UMW TPD4E1U06DBVR

Low Capactiance 4-Line TVS Array

1.Description

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.

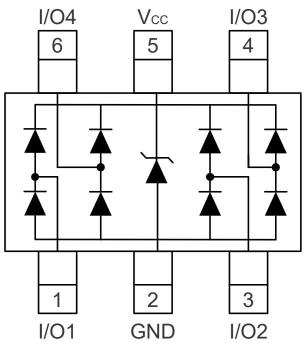
2.Application

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

3.Features

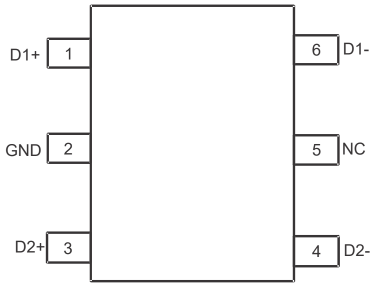
- IEC 61000-4-2 4 ESD protection
  – ± 15kV, with contact discharge
  – ± 15kV, air-gap discharge
- IEC61000-4-4 Transient discharge (EFT) protection
  – 80A (5/50ns)
- IEC61000-4-5 Surge protection
  – 3A (8/20μ s)
- IO capacitance: 0.8 pF (typical value)
- DC breakdown voltage: 6.5V (minimum)
- Ultra-low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

4.Pinning information

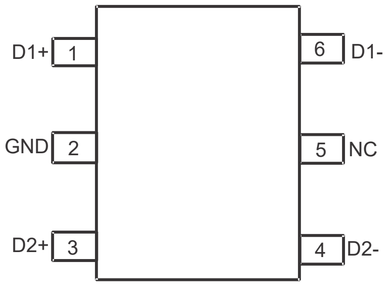


SOT23-6

5.Pin Configuration and Functions



DCK Package 6-Pin
SC70-6 Top View



DBV Package 6-Pin
SOT-23 Top View

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 V_{CC}

6.Absolute Maximum Ratings T_A= 25°C

Parameter	Symbol	MIN	MAX	Units
IEC 61000-4-4 EFT protection (5/50 ns)			80	A
IEC 61000-4-5 surge protection (8/20 μs) peak pulse current	I_{PP}		3	A
IEC 61000-4-5 surge protection (8/20 μs) peak pulse power	P_{PP}		45	W
Junction Temperature		-40	125	°C
Storage temperature	T_{STG}	-65	115	°C

7.ESD Ratings

		VALUE	Units
$V_{(ESD)}$ Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins(1)	±4000	V
	Charged device model (CDM), per JEDEC specification JESD22-C101 all pins(2)	±1500	V

(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.

8.ESD Ratings - IEC Specification

		VALUE	Units
$V_{(ESD)}$ Electrostatic discharge	IEC 61000-4-2 contact ESD	±15000	V
	IEC 61000-4-2 air-gap ESD	±15000	V

9.Recommended Operating Conditions

		MIN	MAX	Units
V_{IO}	Input pin voltage	0	5.5	V
T_A	Operating free-air temperature	-40	125	V

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

10.Thermal Information

THERMAL METRIC[1]	Symbol	DBV (SOT-23)	DBV (SOT-23)	Units
		6 PINS	6 PINS	
Junction-to-ambient thermal resistance	$R_{\theta JA}$	224.3	224.3	°C/W
Junction-to-case (top) thermal resistance	$R_{\theta JC(top)}$	166.1	166.1	°C/W
Junction-to-board thermal resistance	$R_{\theta JB}$	68.4	68.4	°C/W
Junction-to-top characterization parameter	Ψ_{JT}	57.3	57.3	°C/W
Junction-to-board characterization parameter	Ψ_{JB}	67.9	67.9	°C/W

11.Electrical Characteristic (T$_A$=25°C unless otherwise noted)

Parameter	Symbol	Conditions	Min	Typ	Max	Units
Reverse stand-off voltage	V_{RWM}	I_{IO}=10μA			5.5	V
Clamp voltage with ESD strike	V_{CLAMP}	I_{PP}=1A,tp=8/20μs,from I/O to GND(1)		11		V
		I_{PP}=3A,tp=8/20μs,from I/O to GND(1)		15		V
Dynamic resistance	R_{DYN}	Pin x to GND pin(2)		1		Ω
		GND to pin x		0.6		Ω
Line capacitance	C_L	f=1MHz, V_{BIAS}=2.5V, 25°C		0.8	1	pF
Channel to channel input capacitance	C_{CROSS}	Pin2=0V, f=1MHz, V_{BIAS}=2.5V between channel pins		0.006	0.015	pF
				0.01	0.025	pF
Variation of channel input capacitance	$\Delta_{CIO\text{-}TO\text{-}GND}$	Pin2=0V,f=1MHz,V_{BIAS}=2.5V, channel_x pin to ground – channel_y pin to ground		0.025	0.07	pF
Break-down voltage, IO to GND	V_{BR}	I_{IO}=1mA	6.5		8.5	V
Leakage current	I_{LEAK}	V_{IO}=2.5V		1	10	nA

(1) Non-repetitive current pulse 8/20 μs exponentially decaying waveform according to IEC61000-4-5.

