



The LTB5310 bidirectional optical transceiver is ideally suited for 1250 Mb/sec Fiber to the Home, Business or Curb and Gigabit Ethernet Access Networks ONU PON applications where a single SMF fiber is required to simultaneously carry both Tx and Rx signals up to 10 km. The built-in high isolation WDM enables full duplex operation. It is mounted in the MSA compliant 2x10 small form pluggable (SFP) package with the SC optical receptacle. The transmitter and receiver subassemblies incorporate a high performance 1550 nm MQW DFB laser assembly and high sensitivity 1310 nm PIN/TIA photo receiver with limiting amplifier. The differential internally AC coupled Tx and Rx data interfaces are LVPECL compatible. The Rx\_LOS, Tx\_DIS and Tx\_FAULT monitor and control functions are LVTTTL compatible. The two-wire I<sup>2</sup>C interface is compatible with the SFF MSA digital diagnostic standard. It operates from a single 3.3-volt power supply and is rated for operation over the temperature range of -20°C to +75°C. The Class I laser transmitter complies with international safety standards.



#### Applications

- Fiber to the Home (FTTH) ONU PON
- Gigabit Ethernet Access Networks

#### Features and Benefits

- Transmitter and receiver in a single compact package
- Tx/Rx distance up to 10 km
- Integral simplex SC connector
- Single +3.3V power supply
- 60 mA nominal Tx section DC current
- 100 mA nominal Rx section DC current
- Industry standard SFP 2x10 outline
- 1550 nm DFB laser diode transmitter
- High sensitivity 1310 nm PIN/TIA receiver with limiter
- Cross talk > -40 dB
- Differential AC-coupled LVPECL input and output interface
- Operating temperature range -20°C to +75°C

#### Monitor and Control Functions

- Rx\_LOS LVTTTL
- Tx\_DIS LVTTTL
- Tx\_FAULT LVTTTL
- SDA LVTTTL / LVCMOS
- SCL LVTTTL / LVCMOS

#### Laser Safety

This device incorporates a Class 1 laser source and complies with IEC 825, U.S. FDA 21, CFR 1040.10 and 1040.11 regulations. It must be operated within the specified temperature and voltage limits. The module optical ports must be terminated with an optical connector or dust plug. Any internal modification to the transceiver renders the device non-compliant, voids any warranties and could result in a health hazard.

#### Monitor and Control Functions

| Recommended Operating Conditions |  |       |      |       |       |
|----------------------------------|--|-------|------|-------|-------|
| Parameter                        | Symbol   | Min   | Typ  | Max   | Units |
| Ambient Operating Temperature    | T <sub>amb</sub>                                   | -20   | 25   | 75    | °C    |
| DC Supply Voltage                | V <sub>CC</sub>                                    | 3.135 | 3.3  | 3.465 | Volts |
| Module Supply Current            | I <sub>IN</sub>                                    | -     | 160  | 210   | mA    |
| Module Power Dissipation         | P <sub>D</sub>                                     | -     | 525  | 700   | mW    |
| Signaling Speed +/- 100 ppm      | S  | -     | 1250 | -     | Mb/s  |
| Useful Reach                     | D  | -     | 10   | -     | km    |
| Ordering Information             |  |       |      |       |       |
| Part Number                      | Description  |       |      |       |       |
| LTB5310                          | SFP Bidirectional Transceiver, 1550 nm Tx, 1310 Rx |       |      |       |       |



#### Absolute Maximum Ratings

| Parameter                     | Symbol          | Min | Max | Units |  |
|-------------------------------|-----------------|-----|-----|-------|--|
| Storage Temperature           | Tstg            | -40 | +85 | °C    | Exceeding the Absolute Maximum Ratings may cause irreversible damage to the device.  |
| Operating Temperature Range   | Tamb            | -20 | +75 | °C    |  |
| DC Supply                     | VCC             | 0   | 3.6 | Volts |  |
| Relative Humidity - Storage   | RH <sub>s</sub> | 0   | 95  | %     | The device is not intended to be operated under the condition of simultaneous Absolute Maximum Ratings, a condition which may cause irreversible damage to the device. |
| Relative Humidity - Operating | RH <sub>o</sub> | 0   | 85  | %     |  |

