

# PACUSBVB

## USB Downstream Port Terminator with VBUS ESD Protection

### Product Description

The PACUSBVB-D1 is a single-channel USB downstream-port termination network. It integrates EMI/RFI filter components R1 and C1 as recommended by the USB specification, as well as the required 15 kW pull-down resistors (R2) to GND. In addition, PACUSBVB-D1 provides a very high level of protection for sensitive electronic components that may be subjected to electrostatic discharge (ESD). The device pins will safely dissipate ESD strikes of  $\pm 15$  kV, exceeding the maximum requirements of the IEC 61000-4-2 international standard. Using the MIL-STD-883D (Method 3015) specification for Human Body Model (HBM) ESD, all pins are protected from contact discharges to  $\pm 20$  kV.

The PACUSBVB-D1 also features a fifth zener diode (cathode at pin 5) which provides ESD protection for the USB VBUS line.

There are three options for the value of the series resistor R1: 15  $\Omega$ , 33  $\Omega$ , and 22  $\Omega$ . This series resistance, plus the USB driver output resistance, must be close to the USB cable's characteristic impedance of 45  $\Omega$  (each side) to minimize transmission line reflections.

The PACUSBVB-D1 is housed in a 6-pin SOT23 package and is available with optional lead-free finishing.

### Features

- A Low-Capacitance USB Downstream Port Terminator, EMI Filter, and Transient Over-Voltage Protector in a Single Surface-Mounted Package
- ESD Protection to  $\pm 20$  kV Contact Discharge, per MIL-STD-883D, Method 3015
- ESD Protection to  $\pm 15$  kV Contact Discharge, per IEC 61000-4-2 International Standard
- Provides ESD Protection for the VBUS Line
- Compact SOT23-6 Package Saves Board Space and Lowers Manufacturing Costs Compared to Discrete Solutions
- Capacitors Matched to a Precision Exceeding the USB Specification
- These Devices are Pb-Free and are RoHS Compliant

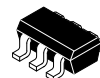
### Applications

- ESD Protection and Termination of USB Downstream Ports
- Desktop PCs
- Notebooks
- Set-Top Boxes
- USB Hubs



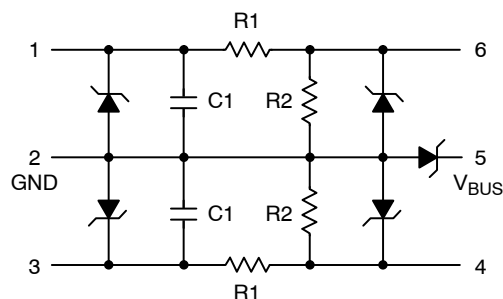
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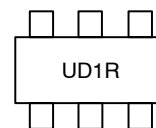


SOT23-6  
CASE 527AJ

### ELECTRICAL SCHEMATIC



### MARKING DIAGRAM



UD1R = PACUSBVB-D1Y6R

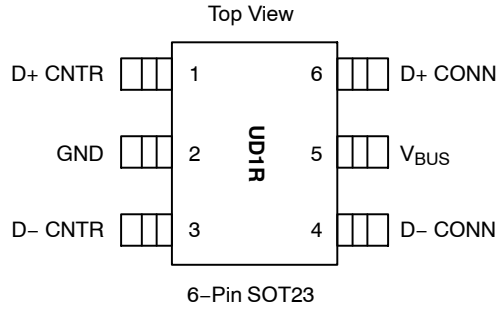
### ORDERING INFORMATION

Device	Package	Shipping†
PACUSBVB-D1Y6R	SOT23-6 (Pb-Free)	3000/Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specification Brochure, BRD8011/D.

