# Product Specification

## Industrial Temperature DWDM 1.2G-11.3G, 40km SFP+ Transceiver

## FTLX3971DTCxx

### 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
- 1.6W max power consumption* at 85°C
- 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:
  - 2x through 10x Fibre Channel
  - 1G through 10G Ethernet
  - CPRI options 2 through 8
  - OTN OTU 1, 2 and 2f

Finisar's FTLX3971DTCxx 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 1G-10G Ethernet, 2x-10x Fibre Channel, 10G OTN traffic and CPRI options 2 through 8 traffic. The FTLX3971DTCxx transceivers are compliant with SFF-8431[1] and SFF-8432[2].

Digital diagnostics functions are available via a 2-wire serial interface, as specified in SFF-8472[3]. Finisar's FTLX3971DTCxx transceivers are RoHS compliant per Directive 2011/65/EU [4,5].

### PRODUCT SELECTION

| Product Part Number |
| --- |
| FTLX3971DTCxx |

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

(*) Please contact Finisar if 1.5W power consumption variant is required.

## Product Ordering Codes / Channel Selection

| Channel | Product Code | Frequency (THz) | Center Wavelength (nm) | | Channel | Product Code | Frequency (THz) | Center Wavelength (nm) |
|---|---|---|---|---|---|---|---|---|
| C20 | FTLX3971DTC20 | 192.00 | 1561.42 | | C41 | FTLX3971DTC41 | 194.10 | 1544.53 |
| C21 | FTLX3971DTC21 | 192.10 | 1560.61 | | C42 | FTLX3971DTC42 | 194.20 | 1543.73 |
| C22 | FTLX3971DTC22 | 192.20 | 1559.79 | | C43 | FTLX3971DTC43 | 194.30 | 1542.94 |
| C23 | FTLX3971DTC23 | 192.30 | 1558.98 | | C44 | FTLX3971DTC44 | 194.40 | 1542.14 |
| C24 | FTLX3971DTC24 | 192.40 | 1558.17 | | C45 | FTLX3971DTC45 | 194.50 | 1541.35 |
| C25 | FTLX3971DTC25 | 192.50 | 1557.36 | | C46 | FTLX3971DTC46 | 194.60 | 1540.56 |
| C26 | FTLX3971DTC26 | 192.60 | 1556.55 | | C47 | FTLX3971DTC47 | 194.70 | 1539.77 |
| C27 | FTLX3971DTC27 | 192.70 | 1555.75 | | C48 | FTLX3971DTC48 | 194.80 | 1538.98 |
| C28 | FTLX3971DTC28 | 192.80 | 1554.94 | | C49 | FTLX3971DTC49 | 194.90 | 1538.19 |
| C29 | FTLX3971DTC29 | 192.90 | 1554.13 | | C50 | FTLX3971DTC50 | 195.00 | 1537.40 |
| C30 | FTLX3971DTC30 | 193.00 | 1553.33 | | C51 | FTLX3971DTC51 | 195.10 | 1536.61 |
| C31 | FTLX3971DTC31 | 193.10 | 1552.52 | | C52 | FTLX3971DTC52 | 195.20 | 1535.82 |
| C32 | FTLX3971DTC32 | 193.20 | 1551.72 | | C53 | FTLX3971DTC53 | 195.30 | 1535.04 |
| C33 | FTLX3971DTC33 | 193.30 | 1550.92 | | C54 | FTLX3971DTC54 | 195.40 | 1534.25 |
| C34 | FTLX3971DTC34 | 193.40 | 1550.12 | | C55 | FTLX3971DTC55 | 195.50 | 1533.47 |
| C35 | FTLX3971DTC35 | 193.50 | 1549.32 | | C56 | FTLX3971DTC56 | 195.60 | 1532.68 |
| C36 | FTLX3971DTC36 | 193.60 | 1548.51 | | C57 | FTLX3971DTC57 | 195.70 | 1531.90 |
| C37 | FTLX3971DTC37 | 193.70 | 1547.72 | | C58 | FTLX3971DTC58 | 195.80 | 1531.12 |
| C38 | FTLX3971DTC38 | 193.80 | 1546.92 | | C59 | FTLX3971DTC59 | 195.90 | 1530.33 |
| C39 | FTLX3971DTC39 | 193.90 | 1546.12 | | C60 | FTLX3971DTC60 | 196.00 | 1529.55 |
| C40 | FTLX3971DTC40 | 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. Not used. | |
| 8 | RX_LOS | Loss of Signal indication. Logic 0 indicates normal operation. | 6 |
| 9 | RS1 | Rate Select 1. Not used. | |
| 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

