SGLS154E – NOVEMBER 2000 – REVISED MAY 2010

FAMILY OF NANOPOWER PUSH-PULL OUTPUT COMPARATORS

FEATURES

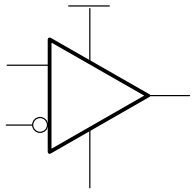
- **Qualified for Automotive Applications**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Low Supply Current . . . 560 nA/Per Channel**
- **Input Common-Mode Range Exceeds the Rails . . . –0.1 V to V_{CC} + 5 V**
- **Supply Voltage Range . . . 2.7 V to 16 V**
- **Reverse Battery Protection Up to 18 V**
- **Push-Pull CMOS Output Stage**
- **Specified Temperature Range**
  - **–40°C to 125°C – Automotive Grade**
- **Ultrasmall Packaging**
  - **5-Pin SOT-23 (TLV3701)**
- **Universal Op-Amp EVM (Reference SLOU060 for more information)**

APPLICATIONS

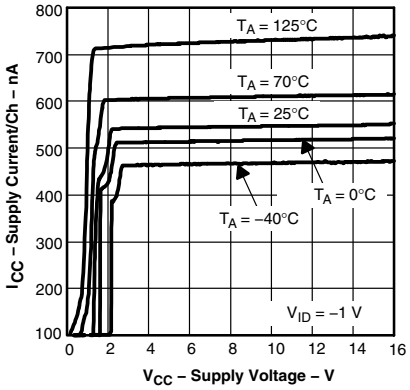
- **Low Power Automotive Electronics**
- **Security Detection Systems**

DESCRIPTION

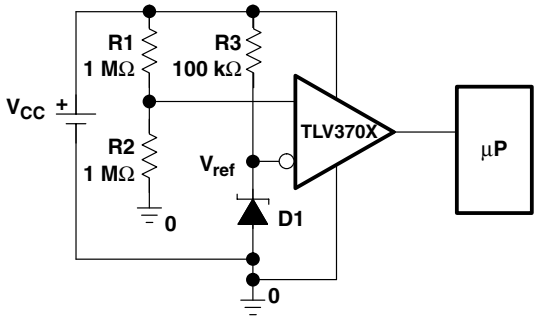
The TLV370x is Texas Instruments' first family of nanopower comparators with only 560 nA per channel supply current, which make this device ideal for low power applications.



SUPPLY CURRENT vs SUPPLY VOLTAGE



high side voltage sense circuit



DESCRIPTION (continued)

The TLV370x has a minimum operating supply voltage of 2.7 V over the extended automotive 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 low power applications where quiescent current is the primary concern. Reverse battery protection guards the amplifier from an over-current 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.

Devices are available in SOIC with the singles in the small SOT-23 package. Other package options may be made available upon request.

A SELECTION OF OUTPUT COMPARATORS†

DEVICE	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
TLV370x	2.5 – 16	250	0.56	80	56	83	22	8	I	PP
TLV340x	2.5 – 16	250	0.47	80	55	30	5	–	I	OD
TLC3702/4	3 – 16	1200	9	5	1.1	0.65	0.5	0.125	–	PP
TLC393/339	3 – 16	1400	11	5	1.1	0.55	0.22	–	–	OD
TLC372/4	3 – 16	1000	75	5	0.65	0.65	–	–	–	OD

† All specifications are typical values measured at 5 V.

TLV3701 AVAILABLE OPTIONS†

T_A	V_{IO}max AT 25°C	PACKAGED DEVICES‡		
		SMALL OUTLINE (D)	SOT-23 (DBV)¶	SYMBOL
-40°C to 125°C	5000 μV	TLV3701QDRQ1§	TLV3701QDBVRQ1	VBCQ

† For the most current package and ordering information, see the Package Option Addendum at the end of this document, or see the TI web site at http://www.ti.com.
‡ Package drawings, thermal data, and symbolization are available at http://www.ti.com/packaging.
§ Product Preview
¶ This package is only available taped and reeled with standard quantities of 3000 pieces per reel.

TLV3702 AVAILABLE OPTIONS

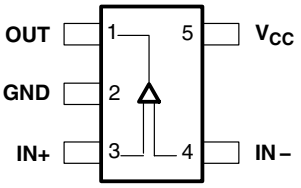
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES	
		SMALL OUTLINE (D)	SYMBOL
–40°C to 125°C	5000 μV	TLV3702QDRQ1	3702Q1

TLV3704 AVAILABLE OPTIONS

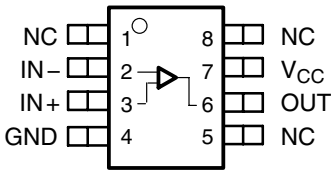
T_A	V_{IO}max AT 25°C	PACKAGED DEVICES
		SMALL OUTLINE (D)
–40°C to 125°C	5000 μV	TLV3704QDRQ1†

† Product Preview

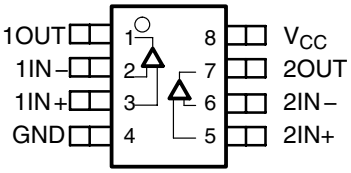
TLV3701
DBV PACKAGE
(TOP VIEW)



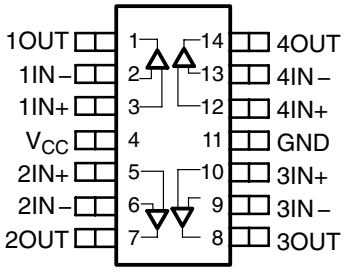
TLV3701
D PACKAGE
(TOP VIEW)



