

TMP300 1.8-V, Resistor-Programmable Temperature Switch and Analog Out Temperature Sensor in SC70

1 Features

- Accuracy: $\pm 1^\circ\text{C}$ (typical at $+25^\circ\text{C}$)
- Programmable trip point
- Programmable hysteresis: $5^\circ\text{C}/10^\circ\text{C}$
- Open-drain outputs
- Low power: $110\ \mu\text{A}$ (maximum)
- Wide voltage range: $+1.8\ \text{V}$ to $+18\ \text{V}$
- Temperature range: -40°C to $+125^\circ\text{C}$
- Analog out: $10\text{mV}/^\circ\text{C}$
- SC70-6 and SOT23-6 packages

2 Applications

- Power-supply systems
- DC-DC modules
- Thermal monitoring
- Electronic protection systems

3 Description

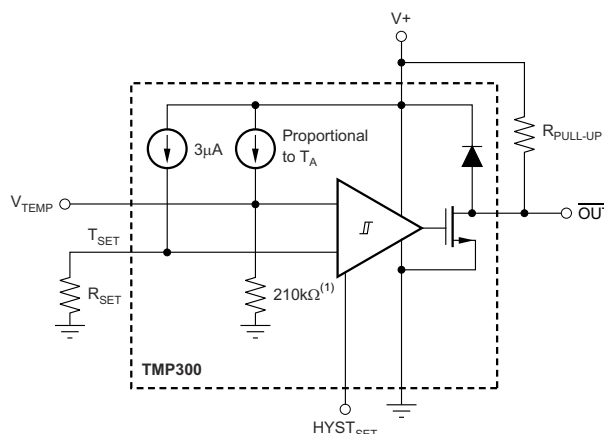
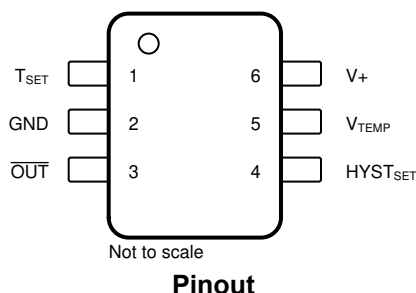
The TMP300 is a low-power, resistor-programmable, digital output temperature switch. The device allows a threshold point to be set by adding an external resistor. Two levels of hysteresis are available. The TMP300 has a V_{TEMP} analog output that can be used as a testing point or in temperature-compensation loops.

Available in two micropackages with proven thermal characteristics, low current consumption, and a supply voltage as low as $1.8\ \text{V}$, the TMP300 is designed for power-sensitive systems that require simple and reliable thermal management.

Package Information⁽¹⁾

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TMP300	SOT-23 (6)	2.90 mm $\times$ 1.60 mm
	SC70 (6)	2.00 mm $\times$ 1.25 mm

- (1) For all available packages, see the orderable addendum at the end of the data sheet.



NOTE: Thin-film resistor with approximately 10% accuracy; however, this accuracy error is trimmed out at the factory.

Application Schematic



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4 Revision History

Changes from Revision E (December 2018) to Revision F (January 2023) Page

- Updated the numbering format for tables, figures, and cross-references throughout the document..... **1**
- Changed *Device Information* table to *Package Information* **1**
- Added parameter to the *Absolute Maximum Ratings* table: input current into any pin..... **4**

Changes from Revision D (January 2016) to Revision E (December 2018) Page

- Added *Pin Configuration and Functions* section **3**

Changes from Revision C (January 2011) to Revision D (January 2016) Page

- Added *Device Information* table, *ESD Ratings* table, *Feature Description* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section..... **1**
- Changed *Temperature Range* Features bullet **1**
- Added package names to pinout **1**
- Deleted *Ordering Information* table **4**
- Changed Temperature Range, *TA*, *Functional Range* parameter name in *Electrical Characteristics* table..... **5**
- Added footnote 4 to *Electrical Characteristics* table **5**

Changes from Revision B (November 2008) to Revision C (January 2011) Page

- Deleted second sentence from *Description* section..... **1**
- Added TMP300B grade device specifications to *Electrical Characteristics* table..... **5**

5 Pin Configuration and Functions

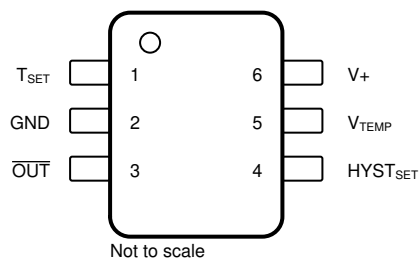


Figure 5-1. DCK and DBV Package 6-Pin SOT-23 and SC70 Top View

Table 5-1. Pin Functions

PIN		I/O	DESCRIPTION
NAME	NO.		
T _{SET}	1	I	Temperature set pin. Connects to a resistor to set the trip point
GND	2	—	Ground
OUT	3	O	Trip output
HYST _{SET}	4	I	Hysteresis Set. Connect to Ground for 5°C hysteresis or connect to V+ for 10°C hysteresis
V _{TEMP}	5	I	Analog Temperature output
V+	6	O	Supply voltage: 1.8 V to 18 V

6 Specifications

6.1 Absolute Maximum Ratings

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

		MIN	MAX	UNIT
V+	Supply voltage		+18	V
	Signal input pins, voltage ⁽²⁾	−0.5	(V+) + 0.5	V
	Signal input pins, current ⁽²⁾	−10	10	mA
	Input current into any pin		10	mA
I _{SC}	Output short-circuit ⁽³⁾	Continuous		
	Open-drain output		(V+) + 0.5	V
T _A	Functional temperature	−40	+150	°C
T _{stg}	Storage temperature	−55	+150	°C
T _J	Junction temperature		+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 any other conditions beyond those indicated under *Recommended Operating Conditions*. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.
- (2) Input pins are diode-clamped to the power-supply rails. Input signals that can swing more than 0.5V beyond the supply rails should be current limited to 10mA or less.
- (3) Short-circuit to ground.

6.2 ESD Ratings

		VALUE	UNIT
V _(ESD)	Electrostatic discharge	Human-body model (HBM)	±4000
		Charged-device model (CDM)	±1000

6.3 Electrical Characteristics

At $V_S = 3.3\text{ V}$ and $T_A = -40^\circ\text{C}$ to $+125^\circ\text{C}$, unless otherwise noted.

