

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 |

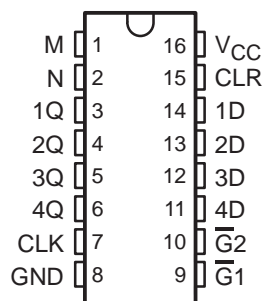
description

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.

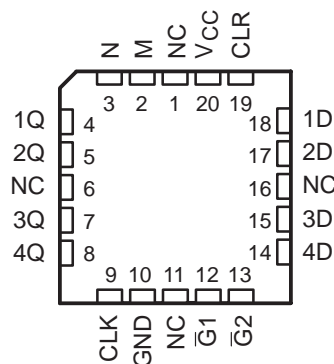
Gated enable inputs are provided on these devices for controlling the entry of data into the flip-flops. When both data-enable ($\overline{G1}$, $\overline{G2}$) inputs are low, data at the D inputs are loaded into their respective flip-flops on the next positive transition of the buffered clock input. 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°C to 125°C . The SN74173 and SN74LS173A are characterized for operation from 0°C to 70°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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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

SN54173, SN54LS173A, SN74173, SN74LS173A

4-BIT D-TYPE REGISTERS

WITH 3-STATE OUTPUTS

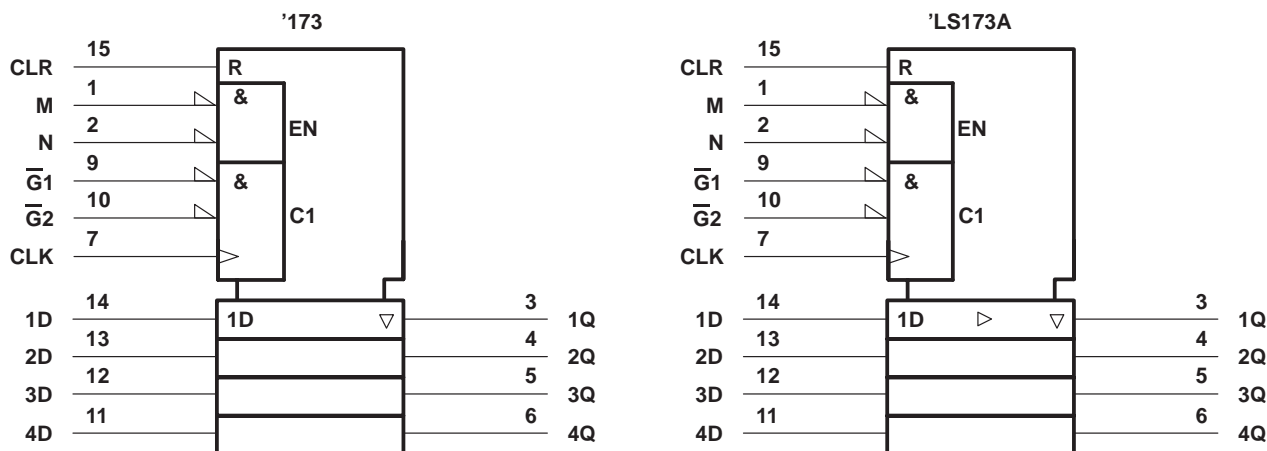
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FUNCTION TABLE

| CLR | CLK | INPUTS | | | OUTPUT Q |
|-----|------------|-----------------|-----------------|--------|----------|
| | | 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†

