

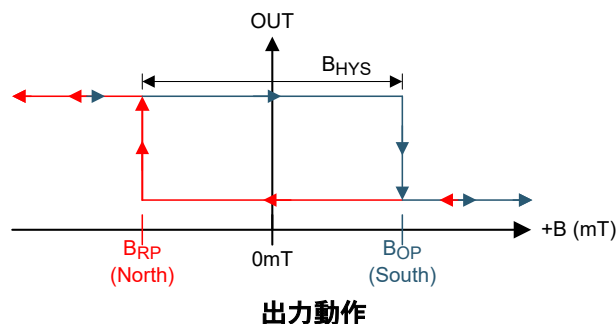
TMAG5213 低コスト、ホール効果ラッチ

1 特長

- Z 軸ホール効果バイポーラ ラッチ
- 磁気サンプリング周波数: 30kHz
- 複数の感度オプション (B_{OP}/B_{RP})
 - $\pm 2.7\text{mT}$ (AD、「デバイス命名規則」を参照)
 - $\pm 6\text{mT}$ (AG、「デバイス命名規則」を参照)
- 広い電圧範囲をサポート
 - $2.5\text{V} \sim 28\text{V}$
 - 外部レギュレータ不要
- 広い動作温度範囲
 - $T_A = -40^\circ\text{C} \sim +125^\circ\text{C}$
- オープンドレイン出力 (30mA シンク)
- パワーオン時間: 35 μs
- 業界標準のパッケージと占有面積
 - 表面実装の 3 ピン SOT-23 (DBZ)
 - $2.92\text{mm} \times 2.37\text{mm}$
 - スルーホール の 3 ピン TO-92 (LPG)
 - $4.00\text{mm} \times 1.52\text{mm}$
- 保護機能:
 - 出力短絡保護
 - 出力電流制限

2 アプリケーション

- 電動工具
- ロボット掃除機
- バルブおよびアクチュエータの制御
- サーボ モーター
- 近接スイッチ
- AC ユニット



- BLDC モーター

3 概要

TMAG5213 は低コストのチョップ安定型ホール効果センサで、全温度範囲で優れた感度安定性を持ち、保護機能を内蔵しています。

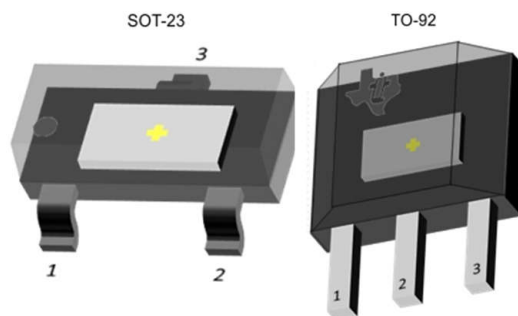
磁界はデジタル双極性ラッチ出力によって示されます。印加されている磁束密度が動作ポイント (B_{OP}) のスレッシュホールドを超えると、低電圧を出力します。出力は、磁束密度がリリース ポイント (B_{RP}) 超えるまで LOW 電圧のまま維持され、その時点でデバイス出力が引き上げられます。このバイポーラ ラッチの磁気応答により、デバイス出力はパッケージの Z 軸を通る正負両方の磁束に敏感に反応します。

TMAG5213 は、 $2.5\text{V} \sim 28\text{V}$ の広い動作電圧範囲と、 $-40^\circ\text{C} \sim 125^\circ\text{C}$ の広い動作温度範囲に対応しており、さまざまな産業用アプリケーション向けに設計されています。出力短絡や過電流に対する内部保護機能が搭載されており、30mA の電流シンク能力を備えたオープン ドレイン出力段を備えています。

パッケージ情報

部品番号	パッケージ ⁽¹⁾	パッケージ サイズ ⁽²⁾
TMAG5213	DBZ (SOT-23, 3)	$2.92\text{mm} \times 2.37\text{mm}$
	LPG (TO-92, 3)	$4\text{mm} \times 1.52\text{mm}$

- (1) 供給されているすべてのパッケージについては、[セクション 11](#) を参照してください。
- (2) パッケージ サイズ (長さ × 幅) は公称値であり、該当する場合はピンも含まれます。



デバイスのパッケージ



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4 Device Comparison

表 4-1. Device Comparison

VERSION	TYPICAL B _{OP} THRESHOLD	TYPICAL HYSTERESIS	+B MAGNETIC RESPONSE	OUTPUT TYPE	SENSING ORIENTATION	SAMPLING RATE	PACKAGES AVAILABLE
TMAG5213AD	2.7mT	5.4mT	Active Low	Open-drain	Z	30kHz	SOT-23, TO-92
TMAG5213AG	6mT	12mT	Active Low	Open-drain	Z	30kHz	SOT-23, TO-92

5 Pin Configuration and Functions

For additional configuration information, see [Device Markings](#) and [Mechanical, Packaging, and Orderable Information](#).

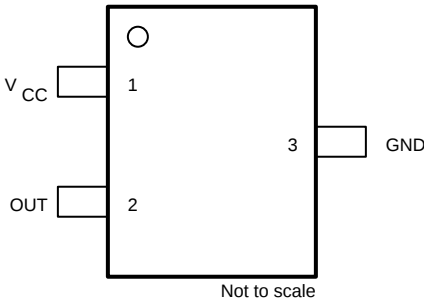


図 5-1. DBZ Package (Preview), 3-Pin SOT-23 (Top View)

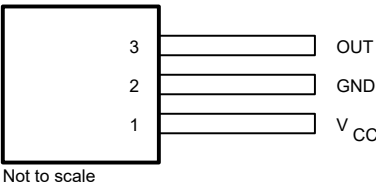


図 5-2. LPG Package, 3-Pin TO-92 (Top View)

表 5-1. Pin Functions

PIN			TYPE	DESCRIPTION
NAME	SOT-23 (DBZ)	TO-92 (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	2.5V to 28V power supply. Bypass this pin to the GND pin with a 0.01μF (minimum) ceramic capacitor rated for V _{CC} .

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}	−0.3	30	V
Output pin voltage	OUT	−0.5	30	V
Magnetic flux density, B _{MAX}		Unlimited		
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.

6.2 ESD Ratings

			VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human body model (HBM), per ANSI/ESDA/JEDEC JS-001, all pins ⁽¹⁾	±2500	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.

6.3 Recommended Operating Conditions

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

		MIN	MAX	UNIT
V _{CC}	Power supply voltage	2.5	28	V
V _O	Output pin voltage (OUT)	0	28	V
I _{SINK}	Output pin current sink (OUT) ⁽¹⁾	0	30	mA
T _A	Operating ambient temperature	−40	125	°C

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

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾		TMAG5213		UNIT
		SOT-23 (DBZ)	TO-92 (LPG)	
		3 PINS	3 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	197.7	180	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	87.1	98.6	
$R_{\theta JB}$	Junction-to-board thermal resistance	27.4	154.9	
Ψ_{JT}	Junction-to-top characterization parameter	3.7	40	
Ψ_{JB}	Junction-to-board characterization parameter	27.1	154.9	

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

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}	Operating power supply voltage		2.5		28	V
I_{CC}	Operating supply current	$V_{CC} = 2.5V$ to $28V$, $T_A = 25^\circ C$		2.7		mA
		$V_{CC} = 2.5V$ to $28V$, $T_A = 125^\circ C$		3	3.5	
t_{on}	Power-on time	AD, AG Versions		35	50	μs
OPEN-DRAIN OUTPUT (OUT)						
$r_{DS(on)}$	FET on-resistance	$V_{CC} = 3.3V$, $I_O = 10mA$, $T_A = 25^\circ C$		22		Ω
		$V_{CC} = 3.3V$, $I_O = 10mA$, $T_A = 125^\circ C$		36	50	
$I_{lkg(off)}$	Off-state leakage current	Output Hi-Z			1	μA
PROTECTION CIRCUITS						
I_{OCP}	Overcurrent protection level	OUT shorted V_{CC}	15	30	45	mA

6.6 Switching Characteristics

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

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_d	Output delay time	$B = B_{RP} - 10mT$ to $B_{OP} + 10mT$ in $1\mu s$		13	25	μs
t_r	Output rise time (10% to 90%)	$R1 = 1k\Omega$, $C_O = 50pF$, $V_{CC} = 3.3V$		200		ns
t_f	Output fall time (90% to 10%)	$R1 = 1k\Omega$, $C_O = 50pF$, $V_{CC} = 3.3V$		31		ns
f_{BW}	Bandwidth ⁽¹⁾		20	30		kHz

