

SCES482D - AUGUST 2003 - REVISED JANUARY 2013

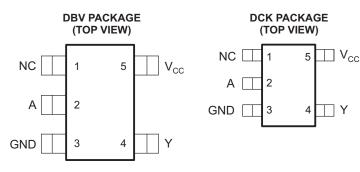
# SINGLE INVERTER GATE

Check for Samples: SN74LVC1G04-Q1

## FEATURES

- Qualified for Automotive Applications
- AEC-Q100 Qualified with the Following Results
  - Device Temperature Grade 1: –40°C to 125°C Ambient Operating Temperature Range
  - Device HBM ESD Classification Level H2
  - Device CDM ESG Classification Level C4B
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)

- Supports 5-V V<sub>CC</sub> Operation
- Inputs Accept Voltages to 5.5 V
- Max t<sub>pd</sub> of 3.3 ns at 3.3 V
- Low Power Consumption, 10-µA Max I<sub>CC</sub>
- ±24-mA Output Drive at 3.3 V
- Ioff Supports Partial-Power-Down Mode
  Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II



See mechanical drawings for dimensions. NC - No internal connection

# **DESCRIPTION AND ORDERING INFORMATION**

This single inverter gate is designed for 1.65-V to 5.5-V  $V_{\text{CC}}$  operation.

The SN74LVC1G04 performs the Boolean function  $Y = \overline{A}$ .

This device is fully specified for partial-power-down applications using I<sub>off</sub>. The I<sub>off</sub> circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

## **ORDERING INFORMATION**<sup>(1)</sup>

T <sub>A</sub>	PACKAGE	(2)	ORDERABLE PART NUMBER	TOP-SIDE MARKING <sup>(3)</sup>
40%C to 125%C	SOT (SOT-23) – DBV	Reel of 3000	SN74LVC1G04QDBVRQ1	C04_
–40°C to 125°C	SOT (SC-70) – DCK	Reel of 3000	SN74LVC1G04QDCKRQ1	CC_
-40°C to 85°C	SOT (SC-70) – DCK	Reel of 3000	SN74LVC1G04IDCKRQ1	CC_

(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.

(3) DBV/DCK: The actual top-side marking has one additional character that designates the wafer fab/assembly site.

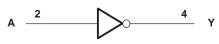
# FUNCTION TABLEINPUTOUTPUTAYHLLH

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Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.



### LOGIC DIAGRAM (POSITIVE LOGIC)



# Absolute Maximum Ratings<sup>(1)</sup>

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

			MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage range		-0.5	6.5	V	
VI	Input voltage range <sup>(2)</sup>		-0.5	6.5	V	
Vo	Voltage range applied to any output in the state <sup>(2)</sup>	age range applied to any output in the high-impedance or power-off $\mathcal{G}^{(2)}$				
Vo	Voltage range applied to any output in the	high or low state <sup>(2)</sup> (3)	-0.5	V <sub>CC</sub> + 0.5	V	
I <sub>IK</sub>	Input clamp current	V <sub>1</sub> < 0		-50	mA	
Ι <sub>ΟΚ</sub>	Output clamp current	V <sub>O</sub> < 0		-50	mA	
Io	Continuous output current			±50	mA	
	Continuous current through $V_{CC}$ or GND			±100	mA	
0	Declares the resulting a decree (4)	DBV package		206	0000	
θ <sub>JA</sub>	Package thermal impedance <sup>(4)</sup>	DCK package		252	°C/W	
T <sub>stg</sub>	Storage temperature range		-65	150	°C	
	Human-body model (HBM) AEC-Q100 clas	sification level H2		2	kV	
ESD rating	Charged-device model (CDM) AEC-Q100 d	classification level C4B		750	V	

(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) The input negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
 (3) The value of V<sub>CC</sub> is provided in the recommended operating conditions table.

(4) The package thermal impedance is calculated in accordance with JESD 51-7.



