400Gb/s OSFP LR4 10km SMF Optical Transceiver

T-OS4CNL-N00

Product Specification

Features

- OSFP 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°C

- 8x53.125Gb/s electrical interface (400GAUI-8)

- Data Rate 106.25Gbps (PAM4) per channel.

- Maximum power consumption 12W

- Duplex LC connector

- RoHS compliant

Module picture shown above is that of InnoLight standard part and is for reference. The actual pull tab is blue.

Applications

- Data Center Interconnect

- 400G Ethernet

- Infiniband interconnects

- Enterprise networking

Part Number Ordering Information

D-OS4CNL-N00	400G OSFP LR4 10km with FEC optical transceiver with full real-time digital diagnostic monitoring and pull tab

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856　　　　　　　　Web:www.do-networks.com　　　　　1 / 14

1. General Description

This product is a 400Gb/s Octal Small Form-factor Pluggable (OSFP) 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 OSFP Multi-Source Agreement (MSA). It has been designed to meet the harshest external operating conditions including temperature, humidity and EMI interference.

2. Functional Description

The module incorporates 4 independent channels on CWDM4 1271/1291/1311/1331nm center wavelength, operating at 100G per channel. The transmitter path incorporates a quad channel EML driver and EML lasers together with an optical multiplexer. On the receiver path, an optical de-multiplexer is coupled to a 4 channel photodiode array. A DSP basis gearbox is used to convert 8 channels of 25GBaud PAM4 signals into 4 channels of 50GBaud PAM4 signals and also an 8-channel retimer and FEC block are integrated in this DSP. The electrical interface is compliant with IEEE 802.3bs and OSFP MSA in the transmitting and receiving directions, and the optical interface is compliant to IEEE 802.3bs with duplex LC connector.

A single +3.3V power supply is required to power up this product. As per MSA specifications the module offers 4 low speed hardware control pins: SCL, SDA, INT/RSTn and LPWn/PRSn

SCL and SDA are a 2-wire serial interface between the host and module using the I2C protocol. SCL is defined as the serial interface clock signal and SDA as the serial interface data signal. Both signals are open-drain and require pull-up resistors to +3.3V on the host. The pull-up resistor value can be 2.2k ohms to 4.7k ohms.

INT/RSTn is a dual function signal that allows the module to raise an interrupt to the host and also allows the host to reset the module. Reset is an active-low signal on the host which is translated to an active-low signal on the module. Interrupt is an active-high signal on the module which gets translated to an active-low signal on the host. The INT/RSTn signal operates in 3 voltage zones to indicate the state of Reset for the module and Interrupt for the host. Figure 1 shows these 3 zones.

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   2 / 14

LPWn/PRSn is a dual function signal that allows the host to signal Low Power mode and the module to indicate Module Present. Low Power mode is an active-low signal on the host which gets converted to an active-low signal on the module. Module Present is controlled by a pull-down resistor on the module which gets converted to an active-low logic signal on the host. The LPWn/PRSn signal operates in 3 voltage zones to indicate the state of Low Power mode for the module and Module Present for the host. Figure 1 shows these 3 zones.
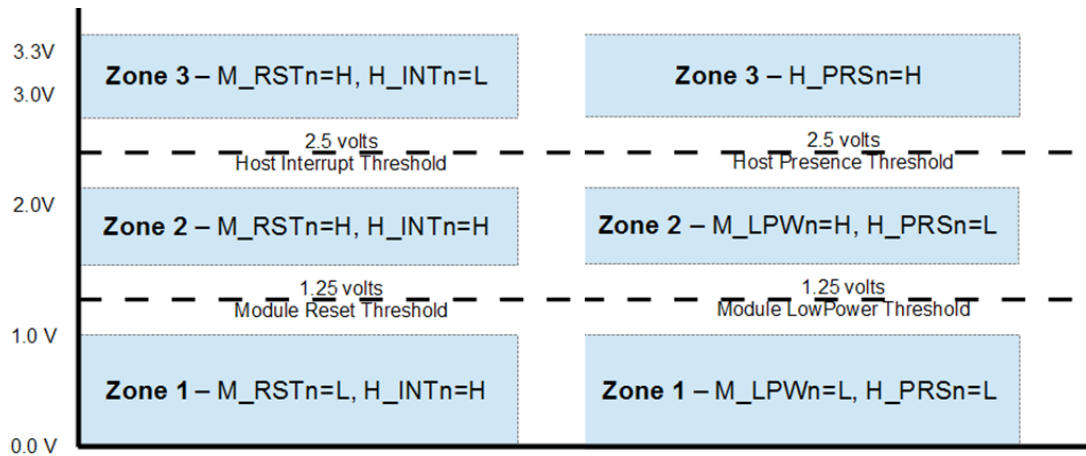
Figure 1. Voltage Zones

