# TPT-MR-04-CCDL5A

## Features

- Compliant with the 300 pin SFF MSA
- Support multi-rate from 9.953Gb/s to 11.3Gbps
- Full C-band integrated tunable laser and MZ modulator
- High sensitivity PIN receiver
- 50GHz channel spacing
- ±800ps/nm chromatic dispersion
- 16-bit parallel 622.08Mbps LVDS data interface
- Compliant I2C MSA (Edition 4.0) interface for monitoring/control
- Built-in SBS dither
- Optional Optical Tx Trace ID (Tx_trace)
- Supply voltage: +5.0V, +3.3V, and -5.2V
- Compact size (2”x3”x0.53”) or (2”x3”x0.45”)
- Operating case temperature: -5°C to +70°C

## Applications

- Metro/Regional/Long haul DWDM system
- SONET/SDH, Ethernet and Fiber Channel system at standard and FEC rates
- Sparing and inventory reduction
- Optical Transport Network (OTN) system

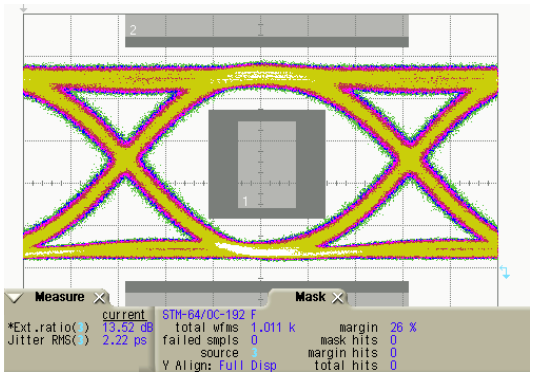
## Description

TPT-MR-04-CCDL5A C-band tunable 300 pin SFF transponder is designed for DWDM system applications with dispersion window from -800 to +800ps/nm. It provides multi-rate capability from 9.95Gbps to 11.3Gbps.

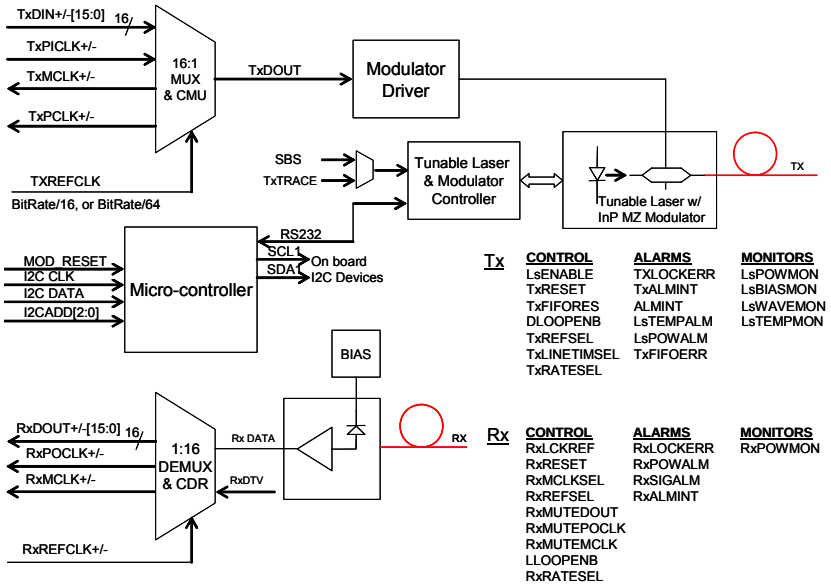
The integrated C band tunable laser and MZ modulator transmitter converts the electrical data into a 10Gbit/s optical signal. The low noise PIN receiver converts the incoming optical signal back to electrical data.

The MUX section multiplexes 16 parallel 622Mb/s electrical channels into a 10Gb/s serial data stream and sends it to the transmitter. The DEMUX section demultiplexes the 10Gb/s electrical data stream into 16 parallel 622Mb/s electrical channels. The parallel data is sent out to and receive from the 300-pin MSA (Multi Source Agreement) compliant connector.

The transmitter and receiver reference clock rates are selectable: divide by either 16 or 64.



