

# TPD4E001 高速データ インターフェイス用の低容量、4 チャンネル ESD 保護

## 1 特長

- IEC 61000-4-2 ESD 保護 (レベル 4)
  - 接触放電:  $\pm 8\text{kV}$
  - 空中放電:  $\pm 15\text{kV}$
- 5.5A ピークパルス電流 (8/20 $\mu\text{s}$  のパルス)
- IO 容量 1.5pF (標準値)
- 低リーク電流: 1nA (最大値)
- 低消費電流: 1nA
- 0.9V ~ 5.5V の動作電源電圧範囲
- 省スペースの DRL、DBV、DCK、DPK、DRS パッケージオプション
- 2、3、6 チャンネルの代替オプションを利用可能:  
TPD2E001、TPD3E001、TPD6E001

## 2 アプリケーション

- USB 2.0
- イーサネット
- FireWire™ シリアルバス
- LVDS
- SVGA ビデオ接続
- 血糖値測定器

## 3 概要

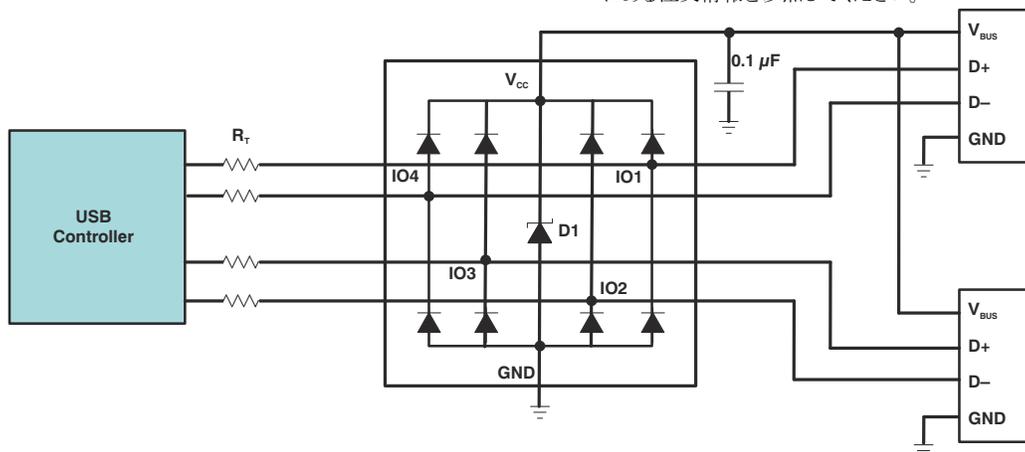
TPD4E001 は、静電放電(ESD)保護ダイオードアレイをベースとする、4 チャンネルの過渡電圧サプレッサ(TVS)です。TPD4E001 は、IEC 61000-4-2 国際規格で規定されている最大レベル(レベル 4)の ESD 耐性を備えています。このデバイスにはチャンネルごとに 1.5pF IO の容量があり、高速データ IO インターフェイスでの使用に理想的です。リーク電流が非常に低いため(最大値 1nA 未満)、血糖値計や心拍数モニタなどのアプリケーションでの高精度アナログ測定に適しています。

TPD4E001 は DRL (SOT)、DBV (SOT-23)、DCK (SC-70)、DRS (QFN)、DPK (PUSON) パッケージで供給され、 $-40^{\circ}\text{C}$  ~  $85^{\circ}\text{C}$  までの動作が規定されています。[PD4E1U06DCKR](#) および [TPD4E1U06DBVR](#) も参照してください。これらは、[TPD4E001DCKR](#) および [TPD4E001DBVR](#) のピン互換品です。これらのデバイスは IEC 保護がより高く、容量が低く、クランピング電圧が低いため、入力コンデンサが必要ありません。

### パッケージ情報

部品番号	パッケージ <sup>(1)</sup>	本体サイズ (公称)
TPD4E001	SOT (6)	1.60mm × 1.20mm 2.90mm × 1.60mm
	SC70 (6)	2.00mm × 1.25mm
	USON (6)	1.60mm × 1.60mm
	SON (6)	3.00mm × 3.00mm

(1) 利用可能なすべてのパッケージについては、データシートの末尾にある注文情報を参照してください。



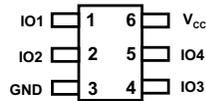
アプリケーション回路図



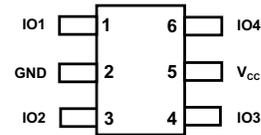
## Table of Contents

<b>1 特長</b> .....	<b>1</b>	<b>7 Application and Implementation</b> .....	<b>8</b>
<b>2 アプリケーション</b> .....	<b>1</b>	7.1 Application Information.....	8
<b>3 概要</b> .....	<b>1</b>	7.2 Typical Application.....	8
<b>4 Pin Configuration and Functions</b> .....	<b>3</b>	<b>8 Layout</b> .....	<b>9</b>
Pin Functions.....	3	8.1 Layout Guidelines.....	9
<b>5 Specifications</b> .....	<b>4</b>	8.2 Layout Example.....	10
5.1 Absolute Maximum Ratings.....	4	<b>9 Device and Documentation Support</b> .....	<b>11</b>
5.2 ESD Ratings—JEDEC Specification.....	4	9.1 サード・パーティ製品に関する免責事項.....	11
5.3 ESD Ratings—IEC Specification.....	4	9.2 Documentation Support.....	11
5.4 Recommended Operating Conditions.....	4	9.3 Receiving Notification of Documentation Updates....	11
5.5 Thermal Information.....	5	9.4 サポート・リソース.....	11
5.6 Electrical Characteristics.....	5	9.5 Trademarks.....	11
5.7 Typical Characteristics.....	6	9.6 静電気放電に関する注意事項.....	11
<b>6 Detailed Description</b> .....	<b>7</b>	9.7 用語集.....	11
6.1 Overview.....	7	<b>10 Revision History</b> .....	<b>11</b>
6.2 Functional Block Diagram.....	7	<b>11 Mechanical, Packaging, and Orderable Information</b> .....	<b>13</b>
6.3 Feature Description.....	7		
6.4 Device Functional Modes.....	7		

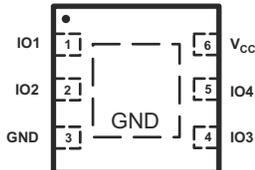
## 4 Pin Configuration and Functions



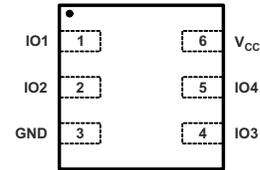
4-1. DRL Package 6-Pin SOT Top View



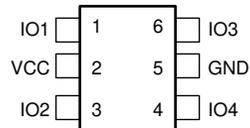
4-2. DBV or DCK Package 6-Pin SOT or SC70 Top View



4-3. DRS Package 6-Pin SON Top View



4-4. DPK Package 6-Pin USON Top View



4-5. TPD4E001R DBV Package 6-Pin SOT Top View

## Pin Functions

NAME	PIN			I/O	DESCRIPTION
	DRS, DRL, DPK	DBV, DCK	TPD4E001R		
GND	3	2	5	—	Ground
IOx	1	1	1	I	ESD-protected channel
	2	3	3		
	4	4	4		
	5	6	6		
V <sub>CC</sub>	6	5	2	I	Power-supply input. Bypass V <sub>CC</sub> to GND with a 0.1- $\mu$ F ceramic capacitor
Exposed thermal pad (DRS package only)				—	Exposed thermal pad. Connect to GND or leave floating

## 5 Specifications

### 5.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted)<sup>(1)</sup>

		MIN	MAX	UNIT
V <sub>CC</sub>		-0.3	7	V
V <sub>I/O</sub>	IO voltage tolerance	-0.3	V <sub>CC</sub> + 0.3	V
I <sub>(Surge)</sub>	IEC 61000-4-5 peak pulse current (T <sub>P</sub> = 8/20μs), IOx pins		5.5	A
P <sub>(Surge)</sub>	IEC 61000-4-5 peak pulse power (T <sub>P</sub> = 8/20μs), IOx pins		100	W
T <sub>J</sub>	Junction temperature		150	°C
Bump temperature (soldering)	Infrared (15s)		220	°C
	Vapor phase (60s)		215	
	Lead temperature (soldering, 10s)		300	°C
T <sub>stg</sub>	Storage temperature	-65	150	°C

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

### 5.2 ESD Ratings—JEDEC Specification

			VALUE	UNIT	
<b>TPD4E001 in DRS, DRL, and DPK Packages</b>					
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	All pins except 1, 2, 4, and 5	±2000	V
			Pins 1, 2, 4, and 5	±15000	
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	All pins	±1000	
<b>TPD4E001 in DBV and DCK Packages</b>					
V <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	All pins except 1, 3, 4, and 6	±2000	V
			Pins 1, 3, 4, and 6	±15000	
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	All pins	±1000	

- (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.

