

## EOL2-BI1696-XX-ADL & EOL2-BI1696-XX-DAL

**Tx: 1270nm/Rx: 1330nm BIDI X2 Transceiver for 10GbE**

**Tx: 1330nm/Rx: 1270nm BIDI X2 Transceiver for 10GbE**

**Simplex LC Single Fiber X2 Transceiver**

**RoHS 6 Compliant**

### Features

- ◆ Operating data rate up to 10.3Gbps
- ◆ Compatible with X2 MSA Rev.2.0b
- ◆ Two types:
  - A: 1270nm DFB Transmitter/ 1330nm Receiver
  - B: 1330nm DFB Transmitter/ 1270nm Receiver
- ◆ Distance up to 10/20/40km over SMF
- ◆ Single 3.3V Power supply and TTL Logic Interface
- ◆ Hot pluggable X2 Footprint Simplex LC Connector Interface
- ◆ Operating Case Temperature Standard: 0~+70°C
- ◆ Hot pluggable 70-pin connector with XAUI electrical interface
- ◆ Management and control via MDIO 2-wire interface
- ◆ Compliant with SFF-8472



### Applications

- ◆ Ethernet
- ◆ Other optical links

### Ordering information

Part No.	Data Rate	Laser	Temp.	Distance	Optical Interface	DDMI
EOL2-BI1696-10-ADL*	10.3Gbps	1270nm DFB	Standard	10km	LC	YES
EOL2-BI1696-10-DAL	10.3Gbps	1330nm DFB	Standard	10km	LC	YES
EOL2-BI1696-20-ADL*	10.3Gbps	1270nm DFB	Standard	20km	LC	YES
EOL2-BI1696-20-DAL	10.3Gbps	1330nm DFB	Standard	20km	LC	YES
EOL2-BI1696-40-ADL*	10.3Gbps	1270nm DFB	Standard	40km	LC	YES
EOL2-BI1696-40-DAL	10.3Gbps	1330nm DFB	Standard	40km	LC	YES

\*Note1: Standard version

## Regulatory Compliance

Feature	Standard	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883G Method 3015.7	Class 1C (>500 V)
Electrostatic Discharge to the enclosure	EN 55024:1998+A1+A2 IEC-61000-4-2 GR-1089-CORE	Compliant with standards
Electromagnetic Interference (EMI)	FCC Part 15 Class B EN55022:2006 CISPR 22B :2006 VCCI Class B	Compliant with standards Noise frequency range: 30 MHz to 6 GHz. Good system EMI design practice required to achieve Class B margins. System margins depend on customer host board and chassis design.
Immunity	EN 55024:1998+A1+A2 IEC 61000-4-3	Compliant with standards. 1kHz sine-wave, 80% AM, from 80 MHz to 1 GHz. No effect on transmitter/receiver performance is detectable between these limits.
Laser Eye Safety	FDA 21CFR 1040.10 and 1040.11 EN (IEC) 60825-1:2007 EN (IEC) 60825-2:2004+A1	CDRH compliant and Class I laser product. TüV Certificate No. 50135086
Component Recognition	UL and CUL EN60950-1:2006	UL file E317337 TüV Certificate No. 50135086 (CB scheme )
RoHS6	2002/95/EC 4.1&4.2 2005/747/EC 5&7&13	Compliant with standards <sup>*note2</sup>

Note2: For update of the equipments and strict control of raw materials, EOPTOLINK has the ability to supply the customized products since Jan 1st, 2007, which meets the requirements of RoHS6 (Restrictions on use of certain Hazardous Substances) of European Union.

In light of item 5 in RoHS exemption list of RoHS Directive 2002/95/EC, Item 5: Lead in glass of cathode ray tubes, electronic components and fluorescent tubes.

In light of item 13 in RoHS exemption list of RoHS Directive 2005/747/EC, Item 13: Lead and cadmium in optical and filter glass. The three exemptions are being concerned for Eoptolink's transceivers, because Eoptolink's transceivers use glass, which may contain Pb, for components such as lenses, isolators, and other electronic components.

