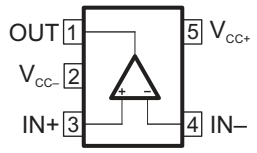
LOW-POWER SINGLE OPERATIONAL AMPLIFIER

FEATURES

- **Qualified for Automotive Applications**
- **Wide Power-Supply Range**
  - **Single Supply: 3 V to 30 V**
  - **Dual Supply: ±1.5 V to ±15 V**
- **Large Output Voltage Swing: 0 V to 3.5 V (Min) (V_{CC} = 5 V)**
- **Low Supply Current: 500 μA (Typ)**
- **Low Input Bias Current: 20 nA (Typ)**
- **Stable With High Capacitive Loads**

DBV (SOT-23-5) PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

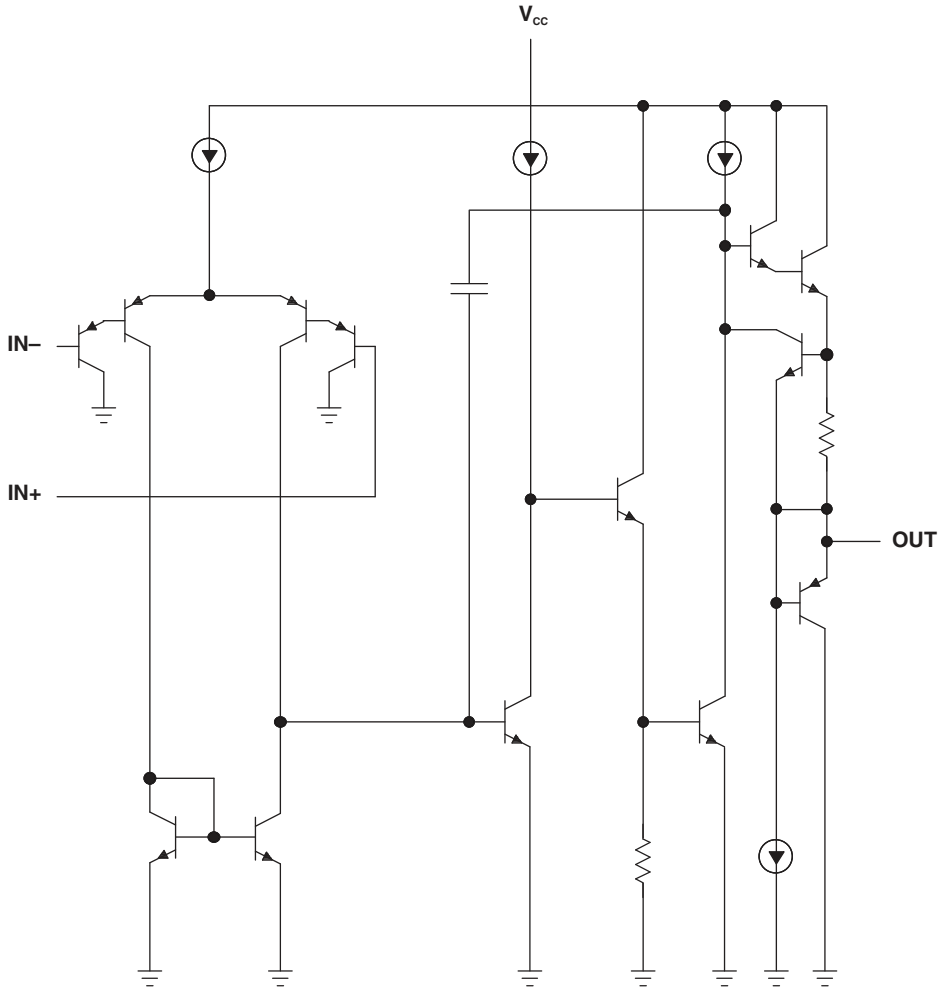
The TS321 is a bipolar operational amplifier for cost-sensitive applications in which space savings are important.

ORDERING INFORMATION(1)

T_A	PACKAGE(2)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 125°C	SOT-23-5 – DBV	Reel of 3000	TS321QDBVRQ1	9CNS

(1) 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 www.ti.com.
(2) Package drawings, thermal data, and symbolization are available at www.ti.com/packaging.

