

# SN54198, SN54199 SN74198, SN74199 8-BIT SHIFT REGISTERS

SDLS078

DECEMBER 1972—REVISED MARCH 1988

## description

These 8-bit shift registers are compatible with most other TTL and MSI logic families. All inputs are buffered to lower the drive requirements to one normalized Series 54/74 load, and input clamping diodes minimize switching transients to simplify system design. Maximum input clock frequency is typically 35 megahertz and power dissipation is typically 360 mW.

Series 54 devices are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ ; Series 74 devices are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

## SN54198 and SN74198

These bidirectional registers are designed to incorporate virtually all of the features a system designer may want in a shift register. These circuits contain 87 equivalent gates and feature parallel inputs, parallel outputs, right-shift and left-shift serial inputs, operating-mode-control inputs, and a direct overriding clear line. The register has four distinct modes of operation, namely:

- Inhibit Clock (Do nothing)
- Shift Right (In the direction  $Q_A$  toward  $Q_H$ )
- Shift Left (In the direction  $Q_H$  toward  $Q_A$ )
- Parallel (Broadside) Load

Synchronous parallel loading is accomplished by applying the eight bits of data and taking both mode control inputs,  $S_0$  and  $S_1$ , high. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

Shift right is accomplished synchronously with the rising edge of the clock pulse when  $S_0$  is high and  $S_1$  is low. Serial data for this mode is entered at the shift-right data input. When  $S_0$  is low and  $S_1$  is high, data shifts left synchronously and new data is entered at the shift-left serial input.

Clocking of the flip-flop is inhibited when both mode control inputs are low. The mode controls should be changed only while the clock input is high.

198  
FUNCTION TABLE

| INPUTS |       |       |       |        |       | OUTPUTS  |          |          |                   |
|--------|-------|-------|-------|--------|-------|----------|----------|----------|-------------------|
| CLEAR  | MODE  |       | CLOCK | SERIAL |       | PARALLEL | $Q_A$    | $Q_B$    | $Q_G$ $Q_H$       |
|        | $S_1$ | $S_0$ |       | LEFT   | RIGHT |          |          |          |                   |
| L      | X     | X     | X     | X      | X     | X        | L        | L        | L                 |
| H      | X     | X     | L     | X      | X     | X        | $Q_{A0}$ | $Q_{B0}$ | $Q_{G0}$ $Q_{H0}$ |
| H      | H     | H     | ↑     | X      | X     | a...h    | a        | b        | g h               |
| H      | L     | H     | ↑     | X      | H     | X        | H        | $Q_{An}$ | $Q_{Fn}$ $Q_{Gn}$ |
| H      | L     | H     | ↑     | X      | L     | X        | L        | $Q_{An}$ | $Q_{Fn}$ $Q_{Gn}$ |
| H      | H     | L     | ↑     | H      | X     | X        | $Q_{Bn}$ | $Q_{Cn}$ | $Q_{Hn}$ H        |
| H      | H     | L     | ↑     | L      | X     | X        | $Q_{Bn}$ | $Q_{Cn}$ | $Q_{Hn}$ L        |
| H      | L     | L     | X     | X      | X     | X        | $Q_{A0}$ | $Q_{B0}$ | $Q_{G0}$ $Q_{H0}$ |

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

X = irrelevant (any input, including transitions)

↑ = transition from low to high level

a...h = the level of steady-state input at inputs A thru H, respectively.

$Q_{A0}$ ,  $Q_{B0}$ ,  $Q_{G0}$ ,  $Q_{H0}$  = the level of  $Q_A$ ,  $Q_B$ ,  $Q_G$ , or  $Q_H$ , respectively, before the indicated steady-state input conditions were established.

$Q_{An}$ ,  $Q_{Bn}$ , etc. = the level of  $Q_A$ ,  $Q_B$ , etc., respectively, before the most-recent ↑ transition of the clock.

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# SN54198, SN54199 SN74198, SN74199

## 8-BIT SHIFT REGISTERS

### SN54199 and SN74199

These registers feature parallel inputs, parallel outputs, J-K serial inputs, shift/load control input, a direct overriding clear line, and gated clock inputs. The register has three modes of operation:

- Inhibit Clock (Do nothing)
- Shift (In the direction  $Q_A$  toward  $Q_H$ )
- Parallel (Broadside) Load

Parallel loading is accomplished by applying the eight bits of data and taking the shift/load control input low when the clock input is not inhibited. The data is loaded into the associated flip-flop and appears at the outputs after the positive transition of the clock input. During loading, serial data flow is inhibited.

