SN74AVC16269
12-BIT TO 24-BIT REGISTERED BUS EXCHANGER WITH 3-STATE OUTPUTS

SCES152G – DECEMBER 1998 – REVISED MAY 2005

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**
- **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.

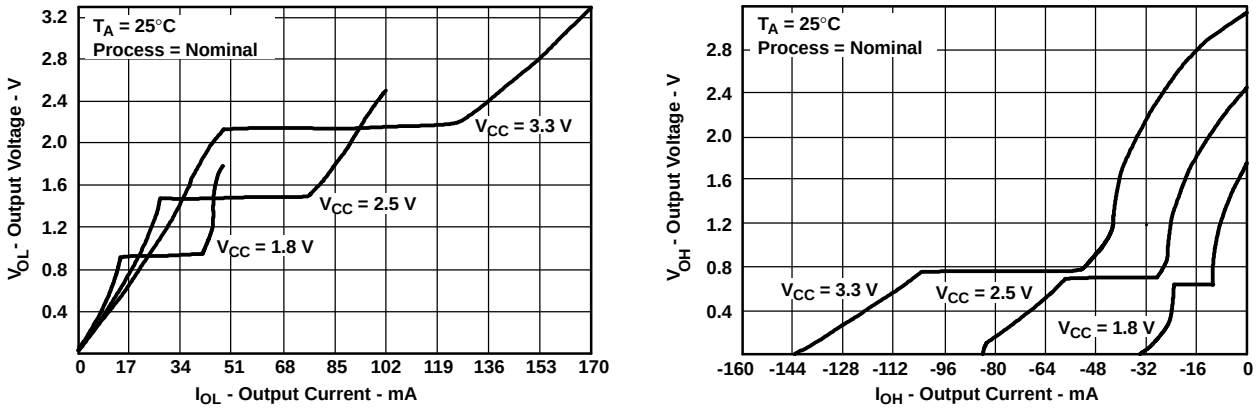


Figure 1. Output Voltage vs Output Current

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.

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 ($\overline{CLKENA}$) 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 ($\overline{SEL}$) 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.

DESCRIPTION (CONTINUED)

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

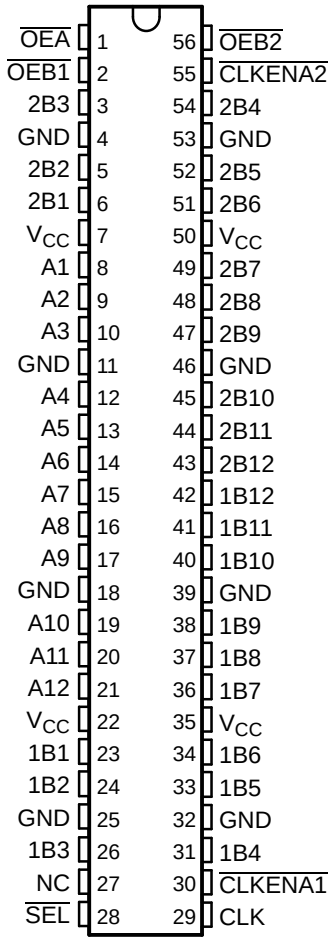
To ensure the high-impedance state during power up or power down, a clock pulse should be applied as soon as possible, and $\overline{OE}$ should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver. Due to $\overline{OE}$ 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_{off}. The I_{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°C to 85°C.

