400Gb/s 10Km QSFP-DD Transceiver

QSFP-DD Series

- **Compliant with IEEE802.3bs/ IEEE 802.3cu standard**
- **Compliant with QSFP-DD MSA HW Rev 5.1/QSFP-DD CMIS Rev 4.0**
- **Maximum power consumption 10W**
- **Two wire serial Interface with digital diagnostic monitoring**
- **Complies with EU Directive 2011/65/EU (RoHS compliant)**
- **Class 1 Laser**

The QSFP56-DD 4X100G-LR1 optical transceiver is a 400Gb/s Quad Small Form Factor Pluggable-double density (QSFP56-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 parallel optical signals, each capable of 100Gb/s operation for an aggregate data rate of 400Gb/s. Reversely, on the receiver side, the module converts 4 channels of parallel optical signals of 100Gb/s each channel for an aggregate data rate of 400Gb/s into 8 channels of 50Gb/s (PAM4) electrical output data.

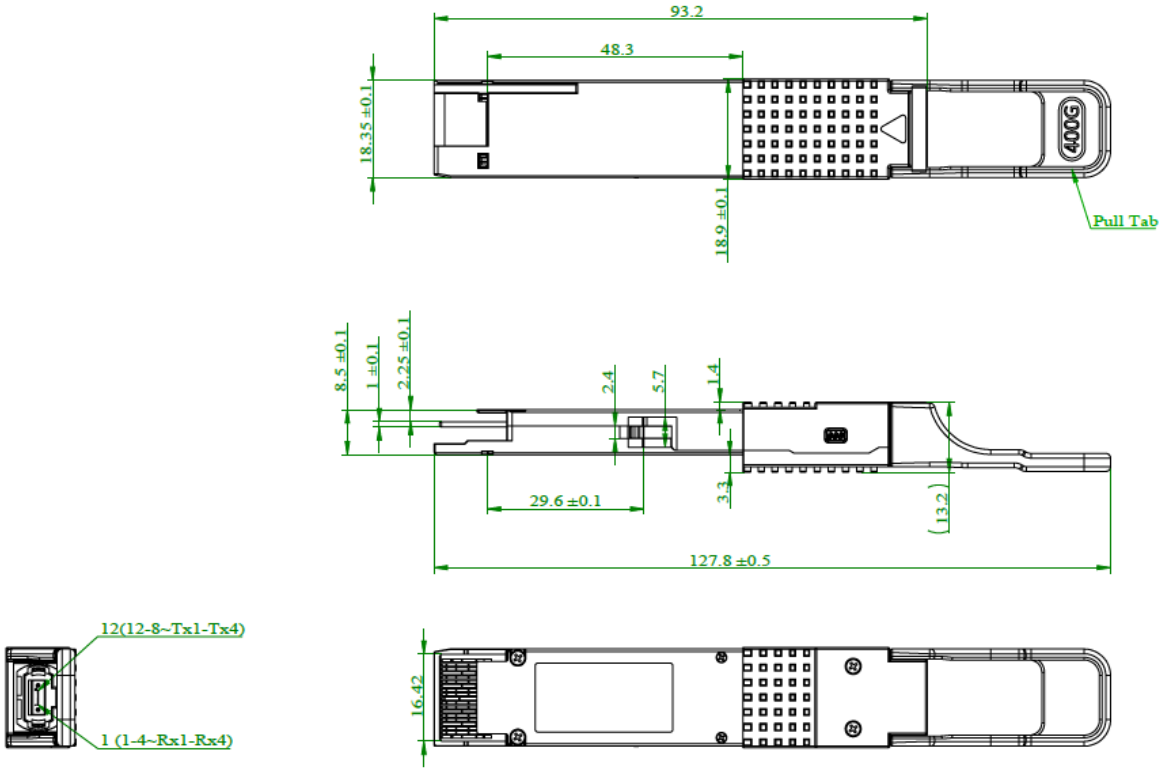
An optical fiber cable with an MTP/MPO-12 connector can be plugged into the module receptacle. Proper alignment is ensured by the guide pins inside the receptacle. The cable usually cannot be twisted for proper channel to channel alignment. Electrical connection is achieved through a QSFP56-DD MSA-compliant edge type connector.

