

## Product Specification

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### RoHS-6 Compliant 10Gb/s Industrial Temperature 10km Single Mode Datacom SFP+ Transceiver

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#### FTLX1471D3BTL

#### PRODUCT FEATURES

- Hot-pluggable SFP+ footprint
- Supports 9.95 to 10.5Gb/s bit rates
- Power dissipation < 1W
- RoHS-6 compliant (lead-free)
- Industrial temperature range  
-40°C to 85°C
- Single 3.3V power supply
- Maximum link length of 10km
- Uncooled 1310nm DFB laser
- Receiver limiting electrical interface
- Duplex LC connector
- Built-in digital diagnostic functions



#### APPLICATIONS

- 10GBASE-LR/LW 10G Ethernet
- 1200-SM-LL-L 10G Fibre Channel

Finisar's FTLX1471D3BTL 10Gb/s Enhanced Small Form Factor Pluggable SFP+ transceivers are designed for use in 10-Gigabit Ethernet links up to 10km over Single Mode fiber. They are compliant with SFF-8431<sup>1</sup>, SFF-8432<sup>2</sup> and IEEE 802.3ae 10GBASE-LR/LW<sup>3</sup>, and 10G Fibre Channel 1200-SM-LL-L<sup>4</sup> Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472<sup>5</sup>. The FTLX1471D3BTL is a "limiting module", i.e., it employs a limiting receiver. Host board designers using an EDC PHY IC should follow the IC manufacturer's recommended settings for interoperating the host-board EDC PHY with a limiting receiver SFP+ module. The transceiver is RoHS compliant and lead free per Directive 2002/95/EC<sup>6</sup>, and Finisar Application Note AN-2038<sup>7</sup>.

#### PRODUCT SELECTION

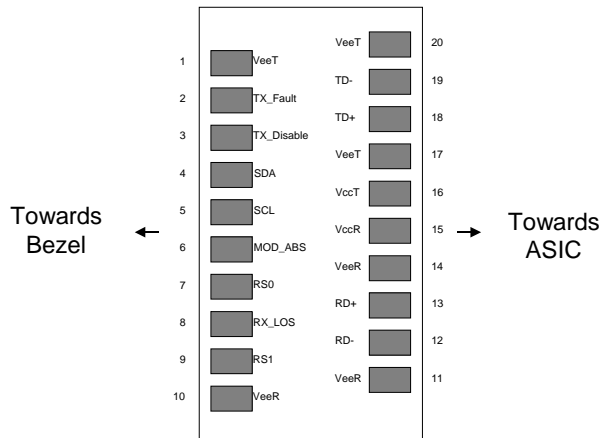
**FTLX1471D3BTL**

**I. Pin Descriptions**

Pin	Symbol	Name/Description	Ref.
1	V <sub>EET</sub>	Transmitter Ground	1
2	T <sub>FAULT</sub>	Transmitter Fault	2
3	T <sub>DIS</sub>	Transmitter Disable. Laser output disabled on high or open.	3
4	SDA	2-wire Serial Interface Data Line	2
5	SCL	2-wire Serial Interface Clock Line	2
6	MOD_ABS	Module Absent. Grounded within the module	2
7	RS0	Rate Select 0. Not Used.	4
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	5
9	RS1	Rate Select 1. Not Used.	4
10	V <sub>EER</sub>	Receiver Ground	1
11	V <sub>EER</sub>	Receiver Ground	1
12	RD-	Receiver Inverted DATA out. AC Coupled.	
13	RD+	Receiver Non-inverted DATA out. AC Coupled.	
14	V <sub>EER</sub>	Receiver Ground	1
15	V <sub>CCR</sub>	Receiver Power Supply	
16	V <sub>CCT</sub>	Transmitter Power Supply	
17	V <sub>EET</sub>	Transmitter Ground	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled.	
19	TD-	Transmitter Inverted DATA in. AC Coupled.	
20	V <sub>EET</sub>	Transmitter Ground	1

Notes:

1. Circuit ground is internally isolated from chassis ground.
2. T<sub>FAULT</sub> is an open collector/drain output, which should be pulled up with a 4.7k – 10k Ohms resistor on the host board if intended for use. Pull up voltage should be between 2.0V to V<sub>cc</sub> + 0.3V. A high output indicates a transmitter fault caused by either the TX bias current or the TX output power exceeding the preset alarm thresholds. A low output indicates normal operation. In the low state, the output is pulled to <0.8V.
3. Laser output disabled on T<sub>DIS</sub> >2.0V or open, enabled on T<sub>DIS</sub> <0.8V.
4. Internally pulled down per SFF-8431 Rev 4.1.
5. LOS is open collector output. Should be pulled up with 4.7k – 10kΩ on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.



**Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names.**

**II. Absolute Maximum Ratings**

Exceeding the limits below may damage the transceiver module permanently.

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Maximum Supply Voltage	V <sub>CC</sub>	-0.5		4.0	V	
Storage Temperature	T <sub>S</sub>	-40		85	°C	
Relative Humidity	RH	0		85	%	1

1. Non-condensing.

**III. Electrical Characteristics (T<sub>OP</sub> = -40 to 85 °C, V<sub>CC</sub> = 3.14 to 3.46 Volts)**

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	V <sub>CC</sub>	3.14	3.30	3.46	V	
Supply Current	I <sub>CC</sub>		200	285	mA	
<b>Transmitter</b>						
Input differential impedance	R <sub>in</sub>		100		Ω	1
Differential data input swing	V <sub>in,pp</sub>	180		700	mV	
Transmit Disable Voltage	V <sub>D</sub>	2		V <sub>CC</sub>	V	
Transmit Enable Voltage	V <sub>EN</sub>	V <sub>EE</sub>		V <sub>EE</sub> +0.8	V	
<b>Receiver</b>						
Differential data output swing	V <sub>out,pp</sub>	300		850	mV	2,6
Output rise time and fall time	T <sub>r</sub> , T <sub>f</sub>	28			ps	3
LOS Fault	V <sub>LOS fault</sub>	2		V <sub>CCHOST</sub>	V	4
LOS Normal	V <sub>LOS norm</sub>	V <sub>EE</sub>		V <sub>EE</sub> +0.8	V	4
Power Supply Noise Tolerance	V <sub>CC</sub> T/V <sub>CC</sub> R	Per SFF-8431 Rev 4.1			mVpp	5

**Notes:**

1. Connected directly to TX data input pins. AC coupling from pins into laser driver IC.
2. Into 100Ω differential termination.
3. 20 – 80%. Measured with Module Compliance Test Board and OMA test pattern. Use of four 1's and four 0's sequence in the PRBS 9 is an acceptable alternative. SFF-8431 Rev 4.1.
4. LOS is an open collector output. Should be pulled up with 4.7kΩ – 10kΩ on the host board. Normal operation is logic 0; loss of signal is logic 1.
5. See Section 2.8.3 of SFF-8431 Rev 4.1.
6. The FTLX1471D3BTL is a “limiting module”, i.e., it employs a limiting receiver. Host board designers using an EDC PHY IC should follow the IC manufacturer's recommended settings for interoperating the host-board EDC PHY with a limiting receiver SFP+ module.

**IV. Optical Characteristics (T<sub>OP</sub> = -40 to 85 °C, V<sub>CC3</sub> = 3.14 to 3.46 Volts)**

Parameter	Symbol	Min	Typ	Max	Unit	Ref.	
<b>Transmitter</b>							
Optical Modulation Amplitude (OMA)	P <sub>OMA</sub>	-5.2			dBm		
Average Launch Power	P <sub>Ave</sub>	-8.2		+0.5	dBm	1	
Optical Wavelength	λ	1260		1355	nm		
Side-Mode Suppression Ratio	SMSR	30			dB		
Optical Extinction Ratio	ER	3.5			dB		
Transmitter and Dispersion Penalty	TDP			3.2	dB		
Average Launch power of OFF transmitter	P <sub>OFF</sub>			-30	dBm		
Tx Jitter	T <sub>Xj</sub>	Per 802.3ae requirements					
Relative Intensity Noise	RIN			-128	dB/Hz		

Receiver						
Receiver Sensitivity (OMA) @ 10.3Gb/s	$R_{SENS1}$			-12.6	dBm	2
Stressed Receiver Sensitivity (OMA) @ 10.3Gb/s	$R_{SENS2}$			-10.3	dBm	3
Average Receive Power	$P_{AVE}$	-14.2		+0.5	dBm	
Optical Center Wavelength	$\lambda_C$	1260		1600	nm	
Receiver Reflectance	$R_{RX}$			-12	dB	
LOS De-Assert	$LOS_D$			-17	dBm	
LOS Assert	$LOS_A$	-30			dBm	
LOS Hysteresis		0.5			dB	

**Notes:**

1. Average power figures are informative only, per IEEE 802.3ae.
2. Valid between 1260 and 1355 nm. Measured with worst ER; BER<10<sup>-12</sup>; 2<sup>31</sup> – 1 PRBS.
3. Valid between 1260 and 1355 nm. Per IEEE 802.3ae.

