DRV5056 Unipolar Ratiometric Linear Hall-Effect Sensor

1 Features

- Unipolar linear hall effect magnetic sensor
- Operates from 3.3V and 5V power supplies
- Analog output with 0.6V quiescent offset:
  - Maximizes voltage swing for high accuracy
- Magnetic sensitivity options (at V_{CC} = 5V):
  - A1/Z1: 200mV/mT, 20mT range
  - A2/Z2: 100mV/mT, 39mT range
  - A3/Z3: 50mV/mT, 79mT range
  - A4/Z4: 25mV/mT, 158mT range
  - A6: 100mV/mT, 39mT range
  - A8: 66.6mV/mT, 64mT range
- Fast 20kHz sensing bandwidth
- Low-noise output with ±1mA drive
- Compensation for magnet temperature drift for A1/A2/A3/A4/A6/A8 versions and None for the Z1/Z2/Z3/Z4 versions
- Standard industry packages:
  - Surface-mount SOT-23
  - Through-hole TO-92

2 Applications

- Precise position sensing
- Industrial automation and robotics
- Home appliances
- Gamepads, pedals, keyboards, triggers
- Height leveling, tilt and weight measurement
- Fluid flow rate measurement
- Medical devices
- Current sensing

3 Description

The DRV5056 is a linear Hall-effect sensor that responds proportionally to flux density of a magnetic south pole. The device can be used for accurate position sensing in a wide range of applications.

Featuring a unipolar magnetic response, the analog output drives 0.6V when no magnetic field is present, and increases when a south magnetic pole is applied. This response maximizes the output dynamic range in applications that sense one magnetic pole. Multiple sensitivity options further maximize the output swing based on the required sensing range.

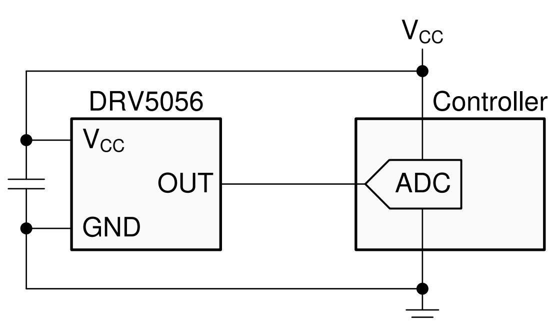
The device operates from 3.3V or 5V power supplies. Magnetic flux perpendicular to the top of the package is sensed, and the two package options provide different sensing directions.

The device uses a ratiometric architecture that can minimize error from V_{CC} tolerance when the external analog-to-digital converter (ADC) uses the same V_{CC} for the reference. Additionally, the device features magnet temperature compensation to counteract how magnets drift for linear performance across a wide –40°C to +125°C temperature range. Device options for no temperature compensation of magnet drift are also available.

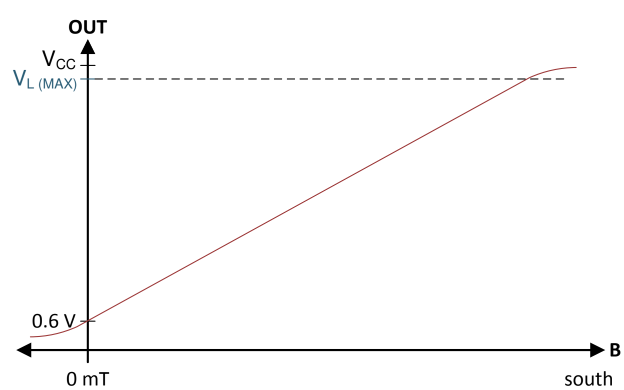
Package Information

PART NUMBER	PACKAGE(1)	PACKAGE SIZE(2)
DRV5056	DBZ (SOT-23, 3)	2.92mm × 2.37mm
	LPG (TO-92, 3)	4.00mm × 1.52mm

(1) For all available packages, see the package option addendum at the end of the data sheet.
(2) The package size (length × width) is a nominal value and includes pins, where applicable.



Typical Schematic



Magnetic Response

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4 Pin Configuration and Functions

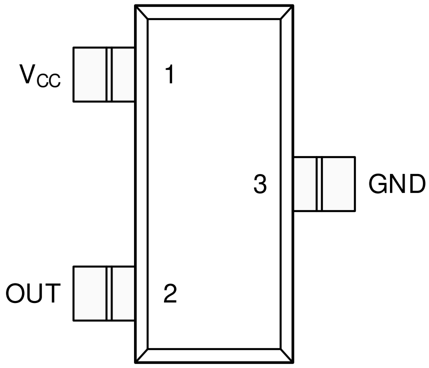


Figure 4-1. DBZ Package 3-Pin SOT-23 Top View

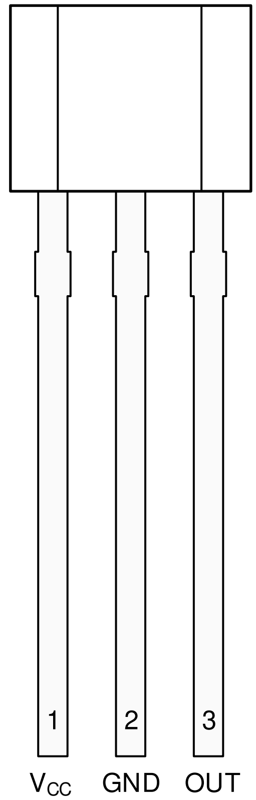


Figure 4-2. LPG Package 3-Pin TO-92 Top View

Table 4-1. Pin Functions

PIN			TYPE	DESCRIPTION
NAME	SOT-23	TO-92		
GND	3	2	Ground	Ground reference
OUT	2	3	Output	Analog output
V_{CC}	1	1	Power	Power supply. TI recommends connecting this pin to a ceramic capacitor to ground with a value of at least 0.1µF.

5 Specifications

5.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
Power supply voltage	V_{CC}	–0.3	7	V
Output voltage	OUT	–0.3	V_{CC} + 0.3	V
Magnetic flux density, B_{MAX}		Unlimited		T
Operating junction temperature, T_J		–40	150	°C
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.

5.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001[(1)]	±2500	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101[(2)]	±750	

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

5.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V_{CC}	Power supply voltage[(1)]	3	3.6	V
		4.5	5.5	
I_O	Output continuous current	–1	1	mA
T_A	A1/Z1-A4/Z4, A8 versions operating ambient temperature[(2)]	–40	125	°C
T_A	A6 version operating ambient temperature[(2)]	0	85	°C

(1) There are two isolated operating V_{CC} ranges. For more information see the Section 6.3.5 section.
(2) Power dissipation and thermal limits must be observed.

5.4 Thermal Information

THERMAL METRIC[(1)]		DRV5056		UNIT
		SOT-23 (DBZ)	TO-92 (LPG)	
		3 PINS	3 PINS	
$R_{θJA}$	Junction-to-ambient thermal resistance	170	121	°C/W
$R_{θJC(top)}$	Junction-to-case (top) thermal resistance	66	67	°C/W
$R_{θJB}$	Junction-to-board thermal resistance	49	97	°C/W
Y_{JT}	Junction-to-top characterization parameter	1.7	7.6	°C/W
Y_{JB}	Junction-to-board characterization parameter	48	97	°C/W

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

5.5 Electrical Characteristics

for V_{CC} = 3 V to 3.63 V and 4.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[(1)]		MIN	TYP	MAX	UNIT
I_{CC}	Operating supply current				6	10	mA
t_{ON}	Power-on time (see Power-On Time)	B = 0 mT, no load on OUT			150	300	µs
f_{BW}	Sensing bandwidth				20		kHz
t_d	Propagation delay time	From change in B to change in OUT			10		µs
B_{ND}	Input-referred RMS noise density	V_{CC} = 5 V			130		$nT/\sqrt{Hz}$
		V_{CC} = 3.3 V			215		
B_N	Input-referred noise	$B_{ND} \times 6.6 \times \sqrt{20\ kHz}$	V_{CC} = 5 V		0.12		mT_{PP}
			V_{CC} = 3.3 V		0.2		
V_N	Output-referred noise[(2)]	$B_N \times S$	DRV5056A1/Z1		24		mV_{PP}
			DRV5056A2/Z2, DRV5056A6		12		
			DRV5056A3/Z3		6		
			DRV5056A4/Z4		3		
			DRV5056A8		4		mV_{PP}

(1) B is the applied magnetic flux density.
(2) V_N describes voltage noise on the device output. If the full device bandwidth is not needed, noise can be reduced with an RC filter.

5.6 Magnetic Characteristics

for V_{CC} = 3 V to 3.63 V and 4.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[(1)]		MIN	TYP	MAX	UNIT
V_Q	Quiescent voltage	B = 0 mT, T_A = 25°C	DRV5056A1/Z1	0.535	0.6	0.665	V
			DRV5056A2/Z2, DRV5056A6	0.54	0.6	0.66	
			DRV5056A3/Z3, DRV5056A4/Z4	0.55	0.6	0.65	
			DRV5056A8	0.55	0.6	0.65	V
$V_{Q\Delta T}$	Quiescent voltage temperature drift	B = 0 mT, T_A = –40°C to 125°C versus 25°C	V_{CC} = 5 V		0.08		V
			V_{CC} = 3.3 V		0.04		
$V_{Q\Delta T}$	Quiescent voltage temperature drift	B = 0 mT, T_A = –40°C to 125°C versus 25°C	DRV5056A8		0		V
$V_{Q\Delta L}$	Quiescent voltage lifetime drift	High-temperature operating stress for 1000 hours			< 0.5%		
S	Sensitivity	V_{CC} = 5 V, T_A = 25°C	DRV5056A1/Z1	190	200	210	mV/mT
			DRV5056A2/Z2, DRV5056A6	95	100	105	
			DRV5056A3/Z3	47.5	50	52.5	
			DRV5056A4/Z4	23.8	25	26.2	
			DRV5056A8	63.3	66.6	69.9	
		V_{CC} = 3.3 V, T_A = 25°C	DRV5056A1/Z1	114	120	126	
			DRV5056A2/Z2, DRV5056A6	57	60	63	
			DRV5056A3/Z3	28.5	30	31.5	
			DRV5056A4/Z4	14.3	15	15.8	
			DRV5056A8	38.0	40	42	

for V_{CC} = 3 V to 3.63 V and 4.5 V to 5.5 V, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[(1)]		MIN	TYP	MAX	UNIT
B_L	Linear magnetic sensing range[(2)]	V_{CC} = 5 V, T_A = 25°C	DRV5056A1/Z1	20			mT
			DRV5056A2/Z2, DRV5056A6	39			
			DRV5056A3/Z3	79			
			DRV5056A4/Z4	158			
			DRV5056A8	64			
		V_{CC} = 3.3 V, T_A = 25°C	DRV5056A1/Z1	19			
			DRV5056A2/Z2, DRV5056A6	39			
			DRV5056A3/Z3	78			
			DRV5056A4/Z4	155			
			DRV5056A8	65			
V_L	Linear range of output voltage[(3)]			V_Q		V_{CC} – 0.2	V
S_{TC}	Sensitivity temperature compensation for magnets[(4)]	DRV5056A6		0.05	0.12	0.19	%/°C
		DRV5056A1, DRV5056A2, DRV5056A3, DRV5056A4, DRV5056A8			0.12		%/°C
		DRV5056Z1, DRV5056Z2, DRV5056Z3, DRV5056Z4			0		%/°C
S_{LE}	Sensitivity linearity error[(3)]	V_{OUT} is within V_L			±1%		
S_{RE}	Sensitivity ratiometry error[(5)]	T_A = 25°C, with respect to V_{CC} = 3.3 V or 5 V		-2.5%		2.5%	
$S_{\Delta L}$	Sensitivity lifetime drift	High-temperature operating stress for 1000 hours			< 0.5%		

(1) B is the applied magnetic flux density.
(2) B_L describes the minimum linear sensing range at 25°C taking into account the maximum V_Q and Sensitivity tolerances.
(3) See the Section 6.3.3 section.
(4) S_{TC} describes the rate the device increases Sensitivity with temperature. For more information, see the Section 6.3.6 section.
(5) See the Section 6.3.4 section.