TERMINAL ASSIGNMENTS

DGG OR DGV PACKAGE
(TOP VIEW)



NC - No internal connection

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	$1B_0$ (1)	$2B_0$ (1)
L	X	↑	L	L	X
L	X	↑	H	H	X
X	L	↑	L	X	L
X	L	↑	H	X	H

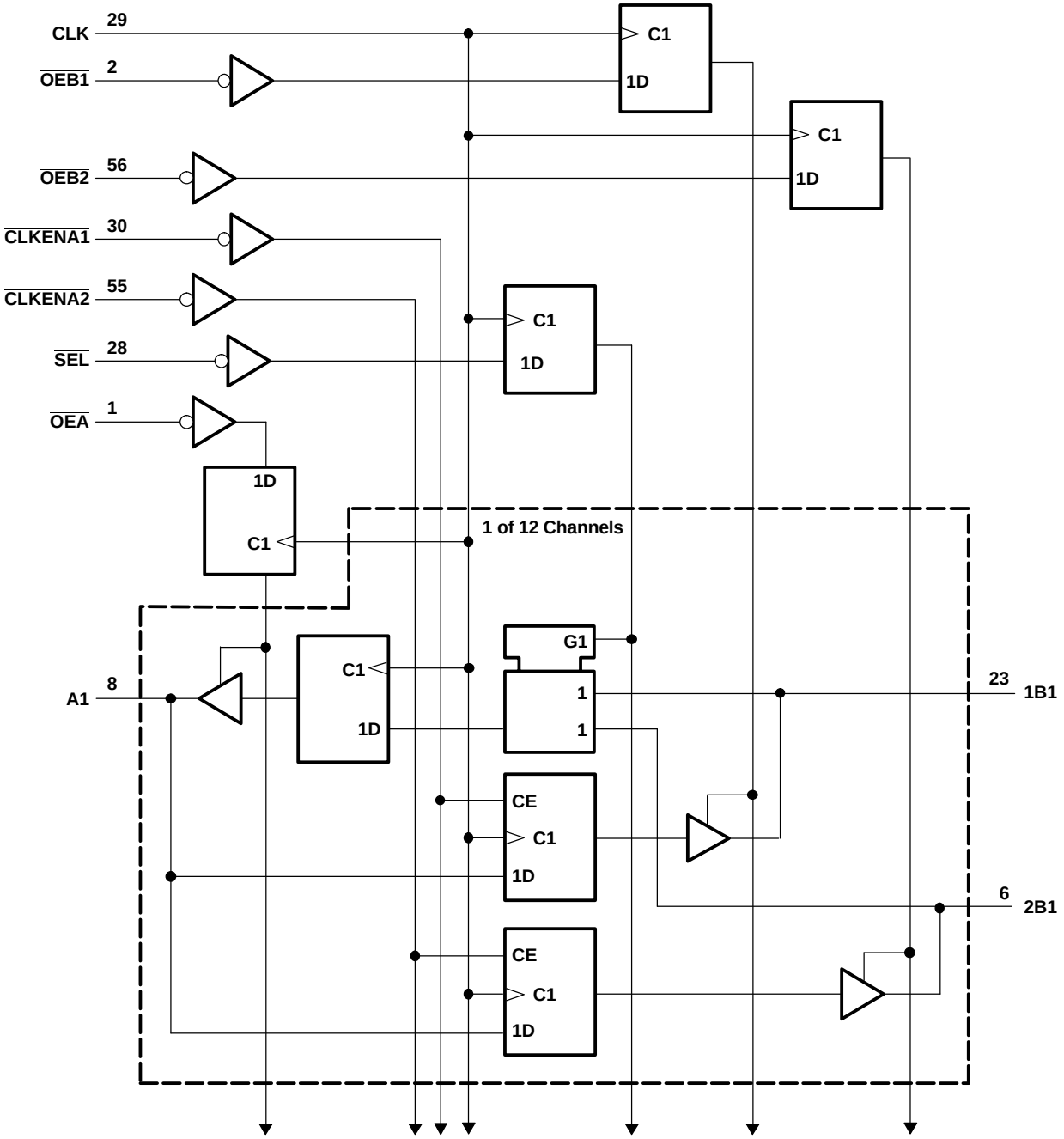
(1) Output level before the indicated steady-state input conditions were established

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

INPUTS				OUTPUT
CLK	$\overline{SEL}$	1B	2B	A
X	H	X	X	A_0 (1)
X	L	X	X	A_0 (1)
↑	H	L	X	L
↑	H	H	X	H
↑	L	X	L	L
↑	L	X	H	H

(1) Output level before the indicated steady-state input conditions were established

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 input/output when the output is in the high-impedance or power-off state(2)		–0.5	4.6	V
V_O	Voltage range applied to any input/output when the output is 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		64	°C/W
		DGV package		48	
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 rating is observed.
(4) The package thermal impedance is calculated in accordance with JESD 51.

