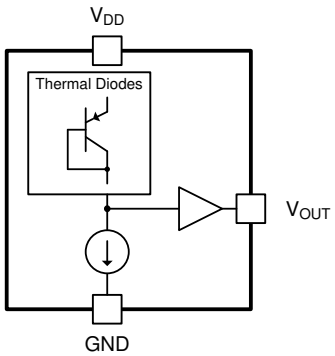
TMP23x-Q1 汽车级高精度模拟输出温度传感器

1 特性

- 符合面向汽车应用的 AEC-Q100 标准
  - TMP235-Q1 0 级：–40°C 至 +150°C
  - TMP236-Q1 1 级：–40°C 至 +125°C
- 提供功能安全
  - 有助于进行功能安全系统设计的文档
- 在宽温度范围内具有高精度：
  - ±2.5°C（上限值）：–40°C 至 +150°C (TMP235-Q1)
  - ±2.5°C（上限值）：–10°C 至 +125°C (TMP236-Q1)
- 正斜率传感器增益，失调电压（典型值）：
  - 10mV/°C，0°C 下 500mV (TMP235-Q1)
  - 19.5mV/°C，0°C 下 400mV (TMP236-Q1)
- 宽工作电源电压范围：
  - 2.3V 至 5.5V (TMP235-Q1)
  - 3.1V 至 5.5V (TMP236-Q1)
- 输出短路保护
- 低功耗：9 µA（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
  - 封装尺寸兼容业界通用的 LMT8x-Q1、LM50-Q1 和 LM20 温度传感器
- 具有成本效益的热敏电阻替代产品

2 应用

- 汽车音响主机
- 电动助力转向 (EPS)
- 换挡系统
- 电池管理系统 (BMS)
- 汽油发动机



功能方框图

3 说明

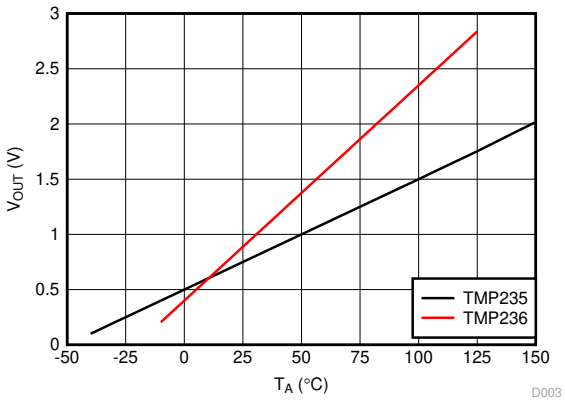
TMP23x-Q1 器件是一系列汽车级精密 CMOS 集成电路线性模拟温度传感器，输出电压与温度成正比，，服务于从动力总成到信息娱乐的各种汽车应用。这些温度传感器 0°C 至 +70°C 范围内的典型精度为 ±0.5°C。TMP235-Q1 器件具有 10mV/°C 的正斜率输出。在 –10°C 至 +125°C 和 3.1V 至 5.5V 电源电压范围内，高增益 TMP236-Q1 传感器的正斜率输出为 19.5mV/°C。

9 µA 典型静态电流和 800µs 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 500µA 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-Q1 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-Q1、TMP236-Q1	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。



输出电压与环境温度间的关系

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4 Revision History

注：以前版本的页码可能与当前版本的页码不同

Changes from Revision C (November 2019) to Revision D (June 2022)	Page
• 更新了整个文档中的表格、图和交叉参考的编号格式	1
• 向*特性* 部分添加了功能安全要点	1

Changes from Revision B (October 2019) to Revision C (November 2019)	Page
• Added temperature accuracy specs for the TMP236-Q1 SOT-23 package	5

Changes from Revision A (May 2019) to Revision B (October 2019)	Page
• 将文档状态从“预告信息”更改为“量产数据”	1

Changes from Revision * (April 2019) to Revision A (May 2019)	Page
• Changed recommended operating temperature range from: –50°C to 150°C to: –40°C to 150°C	4

5 Pin Configuration and Functions

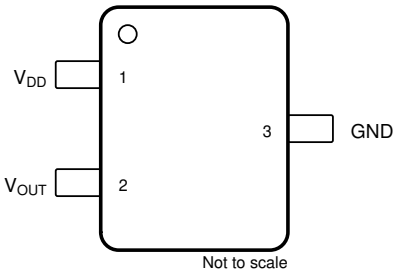
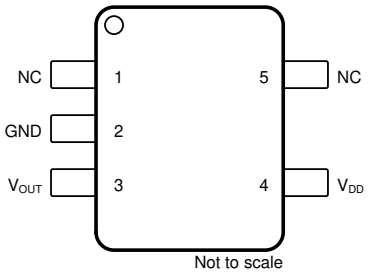


图 5-1. DBZ Package 3-Pin SOT-23 Top View



NC- no internal connection

图 5-2. DCK Package 5-Pin SC70 Top View

表 5-1. 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)	V
Output current	–30	+30	mA
Latch-up current, each pin	–200	+200	mA
Junction temperature (T_J)		+150	°C
Storage temperature (T_{stg})	–65	+150	°C

(1) Stresses beyond those listed under *Absolute Maximum Ratings* may cause permanent damage to the device. These are stress ratings only, which do not imply functional operation of the device at these or anyother 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 AEC Q100-002(1) HBM ESD Classification Level 2		±2000	V
		Charged device model (CDM), per AEC Q100-011 CDM ESD Classification Level C4B	All Pins	±500	V
			Corner Pins	±750	V

(1) AEC Q100-002 indicates that HBM stressing shall be in accordance with the ANSI/ESDA/JEDEC JS-001 specification

6.3 Recommended Operating Conditions

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

		MIN	NOM	MAX	UNIT
V_{DD}	Input voltage (TMP235-Q1)	2.3		5.5	V
	Input voltage (TMP236-Q1)	3.1		5.5	V
T_A	Operating free-air temperature	–40		150	°C

