

Product Specification

**GEPON ONU Optical SFP Module
10km with SC Receptacle**

ESFP-GE-U1

ePHOTON

Preliminary

ESFP-GE-U1

GEAPON ONU PX10 SC Receptacle SFP Transceiver

1 Features

- 1.1 Single fiber bi-directional data links with symmetric 1.25Gbps upstream and 1.25Gbps downstream
- 1.2 Integrated with micro-optics WDM filter for dual wavelength Tx/Rx operation at 1310nm/1490nm
- 1.3 1310nm burst-mode transmitter with FP laser
- 1.4 1490nm continuous-mode receiver with PIN-TIA
- 1.5 Digital Diagnostic Monitoring Function (DDM)
- 1.6 0 to 70°C operating temperature
- 1.7 SFP package with SC receptacle
- 1.8 Single 3.3V power supply
- 1.9 LVPECL compatible data input/output interface
- 1.10 LVTTTL transmitter disable control
- 1.11 LVTTTL transmitter laser failure alarm

2 Applications

- 2.1 Gigabit Ethernet Passive Optical Networks (GE-PON)—ONU side

3 General

ESFP-GE-U1 is Optical Network Unit (ONU) for IEEE802.3ah-2004 1000BASE-PX10-U applications. The transceiver is the high performance module for 1.25Gbps data link in single fiber by using 1310nm burst-mode transmitter and 1490nm continuous-mode receiver. It is capable of serving up to 16 subscribers in advanced TDM P2MP FTTH equipment over distances of up to 10 km.

The transmitter section uses a multiple quantum well 1310nm FP laser and is Class I laser compliant product according to international safety standard IEC-60825. The receiver section uses an integrated 1490 nm PIN and preamplifier mounted an optical header and limiting post-amplifier IC.

The LVTTTL compatible Tx Disable feature controls the laser transmitter and the LVTTTL compatible Rx Signal Loss feature monitors the optical input signal, the device parameters can be accessed in real time by the I C data interface, including the ALARM and WARNING values for temperature, Vcc, Tx BIAS, Tx Burst Mode Optical Power and Rx receiver optical power.



4 Performance Specifications

4.1 Absolute Maximum Ratings

Absolute Maximum Ratings are those values, beyond which, some damages may occur to the devices. Exposure to conditions above the Absolute Maximum Ratings listed in Table 1 may negatively impact the reliability of the products.

| Parameter | Symbol | Min. | Max. | Unit | Note |
|-------------------------------------|---------|------|------|------|------|
| Storage Temperature (Non-Operating) | Tstg | -40 | +85 | °C | |
| Humidity (Operating) | Hop | 5 | 90 | % | |
| Input Voltage | - | GND | Vcc | V | |
| Power Supply Voltage | Vcc-Vee | 0 | +4 | V | |

4.2 Operating Environment

| Parameter | Symbol | Min. | Typ. | Max. | Unit | Note |
|------------------------------|--------|------|-----------|------|------|------|
| Power Supply Voltage | Vcc | +3.1 | +3.3 | +3.5 | V | - |
| Case Temperature (Operating) | Tc | 0 | - | 70 | °C | - |
| Data Rate | | | 1.25/1.25 | | Gb/s | - |
| Data Rate Drift | - | -100 | - | 100 | PPM | - |

4.3 Transmitter Specifications

(Over Operating Case Temperature Range, Vcc = 3.135V to 3.465V)

| Electrical Characteristics | | | | | | |
|------------------------------------|---------------------------------------|------|------|------|------|---------|
| Parameter | Symbol | Min. | Typ. | Max. | Unit | Notes |
| Differential Data Input Swing | Vin,pp | 200 | - | 1600 | mV | 4 |
| Differential Input Impedance | Rin | 90 | 100 | 110 | ohm | - |
| TX_Burst Signal Input Voltage-High | TX_BRST-H | 2.0 | - | Vcc | V | 5 |
| TX_Burst Signal Input Voltage-Low | TX_BRST-L | 0 | - | 0.8 | V | |
| Tx_Fault Output Voltage-High | | 2.0 | - | Vcc | V | 6 |
| Tx_Fault Output Voltage-Low | | 0 | - | 0.8 | V | |
| Burst Turn On Time | Ton | | | 30 | ns | See 4.6 |
| Burst Turn Off Time | Toff | | | 30 | ns | See 4.6 |
| Optical Characteristics | | | | | | |
| Average Launch Optical Power | Peout | -1 | - | +4 | dBm | 1 |
| Average Launch Optical Power-OFF | Peoff | | | -45 | dBm | |
| Optical Extinction Ratio | ER | 9 | | - | dB | 2 |
| Optical Wavelength | λ | 1270 | 1310 | 1350 | nm | |
| Spectral Width (RMS) | σ | - | - | 2.8 | nm | |
| Optical Rise/Fall Time | Tr/Tf | - | | 260 | ps | 3 |
| Optical Return Loss Tolerance | | - | | 15 | dB | |
| Transmitter Reflection | | | | -12 | dB | |
| Optical Eye Diagram | Compliant with IEEE Std 802.3ah™-2004 | | | | | |

Note :

1. Launched into 9/125um Single Mode Fiber.
2. Measured with PRBS 2⁷-1 test pattern @1.25 Gbit/s.
3. Measured with the Bessel-Thompson filter OFF.
4. Compatible with LVPECL input, AC coupled internally.
5. TX_Burst Signal Input (See Pin Function Definitions).

