IBM42B10SNNAA10
IBM42B12SNNAA10

Gigabit Ethernet/Fibre Channel 1X9 Transceiver

Features

- International Class 1 laser safety certified
- 1.0625 Gb/s or 1.25 Gb/s data rates
- (ANSI) Fibre Channel compliant [1]
- (IEEE 802.3) Gigabit Ethernet compliant [3]
- Short wavelength (SW) (distance ≤ 550 m)
- Gigabit electrical serial interface
- Serial electrical ⇔ light conversion
- LVTTL Signal-Detect output
- AC coupling of PECL signals
- Compatible with +3.3 V or +5 V power supplies
- Withstands normal wave solder and aqueous spray cleaning
- UL and CSA approved
- Low bit error rate (< 10^{-12})
- High reliability: AFR < 0.01%/khr@50°C,100 FIT

Applications

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

Description

The 1.0625/1.25 Gb/s 1X9 Transceiver (1X9-1063/1250-SW) is an integrated fiber optic transceiver that provides a high-speed serial link at a signaling rate up to 1.25 Gb/s. The 1X9-1063-SW conforms to the American National Standards Institute's (ANSI) Fibre Channel, FC-PI specification for short wavelength operation (100-M5-SN-I and 100-M6-SN-I). The 1X9-1250-SW conforms to IEEE 802.3z 1000Base-SX standard [3].

The 1X9-1063/1250-SW is ideally suited for Gigabit Ethernet, and 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.

The1X9-1063/1250-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 500 m at 1.0625 Gb/s and 550 m at 1.25 Gb/s. A 50/125 μm multimode optical fiber, terminated with an industry standard SC connector, is the preferred medium. (A 62.5/125 μm multimode fiber can be substituted with shorter maximum link distances.)

Encoded (8B/10B) [4], [5], gigabit serial differential PECL signals traverse a PTH connector interfacing the 1X9-1063/1250-SW to the host card. The incoming 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 SC receptacle. The optical signal is converted to an electrical signal, amplified and delivered to the host card. This module is designed to work with industry standard "10b" Serializer/Deserializer modules.

The 1X9-1063/1250-SW is a Class 1 laser safe product. The optical power levels under normal operation are at eye safe levels, and optical fiber can be connected and disconnected without shutting off the laser transmitter.

Package Outline

Pin Assignments

Pin Name	Type	Pin #
Rx Ground	Ground	1
Rx_DAT +	Signal Out	2
Rx_DAT -	Signal Out	3
Rx_SD	Status Out	4
Rx Power	Power	5
Tx Power	Power	6
Tx_DAT -	Signal In	7
Tx_DAT +	Signal In	8
Tx Ground	Ground	9

Ordering Information

Product Descriptor	IMD Part Number	Wavelength	Maximum Data Rate
1X9-1063-SW	IBM42B10SNNAA10	850 nm	1.0625 Gb/s
1X9-1250-SW	IBM42B12SNNAA10	850 nm	1.25 Gb/s