# PACUSBVB

## PACKAGE / PINOUT DIAGRAMS



**Table 1. PIN DESCRIPTIONS**

Pins	Name	Description
1	D+ CNTR	D+ Data to the USB Controller Circuitry
2	GND	Ground Pin
3	D- CNTR	D- Data to the USB Controller Circuitry
4	D- CONN	D- Data to the USB Connector
5	V <sub>BUS</sub>	V <sub>BUS</sub> Input Pin
6	D+ CONN	D+ Data to the USB Connector

## SPECIFICATIONS

**Table 2. ABSOLUTE MAXIMUM RATINGS**

Parameter	Rating	Units
Storage Temperature Range	-65 to +150	°C
Power Dissipation per Resistor	100	mW
Package Power Dissipation	200	mW
Voltage on any Pin (DC)	6	V

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

**Table 3. STANDARD OPERATING CONDITIONS**

Parameter	Rating	Units
Operating Temperature	-40 to +85	°C
V <sub>BUS</sub> Input Voltage	5	V

# PACUSBVB

## SPECIFICATIONS (Cont'd)

**Table 4. ELECTRICAL OPERATING CHARACTERISTICS**

Symbol	Parameter	Conditions	Min	Typ	Max	Units
R1	Resistance of R1 Resistor	$T_A = 25^\circ\text{C}$	26.4	33	39.6	$\Omega$
R2	Resistance of R2 Resistor	$T_A = 25^\circ\text{C}$		15		$\text{k}\Omega$
TCR	Temperature Coefficient of Resistance			+1300		$\text{ppm}/^\circ\text{C}$
C1	Capacitance of C1 Capacitor	0 V DC, 30 mV AC, 1 MHz, $25^\circ\text{C}$	37.6	47.0	56.4	pF
		2.5 V DC, 30 mV AC, 1 MHz, $25^\circ\text{C}$	25.6	32.0	38.4	pF
TOL <sub>CM</sub>	Matching Tolerance of C1 Capacitors	1 MHz, $25^\circ\text{C}$			$\pm 2$	%
I <sub>LEAK</sub>	Diode Leakage Current to GND	Measured at 3.3 V DC, $25^\circ\text{C}$		1	100	nA
V <sub>RB</sub>	Diode Reverse Bias Voltage	I <sub>LOAD</sub> = 10 $\mu\text{A}$ , $T_A = 25^\circ\text{C}$	5.5			V
V <sub>SIG</sub>	Signal Voltage: Positive Clamp Negative Clamp	I <sub>LOAD</sub> = 10 mA, $T_A = 25^\circ\text{C}$ I <sub>LOAD</sub> = 10 mA, $T_A = 25^\circ\text{C}$	5.6 -0.4	6.8 -0.8	9.0 -1.5	V
V <sub>ESD</sub>	In-system ESD Withstand Voltage MIL-STD-883D, Method 3015 (HBM)  IEC 61000-4-2 Contact Discharge	Pins 1, 3 (Notes 1 and 2) Pins 4, 5 (Note 1) Pins 4, 5 (Note 1)	$\pm 4$ $\pm 20$ $\pm 15$			kV
V <sub>CL</sub>	Clamping Voltage under ESD Discharge	MIL-STD-883D, Method 3015 +8 kV (Note 3)		12		V
		MIL-STD-883D, Method 3015 -8 kV (Note 3)		-7		V

- ESD voltage applied to pins with respect to GND, one at a time; unused pins are left open.
- Pins 1 and 3 are not connected to the USB port connector, and therefore are not exposed to external ESD hazards. Thus, they do not require the high ESD protection levels provided for pins 4, 5, and 6.
- ESD Clamping Voltage is measured at the opposite end of R1 from the pin to which the ESD discharge is applied (e.g., if ESD is applied to pin 6, then the clamping voltage is measured at pin 1).

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## PERFORMANCE INFORMATION

### Capacitance vs. Voltage

The C1 capacitance value as a function of DC voltage across it is presented in Figure 1. The curve is normalized to a capacitance of 1.0 capacitance units at 2.5 V DC.

