

## DRV5011 Low-Voltage, Digital-Latch Hall Effect Sensor

### 1 Features

- Ultra-small X2SON, SOT-23, DSBGA or TO-92 package
- High magnetic sensitivity:  $\pm 2$  mT (typical)
- Robust hysteresis: 4 mT (typical)
- Fast sensing bandwidth: 30-kHz
- $V_{CC}$  operating range: 2.5-V to 5.5-V
- Push-pull CMOS output
  - Capable of 5-mA sourcing, 20-mA sinking
- Operating temperature:  $-40^{\circ}\text{C}$  to  $+135^{\circ}\text{C}$

### 2 Applications

- Brushless dc motor sensors
- Incremental rotary encoding:
  - Brushed dc motor feedback
  - Motor speed (tachometer)
  - Mechanical travel
  - Fluid measurement
  - Knob turning
  - Wheel speed
- E-bikes
- Flow meters

### 3 Description

The DRV5011 device is a digital-latch Hall effect sensor designed for motors and other rotary systems.

The device has an efficient low-voltage architecture that operates from 2.5 V to 5.5 V. The device is offered in standard SOT-23, low-profile X2SON, DSBGA and TO-92 packages. The output is a push-pull driver that requires no pullup resistor, enabling more compact systems.

When a south magnetic pole is near the top of the package and the  $B_{OP}$  threshold is exceeded, the device drives a low voltage. The output stays low until a north pole is applied and the  $B_{RP}$  threshold is crossed, which causes the output to drive a high voltage. Alternating north and south poles are required to toggle the output, and integrated hysteresis separates  $B_{OP}$  and  $B_{RP}$  to provide robust switching.

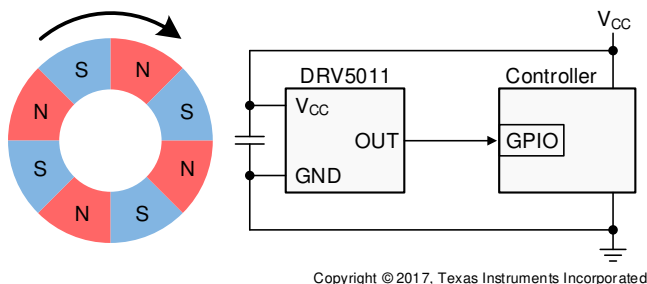
The device produces consistent performance across a wide ambient temperature range of  $-40^{\circ}\text{C}$  to  $+135^{\circ}\text{C}$ .

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

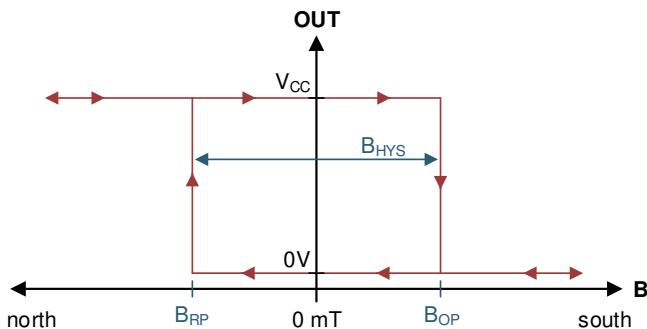
PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV5011	DSBGA (4)	0.80 mm x 0.80 mm
	SOT-23 (3)	2.92 mm x 1.30 mm
	X2SON (4)	1.10 mm x 1.40 mm
	TO-92 (3)	4.00 mm x 3.15 mm

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

#### Typical Schematic



#### Magnetic Response



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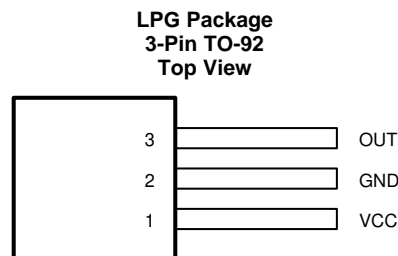
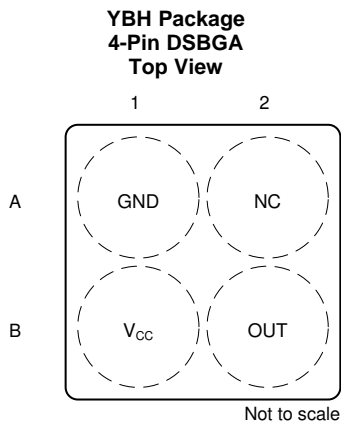
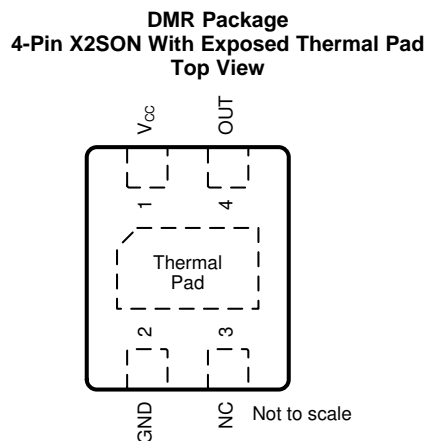
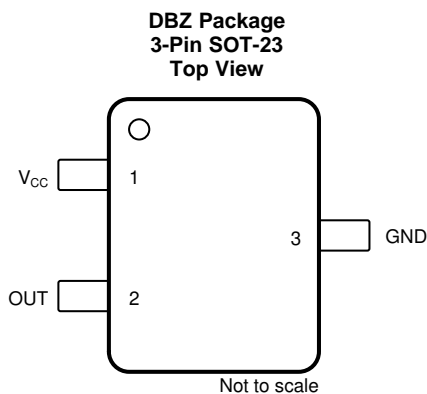
## 4 Revision History

<b>Changes from Revision A (April 2019) to Revision B</b>	<b>Page</b>
• Added LPG (TO-92) package to the data sheet .....	1

<b>Changes from Original (December 2017) to Revision A</b>	<b>Page</b>
• Added YBH (DSBGA) package to data sheet .....	1
• Added recommendation to limit power supply voltage variation to less than 50 mV <sub>PP</sub> to <i>Power Supply Recommendations</i> section .....	15

## 5 Pin Configuration and Functions



### Pin Functions

NAME	PIN				I/O	DESCRIPTION
	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 <sub>CC</sub> or ground level.
V <sub>CC</sub>	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)<sup>(1)</sup>

			MIN	MAX	UNIT
V <sub>CC</sub>	Power-supply voltage	V <sub>CC</sub>	-0.3	5.5	V
	Power-supply voltage slew rate	V <sub>CC</sub>	Unlimited		V/μs
V <sub>O</sub>	Output voltage	OUT	-0.3	V <sub>CC</sub> + 0.3	V
I <sub>O</sub>	Output current	OUT	-5	30	mA
B	Magnetic flux density		Unlimited		T
T <sub>J</sub>	Operating junction temperature			140	°C
T <sub>A</sub>	Operating ambient temperature	For SOT-23 (DBZ), X2SON (DMR) and TO-92 (LPG)	-40	135	°C
		For DSBGA (YBH)	-40	125	
T <sub>stg</sub>	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 <sub>(ESD)</sub>	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001 <sup>(1)</sup>	±6000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 <sup>(2)</sup>	±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 <sub>CC</sub>	Power supply voltage	V <sub>CC</sub>	2.5	5.5	V
V <sub>O</sub>	Output voltage	OUT	0	V <sub>CC</sub>	V
I <sub>O</sub>	Output current <sup>(1)</sup>	OUT	-5	20	mA
T <sub>J</sub>	Operating junction temperature			140	°C
T <sub>A</sub>	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 <sup>(1)</sup>		DRV5011				UNIT
		DBZ (SOT-23)	DMR (X2SON)	YBH (DSBGA)	LPG (TO-92)	
		3 PINS	4 PINS	4 PINS	3 PINS	
R <sub>θJA</sub>	Junction-to-ambient thermal resistance	356	159	194.1	183.1	°C/W
R <sub>θJC(top)</sub>	Junction-to-case (top) thermal resistance	128	77	1.6	74.2	°C/W
R <sub>θJB</sub>	Junction-to-board thermal resistance	94	102	68	158.8	°C/W
Ψ <sub>JT</sub>	Junction-to-top characterization parameter	11.4	0.9	0.8	15.2	°C/W
Ψ <sub>JB</sub>	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<sub>CC</sub> = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

