

# SN54194, SN54LS194A, SN54S194, SN74194, SN74LS194A, SN74S194 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

MARCH 1974—REVISED MARCH 1988

- Parallel Inputs and Outputs
- Four Operating Modes:  
Synchronous Parallel Load  
Right Shift  
Left Shift  
Do Nothing
- Positive Edge-Triggered Clocking
- Direct Overriding Clear

TYPE	TYPICAL MAXIMUM CLOCK FREQUENCY	TYPICAL POWER DISSIPATION
'194	36 MHz	195 mW
'LS194A	36 MHz	75 mW
'S194	105 MHz	425 mW

## description

These bidirectional shift registers are designed to incorporate virtually all of the features a system designer may want in a shift register. The circuit contains 46 equivalent gates and features 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  $Q_D$ )
- Shift left (in the direction  $Q_D$  toward  $Q_A$ )
- Parallel (broadside) load

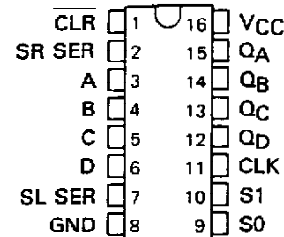
Synchronous parallel loading is accomplished by applying the four bits of data and taking both mode control inputs,  $S_0$  and  $S_1$ , high. The data are loaded into the associated flip-flops and appear at the outputs after the positive transition of the clock input. During loading, serial data flow 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 shift register is inhibited when both mode control inputs are low. The mode controls of the SN54194/SN74194 should be changed only while the clock input is high.

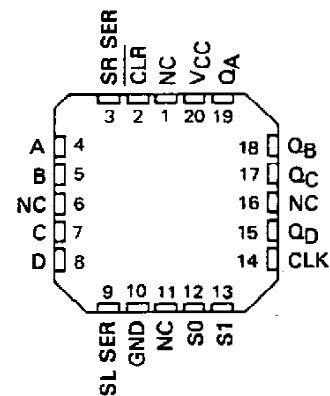
SN54194, SN54LS194A, SN54S194 . . . J OR W PACKAGE  
SN74194 . . . N PACKAGE  
SN74LS194A, SN74S194 . . . D OR N PACKAGE

(TOP VIEW)



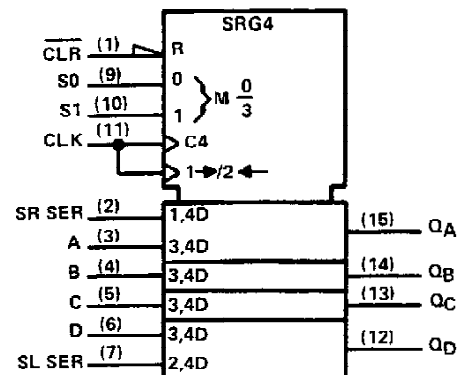
SN54LS194A, SN54S194 . . . FK PACKAGE

(TOP VIEW)



NC - No internal connection

## logic symbol†



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

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

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SN74194, SN74LS194A, SN74S194  
4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS**

