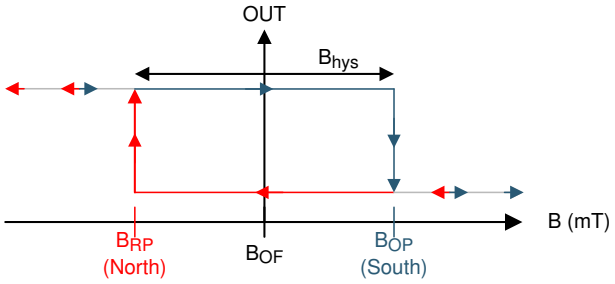
DRV5013-Q1 Automotive, Digital-Latch Hall Effect Sensor

1 Features

- AEC-Q100 qualified for automotive applications:
  - DRV5013xxQ grade 1: T_A = –40°C to 125°C (see *Device Nomenclature*)
  - DRV5013xxE grade 0: T_A = –40°C to 150°C (see *Device Nomenclature*)
- Digital bipolar-latch Hall sensor
- Superior temperature stability
  - B_{OP} ±10% over temperature
- Multiple sensitivity options (B_{OP} / B_{RP})
  - ±1.3 mT (FA, see *Device Nomenclature*)
  - ±2.7 mT (AD, see *Device Nomenclature*)
  - ±6 mT (AG, see *Device Nomenclature*)
  - ±12 mT (BC, see *Device Nomenclature*)
- Supports a wide voltage range
  - 2.7 V to 38 V
  - No external regulator required
- Open-drain output (30-mA sink)
- Fast 35-µs power-on time
- Small package and footprint
  - Surface mount 3-pin SOT-23 (DBZ)
    - 2.92 mm × 2.37 mm
  - Through-hole 3-pin TO-92 (LPG)
    - 4.00 mm × 3.15 mm
- **Protection features:**
  - Reverse supply protection (up to –22 V)
  - Supports up to 40-V load dump
  - Output short-circuit protection
  - Output current limitation
  - OUT short to battery protection



Output State

2 Applications

- Power tools
- Flow meters
- Valve and solenoid status
- Brushless dc motors
- Proximity sensing
- Tachometers

3 Description

The DRV5013-Q1 device is a chopper-stabilized Hall effect sensor that offers a magnetic sensing solution with superior sensitivity stability over temperature and integrated protection features.

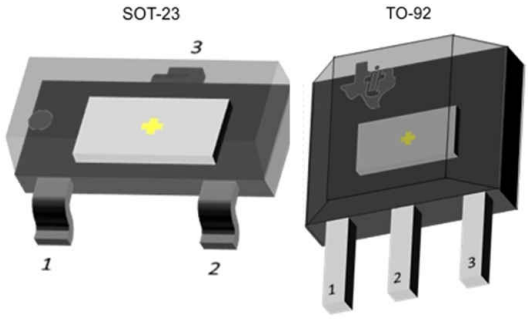
The magnetic field is indicated through a digital bipolar latch output. The IC has an open-drain output stage with 30-mA current sink capability. A wide operating voltage range from 2.7 V to 38 V with reverse polarity protection up to –22 V makes the device suitable for a wide range of automotive applications.

Internal protection functions are provided for reverse supply conditions, load dump, and output short circuit or overcurrent.

Package Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
DRV5013-Q1	SOT-23 (3)	2.92 mm × 1.30 mm
	TO-92 (3)	4.00 mm × 3.15 mm

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



Device Packages

An IMPORTANT NOTICE at the end of this data sheet addresses availability, warranty, changes, use in safety-critical applications, intellectual property matters and other important disclaimers. PRODUCTION DATA.

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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision H (August 2018) to Revision I (February 2023) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document....1
- Changed table title from: Device Information to: Package Information....1
- Moved the *Power Supply Recommendations* and *Layout* sections to the *Application and Implementation* section....18

Changes from Revision G (October 2017) to Revision H (August 2018) **Page**

- Changed *Power Supply Recommendations* section....18

Changes from Revision F (September 2016) to Revision G (October 2017) **Page**

- Changed location of automotive-specific Features bullets to top of Features section....1
- Added device HBM and CDM classification sub-bullets to automotive-specific *Features* bullet....1
- Added last sentence to *Device Functional Modes* section....14

Changes from Revision E (August 2016) to Revision F (September 2016) **Page**

- Made changes to the Power-on time in the *Electrical Characteristics* table....5

Changes from Revision D (June 2016) to Revision E (August 2016) **Page**

- Revised preliminary limits for FA version in the *Magnetic Characteristics* table....6
- Added the *Layout* section....18

Changes from Revision C (May 2016) to Revision D (June 2016) **Page**

- Revised preliminary limits for the FA version....6

Changes from Revision B (February 2016) to Revision C (May 2016) **Page**

- Revised preliminary limits for the FA version....6

Changes from Revision A (December 2015) to Revision B (February 2016) **Page**

- Added the FA device option....1
- Added the typical bandwidth value to the *Magnetic Characteristics* table....6

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Changes from Revision * (December 2014) to Revision A (June 2015) **Page**

- Corrected body size of SOT-23 package and SIP package name to TO-92 1
- Added B_{MAX} to *Absolute Maximum Ratings* 4
- Removed table notes regarding testing for the operating junction temperature in *Absolute Maximum Ratings* . 4
- Added *Community Resources* 19
- Updated package tape and reel options for M and blank 19

5 Pin Configuration and Functions

For additional configuration information, see *Device Markings* and *Mechanical, Packaging, and Orderable Information*.

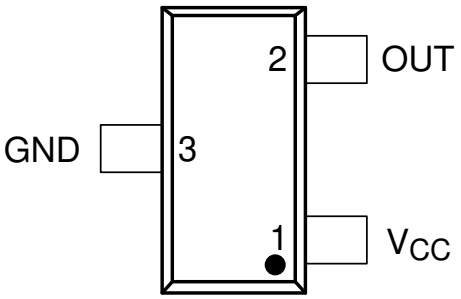


Figure 5-1. DBZ Package 3-Pin SOT-23 Top View

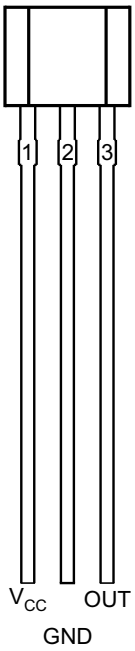


Figure 5-2. LPG Package 3-Pin TO-92 Top View

Table 5-1. Pin Functions

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

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6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Power supply voltage	V_{CC}	–22(2)	40	V
	Voltage ramp rate (V_{CC}), V_{CC} < 5 V	Unlimited		V/µs
	Voltage ramp rate (V_{CC}), V_{CC} > 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_{MAX}		Unlimited		
Operating junction temperature, T_J	Q, see Figure 9-1	–40	150	°C
	E, see Figure 9-1	–40	175	
Storage temperature, T_{stg}		–65	150	°C

(1) Operation outside the *Absolute Maximum Ratings* may cause permanent device damage. *Absolute Maximum Ratings* do not imply functional operation of the device at these or any other conditions beyond those listed under *Recommended Operating Conditions*. If used outside the *Recommended Operating Conditions* but within the *Absolute Maximum Ratings*, the device may not be fully functional, and this may affect device reliability, functionality, performance, and shorten the device lifetime.
(2) Specified by design. Only tested to –20 V.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per AEC Q100-002(1) HBM ESD classification level 2	±2500	V
		Charged-device model (CDM), per AEC Q100-011 Device HBM ESD classification level C4B	±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_{CC}	Power supply voltage		2.7	38	V
V_O	Output pin voltage (OUT)		0	38	V
I_{SINK}	Output pin current sink (OUT)(1)		0	30	mA
T_A	Operating ambient temperature	Q, see Figure 9-1	–40	125	°C
		E, see Figure 9-1	–40	150	

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

6.4 Thermal Information

THERMAL METRIC(1)		DRV5013-Q1		UNIT
		DBZ (SOT-23)	LPG (TO-92)	
		3 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	333.2	180	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	99.9	98.6	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	66.9	154.9	°C/W
ψ_{JT}	Junction-to-top characterization parameter	4.9	40	°C/W
ψ_{JB}	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.

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6.5 Electrical Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLIES (V_{CC})						
V_{CC}	V_{CC} operating voltage		2.7		38	V
I_{CC}	Operating supply current	V_{CC} = 2.7 V to 38 V, T_A = 25°C		2.7		mA
		V_{CC} = 2.7 V to 38 V, T_A = $T_{A, MAX}$ (1)		3	3.5	
t_{on}	Power-on time	AD, AG, BC versions		35	50	µs
		FA version		35	70	
OPEN-DRAIN OUTPUT (OUT)						
$r_{DS(on)}$	FET on-resistance	V_{CC} = 3.3 V, I_O = 10 mA, T_A = 25°C		22		Ω
		V_{CC} = 3.3 V, I_O = 10 mA, T_A = 125 (1)		36	50	
$I_{lkg(off)}$	Off-state leakage current	Output Hi-Z			1	µA
PROTECTION CIRCUITS						
V_{CCR}	Reverse supply voltage		–22			V
I_{OCP}	Overcurrent protection level	OUT shorted V_{CC}	15	30	45	mA

(1) $T_{A, MAX}$ is 125°C for Q Grade 1 devices and 150°C for E Grade 0 devices (see Figure 9-1).

