

## Product Specification

### RoHS-6 Compliant 10Gb/s 220m Multi Mode Datacom SFP+ Transceiver FTLX1371D3BCL

#### PRODUCT FEATURES

- Hot-pluggable SFP+ footprint
- Supports 10.3Gb/s bit rate
- Power dissipation < 1W
- RoHS-6 compliant (lead-free)
- Commercial temperature range  
-5°C to 70°C
- Single 3.3V power supply
- Maximum link length of 220m
- Uncooled directly modulated  
Fabry-Perot (FP) laser at 1310nm
- Receiver linear electrical interface
- Duplex LC connector
- Built-in digital diagnostic functions



#### APPLICATIONS

- 10GBASE-LRM 10G Ethernet
- Legacy FDDI multimode links

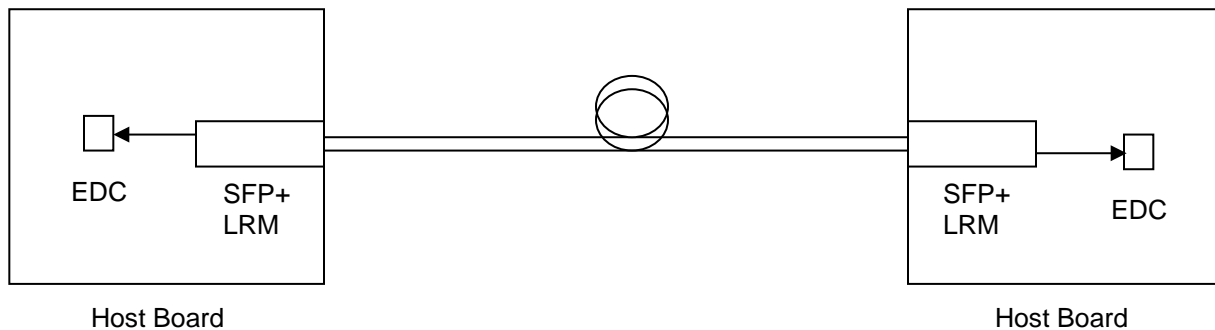
Finisar's FTLX1371D3BCL 10Gb/s Enhanced Small Form Factor Pluggable SFP+ transceivers are designed for use in 10-Gigabit Ethernet links up to 220m over Multi Mode fiber. They are compliant with SFF-8431<sup>1</sup>, SFF-8432<sup>2</sup> and IEEE 802.3 aq<sup>3</sup> 10GBASE-LRM. Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472<sup>4</sup>. The FTLX1371D3BCL is a "linear module" i.e. it employs a linear 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 linear receiver SFP+ module. The optical transceivers are compliant per the RoHS Directive 2011/65/EU. See Finisar Application Note AN-2038 for more details.

#### PRODUCT SELECTION

**FTLX1371D3BCL**

## I. Description

The Finisar FTLX1371D3BCL SFP+ transceiver is a linear-interface transceiver that enables, in conjunction with an Electronic Dispersion Compensation (EDC) on the host board, an IEEE802.3aq 10GBASE-LRM compliant link. The host board EDC provides correction for the severe modal dispersion that may occur during propagation through multimode fiber links, including legacy installed FDDI multimode fiber (see IEEE802.3aq for detailed information regarding fiber coverage).



**Figure 1. Block Diagram of SFP+ LRM Module on Host Board with EDC**

Unlike the XFP MSA transceiver requirements, the SFP+ transceiver does not contain internal retiming circuitry, and thus some of the Transmitter Optical Characteristics stated in this data sheet require that the Host Board is compliant to the SFP+ MSA specifications. See Chapter 3 in Reference [1] for further details.

