

# AFBR-720XPDZ

## 10GbE XFP 850 nm 10Gbps Optical Transceiver



### Data Sheet



#### Description

The 850 nm XFP transceiver is a high performance, cost effective module for serial optical data communications applications specified for signal rates of 9.9 Gb/s to 10.5 Gb/s. It is compliant to XFP MSA Rev 4.5. The module is designed for multi mode fiber and operates at a nominal wavelength of 850 nm. The transmitter section incorporates Avago Technologies' 850 nm Vertical Cavity Surface Emitting Laser (VCSEL). The receiver section uses Avago Technologies' MOVPE grown planar SEDET PIN photodetector for low dark current and excellent responsivity. Integrated Tx and Rx signal conditioners provide high jitter-tolerance for full XFI compliance. The internally ac coupled high speed serial I/O simplifies interfacing to external circuitry. The electrical interface is made using an industry standard 0.8 mm pitch 30-pin right angle connector. Optical connection is made via the duplex LC connector.

The product also offers digital diagnostics using the 2-wire serial interface defined in the XFP MSA. The product provides real time temperature (module and laser), supply voltage, laser bias current, laser average output power and received input power. The digital diagnostic interface also adds the ability to disable the transmitter (TX\_DIS), power down the module, monitor for module faults and monitor for Receiver Loss of Signal (RX\_LOS). Transmitter disable, interrupt, power down/reset, receiver loss of signal and module not ready are also hard wired pins on the 30-pin right angle connector.

#### Features

- RoHS 6/6 Compliance
- Compliant to XFP MSA
- Compliant to IEEE 802.3ae 10GBASE-SR for 10GbE, 10.3125 Gb/s
- Compliant XFI 10G Serial electrical interface
- 3.3V single power supply
- Avago Technologies' 850 nm VCSEL Laser and PIN Photodiode
- No reference clock required
- LC Duplex optical connector interface conforming to ANSI TIA/EIA604-10 (FOCIS 10)
- 1.5W maximum
- Link Lengths up to 300 m with OM3 fiber
- 0 to +70 °C case operating temperature range
- Superior Thermal and EMI integrity performance to support high port densities
- Customizable clip-on heatsink to support a variety of line card environments
- IEC 60825-1 Class 1/CDRH Class 1 laser eye safety

#### Applications

- Fiber Channel Switches
- Host Bus Adapter Cards
- Mass Storage System and Server I/O
- Ethernet Switches
- Core Routers

## Installation

The AFBR-720XPZ can be installed in any XFP port regardless of host equipment operating status. The AFBR-720XPZ 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 XFP cage, mitigating potential damage due to Electro-Static Discharge (ESD). Once fully inserted into the XFP cage, the top surface of the XFP module makes contact with the heatsink through a cutout in the top of the cage ensuring an effective thermal path for module heat.

## Functional Description

### Transmitter Section

The transmitter section includes a 850 nm VCSEL (Vertical Cavity Surface Emitting Laser) light source, a transmitter driver circuit and a signal conditioner circuit on the TX data inputs. (see Figure 1) Optical connection to the transmitter is provided via a LC connector. The optical

output is controlled by an IC that detects the laser output via the monitor photodiode. This IC provides both dc and ac current drive to the laser to ensure correct modulation, eye diagram and extinction ratio over temperature, supply voltage and operating life.

### TX\_DIS

Asserting pin 5, TX\_DIS, will disable the transmitter optical output. The transmitter output can also be disabled and monitored via the two-wire serial interface.

### Eye Safety Circuit

Under normal operating conditions laser power will be maintained below Class 1 eye-safety limits. Should a catastrophic laser fault occur and optical power become uncontrolled, the micro-controller and laser driver IC will detect the fault, shut down the laser, power down the module and assert the hard-wired MOD\_NR flag. The TX\_FAULT output in the 2-wire serial interface will also be asserted.