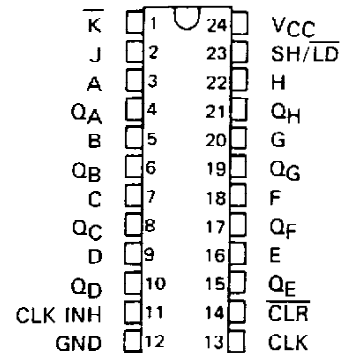
Shifting is accomplished synchronously when shift/load is high and the clock input is not inhibited. Serial data for this mode is entered at the J-K inputs. See the function table for levels required to enter serial data into the first flip-flop.

Both of the clock inputs are identical in function and may be used interchangeably to serve as clock or clock-inhibit inputs. Holding either high inhibits clocking, but when one is held low, a clock input applied to the other input is passed to the eight flip-flops of the register. The clock-inhibit input should be changed to the high level only while the clock input is high.

These shift registers contain the equivalent of 79 TTL gates. Average power dissipation per gate is typically 4.55 mW.

### SN54199 . . . J OR W PACKAGE SN74199 . . . N PACKAGE

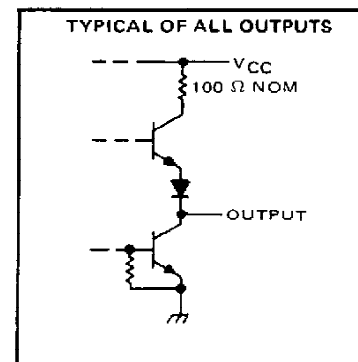
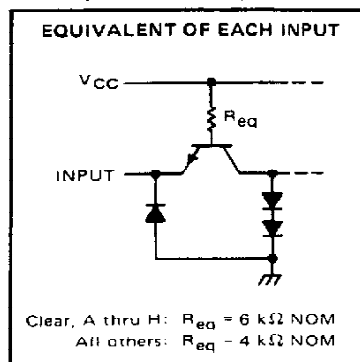
#### (TOP VIEW)



199  
FUNCTION TABLE

| INPUTS |                |                  |       |                       |                       | OUTPUTS        |          |             |          |
|--------|----------------|------------------|-------|-----------------------|-----------------------|----------------|----------|-------------|----------|
| CLEAR  | SHIFT/<br>LOAD | CLOCK<br>INHIBIT | CLOCK | SERIAL<br>J $\bar{K}$ | PARALLEL<br>A . . . H | $Q_A$          | $Q_B$    | $Q_C$ . . . | $Q_H$    |
| L      | X              | X                | X     | X   X                 | X                     | L              | L        | L           | L        |
| H      | X              | L                | L     | X   X                 | X                     | $Q_{A0}$       | $Q_{B0}$ | $Q_{C0}$    | $Q_{H0}$ |
| H      | L              | L                | 1     | X   X                 | a . . . h             | a              | b        | c           | h        |
| H      | H              | L                | 1     | L   H                 | X                     | $Q_{A0}$       | $Q_{A0}$ | $Q_{Bn}$    | $Q_{Gn}$ |
| H      | H              | L                | 1     | L   L                 | X                     | L              | $Q_{An}$ | $Q_{Bn}$    | $Q_{Gn}$ |
| H      | H              | L                | 1     | H   H                 | X                     | H              | $Q_{An}$ | $Q_{Bn}$    | $Q_{Gn}$ |
| H      | H              | L                | 1     | H   L                 | X                     | $\bar{Q}_{An}$ | $Q_{An}$ | $Q_{Bn}$    | $Q_{Gn}$ |
| H      | X              | H                | 1     | X   X                 | X                     | $Q_{A0}$       | $Q_{B0}$ | $Q_{B0}$    | $Q_{H0}$ |

