SN54ALVTH162245, SN74ALVTH162245
2.5-V/3.3-V 16-BIT BUS TRANSCEIVERS
WITH 3-STATE OUTPUTS
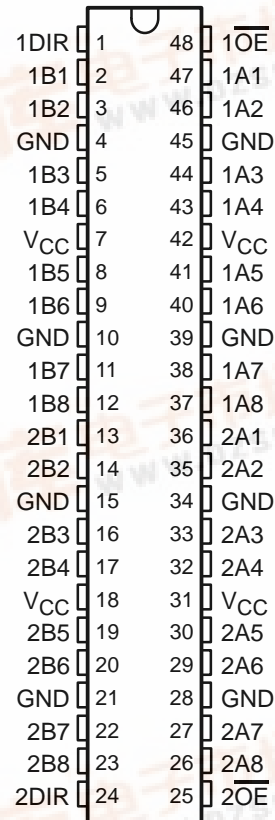
SCES331A – APRIL 2000 – REVISED APRIL 2002

- **State-of-the-Art Advanced BiCMOS Technology (ABT) Widebus™ Design for 2.5-V and 3.3-V Operation and Low Static-Power Dissipation**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 2.3-V to 3.6-V V_{CC})**
- **Typical V_{OLP} (Output Ground Bounce) <0.8 V at V_{CC} = 3.3 V, T_A = 25°C**
- **High Drive**
  - **A Port = –12/12 mA at 3.3-V V_{CC}**
  - **B port = –32/64 mA at 3.3-V V_{CC}**
- **I_{off} and Power-Up 3-State Support Hot Insertion**
- **Use Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating**
- **A-Port Outputs Have Equivalent 30-Ω Series Resistors, So No External Resistors Are Required**
- **Flow-Through Architecture Facilitates Printed Circuit Board Layout**
- **Distributed V_{CC} and GND Pins Minimize High-Speed Switching Noise**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**

SN54ALVTH162245 . . . WD PACKAGE
SN74ALVTH162245 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)

1DIR	1	48	1OE
1B1	2	47	1A1
1B2	3	46	1A2
GND	4	45	GND
1B3	5	44	1A3
1B4	6	43	1A4
V_{CC}	7	42	V_{CC}
1B5	8	41	1A5
1B6	9	40	1A6
GND	10	39	GND
1B7	11	38	1A7
1B8	12	37	1A8
2B1	13	36	2A1
2B2	14	35	2A2
GND	15	34	GND
2B3	16	33	2A3
2B4	17	32	2A4
V_{CC}	18	31	V_{CC}
2B5	19	30	2A5
2B6	20	29	2A6
GND	21	28	GND
2B7	22	27	2A7
2B8	23	26	2A8
2DIR	24	25	2OE

description

The 'ALVTH162245 devices are 16-bit (dual-octal) noninverting 3-state transceivers designed for 2.5-V or 3.3-V V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

These devices can be used as two 8-bit transceivers or one 16-bit transceiver. They allow data transmission from the A bus to the B bus or from the B bus to the A bus, depending on the logic level at the direction-control (DIR) input. The output-enable (OE) input can be used to disable the device so that the buses are effectively isolated.

The A-port outputs, which are designed to source or sink up to 12 mA, include equivalent 30-Ω series resistors to reduce overshoot and undershoot.

These devices are fully specified for hot-insertion applications using I_{off} and power-up 3-state. The I_{off} circuitry disables the outputs, preventing damaging current backflow through the device when it is powered down. The power-up 3-state circuitry places the outputs in the high-impedance state during power up and power down, which prevents driver conflict.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level. Use of pullup or pulldown resistors with the bus-hold circuitry is not recommended.

Please be aware that an important notice concerning availability, standard warranty, and use in critical applications of Texas Instruments semiconductor products and disclaimers thereto appears at the end of this data sheet.

Widebus is a trademark of Texas Instruments.

TEXAS
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SN54ALVTH162245, SN74ALVTH162245
2.5-V/3.3-V 16-BIT BUS TRANSCEIVERS
WITH 3-STATE OUTPUTS

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description (continued)

When V_{CC} is between 0 and 1.2 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.2 V, $\overline{OE}$ 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.