6.4 Thermal Information

THERMAL METRIC (1) (2)		TMP23X-Q1		UNIT
		DCK (SC70)	DBZ (SOT-23)	
		5 PINS	3 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

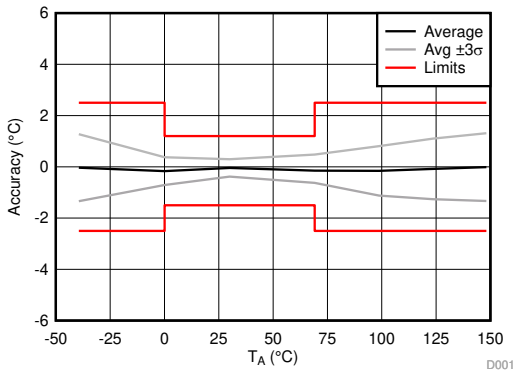
TMP235-Q1: V_{DD} = 2.3 V to 5.5 V, GND = Ground, T_A = –40°C to +125°C and no load (unless otherwise noted)
TMP236-Q1: V_{DD} = 3.1 V to 5.5 V, GND = Ground, T_A = –10°C to +125°C and no load (unless otherwise noted)

PARAMETER			TEST CONDITIONS	MIN	TYP	MAX	UNIT
POWER SUPPLY							
I_{DD}	Operating current		T_A = 25℃, V_{DD} = 2.3 V, TMP235-Q1		9		µA
			T_A = 25℃, V_{DD} = 3.1 V, TMP236-Q1		10		
			T_A = –40℃ to +125℃, TMP235-Q1			14.5	
			T_A = –10℃ to +125℃, TMP236-Q1			15	
			T_A = 150℃, TMP235-Q1			17	
Δ℃/ ΔV_{DD}	Line regulation			–0.1	0.02	0.1	℃/V
SENSOR ACCURACY							
T_{ACY}	Temperature accuracy(1)		T_A = 25°C		±0.5		℃
			T_A = 0°C to 70°C (SC70 Package) (TMP235-Q1)	–1.5	±0.5	+1.2	
			T_A = 0°C to 70°C (SOT-23 Package) (TMP235-Q1)	–1.5	±0.5	+1.2	
			T_A = –40°C to 125°C (TMP235-Q1)	–2.5	±0.5	+2.5	
			T_A = –40°C to 150°C (TMP235-Q1)	–2.5	±0.5	+2.5	
			T_A = –10°C to 125°C (TMP236-Q1)	–2.5	±0.5	+2.5	
T_{ACY}	Temperature accuracy(1)		T_A = 0°C to 70°C (SOT-23 Package) (TMP236-Q1)	–1.5	±0.5	+1.5	℃
SENSOR OUTPUT							
$V_{0℃}$	Output voltage offset at 0 °C		TMP235-Q1		500		mV
			TMP236-Q1		400		
T_C	Temperature coefficient (sensor gain)		TMP235-Q1		10		mV/℃
			TMP236-Q1		19.5		
V_{ONL}	Output nonlinearity(2)		T_A = 0 °C to 70 °C, no load		±0.5		℃
I_{OUT}	Output current					500	µA
Z_{OUT}	Output impedance		IOUT = 100 µA, f = 100 Hz		20		Ω
			IOUT = 100 µA, f = 500 Hz		50		
	Output load regulation		T_A = 0°C to 70°C, IOUT = 100 µA, ΔV_{OUT} / ΔI_{OUT}		1		Ω
t_{ON}	Turn on time		Time to reach accuracy within ±0.5°C		800		µs
C_{LOAD}	Typical load capacitance					1000	pF
t_{RES}	Thermal response to 63%	SC70	30°C (Air) to +125°C (Fluid Bath)		1.3		s

(1) Accuracy is defined as the error between the measured and reference output voltages, tabulated in the TMP235-Q1 Transfer Table and TMP236-Q1 Transfer Table at the specified conditions of supply voltage and temperature (expressed in °C). Accuracy limits include line regulation within the specified conditions. Accuracy limits do not include load regulation; they assume no DC load.
(2) Nonlinearity is defined as the deviation of the output-voltage-versus-temperature curve from the best-fit straight line, over the device's rated temperature range.

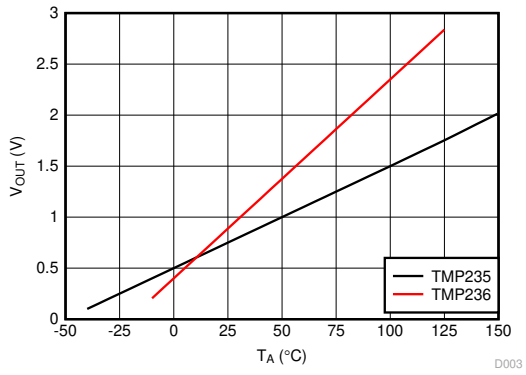
6.6 Typical Characteristics

at T_A = 25°C, (unless otherwise noted)



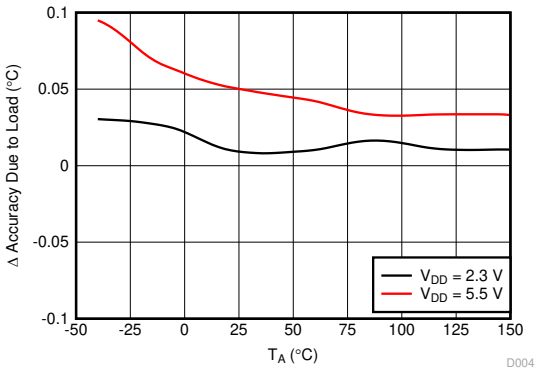
TMP235-Q1: V_{DD} = 2.3 to 5.5 V, I_{OUT} = 0 µA, C_{LOAD} = 1000 pF

