

# HFBR-59L1AGEZ

RoHS Compliant, 1.25 GBd Ethernet and 1.0625 GBd Fibre Channel 850 nm SFF Low Voltage (3.3 V) Optical Transceiver



## Data Sheet

### Description

The HFBR-59L1AGEZ from Avago Technologies is a high performance, cost-effective optical transceiver for serial optical data communications applications operating at 1.25 Gb/s and 1.0625 Gb/s. This module is designed for multimode fiber and operates at a nominal wavelength of 850 nm. The transceiver incorporates 3.3 V DC compatible technology including an 850 nm VCSEL transmitter. The HFBR-59L1AGEZ offers maximum flexibility to Fibre Channel and Ethernet designers, manufacturers, and system integrators. It is designed for use in short reach multimode fiber optic 1000BASE-SX and Fibre Channel (100-M5-SN-1) links. This device is also designed for a wide voltage and temperature range of operation.

This transceiver is compliant with the Small Form Factor Multi-Source Agreement and is fully compliant with all equipment meeting the Gigabit Ethernet (1000 Base-SX) and Fibre Channel (FC-PI 100-M5-SN-I, FC-PI 100-M6-SN-I, FC-PH2 100-M5-SN and FC-PH2 100-M6-SN-I 1.0625 GBd) specifications.

### Related Products

- HFCT-59L1ATLZ : 1300 nm Small Form Factor optical transceiver for 10km Gigabit Ethernet links

### Features

- Fully RoHS Compliant
- Datarate specification:
  - 1.25 GBd operation for IEEE 802.3 Gigabit Ethernet 1000BASE-SX
  - 1.0625 GBd operation for FC-PI 100-M5-SN-I and FC-PI 100-M6-SN-I
- Wide temperature and supply voltage operation
- Industry standard 2 x 5 SFF package
- LC-duplex connector optical interface
- Link lengths at 1.25 GBd:
  - 0.5 to 500 m – 50/125 mm MMF
  - 0.5 to 275 m – 62.5/125 mm MMF
- Link lengths at 1.0625 GBd:
  - 0.5 to 500 m – 50/125 mm MMF
  - 0.5 to 300 m – 62.5/125 mm MMF
- Reliable 850 nm Vertical Cavity Surface Emitting Laser (VCSEL) source technology
- Laser AEL Class I (eye safe) per:
  - US 21 CFR (J)
  - EN 60825-1 (+All)
- Single +3.3 V power supply operation
- Wave solder and aqueous wash process compatible

### Applications

- Short reach Gigabit Ethernet links
- High speed backplane interconnects
- Switched backbones
- iSCSI applications
- Mass storage system I/O
- Computer system I/O
- High speed peripheral interface
- High speed switching systems
- Host adaptor I/O

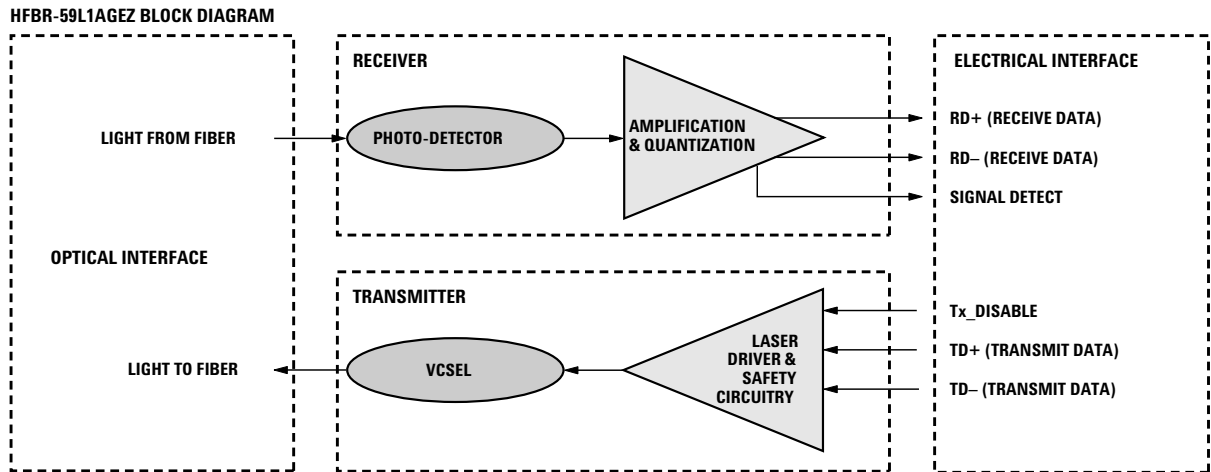


Figure 1. Transceiver functional diagram.

See Table 5 for Process Compatibility Specifications.

### Module Package

Avago Technologies offers the Pin Through Hole package utilizing an integral LC Duplex optical interface connector. The transceiver uses a reliable 850 nm VCSEL source and requires a 3.3 V dc power supply for optimal system design.

### Module Diagrams

Figure 1 illustrates the major functional components of the HFBR-59L1AGEZ. The connection diagram for both modules are shown in Figure 2. Figure 6 depicts the external configuration and dimensions of the module.

### Installation

The HFBR-59L1AGEZ can be installed in any MSA compliant Pin Through Hole port. The module Pin Description is shown in Figure 2.

### Solder and Wash Process Capability

These transceivers are delivered with protective process plugs inserted into the LC connector receptacle. This process plug protects the optical subassemblies during wave solder and aqueous wash processing and acts as a dust cover during shipping. These transceivers are compatible with industry standard wave or hand solder processes.