## Product Description

The EOL2-BI1696-XX-XX is a highly integrated, serial optical transponder module for high-speed, 10Gbit/s data transmission applications. The module is fully compliant to IEEE 802.3ae standard for Ethernet, making it ideally suited for 10GbE datacom (rack to-rack, client interconnection) applications. Designed for distances of up to 40km, the transponder module comprises a transmitter with:

A type: a directly modulated uncooled 1270nm DFB laser, a receiver with a PIN photodiode, a XAUI-Attachment Interface, an integrated Coder /Decoder and multiplexer / de-multiplexer (SERDES: Serializer/Deserializer).

B type: a directly modulated uncooled 1330nm DFB laser, a receiver with a PIN photodiode, a XAUI-Attachment Interface, an integrated Coder /Decoder and multiplexer / de-multiplexer (SERDES: Serializer/Deserializer)

The transponder operates within a wide case temperature range of 0°C to +70°C and offers optimum heat dissipation and excellent electromagnetic shielding which enables high port densities for 10GbE systems.

Digital diagnostic monitoring (DDM) is implemented in EOL2-BI1696-XX-XX and fully compliant with X2 DDM architecture. The unit monitors temperature, receive optical power, transmit optical power, and laser bias current.

## Absolute Maximum Ratings<sup>\*note3</sup>

Rating	Symbol	Min	Max	Units
Storage Ambient Temperature	T <sub>s</sub>	-40	+85	°C
Powered Case Temperature	T <sub>c</sub>	-5	+70	°C
Supply Voltage 3.3V	V <sub>CC3</sub>	-0.3	4.0	V
Supply Voltage 5V	V <sub>CC5</sub>	-0.5	7.0	V
Input Voltage Low Speed Signals	V <sub>I</sub>	-0.5	3.3	V
Clamp Currents Low Speed Signals	I <sub>IK</sub>	-50		mA
XAUI Input Level	V <sub>IXAUI</sub>	-0.4	2.3	V
Differential XAUI Input Amplitude	V <sub>IDXAUI</sub>		1000	mV
Optical Receiver Input Power	P <sub>Rx</sub>		+3	dBm
Static Discharge Voltage			500	V

\*Note3: Exceeding any one of these values may destroy the device permanently.

## Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units
Operating Case Temperature Range	T <sub>c</sub>	0		+70	°C
Operating Humidity		8		80	%
Power Supply Voltage @ 3.3V	V <sub>CC3</sub>	3.135	3.3	3.465	V
Power Supply Voltage @ 5.0V	V <sub>CC5</sub>	4.75	5.00	5.25	V

## Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Units
5V Supply Current	$I_{VCC5}$	-	-	1	A
3.3V Supply Current	$I_{VCC3}$	-	-	2	A
APS Current	$I_{APS}$			2	A

## XAUI Input Characteristics <sup>\*Note4</sup>

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Differential Input Voltage Swing	8B/10B Coded Input Signal	$V_{ID}$	175		2,000	mV <sub>P-P</sub>
Differential Return Loss	100MHz — 2.5GHz	SDD11	10			dB
Common Mode Return Loss	100MHz — 2.5GHz	SCC11	6			dB
Total Peak-to-Peak Jitter Tolerance	Sinusoidal Jitter @ 0~20MHz	$T_{JRDS}$	0.32			UI
Differential Input Impedance		$R_{IND}$	80	100	120	$\Omega$

Note4: XAUI-input-Lanes are ac-inputs.

## XAUI Output Characteristics <sup>\*Note5</sup>

Parameter	Conditions	Symbol	Min	Typ	Max	Units
XAUI Data Rate				10.3125		GBD
Differential Output Voltage Swing	$R_{LOAD}=100 \pm 5\%$	$V_{out}$	800		1,600	mV <sub>P-P</sub>
Differential Output Impedance		$Z_{out}$	80	100	120	$\Omega$
Differential Transition Time	20% - 80%	tr/tf	50		130	ps
Total Output Jitter					0.17	UI
Total Deterministic Output Jitter					0.08	UI

Note5: XAUI-output-Lanes are ac-outputs.