SN74ALVTH162245 . . . GQL PACKAGE
(TOP VIEW)
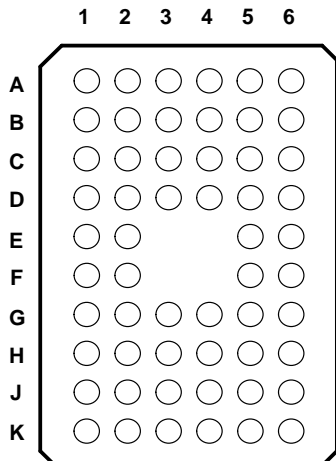
terminal assignments

	1	2	3	4	5	6
A	1DIR	NC	NC	NC	NC	1$\overline{OE}$
B	1B2	1B1	GND	GND	1A1	1A2
C	1B4	1B3	V_{CC}	V_{CC}	1A3	1A4
D	1B6	1B5	GND	GND	1A5	1A6
E	1B8	1B7			1A7	1A8
F	2B1	2B2			2A2	2A1
G	2B3	2B4	GND	GND	2A4	2A3
H	2B5	2B6	V_{CC}	V_{CC}	2A6	2A5
J	2B7	2B8	GND	GND	2A8	2A7
K	2DIR	NC	NC	NC	NC	2$\overline{OE}$

NC – No internal connection

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SSOP – DL	Tape and reel	SN74ALVTH162245LR	ALVTH162245
	TSSOP – DGG	Tape and reel	SN74ALVTH162245GR	ALVTH162245
	TVSOP – DGV	Tape and reel	SN74ALVTH162245VR	VT2245
	VFBGA – GQL	Tape and reel	SN74ALVTH162245QR	
–55°C to 125°C	CFP – WD	Tube	SNJ54ALVTH162245WD	SNJ54ALVTH162245WD

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.
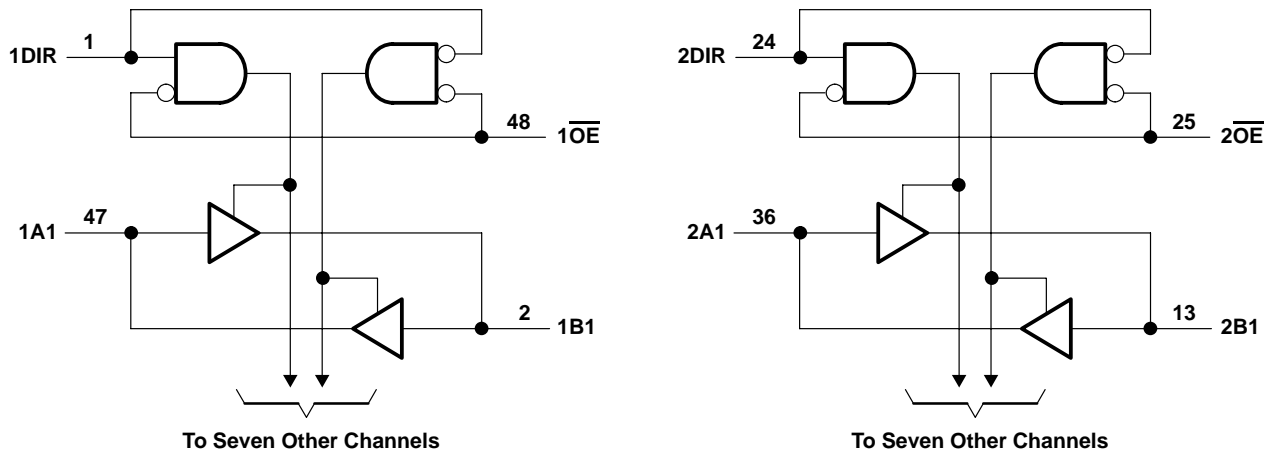
FUNCTION TABLE
(each 8-bit section)

INPUTS		OPERATION
$\overline{OE}$	DIR	
L	L	B data to A bus
L	H	A data to B bus
H	X	Isolation

logic diagram (positive logic)

Pin numbers shown are for the DGG, DGV, DL, and WD packages.

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 7 V

Voltage range applied to any output in the high-impedance
or power-off state, V_O (see Note 1) .... –0.5 V to 7 V

Voltage range applied to any output in the high state, V_O (see Note 1) .... –0.5 V to 7 V

Output current in the low state, I_O: SN54ALVTH162245 .... 96 mA

SN74ALVTH162245 .... 128 mA

Output current in the high state, I_O: SN54ALVTH162245 .... –48 mA

SN74ALVTH162245 .... –64 mA

Continuous current through V_{CC} or GND .... ±100 mA

Input clamp current, I_{IK} ($V_I < 0$) .... –50 mA

Output clamp current, I_{OK} ($V_O < 0$) .... –50 mA

Package thermal impedance, θ_{JA} (see Note 2): DGG package .... 70°C/W

DGV package .... 58°C/W

DL package .... 63°C/W

GQL package .... 42°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 clamp-current ratings are observed.
2. The package thermal impedance is calculated in accordance with JESD 51-7.

