

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 μs のパルス)
- IO容量: 1.5pF (標準値)
- 低いリーク電流: 1nA (最大値)
- 低い消費電流: 1nA
- 電源電圧範囲: 0.9V~5.5V
- 省スペースのDRL、DBV、DCK、DPK、DRSパッケージ・オプション
- 2、3、6チャンネルの代替品も提供: 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
- 血糖値計

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(レベル4)で規定されている最大レベルの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のIO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(最大値1nA未満)ため、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°C ~ $+85^{\circ}\text{C}$ で動作が規定されています。

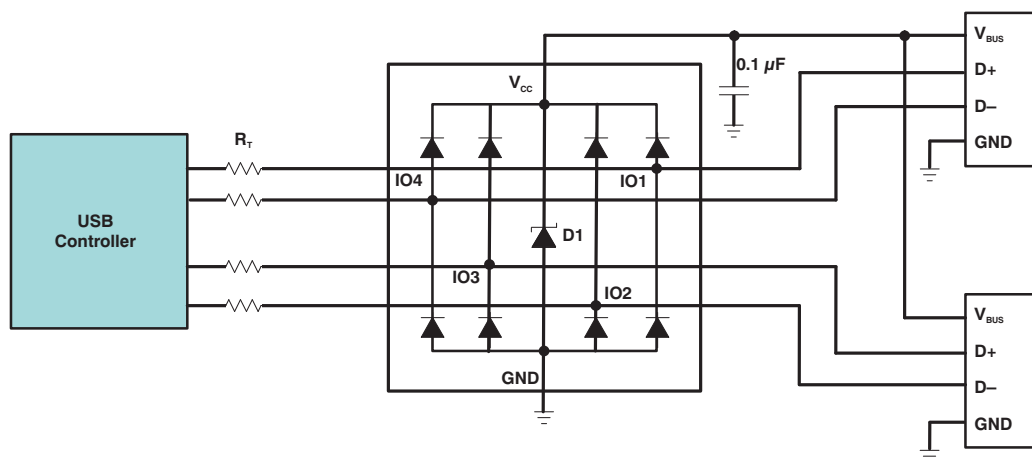
TPD4E1U06DCKRおよびTPD4E1U06DBVRについても参照してください。これらはTPD4E001DCKRおよびTPD4E001DBVRのピン互換品です。これらのデバイスはIEC保護がより高く、容量が低く、クランピング電圧が低く、入力コンデンサが必要ありません。

製品情報⁽¹⁾

型番	パッケージ	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、この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



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4 改訂履歴

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。

Revision N (March 2018) から Revision O に変更	Page
• Added TPD4E001R DBV Package image and updated Pin Functions table	4

Revision M (May 2017) から Revision N に変更	Page
• TPD4E001DBVR デバイスのマーキングを NFY から NFYF に変更	12

Revision L (May 2016) から Revision M に変更	Page
• Updated Pin Functions table and DCK2 Package image	4
• Updated "Surge Protection" to "IEC Specification" in <i>ESD Ratings—IEC Specification</i> table	5

Revision K (January 2015) から Revision L に変更	Page
• Added frequency test condition to <i>Channel input capacitance</i> in the <i>Electrical Characteristics</i> table	6
• 「コミュニティ・リソース」を追加	12

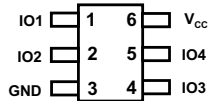
Revision J (December 2013) から Revision K に変更	Page
• 「ピン構成および機能」セクション、「ESD 定格」表、「機能説明」セクション、「デバイスの機能モード」セクション、「アプリケーションと実装」セクション、「電源に関する推奨事項」セクション、「レイアウト」セクション、「デバイスおよびドキュメントのサポート」セクション、「メカニカル、パッケージ、および注文情報」セクション 追加	1

Revision I (September 2012) から Revision J に変更	Page
• 「概要」を更新	1
• Removed Ordering Information table	4

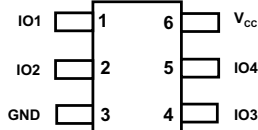
Revision H (August 2012) から Revision I に変更	Page
• Added DCK2 package to Pin Out drawings.	4
• Updated Electrical Characteristics table	6
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Revision G (December 2011) から Revision H に変更	Page
• Updated TOP-SIDE MARKING column in ORDERING INFORMATION table.	4
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Revision F (May 2011) から Revision G に変更	Page
• ドキュメントのフォーマットを更新	1
• Added DPK (PUSON) package and package information.	4
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Revision E (April 2011) から Revision F に変更	Page
• Added Peak Pulse Waveform Graph to Typical Operating Characteristics.	7
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Revision C (April 2007) から Revision D に変更	Page
• Added DBV (SOT-23) package and package information.....	4
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5 Pin Configuration and Functions

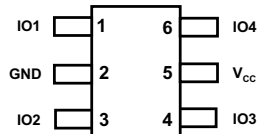
**DRL Package
6-Pin SOT
Top View**



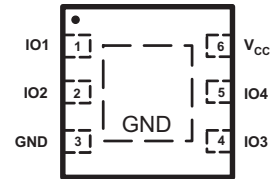
**DCK2 Package
6-Pin SC70
Top View**



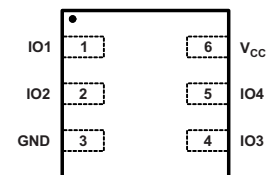
**DBV or DCK Package
6-Pin SOT or SC70
Top View**



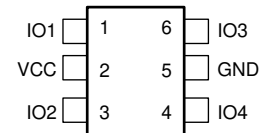
**DRS Package
6-Pin SON
Top View**



**DPK Package
6-Pin USON
Top View**



**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 _{CC}	6	5	2	I	Power-supply input. Bypass V _{CC} to GND with a 0.1- μ F ceramic capacitor
Exposed thermal pad (DRS package only)				—	Exposed thermal pad. Connect to GND or leave floating

6 Specifications

6.1 Absolute Maximum Ratings

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

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

6.2 ESD Ratings—JEDEC Specification

			VALUE	UNIT	
TPD4E001 in DRS, DRL, and DPK Packages					
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	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 ⁽²⁾	All pins	±1000	
TPD4E001 in DBV and DCK Packages					
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	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 ⁽²⁾	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.

6.3 ESD Ratings—IEC Specification

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

6.4 Recommended Operating Conditions

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

		MIN	MAX	UNIT	
T _A	Operating free-air temperature	-40	85	°C	
	Operating voltage	V _{CC} pin	0.9	5.5	V
		IO1, IO2 pins	0	V _{CC}	

6.5 Thermal Information

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

6.6 Electrical Characteristics

over operating free-air temperature range (unless otherwise noted), V_{CC} = 5 V ± 10%

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

(1) Typical values are at V_{CC} = 5 V and T_A = 25°C.