3. Transceiver Block Diagram
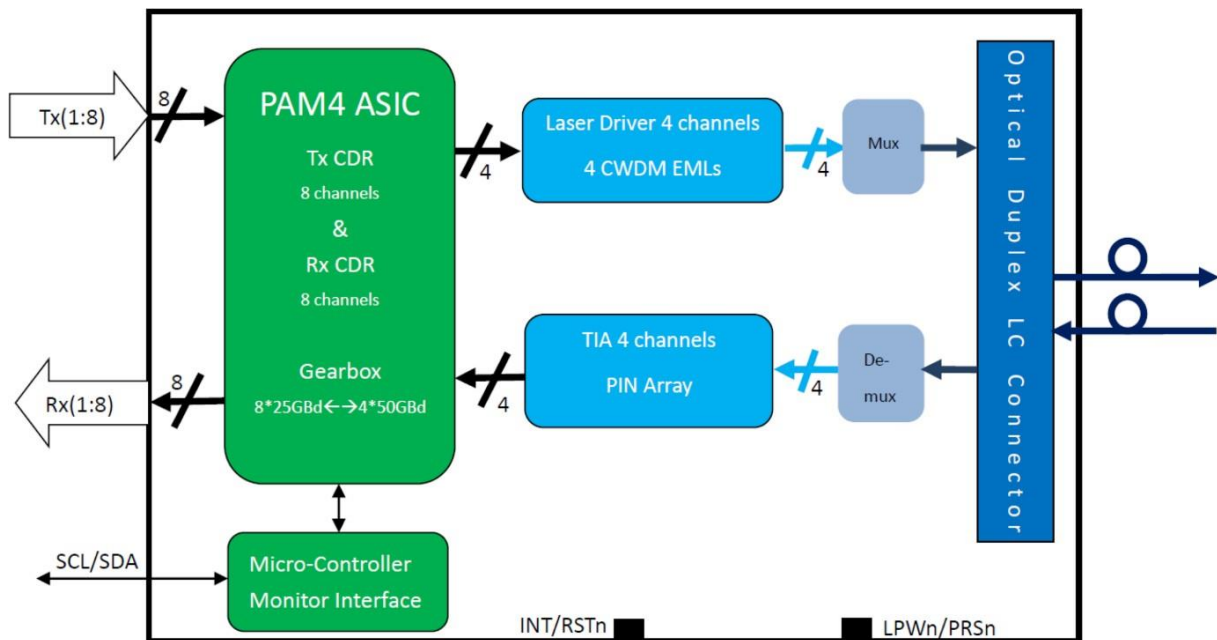

Figure 2. Transceiver Block Diagram

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   3 / 14

4. Pin Assignment and Description

The electrical pinout of the OSFP module is shown in Figure 3 below.