## Function Block Diagram




## Absolute Maximum Ratings

**Table 1 Absolute Maximum Ratings**

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature | $T_S$ | -40 | 85 | °C |
| Supply Voltage | $V_{cc}$ | -0.5 | 5.5 | V |
| | $V_{dd}$ | -0.5 | 3.575 | V |
| | $V_{ee}$ | -6.0 | 0.3 | V |
| Max Rx Input Power | $P_{in\_max}$ | | 2 | dBm |
| Operating Relative Humidity (non-condensing) | RH | 5 | 85 | % |
| Electro-Static Discharge | ESD | - | 500 | V |

## Recommended Operating Conditions

**Table 2 - Recommended Operating Conditions**

| Parameter | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| Operating Case Temperature | $T_C$ | -5 | - | 70 | °C |
| Supply Voltage | $V_{cc}$ | 4.75 | 5.0 | 5.25 | V |
| | $V_{dd}$ | 3.13 | 3.3 | 3.46 | V |
| | $V_{ee}$ | -5.46 | -5.2 | -4.94 | V |
| Supply Current | $I_{cc}$ | - | - | 250 | mA |
| | $I_{dd}$ | - | - | 1800 [1)] | mA |
| | $I_{ee}$ | - | - | 800 [2)] | mA |
| Power consumption | Pd | - | 7 | 10 | W |
| Power supply noise rejection | | - | - | 50 | mVp-p |
| Bit Rate | BR | 9.95 | - | 11.3 | Gbps |

Note: 1) Transient current up to 2000mA.
2) Transient current up to 1300mA.

## Optical Interface Characteristics

**Table 3 - Optical Characteristics**

| Parameter | | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|---|
| **Transmitter** | | | | | | | |
| Wavelength Range | | $\lambda_C$<br>($f_C$) | 1528.77<br>(196.1) | - | 1563.86<br>(191.7) | nm<br>THz | 1 |
| Output Power | | $P_{OUT}$ | 3 | - | 6 | dBm | |
| Output Power Stability | | ΔP | -0.5 | - | 0.5 | dB | |
| Output Power at laser disable | | $P_{OUT-OFF}$ | | | -30 | dBm | |
| Channel Spacing | | CS | 50 | - | - | GHz | |
| Wavelength Tuning Accuracy | | Δλ | -25 | | 25 | pm | |
| Wavelength Stability | | $\lambda_{drift}$ | -25 | | 25 | pm | |
| Tuning Time | | $T_{tuning}$ | | | 30 | s | |
| Side Mode Suppression Ratio | | SMSR | 45 | | | dB | |
| Chirp (α) | | α | -0.1 | | 0.1 | | |
| Extinction Ratio | | ER | 12 | | | dB | |
| Output Optical Eye | | Compliant with Telcordia GR-253-CORE and ITU-T G.691 | | | | | |
| Jitter Generation | 20kHz~80MHz | | | | 0.3 | UIpp | 2 |
| | 4MHz~80MHz | | | | 0.1 | UIpp | 2 |
| **Receiver** | | | | | | | |
| Centre Wavelength | | $\lambda_C$ | 1528 | | 1565 | nm | 3 |
| Receiver Sensitivity | | $P_{in\_L}$ | | -18 | -17 | dBm | 4 |
| Receiver Overload | | $P_{in\_H}$ | 0 | | | dBm | 4 |
| Optical Path Penalty | | OPP | | | 2 | dB | |
| Chromatic Dispersion Tolerance | | CDT | -800 | | 800 | ps/nm | |
| Reflection of Receiver | | | | | -27 | dB | |
| Jitter Tolerance | | Compliant with Telcordia GR-253 and ITU-T G.825 | | | | | |
| Jitter Transfer | | Compliant with Telcordia GR-253 and ITU-T G.825 | | | | | |
| **Mechanical Housing** | | | | | | | |
| Fiber Pigtail Length | | $Fiber_L$ | 1000 | | 1200 | mm | |
| Module Dimension | | LxWxH | 76.07x55.75x13.46 | | | mm | 5 |
| | | | 2.995x2.195x0.53 | | | inch | 5 |

Notes:

