

# TPS7B82-Q1 Automotive 300-mA, High-Voltage, Ultra-Low- $I_Q$ Low-Dropout Regulator

## 1 Features

- AEC-Q100 qualified for automotive applications:
  - Temperature grade 1:  $-40^{\circ}\text{C} \leq T_A \leq 125^{\circ}\text{C}$
  - Temperature grade 0:  $-40^{\circ}\text{C} \leq T_A \leq 150^{\circ}\text{C}$
- Extended junction temperature range:
  - Grade 1:  $-40^{\circ}\text{C} \leq T_J \leq 150^{\circ}\text{C}$
  - Grade 0:  $-40^{\circ}\text{C} \leq T_J \leq 165^{\circ}\text{C}$
- Low quiescent current  $I_Q$ :
  - 300-nA shutdown  $I_Q$
  - 2.7  $\mu\text{A}$  typical at light loads
  - 5  $\mu\text{A}$  maximum at light loads
- 3-V to 40-V wide  $V_{IN}$  input voltage range with up to 45-V transient
- Maximum output current: 300 mA
- 2% output-voltage accuracy
- Maximum dropout voltage: 700 mV at 200-mA load current for fixed 5-V output version
- Stable with low-ESR (0.001- $\Omega$  to 5- $\Omega$ ) ceramic output-stability capacitor (1  $\mu\text{F}$  to 200  $\mu\text{F}$ )
- Fixed 2.5-V, 3.3-V, and 5-V output voltage
- Packages:
  - 8-pin HVSSOP,  $R_{\theta JA} = 63.9^{\circ}\text{C}/\text{W}$
  - 6-pin WSON,  $R_{\theta JA} = 72.8^{\circ}\text{C}/\text{W}$
  - 5-pin TO-252,  $R_{\theta JA} = 31.1^{\circ}\text{C}/\text{W}$
  - 14-pin HTSSOP,  $R_{\theta JA} = 52.0^{\circ}\text{C}/\text{W}$

## 2 Applications

- [Automotive head units](#)
- [Telematics control units](#)
- [Headlights](#)
- [Body control modules](#)
- [Inverter and motor controls](#)

## 3 Description

In automotive battery-connected applications, low quiescent current ( $I_Q$ ) is important to save power and extend battery lifetime. Ultra-low  $I_Q$  must be included for always-on systems.

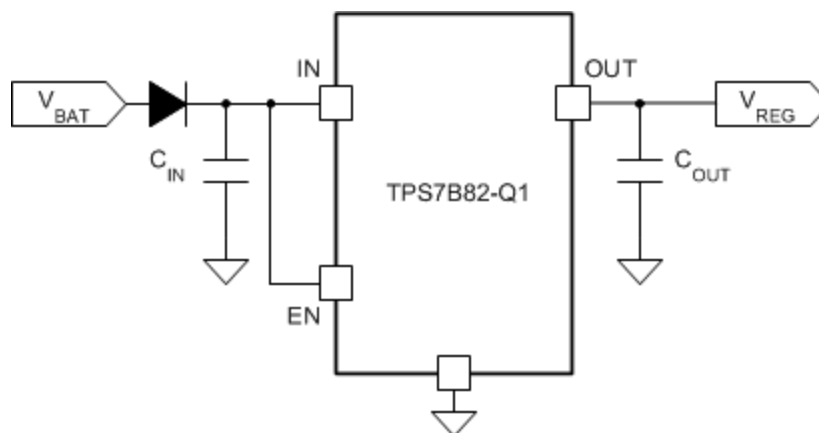
The TPS7B82-Q1 is a low-dropout linear regulator designed to operate with a wide input-voltage range from 3 V to 40 V (45-V load dump protection). Operation down to 3 V allows the TPS7B82-Q1 to continue operating during cold-crank and start and stop conditions. With only 2.7- $\mu\text{A}$  typical quiescent current at light load, this device is an optimal solution for powering microcontrollers (MCUs) and CAN/LIN transceivers in standby systems.

The device features integrated short-circuit and overcurrent protection. This device operates in ambient temperatures from  $-40^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$  and with junction temperatures from  $-40^{\circ}\text{C}$  to  $+150^{\circ}\text{C}$ . Additionally, this device uses a thermally conductive package to enable sustained operation despite significant dissipation across the device. Because of these features, the device is designed as a power supply for various automotive applications.

### Device Information<sup>(1)</sup>

| PART NUMBER | PACKAGE     | BODY SIZE (NOM)   |
|-------------|-------------|-------------------|
| TPS7B82-Q1  | HVSSOP (8)  | 3.00 mm × 3.00 mm |
|             | WSON (6)    | 2.00 mm × 2.00 mm |
|             | TO-252 (5)  | 6.10 mm × 6.60 mm |
|             | HTSSOP (14) | 5.00 mm × 4.40 mm |

(1) For all available packages, see the orderable addendum at the end of the data sheet.



Typical Application Schematic

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## 4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

| <b>Changes from Revision H (March 2021) to Revision I (August 2021)</b>   | <b>Page</b> |
|---|-------------|
| • Changed $I_Q$ parameter maximum specifications from $3.5 \mu A$ to $5 \mu A$ and from $4.5 \mu A$ to $6.5 \mu A$ in the <i>Electrical Characteristics: Grade 0 Options</i> table..... | 6           |
| • Changed $V_{(Load-Reg)}$ parameter maximum specification from $10 mV$ to $20 mV$ in the <i>Electrical Characteristics: Grade 0 Options</i> table.....                                 | 6           |
| • Changed $V_{OUT}$ parameter test condition from $40 V$ to $14 V$ in the <i>Electrical Characteristics: Grade 0 Options</i> table.....   | 6           |

| <b>Changes from Revision G (July 2020) to Revision H (March 2021)</b>  | <b>Page</b> |
|--|-------------|
| • Added PWP (HTSSOP) package to document.....  | 1           |
| • Added grade 0 information to <i>Features</i> section.....  | 1           |
| • Deleted <i>Thermal resistance</i> bullet from <i>Features</i> section.....   | 1           |
| • Changed $R_{\theta JA}$ rating from $38.8^\circ C/W$ to $31.1^\circ C/W$ in <i>TO-252 Packages</i> sub-bullet..... | 1           |
| • Added grade 0 information to <i>junction temperature</i> parameter in <i>Absolute Maximum Ratings</i> .....        | 4           |
| • Added grade 0 information to <i>Recommended Operating Conditions</i> table.....                                    | 4           |
| • Added <i>grade 1 options</i> to condition statement of <i>Electrical Characteristics</i> table.....                | 5           |
| • Added <i>Electrical Characteristics: Grade 0 Options</i> table.....  | 6           |

## 5 Pin Configuration and Functions

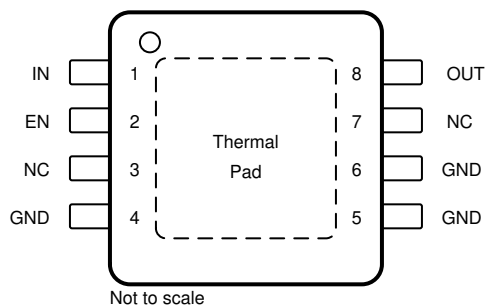


Figure 5-1. DGN Package, 8-Pin HVSSOP PowerPAD™, Top View

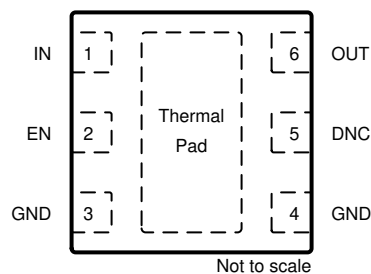


Figure 5-2. DRV Package, 6-Pin WSON PowerPAD™, Top View

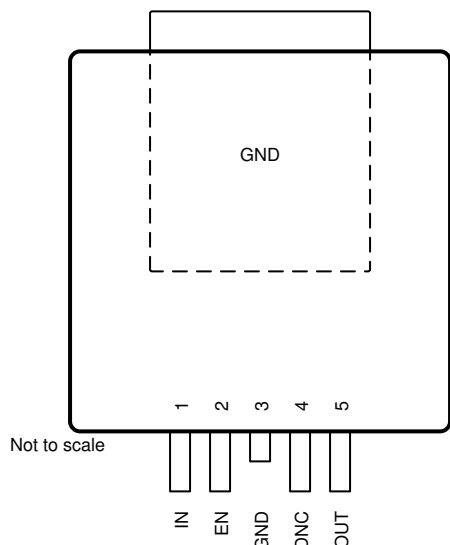


Figure 5-3. KVU Package, 5-Pin TO-252, Top View

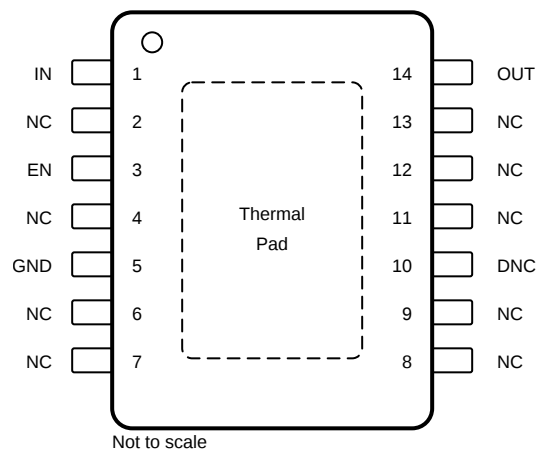


Figure 5-4. PWP Package, 14-Pin HTSSOP, Top View

NC – No internal connection

Table 5-1. Pin Functions

| NAME        | PIN NO. |     |        |                              | I/O | DESCRIPTION   |
|-------------|---------|-----|--------|------------------------------|-----|---|
|             | DGN     | DRV | KVU    | PWP                          |     |   |
| DNC         | —       | 5   | 4      | 10                           | —   | Do not connect to a biased voltage. Tie this pin to ground or leave floating.       |
| EN          | 2       | 2   | 2      | 3                            | I   | Enable input pin  |
| GND         | 4, 5, 6 | 3,4 | 3, TAB | 5                            | —   | Ground reference  |
| IN          | 1       | 1   | 1      | 1                            | I   | Input power-supply pin  |
| NC          | 3, 7    | —   | —      | 2, 4, 6, 7, 8, 9, 11, 12, 13 | —   | Not internally connected  |
| OUT         | 8       | 6   | 5      | 14                           | O   | Regulated output voltage pin  |
| Thermal pad |         |     |        |                              | —   | Connect the thermal pad to a large-area GND plane for improved thermal performance. |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating ambient temperature range (unless otherwise noted)<sup>(1) (2)</sup>

|                  |                                  | MIN  | MAX             | UNIT |
|------------------|----------------------------------|------|-----------------|------|
| V <sub>IN</sub>  | Unregulated input <sup>(3)</sup> | -0.3 | 45              | V    |
| V <sub>EN</sub>  | Enable input <sup>(3)</sup>      | -0.3 | V <sub>IN</sub> | V    |
| V <sub>OUT</sub> | Regulated output                 | -0.3 | 7               | V    |
| T <sub>J</sub>   | Junction temperature (grade 1)   | -40  | 150             | °C   |
|                  | Junction temperature (grade 0)   | -40  | 165             |      |
| T <sub>stg</sub> | Storage temperature range        | -40  | 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.
- (2) All voltage values are with respect to GND.
- (3) Absolute maximum voltage, withstand 45 V for 200 ms.