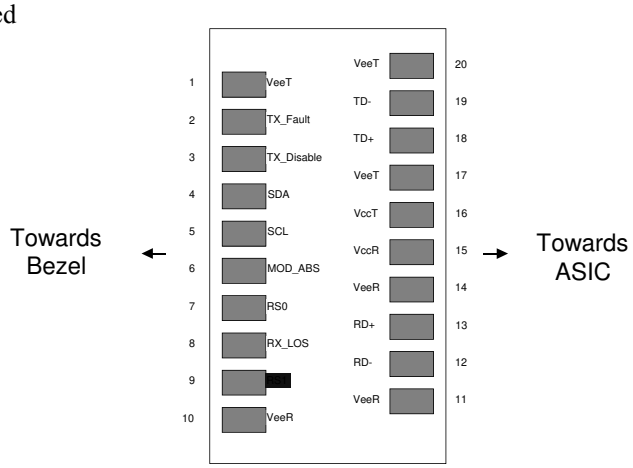



Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names.

## 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 | | | | 1.6 | W | 5,6 |

Notes:

1. Internally AC coupled.
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.
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. Please, contact Finisar if 1.5W power consumption variant is required.

## 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 | | | $\lambda_c$ | As per ITU-T 694.1 | | | nm | 1 |
| Center Wavelength (End of Life) | | | $\lambda_{c_EOL}$ | $\lambda_c$±100pm | | | | |
| Side-Mode Suppression Ratio | | | SMSR | 30 | | | dB | |
| Optical Extinction Ratio | | | ER | 8.2 | | | dB | |
| Average Launch power when Tx is OFF | | | $P_{OFF}$ | | | -30 | dBm | |
| Relative Intensity Noise | | | RIN | | | -128 | dB/Hz | |
| **Receiver (Rx)** | | | | | | | | |
| Optical Center Wavelength | | | $\lambda_C$ | 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 | 2 |
| | 11.1÷11.3 | $<10^{-6}$ | $R_{SENS3}$ | | | -24.0 | | |
| Sensitivity (800ps/nm) | 1.2÷10.7 | $<10^{-12}$ | $R_{SENS4}$ | | | -22.0 | dBm | 2,3 |
| | 11.1÷11.3 | $<10^{-6}$ | $R_{SENS6}$ | | | -22.0 | | 2,3 |
| Overload | <9.83 | | $P_{AVE1}$ | -10 | | | dBm | 4 |
| | ≥9.83 | | $P_{AVE2}$ | -7 | | | dBm | 2 |

Notes:
1. Refer to Tab. 1.
2. Measured with worst ER=8.2dB; $2^{31} - 1$ PRBS.
3. 800ps/nm max chromatic dispersion tolerance over 40km of G.652 single mode fiber
4. Measured with worst ER=8.2dB; $2^7 - 1$ PRBS.