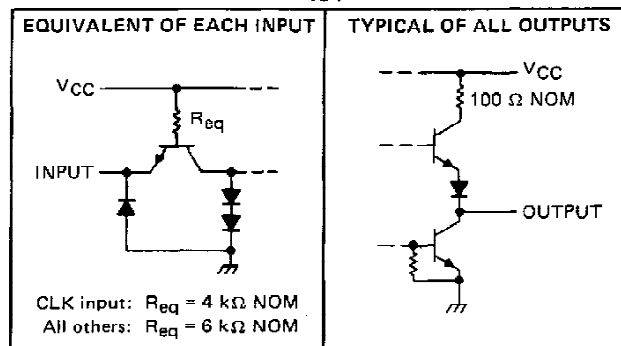
**FUNCTION TABLE**

INPUTS									OUTPUTS				
CLEAR	MODE		CLOCK	SERIAL		PARALLEL				Q <sub>A</sub>	Q <sub>B</sub>	Q <sub>C</sub>	Q <sub>D</sub>
	S1	S0		LEFT	RIGHT	A	B	C	D				
L	X	X	X	X	X	X	X	X	X	L	L	L	L
H	X	X	L	X	X	X	X	X	X	Q <sub>A0</sub>	Q <sub>B0</sub>	Q <sub>C0</sub>	Q <sub>D0</sub>
H	H	H	↑	X	X	a	b	c	d	a	b	c	d
H	L	H	↑	X	H	X	X	X	X	H	Q <sub>An</sub>	Q <sub>Bn</sub>	Q <sub>Cn</sub>
H	L	L	↑	X	L	X	X	X	X	L	Q <sub>An</sub>	Q <sub>Bn</sub>	Q <sub>Cn</sub>
H	H	L	↑	H	X	X	X	X	X	Q <sub>Bn</sub>	Q <sub>Cn</sub>	Q <sub>Dn</sub>	H
H	H	L	↑	L	X	X	X	X	X	Q <sub>Bn</sub>	Q <sub>Cn</sub>	Q <sub>Dn</sub>	L
H	L	L	X	X	X	X	X	X	X	Q <sub>A0</sub>	Q <sub>B0</sub>	Q <sub>C0</sub>	Q <sub>D0</sub>

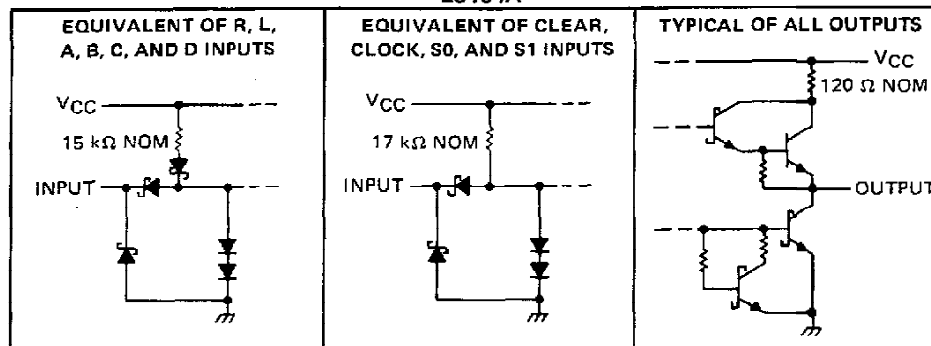
H = high level (steady state)  
L = low level (steady state)  
X = irrelevant (any input, including transitions)  
↑ = transition from low to high level  
a, b, c, d = the level of steady-state input at inputs A, B, C, or D, respectively.  
Q<sub>A0</sub>, Q<sub>B0</sub>, Q<sub>C0</sub>, Q<sub>D0</sub> = the level of Q<sub>A</sub>, Q<sub>B</sub>, Q<sub>C</sub>, or Q<sub>D</sub>, respectively, before the indicated steady-state input conditions were established.  
Q<sub>An</sub>, Q<sub>Bn</sub>, Q<sub>Cn</sub>, Q<sub>Dn</sub> = the level of Q<sub>A</sub>, Q<sub>B</sub>, Q<sub>C</sub>, respectively, before the most-recent ↑ transition of the clock.

