

SN74AVC32373

1.2-V/3.3-V 32-BIT TRANSPARENT D-TYPE LATCHES WITH 3-STATE OUTPUTS

SCES327 – APRIL 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 ± 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
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- Packaged in Plastic Fine-Pitch Ball Grid Array Package

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.

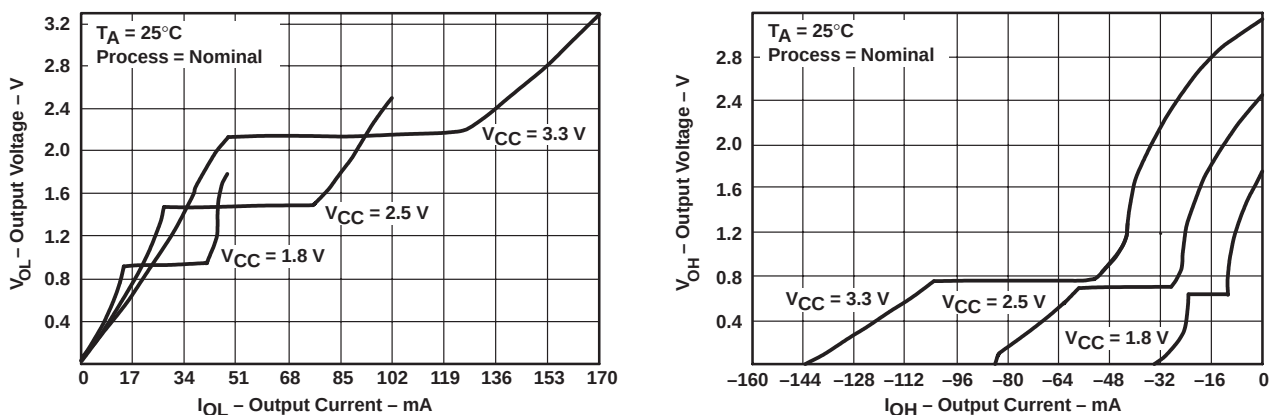


Figure 1. Output Voltage vs Output Current

This 32-bit transparent D-type latch with is operational from 1.2-V or 3.6-V V_{CC} , but is designed specifically for 1.65-V to 3.6-V V_{CC} operation.

The SN74AVC32373 can be used as four 8-bit latches, two 16-bit latches, or one 32-bit latch. When the latch-enable (LE) input is high, the Q outputs follow the data (D) inputs. When LE is taken low, the Q outputs are latched at the levels set up at the D inputs.

A buffered output-enable ($\overline{OE}$) input can be used to place the eight outputs in either a normal logic state (high or low logic levels) or the high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capability to drive bus lines without interface or pullup components.



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SN74AVC32373
1.2-V/3.3-V 32-BIT TRANSPARENT D-TYPE LATCHES
WITH 3-STATE OUTPUTS

SCES327 – APRIL 2000

description (continued)

$\overline{OE}$ does not affect internal operations of the latch. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

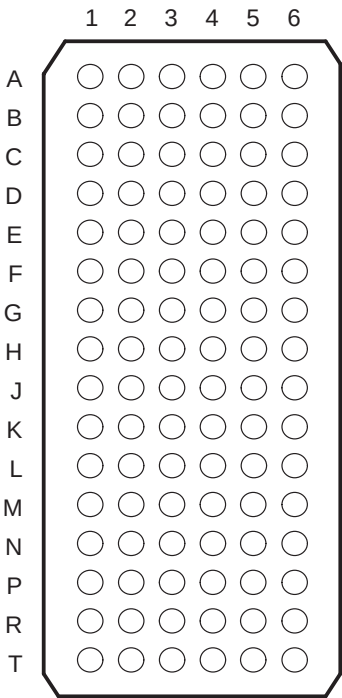
This device is fully specified for partial-power-down applications using I_{off} . The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down.

