

9.8304Gb/s SFP Optical Transceiver Module

SPP5300LH-GL-W

(Multi-rate CPRI application, 1310nm DFB-LD, PIN-PD)

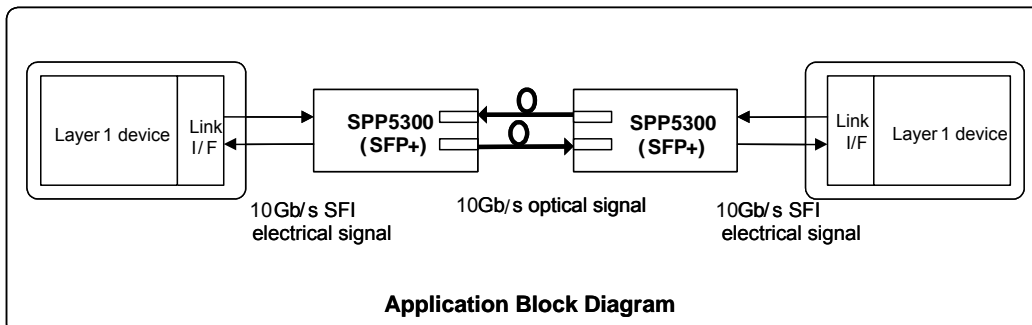
Features

- ◆ CPRI/OBSAI Compatible Optical Interface
 - 6G to 10G multi rate specification
 - 1310nm DFB laser for up to 10km over single mode fiber
 - High sensitivity PIN photodiode with TIA
- ◆ SFP+ MSA Compliant
 - Compliant with SFF 8431 for electrical interface
 - SFI High Speed electrical interface
 - Tx_Disable and Rx_LOS function supported
 - Compliant with SFF 8432 for mechanical interface
 - SFP Mechanical Interface for easy removal
 - Duplex LC Receptacle
 - Compliant with SFF 8742 for 2-wire interface for management and diagnostic monitor
- ◆ Protocol
 - OBSAI/CPRI specification
 - Compatible with Fibre Channel and Gigabit Ethernet applications
- ◆ Power Supply Consumption
 - Less than 1.2W with single 3.3V power supply
 - I-temp Operation
- ◆ RoHS6 compliant



Applications

- ◆ Radio Base Station
 - ◆ Radio Equipment Control (REC)
 - ◆ Radio Equipment (RE)
- ◆ Other high speed data connections



Preliminary

1. General Description

The SPP5300LH-GL-W is a very compact 6.144 to 9.8304Gb/s optical transceiver module for serial optical communication applications for a radio base station system. Also its operating case temperature range is specified under -40 to 85 degree Celsius for SPP5300LH-GL-W Those convert a 10Gb/s serial electrical data stream to 10Gb/s optical output signal and a 10Gb/s optical input signal to 10Gb/s serial electrical data streams. The high speed 10Gb/s electrical interface is fully compliant with SFI specification of SFF-8431. The SPP5300LH-GL-W is designed for multi-rate CPRI/OBSAI standard. The high performance 1310nm DFB-LD transmitter and high sensitivity PIN receiver provide superior performance for such multi-protocol at up to 10km links.

The fully SFP+ MSA 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)	Cable distance
10G SFP+	1310	SMF	Compliant with G.652	10km

2. Functional Description

The SPP5300LH-GL-W 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 SPP5300LH-GL-W SFP Transceiver.

Transmitter Operation

The transceiver module receives 10Gb/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 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

