

- Member of the Texas Instruments Widebus™ Family
- **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**
- **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**

### 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 TI application reports *AVC Logic Family Technology and Applications*, literature number SCEA006, and *Dynamic Output Control (DOC™) Circuitry Technology and Applications*, literature number SCEA009.

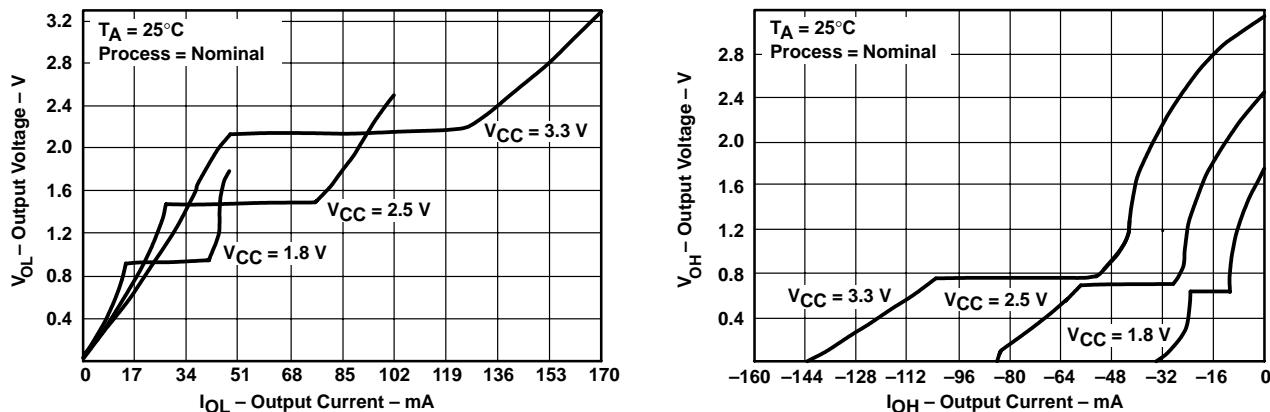


Figure 1. Output Voltage vs Output Current

This 18-bit universal bus driver 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.

Data flow from A to Y is controlled by the output-enable ( $\overline{OE}$ ) input. The device operates in the transparent mode when the latch-enable (LE) input is high. The A data is latched if the clock (CLK) input is held at a high or low logic level. If LE is low, the A data is stored in the latch/flip-flop on the low-to-high transition of CLK. When  $\overline{OE}$  is high, 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.



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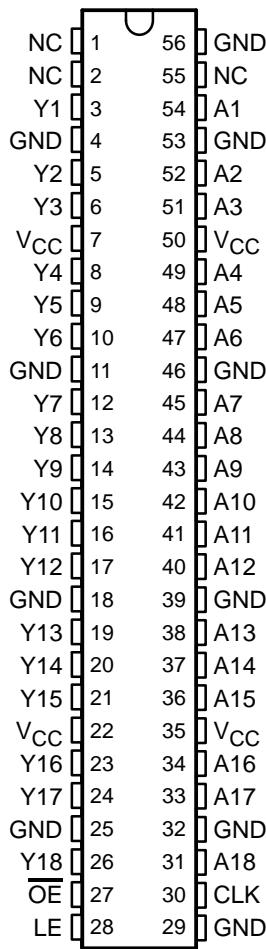
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**SN74AVC16835**  
**18-BIT UNIVERSAL BUS DRIVER**  
**WITH 3-STATE OUTPUTS**

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**terminal assignments**

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



NC – No internal connection

**ORDERING INFORMATION**

T <sub>A</sub>	PACKAGE <sup>†</sup>		ORDERABLE PART NUMBER	TOP-SIDE MARKING
-40°C to 85°C	TSSOP – DGG	Tape and reel	SN74AVC16835DGGR	AVC16835
	TVSOP – DGV	Tape and reel	SN74AVC16835DGVR	CVA835

