DRV8837C 1A 低电压 H 桥驱动器

1 特性

- 独立的 H 桥电机
  - 驱动直流电机或其他负载
  - 低 MOSFET 导通电阻：HS + LS 1 Ω
- 1A 最大驱动电流
- 工作电源电压范围：0V 至 11V
- 标准脉宽调制 (PWM) 接口 (IN1/IN2)
- 低功耗休眠模式，休眠电流最大值仅为 120nA
  - nSLEEP 引脚
- 小型封装尺寸
  - 8 晶圆级小外形无引线 (WSON)（带外露散热焊盘）
  - 2.0mm × 2.0mm
- 保护 特性
  - VCC 欠压闭锁 (UVLO)
  - 过流保护 (OCP)
  - 热关断 (TSD)

2 应用范围

- 摄像机
- 数字单镜头反光 (DSLR) 镜头
- 消费类产品
- 玩具
- 机器人技术
- 医疗设备

3 说明

DRV8837C 器件提供了一套集成型电机驱动器解决方案，主要面向照相机、消费类产品、玩具以及其他低电压和电池供电类运动控制 应用。此器件能够驱动一个直流电机或其他诸如螺线管的器件。输出驱动器模块由配置为 H 桥的 N 沟道功率 MOSFET 组成，用以驱动电机绕组。一个内部电荷泵被用来生成所需的栅极驱动电压。

DRV8837C 器件可以提供高达 1A 的输出电流。该器件的电机电源电压为 0 至 11V，其控制逻辑工作电源轨为 1.8V 至 5V。

DRV8837C 器件有一个 PWM (IN/IN) 输入接口。

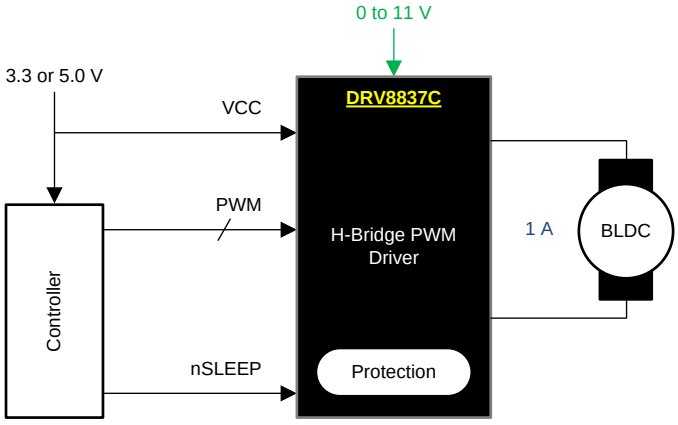
此外，还提供用于过流保护、短路保护、欠压闭锁和过热保护的内部关断功能。

器件信息(1)

器件型号	封装	封装尺寸（标称值）
DRV8837C	WSON (8)	2.00mm x 2.00mm

(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。

DRV8837C 简化框图



目录

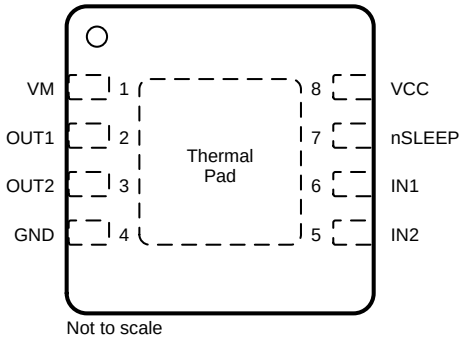
4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Original (July 2016) to Revision A	Page
• 已更改 器件状态，从*产品预览*更改为*量产数据*	1

5 Pin Configuration and Functions

DSG Package
8-Pin WSON With Exposed Thermal Pad
Top View



Not to scale

Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
POWER AND GROUND			
GND	4	PWR	Device ground This pin must be connected to the PCB ground.
VCC	8	PWR	Logic power supply Bypass this pin to the GND pin with a 0.1-µF ceramic capacitor rated for VCC.
VM	1	PWR	Motor power supply Bypass this pin to the GND pin with a 0.1-µF ceramic capacitor rated for VM.
CONTROL			
IN1	6	I	IN1 input
IN2	5	I	IN2 input
nSLEEP	7	I	Sleep mode input When this pin is in logic low, the device enters low-power sleep mode. The device operates normally when this pin is logic high. The pin has an internal pulldown resistor to GND.
OUTPUT			
OUT1	2	O	Motor output Connect this pin to the motor winding.
OUT2	3	O	

6 Specifications

6.1 Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)(1)(2)

		MIN	MAX	UNIT
Motor power-supply voltage	VM	–0.3	12	V
Logic power-supply voltage	V_{CC}	–0.3	7	V
Control pin voltage	IN1, IN2, nSLEEP	–0.5	7	V
Peak drive current	OUT1, OUT2	Internally limited		A
Operating virtual junction temperature, T_J		–40	150	ºC
Storage temperature, T_{stg}		–60	150	ºC

(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 under *Recommended Operating Conditions* is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
(2) All voltage values are with respect to network ground pin.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±4000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±1000	

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

6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V_{VM}	Motor power-supply voltage	0	11	V
V_{CC}	Logic power-supply voltage	1.8	7	V
I_{OUT}	Motor peak current	0	1	A
f_{PWM}	Externally applied PWM frequency	0	250	kHz
V_{LOGIC}	Logic level input voltage	0	5.5	V
T_A	Operating ambient temperature	–40	85	°C

6.4 Thermal Information

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

THERMAL METRIC (1)		DRV8837C DSG (WSON) 8 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	60.9	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	71.4	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	32.2	°C/W
ψ_{JT}	Junction-to-top characterization parameter	1.6	°C/W
ψ_{JB}	Junction-to-board characterization parameter	32.8	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	9.8	°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

