

### Features

- Built-in PHY and MCU supporting SGMII Interface
- 125Mbps IEEE 802.3u 100BASE-FX compliant
- Standard serial ID information Compatible with SFP MSA
- AC-coupled differential inputs and outputs
- 2km link on a multimode fiber and 15km/40km on a single mode fiber
- SFF8472 diagnostic monitoring interface
- LC type pluggable optical interface
- Fully metallic enclosure for low EMI
- +3.3V single power supply
- Operating case temperature: -40 to +85°C

### Applications

- 125 Mbps 100Base-FX Ethernet / FDDI
- Switch to Switch interface
- Switched backplane applications
- Switch/Router to Switch/Router Link
- Other optical transmission systems

### Description

The APAC 100BASE-FX Small Form-Factor Pluggable (SFP) Fast Ethernet interface transceiver is a hot swappable device that plugs into a Gigabit Ethernet SFP port. This SGMII SFP transceiver built-in a PHY chip provides full-duplex 100-Mbps connectivity between switches over multimode fiber (MMF) or single mode fiber (SMF) infrastructures. The host equipment can access this information via the 2-wire serial CMOS EEPROM protocol. For further information, please refer to SFP Multi-Source Agreement (MSA). To meet the increasing demand of Industrial Ethernet fiber solution, SGMII SFP transceiver series that can operate reliably in electrically harsh, climatically demanding, and wide temperature range (-40°C to 85°C) environment.

### Ordering Information

PART NUMBER	MAC Interface	Speed (Mbps)	Fiber Mode	Connector Interface	Distance	Wavelength (nm)	Operating Temp.
LM38-A3C-TI-N-APZ	SGMII	125	Multi-Mode	LC	2Km	1310	-40~85°C
LS38-A3S-TI-N-APZ	SGMII	125	Single Mode	LC	15Km	1310	-40~85°C
LS38-A3L-TI-N-APZ	SGMII	125	Single Mode	LC	40Km	1310	-40~85°C
LS48-A3L-TI-N-APZ	SGMII	125	Single Mode	LC	80Km	1550	-40~85°C

**Note:** the FEFI default is ON for the above part number.



# 100BASE-FX SGMII Optical Transceiver with PHY

## Small Form Pluggable (SFP), 3.3V

### 125 Mbps Link Speed

#### Absolute Maximum Ratings

PARAMETER	SYMBOL	MIN	MAX	UNITS	NOTE
Supply Voltage	$V_{CC}$	3.0	3.65	V	
Storage Temperature	$T_s$	-40	+85	°C	
Case Operating Temperature	$T_C$	-40	+85	°C	
Storage Humidity	$H_s$	5	95	%	Non condensing

#### Recommended Operating Conditions

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS	NOTE
Case Operating Temperature	$T_C$	-40	-	85	°C	
Operating Humidity	$H_o$	10	-	95	%	
Power Supply Voltage	$V_{CC}$	3.14	3.30	3.47	V	
Power Supply Current	$I_{CC}$	-	-	350	mA	1
Data Rate	$D_R$	-	125	-	Mbps	

#### Note:

1) The max power supply current after module work stable.

#### Electrical Characteristics

PARAMETER	SYMBOL	MIN	TYP.	MAX	UNITS	NOTE
<b>Transmitter</b>						
Data Input differential Voltage	$V_{D, TX}$	0.2	-	2.0	V	1
Differential Input Impedance	$Z_{TX}$	80	100	120	$\Omega$	
Transmitter Disable Input-High	$V_{DISH}$	2.0	-	$V_{cc}+0.3$	V	
Transmitter Disable Input-Low	$V_{DISL}$	0	-	0.8	V	
<b>Receiver</b>						
Data Output Differential Voltage	$V_{D, RX}$	0.35	-	0.8	V	3
Differential Output Impedance	$Z_{RX}$	80	100	120	$\Omega$	
Data Output Rise/Fall Time	$T_{r, rx}/T_{f, rx}$	-	175	-	ps	4
LOS Output Voltage – High	$V_{SDHL}$	$V_{cc}-0.5$	-	$V_{cc}+0.3$	V	2
LOS Output Voltage – Low	$V_{SDL}$	0	-	0.5	V	2

