

## SC Receptacle SFP GE-PON OLT Transceiver

### FTM-9712S-SL20(E)(G)

(IEEE 802.3ah™-2004 1000Base-PX20-D)

Members of Flexon™ Family



#### 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 1490/1310nm
- ◆ 1490nm continuous-mode transmitter with DFB laser
- ◆ 1310nm burst-mode receiver with APD-TIA
- ◆ Optical isolator built in for extreme Return Loss tolerance
- ◆ Resetless burst-mode receiver design
- ◆ Support more than 24dB dynamic range
- ◆ 0 to 70°C operating temperature (S-SL20)
- ◆ -40 to 75°C operating temperature (S-SL20E)
- ◆ Spring-latch SFP (Small Form-factor Pluggable) package with SC receptacle optical interface.
- ◆ Detailed product information in EEPROM
- ◆ Digital diagnostic interface compliant with SFF-8472 Rev 9.4
- ◆ Single 3.3V power supply
- ◆ Maximum 1W total power dissipation
- ◆ LVPECL compatible data input/output interface
- ◆ LVTTTL transmitter disable control
- ◆ LVTTTL transmitter laser failure alarm
- ◆ LVTTTL receiver Loss Of Signal(LOS) indication
- ◆ Low EMI and excellent ESD protection
- ◆ Class I laser safety standard IEC-60825 compliant
- ◆ RoHS compliance (S-SL20G and S-SL20EG)

#### Applications

- ◆ Gigabit Ethernet Passive Optical Networks (GE-PON) – OLT side

#### Standard

- ◆ Compliant with IEEE Std 802.3ah™ -2004
- ◆ Compliant with FCC 47 CFR Part 15, Class B
- ◆ Compliant with FDA 21 CFR 1040.10 and 1040.11, Class I
- ◆ Compliant with SFF-8074i Rev 1.0
- ◆ Compliant with SFF-8472 Rev 9.4

#### Description

FTM-9712S-SL20(E)(G) is Optical Line Terminal (OLT) compliant with IEEE 802.3ah™-2004 1000BASE-PX20 application.

The transceiver is the high performance module for 1.25Gbps data link in single fiber by using 1490nm continuous-mode transmitter and 1310nm burst-mode receiver. The transmitter section uses a multiple quantum well 1490nm DFB laser and is Class I laser compliant product according to international safety standard IEC-60825. The receiver section uses an integrated 1310nm APD (Avalanche Photo Diode) and preamplifier mounted in an optical header and limiting post-amplifier IC. Unlike the conventional burst-mode receiver, the receiver does not require reset pulse to receive optical data packets with different optical power.

The optical output can be disabled by LVTTTL logic high-level input of TX Disable. 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.

Enhanced Digital Diagnostic Monitoring Interface (DDMI) compliant with SFF-8472 Rev 9.4 has been incorporated into the transceivers. It allows real time access to the transceiver operating parameters such as transceiver temperature, laser bias current, transmitted optical power, received optical power and transceiver supply voltage by reading a built-in memory with I<sup>2</sup>C interface. For further information, please refer to SFF-8472 Rev 9.4.

## 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 1(>500 V)
Electrostatic Discharge (ESD) to SC Receptacle	IEC 61000-4-2 GR-1089-CORE	Compliant with standards
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
RoHS	2002/95/EC 4.1&4.2	Compliant with standards

## Absolute Maximum Ratings

Absolute Maximum Ratings are those values, beyond which, some damage 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-9712S-SL20(G)
		-40	75		FTM-9712S-SL20E(G)
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		0		dBm	

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

## 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-9712S-SL20(G)
		-40		75		FTM-9712S-SL20E(G)
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-9712S-SL20(G)  $0^{\circ}\text{C} < T_{OPR} < 70^{\circ}\text{C}$  and  $3.13\text{V} < V_{CC} < 3.47\text{V}$

FTM-9712S-SL20E(G)  $-40^{\circ}\text{C} < T_{OPR} < 75^{\circ}\text{C}$  and  $3.13\text{V} < V_{CC} < 3.47\text{V}$

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Optical Center Wavelength	$\lambda_C$	1480		1500	nm	
Optical Spectrum Width (-20dB)	$\Delta\lambda$			1	nm	
Side Mode Suppression Ratio	SMSR	30			dB	
Average Launch Power (BOL)	$P_{OUT}$	+3		+7	dBm	1
Average Launch Power (EOL)		+2		+7	dBm	
Average Launch Power-OFF Transmitter		$P_{OFF}$			-39	
Extinction Ratio	ER	9			dB	2
Total Jitter	TJ			0.43	UI	
Rise/Fall Time (20%-80%)	$T_R/T_F$			260	ps	2,3
RIN <sub>15</sub> OMA				-115	dB/Hz	
Optical Return Loss Tolerance				12	dB	
Transmitter Reflectance				-10	dB	
Transmitter and dispersion Penalty	TDP			2.3	dB	4
Transmitter Eye Diagram	Compliant With IEEE Std 802.3ah™-2004					2,5
Data Input Differential Swing	$V_{IN}$	200		1600	mV <sub>P-P</sub>	6
Input Differential Impedance	$Z_{IN}$	90	100	110	$\Omega$	
Power Supply Current	$I_{CC\_TX}$			180	mA	
Transmitter Disable Voltage - Low	$V_{TDIS\_L}$	0		0.8	V	7
Transmitter Disable Voltage - High	$V_{TDIS\_H}$	2.0		$V_{CC}$	V	
Transmitter Fault Indication Voltage - Low	$V_{TFI\_L}$	0		0.4	V	8
Transmitter Fault Indication Voltage - High	$V_{TFI\_H}$	2.4		$V_{CC}$	V	

