

## Product Specification

### Long-Reach DWDM SFP Transceiver

#### FWLF1634RLxx

#### PRODUCT FEATURES

- Up to 4.25 Gb/s bi-directional links
- Hot-pluggable SFP footprint
- Temperature-stabilized DWDM-rated DFB laser transmitter
- 100GHz ITU Grid, C-Band
- Low dispersion DFB laser
- Extended operating range: -5°C to 70°C case temperature
- Wavelength controlled within  $\pm 0.1$  nm over life and temperature
- Extended link budget with APD receiver technology
- 4x FC compliant
- 1x/2x, GbE compliant\*
- OC-48 LR-2 compliant\*



#### APPLICATIONS

- Amplified DWDM networks
- Bandwidth aggregation
- Ring topologies with fixed and reconfigurable OADMs

Finisar's Dense Wavelength-Division Multiplexing (DWDM) transceivers offer DWDM transport with dramatically lower power and cost in a standard pluggable Small Form Factor Pluggable (SFP) package<sup>1</sup>. The FWLF1634R is designed expressly for service providers deploying DWDM networking equipment in metropolitan access and core networks.

Basic digital diagnostic features for the FWLF1634R are implemented as described in Finisar Application Note AN-2030, "Digital Diagnostic Monitoring Interface for Optical Transceivers"<sup>4</sup>. Enhanced diagnostic features are available as described in the DWDM SFP MSA<sup>6</sup>.

(\*when ordered with rate selection option, and used in low rate mode)

## PRODUCT SELECTION

|                     |
|---------------------|
| <b>FWLF1634Ryxx</b> |
|---------------------|

|    |   |  |
|----|---|--|
| y  | L | Non Rate Selectable - 4x Fibre Channel |
| xx |   | DWDM Wavelength (see table below)      |

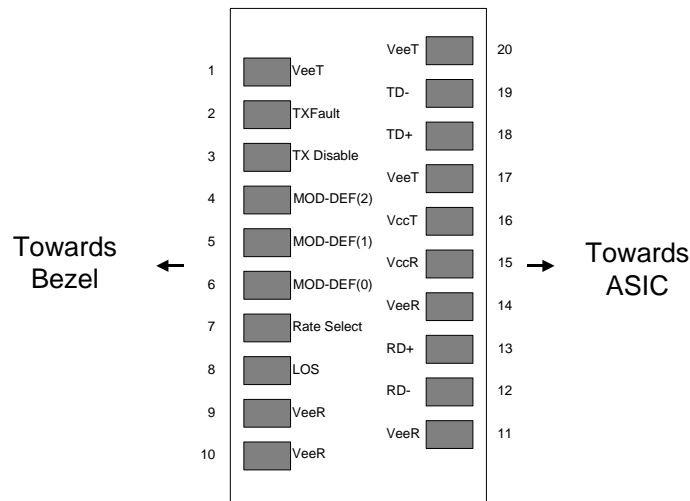
| Product Code | Frequency (THz) | Center Wavelength (nm) |
|--------------|-----------------|------------------------|
| FWLF1634RL17 | 191.7           | 1563.86                |
| FWLF1634RL18 | 191.8           | 1563.05                |
| FWLF1634RL19 | 191.9           | 1562.23                |
| FWLF1634RL20 | 192.0           | 1561.42                |
| FWLF1634RL21 | 192.1           | 1560.61                |
| FWLF1634RL22 | 192.2           | 1559.79                |
| FWLF1634RL23 | 192.3           | 1558.98                |
| FWLF1634RL24 | 192.4           | 1558.17                |
| FWLF1634RL25 | 192.5           | 1557.36                |
| FWLF1634RL26 | 192.6           | 1556.55                |
| FWLF1634RL27 | 192.7           | 1555.75                |
| FWLF1634RL28 | 192.8           | 1554.94                |
| FWLF1634RL29 | 192.9           | 1554.13                |
| FWLF1634RL30 | 193.0           | 1553.33                |
| FWLF1634RL31 | 193.1           | 1552.52                |
| FWLF1634RL32 | 193.2           | 1551.72                |
| FWLF1634RL33 | 193.3           | 1550.92                |
| FWLF1634RL34 | 193.4           | 1550.12                |
| FWLF1634RL35 | 193.5           | 1549.32                |
| FWLF1634RL36 | 193.6           | 1548.51                |
| FWLF1634RL37 | 193.7           | 1547.72                |
| FWLF1634RL38 | 193.8           | 1546.92                |
| FWLF1634RL39 | 193.9           | 1546.12                |
| FWLF1634RL40 | 194.0           | 1545.32                |
| FWLF1634RL41 | 194.1           | 1544.53                |
| FWLF1634RL42 | 194.2           | 1543.73                |
| FWLF1634RL43 | 194.3           | 1542.94                |
| FWLF1634RL44 | 194.4           | 1542.14                |
| FWLF1634RL45 | 194.5           | 1541.35                |
| FWLF1634RL46 | 194.6           | 1540.56                |
| FWLF1634RL47 | 194.7           | 1539.77                |
| FWLF1634RL48 | 194.8           | 1538.98                |
| FWLF1634RL49 | 194.9           | 1538.19                |
| FWLF1634RL50 | 195.0           | 1537.40                |
| FWLF1634RL51 | 195.1           | 1536.61                |
| FWLF1634RL52 | 195.2           | 1535.82                |
| FWLF1634RL53 | 195.3           | 1535.04                |
| FWLF1634RL54 | 195.4           | 1534.25                |
| FWLF1634RL55 | 195.5           | 1533.47                |
| FWLF1634RL56 | 195.6           | 1532.68                |
| FWLF1634RL57 | 195.7           | 1531.90                |
| FWLF1634RL58 | 195.8           | 1531.12                |
| FWLF1634RL59 | 195.9           | 1530.33                |
| FWLF1634RL60 | 196.0           | 1529.55                |
| FWLF1634RL61 | 196.1           | 1528.77                |

