

# 100Gb/s QSFP28 LR4 1310nm 10km Optical Transceiver

## Features

- Hot-pluggable QSFP28 MSA form factor
- Up to 10km transmission distance
- Supports 103.1Gb/s aggregate bit rate
- 4×26Gb/s cooled LAN-WDM DFB TOSA
- 4×26Gb/s PIN ROSA
- Duplex LC receptacles
- I2C management interface
- Low EMI and excellent ESD protection
- Single +3.3V power supply
- Power consumption < 3.5W
- Operating case temperature: 0~70°C

## Applications

- 100GBASE-LR4 Ethernet Links

---

## Compliance

- Compliant with FCC 47 CFR Part 15, Class B
- Compliant to IEEE 802.3ba 100GBASE-LR4
- Compliant with SFF-8665
- Compliant with IEEE802.3bm CAUI-4
- Compliant with RoHS-6

## Description

The QSFP-100G-LR4 optical transceiver integrates the transmit and receive path onto one module. On the transmit side, the four lanes of optical data channels are optically multiplexed by the integrated optical multiplexer. On the receive side, four lanes of optical data streams are optically demultiplexed by an integrated optical demultiplexer. Each data stream is recovered by a PIN photo-detector and transimpedance amplifier, re-timed, and passed on to an output driver.

## Absolute Maximum Ratings

Table1-Absolute Maximum Ratings						
Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Storage Temperature	TSTG	-40		85	°C	
Operating Relative Humidity (non-condensing)	R <sub>H</sub>	5		85	%	
Supply Voltage	V <sub>CC</sub>	-0.5		3.6	V	
Optical Input Power	PIN			5.5	dBm	

## Recommended Operating Conditions

Table2-Recommended Operating Conditions						
Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Case temperature	T <sub>c</sub>	0		70	°C	
Supply Voltage	V <sub>CC</sub>	3.135	3.3	3.465	V	
Module Power Dissipation	P			3.5	W	
Total Data Rate				103.125	Gbps	
Data Rate, each lane			25.78125		Gbps	
Transmission Distance				10	km	

## Optical, Electrical Characteristic

Table3-Transmitter Operating Characteristic-Optical, Electrical						
Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Bit Rate per Lane		25.78125 ± 100 ppm			Gbps	1
Center Wavelength	CH0	λ c1	1294.53	1296.59	nm	
	CH1	λ c2	1299.02	1301.09	nm	
	CH2	λ c3	1303.54	1305.63	nm	
	CH3	λ c4	1308.09	1310.19	nm	
Total Average Launch Power	P <sub>total</sub>			10.5	dBm	
Average Launch Power per Lane	P <sub>each</sub>	-2.9		4.5	dBm	2
Optical modulation amplitude	POMA	-1.3		4.5	dBm	

per lane						
Difference in Launch power between any two lanes(OMA)				5	dB	
Launch Power (OMA-TDP)		-2.3			dBm	
Transmitter and Dispersion Penalty per Lane	TDP			2.2	dB	
Side-Mode Suppression Ratio	SMSR	30			dB	
Extinction Ratio	ER	4			dB	
Average launch power of OFF transmitter, per lane				-30	dBm	
RIN200MA				-130	dB/Hz	
Optical return loss tolerance				20	dB	
Transmitter reflectance				-12	dB	3
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}		{0.25, 0.4, 0.45, 0.25, 0.28, 0.4}			UI	4
Bit Rate per Lane		25.78125 ± 100 ppm			Gbps	1

Notes:

[1] Transmitter consists of 4 lasers operating at 25.78Gb/s each.

[2] Minimum value is informative.

[3] Transmitter reflectance is defined looking into the transmitter.

[4] Hit ratio of  $5 \times 10^{-5}$ , per IEEE 802.3ba.

