

# 10Gb/s SFP+ BiDi Transceiver HB10-0455111 1490nm EML/APD-TIA, 80Km,

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## Features

- ◇ Hot pluggable
- ◇ 10Gb/s serial optical interface
- ◇ 1490nm EML Laser and APD receiver
- ◇ Up to 80km on 9/125um SMF
- ◇ SFP+ MSA package with duplex LC connector
- ◇ 2-wire interface for management and diagnostic monitor
- ◇ SFI High Speed Electrical Interface
- ◇ +3.3V single power supply
- ◇ Power consumption less than 1.8W
- ◇ Operating case temperature: 0~+70°C

## Applications

- ◇ 10GBASE-BX Ethernet
- ◇ 10GBASE-ZR at 10.3125Gbps
- ◇ 10GBASE-ZW at 9.953Gbps

## Standard

- ◇ Compliant with SFF-8431 and SFF-8432
- ◇ Compliant with SFF-8472 Rev 10.2
- ◇ RoHS Compliant

## Description

HB10-0455111 is a very compact 10.3125Gb/s optical transceiver module for serial optical communication applications, supporting data-rate of 10.3125Gbps (10GBASE-ZR), and transmission distance up to 80 km on SMF.

The transceiver consists of two sections: The high performance a 1490nm EML Laser, Transmitter and high sensitivity APD integrated with a TIA Receiver.

The module is hot pluggable into the 20-pin connector. The high-speed electrical interface is based on low voltage logic, with nominal 100 Ohms differential impedance and AC coupled in the module. The optical output can be disabled by LVTTTL logic high-level input of TX\_Disable. Loss of signal (RX\_LOS) output is provided to indicate the loss of an input optical signal of receiver. The receiver RATE\_SELECT pin is not used by the transceiver

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

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Rev1.0  
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## Absolute Maximum Ratings

Parameter	Symbol	Min	Max	Unit
Storage Temperature	T <sub>ST</sub>	-40	+85	°C
Supply Voltage	V <sub>CC3</sub>	0.0	+3.6	V
Relative Humidity	RH	5	95	%

## Recommend Operation Environment

Parameter	Symbol	Min	Typ	Max	Unit
Date Rate			10.3125		Gb/s
Supply Voltage	V <sub>CC</sub>	+3.14	3.3	+3.47	V
Supply Current	I <sub>CC</sub>			500	mA
Power Dissipation	PD		1500	1800	mW
Operating Temperature	T <sub>OP</sub>	0	25	+70	°C

## Optical Characteristics (Condition: T<sub>a</sub>=T<sub>OP</sub>)

Parameter	Symbol	Min	Type	Max	Unit	Note	
<b>Transmitter</b>							
Date Rate			10.3125		Gb/s		
Optical Wavelength	λ	1483.5		1496.5	nm		
Average output power	P <sub>o</sub>	+0		+5	dBm	1	
Optical Extinction Ratio	ER	8.2			dB	1	
Disabled Power	P <sub>off</sub>	-		-30	dBm		
Side Mode Suppression Ratio	SMSR	30			dB		
Tx Jitter	T <sub>xj</sub>	Per 802.3ae requirements					
<b>Receiver</b>							
Date Rate			10.3125		Gb/s		
Optical Wavelength	λ	1543.5		1556.5	nm		
Receiver Sensitivity	R			-23	dBm	2	
Maximum Input Power	P <sub>MAX</sub>	-7.0			dBm		
LOS De-Assert	LOSD			-24	dBm		
LOS Assert	LOSA	-35			dBm		
LOS Hysteresis		0.5		4	dB		
Optical Return loss	ORL			27	dB		

### Notes:

Note 1、 Measured at 10.3125 Gb/s with PRBS 2<sup>31</sup> - 1 NRZ test pattern.

