Agilent AFCT-57M5ATP 1310 nm Digital Diagnostic SFP, for Fibre Channel 2.125/1.0625 GBd and Ethernet 1.25 GBd

Data Sheet

Description

The AFCT-57M5ATP is a state of the art transceiver designed to provide a cost effective, high performance solution for 2.125 GBd and 1.0625 GBd Fibre Channel and 1.25 GBd Ethernet.

As an enhancement to the conventional SFP interface defined in SFF-8074i, the AFCT-57M5ATP is compliant to SFF-8472 (digital diagnostic interface for SFP). Using the 2-wire serial interface defined in the SFP MSA, the AFCT-57M5ATP provides real time temperature, supply voltage, laser bias current, laser average output power and received average input power. This information is in addition to the conventional SFP data. 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).

Applications

- Switch to switch interface
- Switched back-plane applications
- File server interface
- iSCSI applications

Related Products

- HFBR-0534: Evaluation Kit for Agilent SFP's with Diagnostic Monitoring Interface (DMI)
- AFCT-57L5ATP: 1310 nm Digital Diagnostics SFP for 1.0625 Gbd Fibre and GbE
- HFCT-5701LP: 1310 nm SFP for 1.0625 Gbd Fibre and GbE
- AFBR-57M5APZ RoHS Compliant: 850 nm Digital Diagnostics SFP for 2.125/1.0625 Gbd Fibre and GbE
- HFBR-57L5AP: 850 nm Digital Diagnostics SFP for 1.0625 Gbd Fibre Channel and GbE

Features

- Compliant with SFF-8472 Diagnostic Monitoring Interface for Optical Transceivers.
- Real time monitors of:
  - Transmitted Optical Power
  - Received Optical Power
  - Laser Bias Current
  - Temperature
  - Supply Voltage
- SFP Transceiver Specification
  - 2.125 GBd operation for FC- PI 200-SM-LC-L
  - 1.0625 GBd operation for FC- PI 100-SM-LC-L
  - 1.25 GBd operation for Gigabit Ethernet 1000Base-LX per IEEE draft P802.ah/D2.1
- Link Lengths at 2.125 GBd:
  - up to 10 km – SMF
- 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
- LC Duplex optical connector interface conforming to ANSI TIA/EIA604-10 (FOCIS 10A)
- 1310 nm Fabry-Perot laser technology
- IEC 60825-1 Class 1/CDRH Class 1 laser eye safe
- Hot Pluggable Form Factor

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Installation

The AFCT-57M5ATP can be installed in any SFF-8074i compliant Small Form Pluggable (SFP) port regardless of host equipment operating status. The AFCT-57M5ATP is hot-pluggable, allowing the module to be installed while the host system is operating and on-line. Upon insertion, the transceiver housing makes initial contact with the host board SFP cage, mitigating potential damage due to Electro-Static Discharge (ESD).

Digital Diagnostic Interface and Serial Identification

The 2-wire serial protocol is based on the ATMEL AT24C01A. The conventional SFP EEPROM memory, bytes 0-255 at memory address 0xA0, is organized in compliance to SFF-8074i. The new digital diagnostic information, bytes 0-255 at memory address 0xA2, is compliant to SFF-8472. The new diagnostic information provides the opportunity for Predictive Failure Identification, Compliance Prediction, Fault Isolation and Component Monitoring.

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.