### 6.2 ESD Ratings

|                    |                         |  | VALUE                           | UNIT |      |
|--------------------|-------------------------|--|---------------------------------|------|------|
| V <sub>(ESD)</sub> | Electrostatic discharge | Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup><br>HBM ESD classification level H2 | ±2000                           | V    |      |
|                    |                         | Charged-device model (CDM), per AEC Q100-011<br>CDM ESD classification level C3B           | Corner pins<br>(1, 4, 5, and 8) |      | ±750 |
|                    |                         |  | Other pins                      |      | ±500 |

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

over operating ambient temperature range (unless otherwise noted)

|                  |  | MIN   | MAX             | UNIT |
|------------------|--|-------|-----------------|------|
| V <sub>IN</sub>  | Unregulated input voltage                        | 3     | 40              | V    |
| V <sub>EN</sub>  | Enable input voltage                             | 0     | V <sub>IN</sub> | V    |
| C <sub>OUT</sub> | Output capacitor requirements <sup>(1)</sup>     | 1     | 200             | μF   |
| ESR              | Output capacitor ESR requirements <sup>(2)</sup> | 0.001 | 5               | Ω    |
| T <sub>A</sub>   | Ambient temperature (grade 1)                    | -40   | 125             | °C   |
|                  | Ambient temperature (grade 0)                    | -40   | 150             |      |
| T <sub>J</sub>   | Junction temperature (grade 1)                   | -40   | 150             | °C   |
|                  | Junction temperature (grade 0)                   | -40   | 165             |      |

- (1) The output capacitance range specified in the table is the effective value.
- (2) Relevant equivalent series resistance (ESR) value at f = 10 kHz.

## 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |  | TPS7B82-Q1      |               |                 |                 | UNIT |
|-------------------------------|--|-----------------|---------------|-----------------|-----------------|------|
|                               |  | DGN<br>(HVSSOP) | DRV<br>(WSON) | KVU<br>(TO-252) | PWP<br>(HTSSOP) |      |
|                               |  | 8 PINS          | 6 PINS        | 5 PINS          | 14 PINS         |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 63.9            | 72.8          | 31.1            | 52.0            | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 50.2            | 85.8          | 39.9            | 48.2            | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 22.6            | 37.4          | 9.9             | 28.2            | °C/W |
| Ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 1.8             | 2.7           | 4.2             | 2.5             | °C/W |
| Ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 22.3            | 37.3          | 9.9             | 28.1            | °C/W |
| R <sub>θJC(bot)</sub>         | Junction-to-case (bottom) thermal resistance | 12.1            | 13.8          | 2.8             | 10.7            | °C/W |

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

## 6.5 Electrical Characteristics: Grade 1 Options

V<sub>IN</sub> = 14-V, 10-μF ceramic output capacitor, grade 1 options, T<sub>J</sub> = –40°C to +150°C, over operating ambient temperature range (unless otherwise noted)

| PARAMETER                              |  | TEST CONDITIONS   |                      | MIN   | TYP | MAX  | UNIT |
|--|--|---|----------------------|---|-----|------|------|
| <b>SUPPLY VOLTAGE AND CURRENT (IN)</b> |  |   |                      |   |     |      |      |
| V <sub>IN</sub>                        | Input voltage                          |   |                      | V <sub>OUT(NOM)</sub><br>+ V <sub>(Dropout)</sub> |     | 40   | V    |
| I <sub>(SD)</sub>                      | Shutdown current                       | EN = 0 V  |                      |   | 0.3 | 1    | μA   |
| I <sub>(Q)</sub>                       | Quiescent current                      | V <sub>IN</sub> = 6 V to 40 V, EN ≥ 2 V,<br>I <sub>OUT</sub> = 0 mA                                       | DRV and KVU packages |   | 1.9 | 3.5  | μA   |
|  |  |   | DGN package          |   | 1.9 | 5    |      |
|  |  | V <sub>IN</sub> = 6 V to 40 V, EN ≥ 2 V,<br>I <sub>OUT</sub> = 0.2 mA                                     | DRV and KVU packages |   | 2.7 | 4.5  |      |
|  |  |   | DGN package          |   | 2.7 | 6.5  |      |
| V <sub>(IN, UVLO)</sub>                | V <sub>IN</sub> undervoltage detection | Ramp V <sub>IN</sub> down until the output turns OFF  |                      |   |     | 2.7  | V    |
|  |  | Hysteresis  |                      |   | 200 |      | mV   |
| <b>ENABLE INPUT (EN)</b>               |  |   |                      |   |     |      |      |
| V <sub>IL</sub>                        | Logic-input low level                  |   |                      |   |     | 0.7  | V    |
| V <sub>IH</sub>                        | Logic-input high level                 |   |                      | 2   |     |      | V    |
| <b>REGULATED OUTPUT (OUT)</b>          |  |   |                      |   |     |      |      |
| V <sub>OUT</sub>                       | Regulated output                       | V <sub>IN</sub> = V <sub>OUT</sub> + V <sub>(Dropout)</sub> to 40 V,<br>I <sub>OUT</sub> = 1 mA to 300 mA | DRV and KVU packages | –1.5%   |     | 1.5% |      |
|  |  |   | DGN package          | –2%   |     | 2%   |      |
| V <sub>(Line-Reg)</sub>                | Line regulation                        | V <sub>IN</sub> = 6 V to 40 V, I <sub>OUT</sub> = 10 mA   |                      |   |     | 10   | mV   |
| V <sub>(Load-Reg)</sub>                | Load regulation                        | V <sub>IN</sub> = 14 V, I <sub>OUT</sub> = 1 mA to 300 mA   | DRV and KVU packages |   |     | 10   | mV   |
|  |  |   | DGN package          |   |     | 20   |      |

## 6.5 Electrical Characteristics: Grade 1 Options (continued)

$V_{IN} = 14\text{-V}$ , 10- $\mu\text{F}$  ceramic output capacitor, grade 1 options,  $T_J = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ , over operating ambient temperature range (unless otherwise noted)

| PARAMETER                          |                                | TEST CONDITIONS   |                                  |                       | MIN  | TYP  | MAX | UNIT             |
|------------------------------------|--------------------------------|---|----------------------------------|-----------------------|------|------|-----|------------------|
| $V_{(\text{Dropout})}$             | Dropout voltage <sup>(1)</sup> | $V_{\text{OUT}(\text{NOM})} = 5\text{ V}$   | $I_{\text{OUT}} = 300\text{ mA}$ | DRV and KVVU packages | 630  | 1170 | mV  |                  |
|                                    |                                |   |                                  | DGN package           | 1000 |      |     |                  |
|                                    |                                |   | $I_{\text{OUT}} = 200\text{ mA}$ | DRV and KVVU packages | 420  | 780  |     |                  |
|                                    |                                |   |                                  | DGN package           | 400  | 700  |     |                  |
|                                    |                                |   | $I_{\text{OUT}} = 100\text{ mA}$ | DRV and KVVU packages | 210  | 390  |     |                  |
|                                    |                                |   |                                  | DGN package           | 200  | 350  |     |                  |
|                                    |                                | $V_{\text{OUT}} = 3.3\text{ V}$   | $I_{\text{OUT}} = 300\text{ mA}$ | DRV and KVVU packages | 730  | 1350 |     |                  |
|                                    |                                |   |                                  | DGN package           | 1250 |      |     |                  |
|                                    |                                |   | $I_{\text{OUT}} = 200\text{ mA}$ | DRV and KVVU packages | 475  | 900  |     |                  |
|                                    |                                |   |                                  | DGN package           | 850  |      |     |                  |
| $I_{\text{OUT}} = 100\text{ mA}$   |                                | 450   |                                  |                       |      |      |     |                  |
| $I_{\text{OUT}}$                   | Output current                 | $V_{\text{OUT}}$ in regulation  |                                  |                       | 0    |      | 300 | mA               |
| $I_{(\text{CL})}$                  | Output current limit           | $V_{\text{OUT}}$ short to $90\% \times V_{\text{OUT}}$  |                                  |                       | 310  | 510  | 690 | mA               |
| PSRR                               | Power-supply ripple rejection  | $V_{(\text{Ripple})} = 0.5 V_{\text{PP}}$ , $I_{\text{OUT}} = 10\text{ mA}$ , frequency = 100 Hz, $C_{\text{OUT}} = 2.2\ \mu\text{F}$ |                                  |                       |      | 60   |     | dB               |
| <b>OPERATING TEMPERATURE RANGE</b> |                                |   |                                  |                       |      |      |     |                  |
| $T_{(\text{SD})}$                  | Junction shutdown temperature  |   |                                  |                       |      | 175  |     | $^\circ\text{C}$ |
| $T_{(\text{HYST})}$                | Hysteresis of thermal shutdown |   |                                  |                       |      | 20   |     | $^\circ\text{C}$ |

(1) Dropout is not valid for the 2.5-V output because of the minimum input voltage limits.

## 6.6 Electrical Characteristics: Grade 0 Options

$V_{IN} = 14\text{-V}$ , 10- $\mu\text{F}$  ceramic output capacitor, grade 0 options (PWP package),  $T_J = -40^\circ\text{C}$  to  $+165^\circ\text{C}$ , over operating ambient temperature range (unless otherwise noted)

| PARAMETER                              |                                 | TEST CONDITIONS   |  |  | MIN   | TYP | MAX  | UNIT          |
|--|---------------------------------|---|--|--|---|-----|------|---------------|
| <b>SUPPLY VOLTAGE AND CURRENT (IN)</b> |                                 |   |  |  |   |     |      |               |
| $V_{IN}$                               | Input voltage                   |   |  |  | $V_{\text{OUT}(\text{NOM})} + V_{(\text{Dropout})}$ |     | 40   | V             |
| $I_{(\text{SD})}$                      | Shutdown current                | $EN = 0\text{ V}$   |  |  |   | 0.3 | 1    | $\mu\text{A}$ |
| $I_{(\text{Q})}$                       | Quiescent current               | $V_{IN} = 6\text{ V to }40\text{ V}$ , $EN \geq 2\text{ V}$ , $I_{\text{OUT}} = 0\text{ mA}$              |  |  |   | 1.9 | 5    |               |
|  |                                 | $V_{IN} = 6\text{ V to }40\text{ V}$ , $EN \geq 2\text{ V}$ , $I_{\text{OUT}} = 0.2\text{ mA}$            |  |  |   | 2.7 | 6.5  | $\mu\text{A}$ |
| $V_{(\text{IN, UVLO})}$                | $V_{IN}$ undervoltage detection | Ramp $V_{IN}$ down until the output turns OFF   |  |  |   |     | 2.7  | V             |
|  |                                 | Hysteresis  |  |  |   | 200 |      | mV            |
| <b>ENABLE INPUT (EN)</b>               |                                 |   |  |  |   |     |      |               |
| $V_{IL}$                               | Logic-input low level           |   |  |  |   |     | 0.7  | V             |
| $V_{IH}$                               | Logic-input high level          |   |  |  | 2   |     |      | V             |
| <b>REGULATED OUTPUT (OUT)</b>          |                                 |   |  |  |   |     |      |               |
| $V_{\text{OUT}}$                       | Regulated output                | $V_{IN} = V_{\text{OUT}} + V_{(\text{Dropout})}$ to 14 V, $I_{\text{OUT}} = 1\text{ mA to }300\text{ mA}$ |  |  | -1.5%   |     | 1.5% |               |