TLV3702
D PACKAGE
(TOP VIEW)



TLV3704
D PACKAGE
(TOP VIEW)



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{CC} (see Note 1) . . . . . 17 V
Differential input voltage, V_{ID} . . . . . ±20 V
Input voltage range, V_I (see Notes 1 and 2) . . . . . –0.3 V to V_{CC} + 5 V
Input current range, I_I . . . . . ±10 mA
Output current range, I_O . . . . . ±10 mA
Continuous total power dissipation . . . . . See Dissipation Rating Table
Operating free-air temperature range, T_A: Q suffix . . . . . –40°C to 125°C
Maximum junction temperature, T_J . . . . . 150°C
Storage temperature range, T_{stg} . . . . . –65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds . . . . . 260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTES: 1. All voltage values, except differential voltages, are with respect to GND.
2. Input voltage range is limited to 20 V max or V_{CC} + 5 V, whichever is smaller.

DISSIPATION RATING TABLE

PACKAGE	θ_{JC} (°C/W)	θ_{JA} (°C/W)	$T_A \le 25°C$ POWER RATING	$T_A = 125°C$ POWER RATING
D (8)	38.3	176	710 mW	142 mW
D (14)	26.9	122.6	1022 mW	204.4 mW
DBV (5)	55	324.1	385 mW	77.1 mW

recommended operating conditions

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

electrical characteristics at specified operating free-air temperature, V_{CC} = 2.7 V, 5 V, 15 V (unless otherwise noted)

dc performance

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	$V_{IC} = V_{CC}/2$, $R_S = 50\ \Omega$	25°C		250	5000	μV
			Full range			7000	
α_{VIO}	Offset voltage drift		25°C		3		μV/°C
CMRR	Common-mode rejection ratio	V_{IC} = 0 to 2.7 V, $R_S = 50\ \Omega$	25°C	55	72		dB
			Full range	50			
		V_{IC} = 0 to 5 V, $R_S = 50\ \Omega$	25°C	60	76		
			Full range	55			
		V_{IC} = 0 to 15 V, $R_S = 50\ \Omega$	25°C	65	88		
			Full range	60			
A_{VD}	Large-signal differential voltage amplification		25°C		1000		V/mV

† Full range is –40°C to 125°C for Q suffix.

input/output characteristics

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
I_{IO}	Input offset current	$V_{IC} = V_{CC}/2$, $R_S = 50\ \Omega$	25°C		20	100	pA
			Full range			1000	
I_{IB}	Input bias current		25°C		80	250	pA
			Full range			2000	
$r_{i(d)}$	Differential input resistance		25°C		300		MΩ
V_{OH}	High-level output voltage	$V_{IC} = V_{CC}/2$, $I_{OH} = 2\ \mu A$, V_{ID} = 1 V	25°C	V_{CC}– 0.08			mV
		$V_{IC} = V_{CC}/2$, $I_{OH} = -50\ \mu A$, V_{ID} = 1 V	25°C	V_{CC}– 320			
			Full range	V_{CC}– 450			
V_{OL}	Low-level output voltage	$V_{IC} = V_{CC}/2$, $I_{OH} = 2\ \mu A$, V_{ID} = –1 V	25°C		8		mV
		$V_{IC} = V_{CC}/2$, $I_{OH} = 50\ \mu A$, V_{ID} = –1 V	25°C		80	200	
			Full range			300	

† Full range is –40°C to 125°C for Q suffix.

electrical characteristics at specified operating free-air temperature, V_{CC} = 2.7 V, 5 V, 15 V (unless otherwise noted) (continued)

power supply

PARAMETER		TEST CONDITIONS		T_A†	MIN	TYP	MAX	UNIT
I_{CC}	Supply current (per channel)	Output state high		25°C		560	800	nA
				Full range			1200	
PSRR	Power supply rejection ratio	V_{IC} = V_{CC}/2 V, No load	V_{CC} = 2.7 V to 5 V	25°C	75	100		dB
				Full range	70			
			V_{CC} = 5 V to 15 V	25°C	85	105		
				Full range	80			

† Full range is –40°C to 125°C for Q suffix.

switching characteristics at recommended operating conditions, V_{CC} = 2.7 V, 5 V, 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
$t_{(PLH)}$	Propagation response time, low-to-high-level output (see Note 3)	f = 1 kHz, V_{STEP} = 100 mV, C_L = 10 pF, V_{CC} = 2.7 V, V_{IC} = V_{CC}/2	Overdrive = 2 mV		240		µs
			Overdrive = 10 mV		64	150†	
			Overdrive = 50 mV		36		
$t_{(PHL)}$	Propagation response time, high-to-low-level output (see Note 3)		Overdrive = 2 mV		167		
			Overdrive = 10 mV		67	150†	
			Overdrive = 50 mV		37		
t_r	Rise time	C_L = 10 pF, V_{CC} = 2.7 V			7		µs
t_f	Fall time	C_L = 10 pF, V_{CC} = 2.7 V			9		µs

NOTE 3: The response time specified is the interval between the input step function and the instant when the output crosses 1.4 V. Propagation responses are longer at higher supply voltages, refer to Figures 11–16 for further details.

† This limit applies to the TLV3701-Q1 only.