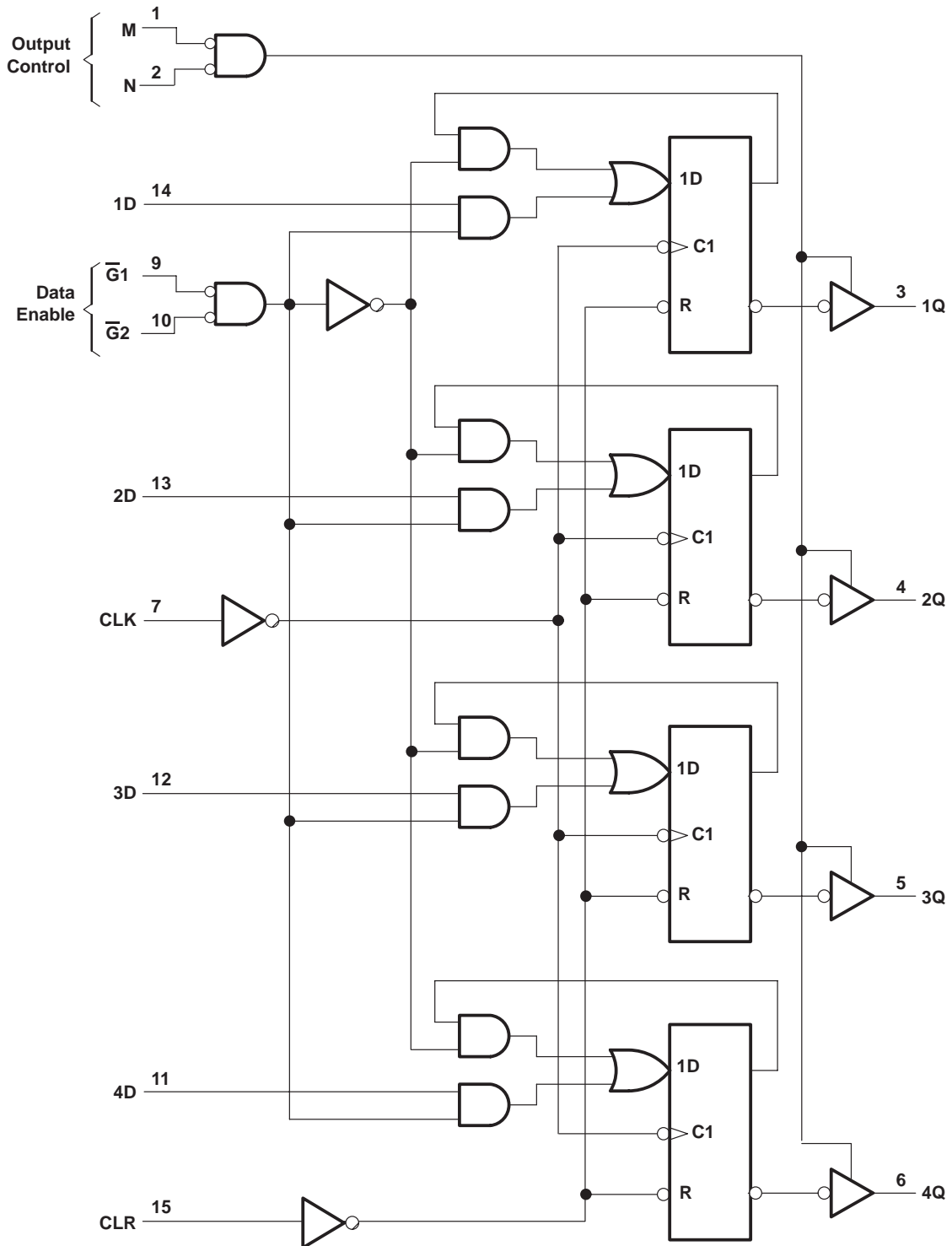


† This symbol is in accordance with ANSI/IEEE Standard 91-1984 and IEC Publication 617-12. Pin numbers shown are for D, J, N, and W packages.

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**4-BIT D-TYPE REGISTERS
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logic diagram (positive logic)