(2) Extraction of RDYN using least squares fit of TLP characteristics between I = 10 A and I = 20 A.

12.1Typical characteristic

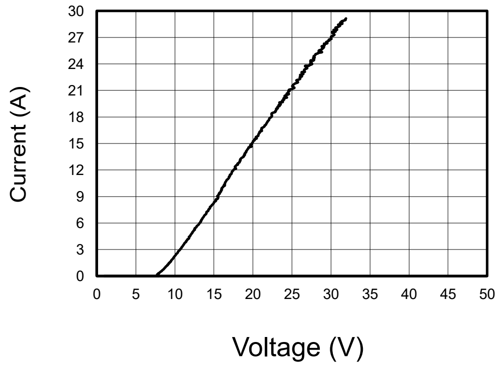


Figure 1: TLP, Data to GND

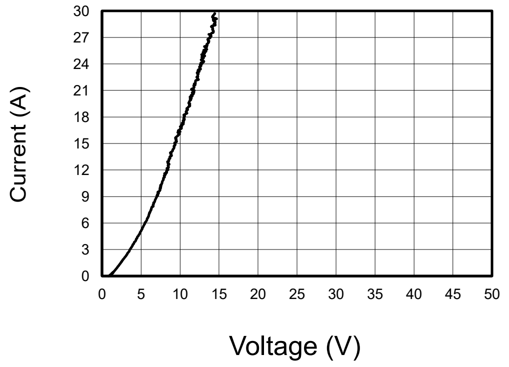


Figure 2: TLP, GND to Data

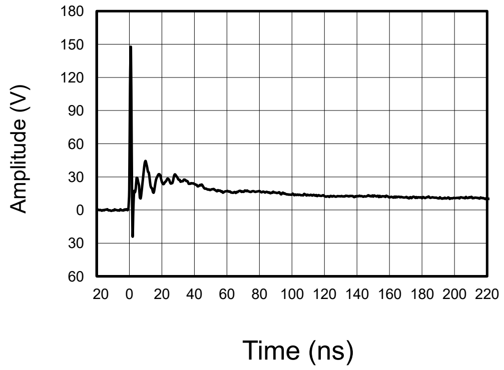


Figure 3: IEC 61000-4-2 Clamping Voltage, 8-kV Contact

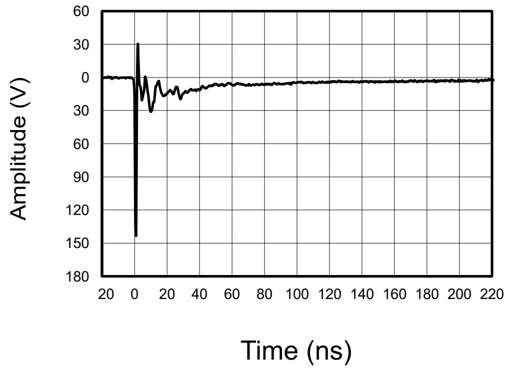


Figure 4: Capacitance

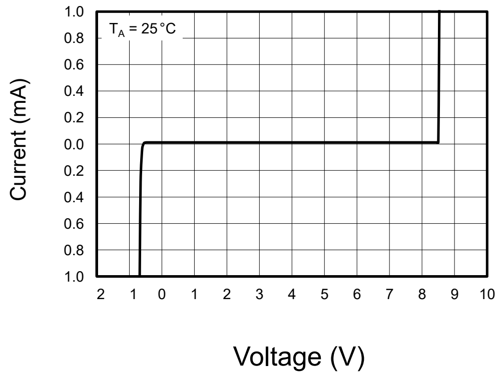


Figure 5: Diode Curve

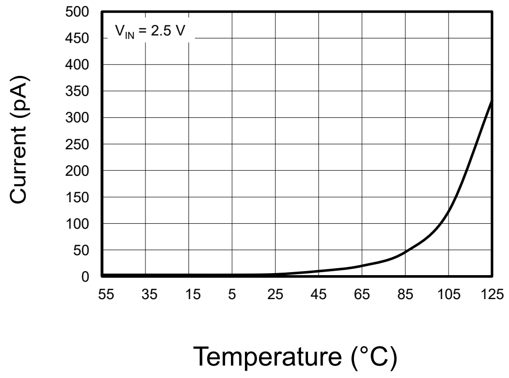


Figure 6: I_{LEAK} vs Temperature

12.2Typical characteristic

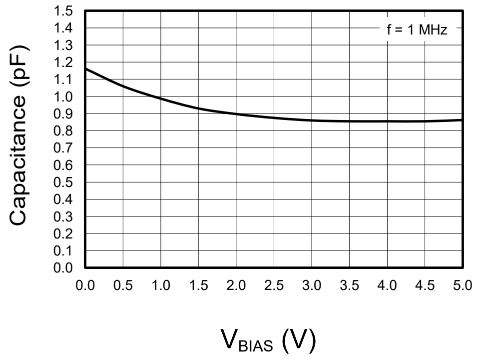


Figure 7: Capacitance Across V_{BIAS}

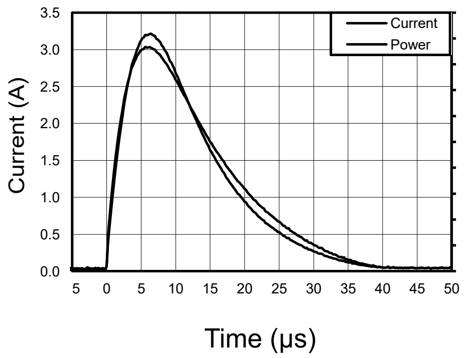