60	GND		GND	1
59	TX1p		TX2p	2
58	TX1n		TX2n	3
57	GND		GND	4
56	TX3p		TX4p	5
55	TX3n		TX4n	6
54	GND		GND	7
53	TX5p		TX6p	8
52	TX5n		TX6n	9
51	GND		GND	10
50	TX7p		TX8p	11
49	TX7n		TX8n	12
48	GND		GND	13
47	SDA		SCL	14
46	VCC		VCC	15
45	VCC		VCC	16
44	INT/RSTn		LPWn/PRSn	17
43	GND		GND	18
42	RX8n		RX7n	19
41	RX8p		RX7p	20
40	GND		GND	21
39	RX6n		RX5n	22
38	RX6p		RX5p	23
37	GND		GND	24
36	RX4n		RX3n	25
35	RX4p		RX3p	26
34	GND		GND	27
33	RX2n		RX1n	28
32	RX2p		RX1p	29
31	GND		GND	30

(Module Card Edge)

Figure 3 MSA Compliant Connector

Pin Definition

Pin#	Symbol	Description	Logic	Direction	Plug Sequence
1	GND		Ground		1
2	TX2p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
3	TX2n	Transmitter Data Inverted	CML-I	Input from Host	3
4	GND		Ground		1
5	TX4p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
6	TX4n	Transmitter Data Inverted	CML-I	Input from Host	3
7	GND		Ground		1
8	TX6p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
9	TX6n	Transmitter Data Inverted	CML-I	Input from Host	3
10	GND		Ground		1
11	TX8p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
12	TX8n	Transmitter Data Inverted	CML-I	Input from Host	3
13	GND		Ground		1

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   4 / 14

14	SCL	2-wire Serial interface clock	LVCMOS-I/O	Bi-directional	3
15	VCC	+3.3V Power		Power from Host	2
16	VCC	+3.3V Power		Power from Host	2
17	LPWn/PRSn	Low-Power Mode / Module Present	Multi-Level	Bi-directional	3
18	GND		Ground		1
19	RX7n	Receiver Data Inverted	CML-O	Output to Host	3
20	RX7p	Receiver Data Non-Inverted	CML-O	Output to Host	3
21	GND		Ground		1
22	RX5n	Receiver Data Inverted	CML-O	Output to Host	3
23	RX5p	Receiver Data Non-Inverted	CML-O	Output to Host	3
24	GND		Ground		1
25	RX3n	Receiver Data Inverted	CML-O	Output to Host	3
26	RX3p	Receiver Data Non-Inverted	CML-O	Output to Host	3
27	GND		Ground		1
28	RX1n	Receiver Data Inverted	CML-O	Output to Host	3
29	RX1p	Receiver Data Non-Inverted	CML-O	Output to Host	3
30	GND		Ground		1
31	GND		Ground		1
32	RX2p	Receiver Data Non-Inverted	CML-O	Output to Host	3
33	RX2n	Receiver Data Inverted	CML-O	Output to Host	3
34	GND		Ground		1
35	RX4p	Receiver Data Non-Inverted	CML-O	Output to Host	3
36	RX4n	Receiver Data Inverted	CML-O	Output to Host	3
37	GND		Ground		1
38	RX6p	Receiver Data Non-Inverted	CML-O	Output to Host	3
39	RX6n	Receiver Data Inverted	CML-O	Output to Host	3
40	GND		Ground		1
41	RX8p	Receiver Data Non-Inverted	CML-O	Output to Host	3
42	RX8n	Receiver Data Inverted	CML-O	Output to Host	3
43	GND		Ground		1
44	INT/RSTn	Module Interrupt / Module Reset	Multi-Level	Bi-directional	3
45	VCC	+3.3V Power		Power from Host	2
46	VCC	+3.3V Power		Power from Host	2
47	SDA	2-wire Serial interface data	LVCMOS-I/O	Bi-directional	3
48	GND		Ground		1

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel： +86-755-26819856   Web:www.do-networks.com   5 / 14