TEXAS
INSTRUMENTS

recommended operating conditions, V_{CC} = 2.5 V $\pm$ 0.2 V (see Note 3)

			SN54ALVTH162245			SN74ALVTH162245			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage		2.3		2.7	2.3		2.7	V
V_{IH}	High-level input voltage		1.7			1.7			V
V_{IL}	Low-level input voltage				0.7			0.7	V
V_I	Input voltage		0	V_{CC}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current (A port)				–6			–8	mA
	High-level output current (B port)				–6			–8	
I_{OL}	Low-level output current (A port)				6			12	mA
	Low-level output current (B port)				6			8	
	Low-level output current; current duty cycle $\leq$ 50%; f $\geq$ 1 kHz (B port)				18			24	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			μs/V
T_A	Operating free-air temperature		–55		125	–40		85	°C

NOTE 3: All unused control 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.

recommended operating conditions, V_{CC} = 3.3 V $\pm$ 0.3 V (see Note 3)

			SN54ALVTH162245			SN74ALVTH162245			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{CC}	Supply voltage		3		3.6	3		3.6	V
V_{IH}	High-level input voltage		2			2			V
V_{IL}	Low-level input voltage				0.8			0.8	V
V_I	Input voltage		0	V_{CC}	5.5	0	V_{CC}	5.5	V
I_{OH}	High-level output current (A port)				–8			–12	mA
	High-level output current (B port)				–24			–32	
I_{OL}	Low-level output current (A port)				8			12	mA
	Low-level output current (B port)				24			32	
	Low-level output current; current duty cycle $\leq$ 50%; f $\geq$ 1 kHz (B port)				48			64	
$\Delta t/\Delta v$	Input transition rise or fall rate	Outputs enabled			10			10	ns/V
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		200			200			μs/V
T_A	Operating free-air temperature		–55		125	–40		85	°C

NOTE 3: All unused control 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.

TEXAS INSTRUMENTS

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 2.5 V $\pm$ 0.2 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH162245			SN74ALVTH162245			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V_{IK}		V_{CC} = 2.3 V,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	A port	V_{CC} = 2.3 V to 2.7 V,	I_{OH} = −100 µA	V_{CC}−0.2			V_{CC}−0.2			V
		V_{CC} = 2.3 V	I_{OH} = −6 mA	1.7						
			I_{OH} = −8 mA				1.7			
	B port	V_{CC} = 2.3 V to 2.7 V,	I_{OH} = −100 µA	V_{CC}−0.2			V_{CC}−0.2			
		V_{CC} = 2.3 V	I_{OH} = −6 mA	1.7						
			I_{OH} = −8 mA				1.7			
V_{OL}	A port	V_{CC} = 2.3 V to 2.7 V,	I_{OL} = 100 µA			0.2			0.2	V
		V_{CC} = 2.3 V	I_{OL} = 6 mA			0.4				
			I_{OL} = 12 mA						0.4	
	B port	V_{CC} = 2.3 V to 2.7 V,	I_{OL} = 100 µA			0.2			0.2	
		V_{CC} = 2.3 V	I_{OL} = 6 mA			0.4				
			I_{OL} = 8 mA						0.4	
			I_{OL} = 18 mA			0.5				
			I_{OL} = 24 mA						0.5	
I_I	Control inputs	V_{CC} = 2.7 V,	V_I = GND			±1			±1	µA
		V_{CC} = 0 or 2.7 V,	V_I = 5.5 V			10			10	
	A or B ports	V_{CC} = 2.7 V	V_I = 5.5 V			20			20	
			V_I = V_{CC}			1			1	
			V_I = 0			−5			−5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V						±100	µA
I_{BHL}‡		V_{CC} = 2.3 V,	V_I = 0.7 V	115			115			µA
I_{BHH}§		V_{CC} = 2.3 V,	V_I = 1.7 V	−10			−10			µA
I_{BHLO}¶		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	300			300			µA
I_{BHHO}#		V_{CC} = 2.7 V,	V_I = 0 to V_{CC}	−300			−300			µA
I_{EX}‖		V_{CC} = 2.3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$☆		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{CC}		V_{CC} = 2.7 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.04	0.1		0.04	0.1	mA
			Outputs low		2.3	4.5		2.3	4.5	
			Outputs disabled		0.04	0.1		0.04	0.1	
C_i		V_{CC} = 2.5 V,	V_I = 2.5 V or 0		3.5			3.5		pF
C_{io}		V_{CC} = 2.5 V,	V_O = 2.5 V or 0		8			8		pF

† All typical values are at V_{CC} = 2.5 V, T_A = 25°C.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

‖ Current into an output in the high state when $V_O > V_{CC}$

☆ High-impedance state during power up or power down

TEXAS INSTRUMENTS

electrical characteristics over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted)

