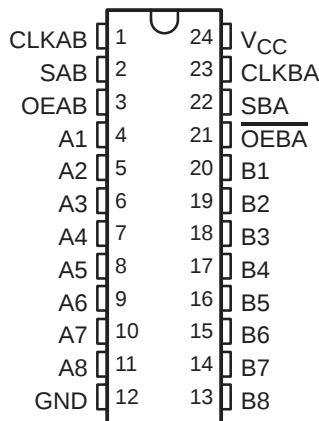


SN54LVTH652, SN74LVTH652 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

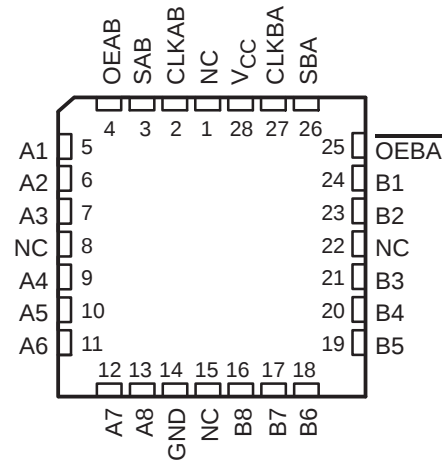
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- Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})
- Support Unregulated Battery Operation Down to 2.7 V
- Typical V_{OLP} (Output Ground Bounce) <0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$
- I_{off} and Power-Up 3-State Support Hot Insertion
- Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors
- Latch-Up Performance Exceeds 500 mA Per JESD 17
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)

SN54LVTH652 . . . JT OR W PACKAGE
SN74LVTH652 . . . DB, DGV, DW, NS, OR PW PACKAGE
(TOP VIEW)



SN54LVTH652 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description/ordering information

These bus transceivers and registers are designed specifically for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	SOIC – DW	Tube	SN74LVTH652DW	LVTH652
		Tape and reel	SN74LVTH652DWR	
	SOP – NS	Tape and reel	SN74LVTH652NSR	LVTH652
	SSOP – DB	Tape and reel	SN74LVTH652DBR	LXH652
	TSSOP – PW	Tube	SN74LVTH652PW	LXH652
		Tape and reel	SN74LVTH652PWR	
-55°C to 125°C	TVSOP – DGV	Tape and reel	SN74LVTH652DGVR	LXH652
	CDIP – JT	Tube	SNJ54LVTH652JT	SNJ54LVTH652JT
	CFP – W	Tube	SNJ54LVTH652W	SNJ54LVTH652W
	LCCC – FK	Tube	SNJ54LVTH652FK	SNJ54LVTH652FK

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



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**TEXAS
INSTRUMENTS**

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**3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS
WITH 3-STATE OUTPUTS**

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description/ordering information (continued)

The 'LVTH652 devices consist of bus-transceiver circuits, D-type flip-flops, and control circuitry arranged for multiplexed transmission of data directly from the data bus or from the internal storage registers.

Output-enable (OEAB and $\overline{\text{OEBA}}$) inputs are provided to control the transceiver functions. Select-control (SAB and SBA) inputs are provided to select whether real-time or stored data is transferred. The circuitry used for select control eliminates the typical decoding glitch that occurs in a multiplexer during the transition between real-time and stored data. A low input selects real-time data and a high input selects stored data. Figure 1 illustrates the four fundamental bus-management functions that can be performed with the 'LVTH652 devices.

Data on the A or B data bus, or both, can be stored in the internal D-type flip-flops by low-to-high transitions at the appropriate clock (CLKAB or CLKBA) inputs, regardless of the select- or enable-control pins. When SAB and SBA are in the real-time transfer mode, it is possible to store data without using the internal D-type flip-flops by simultaneously enabling OEAB and $\overline{\text{OEBA}}$. In this configuration, each output reinforces its input; therefore, when all other data sources to the two sets of bus lines are at high impedance, each set of bus lines remains at its last state.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

When V_{CC} is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 V, $\overline{\text{OE}}$ should be tied to V_{CC} through a pullup resistor and OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

This device is fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

FUNCTION TABLE

INPUTS						DATA I/O [†]		OPERATION OR FUNCTION
OEAB	$\overline{\text{OEBA}}$	CLKAB	CLKBA	SAB	SBA	A1–A8	B1–B8	
L	H	H or L	H or L	X	X	Input	Input	Isolation
L	H	↑	↑	X	X	Input	Input	Store A and B data
X	H	↑	H or L	X	X	Input	Unspecified [‡]	Store A, hold B
H	H	↑	↑	X [‡]	X	Input	Output	Store A in both registers
L	X	H or L	↑	X	X	Unspecified [‡]	Input	Hold A, store B
L	L	↑	↑	X	X [‡]	Output	Input	Store B in both registers
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
H	H	X	X	L	X	Input	Output	Real-time A data to B bus
H	H	H or L	X	H	X	Input	Output	Stored A data to B bus
H	L	H or L	H or L	H	H	Output	Output	Stored A data to B bus and stored B data to A bus

