
Product Specification

RoHS-6 Compliant
10GBASE-LR X2 Transponder

FTLX1441E2/FTLX1441F2

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 |
|--|--|-----|-------------|---|
| Management and Monitoring Ports | | | | |
| MDIO | Open Drain | I/O | 17 | Management Data I/O. Requires external 10 - 22 k Ω 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 Ω 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 Ω 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 Ω 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 Ω resistor to Ground |
| Transmit Functions | | | | |
| 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+ |

| Receive Functions | | | | |
|--------------------------|--|---|---|--|
| 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– |
| DC Power | | | | |
| 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

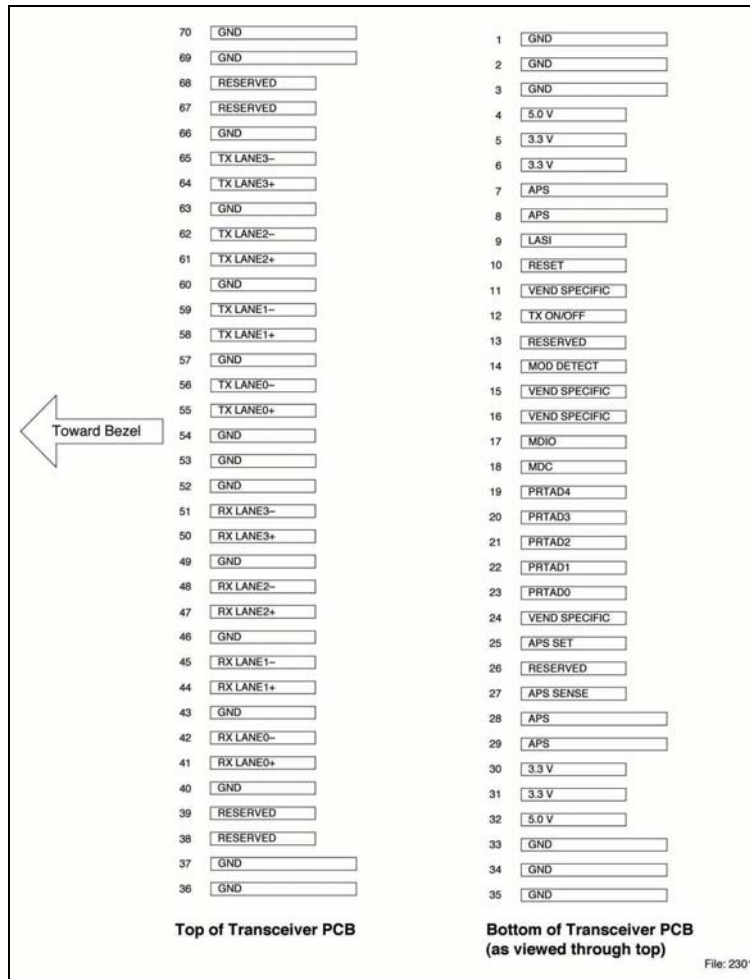


Fig 1-X2 Transponder Electrical Pad Layout

II. Absolute Maximum Ratings

| Parameter | Symbol | Limit Values | | Unit |
|--|-------------|--------------|------|------|
| | | min. | max. | |
| Storage Ambient Temperature ¹⁾ | T_S | -40 | 85 | °C |
| Operating Case Temperature ¹⁾ | 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 ²⁾ | 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 ¹⁾ | 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_{CCaps} | 1.152 | 1.2 | 1.248 | V |
| Supply Current APS | I_{CCaps} | | | 1000 | mA |

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

Electrical DC Characteristics

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

| Parameter | Symbol | Values | | | Unit |
|--|----------------|--------|------|-------|---------------|
| | | min. | typ. | max. | |
| 1.2 V CMOS (1.8 V CMOS Compatible¹⁾) I/O DC Characteristics (PRTAD; LASI; RESET; TX_ONOFF) | | | | | |
| External Pull-up Resistor for Open Drain | R_{pullup} | 10 | | 22 | k Ω |
| Output High Voltage ²⁾ | V_{oh} | 1 | | | V |
| Output Low Voltage ²⁾ | V_{ol} | | | 0.15 | V |
| Input High Voltage | V_{ih} | 0.84 | | 1.5 | V |
| Input Low Voltage | V_{il} | | | 0.36 | V |
| Input Pull-down Current ³⁾ | I_{pd} | 20 | | 120 | μA |
| XAUI I/O DC Characteristics (TXLANE[0..3]; RXLANE[0..3]) | | | | | |
| Differential Input Amplitude (pk-pk) ⁴⁾ | V_{in_xau} | 200 | | 2500 | mV |
| Differential Output Amplitude (pk-pk) ⁴⁾ | V_{out_xau} | 800 | | 1600 | mV |
| MDIO I/O DC Characteristics (MDIO; MDC) | | | | | |
| Output Low Voltage ⁵⁾ | V_{OL} | -0.3 | | 0.2 | V |
| Output Low Current | I_{OL} | | | 4 | mA |
| Input High Voltage | V_{IH} | 0.84 | | 1.5 | V |
| Input Low Voltage | V_{IL} | -0.3 | | 0.36 | V |
| Pull-up Supply Voltage | V_{PU} | 1.152 | 1.2 | 1.248 | V |
| Input Capacitance | C_{IN} | | | 10 | pF |
| Load Capacitance | C_{LOAD} | | | 470 | pF |
| External Pull-up Resistance | R_{LOAD} | 200 | | | Ω |

¹⁾ For 1.8 V CMOS $V_{oh} = 1.65$ V min., $V_{ol} = 0.15$ V max., $V_{ih} = 1.17$ V min., $V_{il} = 0.63$ V max.