The SN74AVC32373 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE
(each 8-bit latch)

INPUTS			OUTPUT Q
$\overline{OE}$	LE	D	
L	H	H	H
L	H	L	L
L	L	X	Q_0
H	X	X	Z

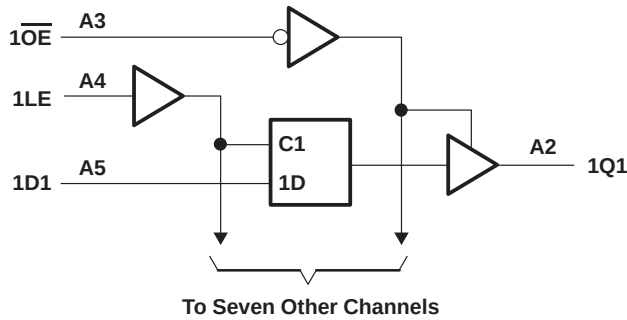
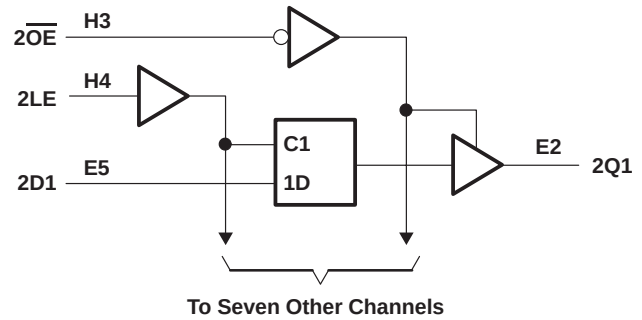
GKE PACKAGE
(TOP VIEW)



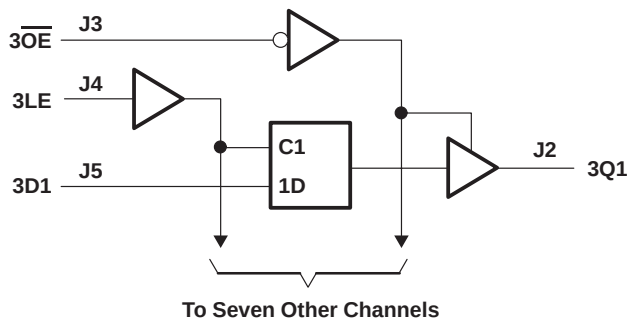
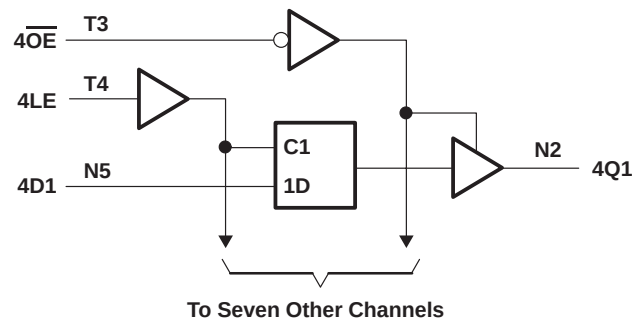
terminal assignments

	1	2	3	4	5	6
A	1Q2	1Q1	$1\overline{OE}$	1LE	1D1	1D2
B	1Q4	1Q3	GND	GND	1D3	1D4
C	1Q6	1Q5	$1V_{CC}$	$1V_{CC}$	1D5	1D6
D	1Q8	1Q7	GND	GND	1D7	1D8
E	2Q2	2Q1	GND	GND	2D1	2D2
F	2Q4	2Q3	$1V_{CC}$	$1V_{CC}$	2D3	2D4
G	2Q6	2Q5	GND	GND	2D5	2D6
H	2Q7	2Q8	$2\overline{OE}$	2LE	2D8	2D7
J	3Q2	3Q1	$3\overline{OE}$	3LE	3D1	3D2
K	3Q4	3Q3	GND	GND	3D3	3D4
L	3Q6	3Q5	$2V_{CC}$	$2V_{CC}$	3D5	3D6
M	3Q8	3Q7	GND	GND	3D7	3D8
N	4Q2	4Q1	GND	GND	4D1	4D2
P	4Q4	4Q3	$2V_{CC}$	$2V_{CC}$	4D3	4D4
R	4Q6	4Q5	GND	GND	4D5	4D6
T	4Q7	4Q8	$4\overline{OE}$	4LE	4D8	4D7

logic diagram (positive logic)



NOTE A: 1V_{CC} is associated with these channels.



