10Gb/s SFP Optical Transceiver Module

SPP5100ZX-GL

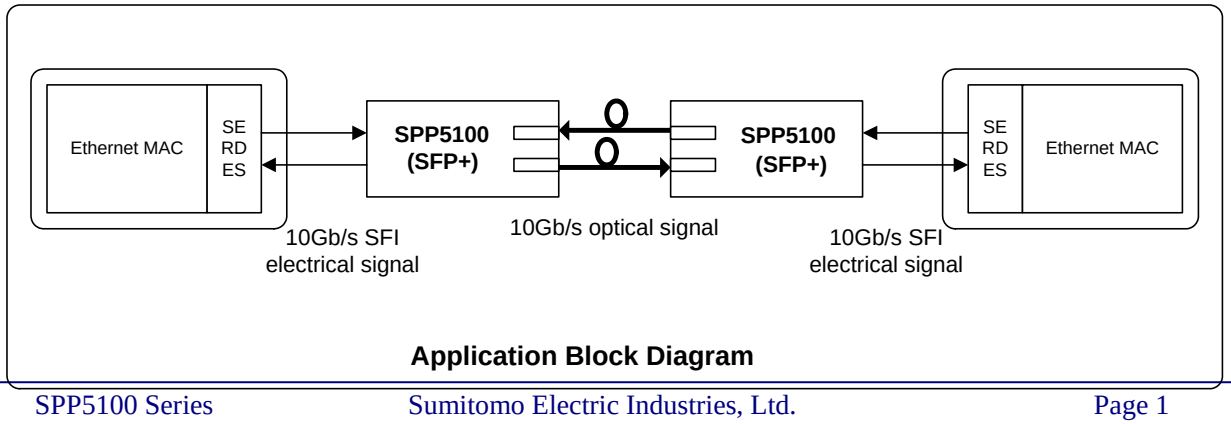
(Multi protocol, 80km 1550nm Cooled EA-DFB-LD, APD)

Features

- 10Gb/s Serial Optical Interface
  - High quality and reliability optical device and sub-assemblies
  - Cooled EA-DFB laser for up to 80km over Single Mode Fiber
  - High sensitivity APD 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 and Rx_LOS functions
- Protocol
  - IEEE802.3ae 10Gigabit Ethernet LAN PHY/WAN PHY
  - OTU2 and OTU2e
- Power Supply
  - Single 3.3V power supply
  - Max 1.6W power consumption
- RoHS6 compliant

Applications

- 10GE Ethernet switches and routers
- 10GE Storage
- Other high speed data connections



Application Block Diagram

1. General Description

The SPP5100ZX-GL is a very compact 10Gb/s optical transceiver module for serial optical communication applications at 10Gb/s. The SPP5100ZX-GL converts 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 SPP5100ZX-GL is designed for Ethernet LAN (10.3Gb/s) and WAN(9.95Gb/s) applications The high performance cooled EA-DFB-LD transmitter and high sensitivity and low noise APD receiver provide superior performance for multi-rate applications at up to 80km links.

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

Table 1.1 Fiber compliance

SFP+ type	Wavelength [nm]	Cable Type	Cable distance
10GB-ZX	1550	SMF	80km *

* Based on single-mode transmission fiber chromatic dispersion value of 17.5 ps/nm-km.

2. Functional Description

The SPP5100ZX-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 SPP5100ZX-GL 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.