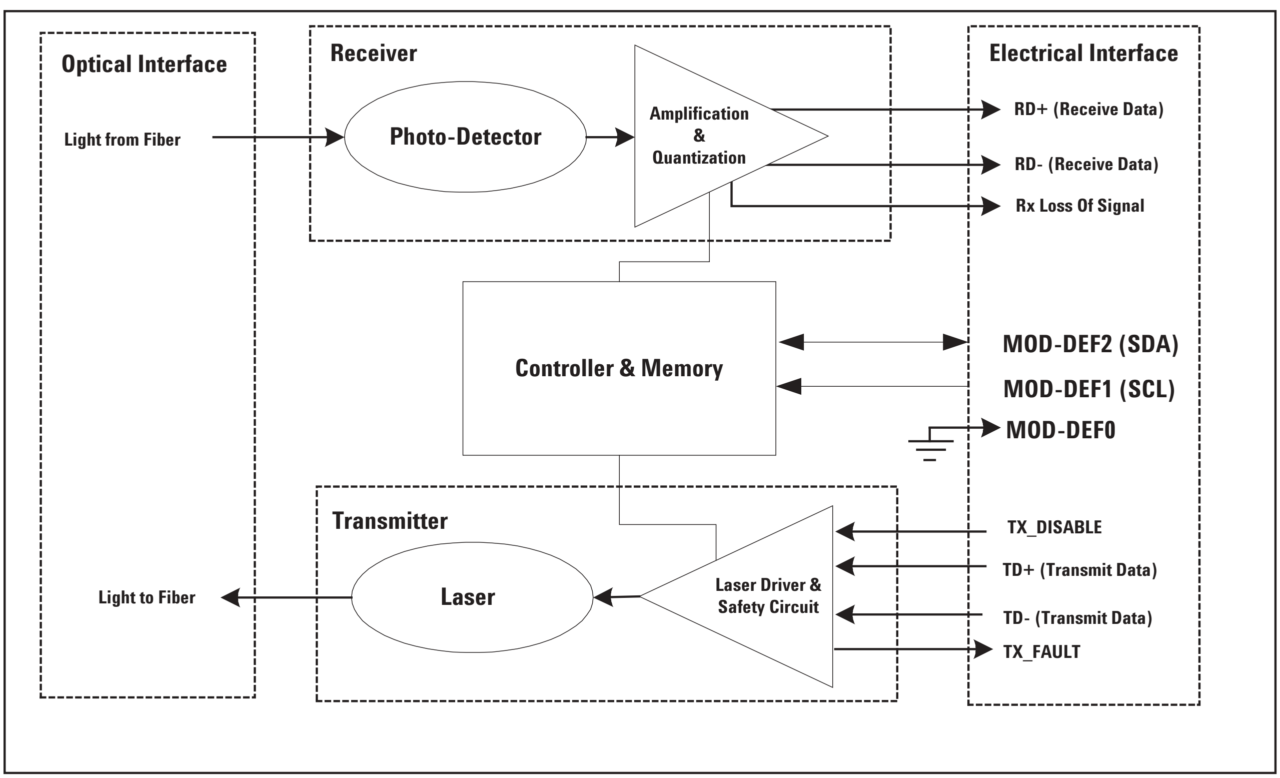


Figure 1. Transceiver Functional Diagram

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.

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. The transmitter output can also be disabled and monitored via the two-wire serial. 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.

TX_FAULT

A laser fault or a low V_{CC} 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 V_{CC}. The transmitter fault condition can also be monitored via the two-wire serial interface (address A2, 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

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 A2, byte 110, bit 1).

Functional Data I/O

Agilent's AFCT-57M5ATP fiber-optic 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.

Application Support

An Evaluation Kit and Reference Designs are available to assist in evaluation of the AFCT-57M5ATP.

Please contact your local Field Sales representative for availability and ordering details.

Caution

The AFCT-57M5ATP contains no user serviceable parts. Tampering with or modifying the performance of the AFCT-57M5ATP will result in voided product warranty. It may also result in improper operation of the AFCT-57M5ATP circuitry, and possible overstress of the laser source. Device degradation or product failure may result. Connection of the AFCT-57M5ATP 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 recertify and reidentify the laser product under the provisions of U.S. 21 CFR (Subchapter J) and the TUV.

Ordering Information

Please contact your local field sales engineer or one of Agilent Technologies franchised distributors for ordering information. For technical information, please visit Agilent Technologies' WEB page at www.agilent.com or contact Agilent Technologies Semiconductor Products Customer Response Center at 1-800-235-0312. For information related to SFF Committee documentation visit www.sffcommittee.org

Regulatory Compliance

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

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-57M5ATP 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-57M5ATP exceeds typical industry standards.

Table 1 documents the ESD immunity to both of these conditions.

Immunity

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

Electromagnetic Interference (EMI)

Most equipment designs using the AFCT-57M5ATP 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 AFCT-57M5ATP minimizes EMI and provides excellent EMI performance.

Eye Safety

The AFCT-57M5ATP transceivers provide Class 1 eye safety by design. Agilent 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-57M5ATP is compliant to UL 94V-0.

Table 1. Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the Electrical Pins	MIL-STD-883C Method 3015.4 JEDEC/EIA JESD22-A114-A	Class 1 (> 2000 Volts)
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	Variation of IEC 61000-4-2	Typically, no damage occurs with 8 kV when the duplex LC connector receptacle is contacted by a Human Body Model probe.
Electrostatic Discharge (ESD) to the Optical Connector	Variation of IEC 61000-4-2	Air discharge of 15 kV contact to connector w/o damage
Electromagnetic Interference (EMI)	FCC Class B CENELEC EN55022 Class B (CISPR 22A) VCCI Class 1	System margins are dependent on customer board and chassis design.
Immunity	Variation of IEC 61000-4-3	Less than 0.5 dB of Rx sensitivity degradation and less than 10% margin reduction of Tx mask at 10 V/m, 10 MHz to 1 GHz w/o chassis enclosure
Laser Eye Safety and Equipment Type Testing	US FDA CDRH AEL Class 1 EN (IEC) 60825-1, 2 EN60950 Class 1	CDRH certification # TBD TUV file # TBD
Component Recognition	Underwriters Laboratories and Canadian Standards Association Joint Component Recognition for Information Technology Equipment Including Electrical Business Equipment	UL File # E173874