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 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(2)	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(2)	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	
$\Delta t/\Delta v$	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

(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 ±24 mA at 3.3-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	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}(2)		V_O = V_{CC} or GND		3.6 V			±12.5	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		3.5		pF
				3.3 V		3.5		
C_{io}	A or B ports	V_O = V_{CC} or GND		2.5 V		8.5		pF
				3.3 V		8.5		

(1) Typical values are measured at T_A = 25°C.
(2) For I/O ports, the parameter I_{OZ} includes the input leakage current.

Timing Requirements

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 2 through Figure 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
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency						75		125		175	MHz
t_w	Pulse duration, CLK high or low					5.8		5		3.5		ns
t_{su}	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		
		$\overline{SEL}$ before CLK↑	4.5	3.4		2.2		1.6		1.3		
		$\overline{CLKENA1}$ or $\overline{CLKENA2}$ before CLK↑	0.9	0.9		1		1.1		1.1		
		$\overline{OE}$ before CLK↑	5.4	5.3		2		1.6		1.1		
t_h	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		
		$\overline{SEL}$ after CLK↑	1	1		0.4		0.3		0.4		
		$\overline{CLKENA1}$ or $\overline{CLKENA2}$ after CLK↑	2.6	2.2		1.4		1.1		1		
		$\overline{OE}$ after CLK↑	0.4	0.4		0.4		0.5		0.3		

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}						75		125		175		MHz
t_{pd}	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_{en}	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_{dis}	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[1]

T_A = 0°C to 85°C, C_L = 0 pF

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 3.3 V ± 0.15 V		UNIT
			MIN	MAX	
t_{pd}	CLK	B	1.4	2.4	ns
		A	1.2	2.1	

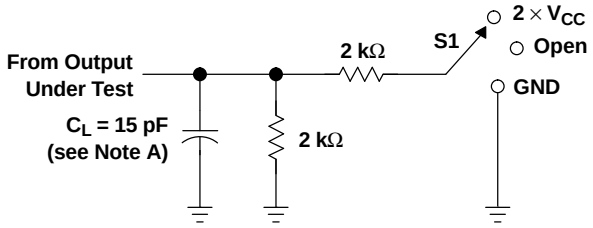
(1) Texas Instruments SPICE simulation data

Operating Characteristics

T_A = 25°C

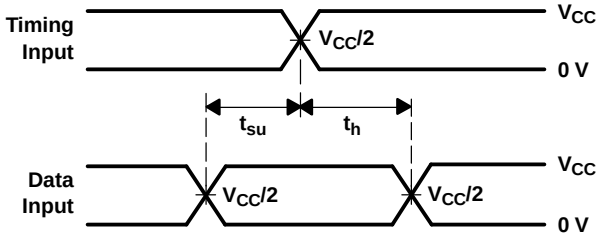
PARAMETER			TEST CONDITIONS	V_{CC} = 1.8 V	V_{CC} = 2.5 V	V_{CC} = 3.3 V	UNIT
				TYP	TYP	TYP	
C_{pd}	Power dissipation capacitance	Outputs enabled	C_L = 0, f = 10 MHz	133	145	168	pF
		Outputs disabled		102	109	124	

