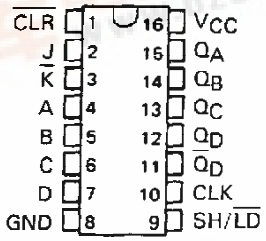
SDLS076

SN54195, SN54LS195A, SN54S195, SN74195, SN74LS195A, SN74S195
4-BIT PARALLEL-ACCESS SHIFT REGISTERS

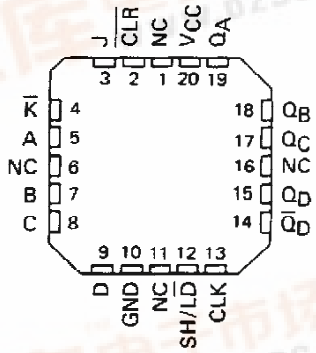
MARCH 1974—REVISED MARCH 1988

- Synchronous Parallel Load
- Positive-Edge-Triggered Clocking
- Parallel Inputs and Outputs from Each Flip-Flop
- Direct Overriding Clear
- J and $\overline{K}$ Inputs to First Stage
- Complementary Outputs from Last Stage
- For Use in High Performance:
  Accumulators/Processors
  Serial-to-Parallel, Parallel-to-Serial
  Converters

SN54195, SN54LS195A, SN54S195 . . . J OR W PACKAGE
SN74195 . . . N PACKAGE
SN74LS195A, SN74S195 . . . D OR N PACKAGE
(TOP VIEW)



SN54LS195, SN54S195 . . . FK PACKAGE
(TOP VIEW)



NC No internal connection

description

These 4-bit registers feature parallel inputs, parallel outputs, J-$\overline{K}$ serial inputs, shift/load (SH/$\overline{LD}$) control input, and a direct overriding clear. All inputs are buffered to lower the input drive requirements. The register has two modes of operation:

Parallel (broadside) load
Shift (in the direction Q_A toward Q_D)

Parallel loading is accomplished by applying the four bits of data and taking SH/$\overline{LD}$ low. 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 SH/$\overline{LD}$ is high. Serial data for this mode is entered at the J-$\overline{K}$ inputs. These inputs permit the first stage to perform as a J-$\overline{K}$, D-, or T-type flip-flop as shown in the function table.

The high-performance 'S195, with a 105-megahertz typical maximum shift-frequency, is particularly attractive for very-high-speed data processing systems. In most cases existing systems can be upgraded merely by using this Schottky-clamped shift register.

TYPE	TYPICAL MAXIMUM CLOCK FREQUENCY	TYPICAL POWER DISSIPATION
'195	39 MHz	195 mW
'LS195A	39 MHz	70 mW
'S195	105 MHz	350 mW

FUNCTION TABLE

INPUTS									OUTPUTS				
CLEAR	SHIFT/$\overline{LOAD}$	CLOCK	SERIAL		PARALLEL				Q_A	Q_B	Q_C	Q_D	$\overline{Q}_D$
			J	$\overline{K}$	A	B	C	D					
L	X	X	X	X	X	X	X	X	L	L	L	L	H
H	L	↑	X	X	a	b	c	d	a	b	c	d	$\overline{d}$
H	H	L	X	X	X	X	X	X	Q_{A0}	Q_{B0}	Q_{C0}	Q_{D0}	$\overline{Q}_{D0}$
H	H	↑	L	H	X	X	X	X	Q_{A0}	Q_{A0}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	L	L	X	X	X	X	L	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	H	X	X	X	X	H	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$
H	H	↑	H	L	X	X	X	X	$\overline{Q}_{An}$	Q_{An}	Q_{Bn}	Q_{Cn}	$\overline{Q}_{Cn}$

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 A, B, C, or D, respectively
Q_{A0}, Q_{B0}, Q_{C0}, Q_{D0} = the level of Q_A, Q_B, Q_C, or Q_D, respectively, before the indicated steady-state input conditions were established
Q_{An}, Q_{Bn}, Q_{Cn} = the level of Q_A, Q_B, or Q_C, respectively, before the most-recent transition of the clock

