

FEATURES

- 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
- Package Options Include Plastic Thin Shrink Small-Outline (DGG) and Thin Very Small-Outline (DGV) Packages

DESCRIPTION/ORDERING INFORMATION

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.

ORDERING INFORMATION

T_A	PACKAGE (1)		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	TSSOP – DGG	Tape and reel	SN74AVC16374DGGR	AVC16374
	TVSOP – DGV	Tape and reel	SN74AVC16374DGVR	CVA374
	VFBGA – GQL	Tape and reel	SN74AVC16374GQLR	CVA374

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

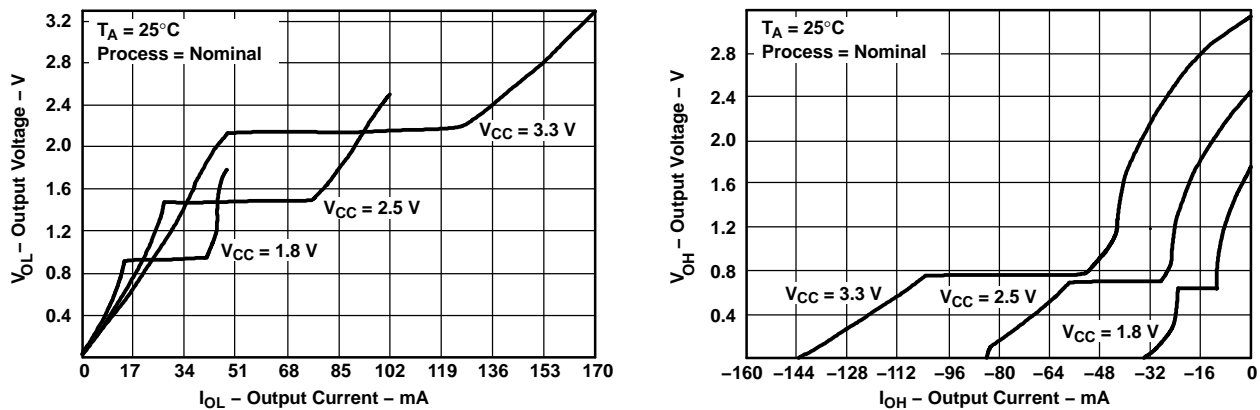


Figure 1. Output Voltage vs Output Current



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SN74AVC16374

16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP WITH 3-STATE OUTPUTS

SCES158H–DECEMBER 1998–REVISED MARCH 2005

DESCRIPTION/ORDERING INFORMATION (CONTINUED)

This 16-bit edge-triggered D-type flip-flop 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.

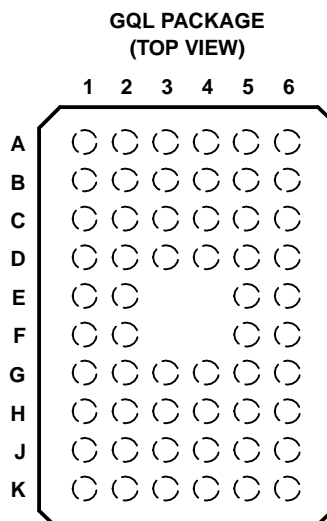
The SN74AVC16374 is particularly suitable for implementing buffer registers, I/O ports, bidirectional bus drivers, and working registers. It can be used as two 8-bit flip-flops or one 16-bit flip-flop. On the positive transition of the clock (CLK) input, the Q outputs of the flip-flop take on the logic levels at the data (D) inputs. \overline{OE} 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 the increased drive provide the capability to drive bus lines without need for interface or pullup components.

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

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.

The SN74AVC16374 is characterized for operation from -40°C to 85°C .

