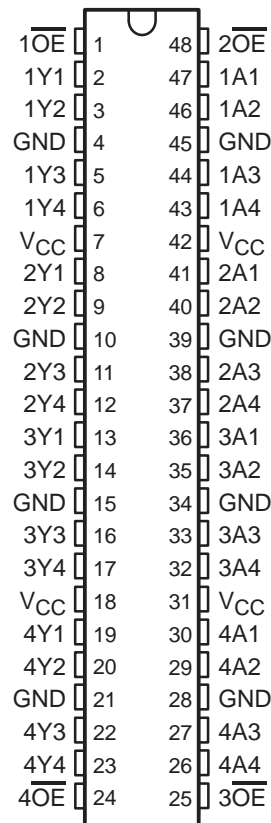


SN54ALVTH16240, SN74ALVTH16240 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCES138A – JULY 1998 – REVISED JANUARY 1999

- 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, $T_A = 25^\circ\text{C}$
- High Drive ($-24/24$ mA at 2.5-V and $-32/64$ mA at 3.3-V V_{CC})
- Power Off Disables Outputs, Permitting Live Insertion
- High-Impedance State During Power Up and Power Down Prevents Driver Conflict
- Use Bus Hold on Data Inputs in Place of External Pullup/Pulldown Resistors to Prevent the Bus From Floating
- Auto3-State Eliminates Bus Current Loading When Output Exceeds $V_{CC} + 0.5$ V
- Latch-Up Performance Exceeds 250 mA Per JESD 17
- ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model; and Exceeds 1000 V Using Charged-Device Model, Robotic Method
- Flow-Through Architecture Facilitates Printed Circuit Board Layout
- Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise
- Package Options Include Plastic Shrink Small-Outline (DL), Thin Shrink Small-Outline (DGG), Thin Very Small-Outline (DGV) Packages, and 380-mil Fine-Pitch Ceramic Flat (WD) Package

SN54ALVTH16240 . . . WD PACKAGE
SN74ALVTH16240 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



description

The 'ALVTH16240 devices are 16-bit buffers/line drivers 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 are designed specifically to improve both the performance and density of 3-state memory address drivers, clock drivers, and bus-oriented receivers and transmitters.



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 Incorporated.

UNLESS OTHERWISE NOTED this document contains PRODUCTION DATA information current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

 **TEXAS
INSTRUMENTS**

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SN54ALVTH16240, SN74ALVTH16240

2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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description (continued)

The devices can be used as four 4-bit buffers, two 8-bit buffers, or one 16-bit buffer. The devices provide inverting outputs and symmetrical active-low output-enable (\overline{OE}) inputs.

When V_{CC} is between 0 and 1.5 V, the device is in the high-impedance state during power up or power down. However, to ensure the high-impedance state above 1.5 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.

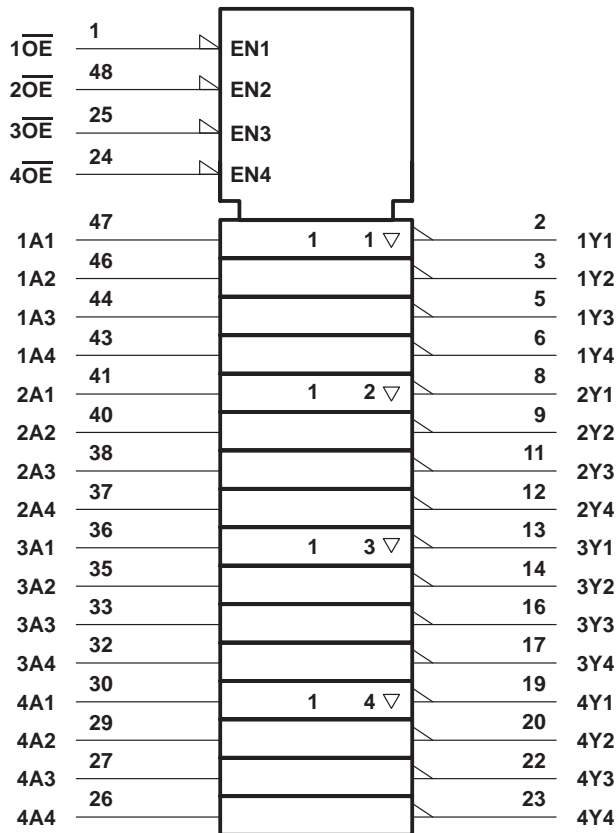
Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

