# AFCT-5701Z and AFCT-5705Z

Families of Single-Mode Small Form Factor Pluggable (SFP) Optical Transceivers with Optional DMI for Gigabit Ethernet (1.25 GBd) and Fibre Channel (1.0625 GBd)

## Data Sheet

### Description

The AFCT-570*x*Z family of Small Form Factor Pluggable (SFP) LC optical transceivers offers a wide range of design options, including optional DMI features (further described later), two temperature ranges (extended or industrial), and choice of standard or bail delatch. The AFCT-5705Z family targets applications requiring DMI, while the AFCT-5701Z family is streamlined for those applications where DMI is not needed. Throughout this datasheet, AFCT-570*x*Z will refer to the entire product family encompassing this full range of product options.

### Part Number Options

The AFCT-570*x*Z SFP family consists of the following products:

| Part Number | DMI | Temperature | Latch Design |
|---|---|---|---|
| AFCT-5701LZ | No | Extended | Standard |
| AFCT-5701PZ | No | Extended | Bail |
| AFCT-5701ALZ | No | Industrial | Standard |
| AFCT-5701APZ | No | Industrial | Bail |
| AFCT-5705LZ | Yes | Extended | Standard |
| AFCT-5705PZ | Yes | Extended | Bail |
| AFCT-5705ALZ | Yes | Industrial | Standard |
| AFCT-5705APZ | Yes | Industrial | Bail |

* Extended Temperature Range is -10 to 85 degrees C
Industrial Temperature Range is -40 to 85 degrees C

### Related Products

- AFBR-5705Z SFP family: 1.25GBd Ethernet (1000BASE-SX) & 1.0625GBd Fibre Channel with DMI
- AFBR-5701Z SFP family: 1.25GBd Ethernet (1000BASE-SX) & 1.0625GBd Fibre Channel without DMI
- AFCT-5715Z SFP family: 1.25GBd Ethernet (1000BASE-LX) with DMI
- AFCT-5710Z SFP family: 1.25GBd Ethernet (1000BASE-LX) without DMI

### Features

- ROHS-6 Compliant
- Optional Digital Diagnostic Monitoring available
  - AFCT-5701Z family: without DMI
  - AFCT-5705Z family: with DMI
- Per SFF-8472, diagnostic features on AFCT-5705Z family enable Diagnostic Monitoring Interface for optical transceivers with real-time monitoring of:
  - Transmitted optical power
  - Received optical power
  - Laser bias current
  - Temperature
  - Supply voltage
- Compliant to IEEE 802.3Z Gigabit Ethernet (1.25 GBd) 1000BASE-LX & ANSI Fibre Channel Physical Interfaces (FC-PI 100-SM-LC-L)
- Small Form Factor Pluggable (SFP) Multi-Source Agreement (MSA) compliant
- Manufactured in an ISO 9001 compliant facility
- Hot-pluggable
- Temperature options
  (Extended) -10°C to +85°C
  (Industrial) -40°C to +85°C
- +3.3 V dc power supply
- 1310 nm longwave laser
- Eye safety certified:
  - US 21 CFR(J)
  - IEC 60825-1 (+All)
- LC-Duplex fiber connector compatible
- Link Lengths at 1.0625 GBd:
  - up to 10 km - SMF
- Link Lengths at 1.25 GBd:
  - 0.5 to 550 m - 50 µm MMF
  - 0.5 to 550 m - 62.5 µm MMF
  - 0.5 m to 10 km - SMF

### Applications

- Ethernet Switch
- Enterprise Router
- Broadband aggregation and wireless infrastructure
- Switched backplane applications
- File server interface
- Storage applications including Fibre Channel and iSCSCI

## Overview

The AFCT-570*x*Z family is compliant with both IEEE 802.3Z (1000BASE-LX) and Fibre Channel 100-SM-LC-L. It also complies with the SFP Multi-Source Agreement (MSA) specification. These transceivers are intended for premise, public and access networking applications. They are qualified in accordance with GR-468-CORE, and transmit data over single-mode (SM) fiber for a link distance of 10 km, in excess of the standard.

The AFCT-5705Z family of optical transceivers adds digital diagnostic monitoring to standard SFP functionality, enabling fault isolation, components monitoring and failure prediction capabilities.

## General Features

The AFCT-570*x*Z is compliant to 1 GbE and 1G FC specifications. This includes specifications for the signal coding, optical fiber and connector types, optical and electrical transmitter characteristics, optical and electrical receiver characteristics, jitter characteristics, and compliance testing methodology for the aforementioned.

This transceiver is capable of implementing both Single Mode (SM) and Multimode (MM) optical fiber applications in that order of precedence in the event of conflicting specifications. In addition, the SM link type exceeds the 2 m to 5 km 1000BASE-LX specification by achieving compliance over 2 m to 10 km. The MM link type is expected to meet the 62.5 µm MMF specification when used with an "offset launch" fiber.

## SFP MSA Compliance

The product package is compliant with the SFP MSA with the LC connector option. The SFP MSA includes specifications for mechanical packaging and performance as well as dc, ac and control signal timing and performance.

The power supply is 3.3 V dc.

The High Speed I/O (HSIO) signal interface is a Low Voltage Differential type. It is ac coupled and terminated internally to the module. The internal termination is a 100 Ohm differential load.

## Installation

The AFCT-570*x*Z can be installed in or removed from any MSA-compliant Pluggable Small Form Factor (SFP) port regardless of whether the host equipment is operating or not. The module is simply inserted, electrical-interface first, under finger-pressure. Controlled hot-plugging is ensured by 3-stage pin sequencing at the electrical interface. This printed circuit board card-edge connector is depicted in Figure 2.

As the module is inserted, first contact is made by the housing ground shield, discharging any potentially component-damaging static electricity. Ground pins engage next and are followed by Tx and Rx power supplies. Finally, signal lines are connected. Pin functions and sequencing are listed in Table 2.