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

Preliminary

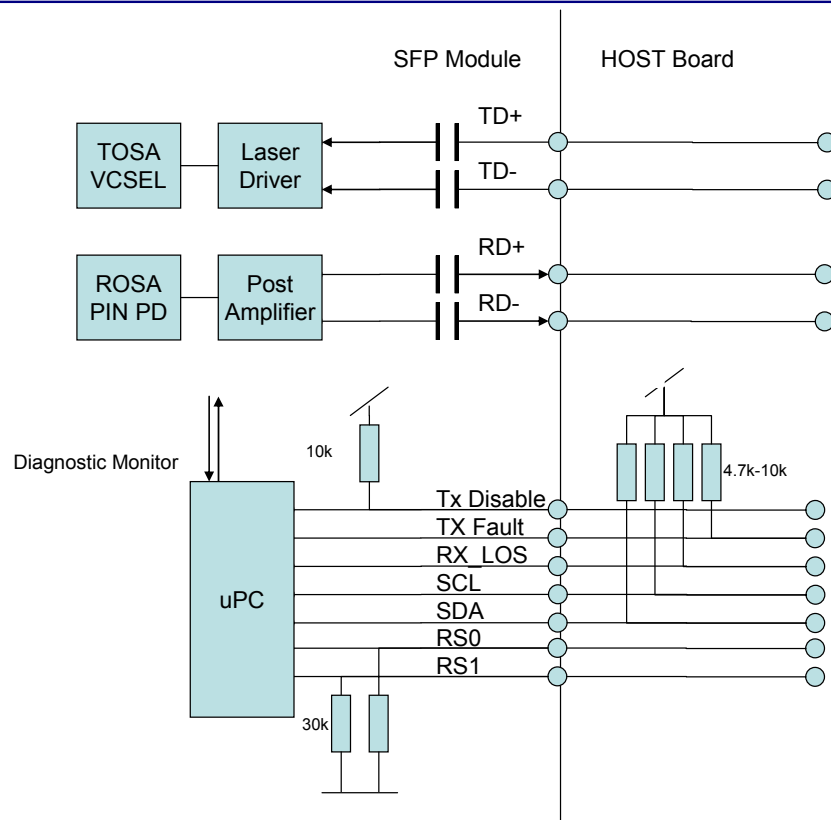


Figure 2.1 Functional Block Diagram

Preliminary

3. Package Dimensions

Figure 3.1 shows the package dimensions of SPP5300LH-GL-W which is designed to be compliant with SFP MSA specification. Package dimensions are specified in SFF-8432.