TYPICAL CHARACTERISTICS

Table of Graphs

			FIGURE
	Input bias/offset current	vs Free-air temperature	1
V_{OL}	Low-level output voltage	vs Low-level output current	2, 4, 6
V_{OH}	High-level output voltage	vs High-level output current	3, 5, 7
I_{CC}	Supply current	vs Supply voltage	8
		vs Free-air temperature	9
	Output fall time/rise time	vs Supply voltage	10
	Low-to-high level output response for various input overdrives		11, 13, 15
	High-to-low level output response for various input overdrives		12, 14, 16

TYPICAL CHARACTERISTICS

INPUT BIAS/OFFSET CURRENT vs FREE-AIR TEMPERATURE

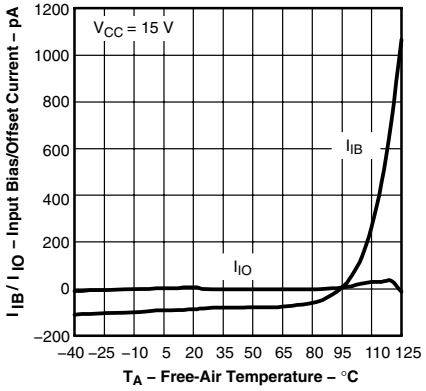


Figure 1

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

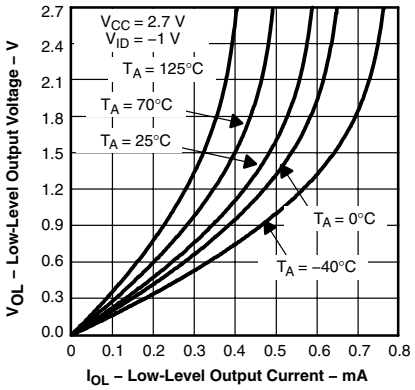


Figure 2

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

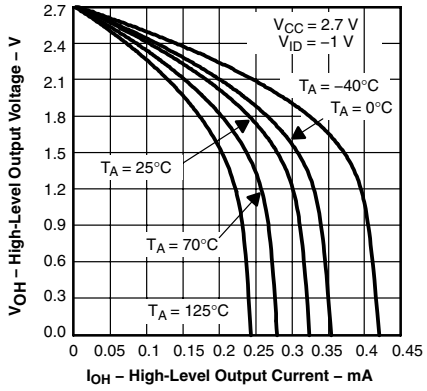


Figure 3

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

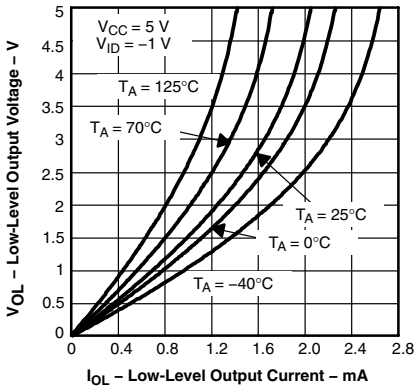


Figure 4

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

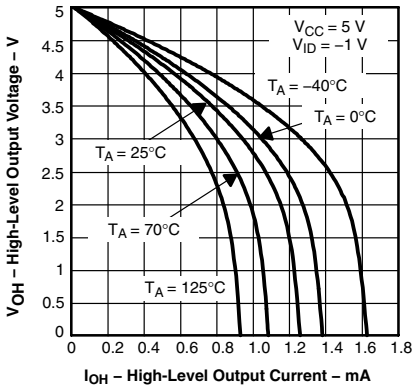


Figure 5

LOW-LEVEL OUTPUT VOLTAGE vs LOW-LEVEL OUTPUT CURRENT

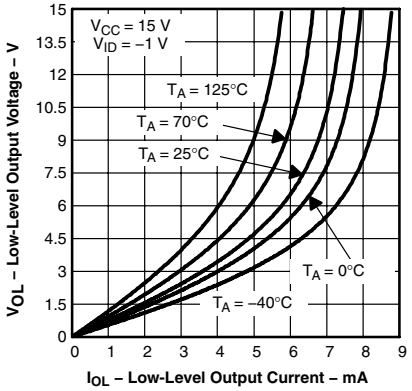


Figure 6

HIGH-LEVEL OUTPUT VOLTAGE vs HIGH-LEVEL OUTPUT CURRENT

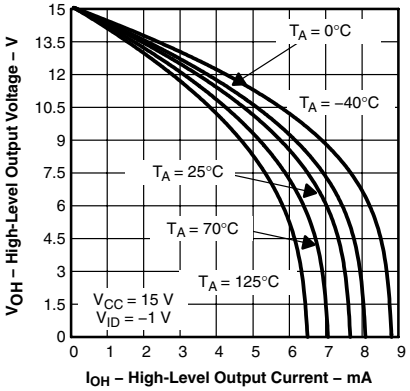


Figure 7

SUPPLY CURRENT vs SUPPLY VOLTAGE

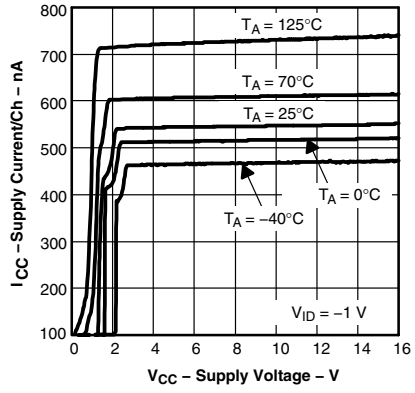


Figure 8

TYPICAL CHARACTERISTICS