Note 2、 Under the ER worst case, measured at 10.3125 Gb/s with PRBS 2<sup>31</sup> - 1 NRZ test pattern for BER < 1x10<sup>-12</sup>

### Electrical Characteristics (Condition: $T_a = T_{OP}$ )

Parameter	Symbol	Min	Typ	Max	Unit	Note
<b>Transmitter</b>						
Differential input voltage swing	VI	150		1600	mVpp	1
C common mode voltage tolerance		15	-	-	mV	
Transmit Disable Input	H	V <sub>IH</sub>	2.0	V <sub>CC</sub> +0.3	V	
	L	V <sub>IL</sub>	0	0.8	V	
Transmit Enable Output	H	V <sub>OH</sub>	2.4	V <sub>CC</sub> +0.3	V	
	L	V <sub>OL</sub>	0	0.4	V	2
Data Dependent Input Jitter	DDJ			0.1	UI	
Data Input Total Jitter	TJ			0.28	UI	
Input Differential Impedance	Z <sub>in</sub>	80	100	120	Ω	
<b>Receiver</b>						
Differential output voltage swing		500		700	mVpp	3
LOS Output	H	V <sub>OH</sub>	2.4	V <sub>CC</sub> +0.3	V	2
	L	V <sub>OL</sub>	0	0.4	V	
Rx Output Rise and Fall Time	Tr/Tf	30			ps	20% to 80%
Total Jitter	TJ			0.7	UI	
Deterministic Jitter	DJ			0.42	UI	
Output Differential Impedance	Z <sub>on</sub>	80	100	120	Ω	

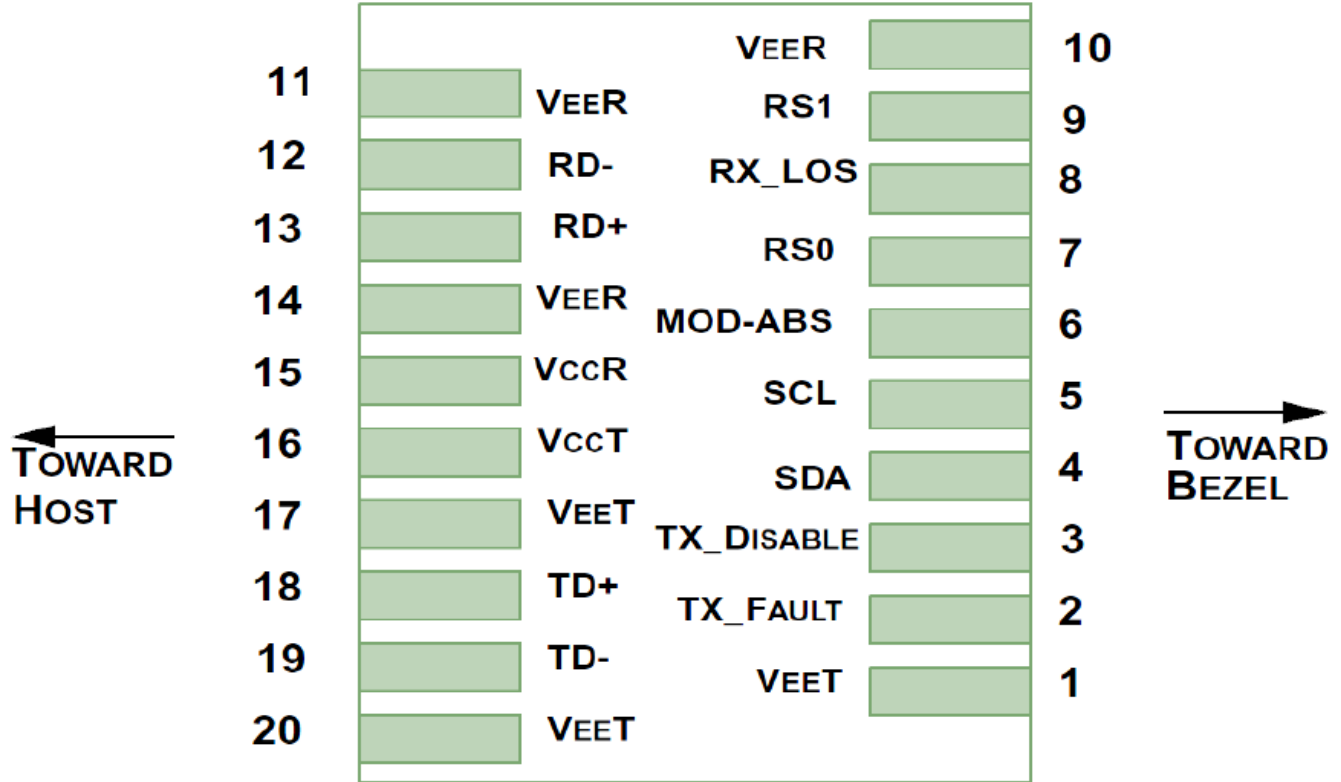
Note 1) TD+/- are internally AC coupled with 100Ω differential termination inside the module.

