

8Gb/s SFP Optical Transceiver Module

SPP5100LX-GL

(2/4/8GFC-LW, 1310nm DFB-LD, PIN-PD)

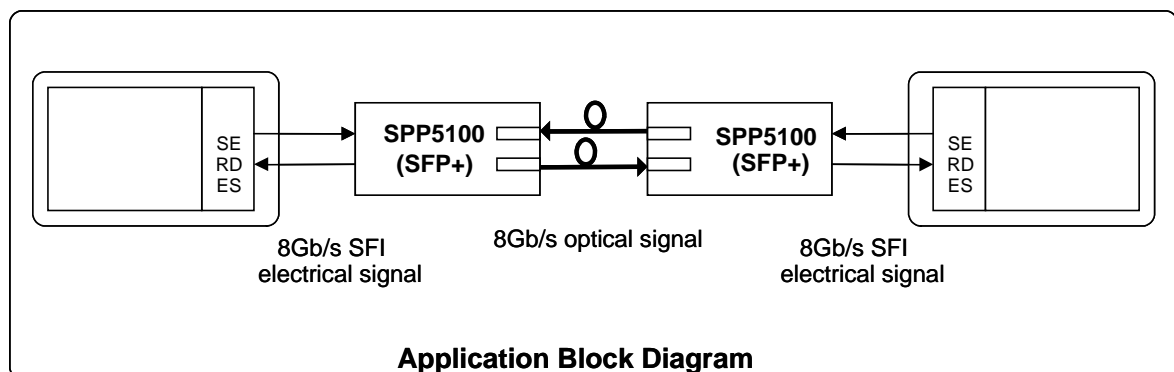
Features

- ◆ 2/4/8Gb/s Serial Optical Interface
 - High quality and reliability optical device and sub-assemblies
 - 1310nm DFB laser for up to 10km over Single Mode Fiber
 - High sensitivity PIN photodiode and TIA
- ◆ SFP+ MSA Compliant
 - Easy supply management for hot pluggability
 - Duplex LC Receptacle
 - SFP Mechanical Interface for easy removal
 - SFI High Speed Electrical Interface
 - 2-wire interface for management and diagnostic monitor
 - Tx_Disable, Rx_LOS and Rate select functions
- ◆ Protocol
 - Fiber Channel FC-FS-2
- ◆ Low Power Consumption
 - Single 3.3V power supply
 - Low power consumption
- ◆ RoHS6 compliant.



Applications

- ◆ 2/4/8GFC switches and routers
- ◆ 2/4/8GFC Storage
- ◆ Inter Rack Connection
- ◆ Other high speed data connections



1. General Description

The SPP5100LX-GL is a very compact 8Gb/s optical transceiver module for serial optical communication applications at multi-rate of 2/4/8Gb/s. The SPP5100LX-GL converts a 8Gb/s serial electrical data stream to 8Gb/s optical output signal and a 8Gb/s optical input signal to 8Gb/s serial electrical data streams. The high speed 8Gb/s electrical interface is fully compliant with SFI specification.

The SPP5100LX-GL is designed for 8G Fiber Channel (8.5Gb/s) applications. The high performance 1310nm DFB transmitter and high sensitivity PIN receiver provide superior performance for Fiber Channel applications at up to 10km links.

The fully SFP compliant form factor provides hot pluggability, easy optical port upgrades and low EMI emission.

Table 1. Fiber compliance

SFP+ type	Wavelength [nm]	Cable Type	Core Size (micron)	Modal Bandwidth [MHz/km]	Cable distance
-800-SM-LC-L (-400-SM-LC-L) (-200-SM-LC-L)	1310	SMF	G.632	-	10km

2. Functional Description

The SPP5100LX-GL contains a duplex LC connector for the optical interface and a 20-pin connector for the electrical interface. Figure 2.1 shows the functional block diagram of SPP5100LX-GL SFP Transceiver.

Transmitter Operation

The transceiver module receives 8Gb/s electrical data and transmits the data as an optical signal.

The transmitter output can be turned off by Tx disable signal, TX_DIS pin. When TX_DIS is asserted High, Transmitter is turned off.

Receiver Operation

The received 8Gb/s optical signal is converted to serial electrical data signal.

The RX_LOS signal indicates insufficient optical power for reliable signal reception at the receiver.

Management Interface

2-wire interface (SCL, SDA) is used for serial ID, digital diagnostics and other control /monitor functions.

