

- Member of the Texas Instruments *Widebus™* Family
- *EPIC™* (Enhanced-Performance Implanted CMOS) Submicron Process
- ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015; Exceeds 200 V Using Machine Model (C = 200 pF, R = 0)
- Latch-Up Performance Exceeds 250 mA Per JEDEC Standard 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

description

This 20-bit flip-flop is designed specifically for 2.3-V to 3.6-V V_{CC} operation.

The SN74ALVCH16721 20 flip-flops are edge-triggered D-type flip-flops with qualified clock storage. On the positive transition of the clock (CLK) input, the device provides true data at the Q outputs if the clock-enable (\overline{CLKEN}) input is low. If \overline{CLKEN} is high, no data is stored.

A buffered output-enable (\overline{OE}) input places the 20 outputs in either a normal logic state (high or low) 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.

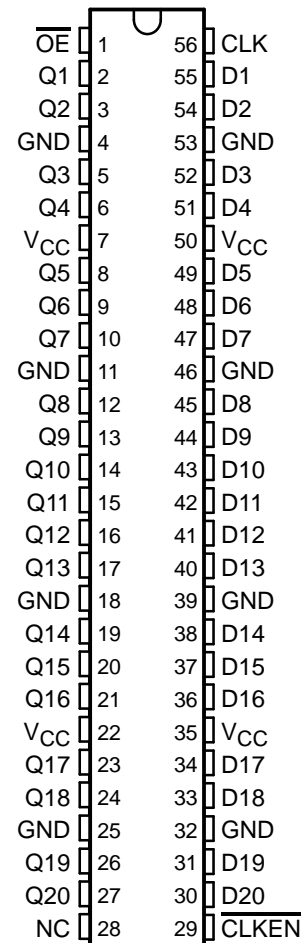
To ensure the high-impedance state during power up or power down, \overline{OE} should be tied to V_{CC} through a pullup resistor; the minimum value of the resistor is determined by the current-sinking capability of the driver.

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

The SN74ALVCH16721 is available in TI's shrink small-outline (DL) and thin shrink small-outline (DGG) packages, which provide twice the I/O pin count and functionality of standard small-outline packages in the same printed-circuit-board area.

The SN74ALVCH16721 is characterized for operation from -40°C to 85°C .

DGG OR DL PACKAGE
(TOP VIEW)



NC – No internal connection



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SN74ALVCH16721
3.3-V 20-BIT FLIP-FLOP
WITH 3-STATE OUTPUTS

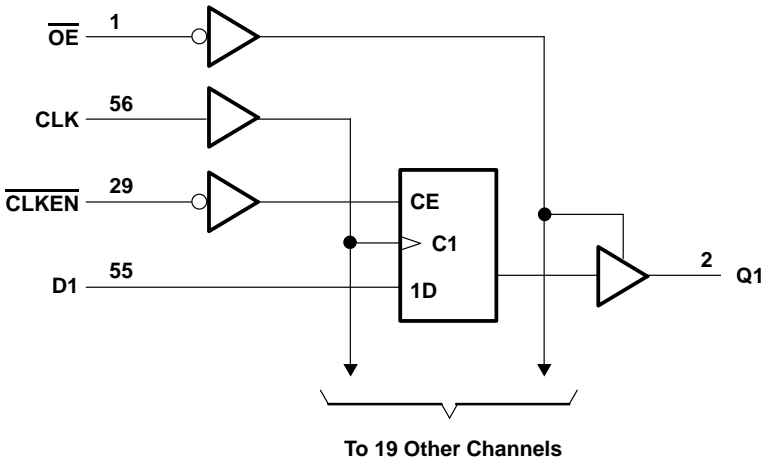
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FUNCTION TABLE

(each flip-flop)