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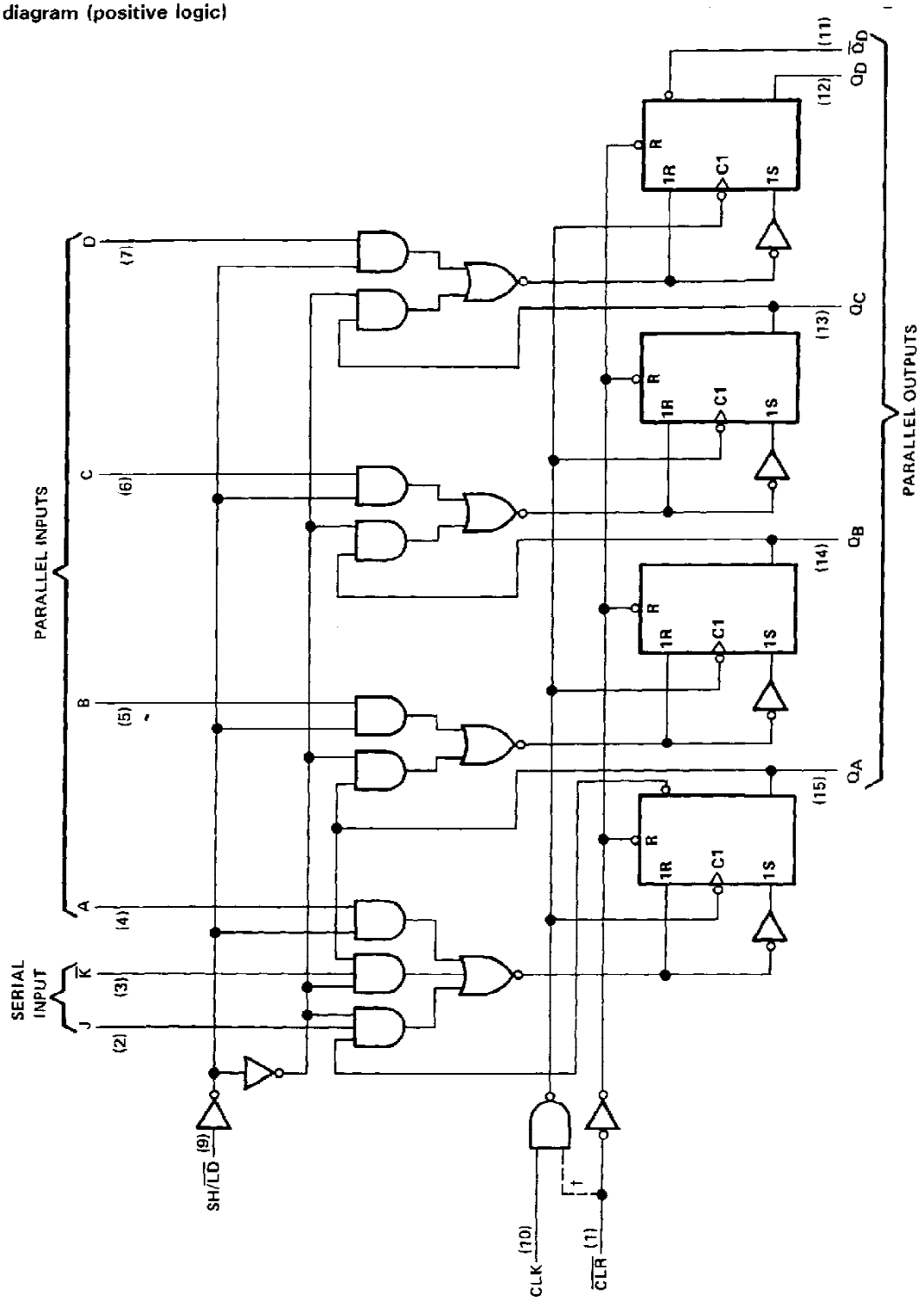
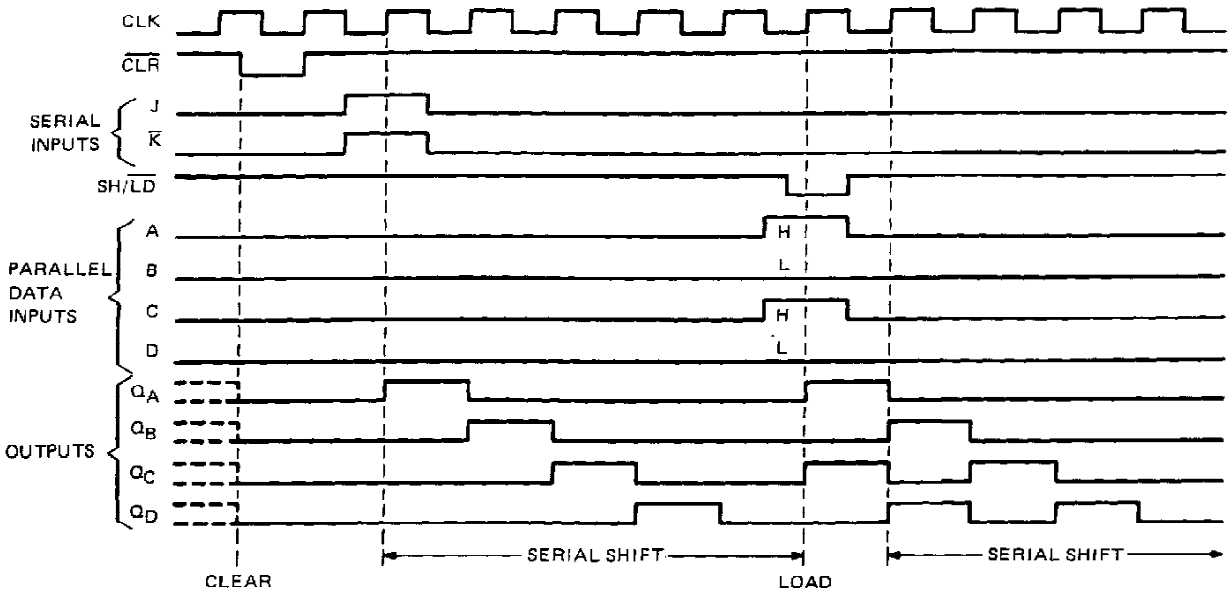
logic diagram (positive logic)

