Product Specification

Industrial Temperature DWDM
10G Multi-Rate, 40km SFP+ Transceiver

FTLX3971MTCxx

PRODUCT FEATURES

- 100 GHz spacing, DWDM C-band
- Up to 40km link length
- 1.2 through 11.3 Gb/s data rates
- -40/85°C case temperature range
- Single 3.3V power supply
- Cooled 1550nm EML laser
- Hot-pluggable SFP+ footprint
- Limiting electrical interface receiver
- Duplex LC connector
- Built-in digital diagnostic functions
- RoHS-6 compliant

APPLICATIONS

- DWDM 40km links for:
  - Fibre Channel 2G through 10G
  - Ethernet 1G through 10G
  - CPRI options 2 through 8
  - OTN OTU 1, 2 and 2f

Finisar FTLX3971MTCxx transceivers are Enhanced Small Form Factor Pluggable SFP+ transceivers designed for use in DWDM links up to 40km of G.652 single mode fiber, for multi-rate applications from 1.2 through 11.3 Gb/s, carrying 1-10G Ethernet, 1-10G Fibre Channel, 10G OTN traffic or CPRI options 2 through 8 traffic. The FTLX3971MTCxx transceivers are compliant with SFF-8431[1] and SFF-8432[2].

Finisar FTLX3971MTCxx transceivers use internal re-timers (clock and data recovery or CDR) for the transmitter and the receiver to guarantees compliance with the SONET/SDH jitter requirements.

Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472[3]. Finisar FTLX3971MTCxx transceivers are RoHS compliant per Directive 2011/65/EU [4,5].

PRODUCT SELECTION

FTLX3971MTCxx

xx=ITU-T Grid Channel (see next page)

Product Ordering Codes / Channel Selection

Channel	Product Code	Frequency (THz)	Center Wavelength (nm)		Channel	Product Code	Frequency (THz)	Center Wavelength (nm)
C20	FTLX3971MTC20	192.00	1561.42		C41	FTLX3971MTC41	194.10	1544.53
C21	FTLX3971MTC21	192.10	1560.61		C42	FTLX3971MTC42	194.20	1543.73
C22	FTLX3971MTC22	192.20	1559.79		C43	FTLX3971MTC43	194.30	1542.94
C23	FTLX3971MTC23	192.30	1558.98		C44	FTLX3971MTC44	194.40	1542.14
C24	FTLX3971MTC24	192.40	1558.17		C45	FTLX3971MTC45	194.50	1541.35
C25	FTLX3971MTC25	192.50	1557.36		C46	FTLX3971MTC46	194.60	1540.56
C26	FTLX3971MTC26	192.60	1556.55		C47	FTLX3971MTC47	194.70	1539.77
C27	FTLX3971MTC27	192.70	1555.75		C48	FTLX3971MTC48	194.80	1538.98
C28	FTLX3971MTC28	192.80	1554.94		C49	FTLX3971MTC49	194.90	1538.19
C29	FTLX3971MTC29	192.90	1554.13		C50	FTLX3971MTC50	195.00	1537.40
C30	FTLX3971MTC30	193.00	1553.33		C51	FTLX3971MTC51	195.10	1536.61
C31	FTLX3971MTC31	193.10	1552.52		C52	FTLX3971MTC52	195.20	1535.82
C32	FTLX3971MTC32	193.20	1551.72		C53	FTLX3971MTC53	195.30	1535.04
C33	FTLX3971MTC33	193.30	1550.92		C54	FTLX3971MTC54	195.40	1534.25
C34	FTLX3971MTC34	193.40	1550.12		C55	FTLX3971MTC55	195.50	1533.47
C35	FTLX3971MTC35	193.50	1549.32		C56	FTLX3971MTC56	195.60	1532.68
C36	FTLX3971MTC36	193.60	1548.51		C57	FTLX3971MTC57	195.70	1531.90
C37	FTLX3971MTC37	193.70	1547.72		C58	FTLX3971MTC58	195.80	1531.12
C38	FTLX3971MTC38	193.80	1546.92		C59	FTLX3971MTC59	195.90	1530.33
C39	FTLX3971MTC39	193.90	1546.12		C60	FTLX3971MTC60	196.00	1529.55
C40	FTLX3971MTC40	194.00	1545.32					

