

# SN54ABT646, SN74ABT646 OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

SCBS068E – JULY 1991 – REVISED JULY 1994

- State-of-the-Art **EPIC-IIIB™** BiCMOS Design Significantly Reduces Power Dissipation
- ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 500 mA Per JEDEC Standard JESD-17
- Typical  $V_{OLP}$  (Output Ground Bounce) < 1 V at  $V_{CC} = 5$  V,  $T_A = 25^\circ\text{C}$
- High-Drive Outputs ( $-32\text{-mA } I_{OH}$ ,  $64\text{-mA } I_{OL}$ )
- Package Options Include Plastic Small-Outline (DW), Shrink Small-Outline (DB), and Thin Shrink Small-Outline (PW) Packages, Ceramic Chip Carriers (FK), and Plastic (NT) and Ceramic (JT) DIPs

## description

These devices consist of bus transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the input bus or from the internal registers. Data on the A or B bus is clocked into the registers on the low-to-high transition of the appropriate clock (CLKAB or CLKBA) input. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the 'ABT646.

Output-enable ( $\overline{OE}$ ) and direction-control (DIR) inputs are provided to control the transceiver functions. In the transceiver mode, data present at the high-impedance port may be stored in either register or in both.

The select-control (SAB and SBA) inputs can multiplex stored and real-time (transparent mode) data. The direction control (DIR) determines which bus will receive data when  $\overline{OE}$  is low. In the isolation mode ( $\overline{OE}$  high), A data may be stored in one register and/or B data may be stored in the other register.

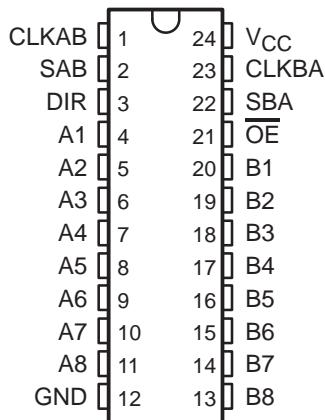
When an output function is disabled, the input function is still enabled and may be used to store and transmit data. Only one of the two buses, A or B, may be driven at a time.

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.

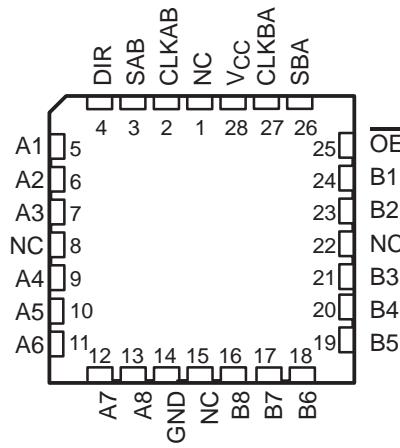
The SN74ABT646 is available in TI's shrink small-outline package (DB), which provides the same I/O pin count and functionality of standard small-outline packages in less than half the printed-circuit-board area.

The SN54ABT646 is characterized for operation over the full military temperature range of  $-55^\circ\text{C}$  to  $125^\circ\text{C}$ . The SN74ABT646 is characterized for operation from  $-40^\circ\text{C}$  to  $85^\circ\text{C}$ .

**SN54ABT646 . . . JT PACKAGE**  
**SN74ABT646 . . . DB, DW, NT, OR PW PACKAGE**  
(TOP VIEW)



**SN54ABT646 . . . FK PACKAGE**  
(TOP VIEW)



NC – No internal connection

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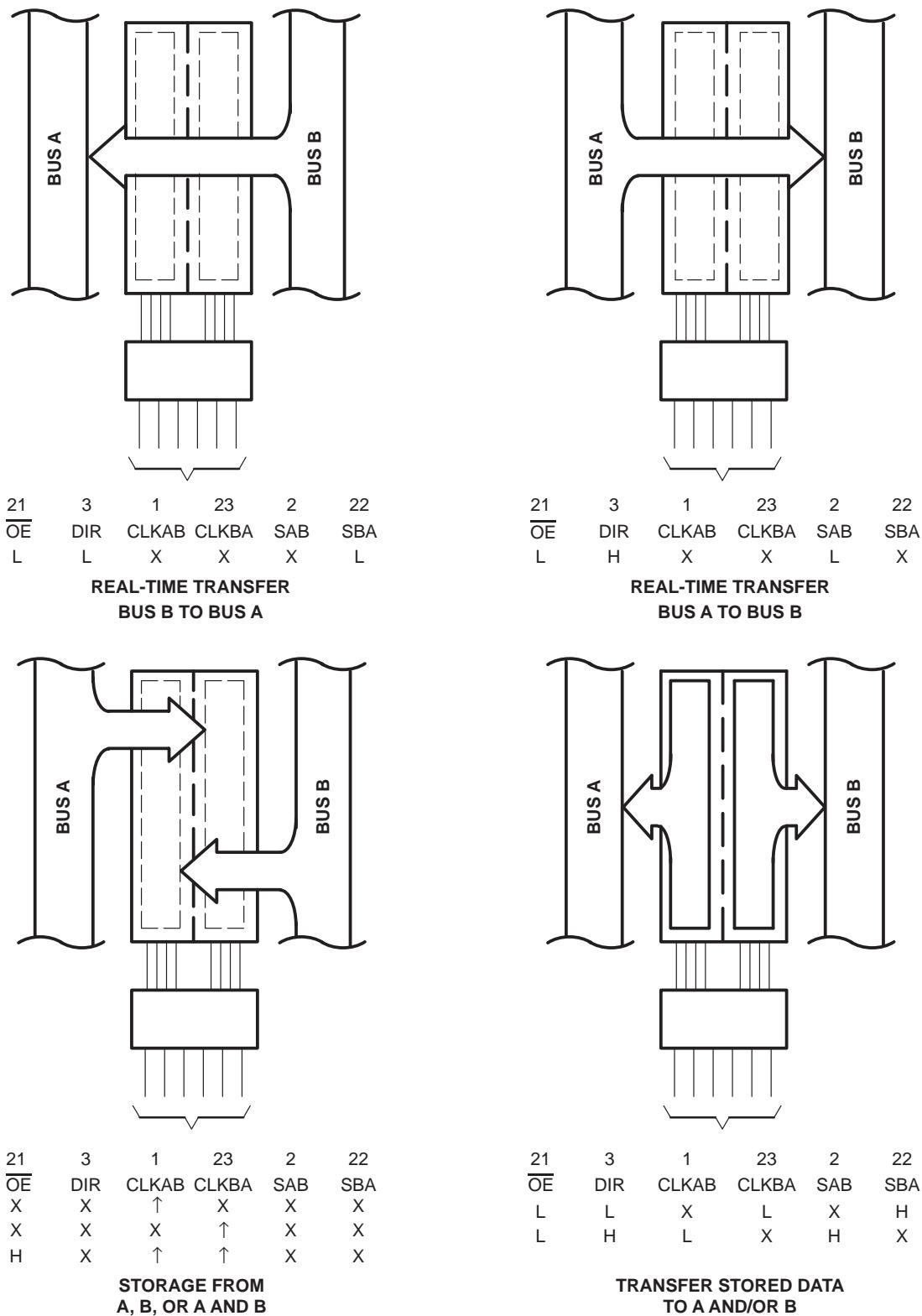
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SCBS068E – JULY 1991 – REVISED JULY 1994



