



## DRV5033-Q1 汽车类 数字全极开关霍尔效应传感器

### 1 特性

- 数字全极开关霍尔传感器
- 符合汽车类应用的 AEC-Q100 标准
  - 1 级:  $T_A = -40$  至  $125^\circ\text{C}$  (Q, 请见图 23)
  - 0 级:  $T_A = -40$  至  $150^\circ\text{C}$  (E, 请见图 23)
- 出色的温度稳定性
  - 在温度范围内  $B_{OP} \pm 10\%$
- 多种灵敏度选项 ( $B_{OP}/B_{RP}$ ):
  - $\pm 3.5/\pm 2\text{mT}$  (FA, 请参见图 23)
  - $\pm 6.9/\pm 3.5\text{mT}$  (AJ, 请参见图 23)
- 检测南北磁场
- 支持宽电压范围
  - 2.7V 至 38V
  - 无需外部稳压器
- 开漏输出 (30mA 灌电流)
- 35 $\mu\text{s}$  快速上电时间
- 小型封装尺寸
  - 表面贴装 3 引脚小外形尺寸晶体管 (SOT)-23 (DBZ)
    - 2.92mm  $\times$  2.37mm
  - 插入式 3 引脚 TO-92 (LPG)
    - 4.00mm  $\times$  3.15mm
- 保护 特性
  - 反向电源保护 (高达 -22V)
  - 支持高达 40V 抛负载
  - 输出短路保护
  - 输出电流限制
  - 电池输出短路保护

### 2 应用

- 对接检测
- 门开关检测
- 接近感测
- 阀定位
- 脉冲计数

### 3 说明

DRV5033-Q1 器件是一款斩波稳定霍尔效应传感器，能够在整个温度范围内提供具有出色灵敏度稳定性和集成保护特性的磁场感测 功能。

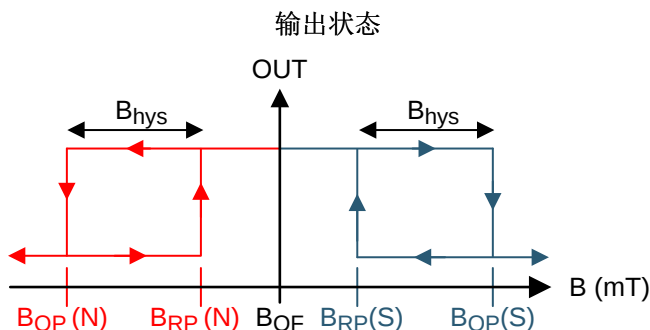
DRV5033-Q1 对磁场两极方向的响应相同。当应用的磁通量密度超过  $B_{OP}$  阈值时，DRV5033-Q1 开漏输出变为低电平。输出将保持低电平，直到磁通量密度降至  $B_{RP}$  以下之后变为高阻抗。输出灌电流能力为 30mA。反向极性保护高达 -22V 的宽工作电压范围 (2.7 至 38V) 使得此器件广泛适用于各种汽车 信号。

该器件提供针对反向电源情况、负载突降以及输出短路或过流故障的内部保护功能。

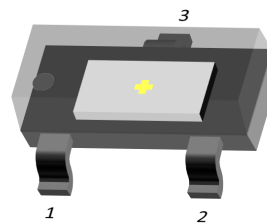
器件信息<sup>(1)</sup>

| 器件型号       | 封装         | 封装尺寸 (标称值)             |
|------------|------------|------------------------|
| DRV5033-Q1 | SOT-23 (3) | 2.92mm $\times$ 1.30mm |
|            | TO-92 (3)  | 4.00mm $\times$ 3.15mm |

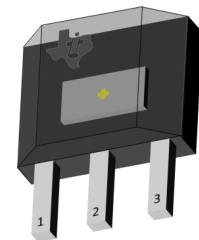
(1) 要了解所有可用封装，请见数据表末尾的可订购产品附录。



SOT-23



TO-92



## 目录

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## 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 Revision D (May 2016) to Revision E                                            | Page |
|---------------------------------------------------------------------------------------------|------|
| • Made changes to the Power-on time in the <a href="#">Electrical Characteristics</a> table | 5    |

| Changes from Revision C (February 2016) to Revision D | Page |
|-------------------------------------------------------|------|
| • Revised preliminary limits for the FA version       | 5    |

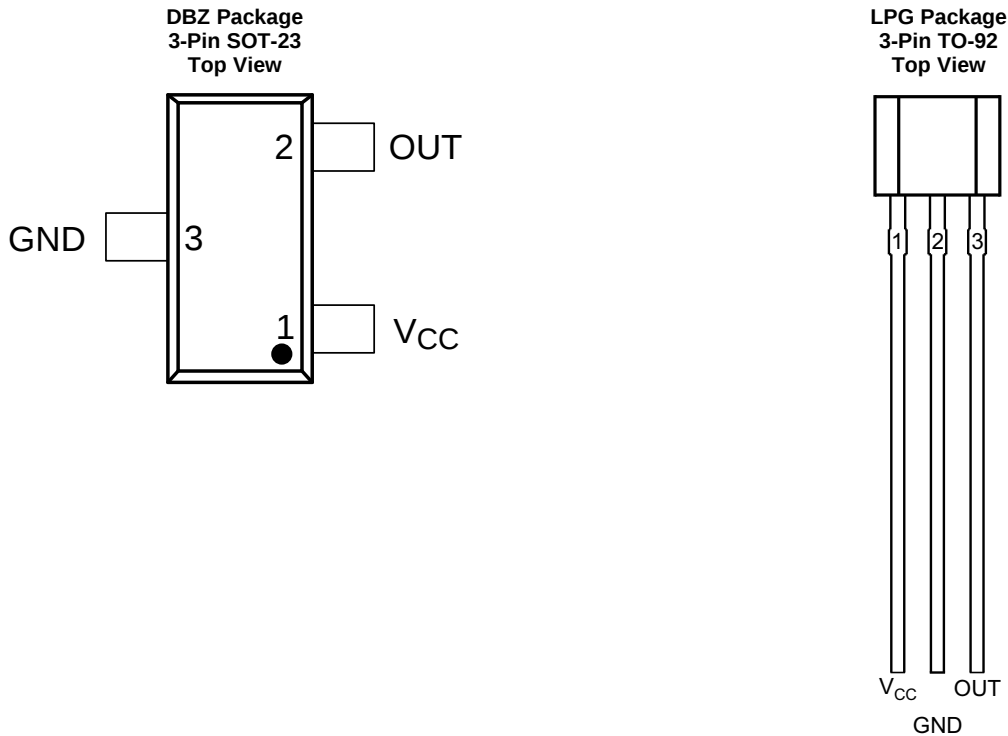
| Changes from Revision B (December 2015) to Revision C                            | Page |
|----------------------------------------------------------------------------------|------|
| • 已添加 FA 器件选项                                                                    | 1    |
| • Added the typical bandwidth value to the <i>Magnetic Characteristics</i> table | 5    |

| Changes from Revision A (May 2015) to Revision B                                                                  | Page |
|-------------------------------------------------------------------------------------------------------------------|------|
| • 已更正 SOT-23 封装体尺寸并将 SIP 封装名称更正为 TO-92                                                                            | 1    |
| • Added B <sub>MAX</sub> to <i>Absolute Maximum Ratings</i>                                                       | 4    |
| • Removed table notes regarding testing for the operating junction temperature in <i>Absolute Maximum Ratings</i> | 4    |
| • 已更新封装卷带选项 M 和空白                                                                                                 | 18   |
| • 已添加 <a href="#">社区资源</a>                                                                                        | 19   |

| Changes from Original (December 2014) to Revision A | Page |
|-----------------------------------------------------|------|
| • 已将器件状态更新为量产数据                                     | 1    |

## 5 Pin Configuration and Functions

For additional configuration information, see [器件标记](#) and [机械、封装和可订购信息](#).



**Pin Functions**

| PIN             |     |     | TYPE   | DESCRIPTION                                                                                                                     |
|-----------------|-----|-----|--------|---------------------------------------------------------------------------------------------------------------------------------|
| NAME            | DBZ | LPG |        |                                                                                                                                 |
| GND             | 3   | 2   | GND    | Ground pin                                                                                                                      |
| OUT             | 2   | 3   | Output | Hall sensor open-drain output. The open drain requires a resistor pullup.                                                       |
| V <sub>CC</sub> | 1   | 1   | PWR    | 2.7 to 38 V power supply. Bypass this pin to the GND pin with a 0.01-μF (minimum) ceramic capacitor rated for V <sub>CC</sub> . |

## 6 Specifications

### 6.1 Absolute Maximum Ratings

over operating free-air temperature range (unless otherwise noted) <sup>(1)</sup>

|                                                            |                                                             | MIN                | MAX | UNIT |
|------------------------------------------------------------|-------------------------------------------------------------|--------------------|-----|------|
| Power supply voltage                                       | V <sub>CC</sub>                                             | –22 <sup>(2)</sup> | 40  | V    |
|                                                            | Voltage ramp rate (V <sub>CC</sub> ), V <sub>CC</sub> < 5 V | Unlimited          |     | V/μs |
|                                                            | Voltage ramp rate (V <sub>CC</sub> ), V <sub>CC</sub> > 5 V | 0                  | 2   |      |
| Output pin voltage                                         |                                                             | –0.5               | 40  | V    |
| Output pin reverse current during reverse supply condition |                                                             | 0                  | 100 | mA   |
| Magnetic flux density, B <sub>MAX</sub>                    |                                                             | Unlimited          |     |      |
| Operating junction temperature, T <sub>J</sub>             | Q, see <a href="#">图 23</a>                                 | –40                | 150 | °C   |
|                                                            | E, see <a href="#">图 23</a>                                 | –40                | 17  |      |
| Storage temperature, T <sub>stg</sub>                      |                                                             | –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.
- (2) Ensured by design. Only tested to –20 V.

### 6.2 ESD Ratings

|                                            |                                                         | VALUE | UNIT |
|--------------------------------------------|---------------------------------------------------------|-------|------|
| V <sub>(ESD)</sub> Electrostatic discharge | Human-body model (HBM), per AEC Q100-002 <sup>(1)</sup> | ±2500 | V    |
|                                            | Charged-device model (CDM), per AEC Q100-011            | ±500  |      |

- (1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification.

