Finisar

Product Specification

10Gb/s, 2/10km Single Mode, Multi-Rate SFP+ Transceiver

FTLX1472M3BCL

PRODUCT FEATURES

- Hot-pluggable SFP+ footprint
- Supports 8.5Gb/s and from 9.95 to 11.3Gb/s bit rates
- Power dissipation < 1.5W
- RoHS-6 compliant (lead-free)
- Commercial temperature range -5°C to 75°C
- Single 3.3V power supply
- Maximum link length of 10km
- Un-cooled 1310nm DFB laser
- Receiver limiting electrical interface
- Duplex LC connector
- Built-in digital diagnostic functions

APPLICATIONS

- 10G NRZ SONET VSR2000-2R1, SDH I-64.1, OTN P1I1-2D1
- 10G Ethernet 10GBASE-LR/-LW
- 10G Fibre Channel 1200-SM-LL-L
- G.709 OTU 1e/2/2e FEC bit rates
- 8.5Gb/s Fibre Channel

Finisar's FTLX1472M3BCL 10Gb/s Enhanced Small Form Factor Pluggable SFP+ transceivers are designed for use in 10-Gigabit, multi-rate links up to a maximum 10km over G.652 single mode fiber. They are compliant with SFF-8431[1], SFF-8432[2] , ITU-T G.693 VSR2000-2R1, SDH I-64.1[3] and OTN P1I1-2D1 (up to 2km), IEEE 802.3ae 10GBASE-LR/LW[4] and 10G Fiber Channel 1200-SM-LL-L[5] (up to 10km).
Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472[6].
The FTLX1472M3BCL transceivers utilize internal clock and data recovery (CDR) units on the transmitter and the receiver chains for SONET/SDH jitter compliance and to enhance the signal integrity on XFP XFI-like host card designs. Finisar's FTLX1472M3BCL transceivers are RoHS compliant and lead free[7,8].

PRODUCT SELECTION

FTLX1472M3BCL

I. Pin Descriptions

Pin	Symbol	Name/Description	Ref.
1	V_{EET}	Transmitter Ground	1
2	T_{FAULT}	Transmitter Fault	2
3	T_{DIS}	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.	4
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	5
9	RS1	Rate Select 1.	4
10	V_{EER}	Receiver Ground	1
11	V_{EER}	Receiver Ground	1
12	RD-	Receiver Inverted DATA out. AC Coupled.	
13	RD+	Receiver Non-inverted DATA out. AC Coupled.	
14	V_{EER}	Receiver Ground	1
15	V_{CCR}	Receiver Power Supply	
16	V_{CCT}	Transmitter Power Supply	
17	V_{EET}	Transmitter Ground	1
18	TD+	Transmitter Non-Inverted DATA in. AC Coupled.	
19	TD-	Transmitter Inverted DATA in. AC Coupled.	
20	V_{EET}	Transmitter Ground	1

Notes:
1. Circuit ground is internally isolated from chassis ground.
2. T_{FAULT} 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 Vcc + 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_{DIS} >2.0V or open, enabled on T_{DIS} <0.8V.
4. Internally pulled down per SFF-8431 Rev 2.0. See Sec. X for the logic table to use for the internal CDRs locking modes.
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.

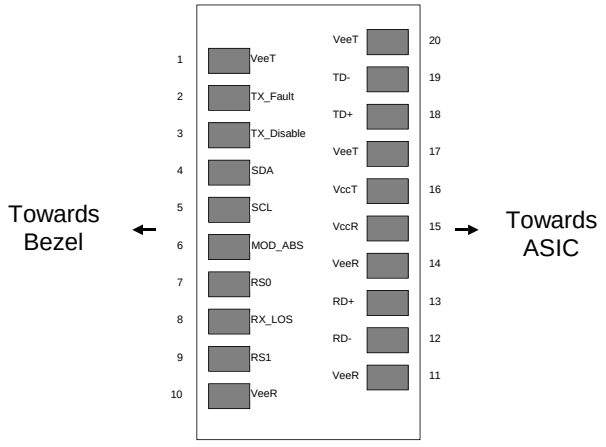


Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names.