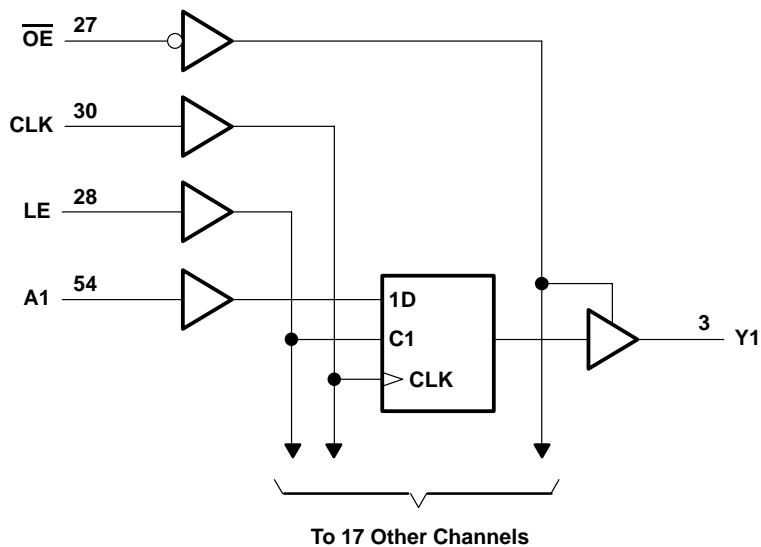
<sup>†</sup> Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at [www.ti.com/sc/package](http://www.ti.com/sc/package).

FUNCTION TABLE  
 (each universal bus driver)

INPUTS				OUTPUT
$\overline{OE}$	LE	CLK	A	Y
H	X	X	X	Z
L	H	X	L	L
L	H	X	H	H
L	L	↑	L	L
L	L	↑	H	H
L	L	L or H	X	$Y_0 \dagger$

<sup>†</sup>Output level before the indicated steady-state input conditions were established, provided that CLK is high before LE goes low

**logic diagram (positive logic)**



To 17 Other Channels

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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 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, $\theta_{JA}$ (see Note 3): DGG package .....	64°C/W
	DGV package .....
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 JEDEC 51-7.



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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>OLOS</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 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 TI application report *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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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>	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, $\overline{OE} = V_{CC}$		3.6 V		±10	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>	CLK input	V <sub>I</sub> = V <sub>CC</sub> or GND		2.5 V	4		pF
				3.3 V	4		
	Control inputs	V <sub>I</sub> = V <sub>CC</sub> or GND		2.5 V	4		
				3.3 V	4		
C <sub>o</sub>	Data inputs	V <sub>I</sub> = V <sub>CC</sub> or GND		2.5 V	2.5		pF
				3.3 V	2.5		
	Outputs	V <sub>O</sub> = V <sub>CC</sub> or GND		2.5 V	6.5		
				3.3 V	6.5		

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

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

		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
			MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Clock frequency				150		150		150		MHz
t <sub>w</sub>	Pulse duration	LE high			3.3		3.3		3.3		ns
		CLK high or low			3.3		3.3		3.3		
t <sub>su</sub>	Setup time	Data before CLK↑		1	0.9	0.7	0.7	0.7	0.7	0.7	ns
		Data before LE↓	CLK high	1.7	1.6	1.2	0.8	0.8	0.8	0.8	
			CLK low	2	0.9	0.7	0.5	0.5	0.5	0.5	
t <sub>h</sub>	Hold time	Data after CLK↑		1.5	1.3	1	0.9	0.9	1.3	1.3	ns
		Data after LE↓	CLK high	3.2	2.4	2	1.7	1.7	1.6	1.6	
			CLK low	2.8	2.1	1.7	1.5	1.5	1.4	1.4	