4.4 Receiver Specifications

(Over Operating Case Temperature Range, Vcc = 3.135V to 3.465V)

| Electrical Characteristics | | | | | | |
|--------------------------------|-------------------------|------|------|-----------------|------|-------|
| Parameter | Symbol | Min. | Typ. | Max. | Unit | Notes |
| Power Supply Current | I _{CC_RX} | | | 150 | mA | |
| Data Output Differential Swing | V _{OUT} | 400 | | 1000 | mV | 4 |
| Los Voltage-Low | V _{SD_L} | 0 | | 0.8 | V | |
| Los Voltage-High | V _{SD_H} | 2.4 | | V _{CC} | V | |
| Los Assert Time | T _{ASS} | | | 100 | uS | |
| Los De-assert Time | T _{DAS} | | | 100 | uS | |
| Optical Characteristics | | | | | | |
| Sensitivity | P _{SEN} | | - | -25 | dBm | 1 |
| Saturation | P _{OV} | -3 | | | dBm | |
| Los Assert Level | P _{LOSA} | | | -27 | dBm | 2 |
| Los De-assert Level | P _{LOSD} | -42 | | | dBm | 3 |
| Los Hysteresis | P _{LOSA-PLOSD} | 0.5 | | 5 | dB | |
| Receiver Reflectance | | | | -12 | dB | |

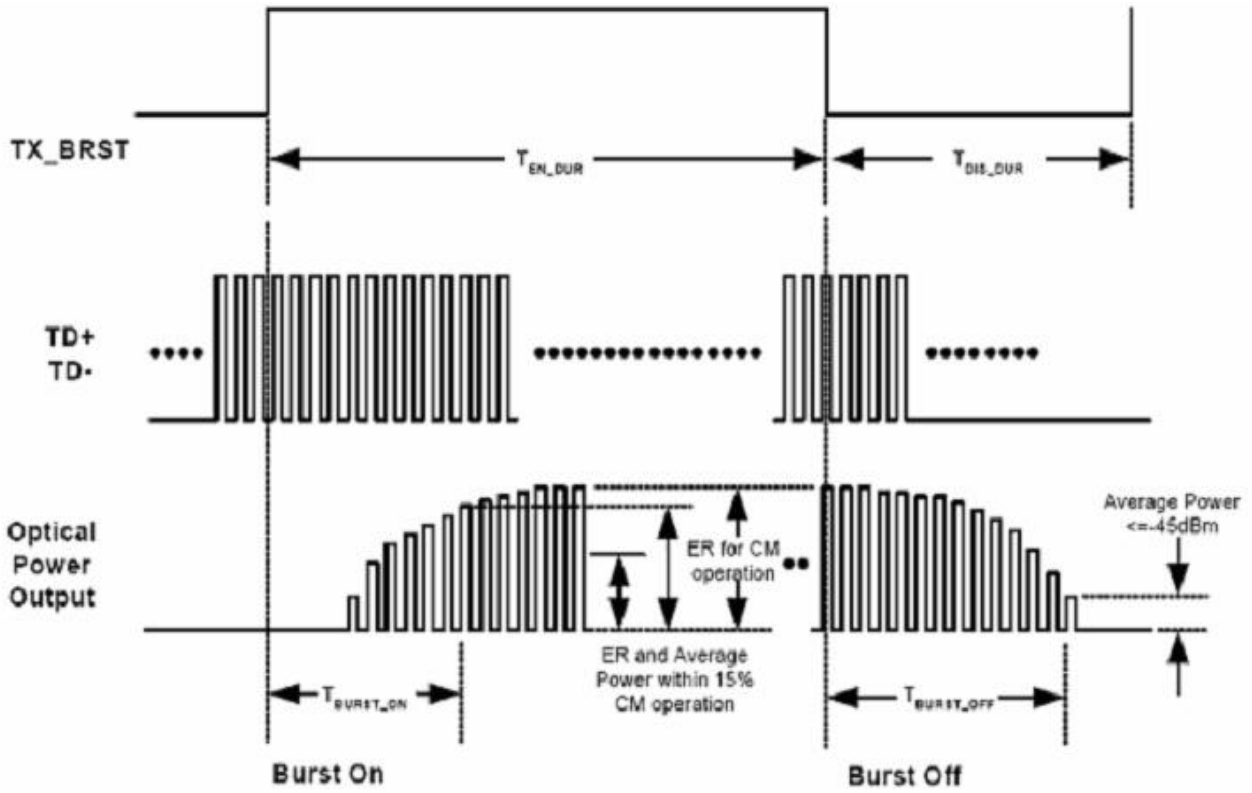
Note :

