

# GPON ONT SFP Transceiver (UGP-L1)

SFP with SC receptacle +3.3V  
1490nm, DFB-LD, Single-Mode

## Feature

- ✧ Single fiber bi-directional data links with asymmetric downstream 2488Mbps and upstream 1244Mbps application
- ✧ 1490nm continuous-mode DFB laser transmitter and 1310nm burst-mode receiver with APD-TIA
- ✧ Reset burst-mode receiver design support more than 15dB dynamic range
- ✧ Digital burst received signal strength indication (RSSI) Function
- ✧ Digital Diagnostic Monitoring (DDM) with external calibration
- ✧ 0 to 70°C operating temperature
- ✧ SFP package with SC receptacle
- ✧ Single 3.3V power supply
- ✧ LVPECL compatible data input/output interface
- ✧ LVTTTL transmitter disable control
- ✧ LVTTTL transmitter laser failure alarm
- ✧ LVTTTL receiver signal-detected indication
- ✧ Low EMI and excellent ESD protection
- ✧ RoHS Compliance
- ✧ Compliant with SFF MSA and SFF-8472 Rev9.5
- ✧ Compliant with ITU-T G.984.2 Class B+

## Applications

- ✧ Gigabit Passive Optical Networks (GPON) – OLT side

## Description

The GPON OLT/ONT SFP transceiver is high performance transceiver modules designed to meet ITU G.984.2 Class B+ requirements for Optical Line Terminal (OLT) application.

The transceiver incorporates a high performance 1310nm Burst Mode APD/TIA receiver and 1490nm Continuous Mode DFB transmitter with internal optical isolator.

The transceiver provides the 8472 I<sup>2</sup>C digital diagnostic interface monitor of its operating conditions and status, including transmitting power, laser bias current, module temperature, supply voltage and the receiver power monitor (RSSI). Calibration and alarm/warning threshold data are written and stored in the internal memory (EEPROM).

## 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.

**Table 1 - Absolute Maximum Ratings**

<b>Parameter</b>	<b>Symbol</b>	<b>Min.</b>	<b>Max.</b>	<b>Unit</b>	<b>Note</b>
Storage Ambient Temperature	<i>T</i> <sub>STG</sub>	-40	85	°C	
Operating Humidity	<i>H</i> <sub>OP</sub>	5	90	%	
Power Supply Voltage	<i>V</i> <sub>CC</sub>	0	4.0	V	
Input Voltage		<i>GND</i>	<i>V</i> <sub>CC</sub>	V	

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Soldering Temperature			400	°C		1
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Note 1: Only for soldering by iron and 10 seconds on leads only

## Recommended Operating Conditions

Table 2 - Recommended Operating Conditions

Parameter	Symbol	Min	Typ	Max	Unit	Note
Power Supply Voltage	V <sub>CC</sub>	3.13	3.3	3.47	V	3.3V±5%
Operating Ambient Temperature	T <sub>OPR</sub>	0		70	°C	
Module Supply Current	I <sub>CC</sub>			500	mA	
Data Rate(Upstream/Downstream)			1.244/2.488		Gbit/s	

## Optical and Electrical Characteristics

Table 3 - Transmitter Optical and Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Note
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 <sub>BOUT</sub>	+1.5		+5	dBm	1
Average Launch Power-OFF Transmitter	P <sub>EOFF</sub>			-39	dBm	
Extinction Ratio	ER	10			dB	2
Rise/Fall Time (20%-80%)	T <sub>R</sub> /T <sub>F</sub>			200	ps	3
Transmitter Reflectance				-10	dB	
Optical Eye Diagram	Compliant With ITU G.984.2					
Data Input Differential Swing	V <sub>IN</sub>	200		1600	mV	4
Input Differential Impedance	Z <sub>IN</sub>	90	100	110	Ω	
Transmitter Disable Voltage - Low	V <sub>TDIS,L</sub>	0		0.8	V	
Transmitter Disable Voltage - High	V <sub>TDIS,H</sub>	2		V <sub>CC</sub>	V	
Laser Failure Alarm Voltage - Low	V <sub>LFAL</sub>	0		0.8	V	
Laser Failure Alarm Voltage - High	V <sub>LFAL,H</sub>	2.4		V <sub>CC</sub>	V	

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

Note 2: Measured with PRBS 2<sup>23</sup>-1 test pattern @2.488 Gbit/s.