#### Note:

- 1) Internally AC coupled and terminated to 100 Ohm differential load.
- 2) Pull up to  $V_{CC}$  with a 4.7K – 10K Ohm resistor on host Board
- 3) Internally AC coupled, but requires a 100 Ohm differential termination at MAC side.
- 4) 20% ~ 80% values



**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
**125 Mbps Link Speed**

**Optical Characteristics (LM38-A3C-TI-N-APZ)**

PARAMETER	SYMBOL	MIN	TYP.	MAX	UNITS	NOTE
<b>Transmitter</b>						
Output Optical Power 62.5/125 $\mu\text{m}$ fiber	$P_{out}$	-20	-	-14	dBm	
Output Optical Power 50/125 $\mu\text{m}$ fiber		-23.5	-	-14	dBm	
Center Wavelength	$\lambda_c$	1260	-	1380	nm	
Spectral Width (FWHM)	$FWHM$	-	-	100	nm	
Extinction Ratio	$ER$	10	-	-	dB	
Rise/Fall Time(10~90%)	$T_r/T_f$	-	-	3	ns	
Output Optical Eye	Compliant with ITU-T recommendation G-957					
<b>Receiver</b>						
Center Wavelength	$\lambda_c$	1260	-	1380	nm	
Optical Input Power-Maximum	$P_{IN}$	-8	-	-	dBm	Note 1
Optical Input Power-Sensitivity	$P_{IN}$	-	-	-31	dBm	Note 1
LOS-Deasserted	$P_D$	-	-	-31	dBm	
LOS-Asserted	$P_A$	-45	-	-	dBm	
Receiver Loss of Signal Output Voltage-Low	$RX\_LOS_L$	0	-	0.5	V	
Receiver Loss of Signal Output Voltage-High	$RX\_LOS_H$	2.4	-	Vcc	V	

**Note:**

1) Measured with 4B/5B code for 100Mbps, worst-case extinction ratio, BER  $\leq 1 \times 10^{-10}$



**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
**125 Mbps Link Speed**

**Optical Characteristics (LS38-A3S-TI-N-APZ)**

PARAMETER	SYMBOL	MIN	TYP.	MAX	UNITS	NOTE
<b>Transmitter</b>						
Output Optical Power 9/125 $\mu$ m fiber	$P_{out}$	-15	-	-8	dBm	
Center Wavelength	$\lambda_C$	1260	-	1360	nm	
Spectral Width (RMS)	$RMS$	v	-	7.7	nm	
Extinction Ratio	$ER$	8.2	-	v	dB	
Rise/Fall Time(10~90%)	$T_r/T_f$	-	v	3	ns	
Output Optical Eye	Compliant with ITU-T recommendation G-957					
<b>Receiver</b>						
Center Wavelength	$\lambda_C$	1260	-	1380	nm	
Optical Input Power-Maximum	$P_{IN}$	-8	-	-	dBm	Note 1
Optical Input Power-Sensitivity	$P_{IN}$	-	-	-31	dBm	Note 1
LOS-Deasserted	$P_D$	-	-	-31	dBm	
LOS-Asserted	$P_A$	-45	-	-	dBm	
Receiver Loss of Signal Output Voltage-Low	$RX\_LOS_L$	0	-	0.5	V	
Receiver Loss of Signal Output Voltage-High	$RX\_LOS_H$	2.4	-	Vcc	V	

**Note:**

1) Measured with 4B/5B code for 100Mbps, worst-case extinction ratio, BER  $\leq 1 \times 10^{-10}$