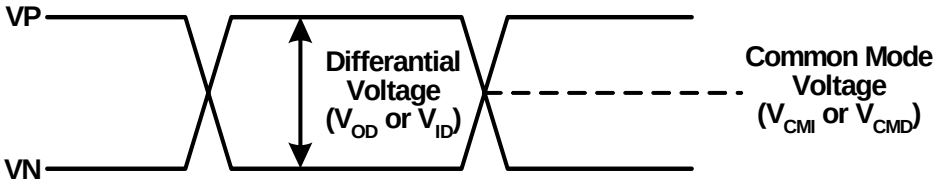
1. 89 channel tuning range is the standard spec. Wider tuning range is available upon special request
2. Measured with a NRZ PRBS $2^{31}$-1 test pattern @ 9.95328Gbps.
3. The Rx can accept a wider input wavelength range from 1290 to 1605nm with some performance degradation.

4. Measured with a NRZ PRBS $2^{31}$-1 test pattern @ 9.95328Gbps, BER ≤1x10-12, Back to back.
5. Thinner thickness of 0.449" or 11.40mm housing is also available.

## Electrical Interface Characteristics

**Table 4 - LVDS Input/Output Specification**

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|
| **LVDS interface** | | | | | | |
| Input High-voltage | $V_{IH}$ | 925 | | 2400 | mV | |
| Input Low-voltage | $V_{IL}$ | 825 | | 1900 | mV | |
| Input Common Mode Voltage | $V_{IC}$ | 850 | | 1800 | mV | |
| Single-ended Input-voltage Swing | $V_{SIN}$ | 100 | | 650 | mV | |
| Differential Input-voltage Swing | $V_{DIN}$ | 200 | | 1300 | mV | |
| Input Differential impedance | $R_{ID}$ | 80 | 100 | 120 | Ω | |
| Output High-voltage | $V_{OH}$ | 1160 | | 1550 | mV | |
| Output Low-voltage | $V_{OL}$ | 925 | | 1200 | mV | |
| Output Common Mode Voltage | VCM | 1050 | | 1425 | mV | |
| Single-ended Output-voltage Swing | $V_{SOUT}$ | 250 | | 450 | mV | |
| Differential Output-voltage Swing | $V_{DOUT}$ | 500 | | 900 | mV | |
| Output Differential impedance | $R_{OD}$ | 40 | 100 | 140 | Ω | |
| Rise Time/Fall time | $T_{rise/fall}$ | 100 | | 250 | ps | |
| Clock Signal Duty Cycle | $T_{DC}$ | 45 | 50 | 55 | % | |




Definition of Differantial Voltage Levels

**Table 5 - LVTTL Input/Output Specification**

| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|
| Input High Voltage | $V_{IH}$ | 2.0 | | | V | |
| Input Low Voltage | $V_{IL}$ | | | 0.65 | V | |
| Input High Current | $I_{IH}$ | | | 45 | μA | |
| Input Low Current | $I_{LH}$ | | | 30 | μA | |
| Output High Voltage | $V_{IH}$ | 2.4 | | | V | $I_{OH}$=600 μA |
| Output Low Voltage | $V_{IL}$ | | | 0.4 | V | $I_{OL}$=-600 μA |
| Rise Time/Fall time | $T_{rise/fall}$ | 1 | | 15 | ns | 10pF capacitive load |
| Operating Frequency | $F_{operating}$ | | | 10 | MHz | |

