

## Product Specification

### Multi-rate CWDM Pluggable SFP Transceiver

#### FWDM-1621-7D-xx

#### PRODUCT FEATURES

- Up to 2.67 Gb/s bi-directional data links
- Hot-pluggable SFP footprint
- Built-in digital diagnostic functions
- Uncooled DFB laser transmitter in 8 possible CWDM wavelengths
- APD Receiver
- Very low jitter
- Metal enclosure, for lower EMI
- Single 3.3V power supply
- Operating temperature range: 0°C to 70°C



#### APPLICATIONS

- Metro Access Rings and Point-to-Point networking for SONET, Gigabit Ethernet and Fibre Channel

Finisar's FWDM-1621-7D-xx CWDM Small Form Factor Pluggable (SFP) transceivers are designed for operation in Metro Access Rings and Point-to-Point networks using SONET<sup>1</sup>, Gigabit Ethernet<sup>2</sup> and Fibre Channel<sup>3</sup> networking equipment. They are available in eight different CWDM wavelengths and comply with the ITU CWDM standard<sup>4</sup>. Digital diagnostics functions are available via an I<sup>2</sup>C serial bus. In addition, they comply with the Small Form Factor Pluggable Multi-Sourcing Agreement (MSA)<sup>5</sup>.

#### PRODUCT SELECTION

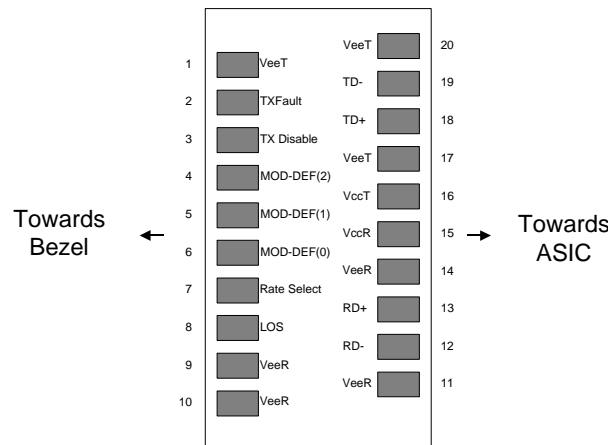
| Wavelength | xx | Clasp Color Code | Wavelength | xx | Clasp Color Code |
|------------|----|------------------|------------|----|------------------|
| 1470 nm    | 47 | Gray             | 1550 nm    | 55 | Yellow           |
| 1490 nm    | 49 | Violet           | 1570 nm    | 57 | Orange           |
| 1510 nm    | 51 | Blue             | 1590 nm    | 59 | Red              |
| 1530 nm    | 53 | Green            | 1610 nm    | 61 | Brown            |

**I. Pin Descriptions**

| Pin | Symbol             | Name/Description  | Ref. |
|-----|--------------------|---|------|
| 1   | V <sub>EET</sub>   | Transmitter Ground (Common with Receiver Ground)  | 1    |
| 2   | T <sub>FAULT</sub> | Transmitter Fault. Not supported.   |      |
| 3   | T <sub>DIS</sub>   | Transmitter Disable. Laser output disabled on high or open.                                       | 2    |
| 4   | MOD_DEF(2)         | Module Definition 2. Data line for Serial ID.   | 3    |
| 5   | MOD_DEF(1)         | Module Definition 1. Clock line for Serial ID.  | 3    |
| 6   | MOD_DEF(0)         | Module Definition 0. Grounded within the module.  | 3    |
| 7   | Rate Select        | No connection required  | 4    |
| 8   | LOS                | Loss of Signal indication. Logic 0 indicates normal operation.                                    | 5    |
| 9   | V <sub>EER</sub>   | Receiver Ground (Common with Transmitter Ground)  | 1    |
| 10  | V <sub>EER</sub>   | Receiver Ground (Common with Transmitter Ground)  | 1    |
| 11  | V <sub>EER</sub>   | Receiver Ground (Common with Transmitter 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 (Common with Transmitter 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 (Common with Receiver Ground)  | 1    |
| 18  | TD+                | Transmitter Non-Inverted DATA in. 100 ohm termination between TD+ and TD-, AC Coupled thereafter. |      |
| 19  | TD-                | Transmitter Inverted DATA in. See TD+   |      |
| 20  | V <sub>EET</sub>   | Transmitter Ground (Common with Receiver Ground)  | 1    |

