TPS7B82-Q1 300-mA High-Voltage Ultralow-I_Q Low-Dropout Regulator

1 Features

- Qualified for Automotive Applications
- AEC-Q100 Qualified With the Following Results:
  - Device Temperature Grade 1: –40°C to 125°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level H2
  - Device CDM ESD Classification Level C3B
- Device Junction Temperature Range: –40°C to 150°C
- 3-V to 40-V Wide V_{IN} Input Voltage Range With up to 45-V Transient
- Maximum Output Current: 300 mA
- Low Quiescent Current I_Q:
  - 300 nA Typical When EN = Low (Shutdown Mode)
  - 2.7 µA Typical at Light Loads
  - 5 µA Maximum at Light Loads
- 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-Ω to 5-Ω) Ceramic Output-Stability Capacitor (1 µF to 200 µF)
- Fixed 5-V and 3.3-V Output Voltage
- Integrated Fault Protection:
  - Thermal Shutdown
  - Short-Circuit and Overcurrent Protection
- Thermal Resistance ($R_{\theta JA}$): 63.9°C/W
- 8-Pin MSOP Package

2 Applications

- Cluster Power Supply
- Body Control Modules
- Always-ON Battery-Connected Applications
  - Gateway Applications
  - Remote Keyless Entry Systems
- Powering MCUs and CAN/LIN Transceivers

3 Description

In automotive battery-connected applications, low quiescent current (I_Q) is important to save power and extend battery lifetime. It is especially necessary to have ultralow I_Q for always-on systems.

The TPS7B82-Q1 is a low-dropout linear regulator designed for up to 40-V V_{IN} applications. With only 2.7-µA typical quiescent current at light load, it is an optimal solution for powering microcontrollers and CAN/LIN transceivers in standyby systems.

The device features integrated short-circuit and overcurrent protection. This device operates in ambient temperatures from –40°C to 125°C and with junction temperatures from –40°C to 150°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 well suited as a power supply for various automotive applications.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TPS7B82-Q1	MSOP (8)	3.00 mm × 3.00 mm

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

Typical Application Schematic

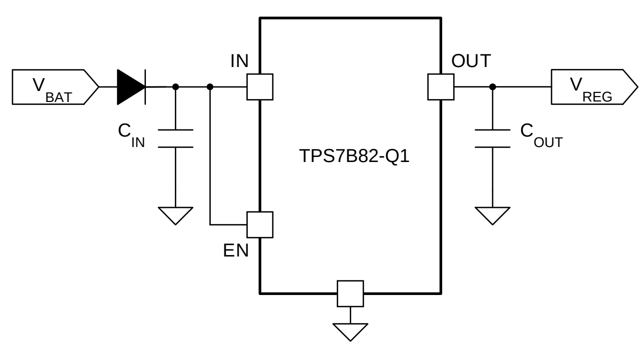


Table of Contents

4 Revision History

Changes from Revision B (February 2018) to Revision C — **Page**

- Added *Feature*: Device Junction Temperature Range: –40°C to 150°C 1
- Changed *Feature* From: Fixed 5-V Output Voltage To: Fixed 5-V and 3.3-V Output Voltage 1
- Added *Feature*: "Thermal Resistance ($R_{\theta JA}$): 63.9°C/W" 1
- Added: "Powering MCUs and CAN/LIN Transceivers" to the *Applications* list 1
- Changed the *Description* section 1
- Changed the *Device Information* table 1
- Added PowerPAD to the DGN package description 3
- Changed pins 5 and 6 From: NC To: GND in the *Pin Configuration and Functions* 3
- Removed Note 3 from V_{OUT} in the *Absolute Maximum Ratings* 4
- Changed the VALUE column for Output voltage From: 5 V To: 5 V or 3.3 V in Table 1 11

Changes from Revision A (November 2017) to Revision B — **Page**

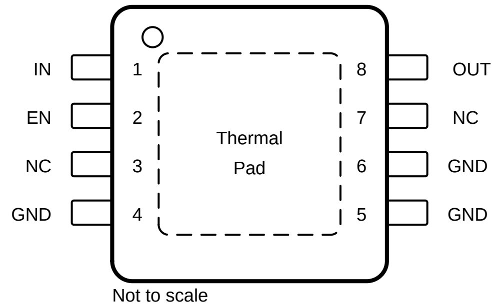
- Deleted values from capacitors C_{IN} and C_{OUT} in the *Typical Application Schematic* 1
- Deleted values from capacitors C_{IN} and C_{OUT} in Figure 15 11

Changes from Original (September 2017) to Revision A — **Page**

- Deleted 2.5-V and 3.3-V device options from the *Features* list 1
- Changed V_{EN} to Enable input in the *Absolute Maximum Ratings* 4
- Deleted the blank NOM column from the *Recommended Operating Conditons* table 4
- Deleted requirements for 3.3-V and 2.5-V device versions from the *Electrical Characteristics* table 5
- Changed conditions for Figure 9 7
- Deleted 3.3-V and 2.5- output voltages from the *Design Requirements* table 11

5 Pin Configuration and Functions

DGN Package
8-Pin MSOP PowerPAD™
Top View



NC – No internal connection

Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
EN	2	I	Enable input pin
GND	4, 5, 6	—	Ground reference
IN	1	I	Input power supply pin
NC	3, 7	—	Not internally connected
OUT	8	O	Regulated output voltage pin

6 Specifications

6.1 Absolute Maximum Ratings[(1)(2)]

over operating ambient temperature range (unless otherwise noted)

		MIN	MAX	UNIT
V_{IN}	Unregulated input[(3)]	–0.3	45	V
V_{EN}	Enable input[(3)]	–0.3	V_{IN}	V
V_{OUT}	Regulated output	–0.3	7	V
T_J	Junction temperature range	–40	150	°C
T_{stg}	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
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per per AEC Q100-002[(1)]		±2000	V
		Charged-device model (CDM), per per AEC Q100-011	Corner pins (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_{IN}	Unregulated input voltage	3	40	V
V_{EN}	Enable input voltage	0	V_{IN}	V
C_{OUT}	Output capacitor requirements[(1)]	1	200	µF
ESR	Output capacitor ESR requirements[(2)]	0.001	5	Ω
T_A	Ambient temperature range	–40	125	°C
T_J	Junction temperature range	–40	150	°C

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

6.4 Thermal Information

THERMAL METRIC[(1)]		TPS7B82-Q1 DGN (MSOP) 8 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	63.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	50.2	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	22.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	1.8	°C/W
ψ_{JB}	Junction-to-board characterization parameter	22.3	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	12.1	°C/W

(1) For more information about traditional and new thermal metrics, see *Semiconductor and IC Package Thermal Metrics*.

