

# SN54173, SN54LS173A, SN74173, SN74LS173A 4-BIT D-TYPE REGISTERS WITH 3-STATE OUTPUTS

SDLS067A – OCTOBER 1976 – REVISED JUNE 1999

- 3-State Outputs Interface Directly With System Bus
- Gated Output-Control Lines for Enabling or Disabling the Outputs
- Fully Independent Clock Virtually Eliminates Restrictions for Operating in One of Two Modes:
  - Parallel Load
  - Do Nothing (Hold)
- For Application as Bus Buffer Registers
- Package Options Include Plastic Small-Outline (D) Packages, Ceramic Flat (W) Packages, Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) DIPs

TYPE	TYPICAL PROPAGATION DELAY TIME	MAXIMUM CLOCK FREQUENCY
'173	23 ns	35 MHz
'LS173A	18 ns	50 MHz

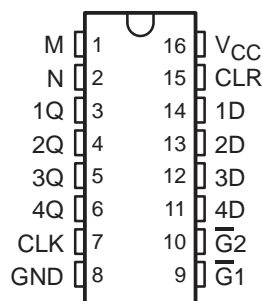
## description

The '173 and 'LS173A 4-bit registers include D-type flip-flops featuring totem-pole 3-state outputs capable of driving highly capacitive or relatively low-impedance loads. The high-impedance third state and increased high-logic-level drive provide these flip-flops with the capability of being connected directly to and driving the bus lines in a bus-organized system without need for interface or pull-up components. Up to 128 of the SN74173 or SN74LS173A outputs can be connected to a common bus and still drive two Series 54/74 or 54LS/74LS TTL normalized loads, respectively. Similarly, up to 49 of the SN54173 or SN54LS173A outputs can be connected to a common bus and drive one additional Series 54/74 or 54LS/74LS TTL normalized load, respectively. To minimize the possibility that two outputs will attempt to take a common bus to opposite logic levels, the output control circuitry is designed so that the average output disable times are shorter than the average output enable times.

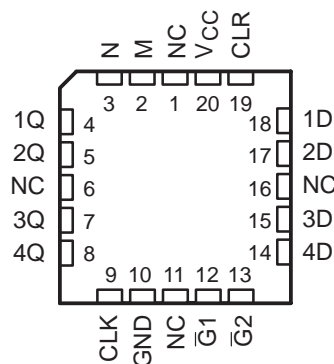
Gated enable inputs are provided on these devices for controlling the entry of data into the flip-flops. When both data-enable ( $\overline{G1}$ ,  $\overline{G2}$ ) inputs are low, data at the D inputs are loaded into their respective flip-flops on the next positive transition of the buffered clock input. Gate output-control (M, N) inputs also are provided. When both are low, the normal logic states (high or low levels) of the four outputs are available for driving the loads or bus lines. The outputs are disabled independently from the level of the clock by a high logic level at either output-control input. The outputs then present a high impedance and neither load nor drive the bus line. Detailed operation is given in the function table.

The SN54173 and SN54LS173A are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74173 and SN74LS173A are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN54173, SN54LS173A ... J OR W PACKAGE  
SN74173 ... N PACKAGE  
SN74LS173A ... D or N PACKAGE  
(TOP VIEW)



SN54LS173A ... FK PACKAGE  
(TOP VIEW)



NC – No internal connection



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PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.

