

# SN74AVC16269

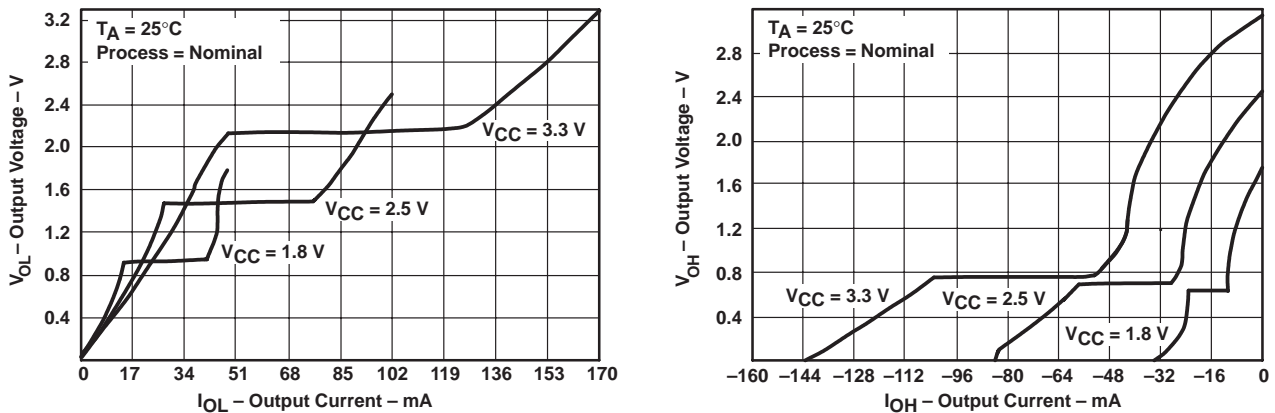
## 12-BIT TO 24-BIT REGISTERED BUS EXCHANGER WITH 3-STATE OUTPUTS

SCES152G – DECEMBER 1998 – REVISED MARCH 2000

- Member of the Texas Instruments *Widebus™* Family
- *EPIC™* (Enhanced-Performance Implanted CMOS) Submicron Process
- *DOC™* (Dynamic Output Control) Circuit Dynamically Changes Output Impedance, Resulting in Noise Reduction Without Speed Degradation
- Dynamic Drive Capability Is Equivalent to Standard Outputs With  $I_{OH}$  and  $I_{OL}$  of  $\pm 24$  mA at 2.5-V  $V_{CC}$
- Overvoltage-Tolerant Inputs/Outputs Allow Mixed-Voltage-Mode Data Communications
- $I_{off}$  Supports Partial-Power-Down Mode Operation
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- Package Options Include Plastic Thin Shrink Small-Outline (DGG) and Thin Very Small-Outline (DGV) Packages

### description

A Dynamic Output Control (DOC) circuit is implemented, which, during the transition, initially lowers the output impedance to effectively drive the load and, subsequently, raises the impedance to reduce noise. Figure 1 shows typical  $V_{OL}$  vs  $I_{OL}$  and  $V_{OH}$  vs  $I_{OH}$  curves to illustrate the output impedance and drive capability of the circuit. At the beginning of the signal transition, the DOC circuit provides a maximum dynamic drive that is equivalent to a high-drive standard-output device. For more information, refer to the TI application reports, *AVC Logic Family Technology and Applications*, literature number SCEA006, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number SCEA009.



**Figure 1. Output Voltage vs Output Current**

This 12-bit to 24-bit registered bus exchanger is operational at 1.2-V to 3.6-V  $V_{CC}$ , but is designed specifically for 1.65-V to 3.6-V  $V_{CC}$  operation.

The SN74AVC16269 is used in applications in which two separate ports must be multiplexed onto, or demultiplexed from, a single port. The device is particularly suitable as an interface between synchronous DRAMs and high-speed microprocessors.



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### description (continued)

Data is stored in the internal B-port registers on the low-to-high transition of the clock (CLK) input when the appropriate clock-enable ( $\overline{\text{CLKENA}}$ ) inputs are low. Proper control of these inputs allows two sequential 12-bit words to be presented as a 24-bit word on the B port. For data transfer in the B-to-A direction, a single storage register is provided. The select ( $\overline{\text{SEL}}$ ) line selects 1B or 2B data for the A outputs. The register on the A output permits the fastest possible data transfer, thus extending the period during which the data is valid on the bus.