### 5.3 ESD Ratings—IEC Specification

			VALUE	UNIT	
<b>TPD4E001 in DRS, DRL, and DPK Packages</b>					
V <sub>(ESD)</sub>	Electrostatic discharge	IEC 61000-4-2 contact discharge	All pins	±8000	V
		IEC 61000-4-2 air-gap discharge	All pins	±15000	
<b>TPD4E001 in DBV and DCK Packages</b>					
V <sub>(ESD)</sub>	Electrostatic discharge	IEC 61000-4-2 contact discharge	All pins	±8000	V
		IEC 61000-4-2 air-gap discharge	All pins	±15000	

### 5.4 Recommended Operating Conditions

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

		MIN	MAX	UNIT	
T <sub>A</sub>	Operating free-air temperature	-40	85	°C	
	Operating voltage	V <sub>CC</sub> pin	0.9	5.5	V
		IO1, IO2 pins	0	V <sub>CC</sub>	

## 5.5 Thermal Information

THERMAL METRIC <sup>(1)</sup>	TPD4E001					UNIT
	DRL (SOT)	DBV (SOT)	DCK (SC70)	DPK (USON)	DRS (SON)	
	6 PINS	6 PINS	6 PINS	6 PINS	6 PINS	
R <sub>θJA</sub> Junction-to-ambient thermal resistance	226.4	259.7	251.1	247.6	91.9	°C/W
R <sub>θJC(top)</sub> Junction-to-case (top) thermal resistance	90.3	186.5	88.1	124.8	106.9	°C/W
R <sub>θJB</sub> Junction-to-board thermal resistance	61.2	107.6	54.8	204.2	64.8	°C/W
ψ <sub>JT</sub> Junction-to-top characterization parameter	6.7	71.4	1.7	19.2	10.2	°C/W
ψ <sub>JB</sub> Junction-to-board characterization parameter	61	107.1	54.1	209.3	64.9	°C/W
R <sub>θJC(bot)</sub> Junction-to-case (bottom) thermal resistance	N/A	N/A	N/A	N/A	29.9	°C/W

(1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.

## 5.6 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted), V<sub>CC</sub> = 5 V ± 10%

PARAMETER	TEST CONDITIONS	MIN	TYP <sup>(1)</sup>	MAX	UNIT
V <sub>CC</sub> Supply voltage		0.9		5.5	V
I <sub>CC</sub> Supply current			1	100	nA
V <sub>F</sub> Diode forward voltage	I <sub>F</sub> = 10mA	0.65		0.95	V
V <sub>BR</sub> Breakdown Voltage	I <sub>BR</sub> = 10mA	11			V
V <sub>C</sub> Channel clamp voltage	T <sub>A</sub> = 25°C, ±15kV HBM, I <sub>F</sub> = 10A	Positive transients		V <sub>CC</sub> + 25	V
		Negative transients		-25	
	T <sub>A</sub> = 25°C, ±8kV contact discharge (IEC 61000-4-2), I <sub>F</sub> = 24A	Positive transients		V <sub>CC</sub> + 60	
		Negative transients		-60	
	T <sub>A</sub> = 25°C, ±15kV air-gap discharge (IEC 61000-4-2), I <sub>F</sub> = 45A	Positive transients		V <sub>CC</sub> + 100	
Negative transients		-100			
	Surge strike on IO pin, GND pin grounded, I <sub>PP</sub> = 5A, 8/20µs <sup>(2)</sup>		17		
V <sub>RWM</sub> Reverse stand-off voltage	IO pin to GND pin			5.5	V
I <sub>I/O</sub> Channel leakage current	V <sub>I/O</sub> = GND to V <sub>CC</sub>			±1	nA
C <sub>I/O</sub> Channel input capacitance	V <sub>CC</sub> = 5V, bias of V <sub>CC</sub> /2; f = 10MHz		1.5		pF

(1) Typical values are at V<sub>CC</sub> = 5V and T<sub>A</sub> = 25°C.

(2) Non-repetitive current pulse 8/20µs exponentially decaying waveform according to ICE61000-4-5.

### 5.7 Typical Characteristics

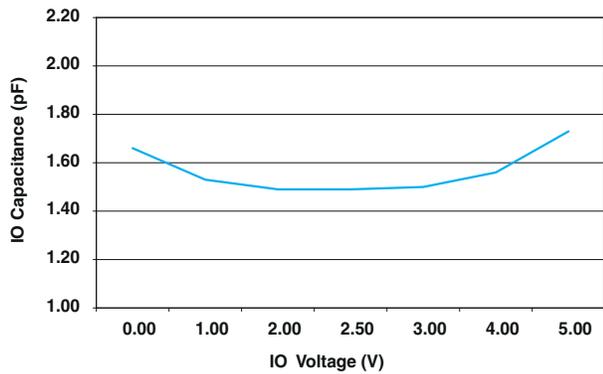


図 5-1. IO Capacitance vs IO Voltage ( $V_{CC} = 5V$ )

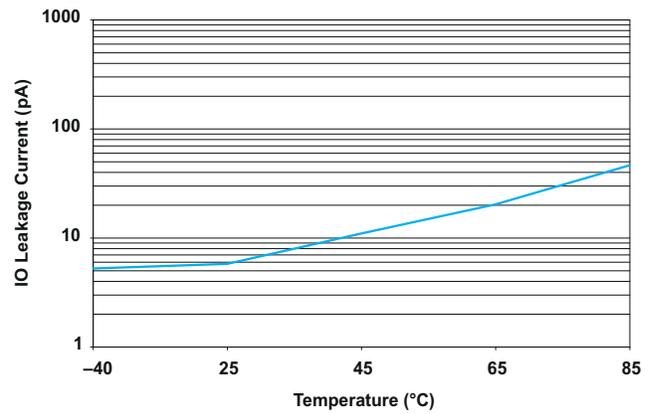


図 5-2. IO Leakage Current vs Temperature ( $V_{CC} = 5.5V$ )

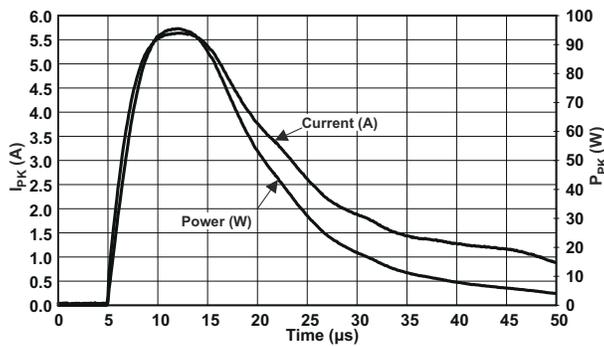


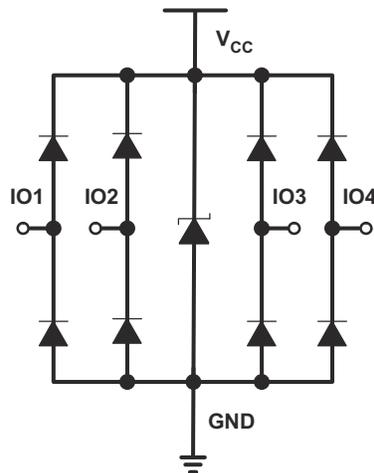
図 5-3. Peak Pulse Waveform,  $V_{CC} = 5.5V$

## 6 Detailed Description

### 6.1 Overview

The TPD4E001 is a four-channel transient voltage suppressor (TVS) based ESD protection diode array. The TPD4E001 is rated to dissipate ESD strikes at the maximum level specified in the IEC 61000-4-2 international standard (Level 4). This device has a 1.5pF IO capacitance per channel, making it ideal for use in high-speed data IO interfaces. The ultra-low leakage current (<1nA maximum) is suitable for precision analog measurements in applications like glucose meters and heart rate monitors.

### 6.2 Functional Block Diagram



### 6.3 Feature Description

The TPD4E001 is a uni-directional ESD protection device with low capacitance. The device is constructed with a central ESD clamp that features two hiding diodes per line to reduce the capacitive loading. This central ESD clamp is also connected to V<sub>CC</sub> to provide protection for the V<sub>CC</sub> line. Each IO line is rated to dissipate ESD strikes above the maximum level specified in the IEC 61000-4-2 level 4 international standard. The TPD4E001's low loading capacitance makes it ideal for protection high-speed signal terminals.

### 6.4 Device Functional Modes

The TPD4E001 is a passive-integrated circuit that activates whenever voltages above V<sub>BR</sub> or below the lower diodes V<sub>forward</sub> (–0.6V) are present upon the circuit being protected. During ESD events, voltages as high as ±15kV can be directed to ground and V<sub>CC</sub> via the internal diode network. Once the voltages on the protected lines fall below the trigger voltage of the TPD4E001 (usually within 10s of nano-seconds) the device reverts back to a high-impedance state.

## 7 Application and Implementation

### 注

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 7.1 Application Information

The TPD4E001 is a diode array type Transient Voltage Suppressor (TVS) which is typically used to provide a path to ground for dissipating ESD events on hi-speed signal lines between a human interface connector and a system. As the current from ESD passes through the TVS, only a small voltage drop is present across the diode. This is the voltage presented to the protected IC. The low  $R_{DYN}$  of the triggered TVS holds this voltage,  $V_{CLAMP}$ , to a tolerable level to the protected IC.