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

Note 4: Compatible with LVPECL input, AC coupled internally.

Table 4 - Receiver Optical and Electrical Characteristics

Parameter	Symbol	Min	Typ	Max	Unit	Note
Operating Wavelength		1270	1310	1350	nm	
Sensitivity	P <sub>SEN</sub>			-28	dBm	1
Saturation	P <sub>OV</sub>	-8			dBm	

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Dynamic Range		15				2
Receiver Threshold Settling Time	$T_{SET}$			32	bits	
Reset width	$T_{RESET}$	16			bits	
LOS Assert Level	$P_{LOSA}$			-30	dBm	
LOS Deassert Level	$P_{LOSD}$	-45			dBm	
LOS Hysteresis	$P_{LOSA} - P_{LOSD}$	0.5		5	dB	
LOS Assert Time	$T_{ASS}$			50	ns	
LOS Deassert Time	$T_{DAS}$			50	ns	
Receiver Reflectance				-12	dB	
Data Output Differential Swing	$V_{OUT}$	400		1000	mV	3
LOS Voltage - Low	$V_{SD,L}$	0		0.8	V	
LOS Voltage - High	$V_{SD,H}$	2.4		VCC	V	

Note 1: Measured with a PRBS  $2^{23-1}$  test pattern @1.244Gbit/s and ER=10dB, BER =  $10^{-12}$ .

Note 2: See Figure 1.

Note 3: LVPECL output, DC coupled internally, guaranteed in the full range of input optical power (-8dBm to -28dBm) (See Recommended Interface Circuit)

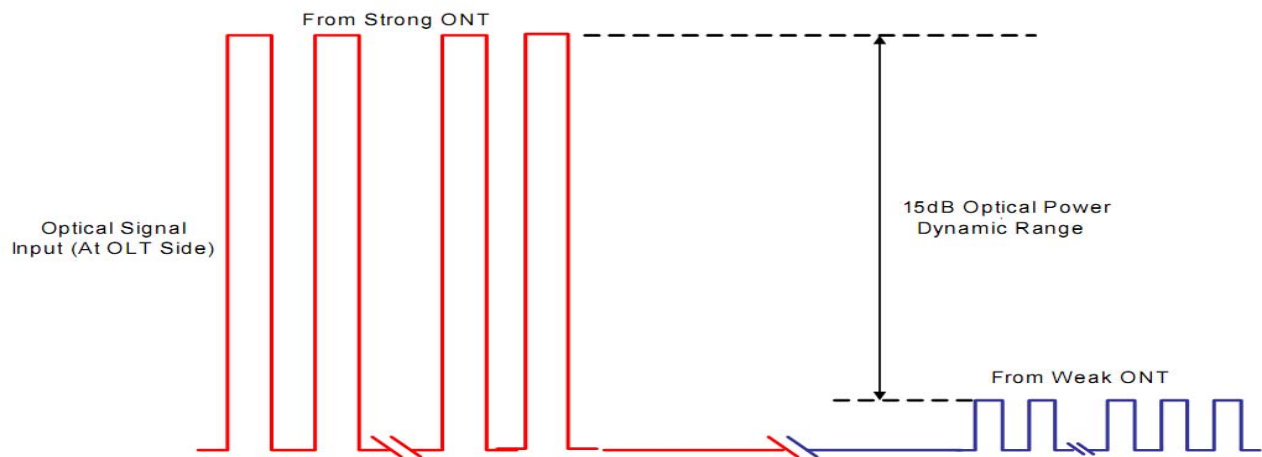


Figure 1 : Burst Mode Receiver Dynamic Range in GPON System

Table 5- Receiver Timing Characteristics

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Reset pulse width	$t_{Res}$	16	-	-	bits
Burst Mode receiver settling time	$t_{settle}$	-	-	32	bits
Burst Packet Detect assert time	$t_{ASS}$	-	-	50	ns
Burst Packet Detect de-assert time	$t_{DAS}$	-	-	50	ns