6.6 Switching Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
OPEN-DRAIN OUTPUT (OUT)						
t_d	Output delay time	B = B_{RP} – 10 mT to B_{OP} + 10 mT in 1 µs		13	25	µs
t_r	Output rise time (10% to 90%)	R1 = 1 kΩ, C_O = 50 pF, V_{CC} = 3.3 V		200		ns
t_f	Output fall time (90% to 10%)	R1 = 1 kΩ, C_O = 50 pF, V_{CC} = 3.3 V		31		ns

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6.7 Magnetic Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT(1)
f_{BW}	Bandwidth(2)		20	30		kHz
DRV5013FA: ±1.3 mT						
B_{OP}	Operate point; see Figure 7-2		–0.6	1.3	3.4	mT
B_{RP}	Release point; see Figure 7-2		–3.4	–1.3	0.6	mT
B_{hys}	Hysteresis; $B_{hys} = (B_{OP} – B_{RP})$		1.2	2.6		mT
B_O	Magnetic offset; $B_O = (B_{OP} + B_{RP}) / 2$		–1.5	0	1.5	mT
DRV5013AD: ±2.7 mT						
B_{OP}	Operate point; see Figure 7-2		1	2.7	5	mT
B_{RP}	Release point; see Figure 7-2		–5	–2.7	–1	mT
B_{hys}	Hysteresis; $B_{hys} = (B_{OP} – B_{RP})$			5.4		mT
B_O	Magnetic offset; $B_O = (B_{OP} + B_{RP}) / 2$		–1.5	0	1.5	mT
DRV5013AG: ±6 mT						
B_{OP}	Operate point; see Figure 7-2		3	6	9	mT
B_{RP}	Release point; see Figure 7-2		–9	–6	–3	mT
B_{hys}	Hysteresis; $B_{hys} = (B_{OP} – B_{RP})$			12		mT
B_O	Magnetic offset; $B_O = (B_{OP} + B_{RP}) / 2$		–1.5	0	1.5	mT
DRV5013BC: ±12 mT						
B_{OP}	Operate point; see Figure 7-2		6	12	18	mT
B_{RP}	Release point; see Figure 7-2		–18	–12	–6	mT
B_{hys}	Hysteresis; $B_{hys} = (B_{OP} – B_{RP})$			24		mT
B_O	Magnetic offset; $B_O = (B_{OP} + B_{RP}) / 2$		–1.5	0	1.5	mT

(1) 1 mT = 10 Gauss.
(2) Bandwidth describes the fastest changing magnetic field that can be detected and translated to the output.

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6.8 Typical Characteristics

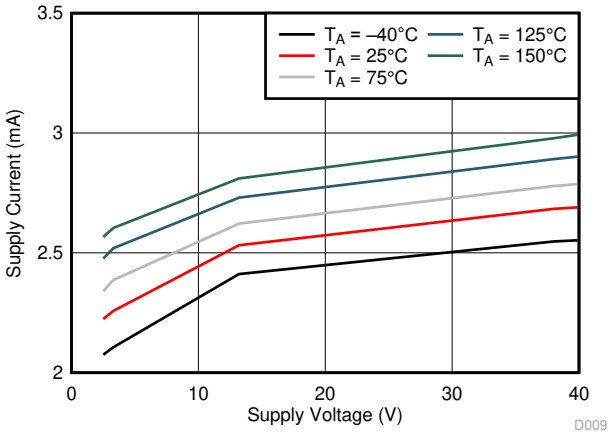


Figure 6-1. I_{CC} vs V_{CC}

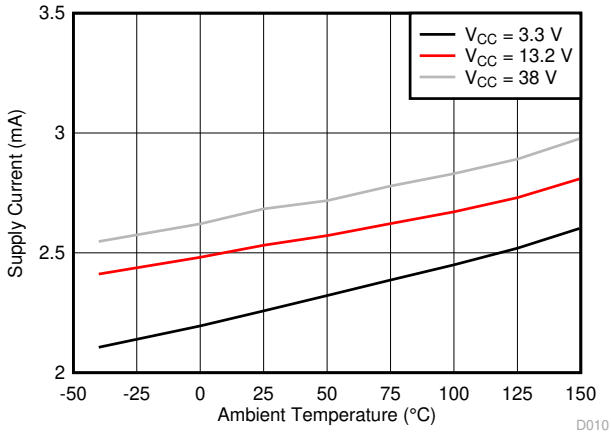
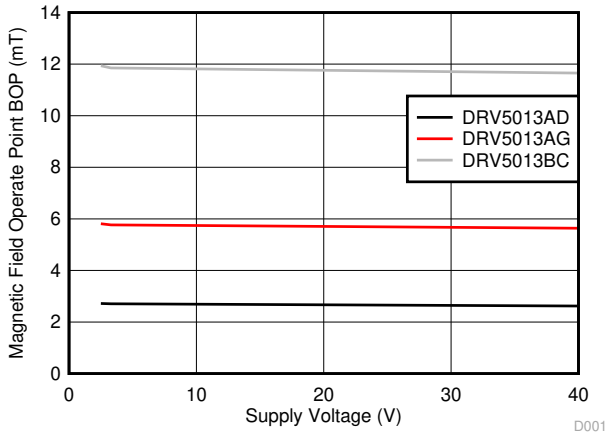
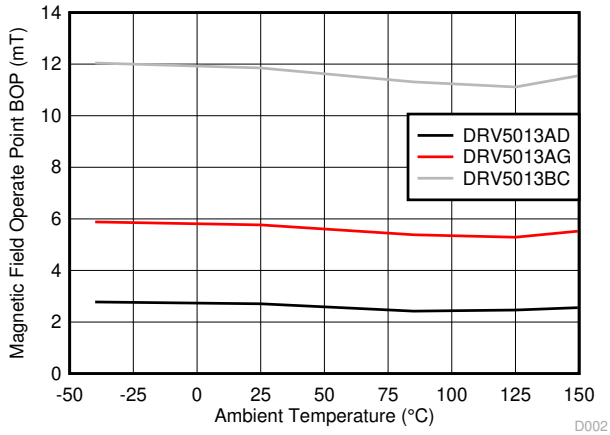


Figure 6-2. I_{CC} vs Temperature



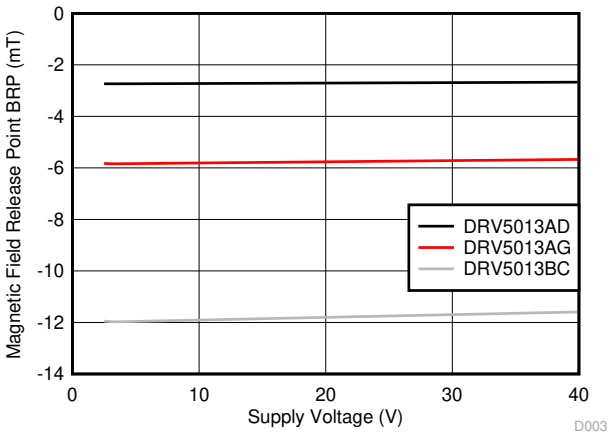
T_A = 25°C

Figure 6-3. B_{OP} vs V_{CC}



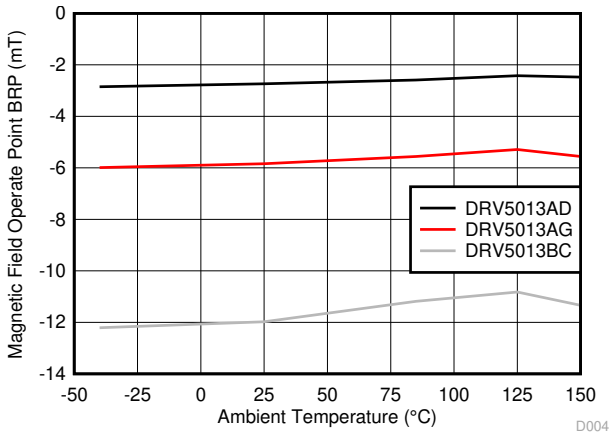
V_{CC} = 3.3 V

Figure 6-4. B_{OP} vs Temperature



T_A = 25°C

Figure 6-5. B_{RP} vs V_{CC}

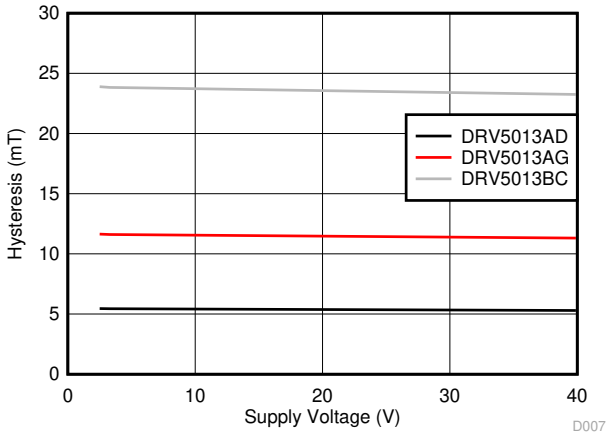


V_{CC} = 3.3 V

Figure 6-6. B_{RP} vs Temperature

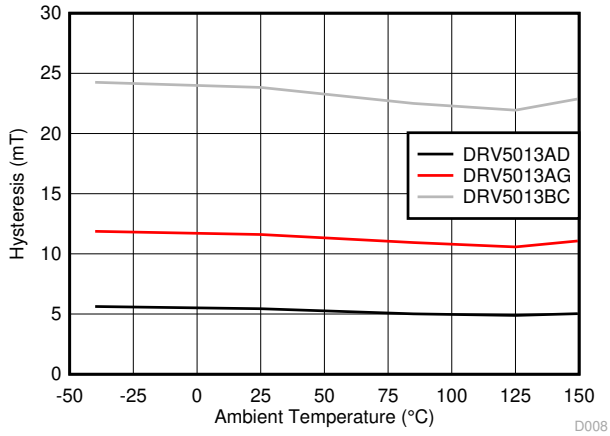
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6.8 Typical Characteristics (continued)