SUPPLY CURRENT vs FREE-AIR TEMPERATURE

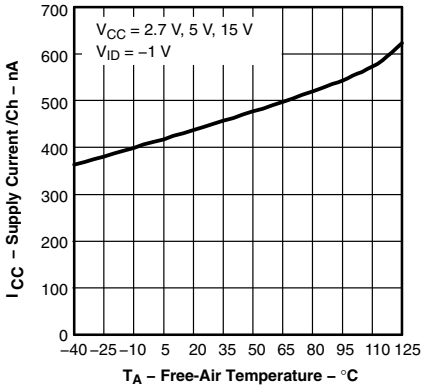


Figure 9

OUTPUT RISE/FALL TIME vs SUPPLY VOLTAGE

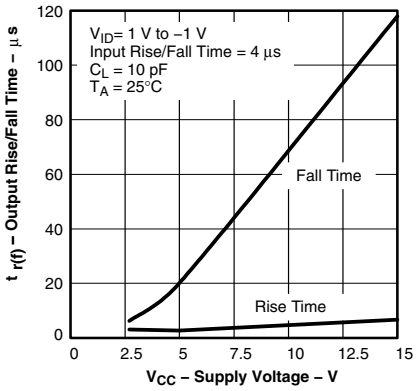


Figure 10

LOW-TO-HIGH OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

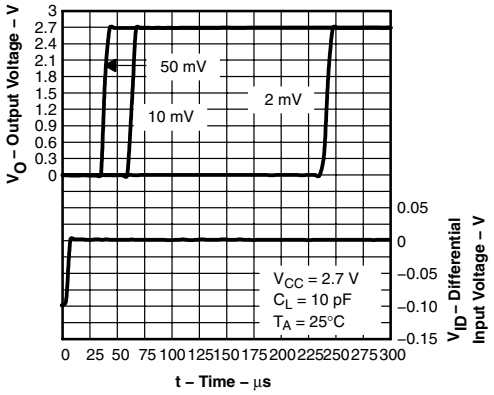


Figure 11

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

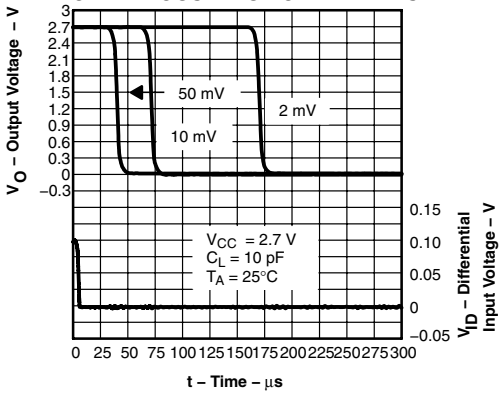


Figure 12

LOW-TO-HIGH LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

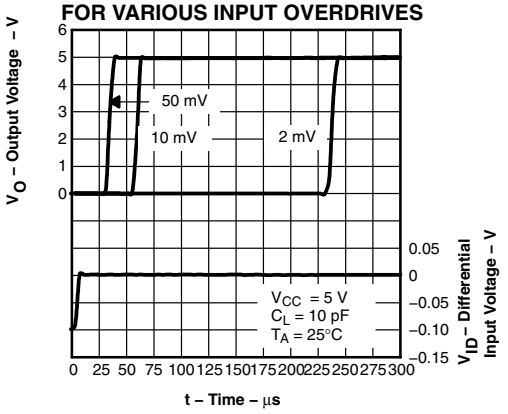


Figure 13

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

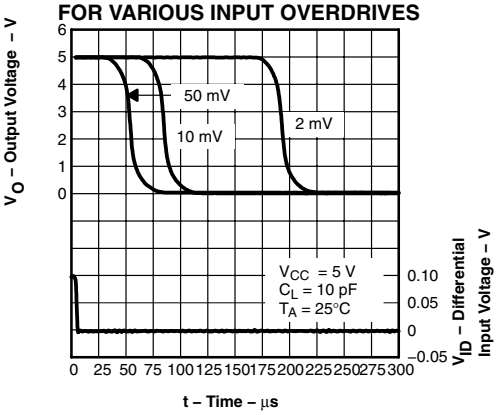


Figure 14

TYPICAL CHARACTERISTICS

LOW-TO-HIGH LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

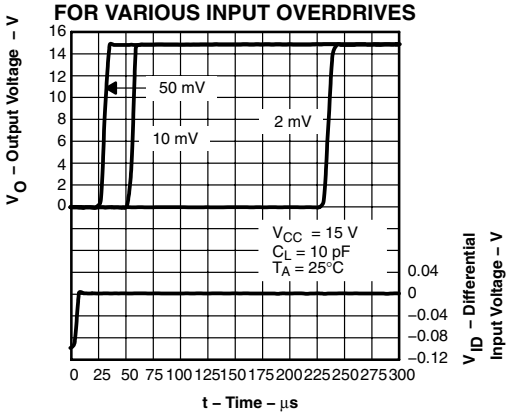


Figure 15

HIGH-TO-LOW LEVEL OUTPUT RESPONSE FOR VARIOUS INPUT OVERDRIVES

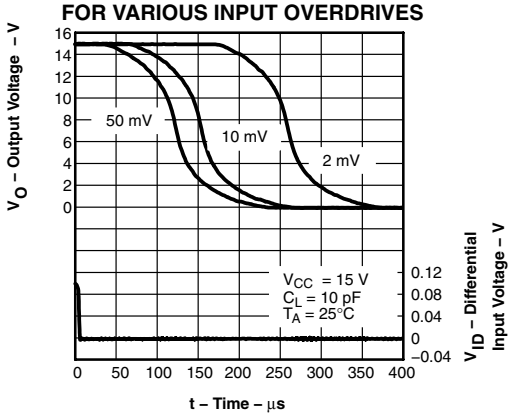


Figure 16

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)
TLV3701QDBVRG4Q1	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	Call TI | Nipdau | Nipdau	Level-1-260C-UNLIM	-40 to 125	VBCQ
TLV3701QDBVRG4Q1.A	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	VBCQ
TLV3701QDBVRQ1	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	Call TI | Nipdau	Level-1-260C-UNLIM	-40 to 125	VBCQ
TLV3701QDBVRQ1.A	Active	Production	SOT-23 (DBV) | 5	3000 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	VBCQ
