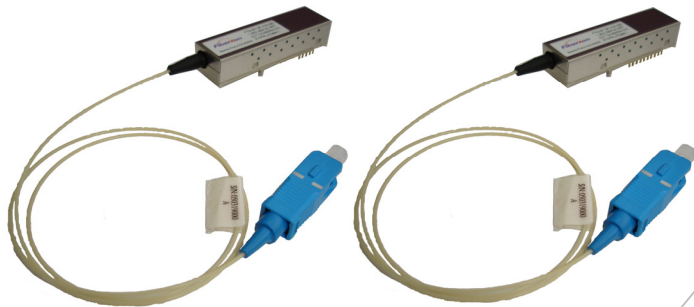


# SFF GE-PON PX10 ONU Transceiver

## FTM-9412P-F10/F10E/F10i/F10U/F10DC

## FTM-9412P-K10/K10E/K10i/K10U/K10DC

(IEEE 802.3ah™-2004 1000BASE-PX10-U)



### Members of Flexon™ Family

#### Standard

- ◆ Compliant with SFF MSA
- ◆ Compliant with IEEE Std 802.3ah™ -2004 1000BASE-PX10-U
- ◆ Compliant with FCC 47 CFR Part 15, Class B
- ◆ Compliant with FDA 21 CFR 1040.10 and 1040.11, Class I

#### Features

- ◆ Single fiber bi-directional data links with symmetric 1.25Gbps upstream and 1.25Gbps downstream
- ◆ Integrated with micro-optics WDM filter for dual wavelength Tx/Rx operation at 1310/1490nm
- ◆ 1310nm burst-mode transmitter with FP laser
- ◆ 1490nm continuous-mode receiver with PIN-TIA and optional 1550nm optical signal rejection
- ◆ Different operating temperature class
  - 0 to 70°C Standard Class
  - 20 to 70°C Extended Class
  - 40 to 85°C Industrial Class
- ◆ 2×5/2×10 SFF package with SC/UPC pigtail
- ◆ Single 3.3V power supply
- ◆ LVPECL compatible data input/output interface
- ◆ LVTTTL transmitter burst-mode control
- ◆ LVTTTL transmitter disable control(2×10 SFF)
- ◆ LVTTTL transmitter laser failure alarm(2×10 SFF)
- ◆ LVTTTL receiver signal-detected indication
- ◆ Low EMI and excellent ESD protection
- ◆ Class I laser safety standard IEC-60825 compliant

#### Applications

- ◆ Gigabit Ethernet Passive Optical Networks (GE-PON) – ONU side
- ◆ Gigabit Ethernet Point-to-Point Bi-directional Transmission
- ◆ Media Converts for Fiber-In-The-Loop (FITL)

#### Description

2×5/2×10 SFF GE-PON PX10 ONU transceiver family is Optical Network Unit (ONU) for IEEE802.3ah™-2004 1000BASE-PX10-U application

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 with optional 1550nm optical signal rejection.

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 1490nm PIN and preamplifier mounted in an optical header and limiting post-amplifier IC.

The optical burst output can be enabled by a LVTTTL logic high-level input of TX\_BRST. Singal Detected (SD) output is provided to indicate the detection of an input optical signal of receiver.

For 2×10 SFF, optical output can be disabled by a LVTTTL logic high-level input of TX\_DIS, and LAS\_nFAIL is provided to indicate that degradation of the laser.

## 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 documentation.

**Table 1 - Regulatory Compliance**

Feature	Standard	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883E Method 3015.7	Class I (>500 V)
Electromagnetic Interference (EMI)	FCC Part 15 Class B EN55022 Class B (CISPR 22B) VCCI Class B	Compliant with standards
Immunity	IEC 61000-4-3	Compliant with standards
Laser Eye Safety	FDA 21CFR 1040.10 and 1040.11 EN60950, EN (IEC) 60825-1,2	Compliant with Class I laser product
Component Recognition	UL and CSA	Compliant with standards

## 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 2 may negatively impact the reliability of the products.

**Table 2 - Absolute Maximum Ratings**

Parameter	Symbol	Min.	Max.	Unit	Note
Storage Ambient Temperature	T <sub>STG</sub>	-40	85	°C	
Operating Ambient Temperature (Note 1)	T <sub>OPR</sub>	0	70	°C	FTM-9412P-F10/F10U/F10DC FTM-9412P-K10/K10U/K10DC
		-20	70		FTM-9412P-F10E/K10E
		-40	85		FTM-9412P-F10i/K10i
Operating Humidity	H <sub>OPR</sub>	5	95	%	
Power Supply Voltage	V <sub>CC</sub>	0	4	V	
Input Voltage		GND	V <sub>CC</sub>	V	
Receiver Damaged Threshold		+2		dBm	
Soldering Temperature			400	°C	2
Bending Radius		30		mm	
Pigtail Fiber Contact Temperature			85	°C	

Note 1: With airflow 1m/sec

Note 2: Only for soldering by iron and 10 seconds on leads only

## Recommended Operating Conditions

**Table 3 - Recommended Operating Conditions**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Power Supply Voltage	$V_{CC}$	3.13	3.3	3.47	V	3.3V±5%
Operating Ambient Temperature (Note 1)	$T_{OPR}$	0		70	°C	FTM-9412P-F10/F10U/F10DC
		-20		70		FTM-9412P-K10/K10U/K10DC
		-40		85		FTM-9412P-F10E/K10E
						FTM-9412P-F10i/K10i
Operating Humidity Range	$H_{OPR}$	5		95	%	
Data Rate			1.25		Gbit/s	
Data Rate Drift		-100		+100	PPM	

Note 1: When ambient temperature is above 60°C, airflow at rate higher than 1m/sec is required

## Optical and Electrical Characteristics

**Table 4 - Transmitter Optical and Electrical Characteristics**

FTM-9412P-F10/F10U/F10DC/K10/K10U/K10DC  $0^{\circ}\text{C} < T_{OPR} < 70^{\circ}\text{C}$  and  $3.13\text{V} < V_{CC} < 3.47\text{V}$

