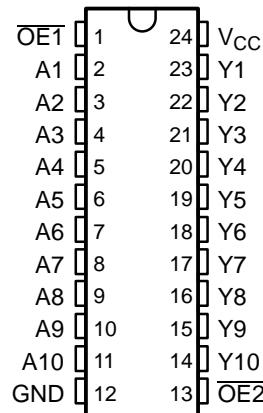


FEATURES

- Operates From 1.65 V to 3.6 V
- Inputs Accept Voltages to 5.5 V
- Max t_{pd} of 6.7 ns at 3.3 V
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Typical V_{OHV} (Output V_{OH} Undershoot) >2 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- Supports Mixed-Mode Signal Operation on All Ports (5-V Input/Output Voltage With 3.3-V V_{CC})
- I_{off} Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)

DB, DGV, DW, NS, OR PW PACKAGE
(TOP VIEW)



DESCRIPTION/ORDERING INFORMATION

This 10-bit buffer/bus driver is designed for 1.65-V to 3.6-V V_{CC} operation.

The SN74LVC828A provides a high-performance bus interface for wide data paths or buses carrying parity.

The 3-state control gate is a 2-input AND gate with active-low inputs so that, if either output-enable ($\overline{OE1}$ or $\overline{OE2}$) input is high, all ten outputs are in the high-impedance state. The SN74LVC828A provides inverting data at its outputs.

Inputs can be driven from either 3.3-V or 5-V devices. This feature allows the use of this device as a translator in a mixed 3.3-V/5-V system environment.

To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

ORDERING INFORMATION

T_A	PACKAGE ⁽¹⁾		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SOIC – DW	Tube of 25	SN74LVC828ADW	LVC828A
		Reel of 2000	SN74LVC828ADWR	
	SOP – NS	Reel of 2000	SN74LVC828ANSR	LVC828A
	SSOP – DB	Reel of 2000	SN74LVC828ADRV	LC828A
		Tube of 60	SN74LVC828APW	
	TSSOP – PW	Reel of 2000	SN74LVC828APWR	LC828A
		Reel of 250	SN74LVC828APWT	
	TVSOP – DGV	Reel of 2000	SN74LVC828ADGVR	LC828A

(1) Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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.

SN74LVC828A

10-BIT BUFFER/DRIVER WITH 3-STATE OUTPUTS

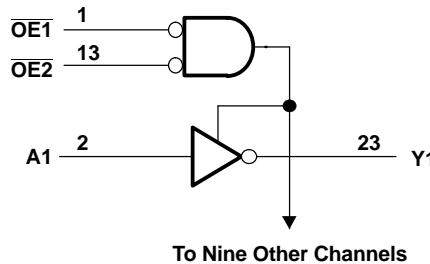
SCAS347H—MARCH 1994—REVISED MARCH 2005

TEXAS
INSTRUMENTS
www.ti.com

FUNCTION TABLE

INPUTS			OUTPUT Y
OE1	OE2	A	
L	L	L	H
L	L	H	L
H	X	X	Z
X	H	X	Z

LOGIC DIAGRAM (POSITIVE LOGIC)



Absolute Maximum Ratings⁽¹⁾

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

		MIN	MAX	UNIT
V_{CC}	Supply voltage range		-0.5	6.5
V_I	Input voltage range ⁽²⁾		-0.5	6.5
V_O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾		-0.5	6.5
V_O	Voltage range applied to any output in the high or low state ⁽²⁾⁽³⁾	-0.5	$V_{CC} + 0.5$	V
I_{IK}	Input clamp current	$V_I < 0$		-50
I_{OK}	Output clamp current	$V_O < 0$		-50
I_O	Continuous output current			± 50
	Continuous current through V_{CC} or GND			mA
θ_{JA}	Package thermal impedance ⁽⁴⁾	DB package	63	°C/W
		DGV package	86	
		DW package	46	
		NS package	65	
		PW package	88	
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) 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_{CC} is provided in the recommended operating conditions table.

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

Recommended Operating Conditions⁽¹⁾

			MIN	MAX	UNIT
V _{CC}	Supply voltage	Operating	1.65	3.6	V
		Data retention only	1.5		
V _{IH}	High-level input voltage	V _{CC} = 1.65 V to 1.95 V	0.65 × V _{CC}		V
		V _{CC} = 2.3 V to 2.7 V	1.7		
		V _{CC} = 2.7 V to 3.6 V	2		
V _{IL}	Low-level input voltage	V _{CC} = 1.65 V to 1.95 V	0.35 × V _{CC}		V
		V _{CC} = 2.3 V to 2.7 V	0.7		
		V _{CC} = 2.7 V to 3.6 V	0.8		
V _I	Input voltage		0	5.5	V
V _O	Output voltage	High or low state	0	V _{CC}	V
		3-state	0	5.5	
I _{OH}	High-level output current	V _{CC} = 1.65 V		-4	mA
		V _{CC} = 2.3 V		-8	
		V _{CC} = 2.7 V		-12	
		V _{CC} = 3 V		-24	
I _{OL}	Low-level output current	V _{CC} = 1.65 V		4	mA
		V _{CC} = 2.3 V		8	
		V _{CC} = 2.7 V		12	
		V _{CC} = 3 V		24	
Δt/Δv	Input transition rise or fall rate			10	ns/V
T _A	Operating free-air temperature		-40	85	°C