The product is designed with form factor, optical/electrical connection and digital diagnostic interface according to the QSFP56-DD Multi-Source Agreement (MSA) Type 2. It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

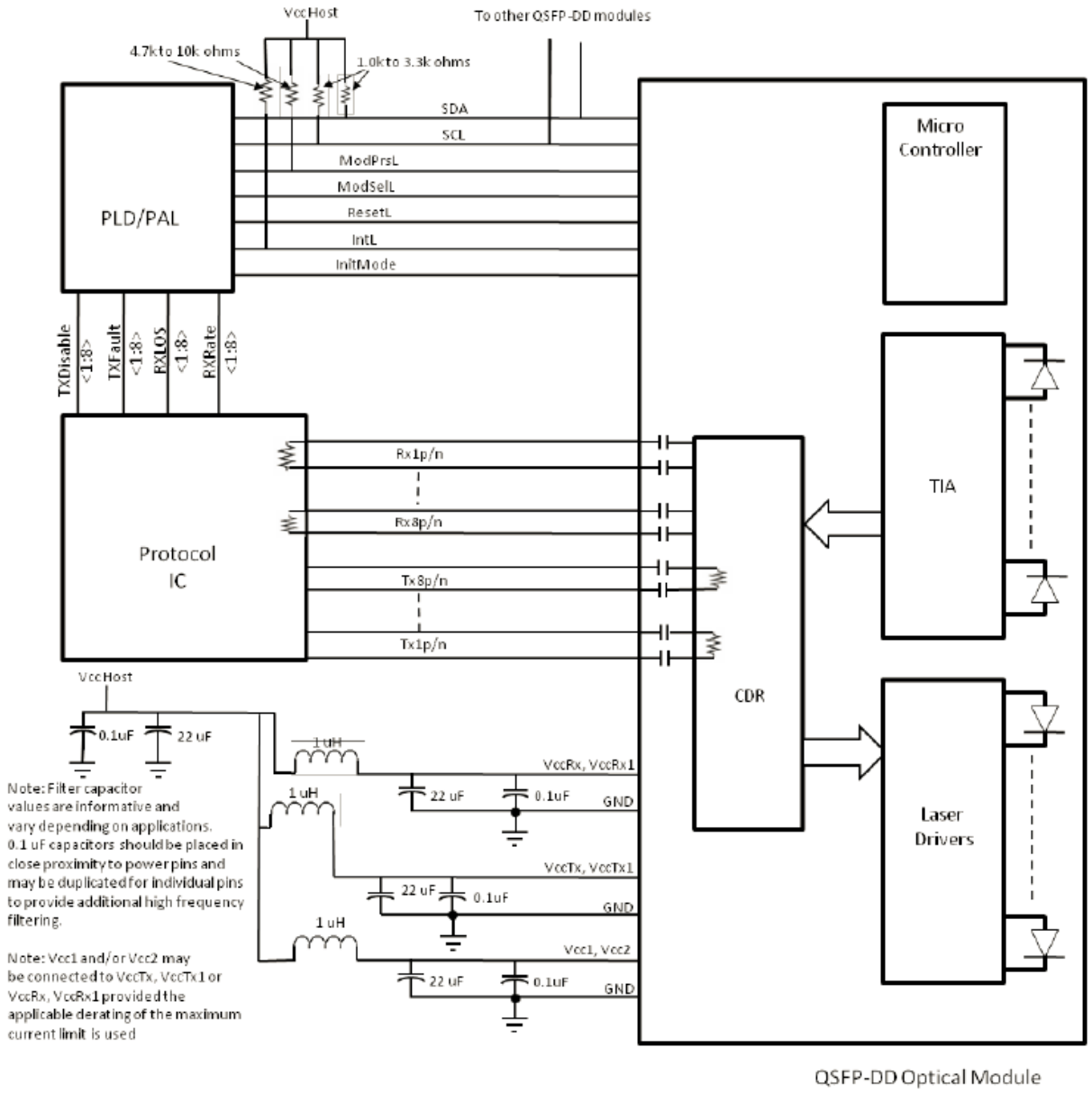
Key Features

- Compliant with IEEE802.3bs standard:
  400GAUI-8 electrical interface
- Compliant with IEEE 802.3cu standards:
  4x100GBASE-LR1 optical interface
- Compliant with QSFP-DD MSA HW Rev 5.1 Type 2 housing with MPO-12 connector
- Compliant with QSFP-DD CMIS Rev 4.0
- Maximum power consumption 10W
- Case operating temperature 0°C to 70°C
- Two wire serial Interface with digital diagnostic monitoring
- Complies with EU Directive 2011/65/EU (RoHS compliant)
- Class 1 Laser