### 6.3 Recommended Operating Conditions

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

|                   |                                              | MIN | MAX | UNIT |
|-------------------|----------------------------------------------|-----|-----|------|
| V <sub>CC</sub>   | Power supply voltage                         | 2.7 | 38  | V    |
| V <sub>O</sub>    | Output pin voltage (OUT)                     | 0   | 38  | V    |
| I <sub>SINK</sub> | Output pin current sink (OUT) <sup>(1)</sup> | 0   | 30  | mA   |
| T <sub>A</sub>    | Operating ambient temperature                | –40 | 125 | °C   |
|                   |                                              | –40 | 150 |      |

- (1) Power dissipation and thermal limits must be observed

### 6.4 Thermal Information

| THERMAL METRIC <sup>(1)</sup> |                                              | DRV5033-Q1   |             | UNIT |
|-------------------------------|----------------------------------------------|--------------|-------------|------|
|                               |                                              | DBZ (SOT-23) | LPG (TO-92) |      |
|                               |                                              | 3 PINS       | 3 PINS      |      |
| R <sub>θJA</sub>              | Junction-to-ambient thermal resistance       | 333.2        | 180         | °C/W |
| R <sub>θJC(top)</sub>         | Junction-to-case (top) thermal resistance    | 99.9         | 98.6        | °C/W |
| R <sub>θJB</sub>              | Junction-to-board thermal resistance         | 66.9         | 154.9       | °C/W |
| ψ <sub>JT</sub>               | Junction-to-top characterization parameter   | 4.9          | 40          | °C/W |
| ψ <sub>JB</sub>               | Junction-to-board characterization parameter | 65.2         | 154.9       | °C/W |

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

## 6.5 Electrical Characteristics

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

| PARAMETER                         | TEST CONDITIONS                   | MIN                                                                                | TYP | MAX | UNIT |    |
|-----------------------------------|-----------------------------------|------------------------------------------------------------------------------------|-----|-----|------|----|
| POWER SUPPLIES (V <sub>CC</sub> ) |                                   |                                                                                    |     |     |      |    |
| V <sub>CC</sub>                   | V <sub>CC</sub> operating voltage | 2.7                                                                                |     | 38  | V    |    |
| I <sub>CC</sub>                   | Operating supply current          | V <sub>CC</sub> = 2.7 to 38 V, T <sub>A</sub> = 25°C                               | 2.7 |     | mA   |    |
|                                   |                                   | V <sub>CC</sub> = 2.7 to 38 V, T <sub>A</sub> = T <sub>A, MAX</sub> <sup>(1)</sup> | 3   | 3.6 |      |    |
| t <sub>on</sub>                   | Power-on time                     | AJ version                                                                         | 35  | 50  | μs   |    |
|                                   |                                   | FA version                                                                         | 35  | 70  |      |    |
| OPEN DRAIN OUTPUT (OUT)           |                                   |                                                                                    |     |     |      |    |
| r <sub>DS(on)</sub>               | FET on-resistance                 | V <sub>CC</sub> = 3.3 V, I <sub>O</sub> = 10 mA, T <sub>A</sub> = 25°C             | 22  |     | Ω    |    |
|                                   |                                   | V <sub>CC</sub> = 3.3 V, I <sub>O</sub> = 10 mA, T <sub>A</sub> = 125°C            | 36  | 50  |      |    |
| I <sub>lkg(off)</sub>             | Off-state leakage current         | Output Hi-Z                                                                        |     | 1   | μA   |    |
| PROTECTION CIRCUITS               |                                   |                                                                                    |     |     |      |    |
| V <sub>CCR</sub>                  | Reverse supply voltage            |                                                                                    | −22 |     | V    |    |
| I <sub>OCP</sub>                  | Overcurrent protection level      | OUT shorted V <sub>CC</sub>                                                        | 15  | 30  | 45   | mA |

(1) T<sub>A, MAX</sub> is 125°C for Q Grade 1 devices and 150°C for E Grade 0 devices (see [Figure 23](#))

## 6.6 Switching Characteristics

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

| PARAMETER                      | TEST CONDITIONS               | MIN                                                            | TYP | MAX | UNIT |
|--------------------------------|-------------------------------|----------------------------------------------------------------|-----|-----|------|
| <b>OPEN DRAIN OUTPUT (OUT)</b> |                               |                                                                |     |     |      |
| t <sub>d</sub>                 | Output delay time             | B = B <sub>RP</sub> – 10 mT to B <sub>OP</sub> + 10 mT in 1 μs |     | 13  | μs   |
| t <sub>r</sub>                 | Output rise time (10% to 90%) | R1 = 1 kΩ, C <sub>O</sub> = 50 pF, V <sub>CC</sub> = 3.3 V     |     | 200 | ns   |
| t <sub>f</sub>                 | Output fall time (90% to 10%) | R1 = 1 kΩ, C <sub>O</sub> = 50 pF, V <sub>CC</sub> = 3.3 V     |     | 31  | ns   |

## 6.7 Magnetic Characteristics

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

| PARAMETER                        | TEST CONDITIONS                                                                    | MIN  | TYP  | MAX  | UNIT <sup>(1)</sup> |
|----------------------------------|------------------------------------------------------------------------------------|------|------|------|---------------------|
| f <sub>BW</sub>                  | Bandwidth <sup>(2)</sup>                                                           | 20   | 30   |      | kHz                 |
| <b>DRV5033FA: ±3.5 / ±2 mT</b>   |                                                                                    |      |      |      |                     |
| B <sub>OP</sub>                  | Operate point; see <a href="#">Figure 12</a>                                       | ±1.8 | ±3.5 | ±6.8 | mT                  |
| B <sub>RP</sub>                  | Release point; see <a href="#">Figure 12</a>                                       | ±0.5 | ±2   | ±4.2 | mT                  |
| B <sub>hys</sub>                 | Hysteresis; B <sub>hys</sub> = (B <sub>OP</sub> – B <sub>RP</sub> ) <sup>(3)</sup> |      | ±1.5 |      | mT                  |
| B <sub>O</sub>                   | Magnetic offset; B <sub>O</sub> = (B <sub>OP</sub> + B <sub>RP</sub> ) / 2         |      | ±2.8 |      | mT                  |
| <b>DRV5033AJ: ±6.9 / ±3.5 mT</b> |                                                                                    |      |      |      |                     |
| B <sub>OP</sub>                  | Operate point; see <a href="#">Figure 12</a>                                       | ±3   | ±6.9 | ±12  | mT                  |
| B <sub>RP</sub>                  | Release point; see <a href="#">Figure 12</a>                                       | ±1   | ±3.5 | ±5   | mT                  |
| B <sub>hys</sub>                 | Hysteresis; B <sub>hys</sub> = (B <sub>OP</sub> – B <sub>RP</sub> ) <sup>(3)</sup> |      | 3.4  |      | mT                  |
| B <sub>O</sub>                   | Magnetic offset; B <sub>O</sub> = (B <sub>OP</sub> + B <sub>RP</sub> ) / 2         |      | 5.2  |      | mT                  |

(1) 1 mT = 10 Gauss

(2) Bandwidth describes the fastest changing magnetic field that can be detected and translated to the output.

(3) |B<sub>OP</sub>| is always greater than |B<sub>RP</sub>|.

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### 6.8 Typical Characteristics

$T_A > 125^\circ\text{C}$  data is valid for Grade 0 devices only (E, see [Figure 23](#))