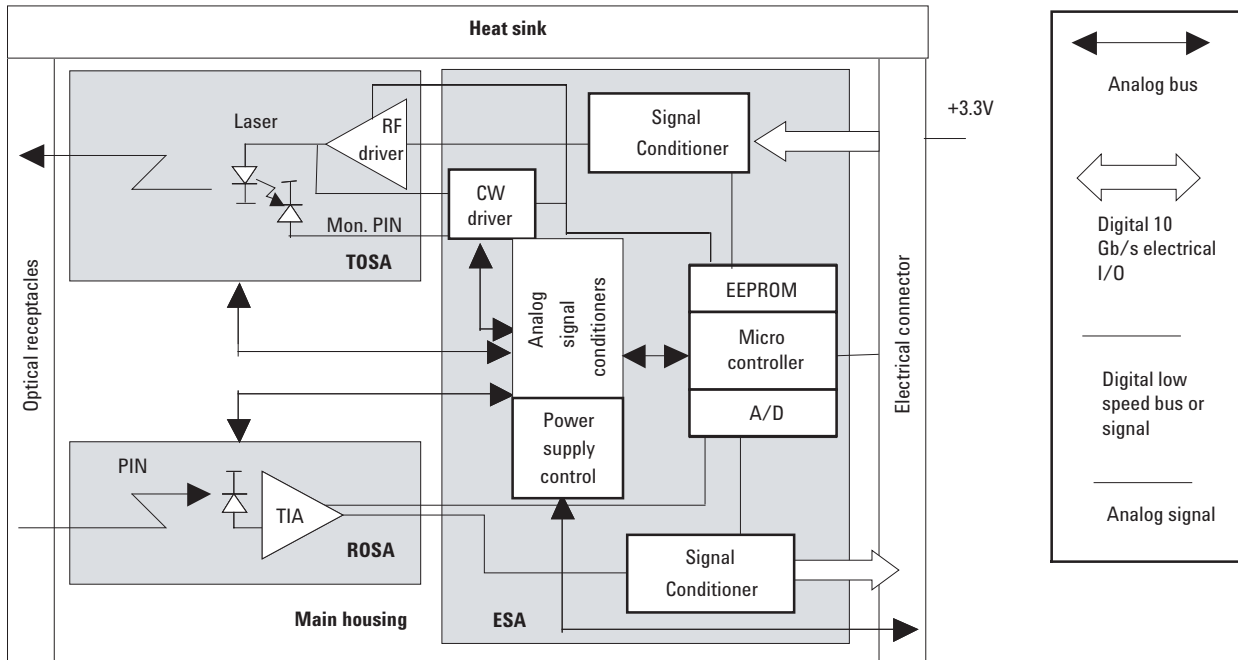


Figure 1. Transceiver Functional Diagram

## Receiver Section

The receiver section includes a PIN detector with amplification quantization signal conditioner circuits. (see Figure 1) Optical 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 reliable signal detection. A high signal indicates loss of modulated signal, indicating link failure such as a broken fiber or nonfunctional remote transmitter. RX\_LOS can also be monitored via the two-wire serial interface (byte 110, bit 1).

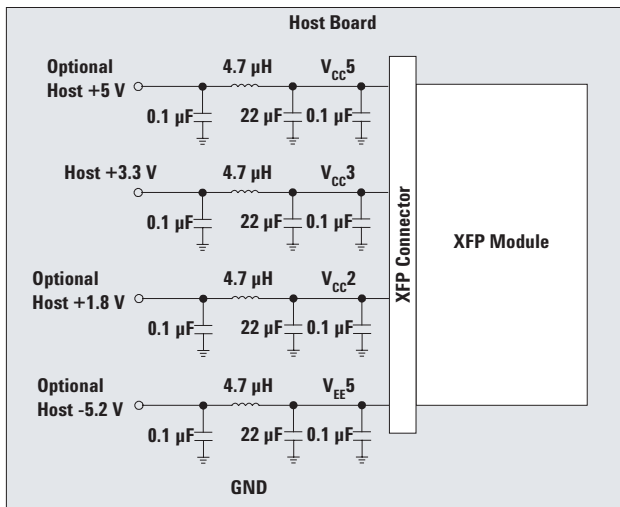


Figure 2. MSA recommended power supply filter

## Functional Data I/O

Avago Technologies' AFBR-720XPDZ fiber-optic transceiver is designed to accept industry standard electrical input differential signals. The transceiver provides ac-coupled, internally terminated data input and output interfaces. Bias resistors and coupling capacitors have been included within the module to reduce the number of components required on the customer's board.

