

DRV5011 低电压数字锁存器霍尔效应传感器

1 特性

- 超小型 X2SON、SOT-23、DSBGA 或 TO-92 封装
- 高磁性灵敏度: $\pm 2\text{mT}$ (典型值)
- 可靠磁滞: 4mT (典型值)
- 快速感应带宽: 30kHz
- V_{CC} 工作范围: 2.5V 至 5.5V
- 推挽式 CMOS 输出
 - 支持 5mA 拉电流和 20mA 灌电流
- 工作温度: -40°C 至 $+135^{\circ}\text{C}$

2 应用

- 无刷直流电机传感器
- 增量旋转编码:
 - 刷式直流电机反馈
 - 电机速度 (转速计)
 - 机械行程
 - 流体测量
 - 旋钮转动
 - 轮速
- 电动自行车
- 流量计

3 说明

DRV5011 器件是一款数字锁存器霍尔效应传感器, 专为电机和其他旋转系统而设计。

此器件具有工作电压范围为 2.5V 至 5.5V 的高效低电压架构, 采用标准 SOT-23 封装以及薄型 X2SON、DSBGA 和 TO-92 封装。输出端采用推挽驱动器, 无需使用上拉电阻器, 使系统更加紧凑小巧。

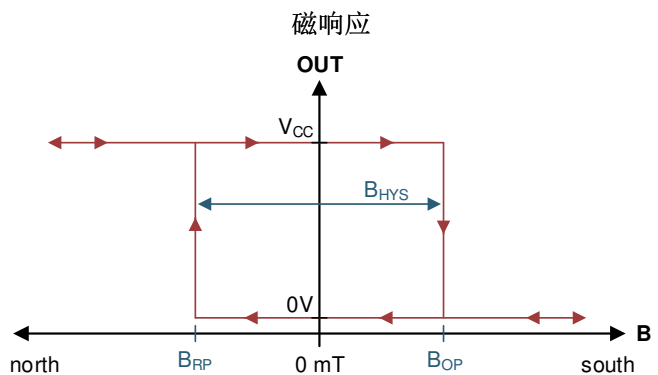
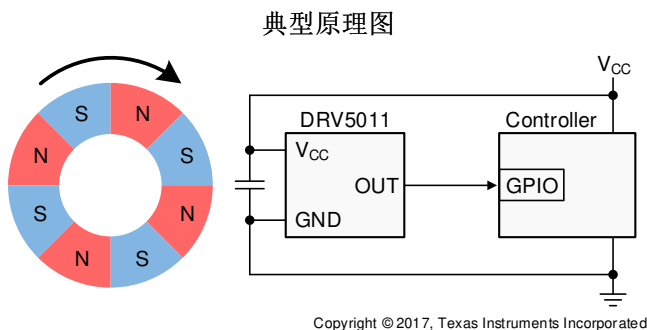
当南磁极靠近封装顶部并且超出 B_{OP} 阈值时, 该器件会驱动低电压。输出会保持低电平, 直到应用北极并且超出 B_{RP} 阈值, 这将使输出驱动高电压。必须交换北极和南极才能切换输出, 且集成的磁滞会分开 B_{OP} 和 B_{RP} 以提供可靠切换。

器件在 -40°C 至 $+135^{\circ}\text{C}$ 的宽环境温度范围内能够保持稳定一致的优异性能。

器件信息⁽¹⁾

器件型号	封装	封装尺寸 (标称值)
DRV5011	DSBGA (4)	$0.80\text{mm} \times 0.80\text{mm}$
	SOT-23 (3)	$2.92\text{mm} \times 1.30\text{mm}$
	X2SON (4)	$1.10\text{mm} \times 1.40\text{mm}$
	TO-92 (3)	$4.00\text{mm} \times 3.15\text{mm}$

(1) 如需了解所有可用封装, 请参阅数据表末尾的封装选项附录。



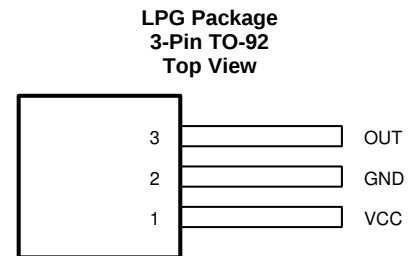
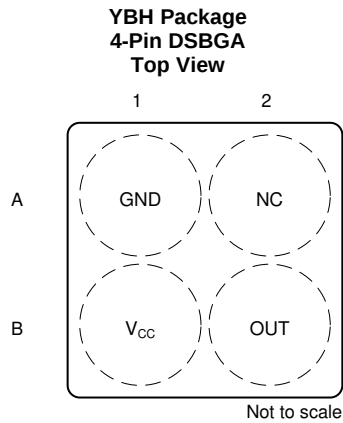
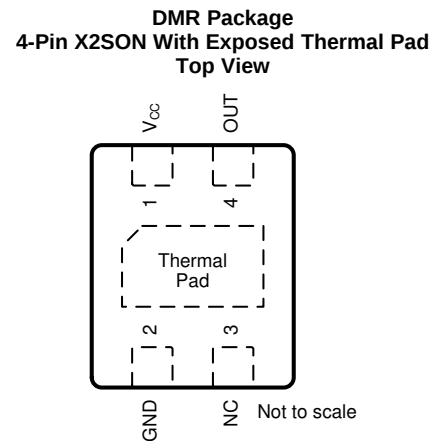
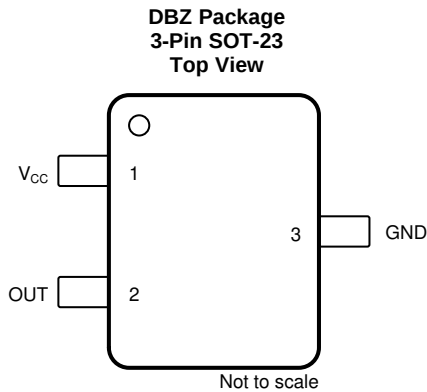
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4 修订历史记录

Changes from Revision A (April 2019) to Revision B	Page
• 向数据表添加了 LPG (TO-92) 封装	1
Changes from Original (December 2017) to Revision A	Page
• 已添加 向数据表添加了 YBH (DSBGA) 封装	1
• 已添加 recommendation to limit power supply voltage variation to less than 50 mV _{PP} to <i>Power Supply Recommendations</i> section	15

5 Pin Configuration and Functions



Pin Functions

PIN					I/O	DESCRIPTION
NAME	DSBGA	SOT-23	X2SON	TO-92		
GND	A1	3	2	2	—	Ground reference
NC	A2	—	3	—	—	No-connect. This pin is not connected to the silicon. Leave this pin floating or tied to ground, and soldered to the board for mechanical support.
OUT	B2	2	4	3	O	Push-pull CMOS output. Drives a V _{CC} or ground level.
V _{CC}	B1	1	1	1	—	2.5-V to 5.5-V power supply. TI recommends connecting this pin to a ceramic capacitor to ground with a value of at least 0.01 μF.
Thermal Pad	—	—	Thermal Pad	—	—	Leave thermal pad floating or tied to ground, and soldered to the board for mechanical support.

6 Specifications

6.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
V _{CC}	Power-supply voltage	V _{CC}	−0.3	5.5	V
	Power-supply voltage slew rate	V _{CC}	Unlimited		V/μs
V _O	Output voltage	OUT	−0.3	V _{CC} + 0.3	V
I _O	Output current	OUT	−5	30	mA
B	Magnetic flux density		Unlimited		T
T _J	Operating junction temperature			140	°C
T _A	Operating ambient temperature	For SOT-23 (DBZ), X2SON (DMR) and TO-92 (LPG)	−40	135	°C
		For DSBGA (YBH)	−40	125	
T _{stg}	Storage temperature		−65	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.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 ⁽¹⁾	±6000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±750	

- (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 _{CC}	Power supply voltage	V _{CC}	2.5	5.5	V
V _O	Output voltage	OUT	0	V _{CC}	V
I _O	Output current ⁽¹⁾	OUT	−5	20	mA
T _J	Operating junction temperature			140	°C
T _A	Operating ambient temperature	For SOT-23 (DBZ), X2SON (DMR) and TO-92 (LPG)	−40	135	°C
		For DSBGA (YBH)	−40	125	

- (1) Device-sourced current is negative. Device-sunk current is positive.