## II. Pin Descriptions

Pin	Symbol	Name/Description	Ref.
1	V <sub>EET</sub>	Transmitter Ground	1
2	T <sub>FAULT</sub>	Transmitter Fault	
3	T <sub>DIS</sub>	Transmitter Disable. Laser output disabled on high or open.	2
4	SDA	2-wire Serial Interface Data Line	3
5	SCL	2-wire Serial Interface Clock Line	3
6	MOD_ABS	Module Absent. Grounded within the module.	3
7	RS0	No connection required	
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	4
9	RS1	No connection required	
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. Laser output disabled on T<sub>DIS</sub> > 2.0V or open, enabled on T<sub>DIS</sub> < 0.8V.
3. Should be pulled up with 4.7k – 10kohms on host board to a voltage between 2.0V and 3.6V. MOD\_ABS pulls line low to indicate module is plugged in.
4. RX\_LOS is open collector output. Should be pulled up with 4.7k – 10kohms on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.

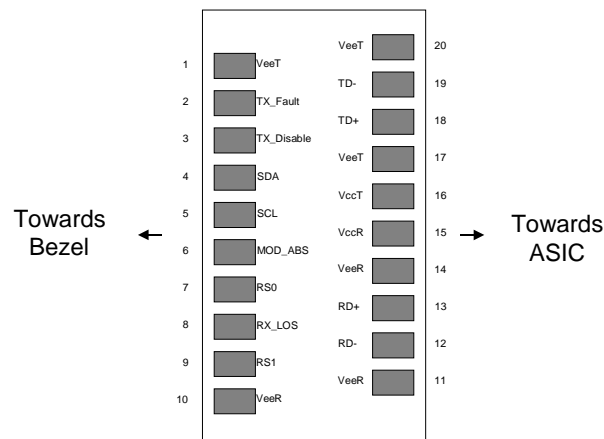


Figure 2. Diagram of Host Board Connector Block Pin Numbers and Names

### III. 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

Notes:

1. Non-condensing.

### IV. Electrical Characteristics (T<sub>OP</sub> = -5 to 70 °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		3.46	V	
Supply Current	I <sub>CC</sub>		200	300	mA	
Power Dissipation	P			1.0	W	
<b>Transmitter</b>						
Input differential impedance	R <sub>in</sub>		100		Ω	1
Single ended data input swing	V <sub>in,pp</sub>	90		350	mV	2
Transmit Disable Voltage	V <sub>D</sub>	2		V <sub>CC</sub>	V	3
Transmit Enable Voltage	V <sub>EN</sub>	V <sub>EE</sub>		V <sub>EE</sub> + 0.8	V	
<b>Receiver</b>						
Termination Mismatch at 1 MHz	ΔZ <sub>M</sub>			5	%	
Single Ended Output Voltage Tolerance		-0.3		4.0	V	
Output AC Common Mode Voltage				7.5	mV RMS	
Output Rise and Fall time (20% to 80%)	Tr, Tf	30			Ps	4
Relative Noise LRM Links with crosstalk	RN		per SFF-8431			5
Difference Waveform Distortion Penalty	dWDP		per SFF-8431		dBo	5,6
Differential Voltage Modulation Amplitude	VMA	180		600	mV	
LOS Fault	V <sub>LOS fault</sub>	2		V <sub>CCHOST</sub>	V	7
LOS Normal	V <sub>LOS norm</sub>	V <sub>EE</sub>		V <sub>EE</sub> +0.8	V	7
Power Supply Noise Tolerance	V <sub>CC</sub> T/V <sub>CC</sub> R		per SFF-8431		mVpp	8

Notes:

1. Connected directly to TX data input pins. AC coupling from pins into laser driver IC.
2. Per SFF-8431 Rev 4.1
3. Into 100 ohms differential termination.
4. Measured with Module Compliance Test Board and OMA test pattern.
5. Values shown in Table 20, SFF-8431. dWDP and RN is calculated by the following equation:  

