



Features

- International Class 1 laser safety certified
- 1.0625 Gb/s or 2.125 Gb/s data rates
- 1x and 2x (ANSI) Fibre Channel compliant [1]
- Short wavelength (SW) (distance \leq 500 m)
- Long wavelength (LW) (distance \leq 10,000 m)
- Gigabit electrical serial interface
- Low Power Dissipation, 500 mW Typical
- LVTTTL Signal-Detect Output
- AC coupling of PECL signals
- Single +3.3 V Power Supply
- Withstand normal wave solder and aqueous spray cleaning
- UL and CSA approved
- Low bit error rate ($< 10^{-12}$)
- High reliability AFR $< 0.01\%/khr@50^{\circ}C$, 100 FIT

Applications

- 2x Gigabit Fibre Channel
- Gigabit Fibre Channel
- Client/Server environments
- Distributed multi-processing
- Fault tolerant applications
- Visualization, real-time video, collaboration
- Channel extenders, data storage, archiving
- Data acquisition

Description

The 1.0625/2.125Gbps Small Form Factor (SFF-PTH-SW/LW-2X5/2X6) is an integrated fiber optic transceiver that provides a high-speed serial link at a signaling rate up to 2.125Gb/s. The SFF-PTH-SW/LW-2X5/2X6 conforms to the American National Standards Institute's (ANSI) Fibre Channel, FC-PI specification for short and long wavelength operation (200-M5-SN-I, 200-M6-SN-I, 100-M5-SN-I, 100-M6-SN-I, 200-SM-LC-L, and 100-SM-LC-L).

The transceiver is insensitive to the data rate of the incoming electrical and optical signals. The transceiver complies with the 1.0625Gb/s Fibre Channel specification and 2.125Gb/s FC Standard without an external control signal.

The SFF-PTH-SW/LW-2X5/2X6 is ideally suited for Fibre Channel applications which include point to point links as well as Fibre Channel Arbitrated Loop (FC-AL). It can also be used for other serial applications where high data rates are required. This specification applies to a pin through hole (PTH) module which has a 2 by 5 electrical connector pin configuration.

The SFF-PTH-2125-SW uses a short wavelength (850nm) VCSEL (Vertical Cavity Surface Emitting Laser) source. This enables low cost data transmission over optical fibers at distances up to 500m at

1.0625Gb/s and 300m at 2.125Gb/s. A 50/125 μ m multimode optical fiber, terminated with an industry standard LC connector, is the preferred medium. (A 62.5/125 μ m multimode fiber can be substituted with shorter maximum link distances.)

The SFF-PTH-LW uses a long wavelength (1310nm) edge emitting laser. This enables data transmission over optical fibers at distances up to 10,000 m on a single mode (9/125 μ m) optical fiber.

Encoded (8B/10B) [3], [4], gigabit/sec serial differential PECL signals traverse a PTH connector interfacing the SFF-PTH-SW/LW-2X5/2X6 to the host card. The serial data modulates the laser and is sent out over the outgoing fiber of a duplex cable.

Incoming modulated light is detected by a photoreceiver mounted in the LC receptacle. The optical signal is converted to an electrical one, amplified and delivered to the host card. This module is designed to work with industry standard "10b" Serializer/Deserializer modules.

The SFF-PTH-SW/LW-2X5/2X6 is a Class 1 laser safe product. The optical power levels, under normal operation, are at eye safe levels. Optical fiber cables can be connected and disconnected without shutting off the laser transmitter.

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Package Outline



Pin Assignments

Pin Name	Type	Pin #
Rx Ground	Ground	1
Rx Power	Power	2
Rx_SD	Status Out	3
Rx_DAT -	Signal Out	4
Rx_DAT +	Signal Out	5
Tx Power	Power	6
Tx Ground	Ground	7
Tx_Disable	Control In	8
Tx_DAT +	Signal In	9
Tx_DAT -	Signal In	10
N/C	Not Connected	A
Tx_Fault (2X6 Only)	Status Out	B

Ordering Information

Product Descriptor	Part Number	Maximum Signaling Rate	Wavelength
SFF-PTH-2125-SW-2X5	IBM42F21SNNA10	2.125Gb/s	850nm
SFF-PTH-LW-2X5	IBM42F21LNNA10	2.125Gb/s	1310nm
SFF-PTH-2125-SW-2X6	IBM42G21SNNA10	2.125Gb/s	850nm
SFF-PTH-LW-2X6	IBM42G21LNNA10	2.125Gb/s	1310nm

Laser Safety Compliance Requirements

The SFF-PTH-SW/LW-2X5/2X6 is designed and certified as a Class 1 laser product. If the power supply voltage exceeds 4.0 volts, the transceiver may no longer remain a Class 1 product. The system using the SFF-PTH-SW/LW-2X5/2X6 must provide power supply over voltage protection that guarantees the supply does not exceed 4.0 volts under all fault conditions.

Caution: Operating the power supply above 4.0V or otherwise operating the SFF-PTH-SW/LW-2X5/2X6 in a manner inconsistent with its design and function may result in hazardous radiation exposure, and may be considered an act of modifying or new manufacturing of a laser product under US regulations contained in 21 CFR(J) or CENELEC regulations

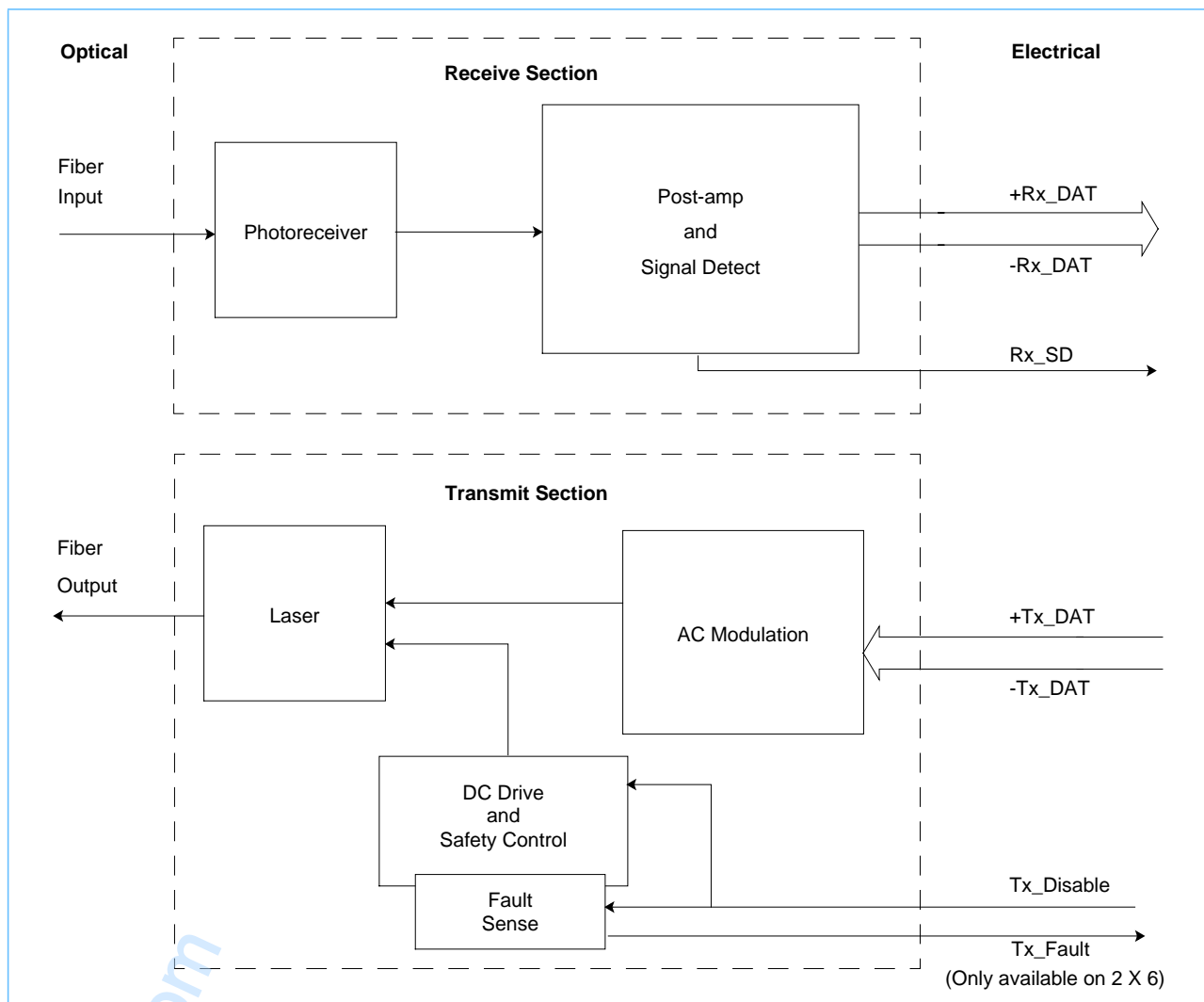
contained in EN 60825. The person(s) performing such an act is required by law to recertify and reidentify the product in accordance with the provisions of 21 CFR(J) for distribution within the United States, and in accordance with provisions of CENELEC EN 60825 (or successive regulations) for distribution within the CENELEC countries or countries using the IEC 825 standard.