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 1.2\text{ V}$	$V_{CC} = 1.5\text{ V} \pm 0.1\text{ V}$		$V_{CC} = 1.8\text{ V} \pm 0.15\text{ V}$		$V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$		$V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$		UNIT
			TYP	MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
$f_{max}$						150		150		150		MHz
$t_{pd}$	A	Y	4.5	1.2	6.2	1.3	5.5	1	3.1	0.9	2.5	ns
	LE		6.2	1.6	9.4	1.3	7.2	1.1	4.7	0.9	3.8	
	CLK		5.2	1.6	7.8	1.5	6	1	3.7	0.8	3.1	
$t_{en}$	$\overline{OE}$	Y	7.1	2.4	10.2	2.2	8.8	1.5	6.7	1.2	6.2	ns
$t_{dis}$	OE	Y	6.9	2.2	10.3	2	8.4	1.2	5.3	1.1	5.3	ns

switching characteristics,  $T_A = 0^\circ\text{C}$  to  $85^\circ\text{C}$ ,  $C_L = 0\text{ pF}^\dagger$

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 3.3\text{ V} \pm 0.15\text{ V}$	UNIT
			MIN	
$t_{pd}$	A	Y	0.6	ns
	CLK		0.7	

<sup>†</sup>Texas Instruments SPICE simulation data

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

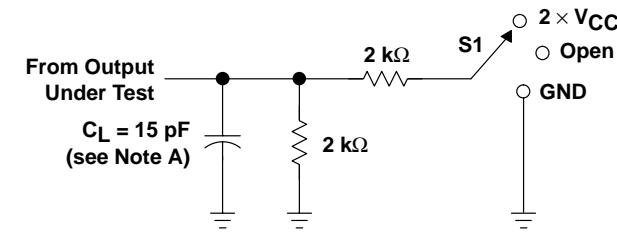
PARAMETER	TEST CONDITIONS	$V_{CC} = 1.8\text{ V}$	$V_{CC} = 2.5\text{ V}$	$V_{CC} = 3.3\text{ V}$	UNIT
		TYP	TYP	TYP	
C <sub>pd</sub>	Power dissipation capacitance	45	48	52	pF
		23	25	28	

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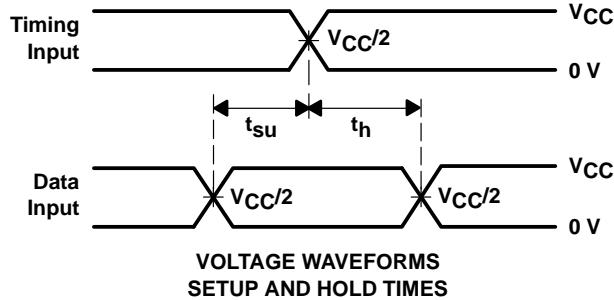
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**PARAMETER MEASUREMENT INFORMATION**

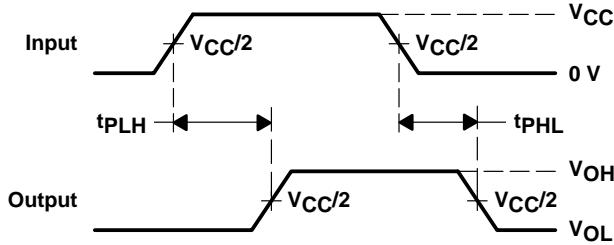
$V_{CC} = 1.2 \text{ V AND } 1.5 \text{ V} \pm 0.1 \text{ V}$