## 6.6 Electrical Characteristics: Grade 0 Options (continued)

$V_{IN} = 14\text{-V}$ , 10- $\mu\text{F}$  ceramic output capacitor, grade 0 options (PWP package),  $T_J = -40^\circ\text{C}$  to  $+165^\circ\text{C}$ , over operating ambient temperature range (unless otherwise noted)

| PARAMETER                          |                                | TEST CONDITIONS   | MIN                       | TYP | MAX  | UNIT             |
|------------------------------------|--------------------------------|---|---------------------------|-----|------|------------------|
| $V_{(\text{Line-Reg})}$            | Line regulation                | $V_{IN} = 6\text{ V to }40\text{ V}$ , $I_{OUT} = 10\text{ mA}$   |                           |     | 10   | mV               |
| $V_{(\text{Load-Reg})}$            | Load regulation                | $V_{IN} = 14\text{ V}$ , $I_{OUT} = 1\text{ mA to }300\text{ mA}$   |                           |     | 20   | mV               |
| $V_{(\text{Dropout})}$             | Dropout voltage <sup>(1)</sup> | $V_{OUT(\text{NOM})} = 5\text{ V}$  | $I_{OUT} = 300\text{ mA}$ | 630 | 1170 | mV               |
|                                    |                                |   | $I_{OUT} = 200\text{ mA}$ | 420 | 780  |                  |
|                                    |                                |   | $I_{OUT} = 100\text{ mA}$ | 210 | 390  |                  |
|                                    |                                | $V_{OUT} = 3.3\text{ V}$  | $I_{OUT} = 300\text{ mA}$ | 730 | 1350 |                  |
|                                    |                                |   | $I_{OUT} = 200\text{ mA}$ | 475 | 900  |                  |
|                                    |                                |   | $I_{OUT} = 100\text{ mA}$ |     | 450  |                  |
| $I_{OUT}$                          | Output current                 | $V_{OUT}$ in regulation   | 0                         |     | 300  | mA               |
| $I_{(\text{CL})}$                  | Output current limit           | $V_{OUT}$ short to $90\% \times V_{OUT}$  | 310                       | 510 | 690  | mA               |
| PSRR                               | Power-supply ripple rejection  | $V_{(\text{Ripple})} = 0.5\text{ V}_{PP}$ , $I_{OUT} = 10\text{ mA}$ , frequency = 100 Hz, $C_{OUT} = 2.2\text{ }\mu\text{F}$ |                           | 60  |      | dB               |
| <b>OPERATING TEMPERATURE RANGE</b> |                                |   |                           |     |      |                  |
| $T_{(\text{SD})}$                  | Junction shutdown temperature  |   |                           | 185 |      | $^\circ\text{C}$ |
| $T_{(\text{HYST})}$                | Hysteresis of thermal shutdown |   |                           | 20  |      | $^\circ\text{C}$ |

### 6.7 Typical Characteristics

$V_{IN} = 14\text{ V}$ ,  $V_{EN} \geq 2\text{ V}$ ,  $T_J = -40^\circ\text{C}$  to  $150^\circ\text{C}$  (unless otherwise noted)

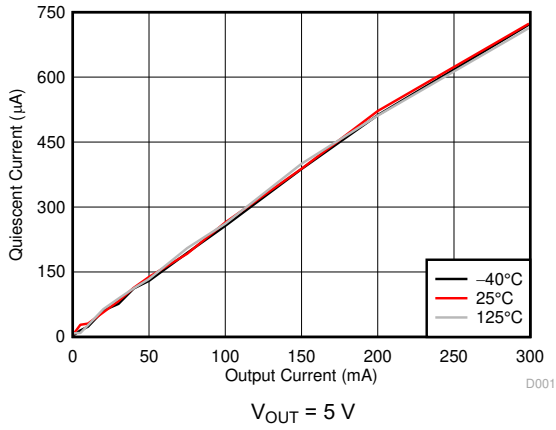


Figure 6-1. Quiescent Current vs Output Current

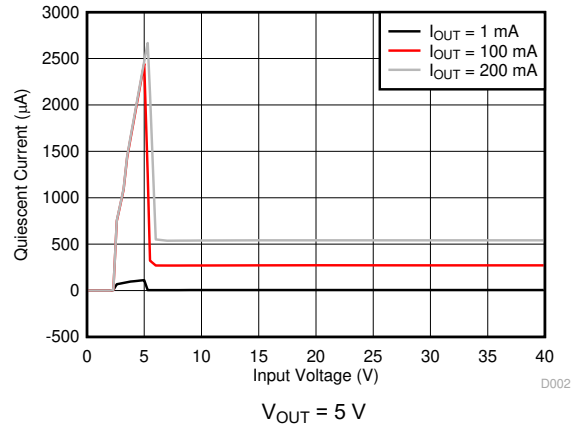


Figure 6-2. Quiescent Current vs Input Voltage

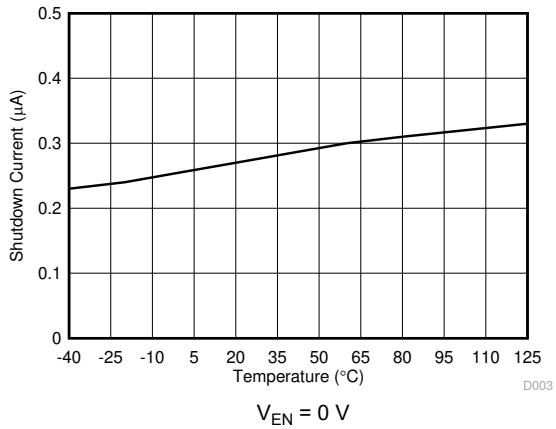


Figure 6-3. Shutdown Current vs Ambient Temperature

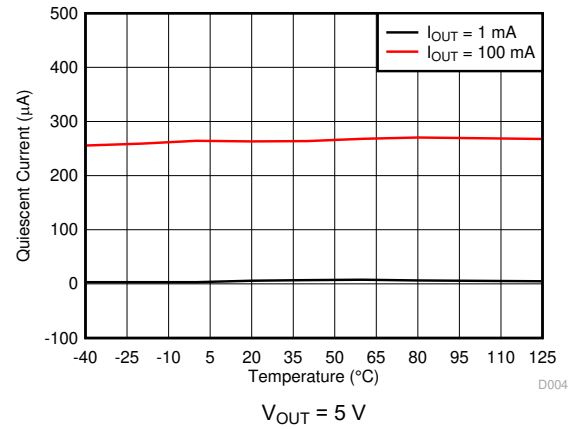


Figure 6-4. Quiescent Current vs Ambient Temperature

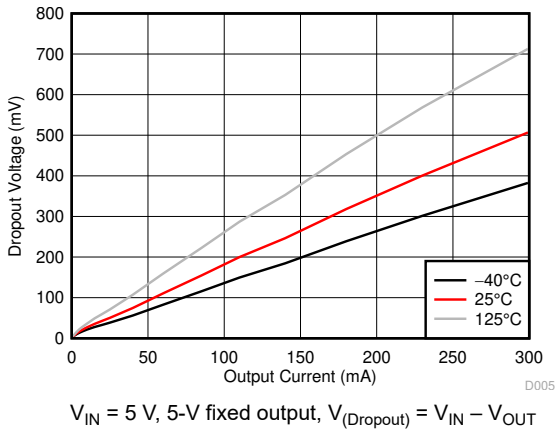


Figure 6-5. Dropout Voltage vs Output Current

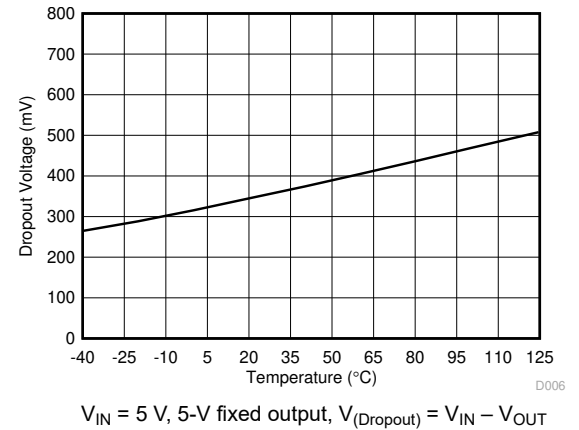


Figure 6-6. Dropout Voltage vs Ambient Temperature



### 6.7 Typical Characteristics (continued)

$V_{IN} = 14\text{ V}$ ,  $V_{EN} \geq 2\text{ V}$ ,  $T_J = -40^\circ\text{C}$  to  $150^\circ\text{C}$  (unless otherwise noted)

