

## Product Features

- Compliant with IEEE Std 802.3-2005,100BASE-BX-U
- Compliant with SFF-8074i and SFF-8472, revision 9.5
- Compliant with SFP MSA Specification
- Digital Diagnostic Monitoring available
- Uncooled 1310nm FP Laser
- Up to 155Mb/s bi-directional data links
- Up to 40km on 9/125µm SMF
- Simplex LC connector compliant
- Single +3.3V DC power supply
- Hot-pluggable SFP footprint
- Class 1 laser safety certified
- Operating temperature Options
  - (Commercial) -10°C to +70°C
  - (Extended) -10°C to +85°C
  - (Industrial) -40°C to +85°C
- RoHS6 Compliant



## Applications

- 100BASE-BX-U
- Point to Point Interface
- Fast Ethernet
- Other Optical Links

## Descriptions

LX2022C(E/I)DR SFP transceivers, according to Small Form Factor Pluggable Multi-Sourcing Agreement (MSA) SFF-8074i and SFF-8472, revision 9.5, are designed for single fiber bidirectional data communication up to 40km. They are compliant with IEEE Std 802.3-2005 100BASE-BX-U.

LX2022C(E/I)DR SFP transceivers offer a wide range of design options, including Digital Diagnostic Monitoring (DDM) features and three temperature options (commercial, extended or industrial).

LX2022C (E/I)DR are compliant with RoHS.

## Ordering Information

**Table 1. Ordering Information**

| Part Number | Transmitter | Output Power | Receiver | Sensitivity | Reach | Temp        | DDM       | RoHS      |
|-------------|-------------|--------------|----------|-------------|-------|-------------|-----------|-----------|
| LX2022CDR   | 1310nm FP   | -5 ~ 0dBm    | 1490 PIN | < -31dBm    | 40km  | -10 ~ 70 °C | Available | Compliant |
| LX2022EDR   | 1310nm FP   | -5 ~ 0dBm    | 1490 PIN | < -31dBm    | 40km  | -10 ~ 85 °C | Available | Compliant |
| LX2022IDR   | 1310nm FP   | -5 ~ 0dBm    | 1490 PIN | < -31dBm    | 40km  | -40 ~ 85 °C | Available | Compliant |

## Pin Description

**Table 2. Pin Description**

| Pin | Name        | Function/Description                                | Engagement order (Insertion) | Notes |
|-----|-------------|---|------------------------------|-------|
| 1   | VeeT        | Transmitter Ground                                  | 1                            | -     |
| 2   | TX Fault    | Transmitter Fault Indication                        | 3                            | 1     |
| 3   | TX Disable  | Transmitter Disable-Module disables on high or open | 3                            | 2     |
| 4   | MOD-DEF2    | Module Definition 2-Two wire serial ID interface    | 3                            | 3     |
| 5   | MOD-DEF1    | Module Definition 1-Two wire serial ID interface    | 3                            | 3     |
| 6   | MOD-DEF0    | Module Definition 0-Grounded in module              | 3                            | 3     |
| 7   | Rate Select | Not Connected                                       | 3                            | -     |
| 8   | LOS         | Loss of Signal                                      | 3                            | 4     |
| 9   | VeeR        | Receiver Ground                                     | 1                            | -     |
| 10  | VeeR        | Receiver Ground                                     | 1                            | -     |
| 11  | Veer        | Receiver Ground                                     | 1                            | -     |
| 12  | RD-         | Inverse Received Data out                           | 3                            | 5     |
| 13  | RD+         | Received Data out                                   | 3                            | 5     |
| 14  | VeeR        | Receiver Ground                                     | 1                            | -     |
| 15  | VccR        | Receiver Power - +3.3V±5%                           | 2                            | 6     |
| 16  | VccT        | Transmitter Power - +3.3 V±5%                       | 2                            | 6     |
| 17  | VeeT        | Transmitter Ground                                  | 1                            | -     |
| 18  | TD+         | Transmitter Data In                                 | 3                            | 7     |
| 19  | TD-         | Inverse Transmitter Data In                         | 3                            | 7     |
| 20  | VeeT        | Transmitter Ground                                  | 1                            | -     |

**Notes:**

- TX Fault is open collector/drain output which should be pulled up externally with a 4.7KΩ-10KΩ resistor on the host board to supply <math>V\_{ccT} + 0.3V</math> or <math>V\_{ccR} + 0.3V</math>. When high, this output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to <math><0.8V</math>.
- TX Disable input is used to shut down the laser output per the state table below. It is pulled up within the module with a 4.7KΩ-10KΩ resistor.