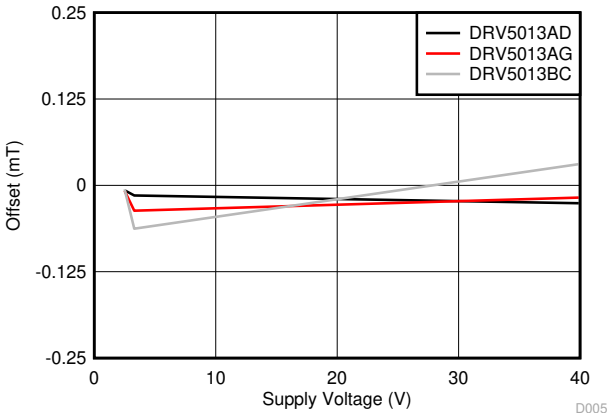
T_A = 25°C

Figure 6-7. Hysteresis vs V_{CC}



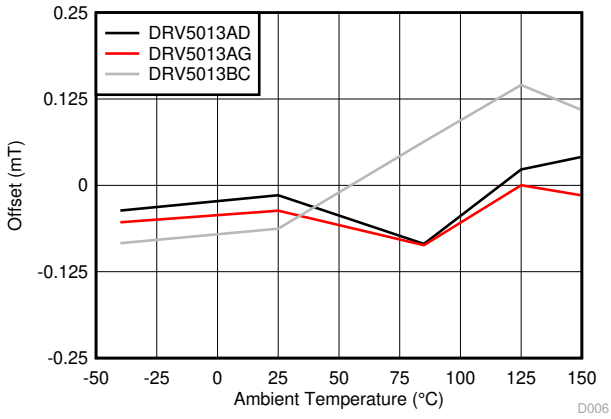
V_{CC} = 3.3 V

Figure 6-8. Hysteresis vs Temperature



T_A = 25°C

Figure 6-9. Offset vs V_{CC}



V_{CC} = 3.3 V

Figure 6-10. Offset vs Temperature

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7 Detailed Description

7.1 Overview

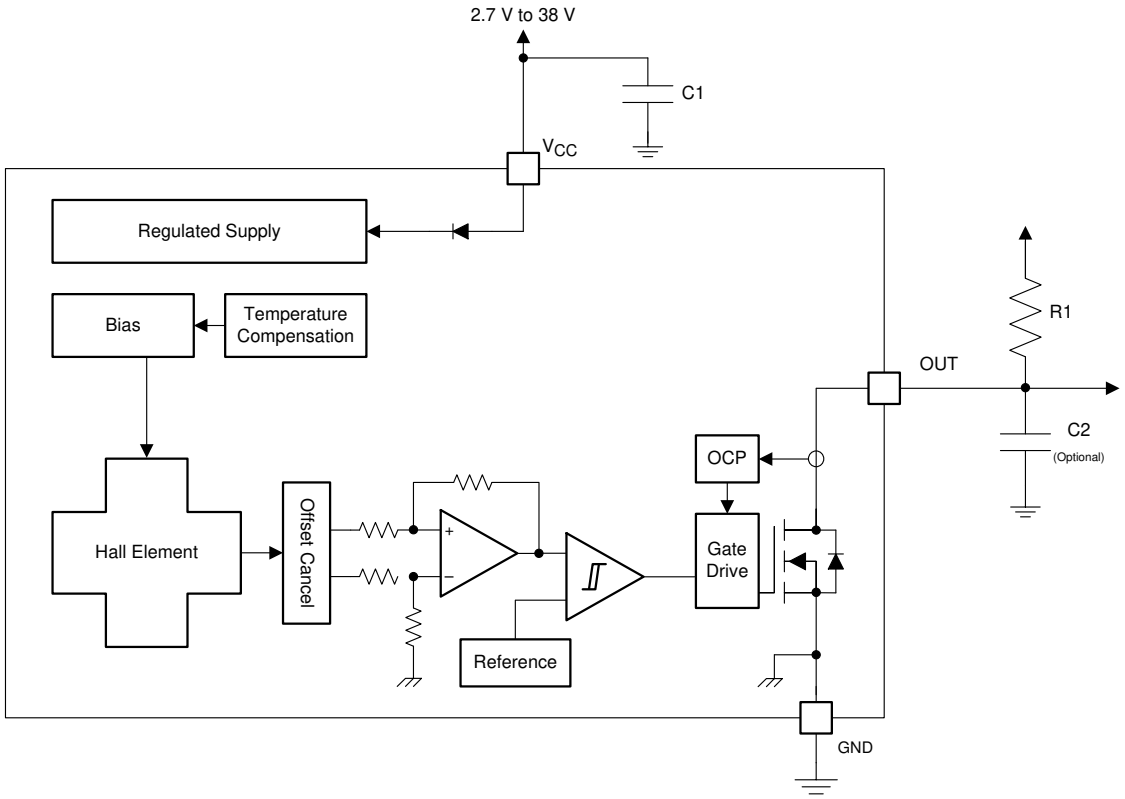
The DRV5013-Q1 device is a chopper-stabilized Hall sensor with a digital latched output for magnetic sensing applications. The DRV5013-Q1 device can be powered with a supply voltage between 2.7 V and 38 V, and continuously survives continuous –22 V reverse-battery conditions. The DRV5013-Q1 device does not operate when –22 V to 2.4 V is applied to the V_{CC} pin (with respect to the GND pin). 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 output state is dependent on the magnetic field perpendicular to the package. A south pole near the marked side of the package causes the output to pull low (operate point, B_{OP}), and a north pole near the marked side of the package causes the output to release (release point, B_{RP}). Hysteresis is included in between the operate point and the release point therefore magnetic-field noise does not accidentally trip the output.

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



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7.3 Feature Description

7.3.1 Field Direction Definition

Figure 7-1 shows the positive magnetic field defined as a south pole near the marked side of the package.

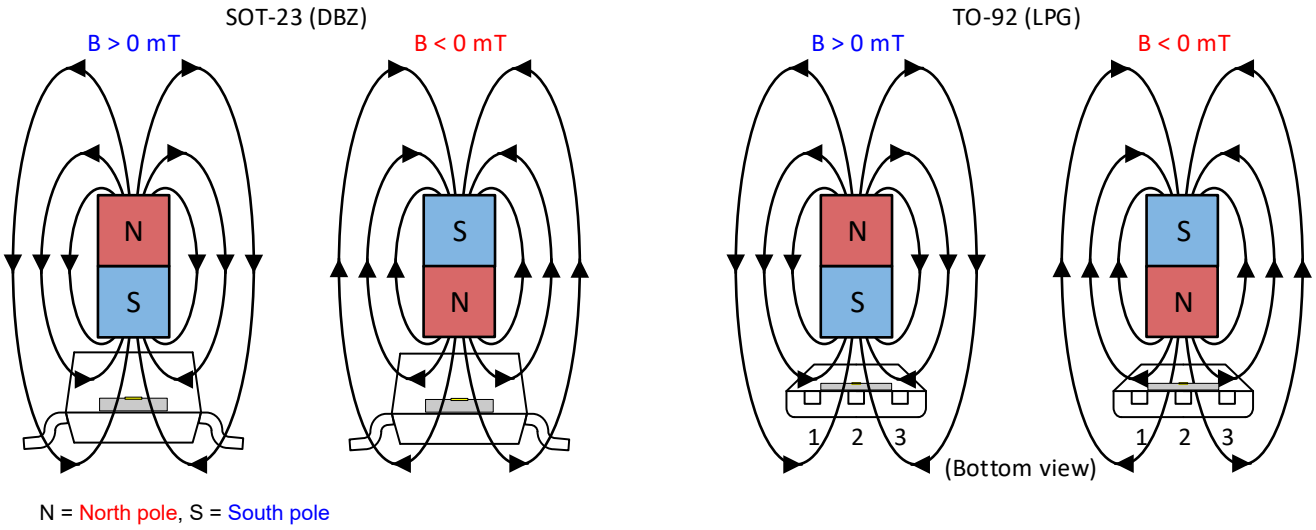


Figure 7-1. Field Direction Definition

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.

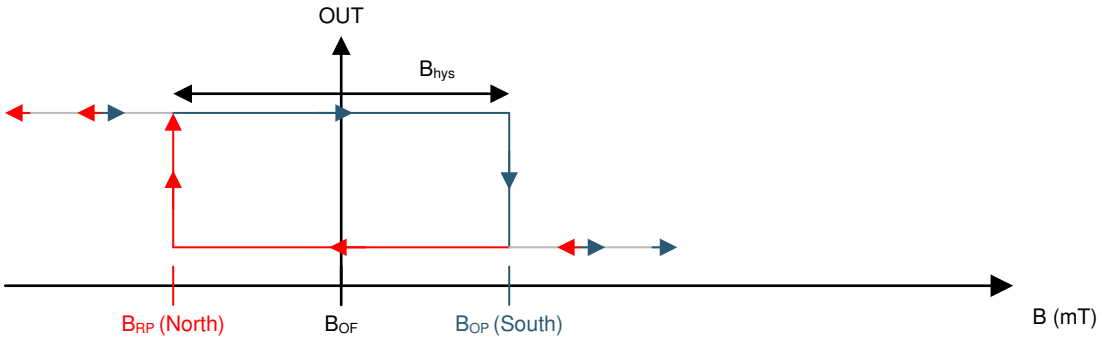


Figure 7-2. DRV5013-Q1 — B_{OP} > 0

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7.3.3 Power-On Time

After applying V_{CC} to the DRV5013-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 7-3 and Figure 7-4 occurs at the end of t_{on}. This pulse can allow the host processor to determine when the DRV5013-Q1 output is valid after start-up. In Case 1 (Figure 7-3) and Case 2 (Figure 7-4), the output is defined assuming a constant magnetic field B > B_{OP} and B < B_{RP}.