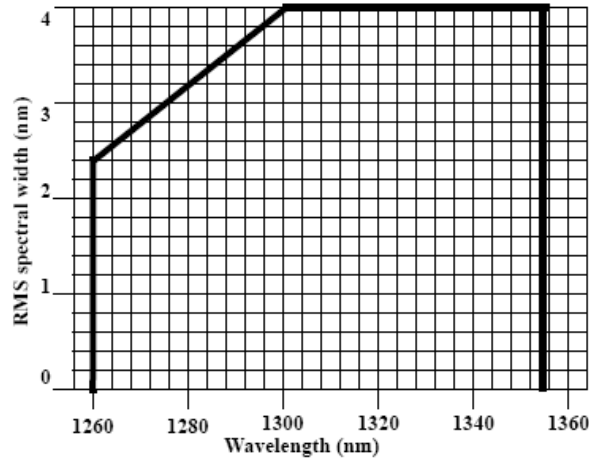
$$RN \leq \min[(m1 \times dWDP + b1), (m2 \times dWDP + b2), RN_{max}]$$
6. Defined with reference receiver with 14 T/2 spaced FFE taps and 5 T spaced DFE taps.
7. LOS is an open collector output. Should be pulled up with 4.7k – 10kΩ on the host board. Normal operation is logic 0; loss of signal is logic 1. Maximum pull-up voltage is 5.5V.
8. As described in Section 2.8.1, SFF-8431 Rev 4.1.

**V. Optical Characteristics** ( $T_{OP} = -5$  to  $70$  °C,  $V_{CC} = 3.14$  to  $3.46$  Volts)

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
<b>Transmitter</b>						
Optical Modulation Amplitude (OMA)	$P_{OMA}$	-4.5		+1.5	dBm	
Average Launch Power	$P_{AVE}$	-6.5		0.5	dBm	1
Peak Launch Power	$P_{MAX}$			3	dBm	
Optical Wavelength	$\lambda$	1260		1355	nm	
RMS Spectral Width	$\lambda_{rms}$ @ 1260nm			2.4	nm	2
	$\lambda_{rms}$ @ 1260nm- 1300nm			See Figure 3		
	$\lambda_{rms}$ @ 1300nm- 1355nm			4		
Optical Extinction Ratio	ER	3.5			dB	
Optical Eye Mask Margin		0			%	3
Transmitter Waveform Dispersion Penalty	TWDP			4.7	dB	4
Average Launch power of OFF transmitter	$P_{OFF}$			-30	dBm	
Uncorrelated Jitter [rms]	$T_{Xj}$			0.033	UI	
Relative Intensity Noise	$RIN_{12}OMA$			-128	dB/Hz	
Encircled Flux	<5 $\mu$ m	30			%	
	<11 $\mu$ m	81				
Transmitter Reflectance				-12	dB	
Optical Return Loss Tolerance		20			dB	
<b>Receiver</b>						
Receiver Overload	$P_{MAX}$	+1.5			dBm	5
Comprehensive Stressed Receiver Sensitivity (OMA) @ 10.3125Gb/s	Precursor			-6.5	dBm	6
	Symmetrical			-6.0		
	Postcursor			-6.5		
Wavelength Range	$\lambda_C$	1260		1355	Nm	
Receiver Reflectance	$R_{rx}$			-12	dB	
LOS De-Assert	$LOS_D$			-11	dBm	
LOS Assert	$LOS_A$	-30			dBm	
LOS Hysteresis		0.5			dB	

Notes:

1. Average power figures are informative only, per IEEE802.3aq
2. Maximum RMS spectral width as specified by Figure 3
3. Optical Eye Mask requires the host board to be SFF-8431 compliant. Optical eye mask per IEEE802.3aq.
4. TWDP figure requires the host board to be SFF-8431 compliant. TWDP is calculated using the Matlab code provided in clause 68.6.6.2 of IEEE802.3aq
5. Receiver overload specified in OMA and under the worst comprehensive stressed condition.
6. Conditions of stressed receiver tests per IEEE802.3aq. CSRS testing requires the host board to be SFF-8431 compliant.



