

3.3-V ABT 16-BIT BUFFERS/DRIVERS WITH 3-STATE OUTPUTS

SCBS692D – MAY 1997 – REVISED APRIL 1999

- **Members of the Texas Instruments *Widebus*™ Family**
- **State-of-the-Art Advanced BiCMOS Technology (ABT) Design for 3.3-V Operation and Low Static-Power Dissipation**
- **Output Ports Have Equivalent 22-Ω Series Resistors, So No External Resistors Are Required**
- **Support Mixed-Mode Signal Operation (5-V Input and Output Voltages With 3.3-V V_{CC})**
- **Support Unregulated Battery Operation Down to 2.7 V**
- **Typical V_{OLP} (Output Ground Bounce) < 0.8 V at $V_{CC} = 3.3$ V, $T_A = 25^\circ\text{C}$**
- **I_{off} and Power-Up 3-State Support Hot Insertion**
- **Bus Hold on Data Inputs Eliminates the Need for External Pullup/Pulldown Resistors**
- **Distributed V_{CC} and GND Pin Configuration Minimizes High-Speed Switching Noise**
- **Flow-Through Architecture Optimizes PCB Layout**
- **Latch-Up Performance Exceeds 500 mA Per JESD 17**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883, Method 3015; Exceeds 200 V Using Machine Model ($C = 200$ pF, $R = 0$)**
- **Package Options Include Plastic Shrink Small-Outline (DL) and Thin Shrink Small-Outline (DGG) Packages and 380-mil Fine-Pitch Ceramic Flat (WD) Package Using 25-mil Center-to-Center Spacings**

SN54LVTH162241 . . . WD PACKAGE
SN74LVTH162241 . . . DGG OR DL PACKAGE
(TOP VIEW)

1OE	1	48	2OE
1Y1	2	47	1A1
1Y2	3	46	1A2
GND	4	45	GND
1Y3	5	44	1A3
1Y4	6	43	1A4
V_{CC}	7	42	V_{CC}
2Y1	8	41	2A1
2Y2	9	40	2A2
GND	10	39	GND
2Y3	11	38	2A3
2Y4	12	37	2A4
3Y1	13	36	3A1
3Y2	14	35	3A2
GND	15	34	GND
3Y3	16	33	3A3
3Y4	17	32	3A4
V_{CC}	18	31	V_{CC}
4Y1	19	30	4A1
4Y2	20	29	4A2
GND	21	28	GND
4Y3	22	27	4A3
4Y4	23	26	4A4
4OE	24	25	3OE

description

These 16-bit buffers/drivers are designed specifically for low-voltage (3.3-V) V_{CC} operation, but with the capability to provide a TTL interface to a 5-V system environment.

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

The outputs, which are designed to source or sink up to 12 mA, include equivalent 22-Ω series resistors to reduce overshoot and undershoot.

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description (continued)

When V_{CC} is between 0 and 1.5 V, the devices are 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 and OE should be tied to GND through a pulldown resistor; the minimum value of the resistor is determined by the current-sinking/current-sourcing capability of the driver.

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

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 devices when they are 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.

The SN54LVTH162241 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74LVTH162241 is characterized for operation from -40°C to 85°C .

FUNCTION TABLES

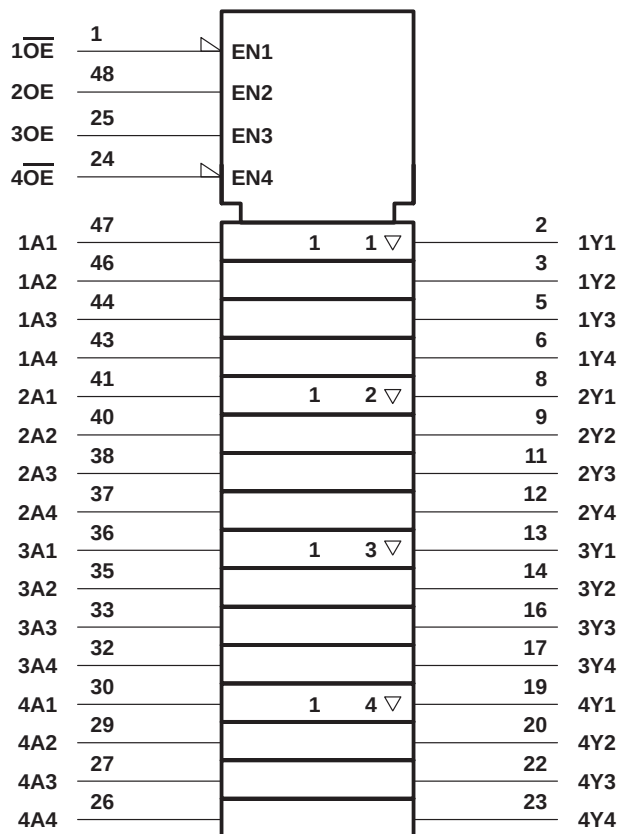
INPUTS		OUTPUTS 1Y, 4Y
$1\overline{OE}, 4\overline{OE}$	1A, 4A	
L	H	H
L	L	L
H	X	Z