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

SN74LVC828A
10-BIT BUFFER/DRIVER
WITH 3-STATE OUTPUTS

SCAS347H—MARCH 1994—REVISED MARCH 2005



Electrical Characteristics

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

PARAMETER	TEST CONDITIONS	V _{CC}	MIN	TYP ⁽¹⁾	MAX	UNIT
V _{OH}	I _{OH} = -100 µA	1.65 V to 3.6 V	V _{CC} - 0.2			V
	I _{OH} = -4 mA	1.65 V	1.2			
	I _{OH} = -8 mA	2.3 V	1.7			
	I _{OH} = -12 mA	2.7 V	2.2			
	I _{OH} = -24 mA	3 V	2.4			
V _{OL}	I _{OL} = 100 µA	1.65 V to 3.6 V		0.2		V
	I _{OL} = 4 mA	1.65 V		0.45		
	I _{OL} = 8 mA	2.3 V		0.7		
	I _{OL} = 12 mA	2.7 V		0.4		
	I _{OL} = 24 mA	3 V		0.55		
I _I	V _I = 0 to 5.5 V	3.6 V		±5	µA	
I _{off}	V _I or V _O = 5.5 V	0		±10	µA	
I _{OZ}	V _O = 0 to 5.5 V	3.6 V		±10	µA	
I _{CC}	V _I = V _{CC} or GND	I _O = 0	3.6 V		10	µA
	3.6 V ≤ V _I ≤ 5.5 V ⁽²⁾				10	
ΔI _{CC}	One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND		2.7 V to 3.6 V		500	µA
C _i	V _I = V _{CC} or GND		3.3 V		5	pF
C _o	V _O = V _{CC} or GND		3.3 V		7	pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

(2) This applies in the disabled state only.

Switching Characteristics

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 1.8 V ± 0.15 V	V _{CC} = 2.5 V ± 0.2 V	V _{CC} = 2.7 V	V _{CC} = 3.3 V ± 0.3 V	UNIT	
			MIN	MAX	MIN	MAX		
t _{pd}	A	Y	(1)	(1)	(1)	(1)	7.1	1 6.7 ns
t _{en}	OE	Y	(1)	(1)	(1)	(1)	8.5	1 7.3 ns
t _{dis}	OE	Y	(1)	(1)	(1)	(1)	7.3	1.8 6.7 ns
t _{sk(o)}							1	ns

(1) This information was not available at the time of publication.

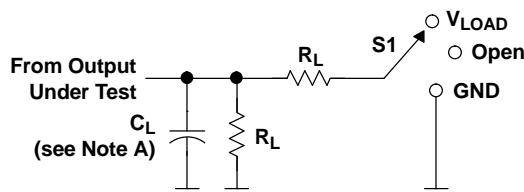
Operating Characteristics

T_A = 25°C

PARAMETER	TEST CONDITIONS	V _{CC} = 1.8 V	V _{CC} = 2.5 V	V _{CC} = 3.3 V	UNIT	
		TYP	TYP	TYP		
C _{pd}	Power dissipation capacitance per buffer/driver	(1)	(1)	24	pF	
	Outputs enabled	f = 10 MHz	(1)	(1)		
	Outputs disabled		(1)	(1)	7	

(1) This information was not available at the time of publication.

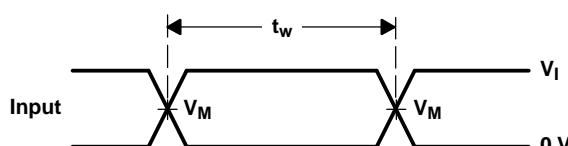
PARAMETER MEASUREMENT INFORMATION



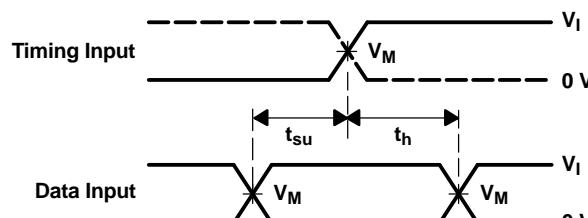
TEST	$S1$
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{LOAD}
t_{PHZ}/t_{PZH}	GND

LOAD CIRCUIT

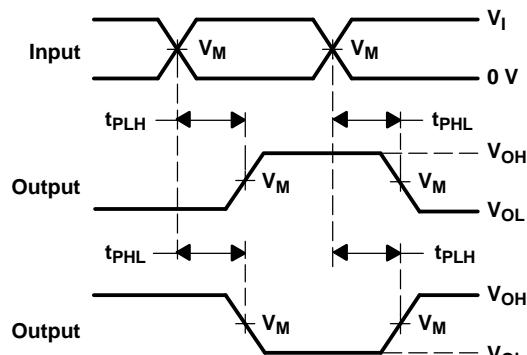
V_{CC}	INPUTS		V_M	V_{LOAD}	C_L	R_L	V_Δ
	V_I	t_r/t_f					
$1.8 \text{ V} \pm 0.15 \text{ V}$	V_{CC}	$\leq 2 \text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	1 k Ω	0.15 V
$2.5 \text{ V} \pm 0.2 \text{ V}$	V_{CC}	$\leq 2 \text{ ns}$	$V_{CC}/2$	$2 \times V_{CC}$	30 pF	500 Ω	0.15 V
2.7 V	2.7 V	$\leq 2.5 \text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V
$3.3 \text{ V} \pm 0.3 \text{ V}$	2.7 V	$\leq 2.5 \text{ ns}$	1.5 V	6 V	50 pF	500 Ω	0.3 V