### schematics of inputs and outputs

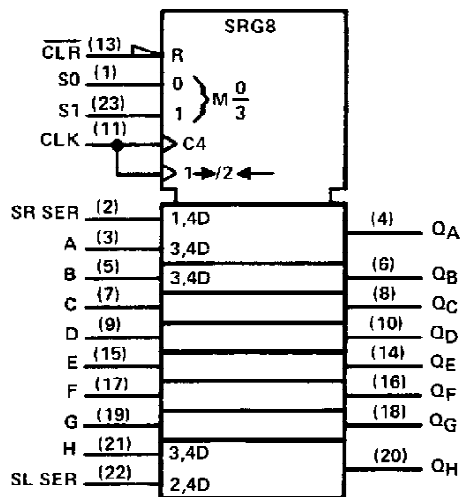


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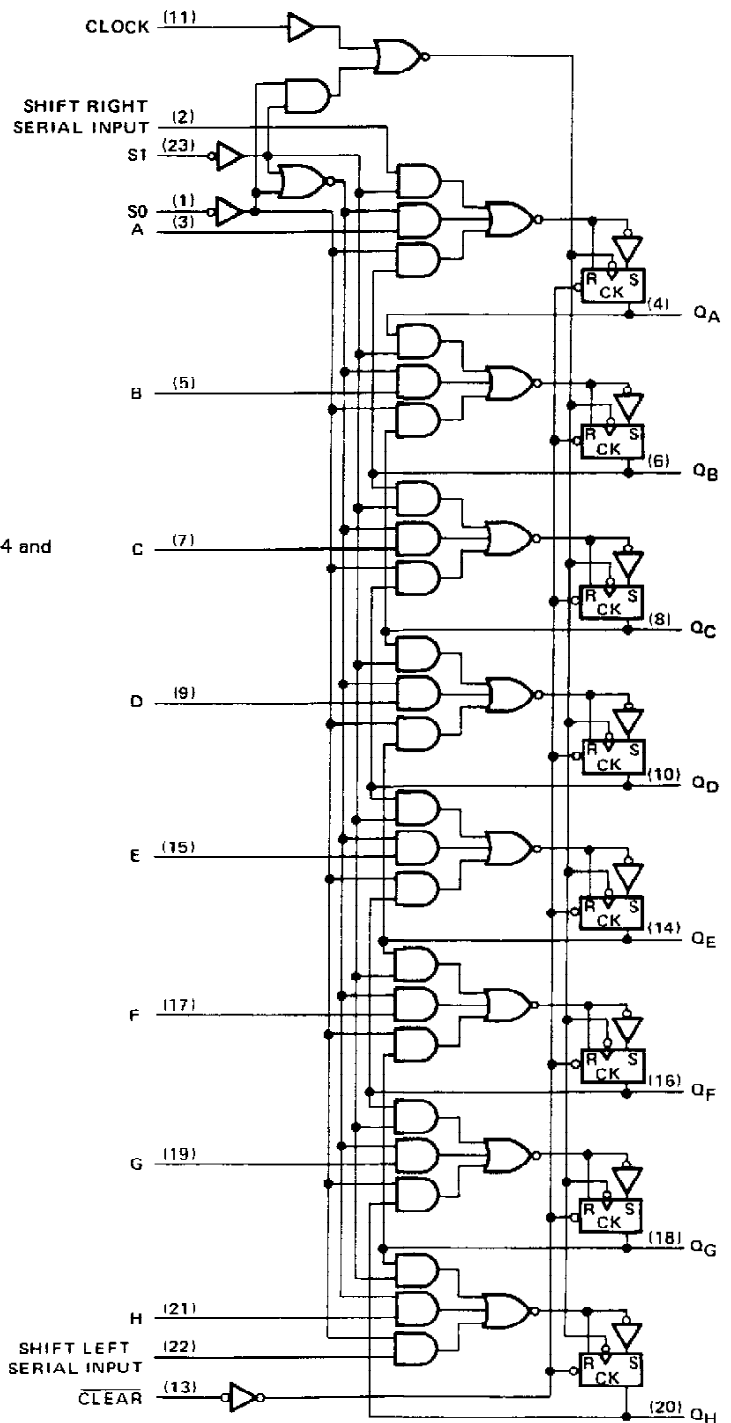
# SN54198, SN74198 8-BIT SHIFT REGISTERS

logic symbol†



† This symbol is in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

logic diagram (positive logic)