Outline Dimensions



Recommended QSFP-DD Host Board Schematic



Operation Modes Switchover

The module can work at 4x100G or 1x400G operation mode, it works at 4x100G mode default after power-up, please refer the following guideline for operation modes switch.

For 1x400G application:
Step 1. Write A0 page 10h 80h to 0xFF;
Step 2. Write A0 page 10h B3h to 0xFF;
Step 3. Write A0 page 10h 80h to 0x00.

For 4x100G application:
Step 1. Write A0 page 10h 80h to 0xFF;
Step 2. Write A0 page 10h 90h to 0xFF;
Step 3. Write A0 page 10h 80h to 0x00.

Warnings

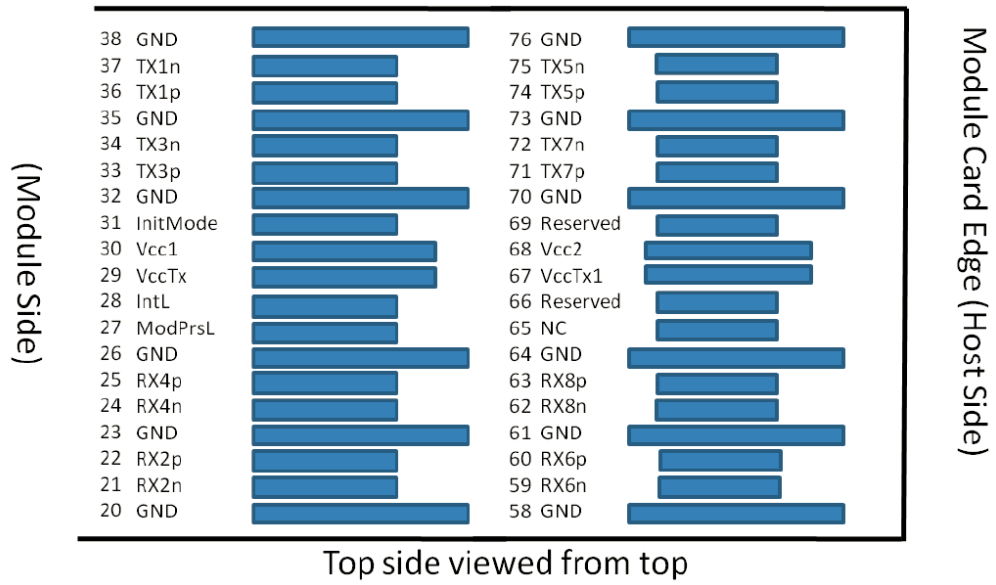
Handling Precautions: This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.
Laser Safety: Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