PARAMETER		TEST CONDITIONS		SN54ALVTH162245 MIN	TYP†	MAX	SN74ALVTH162245 MIN	TYP†	MAX	UNIT
V_{IK}		V_{CC} = 3 V,	I_I = −18 mA			−1.2			−1.2	V
V_{OH}	A port	V_{CC} = 3 V to 3.6 V,	I_{OH} = −100 µA	V_{CC}−0.2			V_{CC}−0.2			V
		V_{CC} = 3 V	I_{OH} = −8 mA	2						
			I_{OH} = −12 mA				2			
	B port	V_{CC} = 3 V to 3.6 V,	I_{OH} = −100 µA	V_{CC}−0.2			V_{CC}−0.2			
		V_{CC} = 3 V	I_{OH} = −24 mA	2						
			I_{OH} = −32 mA				2			
V_{OL}	A port	V_{CC} = 3 V to 3.6 V,	I_{OL} = 100 µA			0.2			0.2	V
		V_{CC} = 3 V	I_{OL} = 8 mA			?				
			I_{OL} = 12 mA						0.8	
	B port	V_{CC} = 3 V to 3.6 V,	I_{OL} = 100 µA			0.2			0.2	
		V_{CC} = 3 V	I_{OL} = 24 mA			0.5				
			I_{OL} = 32 mA						0.5	
			I_{OL} = 48 mA			0.55				
			I_{OL} = 64 mA						0.55	
I_I	Control inputs	V_{CC} = 3.6 V,	V_I = V_{CC} or GND			±1			±1	µA
		V_{CC} = 0 or 3.6 V,	V_I = 5.5 V			10			10	
	A or B ports	V_{CC} = 3.6 V	V_I = 5.5 V			20			20	
			V_I = V_{CC}			1			1	
			V_I = 0			−5			−5	
I_{off}		V_{CC} = 0,	V_I or V_O = 0 to 4.5 V						±100	µA
I_{BHL}‡		V_{CC} = 3 V,	V_I = 0.8 V	75			75			µA
I_{BHH}§		V_{CC} = 3 V,	V_I = 2 V	−75			−75			µA
I_{BHLO}¶		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	500			500			µA
I_{BHHO}#		V_{CC} = 3.6 V,	V_I = 0 to V_{CC}	−500			−500			µA
I_{EX}‖		V_{CC} = 3 V,	V_O = 5.5 V			125			125	µA
$I_{OZ(PU/PD)}$☆		V_{CC} ≤ 1.2 V, V_O = 0.5 V to V_{CC}, V_I = GND or V_{CC}, $\overline{OE}$ = don't care				±100			±100	µA
I_{CC}		V_{CC} = 3.6 V, I_O = 0, V_I = V_{CC} or GND	Outputs high		0.07	0.1		0.07	0.1	mA
			Outputs low		3.2	5		3.2	5	
			Outputs disabled		0.07	0.1		0.07	0.1	
ΔI_{CC}□		V_{CC} = 3 V to 3.6 V, One input at V_{CC} − 0.6 V, Other inputs at V_{CC} or GND				0.2			0.2	mA
C_i		V_{CC} = 3.3 V,	V_I = 3.3 V or 0		3.5			3.5		pF
C_{io}		V_{CC} = 3.3 V,	V_O = 3.3 V or 0		8			8		pF

† All typical values are at V_{CC} = 3.3 V, T_A = 25°C.

‡ The bus-hold circuit can sink at least the minimum low sustaining current at V_{IL} max. I_{BHL} should be measured after lowering V_{IN} to GND and then raising it to V_{IL} max.

§ The bus-hold circuit can source at least the minimum high sustaining current at V_{IH} min. I_{BHH} should be measured after raising V_{IN} to V_{CC} and then lowering it to V_{IH} min.

¶ An external driver must source at least I_{BHLO} to switch this node from low to high.

An external driver must sink at least I_{BHHO} to switch this node from high to low.

‖ Current into an output in the high state when V_O > V_{CC}

☆ High-impedance state during power up or power down

□ This is the increase in supply current for each input that is at the specified TTL voltage level rather than V_{CC} or GND.