II. Absolute Maximum Ratings

Exceeding the limits below may damage the transceiver module permanently.

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Maximum Supply Voltage	Vcc	-0.5		4.0	V	
Storage Temperature	T_S	-40		85	°C	
Relative Humidity	RH	0		85	%	1

Notes:
1. Non-condensing.

III. Electrical Characteristics (T_{OP} = -5 to 75 °C)

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	Vcc	3.14	3.30	3.46	V	
Supply Current	Icc		300	430	mA	
Power Dissipation	P_{diss}			1.5	W	
Transmitter						
Input differential impedance	R_{in}		100		Ω	1
Differential data input swing	Vin,pp	200		1800	mV	
Transmit Disable Voltage	V_D	V_{cc}-0.8		V_{cc}	V	
Transmit Enable Voltage	V_{EN}	V_{ee}		V_{ee}+ 0.8	V	
Receiver						
Differential data output swing	V_{out},pp	300		850	mV	2
Output rise time and fall time	T_r, T_f	28			ps	3
LOS asserted	$V_{LOS\ A}$	V_{cc}-0.8		V_{cc}	V	4
LOS de-asserted	$V_{LOS\ D}$	V_{ee}		V_{ee}+0.8	V	4
Power Supply Noise Tolerance	VccT/VccR	Per SFF-8431 Rev 3.0			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 3.0.
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 3.0.

IV. Optical Characteristics (T_{OP} = -5 to 75 °C, V_{CC} = 3.14 to 3.46 Volts)

Parameter		Symbol	Min	Typ	Max	Unit	Ref.
Transmitter (Tx)							
Optical Modulation Amplitude (OMA)		P_{OMA}	-5.2			dBm	1
Average Launch Power		P_{AVE}	-6		-1	dBm	
Optical Wavelength		λ	1290		1330	nm	
Side-Mode Suppression Ratio		SMSR	30			dB	
Optical Extinction Ratio		ER	6			dB	
Path Penalty		TDP_S			1	dB	2
Transmitter and Dispersion Penalty		TDP_E			3.2	dB	1
Average Launch power when transmitter is OFF		P_{OFF}			-30	dBm	
Tx Jitter 20kHz-80MHz		Tx_{j1}			0.3	UI	2,3
Tx Jitter 4MHz – 80MHz		Tx_{j2}			0.1	UI	2,3
Relative Intensity Noise		RIN			-128	dB/Hz	
Receiver (Rx)							
Sensitivity (Average Power)	9.95/10.7Gb/s	R_{SENS1}			-11.0	dBm	4
	10.3/10.5Gb/s	R_{SENS2}			-14.4	dBm	5
	11.1/11.3Gb/s	R_{SENS3}			-13.4	dBm	6
Sensitivity (OMA)	8.5Gb/s	R_{SENS4}			-13.8	dBm	7
	10.3/10.5Gb/s	R_{SENS5}			-12.6	dBm	
Stressed Sensitivity (OMA)	10.3Gb/s	R_{SENS6}			-10.3	dBm	6
Overload (Average Power)		P_{AVE}			+0.5	dBm	
Optical Center Wavelength		λ_C	1260		1600	nm	
Receiver Reflectance		R_{rx}			-14	dB	
LOS De-Assert		LOS_D			-17	dBm	
LOS Assert		LOS_A	-30			dBm	
LOS Hysteresis		LOS_H	0.5			dB	

Notes:
1. For Ethernet and Fiber Channel applications [4], [5]
2. For SONET/SDH applications the jitter specifications are defined as per [9].
3. If the CDRs are in bypass mode, the Tx jitter is compliant to the specification defined in [4].
4. Measured with worst ER=6 dB; BER<10^{-12}; $2^{31} - 1$ PRBS.
5. As per [4]. As long as the ER measured at the receiver guarantees a min OMA of -12.6 dBm (i.e. average input power of -13.4 dBm for ER=6 dB)
6. As per [4]. Equivalent to an average input power of -11.08 dBm at ER = 6 dB.
7. As per [10]

V. General Specifications

Bit rates: supports 8.5Gb/s and from 9.95328 to 11.3168Gb/s bit rates

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Bit Error Ratio	BER			10^{-12}		1
Max. Supported Link Length	L_{MAX}	2		10	km	2

Notes:
1. Tested with a $2^{31} - 1$ PRBS pattern.
2. Max 2 km over G.652 single mode fiber as per [2]. Max 10 km as per [4], [5].

