

## Professional high-speed optical transceiver

### OPN-XHD35-40LC2

10Gbps / 40 km / 100GHz DWDM XFP Single-Mode Optical Transceiver for 10GbE / OC-352

## PRODUCT FEATURES

- Support 9.95 Gbps to 10.5 Gbps
  - Complaint with XFP MSA
- Compliant with XFI 10G Serial Electrical Interface
  - Maximum Link Length of 40 km
- Temperature-stabilized DWDM EML Transmitter
  - 100 GHz ITU Grid, C Band
- 2-Wire Interface for Integrated Digital Diagnostic Monitoring
  - XFI Loopback Mode Supported
  - No reference Clock required
  - Power Dissipation < 3.5 W
- Dual 5V and +3.3 V Power Supply
  - RoHS Compliant
- 0 to 70°C Case Operating Temperature

## APPLICATIONS

- 10GBASE-ER at 10.3125 Gb/s
- 10GBASE-EW at 9.953 Gb/s
- 40km 10GFC at 10.51875 Gb/s
  - 10G SONET/SDH

## PRODUCT DESCRIPTION

OPN-XHD35-40LC2 series DWDM transceivers are designed for single-mode fibre serial optical data communications such as 10G Ethernet 10GBASE-ER/EW and 10G Fibre Channel.

This module is designed for single mode fiber and operates at a nominal wavelength of 100GHz ITU Grid, C Band DWDM wavelength. A guaranteed minimum optical link budget of 14 dB is offered. The transmitter section consists of a temperature-stabilized DWDM electrical-modulated laser (EML), driver and signal conditioner. The receiver section incorporates a PIN photodiode integrated with a trans-impedance preamplifier (TIA) and signal conditioner.

The module is with the XFP 30-pin connector to allow hot plug capability. Integrated Tx and Rx signal conditioners provide high jitter-tolerance for full XFI compliance and no external reference clock required. The internally ac coupled high speed serial I/O simplifies interfacing to external circuitry. Dual 5V and 3.3V power supply are used. The optical output can be disabled by LVTTTL logic high-level input of TX\_DIS. Loss of signal (RX\_LOS) output is provided to indicate the loss of an input optical signal of receiver.

A serial EEPROM in the transceiver allows the user to access transceiver digital diagnostic monitoring and configuration data via the 2-wire XFP Management Interface. This interface uses a single address, A0h, with a memory map divided into a lower and upper area. Basic digital diagnostic data is held in the lower area while specific data is held in a series of tables in the high memory area.

## ORDER INFORMATION

| P/No.           | Bit Rate(Gb/s) | 10G   | Distance (km) | Spacing (GHz) | Wavelength (nm) | Package      | Case Temp (°C) | RoHS Compliant |
|-----------------|----------------|-------|---------------|---------------|-----------------|--------------|----------------|----------------|
| OPN-XHD35-40LC2 | 9.95-10.52     | ER/EW | 40            | 100           | DWDM*           | XFP with DMI | 0 to 70        | Yes            |

XX: 100GHz ITU Grid wavelength (Please see below)