## Electrical Pinout

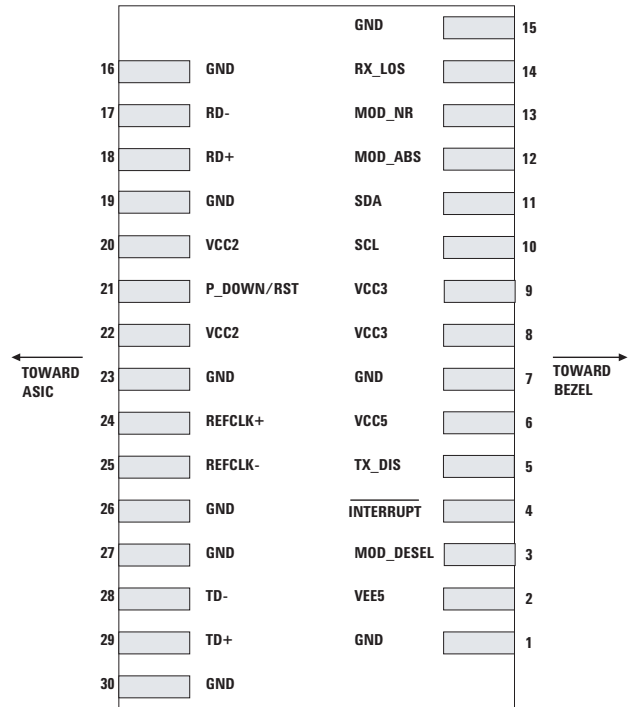


Figure 3. Host PCB XFP Pinout Top View

**Table 1. Electrical Pin Definitions**

Pin	Name	Logic	Function/Description	Notes
1	GND		Module Ground	1
2	V <sub>EE5</sub>		-5.2 V power supply. Not internally connected.	
3	Mod-Desel	LVTTTL-I	Module De-select; When held low allows the module to respond to 2-wire Serial interface commands	
4	Interrupt	LVTTTL-O	Interrupt; Indicates presence of an important condition which can be readover the serial 2-wire interface	2
5	TX_DIS	LVTTTL-I	Transmitter Disable; Transmitter Laser Source Turned Off	
6	V <sub>CC5</sub>		5 V power supply. Not internally connected.	
7	GND		Module Ground	1
8	V <sub>CC3</sub>		+3.3 V Power Supply	
9	V <sub>CC3</sub>		+3.3 V Power Supply	
10	SCL	LVTTTL-I	Two Wire Interface Clock	2
11	SDA	LVTTTL-I/O	Two Wire Interface Data Line	2
12	Mod_Abs	LVTTTL-O	LVTTTL-O Mod_Abs Indicates Module is not present. Grounded in the Module	2
13	Mod_NR	LVTTTL-O	Module Not Ready; Indicating Module Operational Fault	2
14	RX_LOS	LVTTTL-O	Receiver Loss Of Signal Indicator	2
15	GND		Module Ground	1
16	GND		Module Ground	1
17	RD-	CML-O	Receiver Inverted Data Output	
18	RD+	CML-O	Receiver Non-Inverted Data Output	
19	GND		Module Ground	1
20	V <sub>CC2</sub>		+1.8 V Power Supply. Not internally connected.	
21	P_Down/RST	LVTTTL-I	Power down: When high, the module is put into a lower power mode. Serial interface is functional in the low power mode. Reset: The falling edge initiates a complete reset of the module including the serial Interface, equivalent to a power cycle.	
22	V <sub>CC2</sub>		+1.8 V Power Supply. Not internally connected.	
23	GND		Module Ground	1
24	RefCLK+	PECL-I	Reference Clock Non-Inverted Input, ac coupled on the host board (Not Used)	3
25	RefCLK-	PECL-I	Reference Clock Inverted Input, ac coupled on the host board (Not Used)	3
26	GND		Module Ground	1
27	GND		Module Ground	1
28	TD-	CML-I	Transmitter Inverted Data Input	
29	TD+	CML-I	Transmitter Non-Inverted Data Input	
30	GND		Module Ground	1

**Notes:**

1. Module ground pins Gnd are isolated from the module case and chassis ground within the module.
2. Open Collector should be pulled up with 4.7 K-10 Kohms to a voltage between 3.15 V and 3.6 V on the host board.
3. RefCLK+/- are internally terminated (50Ω)

## Absolute Maximum Ratings

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Storage Temperature (non-operating)	T <sub>S</sub>	-40		+85	°C	1, 2
Relative Humidity	RH	10		90	%	1
Supply Voltage	V <sub>CC3</sub>	0		3.6	V	1, 2
Low Speed Input Voltage	V <sub>IN</sub>	-0.5		V <sub>CC</sub> +0.5	V	1

## Recommended Operating Conditions<sup>[4]</sup>

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Case Operating Temperature	T <sub>C</sub>	0		+70	°C	3
Supply Voltage	V <sub>CC3</sub>	3.135		3.465	V	5
Data Rate			10.3125		Gb/s	

## Transceiver Electrical Characteristics

(T<sub>C</sub> = 0 °C to +70 °C, V<sub>CC3</sub> = 3.3 V ± 5%)

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Power Supply Noise Rejection (peak-peak) under 1MHz	PSNR			2% of V <sub>CC</sub>	mV	6
Power Supply Noise Rejection (peak-peak) 1MHz to 10 MHz	PSNR			3% of V <sub>CC</sub>	mV	6
Module supply current	I <sub>CC</sub>			430	mA	
Power Dissipation	P <sub>DISS</sub>		1	1.5	W	
<b>Low Speed Outputs:</b>						
MOD_NR, RX_LOS, MOD_ABS, INTERRUPT	V <sub>OH</sub>	Host_V <sub>CC</sub> -0.5	0.01	Host_V <sub>CC</sub> +0.3	V	7
	V <sub>OL</sub>	0.0		0.4	V	8
<b>Low Speed Inputs:</b>						
TX_DIS, MOD_DESEL, P_DOWN/RST	V <sub>IH</sub>	2.0		V <sub>CC3</sub> +0.3	V	10
	V <sub>IL</sub>	-0.3		0.8	V	9

### 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 Ambient Operating Temperature limitations are based on the Case Operating Temperature limitations and are subject to the host system thermal design.
4. Recommended Operating Conditions are those values for which functional performance and device reliability is implied
5. V<sub>CC</sub> condition applies to supply voltage at the XFP module
6. Filter per XFP specification is required on the host board.
7. 4.7 kΩ to 10 kΩ resistor pull-up to host\_V<sub>CC</sub>, measured at the host side of connector. I<sub>OH</sub>(max) = - 2 mA.
8. 4.7 kΩ to 10 kΩ resistor pull-up to host\_V<sub>CC</sub>, measured at the host side of connector. I<sub>OL</sub>(max) = 2 mA.
9. 4.7 kΩ to 10 kΩ resistor pull-up to host\_V<sub>CC</sub>, measured at the host side of connector. I<sub>IL</sub>(max) = 10 μA.
10. 4.7 kΩ to 10 kΩ resistor pull-up to host\_V<sub>CC</sub>, measured at the host side of connector. I<sub>IH</sub>(max) = - 10 μA.