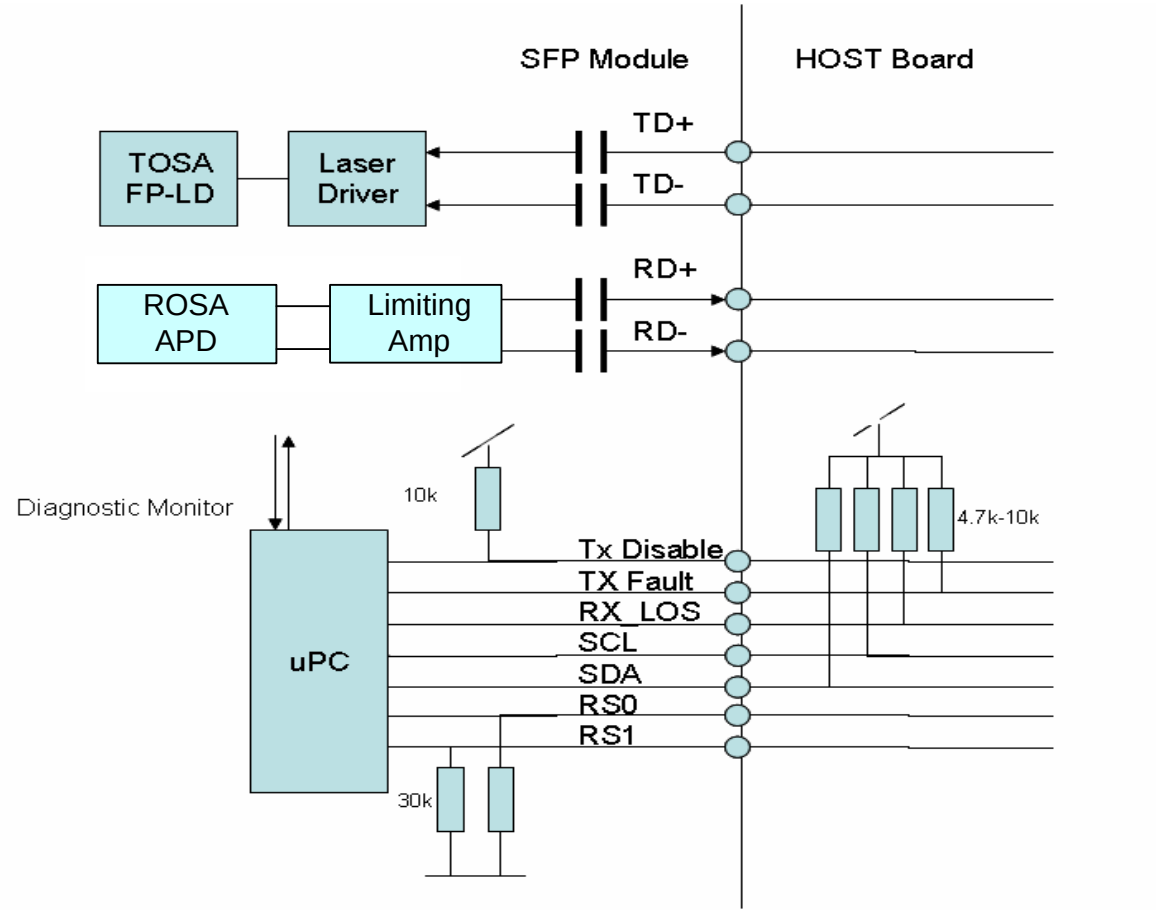


Figure 2.1 Functional Block Diagram

3. Package Dimensions

Figure 3.1. shows the package dimensions of SPP5100ZX-GL. SPP5100ZX-GL is designed to be complaint with SFP MSA specification. Package dimensions are specified in SFF-8432. (Note : Drawing below will be revised in the future./Bail color :**GREEN**)