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| Channel # | Product code    | Frequency (THz) | Center Wavelength (nm) | Label |
|-----------|-----------------|-----------------|------------------------|-------|
| 19        | OPN-XHD19-40LC2 | 191.9           | 1562.23                | D19   |
| 20        | OPN-XHD20-40LC2 | 192.0           | 1561.42                | D20   |
| 21        | OPN-XHD21-40LC2 | 192.1           | 1560.61                | D21   |
| 22        | OPN-XHD22-40LC2 | 192.2           | 1559.79                | D22   |
| 23        | OPN-XHD23-40LC2 | 192.3           | 1558.98                | D23   |
| 24        | OPN-XHD24-40LC2 | 192.4           | 1558.17                | D24   |
| 25        | OPN-XHD25-40LC2 | 192.5           | 1557.36                | D25   |
| 26        | OPN-XHD26-40LC2 | 192.6           | 1556.55                | D26   |
| 27        | OPN-XHD27-40LC2 | 192.7           | 1555.75                | D27   |
| 28        | OPN-XHD28-40LC2 | 192.8           | 1554.94                | D28   |
| 29        | OPN-XHD29-40LC2 | 192.9           | 1554.13                | D29   |
| 30        | OPN-XHD30-40LC2 | 193.0           | 1553.33                | D30   |
| 31        | OPN-XHD31-40LC2 | 193.1           | 1552.52                | D31   |
| 32        | OPN-XHD32-40LC2 | 193.2           | 1551.72                | D32   |
| 33        | OPN-XHD33-40LC2 | 193.3           | 1550.92                | D33   |
| 34        | OPN-XHD34-40LC2 | 193.4           | 1550.12                | D34   |
| 35        | OPN-XHD35-40LC2 | 193.5           | 1549.32                | D35   |
| 36        | OPN-XHD36-40LC2 | 193.6           | 1548.51                | D36   |
| 37        | OPN-XHD37-40LC2 | 193.7           | 1547.72                | D37   |
| 38        | OPN-XHD38-40LC2 | 193.8           | 1546.92                | D38   |
| 39        | OPN-XHD39-40LC2 | 193.9           | 1546.12                | D39   |
| 40        | OPN-XHD40-40LC2 | 194.0           | 1545.32                | D40   |
| 41        | OPN-XHD41-40LC2 | 194.1           | 1544.53                | D41   |
| 42        | OPN-XHD42-40LC2 | 194.2           | 1543.73                | D42   |
| 43        | OPN-XHD43-40LC2 | 194.3           | 1542.94                | D43   |
| 44        | OPN-XHD44-40LC2 | 194.4           | 1542.14                | D44   |
| 45        | OPN-XHD45-40LC2 | 194.5           | 1541.35                | D45   |
| 46        | OPN-XHD46-40LC2 | 194.6           | 1540.56                | D46   |
| 47        | OPN-XHD47-40LC2 | 194.7           | 1539.77                | D47   |
| 48        | OPN-XHD48-40LC2 | 194.8           | 1538.98                | D48   |
| 49        | OPN-XHD49-40LC2 | 194.9           | 1538.19                | D49   |
| 50        | OPN-XHD50-40LC2 | 195.0           | 1537.40                | D50   |
| 51        | OPN-XHD51-40LC2 | 195.1           | 1536.61                | D51   |
| 52        | OPN-XHD52-40LC2 | 195.2           | 1535.82                | D52   |
| 53        | OPN-XHD53-40LC2 | 195.3           | 1535.04                | D53   |
| 54        | OPN-XHD54-40LC2 | 195.4           | 1534.25                | D54   |
| 55        | OPN-XHD55-40LC2 | 195.5           | 1533.47                | D55   |
| 56        | OPN-XHD56-40LC2 | 195.6           | 1532.68                | D56   |
| 57        | OPN-XHD57-40LC2 | 195.7           | 1531.90                | D57   |
| 58        | OPN-XHD58-40LC2 | 195.8           | 1531.12                | D58   |
| 59        | OPN-XHD59-40LC2 | 195.9           | 1530.33                | D59   |
| 60        | OPN-XHD60-40LC2 | 196.0           | 1529.55                | D60   |
| 61        | OPN-XHD61-40LC2 | 196.1           | 1528.77                | D61   |

### Absolute Maximum Ratings

| Parameter                    | Symbol | Min  | Max | Units | Notes                  |
|------------------------------|--------|------|-----|-------|------------------------|
| Storage Temperature          | Tstg   | -50  | 85  | °C    |                        |
| Operating Case Temperature   | Topr   | 0    | 70  | °C    |                        |
| Relative Humidity            | RH     | 0    | 85  | %     | Non condensing         |
| Power Supply Voltage (5V)    | Vcc5   | -0.5 | 3.6 | V     |                        |
| Power Supply Voltage (3.3V)  | Vcc3   | -0.5 | 3.6 | V     |                        |
| Receiver Input Optical Power | Mip    |      | 4   | dBm   | Received average power |

