10GBASE-SR XFP Optical Transceiver

FEATURES

- RoHS compliant
- 850nm Vertical Cavity Surface Emitting Laser (VCSEL) light source
- Standard LC duplex fiber-optic connector
- Compliant with XFP MSA
- I^2C for integrated Digital Optical Monitoring
- Power consumption <1.37 W
- User friendly Plug-and-play style "Hot Swap"
- Small footprint which enables high board density
- XFI high speed I/O electrical interface
- Integrated signal conditioner to extend 200mm FR4 PCB trace signaling

Description

The TSP-10G3A1EER is a hot pluggable 10Gbps small form factor transceiver module integrated with the high performance 850nm VCSEL transmitter, high sensitivity PIN receiver and signal conditioner for 10Gbps applications. It is compliant with the INF-8077i XFP Multi-source Agreement (MSA).

The TSP-10G3A1EER is designed to be compliant with INF-8077i XFP Multi-source Agreement (MSA) with five digital monitoring functions: Temperature, Vcc, Tx optical power, TX laser bias current and RX received optical power.

Application

- 10G LAN switch
- 10G Ethernet switch/router
- 10G Fiber channel
- SAN applications

1. Absolute Maximum Ratings

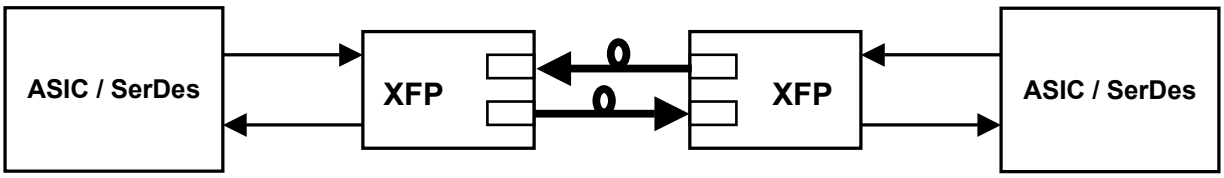
Parameter	Symbol	Min	Typ	Max	Units	Notes
Storage Temperature	T_S	-40		85	°C	
Storage Ambient Humidity	H_A	5		90	%	
+5V Power Supply	V_{CC5}	0		6.0	V	
+3.3V Power Supply	V_{CC3}	0		3.6	V	

2. Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Units	Notes
Operating Ambient Temperature	T_A	0		70	°C	
Ambient Humidity	H_A	5		85	%	[1]
+3.3V Power Supply	V_{CC3}	3.135	3.3	3.465	V	
+5V Power Supply	V_{CC5}	4.75	5	5.25	V	
+3.3V Supply Current	I_{VCC3}		270	350	mA	
+5V Supply Current	I_{VCC5}		10	30	mA	
Total Power Dissipation	P_D			1.37	W	
Differential TX Data Input	$TD^+ - TD^-$	150	500	1000	mVp-p	[2,3]
Differential RX Data Output	$RD^+ - RD^-$	500	650	800	mVp-p	[4]

Notes:

1. Non-condensing
2. The data rate of input data is 10.3125Gb/s
3. Input voltage swing (differential) measured peak-to-peak
4. Output voltage swing (differential) measured peak-to-peak

