

## EOLS-1606-XXXD Series

**SFP Single-Mode for DWDM Application**

**Duplex SFP Transceiver**

**Digital Diagnostic Function**

**RoHS6 Compliant**

### Features

- ◆ Operating Data Rate up to 622Mbps
- ◆ Available in all C-Band Wavelengths on the 50GHz DWDM ITU Grid
- ◆ Single 3.3V Power Supply and TTL Logic Interface
- ◆ Hot-Pluggable SFP Footprint Duplex LC Connector Interface
- ◆ Compliant with Class 1 FDA and IEC60825-1 Laser Safety
- ◆ Compliant with SFP MSA
- ◆ Compliant with SFF-8472
- ◆ Operating Case Temperature:
  - Standard: 0°C to 70°C
  - Industrial: -40°C to 85°C



### Applications

- ◆ Amplified DWDM networks
- ◆ Ring topologies with fixed and reconfigurable OADMs
- ◆ Fast Ethernet, Giga Ethernet
- ◆ Fiber Channel

### Ordering Information

Part No.	Data Rate	Laser	Power budget <sup>*(note2)</sup>	Interface	Temperature
EOLS-1606-28XXX <sup>(note1)</sup> D	622Mbps	DWDM EML	28dB	LC	Standard
EOLS-1606-28XXX <sup>(note1)</sup> DI	622Mbps	DWDM EML	28dB	LC	Industrial
EOLS-1606-34XXX <sup>(note1)</sup> D	622Mbps	DWDM EML	34dB	LC	Standard
EOLS-1606-34XXX <sup>(note1)</sup> DI	622Mbps	DWDM EML	34dB	LC	Industrial
EOLS-1606-39XXX <sup>(note1)</sup> D	622Mbps	DWDM EML	39dB	LC	Standard
EOLS-1606-39XXX <sup>(note1)</sup> DI	622Mbps	DWDM EML	39dB	LC	Industrial

Note1: X XX refers to DWDM Wavelength range as ITU-T specified, please refer the following table for detailed center wavelength information.

Note2: The power budget which is guaranteed.

XXX- Channel refers to the following table:

*Channel (XXX)	Part NO.	Frequency (THz)	Center Wavelength (nm)
200	EOLS-1603-X*200 EOLS-1603-X*200I	192.00	1561.42
205	EOLS-1603-X*205 EOLS-1603-X*205I	192.05	1561.01
210	EOLS-1603-X*210 EOLS-1603-X*210I	192.10	1560.61
215	EOLS-1603-X*215 EOLS-1603-X*215I	192.15	1560.20
220	EOLS-1603-X*220 EOLS-1603-X*220I	192.20	1559.79
225	EOLS-1603-X*225 EOLS-1603-X*225I	192.25	1559.39
230	EOLS-1603-X*230 EOLS-1603-X*230I	192.30	1558.98
235	EOLS-1603-X*235 EOLS-1603-X*235I	192.35	1558.58
240	EOLS-1603-X*240 EOLS-1603-X*240I	192.40	1558.17
245	EOLS-1603-X*245 EOLS-1603-X*245I	192.45	1557.77
250	EOLS-1603-X*250 EOLS-1603-X*250I	192.50	1557.36
255	EOLS-1603-X*255 EOLS-1603-X*255I	192.55	1556.96
260	EOLS-1603-X*260 EOLS-1603-X*260I	192.60	1556.55
265	EOLS-1603-X*265 EOLS-1603-X*265I	192.65	1556.15
270	EOLS-1603-X*270 EOLS-1603-X*270I	192.70	1555.75
275	EOLS-1603-X*275 EOLS-1603-X*275I	192.75	1555.34
280	EOLS-1603-X*280 EOLS-1603-X*280I	192.80	1554.94
285	EOLS-1603-X*285 EOLS-1603-X*285I	192.85	1554.54
290	EOLS-1603-X*290 EOLS-1603-X*290I	192.90	1554.13
295	EOLS-1603-X*295 EOLS-1603-X*295I	192.95	1553.73