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		DRV5011				UNIT
		DBZ (SOT-23)	DMR (X2SON)	YBH (DSBGA)	LPG (TO-92)	
		3 PINS	4 PINS	4 PINS	3 PINS	
R _{θJA}	Junction-to-ambient thermal resistance	356	159	194.1	183.1	°C/W
R _{θJC(top)}	Junction-to-case (top) thermal resistance	128	77	1.6	74.2	°C/W
R _{θJB}	Junction-to-board thermal resistance	94	102	68	158.8	°C/W
ψ _{JT}	Junction-to-top characterization parameter	11.4	0.9	0.8	15.2	°C/W
ψ _{JB}	Junction-to-board characterization parameter	92	100	67.9	158.8	°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

for V_{CC} = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I _{CC}	Operating supply current			2.3	3	mA
t _{ON}	Power-on time (see Figure 10)			40	70	μs
t _d	Propagation delay time	From change in B to change in OUT		13	25	μs
V _{OH}	High-level output voltage	I _O = −1 mA	V _{CC} − 0.35	V _{CC} − 0.1		V
V _{OL}	Low-level output voltage	I _O = 20 mA		0.15	0.4	V

6.6 Magnetic Characteristics

for V_{CC} = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f _{BW}	Sensing bandwidth			30		kHz
B _{OP}	Magnetic threshold operate point (see Figure 8)		0.6	2	3.8	mT
B _{RP}	Magnetic threshold release point (see Figure 8)		−3.8	−2	−0.6	mT
B _{HYS}	Magnetic hysteresis: B _{OP} − B _{RP}		2	4	6	mT

6.7 Typical Characteristics

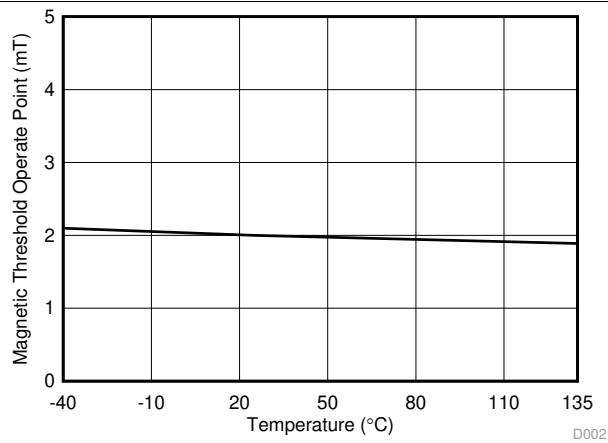


图 1. B_{OP} vs Temperature

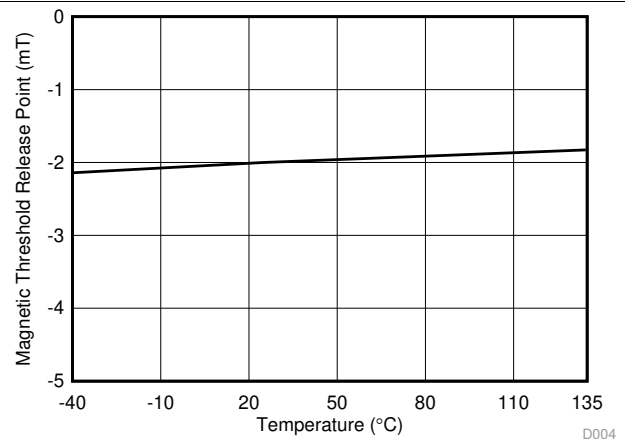


图 2. B_{RP} vs Temperature

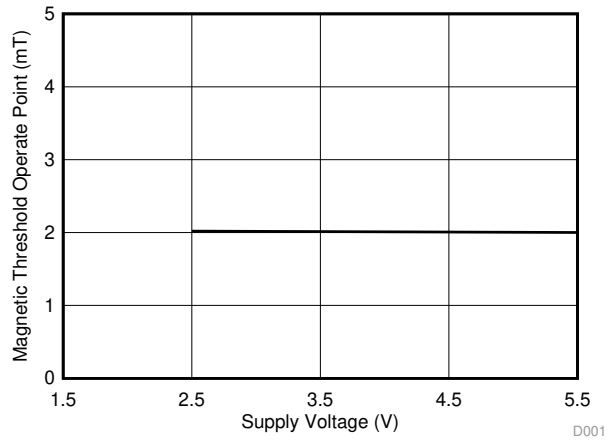


图 3. B_{OP} vs V_{CC}

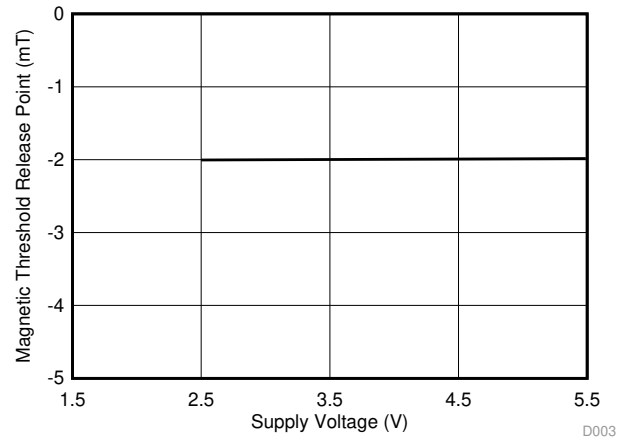


图 4. B_{RP} vs V_{CC}

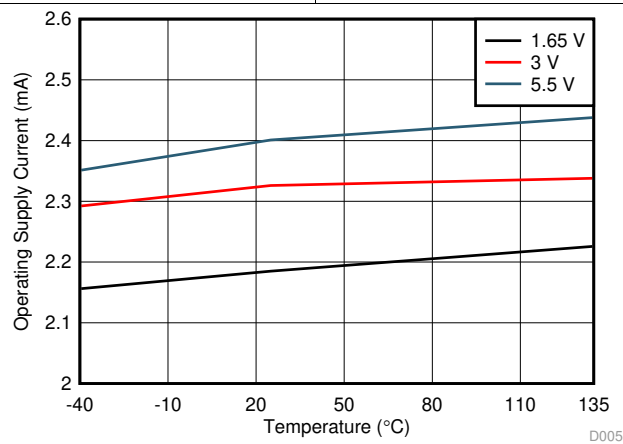


图 5. I_{CC} vs Temperature

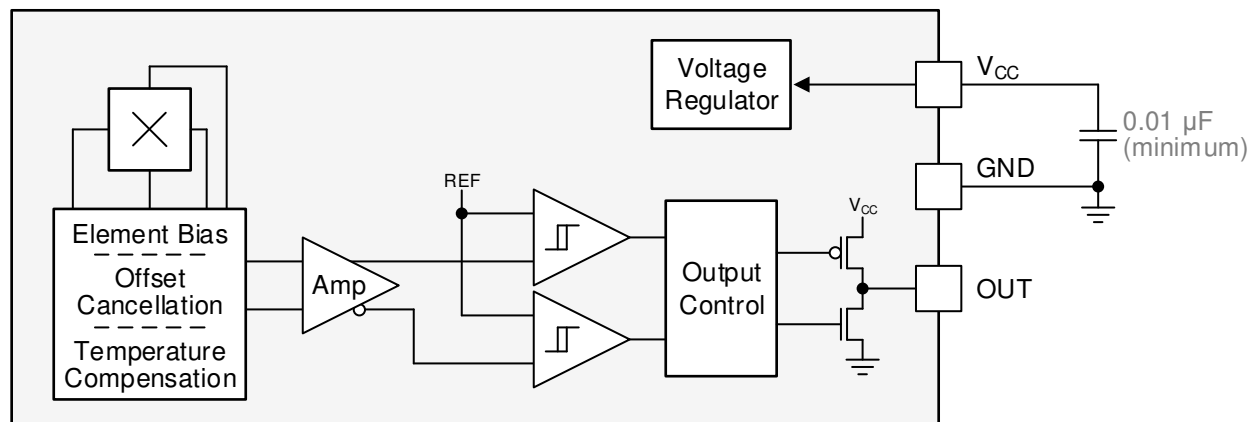
7 Detailed Description

7.1 Overview

The DRV5011 is a magnetic sensor with a digital output that latches the most recent pole measured. Applying a south magnetic pole near the top of the package causes the output to drive low, whereas a north magnetic pole causes the output to drive high, and the absence of a magnetic field causes the output to continue to drive the previous state, whether low or high.

The device integrates a Hall effect element, analog signal conditioning, offset cancellation circuits, amplifiers, and comparators. This provides stable performance across a wide temperature range and resistance to mechanical stress.

7.2 Functional Block Diagram



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7.3 Feature Description

7.3.1 Magnetic Flux Direction

The DRV5011 is sensitive to the magnetic field component that is perpendicular to the top of the package, as shown in 图 6.

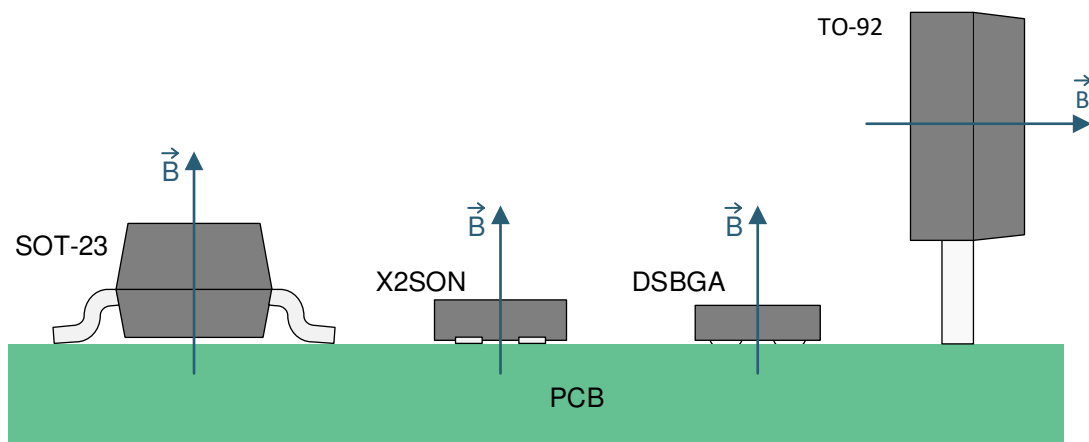


图 6. Direction of Sensitivity

Feature Description (接下页)

The magnetic flux that travels from the bottom to the top of the package is considered positive in this data sheet. This condition exists when a south magnetic pole is near the top of the package. The magnetic flux that travels from the top to the bottom of the package results in negative millitesla values. 图 7 shows the flux direction polarity.

