BROADCOM®

Data Sheet

AFBR-57L1APZ

1310-nm Multimode SFP Transceiver with Diagnostic Monitoring for 1.25-Gigabit Ethernet

Description

The Broadcom® AFBR-57L1APZ small form-factor pluggable (SFP) transceiver is a fiber-optic solution for transmission of 1.25-Gbaud data up to 2 km for multimode fibers. This transceiver is compatible with the IEEE 802.3z Gigabit Ethernet and SFF-8472 diagnostic monitoring interface (DMI) standards. The AFBR-57L1APZ provides the system designer with a product to implement 1.25-Gigabit Ethernet networks with DMI physical layers.

Using the 2-wire serial interface defined in the SFF-8472 multisource agreement (MSA), the AFBR-57L1APZ provides real-time information on temperature, FP laser bias current, FP laser average output power, and FP laser receiver average input power.

Transmitter

The transmitter contains a 1310-nm FP laser. This FP laser is packaged in the optical subassembly of the transmitter. It is driven by an integrated circuit that converts differential LVPECL logic signals into an analog FP laser drive current. This current is monitored by the diagnostic monitoring interface. The light optical output power is measured using a monitor diode in the optical subassembly to compensate the optical output for temperature and voltage variations.

Receiver

The receiver utilizes a PIN photodiode coupled to a transimpedance pre-amplifier IC. It is packaged in the optical subassembly of the receiver. The data output is differential LVPECL. The LOS output is +3.3 V TTL as per SFF-8074i. The PIN photodiode average current is monitored by the diagnostic monitoring interface as a measure for input optical power.

Features

- RoHS compliant
- Lead free
- Industry-standard SFP package
- LC duplex connector optical interface
- Operates with OM1 (62.5-µm/125-µm) and OM4 (50-µm/125-µm) multimode fiber
- Compatible with 1.25-Gigabit Ethernet IEEE 802.3z
- Diagnostic monitoring interface
- Class 1 laser product compliant with EN 60825-1
- Single +3.3V power supply
- Manufactured in an ISO 9001 certified facility
- Operating temperature range: –40°C to 85°C
- Hot-plug capability

Applications

- Factory automation
- Gigabit Ethernet networking over multimode fiber
- Power substation automation
- Transportation

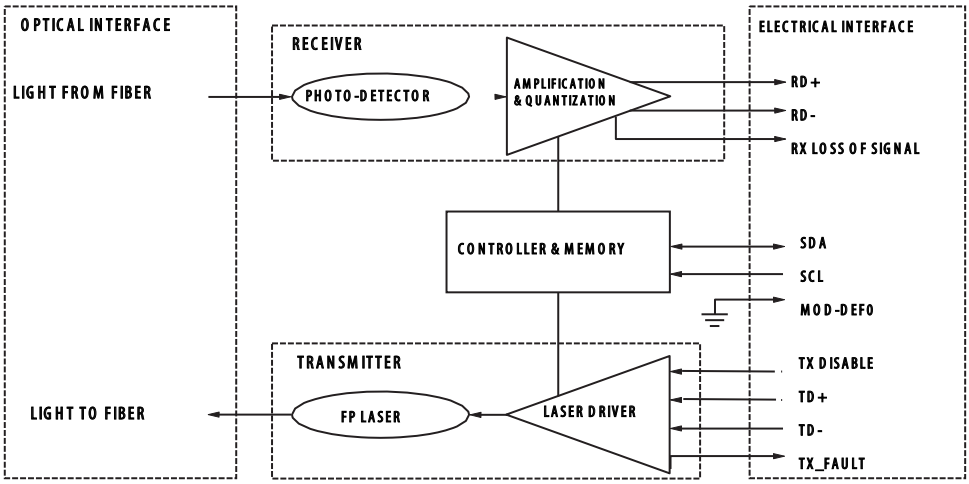
Module Package

The transceiver package is compliant with the SFP MSA with the LC duplex connector option. The hot-pluggable capability of the SFP package allows the module to be installed at any time, including when the host system is online and operating. This capability permits the system to be configured or maintained without system downtime. The AFBR-57L1APZ requires a 3.3V DC power supply for optimal performance.

Module Diagrams

Figure 1 shows the major functional components of the AFBR-57L1APZ, and Figure 2 shows the connection diagram of the module. The dimensions of the module are under construction and will be provided in an updated version of this data sheet.

