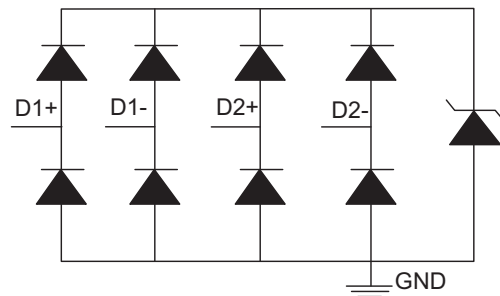


Illustration

TPD 4E1U06 is an electrostatic discharge (ESD) protection diode based on a four-channel one-way transient voltage suppressor (TVS), with ultra-low capacitance. The ESD shock dissipation value of this device is higher than the highest level stipulated by the IEC 61000-4 -2 international standard. Its 0.8 pF line capacitors make it widely applicable to output current sensing resistors and operational amplifiers for various applications. Typical application areas include HDMI, U S B 2.0, MHL, and DisplayPort.



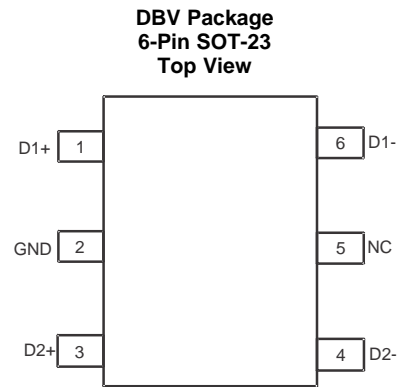
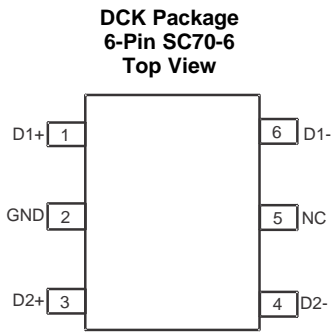
Features

- IEC 61000-4-2 4 ESD protection
 - ± 15kV, with contact discharge
 - ± 15kV, air-gap discharge
- IEC61000-4-4 Transient discharge (EFT) protection
 - 80A (5/50ns)
- IEC61000-4-5 Surge protection
 - 3A (8/20μ s)
- IO capacitance: 0.8 pF (typical value)
- DC breakdown voltage: 6.5V (minimum)
- Ultra-low leakage current: 10 nA (max.)
- Low ESD clamp voltage
- Industrial temperature range: -40°C to + 125°C Small,
- easy-to-wire DCK and DBV packages

Application

- USB 2.0
- Ethernet
- HD Multimedia interface (HDMI) control line Mobile
- industry processor interface (MIPI) bus Low Pressure
- Differential signaling (LVDS)

Pin Configuration and Functions



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
D1+	1	I/O	ESD protected channel. Connect to data line as close to the connector as possible
D1-	6	I/O	
D2-	4	I/O	
D2+	3	I/O	
GND	2	GND	Ground. Connect to ground
NC	5	I/O	No connect. Can be left floating, grounded, or connected to VCC

Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) ⁽¹⁾

		MIN	MAX	UNIT
	IEC 61000-4-4 EFT protection (5/50 ns)		80	A
I _{PP}	IEC 61000-4-5 surge protection (8/20 μs) peak pulse current		3	A
P _{PP}	IEC 61000-4-5 surge protection (8/20 μs) peak pulse power		45	W
	Operating temperature	-40	125	°C
T _{stg}	Storage temperature	-65	115	°C

ESDRatings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	V
		Charged device model (CDM), per JEDEC specification JESD22-C101, all pins ⁽²⁾	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.

(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

ESDRatings—IEC Specification

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	IEC 61000-4-2 contact ESD	V
		IEC 61000-4-2 air-gap ESD	

Recommended Operating Conditions

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

		MIN	MAX	UNIT
V _{IO}	Input pin voltage	0	5.5	V
T _A	Operating free-air temperature	-40	125	°C

Thermal Information

THERMAL METRIC ⁽¹⁾	TPD4E1U06		UNIT	
	DBV (SOT-23)	DCK (SC-70)		
	6 PINS	6 PINS		
R _{θJA}	Junction-to-ambient thermal resistance	224.3	274.3	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	166.1	113.8	°C/W
R _{θJB}	Junction-to-board thermal resistance	68.4	76.7	°C/W
ψ _{JT}	Junction-to-top characterization parameter	57.3	3.6	°C/W
ψ _{JB}	Junction-to-board characterization parameter	67.9	75.9	°C/W

Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V _{RWM}	Reverse stand-off voltage	I _{IO} = 10 μA			5.5	V
V _{CLAMP}	Clamp voltage with ESD strike	I _{PP} = 1 A, tp = 8/20 μs, from I/O to GND ⁽¹⁾		11		V
		I _{PP} = 3 A, tp = 8/20 μs, from I/O to GND ⁽¹⁾		15		V
R _{DYN}	Dynamic resistance	Pin x to GND pin ⁽²⁾		1.0		Ω
		GND to pin x		0.6		
C _L	Line capacitance	f = 1 MHz, V _{BIAS} = 2.5 V, 25°C		0.8	1	pF
C _{CROSS}	Channel to channel input capacitance	Pin 2 = 0 V, f = 1 MHz, V _{BIAS} = 2.5 V, between channel pins	DCK package	0.006	0.015	pF
			DBV package	0.01	0.025	
ΔC _{IO-TO-GND}	Variation of channel input capacitance	Pin 2 = 0 V, f = 1 MHz, V _{BIAS} = 2.5 V, channel_x pin to ground – channel_y pin to ground		0.025	0.07	pF
V _{BR}	Break-down voltage, IO to GND	I _{IO} = 1 mA	6.5		8.5	V
I _{LEAK}	Leakage current	V _{IO} = 2.5 V		1	10	nA

- (1) Non-repetitive current pulse 8/20 μs exponentially decaying waveform according to IEC61000-4-5.
- (2) Extraction of R_{DYN} using least squares fit of TLP characteristics between I = 10 A and I = 20 A.

