TPS7A41 50V 输入电压、50mA 超高电压线性稳压器

1 特性

- 宽输入电压范围：7V 至 50V
- 准确度：
  - 标称：1%
  - 整个线路、负载和温度范围内：2.5%
- 低静态电流：25μA
- 关断时的静态电流：4.1μA
- 最大输出电流：50mA
- CMOS 逻辑电平兼容的使能引脚
- 可调节输出电压范围：约为 1.175V 至 48V
- 与陶瓷电容搭配工作时保持稳定:
  - 输入电容：≥ 1μF
  - 输出电容：≥ 4.7μF
- 压降电压：290mV
- 内置限流和热关断保护
- 封装方式：高散热性能的微型小外形尺寸封装 (MSOP)-8 PowerPAD™
- 工作温度范围：-40°C 至 125°C

2 应用

- 由工业用总线（具有高电压瞬态）供电的微处理器、微控制器
- 工业自动化
- 电信基础设施
- 车用
- 发光二极管 (LED) 照明
- 偏置电源

3 说明

TPS7A41 器件是一款能够耐受超高电压的线性稳压器，不仅融合了耐热增强型封装 (MSOP-8) 的优势，还能够承受持续直流电压或最高达 50V 的瞬态输入电压。

TPS7A41 与任何高于 4.7μF 的输出电容以及高于 1μF 的输入电容搭配使用时均可保持稳定（过热和浪涌保护）。鉴于这款器件的封装 (MSOP-8) 小巧且可能使用的输出电容也较小，因此实现起来只需占用非常小的电路板空间。此外，TPS7A41 还提供了一个与标准 CMOS 逻辑兼容的使能引脚 (EN)，用于使能低电流关断模式。

TPS7A41 具有热关断和电流限制功能，以便在故障情况下保护系统。MSOP-8 封装的工作温度范围为 T_J = -40°C 至 125°C。

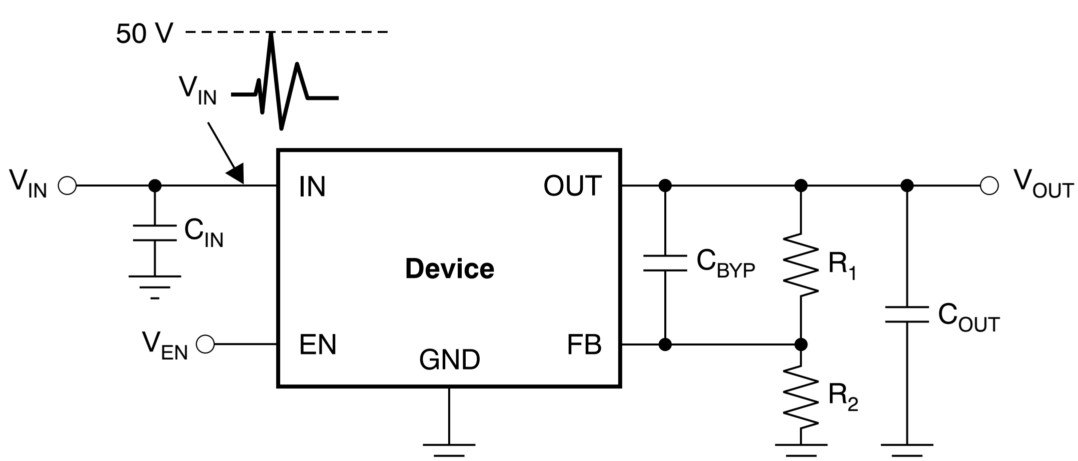
此外，TPS7A41 器件非常适合在电信和工业 应用中利用中间电压轨生成低压电源；该器件不但能够提供一个充分稳压的电压轨，而且能够承受超高的快速电压瞬变并在其间保持稳压状态。这些 功能 相当于一套更为简单且经济高效的电气浪涌保护电路，因此受到各类应用的 使用。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
TPS7A41	HVSSOP (8)	3.00mm x 3.00mm