FTM-9412P-F10E/K10E  $-20^{\circ}\text{C} < T_{OPR} < 70^{\circ}\text{C}$  and  $3.13\text{V} < V_{CC} < 3.47\text{V}$

FTM-9412P-F10i/K10i  $-40^{\circ}\text{C} < T_{OPR} < 85^{\circ}\text{C}$  and  $3.13\text{V} < V_{CC} < 3.47\text{V}$

Parameter	Symbol	Min.	Typ.	Max.	Unit	Note
Optical Center Wavelength	$\lambda_C$	1276		1356	nm	
Optical Spectrum Width (RMS)	$\Delta\lambda$			2.8	nm	
Average Launch Power (BOL)	$P_{OUT}$	0		+4	dBm	1
Average Launch Power (EOL)		-1		+4		
Average Launch Power-OFF Transmitter	$P_{OFF}$			-45	dBm	
Extinction Ratio	ER	9			dB	2
Rise/Fall Time (20%-80%)	$T_R/T_F$			260	ps	2.3
Burst Turn On Time	$T_{BURST\_ON}$			30	ns	4
Burst Turn Off Time	$T_{BURST\_OFF}$			30	ns	
Burst Enable Duration	$T_{EN\_DUR}$	600			ns	
Burst Disable Duration	$T_{DIS\_DUR}$	100			ns	
RIN <sub>15</sub> OMA				-113	dB/Hz	
Optical Return Loss Tolerance				15	dB	
Transmitter Reflectance				-6	dB	
Transmitter and Dispersion Penalty	TDP			2.8	dB	5
Optical Eye Diagram	Compliant With IEEE Std 802.3ah™-2004					2,6
Data Input Differential Swing	$V_{IN}$	200		1600	mV	7
Input Differential Impedance	$Z_{IN}$	90	100	110	$\Omega$	
Common-Mode Input Voltage	$V_{CM}$	$V_{CC}-1.49$	$V_{CC}-1.32$	$V_{CC}-V_{IN}/4$	V	8
Power Supply Current	$I_{CC\_TX}$			200	mA	

Transmitter Burst Control Voltage - Low	$V_{BURST, L}$	0		0.8	V	9
Transmitter Burst Control Voltage - High	$V_{BURST, H}$	2.0		$V_{CC}$	V	
Transmitter Disable Voltage - Low	$V_{TDIS, L}$	0		0.8	V	10
Transmitter Disable Voltage - High	$V_{TDIS, H}$	2.0		$V_{CC}$	V	
Laser Failure Alarm Voltage - Low	$V_{LFA, L}$	0		0.8	V	11
Laser Failure Alarm Voltage - High	$V_{LFA, H}$	2.0		$V_{CC}$	V	

Note 1: Launched into 9/125um Single Mode Fiber.

Note 2: Measured with PRBS 2<sup>7</sup>-1 test pattern @1.25 Gbit/s.

Note 3: Measured with the Bessel-Thompson filter OFF.

Note 4: Refer to [Timing Parameter Definition in Burst Mode Sequence](#).

Note 5: Maximum sensitivity penalty due to transmitter and dispersion effect through 10km of SMF optical fiber.

Note 6: Transmitter eye mask definition is {0.22UI, 0.375UI, 0.20UI, 0.20UI, 0.30UI}.

Note 7: Compatible with LVPECL/CML input

(See [Recommended Interface Circuit](#) and [Table 6 - Electrical Input/Output Coupling Mode](#))

Note 8: Only for FTM-9412P-F10DC/K10DC

Note 9: TX\_BRST (See [Pin Function Definitions](#))

Note 10: TX\_DIS, for 2×10 SFF (See [Pin Function Definitions](#))

Note 11: LAS\_nFAIL, for 2×10 SFF (See [Pin Function Definitions](#))

#### Table 5 - Receiver Optical and Electrical Characteristics

FTM-9412P-F10/F10U/F10DC/K10/K10U/K10DC 0°C <T<sub>OPR</sub><70°C and 3.13V<V<sub>CC</sub><3.47V

FTM-9412P-F10E/K10E -20°C <T<sub>OPR</sub><70°C and 3.13V<V<sub>CC</sub><3.47V

FTM-9412P-F10i/K10i -40°C <T<sub>OPR</sub><85°C and 3.13V<V<sub>CC</sub><3.47V

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Wavelength		1480	1490	1500	nm	Except for F10U/K10U
		1480	1490	1600		For F10U/K10U
Sensitivity	P <sub>SEN</sub>			-26.5	dBm	1
Saturation	P <sub>SAT</sub>	-3			dBm	
Signal-Detected Assert Level	P <sub>SDA</sub>			-27	dBm	2
Signal-Detected Deassert Level	P <sub>SDD</sub>	-39			dBm	3
Signal-Detected Hysteresis	P <sub>SDA</sub> - P <sub>SDD</sub>	0.5		6	dBm	
Receiver Reflectance				-12	dB	
WDM Filter Isolation	ISO(1550)	38			dB	1550nm (Except for F10U/K10U)
	ISO(1650)	35			dB	1650nm (Except for F10U/K10U)
Power Supply Current	I <sub>CC_RX</sub>			120	mA	
Data Output Differential Swing	V <sub>OUT</sub>	400		1600	mV	4
Signal-Detected Voltage - Low	V <sub>SD, L</sub>	0		0.8	V	5
Signal-Detected Voltage - High	V <sub>SD, H</sub>	2.0		$V_{CC}$	V	
Signal-Detected Assert Time	T <sub>ASS</sub>			100	μs	
Signal-Detected Deassert Time	T <sub>DAS</sub>			100	μs	

Note 1: Measured with a PRBS 2<sup>7</sup>-1 test pattern @1.25Gbit/s and ER=9dB, BER = 10<sup>-12</sup>.

Note 2: An increase in optical power above the specified level will cause the Signal Detect output to switch from a low state to a high state.

Note 3: A decrease in optical power below the specified level will cause the Signal Detect output to switch from a high state to a low state.