### 7.2 Typical Application

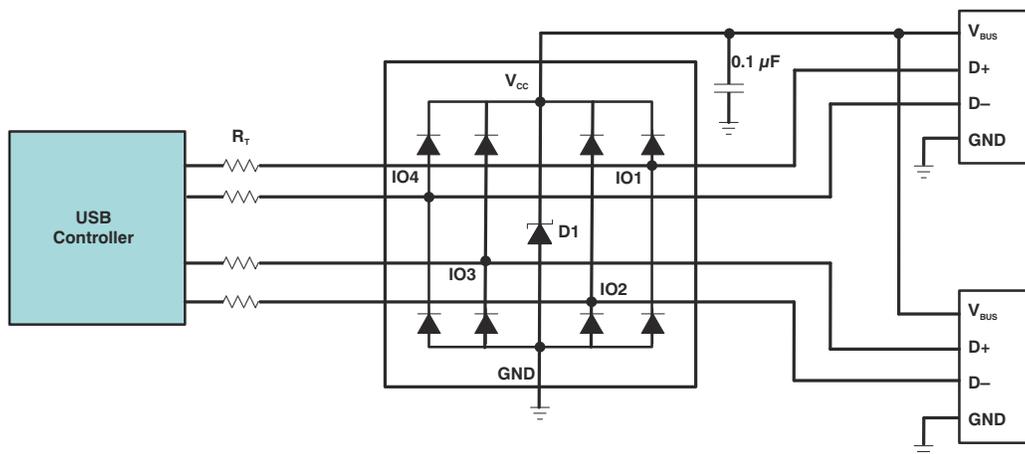


図 7-1. Typical Application Schematic

#### 7.2.1 Design Requirements

For this design example, a single TPD4E001 is used to protect all the pins of two USB2.0 connectors.

Given the USB application, the following parameters in 表 7-1 are known.

表 7-1. Design Parameters

DESIGN PARAMETER	VALUE
Signal range on IO1, IO2, IO3, and IO4	0V to 3.6V
Signal voltage range on $V_{CC}$	0V to 5.25V
Operating Frequency	240MHz

#### 7.2.2 Detailed Design Procedure

When placed near the USB connectors, the TPD4E001 ESD solution offers little or no signal distortion during normal operation due to low IO capacitance and ultra-low leakage current specifications. The TPD4E001 ensures that the core circuitry is protected and the system is functioning properly in the event of an ESD strike. For proper operation, the following layout/ design guidelines must be followed:

1. Place the TPD4E001 solution close to the connectors. This allows the TPD4E001 to take away the energy associated with ESD strike before it reaches the internal circuitry of the system board.

2. Place a 0.1µF capacitor very close to the V<sub>CC</sub> pin. This limits any momentary voltage surge at the IO pin during the ESD strike event.
3. Ensure that there is enough metallization for the V<sub>CC</sub> and GND loop. During normal operation, the TPD4E001 consumes nA leakage current. But during the ESD event, V<sub>CC</sub> and GND may see 15A to 30A of current, depending on the ESD level. Sufficient current path enables safe discharge of all the energy associated with the ESD strike.
4. Leave the unused IO pins floating. In this example of protecting two USB ports, none of the IO pins are left unused.
5. The V<sub>CC</sub> pin can be connected in two different ways:
  - a. If the V<sub>CC</sub> pin is connected to the system power supply, the TPD4E001 works as a transient suppressor for any signal swing above V<sub>CC</sub> + V<sub>F</sub>. A 0.1µF capacitor on the device V<sub>CC</sub> pin is recommended for ESD bypass.
  - b. If the V<sub>CC</sub> pin is not connected to the system power supply, the TPD4E001 can tolerate higher signal swing in the range up to 10V. Please note that a 0.1µF capacitor is still recommended at the V<sub>CC</sub> pin for ESD bypass.

### 7.2.3 Application Curve

Figure 7-2 is a capture of the voltage clamping waveform of TPD4E001DRL on IO3 during an 8kV Contact IEC61000-4-2 ESD strike.

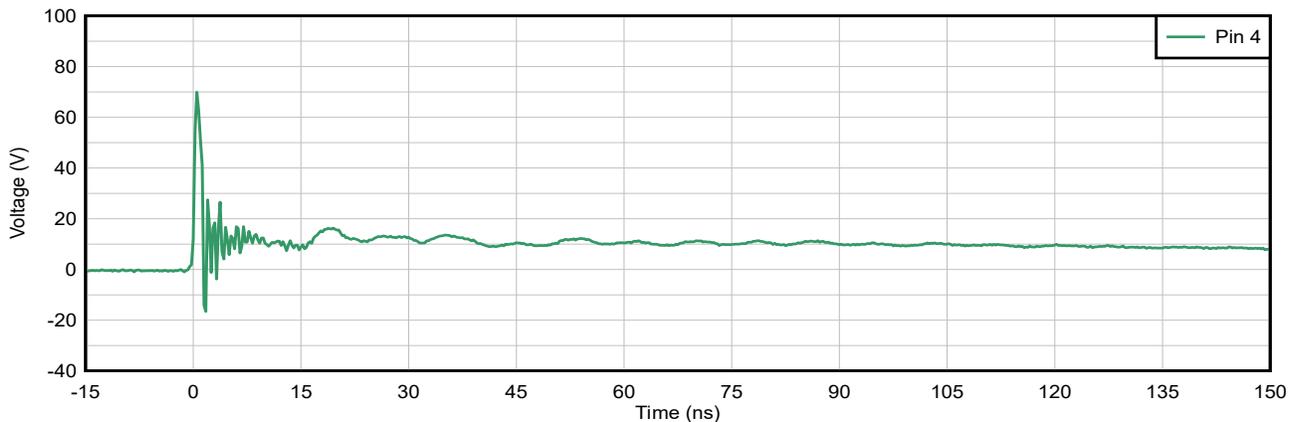


Figure 7-2. TPD4E001DRL IEC61000-4-2 Voltage Clamp Waveform 8kV Contact

## Power Supply Recommendations

This device is a passive ESD protection device so there is no need to power it. Take care to make sure that the maximum voltage specifications for each pin are not violated.

## 8 Layout

### 8.1 Layout Guidelines

- The optimum placement is as close to the connector as possible.
  - EMI during an ESD event can couple from the trace being struck to other nearby unprotected traces, resulting in early system failures.
  - The PCB designer needs to minimize the possibility of EMI coupling by keeping any unprotected traces away from the protected traces which are between the TVS and the connector.
- Route the protected traces as straight as possible.
- Eliminate any sharp corners on the protected traces between the TVS and the connector by using rounded corners with the largest radii possible.
  - Electric fields tend to build up on corners, increasing EMI coupling.

## 8.2 Layout Example

The following is a layout example for protecting two interface ports with the TPD4E001. One example is two USB 2.0 ports, as was discussed in the [セクション 7](#) section. For the USB 2.0 example, IO1 and IO2 is D+ and D–, respectively, of USB port 1. IO3 and IO4 is D– and D+, respectively, of USB port 2.

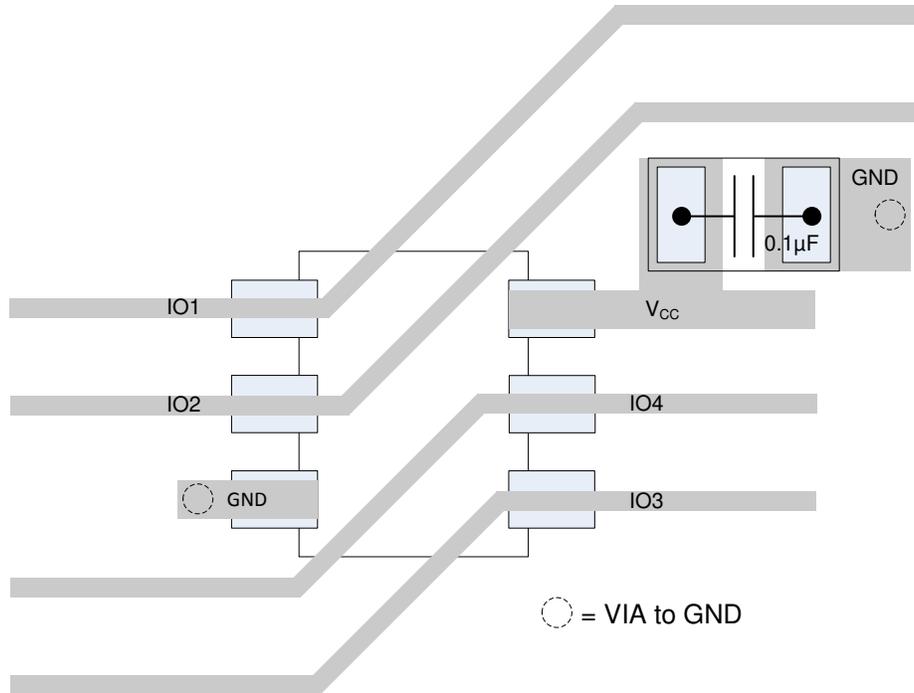


図 8-1. Routing With DRL Package

## 9 Device and Documentation Support

### 9.1 サード・パーティ製品に関する免責事項

サード・パーティ製品またはサービスに関するテキサス・インスツルメンツの出版物は、単独またはテキサス・インスツルメンツの製品、サービスと一緒に提供される場合に関係なく、サード・パーティ製品またはサービスの適合性に関する是認、サード・パーティ製品またはサービスの是認の表明を意味するものではありません。

### 9.2 Documentation Support

#### 9.2.1 Related Documentation

For related documentation see the following:

- Texas Instruments, [Reading and Understanding an ESD Protection Datasheet](#)
- Texas Instruments, [ESD Layout Guide](#)

### 9.3 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

### 9.4 サポート・リソース

[テキサス・インスツルメンツ E2E™ サポート・フォーラム](#)は、エンジニアが検証済みの回答と設計に関するヒントをエキスパートから迅速かつ直接得ることができる場所です。既存の回答を検索したり、独自の質問をしたりすることで、設計に必要な支援を迅速に得ることができます。

リンクされているコンテンツは、各寄稿者により「現状のまま」提供されるものです。これらはテキサス・インスツルメンツの仕様を構成するものではなく、必ずしもテキサス・インスツルメンツの見解を反映したものではありません。テキサス・インスツルメンツの[使用条件](#)を参照してください。

### 9.5 Trademarks

FireWire™ is a trademark of Apple Inc.