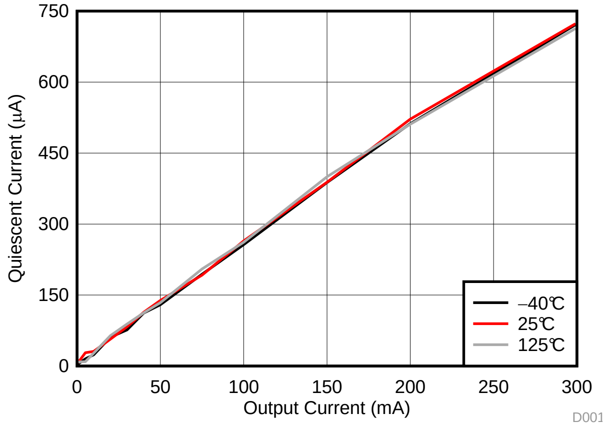
6.5 Electrical Characteristics

V_{IN} = 14-V, 10-µF ceramic output capacitor, T_J = –40ºC to 150ºC, over operating ambient temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
SUPPLY VOLTAGE AND CURRENT (IN)						
V_{IN}	Input voltage	Fixed 5-V output	5 V + $V_{(Dropout)}$		40	V
$I_{(SD)}$	Shutdown current	EN = 0 V		0.3	1	µA
$I_{(Q)}$	Quiescent current	V_{IN} = 6 V to 40 V, EN ≥ 2 V, I_{OUT} = 0 mA		1.9	5	µA
		V_{IN} = 6 V to 40 V, EN ≥ 2 V, I_{OUT} = 0.2 mA		2.7	5	
$V_{(IN, UVLO)}$	V_{IN} undervoltage detection	Ramp V_{IN} down until the output turns OFF			2.7	V
		Hysteresis		200		mV
ENABLE INPUT (EN)						
V_{IL}	Logic-input low level				0.7	V
V_{IH}	Logic-input high level		2			V
REGULATED OUTPUT (OUT)						
V_{OUT}	Regulated output	V_{IN} = V_{OUT} + $V_{(Dropout)}$ to 40 V, I_{OUT} = 1 mA to 300 mA	–2%		2%	
$V_{(Line-Reg)}$	Line regulation	V_{IN} = 6 V to 40 V, I_{OUT} = 10 mA			10	mV
$V_{(Load-Reg)}$	Load regulation	V_{IN} = 14 V, I_{OUT} = 1 mA to 300 mA			20	mV
$V_{(Dropout)}$	Dropout voltage	I_{OUT} = 200 mA, fixed 5-V output		400	700	mV
		I_{OUT} = 100 mA, fixed 5-V output		200	350	
I_{OUT}	Output current	V_{OUT} in regulation	0		300	mA
$I_{(CL)}$	Output current limit	V_{OUT} short to 90% × V_{OUT}	310	510	690	mA
PSRR	Power-supply ripple rejection	$V_{(Ripple)}$ = 0.5 Vpp, I_{OUT} = 10 mA, frequency = 100 Hz, C_{OUT} = 2.2 µF		60		dB
OPERATING TEMPERATURE RANGE						
$T_{(SD)}$	Junction shutdown temperature			175		ºC
$T_{(HYST)}$	Hysteresis of thermal shutdown			20		ºC