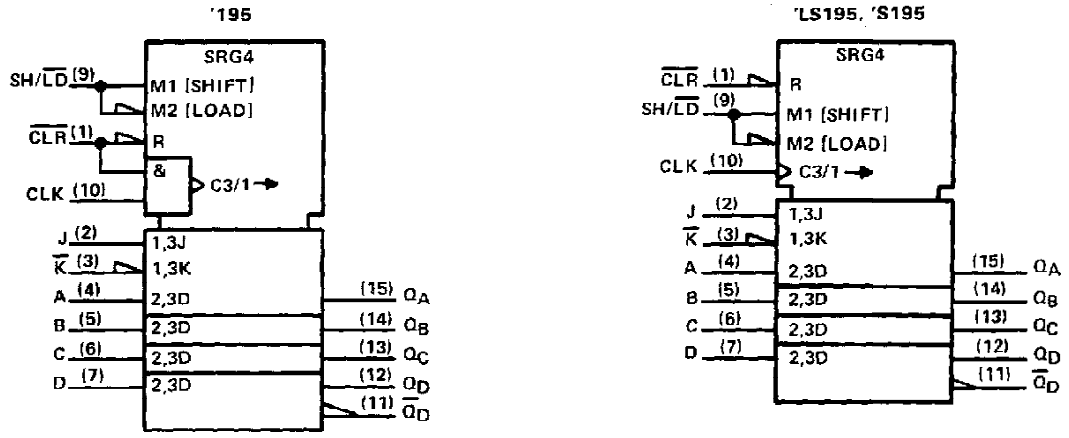


†This connection is made on '195 only.
Pin numbers shown are for D, J, N, and W packages.