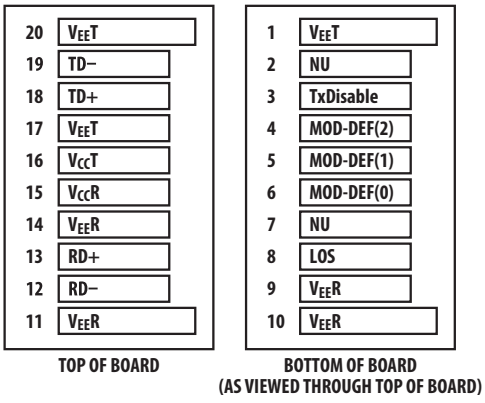
Figure 1: Transceiver Functional Diagram



Installation

The AFBR-57L1APZ can be installed in or removed from any MSA-compliant SFP port regardless of whether the host equipment is operating. The module housing makes initial contact with the host-board EMI shield, mitigating potential damage due to ESD. Controlled hot-plugging is ensured by 3-stage pin sequencing at the electrical interface. The 3-stage pin contact sequencing involves (1) ground, (2) power, and then (3) signal pins making contact with the host-board surface-mount connector—in that order.

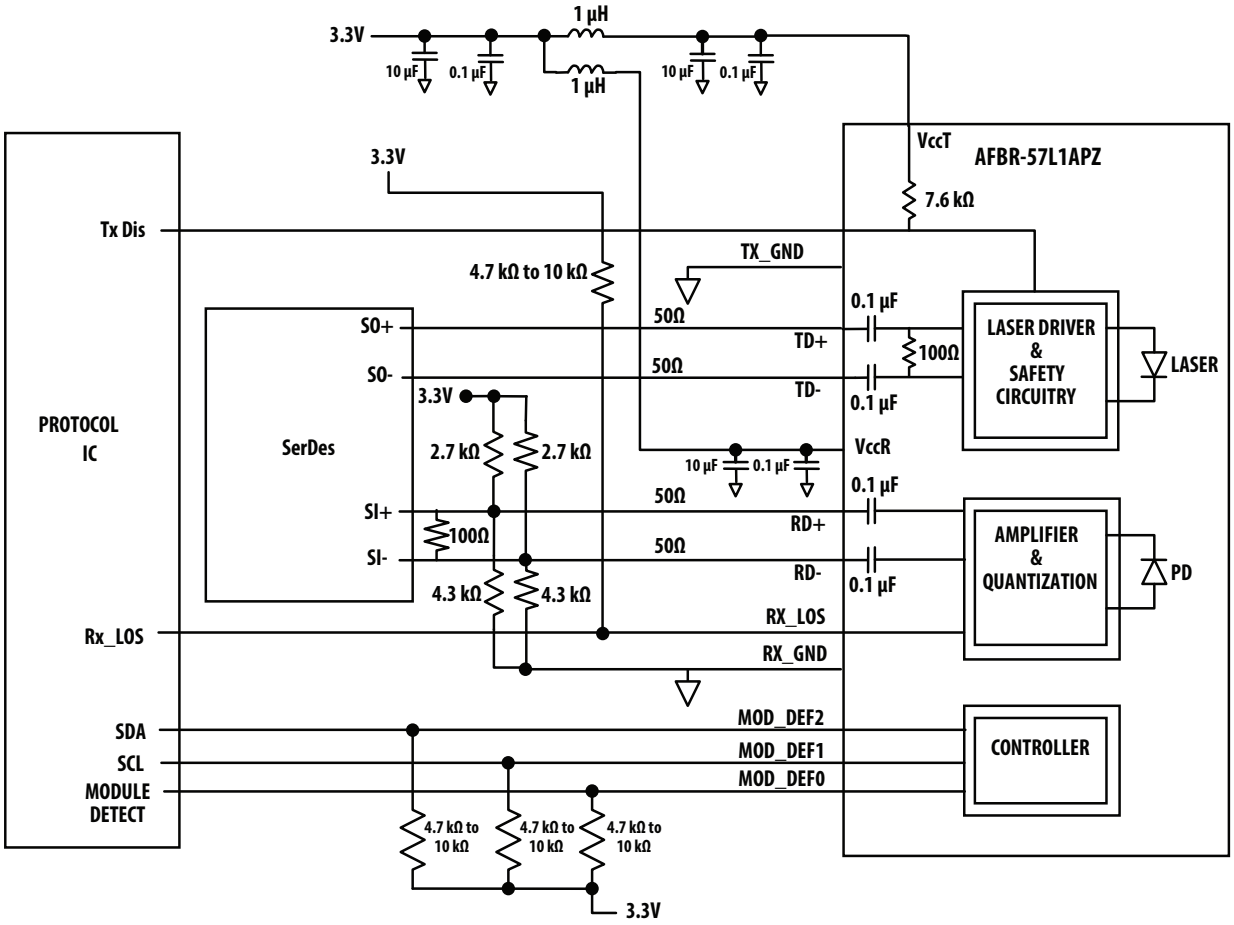
Figure 2: Connection Diagram of Module PCB