Digital Diagnostics

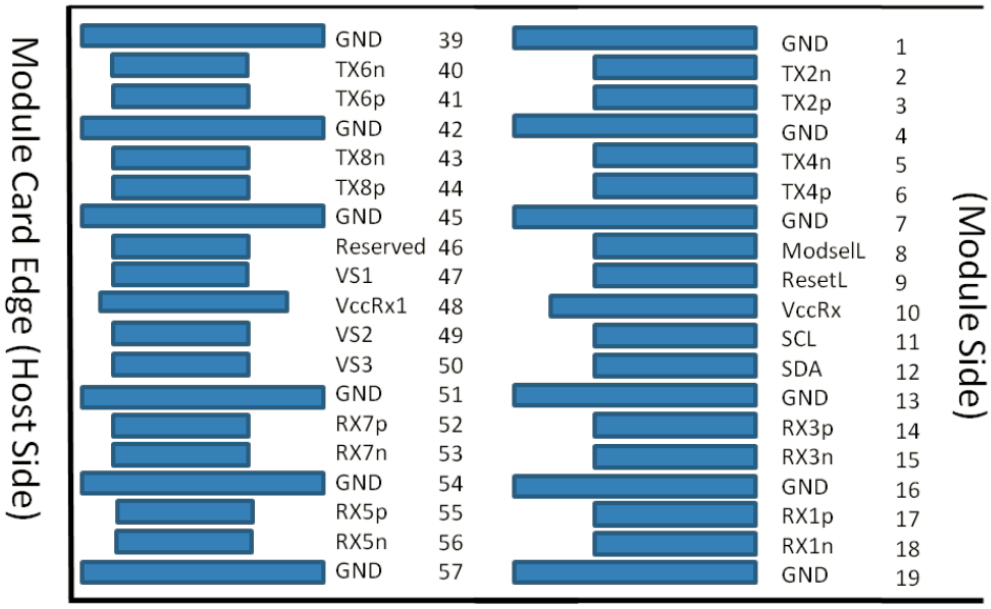
Parameter	Range	Accuracy	Unit	Calibration
Temperature	0 to 70	±3	°C	Internal
Voltage	0 to V_{CC}	3%	V	Internal
Tx Bias Current (Each Lane)	0 to 100	10%	mA	Internal
Tx Output Power (Each Lane)	-1.9 to +4.8	±3	dB	Internal
Rx Receive Power (Each Lane)	-8.2 to +4.8	±3	dB	Internal

Pin Assignment

Pin definitions of the module high speed inputs/outputs

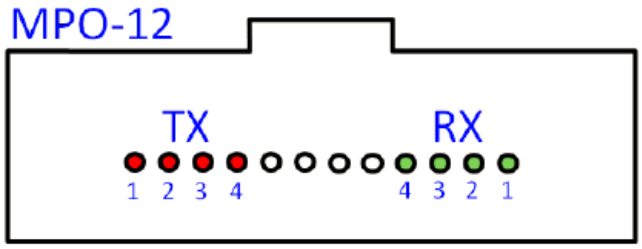


Top side viewed from top



Bottom side viewed from bottom

Active fiber ports in MPO12 connector on module side



Pin #	Logic	Symbol	Definition
1		GND	Ground
2	CML-I	Tx2n	Transmitter Inverted Data Input
3	CML-I	Tx2p	Transmitter Non-inverted Data Input
4		GND	Ground
5	CML-I	Tx4n	Transmitter Inverted Data Input
6	CML-I	Tx4p	Transmitter Non-inverted Data Input
7		GND	Ground
8	LVTTL-I	ModSelL	Module Select
9	LVTTL-I	ResetL	Module Reset
10		VccRx	+3.3V Power Supply Receiver
11	LVCMOS-I/O	SCL	2-wire serial interface clock
12	LVCMOS-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
17	CML-O	Rx1p	Receiver Non-inverted Data Output
18	CML-O	Rx1n	Receiver Inverted Data Output
19		GND	Ground
20		GND	Ground
21	CML-O	Rx2n	Receiver Inverted Data Output
22	CML-O	Rx2p	Receiver Non-inverted Data Output
23		GND	Ground
24	CML-O	Rx4n	Receiver Inverted Data Output
25	CML-O	Rx4p	Receiver Non-inverted Data Output
26		GND	Ground
27	LVTTL-O	ModPrsL	Module Present
28	LVTTL-O	IntL	Interrupt
29		VccTx	+3.3V Power Supply Transmitter
30		Vcc1	+3.3V Power Supply
31	LVTTL-I	InitMode	Initialization mode
32		GND	Ground
33	CML-I	Tx3p	Transmitter Non-inverted Data Input
34	CML-I	Tx3n	Transmitter Inverted Data Input
35		GND	Ground
36	CML-I	Tx1p	Transmitter Non-inverted Data Input
37	CML-I	Tx1n	Transmitter Inverted Data Input
38		GND	Ground
39		GND	Ground
40	CML-I	Tx6n	Transmitter Inverted Data Input
41	CML-I	Tx6p	Transmitter Non-inverted Data Input
42		GND	Ground
43	CML-I	Tx8n	Transmitter Inverted Data Input
44	CML-I	Tx8p	Transmitter Non-inverted Data Input
45		GND	Ground
46		Reserved	

