TMAG5328 电阻器和电压可调节的低功耗霍尔效应开关

1 特性

- 电源电压范围 1.65V 至 5.5V
- 工作温度：-40°C 至 125°C
- B_{OP} 可在 2mT 至 15mT 之间调节
  - 使用 2kΩ 至 15kΩ 电阻器
  - 或 160mV 至 1200mV 电压源
- 全极霍尔开关
- 推挽输出
- 低功耗
  - 占空比为 20Hz（A1D 版本）：1.4μA
  - 连续时间（A1Z 版本）：1.8mA
- 行业标准 SOT-23 封装和引脚排列

2 应用

- 电池关键型位置感应
- 电表篡改检测
- 手机、笔记本电脑或平板电脑保护壳感应
- 电子锁、烟雾探测器、电器
- 医疗设备、物联网系统
- 阀门或螺线管位置检测
- 非接触式诊断或激活

3 说明

TMAG5328 器件是一款高精度、低功耗、电阻器可调的低压霍尔效应开关传感器。

外部电阻器设置器件工作的 B_{OP} 值。根据一个简单的公式，用户可计算出为其设计设置正确的 B_{OP} 值所需的阻值。迟滞值是固定的，因此 B_{RP} 值被定义为 B_{OP} 迟滞值。

TMAG5328 的可调节阈值特性可帮助用户快速进行原型设计，并在发生意外变化时在最后一刻进行修改，从而实现跨不同平台重用。

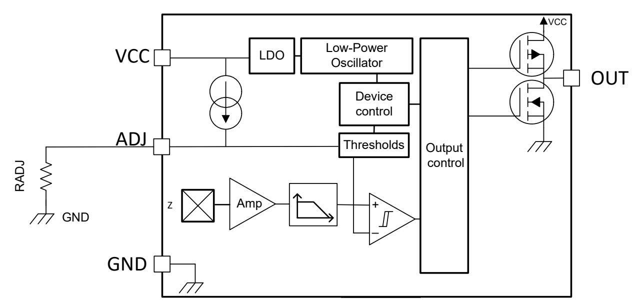
当施加的磁通密度超过 B_{OP} 阈值时，器件会输出低电压。输出会保持低电平，直到磁通密度低于 B_{RP}，随后输出将驱动高电压。通过集成内部振荡器，该器件可对磁场进行采样，并以 20Hz（A1D 版本）的速率更新输出，以便实现超低的电流消耗，或连续更新（A1Z 版本）。TMAG5328 具有全极磁响应。

此器件可在 1.65V 至 5.5V 的 V_{CC} 范围内工作，并采用标准 SOT-23-6 封装。

封装信息

器件型号	封装(1)	封装尺寸(2)
TMAG5328	DBV（SOT-23，6）	2.9mm × 2.8mm

(1) 有关所有可用封装，请参阅节 10。
(2) 封装尺寸（长 × 宽）为标称值，并包括引脚（如适用）。



典型电路原理图

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4 Pin Configuration and Functions

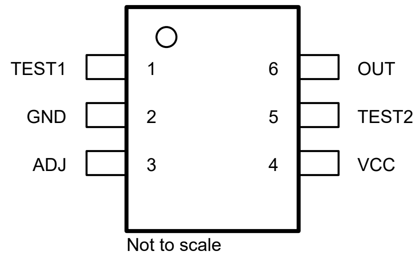


图 4-1. DBV Package 6-Pin SOT-23 Top View

表 4-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	SOT-23		
GND	2	—	Ground reference
OUT	6	O	Omnipolar output that responds to north and south magnetic poles
VCC	4	—	1.65V to 5.5V power supply. TI recommends connecting this pin to a ceramic capacitor to ground with a value of at least 0.1µF
ADJ	3	I	This pin is used to set the thresholds up. Can either be connected to a resistor or voltage source.
TEST1	1	—	TI recommends to leave this pin floating
TEST2	5	—	TI recommends connecting this pin to GND

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	5.5	V
Pin Voltage	OUT, TEST1	–0.3	V_{CC} + 0.3	V
	TEST2	–0.3	0.3	
	ADJ	–0.3	5.5	
Pin current	OUT, TEST1	–5	5	mA
Magnetic Flux Density, BMAX		Unlimited		T
Junction temperature, T_J			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, all pins[1]	±2000	V
		Charged device model (CDM), per ANSI/ESDA/JEDEC JS-002, all pins[2]	± 500	

(1) JEDEC document JEP155 states that 500V HBM allows safe manufacturing with a standard ESD control process.
(2) JEDEC document JEP157 states that 250V 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	1.65	5.5	V
V_{IO}	Pin Voltage. OUT, TEST1	0	V_{CC}	V
	Pin Voltage. TEST2	0	0	
	Pin Voltage. ADJ	0	5	
Io	Pin current. OUT, TEST1	–5	5	mA
T_A	Ambient temperature	–40	125	°C

5.4 Thermal Information

THERMAL METRIC[(1)]		TMAG5328 SOT-23 (DBV) 6 PINS	UNIT
$R_{\theta JA}$	Junction-to-ambient thermal resistance	167.6	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	84.1	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	52.2	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	32	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	51.9	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	–	°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

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

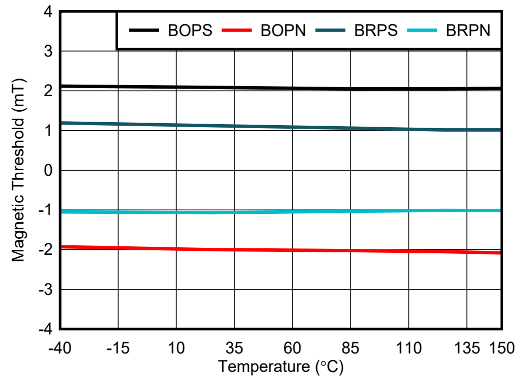
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
ADJ pin						
ADJ_ICC	Current output source			80		µA
ADJ_C	Maximum external capacitance				50	pF
PUSH-PULL OUTPUT DRIVER						
V_{OH}	High-level output voltage	I_{OUT} = –0.5mA	Vcc – 0.35	Vcc – 0.1		V
V_{OL}	Low-level output voltage	I_{OUT} = 0.5mA		0.1	0.3	V
TMAG5328A1D						
fs	Frequency of magnetic sampling			20		Hz
ts	Period of magnetic sampling			50		ms
t_{ACTIVE}	Active time period			65		µs
$I_{CC(PK)}$	Peak current consumption			1.8	3	mA
$I_{CC(SLP)}$	Sleep current consumption			300	600	nA
$I_{CC(AVG)}$	Average current consumption	V_{CC} = 3.3V T_A = 25°C		1.4	1.6	µA
		V_{CC} = 1.65V to 5.5V			2.3	
TMAG5328A1Z						
f_{BW}	Signal bandwidth			20		kHz
$I_{CC(AVG)}$	Average current consumption	V_{CC} = 1.65V to 5.5V		1.8	2.1	mA
ALL VERSIONS						
P_{OS}	Power-on state without external magnetic field	$V_{CC} > V_{CCMIN}$		High		
t_{ON}	Power-on time			125		µs