TLV3702QDRG4Q1	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3702Q1
TLV3702QDRG4Q1.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3702Q1
TLV3702QDRQ1	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3702Q1
TLV3702QDRQ1.A	Active	Production	SOIC (D) | 8	2500 | LARGE T&R	Yes	NIPDAU	Level-1-260C-UNLIM	-40 to 125	3702Q1

(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.

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 TLV3701-Q1, TLV3702-Q1 :

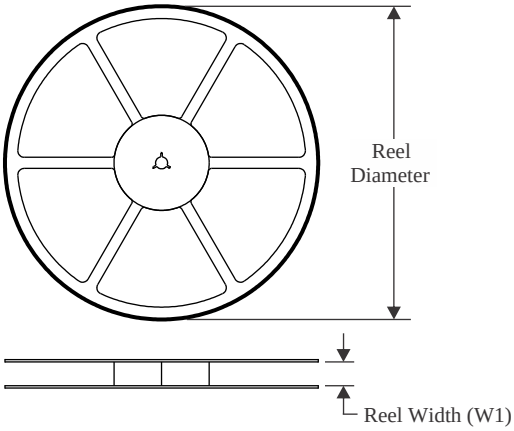
- Catalog : TLV3701, TLV3702
- Enhanced Product : TLV3701-EP

NOTE: Qualified Version Definitions:

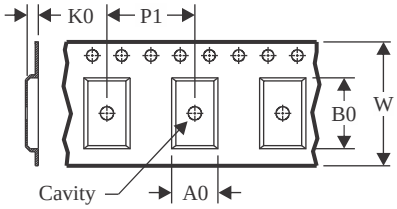
- Catalog - TI's standard catalog product
- Enhanced Product - Supports Defense, Aerospace and Medical Applications

TAPE AND REEL INFORMATION

REEL DIMENSIONS

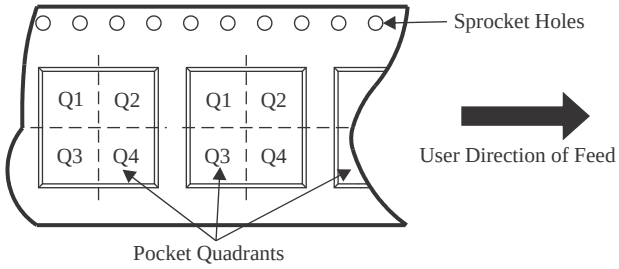


TAPE DIMENSIONS



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

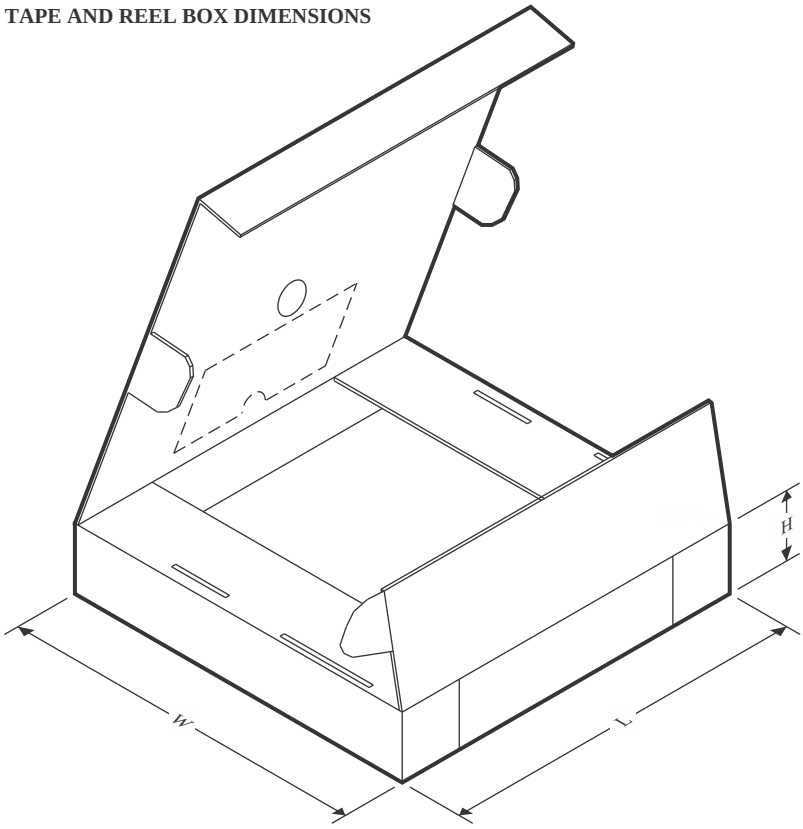
QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*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
TLV3701QDBVRQ1	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV3701QDBVRQ1	SOT-23	DBV	5	3000	180.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
TLV3702QDRG4Q1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1
TLV3702QDRQ1	SOIC	D	8	2500	330.0	12.4	6.4	5.2	2.1	8.0	12.0	Q1