(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。

典型应用图



目录

4 修订历史记录

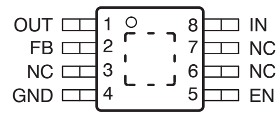
注：之前版本的页码可能与当前版本有所不同。

Changes from Original (December 2011) to Revision A — **Page**

- 已添加 *ESD 额定值表，特性 描述部分，器件功能模式，应用和实施部分，电源相关建议部分，布局部分，器件和文档支持部分以及机械、封装和可订购信息部分。* ... 1
- Changed maximum *Recommended Operation Conditions* values for VIN, VOUT, and VEN. ... 4

5 Pin Configuration and Functions

DGN Package
8-Pin HVSSOP
Top View



Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
OUT	1	O	Regulator output. A capacitor greater than 4.7 µF must be tied from this pin to ground to assure stability.
FB	2	I	This pin is the input to the control-loop error amplifier. It is used to set the output voltage of the device.
NC	3	—	Not internally connected. This pin must either be left open or tied to GND.
	6		
	7		
GND	4	—	Ground
EN	5	I	This pin turns the regulator on or off. If $V_{EN} \geq V_{EN\_HI}$ the regulator is enabled. If $V_{EN} \leq V_{EN\_LO}$, the regulator is disabled. If not used, the EN pin can be connected to IN. Make sure that $V_{EN} \leq V_{IN}$ at all times.
IN	8	I	Input supply
PowerPAD	—	—	Solder to printed-circuit-board (PCB) to enhance thermal performance. **NOTE: The PowerPAD is internally connected to GND.** Although it can be left floating, it is highly recommended to connect the PowerPAD to the GND plane.

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Voltage	IN pin to GND pin	–0.3	55	V
	OUT pin to GND pin	–0.3	55	V
	OUT pin to IN pin	–55	0.3	V
	FB pin to GND pin	–0.3	2	V
	FB pin to IN pin	–55	0.3	V
	EN pin to IN pin	–55	0.3	V
	EN pin to GND pin	–0.3	55	V
Current	Peak output	Internally limited		
Temperature	Operating junction temperature, T_J	–40	125	°C
	Storage, T_{stg}	–65	150	°C

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

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001 [1]	±2500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 [2]	±500	

(1) JEDEC document JEP155 states that 500-V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250-V CDM allows safe manufacturing with a standard ESD control process.

6.3 Recommended Operating Conditions

over operating junction temperature range (unless otherwise noted)

	MIN	NOM	MAX	UNIT
VIN	7		50	V
VOUT	1.161		48	V
VEN	0		50	V
IOUT	0		50	mA

6.4 Thermal Information

THERMAL METRIC [1]		TPS7A41 DGN (HVSSOP) 8 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	66.7	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	54.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	38.1	°C/W
ψ_{JT}	Junction-to-top characterization parameter	2	°C/W
ψ_{JB}	Junction-to-board characterization parameter	37.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	15.5	°C/W

(1) For more information about traditional and new thermal metrics, see the *Semiconductor and IC Package Thermal Metrics* application report, SPRA953.

6.5 Electrical Characteristics

At T_J = –40°C to 125°C, $V_{IN} = V_{OUT(NOM)}$ + 2 V or V_{IN} = 7 V (whichever is greater), $V_{EN} = V_{IN}$, I_{OUT} = 100 µA, C_{IN} = 1 µF, C_{OUT} = 4.7 µF, and FB tied to OUT, unless otherwise noted.

