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**Product Specification**

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**RoHS-6 Compliant**  
**10GBASE-LR X2 Transponder**

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**FTLX1441E2/FTLX1441F2**

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## PRODUCT FEATURES

- Hot pluggable X2 MSA form factor
- Total power consumption: 3.5 W maximum
- RoHS-6 compliant (lead-free)
- Temperature range 0°C to 70°C
- Transmission distance of 10Km
- Uncooled directly modulated Distributed Feedback (DFB) laser at 1310 nm
- SC connector, single mode fiber
- Full duplex transmission mode
- Digital Optics Monitoring (DOM)
- Power supply: +5.0 V, +3.3 V, Adaptable Power Supply (APS: +1.2 V)
- XAUI electrical interface  
4x 3.125 Gb/s Ethernet (FTLX1441E2)  
4x 3.1875 Gb/s Fibre Channel (FTLX1441F2)
- Management and control via MDIO 2-wire bus
- 70-pin connector
- Separated signal/chassis ground
- Mid Pak module variance for front panel mounting
- De-latch mechanism with low extraction force



## APPLICATIONS

- 10GBASE-LR 10G Ethernet (FTLX1441E2)
- 1200-SM-LL-L 10G Fibre Channel (FTLX1441F2)

## PRODUCT SELECTION

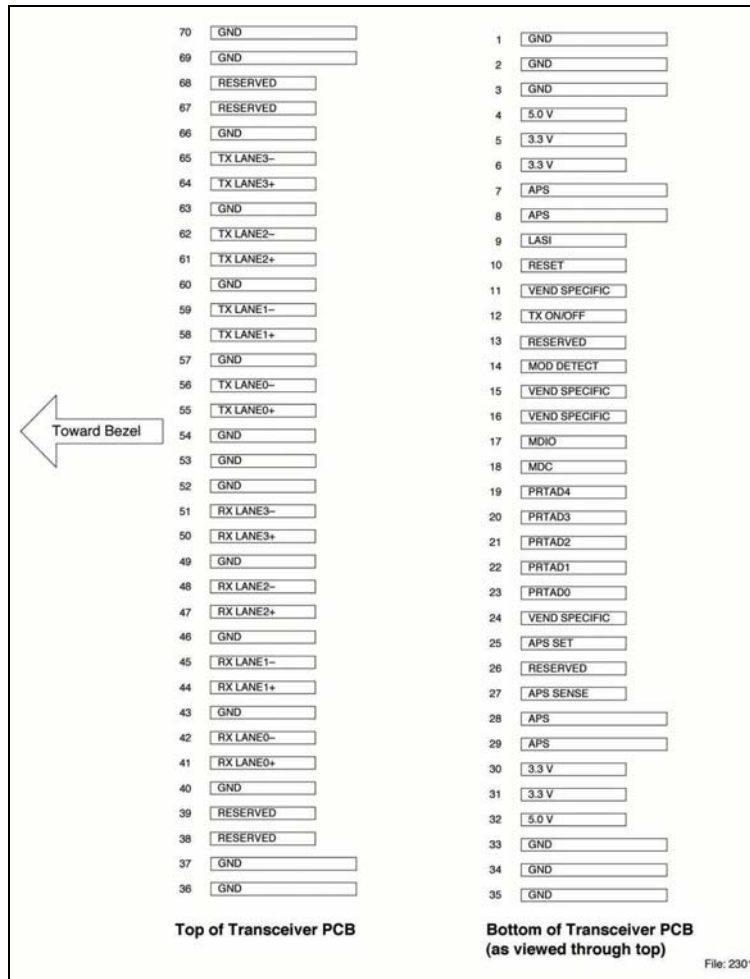
Part Number	Application
FTLX1441E2	10G Ethernet
FTLX1441F2	10G Fibre Channel