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

6.7 Typical Characteristics

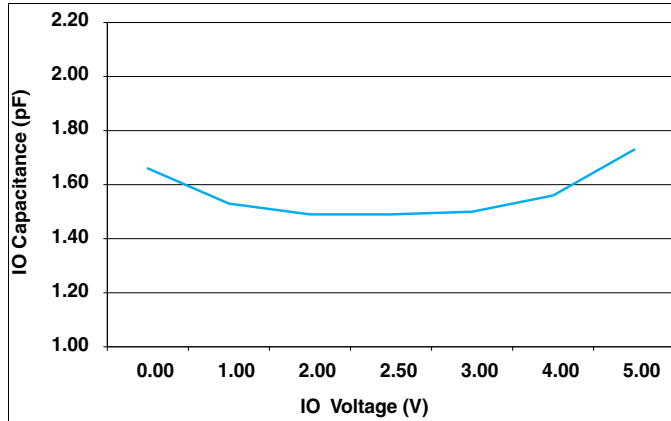


Figure 1. IO Capacitance vs IO Voltage ($V_{CC} = 5\text{ V}$)

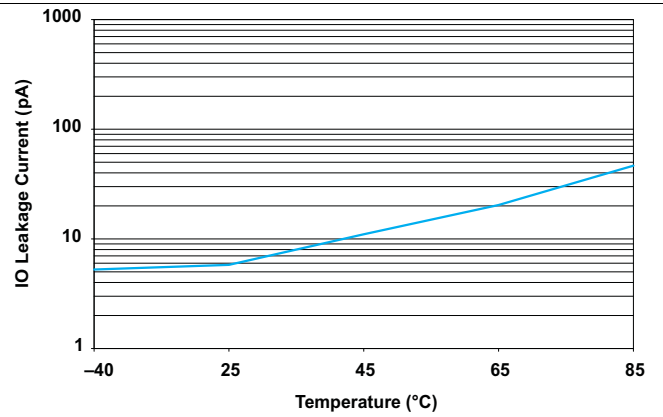


Figure 2. IO Leakage Current vs Temperature ($V_{CC} = 5.5\text{ V}$)

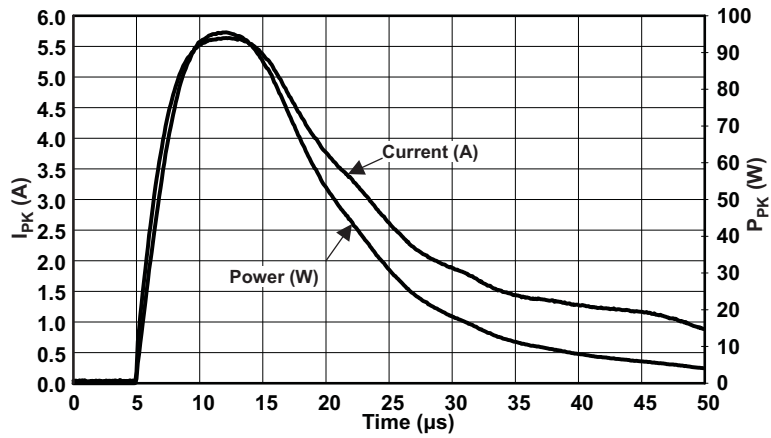


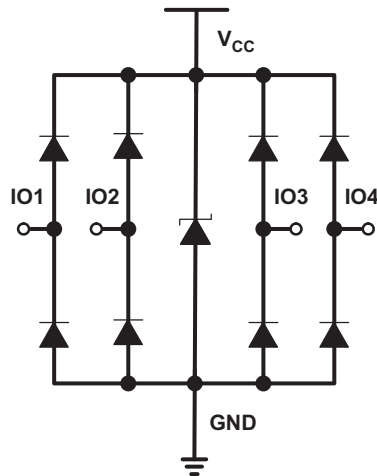
Figure 3. Peak Pulse Waveform, $V_{CC} = 5.5\text{ V}$

7 Detailed Description

7.1 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 1.5-pF IO capacitance per channel, making it ideal for use in high-speed data IO interfaces. The ultra-low leakage current (<1 nA maximum) is suitable for precision analog measurements in applications like glucose meters and heart rate monitors.

7.2 Functional Block Diagram



7.3 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_{CC} to provide protection for the V_{CC} 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.

7.4 Device Functional Modes

The TPD4E001 is a passive-integrated circuit that activates whenever voltages above V_{BR} or below the lower diodes V_{forward} (–0.6 V) are present upon the circuit being protected. During ESD events, voltages as high as ±15 kV can be directed to ground and V_{CC} 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.

8 Application and Implementation

NOTE

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.

8.1 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.

8.2 Typical Application

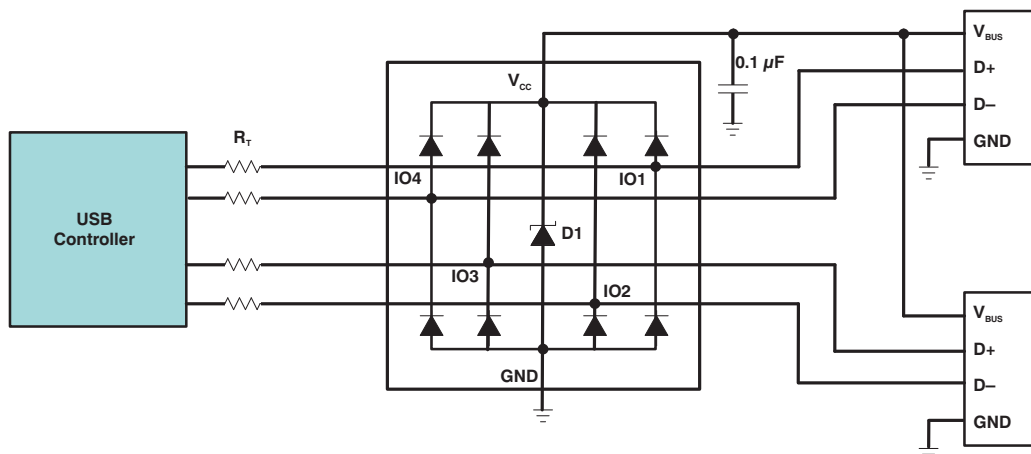


Figure 4. Typical Application Schematic

8.2.1 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 Table 1 are known.