**Figure 1. Bus-Management Functions**

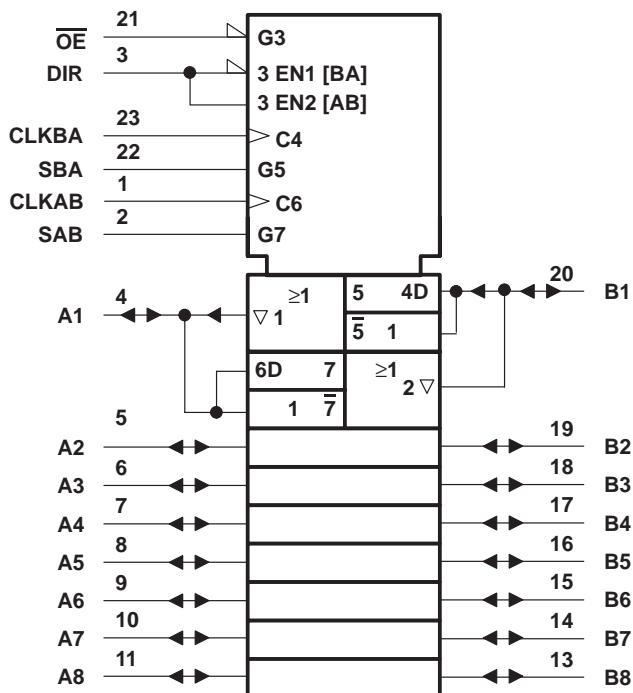
Pin numbers shown are for DB, DW, JT, NT, and PW packages.

FUNCTION TABLE

INPUTS						DATA I/Os		OPERATION OR FUNCTION
OE	DIR	CLKAB	CLKBA	SAB	SBA	A1 THRU A8	B1 THRU B8	
X	X	↑	X	X	X	Input	Unspecified†	Store A, B unspecified†
X	X	X	↑	X	X	Unspecified†	Input	Store B, A unspecified†
H	X	↑	↑	X	X	Input	Input	Store A and B data
H	X	H or L	H or L	X	X	Input disabled	Input disabled	Isolation, hold storage
L	L	X	X	X	L	Output	Input	Real-time B data to A bus
L	L	X	H or L	X	H	Output	Input	Stored B data to A bus
L	H	X	X	L	X	Input	Output	Real-time A data to B bus
L	H	H or L	X	H	X	Input	Output	Stored A data to B bus

† The data output functions may be enabled or disabled by various signals at the OE and DIR inputs. Data input functions are always enabled; i.e., data at the bus pins will be stored on every low-to-high transition of the clock inputs.