49	TX7n	Transmitter Data Inverted	CML-I	Input from Host	3
50	TX7p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
51	GND		Ground		1
52	TX5n	Transmitter Data Inverted	CML-I	Input from Host	3
53	TX5p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
54	GND		Ground		1
55	TX3n	Transmitter Data Inverted	CML-I	Input from Host	3
56	TX3p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
57	GND		Ground		1
58	TX1n	Transmitter Data Inverted	CML-I	Input from Host	3
59	TX1p	Transmitter Data Non-Inverted	CML-I	Input from Host	3
60	GND		Ground		1

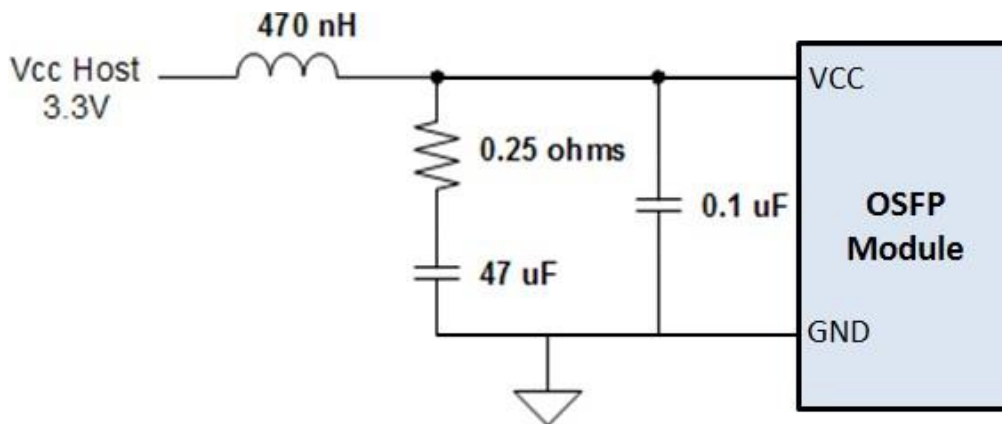## 5. Recommended Power Supply Filter

Figure 4. Recommended Power Supply Filter

6. Absolute Maximum Ratings

It has to be noted that the operation in excess of any individual absolute maximum ratings might cause permanent damage to this module.

Parameter	Symbol	Min	Max	Units	Notes
Storage Temperature	T_S	-40	85	degC	
Operating Case Temperature	T_{OP}	0	70	degC	
Power Supply Voltage	V_{CC}	-0.5	3.6	V	
Relative Humidity (non-condensation)	RH	0	85	%	

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856　　　　　　　　　　Web:www.do-networks.com　　　　　6 / 14

7. Recommended Operating Conditions and Power Supply Requirements

Parameter	Symbol	Min	Typical	Max	Units	Notes
Operating Case Temperature	T_{OP}	0		70	degC	
Power Supply Voltage	V_{CC}	3.135	3.3	3.465	V	
Data Rate, each Lane			26.5625		GBd	PAM4
Data Rate Accuracy		-100		100	ppm	
Pre-FEC Bit Error Ratio				2.4×10^{-4}		
Post-FEC Bit Error Ratio				1×10^{-12}		1
Link Distance	D	0.002		10	km	2

Notes:

1. FEC provided by host system.
2. FEC required on host system to support maximum distance.

8. Electrical Characteristics

The following electrical characteristics are defined over the Recommended Operating Environment unless otherwise specified.

Parameter	Test Point	Min	Typical	Max	Units	Notes
Power Consumption				12	W	
Supply Current	Icc			3.64	A	
Transmitter (each Lane)						
Signaling Rate, each Lane	TP1	26.5625 ± 100 ppm			GBd	
Differential pk-pk Input Voltage Tolerance	TP1a	900			mVpp	1
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				2
Single-ended Voltage Tolerance Range (Min)	TP1a	-0.4 to 3.3			V	

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   7 / 14

DC Common Mode Input Voltage	TP1	-350		2850	mV	3
Receiver (each Lane)						
Signaling Rate, each lane	TP4	26.5625 ± 100 ppm			GBd	
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 (ESMW)	TP4		0.265		UI	
Near-end Eye Height, Differential	TP4	70			mV	
Far-end Eye Symmetry Mask Width (ESMW)	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 (Vcm)	TP4	-350		2850	mV	3

Notes:
1. With the exception to IEEE 802.3bs 120E.3.1.2 that the pattern is PRBS31Q or scrambled idle.
2. Meets BER specified in IEEE 802.3bs 120E.1.1.
3. DC common mode voltage generated by the host. Specification includes effects of ground offset voltage.