Note 4: LVPECL output, AC coupled internally, guaranteed in the full range of input optical power (-3dBm to -27dBm)(See [Recommended Interface Circuit](#))

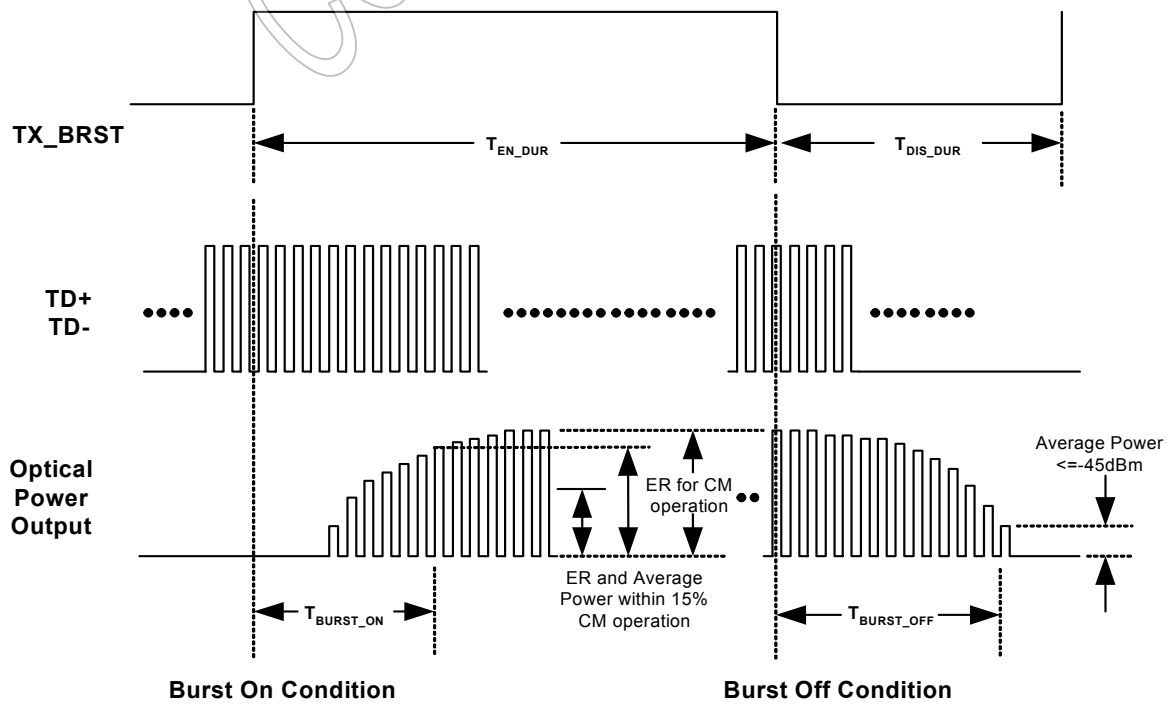
Note 5: SD (See [Pin Function Definitions](#))

**Table 6 - Electrical Input/Output Coupling Mode**

P/N	Input(TD+/TD-)	Output(RD+/RD-)
FTM-9412P-F10/F10E/F10i/F10U	Internal AC Coupling	Internal AC Coupling
FTM-9412P-K10/K10E/K10i/K10U	Internal AC Coupling	Internal AC Coupling
FTM-9412P-F10DC/K10DC	Internal DC Coupling	Internal AC Coupling

**Table 7- 1550nm Optical Signal Rejection Mode**

P/N	TX	RX
FTM-9412P-F10/F10E/F10i/F10DC	1310-window	1490-window
FTM-9412P-K10/K10E/K10i/K10DC	1310-window	1490-window
FTM-9412P-F10U/K10U	1310-window	1490/1550-window