TEXAS INSTRUMENTS

switching characteristics over recommended operating free-air temperature range, C_L = 30 pF, V_{CC} = 2.5 V $\pm$ 0.2 V (unless otherwise noted) (see Figure 1)

| PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162245		SN74ALVTH162245		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	B	0.3	3.6	0.3	3.6	ns
t_{PHL}			0.5	3.5	0.5	3.5	
t_{PLH}	B	A	1.1	4.3	1.1	4.3	ns
t_{PHL}			1.1	3.8	1.1	3.8	
t_{PZH}	$\overline{OE}$	A	2	5.6	2	5.6	ns
t_{PZL}			1.8	4.4	1.8	4.4	
t_{PZH}	$\overline{OE}$	B	1.5	5.1	1.5	5.1	ns
t_{PZL}			1.5	4.1	1.5	4.1	
t_{PHZ}	$\overline{OE}$	A	1.9	4.9	1.9	4.9	ns
t_{PLZ}			1.5	4.3	1.5	4.3	
t_{PHZ}	$\overline{OE}$	B	1.9	4.8	1.9	4.8	ns
t_{PLZ}			1.5	4.1	1.5	4.1	

switching characteristics over recommended operating free-air temperature range, C_L = 50 pF, V_{CC} = 3.3 V $\pm$ 0.3 V (unless otherwise noted) (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH162245		SN74ALVTH162245		UNIT
			MIN	MAX	MIN	MAX	
t_{PLH}	A	B	0.5	3.1	0.5	3.1	ns
t_{PHL}			0.5	3	0.5	3	
t_{PLH}	B	A	1	3.7	1	3.7	ns
t_{PHL}			1	3.4	1	3.4	
t_{PZH}	$\overline{OE}$	A	1.4	4.7	1.4	4.7	ns
t_{PZL}			1.4	3.9	1.4	3.9	
t_{PZH}	$\overline{OE}$	B	1	3.8	1	3.8	ns
t_{PZL}			0.7	3.4	0.7	3.4	
t_{PHZ}	$\overline{OE}$	A	2.4	5	2.4	5	ns
t_{PLZ}			2.6	4.9	2.6	4.9	
t_{PHZ}	$\overline{OE}$	B	2.4	4.7	2.4	4.7	ns
t_{PLZ}			2.3	4.8	2.3	4.8	

TEXAS INSTRUMENTS

PARAMETER MEASUREMENT INFORMATION

LOAD CIRCUIT
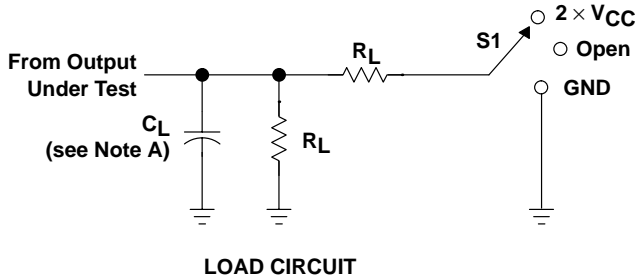
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND

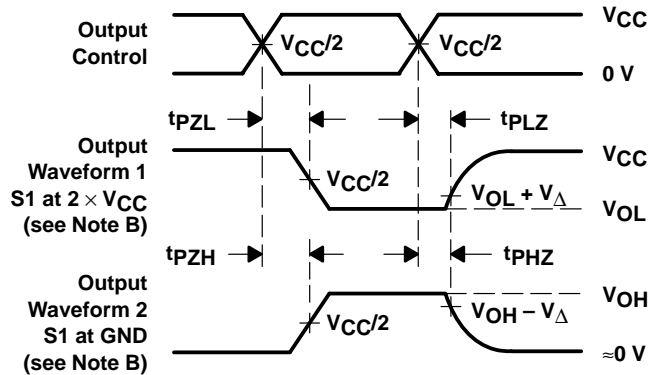| V_{CC}	C_L	R_L	V_Δ
2.5 V ±0.2 V	30 pF	500 Ω	0.15 V
3.3 V ±0.3 V	50 pF	500 Ω	0.3 V
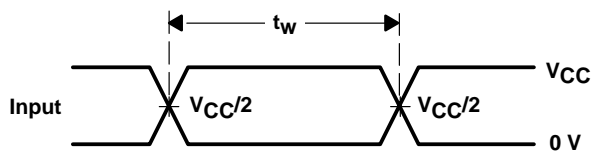
VOLTAGE WAVEFORMS
PULSE DURATION
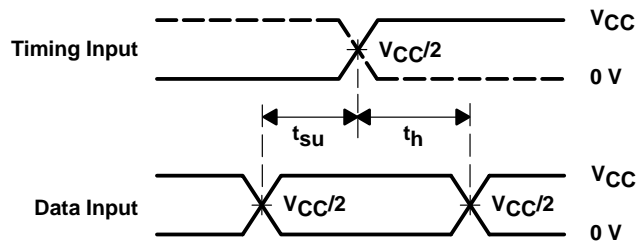
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES
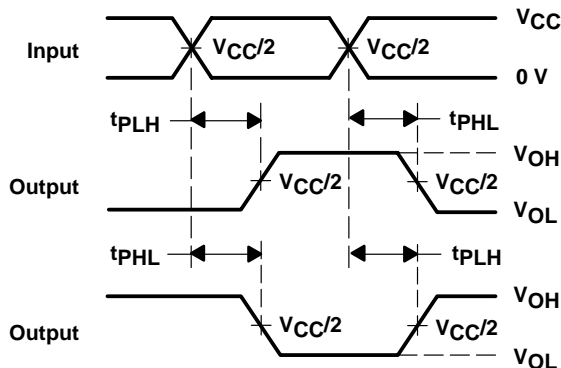
VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS

VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

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. All parameters and waveforms are not applicable to all devices.