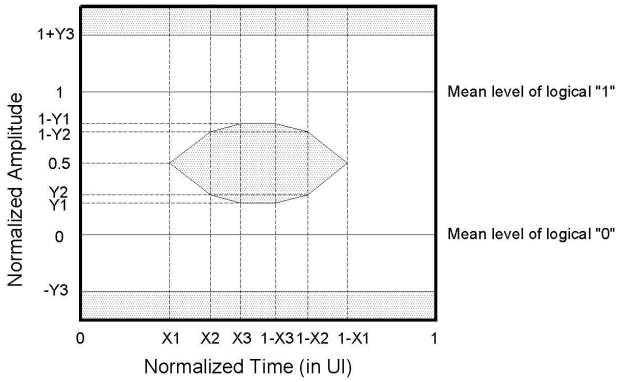


Application Block Diagram

3. Optical Transmitter Characteristics (T_A=0 ºC to 70 ºC)

Parameter	Symbol	Min	Typ	Max	Units	Notes
Data Rate	R		10.3125		Gb/s	
Signaling speed variation from nominal				±100	ppm	
Average Output Power	P_{avg}	-5		-1.8	dBm	
Wavelength	λ	840		860	nm	
Spectral Width RMS				0.45	nm	
Transmitter OFF Output Power	P_{off}			-30	dBm	
Extinction Ratio	ER	3.7			dB	
Optical Modulaion Amplitude	OMA	Compliant with Minimum OMA relation table			dBm	
Relative Intensity Noise	$RIN_{12}OMA$			-128	dB/Hz	
Optical Return Loss Tolerance	ORLT			12	dB	
Transmitter eye mask definition {X1, X2, X3, Y1, Y2, Y3}			{0.25, 0.40, 0.45, 0.25, 0.28, 0.40}			

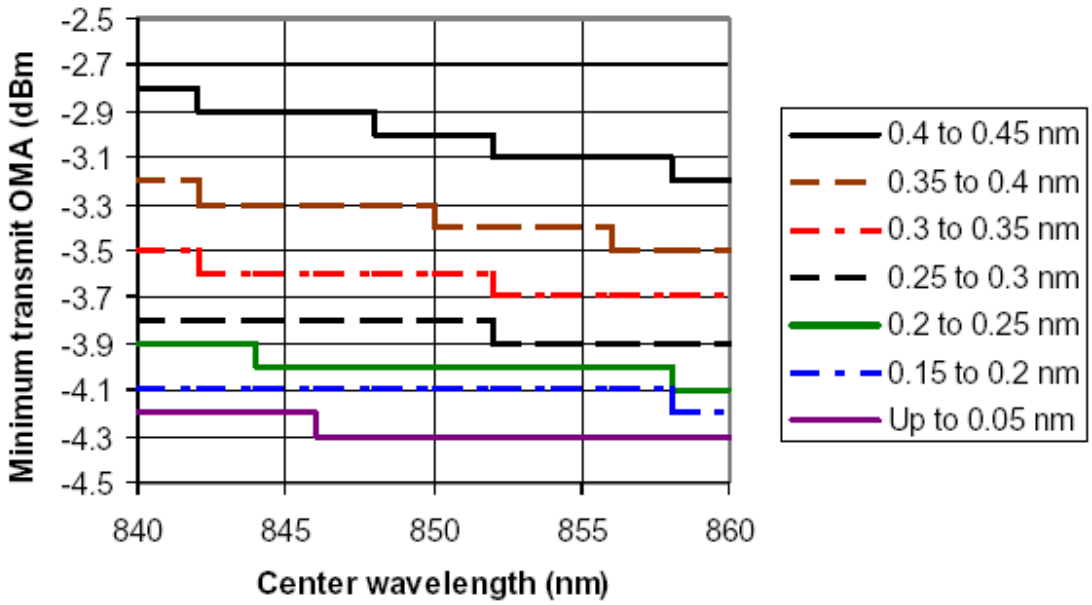
Transmitter eye mask definition



Minimum optical modulation amplitude (dBm) relation table

Center Wavelength (nm)	RMS Specrtal width (nm)								
	Up to 0.05	0.05 to 0.1	0.1 to 0.15	0.15 to 0.2	0.2 to 0.25	0.25 to 0.3	0.3 to 0.35	0.35 to 0.4	0.4 to 0.45
840 to 842	-4.2	-4.2	-4.1	-4.1	-3.9	-3.8	-3.5	-3.2	-2.8
842 to 844	-4.2	-4.2	-4.2	-4.1	-3.9	-3.8	-3.6	-3.3	-2.9
844 to 846	-4.2	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-2.9
846 to 848	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-2.9
848 to 850	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-3.0
850 to 852	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.4	-3.0
852 to 854	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.7	-3.4	-3.1
854 to 856	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.7	-3.4	-3.1
856 to 858	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.7	-3.5	-3.1
858 to 860	-4.3	-4.3	-4.2	-4.2	-4.1	-3.9	-3.7	-3.5	-3.2