The control terminals are registered so that all transactions are synchronous with CLK. Data flow is controlled by the active-low output enables ( $\overline{\text{OEA}}$ ,  $\overline{\text{OEB1}}$ ,  $\overline{\text{OEB2}}$ ).

To ensure the high-impedance state during power up or power down, a clock pulse should be applied as soon as possible, and  $\overline{\text{OE}}$  should be tied to  $V_{\text{CC}}$  through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver. Due to  $\overline{\text{OE}}$  being routed through a register, the active state of the outputs cannot be determined prior to the arrival of the first clock pulse.

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

The SN74AVC16269 is characterized for operation from  $-40^{\circ}\text{C}$  to  $85^{\circ}\text{C}$ .



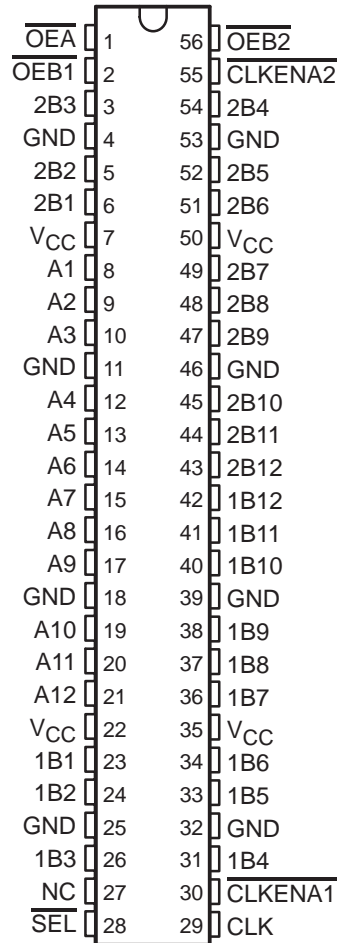
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**terminal assignments**

**DGG OR DGV PACKAGE**  
**(TOP VIEW)**



NC – No internal connection



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**Function Tables**

**OUTPUT ENABLE**

INPUTS			OUTPUTS	
CLK	$\overline{OEA}$	$\overline{OEB}$	A	1B, 2B
↑	H	H	Z	Z
↑	H	L	Z	Active
↑	L	H	Active	Z
↑	L	L	Active	Active

**A-TO-B STORAGE ( $\overline{OEB} = L$ )**

INPUTS				OUTPUTS	
$\overline{CLKENA1}$	$\overline{CLKENA2}$	CLK	A	1B	2B
H	H	X	X	1B <sub>0</sub> <sup>†</sup>	2B <sub>0</sub> <sup>†</sup>
L	X	↑	L	L	X
L	X	↑	H	H	X
X	L	↑	L	X	L
X	L	↑	H	X	H

† Output level before the indicated steady-state input conditions were established

**B-TO-A STORAGE ( $\overline{OEA} = L$ )**

INPUTS				OUTPUT
CLK	$\overline{SEL}$	1B	2B	A
X	H	X	X	A <sub>0</sub> <sup>†</sup>
X	L	X	X	A <sub>0</sub> <sup>†</sup>
↑	H	L	X	L
↑	H	H	X	H
↑	L	X	L	L
↑	L	X	H	H