|                          |                      |
|--------------------------|----------------------|
| Low (0 – 0.8V):          | Transmitter on       |
| Between (0.8V and 2V):   | Undefined            |
| High (2.0 – $V_{ccT}$ ): | Transmitter Disabled |
| Open :                   | Transmitter Disabled |
- Mod-Def 0, 1, 2. These are the module definition pins. They should be pulled up with a 4.7KΩ-10KΩ resistor on the host board to supply less than  $V_{ccT} + 0.3V$  or  $V_{ccR} + 0.3V$ .  
Mod-Def 0 is grounded by the module to indicate that the module is present.  
Mod-Def 1 is clock line of two wire serial interface for optional serial ID.  
Mod-Def 2 is data line of two wire serial interface for optional serial ID.
- LOS (Loss of signal) is an open collector/drain output which should be pulled up externally with a 4.7KΩ-10KΩ resistor on the host board to supply <math>V\_{ccT} + 0.3V</math> or <math>V\_{ccR} + 0.3V</math>. 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 <math><0.8V</math>.

5. RD-/+ : These are the differential receiver outputs. They are AC coupled 100Ω differential lines which should be terminated with 100Ω differential at the user SERDES. The AC coupling is done inside the module and thus not required on the host board.
6. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.3V±5% at the SFP connector pin. The in-rush current will typically be no more than 30mA above steady state supply current after 500ns.
7. TD-/+ : These are the differential transmitter inputs. They are AC coupled differential lines with 100Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on host board.

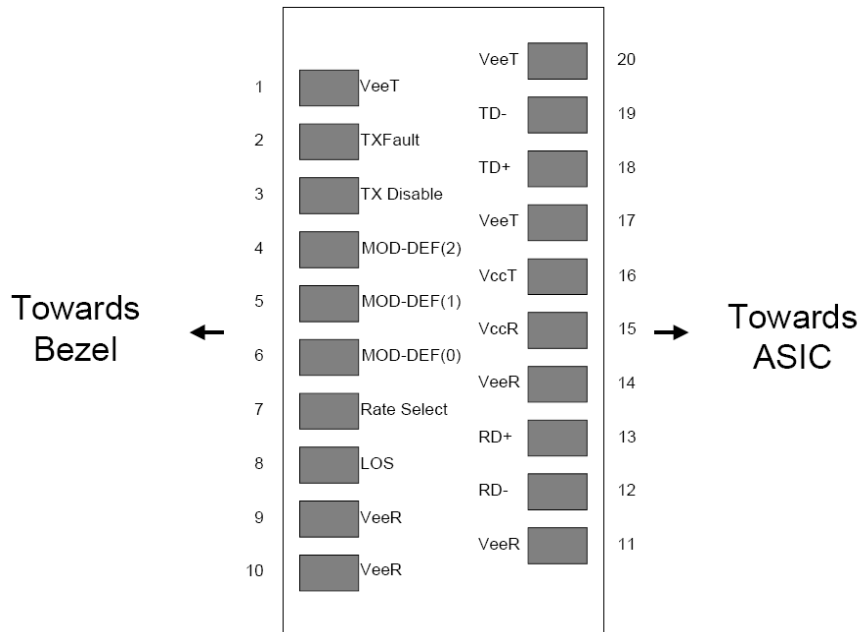


Figure 1. Diagram of Host Board Connector Block Pin Numbers and Names

## Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause permanent damage to the device. These are absolute stress ratings only. Functional operation of the device is not implied at these or any other conditions in excess of those given in the operational sections of the data sheet. Exposure to absolute maximum ratings for extended periods can adversely affect device reliability.

**Table 3. Absolute Maximum Ratings**

| Parameter           | Symbol          | Minimum | Maximum | Unit |
|---------------------|-----------------|---------|---------|------|
| Storage Temperature | T <sub>s</sub>  | -40     | 85      | °C   |
| Relative Humidity   | RH              | 5       | 95      | %    |
| Supply Voltage      | V <sub>CC</sub> | -0.5    | 4.0     | V    |

## Recommended Operating Conditions

**Table 4. Recommended Operating Conditions**

| Parameter                  | Symbol          | Min            | Typ     | Max   | Unit |    |
|----------------------------|-----------------|----------------|---------|-------|------|----|
| Operating Case Temperature | LX2022CDR       | T <sub>C</sub> | -10     | 25    | 70   | °C |
|                            | LX2022EDR       | T <sub>C</sub> | -10     | 25    | 85   | °C |
|                            | LX2022IDR       | T <sub>C</sub> | -40     | 25    | 85   | °C |
| Supply Voltage             | V <sub>CC</sub> | 3.135          | 3.3     | 3.465 | V    |    |
| Data Rate                  | -               | -              | 125/155 | -     | Mb/s |    |