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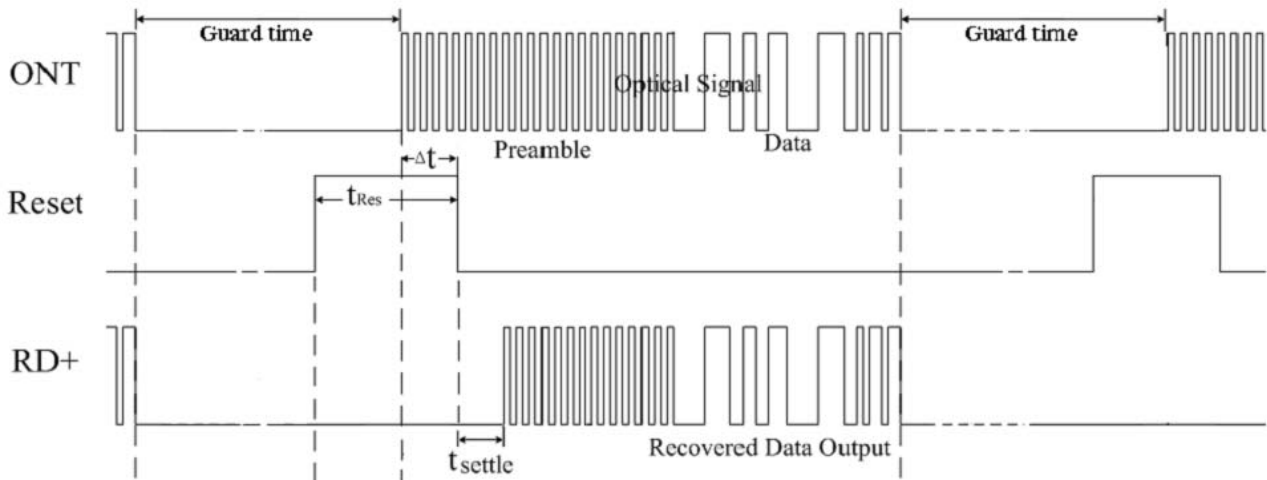


Figure 2 : Burst Mode Receiver Timing Diagram

Table 6-Timing Characteristics for Digital RSSI

PARAMETER	SYMBOL	MIN	TYP	MAX	UNITS
Trigger delay	$T_d$	25	-	-	ns
Trigger width	$T_w$	350	-	-	ns
Sample time	$T_s$	350	-	-	ns
I2C read time	$T_{I2C}$	500	-	-	us
Receiver Power DDM (RSSI) Error <sub>h</sub>	RXDDM			+/-3	dB

