# 100BASE-LX/1000BASE-LX Spring-Latch SFP Transceiver

## (For 10km transmission with MCU version)

**Members of Flexon™ Family**

## Features

- Build-in PHY supporting SGMII Interface
- Build-in high performance MCU supporting easier configuration
- Support more link status monitor, such as CRC, package counter and Far End Fault Indication (FEFI)
- Dual data-rate of 100BASE-LX/1000BASE-LX operation
- 1310nm FP laser and PIN photo-detector
- 0.5m~10km transmission with SMF
- Standard serial ID information Compatible with SFP MSA
- SFP MSA package with duplex LC connector
- With Spring-Latch for high density application
- Very low EMI and excellent ESD protection
- +3.3V single power supply
- Operating case temperature: -40 to +85°C

## Applications

- Switch to Switch interface
- Switched backplane applications
- Router/Server interface
- Other optical transmission systems

## Standard

- Compatible with SFP MSA
- Compatible with IEEE 802.3-2002
- Compatible with IEEE 802.3ah-2004
- Compatible with FCC 47 CFR Part 15, Class B
- Compatible with FDA 21 CFR 1040.10 and 1040.11, Class I
- Compatible with Telcordia GR-468-CORE
- RoHS compliance

## Description

Fiberxon FTM-3413C-SLiCG SFP transceiver is high performance, cost effective module. It is designed for Gigabit Ethernet for 100BASE-LX/1000BASE-LX applications from 0.5m to 10km with SMF.

The transceiver consists of two sections: The standard SFP part and the PHY part. FTM-3413C-SLiCG is built with SGMII interface. It can operate as 100BASE-LX or 1000BASE-LX by software configuration or rate select hardware pin. independently

The optical output can be disabled by a TTL logic high-level input of Tx Disable, and the system also can disable the module via I2C. Tx Fault is provided to indicate that degradation of the laser. Loss of signal (LOS) output is provided to indicate the loss of an input optical signal of receiver or the link status with partner. The system can also get the LOS(or Link)/Disable/Fault information via I2C register access.

The standard serial ID information Compatible with SFP MSA describes the transceiver's capabilities, standard interfaces, manufacturer and other information. The host equipment can access this information via the 2-wire serial CMOS EEPROM protocol. For further information, please refer to SFP Multi-Source Agreement (MSA).

Building-in high performance MCU in this module, Host can more easily configure all functions of FTM-3413C-SLiCG.

## Regulatory Compliance

The transceivers have been tested according to American and European product safety and electromagnetic compatibility regulations (See Table 1). For further information regarding regulatory certification, please refer to Flexon™ regulatory specification and safety guidelines, or contact with Fiberxon, Inc. America sales office listed at the end of the documentation.

**Table 1 - Regulatory Compliance**

| Feature | Standard | Performance |
|---|---|---|
| Electrostatic Discharge (ESD) to the Electrical Pins | MIL-STD-883E Method 3015.7 | Class 1(>500 V) |
| Electrostatic Discharge (ESD) to the Duplex LC Receptacle | IEC 61000-4-2<br>GR-1089-CORE | Compatible with standards |
| Electromagnetic Interference (EMI) | FCC Part 15 Class B<br>EN55022 Class B (CISPR 22B)<br>VCCI Class B | Compatible with standards |
| Immunity | IEC 61000-4-3 | Compatible with standards |
| Laser Eye Safety | FDA 21CFR 1040.10 and 1040.11<br>EN60950, EN (IEC) 60825-1,2 | Compatible with Class I laser product.<br>TUV Certificate No. 50030043 |
| Component Recognition | UL and CSA | UL file E223705 |

## Absolute Maximum Ratings

Stress in excess of the maximum absolute ratings can cause permanent damage to the module.

**Table 2 - Absolute Maximum Ratings**

| Parameter | Symbol | Min. | Max. | Unit |
|---|---|---|---|---|
| Storage Temperature | $T_S$ | -40 | +85 | °C |
| Supply Voltage | $V_{CC}$ | -0.5 | 3.6 | V |
| Operating Relative Humidity | - | 5 | 95 | % |

## Recommended Operating Conditions

**Table 3- Recommended Operating Conditions**

| Parameter | | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|---|
| Operating Case Temperature | | $T_C$ | -40 | | +85 | °C | |
| Power Supply Voltage | | $V_{CC}$ | 3.10 | 3.30 | 3.50 | V | |
| Power Supply Current | | $I_{CC}$ | | | 350 | mA | 1 |
| Date Rate | 1000BASE-LX | | | 1250 | | Mbps | |
| | 100BASE-LX | | | 125 | | | |

Note 1: TBD.