The SN54ALVTH16240 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ALVTH16240 is characterized for operation from -40°C to 85°C .

FUNCTION TABLE
(each 4-bit buffer)

INPUTS		OUTPUT
\overline{OE}	A	Y
L	H	L
L	L	H
H	X	Z

logic symbol†

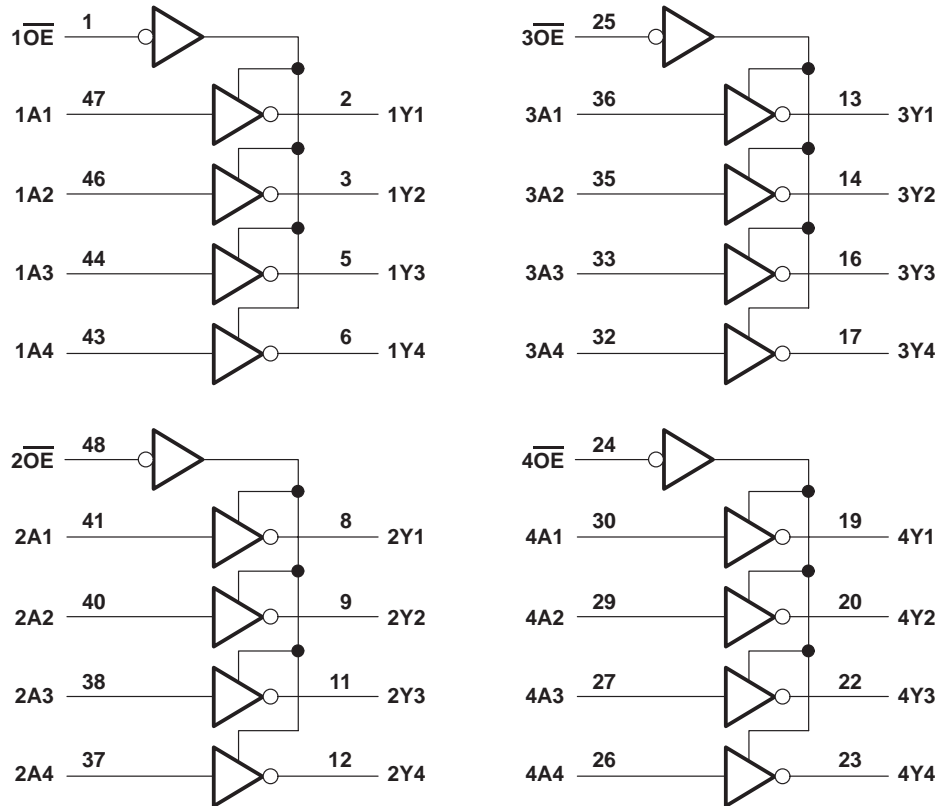


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

SN54ALVTH16240, SN74ALVTH16240 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

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logic diagram (positive logic)



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_{OL} : SN54ALVTH16240	96 mA
SN74ALVTH16240	128 mA
Output current in the high state, I_{OH} : SN54ALVTH16240	-48 mA
SN74ALVTH16240	-64 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	89°C/W
DGV package	93°C/W
DL package	94°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.