NOTE B: 2V_{CC} is associated with these channels.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)[†]

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 output 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 output 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	±50 mA
Continuous current through each V _{CC} or GND	±100 mA
Package thermal impedance, θ _{JA} (see Note 3)	39°C/W
Storage temperature range, T _{stg}	–65°C to 150°C

[†] 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.

SN74AVC32373
1.2-V/3.3-V 32-BIT TRANSPARENT D-TYPE LATCHES
WITH 3-STATE OUTPUTS

SCES327 – APRIL 2000

recommended operating conditions (see Note 4)

			MIN	MAX	UNIT
V _{CC}	Supply voltage	Operating	1.2	3.6	V
V _{IH}	High-level input voltage	V _{CC} = 1.2 V	V _{CC}		V
		V _{CC} = 1.4 V to 1.6 V	0.65 × V _{CC}		
		V _{CC} = 1.65 V to 1.95 V	0.65 × V _{CC}		
		V _{CC} = 2.3 V to 2.7 V	1.7		
		V _{CC} = 3 V to 3.6 V	2		
V _{IL}	Low-level input voltage	V _{CC} = 1.2 V	GND		V
		V _{CC} = 1.4 V to 1.6 V	0.35 × V _{CC}		
		V _{CC} = 1.65 V to 1.95 V	0.35 × V _{CC}		
		V _{CC} = 2.3 V to 2.7 V	0.7		
		V _{CC} = 3 V to 3.6 V	0.8		
V _I	Input voltage		0	3.6	V
V _O	Output voltage	Active state	0	V _{CC}	V
		3-state	0	3.6	
I _{OHS}	Static high-level output current [†]	V _{CC} = 1.4 V to 1.6 V	−2		mA
		V _{CC} = 1.65 V to 1.95 V	−4		
		V _{CC} = 2.3 V to 2.7 V	−8		
		V _{CC} = 3 V to 3.6 V	−12		
I _{OLS}	Static low-level output current [†]	V _{CC} = 1.4 V to 1.6 V	2		mA
		V _{CC} = 1.65 V to 1.95 V	4		
		V _{CC} = 2.3 V to 2.7 V	8		
		V _{CC} = 3 V to 3.6 V	12		
Δt/Δv	Input transition rise or fall rate	V _{CC} = 1.4 V to 3.6 V	5		ns/V
T _A	Operating free-air temperature		−40	85	°C

[†] Dynamic drive capability is equivalent to standard outputs with I_{OH} and I_{OL} of $\pm 24\text{ mA}$ at $2.5\text{-V }V_{CC}$. See Figure 1 for V_{OL} vs I_{OL} and V_{OH} vs I_{OH} 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_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

SN74AVC32373
1.2-V/3.3-V 32-BIT TRANSPARENT D-TYPE LATCHES
WITH 3-STATE OUTPUTS

SCES327 – APRIL 2000

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

PARAMETER		TEST CONDITIONS	V _{CC}	MIN	TYP [†]	MAX	UNIT
V _{OH}		I _{OHS} = –100 µA	1.2 V to 3.6 V	V _{CC} –0.2			V
		I _{OHS} = –2 mA, V _{IH} = 0.91 V	1.4 V	1.05			
		I _{OHS} = –4 mA, V _{IH} = 1.07 V	1.65 V	1.2			
		I _{OHS} = –8 mA, V _{IH} = 1.7 V	2.3 V	1.75			
		I _{OHS} = –12 mA, V _{IH} = 2 V	3 V	2.3			
V _{OL}		I _{OLS} = 100 µA	1. V to 3.6 V			0.2	V
		I _{OLS} = 2 mA, V _{IL} = 0.49 V	1.4 V			0.4	
		I _{OLS} = 4 mA, V _{IL} = 0.57 V	1.65 V			0.45	
		I _{OLS} = 8 mA, V _{IL} = 0.7 V	2.3 V			0.55	
		I _{OLS} = 12 mA, V _{IL} = 0.8 V	3 V			0.7	
I _I	Control inputs	V _I = V _{CC} or GND	3.6 V			±2.5	µA
I _{off}		V _I or V _O = 3.6 V	0			±10	µA
I _{OZ}		V _O = V _{CC} or GND	3.6 V			±10	µA
I _{CC}		V _I = V _{CC} or GND, I _O = 0	3.6 V			40	µA
C _i	Control inputs	V _I = V _{CC} or GND	2.5 V			3	pF
			3.3 V			3	
	Data inputs	V _I = V _{CC} or GND	2.5 V			2.5	
			3.3 V			2.5	
C _O	Outputs	V _O = V _{CC} or GND	2.5 V			6.5	pF
			3.3 V			6.5	