## Clock and Data Interfaces

**Table 6- Reference Clock characteristics**

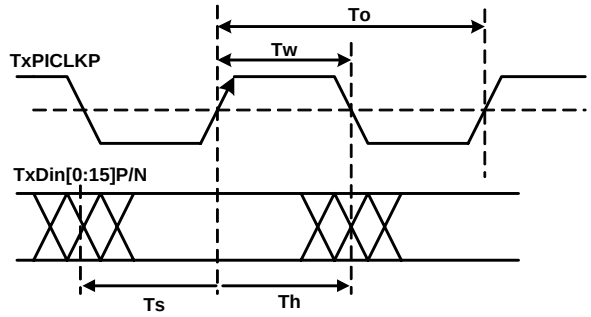
| Parameter | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|
| **Transmitter** | | | | | | |
| Frequency | TxREFCLKP TxREFCLKN | 155.52/622.08 | | | MHz | Serial data-rate is 9.953Gbps |
| Frequency tolerance | | -100 | | +100 | ppm | ±20ppm is required to meet SONET output frequency spec |
| Rise/Fall time | Tr/Tf | 200 | | 800 | ps | 155.52MHz, 20% to 80% amplitude |
| | | 100 | | 300 | ps | 622.08MHz, 20% to 80% amplitude |
| Duty Cycle | $T_{DC}$ | 45 | 50 | 55 | % | |
| **Receiver** | | | | | | |
| Frequency | RxREFCLKP RxREFCLKN | 155.52/622.08 | | | MHz | Serial data-rate is 9.953Gbps |
| Frequency tolerance | | -100 | | +100 | ppm | |
| Rise/Fall time | Tr/Tf | 200 | | 800 | ps | 155.52MHz, 20% to 80% amplitude |
| | | 100 | | 300 | ps | 622.08MHz, 20% to 80% amplitude |
| Duty Cycle | $T_{DC}$ | 45 | 50 | 55 | % | |

**Table 7 - Transmitter/Receiver Parallel Data/Clock Interface**

| Parameter | Symbol | Level | Notes |
|---|---|---|---|
| Transmitter 16-bit parallel Date Input | TxDin[0:15]P/N | LVDS | TxDin0:LSB, TxDin15:MSB |
| Transmitter Source synchronous ParallelInput Clock | TxPICLKP/N | LVDS | |
| Transmitter Counter Clock | TxPCLKP/N | LVDS | |
| Receiver 16-bit parallel Date Output | RxDout[0:15]P/N | LVDS | RxDout0:LSB, RxDout15:MSB |
| Receiver Source synchronous Parallel Output Clock | RxPOCLKP/N | LVDS | |

**Table 8 - Transmitter/Receiver Parallel Data/Clock Timing**

| Parameter | | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|---|
| **Transmitter Data/Clock Timing: SERDES Input Timing at SERDES pin** | | | | | | | |
| TxPICLK | Duty Cycle($T_W/T_O$) | $T_{DC}$ | 40 | 50 | 60 | % | |
| | Rise and Fall time | Tr/Tf | 100 | | 300 | ps | 20 – 80% |
| TxDin | Setup time | Ts | 300 | | | ps | |
| | Hold time | Th | 300 | | | ps | |




**Ts: Measuring from the LHS inner data eye to the immediate rising edge of clock pulse**
**Th: Measuring from the rising edge of clock pulse to the inner RHS of data eye**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Receiver Data/Clock Timing: SERDES Output Timing at SERDES pin** | | | | | | | |
| RxPOCLK | Duty Cycle($T_W/T_O$) | $T_{DC}$ | 45 | | 55 | % | |
| | Rise and Fall time | Tr/Tf | 100 | | 300 | ps | 20 – 80% |
| RxDout | Data/Clock skew | Tcq_min, | -250 | | 250 | ps | |
| | | Tcq_max | -250 | | 250 | ps | |

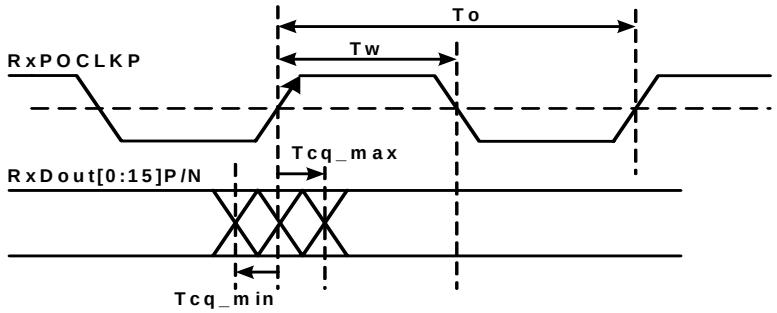



**Table 9 - Monitor Clock**

| Parameter | Symbol | Level | Notes |
|---|---|---|---|
| Transmitter monitor clock | TxMCLKP/N | LVDS | The LVDS TxMCLK is either a 1/16 or 1/64 replica of the clock used to time the serial data output. The rate of the TxMCLK is always the same as that of the TxREFCLK |
| Receiver monitor clock | RxMCLKP/N | LVDS | The LVDS RxMCLK is a 1/16 or 1/64 replica of the clock recovered from the incoming data |