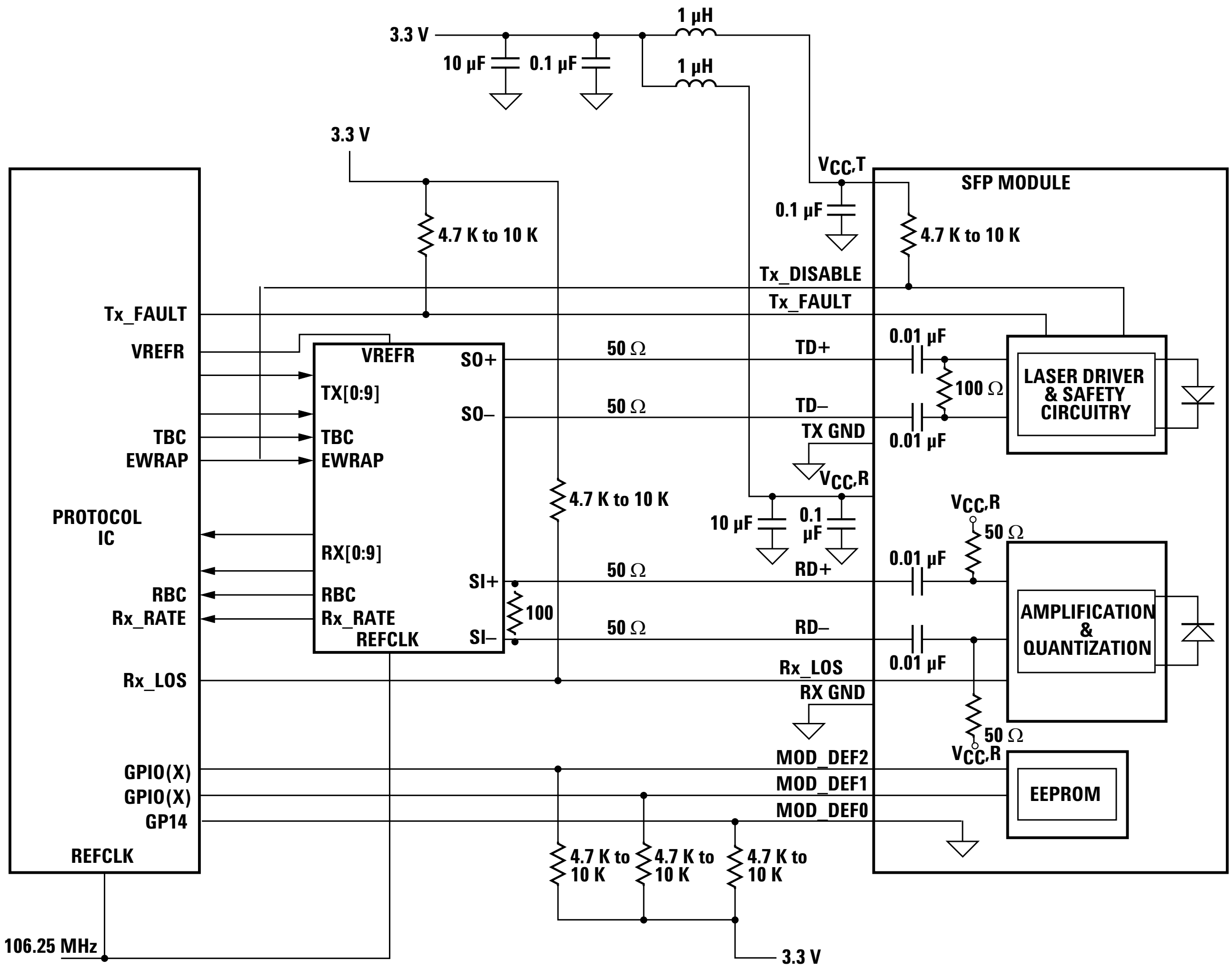
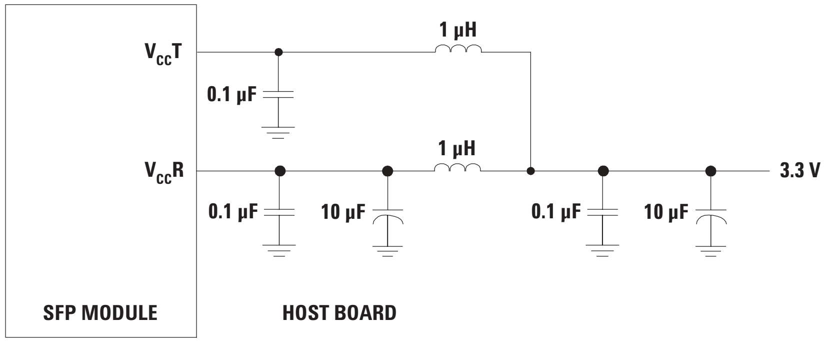


Figure 2. Typical Application Configuration



Note: Inductors must have less than 1 Ohm series resistance to limit voltage drop to the SFP module.

Figure 3. Recommended Power Supply Filter

Table 2. Pin Description

Pin	Name	Function/Description	MSA Notes
1	$V_{EE}T$	Transmitter Ground	
2	TX_FAULT	Transmitter Fault Indication - High indicates a fault condition	1
3	TX_DISABLE	Transmitter Disable - Module optical output disables on high or open	2
4	MOD-DEF2	Module Definition 2 - Two Wire Serial ID Interface Data Line (SDA)	3
5	MOD-DEF1	Module Definition 1 - Two Wire Serial ID Interface Clock Line (SCL)	3
6	MOD-DEF0	Module Definition 0 - Grounded in Module (module present indicator)	3
7		Reserved	
8	RX_LOS	Loss of Signal - High indicates loss of received optical signal	4
9	$V_{EE}R$	Receiver Ground	
10	$V_{EE}R$	Receiver Ground	
11	$V_{EE}R$	Receiver Ground	
12	RD-	Inverse Received Data Out	5
13	RD+	Received Data Out	5
14	$V_{EE}R$	Receiver Ground	
15	$V_{CC}R$	Receiver Power +3.3 V	6
16	$V_{CC}T$	Transmitter Power +3.3 V	6
17	$V_{EE}T$	Transmitter Ground	
18	TD+	Transmitter Data In	7
19	TD-	Inverse Transmitter Data In	7
20	$V_{EE}T$	Transmitter Ground	

