

## Quad Channel High Speed ESD Protection Device

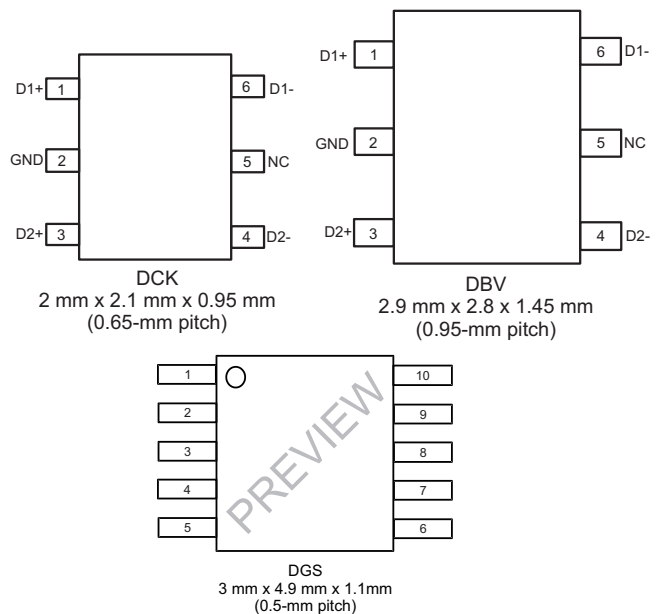
Check for Samples: [TPD4E1U06](#)

### FEATURES

- Provides System Level ESD Protection for Low-Voltage IO Interface
- IEC 61000-4-2 Level 4
  - $\pm 15\text{kV}$  (Contact discharge)
  - $\pm 15\text{kV}$  (Air-gap discharge)
- IO Capacitance 0.8pF (Typ)
- DC Breakdown Voltage 6.5V (Min)
- Ultra low Leakage Current 10nA (Max)
- Low ESD Clamping Voltage
- Industrial Temperature Range:  $-40^{\circ}\text{C}$  to  $125^{\circ}\text{C}$
- Small, Easy-to-Route DCK, DBV, and DGS Package

### APPLICATIONS

- USB2.0
- Ethernet
- HDMI Control Lines
- MIPI Bus
- LVDS
- SATA



### DESCRIPTION

The TPD4E1U06 is a quad channel ultra low cap ESD protection device. It offers  $\pm 15\text{KV}$  IEC air-gap and  $\pm 15\text{KV}$  contact ESD protection. Its 0.8pF line capacitance makes it suitable for a wide range of applications. Typical application areas are HDMI, USB2.0, MHL, and DisplayPort.

### ORDERING INFORMATION

| $T_A$  | PACKAGE <sup>(1)(2)</sup> |               | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|--|---------------------------|---------------|-----------------------|------------------|
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | 3000                      | Tape and reel | TPD4E1U06DCKR         | BPI              |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | 3000                      | Tape and reel | TPD4E1U06DBVR         | NG4I             |
| $-40^{\circ}\text{C}$ to $125^{\circ}\text{C}$ | 3000                      | Tape and reel | TPD4E1U06DGSR         | TBD              |

(1) Package drawings, thermal data, and symbolization are available at [www.ti.com/packaging](http://www.ti.com/packaging).

(2) For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI Web site at [www.ti.com](http://www.ti.com).

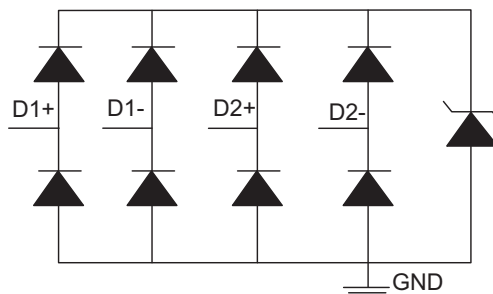


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These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

## FUNCTIONAL BLOCK DIAGRAM



**Figure 1. Circuit Schematic Diagram**

## TERMINAL FUNCTIONS DCK/DBV

| PIN  |         |             |      | DESCRIPTION           | USAGE  |
|------|---------|-------------|------|-----------------------|--|
| NAME | DBV/DCK | DGS         | TYPE |                       |  |
| D1+  | 1       | 1           | I/O  | ESD protected channel | Connect to data line as close to the connector as possible |
| D1–  | 6       | 9           | I/O  |                       |  |
| D2–  | 4       | 4           | I/O  |                       |  |
| D2+  | 3       | 6           | I/O  |                       |  |
| NC   | 5       | 2, 5, 7, 10 | I/O  | No connect            | Can be left floating, grounded, or connected to VCC        |
| GND  | 2       | 3, 8        | GND  | Ground                | Connect to ground  |

