

TMP23x 低功耗高精度模拟输出温度传感器

1 特性

- 具有成本效益的热敏电阻替代产品
- 在宽温度范围内具有高精度：
 - $\pm 2.5^{\circ}\text{C}$ (最大值)： -40°C 至 $+150^{\circ}\text{C}$ (TMP235)
 - $\pm 2.5^{\circ}\text{C}$ (最大值)： -10°C 至 $+125^{\circ}\text{C}$ (TMP236)
- 提供两种精度级别型号：
 - A2 级： $\pm 0.5^{\circ}\text{C}$ (典型值)
 - A4 级： $\pm 1^{\circ}\text{C}$ (典型值)
- 正斜率传感器增益，失调电压 (典型值)：
 - $10\text{mV}/^{\circ}\text{C}$, 0°C 下 500mV (TMP235)
 - $19.5\text{mV}/^{\circ}\text{C}$, 0°C 下 400mV (TMP236)
- 宽工作电源电压范围：
 - 2.3V 至 5.5V (TMP235)
 - 3.1V 至 5.5V (TMP236)
- 输出短路保护
- 低功耗： $9\mu\text{A}$ (典型值)
- 输出强大，可驱动高达 1000pF 的负载
- 提供的封装选项：
 - 5 引脚 SC70 (DCK) 表面贴装
 - 3 引脚 SOT-23 (DBZ) 表面贴装
 - 封装尺寸兼容符合行业标准的 LMT8x-Q1 和 LM20 温度传感器

2 应用

- 电网基础设施
- 无线和电信基础设施
- 汽车信息娱乐系统

- 工厂自动化和控制
- 测试和测量

3 说明

TMP23x 器件是一系列精密 CMOS 集成电路线性模拟温度传感器，其输出电压与温度成正比，工程师可以将其用于多种模拟温度检测应用。这些温度传感器比市面上同类引脚兼容器件的精确度更高，在 0°C 至 $+70^{\circ}\text{C}$ 温度范围内 $\pm 0.5^{\circ}\text{C}$ 的典型精度。该系列器件的精度经提高后，可适用于众多模拟温度检测应用。TMP235 器件在 -40°C 至 $+150^{\circ}\text{C}$ 完全温度范围和 2.3V 至 5.5V 电源电压范围内提供 $10\text{mV}/^{\circ}\text{C}$ 正斜率输出。具有更高增益的 TMP236 传感器在 -10°C 至 $+125^{\circ}\text{C}$ 温度范围和 3.1V 至 5.5V 电源电压范围内提供 $19.5\text{mV}/^{\circ}\text{C}$ 正斜率输出。

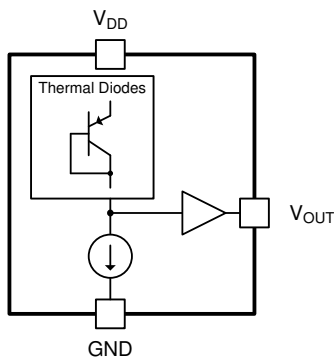
$9\mu\text{A}$ 典型静态电流和 $800\mu\text{s}$ 典型加电时间可实现有效的功率循环架构，以最大限度地降低电池供电设备的功率损耗。AB 类输出驱动器提供强大的 $500\mu\text{A}$ 最高输出，可驱动高达 1000pF 的电容负载，并可直接连接到模数转换器采样保持输入端。凭借出色的精确度和强大的线性输出驱动器，TMP23x 模拟输出温度传感器是具有成本效益的无源热敏电阻替代方案。

器件信息⁽¹⁾

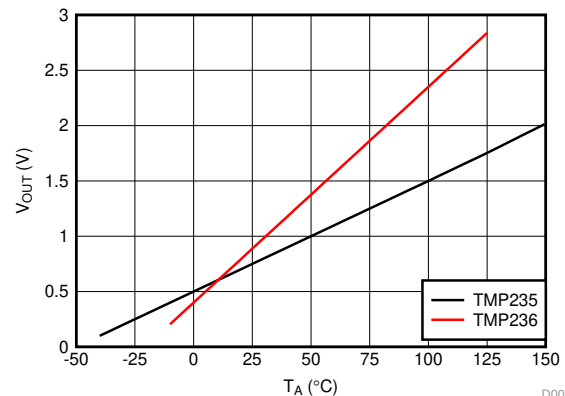
器件型号	封装	封装尺寸 (标称值)
TMP235, TMP236	SC70 (5)	2.00mm × 1.25mm
	SOT-23 (3)	2.92mm × 1.30mm

(1) 如需了解所有可用封装，请参阅产品说明书末尾的可订购产品附录。

功能方框图



输出电压与环境温度间的关系



D003



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4 修订历史记录

注：之前版本的页码可能与当前版本有所不同。

Changes from Revision D (August 2018) to Revision E	Page
• Changed recommended operating temperature range from: -50°C to 150°C to: -40°C to 150°C	4
• Changed power supply bypassing recommendations on how to avoid noise effect on the device output	12

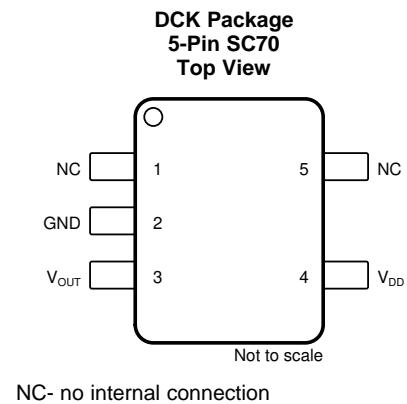
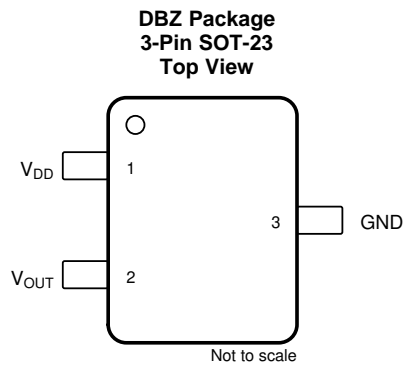
Changes from Revision C (August 2018) to Revision D	Page
• 将 DBZ (SOT-23) 封装状态从预览更改为生产数据	1

Changes from Revision B (February 2018) to Revision C	Page
• 添加了 DBZ (SOT-23) 预览封装	1
• Added TMP236 test conditions to the operating current parameters	5
• Added SOT-23 and SC70 package test conditions to the Accuracy Level 2 (A2) limits in the 0°C to 70°C range	5

Changes from Revision A (December 2017) to Revision B	Page
• 已更改 将典型精度规格参考值从 $\pm 1^{\circ}\text{C}$ 和 $\pm 2^{\circ}\text{C}$ 更改为 $\pm 0.5^{\circ}\text{C}$ 和 $\pm 1^{\circ}\text{C}$	1
• Deleted erroneous AOQL footnote	5
• Changed specification limits indicated in 图 1	6
• Added <i>Device Functional Modes</i> section	10

Changes from Original (September 2017) to Revision A	Page
• 已更改 将文档状态从“预告信息”更改成了“生产数据”	1