5.6 Magnetic Characteristics

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

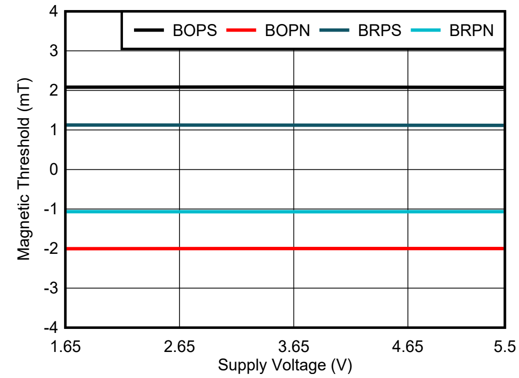
PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
TMAG5328A1D						
$B_{OP(Range\ A)}$	Adjustable Operate Point		±2		±15	mT
$B_{RP(Range\ A)}$	Adjustable Release Point		±1		±14	mT
$V_{ADJ\ (Range\ A)}$	Voltage range		160		1200	mV
$R_{ADJ\ (Range\ A)}$	Resistor range		2		15	kOhm
$B_{OP}(R_{ADJ})$	B_{OP}/R			±1		mT/ kOhm
$B_{OP\_ACC}(R_{ADJ})$	B_{OP} Accuracy (B_{OPSET} ± $B_{OP(MAX/MIN)}$)/B_{OPSET}	2mT ≤ B_{OPSET} < 6mT	−0.85		0.85	mT
		6mT ≤ B_{OPSET} ≤ 15mT	−1.75		1.75	
$B_{RP\_ACC}(R_{ADJ})$	B_{RP} Accuracy (B_{RPSET} ± $B_{RP(MAX/MIN)}$)/B_{RPSET}	2mT ≤ B_{OPSET} < 6mT	−1		1	
		6mT ≤ B_{OPSET} ≤ 15mT	−2.1		2.1	
$B_{HYSA}(R_{ADJ})$	Magnetic hysteresis	$\|B_{OP} - B_{RP}\|$	0.25	1	1.6	
TMAG5328A1Z						
$B_{OP(Range\ A)}$	Adjustable Operate Point		±2		±15	mT
$B_{RP(Range\ A)}$	Adjustable Release Point		±1.5		±14.5	mT
$V_{ADJ\ (Range\ A)}$	Voltage range		160		1200	mV
$R_{ADJ\ (Range\ A)}$	Resistor range		2		15	kOhm
$B_{OP}(R_{ADJ})$	B_{OP}/R			±1		mT/ kOhm
$B_{OP\_ACC}(R_{ADJ})$	B_{OP} Accuracy (B_{OPSET} ± $B_{OP(MAX/MIN)}$)/B_{OPSET}	2mT ≤ B_{OPSET} < 6mT	−0.85		0.85	mT
		6mT ≤ B_{OPSET} ≤ 15mT	−1.75		1.75	mT
$B_{RP\_ACC}(R_{ADJ})$	B_{RP} Accuracy (B_{RPSET} ± $B_{RP(MAX/MIN)}$)/B_{RPSET}	2mT ≤ B_{OPSET} < 6mT	−1		1	mT
		6mT ≤ B_{OPSET} ≤ 15mT	−2.1		2.1	mT
$B_{HYSA}(R_{ADJ})$	Magnetic hysteresis	$\|B_{OP} - B_{RP}\|$	0.04	0.5	1.2	mT

5.7 Typical Characteristics



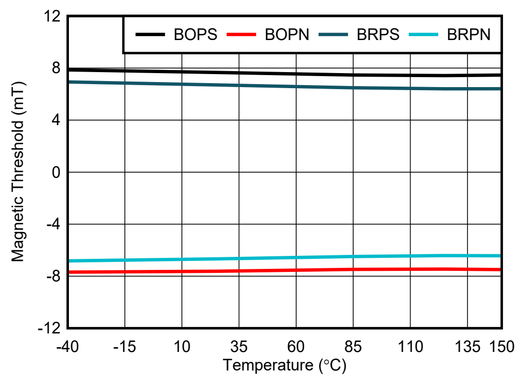
V_{CC} = 3.3V
Version: A1D

图 5-1. 2mT Magnetic Threshold vs Temperature



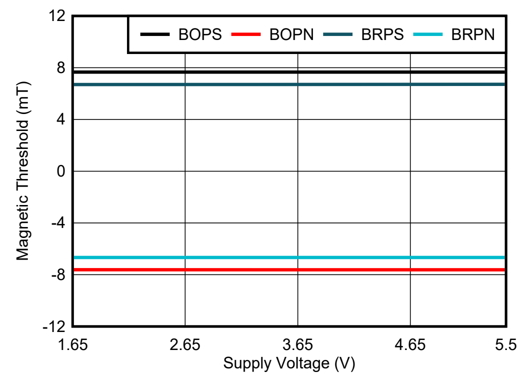
T_A = 25°C
Version: A1D

图 5-2. 2mT Magnetic Threshold vs Supply



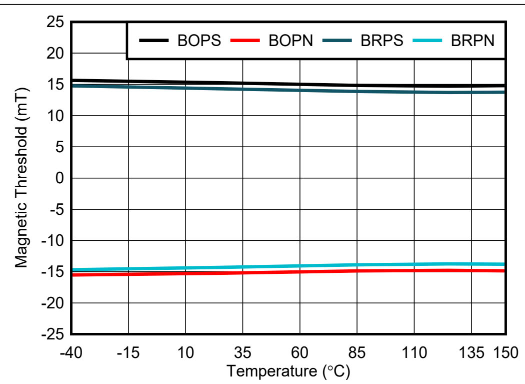
V_{CC} = 3.3V

图 5-3. 7.5mT Magnetic Threshold vs Temperature



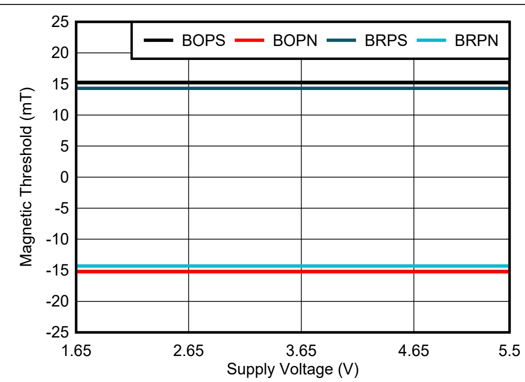
T_A = 25°C

图 5-4. 7.5mT Magnetic Threshold vs Supply



V_{CC} = 3.3V

图 5-5. 15mT Magnetic Threshold vs Temperature



T_A = 25°C

图 5-6. 15mT Magnetic Threshold vs Supply

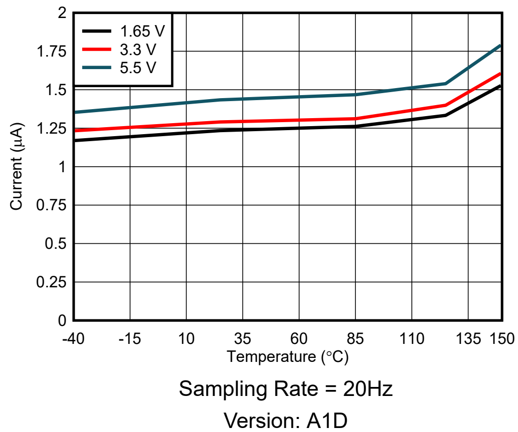


图 5-7. Average I_{CC} vs Temperature

6 Detailed Description

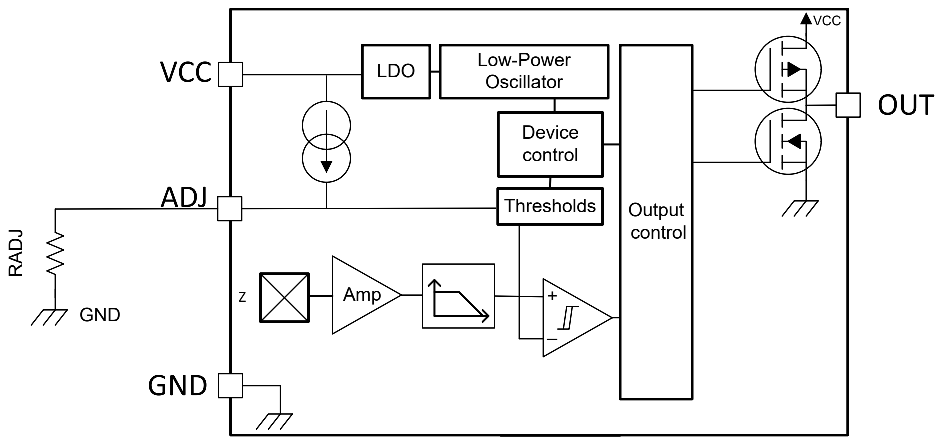
6.1 Overview

The TMAG5328 device is a magnetic sensor with a digital output that indicates when the magnetic flux density threshold has been crossed. The device integrates a Hall effect element, analog signal conditioning, and a low-frequency oscillator that enables ultra-low average power consumption.

While most Hall effect sensors have fixed thresholds, the TMAG5328 offers an extra pin that allows the user to set up a specific threshold of operation. This pin can either be connected to a resistor or a voltage source. While the value can be set at production, it is also possible to allow dynamic change of either the resistor value or the voltage value to dynamically change the threshold value.

Operating from a 1.65V to 5.5V supply, the device periodically measures magnetic flux density, updates the output, and enters into a low-power sleep state.