**I. PIN DESCRIPTION**

Signal Name	Level	I/O	Pin No.	Description
<b>Management and Monitoring Ports</b>				
MDIO	Open Drain	I/O	17	Management Data I/O. Requires external 10 - 22 k $\Omega$ pull-up to the APS on host.
MDC	1.2 V CMOS	I	18	Management Data Clock Input
PRTAD4	1.2 V CMOS	I	19	Port Address Input bit 4
PRTAD3	1.2 V CMOS	I	20	Port Address Input bit 3
PRTAD2	1.2 V CMOS	I	21	Port Address Input bit 2
PRTAD1	1.2 V CMOS	I	22	Port Address Input bit 1
PRTAD0	1.2 V CMOS	I	23	Port Address Input bit 0
LASI	Open Drain	O	9	Link Alarm Status Interrupt Output. Open Drain Compatible Output with 10 - 20 k $\Omega$ pull-up on host. Logic high = Normal Operation Logic low = Status Flag Triggered
RESET	Open Drain	I	10	Reset Input. Open Drain Compatible Input with 22 k $\Omega$ pull-up to APS internal to transponder. Logic high = Normal Operation Logic low = RESET
Vendor Specific			11,15,16,24	Vendor Specific Pins. Leave unconnected when not used.
TX ON/OFF	Open Drain	I	12	TX ON/OFF Input. Open Drain Compatible Input with 22 k $\Omega$ pull-up to APS internal to transponder. Logic high = Transmitter On Logic low = Transmitter Off
MOD DETECT		O	14	Pulled low inside transponder through a 1 k $\Omega$ resistor to Ground
<b>Transmit Functions</b>				
Reserved		I	68	Reserved For Future Use
Reserved		I	67	Reserved For Future Use
TX LANE 3–	AC-coupled, Internally biased differential XAUI	I	65	Module XAUI Input Lane 3–
TX LANE 3+		I	64	Module XAUI Input Lane 3+
TX LANE 2–		I	62	Module XAUI Input Lane 2–
TX LANE 2+		I	61	Module XAUI Input Lane 2+
TX LANE 1–		I	59	Module XAUI Input Lane 1–
TX LANE 1+		I	58	Module XAUI Input Lane 1+
TX LANE 0–		I	56	Module XAUI Input Lane 0–
TX LANE 0+		I	55	Module XAUI Input Lane 0+

<b>Receive Functions</b>				
Reserved		O	38	Reserved For Future Use
Reserved		O	39	Reserved For Future Use
RX LANE 0+	AC-coupled, Internally biased differential XAUI	O	41	Module XAUI Output Lane 0+
RX LANE 0–		O	42	Module XAUI Output Lane 0–
RX LANE 1+		O	44	Module XAUI Output Lane 1+
RX LANE 1–		O	45	Module XAUI Output Lane 1–
RX LANE 2+		O	47	Module XAUI Output Lane 2+
RX LANE 2–		O	48	Module XAUI Output Lane 2–
RX LANE 3+		O	50	Module XAUI Output Lane 3+
RX LANE 3–		O	51	Module XAUI Output Lane 3–
<b>DC Power</b>				
GND	0 V DC		1, 2, 3, 33, 34, 35, 36, 37, 40, 43, 46, 49, 52, 53, 54, 57, 60, 63, 66, 69, 70	Ground connection for signal ground on the module
APS	+1.2 V		7, 8, 28, 29	Input from Adaptive Power Supply
APS SENSE	+1.2 V		27	APS Sense Output. Connected to the APS input inside transponder.
APS SET			25	Feedback input from APS. Connected to GND through a 1180Ω resistor inside the transponder.
3.3 V	+3.3 V DC		5, 6, 30, 31	DC Power Input, +3.3 V DC, Nominal
5.0 V	+5.0 V DC		4, 32	DC Power Input, +5.0 V DC, Nominal
Reserved			26	Reserved for APD.
Reserved			13	Reserved.

**Electrical Pad Layout**



**Fig 1-X2 Transponder Electrical Pad Layout**

**II. Absolute Maximum Ratings**

Parameter	Symbol	Limit Values		Unit
		min.	max.	
Storage Ambient Temperature <sup>1)</sup>	$T_S$	-40	85	°C
Operating Case Temperature <sup>1)</sup>	$T_C$	0	70	°C
Supply Voltage +5.0 V	$V_5$	0	6	V
Supply Voltage +3.3 V	$V_3$	0	4	V
Supply Voltage APS	$V_{aps}$	0	1.5	V
Static Discharge Voltage, All Pins <sup>2)</sup>	$ST_d$		500	V
Average Receive Optical Power	$RxP_{max}$		1.5	dBm

Notes:

- 1) Non-condensing.
- 2) HBM

Exceeding any one of these values may permanently destroy the device.