**Notes:**

- Circuit ground is internally isolated from chassis ground.**
- Laser output disabled on T<sub>DIS</sub> >2.0V or open, enabled on T<sub>DIS</sub> <0.8V.
- Should be pulled up with 4.7k – 10kohms on host board to a voltage between 2.0V and 5.5V. MOD\_DEF(0) pulls line low to indicate module is plugged in.
- Finisar 2x receiver achieves simultaneous 1x and 2x operation without active control.
- LOS is open collector output. Should be pulled up with 4.7k – 10kohms on host board to a voltage between 2.0V and 5.5V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.



**Diagram of Host Board Connector Block Pin Numbers and Names**

**II. Absolute Maximum Ratings**

| Parameter                  | Symbol          | Min  | Typ | Max | Unit | Ref. |
|----------------------------|-----------------|------|-----|-----|------|------|
| Maximum Supply Voltage     | V <sub>CC</sub> | -0.5 |     | 4.7 | V    |      |
| Storage Temperature        | T <sub>S</sub>  | -40  |     | 85  | °C   |      |
| Case Operating Temperature | T <sub>OP</sub> | 0    |     | 70  | °C   |      |

**III. Electrical Characteristics (T<sub>OP</sub> = 0 to 70 °C, V<sub>CC</sub> = 3.15 to 3.60 Volts)**

| Parameter                      | Symbol                 | Min                   | Typ | Max                             | Unit | Ref. |
|--------------------------------|------------------------|-----------------------|-----|---------------------------------|------|------|
| Supply Voltage                 | V <sub>CC</sub>        | 3.15                  |     | 3.60                            | V    |      |
| Supply Current                 | I <sub>CC</sub>        |                       | 210 | 300                             | mA   |      |
| <b>Transmitter</b>             |                        |                       |     |                                 |      |      |
| Input differential impedance   | R <sub>in</sub>        |                       | 100 |                                 | Ω    | 1    |
| Single ended data input swing  | V <sub>in,pp</sub>     | 250                   |     | 1200                            | mV   |      |
| Transmit Disable Voltage       | V <sub>D</sub>         | V <sub>CC</sub> – 1.3 |     | V <sub>CC</sub>                 | V    |      |
| Transmit Enable Voltage        | V <sub>EN</sub>        | V <sub>EE</sub>       |     | V <sub>EE</sub> + 0.8           | V    | 2    |
| Transmit Disable Assert Time   |                        |                       |     | 10                              | us   |      |
| <b>Receiver</b>                |                        |                       |     |                                 |      |      |
| Single ended data output swing | V <sub>out,pp</sub>    | 250                   |     | 800                             | mV   | 3    |
| Data output rise time          | t <sub>r</sub>         |                       | 100 | 180                             | ps   | 4    |
| Data output fall time          | t <sub>f</sub>         |                       | 100 | 180                             | ps   | 4    |
| LOS Fault                      | V <sub>LOS fault</sub> | V <sub>CC</sub> – 0.5 |     | V <sub>CC</sub> <sub>HOST</sub> | V    | 5    |
| LOS Normal                     | V <sub>LOS norm</sub>  | V <sub>EE</sub>       |     | V <sub>EE</sub> +0.5            | V    | 5    |
| Power Supply Rejection         | PSR                    | 100                   |     |                                 | mVpp | 6    |

Notes:

1. Connected directly to TX data input pins. AC coupled thereafter.
2. Or open circuit.
3. Into 100 ohms differential termination.
4. 20 – 80 %
5. Loss Of Signal is LVTTTL. Logic 0 indicates normal operation; logic 1 indicates no signal detected.
6. Receiver sensitivity is compliant with power supply sinusoidal modulation of 20 Hz to 1.5 MHz up to specified value applied through the recommended power supply filtering network.