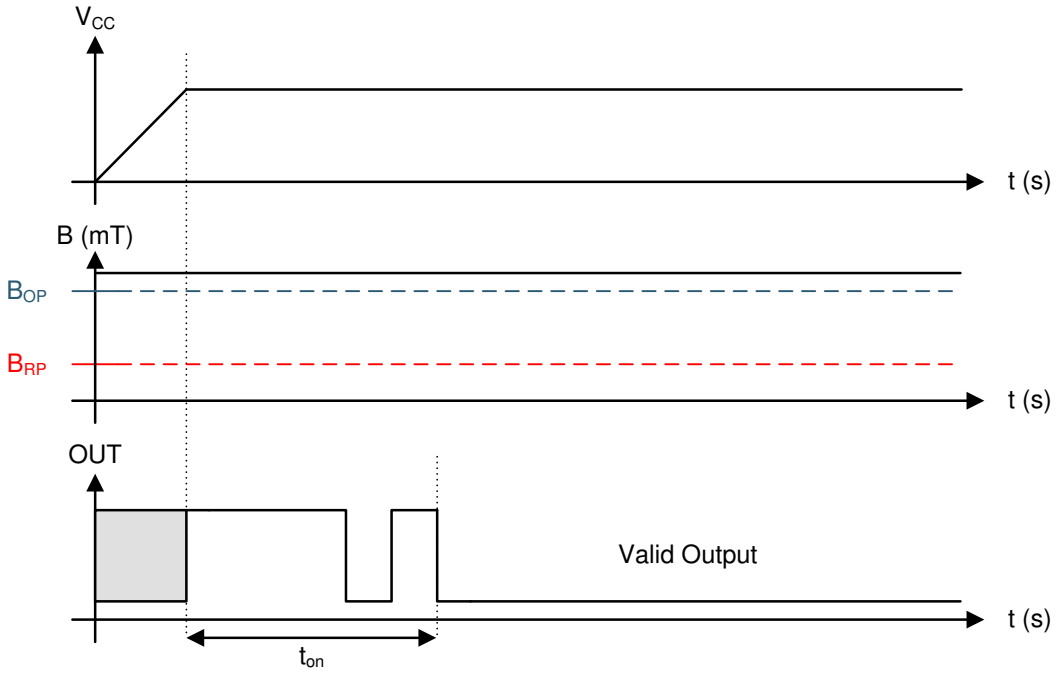


Figure 7-3. Case 1: Power On When B > B_{OP}

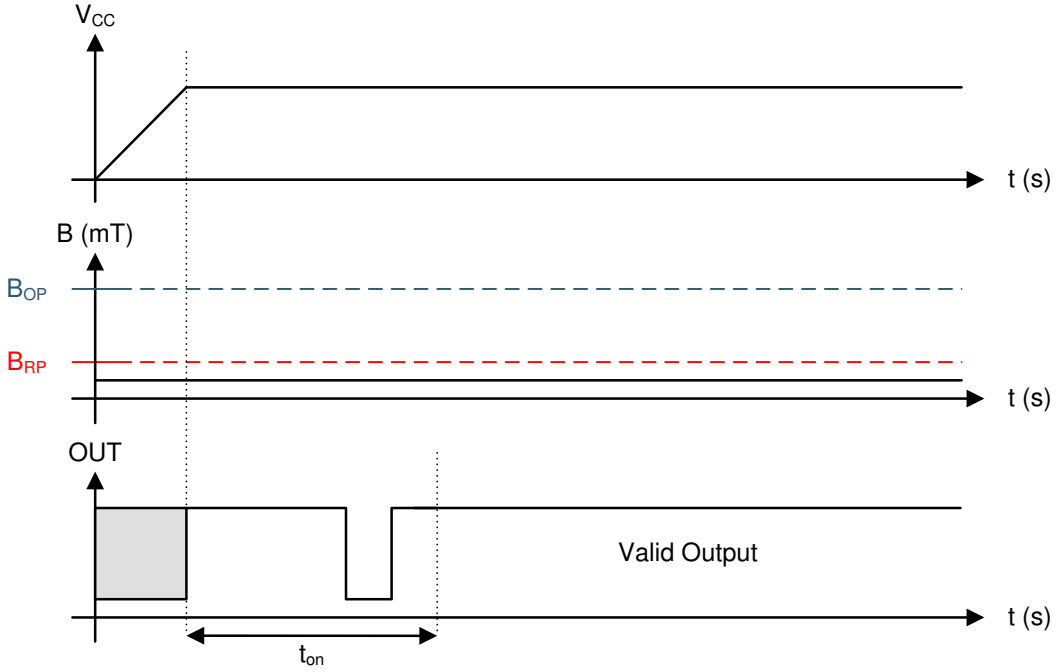


Figure 7-4. Case 2: Power On When B < B_{RP}

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

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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 7-5) and Case 4 (Figure 7-6) show examples of this behavior.

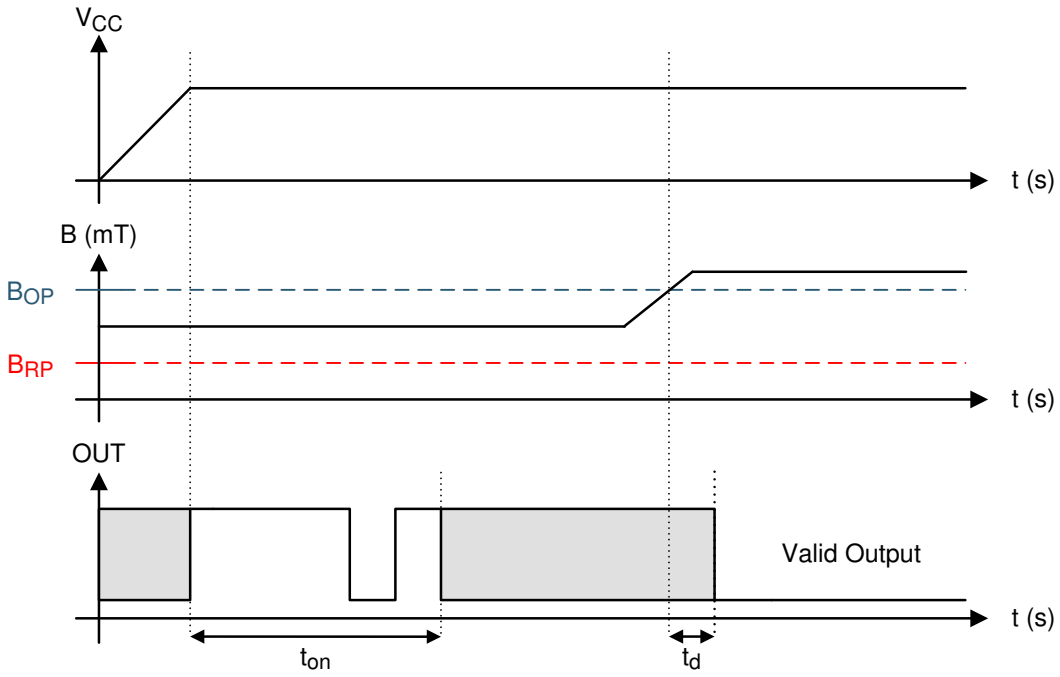


Figure 7-5. Case 3: Power On When $B_{RP} < B < B_{OP}$, Followed by $B > B_{OP}$

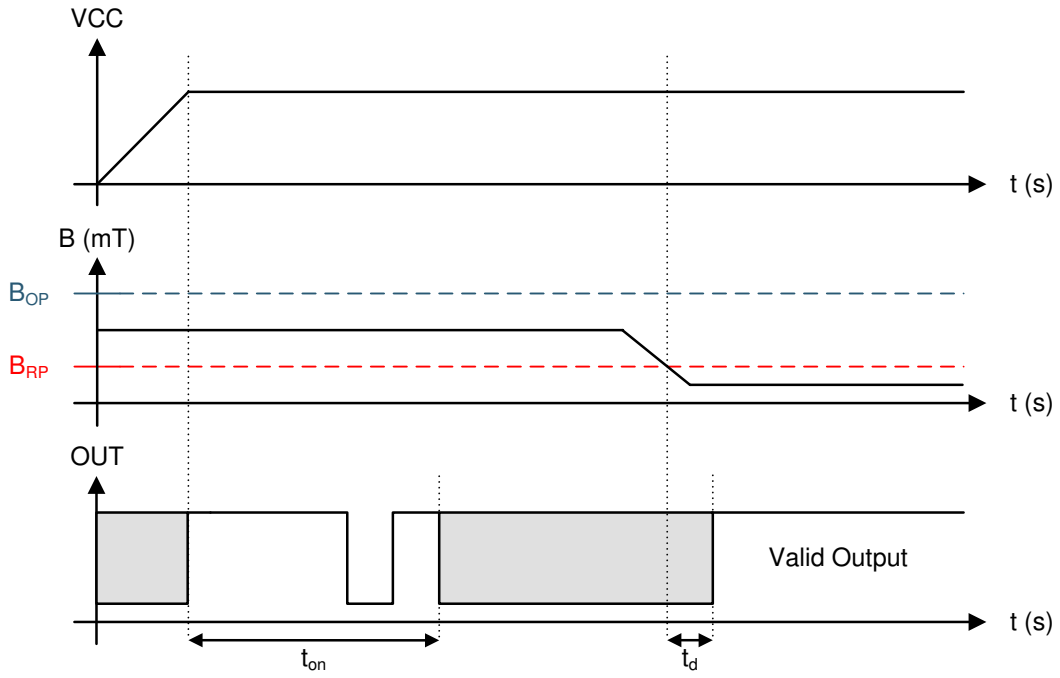


Figure 7-6. Case 4: Power On When $B_{RP} < B < B_{OP}$, Followed by $B < B_{RP}$

7.3.4 Output Stage

Figure 7-7 shows the DRV5013-Q1 open-drain NMOS output structure, rated to sink up to 30 mA of current. For proper operation, use Equation 1 to calculate the value of pullup resistor R1.