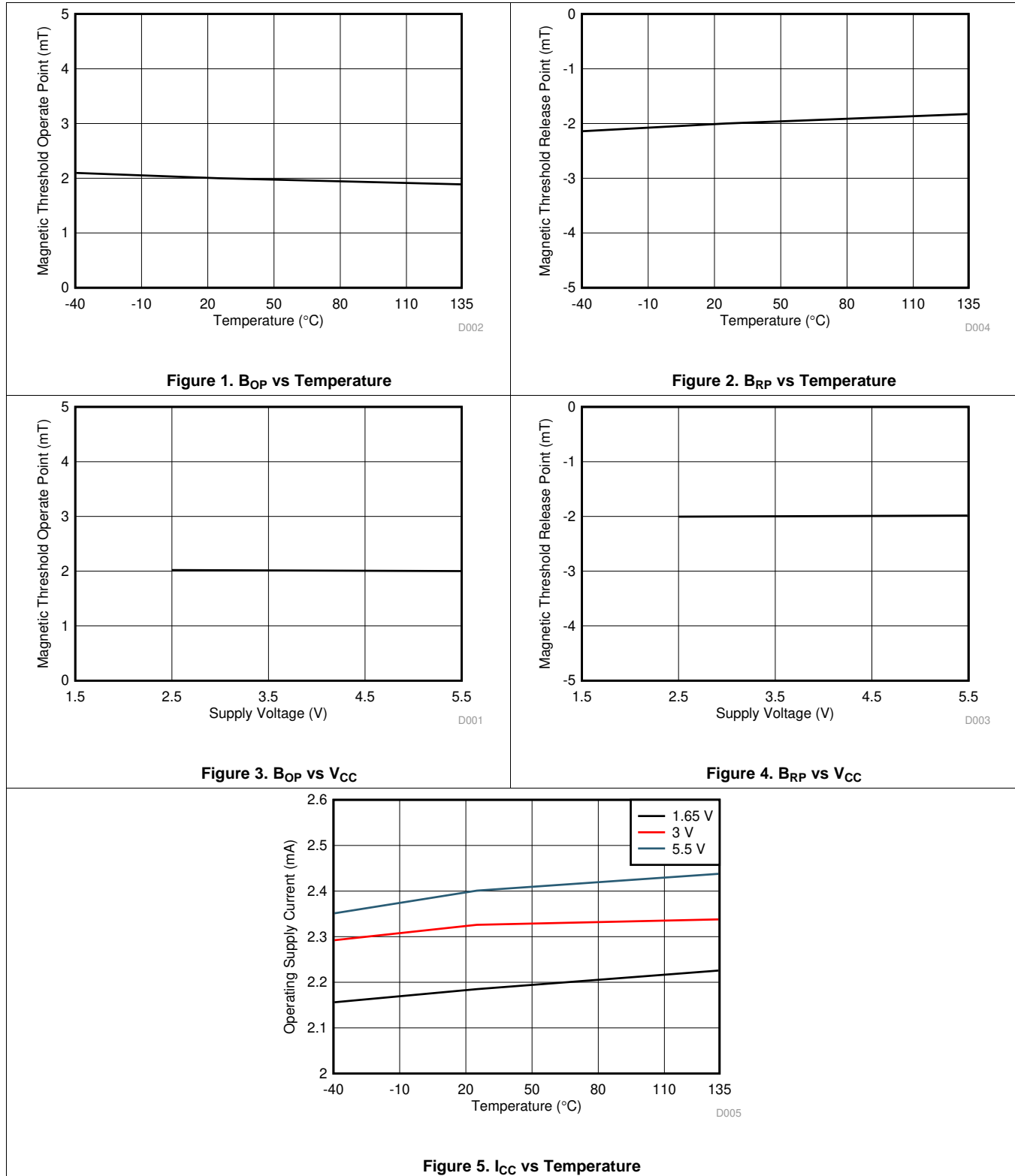
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
I <sub>CC</sub>	Operating supply current			2.3	3	mA
t <sub>ON</sub>	Power-on time (see <a href="#">Figure 10</a> )			40	70	μs
t <sub>d</sub>	Propagation delay time	From change in B to change in OUT		13	25	μs
V <sub>OH</sub>	High-level output voltage	I <sub>O</sub> = -1 mA	V <sub>CC</sub> - 0.35	V <sub>CC</sub> - 0.1		V
V <sub>OL</sub>	Low-level output voltage	I <sub>O</sub> = 20 mA		0.15	0.4	V

## 6.6 Magnetic Characteristics

for V<sub>CC</sub> = 2.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f <sub>BW</sub>	Sensing bandwidth			30		kHz
B <sub>OP</sub>	Magnetic threshold operate point (see <a href="#">Figure 8</a> )		0.6	2	3.8	mT
B <sub>RP</sub>	Magnetic threshold release point (see <a href="#">Figure 8</a> )		-3.8	-2	-0.6	mT
B <sub>HYS</sub>	Magnetic hysteresis:  B <sub>OP</sub> - B <sub>RP</sub>		2	4	6	mT

