F i n i s a r

Preliminary Product Specification

RoHS Compliant DWDM SFP Transceiver

FWLF-1631-XX

PRODUCT FEATURES

- Up to 2.7 Gb/s bi-directional data links

- Hot-pluggable SFP footprint

- Temperature-stabilized DWDM-rated DFB laser transmitter

- 100GHz ITU Grid, C Band

- Low dispersion DFB laser

- RoHS compliant and lead free

- Extended operating range: -5°C to 70°C case temperature

- Wavelength controlled within ± 0.1 nm over life and temperature

- Extended link budget with APD receiver technology

- 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[1]. The FWLF-1631 is designed expressly for service providers deploying DWDM networking equipment in metropolitan access and core networks[2]. The transceiver is RoHS compliant and lead free per Directive 2002/95/EC[3], and Finisar Application Note AN-2038[4].

Basic digital diagnostic features for the FWLF-1631 are implemented as described in Finisar Application Note AN-2030, "Digital Diagnostic Monitoring Interface for Optical Transceivers"[5]. Optional enhanced digital diagnostic features are available per the DWDM SFP MSA[6].

F i n i s a r

## PRODUCT SELECTION

Product Code	Frequency (THz)	Center Wavelength (nm)
FWLF -1631-17	191.7	1563.86
FWLF -1631-18	191.8	1563.05
FWLF -1631-19	191.9	1562.23
FWLF -1631-20	192.0	1561.42
FWLF -1631-21	192.1	1560.61
FWLF -1631-22	192.2	1559.79
FWLF -1631-23	192.3	1558.98
FWLF -1631-24	192.4	1558.17
FWLF -1631-25	192.5	1557.36
FWLF -1631-26	192.6	1556.55
FWLF -1631-27	192.7	1555.75
FWLF -1631-28	192.8	1554.94
FWLF -1631-29	192.9	1554.13
FWLF -1631-30	193.0	1553.33
FWLF -1631-31	193.1	1552.52
FWLF -1631-32	193.2	1551.72
FWLF -1631-33	193.3	1550.92
FWLF -1631-34	193.4	1550.12
FWLF -1631-35	193.5	1549.32
FWLF -1631-36	193.6	1548.51
FWLF -1631-37	193.7	1547.72
FWLF -1631-38	193.8	1546.92
FWLF -1631-39	193.9	1546.12
FWLF -1631-40	194.0	1545.32
FWLF -1631-41	194.1	1544.53
FWLF -1631-42	194.2	1543.73
FWLF -1631-43	194.3	1542.94
FWLF -1631-44	194.4	1542.14
FWLF -1631-45	194.5	1541.35
FWLF -1631-46	194.6	1540.56
FWLF -1631-47	194.7	1539.77
FWLF -1631-48	194.8	1538.98
FWLF -1631-49	194.9	1538.19
FWLF -1631-50	195.0	1537.40
FWLF -1631-51	195.1	1536.61
FWLF -1631-52	195.2	1535.82
FWLF -1631-53	195.3	1535.04
FWLF -1631-54	195.4	1534.25
FWLF -1631-55	195.5	1533.47
FWLF -1631-56	195.6	1532.68
FWLF -1631-57	195.7	1531.90
FWLF -1631-58	195.8	1531.12
FWLF -1631-59	195.9	1530.33
FWLF -1631-60	196.0	1529.55
FWLF -1631-61	196.1	1528.77

I.   Pin Descriptions

Pin	Symbol	Name/Description	Ref.
1	V_{EET}	Transmitter Ground (Common with Receiver Ground)	1
2	T_{FAULT}	Transmitter Fault	
3	T_{DIS}	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_{EER}	Receiver Ground (Common with Transmitter Ground)	1
10	V_{EER}	Receiver Ground (Common with Transmitter Ground)	1
11	V_{EER}	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_{EER}	Receiver Ground (Common with Transmitter Ground)	1
15	V_{CCR}	Receiver Power Supply	
16	V_{CCT}	Transmitter Power Supply	
17	V_{EET}	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_{EET}	Transmitter Ground (Common with Receiver Ground)	1

Notes:

1. **Circuit ground is internally isolated from chassis ground.**
2. Laser output disabled on T_{DIS} >2.0V or open, enabled on T_{DIS} <0.8V.
3. 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.
4. Finisar 2x receiver achieves simultaneous 1x and 2x operation without active control.
5. 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.
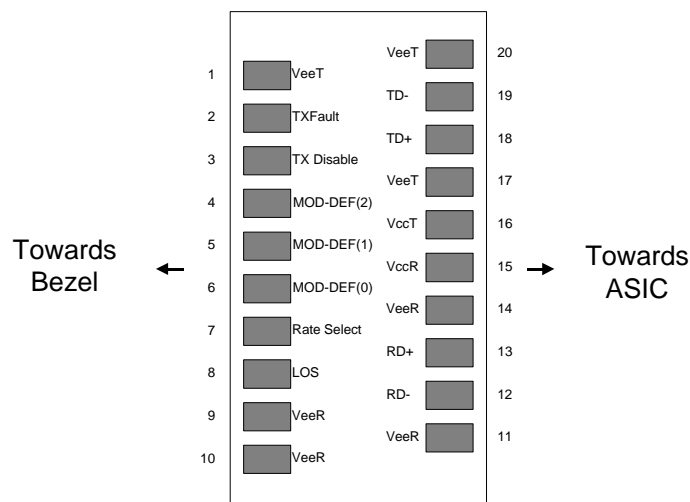
Diagram of Host Board Connector Block Pin Numbers and Names

II.   Absolute Maximum Ratings

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Maximum Supply Voltage	Vcc	-0.5		4.7	V	
Storage Temperature	T_S	-10		85	°C	
Case Operating Temperature	T_{OP}	-5		70	°C	

III.   Electrical Characteristics (T_{OP} = -5 to 70 °C, V_{CC} = 3.13 to 3.50 Volts)

Parameter	Symbol	Min	Typ	Max	Unit	Ref.
Supply Voltage	Vcc	3.13	3.30	3.50	V	
Supply Current	Icc			380	mA	
Inrush Current	I_{surge}			Icc+30	mA	
Maximum Power	Pmax			1.25	W	
TRANSMITTER						
Input differential impedance	R_{in}		100		Ω	1
Single ended data input swing	Vin,pp	250		1200	mV	
Transmit Disable Voltage	V_D	Vcc – 1.3		Vcc	V	
Transmit Enable Voltage	V_{EN}	Vee		Vee+ 0.8	V	2
RECEIVER						
Single ended data output swing	Vout,pp	175		1000	mV	3
Data output rise time	t_r			150	ps	4
Data output fall time	t_f			150	ps	4
LOS Fault	$V_{LOS\ fault}$	Vcc – 0.5		Vcc_{HOST}	V	5
LOS Normal	$V_{LOS\ norm}$	Vee		Vee+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 LVTTL. 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 Deassert Level			-34	-32	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

Parameter	Symbol	Min	Typ	Max	Units	Notes/Conditions
TRANSMITTER CHARACTERISTICS						
Center Wavelength Spacing			100		GHz	Corresponds to approximately 0.8 nm
Spectral Width	$\Delta\lambda_{20}$		0.2	0.3	nm	Full width, -20dB from max
Transmitter Center Wavelength – End of Life	λ_c	X - 100	X	X + 100	pm	X = specified ITU center wavelength
Transmitter Center Wavelength – Start of Life	λ_c	Y - 25	Y	Y + 25	pm	Y = specified BOL center wavelength
Side Mode Suppression Ratio (SMSR)	SMSR	30			dB	Modulated
Optical Rise/Fall Time	t_r / t_f			160	ps	Unfiltered, 80% -20%
Transmitter Optical Output Power	P_{out}	0		+4	dBm	Average power coupled into single mode fiber
Transmitter Extinction Ratio	OMI	8.2			dB	
Transmitter Eye Opening		10			%	OC-48 eye mask margin
Transmitter Jitter (peak to peak)				75	mUI	Parameter per GR-253[8] section 5.6 for OC-48 B
Tolerable Back Reflection	BR			-14	dB	See note 5
Relative Intensity Noise	RIN			-120	dB/Hz	
Dispersion Power Penalty at 120km				3.0	dB	2400ps/nm. See Note 3.
RECEIVER CHARACTERISTICS						
Optical Input Wavelength	P_{in}	1520		1570	nm	
Receiver Jitter Generation				75	mUI	Parameters per GR-253[8] section 5.6 for OC-48 B
Optical Input Power (BER < 10^-9)	P_{in}	-30		-9	dBm	2.5 Gb/s w/ PRBS 2^23 -1
Optical Input Power (BER < 10^-12)	P_{in}	-28		-9	dBm	2.5 Gb/s w/ PRBS 2^23 -1
Optical Input Power – Receiver Damage Threshold				6	dBm	
Receiver Reflectance	R_{RX}			-27	dB	
OSNR Limit	$OSNR_{min}$	20			dB	
OSNR Power Penalty				3.0	dB	For OSNR = $OSNR_{min.}$ See Note 4

