

## 2-CHANNEL ESD SOLUTION FOR HIGH-SPEED (6 GBPS) DIFFERENTIAL INTERFACE

### FEATURES

- 0.05-pF Matching Capacitance Between the Differential Signal Pair
- Single-Pair Differential Lines to Protect the Differential Data and Clock Lines of the LVDS, SATA, Ethernet, or USB High-Speed (HS) Interface
- Flow-Through Pin Mapping for the High-Speed Lines Ensures Zero Additional Skew Due to Board Layout While Placing ESD-Protection Chip Near the Connector
- Supports Data Rates in Excess of 6 Gbps
- ESD Protection Meets or Exceeds IEC61000-4-2 (Level 4)
- 5-A Peak Pulse Current (8/20  $\mu$ s Pulse) for  $V_{BUS}$  and D+, D–, and ID Lines
- Industrial Temperature Range: –40°C to 85°C
- Multiple Space-Saving Package Options

### APPLICATIONS

- Notebooks
- Set-Top Boxes
- DVD Players
- Media Players
- Portable Computers

### DESCRIPTION/ORDERING INFORMATION

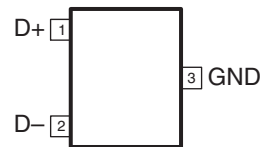
The TPD2E009 provides 2 ESD clamp circuits with flow-through pin mapping for ease of board layout. This device has been designed to protect sensitive components which are connected to ultra high-speed data and transmission lines. The TPD2E009 offers protection from stress caused by ESD (electrostatic discharge). This device also offers 5 A (8/20  $\mu$ s) peak pulse current ratings per IEC 61000-4-5 (lightning) specification.

The monolithic silicon technology allows matching between the differential signal pairs. The less than differential 0.05-pF capacitance ensures that the differential signal distortion due to added ESD clamp remains minimal. The 0.7-pF line capacitance is suitable for high-speed data rate (in excess of 6 Gbps).

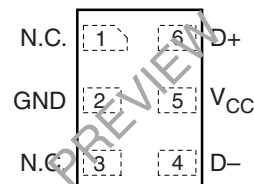
The TPD2E009 conforms to IEC61000-4-2 (Level 4) ESD protection. The DRT (1 mm  $\times$  1 mm) package is offered for space-saving portable applications. The industry standard DBZ (2.4 mm  $\times$  2.9 mm) package offers additional flexibility in the board layout for the system designer.

The TPD2E009 is characterized for operation over ambient air temperature range of –40°C to 85°C.

DBZ/DRT PACKAGE  
(TOP VIEW)



DRY PACKAGE  
(TOP VIEW)



N.C. – No internal connection



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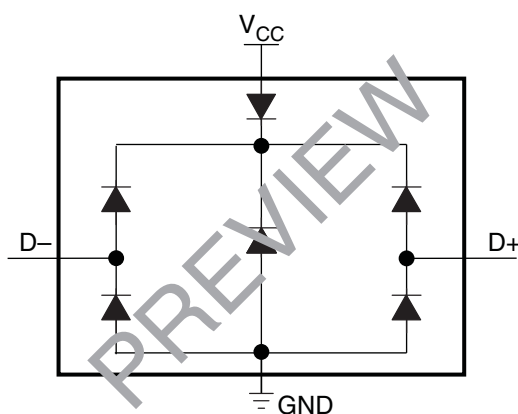
$T_A$	PACKAGE <sup>(1)(2)</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SON – DRY	Tape and reel	TPD2E009DRYR	PREVIEW
	SOP – DBZ	Tape and reel	TPD2E009DBZR	NFLR
	SOT– DRT	Tape and reel	TPD2E009DRTR	4T

(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

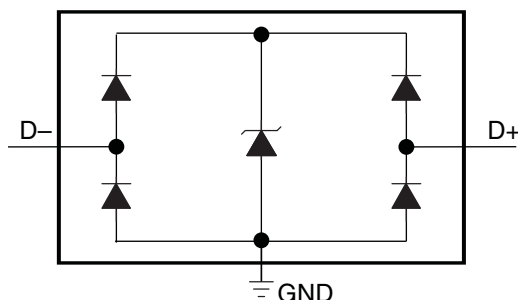
(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI website at [www.ti.com](http://www.ti.com).

## CIRCUIT DIAGRAMS

### DRY Circuit



### DBZ/DRT Circuit



## TERMINAL FUNCTIONS

TERMINAL			TYPE	DESCRIPTION
NAME	DBZ/DRT PIN NO.	DRY <sup>(1)</sup> PIN NO.		
D+, D-	1, 2	4, 6	ESD port	High-speed ESD clamp, provides ESD protection to the high-speed differential data lines
$V_{CC}$	–	5	Supply	Power supply
GND	3	3	GND	Ground

(1) Product Preview

## ABSOLUTE MAXIMUM RATINGS<sup>(1)</sup>

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
	IO voltage tolerance	D+, D– pins	0	6	
T <sub>A</sub>	Operating free-air temperature range		–40	85	°C
T <sub>stg</sub>	Storage temperature range		–65	125	°C
ESD protection	IEC 61000-4-2 Contact Discharge	D+, D– pins		±8	kV
	IEC 61000-4-2 Air-Gap Discharge	D+, D– pins		±8	kV
	Peak pulse current (t <sub>p</sub> = 8/20 μs)	D+, D– pins		5	A
	Peak pulse power (t <sub>p</sub> = 8/20 μs)	D+, D– pins		45	W

- (1) Stresses beyond those listed under "absolute maximum ratings" may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum-rated conditions for extended periods may affect device reliability.