**TEXAS  
INSTRUMENTS**

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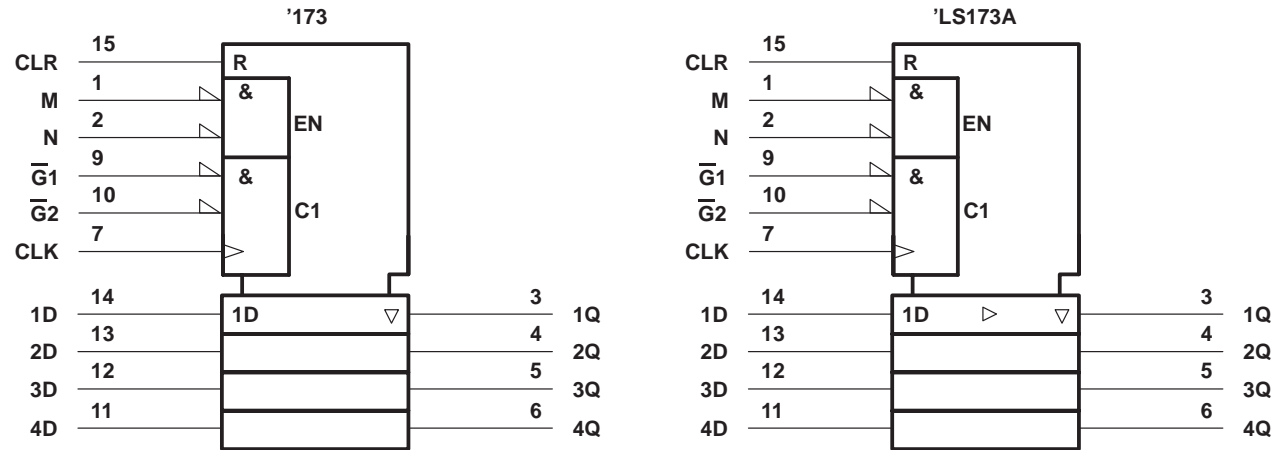
SN54173, SN54LS173A, SN74173, SN74LS173A  
4-BIT D-TYPE REGISTERS  
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FUNCTION TABLE					
INPUTS					OUTPUT Q
CLR	CLK	DATA ENABLE		DATA D	
		$\overline{G1}$	$\overline{G2}$		
H	X	X	X	X	L
L	L	X	X	X	$Q_0$
L	$\uparrow$	H	X	X	$Q_0$
L	$\uparrow$	X	H	X	$Q_0$
L	$\uparrow$	L	L	L	L
L	$\uparrow$	L	L	H	H

When either M or N (or both) is (are) high, the output is disabled to the high-impedance state; however, sequential operation of the flip-flops is not affected.