### logic symbol‡

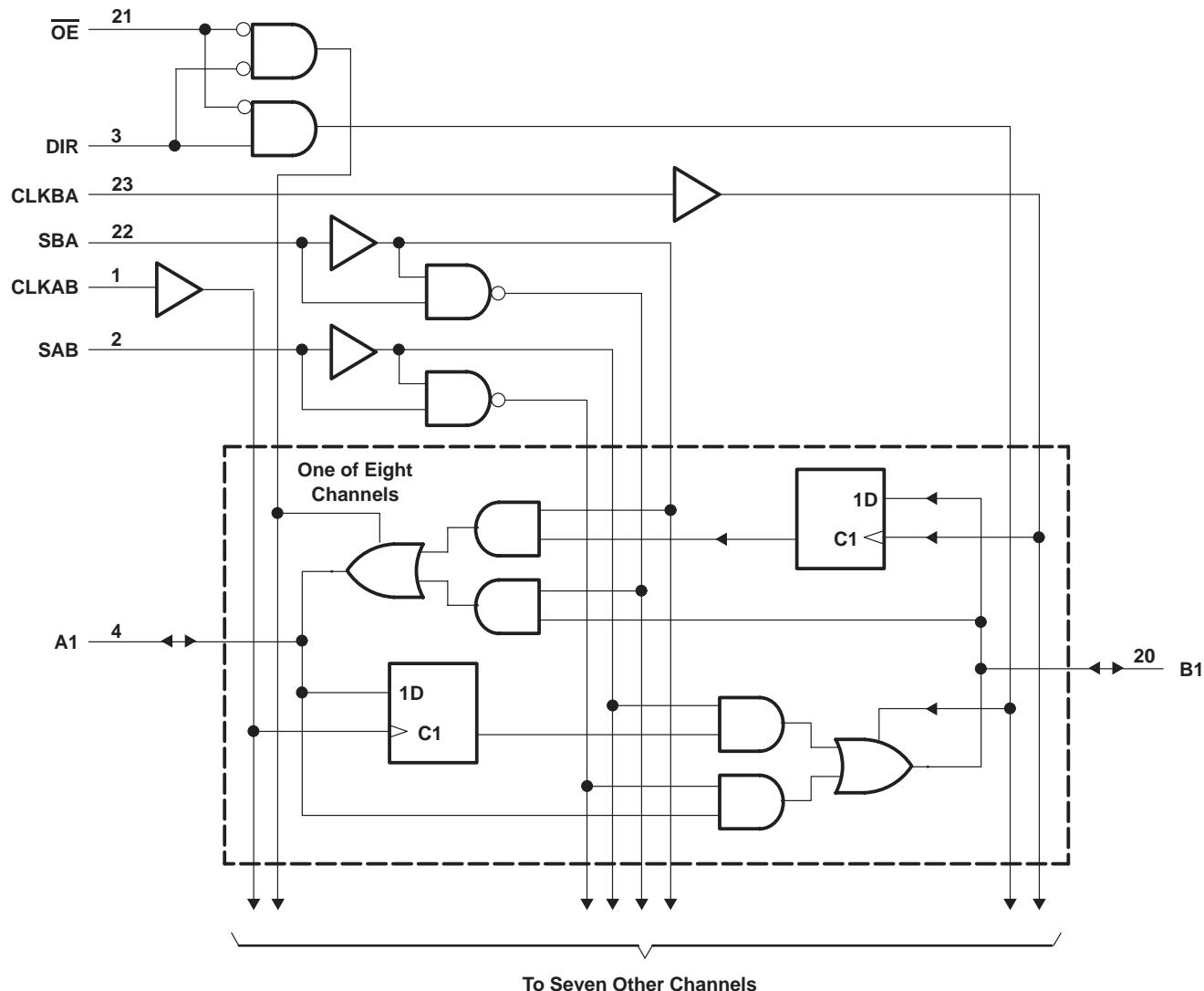


‡ This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.  
 Pin numbers shown are for the DB, DW, JT, NT, and PW packages.

**SN54ABT646, SN74ABT646**  
**OCTAL BUS TRANSCEIVERS AND REGISTERS**  
**WITH 3-STATE OUTPUTS**

SCBS068E – JULY 1991 – REVISED JULY 1994

**logic diagram (positive logic)**



Pin numbers shown are for the DB, DW, JT, NT, and PW packages.

**absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>**

Supply voltage range, $V_{CC}$ .....	-0.5 V to 7 V	
Input voltage range, $V_I$ (except I/O ports) (see Note 1) .....	-0.5 V to 7 V	
Voltage range applied to any output in the high state or power-off state, $V_O$ .....	-0.5 V to 5.5 V	
Current into any output in the low state, $I_O$ : SN54ABT646 .....	96 mA	
SN74ABT646 .....	128 mA	
Input clamp current, $I_{IK}$ ( $V_I < 0$ ) .....	-18 mA	
Output clamp current, $I_{OK}$ ( $V_O < 0$ ) .....	-50 mA	
Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 2): DB package .....	0.65 W	
DW package .....	1.7 W	
NT package .....	1.3 W	
PW package .....	0.7 W	
Storage temperature range .....	-65°C to 150°C	

<sup>†</sup> 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. The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.  
 2. The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils, except for the NT package, which has a trace length of zero. For more information, refer to the *Package Thermal Considerations* application note in the 1994 *ABT Advanced BiCMOS Technology Data Book*, literature number SCBD002B.

**recommended operating conditions (see Note 3)**

		SN54ABT646		SN74ABT646		UNIT
		MIN	MAX	MIN	MAX	
$V_{CC}$	Supply voltage	4.5	5.5	4.5	5.5	V
$V_{IH}$	High-level input voltage	2		2		V
$V_{IL}$	Low-level input voltage		0.8		0.8	V
$V_I$	Input voltage	0	$V_{CC}$	0	$V_{CC}$	V
$I_{OH}$	High-level output current		-24		-32	mA
$I_{OL}$	Low-level output current		48		64	mA
$\Delta t/\Delta v$	Input transition rise or fall rate		5		5	ns/V
$T_A$	Operating free-air temperature	-55	125	-40	85	°C

NOTE 3: Unused or floating pins (input or I/O) must be held high or low.