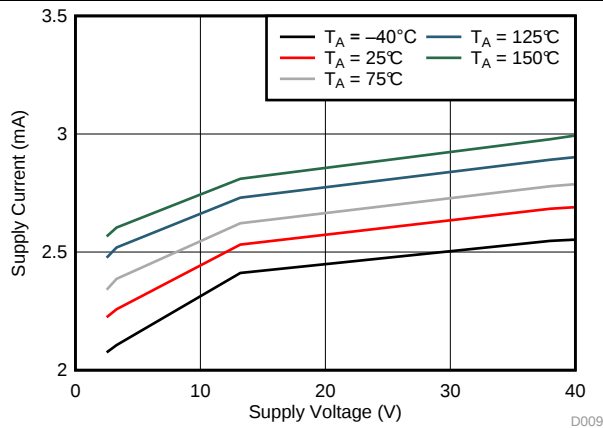


Figure 1.  $I_{CC}$  vs  $V_{CC}$

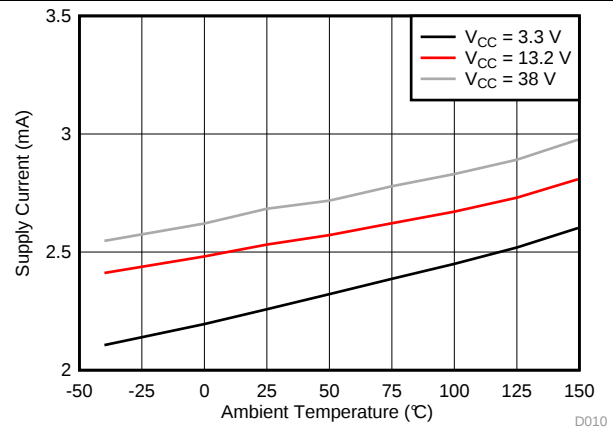


Figure 2.  $I_{CC}$  vs Temperature

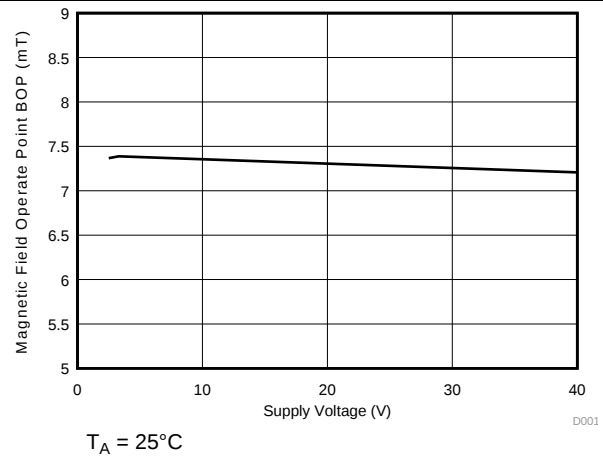


Figure 3. DRV5033-Q1AJ,  $B_{OP}$  vs  $V_{CC}$

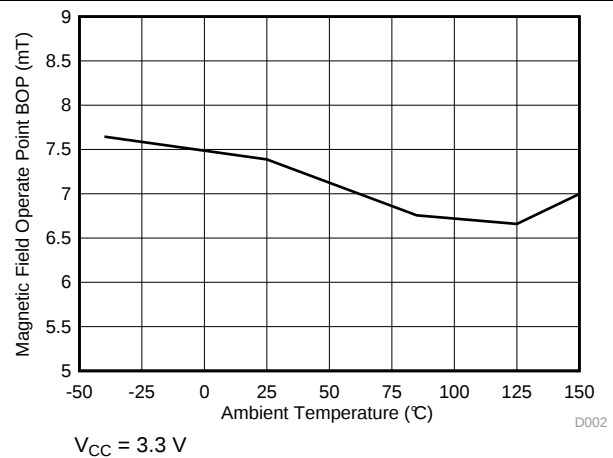


Figure 4. DRV5033-Q1AJ,  $B_{OP}$  vs Temperature

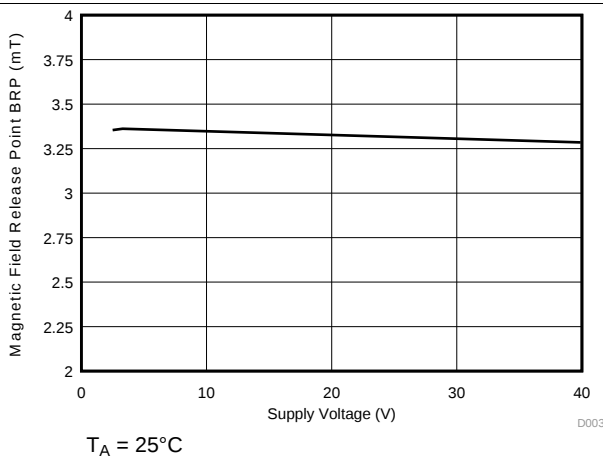


Figure 5. DRV5033-Q1AJ,  $B_{RP}$  vs  $V_{CC}$

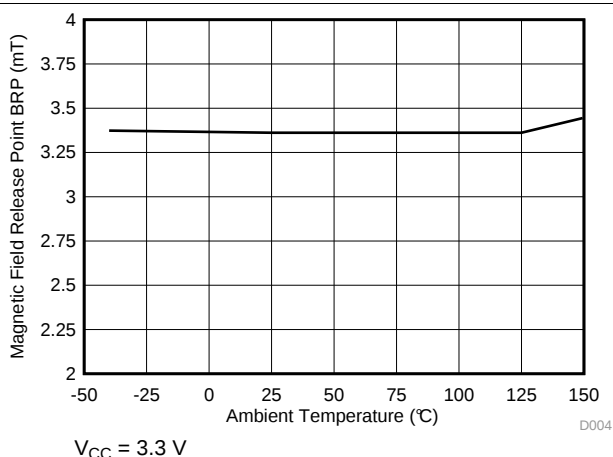
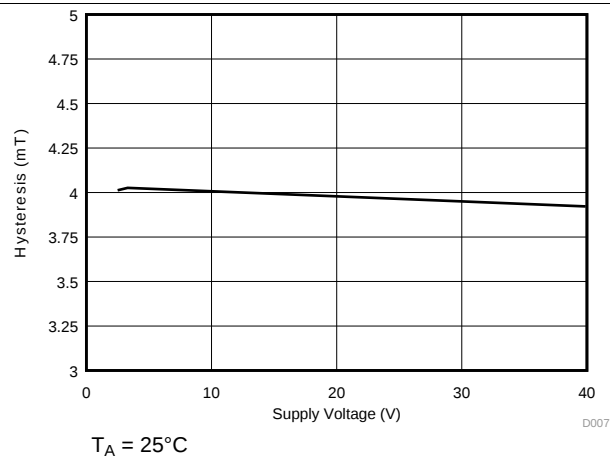


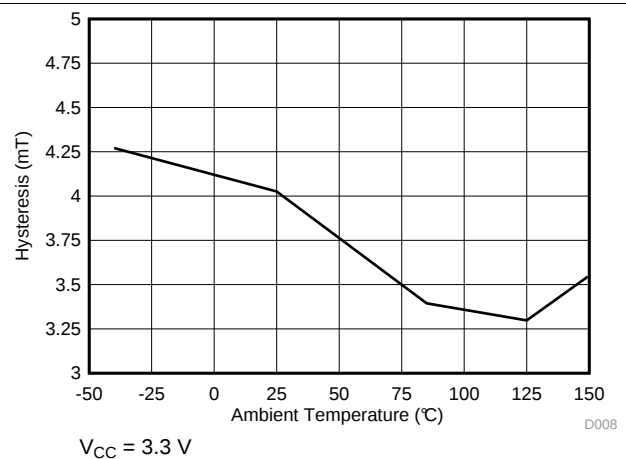
Figure 6. DRV5033-Q1AJ,  $B_{RP}$  vs Temperature

## Typical Characteristics (continued)

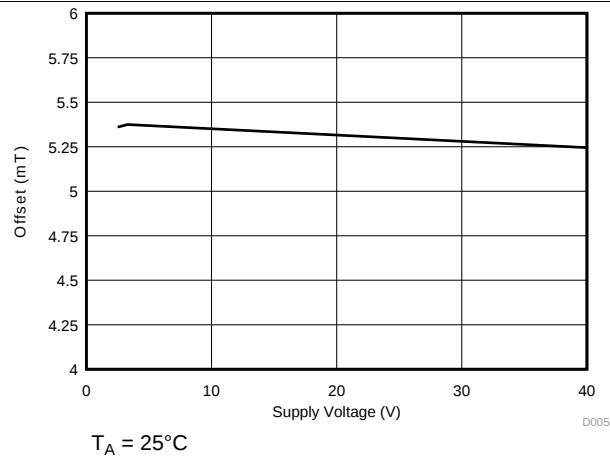
$T_A > 125^\circ\text{C}$  data is valid for Grade 0 devices only (E, see [Figure 23](#))



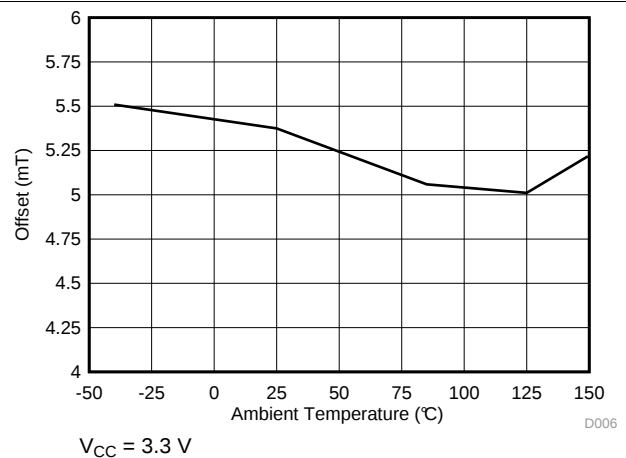
**Figure 7. DRV5033-Q1AJ, Hysteresis vs  $V_{CC}$**



**Figure 8. DRV5033-Q1AJ, Hysteresis vs Temperature**



**Figure 9. DRV5033-Q1AJ, Offset vs  $V_{CC}$**



**Figure 10. DRV5033-Q1AJ, Offset vs Temperature**

## 7 Detailed Description

### 7.1 Overview

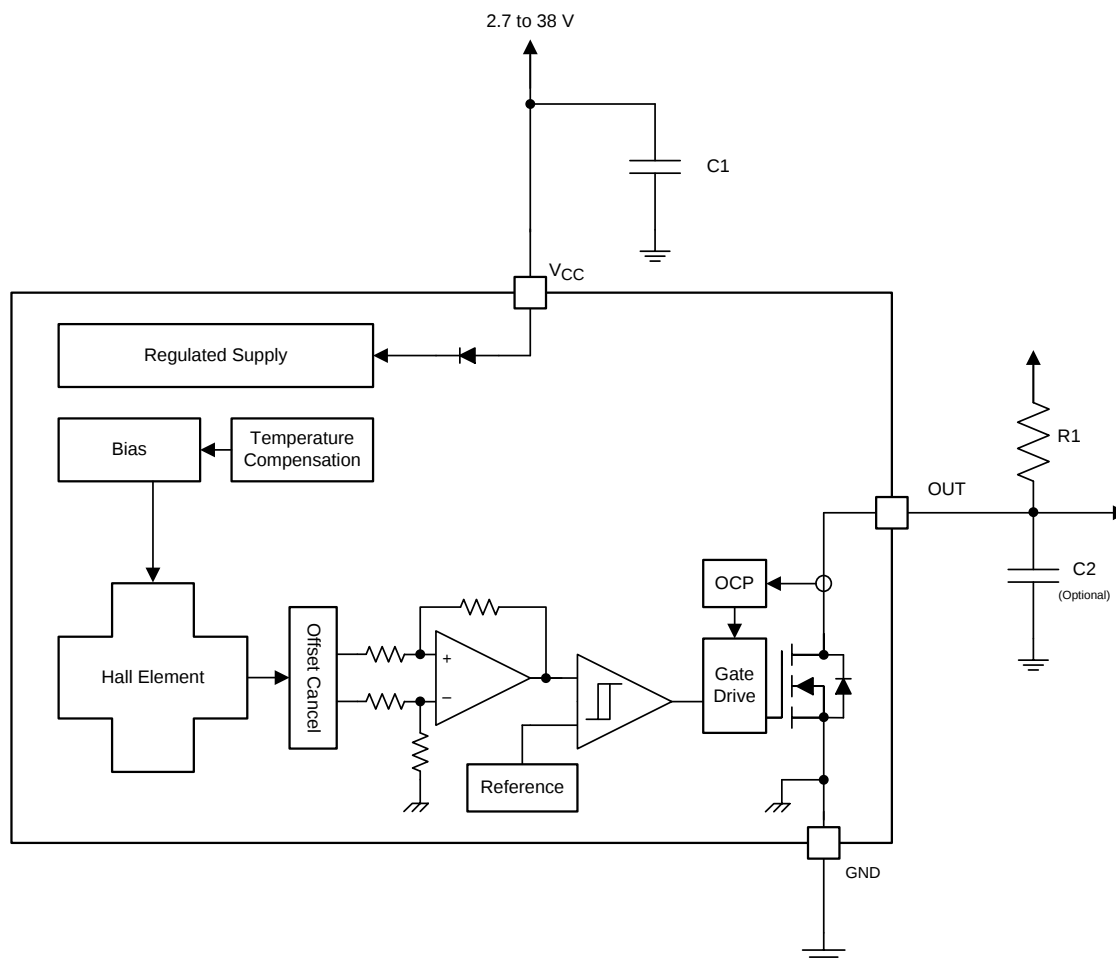
The DRV5033-Q1 device is a chopper-stabilized hall sensor with a digital omnipolar switch output for magnetic sensing applications. The DRV5033-Q1 device can be powered with a supply voltage between 2.7 and 38 V, and will survive –22 V reverse battery conditions continuously. Note that the DRV5033-Q1 device will not be operating when about –22 to 2.4 V is applied to  $V_{CC}$  (with respect to GND). In addition, the device can withstand voltages up to 40 V for transient durations.

The field polarity is defined as follows: a **south pole** near the marked side of the package is a **positive magnetic field**. A **north pole** near the marked side of the package is a **negative magnetic field**.

The omnipolar configuration allows the hall sensor to respond to either a south or north pole. A strong magnetic field of either polarity will cause the output to pull low (operate point,  $B_{OP}$ ), and a weaker magnetic field will cause the output to release (release point,  $B_{RP}$ ). Hysteresis is included in between the operate and release points, so magnetic field noise will not trip the output accidentally.

An external pullup resistor is required on the OUT pin. The OUT pin can be pulled up to  $V_{CC}$ , or to a different voltage supply. This allows for easier interfacing with controller circuits.

### 7.2 Functional Block Diagram



## 7.3 Feature Description

### 7.3.1 Field Direction Definition

A positive magnetic field is defined as a **south pole** near the marked side of the package as shown in Figure 11.