#### Control and Monitor Function Logic Levels

| Parameter | State | Min | Max                   | Units | Condition        | Notes                                       |
|-----------|-------|-----|-----------------------|-------|------------------|---|
| Rx_LOS    | HIGH  | 2.0 | V <sub>cc</sub> + 0.3 | V     | Receiver OFF     | Requires 4.7 K to 10 K Pull-Up              |
|           | LOW   | 0   | 0.8                   | V     | Receiver ON      |   |
| Tx_DIS    | HIGH  | 2.0 | V <sub>cc</sub> + 0.3 | V     | Laser OFF        | Incorporates internal 4.7 K to 10 K Pull-Up |
|           | LOW   | 0   | 0.8                   | V     | Laser ON         |   |
| Tx_FAULT  | HIGH  | 2.0 | V <sub>cc</sub> + 0.3 | V     | Laser FAULT      | Requires 4.7 K to 10 K Pull-Up              |
|           | LOW   | 0   | 0.8                   | V     | Laser NORMAL     |   |
| SDA       | HIGH  | 2.0 | V <sub>cc</sub> + 0.3 | V     | I2C Serial Data  | Requires 4.7 K to 10 K Pull-Up              |
|           | LOW   | 0   | 0.8                   | V     |                  |   |
| SCL       | HIGH  | 2.0 | V <sub>cc</sub> + 0.3 | V     | I2C Serial CLOCK | Requires 4.7 K to 10 K Pull-Up              |
|           | LOW   | 0   | 0.8                   | V     |                  |   |

#### Transmitter Electrical and Optical Characteristics (Tamb = -20 to +75°C, Vcc = 3.3 V unless otherwise noted)

| Parameter                          | Symbol                          | Min                  | Typ  | Max  | Units | Conditions / Notes |
|------------------------------------|---------------------------------|----------------------|------|------|-------|--------------------|
| Transmitter Type                   |                                 | 1550 nm DFB          |      |      |       |                    |
| Transmitter Monitor and Control    |                                 | Tx_FAULT, Tx_DISABLE |      |      |       |                    |
| Average Output Power (9/125 μ SMF) | P <sub>out</sub>                | -9                   | -    | -3   | dBm   |                    |
| Extinction Ratio                   | ER                              | 6                    | 9    | -    | dB    |                    |
| Optical Rise and Fall Time         | t <sub>r</sub> / t <sub>f</sub> | -                    | 150  | 260  | ps    | 20% to 80%         |
| Tx Wavelength                      | λ                               | 1540                 | 1550 | 1560 | nm    |                    |
| Spectral Line Width @ -20 dB       | Δλ                              | -                    | -    | 1.0  | nm    |                    |
| Relative Intensity Noise           | RIN                             | -                    | -    | -115 | dB/Hz |                    |
| Optical Cross Talk                 | CT                              | -                    | 40   | -    | dB    |                    |
| Transmit Reflectance               | RFL                             | -                    | -    | -12  | dB    |                    |
| DC Supply Current                  | I <sub>CCT</sub>                | -                    | 60   | 90   | mA    |                    |
| Differential Input Voltage         |                                 | 350                  | -    | 1600 | mV    | Peak to Peak       |
| Tx_DATA Input Load Impedance       | R <sub>IN</sub>                 | 2500                 | -    | -    | Ohms  |                    |