Triple tradeoff curve



4. Optical Receive Characteristics (T_A=0 ºC to 70 ºC)

Parameter	Symbol	Min	Typ	Max	Units	Notes
Signaling speed (nominal)	Ts		10.3125		Gb/s	
Signaling speed variation from nominal				±100	ppm	
Center Wavelength	λ	840		860	nm	
Overload	P_O			-1	dBm	
Receiver sensitivity in OMA	RSO			-11.1	dBm	[1]
LOS De-assert	LOS_D			-13	dBm	
LOS Assert	LOS_A	-30			dBm	[2]
LOS Hysteresis	LOS_D –LOS_A	0.5			dB	
Receiver Reflectance				-12	dB	[3]
Stressed Receive sensitivity OMA				-7.5	dBm	

Notes:

1. Measured by reference TX with 4.75dB extinction ratio at 10^{-12} BER
2. When LOS asserted, the data output is Low-level (fixed)
3. When the terminal is viewed from the optical path, the reflection toward the optical path of the optical signal with a central wavelength of 840nm to 860nm transmitted to terminal.

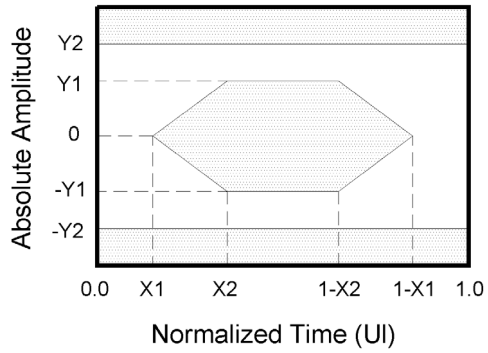
5. XFI Module Receiver Output Jitter Specifications at C'

Parameter – C'	Symbol	Min	Typ	Max	Units	Notes
Deterministic Jitter	DJ			0.18	UI (p-p)	[1]
Total Jitter	TJ			0.34	UI (p-p)	[1]
Eye Mask	X1			0.17	UI	
	X2			0.42	UI	
	Y1	170			mV	
	Y2			425	mV	

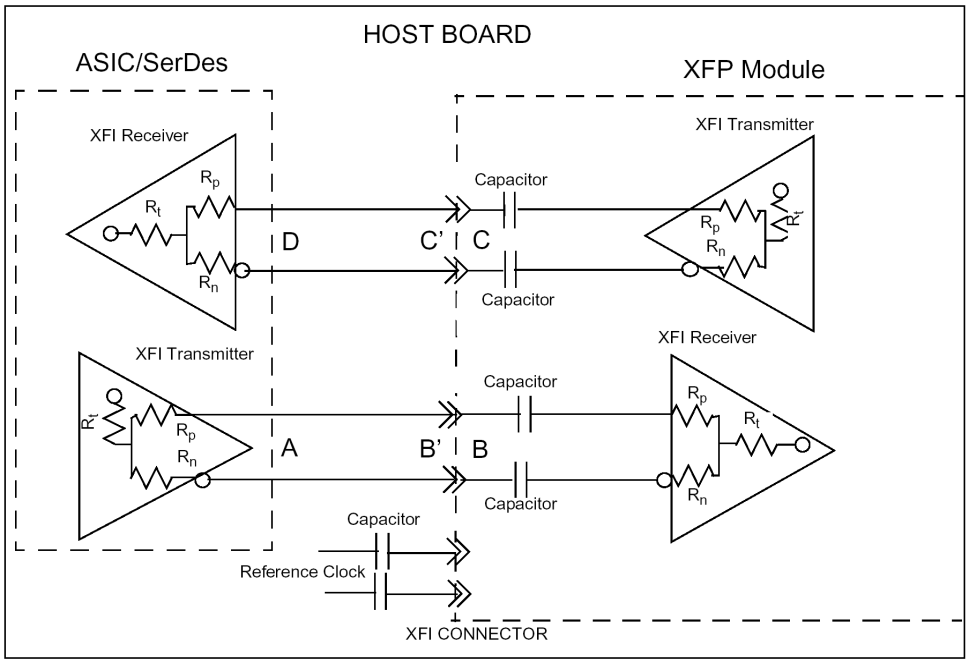
Notes:

1. Includes jitter transferred from the optical receiver during any valid operational input condition.

XFI Module Receiver Differential Output Compliance Mask

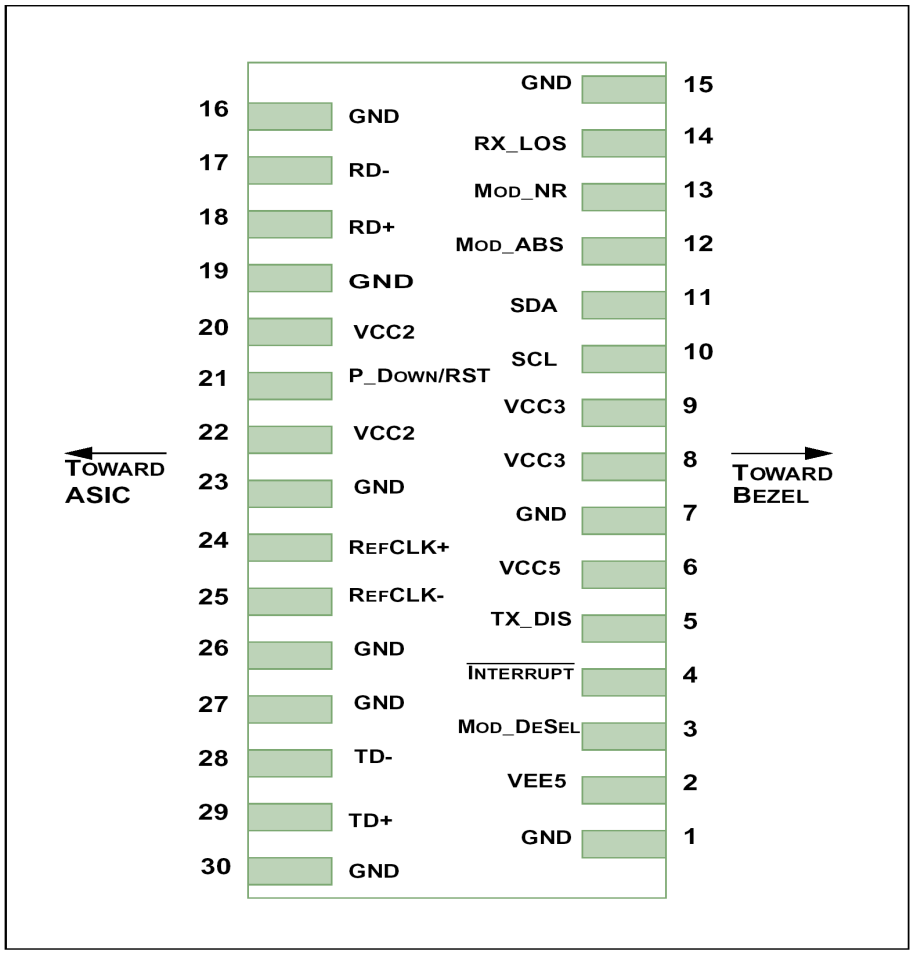


XFI Termination and AC Coupling

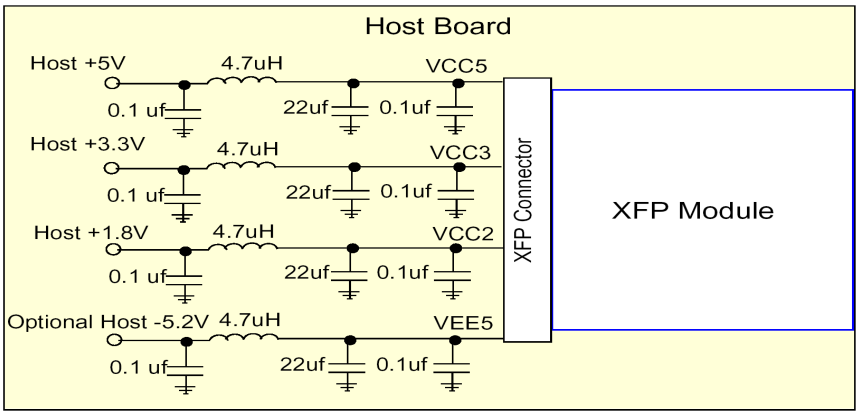


6. Pin Description

XFP Host Board Connector Pad Layout (Top View)