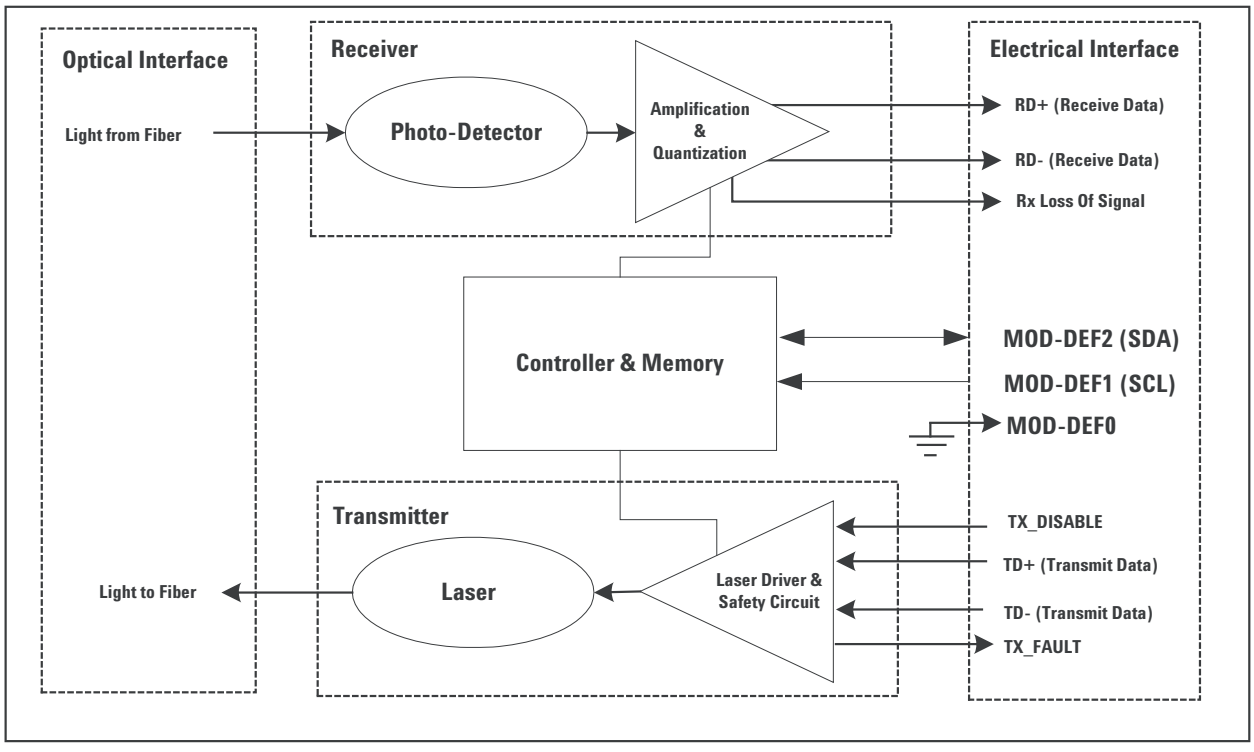



**Figure 1. Transceiver Functional Diagram**

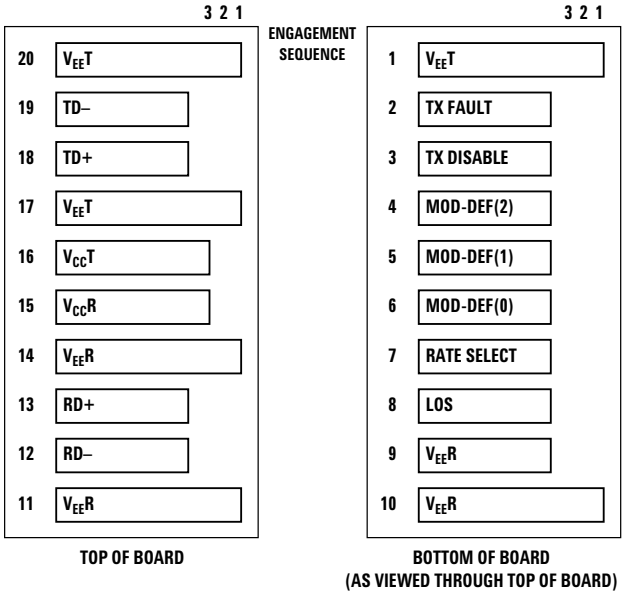



**Figure 2. Pin description of the SFP electrical interface.**

## Transmitter Section

The transmitter section includes a 1310 nm Fabry-Perot laser 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 a LC optical connector.

The transmitter has full IEC 60825 and CDRH Class 1 eye safety.

## TX_DISABLE

The transmitter output can be disabled by asserting pin 3, TX_DISABLE. A high signal asserts this function while a low signal allows normal laser operation. In addition, via the 2-wire serial interface the transmitter output can be disabled (address A2h, byte 110, bit 6) or monitored (address A2h, byte 110, bit 7). The contents of A2h, byte 110, bit 6 are logic OR'd with hardware Tx_Disable (pin 3) to control transmitter operation. In the event of a transceiver fault, such as the activation of the eye safety circuit, toggling of the TX_DISABLE will reset the transmitter, as depicted in Figure 4.

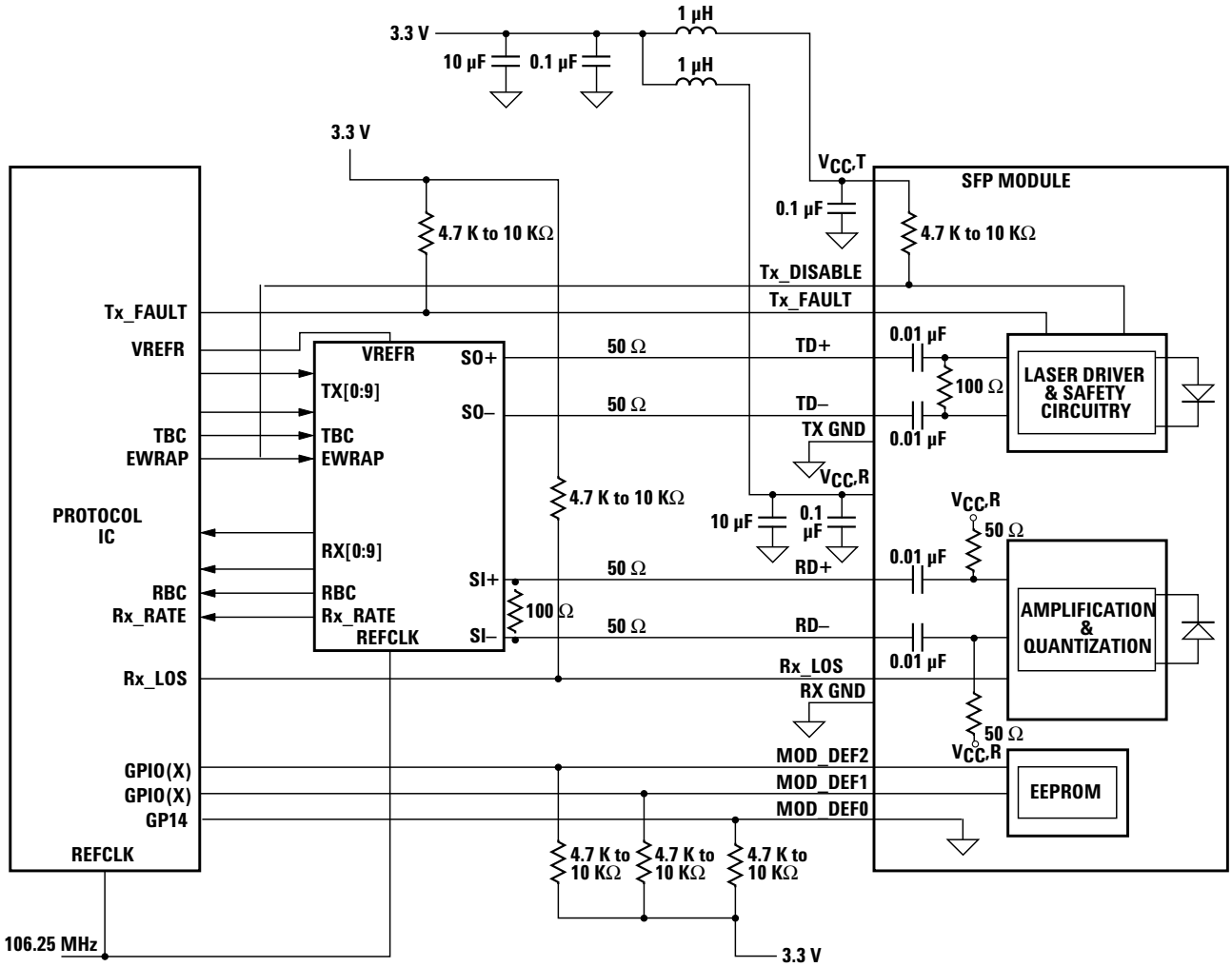



**Figure 3. Typical Application Configuration**

### TX_FAULT

A laser fault or a low VCC condition will activate the transmitter fault signal, TX_FAULT, and disable the laser. This signal is an open collector output (pull-up required on the host board); A low signal indicates normal laser operation and a high signal indicates a fault. The TX_FAULT will be latched high when a laser fault occurs and is cleared by toggling the TX_DISABLE input or power cycling the transceiver. The TX_FAULT is not latched for Low VCC. The transmitter fault condition can also be monitored via the two-wire serial interface (address A2h, byte 110, bit 2).

### Eye Safety Circuit

Under normal operating conditions, the laser power will be maintained below the eye-safety limit. If the eye safety limit is exceeded at any time, a laser fault will occur and the TX_FAULT output will be activated.

### Receiver Section

The receiver section for the AFCT-570*x*Z contains an InGaAs/InP photo detector and a preamplifier mounted in an optical subassembly. This optical subassembly is coupled to a post amplifier/decision circuit on a circuit board. The design of the optical subassembly provides better than 12 dB Optical Return Loss (ORL).

Connection to the receiver is provided via a LC optical connector.

### RX_LOS

The receiver section contains a loss of signal (RX_LOS) circuit to indicate when the optical input signal power is insufficient for Fibre Channel compliance. A high signal indicates loss of modulated signal, indicating link failure such as a broken fiber or a failed transmitter. RX_LOS can be also be monitored via the two-wire serial (address A2h, byte 110, bit 1).

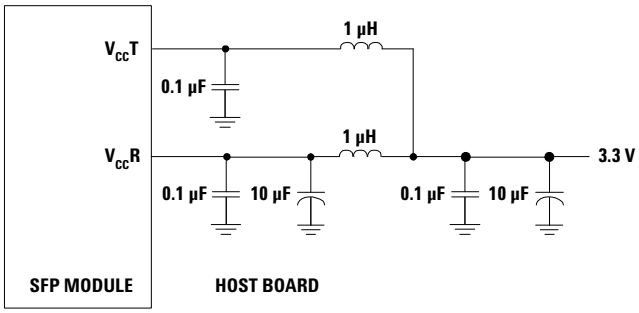



**Figure 4. MSA required power supply filter**

### Functional Data I/O

Avago's AFCT-570*x*Z transceiver is designed to accept industry standard differential signals. The transceiver provides an AC-coupled, internally terminated data interface. Bias resistors and coupling capacitors have been included within the module to reduce the number of components required on the customer's board. Figure 2 illustrates the recommended interface circuit.

### Digital Diagnostic Interface and Serial Identification

The AFCT-570*x*Z family complies with the SFF-8074i specification, which defines the module's serial identification protocol to use the 2-wire serial CMOS EEPROM protocol of the ATMEL AT24C01A or similar. Standard SFP EEPROM bytes 0-255 are addressed per SFF-8074i at memory address 0xA0 (A0h).

As an enhancement to the conventional SFP interface defined in SFF-8074i, the AFCT-5705Z is also compliant to SFF-8472 (the digital diagnostic interface for SFP). This enhancement adds digital diagnostic monitoring to standard SFP functionality, enabling failure prediction, fault isolation, and component monitoring capabilities.