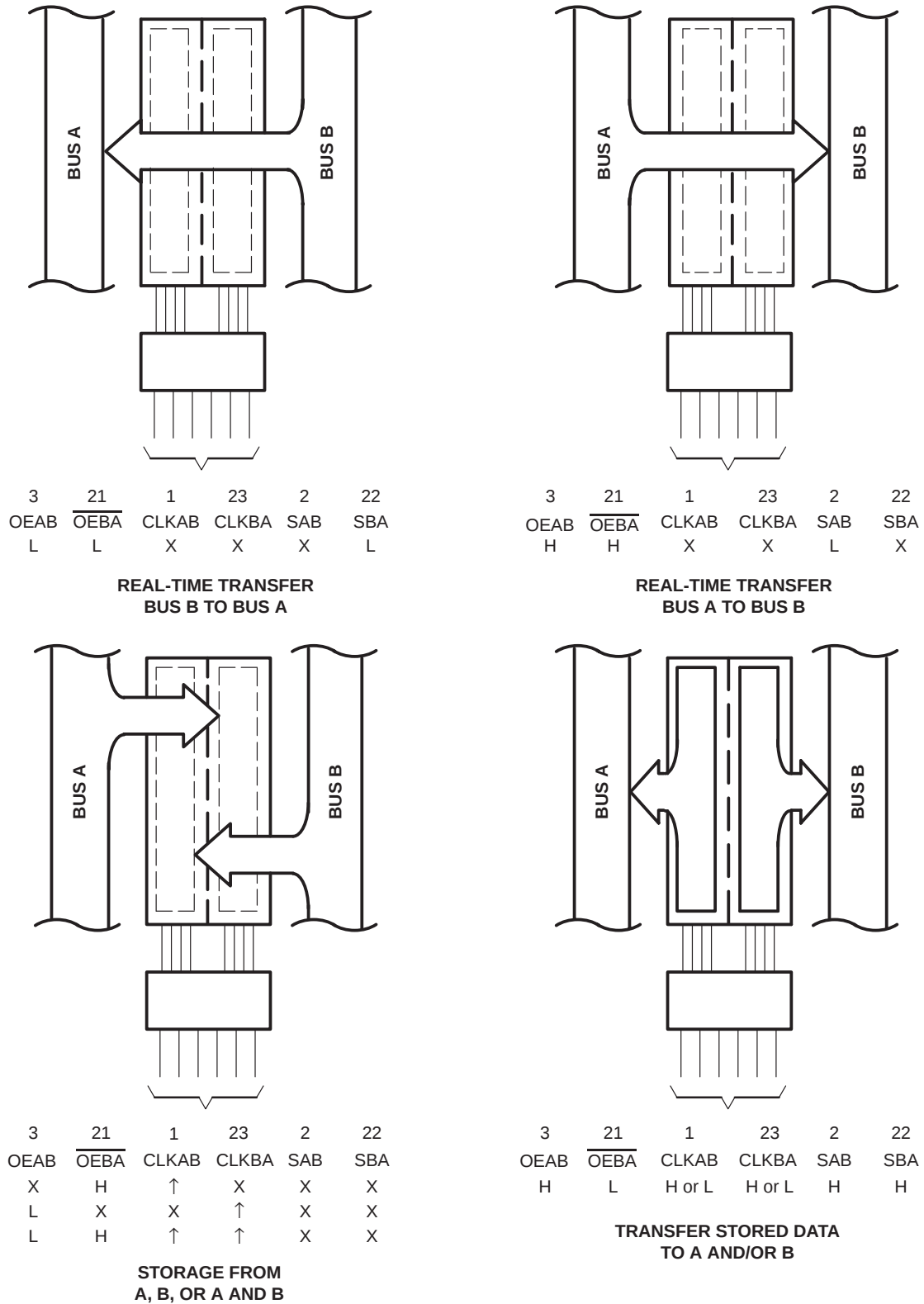
[†] The data-output functions can be enabled or disabled by a variety of level combinations at OEAB or $\overline{\text{OEBA}}$. Data-input functions always are enabled; i.e., data at the bus terminals is stored on every low-to-high transition of the clock inputs.

[‡] Select control = L; clocks can occur simultaneously.

Select control = H; clocks must be staggered to load both registers.

SN54LVTH652, SN74LVTH652 3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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Pin numbers shown are for the DB, DGV, DW, JT, NS, PW, and W packages.

