BotBlox®

10GBASE-T Copper SFP+ Transceiver

Extended Temperature Range

Datasheet

MPN: SFP-10G-T

March 2024

BotBlox®

Contents

1 General Information

1.1 Product Description

SFP-10G-T is a Copper Small Form Pluggable (SFP) transceiver that supports 10GBASE-T ethernet in a SFP form factor, that has been MIL-STD-810H qualified for operation from -40°C to +80°C. This module is compatible with the 10Gbase-T, 5Gbase-T, 2.5Gbase-T and 1000base-T standards as specified in IEEE Std 802.3

1.2 Features

- 10Gbase-T, 5Gbase-T, 2.5Gbase-T, 1000base-T and 100base-Tx on RJ-45 port
- Supports 10Gbase-R, 5Gbase-R, 2.5Gbase-X and SGMII on host port
- Hot-pluggable SFP form-factor
- RJ-45 receptacle
- Supports auto-mdix on RJ-45 port
- RoHS compliant and lead-free
- Single +3.3V power supply
- 3 Watts maximum power consumption
- 10 Gigabit ethernet over Cat 6a cable
- Ambient operating temperature: -40°C to +80°C
- Compatible with UbiSwitch at 10Gbase-T, 5Gbase-T, 2.5Gbase-T and 1000base-T

2 Cable performance Characteristics

2.1 Cable Length Performance

RJ-45 Port	Cable	Reach	Host Port
10Gbase-T	CAT6A	30m	10GBase-R
5Gbase-T	CAT5E	50m	5GBase-R
2.5Gbase-T	CAT5E	50m	2.5GBase-R
1000base-T	CAT5E	100m	SGMII with AN
100base-Tx	CAT5E	100m	SGMII with AN

Table 1: Maximum cable length for different data rates

All tests performed at 25°C, sea level pressure

3 Pinout

Pin	Symbol	Name/Description	Note
1	VEET	Transmitter Ground (Common with Receiver Ground).	1
2	TFAULT	Transmitter Fault (unimplemented in this module).	
3	TDIS	Transmitter Disable. Module input. Laser output is disabled if this signal is high. This signal is pulled up in the module.	2
4	MOD_DEF(2)	SDA for I2C interface. Data line for Serial ID.	3
5	MOD_DEF(1)	SCL for I2C interface.. Clock line for Serial ID.	3
6	MOD_DEF(0)	Module Present. Module output Grounded within the module.	3
7	Rate Select	No connection required.	
8	LOS	Signal Loss. Module output. High indicates no link. Low indicates linked.	
9	VEER	Receiver Ground (Common with Transmitter Ground)	1
10	VEER	Receiver Ground (Common with Transmitter Ground)	1
11	VEER	Receiver Ground (Common with Transmitter Ground)	1

12	RD-	Receiver Inverted Data out. AC Coupled inside the module.	
13	RD+	Receiver Non-inverted Data out. AC Coupled inside the module.	
14	VEER	Receiver Ground (Common with Transmitter Ground).	1
15	VCCR	Receiver Power Supply (3.3V).	
16	VCCT	Transmitter Power Supply (3.3V).	
17	VEET	Transmitter Ground (Common with Receiver Ground).	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled inside the module.	
19	TD-	Transmitter Inverted DATA in. AC Coupled inside the module.	
20	VEET	Transmitter Ground (Common with Receiver Ground).	1

Table 2: Pinout table for the SFP-10G-T

Notes:

1. Circuit ground is connected to chassis ground
2. Transmitter is disabled on TDIS > 2.0V, enabled on TDIS < 0.8V. Signal is pulled up to 3.3V inside the module.
3. Should be pulled up with 4.7k - 10k Ohms on the host board to a voltage between 2.0 V and 3.6 V. MOD_DEF(0) pulls line low to indicate the module is plugged in.