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

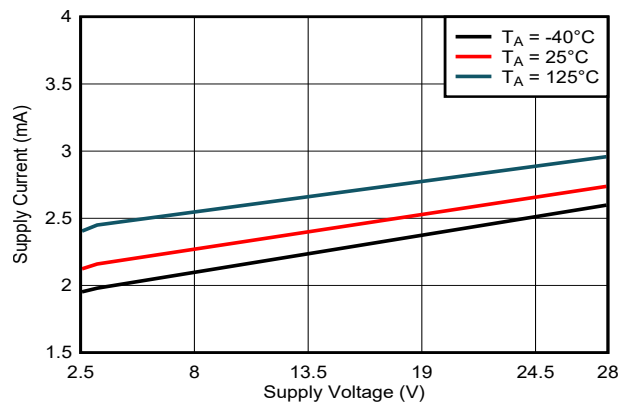
6.7 Magnetic Characteristics

for $V_{CC} = 2.5V$ to $28V$, over operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT ⁽¹⁾
TMAG5213AD: $\pm 2.7mT$						
B _{OP}	Operate point	T _A = 25°C	1	2.7	5	mT
		T _A = –40°C to 125°C	0.83	2.7	5.23	mT
B _{RP}	Release point	T _A = 25°C	–5	–2.7	–1	mT
		T _A = –40°C to 125°C	–5.23	–2.7	–0.83	mT
B _{HYS}	Hysteresis; B _{HYS} = (B _{OP} – B _{RP})	T _A = –40°C to 125°C		5.4		mT
TMAG5213AG: $\pm 6mT$						
B _{OP}	Operate point	T _A = 25°C	3	6	9	mT
		T _A = –40°C to 125°C	2.7	6	9.3	mT
B _{RP}	Release point	T _A = 25°C	–9	–6	–3	mT
		T _A = –40°C to 125°C	–9.3	–6	–2.7	mT
B _{HYS}	Hysteresis; B _{HYS} = (B _{OP} – B _{RP})	T _A = –40°C to 125°C		12		mT

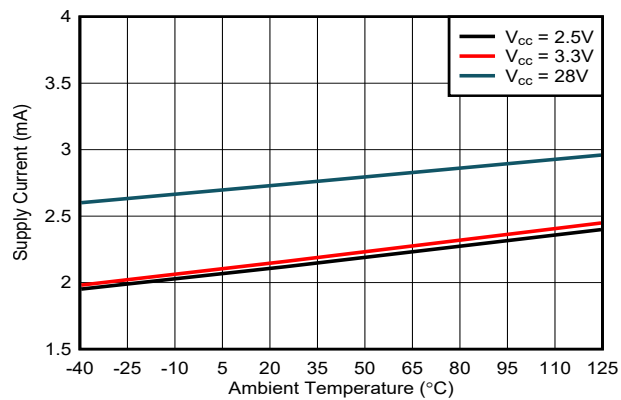
(1) 1mT = 10 Gauss.