## Transceiver Electrical Characteristics

**Table 5. Transceiver Electrical Characteristics**

| Parameter  | Symbol          | Minimum | Typical | Maximum         | Unit              | Notes |
|--|-----------------|---------|---------|-----------------|-------------------|-------|
| Module Supply Current  | I <sub>CC</sub> | -       | -       | 220             | mA                | -     |
| Power dissipation  | P <sub>D</sub>  | -       | -       | 800             | mW                | -     |
| Transmitter Differential Input Voltage (TD +/-)                                | -               | 300     | -       | 2200            | mV <sub>P-P</sub> | 1     |
| Receiver Differential Output Voltage (RD +/-)                                  | -               | 600     | -       | 1200            | mV <sub>P-P</sub> | 2     |
| Low speed output:<br>Transmitter Fault(TX_FAULT) /<br>Loss of Signal (LOS)     | VOH             | 2.0     | -       | V <sub>CC</sub> | V                 | 3     |
|  | VOL             | 0       | -       | 0.8             | V                 | -     |
| Low speed iutput:<br>Transmitter Disable (TX_DISABLE),<br>MOD_DEF 1, MOD_DEF 2 | VIH             | 2.0     | -       | V <sub>CC</sub> | V                 | 4     |
|  | VIL             | 0       | -       | 0.8             | V                 | -     |

**Notes:**

- Internally AC coupled and terminated to 100Ω differential load.
- Internally AC coupled, but requires a 100Ω differential termination or internal to Serializer/Deserializer.
- Pulled up externally with a 4.7KΩ-10KΩ resistor on the host board to V<sub>CCT,R</sub>.
- Mod\_Def1 and Mod\_Def2 must be pulled up externally with a 4.7KΩ-10KΩ resistor on the host board to V<sub>CCT,R</sub>.

## Transmitter Optical Characteristics

**Table 6. Transmitter Optical Characteristics**

| Parameter                 | Symbol                               | Minimum | Typical | Maximum | Unit | Notes |
|---------------------------|--------------------------------------|---------|---------|---------|------|-------|
| Launch Optical Power      | P <sub>o</sub>                       | -5      | -       | 0       | dBm  | -     |
| Center Wavelength Range   | λ <sub>c</sub>                       | 1260    | 1310    | 1360    | nm   | -     |
| Extinction Ratio          | EX                                   | 10      | -       | -       | dB   | -     |
| Spectral Width(RMS)       | Δλ                                   | -       | -       | 7       | nm   | -     |
| Optical Rise/Fall Time    | T <sub>rise</sub> /T <sub>fall</sub> | -       | -       | 1.5     | ns   | -     |
| Pout @TX-Disable Asserted | P <sub>off</sub>                     | -       | -       | -45     | dBm  | -     |

## Receiver Optical Characteristics

**Table 7. Receiver Optical Characteristics**

| Parameter            | Symbol           | Minimum | Typical | Maximum | Unit | Notes |
|----------------------|------------------|---------|---------|---------|------|-------|
| Wavelength Range     | -                | 1470    | 1490    | 1600    | nm   | -     |
| Receiver Sensitivity | S                | -       | -       | -31     | dBm  | 1     |
| Receiver Overload    | P <sub>OL</sub>  | -8      | -       | -       | dBm  | 1     |
| Optical Return Loss  | ORL              | 12      | -       | -       | dB   | -     |
| LOS De-Assert        | LOS <sub>D</sub> | -       | -       | -32     | dBm  | -     |
| LOS Assert           | LOS <sub>A</sub> | -45     | -       | -       | dBm  | -     |
| LOS Hysteresis       | -                | 0.5     | 3       | 5       | dB   | -     |