## Digital Control Signal

**Table 10 - Input Digital signals**

| Function | Symbol | Level | | Description | Note |
|---|---|---|---|---|---|
| Module RESET | MOD_RESET | LVTTL | L | Module reset | Reset both Tx and Rx section (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| **Transmitter** | | | | | |
| Select the frequency of TxREFCLK | TxREFSEL | LVTTL | L | 1/64 data-rate | (LVTTL with pull-up resistor) |
| | | | H | 1/16 data-rate | |
| Enable internal Line Timing | TxLINETIMSEL | LVTTL | L | Enable | (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| Enable/Disable Laser | LsENABLE | LVTTL | L | Normal operation | (LVTTL with pull-down resistor) |
| | | | H | Laser disabled | |
| MUX FIFO reset | TxFIFORES | LVTTL | L | MUX FIFO reset | Internally TxFIFOERR is connected to TxFIFORES, TxFIFOERR will initiate a FIFO reset (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| **Receiver** | | | | | |
| Select the frequency of RxREFCLK | RxREFSEL | LVTTL | L | 1/64 data-rate | (LVTTL with pull-down resistor) |
| | | | H | 1/16 data-rate | |
| Select the frequency of RxMCLK | RxMCLKSEL | LVTTL | L | 1/64 data-rate | (LVTTL with pull-up resistor) |
| | | | H | 1/16 data-rate | |
| Lock RxPOCLK to RxREFCLK | RxLCKREF | LVTTL | L | Lock to RxREFCLK | (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| Mutes the RxDOUT[0:15] | RxMUTEDOUT | LVTTL | L | Mutes the RxDOUT[0:15] | (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| Mutes the receiver output monitor clock | RxMUTEMCLK | LVTTL | L | Mutes the RxMCLK | (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |
| Mutes receiver parallel output clock RxPOCLK | RxMUTEPOCLK | LVTTL | L | Mutes the RxPOCLK | (LVTTL with pull-up resistor) |
| | | | H | Normal operation | |

## Digital Alarm Signal

**Table 11 - Alarms Digital signals**

| Function | Symbol | Level | | Description | Note |
|---|---|---|---|---|---|
| **Common Digital Signal** | | | | | |
| Indicates all alarm active | ALMINT | LVTTL | L | Any alarm from both transmitter and receiver | Activation Time: 50ms<br>Deactivation Time: 50ms |
| | | | H | Normal operation | |
| **Transmitter** | | | | | |
| Loss of Tx PLL lock | TxLOCKERR | LVTTL | L | Alarm active | Loss of transmitter PLL lock<br>Activation Time: 1ms<br>Deactivation Time: 1ms |
| | | | H | Normal operation | |
| MUX FIFO error | TxFIFOERR | LVTTL | L | Alarm active (FIFO overflow) | Internally TxFIFOERR is connected to TxFIFORES, |
| | | | H | Normal operation | |
| Laser bias out of range | LsBIASALM | LVTTL | L | Alarm active (laser bias current alarm) | Activation Time: 50 ms<br>Deactivation Time: 50 ms |
| | | | H | Normal operation | |
| Laser temperature out of range | LsTEMPALM | LVTTL | L | Alarm active | Activation Time : 50ms<br>Deactivation Time : 50ms |
| | | | H | Normal operation | |
| Laser output power out of range | LsPOWALM | LVTTL | L | Alarm active | BOL Activation Time : 50ms<br>Deactivation Time : 50ms |
| | | | H | Normal operation | |
| Tx alarms | TxALMINT | LVTTL | L | Alarm from transmitter | Activation Time: 50 ms;<br>Deactivation Time: 50 ms |
| | | | H | Normal operation | |
| **Receiver** | | | | | |
| Loss of Rx PLL lock | RxLOCKERR | LVTTL | L | Alarm active | Activation Time: 1ms<br>Deactivation Time: 1ms |
| | | | H | Normal operation | |
| Loss of receiver signal power alarm | RxPOWALM | LVTTL | L | Alarm active | Activation Time: <100μs<br>Deactivation Time: <100μs |
| | | | H | Normal operation | |
| Rx alarms | RxALMINT | LVTTL | L | Alarm from receiver | Activation Time: 50 ms;<br>Deactivation Time: 50 ms |
| | | | H | Normal operation | |