5.7 Typical Characteristics

at T_A = 25°C (unless otherwise noted)

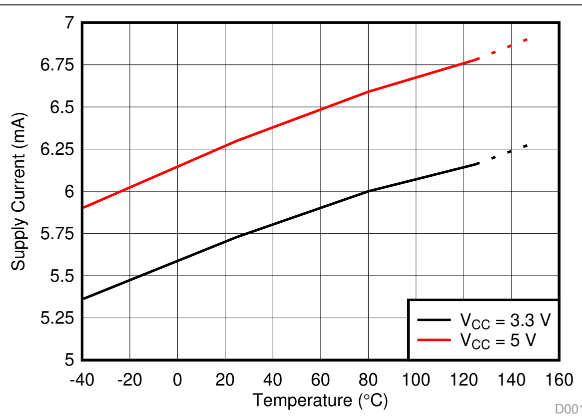


Figure 5-1. Supply Current vs Temperature

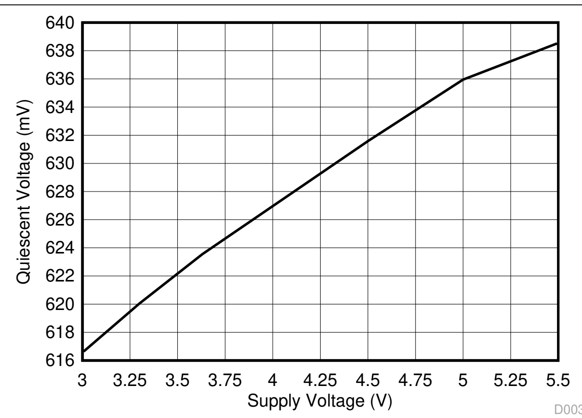
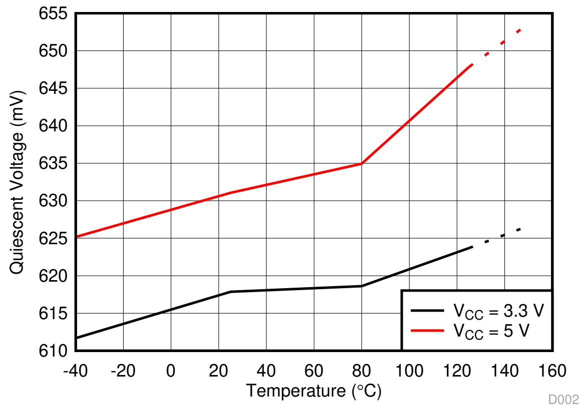
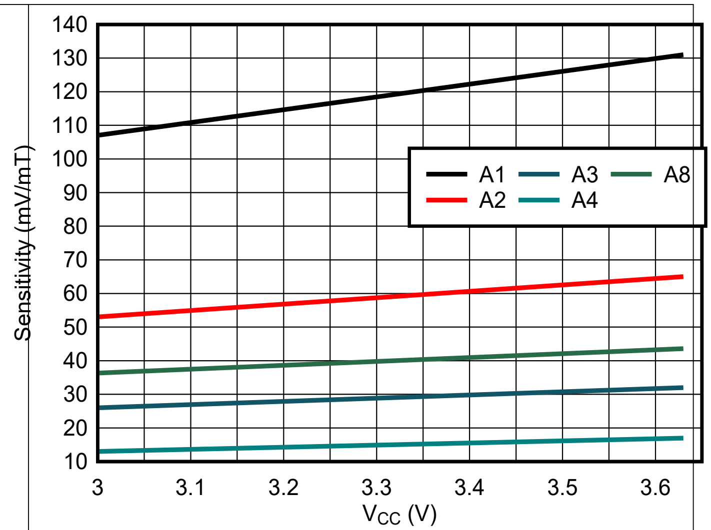


