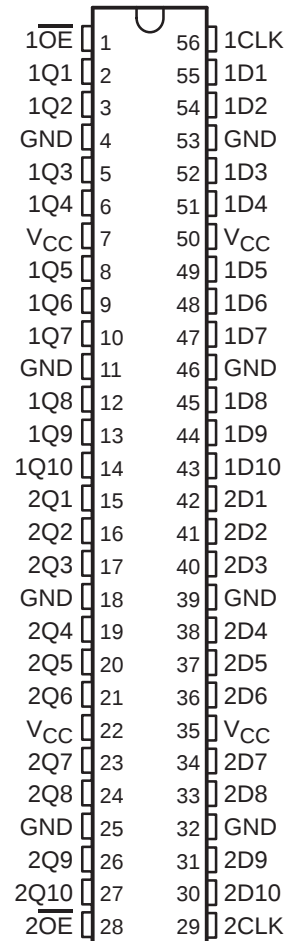


SN54ALVTH16821, SN74ALVTH16821 2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – 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
- Uses 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

SN54ALVTH16821 . . . WD PACKAGE
SN74ALVTH16821 . . . DGG, DGV, OR DL PACKAGE
(TOP VIEW)



description

The 'ALVTH16821 devices are 20-bit bus-interface flip-flops with 3-state outputs 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.

The devices can be used as two 10-bit flip-flops or one 20-bit flip-flop. The 20-bit flip-flops are edge-triggered D-type flip-flops. On the positive transition of the clock (CLK), the flip-flops store the logic levels set up at the D inputs.



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.

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**TEXAS
INSTRUMENTS**

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SN54ALVTH16821, SN74ALVTH16821

2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS

WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

description (continued)

A buffered output-enable ($\overline{OE}$) input can be used to place the ten outputs in either a normal logic state (high or low level) or a high-impedance state. In the high-impedance state, the outputs neither load nor drive the bus lines significantly. The high-impedance state and increased drive provide the capability to drive bus lines without need for interface or pullup components.

$\overline{OE}$ does not affect the internal operation of the flip-flops. Old data can be retained or new data can be entered while the outputs are in the high-impedance state.

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.

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

The SN54ALVTH16821 is characterized for operation over the full military temperature range of -55°C to 125°C . The SN74ALVTH16821 is characterized for operation from -40°C to 85°C .

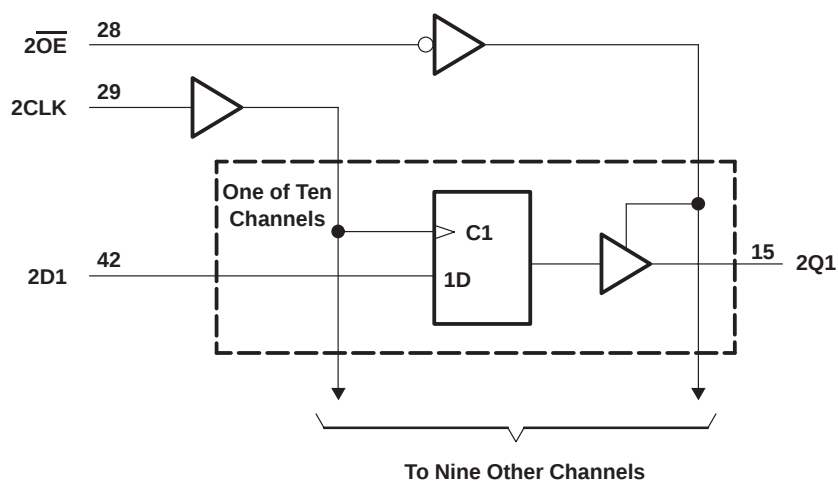
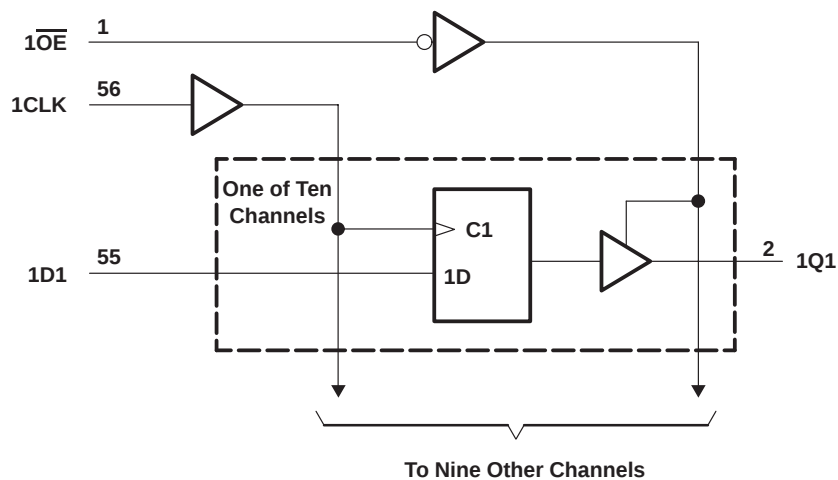
FUNCTION TABLE
(each 10-bit section)