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# **Recommended Operating Conditions**<sup>(1)</sup>

			MIN	MAX	UNIT
V	Currente una literate	Operating	1.65	5.5	V
V <sub>CC</sub>	Supply voltage	Data retention only	1.5		v
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>		
V		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$	1.7		V
VIH	High-level input voltage	$V_{CC} = 3 \vee \text{to } 3.6 \vee$	2		v
		$V_{CC}$ = 4.5 V to 5.5 V	$0.7 \times V_{CC}$		
		$V_{CC} = 1.65 \text{ V} \text{ to } 1.95 \text{ V}$		$0.35 \times V_{CC}$	
		$V_{CC} = 2.3 \text{ V to } 2.7 \text{ V}$		0.7	V
VIL	Low-level input voltage	$V_{CC} = 3 V \text{ to } 3.6 V$		0.8	v
		$V_{CC} = 4.5 V \text{ to } 5.5 V$		$0.3 \times V_{CC}$	
VI	Input voltage		0	5.5	V
Vo	Output voltage		0	V <sub>CC</sub>	V
		V <sub>CC</sub> = 1.65 V		-4	
		V <sub>CC</sub> = 2.3 V		-8	
I <sub>OH</sub>	High-level output current	$V_{CC} = 3 V$		-16	mA
		$V_{CC} = 3 V$		-24	
		$V_{CC} = 4.5 V$		-32	
		V <sub>CC</sub> = 1.65 V		4	
		V <sub>CC</sub> = 2.3 V		8	
I <sub>OL</sub>	Low-level output current	<u> </u>		16	mA
		$V_{CC} = 3 V$		24	
		$V_{CC} = 4.5 V$		32	
		$V_{CC} = 1.8 \text{ V} \pm 0.15 \text{ V}, 2.5 \text{ V} \pm 0.2 \text{ V}$		20	
Δt/Δv	Input transition rise or fall rate	$V_{CC} = 3.3 \text{ V} \pm 0.3 \text{ V}$		10	ns/V
		$V_{CC} = 5 V \pm 0.5 V$		5	
Ŧ	Operating free air temperature	Q-suffix device	-40	125	°C
Τ <sub>Α</sub>	Operating free-air temperature	I-suffix device	-40	85	-0

(1) All unused inputs of the device must be held at V<sub>CC</sub> or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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## **Electrical Characteristics**

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

PARA	METER	TEST CONDITIONS	V <sub>cc</sub>	MIN TYP <sup>(1)</sup>	MAX	UNIT
		I <sub>OH</sub> = -100 μA	1.65 V to 5.5 V	V <sub>CC</sub> – 0.1		
		$I_{OH} = -4 \text{ mA}$	1.65 V	1.2		
		$I_{OH} = -8 \text{ mA}$	2.3 V	1.9		
V <sub>OH</sub>		I <sub>OH</sub> = -16 mA	0.14	2.4		V
		$I_{OH} = -24 \text{ mA}$	- 3 V	2.3		
		$I_{OH} = -32 \text{ mA}$	4.5 V	3.8		
		I <sub>OL</sub> = 100 μA	1.65 V to 5.5 V		0.1	
		$I_{OL} = 4 \text{ mA}$	1.65 V		0.45	
		I <sub>OL</sub> = 8 mA	2.3 V		0.3	
V <sub>OL</sub>		I <sub>OL</sub> = 16 mA	0.14		0.4	V
		I <sub>OL</sub> = 24 mA	- 3 V		0.55	
		I <sub>OL</sub> = 32 mA	4.5 V		0.55	
I <sub>I</sub>	A input	V <sub>I</sub> = 5.5 V or GND	0 to 5.5 V		±5	μA
I <sub>off</sub>		$V_1 \text{ or } V_0 = 5.5 \text{ V}$	0		±10	μA
I <sub>CC</sub>		$V_{\rm I} = 5.5 \text{ V or GND}, \qquad I_{\rm O} = 0$	1.65 V to 5.5 V		10	μA
ΔI <sub>CC</sub>		One input at $V_{CC}$ – 0.6 V, Other inputs at $V_{CC}$ or GND	3 V to 5.5 V		500	μA
Ci		$V_{I} = V_{CC}$ or GND	3.3 V	3.5		pF

(1) All typical values are at V<sub>CC</sub> = 3.3 V,  $T_A$  = 25°C.