## Analog Monitoring Signal

**Table 12 - Monitor Signals**

| Function | Symbol | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|
| **Transmitter** | | | | | |
| Normalized laser power monitor voltage BOL | LsPOWMON | 0.47 | 0.5 | 0.53 | V |
| Laser power monitor voltage slope | | 0.25 V change for 50% power variation | | | |
| Laser bias monitor voltage offset | LsBIASMON | 0.2 | 0 | 2 | V |
| Laser bias monitor voltage slope | | 18 | 20 | 22 | mV/mA |
| Normalized laser temperature Monitor voltage | LsTEMPMON | 2.4 | 2.5 | 2.6 | V |
| Laser temperature Monitor voltage slope | | 23 | 25 | 27 | mV/℃ |
| **Receiver** | | | | | |
| Input optical power monitor voltage slope | RxPOWMON | 6 | 8 | 10 | V/mW |
| Input optical power monitor error | | -2 | | +2 | dB |

## I2C Serial Interface

**Table 13 – I2C Interface**

| Function | Symbol | Level | Description | Note |
|---|---|---|---|---|
| I2C Address | I2CAD0 | LVTTL | I2C address input for module addressing (LSB) | (LVTTL with pull-down resistor) |
| | I2CAD1 | LVTTL | I2C address input for module addressing | (LVTTL with pull-down resistor) |
| | I2CAD2 | LVTTL | I2C address input for module addressing (MSB) | (LVTTL with pull-down resistor) |
| I2C Clock | I2CCLOCK | Open collector | I2C clock input/output for remote access | N/A |
| I2C Data | I2CDATA | Open collector | I2C data input/output for remote access | N/A |