**Figure 3. Transmitter Maximum RMS Spectral Width**

**VI. General Specifications**

Parameter		Symbol	Min	Typ	Max	Units	Ref.
Bit Rate		BR		10.3125		Gb/s	1
Bit Error Ratio		BER			$10^{-12}$		2
<b>Maximum Supported Distances</b>							
Fiber Type	1310nm OFL Bandwidth						
62.5µm	“FDDI” 160MHz/km	Lmax			220	m	3
	OM1 200MHz/km				220		
50µm	400MHz/km	Lmax			100	m	3
	OM2 500MHz/km				220		
	OM3 2000MHz/km				220		

Notes:

- 10GBASE-LRM
- Tested with a  $2^{31} - 1$  PRBS
- Operating range as defined by IEEE standards. Longer reach possible depending upon link implementation.

**VII. Environmental Specifications**

Finisar 1310nm SFP+ transceivers have a commercial operating temperature range from -5 to +70°C case temperature.

<b>Parameter</b>	<b>Symbol</b>	<b>Min</b>	<b>Typ</b>	<b>Max</b>	<b>Units</b>	<b>Ref.</b>
Case Operating Temperature	T <sub>op</sub>	-5		70	°C	
Storage Temperature	T <sub>sto</sub>	-40		85	°C	

### **VIII. Regulatory Compliance**

Finisar transceivers are Class 1 Laser Products and comply with U.S. FDA CDRH 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.

## IX. Digital Diagnostic Functions

Finisar FTLX1371D3BCL SFP+ transceivers support the 2-wire serial communication protocol as defined in the SFF-8472 Specification.

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 SFF-8472 Specification 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 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 SFF-8472 Specification<sup>4</sup>.



## X. Digital Diagnostic Specifications

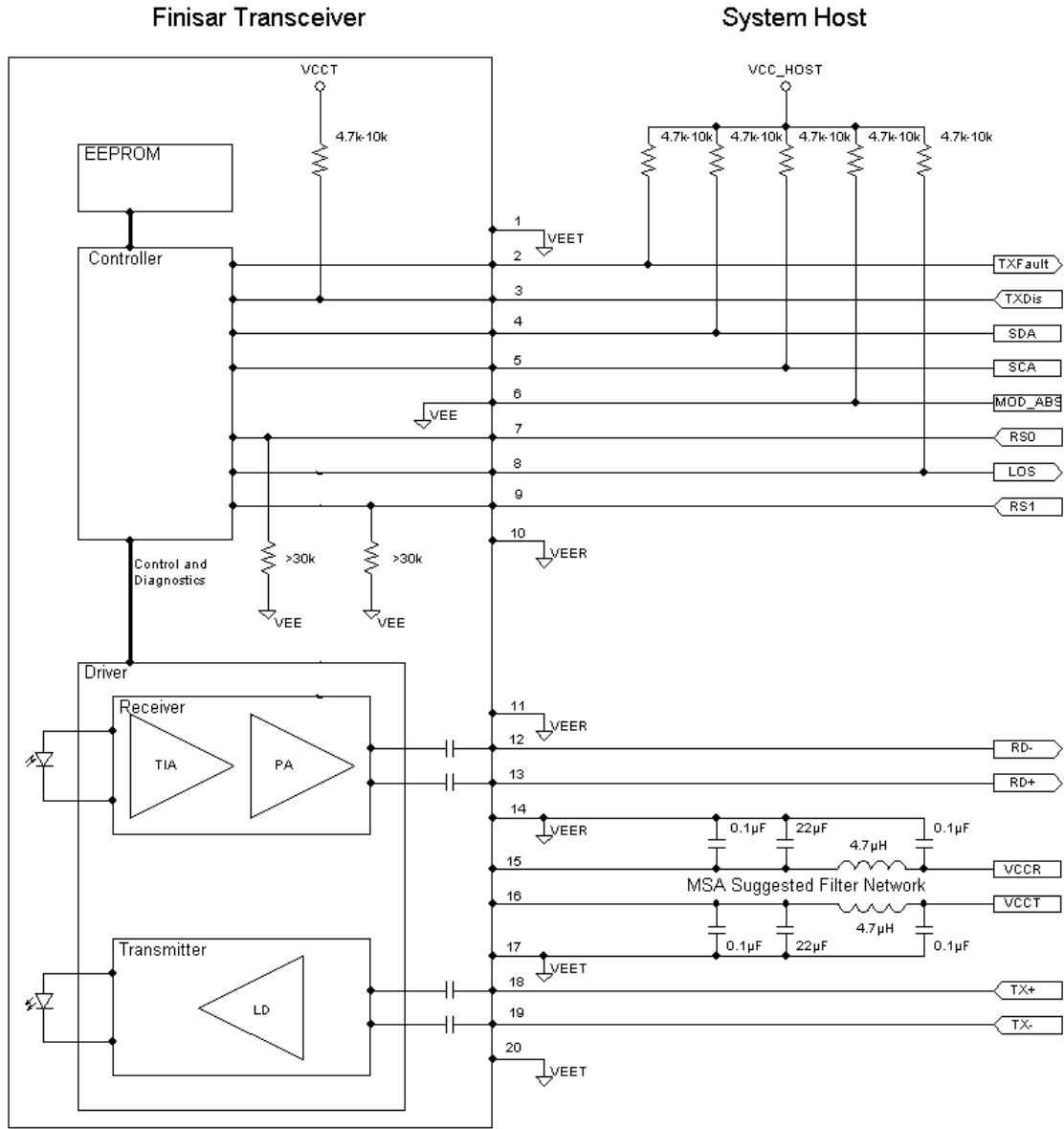
FTLX1371D3BCL transceivers can be used in host systems that require either internally or externally calibrated digital diagnostics.