1. Measured with a PRBS 2⁷⁻¹ test pattern @1.25Gbit/s and ER=10dB, BER =10⁻¹².
2. An increase in optical power above the specified level will cause Loss of Single (LOS) output to switch from a high state to a low state.
3. A decrease in optical power below the specified level will cause Loss of Single (LOS) output to switch from a low state to a high state.
4. LVPECL output, AC coupled internally, guaranteed in the full range of input optical power (-3dBm to -26dBm) (See Recommended Interface Circuit)

4.5 Digital Diagnostic Monitor Accuracy

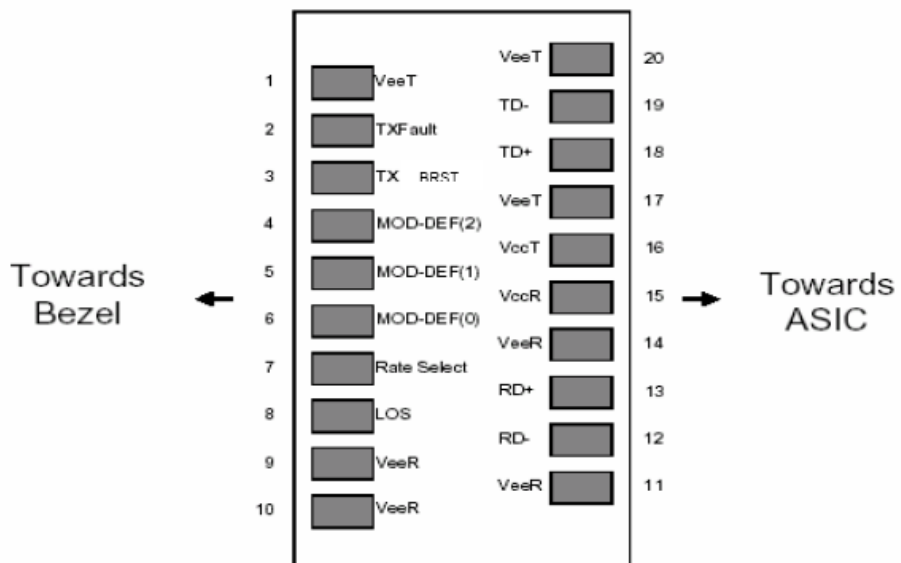
| Parameter | Unit | Accuracy | Range | Calibration |
|----------------------|------|----------|---|-------------|
| Tx Optical Power | dB | ±3 | Full Temperature Range | External |
| | | ±2 | Room Temperature | |
| Rx Optical Power | dB | ±3 | -3dBm to -25dBm | External |
| Bias Current | % | ±10 | I _d : 1-100mA, Recommended Operating Conditions | External |
| Power Supply Voltage | % | ±3 | V _{CC} :3.0-3.6V, Recommended Operating Conditions | External |
| Internal Temperature | °C | ±3 | Recommended Operating Conditions | External |

4.6 Timing Parameter Definition in Burst Mode Sequence



5 Pin Definitions

5.1 Pin Diagram



5.2 Pin Descriptions

| Pin# | Name | Function | Notes |
|------|------------|-----------------------------------|--|
| 1 | VeeT | Transmitter Ground | - |
| 2 | TX Fault | Transmitter Fault Indication | Note 1 |
| 3 | TX Burst | Transmitter Burst on Control | Note 2, Transmitter burst on with this signal high |
| 4 | MOD-DEF2 | Module Definition 2 | Note 3, 2 wire serial ID interface |
| 5 | MOD-DEF1 | Module Definition 1 | Note 3, 2 wire serial ID interface |
| 6 | MOD-DEF0 | Module Definition 0 | Note 3, Grounded in module |
| 7 | RATESELECT | N/A | Not connected |
| 8 | LOS | Loss of Signal | Note 4 |
| 9 | VeeR | Receiver Ground | Note 5 |
| 10 | VeeR | Receiver Ground | Note 5 |
| 11 | VeeR | Receiver Ground | Note 5 |
| 12 | RD- | Inv. Received Data Out, AC | |
| 13 | RD+ | Received Data Out, AC Coupled | |
| 14 | VeeR | Receiver Ground | Note 5 |
| 15 | VccR | Receiver Power | Note 6, 3.3V± 5% |
| 16 | VccT | Transmitter Power | Note 6, 3.3V± 5% |
| 17 | VeeT | Transmitter Ground | Note 5 |
| 18 | TD+ | Transmit Data In, AC Coupled | |
| 19 | TD- | Inv. Transmit Data In, AC Coupled | |
| 20 | VeeT | Transmitter Ground | Note 5 |

Notes:

- TX Fault is an open collector/drain output, which should be pulled up with a 4.7K–10KΩ resistor on the host board. Pull up voltage between 2.0V and VccT, R+0.3V. When high, output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
- TX burst signal input is an input that is used to control burst of transmitter optical signal output. It is pulled up within the module with a 4.7–10 KΩ resistor. TX_BRST states are:
 Low (0 – 0.8V): Transmitter Burst off, LD bias is OFF and modulation is OFF. LD output is less than -45dBm
 High (2.0 – 3.3V): Transmitter Burst on, LD bias is set and modulation is ON;
- Mod-Def 1,2 are the module definition pins. They should be pulled up with a 4.7K – 10KΩ resistor on the host board. The pull-up voltage shall be VccT or VccR.
 Mod-Def 2 is the data line of two wire serial interface for serial ID
 Mod-Def 1 is the clock line of two wire serial interface for serial ID
 Mod-Def 0 is grounded by the module to indicate that the module is present.
- LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K–10KΩ resistor. Pull up voltage between 2.0V and VccT,R+0.3V. When high, this output indicates the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use). Low indicates normal operation. In the low state, the output will be pulled to < 0.8V.
- VeeR and VeeT may be internally connected within the SFP module.
- VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V ±5% at the SFP connector pin. Maximum supply current is 400mA. Recommended host board power supply filtering is shown in (7. Recommended Circuit). Inductors with DC resistance of less than 1Ω should be used in order to maintain the required voltage at the SFP input pin with 3.3V supply voltage. When the recommended supply filtering network is used, hot plugging of the SFP transceiver module will result in an inrush current of no more than 30 mA greater than the steady state value. VccR and VccT may be internally connected within the SFP transceiver module.

6. Serial interface memory map

Module identification and diagnostic information is accessible through the address map shown in the following tables .

6.1 EEPROM serial ID memory contents (A0h)

| Addr | Hex | ASCII | Description | Addr | Hex | ASCII | Description | Addr | Hex | ASCII | Description | |
|------|-----|-----------|---|------|-----|---------------|-------------------------|------|-----|---------------|-------------------------------------|----------|
| 0 | 03 | | SFP | 32 | 20 | | Vendor name | 64 | 00 | | (001Ah=LOS,TX_FAULT, all supported) | |
| 1 | 04 | | SFP function is defined by serial ID only | 33 | 20 | | | 65 | 1A | | | |
| 2 | 01 | | SC connector | 34 | 20 | | | 66 | 00 | | | BR, Max |
| 3 | 00 | | Not defined | 35 | 20 | | | 67 | 00 | | | BR, Min. |
| 4 | 00 | | Not defined | 36 | XX | | Reserved | 68 | XX | | Vendor Serial number | |
| 5 | 00 | | Not defined | 37 | 00 | | Vendor OUI | 69 | XX | | | |
| 6 | 80 | | EPON | 38 | 00 | | | 70 | XX | | | |
| 7 | 00 | | Not defined | 39 | 00 | | | 71 | XX | | | |
| 8 | 00 | | Not defined | 40 | 45 | E | Vendor part number | 72 | XX | | | |
| 9 | 00 | | Not defined | 41 | 53 | S | | 73 | XX | | | |
| 10 | 00 | | Not defined | 42 | 46 | F | | 74 | XX | | | |
| 11 | 01 | | 8B10B | 43 | 50 | P | | 75 | XX | | | |
| 12 | 0C | 1.25G bps | BR in 100Mbps | 44 | 2D | - | | 76 | XX | | | |
| 13 | 00 | | Reserved | 45 | 47 | G | | 77 | XX | | | |
| 14 | 0A | 10 | Length(9u)*km | 46 | 45 | E | | 78 | XX | | | |
| 15 | 64 | 100 | Length(9u)*100m | 47 | 2D | - | | 79 | XX | | | |
| 16 | 00 | | Length(50u)*10m | 48 | 55 | U | | 80 | XX | | | |
| 17 | 00 | | Length(62.5u)*10m | 49 | 31 | 1 | | 81 | XX | | | |
| 18 | 00 | | Length(Copper) | 50 | 20 | | | 82 | XX | | | |
| 19 | XX | | Reserved | 51 | 20 | | | 83 | XX | | | |
| 20 | 65 | e | Vendor name | 52 | 20 | | | 84 | XX | | Vendor data code: Year | |
| 21 | 50 | P | | 53 | 20 | | | 85 | XX | | Vendor data code: Month | |
| 22 | 48 | H | | 54 | 20 | | | 86 | XX | | | |
| 23 | 4F | O | | 55 | 20 | | Vendor PN reversion 1.0 | 87 | XX | | Vendor data code: Day | |
| 24 | 54 | T | | 56 | 31 | | | 88 | XX | | | |
| 25 | 4F | O | | 57 | 2E | . | | 89 | XX | | Blank | |
| 26 | 4E | N | | 58 | 30 | | 90 | 20 | | | | |
| 27 | 20 | | | 59 | 20 | | 91 | 20 | | | | |
| 28 | 20 | | | 60 | XX | | Reserved | 92 | XX | | Reserved | |
| 29 | 20 | | | 61 | XX | | Reserved | 93 | XX | | Reserved | |
| 30 | 20 | | 62 | XX | | Reserved | 94 | XX | | Reserved | | |
| 31 | 20 | | 63 | XX | | CC_BASE(0-62) | 95 | XX | | CC_EXT(64-94) | | |

96-127: 00, Vendor specific
 128-255: 00, Reserved
 XX: denotes hex values which varies from module to module