**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
**125 Mbps Link Speed**

**Optical Characteristics (LS38-A3L-TI-N-APZ)**

PARAMETER	SYMBOL	MIN	TYP.	MAX	UNITS	NOTE
<b>Transmitter</b>						
Output Optical Power 9/125 $\mu$ m fiber	$P_{out}$	-5	-	0	dBm	
Center Wavelength	$\lambda_C$	1260	-	1360	nm	
Spectral Width (RMS)	$RMS$	-	-	4.0	nm	
Extinction Ratio	$ER$	10	-	-	dB	
Rise/Fall Time(10~90%)	$T_r/T_f$	-	-	3	ns	
Output Optical Eye	Compliant with ITU-T recommendation G-957					
<b>Receiver</b>						
Center Wavelength	$\lambda_C$	1260	-	1380	nm	
Optical Input Power-Maximum	$P_{IN}$	0	-	-	dBm	Note 1
Optical Input Power-Sensitivity	$P_{IN}$	-	-	-34	dBm	Note 1
LOS-Deasserted	$P_D$	-	-	-34	dBm	
LOS-Asserted	$P_A$	-45	-	-	dBm	
Receiver Loss of Signal Output Voltage-Low	$RX\_LOS_L$	0	-	0.5	V	
Receiver Loss of Signal Output Voltage-High	$RX\_LOS_H$	2.4	-	Vcc	V	

**Note:**

1) Measured with 4B/5B code for 100Mbps, worst-case extinction ratio, BER  $\leq 1 \times 10^{-10}$



**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
**125 Mbps Link Speed**

**Optical Characteristics (LS48-A3L-TI-N-APZ)**

PARAMETER	SYMBOL	MIN	TYP.	MAX	UNITS	NOTE
<b>Transmitter</b>						
Output Optical Power 9/125 $\mu$ m fiber	$P_{out}$	-10	-	-3	dBm	
Center Wavelength	$\lambda_C$	1480	-	1580	nm	
Spectral Width (-20dB)	$\Delta\lambda$	-	-	1	nm	
Side Mode Suppression Ratio	$SMSR$	30	-	-	dB	
Extinction Ratio	$ER$	10	-	-	dB	
Rise/Fall Time(10~90%)	$T_r/T_f$	-	-	3	ns	
Output Optical Eye	Compliant with ITU-T recommendation G-957					
<b>Receiver</b>						
Center Wavelength	$\lambda_C$	1260	-	1600	nm	
Optical Input Power-Maximum	$P_{IN}$	0	-	-	dBm	Note 1
Optical Input Power-Sensitivity	$P_{IN}$	-	-	-34	dBm	Note 1
LOS-Deasserted	$P_D$	-	-	-34	dBm	
LOS-Asserted	$P_A$	-45	-	-	dBm	
Receiver Loss of Signal Output Voltage-Low	$RX\_LOS_L$	0	-	0.5	V	
Receiver Loss of Signal Output Voltage-High	$RX\_LOS_H$	2.4	-	Vcc	V	

**Note:**

1) Measured with 4B/5B code for 100Mbps, worst-case extinction ratio, BER  $\leq 1 \times 10^{-10}$