### 6.7 Typical Characteristics



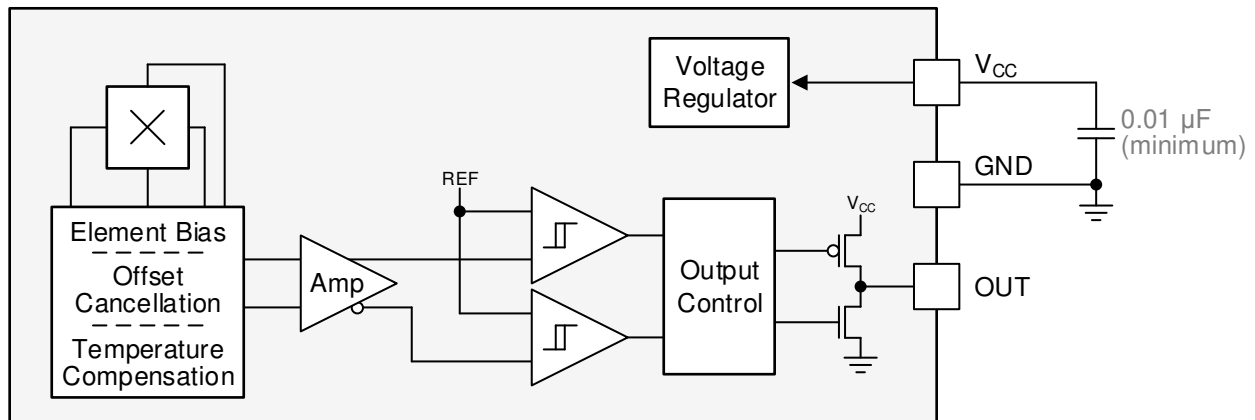
## 7 Detailed Description

### 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 [Figure 6](#).

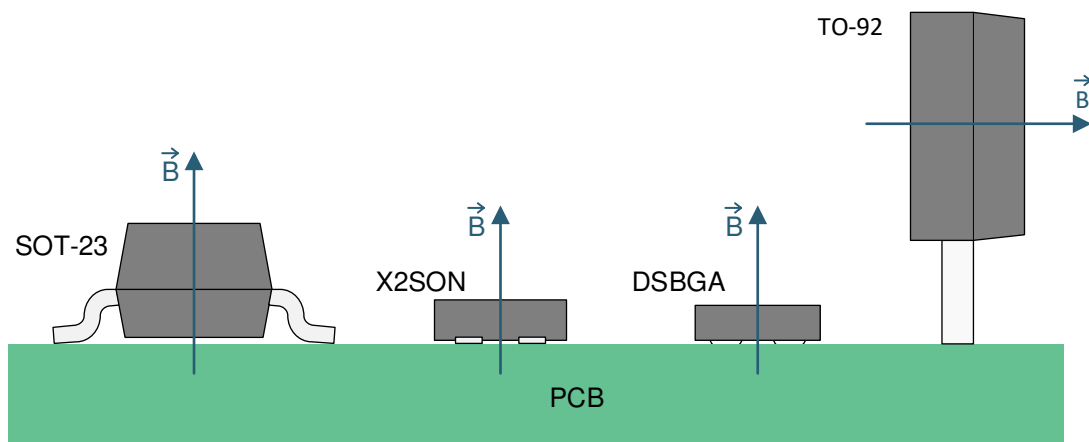
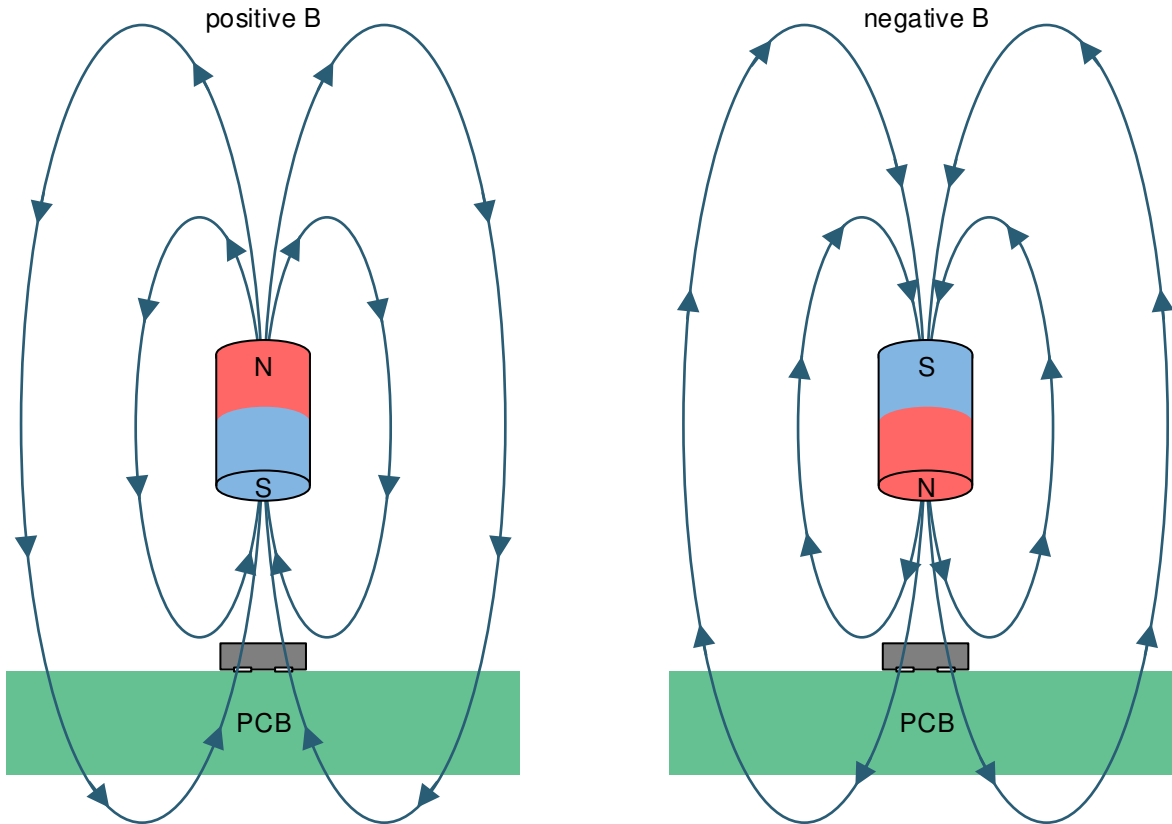


Figure 6. Direction of Sensitivity

**Feature Description (continued)**

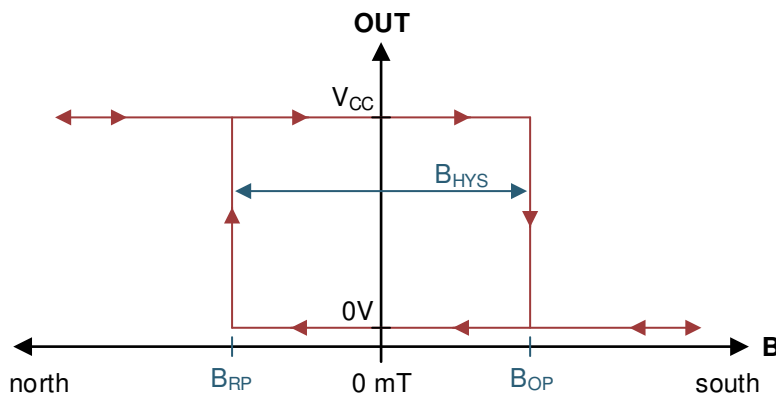
The magnetic flux that travels from the bottom to the top of the package is considered positive in this data sheet. This condition exists when a south magnetic pole is near the top of the package. The magnetic flux that travels from the top to the bottom of the package results in negative millitesla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



**Figure 7. Flux Direction Polarity**

**7.3.2 Magnetic Response**

Figure 8 shows the device functionality and hysteresis.



**Figure 8. Device Functionality**

## Feature Description (continued)

### 7.3.3 Output Driver

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

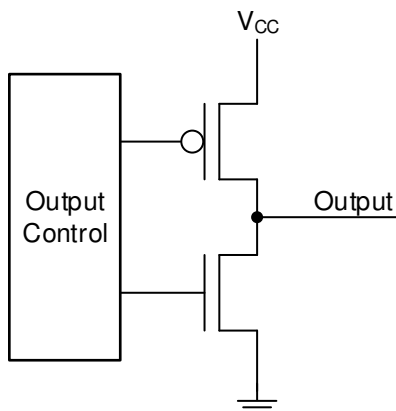


Figure 9. Push-Pull Output (Simplified)

### 7.3.4 Power-On Time

Figure 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.

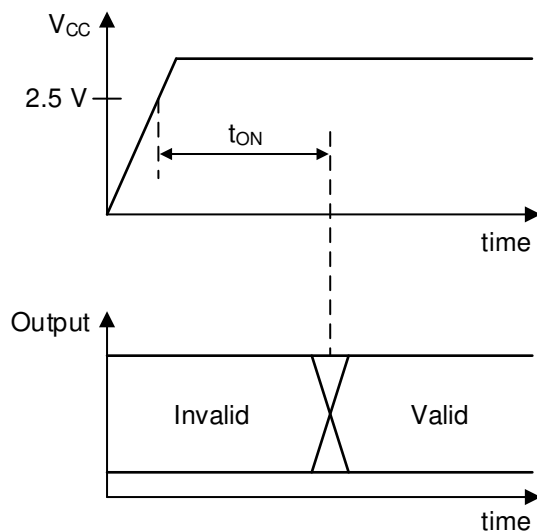


Figure 10.  $t_{ON}$  Definition

## Feature Description (continued)

### 7.3.5 Hall Element Location

The sensing element inside the device is in the center of both packages when viewed from the top. [Figure 11](#) shows the tolerances and side-view dimensions.

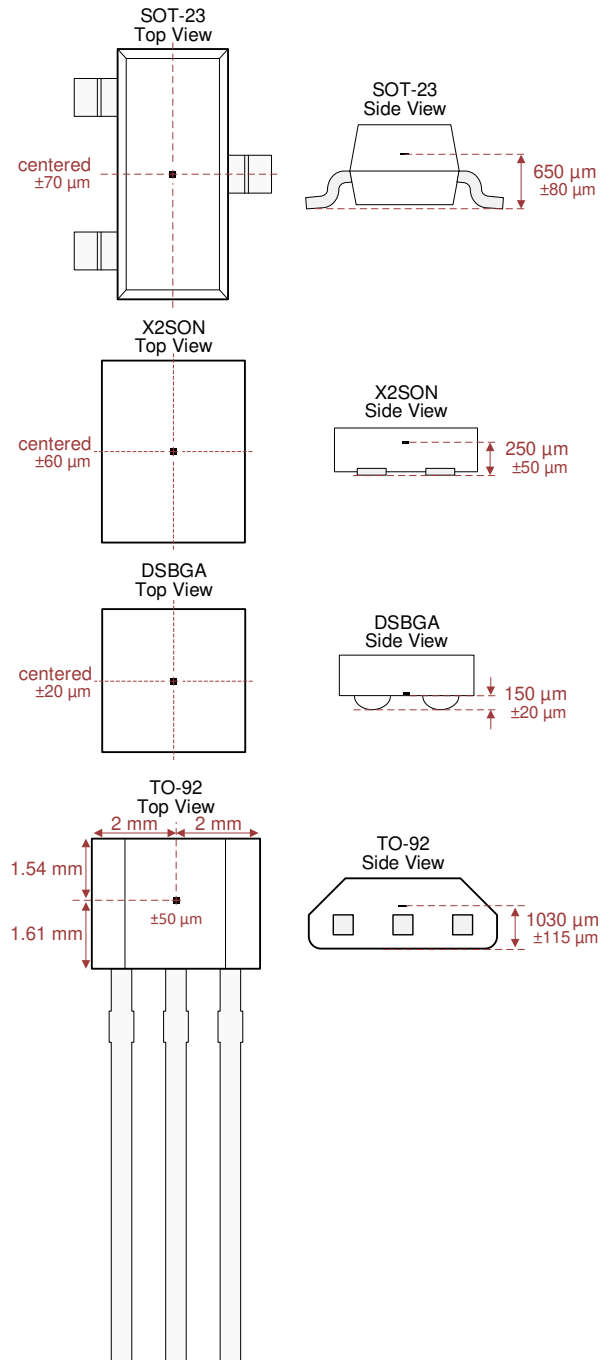


Figure 11. Hall Element Location

## 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

### 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.

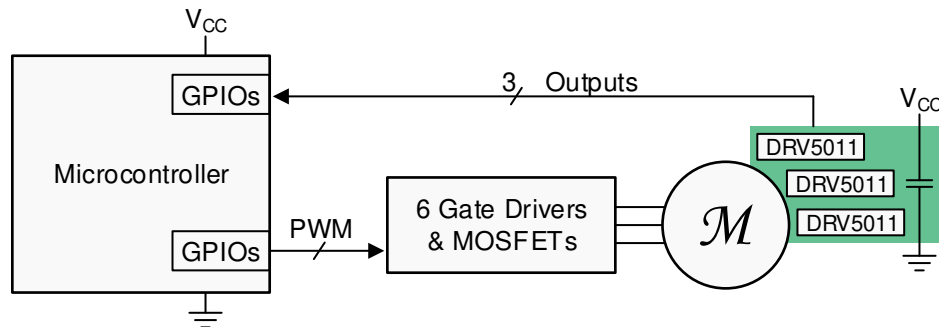
### 8.1 Application Information

The 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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Figure 12. BLDC Motor System

#### 8.2.1.1 Design Requirements

For this design example, use the parameters listed in [Table 1](#).

