TEXAS INSTRUMENTS

TLV3401, TLV3402, TLV3404

SLCS135B – AUGUST 2000 – REVISED JANUARY 2017

TLV340x Family of Nanopower, Open-Drain Output Comparators

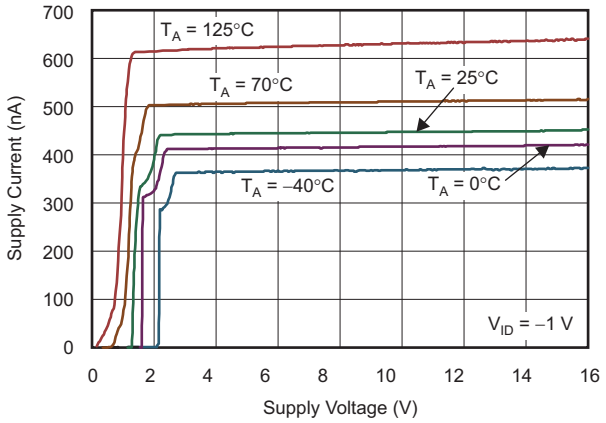
1 Features

- Low Supply Current: 470 nA Per Channel
- Input Common-Mode Range Exceeds the Rails: –0.1 V to V_{CC} + 5 V
- Supply Voltage Range: 2.5 V to 16 V
- Reverse Battery Protection Up to 18 V
- Open-Drain CMOS Output Stage
- Specified Temperature Range:
  - Commercial Grade: 0°C to +70°C
  - Industrial Grade: –40°C to +125°C
- Ultra-Small Packaging:
  - 5-Pin SOT-23 (TLV3401)
  - 8-Pin MSOP (TLV3402)
- Universal Op Amp EVM (See *Universal Operational Amplifier Evaluation Module Selection Guide* For More Information)

2 Applications

- Portable Medical Equipment
- Wireless Security Systems
- Remote Control Systems
- Handheld Instruments
- Ultra-Low Power Systems

Supply Current vs Supply Voltage



3 Description

The TLV340x is TI's first family of nanopower comparators with only 470 nA per channel supply current, which makes this device ideal for battery-powered and wireless handset applications.

The TLV340x has a minimum operating supply voltage of 2.7 V over the extended industrial temperature range (T_A = –40°C to +125°C), while having an input common-mode range of –0.1 to V_{CC} + 5 V. The low supply current makes it an ideal choice for battery-powered portable applications where quiescent current is the primary concern. Reverse battery protection guards the amplifier from an overcurrent condition due to improper battery installation. For harsh environments, the inputs can be taken 5 V above the positive supply rail without damage to the device.

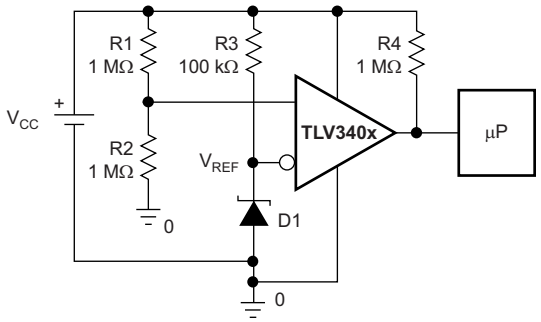
All members are available in PDIP and SOIC with the single versions in the small SOT-23 package, dual versions in the VSSOP package, and quad versions in the TSSOP package.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
TLV3401	SOT-23 (5)	2.90 mm × 1.60 mm
TLV3401, TLV3402	SOIC (8)	4.90 mm × 3.91 mm
TLV3401, TLV3402	PDIP (8)	9.81 mm × 6.35 mm
TLV3402	VSSOP (8)	3.00 mm × 3.00 mm
TLV3404	SOIC (14)	8.65 mm × 3.91 mm
	TSSOP (14)	5.00 mm × 4.40 mm
	PDIP (14)	19.30 mm × 6.35 mm

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

High-Side Voltage Sense Circuit



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4 Revision History

NOTE: Page numbers for previous revisions may differ from page numbers in the current version.

Changes from Revision A (November 2000) to Revision B	Page
• Added *ESD Rating* table, *Feature Description* section, *Device Functional Modes*, *Application and Implementation* section, *Power Supply Recommendations* section, *Layout* section, *Device and Documentation Support* section, and *Mechanical, Packaging, and Orderable Information* section;	1
• Deleted *Available Options* tables; refer to *Package Option Addendum* at the end of this data sheet	3
• Deleted *Dissipation Ratings* table	6

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5 Device Comparison Table

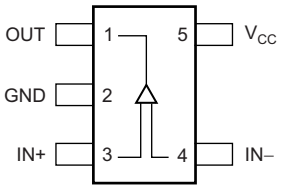
DEVICE(1)	V_{CC} (V)	V_{IO} (µV)	I_{CC}/Ch (µA)	I_{IB} (pA)	t_{PLH} (µs)	t_{PHL} (µs)	t_F (µs)	t_R (µs)	RAIL-TO-RAIL	OUTPUT STAGE
TLV340x	2.5 to 16	250	0.47	80	55	30	5	—	Input	OD
TLV370x	2.5 to 16	250	0.47	80	25	30	5	3.5	Input	PP
TLC3702/4	3 to 16	1200	9	5	1.1	0.65	0.5	0.125	—	PP
TLC393/339	3 to 16	1400	11	5	1.1	0.55	0.22	—	—	OD
TLC372/4	3 to 16	1000	75	5	0.65	0.65	—	—	—	OD

(1) All specifications are typical values measured at 5 V.

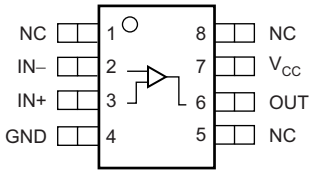
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6 Pin Configuration and Functions

TLV3401: DBV Package
5-Pin SOT-23
Top View



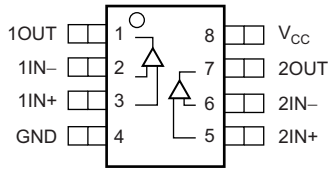
TLV3401: D and P Packages
8-Pin SOIC and VSSOP
Top View



Pin Functions: TLV3401

PIN			I/O	DESCRIPTION
NAME	TLV3401			
	SOT-23	SOIC, PDIP		
GND	2	4	—	Ground
IN–	4	2	I	Negative (inverting) input
IN+	3	3	I	Positive (noninverting) input
NC	—	1, 5, 8	—	No internal connection (can be left floating)
OUT	1	6	O	Output
V_{CC}	5	7	—	Positive power supply

TLV3402: D, DGK, and P Packages
8-PIN SOIC, PDIP, and VSSOP
Top View

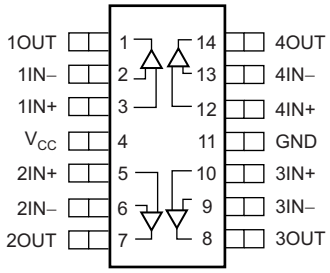


Pin Functions: TLV3402

PIN		I/O	DESCRIPTION
NAME	TLV3402		
	SOIC, PDIP, VSSOP		
GND	4	—	Ground
1IN–	2	I	Inverting input, channel 1
2IN–	6	I	Inverting input, channel 2
1IN+	3	I	Noninverting input, channel 1
2IN+	5	I	Noninverting input, channel 2
1OUT	1	O	Output, channel 1
2OUT	7	O	Output, channel 2
V_{CC}	8	—	Positive power supply

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TLV3404: D, N, and PW Packages
14-PIN SOIC, PDIP, TSSOP
Top View



Pin Functions: TLV3404

PIN		I/O	DESCRIPTION
NAME	TLV3404 SOIC, PDIP, TSSOP		
GND	11	—	Ground
1IN–	2	I	Inverting input, channel 1
2IN–	6	I	Inverting input, channel 2
3IN–	9	I	Inverting input, channel 3
4IN–	13	I	Inverting input, channel 4
1IN+	3	I	Noninverting input, channel 1
2IN+	5	I	Noninverting input, channel 2
3IN+	10	I	Noninverting input, channel 3
4IN+	12	I	Noninverting input, channel 4
1OUT	1	O	Output, channel 1
2OUT	7	O	Output, channel 2
3OUT	8	O	Output, channel 3
4OUT	14	O	Output, channel 4
V_{CC}	4	—	Positive power supply

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7 Specifications

7.1 Absolute Maximum Ratings

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

			MIN	MAX	UNIT
Voltage	Supply, V_{CC}(2)			17	V
	Differential input, V_{ID}		–20	20	
	Input, V_I(2)(3)		0	V_{CC} + 5	
Current	Input, I_I		–10	10	mA
	Output, I_O		–10	10	
Temperature	Operating, T_A	C-suffix versions	0	70	°C
		I-suffix versions	–40	125	
	Junction, T_J			150	
	Storage, T_{stg}		–65	150	

(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) All voltage values, except differential voltages, are with respect to GND.
(3) Input voltage range is limited to 20 V or V_{CC} + 5 V, whichever is smaller.

7.2 ESD Ratings

		VALUE	UNIT
$V_{(ESD)}$ Electrostatic discharge	Human-body model (HBM), per ANSI/ESDA/JEDEC JS-001(1)	±2000	V
	Charged-device model (CDM), per JEDEC specification JESD22-C101(2)	±1500	
	Machine model (MM)	±100	

(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.

7.3 Recommended Operating Conditions

			MIN	MAX	UNIT
Supply voltage, V_{CC}	Single supply	C-suffix versions	2.5	16	V
		I-suffix versions	2.7	16	
	Split supply	C-suffix versions	±1.25	±8	
		I-suffix versions	±1.35	±8	
Common-mode input voltage, V_{ICR}			–0.1	V_{CC} + 5	V
Operating free-air temperature, T_A	C-suffix versions		0	70	°C
	I-suffix versions		–40	125	

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7.4 Thermal Information: TLV3401

THERMAL METRIC(1)		TLV3401			UNIT
		D (SOIC)	DBV (SOT-23)	P (PDIP)	
		8 PINS	5 PINS	8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	201.9	237.8	58.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	92.5	108.7	48.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	123.3	64.1	35.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	23	12.1	25.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	212.6	63.3	35.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	—	°C/W

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

7.5 Thermal Information: TLV3402

THERMAL METRIC(1)		TLV3402			UNIT
		D (SOIC)	DGK (VSSOP)	P (PDIP)	
		8 PINS	8 PINS	8 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	201.9	186.8	58.5	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	92.5	77.5	48.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	123.3	107.8	35.6	°C/W
ψ_{JT}	Junction-to-top characterization parameter	23	15.7	25.9	°C/W
ψ_{JB}	Junction-to-board characterization parameter	212.6	106.2	35.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	—	°C/W

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

7.6 Thermal Information: TLV3404

THERMAL METRIC(1)		TLV3404			UNIT
		D (SOIC)	N (PDIP)	PW (TSSOP)	
		14 PINS	14 PINS	14 PINS	
$R_{\theta JA}$	Junction-to-ambient thermal resistance	83.8	65.5	120.8	°C/W
$R_{\theta JC(top)}$	Junction-to-case (top) thermal resistance	70.7	20.0	34.3	°C/W
$R_{\theta JB}$	Junction-to-board thermal resistance	59.5	25.9	62.8	°C/W
ψ_{JT}	Junction-to-top characterization parameter	11.6	1.9	1	°C/W
ψ_{JB}	Junction-to-board characterization parameter	37.7	25.3	56.5	°C/W
$R_{\theta JC(bot)}$	Junction-to-case (bottom) thermal resistance	—	—	—	°C/W

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

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7.7 Electrical Characteristics

At specified free-air temperature and V_{CC} = 2.7 V, 5 V, 15 V, unless otherwise noted.