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

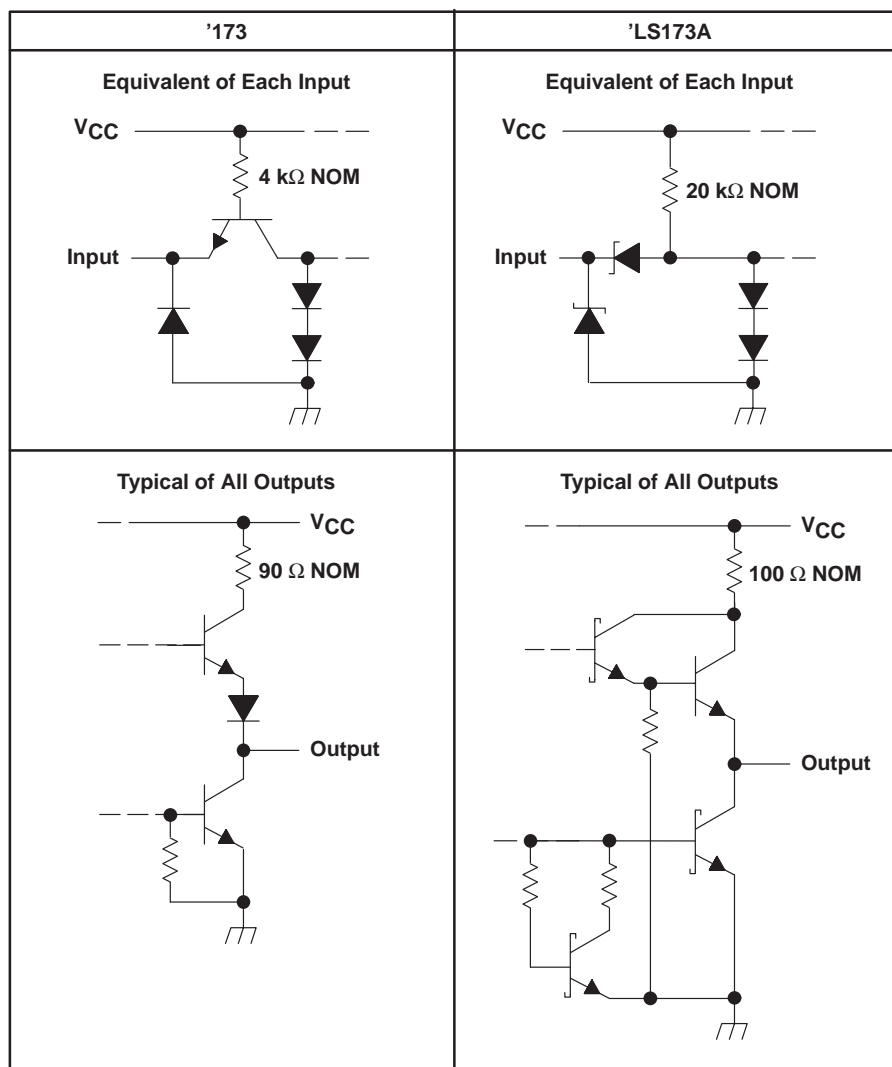
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4-BIT D-TYPE REGISTERS

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schematics of inputs and outputs



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

| | |
|--|-----------------|
| 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, θ_{JA} (see Note 2): D package | 113°C/W |
| N package | 78°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. 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.



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recommended operating conditions (see Note 3)

| | | SN54173 | | | SN74173 | | | UNIT |
|-----------------|--------------------------------|---------|-----|-----|---------|-----|------|------|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| V _{CC} | Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| I _{OH} | High-level output current | | | -2 | | | -5.2 | mA |
| I _{OL} | Low-level output current | | | 16 | | | 16 | mA |
| T _A | Operating free-air temperature | -55 | | 125 | 0 | | 70 | °C |

NOTE 3: 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† | SN54173 | | | SN74173 | | | UNIT | |
|---------------------|---|--|------|------------------------|---------|------|------|------|----|
| | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | | |
| V _{IH} | High-level input voltage | 2 | | | 2 | | | V | |
| V _{IL} | Low-level input voltage | | | 0.8 | | | 0.8 | V | |
| V _{IK} | Input clamp voltage | V _{CC} = MIN, I _I = -12 mA | | -1.5 | | | -1.5 | V | |
| V _{OH} | High-level output voltage | V _{CC} = MIN, V _{IL} = 0.8 V, V _{IH} = 2 V, I _{OH} = MAX | | 2.4 | | | 2.4 | V | |
| V _{OL} | Low-level output voltage | V _{CC} = MIN, V _{IL} = 0.8 V, V _{IH} = 2 V, I _{OL} = 16 mA | | | | | 0.4 | V | |
| I _{O(off)} | Off-state (high-impedance state) output current | V _{CC} = MAX, V _{IH} = 2 V | | V _O = 2.4 V | 150 | | 40 | μA | |
| | | | | V _O = 0.4 V | -150 | | -40 | | |
| I _I | Input current at maximum input voltage | V _{CC} = MAX, V _I = 5.5 V | | | 1 | | 1 | mA | |
| I _{IH} | High-level input current | V _{CC} = MAX, V _I = 2.4 V | | | 40 | | 40 | μA | |
| I _{IL} | Low-level input current | V _{CC} = MAX, V _I = 0.4 V | | | -1.6 | | -1.6 | mA | |
| I _{OS} | Short-circuit output current§ | V _{CC} = MAX | | | -30 | | -70 | mA | |
| I _{CC} | Supply current | V _{CC} = 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_{CC} = 5 V, T_A = 25°C.