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| Recommended Operating Conditions |                  |      |         |      |               |
|----------------------------------|------------------|------|---------|------|---------------|
| Parameter                        | Symbol           | Min  | Typ     | Max  | Units / Notes |
| Power Supply Voltage (5V)        | V <sub>CC5</sub> | 4.75 | 5       | 5.25 | V             |
| Power Supply Voltage (3.3V)      | V <sub>CC3</sub> | 3.13 | 3.3     | 3.47 | V             |
| Power Supply Current (@5V)       | I <sub>CC5</sub> |      |         | 300  | mA / 1        |
| Power Supply Current (@3.3V)     | I <sub>CC3</sub> |      |         | 750  | mA / 1        |
| Power Dissipation                | P <sub>D</sub>   |      |         | 3.5  | W             |
| Operating Case Temperature       | T <sub>opr</sub> | 0    |         | 70   | °C            |
| Data Rate                        |                  | 9.95 | 10.3125 | 10.5 | Gb/s          |

1. Including in rush current. Maximum module current ramp rate is 100 mA/μs.

| Transmitter Optical Specifications (T <sub>opr</sub> = 0 to 70°C, V <sub>CC5</sub> =5V±5%, V <sub>CC3</sub> = 3.3V ±5%) |                     |       |     |       |       |              |
|-------------------------------------------------------------------------------------------------------------------------|---------------------|-------|-----|-------|-------|--------------|
| Parameter                                                                                                               | Symbol              | Min   | Typ | Max   | Units | Notes        |
| Average Launch Power                                                                                                    | P <sub>O, Avg</sub> | -2    |     | +2    | dBm   | 2            |
| Extinction Ratio                                                                                                        | ER                  | 8.2   |     |       | dB    |              |
| Center Wavelength Spacing                                                                                               |                     |       | 100 |       | GHz   | 3            |
| Transmitter Center Wavelength<br>-- over life time                                                                      | λ <sub>c</sub>      | X-100 | X   | X+100 | pm    | 4            |
| Output Spectrum Width                                                                                                   | σ <sub>λ</sub>      |       |     | 1     | nm    | -20 dB width |
| Side Mode Suppression Ratio                                                                                             | SMSR                | 30    |     |       | dB    |              |
| Transmitter and Dispersion<br>Penalty @ 800 ps/nm                                                                       | TDP                 |       |     | 2     | dB    |              |
| Relative Intensity Noise                                                                                                | RIN                 |       |     | -130  | dB/Hz | 10G Ethernet |
| Eye Mask                                                                                                                | 1EEE 802.3ae        |       |     |       |       |              |
| Average Launch Power of OFF<br>Transmitter                                                                              |                     |       |     | -30   | dBm   |              |

2. Output power is power coupled into a 9/125 μm single-mode fiber.

3. Corresponds to approximately 0.8 nm.

4. X = specified ITU Grid wavelength. Wavelength stability is achieved within 60 seconds of power up.

| Receiver Optical Specifications (T <sub>opr</sub> = 0 to 70°C, V <sub>CC5</sub> =5V±5%, V <sub>CC3</sub> = 3.3V ±5%) |                  |      |     |       |       |                         |
|----------------------------------------------------------------------------------------------------------------------|------------------|------|-----|-------|-------|-------------------------|
| Parameter                                                                                                            | Symbol           | Min  | Typ | Max   | Units | Notes                   |
| Sensitivity                                                                                                          | Sen1             |      |     | -16   | dBm   | 5                       |
| Stressed Receiver Sensitivity,<br>OMA                                                                                | Sen2             |      |     | -11.3 | dBm   |                         |
| Receiver Overload                                                                                                    | P <sub>MAX</sub> | -1   | --- |       | dBm   |                         |
| LOS -- Deasserted                                                                                                    | LOS <sub>D</sub> | ---  | --- | -20   | dBm   | Transition: low to high |
| LOS -- Asserted                                                                                                      | LOS <sub>A</sub> | -28  | --- | ---   | dBm   | Transition: high to low |
| LOS -- Hysteresis                                                                                                    |                  | 0.5  | --- |       | dB    |                         |
| Wavelength of Operation                                                                                              | λ <sub>c</sub>   | 1260 |     | 1600  | nm    |                         |
| Optical Return Loss                                                                                                  | ORL              |      |     | -27   | dB    |                         |