LOAD CIRCUIT

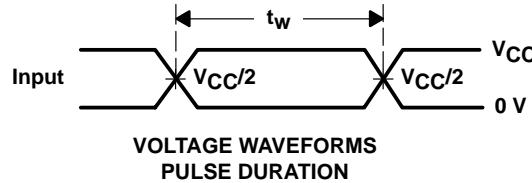


VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES

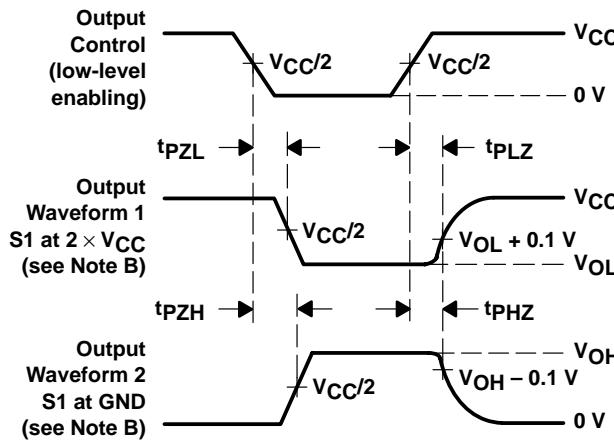


VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES

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



VOLTAGE WAVEFORMS  
PULSE DURATION



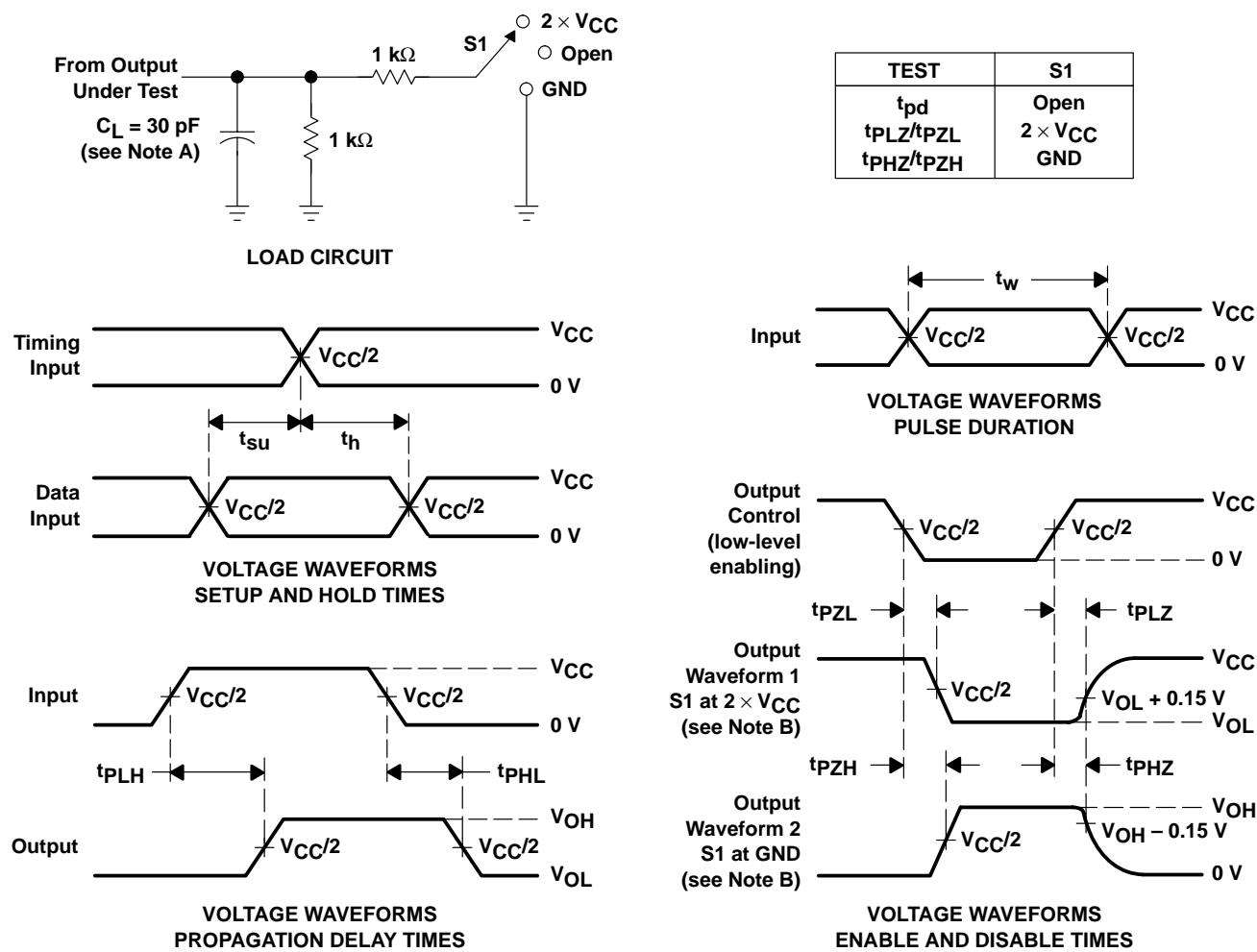
VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

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 2. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION

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



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  $t_{pd}$ .

