SN74ALVCH162601
18-BIT UNIVERSAL BUS TRANSCEIVER WITH 3-STATE OUTPUTS

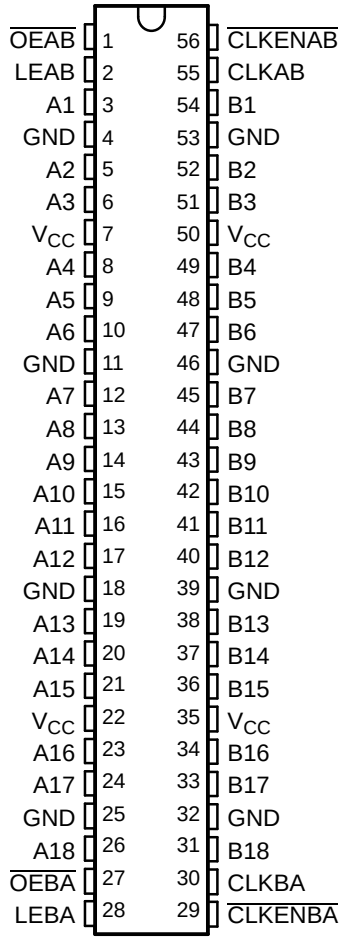
SCES026H – JULY 1995 – REVISED AUGUST 2004

FEATURES

- **Member of the Texas Instruments Widebus™ Family**
- **EPIC™ (Enhanced-Performance Implanted CMOS) Submicron Process**
- **UBT™ (Universal Bus Transceiver) Combines D-Type Latches and D-Type Flip-Flops for Operation in Transparent, Latched, Clocked, or Clock-Enabled Modes**
- **B-Port Outputs Have Equivalent 26-Ω Series Resistors, So No External Resistors Are Required**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)**
- **Latch-Up Performance Exceeds 250 mA Per JESD 17**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Package Options Include Plastic 300-mil Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages**

NOTE: For tape-and-reel order entry, the DGGR package is abbreviated to GR.

DGG OR DL PACKAGE
(TOP VIEW)



DESCRIPTION

This 18-bit universal bus transceiver is designed for 1.65-V to 3.6-V V_{CC} operation.

The SN74ALVCH162601 combines D-type latches and D-type flip-flops to allow data flow in transparent, latched, clocked, and clock-enabled modes.

Data flow in each direction is controlled by output-enable ($\overline{OEAB}$ and $\overline{OEBA}$), latch-enable (LEAB and LEBA), and clock (CLKAB and CLKBA) inputs. The clock can be controlled by the clock-enable ($\overline{CLKENAB}$ and $\overline{CLKENBA}$) inputs. For A-to-B data flow, the device operates in the transparent mode when LEAB is high. When LEAB is low, the A data is latched if CLKAB is held at a high or low logic level. If LEAB is low, the A data is stored in the latch/flip-flop on the low-to-high transition of CLKAB. When $\overline{OEAB}$ is low, the outputs are active. When $\overline{OEAB}$ is high, the outputs are in the high-impedance state.

Data flow for B to A is similar to that of A to B, but uses $\overline{OEBA}$, LEBA, CLKBA, and $\overline{CLKENBA}$.

The B-port outputs include equivalent 26-Ω series resistors to reduce overshoot and undershoot.

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.

Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

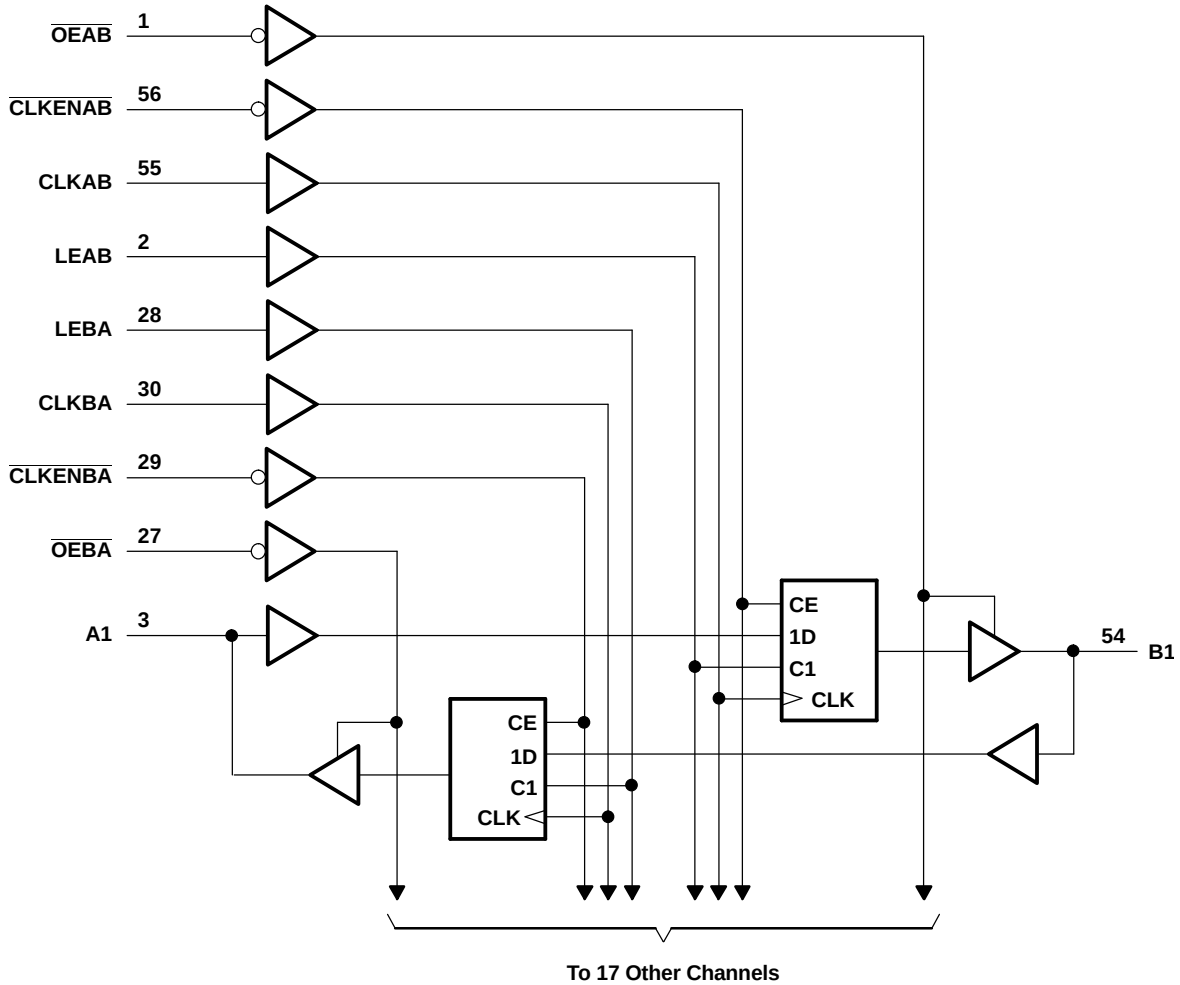
The SN74ALVCH162601 is characterized for operation from -40°C to 85°C.

FUNCTION TABLE(1)

INPUTS					OUTPUT
$\overline{\text{CLKENAB}}$	$\overline{\text{OEAB}}$	LEAB	CLKAB	A	B
X	H	X	X	X	Z
X	L	H	X	L	L
X	L	H	X	H	H
H	L	L	X	X	B_0(2)
H	L	L	X	X	B_0(2)
L	L	L	↑	L	L
L	L	L	↑	H	H
L	L	L	L or H	X	B_0(2)

(1) A-to-B data flow is shown: B-to-A flow is similar, but uses $\overline{\text{OEBA}}$, LEBA, CLKBA, and $\overline{\text{CLKENBA}}$.
(2) 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	Except I/O ports(2)	-0.5	4.6	V
		I/O ports(2)(3)	-0.5	V_{CC} + 0.5	
V_O	Output voltage range(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		81	°C/W
		DL package		74	
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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
(3) This value is limited to 4.6 V maximum.
(4) The package thermal impedance is calculated in accordance with JESD 51.