6.2 Functional Block Diagram



6.3 Feature Description

6.3.1 Magnetic Flux Direction

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

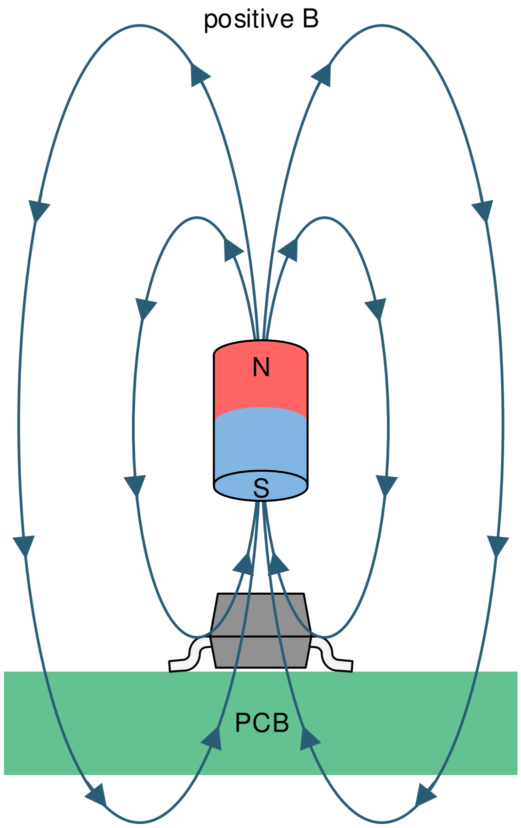


图 6-1. Flux Direction Polarity

6.3.2 Magnetic Response

The TMAG5328A1D and TMAG5328A1Z device versions have an omnipolar functionality, meaning the device responds to both positive and negative magnetic flux densities, as shown in 图 6-2.

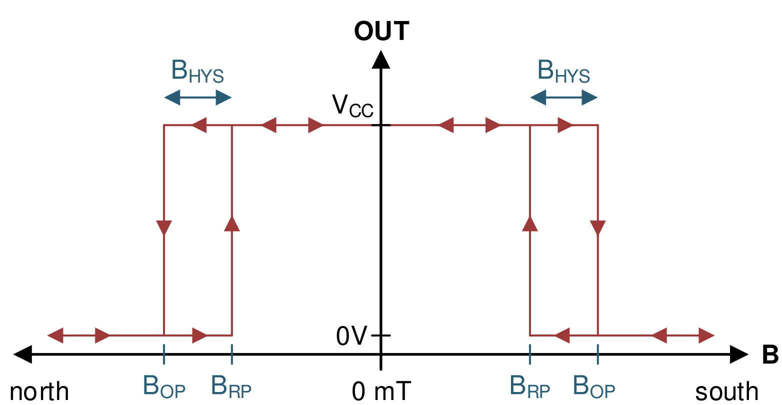


图 6-2. Omnipolar Functionality

6.3.3 Output Type

The TMAG5328A1D and TMAG5328A1Z device versions have a push-pull CMOS output. The push-pull output allows for the lowest system power consumption, because there is no current leakage path when the output drives high or low.

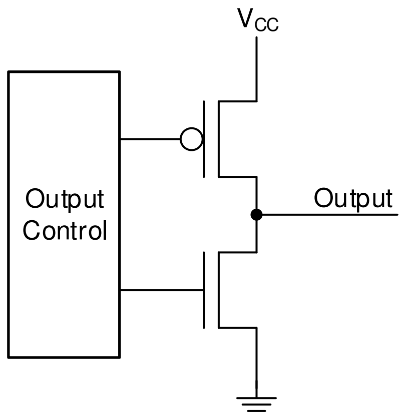


图 6-3. Push-Pull Output (Simplified)

6.3.4 Sampling Rate

When the TMAG5328 device powers up, the device measures the first magnetic sample and sets the output within the t_{ON} time. For the TMAG5328A1D (duty cycled version), the output is latched and the device enters an ultra-low-power sleep state. After each t_{Active} time has passed, the device measures a new sample and updates the output if necessary. If the magnetic field does not change between periods, the output also does not change. While in active mode, the part goes through different steps. The content of the OTP (One-Time-Programmable Memory) is loaded first, and this step takes about 35μs and consumes around 350μA. For the next 5μs, the current source starts up and settles. The part now consumes around 650μA in this step. Finally, the part conducts the Hall sensor conversion for about 25μs and consumes the peak current of around 2mA.

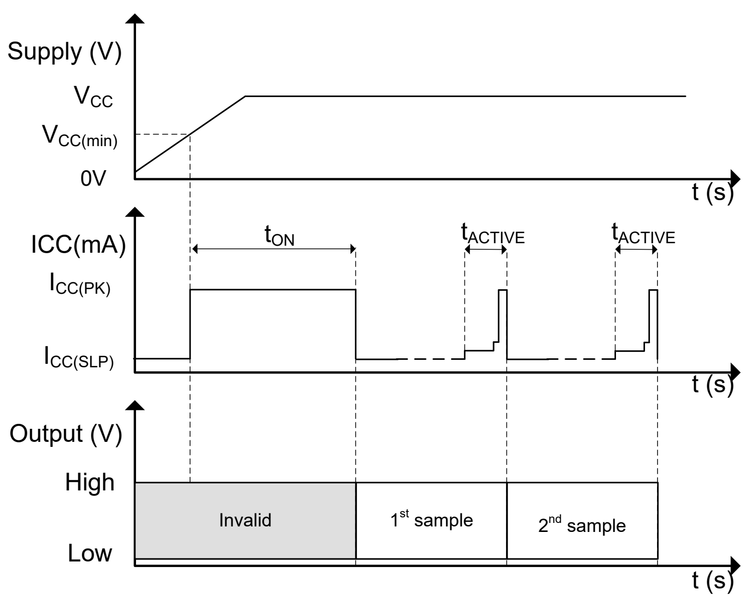


图 6-4. TMAG5328A1D Timing Diagram

The TMAG5328A1Z (continuous time version) stays active after the t_{ON} time has passed (does not go to sleep), enabling a fast signal bandwidth of up to 20kHz (f_{BW}).

6.3.5 Adjustable Threshold

While most Hall Effect switch sensors have fixed magnetic characteristics, the TMAG5328 offers a wide range of adjustable thresholds. The user can use the "ADJ" pin to set the value of B_{OP} threshold. This pin can be used in two different ways. A resistor or a voltage source can be applied on "ADJ". In both scenarios, the resistor or voltage value defines the position of the B_{OP}. While the B_{OP} can be adjusted, the hysteresis has a fixed value. B_{RP} is therefore defined as B_{OP} – Hysteresis.

The TMAG5328A1D (duty cycled version) has an 80µA current generated on pin "ADJ" when the part goes into active mode. The device then reads the "ADJ" pin and defines the value of B_{OP}. The TMAG5328 supports adjusting the B_{OP} dynamically. If the "ADJ" pin value is adjusted while the sensor is in sleep mode, the B_{OP} updates at the next active period of the device. Consequently, the maximum time the internal B_{OP} threshold can take to update for the TMAG5328A1D version is equal to the period of magnetic sampling, t_s (50ms).

The TMAG5328A1Z (continuous time version) has an 80µA current continuously generated on pin "ADJ" to dynamically adjust the B_{OP} threshold if desired. The maximum time the internal B_{OP} threshold can take to update for the TMAG5328A1Z version is 25µs.

6.3.5.1 Adjustable Resistor

One way to set up the B_{OP} is to connect a resistor to the "ADJ" pin. The device generates a fixed current that is injected in the external resistor, and this generates a voltage that represents the B_{OP} value. The relationship between B_{OP} and resistance is defined as $B_{OP}(mT) = R_{ADJ}(k\Omega)$. Note that the generated current on the "ADJ" pin is only present when the device is in active mode and turns OFF when the device is in sleep mode. As a result, the voltage on the "ADJ" pin is only present when the device is in active mode, which is a small duration compared to the time the device is in sleep mode.

The device B_{OP} must be set to any value between 2mT and 15mT. This means R_{ADJ} must be set between 2kΩ and 15kΩ. Operating above and beyond those limits is not recommended and can result in either getting the wrong threshold set or locking up the device into a specific state without the possibility of exiting.

图 6-5 shows the relationship between B_{OP} and R_{ADJ}.