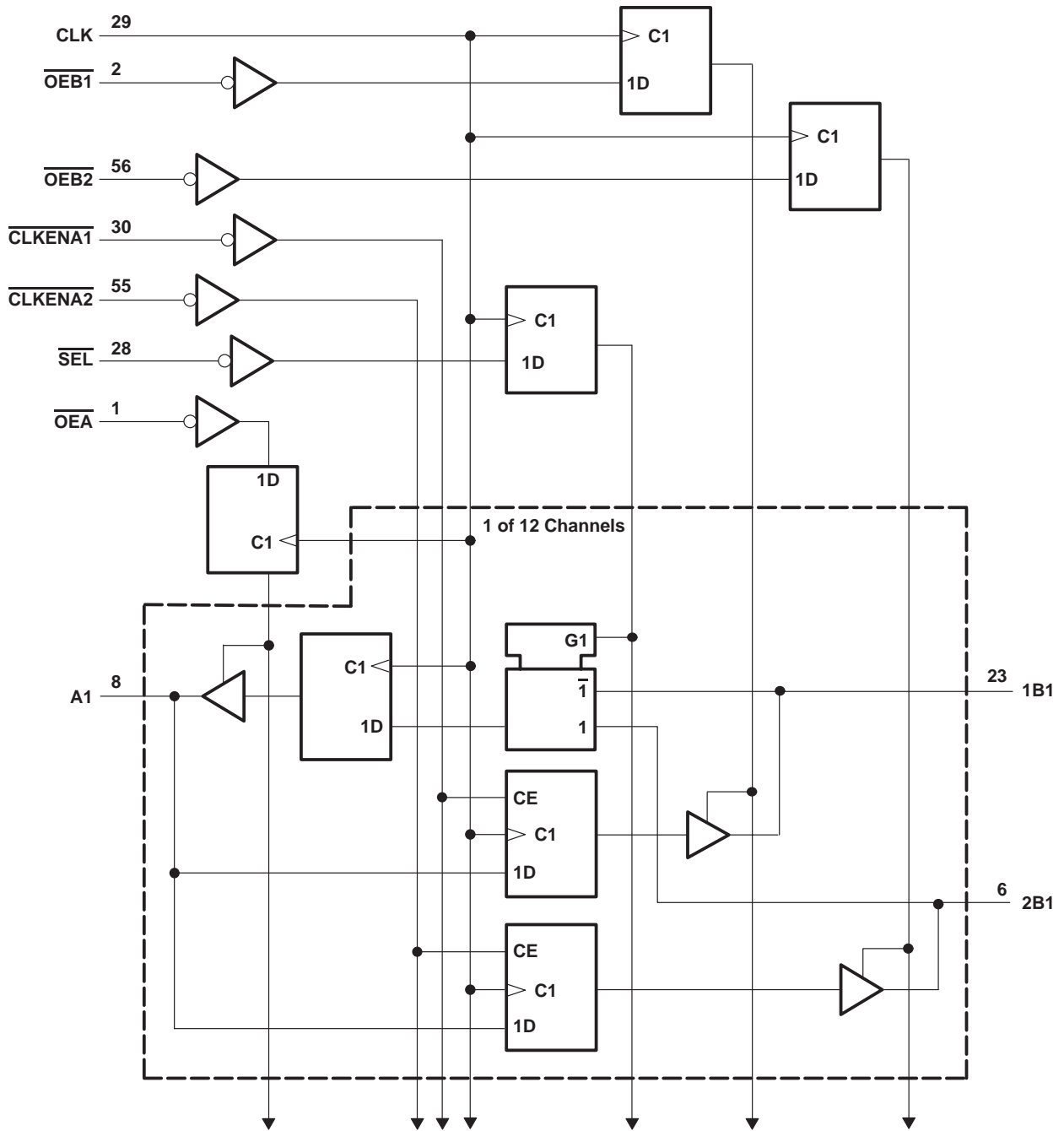
† Output level before the indicated steady-state input conditions were established



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logic diagram (positive logic)



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

Supply voltage range, $V_{CC}$	.....	-0.5 V to 4.6 V
Input voltage range, $V_I$ (see Note 1)	.....	-0.5 V to 4.6 V
Voltage range applied to any input/output when the output is in the high-impedance or power-off state, $V_O$ (see Note 1)	.....	-0.5 V to 4.6 V
Voltage range applied to any input/output when the output is in the high or low state, $V_O$ (see Notes 1 and 2)	.....	-0.5 V to $V_{CC} + 0.5$ V
Input clamp current, $I_{IK}$ ( $V_I < 0$ )	.....	-50 mA
Output clamp current, $I_{OK}$ ( $V_O < 0$ )	.....	-50 mA
Continuous output current, $I_O$	.....	$\pm 50$ mA
Continuous current through each $V_{CC}$ or GND	.....	$\pm 100$ mA
Package thermal impedance, $\theta_{JA}$ (see Note 3): DGG package	.....	64°C/W
	DGV package	48°C/W
Storage temperature range, $T_{stg}$	.....	-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 current ratings are observed.
  2. The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current rating is observed.
  3. The package thermal impedance is calculated in accordance with JESD 51.