300	EOLS-1603-X*300 EOLS-1603-X*300I	193.00	1553.33
305	EOLS-1603-X*305 EOLS-1603-X*305I	193.05	1552.93
310	EOLS-1603-X*310 EOLS-1603-X*310I	193.10	1552.52
315	EOLS-1603-X*315 EOLS-1603-X*315I	193.15	1552.12
320	EOLS-1603-X*320 EOLS-1603-X*320I	193.20	1551.72
325	EOLS-1603-X*325 EOLS-1603-X*325I	193.25	1551.32
330	EOLS-1603-X*330 EOLS-1603-X*330I	193.30	1550.92
335	EOLS-1603-X*335 EOLS-1603-X*335I	193.35	1550.52
340	EOLS-1603-X*340 EOLS-1603-X*340I	193.40	1550.12
345	EOLS-1603-X*345 EOLS-1603-X*345I	193.45	1549.72
350	EOLS-1603-X*350 EOLS-1603-X*350I	193.50	1549.32
355	EOLS-1603-X*355 EOLS-1603-X*355I	193.55	1548.91
360	EOLS-1603-X*360 EOLS-1603-X*360I	193.60	1548.51
365	EOLS-1603-X*365 EOLS-1603-X*365I	193.65	1548.11
370	EOLS-1603-X*370 EOLS-1603-X*370I	193.70	1547.72
375	EOLS-1603-X*375 EOLS-1603-X*375I	193.75	1547.32
380	EOLS-1603-X*380 EOLS-1603-X*380I	193.80	1546.92
385	EOLS-1603-X*385 EOLS-1603-X*385I	193.85	1546.52
390	EOLS-1603-X*390 EOLS-1603-X*390I	193.90	1546.12
395	EOLS-1603-X*395 EOLS-1603-X*395I	193.95	1545.72
400	EOLS-1603-X*400 EOLS-1603-X*400I	194.00	1545.32
405	EOLS-1603-X*405	194.05	1544.92

	EOLS-1603-X*405I		
410	EOLS-1603-X*410 EOLS-1603-X*410I	194.10	1544.53
415	EOLS-1603-X*415 EOLS-1603-X*415I	194.15	1544.13
420	EOLS-1603-X*420 EOLS-1603-X*420I	194.20	1543.73
425	EOLS-1603-X*425 EOLS-1603-X*425I	194.25	1543.33
430	EOLS-1603-X*430 EOLS-1603-X*430I	194.30	1542.94
435	EOLS-1603-X*435 EOLS-1603-X*435I	194.35	1542.54
440	EOLS-1603-X*440 EOLS-1603-X*440I	194.40	1542.14
445	EOLS-1603-X*445 EOLS-1603-X*445I	194.45	1541.75
450	EOLS-1603-X*450 EOLS-1603-X*450I	194.50	1541.35
455	EOLS-1603-X*455 EOLS-1603-X*455I	194.55	1540.95
460	EOLS-1603-X*460 EOLS-1603-X*460I	194.60	1540.56
465	EOLS-1603-X*465 EOLS-1603-X*465I	194.65	1540.16
470	EOLS-1603-X*470 EOLS-1603-X*470I	194.70	1539.77
475	EOLS-1603-X*475 EOLS-1603-X*475I	194.75	1539.37
480	EOLS-1603-X*480 EOLS-1603-X*480I	194.80	1538.98
485	EOLS-1603-X*485 EOLS-1603-X*485I	194.85	1538.58
490	EOLS-1603-X*490 EOLS-1603-X*490I	194.90	1538.19
495	EOLS-1603-X*495 EOLS-1603-X*495I	194.95	1537.79
500	EOLS-1603-X*500 EOLS-1603-X*500I	195.00	1537.40
505	EOLS-1603-X*505 EOLS-1603-X*505I	195.05	1537.00
510	EOLS-1603-X*510 EOLS-1603-X*510I	195.10	1536.61

515	EOLS-1603-X*515 EOLS-1603-X*515I	195.15	1536.22
520	EOLS-1603-X*520 EOLS-1603-X*520I	195.20	1535.82
525	EOLS-1603-X*525 EOLS-1603-X*525I	195.25	1535.43
530	EOLS-1603-X*530 EOLS-1603-X*530I	195.30	1535.04
535	EOLS-1603-X*535 EOLS-1603-X*535I	195.35	1534.64
540	EOLS-1603-X*540 EOLS-1603-X*540I	195.40	1534.25
545	EOLS-1603-X*545 EOLS-1603-X*545I	195.45	1533.86
550	EOLS-1603-X*550 EOLS-1603-X*550I	195.50	1533.47
555	EOLS-1603-X*555 EOLS-1603-X*555I	195.55	1533.07
560	EOLS-1603-X*560 EOLS-1603-X*560I	195.60	1532.68
565	EOLS-1603-X*565 EOLS-1603-X*565I	195.65	1532.29
570	EOLS-1603-X*570 EOLS-1603-X*570I	195.70	1531.90
575	EOLS-1603-X*575 EOLS-1603-X*575I	195.75	1531.51
580	EOLS-1603-X*580 EOLS-1603-X*580I	195.80	1531.12
585	EOLS-1603-X*585 EOLS-1603-X*585I	195.85	1530.72
590	EOLS-1603-X*590 EOLS-1603-X*590I	195.90	1530.33
595	EOLS-1603-X*595 EOLS-1603-X*595I	195.95	1529.94

\*: X refers to the DWDM Power budget (28 34 39) , please contact EOPTOLINK to confirm whether the wavelength is available.