ESD Notice

It is advised that normal static precautions be taken in the handling and assembly of the SFF-PTH-SW/LW-2X5/2X6 to prevent damage and/or degradation which may be introduced by electrostatic discharge.



Block Diagram



Transmit Section

The input, an AC coupled differential data stream from the host, enters the AC Modulation section of the laser driver circuitry where it modulates the output optical intensity of a semiconductor laser. The DC Drive maintains the laser at the correct preset power level. In addition, safety circuits in the DC Drive will shut off the laser if a fault is detected. *The transceiver provides the AC coupling for the +Tx/-Tx lines.* No AC coupling capacitors are required on the host card for proper operation.

Receive Section

The incoming modulated optical signal is converted to an electrical signal by the photoreceiver. This electrical signal is then amplified and converted to a differential serial output data stream and delivered to the host. A transition detector detects sufficient AC level of modulated light entering the photoreceiver. This signal is provided to the host as a signal detect status line. *The transceiver provides the AC coupling for the +Rx/-Rx lines.* No AC coupling capacitors are required on the host card for proper operation.

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Input Signal Definitions

Levels for the signals described in this section are listed in Transmit Signal Interface on page 8 and Control Electrical Interface on page 9.

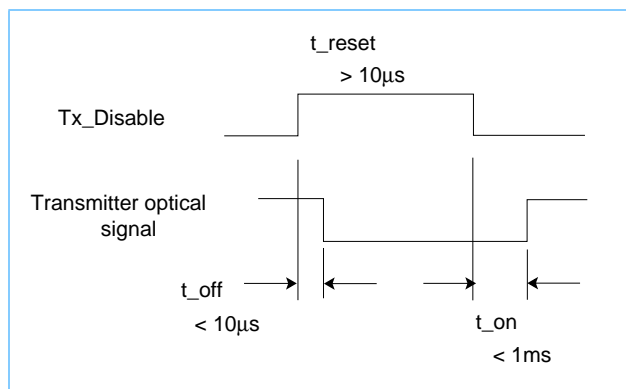
Tx_DAT

A differential PECL serial data stream is presented to the SFF-PTH-SW/LW-2X5/2X6 for transmission onto an optical fiber by modulating the optical output intensity of the laser.

Tx_Disable

When high (a logical one), the Tx_Disable signal turns off the power to both the AC and DC laser driver circuits. It will also reset a laser fault if one should happen. When low (a logical zero), the laser will be turned on within 1 ms if a hard fault is not detected. The transceiver contains a pull-down resistor to enable the laser when the line is not connected on the host side. If driven, this line should be connected to a push-pull output driver.

Timing of Tx_Disable Function





Output Signal Definitions

Levels for the signals described in this section are listed in Receive Signal Interface on page 8 and Control Electrical Interface on page 9.

Rx_DAT

The incoming optical signal is converted and repowered as a differential PECL serial data stream. The Receive Signal Interface table on page 8 gives the voltage levels and timing characteristics for the Rx_DAT signals.

Rx_SD

The Receive Signal Detect line is high (a logical one) when the incoming modulated light intensity is sufficient for reliable operation. This is the state for normal operation. The line is low (a logical zero) when incoming modulated light intensity is below that required to guarantee the correct operation of the link. Normally, this only occurs when either the link is unplugged or the companion transceiver is turned off. This signal is normally used by the system for diagnostic purposes.

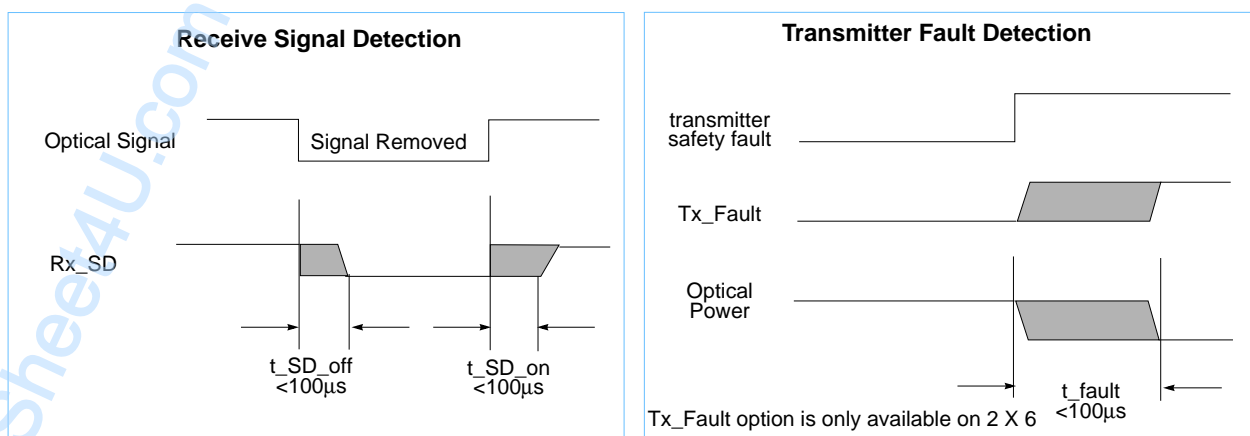
This signal has a push-pull output driver.

Tx_Fault (Only available on 2 X 6)

Upon sensing an improper power level in the laser driver, the SFF sets this signal high and turns off the laser. The Tx_Fault signal can be reset with the Tx_Disable line.

