- **Member of the Texas Instruments *Widebus*™ Family**
- ***EPIC*™ (Enhanced-Performance Implanted CMOS) Submicron Process**
- **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), Thin Shrink Small-Outline (DGG), and Thin Very Small-Outline (DGV) Packages**

**DGG, DGV, OR DL PACKAGE
(TOP VIEW)**

$\overline{OE}$	1	56	CLK
Q1	2	55	D1
Q2	3	54	D2
GND	4	53	GND
Q3	5	52	D3
Q4	6	51	D4
V_{CC}	7	50	V_{CC}
Q5	8	49	D5
Q6	9	48	D6
Q7	10	47	D7
GND	11	46	GND
Q8	12	45	D8
Q9	13	44	D9
Q10	14	43	D10
Q11	15	42	D11
Q12	16	41	D12
Q13	17	40	D13
GND	18	39	GND
Q14	19	38	D14
Q15	20	37	D15
Q16	21	36	D16
V_{CC}	22	35	V_{CC}
Q17	23	34	D17
Q18	24	33	D18
GND	25	32	GND
Q19	26	31	D19
Q20	27	30	D20
NC	28	29	$\overline{CLKEN}$

NC – No internal connection

description

This 20-bit flip-flop is designed specifically for 1.65-V to 3.6-V V_{CC} operation.

The 20 flip-flops of the SN74ALVCH16721 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 the 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.

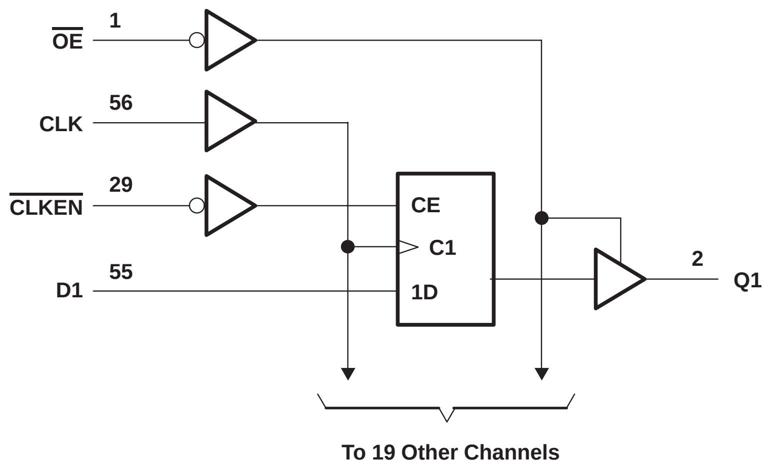
Active bus-hold circuitry is provided to hold unused or floating data inputs at a valid logic level.

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

FUNCTION TABLE
(each flip-flop)

INPUTS				OUTPUT
$\overline{OE}$	$\overline{CLKEN}$	CLK	D	Q
L	H	X	X	Q_0
L	L	↑	H	H
L	L	↑	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) . . . . –50 mA
Continuous output current, I_O . . . . ±50 mA
Continuous current through each V_{CC} or GND . . . . ±100 mA
Package thermal impedance, θ_{JA} (see Note 3): 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 negative-voltage and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 4.6 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

			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 × 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 × 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	V_{CC} = 1.65 V		–4	mA
		V_{CC} = 2.3 V		–12	
		V_{CC} = 2.7 V		–12	
		V_{CC} = 3 V		–24	
I_{OL}	Low-level output current	V_{CC} = 1.65 V		4	mA
		V_{CC} = 2.3 V		12	
		V_{CC} = 2.7 V		12	
		V_{CC} = 3 V		24	
$\Delta t/\Delta v$	Input transition rise or fall rate			10	ns/V
T_A	Operating free-air temperature		–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	V_{CC}	MIN	TYP†	MAX	UNIT
V_{OH}		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			
V_{OL}		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	
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	1.65 V	–25			
		V_I = 0.7 V	2.3 V	45			
		V_I = 1.7 V	2.3 V	–45			
		V_I = 0.8 V	3 V	75			
		V_I = 2 V	3 V	–75			
		V_I = 0 to 3.6 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 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		3.5		pF
	Data inputs				6		
C_o	Outputs	$V_O = V_{CC}$ or GND	3.3 V		7		pF