Note 2) Tx Fault and Rx LOS are open collector outputs, which should be pulled up with 4.7k to 10kΩ resistors on the host board. Pull up voltage between 2.0V and V<sub>CC</sub>+0.3V.

Note 3) RD+/- outputs are internally AC coupled, and should be terminated with 100Ω (differential) at the user SERDES.

## Pin Assignment

Diagram of Host Board Connector Block Pin Numbers and Name



## Pin Function Definitions

PIN #	Name	Function	Notes
1	VeeT	Module transmitter ground	Note 1
2	Tx Fault	Module transmitter fault	Note 2
3	Tx Disable	Transmitter Disable; Turns off transmitter laser output	Note 3
4	SDA	2 wire serial interface data input/output (SDA)	
5	SCL	2 wire serial interface clock input (SCL)	
6	MOD-ABS	Module Absent, connect to VeeR or VeeT in the module	Note 2
7	RS0	Receiver Rate Select	
8	LOS	Receiver Loss of Signal Indication	Note4
9	RS1	Transmitter Rate Select (not used)	
10	VeeR	Module receiver ground	Note 1
11	VeeR	Module receiver ground	Note 1
12	RD-	Receiver inverted data out put	
13	RD+	Receiver non-inverted data out put	
14	VeeR	Module receiver ground	Note 1
15	VCCR	Module receiver 3.3V supply	

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16	VccT	Module transmitter 3.3V supply	
17	VeeT	Module transmitter ground	Note 1
18	TD+	Transmitter inverted data out put	
19	TD-	Transmitter non-inverted data out put	
20	VeeT	Module transmitter ground	Note1

Note 1) The module ground pins shall be isolated from the module case.

Note 2) This pin is an open collector/drain output pin and shall be pulled up with 4.7K-10Kohms to Host\_Vcc on the host board.