logic symbol†

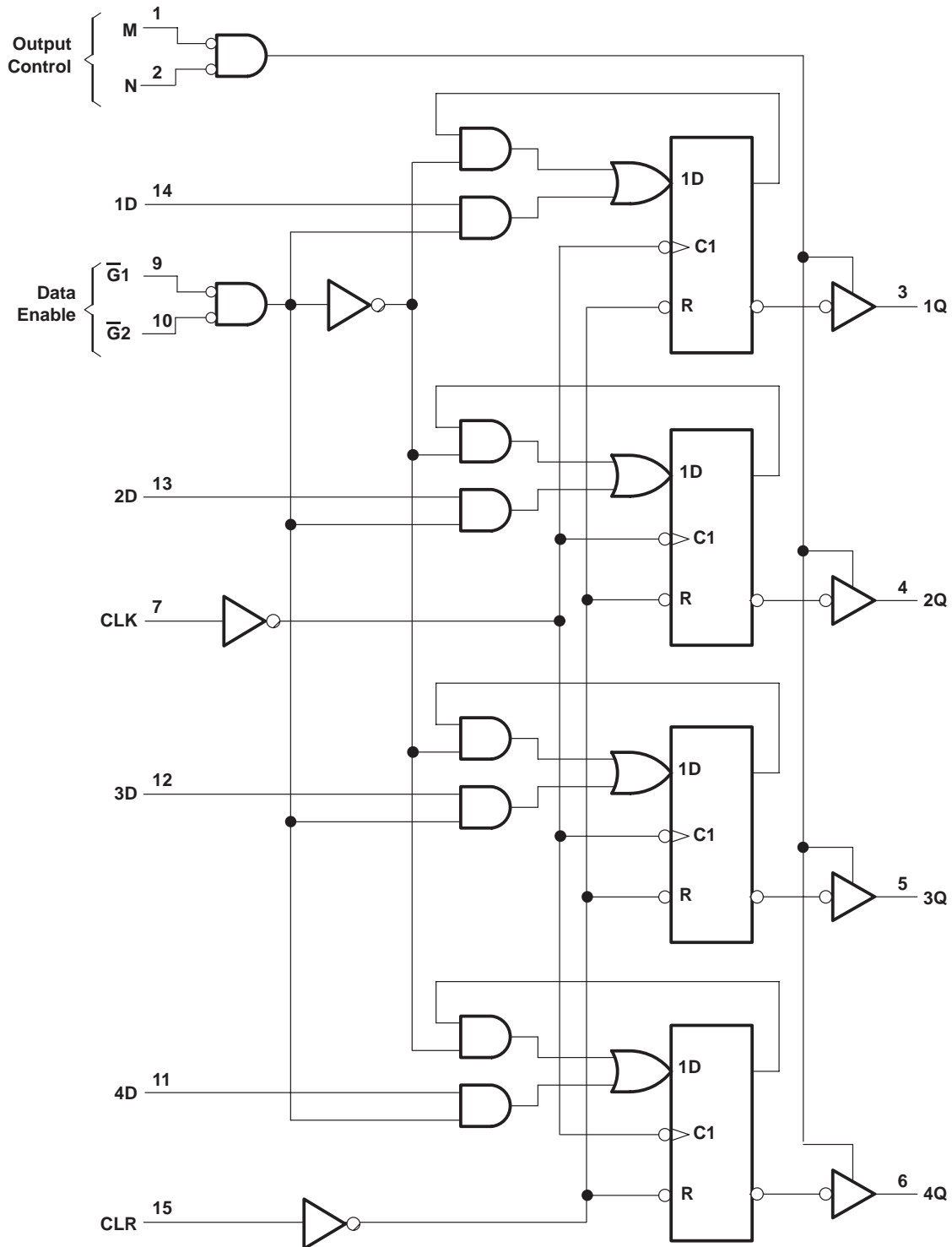


† This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12. Pin numbers shown are for D, J, N, and W packages.

SN54173, SN54LS173A, SN74173, SN74LS173A  
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logic diagram (positive logic)

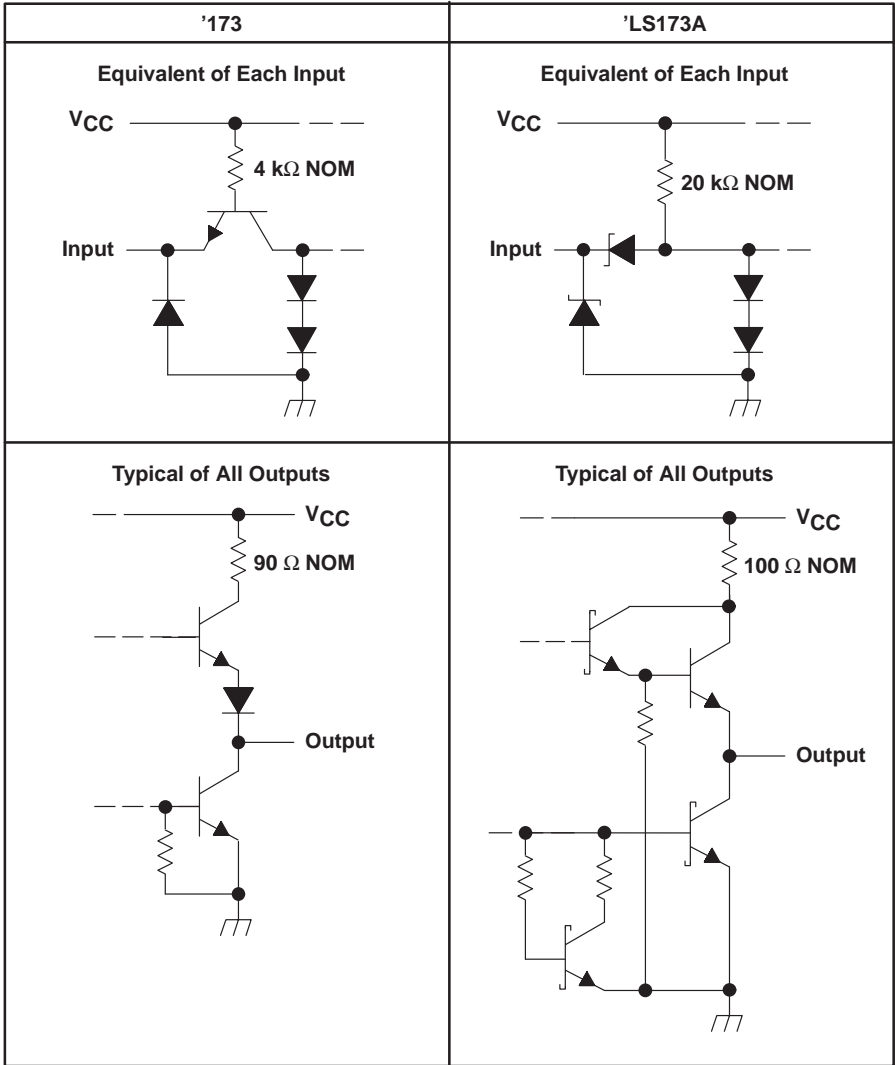


Pin numbers shown are for D, J, N, and W packages.