## 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 patterns and 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 FTLX3971DTCxx'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 FTLX3971DTCxx 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 (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 $E^2$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[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

FTLX3971DTCxx 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 | $\Delta_{DDTemp}$ | ºC | -40 | +85 | ±5ºC | 1 |
| Transceiver supply voltage | $\Delta_{DDVoltage}$ | V | 2.8 | 4.0 | ±3% | |
| Transmitter bias current | $\Delta_{DDBias}$ | mA | 0 | 127 | ±10% | 2 |
| Transmitter output power | $\Delta_{DDTx\text{-}Power}$ | dBm | -2 | +3 | ±2dB | |
| Receiver average optical input power | $\Delta_{DDRx\text{-}Power}$ | 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. SFF-8431 Power-up Sequence

The typical power consumption of the FTLX3971DTCxx exceeds the limit of 1.5W specified for the Power Level II transceivers in [1], for which a power-up sequence is recommended. However, the FTLX3971DTCxx 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 FTLX3971DTCxx does not carry traffic, but the 2-wire serial communication is active.

Please refer to [1] and Finisar Application Note AN-2076 for additional details.

## XI. Receiver Decision Threshold Control

The host can control the Receiver Decision Threshold (RxDT) of Finisar FTLX3971DTCxx 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:

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

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

## XII. Mechanical Specifications

Finisar FTLX3971DTCxx 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 |

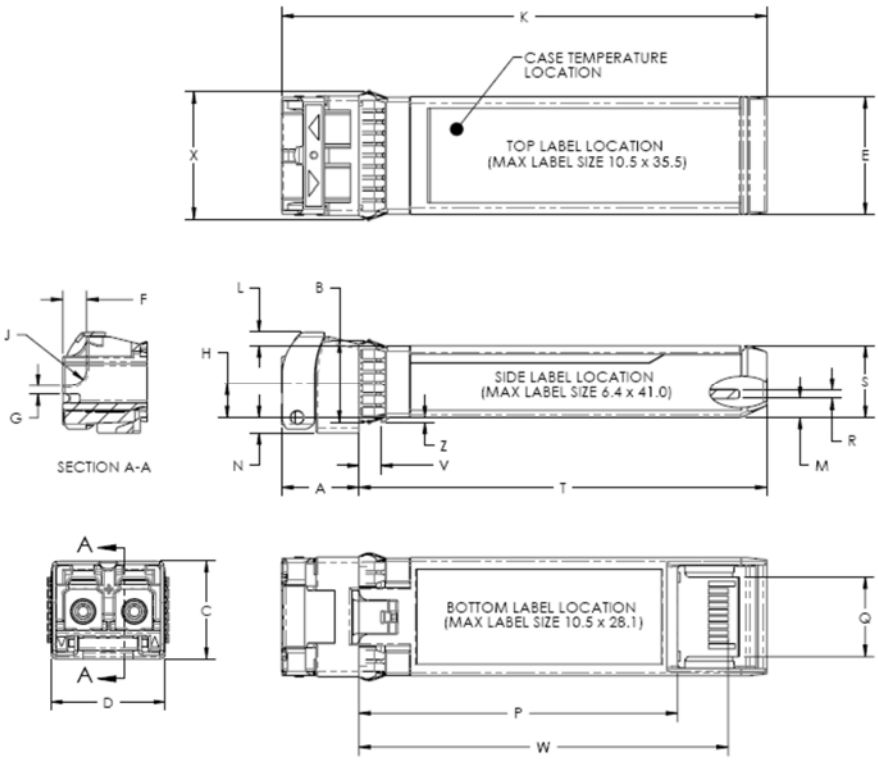



Figure 2. Mechanical Dimensions

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

## XIII. Host Board SFP+ Connector Recommendations

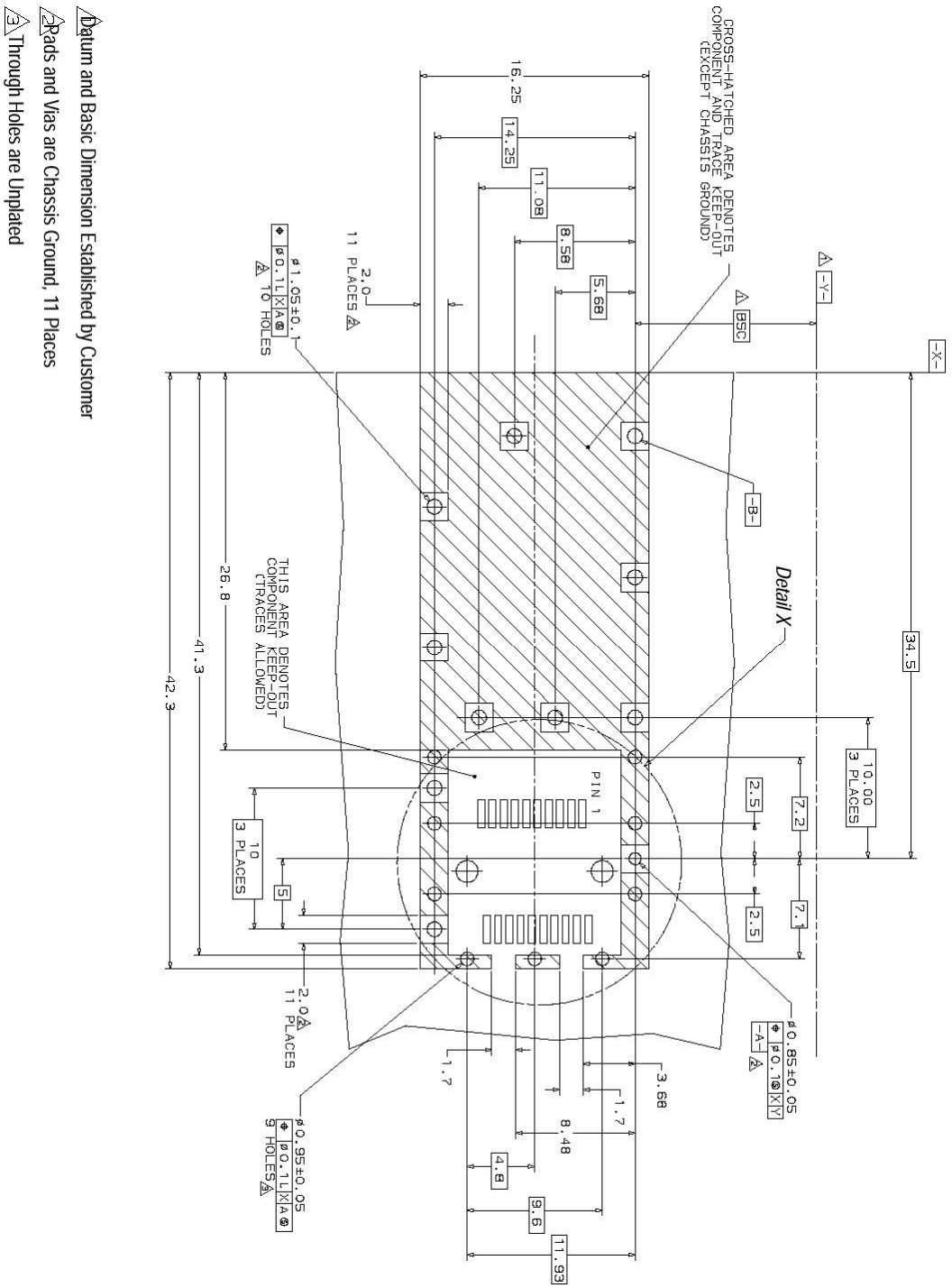
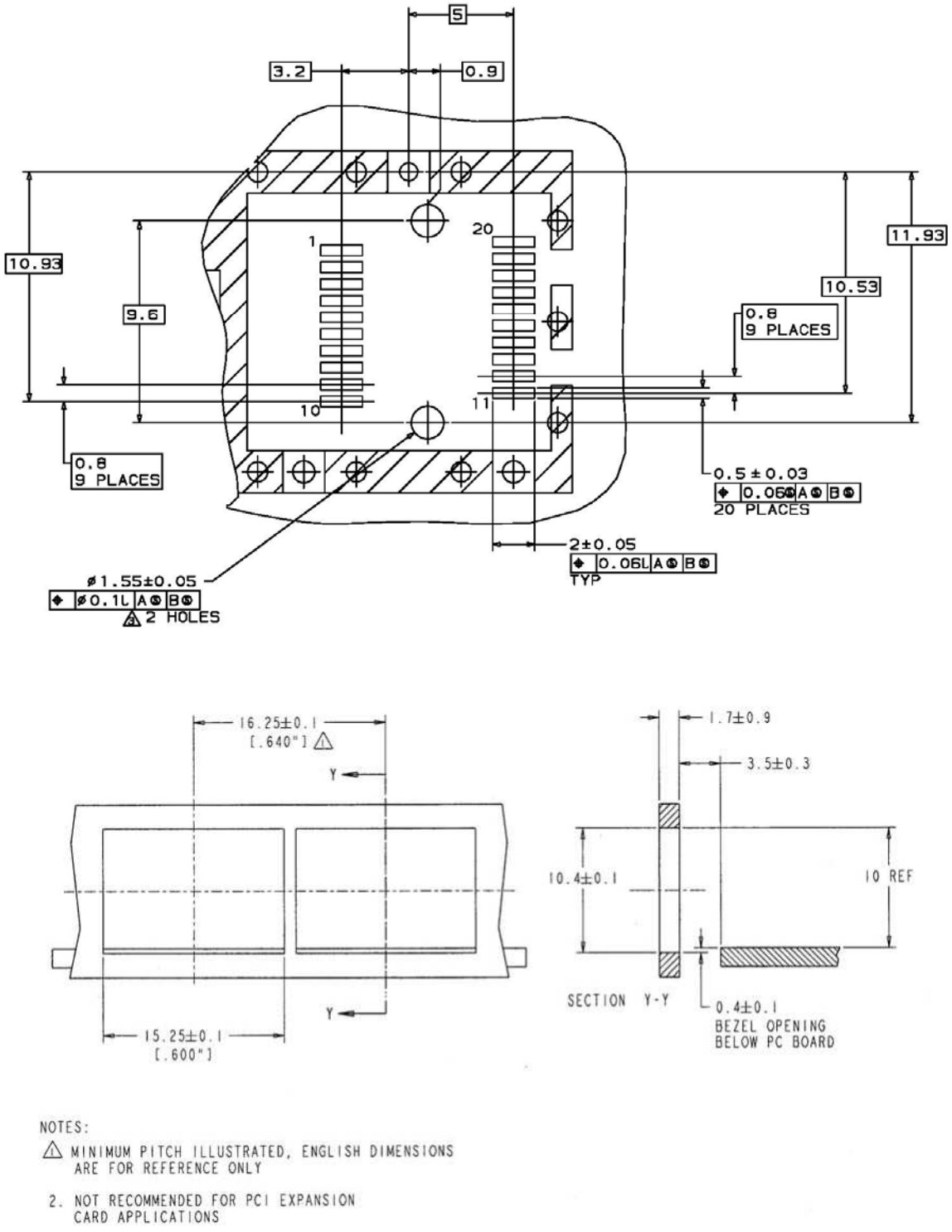