[†] Typical values are measured at V_{CC} = 2.5 V and 3.3 V, T_A = 25°C.

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

		V _{CC} = 1.2 V		V _{CC} = 1.5 V ± 0.1 V		V _{CC} = 1.8 V ± 0.15 V		V _{CC} = 2.5 V ± 0.2 V		V _{CC} = 3.3 V ± 0.3 V		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t _W	Pulse duration, LE high					2.2		2		1.8		ns
t _{su}	Setup time, data before LE↓	1.7		1.2		1.1		0.9		0.8		ns
t _h	Hold time, data after LE↓	2		1.1		1.1		1.1		1		ns

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V _{CC} = 1.2 V		V _{CC} = 1.5 V ± 0.1 V		V _{CC} = 1.8 V ± 0.15 V		V _{CC} = 2.5 V ± 0.2 V		V _{CC} = 3.3 V ± 0.3 V		UNIT
			TYP		MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
t _{pd}	D	Q	5.8		1.2	6.8	1	5.7	0.8	3.3	0.7	2.8	ns
	LE		7.2		1.4	8.3	1.1	6.6	0.8	4	0.7	3.2	
t _{en}	$\overline{\text{OE}}$	Q	7.4		1.6	8.8	1.6	6.7	1.4	4.3	0.7	3.4	ns
t _{dis}	$\overline{\text{OE}}$	Q	8.4		2.5	9.4	2.3	7.8	1.3	4.2	1.2	3.9	ns