Regulatory Compliance

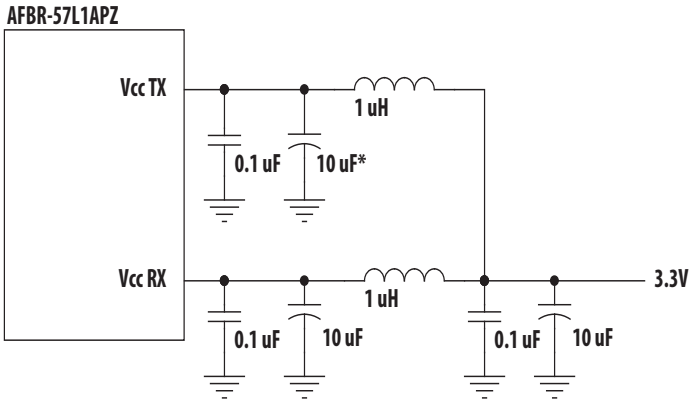
Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	JEDEC JESD22-A114	Meets Class 2 (2000V to 3999V). Withstands up to 2000V applied between electrical pins.
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	Variation of IEC 61000-4-2	Typically withstands at least 8 kV without damage when the LC-connector receptacle is contacted by a human-body-model probe. Typically withstands a 15-kV air discharge on the LC-connector receptacle.
Electromagnetic Interference (EMI)	Emission: EN 55016-2-3, Class B. (Reference is EN 55032:2015 +AC:2016 +A1:2020 +A11:2020) Immunity: EN IEC 61000-6-2:2019	System margins are dependent on the customer board and chassis design.
Eye Safety	IEC 60825-1:2014	Compliant per Broadcom testing under single-fault conditions.
RoHS Compliance	—	Reference to RoHS Directive 2011/65EU Annex II.

Figure 3: Recommended Connection Circuitry



NOTE: Refer to the SerDes supplier's recommendation regarding the interface between the AFBR-57L1APZ and the SerDes. The proposed termination is a general recommendation for LVPECL AC-coupled signals. Other terminations could also be applicable depending on the SerDes interface.

Figure 4: MSA Required Power Supply Filter



NOTE: Inductors should have less than a 1Ω series resistor per MSA.
*Optional capacitance but recommended (required for SFP+).

Pin Description

Pin	Name	Function/Description	MSA Notes
1	VEET	Transmitter Ground	a
2	TX_Fault	Transmitter Fault	—
3	Tx Disable	Transmitter Disable – Module disables on high or open	—
4	MOD-DEF2	Module Definition 2 – Two-wire serial ID interface – SDA serial data signal	b
5	MOD-DEF1	Module Definition 1 – Two-wire serial ID interface – SCL serial clock signal	b
6	MOD-DEF0	Module Definition 0 – Grounded in module	b
7	NU	Not Used – Open circuit	—
8	LOS	Loss of Signal – High indicates loss of signal	c
9	VEER	Receiver Ground	a
10	VEER	Receiver Ground	a
11	VEER	Receiver Ground	a
12	RD-	Inverse Received Data Out	d
13	RD+	Received Data Out	d
14	VEER	Receiver Ground	a
15	VCCR	Receiver Power 3.3V	—
16	VCCT	Transmitter Power 3.3V	—
17	VEET	Transmitter Ground	a
18	TD+	Transmitter Data In	e
19	TD-	Inverse Transmitter Data In	e
20	VEET	Transmitter Ground	a

a. Transmitter and receiver grounds are connected in the transceiver PCB.

b. Mod-Def 0, 1, 2 are the module definition pins. They should be pulled up with a 4.7-kΩ to 10-kΩ resistor on the host board to a supply less than $V_{CC}T$ + 0.3V or $V_{CC}R$ + 0.3V. To use this interface, supply 3.3V to $V_{CC}T$.
– Mod-Def 0 is grounded by the module to indicate that the module is present.
– Mod-Def 1 is the clock line of the two-wire serial interface.
– Mod-Def 2 is the data line of the two-wire serial interface.

c. LOS (Loss Of Signal) is an open collector/drain output, which should be pulled up externally with a 4.7-kΩ to 10-kΩ resistor on the host board to a supply less than $V_{CC}T$,R +0.3V. When high, this output indicates that the received optical power is below the worst-case receiver sensitivity (as defined by the standard in use). In the low state, the output is pulled to a voltage less than 0.8V. LOS is valid only if $V_{CC}T$ and $V_{CC}R$ are powered.

d. RD-/+: These are the differential receiver outputs. They are AC-coupled to 100Ω differential lines, which should be terminated with 100Ω differential at the SERDES. AC-coupling is present inside the module and is not required on the host board.

e. TD-/+: These are the differential transmitter inputs. They are AC-coupled differential lines with 100Ω differential termination inside the module. AC-coupling is present inside the module and is not required on the host board.