Laser Safety Compliance Requirements

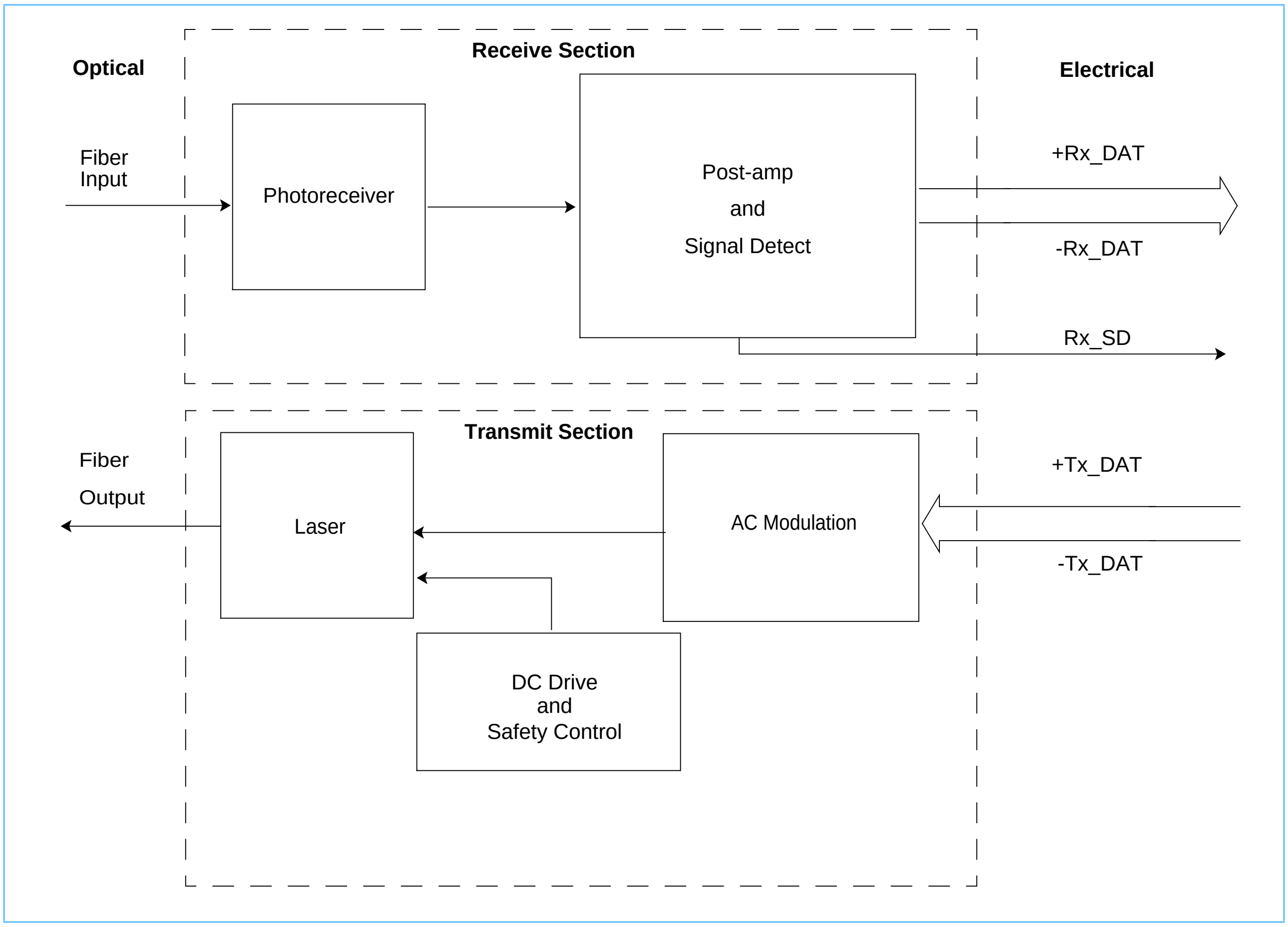
The 1X9-1063/1250-SW is designed and certified as a Class 1 laser product. If the power supply voltage exceeds 6.0 volts, the transceiver may no longer remain a Class 1 product. The system using the 1X9-1063/1250-SW must provide power supply over-voltage protection that guarantees the supply does not exceed 6.0 volts under all conditions.

Caution: Operating the power supply above 6.0V or otherwise operating the 1X9-1063/1250-SW 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 21CFR1010 and 21CFR1040, 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 21CFR1010 and 21CFR1040 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 1X9-1063/1250-SW 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.

Input Signal Definitions

Levels for the signals described in this section are listed in Transmit Signal Interface on page 6 and Control Electrical Interface on page 7.

Tx_DAT

A differential PECL serial data stream is presented to the 1X9-1063/1250-SW for transmission onto an optical fiber by modulating the optical output intensity of the laser. The transceiver provides the AC coupling for the +Tx/-Tx lines.