5 Pin Configuration and Functions



Pin Functions

NAME	PIN		TYPE	DESCRIPTION
	SOT-23	SC70		
GND	3	2	Ground	Power supply ground.
NC	—	5	—	No internal connection. This pin may be left floating or connected to GND.
NC	—	1	—	No internal connection. This pin may be left floating or connected to GND.
V _{OUT}	2	3	O	Outputs voltage proportional to temperature
V _{DD}	1	4	I	Positive supply input

6 Specifications

6.1 Absolute Maximum Ratings

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

	MIN	MAX	UNIT
Supply voltage, V_{DD}		+6	V
Output voltage, V_{OUT}	-0.3	($V_{DD} + 0.3$)	
Output current	-30	+30	mA
Latch-up current, each pin	-200	+200	
Junction temperature (T_J)		+150	°C
Storage temperature (T_{stg})	-65	+150	

- (1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These stress ratings only, which do not imply functional operation of the device at these or any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

6.2 ESD Ratings

			VALUE	UNIT
$V_{(ESD)}$	Electrostatic discharge	Human-body model (HBM) per JESD22-A114 ⁽¹⁾	±4000	V
		Charged-device model (CDM), per JEDEC specification JESD22-C101 ⁽²⁾	±1000	

- (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.

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{DD}	Input voltage (TMP235)	2.3		5.5	V
	Input voltage (TMP236)	3.1		5.5	
T_A	Operating free-air temperature	-40		150	°C

6.4 Thermal Information

THERMAL METRIC ⁽¹⁾⁽²⁾		TMP235		UNIT
		DCK (SC70)	DBZ (SOT-23)	
		PINS	PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance ⁽³⁾⁽⁴⁾	275	167	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	84	90	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	56	146	°C/W
Ψ_{JT}	Junction-to-top characterization parameter	1.2	35	°C/W
Ψ_{JB}	Junction-to-board characterization parameter	55	146	°C/W

- (1) For more information about traditional and new thermal metrics, see the [Semiconductor and IC Package Thermal Metrics](#) application report.
 (2) For information on self-heating and thermal response time see [Layout Guidelines](#) section.
 (3) The junction to ambient thermal resistance ($R_{\theta JA}$) under natural convection is obtained in a simulation on a JEDEC-standard, High-K board as specified in JESD51-7, in an environment described in JESD51-2. Exposed pad packages assume that thermal vias are included in the PCB, per JESD 51-5.
 (4) Changes in output due to self heating can be computed by multiplying the internal dissipation by the thermal resistance.

6.5 Electrical Characteristics

TMP235: $V_{DD} = 2.3\text{ V to }5.5\text{ V}$, GND = Ground, $T_A = -40^\circ\text{C to }+125^\circ\text{C}$ and no load (unless otherwise noted)

TMP236: $V_{DD} = 3.1\text{ V to }5.5\text{ V}$, GND = Ground, $T_A = -10^\circ\text{C to }+125^\circ\text{C}$ and no load (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
POWER SUPPLY							
I_{DD}	Operating current	$T_A = 25^\circ\text{C}$, $V_{DD} = 2.3\text{ V}$, TMP235			9		μA
		$T_A = 25^\circ\text{C}$, $V_{DD} = 3.1\text{ V}$, TMP236			10		
		$T_A = -40^\circ\text{C to }+125^\circ\text{C}$, TMP235				14.5	
		$T_A = -10^\circ\text{C to }+125^\circ\text{C}$, TMP236				15	
		$T_A = 150^\circ\text{C}$, TMP235				17	
$\Delta^\circ\text{C}/\Delta V_{DD}$	Line regulation			-0.1	0.02	0.1	$^\circ\text{C}/\text{V}$
SENSOR ACCURACY							
T_{ACY}	Temperature accuracy ⁽¹⁾		$T_A = 25^\circ\text{C}$		± 0.5		$^\circ\text{C}$
			$T_A = 0^\circ\text{C to }70^\circ\text{C}$ (SC70 Package)	-1	± 0.5	+1	
			$T_A = 0^\circ\text{C to }70^\circ\text{C}$ (SOT-23 Package)	-1.2	± 0.5	+1.2	
			$T_A = -40^\circ\text{C to }+125^\circ\text{C}$ (TMP235A2)	-2	± 0.5	+2	
			$T_A = -10^\circ\text{C to }+125^\circ\text{C}$ (TMP236A2)	-2	± 0.5	+2	
			$T_A = -40^\circ\text{C to }+150^\circ\text{C}$ (TMP235A2)	-2	± 0.5	+2	
		Accuracy Level 4 (A4)	$T_A = 25^\circ\text{C}$		± 1		
			$T_A = 0^\circ\text{C to }70^\circ\text{C}$	-2	± 1	+2	
			$T_A = -40^\circ\text{C to }+125^\circ\text{C}$ (TMP235A4)	-4	± 1	+4	
			$T_A = -10^\circ\text{C to }+125^\circ\text{C}$ (TMP236A4)	-4	± 1	+4	
	$T_A = -40^\circ\text{C to }+150^\circ\text{C}$ (TMP235A4)	-5	± 1	+5			
SENSOR OUTPUT							
$V_{0^\circ\text{C}}$	Output voltage offset at 0°C	TMP235			500		mV
		TMP236			400		
T_C	Temperature coefficient (sensor gain)	TMP235			10		$\text{mV}/^\circ\text{C}$
		TMP236			19.5		
V_{ONL}	Output nonlinearity ⁽¹⁾	$T_A = 0^\circ\text{C to }70^\circ\text{C}$, no load			± 0.5		$^\circ\text{C}$
I_{OUT}	Output current					500	μA
Z_{OUT}	Output impedance	$I_{OUT} = 100\ \mu\text{A}$, $f = 100\text{ Hz}$			20		Ω
		$I_{OUT} = 100\ \mu\text{A}$, $f = 500\text{ Hz}$			50		
	Output load regulation	$T_A = 0^\circ\text{C to }70^\circ\text{C}$, $I_{OUT} = 100\ \mu\text{A}$, $\Delta V_{OUT} / \Delta I_{OUT}$			1		Ω
t_{ON}	Turn on time	Time to reach accuracy within $\pm 0.5^\circ\text{C}$			800		μs
C_{LOAD}	Typical load capacitance					1000	pF
t_{RES}	Thermal response to 63%	SC70	30°C (Air) to $+125^\circ\text{C}$ (Fluid Bath)		1.3		s

- (1) Accuracy is defined as the error between the measured and reference output voltages, tabulated in the [TMP235 Transfer Table](#) and [TMP236 Transfer Table](#) at the specified conditions of supply voltage and temperature (expressed in $^\circ\text{C}$). Accuracy limits include line regulation within the specified conditions. Accuracy limits do not include load regulation; they assume no DC load.

