

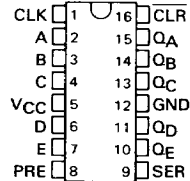
# TYPES SN5496, SN54L96, SN54LS96, SN7496, SN74LS96 5-BIT SHIFT REGISTERS

MARCH 1974—REVISED DECEMBER 1983

- N-Bit Serial-To-Parallel Converter
- N-Bit Parallel-To-Serial Converter
- N-Bit Storage Register

| TYPE  | TYPICAL                   |                   |
|-------|---------------------------|-------------------|
|       | PROPAGATION<br>DELAY TIME | POWER DISSIPATION |
| '96   | 25 ns                     | 240 mW            |
| 'L96  | 50 ns                     | 120 mW            |
| 'LS96 | 25 ns                     | 60 mW             |

SN5496, SN54LS96 ... J OR W PACKAGE  
SN54L96 ... J PACKAGE  
SN7496 ... J OR N PACKAGE  
SN74LS96 ... D, J OR N PACKAGE  
(TOP VIEW)



For chip carrier information on SN54LS96  
and SN74LS96, contact the factory.

## description

These shift registers consist of five R-S master-slave flip-flops connected to perform parallel-to-serial or serial-to-parallel conversion of binary data. Since both inputs and outputs for all flip-flops are accessible, parallel-in/parallel-out or serial-in/serial-out operation may be performed.

All flip-flops are simultaneously set to a low output level by applying a low-level voltage to the clear input while the preset is inactive (low). Clearing is independent of the level of the clock input.

The register may be parallel loaded by using the clear input in conjunction with the preset inputs. After clearing all stages to low output levels, data to be loaded is applied to the individual preset inputs (A, B, C, D, and E) and a high-level load pulse is applied to the preset enable input. Presetting like clearing is independent of the level of the clock input.

Transfer of information to the outputs occurs on the positive-going edge of the clock pulse. The proper information must be set up at the R-S inputs of each flip-flop prior to the rising edge of the clock input waveform. The serial input provides this information to the first flip-flop, while the outputs of the subsequent flip-flops provide information for the remaining R-S inputs. The clear input must be high and the preset or preset enable inputs must be low when clocking occurs.

FUNCTION TABLE

| INPUTS |                  |        |   |   |   |   |       | OUTPUTS |                 |                            |                            |                            |                            |  |
|--------|------------------|--------|---|---|---|---|-------|---------|-----------------|----------------------------|----------------------------|----------------------------|----------------------------|--|
| CLEAR  | PRESET<br>ENABLE | PRESET |   |   |   |   | CLOCK | SERIAL  | Q <sub>A</sub>  | Q <sub>B</sub>             | Q <sub>C</sub>             | Q <sub>D</sub>             | Q <sub>E</sub>             |  |
|        |                  | A      | B | C | D | E |       |         |                 |                            |                            |                            |                            |  |
| L      | L                | X      | X | X | X | X | X     | X       | L               | L                          | L                          | L                          | L                          |  |
| L      | X                | L      | L | L | L | L | X     | X       | L               | L                          | L                          | L                          | L                          |  |
| H      | H                | H      | H | H | H | H | X     | X       | H               | H                          | H                          | H                          | H                          |  |
| H      | H                | L      | L | L | L | L | L     | X       | Q <sub>A0</sub> | Q <sub>B0</sub>            | Q <sub>C0</sub>            | Q <sub>D0</sub>            | Q <sub>E0</sub>            |  |
| H      | H                | H      | L | H | L | H | L     | X       | H               | Q <sub>B0</sub>            | H                          | Q <sub>D0</sub>            | H                          |  |
| H      | L                | X      | X | X | X | X | L     | X       | Q <sub>A0</sub> | Q <sub>A0</sub>            | Q <sub>C0</sub>            | Q <sub>D0</sub>            | Q <sub>E0</sub>            |  |
| H      | L                | X      | X | X | X | X | ↑     | H       | L               | Q <sub>A<sub>n</sub></sub> | Q <sub>B<sub>n</sub></sub> | Q <sub>C<sub>n</sub></sub> | Q <sub>D<sub>n</sub></sub> |  |
| H      | L                | X      | X | X | X | X | ↑     | L       | H               | Q <sub>A<sub>n</sub></sub> | Q <sub>B<sub>n</sub></sub> | Q <sub>C<sub>n</sub></sub> | Q <sub>D<sub>n</sub></sub> |  |

H = high level (steady state), L = low level (steady state)

X = irrelevant (any input, including transitions)

↑ = transition from low to high level

QA0, QB0, etc = the level of QA, QB, etc, respectively before the indicated steady-state input conditions were established.