### Recommended Solder Fluxes

Solder fluxes used with the HFBR-59L1AGEZ should be watersoluble, organic fluxes. Recommended solder fluxes include Lonco 3355-11 from London Chemical West, Inc. of Burbank, CA, and 100 Flux from Alpha-Metals of Jersey City, NJ.

### Recommended Cleaning/Degreasing

#### Chemicals

Alcohols: methyl, isopropyl, isobutyl.  
 Aliphatics: hexane, heptane.  
 Other: naphtha. Do not use partially halogenated hydrocarbons such as 1,1,1 trichloroethane or ketones such as MEK, acetone, chloroform, ethyl acetate, methylene dichloride, phenol, methylene chloride, or N-methylpyrrolidone.

Also, Avago Technologies does not recommend the use of cleaners that use halogenated hydrocarbons because of their potential environmental harm.

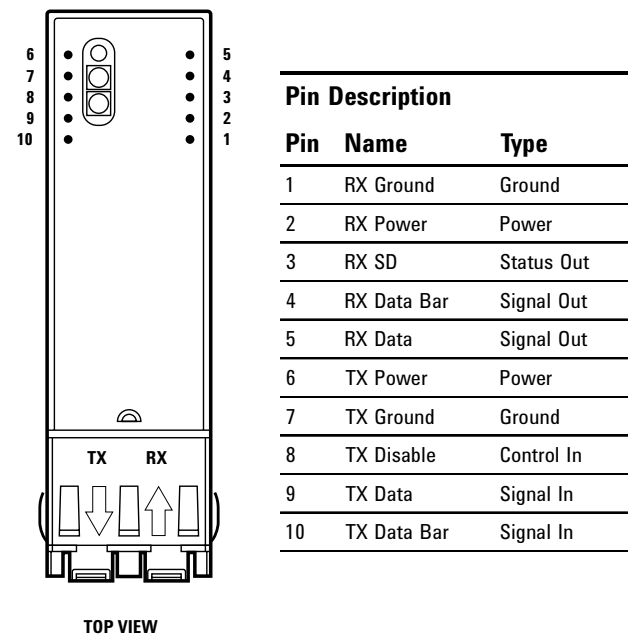


Figure 2. Module pin assignments and pin configuration.

## Transmitter Section

The transmitter section includes an 850 nm VCSEL (Vertical Cavity Surface Emitting Laser) light source and a transmitter driver circuit. The driver circuit maintains a constant optical power level provided that the data pattern is valid 8B/10B code. Connection to the transmitter is provided via an LC optical connector.

## TX Disable

The HFBR-59L1AGEZ accepts a LVTTTL transmit disable control signal input which shuts down the transmitter. A high signal implements this function while a low signal allows normal laser operation. In the event of a fault (e.g., eye safety circuit activated), cycling this control signal resets the module. The TX Disable control should be actuated upon initialization of the module. See Figure 5 for product timing diagrams.

## Eye Safety Circuit

For an optical transmitter device to be eye-safe in the event of a single fault failure, the transmitter will either maintain normal, eye-safe operation or be disabled. In the event of an eye safety fault, the VCSEL will be disabled.

## Receiver Section

Connection to the receiver is provided via an LC optical connector. The receiver circuit also includes a Signal Detect (SD) circuit which provides an open collector logic low output in the absence of a usable input optical signal level.

## Signal Detect

The Signal Detect (SD) output indicates if the optical input signal to the receiver does not meet the minimum detectable level for Fibre Channel compliant signals. When SD is low it indicates loss of signal. When SD is high it indicates normal operation. The Signal Detect thresholds are set to indicate a definite optical fault has occurred (e.g., disconnected or broken fiber connection to receiver, failed transmitter).

## Functional Data I/O

Avago Technologies HFBR-59L1AGEZ fiber-optic transceiver is designed to accept industry standard differential signals. In order to reduce the number of passive components required on the customer's board, Avago Technologies has included the functionality of the transmitter bias resistors and coupling capacitors within the fiber optic module. The transceiver is compatible with an "ac-coupled" configuration and is internally terminated. Figure 1 depicts the functional diagram of the HFBR-59L1AGEZ. Caution should be taken to account for the proper interconnection between the supporting Physical Layer integrated circuits and the HFBR-59L1AGEZ. Figure 3 illustrates the recommended interface circuit.

## Reference Designs

Figure 3 depicts a typical application configuration, while Figure 4 depicts the multisourced power supply filter circuit design.

## Regulatory Compliance

See Table 1 for transceiver Regulatory Compliance performance. The overall equipment design will determine the certification level. The transceiver performance is offered as a figure of merit to assist the designer.

## Electrostatic Discharge (ESD)

There are two conditions in which immunity to ESD damage is important. Table 1 documents our immunity to both of these conditions. The first condition is during handling of the transceiver prior to attachment to the PCB. To protect the transceiver, it is important to use normal ESD handling precautions. These precautions include using grounded wrist straps, work benches, and floor mats in ESD controlled areas. The ESD sensitivity of the HFBR-59L1AGEZ is compatible with typical industry production environments. The second condition is static discharges to the exterior of the host equipment chassis after installation. To the extent that the duplex LC optical interface is exposed to the outside of the host equipment chassis, it may be subject to system-level ESD requirements. The ESD performance of the HFBR-59L1AGEZ exceeds typical industry standards.

## Immunity

Equipment hosting the HFBR-59L1AGEZ modules will be subjected to radio-frequency electromagnetic fields in some environments. The transceivers have good immunity to such fields due to their shielded design.