## ELECTRICAL CHARACTERISTICS

over operating free-air temperature range (unless otherwise noted)

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
V <sub>RWM</sub> Reverse stand-off voltage	D+,D– pins to ground			5.5	V
V <sub>clamp</sub> Clamp voltage	D+,D– pins to ground, I <sub>IO</sub> = 1 A			8	V
I <sub>IO</sub> Current from IO port to supply pins	V <sub>IO</sub> = 2.5 V, I <sub>D</sub> = 8 mA		0.01	0.1	μA
V <sub>D</sub> Diode forward voltage	D+,D– pins, lower clamp diode, V <sub>IO</sub> = 2.5 V, I <sub>D</sub> = 8 mA	0.6	0.8	0.95	V
	D+,D– pins, upper clamp diode, V <sub>CC</sub> = 0 V, I <sub>D</sub> = –8 mA, DRY package	0.6	0.8	0.95	
R <sub>dyn</sub> Dynamic resistance	D+,D– pins, I = 1 A		1		Ω
C <sub>IO</sub> IO capacitance	D+,D– pins, DBZ Package, V <sub>IO</sub> = 2.5 V		0.9		pF
	D+,D– pins, DRT Package, V <sub>IO</sub> = 2.5 V		0.7		pF
V <sub>BR</sub> Break-down voltage	I <sub>IO</sub> = 1 mA	7			V