Table 1. Design Parameters

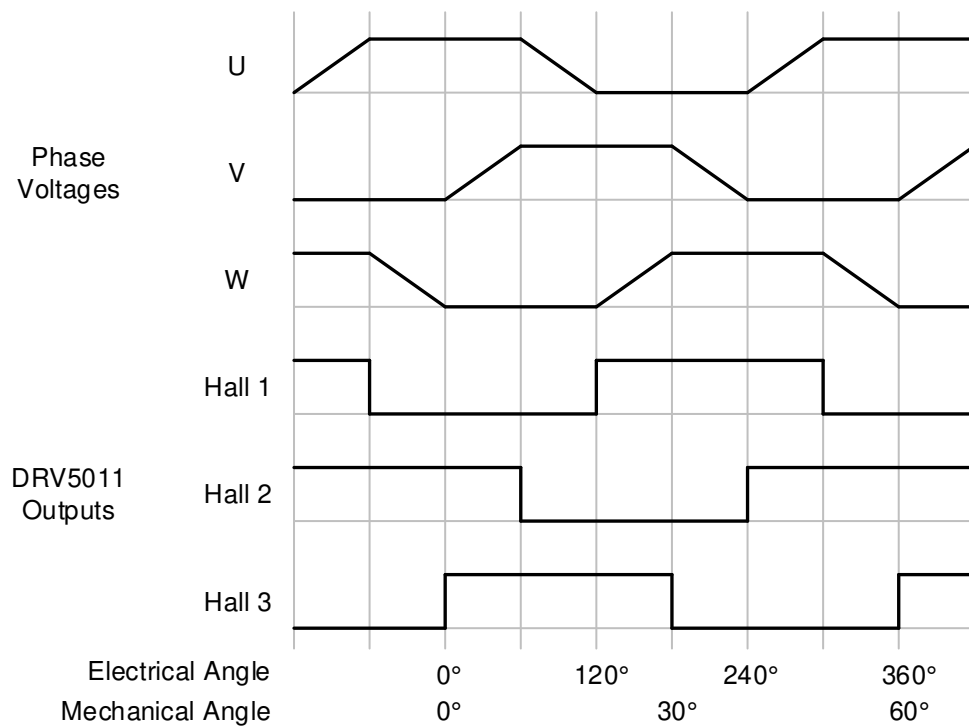
DESIGN PARAMETER	EXAMPLE VALUE
Number of motor phases	3
Motor RPM	15 k
Number of magnet poles on the rotor	12
Magnetic material	Bonded Neodymium
Maximum temperature inside the motor	125°C
Magnetic flux density peaks at the Hall sensors at maximum temperature	±11 mT
Hall sensor $V_{CC}$	5 V ±10%

### 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.

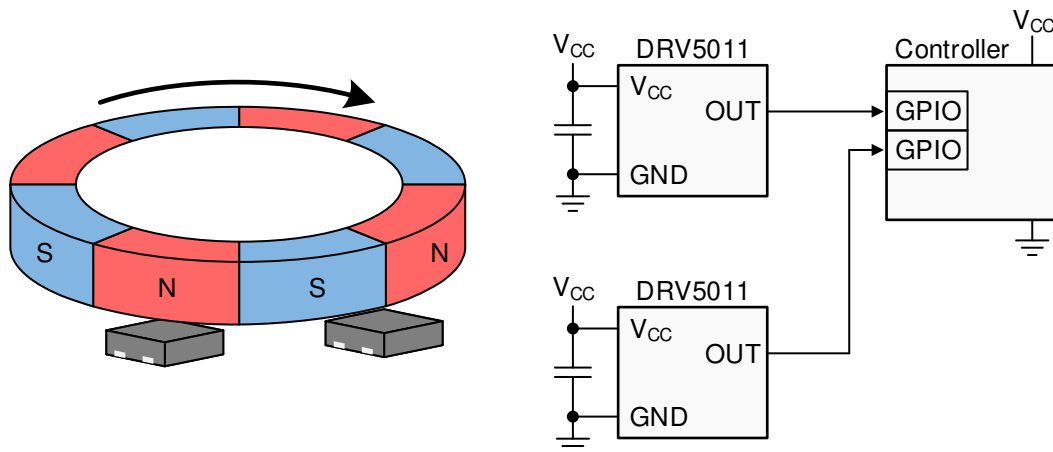
Space the three Hall sensors across the printed-circuit board (PCB) so that they are 120 electrical degrees apart. This configuration creates six 3-bit states with equal time duration for each electrical cycle, which consists of one north and one south magnetic pole. From the center of the motor axis,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



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

## 8.2.2 Incremental Rotary Encoding Application



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Figure 14. Incremental Rotary Encoding System

### 8.2.2.1 Design Requirements

For this design example, use the parameters listed in [Table 2](#).

Table 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

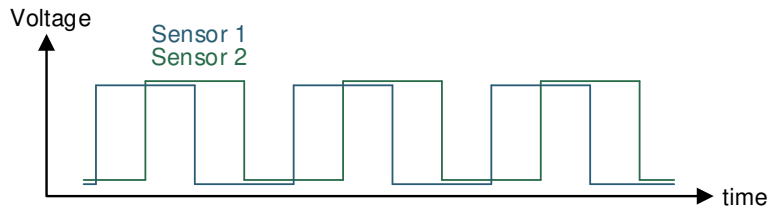
Incremental encoders are used on knobs, wheels, motors, and flow meters to measure relative rotary movement. By attaching a ring magnet to the rotating component and placing a DRV5011 nearby, the sensor generates voltage pulses as the magnet turns. If directional information is also needed (clockwise 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. [Figure 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**

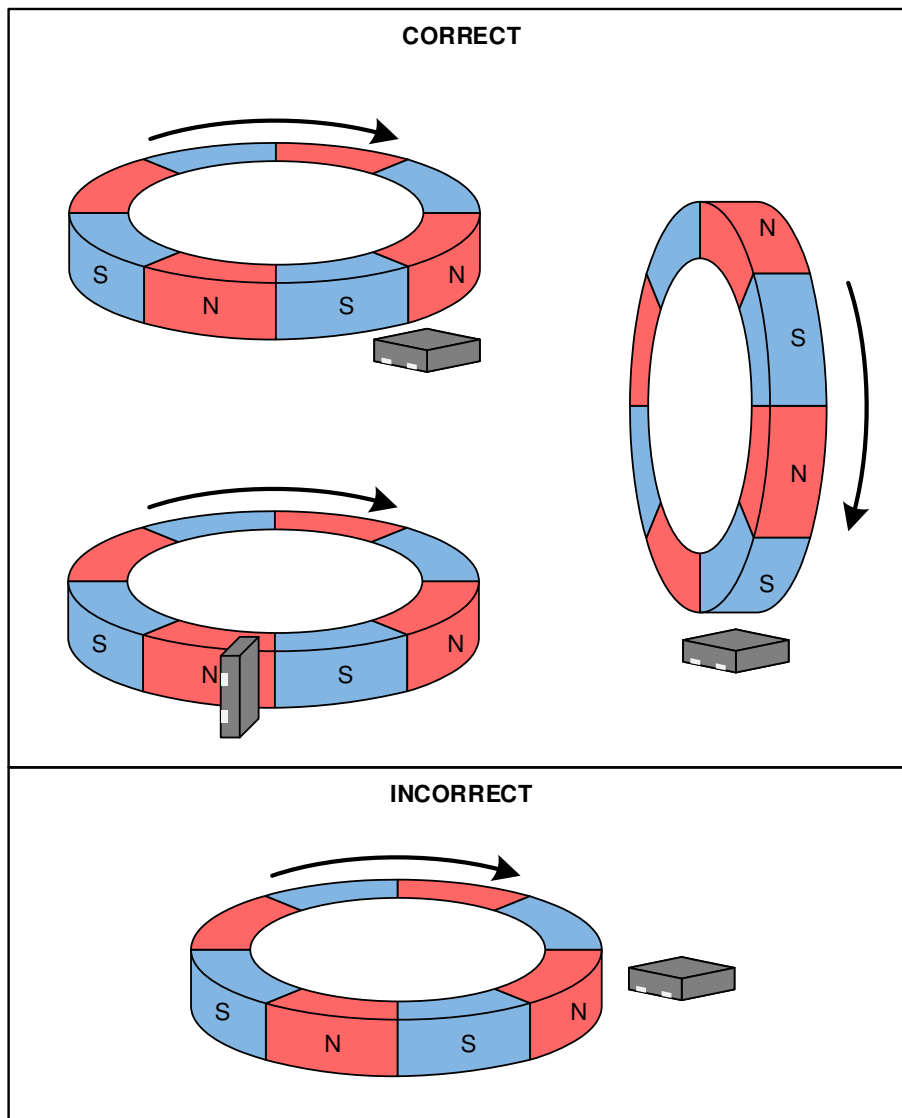
Two signals in quadrature provide movement and direction information. Figure 15 shows how each 2-bit state has unique adjacent 2-bit states for clockwise and counterclockwise.