**IV. Low Speed Signals**

| Parameter              | Symbol     | Min | Typ | Max  | Units | Notes/Conditions   |
|------------------------|------------|-----|-----|------|-------|--|
| RX_LOS Assert Level    |            | -41 |     |      | dBm   |  |
| RX_LOS Deassert Level  |            |     |     | -30  | dBm   |  |
| RX_LOS Hysteresis      |            | 0.5 | 2   |      | dB    |  |
| RX_LOS Assert Delay    | t_loss_on  |     |     | 100  | μsec  | From detection of loss of signal to assertion of RX_LOS  |
| RX_LOS Negate Delay    | t_loss_off |     |     | 100  | μsec  | From detection of presence of signal to negation of RX_LOS   |
| TX_DISABLE Assert Time | t_off      |     |     | 10   | μsec  | Rising edge of TX_DISABLE to fall of output signal below 10% of nominal  |
| TX_DISABLE Negate Time | t_on       |     |     | 1000 | μsec  | Falling edge of TX_DISABLE to rise of output signal above 90% of nominal. Time indicated is under steady-state temperature conditions. |
| TX_DISABLE Reset Time  | t_reset    | 10  |     |      | μsec  | TX_DISABLE HIGH before TX_DISABLE set LOW  |
| TX_FAULT Assert        |            |     |     | 100  | μsec  | From fault to assertion of TX_FAULT  |
| Initialization Time    |            |     |     | 300  | μsec  | From power on to negation of TX_FAULT using TX_DISABLE   |

**V. Optical Characteristics (T<sub>OP</sub> = 0 to 70 °C, V<sub>CC</sub> = 3.15 to 3.60 Volts)**

| Parameter                         | Symbol                          | Min     | Typ   | Max     | Unit  | Ref. |
|-----------------------------------|---------------------------------|---------|-------|---------|-------|------|
| <b>Transmitter</b>                |                                 |         |       |         |       |      |
| Output Opt. Pwr (EOL)             | P <sub>OUT</sub>                | 0       |       | +5      | dBm   | 2    |
| Optical Wavelength                | $\lambda$                       | (X-6.5) | (X+1) | (X+6.5) | nm    | 3    |
| Wavelength Temperature Dependence |                                 |         | 0.08  | 0.125   | nm/°C |      |
| Spectral Width                    | $\Delta\lambda_{20}$            |         |       | 1       | nm    | 4    |
| Optical Extinction Ratio          | ER                              | 8.2     |       |         | dB    | 5    |
| Sidemode Suppression ratio        | SMSR <sub>min</sub>             | 30      |       |         | dB    |      |
| Optical Rise/Fall Time            | t <sub>r</sub> / t <sub>f</sub> |         |       | 180     | ps    | 6    |
| RIN                               | RIN                             |         |       | -120    | dB/Hz |      |
| Transmitter Jitter Generation     |                                 |         |       | 75      | mUI   | 7    |
| Dispersion Penalty at 80 km       |                                 |         |       | 2.5     | dB    | 8    |
| <b>Receiver</b>                   |                                 |         |       |         |       |      |
| Optical Input Power               | P <sub>in</sub>                 | -28     |       | -9      | dBm   | 9    |
| Optical Input Wavelength          | $\lambda_c$                     | 1450    |       | 1620    | nm    |      |
| Receiver Jitter Generation        |                                 |         |       | 75      | mUI   | 7    |
| Optical Return Loss               |                                 | 27      |       |         | dB    |      |

Notes:

- Parameters are specified over temperature and voltage, at end of life unless otherwise noted.
- Class 1 Laser Safety per FDA/CDRH and IEC-825-1 regulations.
- Over case temperature of 0 to 70 °C. The Transmitter Center Wavelength “X” is as specified by the customer. The current available wavelengths are: 1470, 1490, 1510, 1530, 1550, 1570, 1590, and 1610 nm. Please see the “Product Selection” section on page 1.
- Full width, -20dB from peak.
- Measured filtered, at 2.488 Gb/s. Min represents worst-case ER over temperature and at end of life.
- Unfiltered, 20% to 80%.
- Measured per GR-253<sup>2</sup> section 5.6 for OC-48 B.
- SMF-28 fiber used. 80kms represents 1600ps/nm at 1610nm. Measured at 2.488Gb/s with a PRBS 2<sup>23</sup>-1 pattern at a BER<10<sup>-12</sup>.
- P<sub>in</sub> represents the range of input powers where BER<10<sup>-12</sup>. P<sub>in</sub> is valid over all data rates specified in Section IV.

**VI. General Specifications**

| Parameter         | Symbol | Min    | Typ | Max  | Units  | Ref.  |
|-------------------|--------|--------|-----|------|--------|---|
| Data Rate         | BR     | 0.155* |     | 2.67 | Gb/sec | *OC-3/12 compatible. Not compliant w/ all OC-3/12 specifications, such as min ER. (OC-48 compliance takes precedence) |
| Total Link Budget | --     | 28     | 30  |      | dB     | 2.488 Gb/s, BER < 10 <sup>-12</sup> w/ PRBS 2 <sup>23</sup> -1. Does not include dispersion penalty                   |

**VII. Environmental Specifications**

| Parameter                  | Symbol           | Min | Typ | Max | Units | Ref. |
|----------------------------|------------------|-----|-----|-----|-------|------|
| Case Operating Temperature | T <sub>op</sub>  | 0   |     | 70  | °C    |      |
| Storage Temperature        | T <sub>sto</sub> | -40 |     | 85  | °C    |      |

**VIII. Regulatory Compliance**

Finisar CWDM SFP transceivers are Class 1 Laser Products. They are certified per the following standards:

| Feature           | Agency   | Standard   |
|-------------------|----------|--|
| Laser Eye Safety  | FDA/CDRH | CDRH and IEC-825<br>Class 1 Laser Product.<br>See Note 1 |
| Laser Eye Safety  | TÜV      | EN 60950<br>EN 60825-1<br>EN 60825-2                     |
| Electrical Safety | CSA      | CLASS 3862.07<br>CLASS 3862.87                           |

Note 1: Complies with FDA performance standards for laser products except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.

**IX. Digital Diagnostic Functions**

All Finisar SFPs support the 2-wire serial communication protocol outlined in the SFP MSA<sup>5</sup>. These SFPs use an Atmel AT24C01A 128 byte E<sup>2</sup>PROM with an address of A0h (see table below for E<sup>2</sup>PROM contents). For details on interfacing with the E<sup>2</sup>PROM, see the Atmel data sheet titled “AT24C01A/02/04/08/16 2-Wire Serial CMOS E<sup>2</sup>PROM.”<sup>6</sup>