Notes:

1. TX_FAULT is an open collector/drain output, which should be pulled up with a 4.7 k – 10 kΩ resistor on the host board. 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 < 0.4 V.
2. TX_DISABLE is an input that is used to shut down the transmitter optical output. It is pulled up within the transceiver with a 4.7 k – 10 kΩ resistor.
   Low (0 – 0.8 V): Transmitter on
   Between (0.8 V and 2.0 V): Undefined
   High (2.0 – V_{CC} max): Transmitter Disabled
   Open: Transmitter Disabled
3. The signals Mod-Def 0, 1, 2 designate the two wire serial interface pins. They should be pulled up with a 4.7 k – 10 kΩ resistor on the host board.
   Mod-Def 0 is grounded by the module to indicate the module is present
   Mod-Def 1 is clock line (SCL) of two wire serial interface
   Mod-Def 2 is data line (SDA) of two wire serial interface
4. RX_LOS (Rx Loss of Signal) is an open collector/drain output that should be pulled up with a 4.7 k – 10 kΩ resistor on the host board. 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-/+ designate the differential receiver outputs. They are ac coupled 100 Ω differential lines which should be terminated with 100 Ω differential at the host SerDes. Ac coupling is done inside the transceiver and is not required on the host board. The voltage swing on these lines will be between 450 and 2000 mV differential (225 – 1000 mV single ended) when properly terminated.
6. $V_{CC}R$ and $V_{CC}T$ are the receiver and transmitter power supplies. They are defined at the SFP connector pin. The maximum supply current is 300 mA and the associated inrush current will typically be no more than 30 mA above steady state after 500 nanoseconds.
7. TD-/+ designate 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 350 – 2400 mV (175 – 1200 mV single ended).

Absolute Maximum Ratings

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Case Operating Temperature	T_C	-40		+100	°C	Notes 1, 2
Relative Humidity	RH	5		95	%	Note 1
Module Supply Voltage	V_{CC}T, R	-0.5		4.0	V	Note 1, 2, 3
Data/Control Input Voltage	V_{IN}	-0.5		V_{CC} + 0.5	V	Note 1

Recommended Operating Conditions

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Case Operating Temperature	T_C	-10		85	°C	Note 4
Module Supply Voltage	V_{CC}T, R	2.97		3.63	V	Note 4
Data Rate		1.0625		2.125	Gb/s	Note 4

Transceiver Electrical Characteristics

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Ac Electrical Characteristics						
Power Supply Noise Rejection (peak-to-peak)	PSNR		100		mV	Note 5
Dc Electrical Characteristics						
Module Supply Current	I_{CC}			300	mA	
Sense Outputs:						
Transmit Fault (TX_FAULT)	V_{OH}	2.4		V_{CC}T, R + 0.3	V	Note 6
Loss of Signal (RX_LOS), MOD_DEF2	V_{OL}		0.01	0.4	V	
Control Inputs:						
Transmitter Disable (TX_DISABLE)	V_{IH}	2.0		V_{CC}	V	Note 7
MOD-DEF1, 2	V_{IL}	0		0.8	V	

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 Sheet 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.
3. The module supply voltages, V_{CC}T and V_{CC}R must not differ by more than 0.5 V or damage to the device may occur.
4. Recommended Operating Conditions are those values for which functional performance and device reliability is implied. (T_C = -10 °C to +85 °C, V_{CC}T, V_{CC}R = 3.3 V ± 10%)
5. Filter per SFP specification is required on host board to remove 10 Hz to 2 MHz content.
6. Pulled up externally with a 4.7 k – 10 kΩ resistor on the host board to 3.3 V.
7. Pulled up externally with a 4.7 k – 10 kΩ resistor on the host board to 3.3 V.

Transmitter and Receiver Electrical Characteristics

(T_C = -10 °C to +85 °C, $V_{CC}T$, $V_{CC}R$ = 3.3 V ± 10%)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Data Input: Transmitter Differential Input Voltage (TD+/-)	V_I	350		2400	mV	Note 1
Data Output: Receiver Differential Output Voltage (RD+/-)	V_O	600		2000	mV	Note 2
Contributed Deterministic Jitter (Receiver) 2.125 Gb/s	DJ			0.11 52	UI ps	Notes 3
Contributed Total Jitter (Receiver) 2.125 Gb/s	TJ			0.26 122	UI ps	Note 4
Contributed Deterministic Jitter (Receiver) 1.0625 Gb/s	DJ			0.13 122	UI ps	Note 3
Contributed Total Jitter (Receiver) 1.0625 Gb/s	TJ			0.2 188	UI ps	Note 4
Contributed Total Jitter (Receiver) 1.25 Gb/s	TJ			0.332 266	UI ps	Note 6
Receive Data Rise and Fall Times (Receiver)	t_R, t_F		100	250	ps	Note 5

Notes:

1. Internally ac coupled and terminated (100 Ohm differential).
2. Internally ac coupled but requires an external load termination (100 Ohm differential).
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. 20%-80% electrical rise & fall times measured with a 500 MHz signal utilizing a 1010 data pattern.
6. IEEE 802.3