## TYPICAL OPERATING CHARACTERISTICS

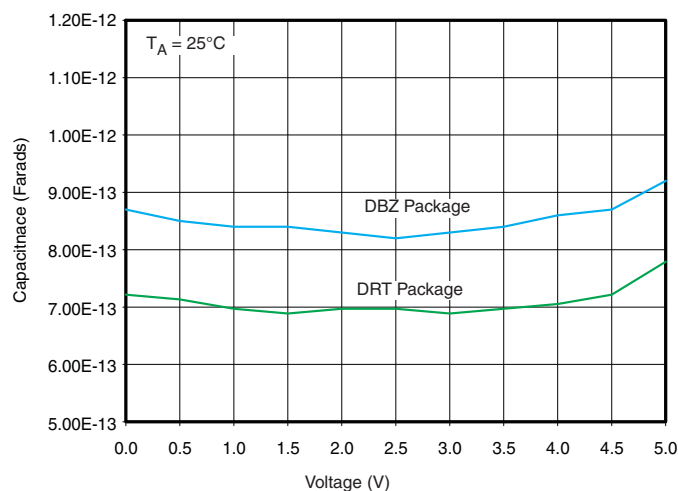


Figure 1. IO Capacitance vs IO Voltage

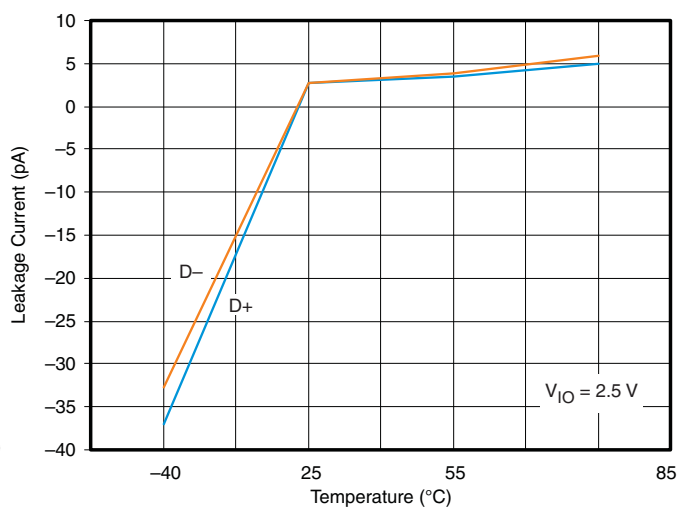


Figure 2. Leakage Current vs Temperature

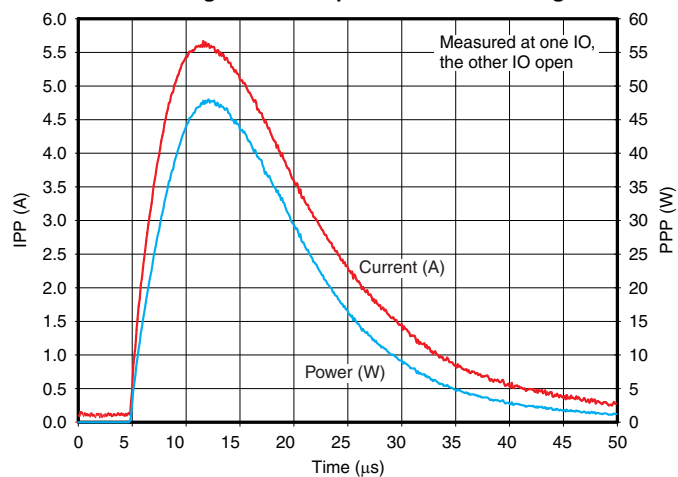


Figure 3. Peak Pulse Waveforms

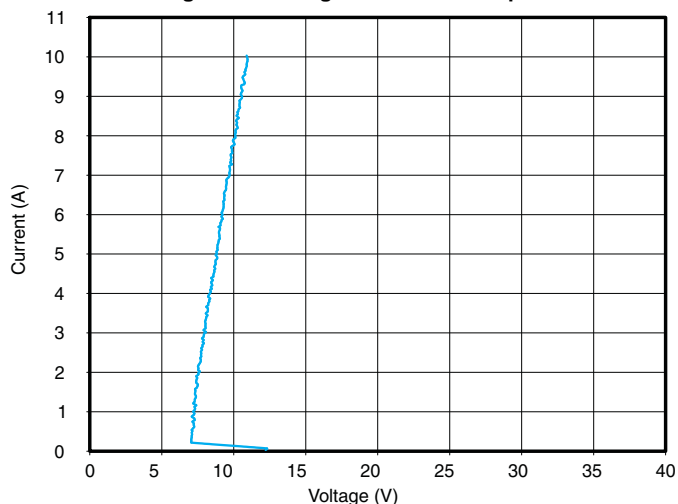


Figure 4. D+,D- Transmission Line Pulsar Plot (100 ns Pulse, 10 ns Rise Time)

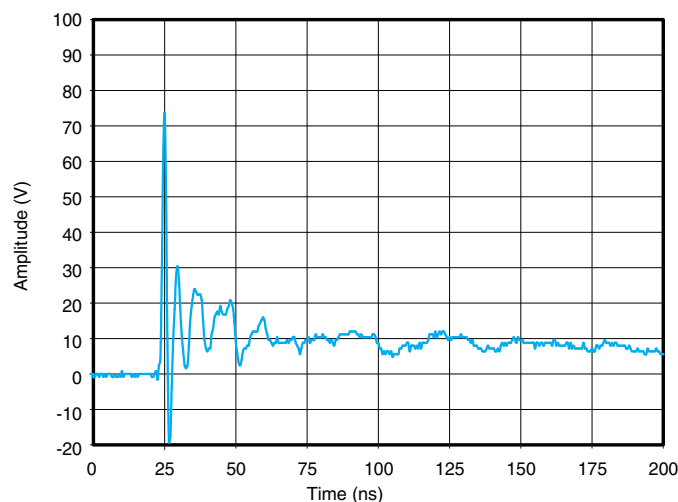


Figure 5. IEC Clamping Waveforms (8 kV Contact)

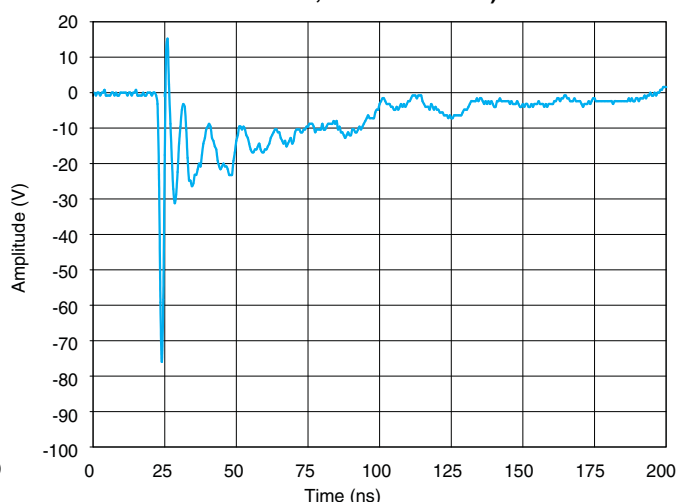
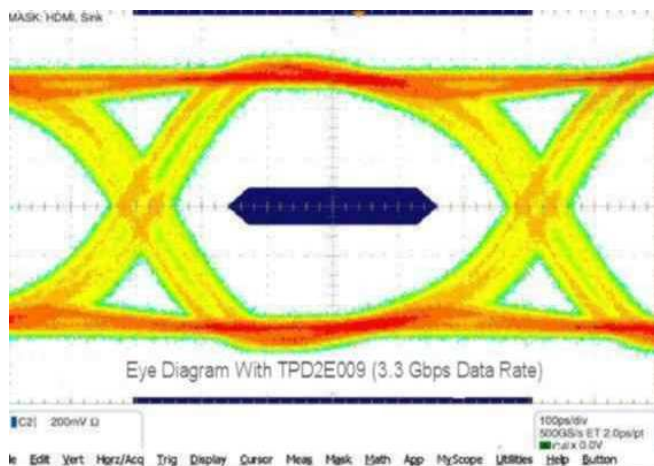