T_A = 25°C, over recommended operating conditions unless otherwise noted

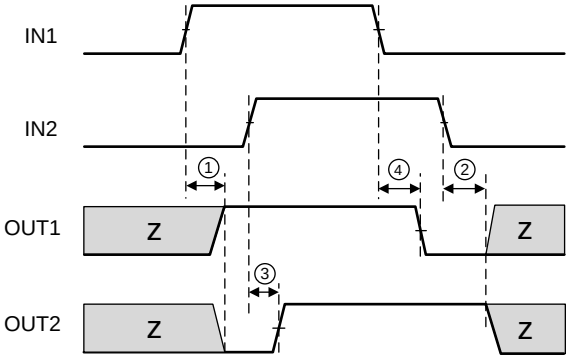
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLIES (VM, V_{CC})						
V_{VM}	VM operating voltage		0		11	V
I_{VM}	VM operating supply current	V_{VM} = 5 V; V_{CC} = 3 V; No PWM		40	100	μA
		V_{VM} = 5 V; V_{CC} = 3 V; 50 kHz PWM		0.8	1.5	mA
I_{VMQ}	VM sleep mode supply current	V_{VM} = 5 V; V_{CC} = 3 V; nSLEEP = 0		30	95	nA
V_{CC}	V_{CC} operating voltage		1.8		7	V
I_{VCC}	V_{CC} operating supply current	V_{VM} = 5 V; V_{CC} = 3 V; No PWM		300	500	μA
		V_{VM} = 5 V; V_{CC} = 3 V; 50 kHz PWM		0.7	1.5	mA
I_{VCCQ}	V_{CC} sleep mode supply current	V_{VM} = 5 V; V_{CC} = 3 V; nSLEEP = 0		5	25	nA
CONTROL INPUTS (IN1/PH, IN2/EN, nSLEEP)						
V_{IL}	Input logic-low voltage				0.25 × V_{CC}	V
V_{IH}	Input logic-high voltage		0.5 × V_{CC}			V
V_{HYS}	Input logic hysteresis			0.08 × V_{CC}		V
I_{IL}	Input logic-low current	V_{INx} = 0 V	–5		5	μA
I_{IH}	Input logic-high current	V_{INx} = 3.3 V			50	μA
R_{PD}	Pulldown resistance			100		kΩ
MOTOR DRIVER OUTPUTS (OUT1, OUT2)						
$R_{DS(ON)}$	HS + LS FET on-resistance	V_{VM} = 5 V; V_{CC} = 3.3 V; I_O = 200 mA; T_J = 25°C		1000		mΩ
I_{OFF}	Off-state leakage current	V_{OUTx} = 0 V	–200		200	nA
PROTECTION CIRCUITS						
V_{UVLO}	V_{CC} undervoltage lockout	V_{CC} falling			1.7	V
		V_{CC} rising			1.8	V
I_{OCP}	Overcurrent protection trip level		1.2			A
t_{DEG}	Overcurrent deglitch time			1		μs
t_{RETRY}	Overcurrent retry time			1		ms
T_{TSD} (1)	Thermal shutdown temperature	Die temperature T_J	150	160	180	°C

(1) Not tested in production; limits are based on characterization data

6.6 Timing Requirements

T_A = 25°C, V_{VM} = 5 V, V_{CC} = 3 V, RL = 20 Ω

NO.				MIN	MAX	UNIT
1	t_7	Output enable time	See 图 1.		300	ns
2	t_8	Output disable time			300	ns
3	t_9	Delay time, INx high to OUTx high			160	ns
4	t_{10}	Delay time, INx low to OUTx low			160	ns
5	t_{11}	Output rise time		20	188	ns
6	t_{12}	Output fall time		20	188	ns
—	t_{wake}	Wake time, nSLEEP rising edge to part active			30	µs



DRV8837C

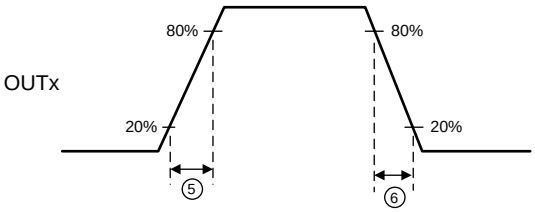


图 1. Input and Output Timing for DRV8837C

6.7 Typical Characteristics

Plots generated using characterization data.