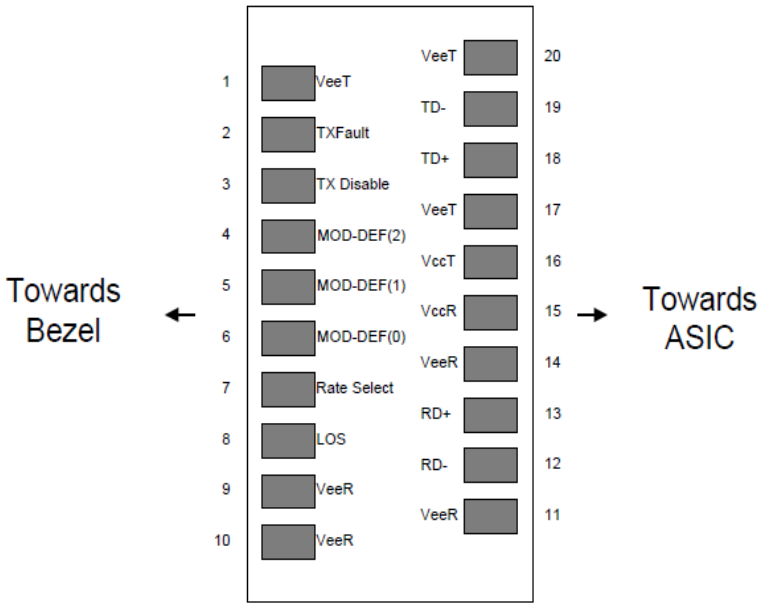

Figure 1: Pinout of host board connector pin numbers and names

4 Electrical Characteristics

4.1 +3.3V Power Interface

SFP-10G-T has an input voltage range of 3.3 V +/- 5%, with a 4V maximum allowable short term voltage.

Parameter	Symbol	Min	Typ	Max	unit	Notes/Conditions
Supply Current	Is		700	900	mA	
Input Voltage	Vcc	3.13	3.3	3.47	V	Referenced to GND
Power Consumption	Pc		2.31	3	W	Qualified over the full range of voltage and temperature. See note below
Maximum Voltage	Vmax			4	V	

Table 3: Electrical characteristics for the SFP-10G-T

Caution: The power consumption of this module is higher than the maximum allowed power consumption of 2W in the SFP MSA specification. This is a commonality among all 10GBASE-T copper transceivers, and is due to the fact that all currently available 10GBASE-T PHY ASICs generate high levels of power. This should be taken into account when plugging this SFP into devices that may not support such a high power level.

4.2 Low Speed IO

MOD_DEF(1) (SCL) and MOD_DEF(2) (SDA), are open drain CMOS signals forming the I2C communication bus with the SFP. Both MOD_DEF(1) and MOD_DEF(2) must be pulled up to the host's Vcc bus.

Parameter	Symbol	Min	Max	unit	Notes/Conditions
SFP Output LOW	VOL	0	0.5	V	4.7k to 10k pull-up to host_Vcc, measured at host side of connector
SFP Output HIGH	VOH	Host_Vcc -0.5	Host_Vcc + 0.3	V	4.7k to 10k pull-up to host_Vcc, measured at host side of connector
SFP Input LOW	VIL	0	0.8	V	4.7k to 10k pull-up to Vcc, measured at SFP side of connector

SFP Input HIGH	VIH	2	Vcc + 0.3	V	4.7k to 10k pull-up to Vcc, measured at SFP side of connector

Table 4: Low speed IO characteristics for the SFP-10G-T

4.3 High Speed Electrical Interfaces

All high-speed signals are AC-coupled internally.

Parameter	Symbol	Min	Typ	Max	unit	Notes/Conditions
Line Frequency	fL		125		MHz	5-level encoding, per IEEE 802.3
Tx Output Impedance	Zout,TX		100		Ohm	Differential, for all frequencies between 1MHz and 125MHz
Rx Input Impedance	Zin,RX		100		Ohm	Differential, for all frequencies between 1MHz and 125MHz

Table 5: High speed electrical interface characteristics for the RJ-45 port

Parameter	Symbol	Min	Typ	Max	unit	Notes/Conditions
Single ended data input swing	Vin_sw	250		1200	mV	Single ended
Single ended data output swing	Vout_sw	350		800	mV	Single ended
Rise/Fall Time	Tr,Tf		175		ps	20%-80%
Tx Input Impedance	Zin		50		Ohm	Single ended
Rx Output Impedance	Zout		50		Ohm	Single ended

Table 6: High speed electrical interface characteristics for the host SFP port

5 Internal EEPROM registers

5.1 EEPROM register table

This module contains an internal EEPROM that can be accessed by the I2C interface on on the SFP. The table below shows the available register addresses and the associated data stored in each register.