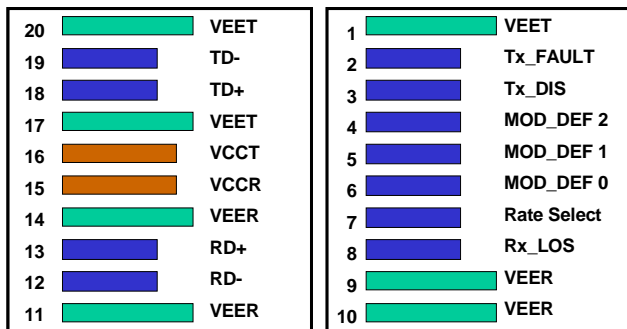


#### Receiver Optical Specifications (Tamb = -20 to +75°C, Vcc = 3.3 V unless otherwise noted)

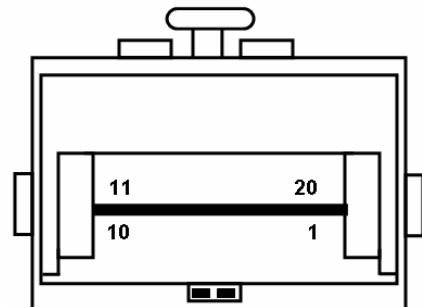
| Parameter                | Symbol           | Min             | Typ  | Max  | Units | Conditions / Notes  |
|--------------------------|------------------|-----------------|------|------|-------|---|
| Receiver Type            |                  | 1310 nm PIN/TIA |      |      |       |   |
| Optical Signal Indicator |                  | Signal Detect   |      |      |       |   |
| Wavelength               | $\lambda$        | 1290            | 1310 | 1330 | nm    |   |
| Received Optical Power   | P <sub>in</sub>  | -20             | -    | -3   | dBm   | BER<10 <sup>-12</sup> , 1250 Mb/s, PRBS 2 <sup>7</sup> -1 |
| Receiver Reflectance     | RFL              | -               | -    | -12  | dB    |   |
| Receiver Settling Time   | t <sub>rx</sub>  | -               | 150  | 260  | ps    | 20% to 80%  |
| Rx_LOS Range             | P <sub>a</sub>   | -33             | -    | -19  | dBm   |   |
| Rx_LOS Hysteresis        | P <sub>hy</sub>  | -               | 3    | 5    | dB    |   |
| Rx_LOS Output Load       | R <sub>SDL</sub> | -               | 50   | -    | Ohms  | To Vcc-2  |
| Cross Talk               | CT               | -               | -    | -40  | dB    |   |
| DC Supply Current        | I <sub>CCR</sub> | -               | 100  | 120  | mA    | Not including RX_DATA load current                        |
| Data Output Voltage      | V <sub>out</sub> | -               | 800  | -    | mV    | Single ended output                                       |
| Rx_DATA Load Impedance   | R <sub>DL</sub>  | -               | 50   | -    | Ohms  | To Vcc-2  |