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

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 4.6 V
Output voltage range, V_O (see Notes 1 and 2)	–0.5 V to $V_{CC} + 0.5$ V
Input clamp current, I_{IK} ($V_I < 0$)	–50 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$)	±50 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	±50 mA
Continuous current through each V_{CC} or GND	±100 mA
Maximum power dissipation at $T_A = 55^\circ\text{C}$ (in still air) (see Note 3): DGG package	1 W
DL package	1.4 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:
- The input and output negative-voltage ratings may be exceeded if the input and output clamp-current ratings are observed.
 - This value is limited to 4.6 V maximum.
 - The maximum package power dissipation is calculated using a junction temperature of 150°C and a board trace length of 750 mils. For more information, refer to the *Package Thermal Considerations* application note in the 1994 *ABT Advanced BiCMOS Technology Data Book*, literature number SCBD002B.

recommended operating conditions (see Note 4)

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

NOTE 4: Unused control inputs must be held high or low to prevent them from floating.

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

PARAMETER	TEST CONDITIONS	V_{CC}^\dagger	MIN	TYP [‡]	MAX	UNIT
V_{OH}	$I_{OH} = -100 \mu\text{A}$	MIN to MAX	$V_{CC} - 0.2$			V
	$I_{OH} = -6 \text{ mA}$, $V_{IH} = 1.7 \text{ V}$	2.3 V	2			
	$I_{OH} = -12 \text{ mA}$, $V_{IH} = 1.7 \text{ V}$	2.3 V	1.7			
	$I_{OH} = -12 \text{ mA}$, $V_{IH} = 2 \text{ V}$	2.7 V	2.2			
	$I_{OH} = -12 \text{ mA}$, $V_{IH} = 2 \text{ V}$	3 V	2.4			
	$I_{OH} = -24 \text{ mA}$, $V_{IH} = 2 \text{ V}$	3 V	2			
V_{OL}	$I_{OL} = 100 \mu\text{A}$	MIN to MAX	0.2			V
	$I_{OL} = 6 \text{ mA}$, $V_{IL} = 0.7 \text{ V}$	2.3 V	0.4			
	$I_{OL} = 12 \text{ mA}$, $V_{IL} = 0.7 \text{ V}$	2.3 V	0.7			
	$I_{OL} = 12 \text{ mA}$, $V_{IL} = 0.8 \text{ V}$	2.7 V	0.4			
	$I_{OL} = 24 \text{ mA}$, $V_{IL} = 0.8 \text{ V}$	3 V	0.55			
I_I	$V_I = V_{CC}$ or GND	3.6 V	± 5			μA
$I_{I(\text{hold})}$	$V_I = 0.7 \text{ V}$	2.3 V	45			μA
	$V_I = 1.7 \text{ V}$		-45			
	$V_I = 0.8 \text{ V}$	3 V	75			
	$V_I = 2 \text{ V}$		-75			
	$V_I = 0 \text{ to } 3.6 \text{ V}$	3.6 V	± 500			
I_{OZ}	$V_O = V_{CC}$ 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 $V_{CC} - 0.6 \text{ V}$, Other inputs at V_{CC} or GND	3 V to 3.6 V	750			μA
C_i	Control inputs	3.3 V	3.5			pF
	Data inputs		6			
C_{io}	Data inputs	3.3 V	7			pF

[†] For conditions shown as MIN or MAX, use the appropriate values under recommended operating conditions.

[‡] Typical values are measured at $V_{CC} = 3.3 \text{ V}$, $T_A = 25^\circ\text{C}$.

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timing requirements over recommended ranges of supply voltage and operating free-air temperature (unless otherwise noted) (see Figures 1 and 2)

			$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{clock}	Clock frequency		0	150	0	150	0	150	MHz
t_w	Pulse duration, CLK high or low		3.3		3.3		3.3		ns
t_{su}	Setup time	Data before CLK \uparrow	4		3.6		3.1		ns
		$\overline{\text{CLKEN}}$ before CLK \uparrow	3.4		3.1		2.7		
t_h	Hold time	Data after CLK \uparrow	0		0		0		ns
		$\overline{\text{CLKEN}}$ after CLK \uparrow	0		0		0		