Figure 3. PCB Layout and Bezel Recommendations, as per [9]




NOTES:

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

**Figure 4**

## XIV. Host-Module Interface Diagram

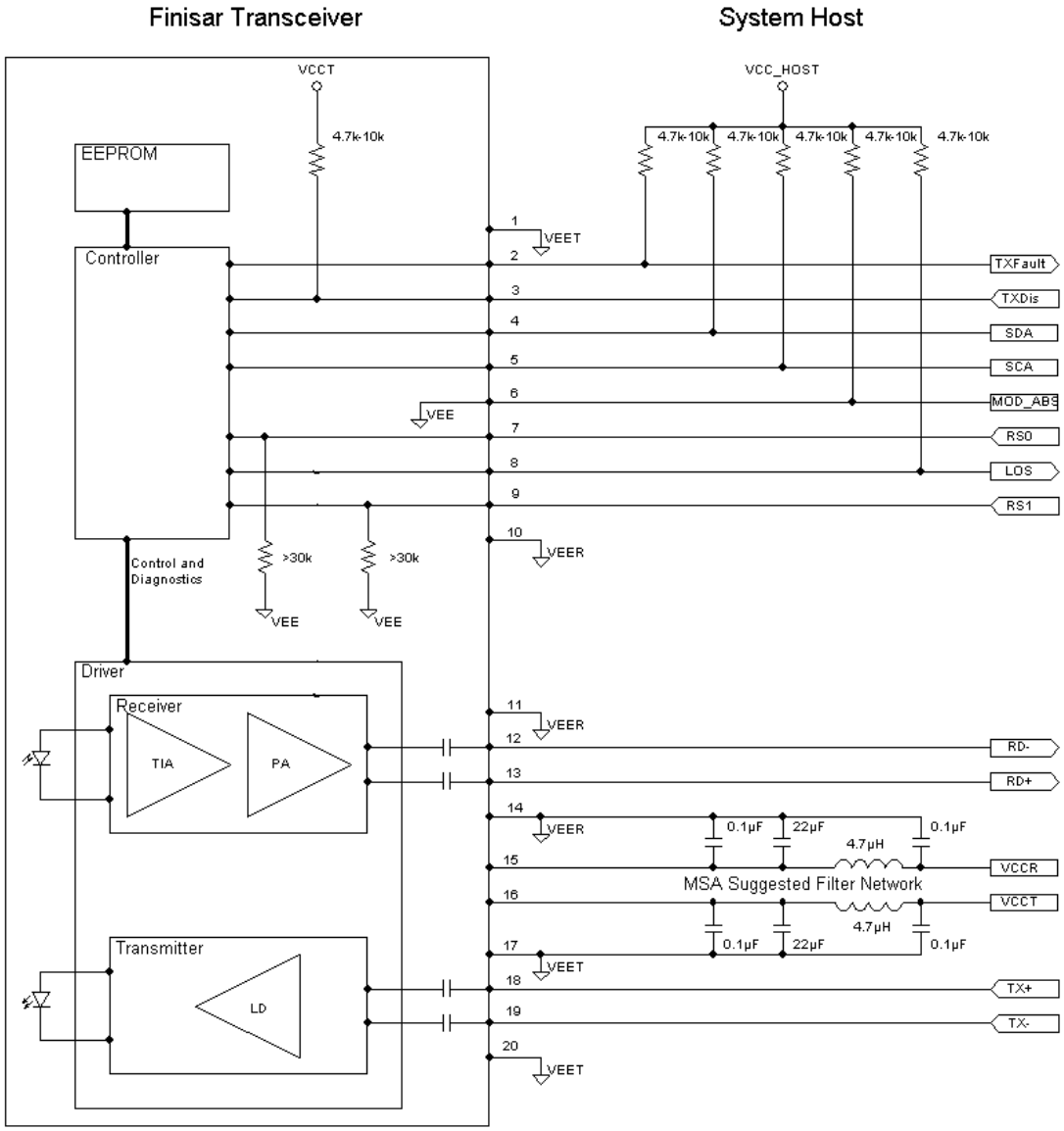



**Figure 5**

## XV. 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"


## XVI. For More Information


Finisar Corporation
1389 Moffett Park Drive
Sunnyvale, CA 94089-1133
Tel. 1-408-548-1000
Fax 1-408-541-6138
sales@finisar.com
www.finisar.com