Using the 2-wire serial interface, the AFCT-5705Z provides real time access to transceiver internal supply voltage and temperature, transmitter output power, laser bias current and receiver average input power, allowing a host to predict system compliance issues. These five parameters are internally calibrated, per the MSA. New digital diagnostic information is accessed per SFF-8472 using EEPROM bytes 0-255 at memory address 0xA2 (A2h).

The digital diagnostic interface also adds the ability to disable the transmitter (TX_DISABLE), monitor for Transmitter Faults (TX_FAULT) and monitor for Receiver Loss of Signal (RX_LOS).

Contents of the MSA-compliant serial ID memory are shown in Tables 10 through 14. The SFF-8074i and SFF-8472 specifications are available from the SFF Committee at http://www.sffcommittee.org.

### Predictive Failure Identification

The diagnostic information allows the host system to identify potential link problems. Once identified, a fail-over technique can be used to isolate and replace suspect devices before system uptime is impacted.

### Compliance Prediction

The real-time diagnostic parameters can be monitored to alert the system when operating limits are exceeded and compliance cannot be ensured.

### Fault Isolation

The diagnostic information can allow the host to pinpoint the location of a link problem and accelerate system servicing and minimize downtime.

### Component Monitoring

As part of the host system monitoring, the real time diagnostic information can be combined with system level monitoring to ensure system reliability.

### Application Support

An Evaluation Kit and Reference Designs are available to assist in evaluation of the AFCT-570*x*Z SFPs. Please contact your local Field Sales representative for availability and ordering details.

### Operating Temperature

The AFCT-570*x*Z family is available in either Extended (-10 to +85°C) or Industrial (-40 to +85°C) temperature ranges.

### Power Supply Noise

The AFCT-570*x*Z can withstand an injection of PSN on the $V_{CC}$ lines of 100 mV ac with a degradation in eye mask margin of up to 10% on the transmitter and a 1 dB sensitivity penalty on the receiver. This occurs when the product is used in conjunction with the MSA recommended power supply filter shown in Figure 3.

### Regulatory Compliance

The transceiver regulatory compliance is provided in Table 1 as a figure of merit to assist the designer. The overall equipment design will determine the certification level.

**Table 1. Regulatory Compliance**

| Feature | Test Method | Performance |
|---|---|---|
| Electrostatic Discharge (ESD) to the Electrical Pins | MIL-STD-883C Method 3015.4<br>JEDEC/EIA JESD22-A114-A | Class 2 (>2000 Volts) |
| Electrostatic Discharge (ESD) to the Duplex LC Receptacle | Bellcore GR1089-CORE | 25 kV Air Discharge |
| | | 10 Zaps at 8 kV (contact discharge) on the electrical faceplate on panel. |
| Electromagnetic Interference (EMI) | FCC Class B | Applications with high SFP port counts are expected to be compliant; however, margins are dependent on customer board and chassis design. |
| Immunity | Variation of IEC 61000-4-3 | No measurable effect from a 10 V/m field swept from 80 to 1000 MHz applied to the transceiver without a chassis enclosure. |
| Eye Safety | US FDA CDRH AEL Class 1<br>EN (IEC) 60825-1, 2,<br>EN60950 Class 1 | CDRH certification # 9521220-132<br>TUV file 933/21201880/12 |
| Component Recognition | Underwriter's Laboratories and Canadian Standards Association Joint Component Recognition for Information Technology Equipment Including Electrical Business Equipment | UL file # E173874 |
| ROHS Compliance | | Less than 1000ppm of: cadmium, lead, mercury, hexavalent chromium, polybrominated biphenyls, and polybrominated biphenyl ethers |

### Electrostatic Discharge (ESD)

There are two conditions in which immunity to ESD damage is important:

The first condition is static discharge to the transceiver during handling such as when the transceiver is inserted into the transceiver port. To protect the transceiver, it is important to use normal ESD handling precautions including the use of grounded wrist straps, work benches, and floor mats in ESD controlled areas. The ESD sensitivity of the AFCT-570*x*Z is compatible with typical industry production environments.

The second condition is static discharge 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 AFCT-570*x*Z exceeds typical industry standards. Table 1 documents ESD immunity to both of these conditions.

### Electromagnetic Interference (EMI)

Most equipment designs using the AFCT-570*x*Z SFPs are subject to the requirements of the FCC in the United States, CENELEC EN55022 (CISPR 22) in Europe and VCCI in Japan. The metal housing and shielded design of the transceiver minimize EMI and provide excellent EMI performance.

### EMI Immunity

The AFCT-570*x*Z transceivers have a shielded design to provide excellent immunity to radio frequency electromagnetic fields which may be present in some operating environments.

### Eye Safety

The AFCT-570*x*Z transceivers provide Class 1 eye safety by design. Avago Technologies has tested the transceiver design for regulatory compliance, under normal operating conditions and under a single fault condition. See Table 1.

### Flammability

The AFCT-570*x*Z family of SFPs is compliant to UL 94V-0.

### Customer Manufacturing Processes

This module is pluggable and is not designed for aqueous wash, IR reflow, or wave soldering processes.

### Caution

The AFCT-570*x*Z contains no user-serviceable parts. Tampering with or modifying the performance of the AFCT-570*x*Z will result in voided product warranty. It may also result in improper operation of the transceiver circuitry, and possible over-stress of the laser source. Device degradation or product failure may result. Connection of the AFCT-570*x*Z to a non-approved optical source, operating above the recommended absolute maximum conditions 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 re-identify the laser product under the provisions of U.S. 21 CF.

**Table 2. Pin description**

| Pin | Name | Function/Description | Engagement Order(insertion) | Notes |
|---|---|---|---|---|
| 1 | VeeT | Transmitter Ground | 1 | |
| 2 | TX Fault | Transmitter Fault Indication | 3 | 1 |
| 3 | TX Disable | Transmitter Disable - Module disables on high or open | 3 | 2 |
| 4 | MOD-DEF2 | Module Definition 2 - Two wire serial ID interface | 3 | 3 |
| 5 | MOD-DEF1 | Module Definition 1 - Two wire serial ID interface | 3 | 3 |
| 6 | MOD-DEF0 | Module Definition 0 - Grounded in module | 3 | 3 |
| 7 | Rate Selection | Not Connected | 3 | |
| 8 | LOS | Loss of Signal | 3 | 4 |
| 9 | VeeR | Receiver Ground | 1 | |
| 10 | VeeR | Receiver Ground | 1 | |
| 11 | VeeR | Receiver Ground | 1 | |
| 12 | RD- | Inverse Received Data Out | 3 | 5 |
| 13 | RD+ | Received Data Out | 3 | 5 |
| 14 | VeeR | Reciver Ground | 1 | |
| 15 | VccR | Receiver Power -3.3 V ±5% | 2 | 6 |
| 16 | VccT | Transmitter Power -3.3 V ±5% | 2 | 6 |
| 17 | VeeT | Transmitter Ground | 1 | |
| 18 | TD+ | Transmitter Data In | 3 | 7 |
| 19 | TD- | Inverse Transmitter Data In | 3 | 7 |
| 20 | VeeT | Transmitter Ground | 1 | |

Notes:

1. TX Fault is an open collector/drain output which should be pulled up externally with a 4.7KΩ – 10 KΩ resistor on the host board to a supply <VccT+0.3 V or VccR+0.3 V. When high, this output indicates a laser fault of some kind. Low indicates normal operation. In the low state, the output will be pulled to < 0.8 V.
2. TX disable input is used to shut down the laser output per the state table below. It is pulled up within the module with a 4.7-10 KΩ 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 Disabled
3. Mod-Def 0,1,2. These are the module definition pins. They should be pulled up with a 4.7-10 KΩ resistor on the host board to a supply less than VccT +0.3 V or VccR+0.3 V.
   Mod-Def 0 is grounded by the module to indicate that the module is present
   Mod-Def 1 is clock line of two wire serial interface for optional serial ID
   Mod-Def 2 is data line of two wire serial interface for optional serial ID
4. LOS (Loss of Signal) is an open collector/drain output which should be pulled up externally with a 4.7 KΩ – 10 KΩ resistor on the host board to a supply < VccT,R+0.3 V. 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 < 0.8 V.
5. RD-/+: These are the differential receiver outputs. They are AC coupled 100 Ω differential lines which should be terminated with 100 Ω 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 must be between 370 and 2000 mV differential (185 – 1000 mV single ended) according to the MSA. Typically it will be 1500mv differential.
6. VccR and VccT are the receiver and transmitter power supplies. They are defined as 3.135 – 3.465 V at the SFP connector pin. The in-rush current will typically be no more than 30 mA above steady state supply current after 500 nanoseconds.
7. TD-/+: These are the differential transmitter inputs. They are AC coupled differential lines with 100 Ω differential termination inside the module. The AC coupling is done inside the module and is thus not required on the host board. The inputs will accept differential swings of 500 – 2400 mV (250 – 1200 mV single ended). However, the applicable recommended differential voltage swing is found in Table 5.