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## 12-BIT TO 24-BIT REGISTERED BUS EXCHANGER WITH 3-STATE OUTPUTS

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### recommended operating conditions (see Note 4)

		MIN	MAX	UNIT	
V <sub>CC</sub>	Supply voltage	Operating	1.4	3.6	V
		Data retention only	1.2		
V <sub>IH</sub>	High-level input voltage	V <sub>CC</sub> = 1.2 V	V <sub>CC</sub>		V
		V <sub>CC</sub> = 1.4 V to 1.6 V	0.65 × V <sub>CC</sub>		
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.65 × V <sub>CC</sub>		
		V <sub>CC</sub> = 2.3 V to 2.7 V	1.7		
		V <sub>CC</sub> = 3 V to 3.6 V	2		
V <sub>IL</sub>	Low-level input voltage	V <sub>CC</sub> = 1.2 V	GND		V
		V <sub>CC</sub> = 1.4 V to 1.6 V	0.35 × V <sub>CC</sub>		
		V <sub>CC</sub> = 1.65 V to 1.95 V	0.35 × V <sub>CC</sub>		
		V <sub>CC</sub> = 2.3 V to 2.7 V	0.7		
		V <sub>CC</sub> = 3 V to 3.6 V	0.8		
V <sub>I</sub>	Input voltage	0	3.6	V	
V <sub>O</sub>	Output voltage	Active state	0	V <sub>CC</sub>	V
		3-state	0	3.6	
I <sub>OHS</sub>	Static high-level output current <sup>†</sup>	V <sub>CC</sub> = 1.4 V to 1.6 V	-2		mA
		V <sub>CC</sub> = 1.65 V to 1.95 V	-4		
		V <sub>CC</sub> = 2.3 V to 2.7 V	-8		
		V <sub>CC</sub> = 3 V to 3.6 V	-12		
I <sub>OLS</sub>	Static low-level output current <sup>†</sup>	V <sub>CC</sub> = 1.4 V to 1.6 V	2		mA
		V <sub>CC</sub> = 1.65 V to 1.95 V	4		
		V <sub>CC</sub> = 2.3 V to 2.7 V	8		
		V <sub>CC</sub> = 3 V to 3.6 V	12		
Δt/Δv	Input transition rise or fall rate	V <sub>CC</sub> = 1.4 V to 3.6 V		5	ns/V
T <sub>A</sub>	Operating free-air temperature	-40	85	°C	

<sup>†</sup> Dynamic drive capability is equivalent to standard outputs with I<sub>OH</sub> and I<sub>OL</sub> of ±24 mA at 2.5-V V<sub>CC</sub>. See Figure 1 for V<sub>OL</sub> vs I<sub>OL</sub> and V<sub>OH</sub> vs I<sub>OH</sub> characteristics. Refer to the TI application reports, *AVC Logic Family Technology and Applications*, literature number **SCEA006**, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number **SCEA009**.

NOTE 4: 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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## 12-BIT TO 24-BIT REGISTERED BUS EXCHANGER

### WITH 3-STATE OUTPUTS

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

PARAMETER		TEST CONDITIONS	V <sub>CC</sub>	MIN	TYP†	MAX	UNIT
V <sub>OH</sub>		I <sub>OHS</sub> = -100 μA	1.4 V to 3.6 V	V <sub>CC</sub> -0.2			V
		I <sub>OHS</sub> = -2 mA, V <sub>IH</sub> = 0.91 V	1.4 V	1.05			
		I <sub>OHS</sub> = -4 mA, V <sub>IH</sub> = 1.07 V	1.65 V	1.2			
		I <sub>OHS</sub> = -8 mA, V <sub>IH</sub> = 1.7 V	2.3 V	1.75			
		I <sub>OHS</sub> = -12 mA, V <sub>IH</sub> = 2 V	3 V	2.3			
V <sub>OL</sub>		I <sub>OLS</sub> = 100 μA	1.4 V to 3.6 V			0.2	V
		I <sub>OLS</sub> = 2 mA, V <sub>IL</sub> = 0.49 V	1.4 V			0.4	
		I <sub>OLS</sub> = 4 mA, V <sub>IL</sub> = 0.57 V	1.65 V			0.45	
		I <sub>OLS</sub> = 8 mA, V <sub>IL</sub> = 0.7 V	2.3 V			0.55	
		I <sub>OLS</sub> = 12 mA, V <sub>IL</sub> = 0.8 V	3 V			0.7	
I <sub>I</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	3.6 V			±2.5	μA
I <sub>off</sub>		V <sub>I</sub> or V <sub>O</sub> = 3.6 V	0			±10	μA
I <sub>OZ</sub> ‡		V <sub>O</sub> = V <sub>CC</sub> or GND	3.6 V			±12.5	μA
I <sub>CC</sub>		V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0	3.6 V			40	μA
C <sub>i</sub>	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND	2.5 V	3.5			pF
			3.3 V	3.5			
C <sub>io</sub>	A or B ports	V <sub>O</sub> = V <sub>CC</sub> or GND	2.5 V	8.5			pF
			3.3 V	8.5			

† Typical values are measured at T<sub>A</sub> = 25°C.