Transmitter Optical Characteristics

(T_C = -10 °C to +85 °C, $V_{CC}T$, $V_{CC}R$ = 3.3 V ± 10%)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Modulated Optical Output Power (OMA) (Peak-to-Peak) 2.125 Gb/s	OMA	213 -6.7			µW dBm	Note 2
Modulated Optical Output Power (OMA) (Peak-to-Peak) 1.0625 Gb/s	OMA	246 -6.1			µW dBm	Note 2
Modulated Optical Output Power (OMA) (Peak-to-Peak) 1.25 Gb/s	OMA	130 -8.7			µW dBm	
Average Optical Output Power	P_{OUT}	-9		-3	dBm	Note 1
Optical Extinction Ratio	ER	9			dB	
TX Optical Eye Mask Margin 2.125 Gb/s	MM	0	30		%	Notes 5, 6
Center Wavelength	λ_C	1260		1360	nm	Note 2
Spectral Width - rms	σ, rms				nm	Note 2
Optical Rise/Fall Time	t_r, t_f			160	ps	20-80%
RIN_{12} (OMA)	RIN			-117	dB/Hz	
Contributed Deterministic Jitter (Transmitter) 2.125 Gb/s	DJ			0.12 57	UI ps	Note 3
Contributed Total Jitter (Transmitter) 2.125 Gb/s	TJ			0.25 120	UI ps	Note 4
Contributed Deterministic Jitter (Transmitter) 1.0625 Gb/s	DJ			0.09 85	UI ps	Note 3
Contributed Total Jitter (Transmitter) 1.0625 Gb/s	TJ			0.27 251	UI ps	Note 4
Contributed Total Jitter (Transmitter) 1.25 Gb/s - MMF	TJ			0.284 227	UI ps	Note 5
Contributed Total Jitter (Transmitter) 1.25 Gb/s - SMF	TJ			0.33 267	UI ps	
P_{OUT} TX_DISABLE Asserted	P_{OFF}			-45	dBm	

Notes:

1. Class 1 Laser Safety per FDA/CDRH
2. In conformance with FC-PI Figures 18 and 19, which define 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

Receiver Optical Characteristics
(T_C = -10 °C to +85 °C, $V_{CC}T$, $V_{CC}R$ = 3.3 V ± 10%)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Input Optical Power	P_{IN}			-3	dBm	Note 1
Input Optical Modulation Amplitude (Peak-to-Peak) 2.125 Gb/s	OMA	15			µW, OMA	Notes 2, 4, 5
Input Optical Modulation Amplitude (Peak-to-Peak) 1.0625 Gb/s	OMA	15			µW, OMA	Notes 2, 4, 5
Receiver Sensitivity (Optical Average Input Power) 1.25 Gb/s	PRMIN			-19.0	dBm	Notes 1, 5
Stressed Receiver Sensitivity (Optical Average Input Power) 1.25 Gb/s				-14.4	dBm	
Return Loss		12			dB	
Loss of Signal - Assert	P_A	-31		-20.7	dBm, avg	Note 3
Loss of Signal - De-Assert	P_D			-20.2	dBm, avg	Note 3
Loss of Signal Hysteresis	$P_D - P_A$	0.5			dB	

Notes:
1. IEEE 802.3
2. An OMA of 15 mW is approximately equal to an average power of –20.2 dBm with an Extinction Ratio of 9 dB
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.
4. Input Optical Modulation Amplitude (commonly known as sensitivity) requires a valid 8B/10B encoded input.
5. BER = 10^{-12}

Transceiver Timing Characteristics
(T_C = -10 °C to +85 °C, $V_{CC}T$, $V_{CC}R$ = 3.3 V ± 10%)

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 DeAssert Time	t_loss_on		100	µs	Note 6
Hardware RX_LOS 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.

Transceiver Digital Diagnostic Monitor (Real Time Sense) Characteristics

(T_C = -10 °C to +85 °C, $V_{CC}T$, $V_{CC}R$ = 3.3V ± 10%)

Parameter	Symbol	Min	Units	Notes
Transceiver Internal Temperature Accuracy	T_{INT}	± 3.0	°C	Valid from T_C = -10 °C to +85 °C
Transceiver Internal Supply Voltage Accuracy	V_{INT}	± 0.1	V	Valid over V_{CC} = 3.3 V ± 10%
Transmitter Laser DC Bias Current Accuracy	I_{INT}	± 10	%	Percentage of actual bias value
Transmitted Average Optical Output Power Accuracy	P_T	± 3.0	dB	Valid from -10 to -3 dBm, avg
Received Average Optical Input Power Accuracy)	P_R	± 3.0	dB	Valid from -20 dBm to -3 dBm avg