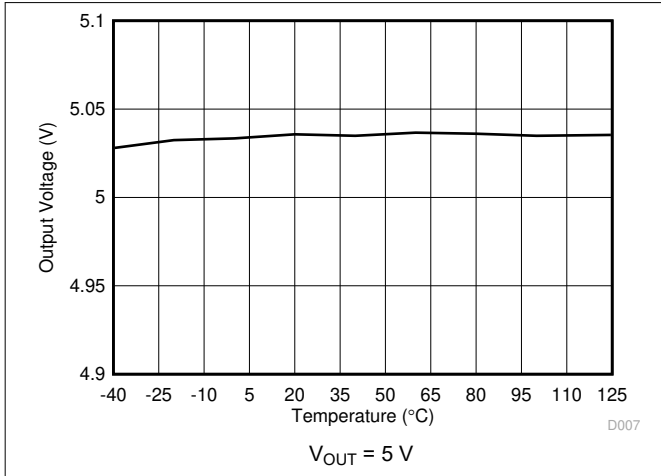


Figure 6-7. Output Voltage vs Ambient Temperature

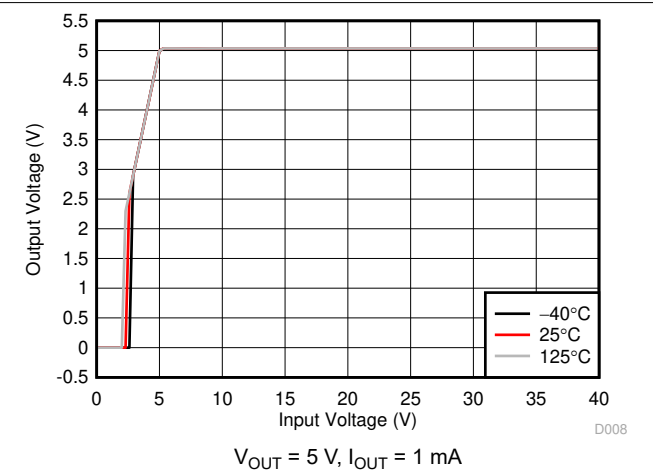


Figure 6-8. Output Voltage vs Input Voltage

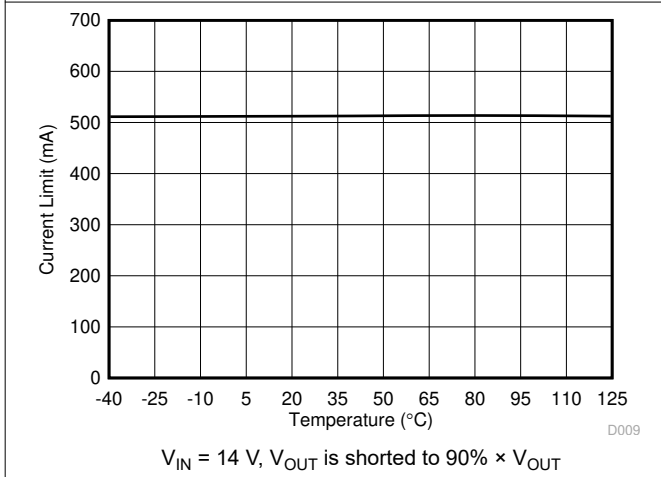


Figure 6-9. Output Current Limit vs Ambient Temperature

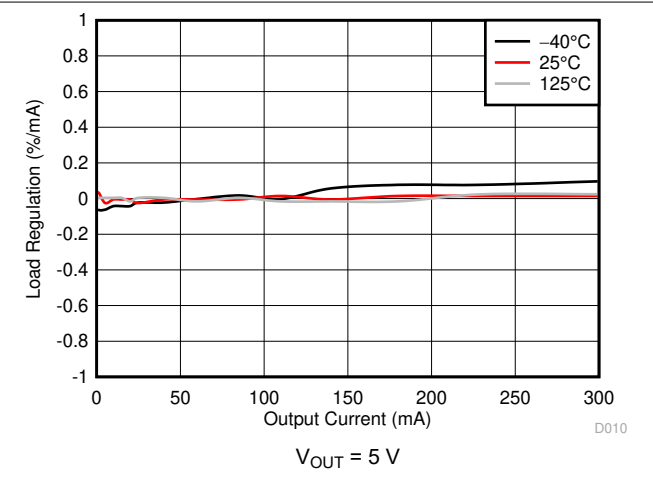


Figure 6-10. Load Regulation

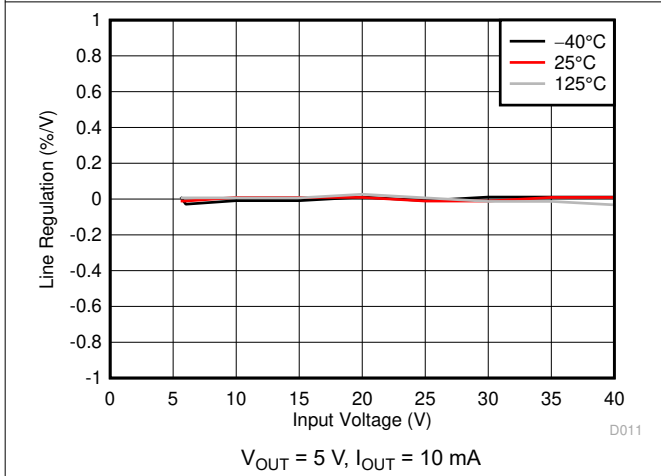


Figure 6-11. Line Regulation

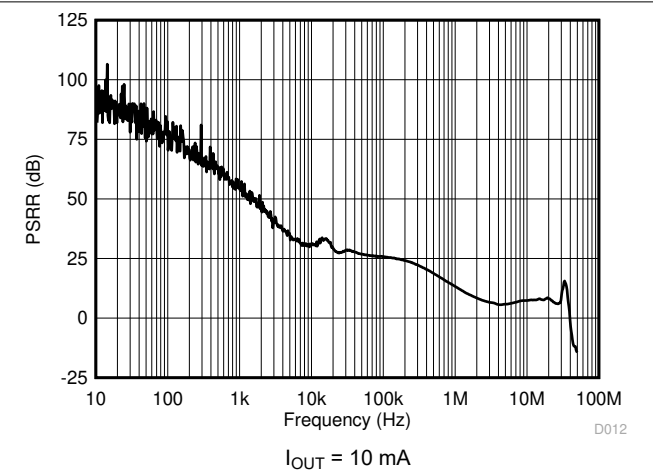
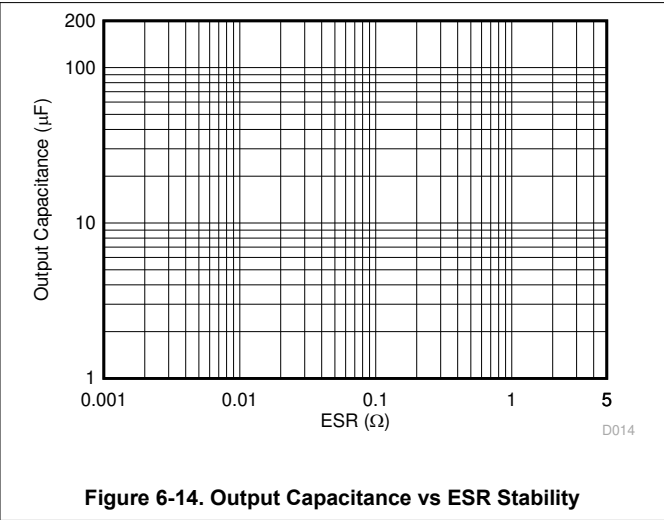
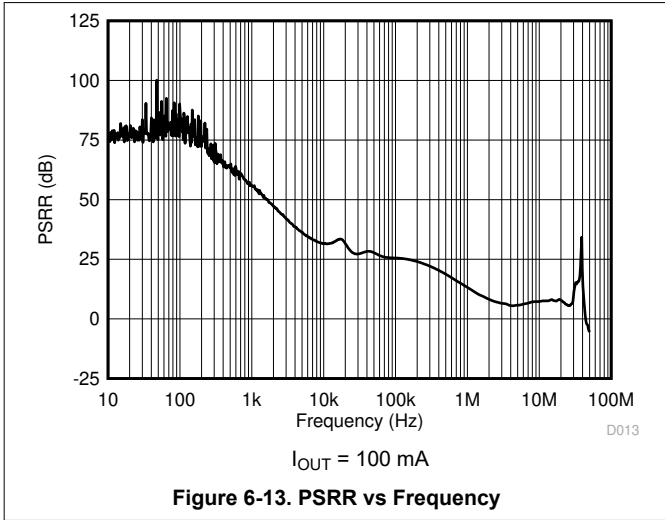


Figure 6-12. PSRR vs Frequency

### 6.7 Typical Characteristics (continued)

$V_{IN} = 14\text{ V}$ ,  $V_{EN} \geq 2\text{ V}$ ,  $T_J = -40^\circ\text{C}$  to  $150^\circ\text{C}$  (unless otherwise noted)

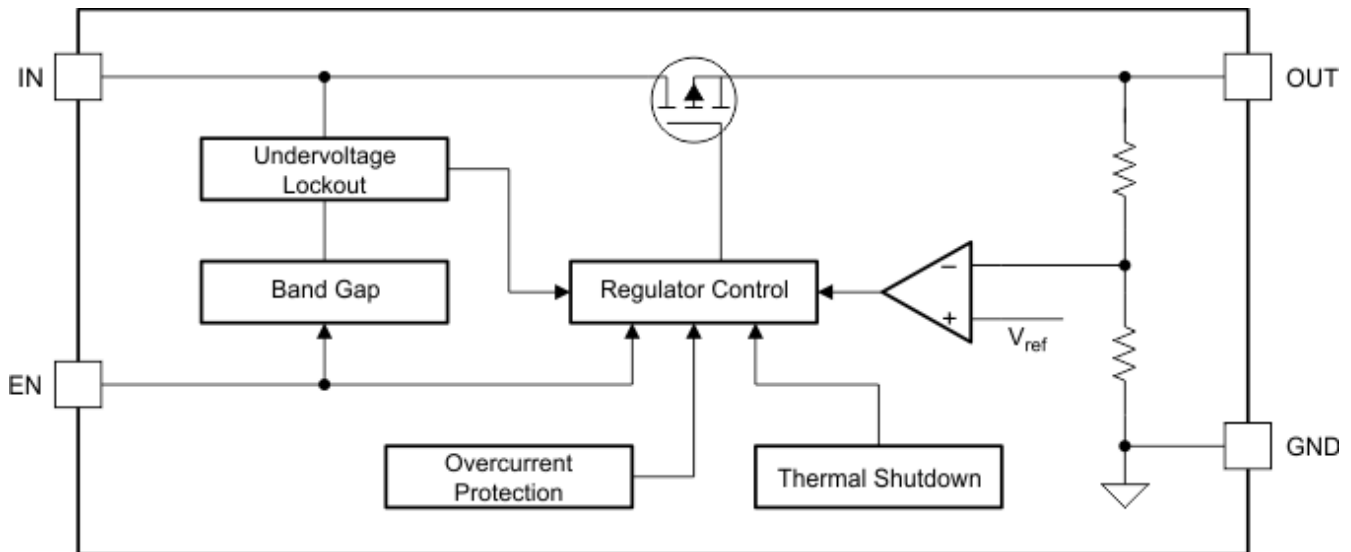


## 7 Detailed Description

### 7.1 Overview

The TPS7B82-Q1 is a 40-V, 300-mA low-dropout (LDO) linear regulator with ultra-low quiescent current. This voltage regulator consumes only 3  $\mu\text{A}$  of quiescent current at light load, and is designed for the automotive always-on application.

### 7.2 Functional Block Diagram



### 7.3 Feature Description

#### 7.3.1 Device Enable (EN)

The EN pin is a high-voltage-tolerant pin. A high input activates the device and turns the regulation ON. Connect this pin to an external microcontroller or a digital circuit to enable and disable the device, or connect to the IN pin for self-bias applications.

#### 7.3.2 Undervoltage Shutdown

This device has an integrated undervoltage lockout (UVLO) circuit to shut down the output if the input voltage ( $V_{\text{IN}}$ ) falls below an internal UVLO threshold ( $V_{\text{UVLO}}$ ). This threshold limit ensures that the regulator does not latch into an unknown state during low-input-voltage conditions. If the input voltage has a negative transient that drops below the UVLO threshold and recovers, the regulator shuts down and powers up with a normal power-up sequence when the input voltage is above the required level.