# SN54173, SN54LS173A, SN74173, SN74LS173A 4-BIT D-TYPE REGISTERS WITH 3-STATE OUTPUTS

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## schematics of inputs and outputs



## absolute maximum ratings over operating free-air temperature range (unless otherwise noted)<sup>†</sup>

Supply voltage, $V_{CC}$ (see Note 1)	−0.5 V to 7 V
Input voltage: '173	−0.5 V to 5.5 V
'LS173A	−0.5 V to 7 V
Off-state output voltage	−0.5 V to 5.5 V
Package thermal impedance, $\theta_{JA}$ (see Note 2): D package	113°C/W
N package	78°C/W
Storage temperature range, $T_{stg}$	−65°C to 150°C

<sup>†</sup> 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. Voltage values are with respect to network ground terminal.  
2. The package thermal impedance is calculated in accordance with JESD 51, except for through-hole packages, which use a trace length of zero.

**recommended operating conditions (see Note 3)**

		SN54173			SN74173			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V <sub>CC</sub>	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
I <sub>OH</sub>	High-level output current			–2			–5.2	mA
I <sub>OL</sub>	Low-level output current			16			16	mA
T <sub>A</sub>	Operating free-air temperature	–55		125	0		70	°C

NOTE 3: All unused inputs of the device must be held at V<sub>CC</sub> 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†	SN54173			SN74173			UNIT
		MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V <sub>IH</sub>	High-level input voltage	2			2			V
V <sub>IL</sub>	Low-level input voltage			0.8			0.8	V
V <sub>IK</sub>	Input clamp voltage	V <sub>CC</sub> = MIN, I <sub>I</sub> = –12 mA		–1.5			–1.5	V
V <sub>OH</sub>	High-level output voltage	V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.8 V, V <sub>IH</sub> = 2 V, I <sub>OH</sub> = MAX		2.4			2.4	V
V <sub>OL</sub>	Low-level output voltage	V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.8 V, V <sub>IH</sub> = 2 V, I <sub>OL</sub> = 16 mA		0.4			0.4	V
I <sub>O(off)</sub>	Off-state (high-impedance state) output current	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2 V	V <sub>O</sub> = 2.4 V				40	μA
			V <sub>O</sub> = 0.4 V				–40	
I <sub>I</sub>	Input current at maximum input voltage	V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V		1			1	mA
I <sub>IH</sub>	High-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.4 V		40			40	μA
I <sub>IL</sub>	Low-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		–1.6			–1.6	mA
I <sub>OS</sub>	Short-circuit output current§	V <sub>CC</sub> = MAX		–30	–70	–30	–70	mA
I <sub>CC</sub>	Supply current	V <sub>CC</sub> = MAX, See Note 4		50	72	50	72	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

§ Not more than one output should be shorted at a time.

NOTE 4: I<sub>CC</sub> is measured with all outputs open; CLR grounded, following momentary connection to 4.5 V, N,  $\overline{G1}$ ,  $\overline{G2}$ , and all data inputs grounded; and CLK and M at 4.5 V.

**timing requirements over recommended operating conditions (unless otherwise noted)**

			SN54173		SN74173		UNIT
			MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Input clock frequency		25		25		MHz
t <sub>w</sub>	Pulse duration	CLK or CLR	20		20		ns
t <sub>su</sub>	Setup time	Data enable ( $\overline{G1}$ , $\overline{G2}$ )	17		17		ns
		Data	10		10		
		CLR (inactive state)	10		10		
t <sub>h</sub>	Hold time	Data enable ( $\overline{G1}$ , $\overline{G2}$ )	2		2		ns
		Data	10		10		

# SN54173, SN54LS173A, SN74173, SN74LS173A

## 4-BIT D-TYPE REGISTERS

### WITH 3-STATE OUTPUTS

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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 400\ \Omega$  (see Figure 1)