**V. General Specifications**

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Bit Rate	BR	9.95		10.5	Gb/s	1
Bit Error Ratio	BER			10 <sup>-12</sup>		2
Max. Supported Link Length	$L_{MAX}$		10		km	1

**Notes:**

1. 10GBASE-LR, 10GBASE-LW, 1200-SM-LL-L 10GFC.
2. Tested with a 2<sup>31</sup> – 1 PRBS.

**VI. Environmental Specifications**

Finisar FTLX1471D3BTL transceivers have an operating temperature range from -40°C to +85°C case temperature.

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Case Operating Temperature	$T_{op}$	-40		85	°C	
Storage Temperature	$T_{sto}$	-40		85	°C	

**VII. Regulatory Compliance**

Finisar transceivers are Class 1 Laser Products and comply with US FDA regulations. These products are certified by TÜV and CSA to meet the Class 1 eye safety requirements of EN (IEC) 60825 and the electrical safety requirements of EN (IEC) 60950. Copies of certificates are available at Finisar Corporation upon request.

## VIII. Digital Diagnostic Functions

Finisar FTLX1471D3BTL SFP+ transceivers support the 2-wire serial communication protocol as defined in the SFP MSA<sup>1</sup>. It is very closely related to the E<sup>2</sup>PROM defined in the GBIC standard, with the same electrical specifications.

The standard SFP serial ID provides access to identification information that describes the transceiver's capabilities, standard interfaces, manufacturer, and other information.

Additionally, Finisar SFP+ transceivers provide an enhanced digital diagnostic monitoring interface, which allows real-time access to device operating parameters such as transceiver temperature, laser bias current, transmitted optical power, received optical power and transceiver supply voltage. It also defines a sophisticated system of alarm and warning flags, which alerts end-users when particular operating parameters are outside of a factory set normal range.

The SFP MSA defines a 256-byte memory map in E<sup>2</sup>PROM that is accessible over a 2-wire serial interface at the 8 bit address 1010000X (A0h). The digital diagnostic monitoring interface makes use of the 8 bit address 1010001X (A2h), so the originally defined serial ID memory map remains unchanged. The interface is identical to, and is thus fully backward compatible with both the GBIC Specification and the SFP Multi Source Agreement. The complete interface is described in Finisar Application Note AN-2030: "Digital Diagnostics Monitoring Interface for SFP Optical Transceivers".

The operating and diagnostics information is monitored and reported by a Digital Diagnostics Transceiver Controller (DDTC) inside the transceiver, which is accessed through a 2-wire serial interface. When the serial protocol is activated, the serial clock signal (SCL, Mod Def 1) is generated by the host. The positive edge clocks data into the SFP transceiver into those segments of the E<sup>2</sup>PROM that are not write-protected. The negative edge clocks data from the SFP transceiver. The serial data signal (SDA, Mod Def 2) is bi-directional for serial data transfer. The host uses SDA in conjunction with SCL to mark the start and end of serial protocol activation. The memories are organized as a series of 8-bit data words that can be addressed individually or sequentially.

For more information, please see the SFP MSA documentation<sup>1,5</sup> and Finisar Application Note AN-2030.

Please note that evaluation board FDB-1027 is available with Finisar ModDEMO software that allows simple to use communication over the 2-wire serial interface.

**IX. Digital Diagnostic Specifications**

FTLX1471D3BTL transceivers can be used in host systems that require either internally or externally calibrated digital diagnostics.