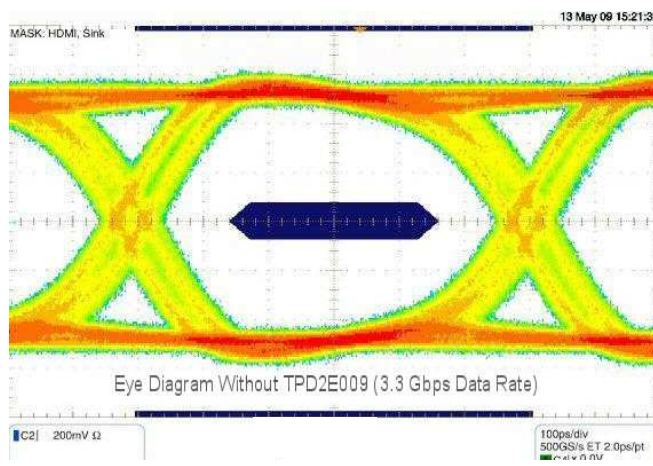
Figure 6. IEC Clamping Waveforms (-8 kV Contact)

## TYPICAL OPERATING CHARACTERISTICS (continued)

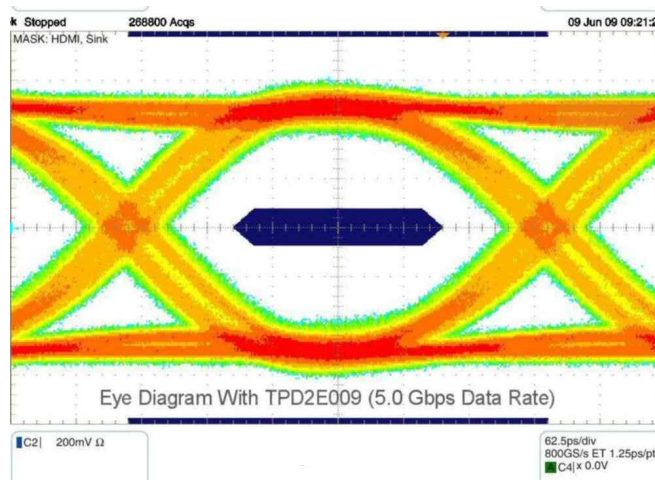
### Eye Diagrams



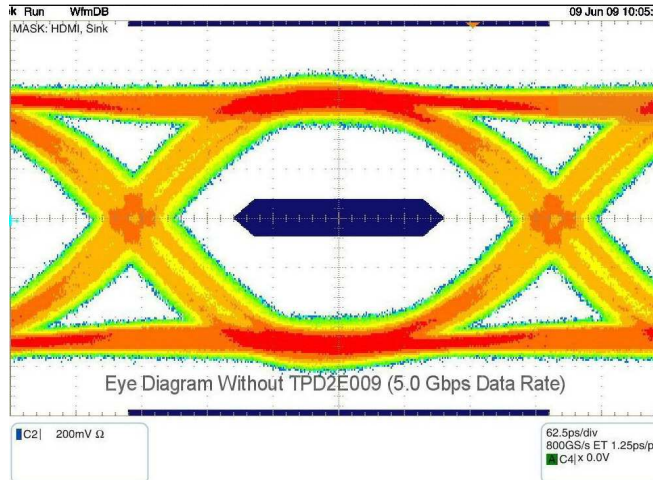
**Figure 7. Eye Diagram With TPD2E009  
(3.3 Gbps Data Rate)  
(3-Pin DBZ Package)**