VI. Environmental Specifications

The operating temperatures of Finisar FTLX1472M3BCL are shown in the following table

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Case Operating Temperature	T_{op}	-5		75	°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 FTLX1472M3BCL SFP+ transceivers support the 2-wire serial communication protocol as defined in the SFP MSA [1]. It is very closely related to the E^2PROM 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 a 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^2PROM 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^2PROM 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 [1], [6] 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

FTLX1472M3BCL transceivers can be used in host systems that require either internally or externally calibrated digital diagnostics.

Parameter	Symbol	Units	Min	Max	Accuracy	Ref.
Accuracy						
Transceiver temperature	ΔDD_{Temp}	ºC	-10	80	±5ºC	1
Transceiver supply voltage	$\Delta DD_{Voltage}$	V	2.8	4.0	±3%	
Transmitter bias current	ΔDD_{Bias}	mA	0	20	±10%	2
Transmitter output power	$\Delta DD_{Tx\text{-}Power}$	dBm	-10	+2	±2dB	
Receiver average optical input power	$\Delta DD_{Rx\text{-}Power}$	dBm	-22	+2	±2dB	

Notes: 1. Internally measured

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

X. Internal CDR's Locking Modes

The FTLX1472M3BCL is equipped with internal CDR units on both the receiver and the transmitter sides. The host can set the CDR's to lock at 8.5Gb/s, 10G (9.95-11.3Gb/s), or in by-pass mode, by setting the rate select pins or the soft bits (logic OR). The different locking modes are shown in the following logic table:

R/S 0 Logic OR of: pin 7 & bit 110.3	R/S 1 Logic OR of: pin 9 & bit 118.3	CDR's Locking Mode
Low or 0	Low or 0	Both CDR's lock at 8.5Gb/s
Low or 0	High or 1	Tx CDR is in bypass mode. Rx CDR locks at 10G (9.95-11.3Gb/s)
High or 1	Low or 0	Tx & Rx CDR's in bypass mode
High or 1	High or 1	Both CDR's lock at 10G (9.95-11.3Gb/s) The bits 110.3 and 118.3 are set to 1 by default at power-up

The RS0 and RS1 pins are internally pulled-down to ground as per [1]. The soft bits 110.3 and 118.3 are both set to "1" at the transceiver power-up, to select the 10G locking mode by default. The host can change this configuration via the 2-wire communication as described in the SFP MSA [1]. Alternative configurations can be factory set upon request. Please refer to Finisar for additional details.

XI. SFF-8431 Power-up Sequence

The typical power consumption of the FTLX1472M3BCL will not exceed the limit of 1.5W specified in [1] for the Power Level II device. Moreover, the FTLX1472M3BCL is factory set to power-up directly to its operating conditions in Power Level Mode II, but upon request, it can be factory set to follow the power-up sequence specified in the SFF-8431 for transceivers exceeding 1W.
For additional details please, refer to [1] and Finisar's Application Note AN-2076.

XII. Mechanical Specifications

Finisar FTLX1472M3BCL 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.

ITEM	DIM (mm)	TOL (mm)
A	9.00	± 0.3
B	9.60	± 0.5
C	11.90	± 0.5
D	13.85	± 0.15
E	13.65	± 0.15
F	2.80	± 0.2
G	1.00	± 0.2
H	4.00	REF
J	2.00	± 0.2
K	56.50	REF
L	1.60	± 0.5
M	2.25	± 0.1
N	1.80	± 0.1
P	37.10	± 0.3
Q	9.15	± 0.15
R	1.00	± 0.1
S	8.55	± 0.15
T	47.50	± 0.2
V	2.55	± 0.1
W	43.00	± 0.2
X	14.70	± 0.5
Z	0.55	± 0.15