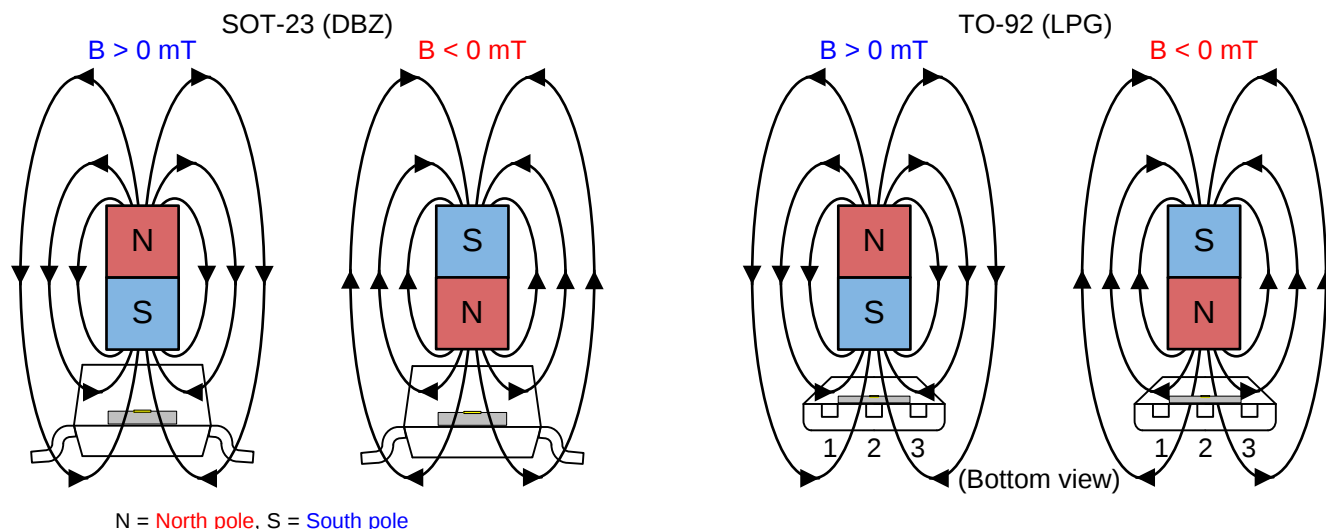


Figure 11. Field Direction Definition

### 7.3.2 Device Output

If the device is powered on with a magnetic field strength between  $B_{RP}$  and  $B_{OP}$ , then the device output is indeterminate and can either be Hi-Z or Low. If the field strength is greater than  $B_{OP}$ , then the output is pulled low. If the field strength is less than  $B_{RP}$ , then the output is released.

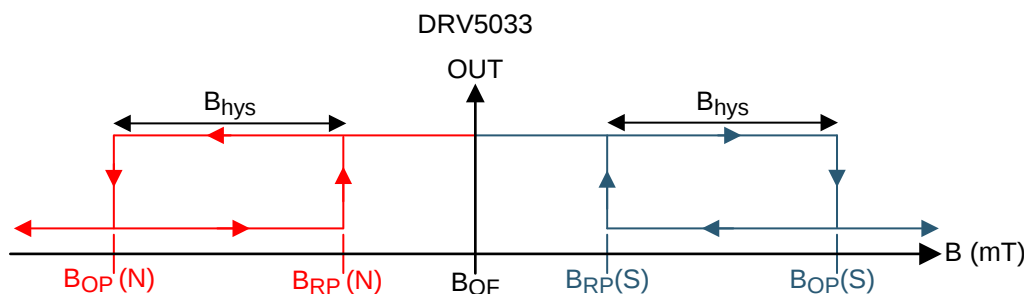
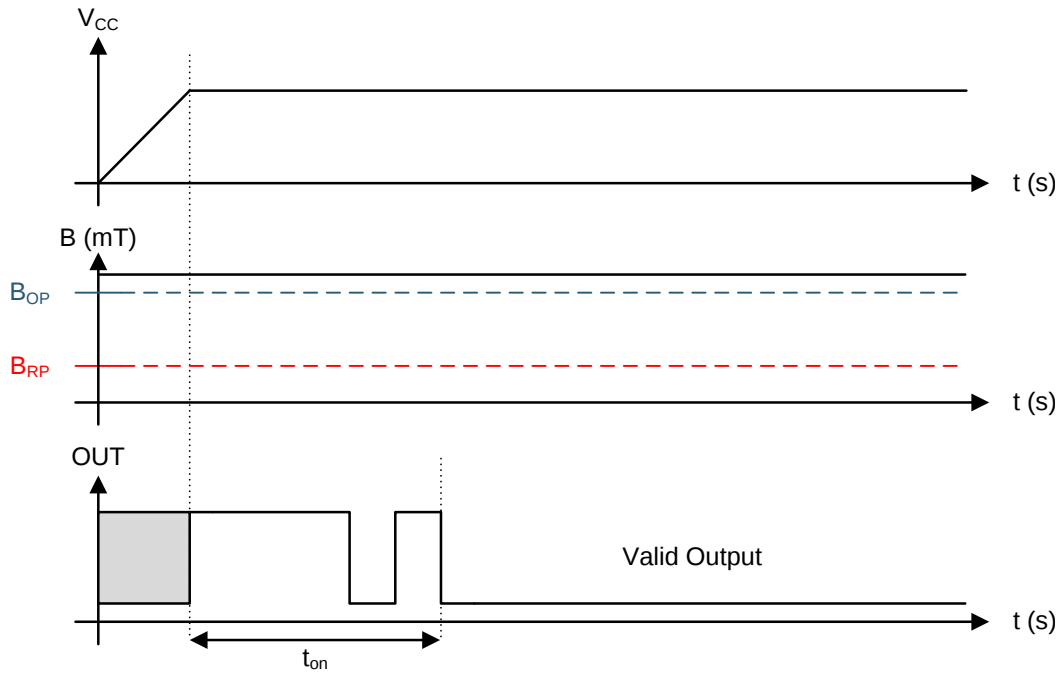


Figure 12. DRV5033-Q1— $B_{OP} > 0$

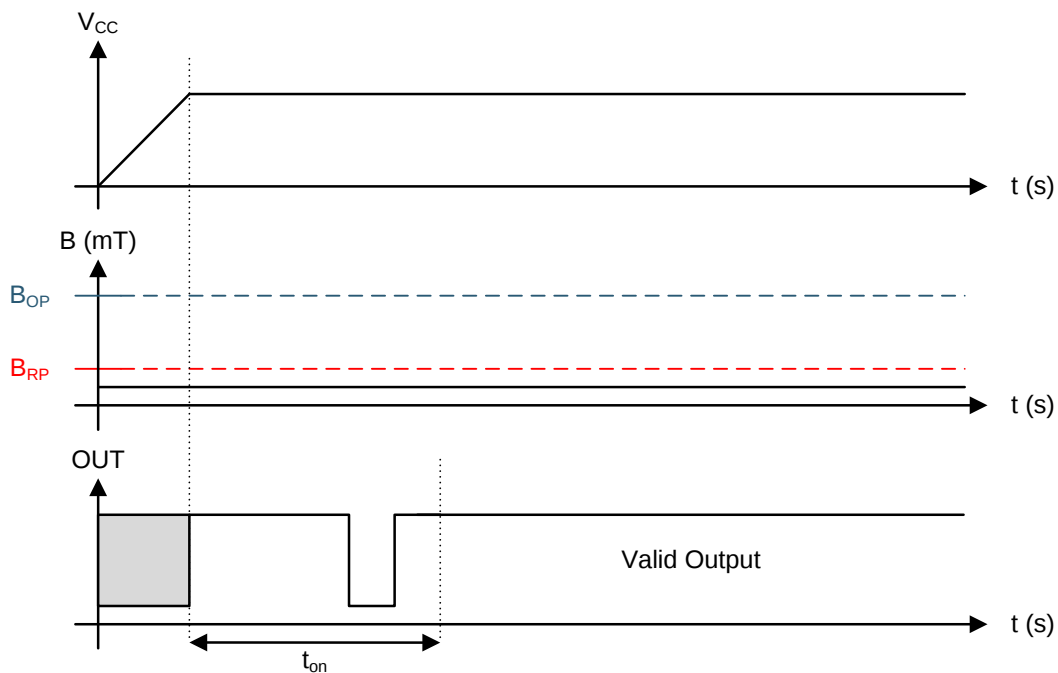
## Feature Description (continued)

### 7.3.3 Power-On Time

After applying  $V_{CC}$  to the DRV5033-Q1 device,  $t_{on}$  must elapse before the OUT pin is valid. During the power-up sequence, the output is Hi-Z. A pulse as shown in Figure 13 and Figure 14 occurs at the end of  $t_{on}$ . This pulse can allow the host processor to determine when the DRV5033-Q1 output is valid after startup. In Case 1 (Figure 13) and Case 2 (Figure 14), the output is defined assuming a constant magnetic field  $B > B_{OP}$  and  $B < B_{RP}$ .



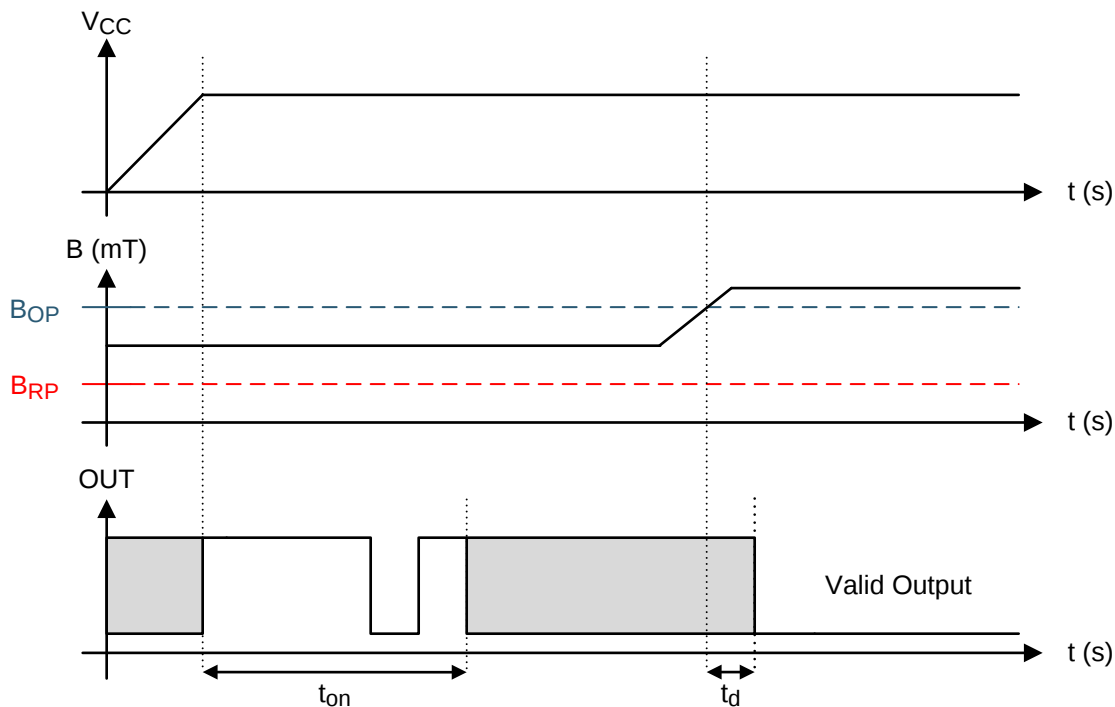
**Figure 13. Case 1: Power On When  $B > B_{OP}$**