6.8 Typical Characteristics



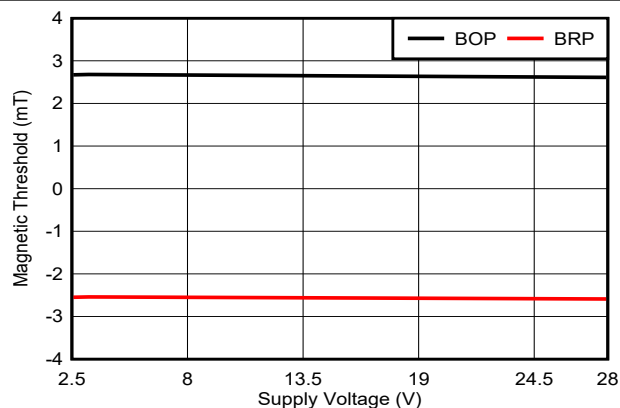
Versions: AD, AG

Figure 6-1. 30kHz: Average I_{CC} vs V_{CC}



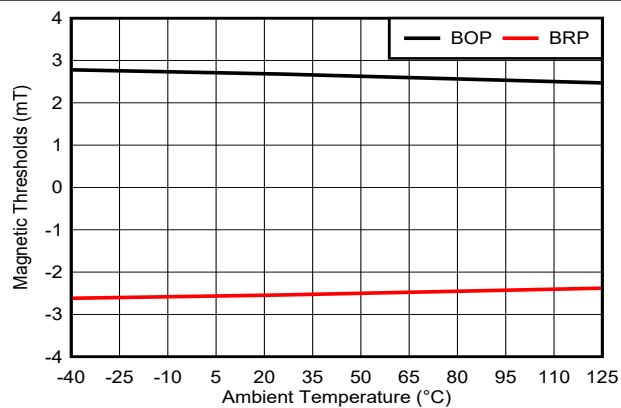
Versions: AD, AG

Figure 6-2. 30kHz: Average I_{CC} vs Temperature

 $T_A = 25^\circ\text{C}$

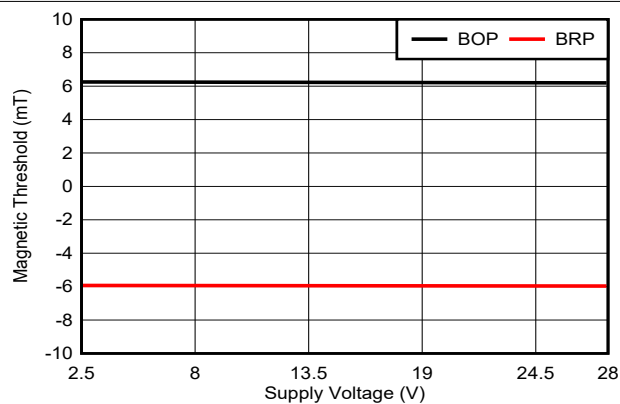
Version: AD

Figure 6-3. 2.7mT B_{OP} : Thresholds vs V_{CC}

 $V_{CC} = 3.3\text{V}$

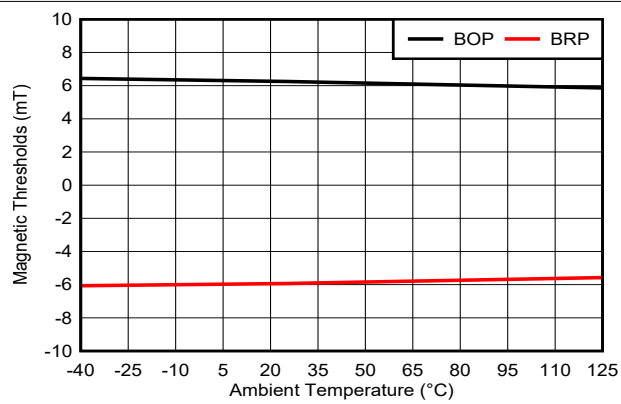
Version: AD

Figure 6-4. 2.7mT B_{OP} : Thresholds vs Temperature

 $T_A = 25^\circ\text{C}$

Version: AG

Figure 6-5. 6mT B_{OP} : Thresholds vs V_{CC}

 $V_{CC} = 3.3\text{V}$

Version: AG

Figure 6-6. 6mT B_{OP} : Thresholds vs Temperature

7 Detailed Description

7.1 Overview

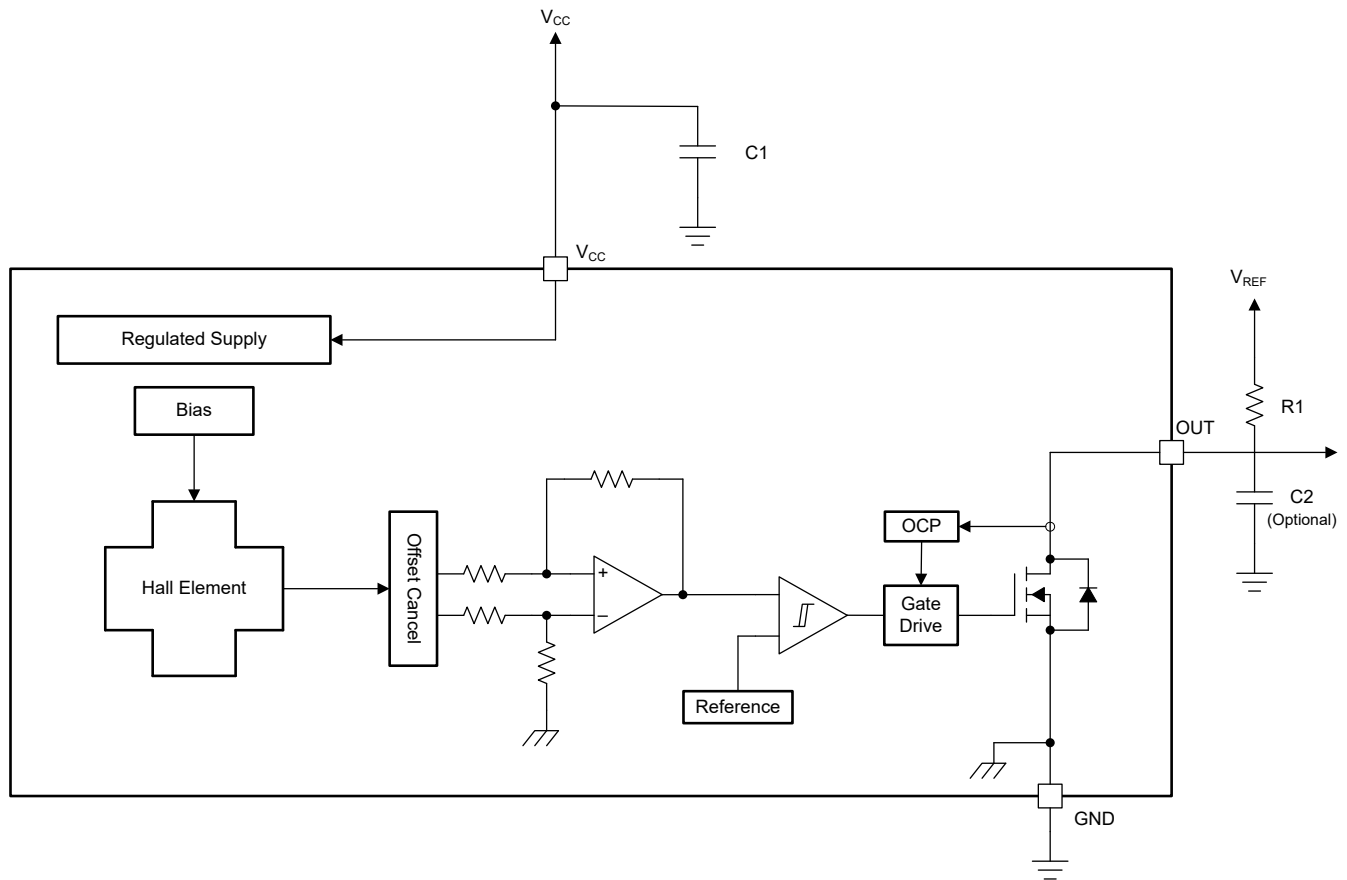
The TMAG5213 is a chopper-stabilized Hall sensor with a digital bipolar latched output for magnetic-sensing applications. The TMAG5213 device can be powered with a supply voltage between 2.5V and 28V.

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 to allow for ease of use with controller circuits.

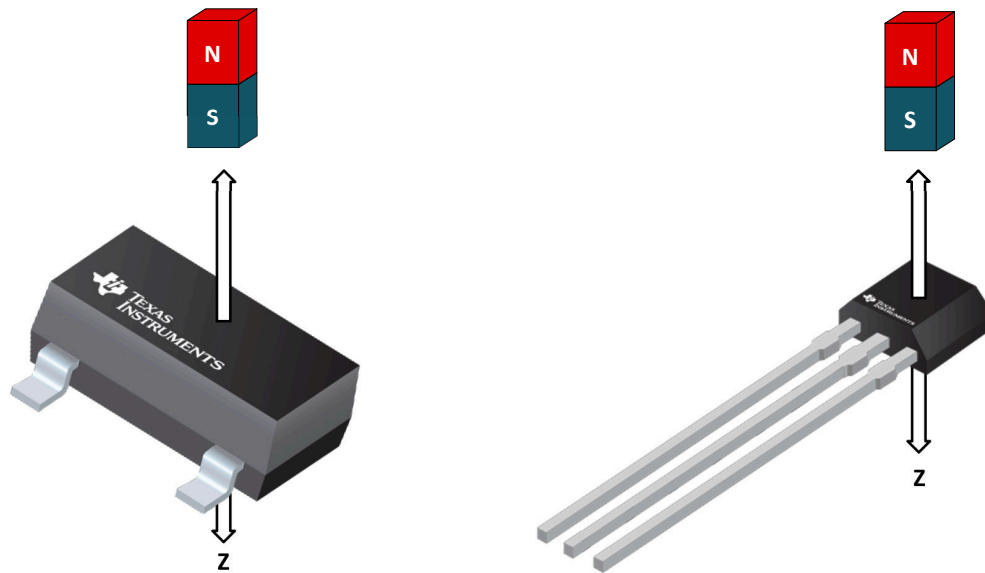
7.2 Functional Block Diagram



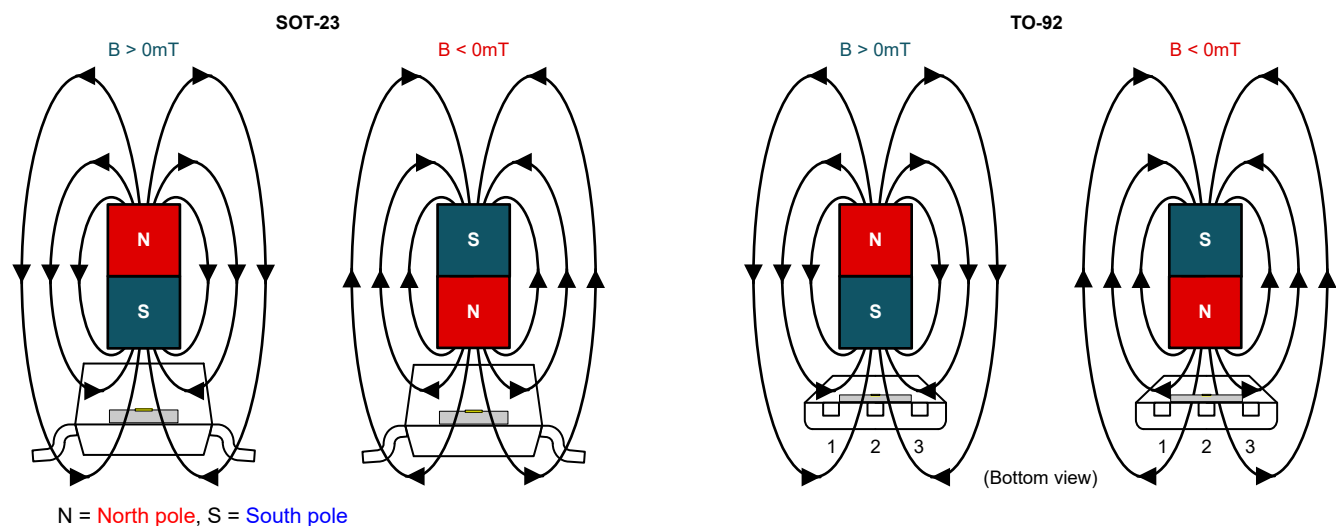
7.3 Feature Description

7.3.1 Field Direction Definition

The TMAG5213 is sensitive to the magnetic field component that is perpendicular to the marked side of the package. This direction is defined as the Z-axis as shown in 7-1. 7-2 shows that a positive magnetic field is defined in this document as what occurs when a **south pole** is near the marked side of the package. A negative magnetic field occurs when a **north pole** is near the marked side of the package.



7-1. Definition of Z-Axis by Package



7-2. Definition of Positive and Negative Field Direction

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.

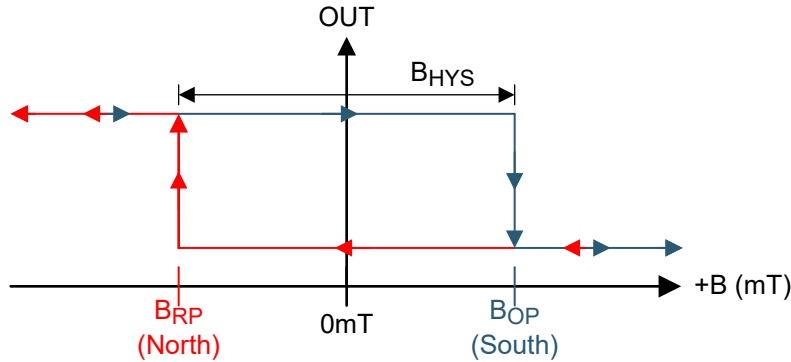


図 7-3. Bipolar Latch Active Low Functionality

7.3.3 Power-On Time

After applying V_{CC} to the TMAG5213 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 図 7-4 and 図 7-5 occurs at the end of t_{on} . This pulse can allow the host processor to determine when the TMAG5213 output is valid after start-up. In Case 1 (図 7-4) and Case 2 (図 7-5), the output is defined assuming a constant magnetic field $B > B_{OP}$ and $B < B_{RP}$.