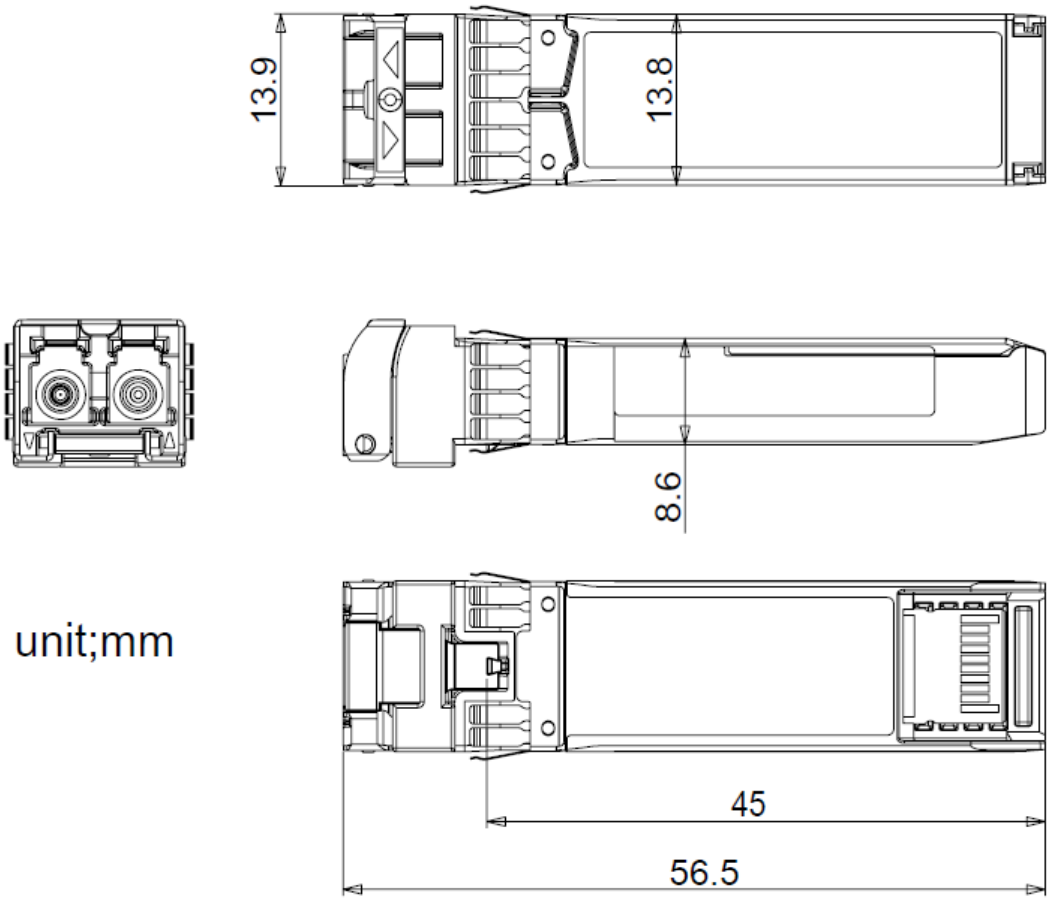


Figure 3.1 Package dimensions

4. Pin Assignment and Pin Description

4.1. SFP Transceiver Electrical Pad Layout

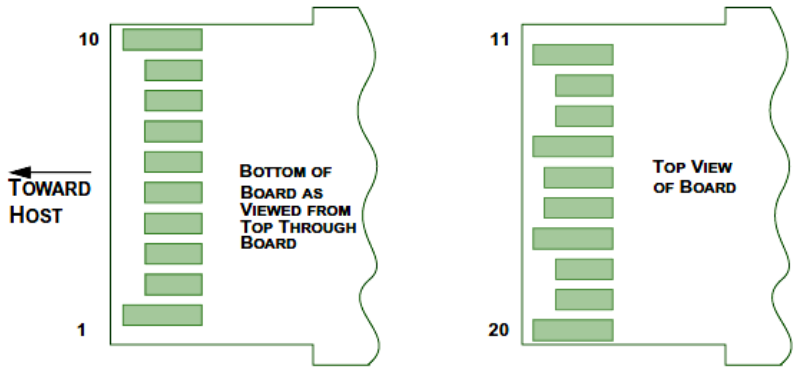


Figure 4.1.1 SFP Transceiver Electrical Pad Layout

4.2. Host PCB SFP Pinout

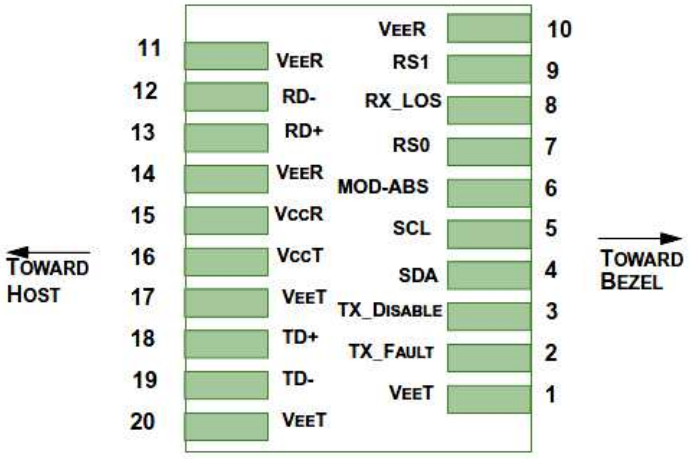


Figure 4.2.1 Host PCB SFP Pinout

4.3. Pin Descriptions

Table 4.3.1 Pin Description

Pin#	Name	Logic	Description	Power Sequence Order	Note
1	VeeT		Module Transmitter Ground	1st	1
2	Tx_Fault	LVTTL-O	Module Transmitter Fault	3rd	2
3	Tx_Disable	LVTTL-I	Transmitter Disable, Turns off transmitter laser output	3rd	3
4	SDA	LVTTL-I/O	2 Wire Serial Interface Data Line	3rd	
5	SCL	LVTTL-I/O	2 Wire Serial Interface Data Line	3rd	
6	MOD_ABS		Module Absent, connected to VeeT or VeeR in the module	3rd	2
7	RS0	LVTTL-I	Rate Select 0 (not functional for 10GE type)	3rd	
8	RX_LOS	LVTTL-O	Receiver Loss of Signal Indication	3rd	2
9	RS1	LVTTL-I	Rate Select 1 (not functional for 10GE type)	3rd	
10	VeeR		Module Receiver Ground	1st	1
11	VeeR		Module Receiver Ground	1st	1
12	RD-	CML-O	Receiver Inverted Data Output	3rd	