PARAMETER		TEST CONDITIONS		T_A (1)	MIN	TYP	MAX	UNIT
DC PERFORMANCE								
V_{IO}	Input offset voltage	$V_{IC} = V_{CC}/2$, R_S = 50 Ω, R_P = 1 MΩ		T_A = 25°C		250	3600	µV
				Full range			4400	
α_{VIO}	Offset voltage drift	$V_{IC} = V_{CC}/2$, R_S = 50 Ω, R_P = 1 MΩ		T_A = 25°C		3		µV/°C
CMRR	Common-mode rejection ratio	V_{IC} = 0 V to 2.7 V, R_S = 50 Ω		T_A = 25°C	55	72		dB
				Full range	50			
		V_{IC} = 0 V to 5 V, R_S = 50 Ω		T_A = 25°C	60	76		
				Full range	55			
		V_{IC} = 0 V to 15 V, R_S = 50 Ω		T_A = 25°C	65	88		
				Full range	60			
A_{VD}	Large-signal differential voltage amplification	R_P = 1 MΩ		T_A = 25°C		1000		V/mV
INPUT/OUTPUT CHARACTERISTICS								
I_{IO}	Input offset current	$V_{IC} = V_{CC}/2$, R_S = 50 Ω, R_P = 1 MΩ		T_A = 25°C		20	100	pA
				Full range			1000	
I_{IB}	Input bias current	$V_{IC} = V_{CC}/2$, R_S = 50 Ω, R_P = 1 MΩ		T_A = 25°C		80	250	pA
				Full range			1500	
$r_{i(d)}$	Differential input resistance			T_A = 25°C		300		MΩ
I_{OZ}	High-impedance output leakage current	$V_{IC} = V_{CC}/2$, $V_O = V_{CC}$, V_{ID} = 1 V		T_A = 25°C		50		pA
V_{OL}	Low-level output voltage	$V_{IC} = V_{CC}/2$, I_{OL} = 2 µA, V_{ID} = –1 V		T_A = 25°C		8		mV
		$V_{IC} = V_{CC}/2$, I_{OL} = 50 µA, V_{ID} = –1 V		T_A = 25°C		80	200	
				Full range			300	
POWER SUPPLY								
I_{CC}	Supply current (per channel)	R_P = no pullup	Output state low	T_A = 25°C		470	550	nA
				Full range			750	
			Output state high	T_A = 25°C		560	640	
				Full range			950	
PSRR	Power-supply rejection ratio	$V_{IC} = V_{CC}/2$, no load	V_{CC} = 2.7 V to 5 V	T_A = 25°C	75	100		dB
				Full range	70			
			V_{CC} = 5 V to 15 V	T_A = 25°C	85	105		
				Full range	80			

(1) Full range is 0°C to 70°C for the C-suffix and –40°C to 125°C for the I-suffix. If not specified, full range is –40°C to 125°C.

7.8 Switching Characteristics

At T_A = 25°C, recommended operating conditions, and V_{CC} = 2.7 V, 5 V, 15 V, unless otherwise noted.

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
$t_{(PLH)}$	Propagation delay time, low-to-high-level output	f = 10 kHz, V_{STEP} = 1 V, R_P = 1 MΩ, C_L = 10 pF	Overdrive = 2 mV	T_A = 25°C		175		µs
			Overdrive = 10 mV	T_A = 25°C		80		
			Overdrive = 50 mV	T_A = 25°C		55		
$t_{(PHL)}$	Propagation delay time, high-to-low-level output	f = 10 kHz, V_{STEP} = 1 V, R_P = 1 MΩ, C_L = 10 pF	Overdrive = 2 mV	T_A = 25°C		300		µs
			Overdrive = 10 mV	T_A = 25°C		60		
			Overdrive = 50 mV	T_A = 25°C		30		
t_F	Fall time	R_P = 1 MΩ, C_L = 10 pF		T_A = 25°C		5		µs

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7.9 Typical Characteristics

Table 1. Table of Graphs

DESCRIPTION			FIGURE NO.
	Input bias/offset current	vs Free-air temperature	Figure 1
	Open collector leakage current	vs Free-air temperature	Figure 2
V_{OL}	Low-level output voltage	vs Low-level output current	Figure 3, Figure 4, Figure 5
I_{DD}	Supply current	vs Supply voltage	Figure 6
I_{DD}	Supply current	vs Free-air temperature	Figure 7
	Low-to-high level output response for various input overdrives		Figure 8, Figure 9, Figure 10
	High-to-low level output response for various input overdrives		Figure 11, Figure 12, Figure 13
	Output fall time	vs Supply voltage	Figure 14

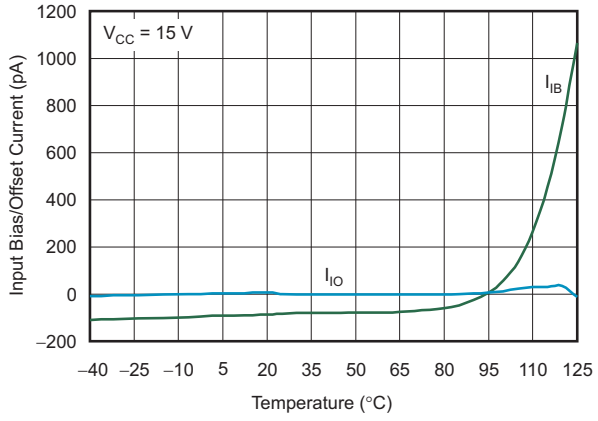


Figure 1. Input Bias/Offset Current vs Free-Air Temperature

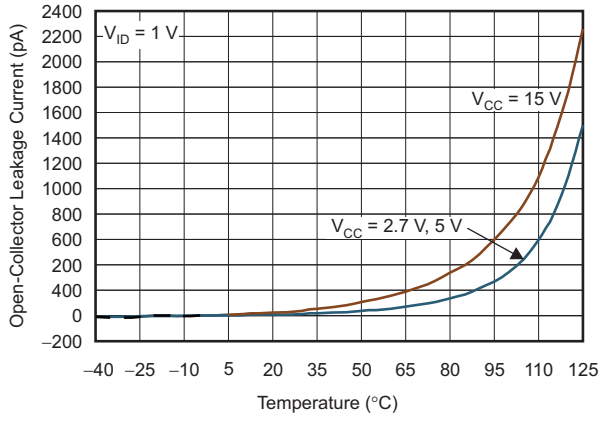


Figure 2. Open-Collector Leakage Current vs Free-Air Temperature

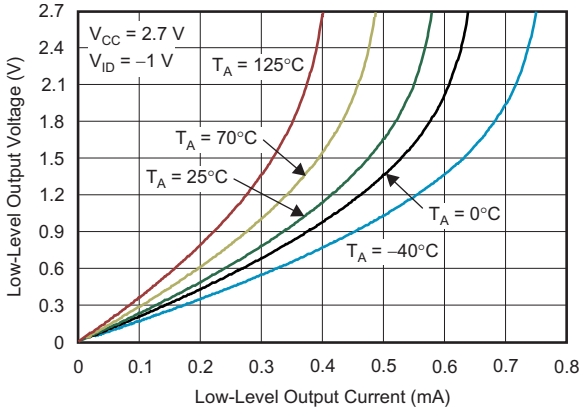


Figure 3. Low-Level Output Voltage vs Low-Level Output Current

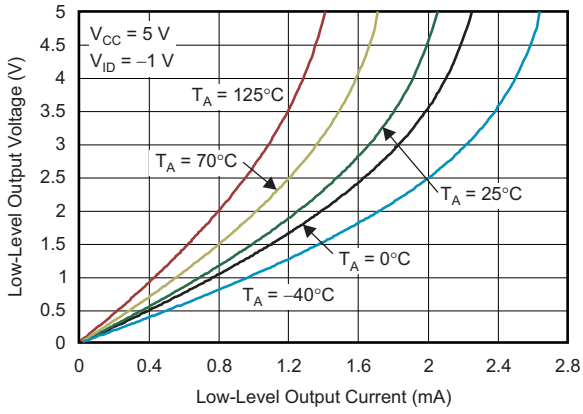


Figure 4. Low-Level Output Voltage vs Low-Level Output Current

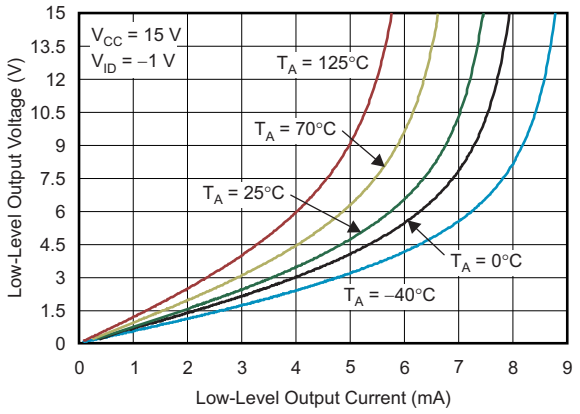


Figure 5. Low-Level Output Voltage vs Low-Level Output Current

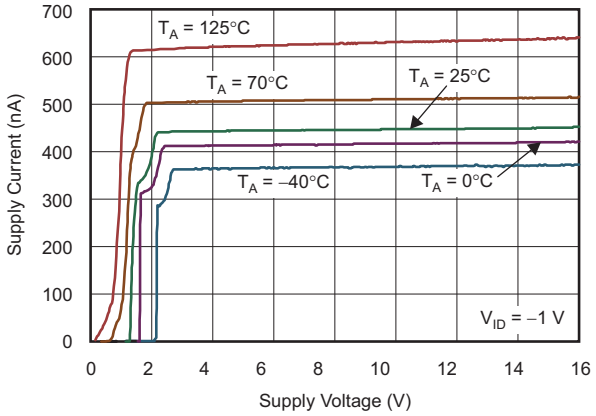


Figure 6. Supply Current vs Supply Voltage

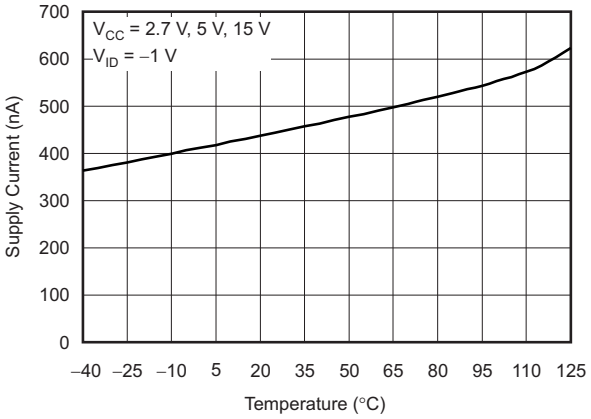


Figure 7. Supply Current vs Free-Air Temperature

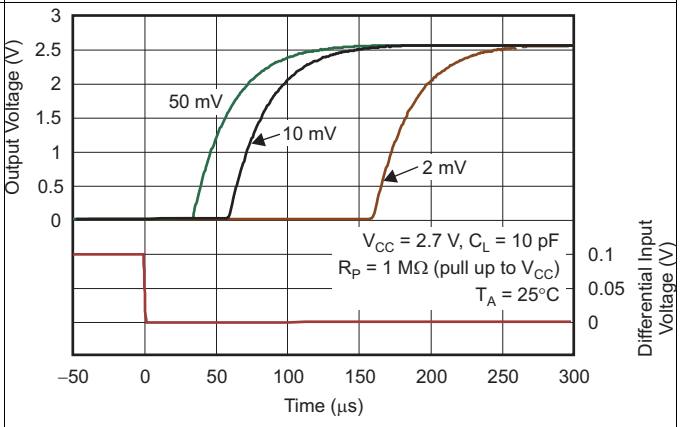


Figure 8. Low-to-High Level Output Response for Various Input Overdrives

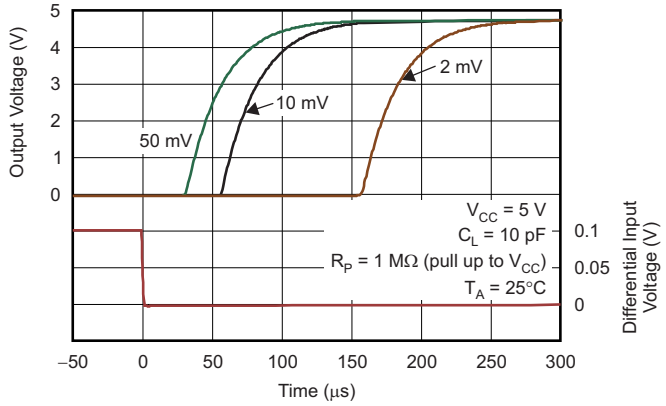


Figure 9. Low-to-High Level Output Response for Various Input Overdrives

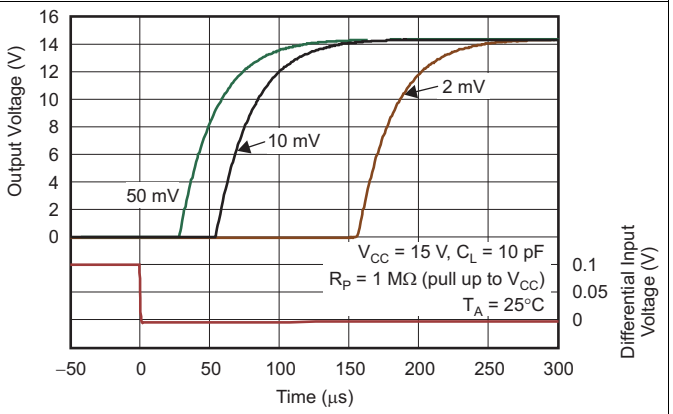


Figure 10. Low-to-High Level Output Response for Various Input Overdrives

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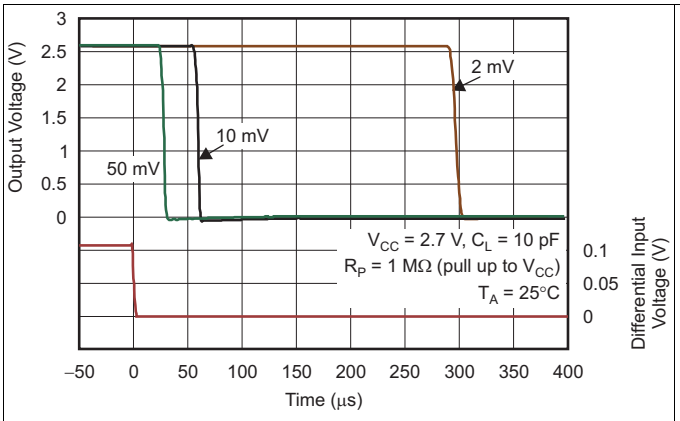