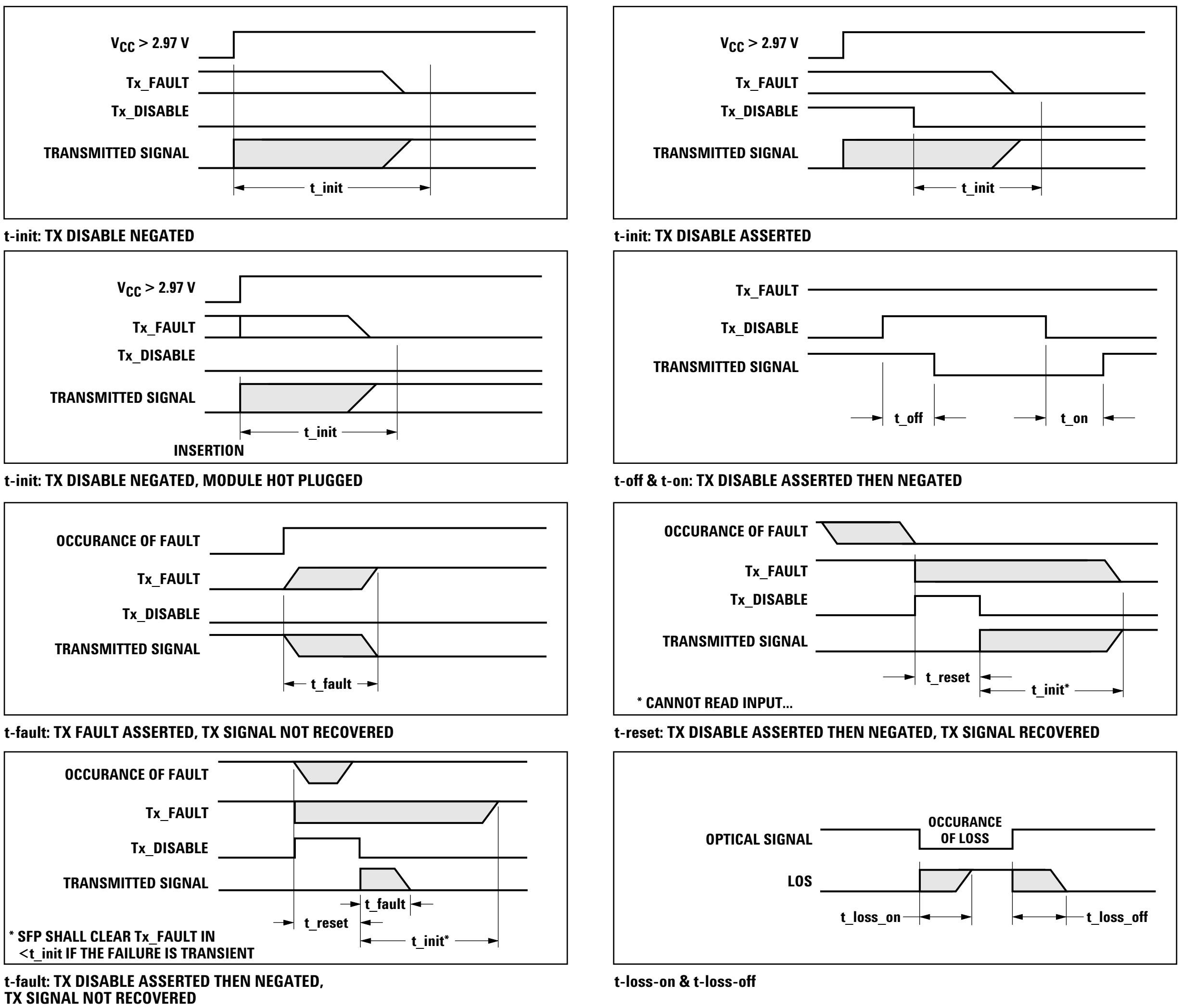


Figure 4. Transceiver Timing Diagrams (Module Installed Except Where Noted)

Table 3. EEPROM Serial ID Memory Contents – Conventional SFP Memory (Address A0h)

Byte # Decimal	Data Hex	Notes	Byte # Decimal	Data Hex	Notes
0	03	SFP physical device	37	00	Hex Byte of Vendor OUI[4]
1	04	SFP function defined by serial ID only	38	30	Hex Byte of Vendor OUI[4]
2	07	LC optical connector	39	D3	Hex Byte of Vendor OUI[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	05	100 MBytes/sec & 200 MBytes/sec FC-PI speed[1]	47	4D	"M" - Vendor Part Number ASCII character
11	01	Compatible with 8B/10B encoded data	48	35	"5" - Vendor Part Number ASCII character
12	15	2100 MBit/sec nominal bit rate	49	41	"A" - Vendor Part Number ASCII character
13	00		50	54	"T" - Vendor Part Number ASCII character
14	0A		51	50	"P" - Vendor Part Number ASCII character
15	64		52	20	" " - Vendor Part Number ASCII character
16	55	Note 2	53	20	" " - Vendor Part Number ASCII character
17	55	Note 3	54	20	" " - Vendor Part Number ASCII character
18	00		55	20	" " - Vendor Part Number ASCII character
19	00		56	20	" " - Vendor Part Number ASCII character
20	41	"A" - Vendor Name ASCII character	57	20	" " - Vendor Part Number ASCII character
21	47	"G" - Vendor Name ASCII character	58	20	" " - Vendor Part Number ASCII character
22	49	"I" - Vendor Name ASCII character	59	20	" " - Vendor Part Number ASCII character
23	4C	"L" - Vendor Name ASCII character	60	05	Hex Byte of Laser Wavelength[5]
24	45	"E" - Vendor Name ASCII character	61	1E	Hex Byte of Laser Wavelength[5]
25	4E	"N" - Vendor Name ASCII character	62	00	
26	54	"T" - Vendor Name ASCII character	63		Checksum for Bytes 0-62[6]
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[7]
32	20	" " - Vendor Name ASCII character	84-91		Vendor Date Code ASCII characters[8]
33	20	" " - Vendor Name ASCII character	92	68	Digital Diagnostics, INT Calibration, Rx Avg
34	20	" " - Vendor Name ASCII character	93	F0	A/W, Soft SFP TX_DISABLE, TX_FAULT & RX_LOS
35	20	" " - Vendor Name ASCII character	94	01	SFF-8472 Compliance to revision 9.1
36	00		95		Checksum for Bytes 64-94[6]
			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 Agilent Technologies is 00-30-D3 (3 bytes of hex).
5. Laser wavelength is represented in 16 unsigned bits. The hex representation of 1310 (nm) is 051E.
6. Addresses 63 and 95 are checksums calculated (per SFF-8472 and SFF-8074) and stored prior to product shipment.
7. Addresses 68-83 specify the AFCT-57M5ATP ASCII serial number and will vary on a per unit basis.
8. Addresses 84-91 specify the AFCT-57M5ATP ASCII date code and will vary on a per date code basis.