**PIN ASSIGNMENT**



**Transceiver Electrical Pad Layout**  
Top View Bottom View



**Transceiver Pin Locations**

**SFP Pin Assignment**

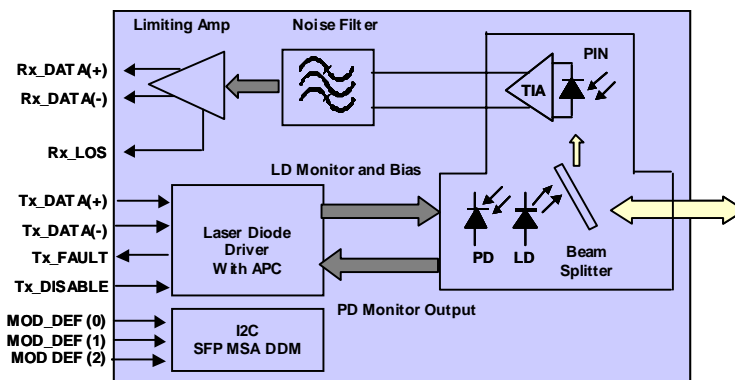
| Pin | Symbol            | Logic Type | Description  | Notes        |
|-----|-------------------|------------|--|--------------|
| 1   | V <sub>EET</sub>  | N/A        | Transmitter Ground   |              |
| 2   | TX_FAULT          | LVTTTL     | Transmitter Fault, LOW = Normal Operation, HIGH = Fault Indication     | Note 1       |
| 3   | TX_DIS            | LVTTTL     | Transmit Disable, LOW = Normal Operation, HIGH = Disables Module       | Note 1       |
| 4   | MOD_DEF 2         | LVTTTL     | Module Definition 2 - Two-Wire Interface - Serial Data                 | Note 1       |
| 5   | MOD_DEF 1         | LVTTTL     | Module Definition 1 - Two-Wire Interface - Clock Signal                | Note 1       |
| 6   | MOD_DEF 0         | LVTTTL     | Module Definition 0 - Two-Wire Interface Digital Ground                |              |
| 7   | Rate Select       | N/A        | Not Connected  |              |
| 8   | RX_LOS            | LVTTTL     | Receiver Loss of Signal, LOW = Normal Operation, HIGH = Loss of Signal | Note 1       |
| 9   | V <sub>EER</sub>  | N/A        | Receiver Ground  |              |
| 10  | V <sub>EER</sub>  | N/A        | Receiver Ground  |              |
| 11  | V <sub>EER</sub>  | N/A        | Receiver Ground  |              |
| 12  | RD-               | LVPECL     | RX_Data Output (Inverted)  | Note 2       |
| 13  | RD+               | LCPECL     | RX_Data Output (Non Inverted)  | Note 2       |
| 14  | V <sub>EER</sub>  | N/A        | Receiver Ground  |              |
| 15  | V <sub>C</sub> CR | N/A        | Receiver DC Power  | 3.3 V +/- 5% |
| 16  | V <sub>C</sub> CT | N/A        | Transmitter DC Power   | 3.3 V +/- 5% |
| 17  | V <sub>EET</sub>  | N/A        | Transmitter Ground   |              |
| 18  | TD+               | LVPECL     | TX_Data Input (Non Inverted)   | Note 3       |
| 19  | TD-               | LVPECL     | TX_Data Input (Inverted)   | Note 3       |
| 20  | V <sub>EET</sub>  | N/A        | Transmitter Ground   |              |

**Notes**

- The uncommitted TX\_Fault, RX\_LOS, MOD\_DEF 1 and MOD\_DEF 2 LVTTTL monitor and control pins each require a pull up resistor of 4.7K to 10K Ohms
- The 100 Ohm differential RX Data output is internally AC coupled and must be terminated with 100 Ohms at the differential user interface.



#### TRANSCEIVER BLOCK



#### APPLICATIONS INFORMATION

##### Transmitter Section

The transmitter section consists of a high reliability 1490 nm DFB laser diode (LD) with back facet monitor photo detector (PD). A driver IC converts the LVPECL differential input data signal into an analog current source that drives the LD. The APC circuit provides for temperature compensation of the laser diode thereby stabilizing the output power and the extinction ratio. The transmitter is provided with the TX\_DISABLE and TX\_FAULT control and monitoring functions. The SFP MSA digital diagnostics are enabled via the 2-wire I<sup>2</sup>C data bus.

##### TX\_FAULT

The TX\_FAULT monitor function is implemented as an open collector/drain output. It requires a 4,700 to 10,000 Ohm Pull Up resistor on the host PCB. Logic HIGH (2.0 to 3.465V) indicates a laser fault, which can be caused by excessive optical output power or excessive laser drive current. Logic LOW (0 to 0.8V) indicates normal operation. The Tx\_FAULT can be reset by toggling the Tx\_DISABLE line. When the logic voltage is >0.8V and <2.0V, the logic state is undefined.

##### TX\_DISABLE

The Tx\_DISABLE is a control function that can be used to shut down the transmitter optical output. It incorporates an internal 4,700 to 10,000 Ohm Pull Up resistor. Logic HIGH (2.0 to 3.465V) shuts down the transmitter. Logic LOW (0 to 0.8V) enables the transmitter. When the logic voltage is >0.8V and <2.0V, the logic state is undefined. If the Tx\_DISABLE port is open the transmitter is disabled.