Note 1: Launched into 9/125um SMF.

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

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

Note 4: Maximum sensitivity penalty due to transmitter and dispersion effect through 20km of SMF optical fiber.

Note 5: Transmitter eye mask definition {0.22UI, 0.375UI, 0.20UI, 0.20UI, 0.30UI}.

Note 6: Compatible with LVPECL input, AC coupled internally. (See [Recommended Interface Circuit](#))

Note 7: TX Disable (See [Pin Function Definitions](#))

Note 8: TX Fault (See [Pin Function Definitions](#))

**Table 5 - Receiver Optical and Electrical Characteristics (0°C <T<sub>OPR</sub><70°C and 3.13V<V<sub>CC</sub><3.47V)**

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Operating Wavelength		1260		1360	nm	
Sensitivity	P <sub>SEN</sub>			-30	dBm	1
Saturation	P <sub>SAT</sub>	-6			dBm	
Receiver Threshold Settling Time	T <sub>SETTLING</sub>			250	ns	1,2
Dynamic Range		-30		-6	dBm	1,3
Loss of Signal Deassert Level	P <sub>LOSD</sub>			-31	dBm	4
Loss of Signal Assert Level	P <sub>LOSA</sub>	-45			dBm	5
LOS Hysteresis	P <sub>LOSD</sub> - P <sub>LOSA</sub>	0.5		6	dB	
Power Supply Current	I <sub>CC_RX</sub>			120	mA	6
Receiver Reflectance				-12	dB	
Data Output Voltage - Low	V <sub>OL</sub> -V <sub>CC</sub>	-1.81		-1.62	V	
Data Output Voltage - High	V <sub>OH</sub> -V <sub>CC</sub>	-1.02		-0.88	V	
Data Output Differential Swing	V <sub>OUT</sub>	400		1600	mV <sub>P-P</sub>	7
Loss of Signal (LOS) Voltage - Low	V <sub>LOS, L</sub>	0		0.8	V	8
Loss of Signal (LOS) Voltage - High	V <sub>LOS, H</sub>	2.0		V <sub>CC</sub>	V	
Loss of Signal (LOS) Assert Time	T <sub>ASS</sub>			500	ns	
Loss of Signal (LOS) Deassert Time	T <sub>DAS</sub>			500	ns	

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

Note 2: See Figure 1, 2. For multiple ONUs application, It isn't easy to test T<sub>SETTLING</sub> directly, but there is a relationship T<sub>SETTLING</sub> = T<sub>GAP</sub>-T<sub>GUARD</sub> when T<sub>ON</sub>=T<sub>OFF</sub>, then T<sub>SETTLING</sub> can be calculated by T<sub>GAP</sub> and a certain guard time at ONU side.

Note 3: See Figure 3. T<sub>GAP</sub> be less than 250ns is guaranteed.

Note 4: An increase in optical power above the specified level will cause Los of Signal (LOS) output to switch from a high state to a low state.

Note 5: A decrease in optical power below the specified level will cause Los of Signal (LOS) output to switch from a low state to a high state.

Note 6: Supply current excluding receiver output load.

Note 7: LVPECL output, DC coupled internally, guaranteed in the full range of input optical power (-6dBm to -31dBm) (See [Recommended Interface Circuit](#))

Note 8: LOS (See [Pin Function Definitions](#))