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IN}	Input voltage range		7		50	V
V_{REF}	Internal reference	T_J = 25°C, $V_{FB} = V_{REF}$, V_{IN} = 9 V, I_{OUT} = 25 mA	1.161	1.173	1.185	V
V_{OUT}	Output voltage range(1)	$V_{IN} \geq V_{OUT(NOM)}$ + 2 V	V_{REF}		48	V
	Nominal accuracy	T_J = 25°C, V_{IN} = 9 V, I_{OUT} = 25 mA	–1		1	$\%V_{OUT}$
	Overall accuracy	$V_{OUT(NOM)}$ + 2 V ≤ V_{IN} ≤ 24 V(2) 100 µA ≤ I_{OUT} ≤ 50 mA	–2.5		2.5	$\%V_{OUT}$
$\Delta V_{O(\Delta VI)}$	Line regulation	7 V ≤ V_{IN} ≤ 50 V		0.03		$\%V_{OUT}$
$\Delta V_{O(\Delta VL)}$	Load regulation	100 µA ≤ I_{OUT} ≤ 50 mA		0.31		$\%V_{OUT}$
V_{DO}	Dropout voltage	V_{IN} = 17 V, $V_{OUT(NOM)}$ = 18 V, I_{OUT} = 20 mA		290		mV
		V_{IN} = 17 V, $V_{OUT(NOM)}$ = 18 V, I_{OUT} = 50 mA		0.78	1.3	V
I_{LIM}	Current limit	V_{OUT} = 90% $V_{OUT(NOM)}$, V_{IN} = 7 V, T_J ≤ 85°C	51	117	200	mA
		V_{OUT} = 90% $V_{OUT(NOM)}$, V_{IN} = 9 V	51	128	200	mA
I_{GND}	Ground current	7 V ≤ V_{IN} ≤ 50 V, I_{OUT} = 0 mA		25	65	µA
		I_{OUT} = 50 mA		25		µA
I_{SHDN}	Shutdown supply current	V_{EN} = 0.4 V		4.1	20	µA
I_{FB}	Feedback current(3)		–0.1	0.01	0.1	µA
I_{EN}	Enable current	7 V ≤ V_{IN} ≤ 50 V, $V_{IN} = V_{EN}$		0.02	1	µA
V_{EN_HI}	Enable high-level voltage		1.5		V_{IN}	V
V_{EN_LO}	Enable low- level voltage		0		0.4	V
V_{NOISE}	Output noise voltage	V_{IN} = 12 V, $V_{OUT(NOM)} = V_{REF}$, C_{OUT} = 10 µF, BW = 10 Hz to 100 kHz		58		μV_{RMS}
		V_{IN} = 12 V, $V_{OUT(NOM)}$ = 5 V, C_{OUT} = 10 µF, C_{BYP}(4) = 10 nF, BW = 10 Hz to 100 kHz		73		μV_{RMS}
PSRR	Power-supply rejection ratio	V_{IN} = 12 V, $V_{OUT(NOM)}$ = 5 V, C_{OUT} = 10 µF, C_{BYP}(4) = 10 nF, f = 100 Hz		65		dB
T_{SD}	Thermal shutdown temperature	Shutdown, temperature increasing		170		°C
		Reset, temperature decreasing		150		°C
T_J	Operating junction temperature range		–40		125	°C

(1) To ensure stability at no-load conditions, a current from the feedback resistive network greater than or equal to 10 µA is required.
(2) Maximum input voltage is limited to 24 V because of the package power dissipation limitations at full load ($P \approx (V_{IN} - V_{OUT}) \times I_{OUT} = (24\ V - V_{REF}) \times 50\ mA \approx 1.14\ W$). The device is capable of sourcing a maximum current of 50 mA at higher input voltages as long as the power dissipated is within the thermal limits of the package plus any external heatsinking.
(3) I_{FB} > 0 flows out of the device.
(4) C_{BYP} refers to a bypass capacitor connected to the FB and OUT pins.

6.6 Dissipation Ratings

BOARD	PACKAGE	$R_{\theta JA}$	$R_{\theta JC}$	DERATING FACTOR ABOVE T_A = 25°C	T_A ≤ 25°C POWER RATING	T_A = 70°C POWER RATING	T_A = 85°C POWER RATING
High-K(1)	DGN	55.9°C/W	8.47°C/W	16.6 mW/°C	1.83 W	1.08 W	0.833 W

(1) The JEDEC High-K (2s2p) board design used to derive this data was a 3-inch x 3-inch multilayer board with 2-ounce internal power and ground planes and 2-ounce copper traces on top and bottom of the board.