**Notes:**

1. Measured with PRBS 2<sup>23</sup>-1 test pattern, 155Mb/s, EX=10dB, BER<10<sup>-12</sup>.

## Timing characteristic

**Table 8. Receiver Optical Characteristics**

| Parameter                                    | Symbol                | Minimum | Typical | Maximum | Unit | Notes |
|--|-----------------------|---------|---------|---------|------|-------|
| Tx_disable assert time                       | T <sub>off</sub>      | -       | -       | 10      | us   | -     |
| Tx_disable negate time                       | T <sub>on</sub>       | -       | -       | 1       | ms   | -     |
| Time to initialize,include reset of TX_FAULT | T <sub>init</sub>     | -       | -       | 300     | ms   | -     |
| TX_FAULT from fault to assertion             | T <sub>fault</sub>    | -       | -       | 100     | us   | -     |
| Tx_disable time to start reset               | T <sub>reset</sub>    | 10      | -       | -       | us   | -     |
| Receiver LOS Assert Time(on to off)          | T <sub>D,RX_LOS</sub> | -       | -       | 80      | us   | -     |
| Receiver LOS Assert Time(off to on)          | T <sub>A,RX_LOS</sub> | -       | -       | 80      | us   | -     |
| Serial I2C Clock Rate                        | I2C_Clock             | -       | -       | 100     | kHz  | -     |

## Digital Diagnostic Memory Map

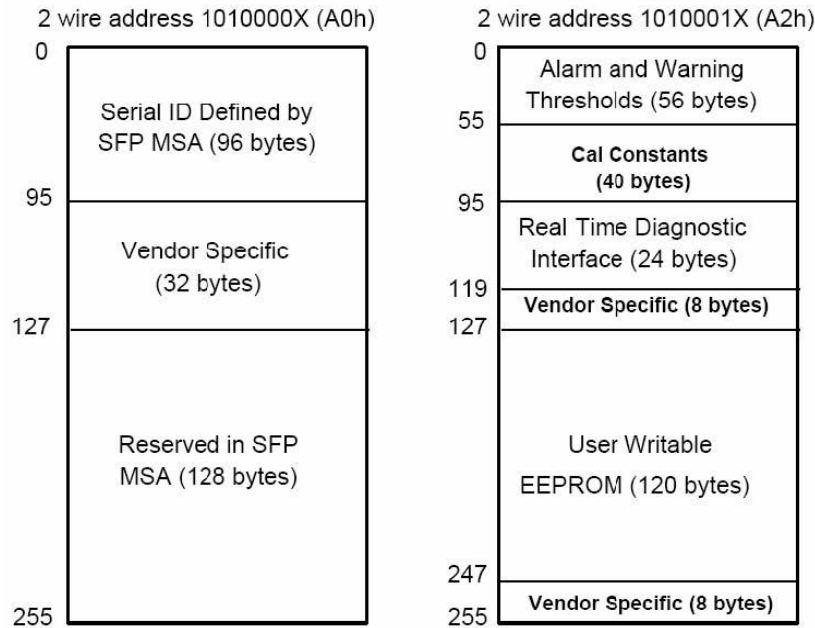


Figure 2. Digital Diagnostic Memory Map Specific Data Field Descriptions

## EEPROM Serial ID Memory Contents

The SFP MSA defines a 256-byte memory map in EEPROM describing the transceiver’s capabilities, standard interfaces, manufacturer, and other information, which is accessible over a 2 wire serial interface at the 8-bit address 1010000X (A0h), and the clock frequency up to 100KHz. The memory contents are shown in Table 9.

**Table 9. Serial ID Memory Contents**

| Data Address | Name of Field     | Contents(Hex)           | Description                          |
|--------------|-------------------|-------------------------|--------------------------------------|
| 0            | Identifier        | 03                      | SFP                                  |
| 1            | Ext. Identifier   | 04                      | SFP function is defined by serial ID |
| 2            | Connector         | 07                      | LC                                   |
| 3-10         | Transceiver       | 00 10 04 00 00 00 00 00 | 100BASE-BX-U                         |
| 11           | Encoding          | 03                      | NRZ                                  |
| 12           | BR, Nominal       | 02                      | 155Mb/s                              |
| 13           | Reserved          | 00                      |                                      |
| 14           | Length (9µm) km   | 28                      | 40km                                 |
| 15           | Length (9µm) 100m | FF                      | 40000m                               |
| 16           | Length (50µm) 10m | 00                      |                                      |
| 17           | Length(62.5µm)10m | 00                      |                                      |
| 18           | Length (Copper)   | 00                      |                                      |