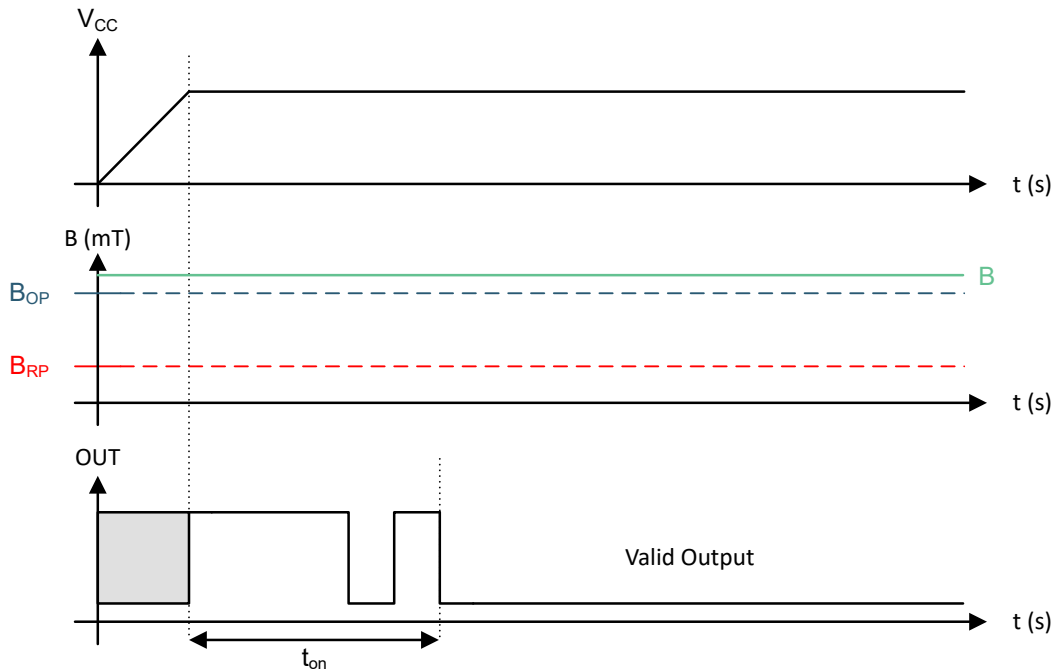


図 7-4. Case 1: Power On When $B > B_{OP}$

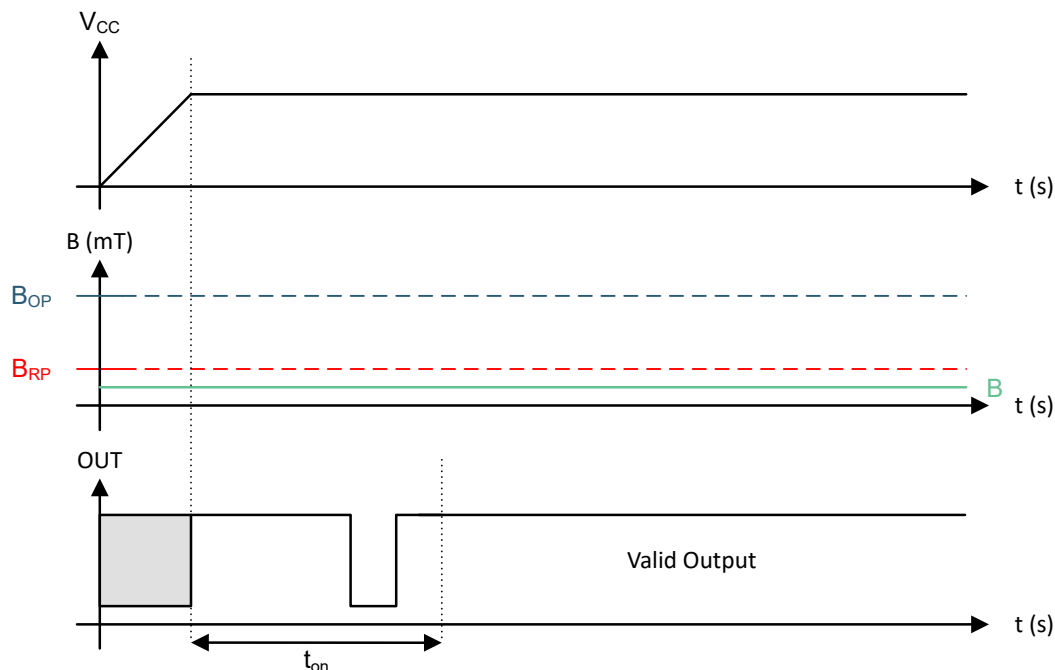


図 7-5. Case 2: Power On When $B < B_{RP}$

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

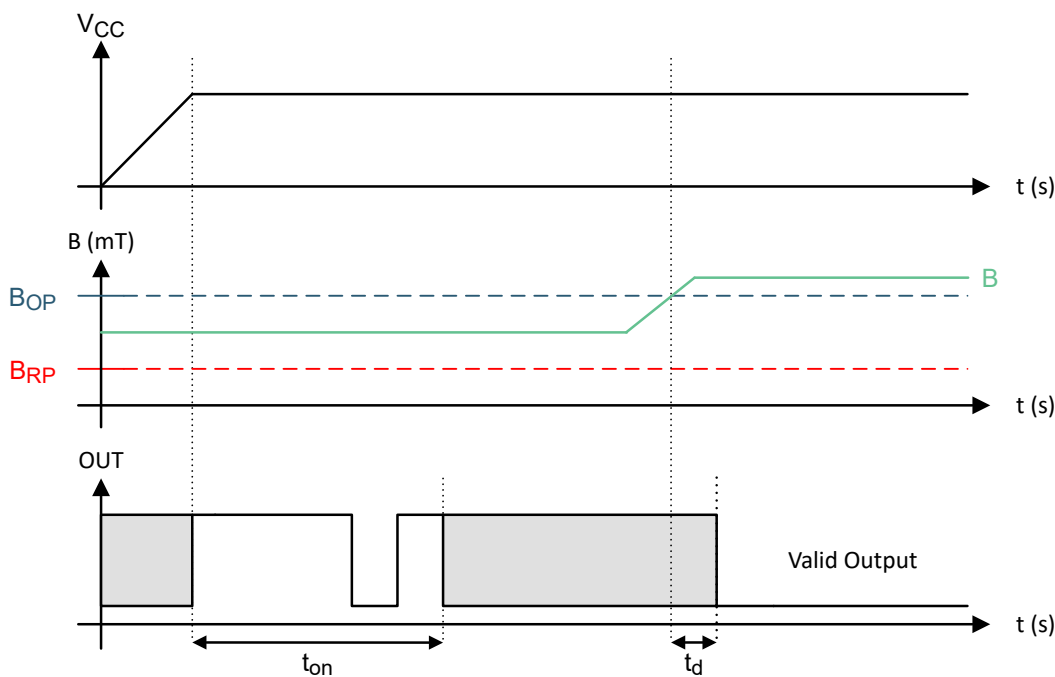


図 7-6. Case 3: Power On When $B_{RP} < B < B_{OP}$, Followed by $B > B_{OP}$

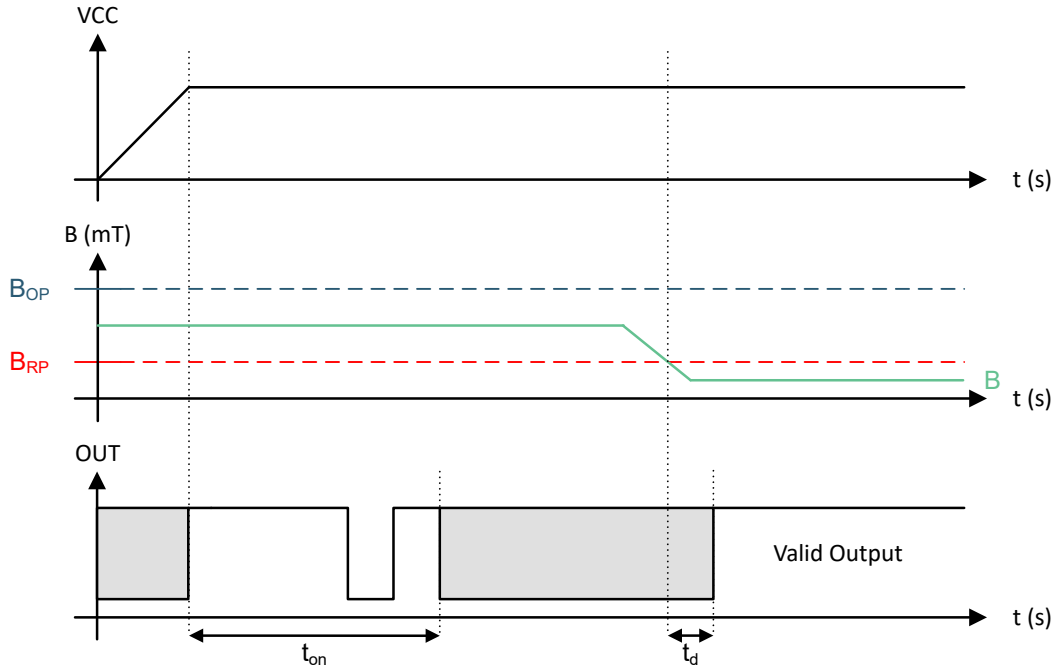


図 7-7. Case 4: Power On When $B_{RP} < B < B_{OP}$, Followed by $B < B_{RP}$

7.3.4 Output Stage

図 7-8 shows the TMAG5213 open-drain NMOS output structure, rated to sink up to 30mA of current. For proper operation, use 式 1 to calculate the value of pullup resistor R1.