## ABSOLUTE MAXIMUM RATINGS

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

|   | MIN | MAX | UNIT |
|---|-----|-----|------|
| Operating temperature range                         | –40 | 125 | °C   |
| Storage temperature                                 | –65 | 155 | °C   |
| IEC 61000-4-2 contact ESD                           |     | ±15 | kV   |
| IEC 61000-4-2 air-gap ESD                           |     | ±15 | kV   |
| I <sub>PP</sub> , peak pulse current (tp = 8/20 µs) |     | 3   | A    |
| P <sub>PP</sub> , peak pulse power (tp = 8/20 µs)   |     | 45  | W    |

## ELECTRICAL CHARACTERISTICS

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

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

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

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

## TYPICAL CHARACTERISTICS

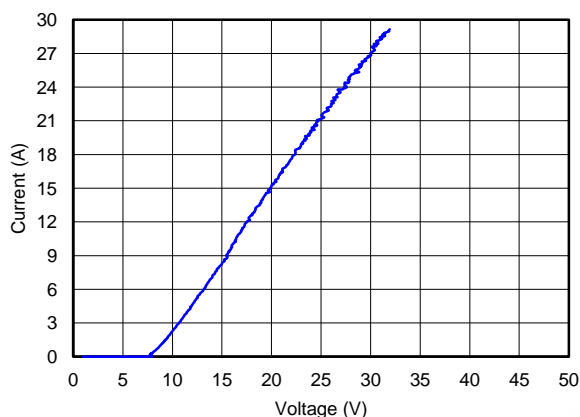


Figure 2. TLP, Data to GND

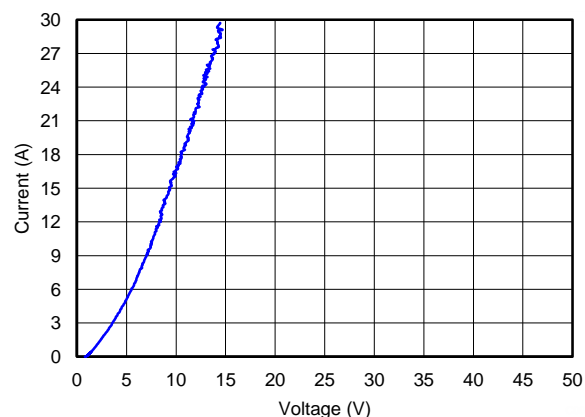


Figure 3. TLP, GND to Data

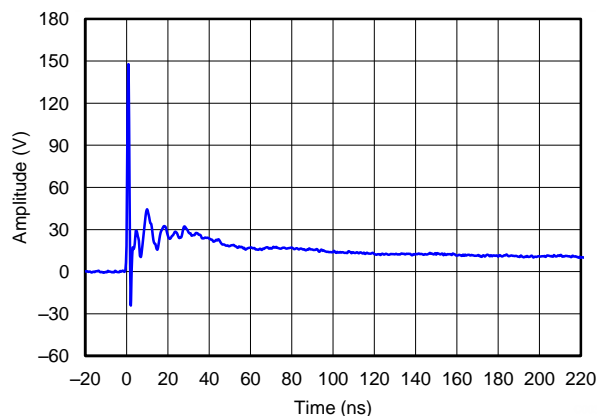


Figure 4. IEC 61000-4-2 Clamping Voltage, +8kV Contact

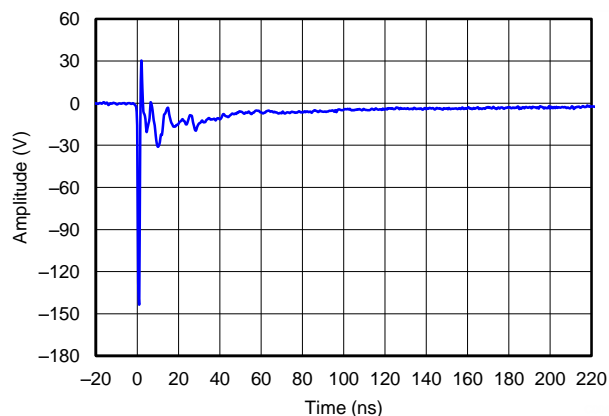


Figure 5. IEC 61000-4-2 Clamping Voltage, -8kV Contact

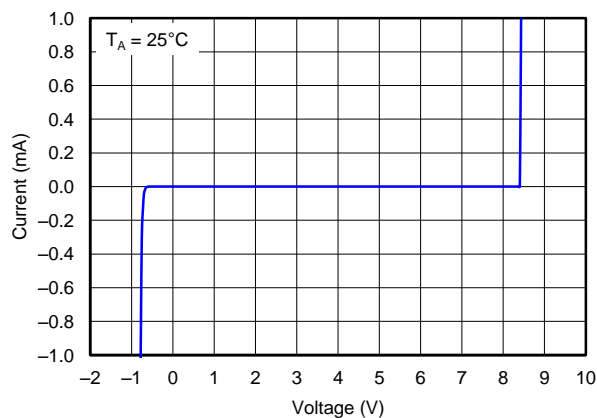


Figure 6. Diode Curve,  $T_A = 25^\circ\text{C}$

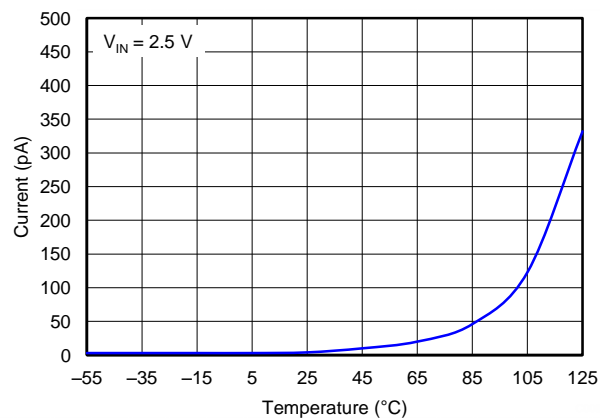