13	RD+	CML-O	Receiver Non-Inverted Data Output	3rd	
14	VeeR		Module Receiver Ground	1st	1
15	VccR		Module Receiver 3.3V Supply	2nd	
16	VccT		Module Transmitter 3.3V Supply	2nd	
17	VeeT		Module Transmitter Ground	1st	1
18	TD+	CML-I	Transmitter Non-Inverted Data Input	3rd	
19	TD-	CML-I	Transmitter Inverted Data Input	3rd	
20	VeeT		Module Transmitter Ground	1st	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
Strage Temperature	Tst	-40	85	degC	
Relative Humidity (non-condensation)	RH	-	85	%	
Supply Voltage	VccR/VccT	-0.5	3.6	V	
Voltage on LVTTL Input	Vilvttl	-0.5	VCC3+0.5	V	
LVTTL Output Current	Iolvttl	-	15	mA	
Voltage on Open Collector Output	Voco	0	6	V	
Receiver Input Optical Power(Average)	Mip	-	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	-	1.6	W	1

Note 1. The inrush current meets SFF-8431 level-II 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.

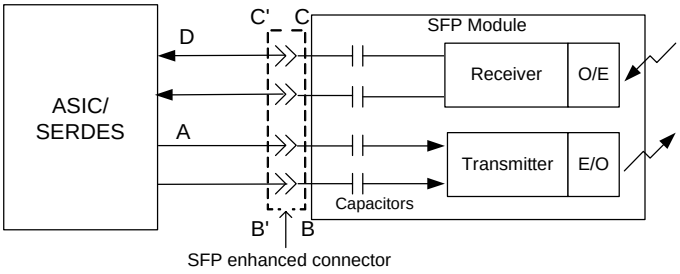


Figure 6.1.1 SFI Application Reference Model

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+13Log10(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 Depandent 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.