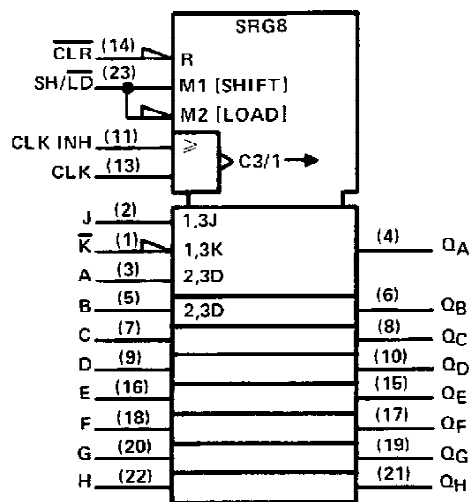


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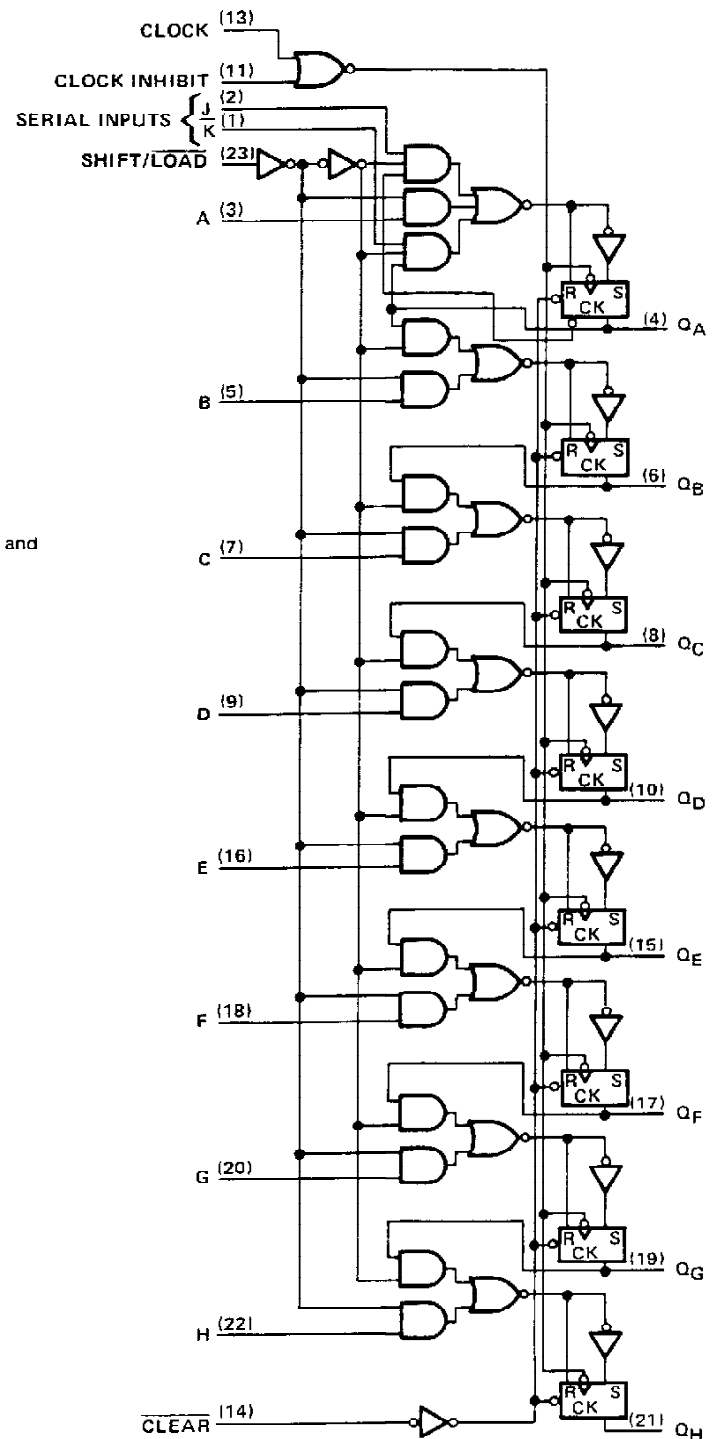
# **SN54199, SN74199** **8-BIT SHIFT REGISTERS**

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logic diagram (positive logic)

