

## Product Specification

### 4 Gigabit RoHS Compliant CWDM SFP Transceiver

#### FWLF1524P2yxx

#### PRODUCT FEATURES

- Up to 4.25Gb/s bi-directional data links
- Hot-pluggable SFP footprint
- Built-in digital diagnostic functions
- CWDM DFB laser transmitter
- Duplex LC connector
- RoHS compliant and Lead Free
- Up to 30 km on 9/125µm SMF at 4.25 Gb/s
- Metal enclosure, for lower EMI
- Single 3.3V power supply
- Commercial operating temperature range: -5°C to 75°C



#### APPLICATIONS

- Metro Access Rings and Point-to-Point networking for Gigabit Ethernet and Fibre Channel
- Link concatenation/aggregation

Finisar's FWLF1524P2yxx Small Form Factor Pluggable (SFP) transceiver is compatible with the Small Form Factor Pluggable Multi-Sourcing Agreement (MSA)<sup>1</sup>. The transceiver is designed for operation in Metro Access Rings and Point-to-Point networks using Fibre Channel<sup>2</sup> Gigabit Ethernet<sup>3</sup> networking equipment by selecting the appropriate line rate. The FWLF1524P2yxx available in eight different CWDM wavelengths; and is RoHS compliant and lead-free per Directive 2002/95/EC<sup>4</sup> and Finisar Application Note AN-2038.

## PRODUCT SELECTION

**FWLF1524P2yxx**

|    |   |                                                                 |
|----|---|-----------------------------------------------------------------|
| y  | L | Non Rate Selectable - 1x, 2x, 4x Fibre Channel                  |
|    | V | Rate Selectable - 1x, 2x, 4x Fibre Channel and Gigabit Ethernet |
| xx |   | CWDM Wavelength (see table below)                               |

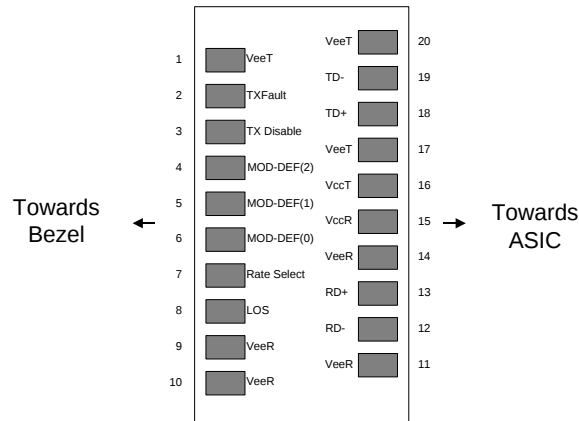
| Wavelength | xx | Clasp Color Code | Wavelength | xx | Clasp Color Code |
|------------|----|------------------|------------|----|------------------|
| 1471 nm    | 47 | Gray             | 1551 nm    | 55 | Yellow           |
| 1491 nm    | 49 | Violet           | 1571 nm    | 57 | Orange           |
| 1511 nm    | 51 | Blue             | 1591 nm    | 59 | Red              |
| 1531 nm    | 53 | Green            | 1611 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        | Open or Low = 1.063 Gb/s or 2.125 Gb/s Fibre Channel, 1.25 Gb/s Gigabit Ethernet (Low Bandwidth)<br>High = 2.125 or 4.25 Gb/s Fibre Channel (High Bandwidth) | 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. AC Coupled.                                                                                                                |      |
| 19  | TD-                | Transmitter Inverted DATA in. AC Coupled.                                                                                                                    |      |
| 20  | V <sub>EET</sub>   | Transmitter Ground (Common with Receiver 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 - 10 kohms on host board to a voltage between 2.0V and 3.6V. MOD\_DEF(0) pulls line low to indicate module is plugged in.
4. **Specific information when selecting line rate:** Rate selection is done in accordance with SFF Committee SFF-8079 Draft, Rev.1.6, Table 3. Note that rate select can also be set through 2-wire bus in accordance with SFF-8472<sup>6</sup> at Bit 3, Byte 110, Address A2h (note: writing '1' selects full bandwidth operation). Rate select is the logic OR of the input state of Rate Select Pin and 2-wire bus. Non Rate Selectable version can operate at 1x, 2x, 4x Fibre Channel independent of rate select pin setting.
5. LOS is open collector output. Should be pulled up with 4.7k - 10 kohms on host board to a voltage between 2.0V and 3.6V. Logic 0 indicates normal operation; logic 1 indicates loss of signal.