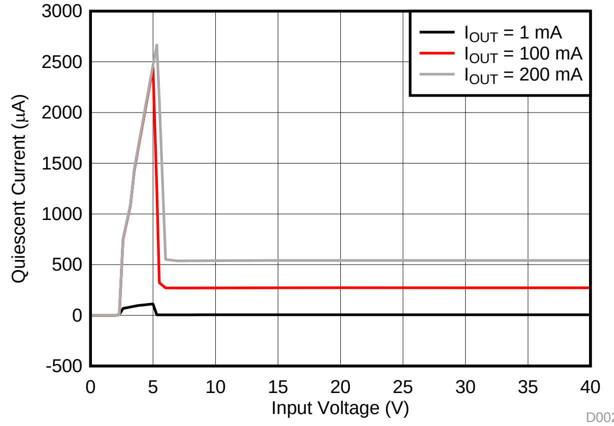
6.6 Typical Characteristics

V_{IN} = 14 V, V_{EN} ≥ 2 V, T_J = –40ºC to 150ºC unless otherwise noted



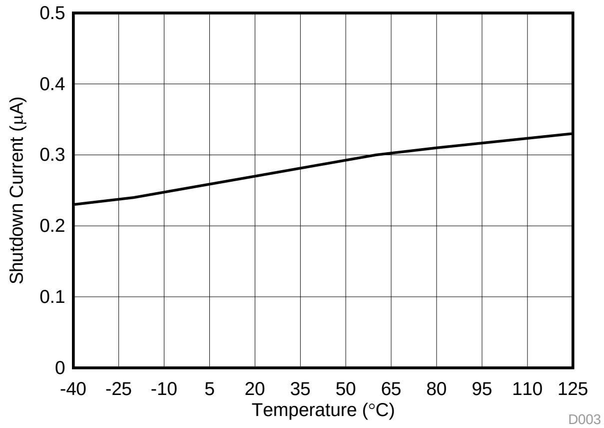
V_{OUT} = 5 V

Figure 1. Quiescent Current vs Output Current



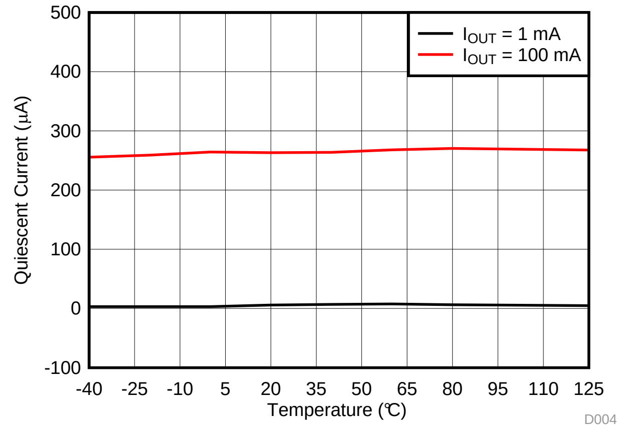
V_{OUT} = 5 V

Figure 2. Quiescent Current vs Input Voltage



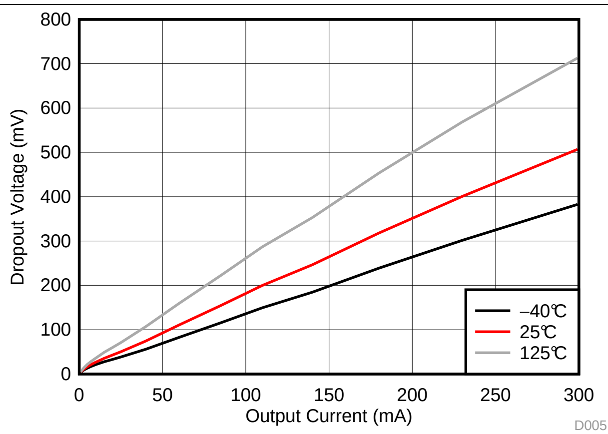
V_{EN} = 0 V

Figure 3. Shutdown Current vs Ambient Temperature



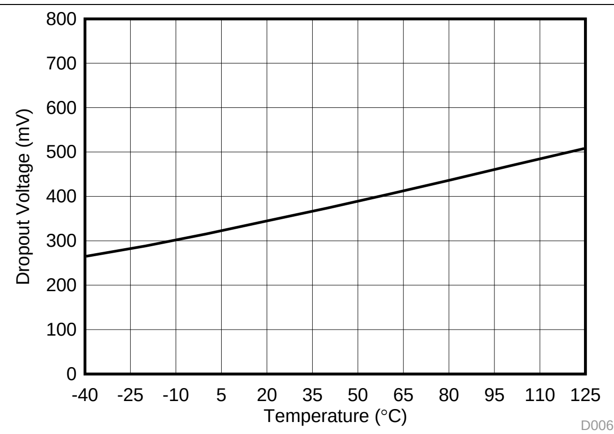
V_{OUT} = 5 V

Figure 4. Quiescent Current vs Ambient Temperature



V_{IN} = 5 V 5-V fixed output $V_{(Dropout)} = V_{IN} – V_{OUT}$

Figure 5. Dropout Voltage vs Output Current

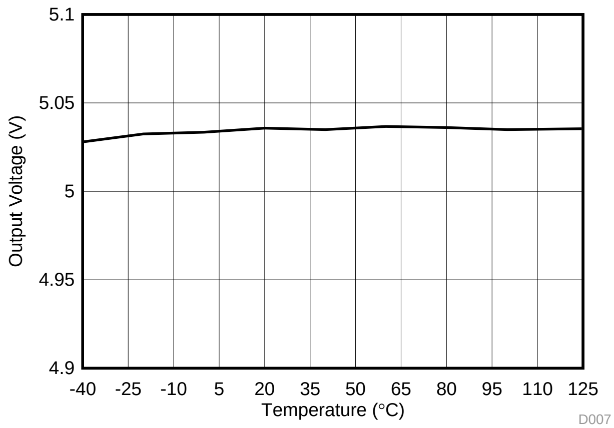


V_{IN} = 5 V 5-V fixed output $V_{(Dropout)} = V_{IN} – V_{OUT}$

Figure 6. Dropout Voltage vs Ambient Temperature

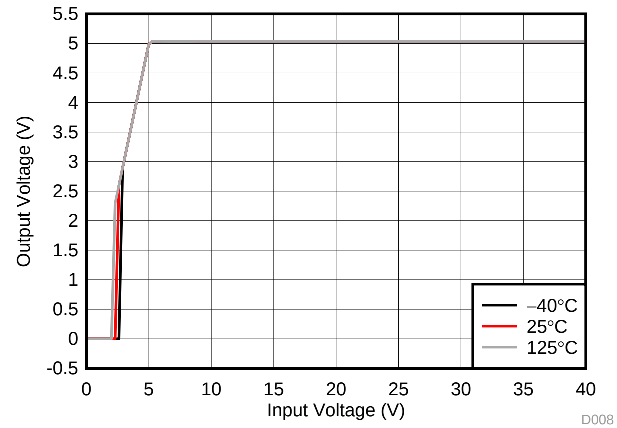
Typical Characteristics (continued)

V_{IN} = 14 V, V_{EN} ≥ 2 V, T_J = –40ºC to 150ºC unless otherwise noted



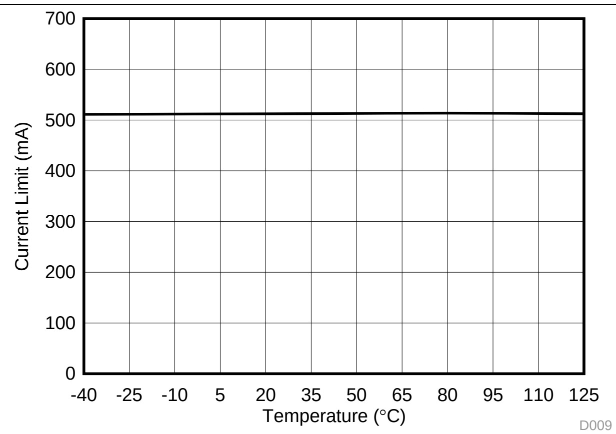
V_{OUT} = 5 V

Figure 7. Output Voltage vs Ambient Temperature



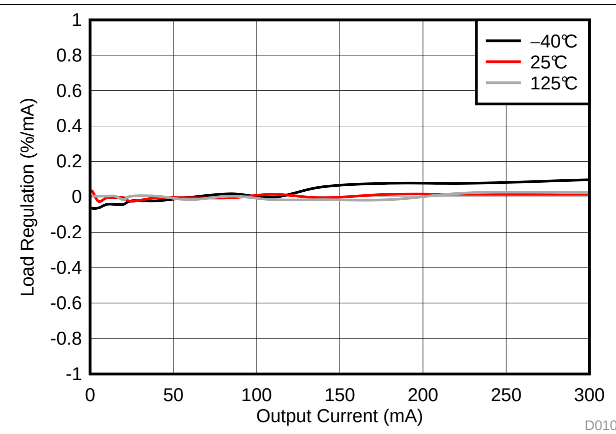
V_{OUT} = 5 V I_{OUT} = 1 mA

Figure 8. Output Voltage vs Input Voltage



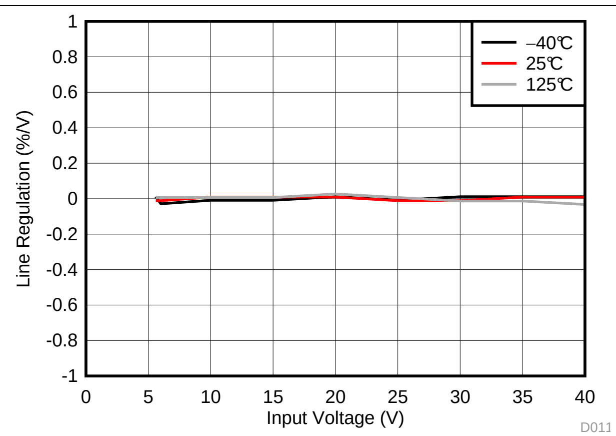
V_{IN} = 14 V V_{OUT} is shorted to 90% × V_{OUT}