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   8 / 14

9. Optical Characteristics

Parameter	Symbol	Min	Typical	Max	Units	Notes
Wavelength Assignment	L0	1264.5	1271	1277.5	nm	
	L1	1284.5	1291	1297.5	nm	
	L2	1304.5	1311	1317.5	nm	
	L3	1324.5	1331	1337.5	nm	
Transmitter						
Data Rate, each Lane		53.125 ± 100 ppm			GBd	
Modulation Format		PAM4				
Side-mode Suppression Ratio	SMSR	30			dB	Modulated
Total Average Launch Power	P_T			10	dBm	
Average Launch Power, each Lane	P_{AVG}	-2.8		4.0	dBm	1
Outer Optical Modulation Amplitude (OMA_{outer}), each Lane	P_{OMA}	0.2		4.2	dBm	2
Launch Power in OMA_{outer} minus TDECQ, each Lane		-1.2			dB	For ER ≥4.5dB
Launch Power in OMA_{outer} minus TDECQ, each Lane		-1.1			dB	For ER <4.5dB
Transmitter and Dispersion Eye Clouser for PAM4, each Lane	TDECQ			3.9	dB	
Extinction Ratio	ER	3.5			dB	
Difference in Launch Power between any Two Lanes (OMA_{outer})				4	dB	
$RIN_{17.1}OMA$	RIN			-136	dB/Hz	
Optical Return Loss Tolerance	TOL			15.6	dB	
Transmitter Reflectance	T_R			-26	dB	
Average Launch Power of OFF Transmitter, each Lane	P_{off}			-20	dBm	
Receiver						
Data Rate, each Lane		53.125 ± 100 ppm			GBd	
Modulation Format		PAM4				

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856　　　　　　　　　　Web:www.do-networks.com　　　　　9 / 14

Damage Threshold, each Lane	TH_d	5			dBm	3
Average Receive Power, each Lane		-9.1		4.0	dBm	4
Receive Power (OMA$_{outer}$), each Lane				4.2	dBm	
Difference in Receiver Power between any Two Lanes (OMA$_{outer}$)				4.6	dB	
Receiver Sensitivity (OMA$_{outer}$), each Lane	SEN			Equation (1)	dBm	5
Stressed Receiver Sensitivity (OMA$_{outer}$), each Lane	SRS	See Figure 5			dBm	6
Receiver Reflectance	R_R			-26	dB	
LOS Assert	LOSA	-30			dBm	
LOS De-assert	LOSD			-12	dBm	
LOS Hysteresis	LOSH	0.5			dB	
Stressed Conditions for Stress Receiver Sensitivity (Note 7)						
Stressed Eye Closure for PAM4 (SECQ), Lane under Test		0.9		3.4	dB	
OMA$_{outer}$ of each Aggressor Lane			1.5		dBm	

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 OMA$_{outer}$ (min) must exceed the minimum value specified here.
3. The receiver shall be able to tolerate, without damage, continuous exposure to an optical input signal having this average power level.
4. 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.
5. Receiver sensitivity (OMAouter), each lane (max) is informative and is defined for a transmitter with a value of SECQ up to 3.9 dB. It should meet Equation (1), which is illustrated in Figure 5.

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel： +86-755-26819856   Web:www.do-networks.com

$RS = \max(-6.6, SECQ - 8.0)\ dBm$ (1)

Where:

RS is the receiver sensitivity, and

SECQ is the SECQ of the transmitter used to measure the receiver sensitivity.