typical clear, shift, and load sequences



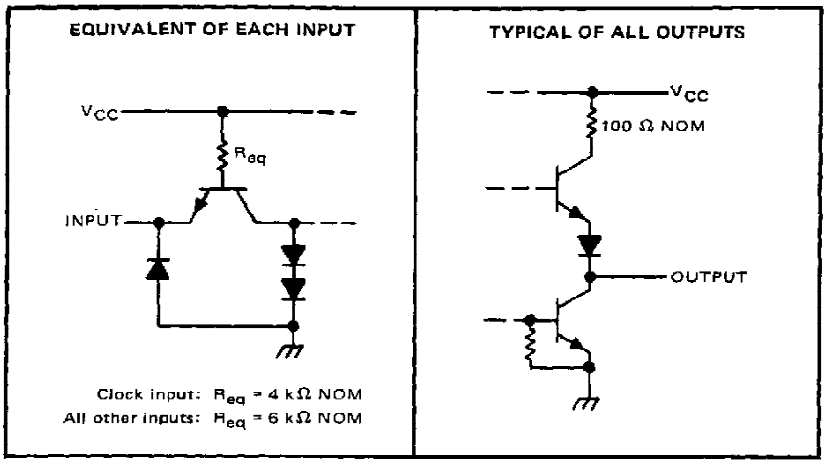
logic symbols†



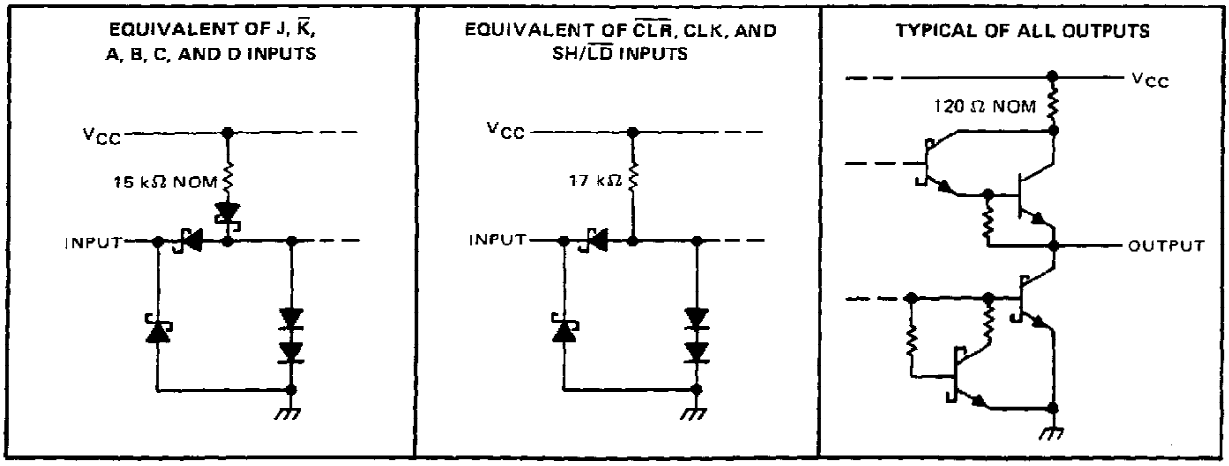
†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.
Pin numbers are for D, J, N, and W packages.

schematics of inputs and outputs

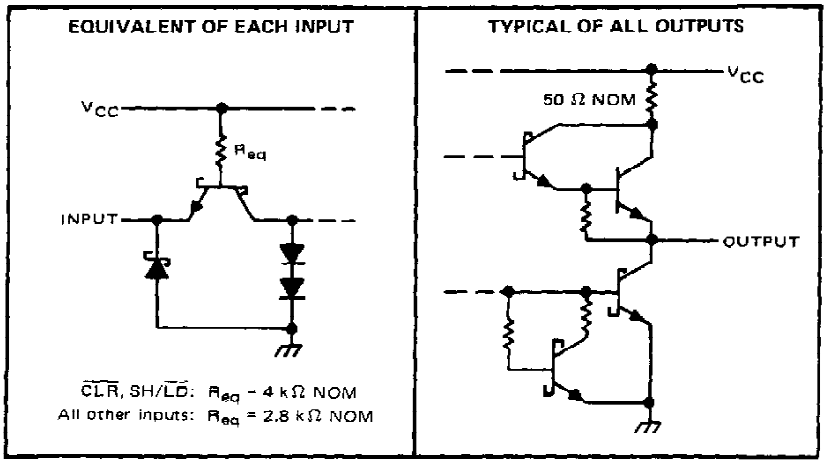
'195



'LS195A



'S195



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: SN54195 . . . . . −55°C to 125°C
SN74195 . . . . . 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