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

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, make sure that the value of R1 > 500 Ω so that 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*.

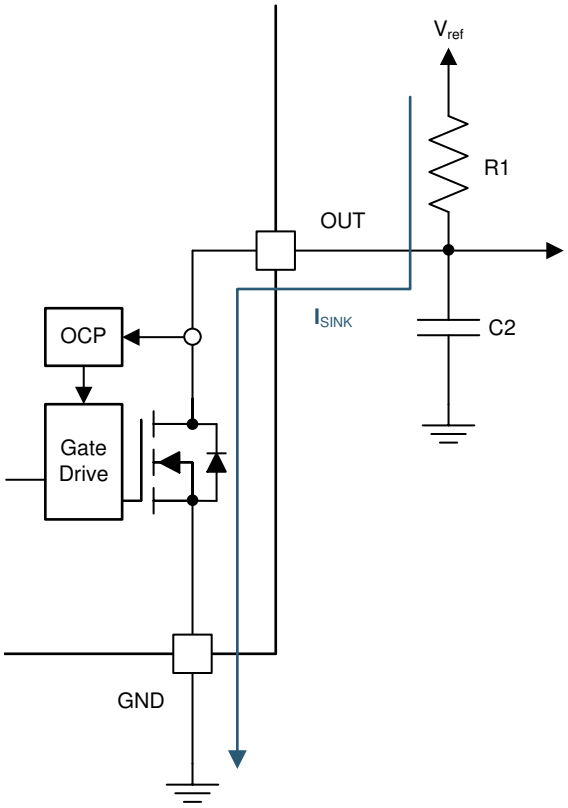


Figure 7-7. NMOS Open-Drain Output

Select a value for C2 based on the system bandwidth specifications as shown in Equation 2.

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

Most applications do not require this C2 filtering capacitor.

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7.3.5 Protection Circuits

The DRV5013-Q1 device is fully protected against overcurrent and reverse-supply conditions. Table 7-1 lists a summary of the protection circuits.

Table 7-1. Protection Circuit Summary

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 V < V_{CC} < 40 V	Operating	Device will operate for a transient duration	$V_{CC} \leq 38$ V
Reverse supply	–22 V < V_{CC} < 0 V	Disabled	Device will survive this condition	$V_{CC} \geq 2.7$ V

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 DRV5013-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 DRV5013-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*.

7.4 Device Functional Modes

The DRV5013-Q1 device is active only when V_{CC} is between 2.7 V and 38 V.

When a reverse supply condition exists, the device is inactive. With regard to some industry standards that require analyzing every possible output from a device, an internal clock is unlikely to couple to the output.

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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, as well as validating and testing their design implementation to confirm system functionality.

8.1 Application Information

The DRV5013-Q1 device is used in magnetic-field sensing applications.

8.2 Typical Applications

8.2.1 Standard Circuit

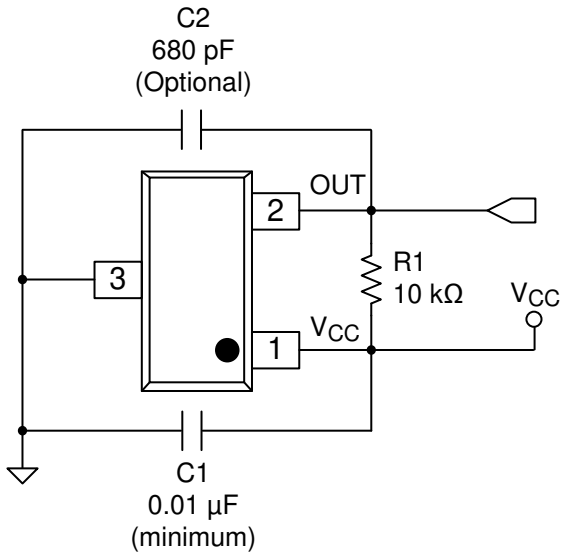


Figure 8-1. Typical Application Circuit

8.2.1.1 Design Requirements

For this design example, use the parameters listed in Table 8-1 as the input parameters.

Table 8-1. 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 8-2. 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	**Optional**: Place a ceramic capacitor to GND
R1	OUT	REF(1)	Requires a resistor pullup

(1) REF is not a pin on the DRV5013-Q1 device, but a REF supply-voltage pullup is required for the OUT pin; the OUT pin may be pulled up to V_{CC}.

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8.2.1.2.1 Configuration Example

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

$$\frac{V_{ref}\,max}{30\ mA} \le R1 \le \frac{V_{ref}\,min}{100\ \mu A} \tag{3}$$

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

$$\frac{3.4\ V}{30\ mA} \le R1 \le \frac{3.2\ V}{100\ \mu A} \tag{4}$$

Therefore:

$$113\ \Omega \le R1 \le 32\ k\Omega \tag{5}$$

After finding the allowable range of R1 (Equation 5), select a value between 500 Ω and 32 kΩ for R1.

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

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

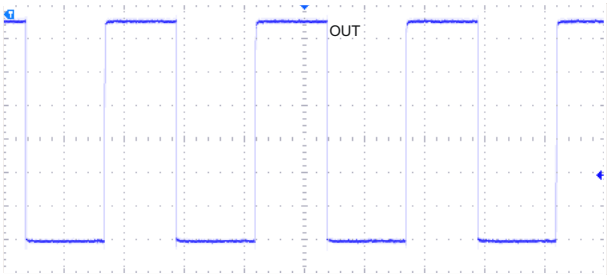
For this design example, use Equation 7 to calculate the value of C2.

$$2 \times 10\ kHz < \frac{1}{2\pi \times R1 \times C2} \tag{7}$$

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

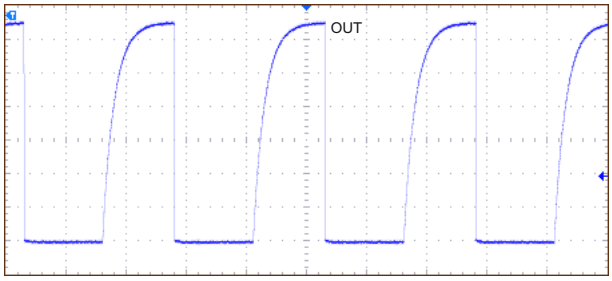
A selection of R1 = 10 kΩ and C2 = 680 pF would cause a low-pass filter with a corner frequency of 23.4 kHz.

8.2.1.3 Application Curves



R1 = 10 kΩ pull-up No C2

Figure 8-2. 10-kHz Switching Magnetic Field



R1 = 10-kΩ pull-up C2 = 680 pF

Figure 8-3. 10-kHz Switching Magnetic Field

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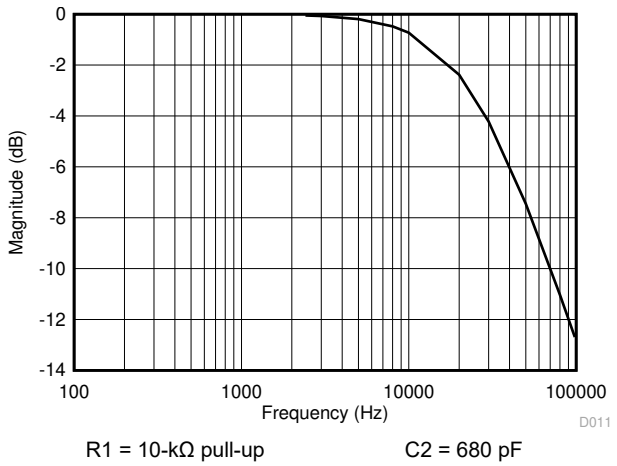


Figure 8-4. Low-Pass Filtering

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.

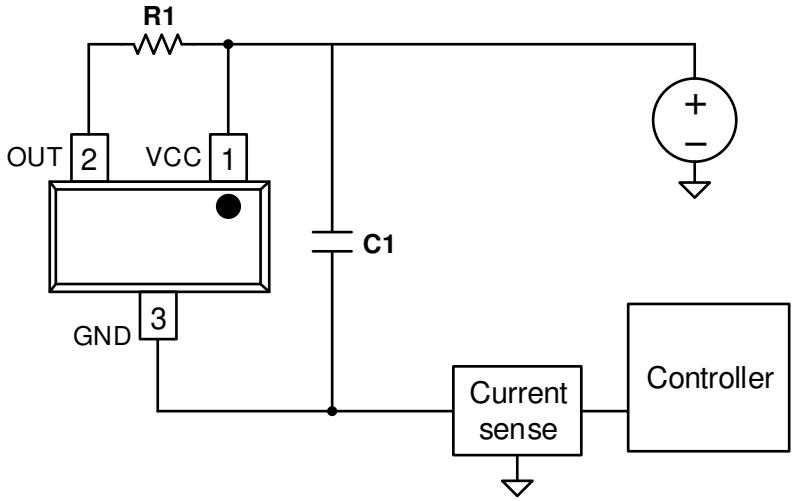


Figure 8-5. 2-Wire Application

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

8.2.2.1 Design Requirements

Table 8-3 lists the related design parameters.

Table 8-3. Design Parameters

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

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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 kΩ, 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 µF, and a larger value if there is high inductance in the power line interconnect.

8.3 Power Supply Recommendations

The DRV5013-Q1 device is designed to operate from an input voltage supply (VM) range between 2.7 V and 38 V. A 0.01-µF (minimum) ceramic capacitor rated for V_{CC} must be placed as close to the DRV5013-Q1 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}.

8.4 Layout

8.4.1 Layout Guidelines

The bypass capacitor should be placed near the DRV5013-Q1 device for efficient power delivery with minimal inductance. The external pullup resistor should be placed near the microcontroller input to provide the most stable voltage at the input; alternatively, an integrated pullup resistor within the GPIO of the microcontroller can be used.