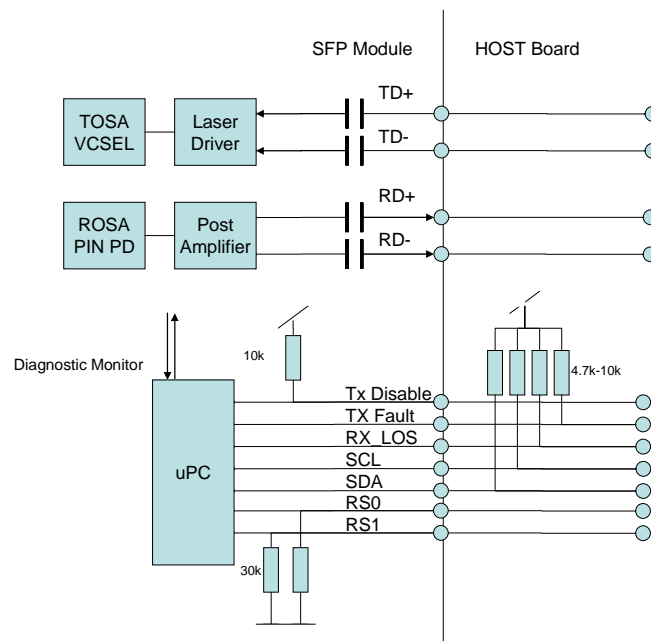


Figure 2.1. Functional Block Diagram

3. Package Dimensions

Figure 3.1. shows the package dimensions of SPP5100LX-GL. SPP5100LX-GL is designed to be compliant with SFP MSA specification. Package dimensions are specified in SFF-8432. (Note : Drawing below will be revised in the future.)