**Figure 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. Figure 16 shows correct and incorrect orientations when using a ring magnet.



**Figure 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- $\mu$ 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<sub>PP</sub>.

## 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

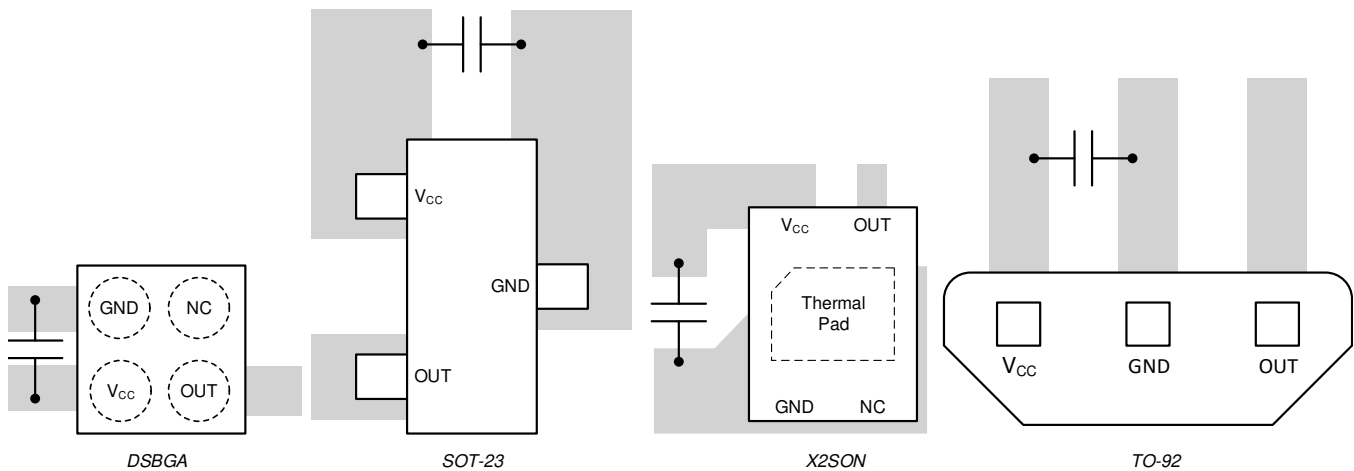


Figure 17. Layout Examples

## 11 Device and Documentation Support

### 11.1 Device Support

#### 11.1.1 Development Support

For additional design reference, see the [Automotive Hall Sensor Rotary Encoder TI design \(TIDA-00480\)](#).

TI also offers the following evaluation modules (EVMs) for the DRV5011:

- Texas Instruments, [DRV5011 Ultra-Low Power, Digital-Latch Hall Effect Sensor Evaluation Module](#)
- Texas Instruments, [Breakout Adapter for SOT-23 and TO-92 Hall Sensor Evaluation](#)

### 11.2 Documentation Support

#### 11.2.1 Related Documentation

For related documentation see the following:

- [DRV5011-5012EVM user's guide](#)
- [HALL-ADAPTER-EVM user's guide](#)

### 11.3 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.

### 11.4 Community Resources

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

Linked content is 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](#).

### 11.5 Trademarks

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

### 11.6 Electrostatic Discharge Caution



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

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

### 11.7 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 devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

**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)
<a href="#">DRV5011ADDBZR</a>	Active	Production	SOT-23 (DBZ)   3	3000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 135	1AD
DRV5011ADDBZR.A	Active	Production	SOT-23 (DBZ)   3	3000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 135	1AD
<a href="#">DRV5011ADDBZT</a>	Obsolete	Production	SOT-23 (DBZ)   3	-	-	Call TI	Call TI	-40 to 135	1AD
<a href="#">DRV5011ADDMRR</a>	Active	Production	X2SON (DMR)   4	3000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 135	1AD
DRV5011ADDMRR.A	Active	Production	X2SON (DMR)   4	3000   LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 135	1AD
<a href="#">DRV5011ADDMRT</a>	Obsolete	Production	X2SON (DMR)   4	-	-	Call TI	Call TI	-40 to 135	1AD
<a href="#">DRV5011ADLPG</a>	Active	Production	TO-92 (LPG)   3	1000   BULK	Yes	SN	N/A for Pkg Type	-40 to 135	11AD
DRV5011ADLPG.A	Active	Production	TO-92 (LPG)   3	1000   BULK	Yes	SN	N/A for Pkg Type	-40 to 135	11AD
<a href="#">DRV5011ADLPGM</a>	Active	Production	TO-92 (LPG)   3	3000   AMMO	Yes	SN	N/A for Pkg Type	-40 to 135	11AD
DRV5011ADLPGM.A	Active	Production	TO-92 (LPG)   3	3000   AMMO	Yes	SN	N/A for Pkg Type	-40 to 135	11AD
<a href="#">DRV5011ADYBHR</a>	Active	Production	DSBGA (YBH)   4	3000   LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	A
DRV5011ADYBHR.A	Active	Production	DSBGA (YBH)   4	3000   LARGE T&R	Yes	SNAGCU	Level-1-260C-UNLIM	-40 to 125	A
<a href="#">DRV5011ADYBHT</a>	Obsolete	Production	DSBGA (YBH)   4	-	-	Call TI	Call TI	-40 to 125	A

(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.

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**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
DRV5011ADDBZR	SOT-23	DBZ	3	3000	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
DRV5011ADYBHR	DSBGA	YBH	4	3000	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
DRV5011ADDMRR	X2SON	DMR	4	3000	200.0	183.0	25.0
DRV5011ADYBHR	DSBGA	YBH	4	3000	182.0	182.0	20.0

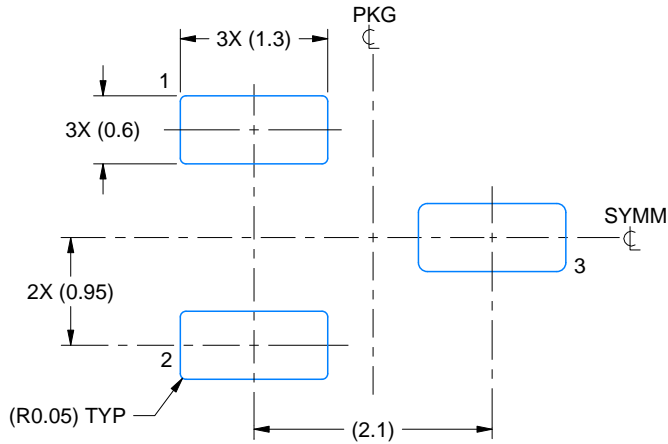


# EXAMPLE BOARD LAYOUT

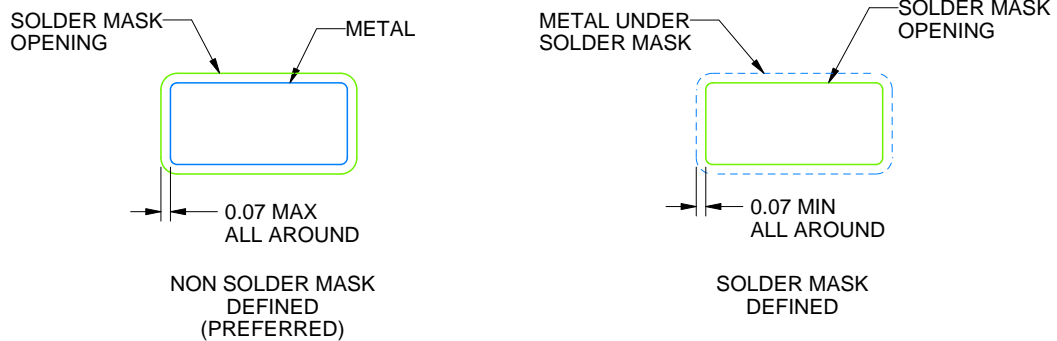
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
SCALE:15X