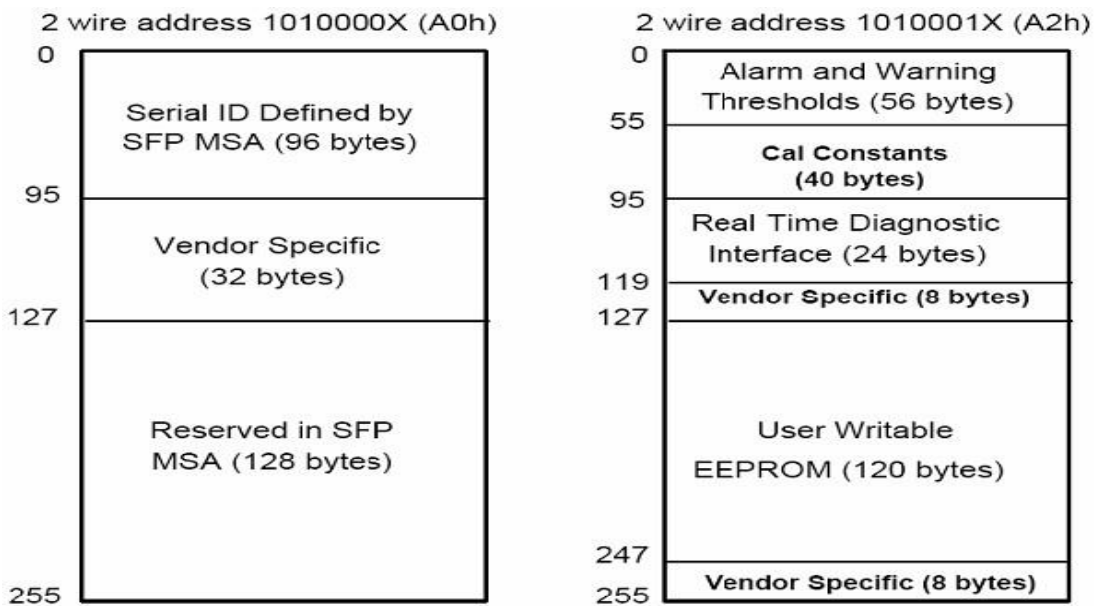
Note 3) This pin shall be pulled up with 4.7K-10Kohms to VccT in the module.

Note 4) This pin is an open collector/drain output pin and shall be pulled up with 4.7K-10Kohms to Host\_Vcc on the host board.

**SFP Module EEPROM Information and Management**

The SFP+ modules implement the 2-wire serial communication protocol as defined in the SFP -8472. The serial ID information of the SFP+ modules and Digital Diagnostic Monitor parameters can be accessed through the I2C interface at address A0h and A2h. The memory is mapped in Table 1. Detailed ID information (A0h) is listed in Table 2. And the DDM specification at address A2h. For more details of the memory map and byte definitions, please refer to the SFF-8472, "Digital Diagnostic Monitoring Interface for Optical Transceivers".

**Table 1.** Digital Diagnostic Memory Map (Specific Data Field Descriptions)



**Table 2 - EEPROM Serial ID Memory Contents (A0h)**

Data Address	Length (Byte)	Name of Length	Description and Contents
Base ID Fields			

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0	1	Identifier	Type of Serial transceiver (03h=SFP)
1	1	Reserved	Extended identifier of type serial transceiver (04h)
2	1	Connector	Code of optical connector type (07=LC)
3-10	8	Transceiver	
11	1	Encoding	64B/66B (06h)
12	1	BR,Nominal	Nominal baud rate, unit of 100Mbps (67h)
13-14	2	Reserved	(0000h)
15	1	Length(9um)	Link length supported for 9/125um fiber, units of 100m
16	1	Length(50um)	Link length supported for 50/125um fiber, units of 10m
17	1	Length(62.5um)	Link length supported for 62.5/125um fiber, units of 10m
18	1	Length(Copper)	Link length supported for copper, units of meters
19	1	Reserved	
20-35	16	Vendor Name	SFP vendor name: HiOptel
36	1	Reserved	
37-39	3	Vendor OUI	SFP transceiver vendor OUI ID
40-55	16	Vendor PN	Part Number: "HB10xxxx" (ASCII)
56-59	4	Vendor rev	Revision level for part number
60-62	3	Reserved	
63	1	CCID	Least significant byte of sum of data in address 0-62
Extended ID Fields			
64-65	2	Option	Indicates which optical SFP signals are implemented (001Ah = LOS, TX_FAULT, TX_DISABLE all supported)
66	1	BR, max	Upper bit rate margin, units of %
67	1	BR, min	Lower bit rate margin, units of %
68-83	16	Vendor SN	Serial number (ASCII)
84-91	8	Date code	HiOptel's Manufacturing date code
92	1	Diagnostic type	
93	1	Enhanced option	
94	1	SFF-8472	
95	1	CCEX	Check code for the extended ID Fields (addresses 64 to 94)
Vendor Specific ID Fields			
96-127	32	Readable	HiOptel specific date, read only
128-255	128	Reserved	Reserved for SFF-8079