Typical Characteristics

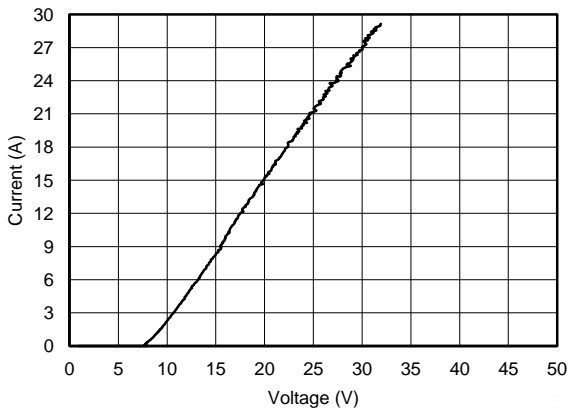


Figure 1. TLP, Data to GND

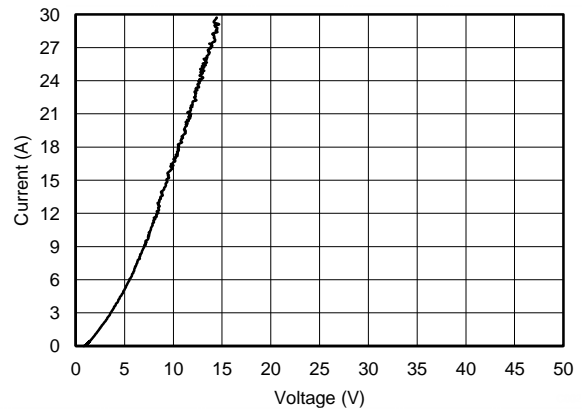


Figure 2. TLP, GND to Data

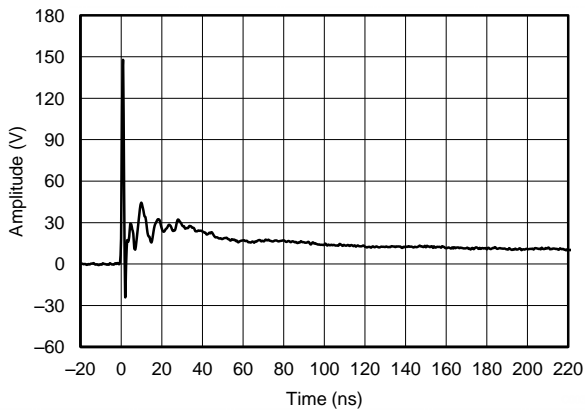


Figure 3. IEC 61000-4-2 Clamping Voltage, 8-kV Contact

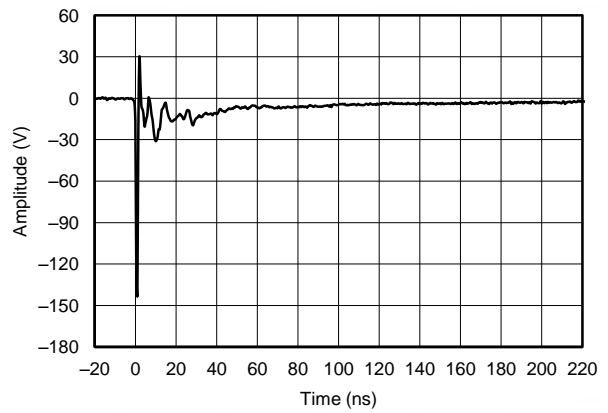


Figure 4. IEC 61000-4-2 Clamping Voltage, -8-kV Contact

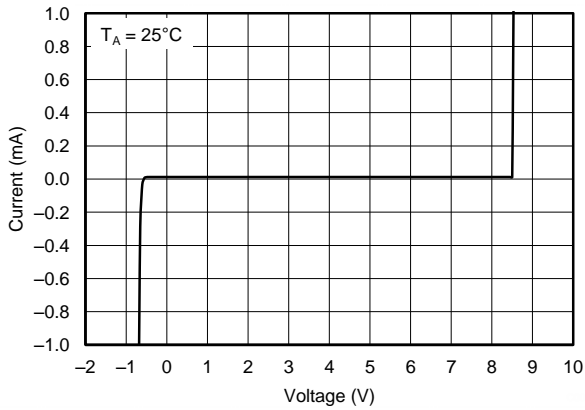


Figure 5. Diode Curve

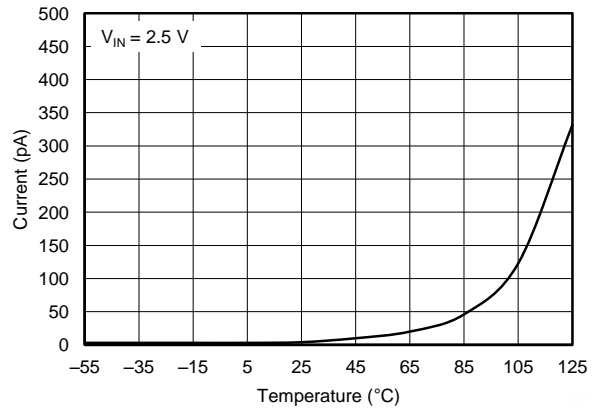


Figure 6. I_{LEAK} vs Temperature

Typical Characteristics (continued)