**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  |      |
| 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.
- Receiver achieves multi-rate 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 |
|----------------------------|-----------------|------|-----|-----|------|
| Maximum Supply Voltage     | V <sub>CC</sub> | -0.5 |     | 4.7 | V    |
| Storage Temperature        | T <sub>S</sub>  | -10  |     | 85  | °C   |
| Case Operating Temperature | T <sub>OP</sub> | -5   |     | 70  | °C   |

**III. Electrical Characteristics (T<sub>OP</sub> = -5 to 70 °C, V<sub>CC</sub> = 3.13 to 3.50 Volts)**

| Parameter                      | Symbol                 | Min                   | Typ  | Max                             | Unit | Ref. |
|--------------------------------|------------------------|-----------------------|------|---------------------------------|------|------|
| Supply Voltage                 | V <sub>CC</sub>        | 3.13                  | 3.30 | 3.50                            | V    |      |
| Supply Current                 | I <sub>CC</sub>        |                       |      | 325                             | mA   | BOL  |
| Inrush Current                 | I <sub>surge</sub>     |                       |      | I <sub>CC</sub> +30             | mA   | BOL  |
| Maximum Power                  | P <sub>max</sub>       |                       |      | 1.25                            | W    |      |
| <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    |
| <b>RECEIVER</b>                |                        |                       |      |                                 |      |      |
| Single ended data output swing | V <sub>out,pp</sub>    | 175                   |      | 1000                            | mV   | 3    |
| Data output rise time          | t <sub>r</sub>         |                       |      | 120                             | ps   | 4    |
| Data output fall time          | t <sub>f</sub>         |                       |      | 120                             | 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 (LOS) 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    |            | -42  | -36 |      | dBm   |  |
| RX_LOS De-assert Level |            |      | -34 | -28  | 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        |            | -0.2 |     | +0.2 | nm    | TX_Fault will assert before the device is outside of specified wavelength range  |