Figure 1. Bus-Management Functions

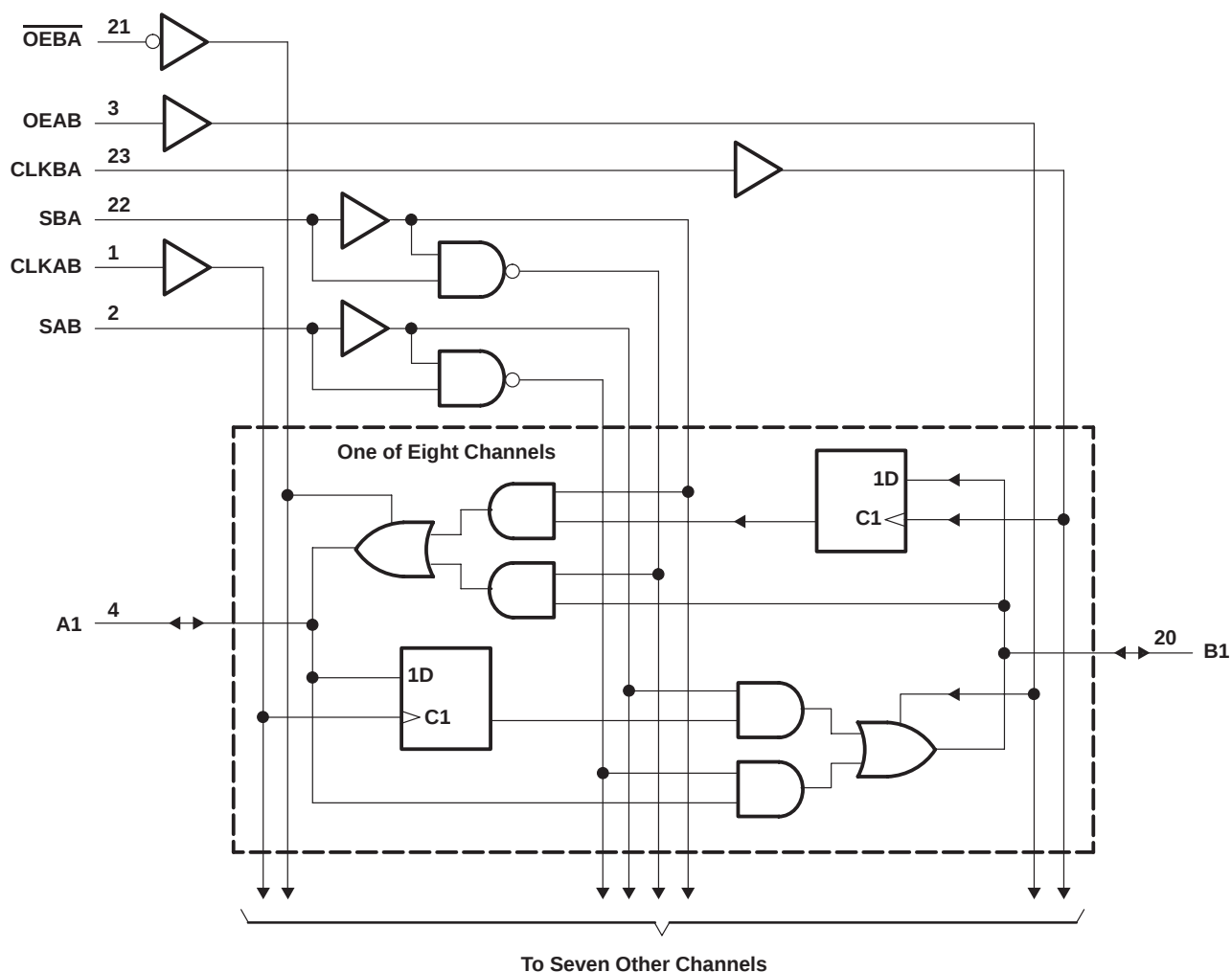
SN54LVTH652, SN74LVTH652

3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS

WITH 3-STATE OUTPUTS

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logic diagram (positive logic)



Pin numbers shown are for the DB, DGV, DW, JT, NS, PW, and W packages.

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SN54LVTH652, SN74LVTH652

3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS

WITH 3-STATE OUTPUTS

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

PARAMETER		TEST CONDITIONS		SN54LVTH652			SN74LVTH652			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V _{IK}		V _{CC} = 2.7 V, I _I = -18 mA		-1.2			-1.2			V
V _{OH}		V _{CC} = 2.7 V to 3.6 V, I _{OH} = -100 μA		V _{CC} -0.2			V _{CC} -0.2			V
		V _{CC} = 2.7 V, I _{OH} = -8 mA		2.4			2.4			
		V _{CC} = 3 V	I _{OH} = -24 mA	2						
			I _{OH} = -32 mA				2			
V _{OL}		V _{CC} = 2.7 V	I _{OL} = 100 μA	0.2			0.2			V
			I _{OL} = 24 mA	0.5			0.5			
			V _{CC} = 3 V	I _{OL} = 16 mA	0.4			0.4		
		I _{OL} = 32 mA		0.5			0.5			
		I _{OL} = 48 mA		0.55						
		I _{OL} = 64 mA					0.55			
I _I	Control inputs	V _{CC} = 3.6 V, V _I = V _{CC} or GND		±1			±1			μA
		V _{CC} = 0 or 3.6 V, V _I = 5.5 V		10			10			
	A or B ports‡	V _{CC} = 3.6 V	V _I = 5.5 V	20			20			
			V _I = V _{CC}	1			1			
			V _I = 0	-5			-5			
I _{off}		V _{CC} = 0, V _I or V _O = 0 to 4.5 V					±100			μA
I _{I(hold)}	A or B ports	V _{CC} = 3 V	V _I = 0.8 V	75			75			μA
			V _I = 2 V	-75			-75			
		V _{CC} = 3.6 V§	V _I = 0 to 3.6 V						±500	
I _{OZPU}		V _{CC} = 0 to 1.5 V, V _O = 0.5 to 3 V, OE/OE = don't care		±100*			±100			μA
I _{OZPD}		V _{CC} = 1.5 V to 0, V _O = 0.5 to 3 V, OE/OE = don't care		±100*			±100			μA
I _{CC}		V _{CC} = 3.6 V, I _O = 0, V _I = V _{CC} or GND	Outputs high	0.19			0.19			mA
			Outputs low	5			5			
			Outputs disabled	0.19			0.19			
ΔI _{CC} ¶		V _{CC} = 3 V to 3.6 V, One input at V _{CC} - 0.6 V, Other inputs at V _{CC} or GND		0.2			0.2			mA
C _i		V _I = 3 V or 0		4			4			pF
C _{io}		V _O = 3 V or 0		9			9			pF