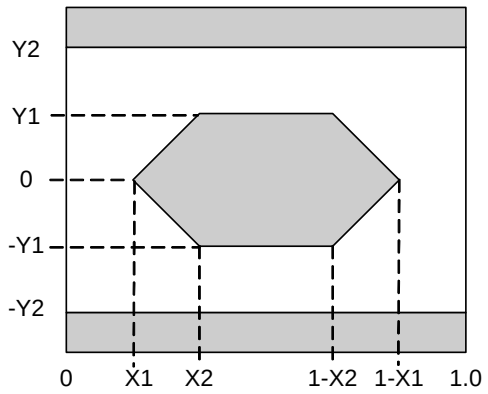


Figure 6.1.2 Transmitter Input Eye Mask

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 × SQRT(f), with f in GHz.

3 : Reflection Coefficient given by equation SDD22(dB)< -6.3 + 13 × log10(f/5.5), with f in GHz.

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

Table 6.1.4 SFP+ Linear 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	X1		0.35			UI
Figure 6.1.3	Y1		150			mV
	Y2		425			mV

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

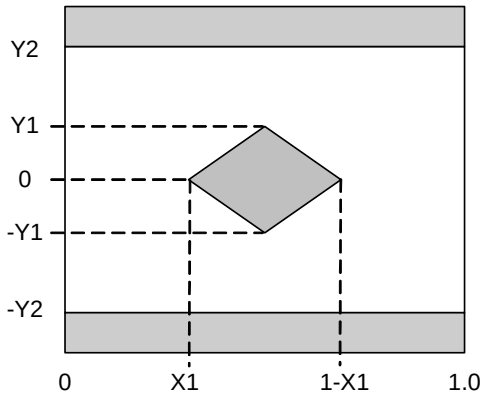


Figure 6.1.3 Receiver Output Eye Mask

6.2. Low speed Electrical Interface

SPP5100ZX-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 Hold-off "Clock Stretching"	t_clock_hold		500	us