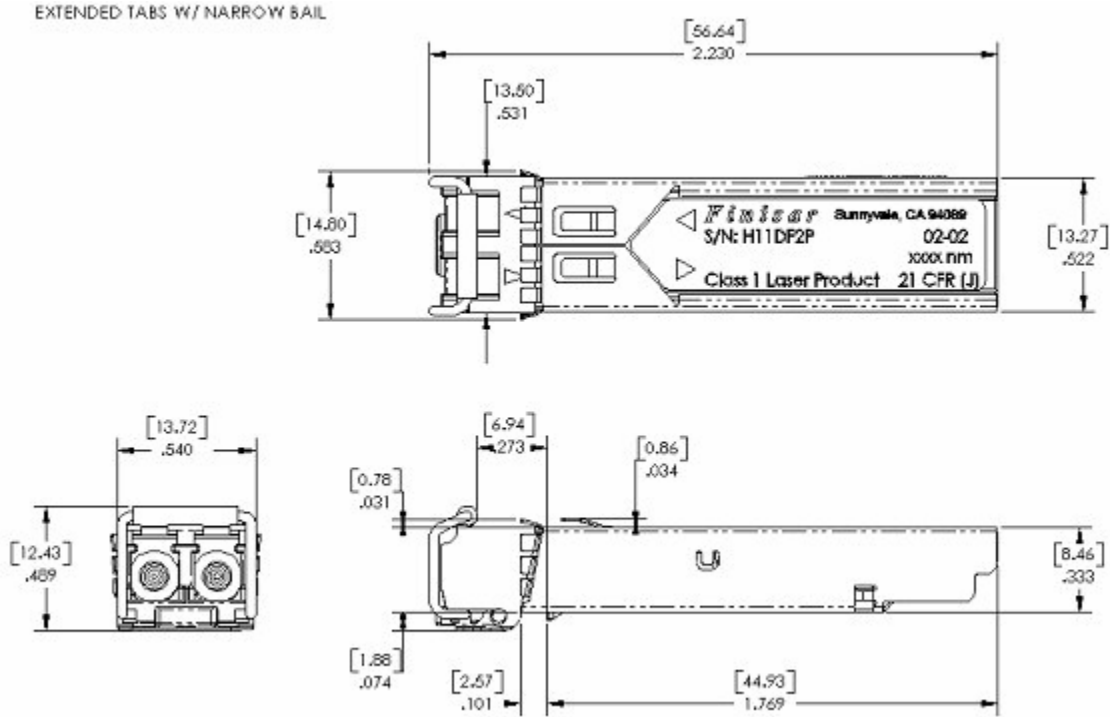
Finisar’s CWDM SFPs also support extended diagnostic features as described in Finisar Applications Note AN-2030, “Digital Diagnostic Monitoring Interface for Optical Transceivers”<sup>7</sup>, and additional information is available in SFF standard titled: “Digital Diagnostic Monitoring Interface for Optical Transceivers”<sup>8</sup> (SFF-8472 rev9.3). A controller IC that monitors system parameters such as laser current, module temperature, transmitter power, and received power is accessible at address A2H.

I2C clock speed, digital diagnostic accuracy and digital diagnostic range can be found in the table below. Values in the table represent the worst-case values over temperature, voltage, and life.

| Parameter                           | Symbol                    | Min | Typ | Max     | Units | Notes/Conditions                                       |
|-------------------------------------|---------------------------|-----|-----|---------|-------|--|
| I <sup>2</sup> C Clock Speed        |                           | 0   |     | 100,000 | Hz    | Bus can be driven blind                                |
| <b>Accuracy</b>                     |                           |     |     |         |       |  |
| Internal Transceiver Temperature    | DD <sub>Temperature</sub> | -3  |     | +3      | °C    | Measured at controller IC                              |
| Internal Transceiver Supply Voltage | DD <sub>Voltage</sub>     | -3  |     | +3      | %     | Measured at controller IC                              |
| Tx Bias Current                     | DD <sub>Bias</sub>        | -10 |     | +10     | %     |  |
| Tx Output Power                     | DD <sub>TxPower</sub>     | -3  |     | +3      | dB    | 100% tested in production tested at room temp to ±2 dB |
| Received Average Power              | DD <sub>RxPower</sub>     | -3  |     | +3      | dB    | 100% tested in production tested at room temp to ±2 dB |
| <b>Range</b>                        |                           |     |     |         |       |  |
| Internal Transceiver Temperature    | DD <sub>Temperature</sub> | -40 |     | 85      | °C    |  |
| Internal Transceiver Supply Voltage | DD <sub>Voltage</sub>     | 3.0 |     | 4.0     | V     |  |
| Tx Bias Current                     | DD <sub>Bias</sub>        | 0   |     | 90      | mA    |  |
| Tx Output Power                     | DD <sub>TxPower</sub>     | -10 |     | 5       | dBm   |  |
| Received Average Power              | DD <sub>RxPower</sub>     | -30 |     | -7      | dBm   |  |

**X. Mechanical Specifications**

Finisar’s Multi-rate CWDM Small Form Factor Pluggable (SFP) transceivers are compatible with the dimensions defined by the SFP Multi-Sourcing Agreement (MSA).