SCHEMATIC DIAGRAM



ABSOLUTE MAXIMUM RATINGS(1)

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

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)	Single		32	V
		Dual		±16	
V_{ID}	Differential input voltage(3)			32	V
V_I	Input voltage range(2)(4)		–0.3	32	V
I_I	Input current(4)			50	mA
t_{short}	Duration of output short circuit to ground			Unlimited	
θ_{JA}	Package thermal impedance, junction to free air(5)(6)	DBV package		206	°C/W
T_J	Operating virtual junction temperature			150	°C
T_{stg}	Storage temperature range		–65	150	°C

(1) 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.
(2) These voltage values are with respect to the midpoint between V_{CC+} and $V_{CC–}$.
(3) Differential voltages are at IN+ with respect to IN–.
(4) Neither input must ever be more positive than V_{CC+} or more negative than $V_{CC–}$.
(5) Maximum power dissipation is a function of $T_J(max)$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) – T_A)/\theta_{JA}$. Selecting the maximum of 150°C can affect reliability.
(6) The package thermal impedance is calculated in accordance with JESD 51-7.

RECOMMENDED OPERATING CONDITIONS

			MIN	MAX	UNIT
V_{CC}	Supply voltage	Single supply	3	30	V
		Dual supply	±1.5	±15	
T_A	Operating free-air temperature		–40	125	°C

ELECTRICAL CHARACTERISTICS

V_{CC+} = 5 V, V_{CC-} = GND, V_O = 1.4 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		T_A	MIN	TYP	MAX	UNIT
V_{IO}	Input offset voltage	R_S = 0, 5 V < V_{CC+} < 30 V, 0 < V_{IC} < (V_{CC+} – 1.5 V)		25°C		0.5	4	mV
				Full range			5	
I_{IO}	Input offset current			25°C		2	30	nA
				Full range			50	
I_{IB}	Input bias current(1)			25°C		20	150	nA
				Full range			200	
A_{VD}	Large-signal differential voltage amplification	V_{CC} = 15 V, R_L = 2 kΩ, V_O = 1.4 V to 11.4 V		25°C	50	100		V/mV
				Full range	25			
V_{ICR}	Common-mode input voltage(2)	V_{CC} = 30 V		25°C	0		V_{CC+} – 1.5	V
				Full range	0		V_{CC+} – 2	
V_{OH}	High-level output voltage	V_{CC} = 30 V	R_L = 2 kΩ	25°C	26	27		V
				Full range	25.5			
			R_L = 10 kΩ	25°C	27	28		
				Full range	26.5			
		V_{CC} = 5 V	R_L = 2 kΩ	25°C	3.5			
				Full range	3			
V_{OL}	Low-level output voltage	R_L = 10 kΩ		25°C		5	15	mV
				Full range			20	
GBP	Gain bandwidth product	V_{CC} = 30 V, V_I = 10 mV, R_L = 2 kΩ, f = 100 kHz, C_L = 100 pF		25°C		0.8		MHz
SR	Slew rate	V_{CC} = 15 V, V_I = 0.5 V to 3 V, R_L = 2 kΩ, C_L = 100 pF, unity gain		25°C		0.4		V/µs
ϕ_m	Phase margin			25°C		60		°
CMRR	Common-mode rejection ratio	R_S ≤ 10 kΩ		25°C	65	85		dB
I_{SOURCE}	Output source current	V_{CC} = 15 V, V_O = 2 V, V_{ID} = 1 V		25°C	20	40		mA
I_{SINK}	Output sink current	V_{CC} = 15 V, V_{ID} = 1 V	V_O = 2 V	25°C	10	20		mA
			V_O = 0.2 V	25°C	12	50		µA
I_O	Short-circuit to GND	V_{CC} = 15 V		25°C		40	60	mA
SVR	Supply-voltage rejection ratio	V_{CC} = 5 V to 30 V		25°C	65	110		dB
I_{CC}	Total supply current	No load	V_{CC} = 5 V	25°C		500	800	µA
			V_{CC} = 30 V			600	900	
			V_{CC} = 5 V	Full range		600	900	
			V_{CC} = 30 V				1000	
THD	Total harmonic distortion	V_{CC} = 30 V, V_O = 2 V_{pp}, A_V = 20 dB, R_L = 2 kΩ, f = 1 kHz, C_L = 100 pF		25°C		0.015		%
e_N	Equivalent input noise voltage	V_{CC} = 30 V, f = 1 kHz, R_S = 100 Ω		25°C		50		nV/√Hz

(1) The direction of the input current is out of the device. This current essentially is constant, independent of the state of the output, so no loading change exists on the input lines.

(2) The input common-mode voltage of either input signal should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is V_{CC+} – 1.5 V, but either or both inputs can go to 32 V without damage.