Generally, using PCB copper planes underneath the DRV5013-Q1 device has no effect on magnetic flux, and does not interfere with device performance. This is because copper is not a ferromagnetic material. However, If nearby system components contain iron or nickel, they may redirect magnetic flux in unpredictable ways.

8.4.2 Layout Example

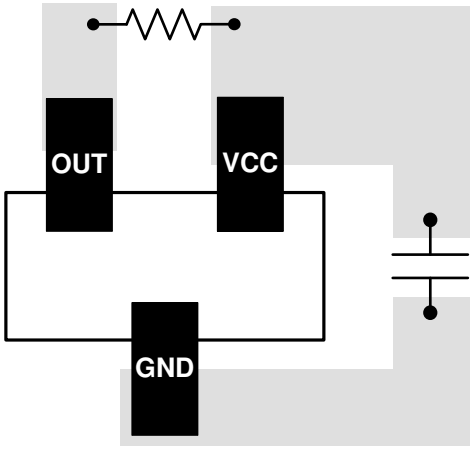


Figure 8-6. DRV5013-Q1 Layout Example

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9 Device and Documentation Support

9.1 Device Support

9.1.1 Device Nomenclature

Figure 9-1 shows a legend for reading the complete device name for and DRV5013-Q1 device.

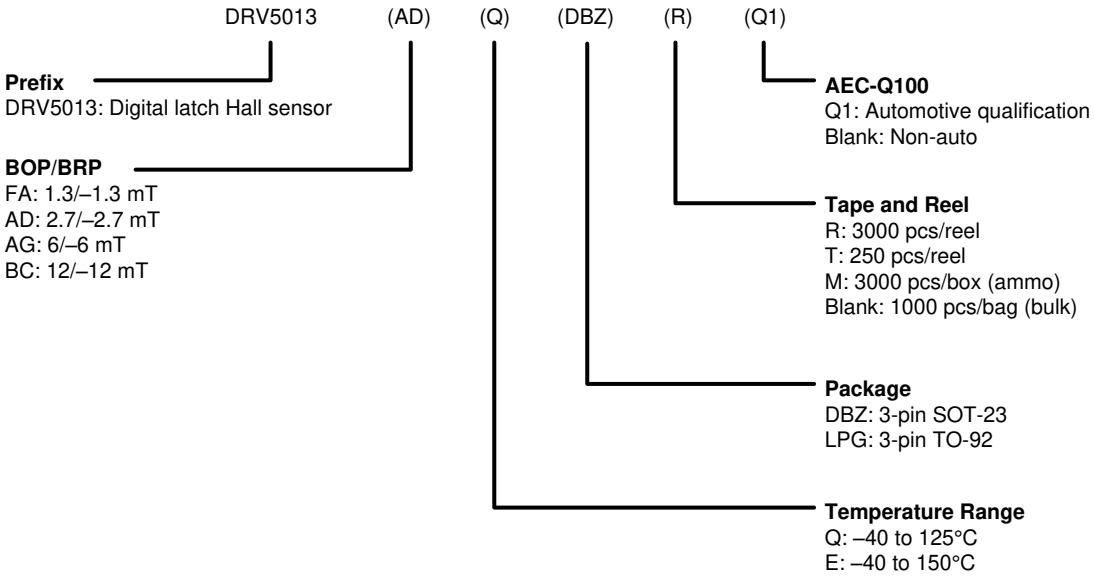


Figure 9-1. Device Nomenclature

9.1.2 Device Markings

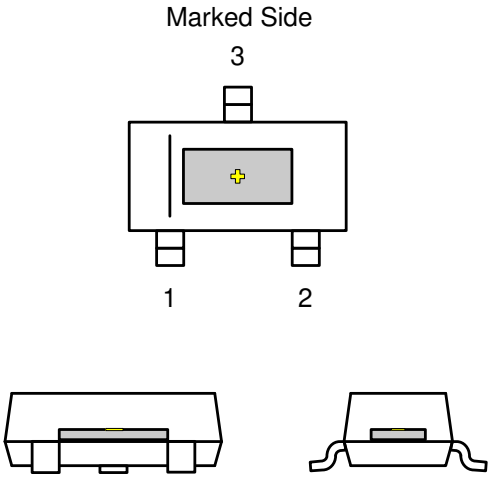


Figure 9-2. SOT-23 (DBZ) Package

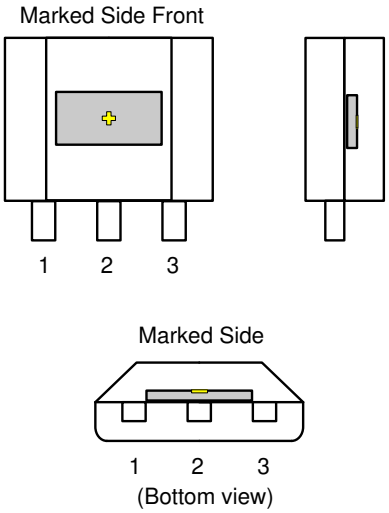


Figure 9-3. TO-92 (LPG) Package

9.2 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. Click on *Subscribe to updates* 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.

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9.3 Support 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.

9.4 Trademarks

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9.5 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.

9.6 Glossary

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

10 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.

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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)
DRV5013ADEDBZJQ1	Active	Production	SOT-23 (DBZ) | 3	10000 | JUMBO T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 150	(+NJAD, NJAD)
DRV5013ADEDBZJQ1.A	Active	Production	SOT-23 (DBZ) | 3	10000 | JUMBO T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	(+NJAD, NJAD)
DRV5013ADEDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 150	(+NJAD, NJAD)
DRV5013ADEDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	(+NJAD, NJAD)
DRV5013ADEDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 150	+NJAD
DRV5013ADELPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAD
DRV5013ADELPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAD
DRV5013ADELPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAD
DRV5013ADELPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAD
DRV5013ADQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 125	(+NKAD, NKAD)
DRV5013ADQDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	(+NKAD, NKAD)
DRV5013ADQDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	+NKAD
DRV5013ADQLPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAD
DRV5013ADQLPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAD
DRV5013ADQLPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAD
DRV5013ADQLPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAD
DRV5013AGEDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 150	(+NJAG, NJAG)
DRV5013AGEDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	(+NJAG, NJAG)
DRV5013AGEDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 150	+NJAG
DRV5013AGELPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAG
DRV5013AGELPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAG
DRV5013AGELPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAG
DRV5013AGELPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJAG
DRV5013AGQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 125	(+NKAG, NKAG)
DRV5013AGQDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	(+NKAG, NKAG)
DRV5013AGQDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	+NKAG
DRV5013AGQLPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAG
DRV5013AGQLPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAG
DRV5013AGQLPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAG

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)
DRV5013AGQLPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKAG
DRV5013BCEDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 150	(+NJBC, NJBC)
DRV5013BCEDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	(+NJBC, NJBC)
DRV5013BCEDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 150	+NJBC
DRV5013BCELPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJBC
DRV5013BCELPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 150	+NJBC
DRV5013BCELPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJBC
DRV5013BCELPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 150	+NJBC
DRV5013BCQDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	NIPDAUAG | SN	Level-1-260C-UNLIM	-40 to 125	(+NKBC, NKBC)
DRV5013BCQDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	(+NKBC, NKBC)
DRV5013BCQDBZTQ1	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	+NKBC
DRV5013BCQLPGMQ1	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKBC
DRV5013BCQLPGMQ1.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	+NKBC
DRV5013BCQLPGQ1	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKBC
DRV5013BCQLPGQ1.A	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	+NKBC
DRV5013FAEDBZRQ1	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	+NJFA
DRV5013FAEDBZRQ1.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 150	+NJFA

(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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In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

OTHER QUALIFIED VERSIONS OF DRV5013-Q1 :

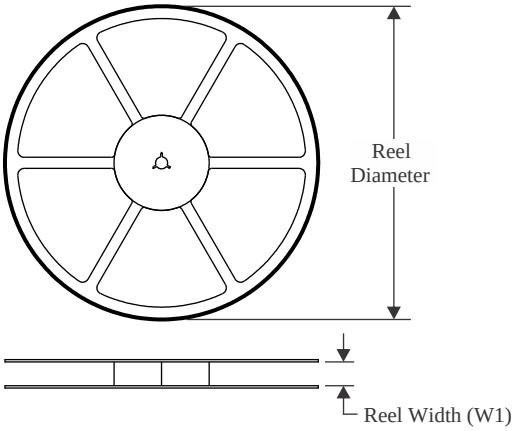
- Catalog : DRV5013

NOTE: Qualified Version Definitions:

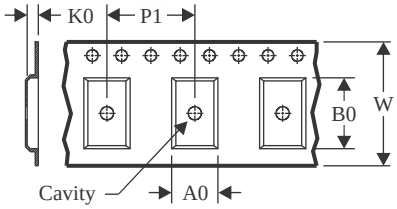
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