6.6 Typical Characteristics

at $T_A = 25^\circ\text{C}$, (unless otherwise noted)

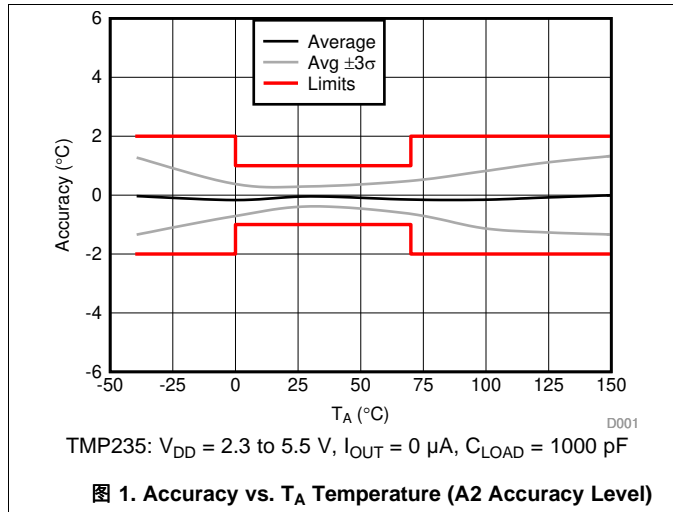


图 1. Accuracy vs. T_A Temperature (A2 Accuracy Level)

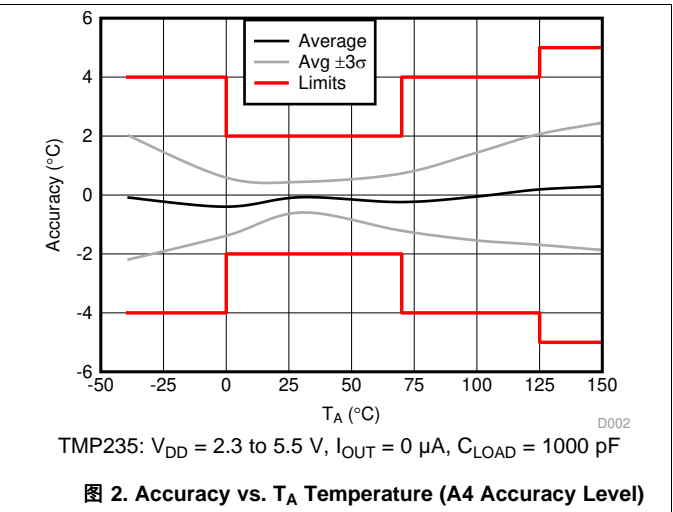


图 2. Accuracy vs. T_A Temperature (A4 Accuracy Level)

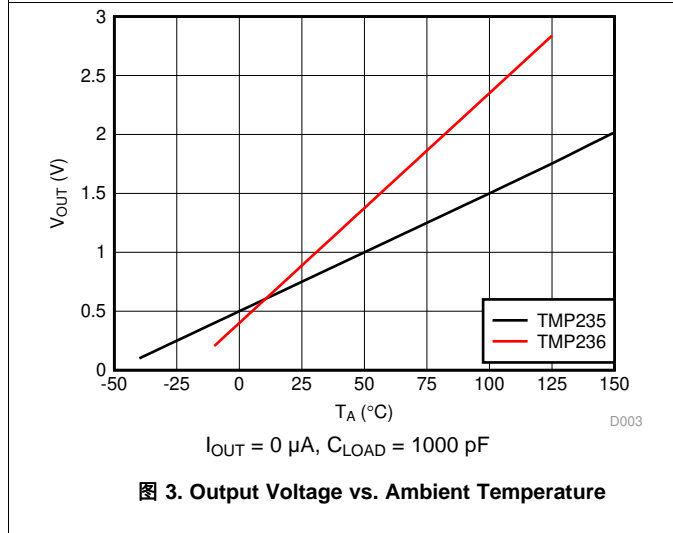


图 3. Output Voltage vs. Ambient Temperature

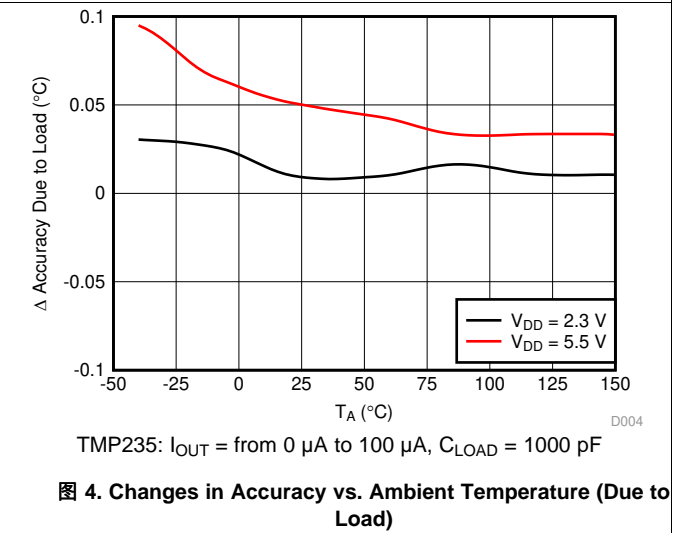


图 4. Changes in Accuracy vs. Ambient Temperature (Due to Load)

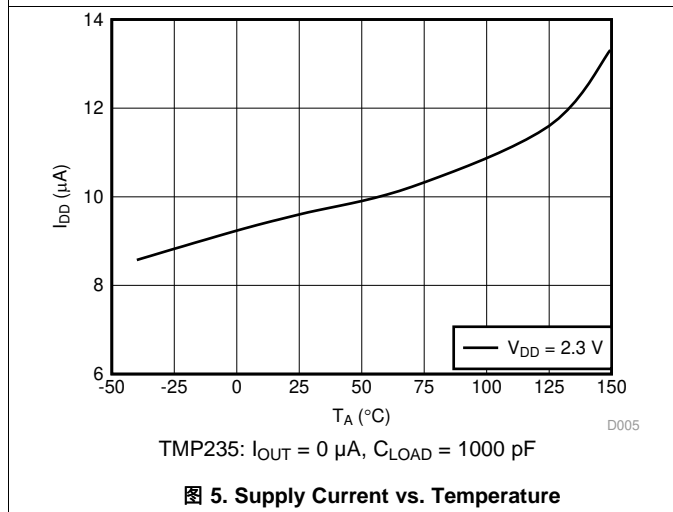


图 5. Supply Current vs. Temperature

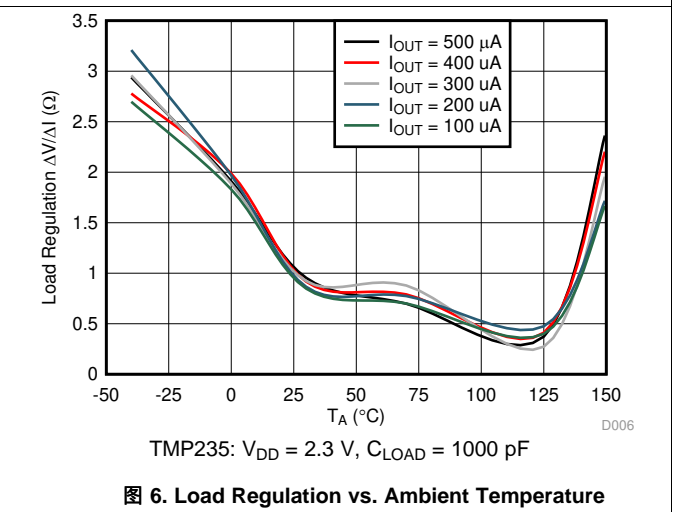


图 6. Load Regulation vs. Ambient Temperature

Typical Characteristics (接下页)

at $T_A = 25^\circ\text{C}$, (unless otherwise noted)