Table 1. Product ordering codes: the central wavelength is defined as per ITU-T 694.1

I. Pin Descriptions

Pin	Symbol	Name/Description	Ref.
1	V_{EET}	Transmitter Ground	1
2	T_{FAULT}	Transmitter Fault	2,3
3	T_{DIS}	Transmitter Disable. Laser output disabled on high or open.	4
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	5
7	RS0	Rate Select 0.	
8	RX_LOS	Loss of Signal indication. Logic 0 indicates normal operation.	6
9	RS1	Rate Select 1.	
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	7
16	V_{CCT}	Transmitter Power Supply	7
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. 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.
3. 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.
4. Laser output disabled on T_{DIS} >2.0V or open, enabled on T_{DIS} <0.8V.
5. Internally pulled down per SFF-8431 Rev 4.1.
6. 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.
7. Internally connected

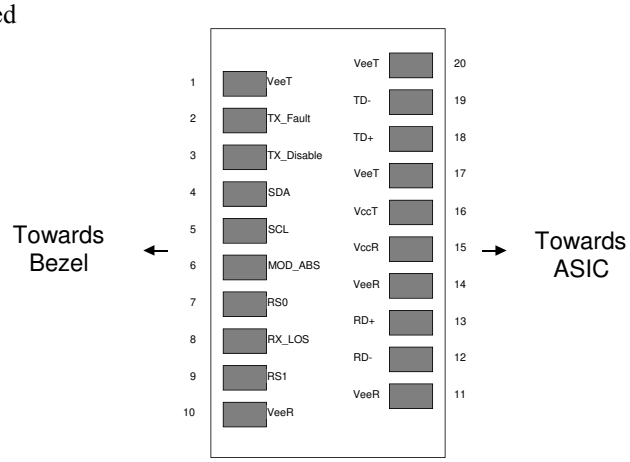


Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names.

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
Receiver Optical Damage Threshold	RxDamage	5			dBm	

Notes:

1. Non-condensing

III. Electrical Characteristics (T_{OP} = -40 to 85 °C)

Parameter		Symbol	Min	Typ.	Max	Unit	Ref.
Supply Voltage		V_{cc}	3.14		3.46		
Transmitter							
Input differential impedance		R_{in}	80	100	120	Ω	
Differential data input swing		Vin,pp	120		850	mV	1
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							
Output differential impedance		R_{out}	80	100	120	Ω	
Differential data output swing		$V_{out,pp}$	300		850	mV	1
Output rise time and fall time		T_r, T_f	24			ps	2
LOS asserted		V_{LOS_A}	V_{cc}-0.8		V_{cc}	V	3
LOS de-asserted		V_{LOS_D}	V_{ee}		V_{ee}+0.8	V	3
Power Supply Noise Tolerance		V_{ccT}/V_{ccR}	Per SFF-8431 Rev 4.1			mV_{pp}	4
Power Consumption	CDR ON	P_{cons}			1.9	W	5,6
	CDR OFF				1.6	W	6,7

Notes:

1. Internally AC coupled. Data pins connect directly to the CDR.
2. 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. Lower limit as per XFP MSA, Tab. 18 (as the SFP+ MSA does not define electrical specifications for transceivers with internal retrimers or CDRs).
3. 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.
4. See Section 2.8.3 of SFF-8431 Rev 4.1.
5. Power consumption measured at 85°C case temperature, beginning of life and 3.3V supply voltage.
6. Contact Finisar if a lower power consumption variant is required.
7. With both receiver and transmitter CDR OFF.