6.7 Typical Characteristics

At T_J = –40°C to 125°C, V_{IN} = $V_{OUT(NOM)}$ + 2 V or V_{IN} = 9 V (whichever is greater), V_{EN} = V_{IN}, I_{OUT} = 100 µA, C_{IN} = 1 µF, C_{OUT} = 4.7 µF, and FB tied to OUT, unless otherwise noted.

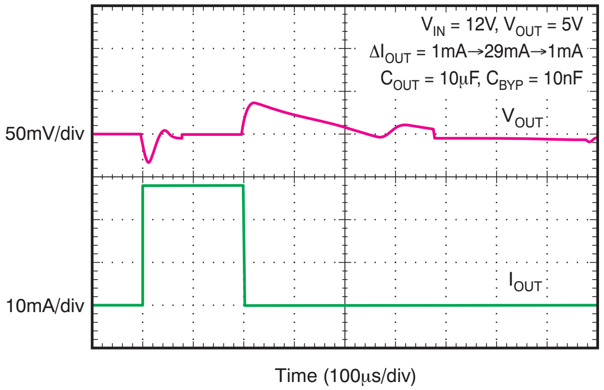


Figure 1. Load Transient Response

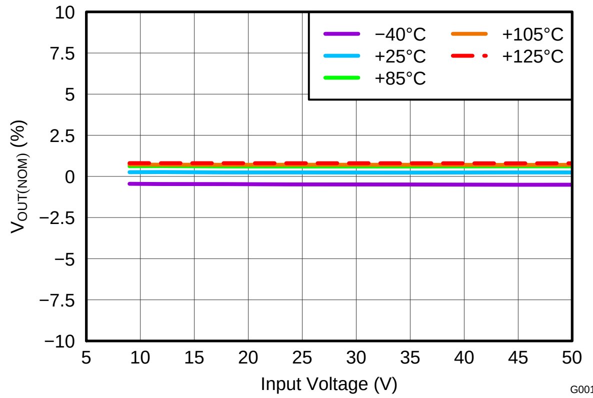


Figure 2. Line Regulation

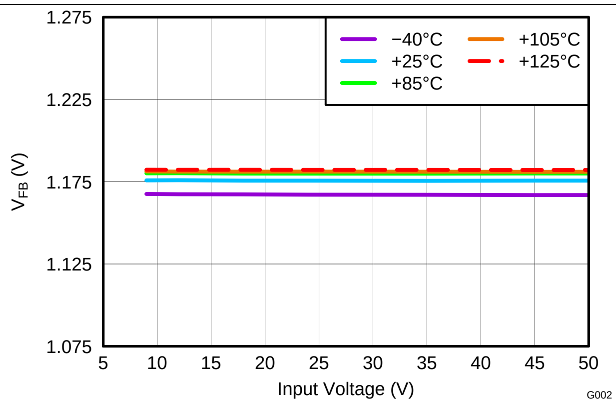


Figure 3. Feedback Voltage

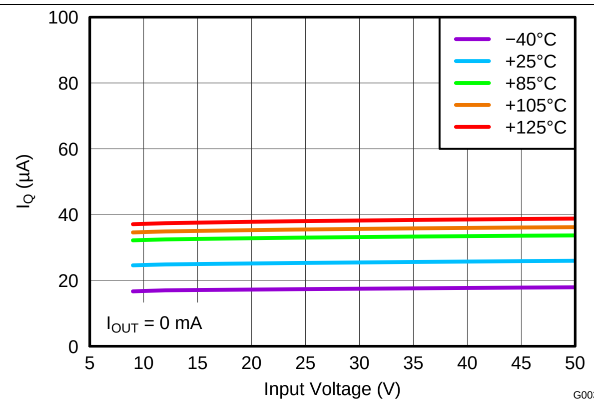


Figure 4. Quiescent Current vs Input Voltage

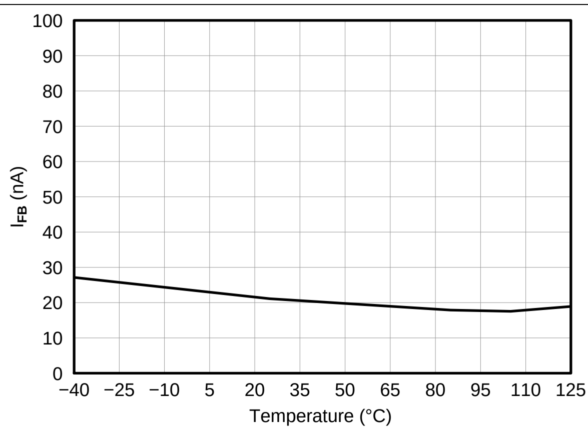


Figure 5. Feedback Current

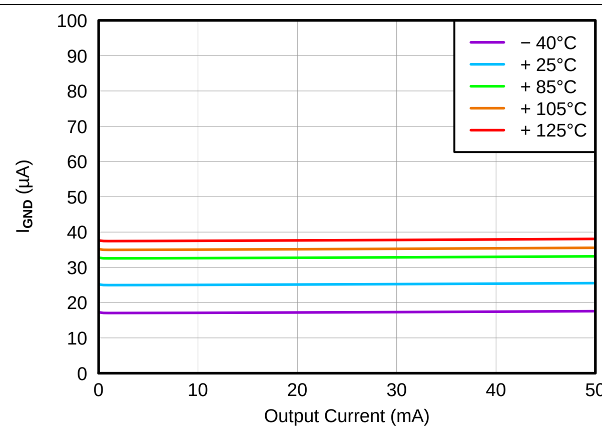


Figure 6. Ground Current

11 器件和文档支持

11.1 社区资源

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.

11.2 商标

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11.3 静电放电警告

这些装置包含有限的内置 ESD 保护。 存储或装卸时，应将导线一起截短或将装置放置于导电泡棉中，以防止 MOS 门极遭受静电损伤。

11.4 Glossary

SLYZ022 — *TI Glossary*.

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

12 机械、封装和可订购信息

以下页中包括机械、封装和可订购信息。这些信息是针对指定器件可提供的最新数据。这些数据会在无通知且不对本文档进行修订的情况下发生改变。欲获得该数据表的浏览器版本，请查阅左侧的导航栏。