schematics of inputs and outputs

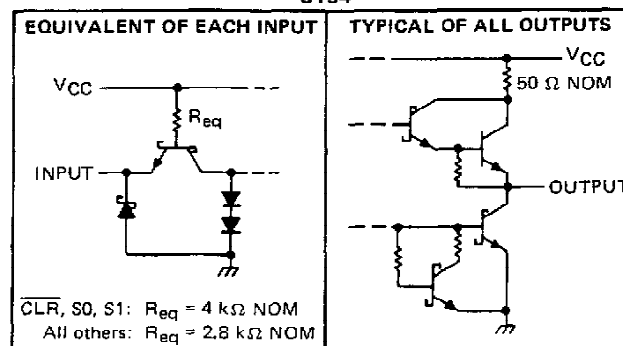
'194



'LS194A



'S194

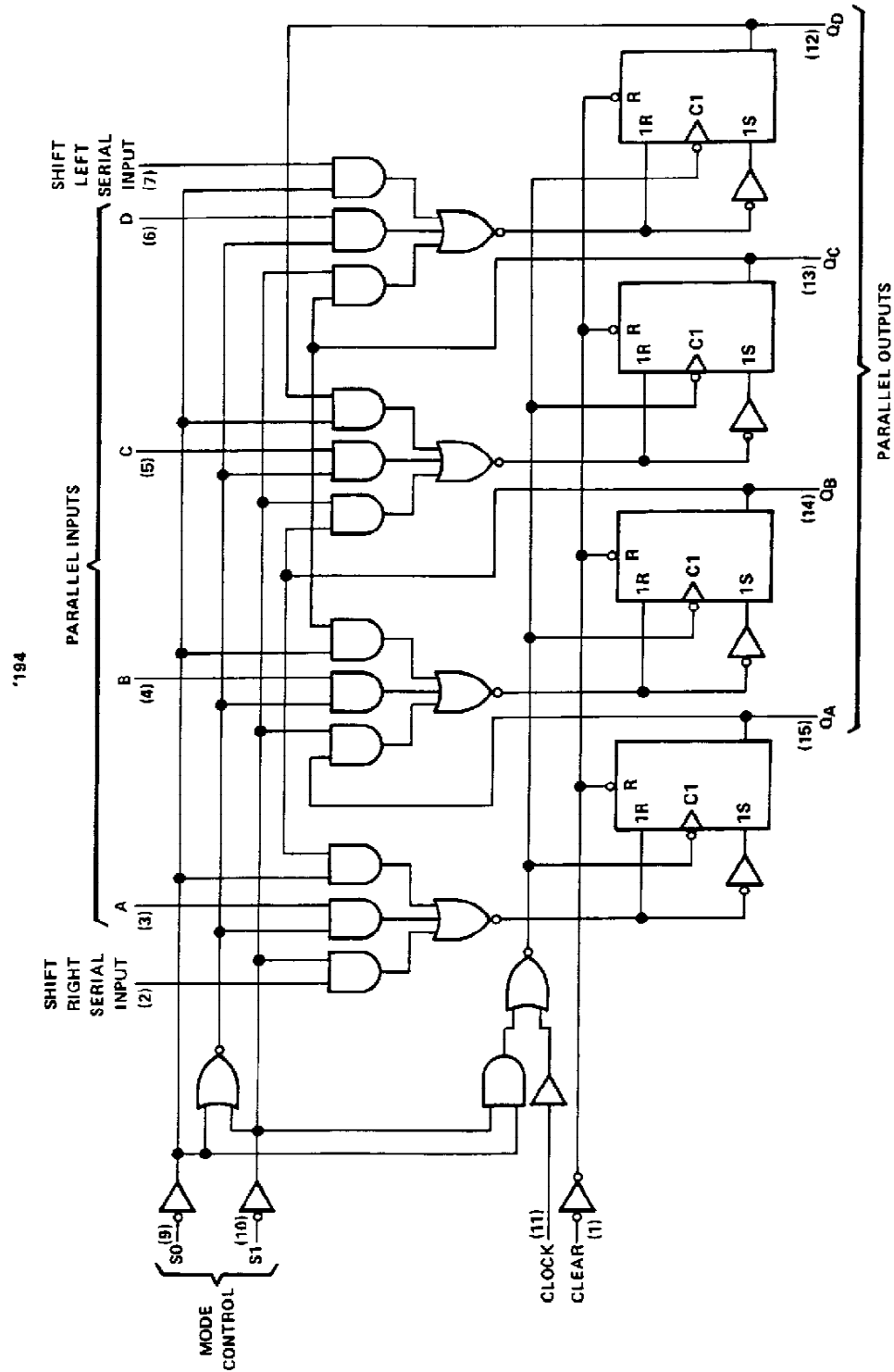


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SN54194, SN74194  
4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

logic diagrams (positive logic)