#### 7.3.3 Current Limit

This device features current-limit protection to keep the device in a safe operating area when an overload or output short-to-ground condition occurs. This limit protects the device from excessive power dissipation. For example, during a short-circuit condition on the output, fault protection limits the current through the pass element to  $I_{\text{(LIM)}}$  to protect the device from excessive power dissipation.

#### 7.3.4 Thermal Shutdown

This device incorporates a thermal shutdown (TSD) circuit as a protection from overheating. For continuous normal operation, the junction temperature must not exceed the TSD trip point. The junction temperature exceeding the TSD trip point causes the output to turn off. When the junction temperature falls below the TSD trip point minus thermal shutdown hysteresis, the output turns on again.

## 7.4 Device Functional Modes

### 7.4.1 Operation With $V_{IN}$ Lower Than 3 V

The device normally operates with input voltages above 3 V. The device can also operate at lower input voltages; the maximum UVLO voltage is 2.7 V. At input voltages below the actual UVLO voltage, the device does not operate.

### 7.4.2 Operation With $V_{IN}$ Larger Than 3 V

When  $V_{IN}$  is greater than 3 V, if  $V_{IN}$  is also higher than the output set value plus the device dropout voltage,  $V_{OUT}$  is equal to the set value. Otherwise,  $V_{OUT}$  is equal to  $V_{IN}$  minus the dropout voltage.

## 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, as well as validating and testing their design implementation to confirm system functionality.

### 8.1 Application Information

The TPS7B82-Q1 is a 300-mA, 40-V low-dropout linear regulator with ultra-low quiescent current. The PSpice transient model is available for download on the product folder and can be used to evaluate the basic function of the device.

### 8.2 Typical Application

Figure 8-1 shows a typical application circuit for the TPS7B82-Q1. Different values of external components can be used, depending on the end application. An application may require a larger output capacitor during fast load steps to prevent a large drop on the output voltage. Use a low-ESR ceramic capacitor with a dielectric of type X5R or X7R.

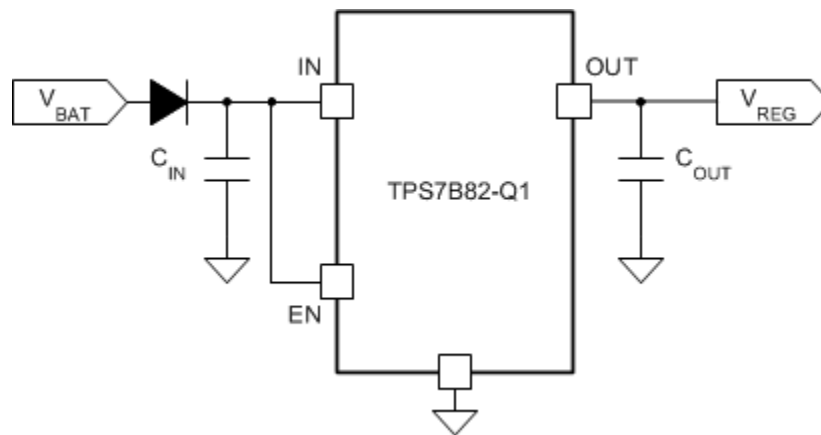


Figure 8-1. TPS7B82-Q1 Typical Application Schematic

#### 8.2.1 Design Requirements

For this design example, use the parameters listed in Table 8-1.

Table 8-1. Design Requirements Parameters

| PARAMETER           | VALUE          |
|---------------------|----------------|
| Input voltage range | 3 V to 40 V    |
| Output voltage      | 5 V or 3.3 V   |
| Output current      | 300 mA maximum |

#### 8.2.2 Detailed Design Procedure

To begin the design process, determine the following:

- Input voltage range
- Output voltage
- Output current

### 8.2.2.1 Input Capacitor

Although an input capacitor is not required for stability, good analog design practice is to connect a 10- $\mu$ F to 22- $\mu$ F capacitor from IN to GND. This capacitor counteracts reactive input sources and improves transient response, input ripple rejection, and PSRR. The voltage rating must be greater than the maximum input voltage.

### 8.2.2.2 Output Capacitor

To ensure the stability of the TPS7B82-Q1, the device requires an output capacitor with a value in the range from 1  $\mu$ F to 200  $\mu$ F and with an ESR range between 0.001  $\Omega$  and 5  $\Omega$ . Select a ceramic capacitor with low ESR to improve the load transient response.

### 8.2.3 Application Curve

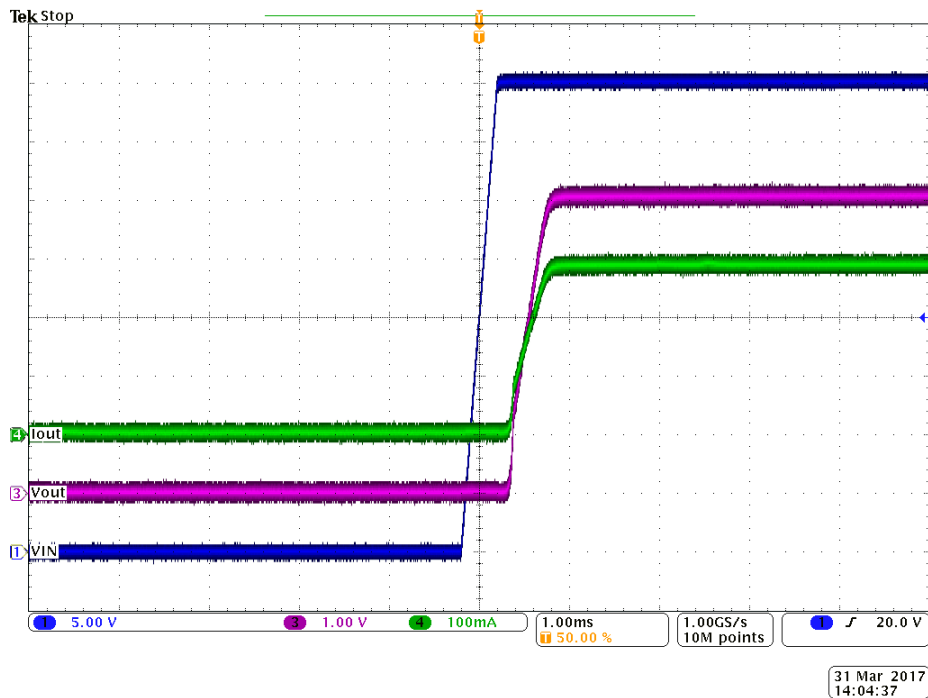


Figure 8-2. TPS7B82-Q1 Power-Up Waveform (5 V)

## 9 Power Supply Recommendations

The device is designed to operate from an input voltage supply range from 3 V to 40 V. This input supply must be well regulated. If the input supply is located more than a few inches from the TPS7B82-Q1, add a capacitor with a value greater than or equal to 10  $\mu\text{F}$  with a 0.1- $\mu\text{F}$  bypass capacitor in parallel at the input.

## 10 Layout

### 10.1 Layout Guidelines

For LDO power supplies, especially high-voltage and large output current supplies, layout is an important step. If layout is not carefully designed, the regulator can fail to deliver enough output current because of thermal limitation. To improve the thermal performance of the device, and to maximize the current output at high ambient temperature, spread the copper under the thermal pad as far as possible and place enough thermal vias on the copper under the thermal pad. [Figure 10-1](#) shows an example layout.

### 10.2 Layout Example

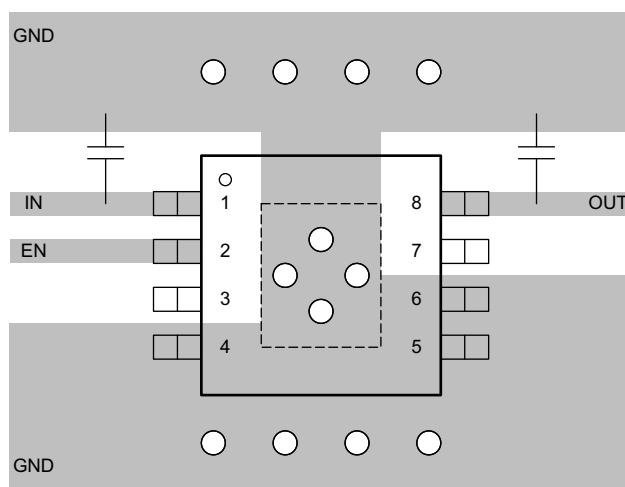


Figure 10-1. TPSB82-Q1 Example Layout Diagram

## 11 Device and Documentation Support

### 11.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Subscribe to updates* 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.

### 11.2 Support Resources

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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### 11.3 Trademarks

PowerPAD™ and TI E2E™ are trademarks of Texas Instruments. All trademarks are the property of their respective owners.

### 11.4 Electrostatic Discharge Caution



This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

### 11.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

## 12 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 device. This data is subject to change without notice and without revision of this document. For browser-based versions of this data sheet, see the left-hand navigation pane.



## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package Drawing | Pins | Package Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|-----------------|------|-------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| TPS7B8225QDGNRQ1 | ACTIVE        | HVSSOP       | DGN             | 8    | 2500        | RoHS & Green    | NIPDAUAG                             | Level-2-260C-1 YEAR  | -40 to 150   | 1QFX                    | <a href="#">Samples</a> |
| TPS7B8233EPWPRQ1 | ACTIVE        | HTSSOP       | PWP             | 14   | 2500        | RoHS & Green    | NIPDAU                               | Level-3-260C-168 HR  | -40 to 150   | 7B8233E                 | <a href="#">Samples</a> |
| TPS7B8233QDGNRQ1 | ACTIVE        | HVSSOP       | DGN             | 8    | 2500        | RoHS & Green    | NIPDAUAG                             | Level-2-260C-1 YEAR  | -40 to 150   | 1GGX                    | <a href="#">Samples</a> |
| TPS7B8233QDRVRQ1 | ACTIVE        | WSON         | DRV             | 6    | 3000        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 150   | 1ORH                    | <a href="#">Samples</a> |
| TPS7B8233QKVURQ1 | ACTIVE        | TO-252       | KVU             | 5    | 2500        | RoHS & Green    | SN                                   | Level-3-260C-168 HR  | -40 to 150   | 7B8233Q1                | <a href="#">Samples</a> |
| TPS7B8250EPWPRQ1 | ACTIVE        | HTSSOP       | PWP             | 14   | 2500        | RoHS & Green    | NIPDAU                               | Level-3-260C-168 HR  | -40 to 150   | 7B8250E                 | <a href="#">Samples</a> |
| TPS7B8250QDGNRQ1 | ACTIVE        | HVSSOP       | DGN             | 8    | 2500        | RoHS & Green    | NIPDAUAG                             | Level-2-260C-1 YEAR  | -40 to 150   | 19TX                    | <a href="#">Samples</a> |
| TPS7B8250QDRVRQ1 | ACTIVE        | WSON         | DRV             | 6    | 3000        | RoHS & Green    | NIPDAU                               | Level-2-260C-1 YEAR  | -40 to 150   | 1UFH                    | <a href="#">Samples</a> |
| TPS7B8250QKVURQ1 | ACTIVE        | TO-252       | KVU             | 5    | 2500        | RoHS & Green    | SN                                   | Level-3-260C-168 HR  | -40 to 150   | 7B8250Q1                | <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) **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.