**Figure 1 Timing Parameter Definition in Burst Mode Sequence**

### Recommended Interface Circuit

Figure 2 shows the recommended interface scheme for FTM-9412P-F10/F10E/F10i/F10U

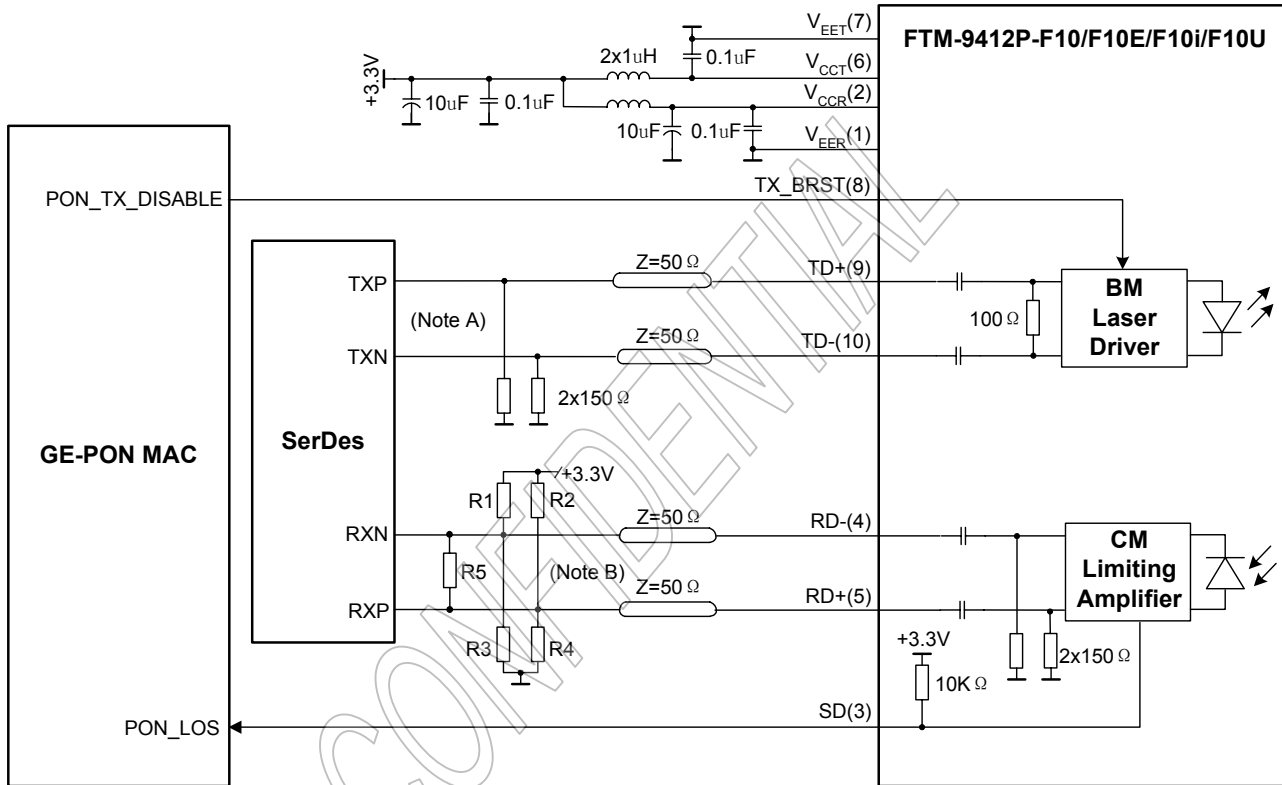


Figure 2 Recommended Interface Circuit (FTM-9412P-F10/F10E/F10i/F10U)

Note A: Open emitter output internally.

Note B: LVPECL output, AC coupled internally.

Input stage in SerDes IC is assumed with high impedance and internal bias to Vcc-1.3V

R1=R2=R3=R4=N.C, R5=100  $\Omega$

Input stage in SerDes IC is assumed without internal bias to Vcc-1.3V

R1=R2=82  $\Omega$  ,R3=R4=130  $\Omega$  ,R5=N.C

Figure 3 shows the recommended interface scheme for FTM-9412P-F10DC

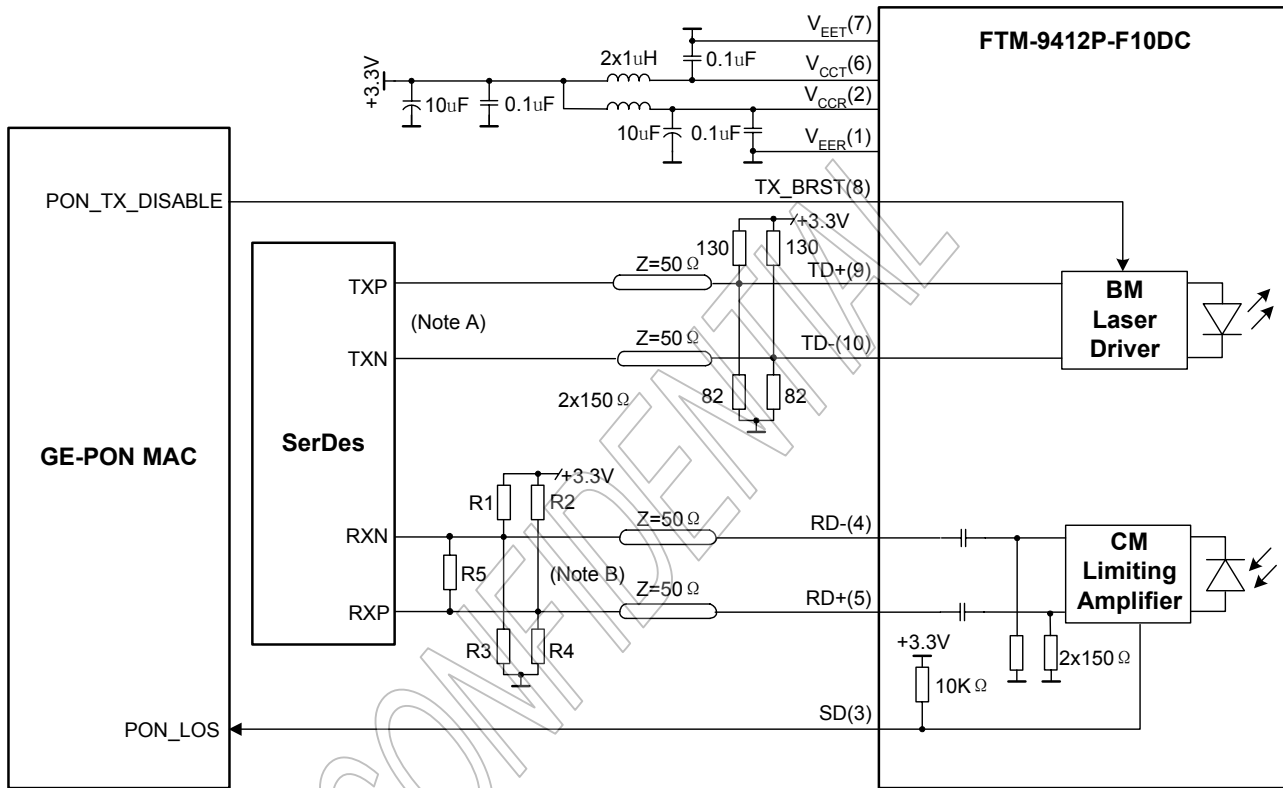


Figure 2 Recommended Interface Circuit (FTM-9412P-F10DC)

Note A: Open emitter output internally.

Note B: LVPECL output, AC coupled internally.

Input stage in SerDes IC is assumed with high impedance and internal bias to Vcc-1.3V