### III. Electrical Characteristics

#### Recommended Operating Conditions

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
Operating Case Temperature <sup>1)</sup>	$T_C$	0		70	°C
Transponder Total Power Consumption	$P$			3.5	W
Supply Voltage +5.0 V	$V_{CC5}$	4.75	5.0	5.25	V
Supply Current +5.0 V	$I_{CC5}$			300	mA
Supply Voltage +3.3 V	$V_{CC3}$	3.14	3.3	3.47	V
Supply Current +3.3 V	$I_{CC3}$			300	mA
Supply Voltage APS	$V_{CC\text{aps}}$	1.152	1.2	1.248	V
Supply Current APS	$I_{CC\text{aps}}$			1000	mA

<sup>1)</sup> Worst case thermal location, see **Figure 11**.  
See also **Environmental Performance**.

#### Electrical DC Characteristics

( $V_{CC5} = 4.75\text{ V to } 5.25\text{ V}$ ,  $V_{CC3} = 3.14\text{ V to } 3.47\text{ V}$ ,  $V_{CC\text{aps}} = 1.152\text{ V to } 1.248\text{ V}$ ,  $T_C = 0^\circ\text{C to } 70^\circ\text{C}$ )

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>1.2 V CMOS (1.8 V CMOS Compatible<sup>1)</sup>) I/O DC Characteristics (PRTAD; LASI; RESET; TX_ONOFF)</b>					
External Pull-up Resistor for Open Drain	$R_{\text{pullup}}$	10		22	k $\Omega$
Output High Voltage <sup>2)</sup>	$V_{\text{oh}}$	1			V
Output Low Voltage <sup>2)</sup>	$V_{\text{ol}}$			0.15	V
Input High Voltage	$V_{\text{ih}}$	0.84		1.5	V
Input Low Voltage	$V_{\text{il}}$			0.36	V
Input Pull-down Current <sup>3)</sup>	$I_{\text{pd}}$	20		120	$\mu\text{A}$
<b>XAUI I/O DC Characteristics (TXLANE[0..3]; RXLANE[0..3])</b>					
Differential Input Amplitude (pk-pk) <sup>4)</sup>	$V_{\text{in\_xaui}}$	200		2500	mV
Differential Output Amplitude (pk-pk) <sup>4)</sup>	$V_{\text{out\_xaui}}$	800		1600	mV
<b>MDIO I/O DC Characteristics (MDIO; MDC)</b>					
Output Low Voltage <sup>5)</sup>	$V_{\text{OL}}$	-0.3		0.2	V
Output Low Current	$I_{\text{OL}}$			4	mA
Input High Voltage	$V_{\text{IH}}$	0.84		1.5	V
Input Low Voltage	$V_{\text{IL}}$	-0.3		0.36	V
Pull-up Supply Voltage	$V_{\text{PU}}$	1.152	1.2	1.248	V
Input Capacitance	$C_{\text{IN}}$			10	pF
Load Capacitance	$C_{\text{LOAD}}$			470	pF
External Pull-up Resistance	$R_{\text{LOAD}}$	200			$\Omega$

<sup>1)</sup> For 1.8 V CMOS  $V_{\text{oh}} = 1.65\text{ V min.}$ ,  $V_{\text{ol}} = 0.15\text{ V max.}$ ,  $V_{\text{ih}} = 1.17\text{ V min.}$ ,  $V_{\text{il}} = 0.63\text{ V max.}$

<sup>2)</sup>  $R_{\text{pull-up}} = 10\text{ k}\Omega\text{ to } 1.8\text{ V}$ .

<sup>3)</sup>  $V_{\text{in}} = 1.2\text{ V}$ .

<sup>4)</sup> AC coupled.

<sup>5)</sup>  $I_{\text{OL}} = 100\ \mu\text{A}$ .