## Electromagnetic Interference (EMI)

Most equipment designs utilizing these high-speed transceivers from Avago Technologies will be required to meet the requirements of FCC in the United States, CENELEC EN55022 (CISPR 22) in Europe and VCCI in Japan. The metal housing and shielded design of the HFBR-59L1AGEZ minimize the EMI challenge facing the host equipment designer.

These transceivers provide superior EMI performance. This greatly assists the designer in the management of the overall system EMI performance.

## Eye Safety

These 850 nm VCSEL-based transceivers provide Class 1 eye safety by design. Avago Technologies has tested the transceiver design for compliance with the requirements listed in Table 1: Regulatory Compliance, under normal operating conditions and under a single fault condition.

## Flammability

The HFBR-59L1AGEZ VCSEL transceiver housing is made of metal and high strength, heat resistant, chemically resistant, and UL 94V-0 flame retardant plastic.

## Caution

There are no user serviceable parts nor is any maintenance required for the HFBR-59L1AGEZ. All adjustments are made at the factory before shipment to our customers.

Tampering with or modifying the performance of the HFBR-59L1AGEZ will result in voided product warranty. It may also result in improper operation of the HFBR-59L1AGEZ circuitry, and possible overstress of the laser source. Device degradation or product failure may result. Connection of the HFBR-59L1AGEZ to a non-approved optical source, operating above the recommended absolute maximum conditions or operating the HFBR-59L1AGEZ in a manner inconsistent with its design and function may result in hazardous radiation exposure and may be considered an act of modifying or manufacturing a laser product.

The person(s) performing such an act is required by law to re-certify and reidentify the laser product under the provisions of U.S. 21 CFR (Subchapter J) and the TUV.

**Table 1. Regulatory Compliance**

| Feature  | Test Method  | Performance   |
|--|--|---|
| Electrostatic Discharge (ESD) to the Electrical Pins | MIL-STD-883 Method 3015  | Class 2 (>2 kV).  |
| Electrostatic Discharge (ESD) to the LC Receptacle   | Variation of IEC 61000-4-2   | Tested to 8 kV contact discharge.   |
| Electromagnetic Interference (EMI)                   | FCC Class B<br>CENELEC EN55022 Class B (CISPR 22A)<br>VCCI Class I   | Margins are dependent on customer board and chassis designs.  |
| Immunity   | Variation of IEC 61000-4-3   | Typically show no measurable effect from a 10 V/m field swept from 27 to 1000 MHz applied to the transceiver without a chassis enclosure. |
| Laser Eye Safety and Equipment Type Testing          | FDA CDRH<br>21-CFR 1040<br>Class 1<br><br>IEC 60825-1<br>Amendment 2<br>2001 - 01  | Accession Number: HFBR-59L1AGEZ ) 9521220-65<br><br>License Number: HFBR-59L1AGEZ ) 933/510219/01   |
| Component Recognition                                | Underwriters Laboratories and Canadian Standards Association Joint Component Recognition for Information Technology Equipment Including Electrical Business Equipment. | UL File Number: E173874   |

## Ordering Information

Please contact your local field sales engineer or one of Avago Technologies franchised distributors for ordering information. For technical information regarding this product, including the MSA, please visit Avago Technologies Website at [www.avagotech.com](http://www.avagotech.com). Use the quick search feature to search for this part number. You may also contact Avago Technologies Customer Response Center.

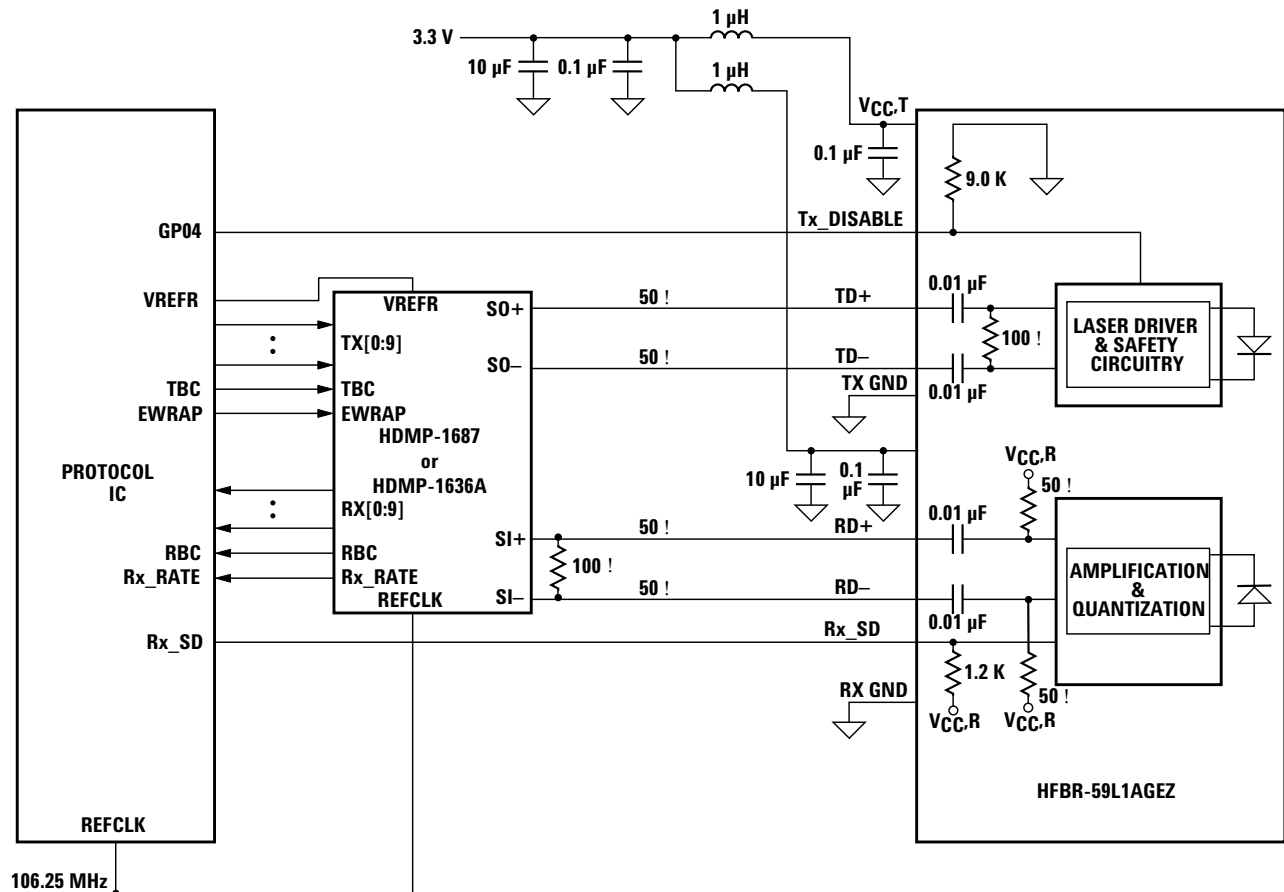
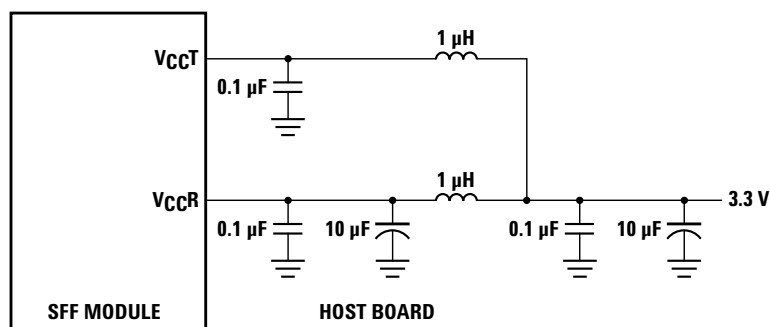