**Figure 8. Eye Diagram Without TPD2E009  
(3.3 Gbps Data Rate)  
(3-Pin DBZ Package)**

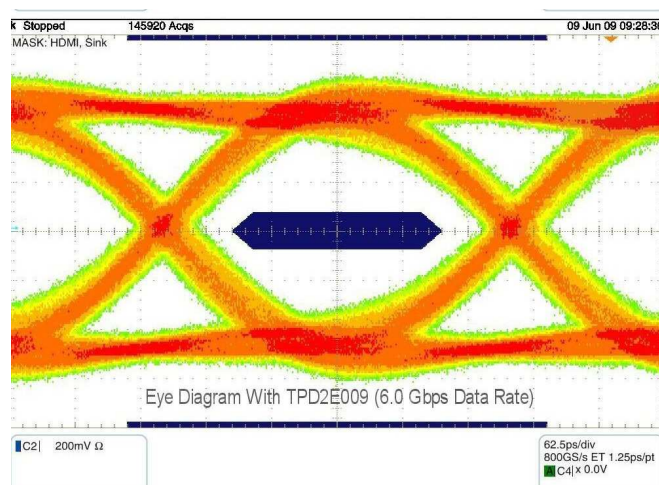


**Figure 9. Eye Diagram With TPD2E009  
(5.0 Gbps Data Rate)  
(3-Pin DBZ Package)**

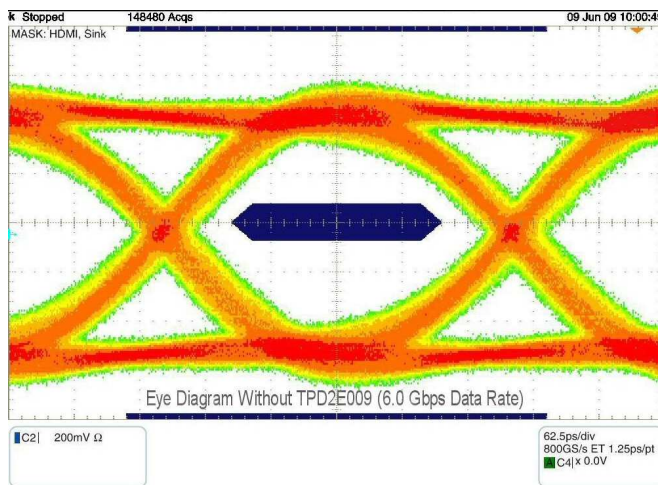


**Figure 10. Eye Diagram Without TPD2E009  
(5.0 Gbps Data Rate)  
(3-Pin DBZ Package)**

## TYPICAL OPERATING CHARACTERISTICS (continued)



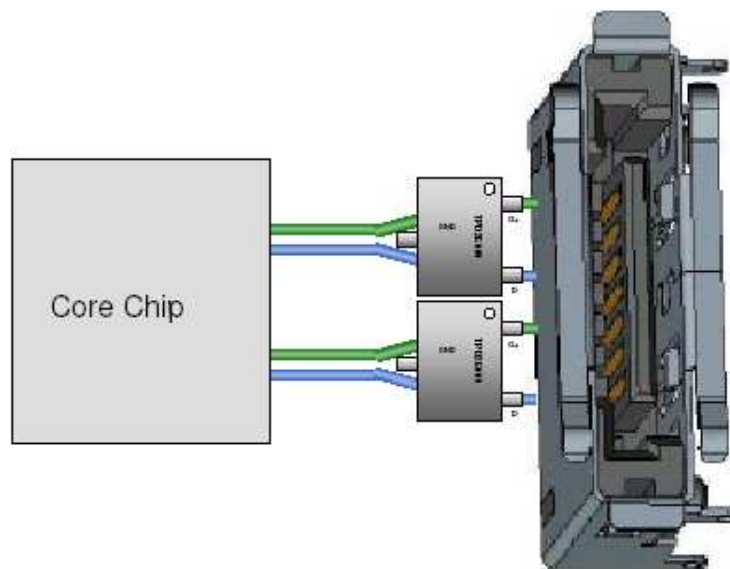
**Figure 11. Eye Diagram With TPD2E009  
(6.0 Gbps Data Rate)  
(3-Pin DBZ Package)**



**Figure 12. Eye Diagram Without TPD2E009  
(6.0 Gbps Data Rate)  
(3-Pin DBZ Package)**

## APPLICATION INFORMATION

### Typical Application



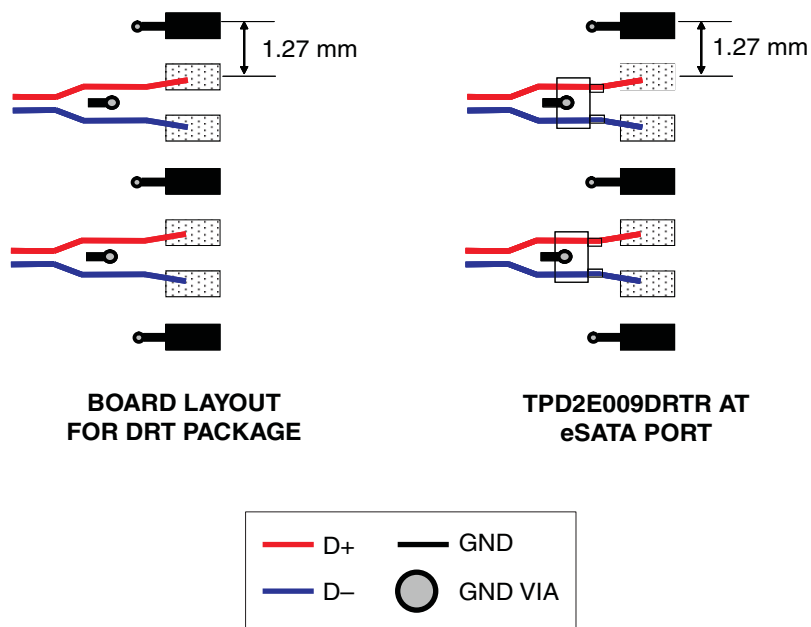
**Figure 13. TPD2E009 in Differential eSATA Interface**

Figure 13 shows the board layout scheme for the D+/D– lines of a single differential pair. It allows the differential signal pairs couple together right after they touch the ESD ports (pin 1 and pin 2) of the TPD2E009.

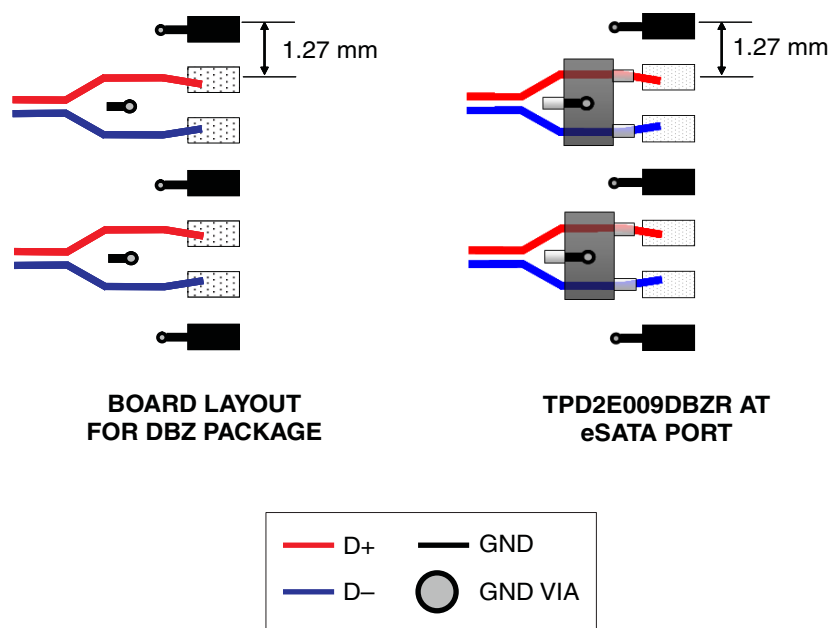
### Designing with High-Speed Differential Signals