PARAMETER		TEST CONDITIONS	TMP300			TMP300B			UNIT
			MIN ⁽¹⁾	TYP ⁽¹⁾	MAX ⁽¹⁾	MIN	TYP	MAX	
TEMPERATURE MEASUREMENT									
Measurement range		V _S = 2.35 V to 18 V	−40		+125	−40		+125	°C
		V _S = 1.8 V to 2.35 V	−40		100 × (V _S − 0.95)	−40		100 × (V _S − 0.95)	
TRIP POINT									
Total accuracy		T _A = −40°C to +125°C	±2		±4 ⁽³⁾	±2		±6	°C
R _{SET} equation		T _C is in °C	R _{SET} = 10 (50 + T _C)/3			R _{SET} = 10 (50 + T _C)/3			kΩ
HYSTERESIS SET INPUT									
LOW threshold					0.4			0.4	V
HIGH threshold			V _S − 0.4			V _S − 0.4			V
Threshold hysteresis		HYST _{SET} = GND	5			5			°C
		HYST _{SET} = V _S	10			10			
DIGITAL OUTPUT									
Logic family			CMOS			CMOS			
Open-drain leakage current		OUT = V _S	10			10			μA
V _{OL}	Logic levels	V _S = 1.8 V to 18 V, I _{SINK} = 5 mA	0.3			0.3			V
ANALOG OUTPUT									
Accuracy			±2		±3	±2		±5	°C
Temperature sensitivity			10			10			mV/°C
Output voltage		T _A = +25°C	720	750	780	720	750	780	mV
V _{TEMP} pin output resistance			210			210			kΩ
POWER SUPPLY									
I _Q Quiescent current ⁽²⁾		V _S = 1.8 V to 18 V, T _A = −40°C to +125°C	110			110			μA
TEMPERATURE RANGE									
T _A	Specified range	V _S = 2.35 V to 18 V	−40		+125	−40		+125	°C
		V _S = 1.8 V to 2.35 V	−40		100 × (V _S − 0.95)	−40		100 × (V _S − 0.95)	
	Functional range ⁽⁴⁾	V _S = 2.35 V to 18 V	−40		+150	−40		+150	
		V _S = 1.8 V to 2.35 V	−50		100 × (V _S − 0.95)	−50		100 × (V _S − 0.95)	
θ _{JA}	Thermal resistance	SC70	250			250			°C/W
		SOT23-6	180			180			

(1) 100% of production is tested at $T_A = +85^\circ\text{C}$. Specifications over temperature range are ensured by design.

(2) See Figure 6-1 for typical quiescent current.

(3) Shaded cells indicate characteristic performance difference.

(4) The TMP300 is functional over this range and no indication of performance is implied.

6.4 Typical Characteristics

At $V_S = 5\text{ V}$, unless otherwise noted.