テキサス・インスツルメンツ E2E™ is a trademark of Texas Instruments.

すべての商標は、それぞれの所有者に帰属します。

### 9.6 静電気放電に関する注意事項



この IC は、ESD によって破損する可能性があります。テキサス・インスツルメンツは、IC を取り扱う際には常に適切な注意を払うことを推奨します。正しい取り扱いおよび設置手順に従わない場合、デバイスを破損するおそれがあります。

ESD による破損は、わずかな性能低下からデバイスの完全な故障まで多岐にわたります。精密な IC の場合、パラメータがわずかに変化するだけで公表されている仕様から外れる可能性があるため、破損が発生しやすくなっています。

### 9.7 用語集

[テキサス・インスツルメンツ用語集](#) この用語集には、用語や略語の一覧および定義が記載されています。

## 10 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision O (July 2019) to Revision P (January 2025)	Page
• Removed DPK2 package from pin out drawings.....	3

Changes from Revision N (March 2018) to Revision O (July 2019)	Page
• Added TPD4E001R DBV Package image and updated Pin Functions table.....	3

<b>Changes from Revision M (May 2017) to Revision N (March 2018)</b>	<b>Page</b>
• TPD4E001DBVR Device Marking changed from NFY to NFYF .....	13

<b>Changes from Revision L (May 2016) to Revision M (May 2017)</b>	<b>Page</b>
• Updated Pin Functions table and DCK2 Package image.....	3
• Updated "Surge Protection" to "IEC Specification" in セクション 5.3 table.....	4

<b>Changes from Revision K (January 2015) to Revision L (May 2016)</b>	<b>Page</b>
• Added frequency test condition to <i>Channel input capacitance</i> in the <i>Electrical Characteristics</i> table.....	5
• Added Community Resources .....	11

<b>Changes from Revision J (December 2013) to Revision K (October 2014)</b>	<b>Page</b>
• 「ピン構成および機能」セクション、「ESD 定格」表、「機能説明」セクション、「デバイスの機能モード」セクション、「アプリケーションと実装」セクション、「電源に関する推奨事項」セクション、「レイアウト」セクション、「デバイスおよびドキュメントのサポート」セクション、「メカニカル、パッケージ、および注文情報」セクションを追加 .....	1

<b>Changes from Revision I (September 2012) to Revision J (November 2013)</b>	<b>Page</b>
• 「概要」を更新.....	1
• Removed Ordering Information table.....	3

<b>Changes from Revision H (August 2012) to Revision I (September 2012)</b>	<b>Page</b>
• Added DCK2 package to pin out drawings.....	3
• Updated Electrical Characteristics table.....	5

<b>Changes from Revision G (December 2011) to Revision H ( )</b>	<b>Page</b>
• Updated TOP-SIDE MARKING column in ORDERING INFORMATION table.....	3

<b>Changes from Revision F (May 2011) to Revision G (December 2011)</b>	<b>Page</b>
• ドキュメントのフォーマットを更新.....	1
• Added DPK (PUSON) package and package information.....	3

<b>Changes from Revision E (April 2011) to Revision F (May 2011)</b>	<b>Page</b>
• Added Peak Pulse Waveform Graph to Typical Operating Characteristics.....	6

<b>Changes from Revision C (April 2007) to Revision D (December 2010)</b>	<b>Page</b>
• Added DBV (SOT-23) package and package information.....	3

## 11 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

## 重要なお知らせと免責事項

テキサス・インスツルメンツは、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、テキサス・インスツルメンツ製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した テキサス・インスツルメンツ製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとします。

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている テキサス・インスツルメンツ製品を使用するアプリケーションの開発の目的でのみ、テキサス・インスツルメンツはその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。テキサス・インスツルメンツや第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、テキサス・インスツルメンツおよびその代理人を完全に補償するものとし、テキサス・インスツルメンツは一切の責任を拒否します。

テキサス・インスツルメンツの製品は、[テキサス・インスツルメンツの販売条件](#)、または [ti.com](https://www.ti.com) やかかる テキサス・インスツルメンツ製品の関連資料などのいずれかを通じて提供する適用可能な条項の下で提供されています。テキサス・インスツルメンツがこれらのリソースを提供することは、適用されるテキサス・インスツルメンツの保証または他の保証の放棄の拡大や変更を意味するものではありません。

お客様がいかなる追加条項または代替条項を提案した場合でも、テキサス・インスツルメンツはそれらに異議を唱え、拒否します。

郵送先住所: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265

Copyright © 2025, Texas Instruments Incorporated

**PACKAGING INFORMATION**

Orderable part number	Status (1)	Material type (2)	Package   Pins	Package qty   Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
<a href="#">TPD4E001DBVR</a>	Active	Production	SOT-23 (DBV)   6	3000   LARGE T&R	Yes	NIPDAU   SN	Level-1-260C-UNLIM	-40 to 85	(NFY5, NFYF) (NFYP, NFYS)
TPD4E001DBVR.B	Active	Production	SOT-23 (DBV)   6	3000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 85	(NFY5, NFYF) (NFYP, NFYS)
<a href="#">TPD4E001DCKR</a>	Active	Production	SC70 (DCK)   6	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2CF, 2CR) (2CP, 2CP) 2CH
TPD4E001DCKR.B	Active	Production	SC70 (DCK)   6	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2CF, 2CR) (2CP, 2CP) 2CH
TPD4E001DCKRG4	Active	Production	SC70 (DCK)   6	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2CF 2CP
TPD4E001DCKRG4.B	Active	Production	SC70 (DCK)   6	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2CF 2CP
<a href="#">TPD4E001DPKR</a>	Active	Production	USON (DPK)   6	5000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
TPD4E001DPKR.B	Active	Production	USON (DPK)   6	5000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
TPD4E001DPKRG4	Active	Production	USON (DPK)   6	5000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
TPD4E001DPKRG4.B	Active	Production	USON (DPK)   6	5000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
<a href="#">TPD4E001DPKT</a>	Active	Production	USON (DPK)   6	250   SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
TPD4E001DPKT.B	Active	Production	USON (DPK)   6	250   SMALL T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7
<a href="#">TPD4E001DRLR</a>	Active	Production	SOT-5X3 (DRL)   6	4000   LARGE T&R	Yes	NIPDAU   NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(2C7, 2CR) (2CG, 2CH)
TPD4E001DRLR.B	Active	Production	SOT-5X3 (DRL)   6	4000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2C7, 2CR) (2CG, 2CH)
TPD4E001DRLRG4	Active	Production	SOT-5X3 (DRL)   6	4000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2C7, 2CR) (2CG, 2CH)
<a href="#">TPD4E001DRSR</a>	Active	Production	SON (DRS)   6	1000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZWM
TPD4E001DRSR.B	Active	Production	SON (DRS)   6	1000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZWM
TPD4E001DRSRG4	Active	Production	SON (DRS)   6	1000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZWM
TPD4E001DRSRG4.B	Active	Production	SON (DRS)   6	1000   LARGE T&R	Yes	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZWM
<a href="#">TPD4E001RDBVR</a>	Active	Production	SOT-23 (DBV)   6	3000   LARGE T&R	Yes	NIPDAU   SN	Level-1-260C-UNLIM	-40 to 85	NRYF
TPD4E001RDBVR.B	Active	Production	SOT-23 (DBV)   6	3000   LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	NRYF

- (1) **Status:** For more details on status, see our [product life cycle](#).
- (2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.
- (3) **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.
- (4) **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.
- (5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.
- (6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "-" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

**Important Information and Disclaimer:** The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

**OTHER QUALIFIED VERSIONS OF TPD4E001 :**

- Automotive : [TPD4E001-Q1](#)

NOTE: Qualified Version Definitions:

- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*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
TPD4E001DBVR	SOT-23	DBV	6	3000	178.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPD4E001DBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3
TPD4E001DCKR	SC70	DCK	6	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TPD4E001DCKRG4	SC70	DCK	6	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TPD4E001DPKR	USON	DPK	6	5000	180.0	9.5	1.75	1.75	0.7	4.0	8.0	Q2
TPD4E001DPKRG4	USON	DPK	6	5000	180.0	9.5	1.75	1.75	0.7	4.0	8.0	Q2
TPD4E001DPKT	USON	DPK	6	250	180.0	9.5	1.75	1.75	0.7	4.0	8.0	Q2
TPD4E001DRLR	SOT-5X3	DRL	6	4000	180.0	8.4	2.0	1.8	0.75	4.0	8.0	Q3
TPD4E001DRSR	SON	DRS	6	1000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPD4E001DRSRG4	SON	DRS	6	1000	330.0	12.4	3.3	3.3	1.1	8.0	12.0	Q2
TPD4E001RDBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TPD4E001RDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	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)
TPD4E001DBVR	SOT-23	DBV	6	3000	208.0	191.0	35.0
TPD4E001DBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0
TPD4E001DCKR	SC70	DCK	6	3000	180.0	180.0	18.0
TPD4E001DCKRG4	SC70	DCK	6	3000	180.0	180.0	18.0
TPD4E001DPKR	USON	DPK	6	5000	184.0	184.0	19.0
TPD4E001DPKRG4	USON	DPK	6	5000	184.0	184.0	19.0
TPD4E001DPKT	USON	DPK	6	250	184.0	184.0	19.0
TPD4E001DRLR	SOT-5X3	DRL	6	4000	210.0	185.0	35.0
TPD4E001DRSR	SON	DRS	6	1000	353.0	353.0	32.0
TPD4E001DRSRG4	SON	DRS	6	1000	353.0	353.0	32.0
TPD4E001RDBVR	SOT-23	DBV	6	3000	210.0	185.0	35.0
TPD4E001RDBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0

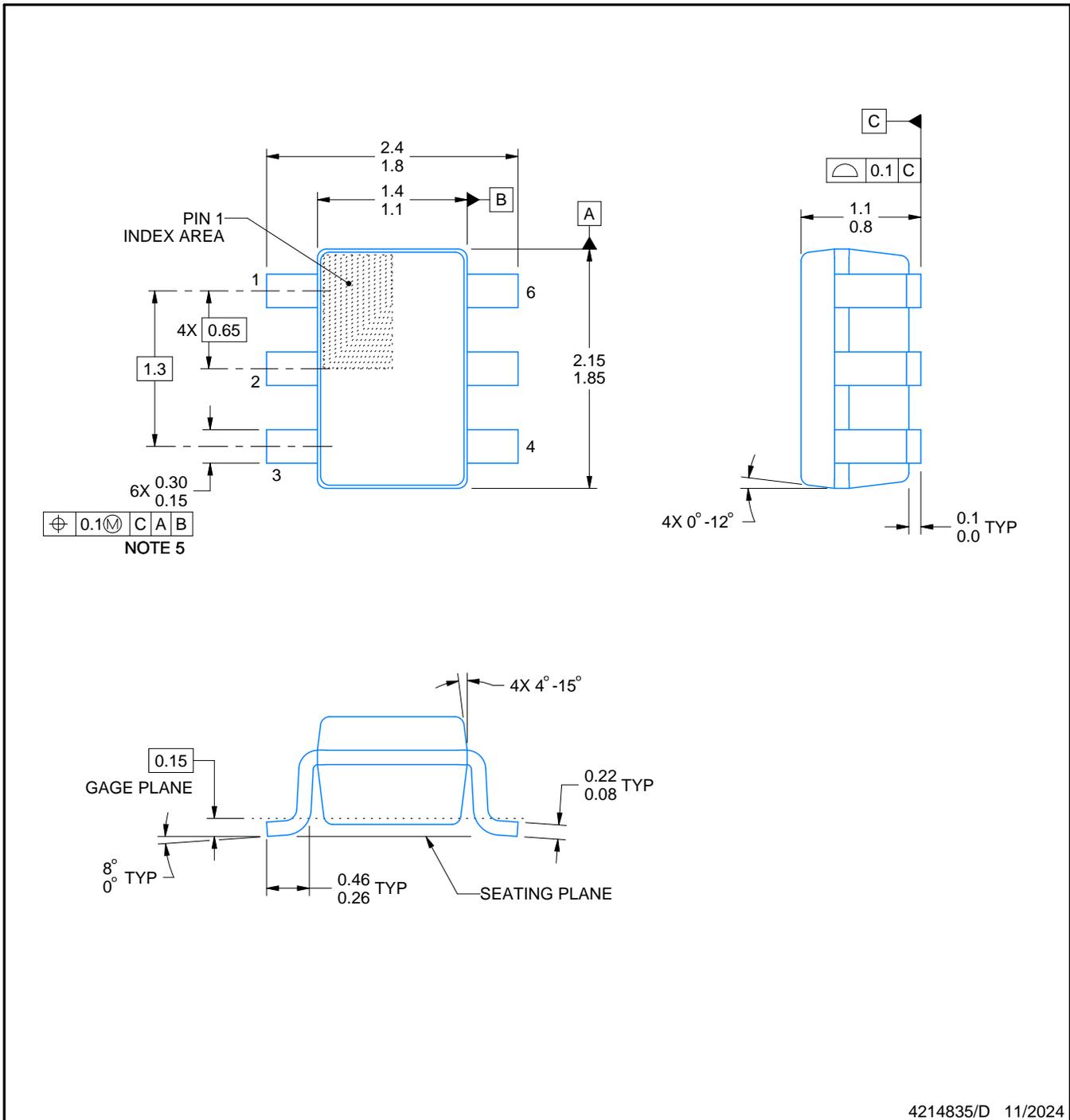
# DCK0006A



# PACKAGE OUTLINE

SOT - 1.1 max height

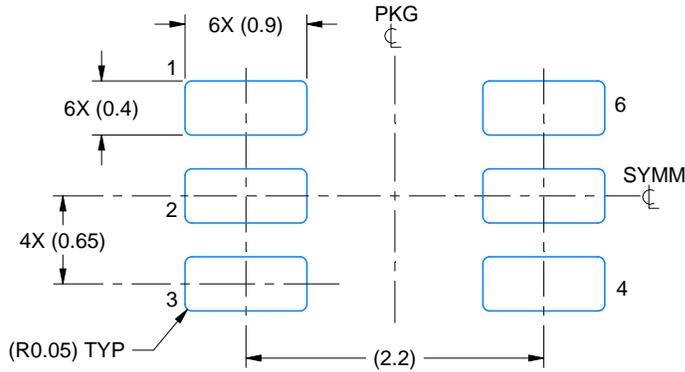
SMALL OUTLINE TRANSISTOR



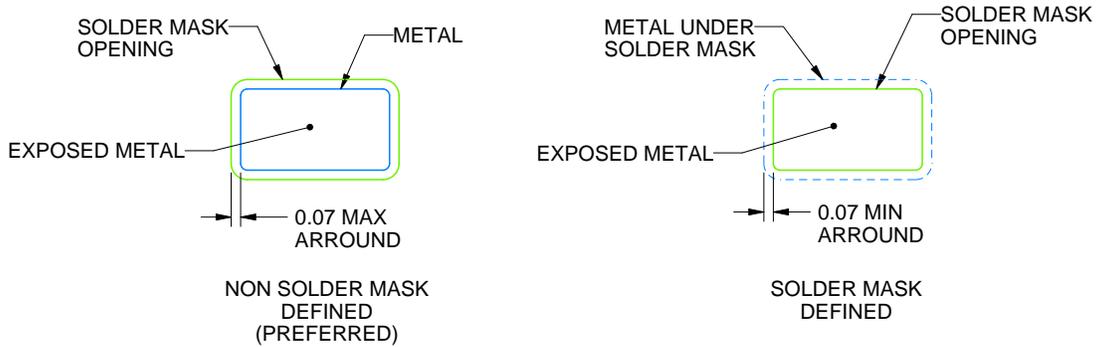
4214835/D 11/2024

## NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Falls within JEDEC MO-203 variation AB.



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:18X

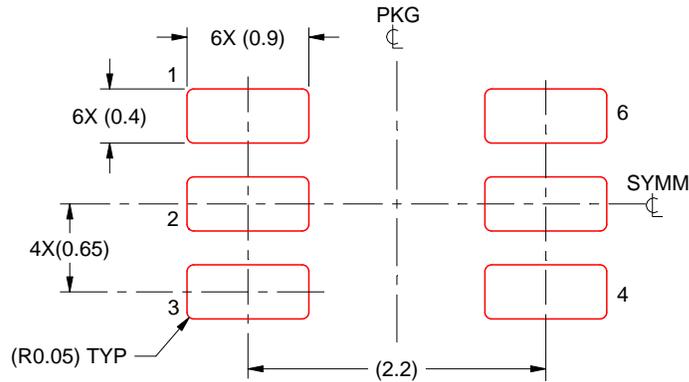


SOLDER MASK DETAILS

4214835/D 11/2024

NOTES: (continued)

- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.