**Recommended Host Board Power Supply Circuit**

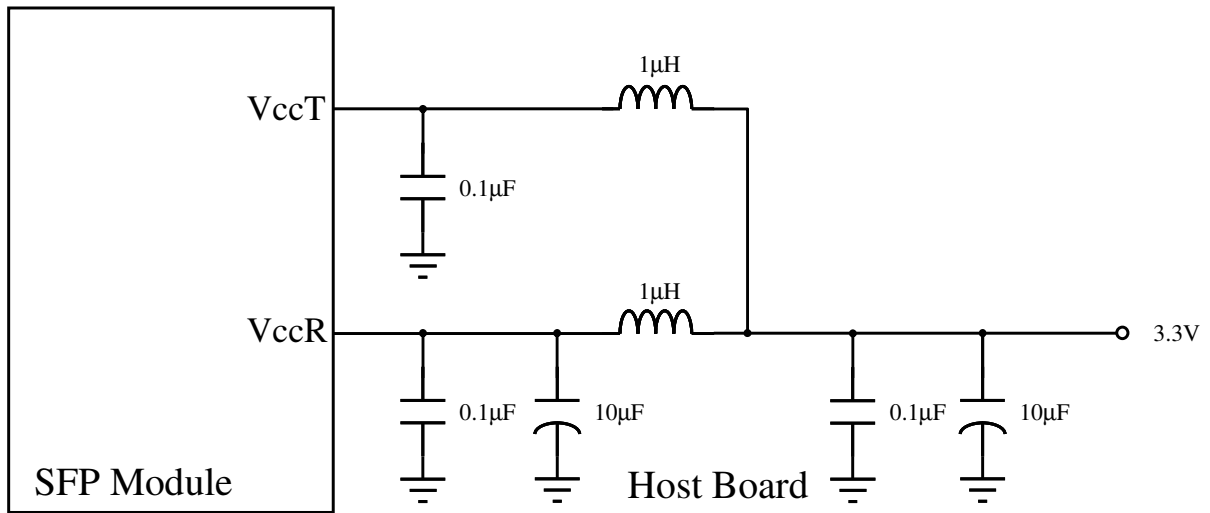
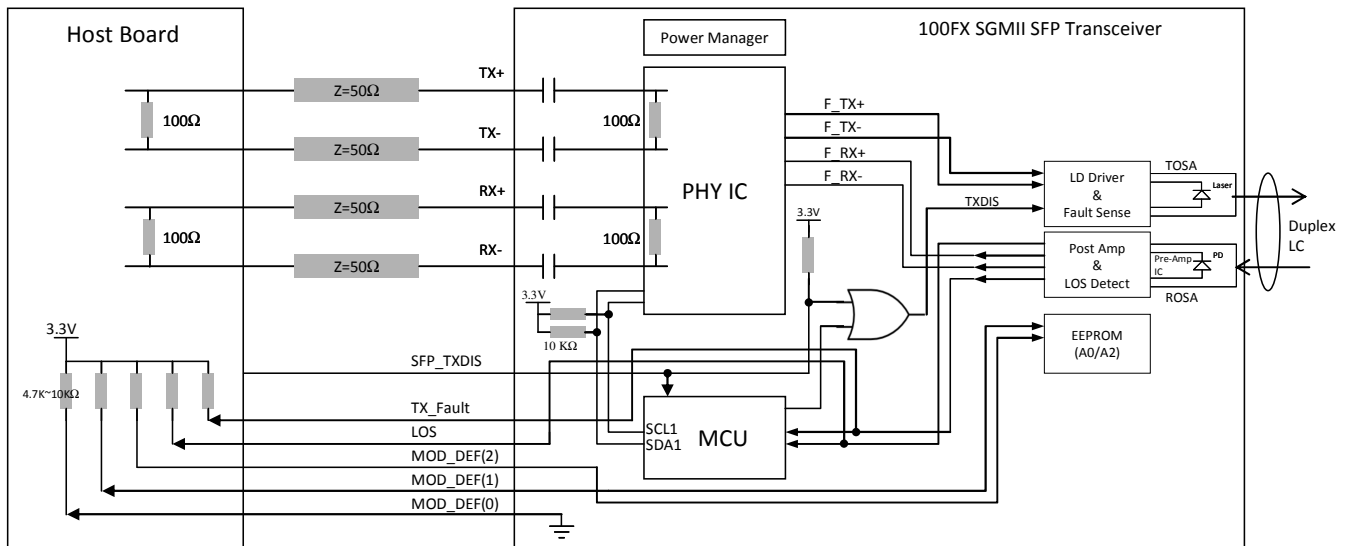


Figure 1: Recommended Host Board Power Supply Circuit

**Block Diagram and Recommended Interface Circuit**



**Note:** the host cannot directly access PHY via I2C.

Figure 2: Recommended Interface Circuit

### **TX\_DISABLE Function**

There are active components in the SFP Transceiver as PHY and MCU so it takes some time to start up MCU and initialize the active PHY. When the TX\_DISABLE is activated, PHY will be reset and re-initialization. The communication path of the SFP is ready after 20ms. The TX\_DISABLE signal is high (TTL logic “1”) to turn off the laser output. The laser will turn on when TX\_DISABLE is low (TTL logic “0”).