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

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

In addition, make sure that the value of $R1 > 500\Omega$ so that the output driver can pull the OUT pin close to GND. Generally, TI recommends to use a resistor with a 10k Ω nominal value.

注

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

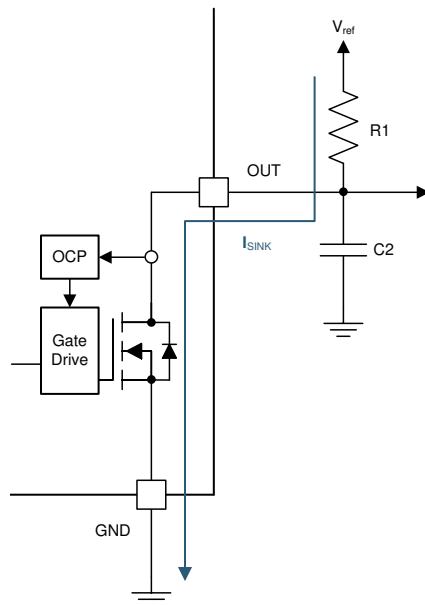


図 7-8. NMOS Open-Drain Output

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

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

Most applications do not require this C2 filtering capacitor.

7.3.5 Protection Circuits

The TMAG5213 device is protected against overcurrent conditions. 表 7-1 lists a summary of the protection circuits.

表 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}	$I_O < I_{OCP}$

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.

7.4 Device Functional Modes

The TMAG5213 device has one mode of operation that applies when operated within the [Recommended Operating Conditions](#).

8 Application and Implementation

注

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 TMAG5213 is used in magnetic position sensing applications. The device features a high-speed architecture to facilitate more precise field measurement. With latching magnetic characteristics, the output is turned low or high respectively with a sufficiently strong south or north pole facing the package top side. When removing the magnetic field, the device keeps its previous state.

For reliable functionality, the magnet must apply a flux density at the sensor greater than the corresponding maximum B_{OP} or B_{RP} numbers specified in the [Magnetic Characteristics](#) table. Add additional margin to account for mechanical tolerance, temperature effects, and magnet variation.

8.2 Typical Applications

8.2.1 Standard Circuit

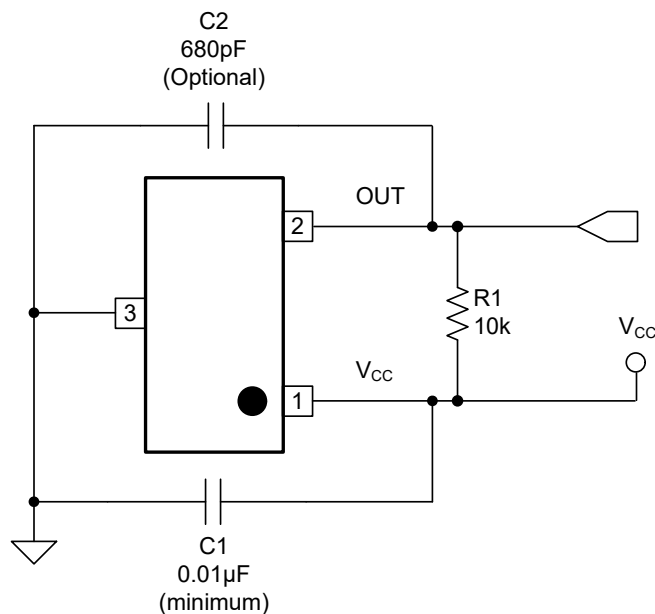


図 8-1. Typical Application Circuit

8.2.1.1 Design Requirements

For this design example, use the parameters listed in [表 8-1](#) as the input parameters.

表 8-1. Design Parameters

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

8.2.1.2 Detailed Design Procedure

表 8-2. External Components

TMAG5213 COMPONENT	PIN 1	PIN 2	RECOMMENDED
C1	V _{CC}	GND	A 0.01μF (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 TMAG5213 device, but a REF supply-voltage pullup is required for the OUT pin; the OUT pin can be pulled up to V_{CC}.

8.2.1.2.1 Configuration Example

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

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

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

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

Therefore:

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

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

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

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

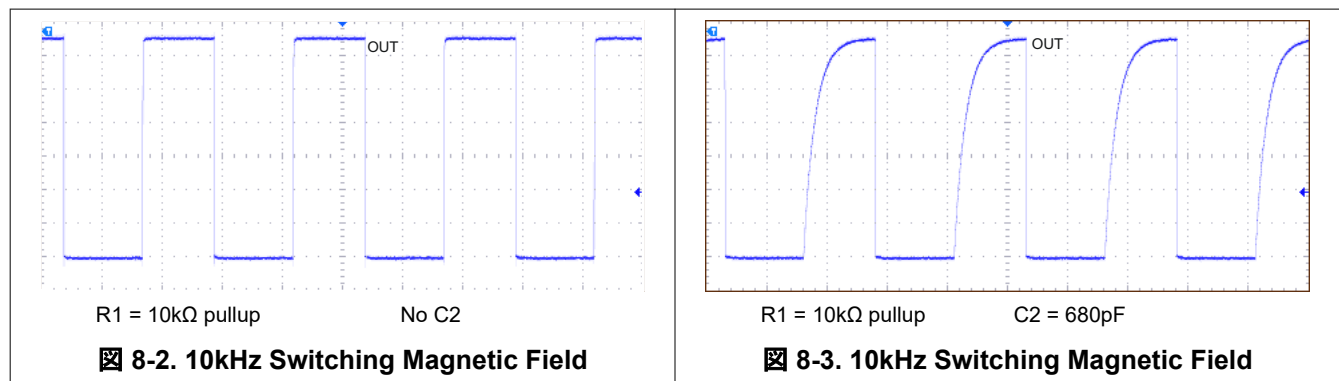
For this design example, use 式 7 to calculate the value of C2.

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

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

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

8.2.1.3 Application Curves



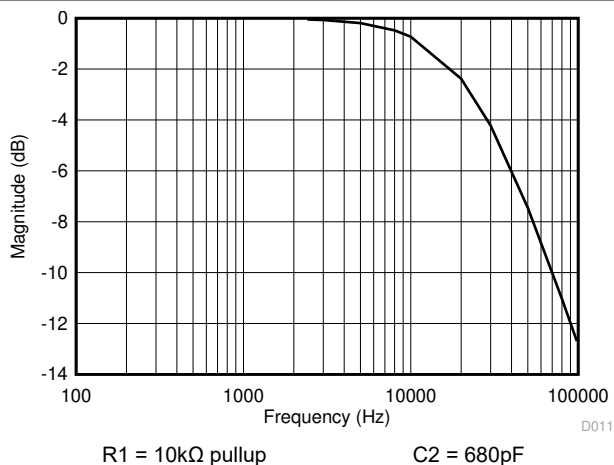


図 8-4. Low-Pass Filtering

8.3 Power Supply Recommendations

The TMAG5213 device is designed to operate from an input voltage supply range between 2.5V and 28V. A bypass 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 (minimum). To attenuate any significant high-frequency ripple and noise components generated by the power source, larger values of the bypass capacitor can be used. TI recommends limiting the supply voltage variation to less than 50mV_{PP}.