Output Signal Definitions

Levels for the signals described in this section are listed in Receive Signal Interface on page 6 and Control Electrical Interface on page 7.

Rx_DAT

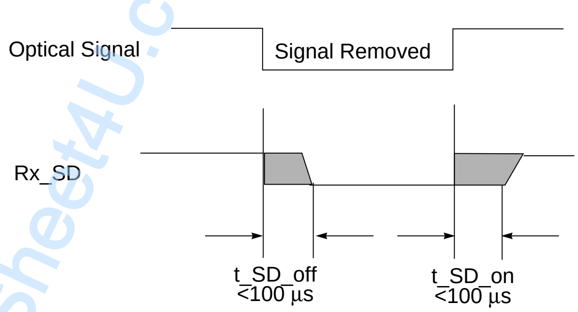
The incoming optical signal is converted and repowered as a differential PECL serial data stream. The Receive Signal Interface table on page 6 gives the voltage levels and timing characteristics for the Rx_DAT signals. The transceiver provides the AC coupling for the +Rx/-Rx lines.

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 the incoming modulated light intensity is below that required to guarantee the correct operation of the link. Normally, this condition 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 .

Receive Signal Detection



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		6.0	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 4 of the 1X9 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
$V_{DD}T$, $V_{DD}R$	Supply Voltage, 3.3 V operation	3.135	3.3	3.465	V
$V_{DD}T$, $V_{DD}R$	Supply Voltage, 5 V operation	4.75	5.0	5.25	V
RH_{OP}	Relative Humidity-Operating	8		80	%

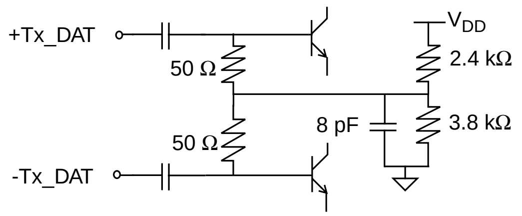
Power Supply Interface

Symbol	Parameter	Min	Typical	Max.	Unit
I_{CC}	Supply Current (@ 3.3 V)		170		mA
I_{CC}	Supply Current (@ 3.465 V)			220	mA
I_{CC}	Supply Current (@ 5 V)		180		mA
I_{CC}	Supply Current (@ 5.25 V)			230	mA
P_{DIS}	Power Dissipation (@ 3.3 V)		560		mW
P_{DIS}	Power Dissipation (@ 3.465 V)			760	mW
P_{DIS}	Power Dissipation (@ 5 V)		900		mW
P_{DIS}	Power Dissipation (@ 5.25 V)			1200	mW
	Ripple & Noise			100	mV (pk-pk)

Transmit Signal Interface (from host to 1X9-1063/1250-SW)

Symbol	Parameter	Min	Max.	Unit	Notes
V_o	PECL Amplitude	400	2000	mV	1
$DJ_{elec\text{-}xmit}$	PECL Deterministic Jitter (1.0625 Gb/s)		0.12	UI	2
$TJ_{elec\text{-}xmt}$	PECL Total Jitter		0.25	UI	2
	PECL Rise/Fall	100	350	ps	3
	PECL Differential Skew		20	ps	

1. At 100 Ω, differential peak-to-peak, the figure below shows the simplified circuit schematic for the 1X9-1063/1250-SW high-speed differential input lines. The PECL input data lines have AC coupling capacitors. The capacitors are not required on the host card.