Pinout of Connector Block on Host Board

## II. Absolute Maximum Ratings

| Parameter                  | Symbol          | Min  | Typ | Max | Unit | Ref. |
|----------------------------|-----------------|------|-----|-----|------|------|
| Maximum Supply Voltage     | V <sub>CC</sub> | -0.5 |     | 4.5 | V    |      |
| Storage Temperature        | T <sub>S</sub>  | -40  |     | 85  | °C   |      |
| Case Operating Temperature | T <sub>OP</sub> | -5   |     | 75  | °C   |      |
| Relative Humidity          | RH              | 0    |     | 85  | %    | 1    |

## III. Electrical Characteristics (T<sub>OP</sub> = -5 to 75 °C, V<sub>CC</sub> = 3.1 to 3.5 Volts)

| Parameter                                     | Symbol                          | Min                   | Typ | Max                   | Unit | Ref. |
|-----------------------------------------------|---------------------------------|-----------------------|-----|-----------------------|------|------|
| Supply Voltage                                | V <sub>CC</sub>                 | 3.1                   |     | 3.5                   | V    |      |
| Supply Current                                | I <sub>CC</sub>                 |                       |     | 300                   | mA   |      |
| <b>Transmitter</b>                            |                                 |                       |     |                       |      |      |
| Input differential impedance                  | R <sub>in</sub>                 |                       | 100 |                       | Ω    | 2    |
| 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    | 3    |
| Transmit Enable Voltage                       | V <sub>EN</sub>                 | V <sub>EE</sub>       |     | V <sub>EE</sub> + 0.8 | V    |      |
| Transmit Disable Assert Time                  |                                 |                       |     | 10                    | us   |      |
| <b>Receiver</b>                               |                                 |                       |     |                       |      |      |
| Single ended data output swing                | V <sub>out,pp</sub>             | 250                   |     | 800                   | mV   | 4    |
| Data output rise/fall time < 4.25 Gb/s        | t <sub>r</sub> , t <sub>f</sub> |                       |     | 175                   | ps   | 5    |
| Data output rise/fall time = 4.25 Gb/s        | t <sub>r</sub> , t <sub>f</sub> |                       |     | 120                   | ps   | 5    |
| LOS Fault                                     | V <sub>LOS fault</sub>          | V <sub>CC</sub> – 0.5 |     | V <sub>CCHOST</sub>   | V    | 6    |
| LOS Normal                                    | V <sub>LOS norm</sub>           | V <sub>EE</sub>       |     | V <sub>EE</sub> + 0.5 | V    | 6    |
| Power Supply Rejection                        | PSR                             | 100                   |     |                       | mVpp | 7    |
| Deterministic Jitter Contribution < 4.25 Gb/s | RX Δ DJ                         |                       |     | 51.7                  | ps   | 8    |
| Total Jitter Contribution < 4.25 Gb/s         | RX Δ TJ                         |                       |     | 122.4                 | ps   |      |
| Deterministic Jitter Contribution = 4.25 Gb/s | RX Δ DJ                         |                       |     | 25.9                  | ps   | 8    |
| Total Jitter Contribution = 4.25 Gb/s         | RX Δ TJ                         |                       |     | 61.2                  | ps   |      |

### Notes:

1. Non-condensing.
2. AC coupled.
3. Or open circuit.
4. Into 100 ohm differential termination.
5. 20 – 80 %
6. LOS is LVTTTL. Logic 0 indicates normal operation; logic 1 indicates no signal detected.
7. All transceiver specifications are compliant with a power supply sinusoidal modulation of 20 Hz to 1.5 MHz up to specified value applied through the power supply filtering network shown on page 23 of the Small Form-factor Pluggable (SFP) Transceiver MultiSource Agreement (MSA)<sup>1</sup>, September 14, 2000.
8. Measured with DJ-free data input signal. In actual application, output DJ will be the sum of input DJ and Δ DJ.