**SN54ABT646, SN74ABT646**  
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**WITH 3-STATE OUTPUTS**

SCBS068E – JULY 1991 – REVISED JULY 1994

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

PARAMETER	TEST CONDITIONS	TA = 25°C			SN54ABT646		SN74ABT646		UNIT
		MIN	TYP†	MAX	MIN	MAX	MIN	MAX	
VIK	VCC = 4.5 V, I <sub>I</sub> = -18 mA			-1.2		-1.2		-1.2	V
VOH	VCC = 4.5 V, I <sub>OH</sub> = -3 mA		2.5		2.5		2.5		V
	VCC = 5 V, I <sub>OH</sub> = -3 mA		3		3		3		
	VCC = 4.5 V	I <sub>OH</sub> = -24 mA		2		2			
		I <sub>OH</sub> = -32 mA		2*				2	
VOL	VCC = 4.5 V	I <sub>OL</sub> = 48 mA			0.55	0.55			V
		I <sub>OL</sub> = 64 mA			0.55*			0.55	
I <sub>I</sub>	VCC = 5.5 V, V <sub>I</sub> = VCC or GND	Control inputs			±1	±1	±1		µA
		A or B ports			±100	±100	±100		
I <sub>OZH</sub> ‡	VCC = 5.5 V, V <sub>O</sub> = 2.7 V				10§	50	10§	µA	
I <sub>OZL</sub> ‡	VCC = 5.5 V, V <sub>O</sub> = 0.5 V				-10§	-50	-10§	µA	
I <sub>off</sub>	VCC = 0, V <sub>I</sub> or V <sub>O</sub> ≤ 4.5 V				±100		±100	µA	
I <sub>CEX</sub>	VCC = 5.5 V, V <sub>O</sub> = 5.5 V	Outputs high			50	50	50	µA	
I <sub>O¶</sub>	VCC = 5.5 V, V <sub>O</sub> = 2.5 V		-50	-100	-180	-50	-180	-50	mA
I <sub>CC</sub>	VCC = 5.5 V, I <sub>O</sub> = 0, V <sub>I</sub> = VCC or GND	Outputs high			250	250	250	µA	
		Outputs low			30	30	30	mA	
		Outputs disabled			250	250	250	µA	
ΔI <sub>CC</sub> ‡	VCC = 5.5 V, One input at 3.4 V, Other inputs at VCC or GND				1.5	1.5	1.5	mA	
C <sub>i</sub>	V <sub>I</sub> = 2.5 V or 0.5 V	Control inputs		7					pF
C <sub>io</sub>	V <sub>O</sub> = 2.5 V or 0.5 V	A or B ports		12					pF

\* On products compliant to MIL-STD-883, Class B, this parameter does not apply.

† All typical values are at VCC = 5 V.

‡ The parameters I<sub>OZH</sub> and I<sub>OZL</sub> include the input leakage current.

§ This data sheet limit may vary among suppliers.

¶ Not more than one output should be tested at a time, and the duration of the test should not exceed one second.

# This is the increase in supply current for each input that is at the specified TTL voltage level rather than VCC or GND.

**timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figure 2)**

		VCC = 5 V, TA = 25°C	SN54ABT646		SN74ABT646		UNIT		
			MIN	MAX	MIN	MAX			
f <sub>clock</sub>	Clock frequency		0	125	0	125	0	125	MHz
t <sub>w</sub>	Pulse duration, CLK high or low		4		4		4		ns
t <sub>su</sub>	Setup time, A or B before CLKAB↑ or CLKBA↑	High	3.5		3.5		3.5		ns
		Low	3		3		3		
t <sub>h</sub>	Hold time, A or B after CLKAB↑ or CLKBA↑		0		0		0		ns

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



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 SCBS068E – JULY 1991 – REVISED JULY 1994

switching characteristics over recommended ranges of supply voltage and operating free-air temperature,  $C_L = 50 \text{ pF}$  (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 5 \text{ V}$ , $T_A = 25^\circ\text{C}$			SN54ABT646	SN74ABT646	UNIT
			MIN	TYP	MAX	MIN	MAX	
$f_{max}$			125				125	MHz
$t_{PLH}$	CLKBA or CLKAB	A or B	2.2	4	6.8		2.2	7.8
$t_{PHL}$			1.7	4	7.4		1.7	8.4
$t_{PLH}$	A or B	B or A	1.5	3	5.9		1.5	6.9
$t_{PHL}$			1.5	3.3	5.9		1.5	6.9
$t_{PLH}$	SAB or SBAT <sup>†</sup>	B or A	1.5	4	6.1		1.5	7.1
$t_{PHL}$			1.5	3.6	6.9		1.5	7.9
$t_{PZH}$	$\overline{OE}$	A or B	1	4.3	5.3		1	6.3
$t_{PZL}$			2.1	5.8	7.4		2.1	8.8
$t_{PHZ}$	$\overline{OE}$	A or B	1.5	3.5	7.3		1.5	8.3
$t_{PLZ}$			1.5	3	7		1.5	7.5
$t_{PZH}$	DIR	A or B	1.2	4.5	5.7		1.2	6.7
$t_{PZL}$			2.5	6.5	9		2.5	9.5
$t_{PHZ}$	DIR	A or B	1.5	3.8	6.7		1.5	7.7
$t_{PLZ}$			1.5	3.8	7.2		1.5	8.2

<sup>†</sup> These parameters are measured with the internal output state of the storage register opposite to that of the bus input.

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.

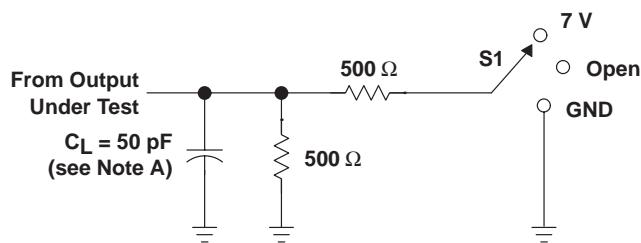


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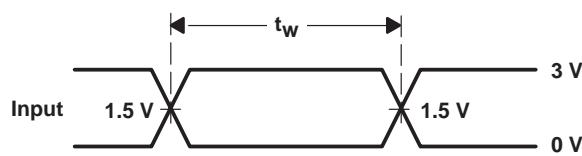
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**PARAMETER MEASUREMENT INFORMATION**