**Table 2 - EEPROM Serial ID Memory Contents (A2h)**

Address	Bytes	Name	Description
00-01	2	Temp High Alarm	MSB at low address
02-03	2	Temp Low Alarm	MSB at low address
04-05	2	Temp High Warning	MSB at low address
06-07	2	Temp Low Warning	MSB at low address

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08-09	2	Voltage High Alarm	MSB at low address
10-11	2	Voltage Low Alarm	MSB at low address
12-13	2	Voltage High Warning	MSB at low address
14-15	2	Voltage Low Warning	MSB at low address
16-17	2	Bias High Alarm	MSB at low address
18-19	2	Bias Low Alarm	MSB at low address
20-21	2	Bias High Warning	MSB at low address
22-23	2	Bias Low Warning	MSB at low address
24-25	2	TX Power High Alarm	MSB at low address
26-27	2	TX Power Low Alarm	MSB at low address
28-29	2	TX Power High Warning	MSB at low address
30-31	2	TX Power Low Warning	MSB at low address
32-33	2	RX Power High Alarm	MSB at low address
34-35	2	RX Power Low Alarm	MSB at low address
36-37	2	RX Power High Warning	MSB at low address
38-39	2	RX Power Low Warning	MSB at low address
40-55	16	Reserved	Reserved for future monitored quantities

Address	#Bytes	Name	Description
56-59	4	Rx_PWR(4)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 56 is MSB. Bit 0 of byte 59 is LSB.
60-63	4	Rx_PWR(3)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 60 is MSB. Bit 0 of byte 63 is LSB.
64-67	4	Rx_PWR(2)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 64 is MSB, bit 0 of byte 67 is LSB.
68-71	4	Rx_PWR(1)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 68 is MSB, bit 0 of byte 71 is LSB.
72-75	4	Rx_PWR(0)	Single precision floating point calibration data - Rx optical power. Bit 7 of byte 72 is MSB, bit 0 of byte 75 is LSB.
76-77	2	Tx_I(Slope)	Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, bit 0 of byte 77 is LSB.
78-79	2	Tx_I(Offset)	Fixed decimal (signed two's complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, bit 0 of byte 79 is LSB
80-81	2	Tx_PWR(Slope)	Fixed decimal (unsigned) calibration data, transmittercoupled output power. Bit 7 of byte 80 is MSB, bit 0 of byte81 is LSB.
82-83	2	Tx_PWR(Offset)	Fixed decimal (signed two's complement) calibration data, transmitter coupled output power.

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			Bit 7 of byte 82 is MSB, bit 0 of byte 83 is LSB.
84-85	2	T(Slope)	Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, bit 0 of byte 85 is LSB.
86-87	2	T(Offset)	Fixed decimal (signed two's complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, bit 0 of byte 87 is LSB.
88-89	2	V(Slope)	Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, bit 0 of byte 89 is LSB.
90-91	2	V(Offset)	Fixed decimal (signed two's complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB. Bit 0 of byte 91 is LSB.
92-95	4	Reserved	Reserved

Byte	Bit	Name	Description
<b>Converted analog values. Calibrated 16 bit data</b>			
96	All	Temperature MSB	Internally measured module temperature.
97	All	Temperature LSB	
98	All	Vcc MSB	Internally measured supply voltage in transceiver.
99	All	Vcc LSB	
100	All	TX Bias MSB	Internally measured TX Bias Current.
101	All	TX Bias LSB	
102	All	TX Power MSB	Measured TX output power.
103	All	TX Power LSB	
104	All	RX Power MSB	Measured RX input power.
105	All	RX Power LSB	
106	All	Reserved MSB	Reserved for 1st future definition of digitized analog input
107	All	Reserved LSB	Reserved for 1st future definition of digitized analog input
108	All	Reserved MSB	Reserved for 2nd future definition of digitized analog input
109	All	Reserved LSB	Reserved for 2nd future definition of digitized analog input
<b>Optional Status/Control Bits</b>			
110	7	TX Disable State	Digital state of the TX Disable Input Pin. Not supported.
110	6	Soft TX Disable	Read/write bit that allows software disable of laser. Not supported.
110	5	Reserved	
110	4	RX Rate Select State	Digital state of the SFP RX Rate Select Input Pin. Not supported.
110	3	Soft RX Rate Select	Read/write bit that allows software RX rate select. Not supported.
			Not supported.