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

† All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

‡ Unused terminals at $V_{CC}\text{ or GND}$

§ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

|| This is the increase in supply current for each input that is at the specified TTL voltage level, rather than $V_{CC}\text{ or GND}$.

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.



SN54LVTH652, SN74LVTH652

3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS WITH 3-STATE OUTPUTS

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timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2)

			SN54LVTH652				SN74LVTH652				UNIT
			$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		$V_{CC} = 2.7\text{ V}$		
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency		150		150		150		150		MHz
t _w	Pulse duration, CLK high or low		3.3		3.3		3.3		3.3		ns
t _{su}	Setup time, A or B before CLKAB↑ or CLKBA↑	Data high	1.3		1.6		1.2		1.5		ns
		Data low	1.9		2.6		1.6		2.2		
t _h	Hold time, A or B after CLKAB↑ or CLKBA↑		1.2		1.2		0.8		0.8		ns

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH652				SN74LVTH652				UNIT	
			V _{CC} = 3.3 V ± 0.3 V		V _{CC} = 2.7 V		V _{CC} = 3.3 V ± 0.3 V			V _{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
f _{max}			150		150		150			150		MHz
t _{PLH}	CLKBA or CLKAB	A or B	1.7	5	5.9		1.8	3.1	4.7	5.6		ns
t _{PHL}			1.7	5	5.9		1.8	3.1	4.7	5.6		
t _{PLH}	A or B	B or A	1.2	3.7	4.3		1.3	2.3	3.5	4.1		ns
t _{PHL}			1.2	3.7	4.3		1.3	2.4	3.5	4.1		
t _{PLH}	SBA or SAB‡	A or B	1.4	5.2	6.3		1.5	3.1	4.9	6		ns
t _{PHL}			1.4	5.2	6.3		1.5	3.4	4.9	6		
t _{PZH}	$\overline{\text{OEBA}}$	A	1	5.4	6.7		1.1	2.9	5.2	6.5		ns
t _{PZL}			1	5.4	6.7		1.1	3.1	5.2	6.5		
t _{PHZ}	$\overline{\text{OEBA}}$	A	2.2	5.9	6.5		2.3	3.5	5.5	6.1		ns
t _{PLZ}			2.2	5.9	6.3		2.3	3.7	5.5	5.9		
t _{PZH}	OEAB	B	1.2	4.9	5.9		1.3	3	4.7	5.7		ns
t _{PZL}			1.2	4.9	5.9		1.3	3.3	4.7	5.7		
t _{PHZ}	OEAB	B	1.4	5.8	7		1.5	3.6	5.6	6.7		ns
t _{PLZ}			1.4	5.9	6.6		1.5	3.7	5.6	6.3		

[†] All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

[‡] These parameters are measured with the internal output state of the storage register opposite that of the bus input.

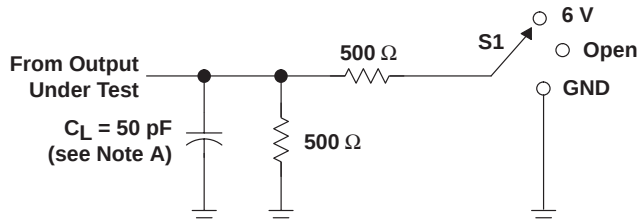
SN54LVTH652, SN74LVTH652

3.3-V ABT OCTAL BUS TRANSCEIVERS AND REGISTERS

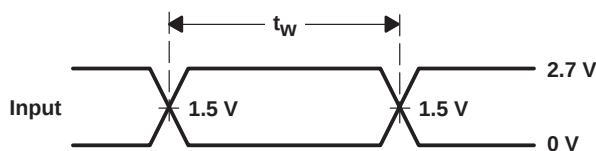
WITH 3-STATE OUTPUTS

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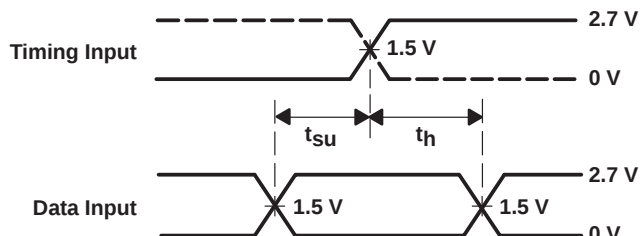
PARAMETER MEASUREMENT INFORMATION