## Transmitter Electrical Input Characteristics

( $T_C = 0\text{ }^{\circ}\text{C}$  to  $+70\text{ }^{\circ}\text{C}$ ,  $V_{CC3} = 3.3\text{ V} \pm 5\%$ )

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Differential Input Impedance	$Z_d$		100		$\Omega$	
Termination Mismatch	$\Delta Z_M$			5	%	
Differential Input Amplitude	DVQDO	120		820	mV	peak to peak (1)
Differential Input Return Loss	SDD11	20			dB	0.05 to 0.1 GHz
Differential Input Return Loss	SDD11	8			dB	0.1 to 5.5 GHz
Differential Input Return Loss	SDD11	8 - 20.66 $\log_{10}(f/5.5)$ f in GHz			dB	5.5 - 12 GHz
Common Mode Input Return Loss	SCC11	3			dB	0.1 to 15 GHz
Differential to Common Mode Conversion	SCD11	10			dB	0.1 to 15 GHz
Jitter and Eye Mask						XFP MSA Compliant

## Receiver Electrical Output Characteristics

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Differential Input Impedance	$Z_d$		100		$\Omega$	
Termination Mismatch	$\Delta Z_M$			5	%	
Differential Output Amplitude		340		850	mV	peak to peak (1)
DC Common Mode Potential	$V_{cm}$	0		3.6	V	
Output AC Common Mode Voltage				15	mV	RMS
Output Rise/Fall time (20% to 80%)	$t_{RH}, t_{FH}$	24			ps	
Common mode output return loss	SCC22	3				0.1 to 15 GHz
Differential output return loss	SDD22	20			dB	0.05 to 0.1 GHz
Differential output return loss	SDD22	8			dB	0.1 to 5.5 GHz
Differential output return loss	SDD22	8 - 20.66 $\log_{10}(f/5.5)$ f in GHz			dB	5.5 - 12 GHz
Jitter and Eye Mask						XFP MSA Compliant

**Note:**

1. The differential input and output amplitudes are per XFP MSA mask at points B' and C'.

### Transmitter Optical Characteristics 10 GbE

( $T_C = 0\text{ }^\circ\text{C}$  to  $+70\text{ }^\circ\text{C}$ ,  $V_{CC3} = 3.3\text{ V} \pm 5\%$ )

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Laser OMA Output Power	$P_{out}$	-4.3			dBm	1, 2, 4
Mean Optical Output Power	$P_{out}$	-7.3		-1	dBm	1, 2, 3, 5
Extinction Ratio	ER	3.0			dB	1, 2
Spectral Width - rms	$\sigma$ , rms			0.45	nm RMS	4
Center Wavelength	$\lambda_C$	840	850	860	nm	
Transmitter and dispersion penalty	TDP			3.9	dB	1, 2
Transmitter OFF Average Optical Output Power	$P_{off}$			-30	dBm	
RIN <sub>12</sub> (OMA)	RIN			-128	dB/Hz	1
Optical Eye Mask	Compliant with IEEE 802.3ae 10GBASE-SR XFP MSA					See Fig 4

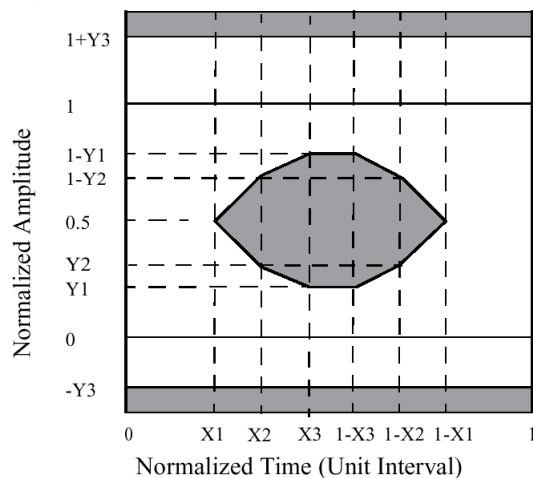
### Receiver Optical Characteristics 10 GbE

( $T_C = 0\text{ }^\circ\text{C}$  to  $+70\text{ }^\circ\text{C}$ ,  $V_{CC3} = 3.3\text{ V} \pm 5\%$ )

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
Stressed receiver sensitivity (OMA)				-7.5	dBm	1
Receiver sensitivity (OMA)	$P_{IN}$			-11.1	dBm	3
Receiver Reflectance				-12	dB	1
Wavelength	$\lambda_C$	840	850	860	nm	

#### Notes:

- 10GFC 1200-MX-SN-I / IEEE 802.3ae 10GBASE-SR compliant
- These parameters are interrelated: see IEEE 802.3ae, Clause 52.
- For information only
- Trade-offs are available between spectral width, center wavelength and minimum Optical Modulation Amplitude (OMA). See Figure 4A and Optical Modulation Table.
- The maximum 10GBASE-SR Average Optical Output Power shall be the lesser of the class 1 safety limit as defined by IEEE 802.3ae 52.10.2 or the average receive power maximum defined by IEEE 802.3ae Table 52-9



Note: where  $X1, X2, X3, Y1, Y2, Y3 = 0.25, 0.40, 0.45, 0.25, 0.28, 0.40$  respectively