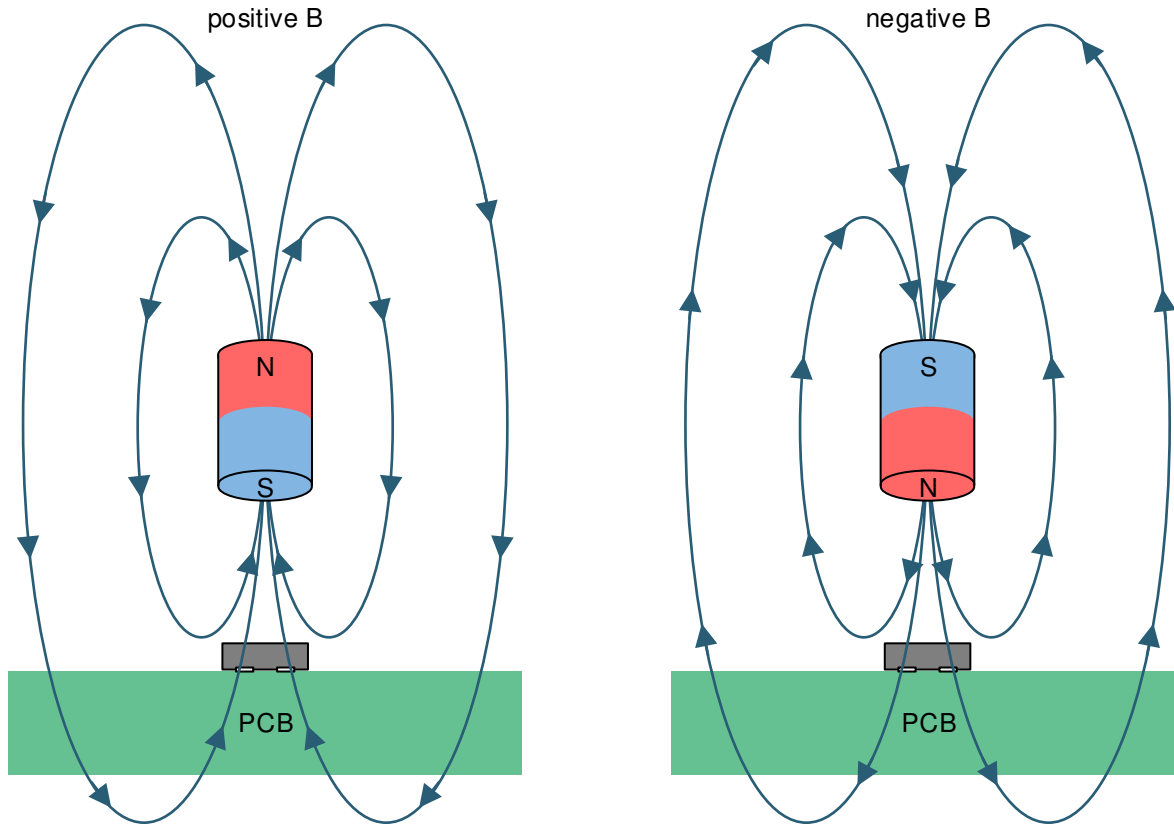


图 7. Flux Direction Polarity

7.3.2 Magnetic Response

图 8 shows the device functionality and hysteresis.

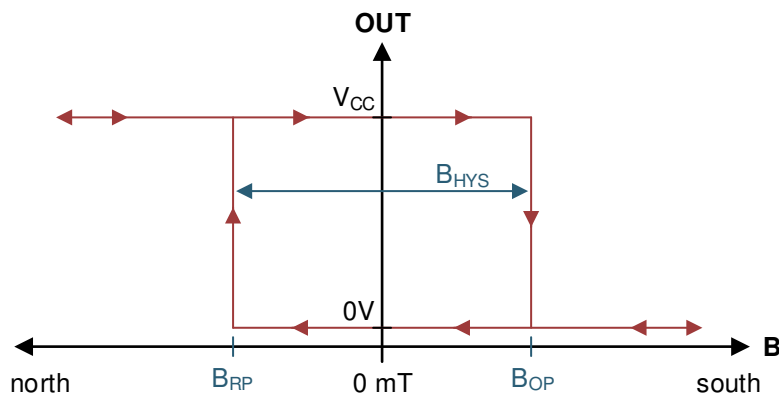


图 8. Device Functionality

Feature Description (接下页)

7.3.3 Output Driver

图 9 shows the device push-pull CMOS output that can drive a V_{CC} or ground level.

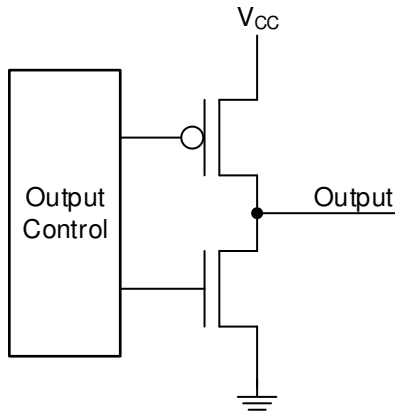


图 9. Push-Pull Output (Simplified)

7.3.4 Power-On Time

图 10 shows that after the V_{CC} voltage is applied, the DRV5011 measures the magnetic field and sets the output within the t_{ON} time.

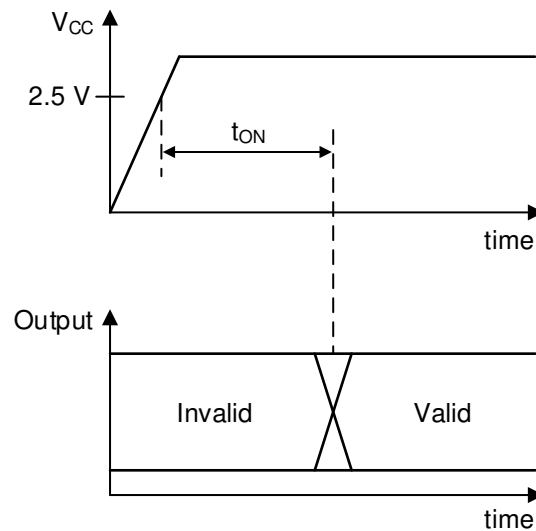


图 10. t_{ON} Definition

Feature Description (接下页)

7.3.5 Hall Element Location

The sensing element inside the device is in the center of both packages when viewed from the top. 图 11 shows the tolerances and side-view dimensions.

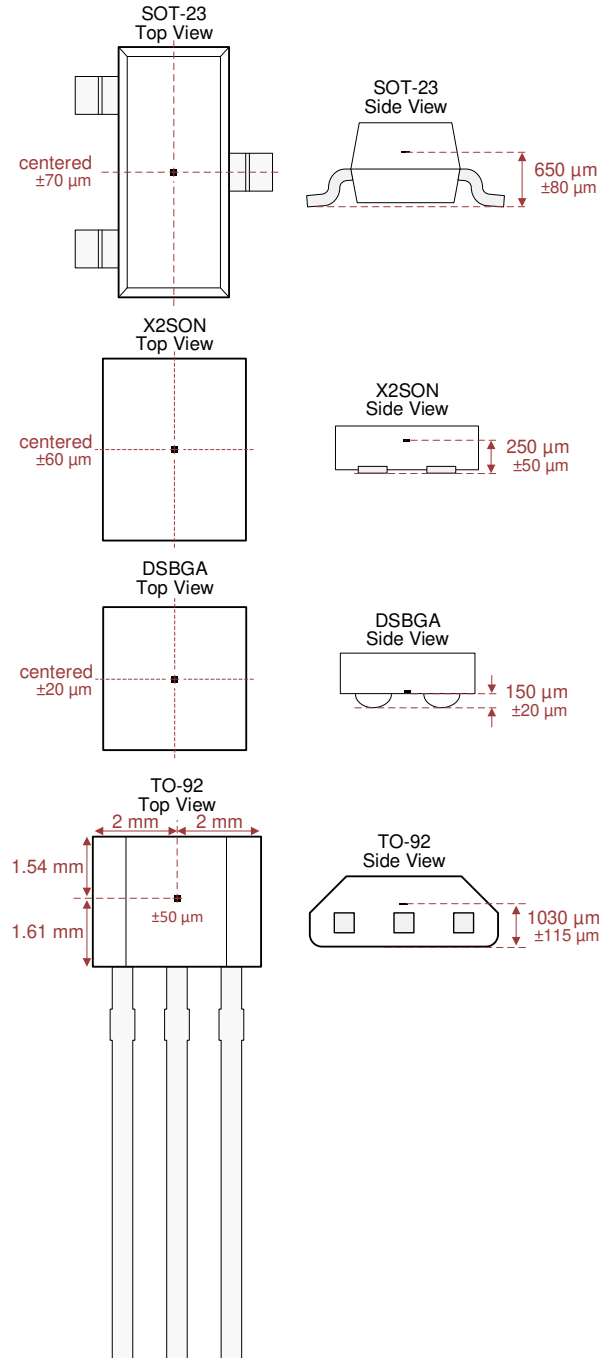


图 11. Hall Element Location

7.4 Device Functional Modes

The DRV5011 has one mode of operation that applies when the *Recommended Operating Conditions* are met.

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.