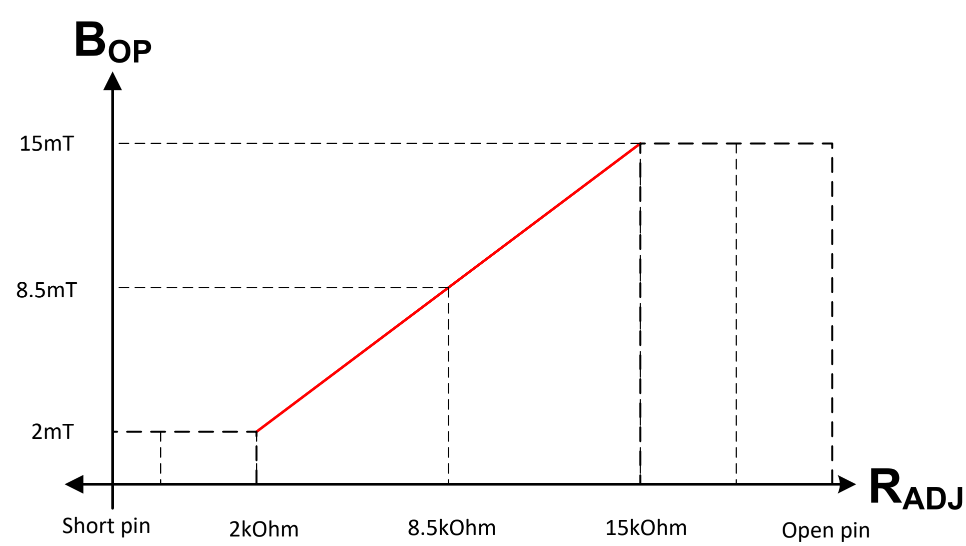


图 6-5. B_{OP} vs R_{ADJ}

6.3.5.2 Adjustable Voltage

One other way to setup the B_{OP} is to apply a voltage to the "ADJ" pin. This voltage is directly proportional to the B_{OP} value. The relationship between B_{OP} and voltage is defined as $B_{OP}(mT) = V_{ADJ}(mV) \times 0.0125$. To apply a voltage on the "ADJ" pin, the voltage source must be able to settle within 4µs after being exposed to a 80µA current on the ADJ pin.

The device B_{OP} must be set to any value between 2mT and 15mT. This means V_{ADJ} must be set between 160mV and 1200mV. Operating above and beyond those limits is not recommended and can result in either getting the wrong threshold set or locking up the device into a specific state without the possibility of exiting.

图 6-6 shows the relationship between B_{OP} and V_{ADJ}.

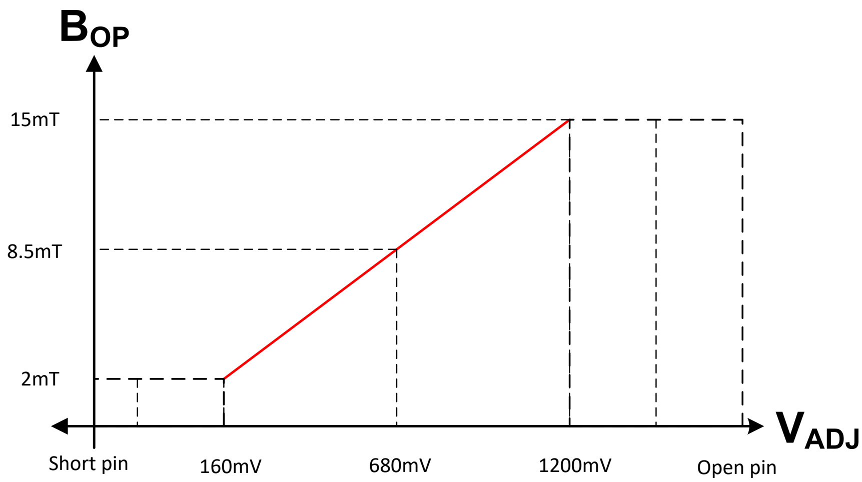


图 6-6. B_{OP} vs R_{ADJ}

6.3.6 Hall Element Location

图 6-7 shows the sensing element location inside the device.

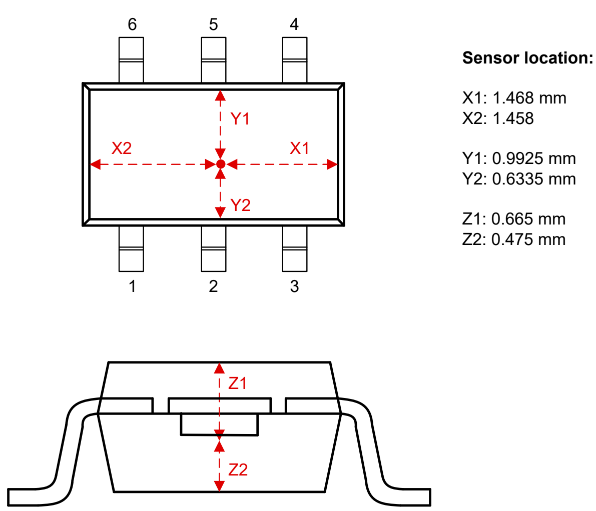


图 6-7. Hall Element Location

6.4 Device Functional Modes

The TMAG5328 device has one mode of operation that applies when the *Recommended Operating Conditions* are met.

7 Application and Implementation

备注

以下应用部分中的信息不属于 TI 器件规格的范围，TI 不担保其准确性和完整性。TI 的客 户应负责确定器件是否适用于其应用。客户应验证并测试其设计，以确保系统功能。

7.1 Application Information

The TMAG5328 device is typically used to detect the proximity of a magnet. The magnet is often attached to a movable component in the system.

7.1.1 Valid TMAG5328 Configurations

The TMAG5328 B_{OP} is set by connecting a resistor or a voltage source to the “ADJ” pin. 图 7-1 shows how to use resistor R1 to set the B_{OP}. 图 7-2 shows hows to use a DAC as a voltage source for setting the B_{OP}. Using the DAC allows the user to dynamically change the B_{OP} with software. To use a DAC, the output of the DAC must settle within 4µs after the 80µA current source of the “ADJ” pin is turned ON.

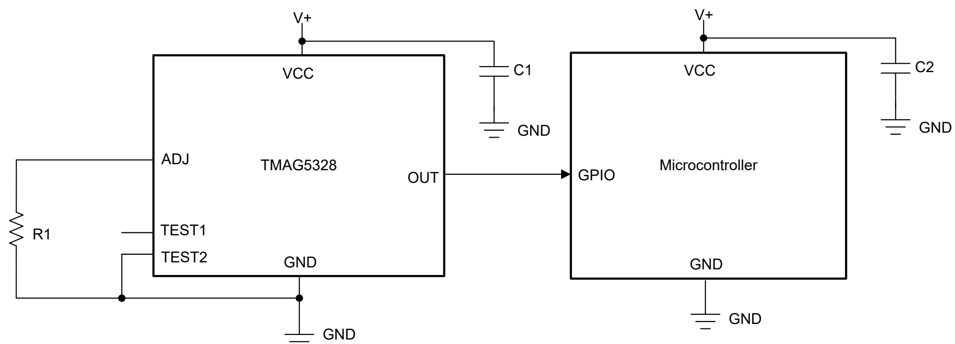


图 7-1. Setting B_{OP} of One TMAG5328 Device Using a Resistor

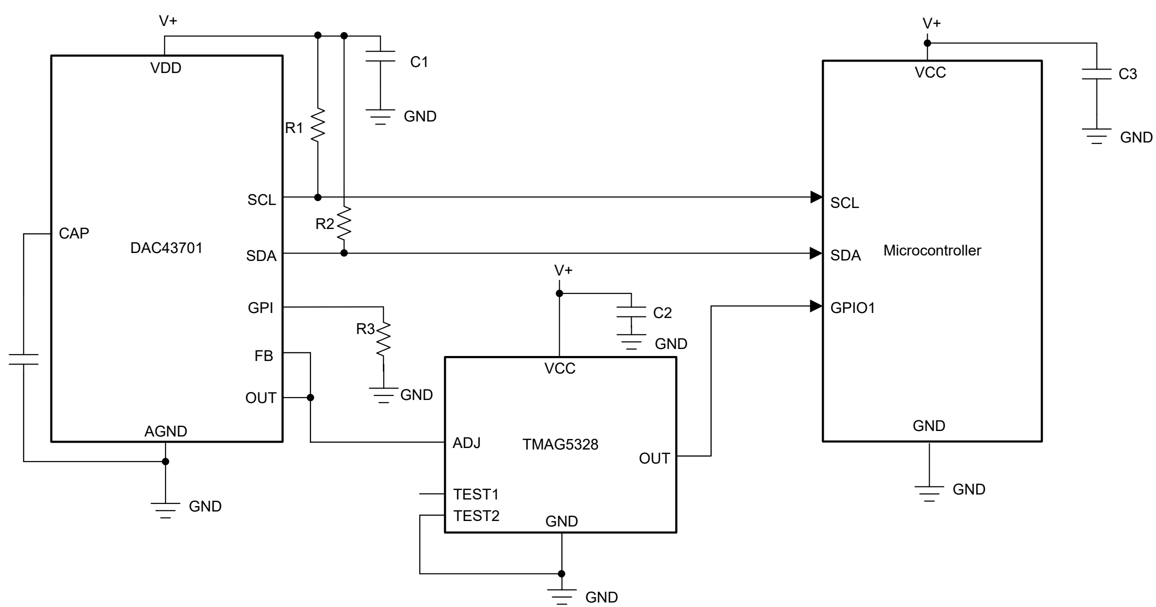


图 7-2. Setting B_{OP} of One TMAG5328 Device Using a DAC

As a DAC alternative, 图 7-3 shows how a voltage divider can be used as a voltage source. In 图 7-3, an operational amplifier is placed between the voltage divider and the “ADJ” pin so that the voltage fed to the “ADJ” pin is not impacted by the internal current source of the TMAG5328 when the current source is turned ON. To use an op amp, the output of the op amp must settle within 4μs after the 80μA current source of the “ADJ” pin is turned ON.