Figure 4. Transmitter Eye Mask Definition

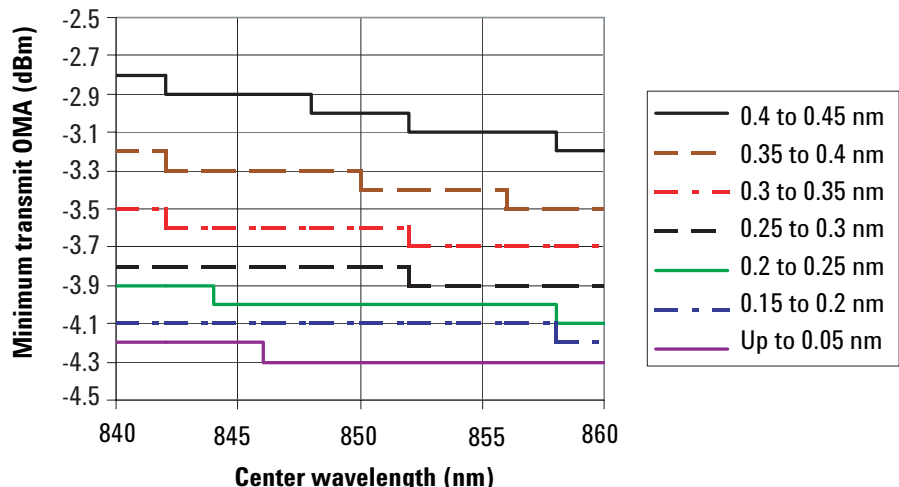


Figure 4a. Triple tradeoff curve for 10GBASE-S (informative)

Optical Modulation

	Up to 0.05	0.05 to 0.1	0.1 to 0.15	0.15 to 0.2	0.2 to 0.25	0.25 to 0.3	0.3 to 0.35	0.35 to 0.4	0.4 to 0.45
840 to 842	-4.2	-4.2	-4.1	-4.1	-3.9	-3.8	-3.5	-3.2	-2.8
842 to 844	-4.2	-4.2	-4.2	-4.1	-3.9	-3.8	-3.6	-3.3	-2.9
844 to 846	-4.2	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-2.9
846 to 848	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-2.9
848 to 850	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.3	-3.0
850 to 852	-4.3	-4.2	-4.2	-4.1	-4.0	-3.8	-3.6	-3.4	-3.0
852 to 854	-4.3	-4.2	-4.2	-4.1	-4.0	-3.9	-3.7	-3.4	-3.1
854 to 856	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.7	-3.4	-3.1
856 to 858	-4.3	-4.3	-4.2	-4.1	-4.0	-3.9	-3.7	-3.5	-3.1
858 to 860	-4.3	-4.3	-4.2	-4.2	-4.1	-3.9	-3.7	-3.5	-3.2



## Transceiver Timing Characteristics

( $T_C = 0\text{ }^{\circ}\text{C}$  to  $+70\text{ }^{\circ}\text{C}$ ,  $V_{CC3} = 3.3\text{ V} \pm 5\%$ )

Parameter	Symbol	Minimum	Typical	Maximum	Unit	Notes
TX_DIS Assert Time	t_off			10	$\mu\text{s}$	Time from rising edge of TX_DIS to when the optical output falls below 10% of nominal.
TX_DIS Negate Time	t_on			2	ms	Time from falling edge of TX_DIS to when the modulated optical output rises above 90% of nominal.
Time to initialize	t_init			300	ms	From power on or hot plug after meeting power supply specs
Interrupt assert delay	Interrupt_on			200	ms	From occurrence of the condition triggering interrupt
Interrupt negate delay	Interrupt_off			500	us	From clear on read interrupt flags
P_Down/ RST assert delay	P_Down/RST_on			100	us	From Power down initiation
P-Down negate delay	P_Down/RST_off			300	ms	Max delay from negate to completion of power up and reset
Mod_NR assert delay	Mod_nr_on			1	ms	From Occurrence of fault to assertion of Mod_NR
Mod_NR negate delay	Mod_nr_off			1	ms	From Occurrence of signal to negation of Mod_NR
Mod_DeSel assert time	T_Mod_DeSel			2	ms	Maximum delay between assertion of Mod_DeSel and end of module response to 2-wire interface communications
Mod_DeSel de-assert time	T_Mod_Sel			2	ms	Maximum delay between de-assertion of Mod_DeSel and proper module response to 2-wire interface communications
P_Down reset time	t_reset	10			$\mu\text{s}$	Min length of P-Down assert to initial reset
RX_LOS Assert delay	T_loss_on			100	$\mu\text{s}$	From Occurrence of loss of signal to assertion of RX_LOS
RX_LOS negate delay	T_loss_off	2.3		100	$\mu\text{s}$	From Occurrence of presence of signal to negation of RX_LOS
Serial ID Clock Rate	f_serial_clock	0		400	kHz	