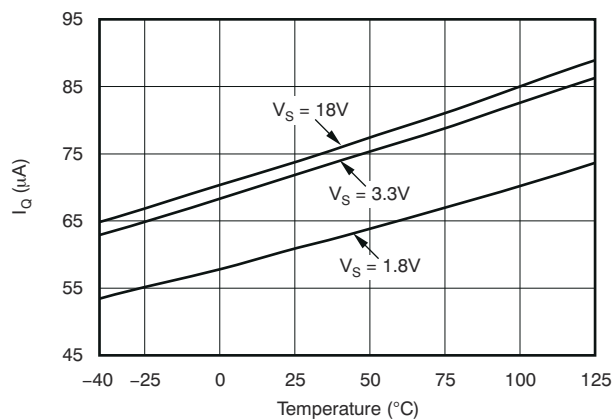


Figure 6-1. Quiescent Current Over Temperature and Supply

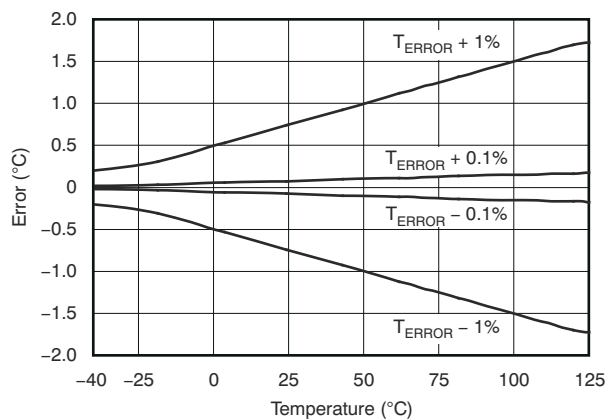


Figure 6-2. R_{SET} Shift Resulting From R_{SET} Tolerance

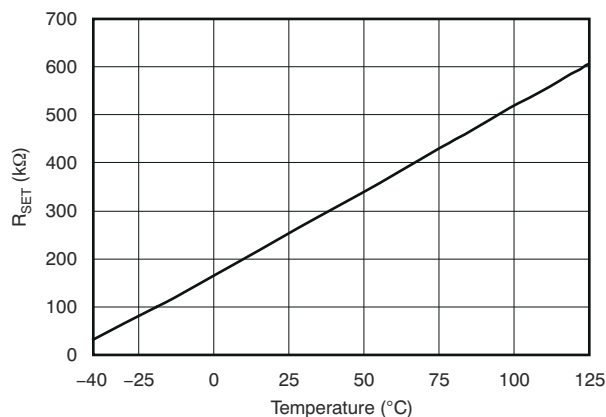


Figure 6-3. R_{SET} vs Temperature

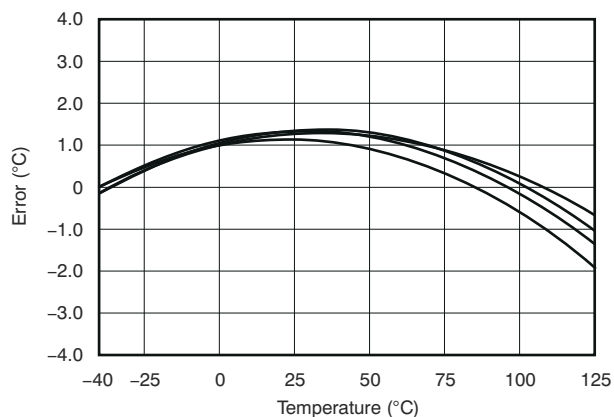


Figure 6-4. Typical Trip Error

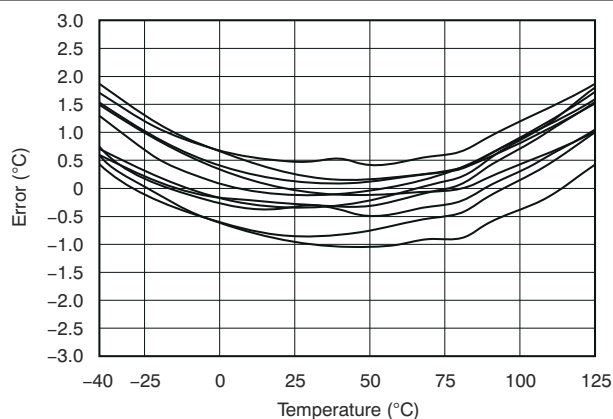


Figure 6-5. Typical Analog Output Error

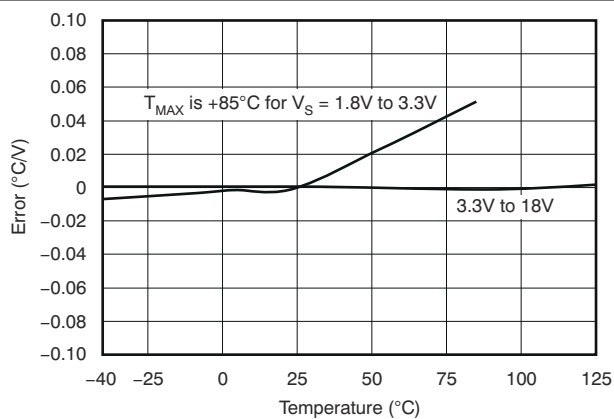


Figure 6-6. Analog PSR Over Temperature

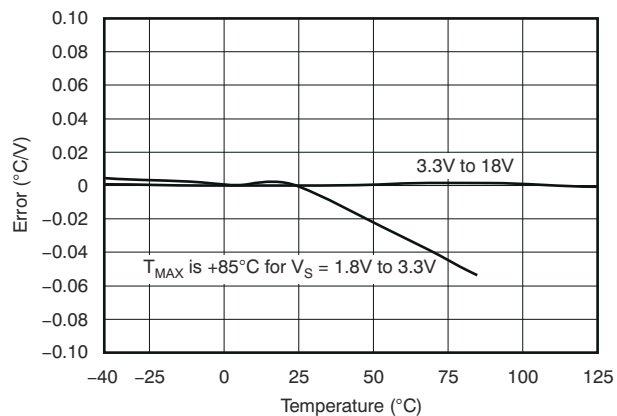


Figure 6-7. Trip PSR Over Temperature

7 Detailed Description

7.1 Overview

The TMP300 is a thermal sensor designed for overtemperature protection circuits in electronic systems. The TMP300 uses a set resistor to program the trip temperature of the digital output. An additional high-impedance (210 kΩ) analog voltage output provides the temperature reading.

7.2 Feature Description

7.2.1 Calculating R_{SET}

The set resistor (R_{SET}) provides a threshold voltage for the comparator input. The TMP300 trips when the V_{TEMP} pin exceeds the T_{SET} voltage. The value of the set resistor is determined by the analog output function and the 3-μA internal bias current.

To set the TMP300 to trip at a preset value, calculate the R_{SET} resistor value according to [Equation 1](#) or [Equation 2](#):

$$R_{SET} = \frac{(T_{SET} \times 0.01 + 0.5)}{3e^{-6}} \quad (1)$$

where

- T_{SET} is in °C; or

$$R_{SET} \text{ in k}\Omega = \frac{10(50 + T_{SET})}{3} \quad (2)$$

where

- T_{SET} is in °C.

7.2.2 Using V_{TEMP} to Trip the Digital Output

The analog voltage output can also serve as a voltage input that forces a trip of the digital output to simulate a thermal event. This simulation facilitates easy system design and test of thermal safety circuits, as shown in [Figure 7-1](#).

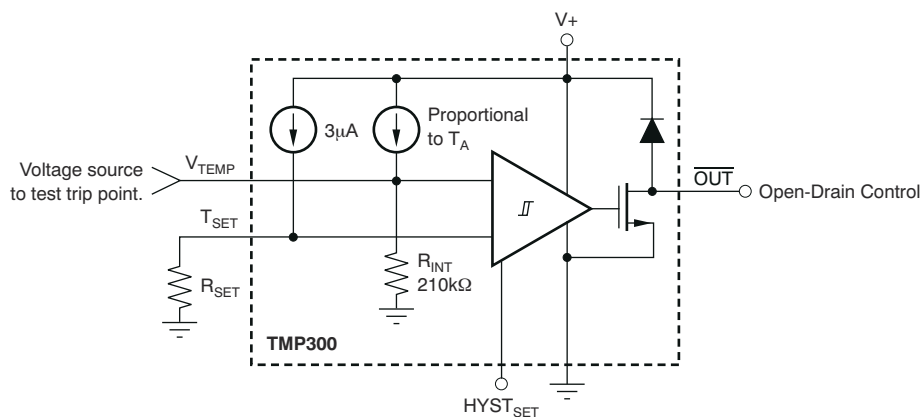


Figure 7-1. Applying Voltage to Trip Digital Output

7.2.3 Analog Temperature Output

The analog out or V_{TEMP} pin is high-impedance (210 k Ω). Avoid loading this pin to prevent degrading the analog out value or trip point. Buffer the output of this pin when used for direct thermal measurement. [Figure 7-2](#) shows buffering of the analog output signal.

