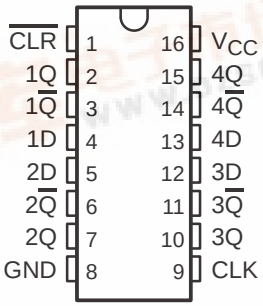
SN54LV175A, SN74LV175A
QUADRUPLE D-TYPE FLIP-FLOPS WITH CLEAR

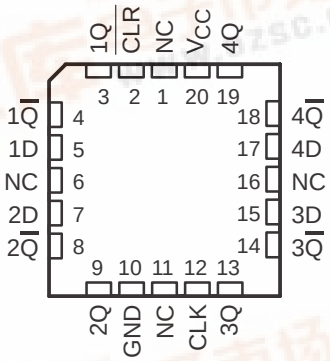
SCLS400B – APRIL 1998 – REVISED OCTOBER 1998

- *EPIC*™ (Enhanced-Performance Implanted CMOS) Process
- Typical V_{OLP} (Output Ground Bounce) < 0.8 V at V_{CC} = 3.3 V, T_A = 25°C
- Typical V_{OHV} (Output V_{OH} Undershoot) > 2 V at V_{CC} = 3.3 V, T_A = 25°C
- Contain Four Flip-Flops With Double-Rail Outputs
- Applications Include:
  - Buffer/Storage Registers
  - Shift Registers
  - Pattern Generators
- 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 (C = 200 pF, R = 0)
- Package Options Include Plastic Small-Outline (D, NS), Shrink Small-Outline (DB), Thin Very Small-Outline (DGV), and Thin Shrink Small-Outline (PW) Packages, Ceramic Flat (W) Packages, Chip Carriers (FK), and DIPs (J)

SN54LV175A . . . J OR W PACKAGE
SN74LV175A . . . D, DB, DGV, NS, OR PW PACKAGE
(TOP VIEW)



SN54LV175A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

The 'LV175A devices are quadruple D-type flip-flops designed for 2-V to 5.5-V V_{CC} operation.

These devices have a direct clear ($\overline{CLR}$) input and feature complementary outputs from each flip-flop.

Information at the data (D) inputs meeting the setup time requirements is transferred to the outputs on the positive-going edge of the clock (CLK) pulse.

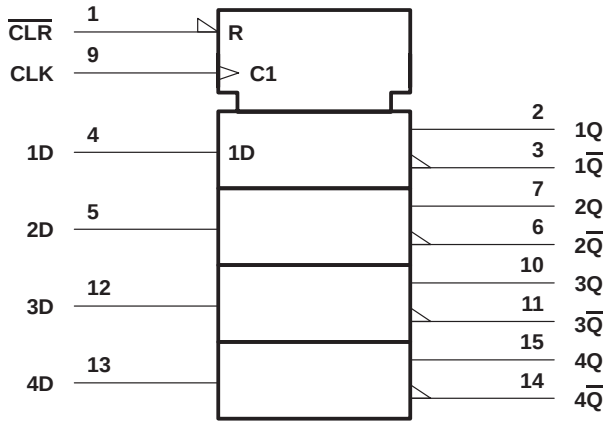
Clock triggering occurs at a particular voltage level and is not directly related to the transition time of the positive-going edge of CLK. When CLK is at either the high or low level, the D input has no effect at the output.

The SN54LV175A is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74LV175A is characterized for operation from –40°C to 85°C.