PARAMETER	TEST CONDITIONS	SN54173			SN74173			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$f_{\max}$	Maximum clock frequency	25	35		25	35		MHz
$t_{PHL}$	Propagation delay time, high-to-low-level output from clear input		18	27		18	27	ns
$t_{PLH}$	Propagation delay time, low-to-high-level output from clock input		28	43		28	43	ns
$t_{PHL}$	Propagation delay time, high-to-low-level output from clock input		19	31		19	31	
$t_{PZH}$	Output enable time to high level	7	16	30	7	16	30	ns
$t_{PZL}$	Output enable time to low level	7	21	30	7	21	30	
$t_{PHZ}$	Output disable time from high level	3	5	14	3	5	14	ns
$t_{PLZ}$	Output disable time from low level	3	11	20	3	11	20	

## recommended operating conditions

		SN54LS173A			SN74LS173A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
V <sub>CC</sub>	Supply voltage	4.5	5	5.5	4.75	5	5.25	V
I <sub>OH</sub>	High-level output current			–1			–2.6	mA
I <sub>OL</sub>	Low-level output current			12			24	mA
T <sub>A</sub>	Operating free-air temperature	–55		125	0		70	°C

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

PARAMETER		TEST CONDITIONS†		SN54LS173A			SN74LS173A			UNIT
				MIN	TYP‡	MAX	MIN	TYP‡	MAX	UNIT
V <sub>IH</sub>	High-level input voltage			2			2			V
V <sub>IL</sub>	Low-level input voltage			0.7			0.8			V
V <sub>IK</sub>	Input clamp voltage	V <sub>CC</sub> = MIN, I <sub>I</sub> = −18 mA		−1.5			−1.5			V
V <sub>OH</sub>	High-level output voltage	V <sub>CC</sub> = MIN, V <sub>IH</sub> = 2 V, V <sub>IL</sub> = V <sub>ILmax</sub> , I <sub>OH</sub> = MAX		2.4 3.4			2.4 3.1			V
V <sub>OL</sub>	Low-level output voltage	V <sub>CC</sub> = MIN, V <sub>IL</sub> = 0.8 V,	I <sub>OL</sub> = 12 mA	0.25 0.4			0.25 0.4			V
			I <sub>OL</sub> = 24 mA				0.35 0.5			V
I <sub>O(off)</sub>	Off-state (high-impedance state) output current	V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2 V	V <sub>O</sub> = 2.7 V	20			20			V
			V <sub>O</sub> = 0.4 V	−20			−20			
I <sub>I</sub>	Input current at maximum input voltage	V <sub>CC</sub> = MAX, V <sub>I</sub> = 7 V		0.1			0.1			mA
I <sub>IH</sub>	High-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 2.7 V		20			20			μA
I <sub>IL</sub>	Low-level input current	V <sub>CC</sub> = MAX, V <sub>I</sub> = 0.4 V		−0.4			−0.4			mA
I <sub>OS</sub>	Short-circuit output current§	V <sub>CC</sub> = MAX		−30 −130			−30 −130			mA
I <sub>CC</sub>	Supply current	V <sub>CC</sub> = MAX, See Note 4		19 30			19 24			mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

§ Not more than one output should be shorted at a time.

NOTE 4: I<sub>CC</sub> is measured with all outputs open; CLR grounded, following momentary connection to 4.5 V, N,  $\overline{G1}$ ,  $\overline{G2}$ , and all data inputs grounded; and CLK and M at 4.5 V.

## timing requirements over recommended operating conditions (unless otherwise noted)

			SN54LS173A		SN74LS173A		UNIT
			MIN	MAX	MIN	MAX	
f <sub>clock</sub>	Input clock frequency		30		25		MHz
t <sub>w</sub>	Pulse duration	CLK or CLR	25		25		ns
t <sub>su</sub>	Setup time	Data enable ( $\overline{G1}$ , $\overline{G2}$ )	35		35		ns
		Data	17		17		
		CLR (inactive state)	10		10		
t <sub>h</sub>	Hold time	Data enable ( $\overline{G1}$ , $\overline{G2}$ )	0		0		ns
		Data	3		3		

# SN54173, SN54LS173A, SN74173, SN74LS173A

## 4-BIT D-TYPE REGISTERS

### WITH 3-STATE OUTPUTS

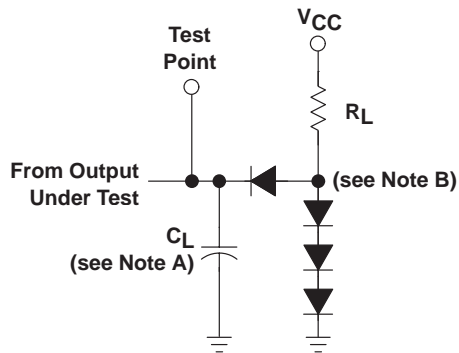
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switching characteristics,  $V_{CC} = 5\text{ V}$ ,  $T_A = 25^\circ\text{C}$ ,  $R_L = 667\ \Omega$  (see Figure 2)