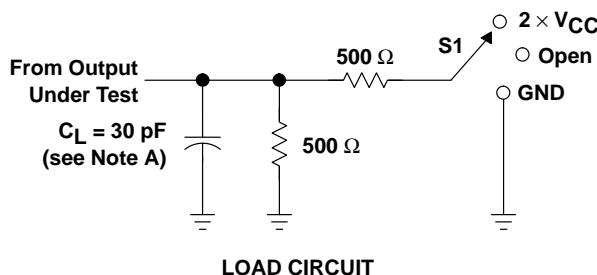
Figure 3. Load Circuit and Voltage Waveforms

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**WITH 3-STATE OUTPUTS**

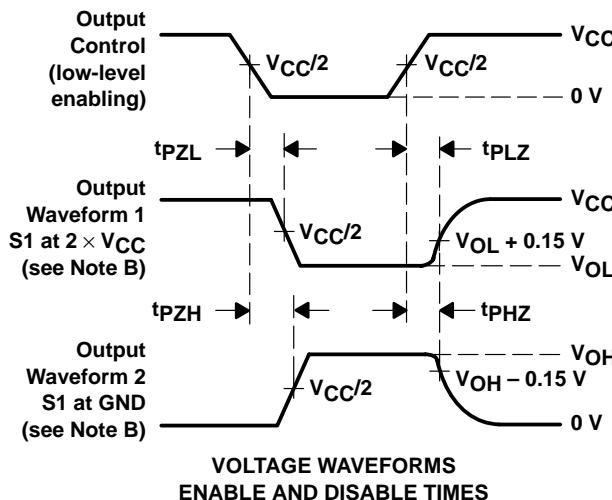
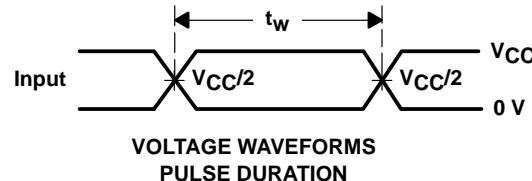
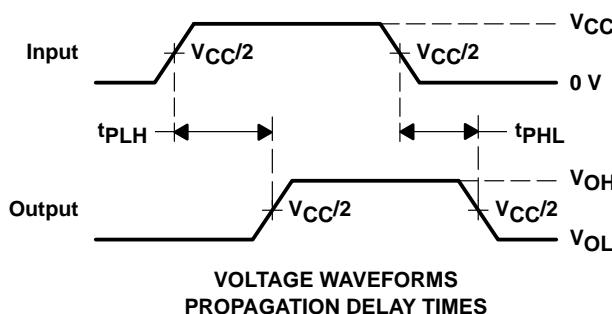
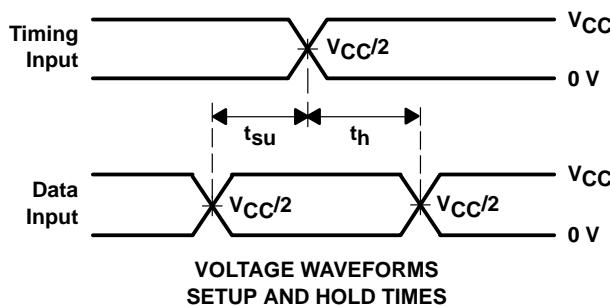
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**PARAMETER MEASUREMENT INFORMATION**

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



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



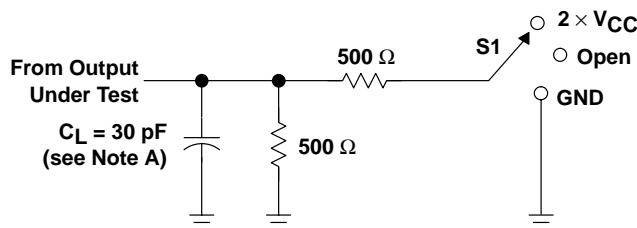
NOTES:

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- All input pulses are supplied by generators having the following characteristics: PRR  $\leq 10 \text{ MHz}$ ,  $Z_O = 50 \Omega$ ,  $t_r \leq 2 \text{ ns}$ ,  $t_f \leq 2 \text{ ns}$ .
- 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 4. Load Circuit and Voltage Waveforms

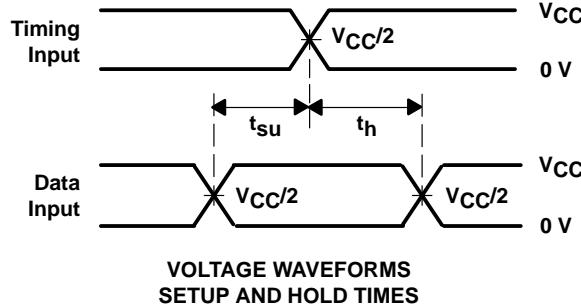
PARAMETER MEASUREMENT INFORMATION

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

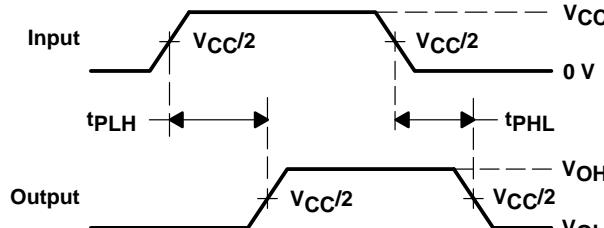


LOAD CIRCUIT

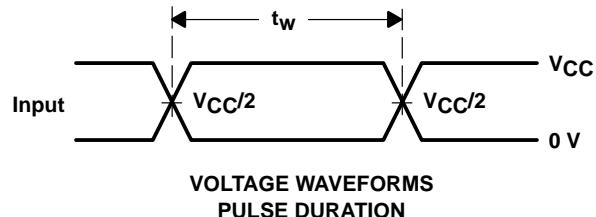
TEST	S1
$t_{pd}$	Open
$t_{PLZ}/t_{PZL}$	$2 \times V_{CC}$
$t_{PHZ}/t_{PZH}$	GND



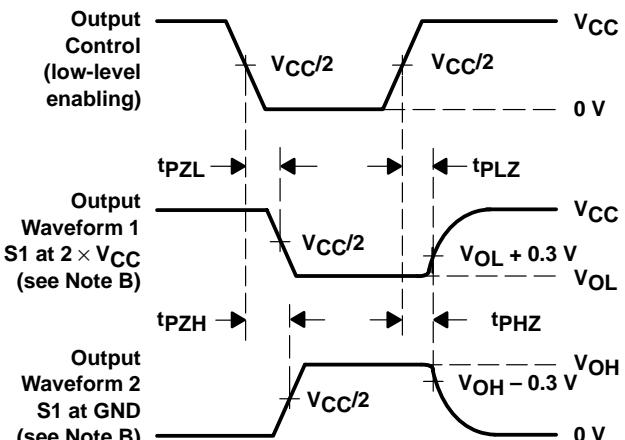
VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
PULSE DURATION



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES

NOTES:

- $C_L$  includes probe and jig capacitance.
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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 5. Load Circuit and Voltage Waveforms

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
74AVC16835DGGRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74AVC16835DGVR4	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74AVC16835DGVRG4	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74AVC16835DGGR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74AVC16835DGVR	ACTIVE	TVSOP	DGV	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

<sup>(1)</sup> 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.

<sup>(2)</sup> Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS) 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.