Figure 7.  $I_{LEAK}$  vs. Temperature,  $V_{IN} = 2.5\text{ V}$

## TYPICAL CHARACTERISTICS (continued)

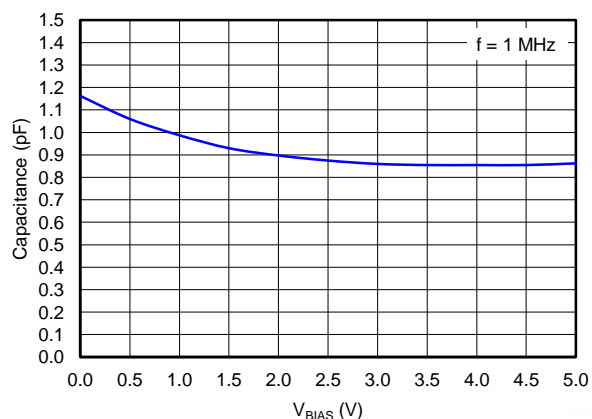


Figure 8. Capacitance Across  $V_{BIAS}$ ,  $f = 1$  MHz

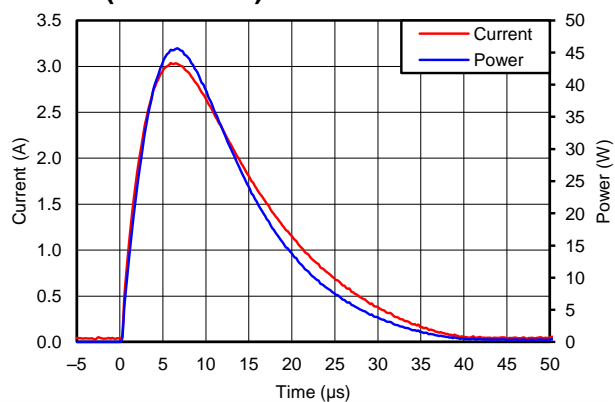


Figure 9. Surge Curve ( $t_p = 8/20 \mu s$ ), Pin IO to GND

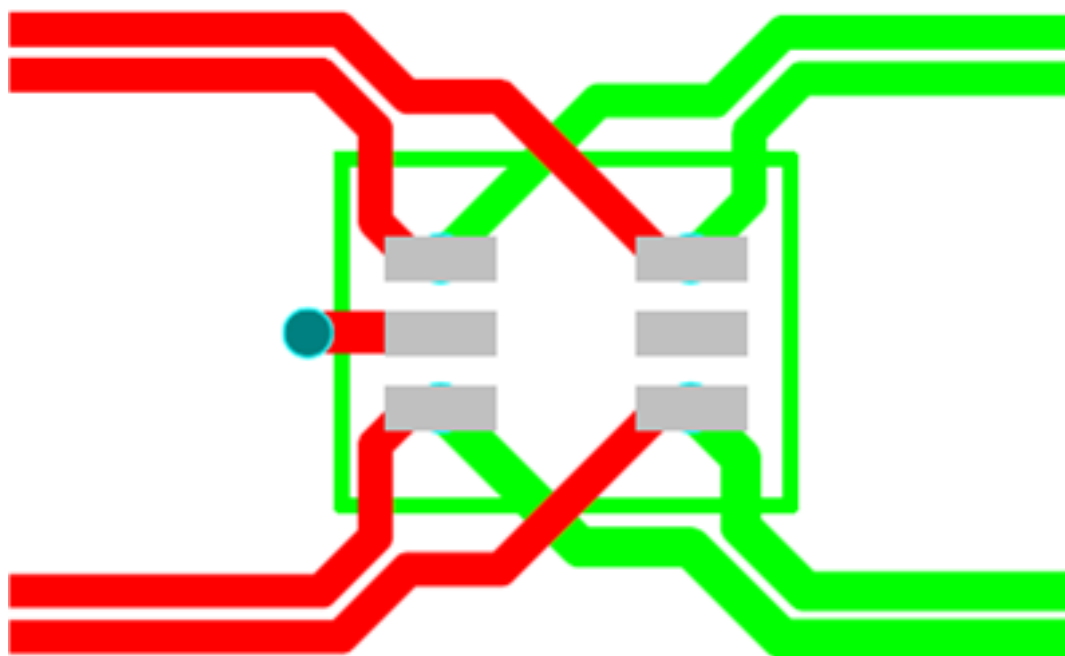


Figure 10. PCB Layout Recommendation

## REVISION HISTORY

| Changes from Revision A (December 2012) to Revision B   | Page              |
|---|-------------------|
| <ul style="list-style-type: none"> <li>Added <math>C_{CROSS}</math> data for DBV package .....</li> </ul> | <a href="#">3</a> |

## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2)         | Lead/Ball Finish<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-------------------------|-------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPD4E1U06DBVR    | ACTIVE        | SOT-23       | DBV             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU SN                   | Level-1-260C-UNLIM   | -40 to 125   | NG4I                    | <a href="#">Samples</a> |
| TPD4E1U06DCKR    | ACTIVE        | SC70         | DCK             | 6    | 3000        | Green (RoHS & no Sb/Br) | CU NIPDAU               | Level-1-260C-UNLIM   | -40 to 125   | (BP6 ~ BPI)             | <a href="#">Samples</a> |

(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.