Figure 5-2. Quiescent Voltage vs Supply Voltage



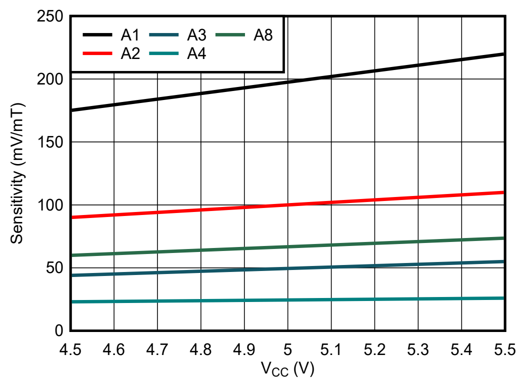
DRV5056Ax

Figure 5-3. Quiescent Voltage vs Temperature



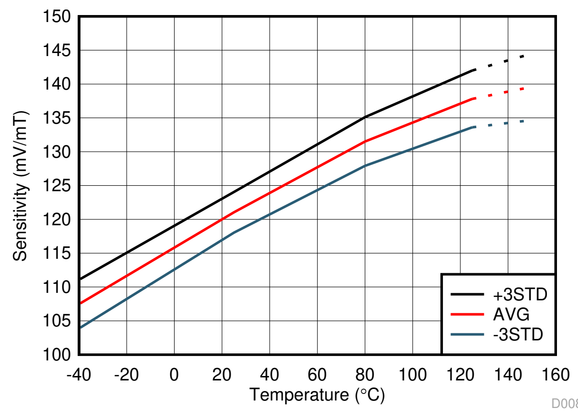
V_{CC} = 3.3V

Figure 5-4. Sensitivity vs Supply Voltage



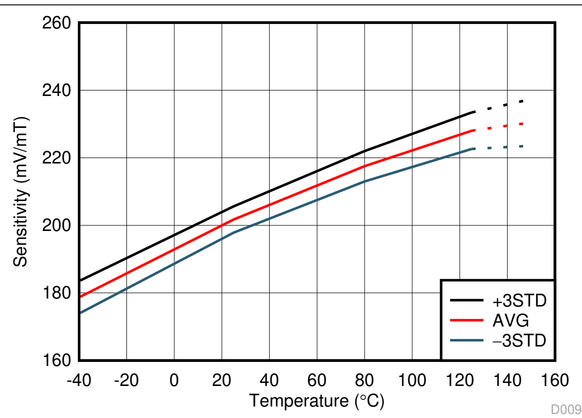
V_{CC} = 5V

Figure 5-5. Sensitivity vs Supply Voltage



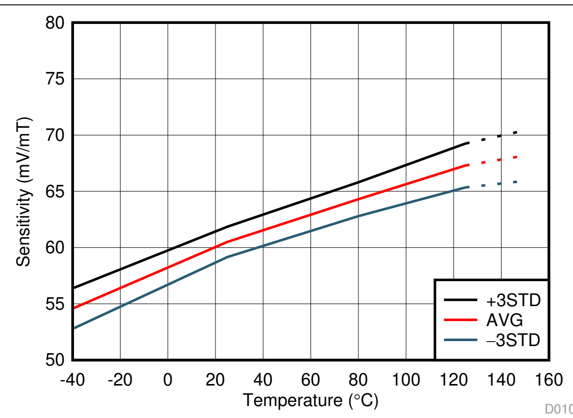
DRV5056A1, V_{CC} = 3.3V

Figure 5-6. Sensitivity vs Temperature



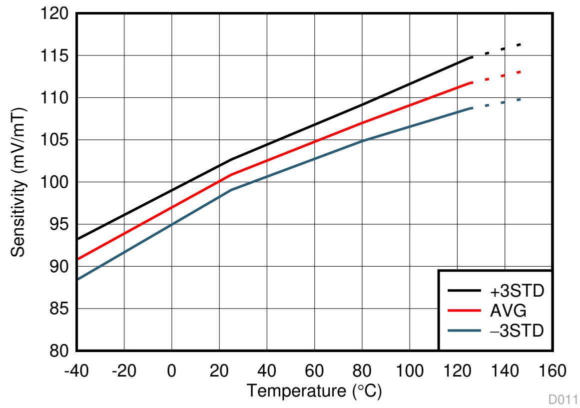
DRV5056A1, V_{CC} = 5.0V

Figure 5-7. Sensitivity vs Temperature



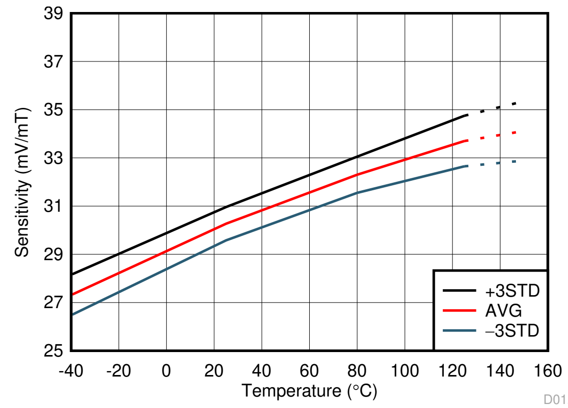
DRV5056A2, V_{CC} = 3.3V

Figure 5-8. Sensitivity vs Temperature



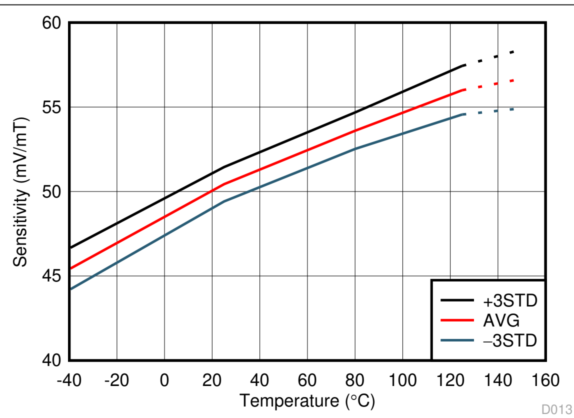
DRV5056A2, V_{CC} = 5.0V

Figure 5-9. Sensitivity vs Temperature



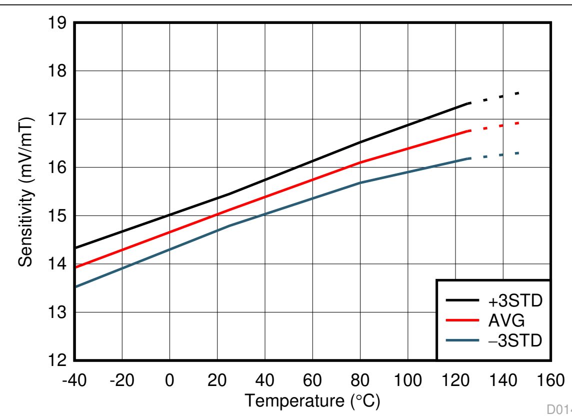
DRV5056A3, V_{CC} = 3.3V

Figure 5-10. Sensitivity vs Temperature



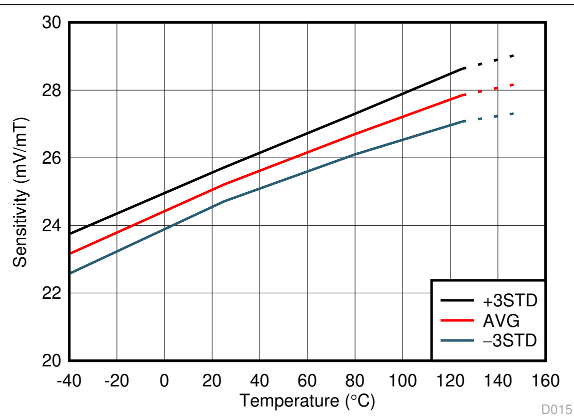
DRV5056A3, V_{CC} = 5.0V

Figure 5-11. Sensitivity vs Temperature



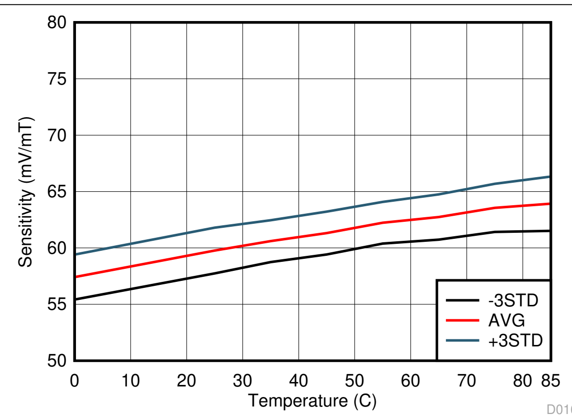
DRV5056A4, V_{CC} = 3.3V

Figure 5-12. Sensitivity vs Temperature



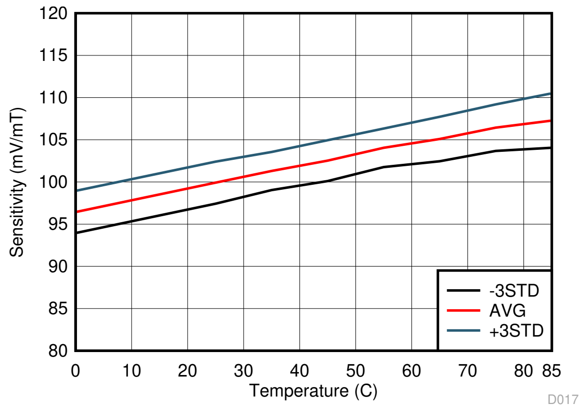
DRV5056A4, V_{CC} = 5.0V

Figure 5-13. Sensitivity vs Temperature



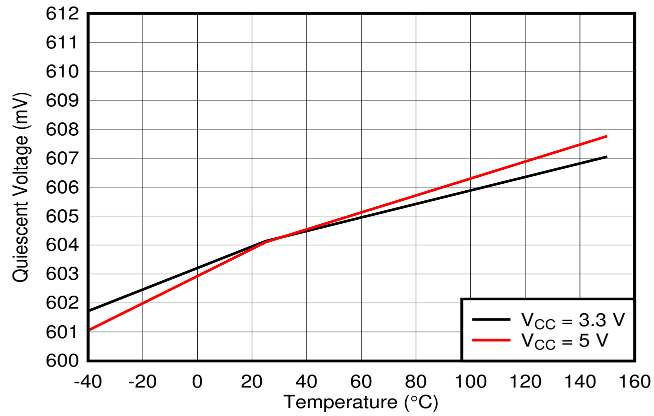
DRV5056A6, V_{CC} = 3.3V

Sensitivity vs Temperature



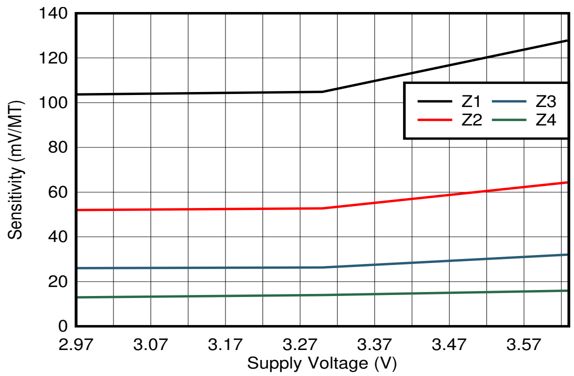
DRV5056A6, V_{CC} = 5.0V

Sensitivity vs Temperature



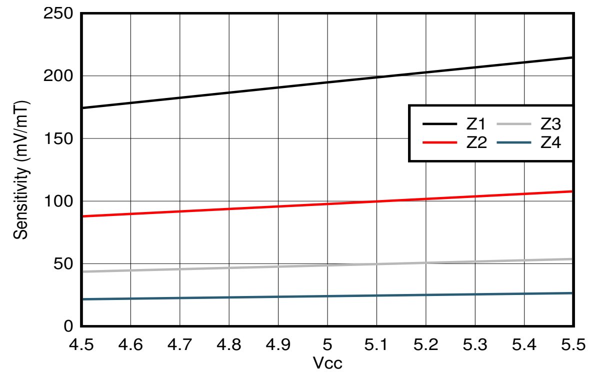
DRV5056Z1/Z2/Z3/Z4

Figure 5-14. Quiescent Voltage vs Temperature



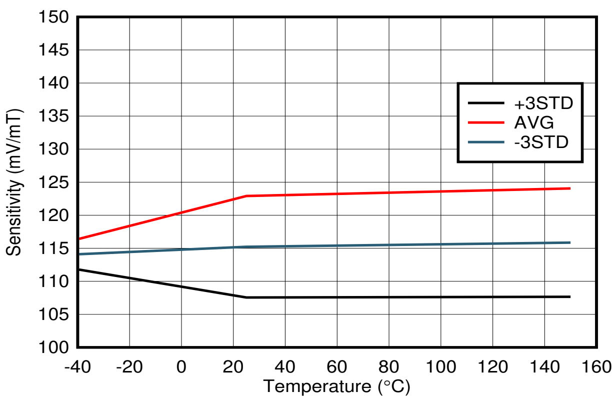
V_{CC} = 3.3V

Figure 5-15. Sensitivity vs Supply Voltage



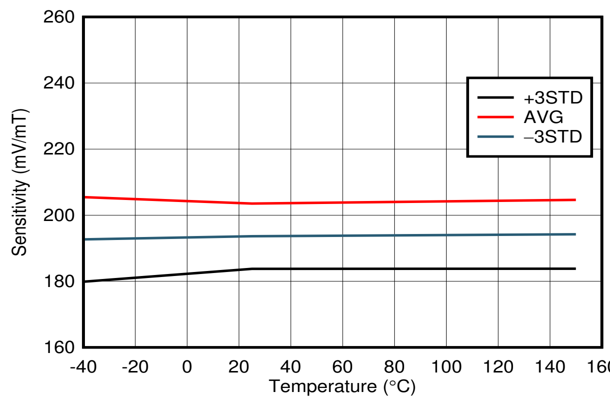
V_{CC} = 5V

Figure 5-16. Sensitivity vs Supply Voltage



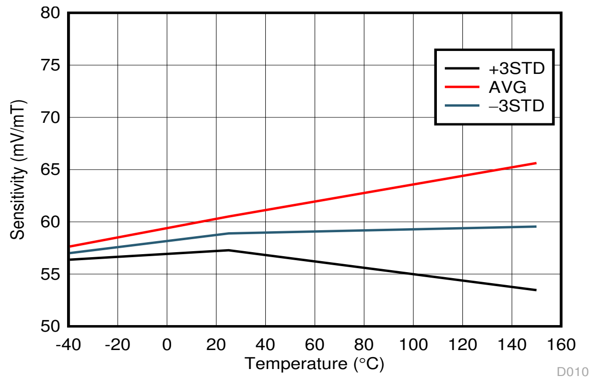
DRV5056Z1, V_{CC} = 3.3V

Figure 5-17. Sensitivity vs Temperature



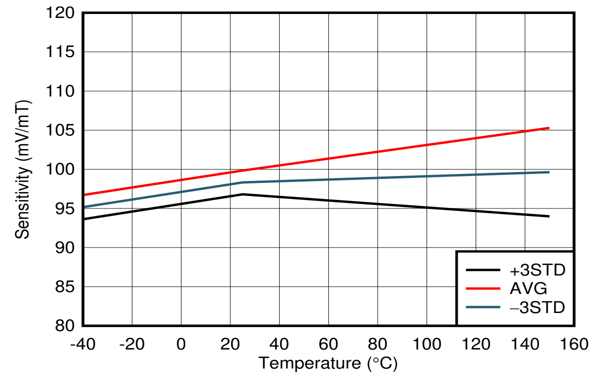
DRV5056Z1, V_{CC} = 5.0V

Figure 5-18. Sensitivity vs Temperature



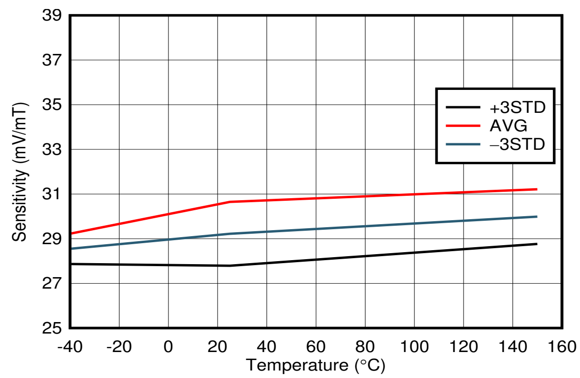
DRV5056Z2, V_{CC} = 3.3V

Figure 5-19. Sensitivity vs Temperature



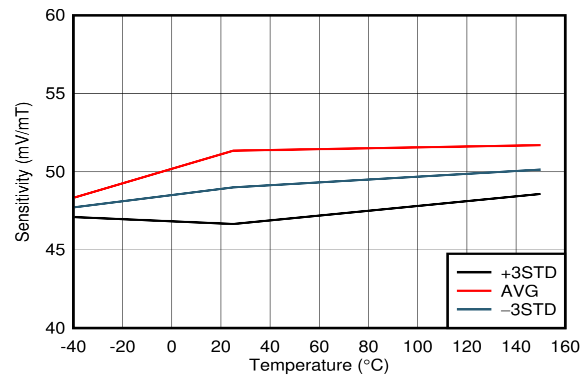
DRV5056Z2, V_{CC} = 5.0V

Figure 5-20. Sensitivity vs Temperature



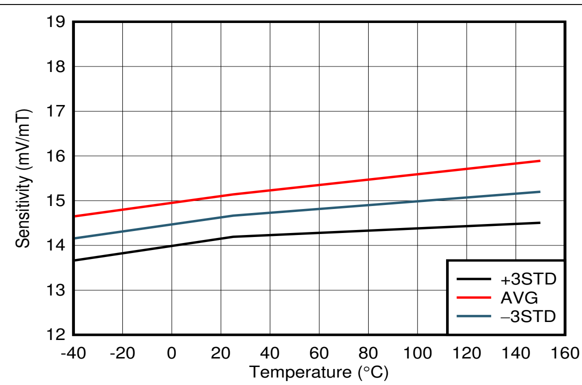
DRV5056Z3, V_{CC} = 3.3V

Figure 5-21. Sensitivity vs Temperature



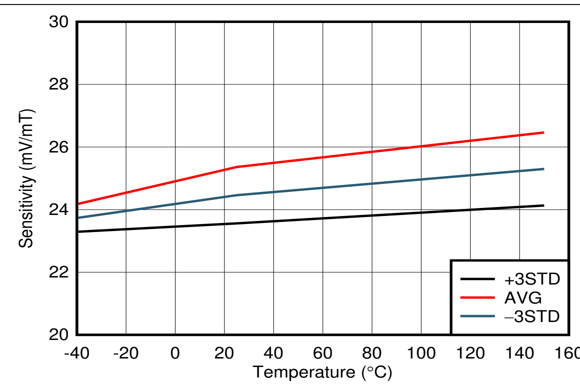
DRV5056Z3, V_{CC} = 5.0V

Figure 5-22. Sensitivity vs Temperature



DRV5056Z4, V_{CC} = 3.3V

Figure 5-23. Sensitivity vs Temperature



DRV5056Z4, V_{CC} = 5.0V

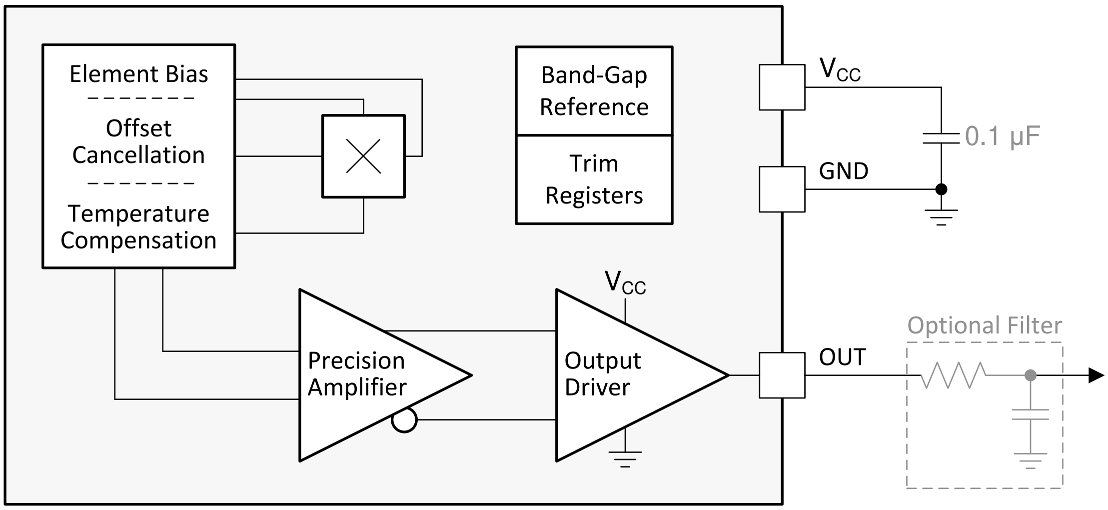
Figure 5-24. Sensitivity vs Temperature

6 Detailed Description

6.1 Overview

The DRV5056 is a 3-pin linear Hall-effect sensor with fully integrated signal conditioning, temperature compensation circuits, mechanical stress cancellation, and amplifiers. The device operates from 3.3V and 5V (±10%) power supplies, measures magnetic flux density, and outputs a proportional analog voltage that is referenced to V_{CC}.

6.2 Functional Block Diagram



6.3 Feature Description

6.3.1 Magnetic Flux Direction

As shown in Figure 6-1, the DRV5056 is sensitive to the magnetic field component that is perpendicular to the die inside the package.

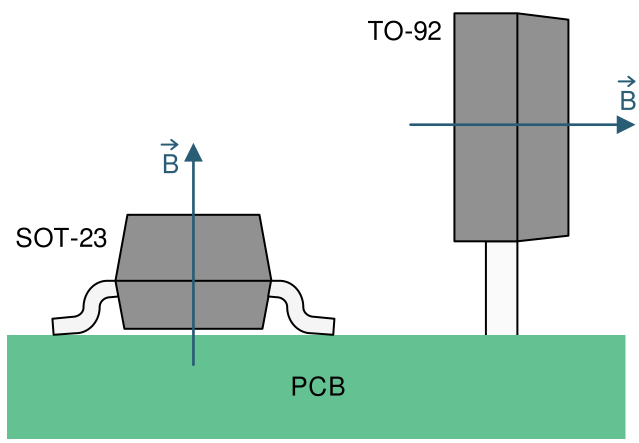


Figure 6-1. Direction of Sensitivity

Magnetic flux that travels from the bottom to the top of the package is considered positive. This condition exists when a south magnetic pole is near the top (marked-side) of the package. Magnetic flux that travels from the top to the bottom of the package results in negative millitesla values.

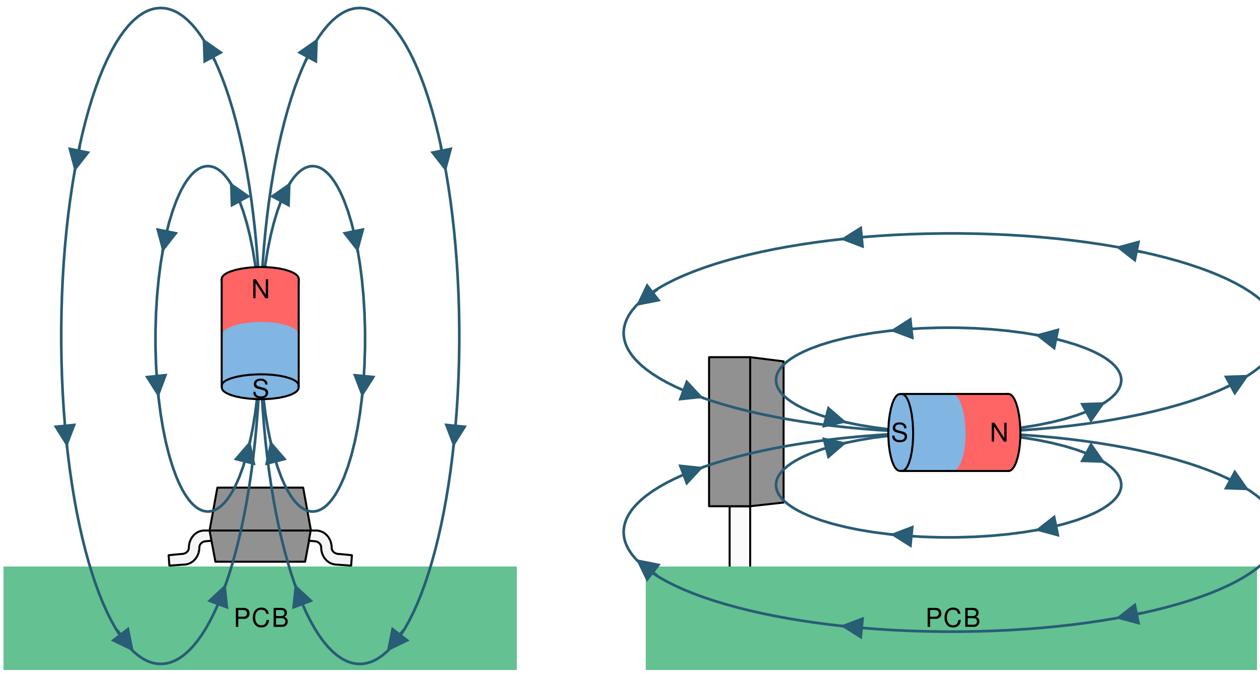