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

NOTE 4: I_{CC} 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 _{clock} | Input clock frequency | | 25 | | 25 | MHz |
| t _w | Pulse duration | CLK or CLR | | 20 | 20 | ns |
| t _{su} | Setup time | Data enable ($\overline{G1}$, $\overline{G2}$) | | 17 | 17 | ns |
| | | Data | | 10 | 10 | |
| | | CLR (inactive state) | | 10 | 10 | |
| t _h | Hold time | Data enable ($\overline{G1}$, $\overline{G2}$) | | 2 | 2 | ns |
| | | Data | | 10 | 10 | |



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4-BIT D-TYPE REGISTERS
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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 | |



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

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recommended operating conditions

| | | SN54LS173A | | | SN74LS173A | | | UNIT |
|-----------------|--------------------------------|------------|-----|-----|------------|-----|------|------|
| | | MIN | NOM | MAX | MIN | NOM | MAX | |
| V _{CC} | Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| I _{OH} | High-level output current | | | -1 | | | -2.6 | mA |
| I _{OL} | Low-level output current | | | 12 | | | 24 | mA |
| T _A | 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 _{IH} | High-level input voltage | | | 2 | | | 2 | | | V | |
| V _{IL} | Low-level input voltage | | | | | 0.7 | | | 0.8 | V | |
| V _{IK} | Input clamp voltage | V _{CC} = MIN, | I _I = -18 mA | | | -1.5 | | | -1.5 | V | |
| V _{OH} | High-level output voltage | V _{CC} = MIN, | V _{IH} = 2 V, V _{IL} = V _{ILmax} , I _{OH} = MAX | 2.4 | 3.4 | | 2.4 | 3.1 | | V | |
| V _{OL} | Low-level output voltage | V _{CC} = MIN, V _{IL} = 0.8 V, | I _{OL} = 12 mA | 0.25 | 0.4 | | 0.25 | 0.4 | | V | |
| | | | I _{OL} = 24 mA | | | | 0.35 | 0.5 | | V | |
| I _{O(off)} | Off-state (high-impedance state) output current | V _{CC} = MAX, V _{IH} = 2 V | V _O = 2.7 V | | 20 | | 20 | | | V | |
| | | | V _O = 0.4 V | | -20 | | -20 | | | | |
| I _I | Input current at maximum input voltage | V _{CC} = MAX, | V _I = 7 V | | | 0.1 | | | 0.1 | mA | |
| I _{IH} | High-level input current | V _{CC} = MAX, | V _I = 2.7 V | | | 20 | | | 20 | μA | |
| I _{IL} | Low-level input current | V _{CC} = MAX, | V _I = 0.4 V | | | -0.4 | | | -0.4 | mA | |
| I _{OS} | Short-circuit output current§ | V _{CC} = MAX | | -30 | | -130 | | | -30 | -130 | mA |
| I _{CC} | Supply current | V _{CC} = MAX, | See Note 4 | | | 19 | | | 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_{CC} = 5 V, T_A = 25°C.

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

NOTE 4: I_{CC} 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 _{clock} | Input clock frequency | | 30 | | 25 | MHz | |
| t _w | Pulse duration | | 25 | | 25 | ns | |
| t _{su} | Setup time | | | CLK or CLR | | | |
| | | | | Data enable ($\overline{G1}$, $\overline{G2}$) | | 35 | 35 |
| | | | | Data | | 17 | 17 |
| t _h | Hold time | | | CLR (inactive state) | | 10 | 10 |
| | | | | Data enable ($\overline{G1}$, $\overline{G2}$) | | 0 | 0 |
| | | | | Data | | 3 | 3 |