图 6-1. Accuracy vs T_A Temperature



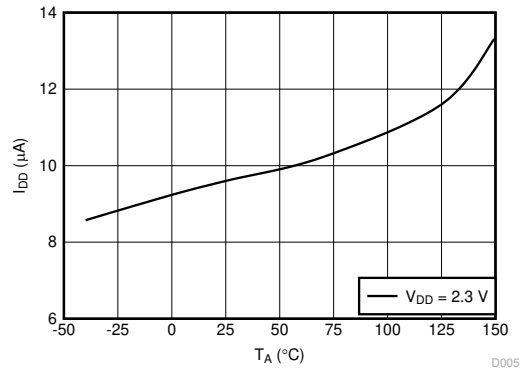
I_{OUT} = 0 µA, C_{LOAD} = 1000 pF

图 6-2. Output Voltage vs Ambient Temperature



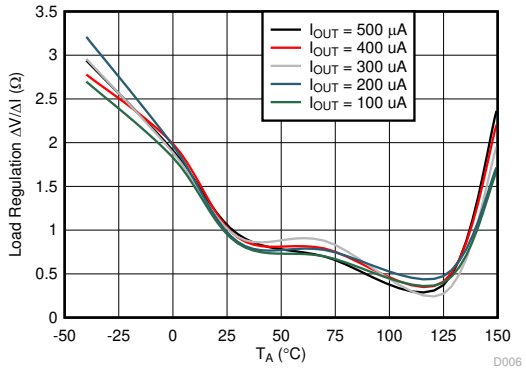
TMP23x-Q1: I_{OUT} = from 0 µA to 100 µA, C_{LOAD} = 1000 pF

图 6-3. Changes in Accuracy vs Ambient Temperature (Due to Load)



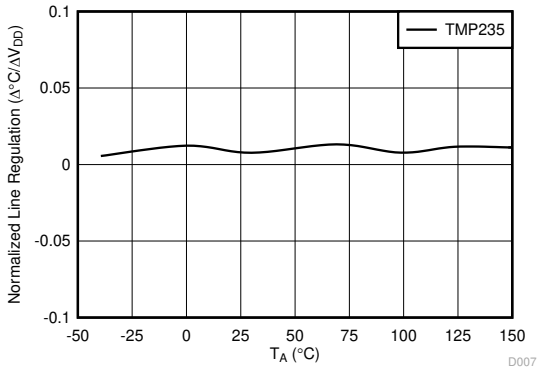
TMP23x-Q1: I_{OUT} = 0 µA, C_{LOAD} = 1000 pF

图 6-4. Supply Current vs Temperature



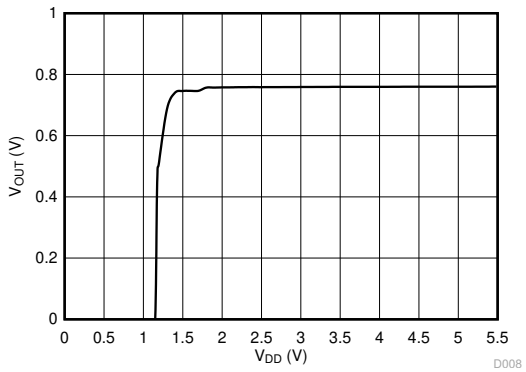
TMP23x-Q1: V_{DD} = 2.3 V, C_{LOAD} = 1000 pF

图 6-5. Load Regulation vs Ambient Temperature



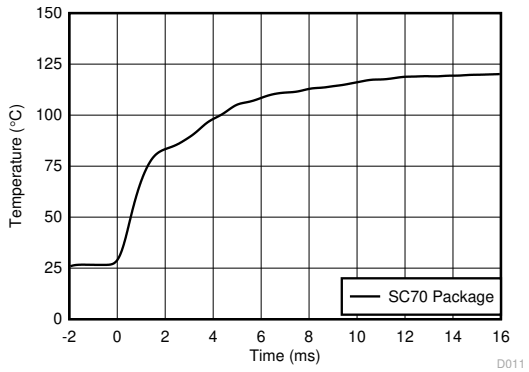
TMP23x-Q1: V_{DD} = 2.3 to 5.5 V, I_{OUT} = 0 µA, C_{LOAD} = 1000 pF

图 6-6. Line Regulation (Δ °C / Δ V_{DD}) vs Ambient Temperature



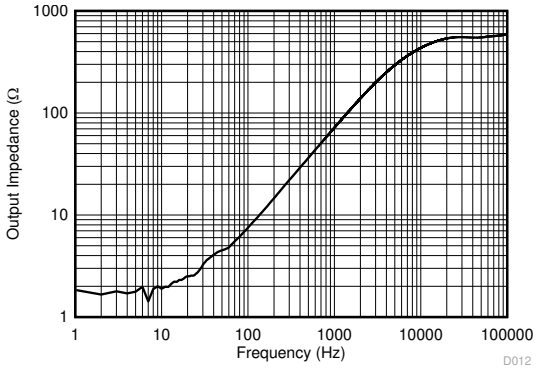
TMP23x-Q1: T_A = 25°C

图 6-7. Output Voltage vs Power Supply



TMP23x-Q1: 1 × 1 (inches) PCB, Air 26°C to Fluid Bath 123°C

图 6-8. Thermal Response (Air-to-Fluid Bath)