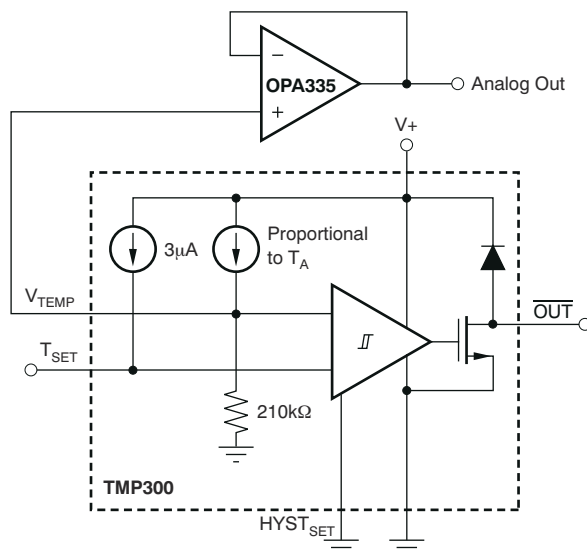


Figure 7-2. Buffering the Analog Output Signal

7.2.4 Using a DAC to Set the Trip Point

The trip point is easily converted by changing the digital-to-analog converter (DAC) code. This technique can be useful for control loops where a large thermal mass is being brought up to the set temperature and the $\overline{OUT}$ pin is used to control the heating element. The analog output can be monitored in a control algorithm that adjusts the set temperature to prevent overshoot. [Figure 7-3](#) shows the trip set voltage error versus temperature, which shows error in $^{\circ}\text{C}$ of the comparator input over temperature. [Figure 7-4](#) shows an alternative method of setting the trip point by using a DAC.

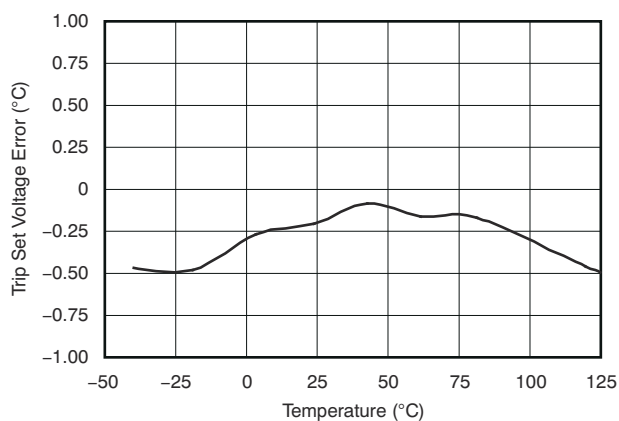


Figure 7-3. Trip Set Voltage Error vs Temperature

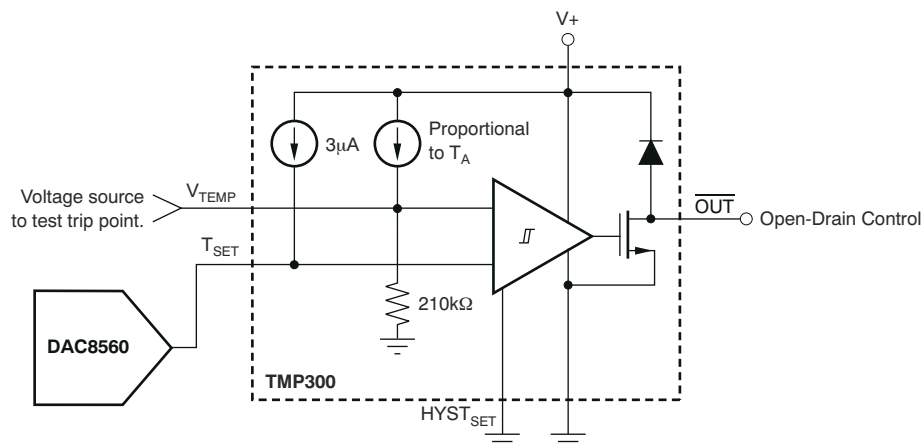


Figure 7-4. DAC Generates the Voltage-Driving T_{SET} Pin

7.2.5 Hysteresis

The hysteresis pin has two settings. Grounding HYST_{SET} results in 5°C of hysteresis. Connecting HYST_{SET} to V_S results in 10°C of hysteresis. [Figure 7-5](#) and [Figure 7-6](#) show the hysteresis error variation over temperature.

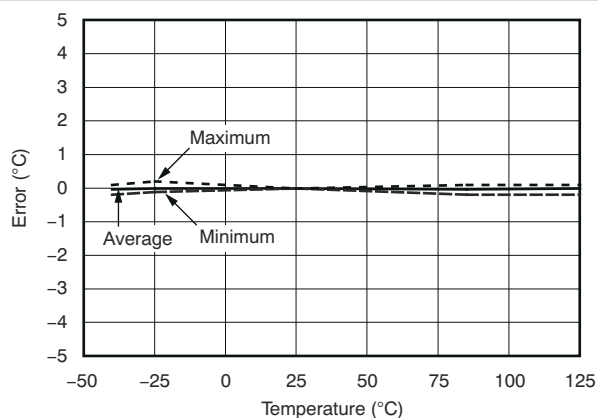


Figure 7-5. 5°C Hysteresis Error vs Temperature

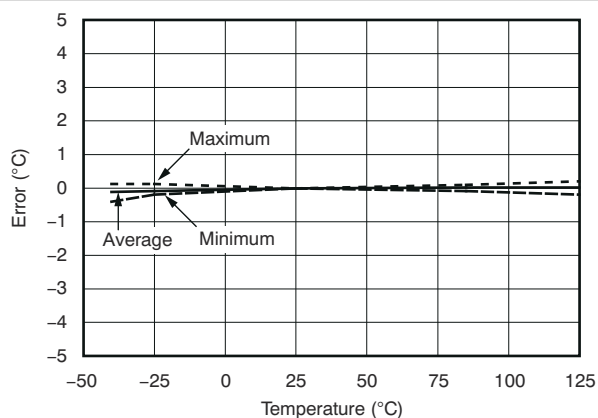


Figure 7-6. 10°C Hysteresis Error vs Temperature

Use bypass capacitors on the supplies as well as on the R_{SET} and analog out (V_{TEMP}) pins when in noisy environments, as shown in Figure 7-7. These capacitors reduce premature triggering of the comparator.