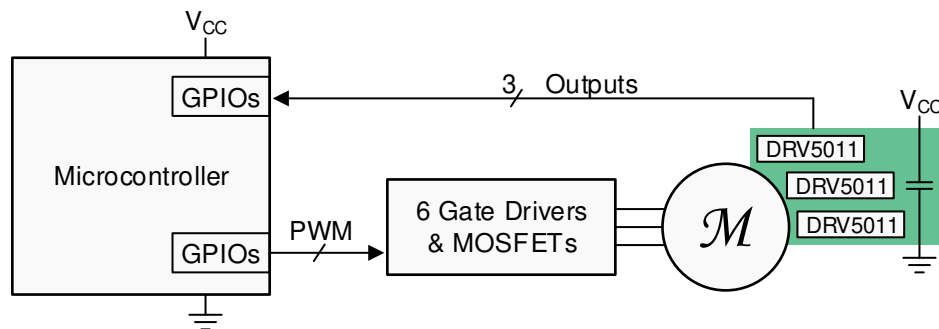
8.1 Application Information

The DRV5011 is typically used in rotary applications for brushless DC (BLDC) motor sensors or incremental rotary encoding.

For reliable functionality, the magnet must apply a flux density at the sensor greater than the maximum B_{OP} and less than the minimum B_{RP} thresholds. Add additional margin to account for mechanical tolerance, temperature effects, and magnet variation. Magnets generally produce weaker fields as temperature increases.

8.2 Typical Applications

8.2.1 BLDC Motor Sensors Application



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图 12. BLDC Motor System

8.2.1.1 Design Requirements

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

表 1. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
Number of motor phases	3
Motor RPM	15 k
Number of magnet poles on the rotor	12
Magnetic material	Bonded Neodymium
Maximum temperature inside the motor	125°C
Magnetic flux density peaks at the Hall sensors at maximum temperature	±11 mT
Hall sensor V_{CC}	5 V ±10%

8.2.1.2 Detailed Design Procedure

Three-phase brushless DC motors often use three Hall effect latch devices to measure the electrical angle of the rotor and tell the controller how to drive the three wires. These wires connect to electromagnet windings, which generate magnetic fields that apply forces to the permanent magnets on the rotor.

Space the three Hall sensors across the printed-circuit board (PCB) so that they are 120 electrical degrees apart. This configuration creates six 3-bit states with equal time duration for each electrical cycle, which consists of one north and one south magnetic pole. From the center of the motor axis, the number of degrees to space each sensor equals $2 / [\text{number of poles}] \times 120^\circ$. In this design example, the first sensor is placed at 0° , the second sensor is placed 20° rotated, and the third sensor is placed 40° rotated. Alternatively, a $3\times$ degree offset can be added or subtracted to any sensor, meaning the third sensor could alternatively be placed at $40^\circ - (3 \times 20^\circ) = -20^\circ$.

8.2.1.3 Application Curve

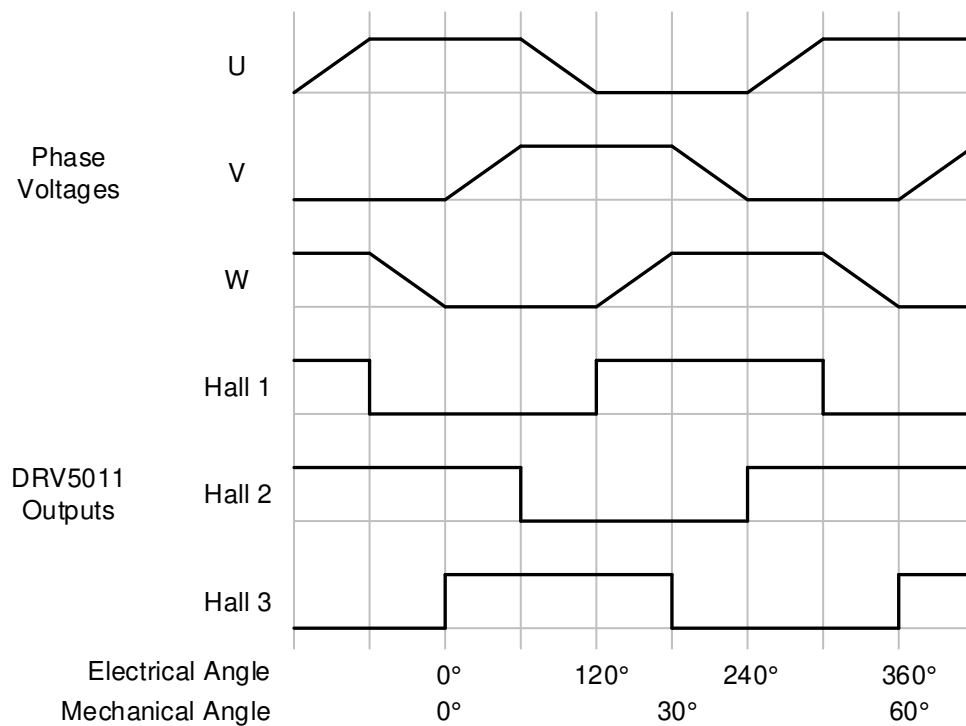


图 13. Phase Voltages and Hall Signals for 3-Phase BLDC Motor

8.2.2 Incremental Rotary Encoding Application

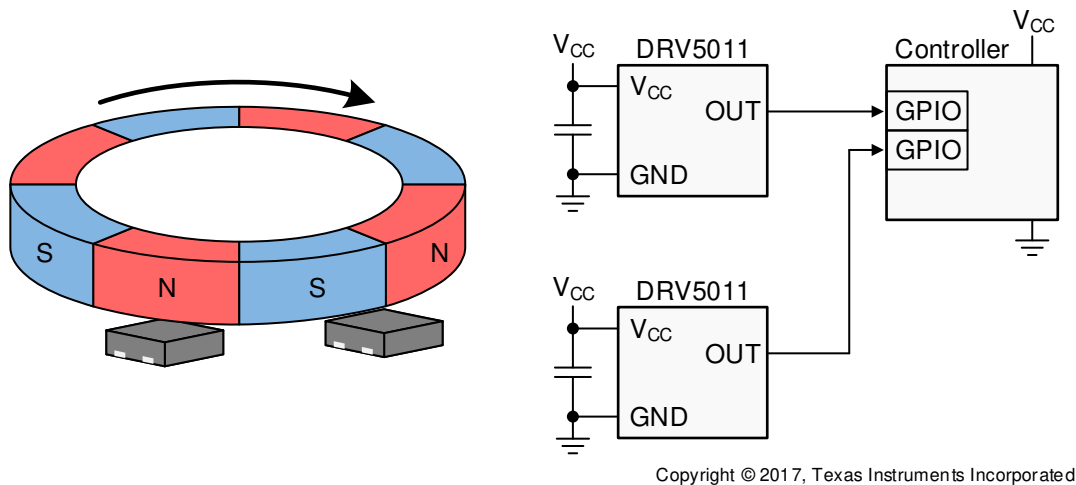


图 14. Incremental Rotary Encoding System

8.2.2.1 Design Requirements

For this design example, use the parameters listed in 表 2.

表 2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
RPM range	0 to 45 k
Number of magnet poles	8
Magnetic material	Ferrite
Air gap above the Hall sensors	2.5 mm
Magnetic flux density peaks at the Hall sensors at maximum temperature	±7 mT

8.2.2.2 Detailed Design Procedure

Incremental encoders are used on knobs, wheels, motors, and flow meters to measure relative rotary movement. By attaching a ring magnet to the rotating component and placing a DRV5011 nearby, the sensor generates voltage pulses as the magnet turns. If directional information is also needed (clockwise versus counterclockwise), a second DRV5011 can be added with a phase offset, and then the order of transitions between the two signals describes the direction.

Creating this phase offset requires spacing the two sensors apart on the PCB, and an ideal 90° quadrature offset is attained when the sensors are separated by half the length of each magnet pole, plus any integer number of pole lengths. 图 14 shows this configuration, as the sensors are 1.5 pole lengths apart. One of the sensors changes its output every $360^\circ / 8 \text{ poles} / 2 \text{ sensors} = 22.5^\circ$ of rotation. For reference, TI Design TIDA-00480, [Automotive Hall Sensor Rotary Encoder](#), uses a 66-pole magnet with changes every 2.7°.

The maximum rotational speed that can be measured is limited by the sensor bandwidth. Generally, the bandwidth must be faster than two times the number of poles per second. In this design example, the maximum speed is 45000 RPM, which involves 6000 poles per second. The DRV5011 sensing bandwidth is 30 kHz, which is five times the pole frequency. In systems where the sensor sampling rate is close to two times the number of poles per second, most of the samples measure a magnetic field that is significantly lower than the peak value, because the peaks only occur when the sensor and pole are perfectly aligned. In this case, add margin by applying a stronger magnetic field that has peaks significantly higher than the maximum B_{OP} .

8.2.2.3 Application Curve

Two signals in quadrature provide movement and direction information. 图 15 shows how each 2-bit state has unique adjacent 2-bit states for clockwise and counterclockwise.

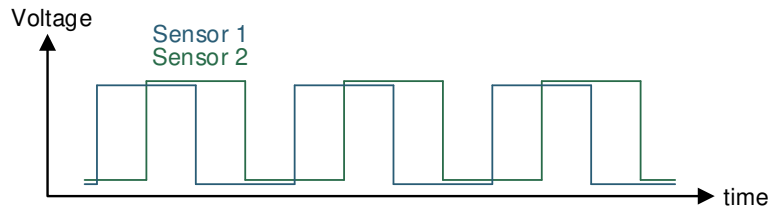


图 15. Quadrature Output (2-Bit)

8.3 Dos and Don'ts

The Hall element is sensitive to magnetic fields that are perpendicular to the top of the package; therefore, the correct magnet orientation must be used for the sensor to detect the field. 图 16 shows correct and incorrect orientations when using a ring magnet.