6. Measured with conformance test signal for BER = 2.4×10^{-4}. A compliant receiver shall have stressed receiver sensitivity (OMA_{outer}), each lane values below the mask of Figure 4, for SECQ values between 0.9 and 3.4 dB.

7. These test conditions are for measuring stressed receiver sensitivity. They are not characteristics of the receiver.
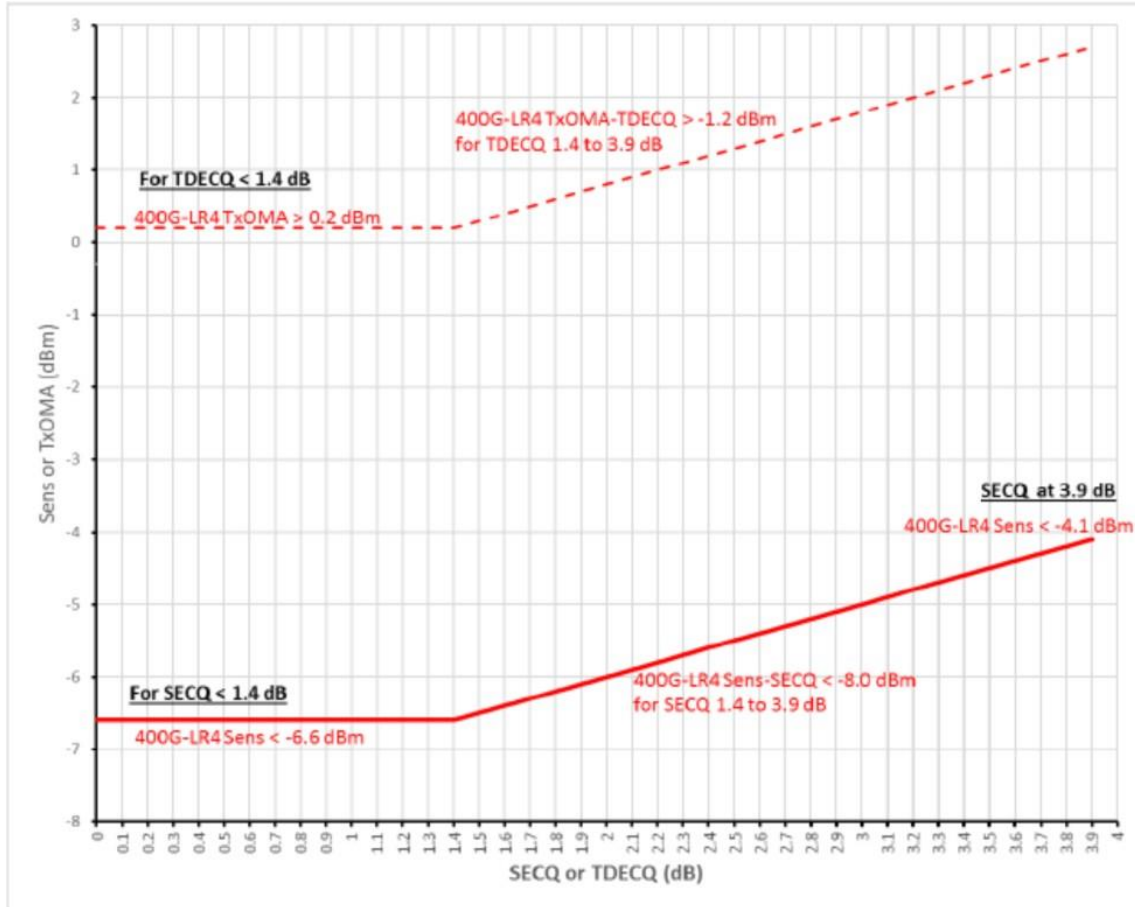
10. Digital Diagnostic Functions

The following digital diagnostic characteristics are defined over the normal operating conditions unless otherwise specified.