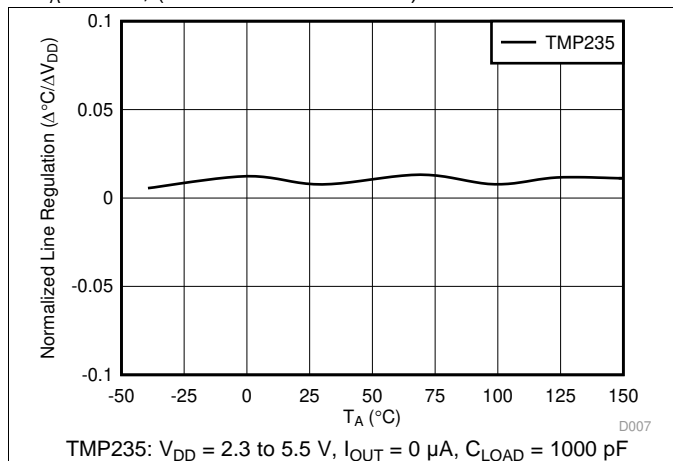


图 7. Line Regulation ($\Delta^\circ\text{C} / \Delta V_{\text{DD}}$) vs. Ambient Temperature

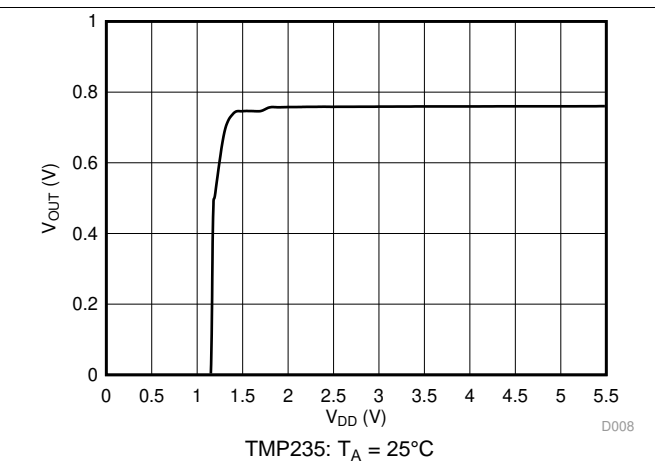


图 8. Output Voltage vs. Power Supply

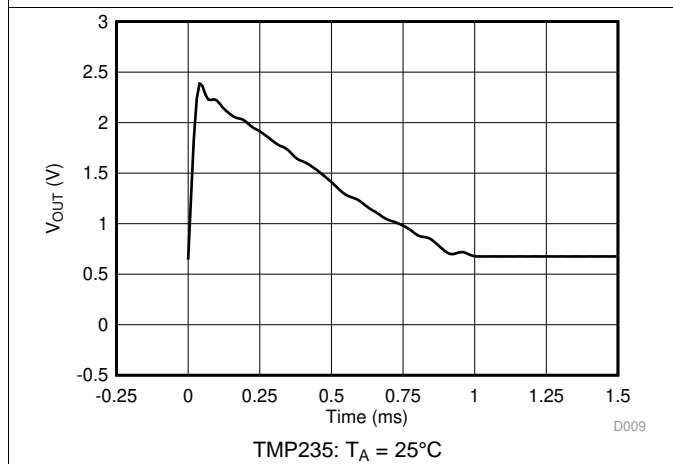


图 9. Output vs. Settling Time to Step V_{DD}

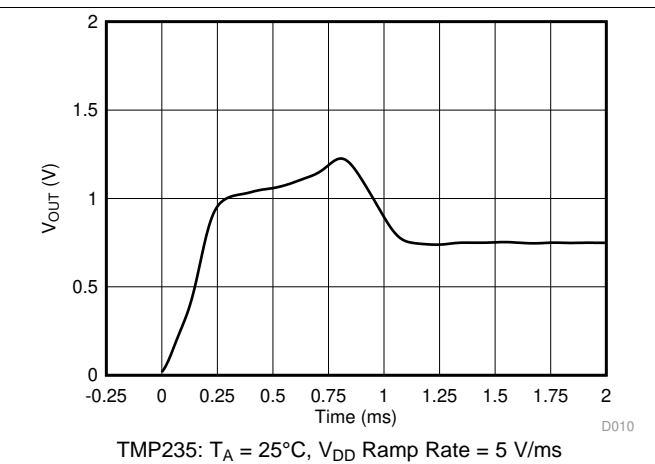


图 10. Output vs. Settling Time to Ramp V_{DD}

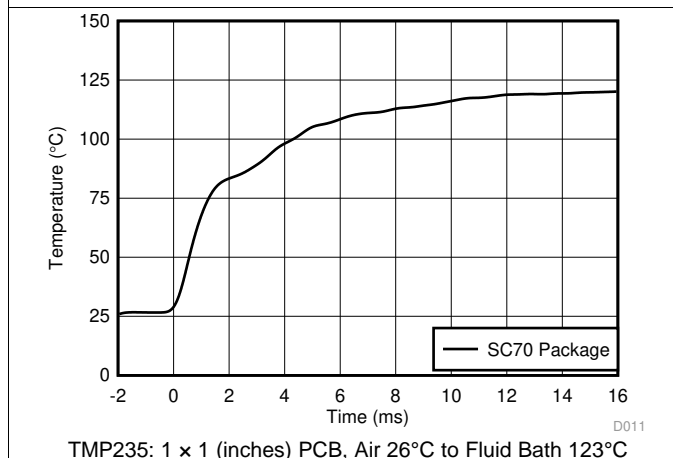


图 11. Thermal Response (Air-to-Fluid Bath)

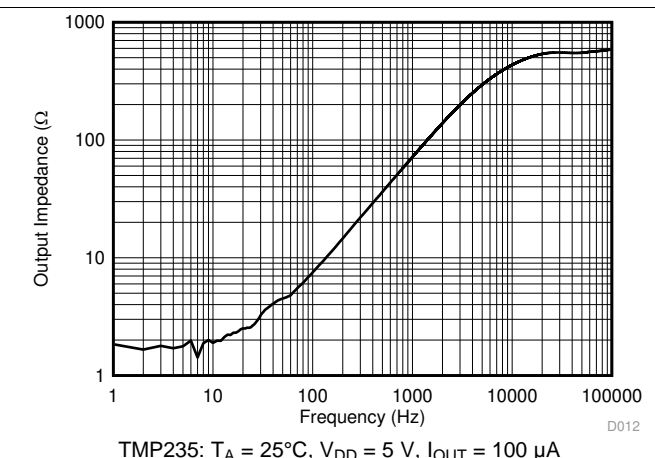


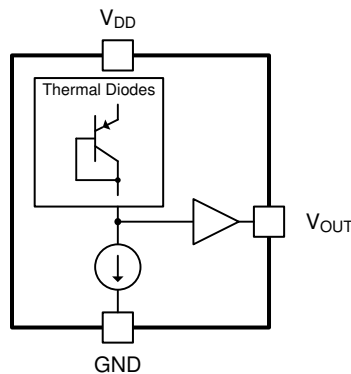
图 12. Output Impedance vs. Frequency

7 Detailed Description

7.1 Overview

The TMP23x devices are a family of linear analog temperature sensors with an output voltage proportional to temperature. These temperature sensors have an accuracy from 0°C to 70°C of ±1.25°C (TMP23xA2) and ±2°C (TMP23xA4). The TMP235 device provides a positive slope output of 10 mV/°C over the full –40°C to +150°C temperature range and a supply range from 2.3 V to 5.5 V. The higher gain TMP236 sensor provides a positive slope output of 19.5 mV/°C from –10°C to +125°C and a supply range from 3.1 V to 5.5 V. A class-AB output driver provides a maximum output of 500 µA to drive capacitive loads up to 1000 pF.