## V. Optical Parameters<sup>1</sup>

| Parameter                                       | Symbol               | Min     | Typ | Max     | Units | Notes/Conditions  |
|---|----------------------|---------|-----|---------|-------|---|
| <b>TRANSMITTER CHARACTERISTICS</b>              |                      |         |     |         |       |   |
| Center Wavelength Spacing                       |                      |         | 100 |         | GHz   | Corresponds to approximately 0.8 nm   |
| Modulated Spectral Width                        | $\Delta\lambda_{20}$ |         | 0.2 | 0.3     | nm    | Full width, -20dB from max. See note 3  |
| Center Wavelength – End of Life                 | $\lambda_c$          | X - 100 | X   | X + 100 | pm    | X = specified center wavelength   |
| Center Wavelength – BOL Offset                  | $\lambda_c$          | Y - 25  | Y   | Y + 25  | pm    | Y = specified center wavelength   |
| Side Mode Suppression Ratio                     | SMSR                 | 30      |     |         | dB    | Modulated   |
| Optical Rise/Fall Time                          | $t_r / t_f$          |         |     | 120     | ps    | Unfiltered, 80% -20%  |
| Optical Output Power                            | $P_{out}$            | +2      |     | +5      | dBm   | Avg. power coupled into SMF-28; see note 4                                    |
| Extinction Ratio, (<=4.25G)                     | OMI                  | 6.0     |     |         | dB    | EOL   |
| Extinction Ratio, SONET                         | OMI                  | 8.2     |     |         | dB    | EOL, Rate Select Option Only  |
| Eye Opening                                     |                      | 10      |     |         | %     |   |
| Jitter Generation, SONET                        |                      |         |     | 75      | mUI   | Parameters per GR-253 <sup>2</sup> section 5.6 for OC-48 B                    |
| Total Jitter                                    |                      |         |     | 59.8    | ps    | (p-to-p)  |
| Deterministic Jitter                            |                      |         |     | 28.2    | ps    | (p-to-p)  |
| Reflectance                                     | $R_{TX}$             |         |     | -27     | dB    |   |
| Tolerable Back Reflection                       | BR                   |         |     | -14     | dB    | See note 5  |
| Relative Intensity Noise                        | RIN                  |         |     | -120    | dB/Hz |   |
| Dispersion Power Penalty                        | DPP                  |         |     | 3.0     | dB    | At 1600 ps/nm. See Note 6   |
| <b>RECEIVER CHARACTERISTICS</b>                 |                      |         |     |         |       |   |
| Optical Input Wavelength                        | $P_{in}$             | 1520    |     | 1570    | nm    |   |
| Jitter Generation , SONET                       |                      |         |     | 75      | mUI   | Parameters per GR-253 <sup>2</sup> section 5.6 for OC-48 B                    |
| Total Jitter                                    |                      |         |     | 61.8    | ps    | (p-to-p)  |
| Deterministic Jitter                            |                      |         |     | 25.9    | ps    | (p-to-p)  |
| Optical Input Power (BER < 10 <sup>-12</sup> )  | $P_{in}$             | -28     |     | -9      | dBm   | 2.5 Gb/s w/ PRBS 2 <sup>23</sup> -1 EOL, & rate select low option implemented |
| Optical Input Power (BER < 10 <sup>-12</sup> )  | $P_{in}$             | -23     |     | -9      | dBm   | 4.25 Gb/s w/ PRBS 2 <sup>7</sup> -1 EOL                                       |
| Optical Input Power – Receiver Damage Threshold |                      |         |     | +6      | dBm   |   |
| Receiver Reflectance                            | $R_{RX}$             |         |     | -27     | dB    |   |
| Min-Required OSNR 0ps/nm                        | OSNR <sub>bb</sub>   | 22      |     |         | dB    | See Note 7  |
| Min-Required OSNR 1600ps/nm                     | OSNR <sub>t</sub>    | 25      |     |         | dB    | See Note 7  |

### Notes:

- Parameters are specified over temperature and voltage, at end of life, and for non-rate select option unless otherwise noted.
- All parameters are measured on a Finisar SFP Evaluation Card unless otherwise noted.
- For accurate  $\Delta\lambda_{20}$  measurements, an OSA with a resolution band width of  $\leq 20$ pm is recommended.
- Output power of +3 to +7dBm is also supported; please contact your local Finisar sales representatives for details.
- Tolerable back reflection is the max back reflection level at which the power penalty will be <1dB. Power penalty is measured over fiber (1600ps/nm) at BER = 10<sup>-12</sup> with OSNR set at 24dB.
- Dispersion power penalty is measured in loop back with OSNR set to 30 dB. Data rate and pattern used same as specified for Optical Input Power. Dispersion power penalty is the difference in Rx power at a BER of 10<sup>-12</sup> for 0ps/nm & 1600ps/nm
- Rx power set between -9dBm and -18dBm. Data rate and pattern used same as specified for Optical Input Power. Measured as the Minimum OSNR to achieve a BER of 10<sup>-12</sup>. Optical filter bandwidth of 0.1nm is used in OSNR measurement.