**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)

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

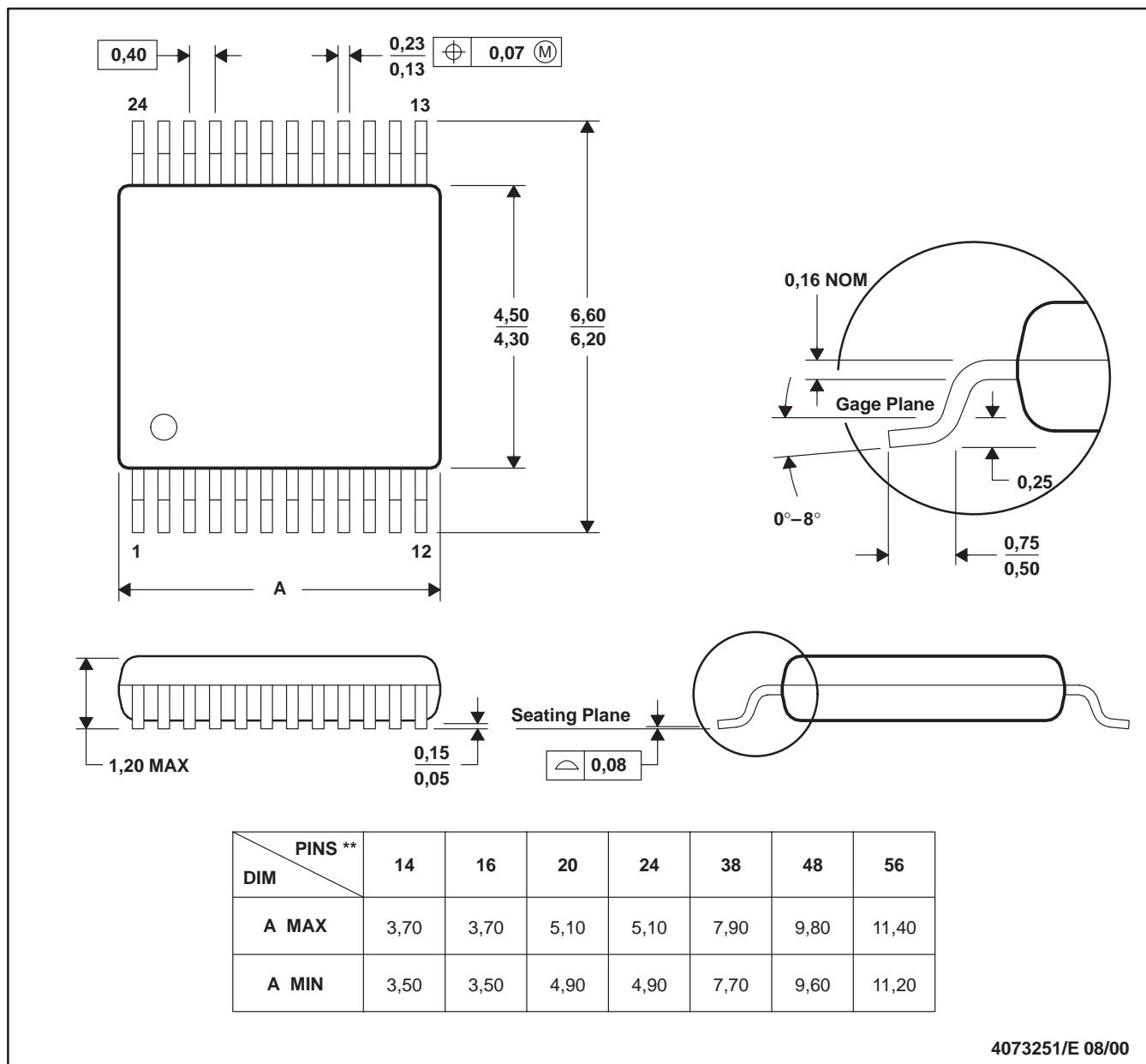
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## DGV (R-PDSO-G\*\*)