‡ For I/O ports, the parameter I<sub>OZ</sub> includes the input leakage current.

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figures 2 through 5)

		V <sub>CC</sub> = 1.2V	V <sub>CC</sub> = 1.5 V ± 0.1 V		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		UNIT
		TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency				75		125		175		MHz
t <sub>w</sub>	Pulse duration, CLK high or low				5.8		5		3.5		ns
t <sub>su</sub>	Setup time	A data before CLK↑	4.7	3.9	2.6	2.1	1.9			ns	
		B data before CLK↑	6.2	4.3	3	2.1	1.9				
		SEL before CLK↑	4.5	3.4	2.2	1.6	1.3				
		CLKENA1 or CLKENA2 before CLK↑	0.9	0.9	1	1.1	1.1				
		OE before CLK↑	5.4	5.3	2	1.6	1.1				
t <sub>h</sub>	Hold time	A data after CLK↑	1.9	2	1.2	1.1	1			ns	
		B data after CLK↑	0.4	1.3	0.5	0.6	0.7				
		SEL after CLK↑	1	1	0.4	0.3	0.4				
		CLKENA1 or CLKENA2 after CLK↑	2.6	2.2	1.4	1.1	1				
		OE after CLK↑	0.4	0.4	0.4	0.5	0.3				





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**12-BIT TO 24-BIT REGISTERED BUS EXCHANGER**  
**WITH 3-STATE OUTPUTS**

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switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 2 through 5)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 1.2 V	V <sub>CC</sub> = 1.5 V ± 0.1 V		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		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>max</sub>						75		125		175		MHz
t <sub>pd</sub>	CLK	B	13.5	3	9.5	2.5	6.7	1.6	4	1.1	3	ns
		A	11.6	2.6	7.4	2.2	5.8	1.5	3.5	1	2.7	
t <sub>en</sub>	CLK	B	16	3.5	12	2.4	8.5	2.1	4.8	1.5	3.8	ns
		A	14.2	3.2	9.3	2	6.7	2	4.4	1.4	3.4	
t <sub>dis</sub>	CLK	B	16	4.9	12.3	3.3	8.5	1.9	4.8	1.3	3.7	ns
		A	11.9	3	8.7	2.1	6.7	1.8	3.6	1.7	3.4	

switching characteristics, T<sub>A</sub> = 0°C to 85°C, C<sub>L</sub> = 0 pF†

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 3.3 V ± 0.15 V		UNIT
			MIN	MAX	
t <sub>pd</sub>	CLK	B	1.4	2.4	ns
		A	1.2	2.1	

† Texas Instruments SPICE simulation data

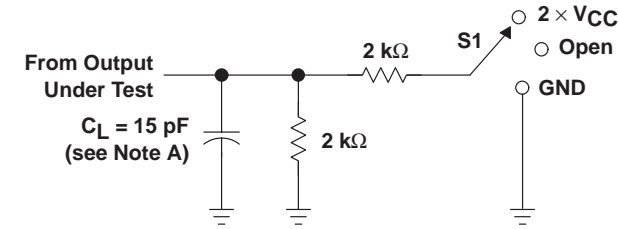
operating characteristics, T<sub>A</sub> = 25°C

PARAMETER		TEST CONDITIONS	V <sub>CC</sub> = 1.8 V	V <sub>CC</sub> = 2.5 V	V <sub>CC</sub> = 3.3 V	UNIT
			TYP	TYP	TYP	
C <sub>pd</sub>	Power dissipation capacitance	C <sub>L</sub> = 0, f = 10 MHz	133	145	168	pF
	Outputs enabled		102	109	124	
	Outputs disabled					