5. Measured with worst ER; BER < 10<sup>-12</sup> and PRBS 2<sup>31</sup>-1. Equivalent to -14.3 dBm OMA at ER=8.2 dB.

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| Electrical Characteristics                               |                  |      |         |                 |       |                          |
|----------------------------------------------------------|------------------|------|---------|-----------------|-------|--------------------------|
| Parameter                                                | Symbol           | Min  | Typ     | Max             | Units | Notes                    |
| <b>High-Speed Signal (CML) Interface Specification</b>   |                  |      |         |                 |       |                          |
| Input Data Rate                                          |                  | 9.95 | 10.3125 | 10.5            | Gb/s  | 6                        |
| Differential Input Impedance                             | R <sub>in</sub>  |      | 100     |                 | Ω     |                          |
| Differential Data Input Amplitude                        |                  | 120  |         | 820             | mVpp  | 7, Internally AC coupled |
| Output Data Rate                                         |                  | 9.95 | 10.3125 | 10.5            | Gb/s  | 6                        |
| Differential Output Impedance                            | R <sub>out</sub> |      | 100     |                 | Ω     |                          |
| Differential Data Output Amplitude                       |                  | 340  | 650     | 850             | mVpp  | 7, Internally AC coupled |
| <b>Low-Speed Signal (LVTTTL) Interface Specification</b> |                  |      |         |                 |       |                          |
| Input High Voltage                                       |                  | 2.0  |         | V <sub>cc</sub> | V     |                          |
| Input Low Voltage                                        |                  | GND  |         | 0.8             | V     |                          |
| Output High Voltage                                      |                  | 2.4  |         | V <sub>cc</sub> | V     |                          |
| Output Low Voltage                                       |                  | GND  |         | 0.5             | V     |                          |
| <b>Reference Clock (LVPECL) Interface Specification</b>  |                  |      |         |                 |       |                          |
| No reference clock required.                             |                  |      |         |                 |       |                          |

6. 10GBASE-ER/EW and 10G Fiber Channel.

7. The differential input and output amplitudes are per XFP MSA mask at points B' and C'.

| Transceiver Timing Characteristics |                           |     |     |     |       |       |
|------------------------------------|---------------------------|-----|-----|-----|-------|-------|
| Parameter                          | Symbol                    | Min | Typ | Max | Units | Notes |
| TX_DIS Assert Time                 | t <sub>off</sub>          |     |     | 10  | μs    |       |
| TX_DIS Negate Time                 | t <sub>on</sub>           |     |     | 2   | ms    |       |
| Time to Initialize                 | t <sub>init</sub>         |     |     | 300 | ms    |       |
| Interrupt Assert Delay             | interrupt <sub>on</sub>   |     |     | 200 | ms    |       |
| Interrupt Negate Delay             | interrupt <sub>off</sub>  |     |     | 500 | μs    |       |
| P_Down/PST Assert Delay            | P_Down/RST <sub>on</sub>  |     |     | 100 | μs    |       |
| P_Down Negate Delay                | P_Down/RST <sub>off</sub> |     |     | 300 | ms    |       |
| Mod_NR Assert Delay                | Mod_nr <sub>on</sub>      |     |     | 1   | ms    |       |
| Mod_NR Negate Delay                | Mod_nr <sub>off</sub>     |     |     | 1   | ms    |       |
| Mod_Desel Assert Time              | T_Mod_Desel               |     |     | 2   | ms    |       |
| Mod_Desel De-Assert Time           | T_Mod_Sel                 |     |     | 2   | ms    |       |
| P_Down Reset Time                  | T <sub>reset</sub>        | 10  |     |     | μs    |       |
| RX_LOS Assert Delay                | T_Los <sub>on</sub>       |     |     | 100 | μs    |       |
| RX_LOS Negate Delay                | T_Los <sub>off</sub>      |     |     | 100 | μs    |       |
| Serial ID Clock Rate               | f <sub>SCL</sub>          | 0   |     | 400 | kHz   |       |