Figure 6-2. The Flux Direction for Positive B

6.3.2 Magnetic Response

The DRV5056 outputs an analog voltage according to Equation 1 when in the presence of a magnetic field:

$$V_{OUT} = V_Q + B \times \left(\text{Sensitivity}_{(25°C)} \times (1 + S_{TC} \times (T_A - 25°C))\right) \quad (1)$$

where

- V_Q is typically 600mV
- B is the applied magnetic flux density
- Sensitivity$_{(25°C)}$ depends on the device option and V_{CC}
- S_{TC} is typically 0.12%/°C for device options DRV5056Ax and is 0%/°C for DRV5056Zx options
- T_A is the ambient temperature
- V_{OUT} is within the V_L range

As an example, consider the DRV5056A3 with V_{CC} = 3.3V, a temperature of 50°C, and 67mT applied. Excluding tolerances, V_{OUT} = 600mV + 67 mT × (30mV/mT × [1 + 0.0012/°C × (50°C – 25°C)]) = 2.67V.

The DRV5056 only responds to the flux density of a magnetic south pole.

6.3.3 Sensitivity Linearity

The device produces a linear response when the output voltage is within the specified V_L range. Outside this range, sensitivity is reduced and nonlinear. Figure 6-3 graphs the magnetic response.

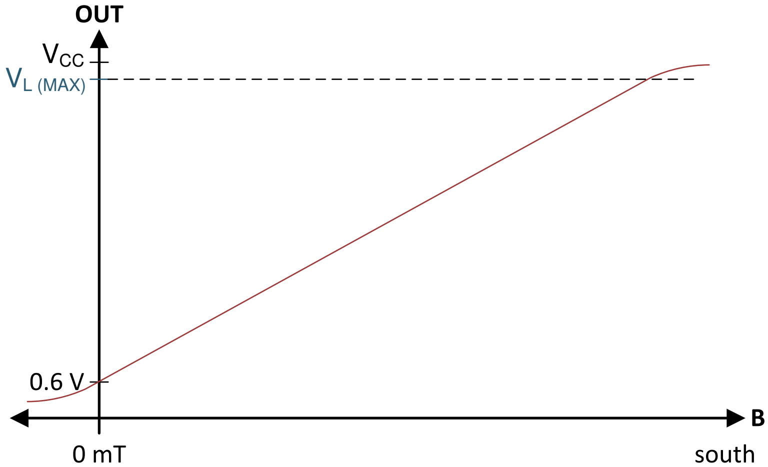


Figure 6-3. Magnetic Response

Equation 2 calculates parameter B_L, the minimum linear sensing range at 25°C taking into account the maximum quiescent voltage and sensitivity tolerances.

$$B_{L(MIN)} = \frac{V_{L(MAX)} - V_{Q(MAX)}}{S_{(MAX)}} \quad (2)$$

The parameter S_{LE} defines linearity error as the difference in sensitivity between any two positive B values when the output is within the V_L range.

6.3.4 Ratiometric Architecture

The DRV5056 has a ratiometric analog architecture that scales the sensitivity linearly with the power-supply voltage. For example, the sensitivity is 5% higher when V_{CC} = 5.25V compared to V_{CC} = 5V. This behavior enables external ADCs to digitize a more consistent value regardless of the power-supply voltage tolerance, when the ADC uses V_{CC} as the reference.

Equation 3 calculates sensitivity ratiometry error:

$$S_{RE} = 1 - \frac{S_{(VCC)} / S_{(5V)}}{V_{CC} / 5V} \text{ for } V_{CC} = 4.5\text{ V to } 5.5\text{ V}, \qquad S_{RE} = 1 - \frac{S_{(VCC)} / S_{(3.3V)}}{V_{CC} / 3.3V} \text{ for } V_{CC} = 3\text{ V to } 3.6\text{ V} \quad (3)$$

where

- $S_{(VCC)}$ is the sensitivity at the current V_{CC} voltage
- $S_{(5V)}$ or $S_{(3.3V)}$ is the sensitivity when V_{CC} = 5V or 3.3V
- V_{CC} is the current V_{CC} voltage

6.3.5 Operating V_{CC} Ranges

The DRV5056 has two recommended operating V_{CC} ranges: 3V to 3.6V and 4.5V to 5.5V. When V_{CC} is in the middle region between 3.6V to 4.5V, the device continues to function, but sensitivity is less known because there is a crossover threshold near 4V that adjusts device characteristics.

6.3.6 Sensitivity Temperature Compensation For Magnets

Magnets generally produce weaker fields as temperature increases. The DRV5056 can either compensate by increasing sensitivity with temperature or keep the sensitivity constant, as defined by the parameters S_{TC} and S_{TCz} respectively. For DRV5056Ax device options, the sensitivity at T_A = 125°C is typically 12% higher than at T_A = 25°C. For DRV5056Zx device options, the sensitivity at T_A = 125°C is typically same as the value at T_A = 25°C.

6.3.7 Power-On Time

After the V_{CC} voltage is applied, the DRV5056 requires a short initialization time before the output is set. The parameter t_{ON} describes the time from when V_{CC} crosses 3V until OUT is within 5% of V_Q, with 0mT applied and no load attached to OUT. Figure 6-4 shows this timing diagram.