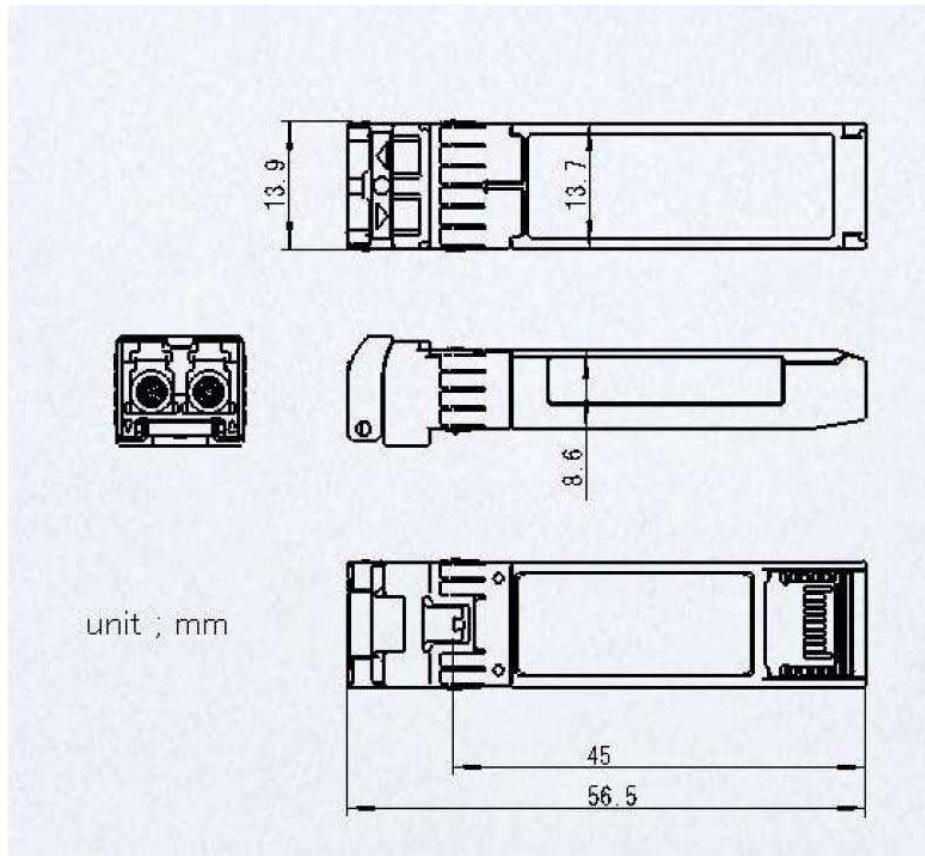


Figure 3.1 Package dimensions

Preliminary

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

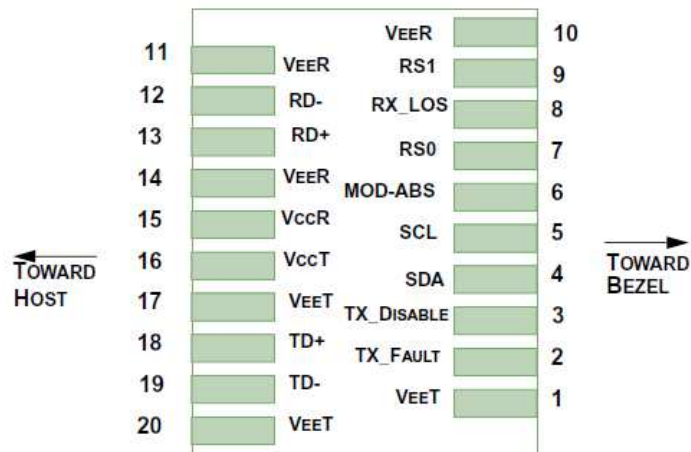


Figure 4.2 Host PCB SFP Pinout

4.3. Pin Descriptions

Table 4.3. Pin Description

Pin#	Name	Logic	Description	Power Sequence Order	Note
1	VeeT		Module Transmitter Ground	1 st	1
2	Tx_Fault	LVTTL-O	Module Transmitter Fault	3 rd	2
3	Tx_Disable	LVTTL-I	Transmitter Disable, Turns off transmitter laser output	3 rd	3
4	SDA	LVTTL-I/O	2 Wire Serial Interface Data Line(Same as MOD-DEF2 as defined in the INF-8074i)	3 rd	
5	SCL	LVTTL-I/O	2 Wire Serial Interface Data Line(Same as MOD-DEF1 as defined in the INF-8074i)	3 rd	
6	MOD_ABS		Module Absent, connected to VeeT or VeeR in the module	3 rd	2
7	RS0	LVTTL-I	Rate Select 0 (not functional for 10GE type)	3 rd	
8	RX_LOS	LVTTL-O	Receiver Loss of Signal Indication	3 rd	2
9	RS1	LVTTL-I	Rate Select 1 (not functional for 10GE type)	3 rd	
10	VeeR		Module Receiver Ground	1 st	1
11	VeeR		Module Receiver Ground	1 st	1
12	RD-	CML-O	Receiver Inverted Data Output	3 rd	
13	RD+	CML-O	Receiver Non-Inverted Data Output	3 rd	
14	VeeR		Module Receiver Ground	1 st	1
15	VccR		Module Receiver 3.3V Supply	2 nd	
16	VccT		Module Transmitter 3.3V Supply	2 nd	
17	VeeT		Module Transmitter Ground	1 st	1
18	TD+	CML-I	Transmitter Non-Inverted Data Input	3 rd	
19	TD-	CML-I	Transmitter Inverted Data Input	3 rd	
20	VeeT		Module Transmitter Ground	1 st	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
Storage Temperature	Tst	-40	85	degC
Relative Humidity (non-condensation)	RH	-	85	%
Supply Voltage	VccR/VccT	-0.5	3.6	V
Voltage on LVTTTL Input	Vilvttl	-0.5	VCC3+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, I-temp	Topc	-40	85	degC	
Relative Humidity(non-condensing)	Rhop	-	85	%	
Power Supply Voltage	VccR/VccT	3.135	3.465	V	
Total Power Consumption	Pd	-	1.2	W	1

Note:

1: The inrush current meets SFF-8431 level-I operation.

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.