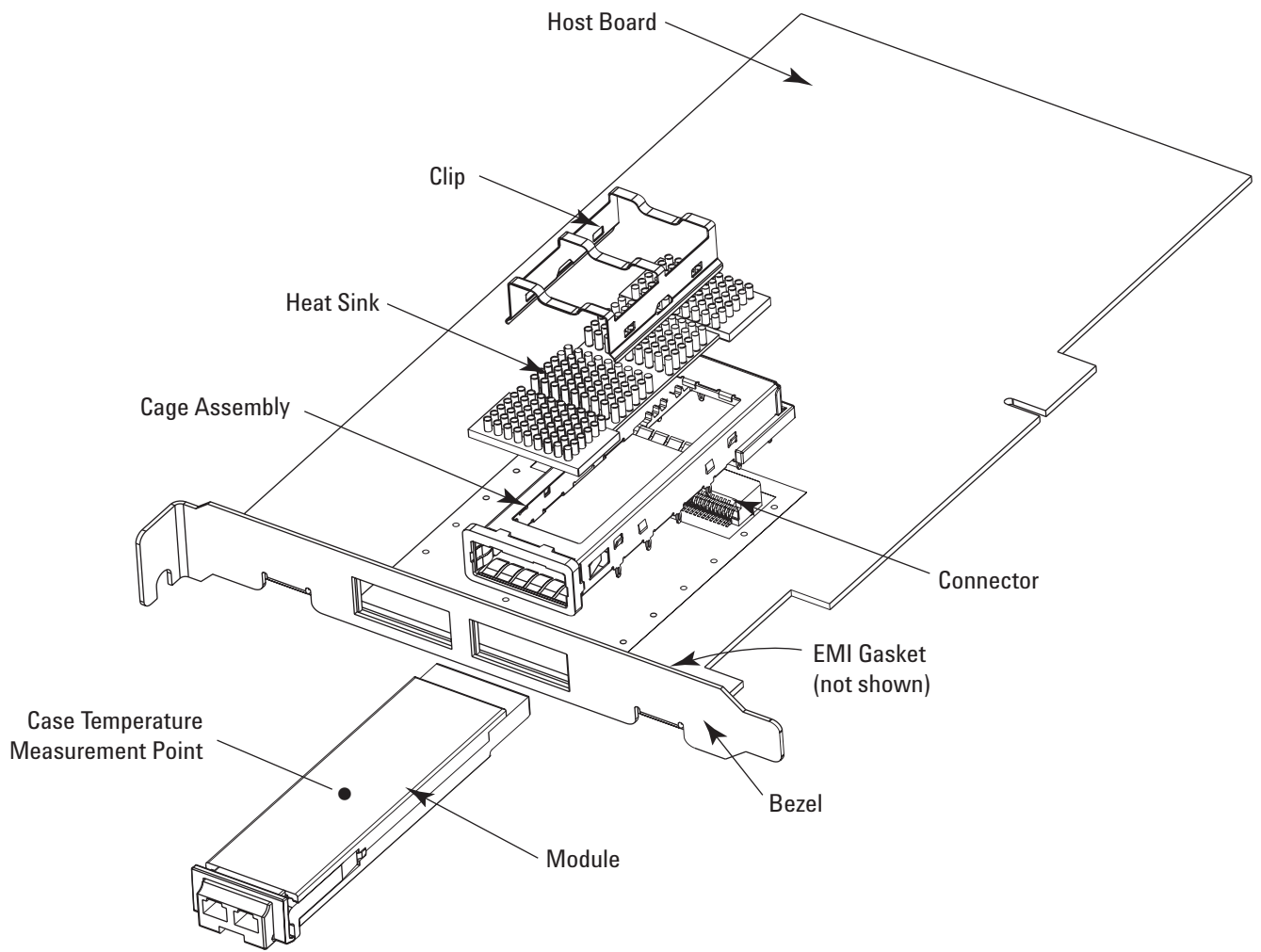


Figure 5. XFP Assembly Drawing

## Digital Diagnostic Interface and Serial Identification

The 2-wire serial interface is explicitly defined in the XFP MSA Rev 4.0. 2-wire timing specifications and the structure of the memory map are per XFP MSA Rev 2.0. The normal 256 Byte I2C address space is divided into lower and upper blocks of 128 Bytes. The lower block of 128 Bytes is always directly available and is used for diagnostic information providing the opportunity for Predictive Failure Identification, Compliance Prediction, Fault Isolation and Component Monitoring. The upper address space tables are used for less frequently accessed functions such as serial ID, user writeable EEPROM, reserved EEPROM and diagnostics and control spaces for future standards definition, as well as Avago Technologies-specific functions.

### 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. As an example, the real time average receive optical power can be used to assess the compliance of the cable plant and remote transmitter.

### 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 host system qualification and verification, real time transceiver diagnostic information can be combined with system level monitoring to ensure performance and operating environment are meeting application requirements.

## Transceiver Internal Temperature

Temperature is measured on the AFBR-720XPZ using sensing circuitry mounted on the internal PCB. The measured temperature will generally be cooler than laser junction and warmer than XFP case and can be indirectly correlated to XFP case or laser junction temperature using thermal resistance and capacitance modeling. This measurement can be used to observe drifts in thermal operating point or to detect extreme temperature fluctuations such as a failure in the system thermal control. For more information on correlating internal temperature to case or laser junction contact Avago Technologies.