Layout considerations, such as package selection, trace routing, etc. must be taken into account while designing the ESD clamp circuit for high-speed interface. Difficult routing can lead the designer to use vias or stubs in the board traces, creating significant disruption in the line impedance in the high-speed signal path. Poor package choice can force designer to route differential traces with unequal lengths and add the skew in the signals. It is recommended to closely couple the differential traces to reduce the EMI interference.

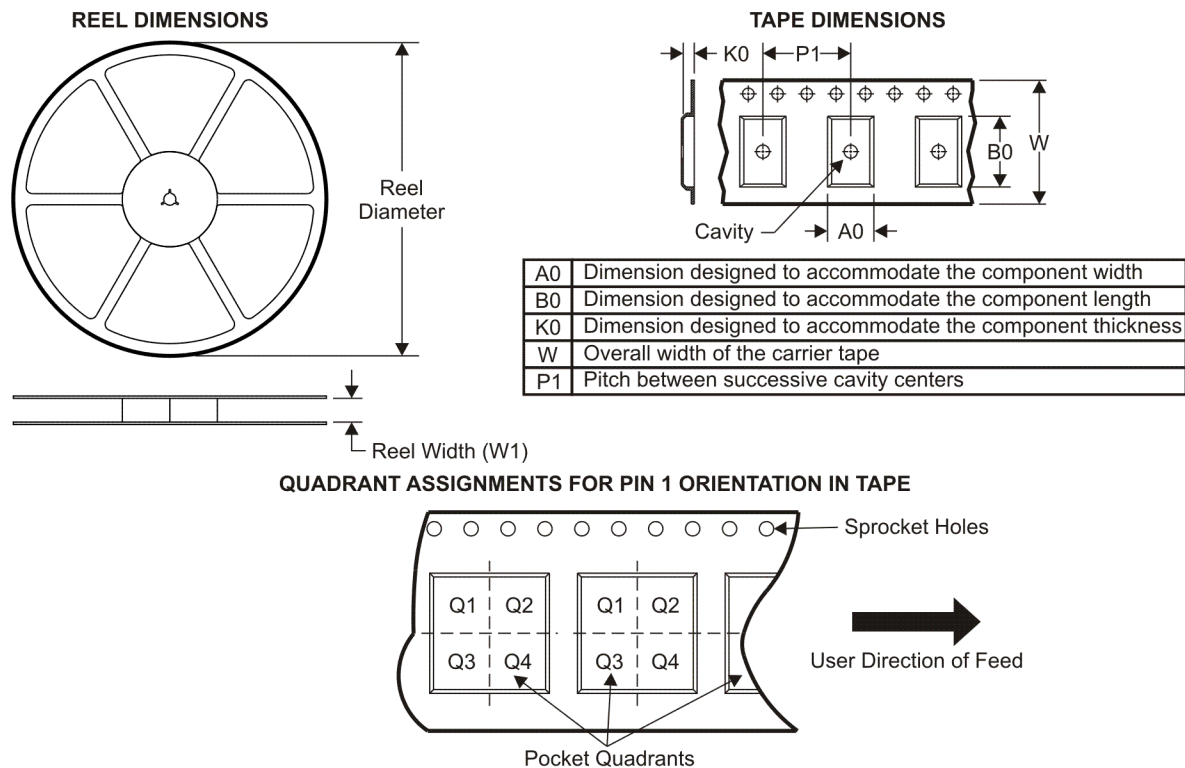
The TPD2E009 can provide system level ESD protection to the high-speed differential ports (>6 Gbps data rate). The flow-through package offers flexibility for board routing with traces up to 15 mills wide. Figure 14 and Figure 15 show the board layout scheme for the D+/D– lines of a single differential pair. It allows the differential signal pairs couple together right after they touch the ESD ports (pin 1 and pin 2) of the TPD2E009.