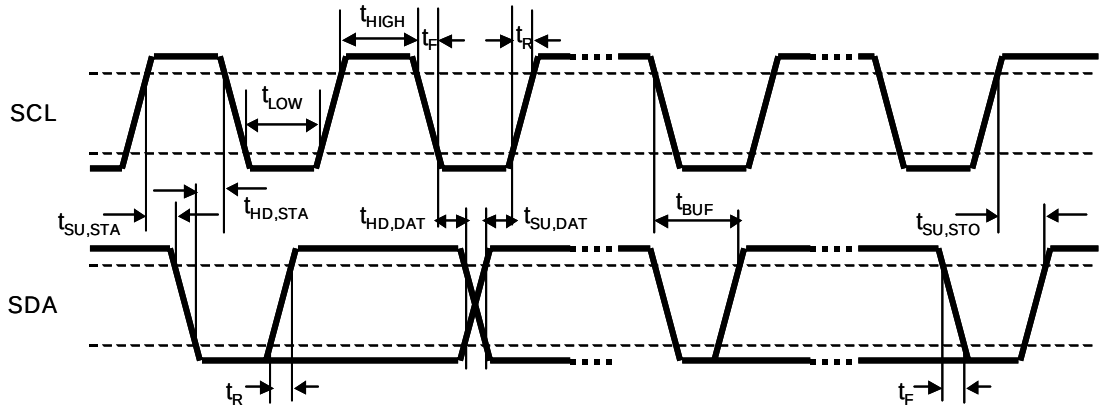


Figure 6.2.1 SFP+ Timing Diagram

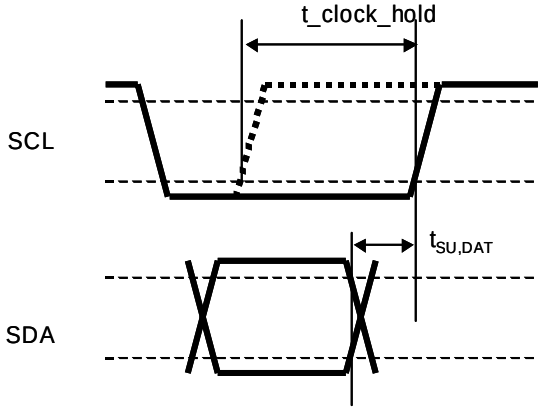


Figure 6.2.2 Detail of Clock Stretching

7. Optical Interface

Optical Interfaces of SPP5100ZX-GL are defined as follows.

7.1. Optical Transmitter

Table 7.1.1 Optical Transmitter Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Signaling Speed (WAN PHY) (LAN PHY)		-	9.95328 10.3125		Gb/s
Signaling speed variation from nominal (max) for 10GE-LAN		-100		+100	ppm
Signaling speed variation from nominal (max) for 10GE-WAN		-20		+20	ppm
Center wavelength		1530		1565	nm
Spectral Width	Δλ	-		1	nm
Side Mode Suppression Ratio	SMSR	30			dB
Average launched power	Pave	0		+4.0	dBm
Average launch power of Tx OFF	Pave_off			-30	dBm
Extinction ratio (Note 1)	ER	8.2			dB
Eye mask (X1,X2,X3,Y1,Y2,Y3)		(0.25, 0.40, 0.45, 0.25, 0.28, 0.40) (Note 1)			

Note 1 : Refer to Figure 7.1.

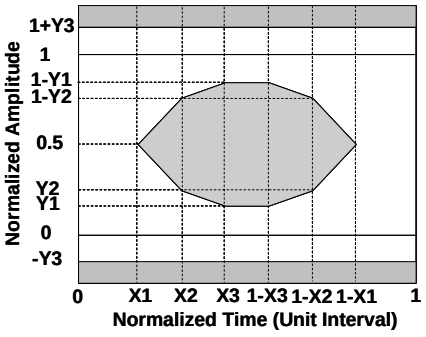


Figure.7.1 Transmission eye mask definition

7.2. Optical Receiver

Table 7.2.1 Optical Receiver Specifications

Parameter	Symbol	Min	Typ	Max	Unit
Wavelength (Note 1)		1260		1565	nm
Receiver Reflectance				-27	dB
Receiver Damage Threshold				+5	dBm
NO FEC APPLICATION					
Receiver Sensitivity @BER=1E-12 with PRBS31 and 10GE frame				-23	dBm
Chromatic Dispersion (CD) Penalty @1400ps/nm (Note 2)				3.0	dB
Receiver Overload		-7			dBm

Note 1 : Receiver Sensitivity specified over 1528-1565 nm only, with 3dB degradation permitted from 1260-1528nm.

Note 2 : Max 3 dB of power penalty on every TX-RX optical SFP+ pair shall be guaranteed.

7.3. Jitter Specification

10GE LAN

10GE LAN shall comply with the appropriate 10Gb/s Ethernet jitter requirements. In Ethernet the jitter requirements are rolled into the eye mask so that in practice all that is required is compliance with the appropriate 10Gb/s Ethernet eye mask

10GE WAN

10GE WAN shall comply with the SONET/SDH jitter requirement according to ITU G.8251 and ITU G.783, Telcordia GR-253 issue 4, and ANSI T1.105.03. Jitter generation methodology is defined in chapter 5.4; jitter transfer and tolerance are for further study.