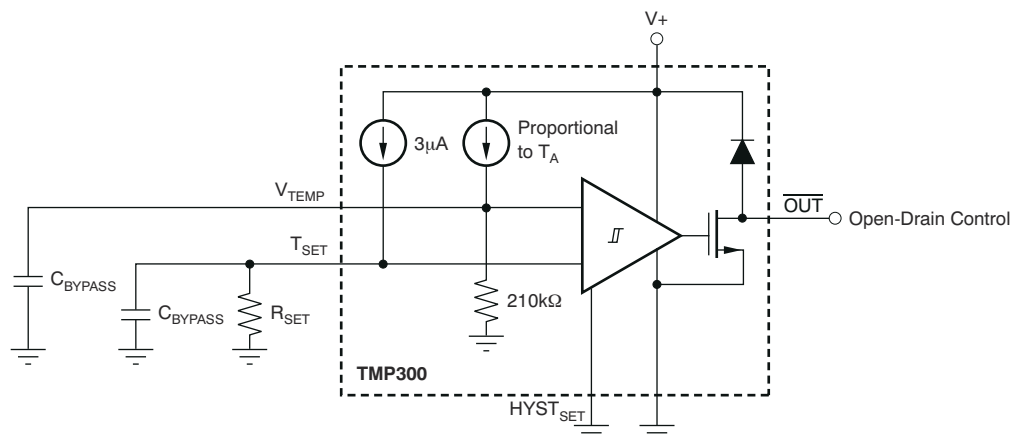


Figure 7-7. Bypass Capacitors Prevent Early Comparator Toggling Due to Circuit Board Noise

8 Device and Documentation Support

8.1 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on [ti.com](https://www.ti.com). Click on *Subscribe to updates* to register and receive a weekly digest of any product information that has changed. For change details, review the revision history included in any revised document.

8.2 Support Resources

TI E2E™ [support forums](#) are an engineer's go-to source for fast, verified answers and design help — straight from the experts. Search existing answers or ask your own question to get the quick design help you need.

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8.3 Trademarks

TI E2E™ is a trademark of Texas Instruments.

All trademarks are the property of their respective owners.

8.4 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.

8.5 Glossary

[TI Glossary](#) This glossary lists and explains terms, acronyms, and definitions.

9 Mechanical, Packaging, and Orderable Information

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

PACKAGING INFORMATION

Orderable part number	Status (1)	Material type (2)	Package Pins	Package qty Carrier	RoHS (3)	Lead finish/ Ball material (4)	MSL rating/ Peak reflow (5)	Op temp (°C)	Part marking (6)
TMP300AIDBVR	NRND	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T300
TMP300AIDBVR.A	NRND	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	T300
TMP300AIDCKR	NRND	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	BPN
TMP300AIDCKR.A	NRND	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	BPN
TMP300BIDBVR	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	DUDC
TMP300BIDBVR.A	Active	Production	SOT-23 (DBV) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	DUDC
TMP300BIDBVT	Obsolete	Production	SOT-23 (DBV) 6	-	-	Call TI	Call TI	-40 to 125	DUDC
TMP300BIDCKR	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	QWL
TMP300BIDCKR.A	Active	Production	SC70 (DCK) 6	3000 LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	QWL
TMP300BIDCKT	Obsolete	Production	SC70 (DCK) 6	-	-	Call TI	Call TI	-40 to 125	QWL

⁽¹⁾ **Status:** For more details on status, see our [product life cycle](#).

⁽²⁾ **Material type:** When designated, preproduction parts are prototypes/experimental devices, and are not yet approved or released for full production. Testing and final process, including without limitation quality assurance, reliability performance testing, and/or process qualification, may not yet be complete, and this item is subject to further changes or possible discontinuation. If available for ordering, purchases will be subject to an additional waiver at checkout, and are intended for early internal evaluation purposes only. These items are sold without warranties of any kind.

⁽³⁾ **RoHS values:** Yes, No, RoHS Exempt. See the [TI RoHS Statement](#) for additional information and value definition.

⁽⁴⁾ **Lead finish/Ball material:** Parts may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

⁽⁵⁾ **MSL rating/Peak reflow:** The moisture sensitivity level ratings and peak solder (reflow) temperatures. In the event that a part has multiple moisture sensitivity ratings, only the lowest level per JEDEC standards is shown. Refer to the shipping label for the actual reflow temperature that will be used to mount the part to the printed circuit board.

⁽⁶⁾ **Part marking:** There may be an additional marking, which relates to the logo, the lot trace code information, or the environmental category of the part.

Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

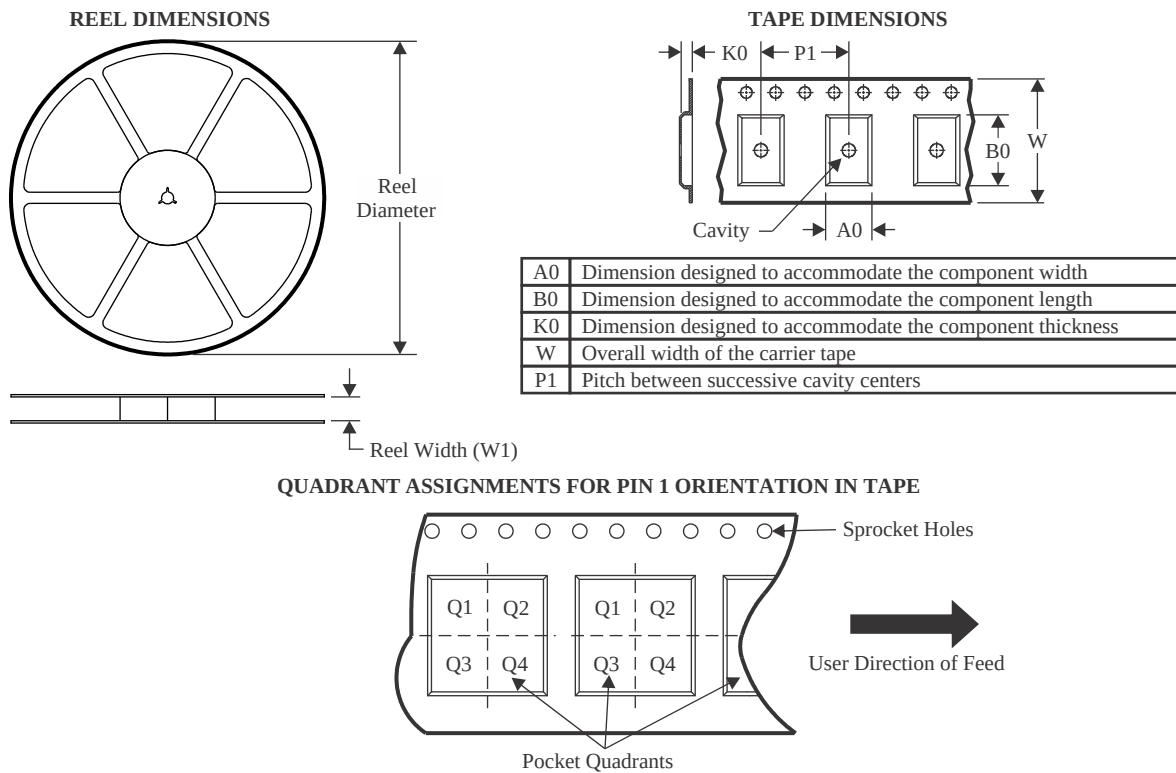
OTHER QUALIFIED VERSIONS OF TMP300 :