**Figure 14. Case 2: Power On When  $B < B_{RP}$**

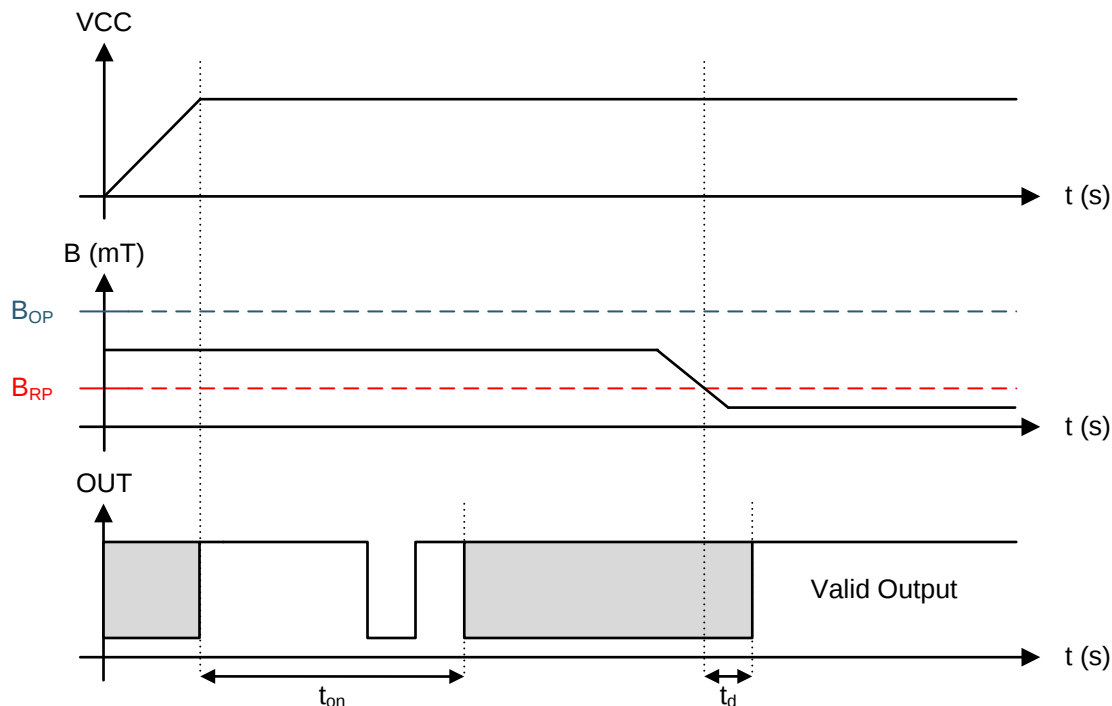
## Feature Description (continued)

If the device is powered on with the magnetic field strength  $B_{RP} < B < B_{OP}$ , then the device output is indeterminate and can either be Hi-Z or pulled low. During the power-up sequence, the output is held Hi-Z until  $t_{on}$  has elapsed. At the end of  $t_{on}$ , a pulse is given on the OUT pin to indicate that  $t_{on}$  has elapsed. After  $t_{on}$ , if the magnetic field changes such that  $B_{OP} < B$ , the output is released. Case 3 (Figure 15) and Case 4 (Figure 16) show examples of this behavior.



**Figure 15. Case 3: Power On When  $B_{RP} < B < B_{OP}$ , Followed by  $B > B_{OP}$**

## Feature Description (continued)



**Figure 16. Case 4: Power On When  $B_{RP} < B < B_{OP}$ , Followed by  $B < B_{RP}$**

### 7.3.4 Output Stage

The DRV5033-Q1 output stage uses an open-drain NMOS, and it is rated to sink up to 30 mA of current. For proper operation, calculate the value of the pullup resistor R1 using [Equation 1](#).

$$\frac{V_{ref\ max}}{30\ mA} \leq R1 \leq \frac{V_{ref\ min}}{100\ \mu A} \quad (1)$$

The size of R1 is a tradeoff between the OUT rise time and the current when OUT is pulled low. A lower current is generally better, however faster transitions and bandwidth require a smaller resistor for faster switching.

In addition, ensure that the value of  $R1 > 500\ \Omega$  to ensure the output driver can pull the OUT pin close to GND.

#### NOTE

$V_{ref}$  is not restricted to  $V_{CC}$ . The allowable voltage range of this pin is specified in the [Absolute Maximum Ratings](#).

## Feature Description (continued)

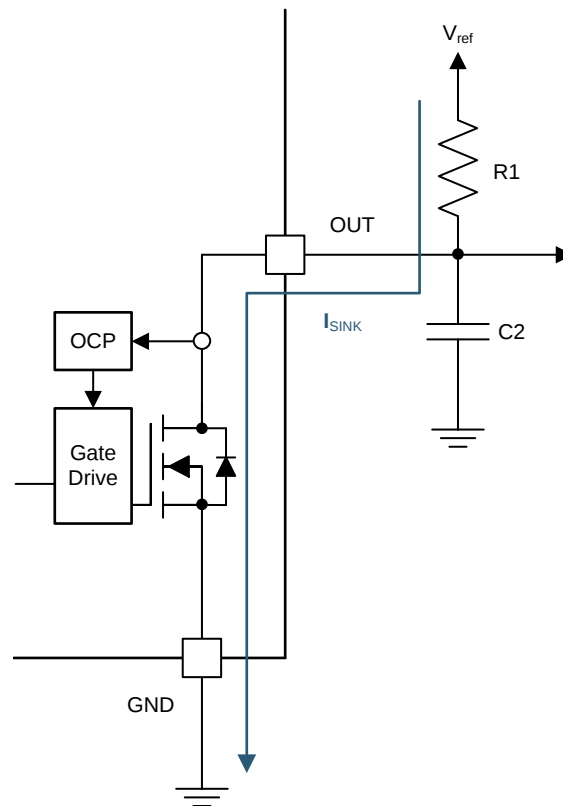


Figure 17.

Select a value for C2 based on the system bandwidth specifications as shown in [Equation 2](#).

$$2 \times f_{BW} \text{ (Hz)} < \frac{1}{2\pi \times R1 \times C2} \quad (2)$$

Most applications do not require this C2 filtering capacitor.

## Feature Description (continued)

### 7.3.5 Protection Circuits

The DRV5033-Q1 device is fully protected against overcurrent and reverse-supply conditions.

#### 7.3.5.1 Overcurrent Protection (OCP)

An analog current-limit circuit limits the current through the FET. The driver current is clamped to  $I_{OCP}$ . During this clamping, the  $r_{DS(on)}$  of the output FET is increased from the nominal value.

#### 7.3.5.2 Load Dump Protection

The DRV5033-Q1 device operates at DC  $V_{CC}$  conditions up to 38 V nominally, and can additionally withstand  $V_{CC} = 40$  V. No current-limiting series resistor is required for this protection.

#### 7.3.5.3 Reverse Supply Protection

The DRV5033-Q1 device is protected in the event that the  $V_{CC}$  pin and the GND pin are reversed (up to  $-22$  V).

#### NOTE

In a reverse supply condition, the OUT pin reverse-current must not exceed the ratings specified in the [Absolute Maximum Ratings](#).

**Table 1.**

| FAULT              | CONDITION                            | DEVICE    | DESCRIPTION                                  | RECOVERY                   |
|--------------------|--------------------------------------|-----------|----------------------------------------------|----------------------------|
| FET overload (OCP) | $I_{SINK} \geq I_{OCP}$              | Operating | Output current is clamped to $I_{OCP}$       | $I_O < I_{OCP}$            |
| Load dump          | $38\text{ V} < V_{CC} < 40\text{ V}$ | Operating | Device will operate for a transient duration | $V_{CC} \leq 38\text{ V}$  |
| Reverse supply     | $-22\text{ V} < V_{CC} < 0\text{ V}$ | Disabled  | Device will survive this condition           | $V_{CC} \geq 2.7\text{ V}$ |

## 7.4 Device Functional Modes

The DRV5033-Q1 device is active only when  $V_{CC}$  is between 2.7 and 38 V.

When a reverse supply condition exists, the device is inactive.

## 8 Application and Implementation

### NOTE

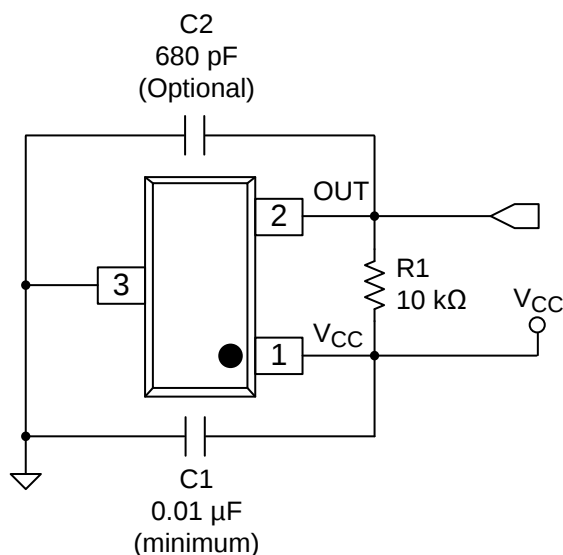
Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

### 8.1 Application Information

The DRV5033-Q1 device is used in magnetic-field sensing applications.

### 8.2 Typical Applications

#### 8.2.1 Standard Circuit



**Figure 18. Typical Application Circuit**

##### 8.2.1.1 Design Requirements

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

**Table 2. Design Parameters**

| DESIGN PARAMETER | REFERENCE | EXAMPLE VALUE |
|------------------|-----------|---------------|
| Supply voltage   | $V_{CC}$  | 3.2 to 3.4 V  |
| System bandwidth | $f_{BW}$  | 10 kHz        |

##### 8.2.1.2 Detailed Design Procedure

**Table 3. External Components**

| COMPONENT | PIN 1    | PIN 2              | RECOMMENDED                                              |
|-----------|----------|--------------------|----------------------------------------------------------|
| C1        | $V_{CC}$ | GND                | A 0.01-μF (minimum) ceramic capacitor rated for $V_{CC}$ |
| C2        | OUT      | GND                | <b>Optional:</b> Place a ceramic capacitor to GND        |
| R1        | OUT      | REF <sup>(1)</sup> | Requires a resistor pullup                               |

(1) REF is not a pin on the DRV5033-Q1 device, but a REF supply-voltage pullup is required for the OUT pin; the OUT pin may be pulled up to  $V_{CC}$ .