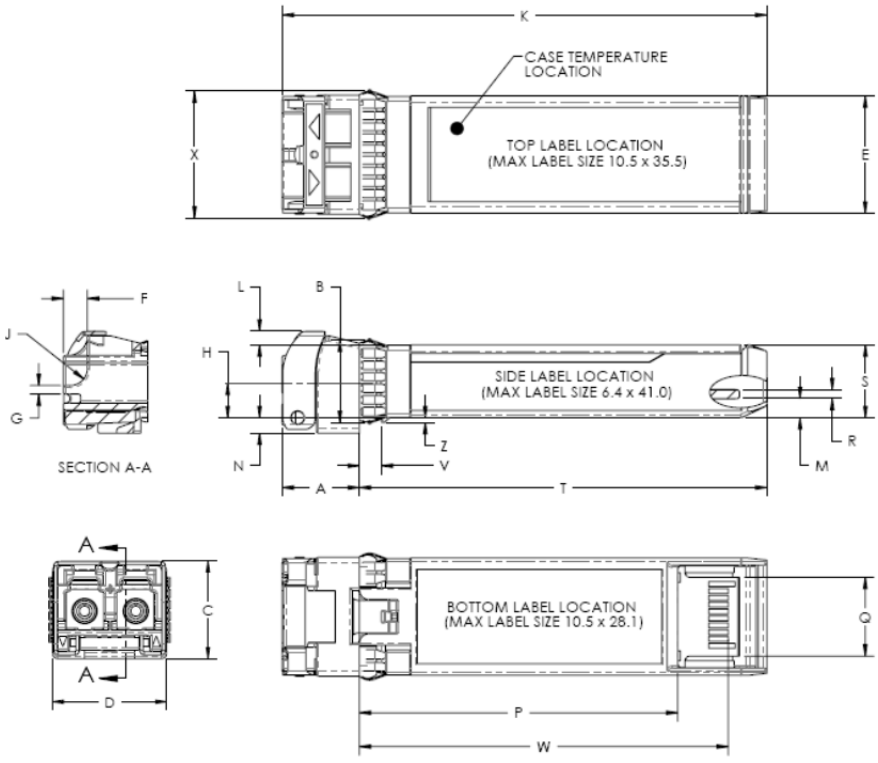


Figure 2. Mechanical Dimensions

XIII. PCB Layout and Bezel Recommendations