Figure 9. Output Current Limit vs Ambient Temperature



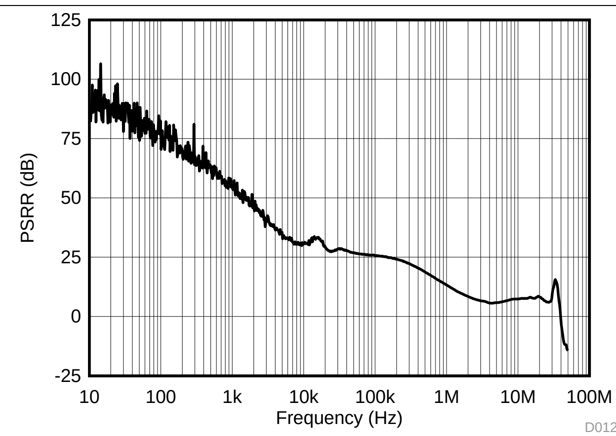
V_{OUT} = 5 V

Figure 10. Load Regulation



V_{OUT} = 5 V I_{OUT} = 10 mA

Figure 11. Line Regulation

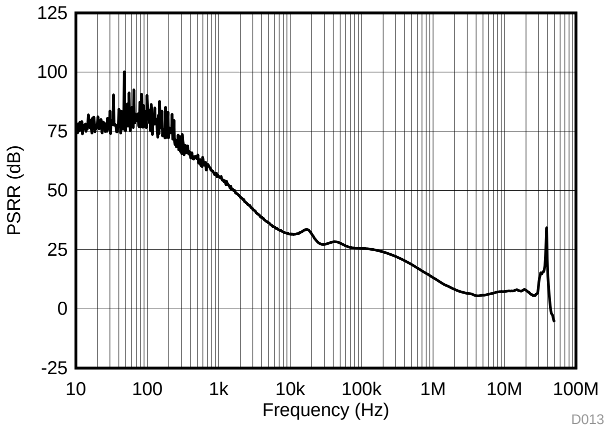


I_{OUT} = 10 mA

Figure 12. PSRR vs Frequency

Typical Characteristics (continued)

V_{IN} = 14 V, V_{EN} ≥ 2 V, T_J = –40ºC to 150ºC unless otherwise noted



I_{OUT} = 100 mA

Figure 13. PSRR vs Frequency

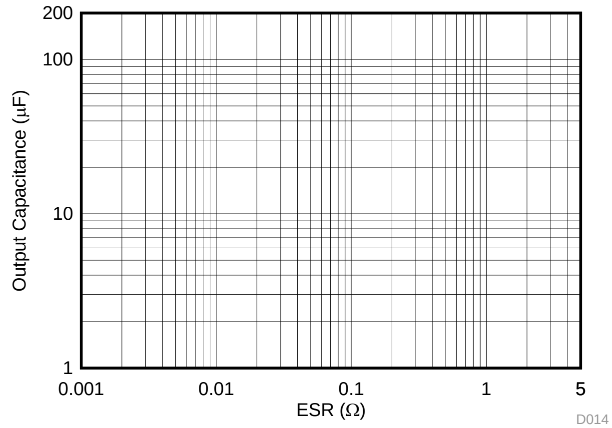


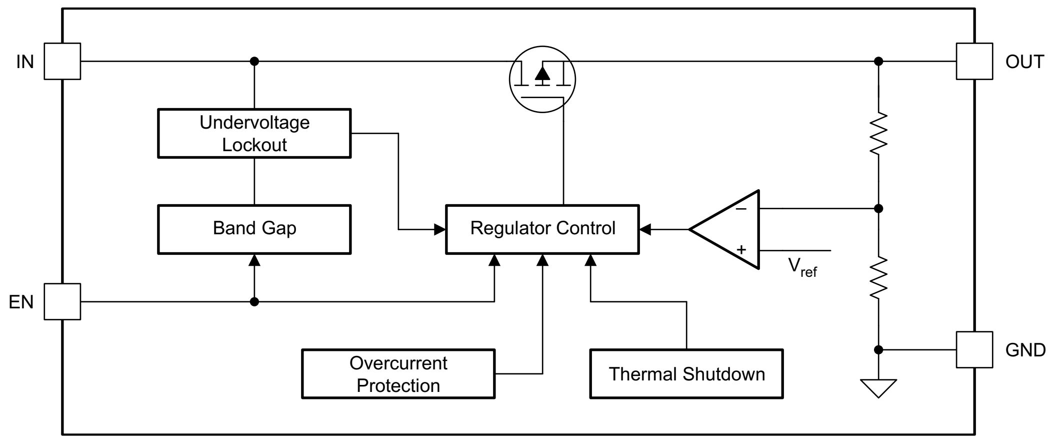
Figure 14. ESR Stability vs Output Capacitance

7 Detailed Description

7.1 Overview

The TPS7B82-Q1 is a family of 40-V 300-mA low-dropout linear regulators with ultralow quiescent current. These voltage regulators consume only 3 µA of quiescent current at light load, and are quite suitable 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_{IN}) falls below an internal UVLO threshold ($V_{(UVLO)}$). This ensures that the regulator does not latch into an unknown state during low-input-voltage conditions. If the input voltage has a negative transient which drops below the UVLO threshold and recovers, the regulator shuts down and powers up with a normal power-up sequence once 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 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 $I_{(LIM)}$ 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 should 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. Customers should validate and test their design implementation to confirm system functionality.