**IV. Optical Characteristics (T<sub>OP</sub> = -5 to 75 °C, V<sub>CC</sub> = 3.1 to 3.5 Volts)**

| Parameter                                      | Symbol                          | Min   | Typ | Max   | Unit  | Ref. |
|------------------------------------------------|---------------------------------|-------|-----|-------|-------|------|
| <b>Transmitter</b>                             |                                 |       |     |       |       |      |
| Output Opt. Power (Rate Select High)           | P <sub>O,RH</sub>               | +1    |     | +5    | dBm   | 1    |
| Output Opt. Power (Rate Select Low)            | P <sub>O,RL</sub>               | +1    |     | +5    | dBm   | 2    |
| Optical Wavelength                             | $\lambda$                       | X-6.5 |     | X+6.5 | nm    | 3    |
| Spectral Width                                 | $\sigma$                        |       |     | 1     | nm    | 3    |
| Optical Modulation Amplitude                   | OMA                             | 290   |     |       | uW    | 4    |
| Optical Extinction Ratio (Rate Select High)    | ER                              | 4     |     |       | dB    |      |
| Optical Extinction Ratio (Rate Select Low)     | ER                              | 9     |     |       | dB    |      |
| Optical Rise/Fall Time = 4.25 Gb/s             | t <sub>r</sub> / t <sub>f</sub> |       |     | 105   | ps    | 5    |
| Optical Rise/Fall Time ≤ 2.125 Gb/s            | t <sub>r</sub> / t <sub>f</sub> |       |     | 160   | ps    | 6    |
| RIN                                            |                                 |       |     | -118  | dB/Hz |      |
| Deterministic Jitter Contribution = 4.25 Gb/s  | TX $\Delta$ DJ                  |       |     | 28.2  | ps    | 7    |
| Total Jitter Contribution = 4.25 Gb/s          | TX $\Delta$ TJ                  |       |     | 59.8  | ps    |      |
| Deterministic Jitter Contribution ≤ 2.125 Gb/s | TX $\Delta$ DJ                  |       |     | 56.5  | ps    | 7    |
| Total Jitter Contribution ≤ 2.125 Gb/s         | TX $\Delta$ TJ                  |       |     | 119   | ps    |      |
| <b>Receiver</b>                                |                                 |       |     |       |       |      |
| Receiver Sensitivity = 4.25 Gb/s               | R <sub>SENS4</sub>              |       |     | 29    | uW    | 8    |
|                                                |                                 |       |     | -16.5 | dBm   | 9    |
| Receiver Sensitivity = 2.125 Gb/s              | R <sub>SENS2</sub>              |       |     | 15    | uW    | 8    |
|                                                |                                 |       |     | -20.5 | dBm   | 9    |
| Receiver Sensitivity = 1.06 Gb/s               | R <sub>SENS1</sub>              |       |     | 15    | uW    | 8    |
|                                                |                                 |       |     | -22.0 | dBm   | 10   |
| Receiver Sensitivity = 1.25 Gb/s               | R <sub>SENS-GE</sub>            |       |     | -22   | dBm   | 10   |
| Stressed RX sens. = 1.25 Gb/s                  |                                 |       |     | -14.5 | dBm   |      |
| Average Received Power                         | R <sub>XMAX</sub>               |       |     | 0     | dBm   |      |
| Receiver Electrical 3dB cutoff freq.           |                                 |       |     | 1500  | MHz   | 11   |
| Receiver Electrical 3dB cutoff freq.           |                                 |       |     | 2500  | MHz   | 12   |
| Optical Center Wavelength                      | $\lambda_C$                     | 1450  |     | 1620  | nm    |      |
| Return Loss                                    |                                 | 12    |     |       | dB    |      |
| LOS De-Assert                                  | LOS <sub>D</sub>                |       |     | -19   | dBm   |      |
| LOS Assert                                     | LOS <sub>A</sub>                | -30   |     |       | dBm   |      |
| LOS Hysteresis                                 |                                 | 0.5   |     |       | dB    |      |