**Table4-Receiver Operating Characteristic-Optical, Electrical**

Parameter		Symbols	Min.	Typical	Max.	Unit	Notes
Bit Rate per Lane			25.78125 ± 100 ppm			Gbps	1
Center Wavelength	CH0	$\lambda_{c1}$	1294.53		1296.59	nm	
	CH1	$\lambda_{c2}$	1299.02		1301.09	nm	
	CH2	$\lambda_{c3}$	1303.54		1305.63	nm	
	CH3	$\lambda_{c4}$	1308.09		1310.19	nm	
Damage threshold		R <sub>dam</sub>	5.5			dBm	
Average receiver power		R <sub>pow</sub>	-10.6		4.5	dBm	2
Receiver power(OMA) per lane		R <sub>ovl</sub>			4.5	dBm	
Difference in receive power between any two lanes(OMA)					5.5	dB	
Receiver sensitivity (OMA), each lane (max)		SE <sub>Neach</sub>			-8.6	dBm	3
3dB electrical upper cutoff frequency					31	GHz	
Stressed Sensitivity per lane		SRS			-10.6 (BER = $1 \times 10^{-12}$ )	dBm	3
					14.5 (BER = $5 \times 10^{-5}$ )		4

Receiver reflectance				-26	dBm	
LOS Assert	LOSA	-25		-12	dBm	
LOS Deassert	LOSD			-11	dBm	
LOS Hysteresis			1.5		dB	

Notes:

- [1] Transmitter consists of 4 lasers operating at 25.78Gb/s each.
- [2] Minimum value is informative, equals min Tx OMA with infinite ER and max channel insertion loss.
- [3] Receiver sensitivity is informative. Measured with 25.78125Gb/s, PRBS31 NRZ, BER=10<sup>-12</sup>
- [4] SRS is measured with vertical eye closure penalty of 1.8 dB max, J2 of 0.30 UI, and J9 of 0.47 UI.

**Table5-Electrical Characteristic- Module input**

Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Signaling rate per lane		25.78125±100ppm			GBd	
Differential data input swing per lane	Vin-pp			900	mV	
Differential input return loss(min)	RLd(f)	9.5-0.37f, 0.01<f<8GHz 4.75-7.4log10(f/14), 8<f<19GHz			dB	
Differential to common mode input return loss (min)	RLc(f)	22-20log10(f/25.78), 0.01<f<12.89GHz 15-6log10(f/25.78), 12.89<f<19GHz			dB	
Differential termination mismatch				10	%	
DC common mode voltage		-350		2850	mV	
Stressed input parameters						
Eye width			0.46		UI	
Applied pk-pk sinusoidal jitter		Per IEEE 802.3bm Table 88-13				
Eye height			95		mV	

**Table6-Electrical Characteristic- Module input**

Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Signaling rate per lane		25.78125±100ppm			GBd	
Differential data output swing	Vout-pp	600		1200	mVpp	1
		400		800	mVpp	
		300		600	mVpp	
		100		400	mVpp	
Differential output return loss(min)	RLd(f)	9.5-0.37f, 0.01<f<8GHz 4.75-7.4log10(f/14), 8<f<19GHz			dB	
Differential to common mode output return loss (min)	RLc(f)	22-20log10(f/25.78), 0.01<f<12.89GHz 15-6log10(f/25.78), 12.89<f<19GHz			dB	
Eye width		0.57			UI	
Vertical eye closure	VEC			5.5	dB	
Differential termination				10	%	

mismatch						
Transition time, 20% to 80%	Tr Tf	12			ps	

Notes:

[1] Output voltage is settable in 4 discrete ranges via I2C. Default range is 400-800 mV. See SFF-8636 Table6-34.