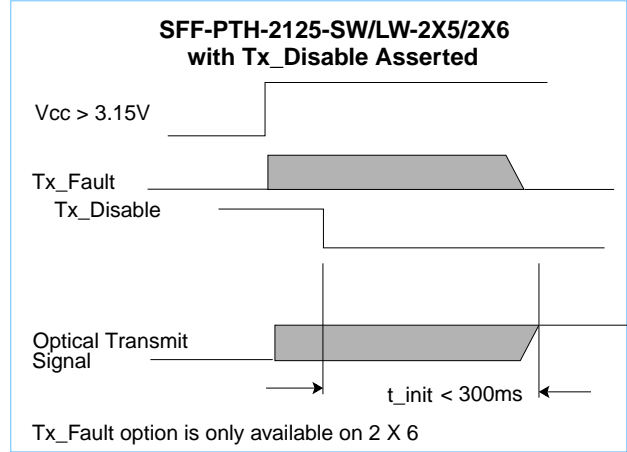
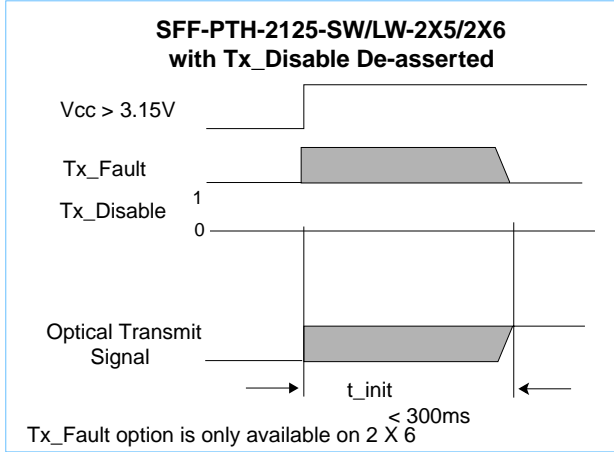
The laser is turned off within 100 μ s as shown in the Transmitter Fault Detection timing diagram below.

This signal has an open drain TTL driver. A pull up resistor is required on the host side of the SFF connector. The recommended value for this resistor is 10 k Ω .



Operation

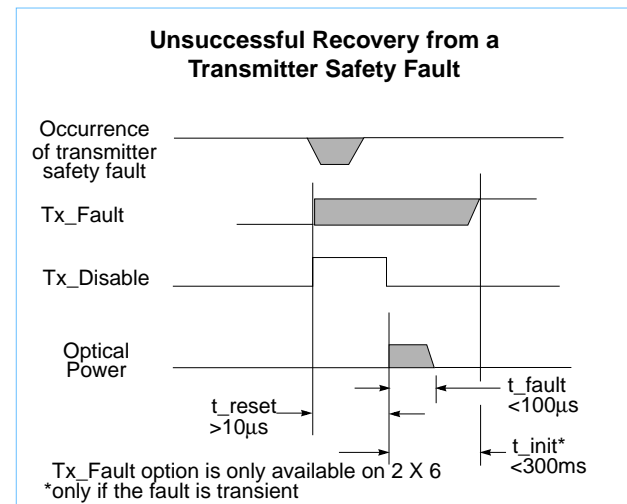
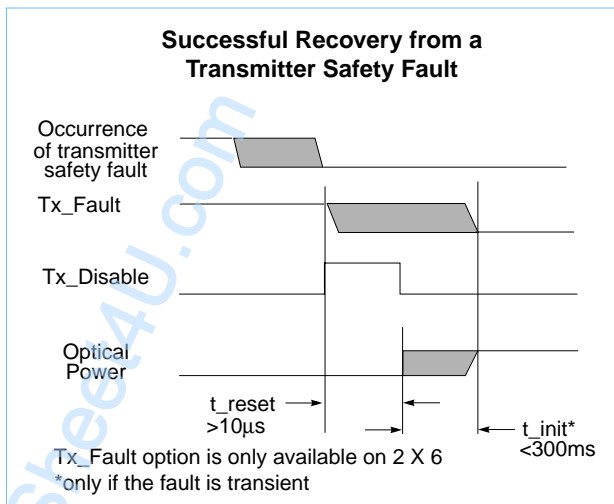
Initialization Timings



Resetting a Laser Fault

Resetting a laser fault by toggling the Tx_Disable input will permit the SFF-PTH-SW/LW-2X5/2X6 to attempt to power on the laser following a fault condition. *Continuous resetting and re-powering of the laser under a hard fault condition could cause a series of optical pulses with sufficient energy to violate laser safety standards.*

To alleviate the possibility of violating laser safety standards, the SFF-PTH-SW/LW-2X5/2X6 will turn off the laser if a second fault is detected within 25 ms of the laser powering on. This lock is cleared during each power on cycle. Please refer to the timing diagrams below.





Absolute Maximum Ratings

Symbol	Parameter	Min.	Typical	Max.	Unit	Notes
T_S	Storage Temperature	-40		85	°C	1
RH_S	Relative Humidity–Storage	0		95	%	1, 2
V_{CC}	Supply Voltage	-0.5		4.0	V	1
V_I	TTL DC Input Voltage	0		$V_{CC} + 0.7$	V	1
T_{SOLD}	Connector Pin Temp during soldering			165/5	°C/s	1,3
T_{SOLD}	Optics Temperature during soldering			100/60	°C/s	4

1. Stresses listed may be applied one at a time without causing permanent damage. Exposure to these values for extended periods may affect reliability. Specification Compliance is only defined within Specified Operating Conditions.
2. Non-condensing environment.
3. The connector pin temperature can be measured with a thermocouple attached to pin 3 of 2x5 header
4. The optics temperature can be measured with a thermocouple on the device with the cover off.

Specified Operating Conditions

Symbol	Parameter	Min.	Typical	Max.	Unit
T_{OP}	Ambient Operating Temperature	0		70	°C
V_{DDT}, V_{DDR}	Supply Voltage	3.135	3.3	3.465	V
RH_{OP}	Relative Humidity-Operating	8		80	%

Power Supply Interface

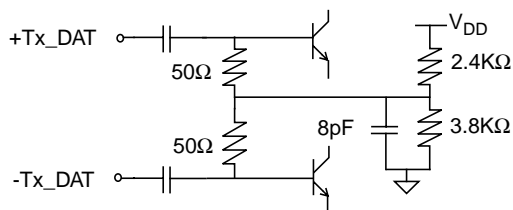
Symbol	Parameter	Min	Typical	Max.	Unit
I_{Tx}	Tx Power Current (@ 3.3 V)		60		mA
I_{Rx}	Rx Power Current (@ 3.3 V)		90		mA
I_{Tx}	Tx Power Current (@ 3.465 V)			85	mA
I_{Rx}	Rx Power Current (@ 3.465 V)			115	mA
P_{Tx}	Tx Power Dissipation (@ 3.3 V)		200		mW
P_{Rx}	Rx Power Dissipation (@ 3.3 V)		300		mW
P_{Tx}	Tx Power Dissipation (@ 3.465 V)			300	mW
P_{Rx}	Rx Power Dissipation (@ 3.465 V)			400	mW
	Ripple & Noise			100	mV (pk-pk)

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Transmit Signal Interface (from host to SFF-PTH-SW/LW-2X5/2X6)

Symbol	Parameter	Min	Max.	Unit	Notes
V_o	PECL Amplitude	400	2000	mV	1
$DJ_{\text{elec-xmit}}$	PECL Deterministic Jitter		0.14	UI	2,4
$TJ_{\text{elec-xmt}}$	PECL Total Jitter		0.26	UI	2,4
	PECL Rise/Fall	50	200	ps	3,4
	PECL Differential Skew		20	ps	4

- At 100 Ω , differential peak-to-peak, the figure below shows the simplified circuit schematic for the SFF-PTH-SW/LW-2X5/2X6 high-speed differential input lines. The PECL input data lines have AC coupling capacitors. The capacitors are not required on the host card.