† 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.

timing requirements over recommended operating free-air temperature range (unless otherwise noted) (see Figures 1 through 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			§		150		150		150	MHz
t_w	Pulse duration, CLK high or low		§		3.3		3.3		3.3		ns
t_{su}	Setup time	Data before CLK↑	§		4		3.6		3.1		ns
		$\overline{\text{CLKEN}}$ before CLK↑	§		3.4		3.1		2.7		
t_h	Hold time	Data after CLK↑	§		0		0		0		ns
		$\overline{\text{CLKEN}}$ after CLK↑	§		0		0		0		

§ This information was not available at the time of publication.

switching characteristics over recommended operating free-air temperature range (unless otherwise noted) (see Figures 1 through 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}			†		150		150		150		MHz
t_{pd}	CLK	Q		†	1	5.6	1	5.1	1	4.3	ns
t_{en}	$\overline{OE}$	Q		†	1	6.1	1	5.8	1	4.8	ns
t_{dis}	$\overline{OE}$	Q		†	1	5.5	1	4.7	1	4.4	ns

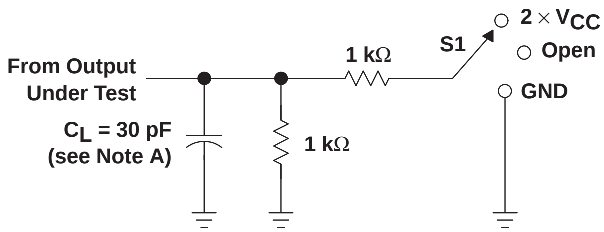
† This information was not available at the time of publication.

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	†	55	59	pF
		Outputs disabled		†	46	49	

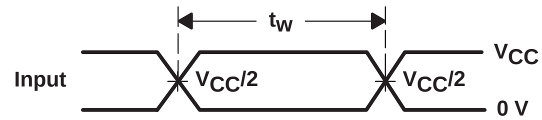
† This information was not available at the time of publication.

PARAMETER MEASUREMENT INFORMATION
V_{CC} = 1.8 V

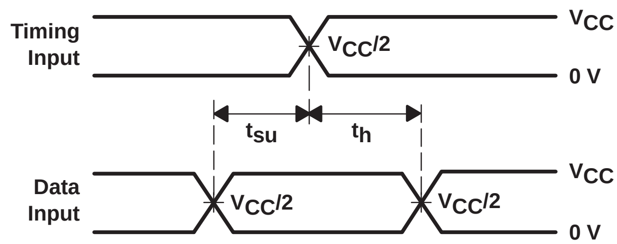


LOAD CIRCUIT

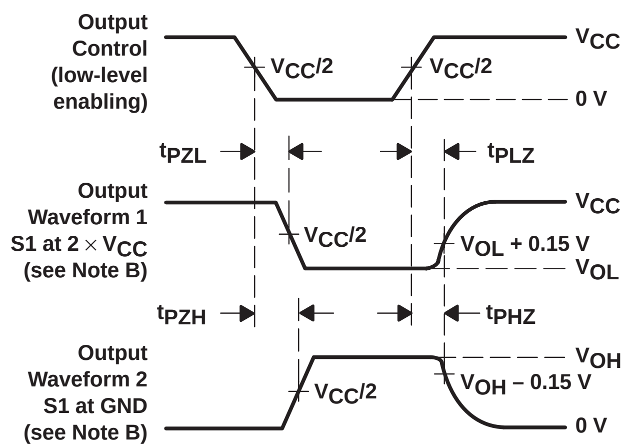
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND



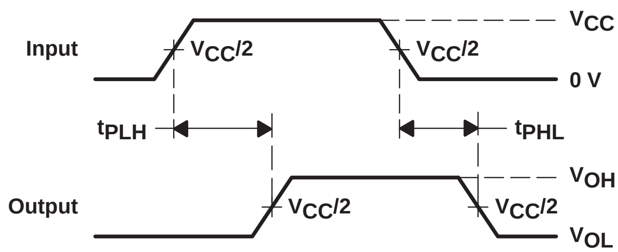
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES

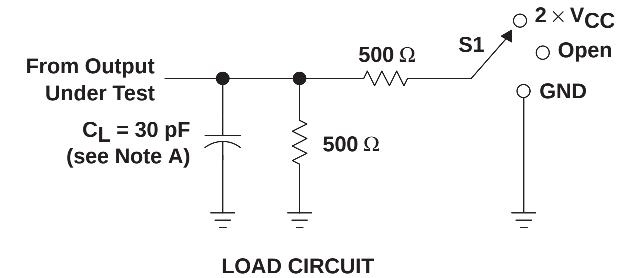


VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES

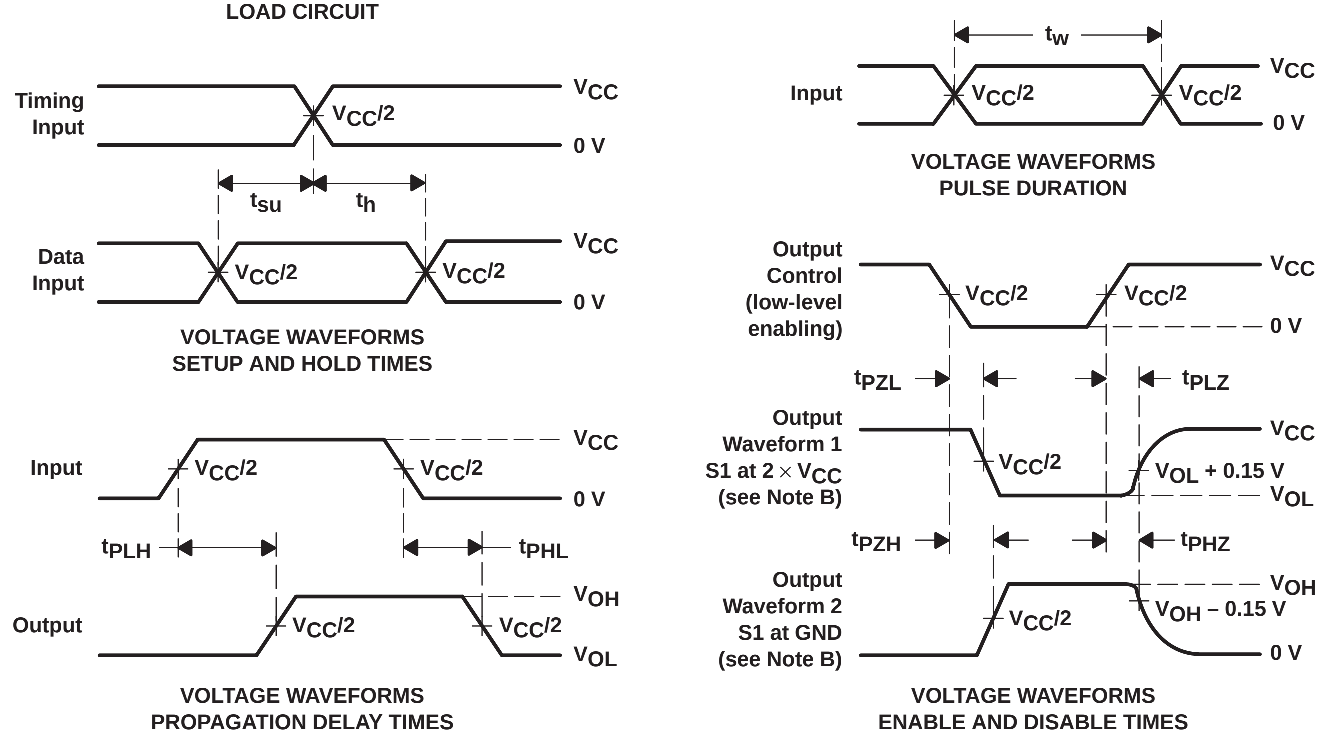
NOTES:
A. C_L includes probe and jig capacitance.
B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
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