Pin #	Logic	Symbol	Definition
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	CML-O	Rx7p	Receiver Non-inverted Data Output
53	CML-O	Rx7n	Receiver Inverted Data Output
54		GND	Ground
55	CML-O	Rx5p	Receiver Non-inverted Data Output
56	CML-O	Rx5n	Receiver Inverted Data Output
57		GND	Ground
58		GND	Ground
59	CML-O	Rx6n	Receiver Inverted Data Output
60	CML-O	Rx6p	Receiver Non-inverted Data Output
61		GND	Ground
62	CML-O	Rx8n	Receiver Inverted Data Output
63	CML-O	Rx8p	Receiver Non-inverted Data Output
64		GND	Ground
65		NC	Not connected
66		Reserved	
67		VccTx1	3.3V Power Supply
68		Vcc2	3.3V Power Supply
69		Reserved	
70		GND	Ground
71	CML-I	Tx7p	Transmitter Non-inverted Data Input
72	CML-I	Tx7n	Transmitter Inverted Data Input
73		GND	Ground
74	CML-I	Tx5p	Transmitter Non-inverted Data Input
75	CML-I	Tx5n	Transmitter Inverted Data Input
76		GND	Ground

Specifications

Absolute Maximum Ratings

Parameter	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	T_s	-40	85	°C	
Supply Voltage	V_{CC}	-0.5	3.6	V	
Relative Humidity (non-condensing)	RH	5	95	%	
Control Input Voltage	V_I	-0.3	V_{CC}+0.5	V	

Recommended Operating Conditions

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Case Temperature	T_{OPR}	0	-	70	ºC	
Power Supply Voltage	V_{CC}	3.135	3.3	3.465	V	
Instantaneous Peak Current at Hot Plug	I_{CC_IP}	-	-	4000	mA	
Sustained Peak Current at Hot Plug	I_{CC_SP}	-	-	3300	mA	
Maximum Power Consumption	P_D	-	-	10	W	
Maximum Power Consumption, Low Power Mode	P_{DLP}	-	-	1.5	W	
Signalling Rate per Lane	SRL	-	53.125	-	GBd	PAM4
Two Wire Serial Interface Clock Rate	-	-	-	400	kHz	
Power Supply Noise Tolerance (10Hz to 10MHz)	-	-	-	66	mV	
Rx Differential Data Output Load	-	-	100	-	Ohm	
Operating Distance	-	2	-	10000	m	

Functional Characteristics (Optical)

The following tables list the performance specifications for the various functional blocks of the integrated optical transceiver module.

Transmitter Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Wavelength	λ_C	1304.5	1311	1317.5	nm	
Side Mode Suppression Ratio	SMSR	30	-	-	dB	
Average Launch Power, each Lane	AOP_L	-1.9	-	4.8	dBm	1
Outer Optical Modulation Amplitude (OMAouter), each Lane	T_{OMA}	-	-	5	dBm	
Outer Optical Modulation Amplitude (OMAouter), each Lane for TDECQ <1.4dB for 1.4≤TDECQ≤3.4dB	T_{OMA}	1.1 -0.3+ TDECQ	-	-	dBm	
Transmitter and Dispersion Eye Closure for PAM4 (TDECQ), each Lane	TDECQ	-	-	3.4	dB	
Transmitter Eye Closure for PAM4(TECQ)	TECQ	-	-	3.4	dB	
| TDECQ - TECQ |	-	-	-	2.5	dB	
Over/Under-Shoot	-	-	-	22	%	

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Transmitter Power Excursion	-	-	-	2.8	dBm	
Average Launch Power of OFF Transmitter, each Lane	T_{OFF}	-	-	-15	dBm	-
Extinction Ratio, each Lane	ER	3.5	-	-	dB	
RIN15.6OMA	R_{IN}	-	-	-136	dB/Hz	
Optical Return Loss Tolerance	ORL	-	-	15.6	dB	
Transmitter Reflectance	T_R	-	-	-26	dB	
Transmitter Transition Time	T_t	-	-	17	ps	

Note: Average launch power, each lane (min) is informative and not the principal indicator of signal strength.