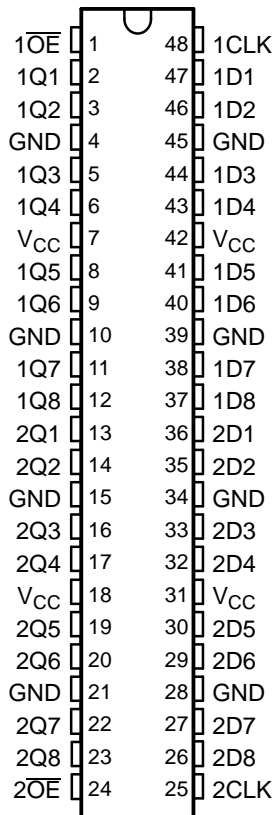


TERMINAL ASSIGNMENTS⁽¹⁾

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

(1) NC - No internal connection

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



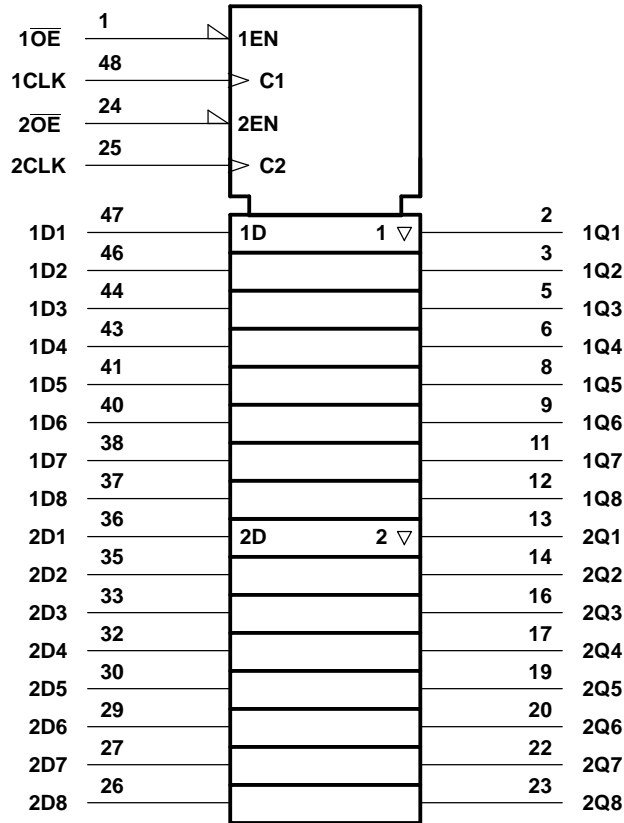
**FUNCTION TABLE
(EACH 8-BIT FLIP FLOP)**

INPUTS			OUTPUT Q
\overline{OE}	CLK	D	
L	↑	H	H
L	↑	L	L
L	H or L	X	Q_0
H	X	X	Z

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16-BIT EDGE-TRIGGERED D-TYPE FLIP-FLOP
WITH 3-STATE OUTPUTS

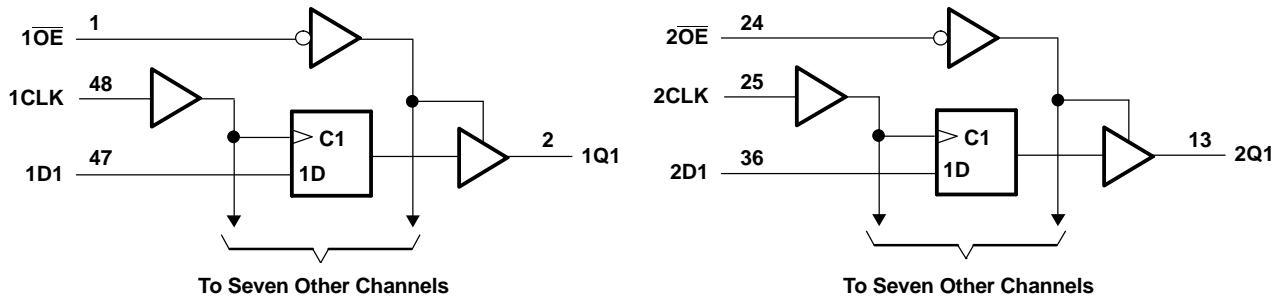
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LOGIC SYMBOL⁽¹⁾



(1) This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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	4.6	V
V_I	Input voltage range ⁽²⁾	-0.5	4.6	V
V_O	Voltage range applied to any output in the high-impedance or power-off state ⁽²⁾	-0.5	4.6	V
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	mA
I_{OK}	Output clamp current	$V_O < 0$	-50	mA
I_O	Continuous output current		±50	mA
	Continuous current through each V_{CC} or GND		±100	mA
θ_{JA}	Package thermal impedance ⁽⁴⁾	DGG package	70	°C/W
		DGV package	58	
		GQL package	42	
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 and output negative-voltage ratings may be exceeded if the input and output current ratings are observed.
- (3) The output positive-voltage rating may be exceeded up to 4.6 V maximum if the output current ratings is observed.
- (4) The package thermal impedance is calculated in accordance with JESD 51.