Figure 3. Typical application configuration.



NOTE: INDUCTORS MUST HAVE LESS THAN 1mΩ SERIES RESISTANCE PER MSA.

Figure 4. MSA recommended power supply filter.

**Table 2. Pin Description**

| Pin | Name              | Function/Description                         | MSA Notes |
|-----|-------------------|--|-----------|
| 1   | V <sub>EE</sub> R | Receiver Ground                              | 1         |
| 2   | V <sub>CC</sub> R | Receiver Power: 3.3 V ±10%                   | 5         |
| 3   | SD                | Signal Detect: Low indicates Loss of Signal  | 3         |
| 4   | RD-               | Inverse Received Data Out                    | 4         |
| 5   | RD+               | Received Data Out                            | 4         |
| 6   | V <sub>CC</sub> T | Transmitter Power: 3.3V ±10%                 | 5         |
| 7   | V <sub>EE</sub> T | Transmitter Ground                           | 1         |
| 8   | TX Disable        | Transmitter Disable: Module disables on High | 2         |
| 9   | TD+               | Transmitter Data In                          |           |
| 10  | TD-               | Inverse Transmitter Data In                  |           |

**Notes:**

- Transmitter and Receiver Ground are common in the internal module PCB. They are electrically connected to signal ground within the module, and to the housing shield (see Note 5 in Figure 7c). This housing shield is electrically isolated from the nose shield which is connected to chassis ground (see Note 4 in Figure 7c).
- TX disable input is used to shut down the laser output per the state table below. It is pulled down internally within the module with a 9.0 K $\Omega$  resistor.

|                            |                      |
|----------------------------|----------------------|
| Low (0 – 0.8 V):           | Transmitter on       |
| Between (0.8 V and 2.0 V): | Undefined            |
| High (2.0 – 3.465 V):      | Transmitter Disabled |
| Open:                      | Transmitter Enabled  |
- SD (Signal Detect) is a normally high LVTTTL output. When high it indicates that the received optical power is adequate for normal operation. When Low, it indicates that the received optical power is below the worst case receiver sensitivity, a fault has occurred, and the link is no longer valid.
- RD-/+ : These are the differential receiver outputs. They are ac coupled 100  $\Omega$  differential lines which should be terminated with 100  $\Omega$  differential at the user SerDes. The ac coupling is done inside the module and is thus not required on the host board. The voltage swing on these lines will be between 400 and 2000 mV differential (200 – 1000 mV single ended) when properly terminated. These levels are compatible with CML and LVPECL voltage swings.
- V<sub>CC</sub>R and V<sub>CC</sub>T are the receiver and transmitter power supplies. They are defined as 2.97 – 3.63 V at the PTH connector pin. The maximum supply current is 200 mA.

## Absolute Maximum Ratings

| Parameter                                  | Symbol       | Minimum | Typical | Maximum        | Unit | Notes |
|--|--------------|---------|---------|----------------|------|-------|
| Storage Temperature                        | $T_s$        | -40     |         | +100           | °C   | 1     |
| Case Temperature                           | $T_c$        | -10     |         | +85            | °C   | 1, 2  |
| Relative Humidity                          | RH           | 5       |         | 95             | %    | 1     |
| Supply Voltage                             | $V_{ccT, R}$ | -0.5    |         | 4              | V    | 1, 2  |
| Data/Control Input Voltage                 | $V_I$        | -0.5    |         | $V_{cc} + 0.3$ | V    | 1     |
| Sense Output Current<br>Signal Detect [SD] | $I_o$        |         |         | 5.0            | mA   | 1     |

### Notes:

1. Absolute Maximum Ratings are those values beyond which damage to the device may occur if these limits are exceeded for other than a short period of time. See Reliability Data Sheets for specific reliability performance.
2. Between Absolute Maximum Ratings and the Recommended Operating Conditions, functional performance is not intended, device reliability is not implied, and damage to the device may occur over an extended period of time.