**Table 3. Absolute Maximum Ratings**

Absolute maximum ratings are those values beyond which functional performance is not intended, device reliability is not implied, and damage to the device may occur.

| Parameter | Symbol | Minimum | Maximum | Unit | Notes |
|---|---|---|---|---|---|
| Storage Temperature (non-operating) | $T_S$ | -40 | +100 | ° C | |
| Relative Humidity | RH | 5 | 95 | % | |
| Case Temperature | $T_C$ | -40 | 85 | ° C | |
| Supply Voltage | $V_{CC}$ | -0.5 | 3.8 | V | 1 |
| Control Input Voltage | $V_I$ | -0.5 | $V_{CC}$+0.5 | V | |

**Table 4. Recommended Operating Conditions**

Typical operating conditions are those values for which functional performance and device reliability is implied.

| Parameter | Symbol | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|---|
| Case Operating Temperature | | | | | | |
| AFCT-5701LZ/PZ & AFCT-5705LZ/PZ | $T_C$ | -10 | | +85 | ° C | |
| AFCT-5701ALZ/APZ & AFCT-5705ALZ/APZ | $T_C$ | -40 | | +85 | ° C | |
| Supply Voltage | $V_{CC}$ | 3.14 | 3.3 | 3.47 | V | |

**Table 5. Transceiver Electrical Characteristics**

| Parameter | Symbol | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|---|
| Module supply current | $I_{CC}$ | | 200 | 240 | mA | 2 |
| Power Dissipation | $P_{DISS}$ | | 660 | 830 | mW | 2 |
| **AC Electrical Characteristics** | | | | | | |
| Power Supply Noise Rejection (peak - peak) | PSNR | | 100 | | mV | 3 |
| Inrush Current | | | | 30 | mA | |
| **DC Electrical Characteristics** | | | | | | |
| **Sense Outputs:** | | | | | | |
| Transmit Fault (TX_FAULT) | $V_{OH}$ | 2.0 | | VccT, R+0.3 | V | 4 |
| Loss of Signal (LOS) MOD-DEF2 | $V_{OL}$ | | | 0.8 | V | |
| **Control Inputs:** | | | | | | |
| Transmitter Disable (TX_DISABLE) | $V_{IH}$ | 2.0 | | Vcc | V | 4,5 |
| MOD-DEF1, 2 | $V_{IL}$ | | | 0.8 | V | |
| **Data Input:** | | | | | | |
| Transmitter Differential Input Voltage (TD+/-) | $V_I$ | 500 | | 2400 | mV | 6 |
| **Data Ouput:** | | | | | | |
| Receiver Differential Output Voltage (RD+/-) | $V_O$ | 370 | | 1600 | mV | 7 |
| Receiver Data Rise and Fall Times | $T_{rf}$ | | | 400 | ps | |
| Receiver Contributed Deterministic Jitter(1.0625Gbps) | DJ | | | 0.13<br>122 | UI<br>ps | 8 |
| Receiver Contributed Total Jitter (1.0625Gbps) | TJ | | | 0.8<br>188 | UI<br>ps | 9 |
| Receiver Contributed Total Jitter (1.25Gbps) | TJ | | | 0.33<br>267 | UI<br>ps | 10 |

Notes:
1 The module supply voltages, $V_{cc}T$ and $V_{cc}R$, must not differ by more than 0.5V or damage to the device may occur.
2. Over temperature and Beginning of Life.
3. MSA filter is required on host board 10 Hz to 1 MHz. See Figure 3
4. LVTTL, External 4.7 - 10 KΩ Pull-Up Resistor required
5. LVTTL, Internal 4.7 - 10 KΩ Pull-Up Resistor required for TX_Disable
6. Internally ac coupled and terminated (100 Ohm differential)
7. Internally ac coupled and load termination located at the user SerDes
8. Contributed DJ is measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern
9. Contributed total jitter is calculated from DJ and RJ measurements using TJ = RJ + DJ. Contributed RJ is calculated for 1x10-12 BER by multiplying the RMS jitter (measured on a single rise or fall edge) from the oscilloscope by 14. Per FC-PI (Table 9 - SM 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.
10. Per IEEE 802.3

## Table 6. Transmitter Optical Characteristics

| Parameter | Symbol | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|---|
| Modulated Optical Output Power (OMA)<br>(Peak-to-Peak) 1.0625 Gb/s | OMA | 174<br>-7.6 | | | µW OMA<br>dBm OMA | Note 2 |
| Average Optical Output Power | POUT | -9.5 | | -3 | dBm | Note 1 |
| Optical Extinction Ratio | ER | 9 | | | dB | |
| TX Optical Eye Mask Margin 1.25 Gb/s | MM | 0 | 30 | | % | Notes 5, 6 |
| Center Wavelength | λC | 1270 | | 1355 | nm | Note 2 |
| Spectral Width - rms | σ, rms | | | 2.1 | nm | Note 2 |
| Optical Rise/Fall Time | tr, tf | | | 260 | ps | 20-80% |
| Relative Intensity Noise | RIN | | | -120 | dB/Hz | |
| Contributed Deterministic Jitter (Transmitter)<br>1.0625 Gb/s | DJ | | | 0.09<br>85 | UI<br>ps | Note 3 |
| Contributed Total Jitter (Transmitter)<br>1.0625 Gb/s | TJ | | | 0.27<br>251 | UI<br>ps | Note 4 |
| Contributed Total Jitter (Transmitter)<br>1.25 Gb/s | TJ | | | 0.284<br>227 | UI<br>ps | Note 5 |
| POUT TX_DISABLE Asserted | POFF | | | -45 | dBm | |

Notes:
1. Class 1 Laser Safety per FDA/CDRH
2. In conformance with FC-PI Figure 18, which defines allowable trade-off between wavelength, spectral width and OMA.
3. Contributed DJ is measured on an oscilloscope in average mode with 50% threshold and K28.5 pattern.
4. Contributed total jitter is calculated from DJ and RJ measurements using TJ = RJ + DJ. Contributed RJ is calculated for 1x10-12 BER by multiplying the RMS jitter (measured on a single rise or fall edge) from the oscilloscope by 14. Per FC-PI (Table 9 - SM 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. IEEE 802.3
6. Eye shall be measured with respect to the mask of the eye using filter defined in IEEE 802.3 section 38.6.5

**Table 7. Receiver Optical Characteristics**

| Parameter | Symbol | Minimum | Typical | Maximum | Unit | Notes |
|---|---|---|---|---|---|---|
| Input Optical Power | $P_{IN}$ | | | -3 | dBm | |
| Receiver Sensitivity | $P_{MIN}$ | | | -20 | dBm | 1, 2 |
| Stressed Receiver Sensitivity (Optical Average Input Power) 1.25Gbps | | | | -14.4 | dBm | 8 |
| Receiver Electrical 3 dB Upper Cutoff Frequency | | | | 1500 | MHz | |
| Operating Center Wavelength | $l_C$ | 1270 | | 1355 | nm | |
| Return Loss (minimum) | | 12 | | | dB | 9 |
| Loss of Signal - Assert | $P_A$ | -30 | | | dBm | 3 |
| Loss of Signal - De-Assert | $P_D$ | | | -20 | dBm | 3 |
| Loss of Signal - Hysteresis | $P_D - P_A$ | 0.5 | | | dB | |

Notes:
1. BER = $10^{-12}$
2. An average power of -20 dBm with an Extinction Ratio of 9 dB is approximately equivalent to an OMA of 15 µW.
3. These average power values are specified with an Extinction Ratio of 9 dB. The loss-of-signal circuitry responds to valid 8B/10B-encoded peak to peak input optical power, not average power.