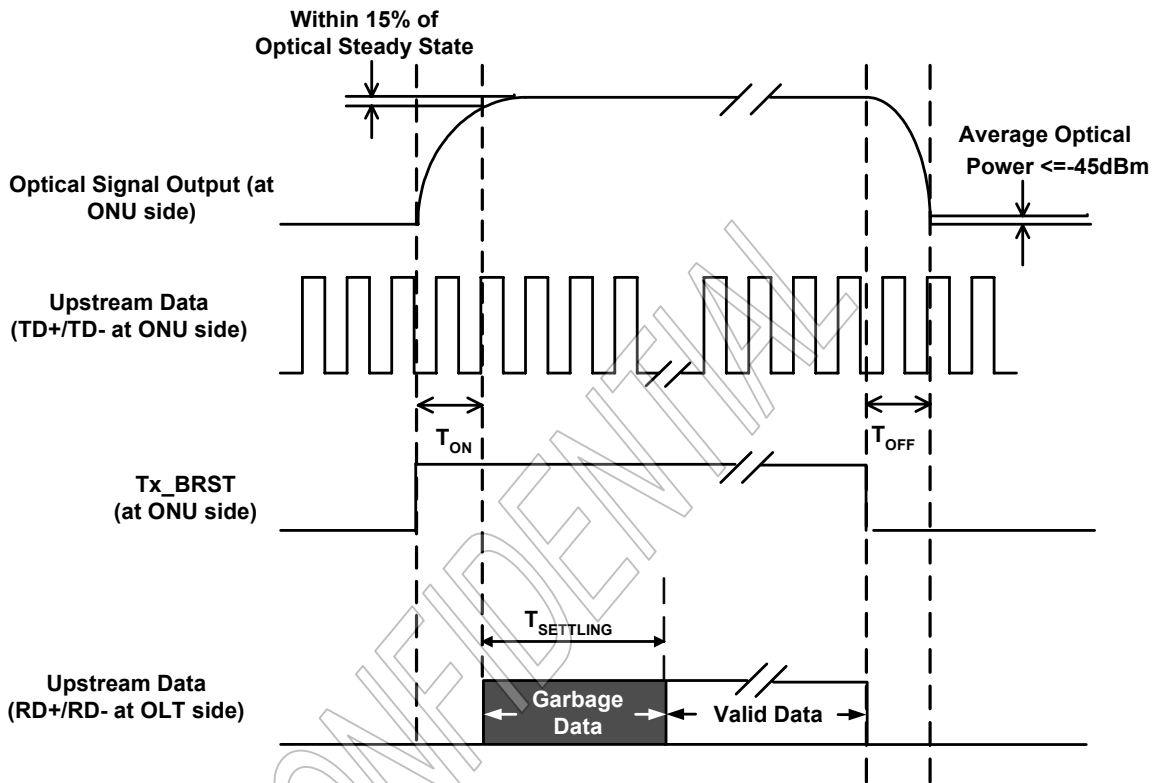


Figure 1 Timing Parameter Definition in Burst Mode Sequence (Sole ONU Application)

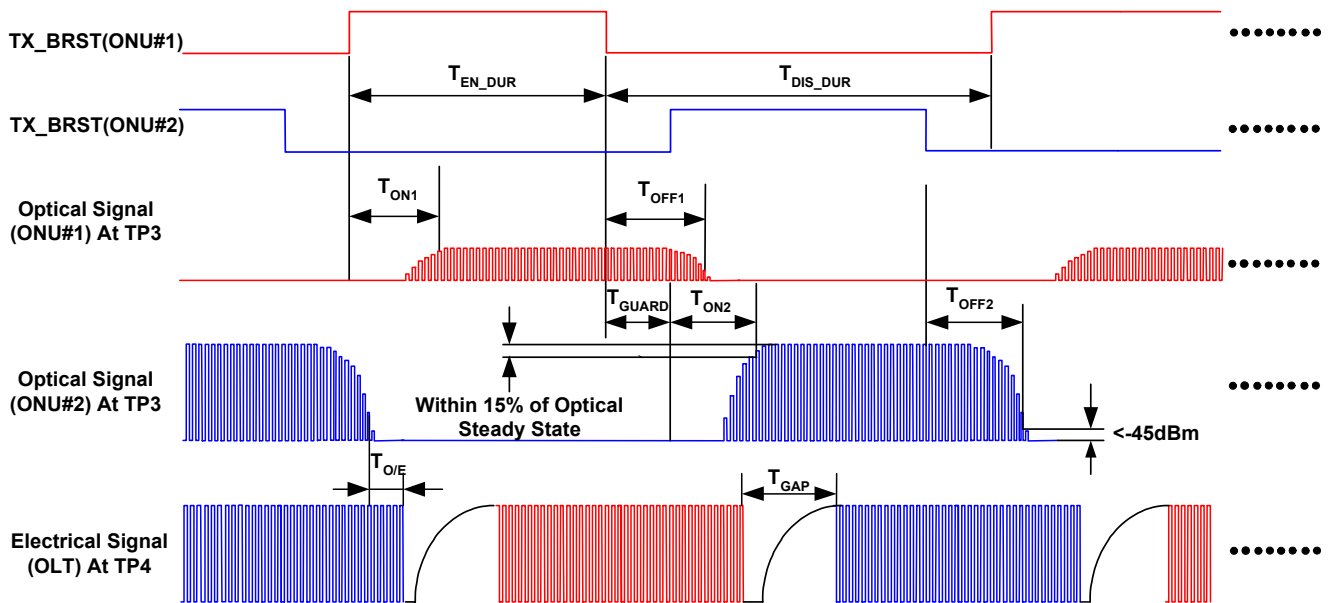


Figure 2 Timing Parameter Definition in Burst Mode Sequence (Dual ONUs Application)