TMP23x-Q1: T_A = 25°C, V_{DD} = 5 V, I_{OUT} = 100 µA

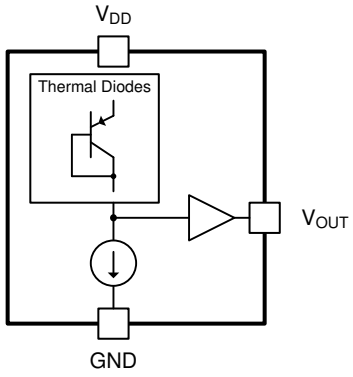
图 6-9. Output Impedance vs Frequency

7 Detailed Description

7.1 Overview

The TMP23x-Q1 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 ±1.5°C. The TMP235-Q1 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-Q1 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 6-2, the TMP23x-Q1 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-Q1 devices across the full operating temperature range are listed in 表 7-3 and 表 7-4. 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 7-1 and 表 7-2. In equation form, the voltage output V_{OUT} of the TMP23x-Q1 is calculated by 方程式 1:

$$V_{OUT} = (T_A - T_{INFL}) \times T_C + V_{OFFS} \quad (1)$$

where

- V_{OUT} is the TMP23x-Q1 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-Q1 temperature coefficient or gain
- V_{OFFS} is the TMP23x-Q1 voltage offset

Therefore, the T_A temperature for a given V_{OUT} voltage output within a piecewise voltage range (V_{RANGE}) is calculated in 方程式 2. For applications where the accuracy enhancement above 100°C is not required, use the first row of 表 7-1 and 表 7-2 for all voltages.

$$T_A = (V_{OUT} - V_{OFFS}) / T_C + T_{INFL} \quad (2)$$

表 7-1. TMP235-Q1 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

表 7-1. TMP235-Q1 Piecewise Linear Function Summary (continued)

T_A RANGE (°C)	V_{RANGE} (mV)	T_{INFL} (°C)	T_C (mV/°C)	V_{OFFS} (mV)
125 to 150	> 1752.5	125	10.6	1752.5

表 7-2. TMP236-Q1 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 7-3. TMP235-Q1 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

表 7-3. TMP235-Q1 Transfer Table (continued)

TEMPERATURE (°C)	V_{OUT} (mV) IDEAL LINEAR VALUES	V_{OUT} (mV) PIECEWISE LINEAR VALUES
135	1850	1858.5
140	1900	1911.5
145	1950	1964.5
150	2000	2017.5

表 7-4. TMP236-Q1 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	—	—

表 7-4. TMP236-Q1 Transfer Table (continued)

TEMPERATURE (°C)	V_{OUT} (mV) IDEAL LINEAR VALUES	V_{OUT} (mV) PIECEWISE LINEAR VALUES
145	—	—
150	—	—

7.4 Device Functional Modes

The singular functional mode of the TMP23x-Q1 is an analog output directly proportional to temperature.

8 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。

8.1 Application Information

The features of the TMP235-Q1 make the series of devices designed for various general temperature-sensing applications. The TMP235-Q1 and TMP236-Q1 devices can operate down to a 2.3-V and a 3.1-V supply with 9-µA power consumption, respectively. The TMP23x-Q1 series is mounted in two surface mount technology packages (SC70 and SOT-23.)

8.2 Typical Application

8.2.1 Connection to an ADC

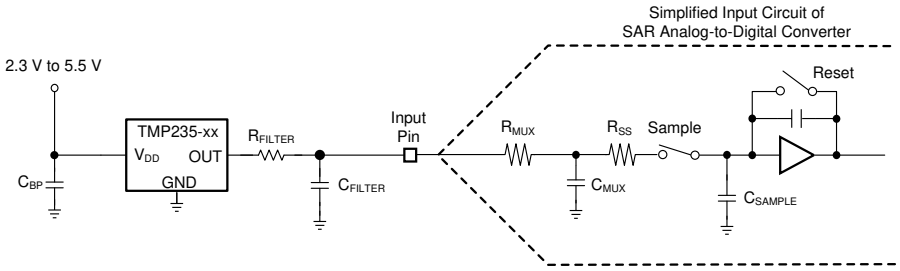


图 8-1. Suggested Connections to an ADC Input Stage

8.2.1.1 Design Requirements

See 图 8-1 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 TMP235-Q1. 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 TMP235-Q1 is specified and characterized with a 1000-pF maximum capacitive load (C_{LOAD}). 图 8-1 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. 图 8-1 shows a general ADC application as an example only.

8.2.1.3 Application Curve

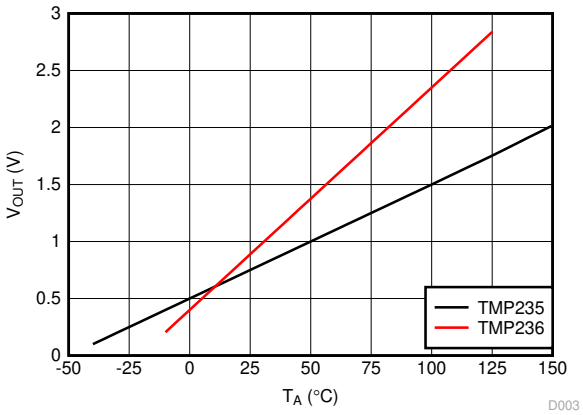


图 8-2. Output Voltage vs. Ambient

9 Power Supply Recommendations

The low supply current and supply range of the TMP23x-Q1 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-μF 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-Q1 series is simple. If a power supply bypass capacitor is used, the capacitor must be connected as *Layout Examples* shows.