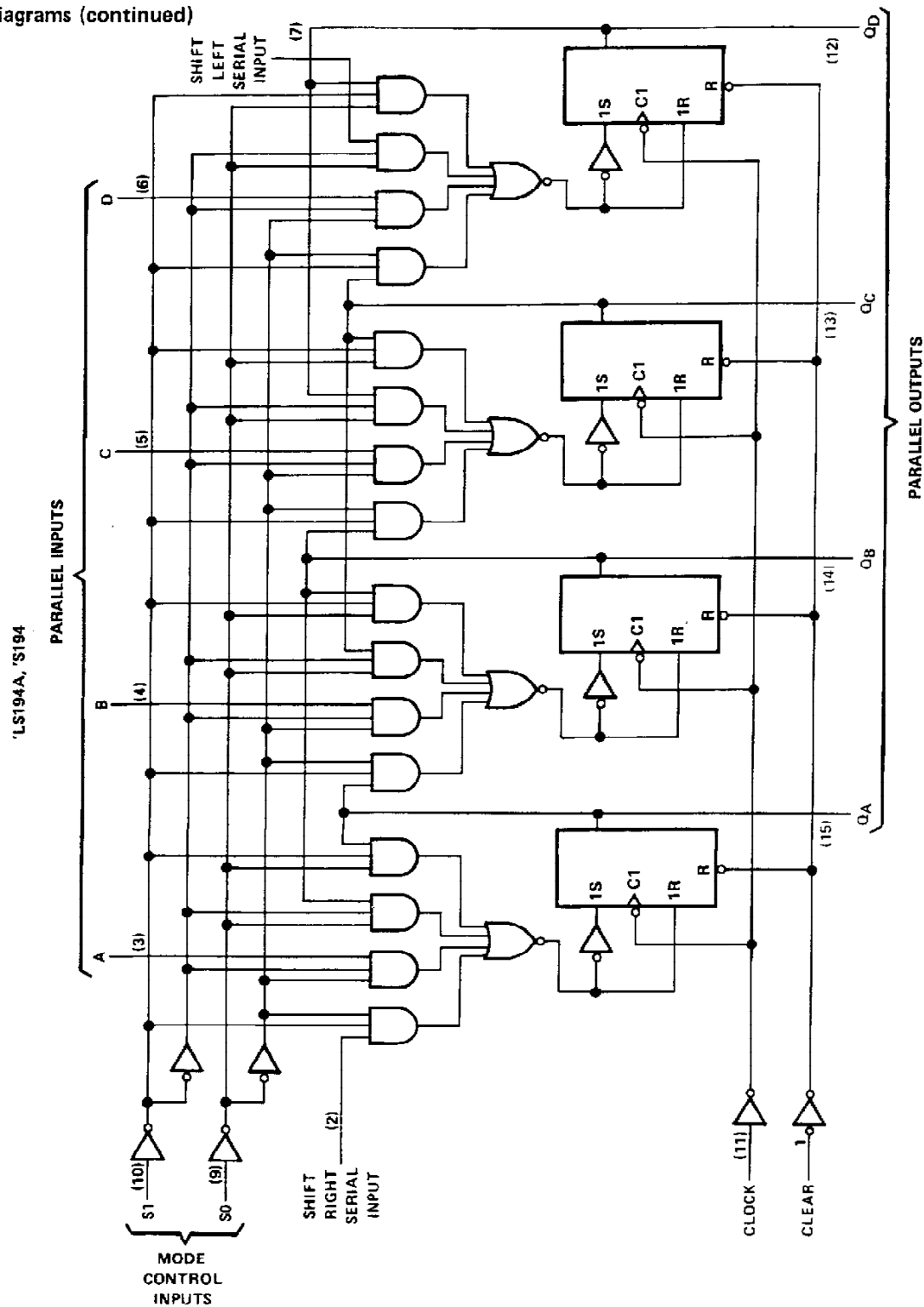
Pin numbers shown are for D, J, N, and W packages.