## Optical and Electrical Characteristics

**Table 4 - Optical and Electrical Characteristics**

| Parameter | | Symbol | Min. | Typical | Max. | Unit | Notes |
|---|---|---|---|---|---|---|---|
| **Transmitter** | | | | | | | |
| Centre Wavelength | | $\lambda_C$ | 1270 | 1310 | 1355 | nm | |
| Average Output Power | 1000BASE-LX | $P_{0ut}$ | -9.5 | | -3 | dBm | 2 |
| | 100BASE-LX | $P_{0ut}$ | -15 | | -8 | | 2 |
| $P_{0ut}$@TX Disable Asserted | | $P_{0ut}$ | | | -45 | dBm | 2 |
| Spectral Width (RMS) | 1000BASE-LX | $\sigma$ | | | 4 | nm | |
| | 100BASE-LX | | | | 7.7 | | |
| Extinction Ratio | | EX | 9 | | | dB | |
| Rise/Fall Time (20%～80%) | 1000BASE-LX | $t_r/t_f$ | | | 0.26 | ns | 3 |
| | 100BASE-LX | | | | 3 | | |
| Total Jitter at TP2 | 1000BASE-LX | $J_T$ | | | 0.481 | UI | 4 |
| | 100BASE-LX | | | | 0.4 | | |
| Deterministic Jitter at TP2 | 1000BASE-LX | $J_D$ | | | 0.250 | UI | 4 |
| | 100BASE-LX | | | | 0.305 | | |
| Output Optical Eye | | Compatible with IEEE 802.3ah-2004 | | | | | 5 |
| Data Input Swing Differential (SGMII Series interface) | | $V_{IN}$ | 200 | | 2100 | mV | 6 |
| Input Differential Impedance | | $Z_{IN}$ | 80 | 100 | 120 | Ω | |
| TX Disable | Disable | | 2.0 | | Vcc | V | |
| | Enable | | Vee | | Vee+0.8 | | |
| TX Fault | Fault | | 2.0 | | Vcc | V | |
| | Normal | | Vee | | Vee+0.5 | | |
| **Receiver** | | | | | | | |
| Centre Wavelength | | $\lambda_C$ | 1260 | 1310 | 1570 | nm | |
| Receiver Sensitivity | 1000BASE-LX | | | | -22 | dBm | 7 |
| | 100BASE-LX | | | | -28 | | 8 |
| Receiver Overload | 1000BASE-LX | | -3 | | | dBm | 7 |
| | 100BASE-LX | | -8 | | | | 8 |
| Return Loss | | | 12 | | | dB | |
| LOS De-Assert | 1000BASE-LX | $LOS_D$ | | | -23 | dBm | |
| | 100BASE-LX | | | | -29 | | |
| LOS Assert | 1000BASE-LX | $LOS_A$ | -35 | | | dBm | |
| | 100BASE-LX | | -45 | | | | |
| LOS Hysteresis | | | 0.5 | | 4.5 | dB | |
| Total Jitter at TP4 | 1000BASE-LX | $J_T$ | | | 0.749 | UI | 4 |
| | 100BASE-LX | | | | 0.51 | | |
| Deterministic Jitter at TP4 | 1000BASE-LX | $J_D$ | | | 0.462 | UI | 4 |
| | 100BASE-LX | | | | 0.305 | | |
| Data Output Swing Differential (SGMII Series Interface) | | $V_{OUT}$ | 370 | | 2000 | mV | 6 |
| LOS | High | | 2.0 | | Vcc+0.3 | V | |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | Low | | Vee | | Vee+0.5 | | |

Notes:

2. The optical power is launched into SMF 9/125um.
3. Unfiltered, measured with 8B/10B code for 1.25Gbps and 4B/5B code for 125Mbps
4. Meet the specified maximum output jitter requirements if the specified maximum input jitter is present.
5. Measured with 8B/10B code for 1.25Gbps and 4B/5B code for 125Mbps.
6. PECL logic, internally AC coupled.
7. Measured with 8B/10B code for 1.25Gbps, worst-case extinction ratio, BER $\leqslant 1\times10^{-12}$.
8. Measured with 4B/5B code for 125Mbps, worst-case extinction ratio, BER $\leqslant 1\times10^{-10}$.