RECOMMENDED OPERATING CONDITIONS[1]

			MIN	MAX	UNIT
V_{CC}	Supply voltage		1.65	3.6	V
V_{IH}	High-level input voltage	V_{CC} = 1.65 V to 1.95 V	$0.65 \times V_{CC}$		V
		V_{CC} = 2.3 V to 2.7 V	1.7		
		V_{CC} = 2.7 V to 3.6 V	2		
V_{IL}	Low-level input voltage	V_{CC} = 1.65 V to 1.95 V		$0.35 \times V_{CC}$	V
		V_{CC} = 2.3 V to 2.7 V		0.7	
		V_{CC} = 2.7 V to 3.6 V		0.8	
V_I	Input voltage		0	V_{CC}	V
V_O	Output voltage		0	V_{CC}	V
I_{OH}	High-level output current (A port)	V_{CC} = 1.65 V		-4	mA
		V_{CC} = 2.3 V		-12	
		V_{CC} = 2.7 V		-12	
		V_{CC} = 3 V		-24	
	High-level output current (B port)	V_{CC} = 1.65 V		-2	
		V_{CC} = 2.3 V		-6	
		V_{CC} = 2.7 V		-8	
		V_{CC} = 3 V		-12	
I_{OL}	Low-level output current (A port)	V_{CC} = 1.65 V		4	mA
		V_{CC} = 2.3 V		12	
		V_{CC} = 2.7 V		12	
		V_{CC} = 3 V		24	
	Low-level output current (B port)	V_{CC} = 1.65 V		2	
		V_{CC} = 2.3 V		6	
		V_{CC} = 2.7 V		8	
		V_{CC} = 3 V		12	
$\Delta t/\Delta v$	Input transition rise or fall rate			10	ns/V
T_A	Operating free-air temperature		-40	85	°C

(1) 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.

ELECTRICAL CHARACTERISTICS

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

PARAMETER		TEST CONDITIONS	V_{CC}	MIN	TYP(1)	MAX	UNIT
V_{OH}	A port	I_{OH} = -100 µA	1.65 V to 3.6 V	V_{CC} - 0.2			V
		I_{OH} = -4 mA	1.65 V	1.2			
		I_{OH} = -6 mA	2.3 V	2			
		I_{OH} = -12 mA	2.3 V	1.7			
			2.7 V	2.2			
			3 V	2.4			
		I_{OH} = -24 mA	3 V	2			
	B port	I_{OH} = -100 µA	1.65 V to 3.6 V	V_{CC} - 0.2			
		I_{OH} = -2 mA	1.65 V	1.2			
		I_{OH} = -4 mA	2.3 V	1.9			
		I_{OH} = -6 mA	2.3 V	1.7			
			3 V	2.4			
		I_{OH} = -8 mA	2.7 V	2			
		I_{OH} = -12 mA	3 V	2			
V_{OL}	A port	I_{OL} = 100 µA	1.65 V to 3.6 V			0.2	V
		I_{OL} = 4 mA	1.65 V			0.45	
		I_{OL} = 6 mA	2.3 V			0.4	
		I_{OL} = 12 mA	2.3 V			0.7	
			2.7 V			0.4	
		I_{OL} = 24 mA	3 V			0.55	
	B port	I_{OL} = 100 µA	1.65 V to 3.6 V			0.2	
		I_{OL} = 2 mA	1.65 V			0.45	
		I_{OL} = 4 mA	2.3 V			0.4	
		I_{OL} = 6 mA	2.3 V			0.55	
			3 V			0.55	
		I_{OL} = 8 mA	2.7 V			0.6	
		I_{OL} = 12 mA	3 V			0.8	
I_I		V_I = V_{CC} or GND	3.6 V			±5	µA
$I_{I(hold)}$		V_I = 0.58 V	1.65 V	25			µA
		V_I = 1.07 V		-25			
		V_I = 0.7 V	2.3 V	45			
		V_I = 1.7 V		-45			
		V_I = 0.8 V	3 V	75			
		V_I = 2 V		-75			
		V_I = 0 to 3.6 V(2)	3.6 V			±500	
I_{OZ}(3)		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
ΔI_{CC}		One input at V_{CC} - 0.6 V, Other inputs at V_{CC} or GND	3 V to 3.6 V			750	µA
C_i	Control inputs	V_I = V_{CC} or GND	3.3 V		4		pF
C_{io}	A or B ports	V_O = V_{CC} or GND	3.3 V		8		pF