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110	2	TX Fault	Digital state of the TX Fault Output Pin.
110	1	LOS	Digital state of the LOS Output Pin.
110	0	Data Ready	Indicates transceiver has achieved power up and data is ready
111	7-0	Reserved	Reserved.

Byte	Bit	Name	Description
Reserved Optional Alarm and Warning Flag Bits			
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level.
112	6	Temp Low Alarm	Set when internal temperature is below low alarm level.
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level.
112	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level.
112	3	TX Bias High Alarm	Set when TX Bias current exceeds high alarm level.
112	2	TX Bias Low Alarm	Set when TX Bias current is below low alarm level.
112	1	TX Power High Alarm	Set when TX output power exceeds high alarm level.
112	0	TX Power Low Alarm	Set when TX output power is below low alarm level.
113	7	RX Power High Alarm	Set when Received Power exceeds high alarm level.
113	6	RX Power Low Alarm	Set when Received Power is below low alarm level.
113	5	Reserved Alarm	
113	4	Reserved Alarm	
113	3	Reserved Alarm	
113	2	Reserved Alarm	
113	1	Reserved Alarm	
113	0	Reserved Alarm	
114	All	Reserved	
115	All	Reserved	
116	7	Temp High Warning	Set when internal temperature exceeds high warning level.
116	6	Temp Low Warning	Set when internal temperature is below low warning level.
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level.
116	4	Vcc Low Warning	Set when internal supply voltage is below low warning level.
116	3	TX Bias High Warning	Set when TX Bias current exceeds high warning level.
116	2	TX Bias Low Warning	Set when TX Bias current is below low warning level.
116	1	TX Power High Warning	Set when TX output power exceeds high warning level.
116	0	TX Power Low Warning	Set when TX output power is below low warning level.
117	7	RX Power High Warning	Set when Received Power exceeds high warning level.
117	6	RX Power Low Warning	Set when Received Power is below low warning level.
117	5	Reserved Warning	
117	4	Reserved Warning	
117	3	Reserved Warning	
117	2	Reserved Warning	

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117	1	Reserved Warning	
117	0	Reserved Warning	
118	All	Reserved	
119	All	Reserved	

Byte	# Byte	Name	Description
120-127	8	Vendor Specific	00h.