Recommended Host Board Supply Filtering Network



Module Electrical Pin Function Definition

Pin	Logic	Symbol	Name/Description	Note
1		GND	Module Ground	[1]
2		VEE5	Optional -5.2V Power Supply --Not Required	
3	LVTTL-I	Mod_DeSel	Module De-select; When held low allows module to respond to 2-wire serial interface	
4	LVTTL-O	Interrupt Bar	Interrupt Bar; Indicates presence of an important condition which can be read over the 2-wire serial interface	[2]
5	LVTTL-I	TX_DIS	Transmitter Disable; Turns off transmitter laser output	
6		VCC5	+5V Power Supply	
7		GND	Module Ground	[1]
8		VCC3	+3.3V Power Supply	
9		VCC3	+3.3V Power Supply	
10	LVTTL-I/O	SCL	2-Wire Serial Interface Clock	[2]
11	LVTTL-I/O	SDA	2-Wire Serial Interface Data Line	[2]
12	LVTTL-O	Mod_Abs	Indicates Module is not present. Grounded in the Module	[2]
13	LVTTL-O	Mod_NR	Module Not Ready; Indicating Module Operational Fault	[2]
14	LVTTL-O	RX_LOS	Receiver Loss Of Signal Indicator	[2]
15		GND	Module Ground	[1]
16		GND	Module Ground	[1]
17	CML-O	RD-	Receiver Inverted Data Output	
18	CML-O	RD+	Receiver Non-Inverted Data Output	
19		GND	Module Ground	[1]
20		VCC2	+1.8V Power Supply --Not Required	
21	LVTTL-I	P_Down/RST	Power down; When high, requires the module to limit power consumption to 1.5W or below. 2-Wire serial interface must be functional in the low power mode.	
22		VCC2	+1.8V Power Supply --Not Required	
23		GND	Module Ground	[1]
24	PECL-I	RefCLK-	Reference Clock Non-Inverted Input, AC coupled on the host board, Not required	
25	PECL-I	RefCLK+	Reference Clock Inverted Input, AC coupled on the host board, Not required	
26		GND	Module Ground	[1]
27		GND	Module Ground	[1]
28	CML-I	TD-	Transmitter Inverted Data Input	
29	CML-I	TD+	Transmitter Non-Inverted Data Input	
30		GND	Module Ground	[1]

Notes:

1. Module ground pins Gnd are isolated from the module case and chassis ground within the module.

2. Shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.

7. Low Speed Electrical Hardware Pins

In addition to the 2-wire serial interface the XFP module has the following low speed pins for control and status:

- Mod_NR
- Mod_DeSel
- Interrupt
- TX_DIS
- Mod_ABS
- RX_Los
- P_Down/RST.

1 MOD_NR

The Mod_NR is an output pin that when High, indicates that the module has detected a condition that renders transmitter and or receiver data invalid, shall consist of logical OR of the following signals:

- Transmit Signal Conditioner Loss of Lock
- Transmitter Laser Fault
- Receiver Signal Conditioner Loss of Lock

Other conditions deemed valuable to the detection of fault may be added to the Mod_NR.
The Mod_NR output pin is an open collector and must be pulled to Host_Vcc on the host board.

2 MOD_DESEL

The Mod_DeSel is an input pin. When held Low by the host, the module responds to 2-wire serial communication commands. The Mod_DeSel allows the use of multiple XFP modules on a single 2-wire interface bus.
When the Mod_DeSel pin is “High”, the module shall not respond to or acknowledge any 2-wire interface communication from the host. Mod_DeSel pin must be pulled to VCC3 in the module.
In order to avoid con.icts, the host system shall not attempt 2-wire interface communications within the Mod_DeSel assert time after any XFP modules are deselected. Similarly, the host must wait at least for the period of the Mod_DeSel deassert time before communicating with the newly selected module. The assertion and de-assertion periods of different modules may overlap as long as the above timing requirements are met.

3 INTERRUPT

Interrupt is an output pin. When “Low”, indicates possible module operational fault or a status critical to the host system. The Interrupt pin is an open collector output and must be pulled up to Host_Vcc the host board.