Address	Field Size (Bytes)	Field name	HEX	Description
0	1	Identifier	03	SFP
1	1	Ext. Identifier	04	MOD4
2	1	Connector	22	RJ45
3-10	8	Transceiver	00 00 00 00 00 00 00 00	Transmitter Code
11	1	Encoding	06	64B66B
12	1	BR, nominal	67	10000M bps
13	1	Reserved	00	
14	1	Length (9um)-km	00	
15	1	Length (9um)	00	
16	1	Length (50um)	08	80
17	1	Length (62.5um)	03	30
18	1	Length (copper)	00	
19	1	Reserved	1E	30
20-35	16	Vendor name	57 49 4E 54 4F 50 20 20 20 20 20 20 20 20 20 20	BOTBLOX
36	1	Reserved	00	
37-39	3	Vendor OUI	00 00 00	
40-55	16	Vendor PN	xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx xx	ASC II
56-59	4	Vendor rev	31 2E 30 20	V1.0
60-61	2	Wavelength	00 00	850nm
62	1	Reserved	00	
63	1	CC BASE	XX	Check sum of byte 0~62
64-65	2	Options	00 1A	LOS, TX_DISABLE, TX_FAULT
66	1	BR, max	00	

67	1	BR, min	00	
68-83	16	Vendor SN	00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00	Unspecified
84-91	8	Vendor date code	XX XX XX 20	Year, Month, Day
92-94	3	Reserved	00	
95	1	CC_EXT	XX	Check sum of byte 64~94
96-255	160	Vendor specific		

Table 7: EEPROM register table

5.2 EEPROM Structure

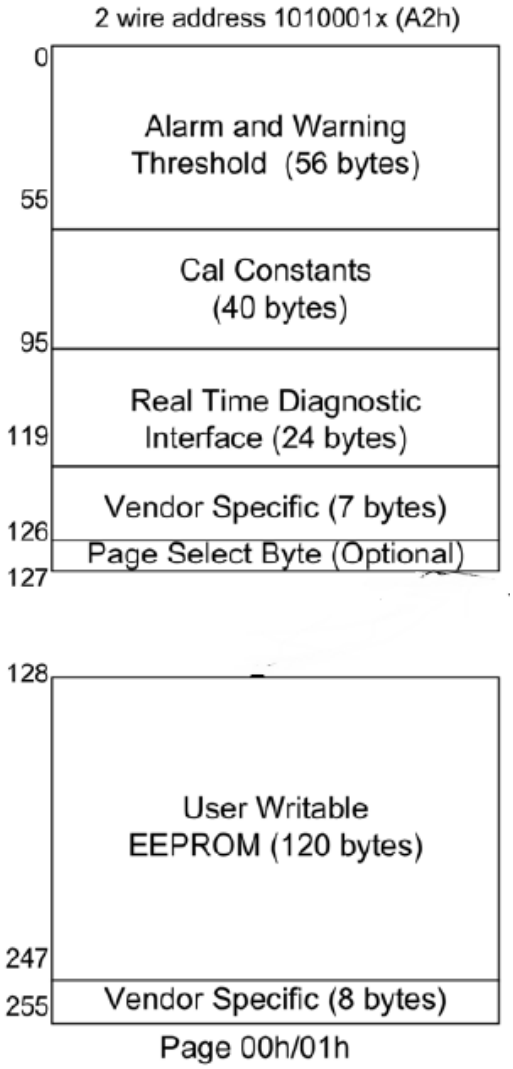

Figure 2: Internal EEPROM memory allocation

6 Serial Communication Protocol

All BotBlox SFPs support the 2-wire serial communication protocol as outlined in the SFP MSA. These SFPs use an internal microcontroller for register memory management which can be accessed with the address of A0h.

Parameter	Symbol	Min	Typ	Max	Unit	Notes/Conditions
I2C Clock Rate		0		200	kHz	

Table 8: 2-wire serial interface timing requirements

7 Environmental Specifications

7.1 General environmental specifications

SFP-10G-T has been qualified per MIL-STD-810H for use in high and low temperatures. The general specifications are listed below.

Parameter	Symbol	Min	Typ	Max	Unit	Notes/Conditions
Operating Temperature	Top	-40		80	°C	Ambient temperature
Storage Temperature	Tsto	-50		105	°C	Ambient temperature

Table 9: Environmental specifications

7.2 MIL-STD-810H: Low Temperature test

SFP-10G-T has been subject to a low temperature test compliant to MIL-STD-810H (Paragraph 502.7). To test this, two SFP-10G-T were plugged into a BotBlox UbiSwitch assembly (BB-UBS-B-1 & BB-UD1-A-1) as shown in figure 3, which was then placed in an environmental test chamber.