Table 1. Design Parameters

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

8.2.2 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 0.1- μ F capacitor very close to the V_{CC} 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_{CC} and GND loop. During normal operation, the TPD4E001 consumes nA leakage current. But during the ESD event, V_{CC} and GND may see 15 A to 30 A 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_{CC} pin can be connected in two different ways:
 - a. If the V_{CC} pin is connected to the system power supply, the TPD4E001 works as a transient suppressor for any signal swing above $V_{CC} + V_F$. A 0.1- μ F capacitor on the device V_{CC} pin is recommended for ESD bypass.
 - b. If the V_{CC} pin is not connected to the system power supply, the TPD4E001 can tolerate higher signal swing in the range up to 10 V. Please note that a 0.1- μ F capacitor is still recommended at the V_{CC} pin for ESD bypass.

8.2.3 Application Curve

Figure 5 is a capture of the voltage clamping waveform of TPD4E001DRL on IO3 during an 8-kV Contact IEC61000-4-2 ESD strike.

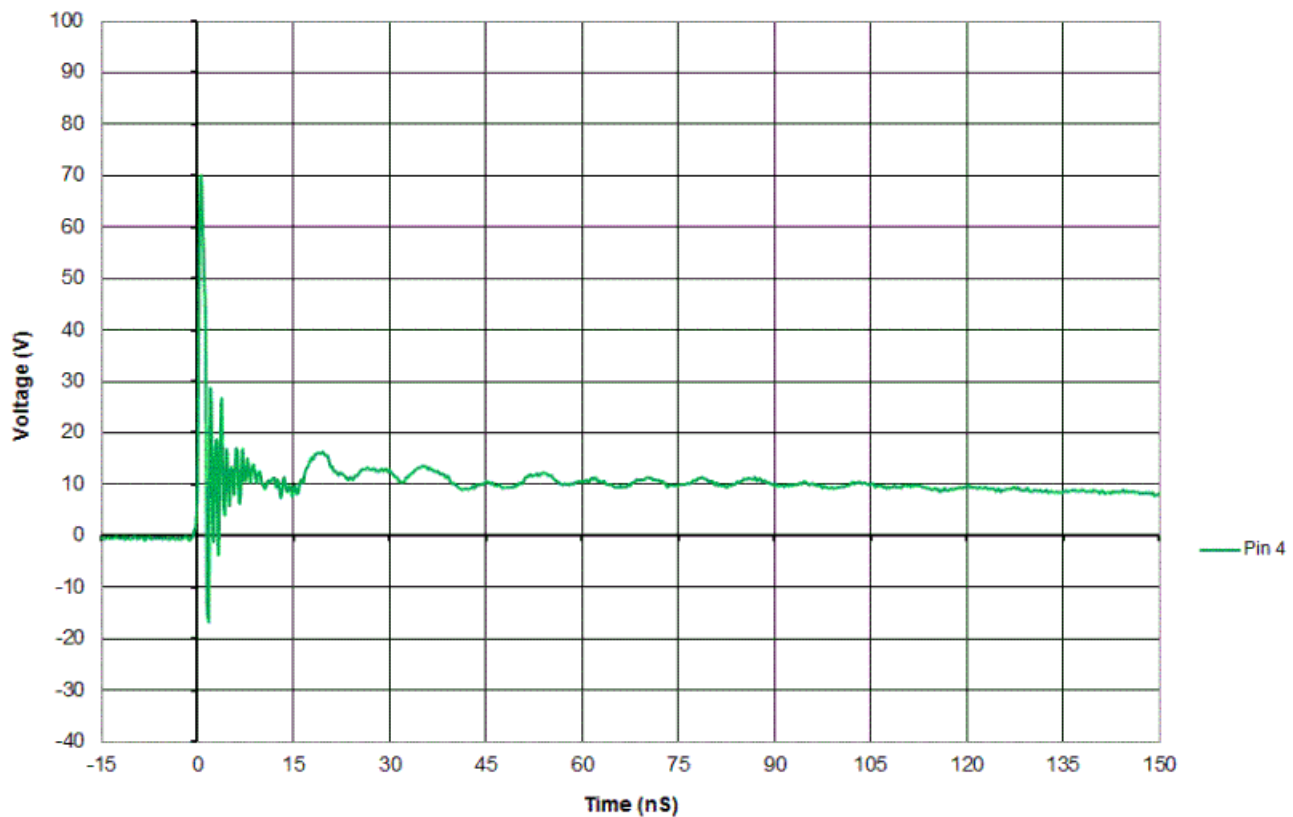


Figure 5. TPD4E001DRL IEC61000-4-2 Voltage Clamp Waveform 8-kV Contact

9 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.

10 Layout

10.1 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.

10.2 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 [Application and Implementation](#) 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.

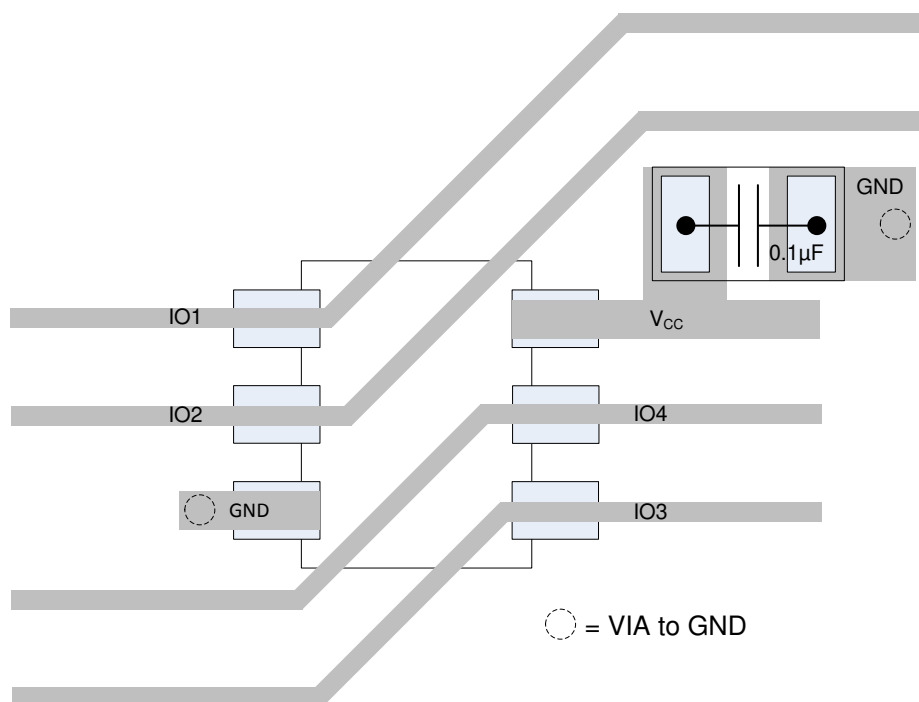


Figure 6. Routing With DRL Package

11 デバイスおよびドキュメントのサポート

11.1 ドキュメントのサポート

11.1.1 関連資料

関連資料については、以下を参照してください。

- 『ESD保護データシートの閲覧と理解』
- 『ESDレアウト・ガイド』

11.2 関連リンク

次の表に、クイック・アクセス・リンクを示します。カテゴリには、技術資料、サポートおよびコミュニティ・リソース、ツールとソフトウェア、およびサンプル注文またはご購入へのクイック・アクセスが含まれます。