SOLDER MASK DETAILS

4214838/F 08/2024

NOTES: (continued)

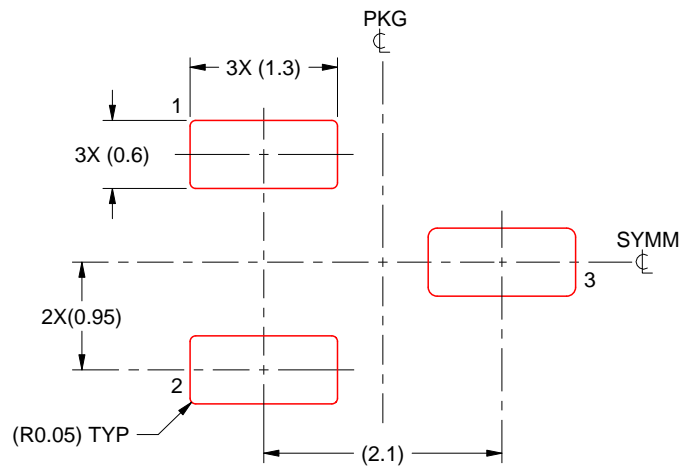
- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

# 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/F 08/2024

NOTES: (continued)

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

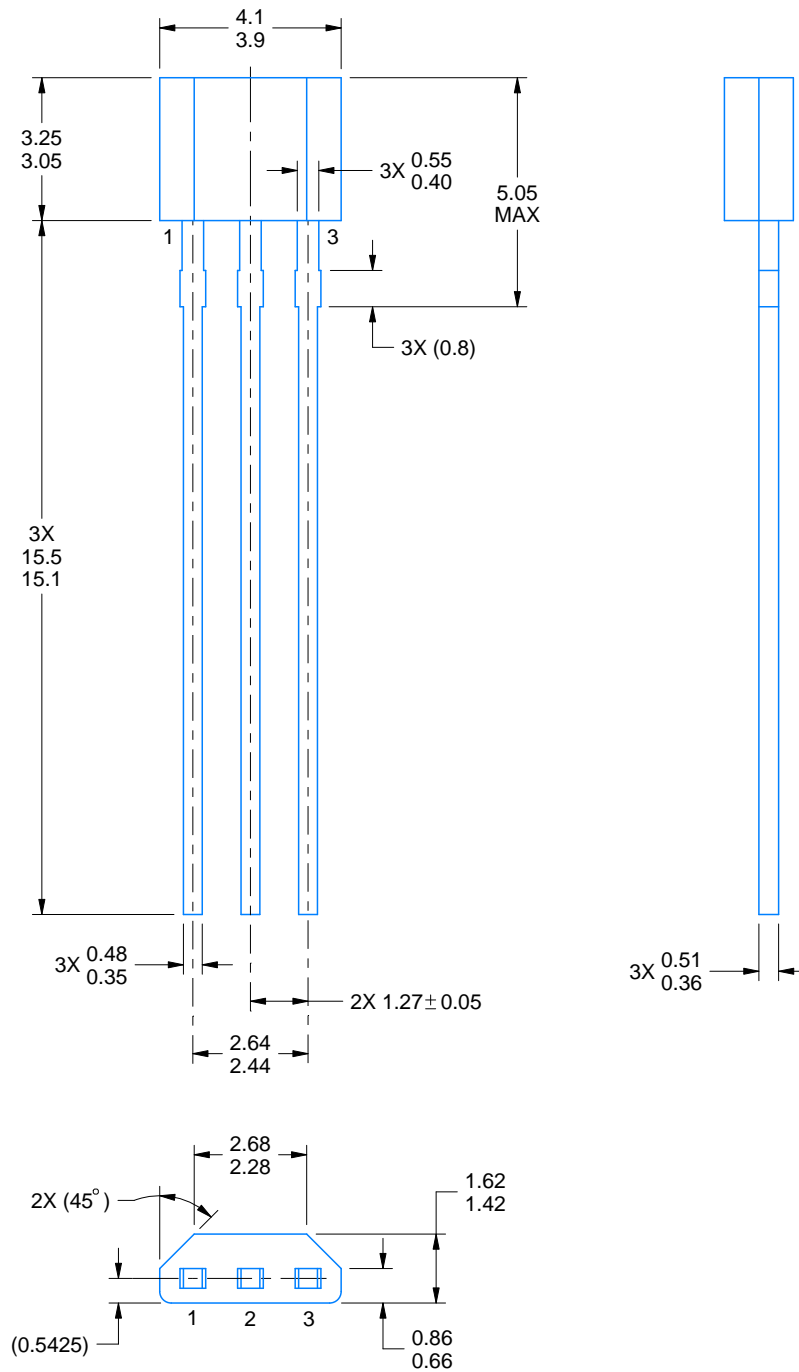
# LPG0003A



# PACKAGE OUTLINE

## TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018

### NOTES:

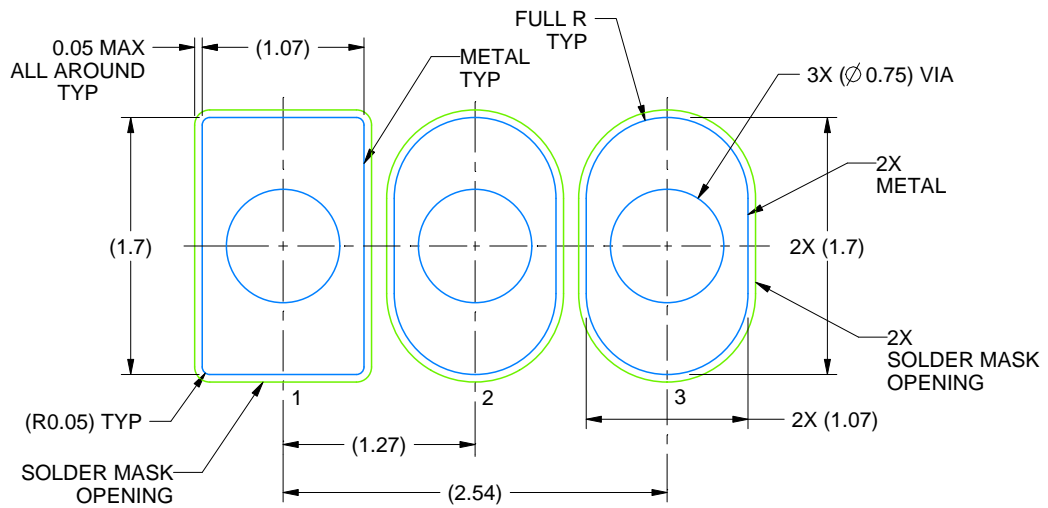
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