6.2 EEPROM serial ID memory contents (A2h)

6.2.1 Alarm and Warning Thresholds, OM Output Calibration ID Fields

| Addr. (DEC) | # Bytes | Name | Value |
|-------------|---------|-----------------------------|---|
| 00-01 | 2 | Temp high alarm | +80°C |
| 02-03 | 2 | Temp low alarm | -13°C |
| 04-05 | 2 | Temp high warning | +75°C |
| 06-07 | 2 | Temp low warning | -8°C |
| 08-09 | 2 | Supply voltage high alarm | +3.6V |
| 10-11 | 2 | Supply voltage low alarm | +3.0V |
| 12-13 | 2 | Supply voltage high warning | +3.47V |
| 14-15 | 2 | Supply voltage low warning | +3.14V |
| 16-17 | 2 | Bias high alarm | 100mA |
| 18-19 | 2 | Bias low alarm | 0mA |
| 20-21 | 2 | Bias high warning | 80mA |
| 22-23 | 2 | Bias low warning | 0mA |
| 24-25 | 2 | Tx power high alarm | +5dBm |
| 26-27 | 2 | Tx power low alarm | -2dBm |
| 28-29 | 2 | Tx power high warning | +4.5dBm |
| 30-31 | 2 | Tx power low warning | -1.5dBm |
| 32-33 | 2 | Rx power high alarm | -4dBm |
| 34-35 | 2 | Rx power low alarm | -29dBm |
| 36-37 | 2 | Rx power high warning | -3.5dBm |
| 38-39 | 2 | Rx power low warning | -28.5dBm |
| 40-55 | 16 | Reserved | Reserved for future monitored quantities |
| 56-59 | 4 | Rx_PWR(4) | Single precision floating point calibration data-Rx optical power. Bit7 of byte 56 is MSB, Bit 0 of byte 59 is LSB |
| 60-63 | 4 | Rx_PWR(3) | Single precision floating point calibration data-Rx optical power. Bit7 of byte 60 is MSB, Bit 0 of byte 63 is LSB |
| 64-67 | 4 | Rx_PWR(2) | Single precision floating point calibration data-Rx optical power. Bit7 of byte 64 is MSB, Bit 0 of byte 67 is LSB |
| 68-71 | 4 | Rx_PWR(1) | Single precision floating point calibration data-Rx optical power. Bit7 of byte 68 is MSB, Bit 0 of byte 71 is LSB |
| 72-75 | 4 | Rx_PWR(0) | Single precision floating point calibration data-Rx optical power. Bit7 of byte 72 is MSB, Bit 0 of byte 75 is LSB |
| 76-77 | 2 | Tx_I(Slope) | Fixed decimal (unsigned) calibration data, laser bias current. Bit 7 of byte 76 is MSB, Bit 0 of byte 77 is LSB. |
| 78-79 | 2 | Tx_I(Offset) | Fixed decimal (signed two's complement) calibration data, laser bias current. Bit 7 of byte 78 is MSB, Bit 0 of byte 79 is LSB |
| 80-81 | 2 | Tx_PWR(Slope) | Fixed decimal (unsigned) calibration data, transmitter coupled output power. Bit 7 of byte 80 is MSB, Bit 0 of byte 81 is LSB |
| 82-83 | 2 | Tx_PWR(Offset) | Fixed decimal (signed two's complement) calibration data, transmitter coupled output power. Bit 7 of byte 82 is MSB, Bit 0 of byte 83 is LSB. |
| 84-85 | 2 | T(Slope) | Fixed decimal (unsigned) calibration data, internal module temperature. Bit 7 of byte 84 is MSB, Bit 0 |

| | | | |
|-------|---|-----------|---|
| | | | of byte 85 is LSB. |
| 86-87 | 2 | T(Offset) | Fixed decimal (signed two's complement) calibration data, internal module temperature. Bit 7 of byte 86 is MSB, Bit 0 of byte 87 is LSB. |
| 88-89 | 2 | V(Slope) | Fixed decimal (unsigned) calibration data, internal module supply voltage. Bit 7 of byte 88 is MSB, Bit 0 of byte 89 is LSB. |
| 90-91 | 2 | V(Offset) | Fixed decimal (signed two's complement) calibration data, internal module supply voltage. Bit 7 of byte 90 is MSB, Bit 0 of byte 91 is LSB. |
| 92-95 | 4 | Reserved | Reserved. |