**OBSOLETE:** TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

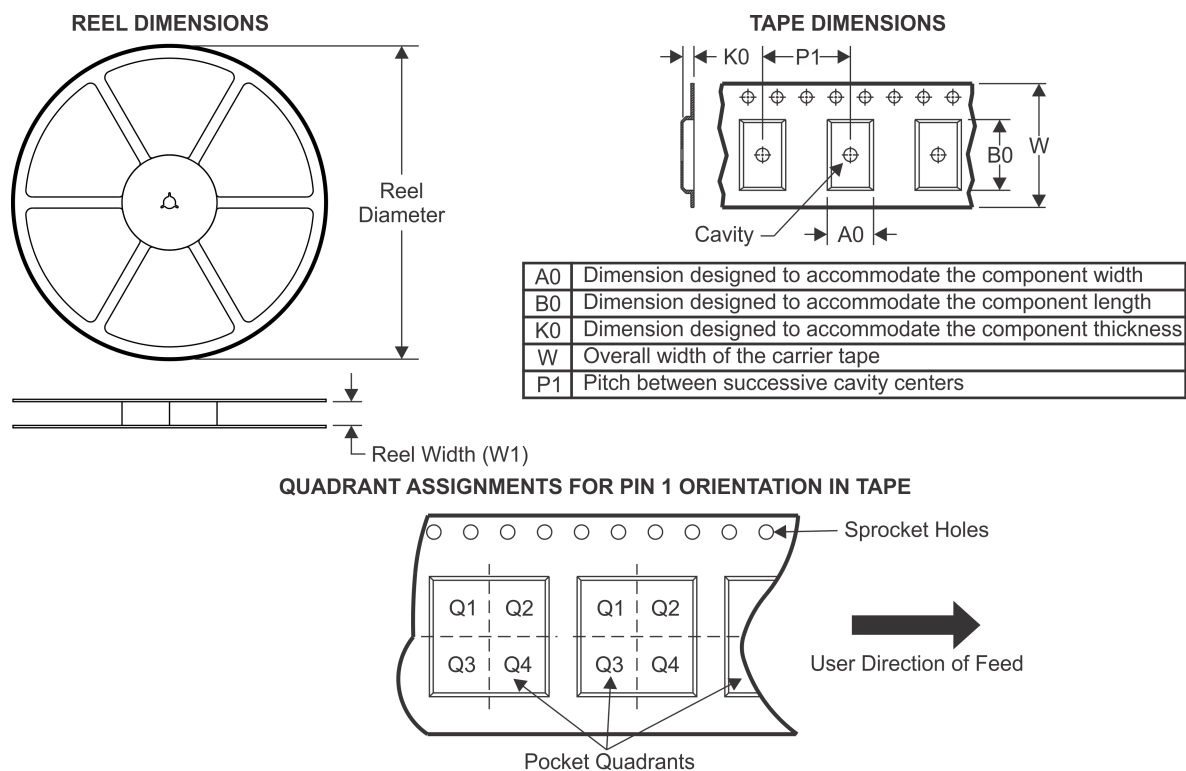
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**


\*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 |
|---------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPD4E1U06DCKR | SC70         | DCK             | 6    | 3000 | 180.0              | 8.4                | 2.25    | 2.4     | 1.22    | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS

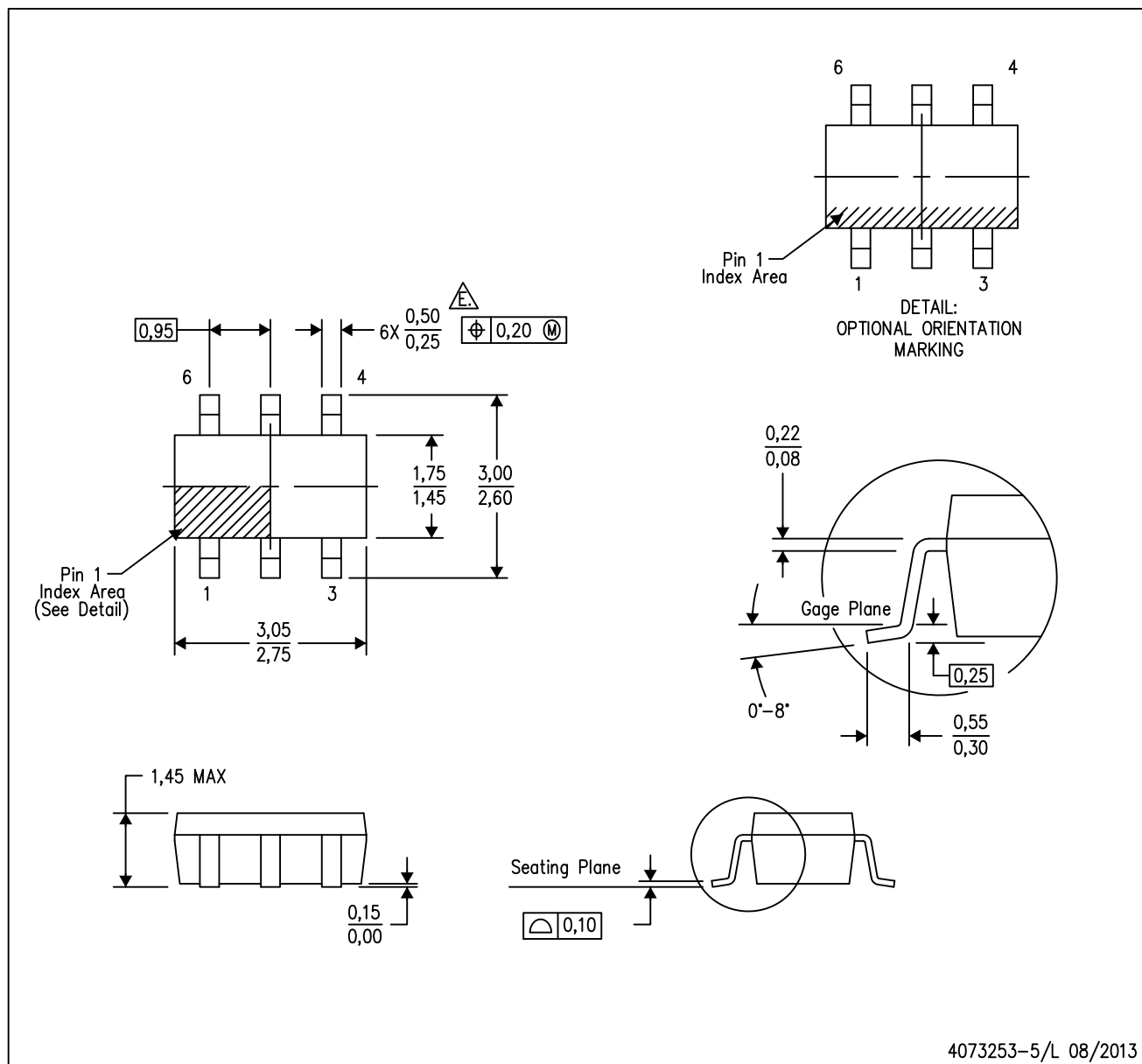


\*All dimensions are nominal

| Device        | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|---------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPD4E1U06DCKR | SC70         | DCK             | 6    | 3000 | 202.0       | 201.0      | 28.0        |