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)

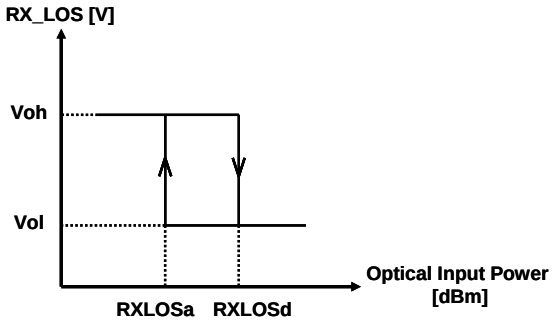


Figure.8.1 Optical Input Power vs. RX_LOS

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.

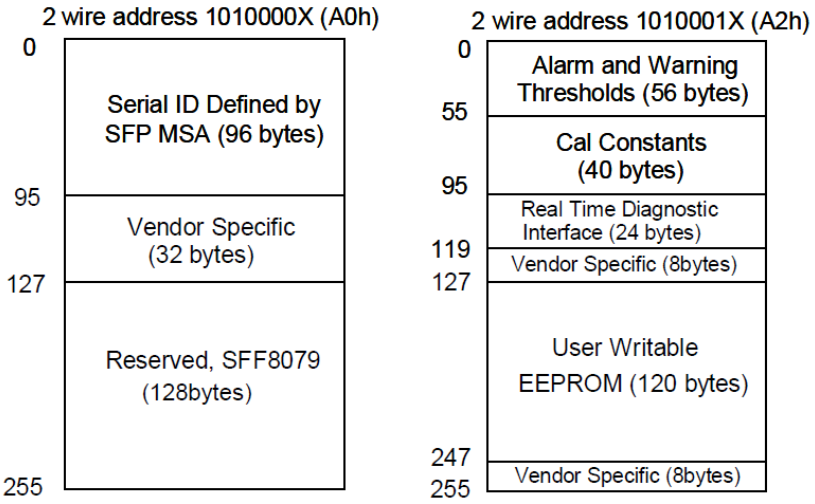


Figure 9.1 2-wire Serial Interface Memory Map

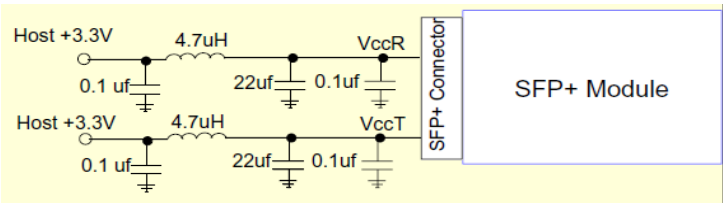


Figure 9.2 Supply Filter

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

Address	Size (Bytes)	Name	Hex	ASC	Description
0	1	Identifier	03		SFP module
1	1	Ext.Identifier	04		Serial ID module
2	1	Connector	07		LC Connector
3	8	Transceiver	00		Unallocated
4			00		
5			00		
6			00		
7			00		
8			00		
9			00		
10			00		
11	1	Encoding	06		64B66B
12	1	BR, Nominal	67		10.3Gbps
13	1	Rate Identifer	00		unspecified
14	1	Length(9um, km)	50		80km
15	1	Length(9um)	FF		> 25.5km
16	1	Length(50um)	00		not support MMF
17	1	Length(62.5um)	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	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			5A	Z	
48			58	X	
49			2D	-	
50			47	G	
51			4C	L	
52			20		
53			20		
54			20		
55			20		
56	4	Vendor rev	41 to 5A	A to Z	*1
57			20		
58			20		
59			20		
60	2	Wavelength	06		1550nm
61			0E		
62	1		00		
63	1	CC_BASE	xx		Check Code *2