- Automotive : [TMP300-Q1](#)

NOTE: Qualified Version Definitions:

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

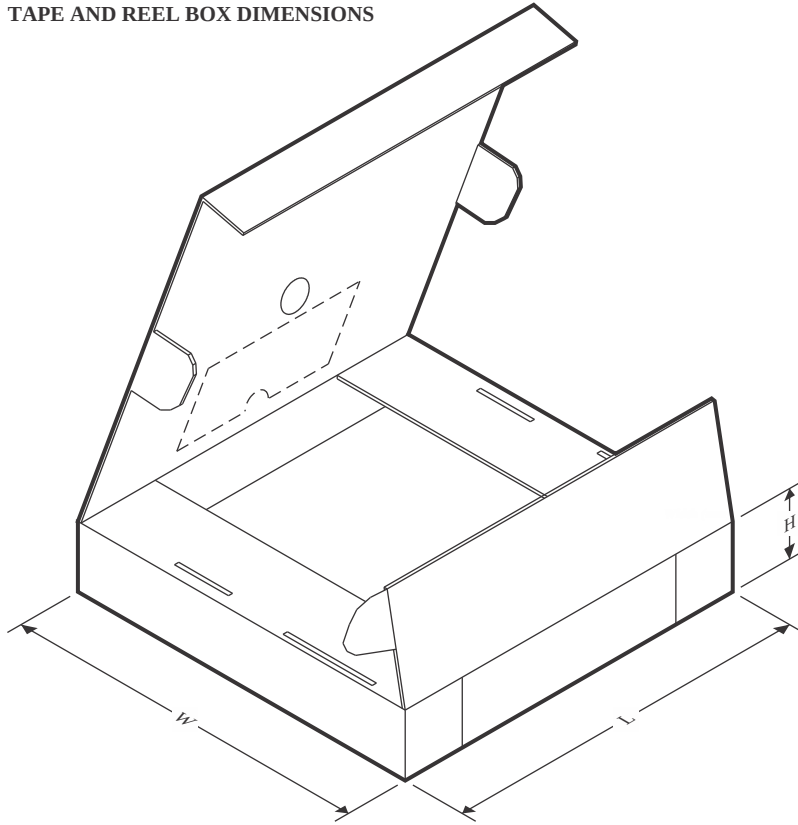
TAPE AND REEL INFORMATION



*All dimensions are nominal

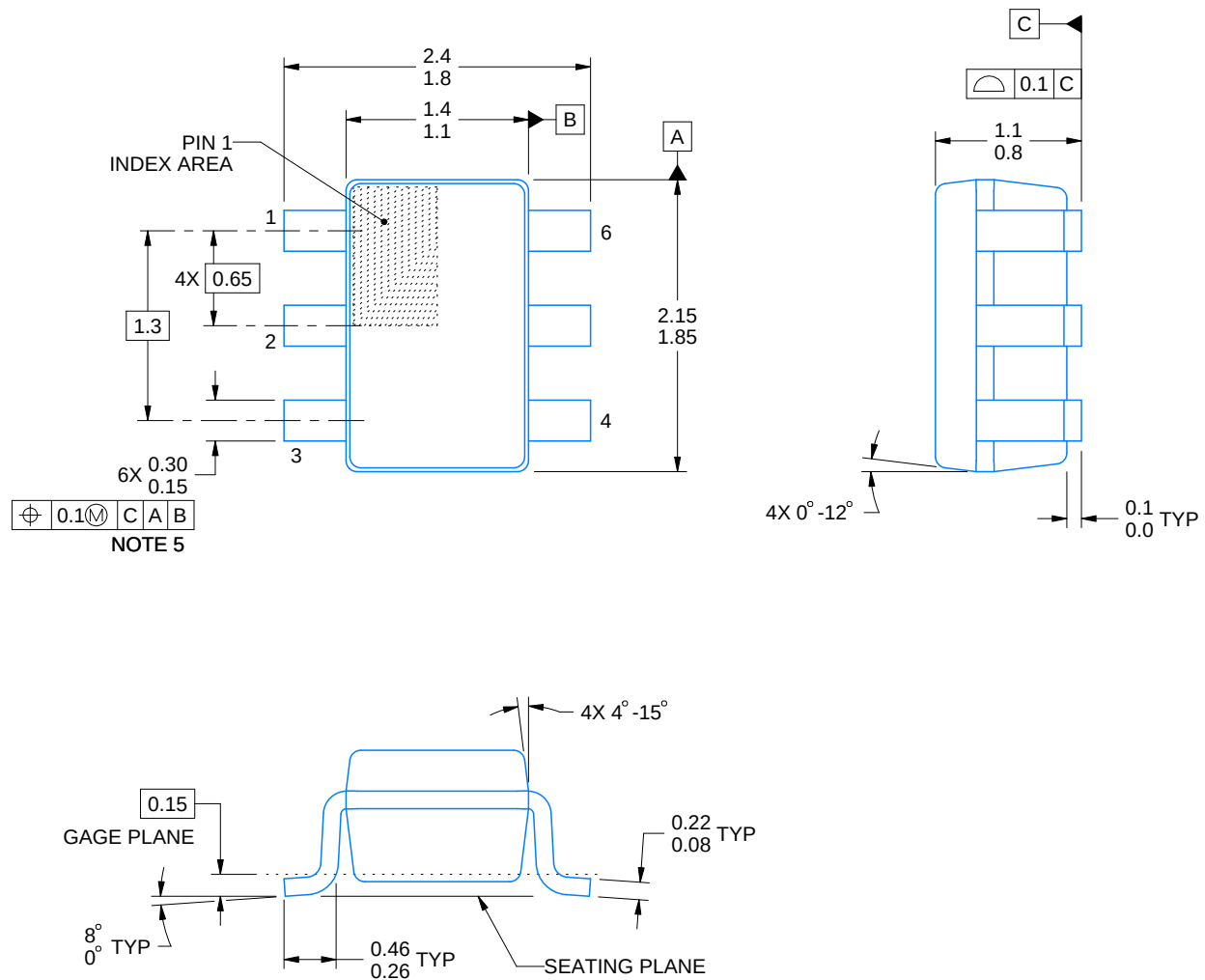
Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
TMP300AIDBVR	SOT-23	DBV	6	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TMP300AIDCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3
TMP300BIDBVR	SOT-23	DBV	6	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TMP300BIDCKR	SC70	DCK	6	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