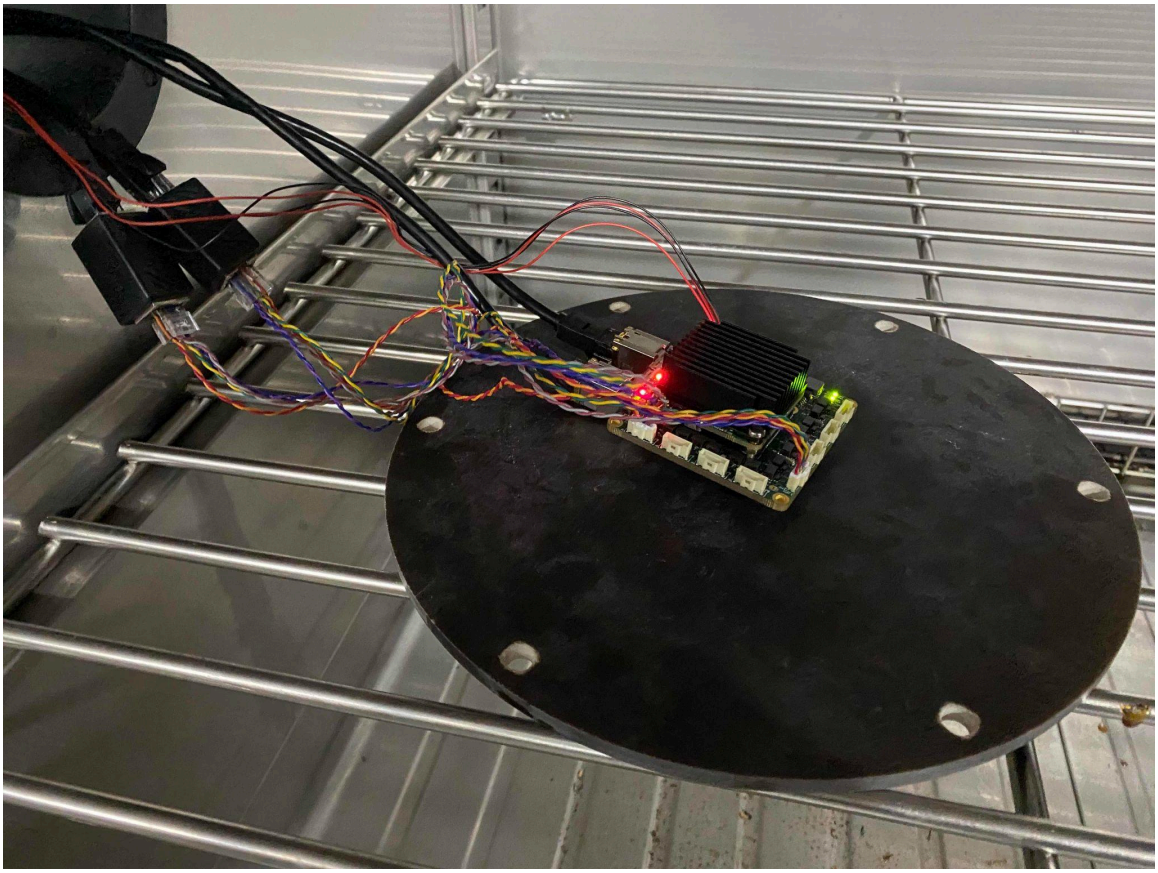

Figure 3: The two SFP-10G-T modules plugged into an UbiSwitch assembly inside the environmental test chamber

A 10Gbps networking test was performed while the assembly was subject to the temperature gradient shown in figure 4.