FUNCTION TABLE
(each flip-flop)

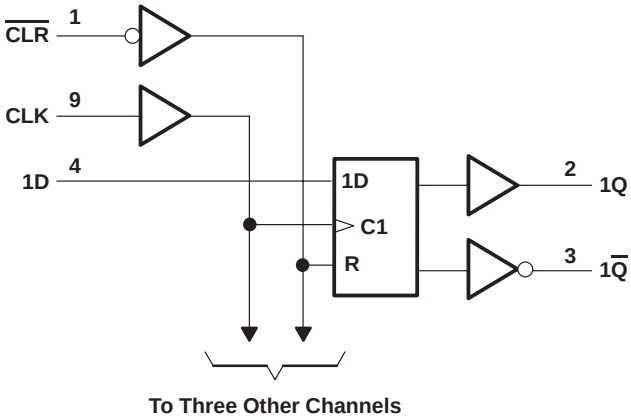
INPUTS			OUTPUTS	
$\overline{CLR}$	CLK	D	Q	$\overline{Q}$
L	X	X	L	H
H	↑	H	H	L
H	↑	L	L	H
H	L	X	Q_0	$\overline{Q}_0$

logic symbol†



† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for the D, DB, DGV, J, NS, PW, and W packages.

logic diagram (positive logic)



Pin numbers shown are for the D, DB, DGV, J, NS, PW, and W packages.

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC} . . . . . –0.5 V to 7 V
Input voltage range, V_I (see Note 1) . . . . . –0.5 V to 7 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) . . . . . –20 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}) . . . . . ±25 mA
Continuous current through V_{CC} or GND . . . . . ±50 mA
Package thermal impedance, θ_{JA} (see Note 3): D package . . . . . 113°C/W
DB package . . . . . 131°C/W
DGV package . . . . . 180°C/W
NS package . . . . . 111°C/W
PW package . . . . . 149°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 voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 7 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

			SN54LV175A		SN74LV175A		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		2	5.5	2	5.5	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5		1.5		V
		V_{CC} = 2.3 V to 2.7 V	$V_{CC}\times0.7$		$V_{CC}\times0.7$		
		V_{CC} = 3 V to 3.6 V	$V_{CC}\times0.7$		$V_{CC}\times0.7$		
		V_{CC} = 4.5 V to 5.5 V	$V_{CC}\times0.7$		$V_{CC}\times0.7$		
V_{IL}	Low-level input voltage	V_{CC} = 2 V		0.5		0.5	V
		V_{CC} = 2.3 V to 2.7 V		$V_{CC}\times0.3$		$V_{CC}\times0.3$	
		V_{CC} = 3 V to 3.6 V		$V_{CC}\times0.3$		$V_{CC}\times0.3$	
		V_{CC} = 4.5 V to 5.5 V		$V_{CC}\times0.3$		$V_{CC}\times0.3$	
V_I	Input voltage		0	5.5	0	5.5	V
V_O	Output voltage		0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 2 V		–50		–50	μA
		V_{CC} = 2.3 V to 2.7 V		–2		–2	mA
		V_{CC} = 3 V to 3.6 V		–6		–6	
		V_{CC} = 4.5 V to 5.5 V		–12		–12	
I_{OL}	Low-level output current	V_{CC} = 2 V		50		50	μA
		V_{CC} = 2.3 V to 2.7 V		2		2	mA
		V_{CC} = 3 V to 3.6 V		6		6	
		V_{CC} = 4.5 V to 5.5 V		12		12	
$\Delta t/\Delta v$	Input transition rise or fall rate	V_{CC} = 2.3 V to 2.7 V	0	200	0	200	ns/V
		V_{CC} = 3 V to 3.6 V	0	100	0	100	
		V_{CC} = 4.5 V to 5.5 V	0	20	0	20	
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 4: All unused 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}	SN54LV175A			SN74LV175A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OH}	I_{OH} = –50 μA	2 V to 5.5 V	V_{CC}–0.1			V_{CC}–0.1			V
	I_{OH} = –2 mA	2.3 V	2			2			
	I_{OH} = –6 mA	3 V	2.48			2.48			
	I_{OH} = –12 mA	4.5 V	3.8			3.8			
V_{OL}	I_{OL} = 50 μA	2 V to 5.5 V			0.1			0.1	V
	I_{OL} = 2 mA	2.3 V			0.4			0.4	
	I_{OL} = 6 mA	3 V			0.44			0.44	
	I_{OL} = 12 mA	4.5 V			0.55			0.55	
I_I	V_I = V_{CC} or GND	5.5 V			±1			±1	μA
I_{CC}	V_I = V_{CC} or GND, I_O = 0	5.5 V			20			20	μA
I_{off}	V_I or V_O = 0 to 5.5 V	0 V			5			5	μA
C_i	V_I = V_{CC} or GND	3.3 V		1.4			1.4		pF