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### MANAGEMENT INTERFACE

The structure of the memory map is shown in Figure 1, which is accessible over a 2-wire serial interface at the 8-bit address 1010000X (A0h). The normal 256 byte I2C address space is divided into low and upper blocks of 128 Bytes. The lower block of 128 Bytes is always directly available and is used for the diagnostics and control function. Multiple blocks of memories are available in the upper 128 Bytes of the address space. These are individually addressed through a table select Byte which the user enters into a location in the lower address space. Thus, there is a total available address space of 128\*256 = 32 Kbytes in this upper memory space. The contents of Table 01h are listed in Table 1 below. Please refer SFF INF-8077i (Revision 4.5) for detailed information.

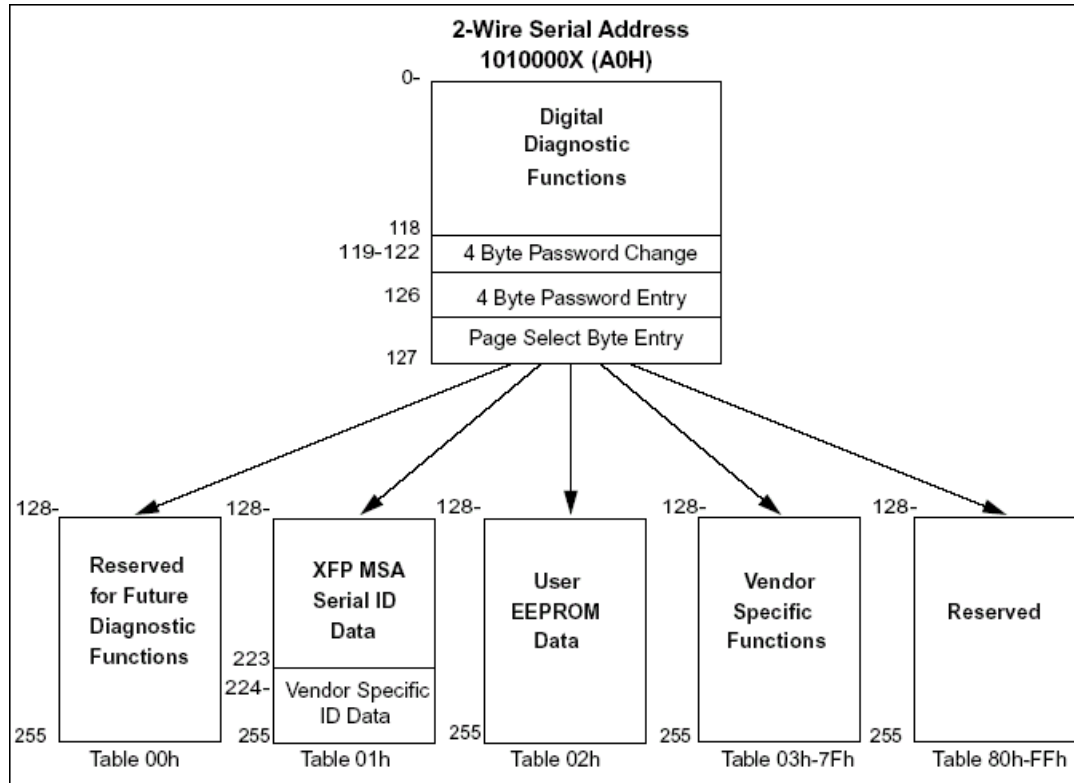


Figure 1. 2-wire Serial Digital Diagnostic Memory Map

Table 1 Monitoring Specification

| Data Address | Parameter   | Accuracy |
|--------------|-------------|----------|
| 96 ~ 97      | Temperature | ± 3°C    |
| 98 ~ 99      | Reserved    |          |
| 100 ~ 101    | Tx Bias     | ± 10%    |
| 102 ~ 103    | Tx Power    | ± 2dB    |
| 104 ~ 105    | Rx Power    | ± 2dB    |
| 106 ~ 107    | Vcc3        | ± 3%     |