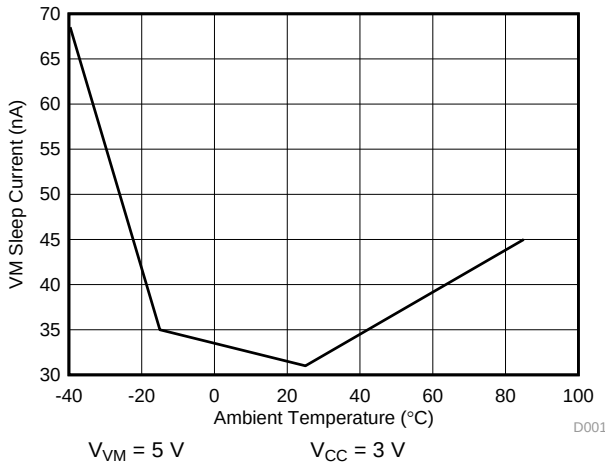


图 2. VM Sleep Current vs Ambient Temperature

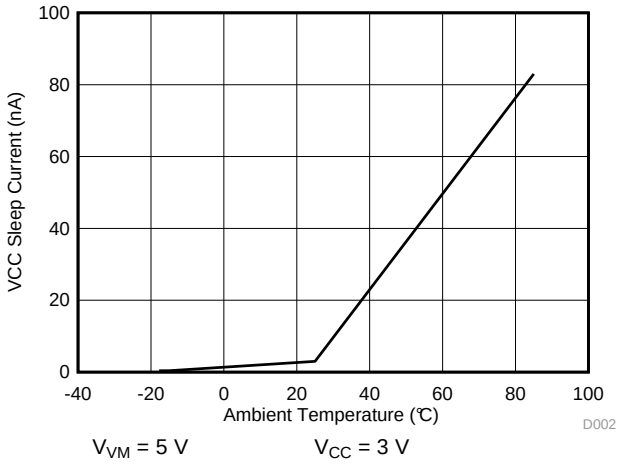


图 3. VCC Sleep Current vs Ambient Temperature

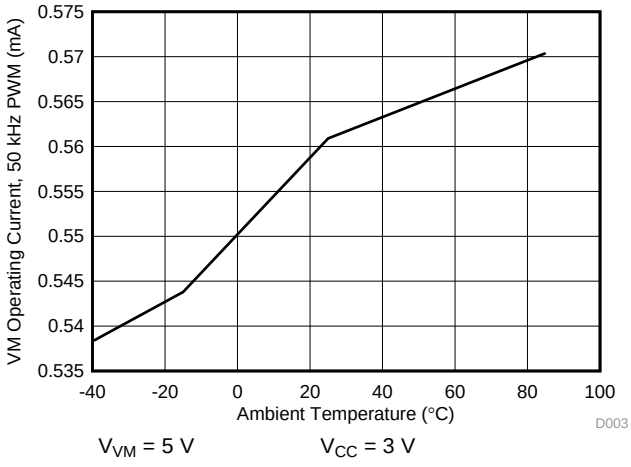


图 4. VM Operating Current vs Ambient Temperature

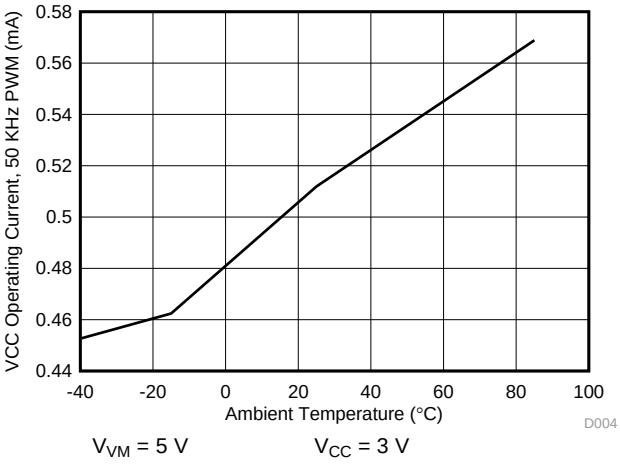


图 5. VCC Operating Current vs Ambient Temperature

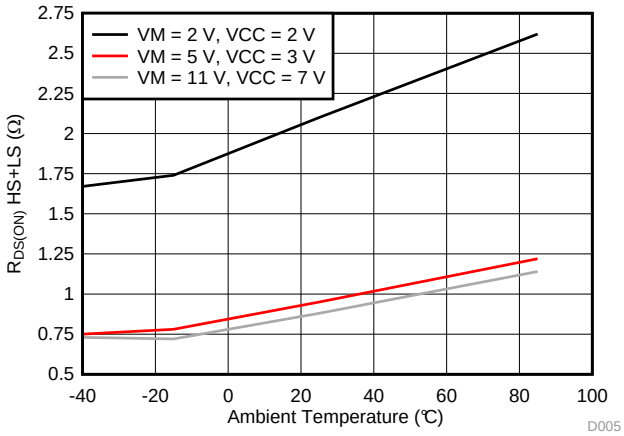


图 6. HS + LS $R_{DS(ON)}$ vs Ambient Temperature

7 Detailed Description

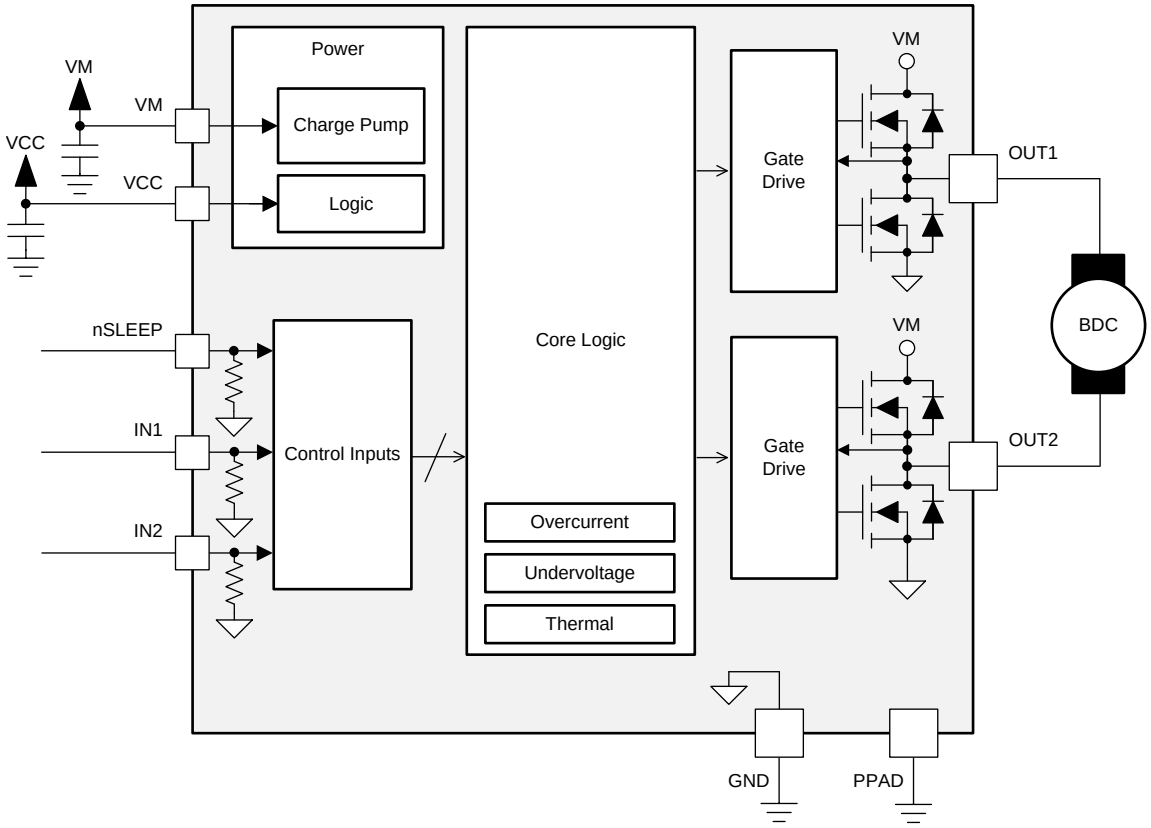
7.1 Overview

The DRV8837C device is an H-bridge driver that can drive one DC motor or other devices like solenoids. The outputs are controlled using a PWM interface (IN1/IN2).