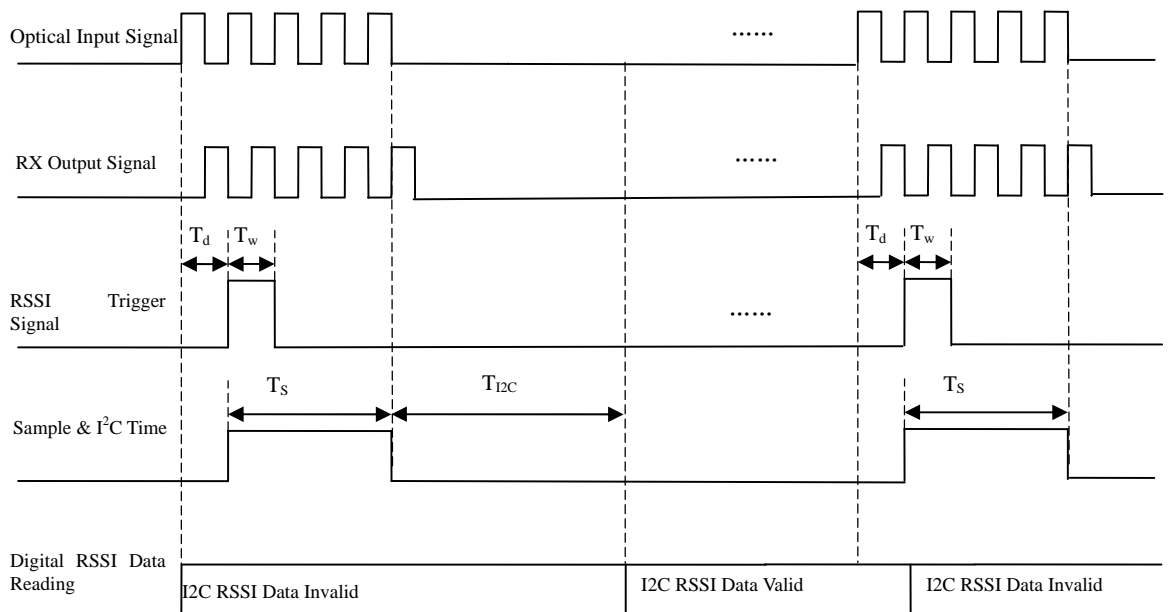


Figure 3 : RSSI Timing Diagram

I2C RSSI Data Inva

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## Recommended Interface Circuit

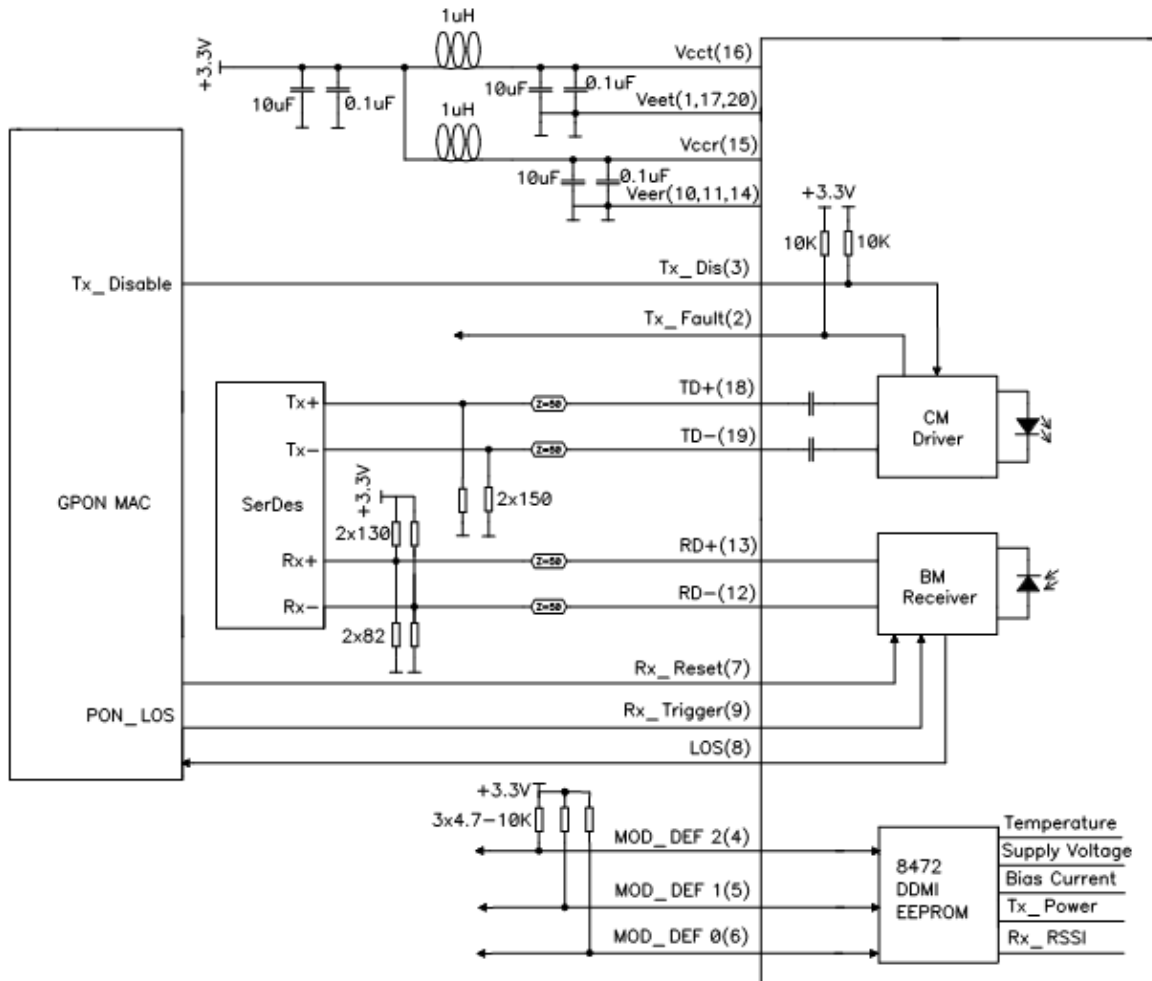


Figure 4 : Shows the recommended interface scheme

## Pin Definitions

Table 7 show the GPON SFP pin information of electrical interface and mounting studs.