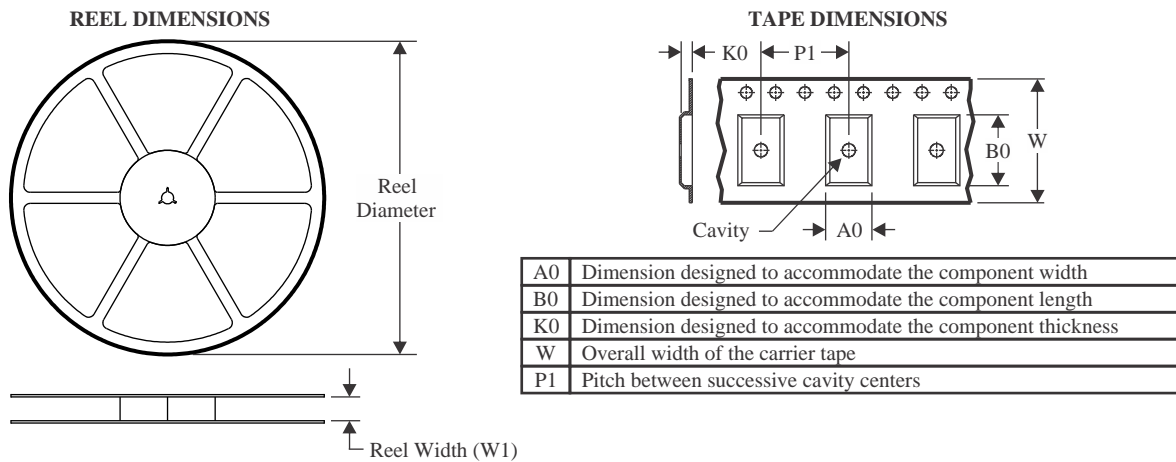
<sup>(5)</sup> Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "-" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

<sup>(6)</sup> 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.

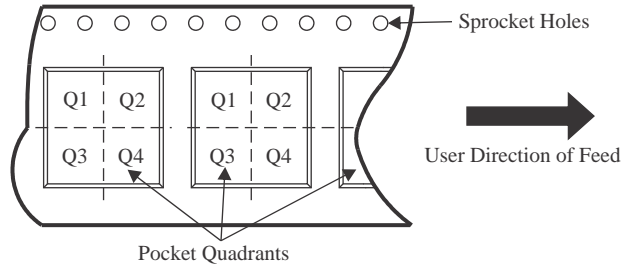
**Important Information and Disclaimer:**The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. 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.

## TAPE AND REEL INFORMATION



### QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



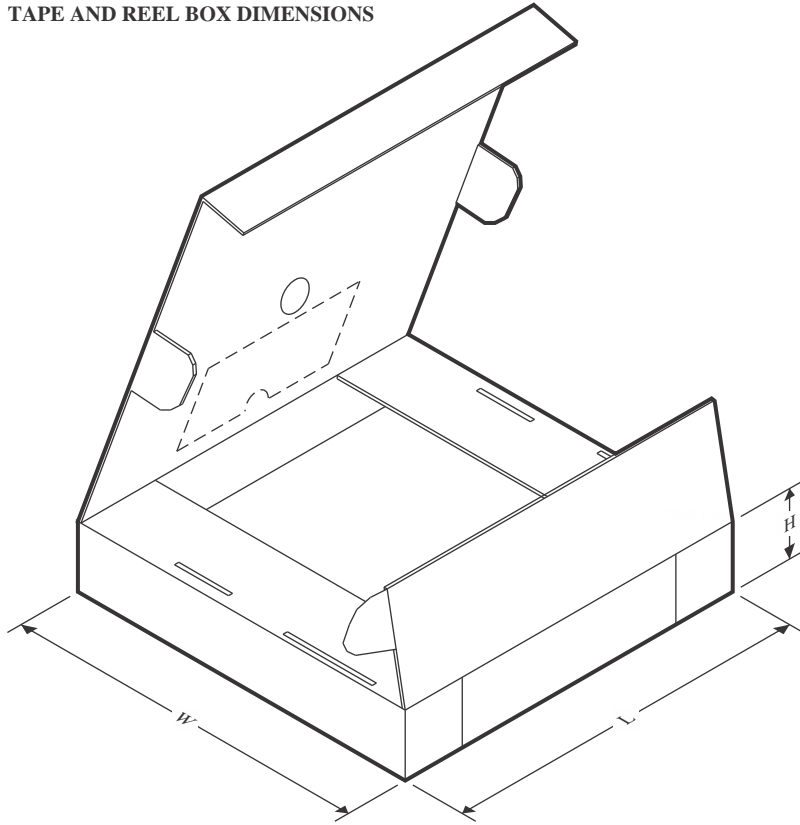
\*All dimensions are nominal

| 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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| TPS7B8225QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TPS7B8233EPWPRQ1 | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TPS7B8233QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TPS7B8233QDRVRQ1 | WSO          | DRV             | 6    | 3000 | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |
| TPS7B8233QKVURQ1 | TO-252       | KVU             | 5    | 2500 | 330.0              | 16.4               | 6.9     | 10.5    | 2.7     | 8.0     | 16.0   | Q2            |
| TPS7B8250EPWPRQ1 | HTSSOP       | PWP             | 14   | 2500 | 330.0              | 12.4               | 6.9     | 5.6     | 1.6     | 8.0     | 12.0   | Q1            |
| TPS7B8250QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 330.0              | 12.4               | 5.3     | 3.4     | 1.4     | 8.0     | 12.0   | Q1            |
| TPS7B8250QDRVRQ1 | WSO          | DRV             | 6    | 3000 | 180.0              | 8.4                | 2.3     | 2.3     | 1.15    | 4.0     | 8.0    | Q2            |
| TPS7B8250QKVURQ1 | TO-252       | KVU             | 5    | 2500 | 330.0              | 16.4               | 6.9     | 10.5    | 2.7     | 8.0     | 16.0   | Q2            |

# PACKAGE MATERIALS INFORMATION

3-Jun-2022

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| TPS7B8225QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| TPS7B8233EPWPRQ1 | HTSSOP       | PWP             | 14   | 2500 | 356.0       | 356.0      | 35.0        |
| TPS7B8233QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| TPS7B8233QDRVRQ1 | WSON         | DRV             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS7B8233QKVURQ1 | TO-252       | KVU             | 5    | 2500 | 340.0       | 340.0      | 38.0        |
| TPS7B8250EPWPRQ1 | HTSSOP       | PWP             | 14   | 2500 | 356.0       | 356.0      | 35.0        |
| TPS7B8250QDGNRQ1 | HVSSOP       | DGN             | 8    | 2500 | 366.0       | 364.0      | 50.0        |
| TPS7B8250QDRVRQ1 | WSON         | DRV             | 6    | 3000 | 210.0       | 185.0      | 35.0        |
| TPS7B8250QKVURQ1 | TO-252       | KVU             | 5    | 2500 | 340.0       | 340.0      | 38.0        |

## GENERIC PACKAGE VIEW

**DGN 8**

**PowerPAD VSSOP - 1.1 mm max height**

3 x 3, 0.65 mm pitch

SMALL OUTLINE PACKAGE

This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



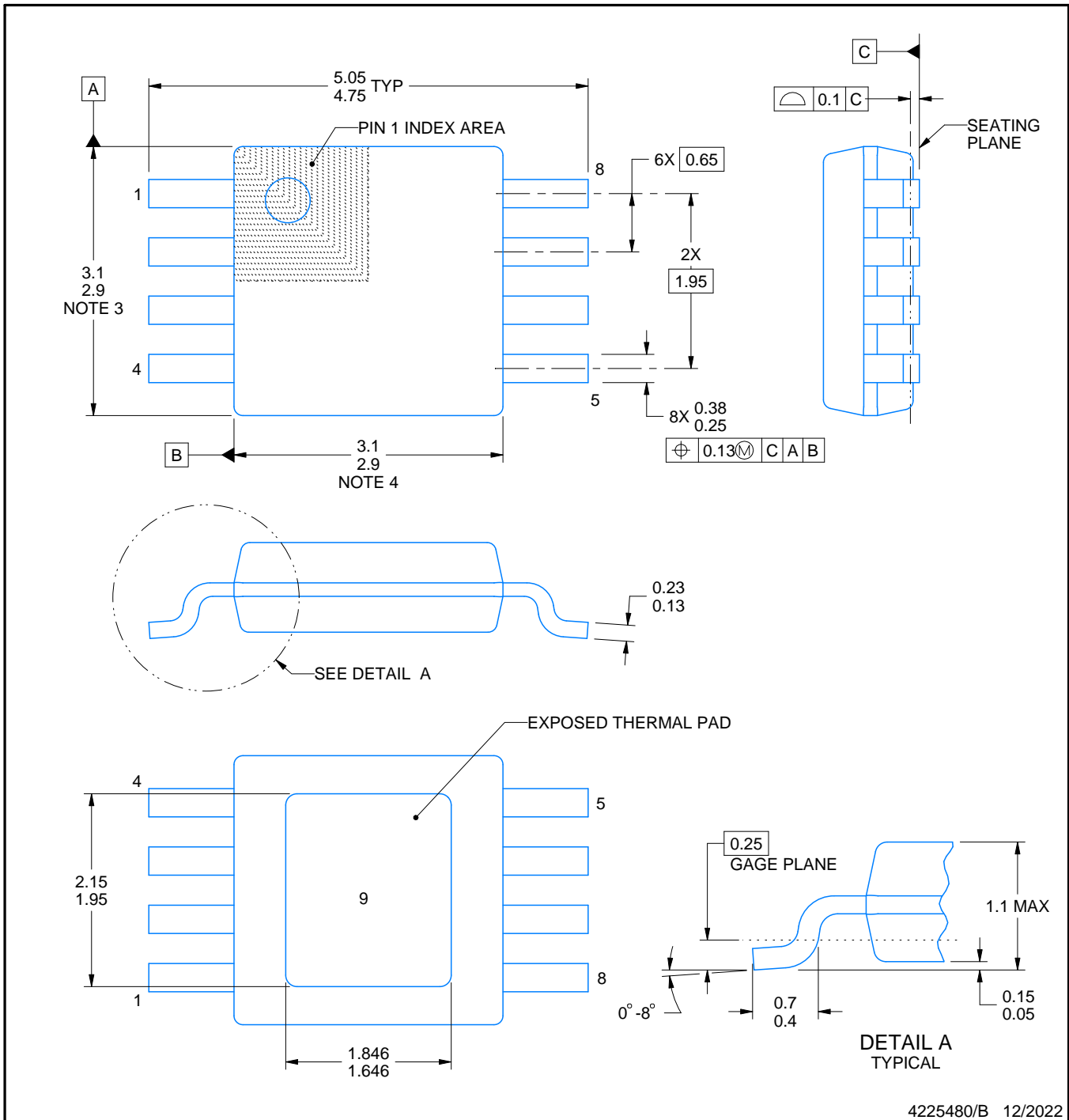
DGN0008G



# PACKAGE OUTLINE

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



4225480/B 12/2022

NOTES:

PowerPAD is a trademark of Texas Instruments.