A low-power sleep mode is included, which can be enabled using the nSLEEP pin.

This device greatly reduces the component count of motor driver systems by integrating the necessary driver FETs and FET control circuitry into a single device. In addition, the DRV8837C device adds protection features beyond traditional discrete implementations: undervoltage lockout, overcurrent protection, and thermal shutdown.

7.2 Functional Block Diagram



7.3 Feature Description

7.3.1 Bridge Control

The DRV8837C device is controlled using a PWM input interface, also called an IN/IN interface. Each output is controlled by a corresponding input pin.

表 1 shows the logic for the DRV8837C device.

表 1. DRV8837C Device Logic

nSLEEP	IN1	IN2	OUT1	OUT2	FUNCTION (DC MOTOR)
0	X	X	Z	Z	Coast
1	0	0	Z	Z	Coast
1	0	1	L	H	Reverse
1	1	0	H	L	Forward
1	1	1	L	L	Brake

7.3.2 Sleep Mode

If the nSLEEP pin is brought to a logic-low state, the DRV8837C device enters a low-power sleep mode. In this state, all unnecessary internal circuitry is powered down.

7.3.3 Power Supplies and Input Pins

The input pins can be driven within the recommended operating conditions with or without the VCC, VM, or both power supplies present. No leakage current path exists to the supply. Each input pin has a weak pulldown resistor (approximately 100 kΩ) to ground.

The VCC and VM supplies can be applied and removed in any order. When the VCC supply is removed, the device enters a low-power state and draws very little current from the VM supply. The VCC and VM pins can be connected together if the supply voltage is between 1.8 and 7 V.

The VM voltage supply does not have any undervoltage-lockout protection (UVLO). As long as V_{CC} > 1.8 V, the internal device logic remains active which means that the VM pin voltage can drop to 0 V, however, the load may not be sufficiently driven at low VM voltages.

7.3.4 Protection Circuits

The DRV8837C is fully protected against VCC undervoltage, overcurrent, and overtemperature events.

VCC undervoltage lockout If at any time the voltage on the VCC pin falls below the undervoltage lockout threshold voltage, all FETs in the H-bridge are disabled. Operation resumes when the VCC pin voltage rises above the UVLO threshold.

Overcurrent protection (OCP) An analog current-limit circuit on each FET limits the current through the FET by removing the gate drive. If this analog current limit persists for longer than t_{DEG}, all FETs in the H-bridge are disabled. Operation resumes automatically after t_{RETRY} has elapsed. Overcurrent conditions are detected on both the high-side and low-side devices. A short to the VM pin, GND, or from the OUT1 pin to theOUT2 pin results in an overcurrent condition.

Thermal shutdown (TSD) If the die temperature exceeds safe limits, all FETs in the H-bridge are disabled. After the die temperature falls to a safe level, operation automatically resumes.

表 2. Fault Behavior

FAULT	CONDITION	H-BRIDGE	RECOVERY
VCC undervoltage (UVLO)	VCC < 1.7 V	Disabled	VCC > 1.8 V
Overcurrent (OCP)	I_{OUT} > 1.2 A (MIN)	Disabled (retries automatically)	t_{RETRY} elapses
Thermal Shutdown (TSD)	T_J > 150°C (MIN)	Disabled (retries automatically)	T_J < 150°C

7.4 Device Functional Modes

The DRV8837C device is active unless the nSLEEP pin is brought logic low. In sleep mode the H-bridge FETs are disabled Hi-Z. The DRV8837C device is brought out of sleep mode automatically if nSLEEP is brought logic high.

The H-bridge outputs are disabled during undervoltage lockout, overcurrent, and overtemperature fault conditions.

表 3. Operation Modes

MODE	CONDITION	H-BRIDGE
Operating	nSLEEP pin = 1	Operating
Sleep mode	nSLEEP pin = 0	Disabled
Fault encountered	Any fault condition met	Disabled (retries automatically)

8 Application and Implementation

注

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 DRV8837C device is device is used to drive one DC motor or other devices like solenoids. The following design procedure can be used to configure the DRV8837C device.

8.2 Typical Application

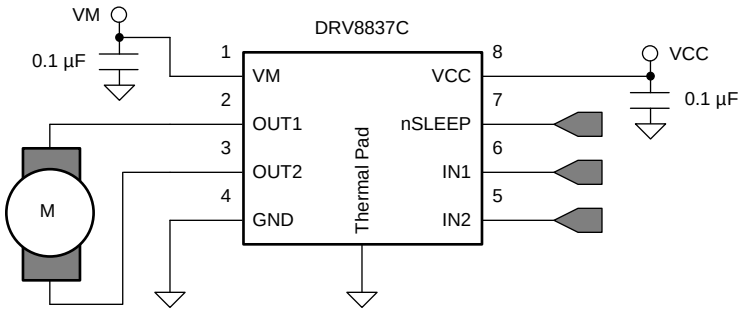


图 7. Schematic of DRV8837C Application

8.2.1 Design Requirements

表 4 lists the required parameters for a typical usage case.

表 4. System Design Requirements

DESIGN PARAMETER	REFERENCE	EXAMPLE VALUE
Motor supply voltage	VM	9 V
Logic supply voltage	VCC	3.3 V
Target RMS current	I_{OUT}	0.8 A

8.2.2 Detailed Design Procedure

8.2.2.1 Motor Voltage

The appropriate motor voltage depends on the ratings of the motor selected and the desired RPM. A higher voltage spins a brushed dc motor faster with the same PWM duty cycle applied to the power FETs. A higher voltage also increases the rate of current change through the inductive motor windings.

8.2.2.2 Low-Power Operation

When entering sleep mode, TI recommends setting all inputs as a logic low to minimize system power.