(1) All typical values are at V_{CC} = 3.3 V, T_A = 25°C.
(2) This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.
(3) 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 1 through Figure 3)

				V_{CC} = 1.8 V		V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		UNIT
				MIN	MAX	MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency				(1)		140		150		150	MHz
t_w	Pulse duration	LE high		(1)		3.3		3.3		3.3		ns
		CLK high or low		(1)		3.3		3.3		3.3		
t_{su}	Setup time	Data before CLK↑		(1)		2.3		2.4		2.1		ns
		Data before LE↓	CLK high	(1)		2		1.6		1.6		
			CLK low	(1)		1.3		1.2		1.1		
		$\overline{CLKEN}$ before CLK↑		(1)		2		2		1.7		
t_h	Hold time	Data after CLK↑		(1)		0.7		0.7		0.8		ns
		Data after LE↓	CLK high	(1)		1.3		1.6		1.4		
			CLK low	(1)		1.7		2		1.7		
		$\overline{CLKEN}$ after CLK↑		(1)		0.3		0.5		0.6		

(1) This information was not available at the time of publication.

SWITCHING CHARACTERISTICS

over recommended operating free-air temperature range (unless otherwise noted) (see Figure 1 through Figure 3)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V_{CC} = 1.8 V		V_{CC} = 2.5 V ± 0.2 V		V_{CC} = 2.7 V		V_{CC} = 3.3 V ± 0.3 V		UNIT
			MIN	TYP	MIN	MAX	MIN	MAX	MIN	MAX	
f_{max}			(1)		140		150		150		MHz
t_{pd}	A	B		(1)	1.3	4.8		5.2	1.6	4.5	ns
	B	A		(1)	1	4.3		4.6	1	4.1	
	LEAB	B		(1)	1	5.5		5.9	1.5	5.1	
	LEBA	A		(1)	1	5		5.3	1	4.7	
	CLKAB	B		(1)	1.5	6.1		6.3	1.6	5.5	
	CLKBA	A		(1)	1.3	5.6		5.8	1.4	5	
t_{en}	$\overline{OEAB}$	B		(1)	1.6	6.1		6.7	1.6	5.7	ns
t_{dis}	$\overline{OEAB}$	B		(1)	1.8	5.7		5.3	1.8	4.8	ns
t_{en}	$\overline{OEBA}$	A		(1)	1.1	5.5		6.1	1.1	5.2	ns
t_{dis}	$\overline{OEBA}$	A		(1)	1.3	5.2		4.8	1.6	4.4	ns

(1) This information was not available at the time of publication.

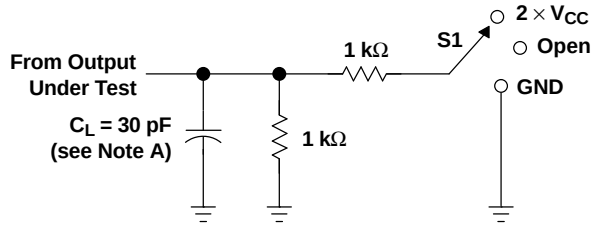
OPERATING CHARACTERISTICS

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 = 50 pF, f = 10 MHz	(1)	41	50	pF
		Outputs disabled		(1)	6	6	

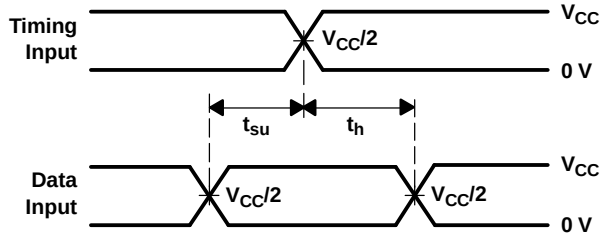
(1) This information was not available at the time of publication.