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数据转换器	www.ti.com.cn/dataconverters	消费电子	www.ti.com/consumer-apps
DLP® 产品	www.dlp.com	能源	www.ti.com/energy
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微控制器 (MCU)	www.ti.com.cn/microcontrollers		
RFID 系统	www.ti.com.cn/rfidsys		
OMAP应用处理器	www.ti.com/omap		
无线连通性	www.ti.com.cn/wirelessconnectivity	德州仪器在线技术支持社区	www.deyisupport.com

邮寄地址： 上海市浦东新区世纪大道1568 号，中建大厦32 楼邮政编码： 200122

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
TPS7A4101DGNR	ACTIVE	MSOP-PowerPAD	DGN	8	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SBB	Samples
TPS7A4101DGNT	ACTIVE	MSOP-PowerPAD	DGN	8	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	SBB	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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

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

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

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

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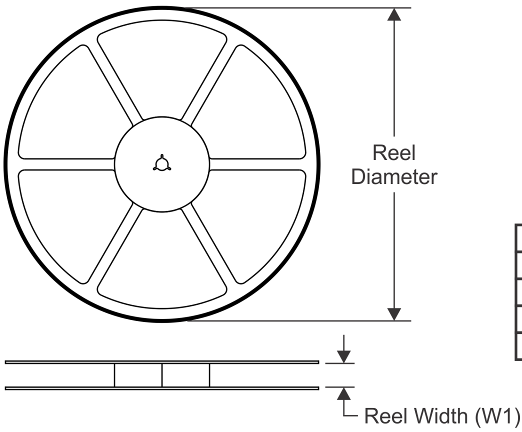
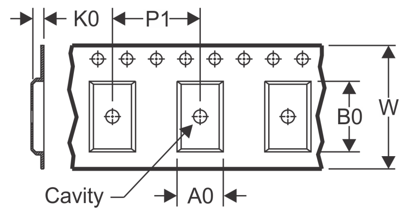
TAPE AND REEL INFORMATION