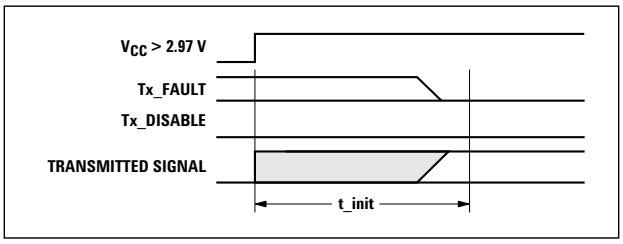
**Table 8. Transceiver Timing Characteristics**

| Parameter | Symbol | Minimum | Maximum | Unit | Notes |
|---|---|---|---|---|---|
| Hardware TX_DISABLE Assert Time | t_off | | 10 | µs | Note 1 |
| Hardware TX_DISABLE Negate Time | t_on | | 1 | ms | Note 2 |
| Time to initialize, including reset of TX_FAULT | t_init | | 300 | ms | Note 3 |
| Hardware TX_FAULT Assert Time | t_fault | | 100 | µs | Note 4 |
| Hardware TX_DISABLE to Reset | t_reset | 10 | | µs | Note 5 |
| Hardware RX_LOS Assert Time | t_loss_on | | 100 | µs | Note 6 |
| Hardware RX_LOS De-Assert Time | t_loss_off | | 100 | µs | Note 7 |
| Software TX_DISABLE Assert Time | t_off_soft | | 100 | ms | Note 8 |
| Software TX_DISABLE Negate Time | t_on_soft | | 100 | ms | Note 9 |
| Software Tx_FAULT Assert Time | t_fault_soft | | 100 | ms | Note 10 |
| Software Rx_LOS Assert Time | t_loss_on_soft | | 100 | ms | Note 11 |
| Software Rx_LOS De-Assert Time | t_loss_off_soft | | 100 | ms | Note 12 |
| Analog parameter data ready | t_data | | 1000 | ms | Note 13 |
| Serial bus hardware ready | t_serial | | 300 | ms | Note 14 |
| Write Cycle Time | t_write | | 10 | ms | Note 15 |
| Serial ID Clock Rate | f_serial_clock | | 400 | kHz | |

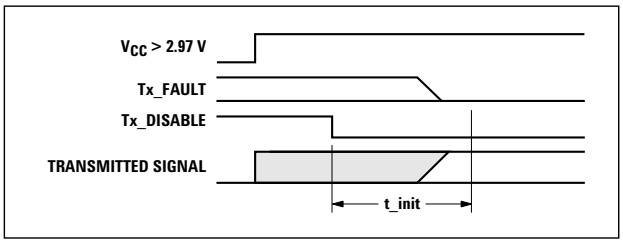
Notes:
1. Time from rising edge of TX_DISABLE to when the optical output falls below 10% of nominal.
2. Time from falling edge of TX_DISABLE to when the modulated optical output rises above 90% of nominal.
3. Time from power on or falling edge of Tx_Disable to when the modulated optical output rises above 90% of nominal.
4. From power on or negation of TX_FAULT using TX_DISABLE.
5. Time TX_DISABLE must be held high to reset the laser fault shutdown circuitry.
6. Time from loss of optical signal to Rx_LOS Assertion.
7. Time from valid optical signal to Rx_LOS De-Assertion.
8. Time from two-wire interface assertion of TX_DISABLE (A2h, byte 110, bit 6) to when the optical output falls below 10% of nominal. Measured from falling clock edge after stop bit of write transaction.
9. Time from two-wire interface de-assertion of TX_DISABLE (A2h, byte 110, bit 6) to when the modulated optical output rises above 90% of nominal.
10. Time from fault to two-wire interface TX_FAULT (A2h, byte 110, bit 2) asserted.
11. Time for two-wire interface assertion of Rx_LOS (A2h, byte 110, bit 1) from loss of optical signal.
12. Time for two-wire interface de-assertion of Rx_LOS (A2h, byte 110, bit 1) from presence of valid optical signal.
13. From power on to data ready bit asserted (A2h, byte 110, bit 0). Data ready indicates analog monitoring circuitry is functional.
14. Time from power on until module is ready for data transmission over the serial bus (reads or writes over A0h and A2h).
15. Time from stop bit to completion of a 1-8 byte write command.

**Table 9. Transceiver Digital Diagnostic Monitor (Real Time Sense) Characteristics**

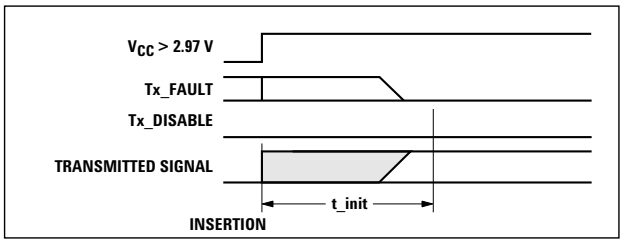
| Parameter | Symbol | Min | Units | Notes |
|---|---|---|---|---|
| Transceiver Internal Temperature Accuracy | $T_{INT}$ | ± 3.0 | °C | Valid from $T_C$ = -40 °C to +85 °C |
| Transceiver Internal Supply Voltage Accuracy | $V_{INT}$ | ± 0.1 | V | Valid over $V_{CC}$ = 3.3 V ± 5% |
| Transmitter Laser DC Bias Current Accuracy | $I_{INT}$ | ± 10 | % | Percentage of nominal bias value |
| Transmitted Average Optical Output Power Accuracy | $P_T$ | ± 3.0 | dB | Valid from 100 µW to 500µW, avg |
| Received Average Optical Input Power Accuracy | $P_R$ | ± 3.0 | dB | Valid from 10 µW to 500µW avg |