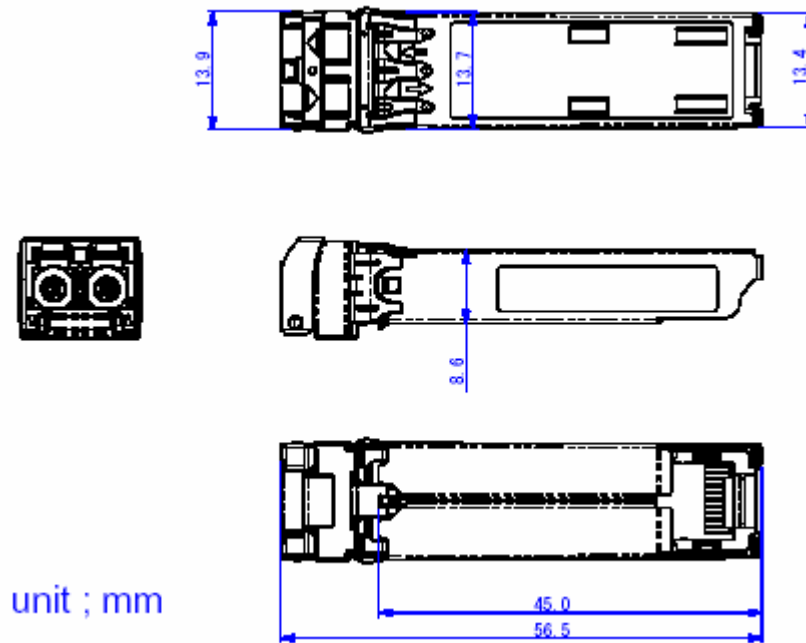


Figure 3.1. Package dimensions

4. Pin Assignment and Pin Description

4.1. SFP Transceiver Electrical Pad Layout

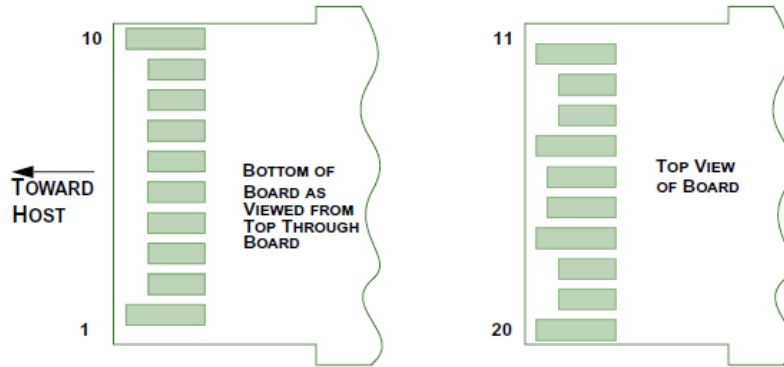


Figure 4.1. SFP Transceiver Electrical Pad Layout

4.2. Host PCB SFP Pinout

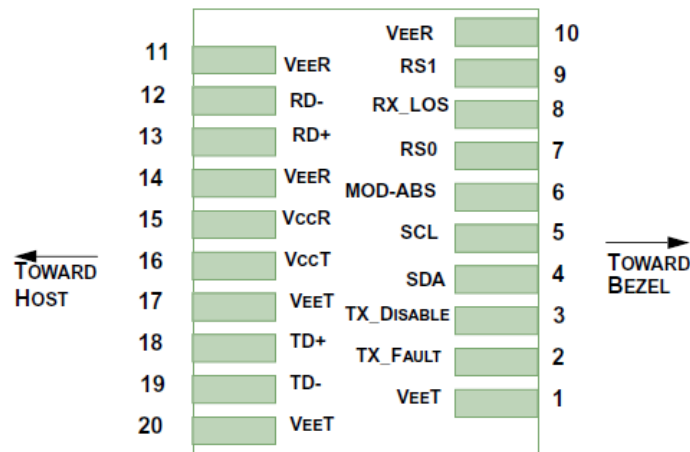


Figure 4.2. Host PCB SFP Pinout

4.3. Pin Descriptions

Table 4.3. Pin Description

Pin#	Name	Logic	Description	Note
1	VeeT		Module Transmitter Ground	1
2	Tx_Fault	LVTTL-O	Module Transmitter Fault	2
3	Tx_Disable	LVTTL-I	Transmitter Disable, Turns off transmitter laser output	3
4	SDA	LVTTL-I/O	2 Wire Serial Interface Data Line(Same as MOD-DEF2 as defined in the INF-8074i)	
5	SCL	LVTTL-I/O	2 Wire Serial Interface Data Line(Same as MOD-DEF1 as defined in the INF-8074i)	
6	MOD_ABS		Module Absent, connected to VeeT or VeeR in the module	2
7	RS0	LVTTL-I	Rate Select 0	
8	RX_LOS	LVTTL-O	Receiver Loss of Signal Indication	2
9	RS1	LVTTL-I	Rate Select 1	
10	VeeR		Module Receiver Ground	1
11	VeeR		Module Receiver Ground	1
12	RD-	CML-O	Receiver Inverted Data Output	
13	RD+	CML-O	Receiver Non-Inverted Data Output	
14	VeeR		Module Receiver Ground	1
15	VccR		Module Receiver 3.3V Supply	
16	VccT		Module Transmitter Ground	
17	VeeT		Module Transmitter Ground	1
18	TD+	CML-I	Transmitter Non-Inverted Data Input	
19	TD-	CML-I	Transmitter Inverted Data Input	
20	VeeT		Module Transmitter Ground	1

Note

- 1: Module ground pins are isolated from the module case and chassis ground within the module.
- 2: Shall be pulled up with 4.7k to 10k ohm to a voltage between 3.15V and 3.45V on the host board.
- 3: Shall be pulled up with 4.7k to 10k ohm to VccT in the module.

5. Absolute Maximum Ratings and Recommended Operating Conditions

Table 5.1. Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit	Note
Storage Temperature	Tst	-40	85	degC	
Relative Humidity (non-condensation)	RH	-	85	%	
Operating Case Temperature	Topc	0	70	degC	
Supply Voltage	VccR/VccT	-0.5	3.6	V	
Voltage on LVTTTL Input	Vilvttl	-0.5	VCC+0.5	V	
LVTTTL Output Current	Iolvttl	-	15	mA	
Voltage on Open Collector Output	Voco	0	6	V	
Receiver Input Optical Power(Average)	Mip	-	1.5	dBm	

Table 5.2. Recommended Operating Conditions and Supply Requirements

Parameter	Symbol	Min	Max	Unit	Note
Operating Case Temperature	Topc	0	70	degC	
Relative Humidity(non-condensing)	Rhop	-	85	%	
Power Supply Voltage	VccR/VccT	3.135	3.465	V	
Total Power Consumption	Pd	-	1.0	W	

6. Electrical Interface

6.1. High Speed Electrical Interface

SFI Application Reference model

Figure 6.1.1. shows the high speed electrical interface (SFI) compliance points.

SFI electrical interface is specified for each compliance point in the SFP MSA specification.

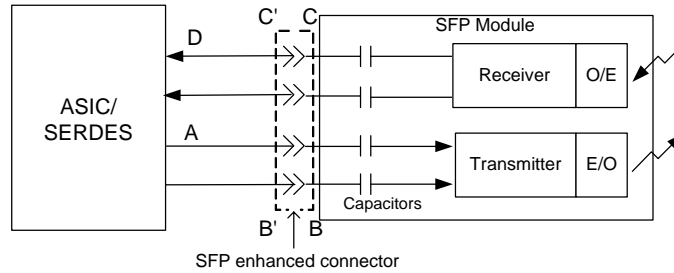


Figure 6.1.1. SFI Application Reference Model

SFI Module Transmitter Input Electrical Interface Specification at B'

Table 6.1.1. SFI Transmitter Input Electrical Specification at B'