Table 4. EEPROM Serial ID Memory Contents – Enhanced Feature Set Memory (Address A2h)

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 Pwr MSB[5]
1	Temp H Alarm LSB[1]	27	Tx Pwr L Alarm LSB[4]	105	Real Time Rx Pwr 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 5
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 6
9	V_{CC} H Alarm LSB[2]	35	Rx Pwr L Alarm LSB[5]	113	Flag Bits - See Table 6
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 6
13	V_{CC} H Warning LSB[2]	39	Rx Pwr L Warning LSB[5]	117	Flag Bits - See Table 6
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]	120-127	Vendor Specific
17	Tx Bias H Alarm LSB[3]	96	Real Time Temperature MSB[1]	128-247	Customer Writable[8]
18	Tx Bias L Alarm MSB[3]	97	Real Time Temperature LSB[1]	248-255	Vendor Specific
19	Tx Bias L Alarm LSB[3]	98	Real Time V_{CC} MSB[2]		
20	Tx Bias H Warning MSB[3]	99	Real Time V_{CC} LSB[2]		
21	Tx Bias H Warning LSB[3]	100	Real Time Tx Bias MSB[3]		
22	Tx Bias L Warning MSB[3]	101	Real Time Tx Bias LSB[3]		
23	Tx Bias L Warning LSB[3]	102	Real Time Tx Power MSB[4]		
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. See Table 7 for details
7. Byte 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).

Table 5. EEPROM Serial ID Memory Contents – Soft Commands (Address A2h, Byte 110)

Bit #	Status/Control Name	Description	Notes
7	TX_ DISABLE State	Digital state of SFP TX_ DISABLE Input Pin (1 = TX_DISABLE asserted)	Note 1
6	Soft TX_ DISABLE	Read/write bit for changing digital state of SFP TX_DISABLE function	Notes 1, 2
5	reserved		
4	reserved		
3	reserved		
2	TX_FAULT State	Digital state of the SFP TX_FAULT Output Pin (1 = TX_FAULT asserted)	Note 1
1	RX_LOS State	Digital state of the SFP RX_LOS Output Pin (1 = RX_LOS asserted)	Note 1
0	Data Ready (Bar)	Indicates transceiver is powered and real time sense data is ready. (0 = Ready)	Note 1

Notes:

1. The response time for soft commands of the AFCT-57M5ATP is 100 msec as specified by the MSA SFF-8472
2. Bit 6 is logic OR'd with the SFP TX_DISABLE input pin 3; either asserted will disable the SFP transmitter.

Table 6. EEPROM Serial ID Memory Contents – Alarms and Warnings (Address A2h, Bytes 112, 113, 116, 117)

Byte	Bit	Flag Bit Name	Description
112	7	Temp High Alarm	Set when transceiver internal temperature exceeds high alarm threshold.
	6	Temp Low Alarm	Set when transceiver internal temperature exceeds low 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 average optical power exceeds high alarm threshold.
	6	Rx Power Low Alarm	Set when received average 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 average optical power exceeds high warning threshold.
	6	Rx Power Low Warning	Set when received average optical power exceeds low warning threshold.
	0-5	reserved	