R1=R2=R3=R4=N.C, R5=100 Ω

Input stage in SerDes IC is assumed without internal bias to Vcc-1.3V

R1=R2=82 Ω ,R3=R4=130 Ω ,R5=N.C

Figure 4 shows the recommended interface scheme for FTM-9412P-K10/K10E/K10i/K10U

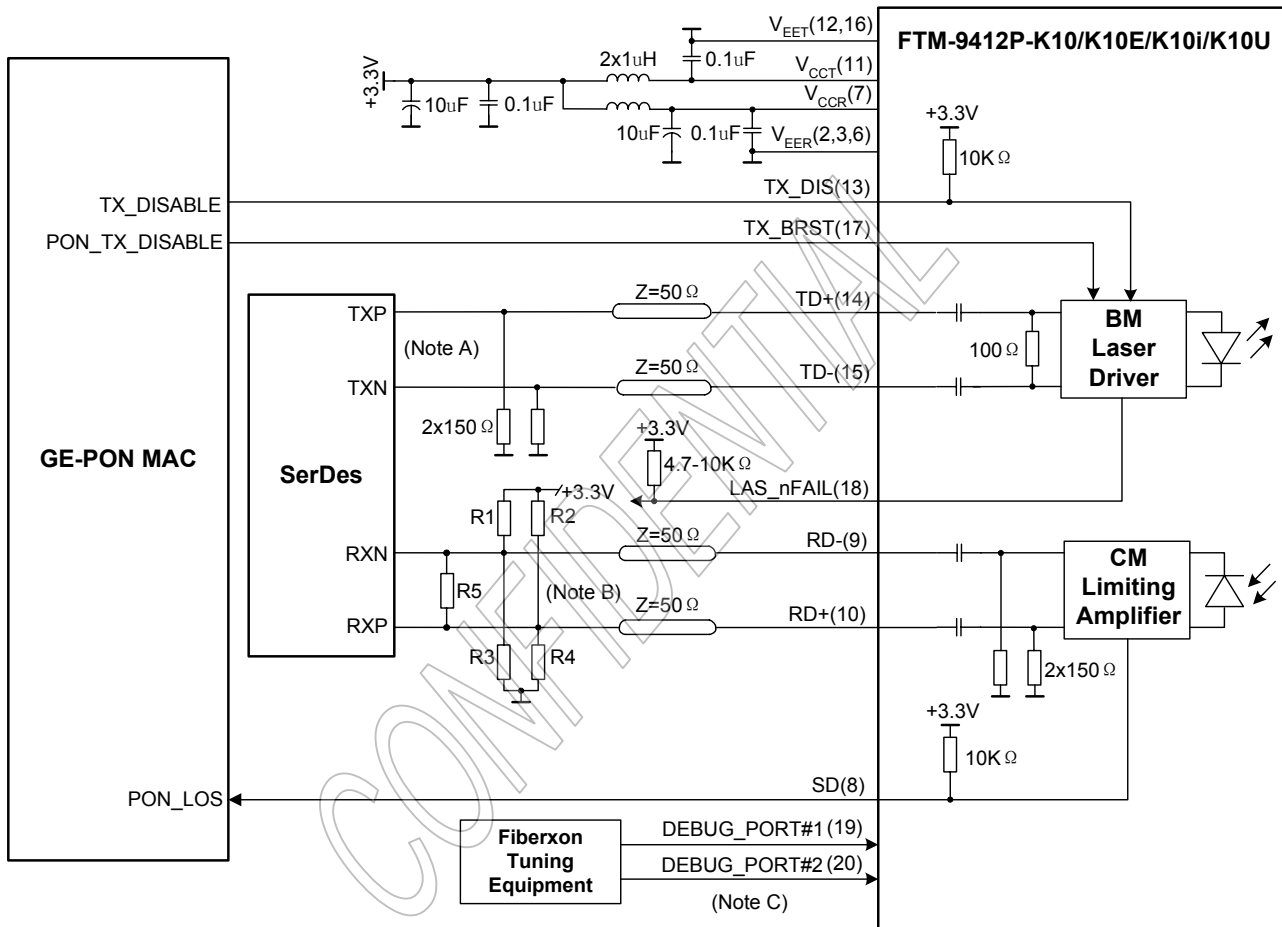


Figure 4 Recommended Interface Circuit (FTM-9412P-K10/K10E/K10i/K10U)

Note A: Open emitter output internally.

Note B: LVPECL output, AC coupled internally.

Input stage in SerDes IC is assumed with high impedance and internal bias to Vcc-1.3V

R1=R2=R3=R4=N.C, R5=100 Ω

Input stage in SerDes IC is assumed without internal bias to Vcc-1.3V

R1=R2=82 Ω ,R3=R4=130 Ω ,R5=N.C

Note C: Fiberxon reserve the two-wire debug port for module tuning.