表 2. 関連リンク

製品	プロダクト・フォルダ	サンプルとご購入	技術資料	ツールとソフトウェア	サポートとコミュニティ
TPD4E001	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック
TPD4E1U06	ここをクリック	ここをクリック	ここをクリック	ここをクリック	ここをクリック

11.3 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、ti.comのデバイス製品フォルダを開いてください。右上の「アラートを受け取る」をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取れます。変更の詳細については、修正されたドキュメントに含まれている改訂履歴をご覧ください。

11.4 コミュニティ・リソース

The following links connect to TI community resources. Linked contents are provided "AS IS" by the respective contributors. They do not constitute TI specifications and do not necessarily reflect TI's views; see TI's [Terms of Use](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

11.5 商標

E2E is a trademark of Texas Instruments.

FireWire is a trademark of Apple Inc.

All other trademarks are the property of their respective owners.

11.6 静電気放電に関する注意事項



これらのデバイスは、限定的なESD(静電破壊)保護機能を内蔵しています。保存時または取り扱い時は、MOSゲートに対する静電破壊を防止するために、リード線同士をショートさせておくか、デバイスを導電フォームに入れる必要があります。

11.7 Glossary

[SLYZ022](#) — *TI Glossary*.

This glossary lists and explains terms, acronyms, and definitions.

12 メカニカル、パッケージ、および注文情報

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPD4E001DBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	NIPDAU SN	Level-1-260C-UNLIM	-40 to 85	(NFY5, NFYF) (NFYP, NFYS)	Samples
TPD4E001DCKR	ACTIVE	SC70	DCK	6	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2CF, 2CR) (2CP, 2CP) 2CH	Samples
TPD4E001DPKR	ACTIVE	USON	DPK	6	5000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7	Samples
TPD4E001DPKT	ACTIVE	USON	DPK	6	250	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	2C7	Samples
TPD4E001DRLR	ACTIVE	SOT-5X3	DRL	6	4000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 85	(2C7, 2CR) (2CG, 2CH)	Samples
TPD4E001DRLRG4	ACTIVE	SOT-5X3	DRL	6	4000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	(2C7, 2CR) (2CG, 2CH)	Samples
TPD4E001DRSR	ACTIVE	SON	DRS	6	1000	RoHS & Green	NIPDAU	Level-2-260C-1 YEAR	-40 to 85	ZWM	Samples
TPD4E001RDBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 85	NRYF	Samples

(1) The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSELETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices 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.

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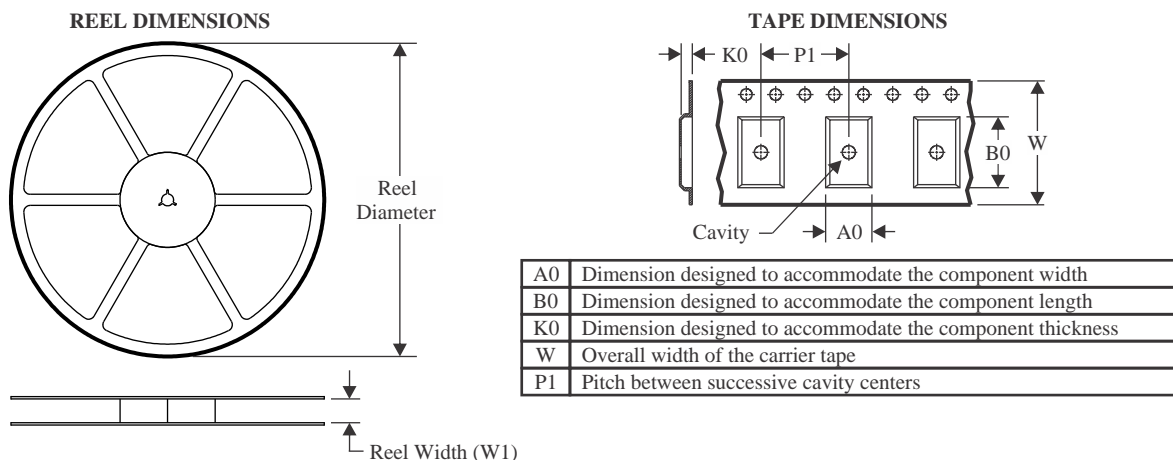
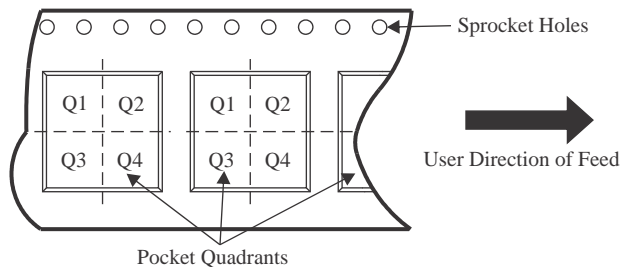
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OTHER QUALIFIED VERSIONS OF TPD4E001 :

- 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


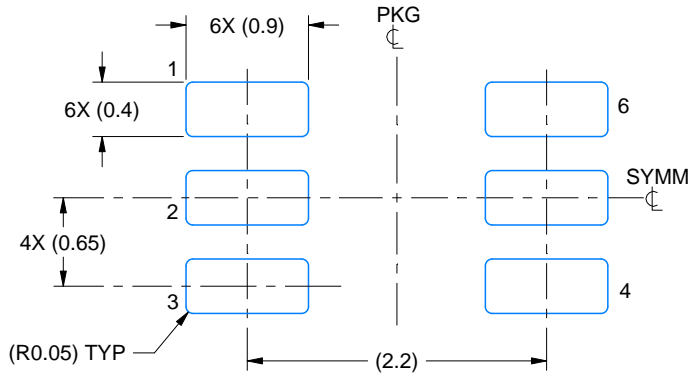
*All dimensions are nominal

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	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
TPD4E001DPKR	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
TPD4E001RDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.23	3.17	1.37	4.0	8.0	Q3