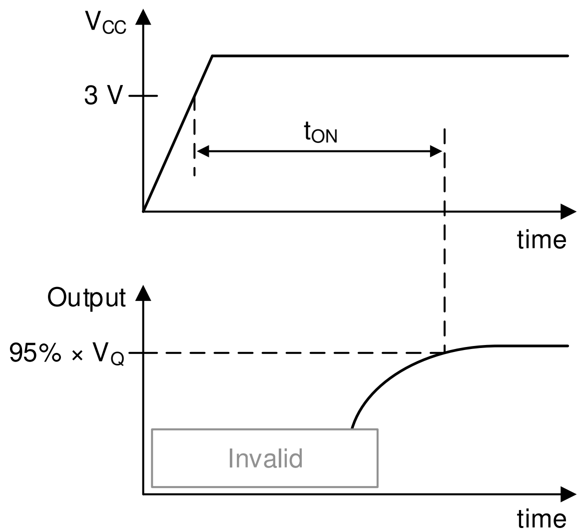


Figure 6-4. t_{ON} Definition

6.3.8 Hall Element Location

Figure 6-5 shows the location of the sensing element inside each package option.

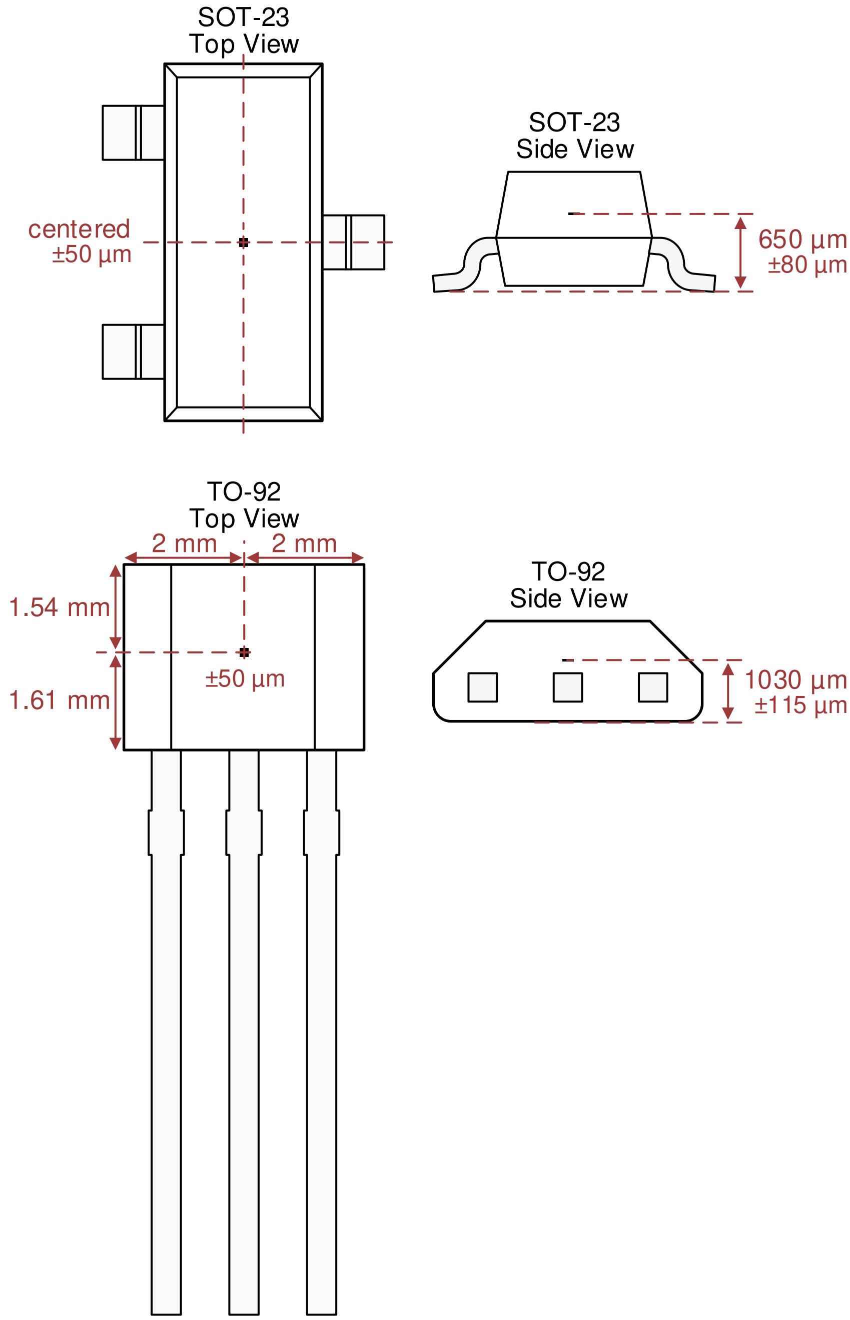


Figure 6-5. Hall Element Location

6.4 Device Functional Modes

The DRV5056 has one mode of operation that applies when the *Recommended Operating Conditions* are met.

7 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.

7.1 Application Information

7.1.1 Selecting the Sensitivity Option

Select the highest DRV5056 sensitivity option that can measure the required range of magnetic flux density, so that the output voltage swing is maximized.

Larger magnets and greater sensing distances can generally enable better positional accuracy than very small magnets at close distances, because magnetic flux density increases exponentially with the proximity to a magnet.

7.1.2 Temperature Compensation for Magnets

The DRV5056 temperature compensation is designed to directly compensate the average drift of neodymium (NdFeB) magnets and partially compensate ferrite magnets. The residual flux density (B_r) of a magnet typically reduces by 0.12%/°C for NdFeB, and 0.20%/°C for ferrite. When the operating temperature range of a system is reduced, temperature drift errors are also reduced.

7.1.3 Adding a Low-Pass Filter

As illustrated in the *Functional Block Diagram*, an RC low-pass filter can be added to the device output for the purpose of minimizing voltage noise when the full 20kHz bandwidth is not needed. This filter can improve the signal-to-noise ratio (SNR) and overall accuracy. Do not connect a capacitor directly to the device output without a resistor in between because doing so can make the output unstable.

7.1.4 Designing for Wire Break Detection

Some systems must detect if interconnect wires become open or shorted. The DRV5056 can support this function.

First, select a sensitivity option that causes the output voltage to stay within the V_L range during normal operation. Second, add a pullup resistor between OUT and V_{CC}. TI recommends a value between 20kΩ to 100 kΩ, and the current through OUT must not exceed the I_O specification, including current going into an external ADC. Then, if the output voltage is ever measured to be within 150mV of V_{CC} or GND, a fault condition exists. Figure 7-1 shows the circuit, and Table 7-1 describes fault scenarios.

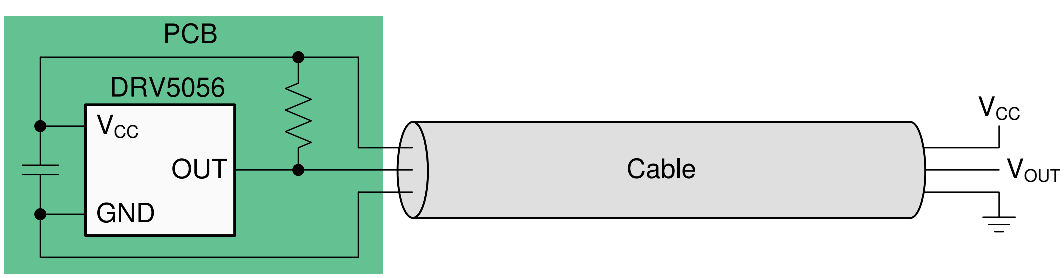


Figure 7-1. Wire Fault Detection Circuit

Table 7-1. Fault Scenarios and the Resulting V_{OUT}

FAULT SCENARIO	V_{OUT}
V_{CC} disconnects	Close to GND
GND disconnects	Close to V_{CC}
V_{CC} shorts to OUT	Close to V_{CC}
GND shorts to OUT	Close to GND

7.2 Typical Application

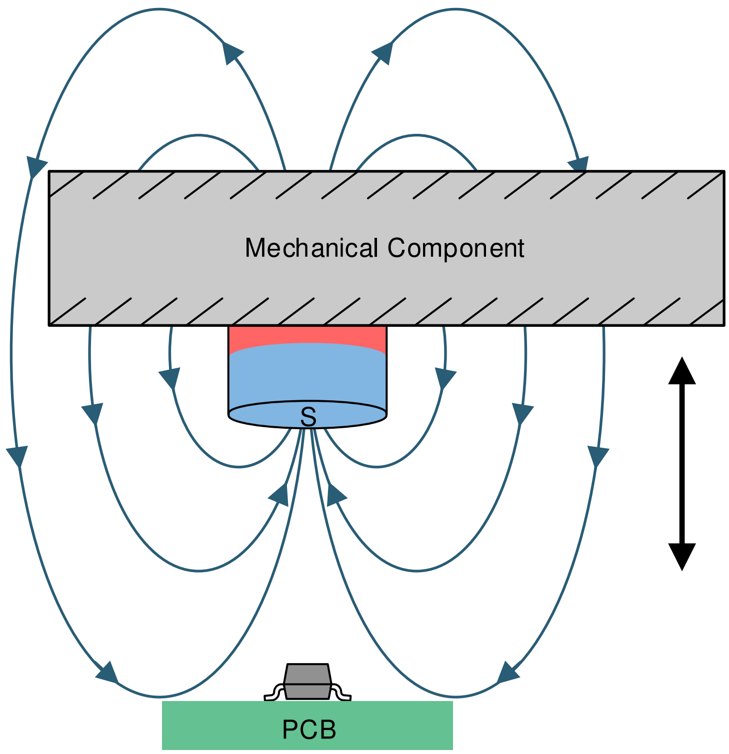


Figure 7-2. Unipolar Sensing Application

7.2.1 Design Requirements

Use the parameters listed in Table 7-2 for this design example.

Table 7-2. Design Parameters

DESIGN PARAMETER	EXAMPLE VALUE
V_{CC}	3.3V
Magnet	10mm diameter × 6mm long cylinder, ferrite
Distance from magnet to sensor	From 20mm to 3mm
Maximum B at the sensor at 25°C	72mT at 3mm
Device option	DRV5056A3

7.2.2 Detailed Design Procedure

This design example consists of a mechanical component that moves back and forth, an embedded magnet with the south pole facing the printed-circuit board, and a DRV5056 . The DRV5056 outputs an analog voltage that describes the precise position of the component. The component must not contain ferromagnetic materials such as iron, nickel, and cobalt because these materials change the magnetic flux density at the sensor.

When designing a linear magnetic sensing system, always consider these three variables: the magnet, sensing distance, and range of the sensor. Select the DRV5056 with the highest sensitivity that has a B_L (linear magnetic sensing range) that is larger than the maximum magnetic flux density in the application.

Magnets are made from various ferromagnetic materials that have tradeoffs in cost, drift with temperature, absolute maximum temperature ratings, remanence or residual induction (B_r), and coercivity (H_c). The B_r and the dimensions of a magnet determine the magnetic flux density (B) produced in 3-dimensional space. For simple magnet shapes, such as rectangular blocks and cylinders, there are simple equations that solve B at a given distance centered with the magnet. Figure 7-3 shows diagrams for Equation 4 and Equation 5.