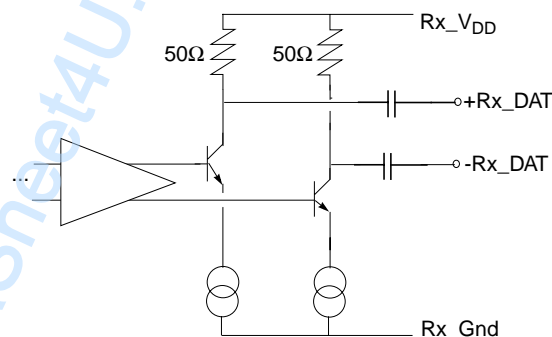


- Deterministic jitter (DJ) and total jitter (TJ) values are measured according to the methods defined in [2]. Jitter values at the output of a transmitter or receiver section assume worst case jitter values at its respective input. [1UI(Unit Interval)=470.6ps at 2.125Gb/s]
- Rise and fall times are measured from 20 - 80%, 100 Ω differential.
- When in 1Gb/s mode the transceiver is compliant with 1G specifications as defined in [1].

Receive Signal Interface (from SFF-PTH-SW/LW-2X5/2X6 to host)

Symbol	Parameter	Min	Max.	Unit	Note(s)
V_o	PECL Amplitude	600	1000	mV	1
$DJ_{\text{elec-rcv}}$	PECL Deterministic Jitter		0.39	UI	2,3
$TJ_{\text{elec-rcv}}$	PECL Total Jitter		0.64	UI	2,3
	PECL Differential Skew		102	ps	3

- At 100 Ω , differential peak-to-peak, the figure below shows the simplified circuit schematic for the SFF-PTH-SW/LW-2X5/2X6 high-speed differential output lines. The PECL input data lines have AC coupling capacitors. The capacitors are not required on the host card.



- Deterministic jitter (DJ) and total jitter (TJ) values are measured according to the methods defined in [2]. Jitter values at the output of a transmitter or receiver section assume worst case jitter values at its respective input. [1UI(Unit Interval)=470.6ps at 2.125Gb/s]
- When in 1Gb/s mode the transceiver is compliant with 1G specifications as defined in [1]. 1UI(Unit Interval)=941.2ps at 1.0625Gb/s)



Control Electrical Interface

Symbol	Parameter	Min	Max.	Unit	Note(s)
Voltage Levels					
V_{OL}	TTL Output (from SFF-PTH-SW/LW-2X5/2X6)	0.0	0.50	V	
V_{OH}		$V_{CC}-0.5$	$V_{CC}+0.3$	V	
V_{IL}	TTL Input (to SFF-PTH-SW/LW-2X5/2X6)	0	0.8	V	1
V_{IH}		2.0	$V_{DDT}+0.3$	V	
Timing Characteristics					
t_{off}	Tx_Disable Assert time		10	μ s	2
t_{on}	Tx_Disable De-assert time		1	ms	2
t_{reset}	Tx_Disable Time to start reset	10		μ s	2
t_{init}	Initialization Time		300	ms	3
t_{fault}	Tx_Fault Assert Time (only available on the 2 X 6)		100	μ s	3
t_{SD_on}	Rx_SD Assert Delay		100	μ s	4
t_{SD_off}	Rx_SD De-Assert Delay		100	μ s	4
<ol style="list-style-type: none"> 1. A 1 kΩ pull-down resistor to GND is present on the SFF-PTH-SW/LW-2X5/2X6 to allow the laser to be active when no input signal is provided on Tx_Disable. 2. See Tx_Disable on page 4 for timing relationships. 3. See Operation on page 6 4. See Rx_SD on page 5 for timing relations. 					



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Optical Specifications (Short Wavelength)

Receiver Specifications

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
λ	Operating Wavelength	830		860	nm	
RL	Return Loss of Receiver	12			dB	
OMA	Optical Modulation Amplitude - 2.125Gb/s	49		2000	μ W (pk-pk)	1, 2
OMA	Optical Modulation Amplitude - 1.0625Gb/s	31		2000	μ W (pk-pk)	1, 2
P _{off}	Rx_SD De-Assert (negate) Level	-27.0		-17.5	dBm (avg)	3
P _{on}	Rx_SD Assert Level			-17.0	dBm (avg)	3
	Rx_SD Hysteresis	0.5	2.5	5.0	dB (optical)	3

1. The minimum and maximum values of the average received power in dBm give the input power range to maintain a BER $< 10^{-12}$ when the data is sampled in the center of the receiver eye. These values take into account power penalties caused by the use of a laser transmitter with a worst-case combination of spectral width, extinction ratio and pulse shape characteristics.
2. Optical Modulation Amplitude (OMA) is defined as the difference in optical power between a logic level one and a logic level zero. The Optical Modulation Amplitude is defined in terms of average optical power (P_{AVG} in μ W) and extinction ratio (ER) as given by $OMA=2P_{AVG}((ER-1)/(ER+1))$. The extinction ratio, defined as the ratio of the average optical power (in μ W) in a logic level one to the average optical power in a logic level zero measured under fully modulated conditions in the presence of worst case reflections, must be the absolute (unitless linear) ratio and not expressed in dB. The specified Optical Modulation Amplitude at 2.125Gb/s is equivalent to an average power of -15 dBm at an extinction ratio of 9 dB. At 1.0625Gb/s, the specified OMA is equivalent to an average power of -17 dBm at an ER of 9 dB.
3. The Rx_SD has hysteresis to minimize "chatter" on the output line. In principle, hysteresis alone does not guarantee chatter-free operation. The SFF-PTH-SW/LW-2X5/2X6, however, presents an Rx_SD line without chatter, where chatter is defined as a transient response having a voltage level of greater than 0.5 volts (in the case of going from the negate level to the assert level) and of any duration that can be sensed by the host logic.