## EEPROM Information

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). For the memory contents, please refer to Table 5.

**Table 5 - EEPROM Serial ID Memory Contents (A0h)**

| Addr. | Field Size (Bytes) | Name of Field | Hex | Description |
|---|---|---|---|---|
| 0 | 1 | Identifier | 03 | SFP |
| 1 | 1 | Ext. Identifier | 04 | MOD4 |
| 2 | 1 | Connector | 07 | LC |
| 3—10 | 8 | Transceiver | 00 00 00 12 00 00 00 00 | Transmitter Code |
| 11 | 1 | Encoding | 01 | 8B10B |
| 12 | 1 | BR, nominal | 0D | 1.25Gbps |
| 13 | 1 | Reserved | 00 | |
| 14 | 1 | Length (9um)-km | 0A | 10km |
| 15 | 1 | Length (9um) | 64 | |
| 16 | 1 | Length (50um) | 00 | |
| 17 | 1 | Length (62.5um) | 00 | |
| 18 | 1 | Length (copper) | 00 | |
| 19 | 1 | Reserved | 00 | |
| 20—35 | 16 | Vendor name | 46 49 42 45 52 58 4F 4E 20 49 4E 43 2E 20 20 20 | "FIBERXON INC. "(ASCⅡ) |
| 36 | 1 | Reserved | 00 | |
| 37—39 | 3 | Vendor OUI | 00 00 00 | |
| 40—55 | 16 | Vendor PN | 46 54 4D 2D 33 34 31 33 43 2D 53 4C 69 43 47 20 | "FTM-3413C-SLiCG" (ASCⅡ) |
| 56—59 | 4 | Vendor rev | xx xx xx xx | ASCⅡ( "31 30 20 20" means 1.0 revision) |
| 60—61 | 2 | Wavelength | 05 1E | 1310nm |
| 62 | 1 | Reserved | 00 | |
| 63 | 1 | CC BASE | xx | Check sum of bytes 0 - 62 |
| 64—65 | 2 | Options | 00 1A | LOS, TX_FAULT and TX_DISABLE |
| 66 | 1 | BR, max | 00 | |
| 67 | 1 | BR, min | 00 | |

| | | | | |
|---|---|---|---|---|
| 68—83 | 16 | Vendor SN | xx xx xx xx xx xx xx xx<br>xx xx xx xx xx xx xx xx | ASC II |
| 84—91 | 8 | Vendor date code | xx xx xx xx xx xx 20 20 | Year(2 bytes), Month(2 bytes), Day (2 bytes) |
| 92—94 | 3 | Reserved | 00 00 00 | |
| 95 | 1 | CC_EXT | xx | Check sum of bytes 64 - 94 |
| 96—154 | 58 | Vendor specific | | |
| 155 | 1 | Reserved | | Read only |
| 156-247 | | Vendor specific | | |
| 248 | 1 | Reserved | | Read only |
| 249 | 1 | Reserved | | Read only |
| 250 | 1 | CFG0 | | Work mode configuration |
| 251 | 1 | CFG1 | | Work mode configuration |
| 252 | 1 | Status | | Module status indication |
| 253 | 1 | Reserved | | Read only |
| 254 | 1 | PSWH | | Password entry |
| 255 | 1 | PSWL | | Password entry |

Note: The “xx” byte should be filled in according to practical case. For more information, please refer to the related document of SFP Multi-Source Agreement (MSA) and application note of FTM-3413C-SLiCG.

## Easier Configuration

Designing-in a high performance MCU in FTM-3413C-SLiCG, host can configure Fiberxon’s SGMII series product easily.

For FTM-3413C-SLiCG, host only need access few registers of A0H via I2C to configure SGMII series module, such as speed-selection, Auto-negotiation, LOS/Link detection, TX disable, FEFI/RFI and CRC counter function support. Host can get inner status via access specific register of FTM-3413C-SLiCG.

The operation data rate can be configured via hardware pin and I2C bus independently.

For more detailed information, please refer to application note of FTM-3413C-SLiCG.