INPUTS			OUTPUT
$\overline{OE}$	CLK	D	Q
L	$\uparrow$	H	H
L	$\uparrow$	L	L
L	H or L	X	Q_0
H	X	X	Z

SN54ALVTH16821, SN74ALVTH16821
2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

logic diagram (positive logic)



SN54ALVTH16821, SN74ALVTH16821

2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS

WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

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 : SN54ALVTH16821	96 mA
SN74ALVTH16821	128 mA
Output current in the high state, I_O : SN54ALVTH16821	–48 mA
SN74ALVTH16821	–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	81°C/W
DGV package	86°C/W
DL package	74°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.

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

		SN54ALVTH16821			SN74ALVTH16821			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			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	°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.

SN54ALVTH16821, SN74ALVTH16821
2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

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

			SN54ALVTH16821			SN74ALVTH16821			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.

SN54ALVTH16821, SN74ALVTH16821

2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS

WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

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

PARAMETER		TEST CONDITIONS		SN54ALVTH16821			SN74ALVTH16821			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}		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							
			I _{OH} = −8 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			10			
			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 _{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	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 _O		V _{CC} = 2.5 V, V _O = 2.5 V or 0		6.5			6.5			pF	

† All typical values are at $V_{CC} = 2.5 \text{ V}$, $T_A = 25^\circ\text{C}$.

‡ 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

SN54ALVTH16821, SN74ALVTH16821
2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

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

PARAMETER		TEST CONDITIONS	SN54ALVTH16821			SN74ALVTH16821			UNIT
			MIN	TYP [†]	MAX	MIN	TYP [†]	MAX	
V_{IK}		$V_{CC} = 3 \text{ V}$, $I_I = -18 \text{ mA}$			-1.2			-1.2	V
V_{OH}		$V_{CC} = 3 \text{ V to } 3.6 \text{ V}$, $I_{OH} = -100 \mu\text{A}$	$V_{CC}-0.2$			$V_{CC}-0.2$			V
	$V_{CC} = 3 \text{ V}$	$I_{OH} = -24 \text{ mA}$	2						
		$I_{OH} = -32 \text{ mA}$				2			
V_{OL}		$V_{CC} = 3 \text{ V to } 3.6 \text{ V}$, $I_{OL} = 100 \mu\text{A}$			0.2			0.2	V
	$V_{CC} = 3 \text{ V}$	$I_{OL} = 16 \text{ mA}$						0.4	
		$I_{OL} = 24 \text{ mA}$			0.5				
		$I_{OL} = 32 \text{ mA}$						0.5	
		$I_{OL} = 48 \text{ mA}$			0.55				
		$I_{OL} = 64 \text{ mA}$						0.55	
I_I	Control inputs	$V_{CC} = 3.6 \text{ V}$, $V_I = V_{CC} \text{ or GND}$			± 1			± 1	μA
		$V_{CC} = 0 \text{ or } 3.6 \text{ V}$, $V_I = 5.5 \text{ V}$			10			10	
	Data inputs	$V_{CC} = 3.6 \text{ V}$, $V_I = 5.5 \text{ V}$			10			10	
		$V_I = V_{CC}$			1			1	
		$V_I = 0$			-5			-5	
I_{off}		$V_{CC} = 0$, $V_I \text{ or } V_O = 0 \text{ to } 4.5 \text{ V}$						± 100	μA
$I_{BHL}^{\ddagger}$		$V_{CC} = 3 \text{ V}$, $V_I = 0.8 \text{ V}$	75			75			μA
$I_{BHH}^{\S}$		$V_{CC} = 3 \text{ V}$, $V_I = 2 \text{ V}$	-75			-75			μA
$I_{BHLO}^{\P}$		$V_{CC} = 3.6 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	500			500			μA
$I_{BHHO}^{\#}$		$V_{CC} = 3.6 \text{ V}$, $V_I = 0 \text{ to } V_{CC}$	-500			-500			μA
$I_{EX}^{\parallel}$		$V_{CC} = 3 \text{ V}$, $V_O = 5.5 \text{ V}$			125			125	μA
$I_{OZ(PU/PD)}^{\star}$		$V_{CC} \leq 1.2 \text{ V}$, $V_O = 0.5 \text{ V to } V_{CC}$, $V_I = \text{GND or } V_{CC}$, $\overline{OE} = \text{don't care}$			± 100			± 100	μA
I_{OZH}		$V_{CC} = 3.6 \text{ V}$, $V_O = 3 \text{ V}$, $V_I = 0.8 \text{ V or } 2 \text{ V}$			5			5	μA
I_{OZL}		$V_{CC} = 3.6 \text{ V}$, $V_O = 0.5 \text{ V}$, $V_I = 0.8 \text{ V or } 2 \text{ V}$			-5			-5	μA
I_{CC}	$V_{CC} = 3.6 \text{ V}$, $I_O = 0$, $V_I = V_{CC} \text{ or GND}$	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		
$\Delta I_{CC}^{\square}$		$V_{CC} = 3 \text{ V to } 3.6 \text{ V}$, One input at $V_{CC} - 0.6 \text{ V}$, Other inputs at $V_{CC} \text{ or GND}$			0.4			0.4	mA
C_i		$V_{CC} = 3.3 \text{ V}$, $V_I = 3.3 \text{ V or } 0$			3.5			3.5	pF
C_o		$V_{CC} = 3.3 \text{ V}$, $V_O = 3.3 \text{ V or } 0$			6			6	pF