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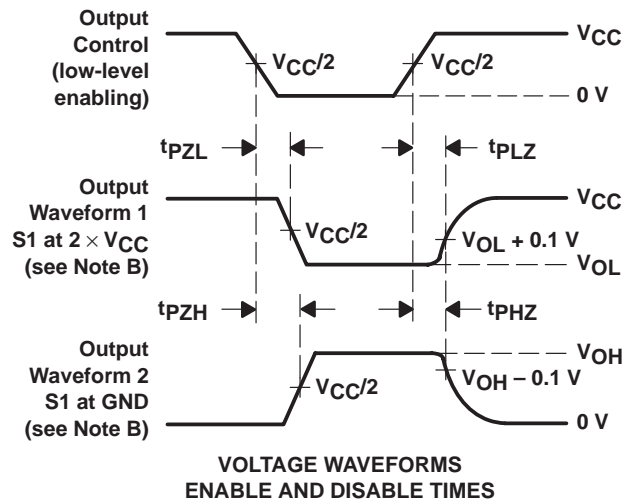
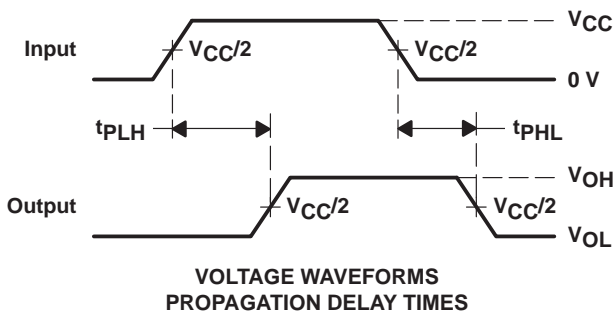
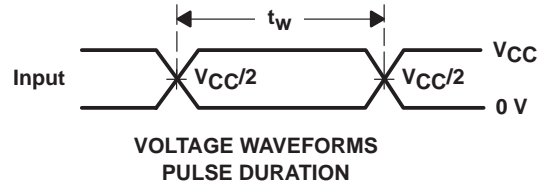
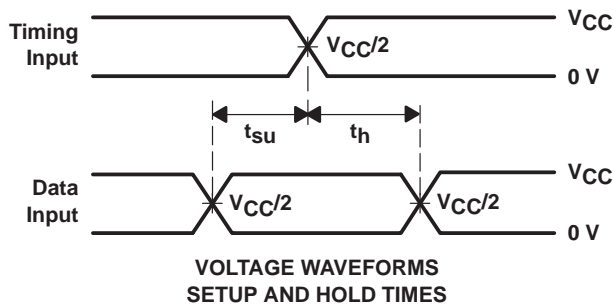
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**PARAMETER MEASUREMENT INFORMATION**  
 $V_{CC} = 1.2\text{ V AND }1.5\text{ V} \pm 0.1\text{ V}$



**LOAD CIRCUIT**

TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	$2 \times V_{CC}$
$t_{PHZ}/t_{PHZ}$	GND

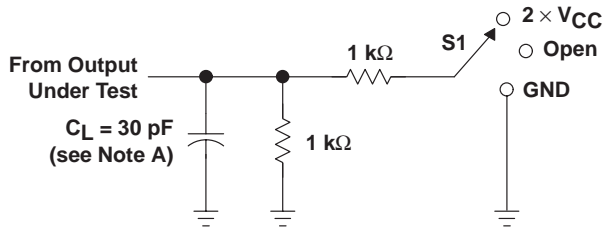


- NOTES:
- A.  $C_L$  includes probe and jig capacitance.
  - B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
  - C. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2\text{ ns}$ ,  $t_f \leq 2\text{ ns}$ .
  - 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  $t_{pd}$ .

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

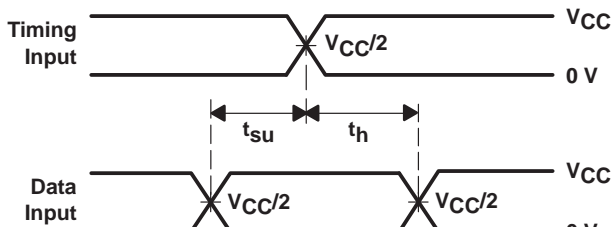
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$