10.2 Layout Examples

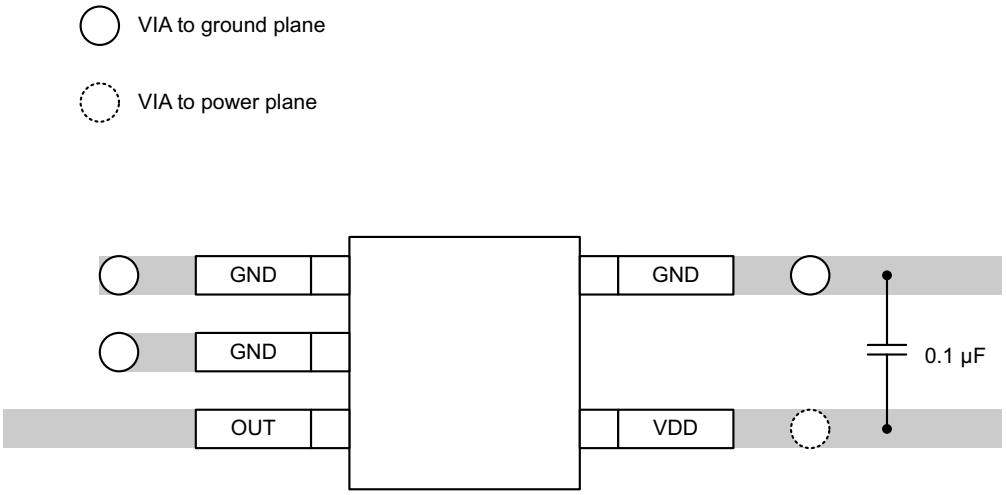


图 10-1. Recommended Layout: SC70 Package

11 Device and Documentation Support

11.1 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 *订阅更新* 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。

11.2 支持资源

TI E2E™ 支持论坛是工程师的重要参考资料，可直接从专家获得快速、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可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》。

11.3 Trademarks

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

11.4 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.5 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。

12 Mechanical, Packaging, and Orderable Information

The following pages include mechanical, packaging, and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser-based versions of this data sheet, refer to the left-hand navigation.

PACKAGING INFORMATION

Orderable 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
TMP235AEDBZRQ1	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	235E	Samples
TMP235AEDBZTQ1	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	235E	Samples
TMP235AEDCKRQ1	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	1CF	Samples
TMP235AEDCKTQ1	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 150	1CF	Samples
TMP235AQDBZRQ1	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	235Q	Samples
TMP235AQDBZTQ1	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	235Q	Samples
TMP235AQDCKRQ1	ACTIVE	SC70	DCK	5	3000	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	1CG	Samples
TMP235AQDCKTQ1	ACTIVE	SC70	DCK	5	250	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	1CG	Samples
TMP236AQDBZRQ1	ACTIVE	SOT-23	DBZ	3	3000	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	236Q	Samples
TMP236AQDBZTQ1	ACTIVE	SOT-23	DBZ	3	250	RoHS & Green	NIPDAUAG	Level-2-260C-1 YEAR	-40 to 125	236Q	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.

OTHER QUALIFIED VERSIONS OF TMP235-Q1, TMP236-Q1 :

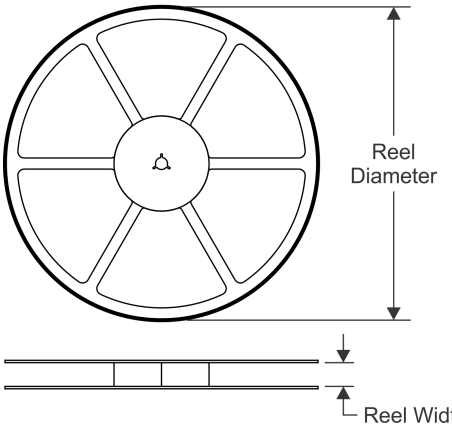
- Catalog : TMP235, TMP236

NOTE: Qualified Version Definitions:

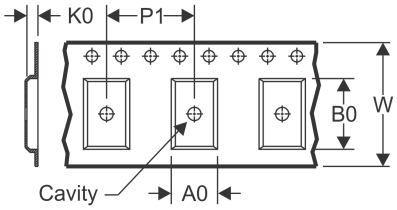
- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

REEL DIMENSIONS

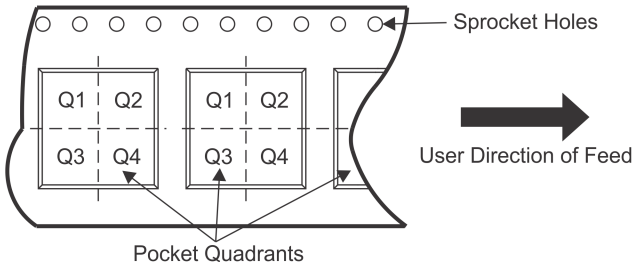


TAPE DIMENSIONS



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

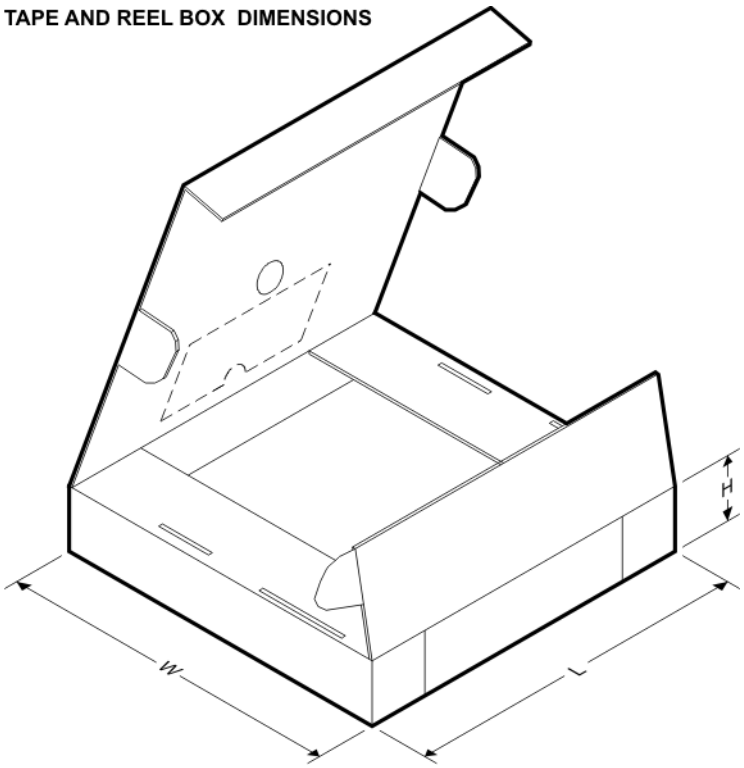
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMP235AEDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TMP235AEDBZTQ1	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TMP235AEDCKRQ1	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235AEDCKTQ1	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TMP235AQDBZTQ1	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TMP235AQDCKRQ1	SC70	DCK	5	3000	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP235AQDCKTQ1	SC70	DCK	5	250	180.0	8.4	2.47	2.3	1.25	4.0	8.0	Q3
TMP236AQDBZRQ1	SOT-23	DBZ	3	3000	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3
TMP236AQDBZTQ1	SOT-23	DBZ	3	250	180.0	8.4	3.15	2.77	1.22	4.0	8.0	Q3