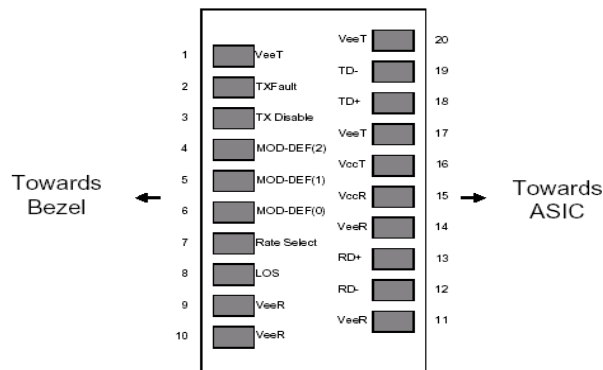


Figure 5 : SFP Outline

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Table 7- Pin Function Definitions (GPON OLT SFP)

Pin#	Name	Function	Notes
1	VeeT	Transmitter Ground	-
2	TX_Fault	Transmitter Fault Indication	High:abnormal Low:normal
3	TX_DIS	Transmitter Disable	High:Transmitter disable Low:Transmitter enable
4	MOD-DEF2	Module Definition 2	Note 1, 2 wire serial ID interface
5	MOD-DEF1	Module Definition 1	Note 1, 2 wire serial ID interface
6	MOD-DEF0	Module Definition 0	Note 1, Grounded in Module
7	RESET	Receiver Reset	High:Reset Low:Normal Operation
8	SD	Signal Detect	High: Normal Operation Low: Loss of Singal
9	RSSI_TRI	RSSI Trigger Input	High:Enable RSSI A/D conversion
10	VeeR	Receiver Ground	
11	VeeR	Receiver Ground	
12	RD-	Inv. Received Data Out	Note 2
13	RD+	Received Data Out	Note 2
14	VeeR	Receiver Ground	
15	VccR	Receiver Power	
16	VccT	Transmitter Power	
17	VeeT	Transmitter Ground	
18	TD+	Transmit Data In	Note 3
19	TD-	Inv. Transmit Data In	Note 3
20	VeeT	Transmitter Ground	

Notes:

1. Mod-Def 0,1,2. 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 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
2. RD-/+ : 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.
3. TD-/+ : 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.

### Serial ID Memory Contents(A0H):

Data Address	Length (Byte)	Name of Length	Description and Contents
Base ID Fields			
0	1	Identifier	Type of Serial transceiver (03h=SFP)
1	1	Reserved	Extended identifier of type serial transceiver (04h)
2	1	Connector	Code of optical connector type (01h=SC)
3-10	8	Transceiver	Not Defined(0000...)
11	1	Encoding	NRZ (03h)
12	1	BR,Nominal	2.488Gbps(19h)

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13-14	2	Reserved	(0000h)
15	1	Length(9um)	Link length supported for 9/125um fiber, units of 100m
16	1	Length(50um)	Link length supported for 50/125um fiber, units of 10m
17	1	Length(62.5um)	Link length supported for 62.5/125um fiber, units of 10m
18	1	Length(Copper)	Link length supported for copper, units of meters
19	1	Reserved	
20-35	16	Vendor Name	SFP vendor name: Hi-Optel
36	1	Reserved	
37-39	3	Vendor OUI	SFP transceiver vendor OUI ID
40-55	16	Vendor PN	Part Number: "HOLT-xxxxxx" (ASCII)
56-59	4	Vendor rev	Revision level for part number
60-62	3	Reserved	
63	1	CCID	Least significant byte of sum of data in address 0-62
Extended ID Fields			
64-65	2	Option	Indicates which optical SFP signals are implemented (001Ah = LOS, TX_FAULT, TX_DISABLE all supported)
66	1	BR, max	Upper bit rate margin, units of %
67	1	BR, min	Lower bit rate margin, units of %
68-83	16	Vendor SN	Serial number (ASCII)
84-91	8	Date code	Hi-Optel's Manufacturing date code
92-94	3	Reserved	
95	1	CCEX	Check code for the extended ID Fields (addresses 64 to 94)
Vendor Specific ID Fields			
96-127	32	Readable	Hi-Optel specific date, read only