## Recommended Operating Conditions

| Parameter             | Symbol       | Minimum | Typical | Maximum | Unit | Notes |
|-----------------------|--------------|---------|---------|---------|------|-------|
| Case Temperature      | $T_c$        | -10     | +25     | +85     | °C   | 1     |
| Module Supply Voltage | $V_{ccT, R}$ | 2.97    | 3.3     | 3.63    | V    | 1     |
| Data Rate:            |              |         |         |         |      |       |
| Fibre Channel         |              |         | 1.0625  |         | Gb/s | 1     |
| Ethernet              |              |         | 1.25    |         | Gb/s | 1     |

### Note:

1. Recommended operating conditions are those values outside of which functional performance is not intended, device reliability is not implied, and damage to the device may occur over an extended period of time. See Reliability Data Sheet for specific reliability performance.

## Process Compatibility

| Parameter                                       | Symbol       | Minimum | Typical | Maximum | Unit | Notes |
|---|--------------|---------|---------|---------|------|-------|
| Hand Lead Solder:<br>Temperature                | $T_{solder}$ |         |         | +260    | °C   |       |
| Time  | $t_{time}$   |         |         | 10      | sec  |       |
| Wave Solder and<br>Aqueous Wash:<br>Temperature | $T_{solder}$ |         |         | +260    | °C   | 1     |
| Time  | $t_{time}$   |         |         | 10      | sec  |       |

### Note:

1. Aqueous wash pressure < 110 psi.

## Transceiver Electrical Characteristics

( $T_C = -10\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{CC}T$ ,  $R = 3.3\text{ V} \pm 10\%$ )

| Parameter                                   | Symbol               | Minimum    | Typical | Maximum                | Unit   | Notes |
|---|----------------------|------------|---------|------------------------|--------|-------|
| <b>AC Electrical Characteristics</b>        |                      |            |         |                        |        |       |
| Power Supply Noise Rejection (Peak-to-Peak) | PSNR                 |            | 100     |                        | mV     | 1     |
| <b>DC Electrical Characteristics</b>        |                      |            |         |                        |        |       |
| Module Supply Current                       | $I_{CC}$             |            |         | 200                    | mA     |       |
| Power Dissipation                           | $P_{DISS}$           |            |         | 726                    | mW     |       |
| <b>Sense Outputs:</b>                       |                      |            |         |                        |        |       |
| Signal Detect [SD]                          | $V_{OH}$<br>$V_{OL}$ | 2.4        |         | $V_{CC}R + 0.3$<br>0.4 | V<br>V | 2     |
| <b>Control Inputs:</b>                      |                      |            |         |                        |        |       |
| Transmitter Disable [TX_DISABLE]            | $V_{IH}$<br>$V_{IL}$ | 2.4<br>0.0 |         | $V_{CC} + 0.3$<br>0.4  | V<br>V | 3     |

### Notes:

1. MSA filter is required on host board 10 Hz to 2 MHz.
2. LVTTTL, 1.2 k $\Omega$  internal pull-up resistor to  $V_{CC}R$ .
3. 9.0 k $\Omega$  internal pull-down resistor to  $V_{EE}$ .
4. Please refer to the HFBR-59L1AGEZ characterization report for typical values.



## Transmitter and Receiver Electrical Characteristics

( $T_C = -10\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{CC}T$ ,  $R = 3.3\text{ V} \pm 10\%$ )

| Parameter  | Symbol                 | Minimum | Typical | Maximum | Unit | Notes |
|--|------------------------|---------|---------|---------|------|-------|
| <b>Data Input:</b><br>Transmitter Differential Input<br>Voltage (TD +/-) | $V_i$                  | 400     |         | 2400    | mV   | 1     |
| <b>Data Output:</b><br>Receiver Differential Output<br>Voltage (RD +/-)  | $V_o$                  | 400     | 625     | 2000    | mV   | 2     |
| Receive Data Rise and Fall<br>Times (Receiver)                           | $T_{\text{rise/fall}}$ |         |         | 260     | ps   | 3     |
| Contributed Deterministic Jitter<br>(Receiver) 1.25 Gb/s                 | DJ                     |         |         | 0.212   | UI   | 4, 6  |
|  |                        |         |         | 170     | ps   |       |
| Contributed Deterministic Jitter<br>(Receiver) 1.0625 Gb/s               | DJ                     |         |         | 0.12    | UI   |       |
|  |                        |         |         | 113     | ps   |       |
| Contributed Random Jitter<br>(Receiver) 1.25 Gb/s                        | RJ                     |         |         | 0.120   | UI   | 5, 6  |
|  |                        |         |         | 96      | ps   |       |
| Contributed Random Jitter<br>(Receiver) 1.0625 Gb/s                      | RJ                     |         |         | 0.098   | UI   |       |
|  |                        |         |         | 92      | ps   |       |