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**SN54LS194A, SN54S194  
SN74LS194A, SN74S194  
4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS**

logic diagrams (continued)



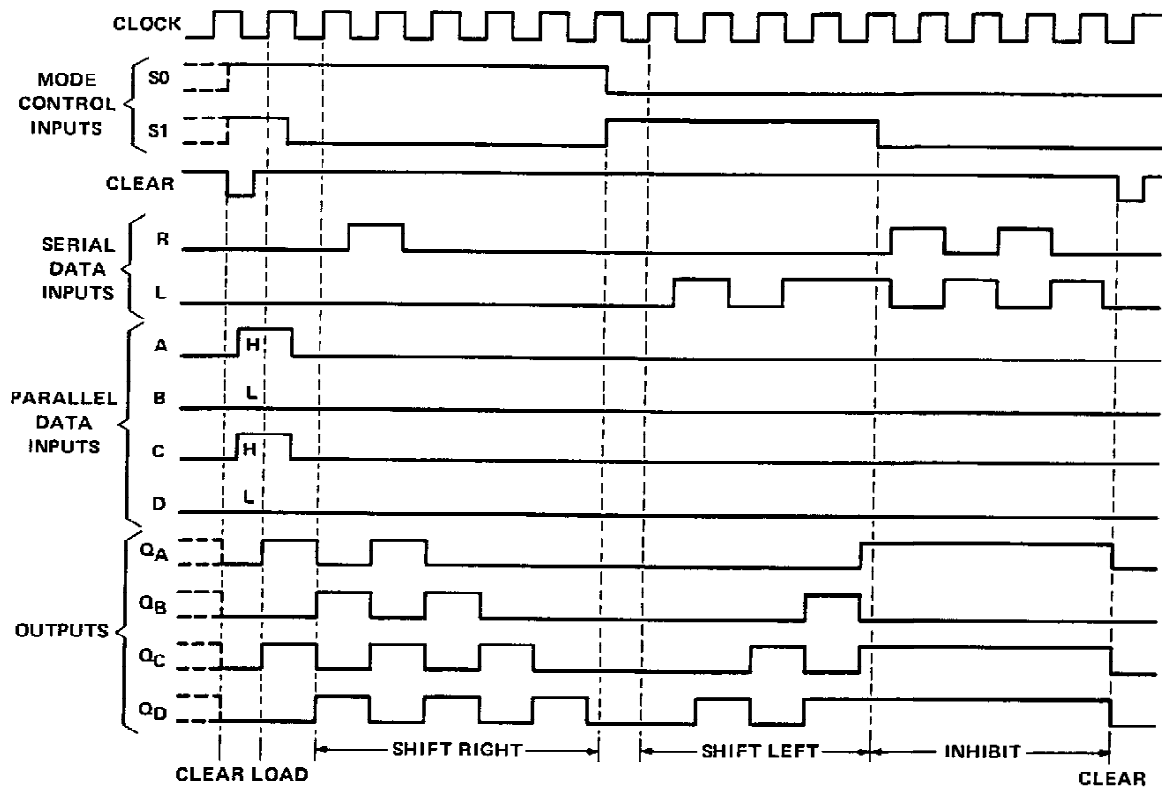
Pin numbers shown on logic notation are for D, J or N, and W packages.