**Notes:**

1. High Bandwidth Mode. Class 1 Laser Safety per FDA/CDRH and EN (IEC) 60825 regulations.
2. Low Bandwidth Mode. Class 1 Laser Safety per FDA/CDRH and EN (IEC) 60825 regulations.
3. Over case temperature of -5 to 75 °C. The Transmitter Center Wavelength “X” is as specified by the customer. The current available wavelengths are: 1471, 1491, 1511, 1531, 1551, 1571, 1591, and 1611 nm. Please see the “Product Selection” section on page 2. It is possible to offer wavelength range (X+5) nm to (X-7) nm. Please contact Finisar sales team for this if needed.
4. Equivalent extinction ration specification for Fibre Channel. Allows smaller ER at higher average power
5. Unfiltered, 20-80% measured w/ a “00001111” pattern. Complies with FC 4x eye mask when filtered.
6. Unfiltered, 20-80% measured w/ a “00001111” pattern. Complies with IEEE 802.3 (Gig. E), FC 1x and 2x eye masks when filtered.
7. Measured with DJ-free data input signal. In actual application, output DJ will be the sum of input DJ and  $\Delta$  DJ.
8. Measured with conformance signals defined in FC-PI-2 Rev. 10.0 specifications. Value in OMA. Measured with PRBS 2<sup>7</sup>-1 at 10<sup>-12</sup> BER.

9. Represents sensitivity at minimum Extinction Ratio with rate select high. Measured with PRBS 2<sup>7</sup>-1 at 10<sup>-12</sup> BER.
10. Represents sensitivity at minimum Extinction Ratio with rate select low. Measured with PRBS 2<sup>7</sup>-1 at 10<sup>-12</sup> BER
11. Rate Selectable version in low bandwidth mode.
12. Rate Selectable version in high bandwidth mode.

## V. General Specifications

| Parameter                                                           | Symbol            | Min  | Typ | Max               | Units  | Ref. |
|---------------------------------------------------------------------|-------------------|------|-----|-------------------|--------|------|
| Data Rate                                                           | BR                | 1062 |     | 4250              | Mb/sec | 1    |
| Bit Error Rate                                                      | BER               |      |     | 10 <sup>-12</sup> |        | 2    |
| Max. Supported Link Length on 9/125 μm SMF @ 4X Fibre Channel       | L <sub>MAX1</sub> |      | 30  |                   | km     | 3    |
| Max. Supported Link Length on 9/125μm SMF @ 1X and 2X Fibre Channel | L <sub>MAX2</sub> |      | 50  |                   | km     | 3    |
| Max. Supported Link Length on 9/125μm SMF @ Gigabit Ethernet        | L <sub>MAX3</sub> |      | 50  |                   | km     | 3    |

### Notes:

1. Gigabit Ethernet and 1x/2x/4x Fibre Channel compliant.
2. Tested with a PRBS 2<sup>7</sup>-1 test pattern.
3. A 3 dB penalty is included for dispersion on data rates >2Gb/s and 2dB penalty is included for data rates <2Gb/s. Distances are indicative only. Please refer to the Optical Specifications in Table IV to calculate a more accurate link budget based on specific conditions in your application

## VI. Environmental Specifications

| Parameter                  | Symbol           | Min | Typ | Max | Units | Ref. |
|----------------------------|------------------|-----|-----|-----|-------|------|
| Case Operating Temperature | T <sub>op</sub>  | -5  |     | 75  | °C    |      |
| Storage Temperature        | T <sub>sto</sub> | -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