REEL DIMENSIONS

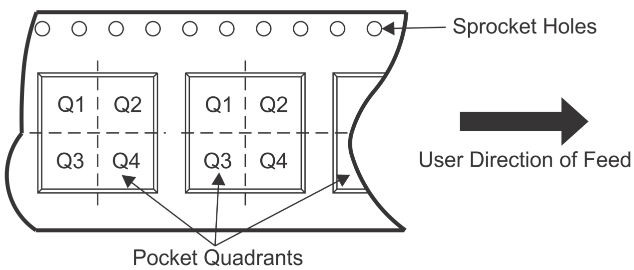


TAPE DIMENSIONS



A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

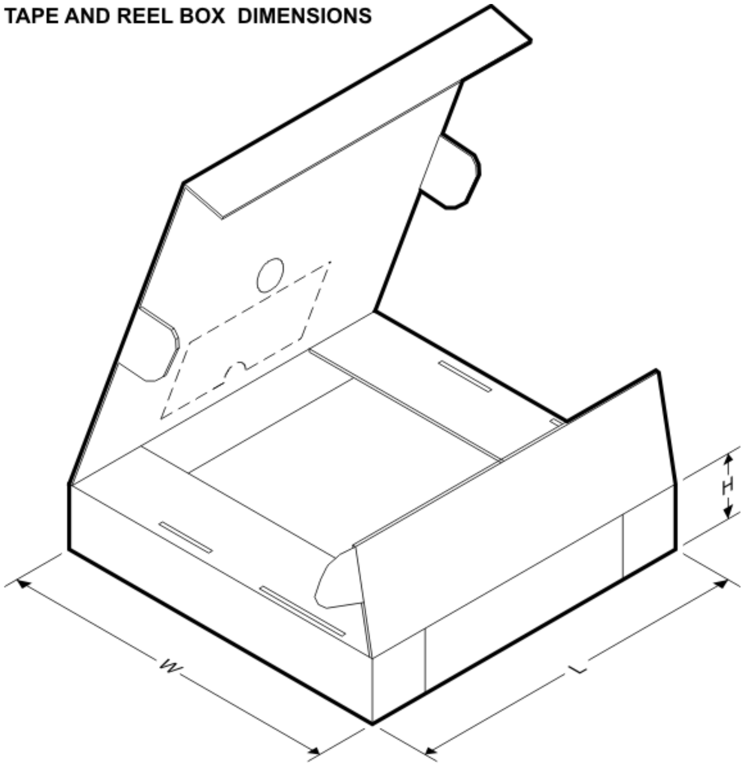
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TPS7A4101DGNR	MSOP-PowerPAD	DGN	8	2500	330.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1
TPS7A4101DGNT	MSOP-PowerPAD	DGN	8	250	180.0	12.4	5.3	3.3	1.3	8.0	12.0	Q1