**(DO NOT connect these pins to any circuit on host board)**



Figure 5 shows the recommended interface scheme for FTM-9412P-K10DC

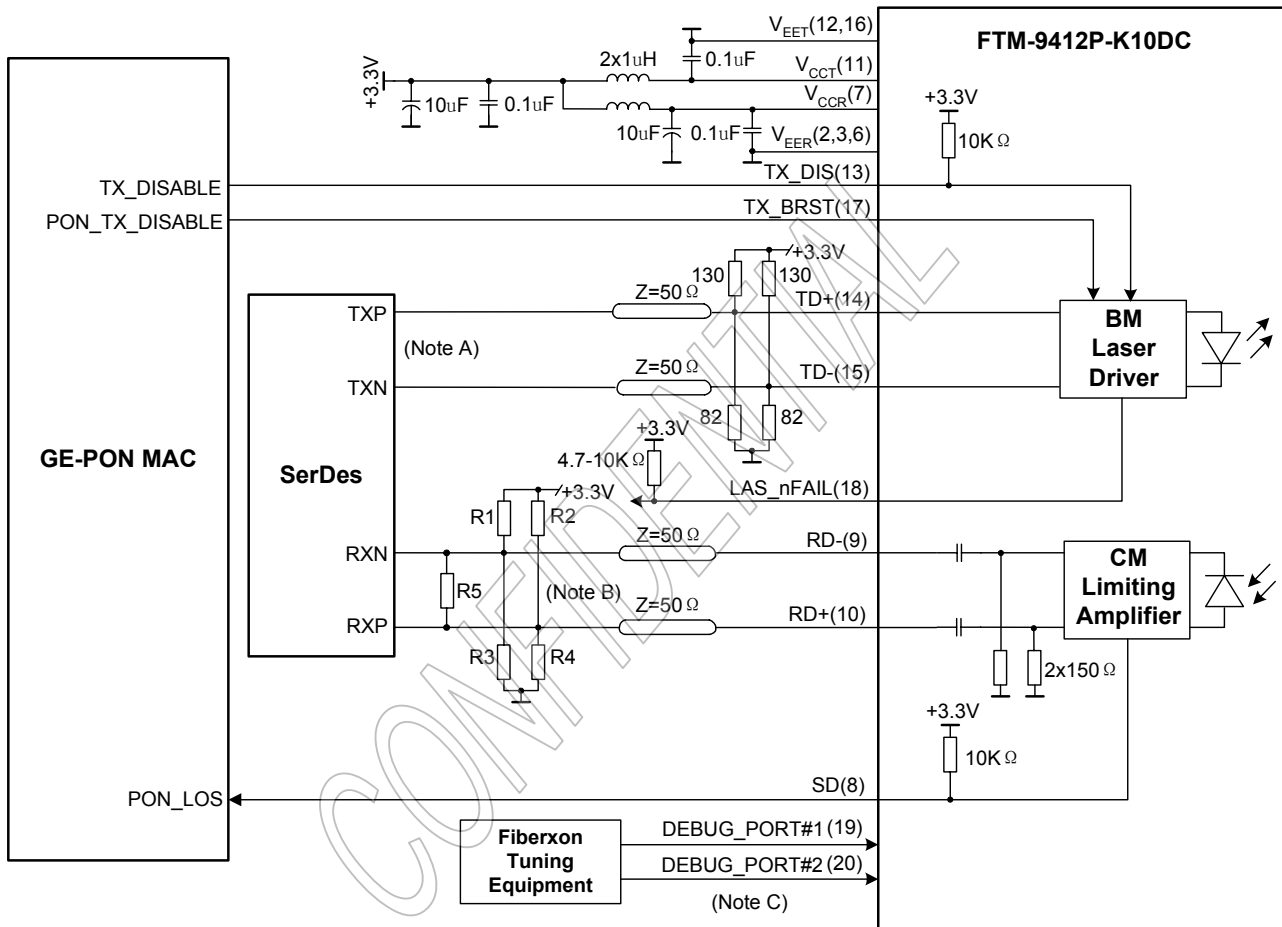


Figure 5 Recommended Interface Circuit (FTM-9412P-K10DC)

Note A: Open emitter output internally.

Note B: LVPECL output, AC coupled internally.

Input stage in SerDes IC is assumed with high impedance and internal bias to Vcc-1.3V

R1=R2=R3=R4=N.C, R5=100 Ω

Input stage in SerDes IC is assumed without internal bias to Vcc-1.3V

R1=R2=82 Ω ,R3=R4=130 Ω ,R5=N.C

Note C: Fiberxon reserve the two-wire debug port for module tuning.

**(DO NOT connect these pins to any circuit on host board)**

### Pin Definitions

2×5/2×10 SFF planform in Figure 6 below shows the pin information of electrical interface and mounting studs. Functions are described in Table 8 and Table 9 with some accompanying notes.

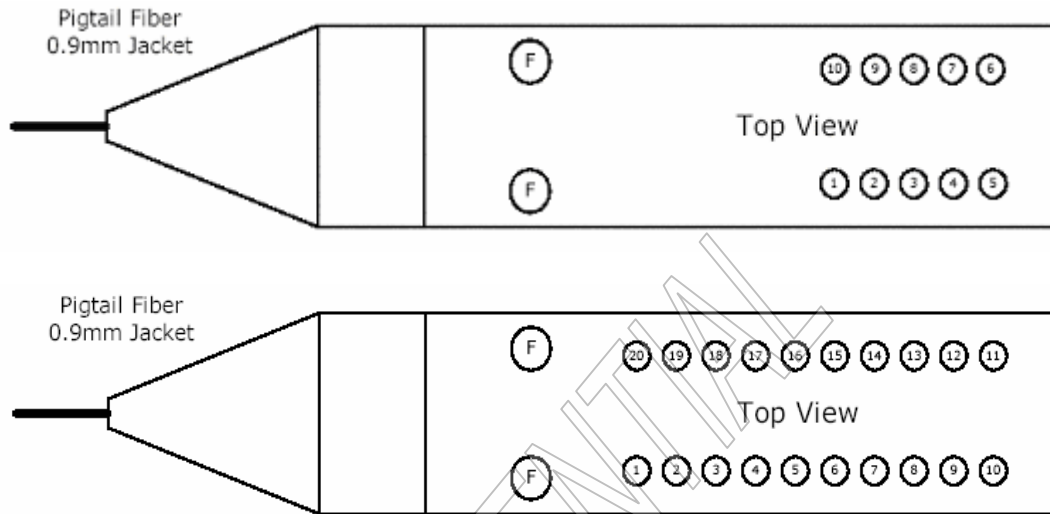


Figure 6 2×5/2×10 SFF Platform

Table 8 - Pin Function Definitions (2×5 SFF)

Pin No.	Name	Description	Notes
1	V <sub>EER</sub>	Receiver Signal Ground	
2	V <sub>CCR</sub>	Receiver Power Supply	
3	SD	Receiver Signal-Detected Indication	1
4	RD-	Inverted Receiver Data Output	2
5	RD+	Non-inverted Receiver Data Output	
6	V <sub>CCT</sub>	Transmitter Power Supply	
7	V <sub>EET</sub>	Transmitter Signal Ground	
8	TX_BRST	Transmitter Burst Control	3
9	TD+	Transmitter Non-inverted Data Input	4
10	TD-	Transmitter Inverted Data Input	
F	MS	Mounting Studs	5

Table 9 - Pin Function Definitions (2×10 SFF)

Pin No.	Name	Description	Notes
1	NC	No Function Definition	Not connected
2	V <sub>EER</sub>	Receiver Signal Ground	
3	V <sub>EER</sub>	Receiver Signal Ground	
4	NC	No Function Definition	Not connected
5	NC	No Function Definition	Not connected
6	V <sub>EER</sub>	Receiver Signal Ground	
7	V <sub>CCR</sub>	Receiver Power Supply	
8	SD	Receiver Signal-Detected Indication	1
9	RD-	Inverted Receiver Data Output	2
10	RD+	Non-inverted Receiver Data Output	

11	V <sub>CCT</sub>	Transmitter Power Supply	
12	V <sub>EET</sub>	Transmitter Signal Ground	
13	TX_DIS	Transmitter Disable	6
14	TD+	Transmitter Non-inverted Data Input	4
15	TD-	Transmitter Inverted Data Input	
16	V <sub>EET</sub>	Transmitter Signal Ground	
17	TX_BRST	Transmitter Burst Control	3
18	LAS_nFAIL	Laser Failure Alarm Indication	7
19	DEBUG PORT#1	Reserved For Module Debugging	8
20	DEBUG PORT#2	Reserved For Module Debugging	
F	MS	Mounting Studs	5

Note 1: TTL logic output, with internal 10K $\Omega$  pull-up resistor.