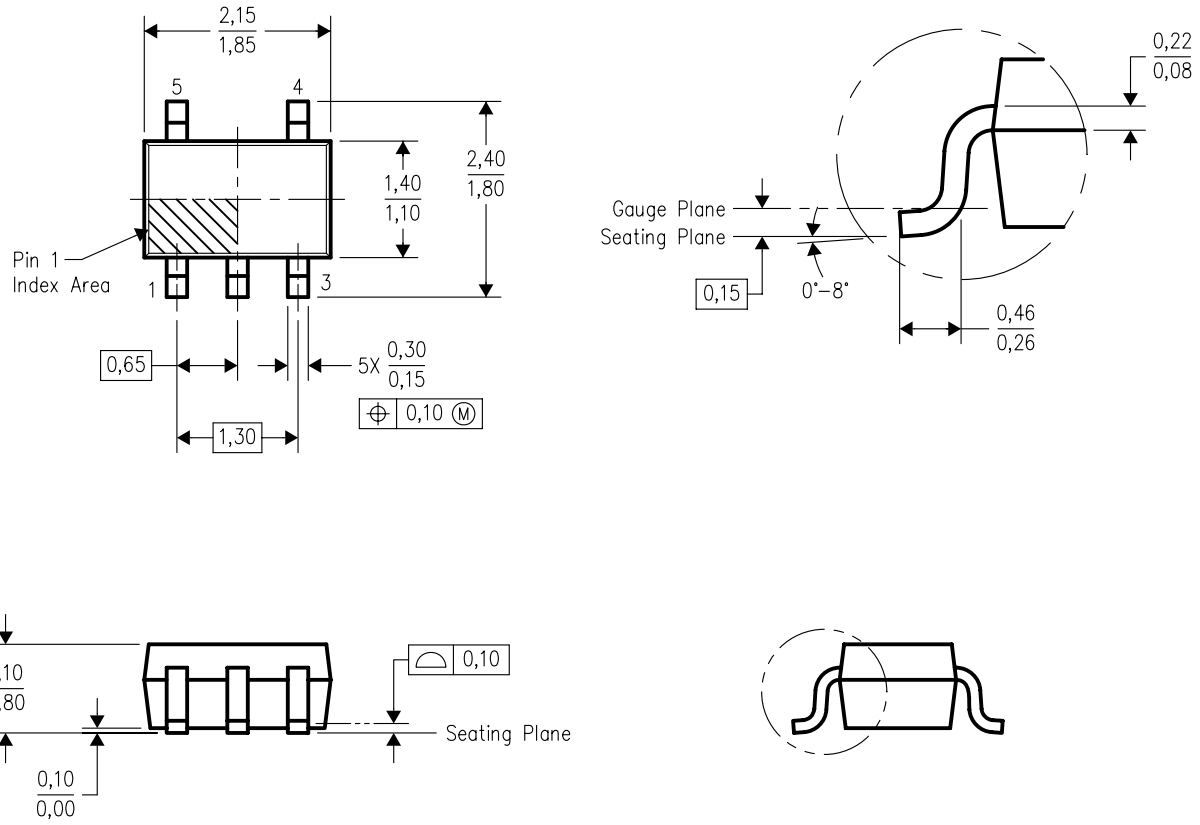
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP235AEDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
TMP235AEDBZTQ1	SOT-23	DBZ	3	250	213.0	191.0	35.0
TMP235AEDCKRQ1	SC70	DCK	5	3000	213.0	191.0	35.0
TMP235AEDCKTQ1	SC70	DCK	5	250	213.0	191.0	35.0
TMP235AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
TMP235AQDBZTQ1	SOT-23	DBZ	3	250	213.0	191.0	35.0
TMP235AQDCKRQ1	SC70	DCK	5	3000	213.0	191.0	35.0
TMP235AQDCKTQ1	SC70	DCK	5	250	213.0	191.0	35.0
TMP236AQDBZRQ1	SOT-23	DBZ	3	3000	213.0	191.0	35.0
TMP236AQDBZTQ1	SOT-23	DBZ	3	250	213.0	191.0	35.0