4 TX_DIS

TX_DIS is an input pin. When TX_DIS is asserted High, the XFP module transmitter output must be turned off. The TX_DIS pin must be pulled up to VCC3 in the XFP module.

5 MOD_ABS

Mod_ABS is pulled up to Host_Vcc on the host board and grounded in the XFP module. Mod_ABS is then asserted "High" when the XFP module is physically absent from a host slot.

6 RX_LOS

The RX_LOS when High indicates insuf.cient optical power for reliable signal reception. The RX_LOS pin is an open collector output and must be pulled up to Host_Vcc on the host board.

7 P_DOWN/RST

This is a multifunction pin for module Power Down and Reset. The P_Down/RST pin must be pulled up to VCC3 in the XFP module.

7.1 POWER DOWN FUNCTION

The P_Down pin, when held High by the host, places the module in the standby (Low Power) mode with a maximum power dissipation of 1.5W.

This protects hosts which are not capable of cooling higher power modules which may be accidentally inserted.

The module's 2-wire serial interface and all laser safety functions must be fully functional in this low power mode.

During P_Down, the module shall still support the completion of reset Interrupt, as well as maintain functionality of the variable power supply as described in XFP MSA Revision 3.1 section 5.7.

7.2 RESET FUNCTION

The negative edge of P_Down/RST signal initiates a complete module reset.

7.3 MODULE BEHAVIOR DURING POWER DOWN AND RESET

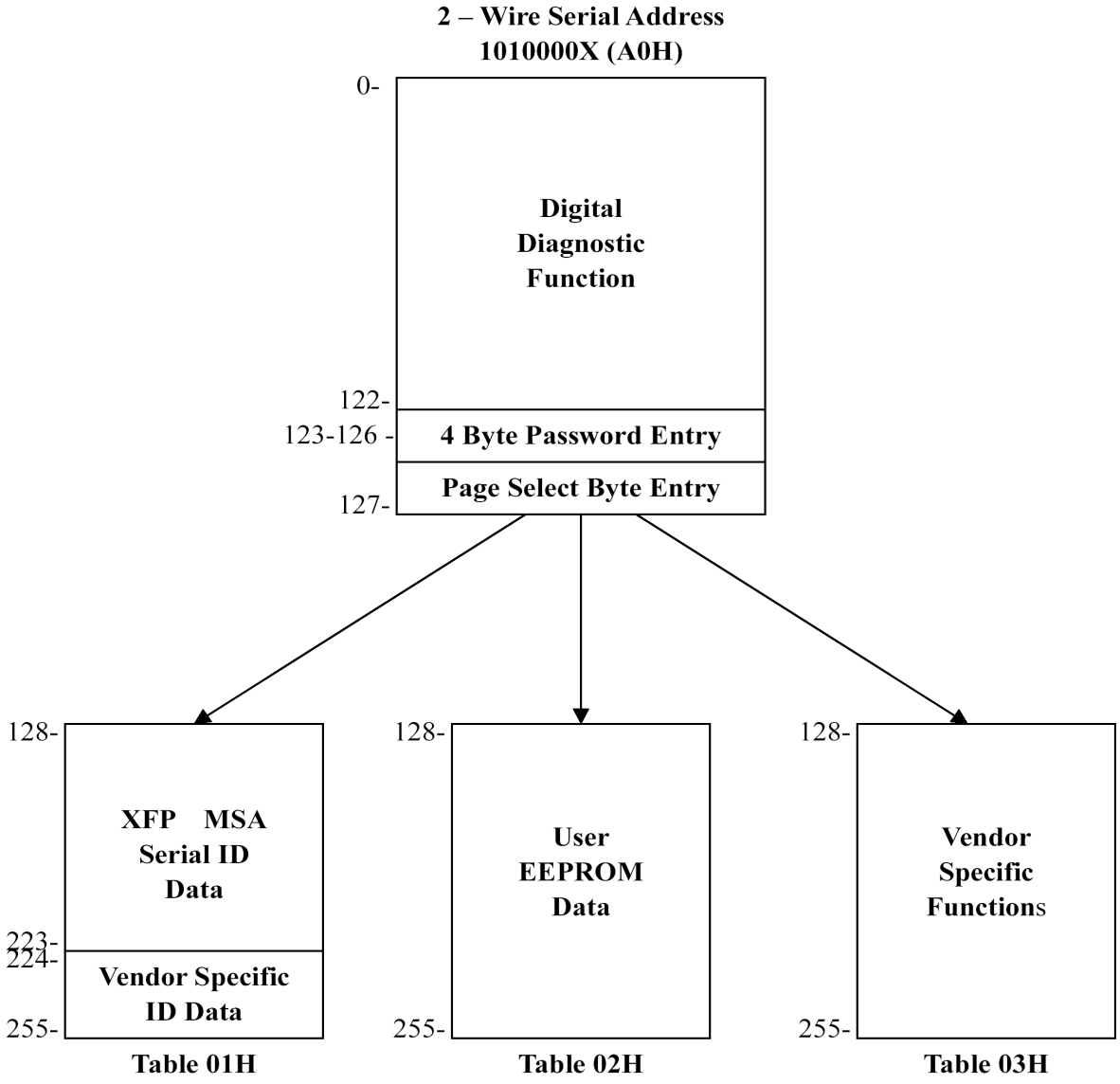
During execution of a reset (t_init) or while held in Power Down mode, a module may be unable to determine the correct value for Mod_NR and RX_LOS. These outputs as well as all interrupt related .ags, except completion of Reset .ag, shall be disregarded by the host. When the module completes a Reset and is not in Power Down mode, the module must represent the correct value of both signals on its outputs before posting a completion of reset interrupt to the host (see XFP MSA Revision 3.1 Table 39, bit 0 register address 84).