Package Dimensions

Figure 5: Module Drawing

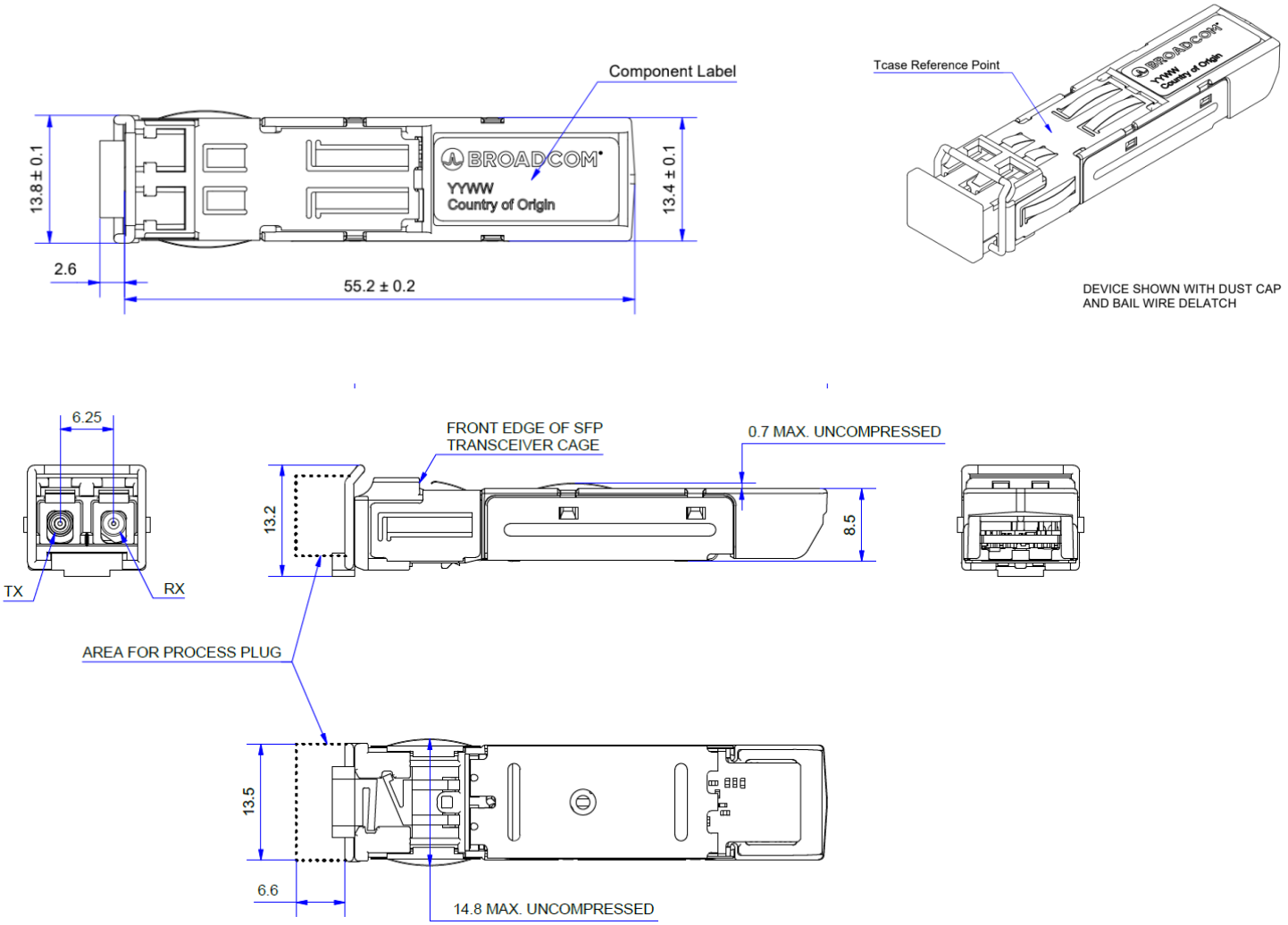