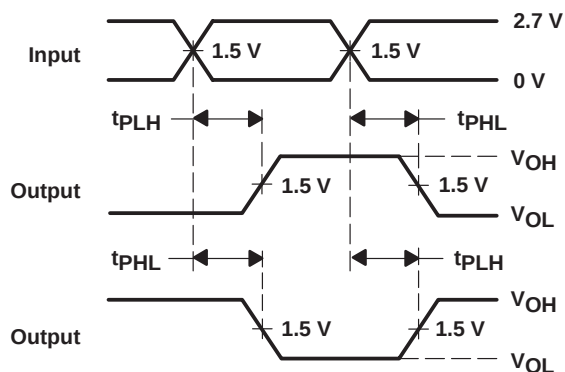
LOAD CIRCUIT



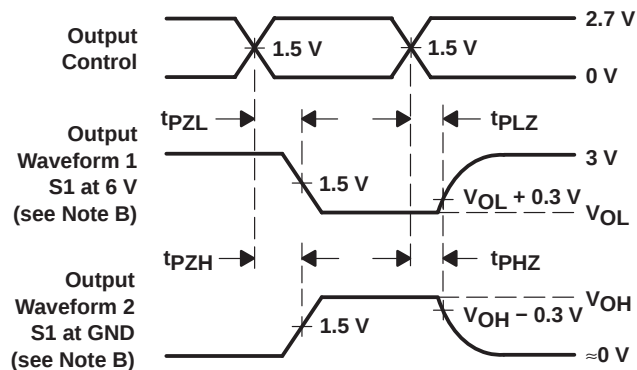
VOLTAGE WAVEFORMS
PULSE DURATION



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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
- D. The outputs are measured one at a time with one transition per measurement.
- E. All parameters and waveforms are not applicable to all devices.

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	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
SN74LVTH652DBLE	OBSOLETE	SSOP	DB	24		TBD	Call TI	Call TI	
SN74LVTH652DBR	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DBRE4	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DBRG4	ACTIVE	SSOP	DB	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DGVR	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DGVRE4	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DGVRG4	ACTIVE	TVSOP	DGV	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DW	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DWE4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DWG4	ACTIVE	SOIC	DW	24	25	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652DWRE4	ACTIVE	SOIC	DW	24		TBD	Call TI	Call TI	
SN74LVTH652DWRG4	ACTIVE	SOIC	DW	24		TBD	Call TI	Call TI	
SN74LVTH652PW	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652PWE4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652PWG4	ACTIVE	TSSOP	PW	24	60	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652PWLE	OBSOLETE	TSSOP	PW	24		TBD	Call TI	Call TI	
SN74LVTH652PWR	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	
SN74LVTH652PWRE4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/ Ball Finish	MSL Peak Temp ⁽³⁾	Samples (Requires Login)
SN74LVTH652PWRG4	ACTIVE	TSSOP	PW	24	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	

⁽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.

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OTHER QUALIFIED VERSIONS OF SN74LVTH652 :

- Enhanced Product: [SN74LVTH652-EP](#)

NOTE: Qualified Version Definitions:

- Enhanced Product - Supports Defense, Aerospace and Medical Applications

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
SN74LVTH652DBR	SSOP	DB	24	2000	330.0	16.4	8.2	8.8	2.5	12.0	16.0	Q1
SN74LVTH652DGVR	TVSOP	DGV	24	2000	330.0	12.4	6.9	5.6	1.6	8.0	12.0	Q1
SN74LVTH652PWR	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)
SN74LVTH652DBR	SSOP	DB	24	2000	346.0	346.0	33.0
SN74LVTH652DGVR	TVSOP	DGV	24	2000	346.0	346.0	29.0
SN74LVTH652PWR	TSSOP	PW	24	2000	346.0	346.0	33.0