**Electrical AC Characteristics**(V<sub>CC5</sub> = 4.75 V to 5.25 V, V<sub>CC3</sub> = 3.14 V to 3.47 V, V<sub>CCaps</sub> = 1.152 V to 1.248 V, T<sub>C</sub> = 0°C to 70°C)

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>XAUI Input AC Characteristics (TXLANE[0..3])</b>					
Baud Rate Fibre Channel Ethernet	R <sub>XAUIIN</sub>		3.1875 3.125		Gbit/s
Baud Rate Tolerance	R <sub>TOLXAUI</sub>	-100		100	ppm
Differential Input Impedance	Z <sub>INXAUI</sub>	80	100	120	Ω
Differential Return Loss <sup>1)</sup>	S <sub>11</sub>	10			dB
Input Differential Skew <sup>2)</sup>	t <sub>SKEWIN</sub>			75	ps
Jitter Amplitude Tolerance <sup>3)</sup>	J <sub>XAUITOL</sub>			0.65	UI <sub>p-p</sub>
<b>XAUI Output AC Characteristics (RXLANE[0..3])</b>					
Baud Rate Fibre Channel Ethernet	R <sub>XAUIOUT</sub>		3.1875 3.125		Gbit/s
Baud Rate Variation	R <sub>XAUIVAR</sub>	-100		100	ppm
XAUI Eye Mask (far-end)	According to IEEE 802.3ae and Fibre Channel 1200-SM-LL-L				
Output Differential Skew	t <sub>SKEWOUT</sub>			15	ps
Output Differential Impedance	Z <sub>OUTXAUI</sub>	80	100	120	Ω
Differential Output Return Loss <sup>1)</sup>	S <sub>22</sub>	10			dB
Total Jitter <sup>4)</sup>	TJ <sub>XAUI</sub>			0.35	UI
Deterministic Jitter <sup>4)</sup>	DJ <sub>XAUI</sub>			0.37	UI
<b>Power-On Reset AC Characteristics</b>					
Power-On Reset and TX_ONOFF Characteristics	According to XENPAK MSA Issue 3.0, 2002-9-18				
<b>MDIO I/O AC Characteristics (MDIO; MDC)</b>					
MDIO Data Hold Time	t <sub>HOLD</sub>	10			ns
MDIO Data Setup Time	t <sub>SU</sub>	10			ns
Delay from MDC Rising Edge to MDIO Data Change	t <sub>DELAY</sub>			300	ns
MDC Clock Rate	f <sub>MAX</sub>			2.5	MHz

<sup>1)</sup> 100 MHz to 2.5 GHz.<sup>2)</sup> At crossing point.<sup>3)</sup> Per IEEE Std 802.3ae.<sup>4)</sup> At near-end, No pre-equalization, 1 UI = 320 ps.

#### IV. Optical Characteristics

( $V_{CC5} = 4.75 \text{ V to } 5.25 \text{ V}$ ,  $V_{CC3} = 3.14 \text{ V to } 3.47 \text{ V}$ ,  $V_{CC\text{aps}} = 1.152 \text{ V to } 1.248 \text{ V}$ ,  $T_C = 0^\circ\text{C to } 70^\circ\text{C}$ , BER 1E-12, Bit Rate 10.3125)

Parameter	Symbol	Values			Unit
		min.	typ.	max.	
<b>Transmitter</b>					
Launch Power in OMA minus TDP	$P_{O\text{-OMA}}$	-5.2			dBm
Average Launch Power	$P_{O\text{-Avg}}$	-8.2		0.5	dBm
Center Wavelength Range	$\lambda_{C\text{-Tx}}$	1290		1330	nm
Spectral Width (-20 dB)	$\sigma_I$			0.6	nm
Side Mode Suppression Ratio	SMSR	30			dB
Extinction Ratio	ER	3.5			dB
Relative Intensity Noise <sub>12</sub> OMA	RIN			-128	dB/Hz
Optical Modulation Aplitude (OMA)	OMA	-5.2			dBm
Transmitter and Dispersion Penalty	TDP			3.2	dB
Average Launch Power of OFF Transmitter	$P_{O\text{-OFF}}$			-30	dBm
Optical Return Loss Tolerance	$ORL_T$			12	dB
Transmitter Reflectance	$REF_{TX}$			-12	dB
Eye Mask Definition	According to IEEE 802.3ae and Fibre Channel 1200-SM-LL-L				
<b>Receiver</b>					
Stressed Receiver Sensitivity	$P_{IN\text{-S}}$			-10.3	dBm
Rx Sensitivity in OMA <sup>1)</sup>	$P_{IN\text{-O}}$			-12.6	dBm
Average Receiver Power <sup>1)</sup>	$P_{IN}$	-14.4		0.5	dBm
Receiver Damage Power	$P_{IN\text{-dmg}}$			1.5	dBm
Loss Of Signal Assert Level	$P_{LOSa}$			-13	dBm
Loss Of Signal Hysteresis	$P_{LOSh}$	1			dB
Receiver Reflectance	$REF_{RX}$			-12	dB
Receive Electrical 3dB Upper Cutoff Frequency	$F_C$			12.3	GHz
Center Wavelength Range	$\lambda_{C\text{-RX}}$	1260		1355	nm
<b>Stressed Signal Calibration</b>					
Vertical Eye Closure Penalty		2.2			dB
Stressed Eye Jitter		0.3			UIpp

<sup>1)</sup> Average Receiver Power (min), which is defined for an ideal input signal, is informative only.