### Transmitter Laser DC Bias Current

Laser bias current is measured using sensing circuitry located on the transmitter laser driver IC. Normal variations in laser bias current are expected to accommodate the impact of changing transceiver temperature and supply voltage operating points. The AFBR-720XPZ uses a closed loop laser bias feedback circuit to maintain constant optical power. This circuit compensates for normal laser parametric variations in quantum efficiency, forward voltage and lasing threshold due to changing transceiver operating points.

### Transmitted Average Optical Output Power

Variations in average optical power are not expected under normal operation because the AFBR-720XPZ uses a closed loop laser bias feedback circuit to maintain constant optical power. This circuit compensates for normal laser parametric variations due to changing transceiver operating points. Only under extreme laser bias conditions will significant drifting in transmitted average optical power be observable. Therefore it is recommended Tx average optical power be used for fault isolation, rather than predictive failure purposes.

### Received Average Optical Input Power

Received average optical power measurements are a valuable asset for installers to verify cable plant compliance. Drifts in average power can be observed from the cable plant and remote transmitter for potential predictive failure use. Received average optical power can be used for fault isolation.

### Auxiliary Monitors

In addition to the parameters mentioned above, 3.3V Supply Voltage (AUX1) is also reported as auxiliary parameter 1.

# Mechanical Specifications

## Package Dimensions

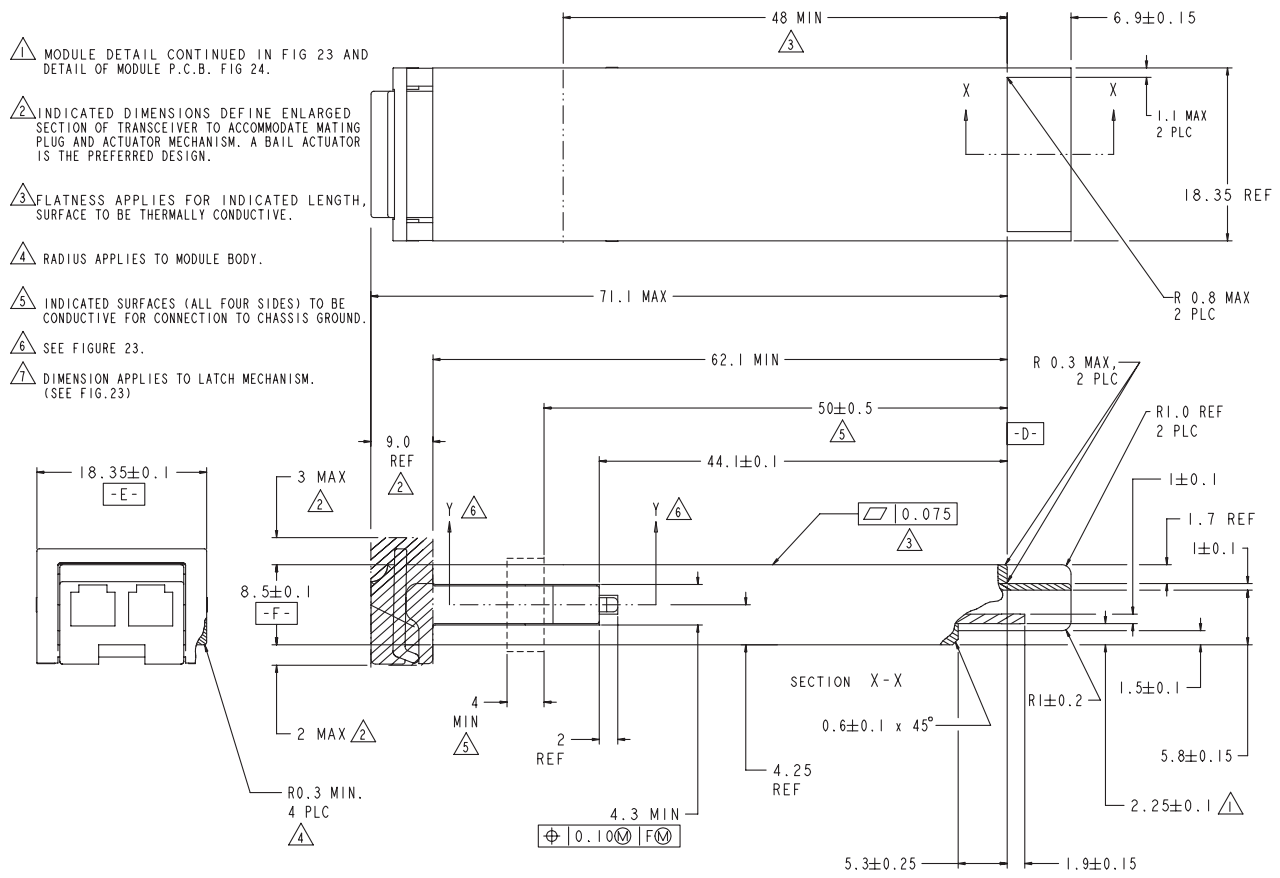


Figure 6a. Module Drawing

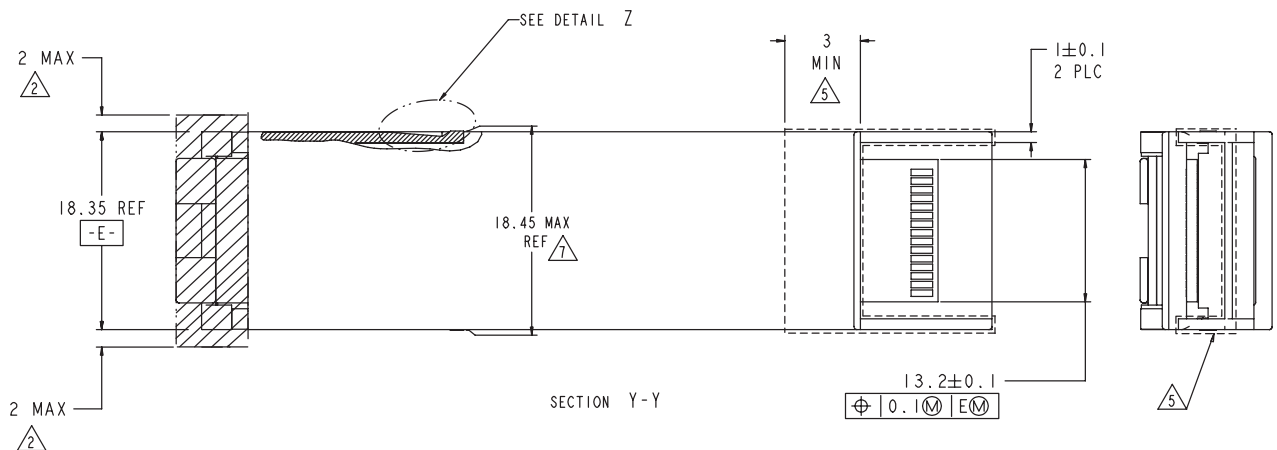
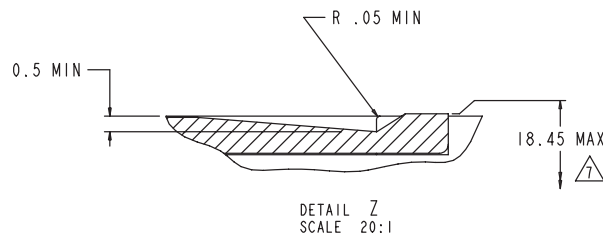


Figure 6b. Module Drawing



## Application Support

An Evaluation Kit and Reference Designs are available to assist in evaluation of the AFBR-720XPDZ. Please contact your local Field Sales representative for availability and ordering details.

## Regulatory Compliance

The transceiver Regulatory Compliance performance is provided in Table 2 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. Table 13 documents the ESD immunity to both of these conditions.

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 AFBR-720XPDZ 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 AFBR-720XPDZ exceeds typical industry standards.

## Regulatory Compliance

Feature	Test Method	Performance