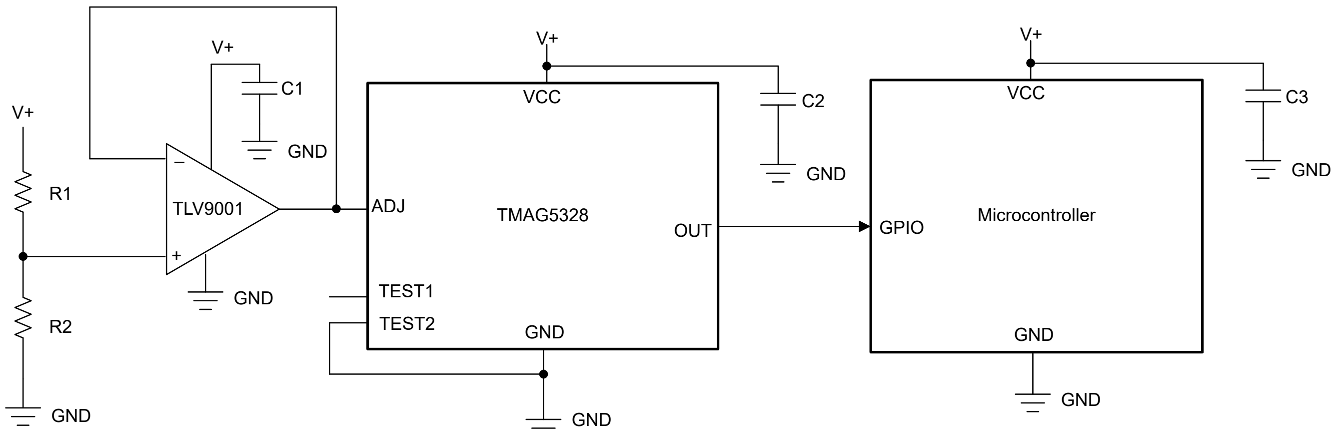


图 7-3. Setting B_{OP} of One TMAG5328 Device Using a Voltage Divider

A potentiometer or rheostat can be integrated into a voltage divider, and the user can adjust this potentiometer to dynamically update the B_{OP}. 图 7-4 shows how to use a potentiometer in a voltage divider to set the B_{OP} of the TMAG5328. The maximum output voltage, which determines the maximum B_{OP}, is set based on the values of resistors R1 and R3. The minimum output voltage, which determines the minimum B_{OP}, is set based on the values of the maximum potentiometer resistance, R1 resistance, and R3 resistance. Select a minimum output voltage greater than 0.16V and a maximum output voltage less than 1.2V.

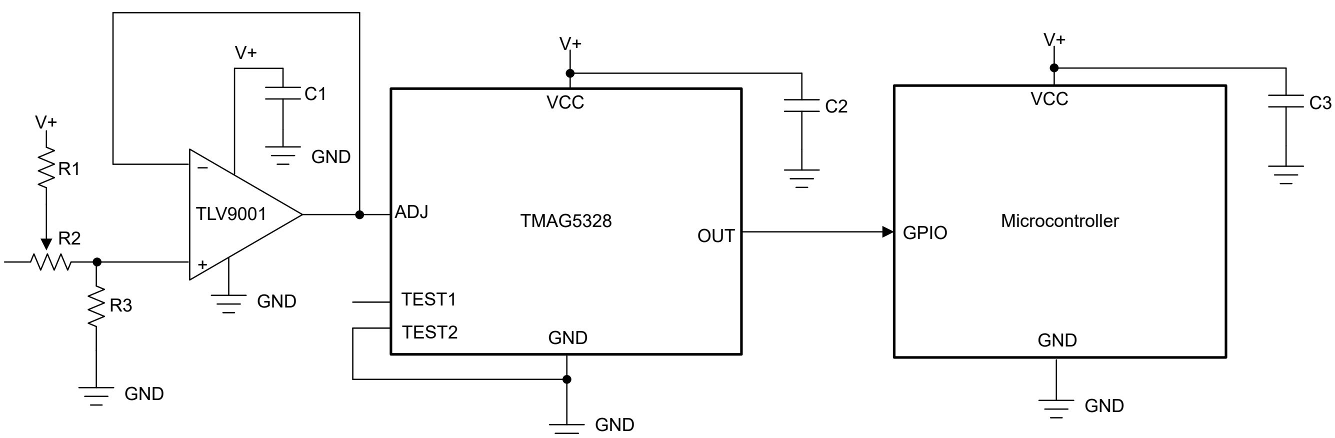


图 7-4. Setting B_{OP} of One TMAG5328 Device Using a Voltage Divider and Potentiometer

图 7-5 shows how the TMAG5328’s internal current source can drive a potentiometer or rheostat instead of a voltage divider. In this implementation, make sure the resistor R2 is at least 2kΩ to ensure that the “ADJ” resistance is always above the minimum 2kΩ. The sum of the maximum potentiometer resistance and the resistance of R1 must also be less than 15kΩ.

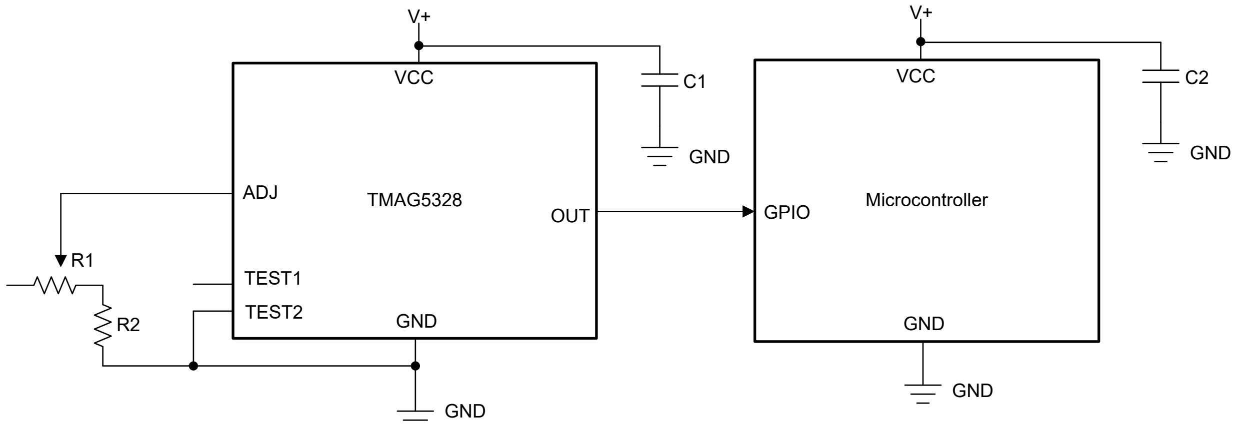


图 7-5. Setting B_{OP} of One TMAG5328 Device Using a Potentiometer and the TMAG5328’s Internal Current Source

Multiple TMAG5328 devices can be used in the same system. When setting the B_{OP} using a resistor, TI recommends that each TMAG5328 has a “ADJ” resistor, even if multiple TMAG5328 devices have the same “ADJ” resistor value. 图 7-6 shows an example implementation that has three TMAG5328 devices. If each device is set to the same B_{OP}, then the resistances of R1, R2, and R3 are equal.