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

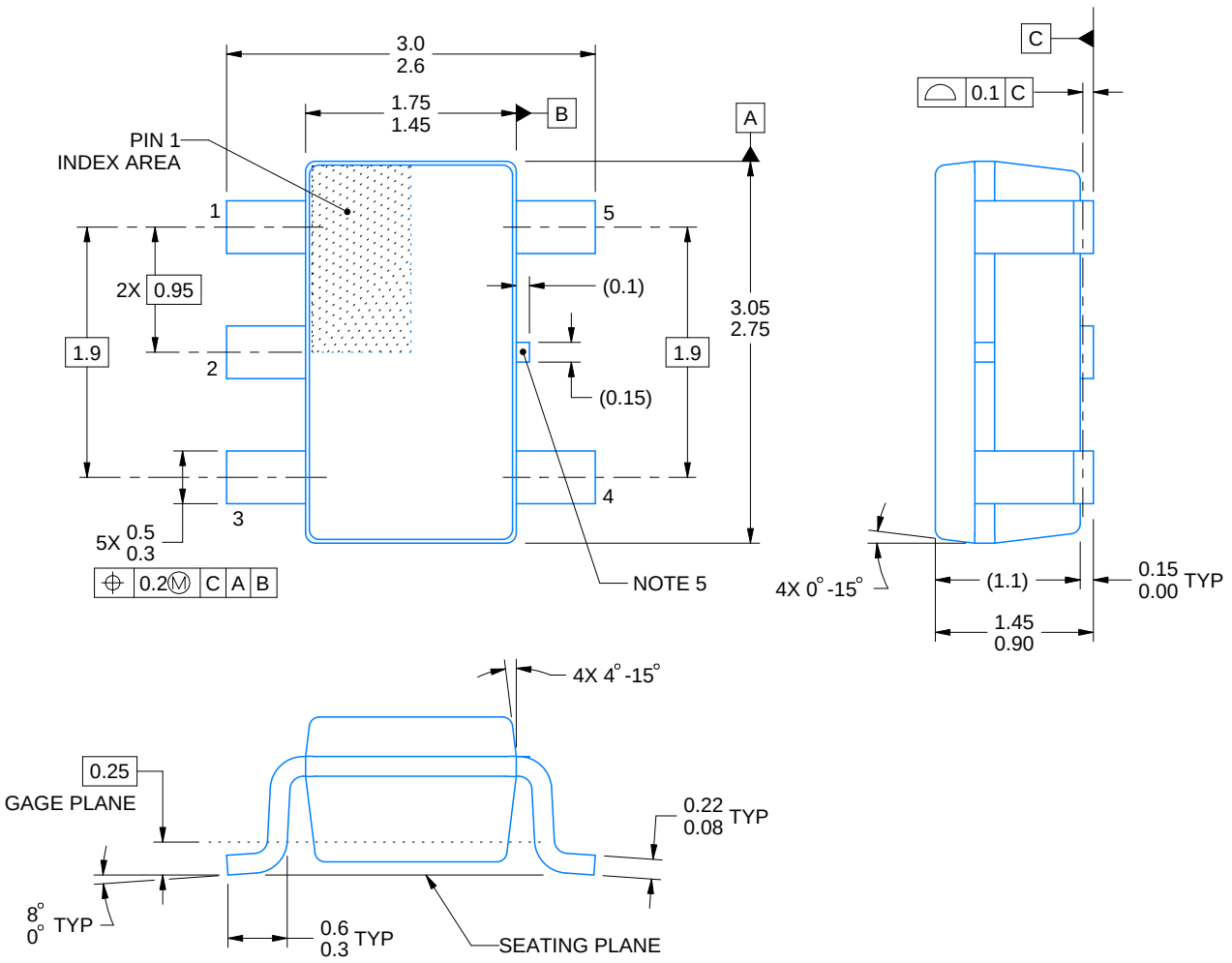
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TLV3701QDBVRQ1	SOT-23	DBV	5	3000	210.0	185.0	35.0
TLV3701QDBVRQ1	SOT-23	DBV	5	3000	210.0	185.0	35.0
TLV3702QDRG4Q1	SOIC	D	8	2500	353.0	353.0	32.0
TLV3702QDRQ1	SOIC	D	8	2500	353.0	353.0	32.0