**Figure 14. TPD2E009DRTR at eSATA Connector Interface**



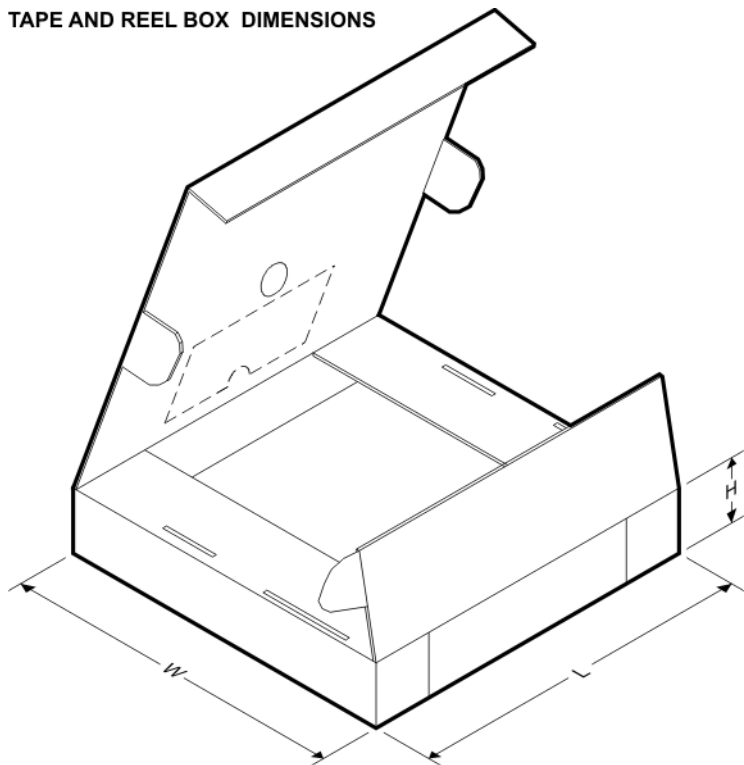
**Figure 15. TPD2E009DBZR at eSATA Connector Interface**

**TAPE AND REEL INFORMATION**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TPD2E009DBZR	SOT-23	DBZ	3	3000	180.0	9.2	3.18	3.28	1.32	4.0	8.0	Q3
TPD2E009DRTR	SOT	DRT	3	3000	180.0	8.4	1.16	1.16	0.63	4.0	8.0	Q3

## TAPE AND REEL BOX DIMENSIONS

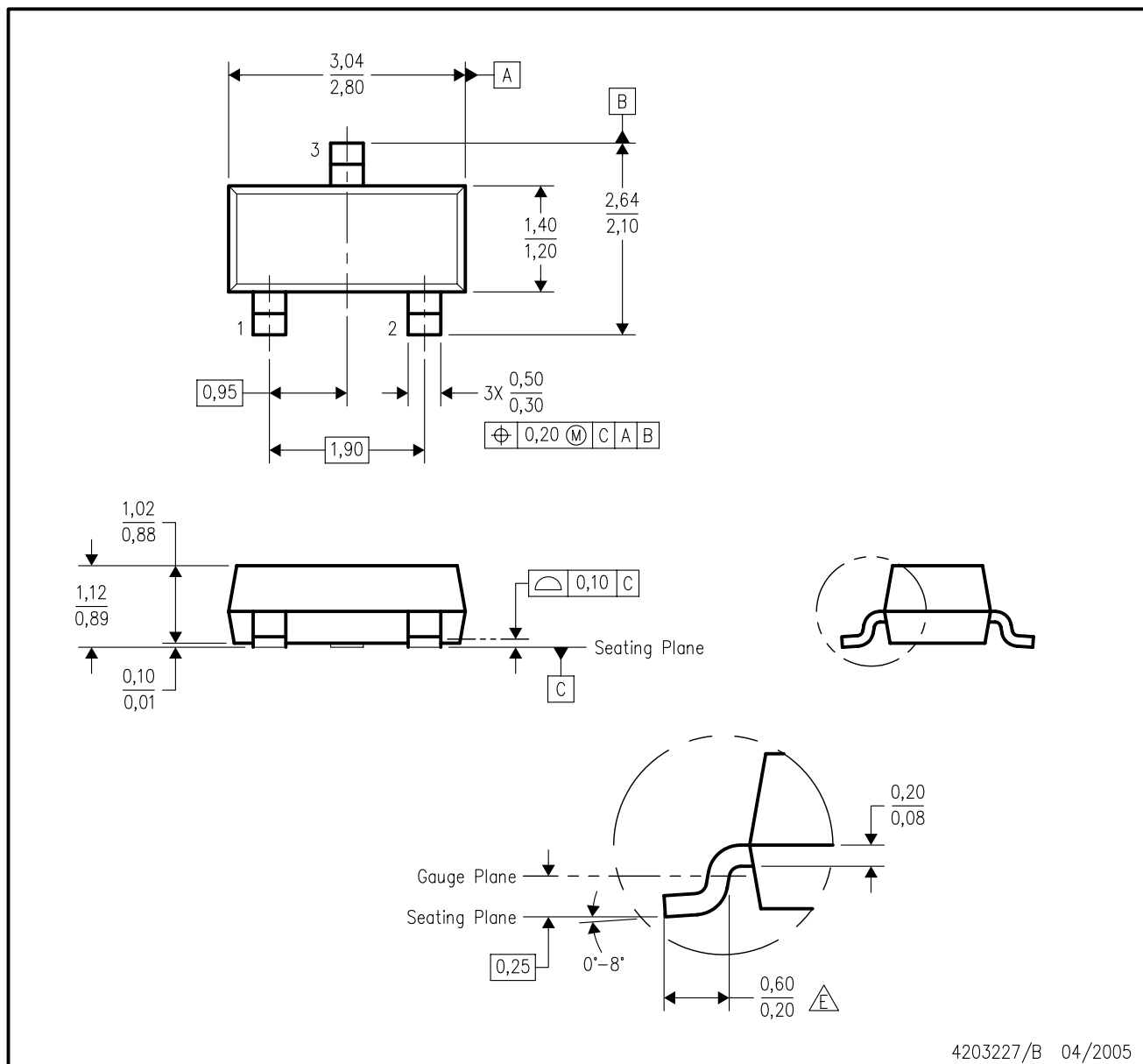


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPD2E009DBZR	SOT-23	DBZ	3	3000	202.0	201.0	28.0
TPD2E009DRTR	SOT	DRT	3	3000	180.0	180.0	85.0