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### CONNECTION DIAGRAM

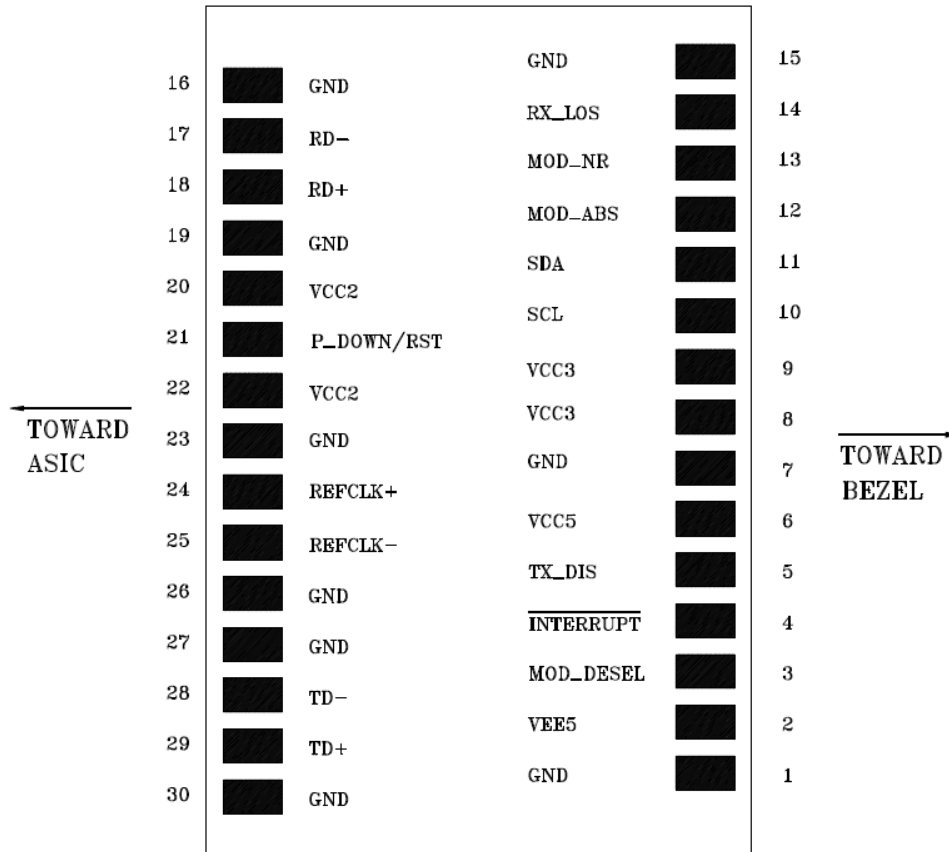


Table 2 PIN Description

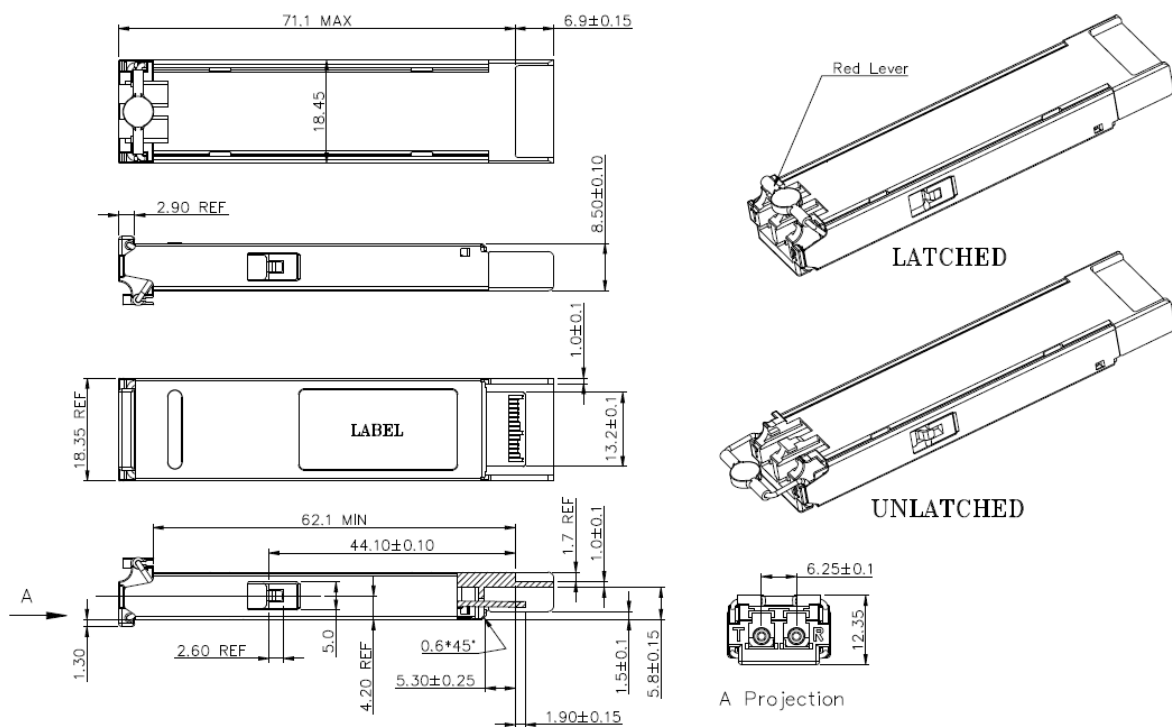
| PIN | Logic     | Signal Name | Description                                                                                               | Note |
|-----|-----------|-------------|-----------------------------------------------------------------------------------------------------------|------|
| 1   |           | GND         | Module Ground                                                                                             | 1    |
| 2   |           | VEE5        | -5.2V Power Supply <b>(Not required)</b>                                                                  | 3    |
| 3   | LVTTL-I   | Mod_Desel   | Module De-select; When held low allows module to respond to 2-wire serial interface                       |      |
| 4   | LVTTL-O   | Interrupt   | Interrupt; Indicates presence of an important condition which can be read over the 2wire serial interface | 2    |
| 5   | LVTTL-I   | TX_DIS      | Transmitter Disable; Turns off transmitter laser output                                                   |      |
| 6   |           | VCC5        | +5V Power Supply                                                                                          | 3    |
| 7   |           | GND         | Module Ground                                                                                             | 1    |
| 8   |           | VCC3        | +3.3V Power Supply                                                                                        |      |
| 9   |           | VCC3        | +3.3V Power Supply                                                                                        |      |
| 10  | LVTTL-I/O | SCL         | Serial 2-wire interface clock                                                                             | 2    |
| 11  | LVTTL-I/O | SDA         | Serial 2-wire interface data line                                                                         | 2    |
| 12  | LVTTL-O   | Mod_Abs     | Indicates Module is not present. Grounded in the Module                                                   | 2    |
| 13  | LVTTL-O   | Mod_NR      | Module Not Ready; Indicating Module Operational Fault                                                     | 2    |
| 14  | LVTTL-O   | RX_LOS      | Receiver Loss Of Signal Indicator                                                                         | 2    |
| 15  |           | GND         | Module Ground                                                                                             | 1    |
| 16  |           | GND         | Module Ground                                                                                             | 1    |
| 17  | CML-O     | RD-         | Receiver Inverted Data Output                                                                             |      |
| 18  | CML-O     | RD+         | Receiver Non-Inverted Data Output                                                                         |      |
| 35  |           | GND         | Module Ground                                                                                             | 1    |
| 20  |           | VCC2        | +1.8V Power Supply <b>(Not required)</b>                                                                  | 3    |