QAn, QBn, etc = the level of QA, QB, etc, respectively before the most recent ↑ transition of the clock.

## PRODUCTION DATA

This document contains information 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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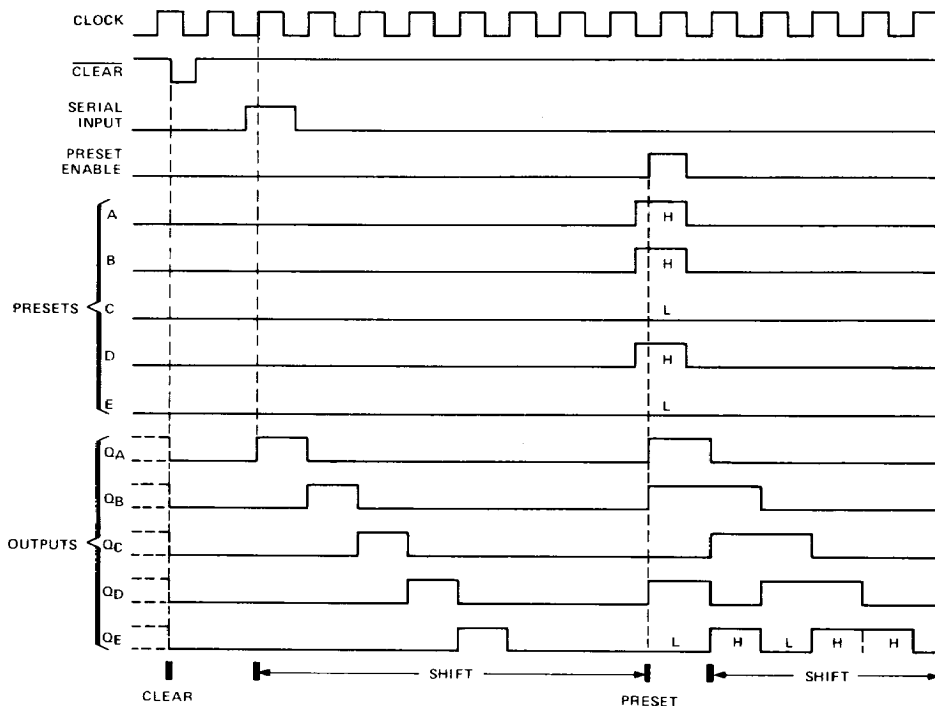
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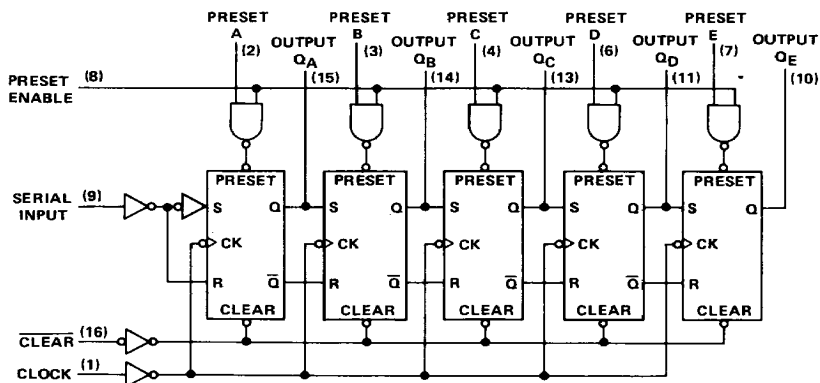
TTL DEVICES