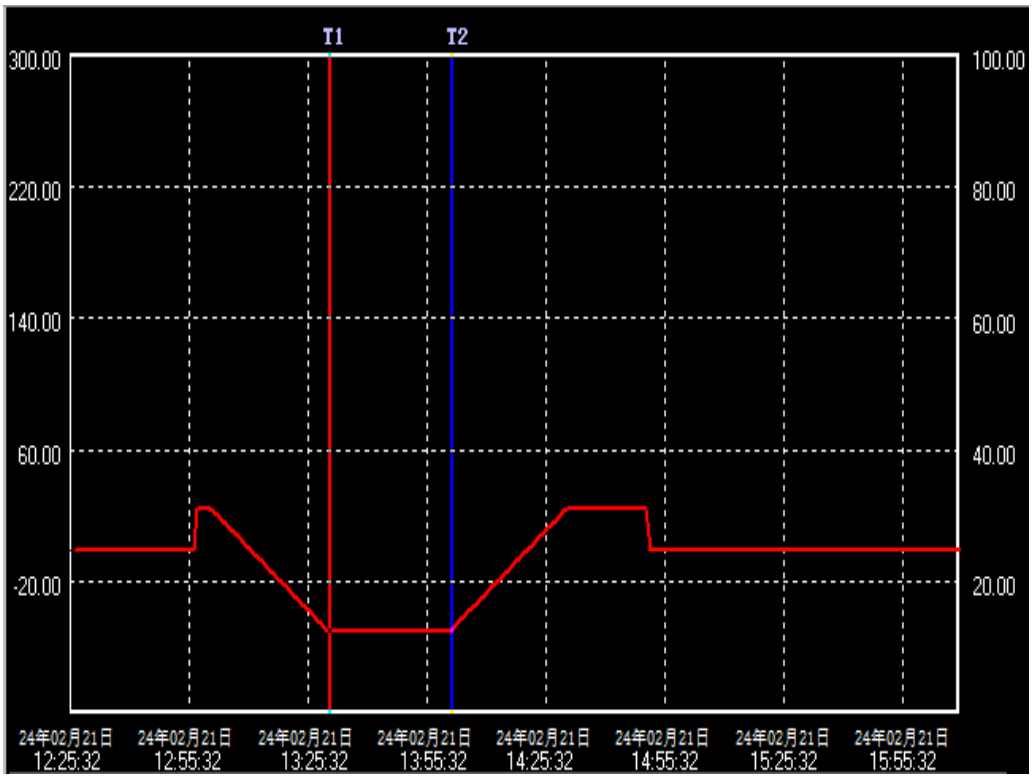

Figure 4: The temperature gradient applied to the SFP-10G-T modules in the low temperature test

This test involved running the devices at 50°C for 30 minutes. There were no data interruptions or losses of link, and the average data rate for the entire test was above 75%.

7.3 MIL-STD-810H: High Temperature test

SFP-10G-T has been subject to a high temperature test compliant to MIL-STD-810H (Paragraph 501.7). To test this, two SFP-10G-T were plugged into a BotBlox UbiSwitch assembly (BB-UBS-B-1 & BB-UD1-A-1) as shown in figure 3, which was then placed in an environmental test chamber. A 10Gbps networking test was performed while the assembly was subject to the temperature gradient shown in figure 5.