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WITH 3-STATE OUTPUTS

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Recommended Operating Conditions⁽¹⁾

			MIN	MAX	UNIT
V_{CC}	Supply voltage	Operating	1.4	3.6	V
		Data retention only	1.2		
V_{IH}	High-level input voltage	$V_{CC} = 1.2\text{ V}$	V_{CC}		V
		$V_{CC} = 1.4\text{ V to }1.6\text{ V}$	$0.65 \times V_{CC}$		
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.65 \times V_{CC}$		
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	1.7		
		$V_{CC} = 3\text{ V to }3.6\text{ V}$	2		
V_{IL}	Low-level input voltage	$V_{CC} = 1.2\text{ V}$	GND		V
		$V_{CC} = 1.4\text{ V to }1.6\text{ V}$	$0.35 \times V_{CC}$		
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	$0.35 \times V_{CC}$		
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	0.7		
		$V_{CC} = 3\text{ V to }3.6\text{ V}$	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 ⁽²⁾	$V_{CC} = 1.4\text{ V to }1.6\text{ V}$	–2		mA
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	–4		
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	–8		
		$V_{CC} = 3\text{ V to }3.6\text{ V}$	–12		
I_{OLS}	Static low-level output current ⁽²⁾	$V_{CC} = 1.4\text{ V to }1.6\text{ V}$	2		mA
		$V_{CC} = 1.65\text{ V to }1.95\text{ V}$	4		
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	8		
		$V_{CC} = 3\text{ V to }3.6\text{ V}$	12		
$\Delta t/\Delta v$	Input transition rise or fall rate	$V_{CC} = 1.4\text{ V to }3.6\text{ V}$	5		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.
- (2) Dynamic drive capability is equivalent to standard outputs with I_{OH} and I_{OL} of $\pm 24\text{ mA}$ at 2.5-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.

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 _{OHS} = -100 μA	1.4 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	1.4 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		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			

(1) 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)

		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	
f _{clock}	Clock frequency					160		200		200		MHz
t _w	Pulse duration, CLK high or low					3.1		2.5		2.5		ns
t _{su}	Setup time, data before CLK↑	4.1		2.7		1.9		1.4		1.4		ns
t _h	Hold time, data after CLK↑	1.7		1.3		1.2		1.1		1.1		ns

Switching Characteristics

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2 through Figure 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	
f _{max}							160		200		200		MHz
t _{pd}	CLK	Q	7.3		1.5	8.4	1.2	6.7	0.8	4.1	0.7	3.3	ns
t _{en}	\overline{OE}	Q	7.4		1.6	8.5	1.6	6.7	0.9	4.3	0.7	3.4	ns
t _{dis}	\overline{OE}	Q	8.4		2.5	9.4	2.3	7.8	1	4.2	1.5	3.9	ns

SN74AVC16374
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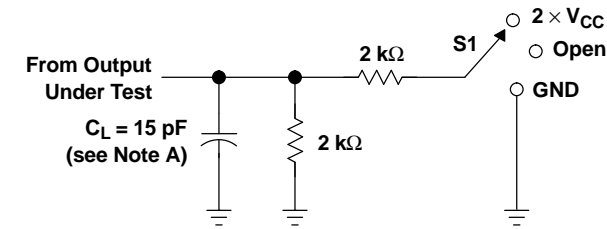
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Operating Characteristics