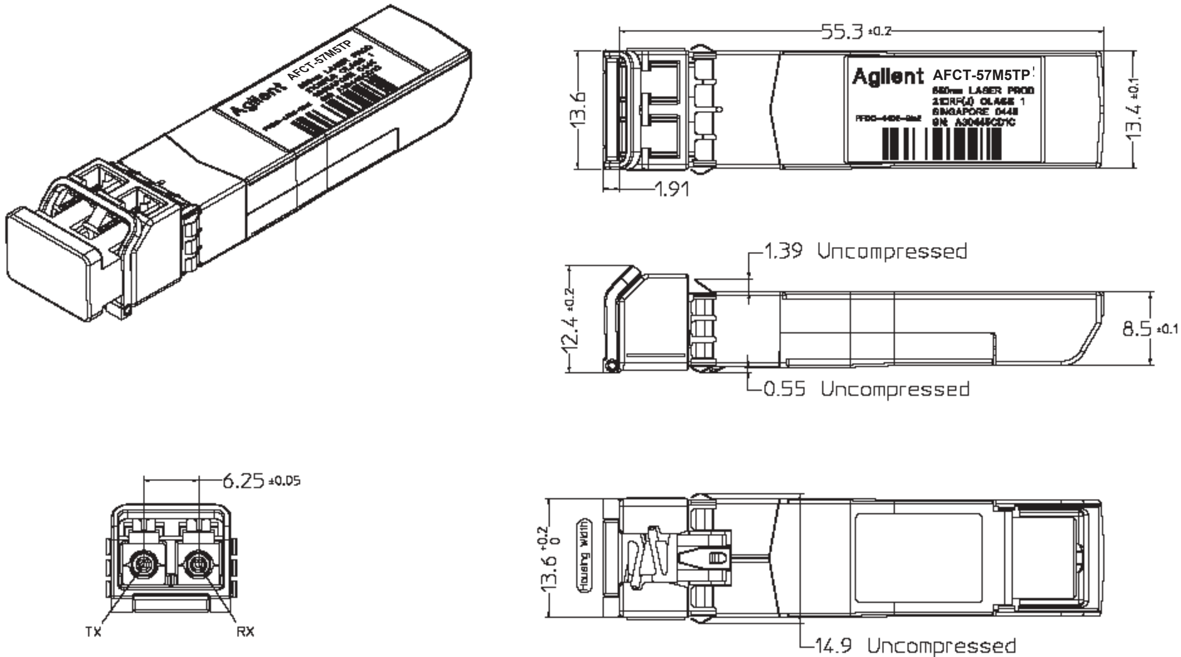


Figure 5. Module drawing - dimensions are in millimeters [inches]

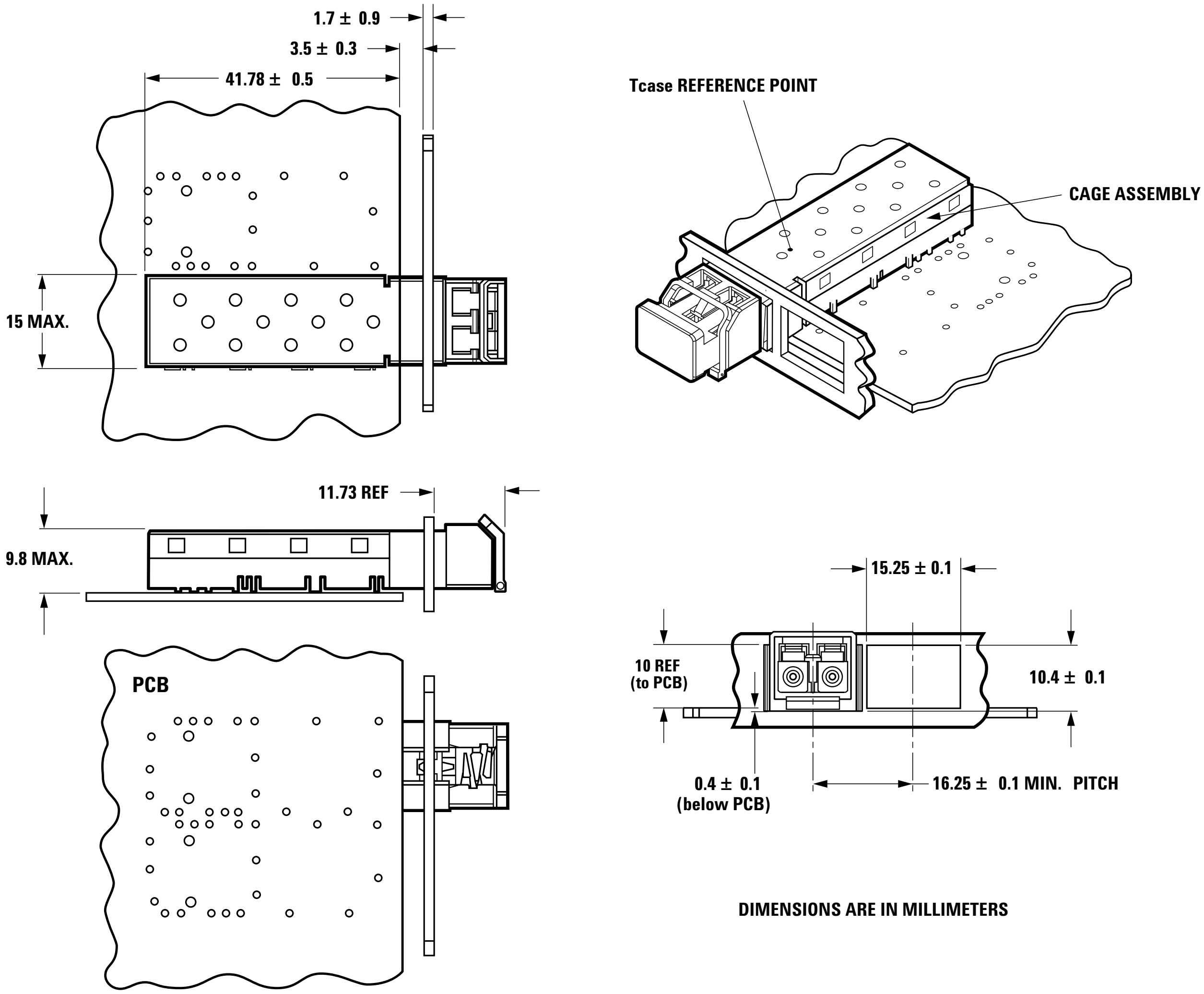


Figure 6. SFP Assembly Drawing

Customer Manufacturing Processes

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

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