**TYPES SN5496, SN54L96, SN54LS96,  
SN7496, SN74LS96  
5-BIT SHIFT REGISTERS**

typical clear, shift, preset, and shift sequences



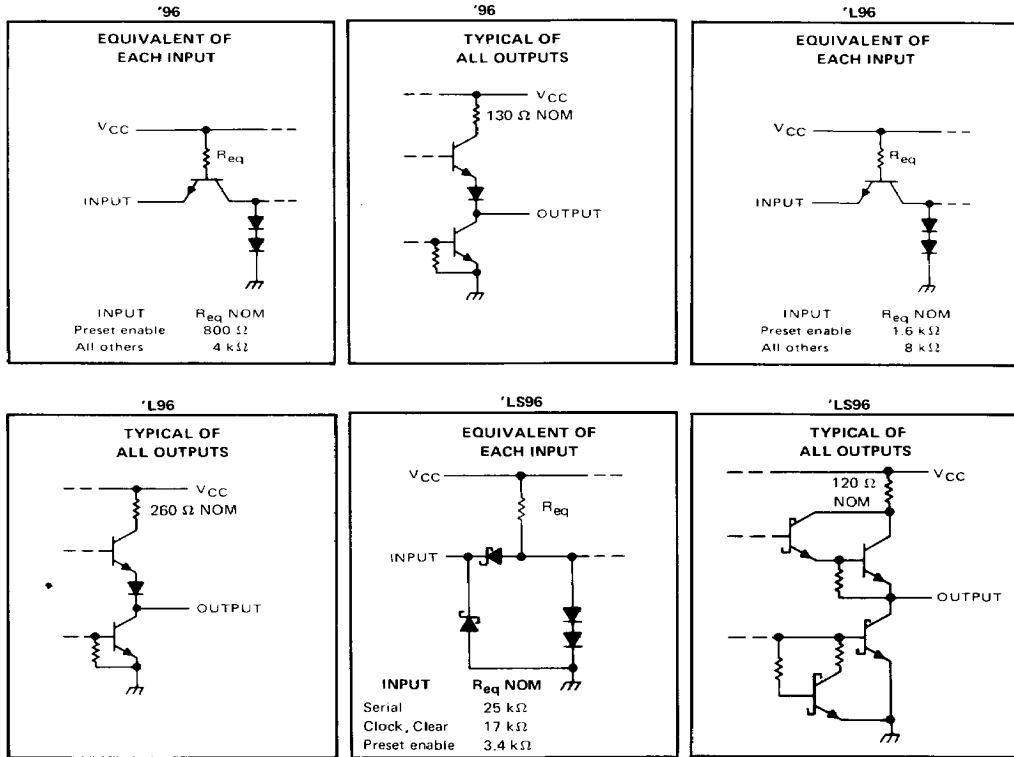
logic diagram



Pin numbers shown on logic notation are for D, J or N packages.

**TYPES SN5496, SN54L96, SN54LS96,  
SN7496, SN74LS96  
5-BIT SHIFT REGISTERS**

**schematics of inputs and outputs**



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**TTL DEVICES**

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

|                                       |                |
|---------------------------------------|----------------|
| Supply voltage, $V_{CC}$ (see Note 1) | 7 V            |
| Input voltage (see Note 2): '96, 'L96 | 5.5 V          |
| 'LS96                                 | 7 V            |
| Operating free air temperature: SN54' | -55°C to 125°C |
| SN74'                                 | 0°C to 70°C    |
| Storage temperature range             | -65°C to 150°C |

NOTES: 1. Voltage values are with respect to network ground terminal.

2. Input voltages must be zero or positive with respect to network ground terminal.

# TYPES SN5496, SN7496

## 5-BIT REGISTERS

### recommended operating conditions

|                                                  | SN5496 |     |      | SN7496 |     |      | UNIT         |
|--------------------------------------------------|--------|-----|------|--------|-----|------|--------------|
|                                                  | MIN    | NOM | MAX  | MIN    | NOM | MAX  |              |
| Supply voltage, $V_{CC}$                         | 4.5    | 5   | 5.5  | 4.75   | 5   | 5.25 | V            |
| High-level output current, $I_{OH}$              |        |     | -400 |        |     | -400 | $\mu$ A      |
| Low-level output current, $I_{OL}$               |        |     | 16   |        |     | 16   | mA           |
| Clock frequency, $f_{clock}$                     | 0      |     | 10   | 0      |     | 10   | MHz          |
| Width of clock input pulse, $t_w(\text{clock})$  |        | 35  |      |        | 35  |      | ns           |
| Width of preset and clear input pulse, $t_w$     |        | 30  |      |        | 30  |      | ns           |
| Serial input setup time, $t_{su}$ (see Figure 1) |        | 30  |      |        | 30  |      | ns           |
| Serial input hold time, $t_h$ (see Figure 1)     |        | 0   |      |        | 0   |      | ns           |
| Operating free-air temperature, $T_A$            | -55    |     | 125  | 0      |     | 70   | $^{\circ}$ C |