8.1 Application Information

The TPS7B82-Q1 device is a 300-mA 40-V low-dropout linear regulator with ultralow 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 15 shows a typical application circuit for the TPS7B82-Q1 device. 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. TI recommends using a low-ESR ceramic capacitor with a dielectric of type X5R or X7R.

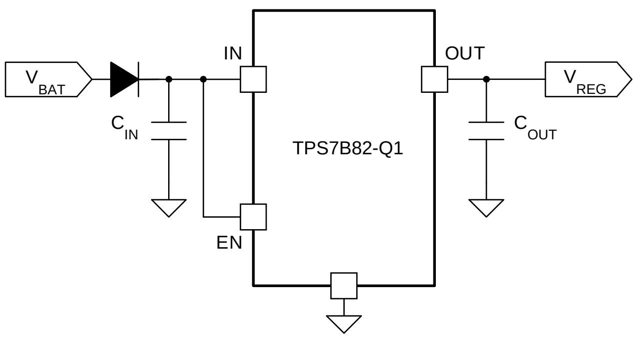


Figure 15. TPS7B82-Q1 Typical Application Schematic

8.2.1 Design Requirements

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

Table 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

When using the TPS7B82-Q1 device, TI recommends adding a 10-µF to 22-µF capacitor with a 0.1–µF bypass capacitor in parallel at the input to keep the input voltage stable. 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 device, the device requires an output capacitor with a value in the range from 1 μF to 200 μF and with an ESR range between 0.001 Ω and 5 Ω. TI recommends selecting a ceramic capacitor with low ESR to improve the load transient response.

8.2.3 Application Curve

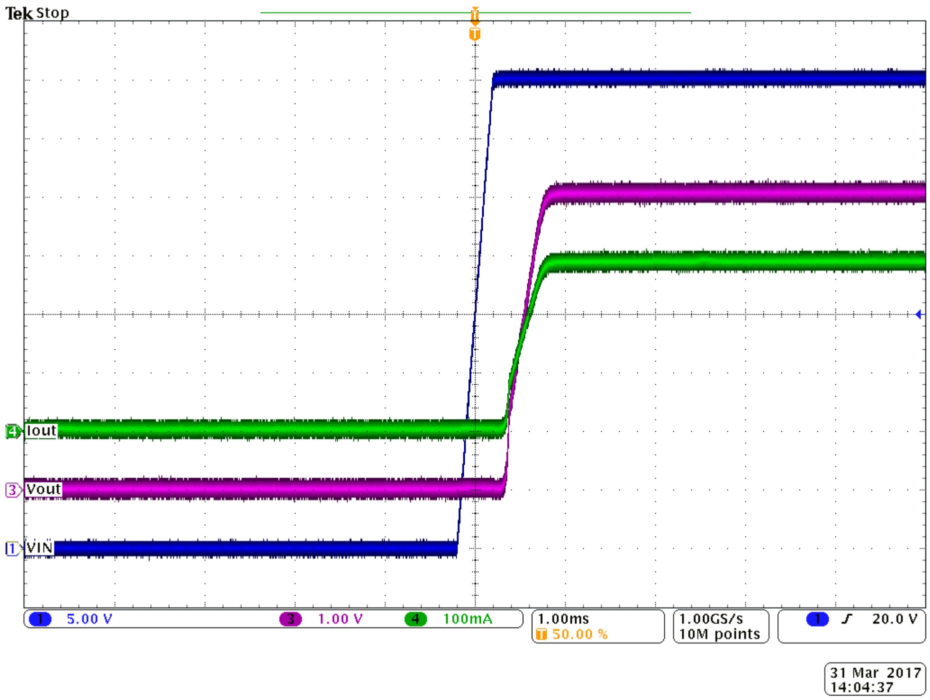


Figure 16. TPS7B82-Q1 Power-Up Waveform (5 V)

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 device, TI recommends adding a capacitor with a value greater than or equal to 10 μF with a 0.1-μF bypass capacitor in parallel at the input.

10 Layout

10.1 Layout Guidelines

For LDO power supplies, especially these high-voltage and large-output-current ones, layout is an important step. If layout is not carefully designed, the regulator could fail to deliver enough output current because of thermal limitation. To improve the thermal performance of the device, and maximize the current output at high ambient temperature, it is recommended to spread the copper under the thermal pad as far as possible and put enough thermal vias on the copper under the thermal pad. Figure 17 shows an example layout.

10.2 Layout Example

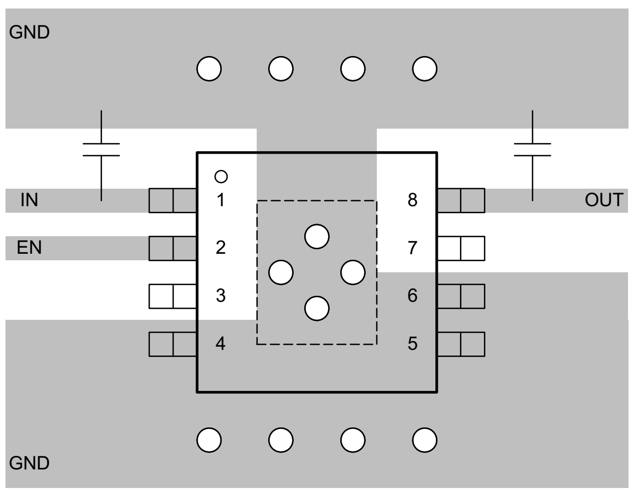


Figure 17. TPSB82-Q1 Example Layout Diagram

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

11.2 Community Resources

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.

11.3 Trademarks

PowerPAD, E2E are trademarks of Texas Instruments.
All other trademarks are the property of their respective owners.

11.4 Electrostatic Discharge Caution

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.

11.5 Glossary

SLYZ022 — *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.

PACKAGE OPTION ADDENDUM

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TPS7B8233QDGNRQ1	PREVIEW	MSOP-PowerPAD	DGN	8	2500	TBD	Call TI	Call TI	-40 to 150		
TPS7B8250QDGNRQ1	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	19TX	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.
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.