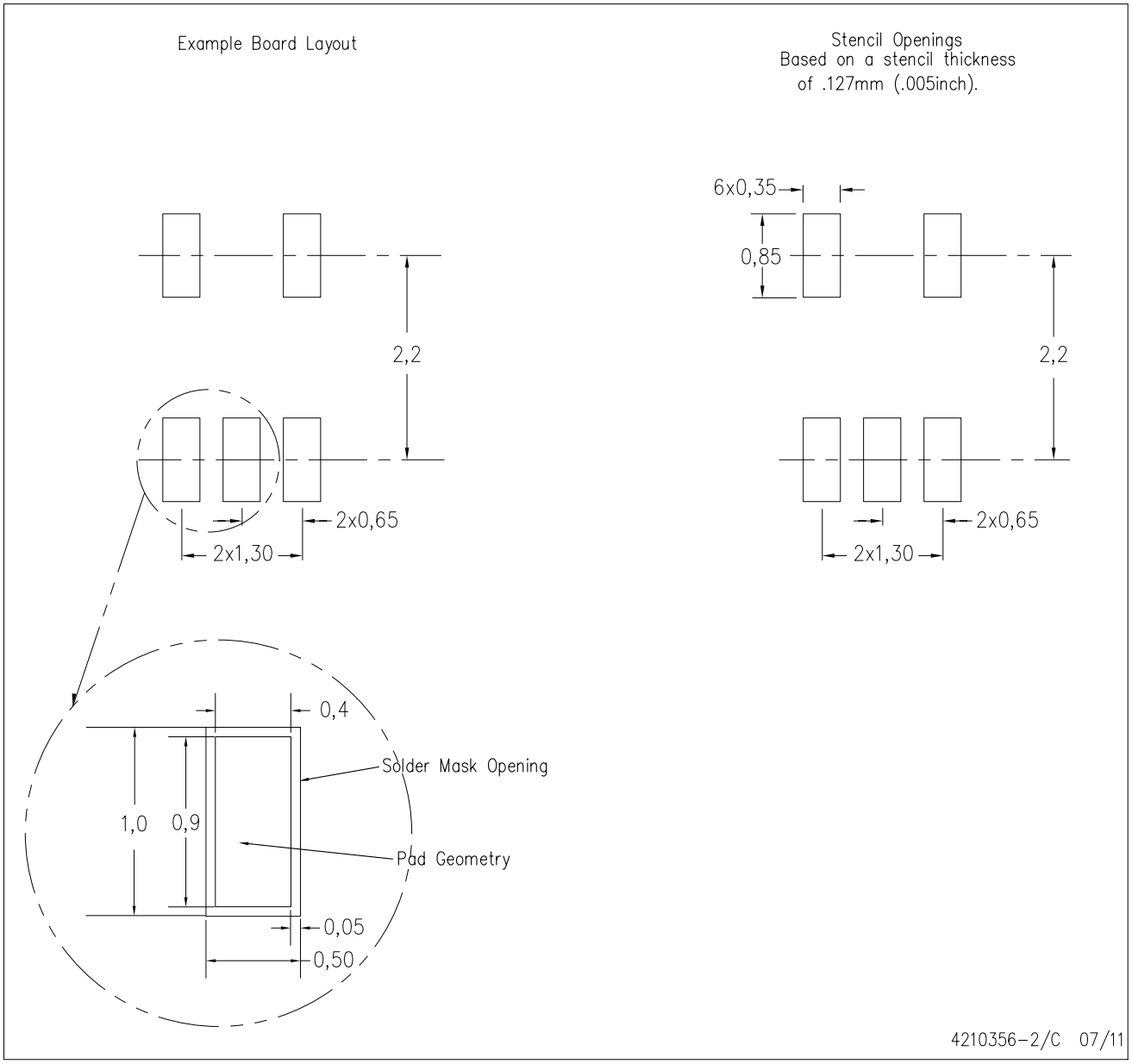
DCK (R–PDSO–G5) PLASTIC SMALL–OUTLINE PACKAGE



4093553–3/G 01/2007

NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
D. Falls within JEDEC MO–203 variation AA.

DCK (R–PDSO–G5) PLASTIC SMALL OUTLINE

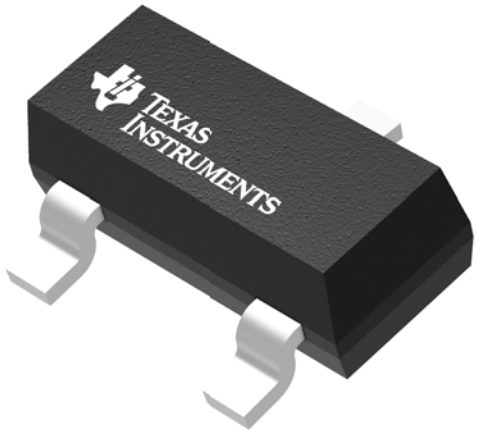


NOTES:
A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
D. Publication IPC–7351 is recommended for alternate designs.
E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC–7525 for other stencil recommendations.