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 1.2 V AND 1.5 V ± 0.1 V

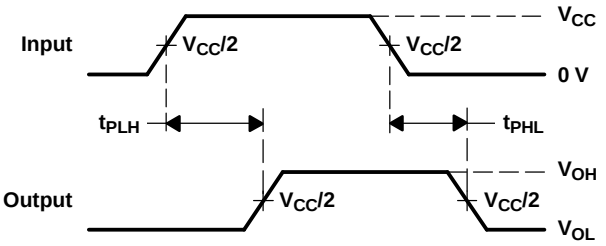


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

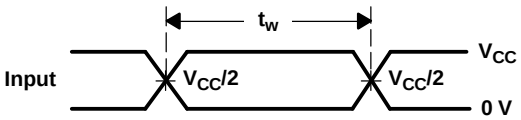
LOAD CIRCUIT



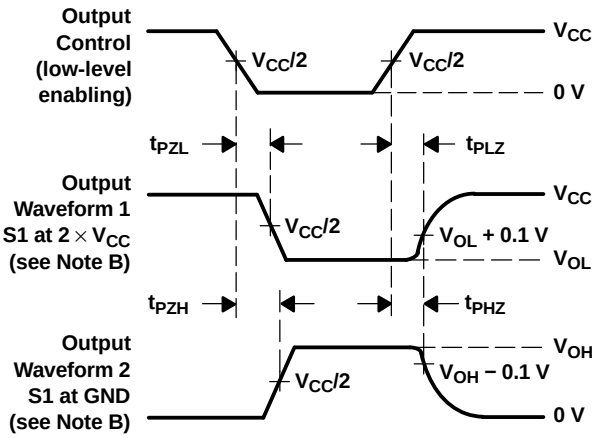
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

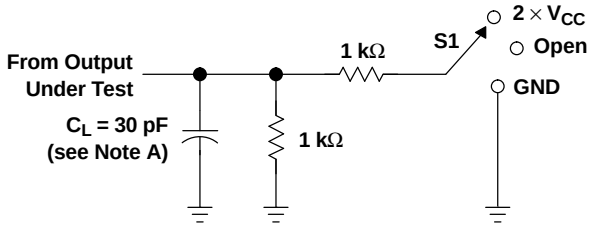


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 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}.

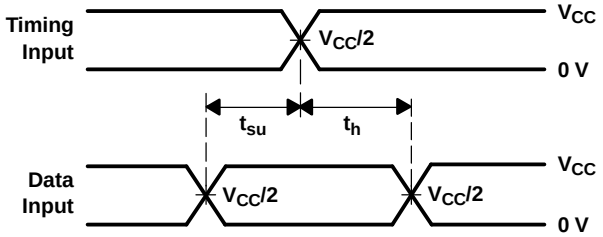
Figure 2. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 1.8 V ± 0.15 V

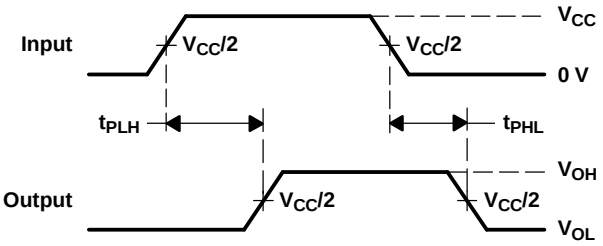


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

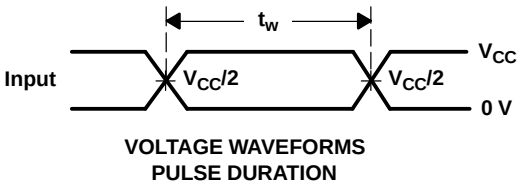
LOAD CIRCUIT



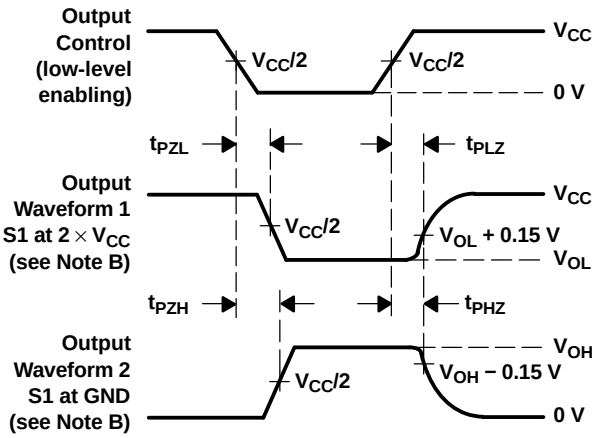
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