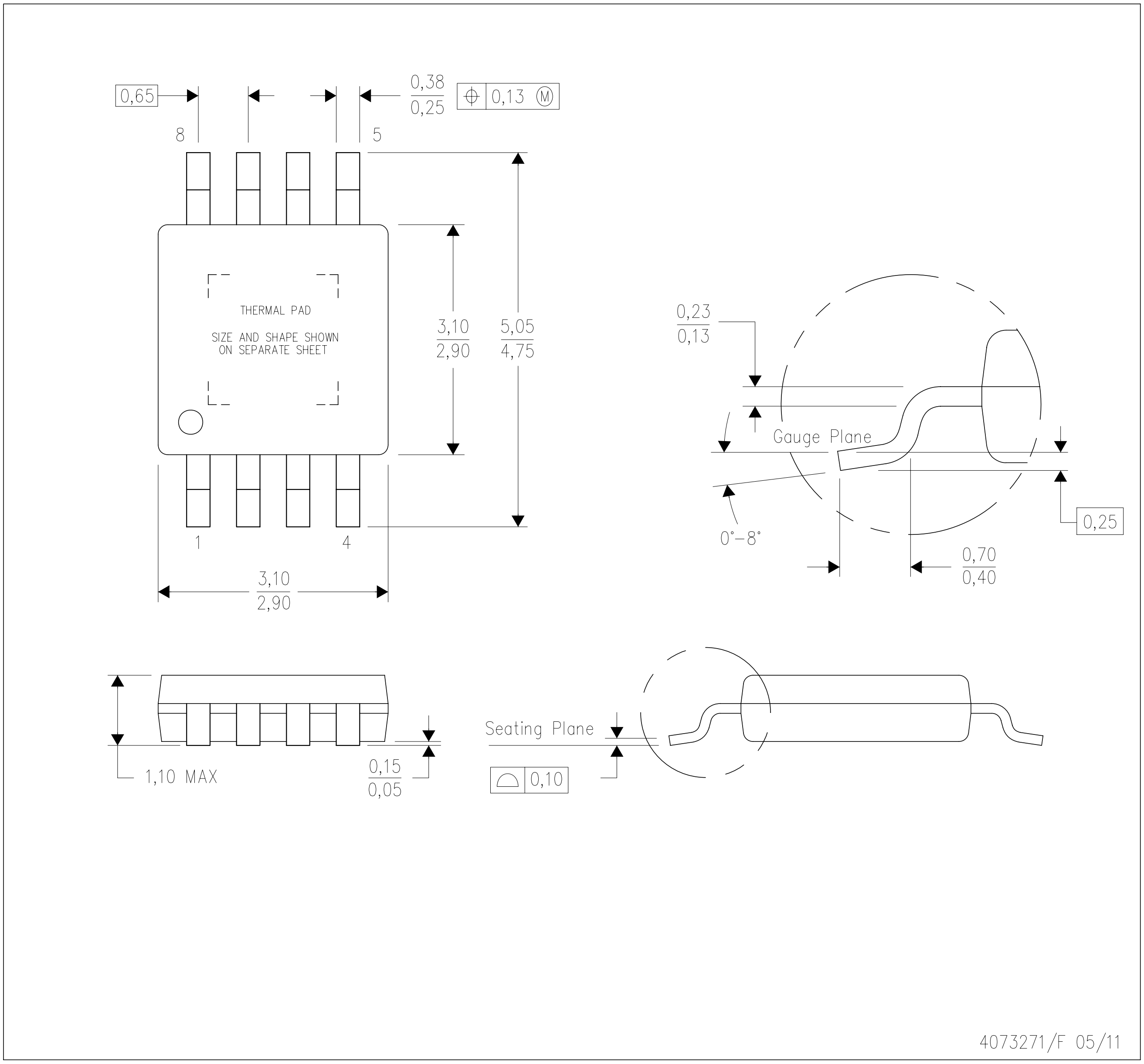
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TPS7A4101DGNR	MSOP-PowerPAD	DGN	8	2500	346.0	346.0	35.0
TPS7A4101DGNT	MSOP-PowerPAD	DGN	8	250	203.0	203.0	35.0

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.

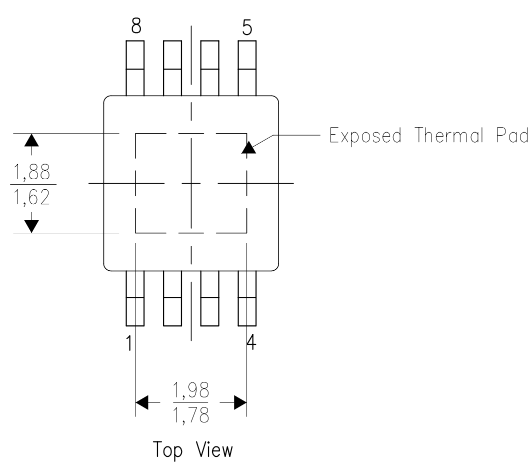
DGN (S-PDSO-G8) PowerPAD™ PLASTIC SMALL OUTLINE

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.