### Notes:

- Internally ac coupled and terminated (100 Ohm differential). These levels are compatible with CML and LVPECL voltage swings.
- Internally ac coupled with internal 50 ohm pullups to  $V_{CC}$  (single-ended) and a required external 100 Ohm differential load termination.
- 20% - 80% rise and fall times measured with a 500 MHz signal utilizing a 1010 data pattern.
- Contributed DJ is measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern.
- Contributed RJ is calculated for  $1E-12$  BER by multiplying the RMS jitter (measured on a single rise or fall edge) from the oscilloscope by 14. Per the FC-PI standard (Table 13 - MM jitter output, note 1), the actual contributed RJ is allowed to increase above its limit if the actual contributed DJ decreases below its limits, as long as the component output DJ and TJ remain within their specified FC-PI maximum limits with the worst case specified component jitter input.
- In a network link, each component's output jitter equals each component's input jitter combined with each component's contributed jitter.  
Contributed DJ adds in a linear fashion and contributed RJ adds in a RMS fashion. In the Fibre Channel specification, there is a table specifying the input and output DJ and TJ for the receiver at each data rate. In that table, RJ is found from  $TJ - DJ$ , where the RX input jitter is noted as Gamma R, and the Rx output jitter is noted as Delta R. The HFBR-59L1AGEZ contributed jitter is such that, if the maximum specified input jitter is present, and is combined with our maximum contributed jitter, then we meet the specified maximum output jitter limits listed in the FC-PI MM jitter specification table.
- Please refer to the HFBR-59L1AGEZ characterization report for typical values.

## Transmitter Optical Characteristics

( $T_C = -10\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{CC,T}$ ,  $R = 3.3\text{ V} \pm 10\%$ )

| Parameter   | Symbol                 | Minimum | Typical | Maximum | Unit          | Notes  |
|---|------------------------|---------|---------|---------|---------------|--|
| Output Optical Power (Average)                                | POUT                   | -9.5    |         | 0       | dBm           | 50/125 $\mu\text{m}$<br>NA = 0.2<br>Note 1     |
|   | POUT                   | -9.5    |         | 0       | dBm           | 62.5/125 $\mu\text{m}$<br>NA = 0.275<br>Note 1 |
| Optical Extinction Ratio                                      | ER                     | 9       |         |         | dB            |  |
| Optical Modulation Amplitude<br>(Peak-to-Peak) 1.0625 Gb/s    | OMA                    | 156     |         |         | $\mu\text{W}$ | FC-PI Std<br>Note 3                            |
| Center Wavelength   | $\lambda_c$            | 830     |         | 860     | nm            | FC-PI Std                                      |
| Spectral Width - rms  | s                      |         |         | 0.85    | nm            | FC-PI Std                                      |
| Optical Rise/Fall Time  | $T_{\text{rise/fall}}$ |         |         | 150     | ps            | 20%-80%,<br>FC-PI Std                          |
| RIN <sub>12</sub> (OMA), maximum                              | RIN                    |         |         | -117    | dB/Hz         | FC-PI Std                                      |
| Contributed Deterministic Jitter<br>(Transmitter) 1.25 Gb/s   | DJ                     |         |         | 0.1     | UI            | Notes 3, 4                                     |
|   | DJ                     |         |         | 80      | ps            |  |
| Contributed Deterministic Jitter<br>(Transmitter) 1.0625 Gb/s | DJ                     |         |         | .09     | UI            | Notes 3, 4                                     |
|   | DJ                     |         |         | 85      | ps            |  |
| Contributed Random Jitter<br>(Transmitter) 1.25 Gb/s          | RJ                     |         |         | .184    | UI            | Notes 4, 5                                     |
|   | RJ                     |         |         | 147     | ps            |  |
| Contributed Random Jitter<br>(Transmitter) 1.0625 Gb/s        | RJ                     |         |         | .177    | UI            | Notes 4, 5                                     |
|   | RJ                     |         |         | 167     | ps            |  |
| $P_{\text{OUT}}$ TX_DISABLE Asserted                          | $P_{\text{OFF}}$       |         |         | -35     | dBm           |  |

### Notes:

1. Max Pout is the lesser of 0 dBm or Maximum allowable per Eye Safety Standard.
2. An OMA of 156 is approximately equal to an average power of -10 dBm assuming an Extinction Ratio of 9 dB.
3. Contributed DJ is measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern.
4. Contributed RJ is calculated for 1E-12 BER by multiplying the RMS jitter (measured on a single rise or fall edge) from the oscilloscope by 14. Per the FC-PI standard (Table 13 - MM jitter output, note 1), the actual contributed RJ is allowed to increase above its limit if the actual contributed DJ decreases below its limits, as long as the component output DJ and TJ remain within their specified FC-PI maximum limits with the worst case specified component jitter input.
5. In a network link, each component's output jitter equals each component's input jitter combined with each component's contributed jitter. Contributed DJ adds in a linear fashion and contributed RJ adds in a RMS fashion. In the Fibre Channel specification, there is a table specifying the input and output DJ and TJ for the transmitter at each data rate. In that table, RJ is found from  $TJ - DJ$ , where the TX input jitter is noted as Delta T, and the TX output jitter is noted as Gamma T. The HFBR-59L1AGEZ contributed jitter is such that, if the maximum specified input jitter is present, and is combined with our maximum contributed jitter, then we meet the specified maximum output jitter limits listed in the FC-PI MM jitter specification table.
6. Please refer to the HFBR-59L1AGEZ characterization report for typical values.