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

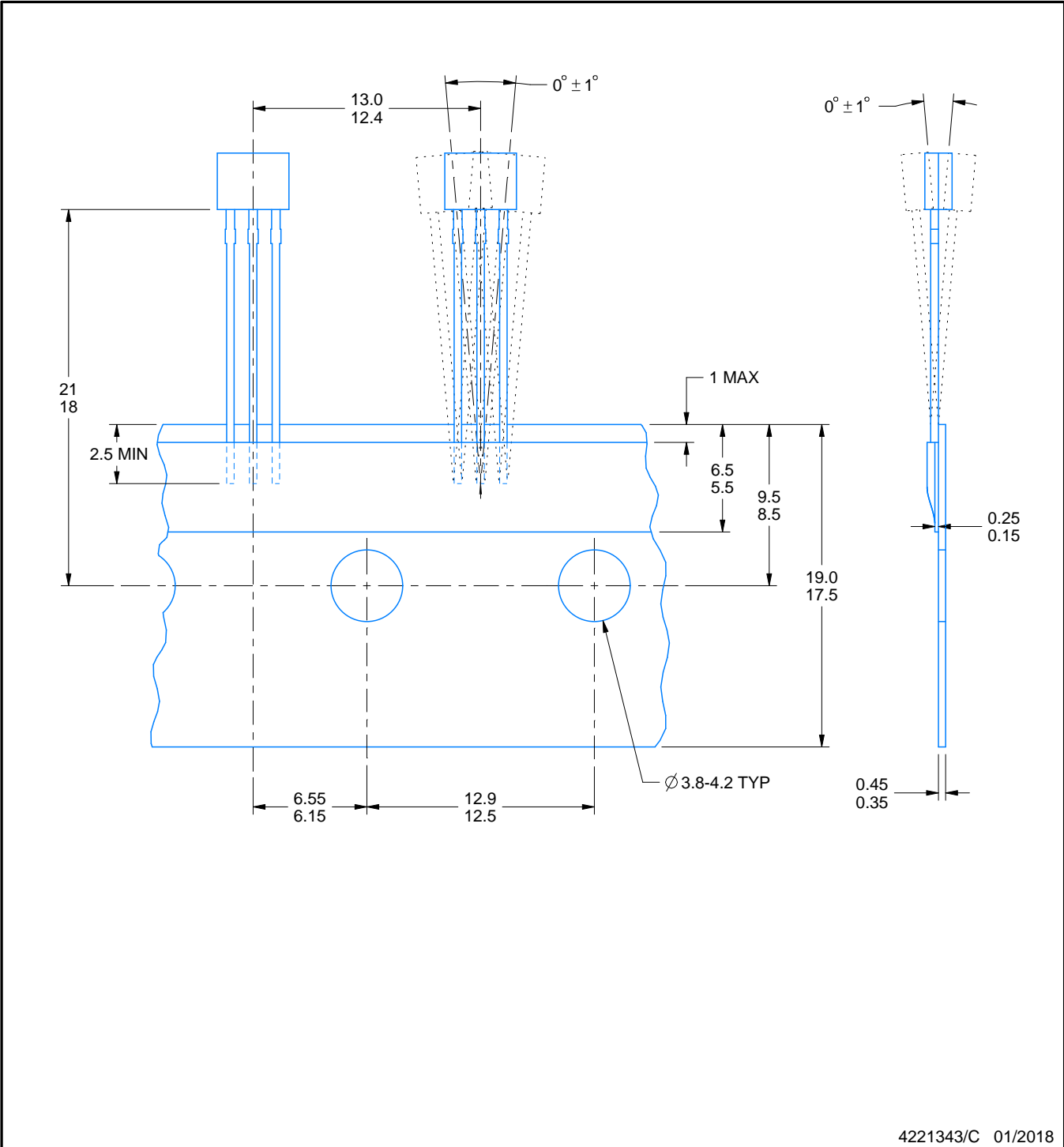
4221343/C 01/2018

# TAPE SPECIFICATIONS

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018

## GENERIC PACKAGE VIEW

**DMR 4**

**X2SON - 0.4 mm max height**

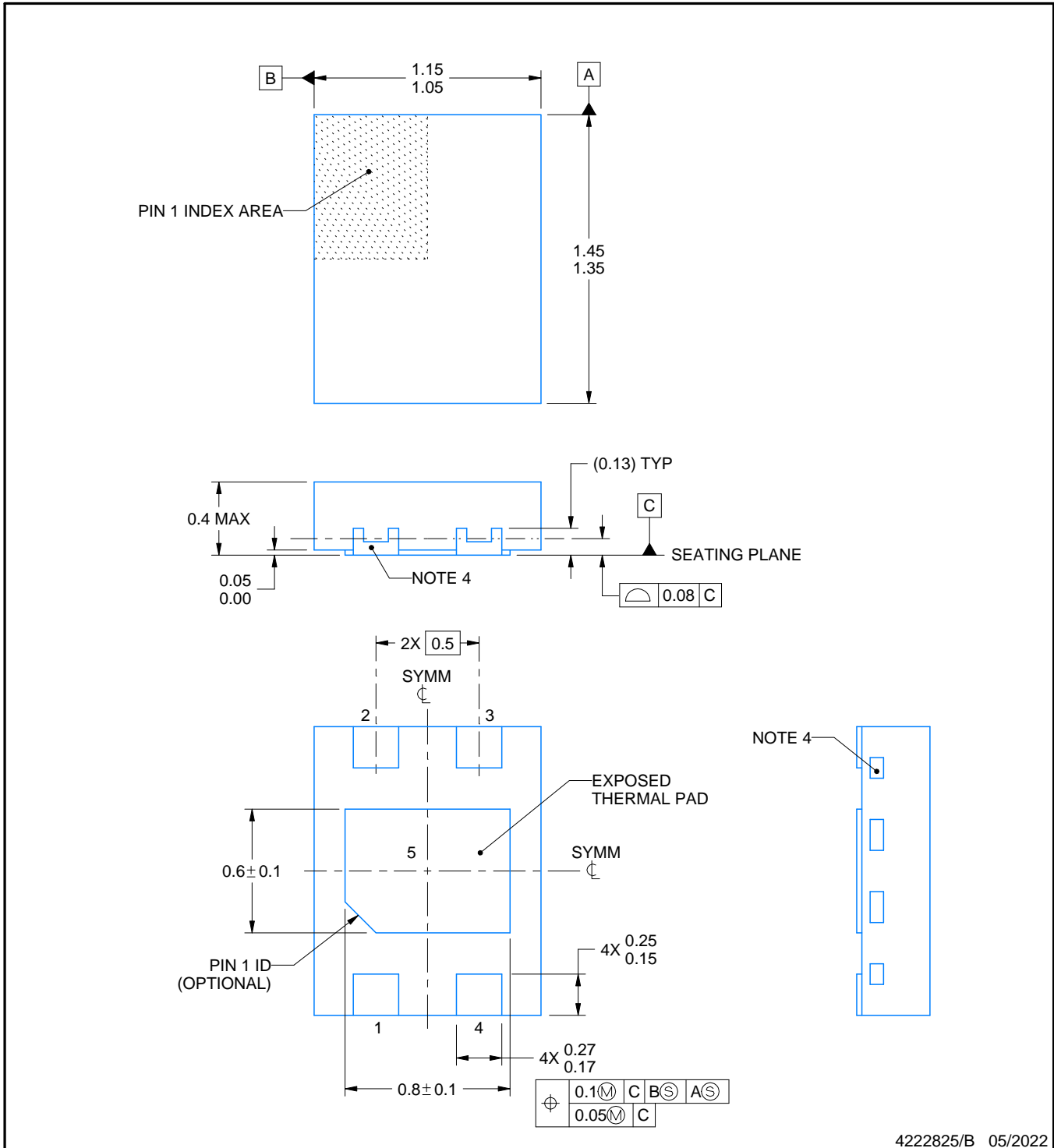
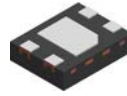
1.1 x 1.4, 0.5 mm pitch

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.



4229480/A



4222825/B 05/2022

NOTES:

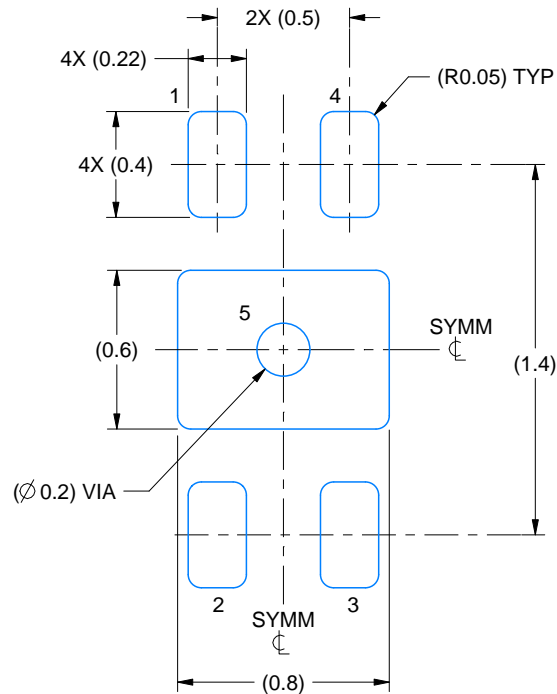
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. The package thermal pad must be soldered to the printed circuit board for thermal and mechanical performance.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