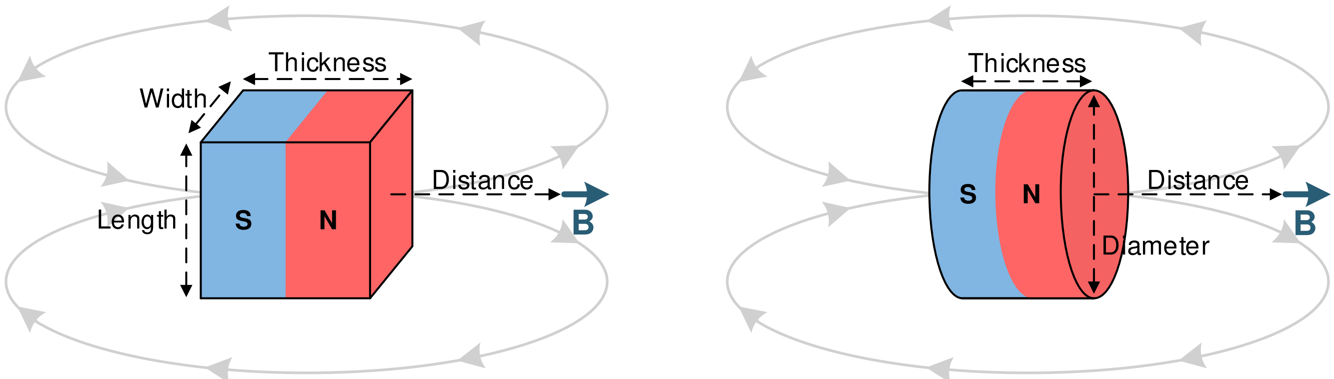


Figure 7-3. Rectangular Block and Cylinder Magnets

Use Equation 4 for the rectangular block shown in Figure 7-3:

$$\vec{B} = \frac{B_r}{\pi}\left(\arctan\left(\frac{WL}{2D\sqrt{4D^2 + W^2 + L^2}}\right) - \arctan\left(\frac{WL}{2(D + T)\sqrt{4(D + T)^2 + W^2 + L^2}}\right)\right) \tag{4}$$

Use Equation 5 for the cylinder shown in Figure 7-3:

$$\vec{B} = \frac{B_r}{2}\left(\frac{D + T}{\sqrt{(0.5C)^2 + (D + T)^2}} - \frac{D}{\sqrt{(0.5C)^2 + D^2}}\right) \tag{5}$$

where

- W is width
- L is length
- T is thickness (the direction of magnetization)
- D is distance
- C is diameter

7.2.3 Application Curve

Figure 7-4 shows the magnetic flux density versus distance for a 10mm × 6mm cylinder ferrite magnet.

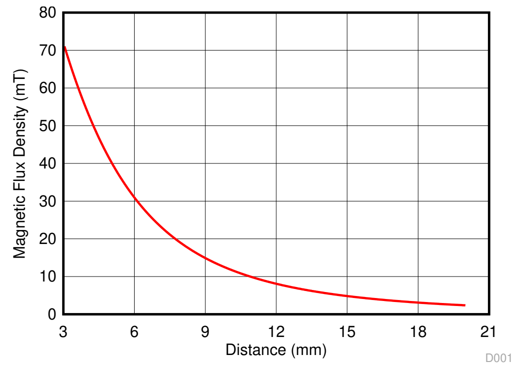


Figure 7-4. Magnetic Profile of a 10mm × 6mm Cylindrical Ferrite Magnet

7.3 Best System Practices

Because the Hall element is sensitive to magnetic fields that are perpendicular to the top of the package, a correct magnet approach must be used for the sensor to detect the field. Figure 7-5 illustrates correct and incorrect approaches.

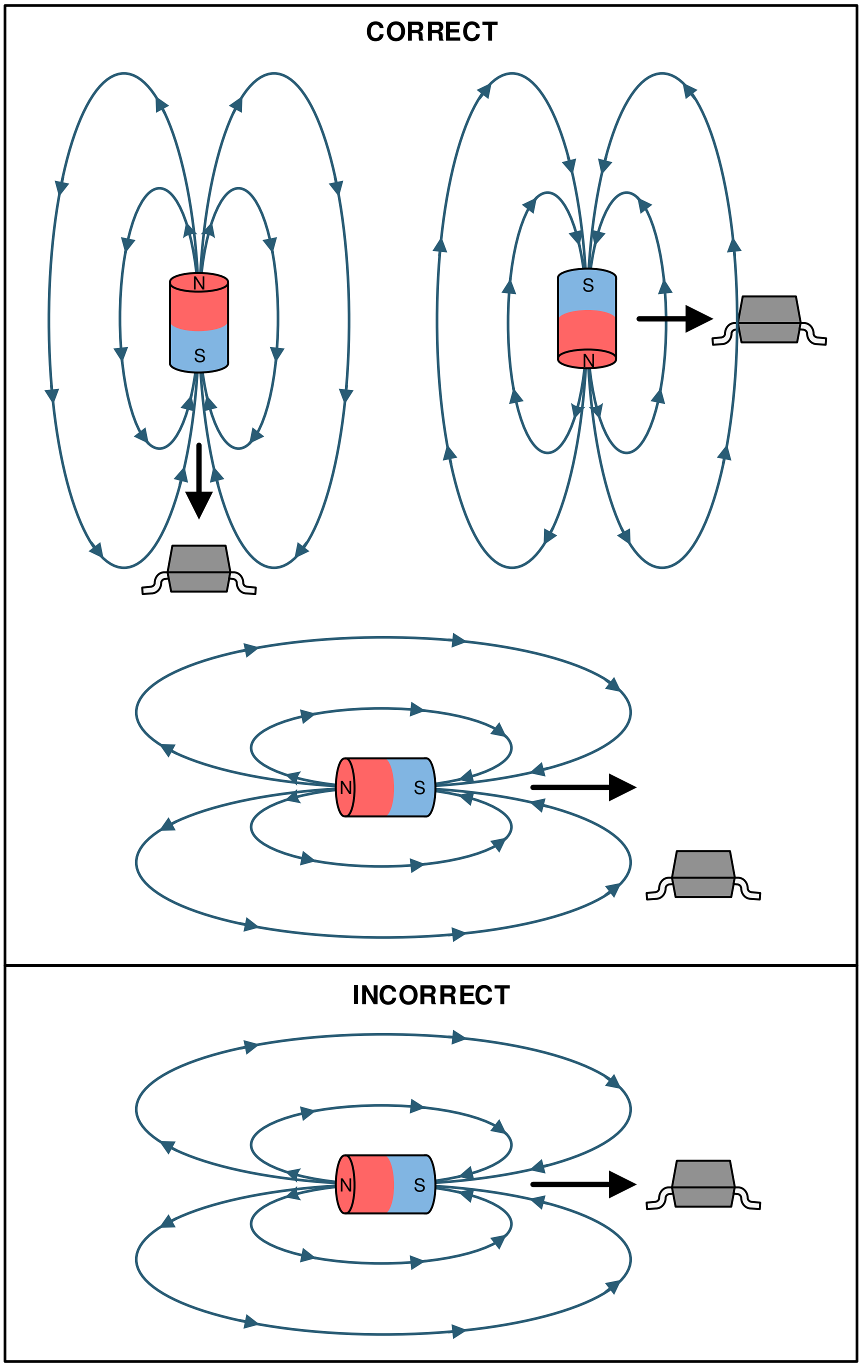


Figure 7-5. Correct and Incorrect Magnet Approaches

7.4 Power Supply Recommendations

A decoupling capacitor close to the device must be used to provide local energy with minimal inductance. TI recommends using a ceramic capacitor with a value of at least 0.01µF.

7.5 Layout

7.5.1 Layout Guidelines

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

7.5.2 Layout Examples

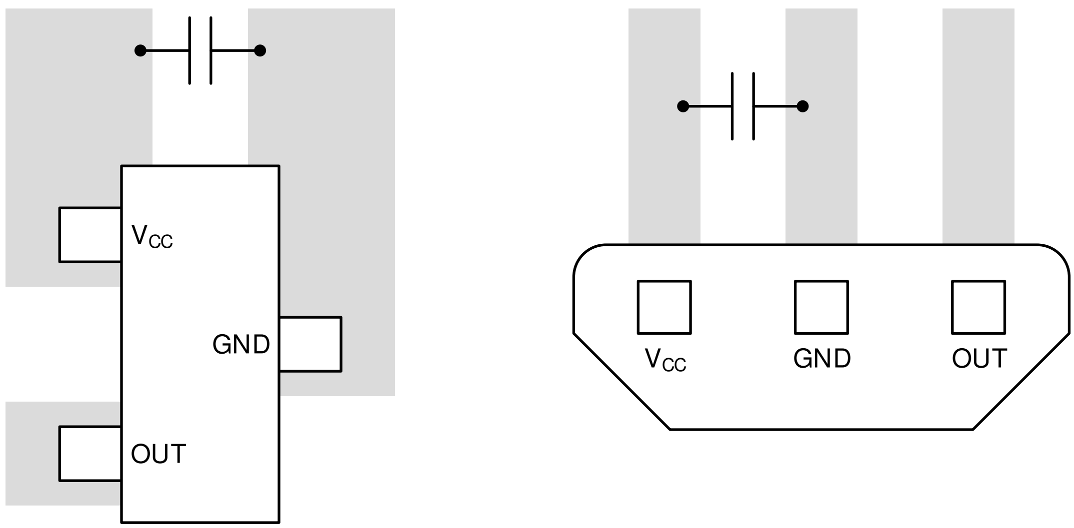


Figure 7-6. Layout Examples

8 Device and Documentation Support

8.1 Documentation Support

8.1.1 Related Documentation

For related documentation see the following:

- Texas Instruments, *Incremental rotary encoder design considerations application note*
- Texas Instruments, *Using linear hall effect sensors to measure angle application note*
- Texas Instruments, *Angle measurements with linear hall effect sensors*

8.2 Receiving Notification of Documentation Updates

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

8.3 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.

8.4 Trademarks

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

8.5 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.

8.6 Glossary

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

9 Revision History

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

Changes from Revision B (March 2020) to Revision C (December 2025) **Page**

- Updated the numbering format for tables, figures, and cross-references throughout the document.... 1
- Updated Features list with A8 variant information.... 1
- Changed *Device Information* table to *Package Information* 1
- Added DRV5056A8 Output-refferred noise to *Electrical Characteristics* 5
- Added DRV5056A8 Quiescent voltage to *Magnetic Characteristics* 5
- Added DRV5056A8 Sensitivity to *Magnetic Characteristics* 5
- Added DRV5056A8 Linear magnetic sensing range to *Magnetic Characteristics* 5
- Updated the device naming in *Magnetic Response* 12
- Updated the device naming in *Sensitivity Temperature Compensation For Magnets* 14
- Changed *What to Do and What Not to Do* section to *Best System Practices* 19

Changes from Revision * (February 2019) to Revision B (March 2020) **Page**

- Added Zero TC sensitivity options 1

- Added Zero TC information to Recommended Operating Conditions section....4
- *Added Zero TC information to Electrical Characterstics* 5
- Added Zero TC information to Magnetic Characterstics....5
- Added graphs for DRV5056Z1/Z2/Z3/Z4 options in the *Typical Characteristics* section....6
- Updated S_{TC} definition in Equation 1 12
- Updated the *Sensitivity Temperature Compensation For Magnets* section for Zero TC options....14

Changes from Revision * (April 2018) to Revision A (February 2019)	Page

- Added new A6 magnetic sensitivity option to the data sheet.... 1

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.