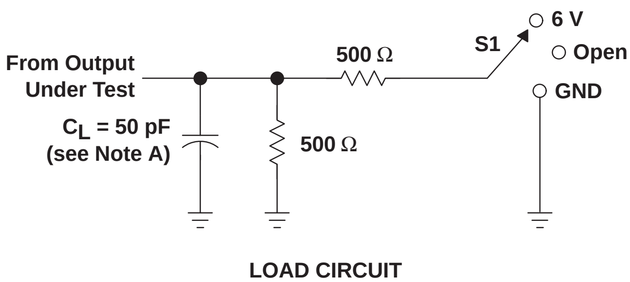
TEST	S1
t_{pd}	Open
t_{PLZ}/t_{PZL}	2 × V_{CC}
t_{PHZ}/t_{PZH}	GND



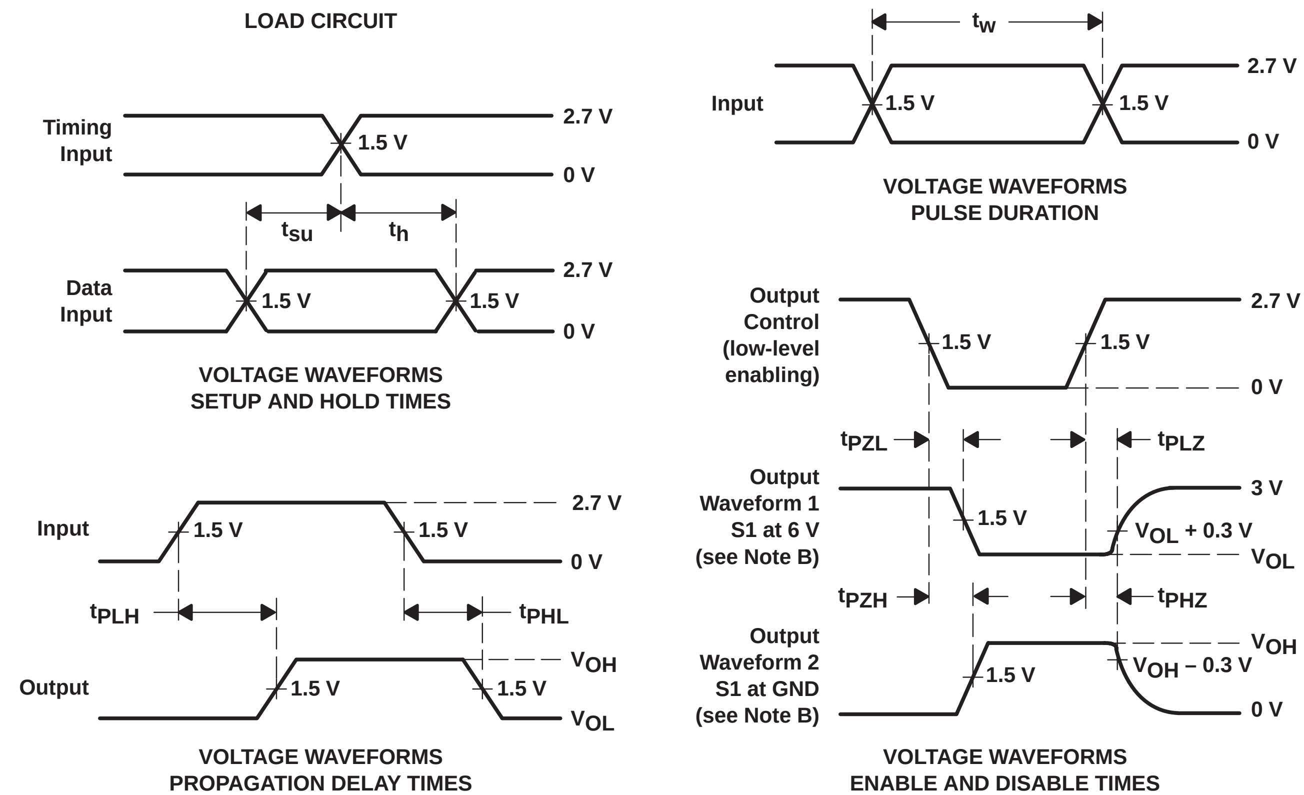
NOTES:
- A. C_L includes probe and jig capacitance.
- B. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
- 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



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

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