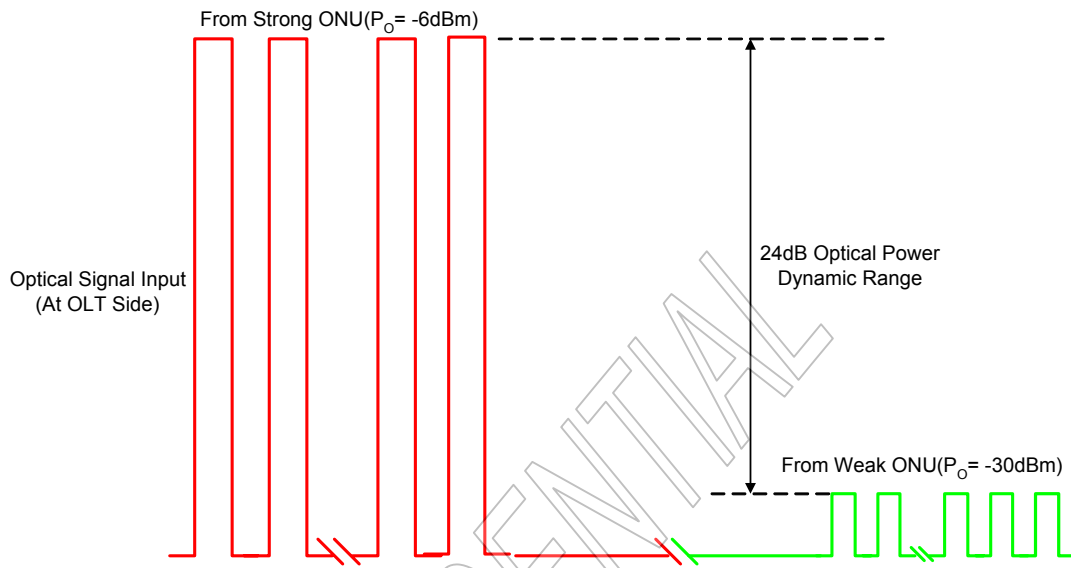


Figure 3 Burst Mode Receiver Dynamic Range in GE-PON System

### Recommended Host Board Power Supply Circuit

Figure 4 shows the recommended host board supply circuit.

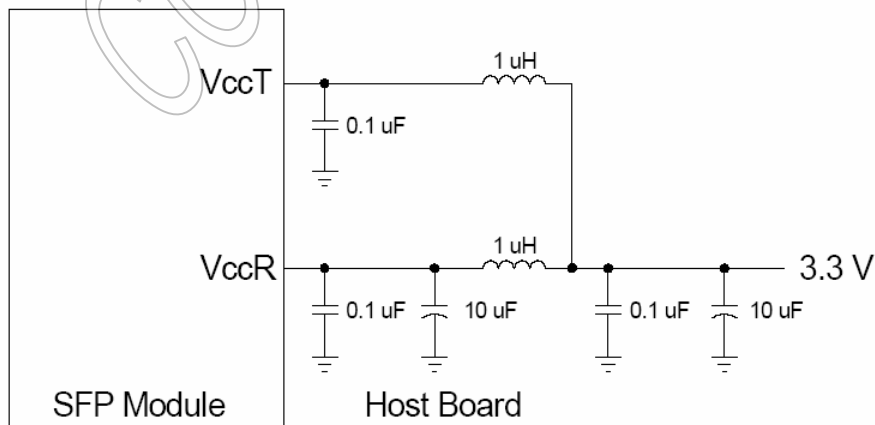


Figure 4 Recommended Host Board Power Supply Filtering Network

### Recommended Interface Circuit

Figure 5 shows the recommended interface schemes.