### **LOS Function**

The SFP MSA specification defines a pin called LOS to indicate loss of signal to the motherboard. This should be pulled up with a 4.7K to 10K resistor. Pull up voltage between 2.0V and Vcc-T/R+0.3V. When high, this output indicates link fail. Low indicates normal operation. In the low state, the output will be pulled to <0.8V.

### **Termination Circuits**

Inputs to the transceiver are AC coupled and internally terminated through 50 ohms. These modules can operate with PECL or ECL logic levels. The input signal must have at least a 250mV peak-to-peak (single ended) signal swing. Output from the receiver section of the module is also AC coupled and is expected to drive a 50 ohm load. Different termination strategies may be required depending on the particular Serializer/Deserializer chip set used.

### **FEFI (Far End Fault Indication) Function**

The FEF represents Far End Fault. The default is always turn on and cannot be disabled. It is a protocol compliant with IEEE 802.3u standard to sense remote data link errors in a network. When Far End Fault is supported and enabled, a loss of receive signal (link) will cause the transmitter to generate a Far End Fault pattern in order to inform the device at the far end of the fiber pair that a fault has occurred. When the local receiver again detects a signal, the local transmitter automatically returns to normal operation.

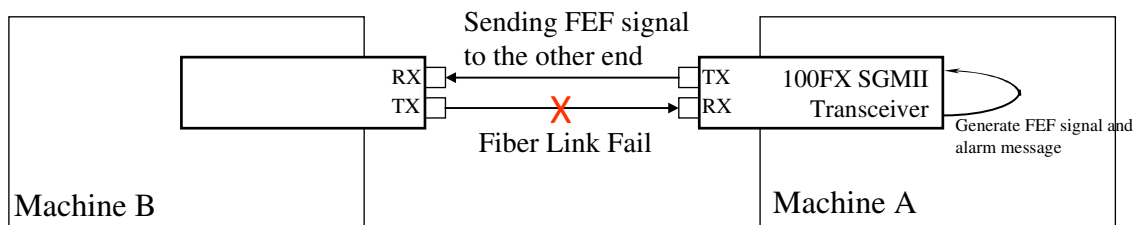


Figure 3: Far End Fault





**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
**125 Mbps Link Speed**

**EEPROM Section**

The Smart SFP support the 2-wire serial communication protocol defined in the SFP MSA. These SFP use a 128 byte EEPROM with an address of A0H. Accessing Serial ID Memory uses the 2 wire address 10100000 (A0H). Memory Contents of Serial ID are shown in Table 1.

**Table 1 Serial ID Memory Contents**

Addr.	Size (Bytes)	Name of Field	Hex	Description
0	1	identifier	03	SFP or SFP+
1	1	Ext.Identifier	04	GBIC/SFP function is defined by two-wire interface ID only
2	1	Connector	07	LC
3-10	8	Transceiver	00 00 00 20 00 00 00 00	100BASE-FX
11	1	Encoding	02	4B/5B
12	1	BR(Nominal)	01	125Mbps
13	1	Rate Identifier	00	Unspecified
14	1	Length(SMFm)-km	00	N/A
15	1	Length(SMF)	00	N/A
16	1	Length(50µm)	C8	2Km
17	1	Length(62.5µm)	C8	2Km
18	1	Length(cable)	00	N/A
19	1	Length(OM3)	00	N/A
20-35	16	Vendor name	XX XX XX XX XX XX XX 20 20 20 20 20 20 20 20 20	Vendor name (ASCII)
36	1	Transceiver	00	Unallocated
37-39	3	Vendor OUI	XX XX XX	Vendor OUI
40-55	16	Vendor PN	XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX XX	Transceiver part number
56-59	4	Vendor rev	XX XX XX XX	Vendor rev
60-61	2	Wavelength	05 1E	1310nm
62	1	Unallocated	00	Unallocated
63	1	CC_BASE	Check Sum (Variable)	Check code for Base ID Fields
64-65	2	Options	00 1A	LOS, TX_FALUT, and TX_DISABLE
66	1	BR	00	max
67	1	BR	00	min
68-83	16	Vendor SN	41 34 32 30 33 30 30 34 20 20 20 20 20 20 20 20	Serial Number of transceiver (ASCII). For example“A4203004”.
84-91	8	Date code	XX XX XX XX XX XX XX XX	Manufacture date code
92	1	Diagnostic Monitoring Type	68	N/A
93	1	Enhanced Options	B0	N/A
94	1	SFF-8472 Compliance	02	Digital diagnostic function not included or undefined
95	1	CC_EXT	Check Sum (Variable)	Check sum for Extended ID Field.
96-127	32	Vendor Specific	Read only	Depends on customer information

