

SN54LV594A, SN74LV594A 8-BIT SHIFT REGISTERS WITH OUTPUT REGISTERS

SCLS413G – APRIL 1998 – REVISED SEPTEMBER 2003

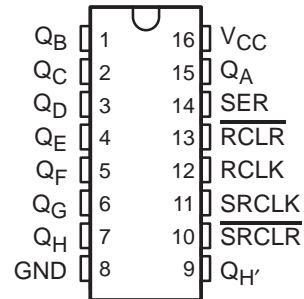
- 2-V to 5.5-V V_{CC} Operation
- Max t_{pd} of 6.5 ns at 5 V
- Typical V_{OLP} (Output Ground Bounce) <math><0.8\text{ V}</math> at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$
- Typical V_{OHV} (Output V_{OH} Undershoot) >math>>2.3\text{ V}</math> at $V_{CC} = 3.3\text{ V}$, $T_A = 25^\circ\text{C}$
- Support Mixed-Mode Voltage Operation on All Ports
- 8-Bit Serial-In, Parallel-Out Shift Registers With Storage
- Independent Direct Overriding Clears on Shift and Storage Registers
- Independent Clocks for Shift and Storage Registers
- Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II
- ESD Protection Exceeds JESD 22
 - 2000-V Human-Body Model (A114-A)
 - 200-V Machine Model (A115-A)
 - 1000-V Charged-Device Model (C101)

description/ordering information

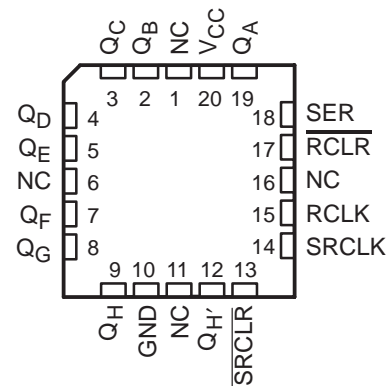
The 'LV594A devices are 8-bit shift registers designed for 2-V to 5.5-V V_{CC} operation.

These devices contain an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. Separate clocks (RCLK, SRCLK) and direct overriding clear ($\overline{\text{RCLR}}$, $\overline{\text{SRCLR}}$) inputs are provided on the shift and storage registers. A serial output (Q_H) is provided for cascading purposes.

SN54LV594A . . . J OR W PACKAGE
SN74LV594A . . . D, DB, NS, OR PW PACKAGE
(TOP VIEW)



SN54LV594A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

ORDERING INFORMATION

T_A	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
–40°C to 85°C	SOIC – D	Tube of 40	SN74LV594AD	LV594A
		Reel of 2500	SN74LV594ADR	
	SOP – NS	Reel of 2000	SN74LV594ANSR	74LV594A
	SSOP – DB	Reel of 2000	SN74LV594ADBR	LV594A
	TSSOP – PW	Tube of 90	SN74LV594APW	LV594A
Reel of 2000		SN74LV594APWR		
Reel of 250		SN74LV594APWT		
–55°C to 125°C	CDIP – J	Tube of 25	SNJ54LV594AJ	SNJ54LV594AJ
	CFP – W	Tube of 150	SNJ54LV594AW	SNJ54LV594AW
	LCCC – FK	Tube of 55	SNJ54LV594AFK	SNJ54LV594AFK

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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 **TEXAS
INSTRUMENTS**

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description/ordering information (continued)

The shift-register (SRCLK) and storage-register (RCLK) clocks are positive-edge triggered. If the clocks are tied together, the shift register always is one clock pulse ahead of the storage register.

FUNCTION TABLE

INPUTS					FUNCTION
SER	SRCLK	$\overline{\text{SRCLR}}$	RCLK	$\overline{\text{RCLR}}$	
X	X	L	X	X	Shift register is cleared.
L	↑	H	X	X	First stage of shift register goes low. Other stages store the data of previous stage, respectively.
H	↑	H	X	X	First stage of shift register goes high. Other stages store the data of previous stage, respectively.
L	↓	H	X	X	Shift register state is not changed.
X	X	X	X	L	Storage register is cleared.
X	X	X	↑	H	Shift register data is stored in the storage register.
X	X	X	↓	H	Storage register state is not changed.