## **Switching Characteristics**

over recommended operating free-air temperature range,  $C_L = 15 \text{ pF}$  (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 1.8 V ± 0.15 V		V <sub>CC</sub> = 2.5 V ± 0.2 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 5 V ± 0.5 V		UNIT
	(INFOT)	(001701)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	А	Y	2	6.4	1	4.2	0.7	3.3	0.7	3.1	ns

## **Switching Characteristics**

over recommended operating free-air temperature range,  $C_L = 30 \text{ pF}$  or 50 pF (unless otherwise noted) (see Figure 2)

PARAMETER FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 1.8 V ± 0.15 V		V <sub>CC</sub> = 2.5 V ± 0.2 V		V <sub>CC</sub> = 3.3 V ± 0.3 V		V <sub>CC</sub> = 5 V ± 0.5 V		UNIT	
	(INFOT)	(001701)	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t <sub>pd</sub>	А	Y	3	7.5	1.4	5.2	1	4.2	1	3.7	ns

## **Operating Characteristics**

 $T_A = 25^{\circ}C$ 

	PARAMETER	TEST CONDITIONS	V <sub>CC</sub> = 1.8 V	V <sub>CC</sub> = 2.5 V	$V_{CC} = 3.3 V$	$V_{CC} = 5 V$	UNIT	
	FARAMETER	TEST CONDITIONS	ТҮР	ТҮР	ТҮР	ТҮР		
$\mathbf{C}_{pd}$	Power dissipation capacitance	f = 10 MHz	16	18	18	20	pF	

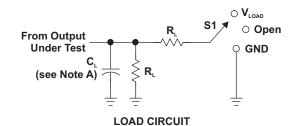
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# SN74LVC1G04-Q1

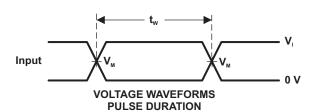
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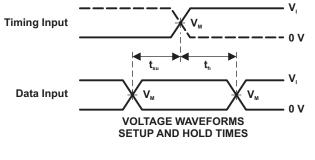
#### PARAMETER MEASUREMENT INFORMATION

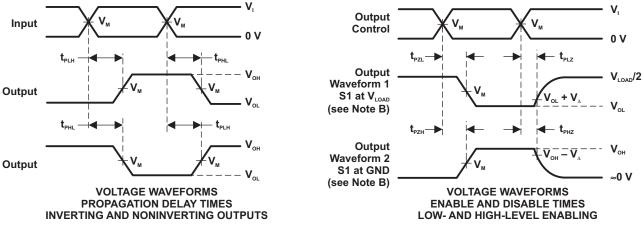


TEST	S1
t <sub>PLH</sub> /t <sub>PHL</sub>	Open
$t_{PLZ}/t_{PZL}$	VLOAD
$t_{PHZ}/t_{PZH}$	GND

	INF	PUTS			_	-	N
V <sub>cc</sub>	V	t,/t,	V <sub>M</sub>	$V_{load}$	CL	R	V
$1.8 V \pm 0.15 V$	$V_{cc}$	≤2 ns	V <sub>cc</sub> /2	2 × V <sub>cc</sub>	15 pF	<b>1 Μ</b> Ω	0.15 V
$2.5 V \pm 0.2 V$	$V_{cc}$	≤2 ns	V <sub>cc</sub> /2	2 × V <sub>cc</sub>	15 pF	<b>1 Μ</b> Ω	0.15 V
$3.3 V \pm 0.3 V$	3 V	≤2.5 ns	1.5 V	6 V	15 pF	<b>1 Μ</b> Ω	0.3 V
$5 V \pm 0.5 V$	$V_{cc}$	≤2.5 ns	V <sub>cc</sub> /2	2 × V <sub>cc</sub>	15 pF	<b>1 Μ</b> Ω	0.3 V