## Regulatory Compliance\*

Product Certificate	Certificate Number	Applicable Standard
TUV	R50135086	EN 60950-1:2006+A11+A1+A12+A2
		EN 60825-1:2014
		EN 60825-2:2004+A1+A2
UL	E317337	UL 60950-1
		CSA C22.2 No. 60950-1-07
EMC CE	AE 50285865 0001	EN 55022:2010
		EN 55024:2010
FCC	WTF14F0514417E	47 CFR PART 15 OCT., 2013
FDA	/	CDRH 1040.10
ROHS	/	2011/65/EU

\*The above certificate number updated to June 2014, because some certificate will be updated every year, such as FDA and ROHS. For the latest certification information, please check with Eoptolink.

## Product Description

The EOLS-1606-XXXD series single mode transceiver is small form factor pluggable module for duplex optical data communications. This module is designed for single mode fiber and operates at a nominal DWDM wavelength from 1561.42nm to 1563.86nm as specified by the ITU-T. It is designed to deploy in the DWDM networking equipment in metropolitan access and core networks.

It is with the SFP 20-pin connector to allow hot plug capability. The transmitter section uses a DWDM multiple quantum well EML laser and is a class 1 laser compliant according to International Safety Standard IEC-60825.

The EOLS-1606-XXXD series are designed to be compliant with SFF-8472 Multi-Source Agreement (MSA).

## Absolute Maximum Ratings\*note3

Parameter	Symbol	Min.	Max.	Unit
Storage Temperature	$T_s$	-40	+85	°C
Supply Voltage	$V_{CC}$	-0.5	3.6	V
Operating Relative Humidity		-	95	%

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

## Recommended Operating Conditions

Parameter	Symbol	Min.	Typical	Max.	Unit	
Operating Case Temperature	$T_c$	EOLS-1606-XXD	0	-	+70	°C
		EOLS-1606-XXDI	-40	-	+85	
Power Supply Voltage	$V_{CC}$	3.15	3.3	3.45	V	
Power Supply Current	$I_{CC}$	-	-	450	mA	

Power Supply Current	Icc	-	-	540*	mA
Date Rate				622M	bps

\*540mA only for Industrial operating case temperature

## Performance Specifications - Electrical

Parameter	Symbol	Min.	Typ.	Max	Unit	Notes
<b>Transmitter</b>						
LVPECL Inputs(Differential)	Vin	400		2000	mVpp	AC coupled inputs*(note4)
Input Impedance (Differential)	Zin	85	100	115	ohm	Rin > 100 kohm @ DC
TX_Dis	Disable	2		Vcc	V	
	Enable	0		0.8		
TX_FAULT	Fault	2		Vcc	V	
	Normal	0		0.8		
<b>Receiver</b>						
LVPECL Outputs (Differential)	Vout	370		2000	mVpp	AC coupled outputs*(note4)
Output Impedance (Differential)	Zout	85	100	115	ohm	
RX_LOS	LOS	2		Vcc	V	
	Normal	0		0.8	V	
MOD_DEF ( 0:2 )	VoH	2.5			V	
	VoL	0		0.8	V	

## Performance Specifications – Optical

(DWDM EML and PIN/TIA, 28dB Power Budget at Least)

Parameter	Symbol	Min.	Typical	Max.	Unit
Data Rate			622M		bps
<b>Transmitter</b>					
Center Wavelength	$\lambda$	1528		1564	nm
Spectral Width (-20dB)	$\Delta\lambda$			0.3	nm
Side Mode Suppression Ratio	SMSR	30			dB
Channel Spacing	$\Delta f$		50		GHz
Deviation From Central Frequency@EOL		-6		6	GHz
Average Output Power*(note5)	Pout	0		5	dBm
Average Launch Power (Tx: OFF)	Poff			-45	dBm
Extinction Ratio*(note6)	ER	8.2			dB
Rise/Fall Time(20%~80%)	tr/ff			520	ps
Output Optical Eye*(note6)	Compatible with IEEE 802.3*(note8)				
TX_Disable Assert Time	t_off			10	us
P <sub>out</sub> @TX Disable Asserted	Pout			-45	dBm

Relative Intensity Noise	RIN			-135	dB/Hz
<b>Receiver</b>					
Center Wavelength	$\lambda$	1528		1664	nm
Receiver Sensitivity*(note7)	Pmin			-28	dBm
Receiver Overload	Pmax	-8			dBm
LOS De-Assert	LOSD			-29	dBm
LOS Assert	LOSA	-42			dBm
LOS Hysteresis*(note9)		0.5			dB