Parameter	Symbol	Min	Typ	Max	Units	Ref.
<b>Accuracy</b>						
Internally measured transceiver temperature	DD <sub>Temperature</sub>			3	°C	
Internally measured transceiver supply voltage	DD <sub>Voltage</sub>			100	mV	
Measured TX bias current	DD <sub>Bias</sub>			10	%	1
Measured TX output power	DD <sub>Tx-Power</sub>			2	dB	
Measured RX received average optical power	DD <sub>Rx-Power</sub>			2	dB	
<b>Dynamic Range for Rated Accuracy</b>						
Internally measured transceiver temperature	DD <sub>Temperature</sub>	-5		75	°C	
Internally measured transceiver supply voltage	DD <sub>Voltage</sub>	3.1		3.5	V	
Measured TX bias current	DD <sub>Bias</sub>	0		75	mA	
Measured TX output power	DD <sub>Tx-Power</sub>	-6.5		0.5	dBm	
Measured RX received average optical power	DD <sub>Rx-Power</sub>	-20		-10	dBm	
<b>Max Reporting Range</b>						
Internally measured transceiver temperature	DD <sub>Temperature</sub>	-40		125	°C	
Internally measured transceiver supply voltage	DD <sub>Voltage</sub>	2.8		4.0	V	
Measured TX bias current	DD <sub>Bias</sub>	0		75	mA	
Measured TX output power	DD <sub>Tx-Power</sub>	-10		3	dBm	
Measured RX received average optical power	DD <sub>Rx-Power</sub>	-22		0	dBm	