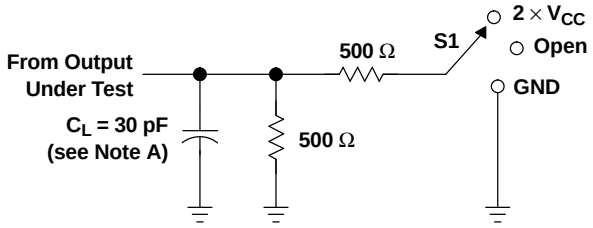


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 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}.

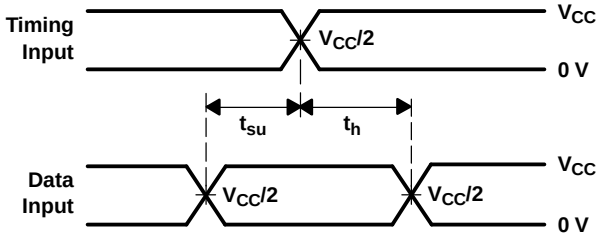
Figure 3. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 2.5 V ± 0.2 V

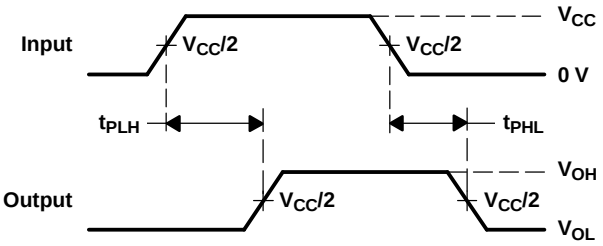


LOAD CIRCUIT

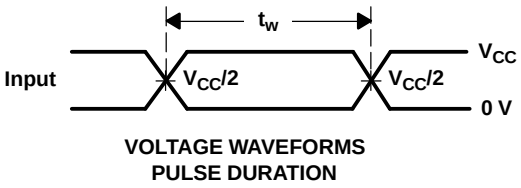
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND



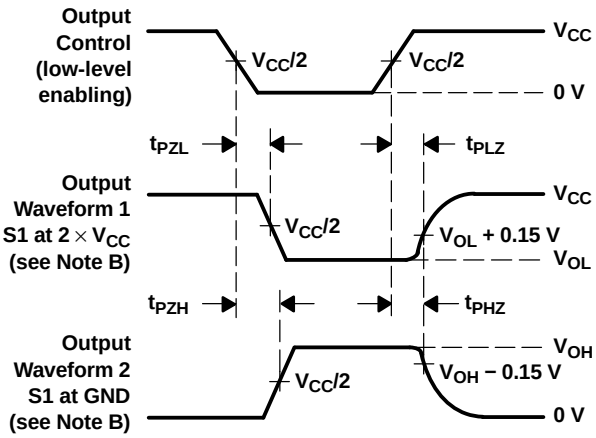
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

NOTES: A. C_L includes probe and jig capacitance.
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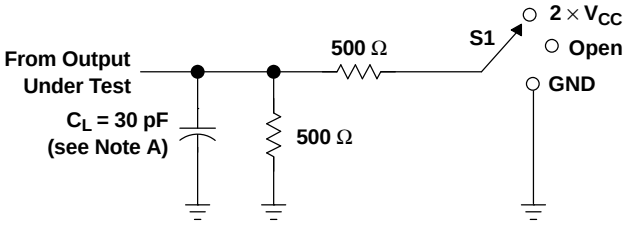
E. t_{PLZ} and t_{PHZ} are the same as t_{dis}.
F. t_{PZL} and t_{PZH} are the same as t_{en}.
G. t_{PLH} and t_{PHL} are the same as t_{pd}.