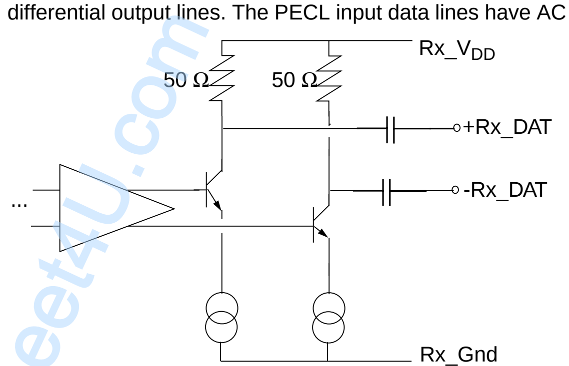


2. Deterministic jitter (DJ) and total jitter (TJ) values are measured according to the methods defined in [2]. [1UI(Unit Interval)=800 ps at 1.25 Gb/s, and 1UI=941 ps at 1.0625 Gb/s]. Listed values apply to 1.0625 Gb/s, 1.25 Gb/s transceivers accept TJ < 0.24 UI.
3. Rise and fall times are measured from 20 - 80%, 100 Ω differential.

Receive Signal Interface (from 1X9-1063/1250-SW to host)

Symbol	Parameter	Min	Max.	Unit	Note(s)
V_o	PECL Amplitude	600	1000	mV	1
$DJ_{elec\text{-}rcv}$	PECL Deterministic Jitter (1.0625 Gb/s)		0.36	UI	2
$TJ_{elec\text{-}rcv}$	PECL Total Jitter		0.61	UI	2
	PECL Differential Skew		205	ps	

1. At 100 Ω, differential peak-to-peak, the figure below shows the simplified circuit schematic for the 1X9-1063/1250-SW high-speed differential output lines. The PECL input data lines have AC coupling capacitors. The capacitors are not required on the host card.



2. Deterministic jitter (DJ) and total jitter (TJ) values are measured according to the methods defined in [2]. Jitter values assume worst case input jitter. [1 UI(Unit Interval)=800 ps at 1.25 Gb/s, and 1UI=941 ps at 1.0625 Gb/s]. Listed values apply to 1.0625 Gb/s, 1.25 Gb/s transceivers have TJ < 0.749 UI.

Control Electrical Interface

Symbol	Parameter	Min	Max.	Unit	Note(s)
Voltage Levels					
V_{OL}	TTL Output (from 1X9-1063/1250-SW)	0.0	0.5	V	
V_{OH}		2.8	3.6	V	
Timing Characteristics					
t_init	Initialization Time		300	ms	
t_SD_on	Rx_SD Assert Time		100	µs	1
t_SD_off	Rx_SD De-Assert Time		100	µs	1

1. See Rx_SD on page 4 for timing relations.

Optical Specifications

Receiver Specifications

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
λ	Operating Wavelength	770		860	nm	
RL	Return Loss of Receiver	12			dB	
	Average Received Power (1.25 Gb/s)	-17		0	dBm	1
OMA	Optical Modulation Amplitude (1.0625 Gb/s)	31		2000	µW (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 OMA is defined in terms of average optical power (P_{AVG} in µW) and extinction ratio (ER) as given by OMA=$2P_{AVG}$((ER-1)/(ER+1)). In this expression the extinction ratio, defined as the ratio of the average optical power (in µW) 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 ratio of 9 dB. At 1.0625 Gb/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 1X9-1063/1250-SW, however, presents a 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	-9.5		-4.0	dBm (avg)	1
T_{rise}/T_{fall}	Optical Rise/Fall Time			260	ps	2
	Optical Extinction Ratio (1.25 Gb/s)	9			dB	3
OMA	Optical Modulation Amplitude (1.0625 Gb/s)	156			µW (pk-pk)	4
RIN_{12}	Relative Intensity Noise			-117	dB/Hz	5
	Eye Opening	0.57			UI	6
DJ	Deterministic Jitter (1.0625 Gb/s)			0.20	UI	7
CPR	Coupled Power Ratio	9			dB	8