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SN54194, SN54LS194A, SN54S194,  
SN74194, SN74LS194A, SN74S194  
4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

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



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# SN54194, SN74194

## 4-BIT BIDIRECTIONAL UNIVERSAL 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: SN54194	-55°C to 125°C
SN74194	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

	SN54194			SN74194			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	$\mu$ A
Low-level output current, $I_{OL}$			16			16	mA
Clock frequency, $f_{clock}$	0		25	0		25	MHz
Width of clock or clear pulse, $t_W$	20			20			ns
Setup time, $t_{SU}$	Mode control			30			ns
	Serial and parallel data			20			ns
	Clear inactive-state			25			ns
Hold time at any input, $t_H$	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†	SN54194			SN74194			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	$V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$			-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	$\mu$ A
$I_{IL}$ 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	$V_{CC} = \text{MAX}, \text{ See Note 2}$		39	63		39	63	mA

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

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

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

NOTE 2: With all outputs open, inputs A through D grounded, and 4.5 V applied to S0, S1, clear, and the serial inputs,  $I_{CC}$  is tested with a momentary GND, then 4.5 V applied to clock.

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	$C_L = 15 \text{ pF}, R_L = 400 \Omega, \text{ See Figure 1}$	25	36		MHz
$t_{PHL}$ Propagation delay time, high-to-low-level output from clear			19	30	ns
$t_{PLH}$ Propagation delay time, low-to-high-level output from clock			14	22	ns
$t_{PHL}$ Propagation delay time, high-to-low-level output from clock			17	26	ns

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# SN54LS194A, SN74LS194A

## 4-BIT BIDIRECTIONAL UNIVERSAL 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	7 V
Operating free-air temperature range: SN54LS194A	$-55^{\circ}\text{C}$ to $125^{\circ}\text{C}$
SN74LS194A	$0^{\circ}\text{C}$ to $70^{\circ}\text{C}$
Storage temperature range	$-65^{\circ}\text{C}$ to $150^{\circ}\text{C}$

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

recommended operating conditions

		SN54LS194A			SN74LS194A			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	$\mu\text{A}$
Low-level output current, $I_{OL}$				4			8	mA
Clock frequency, $f_{\text{clock}}$		0		25	0		25	MHz
Width of clock or clear pulse, $t_W$		20			20			ns
Setup time, $t_{SU}$	Mode control	30			30			ns
	Serial and parallel data	20			20			ns
	Clear inactive-state	25			25			ns
Hold time at any input, $t_H$		0			0			ns
Operating free-air temperature, $T_A$		-55		125	0		70	$^{\circ}\text{C}$

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

PARAMETER	TEST CONDITIONS†	SN54LS194A			SN74LS194A			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
$V_I$ Input clamp voltage	$V_{CC} = \text{MIN}$ , $I_I = -18 \text{ mA}$			-1.5			-1.5	V
$V_{OH}$ High-level output voltage	$V_{CC} = \text{MIN}$ , $V_{IH} = 2 \text{ V}$ , $V_{IL} = V_{IL \text{ max}}$ , $I_{OH} = -400 \mu\text{A}$	2.5	3.5		2.7	3.5		V
$V_{OL}$ Low-level output voltage	$V_{CC} = \text{MIN}$ , $V_{IH} = 2 \text{ V}$ , $V_{IL} = V_{IL \text{ max}}$ , $I_{OL} = 4 \text{ mA}$ $I_{OL} = 8 \text{ mA}$		0.25	0.4		0.25	0.4	V
$I_I$ Input current at maximum input voltage	$V_{CC} = \text{MAX}$ , $V_I = 7 \text{ V}$			0.1			0.1	mA
$I_{IH}$ High-level input current	$V_{CC} = \text{MAX}$ , $V_I = 2.7 \text{ V}$			20			20	$\mu\text{A}$
$I_{IL}$ Low-level input current	$V_{CC} = \text{MAX}$ , $V_I = 0.4 \text{ V}$			-0.4			-0.4	mA
$I_{OS}$ Short-circuit output current§	$V_{CC} = \text{MAX}$	-20		-100	-20		-100	mA
$I_{CC}$ Supply current	$V_{CC} = \text{MAX}$ , See Note 2		15	23		15	23	mA

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

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

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

NOTE 2: With all outputs open, inputs A through D grounded, and 4.5 V applied to S0, S1, clear, and the serial inputs,  $I_{CC}$  is tested with a momentary GND, then 4.5 V, applied to clock.