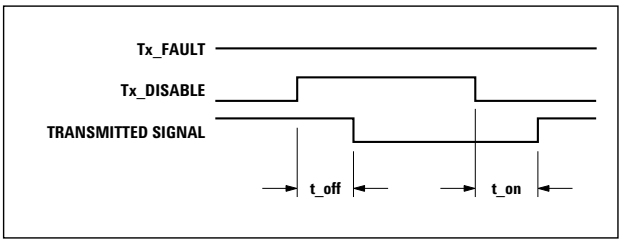

t-init: TX DISABLE NEGATED



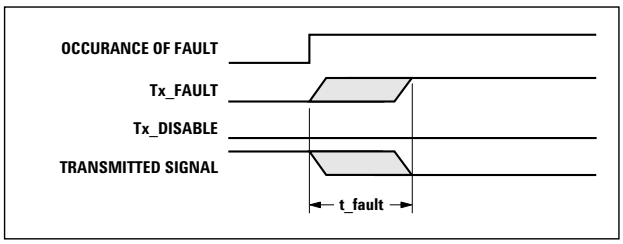

t-init: TX DISABLE ASSERTED



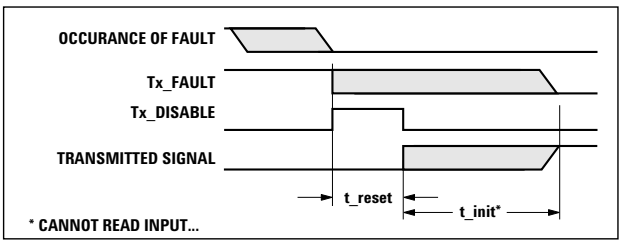

t-init: TX DISABLE NEGATED, MODULE HOT PLUGGED



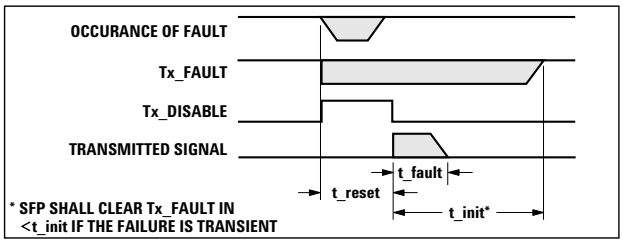

t-off & t-on: TX DISABLE ASSERTED THEN NEGATED



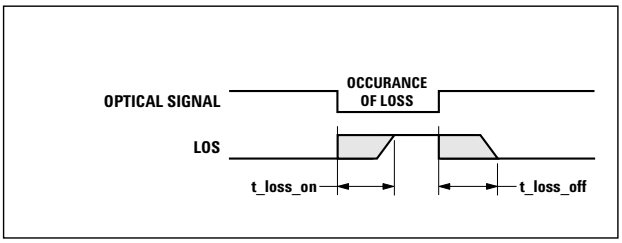

t-fault: TX FAULT ASSERTED, TX SIGNAL NOT RECOVERED




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




t-fault: TX DISABLE ASSERTED THEN NEGATED,
TX SIGNAL NOT RECOVERED




t-loss-on & t-loss-off

**Figure 5. Transceiver Timing Diagrams (Module Installed Except Where Noted)**

**Table 10. EEPROM Serial ID Memory Contents - Page A0h**

| Byte #Decimal | Data Hex | Notes | Byte #Decimal | Data Hex | Notes |
|---|---|---|---|---|---|
| 0 | 03 | SFP physical device | 37 | 00 | Hex Byte of Vendor OUI (note 4) |
| 1 | 04 | SFP function defined by serial ID only | 38 | 17 | Hex Byte of Vendor OUI (note 4) |
| 2 | 07 | LC optical connector | 39 | 6A | Hex Byte of Vendor OUI (note 4) |
| 3 | 00 | | 40 | 41 | "A" - Vendor Part Number ASCII character |
| 4 | 00 | | 41 | 46 | "F" - Vendor Part Number ASCII character |
| 5 | 00 | | 42 | 43 | "C" - Vendor Part Number ASCII character |
| 6 | 02 | 1000BASE-LX | 43 | 54 | "T" - Vendor Part Number ASCII character |
| 7 | 12 | long distance (per FC-PI) | 44 | 2D | "-" - Vendor Part Number ASCII character |
| 8 | 00 | | 45 | 35 | "5" - Vendor Part Number ASCII character |
| 9 | 01 | Single-mode (SM) | 46 | 37 | "7" - Vendor Part Number ASCII character |
| 10 | 01 | 100 MBytes/sec FC-PI speed (note 1) | 47 | 30 | "0" - Vendor Part Number ASCII character |
| 11 | 01 | Compatible with 8B/10B encoded data | 48 | | Note 5 |
| 12 | 0C | 1200 MBit/sec nominal bit rate | 49 | | Note 5 |
| 13 | 00 | | 50 | | Note 5 |
| 14 | 0A | | 51 | | Note 5 |
| 15 | 64 | | 52 | 20 | " " - Vendor Part Number ASCII character |
| 16 | 37 | Note 2 | 53 | 20 | " " - Vendor Part Number ASCII character |
| 17 | 37 | Note 3 | 54 | 20 | " " - Vendor Part Number ASCII character |
| 18 | 00 | | 55 | 20 | " " - Vendor Part Number ASCII character |
| 19 | 00 | | 56 | 30 | " " - Vendor Revision Number ASCII character |
| 20 | 41 | "A" - Vendor Name ASCII character | 57 | 30 | " " - Vendor Revision Number ASCII character |
| 21 | 56 | "V" - Vendor Name ASCII character | 58 | 30 | " " - Vendor Revision Number ASCII character |
| 22 | 41 | "A" - Vendor Name ASCII character | 59 | 30 | " " - Vendor Revision Number ASCII character |
| 23 | 47 | "G" - Vendor Name ASCII character | 60 | 05 | Hex Byte of Laser Wavelength (Note 6) |
| 24 | 4F | "O" - Vendor Name ASCII character | 61 | 1E | Hex Byte of Laser Wavelength (Note 6) |
| 25 | 20 | " " - Vendor Name ASCII character | 62 | 00 | |
| 26 | 20 | " " - Vendor Name ASCII character | 63 | | Checksum for Bytes 0-62 (Note 7) |
| 27 | 20 | " " - Vendor Name ASCII character | 64 | 00 | |
| 28 | 20 | " " - Vendor Name ASCII character | 65 | 1A | Hardware SFP TX_DISABLE, TX_FAULT & RX_LOS |
| 29 | 20 | " " - Vendor Name ASCII character | 66 | 00 | |
| 30 | 20 | " " - Vendor Name ASCII character | 67 | 00 | |
| 31 | 20 | " " - Vendor Name ASCII character | 68-83 | | Vendor Serial Number ASCII characters (Note8) |
| 32 | 20 | " " - Vendor Name ASCII character | 84-91 | | Vendor Date Code ASCII characters (Note 9) |
| 33 | 20 | " " - Vendor Name ASCII character | 92 | | Note 5 |
| 34 | 20 | " " - Vendor Name ASCII character | 93 | | Note 5 |
| 35 | 20 | " " - Vendor Name ASCII character | 94 | | Note 5 |
| 36 | 00 | | 95 | | Checksum for Bytes 64-94 (Note 7) |
| | | | 96 - 255 | 00 | |

Notes:
1. FC-PI speed 100 MBytes/sec is a serial bit rate of 1.0625 GBit/sec.
2. Link distance with 50/125 µm cable.
3. Link distance with 62.5/125 µm.
4. The IEEE Organizationally Unique Identifier (OUI) assigned to Avago Technologies is 00-17-6A (3 bytes hex).
5. See Table 11 on following page for part number extensions and data-fields.
6. Laser wavelength is represented in 16 unsigned bits. The hex representation of 1310 (nm) is 051E.
7. Addresses 63 and 95 are checksums calculated (per SFF-8472 and SFF-8074) and stored prior to product shipment.
8. Addresses 68-83 specify the ASCII serial number and will vary on a per unit basis.
9. Addresses 84-91 specify the ASCII date code and will vary on a per date code basis.

**Table 11. Part Number Extensions and Datafields**

| AFCT-5701ALZ | | | AFCT-5701APZ | | | AFCT-5701LZ | | | AFCT-5701PZ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** |
| 48 | 31 | 1 | 48 | 31 | 1 | 48 | 31 | 1 | 48 | 31 | 1 |
| 49 | 41 | A | 49 | 41 | A | 49 | 4C | L | 49 | 50 | P |
| 50 | 4C | L | 50 | 50 | P | 50 | 5A | Z | 50 | 5A | Z |
| 51 | 5A | Z | 51 | 5A | Z | 51 | 20 | | 51 | 20 | |
| 92 | 0 | | 92 | 0 | | 92 | 0 | | 92 | 0 | |
| 93 | 0 | | 93 | 0 | | 93 | 0 | | 93 | 0 | |
| 94 | 0 | | 94 | 0 | | 94 | 0 | | 94 | 0 | |

| AFCT-5705ALZ | | | AFCT-5705APZ | | | AFCT-5705LZ | | | AFCT-5705PZ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** | **Address** | **Hex** | **ASCII** |
| 48 | 35 | 5 | 48 | 35 | 5 | 48 | 35 | 5 | 48 | 35 | 5 |
| 49 | 41 | A | 49 | 41 | A | 49 | 4C | L | 49 | 50 | P |
| 50 | 4C | L | 50 | 50 | P | 50 | 5A | Z | 50 | 5A | Z |
| 51 | 5A | Z | 51 | 5A | Z | 51 | 20 | | 51 | 20 | |
| 92 | 68 | | 92 | 68 | | 92 | 68 | | 92 | 68 | |
| 93 | F0 | | 93 | F0 | | 93 | F0 | | 93 | F0 | |
| 94 | 1 | | 94 | 1 | | 94 | 1 | | 94 | 1 | |

**Table 12. EEPROM Serial ID Memory Contents - Address A2h (AFCT-5705Z family only)**

| Byte # Decimal | Notes | Byte # Decimal | Notes | Byte # Decimal | Notes |
|---|---|---|---|---|---|
| 0 | Temp H Alarm MSB[1] | 26 | Tx Pwr L Alarm MSB[4] | 104 | Real Time Rx $P_{AV}$ MSB[5] |
| 1 | Temp H Alarm LSB[1] | 27 | Tx Pwr L Alarm LSB[4] | 105 | Real Time Rx $P_{AV}$ LSB[5] |
| 2 | Temp L Alarm MSB[1] | 28 | Tx Pwr H Warning MSB[4] | 106 | Reserved |
| 3 | Temp L Alarm LSB[1] | 29 | Tx Pwr H Warning LSB[4] | 107 | Reserved |
| 4 | Temp H Warning MSB[1] | 30 | Tx Pwr L Warning MSB[4] | 108 | Reserved |
| 5 | Temp H Warning LSB[1] | 31 | Tx Pwr L Warning LSB[4] | 109 | Reserved |
| 6 | Temp L Warning MSB[1] | 32 | Rx Pwr H Alarm MSB[5] | 110 | Status/Control - see Table 13 |
| 7 | Temp L Warning LSB[1] | 33 | Rx Pwr H Alarm LSB[5] | 111 | Reserved |
| 8 | $V_{CC}$ H Alarm MSB[2] | 34 | Rx Pwr L Alarm MSB[5] | 112 | Flag Bits - see Table 14 |
| 9 | $V_{CC}$ H Alarm LSB[2] | 35 | Rx Pwr L Alarm LSB[5] | 113 | Flag Bit - see Table 14 |
| 10 | $V_{CC}$ L Alarm MSB[2] | 36 | Rx Pwr H Warning MSB[5] | 114 | Reserved |
| 11 | $V_{CC}$ L Alarm LSB[2] | 37 | Rx Pwr H Warning LSB[5] | 115 | Reserved |
| 12 | $V_{CC}$ H Warning MSB[2] | 38 | Rx Pwr L Warning MSB[5] | 116 | Flag Bits - see Table 14 |
| 13 | $V_{CC}$ H Warning LSB[2] | 39 | Rx Pwr L Warning LSB[5] | 117 | Flag Bits - see Table 14 |
| 14 | $V_{CC}$ L Warning MSB[2] | 40-55 | Reserved | 118 | Reserved |
| 15 | $V_{CC}$ L Warning LSB[2] | 56-94 | External Calibration Constants[6] | 119 | Reserved |
| 16 | Tx Bias H Alarm MSB[3] | 95 | Checksum for Bytes 0-94[7] | 120-122 | Reserved |
| 17 | Tx Bias H Alarm LSB[3] | 96 | Real Time Temperature MSB[1] | 123 | |
| 18 | Tx Bias L Alarm MSB[3] | 97 | Real Time Temperature LSB[1] | 124 | |
| 19 | Tx Bias L Alarm LSB[3] | 98 | Real Time Vcc MSB[2] | 125 | |
| 20 | Tx Bias H Warning MSB[3] | 99 | Real Time Vcc LSB[2] | 126 | |
| 21 | Tx Bias H Warning LSB[3] | 100 | Real Time Tx Bias MSB[3] | 127 | Reserved[8] |
| 22 | Tx Bias L Warning MSB[3] | 101 | Real Time Tx Bias LSB[3] | 128-247 | Customer Writable[9] |
| 23 | Tx Bias L Warning LSB[3] | 102 | Real Time Tx Power MSB[4] | 248-255 | Vendor Specific |
| 24 | Tx Pwr H Alarm MSB[4] | 103 | Real Time Tx Power LSB[4] | | |
| 25 | Tx Pwr H Alarm LSB[4] | | | | |

Notes:
1. Temperature (Temp) is decoded as a 16 bit signed twos compliment integer in increments of 1/256 °C.
2. Supply voltage ($V_{CC}$) is decoded as a 16 bit unsigned integer in increments of 100 µV.
3. Laser bias current (Tx Bias) is decoded as a 16 bit unsigned integer in increments of 2 µA.
4. Transmitted average optical power (Tx Pwr) is decoded as a 16 bit unsigned integer in increments of 0.1 µW.
5. Received average optical power (Rx Pwr) is decoded as a 16 bit unsigned integer in increments of 0.1 µW.
6. Bytes 55-94 are not intended from use with AFCT-5705xxxx, but have been set to default values per SFF-8472.
7. Bytes 95 is a checksum calculated (per SFF-8472) and stored prior to product shipment.
8. Byte 127 accepts a write but performs no action (reserved legacy byte).
9. Bytes 128-247 are write enabled (customer writable).