$T_A = 25^\circ\text{C}$

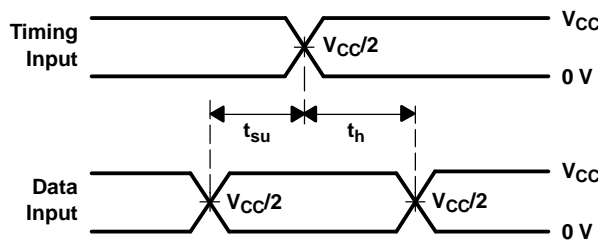
PARAMETER		TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
			TYP	TYP	TYP	
C_{pd}	Power dissipation capacitance	$C_L = 0,$ $f = 10\text{ MHz}$	74	81	89	pF
	Outputs enabled		52	57	63	
	Outputs disabled					

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

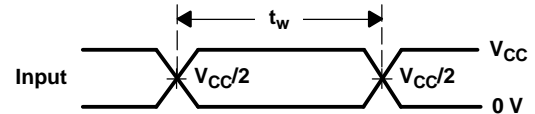


LOAD CIRCUIT

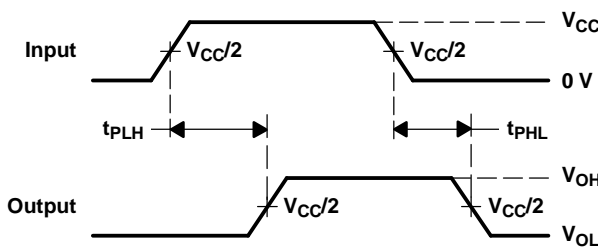
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



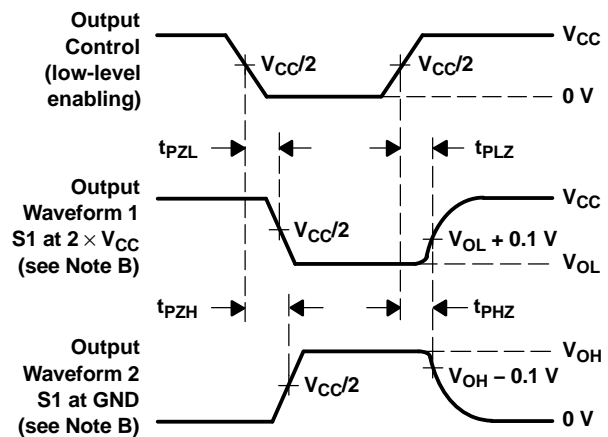
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



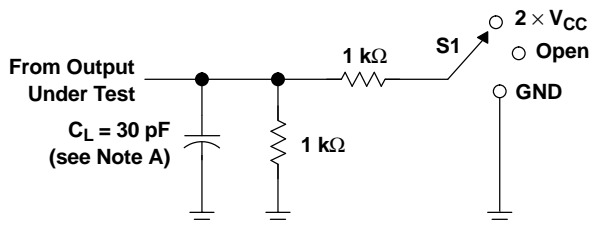
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- 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 2. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

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

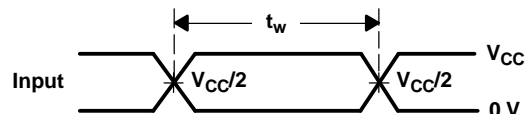


LOAD CIRCUIT

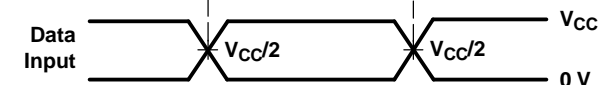
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



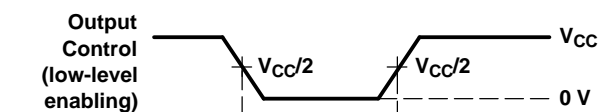
**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS
PULSE DURATION**



**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**

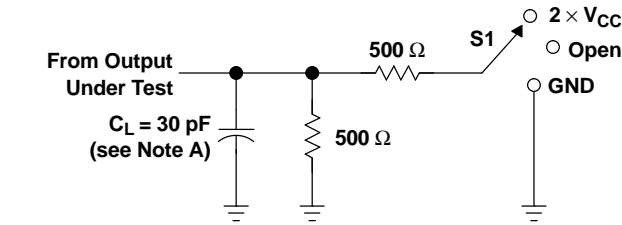


**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES**

- 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.
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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} .