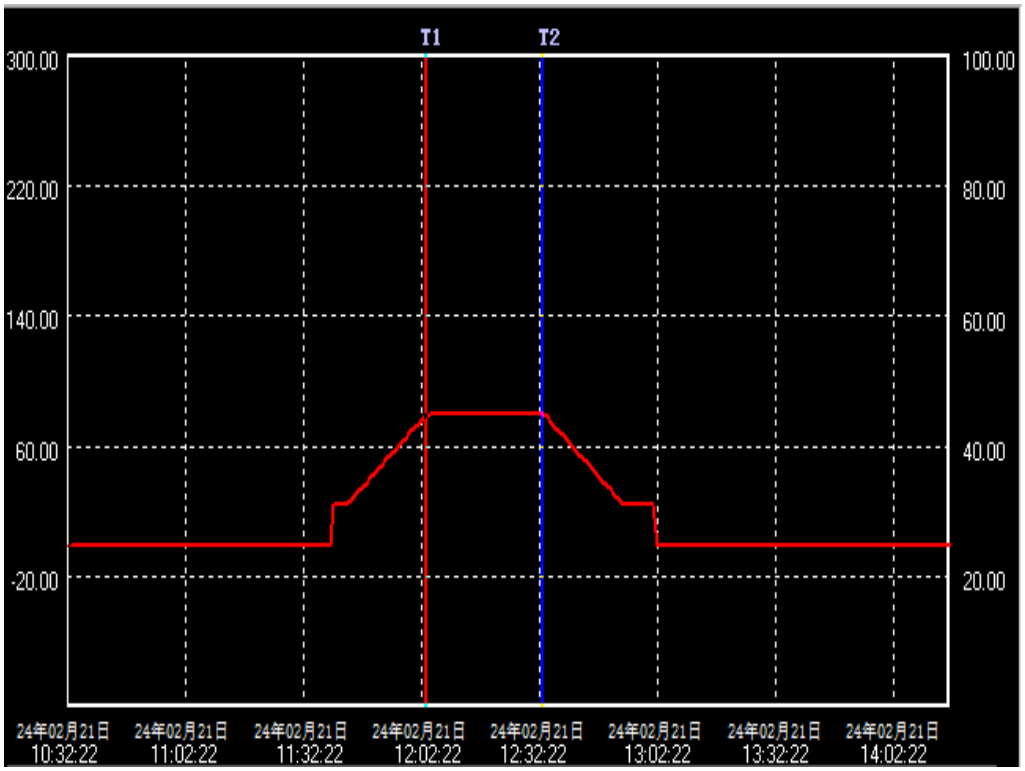

Figure 5: The temperature gradient applied to the SFP-10G-T modules in the high temperature test

This test involved running the devices at 80°C for 30 minutes. There were no data interruptions or losses of link, and the average data rate for the entire test was above 75%.

8 Recommended Application Circuit

A basic application circuit is detailed in figure 6 below to assist the user in the design of their own custom host board. An alternative application circuit can also be found by studying the UbiSwitch Baseboard design, which can be found at the github link below.