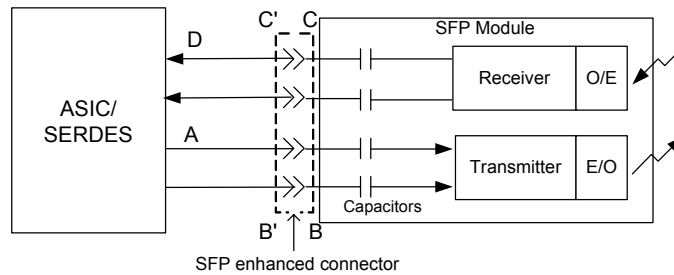


Figure 6.1.1. SFI Application Reference Model

SFI Module Transmitter Input Electrical Interface Specification at B' and Calibrated B''

Table 6.1.1. SFI Transmitter Input Electrical Specification at B'

Parameter B'	Symbol	Condition	Min	Typ.	Max.	Unit
Single Ended Output Voltage Tolerance		Referenced to VeeT	-0.3		4.0	V
AC common Input S-parameter		Note 1	15			mV
Differential Input S-parameter (note 1)	SDD11	0.01-4.1GHz			Note 2	dB
		4.1-11.1GHz			Note 3	dB
Reflected Differential to Common Mode Conversion	SCD11	0.01-11.1GHz			-10	dB

Note 1. Measured at B'' with Host Compliance Board and Module Compliance Board pair.

2. Maximum Reflection Coefficient given by equation $SDD11(dB) = -12 + 2 * \sqrt{f}$, with f in GHz.

3. Maximum Reflection Coefficient given by equation $SDD11(dB) = -6.3 + 13 \log_{10}(f/5.5)$, with f in GHz

Table 6.1.2. SFI Transmitter Input Electrical Specification at B"

Parameter B"	Symbol	Condition	Min	Typ.	Max.	Unit
Crosstalk Source Rise/Fall time (20% to 80%)	Tr, Tf	Note 1, 2		34		ps
Crosstalk Source Amplitude (p-p differential)		Note 1, 2		1000		mV
AC Common Mode Voltage		Note 3			15	mV(RMS)
Total Jitter	TJ				0.28	UIpp
Data Dependent Jitter	DDJ			0.10		UIpp
Pulse Width Shrinkage Jitter	DDPWS			0.055		UIpp
Uncorrelated Jitter	UJ	Note 4		0.023		UIrms
Eye Mask Figure 6.1.2	X1			0.12		UI
	X2			0.33		UI
	Y1			95		mV
	Y2			350		mV

- Note
1. Measured at C" with Host Compliance Board and Module Compliance Board pair.
 2. Since the minimum module output transition time is faster than the crosstalk transition time the amplitude of crosstalk source is increased to achieve the same slew rate.
 3. The tester is not expected to generate this common mode voltage however its output must not exceed this value.
 4. It is not possible to have the worst UJ and DDJ simultaneously and meet the TJ specifications if the UJ is all Gaussian.

SFI Module Receiver Output Electrical Interface Specification at C'

Table 6.1.3. SFI Receiver Output Electrical Specification at C'

Parameter – C'	Symbol	Conditions	Min	Typ	Max	Units
Crosstalk source rise/fall time (20% to 80%)	Tr, Tf	Note 1		34		ps
Crosstalk Source Amplitude Differential (p-p)		Note 2		700		mV
Termination Mismatch at 1 MHz	ΔZ_M				5	%
Single Ended Output Voltage Tolerance			-0.3		4.0	V
Output AC Common Mode Voltage					7.5	mV (RMS)
Differential Output S-parameter (Note 3)	SDD22	0.01-4.1GHz			Note 2	dB
		4.1-11.1GHz			Note 3	dB
Common Mode Output Reflection Coefficient (Note 5)	SCC22	0.01-2.5GHz			Note 4	dB
		2.5-11.1GHz			-3	dB

Note 1 : Measured at B" with the Host Compliance Board and Module Compliance Board pair.

2 : Reflection Coefficient given by equation $SDD22(dB) < -12 + 2 \times \text{SQRT}(f)$, with f in GHz.

3 : Reflection Coefficient given by equation $SDD22(dB) < -6.3 + 13 \times \log_{10}(f/5.5)$, with f in GHz.

4 : Reflection coefficient given by equation $SCC22(dB) < -7 + 1.6 \times f$, with f in GHz.

Table 6.1.4. SFP+ Limiting Output Jitter and Eye Mask Specification at C'

Parameter – C'	Symbol	Conditions	Min	Typ	Max	Units
Output rise/fall time (20% to 80%)	Tr, Tf		28			ps
Total Jitter	TJ				0.70	UIpp
99% Jitter	J2	Note 1			0.42	UIpp
Eye Mask Figure 6.1.3	X1		0.35			UI
	Y1		150			mV
	Y2		425			mV

Note 1 : J2 is defined from the 0.5th to the 99.5th percentile of the jitter histogram.