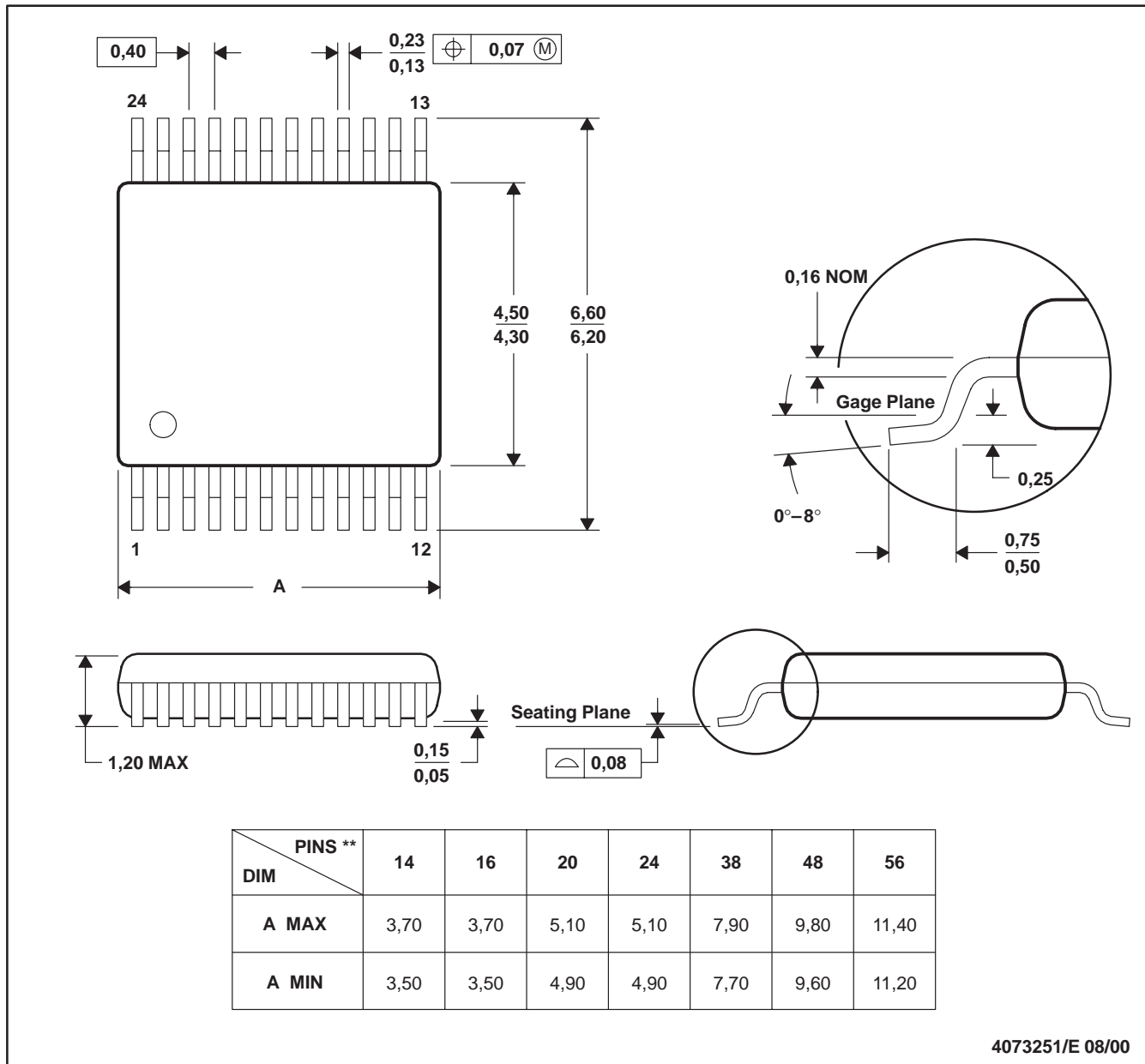**Figure 1. Load Circuit and Voltage Waveforms**

TEXAS
INSTRUMENTS

DGV (R-PDSO-G**)