		SN54195			SN74195			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		30	0		30	MHz
Width of clock input pulse, $t_{w(clock)}$		16			16			ns
Width of clear input pulse, $t_{w(clear)}$		12			12			ns
Setup time, t_{su} (see Figure 1)	Shift/load	25			25			ns
	Serial and parallel data	20			20			
	Clear inactive-state	25			25			
Shift/load release time, $t_{release}$ (see Figure 1)				10			10	ns
Serial and parallel data hold time, 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†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage			2			V
V_{IL}	Low-level input voltage					0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = −12 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −800 μA		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA			0.2	0.4	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	V_{CC} = MAX, V_I = 2.4 V				40	μA
I_{IL}	Low-level input current	V_{CC} = MAX, V_I = 0.4 V				−1.6	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX	SN54195	−20		−57	mA
			SN74195	−18		−57	
I_{CC}	Supply current	V_{CC} = MAX, See Note 2			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 V, T_A = 25°C.
§Not more than one output should be shorted at a time.
NOTE 2: With all outputs open, shift/load grounded, and 4.5 V applied to the J, $\overline{K}$, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5 V, to clear and then applying a momentary ground, followed by 4.5 V, to clock.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 400 Ω, See Figure 1	30	39		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

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: SN54LS195A . . . . . −55°C to 125°C
SN74LS195A . . . . . 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

		SN54LS195A			SN74LS195A			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	μA
Low-level output current, I_{OL}				4			8	mA
Clock frequency, f_{clock}		0		30	0		30	MHz
Width of clock or clear pulse, $t_{w(clock)}$		16			16			ns
Width of clear input pulse, $t_{w(clear)}$		12			12			ns
Setup time, t_{su} (see Figure 1)	Shift/load	25			25			ns
	Serial and parallel data	15			15			
	Clear inactive-state	25			25			
Shift/load release time, $t_{release}$ (see Figure 1)				10			20	ns
Serial and parallel data hold time, 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†		SN54LS195A			SN74LS195A			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} = 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_{IL} max, I_{OH} = −400 μA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 8 mA					0.35	0.5	
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		−20		−100	−20		−100	mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 2			14	21		14	21	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, and duration of the short-circuit should not exceed one second.
NOTE 2: With all outputs open, shift/load grounded, and 4.5 V applied to the J, K, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5 V, to clear and then applying a momentary ground, followed by 4.5 V, to clock.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 2 kΩ, See Figure 1	30	39		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

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: SN54S195 . . . . . −55°C to 125°C
SN74S195 . . . . . 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

		SN54S195			SN74S195			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 input pulse, $t_{w(clock)}$		7			7			ns
Width of clear input pulse, $t_{w(clear)}$		12			12			ns
Setup time, t_{su} (see Figure 1)	Shift/load	11			11			ns
	Serial and parallel data	5			5			
	Clear inactive-state	9			9			
Shift/load release time, $t_{release}$ (see Figure 1)				2			6	ns
Serial and parallel data hold time, t_h (see Figure 1)		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)

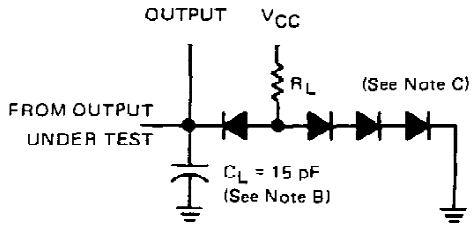
PARAMETER		TEST CONDITIONS†			MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA				−1.2	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OH} = −1 mA	SN54S195	2.5	3.4		V
				SN74S195	2.7	3.4		
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OL} = 20 mA				0.5	V
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 5.5 V				1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V				50	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.5 V				−2	mA
I_{OS}	Short-circuit output current§	V_{CC} = MAX			−40		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 2	SN54S195		70	99	mA
				SN74S195		70	109	