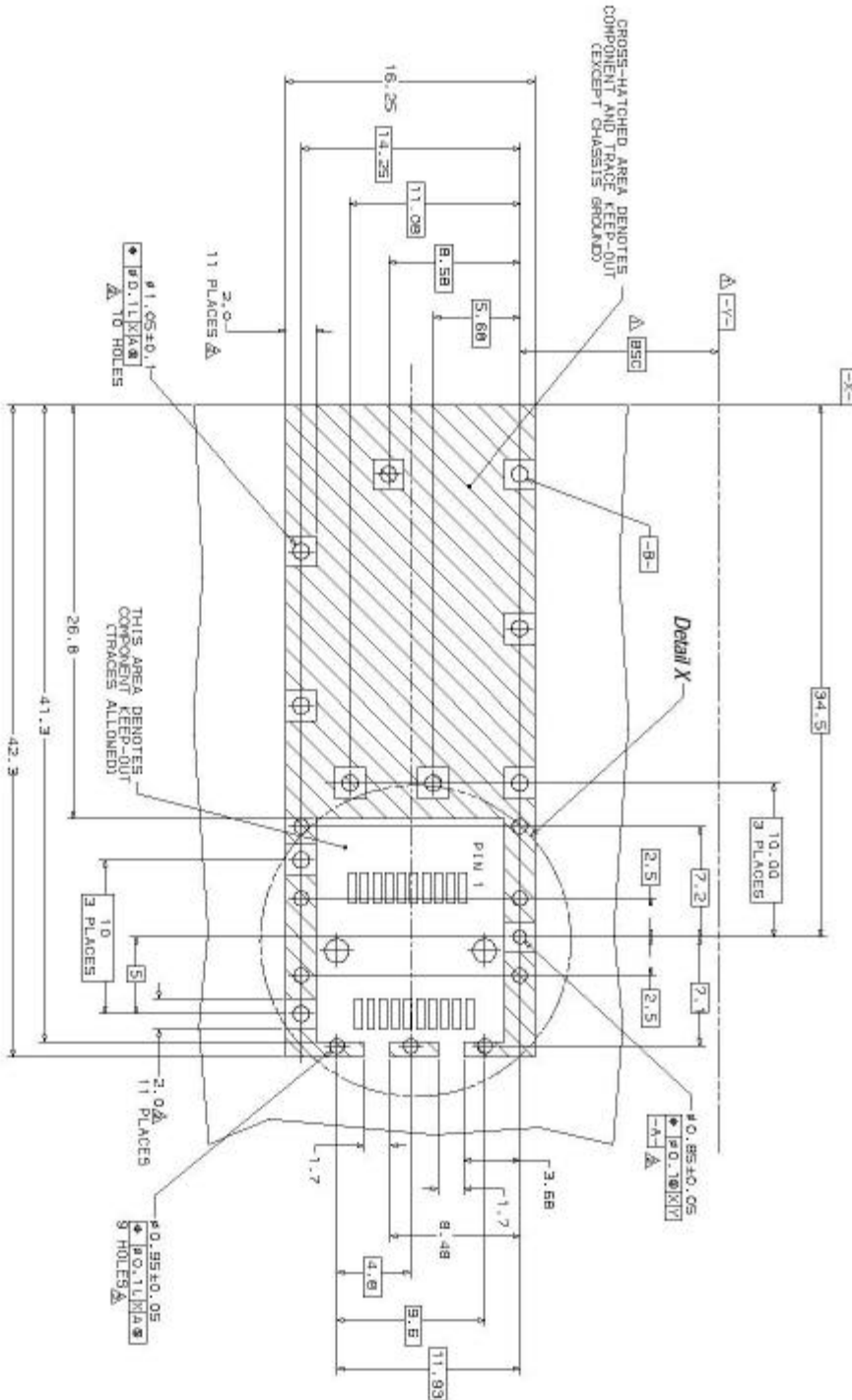


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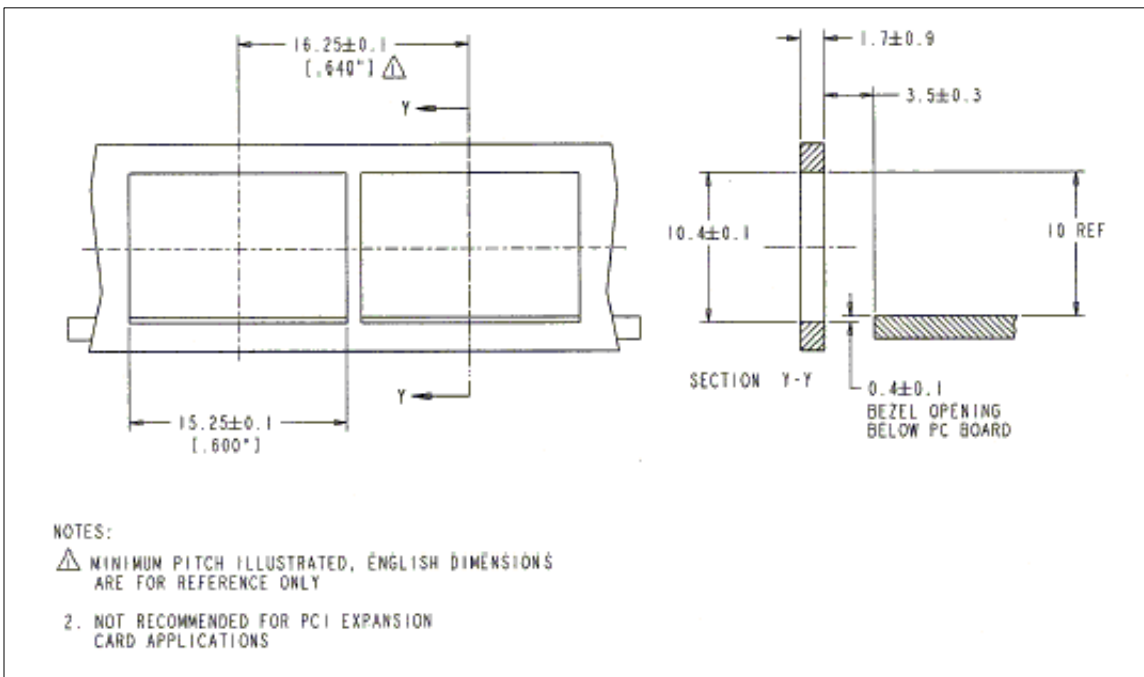