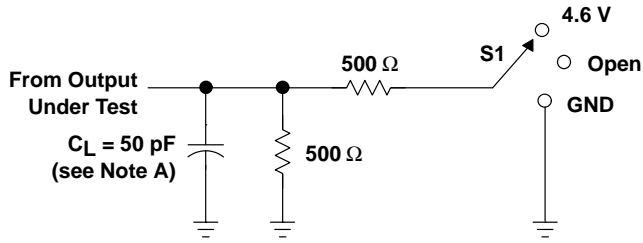
switching characteristics over recommended operating free-air temperature range, $C_L = 50\text{ pF}$ (unless otherwise noted) (see Figures 1 and 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$		$V_{CC} = 2.7\text{ V}$		$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
f_{max}			150		150		150		MHz
t_{pd}	CLK	Q	1	7	1	5.7	1	4.9	ns
t_{en}	$\overline{\text{OE}}$	Q	1	7.4	1	6.5	1	5.4	ns
t_{dis}	$\overline{\text{OE}}$	Q	1	6.2	1	5.1	1	4.8	ns

operating characteristics, $T_A = 25^\circ\text{C}$

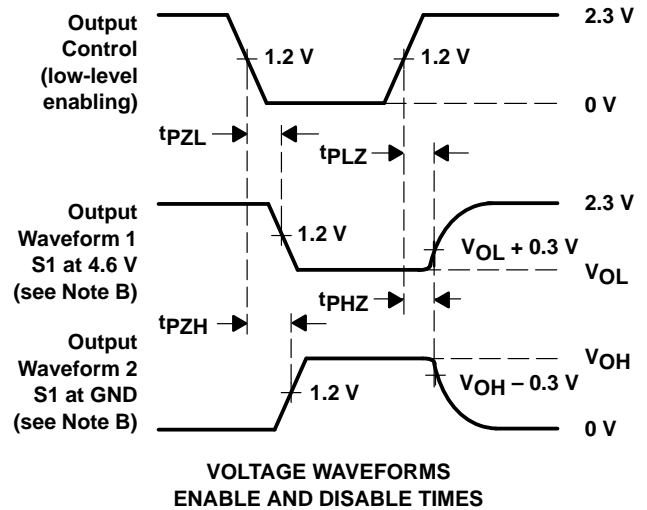
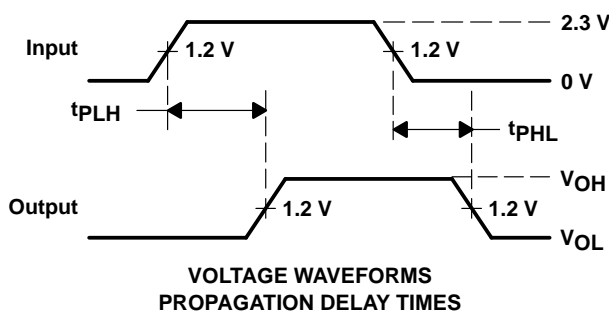
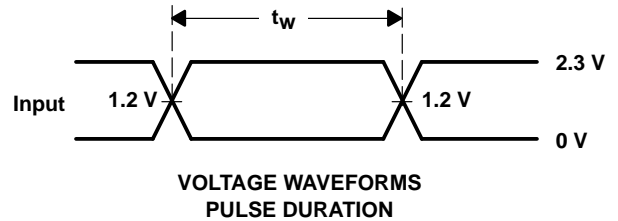
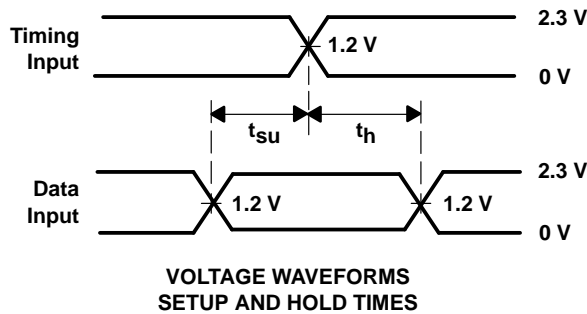
PARAMETER			TEST CONDITIONS	$V_{CC} = 2.5\text{ V}$ $\pm 0.2\text{ V}$	$V_{CC} = 3.3\text{ V}$ $\pm 0.3\text{ V}$	UNIT
				TYP	TYP	
C_{pd}	Power dissipation capacitance	Outputs enabled	$C_L = 50\text{ pF}, f = 10\text{ MHz}$	55	59	pF
		Outputs disabled		46	49	