Notes:
1. Parameters are specified over temperature and voltage, at end of life unless otherwise noted.
2. All parameters are measured on a Finisar SFP Evaluation Card unless otherwise noted.
3. Dispersion power penalty is measured in loop back with OSNR set at Rx $\leq$ 28 dB. Data rate and pattern used same as specified for Optical Input Power. Dispersion penalty is measured at BER = 10^{-10}
4. OSNR power penalty is measured in loop back. Data rate and pattern used is same as specified for Optical Input Power. OSNR penalty is measured at BER = 10^{-10}
5. Tolerable back reflection is the max back reflection level at which the power penalty will be <1dB. Power penalty is measured over fiber (2400ps/nm) at BER = 10^{-10} under high OSNR (>28dB) conditions.

VI. Wavelength Stabilization

The laser transmitter will not be turned on until its temperature is adjusted to ensure operation within the specified channel (X +/- 0.4nm). This temperature stabilization time is dependent on the ambient temperature conditions, but will typically occur within 30 seconds of powering the device. The device will transmit within the specified wavelength tolerance (X +/- 0.1nm) within 5 seconds of transmitter operation.

VII. General Specifications

Parameter	Symbol	Min	Typ	Max	Units	Notes/Conditions
Data Rate	BR	0.155		2.7	Gb/sec	SONET OC-3/12/48 compatible
Total System Budget		28	30		dB	@ 2.5 Gb/s, BER <10^{-12} w/ PRBS 2^{-23}-1. See Note 1

Note 1: Total system budget is defined as P_{out} – P_{in} – typical connector losses.

VIII.   Environmental Specifications

Parameter	Symbol	Min	Typ	Max	Units	Notes/Conditions
Operating Temp	T_{op}	-5		70	°C	Case temperature measured on top-side of device
Storage Temp	T_{sto}	-10		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 outlined in the SFP MSA[1]. These SFPs use an Atmel AT24C01A 128 byte E^2PROM with an address of A0h. For details on interfacing with the E^2PROM, see the Atmel data sheet titled "AT24C01A/02/04/08/16 2-Wire Serial CMOS E^2PROM."[7]

Finisar's DWDM SFPs also support extended diagnostic features as described in Finisar Applications Note AN-2030, "Digital Diagnostic Monitoring Interface for Optical Transceivers"[5]. (Additional information is available in document titled: "Digital Diagnostic Monitoring Interface for Optical Transceivers Rev 9.3"[8]). A controller IC that monitors system parameters such as laser current, module temperature, transmitter power, and received power is accessible at address A2H.

Parameter	Symbol	Min	Typ	Max	Units	Notes/Conditions
I^2C Clock for Atmel (A0H) and Controller IC (A2H)	C_{atmel}	0		100,000	Hz	Bus can be driven blind.

Serial ID Data Fields – Address A0

Data Address	Value	Name of Field	Description of Field
BASE ID FIELDS			
0	0Bh	Identifier	Type of serial transceiver
1	24h	Ext. Identifier	Extended identifier of type of serial transceiver
2	07h	Connector	Code for connector type
3	00h	Transceiver	Code for electronic compatibility or optical compatibility
4	0Ch		
5	00h		
6	02h		
7	80h		
8	10h		
9	01h		
10	05h		
11	05h	Encoding	Code for serial encoding algorithm
12	19h	BR, Nominal	Nominal bit rate, units of 100 MBits/sec
13	00h	Length(9µm) - km	Link length supported for 9/125 µm fiber, units of km
14	78h		
15	46h	Max Temp	Maximum operating case temperature in ºC
16	FBh	Min Temp	Minimum operating case temperature in ºC
17	5Fh	Max Supply Current	Maximum supply current in units of 4 mA
18	00h	Reserved	
19	41h	Channel spacing and Tuning	Channel spacing compatibility and number of ITU channels supported
20-35	FINISAR CORP.	Vendor name	SFP vendor name (ASCII, padded with spaces)
36	02h	Opt. features	Implemented optional DWDM features
37	00h	Vendor OUI	Finisar IEEE company ID
38	90h		
39	65h		
40-55	FWLF-1631-XX	Vendor PN	Part number provided by Finisar (ASCII, padded with spaces)
56-59	41h	Vendor rev	Revision level for part number provided by Finisar (ASCII, padded with spaces)
60-61	Varies based on channel number	Wavelength	Laser wavelength (in nm)
62		Wavelength	Laser wavelength (fractional part in units of 10pm).
63		CC_BASE	Check code for Base ID Fields (addresses 0 to 62)