**Table7-Digital Diagnostic Functions**

Parameter	Symbols	Min.	Typical	Max.	Unit	Notes
Temperature Monitor Absolute Error	DMI_Temp	-3		3	°C	Over Operating Temperature
Supply Voltage Monitor Absolute Error	DMI_Vcc	-3%		3%	V	Over Operating Voltage
Bias Current Monitor Absolute Error	DMI_Ibias	-10%		10%	mA	
Laser Power Monitor Absolute Error	DMI_Tx	-3		3	dB	
RX Power Monitor Absolute Error	DMI_Rx	-3		3	dB	

**Table8-Digital Diagnostic Functions**

Parameter	Symbols	Min.	Max.	Unit	Notes
Initialization time	t_init		2000	ms	1
Reset InitAssert Time	t_reset_init	10		us	2
Serial Bus Hardware Ready Time	t_serial		2000	ms	3
Reset Assert Time	t_reset		2000	ms	4
Monitor Data Ready Time	t_data		2000	ms	5
LPMode/TxDis mode change time	t_LPMode/TxDis		100	ms	6
LPMode Assert Time	ton_LPMode		100	ms	7
LPMode De-assert Time	Toff_LPMode		300	ms	8
IntL/RxLOSL mode change time	t_IntL/RxLOSL		100	ms	9
IntL Assert Time	ton_IntL		200	ms	10
IntL Deassert Time	toff_IntL		500	us	11
RxLOSL Assert Time (Optional Fast Mode)	ton_f_LOS		1	ms	12
RxLOSL Deassert Time (Optional Fast Mode)	toff_f_LOS		3	ms	13
Rx LOS Assert Time	ton_los		100	ms	14
Tx Fault Assert Time	ton_Txfault		200	ms	15
Flag Assert Time	ton_flag		200	ms	16
Mask Assert Time	ton_mask		100	ms	17
Mask De-assert Time	toff_mask		100	ms	18
Power_over rideor Power_set Assert Time	ton_Pdown		100	ms	19
Power_over rideor Power_set Deassert Time	toff_Pdown		300	ms	20

Notes:

- [1] Time from power on, hot plug or rising edge of reset until the module is fully functional. This time does not apply to non-Power level 0 modules in Low Power State.
- [2] A Reset is generated by a low level longer than  $t_{\text{reset\_init}}$  present on the ResetL input.
- [3] Time from power on until the module responds to data transmission over the two wire serial bus.
- [4] Time from assertion of LPMode (Vin:LPMode =Vih) until module power consumption reaches Power Level 1.
- [5] Time from power on to Data\_Not\_Ready, Byte 2 bit 0, cleared to 0 and IntL output pulled low.
- [6] Time to change between LPMode and TxDis modes of the dual-mode signal LPMode/TxDis.
- [7] Time from deassertion of LPMode (Vin:LPMode =Vil) until module is fully functional.
- [8] Time from occurrence of condition triggering IntL until Vout:IntL=Vol.
- [9] Time to change between IntL and RxLOSL modes of the dual-mode signal IntL/RxLOSL.
- [10] Time from clear on read operation of associated flag until Vout:IntL=Voh. This includes deassert times for Rx LOS, Tx Fault and other flag bits.
- [11] Time from Rx LOS state to Rx LOS bit set(value = 1b) and IntL asserted.
- [12] Optional fast mode is advertised via the management interface (SFF-8636). Time from optical loss of signal to RxLOSL signal pulled low by the module.
- [13] Optional fast mode is advertised via the management interface (SFF-8636). Time from optical signal above the LOS deassert threshold to when the module releases the RxLOSL signal to high.
- [14] Time from Tx Fault state to Tx Fault bit set(value = 1b) and IntL asserted.
- [15] Time from condition triggering flag to associated flag bit set (value = 1b) and IntL asserted.
- [16] Time from mask bit set (value = 1b) until associated IntL assertion is inhibited.
- [17] Time from mask bit cleared (value = 0b) until associated IntL operation resumes.
- [18] Time from change of state of Application or Rate Select bit until transmitter or receiver bandwidth is in conformance with appropriate specification.
- [19] Time from P\_Down bit set (value = 1b) until module power consumption reaches Power Level1.
- [20] Time from P\_Down bit cleared (value = 0b) until module is fully functional.