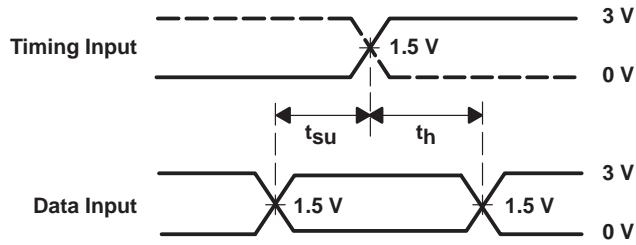


TEST	S1
tPLH/tPHL	Open
tPLZ/tPZL	7 V
tPHZ/tPZH	Open

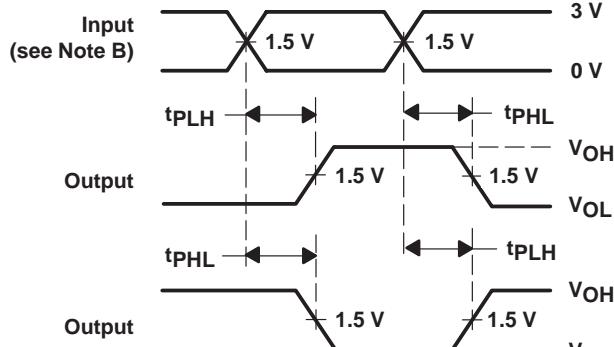
LOAD CIRCUIT FOR OUTPUTS



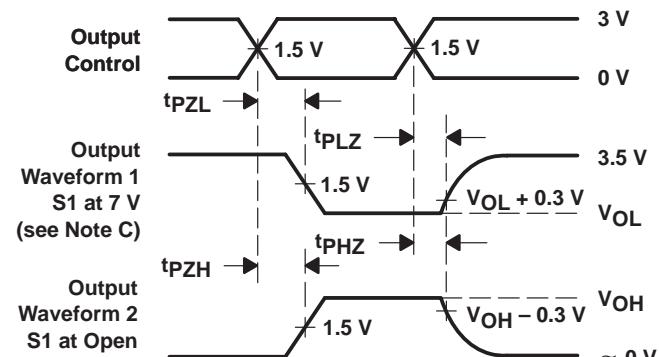
VOLTAGE WAVEFORMS  
PULSE DURATION



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:

- $C_L$  includes probe and jig capacitance.
- All input pulses are supplied by generators having the following characteristics: PRR  $\leq$  10 MHz,  $Z_O = 50 \Omega$ ,  $t_r \leq 2.5$  ns,  $t_f \leq 2.5$  ns.
- 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.
- The outputs are measured one at a time with one transition per measurement.

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

## PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74ABT646DBLE	OBsolete	SSOP	DB	24		TBD	Call TI	Call TI	-40 to 85		
SN74ABT646DBR	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	AB646	Samples
SN74ABT646DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT646	Samples
SN74ABT646DWR	ACTIVE	SOIC	DW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	ABT646	Samples
SN74ABT646NT	ACTIVE	PDIP	NT	24	15	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type	-40 to 85	SN74ABT646NT	Samples
SN74ABT646PW	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	AB646	Samples
SN74ABT646PWLE	OBsolete	TSSOP	PW	24		TBD	Call TI	Call TI	-40 to 85		
SN74ABT646PWR	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	AB646	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.

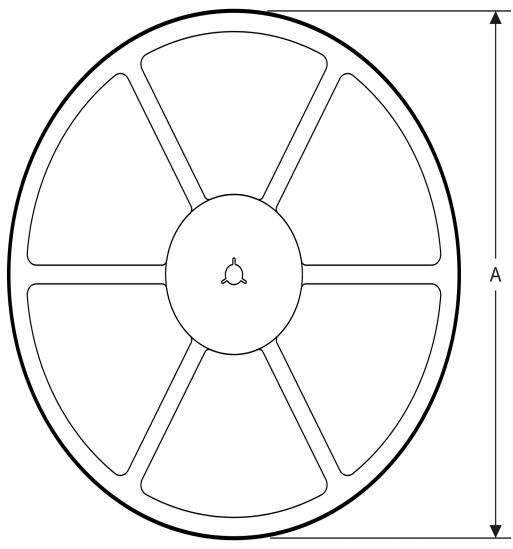
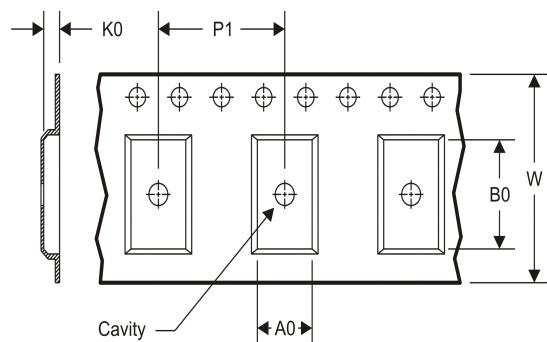
(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

(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.

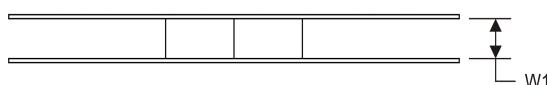
(6) Lead/Ball Finish - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead/Ball Finish values may wrap to two lines if the finish value exceeds the maximum column width.

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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


**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
SN74ABT646DBR	SSOP	DB	24	2000	330.0	16.4	8.2	8.8	2.5	12.0	16.0	Q1
SN74ABT646PWR	TSSOP	PW	24	2000	330.0	16.4	6.95	8.3	1.6	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