INPUTS		OUTPUTS 2Y, 3Y
2OE, 3OE	2A, 3A	
H	H	H
H	L	L
L	X	Z

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logic symbol[†]



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

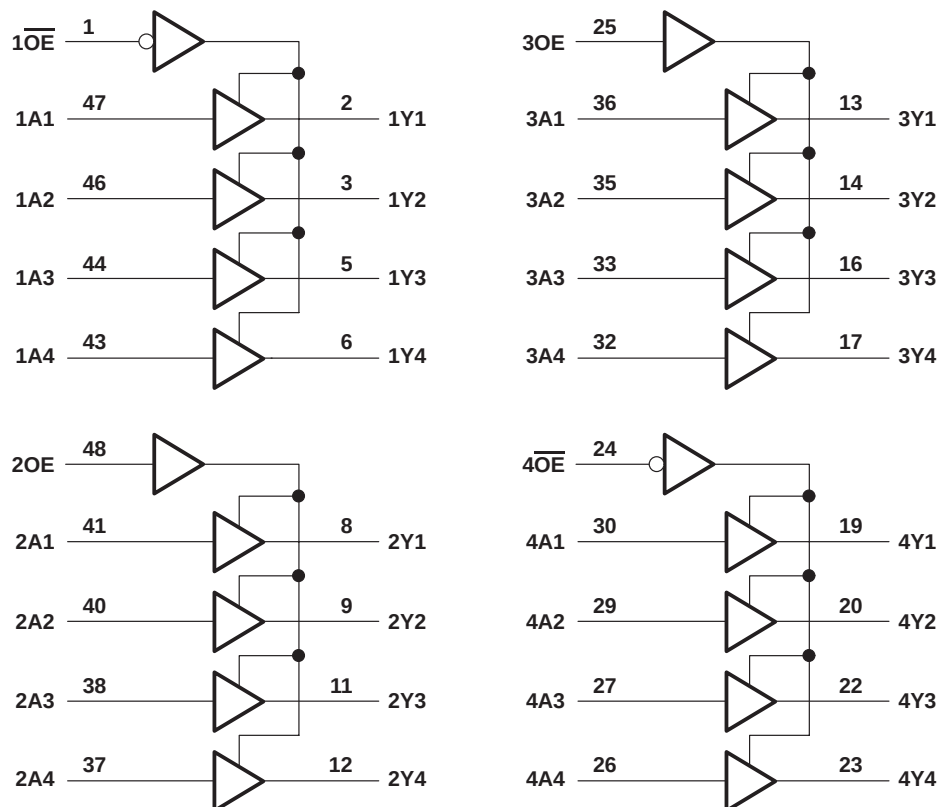
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logic diagram (positive logic)



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 $V_{CC} + 0.5$ V
Current into any output in the low state, I_O	30 mA
Current into any output in the high state, I_O (see Note 2)	30 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 3): DGG package	89°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. This current flows only when the output is in the high state and $V_O > V_{CC}$.
 3. The package thermal impedance is calculated in accordance with JESD 51.

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recommended operating conditions (see Note 4)

			SN54LVTH162241		SN74LVTH162241		UNIT
			MIN	MAX	MIN	MAX	
V _{CC}	Supply voltage		2.7	3.6	2.7	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			5.5		5.5	V
I _{OH}	High-level output current			–12		–12	mA
I _{OL}	Low-level output current			12		12	mA
Δt/Δv	Input transition rise or fall rate	Outputs enabled		10		10	ns/V
Δt/ΔV _{CC}	Power-up ramp rate		200		200		μs/V
T _A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 4: 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		SN54LVTH162241			SN74LVTH162241			UNIT
				MIN	TYP†	MAX	MIN	TYP†	MAX	
V _{IK}		V _{CC} = 2.7 V, I _I = –18 mA				–1.2			–1.2	V
V _{OH}		V _{CC} = 3 V, I _{OH} = –12 mA		2			2			V
V _{OL}		V _{CC} = 3 V, I _{OL} = 12 mA				0.8			0.8	V
I _I		V _{CC} = 0 or 3.6 V, V _I = 5.5 V				10			10	μA
	Control inputs	V _{CC} = 3.6 V, V _I = V _{CC} or GND				±1			±1	
	Data inputs	V _{CC} = 3.6 V, 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			±100	μA
I _I (hold)	Data inputs	V _{CC} = 3 V, V _I = 0.8 V		75			75			μA
		V _I = 2 V		–75			–75			
		V _{CC} = 3.6 V‡, V _I = 0 to 3.6 V							500 –750	
I _{OZH}		V _{CC} = 3.6 V, V _O = 3 V				5			5	μA
I _{OZL}		V _{CC} = 3.6 V, V _O = 0.5 V				–5			–5	μA
I _{OZPU}		V _{CC} = 0 to 1.5 V, V _O = 0.5 V to 3 V, OE/OE = don't care				±100*			±100	μA
I _{OZPD}		V _{CC} = 1.5 V to 0, V _O = 0.5 V to 3 V, OE/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			0.19			0.19	mA
			Outputs low			5			5	
			Outputs disabled			0.19			0.19	
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 _I = 3 V or 0				4			4	pF
C _o		V _O = 3 V or 0				9			9	pF

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

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

‡ This is the bus-hold maximum dynamic current. It is the minimum overdrive current required to switch the input from one state to another.