**(DWDM EML and APD, 34dB Power Budget at Least)**

Parameter	Symbol	Min.	Typical	Max.	Unit
Data Rate			622M		bps
<b>Transmitter</b>					
Center Wavelength	$\lambda$	1528		1564	nm
Spectral Width (-20dB)	$\Delta\lambda$			0.3	nm
Side Mode Suppression Ratio	SMSR	30			dB
Channel Spacing	$\Delta f$		50		GHz
Deviation From Central Frequency@EOL		-6		6	GHz
Average Output Power*(note5)	Pout	2		5	dBm
Average Launch Power (Tx: OFF)	Poff			-45	dBm
Extinction Ratio*(note6)	ER	8.2			dB
Rise/Fall Time(20%~80%)	tr/tf			520	ps
Output Optical Eye*(note6)	Compatible with IEEE 802.3*(note8)				
TX_Disable Assert Time	t_off			10	us
P <sub>out</sub> @TX Disable Asserted	Pout			-45	dBm
Relative Intensity Noise	RIN			-135	dB/Hz
<b>Receiver</b>					
Center Wavelength	$\lambda$	1528		1664	nm
Receiver Sensitivity*(note7)	Pmin			-32	dBm
Receiver Overload	Pmax	-10			dBm
LOS De-Assert	LOSD			-33	dBm
LOS Assert	LOSA	-45			dBm
LOS Hysteresis*(note9)		0.5			dB

**(DWDM EML and APD, 39dB Power Budget at Least)**

Parameter	Symbol	Min.	Typical	Max.	Unit
Data Rate			622M		bps
<b>Transmitter</b>					
Center Wavelength	$\lambda$	1528		1564	nm
Spectral Width (-20dB)	$\Delta\lambda$			0.3	nm
Side Mode Suppression Ratio	SMSR	30			dB
Channel Spacing	$\Delta f$		50		GHz
Deviation From Central Frequency@EOL		-6		6	GHz

Average Output Power <sup>*(note5)</sup>	P <sub>out</sub>	2		5	dBm
Average Launch Power (Tx: OFF)	P <sub>off</sub>			-45	dBm
Extinction Ratio <sup>*(note6)</sup>	ER	8.2			dB
Rise/Fall Time(20%~80%)	tr/ff			520	ps
Output Optical Eye <sup>*(note6)</sup>	Compatible with IEEE 802.3 <sup>*(note8)</sup>				
TX_Disable Assert Time	t <sub>off</sub>			10	us
P <sub>out</sub> @TX Disable Asserted	P <sub>out</sub>			-45	dBm
Relative Intensity Noise	RIN			-135	dB/Hz
<b>Receiver</b>					
Center Wavelength	$\lambda$	1528		1664	nm
Receiver Sensitivity <sup>*(note7)</sup>	P <sub>min</sub>			-37	dBm
Receiver Overload	P <sub>max</sub>	-10			dBm
LOS De-Assert	LOSD			-38	dBm
LOS Assert	LOSA	-45			dBm
LOS Hysteresis <sup>*(note9)</sup>		0.5			dB

Note3: LVPECL logic, internally AC coupled.

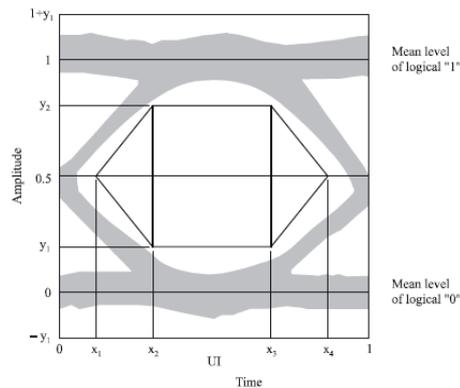
Note4: Output is coupled into a 9/125 $\mu$ m single-mode fiber.

Note5: Filtered, measured with a PRBS 2<sup>23</sup>-1 test pattern @622Mbps

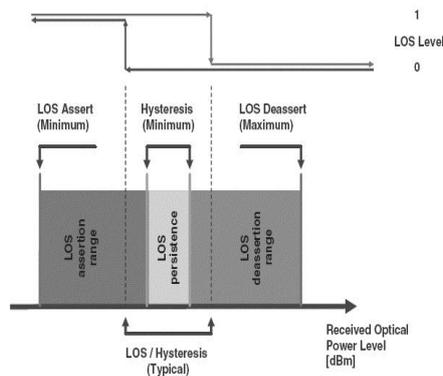
Note6: Minimum average optical power measured at BER less than 1E-10 with a 2<sup>23</sup>-1 PRBS.

Note7: Measured with a PRBS 2<sup>23</sup>-1 test pattern @622Mbps, G.652 SMF, BER  $\leq 1 \times 10^{-10}$ .