Figure 11. High-to-Low Level Output Response for Various Input Overdrives

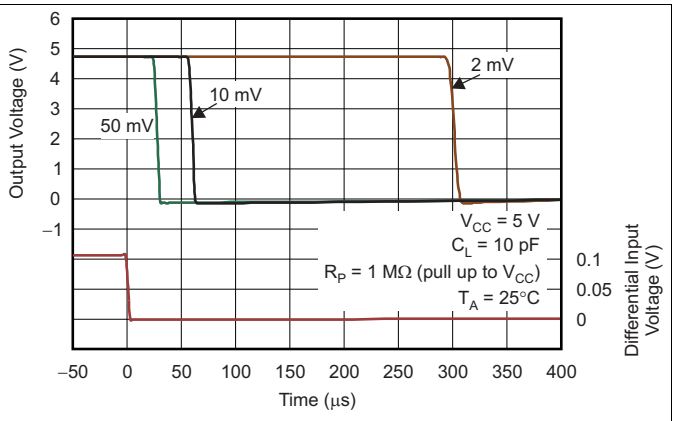


Figure 12. High-to-Low Level Output Response for Various Input Overdrives

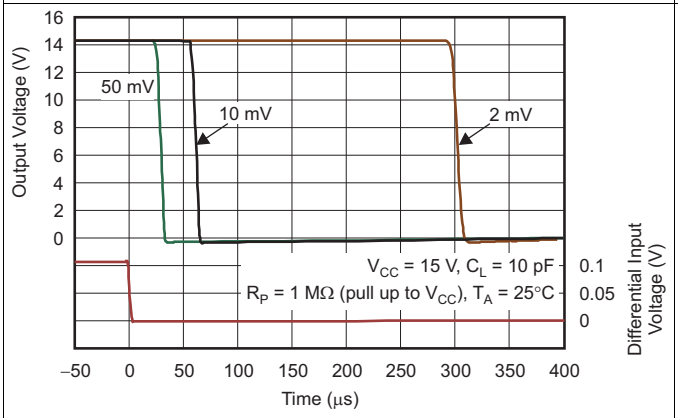


Figure 13. High-to-Low Level Output Response for Various Input Overdrives

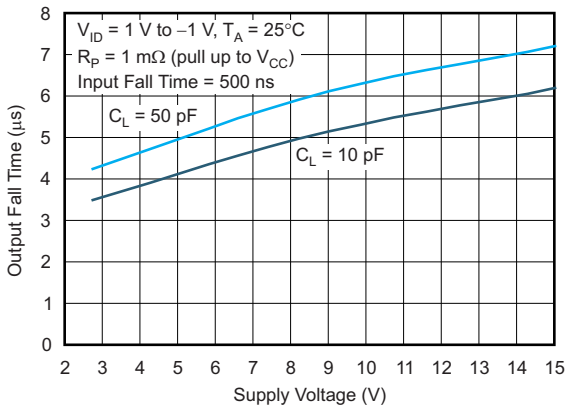


Figure 14. Output Fall Time vs Supply Voltage

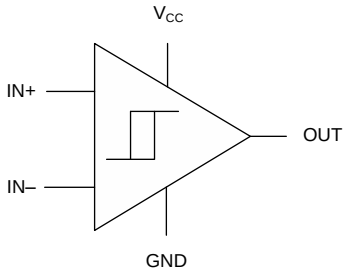
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8 Detailed Description

8.1 Overview

The TLV340x is a family of nanopower comparators drawing only 470 nA per channel supply current. Having a minimum operating supply voltage of 2.7 V over the extended industrial temperature range (T_A = –40°C to +125°C), while having an input common-mode range of –0.1 to V_{CC} + 5 V makes this device ideal for battery-powered and wireless handset applications.

8.2 Functional Block Diagram



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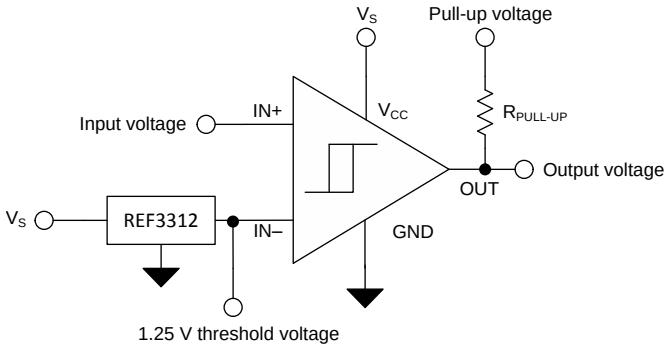
8.3 Feature Description

8.3.1 Operating Voltage

The TLV340x comparators are specified for use on a single supply from 2.5 V to 16 V (or a dual supply from ±1.25 V to ±16 V) over a temperature range of −40°C to +125°C.

8.3.2 Setting the Threshold

Using a low-power, stable reference is important when setting the transition point for the TLV340x devices. The REF3312, as shown in Figure 15, provides a 1.25-V reference voltage with low drift and only 3.9 µA of quiescent current.



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Figure 15. Setting the Threshold

8.4 Device Functional Modes

The TLV340x has a single functional mode and is operational when the power supply voltage applied ranges from 2.5 V (±1.25 V) to 16 V (±8 V).

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9 Application and Implementation

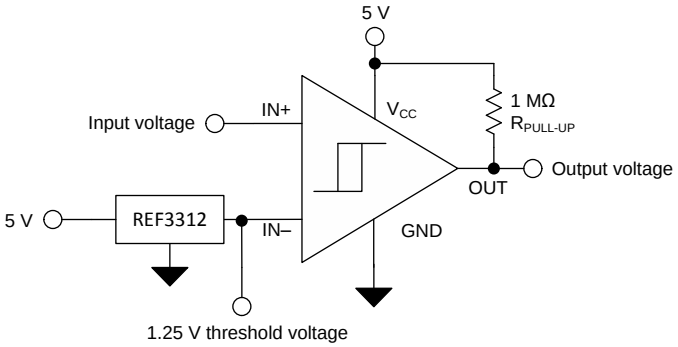
NOTE

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.

9.1 Application Information

Many applications require the detection of a signal (voltage or current) that exceeds a particular threshold voltage or current. Using a comparator to make that threshold detection is the easiest, lowest power and highest speed way to make a threshold detection.

9.2 Typical Application



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Figure 16. 1.25-V Threshold Detector

9.2.1 Design Requirements

- Detect when a signal is above or below 1.25 V
- Operate from a single 5-V power supply
- Rail-to-rail input voltage range from 0 to 5 V
- Rail-to-rail output voltage range from 0 to 5 V

9.2.2 Detailed Design Procedure

The input voltage range in the circuit illustrated in Figure 16 is limited only by the power supply applied to the TV3401. In this example with the selection of a 5-V, single-supply power supply, the input voltage range is limited to 0 to V_S + 5 V, or 0 to 10 V. The threshold voltage of 1.25 V can de derived in a variety of ways. As the TLV3401 is a very low-power device, it is desirable to also use very low power to create the threshold voltage. The REF3312 series voltage reference is selected for its stable output voltage of 1.25 V and its low power consumption of only 3.9 µA. The TLV3401 is an open-drain output comparator, requiring a pullup resistor from output to the power supply. Proper selection of the pullup resistor value requires maximizing the output voltage swing while at the same time minimizing power dissipated in the resistor when the output voltage is low. Too small of a pullup resistor can result in too much power dissipation, while too large of a pullup resistor can result in slower response times. The TLV3401 is fully specified with a 1-MΩ pullup resistor and using a 1-MΩ pullup resistor results in meeting the performance specifications listed in the *Electrical Characteristics*.

Typical Application (continued)

9.2.3 Application Curve

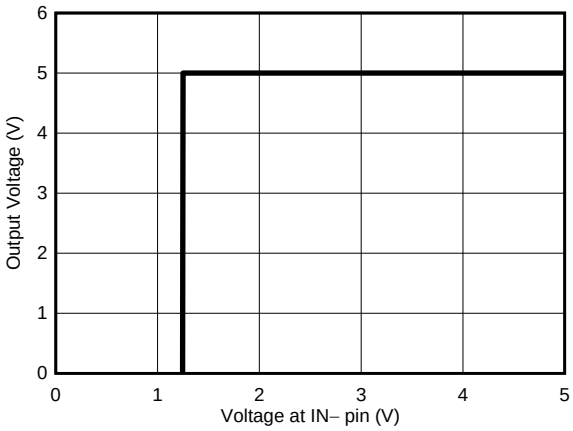


Figure 17. Transfer Function for the Threshold Detector

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10 Power Supply Recommendations

The TLV340x device is specified for operation from 2.5 V to 16 V (±1.25 to ±8 V); many specifications apply from –40°C to +125°C. Parameters that can exhibit significant variance with regard to operating voltage or temperature are presented in *Typical Characteristics*.

11 Layout

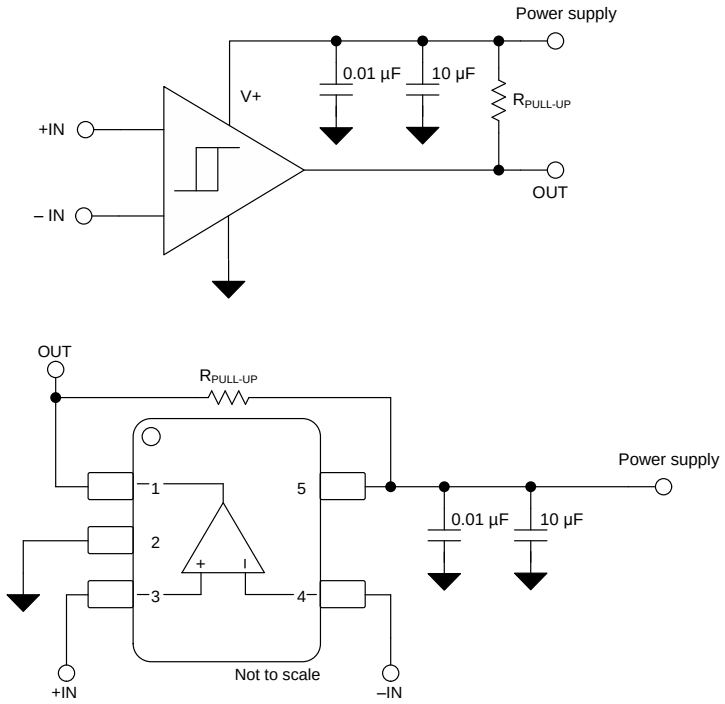
11.1 Layout Guidelines

Figure 18 shows the typical connections for the TLV340x. To minimize supply noise, power supplies must be capacitively decoupled by a 0.01-µF ceramic capacitor in parallel with a 10-µF electrolytic capacitor. Comparators are very sensitive to input noise. Proper grounding (the use of a ground plane) helps to maintain the specified performance of the TLV340x family.