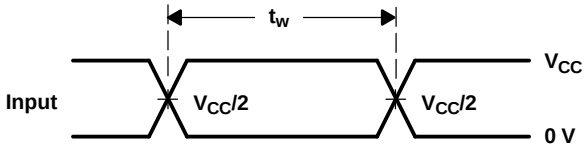
Figure 4. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 3.3 V ± 0.3 V

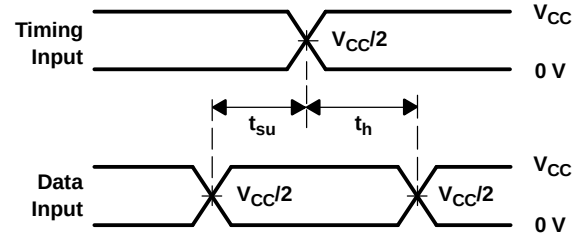


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

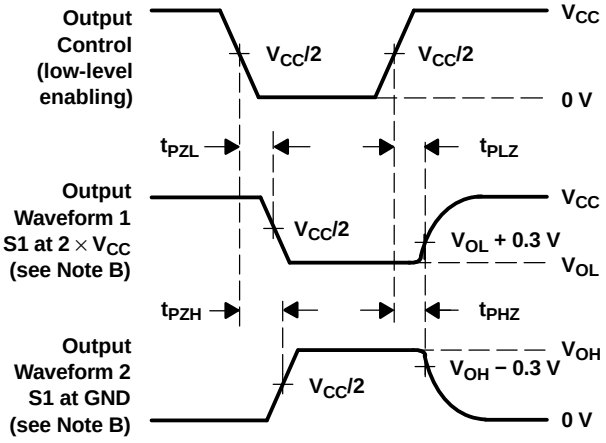
LOAD CIRCUIT



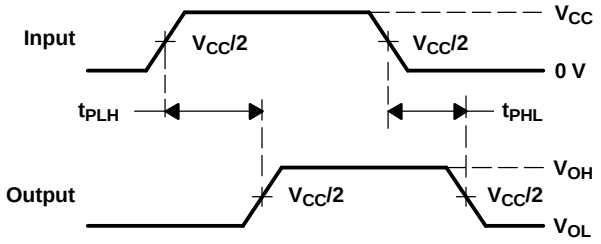
VOLTAGE WAVEFORMS
PULSE DURATION



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.
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 ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2 ns, t_f ≤ 2 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/Ball Finish (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
74AVC16269DGGRE4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI	-40 to 85		Samples
74AVC16269DGGRG4	ACTIVE	TSSOP	DGG	56		TBD	Call TI	Call TI	-40 to 85		Samples