\*All dimensions are nominal

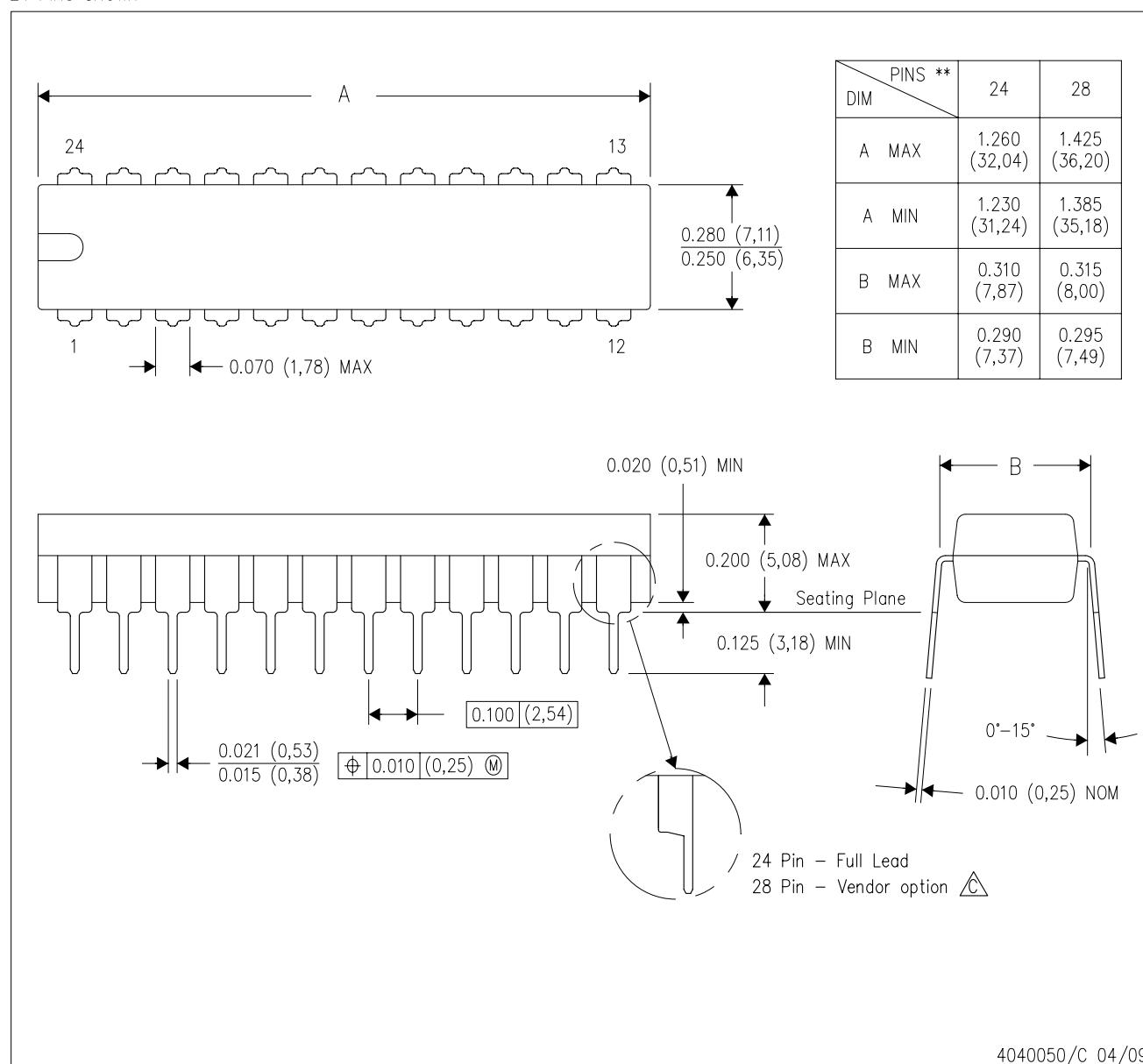
Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74ABT646DBR	SSOP	DB	24	2000	367.0	367.0	38.0
SN74ABT646PWR	TSSOP	PW	24	2000	367.0	367.0	38.0

## MECHANICAL DATA

NT (R-PDIP-T\*\*)

24 PINS SHOWN

PLASTIC DUAL-IN-LINE PACKAGE



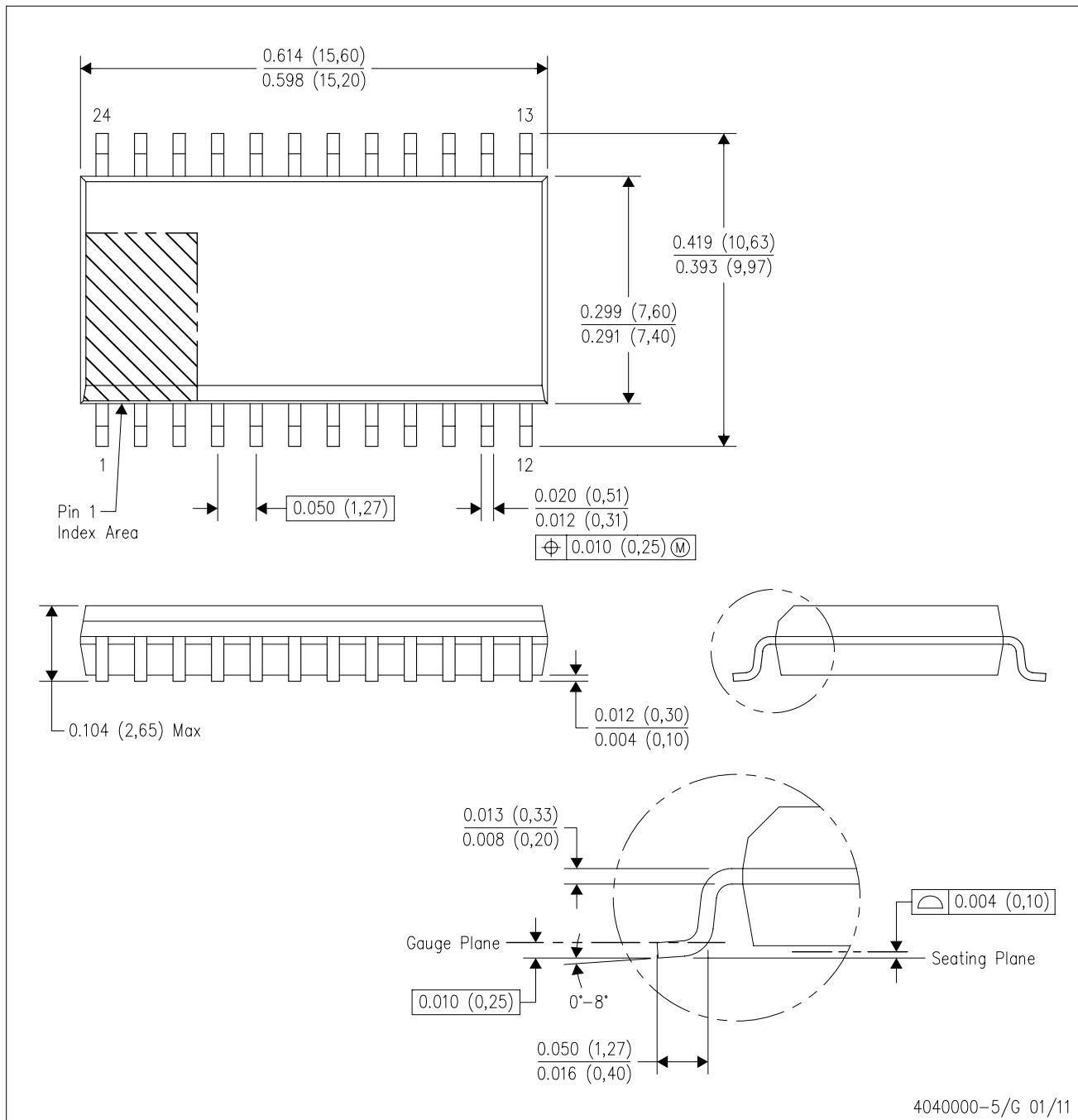
NOTES: A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.