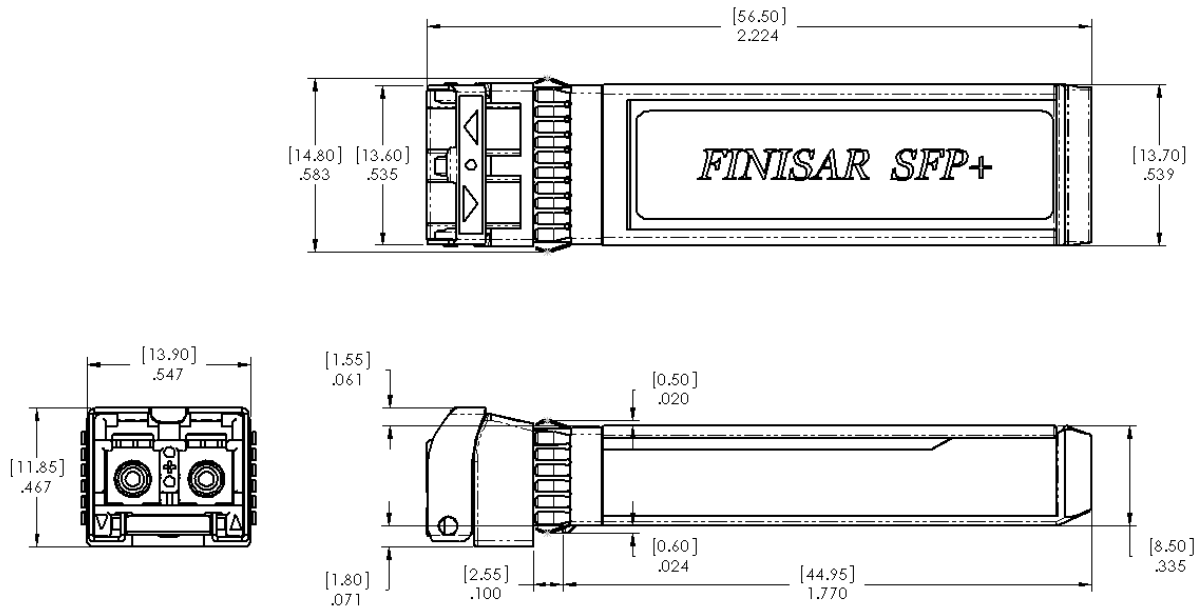
Parameter	Symbol	Min	Typ	Max	Units	Ref.
<b>Accuracy</b>						
Internally measured transceiver temperature	$\Delta DD_{\text{Temperature}}$			3	°C	
Internally measured transceiver supply voltage	$\Delta DD_{\text{Voltage}}$			3	%	
Measured TX bias current	$\Delta DD_{\text{Bias}}$			10	%	1
Measured TX output power	$\Delta DD_{\text{Tx-Power}}$			2	dB	
Measured RX received average optical power	$\Delta DD_{\text{Rx-Power}}$			2	dB	
<b>Dynamic Range for Rated Accuracy</b>						
Internally measured transceiver temperature	$DD_{\text{Temperature}}$	-40		85	°C	
Internally measured transceiver supply voltage	$DD_{\text{Voltage}}$	3.1		3.5	V	
Measured TX bias current	$DD_{\text{Bias}}$	10		90	mA	
Measured TX output power	$DD_{\text{Tx-Power}}$	-8.2		+0.5	dBm	
Measured RX received average optical power	$DD_{\text{Rx-Power}}$	-14.2		+0.5	dBm	
<b>Max Reporting Range</b>						
Internally measured transceiver temperature	$DD_{\text{Temperature}}$	-40		125	°C	
Internally measured transceiver supply voltage	$DD_{\text{Voltage}}$	2.8		4.0	V	
Measured TX bias current	$DD_{\text{Bias}}$	0		20	mA	
Measured TX output power	$DD_{\text{Tx-Power}}$	-10		+2	dBm	
Measured RX received average optical power	$DD_{\text{Rx-Power}}$	-22		+2	dBm	

Notes:

- Accuracy of measured Tx bias current is 10% of the actual bias current from the laser driver to the laser.