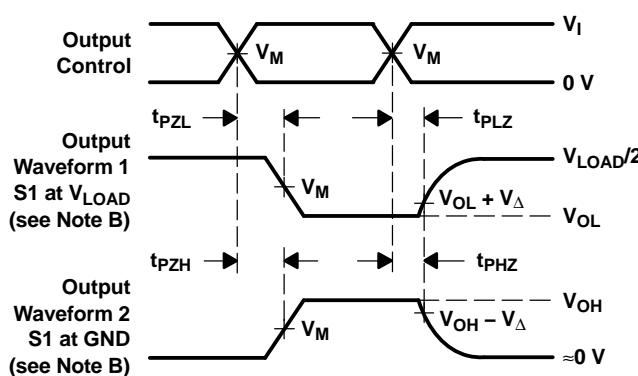
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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 $\leq 10 \text{ MHz}$, $Z_O = 50 \Omega$.
- 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_{PZL} and t_{PZH} are the same as t_{en} .
- G. t_{PLH} and t_{PHL} are the same as t_{pd} .
- H. All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
SN74LVC828ADBLE	OBsolete	SSOP	DB	24		TBD	Call TI	Call TI	-40 to 85		
SN74LVC828ADBR	OBsolete	SSOP	DB	24		TBD	Call TI	Call TI	-40 to 85	LC828A	
SN74LVC828ADBRE4	OBsolete	SSOP	DB	24		TBD	Call TI	Call TI	-40 to 85		
SN74LVC828ADB RG4	OBsolete	SSOP	DB	24		TBD	Call TI	Call TI	-40 to 85		
SN74LVC828ADGVR	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828ADGVRE4	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828ADGVRG4	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828ADW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828ADWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828ADWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828ADWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828ADWRE4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828ADWRG4	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LVC828A	Samples
SN74LVC828APW	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWE4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWG4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWLE	OBsolete	TSSOP	PW	24		TBD	Call TI	Call TI	-40 to 85		
SN74LVC828APWR	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWRE4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)	Op Temp (°C)	Top-Side Markings (4)	Samples
SN74LVC828APWRG4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWT	ACTIVE	TSSOP	PW	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWTE4	ACTIVE	TSSOP	PW	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	Samples
SN74LVC828APWTG4	ACTIVE	TSSOP	PW	24	250	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	LC828A	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⁾ 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.

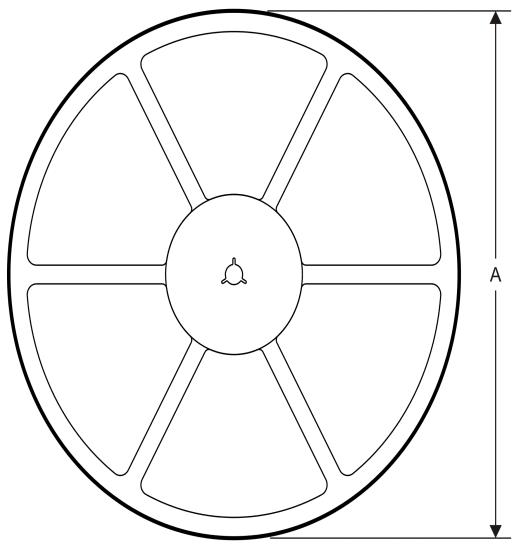
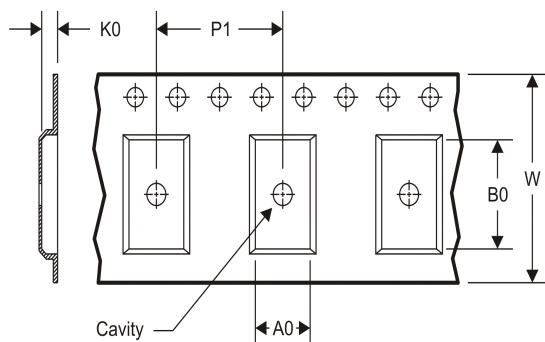
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

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

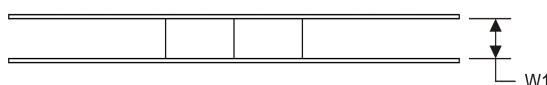
⁽⁴⁾ Only one of markings shown within the brackets will appear on the physical device.

Important Information and Disclaimer: The information provided on this page represents TI's knowledge and belief as of the date that it is provided. TI bases its knowledge and belief on information provided by third parties, and makes no representation or warranty as to the accuracy of such information. Efforts are underway to better integrate information from third parties. TI has taken and continues to take reasonable steps to provide representative and accurate information but may not have conducted destructive testing or chemical analysis on incoming materials and chemicals. TI and TI suppliers consider certain information to be proprietary, and thus CAS numbers and other limited information may not be available for release.

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

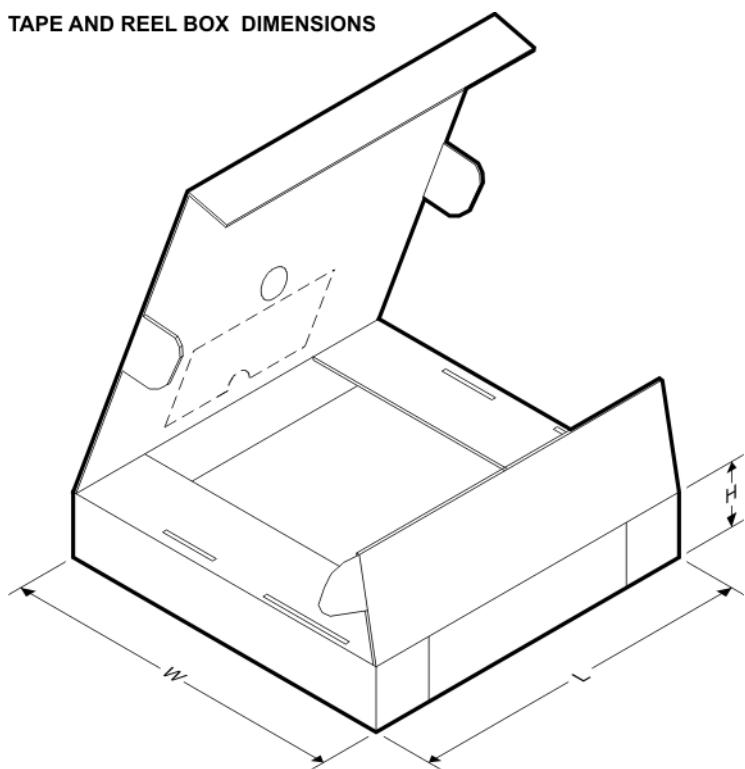
TAPE AND REEL INFORMATION
REEL DIMENSIONS