**Note:** The “XX” byte should be filled in according to practical case. For more information, please refer to the related document of SFP Multi-Source Agreement (MSA).

The SGMII SFP transceiver provides diagnostic information about the present operating conditions. This transceiver generates this diagnostic data by digitization of internal analog signals. Calibration and alarm/warning threshold data is written during device manufacture. Received power monitoring, transmitted power monitoring, bias current monitoring, supply voltage monitoring and temperature monitoring all are implemented. The diagnostic data are raw A/D values and must be converted to real world units using calibration constants stored in EEPROM locations 56 – 95 at wire serial bus address **A2h**. The digital diagnostic memory map specific data field defined as following.

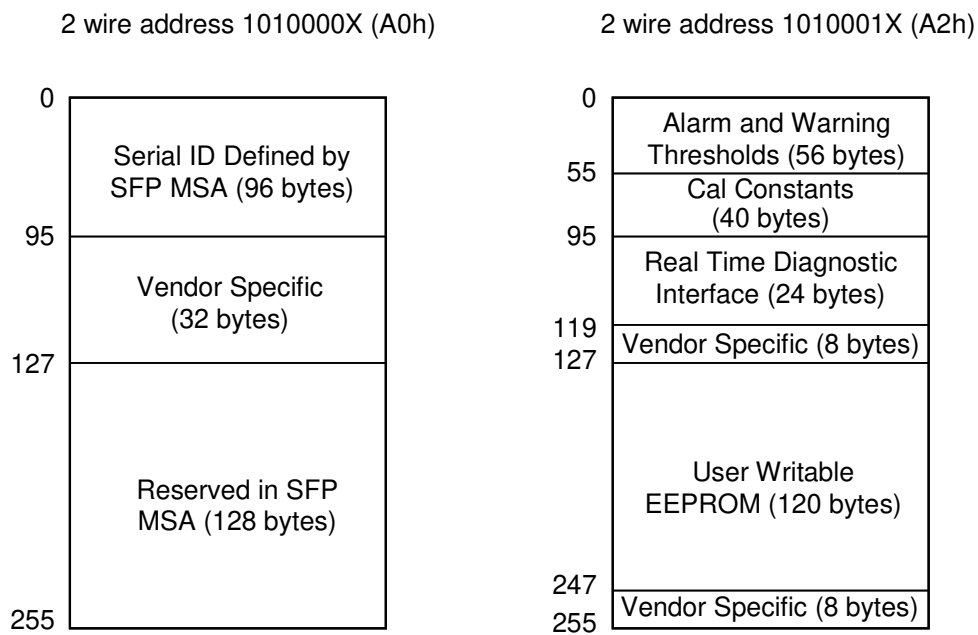


Figure 4: EEPROM Section

### SFP Pin Definitions

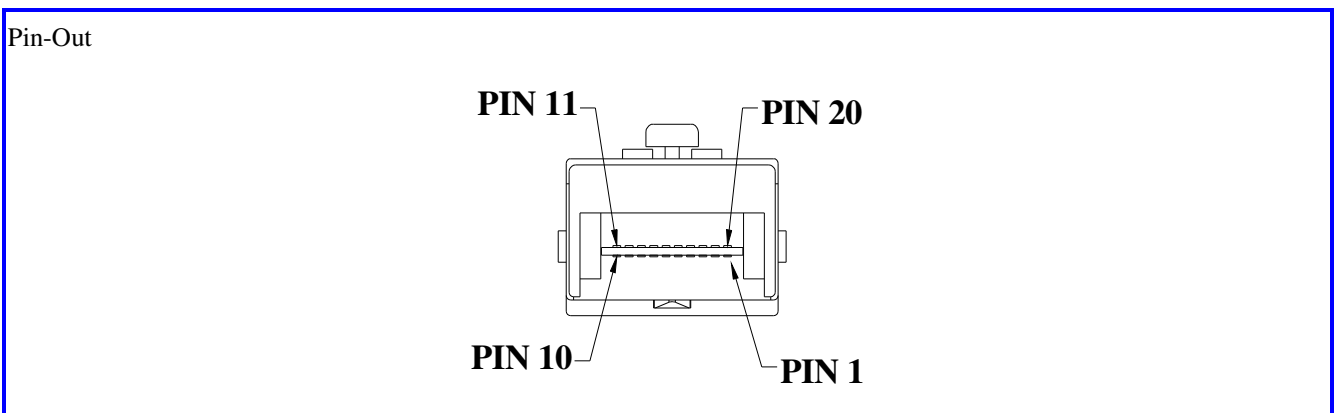


Figure 5: Pin View



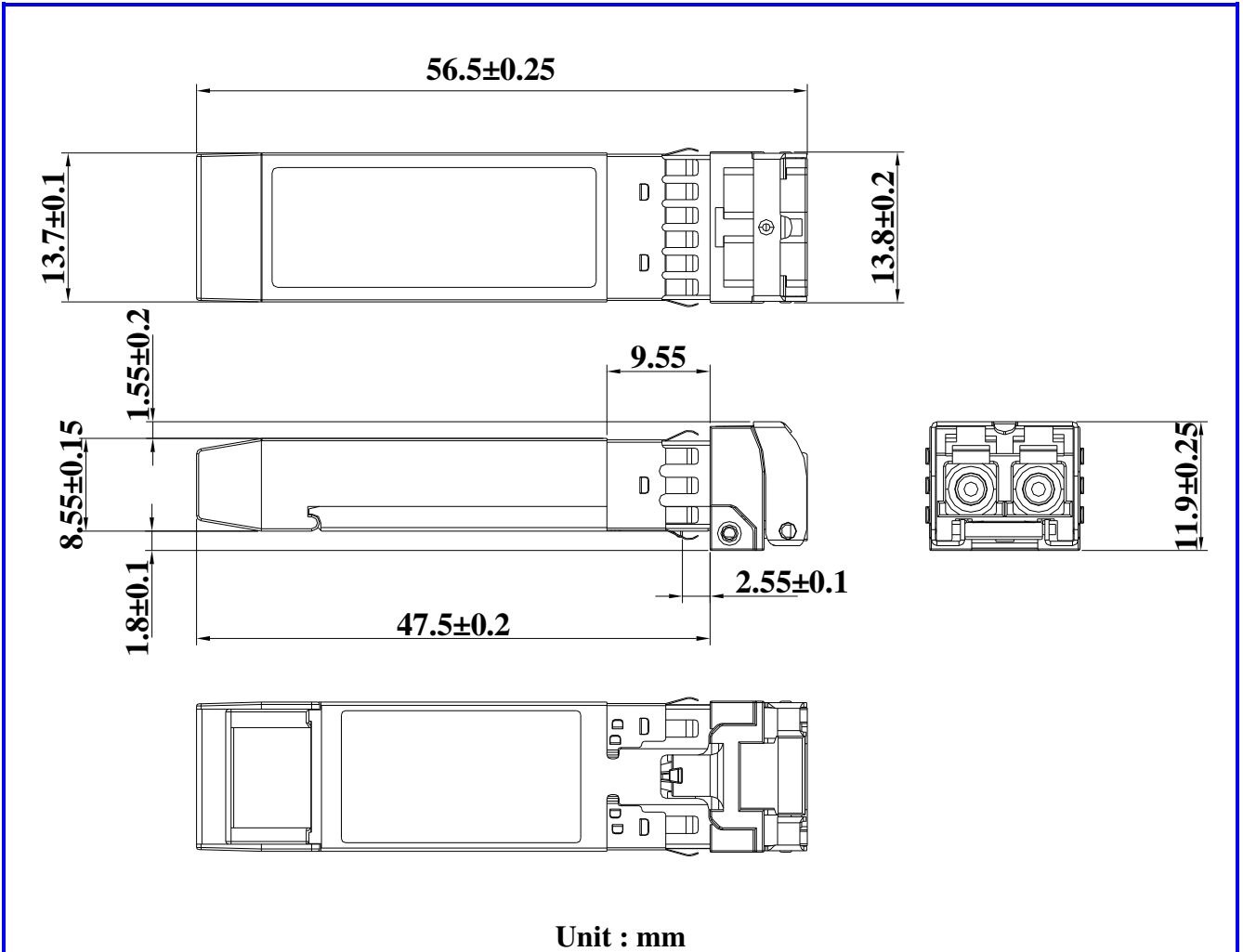
**100BASE-FX SGMII Optical Transceiver with PHY**  
**Small Form Pluggable (SFP), 3.3V**  
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Pin	Signal Name	Function	NOTES