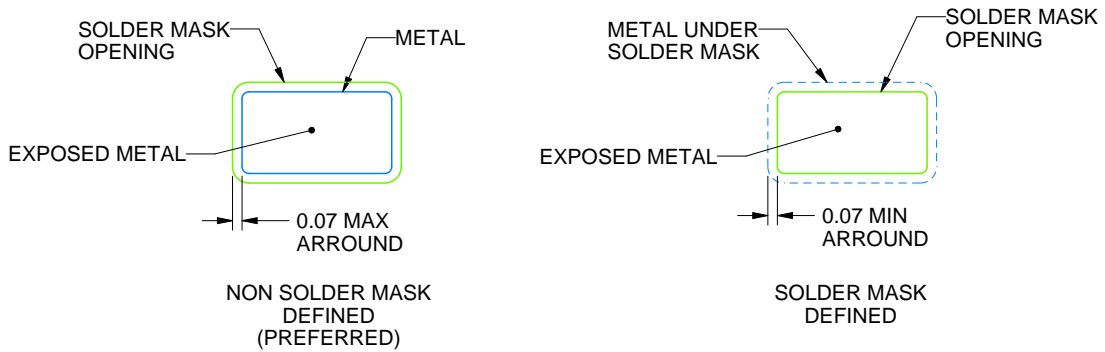
TAPE AND REEL BOX DIMENSIONS


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPD4E001DBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0
TPD4E001DCKR	SC70	DCK	6	3000	180.0	180.0	18.0
TPD4E001DPKR	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	356.0	356.0	35.0
TPD4E001RDBVR	SOT-23	DBV	6	3000	180.0	180.0	18.0



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

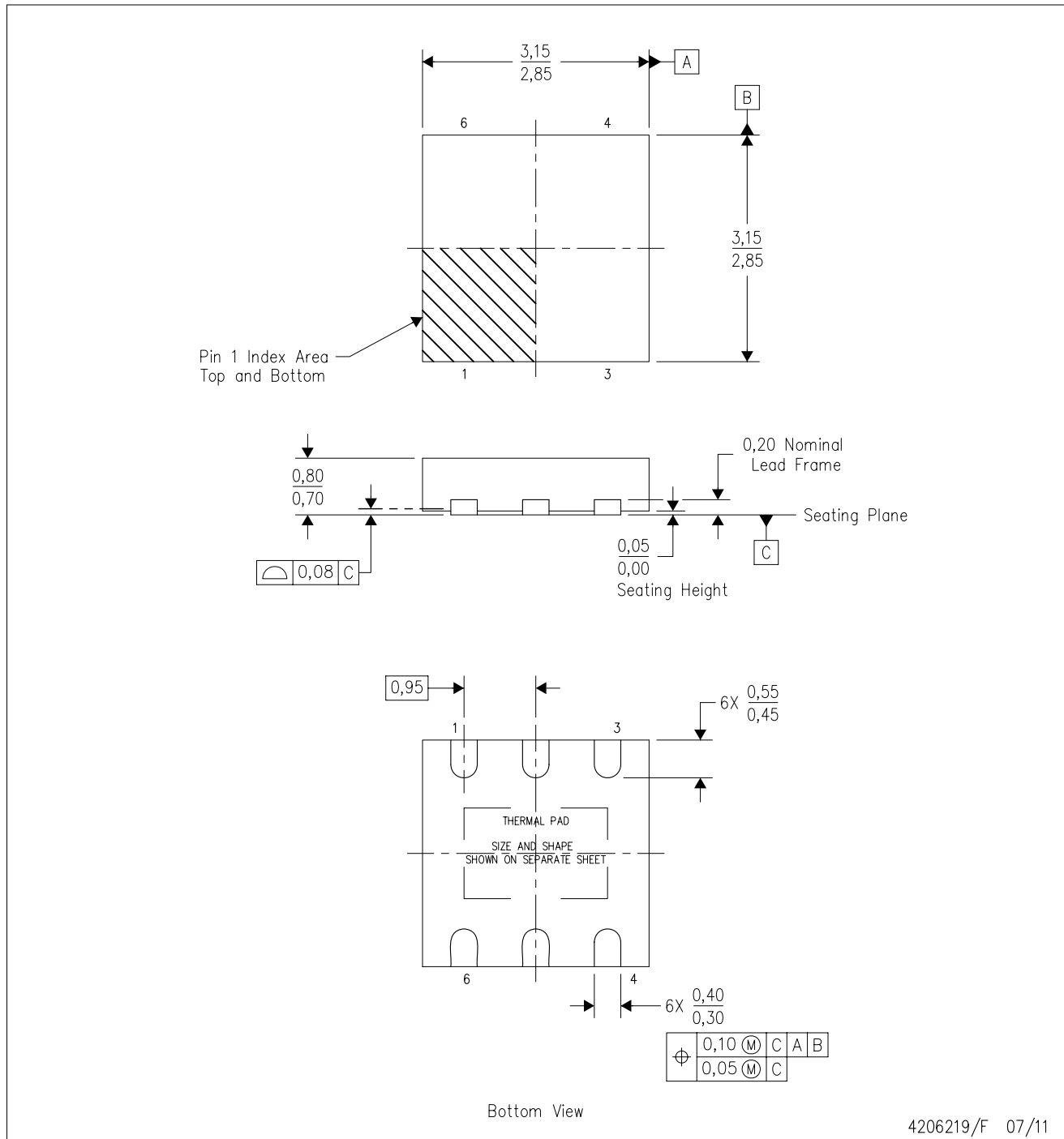
4214835/D 11/2024

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)

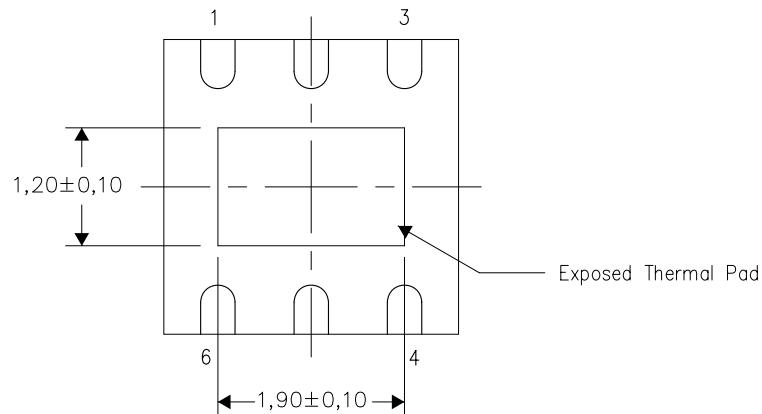
PLASTIC SMALL OUTLINE NO-LEAD

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.