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


TAPE AND REEL INFORMATION

*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74LVC828ADGVR	TVSOP	DGV	24	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN74LVC828ADWR	SOIC	DW	24	2000	330.0	24.4	10.75	15.7	2.7	12.0	24.0	Q1
SN74LVC828APWR	TSSOP	PW	24	2000	330.0	16.4	6.95	8.3	1.6	8.0	16.0	Q1
SN74LVC828APWT	TSSOP	PW	24	250	330.0	16.4	6.95	8.3	1.6	8.0	16.0	Q1

TAPE AND REEL BOX DIMENSIONS


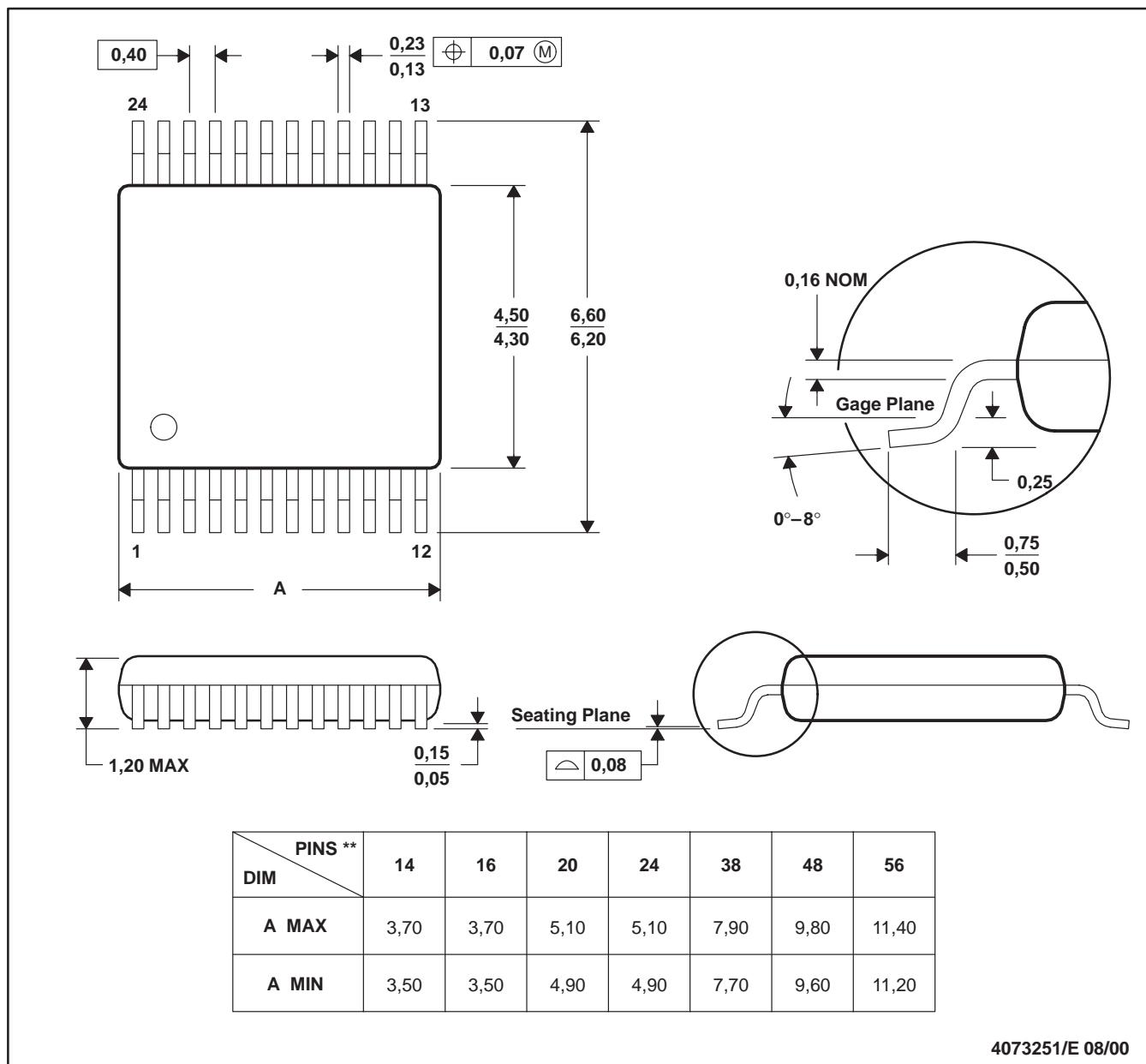
*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74LVC828ADGVR	TVSOP	DGV	24	2000	367.0	367.0	35.0
SN74LVC828ADWR	SOIC	DW	24	2000	367.0	367.0	45.0
SN74LVC828APWR	TSSOP	PW	24	2000	367.0	367.0	38.0
SN74LVC828APWT	TSSOP	PW	24	250	367.0	367.0	38.0