SN54ALVTH16240, SN74ALVTH16240

2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS

WITH 3-STATE OUTPUTS

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

		SN54ALVTH16240			SN74ALVTH16240			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			-6			-8	mA
I_{OL}	Low-level output current			6			8	mA
	Low-level output current; current duty cycle $\leq 50\%$; $f \geq 1\text{ kHz}$			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			$\mu\text{s/V}$
T_A	Operating free-air temperature	-55		125	-40		85	$^{\circ}\text{C}$

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

		SN54ALVTH16240			SN74ALVTH16240			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			-24			-32	mA
I_{OL}	Low-level output current			24			32	mA
	Low-level output current; current duty cycle $\leq 50\%$; $f \geq 1\text{ kHz}$			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			$\mu\text{s/V}$
T_A	Operating free-air temperature	-55		125	-40		85	$^{\circ}\text{C}$

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.

SN54ALVTH16240, SN74ALVTH16240 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

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

PARAMETER		TEST CONDITIONS	SN54ALVTH16240		SN74ALVTH16240		UNIT
			MIN	TYP†	MAX	MIN	
V _{IK}		V _{CC} = 2.3 V, I _I = -18 mA	-1.2		-1.2		V
V _{OH}		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	1.8				
V _{OL}		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} = 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 = V _{CC} or GND	±1		±1		μA
		V _{CC} = 0 or 2.7 V, V _I = 5.5 V	10		10		
	Data inputs	V _{CC} = 2.7 V	V _I = 5.5 V		10		
			V _I = V _{CC}		1		
		V _I = 0		-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 _{OZH}		V _{CC} = 2.7 V, V _O = 2.3 V, V _I = 0.7 V or 1.7 V	5		5		μA
I _{OZL}		V _{CC} = 2.7 V, V _O = 0.5 V, V _I = 0.7 V or 1.7 V	-5		-5		μA
I _{CC}		V _{CC} = 2.7 V, I _O = 0, V _I = V _{CC} or GND	Outputs high		0.04 0.1		mA
			Outputs low		2.3 4.5		
			Outputs disabled		0.04 0.1		
C _i		V _{CC} = 2.5 V, V _I = 2.5 V or 0	3.5		3.5		pF
C _o		V _{CC} = 2.5 V, V _O = 2.5 V or 0	6		6		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

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



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SN54ALVTH16240, SN74ALVTH16240 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCES138A – JULY 1998 – REVISED JANUARY 1999

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

PARAMETER	TEST CONDITIONS		SN54ALVTH16240		SN74ALVTH16240		UNIT
			MIN	TYP†	MAX	MIN	
V _{IK}	V _{CC} = 3 V, I _I = -18 mA		-1.2		-1.2		V
V _{OH}	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} = -24 mA	2		2		
V _{OL}	V _{CC} = 3 V to 3.6 V, I _{OL} = 100 μA		0.2		0.2		V
	V _{CC} = 3 V	I _{OL} = 16 mA			0.4		
		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		
	Data inputs	V _{CC} = 3.6 V, V _I = 5.5 V	10		10		
		V _{CC} = 3.6 V, V _I = V _{CC}	1		1		
		V _{CC} = 3.6 V, 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} , OE = don't care		±100		±100		μA
I _{OZH}	V _{CC} = 3.6 V	V _O = 3 V, V _I = 0.8 V or 2 V	5		5		μA
I _{OZL}	V _{CC} = 3.6 V	V _O = 0.5 V, V _I = 0.8 V or 2 V	-5		-5		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	5.5	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		0.4		0.4		mA
C _i	V _{CC} = 3.3 V, V _I = 3.3 V or 0		3.5		3.5		pF
C _o	V _{CC} = 3.3 V, V _O = 3.3 V or 0		6		6		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.

PRODUCT PREVIEW information concerns products in the formative or design phase of development. Characteristic data and other specifications are design goals. Texas Instruments reserves the right to change or discontinue these products without notice.