#### V. General Specifications

##### Optical Interface Standard Specifications

Standard	Differential Group Delay Maximum (ps)	Operating Range <sup>1)</sup> (meters)
B1.1 SMF	10	2 to 10,000
B1.3 SMF	10	2 to 10,000

Notes:

1) Operating range as defined by IEEE and Fibre Channel standards. Longer reach possible depending upon link implementation.

**Environmental Performance**

Operating case temperature: 0°C to +70°C  
 Operating humidity: 0% -95% RH non-condensing

**Fibers and Connectors**

The transponder has SC receptacles for both Tx and Rx. The transponder is designed for single mode SC cables, 0° polished endface (PC).

**70-pin Connector**

The module interface connector is a 70-pin, printed circuit board edge connection with a 0.5 mm pitch. The appropriate mating connector for the customer PCB is a 70-pin SMT, dual row, right angled, edge connector, 0.5 mm pitch (Tyco Electronics part number 1367337-1, Molex part number 74441-0003 or equivalent).

**Rail Requirement**

The X2 rail system required to mount the X2 module is fully defined by the MSA. (Tyco Electronics part number 1367608-1: designed for belly to belly applications; and 1367610-1: designed for single sided board mount to fit into the standard host PCB footprint, or equivalent). For further details, please refer to vendor-supplied information.

**Aqueous Wash**

Finisar X2 transponders are neither solderable nor aqueous washable and are not intended for these processes.

**VI. Regulatory Compliance**

Feature	Standard	Comments
ESD: Electrostatic Discharge to the Electrical Pins (HBM)	EIA/JESD22-A114-B (MIL-STD 883D Method 3015.7)	Class 1a (> 500 V)
Immunity: Against Electrostatic Discharge (ESD) to the Module Receptacle	EN 61000-4-2 IEC 61000-4-2	Discharges ranging from ±2 kV to ±25 kV to the front end / faceplate / receptacle cause no damage to module (under recommended conditions).
Immunity: Against Radio Frequency Electromagnetic Field	EN 61000-4-3 IEC 61000-4-3	With a field strength of 10 V/m, noise frequency ranges from 10 MHz to 2 GHz. No effect on module performance between the specification limits.
Emission: Electromagnetic Interference (EMI)	FCC 47 CFR Part 15, Class B EN 55022 Class B CISPR 22	Noise frequency range: 30 MHz to 40 GHz Radiated emission does not exceed specified limits when measured inside a shielding enclosure with MSA conform cutout.



**Eye Safety**

Finisar FTLX1441 transponders are Class 1 Laser Products. They are certified per the following standards:

<b>Feature</b>	<b>Agency</b>	<b>Standard</b>	<b>Certificate Number</b>
Laser Eye Safety	FDA/CDRH	CDRH 21 CFR 1040 and Laser Notice 50	9210976-77
Laser Eye Safety	TÜV	EN 60825-1: 1994+A11:1996+A2:2001 IEC 60825-1: 1993+A1:1997+A2:2001 IEC 60825-2: 2000, Edition 2	R 72052602
Electrical Safety	TÜV	EN 60950	R 72052602
Electrical Safety	UL/CSA	CLASS 3862.07 CLASS 3862.87	1439230

Copies of the referenced certificates will be available at Finisar Corporation upon request.

**VII. DOM Parameters**

<b>Parameter</b>	<b>Values</b>			<b>Unit</b>
	<b>min.</b>	<b>typ.</b>	<b>max.</b>	
Transponder Temperature Monitor Accuracy <sup>1)</sup>	-5		+5	°C
Laser Bias Current Monitor Accuracy <sup>2)</sup>	-10		+10	%
Transmit Power Monitor Accuracy <sup>3)</sup>	-3		+3	dB
Receive Power Monitor Accuracy <sup>3)</sup>	-3		+3	dB

<sup>1)</sup> 0 to 70°C case temperature.