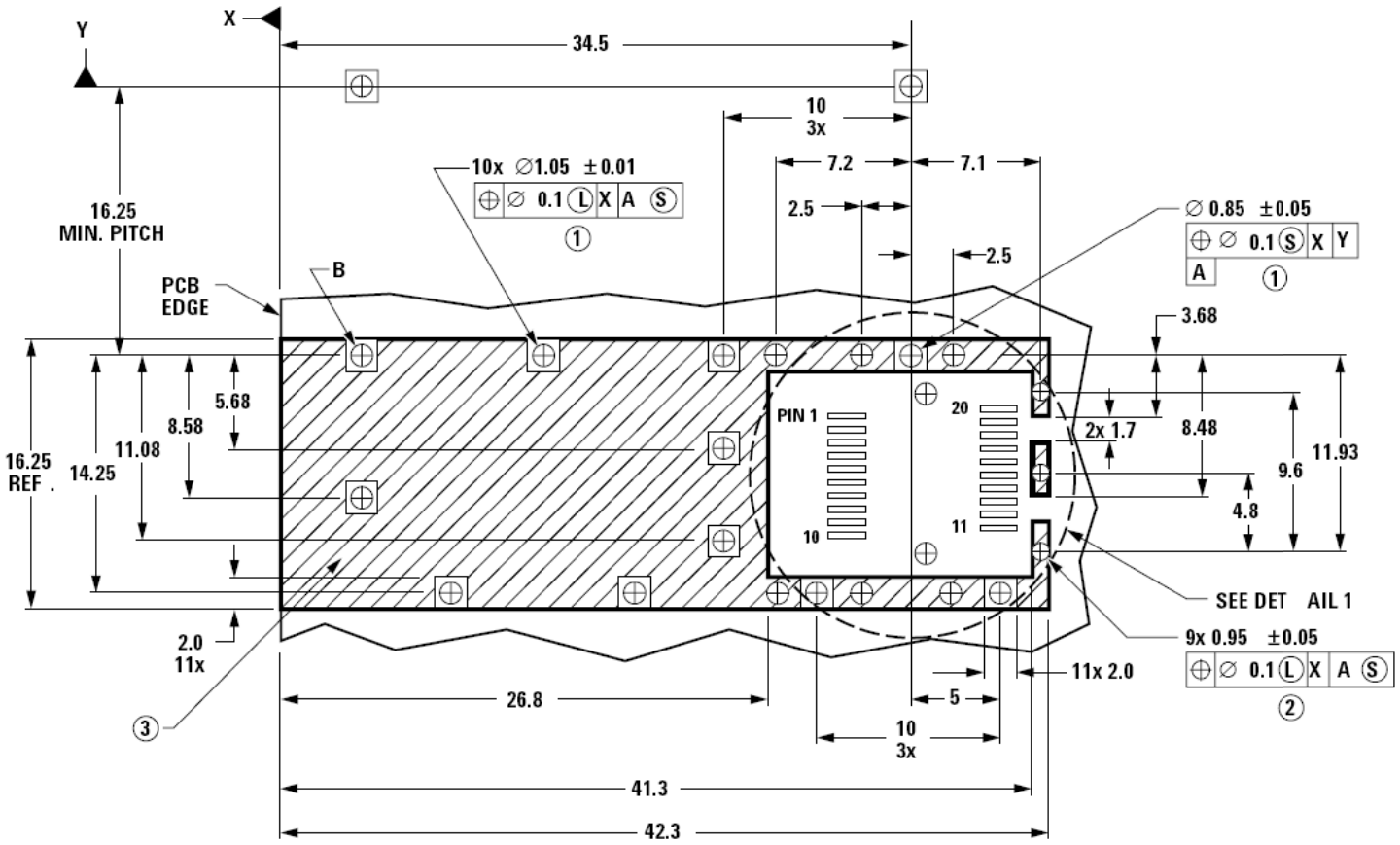
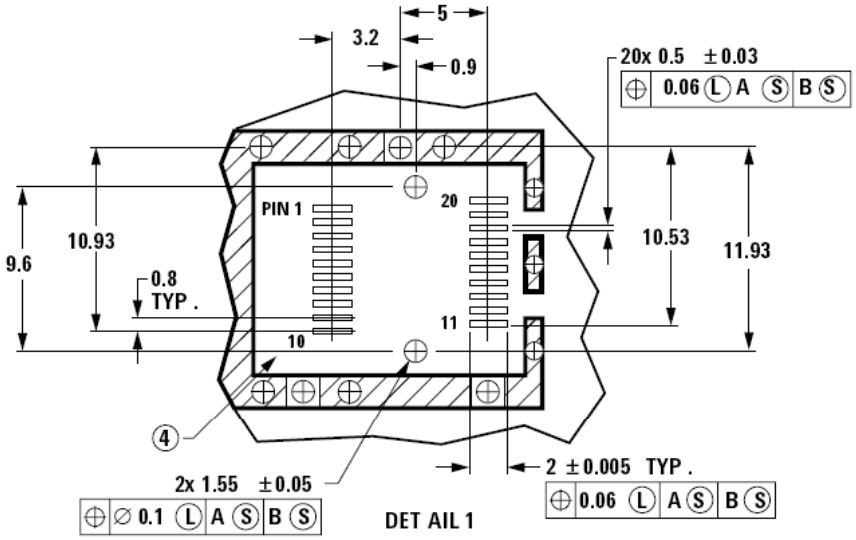