1	VeeT	Transmitter Ground	VeeT and VeeR are connected in SFP.
2	TX_FAULT	Transmitter Fault Indication	Transmit Fault
3	TX_DISABLE	Transmitter Disable	Connected to PHY reset
4	MOD DEF (2)	Module Definition 2	Data Line for Serial ID (SDA).
5	MOD DEF (1)	Module Definition 1	Clock Line for Serial ID (SCL).
6	MOD DEF (0)	Module Definition 0	Tied to Vee in SFP.
7	RATE SELECT	Not Implemented	Not implemented.
8	LOS	Loss of Signal	See LOS option.
9	VeeR	Receiver Ground	VeeT and VeeR are connected in SFP.
10	VeeR	Receiver Ground	VeeT and VeeR are connected in SFP.
11	VeeR	Receiver Ground	VeeT and VeeR are connected in SFP.
12	RD-	Inverted Received Data out	AC coupled 100 ohm differential high speed data lines.
13	RD+	Non-Inverted Received Data out	AC coupled 100 ohm differential high speed data lines.
14	VeeR	Receiver Ground	VeeT and VeeR are connected in SFP.
15	VccR	Receiver Power	VccR and VccT are connected in SFP.
16	VccT	Transmitter Power	VccR and VccT are connected in SFP.
17	VeeT	Transmitter Ground	VeeT and VeeR are connected in SFP.
18	TD+	Non-inverted Data In	AC coupled 100 ohm differential high speed data lines.
19	TD-	Inverted Data In	AC coupled 100ohm differential high speed data lines
20	VeeT	Transmitter Ground	Veet and VeeR are connected in SFP