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

PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{\text{max}}$ Maximum clock frequency	$C_L = 15 \text{ pF}$ , $R_L = 2 \text{ k}\Omega$ , See Figure 1	25	36		MHz
$t_{PHL}$ Propagation delay time, high-to-low-level output from clear			19	30	ns
$t_{PLH}$ Propagation delay time, low-to-high level output from clock			14	22	ns
$t_{PHL}$ Propagation delay time, high-to-low level output from clock			17	26	ns

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# SN54S194, SN74S194

## 4-BIT BIDIRECTIONAL UNIVERSAL 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: SN54S194	-55°C to 125°C
SN74S194	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

	SN54S194			SN74S194			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, $I_{OH}$			-1			-1	mA
Low-level output current, $I_{OL}$			20			20	mA
Clock frequency, $f_{clock}$	0		70	0		70	MHz
Width of clock pulse, $t_w(\text{clock})$	7			7			ns
Width of clear pulse, $t_w(\text{clear})$	12			12			ns
Setup time, $t_{su}$	Mode control			11			ns
	Serial and parallel data			5			ns
	Clear inactive-state			9			ns
Hold time at any input, $t_h$	3			3			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†	SN54S194			SN74S194			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	$V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$			-1.2			-1.2	V
$V_{OH}$ High-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$	2.5	3.4		2.7	3.4		V
$V_{OL}$ Low-level output voltage	$V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V},$ $V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$			0.5			0.5	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	$V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$			50			50	µA
$I_{IL}$ Low-level input current	$V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$			-2			-2	mA
$I_{OS}$ Short-circuit output current§	$V_{CC} = \text{MAX}$	-40		-100	-40		-100	mA
$I_{CC}$ Supply current	$V_{CC} = \text{MAX},$ See Note 2		85	135		85	135	mA
	$V_{CC} = \text{MAX},$							
	$T_A = 125^\circ\text{C},$ See Note 2 W package			110				

† For conditions shown as 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, and duration of the short-circuit should not exceed one second.

NOTE 2: With all outputs open, inputs A through D grounded, and 4.5 V applies to S0, S1, clear, and the serial inputs,  $I_{CC}$  is tested with a momentary GND, then 4.5 V, applied to clock.

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

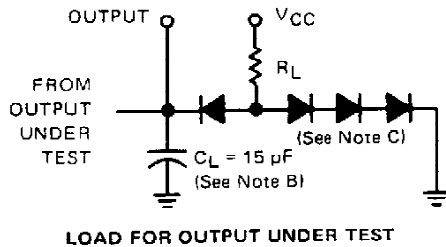
PARAMETER	TEST CONDITIONS	MIN	TYP	MAX	UNIT
$f_{max}$ Maximum clock frequency	$C_L = 15 \text{ pF},$ $R_L = 280 \Omega,$ See Figure 1	70	106		MHz
$t_{PHL}$ Propagation delay time, high-to-low-level output from clear			12.5	18.5	ns
$t_{PLH}$ Propagation delay time, low-to-high-level output from clock		4	8	12	ns
$t_{PHL}$ Propagation delay time, high-to-low-level output from clock		4	11	16.5	ns