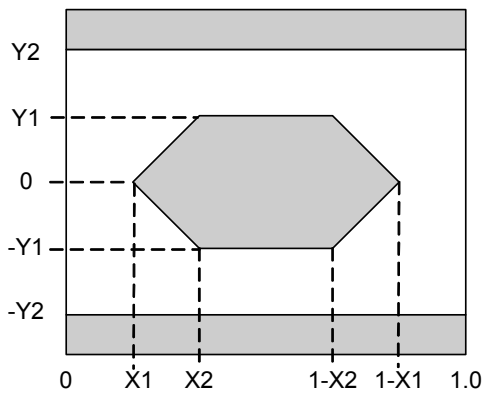


Figure 6.1.2.
Transmitter Input Eye Mask

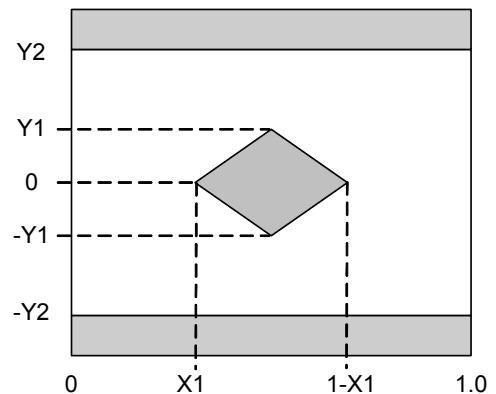


Figure 6.1.3.
Receiver Output Eye Mask

Preliminary

6.2. Low speed Electrical Interface

SPP5300LH-GL-W 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" (Note 1)	t _{clock_hold}		500	us

Note 1 : 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 white operation.

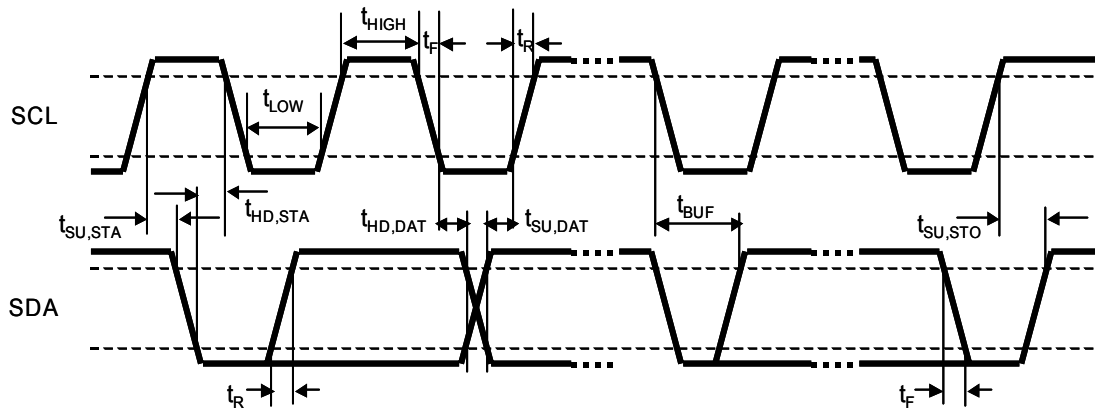


Figure 6.1.4. SFP+ Timing Diagram

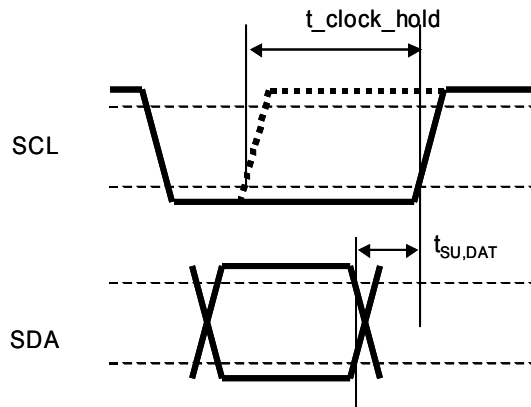


Figure 6.1.5. Detail of Clock Stretching

7. Optical Interface

Optical Interfaces of SPP5300LH-GL-W are defined in the related optical communication specification like FC-PI-4 or IEEE802.3.