For best results, maintain the following layout guidelines:

1. Use a printed-circuit board (PCB) with a good, unbroken low-inductance ground plane.
2. Place a decoupling capacitor (0.1-µF ceramic, surface-mount capacitor) as close as possible to V_{CC}.
3. On the inputs and the output, keep lead lengths as short as possible to avoid unwanted parasitic feedback around the comparator. Keep inputs away from the output.
4. Solder the device directly to the PCB rather than using a socket.
5. For slow-moving input signals, take care to prevent parasitic feedback. A small capacitor (1000 pF or less) placed between the inputs can help eliminate oscillations in the transition region. This capacitor causes some degradation to propagation delay when the impedance is low. The top-side ground plane runs between the output and inputs.
6. The ground pin ground trace runs under the device up to the bypass capacitor, shielding the inputs from the outputs.

11.2 Layout Example



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Figure 18. TLV340x Layout Example

12 Device and Documentation Support

12.1 Device Support

12.1.1 Development Support

12.1.1.1 DIP Adapter EVM

The DIP Adapter EVM tool provides an easy, low-cost way to prototype small surface mount ICs. The evaluation tool these TI packages: D or U (8-pin SOIC), PW (8-pin TSSOP), DGK (8-pin MSOP), DBV (6-pin SOT-23, 5-pin SOT23, and 3-pin SOT-23), DCK (6-pin SC-70 and 5-pin SC-70), and DRL (6-pin SOT-563). The DIP Adapter EVM may also be used with terminal strips or may be wired directly to existing circuits.

12.1.1.2 Universal Op Amp EVM

The Universal Op Amp EVM is a series of general-purpose, blank circuit boards that simplify prototyping circuits for a variety of IC package types. The evaluation module board design allows many different circuits to be constructed easily and quickly. Five models are offered, with each model intended for a specific package type. PDIP, SOIC, MSOP, TSSOP, and SOT-23 packages are all supported.

NOTE

These boards are unpopulated, so users must provide their own ICs. TI recommends requesting several op amp device samples when ordering the Universal Op Amp EVM.

12.2 Documentation Support

12.2.1 Related Documentation

The following documents are relevant for using the TLV340x devices and are recommended for reference. All are available for download at www.ti.com (unless otherwise noted):

- *Universal Op Amp EVM User Guide* (SLOU060)
- *Hardware Pace using Slope Detection* (SLAU511)
- *Bipolar High-voltage Differential Interface for Low-voltage Comparators* (TIDU039)
- *AC-Coupled Single Supply Comparator* (SLAU505)
- *ECG Implementation on the TMS320VC5505 DSP Medical Development Kit* (SPRAB36)
- *REF33xx 3.9-μA, SC70-3, SOT-23-3, and UQFN-8, 30-ppm/ °C Drift Voltage Reference* (SBOS392)

12.3 Related Links

Table 2 lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 2. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
TLV3401	Click here	Click here	Click here	Click here	Click here
TLV3402	Click here	Click here	Click here	Click here	Click here
TLV3404	Click here	Click here	Click here	Click here	Click here

12.4 Receiving Notification of Documentation Updates

To receive notification of documentation updates, navigate to the device product folder on ti.com. In the upper right corner, click on *Alert me* 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.

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12.5 Community Resource

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.

12.6 Trademarks

E2E is a trademark of Texas Instruments.
All other trademarks are the property of their respective owners.

12.7 Electrostatic Discharge Caution



These devices have limited built-in ESD protection. The leads should be shorted together or the device placed in conductive foam during storage or handling to prevent electrostatic damage to the MOS gates.

12.8 Glossary

SLYZ022 — *TI Glossary*.

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

13 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 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)
TLV3401CD	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	3401C
TLV3401CD.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	3401C
TLV3401CDBVR	Obsolete	Production	SOT-23 (DBV) | 5	-	-	Call TI	Call TI	0 to 70	VBDC
TLV3401CDBVT	Obsolete	Production	SOT-23 (DBV) | 5	-	-	Call TI	Call TI	0 to 70	VBDC
TLV3401ID	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3401I
TLV3401ID.A	Active	Production	SOIC (D) | 8	75 | TUBE	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3401I
TLV3401IDBVR	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	VBDI
TLV3401IDBVR.A	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	VBDI
TLV3401IDBVRG4	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	-	Call TI	Call TI	-40 to 125	
TLV3401IDR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3401I
TLV3401IDR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3401I
TLV3401IP	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3401I
TLV3401IP.A	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3401I
TLV3402CD	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	3402C
TLV3402CDGK	Obsolete	Production	VSSOP (DGK) | 8	-	-	Call TI	Call TI	0 to 70	AJJ
TLV3402CDGKR	Obsolete	Production	VSSOP (DGK) | 8	-	-	Call TI	Call TI	0 to 70	AJJ
TLV3402CDR	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	0 to 70	3402C
TLV3402ID	Obsolete	Production	SOIC (D) | 8	-	-	Call TI	Call TI	-40 to 125	3402I
TLV3402IDGK	Obsolete	Production	VSSOP (DGK) | 8	-	-	Call TI	Call TI	-40 to 125	AJK
TLV3402IDGKR	Active	Production	VSSOP (DGK) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AJK
TLV3402IDGKR.A	Active	Production	VSSOP (DGK) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	AJK
TLV3402IDR	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3402I
TLV3402IDR.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3402I
TLV3402IDRG4	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	-	Call TI	Call TI	-40 to 125	
TLV3402IP	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3402I
TLV3402IP.A	Active	Production	PDIP (P) | 8	50 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3402I
TLV3404CD	Obsolete	Production	SOIC (D) | 14	-	-	Call TI	Call TI	0 to 70	3404C
TLV3404CDR	Obsolete	Production	SOIC (D) | 14	-	-	Call TI	Call TI	0 to 70	3404C
TLV3404CPW	Obsolete	Production	TSSOP (PW) | 14	-	-	Call TI	Call TI	0 to 70	3404C

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)
TLV3404CPWR	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	3404C
TLV3404CPWR.A	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	0 to 70	3404C
TLV3404ID	Obsolete	Production	SOIC (D) | 14	-	-	Call TI	Call TI	-40 to 125	3404I
TLV3404IDR	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3404I
TLV3404IDR.A	Active	Production	SOIC (D) | 14	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3404I
TLV3404IN	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3404I
TLV3404IN.A	Active	Production	PDIP (N) | 14	25 | TUBE	Yes	NIPDAU	N/A for Pkg Type	-40 to 125	TLV3404I
TLV3404IPW	Obsolete	Production	TSSOP (PW) | 14	-	-	Call TI	Call TI	-40 to 125	3404I
TLV3404IPWR	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3404I
TLV3404IPWR.A	Active	Production	TSSOP (PW) | 14	2000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3404I

(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.

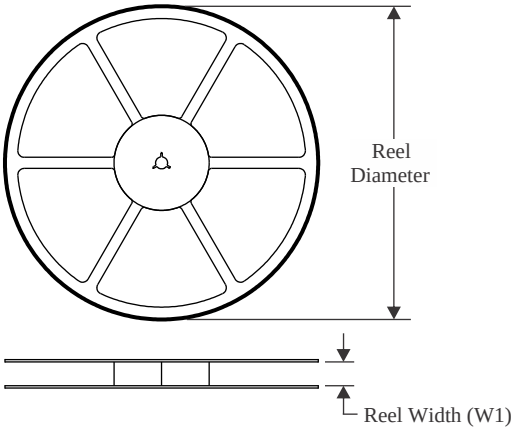
Multiple part markings will be inside parentheses. Only one part marking contained in parentheses and separated by a "~" will appear on a part. If a line is indented then it is a continuation of the previous line and the two combined represent the entire part marking for that device.

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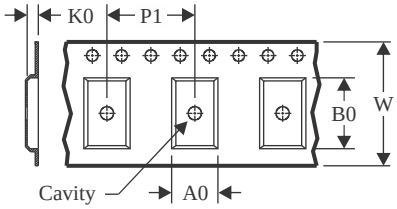
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TAPE AND REEL INFORMATION

REEL DIMENSIONS

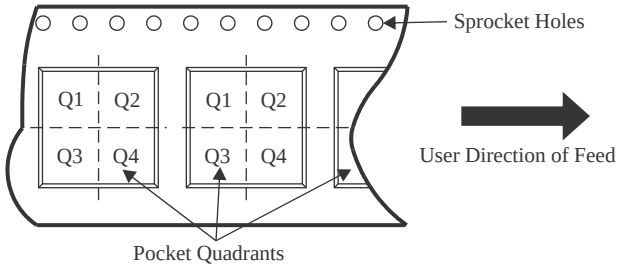


TAPE DIMENSIONS



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

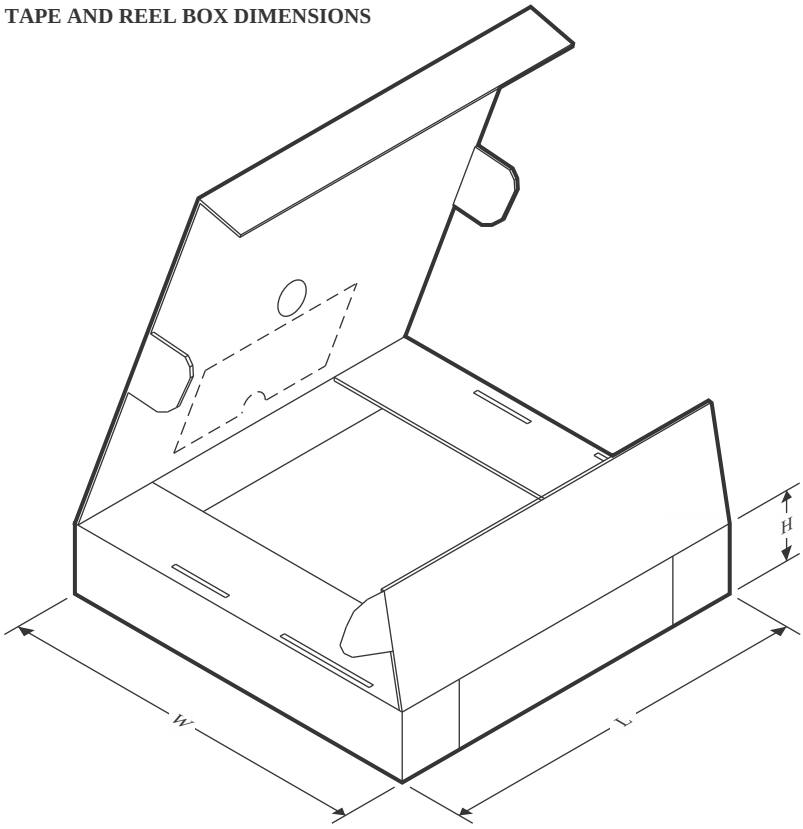
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TLV3401IDBVR	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV3401IDBVR	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV3401IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV3402IDGKR	VSSOP	DGK	8	2500	330.0	12.4	5.3	3.4	1.4	8.0	12.0	Q1
TLV3402IDR	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV3404CPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
TLV3404IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLV3404IDR	SOIC	D	14	2500	330.0	16.4	6.5	9.0	2.1	8.0	16.0	Q1
TLV3404IPWR	TSSOP	PW	14	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1

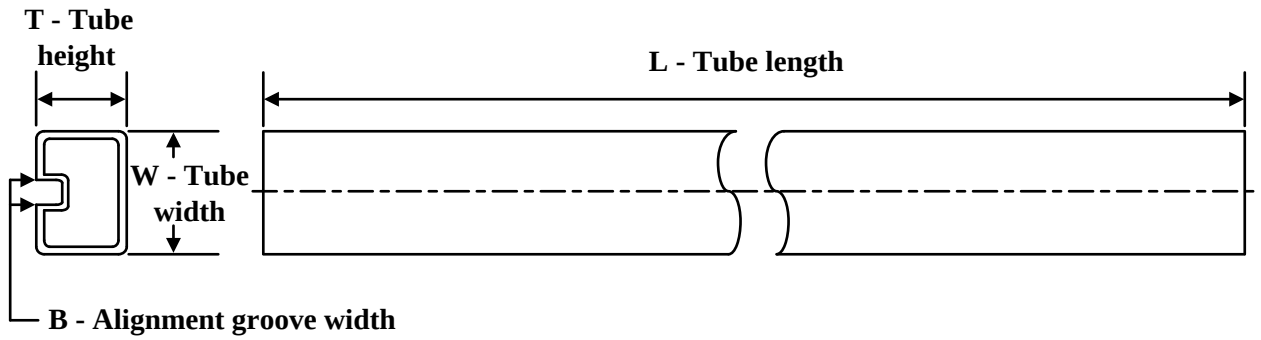
TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV3401IDBVR	SOT-23	DBV	5	3000	210.0	185.0	35.0
TLV3401IDBVR	SOT-23	DBV	5	3000	210.0	185.0	35.0
TLV3401IDR	SOIC	D	8	2500	340.5	338.1	20.6
TLV3402IDGKR	VSSOP	DGK	8	2500	353.0	353.0	32.0
TLV3402IDR	SOIC	D	8	2500	353.0	353.0	32.0
TLV3404CPWR	TSSOP	PW	14	2000	353.0	353.0	32.0
TLV3404IDR	SOIC	D	14	2500	340.5	336.1	32.0
TLV3404IDR	SOIC	D	14	2500	340.5	336.1	32.0
TLV3404IPWR	TSSOP	PW	14	2000	353.0	353.0	32.0