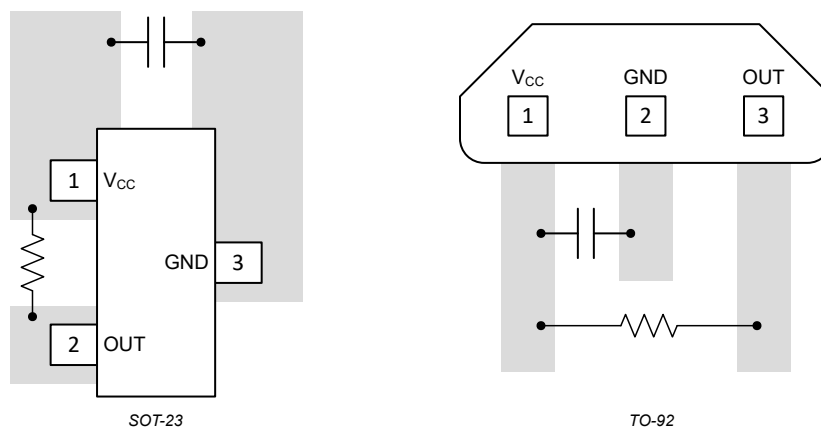
8.4 Layout

8.4.1 Layout Guidelines

Place the bypass capacitor near the TMAG5213 device for efficient power delivery with minimal inductance. Place the external pullup resistor 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.

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 (PCBs), which makes the placement of the magnet on the opposite side possible. Generally, using PCB copper planes underneath the TMAG5213 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, these components can redirect magnetic flux in unpredictable ways.

8.4.2 Layout Example



8-5. TMAG5213 Layout Example

9 Device and Documentation Support

9.1 Device Support

9.1.1 Device Nomenclature

図 9-1 shows a legend for reading the complete device name for and TMAG5213 device.

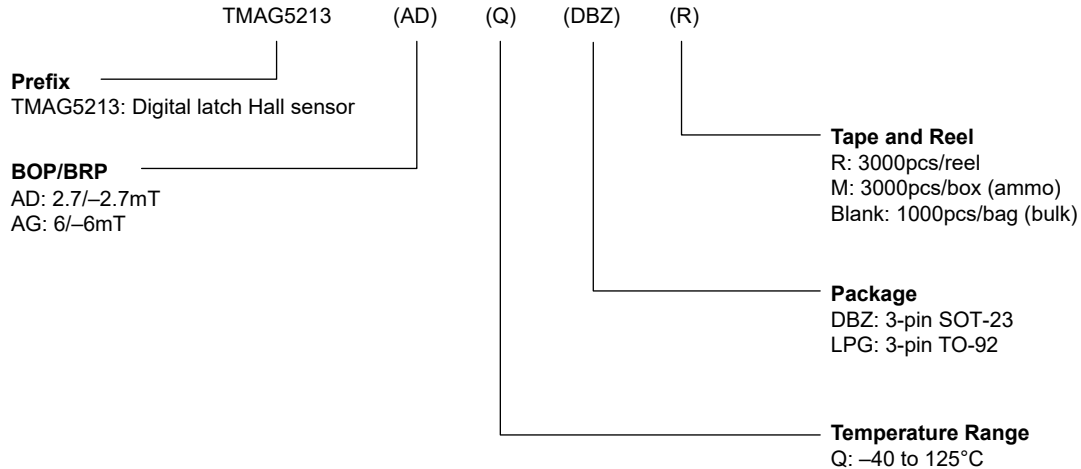


図 9-1. Device Nomenclature

9.1.2 Device Markings

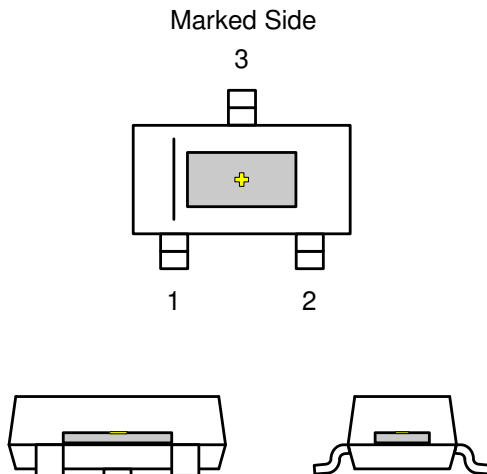


図 9-2. SOT-23 (DBZ) Package

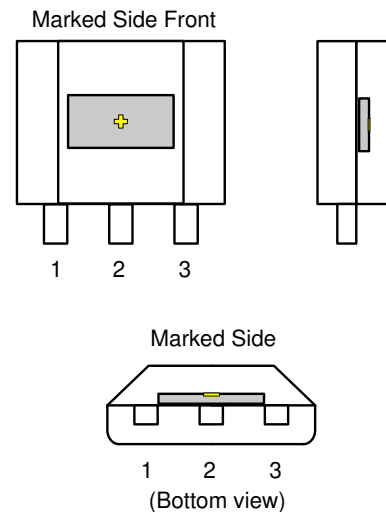


図 9-3. TO-92 (LPG, LPE) Package

9.2 ドキュメントの更新通知を受け取る方法

ドキュメントの更新についての通知を受け取るには、www.tij.co.jp のデバイス製品フォルダを開いてください。[通知] をクリックして登録すると、変更されたすべての製品情報に関するダイジェストを毎週受け取ることができます。変更の詳細については、改訂されたドキュメントに含まれている改訂履歴をご覧ください。

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9.6 用語集

[テキサス・インスツルメンツ用語集](#)

この用語集には、用語や略語の一覧および定義が記載されています。

10 Revision History

資料番号末尾の英字は改訂を表しています。その改訂履歴は英語版に準じています。

Changes from Revision * (March 2024) to Revision A (April 2024)	Page
• DBZ (SOT-23, 3) パッケージからプレビューの注を削除.....	1

11 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 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
TMAG5213ADQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	3ECH	Samples
TMAG5213ADQLPG	ACTIVE	TO-92	LPG	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 125	3EEJ	Samples
TMAG5213ADQLPGM	ACTIVE	TO-92	LPG	3	3000	RoHS & Green	SN	N / A for Pkg Type	-40 to 125	3EEJ	Samples
TMAG5213AGQDBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	SN	Level-1-260C-UNLIM	-40 to 125	3EDH	Samples
TMAG5213AGQLPG	ACTIVE	TO-92	LPG	3	1000	RoHS & Green	SN	N / A for Pkg Type	-40 to 125	3EFJ	Samples
TMAG5213AGQLPGM	ACTIVE	TO-92	LPG	3	3000	RoHS & Green	SN	N / A for Pkg Type	-40 to 125	3EFJ	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.

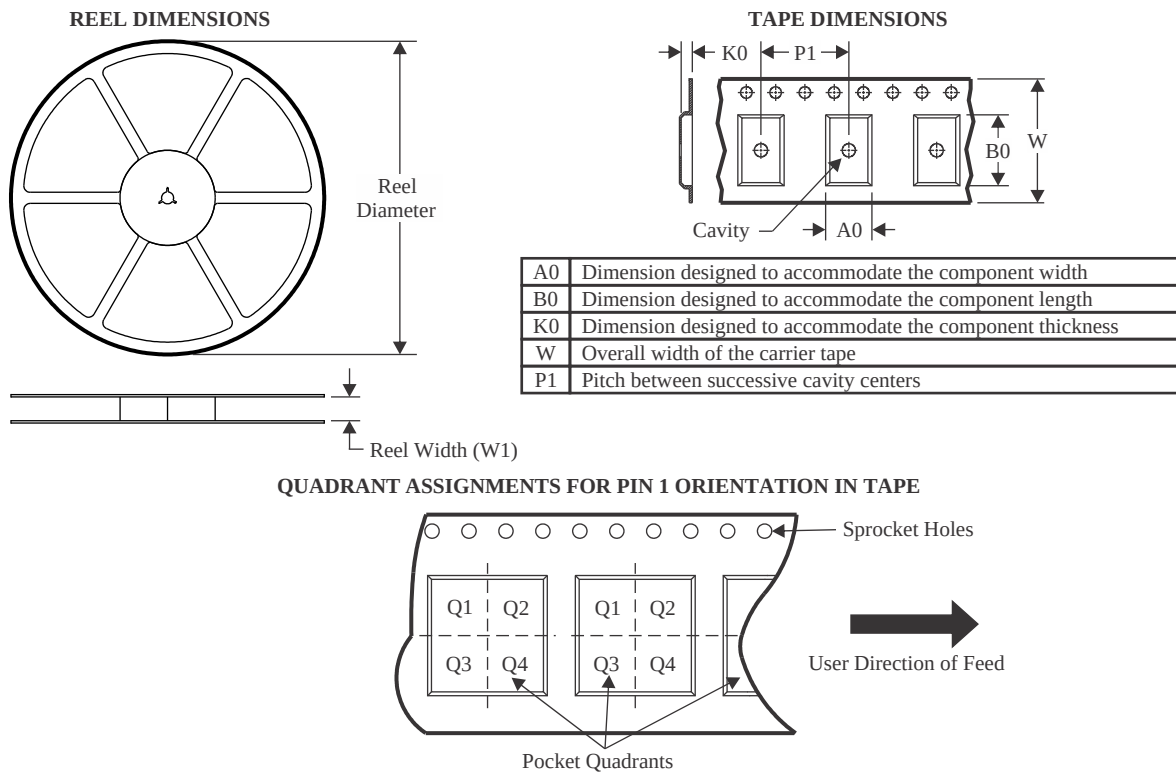
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(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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TAPE AND REEL INFORMATION