Table 7.1. Transmitter Optical Interface

Parameter	Symbol	Min	Typ	Max	Unit
Signaling Speed		6.144		9.8304	Gb/s
Signaling speed variation from nominal (max)		-100		+100	ppm
Center wavelength		1260		1355	nm
Side Mode Suppression Ratio	SMSR	30			dB
Average launched power	Pave	-8.2		+0.5	dBm
OMA	Poma	-5.2			dBm
OMA-TDP		-6.2			dBm
Transmitter and dispersion penalty	DP			3.2	dB
Average launch power of Tx OFF	Pave_off			-30	dBm
Extinction ratio	ER	3.5			dB
RIN OMA	RIN			-128	dB/Hz
Optical Return Loss Tolerance	ORLT			12	dB
Transmitter Reflectance				-12	dB
Eye mask(X1,X2,X3,Y1,Y2,Y3)	(0.25,0.40,0.45,0.25,0.28,0.40) Note1				

Note 1 Refer to Figure 7.1.

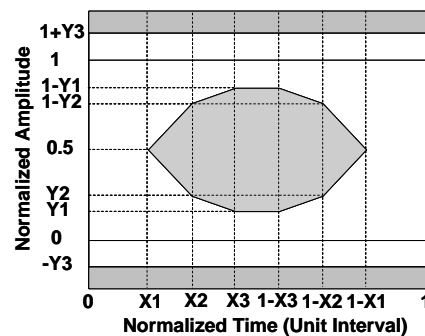


Figure.7.1. Transmission eye mask definition

7.2 . Optical Receiver

Table 7.2. Receiver Optical Interface

Parameter	Symbol	Min	Typ	Max	Unit
Center Wavelength		1260		1355	nm
Signaling Speed		6.144		9.8304	Gb/s
Signaling speed variation from nominal (max)		-100		+100	ppm
Average receive power		-14.4		+0.5	dBm
Receiver sensitivity in OMA (Note 1)				-11.2	dBm
Receiver Reflectance				-12	dB
Stressed receiver sensitivity in OMA (Note1,2)				-10.3	dBm

Note 1: Receiver sensitivity is informative. Stressed receiver sensitivity shall be measured with Conformance test signal for BER=10⁻¹².

2: The stressed sensitivity values in the table are for system level BER measurements which include the effects of CDR circuit.

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)

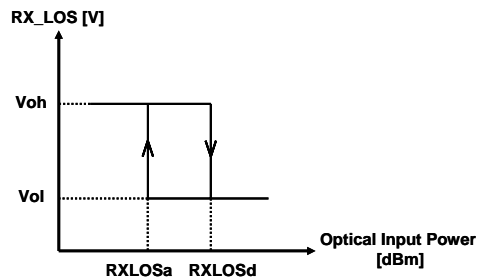


Figure.8.1. Optical Input Power vs. RX_LOS

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.

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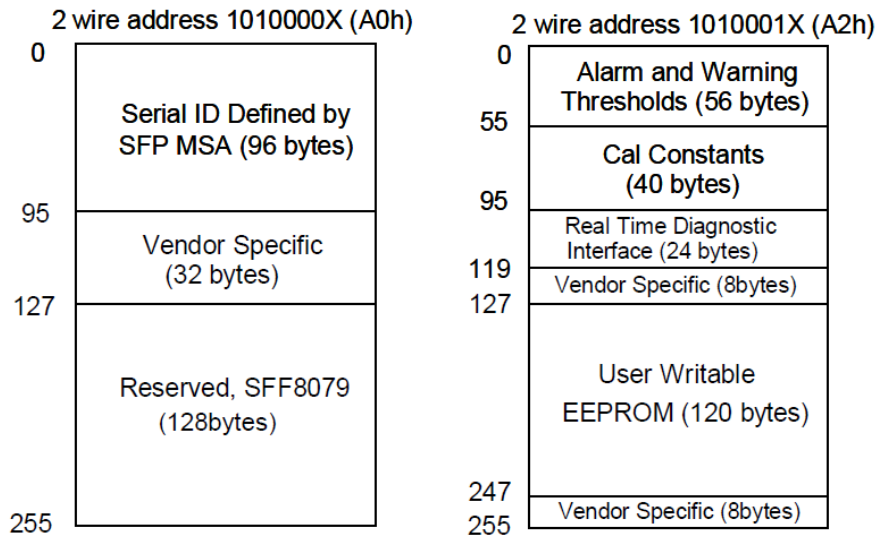


Figure 9.1. 2-wire Serial Interface Memory Map

To identify multi-sourcing OSA, vendor revision byte can be utilized as described memory map table.