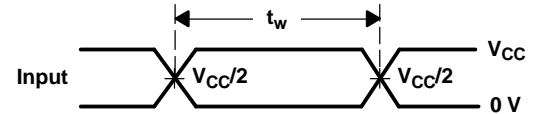
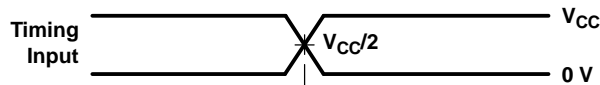
Figure 3. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
 $V_{CC} = 2.5 V \pm 0.2 V$

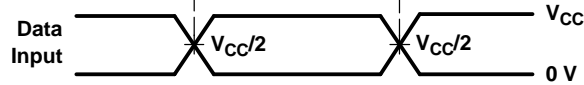


LOAD CIRCUIT

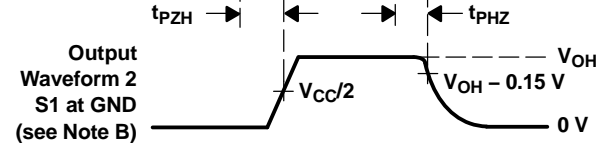
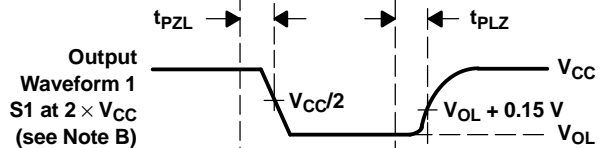
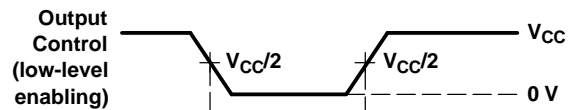
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



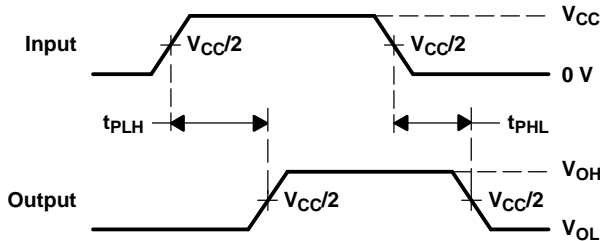
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

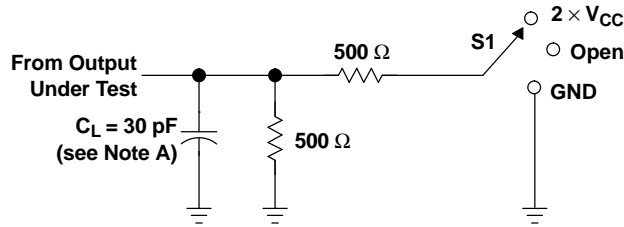


VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

- NOTES: A. C_L includes probe and jig capacitance.
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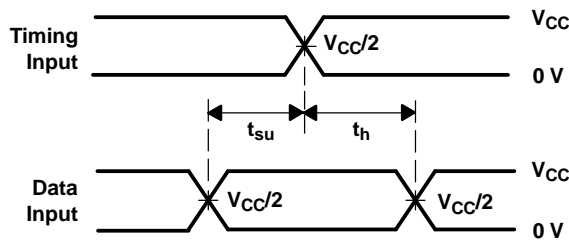
Figure 4. Load Circuit and Voltage Waveforms

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

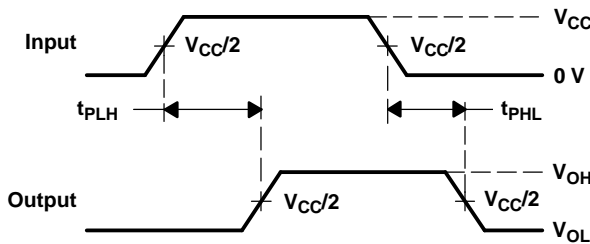


LOAD CIRCUIT

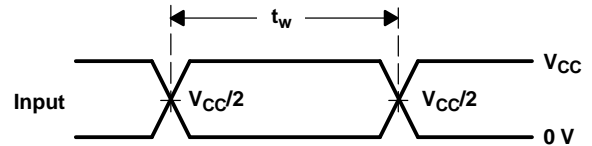
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t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