GENERIC PACKAGE VIEW

DBZ 3 SOT-23 - 1.12 mm max height

SMALL OUTLINE TRANSISTOR



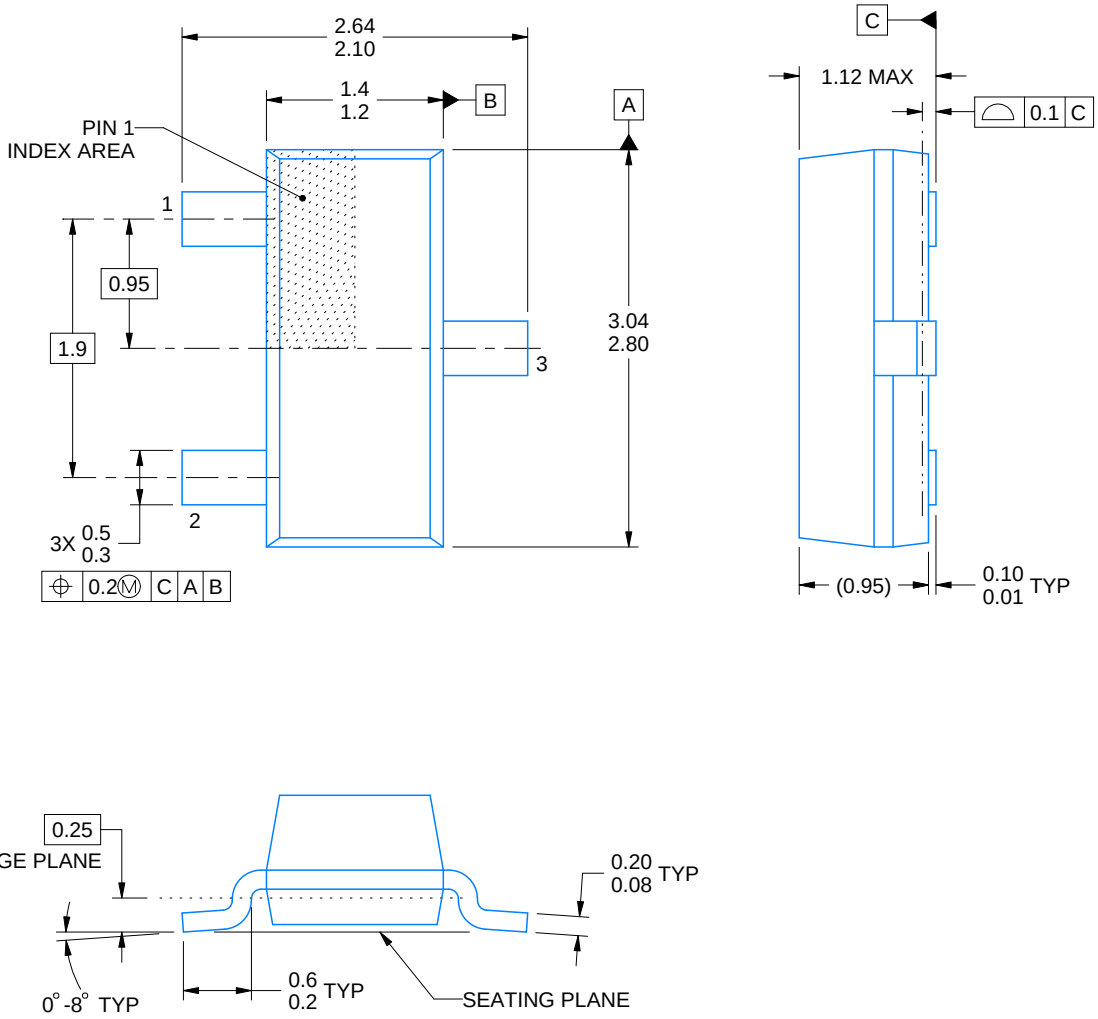
Images above are just a representation of the package family, actual package may vary.
Refer to the product data sheet for package details.

PACKAGE OUTLINE

DBZ0003A

SOT-23 - 1.12 mm max height

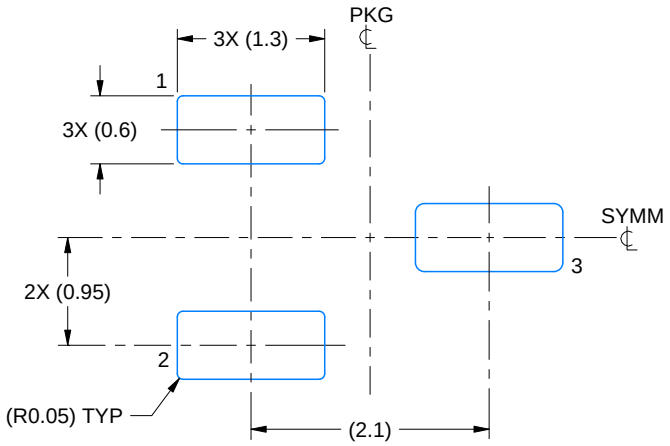
SMALL OUTLINE TRANSISTOR



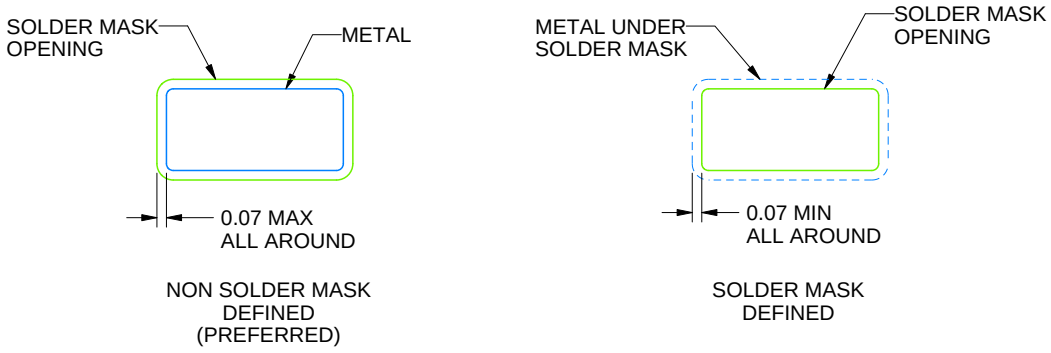
4214838/C 04/2017

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.



LAND PATTERN EXAMPLE
SCALE:15X



SOLDER MASK DETAILS

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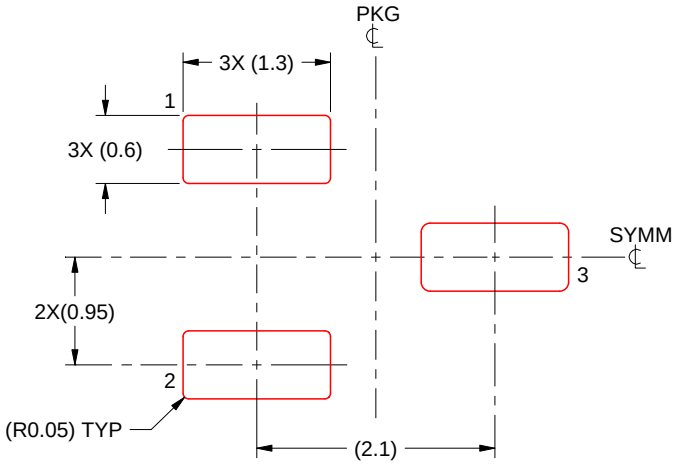
NOTES: (continued)

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



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

4214838/C 04/2017

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.

重要声明和免责声明

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