1. Launched optical power is measured at the end of a two meter section of a 50/125 µm 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.
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. Extinction Ratio is the ratio of the average optical power (in dB) in a logical level one to the average optical power in a logical level zero measured under fully modulated conditions with a pattern of five 1s followed by five 0s, in the presence of worst case reflections.
4. Optical Modulation Amplitude (OMA) is defined as the difference in optical power between a logical level one and a logical level zero. The OMA is defined in terms of average optical power (P_{AVG} in µW) and extinction ratio (ER) as given by $OMA=2P_{AVG}((ER-1)/(ER+1))$. In this expression, the extinction ratio, defined as the ratio of the average optical power (in µW) 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. At 1.0625 Gb/s, the specified OMA is equivalent to an average power of -9 dBm at an extinction ratio of 9 dB.
5. RIN12 is the laser noise, integrated over a specified bandwidth, measured relative to average optical power with 12dB return loss. See Ref[1], Annex A.
6. Eye opening is the portion of the bit time where the bit error rate (BER) $\leq 10^{-12}$.
7. Deterministic Jitter is defined in Ref [1][2].
8. 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.

Optical Cable and Connector Specifications

Symbol	Parameter	Min	Typical	Max.	Unit	Notes
50/125 µm Cable Specifications (Multimode 850 nm, 400 MHz-km)						
L	Length - 1.25 Gb/s	2		500	m	
L	Length - 1.0625 Gb/s	2		450	m	
BW	Bandwidth @ λ = 850 nm	400			MHz-km	
μ_c	Attenuation @ λ = 850 nm			3.5	dB/km	
N.A.	Numerical Aperture		0.20			
50/125 µm Cable Specifications (Multimode 850 nm, 500 MHz-km)						
L	Length - 1.25 Gb/s	2		550	m	
L	Length - 1.0625 Gb/s	2		500	m	
BW	Bandwidth @ λ = 850 nm	500			MHz-km	
μ_c	Attenuation @ λ = 850 nm			3.5	dB/km	
N.A.	Numerical Aperture		0.20			
62.5/125 µm Cable Specifications (Multimode 850 nm, 160 MHz-km)						
	Length - 1.25 Gb/s	2		220	m	
	Length - 1.0625 Gb/s	2		250	m	
BW	Bandwidth @ λ = 850 nm	160			MHz-km	
	Attenuation @ λ = 850 nm			3.75	dB/km	
N.A.	Numerical Aperture		0.275			
62.5/125 µm Cable Specifications (Multimode 850 nm, 200 MHz-km)						
	Length - 1.25 Gb/s	2		275	m	
	Length - 1.0625 Gb/s	2		300	m	
BW	Bandwidth @ λ = 850 nm	200			MHz-km	
	Attenuation @ λ = 850 nm			3.75	dB/km	
N.A.	Numerical Aperture		0.275			
SC Optical Connector Specifications (Multimode)						
μ_{con}	Nominal Attenuation		0.3	0.5	dB	1
σ_{con}	Attenuation Standard Deviation		0.2		dB	1
	Connects/Disconnects			250	cycles	1

1. The optical interface connector dimensionally conforms to the industry standard SC type connector documented in [1]. A dual keyed SC receptacle mechanically aligns the optical transmission fiber to the 1X9-1063/1250-SW.

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_{SC}	Air Discharge into Front Bezel	± 15000	V	2