IV. Optical Characteristics (TOP = -40 to 85 °C, VCC = 3.14 to 3.46 Volts)

Parameter			Symbol	Min	Typ	Max	Unit	Ref.
Transmitter (Tx)								
Average Launch Power			P_{AVE}	1		+4	dBm	
Optical Wavelength			λ_c	As per ITU-T 694.1			nm	1
Center Wavelength (End of Life)			λ_{c_EOL}	λ_c±100pm				
Side-Mode Suppression Ratio			SMSR	30			dB	
Optical Extinction Ratio			ER	8.2			dB	
Tx Jitter 20kHz - 80MHz			Tx_{j1}			0.3	UI	
Tx Jitter 4MHz - 80MHz			Tx_{j2}			0.1	UI	2
Average Launch power when Tx is OFF			P_{OFF}			-30	dBm	
Relative Intensity Noise			RIN			-128	dB/Hz	
Receiver (Rx)								
Optical Center Wavelength			λ_C	1260		1600	nm	
Reflectance			R_{rx}			-27	dB	
Sensitivity (0ps/nm)	Bit Rate (Gb/s)	BER						
	1.2÷10.7	$<10^{-12}$	R_{SENS1}			-24.0	dBm	3,4
	11.1÷11.3	$<10^{-6}$	R_{SENS3}			-24.0		3,5
Sensitivity (800ps/nm)	1.2÷10.7	$<10^{-12}$	R_{SENS4}			-22.0	dBm	3,4,5
	11.1÷11.3	$<10^{-6}$	R_{SENS6}			-22.0		3,5
Overload	<9.83		P_{OVER1}	-10			dBm	6
	≥9.83		P_{OVER2}	-7			dBm	3
Rx Noise-Limited Performance (OSNR)								
Bit Rate (Gb/s)	Max CD (ps/nm)	BER		Max OSNR (dB)			RDT	
1.2÷10.7	0	1E-12	$OSNR_1$	22			Default	3,5, 7,8
	800		$OSNR_2$	26			Default	
11.1÷11.3	0	1E-6	$OSNR_3$	18			Default	
	800		$OSNR_4$	22			Default	

Notes:
1. Refer to Tab. 1.
2. With both internal CDRs ON.
3. Measured with worst ER=8.2dB; $2^{31} - 1$ PRBS.
4. Bit rates below 9.83Gb/s are supported with the internal CDRs in bypass mode. Please see Sec. X for additional details.
5. 800ps/nm max chromatic dispersion tolerance over 40km of G.652 single mode fiber
6. Measured with worst ER=8.2dB; $2^7 - 1$ PRBS.
7. With optical input power at the receiver between -9 and -18 dBm
8. Please see Sec. XII for additional details on the Receiver Decision Threshold (RDT).

V. General Specifications

Parameter	Symbol	Min	Typ	Max	Units	Ref.
Bit Rate	BR	1.2288		11.3176	Gb/s	1
Max. Supported Link Length	L_{MAX}			40	km	2

Notes:
1. Tested with a $2^{31} – 1$ PRBS pattern at the BER defined in Table IV.
2. Over G.652 single mode fiber.

Timing Parameters

Parameter	Symbol	Min	Max	Units	Ref.
Time to initialize cooled module	t_start_up_cooled		10	s	

VI. Environmental Specifications

Finisar FTLX3971MTCxx's operating case temperature range:

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 FTLX3971MTCxx SFP+ transceivers support the 2-wire serial communication protocol as defined in the SFP MSA[1]. It is very closely related to the memory map 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 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" [7].

The operating and diagnostics information is monitored and reported by a Digital Diagnostics Transceiver Controller (DMTC) 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[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

FTLX3971MTCxx transceivers can be used in host systems that require either internally or externally calibrated digital diagnostics.

Parameter	Symbol	Units	Min	Max	Accuracy	Ref.
Transceiver temperature	Δ_{DMTemp}	ºC	-40	+85	±5ºC	1
Transceiver supply voltage	$\Delta_{DDVoltage}$	V	2.8	4.0	±3%	
Transmitter bias current	Δ_{DDBias}	mA	0	127	±10%	2
Transmitter output power	$\Delta_{DMTx-Power}$	dBm	-2	+3	±2dB	
Receiver average optical input power	$\Delta_{DDRx-Power}$	dBm	-25	-7	±2dB	

Notes: 1. Internally measured
2. The accuracy of the Tx bias current is 10% of the actual current from the laser driver to the laser