##### TX\_DATA

Tx\_DATA (Inverted) and Tx\_DATA (Non Inverted) are the differential transmitter input signal lines. They are internally AC-coupled and differentially terminated with 100 Ohms. The inputs will accept differ-

ential swings of 500 – 2400 mV (250 – 1200 mV single-ended), though it is recommended that values between 500 and 1200 mV differential (250 – 600 mV single-ended) be used for best EMI performance.

##### Receiver Section

The receiver optical subassembly (ROSA) incorporates a planar In-GaAs PIN photo detector, which can detect optical signals in the range of 1100 nm to 1700 nm. The high-reliability photo detector is characterized by its low dark current. The receiver electronics includes an integrated low noise preamplifier and AGC amplifier (TIA), which are mounted in a TO-Metal Can assembly with the photo detector. The TIA drives the band pass filter (BPF) and limiting amplifier. The differential output of the limiting amplifier is LVPECL compatible. The receiver is provided with the Rx\_SIGNAL DECECT monitor function.

##### Rx\_LOS

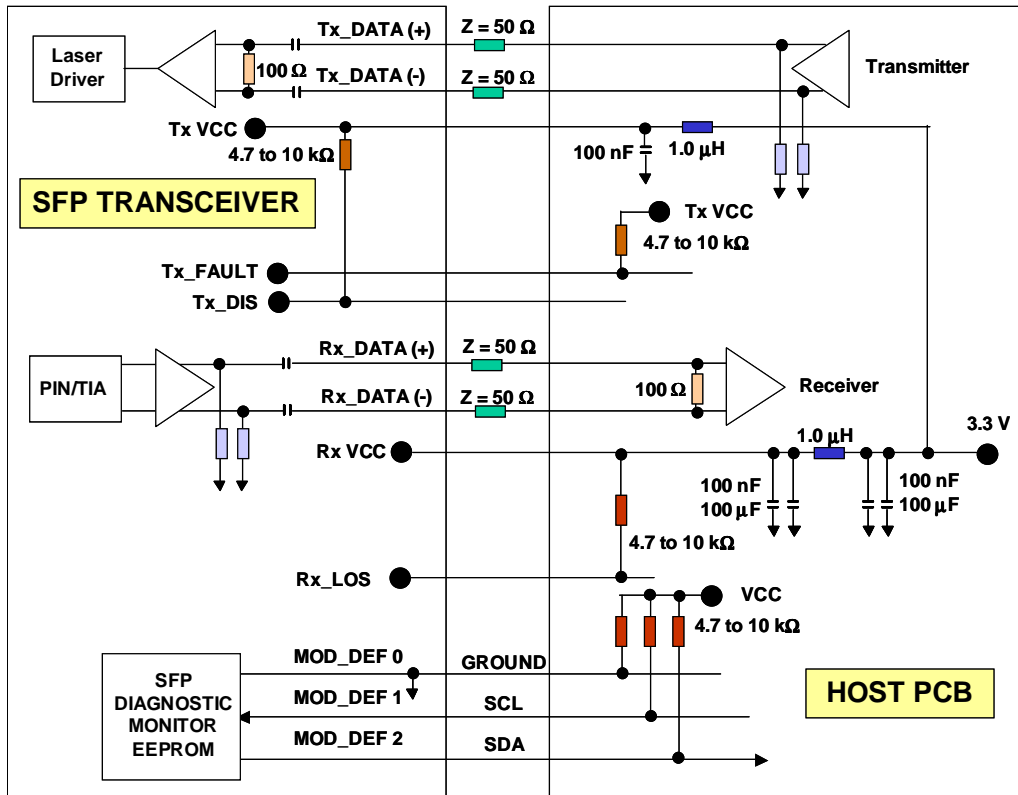
The Rx\_LOS monitor function is an open collector/drain output. It requires a 4,700 to 10,000 Ohm Pull Up resistor on the host PCB. Logic HIGH (2.0 to 3.465V) indicates loss of signal, which can be caused by “no signal” arriving at the optical input, a weak signal arriving at the optical input, a broken fiber or a disconnected optical connector. Logic LOW (0 to 0.8V) indicates normal operation. When the logic voltage is >0.8V and <2.0V, the logic state is undefined.