## Receiver Optical Characteristics

( $T_C = -10\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{CC,T}$ ,  $R = 3.3\text{ V} \pm 10\%$ )

| Parameter  | Symbol      | Minimum | Typical | Maximum | Unit          | Notes               |
|--|-------------|---------|---------|---------|---------------|---------------------|
| Optical Power  | PIN         |         |         | 0       | dBm           | FC-PI Std           |
| Receiver Sensitivity (Optical Input Power) 1.25 Gb/s             | PRMIN       |         |         | -17     | dBm           | Note 1              |
| Min Optical Modulation Amplitude (Peak-to-Peak) 1.0625 Gb/s      | OMA         | 31      |         |         | $\mu\text{W}$ | FC-PI Std<br>Note 2 |
| Stressed Receiver Sensitivity 62.5 $\mu\text{m}$ fiber 1.25 Gb/s | PRMIN       |         |         | -12.5   | dBm           | Note 3              |
| 62.5 $\mu\text{m}$ fiber 1.0625 Gb/s                             | OMA         | 67      |         |         | $\mu\text{W}$ |                     |
| 50 $\mu\text{m}$ fiber 1.25 Gb/s                                 | PRMIN       |         |         | -13.5   | dBm           | Note 4              |
| 50 $\mu\text{m}$ fiber 1.0625 Gb/s                               | OMA         | 55      |         |         | $\mu\text{W}$ |                     |
| Return Loss  |             | 12      |         |         | dB            | FC-PI Std           |
| Signal Detect - De-Assert  | $P_D$       | -31     |         | -17.5   | dBm           | Note 5              |
| Signal Detect - Assert   | $P_A$       |         |         | -17.0   | dBm           | Note 5              |
| Signal Detect - Hysteresis                                       | $P_A - P_D$ | 0.5     | 2.1     | 5       | dB            |                     |

### Notes:

- Sensitivity measurements are made at eye center with  $\text{BER} = 1\text{E-}12$ .
- An OMA of 31 is approximately equal to an average power of  $-17\text{ dBm}$  assuming an Extinction Ratio of 9 dB.
- 1.25 Gb/s Stressed receiver vertical eye closure penalty (ISI) min. is 2.2 dB for 50  $\mu\text{m}$  fiber and 2.6 dB for 62.5  $\mu\text{m}$  fiber. Stressed receiver DCD component min. (at TX) is 65 ps.
- 1.0625 Gb/s Stressed receiver vertical eye closure penalty (ISI) min. is 0.96 dB for 50  $\mu\text{m}$  fiber and 2.18 dB for 62.5  $\mu\text{m}$  fiber. Stressed receiver DCD component min. (at TX) is 80 ps.
- These average power values are specified with an Extinction Ratio of 9dB. The Signal Detect circuitry responds to OMA (peak-to-peak) power, not to average power.
- Please refer to the HFBR-59L1AGEZ characterization report for typical values.

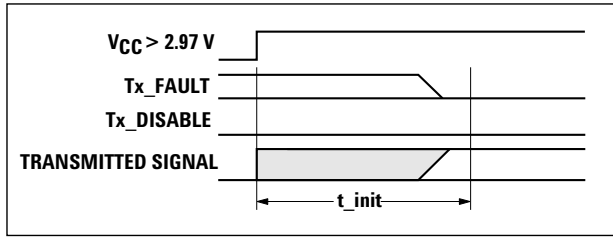
## Transceiver Timing Characteristics

( $T_C = -10\text{ }^\circ\text{C}$  to  $+85\text{ }^\circ\text{C}$ ,  $V_{CC,T}$ ,  $R = 3.3\text{ V} \pm 10\%$ )

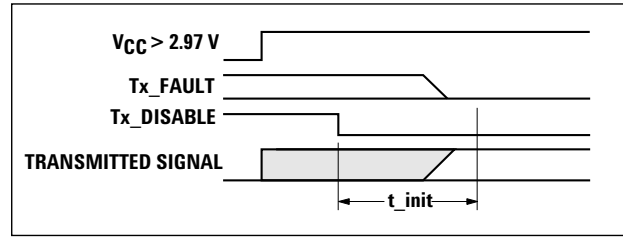
| Parameter              | Symbol                 | Minimum | Typical | Maximum | Unit          | Notes |
|------------------------|------------------------|---------|---------|---------|---------------|-------|
| TX Disable Assert Time | $t_{\text{off}}$       |         |         | 10      | $\mu\text{s}$ | 1     |
| TX Disable Negate Time | $t_{\text{on}}$        |         |         | 1       | ms            | 2     |
| Time to Initialize     | $t_{\text{init}}$      |         |         | 300     | ms            | 3     |
| TX Disable to Reset    | $t_{\text{reset}}$     | 10      |         |         | $\mu\text{s}$ | 4     |
| SD Assert Time         | $t_{\text{loss\_on}}$  |         |         | 100     | $\mu\text{s}$ | 5     |
| SD De-assert Time      | $t_{\text{loss\_off}}$ |         |         | 100     | $\mu\text{s}$ | 6     |

### Notes:

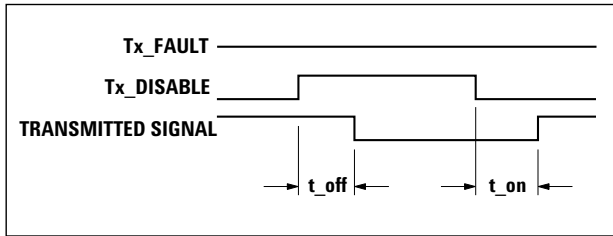
- Time from rising edge of TX Disable to when the optical output falls below 10% of nominal.
- Time from falling edge of TX Disable to when the modulated optical output rises above 90% of nominal.
- From power on or negation of TX Fault using TX Disable.
- Time TX Disable must be held high to reset TX Fault.
- Time from optical signal loss to SD assert. See transceiver timing diagrams.
- Time from optical signal recovery to SD deassert. See transceiver timing diagrams.