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 1.8 V

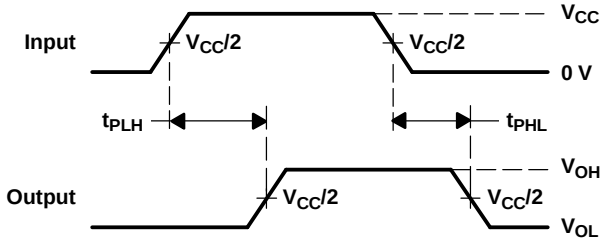


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

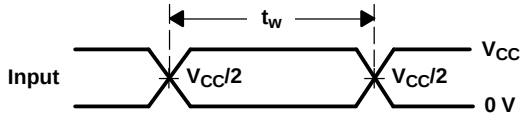
LOAD CIRCUIT



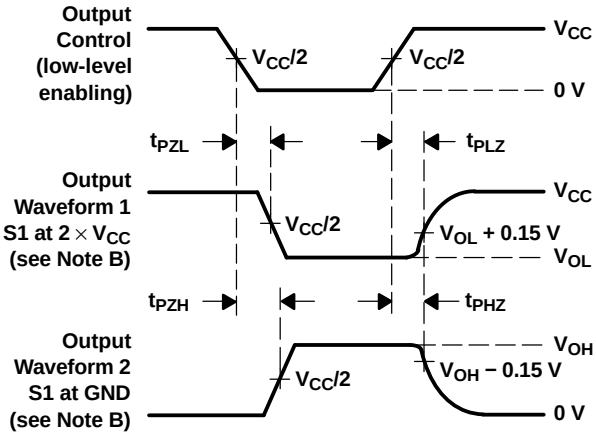
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

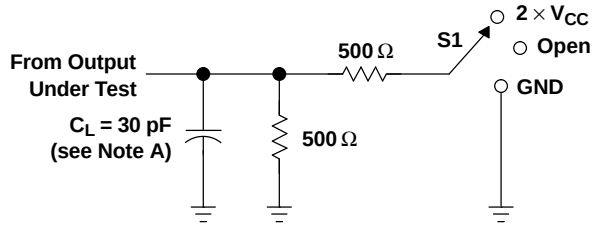


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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}.

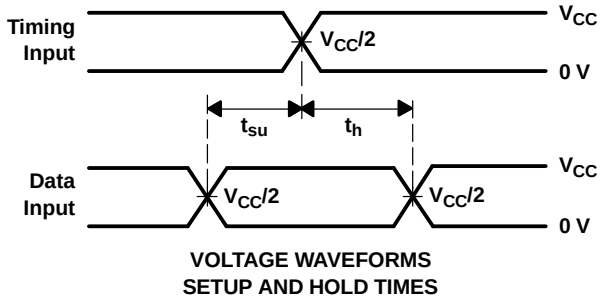
Figure 1. Load Circuit and Voltage Waveforms