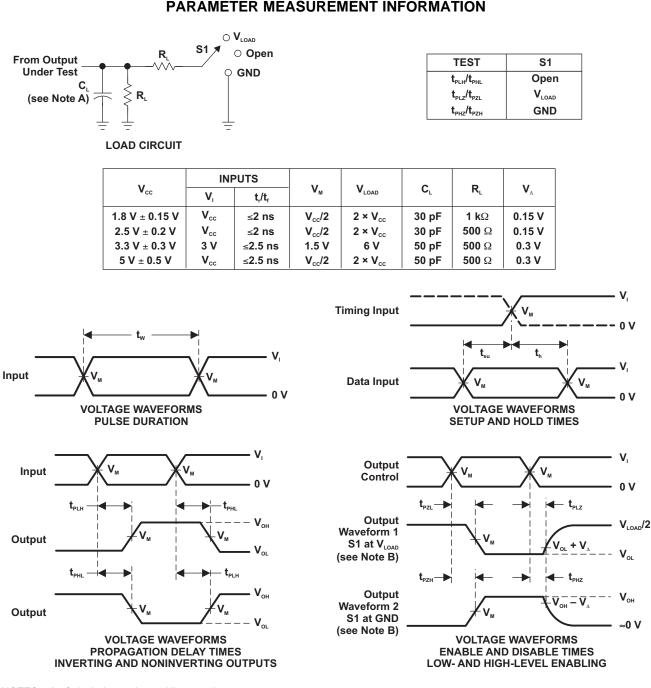
NOTES: A. C<sub>L</sub> includes probe and jig capacitance.

- B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control. C. All input pulses are supplied by generators having the following characteristics: PRR  $\leq$  10 MHz, Z<sub>0</sub> = 50  $\Omega$ .
- D. The outputs are measured one at a time, with one transition per measurement.
- E.  $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
- F.  $t_{\mbox{\tiny PZL}}$  and  $t_{\mbox{\tiny PZH}}$  are the same as  $t_{\mbox{\tiny en}}.$
- G.  $t_{\mbox{\tiny PLH}}$  and  $t_{\mbox{\tiny PHL}}$  are the same as  $t_{\mbox{\tiny pd}}$
- H. All parameters and waveforms are not applicable to all devices.

## Figure 1. Load Circuit and Voltage Waveforms



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NOTES: A.  $C_{L}$  includes probe and jig capacitance.

- B. Waveform 1 is for an output with internal conditions such that the output is low, except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high, except when disabled by the output control.
  C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z<sub>0</sub> = 50 Ω.
- D. The outputs are measured one at a time, with one transition per measurement.
- E.  $t_{PLZ}$  and  $\dot{t}_{PHZ}$  are the same as  $t_{dis}$ .
- F.  $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
- G.  $t_{\text{PLH}}$  and  $t_{\text{PHL}}$  are the same as  $t_{\text{pd}}$ .
- H. All parameters and waveforms are not applicable to all devices.

#### Figure 2. Load Circuit and Voltage Waveforms



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## **REVISION HISTORY**

Cł	Changes from Revision C (APRIL 2008) to Revision D						
•	Added new ListItem in Features, second one with sub list items	1					
•	Added ESD ratings to absmax table.	2					



11-Apr-2013

## **PACKAGING INFORMATION**

Orderable Device	Status	Package Type	•	Pins	Package	Eco Plan	Lead/Ball Finish	MSL Peak Temp	Op Temp (°C)	Top-Side Markings	Samples
	(1)		Drawing		Qty	(2)		(3)		(4)	
SN74LVC1G04QDBVRQ1	ACTIVE	SOT-23	DBV	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	C04O	Samples
SN74LVC1G04QDCKRQ1	ACTIVE	SC70	DCK	5	3000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 125	ССО	Samples

<sup>(1)</sup> 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) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.

**TBD:** The Pb-Free/Green conversion plan has not been defined.

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes. **Pb-Free (RoHS Exempt):** This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between

the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

(4) Multiple Top-Side Markings will be inside parentheses. Only one Top-Side 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 Top-Side Marking for that device.