SN74AVC32373

1.2-V/3.3-V 32-BIT TRANSPARENT D-TYPE LATCHES

WITH 3-STATE OUTPUTS

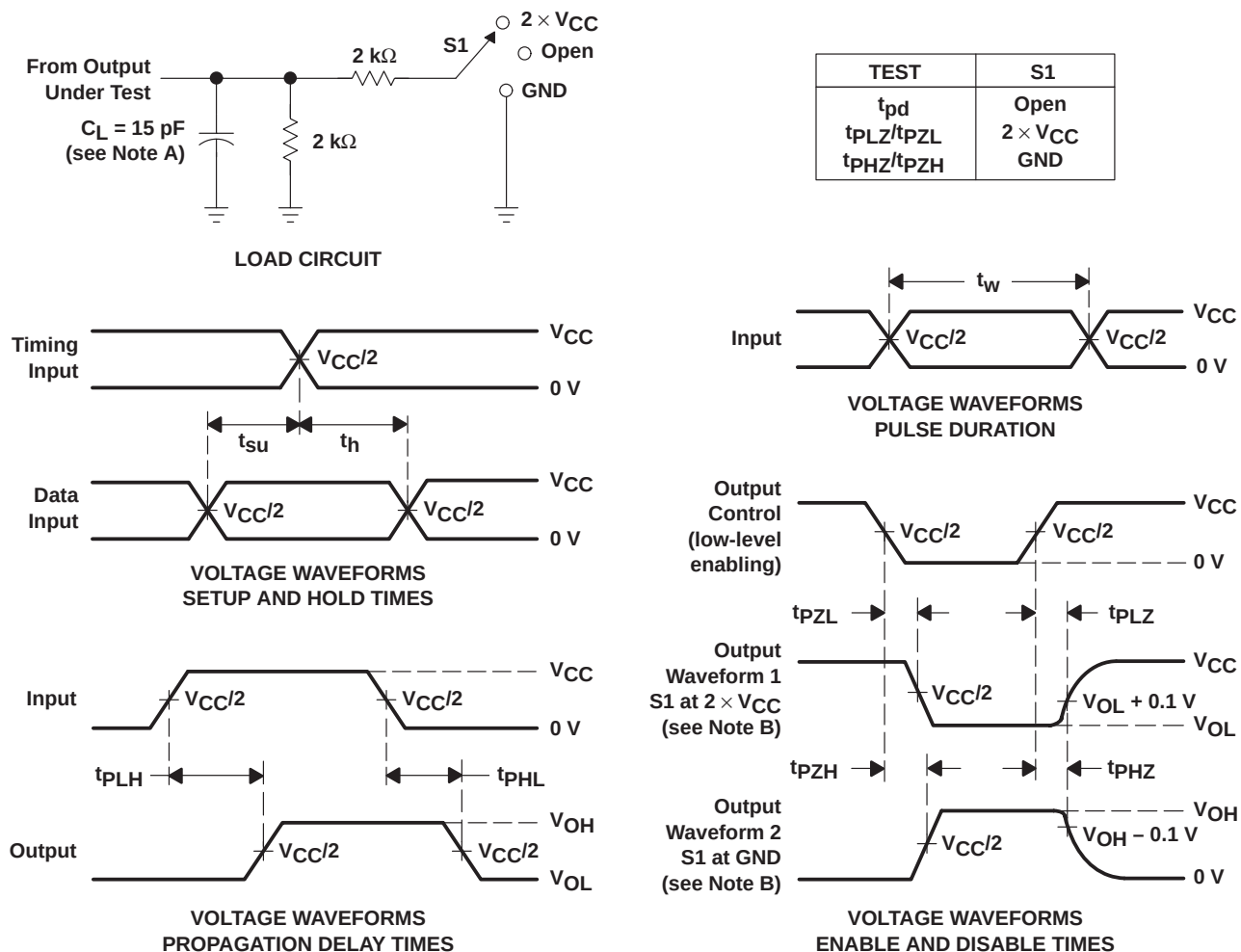
SCES327 – APRIL 2000

operating characteristics, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
			TYP	TYP	TYP	
C_{pd} Power dissipation capacitance	Outputs enabled	$C_L = 0$, $f = 10\text{ MHz}$	40	43	47	pF
	Outputs disabled		20	22	24	

PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 1.2\text{ V}$ AND $1.5\text{ V} \pm 0.1\text{ V}$

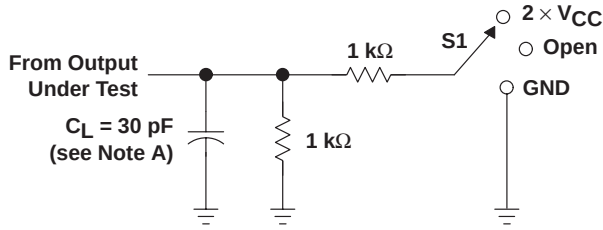


- NOTES:
- C_L includes probe and jig capacitance.
 - Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 - 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 2. Load Circuit and Voltage Waveforms

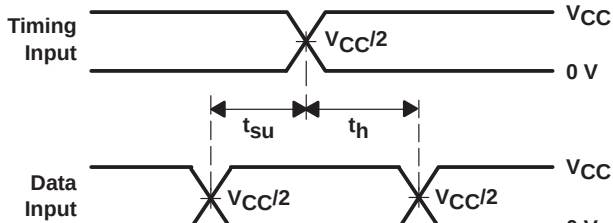
PARAMETER MEASUREMENT INFORMATION

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

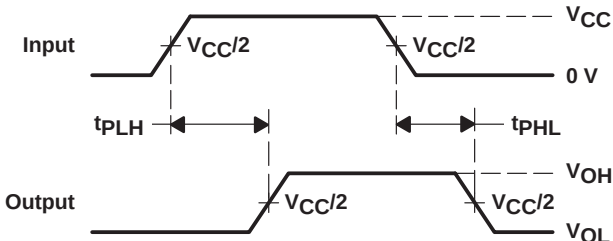


LOAD CIRCUIT

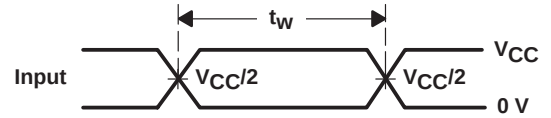
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