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
TS321QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 125	9CNS	Samples

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".
RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.
Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

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

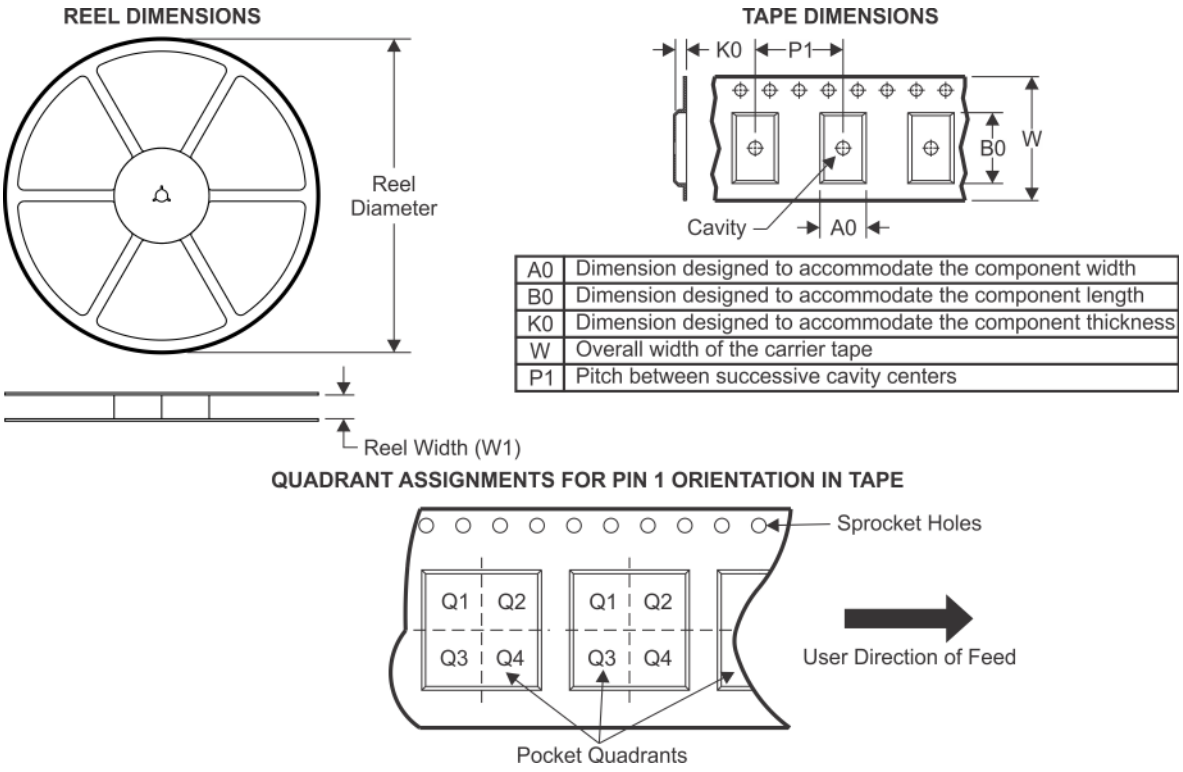
OTHER QUALIFIED VERSIONS OF TS321-Q1 :

- Catalog: TS321

NOTE: Qualified Version Definitions:

- Catalog - TI's standard catalog product

TAPE AND REEL INFORMATION

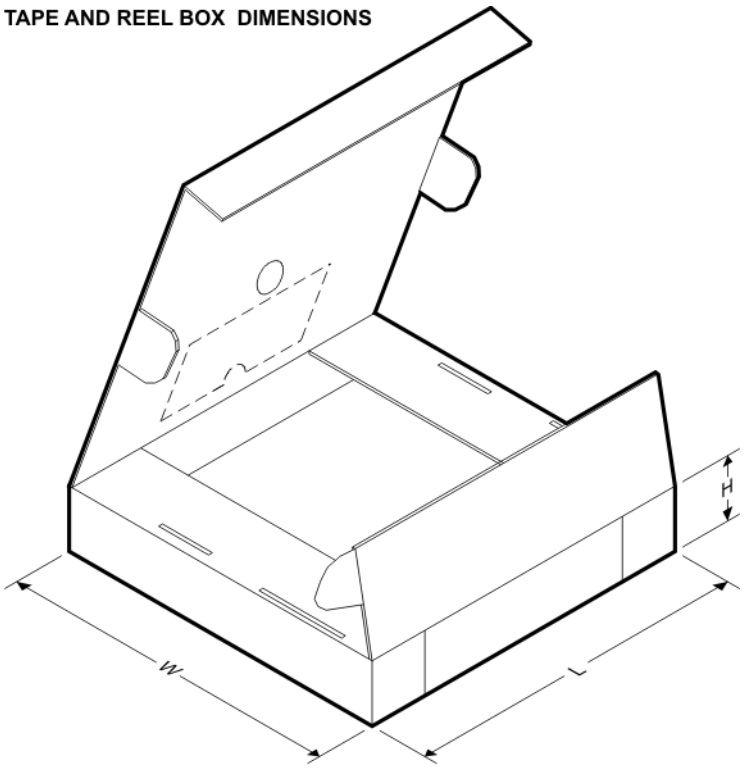


A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

*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
TS321QDBVRQ1	SOT-23	DBV	5	3000	180.0	8.4	3.23	3.17	1.37	4.0	8.0	Q3

TAPE AND REEL BOX DIMENSIONS



*All dimensions are nominal

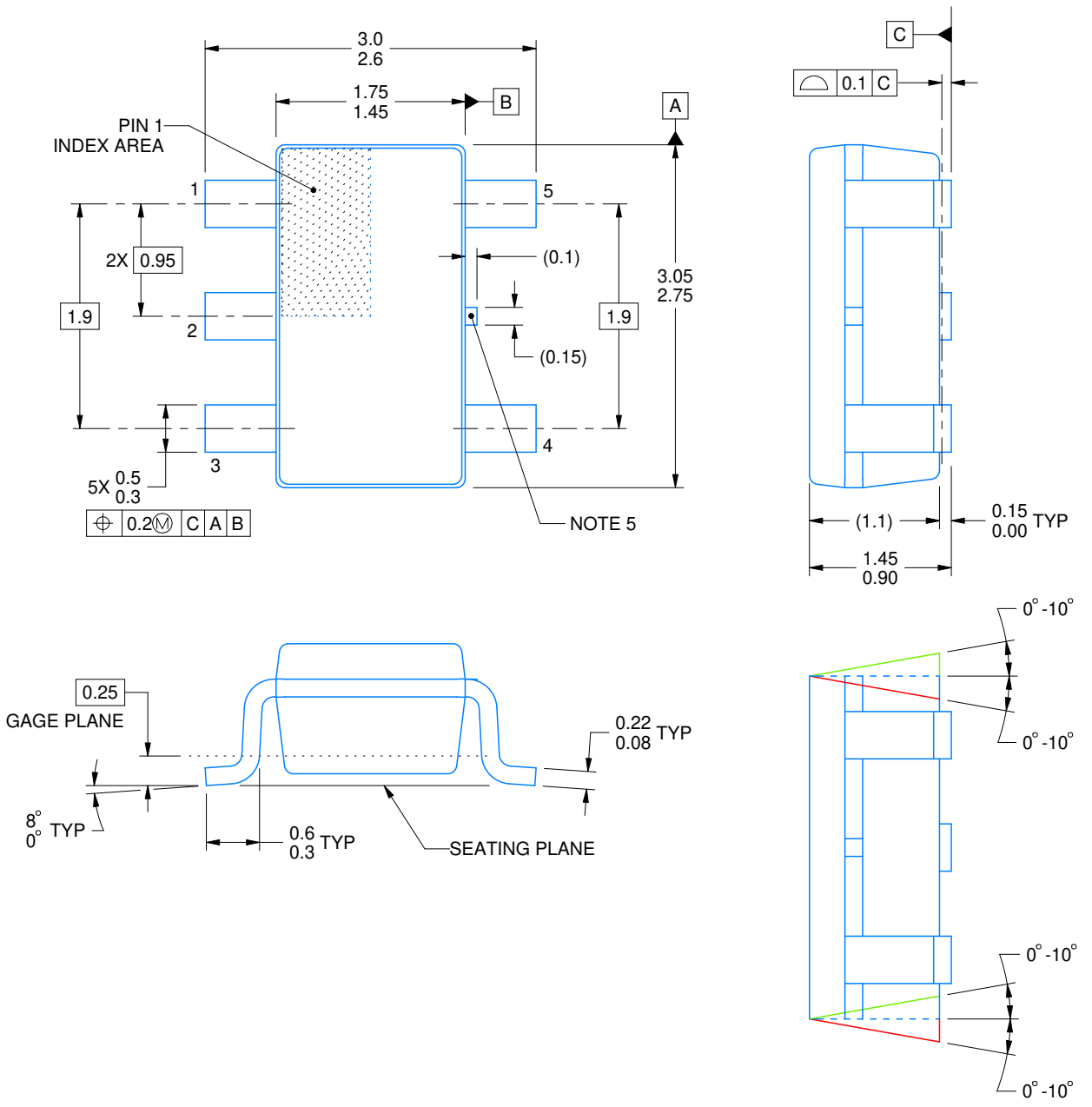
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
TS321QDBVRQ1	SOT-23	DBV	5	3000	202.0	201.0	28.0