Address	Size (Bytes)	Name	Hex	ASC	Description
64	2	Options	05		Cooled Transceiver Linear Receiver Output
65			1A		TxDisable, TxFault , LOS implemented
66	1	BR,max	00		
67	1	BR,min	00		
68	16	Verdor SN	xx		
69			xx		
70			xx		
71			xx		
72			xx		
73			xx		
74			xx		
75			xx		
76			xx		
77			xx		
78			xx		
79			20		
80			20		
81			20		
82			20		
83			20		
84	8	Date Code	xx		Year code
85			xx		
86			xx		Month code
87			xx		
88			xx		Day code
89			xx		
90			xx		LOT code
91			xx		
92	1	Diagnostis Monitoring Type	68		Internal cal , Average Power
93	1	Enhanced Options	F0		Alarm/Warning flags, Soft TxDisable, Soft TxFault, Soft RxLOS implemented
94	1	SFF-8472 Compliance	04		Rev.10.4
95	1	CC_EXT	xx		Check Code *3
96-127	32	Vender Specific	xx		
128-255	125	Reserved	00		

*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

9.4. Alarm/Warming threshold

A2h address	Meaning	Unit	SPP5100ZX-GL
0-1	Temperature High Alarm	deg.C	75
2-3	Temperature Low Alarm	deg.C	-5
4-5	Temperature High Warning	deg.C	70
6-7	Temperature Low Warning	deg.C	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	120
18-19	Tx Bias Low Alarm	mA	17
20-21	Tx Bias High Warning	mA	112
22-23	Tx Bias Low Warning	mA	20
24-25	Tx Power High Alarm	dBm	6.0
26-27	Tx Power Low Alarm	dBm	-5.0
28-29	Tx Power High Warning	dBm	3.0
30-31	Tx Power Low Warning	dBm	-1.0
32-33	Rx Power High Alarm	dBm	-3.0
34-35	Rx Power Low Alarm	dBm	-31.0
36-37	Rx Power High Warning	dBm	-7.0
38-39	Rx Power Low Warning	dBm	-27.0

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

9.5. Digital Diagnostic Monitor Accuracy

The following characteristics are defined over recommended operating conditions.

Parameter	Accuracy	Unit
Internally measured transceiver temperature	+/- 3	deg.C
Internally measured transceiver supply voltage	+/- 3	%
Measured Tx bias current	+/- 10	%
Measured Tx output power	+/- 2	dB
Measured Rx received average optical power	+/- 3	dB

10. RoHS COMPLIANCY

Compliancy 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

SPP5100ZX-GL 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

SPP5100ZX-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 60825-1:2007 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)

SPP5100ZX-GL is designed to meet FCC Class B limits for emissions and noise immunity per CENELEC EN50 081 and 082 specifications.

RF Immunity

SPP5100ZX-GL has an immunity to operate when tested in accordance with IEC 61000-4-3 (80- 1000MHz, Test Level 3) and GR-1089.

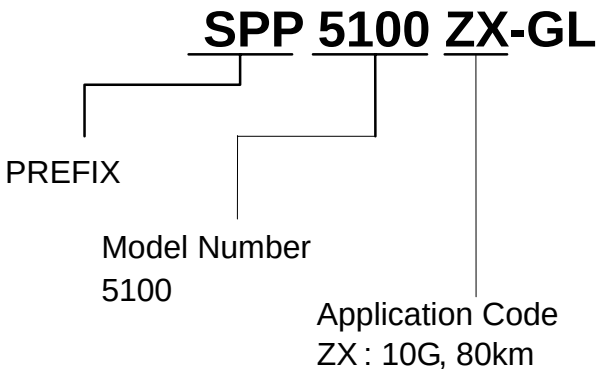
Electrostatic Discharge (ESD) Immunity

SPP5100ZX-GL has an immunity against direct and indirect ESD when tested accordance with IEC 61000-4-2.

14. Firmware version

15. Ordering Information

15.1. Part Numbering System



15.2. Ordering Number Code

Table 15.1 SPP5100ZX Application Code

Part Number	Temperature Range	Distance	Fiber	E/O	O/E	IEEE
SPP5100ZX-GL	0 to 70 deg.C	80km	SMF	Cooled EA-DFB 1550nm	APD	802.3ae

16. Label information

(Top label)

(Case Label)

17. Contact Information

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