Parameter B'	Symbol	Condition	Min	Typ.	Max.	Unit
Reference Differential Input Impedance	Zd			100		ohm
Termination Mismatch	dZm				5	%
DC Common Mode Voltage	Vcm		0		3.6	V
Input AC Common Mode Voltage					12.5	mV(RMS)
Differential Input S-parameter	SDD11	0.01-3.9GHz			-10	dB
		3.9-11.1GHz	Note2		Note1	dB
Differential to Common Mode Conversion	SCD11	0.01-11.1GHz			-10	dB
Total Jitter	TJ				0.28	UI(pp)
Data Dependent Jitter	DDJ				0.10	UI(pp)
Uncorrelated jitter	UJ				0.023	UI(RMS)
Eye Mask Figure 6.1.2	X1				0.14	UI
	X2				0.35	UI
	Y1		90			mV
	Y2				350	mV

Note

- Reference differential impedance is 100 ohm
- Return Loss given by equation $SDD11(dB) = -8 + 13.33 \log_{10}(f/5.5)$, with f in GHz

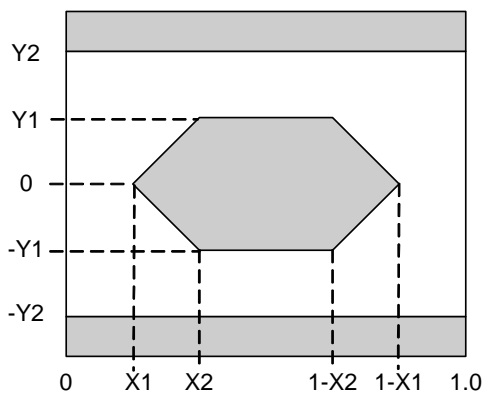
SFI Module Receiver Output Electrical Interface Specification at C'

Table 6.1.2. SFI Receiver Output Electrical Specification at C'

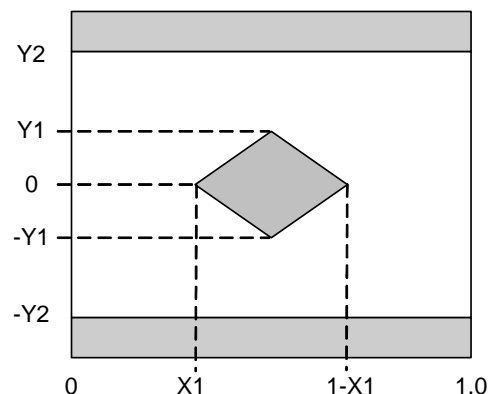
Parameter – C'	Symbol	Conditions	Min	Typ	Max	Units
Termination Mismatch	dZM				5	%
DC Common Mode Voltage	V _{cm}		0		3.6	V
Output AC Common Mode Voltage					7.5	mV (RMS)
Output Rise and Fall time(20%-80%)	Tr/Tf		24			ps
Differential Output S-parameter	SDD22	0.01-3.9GHz			-10	dB
		3.9-11.1GHz			Note 2	dB
Common Mode Output Return Loss	SCC22	0.01-6.5GHz			-7	dB
		6.5-11.1GHz			-3	dB
Deterministic Jitter	DJ				0.42	UI _{pp}
Total Jitter	TJ				0.70	UI _{pp}
Eye Mask Figure 6.1.3	X1				0.35	UI
	Y1		150			mV
	Y2				425	mV

Note 1:Reference differential impedance is 100ohm

2:Return loss given by equation $S_{xx22}(dB) = -8 + 13.33 \text{ Log}_{10}(f/5.5)$, with f in GHz



**Figure 6.1.2.
Transmitter Input Eye Mask**



**Figure 6.1.3.
Receiver Output Eye Mask**

6.2. Low speed Electrical Interface

SPP5100LX-GL low speed interface is based on 2-wire interface. Management memory map is based on SFF-8472.

2-wire Electrical Specifications

Parameter	Symbol	Min	Max	Unit
Host 2-wire Vcc	Vcc_host	3.14	3.46	V
SCL and SDA	V _{OL}	0.0	0.40	V
	V _{OH}	Vcc_host-0.5	Vcc_host+0.3	V
SCL and SDA	V _{IL}	-0.3	VccT*0.3	V
	V _{IH}	VccT*0.7	VccT+0.5	V
Input current on the SCL and SDA contacts		-10	10	uA
Capacitance on SCL and SDA I/O contact			14	pF

2-wire Timing Specifications

Parameter	Symbol	Min	Max	Unit
Clock Frequency	f _{SCL}	0	400	kHz
Clock Pulse Width Low	t _{LOW}	1.3		us
Clock Pulse Width High	t _{HIGH}	0.6		us
Time bus free before new transmission can start	t _{BUF}	20		us
START Hold Time	t _{HD, STA}	0.6		us
START Set-up Time	t _{SU, STA}	0.6		us
Data In Hold Time	t _{HD, DAT}	0		us
Data In Set-up Time	t _{SU, DAT}	0.1		us
Input Rise Time (100kHz)	t _{R, 100}		1000	ns
Input Rise Time (400kHz)	t _{R, 400}		300	ns
Input Fall Time (100kHz)	t _{F, 100}		300	ns
Input Fall Time (400kHz)	t _{F, 400}		300	ns
STOP Set-up Time	t _{SU, STO}	0.6		us
Serial Interface Clock Holdoff “Clock Stretching”	t _{clock_hold}		500	us