## Serial ID Memory Contents: (A2H)

Address	# Bytes	Name	Description
00-01	2	Temp High Alarm	MSB at low address
02-03	2	Temp Low Alarm	MSB at low address
04-05	2	Temp High Warning	MSB at low address
06-07	2	Temp Low Warning	MSB at low address
08-09	2	Voltage High Alarm	MSB at low address
10-11	2	Voltage Low Alarm	MSB at low address
12-13	2	Voltage High Warning	MSB at low address
14-15	2	Voltage Low Warning	MSB at low address
16-17	2	Bias High Alarm	MSB at low address
18-19	2	Bias Low Alarm	MSB at low address
20-21	2	Bias High Warning	MSB at low address
22-23	2	Bias Low Warning	MSB at low address
24-25	2	TX Power High Alarm	MSB at low address
26-27	2	TX Power Low Alarm	MSB at low address
28-29	2	TX Power High Warning	MSB at low address
30-31	2	TX Power Low Warning	MSB at low address

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32-33	2	RX Power High Alarm	MSB at low address
34-35	2	RX Power Low Alarm	MSB at low address
36-37	2	RX Power High Warning	MSB at low address
38-39	2	RX Power Low Warning	MSB at low address
40-55	16	Reserved	Reserved for future monitored quantities

Address	# Bytes	Name	Description
56-59	4	Rx_PWR(4)	Single precision floating point calibration data - Rx optical power. Bit 7 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. Bit 7 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. Bit 7 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. Bit 7 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. Bit 7 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, transmittercoupled output power. Bit 7 of byte 80 is MSB, bit 0 of byte81 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

Byte	Bit	Name	Description
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Converted analog values. Calibrated 16 bit data			
96	All	Temperature MSB	Internally measured module temperature.
97	All	Temperature LSB	
98	All	Vcc MSB	Internally measured supply voltage in transceiver.
99	All	Vcc LSB	
100	All	TX Bias MSB	Internally 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 1st future definition of digitized analog input
107	All	Reserved LSB	Reserved for 1st future definition of digitized analog input
108	All	Reserved MSB	Reserved for 2nd future definition of digitized analog input
109	All	Reserved LSB	Reserved for 2nd 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.

Byte	Bit	Name	Description
Reserved Optional Alarm and Warning Flag Bits			
112	7	Temp High Alarm	Set when internal temperature exceeds high alarm level.
112	6	Temp Low Alarm	Set when internal temperature is below low alarm level.
112	5	Vcc High Alarm	Set when internal supply voltage exceeds high alarm level.
112	4	Vcc Low Alarm	Set when internal supply voltage is below low alarm level.
112	3	TX Bias High Alarm	Set when TX Bias current exceeds high alarm level.
112	2	TX Bias Low Alarm	Set when TX Bias current is below low alarm level.
112	1	TX Power High Alarm	Set when TX output power exceeds high alarm level.
112	0	TX Power Low Alarm	Set when TX output power is below low alarm level.
113	7	RX Power High	Set when Received Power exceeds high alarm level.

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		Alarm	
113	6	RX Power Low Alarm	Set when Received Power is below low alarm level.
113	5	Reserved Alarm	
113	4	Reserved Alarm	
113	3	Reserved Alarm	
113	2	Reserved Alarm	
113	1	Reserved Alarm	
113	0	Reserved Alarm	
114	All	Reserved	
115	All	Reserved	
116	7	Temp High Warning	Set when internal temperature exceeds high warning level.
116	6	Temp Low Warning	Set when internal temperature is below low warning level.
116	5	Vcc High Warning	Set when internal supply voltage exceeds high warning level.
116	4	Vcc Low Warning	Set when internal supply voltage is below low warning level.
116	3	TX Bias High Warning	Set when TX Bias current exceeds high warning level.
116	2	TX Bias Low Warning	Set when TX Bias current is below low warning level.
116	1	TX Power High Warning	Set when TX output power exceeds high warning level.
116	0	TX Power Low Warning	Set when TX output power is below low warning level.
117	7	RX Power High Warning	Set when Received Power exceeds high warning level.
117	6	RX Power Low Warning	Set when Received Power is below low warning level.
117	5	Reserved Warning	
117	4	Reserved Warning	
117	3	Reserved Warning	
117	2	Reserved Warning	
117	1	Reserved Warning	
117	0	Reserved Warning	
118	All	Reserved	
119	All	Reserved	