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. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.

# EXAMPLE BOARD LAYOUT

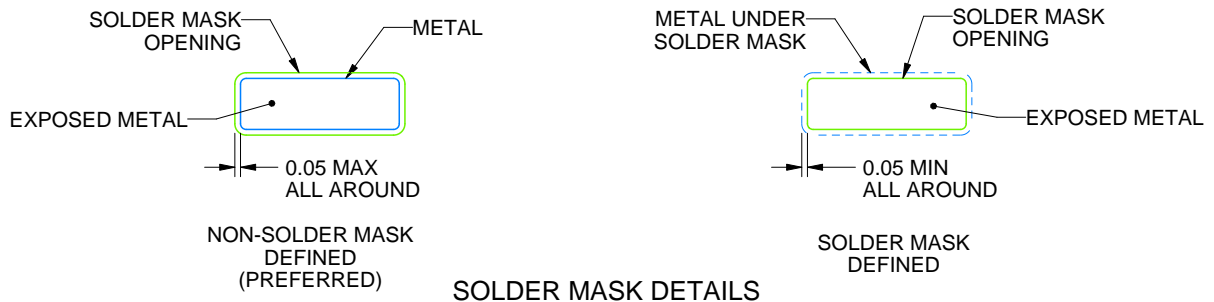
DGN0008G

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE  
EXPOSED METAL SHOWN  
SCALE: 15X



4225480/B 12/2022

NOTES: (continued)

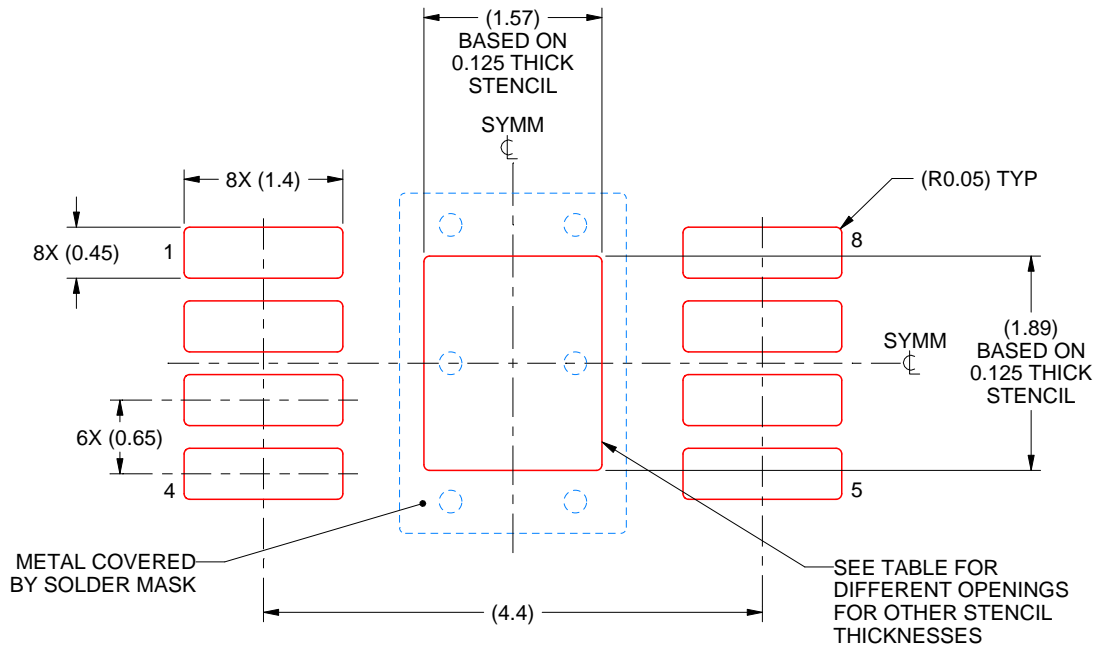
- 6. Publication IPC-7351 may have alternate designs.
- 7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.
- 8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
- 9. Size of metal pad may vary due to creepage requirement.

# EXAMPLE STENCIL DESIGN

DGN0008G

PowerPAD™ VSSOP - 1.1 mm max height

SMALL OUTLINE PACKAGE



**SOLDER PASTE EXAMPLE**  
 EXPOSED PAD 9:  
 100% PRINTED SOLDER COVERAGE BY AREA  
 SCALE: 15X

| STENCIL THICKNESS | SOLDER STENCIL OPENING |
|-------------------|------------------------|
| 0.1               | 1.76 X 2.11            |
| 0.125             | 1.57 X 1.89 (SHOWN)    |
| 0.15              | 1.43 X 1.73            |
| 0.175             | 1.33 X 1.60            |

4225480/B 12/2022

NOTES: (continued)

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



## GENERIC PACKAGE VIEW

**PWP 14**

**PowerPAD TSSOP - 1.2 mm max height**

4.4 x 5.0, 0.65 mm pitch

PLASTIC SMALL OUTLINE

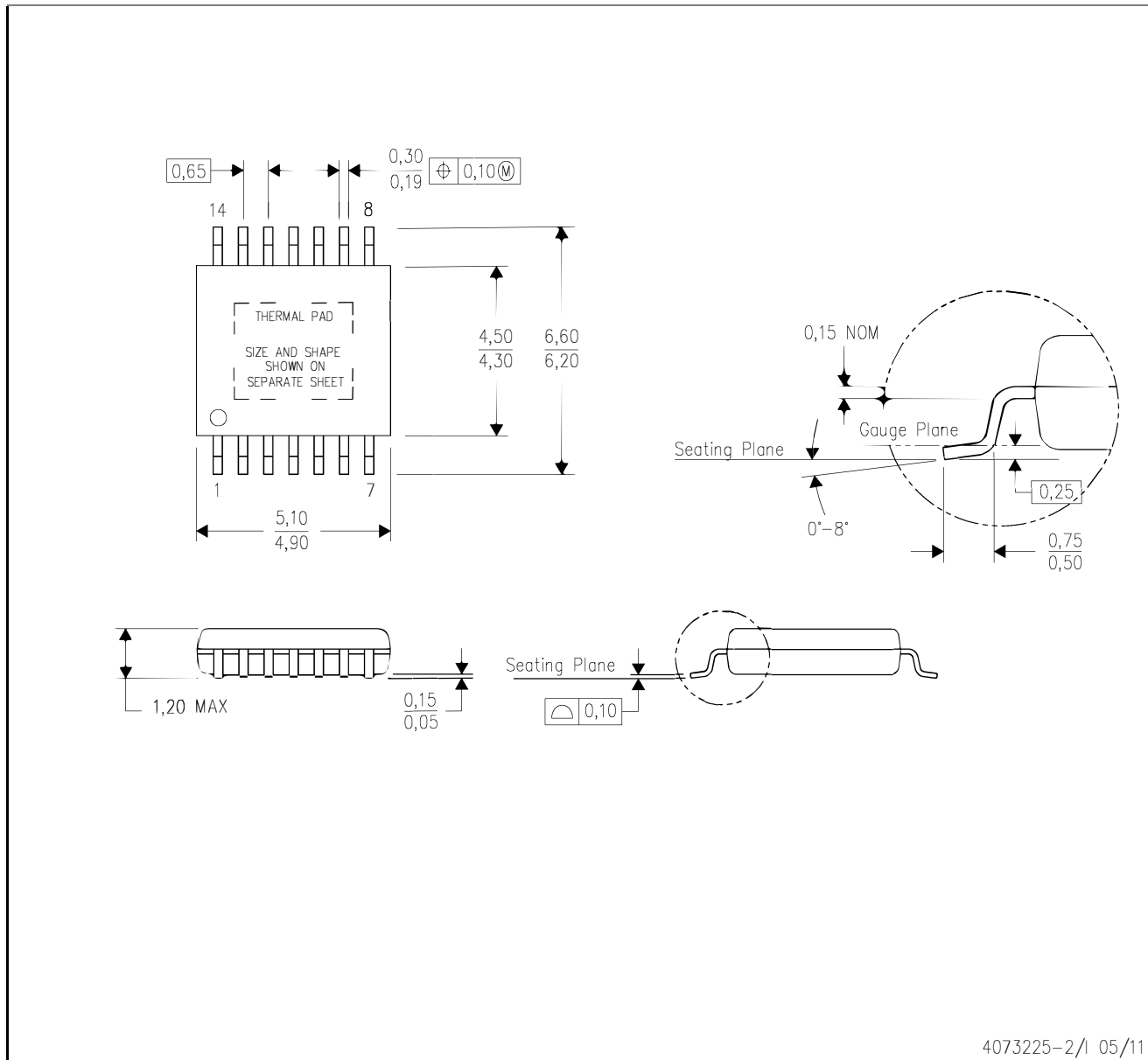
This image is a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.



# MECHANICAL DATA

PWP (R-PDSO-G14)

PowerPAD™ PLASTIC SMALL OUTLINE



4073225-2/1 05/11

- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Body dimensions do not include mold flash or protrusions. Mold flash and protrusion shall not exceed 0.15 per side.
  - This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 for information regarding recommended board layout. This document is available at [www.ti.com](http://www.ti.com) <<http://www.ti.com>>.
  - See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
  - Falls within JEDEC MO-153

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## THERMAL PAD MECHANICAL DATA

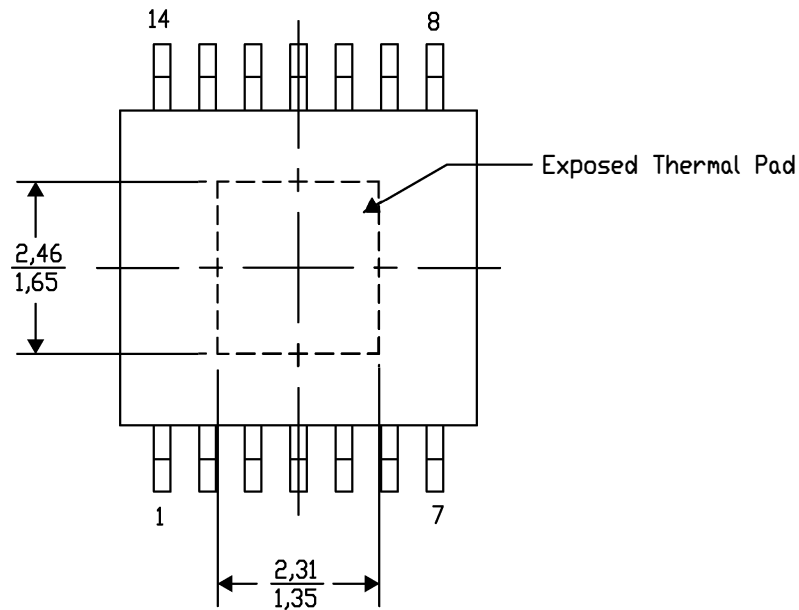
### PWP (R-PDSO-G14) PowerPAD™ SMALL PLASTIC OUTLINE

#### THERMAL INFORMATION

This PowerPAD™ package incorporates an exposed thermal pad that is designed to be attached to a printed circuit board (PCB). The thermal pad must be soldered directly to the 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 additional information on the PowerPAD package and how to take advantage of its heat dissipating abilities, refer to Technical Brief, PowerPAD Thermally Enhanced Package, Texas Instruments Literature No. SLMA002 and Application Brief, PowerPAD Made Easy, Texas Instruments Literature No. SLMA004. Both documents are available at [www.ti.com](http://www.ti.com).