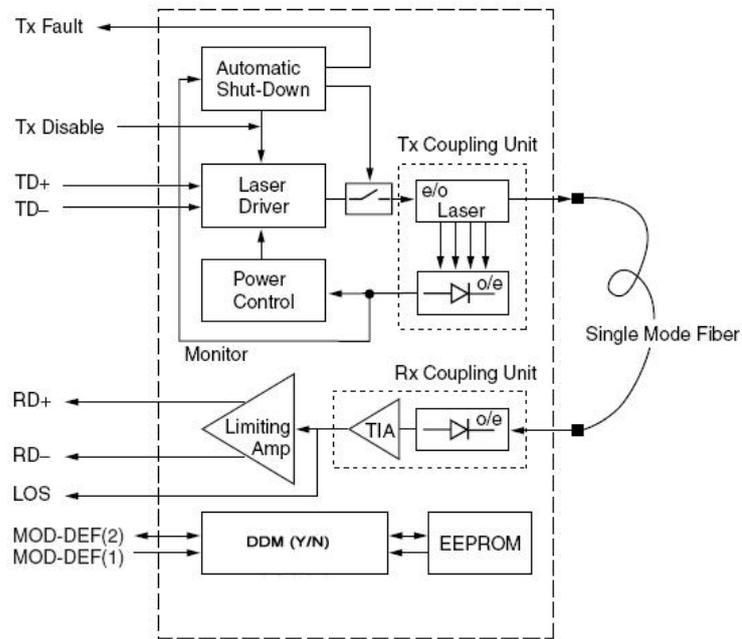
Note8: Eye Pattern Mask



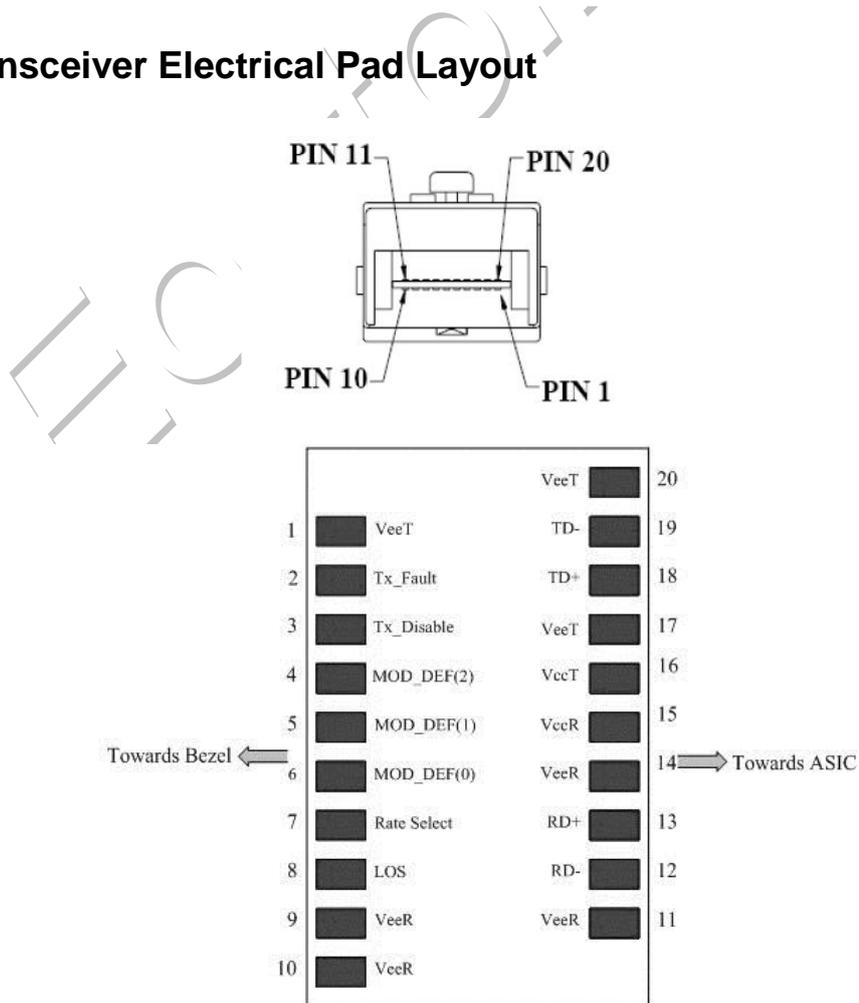
Note9: LOS Hysteresis



## Functional Description of Transceiver



## SFP Transceiver Electrical Pad Layout



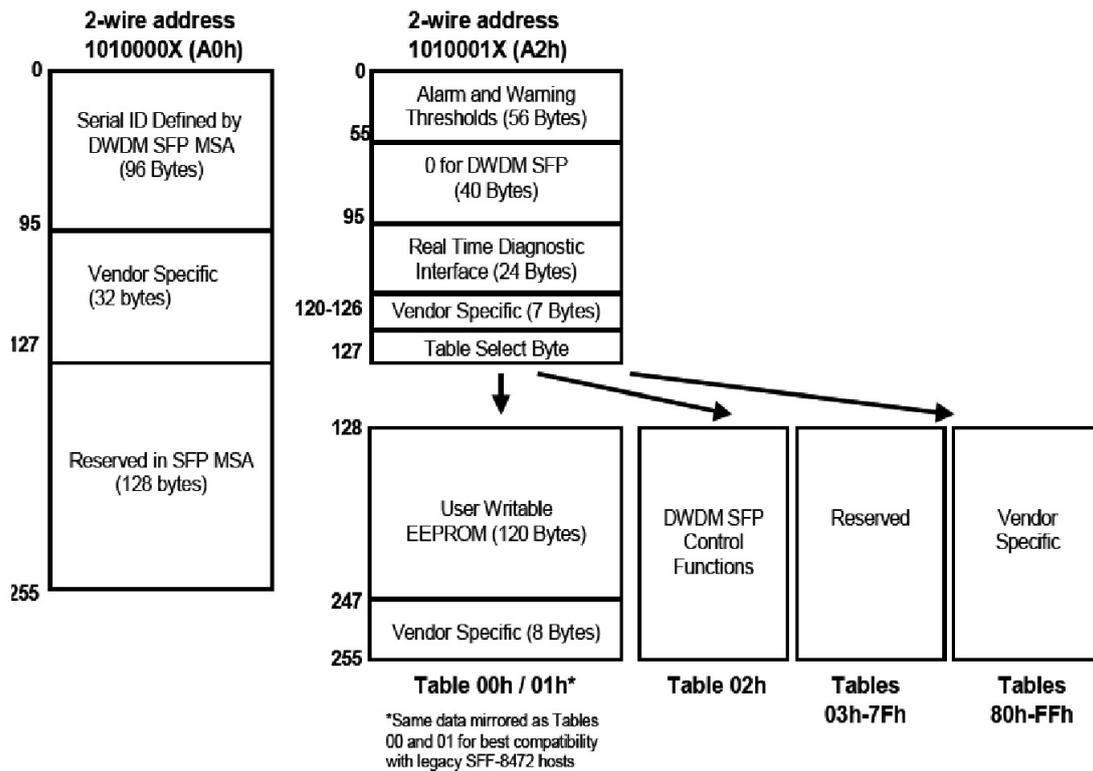
## Pin Function Definitions

Pin Num.	Name	Function Description
1	VeeT	Transmitter Ground
2	TX Fault	Transmitter Fault Indication, open collector/drain output
3	TX Disable	Transmitter Disable
4	MOD-DEF2	Module Definition 2, Data line for Serial ID.
5	MOD-DEF1	Module Definition 1, Clock line for Serial ID.
6	MOD-DEF0	Module Definition 0, Grounded within the module.
7	Rate Select	Not Connect, Function not available
8	LOS	Loss of Signal, open collector/drain output
9	VeeR	Receiver Ground
10	VeeR	Receiver Ground
11	VeeR	Receiver Ground
12	RD-	Inv. Received Data Out
13	RD+	Received Data Out
14	VeeR	Receiver Ground
15	VccR	Receiver Power, 3.3 ± 5%
16	VccT	Transmitter Power, 3.3 ± 5%
17	VeeT	Transmitter Ground
18	TD+	Transmit Data In
19	TD-	Inv. Transmit Data In
20	VeeT	Transmitter Ground

### EEPROM

The serial interface uses the 2-wire serial CMOS EEPROM protocol defined for the ATMEL AT24C02/04 family of components. When the serial protocol is activated, the host generates the serial clock signal (SCL). The positive edge clocks data into those segments of the EEPROM that are not write protected within the SFP transceiver. The negative edge clocks data from the SFP transceiver. The serial data signal (SDA) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

The Module provides diagnostic information about the present operating conditions. The transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture. Received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring all are implemented. If the module is defined as external calibrated, the diagnostic data are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at wire serial bus address A2H. The digital diagnostic memory map specific data field define as following .For detail EEPROM information, please refer to the related document of SFF 8472 Rev 9.3.



## EEPROM Serial ID Memory Contents

Accessing Serial ID Memory uses the 2 wire address 1010000X(A0H). Memory Contents of Serial ID are shown in Table 1.