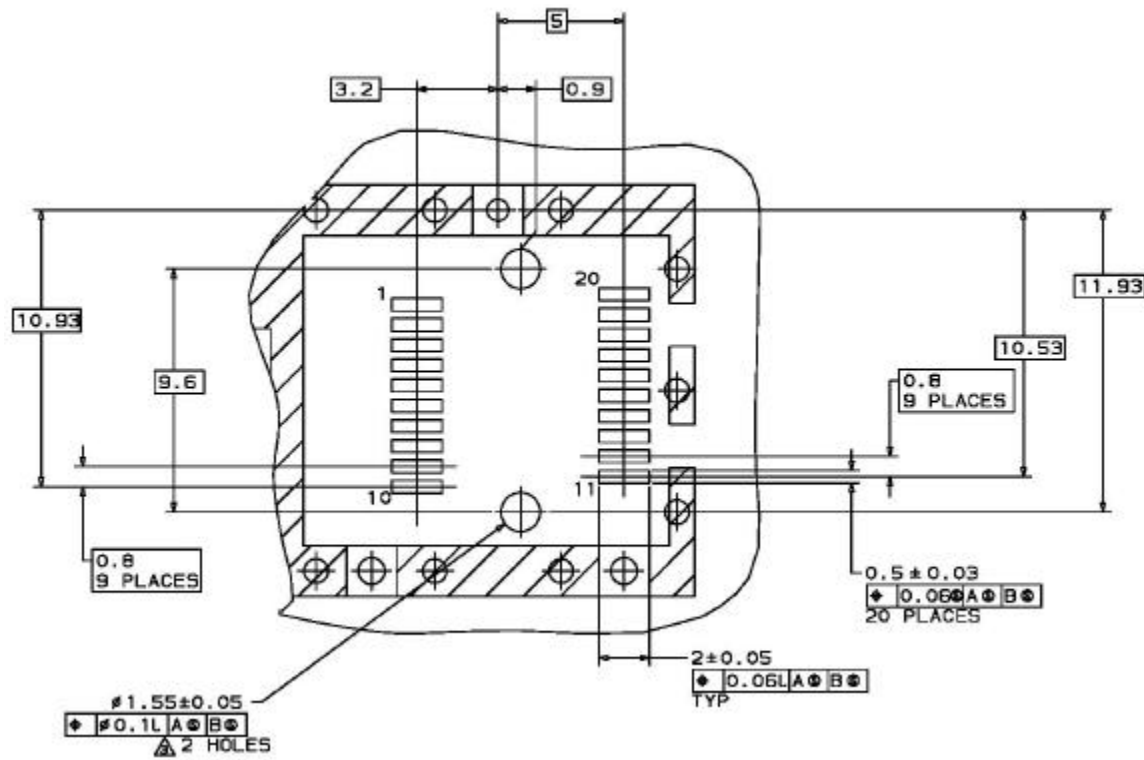
**FWDM-1621-7D-xx Outline Drawing - units in inches [mm]**