7.2 Functional Block Diagram



7.3 Feature Description

As shown in 图 3, the TMP23x devices are linear. A small V_{OUT} gain shift, however, is present at temperatures above 100°C. When small shifts are expected, a piecewise linear function provides the best accuracy and is used for the device accuracy specifications (see [Specifications](#)). Typical output voltages of the TMP23x devices across the full operating temperature range are listed in 表 3 and 表 4. The ideal linear columns represent the ideal linear V_{OUT} output response with respect to temperature, while the piecewise linear columns indicate the small voltage shift at elevated temperatures.

The piecewise linear function uses three temperature ranges listed in 表 1 and 表 2. In equation form, the voltage output V_{OUT} of the TMP23x is calculated by 公式 1:

$$V_{OUT} = (T_A - T_{INFL}) \times T_C + V_{OFFS}$$

where

- V_{OUT} is the TMP23x voltage output for a given temperature
- T_A is the ambient temperature in °C
- T_{INFL} is the temperature inflection point for a piecewise segment in °C
- T_C is the TMP23x temperature coefficient or gain
- V_{OFFS} is the TMP23x voltage offset

(1)

Therefore, the T_A temperature for a given V_{OUT} voltage output within a piecewise voltage range (V_{RANGE}) is calculated in 公式 2. For applications where the accuracy enhancement above 100°C is not required, use the first row of 表 1 and 表 2 for all voltages.

$$T_A = (V_{OUT} - V_{OFFS}) / T_C + T_{INFL}$$

(2)

表 1. TMP235 Piecewise Linear Function Summary

T_A RANGE (°C)	V_{RANGE} (mV)	T_{INFL} (°C)	T_C (mV/°C)	V_{OFFS} (mV)
–40 to +100	< 1500	0	10	500
100 to 125	1500 to 1752.5	100	10.1	1500
125 to 150	> 1752.5	125	10.6	1752.5

表 2. TMP236 Piecewise Linear Function Summary

T _A RANGE (°C)	V _{RANGE} (mV)	T _{INFL} (°C)	T _C (mV/°C)	V _{OFFS} (mV)
-40 to +100	≤ 2350	0	19.5	400
100 to 125	> 2350	100	19.7	2350
125 to 150	—	—	—	—

表 3. TMP235 Transfer Table

TEMPERATURE (°C)	V _{OUT} (mV) IDEAL LINEAR VALUES	V _{OUT} (mV) PIECEWISE LINEAR VALUES
-40	100	100
-35	150	150
-30	200	200
-25	250	250
-20	300	300
-15	350	350
-10	400	400
-5	450	450
0	500	500
5	550	550
10	600	600
15	650	650
20	700	700
25	750	750
30	800	800
35	850	850
40	900	900
45	950	950
50	1000	1000
55	1050	1050
60	1100	1100
65	1150	1150
70	1200	1200
75	1250	1250
80	1300	1300
85	1350	1350
90	1400	1400
95	1450	1450
100	1500	1500
105	1550	1550.5
110	1600	1601
115	1650	1651.5
120	1700	1702
125	1750	1752.5
130	1800	1805.5
135	1850	1858.5
140	1900	1911.5
145	1950	1964.5
150	2000	2017.5

表 4. TMP236 Transfer Table

TEMPERATURE (°C)	V _{OUT} (mV) IDEAL LINEAR VALUES	V _{OUT} (mV) PIECEWISE LINEAR VALUES
-40	—	—
-35	—	—
-30	—	—
-25	—	—
-20	—	—
-15	—	—
-10	205	205
-5	303	303
0	400	400
5	498	498
10	595	595
15	693	693
20	790	790
25	888	888
30	985	985
35	1083	1083
40	1180	1180
45	1278	1278
50	1375	1375
55	1473	1473
60	1570	1570
65	1668	1668
70	1765	1765
75	1863	1863
80	1960	1960
85	2058	2058
90	2155	2155
95	2253	2253
100	2350	2350
105	2448	2448.5
110	2545	2547
115	2643	2645.4
120	2740	2743.9
125	2838	2842.4
130	—	—
135	—	—
140	—	—
145	—	—
150	—	—

7.4 Device Functional Modes

The singular functional mode of the TMP23x is an analog output directly proportional to temperature.

8 Application and Implementation

NOTE

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

8.1 Application Information

The features of the TMP235 make the series of devices designed for various general temperature-sensing applications. The TMP235 and TMP236 devices can operate down to a 2.3-V and a 3.1-V supply with 9- μ A power consumption, respectively. As a result, the series is designed for battery-powered applications. The TMP23x series is mounted in two surface mount technology packages (SC70 and SOT-23.)

8.2 Typical Application

8.2.1 Connection to an ADC

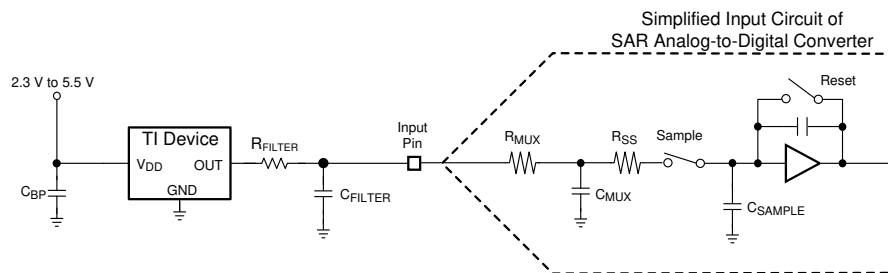


Figure 13. Suggested Connections to an ADC Input Stage

8.2.1.1 Design Requirements

See [Figure 13](#) for suggested connections to an ADC input stage. Most CMOS-based ADCs have a sampled data comparator input structure. When the ADC charges the sampling capacitor (C_{SAMPLE}), the capacitor requires instantaneous charge from the output of the analog source temperature sensor, such as the TMP23x. Therefore, the output impedance of the temperature sensor can affect ADC performance. In most cases, adding an external capacitor (C_{FILTER}) mitigates design challenges. The TMP23x is specified and characterized with a 1000-pF maximum capacitive load (C_{LOAD}). [Figure 13](#) shows C_{LOAD} as the sum of $C_{FILTER} + C_{MUX} + C_{SAMPLE}$. TI recommends maximizing the C_{FILTER} value while allowing for the maximum specified ADC input capacitance ($C_{MUX} + C_{SAMPLE}$) to limit the total C_{LOAD} at 1000 pF. In most cases, a 680-pF C_{FILTER} provides a reasonable allowance for ADC input capacitance to minimize ADC sampling error and reduce noise coupling. An optional series resistor (R_{FILTER}) and C_{FILTER} provides additional low-pass filtering to reject system level noise. TI recommends placing R_{FILTER} and C_{FILTER} as close as possible to the ADC input for optimal performance.