**Table 13. EEPROM Serial ID Memory Contents - Address A2h, Byte 110 (AFCT-5705Z family only)**

| Bit # | Status/Control Name | Description |
|---|---|---|
| 7 | Tx Disable State | Digital state of SFP Tx Disable Input Pin (1 = Tx_ Disable asserted) |
| 6 | Soft Tx Disable | Read/write bit for changing digital state of SFP Tx_Disable function[1] |
| 5 | Reserved | |
| 4 | Rx Rate Select State | Digital state of SFP Rate Select Input Pin (1 = full bandwidth of 155 Mbit)[2] |
| 3 | Reserved | |
| 2 | Tx Fault State | Digital state of the SFP Tx Fault Output Pin (1 = Tx Fault asserted) |
| 1 | Rx LOS State | Digital state of the SFP LOS Output Pin (1 = LOS asserted) |
| 0 | Data Ready (Bar) | Indicates transceiver is powered and real time sense data is ready (0 = Ready) |

**Notes:**
1. Bit 6 is logic OR'd with the SFP Tx_Disable input pin 3 ... either asserted will disable the SFP transmitter.
2. AFCT-5705Z does not respond to state changes on Rate Select Input Pin. It is internally hardwired to full bandwidth.

**Table 14. EEPROM Serial ID Memory Contents - Address A2h, Bytes 112, 113, 116, 117 (AFCT-5705Z family only)**

| Byte | Bit # | Flag Bit Name | Description |
|---|---|---|---|
| 112 | 7 | Temp High Alarm | Set when transceiver nternal temperature exceeds high alarm threshold. |
| | 6 | Temp Low Alarm | Set when transceiver internal temperature exceeds alarm threshold. |
| | 5 | $V_{CC}$ High Alarm | Set when transceiver internal supply voltage exceeds high alarm threshold. |
| | 4 | $V_{CC}$ Low Alarm | Set when transceiver internal supply voltage exceeds low alarm threshold. |
| | 3 | Tx Bias High Alarm | Set when transceiver laser bias current exceeds high alarm threshold. |
| | 2 | Tx Bias Low Alarm | Set when transceiver laser bias current exceeds low alarm threshold. |
| | 1 | Tx Power High Alarm | Set when transmitted average optical power exceeds high alarm threshold. |
| | 0 | Tx Power Low Alarm | Set when transmitted average optical power exceeds low alarm threshold. |
| 113 | 7 | Rx Power High Alarm | Set when received P_Avg optical power exceeds high alarm threshold. |
| | 6 | Rx Power Low Alarm | Set when received P_Avg optical power exceeds low alarm threshold. |
| | 0-5 | Reserved | |
| 116 | 7 | Temp High Warning | Set when transceiver internal temperature exceeds high warning threshold. |
| | 6 | Temp Low Warning | Set when transceiver internal temperature exceeds low warning threshold. |
| | 5 | $V_{CC}$ High Warning | Set when transceiver internal supply voltage exceeds high warning threshold. |
| | 4 | $V_{CC}$ Low Warning | Set when transceiver internal supply voltage exceeds low warning threshold. |
| | 3 | Tx Bias High Warning | Set when transceiver laser bias current exceeds high warning threshold. |
| | 2 | Tx Bias Low Warning | Set when transceiver laser bias current exceeds low warning threshold. |
| | 1 | Tx Power High Warning | Set when transmitted average optical power exceeds high warning threshold. |
| | 0 | Tx Power Low Warning | Set when transmitted average optical power exceeds low warning threshold. |
| 117 | 7 | Rx Power High Warning | Set when received P_Avg optical power exceeds high warning threshold. |
| | 9 | Rx Power Low Warning | Set when received P_Avg optical power exceeds low warning threshold. |
| | 0-5 | Reserved | |

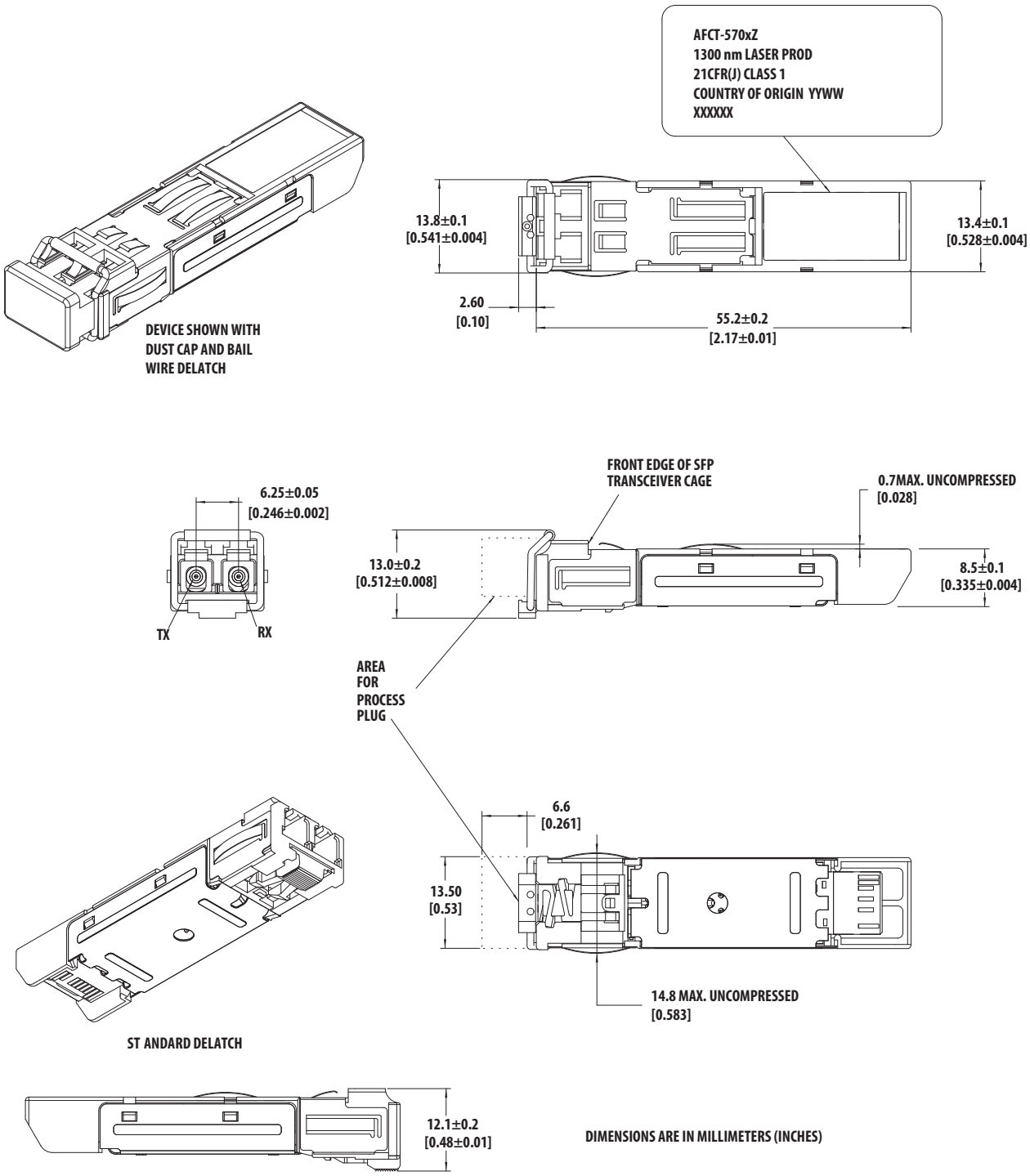
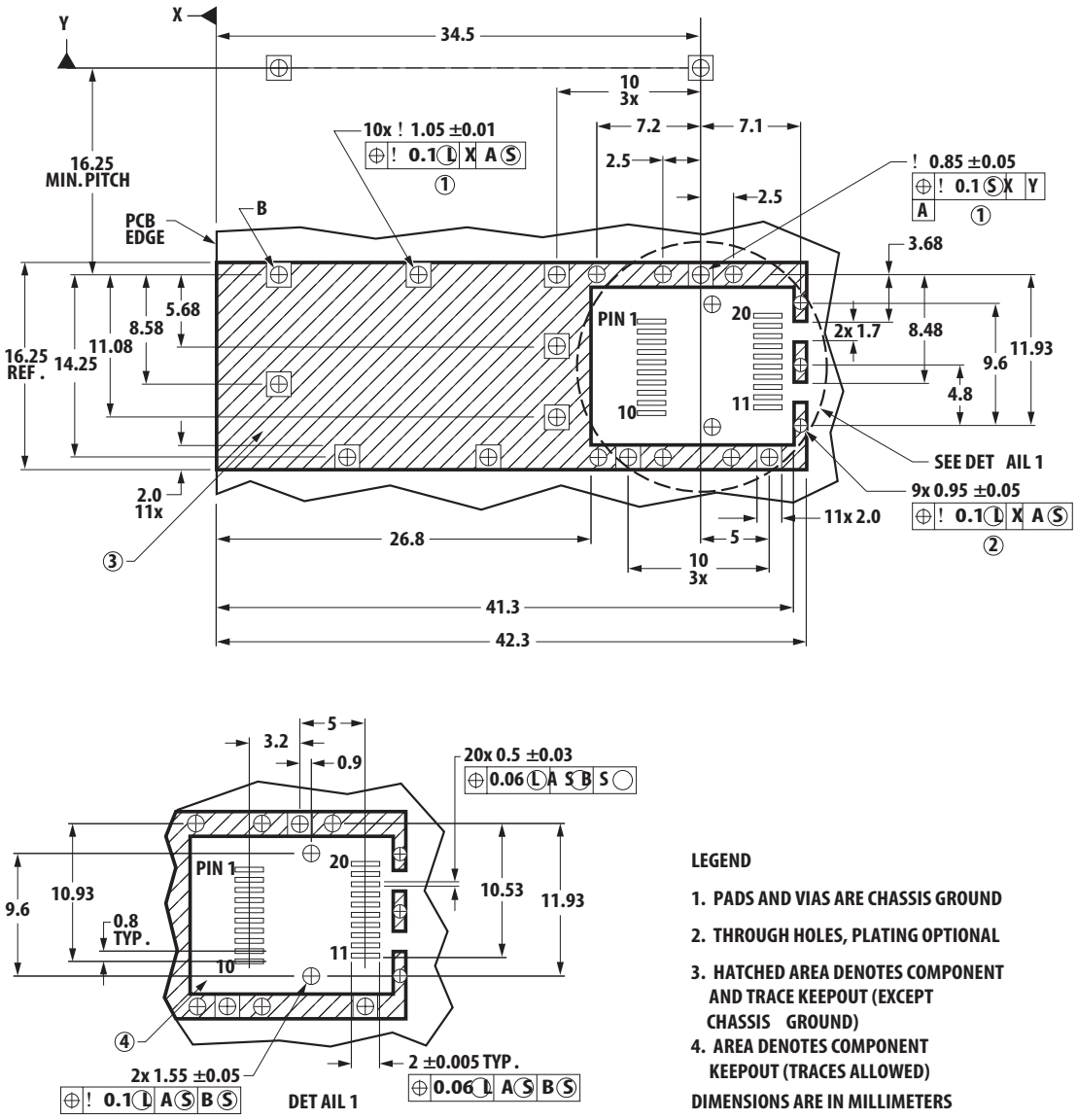