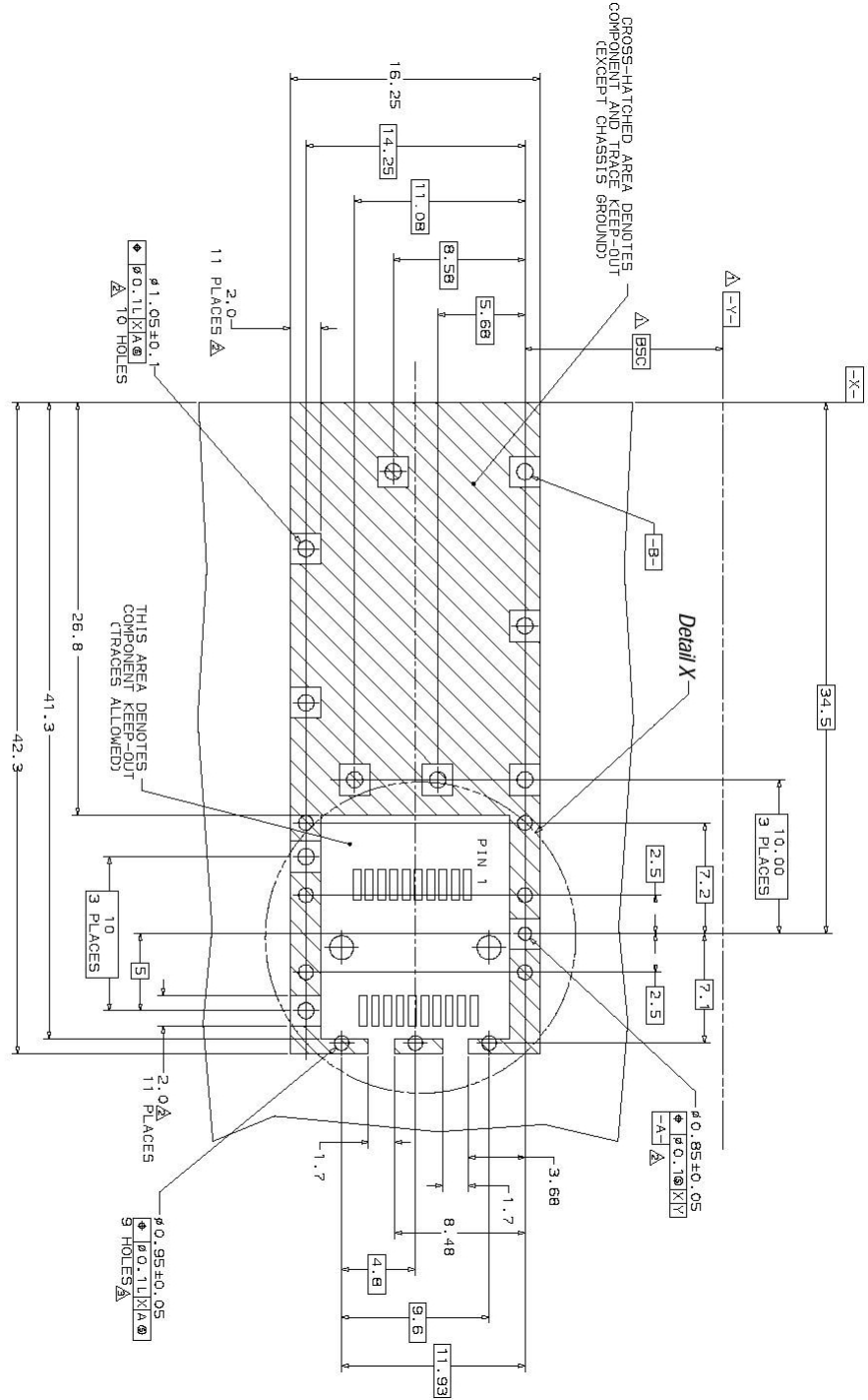
**X. Mechanical Specifications**

Finisar FTLX1471D3BTL SFP+ transceivers are compatible with the SFF-8432 specification for improved pluggable form factor, and shown here for reference purposes only. Bail color is blue.