X. Internal CDRs (retimers) Locking Modes

The FTLX3971MTCxx is equipped with internal receiver and the transmitter retimers. The host can set the either retimer to lock between 9.835 and 11.31 Gb/s, or in by-pass mode, via 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	Tx & Rx CDR's in bypass mode
Low or 0	High or 1	Tx CDR is in bypass mode. Rx CDR locks at 10G (9.83-11.3Gb/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 (9.83-11.3Gb/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 FTLX3971MTCxx exceeds the limit of 1.5W specified for the Power Level II transceivers [1], for which a power-up sequence is recommended. However, the FTLX3971MTCxx is factory set to power-up directly to its operating conditions in Power Level Mode II. Upon request, it can be factory set to follow the power-up sequence specified for transceivers exceeding 1W, as per [1]. In power level

I, the FTLX3971MTCxx does not carry traffic, but the 2-wire serial communication is active.

Please refer to [1,3] and Finisar Application Note AN-2124 for additional details.

XII. Receiver Decision Threshold Control

The host can control the Receiver Decision Threshold (RxMT) of Finisar FTLX3971MTCxx SFP+ transceivers via the 2-wire serial communication, by setting the byte 131 of Table 02h. The availability of this function is indicated in Bit 3, Byte 64 of A0h in the serial ID section. Byte 131 is a 2's complement 7 bit value (-128 - +127) The decision threshold set is given by:

RxMT = default RxMT + [Byte(131)/256]*100%.

On power-up the byte 131 defaults to 0, corresponding to the RxMT optimum value. The actual RxMT range the formula covers is about ±20% around the default optimum value.

XIII. Mechanical Specifications

Finisar FTLX3971MTCxx SFP+ transceivers are compatible with the SFF-8432 specification for improved pluggable form factor, and shown here for reference purposes only. Bail color is red.

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

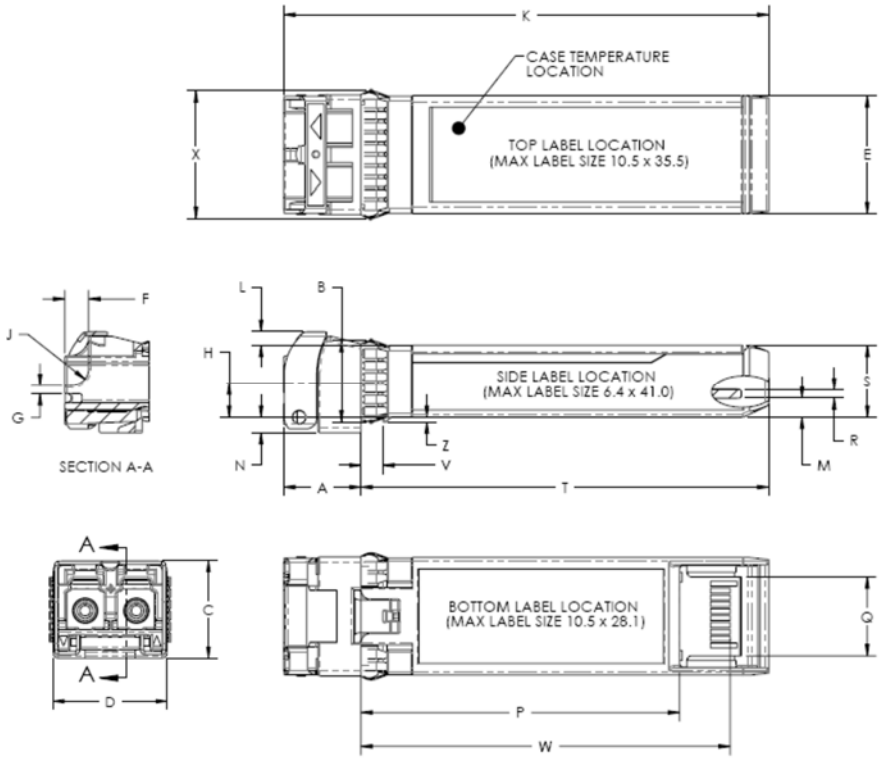


Figure 2. Mechanical Dimensions

Note: the option of the label on the top side of the transceiver is not recommended.