**Table 1 Serial ID Memory Contents**

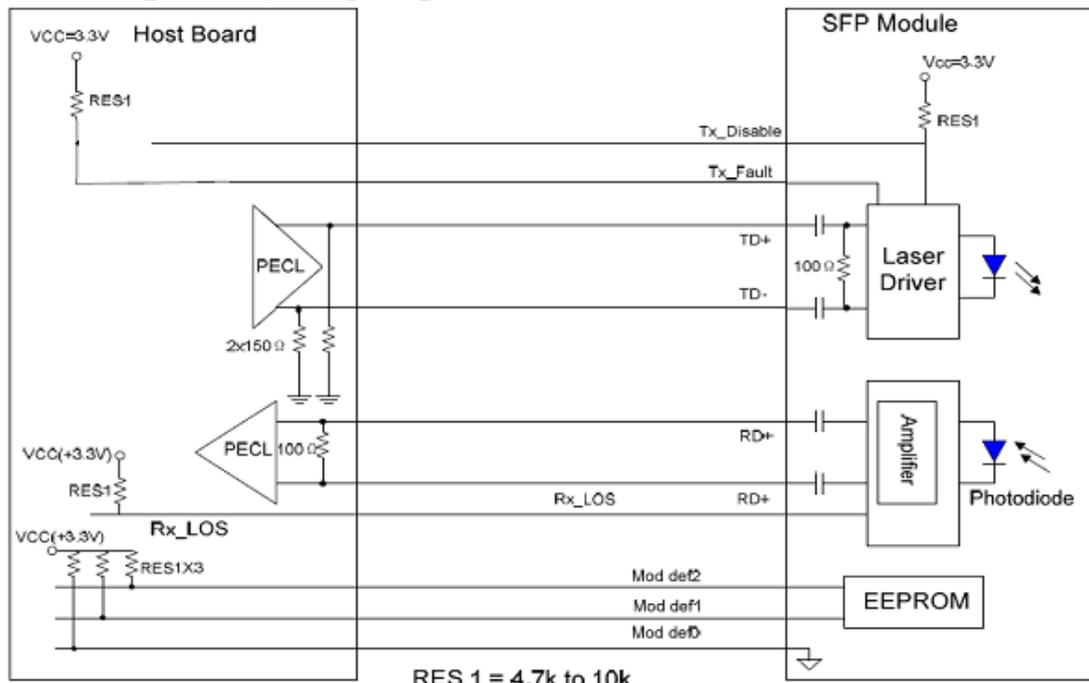
Addr.	Size(bytes)	Name of field	Vaule(Hex)	Description
0	1	Identifier	0B	DWDM SFP
1	1	Ext. Identifier	XX	
2	1	Connector	07	LC connector
3-10	8	Transceiver Codes	00	Reserved
			00	-
			00	-
			XX	
			XX	
			XX	
			01	Single mode
			XX	
11	1	Encoding	XX	
12	1	BR, Nominal	06	622Mbps
13	1	Reserved	00	-
14	1	Length (9µm)km	XX	
15	1	Length(9µm)100m	FF	
16	1	Length (50µm) 10m	00	

17	1	Length(62.5µm)10m	00	
18	1	Length (Copper)	00	Not compliant
19	1	Reserved	00	
20~35	16	Vendor Name	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX <sup>(note11)</sup>	Vendor name
36	1	Implemented Optional DWDM Features	00	-
37-39	3	Vendor OUI	00 00 00	-
40-55	16	Vendor PN	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX <sup>(note11)</sup>	PN
56-59	4	Vendor Rev	XX XX XX XX <sup>(note11)</sup>	
60-62	3	Wavelength	XX	Laser Wavelength
63	1	CC-BASE	XX	CC for Base ID fields implemented (addresses 0 to62)
64~65	2	Options	00	Reserved
			1A	1.TX_DISABLE is implemented and disables the serial output; 2.TX_FAULT signal implemented; 3.Loss of Signal implemented
66	1	BR, max	00	-
67	1	BR, max	00	-
68~83	16	Vendor SN	XX	Serial number of Transceiver (ASCII)
84~89	6	Date code	XX	The vendor's date code (ASCII)
90~91	2	Vendor specific lot code	XX XX	-
92	1	Diagnostic Monitoring Type	XX	1. Digital diagnostic monitoring implemented 2.Internally/Externally