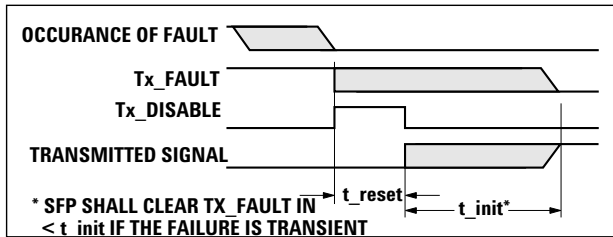
t-init: TX DISABLE DE-ASSERTED



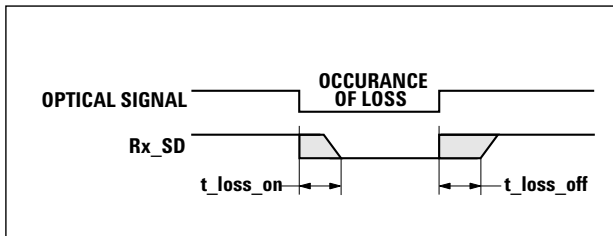
t-init: TX DISABLE ASSERTED



t-off & t-on: TX DISABLE ASSERTED THEN NEGATED

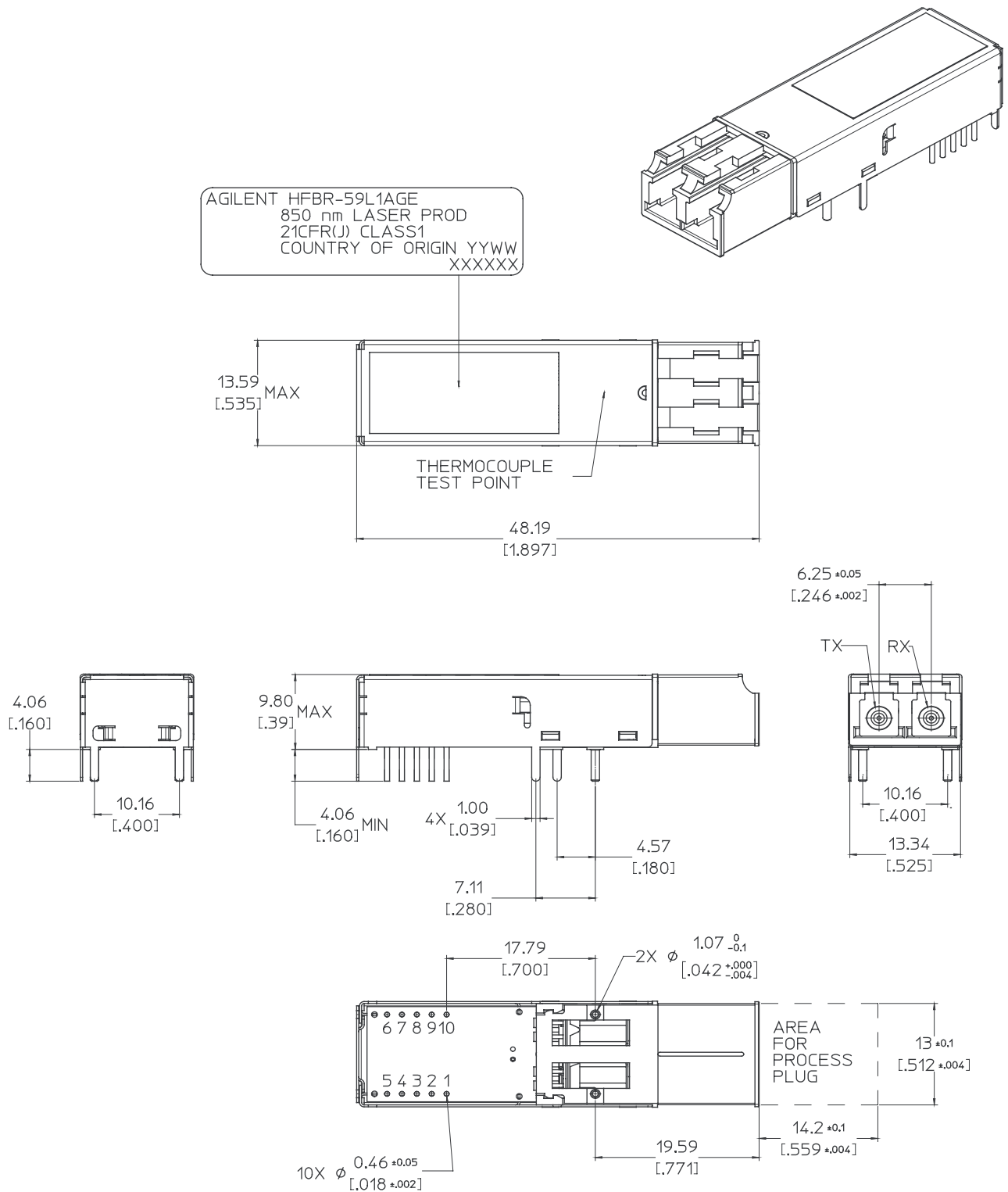


t-reset: TX DISABLE ASSERTED THEN NEGATED, TX SIGNAL RECOVERED



t-loss-on & t-loss-off

Figure 5. Transceiver timing diagrams.



DATA SHEET  
PRODUCTION ALTERNATE BEZEL WITH FOCIS-10A NOSE LENGTH  
AND LONG PINS (0.16 inch to stand off).

SAM SHAKHMAN  
7 FEBRUARY 2003

DIMENSIONS ARE IN MILLIMETERS [INCHES]

**Figure 6a. Module drawing.**

For product information and a complete list of distributors, please go to our web site: [www.avagotech.com](http://www.avagotech.com)

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