Transmitter Specifications

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
λ_C	Spectral Center Wavelength	830		860	nm	
$\Delta\lambda$	Spectral Width			0.85	nm (rms)	
PT	Launched Optical Power	-10		-4.0	dBm (avg)	1
T_{rise}/T_{fall}	Optical Rise/Fall Time			150	ps	2
OMA	Optical Modulation Amplitude (2.125Gb/s)	196			μ W (pk-pk)	3
OMA	Optical Modulation Amplitude (1.0625Gb/s)	156			μ W (pk-pk)	3
RIN_{12}	Relative Intensity Noise			-117	dB/Hz	4
	Eye Opening	0.56			UI	5
DJ	Deterministic Jitter			0.26	UI	6
CPR	Coupled Power Ratio	9			dB	7

- Launched optical power is measured at the end of a two meter section of a 50/125m fiber (N.A.=0.20). The maximum and minimum of the allowed range of average transmitter power coupled into the fiber are worst case values to account for manufacturing variances, drift due to temperature variations, and aging effects. The minimum launched optical power specified assumes an infinite extinction ratio at the minimum specified OMA.
- Optical transition time is the time interval required for the rising or falling edge of an optical pulse to transition between the 20% and 80% amplitudes relative to the logical 1 and 0 levels. This is measured through a 4th order Bessel -Thompson filter with $0.75 * \text{Data Rate}$ 3-dB bandwidth and corrected to the full bandwidth value.
- Optical Modulation Amplitude (OMA) is defined as the difference in optical power between a logic level one and a logic level zero. The Optical Modulation Amplitude is defined in terms of average optical power (P_{AVG} in μ W) and extinction ratio (ER) as given by $OMA=2P_{AVG}((ER-1)/(ER+1))$. In this expression, the extinction ratio, the ratio of the average optical power (in μ W) in a logic level one to the average optical power in a logic level zero measured under fully modulated conditions in the presence of worst case reflections, must be the absolute (unitless linear) ratio and not expressed in dB. The specified Optical Modulation Amplitude is equivalent to an average power of -9 dBm at an extinction ratio of 9 dB.
- RIN_{12} is the laser noise, integrated over a specified bandwidth, measured relative to average optical power with 12dB return loss. See ANSI Fibre Channel Specification Annex A.
- Eye opening is the portion of the bit time where the bit error rate (BER) $\leq 10^{-12}$. 1.0625Gb/s values meet the criteria listed in Ref [1].
- Deterministic Jitter is measured as the peak-to-peak timing variation of the 50% optical signal crossings when transmitting repetitive K28.5 characters. It is defined in FC-PH, version 4.3, clause 3.1.87 as:
Timing distortions caused by normal circuit effects in the transmission system. Deterministic jitter is often subdivided into duty cycle distortion (DCD) caused by propagation differences between the two transitions of a signal and data dependent jitter (DDJ) caused by the interaction of the limited bandwidth of the transmission system components and the symbol sequence. 1.0625Gb/s values meet the criteria listed in Ref [1].
- Coupled Power Ratio is the ratio of the average power coupled into a multimode fiber to the average power coupled into a single mode fiber. This measurement is defined in EIA/TIA-526-14A.



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Optical Specifications (Long Wavelength)

Receiver Specifications

Symbol	Parameters	Min	Typical	Max	Units	Notes
λ	Operating Wavelength	1270		1355	nm	
RL	Return Loss of Receiver	12			dB	
OMA	Optical Modulation Amplitude (2.125Gb/s and 1.0625Gb/s)	15		1000	μ W	1,2
P _{off}	Rx_SD De-Assert (negate) Level	-30.0		-20.0	dBm (avg)	3
P _{on}	Rx_SD Assert Level			-20.5	dBm (avg)	3
	Rx_SD Hysteresis	0.5	2.5	5.0	dB (optical)	3

1. The minimum and maximum values of the average received power in dBm allow the input power range to maintain a BER 10^{-12} when the data is sampled in the center of the receiver eye. These values take into account power penalties caused by the use of a laser transmitter with a worst-case combination of spectral width, extinction ratio, and pulse shape characteristics.
2. Optical Modulation Amplitude (OMA) is defined as the difference in optical power between a logic level one and a logic level zero. The Optical Modulation Amplitude is defined in terms of average optical power (P_{AVG} in μ W) and extinction ratio (ER) as given by $OMA=2P_{AVG}((ER-1)/(ER+1))$. The extinction ratio, defined as the ratio of the average optical power (in μ W) in a logic level one to the average optical power in a logic level zero measured under fully modulated conditions in the presence of worst case reflections, must be the absolute (unitless linear) ratio and not expressed in dB. The specified Optical Modulation Amplitude at 2.125Gb/s is equivalent to an average power of -15 dBm at an extinction ratio of 9 dB. At 1.0625Gb/s, the specified OMA is equivalent to an average power of -17 dBm at an ER of 9 dB.
3. The RX_SD has hysteresis to minimize "chatter" on the output line. In principle, hysteresis alone does not guarantee chatter-free operation. These SFFs, however, present an RX_SD line without chatter, where chatter is defined as a transient response having a voltage level of greater than 0.5 volts (in the case of going from the negate level to the assert level) and of any duration that can be sensed by the host logic.



Transmitter Specifications

Symbol	Parameter	Min	Typical	Max	Units	Notes
λ_C	Spectral Center Wavelength	1295		1335	nm	
$\Delta\lambda$	Spectral Width			2.0	nm (rms)	
PT	Launched Optical Power	-8.0		-3.0	dBm (avg)	1
T_{rise}/T_{fall}	Optical Rise/Fall Time			160	ps	2
OMA	Optical Modulation Amplitude	150			μ W	3
RIN_{12}	Relative Intensity Noise			-117	dB/Hz	4
	Eye Opening	0.56			UI	5
DJ	Deterministic Jitter			0.26	UI	6

1. Launched optical power is measured at the end of a two meter section of a 9/125 μ m fiber for the SFF-PTH-LW. The maximum and minimum of the allowed range of average transmitter power coupled into the fiber are worst case values to account for manufacturing variances, drift due to temperature variations, and aging effects. The minimum launched optical power specified assumes an infinite extinction ratio at the minimum specified OMA.
2. Optical transition time is the time interval required for the rising or falling edge of an optical pulse to transition between the 20% and 80% amplitudes relative to the logical 1 and 0 levels. This is measured through a 4th order Bessel -Thompson filter with 0.75 * Data Rate 3-dB bandwidth and corrected to the full bandwidth value.
3. Optical Modulation Amplitude (OMA) is defined as the difference in optical power between a logic level one and a logic level zero. The Optical Modulation Amplitude is defined in terms of average optical power (P_{AVG} in μ W) and extinction ratio (ER) as given by $OMA=2P_{AVG}((ER-1)/(ER+1))$. In this expression, the extinction ratio, the ratio of the average optical power (in μ W) in a logic level one to the average optical power in a logic level zero measured under fully modulated conditions in the presence of worst case reflections, must be the absolute (unitless linear) ratio and not expressed in dB. The specified Optical Modulation Amplitude is equivalent to an average power of -9 dBm at an extinction ratio of 9 dB.
4. RIN_{12} is the laser noise, integrated over a specified bandwidth, measured relative to average optical power with 12 dB return loss. See ANSI Fibre Channel Specification Annex A.5.
5. Eye opening is the portion of the bit time where the bit error rate (BER) is $< 10^{-12}$. 1.0625Gb/s values meet the criteria listed in Ref [1].
6. Deterministic Jitter is measured as the peak-to-peak timing variation of the 50% optical signal crossings when transmitting repetitive K28.5 characters. It is defined in FC-PC, version 4.3, clause 3.1.87 as: *Timing distortions caused by normal circuit effects in the transmission system. Deterministic jitter is often subdivided into duty cycle distortion (DCD) caused by propagation differences between the two transitions of a signal and data dependent jitter (DDJ) caused by the interaction of the limited bandwidth of the transmission system components and the symbol sequence.* 1.0625Gb/s values meet the criteria listed in Ref [1].