## Pin Definitions

**Table 14 - Pin Function Definitions**

| | K | J | H | G | F | E | D | C | B | A |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | +5V | NUC | GND | RxDout12P | NUC | RxDout8P | GND | RxDout4P | GND | RxDout0P |
| 2 | +5V | FFU | GND | RxDout12N | NUC | RxDout8N | GND | RxDout4N | GND | RxDout0N |
| 3 | RxRATESEL0 | RxRATESEL1 | NUC | GND | RxPOWMON | GND | I2CAD0 | GND | RxDTV | GND |
| 4 | +3.3V | NUC | GND | RxDout13P | +3.3V | RxDout9P | GND | RxDout5P | GND | RxDout1P |
| 5 | +3.3V | NUC | GND | RxDout13N | +3.3V | RxDout9N | GND | RxDout5N | GND | RxDout1N |
| 6 | RxRESET | NUC | DLOOPENB | GND | RxPOWALM | GND | I2CAD1 | GND | RxMUTE Dout | GND |
| 7 | +3.3V | FFU | GND | RxDout14P | +3.3V | RxDout10P | GND | RxDout6P | GND | RxDout2P |
| 8 | +3.3V | FFU | GND | RxDout14N | +3.3V | RxDout10N | GND | RxDout6N | GND | RxDout2N |
| 9 | RxMUTEPOCLK | NUC | FFU | GND | NUC | GND | I2CAD2 | GND | RxLCKREF | GND |
| 10 | -5.2V | NUC | GND | RxDout15P | -5.2V | RxDout11P | GND | RxDout7P | GND | RxDout3P |
| 11 | -5.2V | NUC | GND | RxDout15N | -5.2V | RxDout11N | GND | RxDout7N | GND | RxDout3N |
| 12 | RxMUTEMCLK | NUC | FFU | GND | RxSIGALM | GND | MOD_RESET | GND | RxMCLKSEL | GND |
| 13 | -5.2V | FFU | GND | FFU | -5.2V | RxPOCLKP | GND | RxMCLKP | GND | RxREFCLKP |
| 14 | -5.2V | RxALMINT | GND | FFU | -5.2V | RxPOCLKN | GND | RxMCLKN | GND | RxREFCLKN |
| 15 | I2CCLOCK | NUC | ALMINT | GND | RxREFSEL | GND | FFU | GND | RxLOCKERR | GND |
| 16 | +5V | TxALMINT | GND | TxDin12P | NUC | TxDin8P | GND | TxDin4P | GND | TxDin0P |
| 17 | +5V | FFU | GND | TxDin12N | NUC | TxDin8N | GND | TxDin4N | GND | TxDin0N |
| 18 | I2CDATA | NUC | FFU | GND | LsBIASMON | GND | LsPOWMON | GND | NUC | GND |
| 19 | +3.3V | NUC | GND | TxDin13P | +3.3V | TxDin9P | GND | TxDin5P | GND | TxDin1P |
| 20 | +3.3V | NUC | GND | TxDin13N | +3.3V | TxDin9N | GND | TxDin5N | GND | TxDin1N |
| 21 | TxRATESEL0 | TxRATESEL1 | FFU | GND | LsENABLE | GND | LsTEMPMON | GND | NUC | GND |
| 22 | +3.3V | FFU | GND | TxDin14P | +3.3V | TxDin10P | GND | TxDin6P | GND | TxDin2P |
| 23 | +3.3V | FFU | GND | TxDin14N | +3.3V | TxDin10N | GND | TxDin6N | GND | TxDin2N |
| 24 | TxRESET | NUC | FFU | GND | LsBIASALM | GND | FFU | GND | FFU | GND |
| 25 | -5.2V | NUC | GND | TxDin15P | -5.2V | TxDin11P | GND | TxDin7P | GND | TxDin3P |
| 26 | -5.2V | NUC | GND | TxDin15N | -5.2V | TxDin11N | GND | TxDin7N | GND | TxDin3N |
| 27 | TxFIFORES | NUC | LLOOPENB | GND | LsTEMPALM | GND | FFU | GND | TxPICLKSEL | GND |
| 28 | -5.2V | FFU | GND | TxPICLKP | -5.2V | TxPCLKP | GND | TxMCLKP | GND | TxREFCLKP |
| 29 | -5.2V | TxTRACE | GND | TxPICLKN | -5.2V | TxPCLKN | GND | TxMCLKN | GND | TxREFCLKN |
| 30 | TxFIFOERR | NUC | LINETIMESEL | GND | TxREFSEL | GND | LsPOWALM | GND | TxLOCKERR | GND |
| | FFU: Reserved for Future Use | | | NUC: No Use Connection | | | | | | |

## Mechanical Design Diagram

The mechanical design diagram is shown in Figure 2.