8.2.1.2 Detailed Design Procedure

Depending on the input characteristics of the ADC, an external C_{FILTER} may be required. The value of C_{FILTER} depends on the size of the sampling capacitor (C_{SAMPLE}) and the sampling frequency while observing a maximum C_{LOAD} of 1000 pF. The capacitor requirements can vary because the input stages of all ADCs are not identical. [Figure 13](#) shows a general ADC application as an example only.

Typical Application (continued)

8.2.1.3 Application Curve

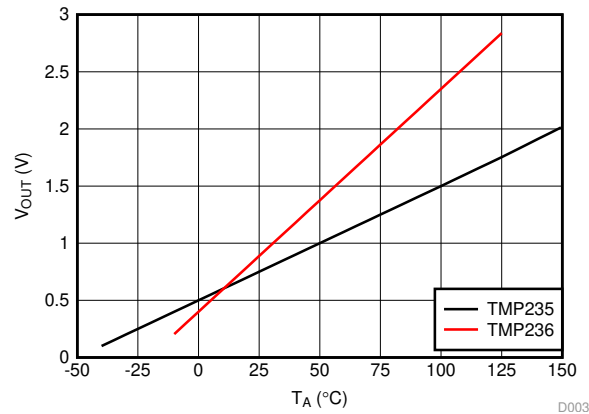


Figure 14. Output Voltage vs. Ambient

9 Power Supply Recommendations

The low supply current and supply range of the TMP23x allow the device to be easily powered from many sources.



Power supply bypassing is strongly recommended. In noisy environments, TI recommends to add a filter with 0.1- μ F capacitor and 100- Ω resistor between external supply and V_{DD} to limit the power supply noise. Larger capacitances may be required and are dependent on the noise of the power supply.

10 Layout

10.1 Layout Guidelines

The layout of the TMP23x series is simple. If a power supply bypass capacitor is used, the capacitor must be connected as [Layout Examples](#) shows.

10.2 Layout Examples

-  VIA to ground plane
-  VIA to power plane

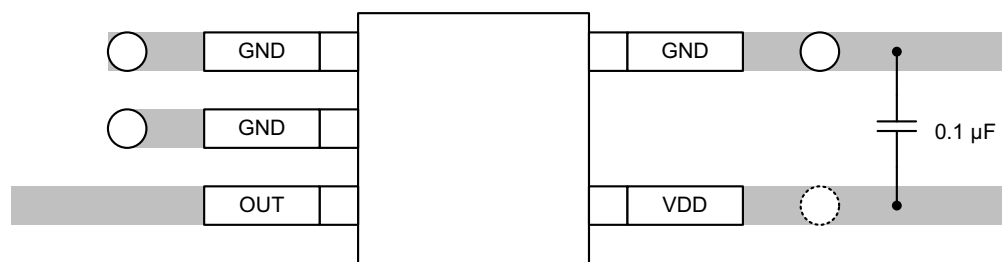


Figure 15. Recommended Layout: SC70 Package

11 器件和文档支持

11.1 相关链接

下表列出了快速访问链接。类别包括技术文档、支持和社区资源、工具和软件，以及立即订购快速访问。

表 5. 相关链接

器件	产品文件夹	立即订购	技术文档	工具与软件	支持和社区
TMP235	单击此处	单击此处	单击此处	单击此处	单击此处
TMP236	单击此处	单击此处	单击此处	单击此处	单击此处

11.2 接收文档更新通知

要接收文档更新通知，请导航至 TI.com.cn 上的器件产品文件夹。单击右上角的 [通知我](#) 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。

11.3 社区资源

The following links connect to TI community resources. Linked contents are 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](#).

TI E2E™ Online Community *TI's Engineer-to-Engineer (E2E) Community*. Created to foster collaboration among engineers. At e2e.ti.com, you can ask questions, share knowledge, explore ideas and help solve problems with fellow engineers.

Design Support *TI's Design Support* Quickly find helpful E2E forums along with design support tools and contact information for technical support.

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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。

11.6 Glossary

[SLYZ022](#) — *TI Glossary*.

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

12 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
TMP235A2DBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-40 to 150	2352	Samples
TMP235A2DBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-40 to 150	2352	Samples
TMP235A2DCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 150	19L	Samples
TMP235A2DCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 150	19L	Samples
TMP235A4DBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-40 to 150	2354	Samples
TMP235A4DBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-40 to 150	2354	Samples
TMP235A4DCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 150	19M	Samples
TMP235A4DCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-40 to 150	19M	Samples
TMP236A2DBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-10 to 125	2362	Samples
TMP236A2DBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-10 to 125	2362	Samples
TMP236A2DCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-10 to 125	1BS	Samples
TMP236A2DCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-10 to 125	1BS	Samples
TMP236A4DBZR	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-10 to 125	2364	Samples
TMP236A4DBZT	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG SN	Level-1-260C-UNLIM	-10 to 125	2364	Samples
TMP236A4DCKR	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-10 to 125	1BT	Samples
TMP236A4DCKT	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAU NIPDAUAG	Level-1-260C-UNLIM	-10 to 125	1BT	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.

OBSELETE: 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 ≤ 1000 ppm threshold. Antimony trioxide based flame retardants must also meet the ≤ 1000 ppm 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.

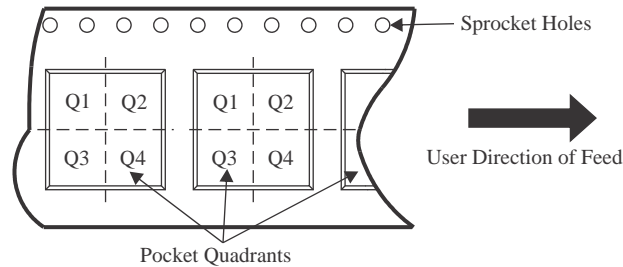
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TAPE AND REEL INFORMATION



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
TMP235A2DBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP235A2DBZT	SOT-23	DBZ	3	250	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP235A2DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP235A2DCKR	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235A2DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP235A2DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235A2DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235A4DBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP235A4DBZT	SOT-23	DBZ	3	250	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP235A4DCKR	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235A4DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP235A4DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP235A4DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235A4DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP236A2DBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP236A2DBZT	SOT-23	DBZ	3	250	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP236A2DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP236A2DCKR	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMP236A2DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP236A2DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP236A4DBZR	SOT-23	DBZ	3	3000	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP236A4DBZT	SOT-23	DBZ	3	250	180.0	8.4	3.2	2.85	1.3	4.0	8.0	Q3
TMP236A4DCKR	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP236A4DCKR	SC70	DCK	5	3000	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3
TMP236A4DCKT	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP236A4DCKT	SC70	DCK	5	250	178.0	9.0	2.4	2.5	1.2	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS

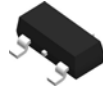


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP235A2DBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TMP235A2DBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
TMP235A2DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
TMP235A2DCKR	SC70	DCK	5	3000	183.0	183.0	20.0
TMP235A2DCKT	SC70	DCK	5	250	180.0	180.0	18.0
TMP235A2DCKT	SC70	DCK	5	250	183.0	183.0	20.0
TMP235A4DBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TMP235A4DBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
TMP235A4DCKR	SC70	DCK	5	3000	183.0	183.0	20.0
TMP235A4DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
TMP235A4DCKT	SC70	DCK	5	250	180.0	180.0	18.0
TMP235A4DCKT	SC70	DCK	5	250	183.0	183.0	20.0
TMP236A2DBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TMP236A2DBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
TMP236A2DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
TMP236A2DCKR	SC70	DCK	5	3000	183.0	183.0	20.0
TMP236A2DCKT	SC70	DCK	5	250	180.0	180.0	18.0
TMP236A2DCKT	SC70	DCK	5	250	183.0	183.0	20.0

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP236A4DBZR	SOT-23	DBZ	3	3000	210.0	185.0	35.0
TMP236A4DBZT	SOT-23	DBZ	3	250	210.0	185.0	35.0
TMP236A4DCKR	SC70	DCK	5	3000	183.0	183.0	20.0
TMP236A4DCKR	SC70	DCK	5	3000	180.0	180.0	18.0
TMP236A4DCKT	SC70	DCK	5	250	183.0	183.0	20.0
TMP236A4DCKT	SC70	DCK	5	250	180.0	180.0	18.0

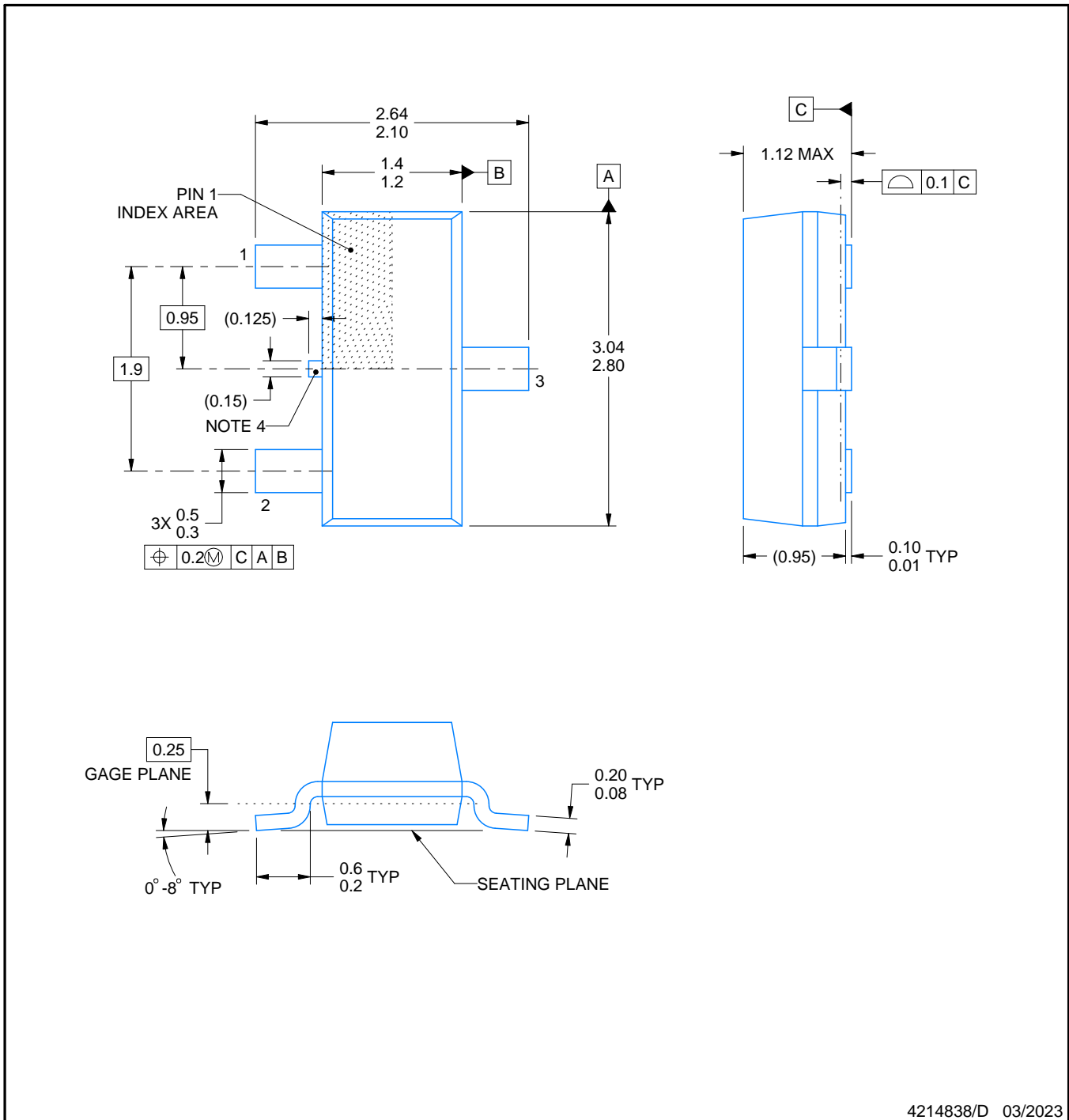
DBZ0003A



PACKAGE OUTLINE

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



4214838/D 03/2023

NOTES:

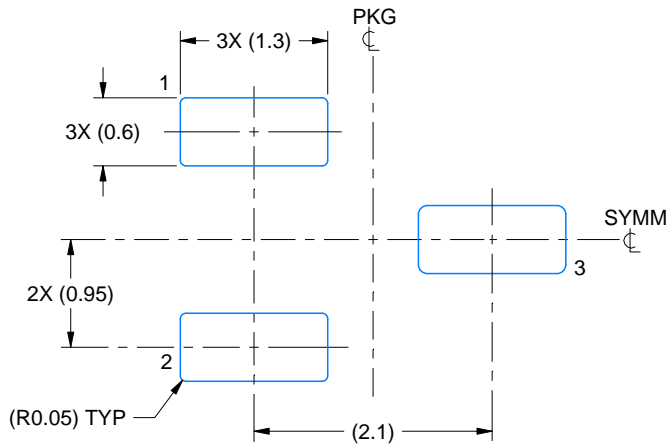
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC registration TO-236, except minimum foot length.
4. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