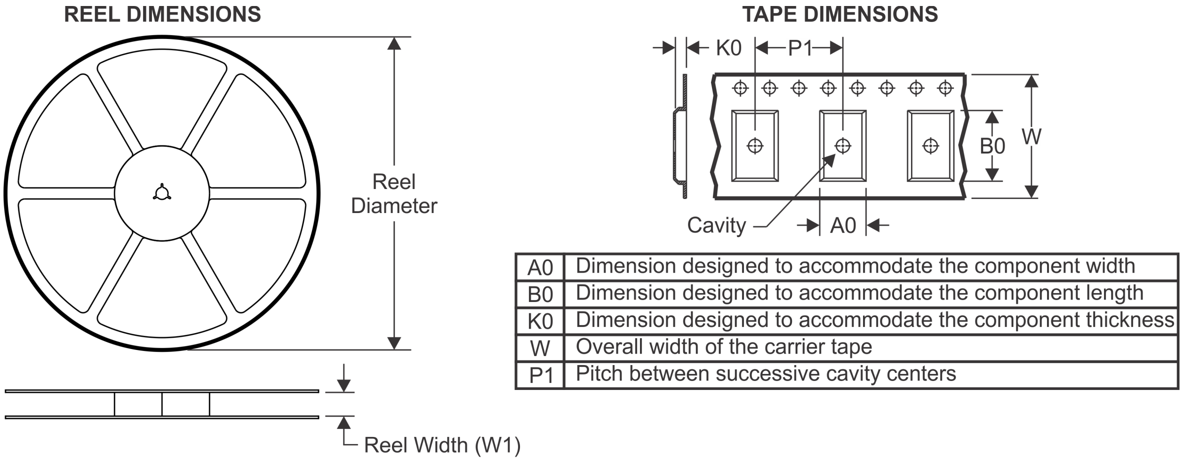
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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.

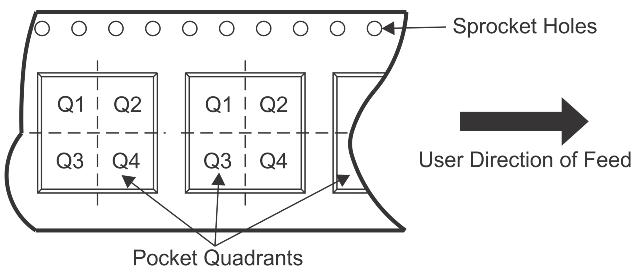
Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information.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



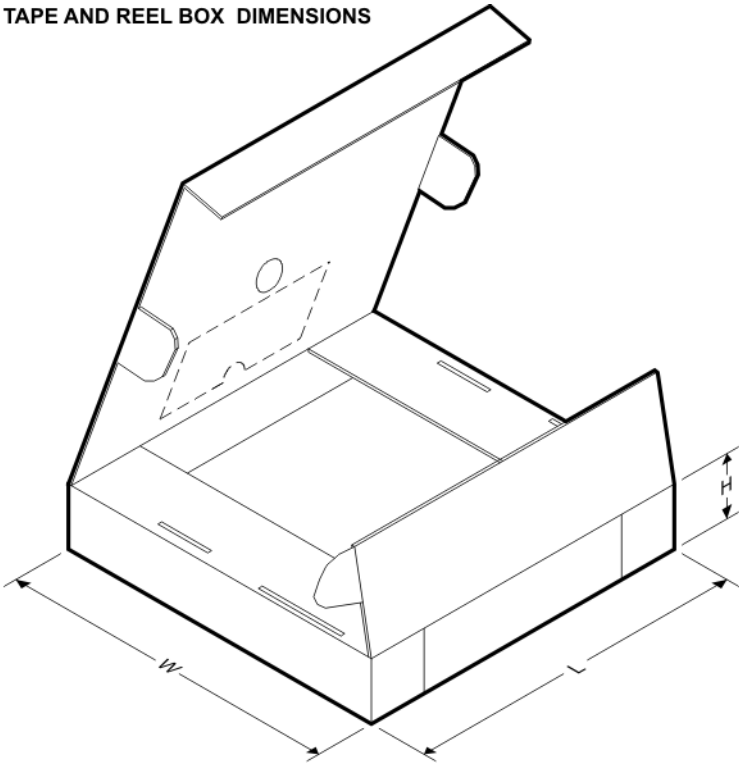
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS7B8250QDGNRQ1	MSOP-PowerPAD	DGN	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1

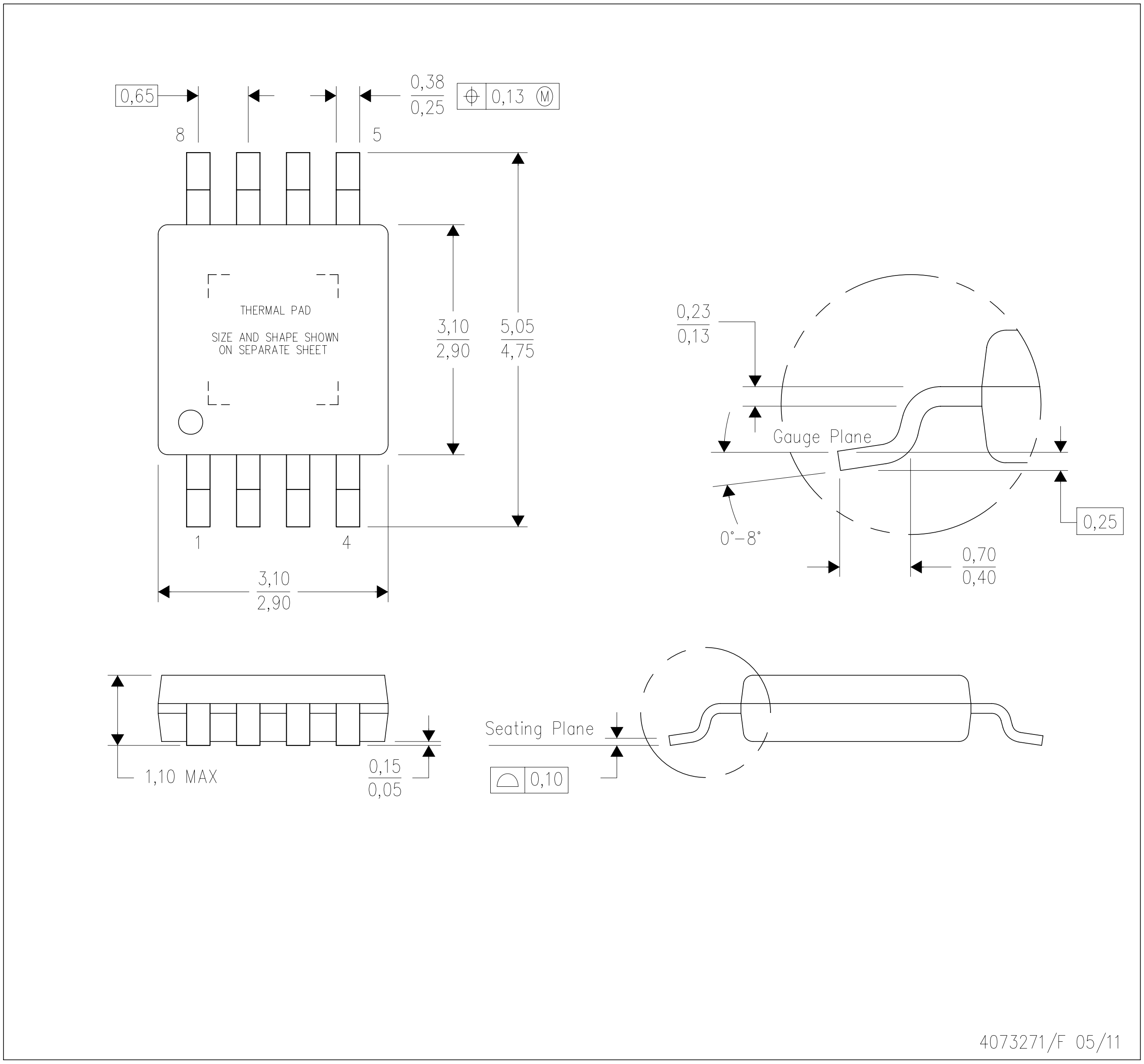
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS7B8250QDGNRQ1	MSOP-PowerPAD	DGN	8	2500	366.0	364.0	50.0