At no time shall a module cause spurious assertion of the Interrupt pin.

When a host initially applies power to a module with the P_Down/RST signal asserted, a module comes up in power down mode. The module shall only assert the Interrupt signal pin to informthe host it has completed a reset. The completion of reset .ag (see XFP MSA Revision 3.1 Table 39, bit 0 register address 84) shall be the only interrupt source .ag set during power down mode.

The host is expected to clear this interrupt before releasing the module from the power down mode. The transition from power down mode to normal mode will trigger a reset of the module and result in a 2nd module reset and a 2nd reset completion interrupt to the host

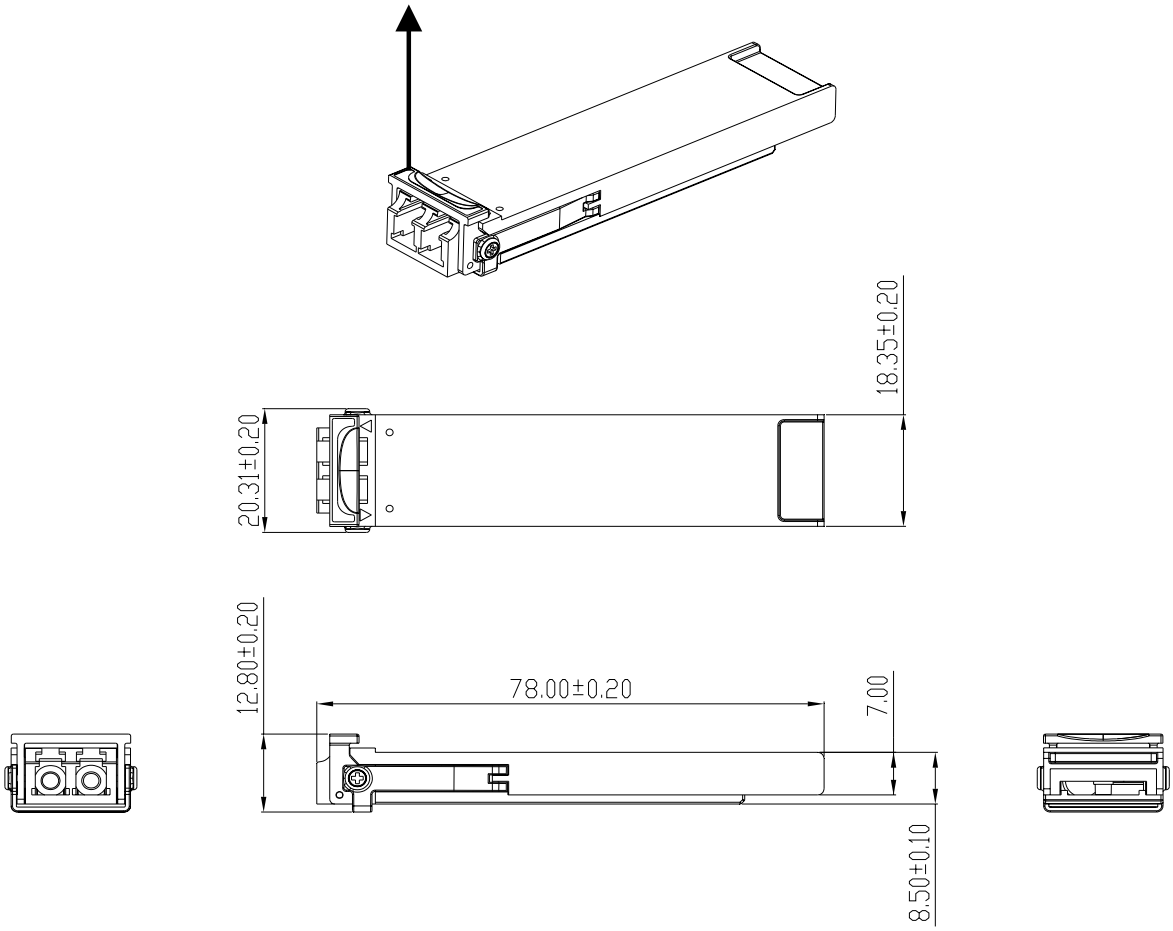
8. Memory Map of Management Interface



The lower memory table (Byte 0~127) is for digital diagnostics and control functions. Besides, it has been allocated three upper memory tables for serial ID, user writable and vendor specific functions. The detail definition of memory content is listed as following table.

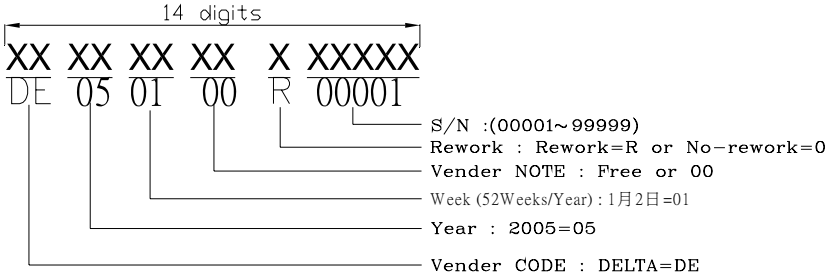
9. Mechanical Outline Dimensions