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

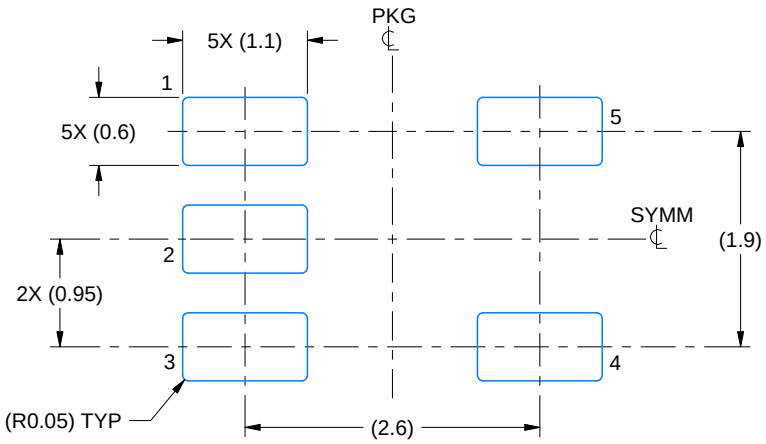
SMALL OUTLINE TRANSISTOR



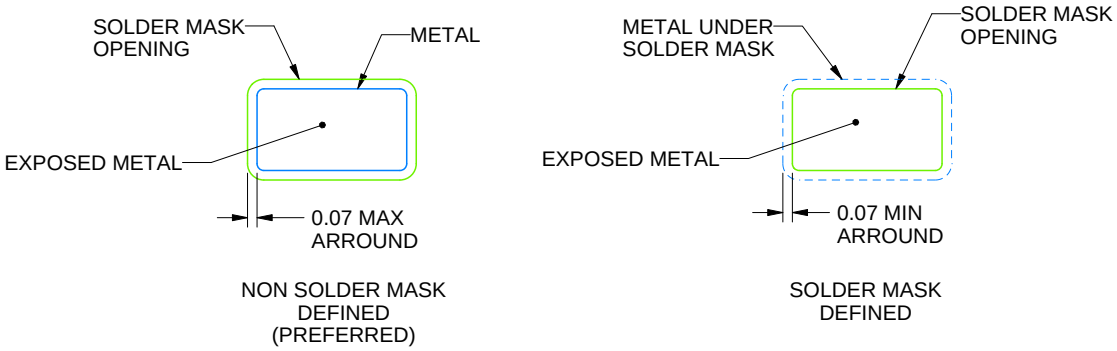
4214839/K 08/2024

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

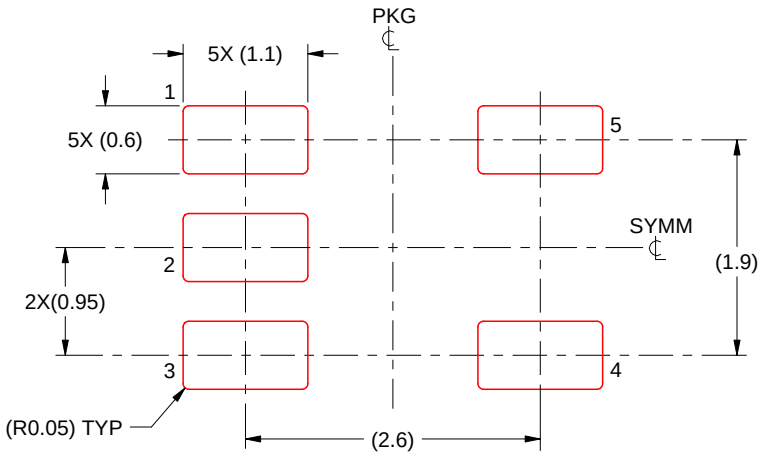


SOLDER MASK DETAILS

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.

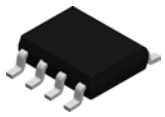


SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:15X

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.