8.2.3 Application Curves

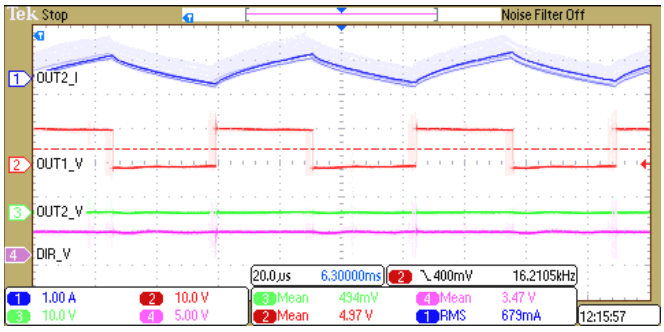


图 8. 50% Duty Cycle, Forward Direction

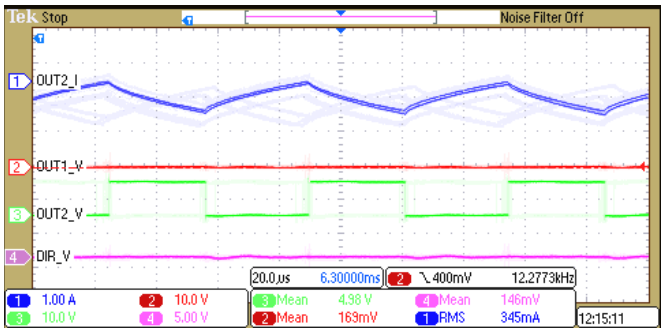


图 9. 50% Duty Cycle, Reverse Direction

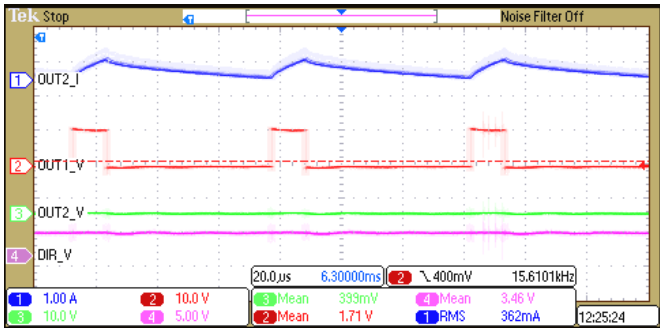


图 10. 20% Duty Cycle, Forward Direction

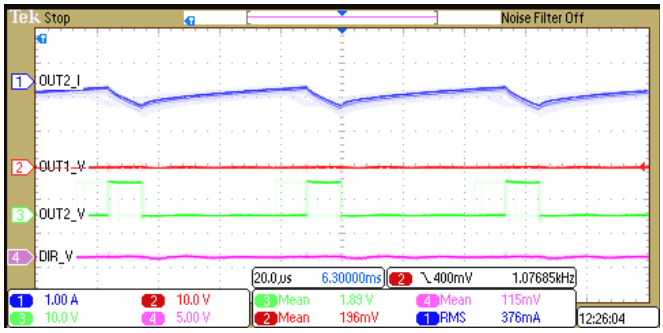


图 11. 20% Duty Cycle, Reverse Direction

9 Power Supply Recommendations

9.1 Bulk Capacitance

Having appropriate local bulk capacitance is an important factor in motor-drive system design. It is generally beneficial to have more bulk capacitance, while the disadvantages are increased cost and physical size.

The amount of local capacitance needed depends on a variety of factors, including:

- The highest current required by the motor system
- The power-supply capacitance and ability to source current
- The amount of parasitic inductance between the power supply and motor system
- The acceptable voltage ripple
- The type of motor used (brushed dc, brushless dc, stepper)
- The motor braking method

The inductance between the power supply and motor drive system limits the rate at which current can change from the power supply. If the local bulk capacitance is too small, the system responds to excessive current demands or dumps from the motor with a change in voltage. When adequate bulk capacitance is used, the motor voltage remains stable and high current can be quickly supplied.

The data sheet generally provides a recommended value, but system-level testing is required to determine the appropriate size of bulk capacitor.

Bulk Capacitance (接下页)

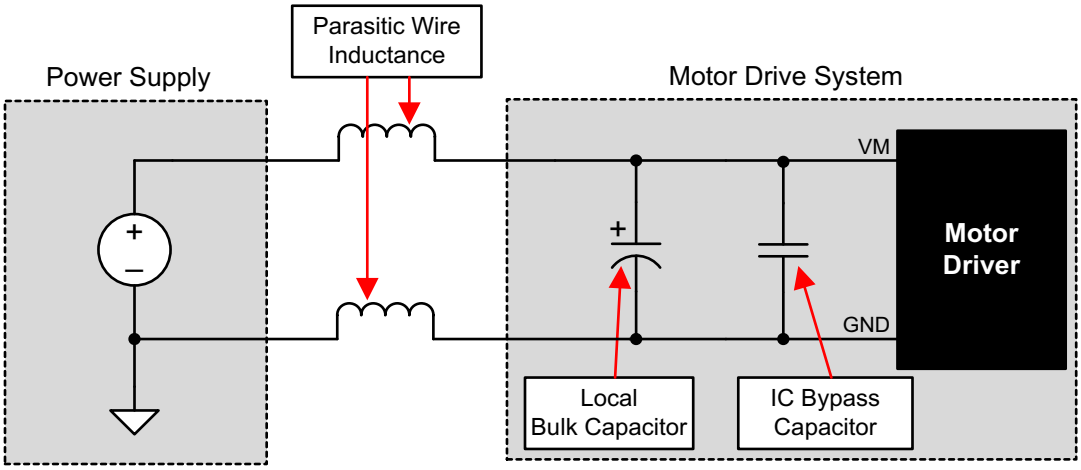


图 12. Example Setup of Motor Drive System With External Power Supply

The voltage rating for bulk capacitors should be higher than the operating voltage, to provide margin for cases when the motor transfers energy to the supply

10 Layout

10.1 Layout Guidelines

The VM and VCC pins should be bypassed to GND using low-ESR ceramic bypass capacitors with a recommended value of 0.1 µF rated for the VM and VCC supplies. These capacitors should be placed as close to the VM and VCC pins as possible with a thick trace or ground plane connection to the device GND pin. In addition bulk capacitance is required on the VM pin.