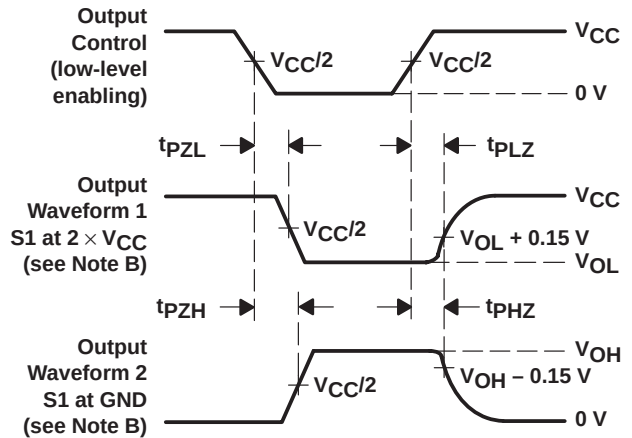
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES:
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 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2 \text{ ns}$, $t_f \leq 2 \text{ ns}$.
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 - t_{PZL} and t_{PZH} are the same as t_{en} .
 - t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 3. Load Circuit and Voltage Waveforms

SN74AVC32373

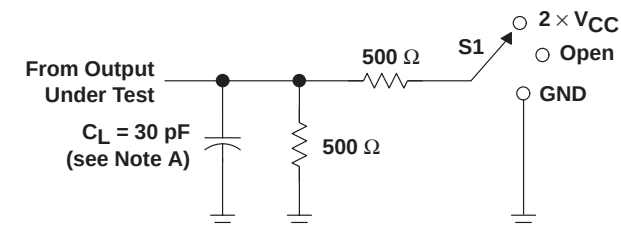
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SCES327 – APRIL 2000

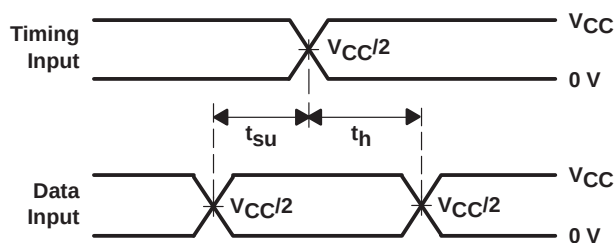
PARAMETER MEASUREMENT INFORMATION

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

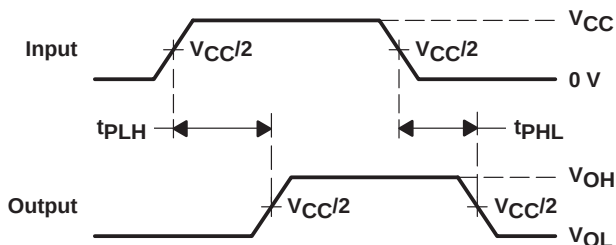


LOAD CIRCUIT

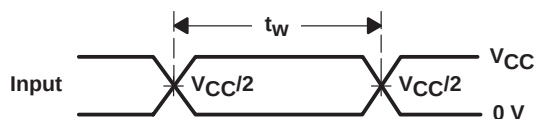
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



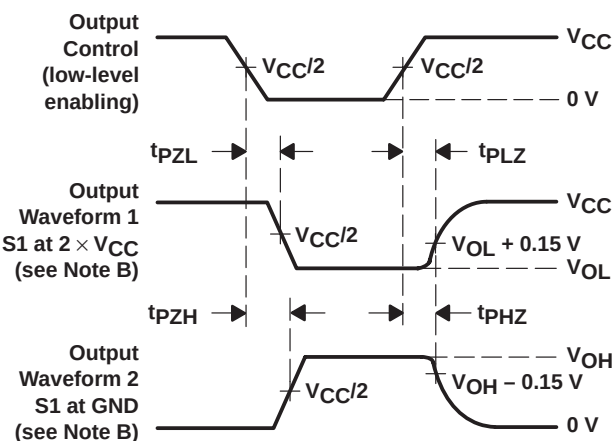
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