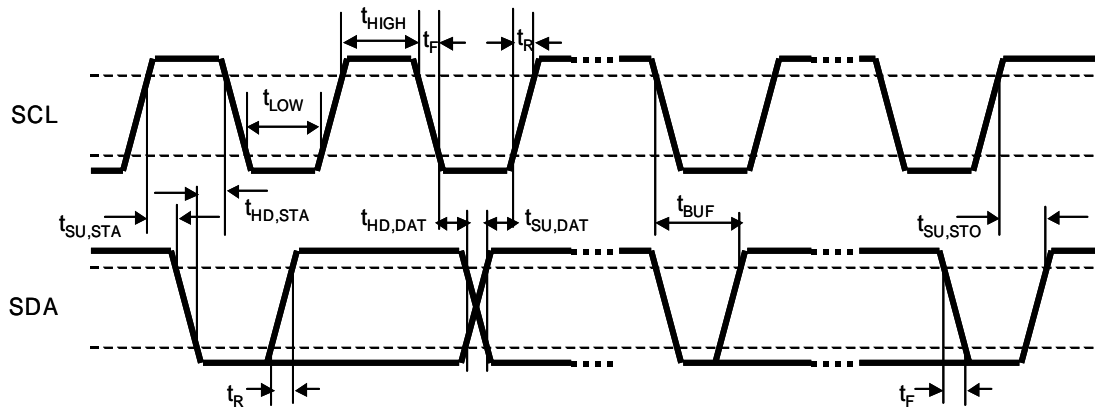


Figure 6.1.4. SFP+ Timing Diagram

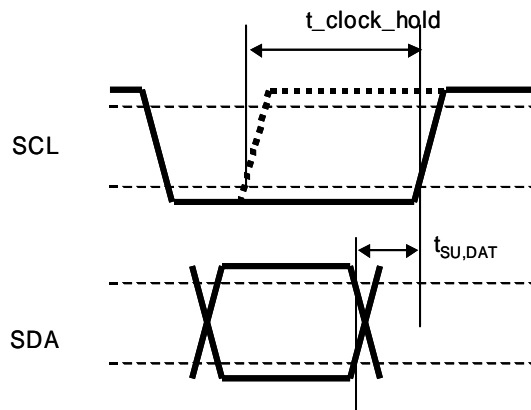


Figure 6.1.5. Detail of Clock Stretching

7. Optical Interface

Optical Interfaces of SPP5100LX-GL are defined in the FC-PI-4(Fiber Channel Physical Interface).

Optical Transmitter : 2/4/8GFC for single mode fiber

Parameter	Symbol	Min	Typ	Max	Unit
Signaling Speed, 8GFC			8.5		Gb/s
Signaling Speed, 4GFC			4.25		Gb/s
Signaling Speed, 2GFC			2.125		Gb/s
Signaling speed variation from nominal (max)		-100		+100	ppm
Center wavelength		1260		1360	nm
Side mode suppression	SMSR	30			dB
-20dB spectral width				1	nm
Average launched power, 8GFC	Pave	-8.4		0.5	dBm
Average launched power, 4GFC		-8.4		-1	
Average launched power, 2GFC		-11.7		-3	
OMA, 8GFC	Poma	-5.4			dBm
OMA, 4GFC		-5.4			
OMA, 2GFC		-8.7			
Rise/Fall time (20% to 80%), 4GFC (Note 2)	Tr/Tf			90	ps
Rise/Fall time (20% to 80%), 2GFC (Note 2)				160	
RIN OMA	RIN			-128	dB/Hz
Extinction Ratio, 8GFC	ER	3.5			dB
Transmitter and dispersion penalty, 8GFC	TDP			3.2	dB

Note 1: Applied to 2G/4G/8GFC operation if nothing specified

Note 2: Optical rise and fall time specifications are based on the unfiltered waveforms. For the purpose of standardizing the measurement method, measured waveforms shall conform to the mask as defined in FC-PI-4, transmitter eye diagram mask. The optical signal may have different rise and fall times. Any filter should have an impulse response equivalent to a fourth order Bessel-Thomson Filter.