### 8.2.1.2.1 Configuration Example

In a 3.3-V system,  $3.2\text{ V} \leq V_{\text{ref}} \leq 3.4\text{ V}$ . Use Equation 3 to calculate the allowable range for R1.

$$\frac{V_{\text{ref max}}}{30\text{ mA}} \leq R1 \leq \frac{V_{\text{ref min}}}{100\text{ }\mu\text{A}} \quad (3)$$

For this design example, use Equation 4 to calculate the allowable range of R1.

$$\frac{3.4\text{ V}}{30\text{ mA}} \leq R1 \leq \frac{3.2\text{ V}}{100\text{ }\mu\text{A}} \quad (4)$$

Therefore:

$$113\text{ }\Omega \leq R1 \leq 32\text{ k}\Omega \quad (5)$$

After finding the allowable range of R1 (Equation 5), select a value between 500  $\Omega$  and 32 k $\Omega$  for R1.

Assuming a system bandwidth of 10 kHz, use Equation 6 to calculate the value of C2.

$$2 \times f_{\text{BW}} (\text{Hz}) < \frac{1}{2\pi \times R1 \times C2} \quad (6)$$

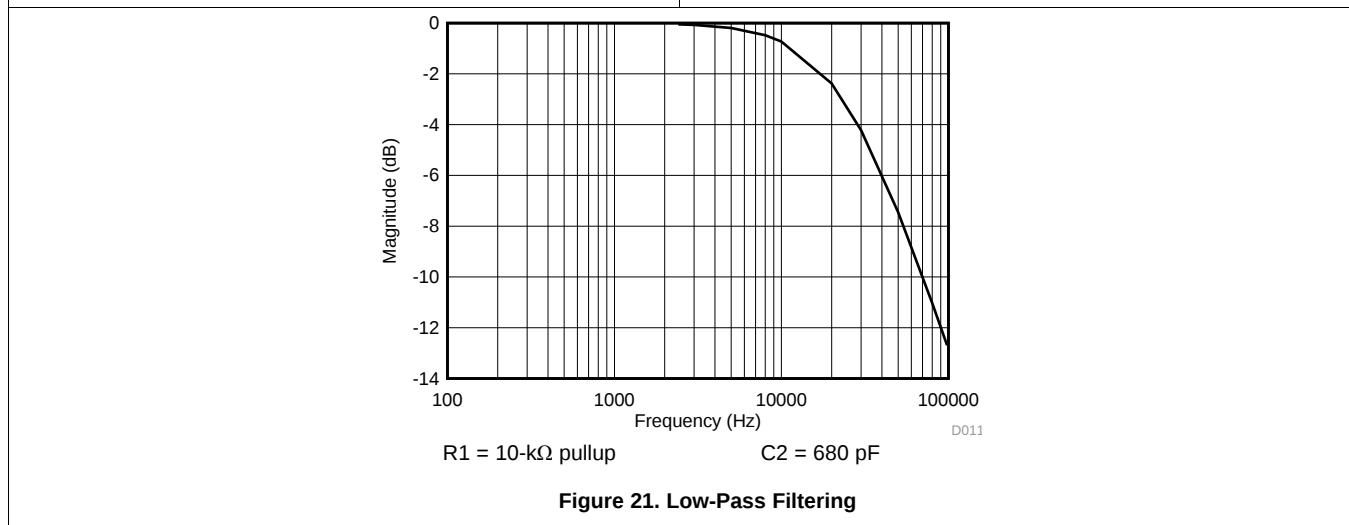
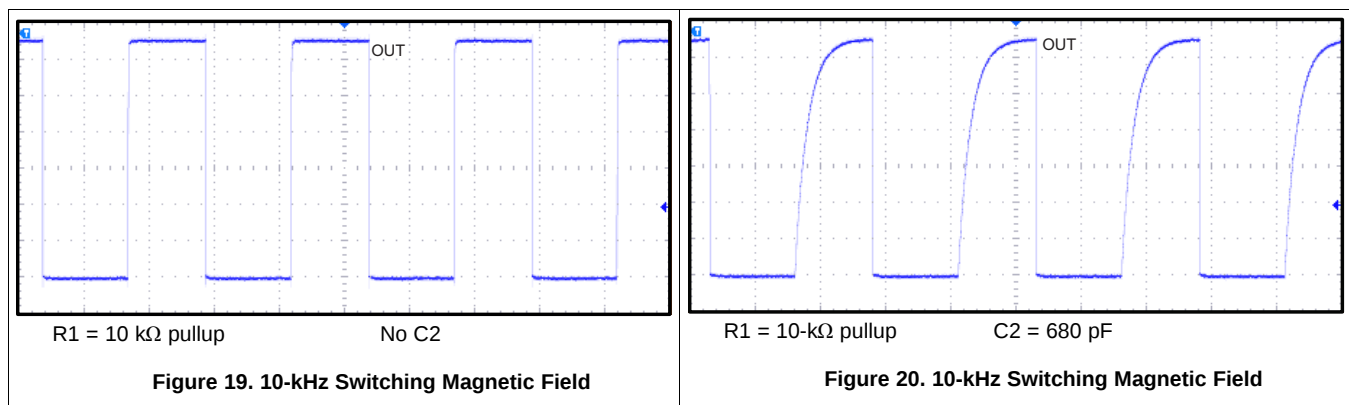
For this design example, use Equation 7 to calculate the value of C2.

$$2 \times 10\text{ kHz} < \frac{1}{2\pi \times R1 \times C2} \quad (7)$$

An R1 value of 10 k $\Omega$  and a C2 value less than 820 pF satisfy the requirement for a 10-kHz system bandwidth.

A selection of R1 = 10 k $\Omega$  and C2 = 680 pF would cause a low-pass filter with a corner frequency of 23.4 kHz.

### 8.2.1.3 Application Curves



## 8.2.2 Alternative Two-Wire Application

For systems that require minimal wire count, the device output can be connected to  $V_{CC}$  through a resistor, and the total supplied current can be sensed near the controller.

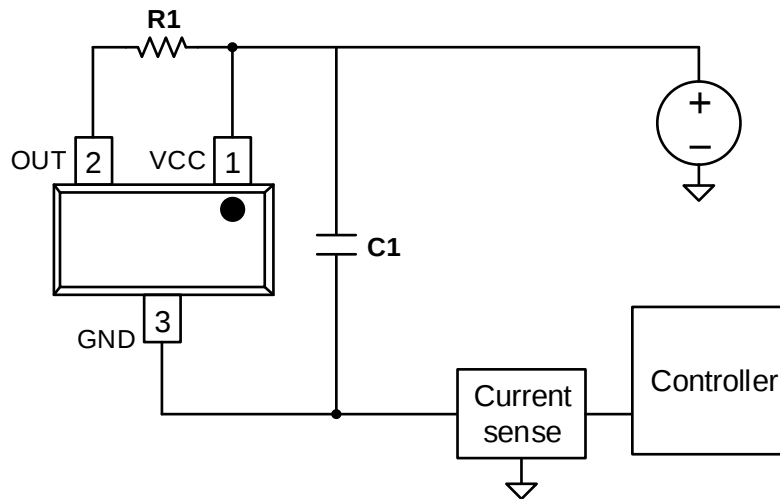


Figure 22. 2-Wire Application

Current can be sensed using a shunt resistor or other circuitry.

### 8.2.2.1 Design Requirements

Table 4 lists the related design parameters.

Table 4. Design Parameters

| DESIGN PARAMETER          | REFERENCE     | EXAMPLE VALUE |
|---------------------------|---------------|---------------|
| Supply voltage            | $V_{CC}$      | 12 V          |
| OUT resistor              | R1            | 1 k $\Omega$  |
| Bypass capacitor          | C1            | 0.1 $\mu$ F   |
| Current when $B < B_{RP}$ | $I_{RELEASE}$ | About 3 mA    |
| Current when $B > B_{OP}$ | $I_{OPERATE}$ | About 15 mA   |

### 8.2.2.2 Detailed Design Procedure

When the open-drain output of the device is high-impedance, current through the path equals the  $I_{CC}$  of the device (approximately 3 mA).

When the output pulls low, a parallel current path is added, equal to  $V_{CC} / (R1 + r_{DS(on)})$ . Using 12 V and 1 k $\Omega$ , the parallel current is approximately 12 mA, making the total current approximately 15 mA.

The local bypass capacitor C1 should be at least 0.1  $\mu$ F, and a larger value if there is high inductance in the power line interconnect.

## 9 Power Supply Recommendations

The DRV5033-Q1 device is designed to operate from an input voltage supply (VM) range between 2.7 and 38 V. A 0.01- $\mu$ F (minimum) ceramic capacitor rated for  $V_{CC}$  must be placed as close to the DRV5033-Q1 device as possible.