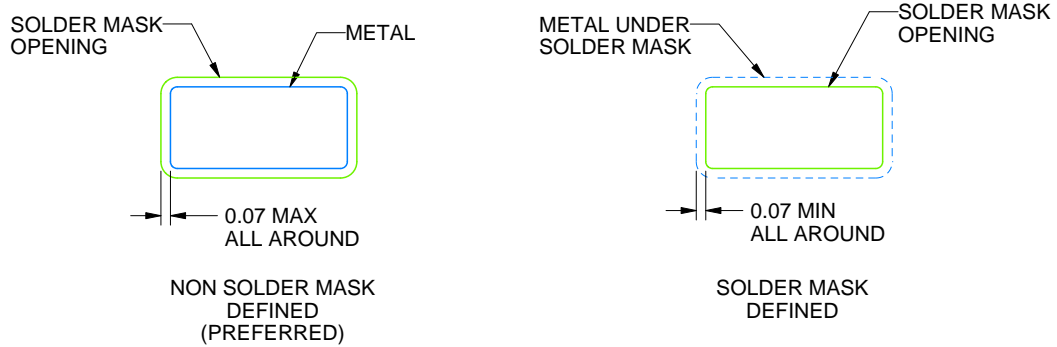
DBZ0003A

SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

4214838/D 03/2023

NOTES: (continued)

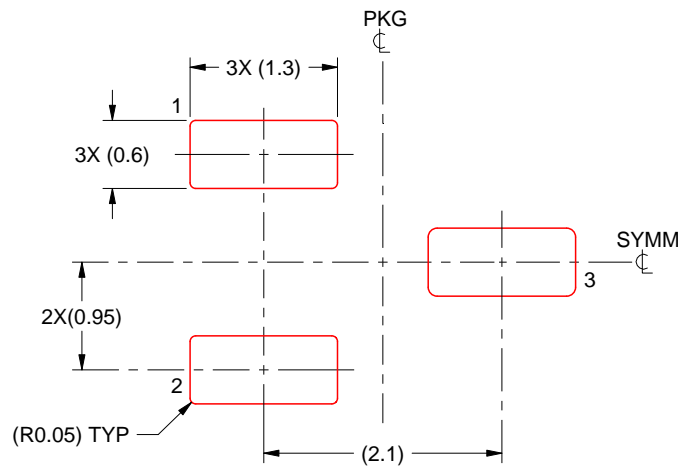
4. Publication IPC-7351 may have alternate designs.
5. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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.

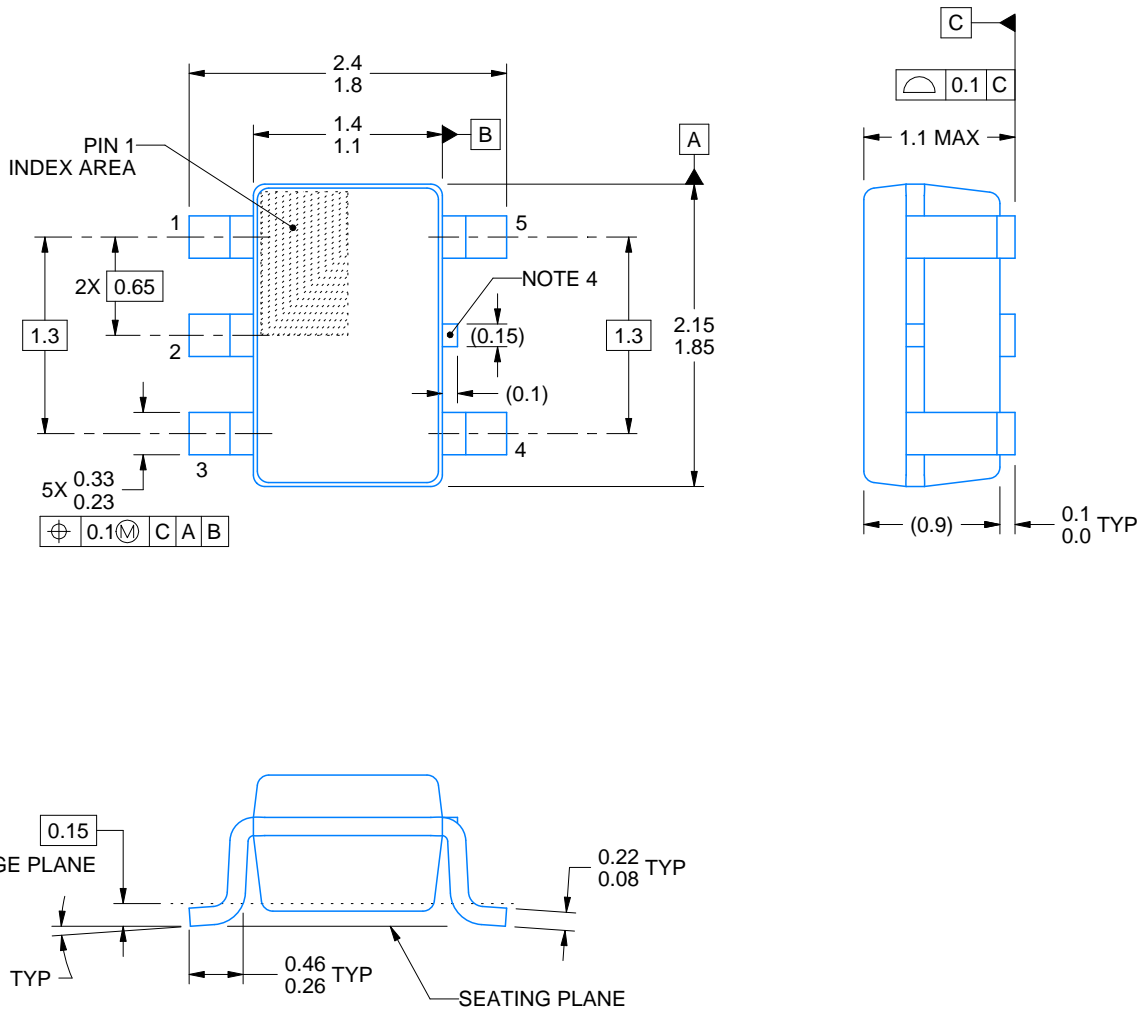
DCK0005A



PACKAGE OUTLINE

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



4214834/C 03/2023

NOTES:

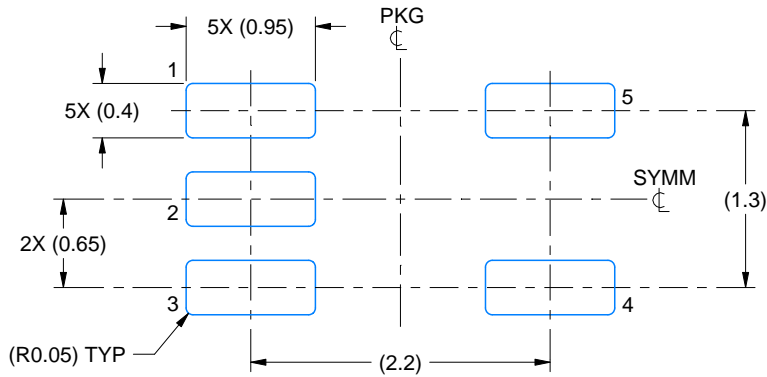
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Reference JEDEC MO-203.
4. Support pin may differ or may not be present.

EXAMPLE BOARD LAYOUT

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X



SOLDER MASK DETAILS

4214834/C 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

DCK0005A

SOT - 1.1 max height

SMALL OUTLINE TRANSISTOR



SOLDER PASTE EXAMPLE
BASED ON 0.125 THICK STENCIL
SCALE:18X

4214834/C 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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