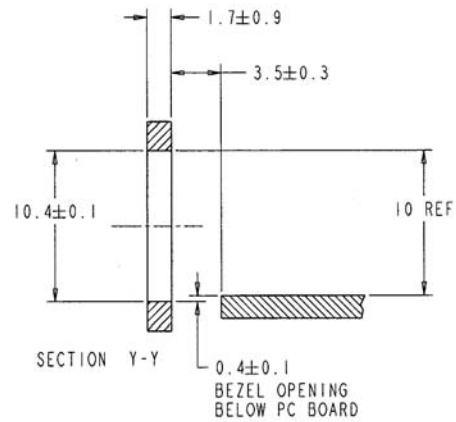
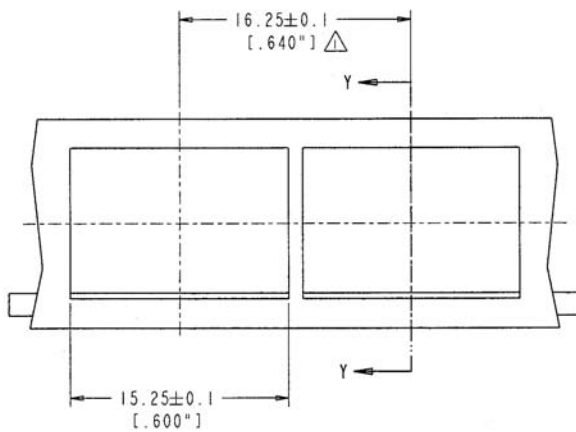
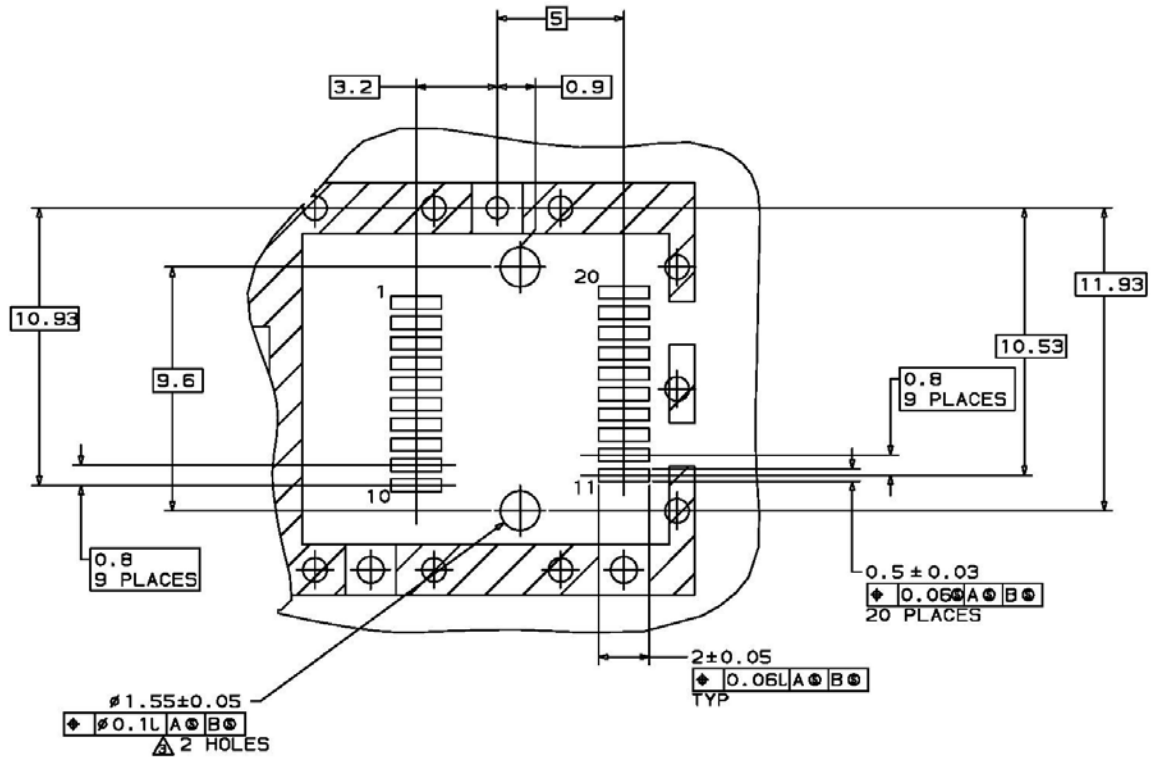
**Figure 2. FTLX1471D3BTL Mechanical Dimensions.**

**XI. PCB Layout and Bezel Recommendations**



- ▲ Datum and Basic Dimension Established by Customer
- ▲ Rads and Vias are Chassis Ground, 11 Places
- ▲ Through Holes are Unplated