Parameter	Symbol	Min	Max	Units	Notes
Temperature monitor absolute error	DMI_Temp	-3	3	degC	Over operating temperature range

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel：+86-755-26819856   Web:www.do-networks.com   11 / 14

Supply voltage monitor absolute 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

Notes:
1. Due to measurement accuracy of different single mode fibers, there could be an additional +/-1 dB fluctuation, or a +/- 3 dB total accuracy.
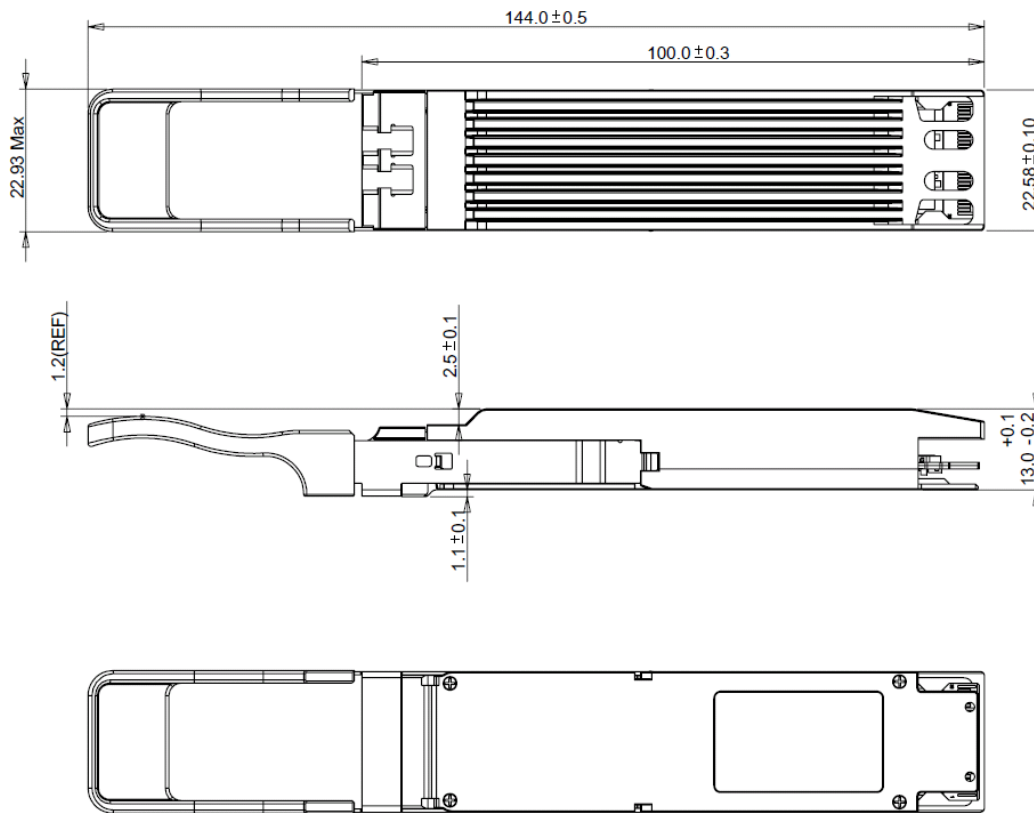
11. Mechanical Dimensions

Figure 6. Mechanical Outline

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel： +86-755-26819856   Web:www.do-networks.com   12 / 14

12. ESD

This transceiver is specified as ESD threshold 1kV for high speed data pins and 2kV for all other 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.

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel: +86-755-26819856　　　　　　　　　Web:www.do-networks.com　　　　　　　13 / 14

13. Laser Safety

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).

Caution: Use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

Address : Room 426 Bu,No.4 Building, 1st. Software Park, KeJi Middle 3rd, Middle Zone, Hi-Tech Park,Shenzhen,China

Tel： +86-755-26819856   Web:www.do-networks.com   14 / 14