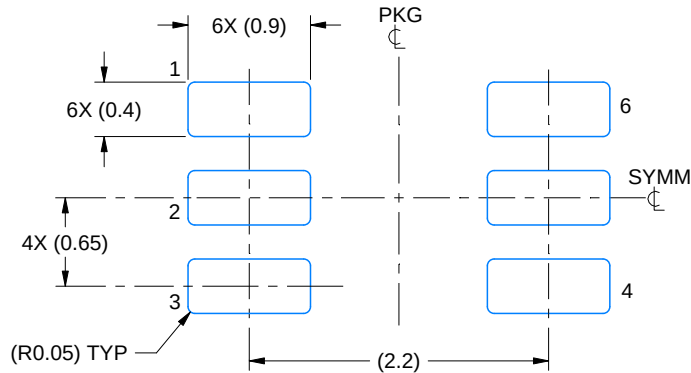
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TMP300AIDBVR	SOT-23	DBV	6	3000	200.0	183.0	25.0
TMP300AIDCKR	SC70	DCK	6	3000	200.0	183.0	25.0
TMP300BIDBVR	SOT-23	DBV	6	3000	200.0	183.0	25.0
TMP300BIDCKR	SC70	DCK	6	3000	200.0	183.0	25.0



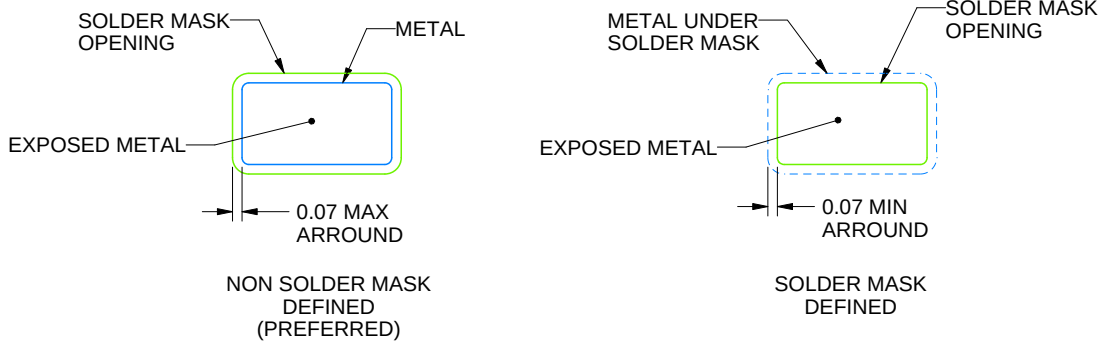
4214835/D 11/2024

NOTES:

1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side.
4. Falls within JEDEC MO-203 variation AB.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:18X

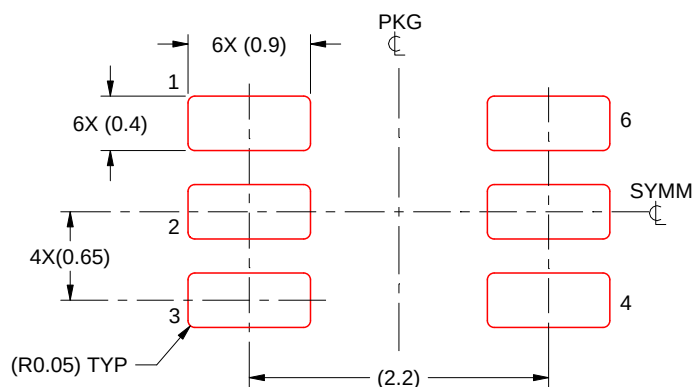


SOLDER MASK DETAILS

4214835/D 11/2024

NOTES: (continued)