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SN54ALVTH16240, SN74ALVTH16240
2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS
WITH 3-STATE OUTPUTS

SCES138A – JULY 1998 – REVISED JANUARY 1999

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)	SN54ALVTH16240		SN74ALVTH16240		UNIT
			MIN	MAX	MIN	MAX	
t _{PLH}	A	Y	1	3.8	1	3.7	ns
t _{PHL}			1	3.6	1	3.5	
t _{PZH}	\overline{OE}	Y	1	5.4	1	5.3	ns
t _{PZL}			1	4.3	1	4.2	
t _{PHZ}	\overline{OE}	Y	1	4.8	1	4.7	ns
t _{PLZ}			1	3.6	1	3.5	

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)	SN54ALVTH16240		SN74ALVTH16240		UNIT
			MIN	MAX	MIN	MAX	
t _{PLH}	A	Y	1	3.4	1	3.3	ns
t _{PHL}			1	3.3	1	3.2	
t _{PZH}	\overline{OE}	Y	1	3.8	1	3.7	ns
t _{PZL}			1	3.2	1	3.1	
t _{PHZ}	\overline{OE}	Y	1.4	5.1	1.5	5	ns
t _{PLZ}			1.4	4.2	1.5	4.1	

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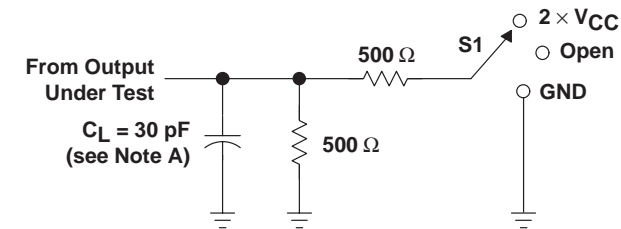


SN54ALVTH16240, SN74ALVTH16240 2.5-V/3.3-V 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

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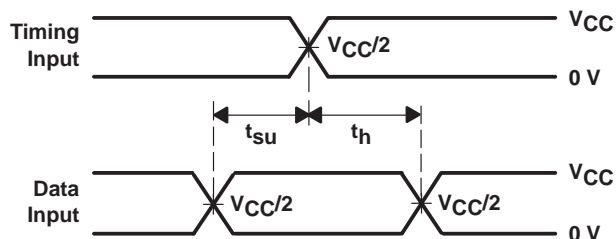
PARAMETER MEASUREMENT INFORMATION

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

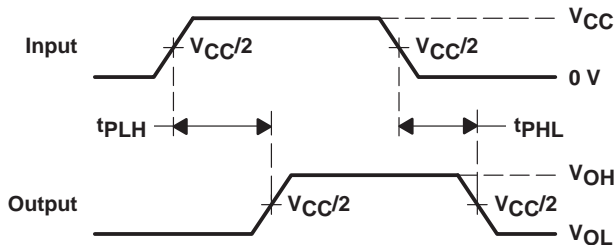


LOAD CIRCUIT

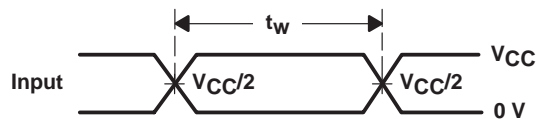
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	2 $\times V_{CC}$
t_{PHZ}/t_{PZH}	GND



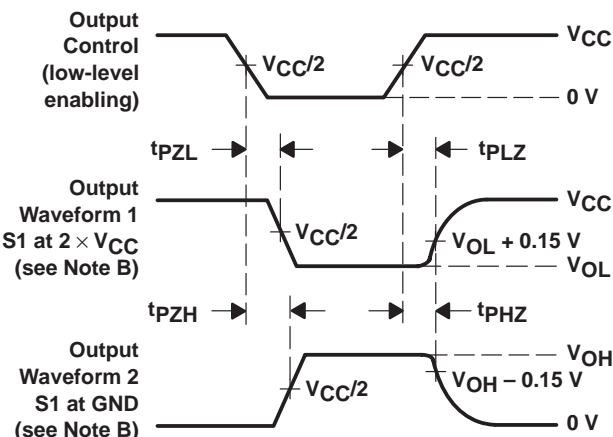
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