**Figure 6. Drawing of SFP Transceiver**

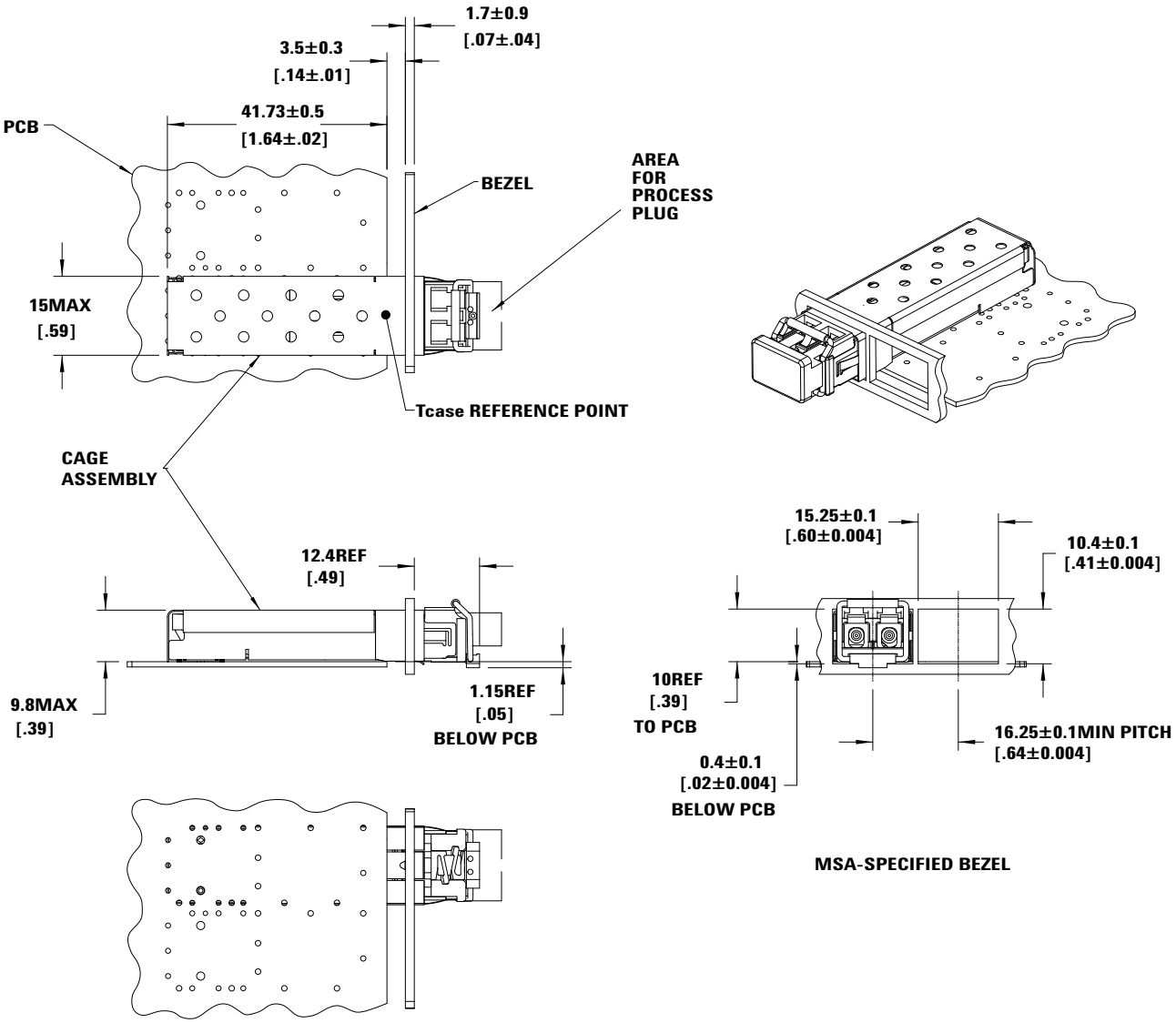



**LEGEND**

1. **PADS AND VIAS ARE CHASSIS GROUND**
2. **THROUGH 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 host board mechanical layout**




**DIMENSIONS ARE IN MILLIMETERS [INCHES].**

**Figure 8. Assembly Drawing**

**Ordering Information**

Please contact your local field sales engineer or one of Avago Technologies franchised distributors for ordering information. For technical information, please visit Avago Technologies' web-page at **www.avagotech.com** or contact one of Avago Technologies' regional Technical Response Centers.

For information related to SFF Committee documentation visit **www.sffcommittee.org**.

| | | | |
|---|---|---|---|
| AFCT-5705LZ | DMI | Extended Temperature (-10°C to 85°C) | Standard Delatch |
| AFCT-5705PZ | DMI | Extended Temperature (-10°C to 85°C) | Bail Delatch |
| AFCT-5705ALZ | DMI | Industrial Temperature (-40°C to 85°C) | Standard Delatch |
| AFCT-5705APZ | DMI | Industrial Temperature (-40°C to 85°C) | Bail Delatch |
| AFCT-5701LZ | No DMI | Extended Temperature (-10°C to 85°C) | Standard Delatch |
| AFCT-5701PZ | No DMI | Extended Temperature (-10°C to 85°C) | Bail Delatch |
| AFCT-5701ALZ | No DMI | Industrial Temperature (-40°C to 85°C) | Standard Delatch |
| AFCT-5701APZ | No DMI | Industrial Temperature (-40°C to 85°C) | Bail Delatch |

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