(Continued…)

Serial ID Data Fields – Address A0 (Continued)

Data Address	Value	Name of Field	Description of Field
EXTENDED ID FIELDS			
64	00h	Options	Indicates which optional transceiver signals are implemented
65	1Ah		
66	00h	BR, max	Upper bit rate margin, units of %
67	00h	BR, min	Lower bit rate margin, units of %
68-83	e.g., A000000	Vendor SN	Serial number provided by Finisar (ASCII, padded with spaces)
84-91	e.g., 990225	Date code	Finisar's manufacturing date code (ASCII)
92	68h	Diagnostic Monitoring Type	Indicates which type of diagnostic monitoring is implemented (if any) in the transceiver
93	F0h	Enhanced Options	Indicates which optional enhanced features are implemented (if any) in the transceiver
94	01h	SFF-8472 Compliance	Indicates which revision of SFF-8472 the transceiver complies with
95		CC_EXT	Check code for the Extended ID Fields (addresses 64 to 94)
VENDOR SPECIFIC ID FIELDS			
96-127	00h	Vendor Specific	Vendor Specific EEPROM
128-255	00h	Reserved	Reserved for future use.

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)[6].
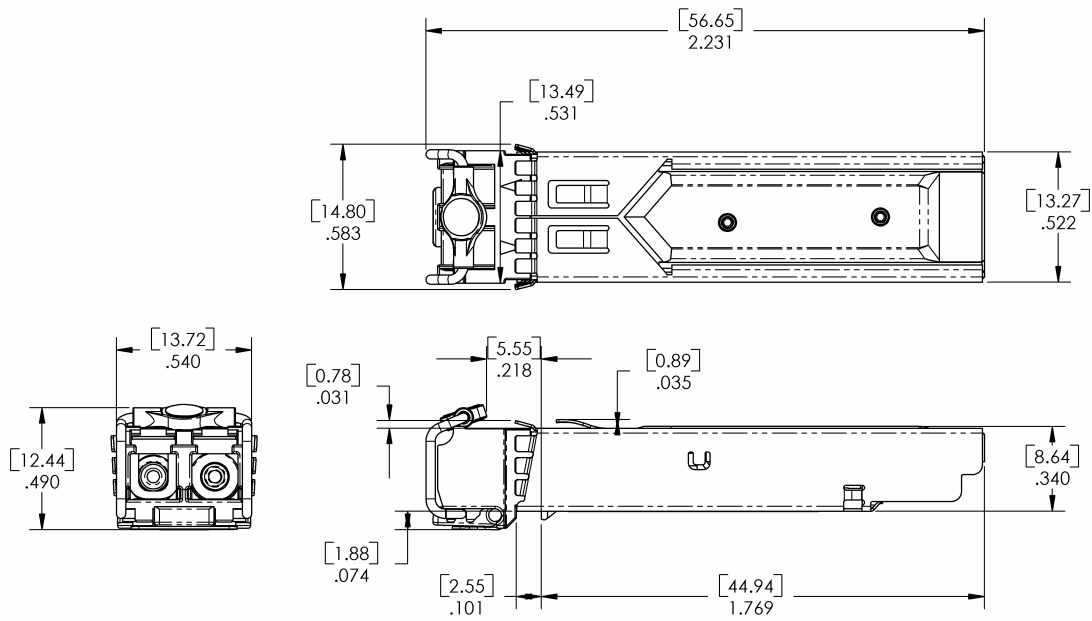

Figure 1. DWDM SFP Outline Drawing

XI. Ordering Information

Part Number   **Description**
FWLF-1631-XX   DWDM SFP with APD Receiver
                         XX = channel number (see product selection on page 2)

XII. References/Endnotes

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, Sept 2000.

3. 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.

4. "Application Note AN-2038: Finisar Implementation Of RoHS Compliant Transceivers", Finisar Corporation, January 21, 2005.

5. "Application Note AN-2030: Digital Diagnostic Monitoring Interface for Optical Transceivers", Finisar Corporation, April 2002.

6. "Specifications for DWDM SFP Transceiver Draft 0.9", June 21 2005. Documentation is available from Finisar upon request.

7. "AT24C01A/02/04/08/16 2-Wire Serial CMOS E^{2}PROM", Atmel Corporation. www.Atmel.com

8. "Digital Diagnostic Monitoring Interface For Optical Transceivers Rev 9.3". SFF Document No. SFF-8472.

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