TUBE



*All dimensions are nominal

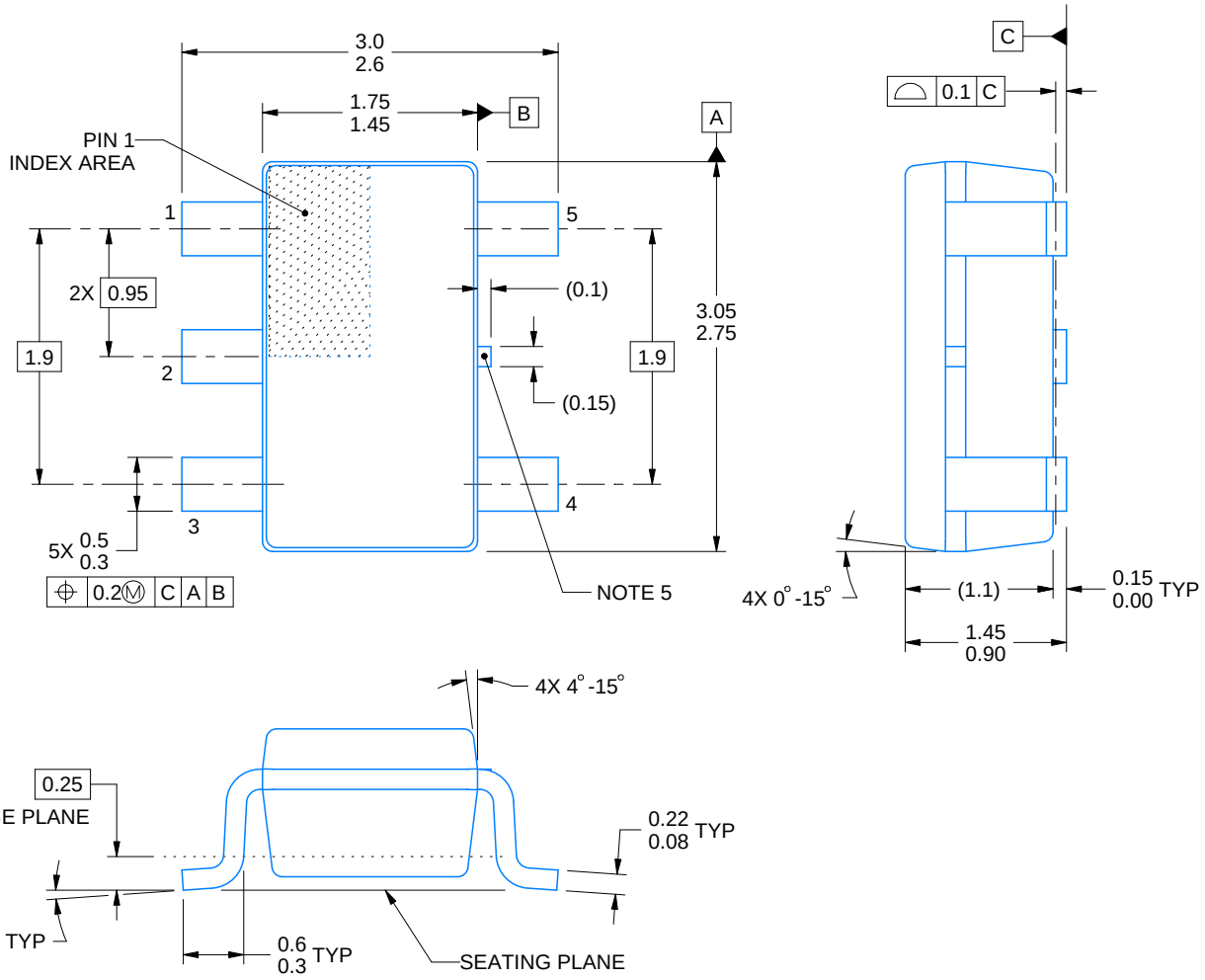
Device	Package Name	Package Type	Pins	SPQ	L (mm)	W (mm)	T (µm)	B (mm)
TLV3401CD	D	SOIC	8	75	507	8	3940	4.32
TLV3401CD.A	D	SOIC	8	75	507	8	3940	4.32
TLV3401ID	D	SOIC	8	75	507	8	3940	4.32
TLV3401ID.A	D	SOIC	8	75	507	8	3940	4.32
TLV3401IP	P	PDIP	8	50	506	13.97	11230	4.32
TLV3401IP.A	P	PDIP	8	50	506	13.97	11230	4.32
TLV3402IP	P	PDIP	8	50	506	13.97	11230	4.32
TLV3402IP.A	P	PDIP	8	50	506	13.97	11230	4.32
TLV3404IN	N	PDIP	14	25	506	13.97	11230	4.32
TLV3404IN.A	N	PDIP	14	25	506	13.97	11230	4.32

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

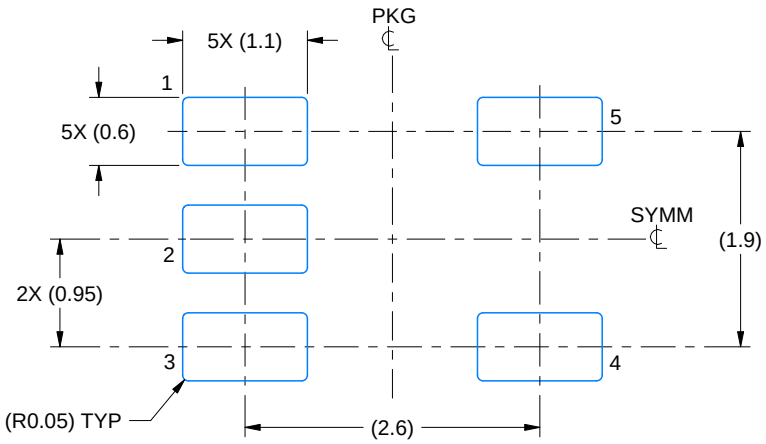
SMALL OUTLINE TRANSISTOR



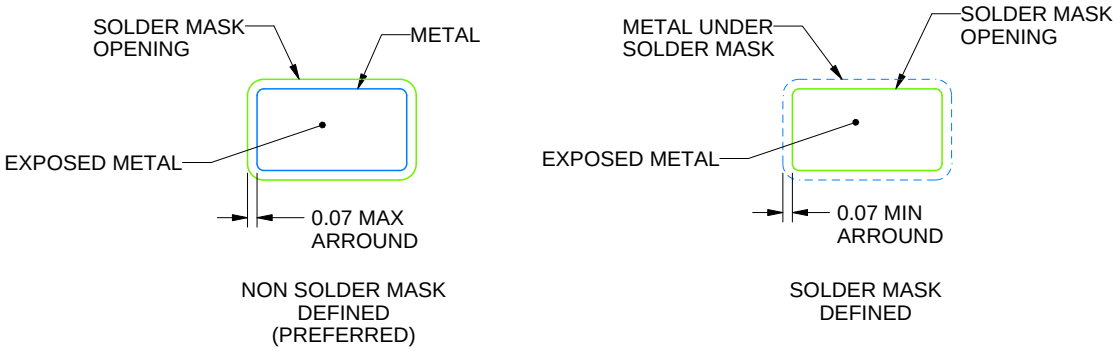
4214839/K 08/2024

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. Refernce JEDEC MO-178.
4. Body dimensions do not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.25 mm per side.
5. Support pin may differ or may not be present.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:15X

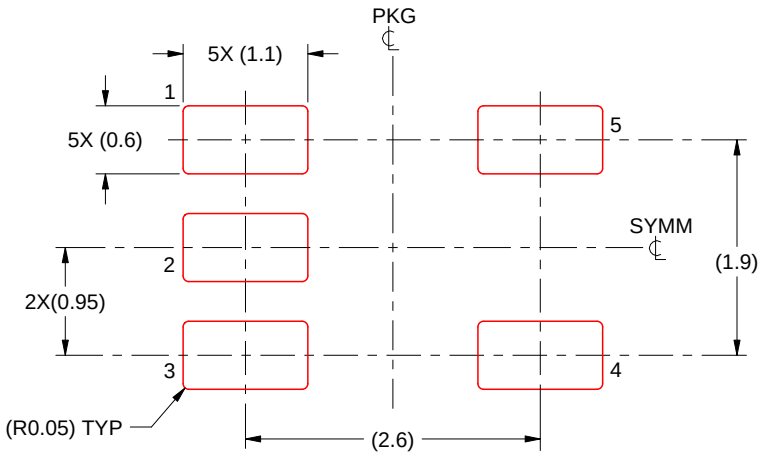


SOLDER MASK DETAILS

4214839/K 08/2024

NOTES: (continued)

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



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

4214839/K 08/2024

NOTES: (continued)

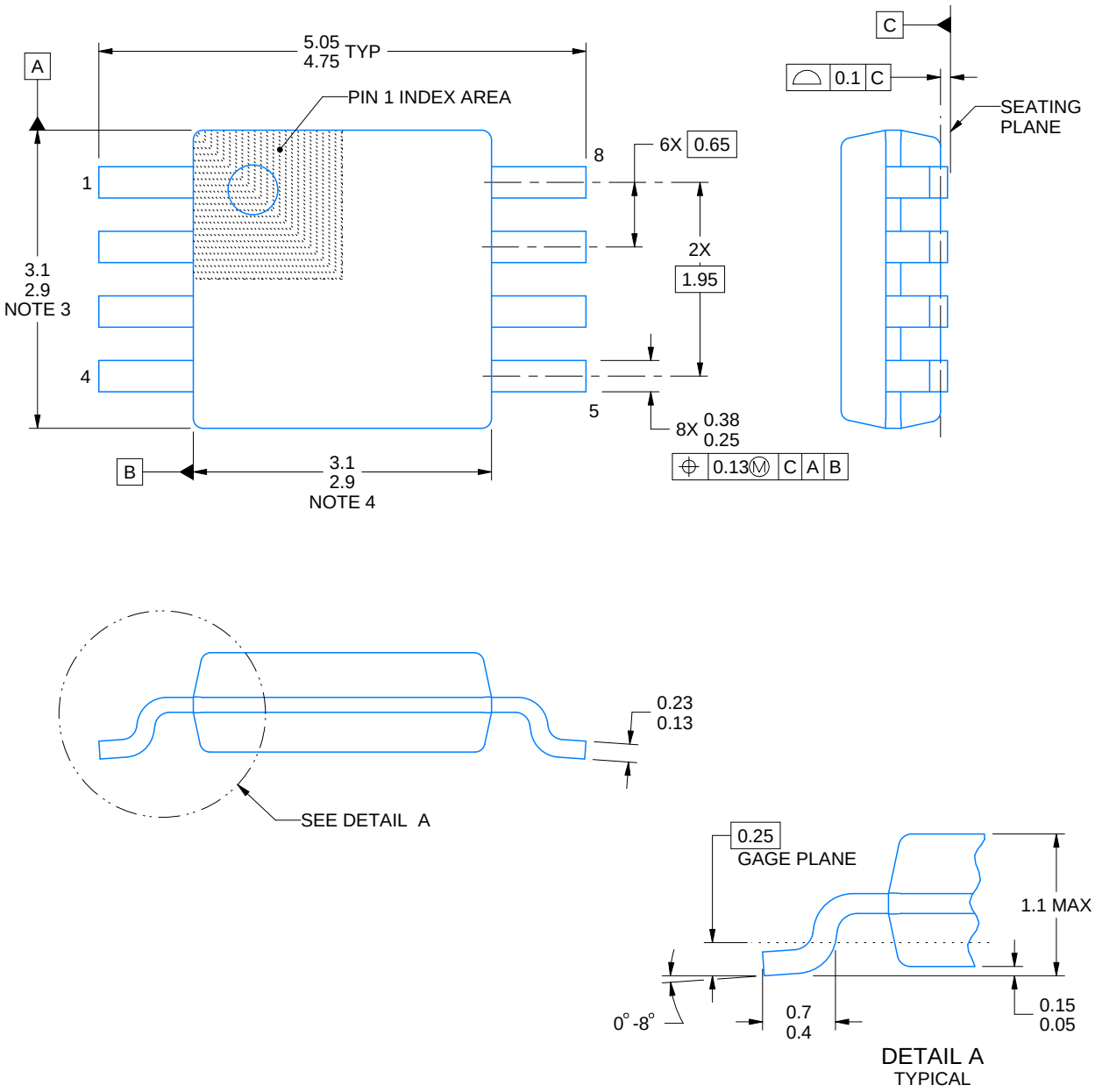
8. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
9. Board assembly site may have different recommendations for stencil design.