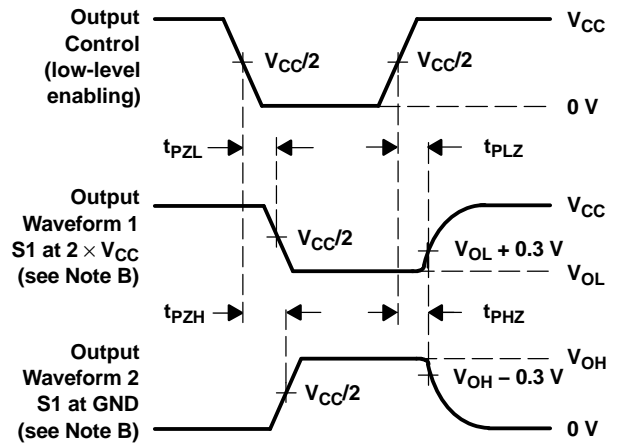
VOLTAGE WAVEFORMS
 SETUP AND HOLD TIMES



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 5. Load Circuit and Voltage Waveforms

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AVC16374DGGR	ACTIVE	TSSOP	DGG	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16374	Samples
SN74AVC16374DGVR	ACTIVE	TVSOP	DGV	48	2000	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	-40 to 85	CVA374	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) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

RoHS Exempt: TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

Green: TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

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

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TAPE AND REEL INFORMATION

QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE

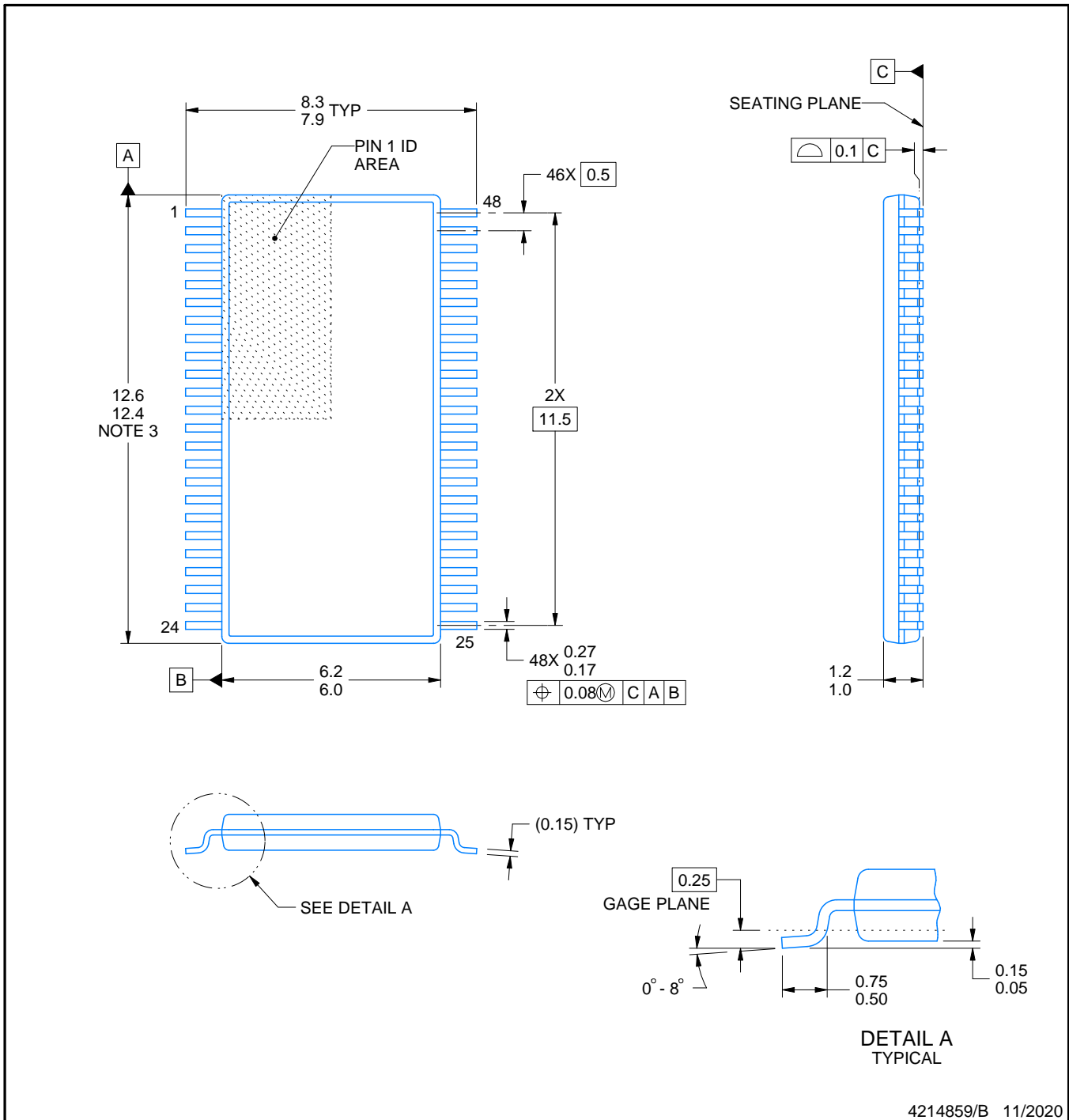
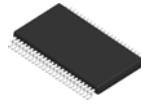