DGN (S-PDSO-G8) PowerPAD™ PLASTIC SMALL OUTLINE



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.
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 for information regarding recommended board layout. This document is available at www.ti.com <http://www.ti.com>.
E. See the additional figure in the Product Data Sheet for details regarding the exposed thermal pad features and dimensions.
F. Falls within JEDEC MO-187 variation AA-T

PowerPAD is a trademark of Texas Instruments.

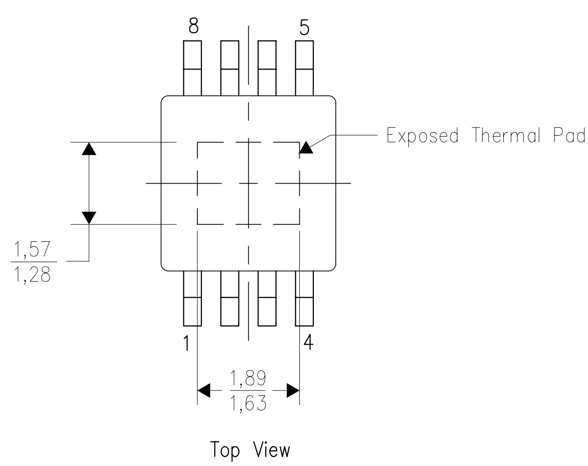
DGN (S–PDSO–G8) PowerPAD™ PLASTIC SMALL OUTLINE

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.

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



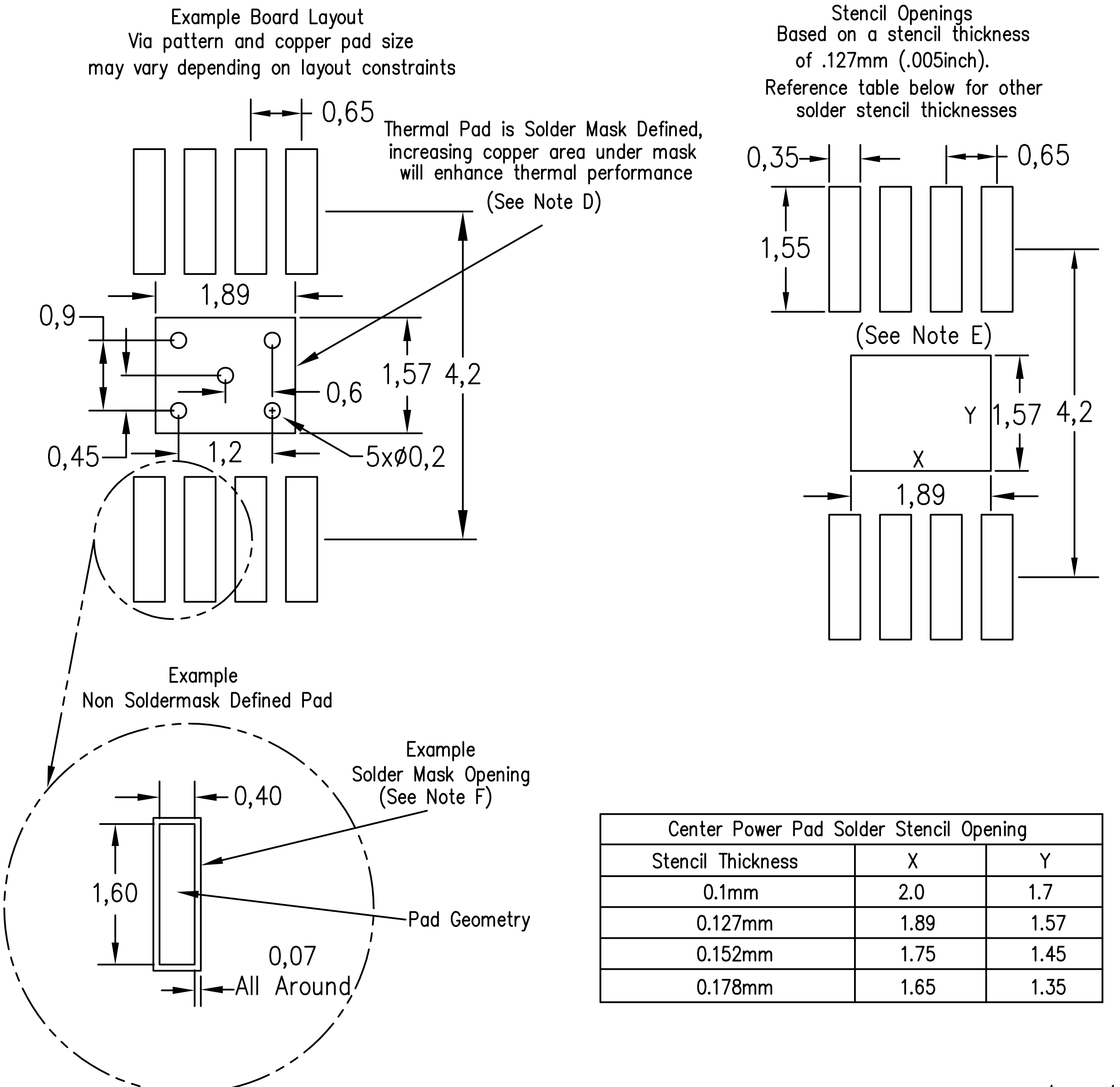
Exposed Thermal Pad Dimensions

4206323–2/I 12/11

NOTE: All linear dimensions are in millimeters

PowerPAD is a trademark of Texas Instruments

DGN (R–PDSO–G8) PowerPAD™ PLASTIC SMALL OUTLINE



Center Power Pad Solder Stencil Opening		
Stencil Thickness	X	Y
0.1mm	2.0	1.7
0.127mm	1.89	1.57
0.152mm	1.75	1.45
0.178mm	1.65	1.35

4207737-2/F 02/13

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>.
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.