DBV (R-PDSO-G6)

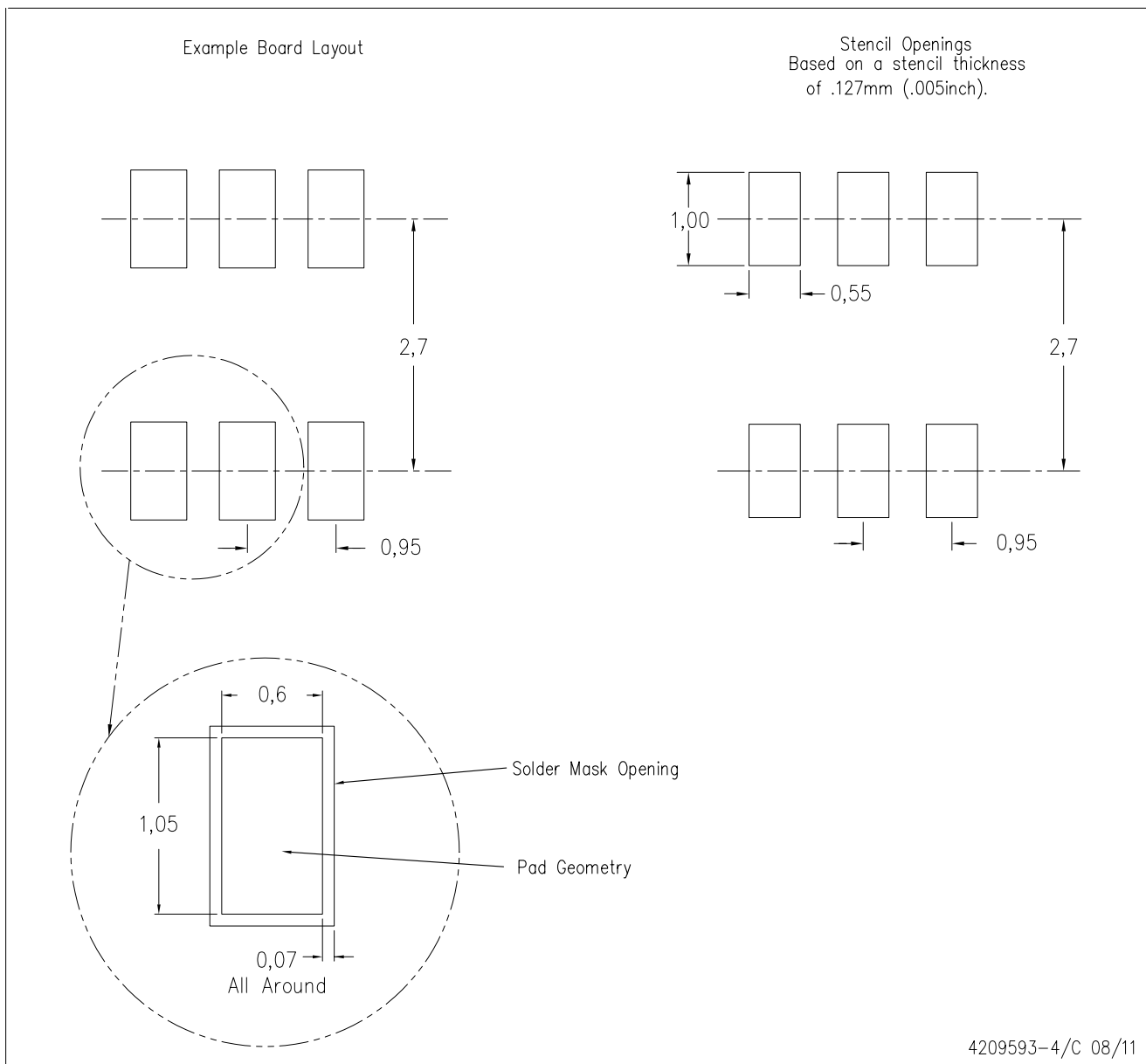
PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
  - D. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
  - E. Falls within JEDEC MO-178 Variation AB, except minimum lead width.