24 PINS SHOWN

PLASTIC SMALL-OUTLINE

PINS ** DIM	14	16	20	24	38	48	56
A MAX	3,70	3,70	5,10	5,10	7,90	9,80	11,40
A MIN	3,50	3,50	4,90	4,90	7,70	9,60	11,20

4073251/E 08/00

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
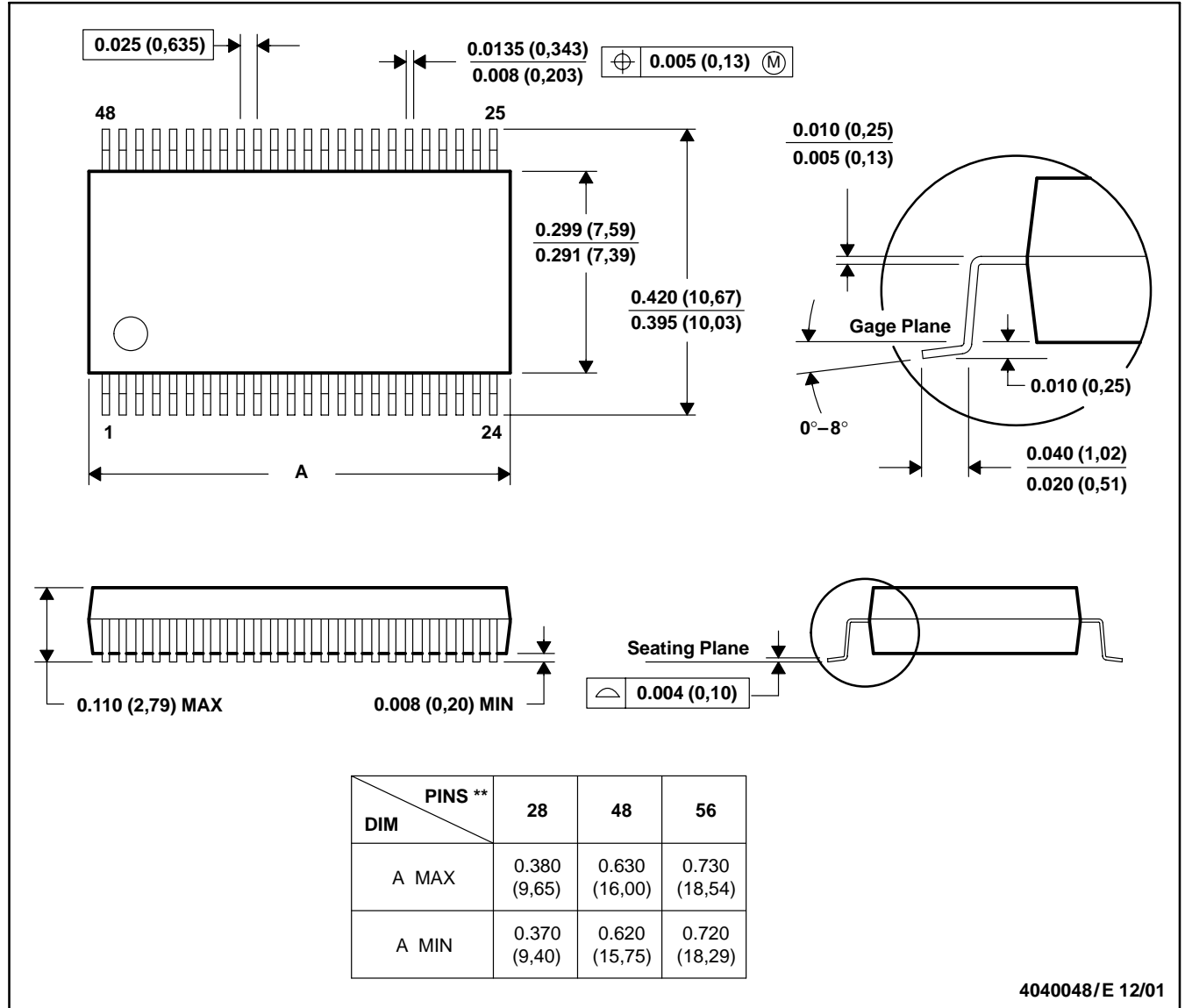14/16/20/56 Pins – MO-194

**TEXAS
INSTRUMENTS**

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

48 PINS SHOWN

0.025 (0,635)   0.0135 (0,343) / 0.008 (0,203)   ⊕ 0.005 (0,13) Ⓜ

48   25

0.299 (7,59) / 0.291 (7,39)

0.420 (10,67) / 0.395 (10,03)

0.010 (0,25) / 0.005 (0,13)

Gage Plane

0.010 (0,25)

0°–8°

1   24

0.040 (1,02) / 0.020 (0,51)