10.2 Layout Example

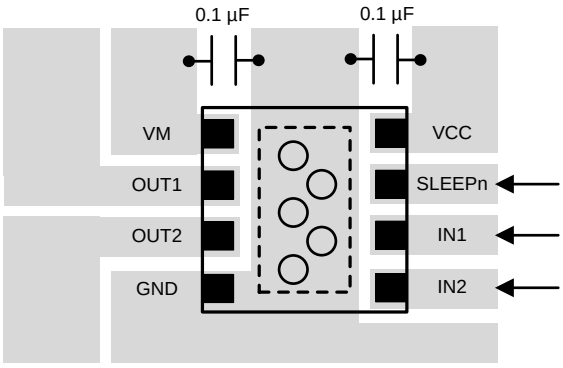


图 13. Simplified Layout Example

10.3 Power Dissipation

Power dissipation in the DRV8837C device is dominated by the power dissipated in the output FET resistance, or $R_{DS(ON)}$. Use 公式 1 to estimate the average power dissipation when running a brushed-DC motor.

$$P_{TOT} = R_{DS(ON)} \times (I_{OUT(RMS)})^2 \quad (1)$$

where

- P_{TOT} is the total power dissipation
- $R_{DS(ON)}$ is the resistance of the HS plus LS FETs
- $I_{OUT(RMS)}$ is the RMS or DC output current being supplied to the load

The maximum amount of power that can be dissipated in the device is dependent on ambient temperature and heatsinking.

注

The value of $R_{DS(ON)}$ increases with temperature, so as the device heats, the power dissipation increases.

The DRV8837C device has thermal shutdown protection. If the die temperature exceeds approximately 150°C, the device is disabled until the temperature drops to a safe level.

Any tendency of the device to enter thermal shutdown is an indication of either excessive power dissipation, insufficient heatsinking, or too high an ambient temperature.

11 器件和文档支持

11.1 文档支持

11.1.1 相关文档

相关文档请参见以下部分：

- *《计算电机驱动器功耗》*（文献编号：SLVA504）
- *用户指南《DRV8837C 评估模块》*（文献编号：SLVUAS3）。
- *《了解电机驱动器电流额定值》*（文献编号：SLVA505）

11.2 接收文档更新通知

如需接收文档更新通知，请访问 www.ti.com.cn 网站上的器件产品文件夹。点击右上角的*提醒我* (Alert me) 注册后，即可每周定期收到已更改的产品信息。有关更改的详细信息，请查阅已修订文档中包含的修订历史记录。

11.3 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.

11.4 商标

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

11.5 静电放电警告

ESD 可能会损坏该集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理措施和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。 精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

11.6 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。

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package | Pins	Package qty | Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
DRV8837CDSGR	Active	Production	WSON (DSG) | 8	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	837C
DRV8837CDSGR.B	Active	Production	WSON (DSG) | 8	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	837C
DRV8837CDSGRG4.B	Active	Production	WSON (DSG) | 8	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 85	837C
DRV8837CDSGT	Obsolete	Production	WSON (DSG) | 8	-	-	Call TI	Call TI	-40 to 85	837C

(1) **Status:** For more details on status, see our product life cycle.

(2) **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

(3) **RoHS values:** Yes, No, RoHS Exempt. See the TI RoHS Statement for additional information and value definition.

(4) **Lead finish/Ball material:** Parts 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.

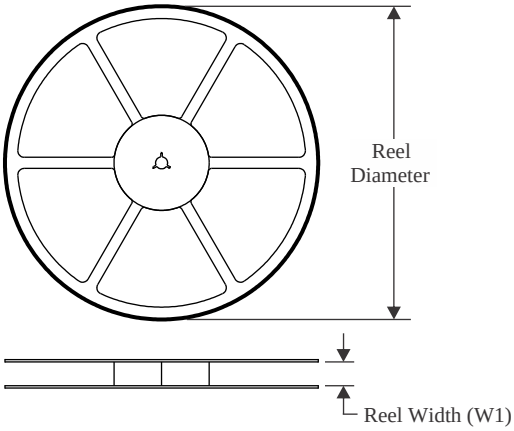
(5) **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

(6) **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

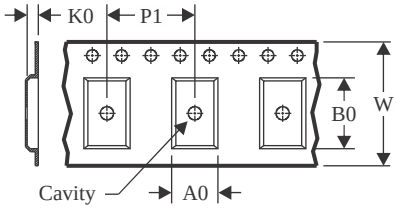
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

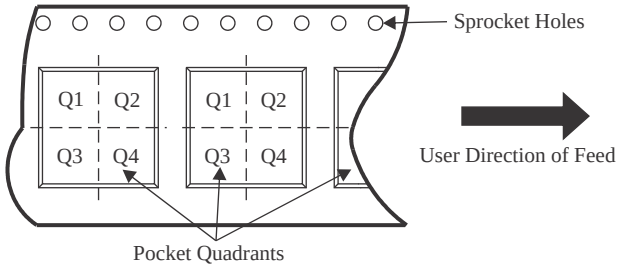


TAPE DIMENSIONS



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

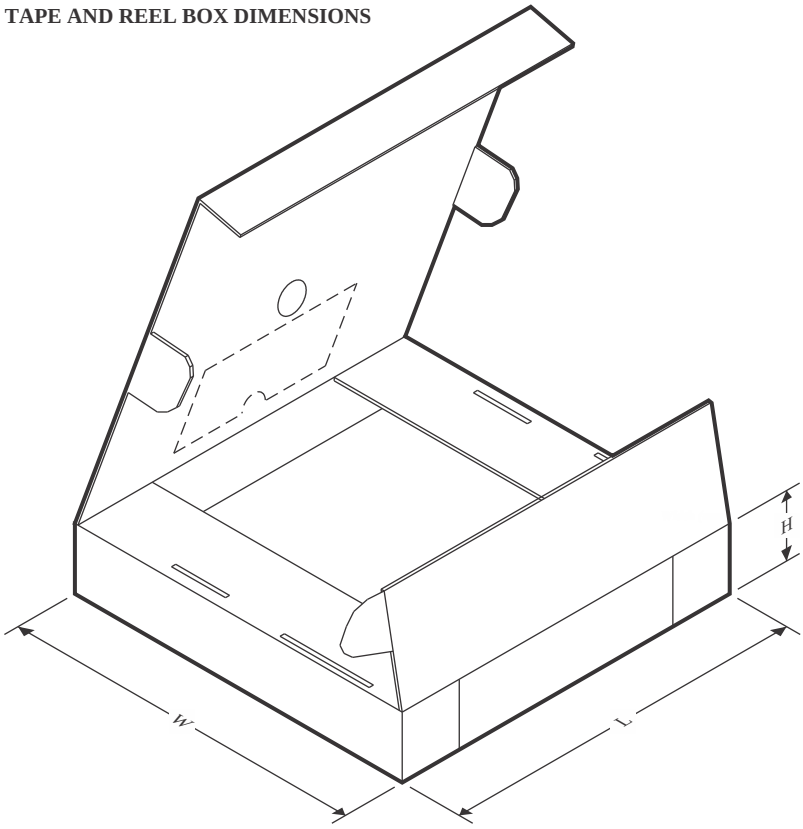
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
DRV8837CDSGR	WSON	DSG	8	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2
DRV8837CDSGR	WSON	DSG	8	3000	180.0	8.4	2.3	2.3	1.15	4.0	8.0	Q2