DBV (R-PDSO-G6)

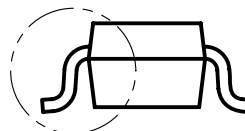
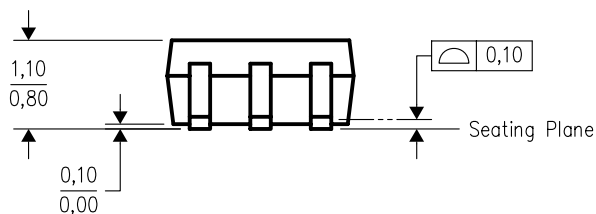
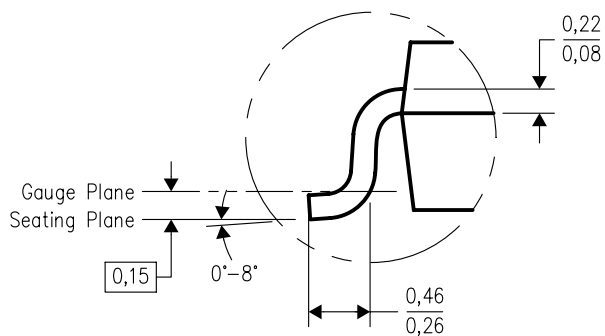
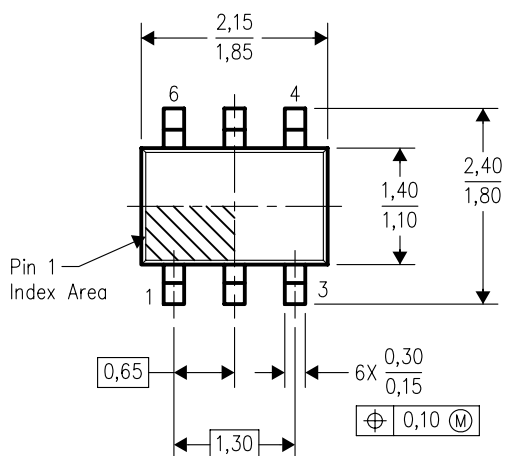
PLASTIC SMALL OUTLINE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. Publication IPC-7351 is recommended for alternate designs.
  - 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

DCK (R-PDSO-G6)