## Recommended Host Board Power Supply Circuit

Figure 1 shows the recommended host board power supply circuit.

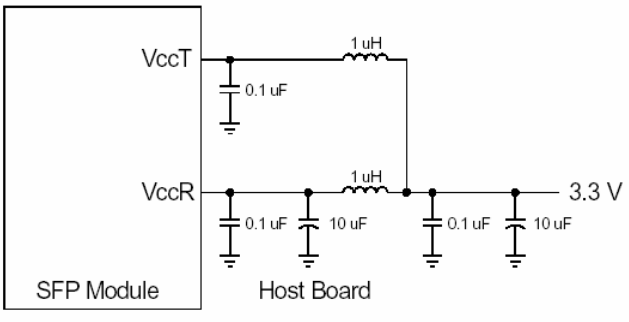



**Figure 1, Recommended Host Board Power Supply Circuit**

## Recommended Interface Circuit

Figure 2 shows the recommended interface circuit.

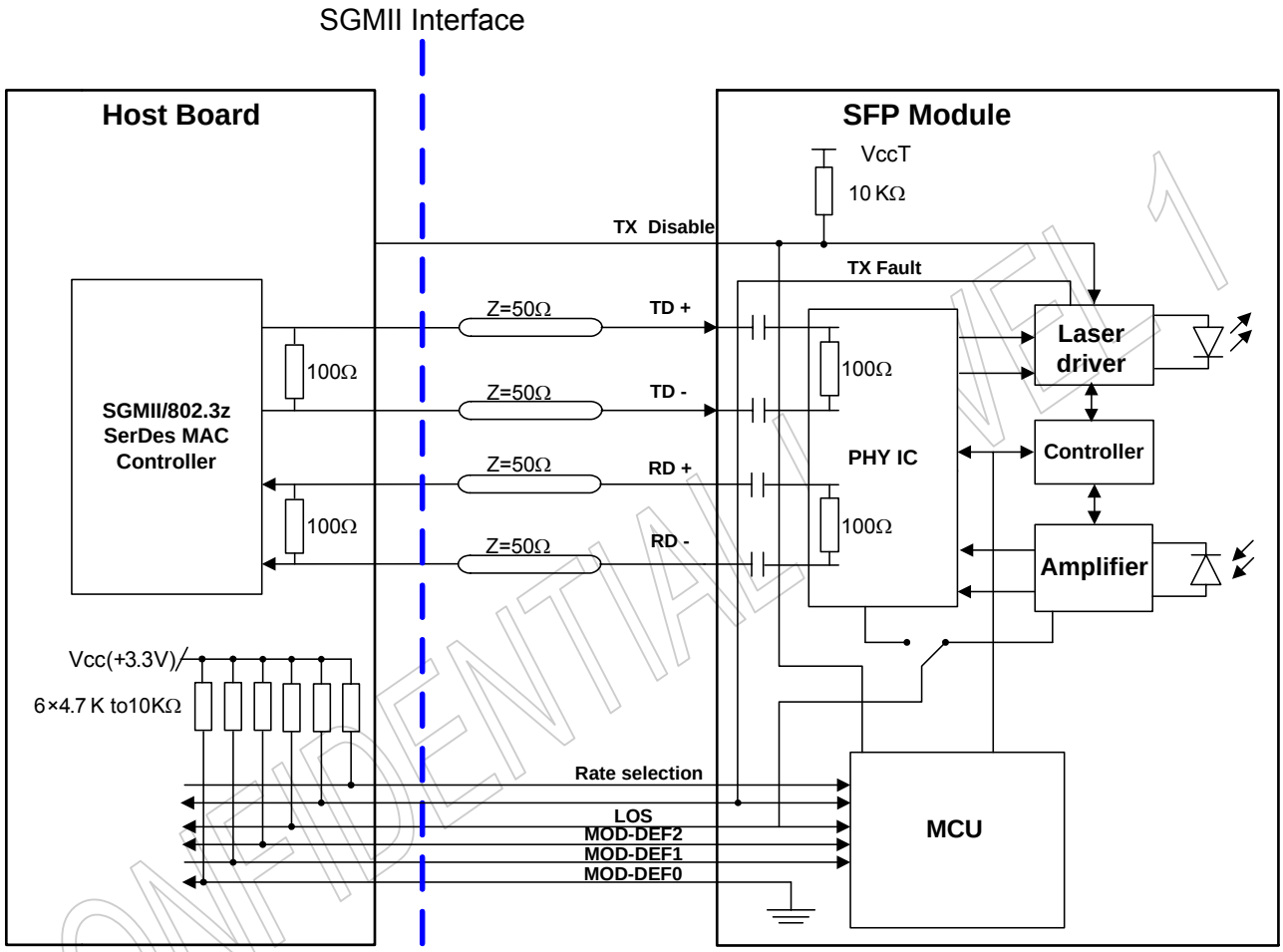



**Figure 2, Recommended Interface Circuit**

## Pin Definitions

Figure 3 below shows the pin numbering of SFP electrical interface. The pin functions are described in Table 6 with some accompanying notes.

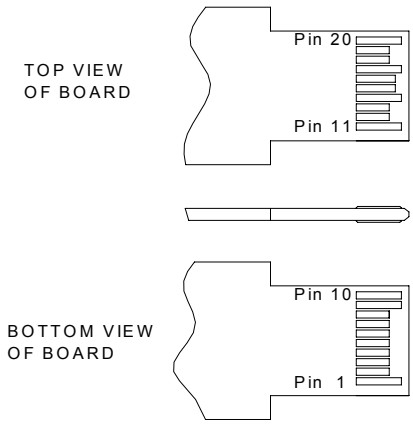



**Figure 3, Pin View**

**Table 6– Pin Function Definitions**

| Pin No. | Name | Function | Plug Seq. | Notes |
|---|---|---|---|---|
| 1 | VeeT | Transmitter Ground | 1 | |
| 2 | TX Fault | Transmitter Fault Indication | 3 | Note 1 |
| 3 | TX Disable | Transmitter Disable | 3 | Note 2 |
| 4 | MOD-DEF2 | Module Definition 2 | 3 | Note 3 |
| 5 | MOD-DEF1 | Module Definition 1 | 3 | Note 3 |
| 6 | MOD-DEF0 | Module Definition 0 | 3 | Note 3 |
| 7 | Rate Select | 100Base-LX/1000Base-LX selection | 3 | Note 7 |
| 8 | LOS | Loss of Signal | 3 | Note 4 |
| 9 | VeeR | Receiver Ground | 1 | |
| 10 | VeeR | Receiver Ground | 1 | |
| 11 | VeeR | Receiver Ground | 1 | |
| 12 | RD- | Inv. Received Data Out | 3 | Note 5 |
| 13 | RD+ | Received Data Out | 3 | Note 5 |
| 14 | VeeR | Receiver Ground | 1 | |
| 15 | VccR | Receiver Power | 2 | |
| 16 | VccT | Transmitter Power | 2 | |
| 17 | VeeT | Transmitter Ground | 1 | |
| 18 | TD+ | Transmit Data In | 3 | Note 6 |