SOLDER PASTE EXAMPLE  
BASED ON 0.125 THICK STENCIL  
SCALE:18X

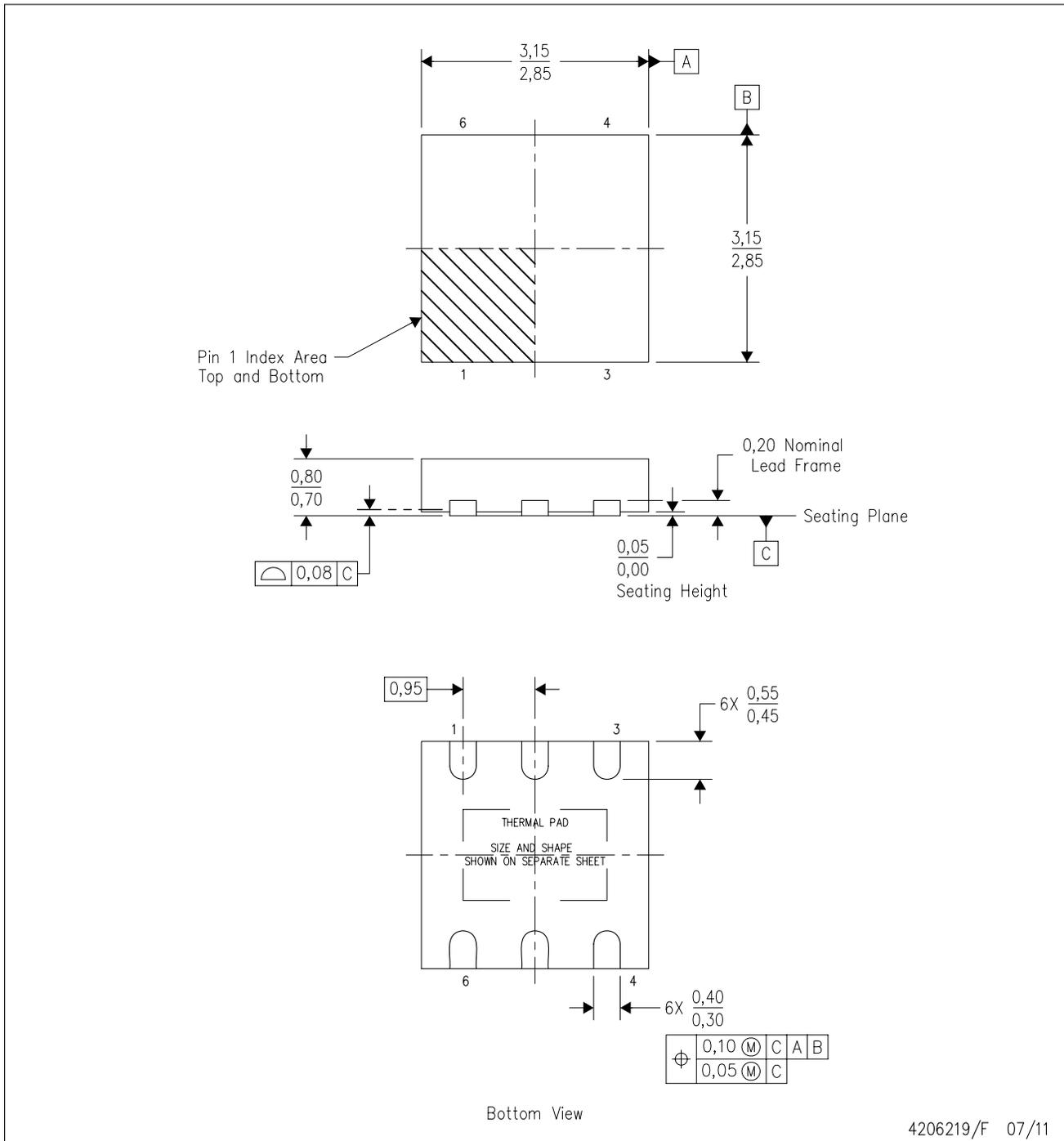
4214835/D 11/2024

NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

DRS (S-PWSON-N6)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
  - This drawing is subject to change without notice.
  - SON (Small Outline No-Lead) package configuration.
  - The package thermal pad must be soldered to the board for thermal and mechanical performance.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.

## THERMAL PAD MECHANICAL DATA

DRS (S-PWSON-N6)

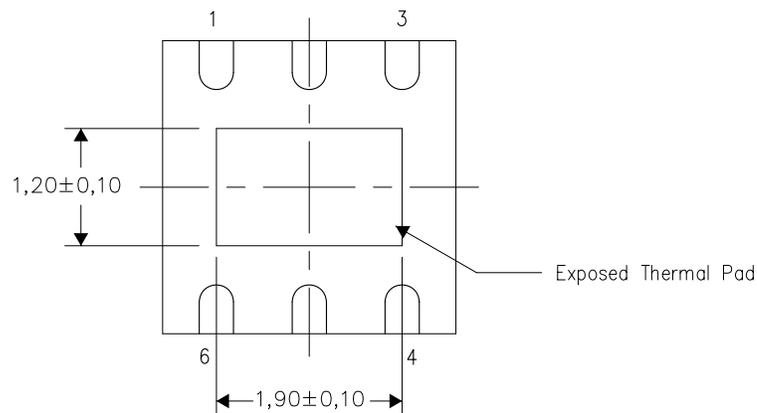
PLASTIC SMALL OUTLINE NO-LEAD

### THERMAL INFORMATION

This package incorporates an exposed thermal pad that is designed to be attached directly to an external heatsink. The thermal pad must be soldered directly to the printed circuit board (PCB). After soldering, the PCB can be used as a heatsink. In addition, through the use of thermal vias, the thermal pad can be attached directly to the appropriate copper plane shown in the electrical schematic for the device, or alternatively, can be attached to a special heatsink structure designed into the PCB. This design optimizes the heat transfer from the integrated circuit (IC).

For information on the Quad Flatpack No-Lead (QFN) package and its advantages, refer to Application Report, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271. This document is available at [www.ti.com](http://www.ti.com).

The exposed thermal pad dimensions for this package are shown in the following illustration.



Bottom View

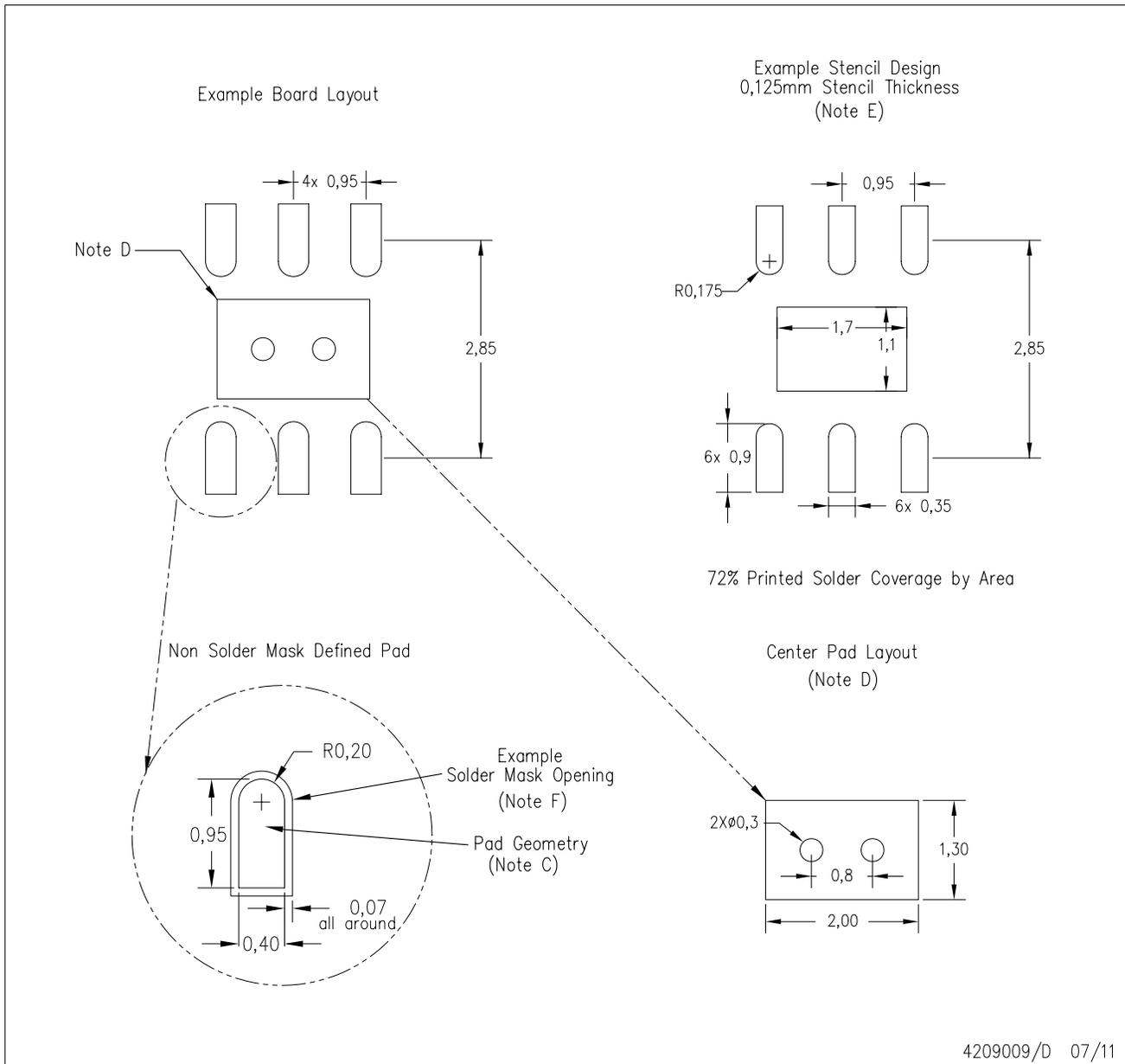
Exposed Thermal Pad Dimensions

4207663/E 07/11

NOTE: All linear dimensions are in millimeters

DRS (S-PWSON-N6)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Application Note, QFN/SON PCB Attachment, Texas Instruments Literature No. SLUA271, and also the Product Data Sheets for specific thermal information, via requirements, and recommended board layout. These documents are available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - F. Customers should contact their board fabrication site for solder mask tolerances.