DGV (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

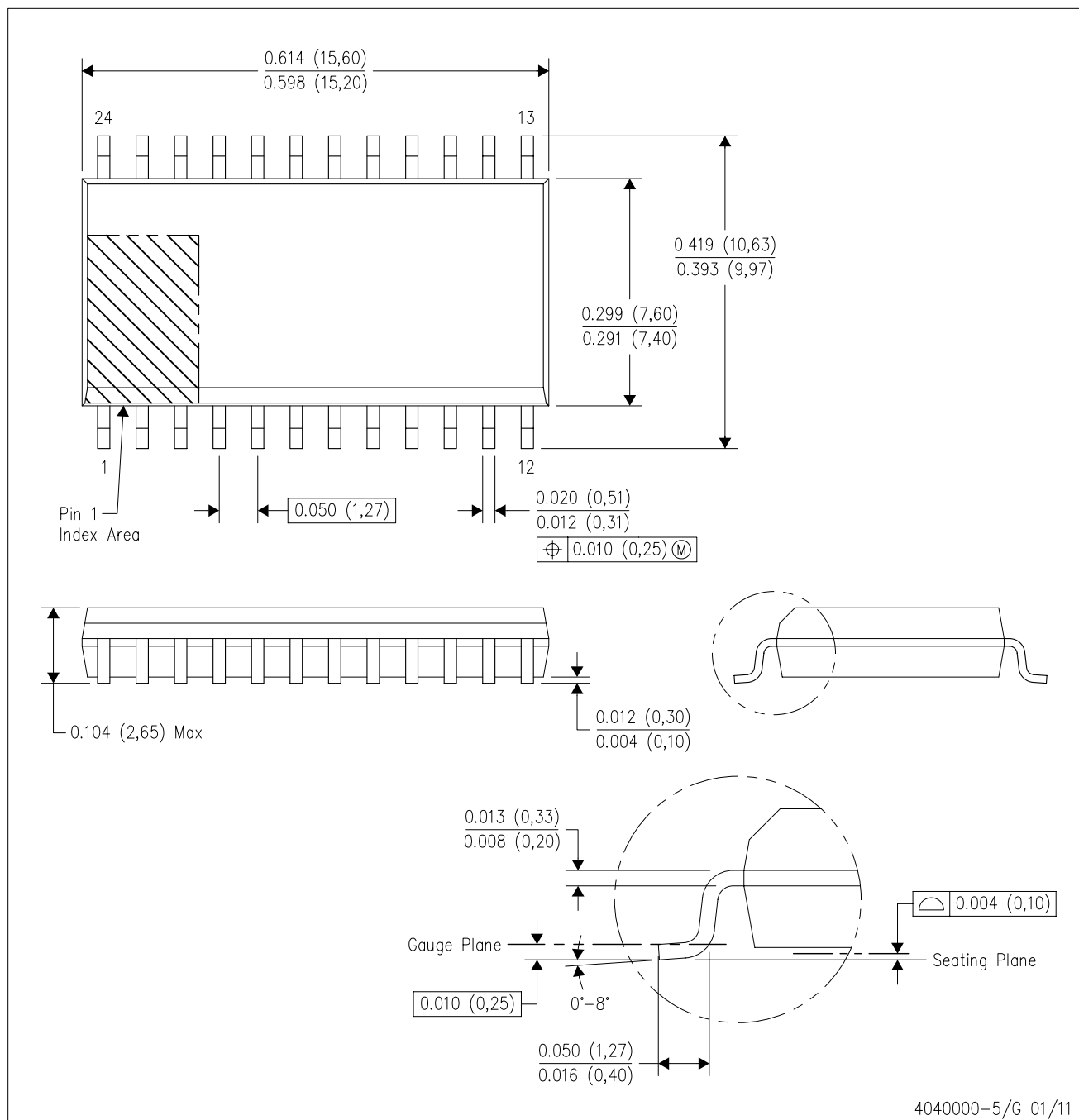
24 PINS SHOWN



- 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)