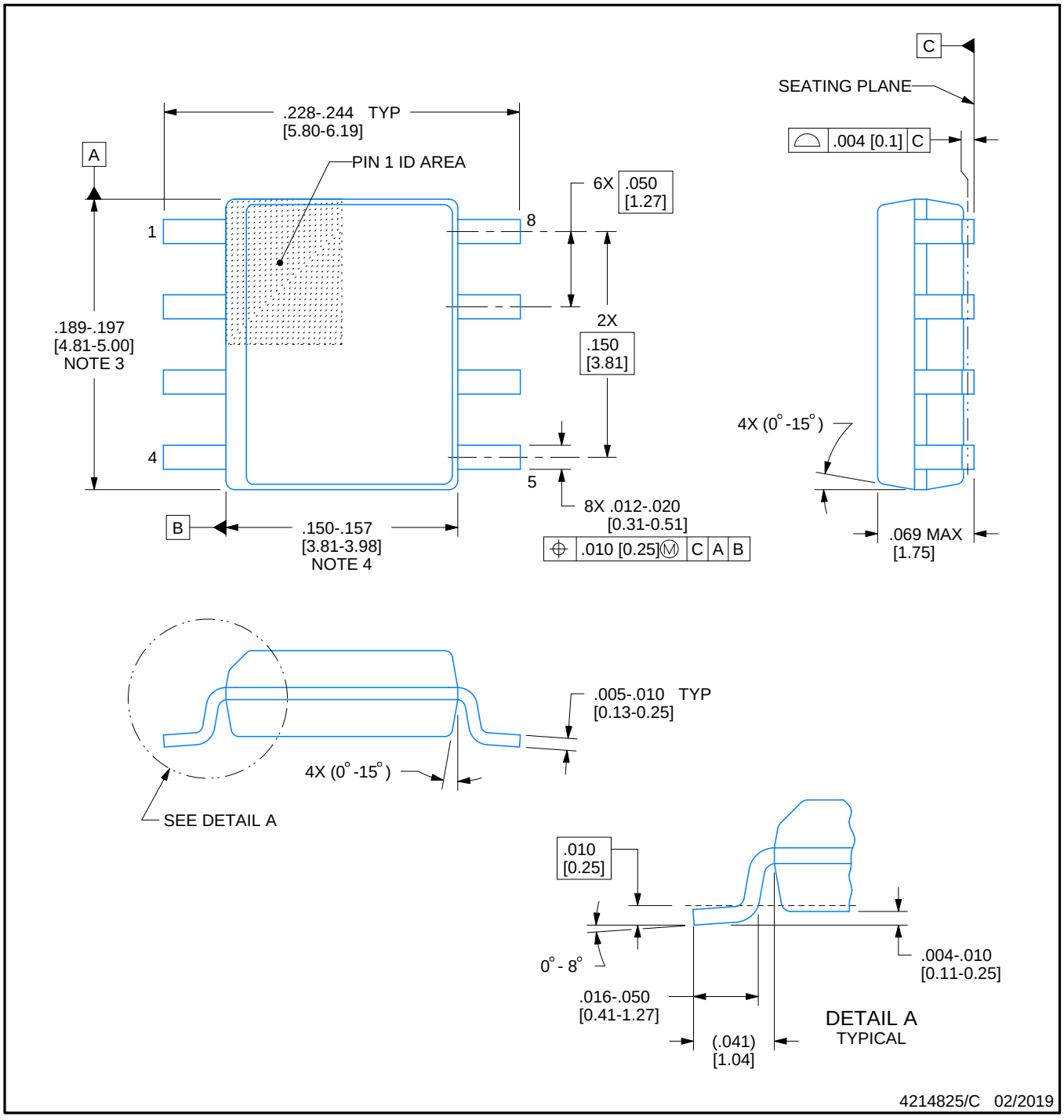


PACKAGE OUTLINE

D0008A

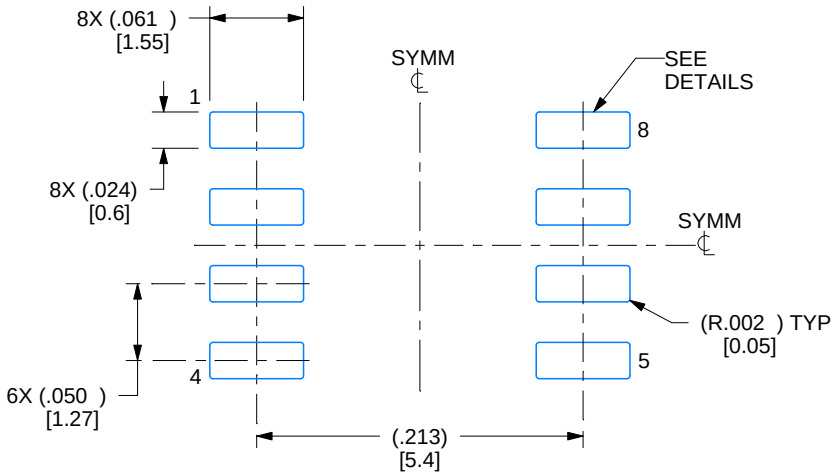
SOIC - 1.75 mm max height

SMALL OUTLINE INTEGRATED CIRCUIT

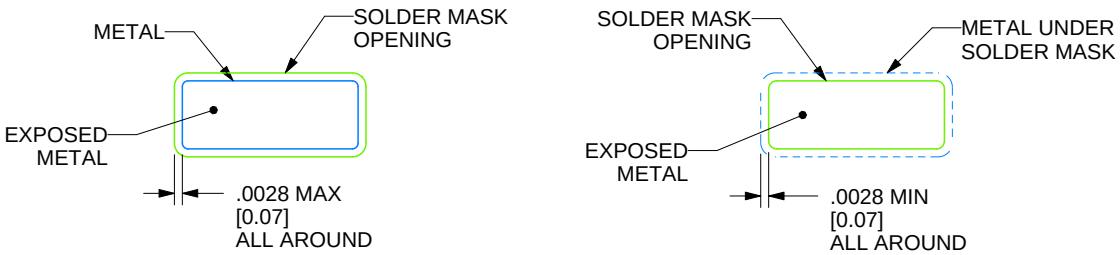


NOTES:

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)

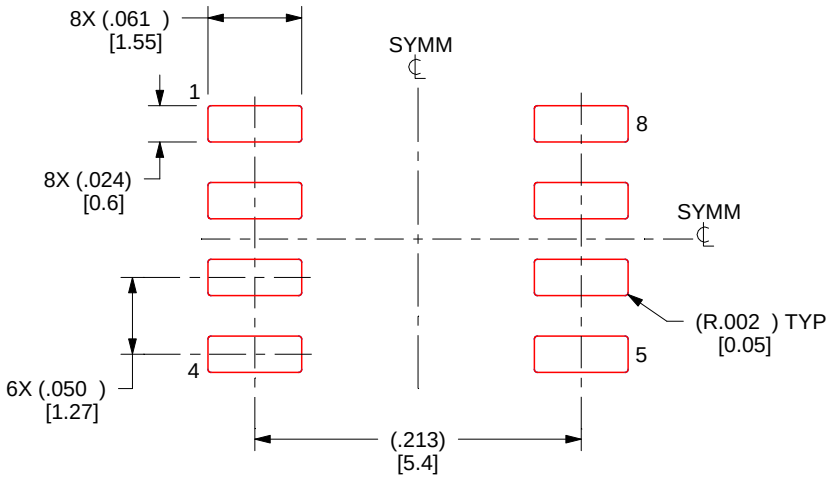
6. Publication IPC-7351 may have alternate designs.
7. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

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.

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