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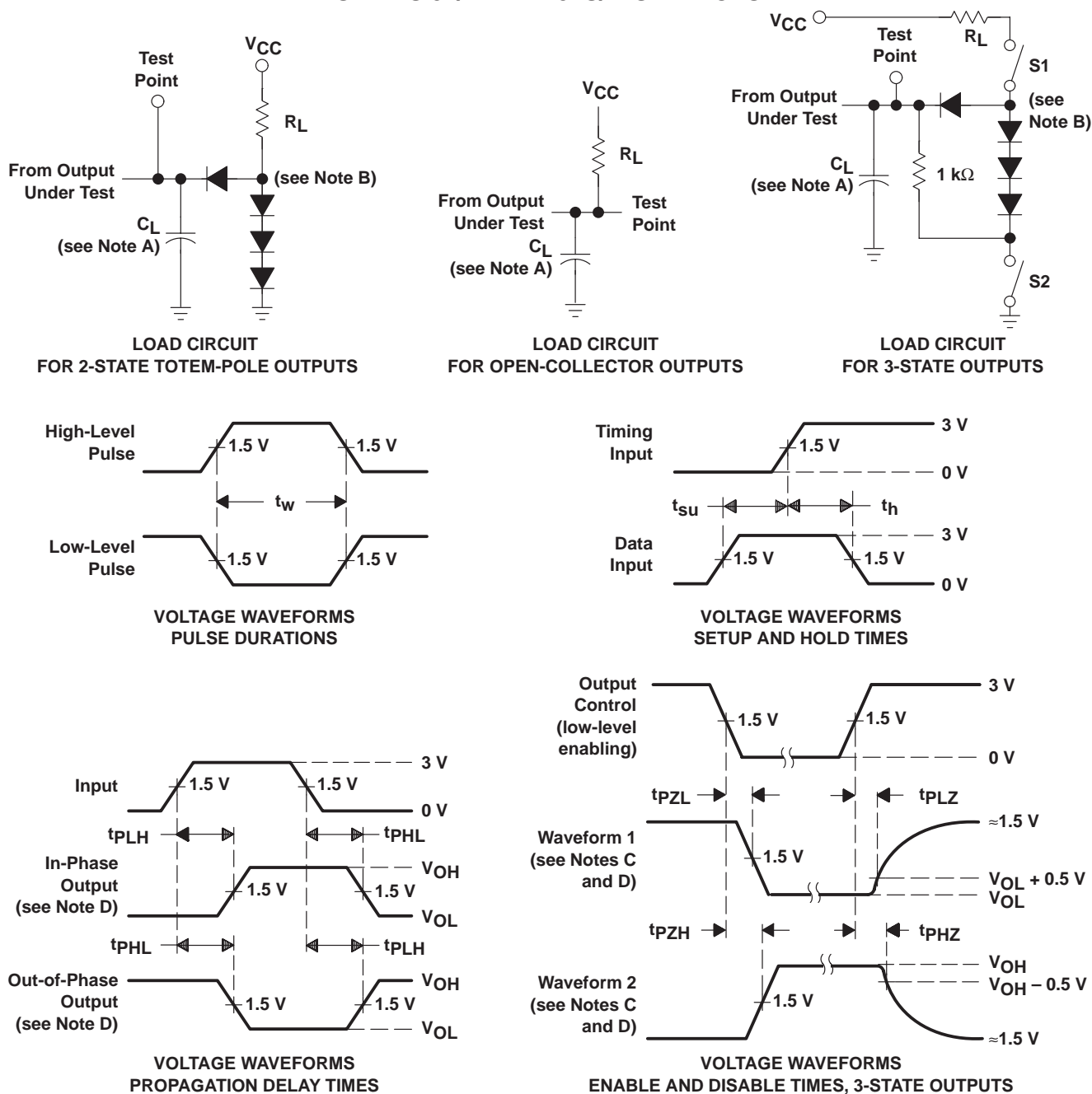
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switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$, $R_L = 667\ \Omega$ (see Figure 2)

| PARAMETER | | TEST CONDITIONS | SN54LS173A | | | SN74LS173A | | | UNIT |
|-----------|---|----------------------|------------|-----|-----|------------|-----|-----|------|
| | | | MIN | TYP | MAX | MIN | TYP | MAX | |
| f_{max} | Maximum clock frequency | $C_L = 45\text{ pF}$ | 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 | $C_L = 5\text{ pF}$ | | 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



- 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

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