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



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

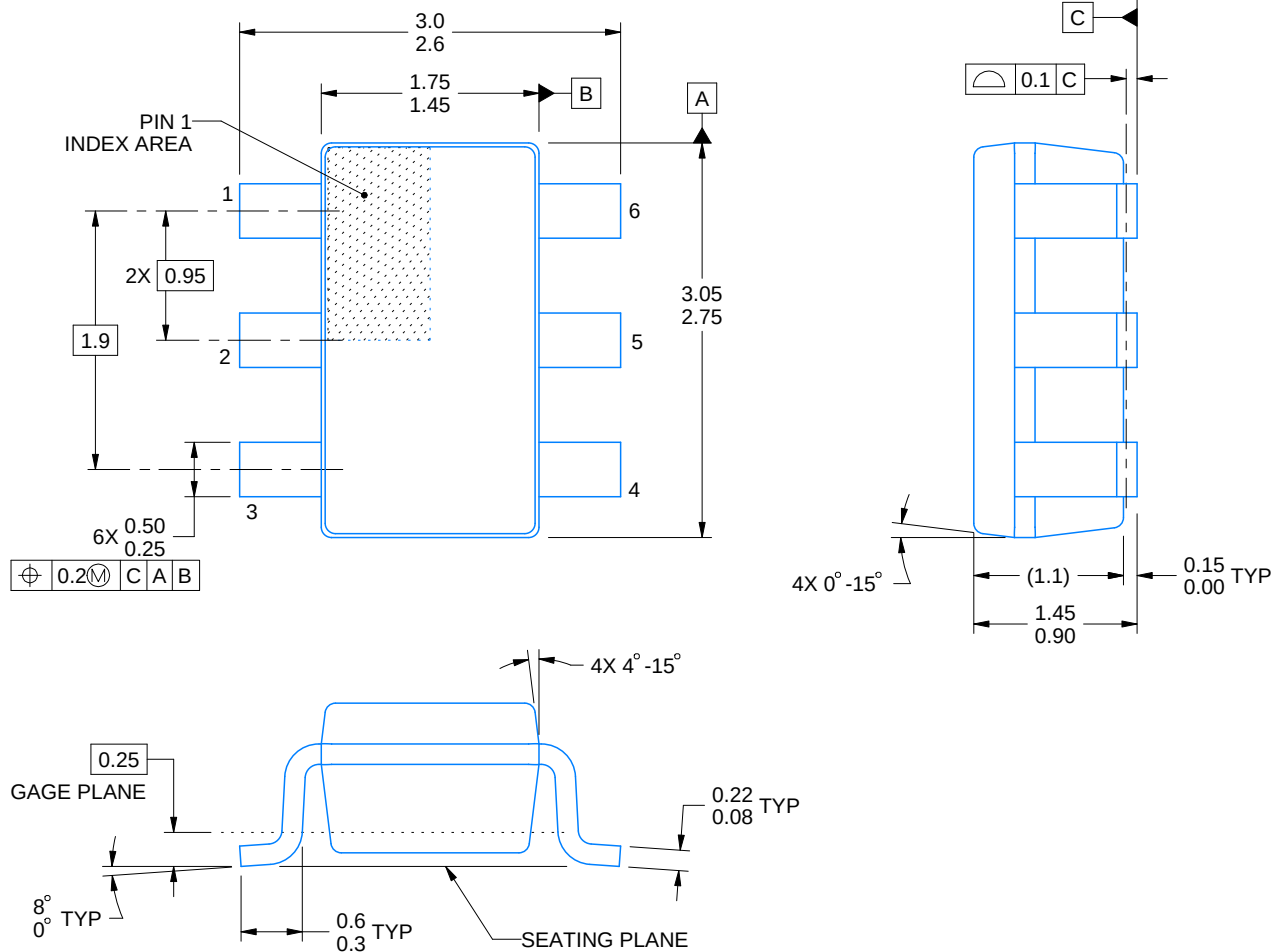
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NOTES: (continued)

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

DBV0006A**PACKAGE OUTLINE****SOT-23 - 1.45 mm max height**

SMALL OUTLINE TRANSISTOR



4214840/G 08/2024

NOTES:

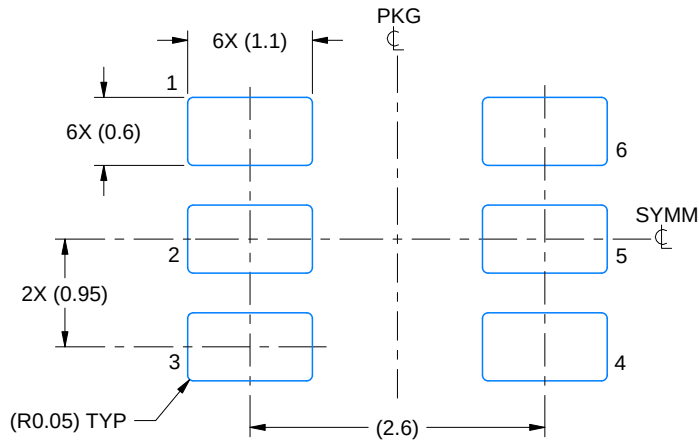
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.25 per side.
4. Leads 1,2,3 may be wider than leads 4,5,6 for package orientation.
5. Reference JEDEC MO-178.

EXAMPLE BOARD LAYOUT

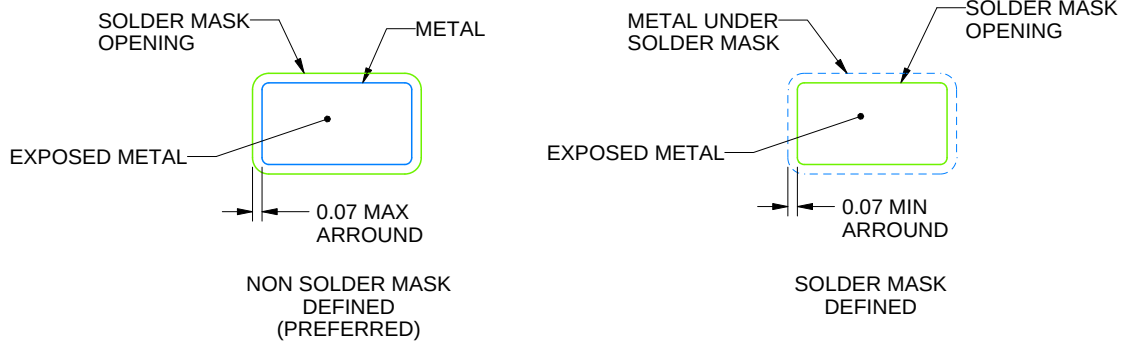
DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X



SOLDER MASK DETAILS

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NOTES: (continued)

6. Publication IPC-7351 may have alternate designs.

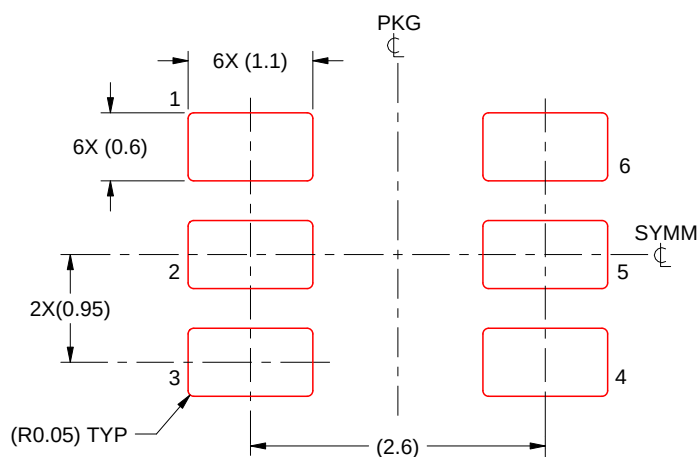
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DBV0006A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



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

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NOTES: (continued)

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

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