|        |                  |   |   |
|--------|------------------|---|---|
| 19     | Reserved         | 00  |   |
| 20-35  | Vendor name      | 4C 49 4E 4B 54<br>45 4C 20 20 20<br>20 2020 20 20 20  | “LINKTEL”(ASCII)  |
| 36     | Reserved         | 00  |   |
| 37-39  | Vendor OUI       | 00 00 00  |   |
| 40-55  | Vendor PN        | 4C 58 32 30 32 32<br>xx 44 52 20 20 20 20<br>20 20 20 | “LX2022xDR ” (ASCII)  |
| 56-59  | Vendor rev       | 31 2E 30 20   | Rev 1.0 ( ASCII)  |
| 60-61  | Wavelength       | 05 1E   | 1310nm  |
| 62     | Reserved         | 00  |   |
| 63     | CC BASE          | xx  | Check sum of bytes 0 - 62   |
| 64-65  | Options          | 00 1A   | LOS, TX_FAULT and TX_DISABLE  |
| 66     | BR, max          | 00  |   |
| 67     | BR, min          | 00  |   |
| 68-83  | Vendor SN        | xx xx xx xx xx xx xx<br>xx xx xx xx xx xx xx<br>xx xx | ASCII   |
| 84-91  | Vendor date code | xx xx xx xx xx xx 20<br>20                            | Year (2 bytes), Month (2 bytes), Day (2 bytes)                                      |
| 92     | Diagnostic type  | 68  | Diagnostics (Internally Cal)  |
| 93     | Enhanced option  | B0  | Diagnostics(Optional Alarm/warning flags, Soft TX_FAULT and Soft TX_LOS monitoring) |
| 94     | SFF-8472         | 02  | Diagnostics(SFF-8472 Rev 9.5)   |
| 95     | CC_EXT           | xx  | Check sum for bytes 64-94   |
| 96-255 |                  | 00  |   |

**Note:** The “xx” byte should be filled in according to practical case. For more information, please refer to the related document of SFF-8472 Rev 9.5.

## Diagnostic Monitor Specifications

The digital diagnostic monitoring interface also defines another 256-byte memory map in EEPROM, which makes use of the 8 bit address 1010001X (A2h). Please see Figure 2. For detail EEPROM information, please refer to the related document of SFF-8472 Rev 9.5. The monitoring specification of this product is described in Table 10.

**Table 10. Diagnostic Monitor Specifications**

|              | Parameter | Range        | Accuracy | Calibration |
|--------------|-----------|--------------|----------|-------------|
| Temperature  | LX2022CDR | -15 to +80°C | ±3°C     | Internal    |
|              | LX2022EDR | -15 to +95°C | ±3°C     | Internal    |
|              | LX2022IDR | -40 to +95°C | ±3°C     | Internal    |
| Voltage      |           | 3.0 to 3.6V  | ±3%      | Internal    |
| Bias Current |           | 0 to 80mA    | ±10%     | Internal    |

|          |              |      |          |
|----------|--------------|------|----------|
| TX Power | -6 to +1dBm  | ±3dB | Internal |
| RX Power | -32 to -7dBm | ±3dB | Internal |

## Required Host Board Components

The MSA power supply noise rejection filter is required on the host PCB to meet data sheet performance. The MSA filter incorporates an inductor which should be rated 400mA DC and 1Ω serial resistance or better. It should not be replaced with a ferrite. The required filter is illustrated in Figure 3. The MSA also specifies that 4.7KΩ to 10KΩ pull-up resistors for TX\_FAULT, LOS, and MOD\_DEF0,1,2 are required on the host PCB. Figure is the suggested transceiver/host interface.

Figure 3 shows the recommended host board power supply circuit.