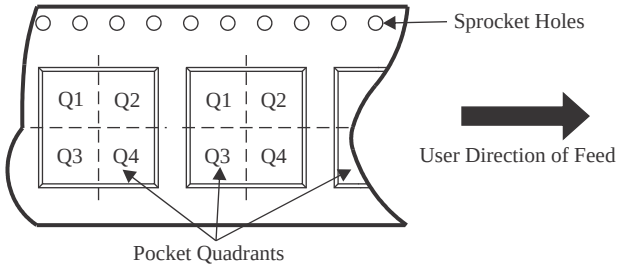


TAPE DIMENSIONS



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

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

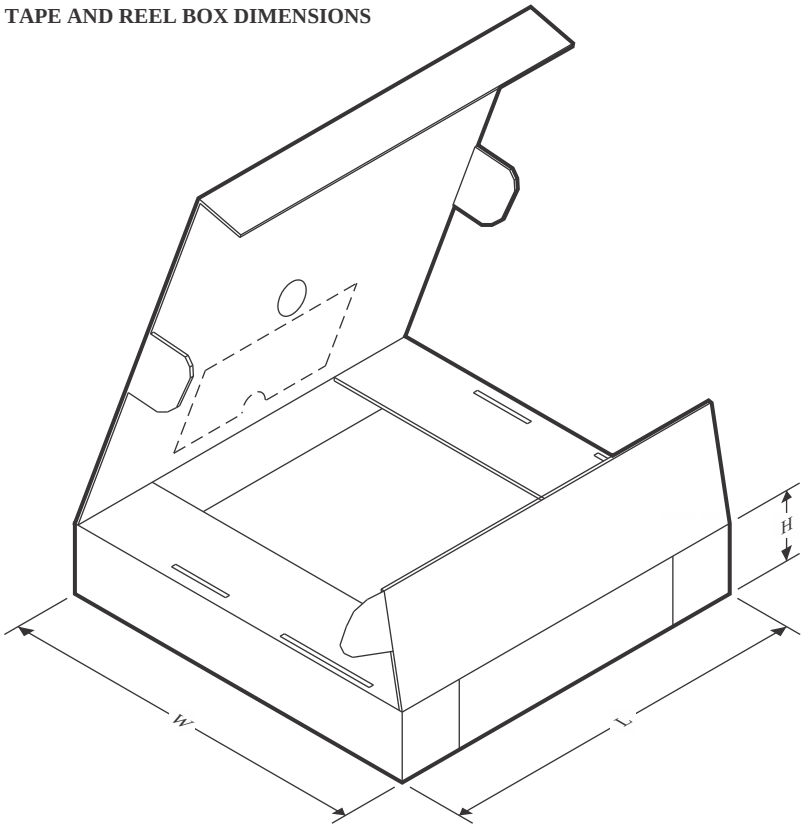


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV5013ADEDBZJQ1	SOT-23	DBZ	3	10000	330.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013ADEDBZJQ1	SOT-23	DBZ	3	10000	330.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	178.0	9.0	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013AGEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013AGEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013AGQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013AGQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013BCEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013BCEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5013BCQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013BCQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3

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
DRV5013FAEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5013FAEDBZRQ1	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)
DRV5013ADEDBZJQ1	SOT-23	DBZ	3	10000	367.0	367.0	35.0
DRV5013ADEDBZJQ1	SOT-23	DBZ	3	10000	346.0	346.0	29.0
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	180.0	180.0	18.0
DRV5013ADEDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	180.0	180.0	18.0
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013ADQDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013AGEDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013AGEDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013AGQDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013AGQDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013BCEDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013BCEDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013BCQDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013BCQDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0
DRV5013FAEDBZRQ1	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5013FAEDBZRQ1	SOT-23	DBZ	3	3000	202.0	201.0	28.0

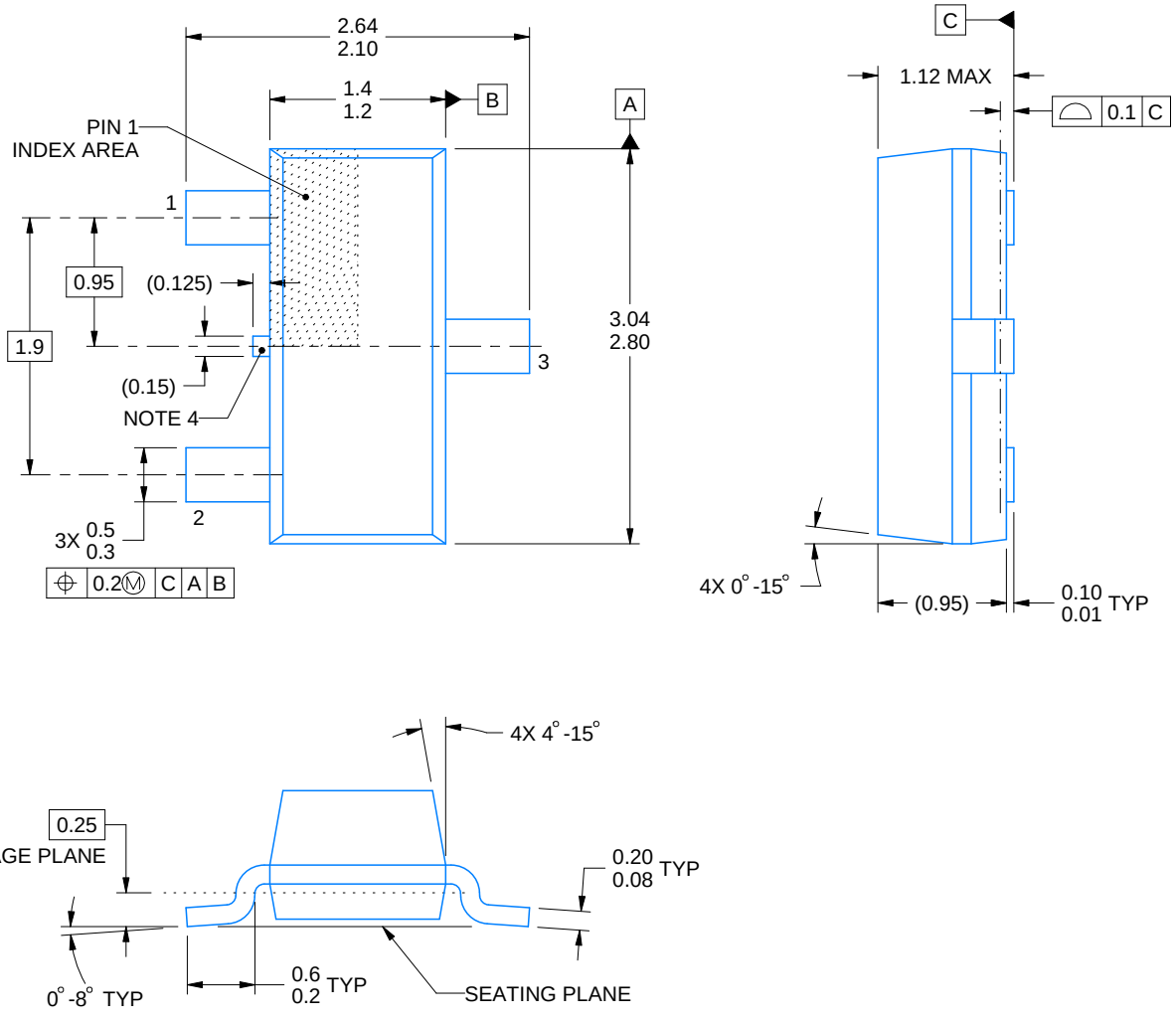
PACKAGE OUTLINE

DBZ0003A



SOT-23 - 1.12 mm max height

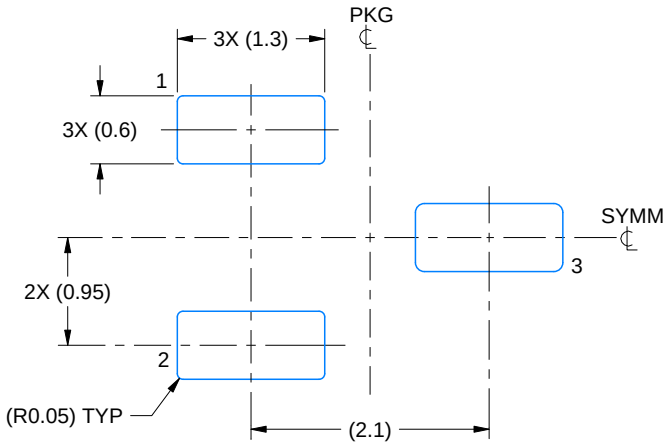
SMALL OUTLINE TRANSISTOR



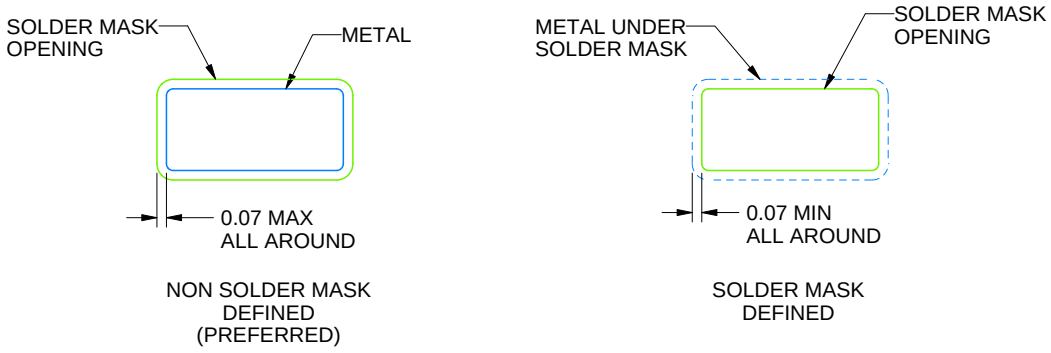
4214838/F 08/2024

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.
4. Support pin may differ or may not be present.
5. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25mm per side



LAND PATTERN EXAMPLE
SCALE:15X

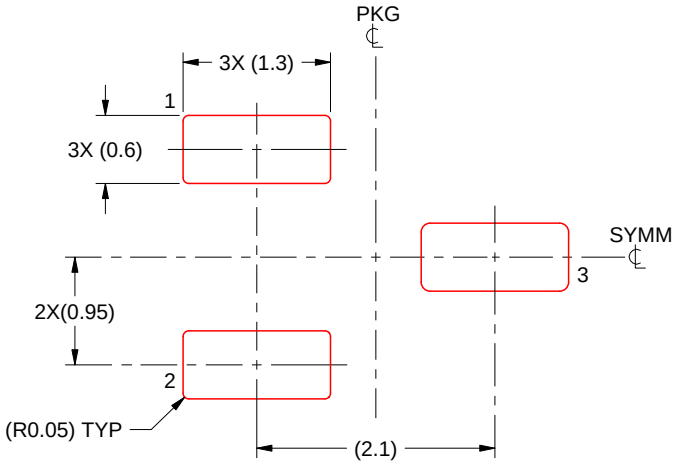


SOLDER MASK DETAILS

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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.