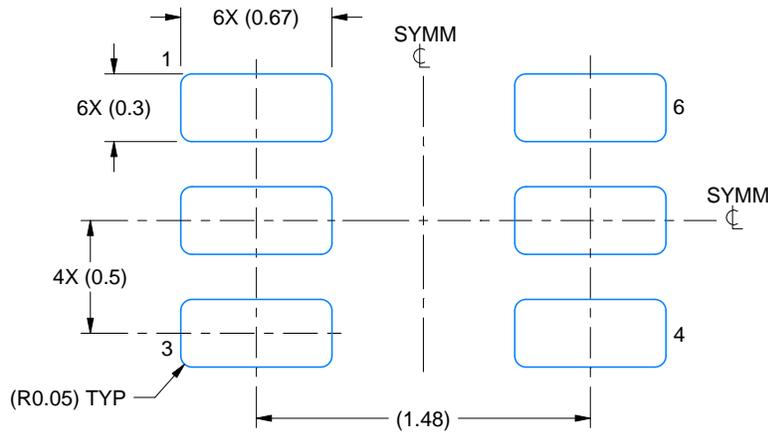


# EXAMPLE BOARD LAYOUT

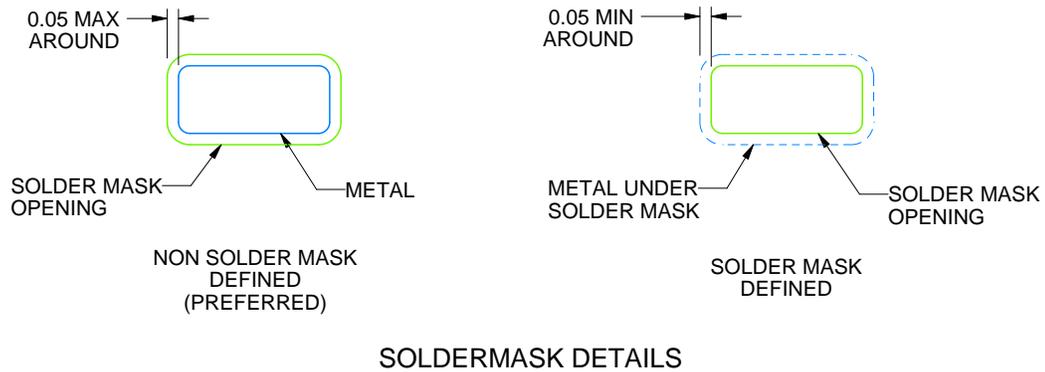
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE  
SCALE:30X



SOLDERMASK DETAILS

4223266/F 11/2024

NOTES: (continued)

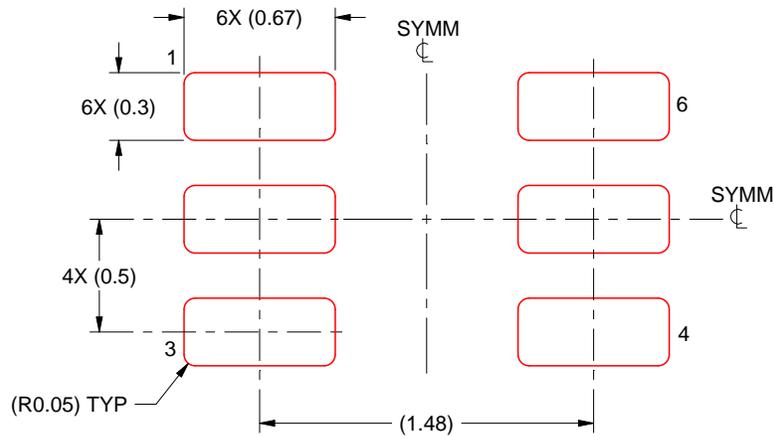
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. Land pattern design aligns to IPC-610, Bottom Termination Component (BTC) solder joint inspection criteria.

# EXAMPLE STENCIL DESIGN

DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



SOLDER PASTE EXAMPLE  
BASED ON 0.1 mm THICK STENCIL  
SCALE:30X

4223266/F 11/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

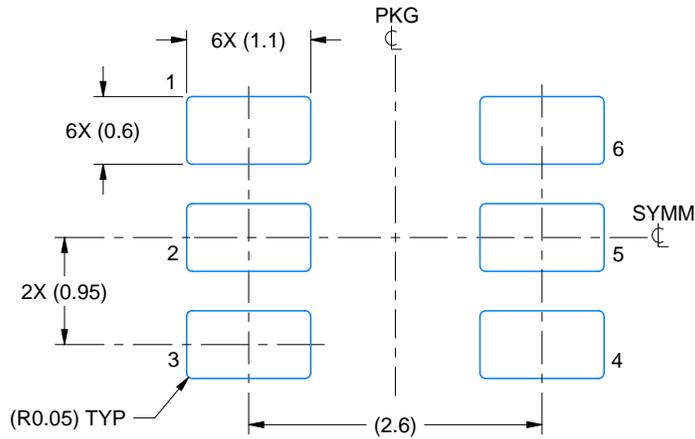


# EXAMPLE BOARD LAYOUT

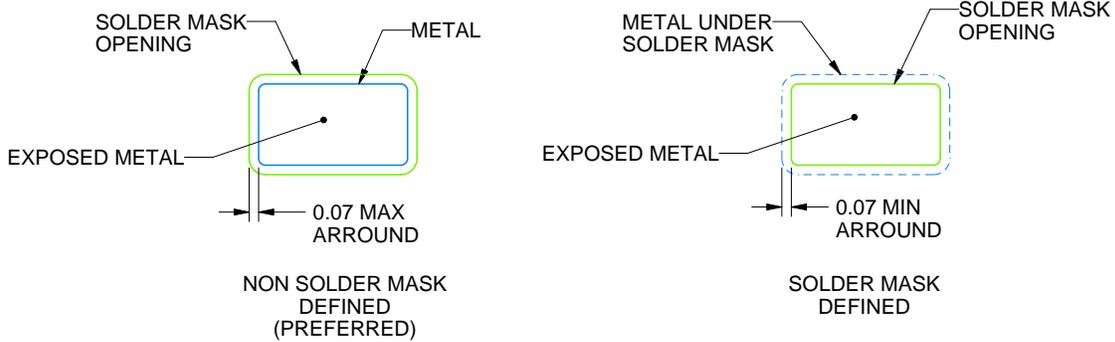
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE:15X



SOLDER MASK DETAILS

4214840/G 08/2024

NOTES: (continued)

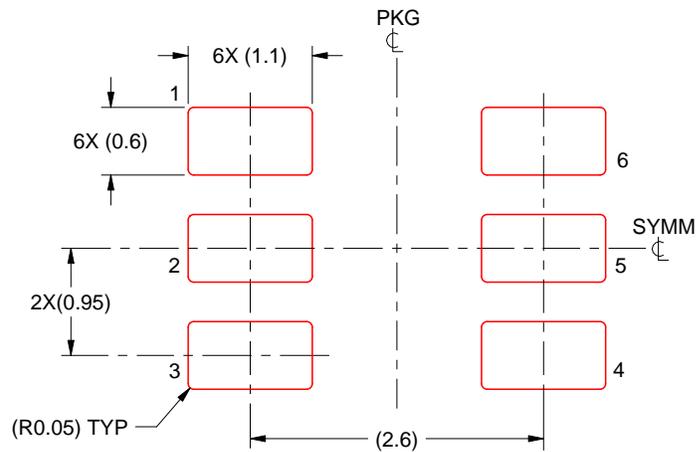
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL  
SCALE:15X