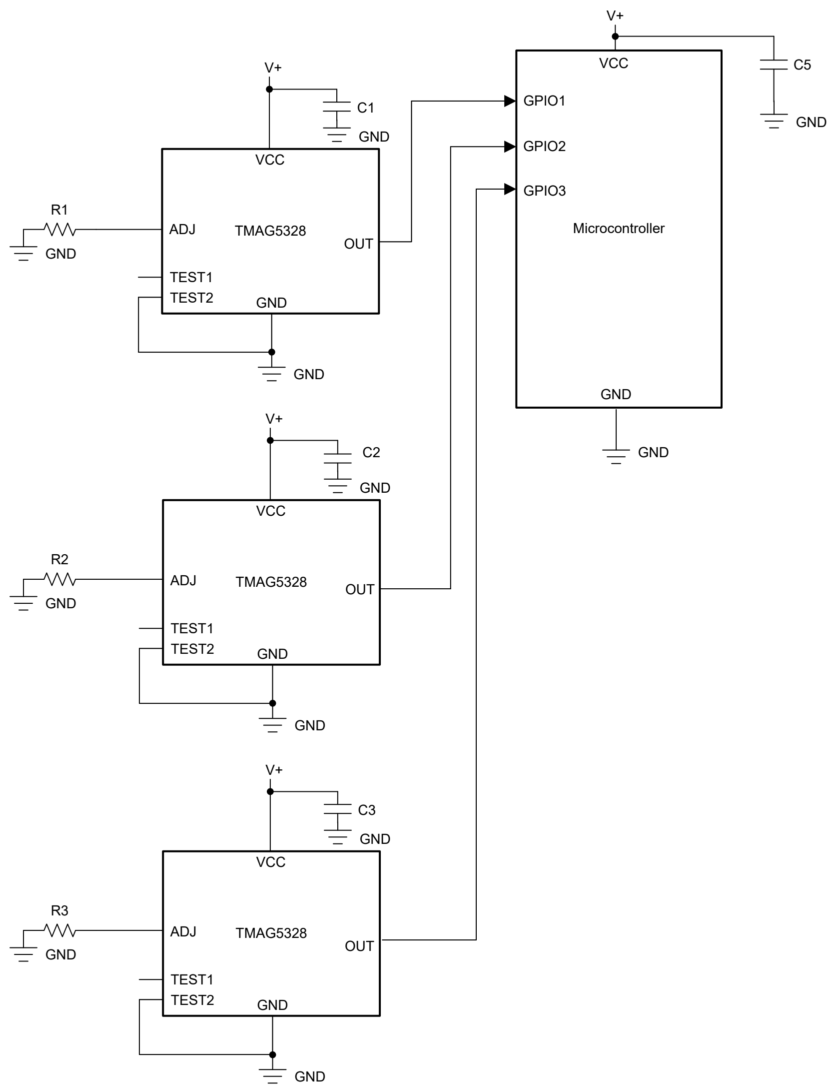


图 7-6. Setting B_{OP} of Three TMAG5328 Devices Using Three Resistors

When setting the B_{OP} using a DAC, one DAC can be used to set the “ADJ” pin voltage of multiple devices only if the output of the DAC can sink the current from all of the TMAG5328 devices. 图 7-7 shows an example of a DAC driving the “ADJ” pin of three TMAG5328 devices. A DAC can only work reliably in this specific scenario if the output of the DAC can settle within 4μs after being exposed to the three “ADJ” current sources. Each current source is 80μA, therefore the DAC can only reliably work if the output of the DAC can settle within 4μs after being exposed to 80 x 3 = 240μA of current.

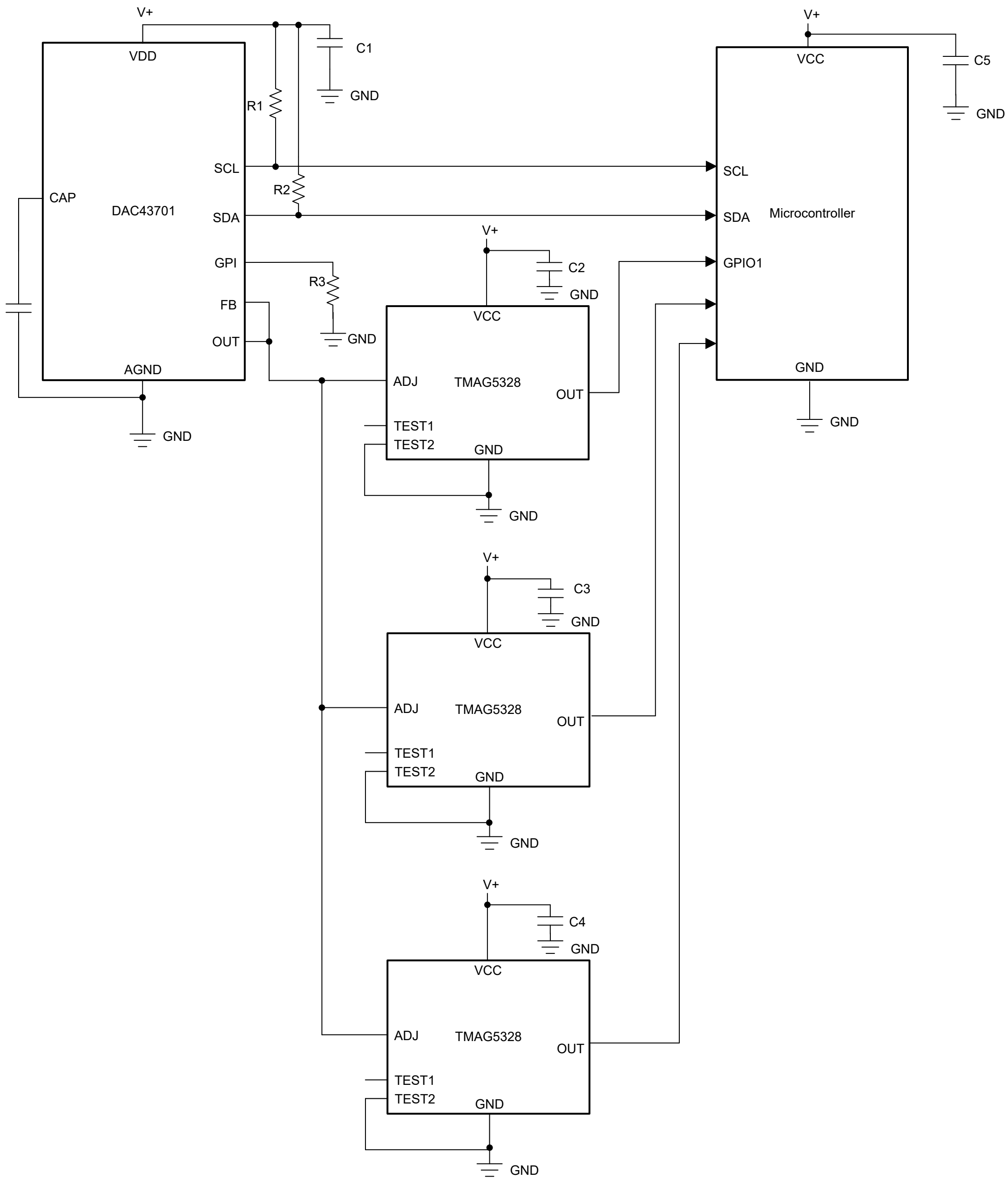


图 7-7. Setting B_{OP} of Three TMAG5328 Devices Using a DAC

7.2 Typical Applications

The TMAG5328 can be used in a large variety of industrial applications. For almost all these applications, the sensor is fixed and the magnet is attached to a movable component in the system.

7.2.1 Refrigerator Door Open/Close Detection

This application section describes how to use the same device for two identical applications with different mechanical characteristic.

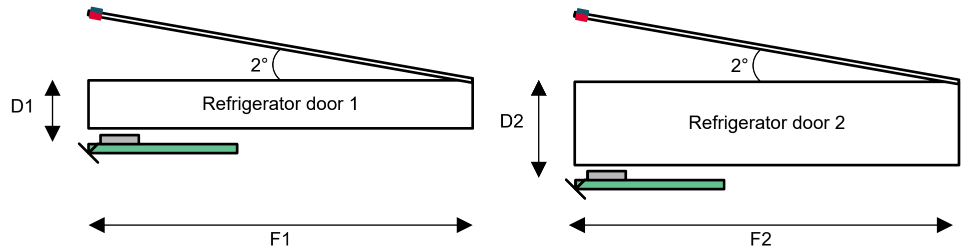


图 7-8. Refrigerator 1 and Refrigerator 2 Principal Diagram

7.2.1.1 Design Requirements

For this design example, use the parameters listed in 表 7-1.

表 7-1. Design Parameters for Fridge 1

DESIGN PARAMETER	EXAMPLE VALUE
Hall effect device	TMAG5328A1D
V_{CC}	5V
Magnet	10mm cubic N35
D1	7.025mm
F1	500mm
Door opening angle	2°
Calculated threshold needed (B_{OP})	7.87mT
R_{ADJ}	7.87kΩ

表 7-2. Design Parameters for Fridge 2

DESIGN PARAMETER	EXAMPLE VALUE
Hall effect device	TMAG5328A1D
V_{CC}	5V
Magnet	10mm cubic N35
D2	16.08mm
F2	500mm
Door opening angle	2°
Calculated threshold needed (B_{OP})	3.49mT
R_{ADJ}	3.48kΩ

7.2.1.2 Detailed Design Procedure

For both applications, the Hall sensor is used to detect if the refrigerator door is open or closed. Both refrigerator doors are different from each other and therefore have different mechanical design. This means the Hall sensor and the magnet are positioned differently from each other. In other terms, if the user wants to detect a specific distance for both refrigerator doors, they must use either a different magnet or a different sensor. For the purpose of this application, there is no flexibility in the choice of magnet. The electronic board can also be reused across platforms and therefore can use the same sensor.