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

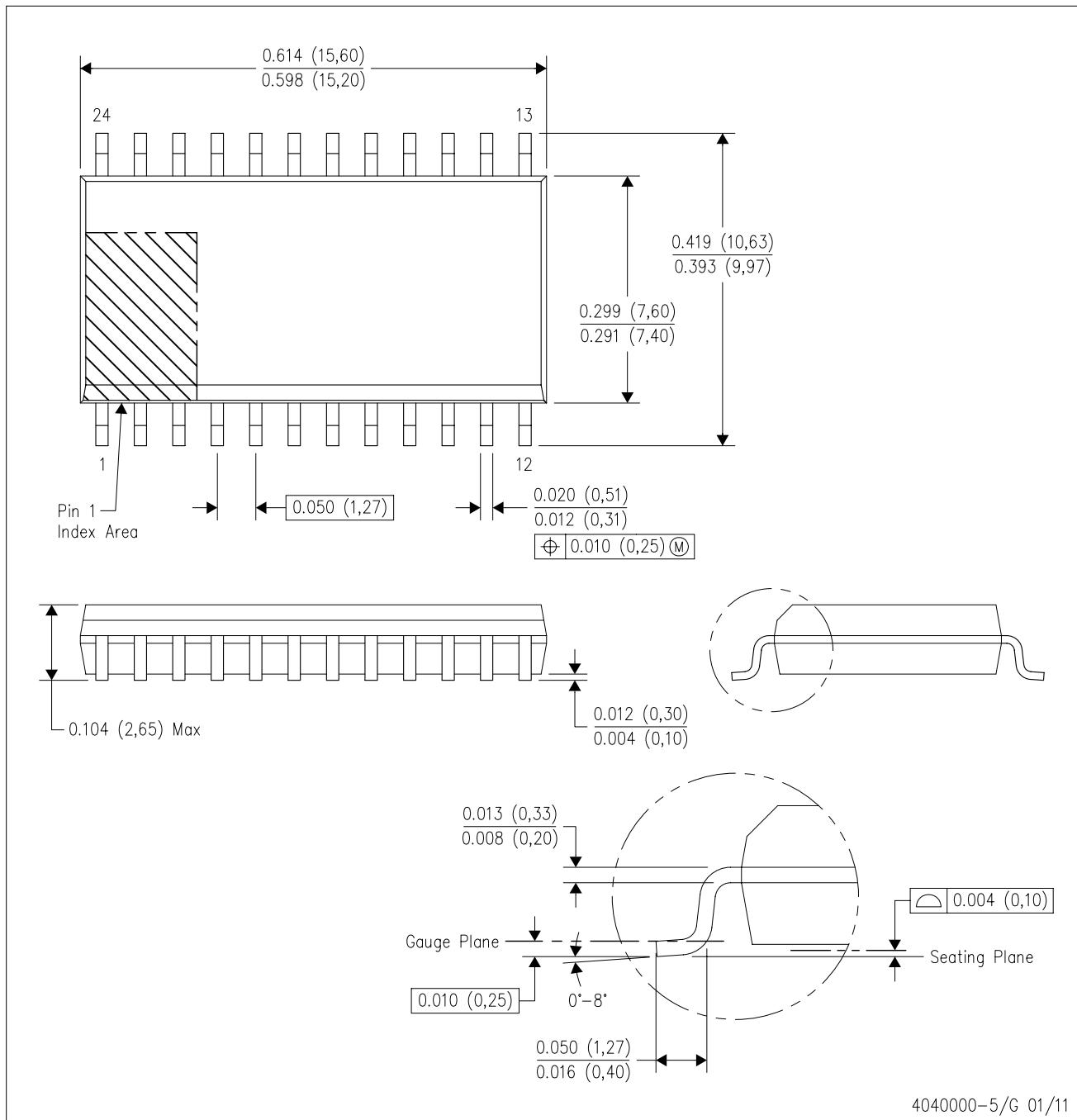
24 PINS SHOWN



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, not to exceed 0,15 per side.
 D. Falls within JEDEC: 24/48 Pins – MO-153
 14/16/20/56 Pins – MO-194

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



NOTES:

- All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
- This drawing is subject to change without notice.
- Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0.15).
- Falls within JEDEC MS-013 variation AD.

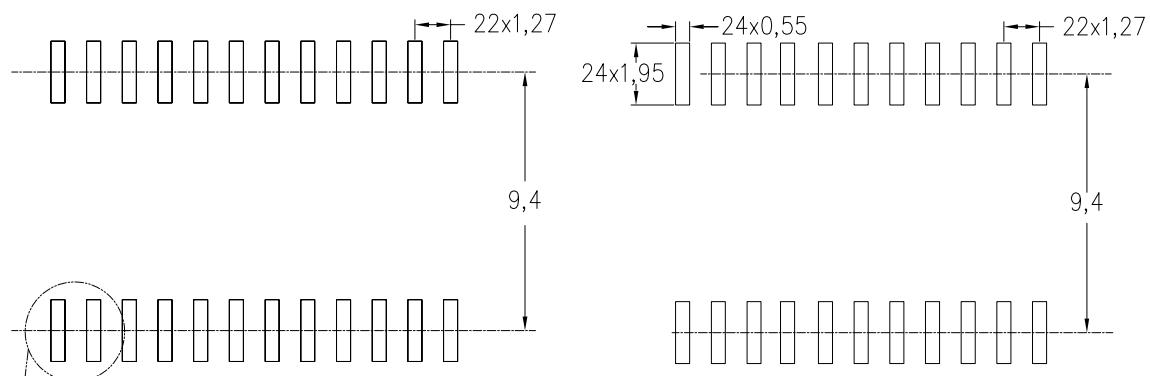
LAND PATTERN DATA

DW (R-PDSO-G24)