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV8837CDSGR	WSON	DSG	8	3000	210.0	185.0	35.0
DRV8837CDSGR	WSON	DSG	8	3000	182.0	182.0	20.0

GENERIC PACKAGE VIEW

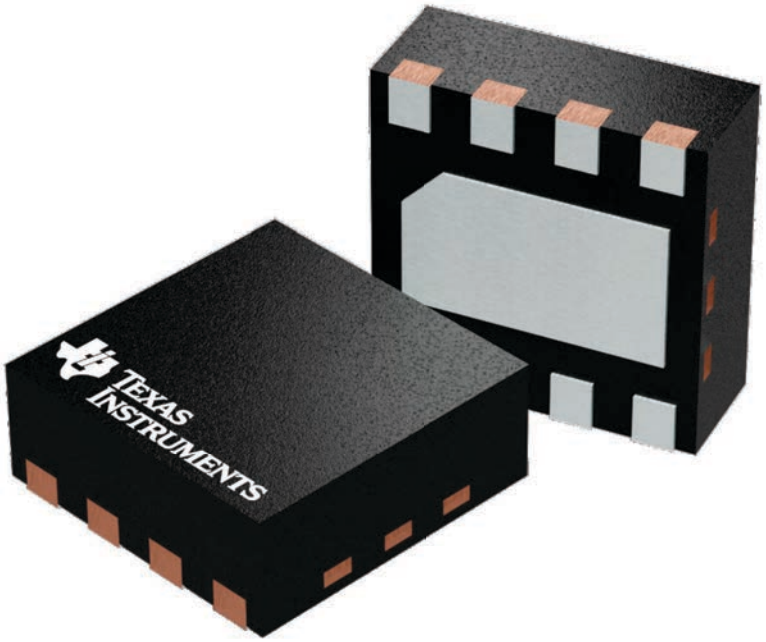
DSG 8

WSON - 0.8 mm max height

2 x 2, 0.5 mm pitch

PLASTIC SMALL OUTLINE - NO LEAD

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



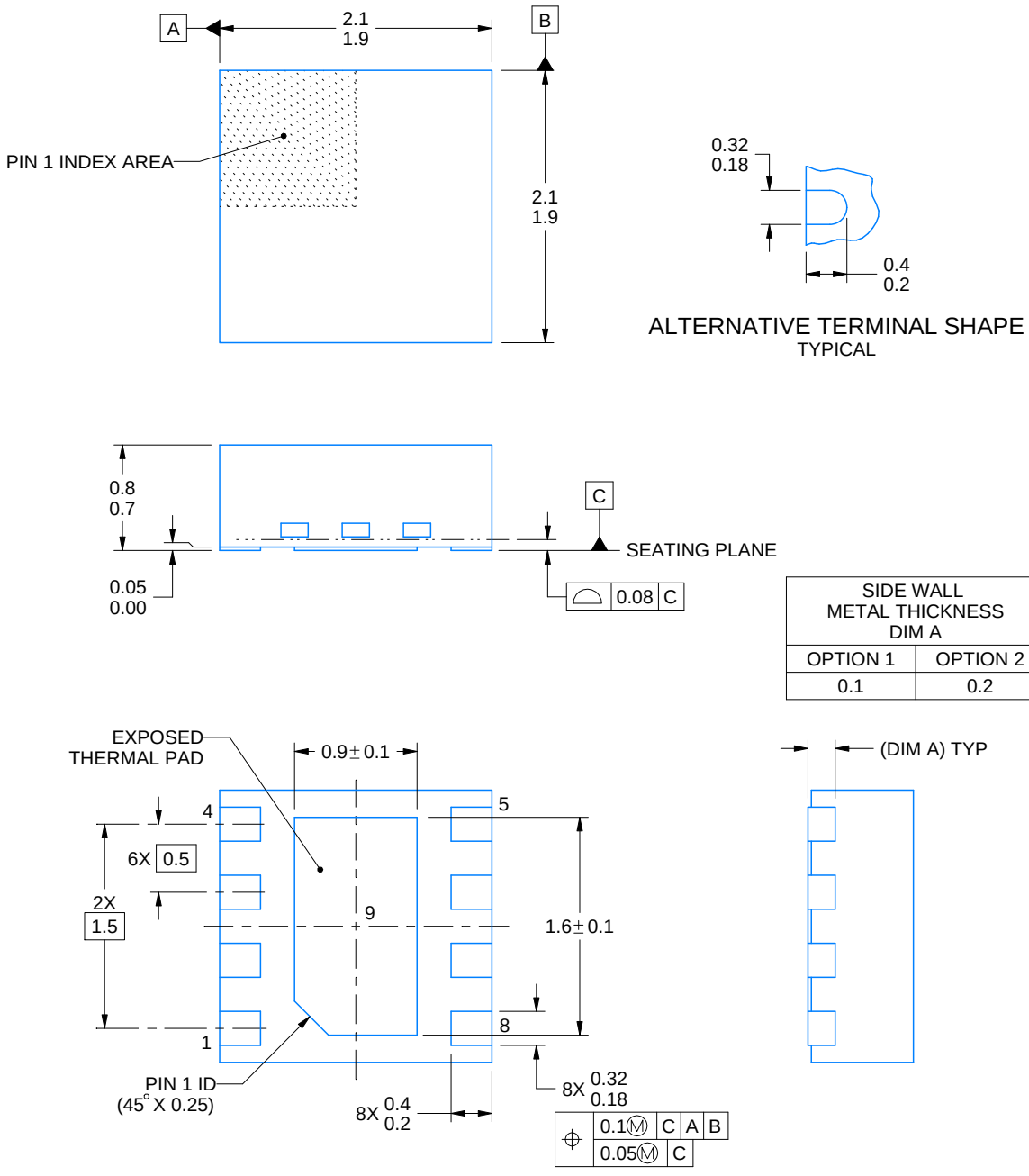
4224783/A

PACKAGE OUTLINE

DSG0008A

WSON - 0.8 mm max height

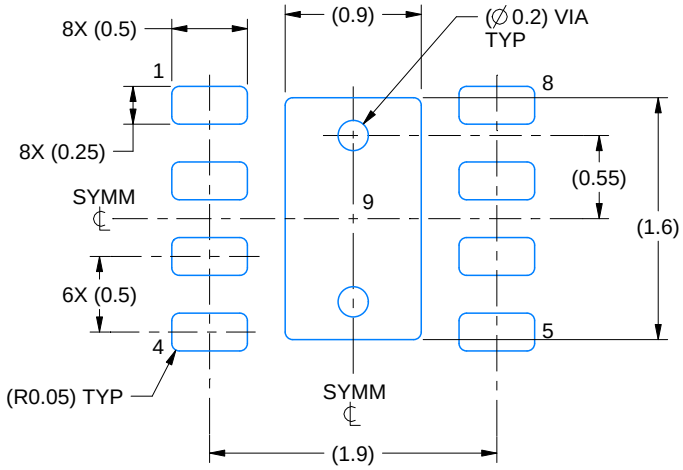
PLASTIC SMALL OUTLINE - NO LEAD



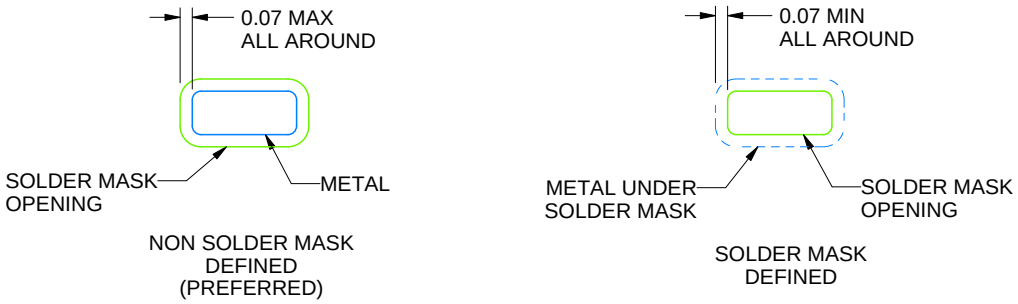
4218900/E 08/2022

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.



LAND PATTERN EXAMPLE
SCALE:20X

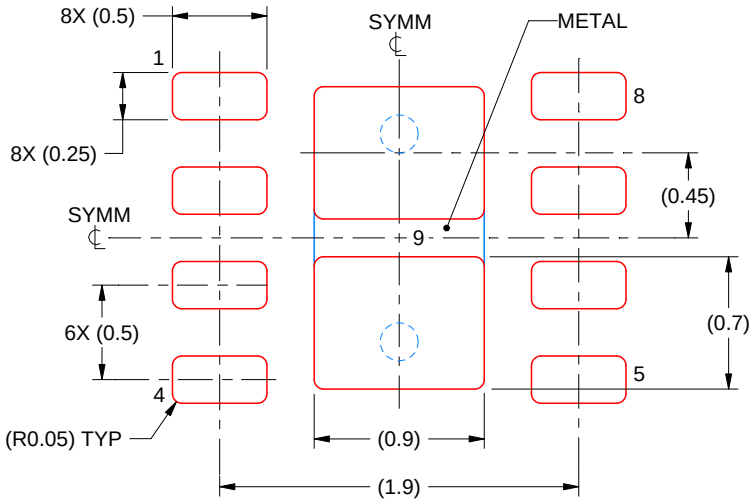


SOLDER MASK DETAILS

4218900/E 08/2022

NOTES: (continued)

4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/slua271).