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

			T_A = 25°C		SN54LV175A		SN74LV175A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$ low	6		6		6		ns
		CLK high or low	6.5		7		7		
t_{su}	Setup time before CLK↑	Data	7		7.5		7.5		ns
		$\overline{CLR}$ inactive	7		7.5		7.5		
t_h	Hold time, data after CLK↑		0.5		1		1		ns

timing requirements over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

			T_A = 25°C		SN54LV175A		SN74LV175A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$ low	5		5		5		ns
		CLK high or low	5		5		5		
t_{su}	Setup time before CLK↑	Data	5		5		5		ns
		$\overline{CLR}$ inactive	5		5		5		
t_h	Hold time, data after CLK↑		1		1		1		ns

timing requirements over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

			T_A = 25°C		SN54LV175A		SN74LV175A		UNIT
			MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$ low	5		5		5		ns
		CLK high or low	5		5		5		
t_{su}	Setup time before CLK↑	Data	4		4		4		ns
		$\overline{CLR}$ inactive	5		5		5		
t_h	Hold time, data after CLK↑		1		1		1		ns

switching characteristics over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN54LV175A		SN74LV175A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			C_L = 15 pF*	50	105		45		45		MHz
			C_L = 50 pF	40	80		35		35		
t_{pd}*	$\overline{CLR}$	Any	C_L = 15 pF		7.9	16.6	1	20	1	20	ns
	CLK	Any			9.3	18.8	1	22	1	22	
t_{pd}	$\overline{CLR}$	Any	C_L = 50 pF		10.4	21.6	1	25.5	1	25.5	ns
	CLK	Any			12	23.3	1	27	1	27	

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

switching characteristics over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN54LV175A		SN74LV175A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			C_L = 15 pF*	90	155		75		75		MHz
			C_L = 50 pF	50	120		45		45		
t_{pd}*	$\overline{CLR}$	Any	C_L = 15 pF		5.5	10.1	1	12	1	12	ns
	CLK	Any			6.5	11.5	1	13.5	1	13.5	
t_{pd}	$\overline{CLR}$	Any	C_L = 50 pF		7.4	13.6	1	15.5	1	15.5	ns
	CLK	Any			8.4	15	1	17	1	17	

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

switching characteristics over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	T_A = 25°C			SN54LV175A		SN74LV175A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{max}			C_L = 15 pF*	150	215		125		125		MHz
			C_L = 50 pF	85	165		75		75		
t_{pd}*	$\overline{CLR}$	Any	C_L = 15 pF		3.7	6.4	1	7.5	1	7.5	ns
	CLK	Any			4.6	7.3	1	8.5	1	8.5	
t_{pd}	$\overline{CLR}$	Any	C_L = 50 pF		5.3	8.4	1	9.5	1	9.5	ns
	CLK	Any			6	9.3	1	10.5	1	10.5	

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

noise characteristics, V_{CC} = 3.3 V, C_L = 50 pF, T_A = 25°C (see Note 5)

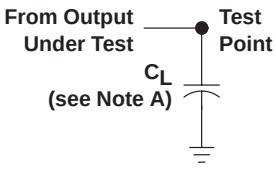
PARAMETER		SN74LV175A			UNIT
		MIN	TYP	MAX	
$V_{OL(P)}$	Quiet output, maximum dynamic V_{OL}		0.3	0.8	V
$V_{OL(V)}$	Quiet output, minimum dynamic V_{OL}		–0.3	–0.8	V
$V_{OH(V)}$	Quiet output, minimum dynamic V_{OH}		3		V
$V_{IH(D)}$	High-level dynamic input voltage	2.3			V
$V_{IL(D)}$	Low-level dynamic input voltage			0.97	V

NOTE 5: Characteristics are for surface-mount packages only.