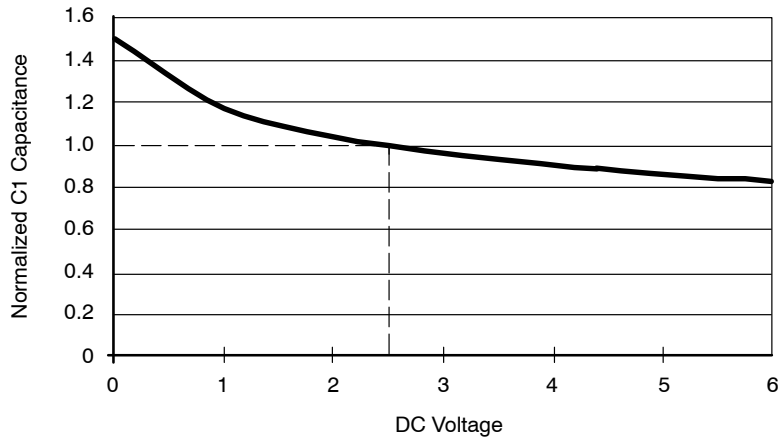


Figure 1. Diode Capacitance vs. DC Voltage (Normalized)

### Insertion Loss vs. Frequency Characteristics

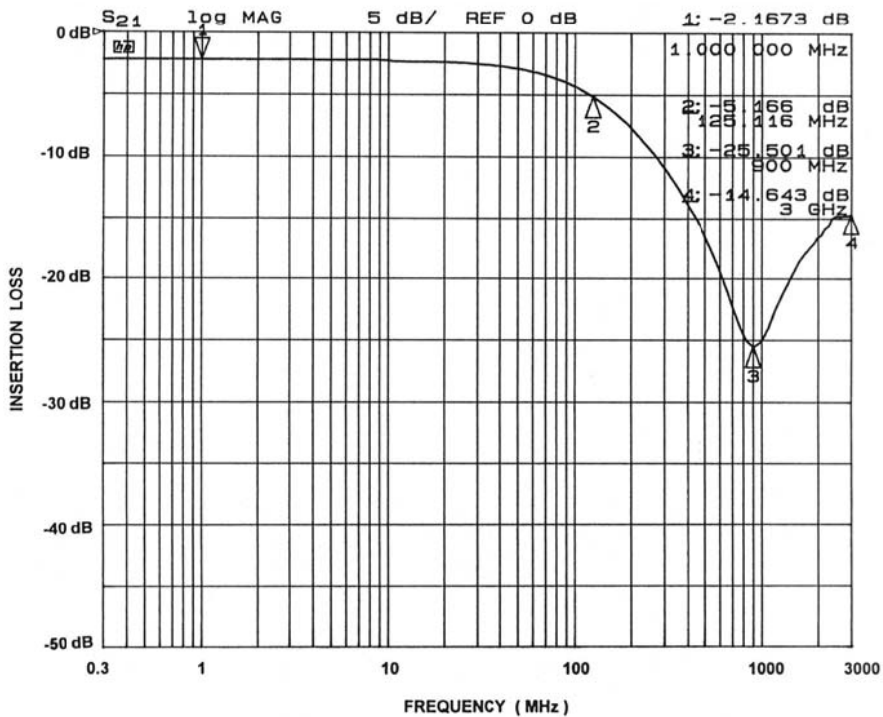


Figure 2. Insertion Loss vs. Frequency Performance Curve, PACUSBVB-D1 (SOT23-6)

# PACUSBVB

## APPLICATION INFORMATION

The PACUSBVB-D1 provides a complete interface for a single downstream USB port typically found in computers and USB hubs. It integrates the series resistors (R1) and the 15 kΩ pull-down resistors (R2) for both USB data lines (D+ and D-) as well as the capacitors to ground for EMI suppression. Zener diodes provide ESD protection up to 15 kV contact discharge per the IEC 61000-4-2 standard and protect the USB controller on both data lines. The 6-lead PACUSBVB-D1 device provides an additional zener diode to protect the VBUS USB power line.

The PACUSBVB-D1 should be placed on the PCB between the USB controller and the USB connector, as shown on the Connection Diagram, Figure 3.