6.2.2 A/D Values and Status Bits

| Addr. (DEC) | Bit | Name | Description |
|-------------------------------------|-----|----------------------|--|
| 96 | All | Temperature MSB | Internally measured module temperature |
| 97 | All | Temperature LSB | |
| 98 | All | Vcc MSB | Internal measured supply voltage |
| 99 | All | Vcc LSB | |
| 100 | All | Tx bias MSB | Internal measured Tx bias current |
| 101 | All | Tx bias LSB | |
| 102 | All | Tx power MSB | Measured TX output power |
| 103 | All | Tx power LSB | |
| 104 | All | Rx Power MSB | Measured RX input power |
| 105 | All | Rx Power LSB | |
| 106 | All | Reserved MSB | Reserved for 1 st future definition of digitized analog input |
| 107 | All | Reserved LSB | Reserved for 1 st future definition of digitized analog input |
| 108 | All | Reserved MSB | Reserved for 2 nd future definition of digitized analog input |
| 109 | All | Reserved LSB | Reserved for 2 nd future definition of digitized analog input |
| Optional status/control bits | | | |
| 110 | 7 | TX Disable State | Digital state of the TX Disable Input Pin. Not supported |
| 110 | 6 | Soft TX Disable | Read/Write bit that allows software disable of laser. Not supported |
| 110 | 5 | Reserved | |
| 110 | 4 | RX Rate Select State | Digital state of the SFP RX Rate Select Input Pin. Not supported |
| 110 | 3 | Soft RX Rate Select | Read/Write bit that allows software RX rate select, Not supported |
| 110 | 2 | TX fault | Digital state of the TX Fault Output Pin. |
| 110 | 1 | LOS | Digital state of the LOS Output Pin. |
| 110 | 0 | Data_Ready | Indicates transceiver has achieved power up and data is ready |
| 111 | 7-0 | Reserved | Reserved |

6.2.3 Alarm and Warning Flags

| Addr. (DEC) | Bit | Name | Description |
|-------------|-----|-----------------------|--|
| 112 | 7 | Temp high alarm | Set when internal temperature exceeds high alarm level |
| | 6 | Temp low alarm | Set when internal temperature below low alarm level |
| | 5 | Vcc high alarm | Set when internal supply voltage exceeds high alarm level |
| | 4 | Vcc low alarm | Set when internal supply voltage below low alarm level |
| | 3 | Tx bias high alarm | Set when internal Tx bias current exceeds high alarm level |
| | 2 | Tx bias low alarm | Set when internal Tx bias current below low alarm level |
| | 1 | Tx power high alarm | Set when internal Tx output power exceeds high alarm level |
| | 0 | Tx power low alarm | Set when internal Tx output power below low alarm level |
| 113 | 7 | Rx power high alarm | Set when received power exceeds high alarm level |
| | 6 | Rx power low alarm | Set when received power is below low alarm level |
| | 5-0 | Reserved alarm | |
| 114-115 | All | Reserved | |
| 116 | 7 | Temp high warning | Set when internal temperature exceeds high warning level |
| | 6 | Temp low warning | Set when internal temperature below low warning level |
| | 5 | Vcc high warning | Set when internal supply voltage exceeds high warning level |
| | 4 | Vcc low warning | Set when internal supply voltage below low warning level |
| | 3 | Tx bias high warning | Set when internal Tx bias current exceeds high warning level |
| | 2 | Tx bias low warning | Set when internal Tx bias current below low warning level |
| | 1 | Tx power high warning | Set when internal Tx output power exceeds high warning level |
| | 0 | Tx power low warning | Set when internal Tx output power below low warning level |
| 117 | 7 | Rx power high warning | Set when received power exceeds high warning level |
| | 6 | Rx power low warning | Set when received power is below low warning level |
| | 5-0 | Reserved warning | |
| 118-119 | all | Reserved | |