## DRV5033-Q1

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## 10 器件和文档支持

### 10.1 器件支持

#### 10.1.1 器件命名规则

图 23 显示了读取 DRV5033-Q1 器件完整器件名称的图例。

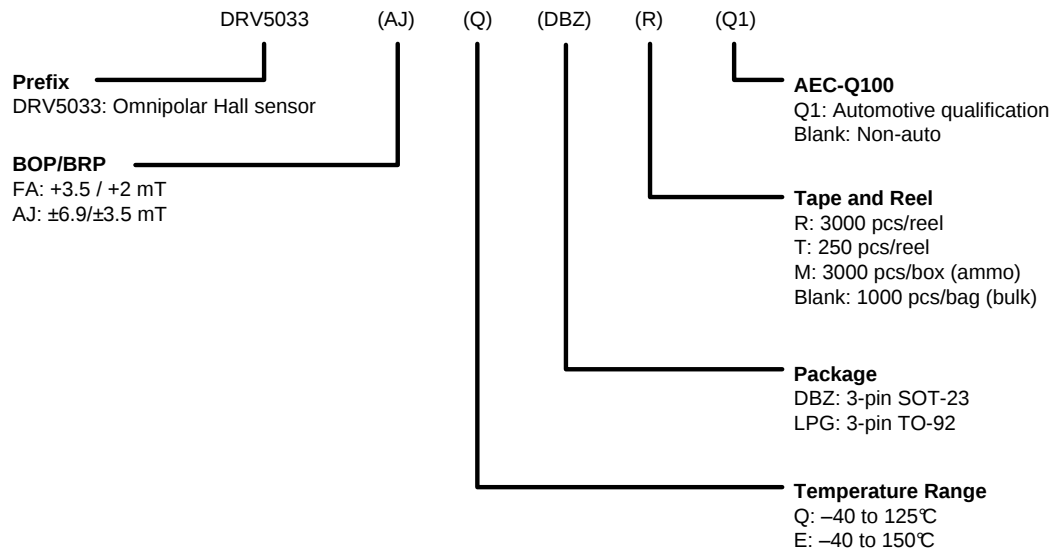


图 23. 器件命名规则

#### 10.1.2 器件标记

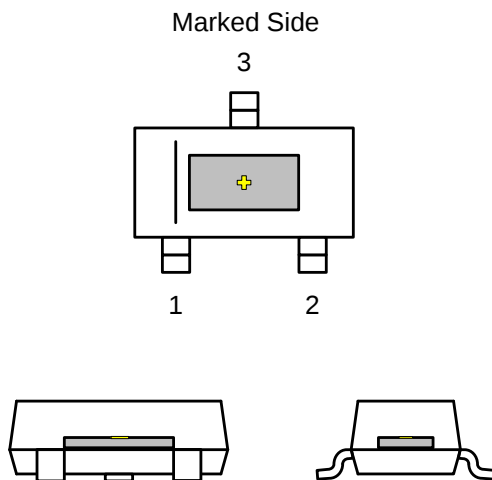


图 24. SOT-23 (DBZ) 封装

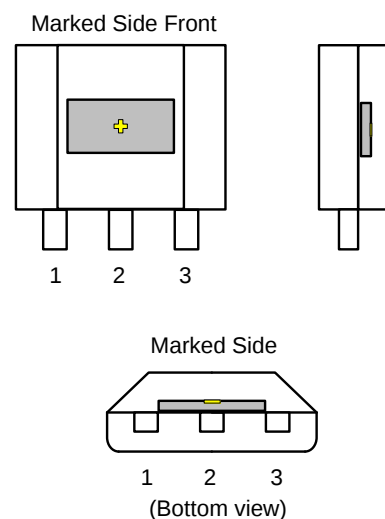


图 25. TO-92 (LPG) 封装

✚ 表示霍尔效应传感器（未按比例显示）。霍尔元件置于封装中央位置，容差为  $\pm 100\mu\text{m}$ 。在 DBZ 封装中，霍尔元件与封装底部的距离为  $0.7\text{mm} \pm 50\mu\text{m}$ ；在 LPG 封装中，霍尔元件与封装底部的距离为  $0.987\text{mm} \pm 50\mu\text{m}$ 。

## 10.2 社区资源

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## 10.5 Glossary

[SLYZ022](#) — *TI Glossary*.

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

## 11 机械、封装和可订购信息

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

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| 放大器和线性器件      | <a href="http://www.ti.com.cn/amplifiers">www.ti.com.cn/amplifiers</a>                     | 计算机及周边       | <a href="http://www.ti.com.cn/computer">www.ti.com.cn/computer</a>           |
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| DLP® 产品       | <a href="http://www.dlp.com">www.dlp.com</a>                                               | 能源           | <a href="http://www.ti.com.cn/energy">www.ti.com.cn/energy</a>               |
| DSP - 数字信号处理器 | <a href="http://www.ti.com.cn/dsp">www.ti.com.cn/dsp</a>                                   | 工业应用         | <a href="http://www.ti.com.cn/industrial">www.ti.com.cn/industrial</a>       |
| 时钟和计时器        | <a href="http://www.ti.com.cn/clockandtimers">www.ti.com.cn/clockandtimers</a>             | 医疗电子         | <a href="http://www.ti.com.cn/medical">www.ti.com.cn/medical</a>             |
| 接口            | <a href="http://www.ti.com.cn/interface">www.ti.com.cn/interface</a>                       | 安防应用         | <a href="http://www.ti.com.cn/security">www.ti.com.cn/security</a>           |
| 逻辑            | <a href="http://www.ti.com.cn/logic">www.ti.com.cn/logic</a>                               | 汽车电子         | <a href="http://www.ti.com.cn/automotive">www.ti.com.cn/automotive</a>       |
| 电源管理          | <a href="http://www.ti.com.cn/power">www.ti.com.cn/power</a>                               | 视频和影像        | <a href="http://www.ti.com.cn/video">www.ti.com.cn/video</a>                 |
| 微控制器 (MCU)    | <a href="http://www.ti.com.cn/microcontrollers">www.ti.com.cn/microcontrollers</a>         |              |                                                                              |
| RFID 系统       | <a href="http://www.ti.com.cn/rfidsys">www.ti.com.cn/rfidsys</a>                           |              |                                                                              |
| OMAP应用处理器     | <a href="http://www.ti.com.cn/omap">www.ti.com.cn/omap</a>                                 |              |                                                                              |
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## PACKAGING INFORMATION

| Orderable Device | Status<br>(1) | Package Type | Package<br>Drawing | Pins | Package<br>Qty | Eco Plan<br>(2) | Lead finish/<br>Ball material<br>(6) | MSL Peak Temp<br>(3) | Op Temp (°C) | Device Marking<br>(4/5) | Samples                 |
|------------------|---------------|--------------|--------------------|------|----------------|-----------------|--------------------------------------|----------------------|--------------|-------------------------|-------------------------|
| DRV5033AJEDBZRQ1 | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 150   | +QJAJ                   | <a href="#">Samples</a> |
| DRV5033AJEDBZTQ1 | ACTIVE        | SOT-23       | DBZ                | 3    | 250            | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 150   | +QJAJ                   | <a href="#">Samples</a> |
| DRV5033AJELPGMQ1 | ACTIVE        | TO-92        | LPG                | 3    | 3000           | RoHS & Green    | SN                                   | N / A for Pkg Type   | -40 to 150   | +QJAJ                   | <a href="#">Samples</a> |
| DRV5033AJELPGQ1  | ACTIVE        | TO-92        | LPG                | 3    | 1000           | RoHS & Green    | SN                                   | N / A for Pkg Type   | -40 to 150   | +QJAJ                   | <a href="#">Samples</a> |
| DRV5033AJQDBZRQ1 | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 125   | +QKAJ                   | <a href="#">Samples</a> |
| DRV5033AJQDBZTQ1 | ACTIVE        | SOT-23       | DBZ                | 3    | 250            | RoHS & Green    | NIPDAUAG                             | Level-1-260C-UNLIM   | -40 to 125   | +QKAJ                   | <a href="#">Samples</a> |
| DRV5033AJQLPGMQ1 | ACTIVE        | TO-92        | LPG                | 3    | 3000           | RoHS & Green    | SN                                   | N / A for Pkg Type   | -40 to 125   | +QKAJ                   | <a href="#">Samples</a> |
| DRV5033AJQLPGQ1  | ACTIVE        | TO-92        | LPG                | 3    | 1000           | RoHS & Green    | SN                                   | N / A for Pkg Type   | -40 to 125   | +QKAJ                   | <a href="#">Samples</a> |
| DRV5033FAEDBZRQ1 | ACTIVE        | SOT-23       | DBZ                | 3    | 3000           | RoHS & Green    | SN                                   | Level-1-260C-UNLIM   | -40 to 150   | +QJFA                   | <a href="#">Samples</a> |

(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.

<sup>(5)</sup> 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.

<sup>(6)</sup> 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 |
|------------------|--------------|-----------------|------|------|--------------------|--------------------|---------|---------|---------|---------|--------|---------------|
| DRV5033AJEDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 180.0              | 8.4                | 3.15    | 2.77    | 1.22    | 4.0     | 8.0    | Q3            |
| DRV5033AJEDBZTQ1 | SOT-23       | DBZ             | 3    | 250  | 180.0              | 8.4                | 3.15    | 2.77    | 1.22    | 4.0     | 8.0    | Q3            |
| DRV5033AJQDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 180.0              | 8.4                | 3.15    | 2.77    | 1.22    | 4.0     | 8.0    | Q3            |
| DRV5033AJQDBZTQ1 | SOT-23       | DBZ             | 3    | 250  | 180.0              | 8.4                | 3.15    | 2.77    | 1.22    | 4.0     | 8.0    | Q3            |
| DRV5033FAEDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 180.0              | 8.4                | 3.15    | 2.77    | 1.22    | 4.0     | 8.0    | Q3            |

## TAPE AND REEL BOX DIMENSIONS



\*All dimensions are nominal

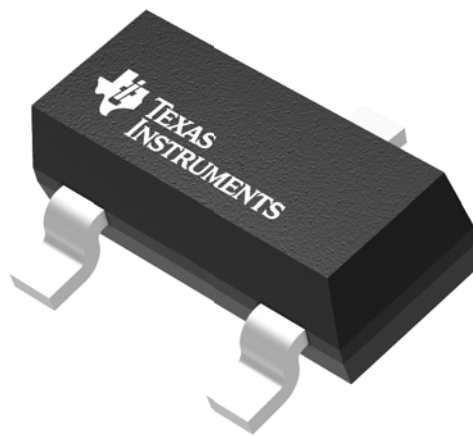
| Device           | Package Type | Package Drawing | Pins | SPQ  | Length (mm) | Width (mm) | Height (mm) |
|------------------|--------------|-----------------|------|------|-------------|------------|-------------|
| DRV5033AJEDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 202.0       | 201.0      | 28.0        |
| DRV5033AJEDBZTQ1 | SOT-23       | DBZ             | 3    | 250  | 202.0       | 201.0      | 28.0        |
| DRV5033AJQDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 202.0       | 201.0      | 28.0        |
| DRV5033AJQDBZTQ1 | SOT-23       | DBZ             | 3    | 250  | 202.0       | 201.0      | 28.0        |
| DRV5033FAEDBZRQ1 | SOT-23       | DBZ             | 3    | 3000 | 202.0       | 201.0      | 28.0        |