SN74AVC16269DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM	-40 to 85	AVC16269	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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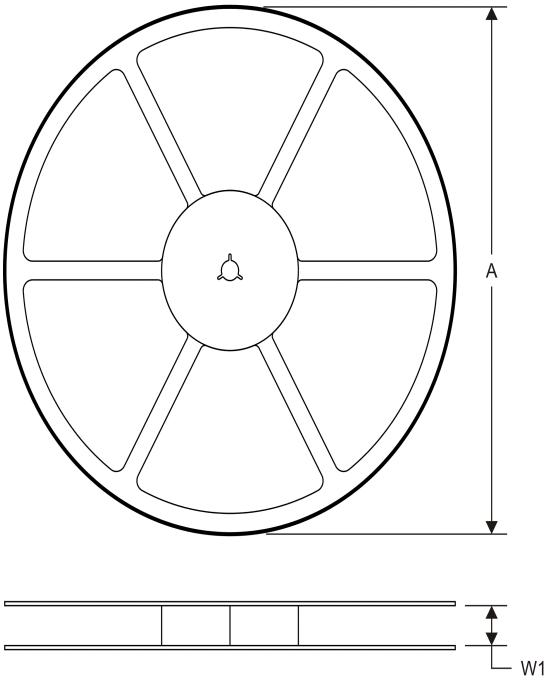
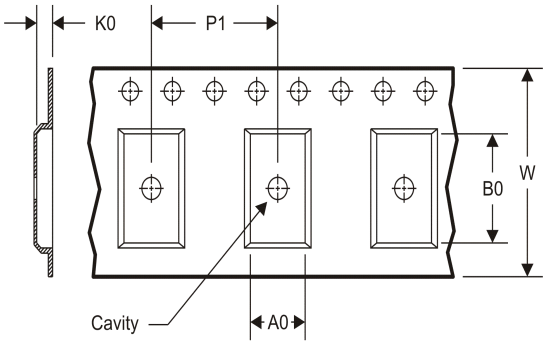
TAPE AND REEL INFORMATION

REEL DIMENSIONS



TAPE DIMENSIONS



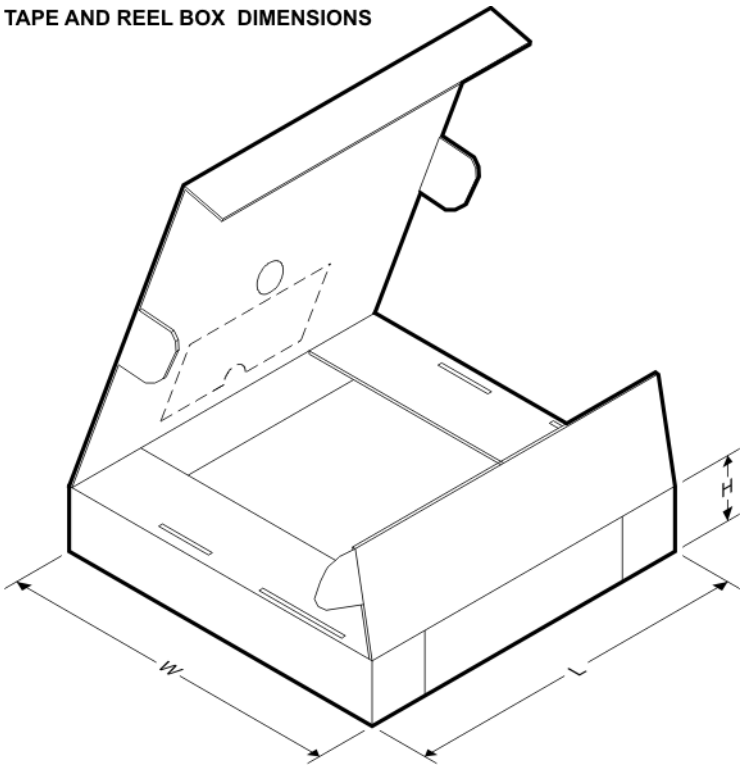
A0	Dimension designed to accommodate the component width
B0	Dimension designed to accommodate the component length
K0	Dimension designed to accommodate the component thickness
W	Overall width of the carrier tape
P1	Pitch between successive cavity centers

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
SN74AVC16269DGGR	TSSOP	DGG	56	2000	330.0	24.4	8.6	15.6	1.8	12.0	24.0	Q1