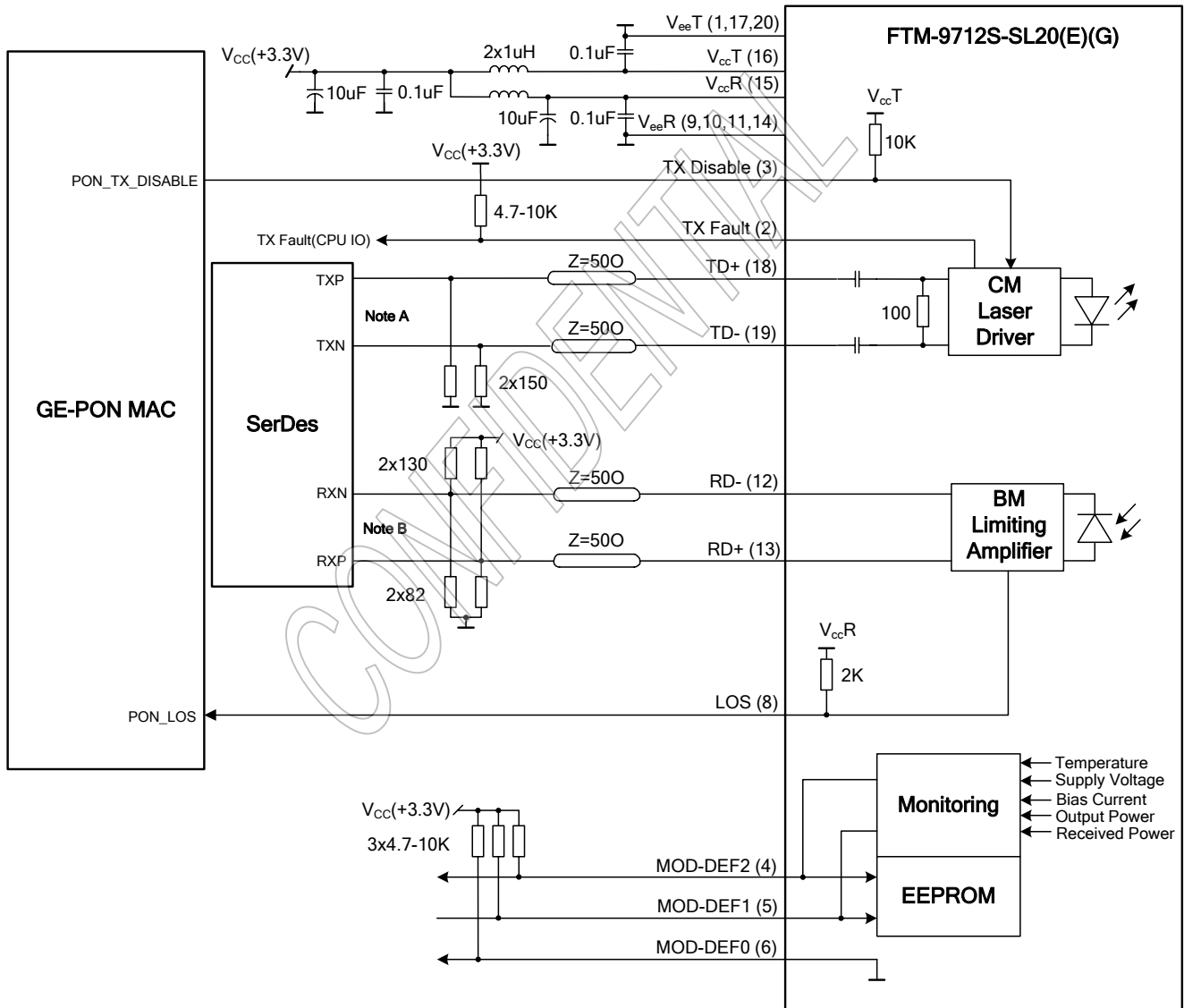


Figure 5 Recommended Interface Circuit

Note A: Circuit assumes open emitter output

Note B: Circuit assumes that proper internal bias voltage is not provided

### Pin Definitions

Figure 6 below shows the pin numbering of SFP electrical interface (Golden Finger). The pin functions are described in Table 6 and the accompanying notes.

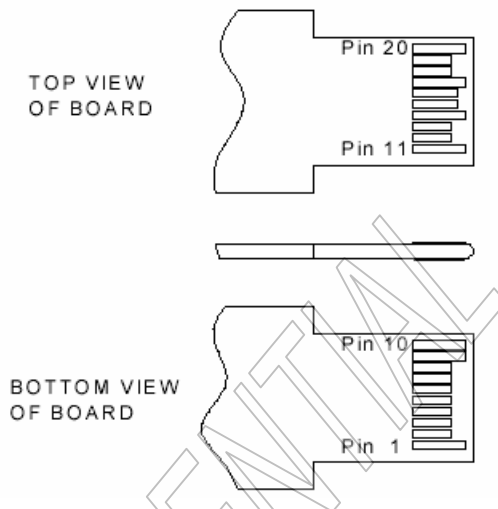


Figure 6 SFP Pin View (Golden Finger)

Table 6 - Pin Function Definitions

Pin No.	Name	Description	Notes
1	V <sub>ee</sub> T	Transmitter Ground	
2	TX Fault	Transmitter Fault Indication	1
3	TX Disable	Transmitter Disable	2
4	MOD-DEF2	Module Definition 2	3
5	MOD-DEF1	Module Definition 1	
6	MOD-DEF0	Module Definition 0	
7	NC	Reserved for Module Tuning	4
8	LOS	Loss of Signal	5
9	V <sub>ee</sub> R	Receiver Ground	
10	V <sub>ee</sub> R	Receiver Ground	
11	V <sub>ee</sub> R	Receiver Ground	
12	RD-	Inv. Receiver Data Out	7
13	RD+	Receiver Data Out	
14	V <sub>ee</sub> R	Received Ground	
15	V <sub>cc</sub> R	Receiver Power	6
16	V <sub>cc</sub> T	Transmitter Power	
17	V <sub>ee</sub> T	Transmitter Ground	
18	TD+	Transmit Data In	8
19	TD-	Inv. Transmit Data In	
20	V <sub>ee</sub> T	Transmitter Ground	

Note 1: 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 V<sub>cc</sub>T, 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.