5. 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.



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL

EXPOSED PAD 9:
87% PRINTED SOLDER COVERAGE BY AREA UNDER PACKAGE
SCALE:25X

4218900/E 08/2022

NOTES: (continued)

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

重要通知和免责声明

TI“按原样”提供技术和可靠性数据（包括数据表）、设计资源（包括参考设计）、应用或其他设计建议、网络工具、安全信息和其他资源，不保证没有瑕疵且不做出任何明示或暗示的担保，包括但不限于对适销性、某特定用途方面的适用性或不侵犯任何第三方知识产权的暗示担保。

这些资源可供使用 TI 产品进行设计的熟练开发人员使用。您将自行承担以下全部责任：(1) 针对您的应用选择合适的 TI 产品，(2) 设计、验证并测试您的应用，(3) 确保您的应用满足相应标准以及任何其他功能安全、信息安全、监管或其他要求。

这些资源如有变更，恕不另行通知。TI 授权您仅可将这些资源用于研发本资源所述的 TI 产品的相关应用。 严禁以其他方式对这些资源进行复制或展示。您无权使用任何其他 TI 知识产权或任何第三方知识产权。您应全额赔偿因在这些资源的使用中对 TI 及其代表造成的任何索赔、损害、成本、损失和债务，TI 对此概不负责。

TI 提供的产品受 TI 的销售条款或 ti.com 上其他适用条款/TI 产品随附的其他适用条款的约束。TI 提供这些资源并不会扩展或以其他方式更改 TI 针对 TI 产品发布的适用的担保或担保免责声明。

TI 反对并拒绝您可能提出的任何其他或不同的条款。

邮寄地址：Texas Instruments, Post Office Box 655303, Dallas, Texas 75265