TAPE AND REEL BOX DIMENSIONS

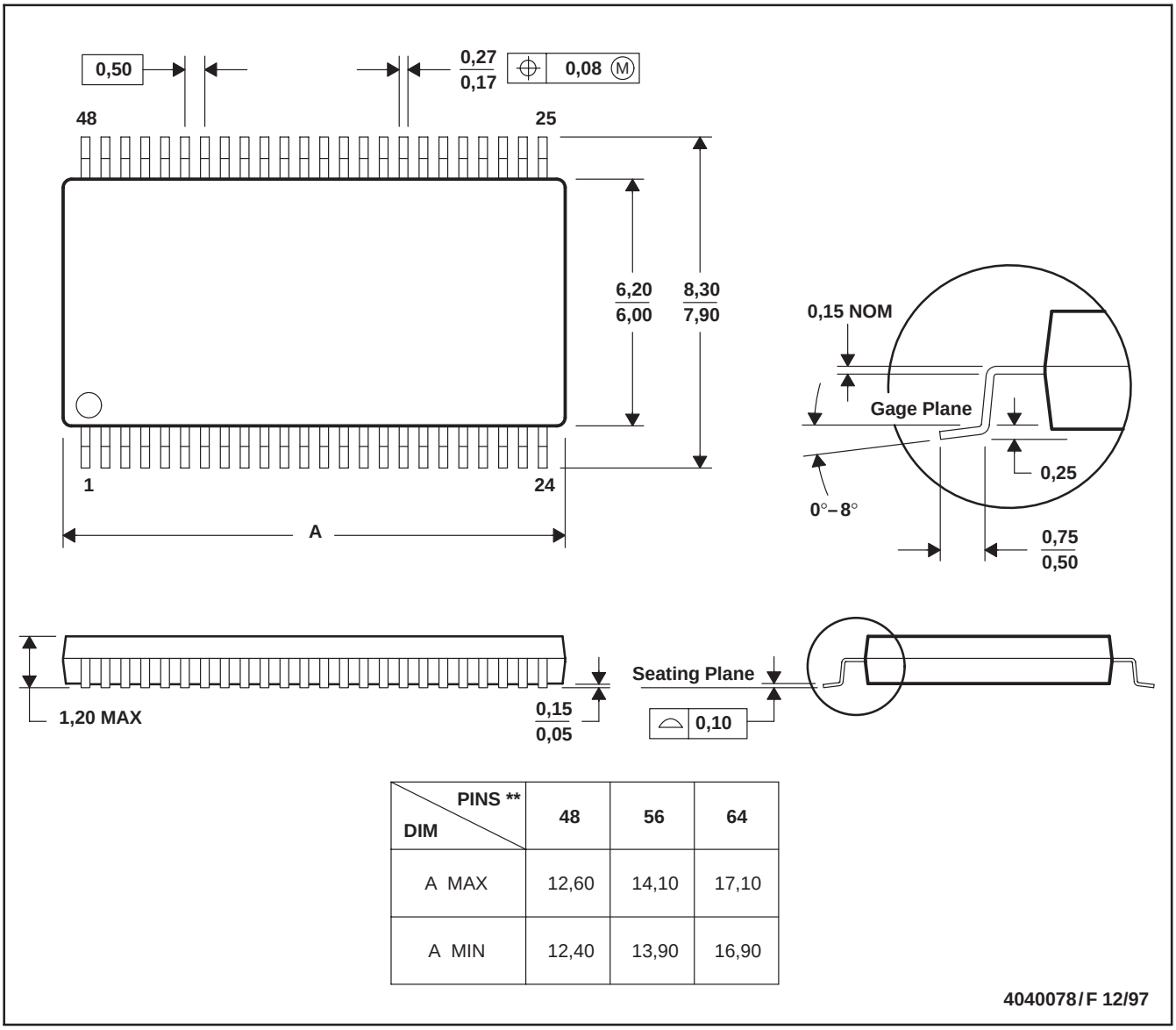


*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AVC16269DGGR	TSSOP	DGG	56	2000	367.0	367.0	45.0

DGG (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

48 PINS SHOWN



DIM \ PINS **	48	56	64
A MAX	12,60	14,10	17,10
A MIN	12,40	13,90	16,90

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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