²⁾ $R_{pull-up} = 10$ k Ω to 1.8 V.

³⁾ $V_{in} = 1.2$ V.

⁴⁾ AC coupled.

⁵⁾ $I_{OL} = 100$ μA .

Electrical AC Characteristics(V_{CC5} = 4.75 V to 5.25 V, V_{CC3} = 3.14 V to 3.47 V, V_{CCaps} = 1.152 V to 1.248 V, T_C = 0°C to 70°C)

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

¹⁾ 100 MHz to 2.5 GHz.²⁾ At crossing point.³⁾ Per IEEE Std 802.3ae.⁴⁾ 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. | |
| Transmitter | | | | | |
| 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) | σ_I | | | 0.6 | nm |
| Side Mode Suppression Ratio | SMSR | 30 | | | dB |
| Extinction Ratio | ER | 3.5 | | | dB |
| Relative Intensity Noise ₁₂ 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 | | | | |
| Receiver | | | | | |
| Stressed Receiver Sensitivity | $P_{IN\text{-S}}$ | | | -10.3 | dBm |
| Rx Sensitivity in OMA ¹⁾ | $P_{IN\text{-O}}$ | | | -12.6 | dBm |
| Average Receiver Power ¹⁾ | 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 |
| Stressed Signal Calibration | | | | | |
| Vertical Eye Closure Penalty | | 2.2 | | | dB |
| Stressed Eye Jitter | | 0.3 | | | UIpp |

¹⁾ 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 ¹⁾ (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:

| Feature | Agency | Standard | Certificate Number |
|-------------------|----------|--|--------------------|
| 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

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

¹⁾ 0 to 70°C case temperature.

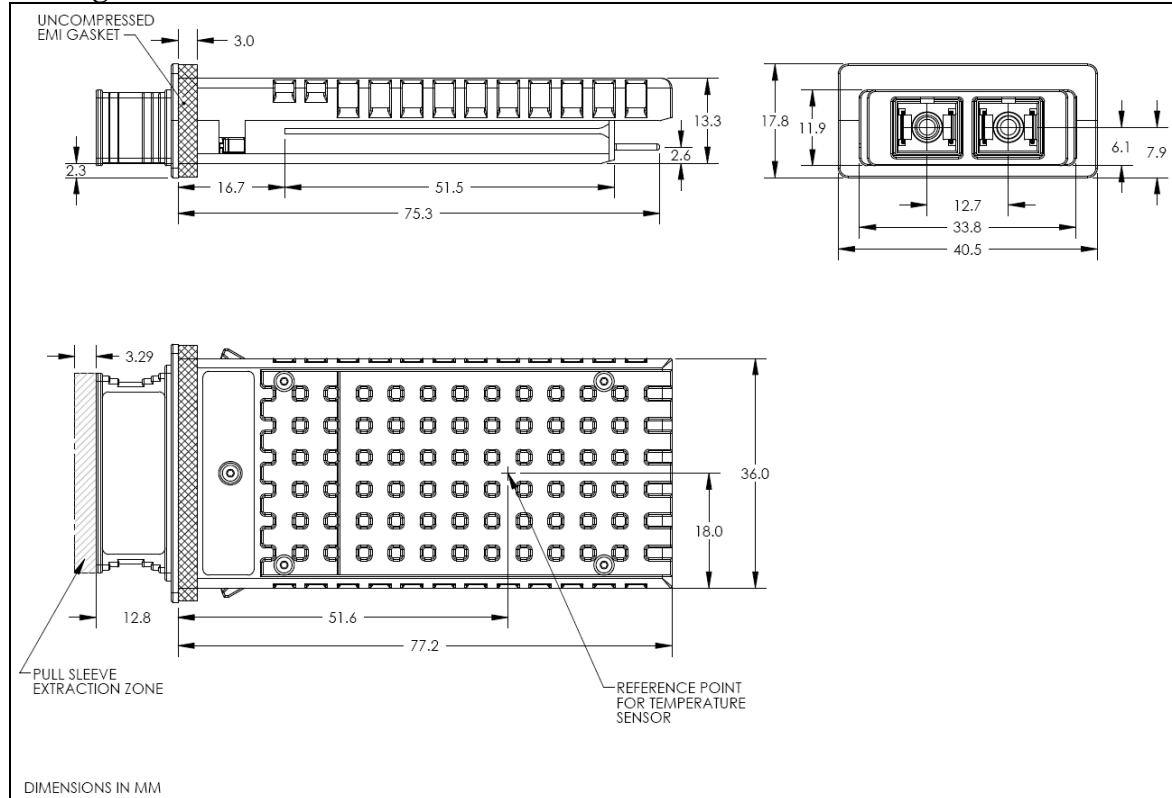
²⁾ 0 to 12.5 mA.

³⁾ -8.2 dBm to +0.5 dBm.

VIII. Mechanical Characteristics

| Parameter | Symbol | Values | | | Unit |
|--|--------------------|--------|------|------|------|
| | | min. | typ. | max. | |
| Module Retention Force (latch strength) | F _{RET} | | 200 | | N |
| Module Insertion Force | F _{IN} | | 40 | | N |
| Module Extraction Force (with kick-out) | F _{EXT-K} | | 16 | | N |
| Module Extraction Force (without kick-out) | F _{EXT} | | 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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