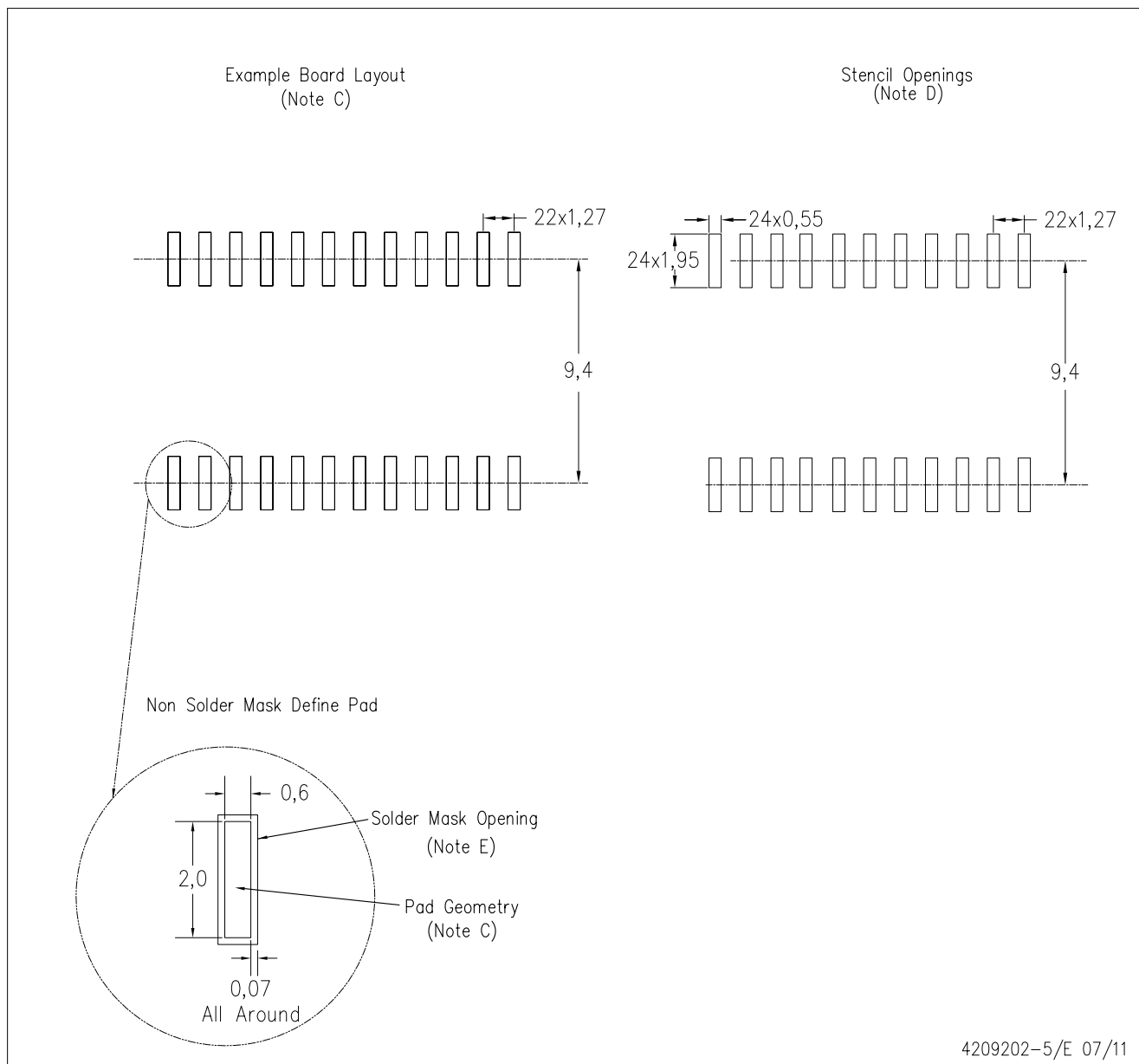
PLASTIC SMALL OUTLINE



- NOTES: A. All linear dimensions are in inches (millimeters). Dimensioning and tolerancing per ASME Y14.5M-1994.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-013 variation AD.

DW (R-PDSO-G24)