XIV. Host Board SFP+ Connector Recommendations

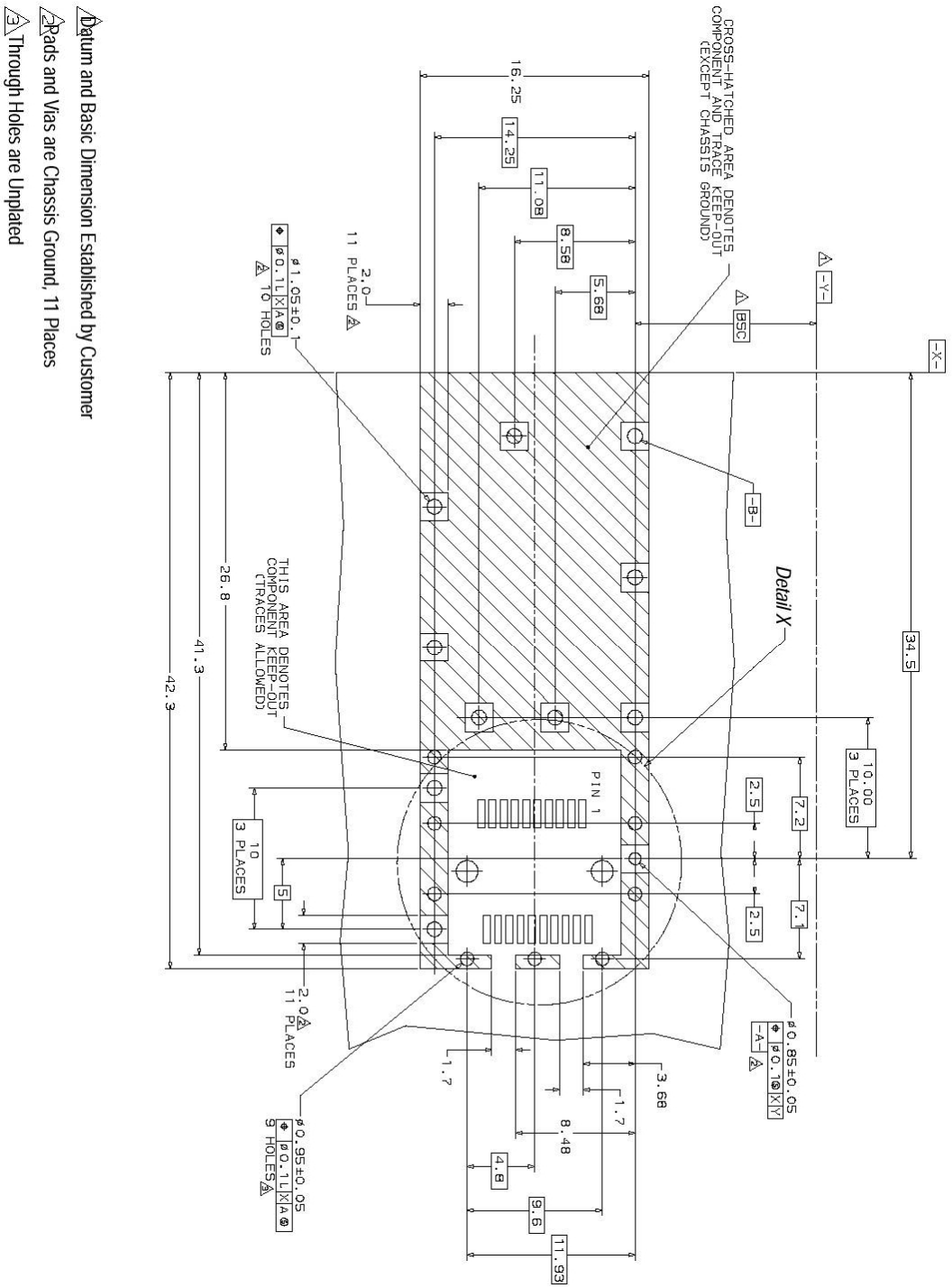
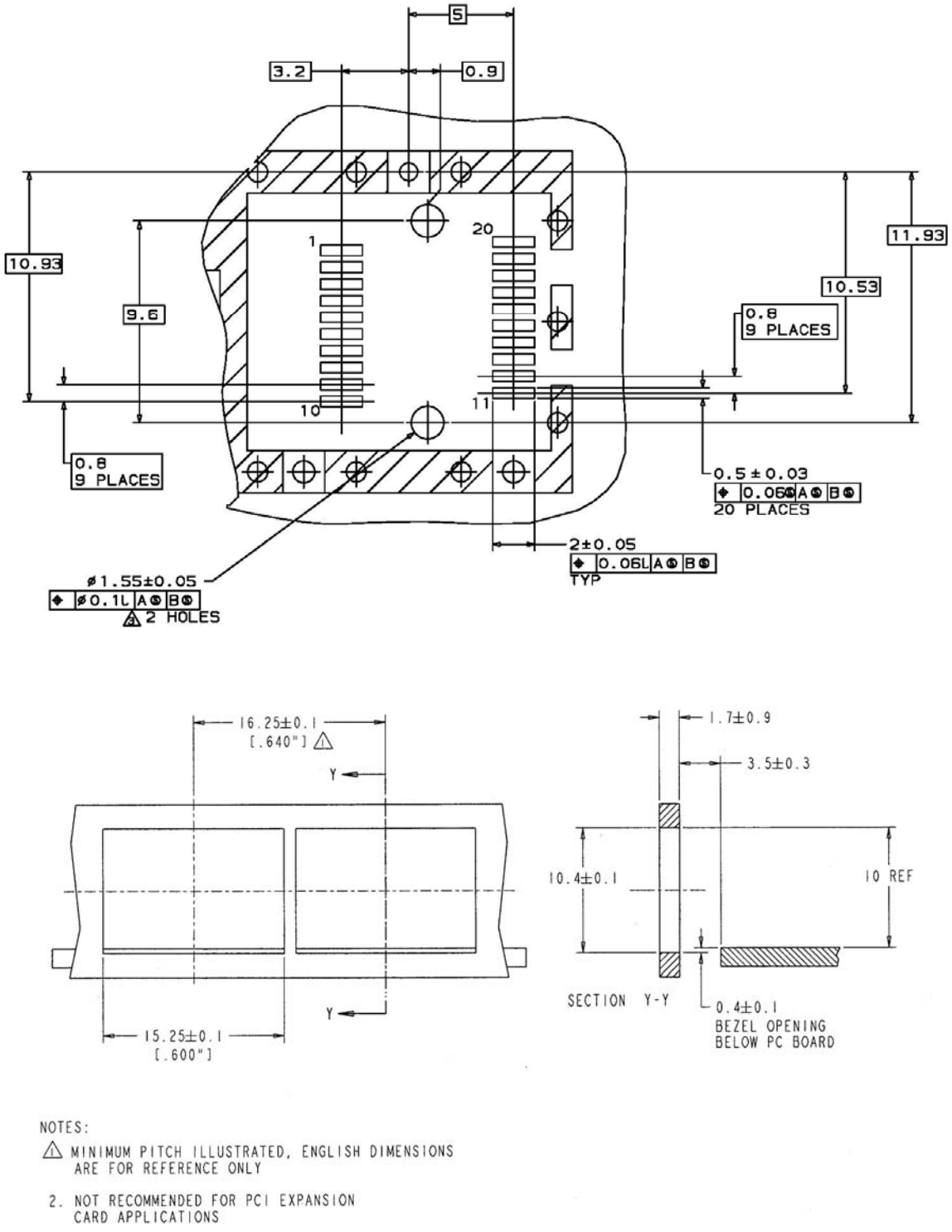