Figure 6: SFP Host-Board Mechanical Layout



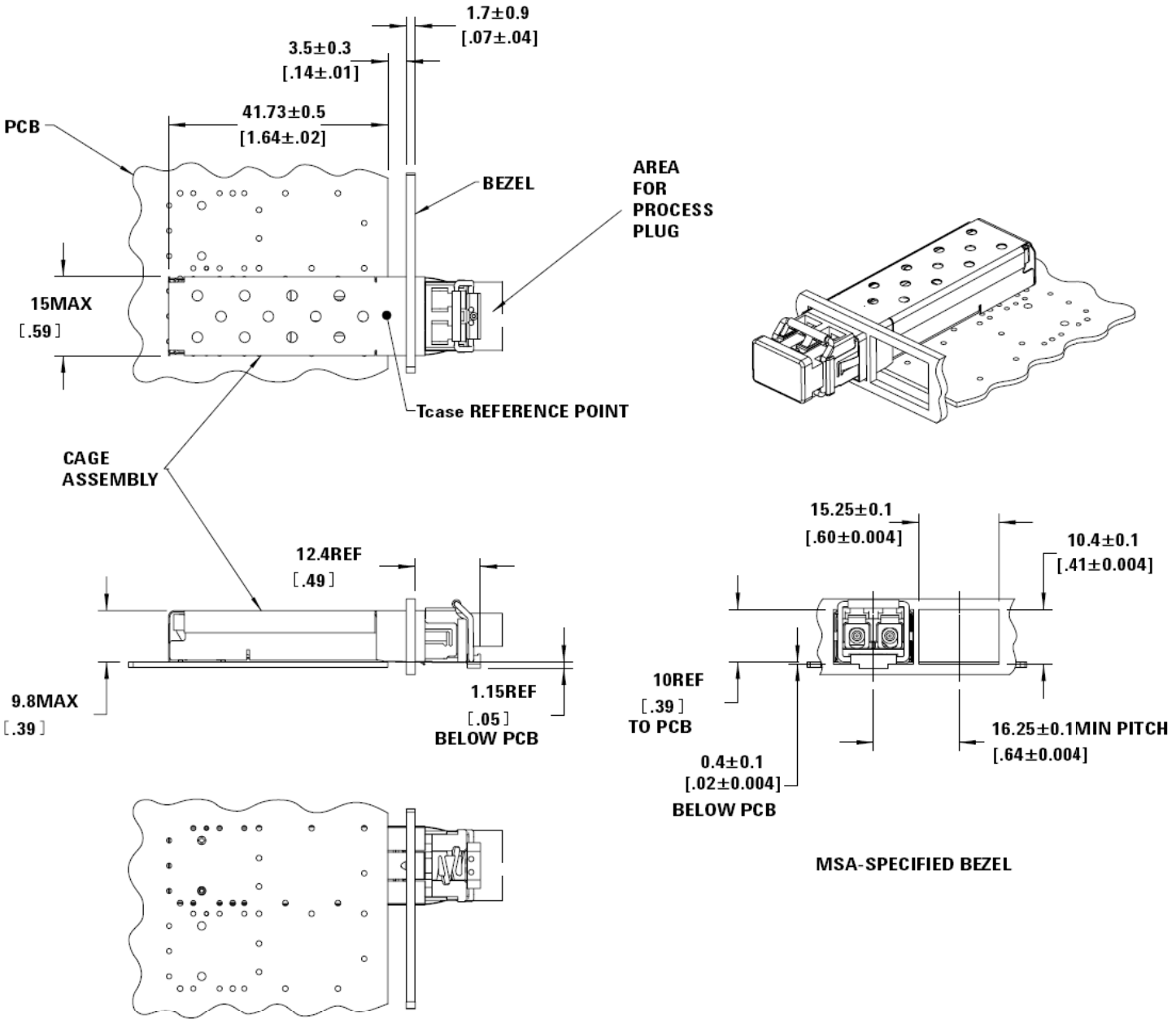


LEGEND

1. PADS AND VIAS ARE CHASSIS GROUND
2. THR OUGH HOLES, PLATING OPTIONAL
3. HATCHED AREA DENOTES COMPONENT AND TRACE KEEPOUT (EXCEPT CHASSIS GROUND)
4. AREA DENOTES COMPONENT KEEPOUT (TRACES ALLOWED)

DIMENSIONS ARE IN MILLIMETERS

Figure 7: SFP Assembly Drawing



DIMENSIONS ARE IN MILLIMETERS [INCHES].

Absolute Maximum Ratings

Stresses in excess of the absolute maximum ratings can cause catastrophic damage to the device. Limits apply to each parameter in isolation, all other parameters having values within the recommended operation conditions. It should not be assumed that limiting values of more than one parameter can be applied to the product at the same time. Exposure to the absolute maximum ratings for extended periods can adversely affect device reliability.

Parameter	Symbol	Min.	Max.	Unit	Notes
Storage Temperature	T_S	–40	+85	°C	—
Supply Voltage	V_{CC}	–0.4	4	V	—
Data Input Voltage	V_I	–0.5	V_{CC}	V	—
Receiver Optical Input Power	P_{in}	—	0	dBm	—

Recommended Operating Conditions

All the data in this specification refers to the following operating conditions and over lifetime unless otherwise stated.