# EXAMPLE BOARD LAYOUT

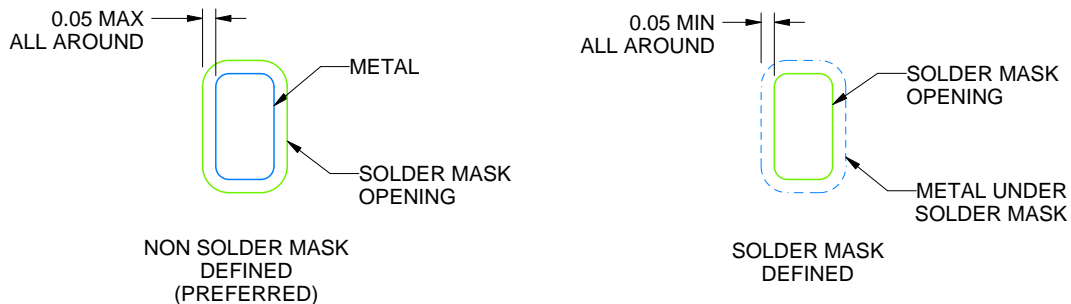
DMR0004A

X2SON - 0.4 mm max height

PLASTIC SMALL OUTLINE - NO LEAD



LAND PATTERN EXAMPLE  
SCALE:35X



SOLDER MASK DETAILS

4222825/B 05/2022

NOTES: (continued)

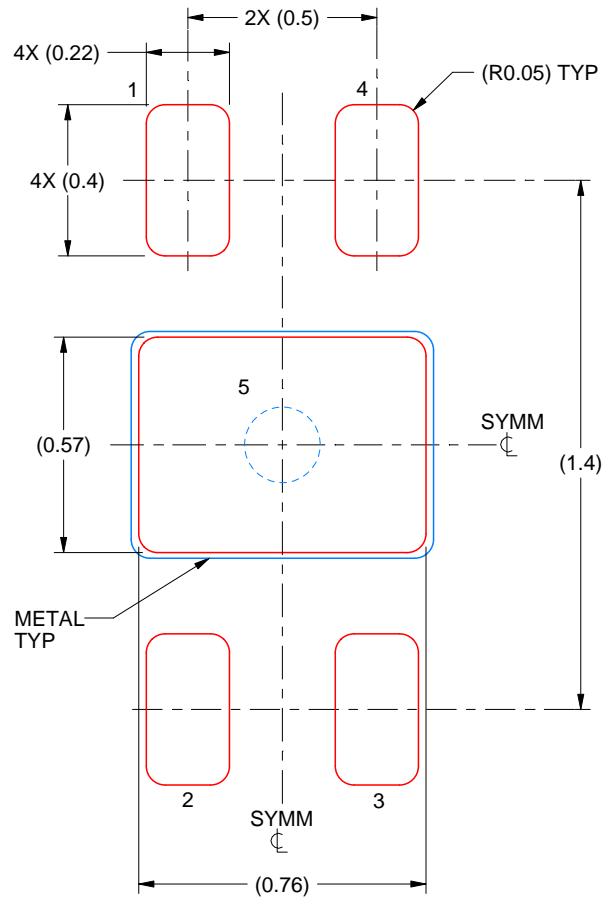
5. This package is designed to be soldered to a thermal pad on the board. For more information, see Texas Instruments literature number SLUA271 ([www.ti.com/lit/slua271](http://www.ti.com/lit/slua271)).
6. Vias are optional depending on application, refer to device data sheet. If all or some are implemented, 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/B 05/2022

NOTES: (continued)

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

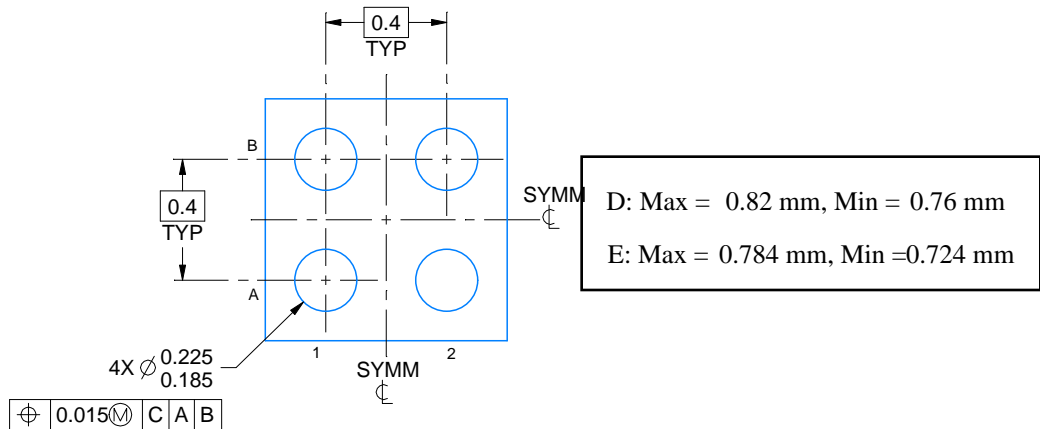
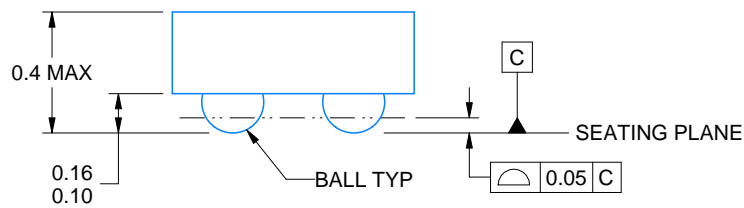
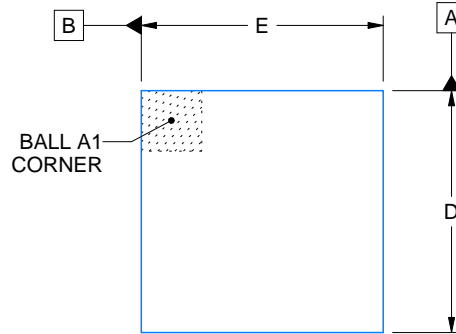
YBH0004



PACKAGE OUTLINE

DSBGA - 0.4 mm max height

DIE SIZE BALL GRID ARRAY



4224051/A 11/2017

NOTES:

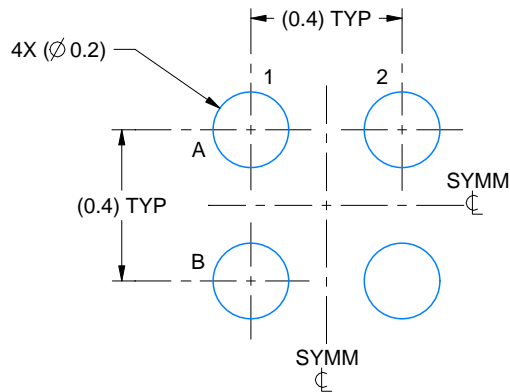
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

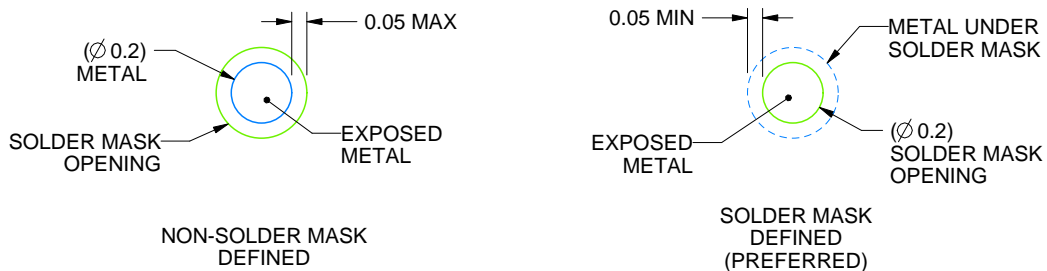
YBH0004

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)

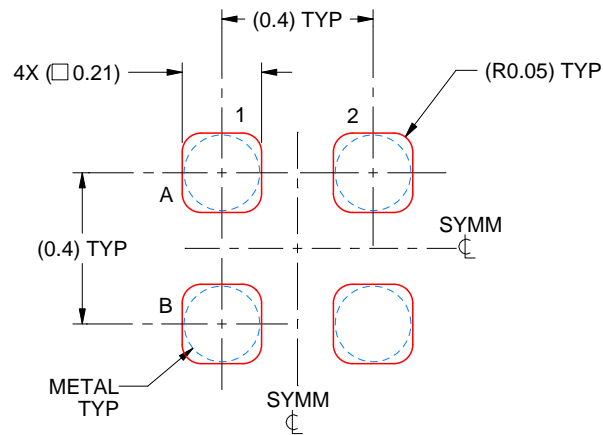
- Final dimensions may vary due to manufacturing tolerance considerations and also routing constraints. See Texas Instruments Literature No. SNVA009 ([www.ti.com/lit/snva009](http://www.ti.com/lit/snva009)).

# 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.

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Last updated 10/2025