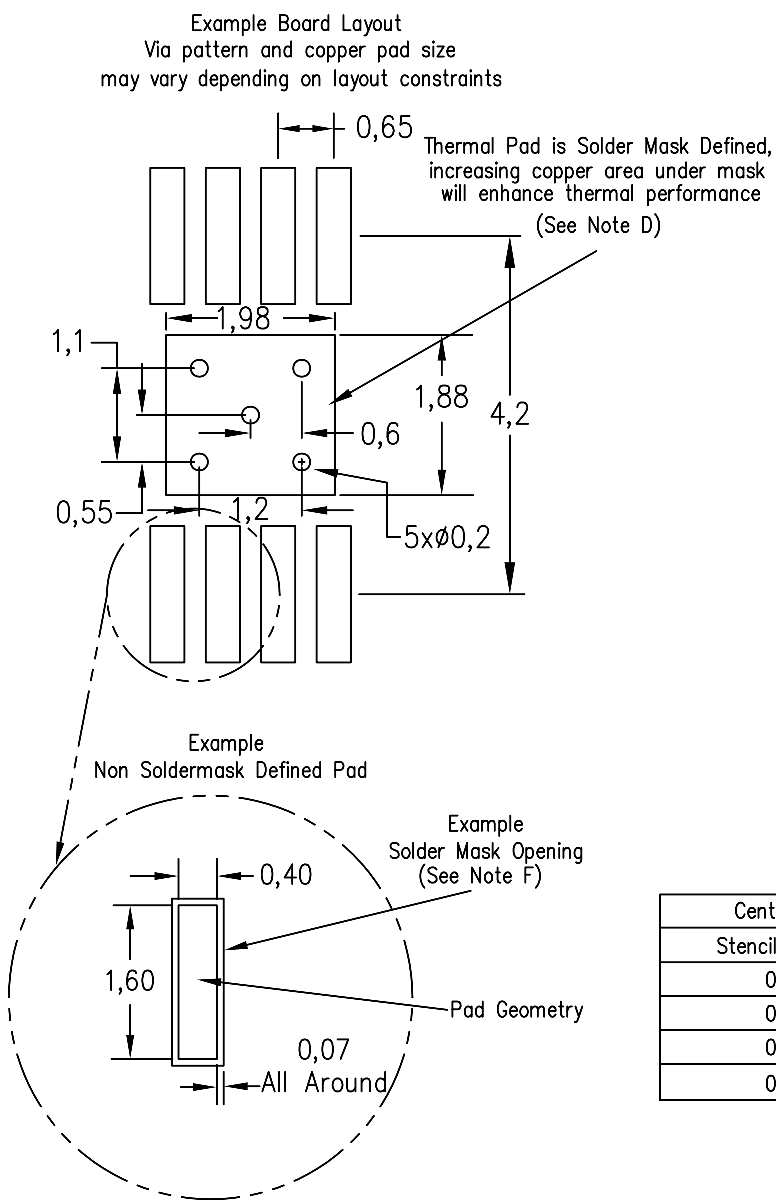
Exposed Thermal Pad Dimensions

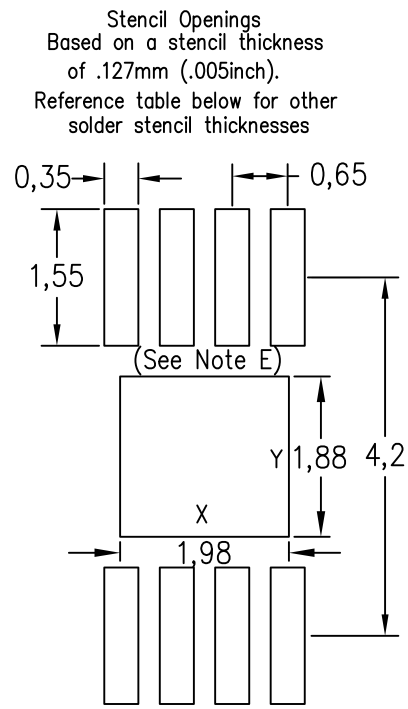
4206323-3/I 12/11

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	2.2	2.1
0.127mm	1.98	1.88
0.152mm	1.85	1.75
0.178mm	1.75	1.60

4207737–3/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.

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