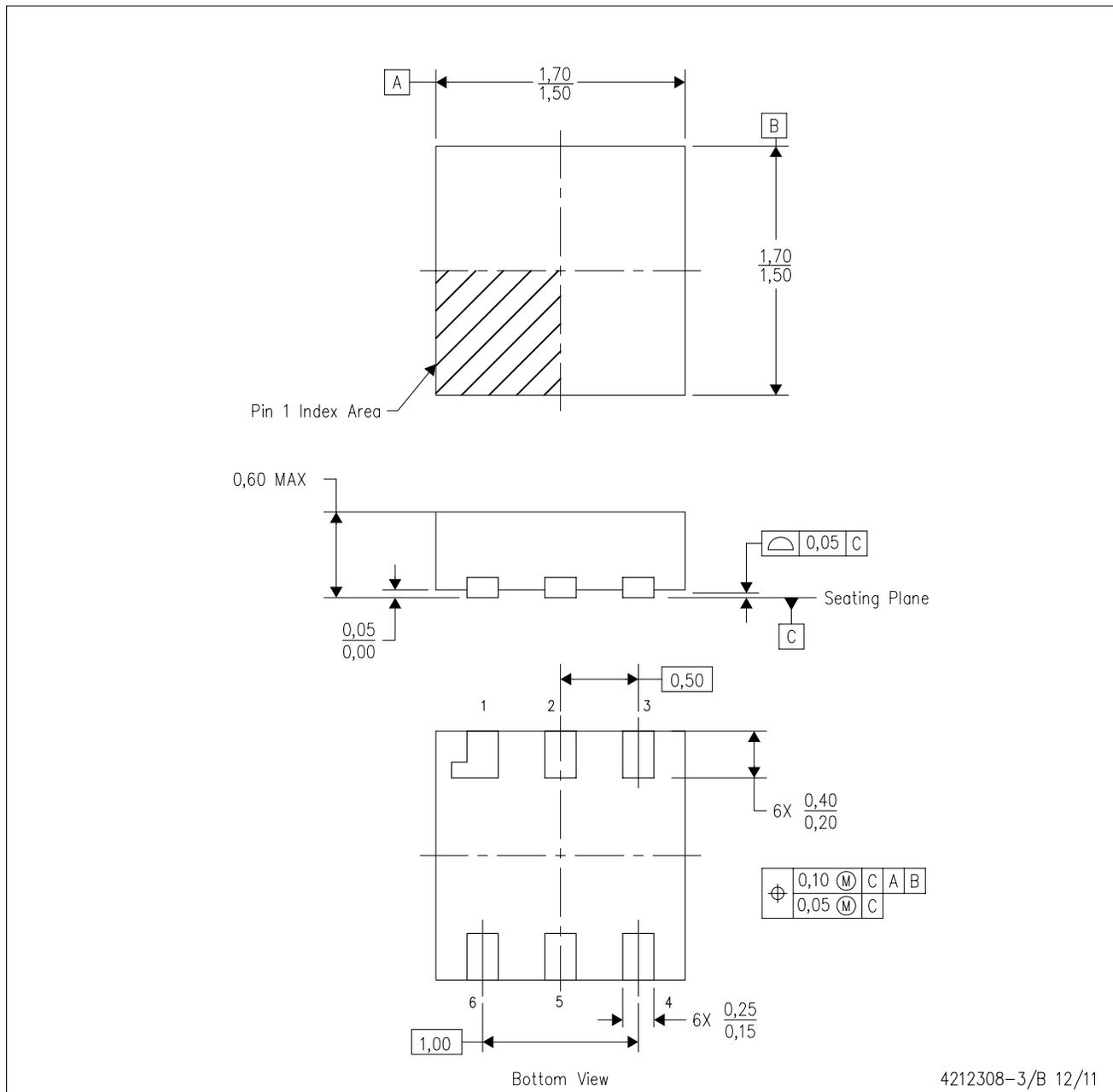
4214840/G 08/2024

NOTES: (continued)

8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

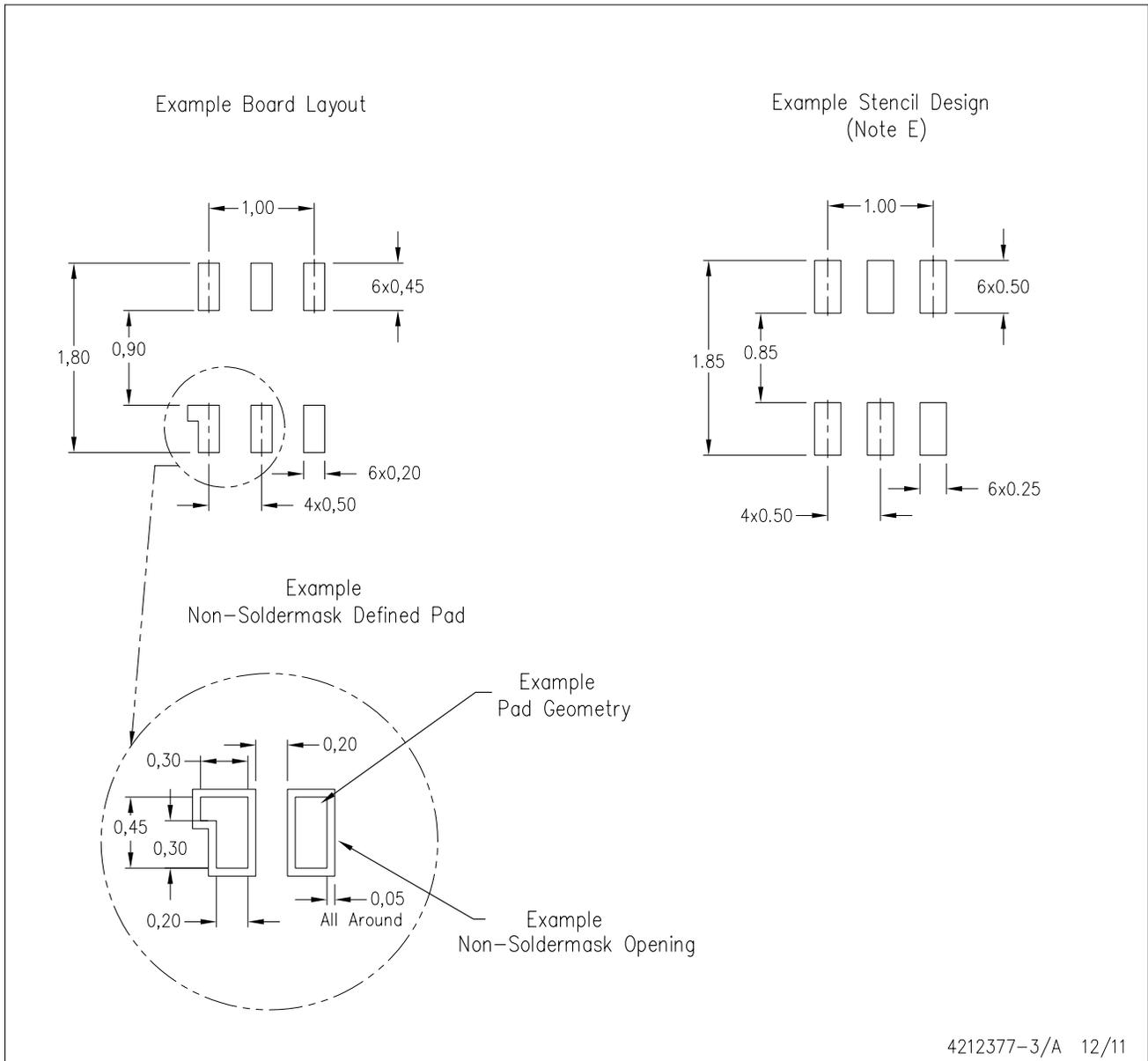
DPK (S-PUSON-N6)

PLASTIC SMALL OUTLINE NO-LEAD



4212308-3/B 12/11

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.



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-7351 is recommended for alternate designs.
  - D. Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
  - E. Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
  - F. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC 7525 for stencil design considerations.
  - G. Side aperture dimensions over-print land for acceptable area ratio > 0.66. Customer may reduce side aperture dimensions if stencil manufacturing process allows for sufficient release at smaller opening.

## 重要なお知らせと免責事項

TI は、技術データと信頼性データ (データシートを含みます)、設計リソース (リファレンス デザインを含みます)、アプリケーションや設計に関する各種アドバイス、Web ツール、安全性情報、その他のリソースを、欠陥が存在する可能性のある「現状のまま」提供しており、商品性および特定目的に対する適合性の黙示保証、第三者の知的財産権の非侵害保証を含むいかなる保証も、明示的または黙示的にかかわらず拒否します。

これらのリソースは、TI 製品を使用する設計の経験を積んだ開発者への提供を意図したものです。(1) お客様のアプリケーションに適した TI 製品の選定、(2) お客様のアプリケーションの設計、検証、試験、(3) お客様のアプリケーションに該当する各種規格や、その他のあらゆる安全性、セキュリティ、規制、または他の要件への確実な適合に関する責任を、お客様のみが単独で負うものとし、

上記の各種リソースは、予告なく変更される可能性があります。これらのリソースは、リソースで説明されている TI 製品を使用するアプリケーションの開発の目的でのみ、TI はその使用をお客様に許諾します。これらのリソースに関して、他の目的で複製することや掲載することは禁止されています。TI や第三者の知的財産権のライセンスが付与されている訳ではありません。お客様は、これらのリソースを自身で使用した結果発生するあらゆる申し立て、損害、費用、損失、責任について、TI およびその代理人を完全に補償するものとし、TI は一切の責任を拒否します。

TI の製品は、[TI の販売条件](#)、[TI の総合的な品質ガイドライン](#)、[ti.com](#) または TI 製品などに関連して提供される他の適用条件に従い提供されます。TI がこれらのリソースを提供することは、適用される TI の保証または他の保証の放棄の拡大や変更を意味するものではありません。TI がカスタム、またはカスタマー仕様として明示的に指定していない限り、TI の製品は標準的なカタログに掲載される汎用機器です。

お客様がいかなる追加条項または代替条項を提案する場合も、TI はそれらに異議を唱え、拒否します。

Copyright © 2026, Texas Instruments Incorporated

最終更新日 : 2025 年 10 月