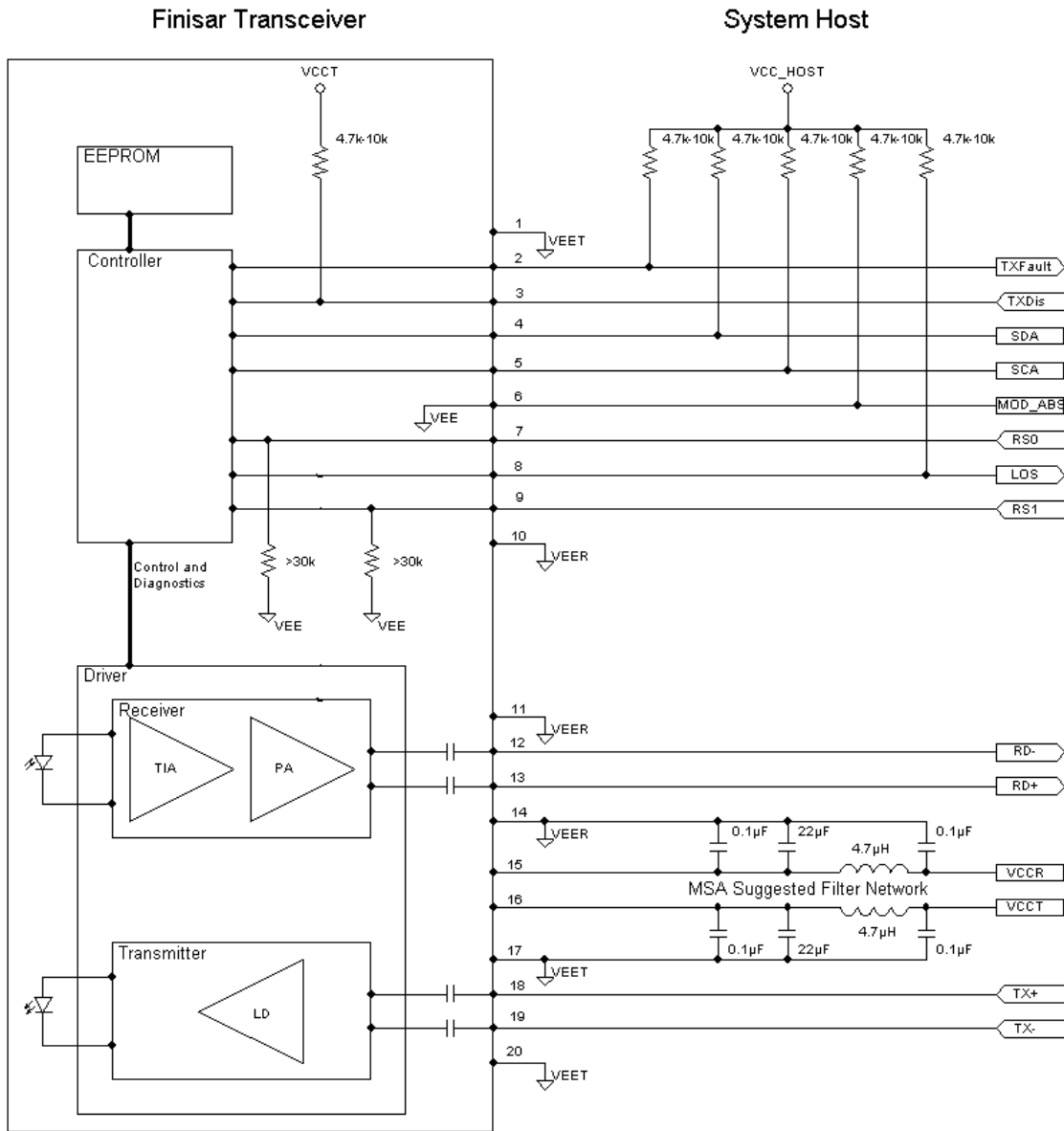


NOTES:

△ MINIMUM PITCH ILLUSTRATED, ENGLISH DIMENSIONS ARE FOR REFERENCE ONLY

2. NOT RECOMMENDED FOR PCI EXPANSION CARD APPLICATIONS

**XII. Host - Transceiver Interface Block Diagram**



**Figure 6-Host-Module Interface**

**XIII. References**

1. “Specifications for Enhanced 8.5 and 10 Gigabit Small Form Factor Pluggable Module ‘SFP+ ’”, SFF Document Number SFF-8431, Revision 4.1.
2. “Improved Pluggable Form factor”, SFF Document Number SFF-8432, Revision 4.2, April 18, 2007.
3. IEEE Std 802.3ae, Clause 52, PMD Type 10GBASE-LR. IEEE Standards Department.
4. American National Standard for Information Technology - Fibre Channel - 10 Gigabit Fibre Channel, Rev 3.5, April 9, 2003.
5. “Digital Diagnostics Monitoring Interface for Optical Transceivers”. SFF Document Number SFF-8472, Revision 10.1, March 1, 2007.
6. Directive 2002/95/EC of the European Council Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment”. January 27, 2003.
7. “Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers”, Finisar Corporation, January 21, 2005.

**XIV. For More Information**

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