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



Bottom View

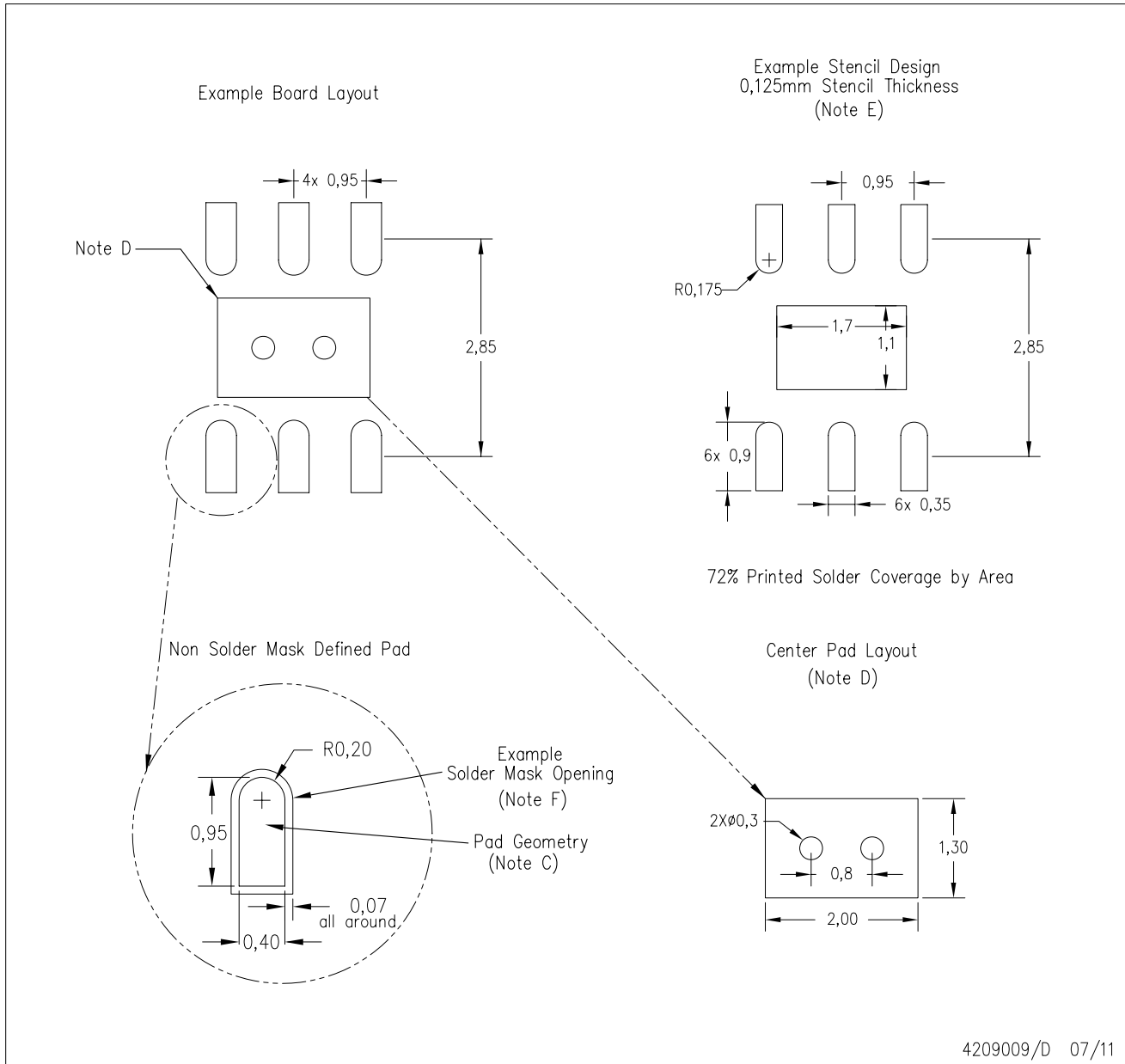
Exposed Thermal Pad Dimensions

4207663/E 07/11

NOTE: All linear dimensions are in millimeters

DRS (S-PWSON-N6)

PLASTIC SMALL OUTLINE NO-LEAD



- NOTES:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - 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>>.
 - 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.
 - Customers should contact their board fabrication site for solder mask tolerances.