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



Top View

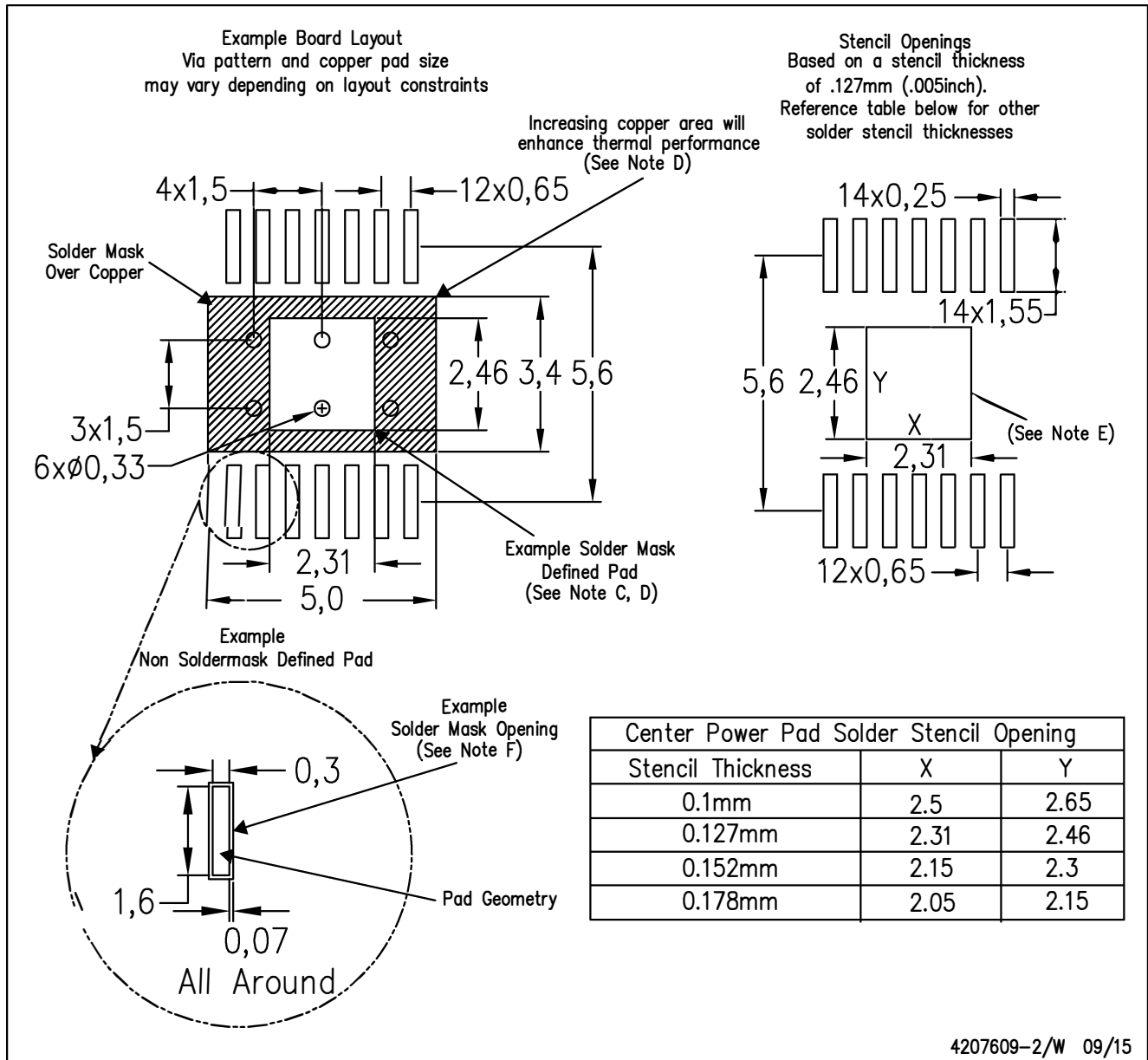
Exposed Thermal Pad Dimensions

4206332-2/AO 01/16

NOTE: A. All linear dimensions are in millimeters

PWP (R-PDSO-G14)

PowerPAD™ PLASTIC SMALL OUTLINE



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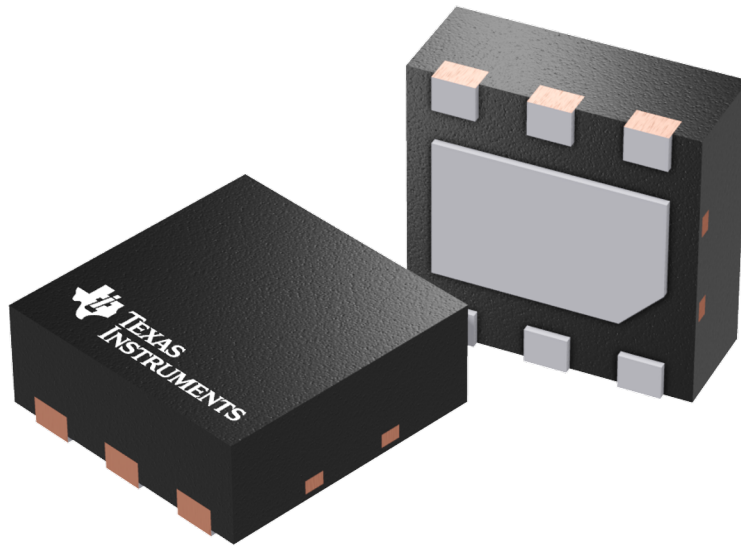
- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
  - D. This package is designed to be soldered to a thermal pad on the board. Refer to Technical Brief, PowerPad Thermally Enhanced Package, Texas Instruments Literature No. SLMA002, SLMA004, 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>>. 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.
  - F. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

## GENERIC PACKAGE VIEW

DRV 6

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



Images above are just a representation of the package family, actual package may vary.  
Refer to the product data sheet for package details.

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4222173/B 04/2018

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. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.



# EXAMPLE STENCIL DESIGN

DRV0006A

WSON - 0.8 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE  
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD #7  
88% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE  
SCALE:30X

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NOTES: (continued)

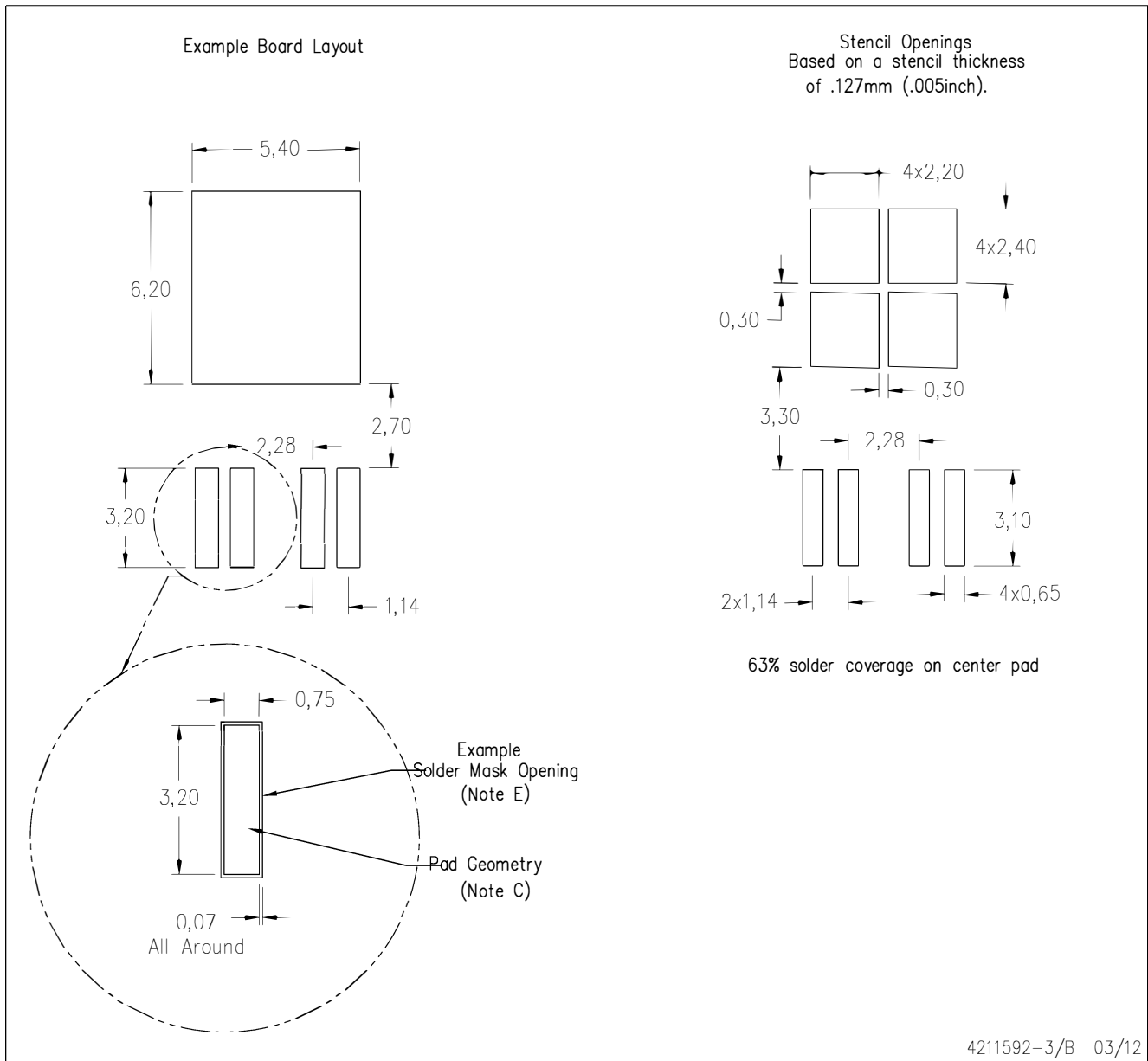
6. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.





KVU (R-PSFM-G5)

PLASTIC FLANGE MOUNT PACKAGE



- NOTES:
- A. All linear dimensions are in millimeters.
  - B. This drawing is subject to change without notice.
  - C. Publication IPC-SM-782 is an alternate information source for PCB land pattern designs.
  - D. 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 other stencil recommendations.
  - E. Customers should contact their board fabrication site for recommended solder mask tolerances and via tenting recommendations for vias placed in thermal pad.

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