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Optical Cable and Connector Specifications (Short Wavelength)

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
50/125 μm Cable Specifications (Multimode 850nm, 400 MHz-km)						
L	Length - 2.125Gb/s	2		260	m	
L	Length - 1.0625Gb/s	2		450	m	
BW	Bandwidth @ $\lambda = 850\text{nm}$	400			MHz-km	
μ_c	Attenuation @ $\lambda = 850\text{nm}$			3.5	dB/km	
N.A.	Numerical Aperture		0.20			
50/125 μm Cable Specifications (Multimode 850nm, 500 MHz-km)						
L	Length - 2.125Gb/s	2		300	m	
L	Length - 1.0625Gb/s	2		500	m	
BW	Bandwidth @ $\lambda = 850\text{nm}$	500			MHz-km	
μ_c	Attenuation @ $\lambda = 850\text{nm}$			3.5	dB/km	
N.A.	Numerical Aperture		0.20			
62.5/125 μm Cable Specifications (Multimode 850nm, 160 MHz-km)						
	Length - 2.125Gb/s	2		120	m	
	Length - 1.0625Gb/s	2		250	m	
BW	Bandwidth @ $\lambda = 850\text{nm}$	160			MHz-km	
	Attenuation @ $\lambda = 850\text{nm}$			3.75	dB/km	
N.A.	Numerical Aperture		0.275			
62.5/125 μm Cable Specifications (Multimode 850nm, 200 MHz-km)						
	Length - 2.125Gb/s	2		150	m	
	Length - 1.0625Gb/s	2		300	m	
BW	Bandwidth @ $\lambda = 850\text{nm}$	200			MHz-km	
	Attenuation @ $\lambda = 850\text{nm}$			3.75	dB/km	
N.A.	Numerical Aperture		0.275			
LC Optical Connector Specifications (Multimode)						
μ_{con}	Nominal Attenuation		0.25	0.4	dB	1
σ_{con}	Attenuation Standard Deviation		0.15		dB	1
	Connects/Disconnects			250	cycles	1
<p>1. The optical interface connector dimensionally conforms to the industry standard LC type connector documented in [1]. A dual keyed LC receptacle mechanically aligns the optical transmission fiber to the SFF-PTH-SW/LW-2X5/2X6.</p>						



Optical Cable and Connector Specifications (Long Wavelength)

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
9/125μm Cable Specifications (Singlemode 1310nm)						
L	Length - 2.125Gb/s			10000	m	
L	Length - 1.0625Gb/s			10000	m	
μ_c	Attenuation @ $\lambda = 1310\text{nm}$			0.5	dB/km	
LC Optical Connector (Singlemode)						
μ_{con}	Nominal Attenuation		0.2	0.4	dB	1
σ_{con}	Attenuation Standard Deviation		0.1		dB	1
	Connects/Disconnects			250	cycles	1
1. The optical interface connector dimensionally conforms to the industry standard LC type connector documented in [1]. A dual keyed LC receptacle mechanically aligns the optical transmission fiber to the SFF-PTH-SW/LW-2X5/2X6.						



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2x / 1x Fibre Channel Small Form Factor PTH Transceiver**Reliability Projections**

Symbol	Parameter	Max.	Unit	Note
AFR	Average Failure Rate	0.01	%/khr	1

1. AFR specified over 44 khours at 50 C, with minimum airflow of 100 fpm.

ESD Compliance

Symbol	Parameter	Compliance	Unit	Notes
ESD _{EP}	HBM ESD Rating to Electrical Pins	+/- 2000	V	1
ESD _{LC}	Air Discharge into Front Bezel	+/- 15000	V	2

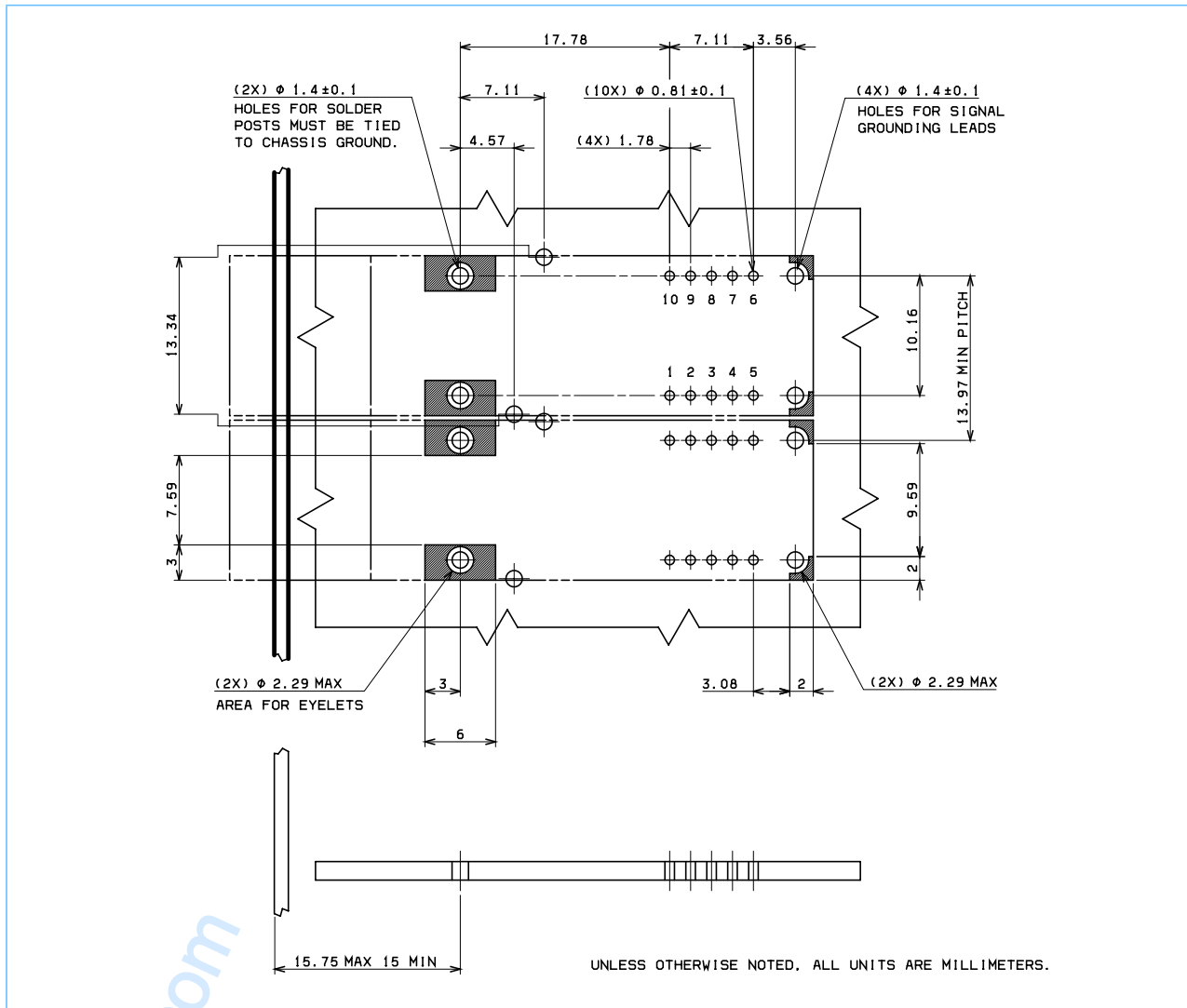
1. The HBM (human body model) is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin per JESD22-A114-B.
2. Complies with European ESD Immunity Test (C-B-2-0001-034).