The TMAG5328 is a resistor adjustable Hall effect switch that allows the user to set up whatever threshold is needed between 2mT and 15mT.

For this application, the refrigerator door manufacturer can use the same printed circuit board (PCB) with the same semiconductor content and only has to change the resistor value depending on which refrigerator version is manufactured.

For both refrigerator doors, the opening angle is the same. Now refrigerator door 1 is a thinner model than refrigerator door 2. This means the PCB is located further away for refrigerator door 2 and therefore the sensitivity required to detect the position of the door is impacted.

Knowing the door dimensions, the door opening angle required, and the distance from the magnet to the PCB, it is possible to use a simulation tool that can calculate the magnet strength at the desired position. For refrigerator door 1, the sensitivity calculated is 7.87mT at a distance of 7.025mm. For Refrigerator 2, the sensitivity is 3.49mT at a distance of 16.08mm. Based on those values, a resistor value can be selected from the E48 series. A resistor of 7.87kΩ can be used for refrigerator door 1 and resistor of 3.48kΩ can be used for refrigerator door 2.

7.3 Power Supply Recommendations

The TMAG5328 device is powered from 1.65V to 5.5V DC power supplies. 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 0.1µF.

7.4 Layout

7.4.1 Layout Guidelines

Magnetic fields pass through most non-ferromagnetic 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.

7.4.2 Layout Example

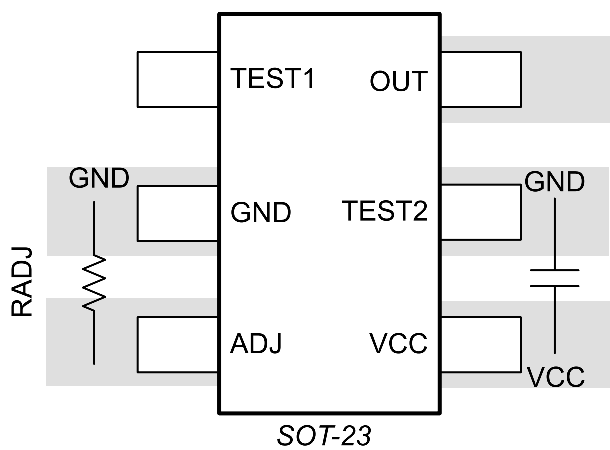


图 7-9. SOT-23 Layout Example

8 Device and Documentation Support

8.1 Device Nomenclature

图 8-1 shows a legend for reading the complete device name for the TMAG5328.

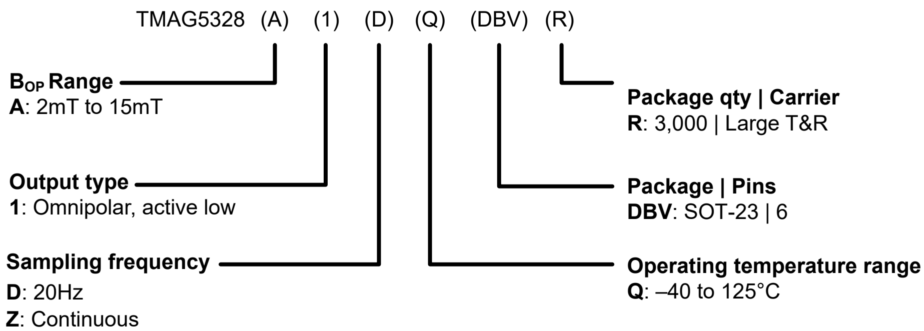


图 8-1. TMAG5328 Device Nomenclature

8.2 接收文档更新通知

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

8.3 支持资源

TI E2E™ 中文支持论坛是工程师的重要参考资料，可直接从专家处获得快速、经过验证的解答和设计帮助。搜索现有解答或提出自己的问题，获得所需的快速设计帮助。

链接的内容由各个贡献者“按原样”提供。这些内容并不构成 TI 技术规范，并且不一定反映 TI 的观点；请参阅 TI 的使用条款。

8.4 Trademarks

TI E2E™ is a trademark of Texas Instruments.
所有商标均为其各自所有者的财产。

8.5 静电放电警告

静电放电 (ESD) 会损坏这个集成电路。德州仪器 (TI) 建议通过适当的预防措施处理所有集成电路。如果不遵守正确的处理和安装程序，可能会损坏集成电路。

ESD 的损坏小至导致微小的性能降级，大至整个器件故障。精密的集成电路可能更容易受到损坏，这是因为非常细微的参数更改都可能会导致器件与其发布的规格不相符。

8.6 术语表

TI 术语表	本术语表列出并解释了术语、首字母缩略词和定义。

9 Revision History

Changes from Revision A (June 2022) to Revision B (May 2024)	Page
• 向数据表添加了 A1Z 器件版本	1

Changes from Revision * (December 2021) to Revision A (June 2022)	Page
• 将数据表状态从*预告信息* 更改为*量产数据*	1

10 机械、封装和可订购信息

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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TMAG5328A1DQDBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	A1D	Samples
TMAG5328A1ZQDBVR	ACTIVE	SOT-23	DBV	6	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	A1Z	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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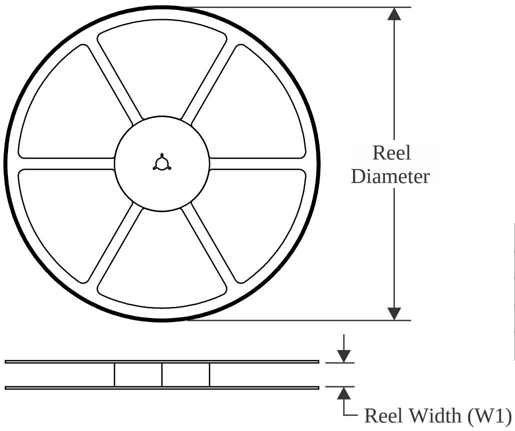
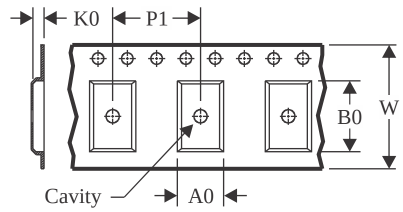
In no event shall TI's liability arising out of such information exceed the total purchase price of the TI part(s) at issue in this document sold by TI to Customer on an annual basis.

TAPE AND REEL INFORMATION

REEL DIMENSIONS

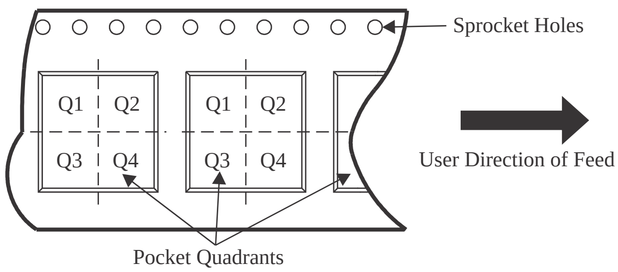


TAPE DIMENSIONS



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

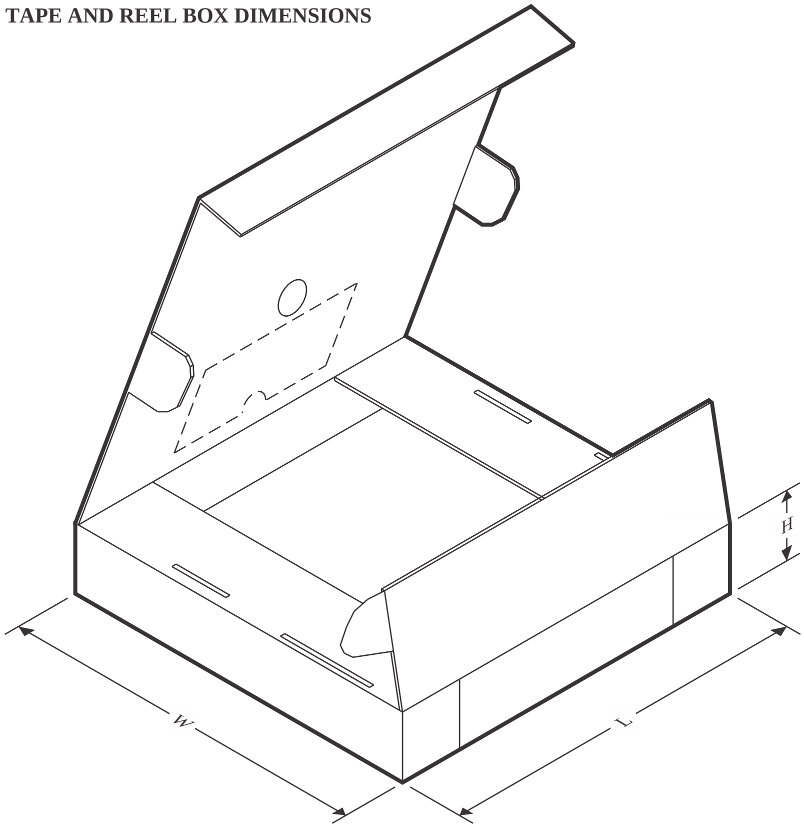
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