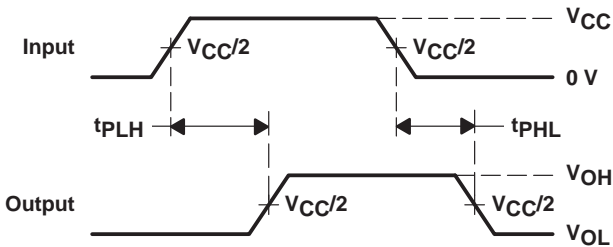


LOAD CIRCUIT

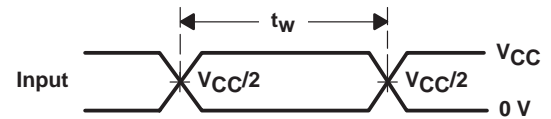
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	2 $\times$ $V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



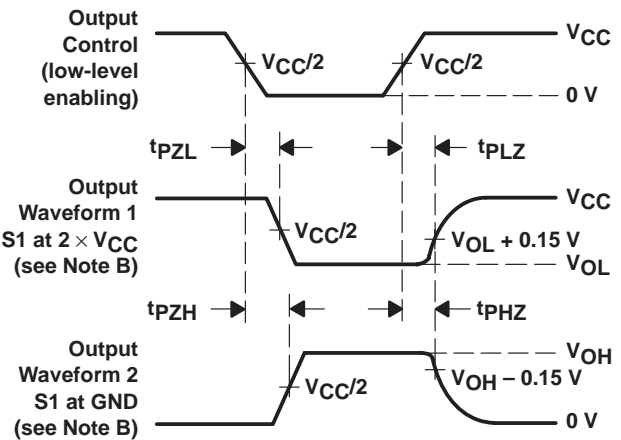
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

- 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 MHz,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2\text{ ns}$ ,  $t_f \leq 2\text{ ns}$ .  
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  $t_{pd}$ .

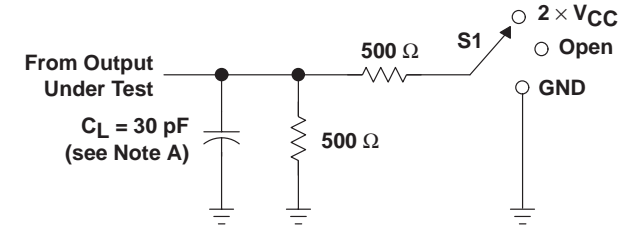
Figure 3. Load Circuit and Voltage Waveforms

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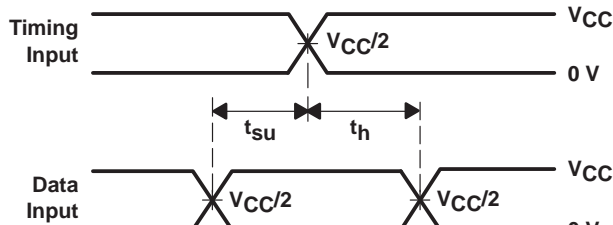
**PARAMETER MEASUREMENT INFORMATION**

$V_{CC} = 2.5 V \pm 0.2 V$

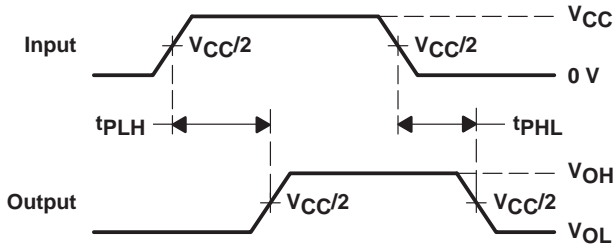


**LOAD CIRCUIT**

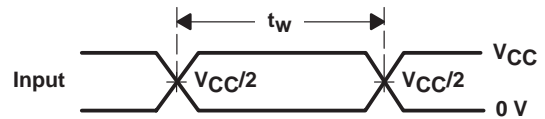
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	2 $\times V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



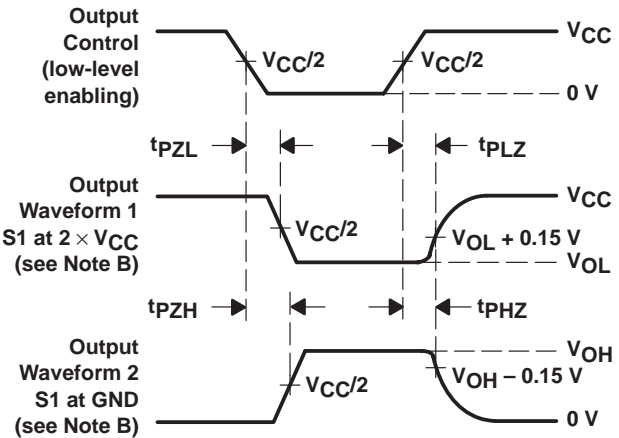
**VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS  
PULSE DURATION**