## Optical Interface

### Recommended Operating Conditions

Parameter	Remark	Symbol	Min	Typ	Max	Units
Operating Range	Single Mode Fiber				10/20 /40	Km
Input Data Rate				10.3125		GBD
Receiver Input Signal	Center Wavelength	$\lambda_{c@A}$ type		1270		nm
		$\lambda_{c@B}$ type		1330		

### Optical and Electrical Characteristics

(EOL2-BI1696-10-ADX, 1270nm DFB & PIN/TIA)

#### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1260	1270	1280	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		$P_{out}$	-5		0	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

#### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Center Wavelength Range		$\lambda_c$	1320		1340	nm
Receiver Sensitivity	BER 10 <sup>-12</sup> @2 <sup>31-1</sup>	$P_{in}$			-12	dBm
Saturation Input Power		$P_{max}$	0.5			dBm

## (EOL2-BI1696-10-DAX, 1330nm DFB & PIN/TIA)

### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1320	1330	1340	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		P <sub>out</sub>	-5		0	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Center Wavelength Range		$\lambda_c$	1260		1280	nm
Receiver Sensitivity	BER 10-12@231-1	P <sub>in</sub>			-12	dBm
Saturation Input Power		P <sub>max</sub>	0.5			dBm

## (EOL2-BI1696-20-ADX, 1270nm DFB & PIN/TIA)

### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1260	1270	1280	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		P <sub>out</sub>	-2		3	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD

Center Wavelength Range		$\lambda_c$	1320		1340	nm
Receiver Sensitivity	BER 10-12@231-1	Pin			-13	dBm
Saturation Input Power		Pmax	0.5			dBm

### (EOL2-BI1696-20-DAX, 1330nm DFB & PIN/TIA)

#### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1320	1330	1340	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		Pout	-2		3	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

#### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Center Wavelength Range		$\lambda_c$	1260		1280	nm
Receiver Sensitivity	BER 10-12@231-1	Pin			-13	dBm
Saturation Input Power		Pmax	0.5			dBm

### (EOL2-BI1696-40-ADX, 1270nm DFB & PIN/TIA)

#### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1260	1270	1280	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		Pout	3		5	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

#### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Center Wavelength Range		$\lambda_c$	1320		1340	nm
Receiver Sensitivity	BER 10-12@231-1	Pin			-14	dBm
Saturation Input Power		Pmax	0.5			dBm

**(EOL2-BI1696-40-DAX, 1330nm DFB & PIN/TIA)**

### Transmitter Characteristics

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Characteristic	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Nominal Wavelength		$\lambda_c$	1320	1330	1340	nm
Spectral Width (-20 dB)		$\Delta\lambda$			1	nm
SMSR		SMSR	30			dB
Optical Output Power		Pout	3		5	dBm
Extinction Ratio		ER	3.5			dB
Transmitter Penalty	Bessel-Thompson Filter	TP			3	dB

### Receiver Characteristics <sup>\*Note6</sup>

(If not mentioned it will be under recommended operating conditions and standard compliant single mode fiber.)

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Data Rate				10.3125		GBD
Center Wavelength Range		$\lambda_c$	1260		1280	nm
Receiver Sensitivity	BER 10-12@231-1	Pin			-14	dBm
Saturation Input Power		Pmax	0.5			dBm

Note6: The specified characteristics are met within the recommended range of operating conditions and under the default settings of output power and modulation amplitude. Changing the settings of the optical output power will affect the dynamic behavior of the output signal. Unless otherwise noted, typical data is quoted at nominal voltages and +25 °C ambient temperature.