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>

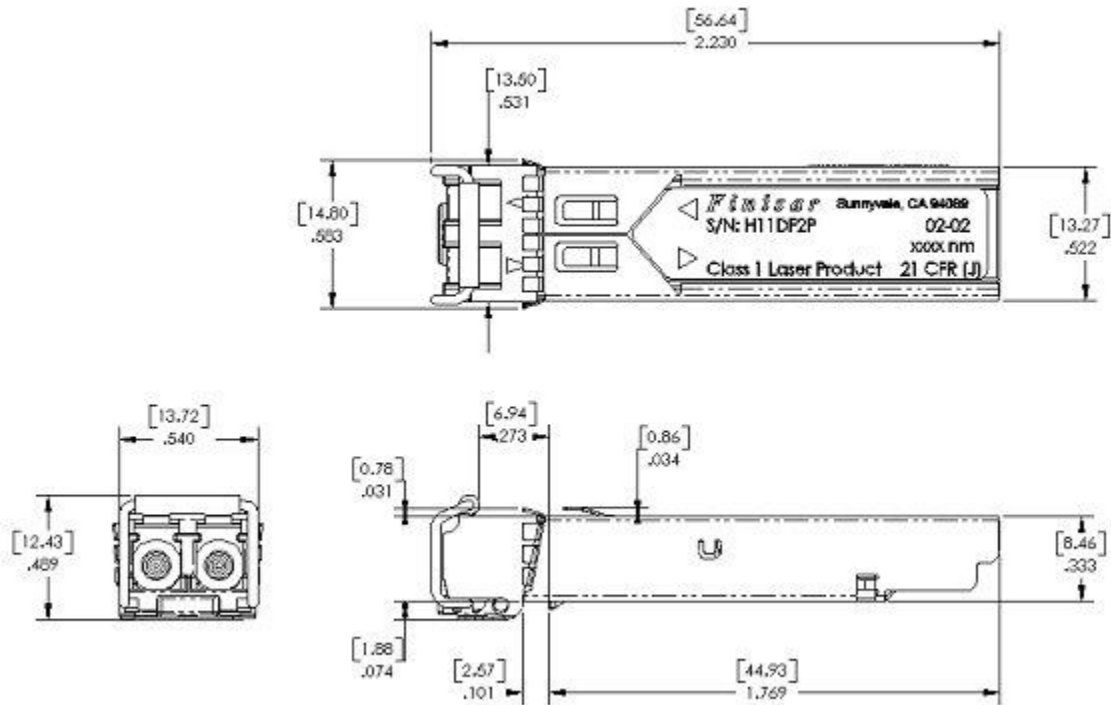
Finisar’s CWDM SFPs also support extended diagnostic features as described in Finisar Applications Note AN-2030, “Digital Diagnostic Monitoring Interface for Optical Transceivers”<sup>7</sup>, and additional information is available in SFF standard titled: “Digital Diagnostic Monitoring Interface for 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>              |                           |     |     |         |       |                                              |
| Transceiver Temperature      | DD <sub>Temperature</sub> | -5  |     | +5      | °C    | Case temperature                             |
| Transceiver Supply Voltage   | DD <sub>Voltage</sub>     | -3  |     | +3      | %     |                                              |
| Tx Bias Current              | DD <sub>Bias</sub>        | -10 |     | +10     | %     |                                              |
| Tx Output Power              | DD <sub>TxPower</sub>     | -3  |     | +3      | dB    | 100% tested in production over temp to ±2 dB |
| Received Average Power       | DD <sub>RxPower</sub>     | -3  |     | +3      | dB    | 100% tested in production over temp to ±2 dB |
| <b>Range</b>                 |                           |     |     |         |       |                                              |
| Transceiver Temperature      | DD <sub>Temperature</sub> | -10 |     | 80      | °C    |                                              |
| Transceiver Supply Voltage   | DD <sub>Voltage</sub>     | 3.0 |     | 4.0     | V     |                                              |
| Tx Bias Current              | DD <sub>Bias</sub>        | 0   |     | 100     | mA    |                                              |
| Tx Output Power              | DD <sub>TxPower</sub>     | -10 |     | +5      | dBm   |                                              |
| Received Average Power       | DD <sub>RxPower</sub>     | -25 |     | +1      | dBm   |                                              |