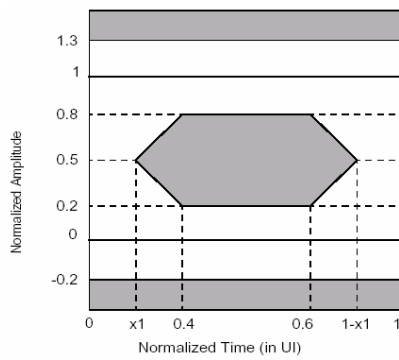


Figure.7.1. Transmission eye mask definition for 2G and 4G

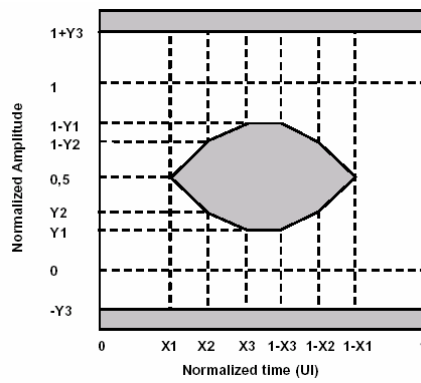


Figure.7.2. Transmission eye mask definition for 8G

Optical Receiver : 2/4/8GFC for single mode fiber

Parameter	Symbol	Min	Typ	Max	Unit
Wavelength		1260		1370	nm
Signaling Speed, 8GFC			8.5		Gb/s
Signaling Speed, 4GFC			4.25		Gb/s
Signaling Speed, 2GFC			2.125		Gb/s
Signaling speed variation from nominal (max)		-100		+100	ppm
Average received power, 8GFC				0.5	dBm
Average received power, 4GFC				-1	dBm
Average received power, 2GFC				-3	dBm
Unstressed receiver sensitivity in OMA, 8GFC (Note 3)				-13.8	dBm
Unstressed receiver sensitivity in OMA, 4GFC (Note 3)				-15.4	dBm
Unstressed receiver sensitivity in OMA, 2GFC (Note 3)				-18.2	dBm
Return loss of receiver		12			dB
Rx jitter tolerance test in OMA, 8GFC				-11.8	dBm
Rx jitter tolerance test in OMA, 4GFC				-13.2	dBm
Rx jitter tolerance test in OMA, 2GFC				-16.6	dBm

Note 3: Whereas receiver sensitivity testing for the single-mode variants allowed to be done with fast rise and fall time test signals, in application, some combinations of transmitters and cables plants may develop slowed rise and fall times and vertical eye closure due to the low pass filtering effects of chromatic dispersion. It is advised that optical receivers have sufficiently broad bandwidths in anticipation of this possibility.

8. Electrical and Optical I/O Signal Relationship

Table.8.1. TX_DIS vs. Optical Output Power

TX_DIS	Optical Output Power
Low ($V_{IL} = -0.3$ to $0.8V$)	Enabled
High ($V_{IH} = 2.0$ to $VCC3+0.3V$)	Disabled ($<-30dBm$)

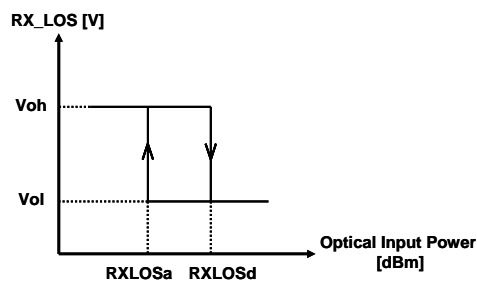


Figure.8.1. Optical Input Power vs. RX_LOS

9. User Interface

9.1. SFP Mechanical Interface

SFP Mechanical Interface is specified in the SFF-8432. Also, bail latch system is adequate for the particular specification.

9.2. Management Interface

SFP 2-Wire Serial Interface Protocol

SFP 2-wire serial interface is specified in the SFF-8472.

The SFP 2-wire serial interface is used for serial ID, digital diagnostics, and certain control functions. The 2-wire serial interface is mandatory for all SFP modules.

The 2-wire serial interface address of the SFP module is A0h and A2h. In order to access to a specific module on the 2-wire serial bus, the SFP has a MOD_ABS (module absent pin). This pin, which is pulled down in the module, must be held low to notify a module installation and to allow communication over 2-wire serial interface.

SFP Management Interface

SFP Managed interface is specified in the SFF-8472.

The Figure 9.2. shows the structure of the memory map. The normal 256 Byte address space is divided into lower and upper blocks of 128 Bytes. The lower block of 128 Byte is always directly available and is used for the diagnostics and control functions that must

be accessed repeatedly. Multiple blocks of memories are available in the upper 128 Bytes of the address space. These are individually addressed through a table select Byte which the user enters into a location in the lower address space. The upper address space tables are used for less frequently accessed functions and control space for future standards definition.