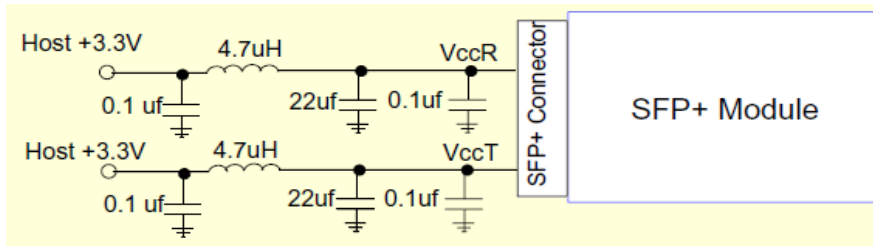


Figure 9.2 Supply Filter



Preliminary

9.3. Serial ID Memory Map (Data Field – Address A0h)

Address	Size (Bytes)	Name	Hex	ASC	Description
0	1	Identifier	03		SFP Transceiver
1	1	Ext.Identifier	04		
2	1	Connector	07		LC Connector
3	8	Transceiver	00		
4			00		
5			00		
6			00		
7			00		
8			00		
9			00		
10			00		
11	1	Encoding	01		
12	1	BR.Nominal	3D		
13	1	Rate Identifier	03		
14	1	Length(SMF)-km	A		10km
15	1	Length(E-50 μm)	64		10km
16	1	Length(50 μm)	00		not support MMF
17	1	Length(62.5 μm)	00		not support MMF
18	1	Length(Copper)	00		not support copper
19	1	Length(OM3)	00		not support MMF
20	16	Vendor name	53	S	
21			75	u	
22			6D	m	
23			69	i	
24			74	t	
25			6F	o	
26			6D	m	
27			6F	o	
28			45	E	
29			6C	l	
30			65	e	
31			63	c	
32			74	t	
33			72	r	
34			69	i	
35			63	c	
36	1	Reserved	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			33	3	
45			30	0	
46			30	0	
47			4C	L	
48			48	H	
49			2D	-	
50			47	G	
51			4C	L	
52			2D	-	*1
53			57	W	*1
54			20		
55			20		
56	41	A	*2		
57	20				
58	20				
59	20				
60	2	Wavelength	05		1310nm
61			1E		
62	1	Reserved	00		
63	1	CC BASE			Check Code *3

Address	Size (Bytes)	Name	Hex	ASC	Description
64	2	Options	00		Power Class 1, limit Receiver Output
65			1A		LOS/TX Fault/TX Disable implemented, Ratesel no support.
66	1	BR,max	00		
67	1	BR,min	00		
68	16	Vendor SN	20		
69			20		
70			20		
71			20		
72			20		
73			20		
74			20		
75			20		
76			20		
77			20		
78			20		
79			20		
80			20		
81			20		
82			20		
83			20		
84	8	Date Code	20		Y
85			20		Y
86			20		M
87			20		M
88			20		D
89			20		D
90			20		LOT
91			20		LOT
92	1	Diagnosis Monitoring Type	68		Internal cal., Average Power Alarm/Warning flags, Soft TxDisable, Soft TxFault, Soft RxLOS, Rate Select
93	1	Enhanced Options	F0		Rev.10.0
94	1	SFF-8472 Compliance	03		Check Code *4
95	1	CC_EXT			
96-127	32	Vendor Specific	00		
128-255	128	Reserved	00		

*1 : "20"(space) for SPP5300LH-GL "W" for I-temp
 *2 : Revision level for part number provided by vendor (ASCII). Variable.
 And it identifies OSA source. (ex. Rev. A : prime source, Rev. A2 : second source)
 *3 : Checksum of Add.0 to 62
 *4 : Checksum of Add.64 to 94