Soldering Information

The SFF transceiver comes with a process/dust plug. When the plug is in place the transceiver can withstand normal wave soldering and aqueous spray cleaning processes. While the transceiver is able to withstand an aqueous cleaning process, it is not hermetically sealed; it was not designed to be immersed in cleaning solvents. An opening in the back of the top lid is to allow compressed air to be blown into the module to aid in the removal of trapped water. This process should be performed after aqueous cleaning with the plug still inserted. If the plug was not contaminated during the wave soldering and aqueous spray cleaning process it can be reused as a dust plug.

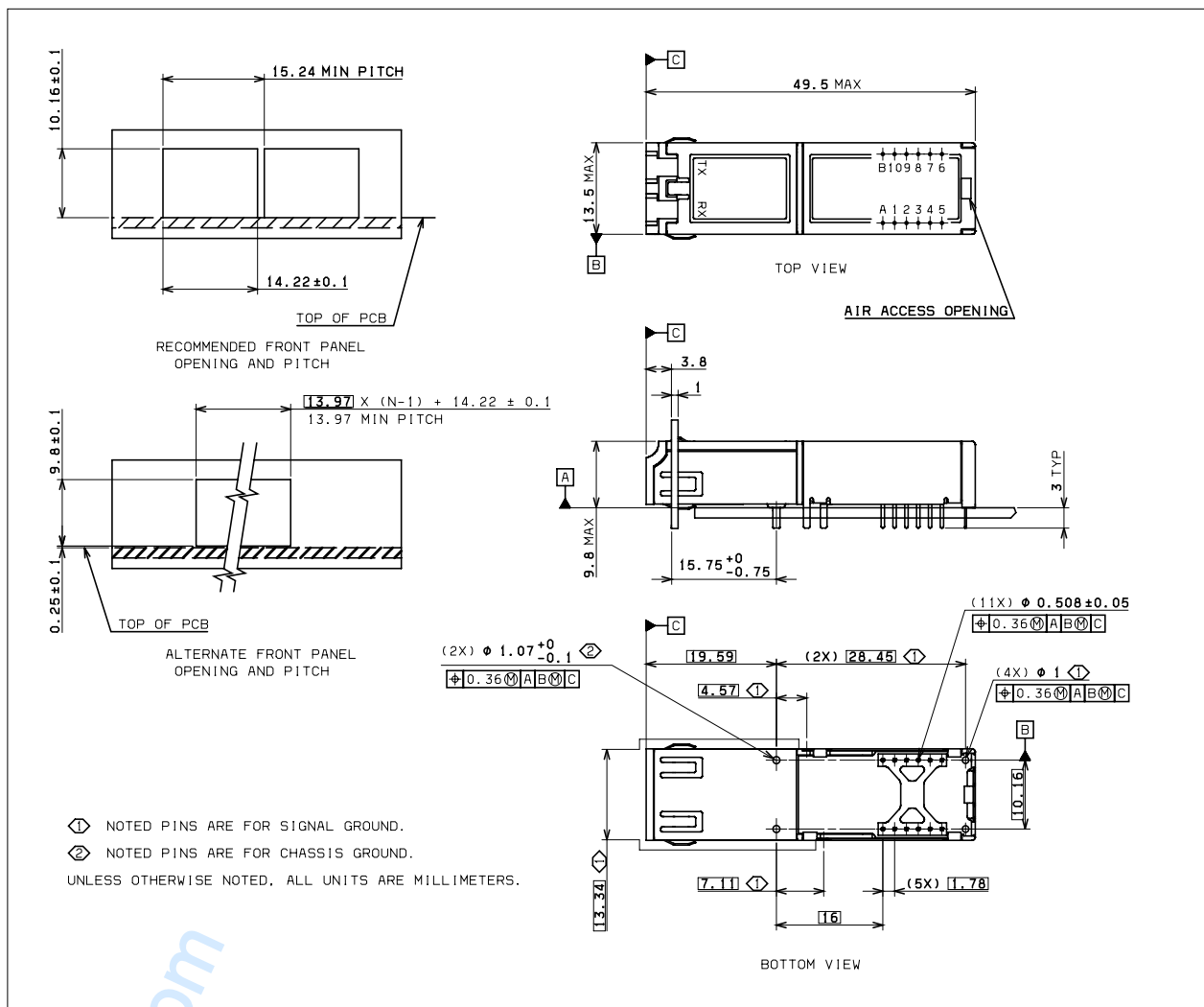
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2x / 1x Fibre Channel Small Form Factor PTH Transceiver

Host Card Footprint (2 X 5 Pin Configuration)





Mechanical Description (2 X 6 Pin Configuration)