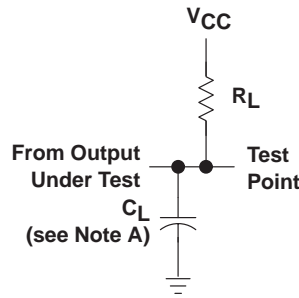
PARAMETER	TEST CONDITIONS	SN54LS173A			SN74LS173A			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
$f_{\max}$	Maximum clock frequency	30	50		30	50		MHz
$t_{PHL}$	Propagation delay time, high-to-low-level output from clear input		26	35		26	35	ns
$t_{PLH}$	Propagation delay time, low-to-high-level output from clock input		17	25		17	25	ns
$t_{PHL}$	Propagation delay time, high-to-low-level output from clock input		22	30		22	30	
$t_{PZH}$	Output enable time to high level		15	23		15	23	ns
$t_{PZL}$	Output enable time to low level		18	27		18	27	
$t_{PHZ}$	Output disable time from high level		11	20		11	20	ns
$t_{PLZ}$	Output disable time from low level		11	17		11	17	



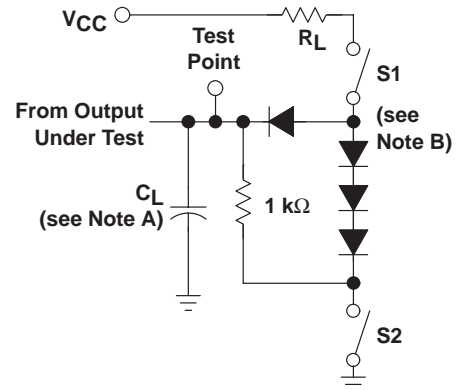
PARAMETER MEASUREMENT INFORMATION  
SERIES 54/74 AND 54S/74S DEVICES



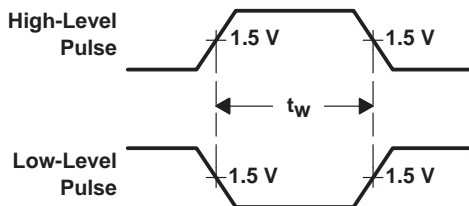
LOAD CIRCUIT  
FOR 2-STATE TOTEM-POLE OUTPUTS



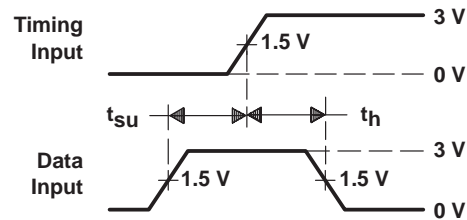
LOAD CIRCUIT  
FOR OPEN-COLLECTOR OUTPUTS