Note 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 4.7-10 K $\Omega$  resistor. Its states are:

Low (0-0.8V): Transmitter on

(>0.8, < 2.0V): Undefined

High (2.0-3.465V): Transmitter Disabled

Open: Transmitter Disabled

Note 3: MOD-DEF0,1,2. These are the module definition pins. They should be pulled up with a 4.7K-10K $\Omega$  resistor on the host board. The pull-up voltage shall be  $V_{ccT}$  or  $V_{ccR}$ .

MOD-DEF0 is grounded by the module to indicate that the module is present

MOD-DEF1 is the clock line of two-wire serial interface for serial ID

MOD-DEF2 is the data line of two-wire serial interface for serial ID

Note 4: Reserved for module tuning and compulsive for system designer that any circuit doesn't be connected to it.

Note 5: LOS (Loss of Signal) is an open collector/drain output, which should be pulled up with a 4.7K-10K $\Omega$  resistor.

Pull up voltage between 2.0V and  $V_{ccT}$ ,  $R+0.3V$ . 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.

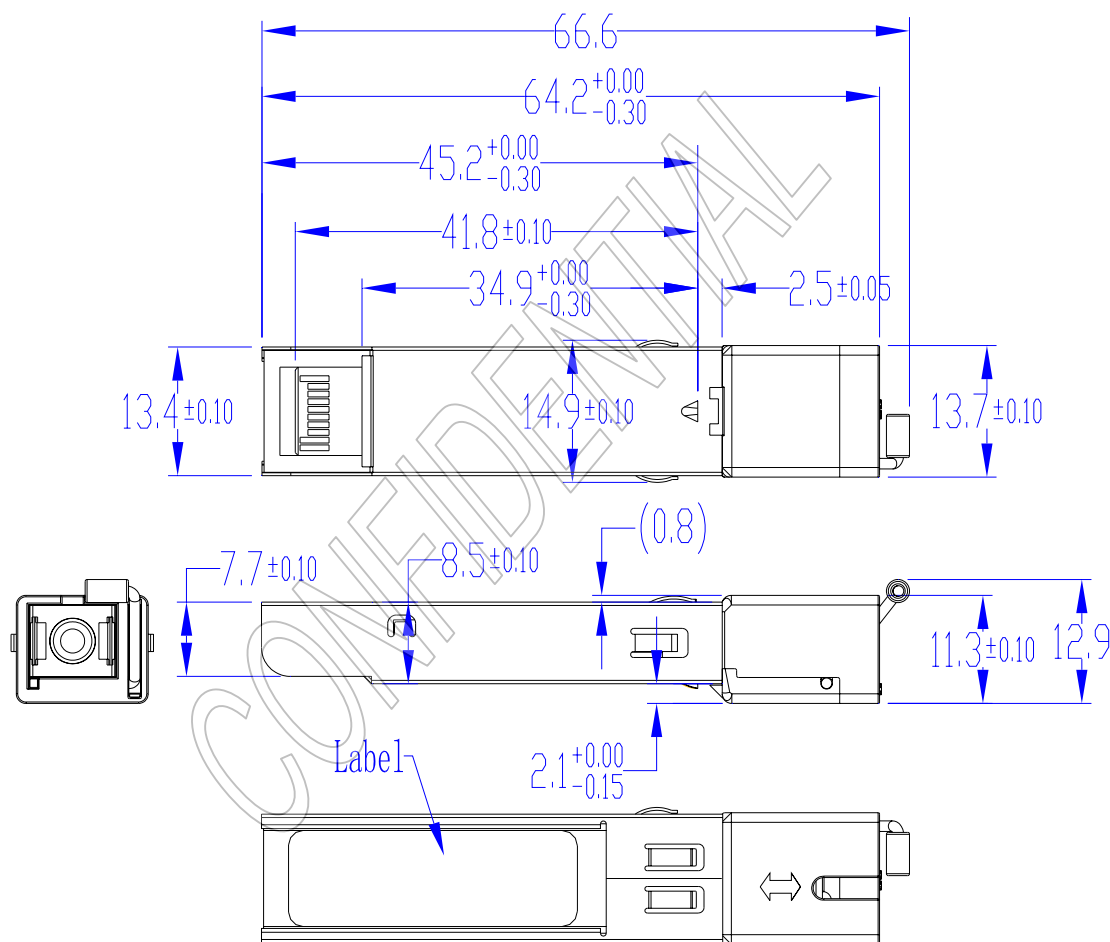
Note 6:  $V_{ccR}$  and  $V_{ccT}$  are the receiver and transmitter power supplies. They are defined as  $3.3V\pm5\%$  at the SFP connector pin. Maximum supply current is 300 mA. Recommended host board power supply filtering is shown in figure 4. Inductors with DC resistance of less than 1 $\Omega$  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.