PACKAGE OUTLINE

DGK0008A

VSSOP - 1.1 mm max height

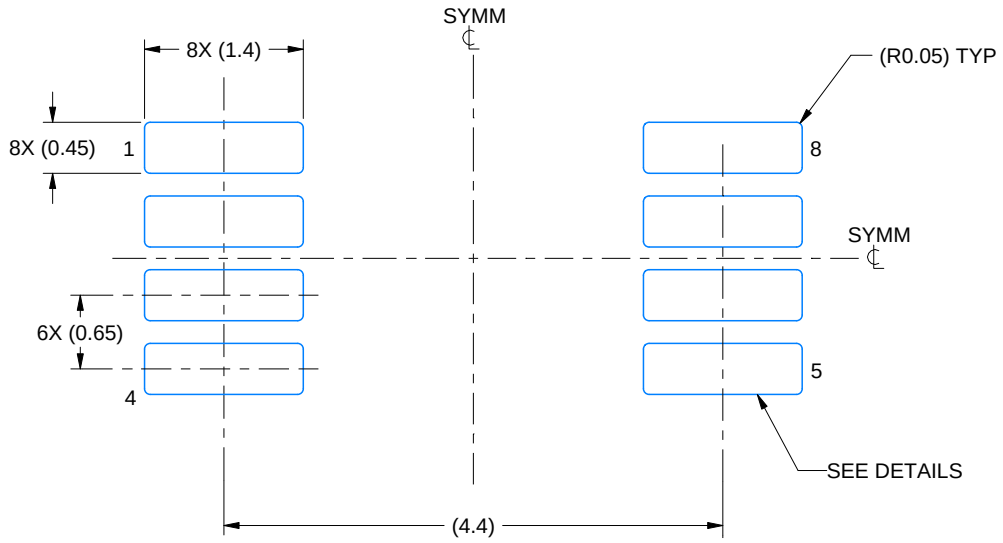
SMALL OUTLINE PACKAGE



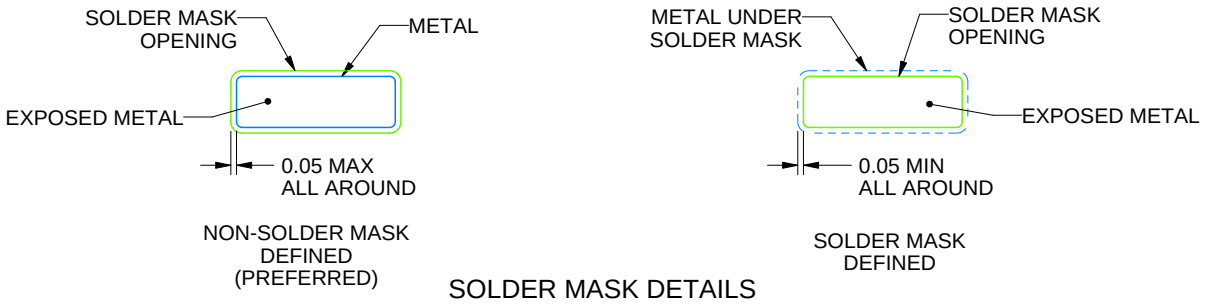
PowerPAD is a trademark of Texas Instruments.

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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-187.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 15X

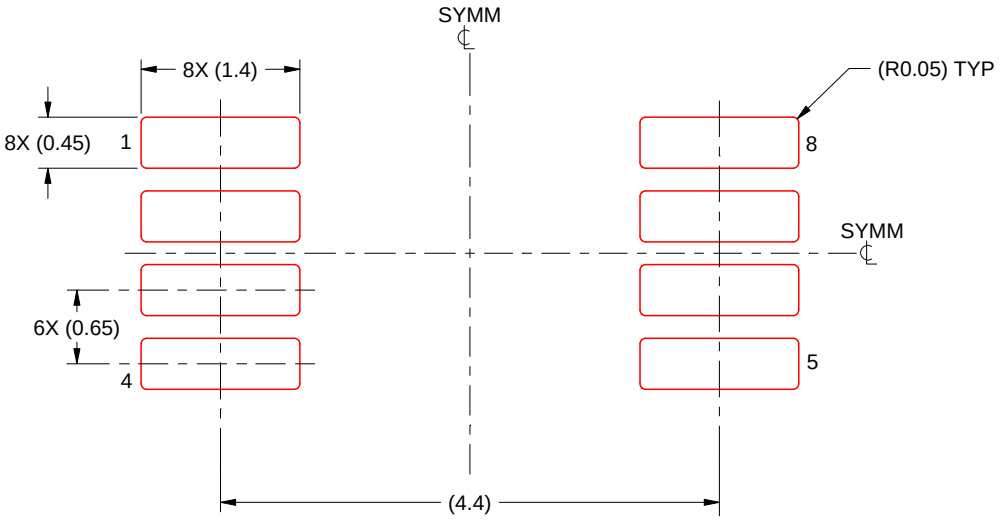


SOLDER MASK DETAILS

4214862/A 04/2023

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.
8. Vias are optional depending on application, refer to device data sheet. If any vias are implemented, refer to their locations shown on this view. It is recommended that vias under paste be filled, plugged or tented.
9. Size of metal pad may vary due to creepage requirement.

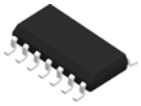


SOLDER PASTE EXAMPLE
SCALE: 15X

4214862/A 04/2023

NOTES: (continued)

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

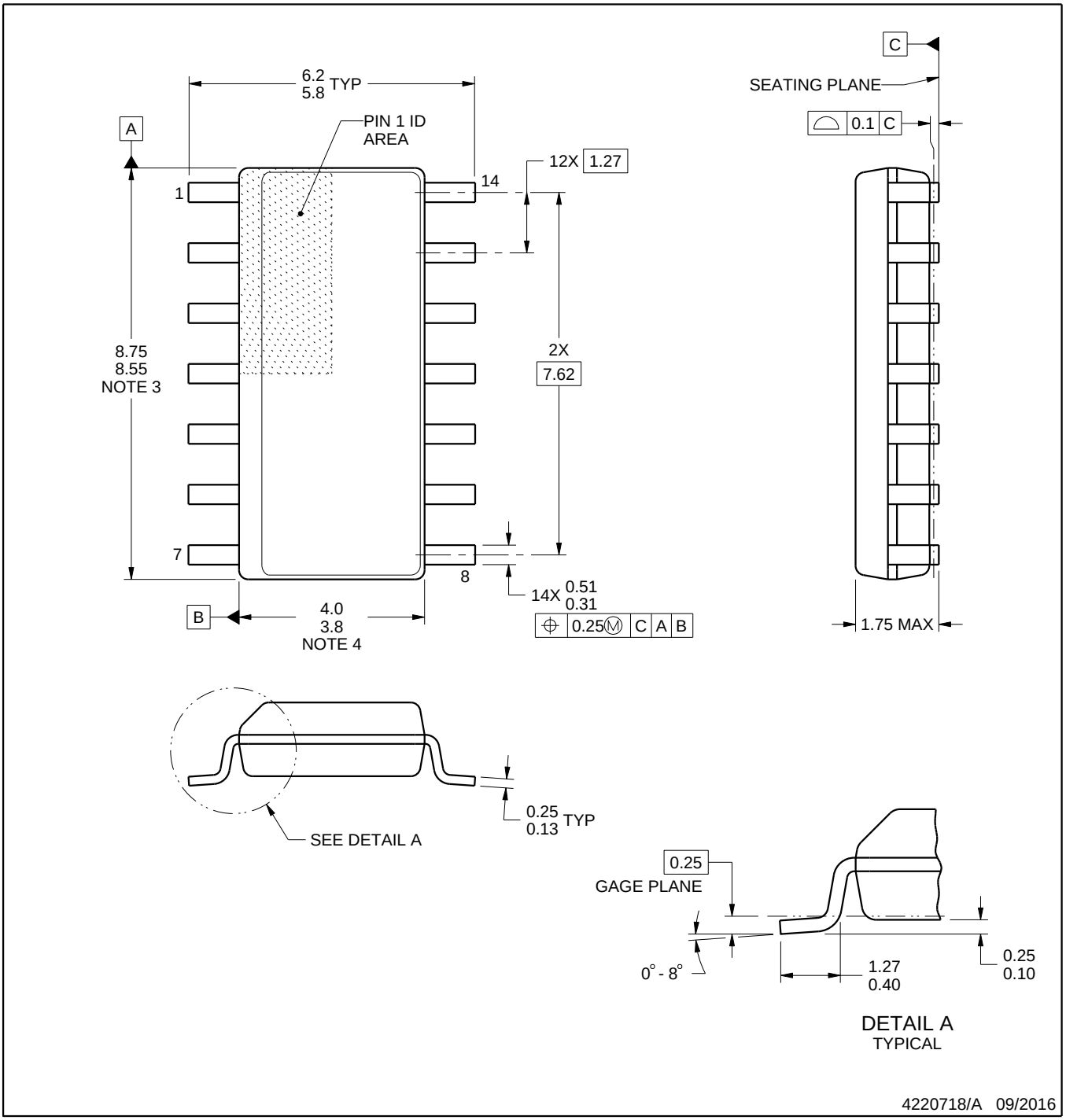


PACKAGE OUTLINE

D0014A

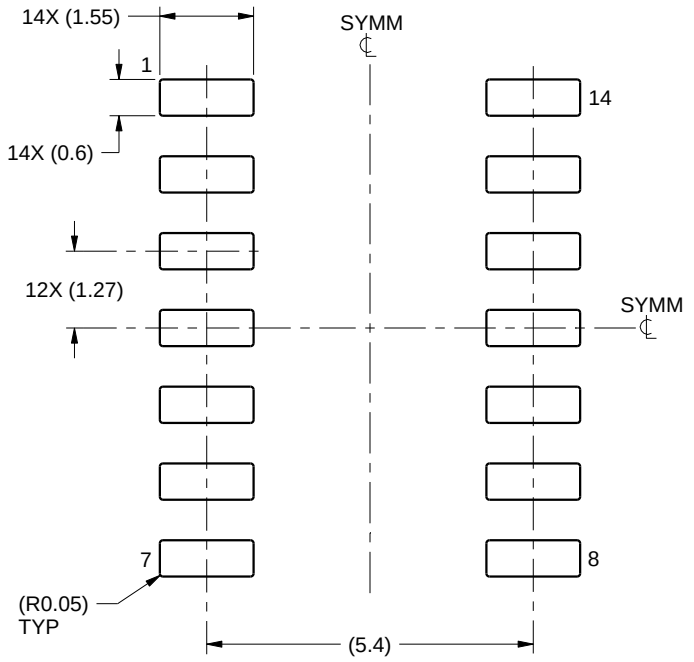
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

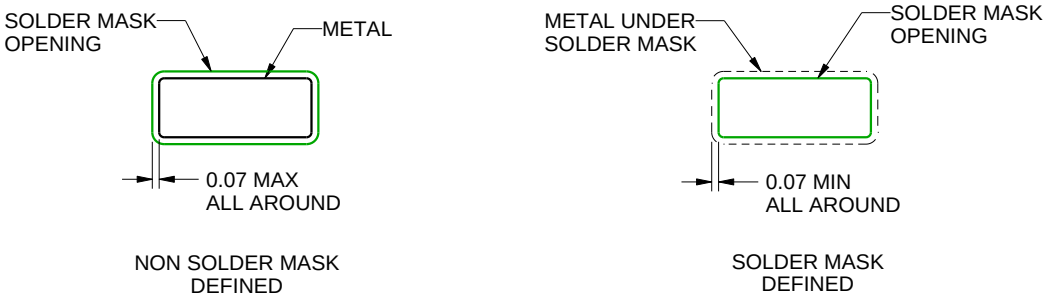


NOTES:

1. All linear dimensions are in millimeters. Dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm, per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.43 mm, per side.
5. Reference JEDEC registration MS-012, variation AB.