## MDIO Interface

### DC Characteristics

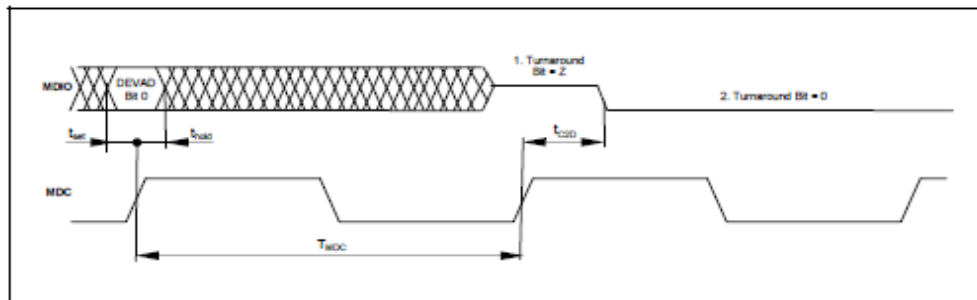
(If not mentioned it will be under the recommended operating conditions.)

Characteristic	Condition	Symbol	Minimum	Maximum	Unit
Input high voltage		$V_H$	0.84	1.5	V
Input low voltage		$V_L$	-0.3	0.36	V
MDIO Input current	MMD Driver in tri-state	$I_{MDIO}$	-10	8	uA
MDC Input current		$I_{MDC}$	-5	5	uA
Output low voltage	$I_{OL} = 100\text{pA}$	$V_{QL}$	-0.3		V
	$I_{OL} = 4\text{mA}$	$V_{QL}$		0.2	V
Output high voltage	$R_{PULL-Up} = 357\Omega \pm 1\%$ $V_{PULL-Up} = 1.14 \sim 1.5\text{V}$	$V_{QH}$	1.136	1.5	V
Output low current	$V_I = 0.2\text{V}$	$I_{QL}$	4		mA
MDIO Input capacitance	$V_I = 0 \sim 1.5\text{V}$	$C_{in}$		10	pF

## AC Characteristics

If not mentioned it will be under the recommended operating conditions. Furthermore it's recommended that clock period time  $T_{MDC}$  is not less than 310ns and the sum of input currents of loads on the bus does not exceed 256pA at high and at low not below -320pA.

Characteristic	Condition	Symbol	Minimum	Maximum	Unit
Set Up Time		$t_{set}$		10	ns
Hold Time		$t_{hold}$		10	ns
Clock to Data Time	$R_{PULL-Up} = 357\Omega \pm 1\%$ , $C_{BUS} \leq 470\text{pF}$	$t_{C2D}$	0	300	ns



Example Timing Diagram: Turnover Timing at Read Cycle

## Electro Static Discharge (ESD)

The maximum electrostatic charge based on a human body model and the conditions as outlined below is:

Parameter	Conditions	Symbol	Min	Typ	Max	Units
Static Discharge Voltage	MIL STD 883 Method				500	V

## Thermal Management

The transponder is designed for an operation within a case temperature range between 0 to +70°C at an altitude of < 3km. The built in heat sink provides an optimized thermal performance.

The user needs to guarantee per system design not to exceed this temperature range. It has to be considered that in case of usage of multiple modules on a single host board that there is a temperature rise among the modules hosted side by side. Airflow direction and air speed needs to be chosen accordingly. For further information it is referred to the MSA document.

### DDM Monitoring Specification

#### (EOL2-1696-10-XX)

Parameter	Range	Accuracy	Calibration
Temperature	-10 to +80°C	± 3°C	Internal
Voltage	+3 to +3.5	± 3%	Internal
TX Power	-6 to +1 dBm	± 3dB	Internal
RX Power	-13 to +1.5 dBm	± 3dB	Internal