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

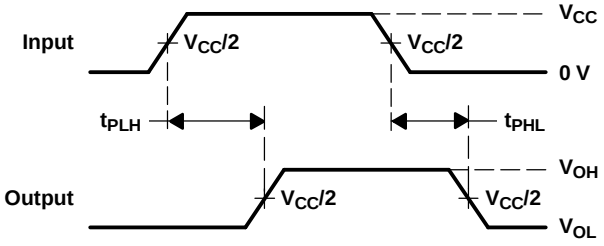


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND

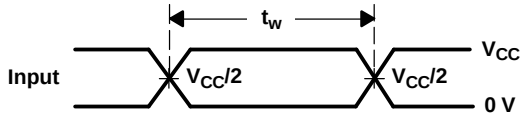
LOAD CIRCUIT



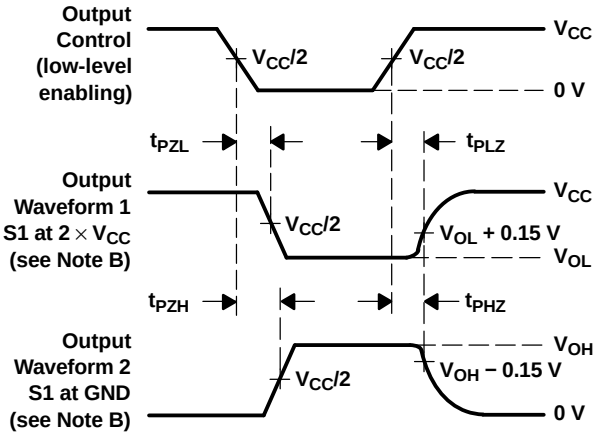
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION

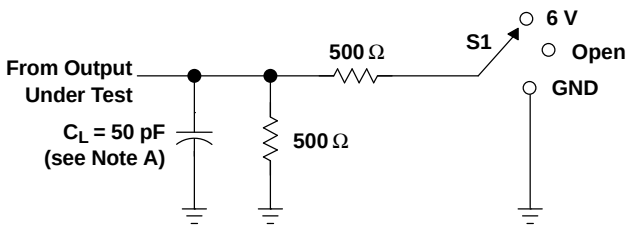


VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

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}.

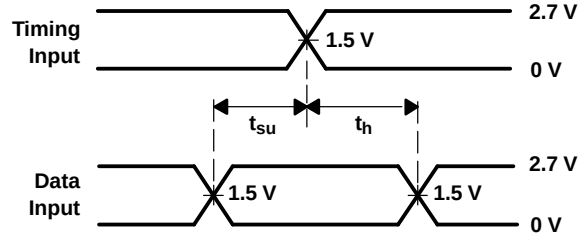
Figure 2. Load Circuit and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 2.7 V AND 3.3 V ± 0.3 V

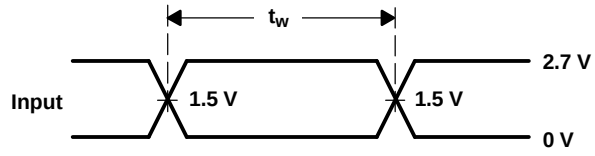


TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND

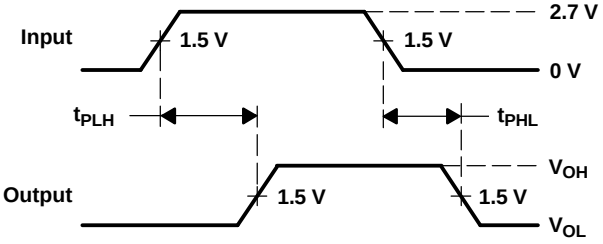
LOAD CIRCUIT



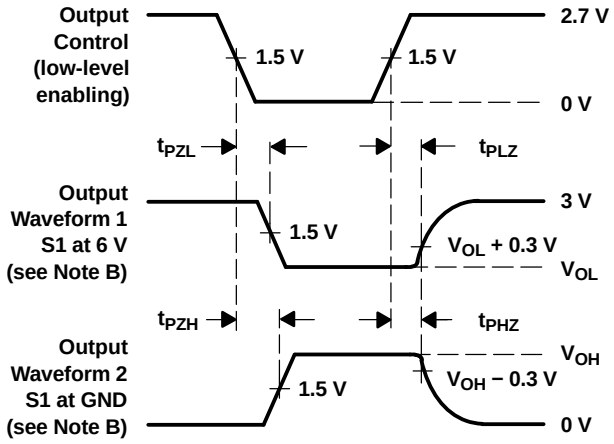
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



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.
C. All input pulses are supplied by generators having the following characteristics: PRR ≤ 10 MHz, Z_O = 50 Ω, t_r ≤ 2.5 ns, t_f ≤ 2.5 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

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
74ALVCH162601DLG4	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCH162601DLRG4	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
74ALVCH162601GRE4	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCH162601DGGR	OBSOLETE	TSSOP	DGG	56		TBD	Call TI	Call TI
SN74ALVCH162601DL	ACTIVE	SSOP	DL	56	20	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCH162601DLR	ACTIVE	SSOP	DL	56	1000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74ALVCH162601GR	ACTIVE	TSSOP	DGG	56	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM

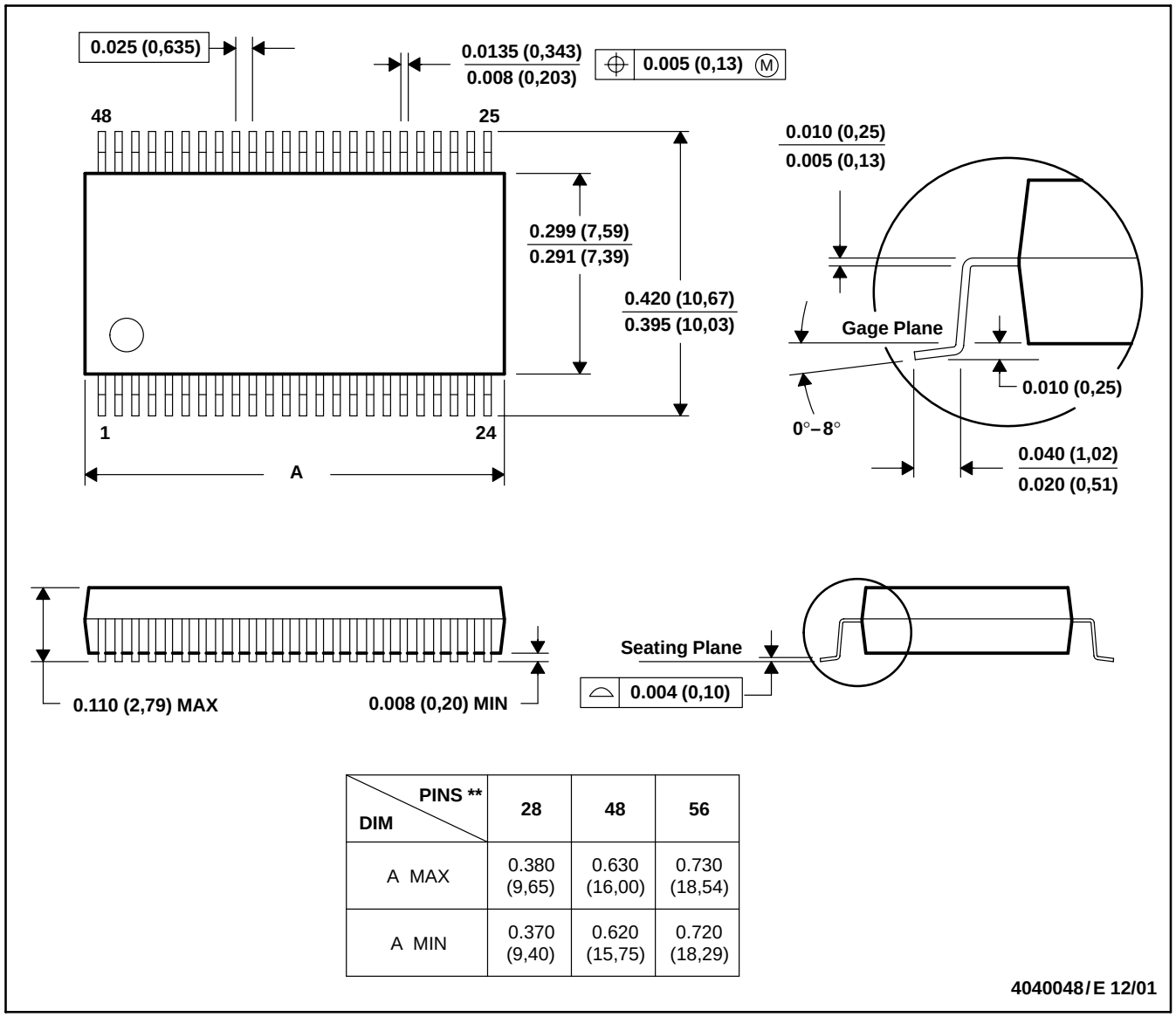
(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, 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.