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

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switching characteristics over recommended operating free-air temperature range, $C_L = 50$ pF
(unless otherwise noted) (see Figure 1)

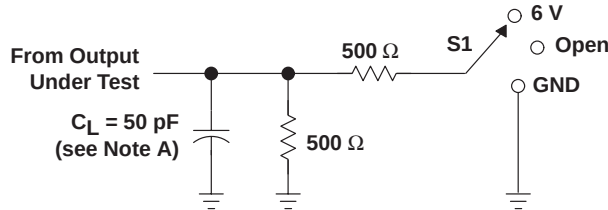
PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54LVTH162241				SN74LVTH162241				UNIT	
			V _{CC} = 3.3 V ± 0.3 V		V _{CC} = 2.7 V		V _{CC} = 3.3 V ± 0.3 V			V _{CC} = 2.7 V		
			MIN	MAX	MIN	MAX	MIN	TYP†	MAX	MIN		MAX
t _{PLH}	A	Y	1.3	4.3		4.9	1.4	3	4.1		4.7	ns
t _{PHL}			1.3	4.3		4.9	1.4	2.4	4.1		4.7	
t _{PZH}	OE or OE	Y	1.1	5.2		5.9	1.2	3.5	4.9		5.7	ns
t _{PZL}			1.4	5		5.4	1.5	3.5	4.8		5.2	
t _{PHZ}	OE or OE	Y	1.9	5.5		6.2	2	3.7	5.3		5.9	ns
t _{PLZ}			1.9	5.2		5.7	2	3.6	4.9		5.4	
t _{sk(o)}									0.5		0.5	ns

[†] All typical values are at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$.

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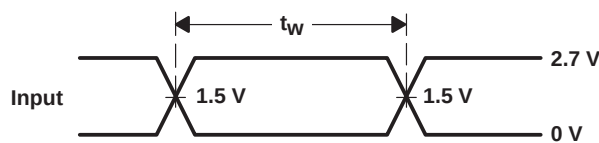
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PARAMETER MEASUREMENT INFORMATION

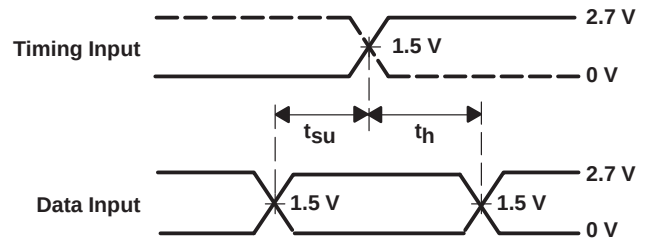


LOAD CIRCUIT

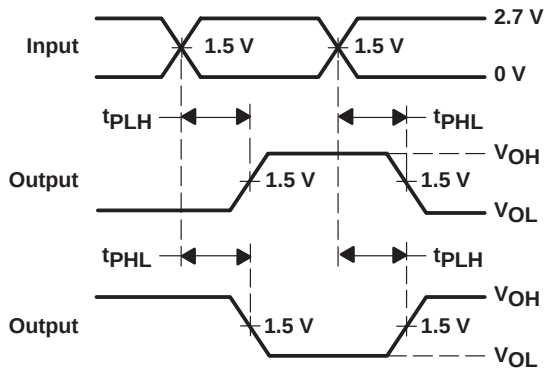
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



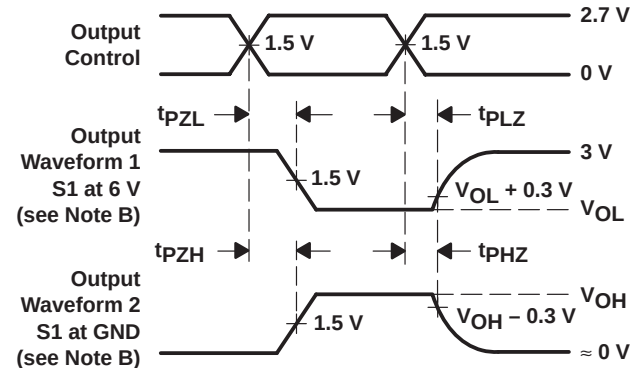
VOLTAGE WAVEFORMS
PULSE DURATION



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

Figure 1. Load Circuit and Voltage Waveforms

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