| 19 | TD- | Inv. Transmit Data In | 3 | Note 6 |
| 20 | VeeT | Transmitter Ground | 1 | |

Notes:

1. TX Fault is an open collector output, which should be pulled up with a 4.7k~10kΩ resistor on the host board to a voltage between 2.0V and Vcc+0.3V. Logic 0 indicates normal operation; logic 1 indicates a laser fault of some kind. In the low state, the output will be pulled to less than 0.8V.
2. TX Disable is an input that is used to shut down the transmitter optical output. It is pulled up within the module with a 4.7k~10kΩ resistor. Its states are:
   Low (0~0.8V): Transmitter on
   (>0.8V, <2.0V): Undefined
   High (2.0~3.465V): Transmitter Disabled
   Open: Transmitter Disabled
3. MOD-DEF 0,1,2 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 0 is grounded by the module to indicate that the module is present
   MOD-DEF 1 is the clock line of two wire serial interface for serial ID
   MOD-DEF 2 is the data line of two wire serial interface for serial ID
4. LOS is an open collector output, which should be pulled up with a 4.7k~10kΩ resistor on the host board to a voltage between 2.0V and Vcc+0.3V. Logic 0 indicates normal operation; logic 1 indicates loss of signal. In the low state, the output will be pulled to less than 0.8V.
5. These are the differential receiver output. They are internally AC-coupled 100Ω differential lines which should be terminated with 100Ω (differential) at host with SGMII interface.
6. These are the differential transmitter inputs. They are AC-coupled, differential lines with 100Ω differential

termination inside the module.