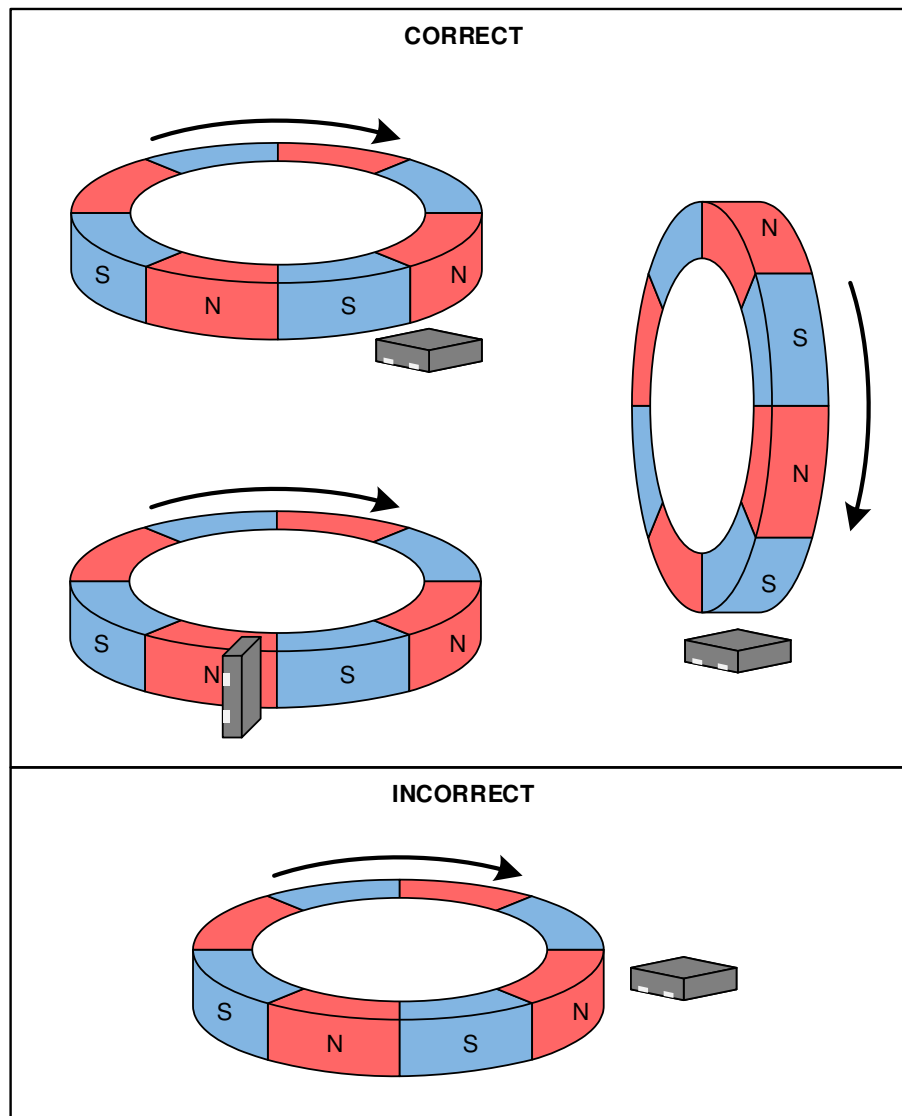


图 16. Correct and Incorrect Magnet Orientations

9 Power Supply Recommendations

The DRV5011 is powered from 2.5-V to 5.5-V dc power supplies. A 0.01- μ F (minimum) ceramic capacitor rated for V_{CC} must be placed as close to the DRV5011 device as possible. Larger values of the bypass capacitor may be needed to attenuate any significant high-frequency ripple and noise components generated by the power source. TI recommends limiting the supply voltage variation to less than 50 mV_{PP}.

10 Layout

10.1 Layout Guidelines

Magnetic fields pass through most nonferromagnetic materials with no significant disturbance. Embedding Hall effect sensors within plastic or aluminum enclosures and sensing magnets on the outside is common practice. Magnetic fields also easily pass through most PCBs, which makes placing the magnet on the opposite side possible.

10.2 Layout Examples

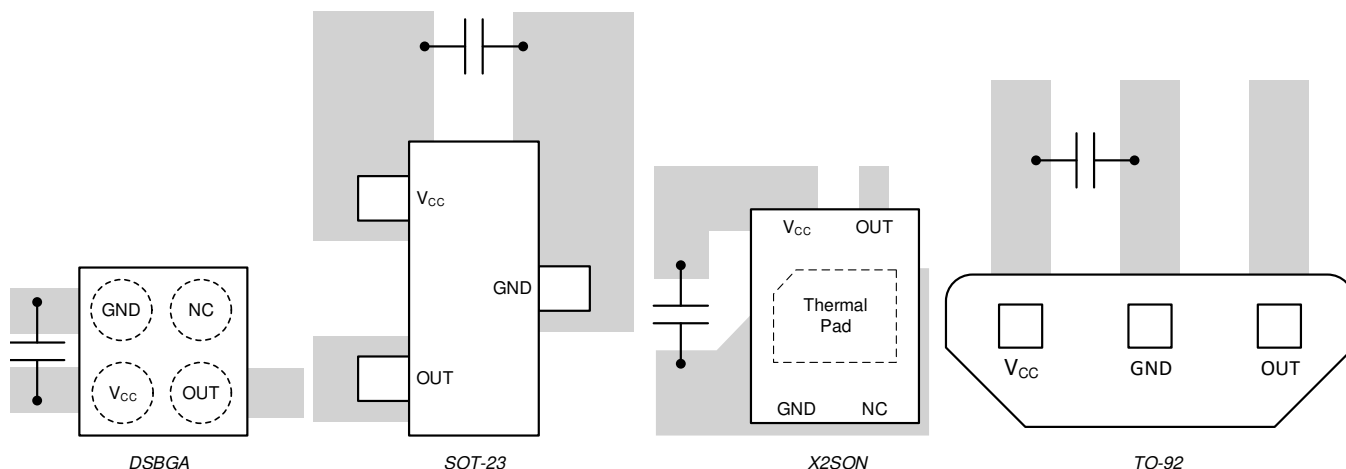


图 17. Layout Examples

11 器件和文档支持

11.1 器件支持

11.1.1 开发支持

有关其他设计参考，请参阅[汽车霍尔传感器旋转编码器 TI 设计 \(TIDA-00480\)](#)。

TI 还为 DRV5011 提供了以下评估模块 (EVM)：

- 德州仪器 (TI)，[DRV5011 超低功耗、数字锁存器霍尔效应传感器评估模块](#)
- 德州仪器 (TI)，[用于评估 SOT-23 和 TO-92 霍尔传感器的分线适配器](#)

11.2 文档支持

11.2.1 相关文档

请参阅如下相关文档：

- [DRV5011-5012EVM 用户指南](#)
- [HALL-ADAPTER-EVM 用户指南](#)

11.3 接收文档更新通知

要接收文档更新通知，请导航至 [ti.com](#) 上的器件产品文件夹。单击右上角的[通知我](#)进行注册，即可每周接收产品信息更改摘要。有关更改的详细信息，请查看任何已修订文档中包含的修订历史记录。

11.4 社区资源

[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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11.5 商标

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All other trademarks are the property of their respective owners.

11.6 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。

11.7 Glossary

[SLYZ022](#) — *TI Glossary*.

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

12 机械、封装和可订购信息

以下页面包含机械、封装和可订购信息。这些信息是指定器件的最新可用数据。数据如有变更，恕不另行通知，且不会对此文档进行修订。如需获取此数据表的浏览器版本，请查阅左侧的导航栏。

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PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
DRV5011ADDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDMRR	ACTIVE	X2SON	DMR	4	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADDMRT	ACTIVE	X2SON	DMR	4	250	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 135	1AD	Samples
DRV5011ADLPG	ACTIVE	TO-92	LPG	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 135	11AD	Samples
DRV5011ADLPGM	ACTIVE	TO-92	LPG	3	3000	RoHS & Green	SN	N / A for Pkg Type	-40 to 135	11AD	Samples
DRV5011ADYBHR	ACTIVE	DSBGA	YBH	4	3000	RoHS & Green	SAC396	Level-1-260C-UNLIM	-40 to 125	A	Samples
DRV5011ADYBHT	ACTIVE	DSBGA	YBH	4	250	RoHS & Green	SAC396	Level-1-260C-UNLIM	-40 to 125	A	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 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.