https://github.com/botblox/UbiSwitch-DaughterBoard-Designs

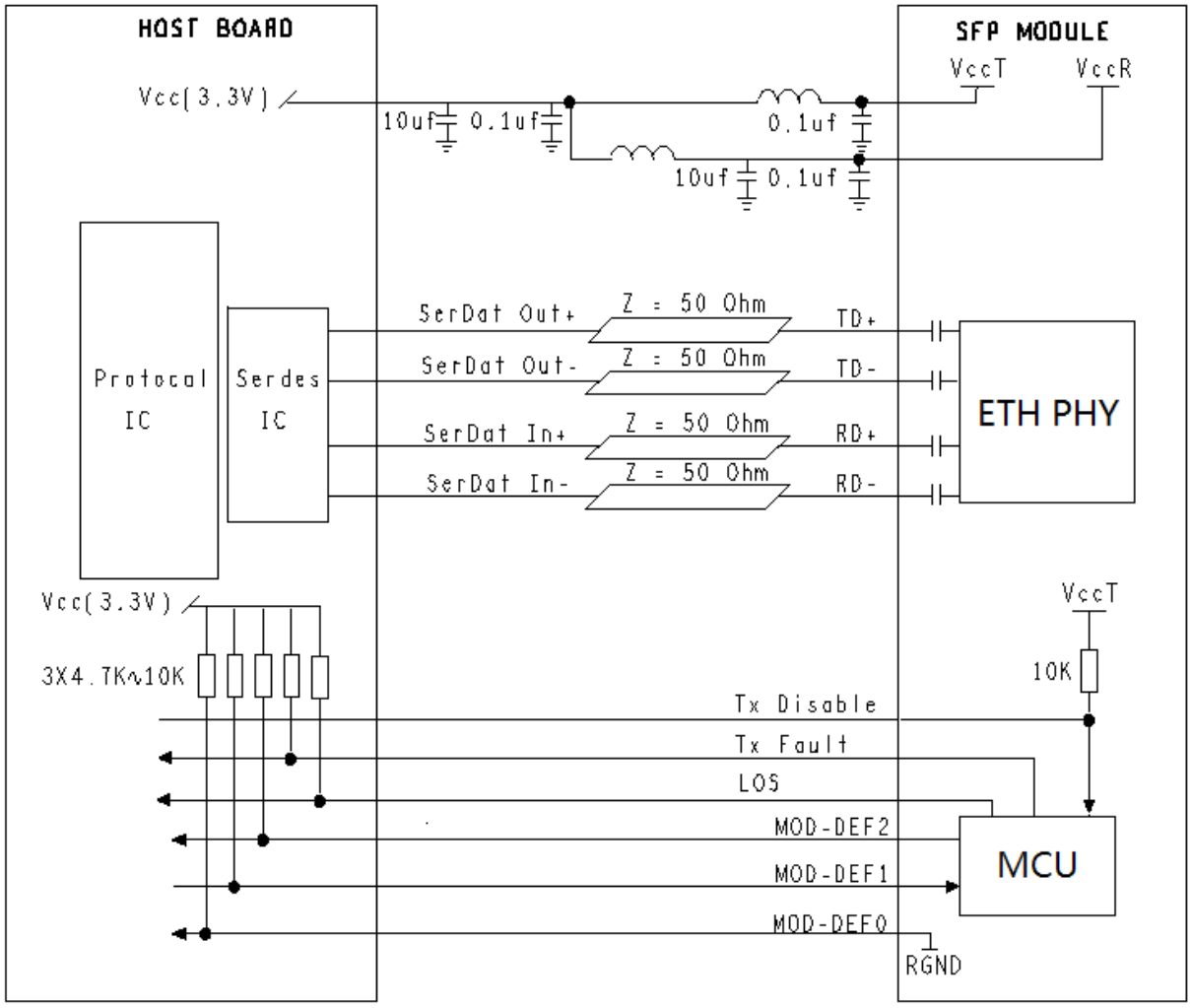

Figure 6: An example circuit for the host circuitry necessary to interact with the SFP-10G-T

9 Mechanical Specifications

The mechanical dimensions of SFP-10G-T are in compliance with the SFP MSA specification; a basic dimensional drawing of the module is provided in figure 7 below for convenience.

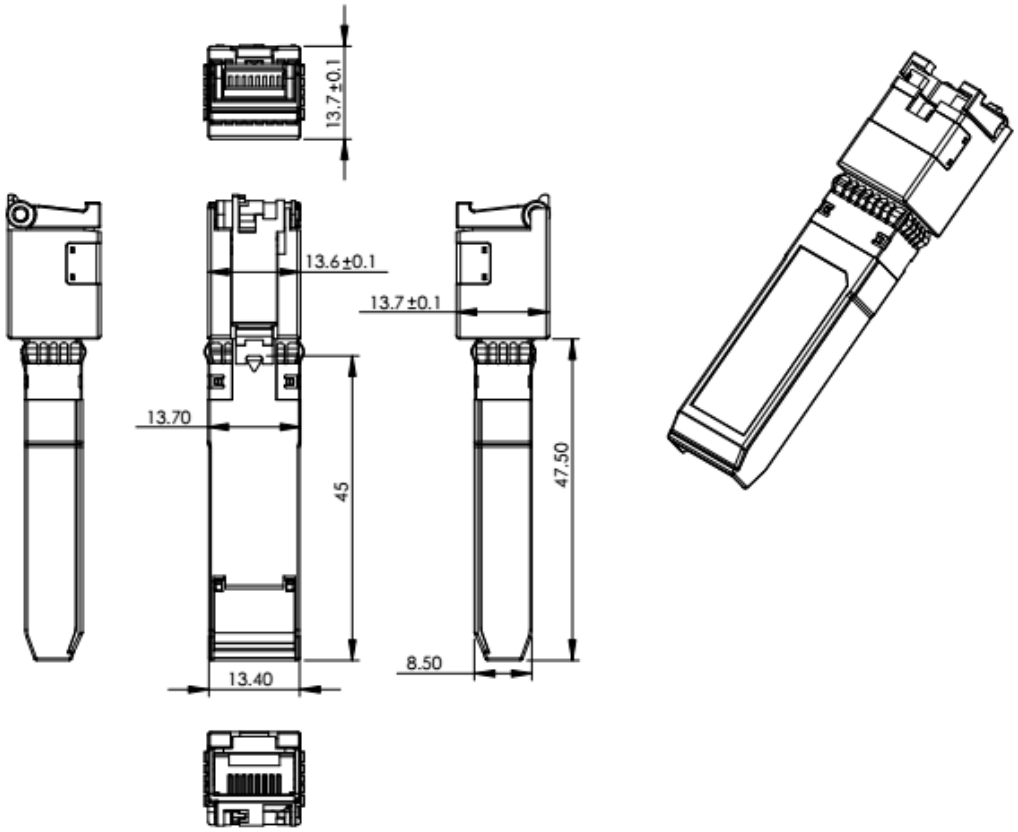

Figure 7: Mechanical diagram of SFP-10G-T

10 Datasheet Changelog

Date	Datasheet Version	Author	Notes
30/3/2024	A_A	Josh Elijah	Initial release

11 Contact

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