Byte	# Byte	Name	Description
120-127	8	Vendor Specific	00h.
128-255	128		Writable Memory

**Table 8- Digital Diagnostic Monitor Accuracy**

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Parameter	Unit	Accuracy	Range	Calibration
Tx Optical Power	dB	$\pm 3$	Full temperature range	Internal
		$\pm 2$	Room temperature	
Rx Optical Power	dB	$\pm 3$	-8dBm to -28dBm	Internal
Bias Current	%	$\pm 10$	Id: 1-100mA, Recommended operating conditions	Internal
Power Supply Voltage	%	$\pm 3$	Vcc: 3.0-3.6V, Recommended operating conditions	Internal
Internal Temperature	$^{\circ}\text{C}$	$\pm 3$	Recommended operating conditions	Internal

## Mechanical Design Diagram

The mechanical design diagram of the SFP form factor with SC receptacle is shown in Figure 6. (Dimension in mm)

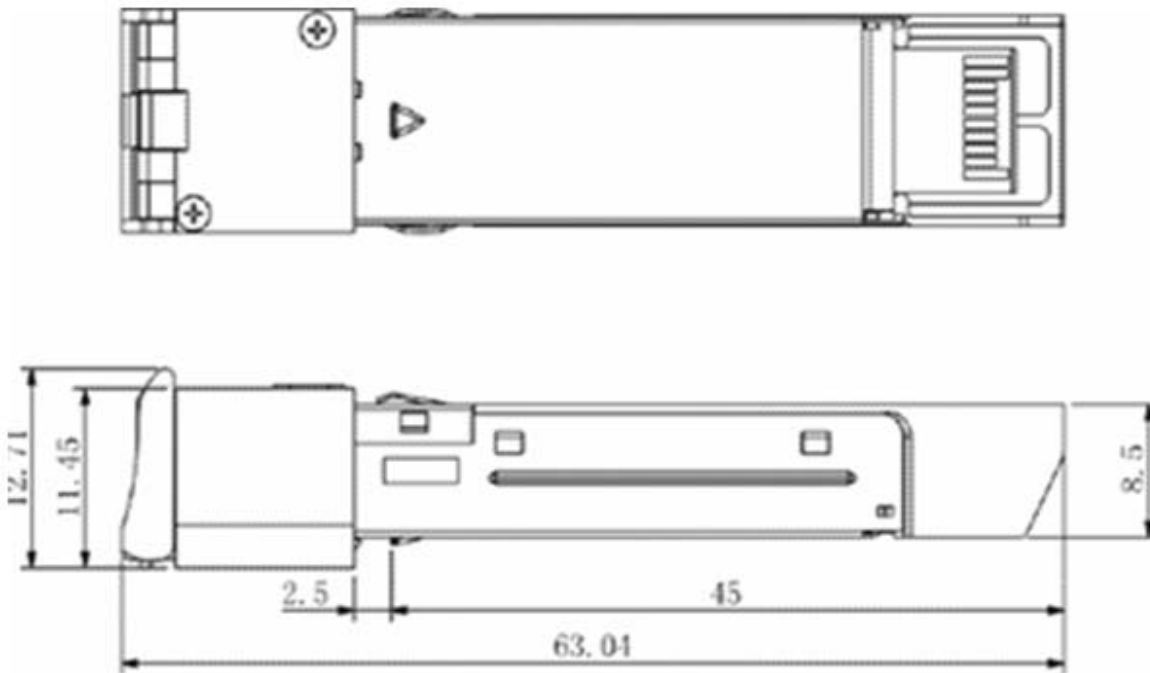


Figure 6: Mechanical Diagram

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