# PLASTIC SMALL-OUTLINE PACKAGE

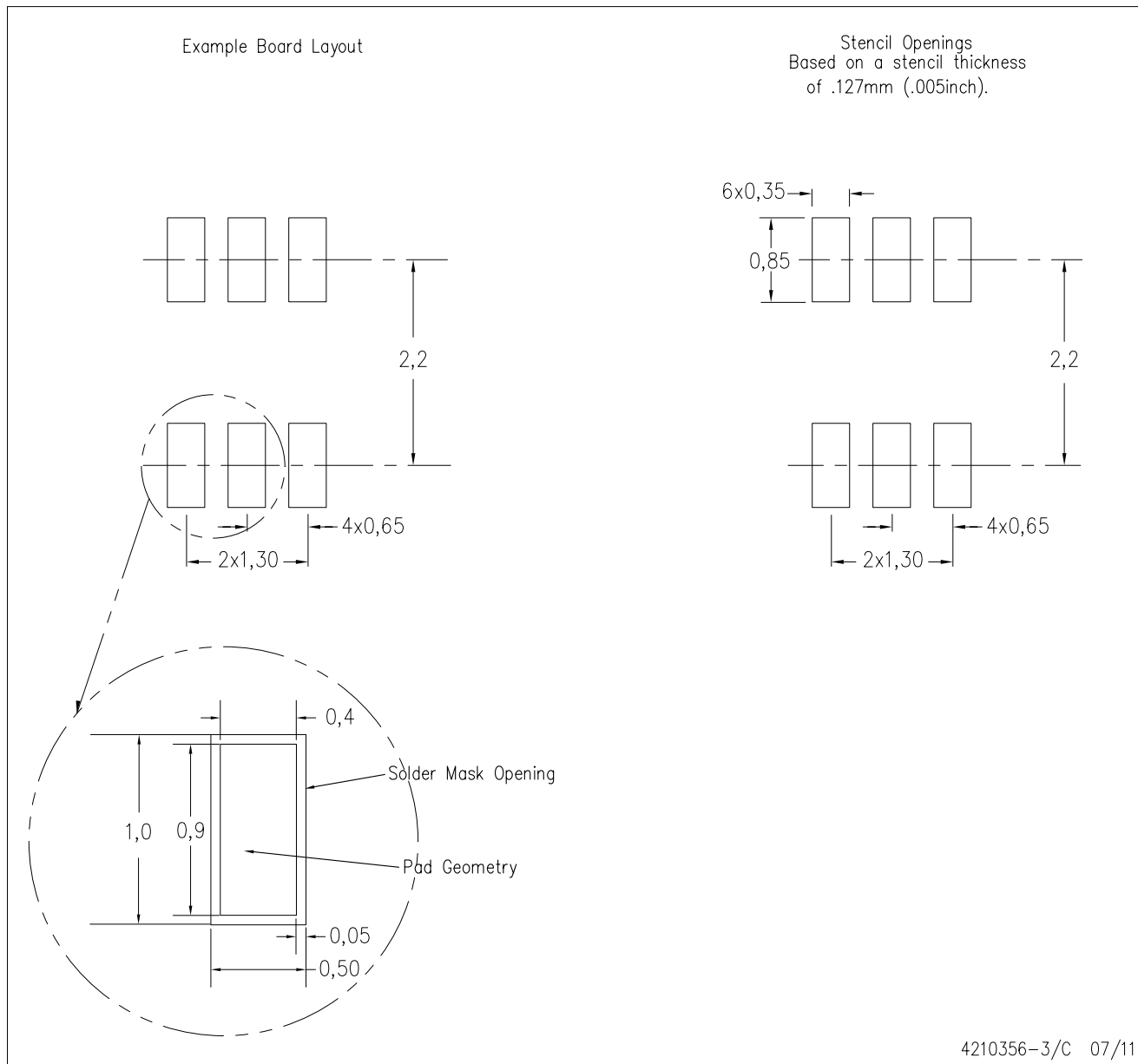


4093553-4/G 01/2007

- NOTES: A. All linear dimensions are in millimeters.  
B. This drawing is subject to change without notice.  
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.  
D. Falls within JEDEC MO-203 variation AB.

DCK (R-PDSO-G6)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - Publication IPC-7351 is recommended for alternate designs.
  - 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. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.

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