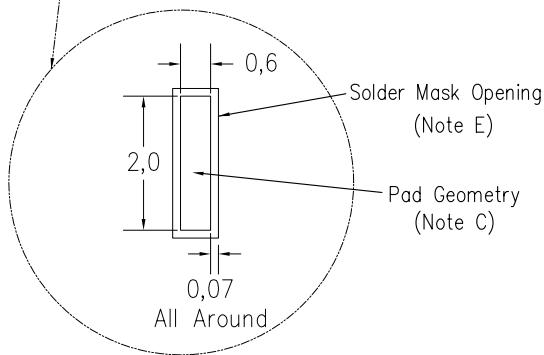
PLASTIC SMALL OUTLINE

Example Board Layout
(Note C)

Stencil Openings
(Note D)



Non Solder Mask Define Pad



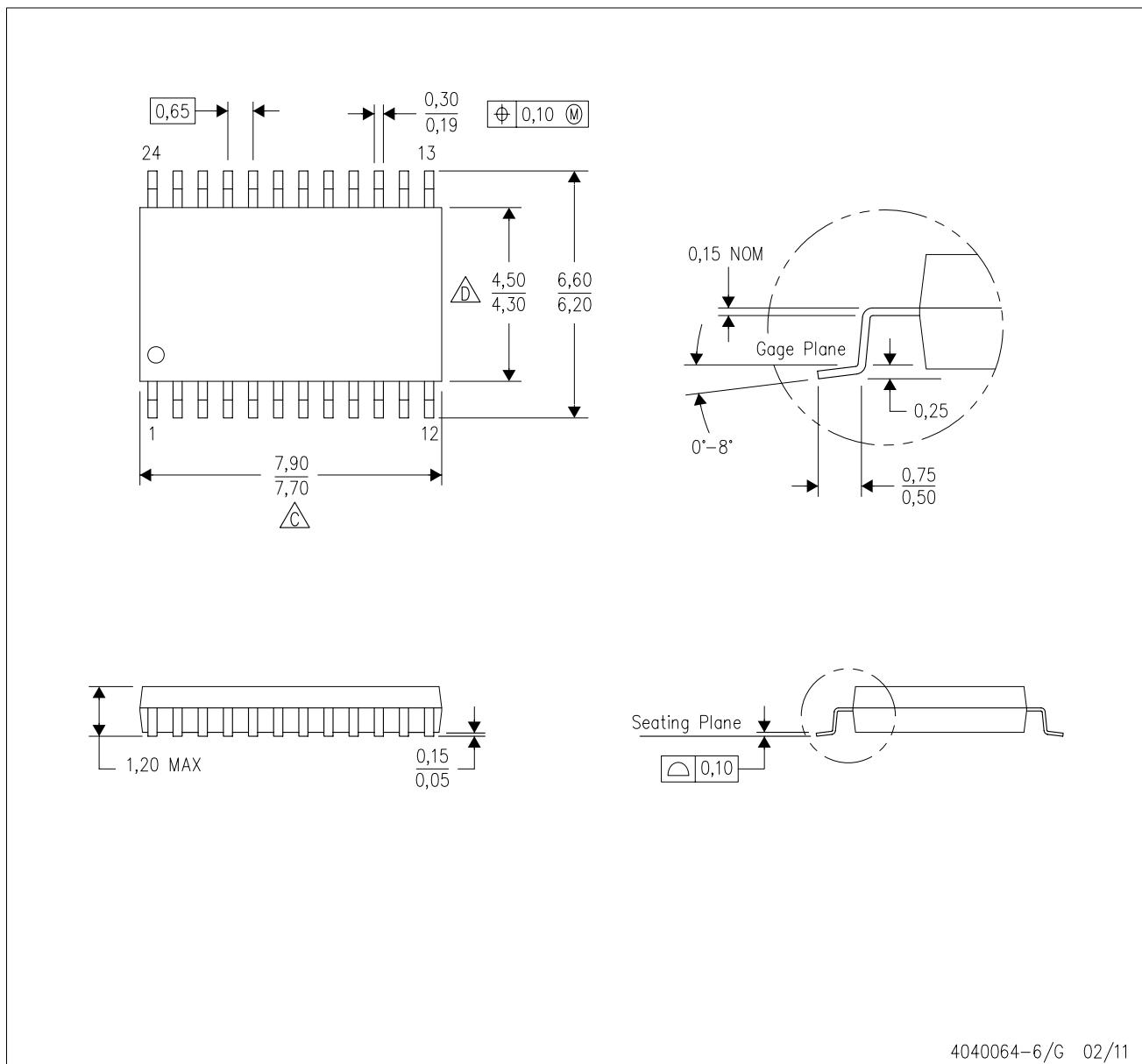
4209202-5/E 07/11

NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Refer to IPC7351 for alternate board design.
- D. 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. Refer to IPC-7525
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



4040064-6/G 02/11

NOTES:

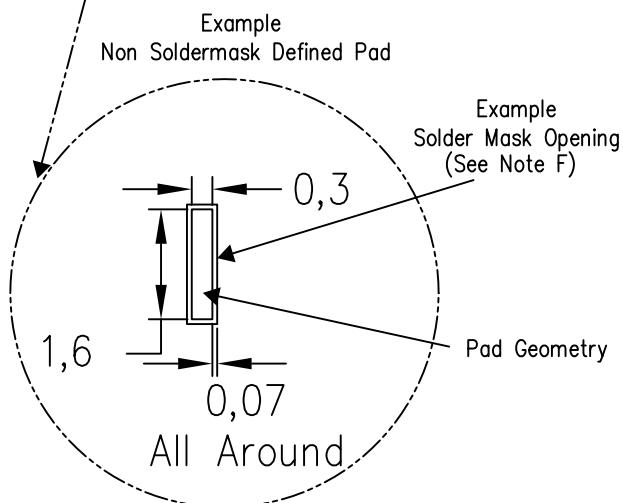
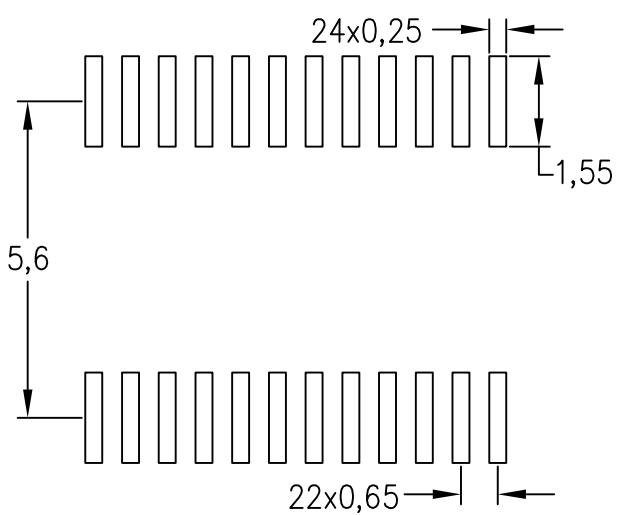
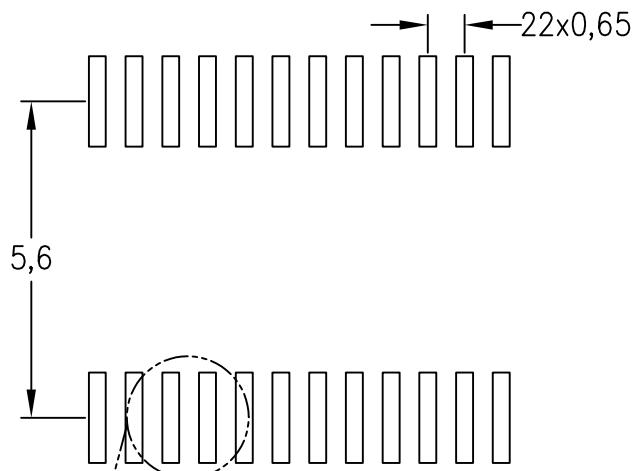
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
- B. This drawing is subject to change without notice.
-  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
-  D. Body width does not include interlead flash. Interlead flash shall not exceed 0,25 each side.
- E. Falls within JEDEC MO-153

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

Example Board Layout

Stencil Openings
Based on a stencil thickness
of .127mm (.005inch).



4211284-4/F 12/12

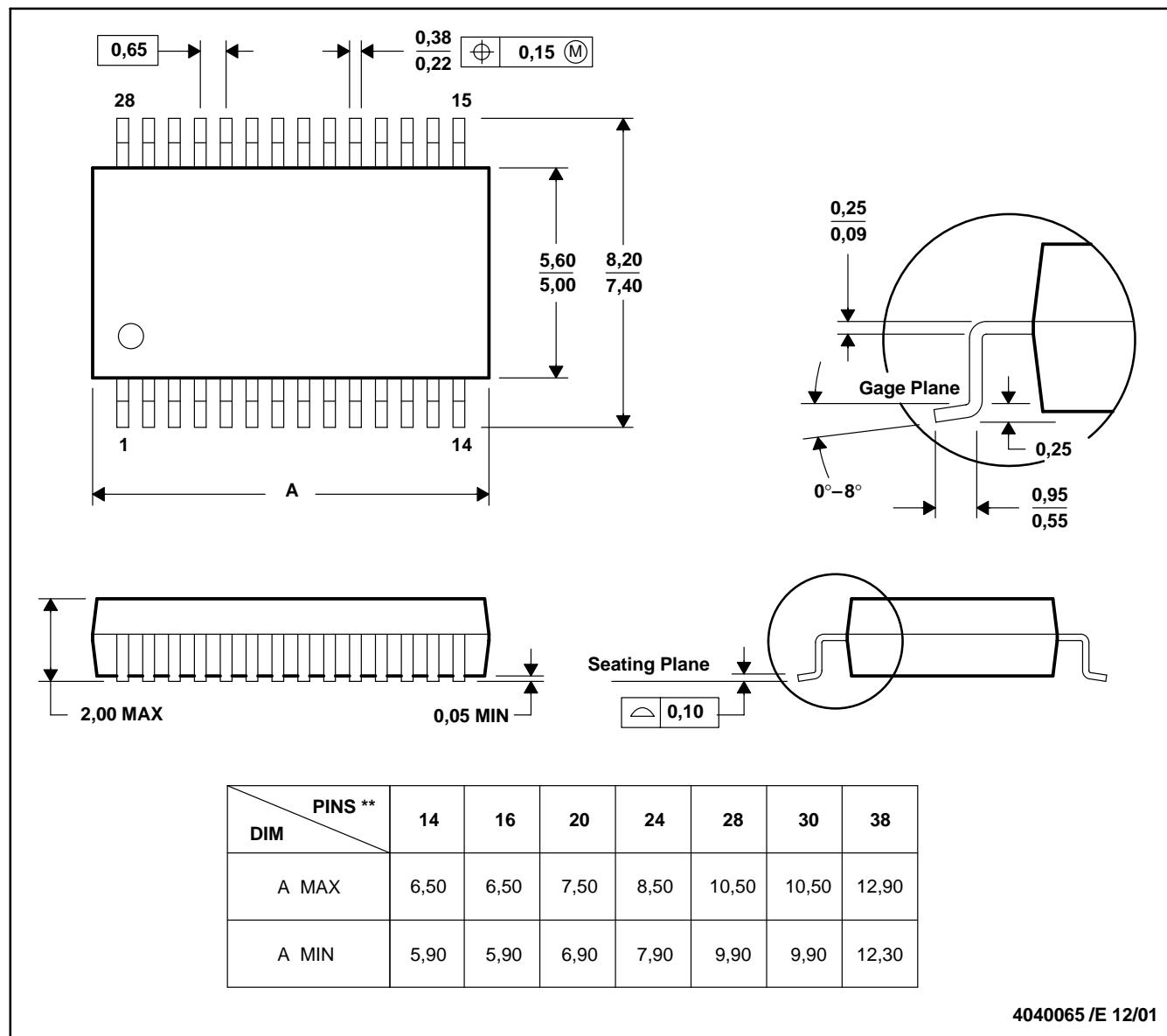
NOTES:

- A. All linear dimensions are in millimeters.
- B. This drawing is subject to change without notice.
- C. Publication IPC-7351 is recommended for alternate design.
- D. 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. Refer to IPC-7525 for other stencil recommendations.
- E. Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



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 not to exceed 0,15.
 D. Falls within JEDEC MO-150

IMPORTANT NOTICE

Texas Instruments Incorporated and its subsidiaries (TI) reserve the right to make corrections, enhancements, improvements and other changes to its semiconductor products and services per JESD46, latest issue, and to discontinue any product or service per JESD48, latest issue. Buyers should obtain the latest relevant information before placing orders and should verify that such information is current and complete. All semiconductor products (also referred to herein as "components") are sold subject to TI's terms and conditions of sale supplied at the time of order acknowledgment.

TI warrants performance of its components to the specifications applicable at the time of sale, in accordance with the warranty in TI's terms and conditions of sale of semiconductor products. Testing and other quality control techniques are used to the extent TI deems necessary to support this warranty. Except where mandated by applicable law, testing of all parameters of each component is not necessarily performed.

TI assumes no liability for applications assistance or the design of Buyers' products. Buyers are responsible for their products and applications using TI components. To minimize the risks associated with Buyers' products and applications, Buyers should provide adequate design and operating safeguards.

TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right relating to any combination, machine, or process in which TI components or services are used. Information published by TI regarding third-party products or services does not constitute a license to use such products or services or a warranty or endorsement thereof. Use of such information may require a license from a third party under the patents or other intellectual property of the third party, or a license from TI under the patents or other intellectual property of TI.

Reproduction of significant portions of TI information in TI data books or data sheets is permissible only if reproduction is without alteration and is accompanied by all associated warranties, conditions, limitations, and notices. TI is not responsible or liable for such altered documentation. Information of third parties may be subject to additional restrictions.

Resale of TI components or services with statements different from or beyond the parameters stated by TI for that component or service voids all express and any implied warranties for the associated TI component or service and is an unfair and deceptive business practice. TI is not responsible or liable for any such statements.

Buyer acknowledges and agrees that it is solely responsible for compliance with all legal, regulatory and safety-related requirements concerning its products, and any use of TI components in its applications, notwithstanding any applications-related information or support that may be provided by TI. Buyer represents and agrees that it has all the necessary expertise to create and implement safeguards which anticipate dangerous consequences of failures, monitor failures and their consequences, lessen the likelihood of failures that might cause harm and take appropriate remedial actions. Buyer will fully indemnify TI and its representatives against any damages arising out of the use of any TI components in safety-critical applications.

In some cases, TI components may be promoted specifically to facilitate safety-related applications. With such components, TI's goal is to help enable customers to design and create their own end-product solutions that meet applicable functional safety standards and requirements. Nonetheless, such components are subject to these terms.

No TI components are authorized for use in FDA Class III (or similar life-critical medical equipment) unless authorized officers of the parties have executed a special agreement specifically governing such use.

Only those TI components which TI has specifically designated as military grade or "enhanced plastic" are designed and intended for use in military/aerospace applications or environments. Buyer acknowledges and agrees that any military or aerospace use of TI components which have **not** been so designated is solely at the Buyer's risk, and that Buyer is solely responsible for compliance with all legal and regulatory requirements in connection with such use.

TI has specifically designated certain components as meeting ISO/TS16949 requirements, mainly for automotive use. In any case of use of non-designated products, TI will not be responsible for any failure to meet ISO/TS16949.

Products	Applications
Audio	www.ti.com/audio
Amplifiers	amplifier.ti.com
Data Converters	dataconverter.ti.com
DLP® Products	www.dlp.com
DSP	dsp.ti.com
Clocks and Timers	www.ti.com/clocks
Interface	interface.ti.com
Logic	logic.ti.com
Power Mgmt	power.ti.com
Microcontrollers	microcontroller.ti.com
RFID	www.ti-rfid.com
OMAP Applications Processors	www.ti.com/omap
Wireless Connectivity	www.ti.com/wirelessconnectivity
	TI E2E Community
	e2e.ti.com