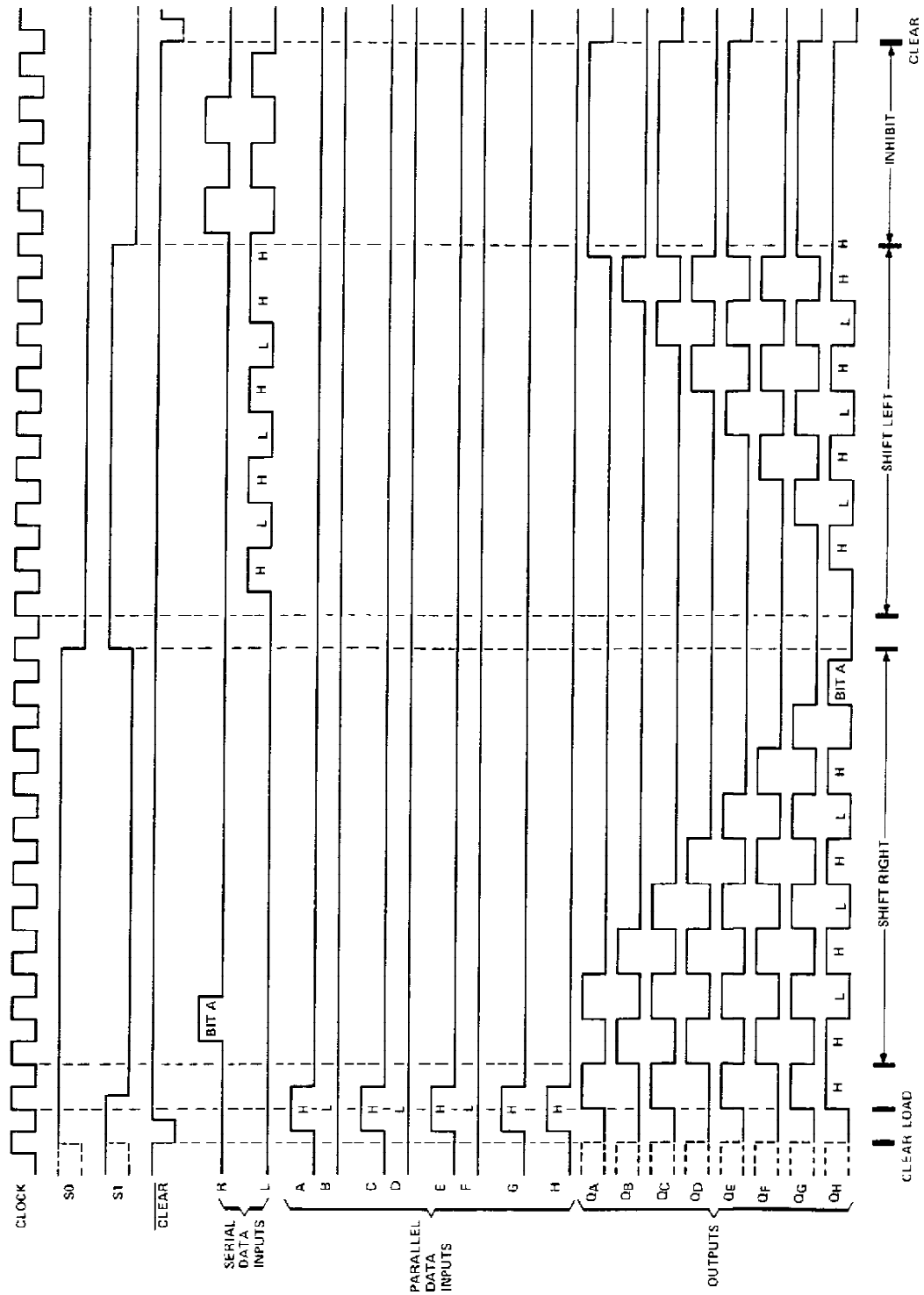


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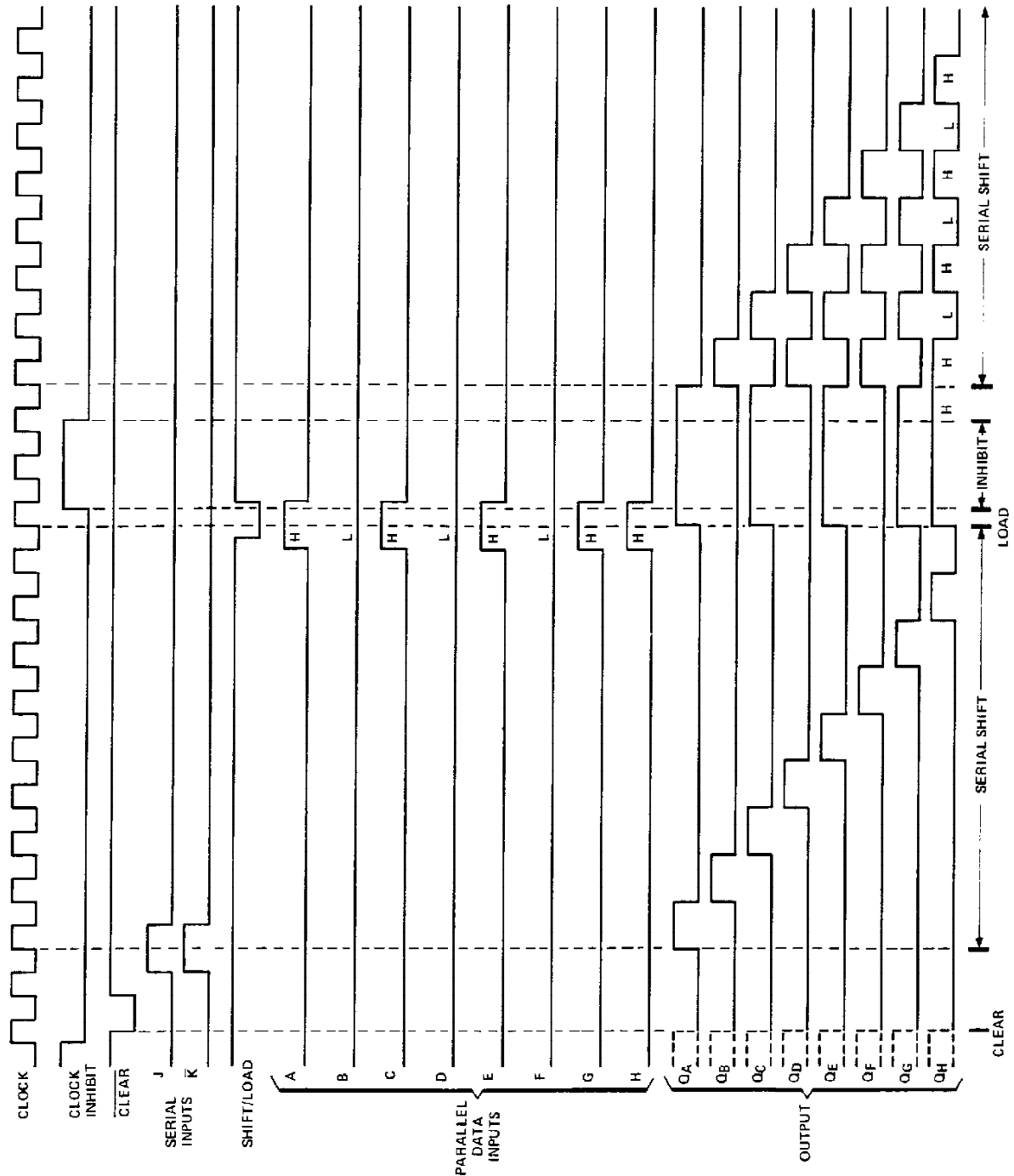
typical clear, load, right-shift, left-shift, inhibit, and clear sequences



# **SN54199, SN74199** **8-BIT SHIFT REGISTERS**

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typical clear, shift, load, and inhibit sequences



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# SN54198, SN54199, SN74198, SN74199 8-BIT SHIFT REGISTERS

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

|                                                                  |                |
|------------------------------------------------------------------|----------------|
| Supply voltage, $V_{CC}$ (see Note 1)                            | 7 V            |
| Input voltage                                                    | 5.5 V          |
| Operating free-air temperature range: SN54 <sup>†</sup> Circuits | −55°C to 125°C |
| SN74 <sup>†</sup> Circuits                                       | 0°C to 70°C    |
| Storage temperature range                                        | −65°C to 150°C |