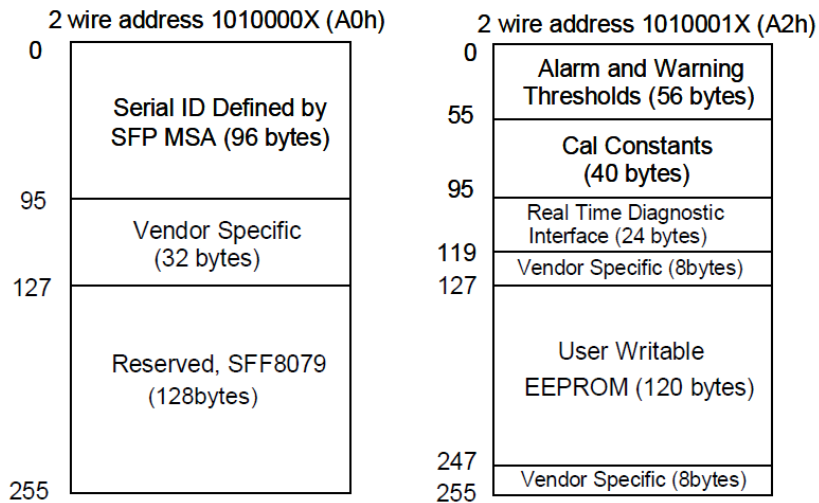


Figure 9.2. 2-wire Serial Interface Memory Map

9.3. Serial ID Memory Map (Data Field – Page 01h)

Address	Size (Bytes)	Name	Hex	ASC	Description	Address	Size (Bytes)	Name	Hex	ASC	Description	
0	1	Identifier	03		SFP module	64	2	Options	00		Uncooled LD, Limiting Receiver output	
1	1	Ext.Identifier	04		Serial ID module	65			3A	TxDisable, TxFault, LOS, Rate_Select implemented		
2	1	Connector	07		LC Connector	66	1	BR_max	00			
3	8	Transceiver	00			67	1	BR_min	00			
4			00			68	16	Vendor SN	xx			
5			00			69			xx			
6			00			70			xx			
7			12	8GFC-LW					71	xx		
8			00	8GFC-LW					72	xx		
9			01	8GFC-LW					73	xx		
10			54	8GFC-LW					74	xx		
11	01	Encoding	01		8B10B	75			xx			
12	1	BR, Nominal	55		8.5Gbps	76	xx					
13	1	Rate Identifier	03		Rate_Select	77	xx					
14	1	Length(9um, km)	0A		10km	78	xx					
15	1	Length(9um)	64		10km	79	xx					
16	1	Length(50um)	00		not support MMF	80	xx					
17	1	Length(62.5um)	00		not support MMF	81	xx					
18	1	Length(Copper)	00		not support copper	82	xx					
19	1	Length(OM3)	00		not support MMF	83	xx					
20	16	Vendor name	53	S		84	8	Date Code	xx			
21			75	u					85	xx	Year code	
22			6D	m					86	xx	Month code	
23			69	i					87	xx	Day code	
24			74	t					88	xx	LOT code	
25			6F	o					89	xx		
26			6D	m					90	xx		
27			6F	o					91	xx		
28			45	E			92	1	Diagnosis Monitoring Type	68		Internal cal, Average Power Alarm/Warning flags, Soft TxDisable, Soft TxFault, Soft RxLOS, Soft RS
29			6C	l			93	1	Enhanced Options	FA		Rev 10.0
30			65	e			94	1	SFF-8472 Compliance	03		Check Code *3
31			63	c			95	1	CC_EXT	xx		
32			74	t			96-126	32	Vendor Specific	xx		
33			72	r			127-255	125	Reserved	00		
34			69	i								
35			63	c								
36	1	Channel Spacing	00									
37	3	Vendor OUI	00									
38			00									
39			5F									
40	16	Vendor PN	53	S								
41			50	P								
42			50	P								
43			35	5								
44			31	1								
45			30	0								
46			30	0								
47			4C	L								
48			58	X								
49			2D	-								
50			47	G								
51			4C	L								
52			20									
53			20									
54			20									
55			20									
56	4	Vendor rev	41	A	*1							
57	20											
58	20											
59	20											
60	2	Wavelength	05									
61	1E											
62	1	DWDM Wavelength	00									
63	1	CC BASE	84		Check Code *2							

*1 : Revision level for part number provided by vendor (ASCII). Variable
 *2 : Checksum of Add.0 to 62
 *3 : Checksum of Add.64 to 94

Note 1.The guaranteed +/- range of transmitter output wavelength under all normal operating conditions.