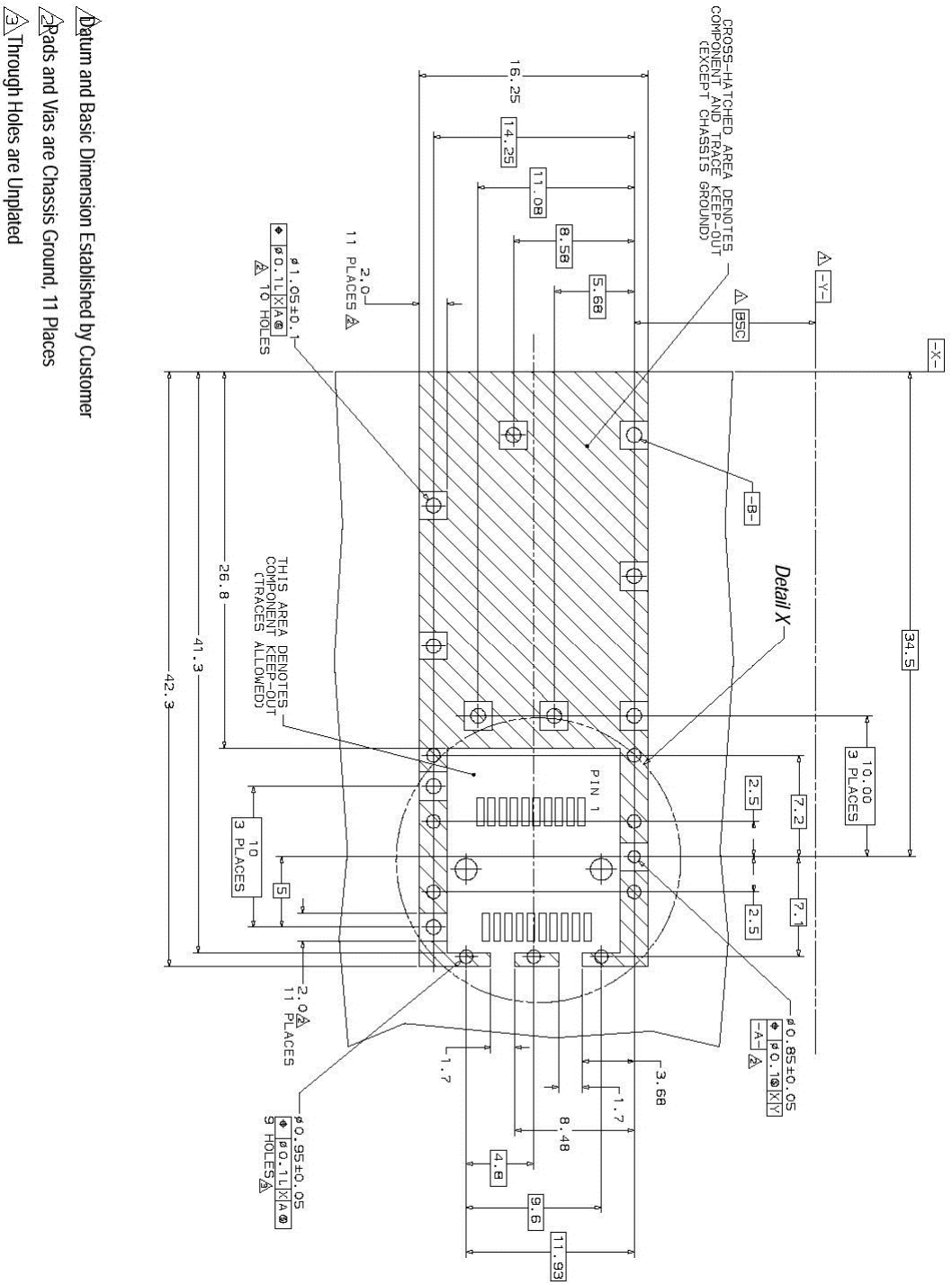
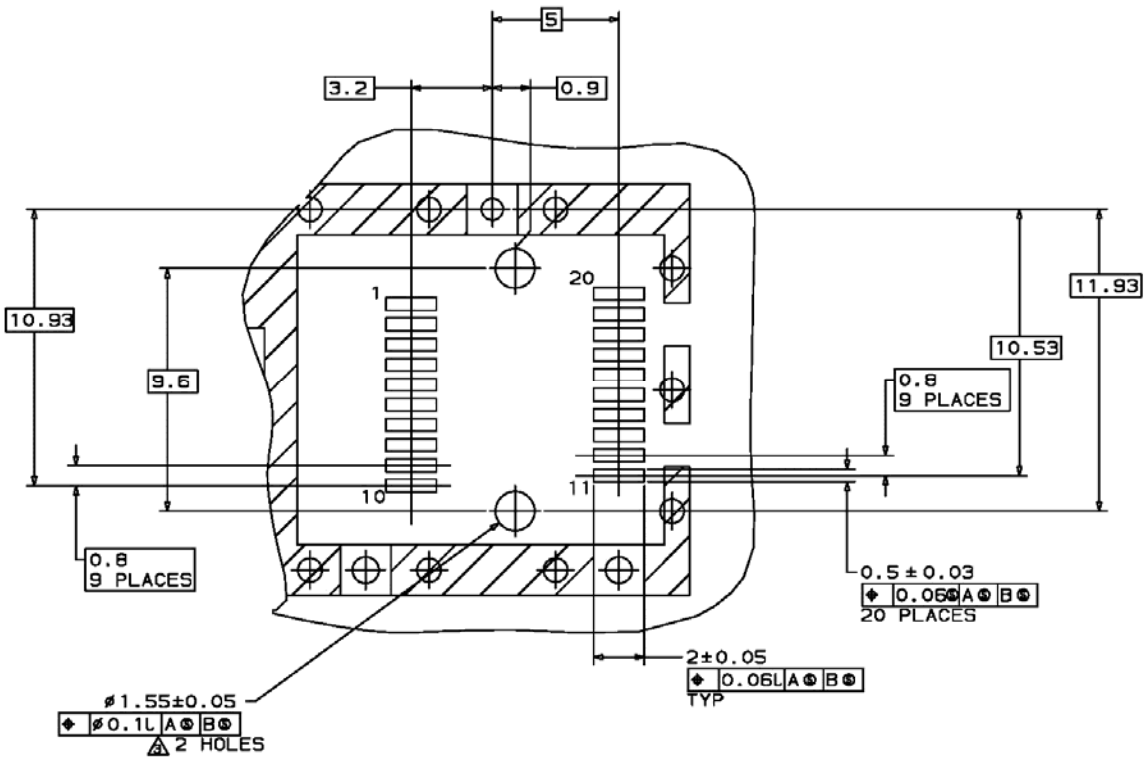
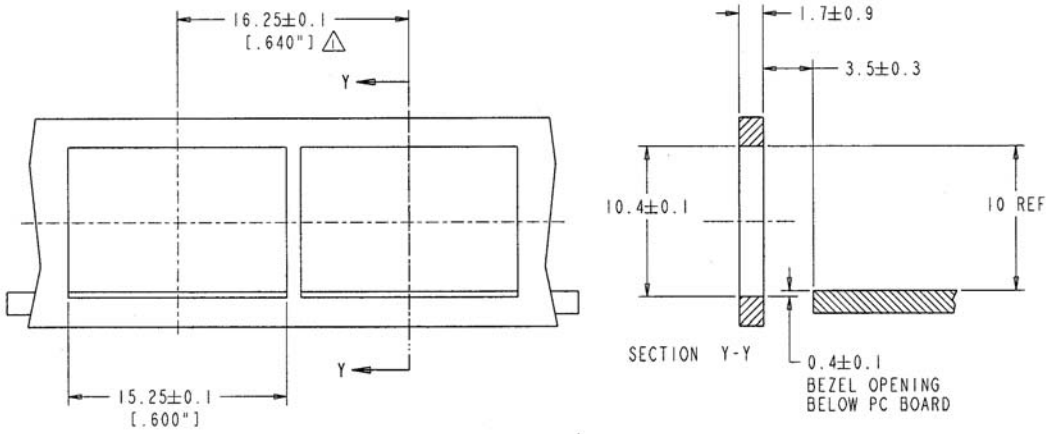