IMPORTANT NOTICE

Texas Instruments Incorporated (TI) reserves the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete.

TI's published terms of sale for semiconductor products (http://www.ti.com/sc/docs/stdterms.htm) apply to the sale of packaged integrated circuit products that TI has qualified and released to market. Additional terms may apply to the use or sale of other types of TI products and services.

Reproduction of significant portions of TI information in TI data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such reproduced documentation. Information of third parties may be subject to additional restrictions. Resale of TI products or services with statements different from or beyond the parameters stated by TI for that product or service voids all express and any implied warranties for the associated TI product or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyers and others who are developing systems that incorporate TI products (collectively, "Designers") understand and agree that Designers remain responsible for using their independent analysis, evaluation and judgment in designing their applications and that Designers have full and exclusive responsibility to assure the safety of Designers' applications and compliance of their applications (and of all TI products used in or for Designers' applications) with all applicable regulations, laws and other applicable requirements. Designer represents that, with respect to their applications, Designer has all the necessary expertise to create and implement safeguards that (1) anticipate dangerous consequences of failures, (2) monitor failures and their consequences, and (3) lessen the likelihood of failures that might cause harm and take appropriate actions. Designer agrees that prior to using or distributing any applications that include TI products, Designer will thoroughly test such applications and the functionality of such TI products as used in such applications.

TI's provision of technical, application or other design advice, quality characterization, reliability data or other services or information, including, but not limited to, reference designs and materials relating to evaluation modules, (collectively, "TI Resources") are intended to assist designers who are developing applications that incorporate TI products; by downloading, accessing or using TI Resources in any way, Designer (individually or, if Designer is acting on behalf of a company, Designer's company) agrees to use any particular TI Resource solely for this purpose and subject to the terms of this Notice.

TI's provision of TI Resources does not expand or otherwise alter TI's applicable published warranties or warranty disclaimers for TI products, and no additional obligations or liabilities arise from TI providing such TI Resources. TI reserves the right to make corrections, enhancements, improvements and other changes to its TI Resources. TI has not conducted any testing other than that specifically described in the published documentation for a particular TI Resource.

Designer is authorized to use, copy and modify any individual TI Resource only in connection with the development of applications that include the TI product(s) identified in such TI Resource. NO OTHER LICENSE, EXPRESS OR IMPLIED, BY ESTOPPEL OR OTHERWISE TO ANY OTHER TI INTELLECTUAL PROPERTY RIGHT, AND NO LICENSE TO ANY TECHNOLOGY OR INTELLECTUAL PROPERTY RIGHT OF TI OR ANY THIRD PARTY IS GRANTED HEREIN, including but not limited to any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI products or services are used. Information regarding or referencing third-party products or services does not constitute a license to use such products or services, or a warranty or endorsement thereof. Use of TI Resources may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

TI RESOURCES ARE PROVIDED "AS IS" AND WITH ALL FAULTS. TI DISCLAIMS ALL OTHER WARRANTIES OR REPRESENTATIONS, EXPRESS OR IMPLIED, REGARDING RESOURCES OR USE THEREOF, INCLUDING BUT NOT LIMITED TO ACCURACY OR COMPLETENESS, TITLE, ANY EPIDEMIC FAILURE WARRANTY AND ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE, AND NON-INFRINGEMENT OF ANY THIRD PARTY INTELLECTUAL PROPERTY RIGHTS. TI SHALL NOT BE LIABLE FOR AND SHALL NOT DEFEND OR INDEMNIFY DESIGNER AGAINST ANY CLAIM, INCLUDING BUT NOT LIMITED TO ANY INFRINGEMENT CLAIM THAT RELATES TO OR IS BASED ON ANY COMBINATION OF PRODUCTS EVEN IF DESCRIBED IN TI RESOURCES OR OTHERWISE. IN NO EVENT SHALL TI BE LIABLE FOR ANY ACTUAL, DIRECT, SPECIAL, COLLATERAL, INDIRECT, PUNITIVE, INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES IN CONNECTION WITH OR ARISING OUT OF TI RESOURCES OR USE THEREOF, AND REGARDLESS OF WHETHER TI HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES.

Unless TI has explicitly designated an individual product as meeting the requirements of a particular industry standard (e.g., ISO/TS 16949 and ISO 26262), TI is not responsible for any failure to meet such industry standard requirements.

Where TI specifically promotes products as facilitating functional safety or as compliant with industry functional safety standards, such products are intended to help enable customers to design and create their own applications that meet applicable functional safety standards and requirements. Using products in an application does not by itself establish any safety features in the application. Designers must ensure compliance with safety-related requirements and standards applicable to their applications. Designer may not use any TI products in life-critical medical equipment unless authorized officers of the parties have executed a special contract specifically governing such use. Life-critical medical equipment is medical equipment where failure of such equipment would cause serious bodily injury or death (e.g., life support, pacemakers, defibrillators, heart pumps, neurostimulators, and implantables). Such equipment includes, without limitation, all medical devices identified by the U.S. Food and Drug Administration as Class III devices and equivalent classifications outside the U.S.

TI may expressly designate certain products as completing a particular qualification (e.g., Q100, Military Grade, or Enhanced Product). Designers agree that it has the necessary expertise to select the product with the appropriate qualification designation for their applications and that proper product selection is at Designers' own risk. Designers are solely responsible for compliance with all legal and regulatory requirements in connection with such selection.

Designer will fully indemnify TI and its representatives against any damages, costs, losses, and/or liabilities arising out of Designer's non-compliance with the terms and provisions of this Notice.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265