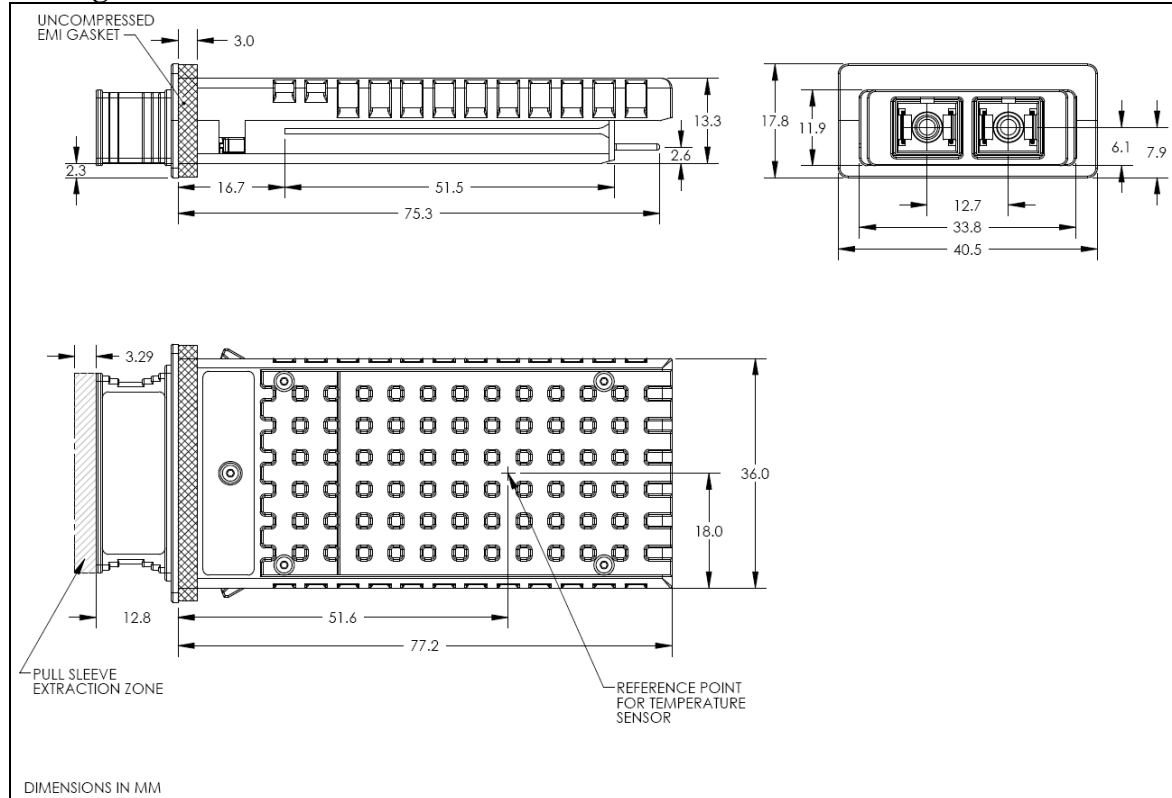
<sup>2)</sup> 0 to 12.5 mA.

<sup>3)</sup> -8.2 dBm to +0.5 dBm.

**VIII. Mechanical Characteristics**

<b>Parameter</b>	<b>Symbol</b>	<b>Values</b>			<b>Unit</b>
		<b>min.</b>	<b>typ.</b>	<b>max.</b>	
Module Retention Force (latch strength)	F <sub>RET</sub>		200		N
Module Insertion Force	F <sub>IN</sub>		40		N
Module Extraction Force (with kick-out)	F <sub>EXT-K</sub>		16		N
Module Extraction Force (without kick-out)	F <sub>EXT</sub>		25		N

Pull Sleeve front face color is blue.

**Package Outline****Figure 2-X2 Mechanical Dimensions****IX. References**

The following references are provided for informational purposes only. The parameters and operational behavior outlined in this specification describe the complete functionality of the 10G Transponder. Contact Finisar for any items concerning the operational characteristics of this device.

- IEEE Std 802.3æ™-2002 clause 52, 10GBASE-LR
- Fibre Channel 10GFC Draft 4.0, 1200-SM-LL-L
- X2 MSA Issue 2.0b

**X. For More Information**

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