DBZ (R-PDSO-G3)

PLASTIC SMALL-OUTLINE

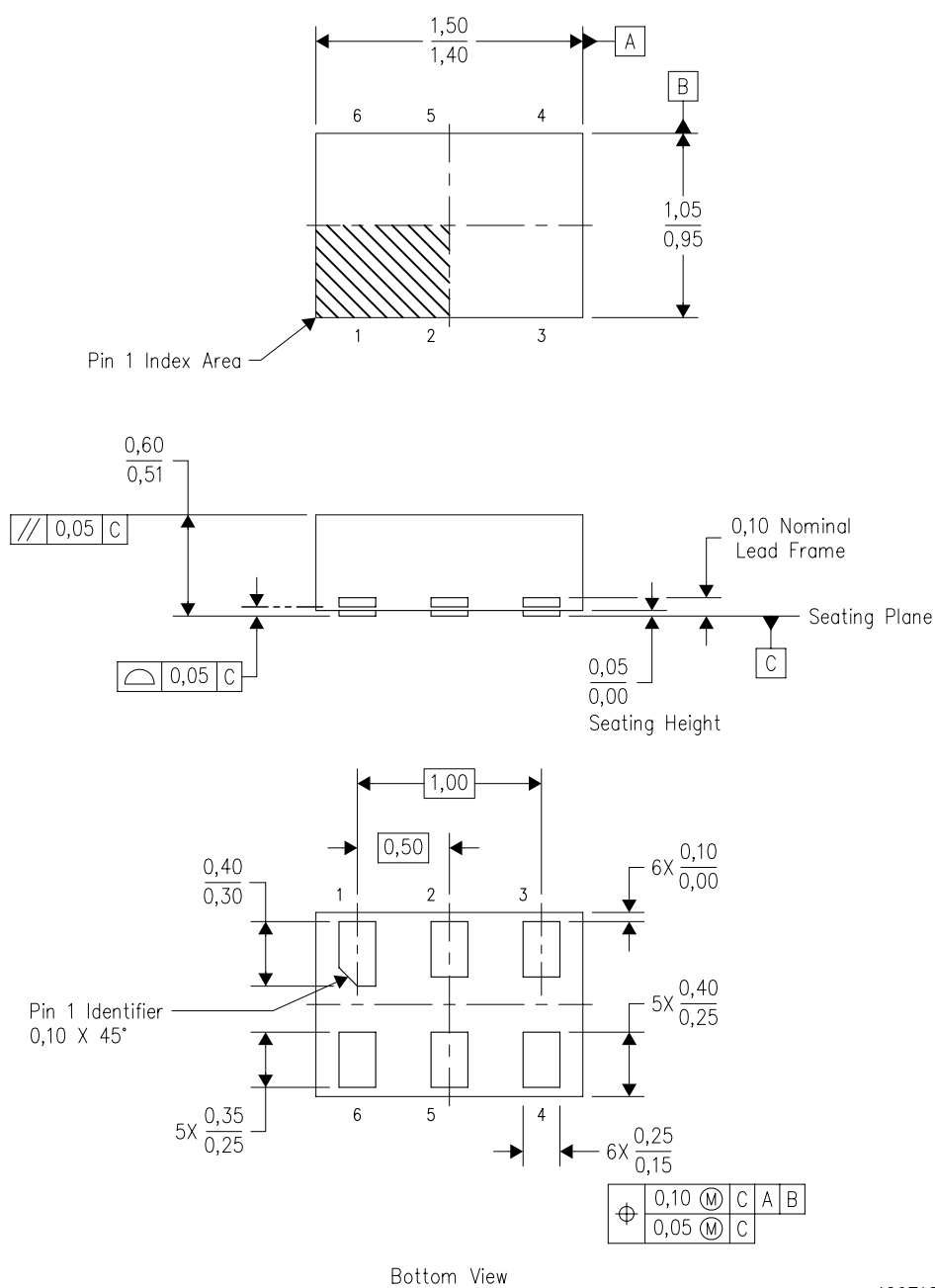


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- NOTES:
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - B. This drawing is subject to change without notice.
  - C. Lead dimensions are inclusive of plating.
  - D. Body dimensions are exclusive of mold flash and protrusion. Mold flash and protrusion not to exceed 0.25 per side.
  - E. Falls within JEDEC TO-236 variation AB, except minimum foot length.

DRY (R-PDSO-N6)

## PLASTIC SMALL OUTLINE



4207181/C 02/2009

- NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.  
B. This drawing is subject to change without notice.  
C. SON (Small Outline No-Lead) package configuration.  
D. This package complies to JEDEC MO-287 variation UFAD.

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### Applications

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