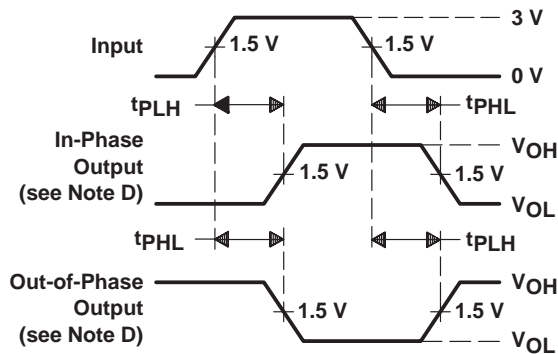
LOAD CIRCUIT  
FOR 3-STATE OUTPUTS



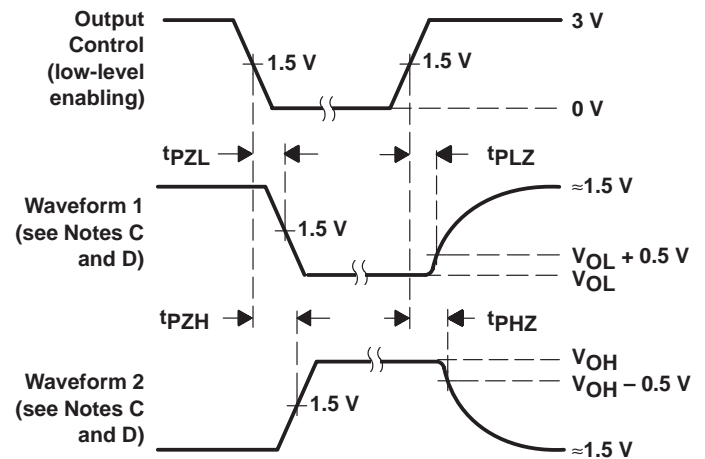
VOLTAGE WAVEFORMS  
PULSE DURATIONS



VOLTAGE WAVEFORMS  
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS  
PROPAGATION DELAY TIMES



VOLTAGE WAVEFORMS  
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS

- NOTES: A.  $C_L$  includes probe and jig capacitance.  
B. All diodes are 1N3064 or equivalent.  
C. 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.  
D. S1 and S2 are closed for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{PHZ}$ , and  $t_{PLZ}$ ; S1 is open and S2 is closed for  $t_{PZH}$ ; S1 is closed and S2 is open for  $t_{PZL}$ .  
E. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1$  MHz,  $Z_O \approx 50 \Omega$ ,  $t_r$  and  $t_f \leq 7$  ns for Series 54/74 devices and  $t_r$  and  $t_f \leq 2.5$  ns for Series 54S/74S devices.  
F. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