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

48 PINS SHOWN



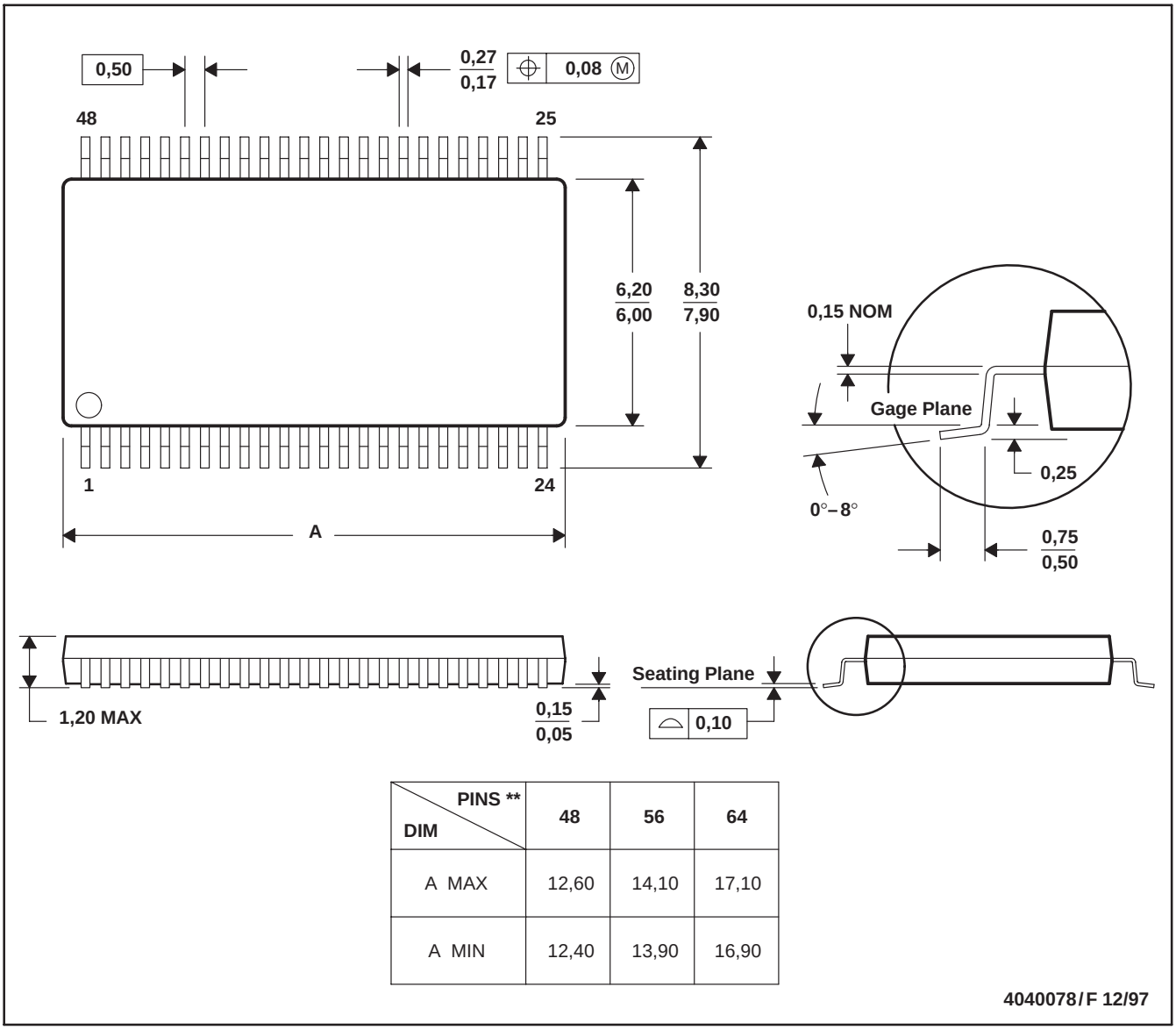
DIM \ PINS **	28	48	56
A MAX	0.380 (9,65)	0.630 (16,00)	0.730 (18,54)
A MIN	0.370 (9,40)	0.620 (15,75)	0.720 (18,29)

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

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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