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TAPE AND REEL INFORMATION


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV5011ADBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5011ADBZT	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5011ADDMRR	X2SON	DMR	4	3000	180.0	8.4	1.27	1.57	0.5	4.0	8.0	Q1
DRV5011ADDMRT	X2SON	DMR	4	250	180.0	8.4	1.27	1.57	0.5	4.0	8.0	Q1
DRV5011ADYBHR	DSBGA	YBH	4	3000	180.0	8.4	0.85	0.89	0.51	2.0	8.0	Q2
DRV5011ADYBHT	DSBGA	YBH	4	250	180.0	8.4	0.85	0.89	0.51	2.0	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)
DRV5011ADDBZR	SOT-23	DBZ	3	3000	183.0	183.0	20.0
DRV5011ADDBZT	SOT-23	DBZ	3	250	183.0	183.0	20.0
DRV5011ADDMRR	X2SON	DMR	4	3000	200.0	183.0	25.0
DRV5011ADDMRT	X2SON	DMR	4	250	200.0	183.0	25.0
DRV5011ADYBHR	DSBGA	YBH	4	3000	182.0	182.0	20.0
DRV5011ADYBHT	DSBGA	YBH	4	250	182.0	182.0	20.0

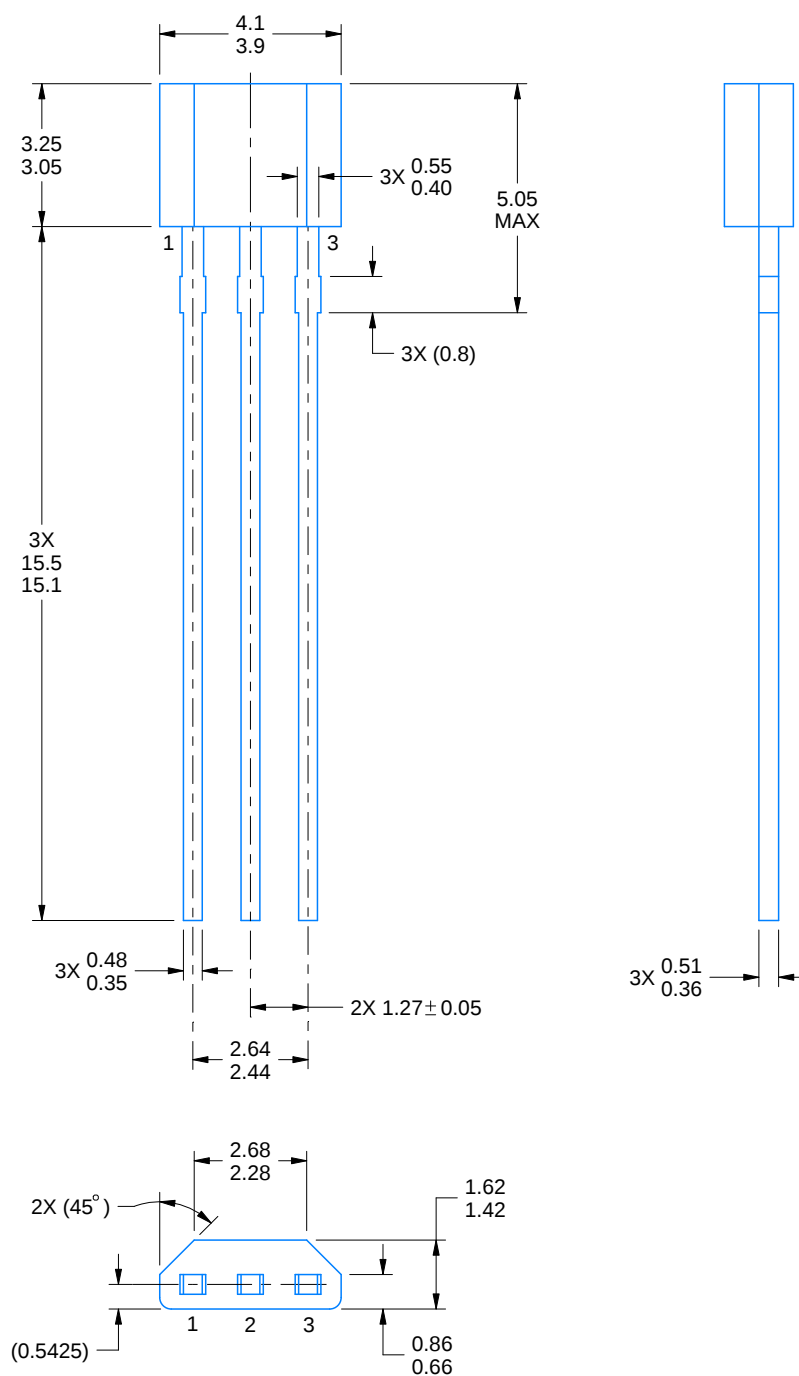
LPG0003A



PACKAGE OUTLINE

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018

NOTES:

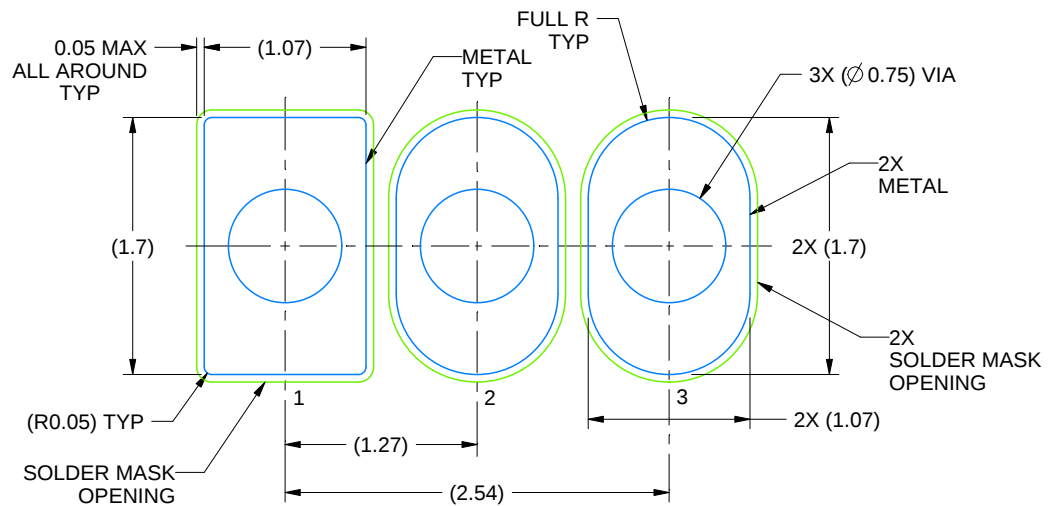
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