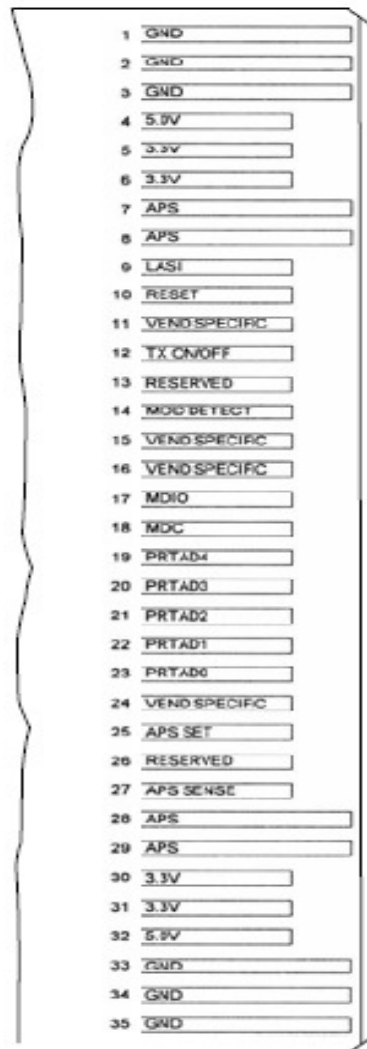
#### (EOL2-1696-20-XX)

Parameter	Range	Accuracy	Calibration
Temperature	-10 to +80°C	± 3°C	Internal
Voltage	+3 to +3.5	± 3%	Internal
TX Power	-3 to +4 dBm	± 3dB	Internal
RX Power	-14 to +1.5 dBm	± 3dB	Internal

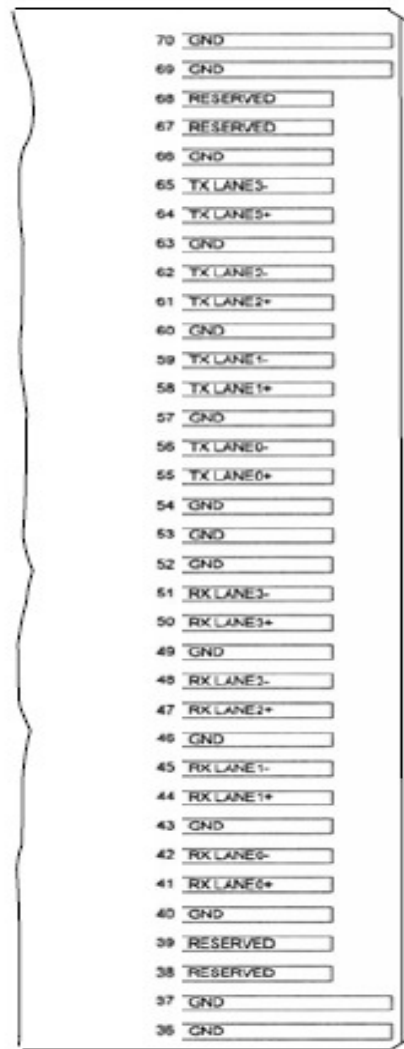
#### (EOL2-1696-40-XX)

Parameter	Range	Accuracy	Calibration
Temperature	-10 to +80°C	± 3°C	Internal
Voltage	+3 to +3.5	± 3%	Internal
TX Power	+2 to +6 dBm	± 3dB	Internal
RX Power	-15 to +1.5 dBm	± 3dB	Internal

## Card-Edge-Connector-Pinning and Layout



Top view -Top side



Top view-Bottom row

## Electrical Pin Definition

Symbol	Logic	PIN	Name/Description	Note
3.3V		5, 6, 30, 31	Power Supply of Optical Receiver and Transmitter and Control Circuits	2
5.0V		4, 32	Power Supply of Optical Receiver Frontend	2
APS		7, 8, 28, 29	Adaptive Power Supply, Supply of PHY	2