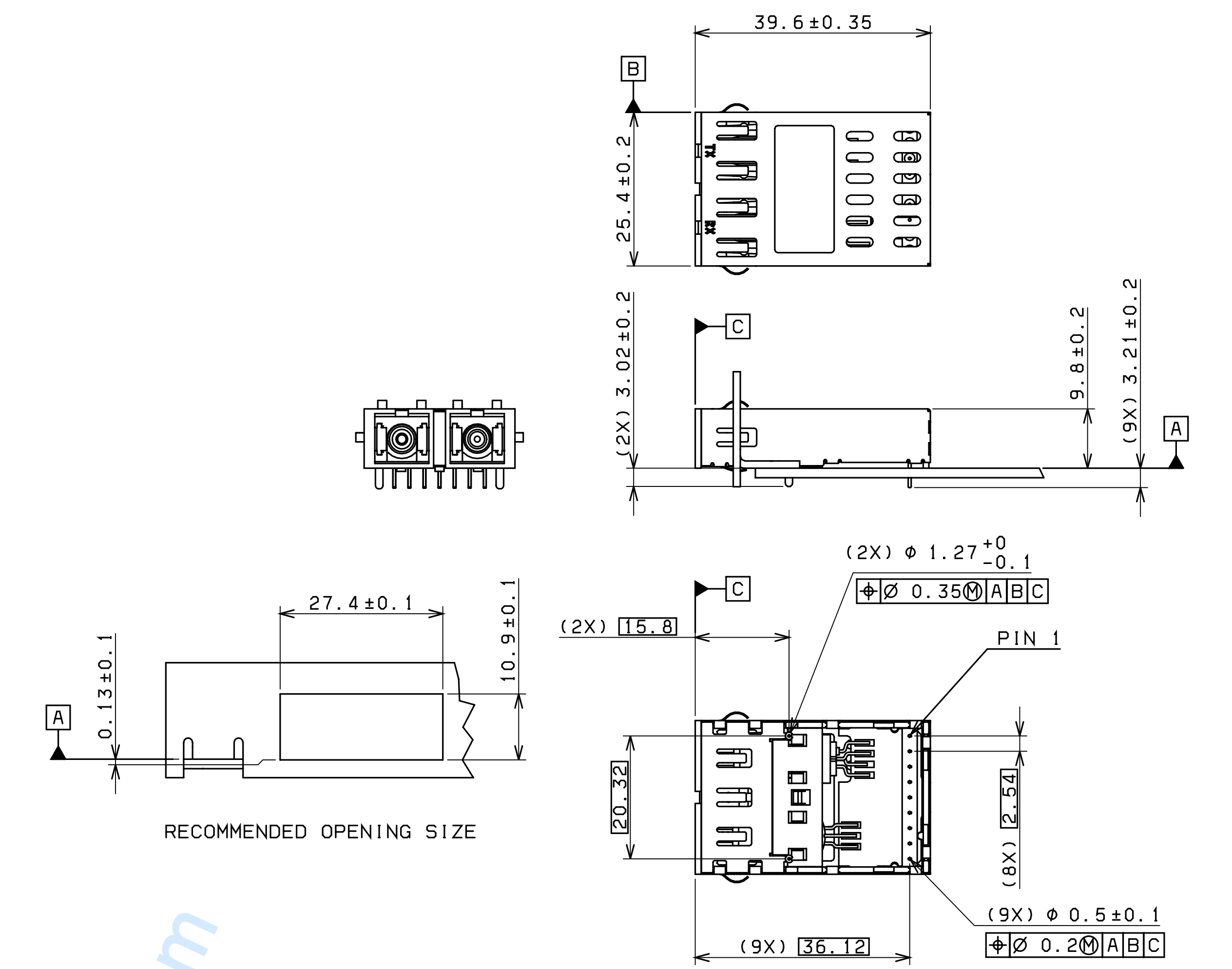
1. The HBM (human body model) is a 100 pF capacitor discharged through a 1.5 kΩ resistor into each pin per JESD22-A114-B.
2. Complies with European ESD Immunity Test (C-B-2-0001-034).

Soldering Information

The 1X9 transceiver comes with a process/dust plug. When the process/dust 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, since it is not hermetically sealed, it was not designed to be immersed in cleaning solvents. If the process/dust plug is not contaminated during the wave soldering and aqueous spray cleaning process it can be reused as a dust plug.