PACKAGE OUTLINE

DBV0005A

SOT-23 - 1.45 mm max height

SMALL OUTLINE TRANSISTOR



ALTERNATIVE PACKAGE SINGULATION VIEW

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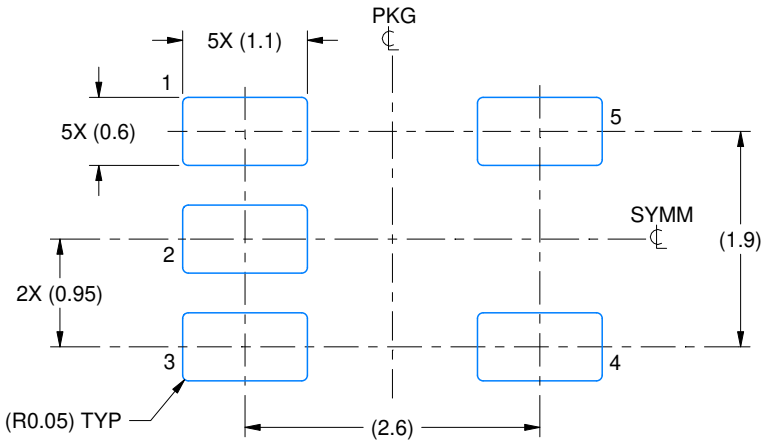
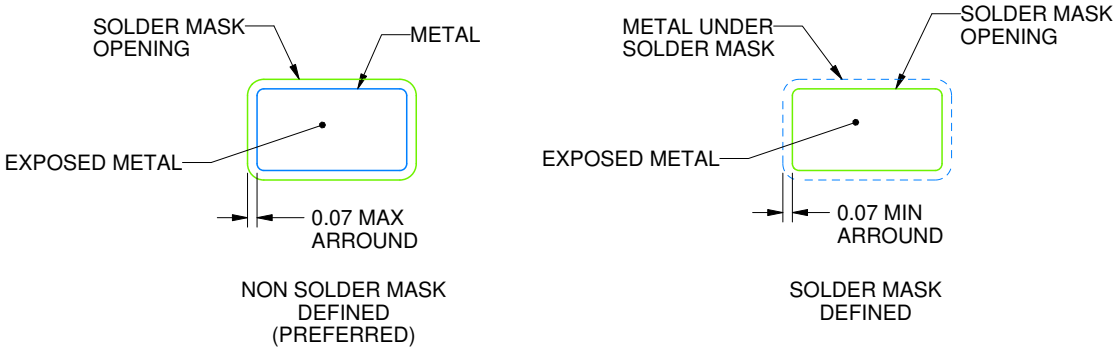
NOTES:

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

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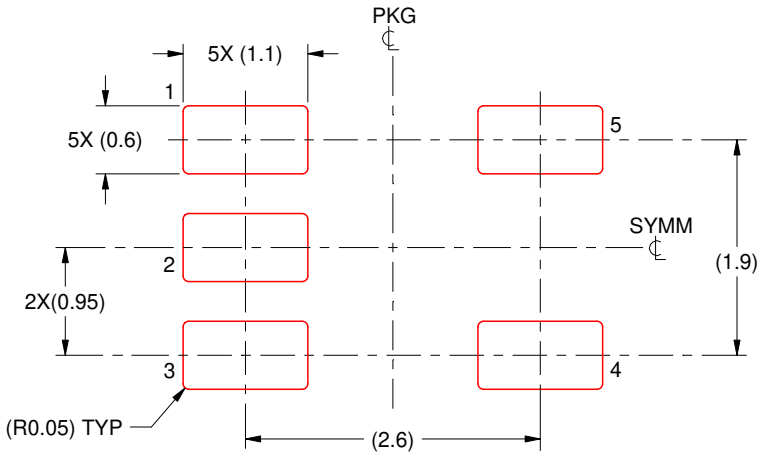
NOTES: (continued)

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



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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