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)
DRV5056A1QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A1
DRV5056A1QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A1
DRV5056A1QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A1
DRV5056A1QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56A1
DRV5056A1QLPG	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A1
DRV5056A1QLPG.B	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A1
DRV5056A1QLPGM	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A1
DRV5056A1QLPGM.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A1
DRV5056A1QLPGM.B	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A1
DRV5056A2QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A2
DRV5056A2QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A2
DRV5056A2QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A2
DRV5056A2QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56A2
DRV5056A2QLPG	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A2
DRV5056A2QLPG.B	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A2
DRV5056A2QLPGM	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A2
DRV5056A2QLPGM.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A2
DRV5056A2QLPGM.B	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A2
DRV5056A3QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A3
DRV5056A3QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A3
DRV5056A3QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A3
DRV5056A3QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56A3
DRV5056A3QLPG	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A3
DRV5056A3QLPG.B	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A3
DRV5056A3QLPGM	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A3
DRV5056A3QLPGM.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A3
DRV5056A3QLPGM.B	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A3
DRV5056A4QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A4
DRV5056A4QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A4

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)
DRV5056A4QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A4
DRV5056A4QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56A4
DRV5056A4QLPG	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A4
DRV5056A4QLPG.B	Active	Production	TO-92 (LPG) | 3	1000 | BULK	Yes	SN	N/A for Pkg Type	-40 to 125	56A4
DRV5056A4QLPGM	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A4
DRV5056A4QLPGM.A	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A4
DRV5056A4QLPGM.B	Active	Production	TO-92 (LPG) | 3	3000 | AMMO	Yes	SN	N/A for Pkg Type	-40 to 125	56A4
DRV5056A6QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A6
DRV5056A6QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A6
DRV5056A6QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56A6
DRV5056A6QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56A6
DRV5056A8QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-1-260C-UNLIM	-40 to 125	56A8
DRV5056Z1QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z1
DRV5056Z1QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z1
DRV5056Z1QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z1
DRV5056Z1QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56Z1
DRV5056Z2QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z2
DRV5056Z2QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z2
DRV5056Z2QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z2
DRV5056Z3QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z3
DRV5056Z3QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z3
DRV5056Z3QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z3
DRV5056Z3QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56Z3
DRV5056Z4QDBZR	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z4
DRV5056Z4QDBZR.A	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z4
DRV5056Z4QDBZR.B	Active	Production	SOT-23 (DBZ) | 3	3000 | LARGE T&R	Yes	SN	Level-2-260C-1 YEAR	-40 to 125	56Z4
DRV5056Z4QDBZT	Obsolete	Production	SOT-23 (DBZ) | 3	-	-	Call TI	Call TI	-40 to 125	56Z4

(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.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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 DRV5056 :

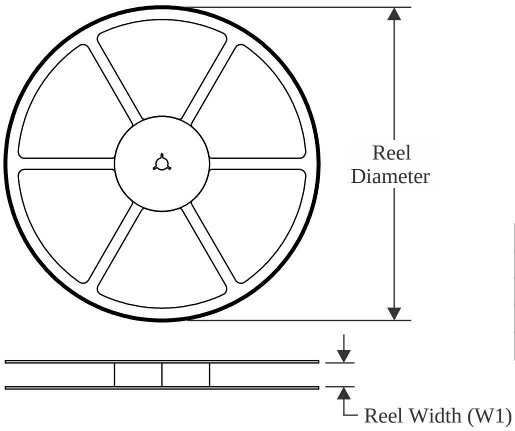
- Automotive : DRV5056-Q1

NOTE: Qualified Version Definitions:

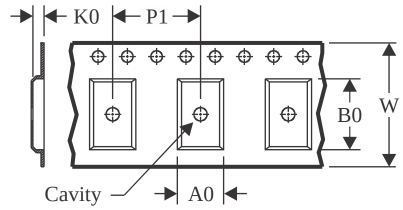
- Automotive - Q100 devices qualified for high-reliability automotive applications targeting zero defects

TAPE AND REEL INFORMATION

REEL DIMENSIONS

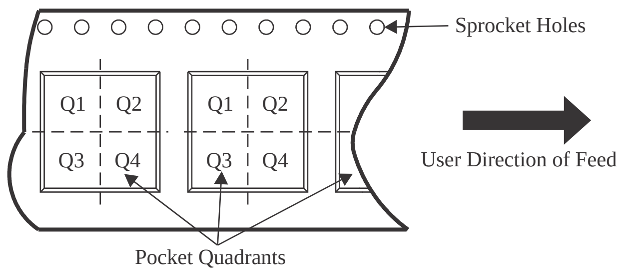


TAPE DIMENSIONS



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

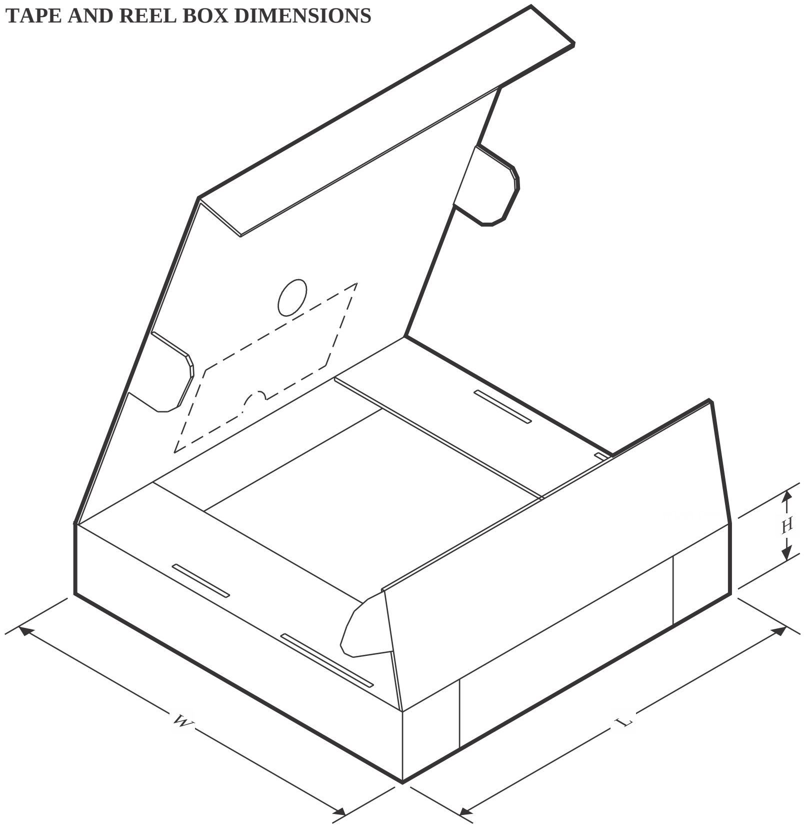
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

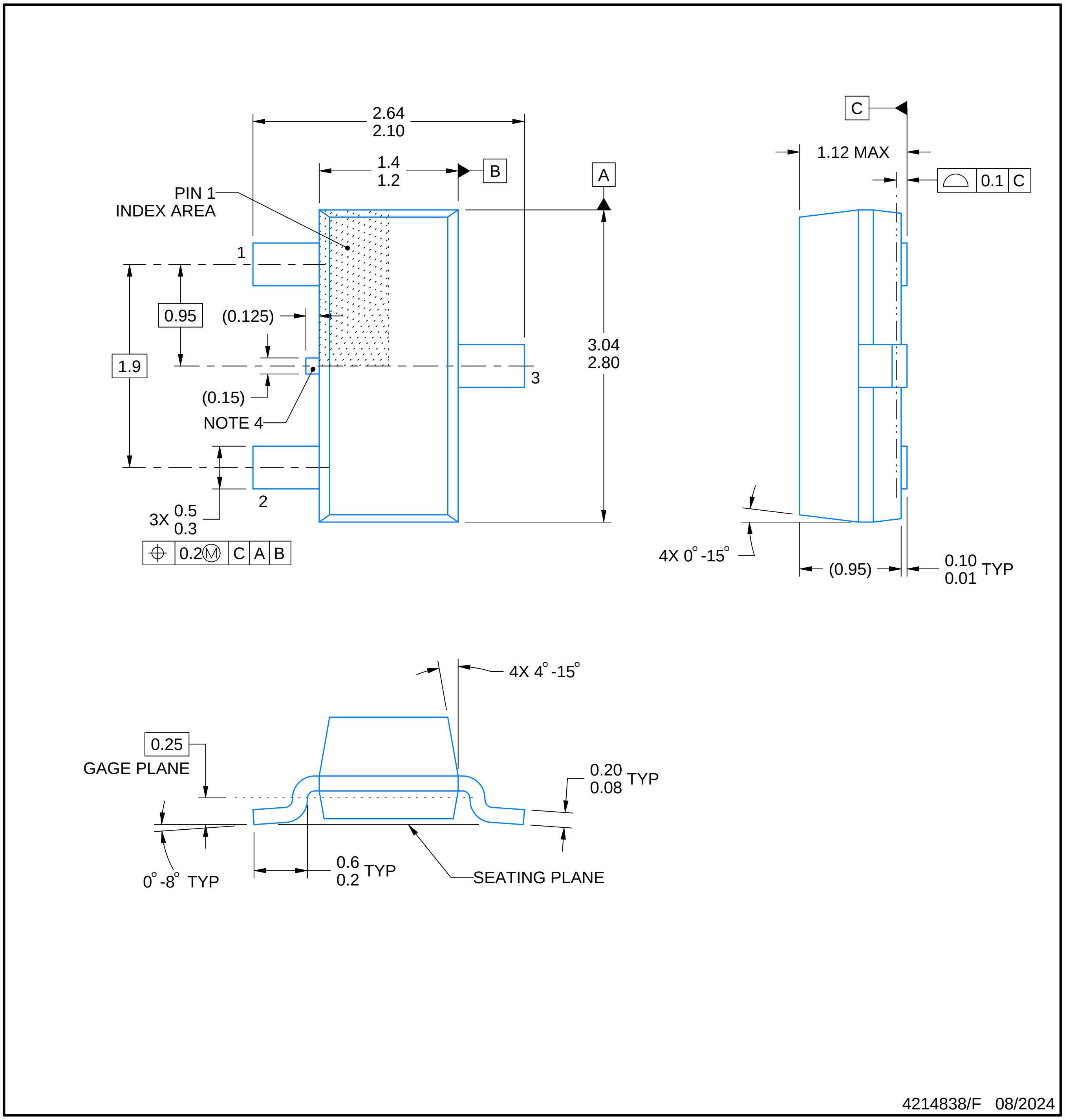
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
DRV5056A1QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A2QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A2QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A3QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A3QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A4QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A4QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A6QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056A6QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
DRV5056A8QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z1QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z1QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z2QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z3QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z4QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
DRV5056Z4QDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



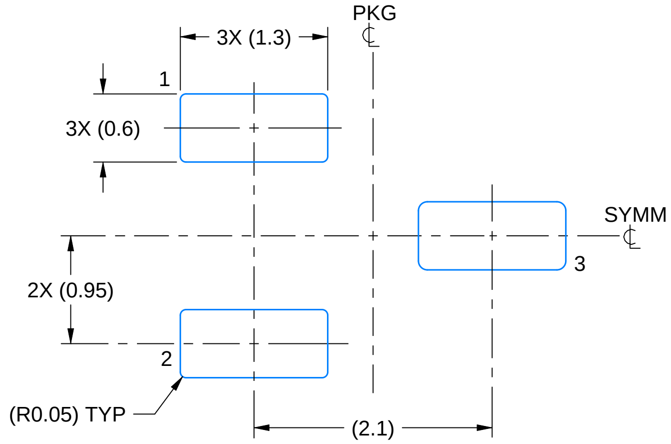
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
DRV5056A1QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A2QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A2QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A3QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A3QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A4QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A4QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A6QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056A6QDBZR	SOT-23	DBZ	3	3000	213.0	191.0	35.0
DRV5056A8QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z1QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z1QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z2QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z3QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z4QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
DRV5056Z4QDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0