## PLASTIC SMALL-OUTLINE

24 PINS SHOWN

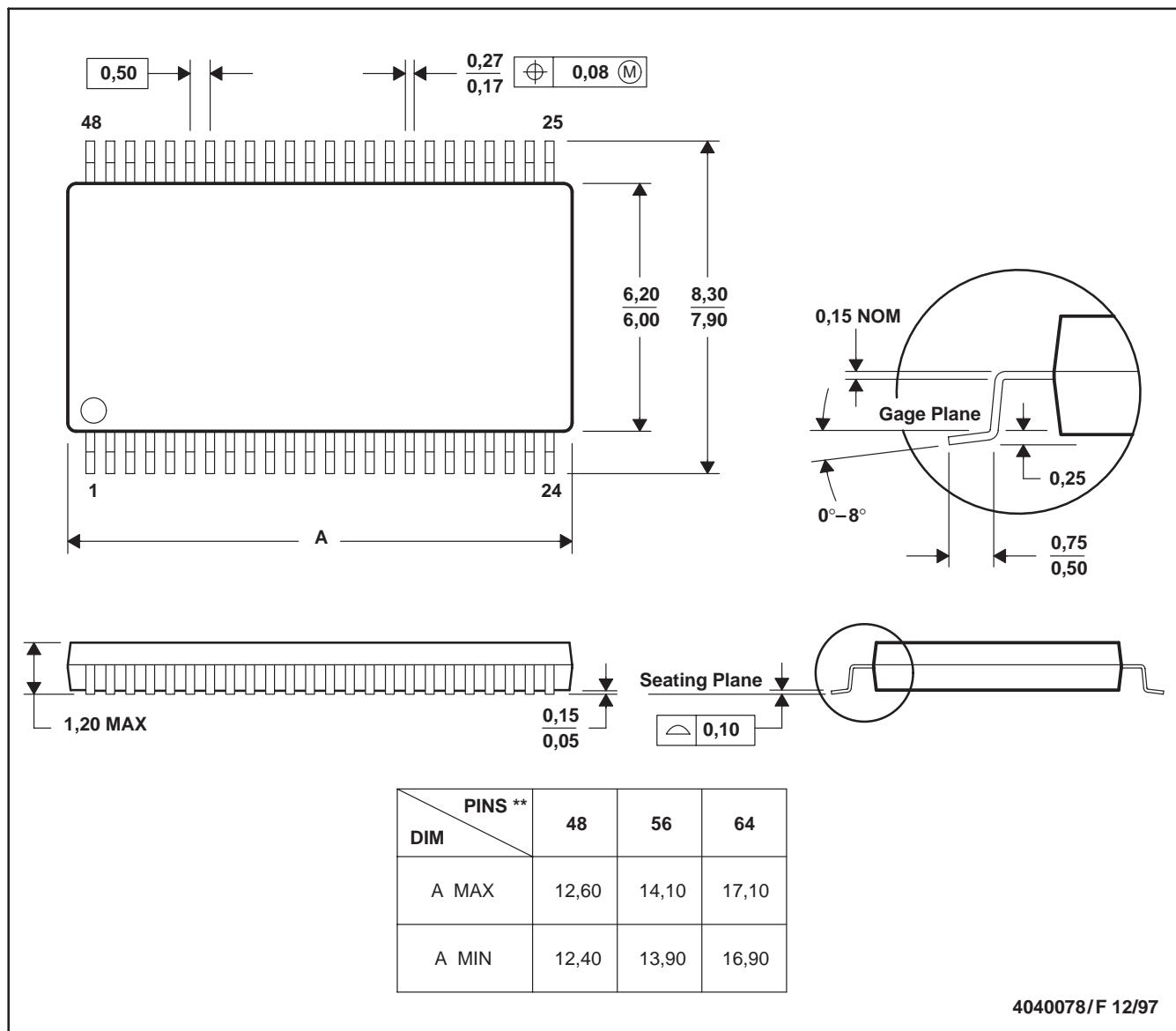


NOTES: A. All linear dimensions are in millimeters.  
 B. This drawing is subject to change without notice.  
 C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15 per side.  
 D. Falls within JEDEC: 24/48 Pins – MO-153  
 14/16/20/56 Pins – MO-194

## 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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