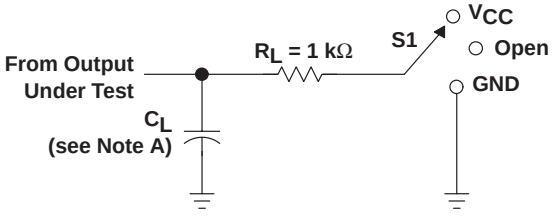
operating characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS	V_{CC}	TYP	UNIT
C_{pd}	Power dissipation capacitance	C_L = 50 pF, f = 10 MHz	3.3 V	13.6	pF
			5 V	14.5	

PARAMETER MEASUREMENT INFORMATION

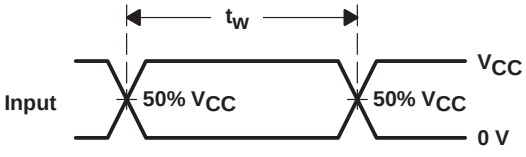


LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

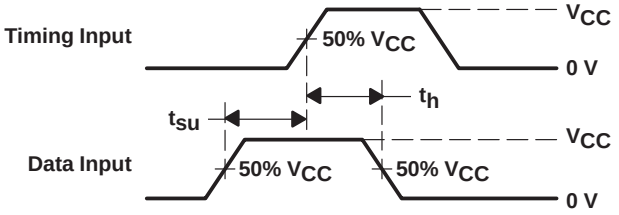


LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS

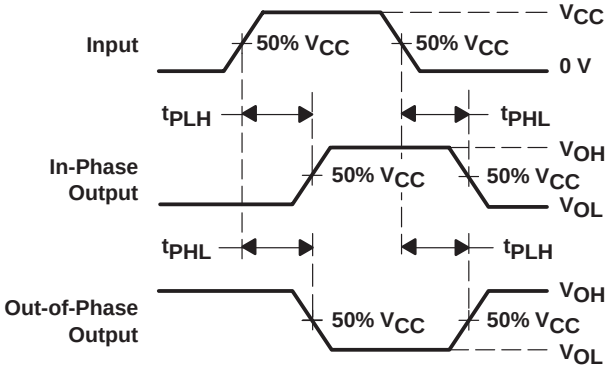
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{CC}
t_{PHZ}/t_{PZH}	GND
Open Drain	V_{CC}



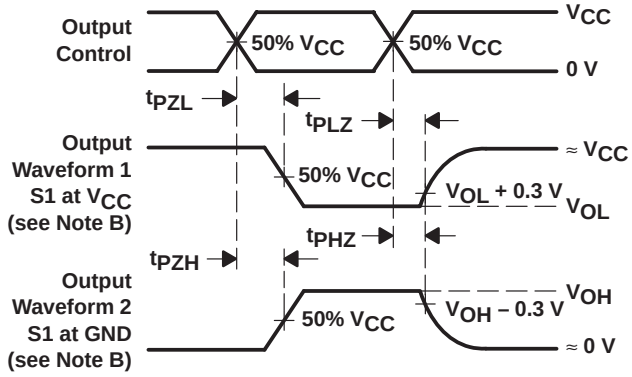
VOLTAGE WAVEFORMS
PULSE DURATION



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: 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 ≤ 1 MHz, Z_O = 50 Ω, t_r ≤ 3 ns, t_f ≤ 3 ns.
D. The outputs are measured one at a time with one input 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_{PHL} and t_{PLH} are the same as t_{pd}.

Figure 1. Load Circuit and Voltage Waveforms

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.