## 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

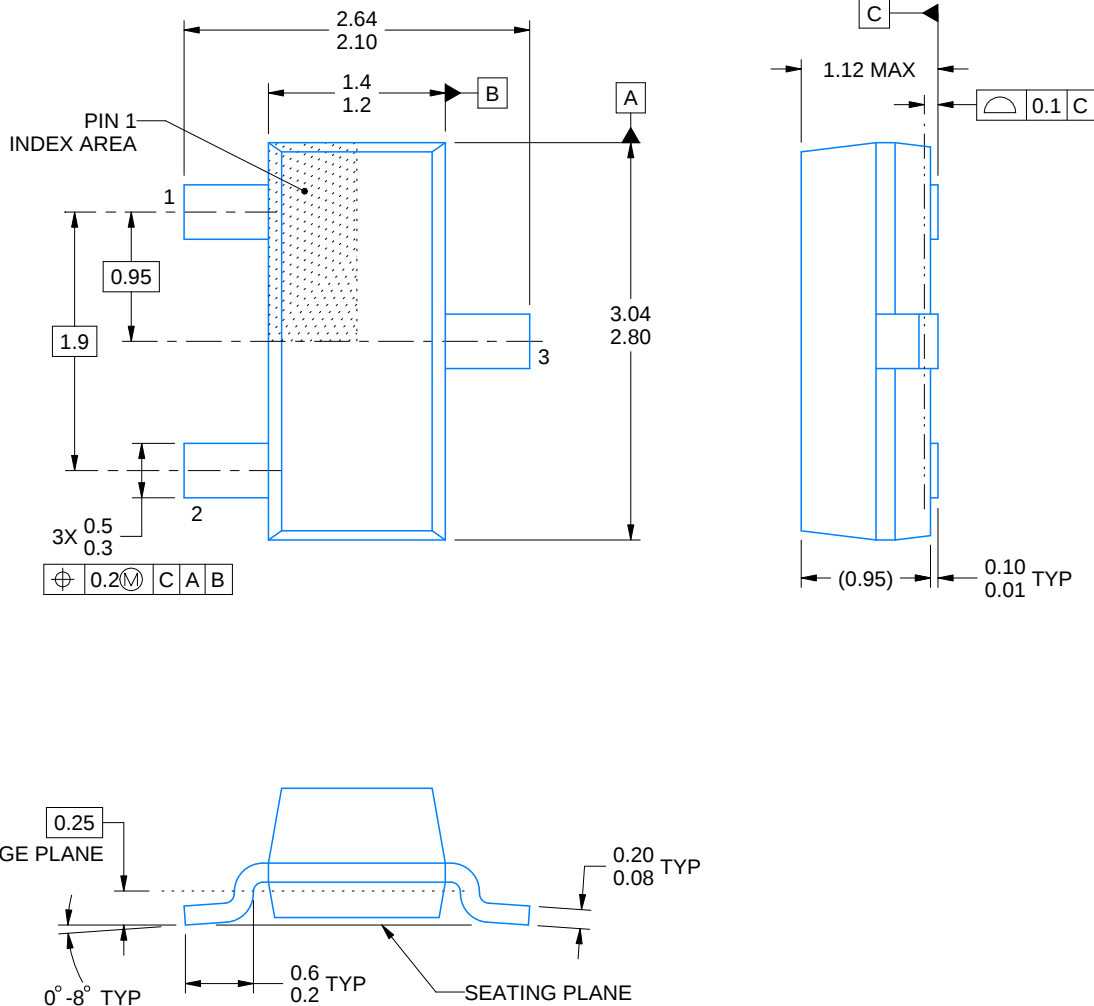
DBZ0003A



## PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



4214838/C 04/2017

### NOTES:

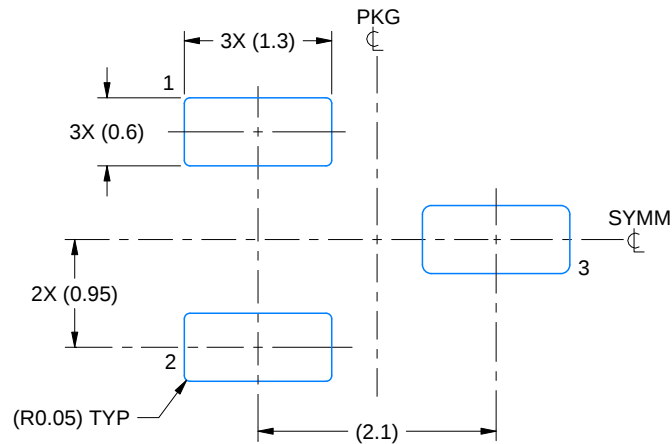
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.

# EXAMPLE BOARD LAYOUT

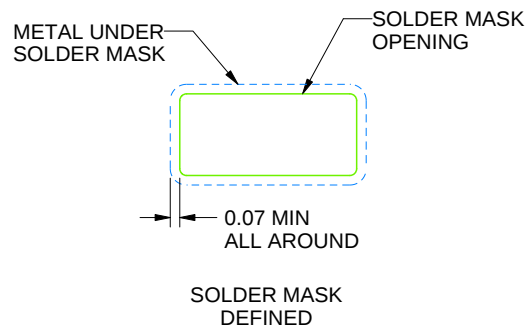
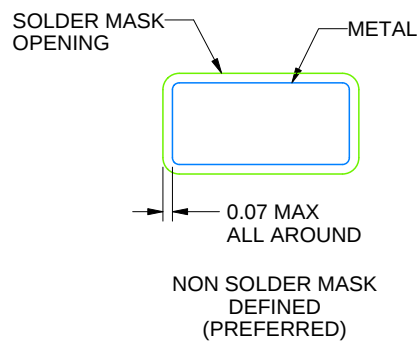
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE  
SCALE:15X



SOLDER MASK DETAILS

4214838/C 04/2017

NOTES: (continued)

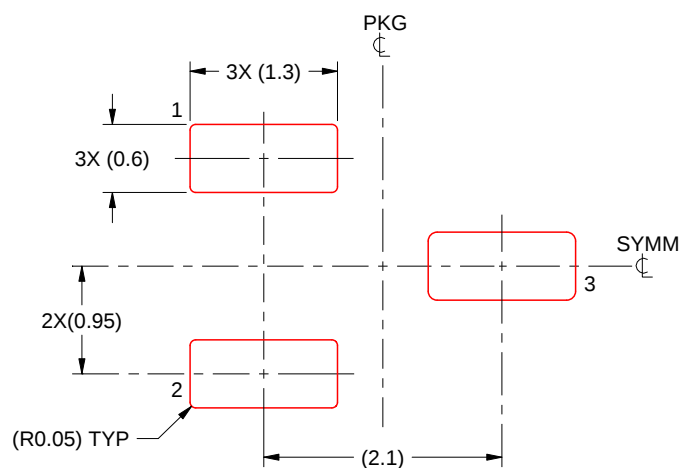
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

## 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.



## PACKAGE OUTLINE

**TO-92 - 5.05 mm max height**

## TRANSISTOR OUTLINE



1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.

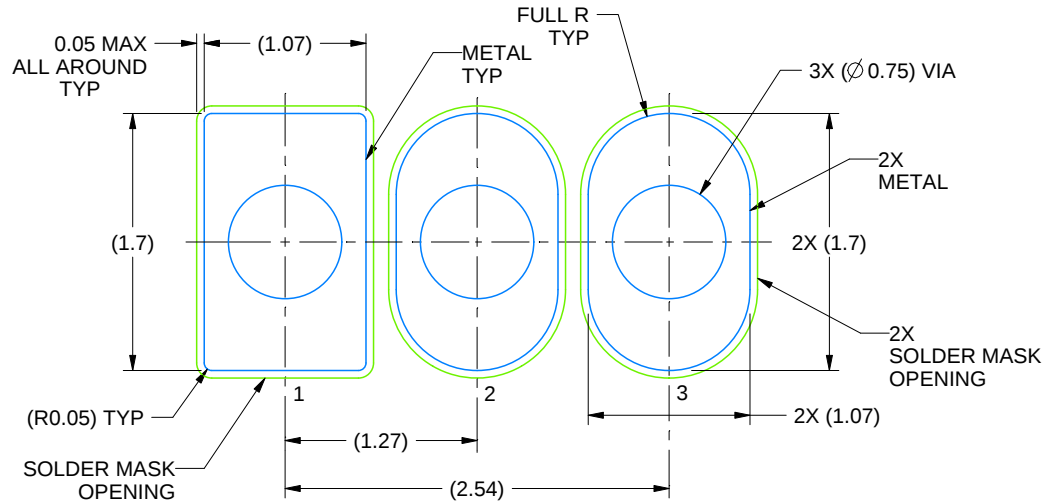
2. This drawing is subject to change without notice.

# EXAMPLE BOARD LAYOUT

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



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

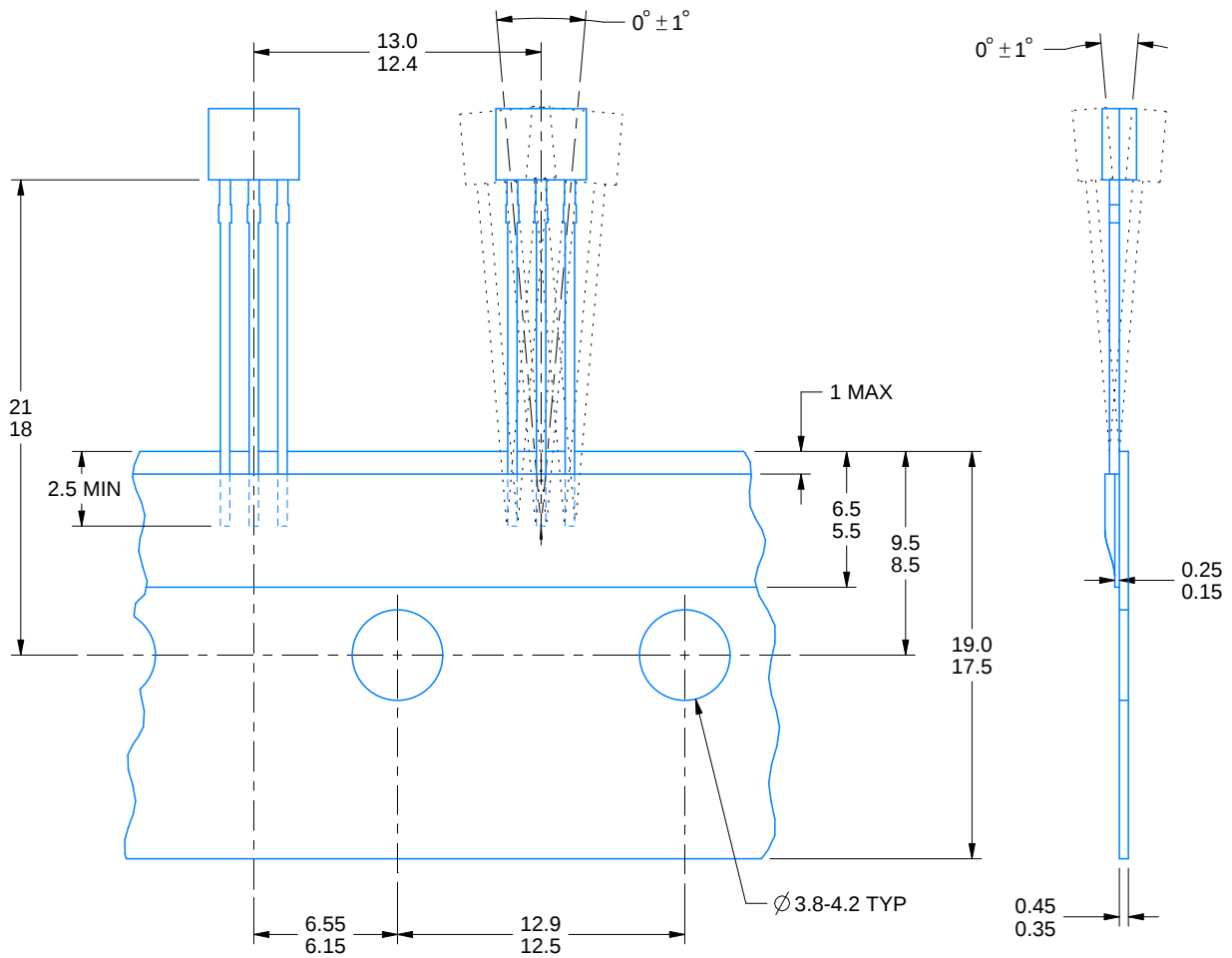
4221343/C 01/2018

# TAPE SPECIFICATIONS

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018

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