**XI. PCB Layout and Bezel Recommendations**



- △ Bezel and Basic Dimension Established by Customer
- △ Traces and Vias are Chassis Ground, 11 Places
- △ Through Holes are Unplated



## **XII. References**

1. “SONET Transport Systems: Common Generic Criteria”, Telcordia Technologies, GR-253-CORE, Issue 3, September 2000.
2. IEEE Std 802.3. IEEE Standards Department, 2000.<sup>(\*)</sup>
3. “Fibre Channel Draft Physical Interface Specification (FC-PI 10.0)”. American National Standard for Information Systems.<sup>(\*)</sup>
4. “Optical Interfaces for Course Wavelength Division Multiplexing Applications”, ITU-T Recommendation G.695, January 2005
5. Small Form Factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA), September 2000. Documentation is currently available at Finisar upon request.
6. “AT24C01A/02/04/08/16 2-Wire Serial CMOS E<sup>2</sup>PROM”, Atmel Corporation.  
[www.Atmel.com](http://www.Atmel.com)
7. “Application Note AN-2030: Digital Diagnostic Monitoring Interface for Optical Transceivers”, Finisar Corporation, April 2002.
8. “Digital Diagnostic Monitoring Interface For Optical Transceivers Rev 9.3”. SFF Document No. SFF-8472.

(\*) Neither IEEE 802.3 nor FC-PI 10.0 specifies a 1621 nm DFB single mode interface. The FWDM-16217Dxx complies with these specifications except for the following optical parameters, which have different values: transmitter wavelength, extinction ratio, receiver sensitivity, and transmit output power. See Section V for details.

### **For More Information**

Finisar Corporation  
1308 Moffett Park Drive  
Sunnyvale, CA 94089-1133  
Tel. 1-408-548-1000  
Fax 1-408-541-6138  
[sales@finisar.com](mailto:sales@finisar.com)  
[www.finisar.com](http://www.finisar.com)