Figure 8: Transfer Characteristics

13.Detailed Description

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

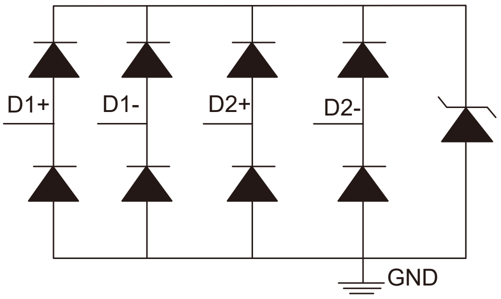


Figure 9. Circuit Schematic Diagram

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-μs 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 (IPP = 1 A).

Industrial Temperature Range

This device features an industrial operating range of –40°C to +125°C.

14.Typical Application(continued)

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

Table 1. Design Parameters

Parameter	Parameter
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

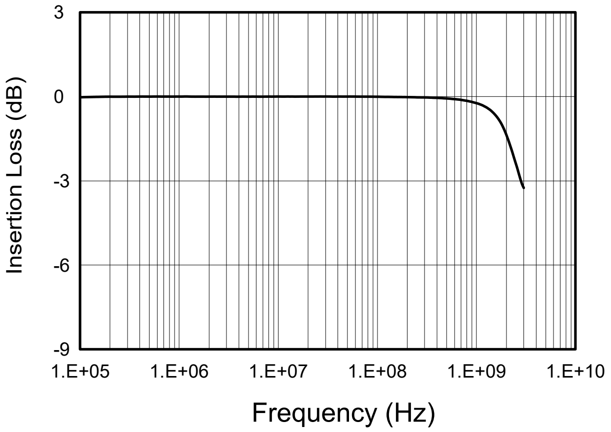
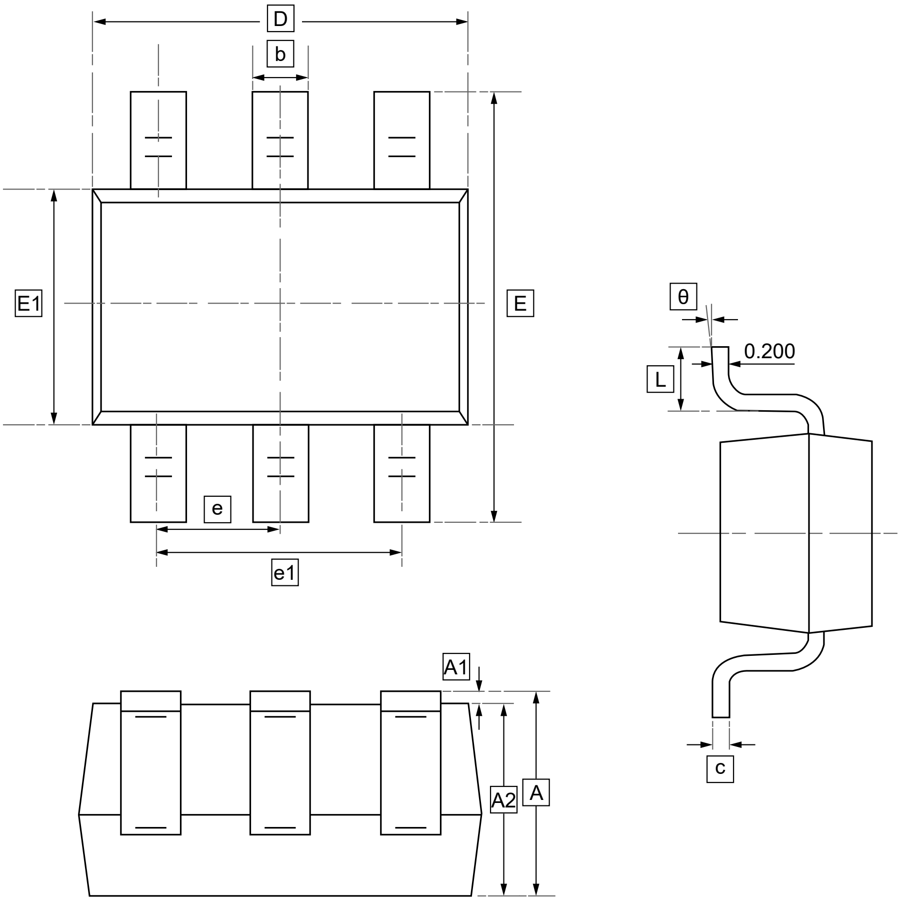