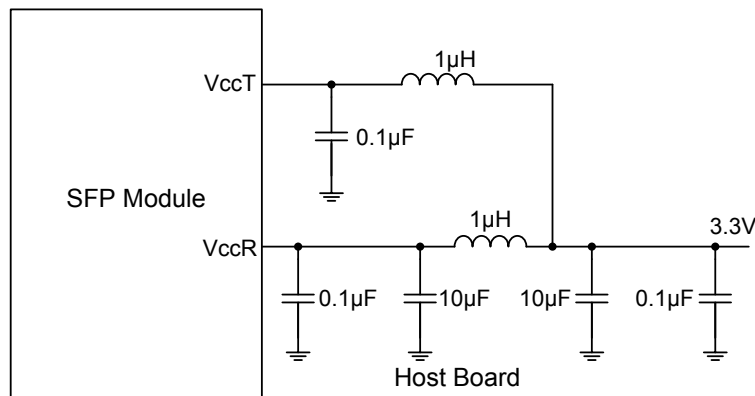


Figure 3. Recommended Host Board Power Supply Circuit



## Recommended Application Interface Circuit

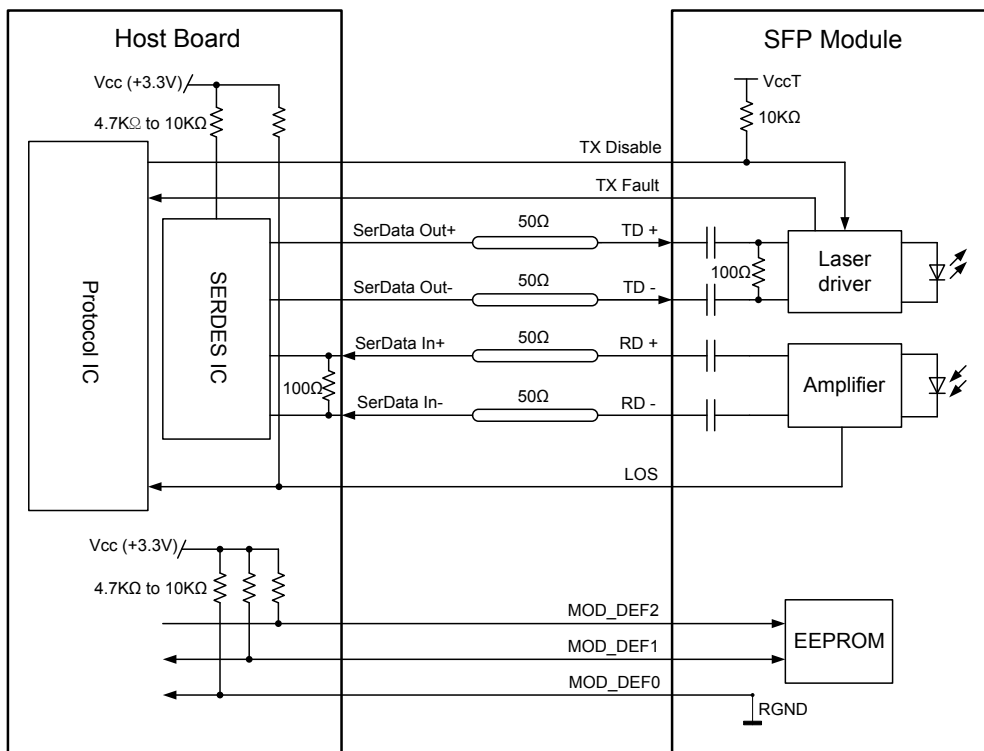


Figure 4. Recommended Application Interface Circuit

## Mechanical specifications

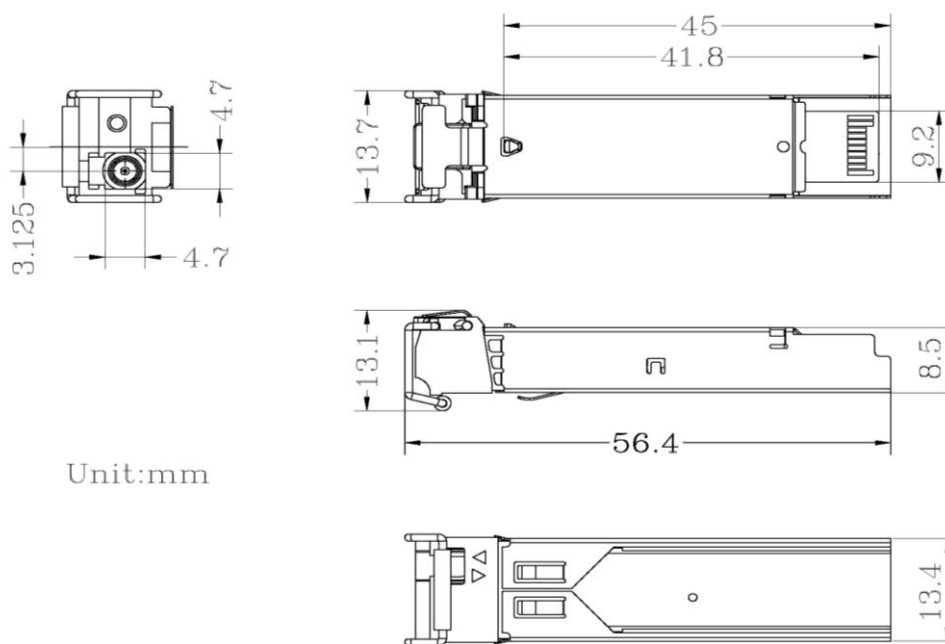


Figure 5. Outline Drawing



## **For More Information**

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