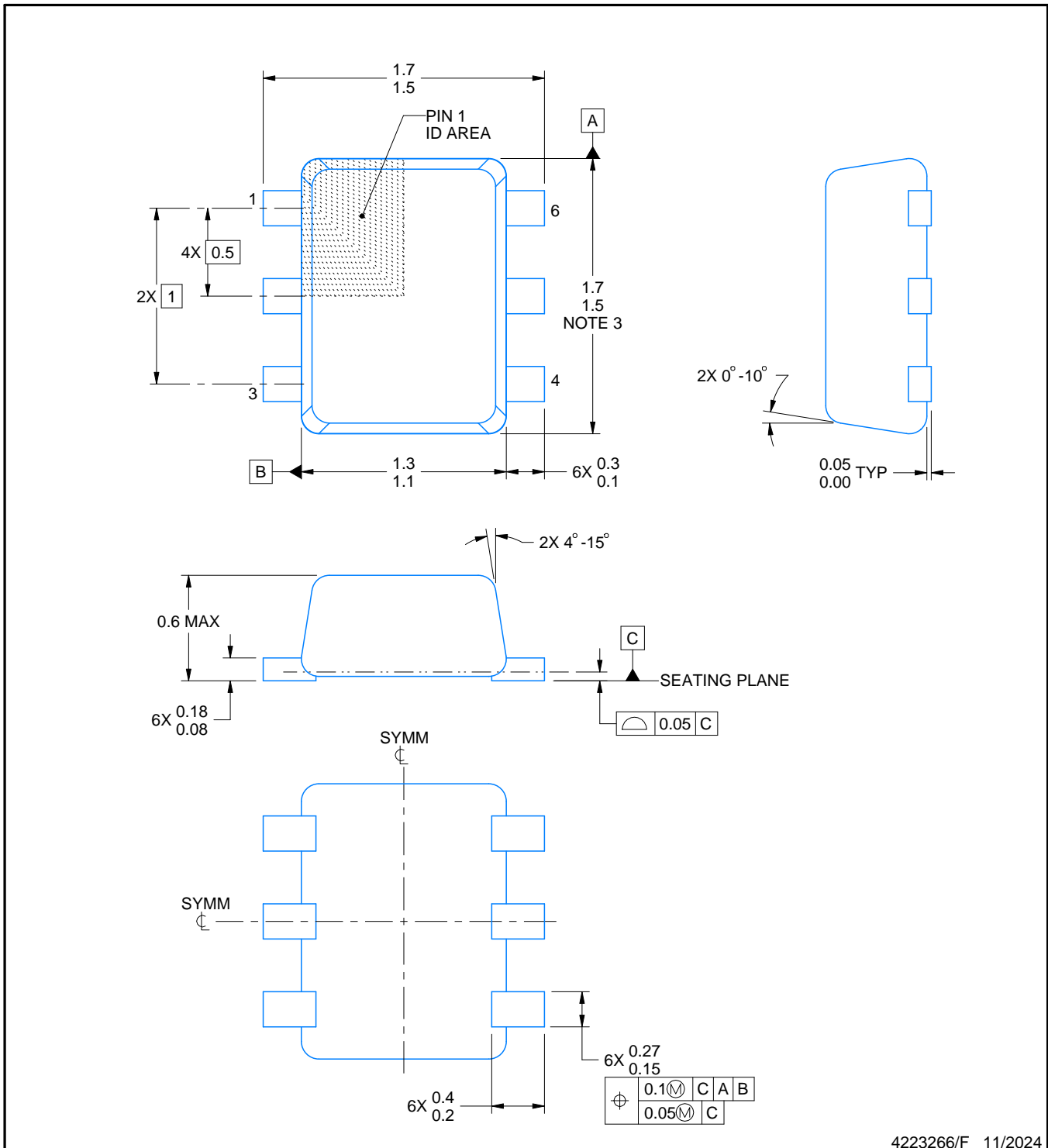
DRL0006A



PACKAGE OUTLINE

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



4223266/F 11/2024

NOTES:

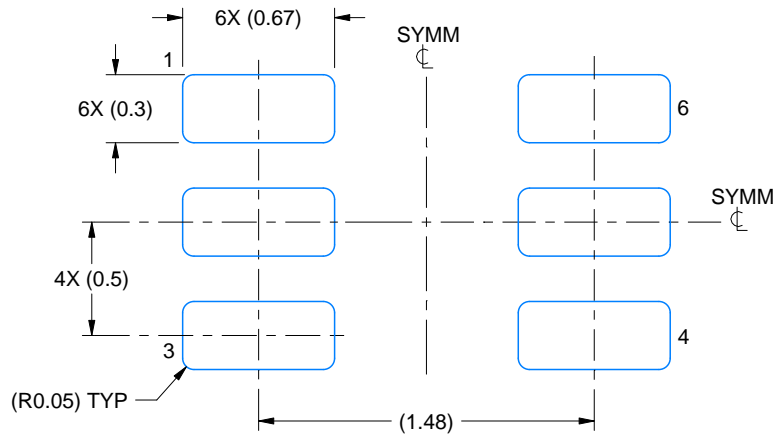
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-293 Variation UAAD

EXAMPLE BOARD LAYOUT

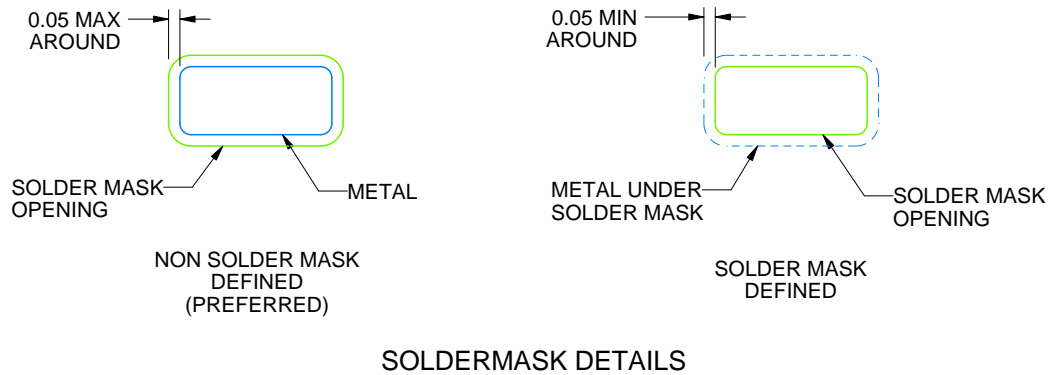
DRL0006A

SOT - 0.6 mm max height

PLASTIC SMALL OUTLINE



LAND PATTERN EXAMPLE
SCALE:30X



SOLDERMASK DETAILS

4223266/F 11/2024

NOTES: (continued)

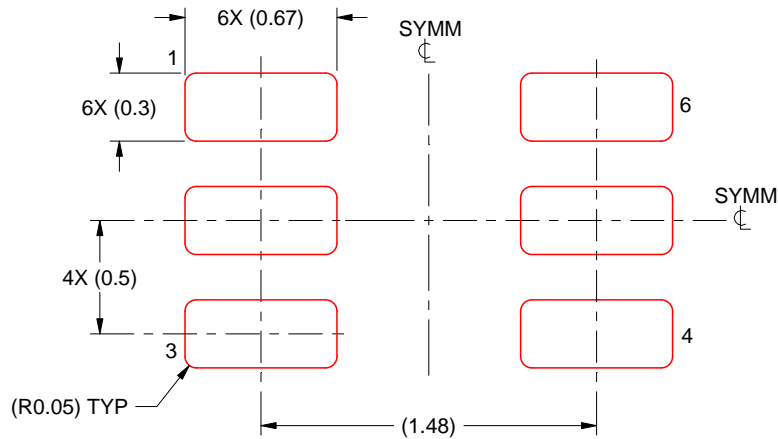
5. Publication IPC-7351 may have alternate designs.
6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
7. Land pattern design aligns to IPC-610, Bottom Termination Component (BTC) solder joint inspection criteria.

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.



DBV0006A

PACKAGE OUTLINE

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



4214840/G 08/2024

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 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Reference JEDEC MO-178.