Transmitter Wavelength / Application	Latch Color Identifier
850nm / SR	Beige



UNIT: MM

S/N



10. Regulatory Compliance

Feature	Test Method	Reference	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	Human Body Model (HBM)	MIL-STD-883E Method 3015.7 EIA-JESD22-A114	(1) Satisfied with electrical characteristics of product spec. (2) No physical damage
	Machine Model (MM)	EIA-JESD22-A115	
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	Contact Discharge	IEC/EN 61000-4-2	
	Air Discharge	IEC/EN 61000-4-2	
Radio Frequency Electromagnetic Field Immunity		IEC/EN 61000-4-3	
Electromagnetic Interference (EMI)		FCC Part 15 Class B EN 55022 Class B (CISPR 22A)	
Laser Eye Safety	FDA/CDRH TUV	FDA 21CFR 1040.10, 1040.11 IEC/EN 60825-1 IEC/EN 60825-2	CDRH File # 0420993 TUV Certificate # R50067719
Component Recognition	TUV UL/CSA	IEC/EN 60950 UL 60950	 UL File # E239394

Appendix A. Document Revision

Version No.	Date	Description
S0	2006-04-25	Preliminary datasheet for RoHS version
S1	2006-08-25	Update module characteristics
S2	2007-01-04	Update Spectral Width RMS from 0.65nm to 0.45nm
S3	2007-04-10	Update Optical Modulaion Amplitude (OMA) specification