### Notes:

1. Accuracy of Measured Tx Bias Current is 10% of the actual Bias Current from the laser driver to the laser.

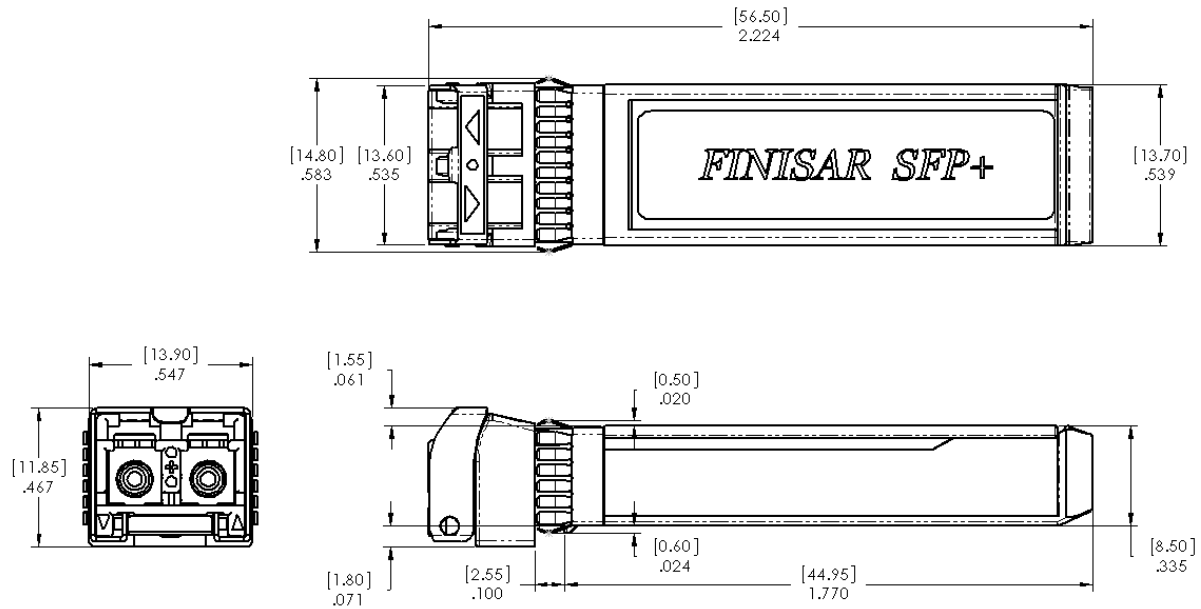
**XI. Host - Transceiver Interface Block Diagram**