Figure 3. PCB Layout and Bezel Recommendations, as per [9]



NOTES:

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

Figure 4

XV. Host-Module Interface Diagram

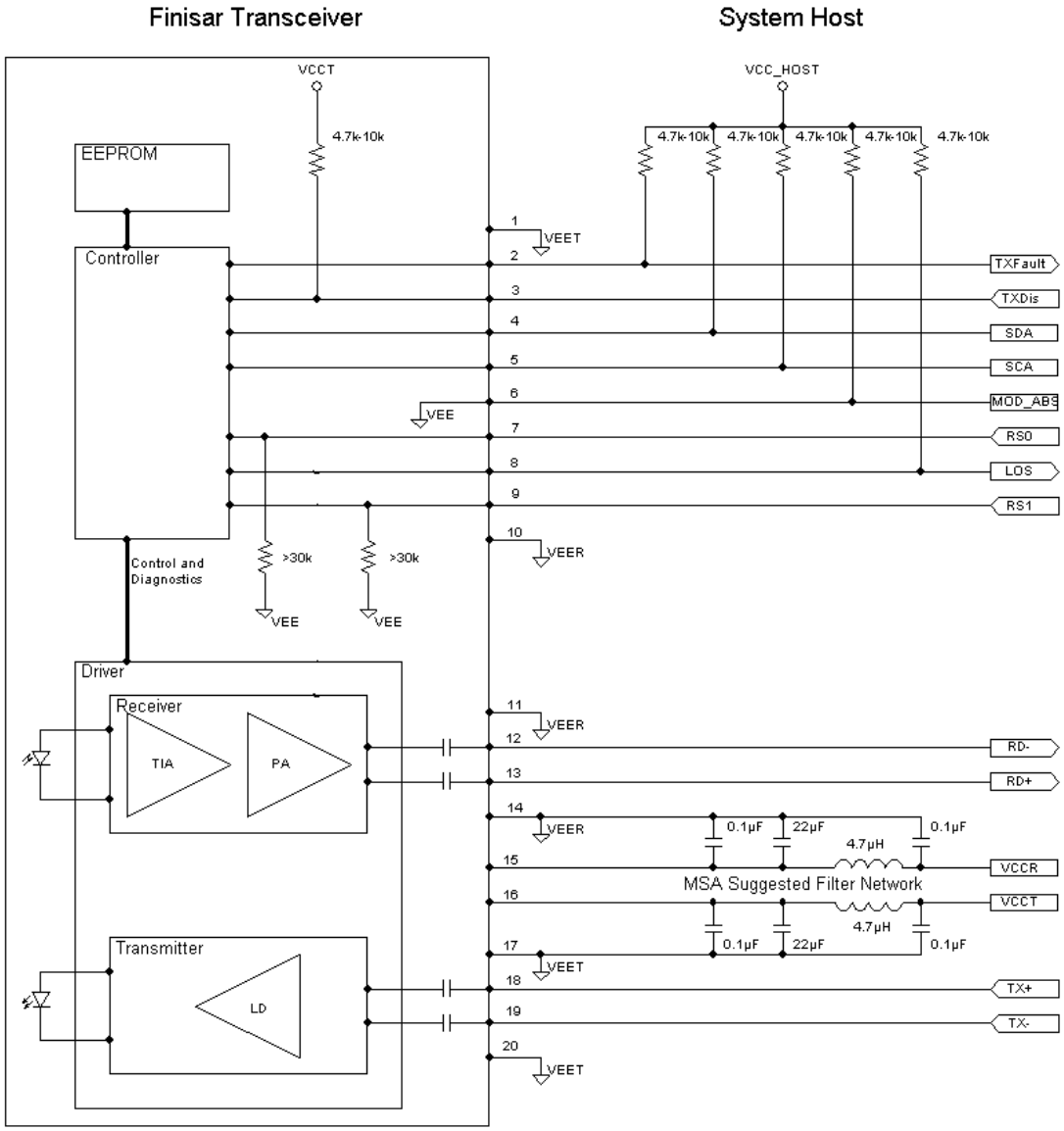


Figure 5

XVI. 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. "Digital Diagnostics Monitoring Interface for Optical Transceivers". SFF Document Number SFF-8472, Revision 12.2, November 21, 2014.
4. Directive 2011/65/EU of the European 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 exemption as allowed by the directive.
5. "Application Note AN-2038: Finisar Implementation of RoHS Compliant Transceivers", Finisar Corporation, January 21, 2005.
6. Small Form-factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA)
7. "Application Note AN-2030: Digital Diagnostic Monitoring Interface for SFP Optical Transceivers"
8. "Application Note AN-2076: SFP+ Level II Power Up Sequence", Rev B
9. "Application Note AN-2124: Addendum to AN-2030 with changes from SFF-8472 revision 12.2"

XVII. For More Information

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