†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, and duration of the short-circuit should not exceed one second.
NOTE 2: With all outputs open, shift/load grounded, and 4.5 V applied to the J, $\overline{K}$, and data inputs, I_{CC} is measured by applying a momentary ground, followed by 4.5 V, to clear, and then applying a momentary ground, followed by 4.5 V, to clock.

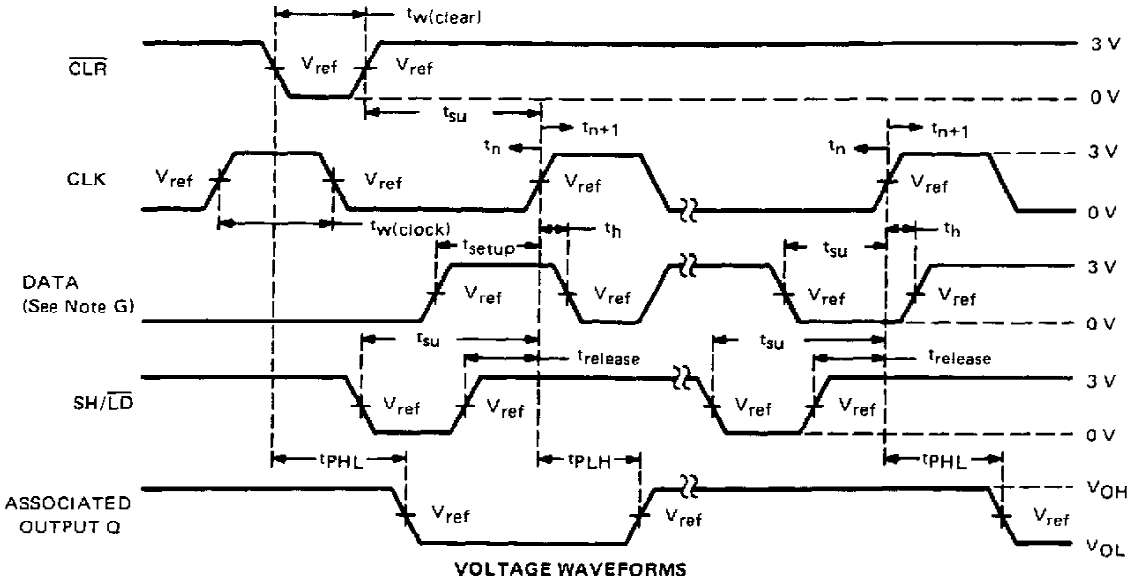
switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
f_{max}	Maximum clock frequency	C_L = 15 pF, R_L = 280 Ω, See Figure 1	70	105		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			8	12	ns
t_{PHL}	Propagation delay time, high-to-low-level output from clock			11	16.5	ns

PARAMETER MEASUREMENT INFORMATION



LOAD FOR OUTPUT UNDER TEST



VOLTAGE WAVEFORMS

NOTES: A. The clock pulse generator has the following characteristics: $Z_{out} \approx 50\ \Omega$ and PRR ≤ 1 MHz. For '195, $t_r \leq 7$ ns and $t_f \leq 7$ ns. For 'LS195A, $t_r \leq 15$ ns and $t_f \leq 6$ ns. For 'S195, $t_r = 2.5$ ns and $t_f = 2.5$ ns. When testing f_{max}, vary the clock PRR.

B. C_L includes probe and jig capacitance.

C. All diodes are 1N3064 or equivalent.

D. A clear pulse is applied prior to each test.

E. For '195 and 'S195, $V_{ref} = 1.5$ V; for 'LS195A, $V_{ref} = 1.3$ 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. J and $\overline{K}$ inputs are tested the same as data A, B, C, and D inputs except that shift/load input remains high.

H. 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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