Note 7: These are the differential receiver outputs. They are DC coupled 100  $\Omega$  differential lines which should be terminated with 100  $\Omega$  (differential) at the user SERDES. (See [Recommended Interface Circuit](#))

Note 8: These are the differential transmitter inputs. They are AC coupled differential lines with 100 $\Omega$  differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. (See [Recommended Interface Circuit](#))

## Mechanical Design Diagram

The mechanical design diagram is shown in figure 7. (Dimension: mm)



**Figure 7 Mechanical Design Diagram (SFP with Spring-latch)**

## 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). The memory contents refer to Table 7.

**Table7 – EEPROM Serial ID Memory Contents (A0h)**

Addr.	Field Size (Bytes)	Name of Field	Hex	Description
0	1	Identifier	03	SFP transceiver
1	1	Ext. Identifier	04	MOD4
2	1	Connector	01	SC
3-10	8	Transceiver	00 00 00 80 00 00 00 00	BASE-PX

11	1	Encoding	01	8B10B
12	1	BR, Nominal	0D	1.25Gbps
13	1	Reserved	00	
14	1	Length (9um)-km	14	20(km)
15	1	Length (9um)	C8	200(100m)
16	1	Length (50um)	00	Not Support MMF
17	1	Length (62.5um)	00	Not Support MMF
18	1	Length (Copper)	00	Not Support Copper
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 39 37 31 32 53 2D 53 4C 32 30 20 20	"FTM-9712S-SL20" (ASCII)
			46 54 4D 2D 39 37 31 32 53 2D 53 4C 32 30 45 20	"FTM-9712S-SL20E" (ASCII)
			46 54 4D 2D 39 37 31 32 53 2D 53 4C 32 30 47 20	"FTM-9712S-SL20G" (ASCII)
			46 54 4D 2D 39 37 31 32 53 2D 53 4C 32 30 45 47	"FTM-9712S-SL20EG" (ASCII)
56-59	4	Vendor Rev	xx xx 20 20	ASCII("31 30 20 20" means 1.0 Revision)
60-61	2	Wavelength	05 D2	1490nm Laser Wavelength
62	1	Reserved	00	
63	1	CC_BASE	xx	Check sum of byte 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 xx xx xx xx xx xx xx xx	ASCII
84-91	8	Date code	xx xx xx xx xx xx 20 20	Year(2 bytes),Month(2 bytes),Day(2 bytes)
92	1	Diagnostic Monitoring Type	58	Compliant with SFF-8472 V9.4 Externally Calibrated Received power measurement type -Average Power
93	1	Enhanced Options	B0	Diagnostics (Optional Alarm/warning flags) Soft TX_FAULT monitoring implemented Soft RX_LOS monitoring implemented
94	1	SFF-8472 Compliance	02	Diagnostics Compliance(SFF-8472 V9.4)
95	1	CC_EXT		Check sum of byte 64-94
96-255	64	Vendor Specific		

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 9.4.

### Monitoring Specification

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 8. For detail EEPROM information, please refer to the related document of SFF-8472 Rev 9.4. The monitoring specification of this product is described in Table 8.