Optical Signal-Detected: High; Optical Signal Loss: Low

Note 2: LVPECL logic output, AC coupled internally. (See [Recommended Interface Circuit](#))

Note 3: A positive level enable optical signal output under burst mode.

(See [Timing Parameter Definition in Burst Mode Sequence](#))

Note 4: Compatible with LVPECL/CML input

(See [Recommended Interface Circuit](#) and [Table 6 - Electrical Input/Output Coupling Mode](#))

Note 5: The mounting studs are provided for transceiver mechanical attachment to circuit board. They may also provide an optional connection of the transceiver to the equipment chassis ground. The holes in the circuit board must be tied to chassis ground. It is not recommended that the mounting studs be connected to signal ground.

Note 6: LVTTTL logic input, with internal 10K $\Omega$  pull-up resistor.

Transmitter Disabled: High; Transmitter Enabled: Low

Note 7: TTL logic output, pulled up by a 4.7-10K $\Omega$  resistor on the host board.

Laser Normal State: High; Laser Failure State: Low

Note 8: Reserved for module tuning and compulsive for system application that any circuit doesn't be connected to them.

## Mechanical Design Diagram

The form factor is 2 $\times$ 5/2 $\times$ 10 SFF with pigtail fiber. The pigtail fiber has a length 520 - 550mm and 30mm minimum bending radius. The fiber connector type is SC/UPC. The mechanical design diagram is shown in Figure 7 and Figure 8. (Dimension in mm)

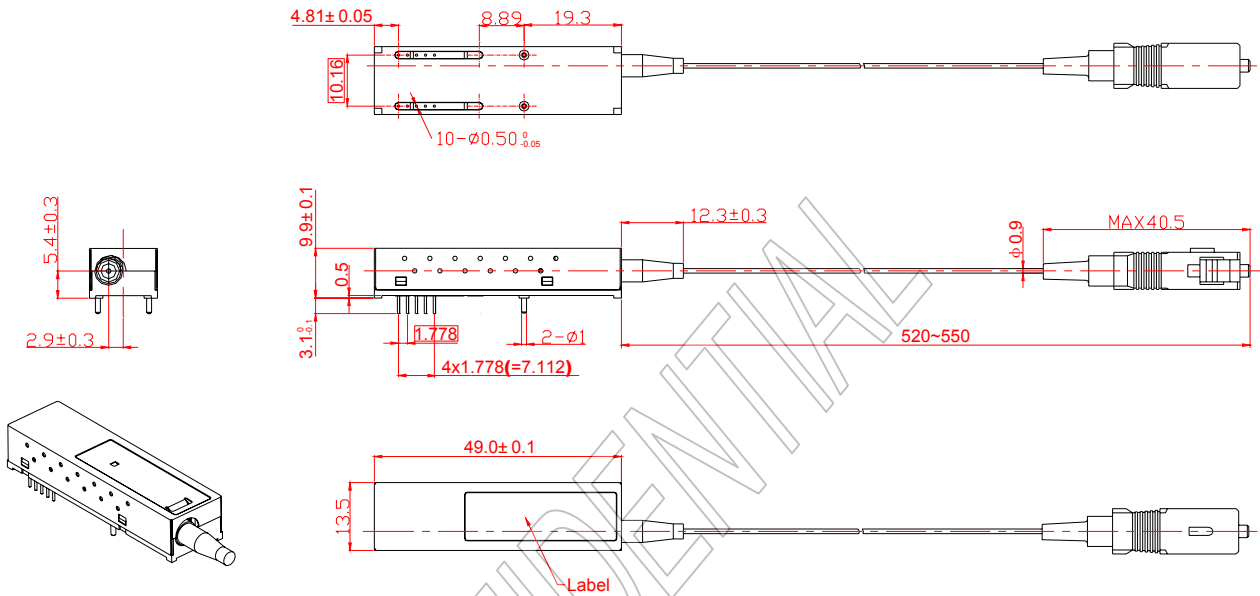


Figure 7 Mechanical Design Diagram (2×5 SFF)

