output	
64	GND	Ground	
65	NC	No Connect	
66	Reserved	For future use	
67	VccTx1	3.3V Power Supply	
68	Vcc2	3.3V Power Supply	
69	Reserved	For Future Use	
70	GND	Ground	
71	Tx7p	Transmitter Non-Inverted Data Input	
72	Tx7n	Transmitter Inverted Data Input	
73	GND	Ground	
74	Tx5p	Transmitter Non-Inverted Data Input	
75	Tx5n	Transmitter Inverted Data Input	
76	GND	Ground	

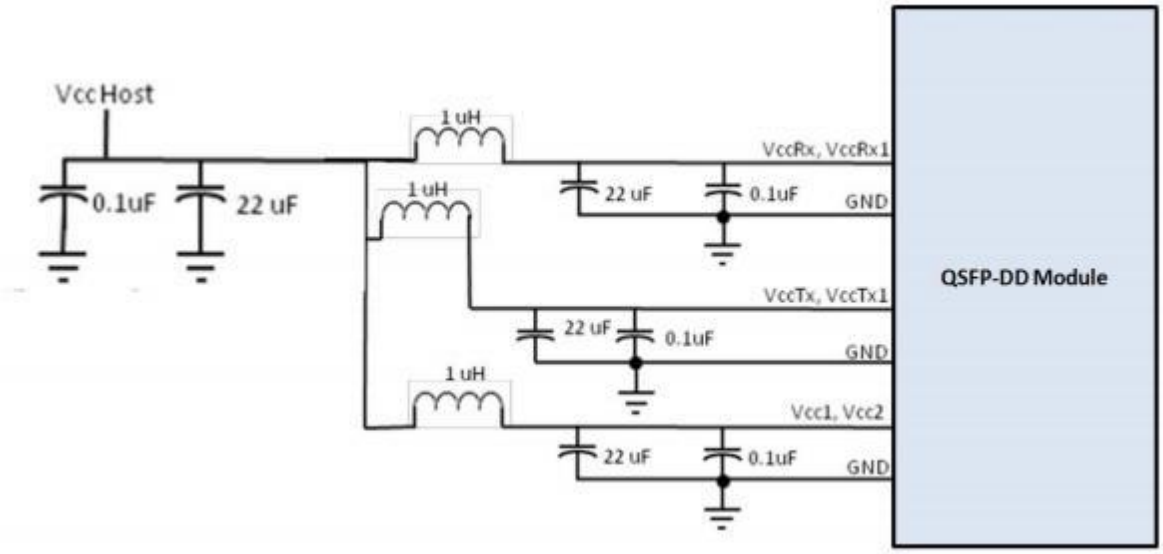
TITLE	DOC No. RFD-20230616005-001	
400G QSFP-DD LR4 10Km Transceiver	REVISION：01	AUTHORIZED BY：Mike Sun
	DATE：2023/06/21	CLASSIFICATION：Optical Transceiver

Block Diagram of Transceiver



Block Diagram of Transceiver

Recommended Power Supply Filter



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7. Digital Diagnostic Functions

Parameter	Symbol	Min	Max	Units	Notes
Temperature Monitor Absolute Error	DMI_Temp	-3	3	degC	Over operating temperature range
Supply Voltage Monitor Absolut Error	DMI _VCC	-0.1	0.1	V	Over full operating range
Channel RX Power Monitor Absolute Error	DMI_RX_Ch	-2	2	dB	1
Channel Bias Current Monitor	DMI_Ibias_Ch	-10%	10%	mA	
Channel TX Power Monitor Absolute Error	DMI_TX_Ch	-2	2	dB	1

8. Modification History

Rev.	Comments	Date	Originator	Approval
01	Preliminary Draft	2023/06/21	Albert Lin	Mike Sun