*All dimensions are nominal

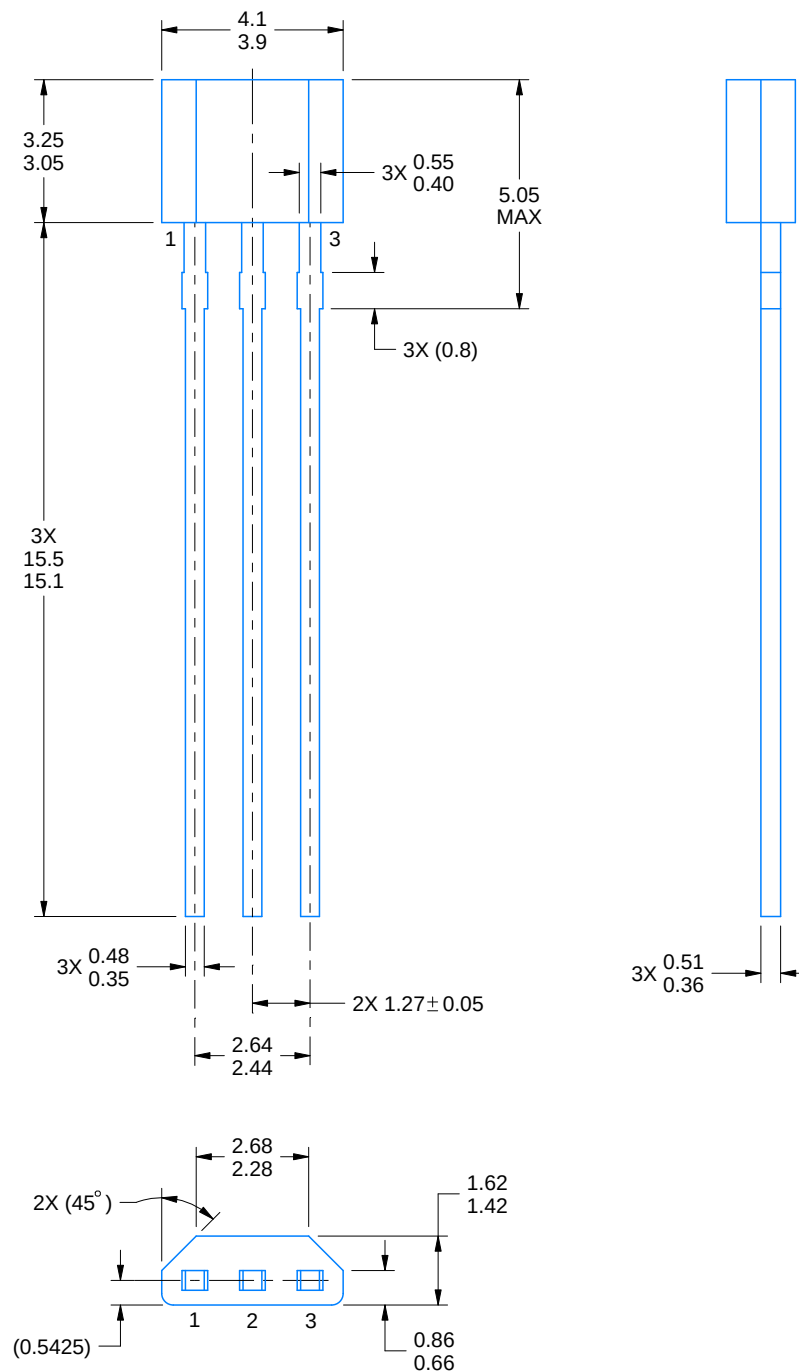
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMAG5213ADQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMAG5213AGQDBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMAG5213ADQDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TMAG5213AGQDBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0



4221343/C 01/2018

NOTES:

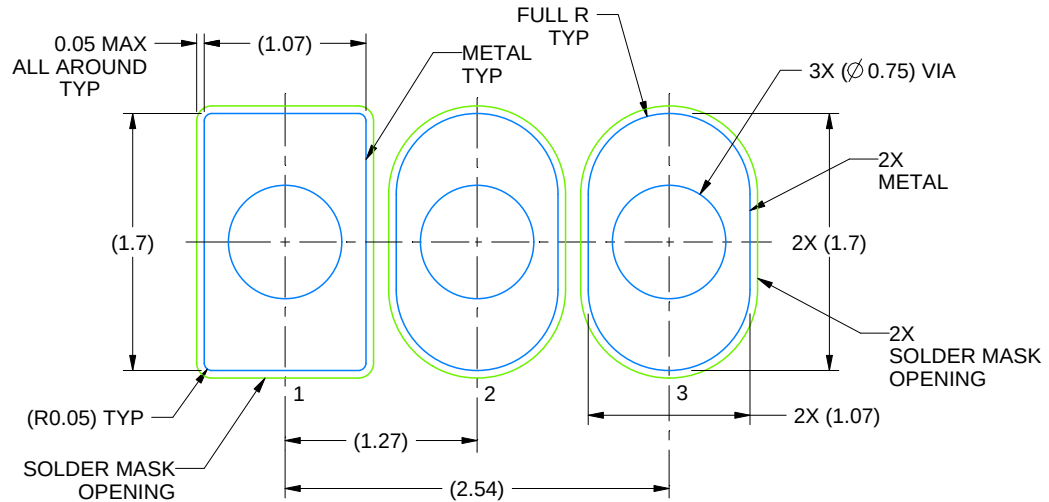
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.