**VI. Wavelength Stabilization**

The laser transmitter will not be turned on until its temperature is adjusted to ensure operation within the specified channel ( $X \pm 300\text{pm}$ ). This temperature stabilization time is dependent on the ambient temperature conditions, but will typically occur within 5 seconds of powering the device. The module will transmit within the specified wavelength tolerance ( $X \pm 100\text{pm}$ ) within 10 ms of transmitter operation.

**VII. General Specifications**

| Parameter         | Symbol | Min   | Typ | Max  | Units  | Notes/Conditions  |
|-------------------|--------|-------|-----|------|--------|---|
| Data Rate         | BR     | 0.155 |     | 4.25 | Gb/sec | SONET OC-3/12/48 compatible                                 |
| Total Link Budget |        | 26    | 30  |      | dB     | @ 4.25 Gb/s, BER $<10^{-12}$ w/ PRBS $2^7-1$ . See Note 1   |
| Total Link Budget |        | 31    | 34  |      | dB     | @ 2.5 Gb/s, BER $<10^{-12}$ w/ PRBS $2^{23}-1$ . See Note 1 |

Note 1: Total link budget is defined as  $P_{\text{out}} - P_{\text{in}}$  – typical connector losses. Operating in low rate mode

**VIII. Environmental Specifications**

| Parameter      | Symbol           | Min | Typ | Max | Units | Notes/Conditions                                   |
|----------------|------------------|-----|-----|-----|-------|--|
| Operating Temp | $T_{\text{op}}$  | -5  |     | 70  | °C    | Case temperature measured on top-side of device    |
| Storage Temp   | $T_{\text{sto}}$ | -40 |     | 85  | °C    | Ambient temperature                                |
| Eye Safety     |                  |     |     |     |       | CDRH and IEC-825 Class 1 Laser Product. See Note 1 |

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

**IX. Serial Communication Protocol**

All Finisar SFPs support the 2-wire serial communication protocol to provide module ID information as outlined in the SFP MSA<sup>1</sup>. These SFPs use an Atmel AT24C01A 128 byte E<sup>2</sup>PROM with an address of A0h. 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>3</sup>

Finisar SFPs also support diagnostic features as described in Finisar Applications Note AN-2030<sup>4</sup> and SFF-8472<sup>5</sup>, “Digital Diagnostic Monitoring Interface for Optical Transceivers”. A controller IC that monitors system parameters such as laser current, module temperature, transmitter power, and received power is accessible at address A2H. In addition, Finisar’s DWDM SFPs provide extended set of ID information and diagnostic features as described in the DWDM SFP MSA<sup>6</sup>.

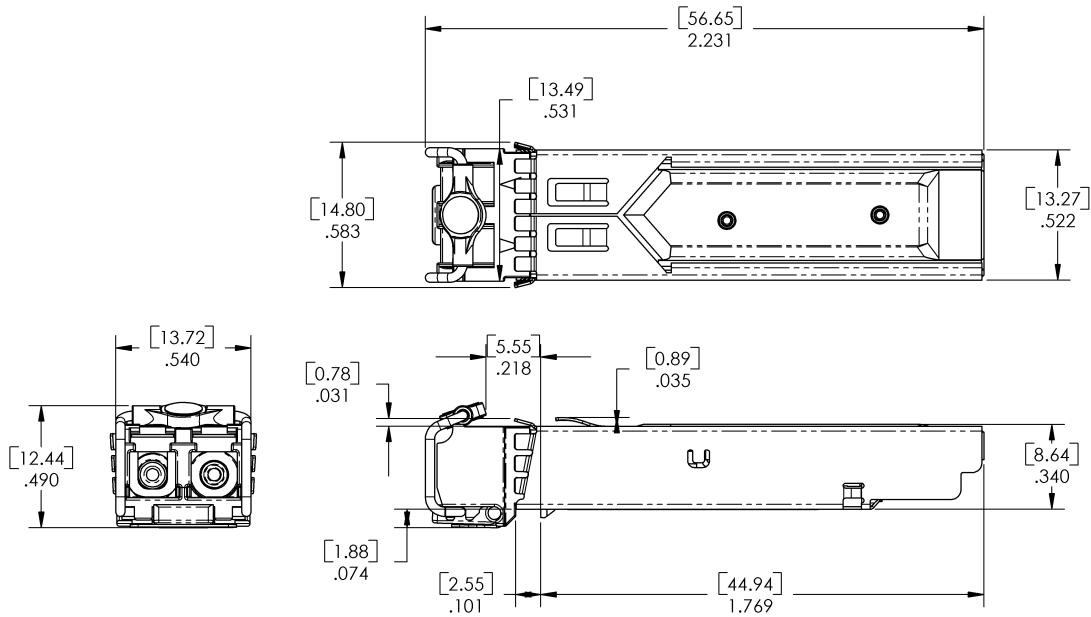
I<sup>2</sup>C clock speed, digital diagnostic accuracy and digital diagnostic range can be found in the table below. Values in the table represent the worst-case values over temperature, voltage, and life.