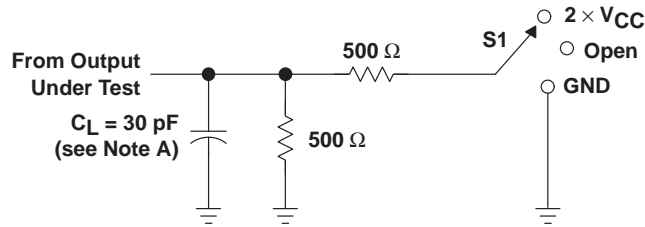
**VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES**

- 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:  $PRR \leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2 \text{ ns}$ ,  $t_f \leq 2 \text{ ns}$ .
  - 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  $t_{pd}$ .

**Figure 4. Load Circuit and Voltage Waveforms**

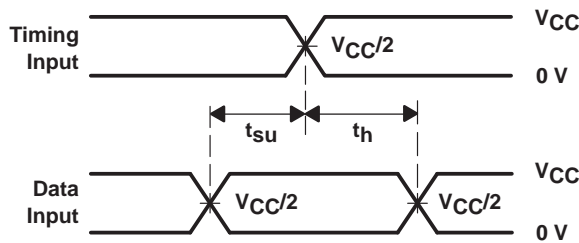
**PARAMETER MEASUREMENT INFORMATION**

$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$

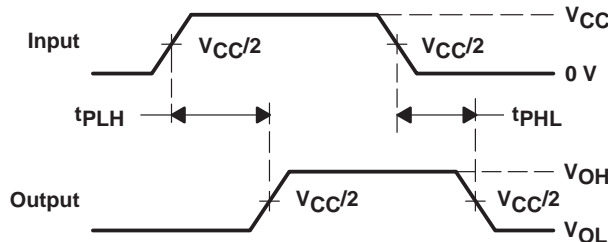


**LOAD CIRCUIT**

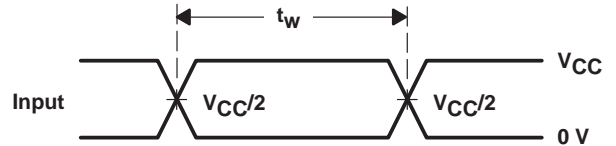
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	2 $\times$ $V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



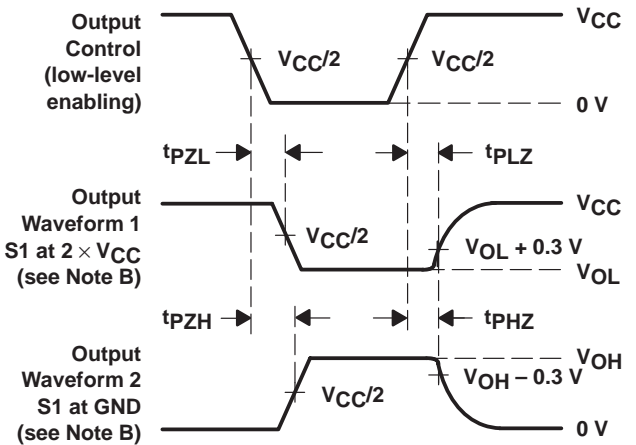
**VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES**



**VOLTAGE WAVEFORMS  
PULSE DURATION**



**VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES**

- NOTES:
- $C_L$  includes probe and jig capacitance.
  - 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.
  - All input pulses are supplied by generators having the following characteristics: PRR  $\leq 10\text{ MHz}$ ,  $Z_O = 50\ \Omega$ ,  $t_r \leq 2\text{ ns}$ ,  $t_f \leq 2\text{ ns}$ .
  - The outputs are measured one at a time with one transition per measurement.
  - $t_{PLZ}$  and  $t_{PHZ}$  are the same as  $t_{dis}$ .
  - $t_{PZL}$  and  $t_{PZH}$  are the same as  $t_{en}$ .
  - $t_{PLH}$  and  $t_{PHL}$  are the same as  $t_{pd}$ .

**Figure 5. Load Circuit and Voltage Waveforms**

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