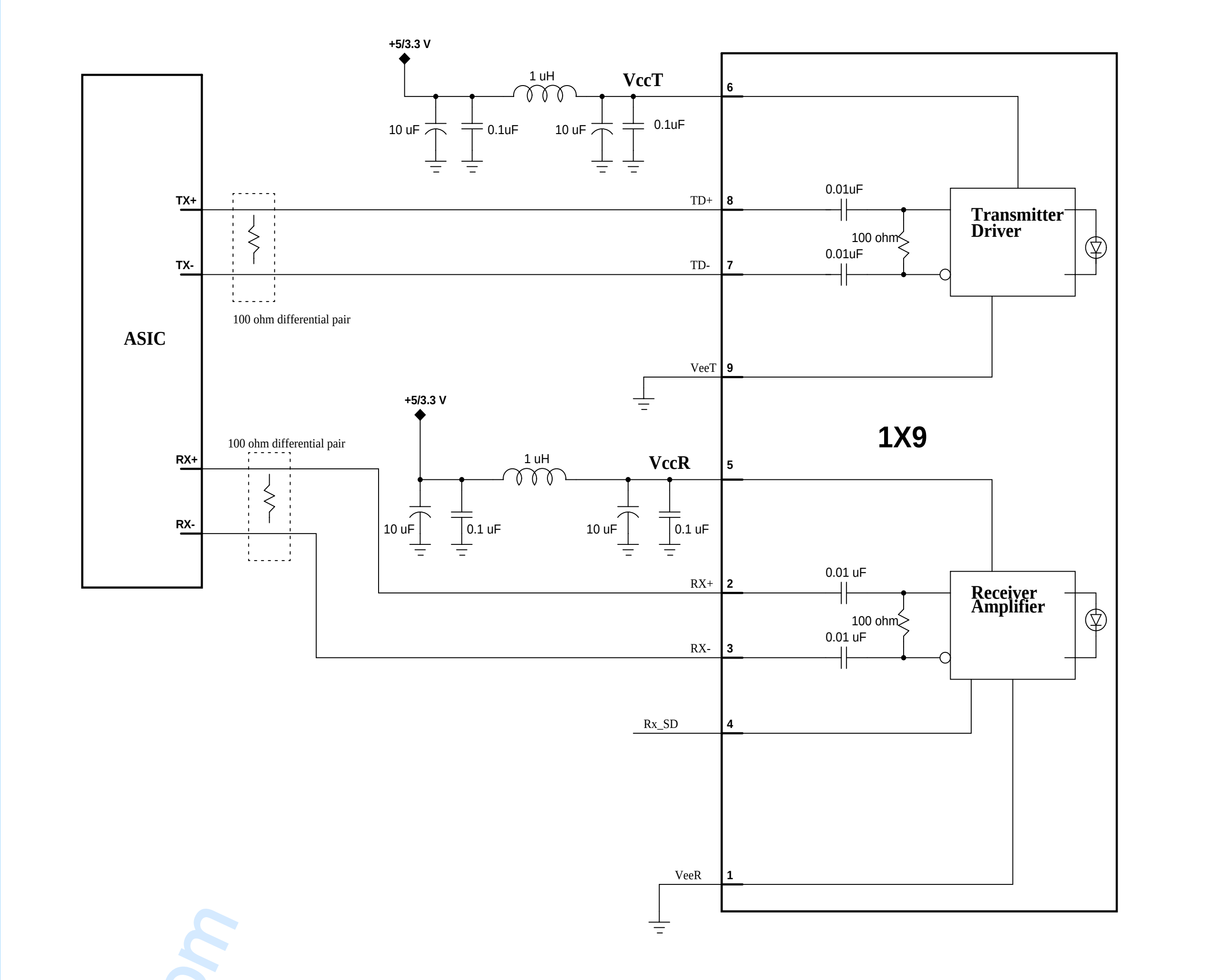
Mechanical Description

Package Diagram



The 1X9-1063/1250-SW is intended to be used on a host card having a thickness of 0.062" to 0.100”.

Recommended Transceiver/Host Interface



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>

3. IEEE 802.3z Gigabit Ethernet Network Standard. Copies of this document may be purchased from:

   Global Engineering
   15 Inverness Way East
   Englewood, CO 80112-5704
   Phone: (800) 854-7179 or (303) 792-2181
   Fax: (303) 792-2192

Industry Specifications

4. 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.

5. 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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