Electrostatic Discharge (ESD) to the electrical pins of the XFP module	MIL-STD-883 Method 3015	500 Volts to the high speed pins, 2000 Volts to the low speed pins
Electrostatic Discharge (ESD) to the Duplex LC Receptacle	Variation of IEC 61000-4-2	Typically, no damage occurs with 25 kV when the duplex LC connector receptacle is contacted.
Electrostatic Discharge (ESD) to the Optical Connector	GR1089	8 KV on the electrical faceplate with device inserted into a panel.
Electrostatic Discharge (ESD) to the Optical Connector	IEC6100-4-2	Air discharge of 15 kV(min) 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	No bit error at 10V/m, 10MHz to 1G w/o chassis enclosure
Laser Eye Safety and Equipment Type Testing	US FDA CDRH AEL Class 1 US21 CFR, Subchapter J per Paragraphs 1002.10 and 1002.12.  (IEC) EN60825-1: 1994 + A11+A2 (IEC) EN60825-2: 1994 + A1 (IEC) EN60950: 1992 + A1 + A2 + A3 + A4 + A11	CDRH certification # 9720151-072 TUV certification # R72071411
Component Recognition	Underwriters Laboratories and Canadian Standards Association Joint Component Recognition for Information Technology Equipment Including Electrical Business Equipment	UL file # E173874

## 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 AFBR-720XPZ 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 AFBR-720XPZ minimizes EMI and provides excellent EMI performance.

## Eye Safety

The AFBR-720XPZ transceivers provide Class 1 eye safety by design. Avago Technologies has tested the transceiver design for regulatory compliance, under normal operating conditions and under single fault conditions. See Table 2.

## Flammability

The AFBR-720XPZ is compliant to UL 94V-0.

## Caution

The AFBR-720XPZ contains no user serviceable parts. Tampering with or modifying the performance of the AFBR-720XPZ will result in voided product warranty. It may also result in improper operation of the AFBR-720XPZ circuitry, and possible overstress of the laser source. Device degradation or product failure may result. Connection of the AFBR-720XPZ 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 Avago Technologies franchised distributors for ordering information. For technical information, please visit Avago Technologies' WEB page at [www.avagotech.com](http://www.avagotech.com) or contact Avago Technologies Semiconductor Products Customer Response Center at 1-800-235-0312. For information related to XFP MSA documentation visit [www.xfpmsa.org](http://www.xfpmsa.org)

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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