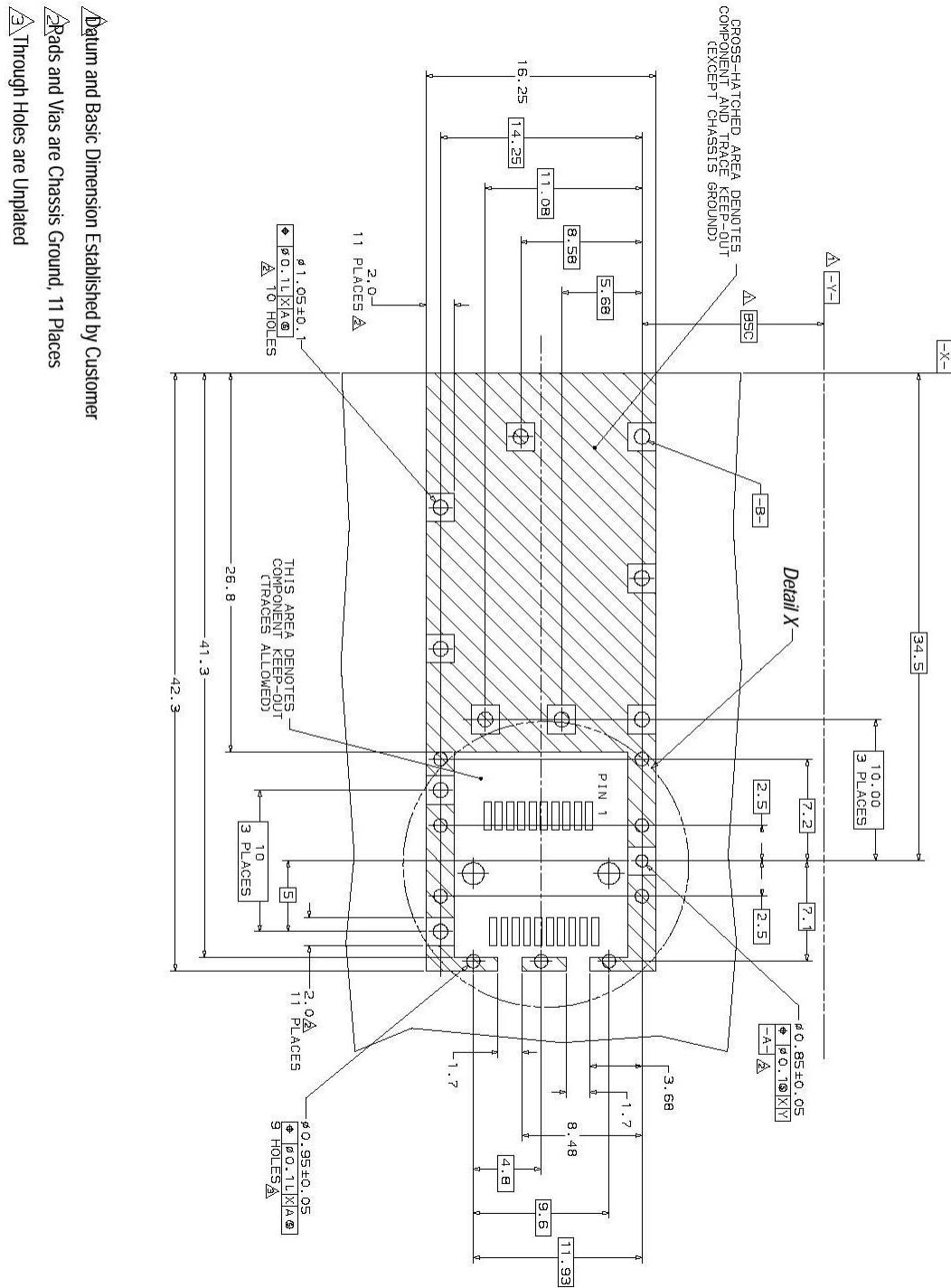
**IX. Mechanical Specifications**

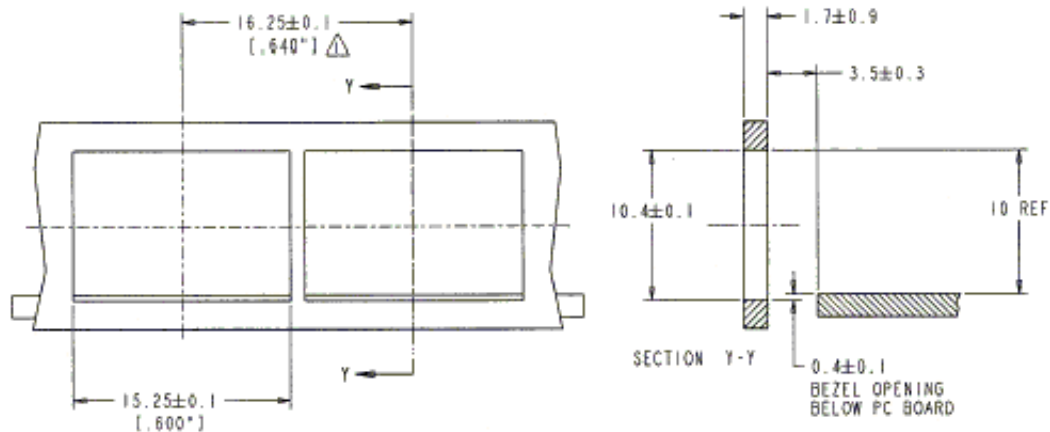
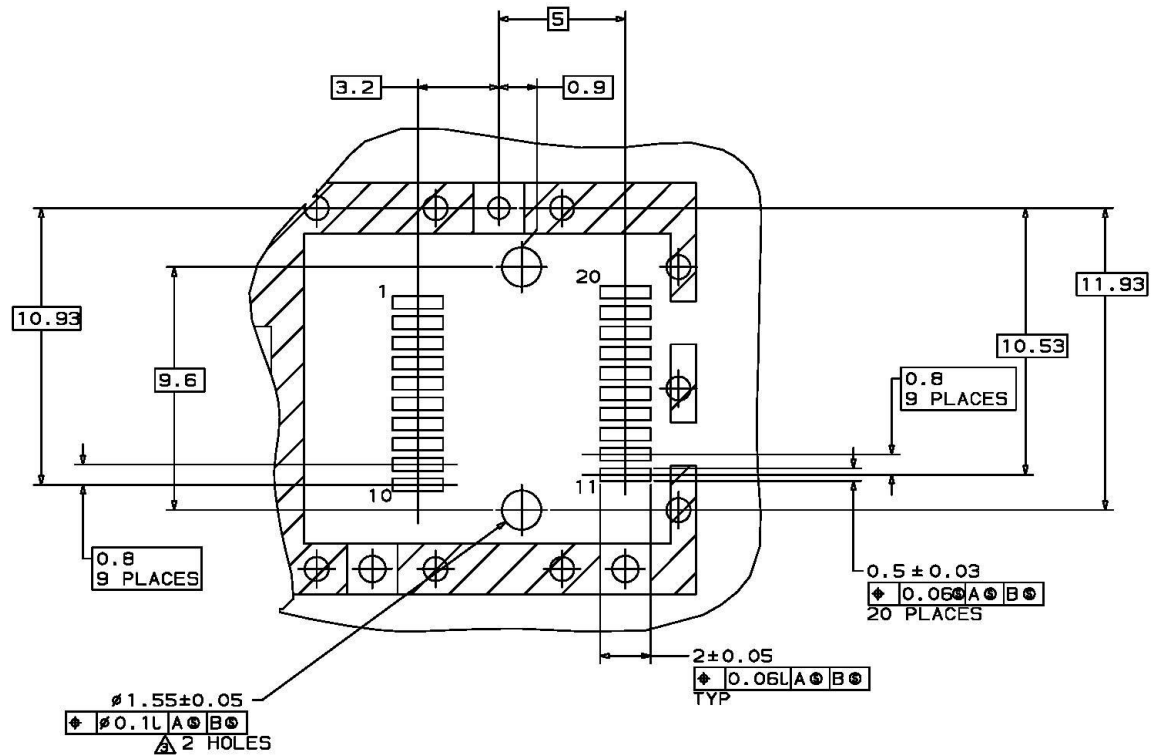
Finisar's Small Form Factor Pluggable (SFP) transceivers are compatible with the dimensions defined by the SFP Multi-Sourcing Agreement (MSA)<sup>1</sup>.



**FWLF1524P2Vxx Outline Drawing**

## X. PCB Layout and Bezel Recommendations





## NOTES:

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

## **XI. References**

1. Small Form-factor Pluggable (SFP) Transceiver Multi-source Agreement (MSA), September 14, 2000.
2. “Fibre Channel Draft Physical Interface Specification (FC-P1-2 Rev. 10.0)”. American National Standard for Information Systems.
3. IEEE Std 802.3, 2002 Edition, Clause 38, PMD Type 1000BASE-LX. IEEE Standards Department, 2002.
4. Directive 2002/95/EC of the European Council Parliament and of the Council, “on the restriction of the use of certain hazardous substances in electrical and electronic equipment.” January 27, 2003.
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.

## **XII. For More Information**

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