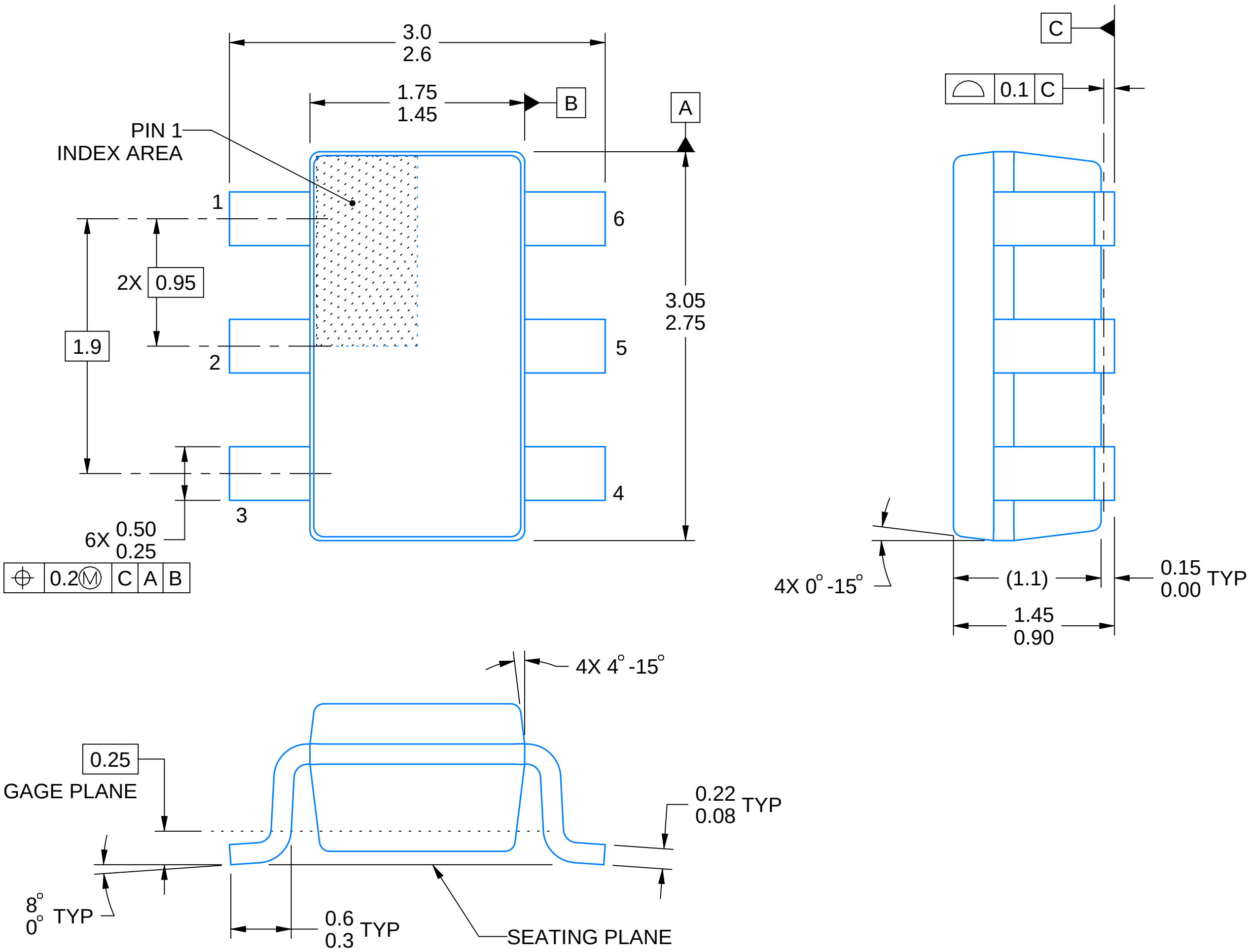
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMAG5328A1DQDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3
TMAG5328A1ZQDBVR	SOT-23	DBV	6	3000	178.0	9.0	3.3	3.2	1.4	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMAG5328A1DQDBVR	SOT-23	DBV	6	3000	190.0	190.0	30.0
TMAG5328A1ZQDBVR	SOT-23	DBV	6	3000	190.0	190.0	30.0



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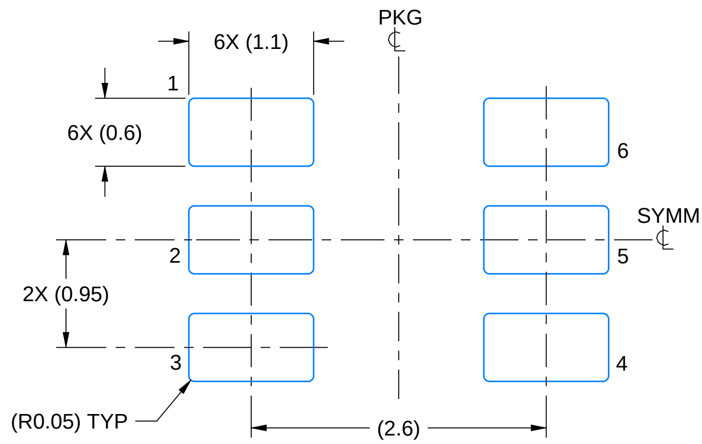
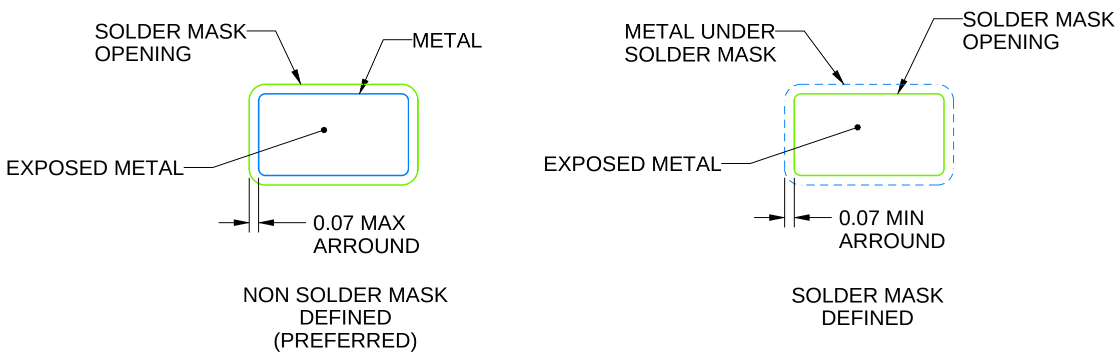
NOTES:

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.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Refernce JEDEC MO-178.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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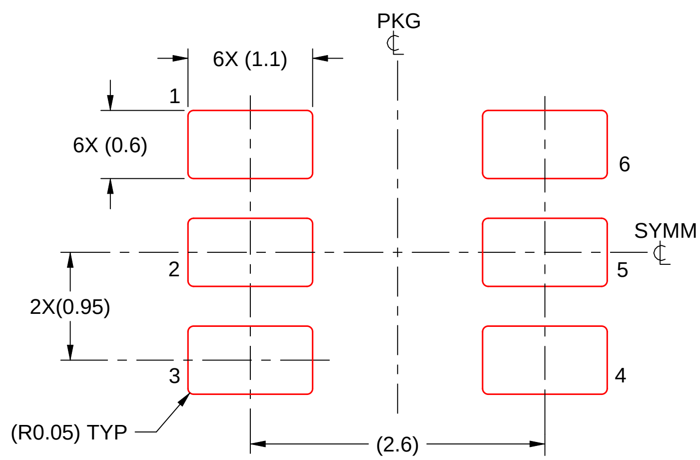
NOTES: (continued)

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



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

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NOTES: (continued)

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