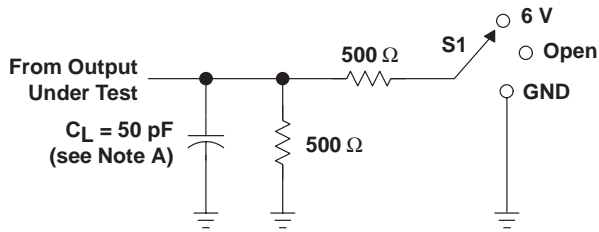
VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES:
- C_L includes probe and jig capacitance.
 - 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.

Figure 1. Load Circuit and Voltage Waveforms

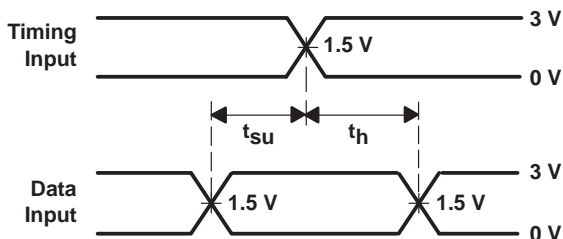
PARAMETER MEASUREMENT INFORMATION

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

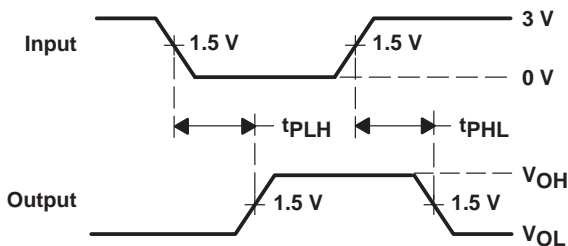


LOAD CIRCUIT

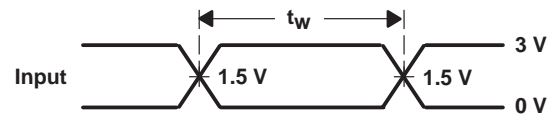
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



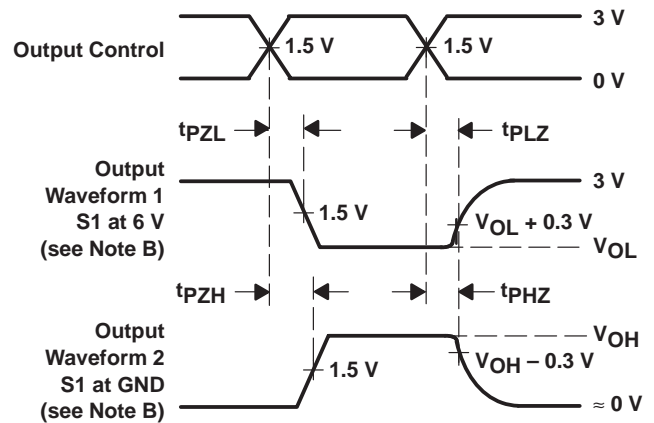
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
PULSE DURATION



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: $PRR \leq 10 \text{ MHz}$, $Z_O = 50 \Omega$, $t_r \leq 2.5 \text{ ns}$, $t_f \leq 2.5 \text{ ns}$.
D. The outputs are measured one at a time with one transition per measurement.

Figure 2. 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
SN74ALVTH16240GR	OBSOLETE	TSSOP	DGG	48		TBD	Call TI	Call TI	-40 to 85	ALVTH16240	

(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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EXAMPLE BOARD LAYOUT

DGG0048A

TSSOP - 1.2 mm max height

SMALL OUTLINE PACKAGE



LAND PATTERN EXAMPLE
SCALE:6X



SOLDER MASK DETAILS

4214859/B 11/2020

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

4214859/B 11/2020

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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