**Figure 4-Host-Module Interface**

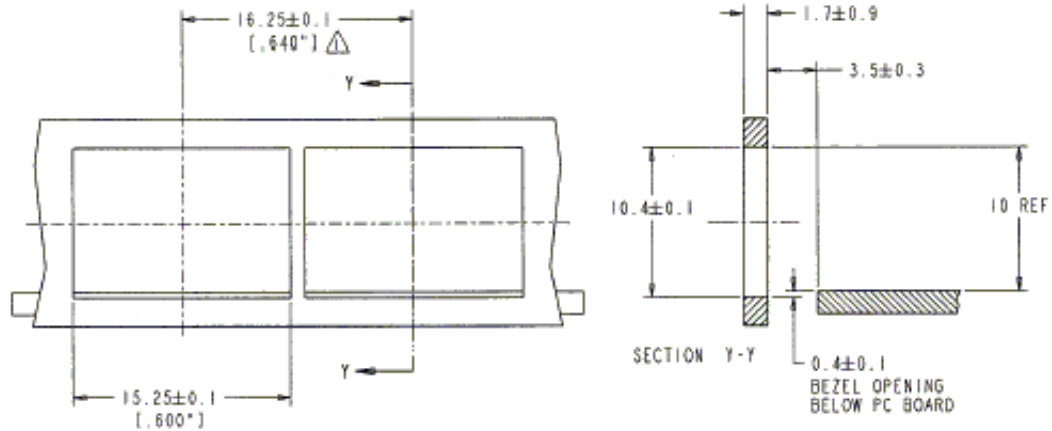
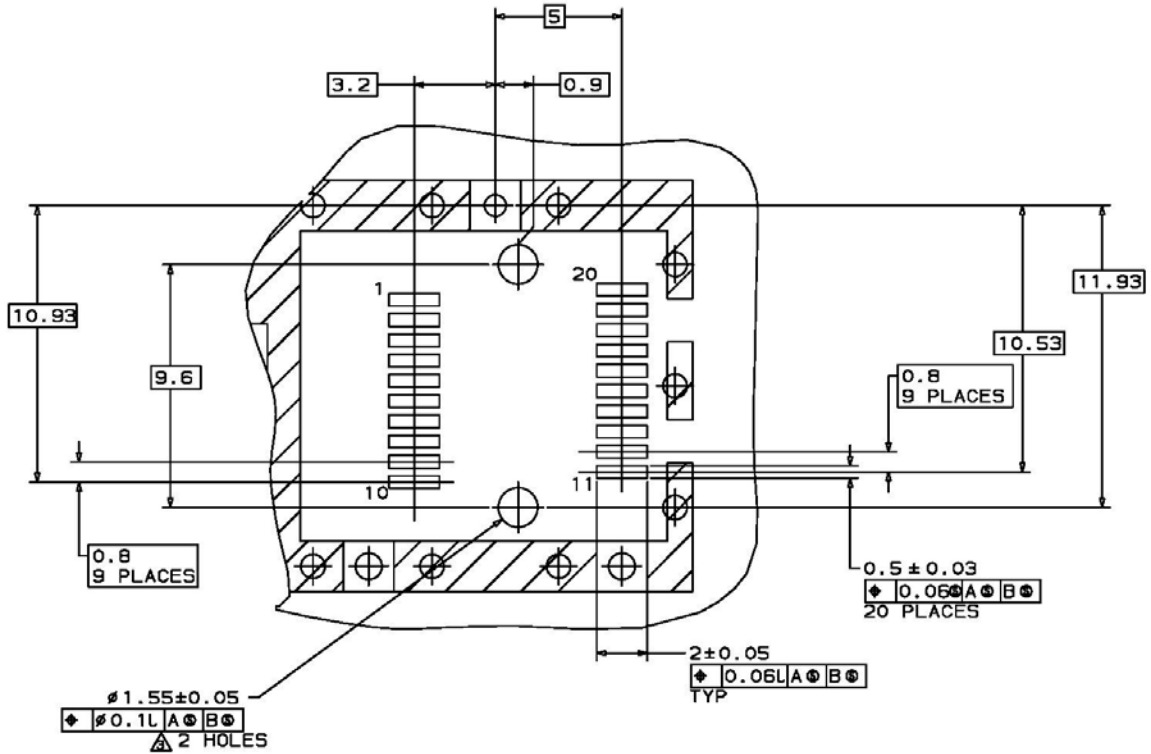
## XII. Mechanical Specifications

Finisar's SFP+ transceivers are compatible with the dimensions defined by the SFP+ Specification SFF-8432. Bail color is orange.



**Figure 5. FTLX1371D3BCL Mechanical Dimensions**





NOTES:

△ MINIMUM PITCH ILLUSTRATED, ENGLISH DIMENSIONS ARE FOR REFERENCE ONLY

2. NOT RECOMMENDED FOR PCI EXPANSION CARD APPLICATIONS

#### **XIV. References**

1. SFF-8431 Specifications for Enhanced 10 Gigabit Small Form Factor Pluggable Module “SFP+” Revision 4.1.
2. SFF-8432 Specification for Improved Pluggable Form Factor, Revision 5, July 16, 2007
3. IEEE Std 802.3aq-2006, PMD Type 10GBASE-LRM. IEEE Standards Department, 18 October 2006
4. “Digital Diagnostics Monitoring Interface for Optical Transceivers”. SFF Document Number SFF-8472, Revision 10.3, December 1, 2007.
5. Directive 2011/65/EU of the European Council Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment”. Certain products may use one or more exemptions as allowed by the Directive.
6. “Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers”

#### **XV. For More Information**

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