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

| PARAMETER |                                        | TEST CONDITIONS†                                                                               | SN5496 |      |     | SN7496 |      |     | 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       |
| $V_{OH}$  | High-level output voltage              | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -400 \mu\text{A}$ | 2.4    | 3.4  |     | 2.4    | 3.4  |     | V       |
| $V_{OL}$  | Low-level output voltage               | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 16 \text{ mA}$    |        | 0.2  | 0.4 |        | 0.2  | 0.4 | V       |
| $I_I$     | Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$                                                     |        | 1    |     |        | 1    |     | mA      |
| $I_{IH}$  | High-level input current               | any input except preset enable                                                                 |        | 40   |     |        | 40   |     | $\mu$ A |
|           |                                        | preset enable                                                                                  |        | 200  |     |        | 200  |     |         |
| $I_{IL}$  | Low-level input current                | any input except preset enable                                                                 |        | -1.6 |     |        | -1.6 |     | mA      |
|           |                                        | preset enable                                                                                  |        | -8   |     |        | -8   |     |         |
| $I_{OS}$  | Short-circuit output current§          | $V_{CC} = \text{MAX}$                                                                          | -20    | -57  |     | -18    | -57  |     | mA      |
| $I_{CC}$  | Supply current                         | $V_{CC} = \text{MAX}, \text{ See Note 3}$                                                      | 48     | 68   |     | 48     | 79   |     | mA      |

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

‡All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$ .

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

NOTE 3:  $I_{CC}$  is measured with the clear input grounded and all other inputs and outputs open.

### switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$

| PARAMETER |                                                                               | TEST CONDITIONS                                          | MIN | TYP | MAX | UNIT |
|-----------|-------------------------------------------------------------------------------|----------------------------------------------------------|-----|-----|-----|------|
|           |                                                                               |                                                          |     |     |     |      |
| $t_{PLH}$ | Propagation delay time, low-to-high-level output from clock                   | $C_L = 15 \text{ pF}, R_L = 400 \Omega,$<br>See Figure 1 |     | 25  | 40  | ns   |
| $t_{PHL}$ | Propagation delay time, high-to-low-level output from clock                   |                                                          |     | 25  | 40  | ns   |
| $t_{PLH}$ | Propagation delay time, low-to-high-level output from preset or preset enable |                                                          |     | 28  | 35  | ns   |
| $t_{PHL}$ | Propagation delay time, high-to-low-level output from clear                   |                                                          |     |     | 55  | ns   |

recommended operating conditions

|             |                                        | SN54L96 |     |      | UNIT |
|-------------|----------------------------------------|---------|-----|------|------|
|             |                                        | MIN     | NOM | MAX  |      |
| $V_{CC}$    | Supply voltage                         | 4.5     | 5   | 5.5  | V    |
| $V_{IH}$    | High-level input voltage               | 2       |     |      | V    |
| $V_{IL}$    | Low-level input voltage                |         |     | 0.8  | V    |
| $I_{OH}$    | High-level output current              |         |     | -0.2 | mA   |
| $I_{OL}$    | Low-level output current               |         |     | 8    | mA   |
| $f_{clock}$ | Clock frequency                        | 0       |     | 5    | MHz  |
| $t_w$       | Width of clock, preset, or clear input | 100     |     |      | ns   |
| $t_{su}$    | Serial input setup time (See Figure 1) | 100     |     |      | ns   |
| $t_h$       | Serial input hold time (See Figure 1)  | 0       |     |      | ns   |
| $T_A$       | Operating free-air temperature         | -55     |     | 125  | °C   |

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

| PARAMETER | TEST CONDITIONS†                                                                              | SN54L96 |      |      | UNIT |
|-----------|-----------------------------------------------------------------------------------------------|---------|------|------|------|
|           |                                                                                               | MIN     | TYP‡ | MAX  |      |
| $V_{OH}$  | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -0.2 \text{ mA}$ | 2.4     | 3.2  |      | V    |
| $V_{OL}$  | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 8 \text{ mA}$    |         | 0.2  | 0.4  | V    |
| $I_I$     | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$                                                    |         |      | 1    | mA   |
| $I_{IH}$  | Any input except preset enable                                                                |         |      | 20   | µA   |
|           | Preset enable                                                                                 |         |      | 0.1  | mA   |
| $I_{IL}$  | Any input except preset enable                                                                |         |      | -0.8 | mA   |
|           | Preset enable                                                                                 |         |      | -4   | mA   |
| $I_{OS}§$ | $V_{CC} = \text{MAX}$                                                                         | -10     |      | -29  | mA   |
| $I_{CC}$  | $V_{CC} = \text{MAX}, \text{ See Note 3}$                                                     |         | 24   | 34   | mA   |

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

‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$ .