Figure 11: Insertion Loss Graph

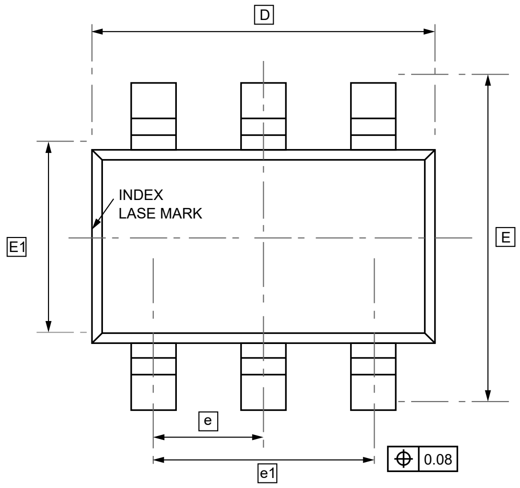
8.SOT-23-6 Package Outline Dimensions

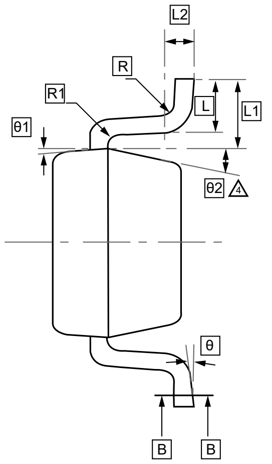


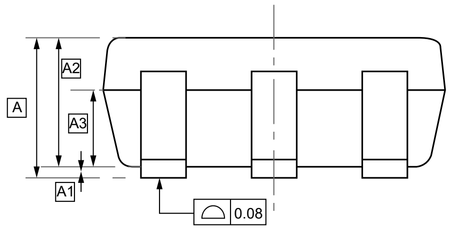
DIMENSIONS (mm are the original dimensions)

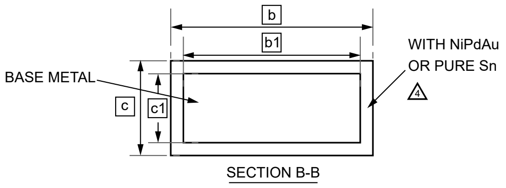
Symbol	A	A1	A2	b	c	D	E1	E	e	e1	L	θ
Min	1.050	0.000	1.050	0.300	0.100	2.820	1.500	2.650	0.950	1.800	0.300	0°
Max	1.250	0.100	1.150	0.500	0.200	3.020	1.700	2.950	BSC	2.000	0.600	8°

16.SC70-6 Package Outline Dimensions







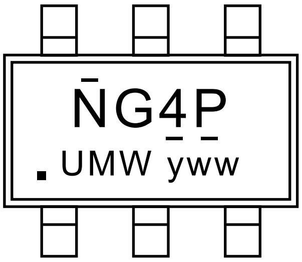


DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	A3	b		b1	c		c1	D	E	E1	e	e1	L
					NiPdAu	PURE Sn		NiPdAu	PURE Sn							
Min	0.85	0	0.80	0.47	0.22	0.23	0.22	0.115	0.12	0.115	2.02	2.20	1.25	0.60	1.20	0.28
Max	1.05	0.10	1.00	0.57	0.29	0.33	0.28	0.15	0.18	0.14	2.12	2.40	1.35	0.70	1.40	0.38

Symbol	L1	L2	R	R1	θ	θ1	θ2
Min	0.50	0.15	0.10	0.10	0°	6°	6°
Max	REF	BSC	-	0.25	8°	12°	12°

17.Ordering information



yww: Batch Code

Order Code	Package	Base QTY	Delivery Mode
UMW TPD4E1U06DBVR	SOT23-6	3000	Tape and reel
UMW TPD4E1U06DCKR	SC70-6	3000	Tape and reel

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