##### Rx\_DATA

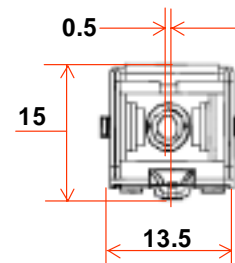
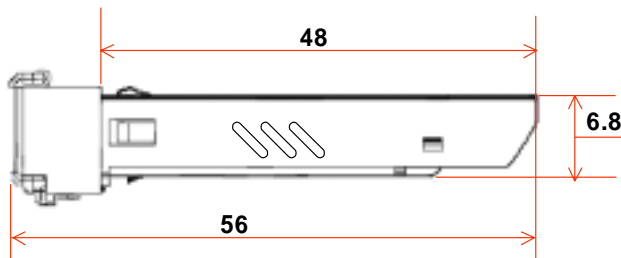
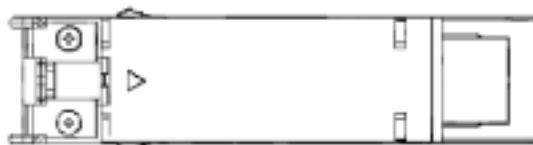
The Rx\_DATA (Inverted) and Rx\_DATA (Non Inverted) are differential receiver output signal lines. They are internally AC-coupled and require a 100 OHM differential termination at the user interface. The voltage swing on these lines will be between 370 and 2000 mV differential (185 – 1000 mV single ended) when properly terminated.



#### RECOMMENDED INTERFACE CIRCUIT



#### SFP OUTLINE



Dimensions are in mm



#### REGULATORY INFORMATION

##### Eye Safety

The transceiver is a Class 1 eye-safe device according to FDA 21CFR1040.10 and IEC 60825-1.

##### Electromagnetic Interference (EMI), Immunity and Product Safety

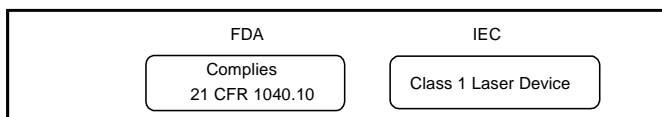
The transceiver is ESD safe (electrical pins) when tested according to MIL-STD-883, Method 3015.7 and ESD safe (optical connector) when tested according to IEC 61000-4-2. The device is immune to strong RF fields when tested in accordance with IEC 610004-3. The device complies with (US) FCC, Part 15, Subpart J; (Europe) CENELEC EN 55022; (Canada) Class B (CISPR22A); and (Japan) VCCI Class 1. The device has been designed to conform to product safety requirements including UL1950, CSA 22.2, and IEC 60950-1, and has been designed to meet the flammability requirements of UL94.

##### Notice

The factory has made all adjustments to this device prior to shipment. No adjustments or modifications to the device are required or permitted. Any adjustment, modification or tampering of the device voids the product warranty. The US Food and Drug Administration may consider that any adjustment or modification to this device is an act of manufacturing and therefore will require that the device be recertified in accordance with 21 CFR 1040.10 Subpart j.

| Laser Radiation Information                      |                     |
|--|---------------------|
| Wavelength                                       | 1550 nm             |
| FDA Total Pout: 7 mm aperture at 20 cm distance  | < 790 microwatts    |
| IEC Total Pout : 7 mm aperture at 10 cm distance | < 10,000 microwatts |
| Beam Divergence                                  | 17.25°              |

##### Required Label



##### Laser Emission