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

NOTE 3:  $I_{CC}$  is measured with the clear input grounded and all other inputs and outputs open.

switching characteristics,  $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

| PARAMETER | FROM (INPUT)  | TO (OUTPUT) | TEST CONDITIONS                                         | MIN | TYP | MAX | UNIT |
|-----------|---------------|-------------|---------------------------------------------------------|-----|-----|-----|------|
| $t_{PLH}$ | Clock         | Any         | $R_L = 800 \Omega, C_L = 15 \text{ pF}$<br>See Figure 1 | 60  | 80  |     | ns   |
| $t_{PHL}$ |               |             |                                                         | 50  | 80  |     | ns   |
| $t_{PLH}$ | Preset or     |             |                                                         | 56  | 70  |     | ns   |
|           | Preset enable |             |                                                         |     |     |     |      |
| $t_{PHL}$ | Clear         |             |                                                         |     | 110 |     | ns   |

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TTL DEVICES

# TYPES SN54LS96, SN74LS96 5-BIT SHIFT REGISTERS

## recommended operating conditions

|                                                     | SN54LS96 |     |      | SN74LS96 |     |      | UNIT        |
|-----------------------------------------------------|----------|-----|------|----------|-----|------|-------------|
|                                                     | MIN      | NOM | MAX  | MIN      | NOM | MAX  |             |
| Supply voltage, $V_{CC}$                            | 4.5      | 5   | 5.5  | 4.75     | 5   | 5.25 | V           |
| High-level output current, $I_{OH}$                 |          |     | -400 |          |     | -400 | $\mu A$     |
| Low-level output current, $I_{OL}$                  |          |     | 4    |          |     | 8    | mA          |
| Clock frequency, $f_{clock}$                        | 0        |     | 25   | 0        |     | 25   | MHz         |
| Width of clock input pulse, $t_{w(clock)}$          | 20       |     |      | 20       |     |      | ns          |
| Width of preset and clear input pulse, $t_w$        | 30       |     |      | 30       |     |      | ns          |
| Serial input setup time, $t_{setup}$ (see Figure 1) | 30       |     |      | 30       |     |      | ns          |
| Serial input hold time, $t_{hold}$ (see Figure 1)   | 0        |     |      | 0        |     |      | ns          |
| Operating free-air temperature, $T_A$               | -55      |     | 125  | 0        |     | 70   | $^{\circ}C$ |

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

| PARAMETER |                                        | TEST CONDITIONS†                                                                                                           | SN54LS96                                   |      |      | SN74LS96 |      |      | UNIT    |
|-----------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------|--------------------------------------------|------|------|----------|------|------|---------|
|           |                                        |                                                                                                                            | MIN                                        | TYP‡ | MAX  | MIN      | TYP‡ | MAX  |         |
| $V_{IH}$  | High-level input voltage               |                                                                                                                            | 2                                          |      |      | 2        |      |      | V       |
| $V_{IL}$  | Low-level input voltage                |                                                                                                                            |                                            |      | 0.7  |          |      | 0.8  | V       |
| $V_{IK}$  | Input clamp voltage                    | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$                                                                                |                                            |      | -1.5 |          |      | -1.5 | V       |
| $V_{OH}$  | High-level output voltage              | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OH} = -400 \mu A$                              | 2.5                                        | 3.5  |      | 2.7      | 3.5  |      | V       |
| $V_{OL}$  | Low-level output voltage               | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OL} = 4 \text{ mA}$<br>$I_{OL} = 8 \text{ mA}$ | 0.25                                       | 0.4  |      | 0.25     | 0.4  |      | V       |
| $I_I$     | Input current at maximum input voltage | Preset enable                                                                                                              | $V_{CC} = \text{MAX}, V_I = 7 \text{ V}$   |      |      | 0.5      |      | 0.5  | mA      |
|           |                                        | All others                                                                                                                 |                                            |      |      | 0.1      |      | 0.1  |         |
| $I_{IH}$  | High-level input current               | Preset enable                                                                                                              | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$ |      |      | 100      |      | 100  | $\mu A$ |
|           |                                        | All others                                                                                                                 |                                            |      |      | 20       |      | 20   |         |
| $I_{IL}$  | Low-level input current                | Preset enable                                                                                                              | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$ |      |      | -2       |      | -2   | mA      |
|           |                                        | All others                                                                                                                 |                                            |      |      | -0.4     |      | -0.4 |         |
| $I_{OS}$  | Short-circuit output current §         | $V_{CC} = \text{MAX}$                                                                                                      | -20                                        |      | -100 | -20      |      | -100 | mA      |
| $I_{CC}$  | Supply current                         | $V_{CC} = \text{MAX}$ , See Note 3                                                                                         | 12                                         |      | 20   | 12       |      | 20   | mA      |

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

‡ All typical values are at  $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}C$ .