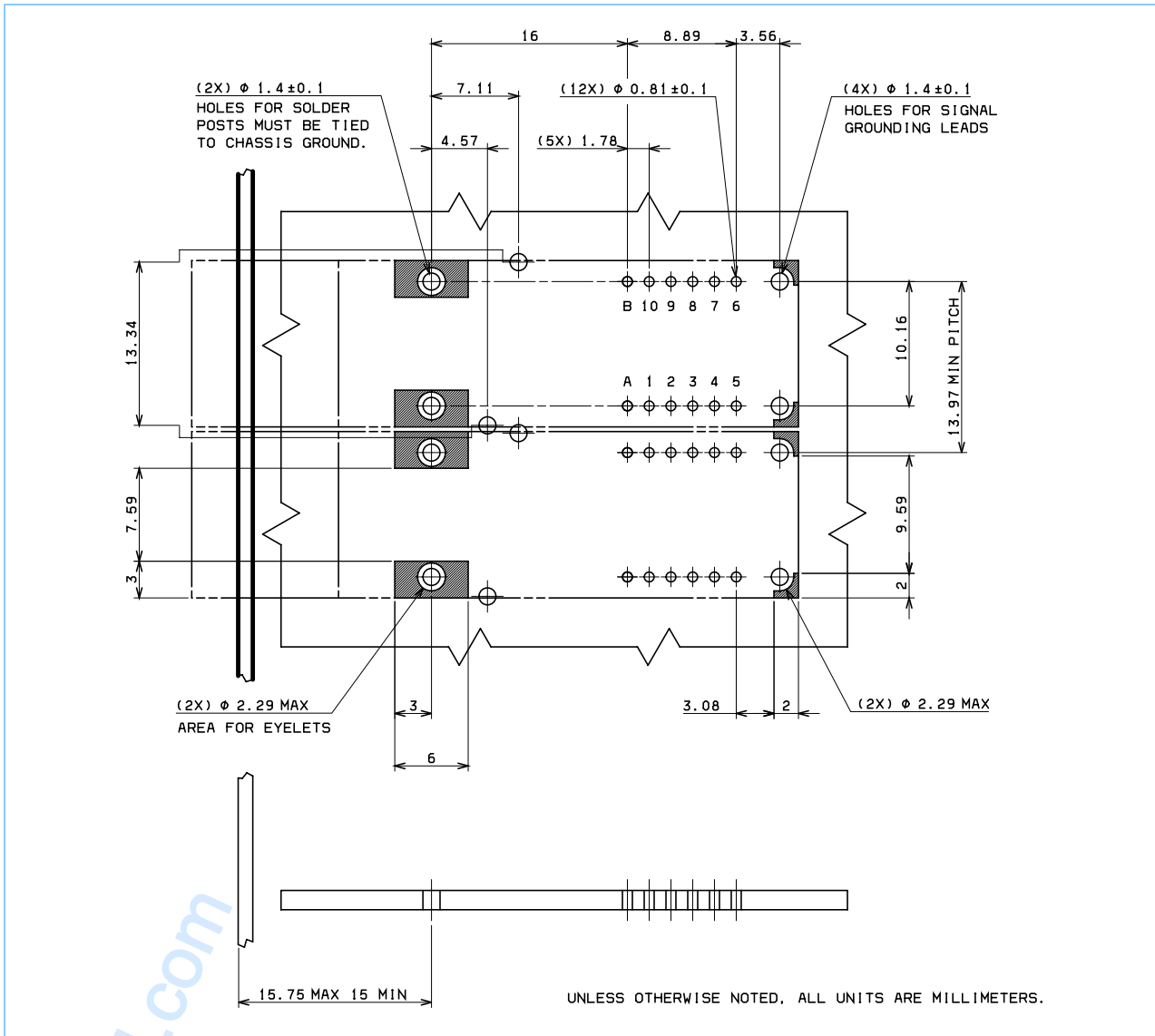


The SFF-PTH-SW/LW-2X5/2X6 is intended to be used on a host card having a thickness of 0.062" to 0.100". The host card footprint with essential keepouts and drill holes is shown in Host Card Footprint (2 X 6 Pin Configuration) on page 20.



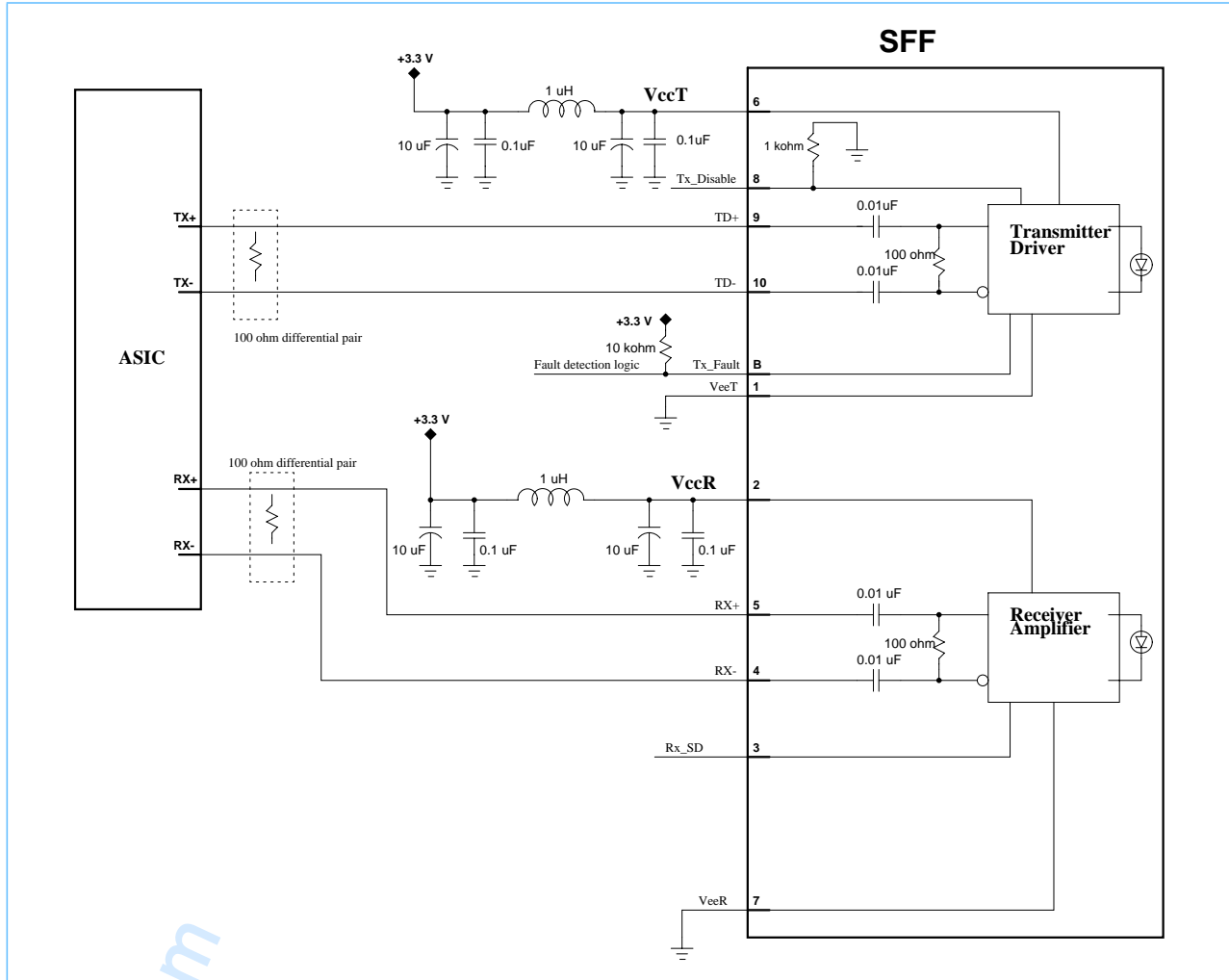
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2x / 1x Fibre Channel Small Form Factor PTH Transceiver

Host Card Footprint (2 X 6 Pin Configuration)





Suggested Transceiver/Host Interface





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IBM42F21LNNA10 IBM42G21LNNA10
2x / 1x Fibre Channel Small Form Factor PTH Transceiver

References

Standards

1. American National Standards Institute Inc. (ANSI), T11/Project 1235-DT/Rev 10, Fibre Channel-Physical Interface (FC-PI). Drafts of this standard are available to members of the standards working committee. For further information see the T11.2 website at www.t11.org. To be added to the email reflector, send an E-mail to:

majordomo@dpt.com

containing the line:

subscribe t11.2 <your email address>

2. American National Standards Institute Inc. (ANSI), T11.2/Project 1230/Rev10, Fibre Channel-Methodologies for Jitter Specifications (MJS). Drafts of this standard are available to members of the standards working committee. For further information see the T11.2 website at www.t11.org. To be added to the email reflector, send an E-mail to:

majordomo@network.com

containing the line:

subscribe T11 <your email address>

Industry Specifications

3. A.X. Widmer and P.A. Franaszek, "A DC-Balanced, Partitioned-Block, 8B/10B Transmission Code," *IBM Journal of Research and Development*, vol. 27, no. 5, pp. 440-451, September 1983. This paper fully defines the 8B/10B code. It is primarily theoretical.
4. A.X. Widmer, The ANSI Fibre Channel Transmission Code, *IBM Research Report, RC 18855 (82405)*, April, 23 1993. Copies may be requested from:

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Revision Log

Date	Description of Modification
08/15/00	Initial release.
3/14/01	Page 1, Added Dissipation words Page 7, Added Dissipation words and rounded off numbers Page 13, Changed Fall Time, Wavelength, Launched Power, and OMA to match industry specs. Page 16, Rearranged ESD table Page 21, New updated schematic Page 17,19, New pictures with air access hole

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