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Case Operating Temperature	T_C	–40	—	+85	°C	a, b
Supply Voltage	V_{CC}	3.1	3.3	3.5	V	a
Data Output Load	R_L	—	100	—	Ω	Differential
Signaling Rate (1.25-Gigabit Ethernet)	B	—	1.25	—	Gbaud	—

a. The case temperature is measured at the surface of the topside using a thermocouple connected to the housing.

b. Electrical and optical specifications of the product are guaranteed across recommended case operating temperature only.

Transmitter Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply Current	I_{CC}	—	63	109	mA	—
Power Dissipation	P_{DISS}	—	208	382	mW	—
Differential Input Voltage	V_{DIFF}	0.4	—	2	V	a

a. Tx data inputs are AC-coupled.

Receiver Electrical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Supply Current	I_{CC}	—	85	115	mA	a
Power Dissipation	P_{DISS}	—	280	402	mW	a
Data Output: Receiver Differential Output Voltage (RD+/-)	$\|V_{OH}–V_{OL}\|$	0.5	—	1.2	V	b
Data Output Rise Time (20%–80%)	T_r	—	—	0.35	ns	—
Data Output Fall Time (80%–20%)	T_f	—	—	0.35	ns	—
Loss of Signal Output Voltage – Low	$LOSV_{OL}$	—	—	0.5	V	c
Loss of Signal Output Voltage – High	$LOSV_{OH}$	2.4	—	Vcc	V	c

a. Typical values are for room temperature at 3.3V.

b. The differential output voltage is internally AC-coupled. The low and high voltages are measured using 100Ω differential termination.

c. The RD+ and RD- outputs are squelched at LOS assert/deassert levels.

Transmitter Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Output Optical Power, 62.5/125 µm	Po	–9	—	–1	dBm	a, b
Output Optical Power, 50/125 µm	Po	–9	—	–1	dBm	a, b
Extinction Ratio	ER	9	—	—	dB	—
Central Wavelength	λ	1270	1310	1355	nm	c
Spectral Width – FWHM	Δλ	—	—	3	nm	—
Optical Rise Time (20%–80%)	T_r	—	—	260	ps	—
Optical Fall Time (80%–20%)	T_f	—	—	260	ps	—
Output Eye	Compatible with IEEE 802.3z					
Transmitter Total Jitter	TJ	—	—	227	ps	d
Transmitter Disable (High)	$P_{o(off)}$	—	—	–45	dBm	—

a. Optical values are measured over the specified operating voltage and temperature ranges. The average power can be converted to a peak value by adding 3 dB.

b. Average.

c. Maximum deviation across the full temperature range: –40°C to 85°C.

d. Characterized with a 1.25-Gbaud PRBS7 pattern.

Receiver Optical Characteristics

Parameter	Symbol	Min.	Typ.	Max.	Unit	Notes
Optical Input Power	P_{IN}	–19	—	–1	dBm	a
Operating Wavelength	λ	1260	1310	1380	nm	—
Signal Detect – Asserted	P_A	—	—	–19.0	dBm	—
Signal Detect – Deasserted	P_D	–35	—	—	dBm	—

a. This specification is intended to indicate the performance of the receiver section of the transceiver when optical input power signal characteristics are present per the following definitions:
– Over the specified operating temperature and voltage ranges
– Bit error rate (BER) better than or equal to 1×10^{-12}
– Over OM1 and OM4 2-km fiber links

Module Diagnostics

Parameter	Range	Typ. Accuracy	Unit	Notes
Temperature	–40 to 85	±3	°C	a, b
Voltage	0 to VCC	±0.1	V	c
Bias Current	0 to 120	±5	mA	—
TX Power	–11 to +1	±3 dB	dBm	—
RX Power	–19 to –3	±3 dB	dBm	—

a. After case-to-PCB stabilization. Temperature is measured internal to the transceiver. Valid from a –40°C to a +85°C case temperature with Tx Enabled.

b. Measured at 3.3V.

c. The supply voltage is measured internal to the transceiver and can, with less accuracy, be correlated to the voltage at the SFP V_{CC} pin.

EEPROM Memory Maps

A0 Memory Map

Addr	Hex	ASCII	INFO	Addr	Hex	ASCII	INFO	Addr	Hex	ASCII	INFO
00	03		SFP	28	20			56	20		
01	04			29	20			57	20		
02	07		LC	30	20			58	20		
03	00			31	20			59	20		
04	00			32	20			60	05		1310 nm
05	00			33	20			61	1E		1310 nm
06	00			34	20			62	00		
07	22		Longwave Laser Intermediate Distance	35	20			63			Note [a]
08	00			36	00			64	00		
09	0C		50 µm (MM) 62.5 µm (MM)	37	00			65	12		
10	00		100 MB/s	38	17			66	00		
11	01		8b/10b	39	6A			67	00		
12	0D		1250 Mb/s	40	41	A		68-83			Note [b]
13	00			41	46	F		84-91			Note [c]
14	00			42	42	B		92	68		Note [d]
15	00			43	52	R		93	D0		Note [e]
16	00			44	2D	-		94	06		Note [f]
17	C8		2-km OM1	45	35	5		95			Note [a]
18	C8		2-km OM4	46	37	7		96-127	00		Note [g]
19	00			47	4C	L		128-255	00		Note [h]
20	42	B		48	31	1					
21	52	R		49	41	A					
22	4F	O		50	50	P					
23	41	A		51	5A	Z					
24	44	D		52	20						
25	43	C		53	20						
26	4F	O		54	20						
27	4D	M		55	20						

a. Addresses 63 and 95 are checksums. Address 63 is the checksum for bytes 0-62, and address 95 is the checksum for bytes 64-94.