**Notes:**

1. TX Fault is an open collector output, which should be pulled up with a 4.7k-10k $\Omega$  resistor on the host board to a voltage between 2.0V and Vcc+0.3V. Logic 0 indicates normal operation; Logic 1 indicates a laser fault of some kind. In the low state, the output will be pulled to less than 0.8V.
2. TX Disable as described in the MSA is connected to PHY reset and optical module for the 100BASE-FX application.
3. Mod-Def 0, 1, 2 are the module definition pins. They should be pulled up with a 4.7k-10k $\Omega$  resistor on the host board to a supply less than VccT + 0.3 V or VccR + 0.3 V.
4. RD-/+ : These are the differential receiver outputs. They are ac coupled 100 $\Omega$  differential lines which should be terminated with 100 $\Omega$  differentials. The ac coupling is done inside the module and is thus not required on the host board. The voltage swing levels are compatible with CML and LVPECL voltage swings.
5. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V  $\pm$  5% at the SFP connector pin.
6. TD-/+ : These are the differential transmitter inputs. They are ac coupled differential lines with 100 $\Omega$  differential terminations inside the module. The ac coupling is done inside the module and is thus not required on the host board. The inputs levels are compatible with CML and LVPECL voltage swings.

**Drawing Dimensions**



**Warnings**

Laser Safety: Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.