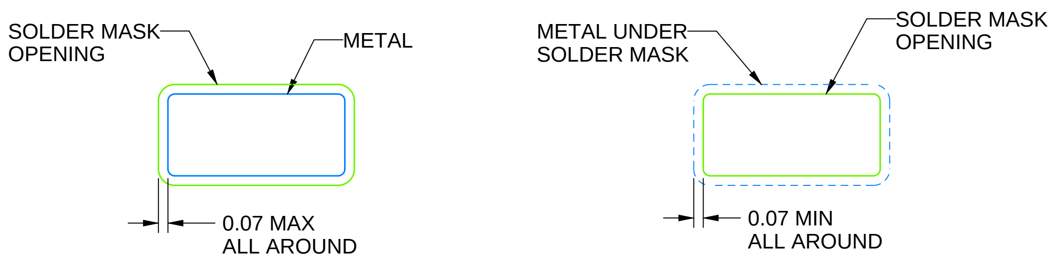


NOTES:

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



NON SOLDER MASK DEFINED (PREFERRED)

SOLDER MASK DEFINED

SOLDER MASK DETAILS

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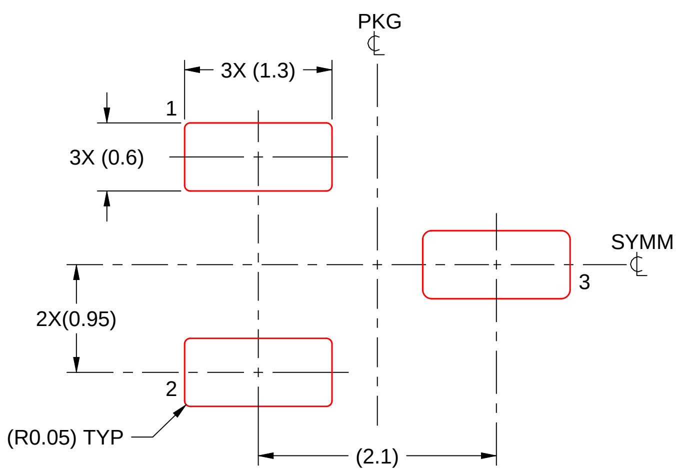
NOTES: (continued)

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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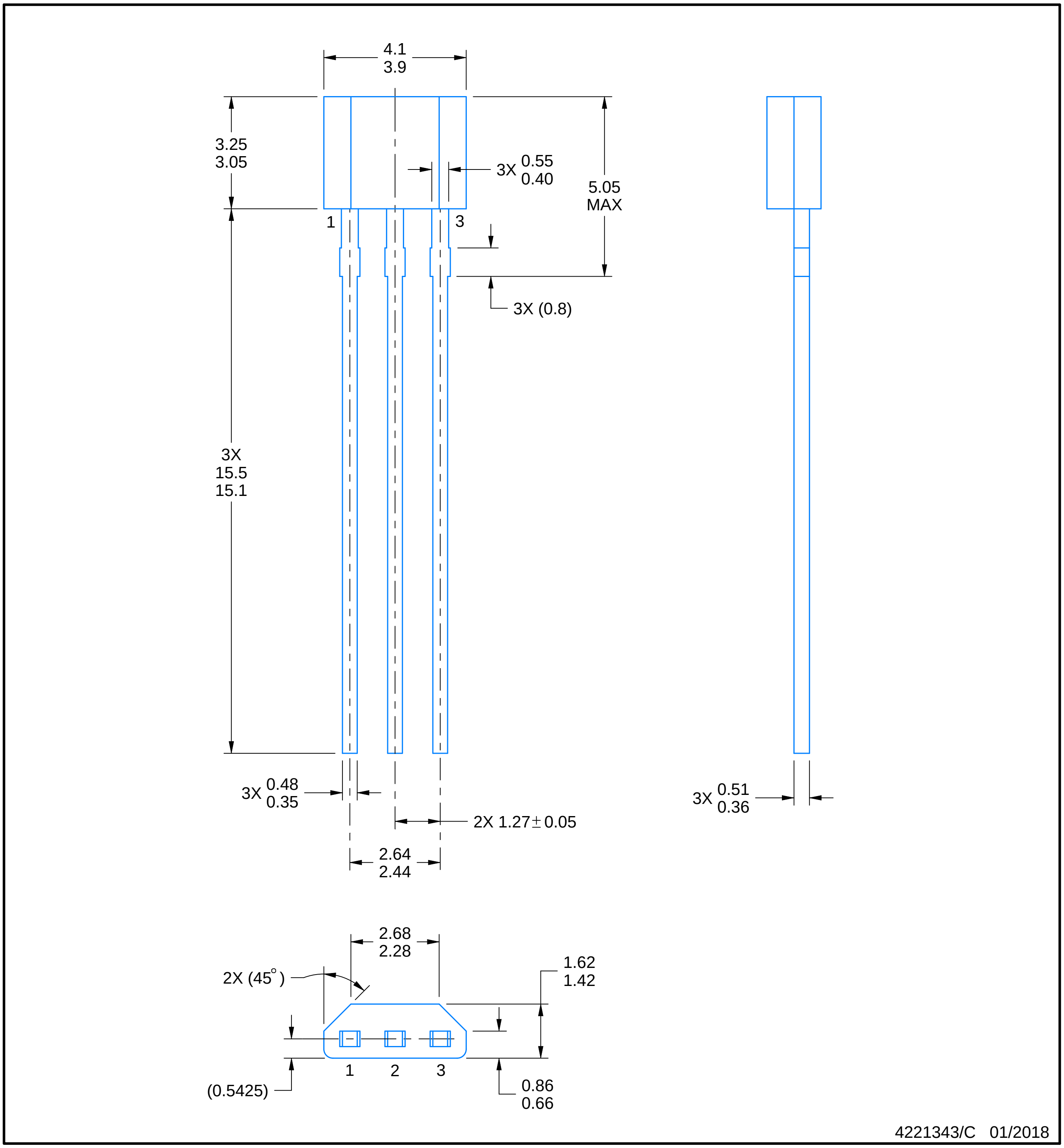
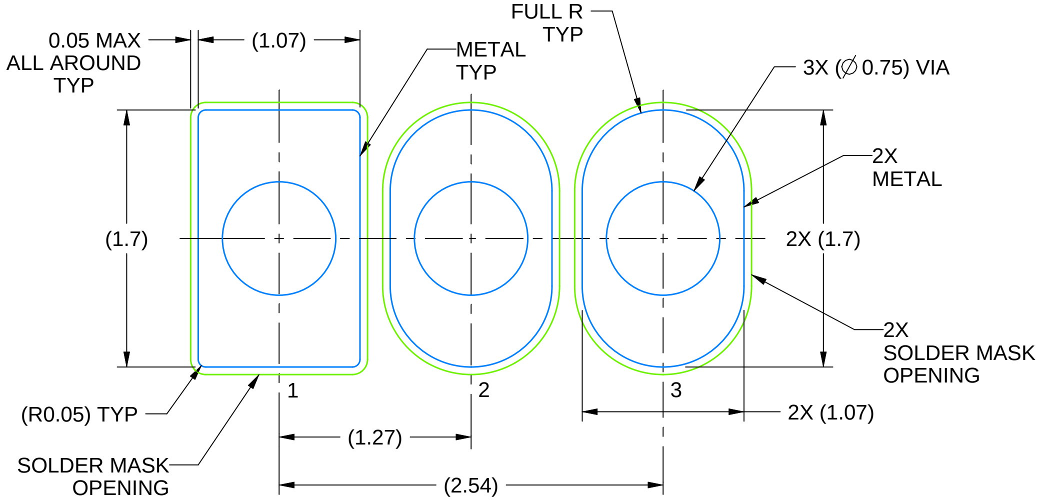
NOTES: (continued)

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.

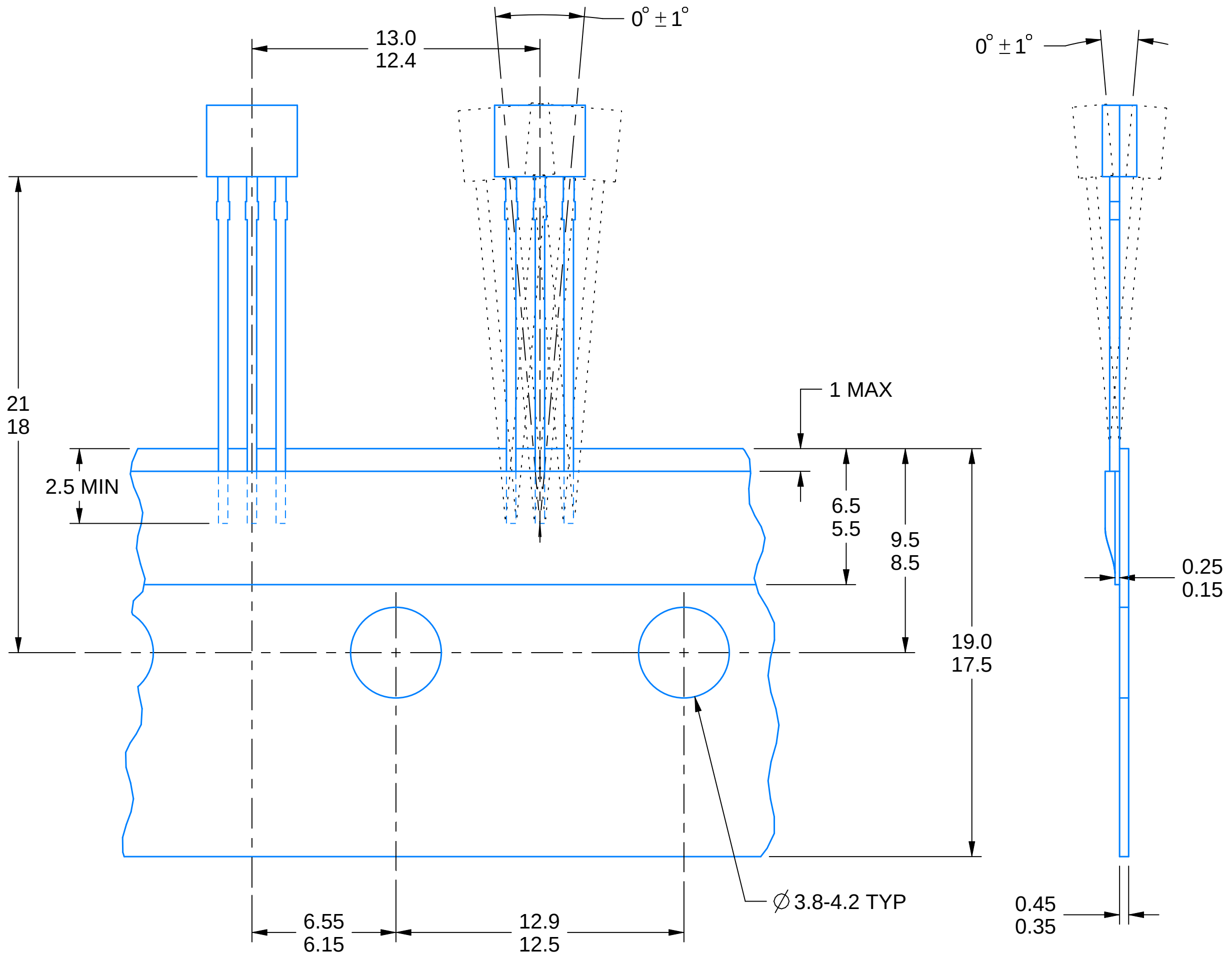


NOTES:

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

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