6.2.4 Vendor Specific Memory Addresses

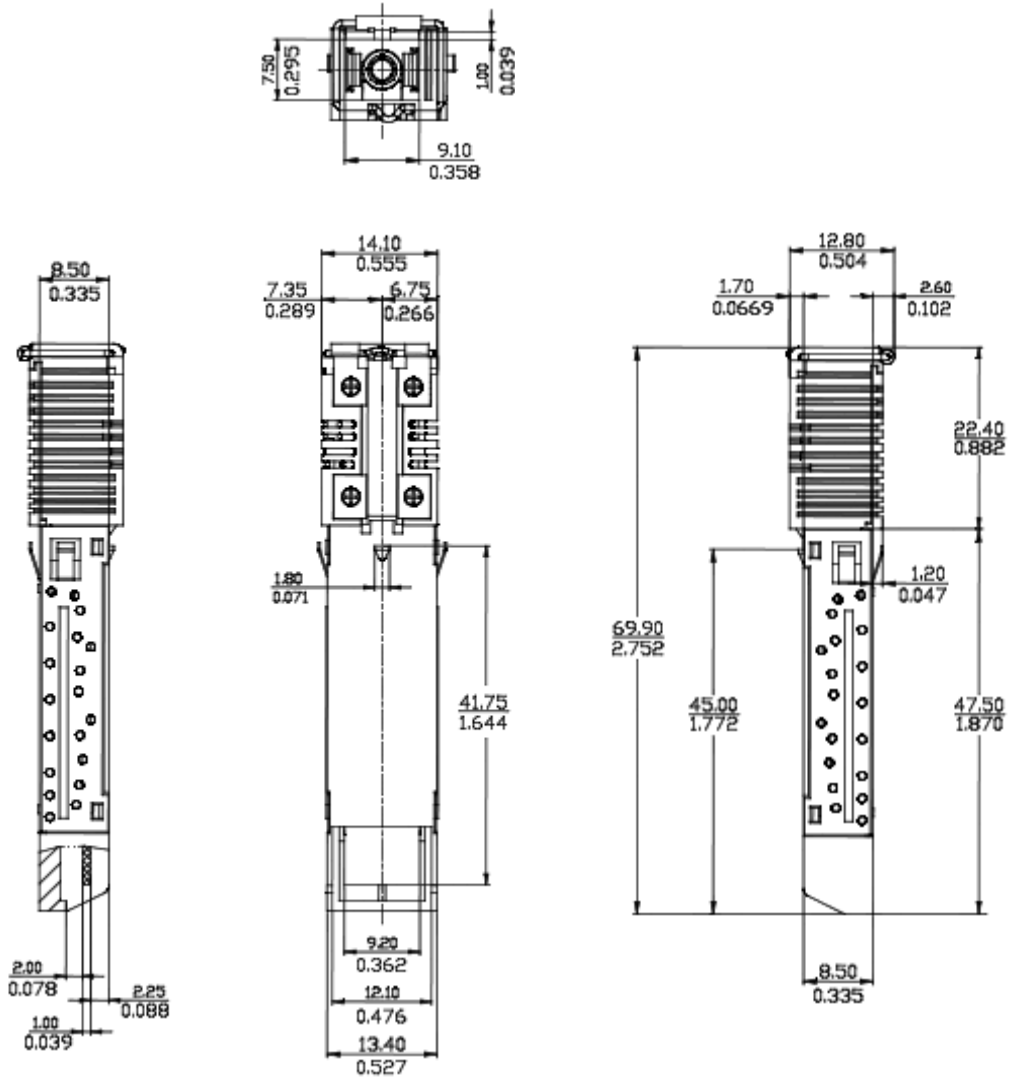
| Addr. (DEC) | # Bytes | Name | Description |
|-------------|---------|-----------------|-----------------|
| 120-127 | 8 | Vendor specific | Vendor specific |

6.2.5 User EEPROM

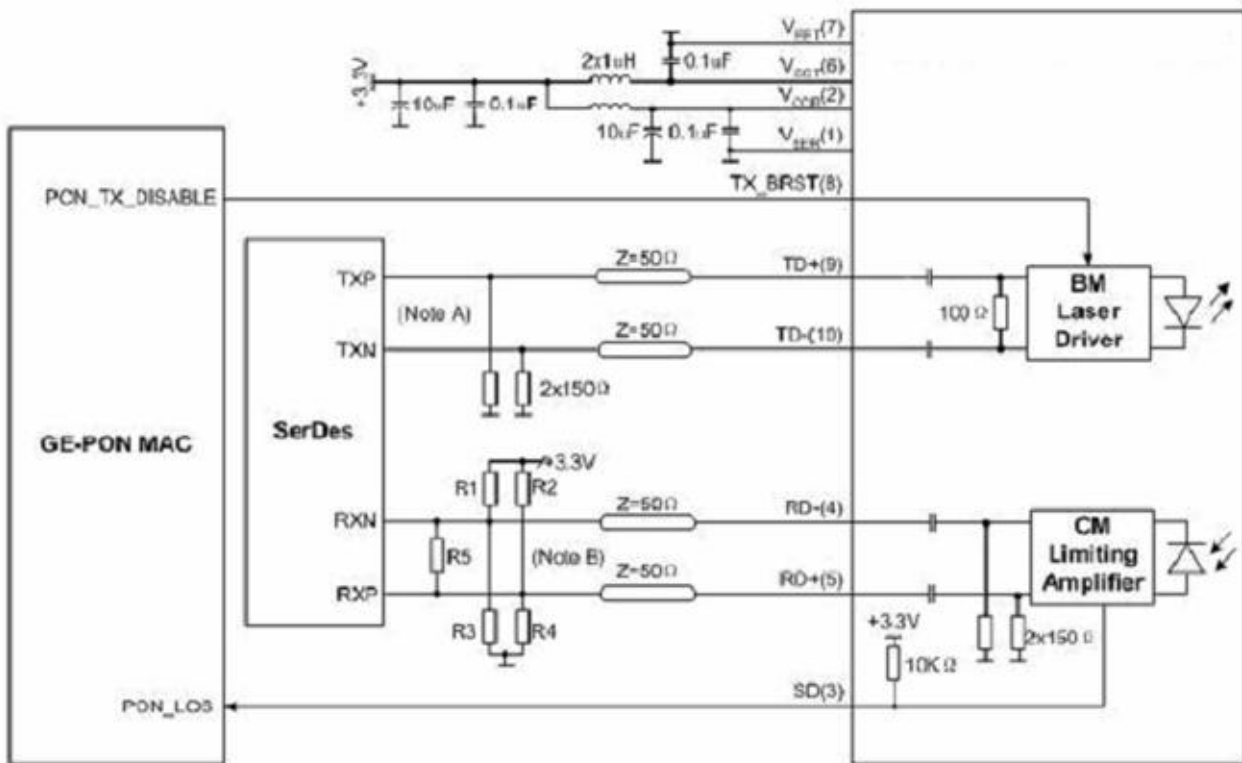
| Addr. (DEC) | # Bytes | Name | Description |
|-------------|---------|----------------------|-----------------------------------|
| 128-247 | 120 | Vendor Writable Area | Vendor writable EEPROM |
| 248-255 | 8 | Vendor specific | Vendor specific control functions |