| <b>Parameter</b>             | <b>Symbol</b>             | <b>Min</b> | <b>Typ</b> | <b>Max</b> | <b>Units</b> | <b>Notes/Conditions</b>                     |
|------------------------------|---------------------------|------------|------------|------------|--------------|---|
| I <sup>2</sup> C Clock Speed |                           | 0          |            | 100,000    | Hz           | Bus can be driven blind                     |
| <b>Accuracy</b>              |                           |            |            |            |              |   |
| Transceiver Case Temperature | DD <sub>Temperature</sub> | -10        |            | +10        | °C           | Measured on the top-side of the module case |
| 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>     | -2         |            | +2         | dB           |   |
| Received Average Power       | DD <sub>RxPower</sub>     | -2         |            | +2         | dB           |   |
| <b>Range</b>                 |                           |            |            |            |              |   |
| Transceiver Case Temperature | DD <sub>Temperature</sub> | -40        |            | 85         | °C           |   |
| 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>     | -5         |            | +10        | dBm          |   |
| Received Average Power       | DD <sub>RxPower</sub>     | -30        |            | -7         | dBm          |   |



**X. Mechanical Specifications**

Finisar's Multi-rate DWDM Small Form Factor Pluggable (SFP) transceivers are compatible with the dimensions defined by the DWDM SFP Multi-Sourcing Agreement (MSA)<sup>6</sup>.



**Figure 1. DWDM SFP Outline Drawing (units in inches [mm])**

**XI. Ordering Information**

| <b>Part Number</b> | <b>Description</b>  |
|--------------------|---|
| FWLF1634Ryxx       | DWDM SFP with APD Receiver<br>y = L: non rate select<br>xx = channel number (see product selection on page 2) |

**XII. References**

1. Small Form Factor Pluggable (SFP) Transceiver Multi-Source Agreement (MSA), September 2000. Documentation is currently available from Finisar upon request.
2. “SONET Transport Systems: Common Generic Criteria”, Telcordia Technologies, GR-253-CORE, Issue 3, September 2000.
3. “AT24C01A/02/04/08/16 2-Wire Serial CMOS E<sup>2</sup>PROM”, Atmel Corporation. [www.Atmel.com](http://www.Atmel.com).
4. “Application Note AN-2030: Digital Diagnostic Monitoring Interface for Optical Transceivers”, Finisar Corporation, April 2002.
5. “Digital Diagnostic Monitoring Interface For Optical Transceivers Rev 9.3”. SFF Document No. SFF-8472.
6. Specifications for DWDM SFP Transceiver Draft 1.0.October 21 2005. Documentation is available from Finisar upon request.

**XIII. Revision HistoRL**

| <b>Revision</b> | <b>Date</b> | <b>Description</b>   |
|-----------------|-------------|--|
| A               | 8-15-2007   | • Document created.  |
| B               | 1-20-2008   | • Modified by FF for preliminaRL customer distribution                           |
| C               | 6-3-2008    | • Modified to reflect new optical output power level                             |
| C1              | 8-25-08     | • Updated rise/fall time to 120ps  |
| C2              | 2-23-09     | • Replace “Dispersion Noise Penalty” with “Min-OSNR requirement” at BB/1600ps/nm |
|                 |             | •  |
|                 |             | •  |
|                 |             | •  |
|                 |             | •  |

**XIV. For More Information:**

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