Preliminary

9.4. Alarm/Warming threshold

A2h address	Meaning	Unit	SPP5300LH-GL-W
0-1	Temperature High Alarm	deg	90
2-3	Temperature Low Alarm	deg	45
4-5	Temperature High Warning	deg	85
6-7	Temperature Low Warning	deg	-40
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	TBD
18-19	Tx Bias Low Alarm	mA	TBD
20-21	Tx Bias High Warning	mA	TBD
22-23	Tx Bias Low Warning	mA	TBD
24-25	Tx Power High Alarm	dBm	3.5
26-27	Tx Power Low Alarm	dBm	-12.2
28-29	Tx Power High Warning	dBm	-0.5
30-31	Tx Power Low Warning	dBm	-8.2
32-33	Rx Power High Alarm	dBm	3.5
34-35	Rx Power Low Alarm	dBm	-18.4
36-37	Rx Power High Warning	dBm	0.5
38-39	Rx Power Low Warning	dBm	-14.4

Note.

- Alarm /Warming flag is linked to TxFault by default setting.
- Temperature Low Alarm/Warning is variable for operation range options
E-temp : Temperature Low Alarm= "-10", Temperature Low Warning= "-5"
- Tx Bias Alarm/Warming is describing both prime OSA source. The parentheses value is second source case.

9.5. Digital Diagnostic Monitor Accuracy

The following characteristics are defined over recommended operating conditions.

Parameter	Accuracy	Unit
Internally measured transceiver temperature	+/- 5	deg.C
Internally measured transceiver supply voltage	+/- 3	%
Measured Tx bias current	+/- 10	%
Measured Tx output power	+/- 3	dB
Measured Rx received average optical power	+/- 3	dB

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

SPP5300LH-GL-W 10Gb/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

SPP5300LH-GL-W 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 IEC60825-1:2007 and IEC60825-1:2001 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)

SPP5300LH-GL-W is designed to meet FCC Class B limits for emissions and noise immunity per CENELEC EN50 081 and 082 specifications.

RF Immunity

SPP5300LH-GL-W has an immunity to operate when tested in accordance with IEC 61000-4-3 (80- 1000MHz, Test Level 3) and GR-1089.

Preliminary

Electrostatic Discharge (ESD) Immunity

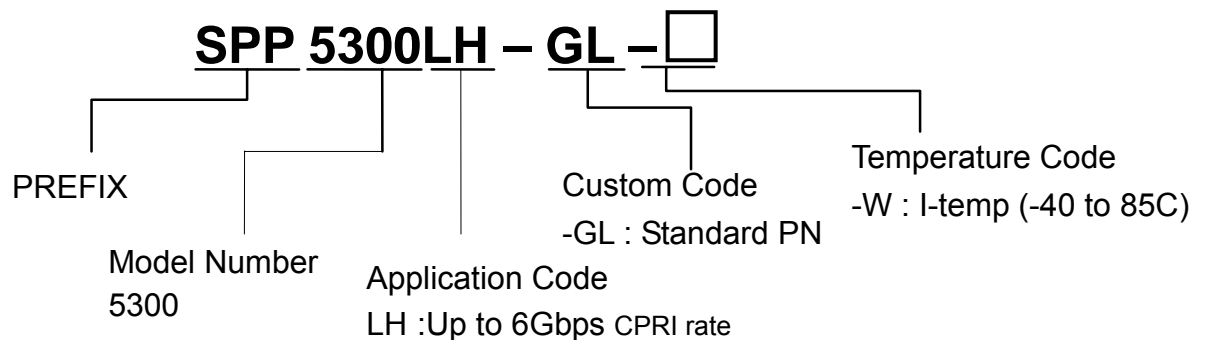
SPP5300LH-GL-W has an immunity against direct and indirect ESD when tested accordance with IEC 61000-4-2.

14. Firmware version

This product contains the firmware to control and monitor the module. Sumitomo Electric may upgrade the firmware version without advance notice as far as such would be upper compatible. When customers should prefer to have the current firmware version, Sumitomo Electric will accommodate such request and will assign customized part number for this purpose.

15. Ordering Information

15.1. Part Numbering System



15.2. Ordering Number Code

Table 13-1. SPP5300LH Application Code

Part Number	Temperature Range	Distance	Fiber	E/O	O/E
SPP5300LH-GL-W	-40 to 85 deg.C	10km	SMF	DFB-LD 1310nm	PIN

16. Label information (Top label)



17. Contact Information

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