7 Package Information

The mechanical design diagram of the SFP transceiver with SC receptacle (dimension in mm)



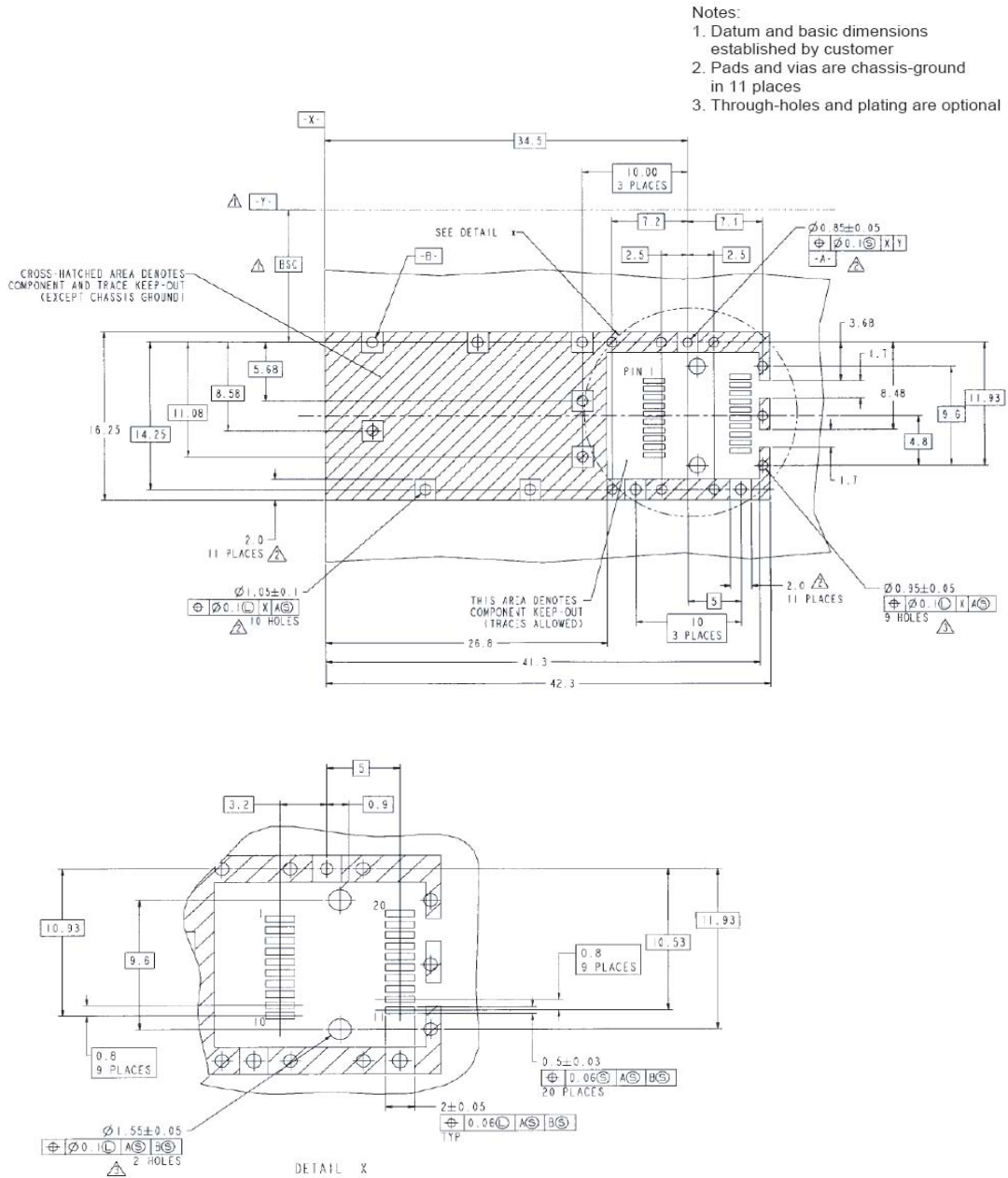
8 Recommended Circuit



Note :

1. Open emitter output internally.
2. LVPECL output, AC coupled internally.
 Input stage in SerDes IC is assumed with high impedance and internal bias to V_{cc}-1.3V
 R1=R2=R3=R4=N.C, R5=100Ω
 Input stage in SerDes IC is assumed without internal bias to V_{cc}-1.3V
 R1=R2=82Ω, R3=R4=130Ω, R5=N.C

10 Recommended PCB Layout



11 Ordering Information

| Part Number | Description |
|-------------|--|
| ESFP-GE-U1 | GEAPON ONU SFP, Receptacle SC, PX10,DDM,0~70°C |

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