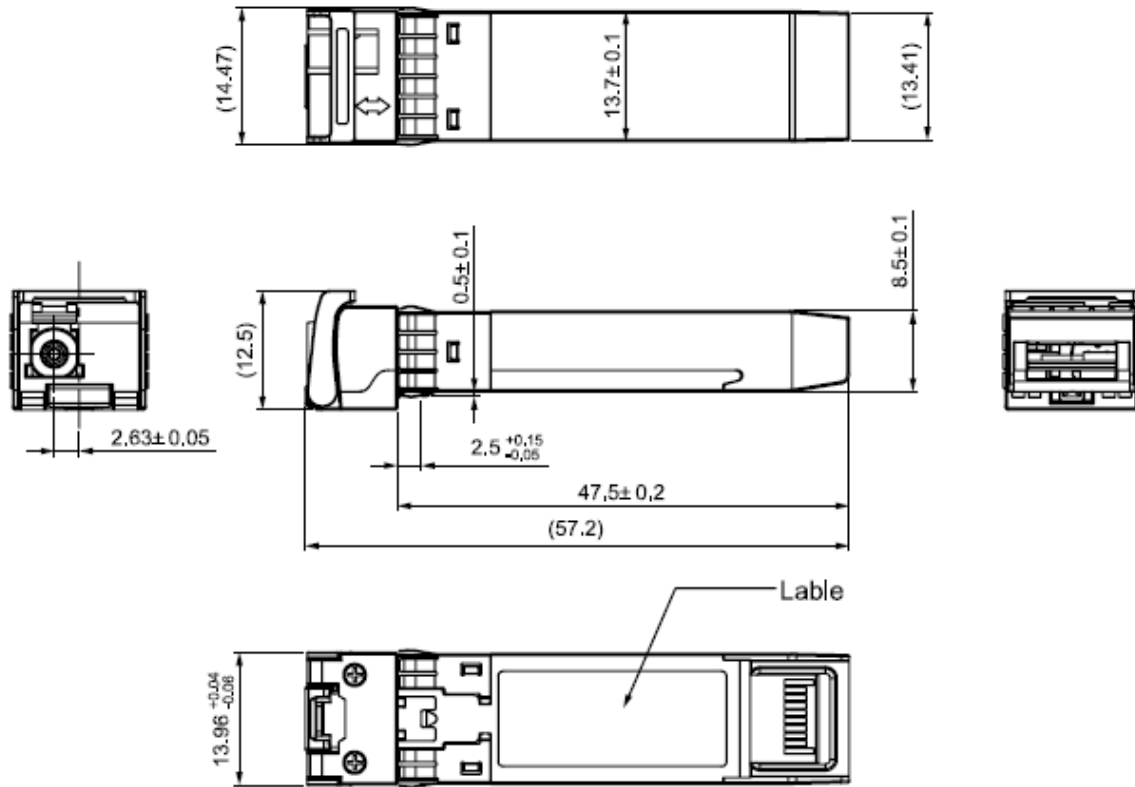
### Digital Diagnostic Monitor Characteristics

Parameter	Symbol	Min.	Max	Unit
Temperature monitor absolute error	DMI_Temp	-3	3	°C
Laser power monitor absolute error	DMI_TX	-3	3	dBm
RX power monitor absolute error	DMI_RX	-3	3	dBm
Supply voltage monitor absolute error	DMI_VCC	-0.08	0.08	V
Bias current monitor	DMI_Ibias	-10%	10%	mA

### Mechanical Dimensions

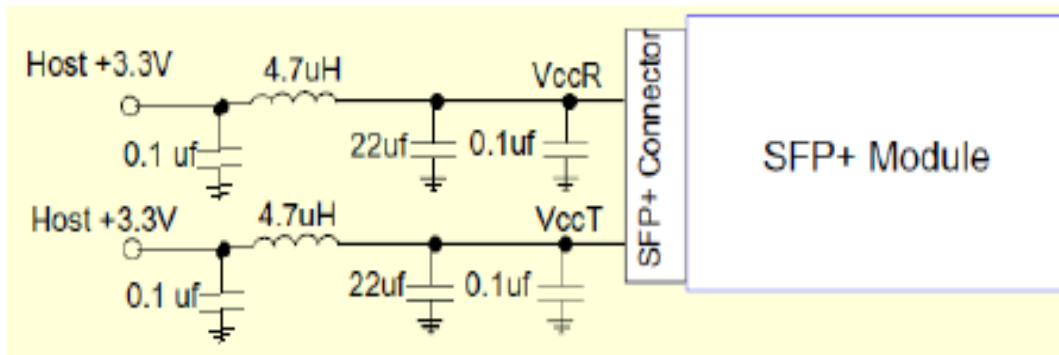
Comply to SFF-8432 rev. 5.1 Improved Pluggable formfactor specification.