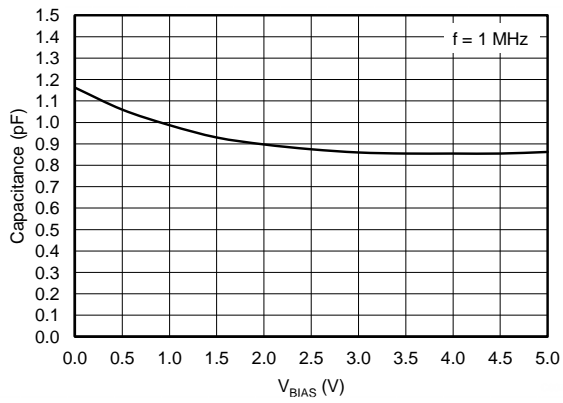


Figure 7. Capacitance Across V_{BIAS}

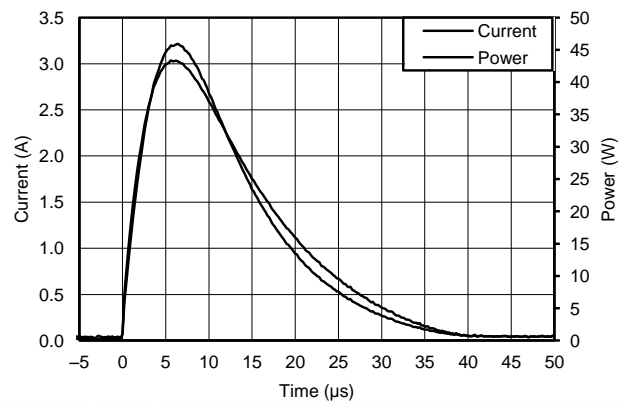


Figure 8. Surge Curve (t_p = 8/20 μs), Pin IO to GND

Detailed Description

Overview

The TPD4E1U06 is a quad channel unidirectional TVS ESD protection diode with ultra low capacitance. This device can dissipate ESD strikes above the maximum level specified by the IEC 61000-4-2 international standard. Typical application areas include HDMI, USB2.0, MHL, and DisplayPort. Its 0.8-pF line capacitance makes it suitable for a wide range of applications.

Functional Block Diagram

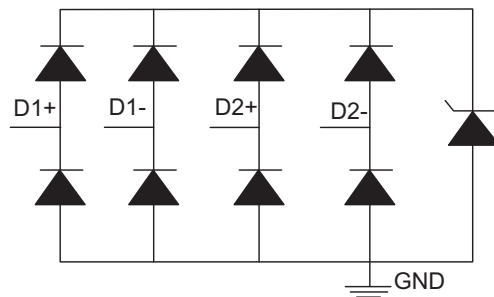


Figure 9. Circuit Schematic Diagram

Feature Description

IEC 61000-4-2 Level 4 ESD Protection

The I/O pins can withstand ESD events up to ± 15 -kV contact and air. An ESD/surge clamp diverts the current to ground.

IEC 61000-4-5 Surge Protection

The IO pins can withstand surge events up to 3 A and 45 W (8/20- μ s waveform). An ESD-surge clamp diverts this current to ground.

IEC 61000-4-4 EFT Protection

The IO pins can withstand an electrical fast transient burst of up to 80 A (5/50-ns waveform, 4 kV with 50- Ω impedance). An ESD-surge clamp diverts the current to ground.

IO Capacitance

The capacitance between each I/O pin to ground is 0.8 pF.

DC Breakdown Voltage

The DC breakdown voltage of each I/O pin is a minimum of 6.5 V. This ensures that sensitive equipment is protected from surges above the reverse standoff voltage of 5.5 V.

Ultra Low Leakage Current

The I/O pins feature an ultra-low leakage current of 10 nA (Maximum) with a bias of 2.5 V.

Low ESD Clamping Voltage

The I/O pins feature an ESD clamp that is capable of clamping the voltage to 11 V ($I_{PP} = 1$ A).

Industrial Temperature Range

This device features an industrial operating range of -40°C to $+125^{\circ}\text{C}$.

Typical Application(continued)

Design Requirements

Given the USB 2.0 application, the parameters in Table 1 are known.

Table 1. Design Parameters

DESIGN PARAMETER	VALUE
Signal range on pins 1, 3, 4, or 6	0 V to 5 V
Operating frequency	240 MHz

Detailed Design Procedure

Signal Range on Pins 1, 3, 4, or 6

The TPD4E1U06 has 4 identical protection channels for signal lines. The symmetry of the device provides flexibility when selecting which of the 4 I/O channels protect which signal lines. Any I/O supports a signal range of 0 to 5.5 V.

Operating Frequency

The TPD4E1U06 has a capacitance of 0.8 pF (typical), supporting USB 2.0 data rates.