LAND PATTERN EXAMPLE
SCALE:8X



SOLDER MASK DETAILS

4220718/A 09/2016

NOTES: (continued)

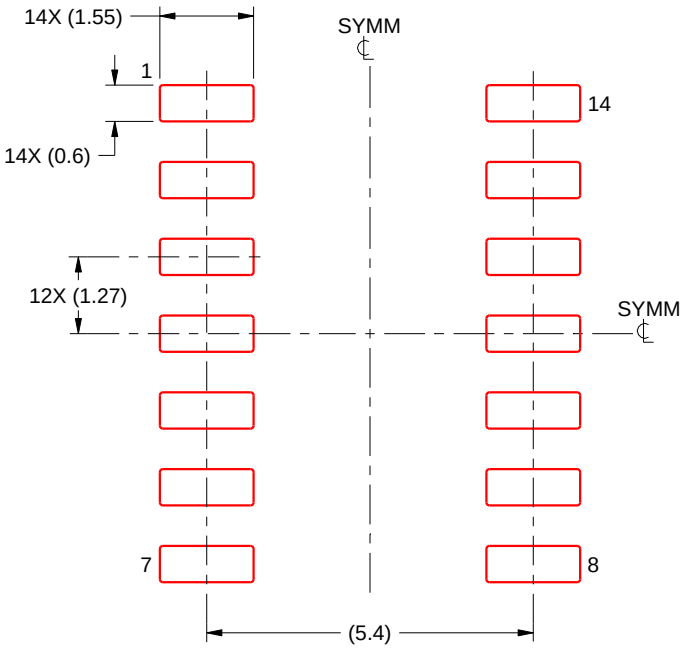
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0014A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

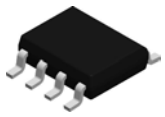


SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:8X

4220718/A 09/2016

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.

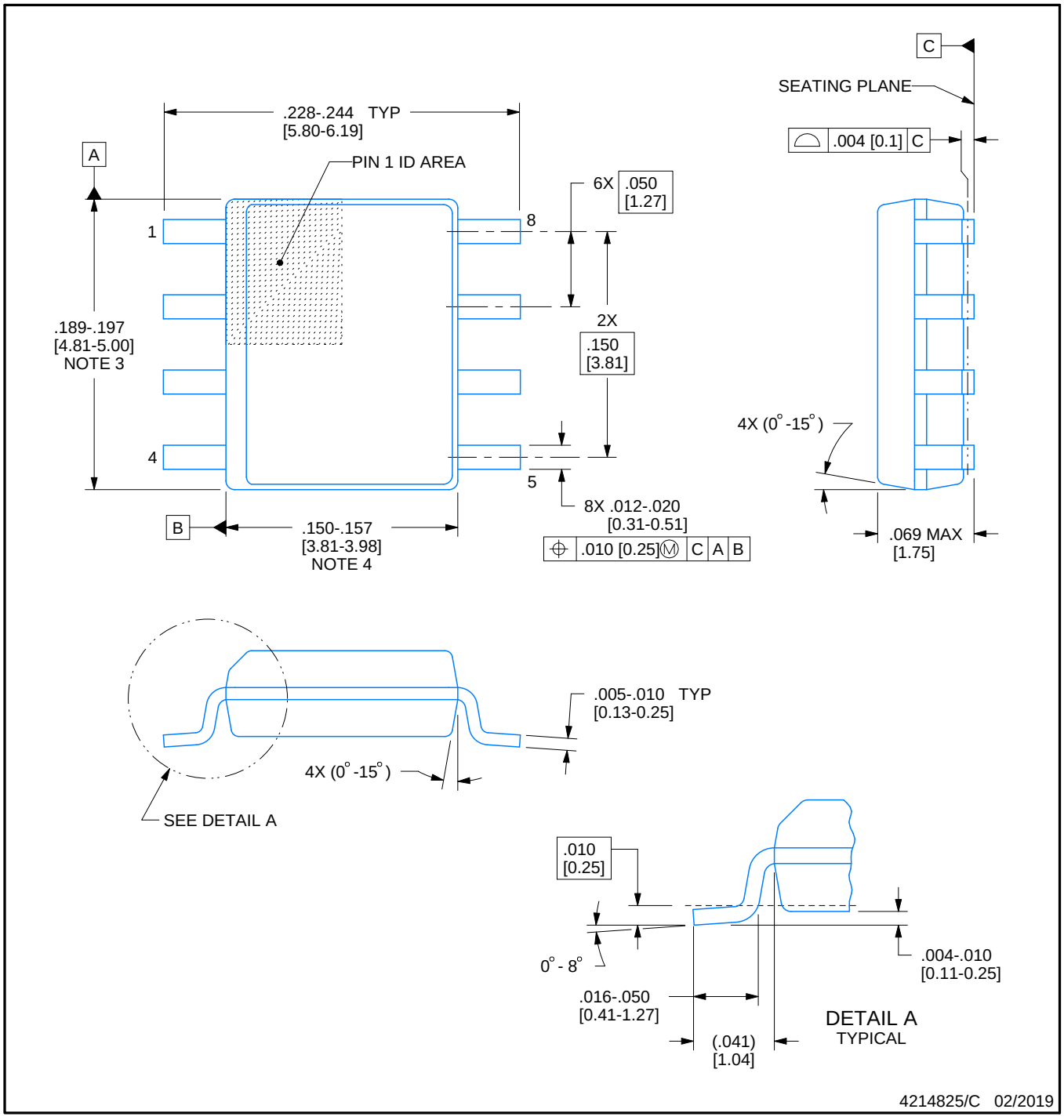


PACKAGE OUTLINE

D0008A

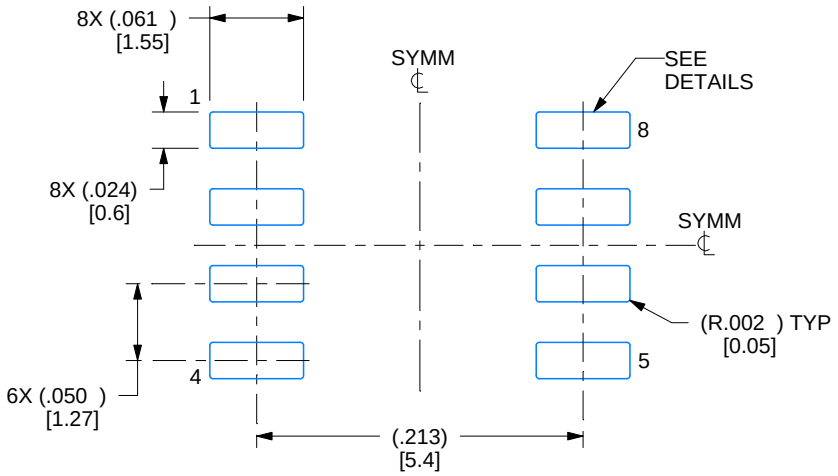
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

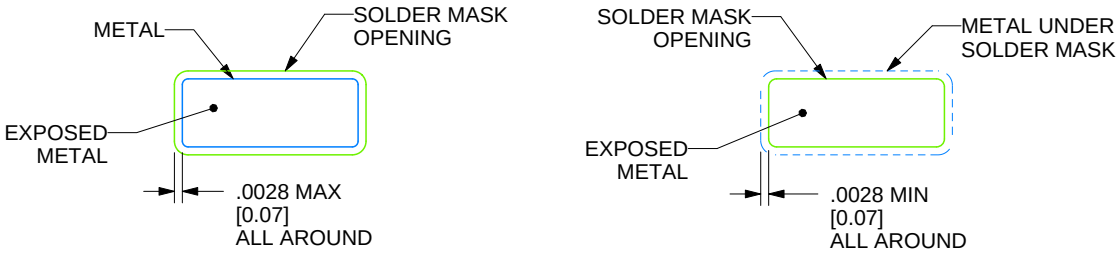


NOTES:

1. Linear dimensions are in inches [millimeters]. Dimensions in parenthesis are for reference only. Controlling dimensions are in inches. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 [0.15] per side.
4. This dimension does not include interlead flash.
5. Reference JEDEC registration MS-012, variation AA.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE:8X



SOLDER MASK DETAILS

4214825/C 02/2019

NOTES: (continued)

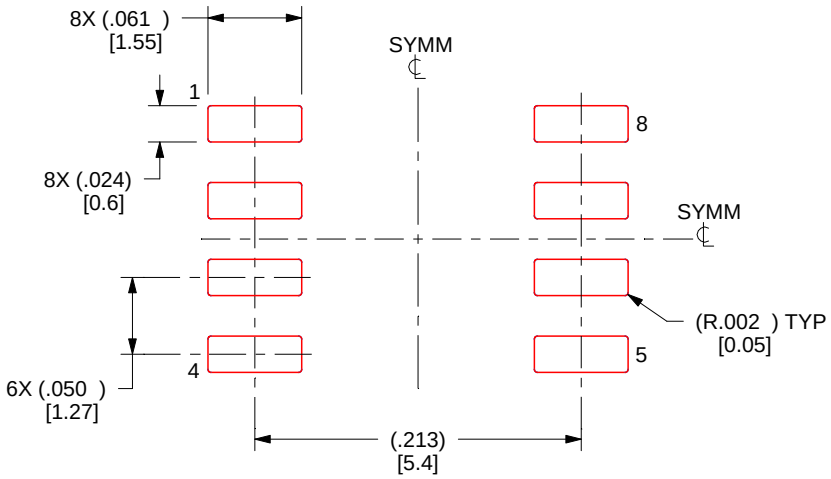
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

D0008A

SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT



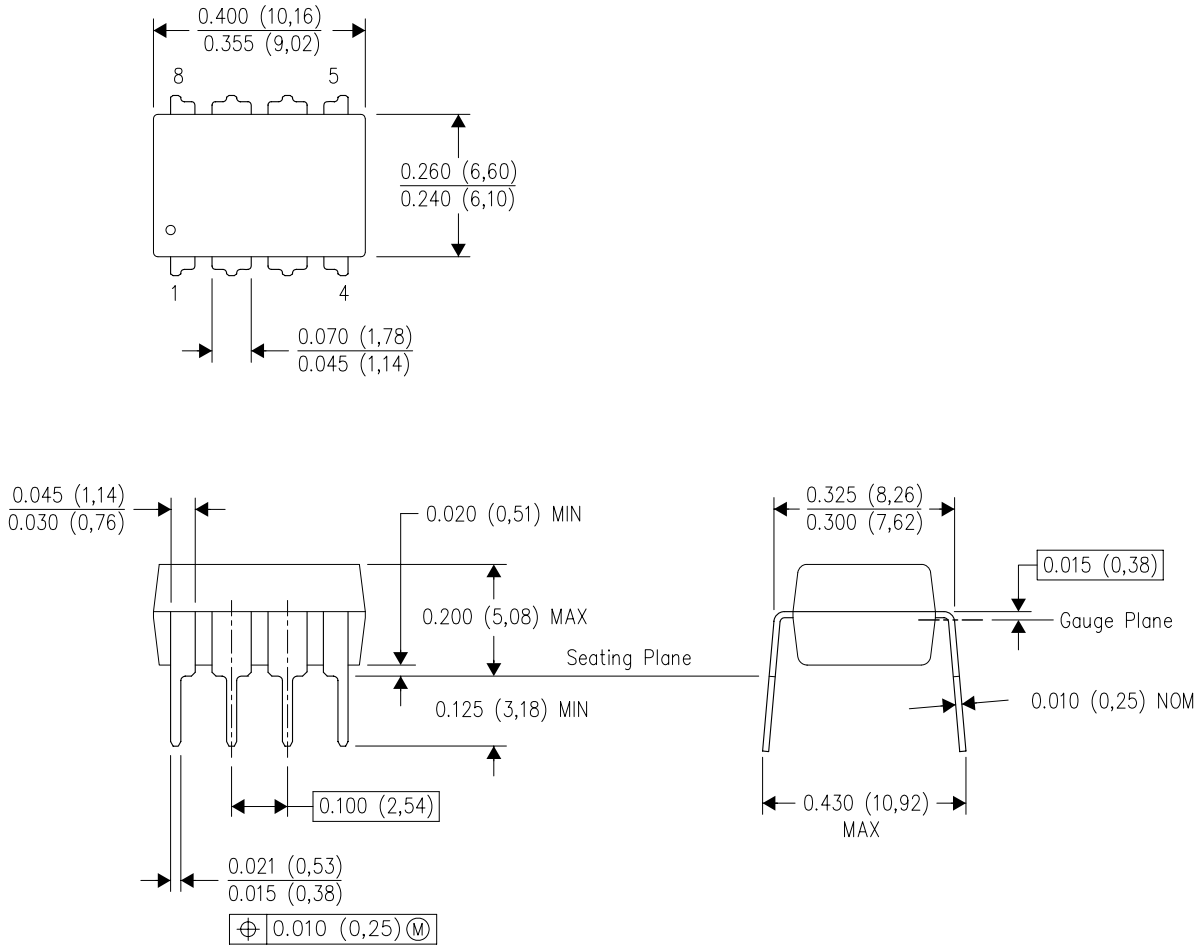
SOLDER PASTE EXAMPLE
BASED ON .005 INCH [0.125 MM] THICK STENCIL
SCALE:8X

4214825/C 02/2019

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.