*All dimensions are nominal

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
SN74AVC16374DGGR	TSSOP	DGG	48	2000	330.0	24.4	8.6	13.0	1.8	12.0	24.0	Q1
SN74AVC16374DGVR	TVSOP	DGV	48	2000	330.0	16.4	7.1	10.2	1.6	12.0	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)
SN74AVC16374DGGR	TSSOP	DGG	48	2000	367.0	367.0	45.0
SN74AVC16374DGVR	TVSOP	DGV	48	2000	356.0	356.0	35.0



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NOTES:

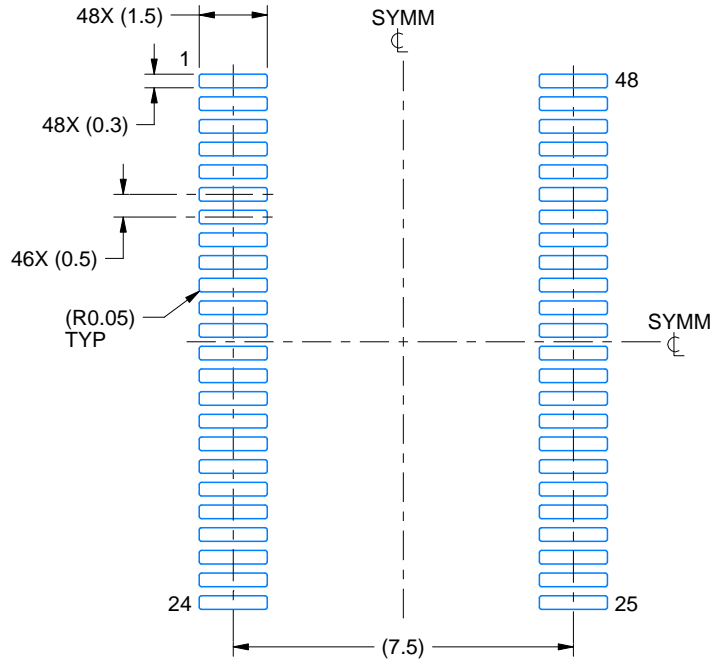
1. All linear dimensions are in millimeters. Any dimensions in parenthesis are for reference only. Dimensioning and tolerancing per ASME Y14.5M.
2. This drawing is subject to change without notice.
3. This dimension does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed 0.15 mm per side.
4. Reference JEDEC registration MO-153.

EXAMPLE BOARD LAYOUT

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

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NOTES: (continued)

- 5. Publication IPC-7351 may have alternate designs.
- 6. Solder mask tolerances between and around signal pads can vary based on board fabrication site.

EXAMPLE STENCIL DESIGN

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



SOLDER PASTE EXAMPLE
BASED ON 0.125 mm THICK STENCIL
SCALE:6X

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NOTES: (continued)

7. Laser cutting apertures with trapezoidal walls and rounded corners may offer better paste release. IPC-7525 may have alternate design recommendations.
8. Board assembly site may have different recommendations for stencil design.

DGG (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

48 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 protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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