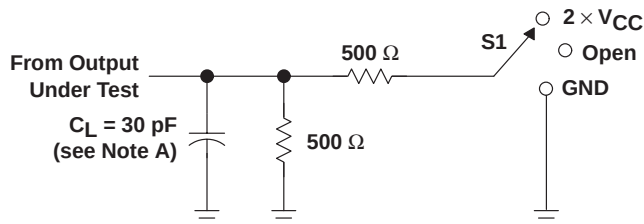
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES:
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 - t_{PZL} and t_{PZH} are the same as t_{en} .
 - t_{PLH} and t_{PHL} are the same as t_{pd} .

Figure 4. Load Circuit and Voltage Waveforms

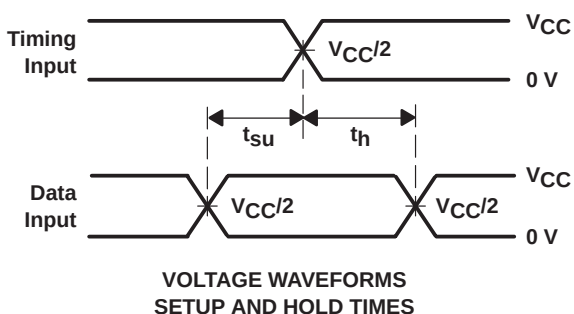
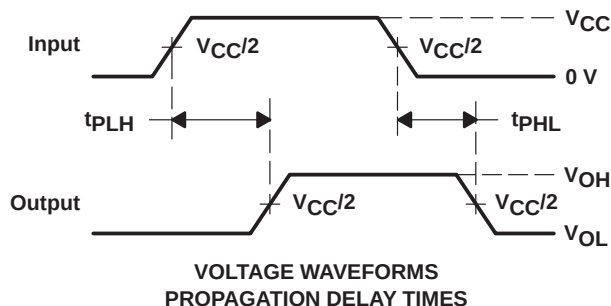
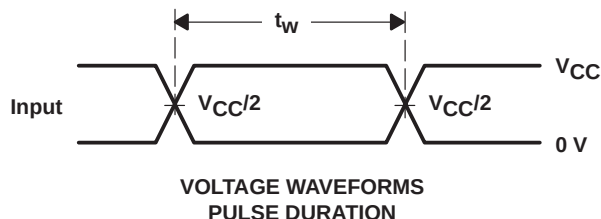
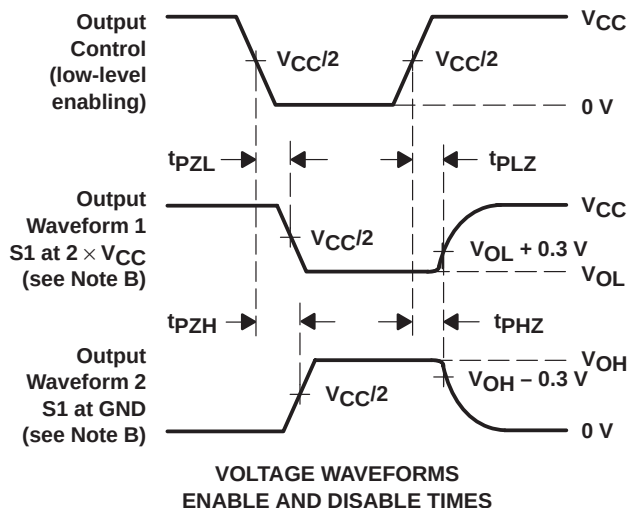
PARAMETER MEASUREMENT INFORMATION

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



LOAD CIRCUIT

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



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Figure 5. Load Circuit and Voltage Waveforms

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