B. This drawing is subject to change without notice.

$\triangle$  The 28 pin end lead shoulder width is a vendor option, either half or full width.

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

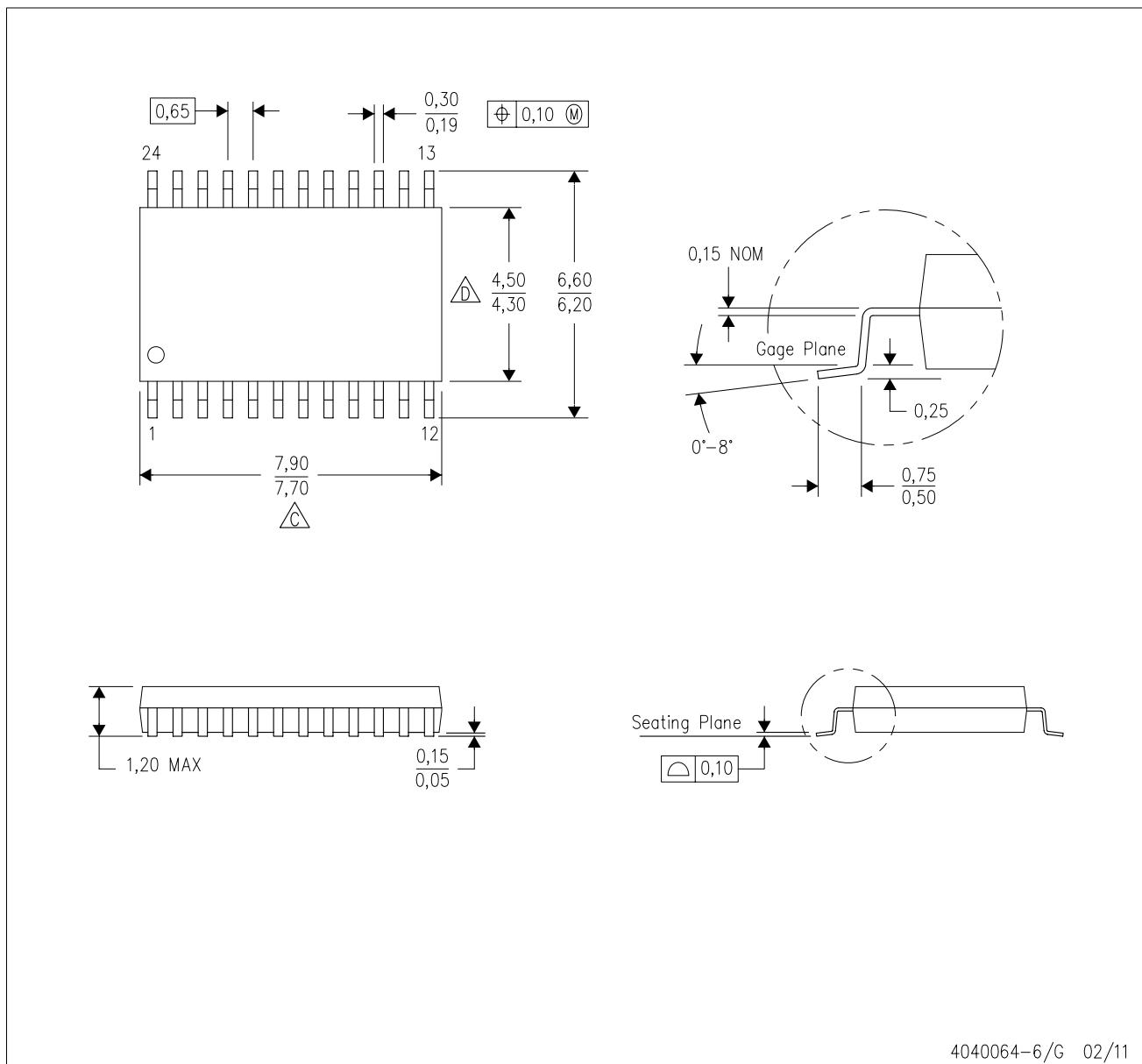


NOTES:

- 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.