7. When hardware rate selection has higher priority than software configuration via I2C, this pin can be used to select bit rate by host hardware.

## SGMII Interface

SGMII uses two data signals and two clock signals to convey frame data and link rate information between a 100/1000 PHY and an Ethernet MAC. The data signals operate at 1.25 Gbaud and the clocks operate at 625 MHz (a DDR interface). Due to the speed of operation, each of these signals is realized as a differential pair thus providing signal integrity while minimizing system noise.

However, specific implementations may desire to recover clock from the data rather than use the supplied clock, such as in our transceiver design. This operation is allowed.

Clearly, SGMII's 1.25 Gbaud transfer rate is excessive for interfaces operating at 100 Mbps. When these situations occur, the interface "elongates" the frame by replicating each frame byte 10 times for 100 Mbps. This frame elongation takes place "above" the 802.3z PCS layer, thus the start frame delimiter only appears once per frame.The 802.3z PCS layer may remove the first byte of the "elongated" frame.

For further information about how to use transceivers with SGMII interface, please refer to the application note of FTM-3413C-SLiCG

## Mechanical Design Diagram

The mechanical design diagram is shown in Figure 4.

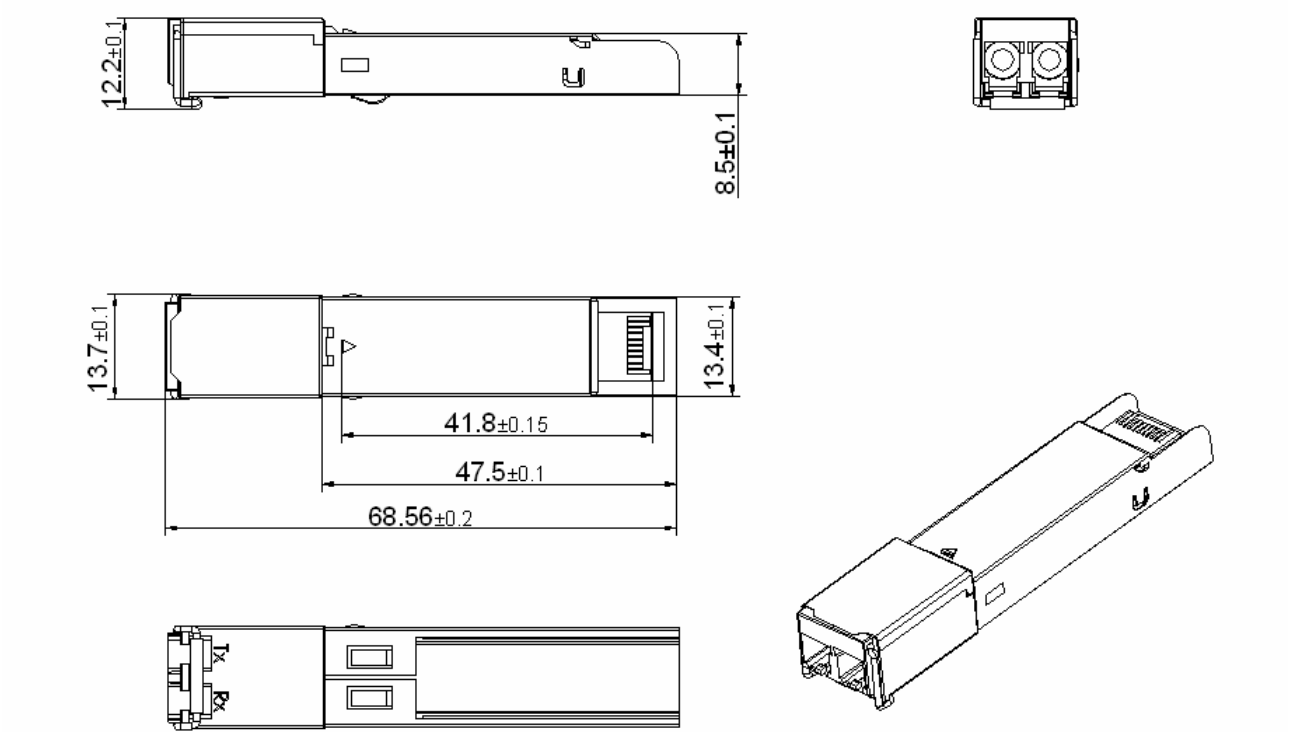
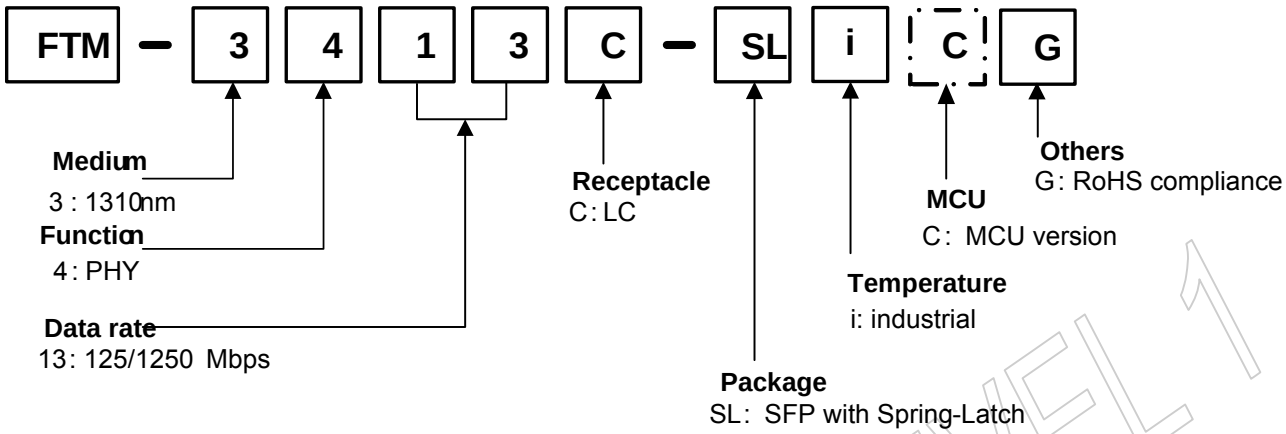