b. Addresses 68-83 specify a unique identifier for each device.

c. Addresses 84-89 specify the date code (YYMMDD). Addresses 90-91 specify the vendor-specific lot code.

d. Digital diagnostics implemented. Internally calibrated. Average RX power.

e. Alarm warnings, SoftTX_Disable, and Soft RX_LOS implemented.

f. Includes functionality described in Rev 11.3 of SFF-8472.

g. Addresses 96-127 are vendor specific.

h. Addresses 128-255 are reserved and are all set to zero.

A2 Memory Map

Byte No. (Decimal)	Notes	Byte No. (Decimal)	Notes	Byte No. (Decimal)	Notes
0	Temp H Alarm MSB [a]	26	Tx Power L Alarm MSB [g]	104	Real Time Rx Power MSB [b]
1	Temp H Alarm LSB [a]	27	Tx Power L Alarm LSB [g]	105	Real Time Rx Power LSB [b]
2	Temp L Alarm MSB [a]	28	Tx Power H Warning MSB [g]	106	Reserved
3	Temp L Alarm LSB [a]	29	Tx Power H Warning LSB [g]	107	Reserved
4	Temp H Warning MSB [a]	30	Tx Power L Warning MSB [g]	108	Reserved
5	Temp H Warning LSB [a]	31	Tx Power L Warning LSB [g]	109	Reserved
6	Temp L Warning MSB [a]	32	Rx Power H Alarm MSB [b]	110	Status/Control
7	Temp L Warning LSB [a]	33	Rx Power H Alarm LSB [b]	111	Reserved
8	Vcc H Alarm MSB [c]	34	Rx Power L Alarm MSB [b]	112-113	Flag Bits [d]
9	Vcc H Alarm LSB [c]	35	Rx Power L Alarm LSB [b]	114	Reserved
10	Vcc L Alarm MSB [c]	36	Rx Power H Warning MSB [b]	115	Reserved
11	Vcc L Alarm LSB [c]	37	Rx Power H Warning LSB [b]	116-117	Flag Bits [d]
12	Vcc H Warning MSB [c]	38	Rx Power L Warning MSB [b]	118-127	Reserved
13	Vcc H Warning LSB [c]	39	Rx Power L Warning LSB [b]	128-247	Customer Writable
14	Vcc L Warning MSB [c]	40-55	Reserved	248-255	Vendor Specific
15	Vcc L Warning LSB [c]	56-91	External Calibration Constants		
16	Tx Bias H Alarm MSB [e]	92-94	Reserved		
17	Tx Bias H Alarm LSB [e]	95	Checksum for Bytes 0-94 [f]		
18	Tx Bias L Alarm MSB [e]	96	Real Time Temperature MSB [a]		
19	Tx Bias L Alarm LSB [e]	97	Real Time Temperature LSB [a]		
20	Tx Bias H Warning MSB [e]	98	Real Time Vcc MSB [c]		
21	Tx Bias H Warning LSB [e]	99	Real Time Vcc LSB [c]		
22	Tx Bias L Warning MSB [e]	100	Real Time Tx Bias MSB [e]		
23	Tx Bias L Warning LSB [e]	101	Real Time Tx Bias LSB [e]		
24	Tx Power H Alarm MSB [g]	102	Real Time Tx Power MSB [g]		
25	Tx Power H Alarm LSB [g]	103	Real Time Tx Power LSB [g]		

a. Temperature (Temp) is decoded as a 16-bit signed two's-complement integer in increments of 1/256°C.

b. Received average optical power (Rx Pwr) is decoded as a 16-bit unsigned integer in increments of 0.1 µW.

c. Supply voltage (Vcc) is decoded as a 16-bit unsigned integer in increments of 100 µV.

d. Addresses 112-113 and 116-117 are used for the TX/RX Alarm and Warning flags.

e. Tx bias current (Tx Bias) is decoded as a 16-bit unsigned integer in increments of 2 µA.

f. Byte 95 is a checksum that is calculated (per SFF-8472) and stored prior to product shipment.

g. Transmitted average optical power (Tx Pwr) is decoded as a 16-bit unsigned integer in increments of 0.1 µW.

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Lead (Pb) Free
RoHS 6 fully compliant
RoHS 6 fully compliant options available; -xxxE denotes a lead-free product