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



LOAD CIRCUIT

TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	4.6 V
t_{PHZ}/t_{PZH}	GND



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

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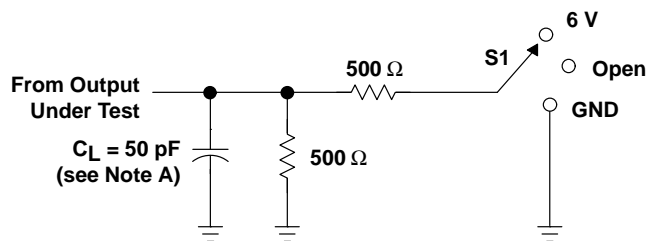
3.3-V 20-BIT FLIP-FLOP

WITH 3-STATE OUTPUTS

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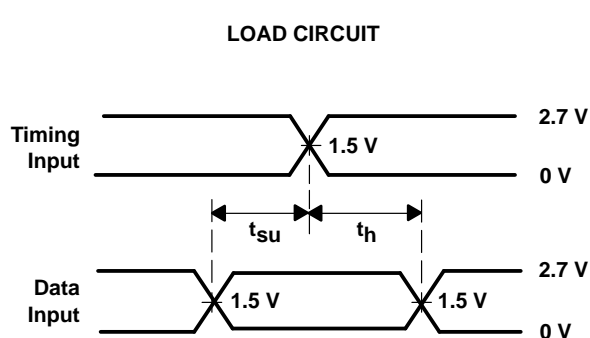
PARAMETER MEASUREMENT INFORMATION

$V_{CC} = 2.7 \text{ V AND } 3.3 \text{ V} \pm 0.3 \text{ V}$

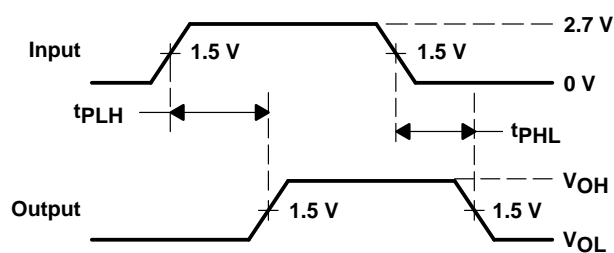


LOAD CIRCUIT

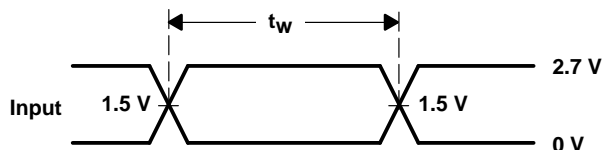
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	6 V
t_{PHZ}/t_{PZH}	GND



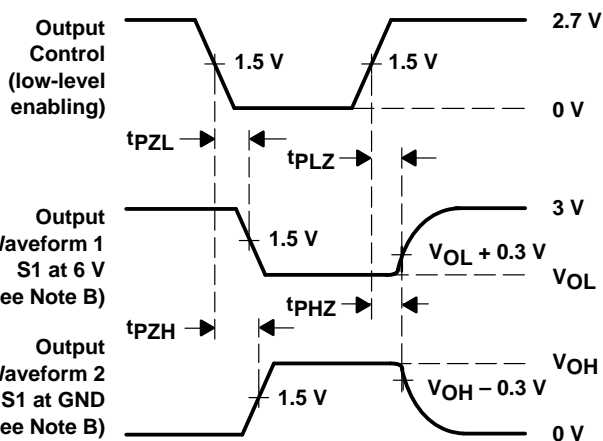
VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

- NOTES: 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.
- 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

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