P (R–PDIP–T8) PLASTIC DUAL–IN–LINE PACKAGE

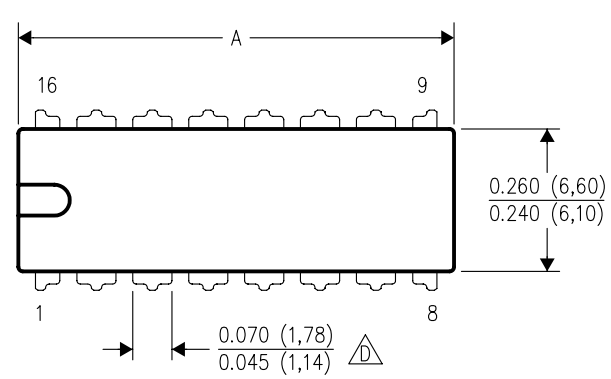


NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001 variation BA.

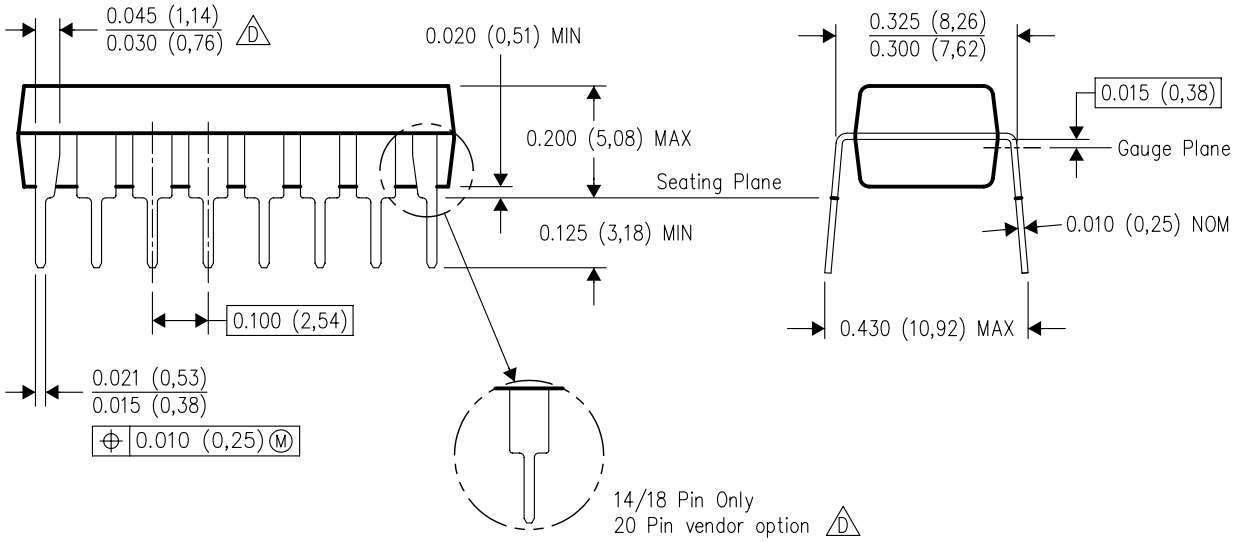
N (R–PDIP–T**)

PLASTIC DUAL–IN–LINE PACKAGE

16 PINS SHOWN



DIM \ PINS **	14	16	18	20
A MAX	0.775 (19,69)	0.775 (19,69)	0.920 (23,37)	1.060 (26,92)
A MIN	0.745 (18,92)	0.745 (18,92)	0.850 (21,59)	0.940 (23,88)
MS–001 VARIATION (C)	AA	BB	AC	AD



4040049/E 12/2002

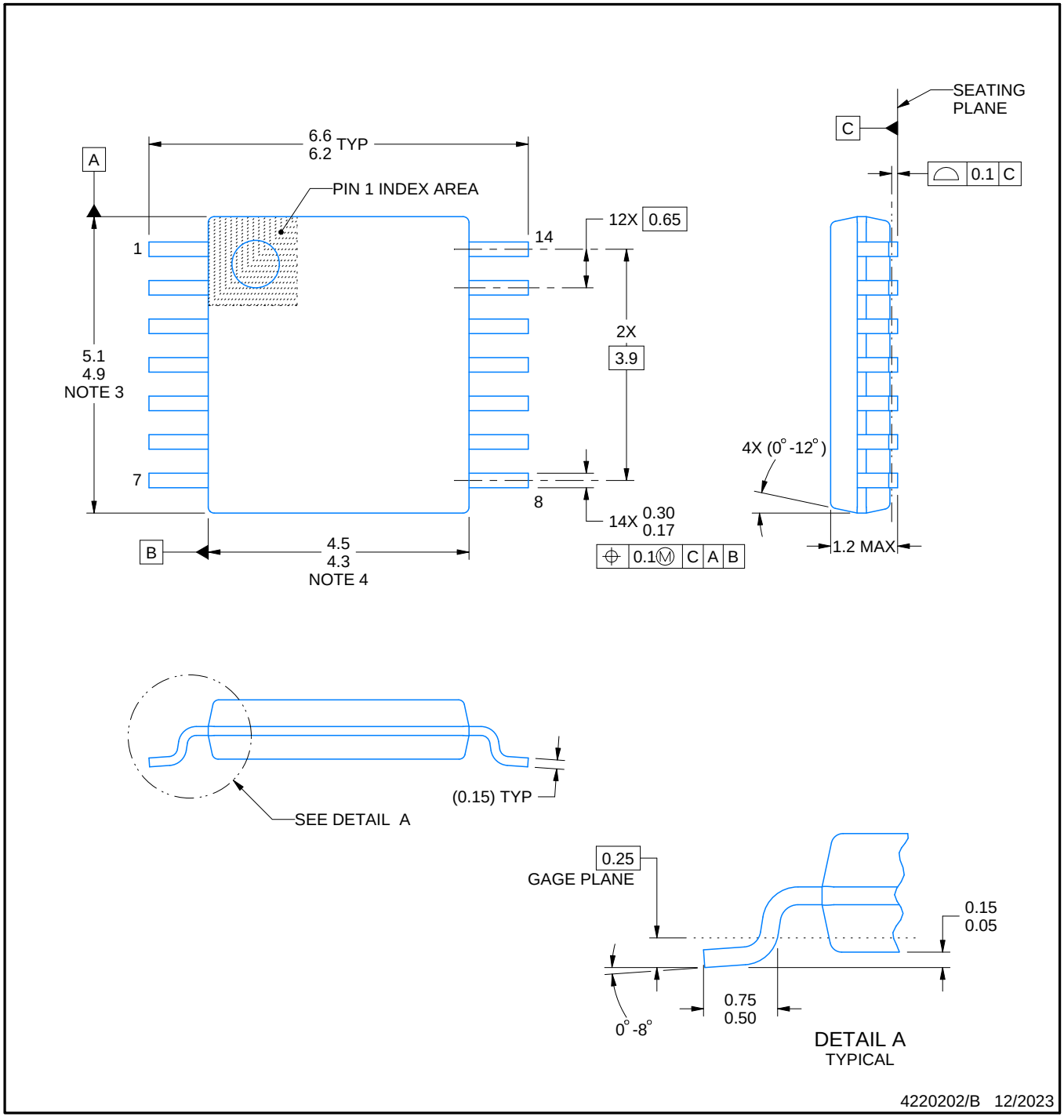
NOTES:
A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS–001, except 18 and 20 pin minimum body length (Dim A).
D. The 20 pin end lead shoulder width is a vendor option, either half or full width.

PACKAGE OUTLINE

PW0014A

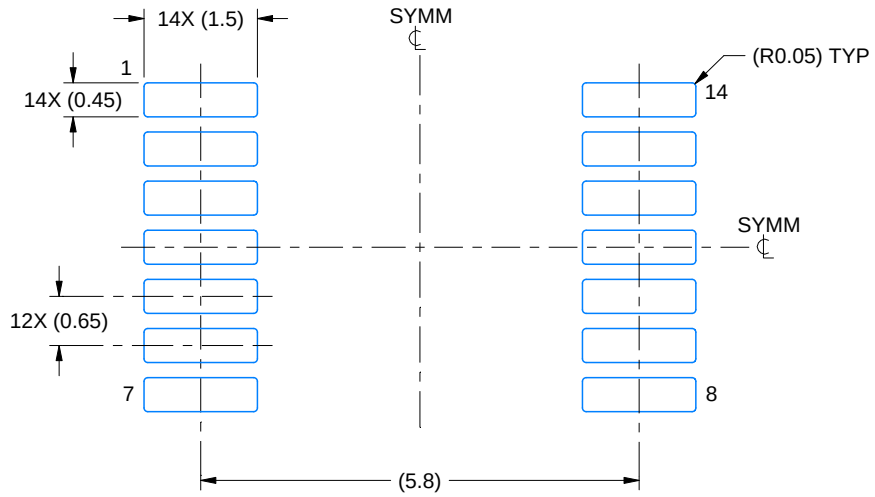
TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE

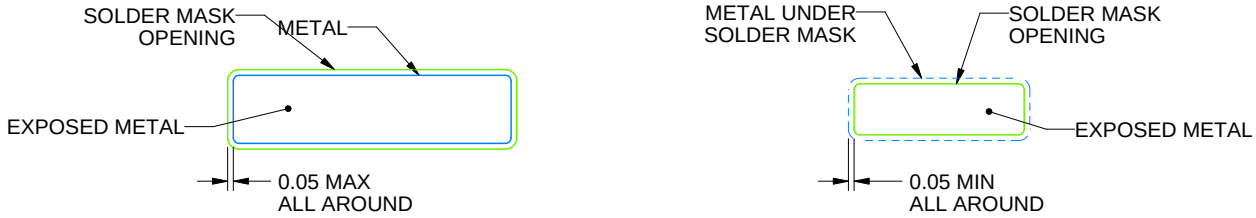


NOTES:

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. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. This dimension does not include interlead flash. Interlead flash shall not exceed 0.25 mm per side.
5. Reference JEDEC registration MO-153.



LAND PATTERN EXAMPLE
EXPOSED METAL SHOWN
SCALE: 10X

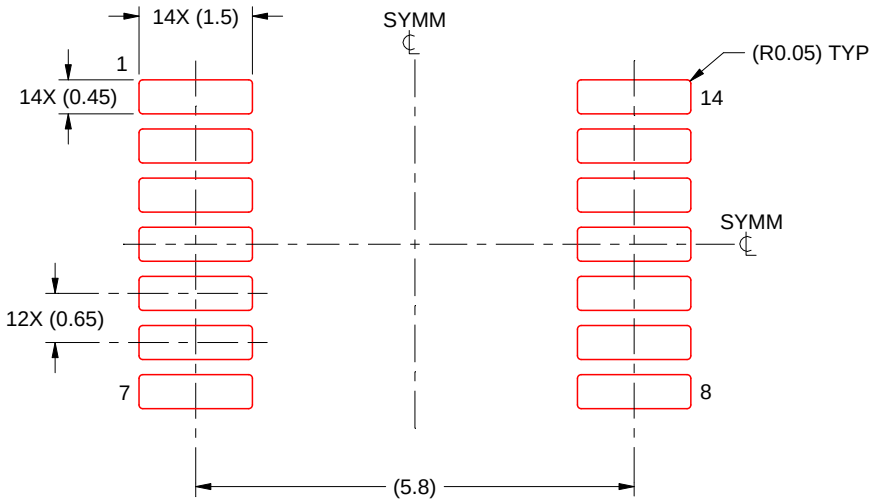


SOLDER MASK DETAILS

4220202/B 12/2023

NOTES: (continued)

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



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE: 10X

4220202/B 12/2023

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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