Application Curve

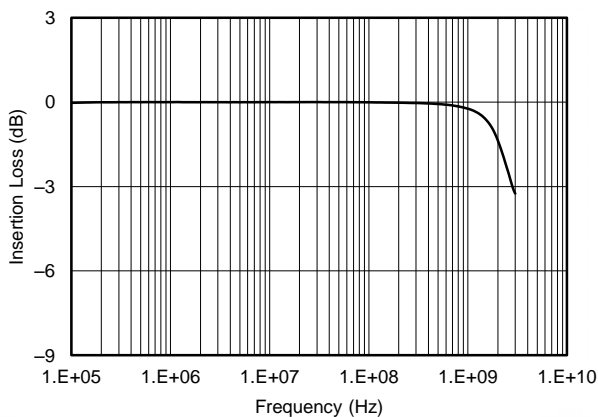
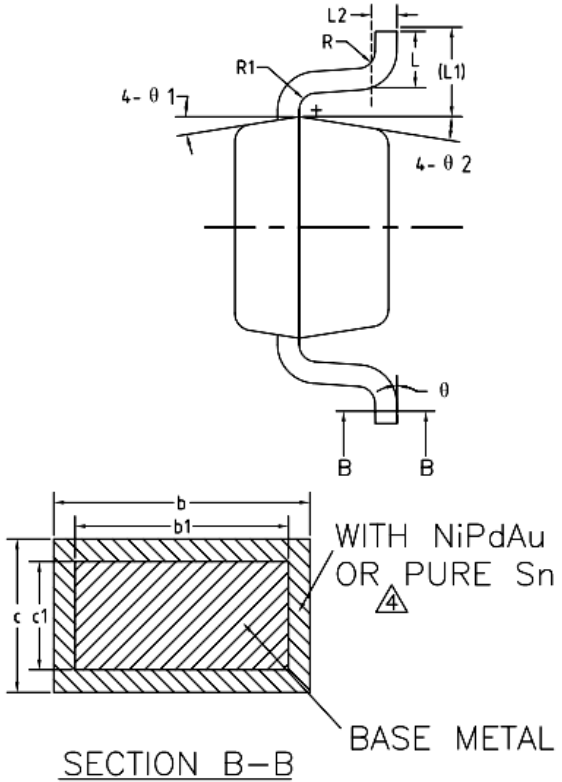
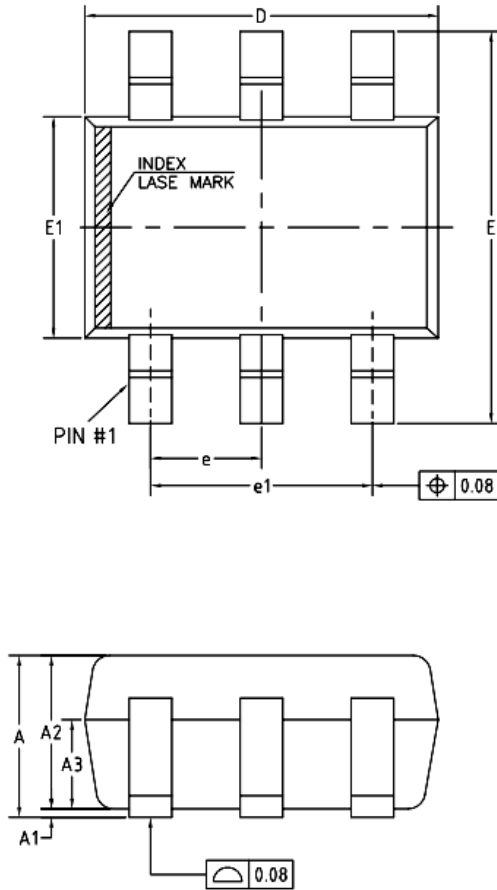


Figure 11. Insertion Loss Graph

SOT23-6

SC70-6



COMMON DIMENSIONS
(UNITS OF MEASURE=MILLIMETER)

SYMBOL	MIN	NOM	MAX
A	0.85	—	1.05
A1	0	—	0.10
A2	0.80	0.90	1.00
A3	0.47	0.52	0.57
b	NiPdAu 0.22 PURE Sn 0.23	—	0.29 0.33
b1	0.22	0.25	0.28
c	NiPdAu 0.115 PURE Sn 0.12	—	0.15 0.18
c1	0.115	0.13	0.14
D	2.02	2.07	2.12
E	2.20	2.30	2.40
E1	1.25	1.30	1.35
e	0.60	0.65	0.70
e1	1.20	1.30	1.40
L	0.28	0.33	0.38
L1	0.50REF		
L2	0.15BSC		
R	0.10	—	—
R1	0.10	—	0.25
θ	0°	—	8°
θ 1	6°	9°	12°
θ 2	6°	9°	12°

Ordering information

Order code	Package	Baseqty	Delivery mode	Marking
UMW TPD4E1U06DBVR	SOT23-6	3000	Tape and reel	BYP U
UMW TPD4E1U06DCKR	SC70-6	3000	Tape and reel	NG4P U

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