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

[‡] 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.

^{\P} 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.

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

^{\star} High-impedance state during power up or power down

^{\square} 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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SN54ALVTH16821, SN74ALVTH16821
2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS
WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

timing requirements over recommended operating free-air temperature range, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

			SN54ALVTH16821		SN74ALVTH16821		UNIT
			MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency		150		150		MHz
t _w	Pulse duration, CLK high or low		1.6		1.5		ns
t _{su}	Setup time, data before CLK↑	Data high	1.6		1.5		ns
		Data low	2.1		2		
t _h	Hold time, data after CLK↑	Data high	0.4		0.3		ns
		Data low	1.1		1		

timing requirements over recommended operating free-air temperature range, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 2)

			SN54ALVTH16821		SN74ALVTH16821		UNIT
			MIN	MAX	MIN	MAX	
f _{clock}	Clock frequency		150		150		MHz
t _w	Pulse duration, CLK high or low		1.6		1.5		ns
t _{su}	Setup time, data before CLK↑	Data high	1.6		1.5		ns
		Data low	1.6		1.5		
t _h	Hold time, data after CLK↑	Data high	1.1		1		ns
		Data low	1.1		1		

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH16821		SN74ALVTH16821		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			150		150		MHz
t_{PLH}	CLK	Q	1	4.2	1	4.1	ns
t_{PHL}			1	4.5	1	4.4	
t_{PZH}	$\overline{\text{OE}}$	Q	1.5	4.7	1.5	4.6	ns
t_{PZL}			1	4.2	1	4.1	
t_{PHZ}	$\overline{\text{OE}}$	Q	1.5	4.6	1.5	4.5	ns
t_{PLZ}			1	5	1	4.9	

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

PARAMETER	FROM (INPUT)	TO (OUTPUT)	SN54ALVTH16821		SN74ALVTH16821		UNIT
			MIN	MAX	MIN	MAX	
f_{max}			150		150		MHz
t_{PLH}	CLK	Q	1	3.6	1	3.5	ns
t_{PHL}			1	3.6	1	3.5	
t_{PZH}	$\overline{\text{OE}}$	Q	1	4.2	1	4.1	ns
t_{PZL}			1	3.7	1	3.6	
t_{PHZ}	$\overline{\text{OE}}$	Q	1	4.9	1	4.8	ns
t_{PLZ}			1	4.8	1	4.6	

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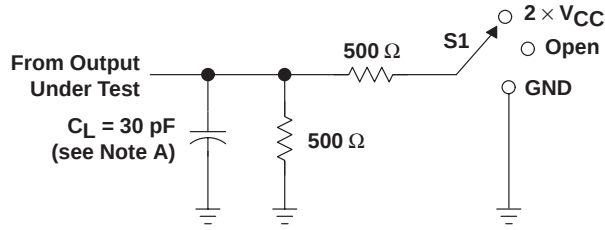
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SN54ALVTH16821, SN74ALVTH16821 2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