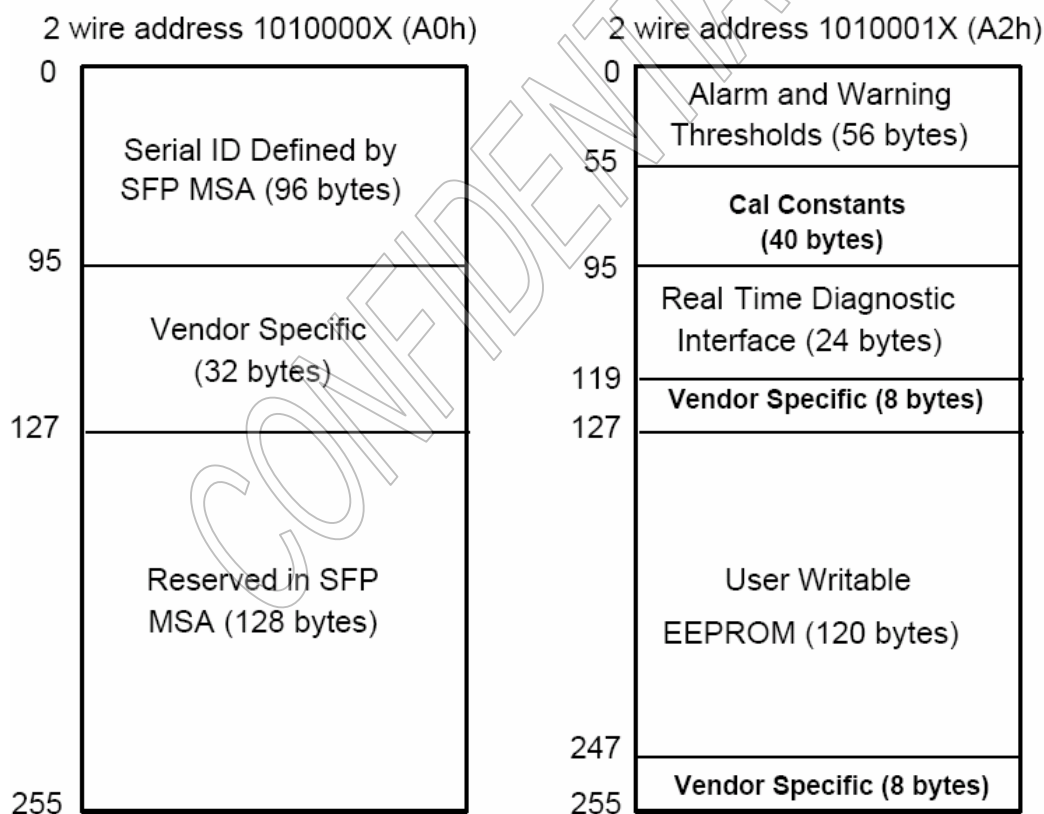
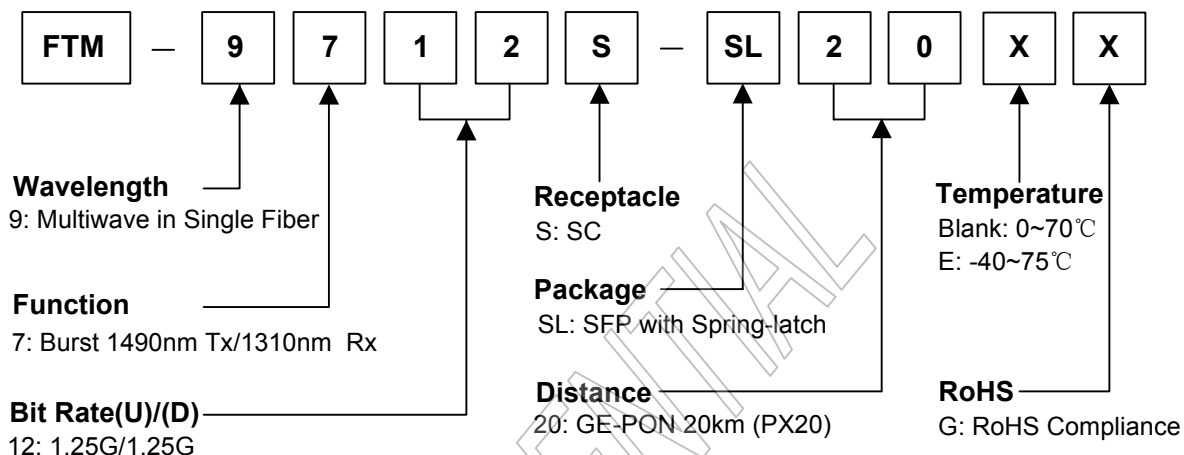


Figure 8 EEPROM Memory Map Specific Data Field Descriptions

Table 8 - Monitoring Specification

Parameter	Range	Accuracy	Calibration
Temperature	-40 to 80°C	±3°C	External
Voltage	3.0 to 3.6V	±3%	External
Bias Current	0 to 100mA	±10%	External
TX Power	0 to 8 dBm	±3dB	External
RX Power	-32 to -5dBm	±3dB	External

## Ordering Information



Part No.	Product Description
FTM-9712S-SL20	1490nm(Tx)/1310nm(Rx), SC Receptacle SFP with Spring-latch, GE-PON OLT, 20km application, Monitoring Function, 0°C ~70°C
FTM-9712S-SL20E	1490nm(Tx)/1310nm(Rx), SC Receptacle SFP with Spring-latch, GE-PON OLT, 20km application, Monitoring Function, -40°C ~75°C
FTM-9712S-SL20G	1490nm(Tx)/1310nm(Rx), SC Receptacle SFP with Spring-latch, GE-PON OLT, 20km application, Monitoring Function, 0°C ~70°C, RoHS Compliance
FTM-9712S-SL20EG	1490nm(Tx)/1310nm(Rx), SC Receptacle SFP with Spring-latch, GE-PON OLT, 20km application, Monitoring Function, -40°C ~75°C, RoHS Compliance

## Related Documents

For further information, please refer to the following documents:

- *Fiberxon Spring-latch SFP Installation Guide*
- *IEEE Std 802.3ah<sup>TM</sup>-2004*
- *SFP Multi-Source Agreement (MSA) SFF-8074i Rev 1.0*
- *SFF-8472 Rev 9.4*

## Obtaining Document

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## Revision History

Reversion	Initiate	Review	Approve	Subject	Release Date
Pre 1a	Frank Zeng	Peter Tang	Peter Tang	Initial datasheet (Doc No. DS3513009-1a)	Aug.8,2005
Pre 1b	Jacob Cai	Frank Zeng	Peter Tang	Revised datasheet 1. Add part FTM-9712S-SL20E 2. Add RoHS part 3. Update Figure 5 and Table 7 4. Modify "Loss of Signal (LOS) Assert Time" and "Loss of Signal (LOS) Deassert Time" to (Max.) 500ns in Table 5 (Doc No. DS3513009-1b)	Feb.15,2006
Pre 1c	Jacob Cai	Frank Zeng	Peter Tang	Revised datasheet Modify "Receiver Threshold Settling Time" in Table 5 to MAX. 250ns (Doc No. DS3513009-1c)	Apr.28,2006

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