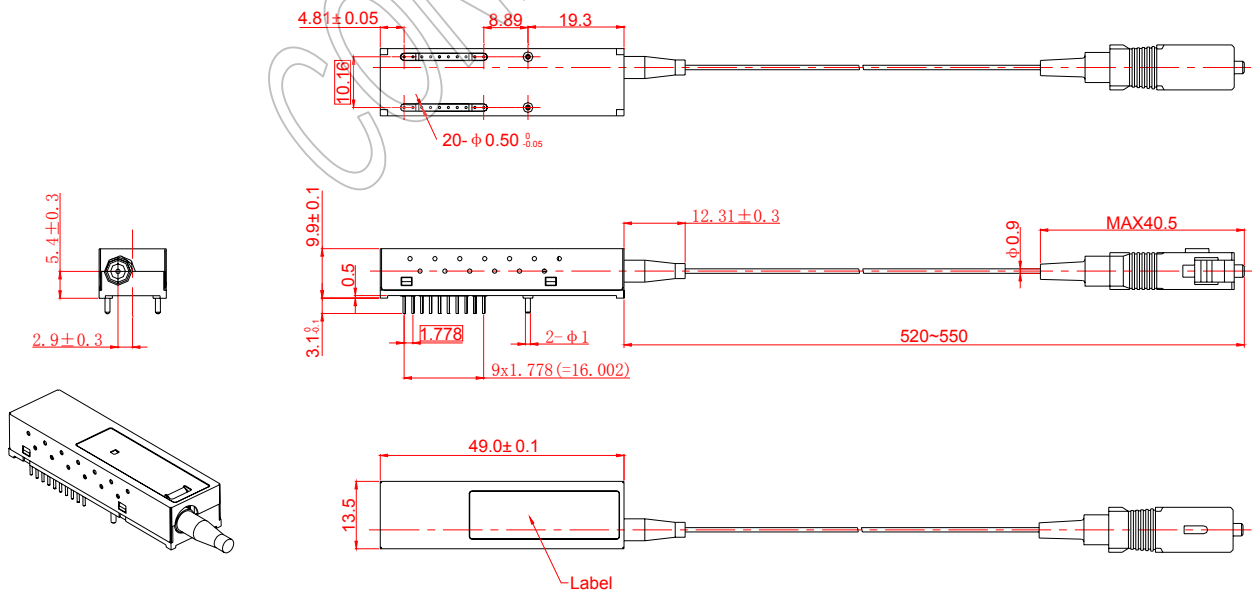
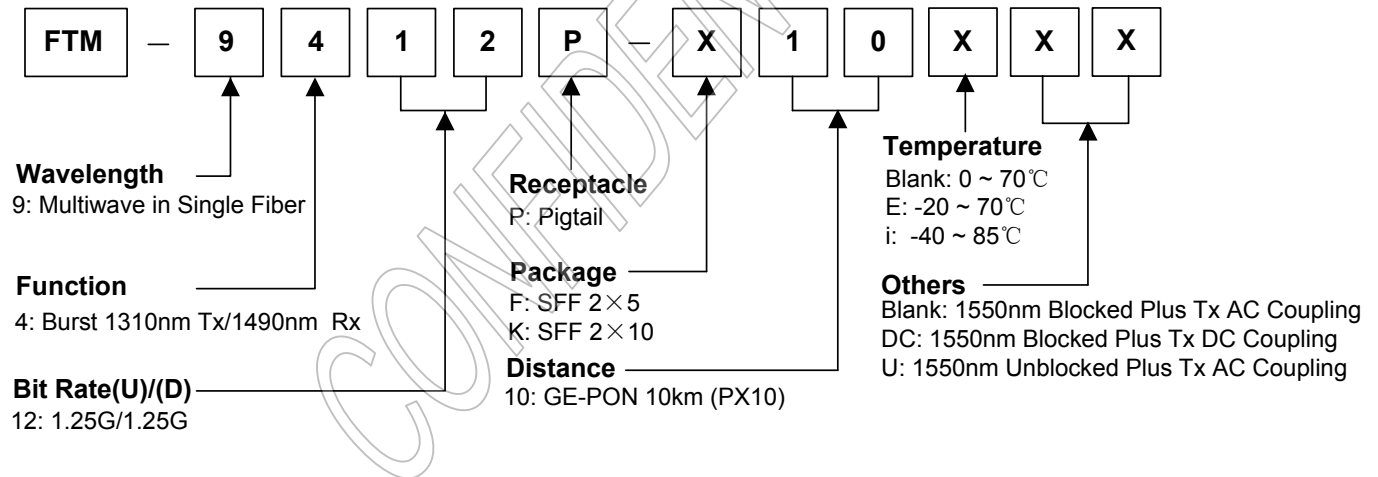


Figure 8 Mechanical Design Diagram (2×10 SFF)

**Table 10 - Pigtail Fibre Characteristics**

Parameter	Min.	Typical	Max.	Unit
Mode Field Diameter		9		µm
Gladding Diameter		125		µm
Jacket Diameter		0.9		mm
Bending Radius of Pigtail Fiber	30			mm
Tension Force on Pigtail Fiber			1	Kg
Pigtail Fiber Length	520		550	mm
Optical Return Loss (UPC type) -1310nm	50			dB

**Ordering Information**



Part No.	Product Description
FTM-9412P-F10	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×5 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, 0°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-F10E	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×5 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, -20°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-F10i	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×5 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, -40°C ~ 85°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-F10U	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×5 SFF for GE-PON ONU 10km application, with 1550nm optical signal unblocked, 0°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-F10DC	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×5 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, 0°C ~ 70°C, Tx DC Coupling, Rx AC Coupling
FTM-9412P-K10	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×10 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, 0°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-K10E	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×10 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, -20°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-K10i	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×10 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, -40°C ~ 85°C, Tx AC Coupling, Rx AC Coupling

FTM-9412P-K10U	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×10 SFF for GE-PON ONU 10km application, with 1550nm optical signal unblocked, 0°C ~ 70°C, Tx AC Coupling, Rx AC Coupling
FTM-9412P-K10DC	1310nm(TX)/1490nm(RX), SC/UPC Pigtailed 2×10 SFF for GE-PON ONU 10km application, with 1550nm optical signal blocked, 0°C ~ 70°C, Tx DC Coupling, Rx AC Coupling

## Related Documents

For further information, please refer to the following documents:

- IEEE Std 802.3ah<sup>TM</sup>-2004.PDF

## 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

Reversion	Initiate	Review	Approve	Subject	Release Date
Pre 1a	Zachary Lu	Johnny Yang	Peter Tang	Initial datasheet (Using External ONU BOSA) Only including FTM-9412P-F10 (Doc No. DS3493000-1a)	Dec.10,2004
Pre 2a	Zachary Lu	Johnny Yang	Peter Tang	Revised datasheet (Using External ONU BOSA) Combine all PX10 ONU TRx into one datasheet 1. Add new P/Ns: FTM-9412P-F10DC, FTM-9412P-F10E, FTM-9412P-F10i, FTM-9412P-K10, FTM-9412P-K10U, 2. Improve Burst Turn On Time and Burst Turn Off Time specification from 64ns(Max.) to 30ns(Max.) in Table 4, Page 3 3. Add WDM Filter Isolation Specification in Table 5, Page 4 (Doc No. DS3493000-2a)	May.10,2005
Pre 3a	Zachary Lu	Johnny Yang	Peter Tang	Revised datasheet (Using Internal ONU BOSA) 1. Add new P/Ns: FTM-9412P-F10U FTM-9412P-K10E, FTM-9412P-K10i, FTM-9412P-K10DC 2. Update Mechanical Design Diagram in Figure 7&8, Page 12 3. Improved Sensitivity Specification from -26.0dBm(Max.) to -26.5dBm(Max.) for FTM-9412P-K10U in Table 5, Page 4 (Doc No. DS3493000-3a)	Aug.9,2005

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