Receiver Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Wavelength	λ_C	1304.5	1311	1317.5	nm	
Damage Threshold, each Lane	AOP_D	5.8	-	-	dBm	
Average Receive Power, each Lane	AOP_R	-8.2	-	4.8	dBm	1
Receive Power (OMAouter), each Lane	OMA_R	-	-	5	dBm	
Receiver Reflectance	RR	-	-	-26	dB	
Receiver Sensitivity (OMAouter), each Lane	S_{OMA}	-		-6.1	dBm	
for TECQ <1.4dB				-7.5+TECQ		
for 1.4≤TECQ≤3.4dB						
Stressed Receiver Sensitivity (OMAouter), each Lane	SRS	-	-	-4.1	dBm	2
Conditions of Stressed Receiver Sensitivity Test	-	-		-		
Stressed Eye Closure for PAM4 (SECQ)	-	-	3.4	-	dB	

Notes:

1. Average receive power, (min) is informative and not the principal indicator of signal strength.
2. Measured with conformance test signal at TP3 for the BER = $2.4x10^{-4}$.

Functional Characteristics (Electrical)

Electrical Specification High Speed Signal (compliant with IEEE 802.3 400GAUI-8)

Parameter	Symbol	Min.	Max.	Unit	Notes
Receiver (Module Output)					
AC Common-Mode Output Voltage (RMS)		-	17.5	mV	
Differential Output Voltage		-	900	mV	
Near-End Eye Height, Differential		70	-	mV	
Far-End Eye Height, Differential		30	-	mV	
Far End Pre-Cursor Ratio		-4.5	2.5	%	
Differential Termination Mismatch		-	10	%	
Transition Time (Min, 20% to 80%)		9.5	-	ps	
DC Common Mode Voltage		-350	2850	mV	

Parameter	Symbol	Min.	Max.	Unit	Notes
Transmitter (Module Input)					
Differential Pk-Pk Input Voltage Tolerance		900	-	mV	
Differential Termination Mismatch		-	10	%	
Single-Ended Voltage Tolerance Range		-0.4	3.3	V	
DC Common Mode Voltage		-350	2850	mV	

Electrical Specification Low Speed Signal (compliant with QSFP-DD HW Rev 5.1)

Parameter	Symbol	Min.	Max.	Unit	Notes
Module Output SCL and SDA	V_{OL}	0	0.4		
Module Input SCL and SDA	V_{IL}	-0.3	V_{CC}*0.3		
	V_{IH}	V_{CC}*0.7	V_{CC}+0.5		
InitMode, ResetL and ModSelL	V_{IL}	-0.3	0.8		
	V_{IH}	2	V_{CC}+0.3		
IntL	V_{OL}	0	0.4		
	V_{OH}	V_{CC}-0.5	V_{CC}+0.3		

Timing for Soft Control and Status Functions

Parameter	Symbol	Min.	Max.	Unit	Notes
MgmtInit Duration		-	2000	ms	
ResetL Assert Time	t_reset_init	10	-	µs	
IntL Assert Time	ton_IntL	-	200	ms	
IntL Deassert Time	toff_IntL	-	500	µs	
Rx LOS Assert Time (Optional Fast Mode)	ton_losf	-	1	ms	
Tx Fault Assert Time	ton_Txfault	-	200	ms	
Flag Assert Time	ton_flag	-	200	ms	
Mask Assert Time	ton_mask	-	100	ms	
Mask Deassert Time	toff_mask	-	100	ms	

I/O Timing for Squelch and Disable

Parameter	Symbol	Min.	Max.	Unit	Notes
Rx Squelch Assert Time	ton_Rxsq	-	150	ms	
Tx Squelch Assert Time	ton_Txsq	-	400	ms	
Tx Squelch Deassert Time	toff_Txsq	-	1.5	s	
Tx Disable Assert Time (Optional Fast Mode)	ton_Txdisf	-	3	ms	
Tx Disable Deassert Time (Optional Fast Mode)	toff_Txdisf	-	10	ms	
Rx Output Disable Assert Time	ton_Rxdis	-	100	ms	
Rx Output Disable Deassert Time	toff_Rxdis	-	100	ms	
Squelch Disable Assert Time	ton_sqdis	-	N/A		Note, not support
Squelch Disable Deassert Time	toff_sqdis	-	N/A		Note, not support

Ordering Information

Product Name	Product Description
QDD-4X100G-LR1	QSFP56-DD 400GBASE PAM4 4X100G-LR1 1310nm 10km DOM MPO12, SMF Optical Module

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