EXAMPLE BOARD LAYOUT

LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



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

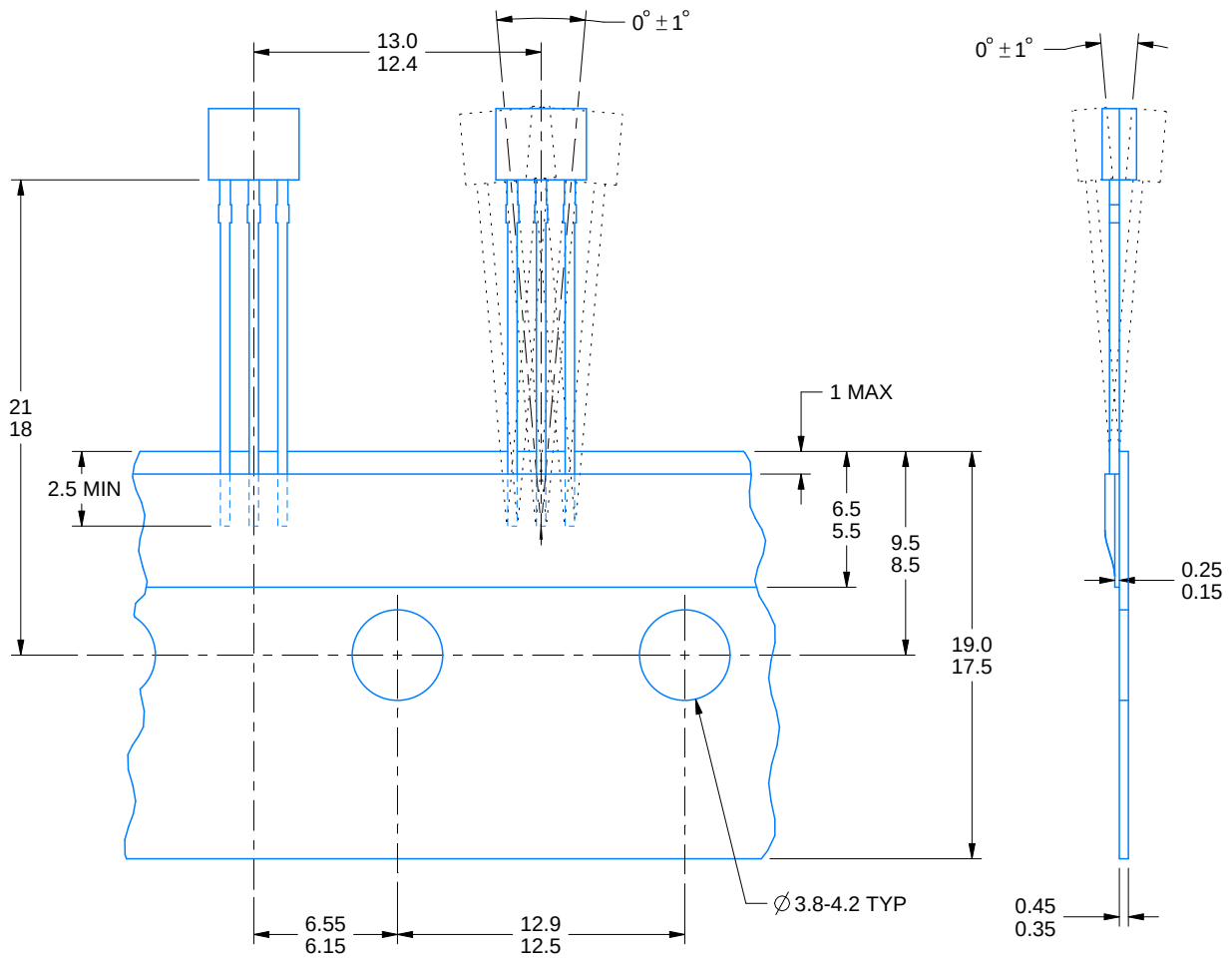
4221343/C 01/2018

TAPE SPECIFICATIONS

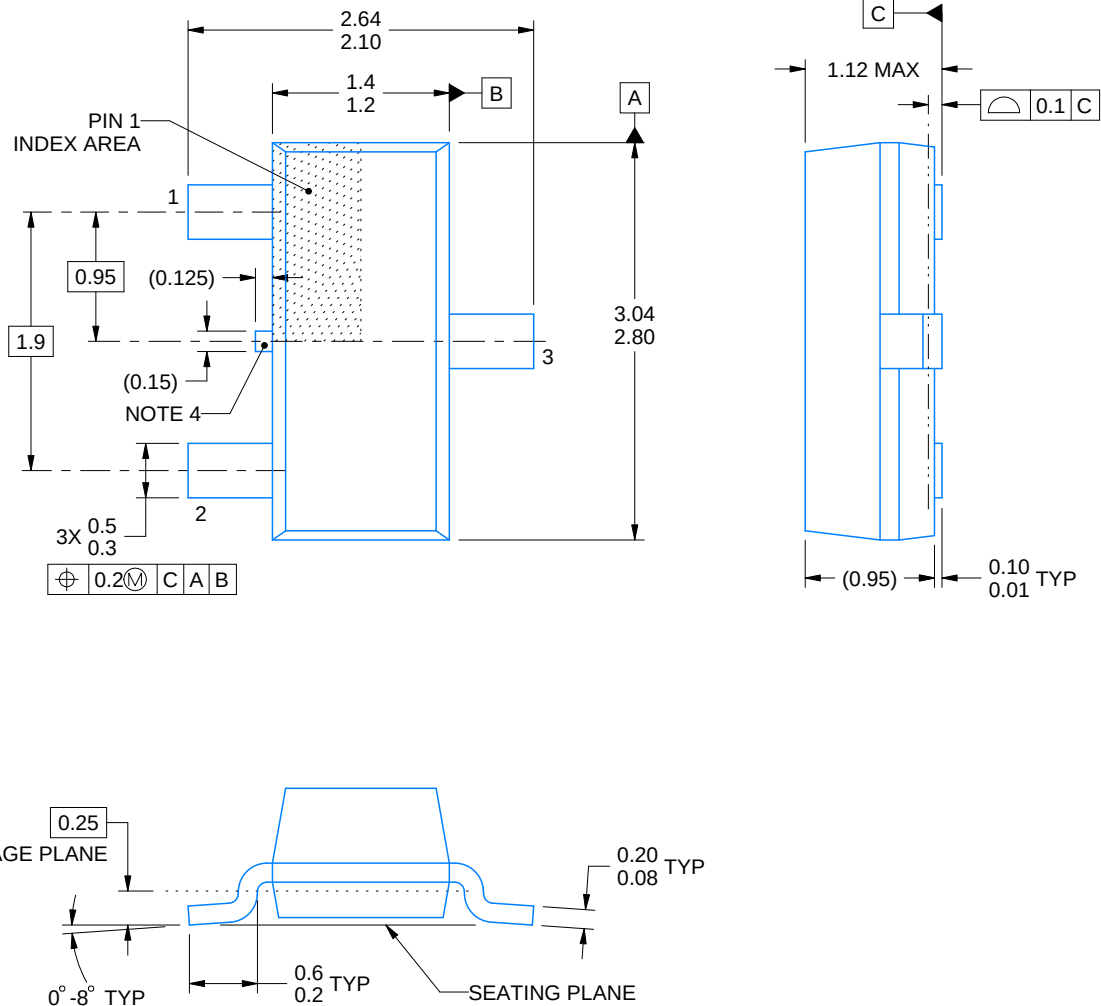
LPG0003A

TO-92 - 5.05 mm max height

TRANSISTOR OUTLINE



4221343/C 01/2018



4214838/D 03/2023

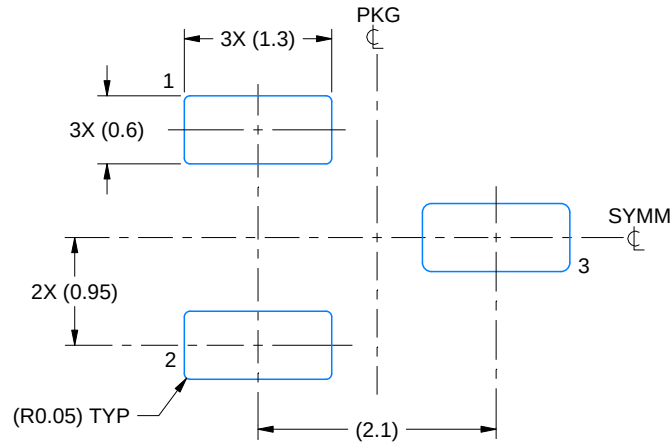
NOTES:

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.

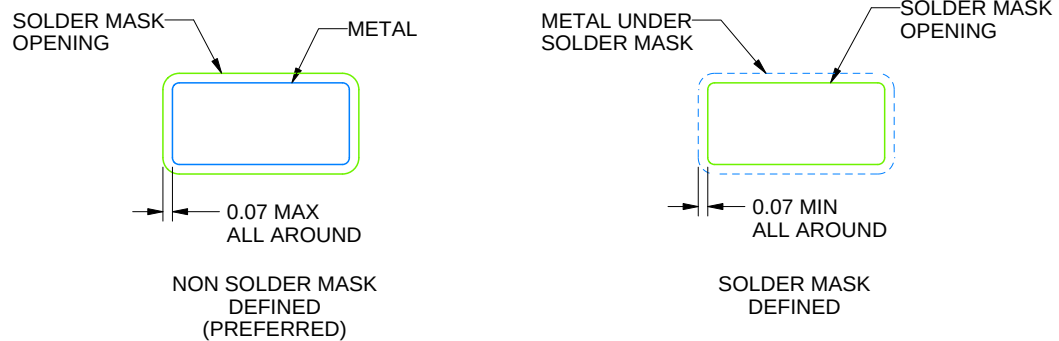
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/D 03/2023

NOTES: (continued)

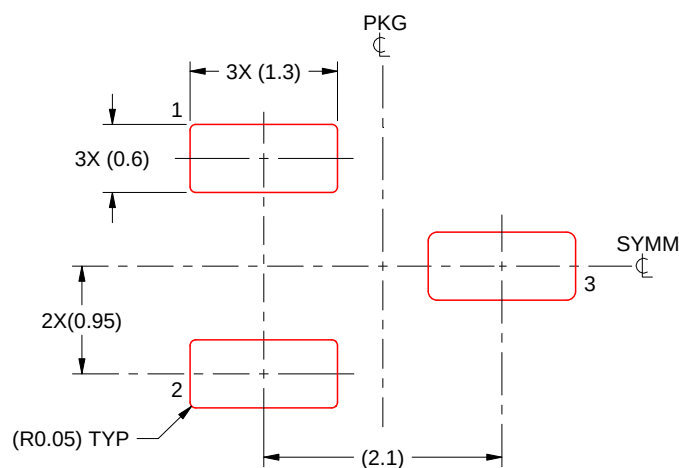
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



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

4214838/D 03/2023

NOTES: (continued)

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

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