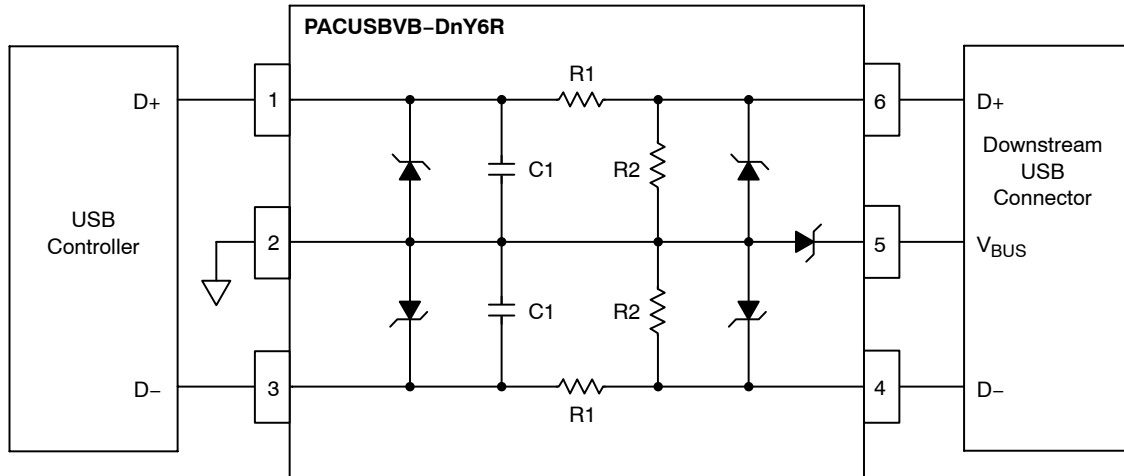


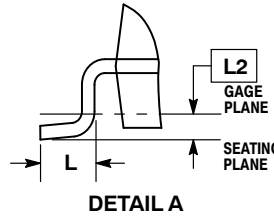
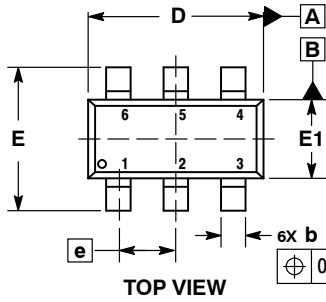
Figure 3. Connection Diagram for PACUSBVB-D1

To guarantee the best ESD and filtering performance, it is recommended that the PACUSBVB-D1 be located close to the USB connector. Also, the trace lengths between the PACUSBVB-D1 and the USB controller should be kept as short as possible.

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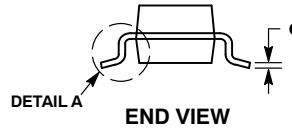
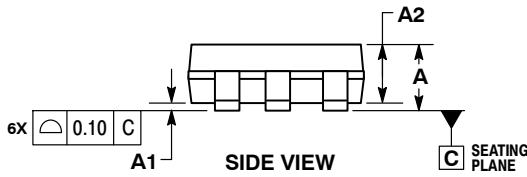
## PACKAGE DIMENSIONS

SOT-23, 6 Lead  
CASE 527AJ-01  
ISSUE A

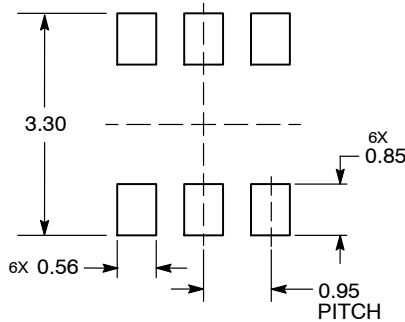


- NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
  2. CONTROLLING DIMENSION: MILLIMETERS.
  3. DATUM C IS THE SEATING PLANE.

MILLIMETERS		
DIM	MIN	MAX
A	---	1.45
A1	0.00	0.15
A2	0.90	1.30
b	0.20	0.50
c	0.08	0.26
D	2.70	3.00
E	2.50	3.10
E1	1.30	1.80
e	0.95 BSC	
L	0.20	0.60
L2	0.25 BSC	



### RECOMMENDED SOLDERING FOOTPRINT\*



DIMENSIONS: MILLIMETERS

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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