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

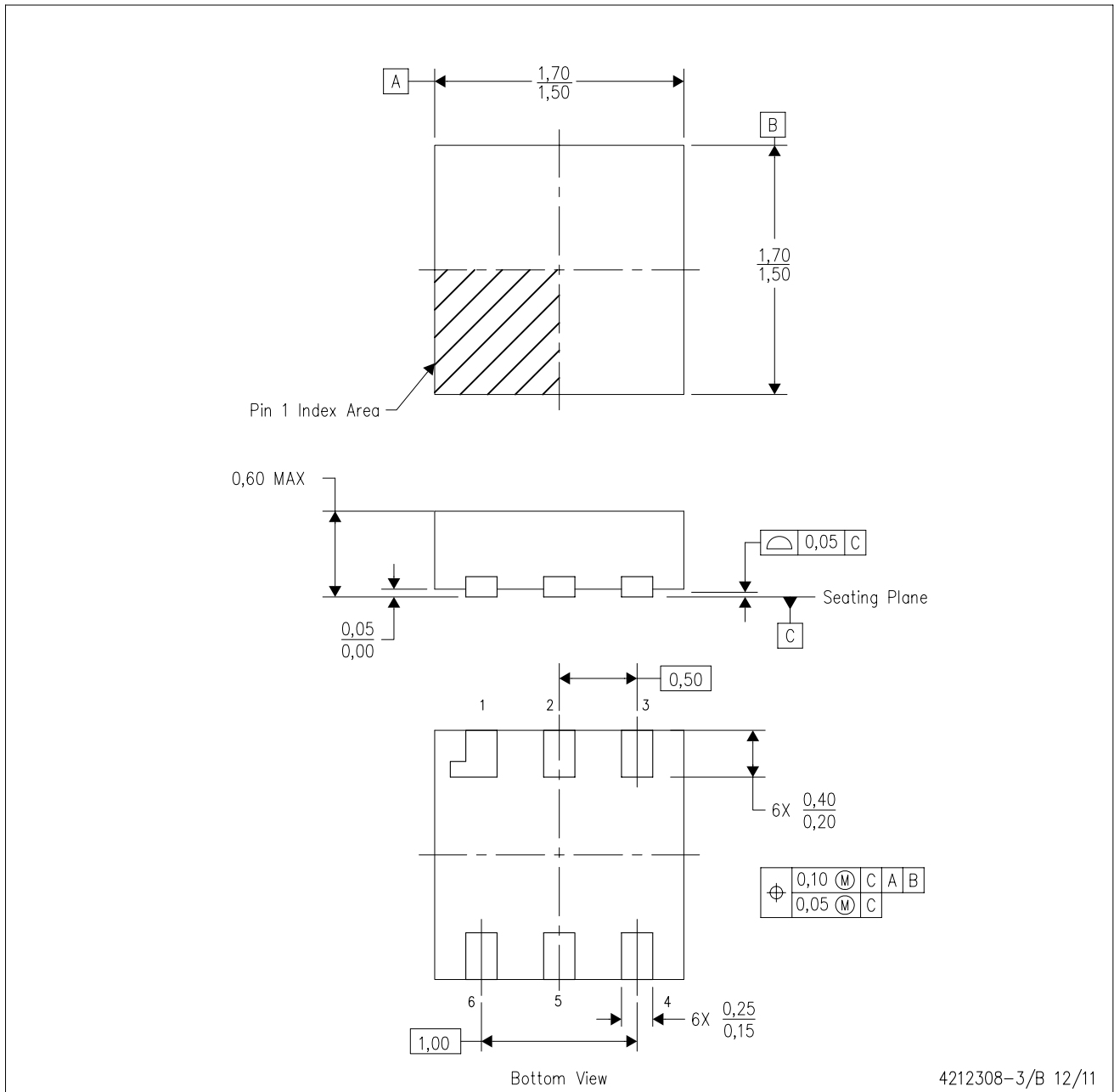
4214840/G 08/2024

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.

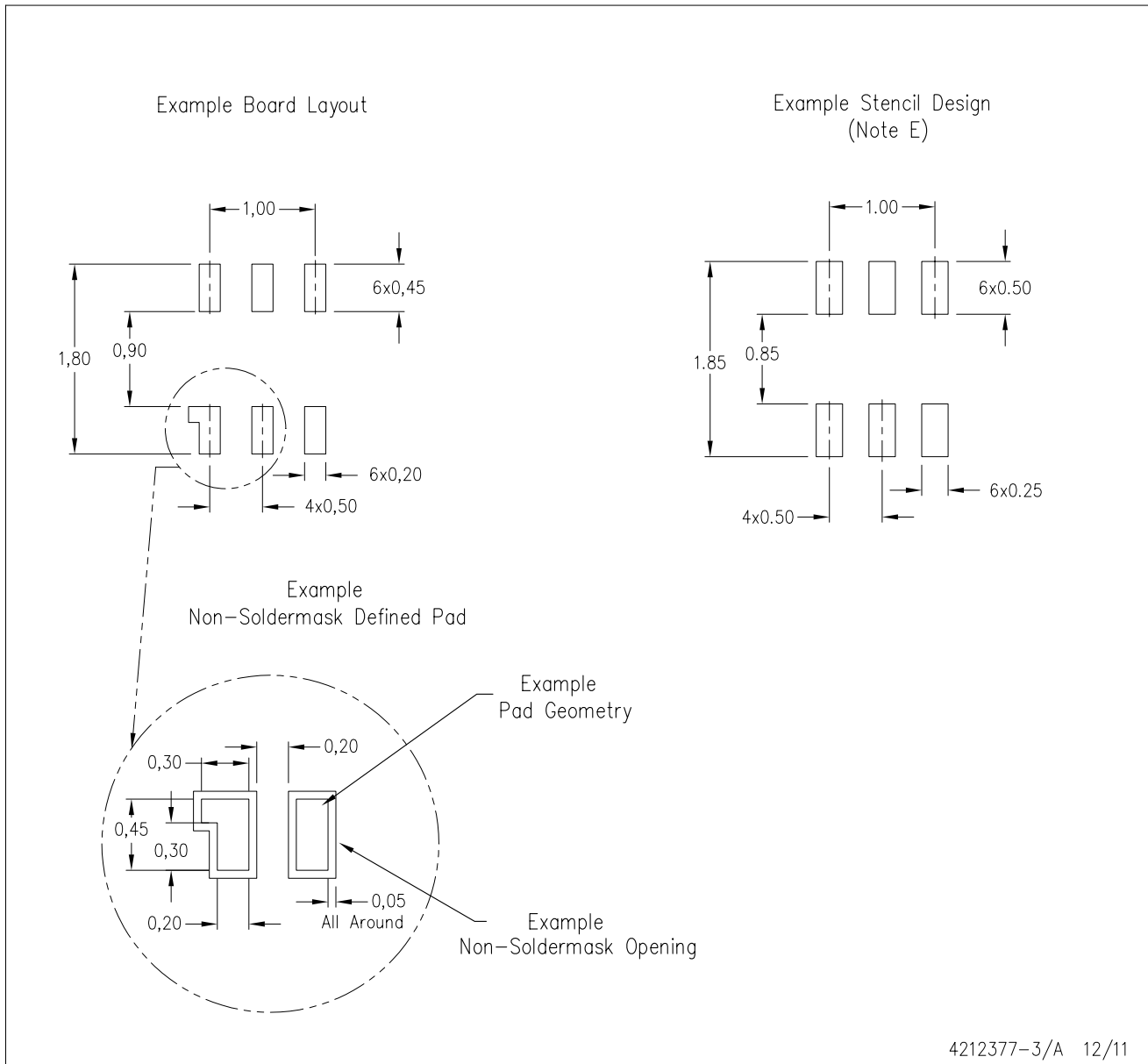
DPK (S-PUSON-N6)

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:
- All linear dimensions are in millimeters.
 - This drawing is subject to change without notice.
 - Publication IPC-7351 is recommended for alternate designs.
 - Customers should contact their board fabrication site for minimum solder mask web tolerances between signal pads.
 - Maximum stencil thickness 0,127 mm (5 mils). All linear dimensions are in millimeters.
 - 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.
 - 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.

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