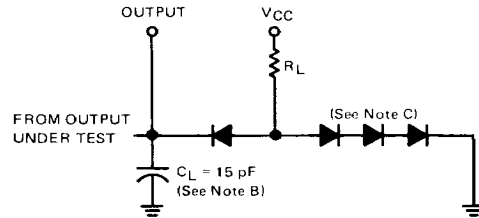
§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

NOTE 3:  $I_{CC}$  is measured with the clear input grounded and all other inputs and outputs open.

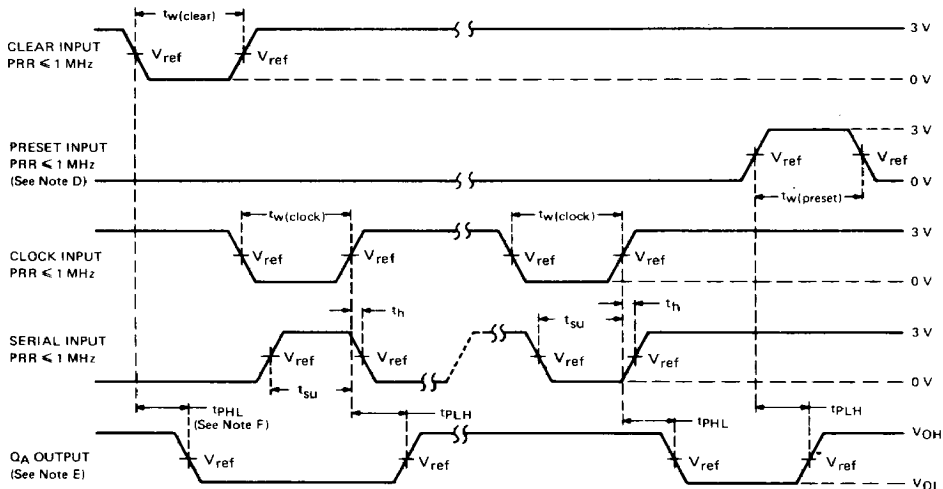
## switching characteristics, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}C$

| PARAMETER | TEST CONDITIONS                                                               | MIN | TYP | MAX | UNIT |
|-----------|-------------------------------------------------------------------------------|-----|-----|-----|------|
| $t_{PLH}$ | Propagation delay time, low-to-high-level output from clock                   |     | 25  | 40  | ns   |
| $t_{PHL}$ | Propagation delay time, high-to-low-level output from clock                   |     | 25  | 40  | ns   |
| $t_{PLH}$ | Propagation delay time, low-to-high-level output from preset or preset enable |     | 28  | 35  | ns   |
| $t_{PHL}$ | Propagation delay time, high-to-low-level output from clear                   |     |     | 55  | ns   |

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT



VOLTAGE WAVEFORMS

- NOTES: A. Input pulses are supplied by pulse generators having the following characteristics: duty cycle ≤ 50%,  $Z_{out} \approx 50 \Omega$ ; for '96 and 'L96,  $t_r \leq 10$  ns,  $t_f \leq 10$  ns, and for 'LS96  $t_r = 15$  ns,  $t_f = 6$  ns.
- B.  $C_L$  includes probe and jig capacitance.
- C. All diodes are 1N3064 or equivalent.
- D. Preset may be tested by applying a high-level voltage to the individual preset inputs and pulsing the preset enable or by applying a high-level voltage to the preset enable and pulsing the individual preset inputs.
- E. QA output is illustrated. Relationship of serial input to other Q outputs is illustrated in the typical shift sequence.
- F. Outputs are set to the high level prior to the measurement of  $t_{PHL}$  from the clear input.
- G. For '96 and 'L96,  $V_{ref} = 1.5$  V; for 'LS96  $V_{ref} = 1.3$  V.

FIGURE 1—SWITCHING TIMES