**Figure 4, Mechanical Design Diagram of the SFP with Spring- Latch**

## Ordering information




| Product part Number | Media | Data Rate(Mbps) | Transmission Distance(km) | Note | Temperature |
|---|---|---|---|---|---|
| FTM-3413C-SLiCG | SMF | 125/1250 | 10 | MCU version | -40~+85°C |

## Related SGMII SFP Products

| Product part Number | Media | Data Rate(Mbps) | Transmission Distance | Note | Temperature |
|---|---|---|---|---|---|
| FTM-C012R-LCG | Cat. 5 Copper | 10/100/1000 | 100m | | 0~+70°C |
| FTM-3401C-SL2CG | MMF | 125 | 2km | MCU version | 0~+70°C |
| FTM-3401C-SL10CG | SMF | 125 | 10km | MCU version | 0~+70°C |
| FTM-3413C-SLCG | SMF | 125/1250 | 10km | MCU version | 0~+70°C |
| FTM-3413C-SL05CG | MMF | 125/1250 | 550m | MCU version | 0~+70°C |
| FTM-3401C-SL2iCG | MMF | 125 | 2km | MCU version | -40~+85°C |
| FTM-3401C-SL10iCG | SMF | 125 | 10km | MCU version | -40~+85°C |
| FTM-3413C-SL05iCG | MMF | 125/1250 | 550m | MCU version | -40~+85°C |

## Related Documents

For further information, please refer to the following documents:

- *Fiberxon Spring-Latch SFP Installation Guide*
- *Fiberxon SFP Application Notes*
- *SFP Multi-Source Agreement (MSA)*

## Obtaining Document

You can visit our website:

http://www.fiberxon.com

Or contact with Fiberxon, Inc. America Sales Office listed at the end of documentation to get the latest documents.

## Revision History

| Revision | Initiate | Review | Approve | Subject | Release Date |
|---|---|---|---|---|---|
| Rev. 1a | Henry.Xiao | Tripper.Huang | Walker.Wei | Initial datasheet | Feb. 5, 2007 |
| | | | | | |



**Contact**
U.S.A. Headquarter:
5201 Great America Parkway, Suite 340
Santa Clara, CA 95054
U. S. A.
Tel: 408-562-6288
Fax: 408-562-6289
Or visit our website: http://www.fiberxon.com