PW (R-PDSO-G24)

PLASTIC SMALL OUTLINE



4040064-6/G 02/11

NOTES:

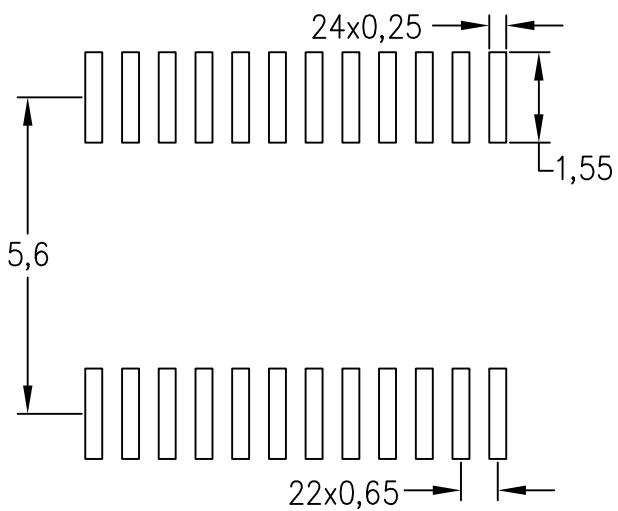
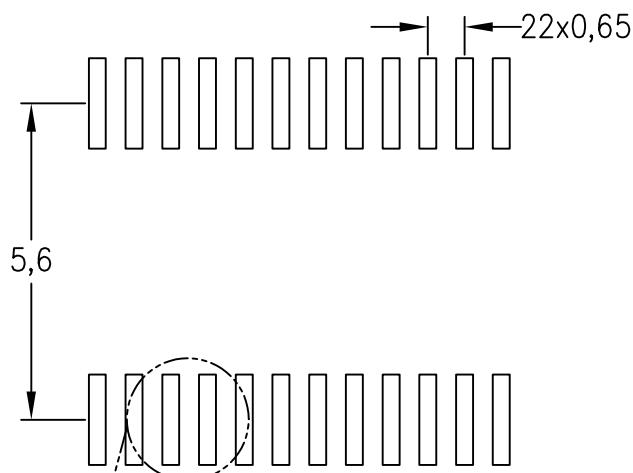
- A. All linear dimensions are in millimeters. Dimensioning and tolerancing per ASME Y14.5M-1994.
- B. This drawing is subject to change without notice.
-  C. Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0,15 each side.
-  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).

Example  
Non Soldermask Defined PadExample  
Solder Mask Opening  
(See Note F)

Pad Geometry

0,3  
1,6  
0,07  
All Around

4211284-4/F 12/12

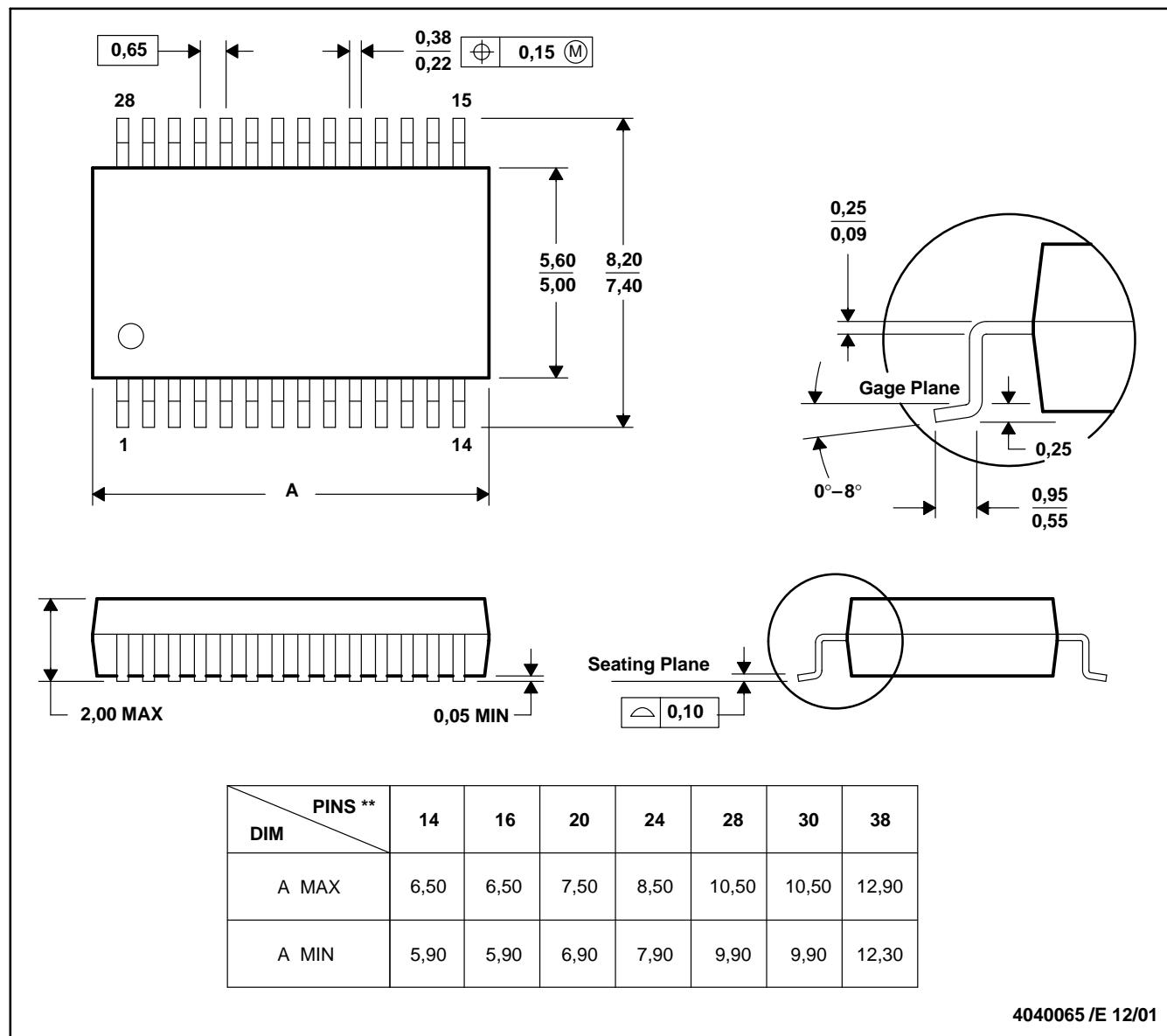
NOTES:

- 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

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