Figure 3. PCB Layout and Bezel Recommendations





NOTES:

1. MINIMUM PITCH ILLUSTRATED, ENGLISH DIMENSIONS ARE FOR REFERENCE ONLY
2. NOT RECOMMENDED FOR PCI EXPANSION CARD APPLICATIONS

XIV. References

1. "Specifications for Enhanced 8.5 and 10 Gigabit Small Form Factor Pluggable Module 'SFP+ '", SFF Document Number SFF-8431, Revision 4.1, including SFF-8431 Rev 4.1 Addendum. September 15, 2013
2. "Improved Pluggable Form factor", SFF Document Number SFF-8432, Revision 4.2, April 18, 2007.
3. ITU-T G.693, VSR2000-2R1 Optical interface parameters specified for SONET/SDH applications with 2km target distance
4. IEEE 802.3ae, Clause 52, PMD Type 10GBASE-LR. IEEE Standards Department.
5. American National Standard for Information Technology - Fibre Channel - 10 Gigabit Fibre Channel, Rev 3.5, April 9, 2003.
6. "Digital Diagnostics Monitoring Interface for Optical Transceivers". SFF Document Number SFF-8472, Revision 10.1, March 1, 2007.
7. 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". 08-June 2011, which supersedes the previous ROHS Directive 2002/95/EC.
8. "Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers", Finisar Corporation, January 21, 2005.
9. ITU-T G.8251, The control of jitter and wander within the optical transport network (OTN)
10. Fibre Channel, Physical Interface-5, (FC-PI-5), REV 6.00, September 21, 2010

XV. Revision History

Revision	Date	Description
A	08/29/2011	First Release
B	01/02/2012	Narrower transmitter wavelength range definition
B2	12/15/2013	Modified CDR's control logic table

XVI. For More Information

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