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

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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.

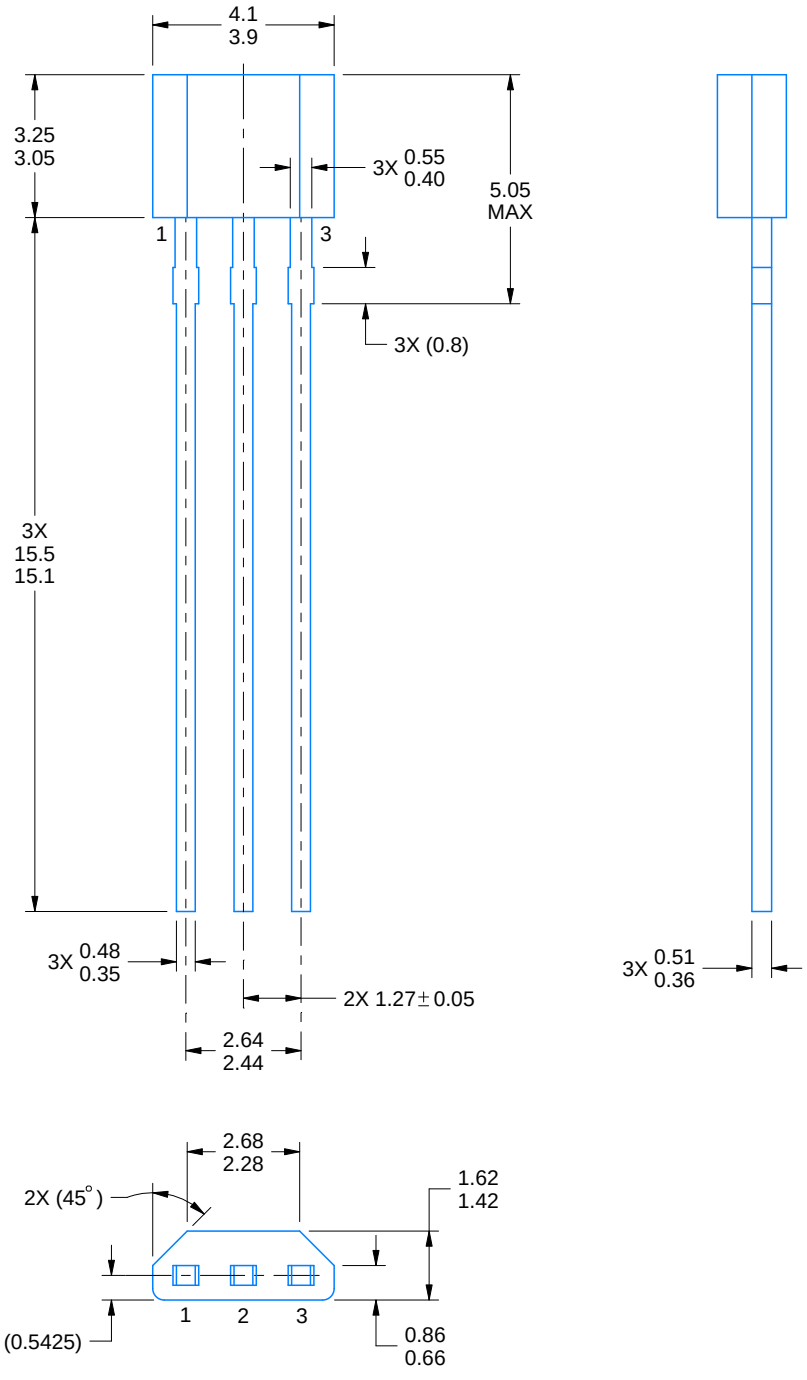


PACKAGE OUTLINE

LPG0003A

TO-92 - 5.05 mm max height

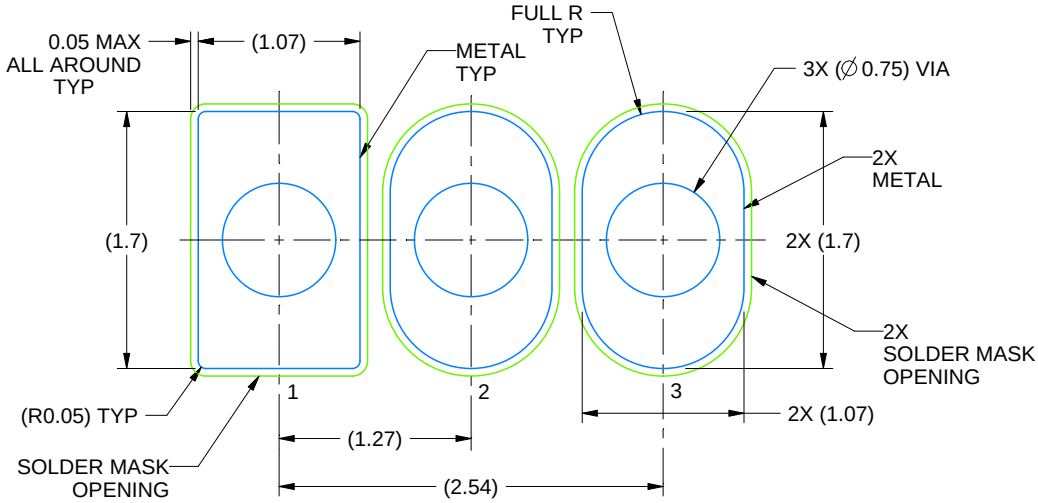
TRANSISTOR OUTLINE



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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.



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

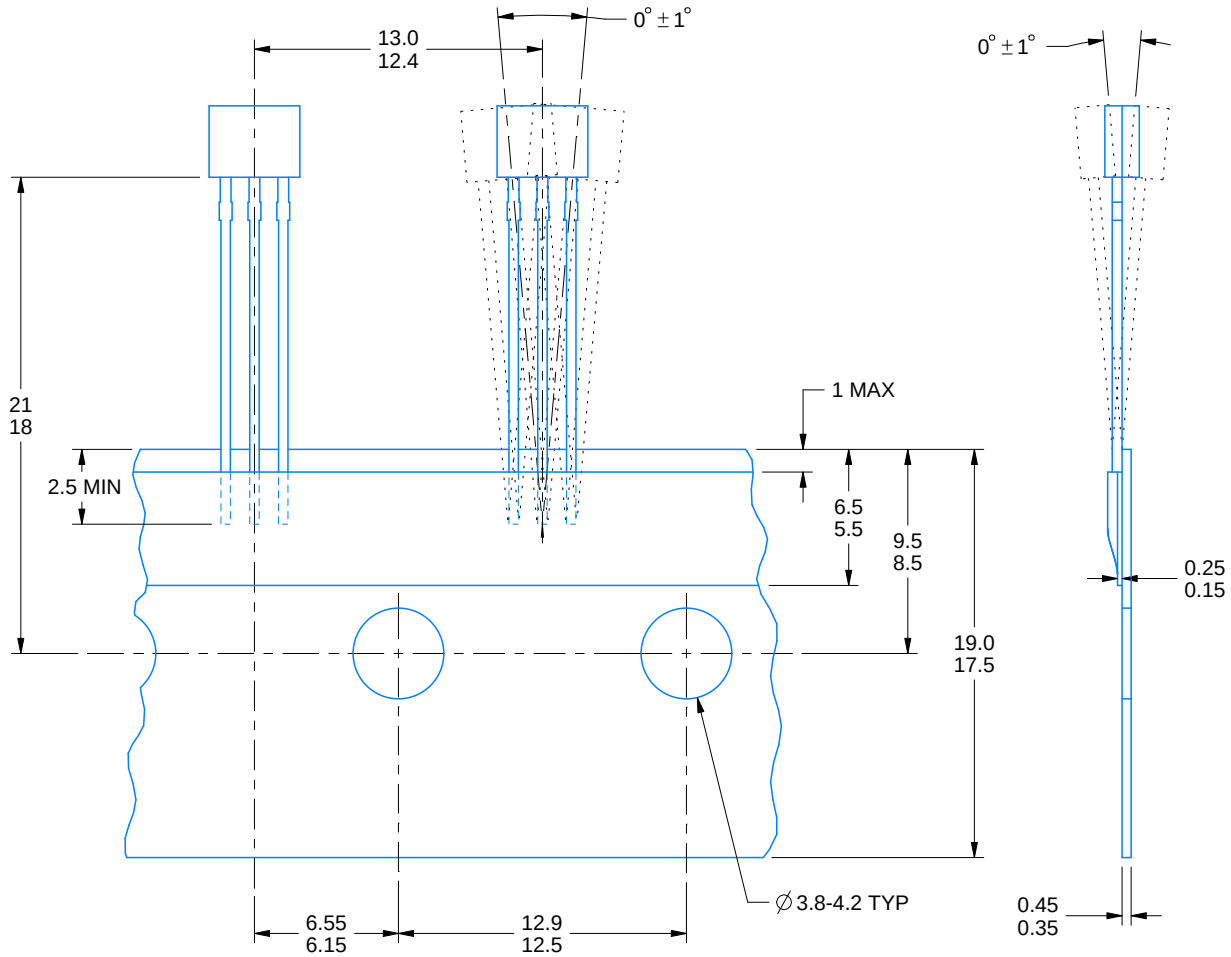
4221343/C 01/2018

TAPE SPECIFICATIONS

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



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