PLASTIC SMALL OUTLINE

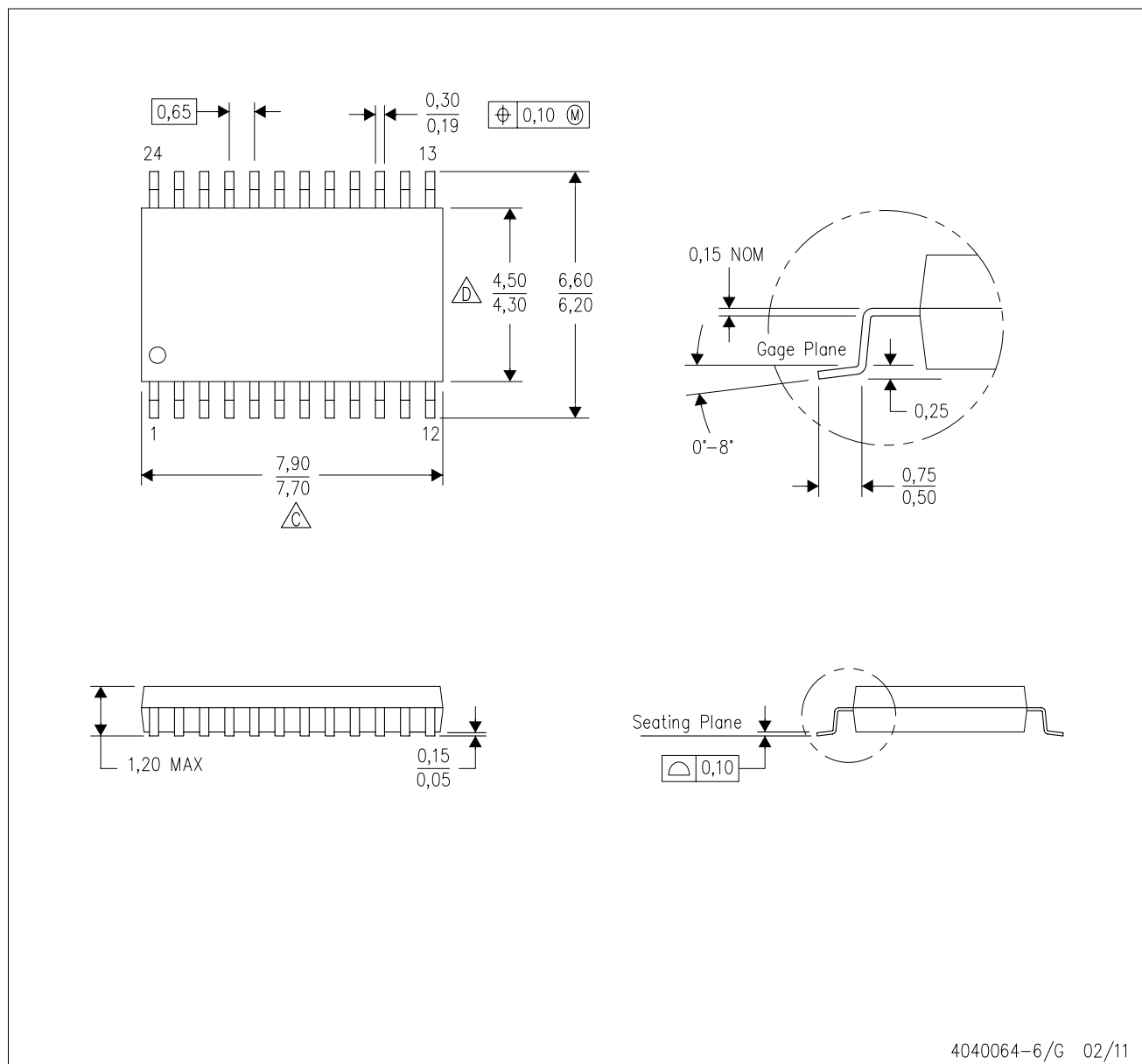


4209202-5/E 07/11

- 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)

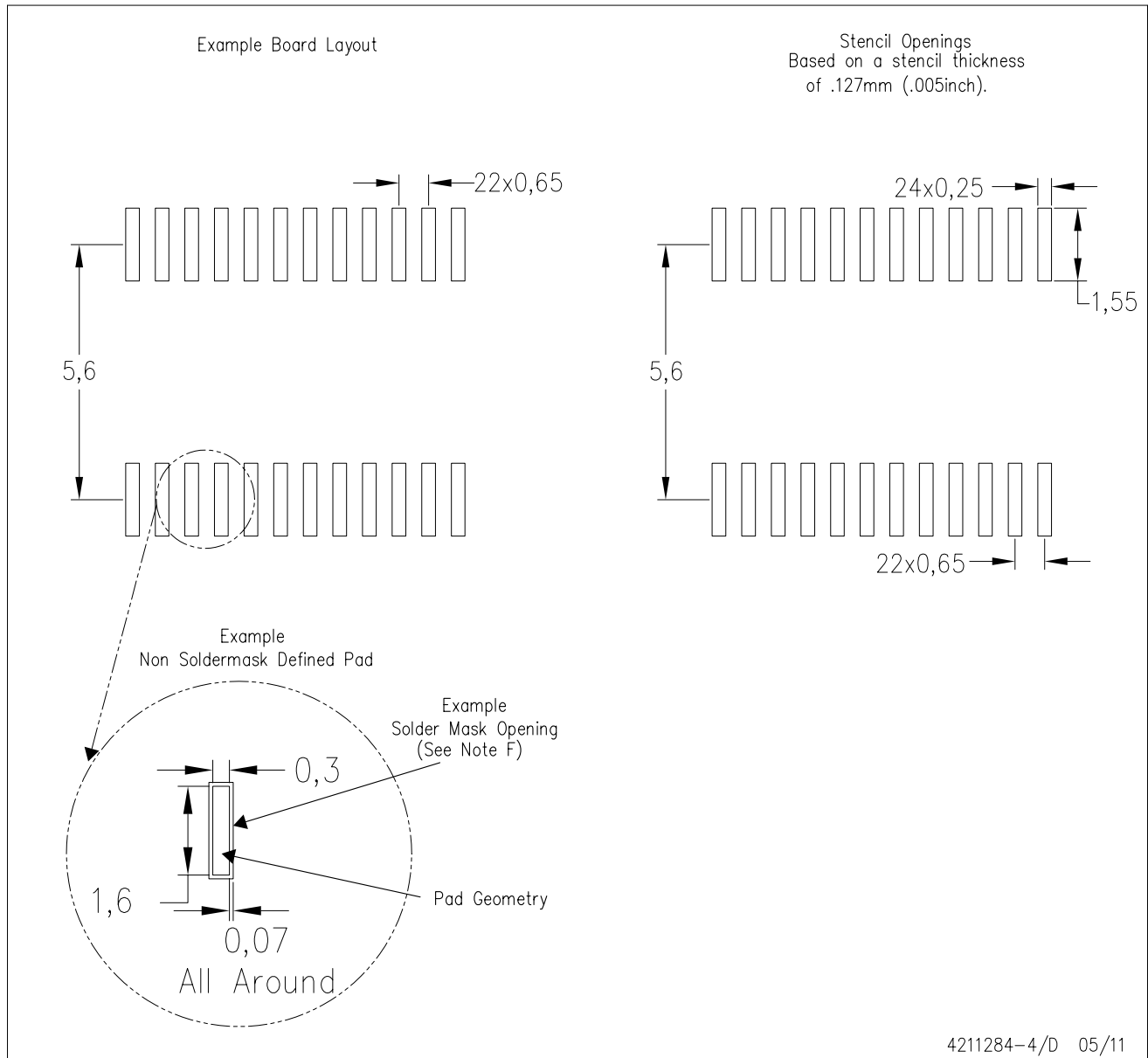
PLASTIC SMALL OUTLINE



- 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



- 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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