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

recommended operating conditions

|                                                     | SN54198<br>SN54199 |     |      | SN74198<br>SN74199 |     |      | 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, $I_{OH}$                 |                    |     | −800 |                    |     | −800 | μA   |
| Low-level output current, $I_{OL}$                  |                    |     | 16   |                    |     | 16   | mA   |
| Clock frequency, $f_{clock}$                        | 0                  |     | 25   | 0                  |     | 25   | MHz  |
| Width of clock or clear pulse, $t_W$ (see Figure 1) | 20                 |     |      | 20                 |     |      | ns   |
| Mode-control setup time, $t_{SU}$                   | 30                 |     |      | 30                 |     |      | ns   |
| Data setup time, $t_{SU}$ (see Figure 1)            | 20                 |     |      | 20                 |     |      | ns   |
| Hold time at any input, $t_H$ (see Figure 1)        | 0                  |     |      | 0                  |     |      | ns   |
| Operating free-air temperature, $T_A$               | −55                |     | 125  | 0                  |     | 70   | °C   |

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

| PARAMETER                                    | TEST CONDITIONS <sup>†</sup>                                                                   | SN54198<br>SN54199 |                  |      | SN74198<br>SN74199 |                  |      | UNIT |
|----------------------------------------------|------------------------------------------------------------------------------------------------|--------------------|------------------|------|--------------------|------------------|------|------|
|                                              |                                                                                                | MIN                | TYP <sup>‡</sup> | MAX  | MIN                | TYP <sup>‡</sup> | 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                 | $V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$                                                    |                    |                  | −1.5 |                    |                  | −1.5 | V    |
| $V_{OH}$ High-level output voltage           | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -800 \mu\text{A}$ | 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            | $V_{CC} = \text{MAX}, V_I = 2.4 \text{ V}$                                                     |                    |                  | 40   |                    |                  | 40   | μA   |
| $I_{IL}$ Low-level input current             | $V_{CC} = \text{MAX}, V_I = 0.4 \text{ V}$                                                     |                    |                  | −1.6 |                    |                  | −1.6 | mA   |
| $I_{OS}$ Short-circuit output current §      | $V_{CC} = \text{MAX}$                                                                          | −20                |                  | −57  | −18                |                  | −57  | mA   |
| $I_{CC}$ Supply current                      | $V_{CC} = \text{MAX}, \text{ See Table Below}$                                                 | 90                 |                  | 127  | 90                 |                  | 127  | mA   |

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

<sup>‡</sup> 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.

## TEST CONDITIONS FOR $I_{CC}$ (ALL OUTPUTS ARE OPEN)

| TYPE             | APPLY 4.5 V              | FIRST GROUND,<br>THEN APPLY 4.5 V | GROUND                           |
|------------------|--------------------------|-----------------------------------|----------------------------------|
| SN54198, SN74198 | Serial Input, $S_0, S_1$ | Clock                             | Clear, Inputs A thru H           |
| SN54199, SN74199 | J, K, Inputs A thru H    | Clock                             | Clock inhibit, Clear, Shift/Load |

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

| PARAMETER                                                             | TEST CONDITIONS                                              | MIN | TYP | MAX | UNIT |
|-----------------------------------------------------------------------|--------------------------------------------------------------|-----|-----|-----|------|
| $f_{max}$ Maximum clock frequency                                     | $C_L = 15\text{ pF}$ , $R_L = 400\ \Omega$ ,<br>See Figure 1 | 25  | 35  |     | MHz  |
| $t_{PHL}$ Propagation delay time, high-to-low-level output from clear |                                                              |     | 23  | 35  | ns   |
| $t_{PHL}$ Propagation delay time, high-to-low-level output from clock |                                                              |     | 20  | 30  | ns   |
| $t_{PLH}$ Propagation delay time, low-to-high-level output from clock |                                                              |     | 17  | 26  | ns   |

# SN54198, SN54199, SN74198, SN74199 8-BIT SHIFT REGISTERS

## PARAMETER MEASUREMENT INFORMATION

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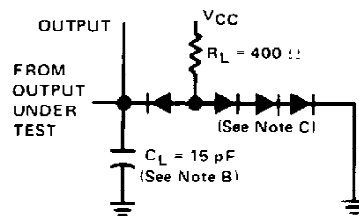
TEST TABLE FOR SYNCHRONOUS INPUTS