LAND PATTERN EXAMPLE
NON-SOLDER MASK DEFINED
SCALE:20X

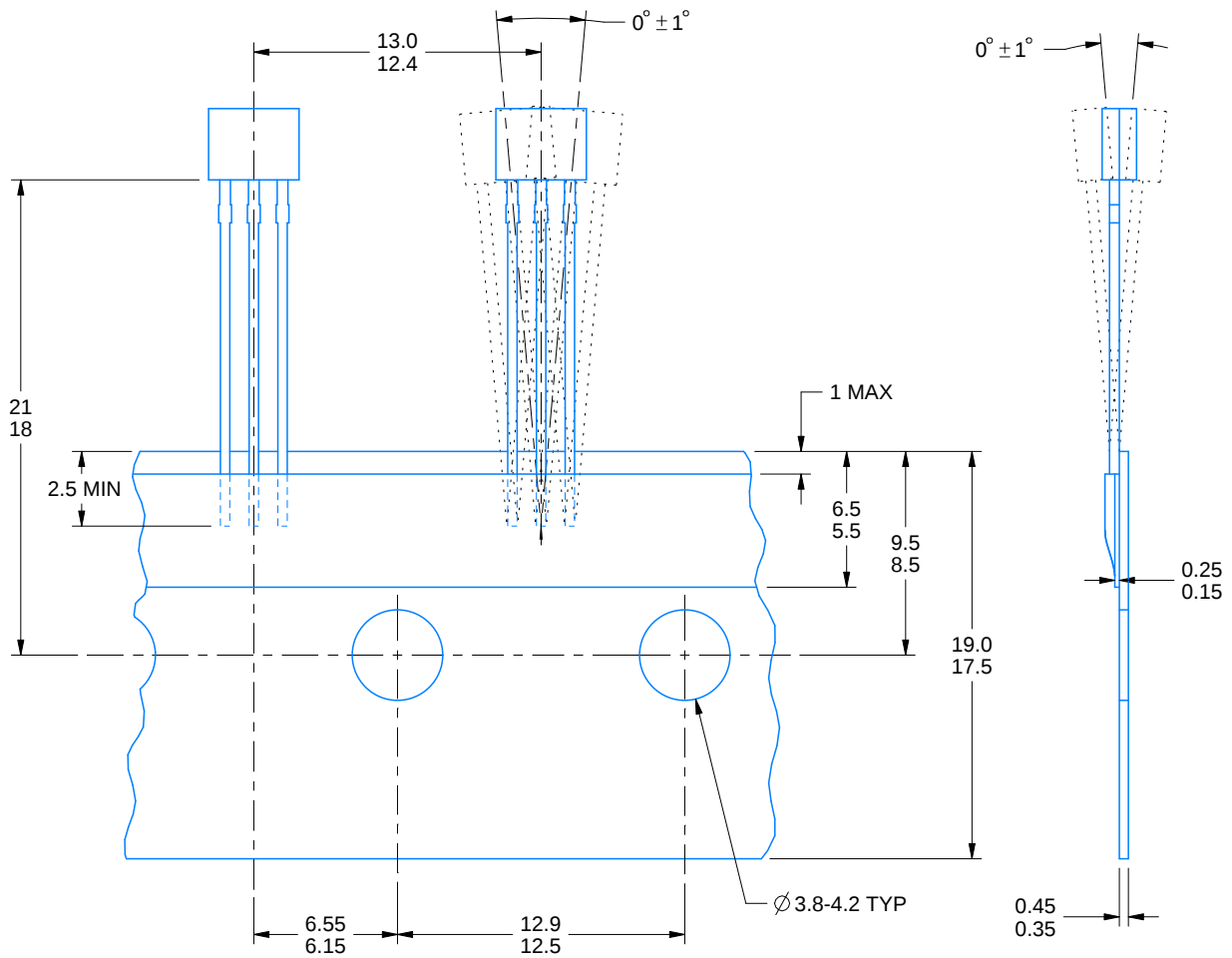
4221343/C 01/2018

TAPE SPECIFICATIONS

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018

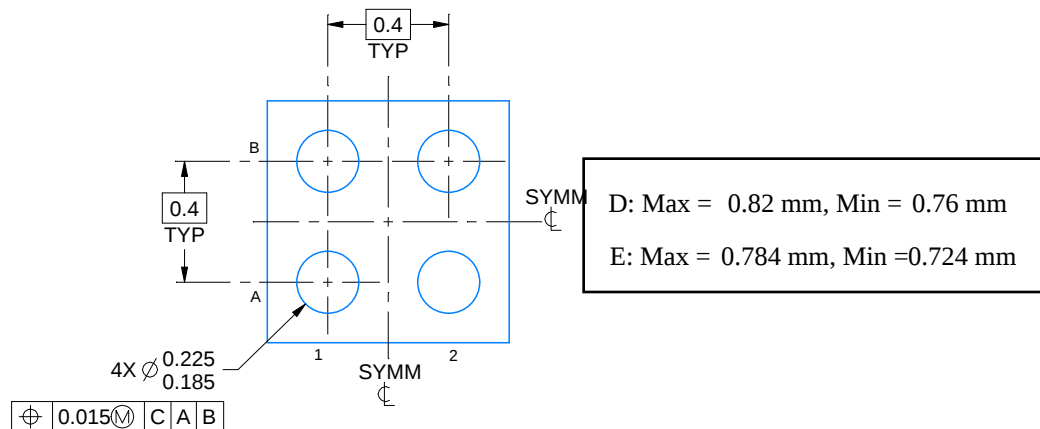
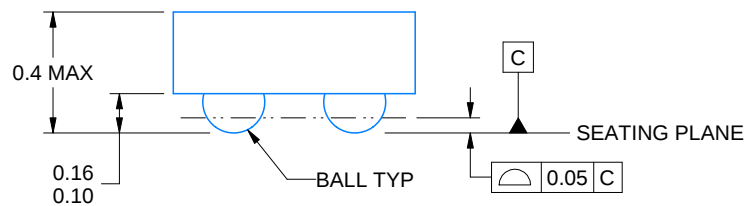
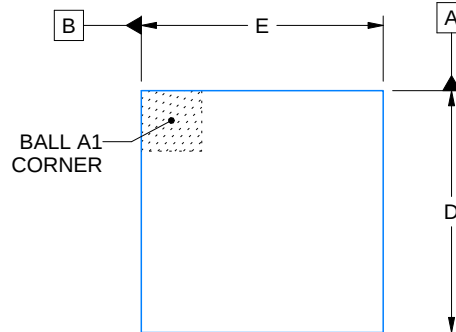
YBH0004



PACKAGE OUTLINE

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



4224051/A 11/2017

NOTES:

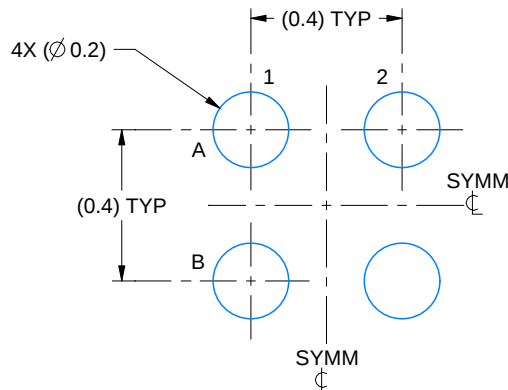
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

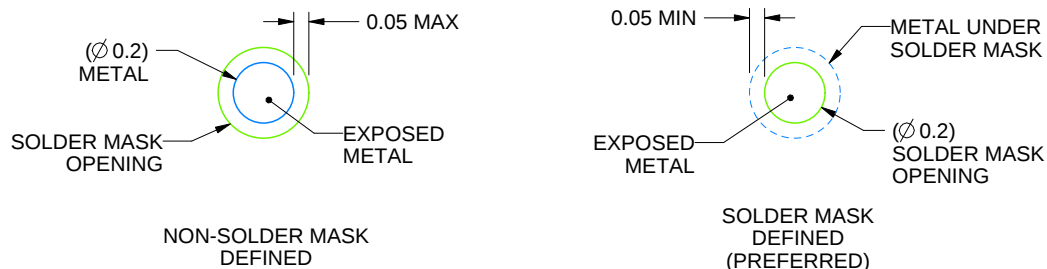
YBH0004

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 50X



SOLDER MASK DETAILS
NOT TO SCALE

4224051/A 11/2017

NOTES: (continued)

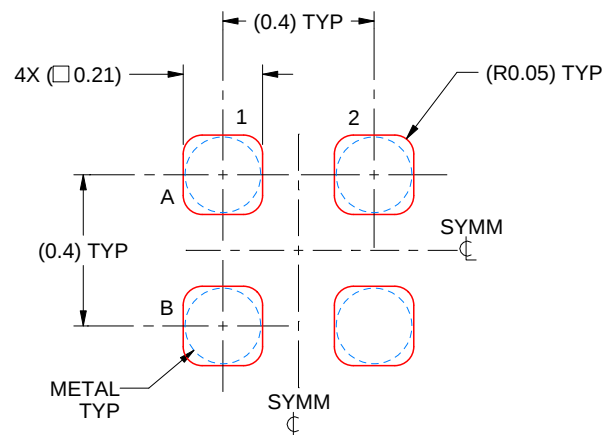
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints.
See Texas Instruments Literature No. SNVA009 (www.ti.com/lit/snva009).

EXAMPLE STENCIL DESIGN

YBH0004

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



SOLDER PASTE EXAMPLE
BASED ON 0.075 mm THICK STENCIL
SCALE: 50X

4224051/A 11/2017

NOTES: (continued)

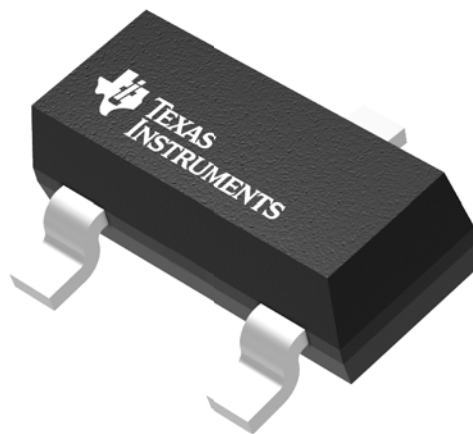
4. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release.

GENERIC PACKAGE VIEW

DBZ 3

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



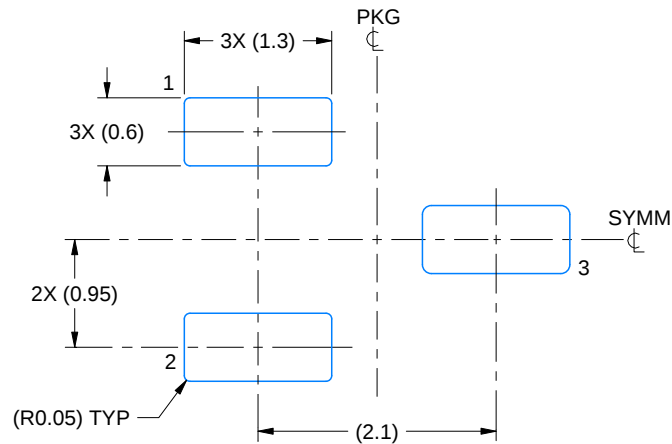
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

4203227/C

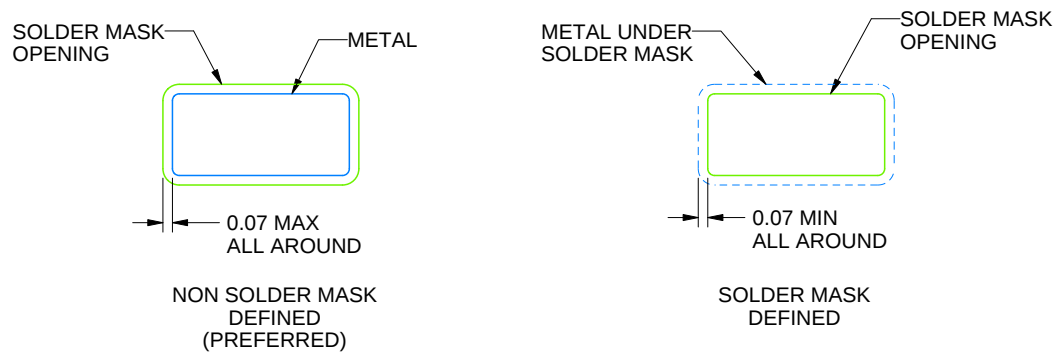
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/C 04/2017

NOTES: (continued)