## Pin Description

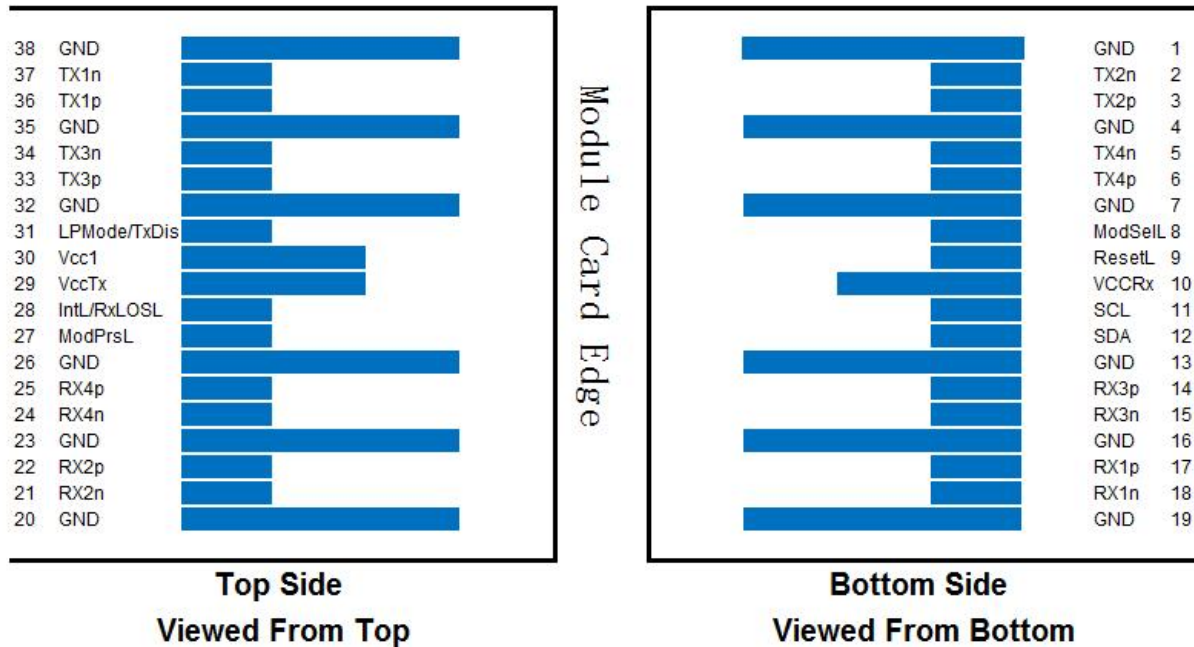


Figure 1 Pin view

## Pin Function Definitions

Pin	Symbols	Description	Notes
1	GND	Ground	1
2	Tx2n	Transmitter Inverted Data Input	
3	Tx2p	Transmitter Non-Inverted Data Input	
4	GND	Ground	1
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	Vcc Rx	+3.3V Power Supply Receiver	2
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	GND	Ground	1

17	Rx1p	Receiver Non-Inverted Data Output	
18	Rx1n	Receiver Inverted Data Output	1
19	GND	Ground	1
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	1
27	ModPrsL	Module Present	
28	IntL	Interrupt	
29	VccTx	+3.3V Power supply transmitter	2
30	Vcc1	+3.3V Power supply	2
31	LPMode	Low Power Mode	
32	GND	Ground	1
33	Tx3p	Transmitter Non-Inverted Data Input	
34	Tx3n	Transmitter Inverted Data Input	
35	GND	Ground	1
36	Tx1p	Transmitter Non-Inverted Data Input	
37	Tx1n	Transmitter Inverted Data Input	
38	GND	Ground	1

Notes:

[1] GND is the symbol for signal and supply (power) common for the module. All are common within the module and all module voltages are referenced to this potential unless otherwise noted. Connect these directly to the host board signal-common ground plane.

[2] Vcc Rx, Vcc1 and Vcc Tx are the receiver and transmitter power supplies and shall be applied concurrently. Recommended host board power supply filtering is shown in Figure2. Vcc Rx Vcc1 and Vcc Tx may be internally connected within the Module in any combination. The connector pins are each rated for a maximum current of 1000 mA.