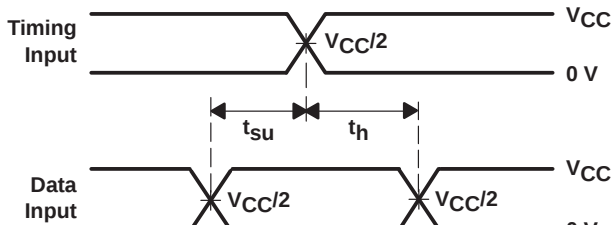
PARAMETER MEASUREMENT INFORMATION

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

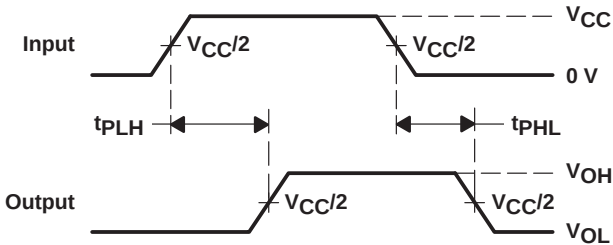


LOAD CIRCUIT

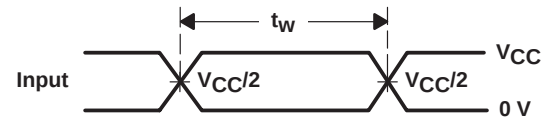
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	$2 \times V_{CC}$
t_{PHZ}/t_{PZH}	GND



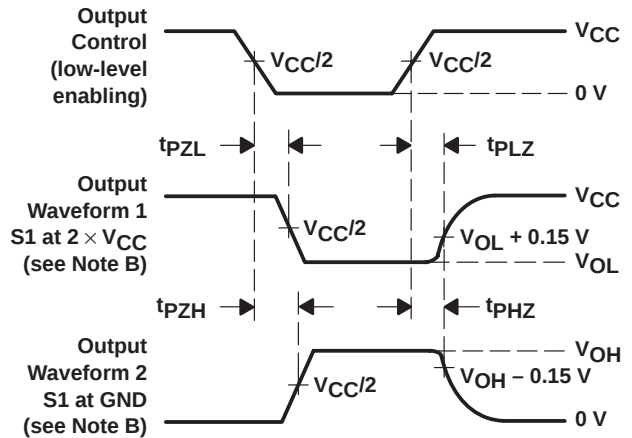
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



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

SN54ALVTH16821, SN74ALVTH16821

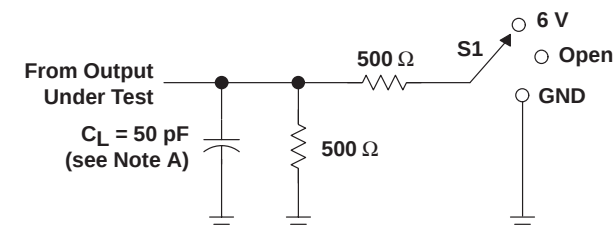
2.5-V/3.3-V 20-BIT BUS-INTERFACE FLIP-FLOPS

WITH 3-STATE OUTPUTS

SCES078E – JULY 1996 – REVISED JANUARY 1999

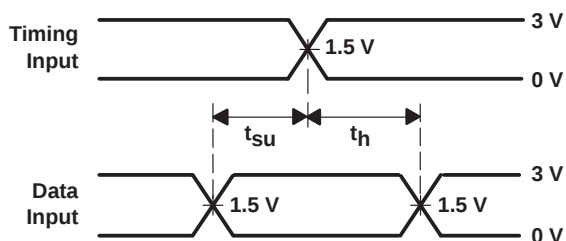
PARAMETER MEASUREMENT INFORMATION

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

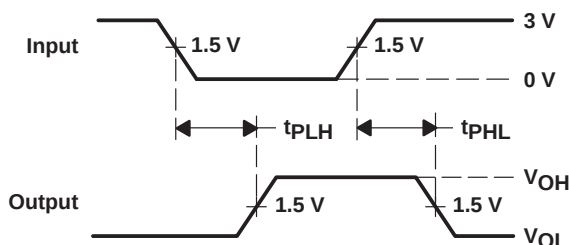


LOAD CIRCUIT

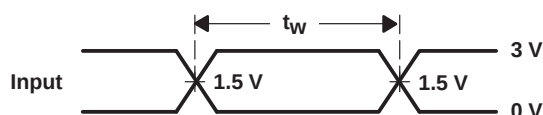
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



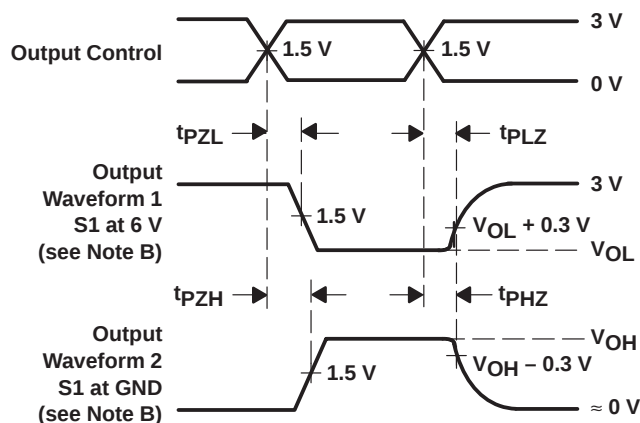
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



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

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