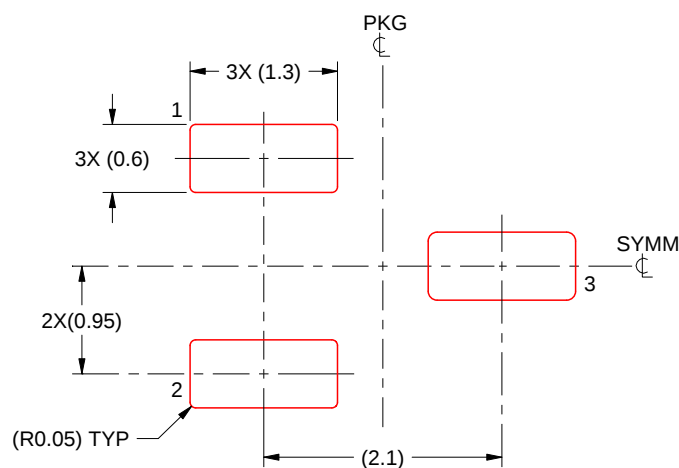
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR

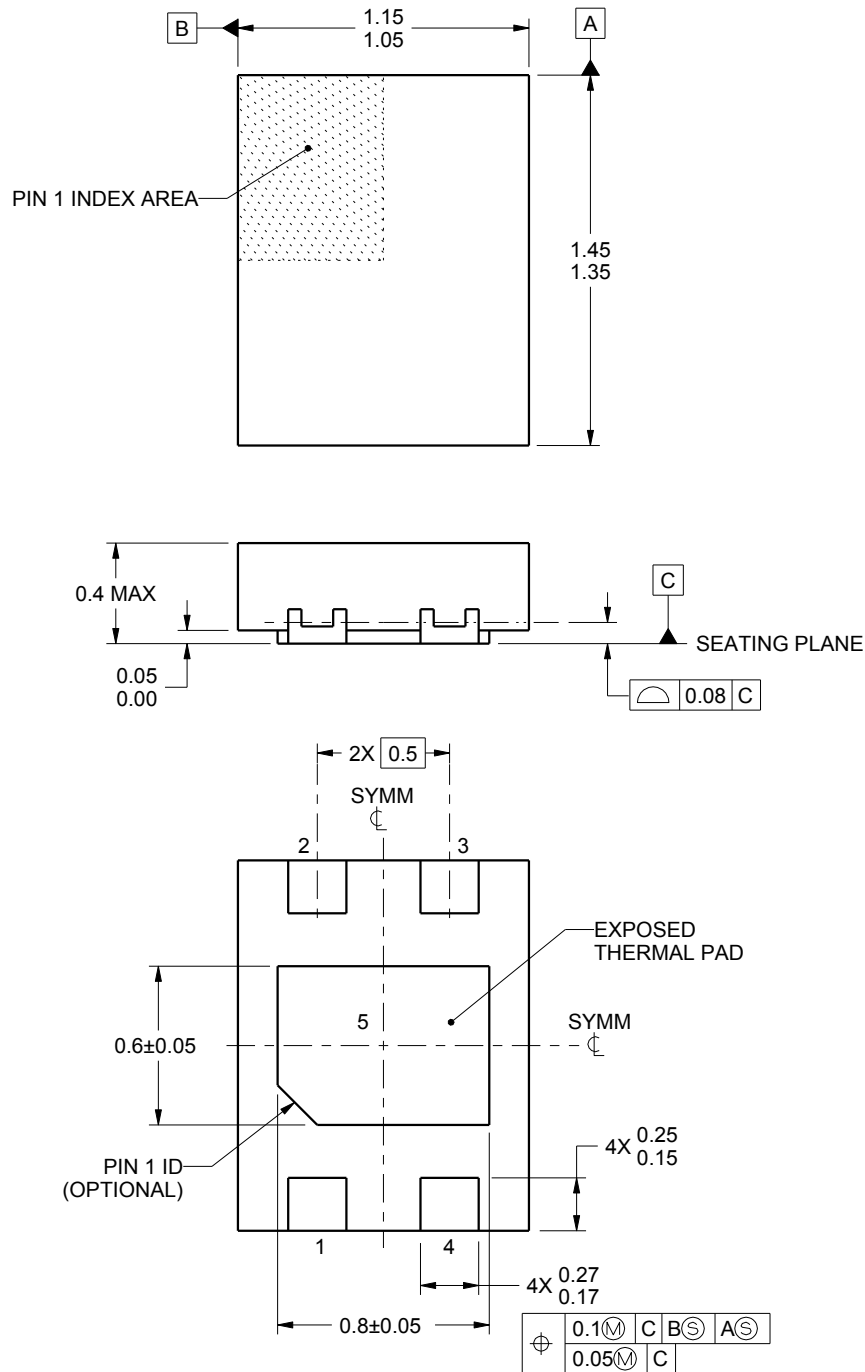
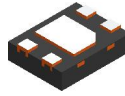


SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:15X

4214838/C 04/2017

NOTES: (continued)

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



4222825/A 03/2016

NOTES:

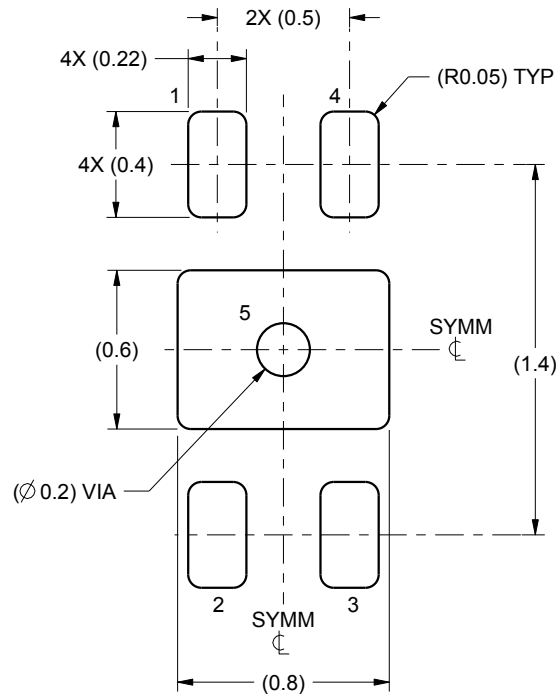
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.

EXAMPLE BOARD LAYOUT

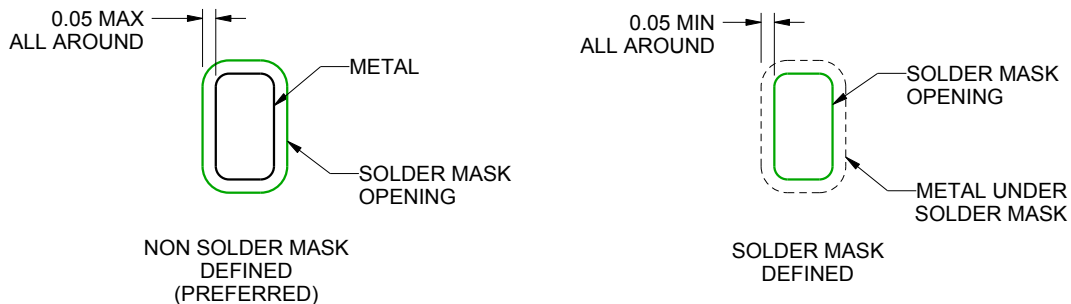
DMR0004A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE
SCALE:35X



SOLDER MASK DETAILS

4222825/A 03/2016

NOTES: (continued)

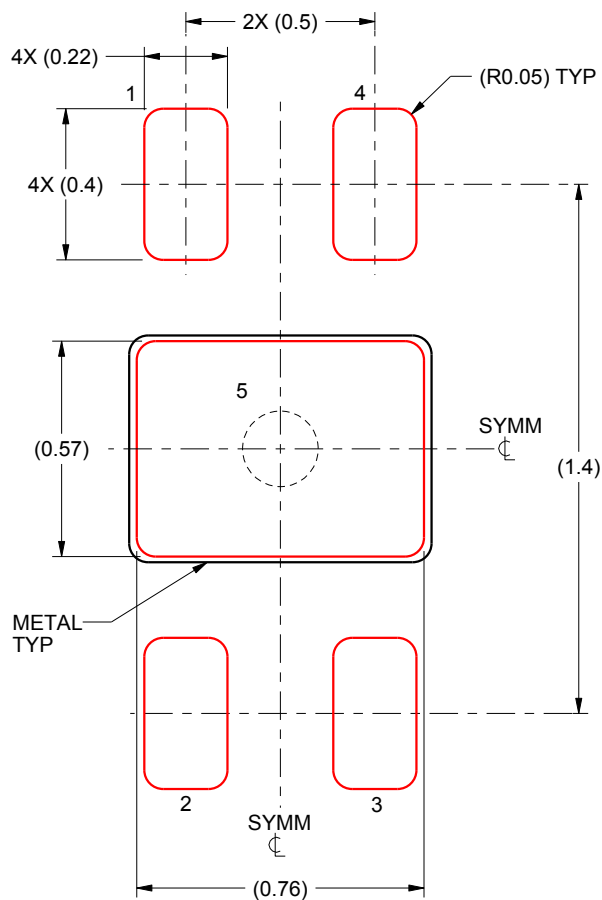
4. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 (www.ti.com/lit/sluea271).
5. Vias are optional depending on application, refer to device data sheet. If all or some are implemented, recommended via locations are shown. It is recommended that vias under paste be filled, plugged or tented.

EXAMPLE STENCIL DESIGN

DMR0004A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



SOLDER PASTE EXAMPLE
BASED ON 0.1 mm THICK STENCIL

EXPOSED PAD 5:
90% PRINTED SOLDER COVERAGE BY AREA
SCALE:50X

4222825/A 03/2016

NOTES: (continued)

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

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