XS and PCS Layer Devices			
APS SENSE		27	APS Sense Output for APS Control Circuit
APS SET		25	Feedback Input for APS, Input of APS Setting Resistor
GND		1, 2, 3, 33, 34, 35, 36, 37, 40, 43, 46, 49, 52, 53, 54, 57, 60, 63, 66, 69, 70	Common Electrical Ground
LASI	1.2V CMOS Open Drain Output	9	Link Alarm Status Interrupt, low active, Open Drain Output Supposed to operate with 10KΩ - 22KΩ pull upon host. Logic High: Normal Operation Logic Low: Link Alarm is indicated
MDC		18	Management Clock Input
MDIO		17	Management Data IO
MOD DETECT		14	1kΩ to Ground for APS Circuit Environment
PRTADO	1.2V CMOS Input	23	Port Address Bit 0 (Low = 0), internally pulled up by 18kΩ
PRTAD1	1.2V CMOS Input	22	Port Address Bit 1 (Low = 0), internally pulled up by 18kΩ
PRTAD2	1.2V CMOS Input	21	Port Address Bit 2 (Low = 0), internally pulled up by 18kΩ
PRTAD3	1.2V CMOS Input	20	Port Address Bit 3 (Low = 0), internally pulled up by 18kΩ
PRTAD4	1.2V CMOS Input	19	Port Address Bit 4 (Low = 0), internally pulled up by 18kΩ
RESERVED		13, 38, 39, 67, 68	Reserved by MSA, internally not connected
RESERVED		26	Reserved for Avalanche Photodiode use, internally not connected
RESET	1.2V CMOS Input	10	Low active Reset Input 10KΩ pull-up on Transceiver Logic high = Normal Operation

			Logic Low = Reset asserted	
TX ON/OFF	1.2V CMOS Input	12	High active Transmitter Enable Input 10K $\Omega$ pull-up on Transceiver Logic high = Transmitter active (normal Operation) And Register Bit 1.9.0 set to low as well Logic Low = shut down of Transmitter	
VENDSPECIFIC		11, 15, 16, 24	Vendor Specific Pin,. for proper operation leave unconnected	5
RX LANE0+		41	Module XAUI Output Lane 0+	4
RX LANE0-		42	Module XAUI Output Lane 0-	4
RXLANE1+		44	Module XAUI Output Lane 1+	4
RXLANE1-		45	Module XAUI Output Lane 1-	4
RX LANE2+		47	Module XAUI Output Lane 2+	4
RX LANE2-		48	Module XAUI Output Lane 2-	4
RX LANE3+		50	Module XAUI Output Lane 3+	4
RX LANE3-		51	Module XAUI Output Lane 3-	4
TX LANE0+		55	Module XAUI Input Lane 0+	4
TX LANE0-		56	Module XAUI Input Lane 0-	4
TXLANE1+		58	Module XAUI Input Lane 1+	4
TXLANE1-		59	Module XAUI Input Lane 1-	4
TX LANE2+		61	Module XAUI Input Lane 2+	4
TX LANE2-		62	Module XAUI Input Lane 2-	4
TX LANE3+		64	Module XAUI Input Lane 3+	4
TX LANE3-		65	Module XAUI Input Lane 3-	4

### Notes:

- 1) Ground connections are common for TX and RX.
- 2) Each connector contact is rated at 0.5A.
- 3) MDIO and MDC timing must comply with IEEE 802.3ae clause 45.3.
- 4) XAUI output characteristics comply with IEEE 802.3ae clause 47.
- 5) Transceivers will be MSA compliant when no signals are present on the vendor specific pins.

## Eye Safety

This single-mode transceiver is a Class 1 laser product. It complies with IEC-60825 and FDA 21 CFR 1040.10 and 1040.11. The transceiver must be operated within the specified temperature and voltage limits. The optical ports of the module shall be terminated with an optical connector or with a dust plug.

## Obtaining Document

You can visit our website:

<http://www.eoptolink.com>

Or contact Eoptolink Technology Inc., Ltd. listed at the end of the documentation to get the latest document.

## Revision History

Revision	Initiated	Reviewed	Approved	DCN	Release Date
V1.a	Kelly			Released.	Dec 3, 2009
V1.b	Kelly			Updating the PN.	2010-4-22
V1.c	Cathy			Integrated d10km 20km 40km in a datasheet.	October 24, 2010

## Notice:

Eoptolink reserves the right to make changes to or discontinue any optical link product or service identified in this publication, without notice, in order to improve design and/or performance. Applications that are described herein for any of the optical link products are for illustrative purposes only. Eoptolink makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

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