A

0.110 (2,79) MAX   0.008 (0,20) MIN

Seating Plane

0.004 (0,10)

DIM \ PINS **	28	48	56
A MAX	0.380 (9,65)	0.630 (16,00)	0.730 (18,54)
A MIN	0.370 (9,40)	0.620 (15,75)	0.720 (18,29)

4040048 / E 12/01

NOTES: A. All linear dimensions are in inches (millimeters).
       B. This drawing is subject to change without notice.
       C. Body dimensions do not include mold flash or protrusion not to exceed 0.006 (0,15).
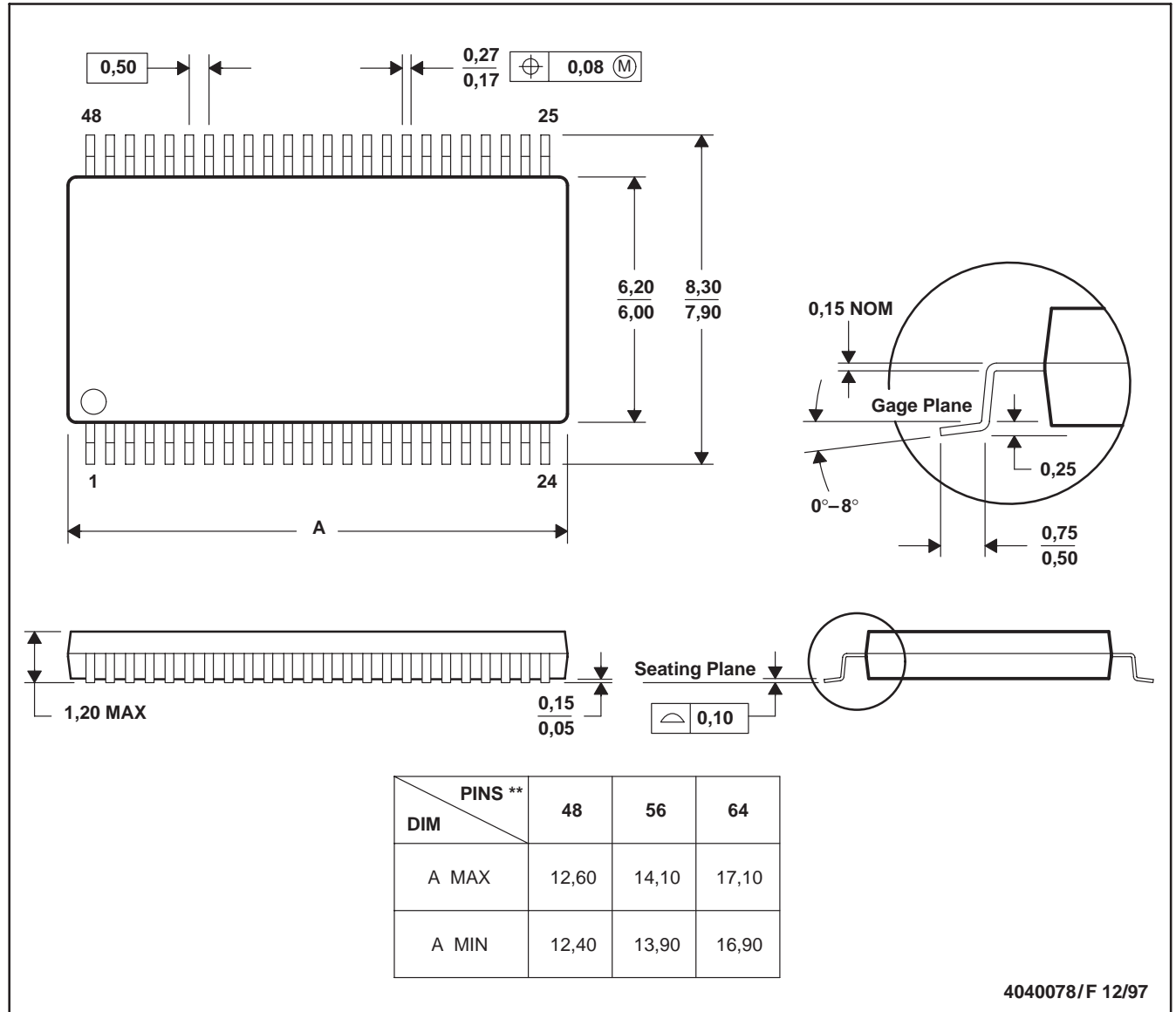   D. Falls within JEDEC MO-118

TEXAS
INSTRUMENTS

MECHANICAL DATA

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

48 PINS SHOWN

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

4040078 / F 12/97

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

TEXAS
INSTRUMENTS

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