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#### OTHER QUALIFIED VERSIONS OF SN74LVC1G04-Q1 :



# PACKAGE OPTION ADDENDUM

11-Apr-2013

#### Catalog: SN74LVC1G04

Enhanced Product: SN74LVC1G04-EP

NOTE: Qualified Version Definitions:

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

# PACKAGE MATERIALS INFORMATION

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## TAPE AND REEL INFORMATION





# QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE



*All dimensions are nominal												
Device	Package Type	Package Drawing		SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74LVC1G04QDBVRQ1	SOT-23	DBV	5	3000	179.0	8.4	3.2	3.2	1.4	4.0	8.0	Q3
SN74LVC1G04QDCKRQ1	SC70	DCK	5	3000	179.0	8.4	2.2	2.5	1.2	4.0	8.0	Q3

TEXAS INSTRUMENTS

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# PACKAGE MATERIALS INFORMATION

14-Mar-2013

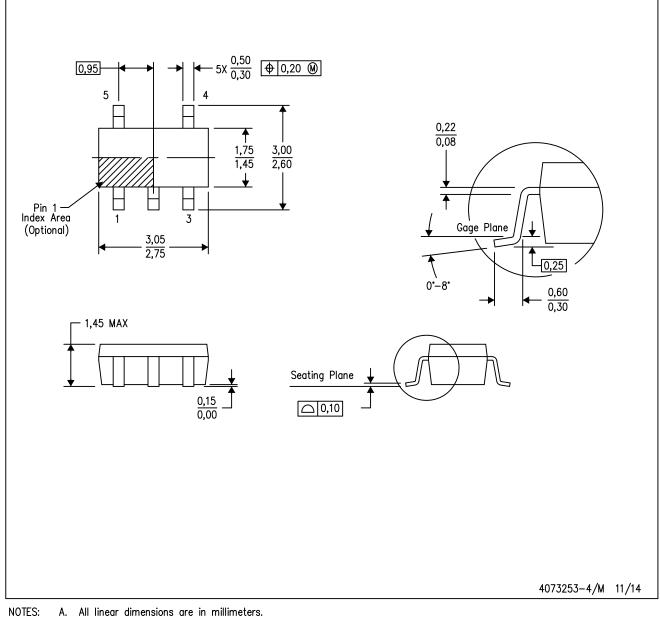


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVC1G04QDBVRQ1	SOT-23	DBV	5	3000	203.0	203.0	35.0
SN74LVC1G04QDCKRQ1	SC70	DCK	5	3000	203.0	203.0	35.0

DBV (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



- A. All linear dimensions are in millimeters.
  - This drawing is subject to change without notice. Β.
  - Body dimensions do not include mold flash or protrusion. Mold flash and protrusion shall not exceed 0.15 per side. C.
  - D. Falls within JEDEC MO-178 Variation AA.



DBV (R-PDSO-G5)

PLASTIC SMALL OUTLINE



NOTES:

A. All linear dimensions are in millimeters.B. This drawing is subject to change without notice.

- C. Customers should place a note on the circuit board fabrication drawing not to alter the center solder mask defined pad.
- D. Publication IPC-7351 is recommended for alternate designs.
- E. Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Example stencil design based on a 50% volumetric metal load solder paste. Refer to IPC-7525 for other stencil recommendations.



DCK (R-PDSO-G5)

PLASTIC SMALL-OUTLINE PACKAGE



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



# LAND PATTERN DATA



NOTES:

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



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Products		Applications			
Audio	www.ti.com/audio	Automotive and Transportation	www.ti.com/automotive		
Amplifiers	amplifier.ti.com	Communications and Telecom	www.ti.com/communications		
Data Converters	dataconverter.ti.com	Computers and Peripherals	www.ti.com/computers		
DLP® Products	www.dlp.com	Consumer Electronics	www.ti.com/consumer-apps		
DSP	dsp.ti.com	Energy and Lighting	www.ti.com/energy		
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