# SN54173, SN54LS173A, SN74173, SN74LS173A

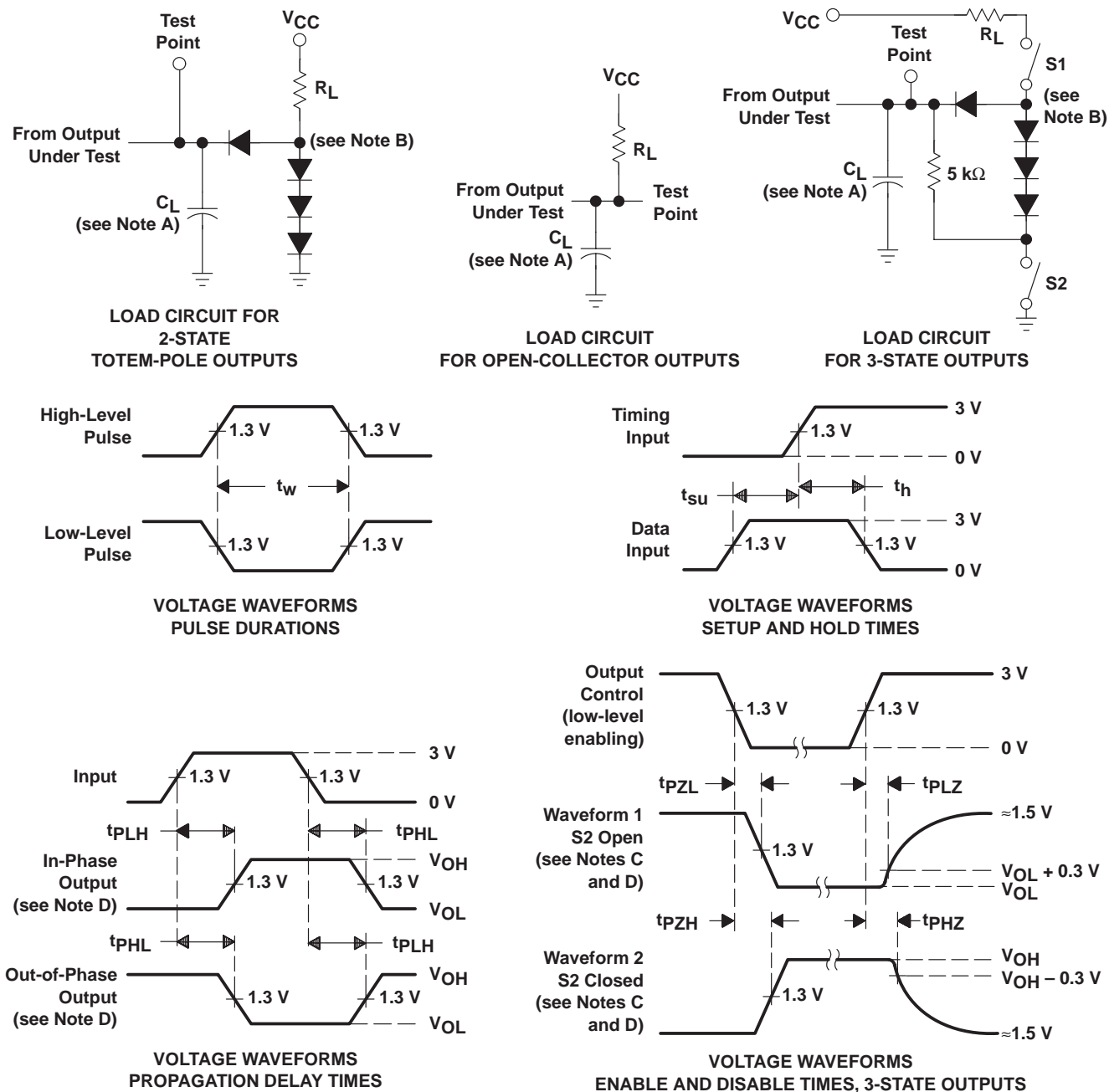
## 4-BIT D-TYPE REGISTERS

### WITH 3-STATE OUTPUTS

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#### PARAMETER MEASUREMENT INFORMATION

##### SERIES 54LS/74LS DEVICES



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. All diodes are 1N3064 or equivalent.  
 C. 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.  
 D. S1 and S2 are closed for  $t_{PLH}$ ,  $t_{PHL}$ ,  $t_{PHZ}$ , and  $t_{PLZ}$ ; S1 is open and S2 is closed for  $t_{PZH}$ ; S1 is closed and S2 is open for  $t_{PZL}$ .  
 E. Phase relationships between inputs and outputs have been chosen arbitrarily for these examples.  
 F. All input pulses are supplied by generators having the following characteristics:  $PRR \leq 1$  MHz,  $Z_O \approx 50 \Omega$ ,  $t_r \leq 15$  ns,  $t_f \leq 6$  ns.  
 G. The outputs are measured one at a time with one input transition per measurement.

Figure 2. Load Circuits and Voltage Waveforms

**PACKAGING INFORMATION**

Orderable Device	Status <sup>(1)</sup>	Package Type	Package Drawing	Pins	Package Qty	Eco Plan <sup>(2)</sup>	Lead/Ball Finish	MSL Peak Temp <sup>(3)</sup>
JM38510/36101B2A	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
JM38510/36101BEA	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
JM38510/36101BFA	ACTIVE	CFP	W	16	1	None	Call TI	Level-NC-NC-NC
JM38510/36101SEA	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
JM38510/36101SFA	ACTIVE	CFP	W	16	1	None	Call TI	Level-NC-NC-NC
SN54173J	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
SN54LS173AJ	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
SN74173N	OBSOLETE	PDIP	N	16		None	Call TI	Call TI
SN74LS173AD	ACTIVE	SOIC	D	16	40	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
SN74LS173ADR	ACTIVE	SOIC	D	16	2500	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
SN74LS173AN	ACTIVE	PDIP	N	16	25	Pb-Free (RoHS)	CU NIPDAU	Level-NC-NC-NC
SN74LS173ANSR	ACTIVE	SO	NS	16	2000	Pb-Free (RoHS)	CU NIPDAU	Level-2-260C-1 YEAR/ Level-1-235C-UNLIM
SNJ54173J	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
SNJ54173W	OBSOLETE	CFP	W	16		None	Call TI	Call TI
SNJ54LS173AFK	ACTIVE	LCCC	FK	20	1	None	Call TI	Level-NC-NC-NC
SNJ54LS173AJ	ACTIVE	CDIP	J	16	1	None	Call TI	Level-NC-NC-NC
SNJ54LS173AW	ACTIVE	CFP	W	16	1	None	Call TI	Level-NC-NC-NC

<sup>(1)</sup> The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

<sup>(2)</sup> Eco Plan - May not be currently available - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

**None:** Not yet available Lead (Pb-Free).

**Pb-Free (RoHS):** TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

**Green (RoHS & no Sb/Br):** TI defines "Green" to mean "Pb-Free" and in addition, uses package materials that do not contain halogens, including bromine (Br) or antimony (Sb) above 0.1% of total product weight.

<sup>(3)</sup> MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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