| DATA INPUT FOR TEST | S1    | S0    | OUTPUT TESTED (SEE NOTE E) |
|---------------------|-------|-------|----------------------------|
| A                   | 4.5 V | 4.5 V | $Q_A$ at $t_{n+1}$         |
| B                   | 4.5 V | 4.5 V | $Q_B$ at $t_{n+1}$         |
| C                   | 4.5 V | 4.5 V | $Q_C$ at $t_{n+1}$         |
| D                   | 4.5 V | 4.5 V | $Q_D$ at $t_{n+1}$         |
| E                   | 4.5 V | 4.5 V | $Q_E$ at $t_{n+1}$         |
| F                   | 4.5 V | 4.5 V | $Q_F$ at $t_{n+1}$         |
| G                   | 4.5 V | 4.5 V | $Q_G$ at $t_{n+1}$         |
| H                   | 4.5 V | 4.5 V | $Q_H$ at $t_{n+1}$         |
| L Serial Input      | 4.5 V | 0 V   | $Q_A$ at $t_{n+8}$         |
| R Serial Input      | 0 V   | 4.5 V | $Q_H$ at $t_{n+8}$         |

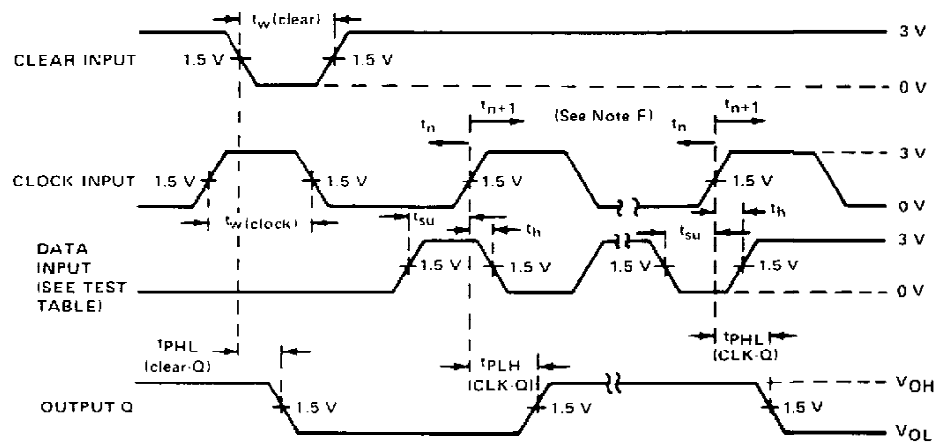
SN54199, SN74199

TEST TABLE FOR SYNCHRONOUS INPUTS

| DATA INPUT FOR TEST | SHIFT/LOAD | OUTPUT TESTED (SEE NOTE E) |
|---------------------|------------|----------------------------|
| A                   | 0 V        | $Q_A$ at $t_{n+1}$         |
| B                   | 0 V        | $Q_B$ at $t_{n+1}$         |
| C                   | 0 V        | $Q_C$ at $t_{n+1}$         |
| D                   | 0 V        | $Q_D$ at $t_{n+1}$         |
| E                   | 0 V        | $Q_E$ at $t_{n+1}$         |
| F                   | 0 V        | $Q_F$ at $t_{n+1}$         |
| G                   | 0 V        | $Q_G$ at $t_{n+1}$         |
| H                   | 0 V        | $Q_H$ at $t_{n+1}$         |
| J and $\bar{K}$     | 4.5 V      | $Q_H$ at $t_{n+8}$         |



LOAD FOR OUTPUT UNDER TEST



VOLTAGE WAVEFORMS

- NOTES: A. The clock pulse has the following characteristics:  $t_{w(\text{clock})} = 20$  ns and  $\text{PRR} = 1$  MHz. The clear pulse has the following characteristics:  $t_{w(\text{clear})} = 20$  ns and  $t_{\text{hold}} = 0$  ns. When testing  $t_{\text{max}}$ , vary the clock PRR.
- B.  $C_L$  includes probe and jig capacitance.
- C. All diodes are 1N3064.
- D. A clear pulse is applied prior to each test.
- E. Propagation delay times ( $t_{\text{PLH}}$  and  $t_{\text{PHL}}$ ) are measured at  $t_{n+1}$ . Proper shifting of data is verified at  $t_{n+8}$  with a functional test.
- F.  $t_n =$  bit time before clocking transition  
 $t_{n+1} =$  bit time after one clocking transition  
 $t_{n+8} =$  bit time after eight clocking transitions

FIGURE 1

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