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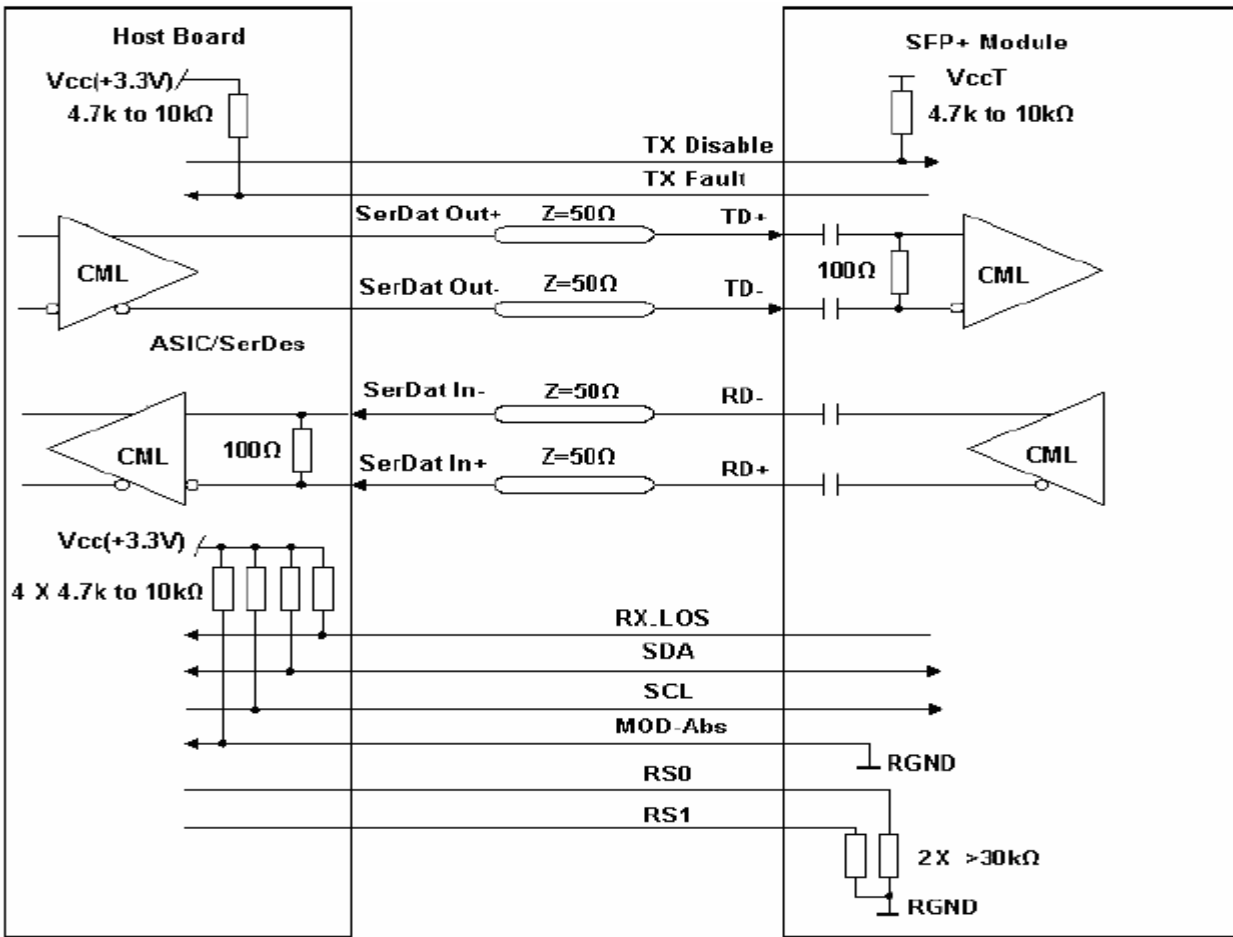
10G SFP+ Bi-di Transceiver  
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**Recommended Circuit**



**Recommended Host Board Power Supply Circuit**

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**HB10-0455111**  
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**Recommended High-speed Interface Circuit**