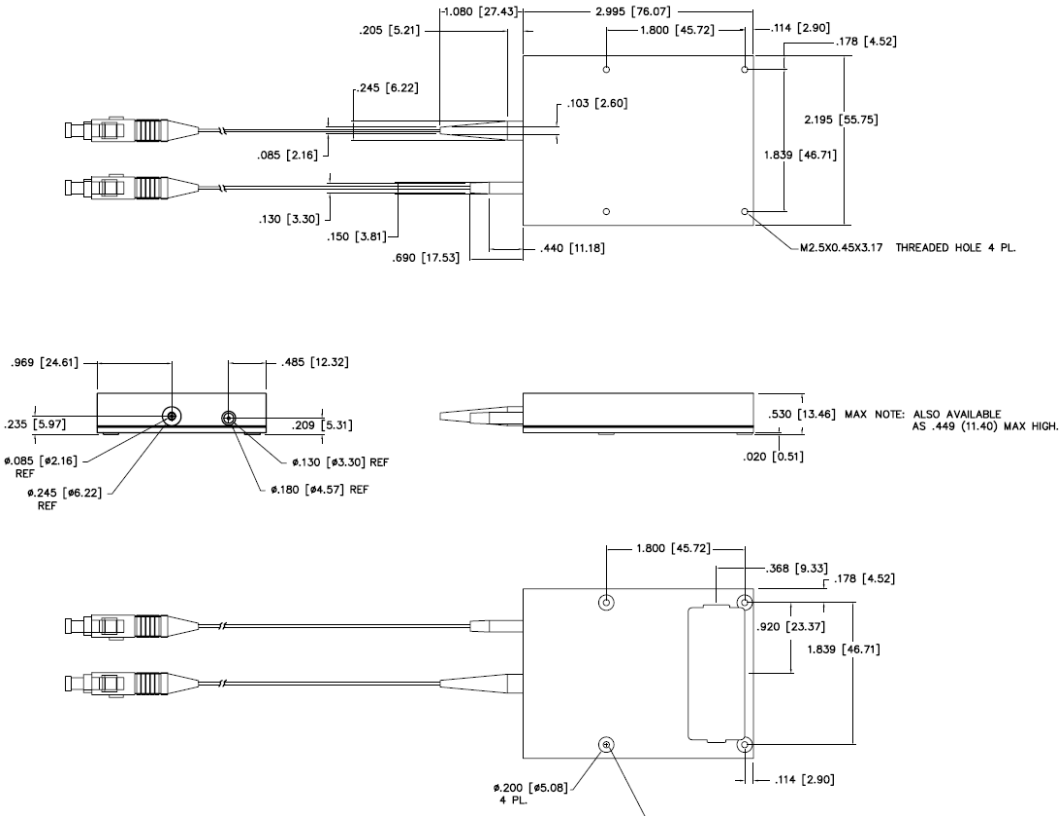
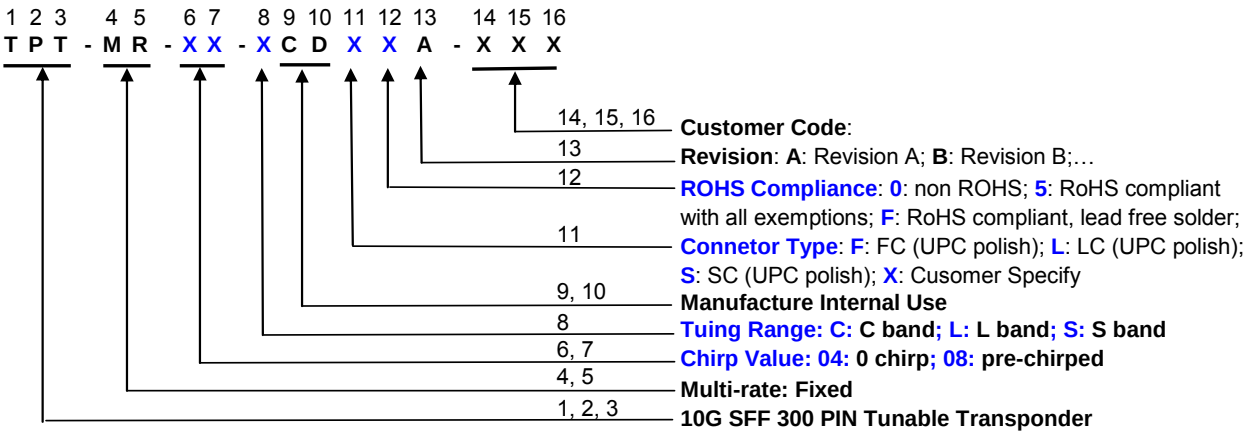



**Figure 2, Mechanical Diagram**

## Ordering Information

Example:

| Part No. | Product Description |
|---|---|
| TPT-MR-*04*-*C*CD*L5*A-XXX | General C-band Tunable, 9.95~11.3Gbps, zero-chirped optical transmitter, 10G SFF 300pin, LC connector, -5°C~+70°C |



## Warnings

**Handling Precautions:** This device is susceptible to damage as a result of electrostatic discharge (ESD). A static free environment is highly recommended. Follow guidelines according to proper ESD procedures.

**Laser Safety:** Radiation emitted by laser devices can be dangerous to human eyes. Avoid eye exposure to direct or indirect radiation.

## Legal Notice

**IMPORTANT NOTICE!**

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