## Monitoring Specification

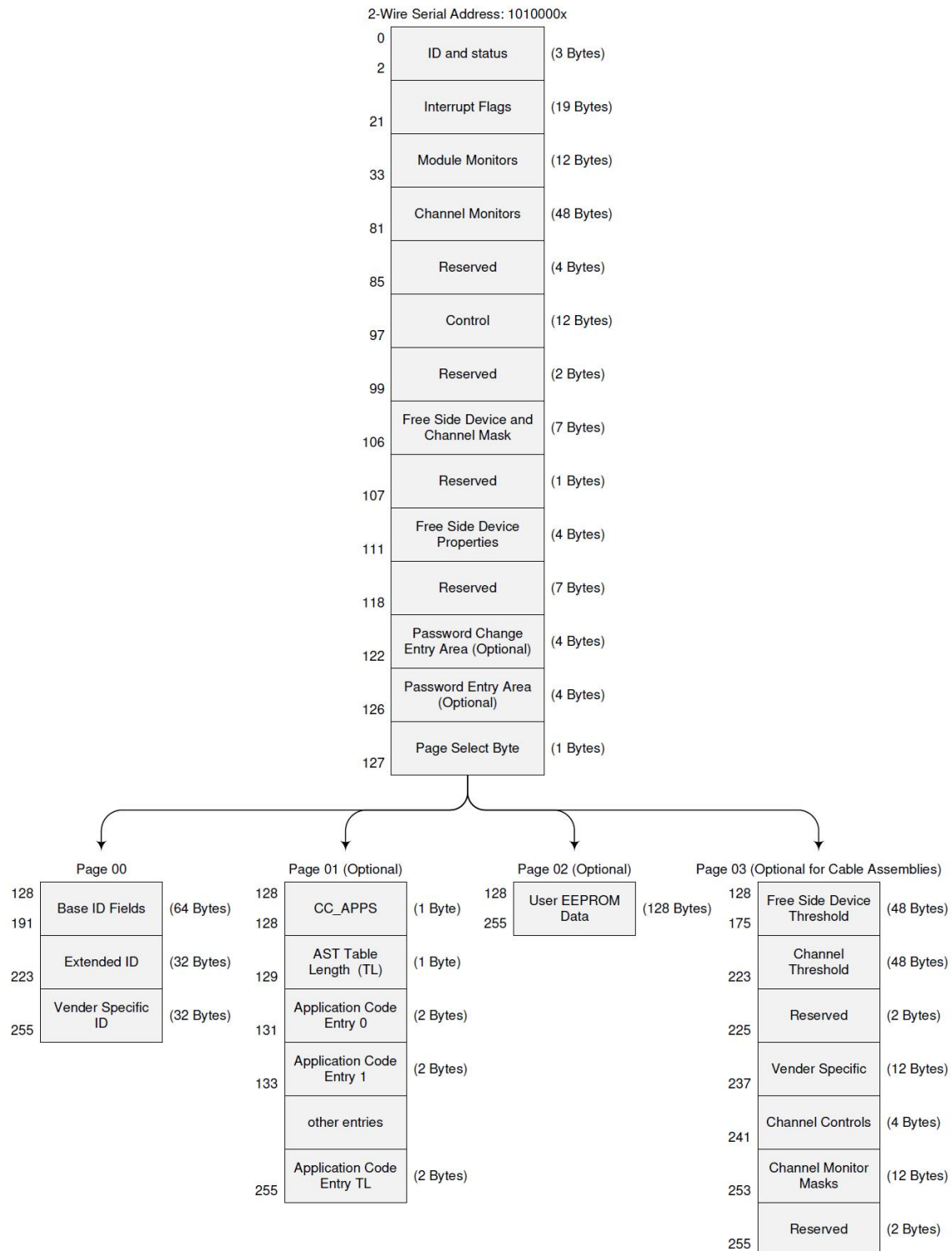


Figure 2 Memory map

## Mechanical Dimensions

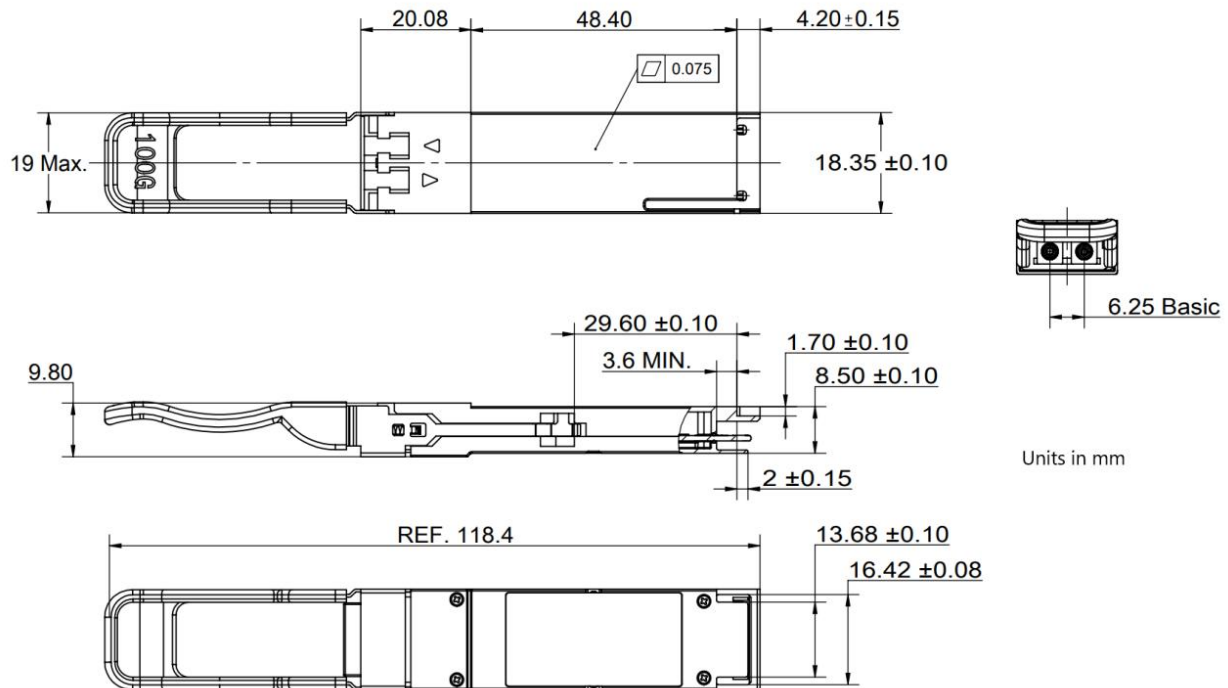


Figure3 Mechanical Outline

## 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.

## 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.

## Further Information:

---

Web [www.naddod.com](http://www.naddod.com)

Email For order requirements: [sales@naddod.com](mailto:sales@naddod.com)  
For customer service: [support@naddod.com](mailto:support@naddod.com)  
For technical support: [tech@naddod.com](mailto:tech@naddod.com)

For cooperation: [agency@naddod.com](mailto:agency@naddod.com)

For other informations: [info@naddod.com](mailto:info@naddod.com)

## Disclaimer

---

1. We are committed to continuous product improvement and feature upgrades, and the contents contained in this manual are subject to change without notice.
  2. Nothing herein should be construed as constituting an additional warranty.
  3. NADDOD assumes no responsibility for the use or reliability of equipment or software not provided by NADDOD.
- Copyright © NADDOD.COM All Rights



PNY Technologies Europe  
9 rue Joseph Cugnot  
33708 Mérignac cedex | France  
T +33 (0)5 40 240 240 | [pnipro@pny.eu](mailto:pnipro@pny.eu)