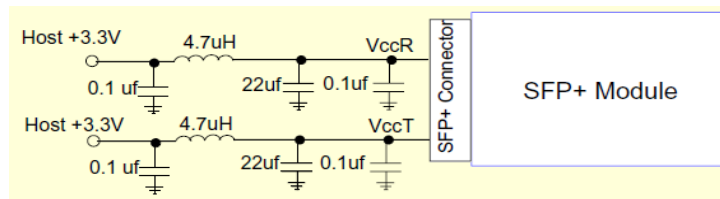


Figure 9.5. Supply Filter

9.4. Alarm/Warming threshold

A2h address	Meaning	Unit	SPP5100LX-GL
0-1	Temperature High Alarm	deg	75
2-3	Temperature Low Alarm	deg	-5
4-5	Temperature High Warning	deg	70
6-7	Temperature Low Warning	deg	0
8-9	Voltage High Alarm	V	3.63
10-11	Voltage Low Alarm	V	2.97
12-13	Voltage High Warning	V	3.465
14-15	Voltage Low Warning	V	3.135
16-17	Tx Bias High Alarm	mA	102
18-19	Tx Bias Low Alarm	mA	22
20-21	Tx Bias High Warning	mA	102
22-23	Tx Bias Low Warning	mA	22
24-25	Tx Power High Alarm	dBm	3.5
26-27	Tx Power Low Alarm	dBm	-14.4
28-29	Tx Power High Warning	dBm	0.5
30-31	Tx Power Low Warning	dBm	-8.4
32-33	Rx Power High Alarm	dBm	3.5
34-35	Rx Power Low Alarm	dBm	-17.8
36-37	Rx Power High Warning	dBm	0.5
38-39	Rx Power Low Warning	dBm	-13.8

Note. Alarm /Warming flag is linked to TxFault by default setting.

10. RoHS COMPLIANCY

Compliance versus requirements contained inside the following reference document is guaranteed: "Directive 2002/95/EC of 27 January 2003 on the restriction of the use of certain hazardous substances in electrical and electronic equipment" from official journal of European Union (European Parliament and of the Council). This product is Compliant at RoHS-6/6 level and contains no leaded solders.

11. Qualification Testing

SPP5100LX-GL 8.5Gb/s transceiver is qualified to Sumitomo Electric Industries internal design and manufacturing standards. Telecordia GR-468-CORE reliability test standards, using methods per MIL-STD-883 for mechanical integrity, endurance, moisture, flammability and ESD thresholds, are followed.

12. Laser Safety Information

SPP5100LX-GL transceiver uses a semiconductor laser system that is classified as Class 1 laser products per the Laser Safety requirements of FDA/CDRH, 21 CFR1040.10 and 1040.11. These products have also been tested and certified as Class 1 laser products per IEC 60825-1:2001 International standards.

Caution

If this product is used under conditions not recommended in the specification or is used with unauthorized revision, the classification for laser product safety is invalid. Reclassify the product at your responsibility and take appropriate safety measures.

13. Electromagnetic Compatibility

EMI (Emission)

SPP5100LX-GL is designed to meet FCC Class B limits for emissions and noise immunity per CENELEC EN50 081 and 082 specifications.

RF Immunity

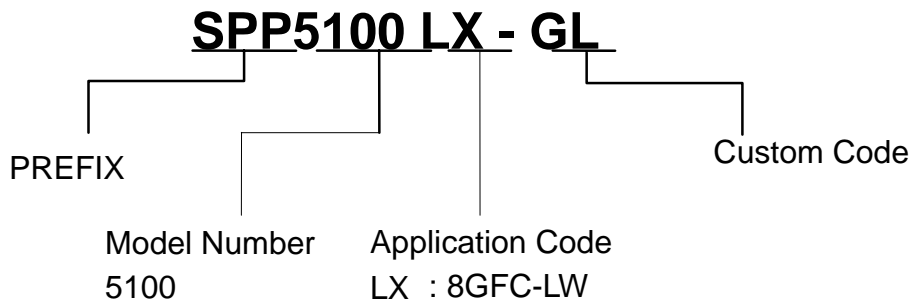
SPP5100LX-GL has an immunity to operate when tested in accordance with IEC 61000-4-3 (80- 1000MHz, Test Level 3) and GR-1089.

Electrostatic Discharge (ESD) Immunity

SPP5100LX-GL has an immunity against direct and indirect ESD when tested accordance with IEC 61000-4-2.

14. Ordering Information

14.1. Part Numbering System



14.2. Ordering Number Code

Table 14-1. SPP5100LX Application Code

P/N	Distance	Fiber	E/O	O/E	ITU-T G.691	Telecordia GR-253	FC-PI-4
SPP5100LX-GL	10km	SMF	1310nm DFB	PIN	-	-	800SM-LC-L

14.3. 2-wire Serial Interface

If the serial clock(SCL) is more than 100kHz, the SCL is held in line low (clock stretching) during an 2-WIRE SERIAL INTERFACE read or write operation.

15. Label information



16. Contact Information

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