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|    |          |            |                                                                                                                                                                                                                                                                                                   |   |
|----|----------|------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---|
| 21 | LVTTTL-I | P_Down/RST | Power down; When high, requires the module to limit power consumption to 1.5W or below. 2-Wire serial interface must be functional in the low power mode.<br>Reset; The falling edge initiates a complete reset of the module including the 2-wire serial interface, equivalent to a power cycle. |   |
| 22 |          | VCC2       | +1.8V Power Supply ( <b>Not required</b> )                                                                                                                                                                                                                                                        | 3 |
| 23 |          | GND        | Module Ground                                                                                                                                                                                                                                                                                     | 1 |
| 24 | PECL-I   | RefCLK+    | Reference Clock Non-Inverted Input, AC coupled on the host board. ( <b>Not used. Internally terminated to 50 ohm (100 ohm diff.)</b> )                                                                                                                                                            | 4 |
| 25 | PECL-I   | RefCLK-    | Reference Clock Inverted Input, AC coupled on the host board. ( <b>Not used. Internally terminated to 50 ohm (100 ohm diff.)</b> )                                                                                                                                                                | 4 |
| 26 |          | GND        | Module Ground                                                                                                                                                                                                                                                                                     | 1 |
| 27 |          | GND        | Module Ground                                                                                                                                                                                                                                                                                     | 1 |
| 28 | CML-I    | TD-        | Transmitter Inverted Data Input                                                                                                                                                                                                                                                                   |   |
| 29 | CML-I    | TD+        | Transmitter Non-Inverted Data Input                                                                                                                                                                                                                                                               |   |
| 30 |          | GND        | Module Ground                                                                                                                                                                                                                                                                                     | 1 |

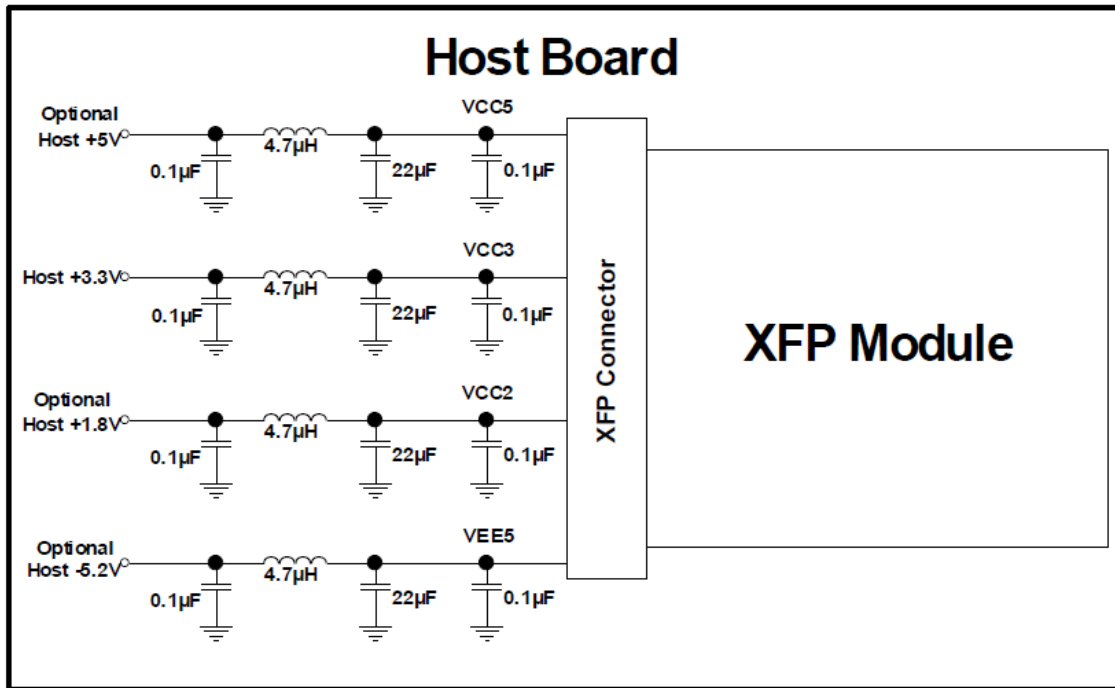
1. Module ground pins GND are isolated from the module case and chassis ground within the module.
2. Shall be pulled up with 4.7K-10Kohms to a voltage between 3.15V and 3.45V on the host board.
3. These PINs are open within module.
4. A Reference Clock input is not required. If present, it will be ignored.

## MECHANICAL SPECIFICATION (UNITS IN MM)



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### RECOMMENDED POWER CIRCUIT SCHEMATIC



### RECOMMENDED INTERFACE CIRCUIT