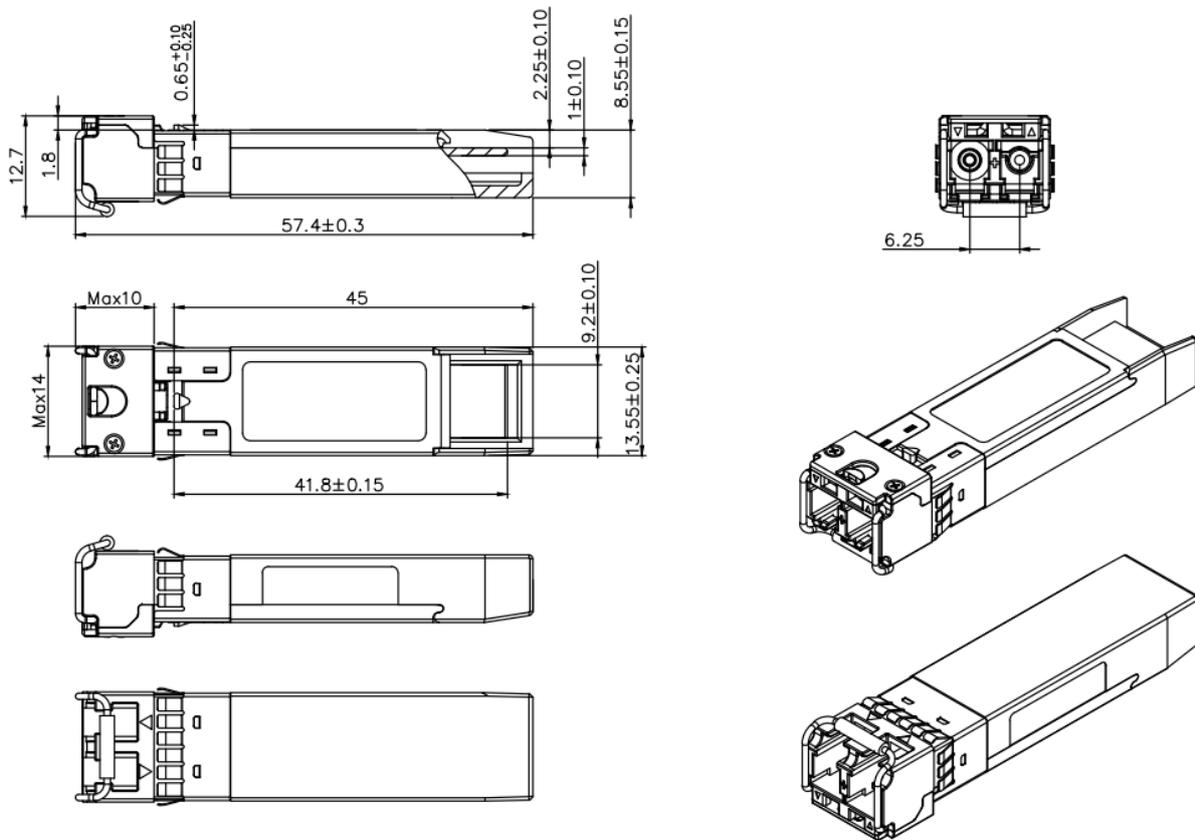
				Calibrated; 3.Received power measurement type is Average Power
93	1	Enhanced Options	F0	1.Optional Alarm/warning flags implemented for all monitored quantities 2. Optional Soft TX_DISABLE control and monitoring implemented 3. Optional Soft TX_FAULT monitoring Implemented 4. Optional Soft RX_LOS monitoring Implemented
94	1	SFF-8472 Compliance	01	Includes functionality described in Rev 9.3 of SFF-8472.
95	1	CC_EXT	XX	CC for the extended ID Fields (addresses 64 to 94) implemented.
96~127	32	Vendor Specific	XX	Read only memory
128-255	128	Reserved	Read only	

Note11: The "XX" byte should be filled in according to practical case. For more information, please refer to the related document of SFP Multi-Source Agreement (MSA).

## Recommend Circuit Schematic



## Mechanical Specifications



Unremarked tolerances  $\pm 0.2\text{mm}$

## 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 documents.

## Revision History

Revision	Initiated	Reviewed	Approved	Revision History	Release Date
V2.a	Tim.Liang	Kelly.Cao		Released.	Oct 24, 2009
V2.b	Kelly			Revise the A2H.	Nov 24, 2009
V2.c	Kelly			Complete the DWDM wavelength.	Jan 18, 2010
V2.d	Kelly			Correct Rx $\lambda$ range.	Apr 8, 2010
V3.a	Kelly			Update PN&LOGO.	July 21, 2011

V3.b	Jans	Kelly		Update EEPROM map, integrate 3 products.	Sep 21, 2011
V3.c	Angela	Lyn/Jason/ Walt/Nygai		Update regulatory compliance, lcc, Tr/Toff and the Pout of 34dB and 39dB products.	Sep 25,2013
V3.d	Oliver	Abby/Chao/Downey/Phlio /Picard/Marvin/Kelly/Lyn/ Elaine/Nico/Jp/John/Flagon		Add the industrial temperature range, update the laser type, the label picture, the regulatory compliance and 2D drawing.	Feb 9,2017

### Notice:

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