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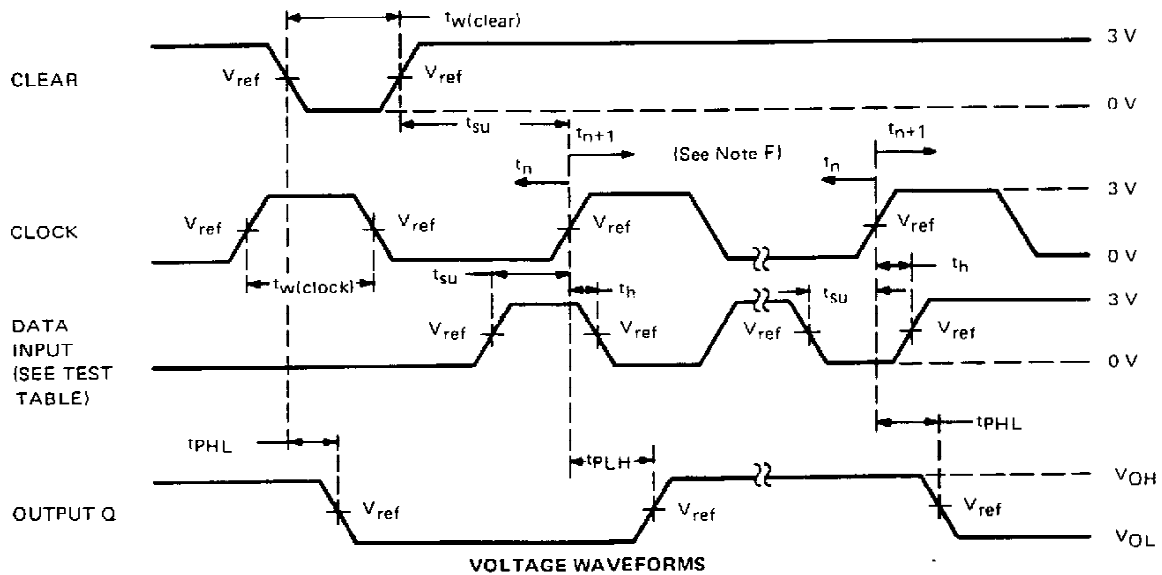
**SN54194, SN54LS194A, SN54S194,  
SN74194, SN74LS194A, SN74S194**  
**4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS**

**PARAMETER MEASUREMENT INFORMATION**



**TEST TABLE FOR SYNCHRONOUS INPUTS**

DATA INPUT FOR TEST	S1	S0	OUTPUT TESTED (SEE NOTE E)
A	4.5 V	4.5 V	QA at $t_{n+1}$
B	4.5 V	4.5 V	QB at $t_{n+1}$
C	4.5 V	4.5 V	QC at $t_{n+1}$
D	4.5 V	4.5 V	QD at $t_{n+1}$
L Serial Input	4.5 V	0 V	QA at $t_{n+4}$
R Serial Input	0 V	4.5 V	QD at $t_{n+4}$



- NOTES:**
- A. The clock pulse generator has the following characteristics:  $Z_{out} \approx 50 \Omega$  and  $PRR \leq 1 \text{ MHz}$ . For '194,  $t_r \leq 7 \text{ ns}$  and  $t_f \leq 7 \text{ ns}$ . For 'LS194A,  $t_r \leq 15 \text{ ns}$  and  $t_f \leq 6 \text{ ns}$ . For 'S194,  $t_r \leq 2.5 \text{ ns}$  and  $t_f \leq 2.5 \text{ ns}$ . When testing  $f_{max}$ , vary PRR.
  - B.  $C_L$  includes probe and jig capacitance.
  - C. All diodes are 1N3064 or 1N916.
  - D. A clear pulse is applied prior to each test.
  - E. For '194 and 'S194,  $V_{ref} = 1.5 \text{ V}$ ; for 'LS194A,  $V_{ref} = 1.3 \text{ V}$ .
  - F. Propagation delay times ( $t_{PLH}$  and  $t_{PHL}$ ) are measured at  $t_{n+1}$ . Proper shifting of data is verified at  $t_{n+4}$  with a functional test.
  - G.  $t_n$  = bit time before clocking transition.  
 $t_{n+1}$  = bit time after one clocking transition.  
 $t_{n+4}$  = bit time after four clocking transitions.

**FIGURE 1—SWITCHING TIMES**

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