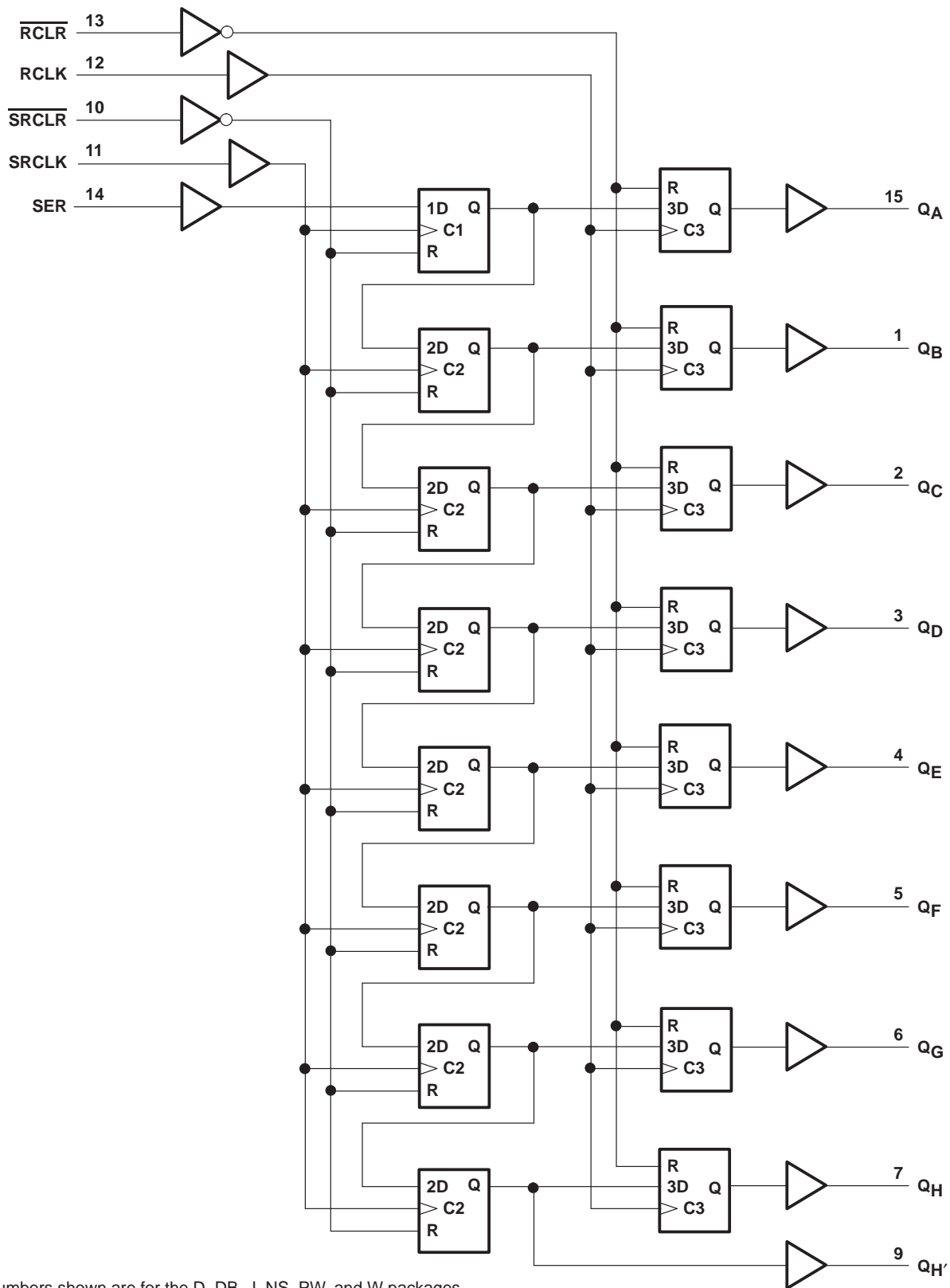


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logic diagram (positive logic)



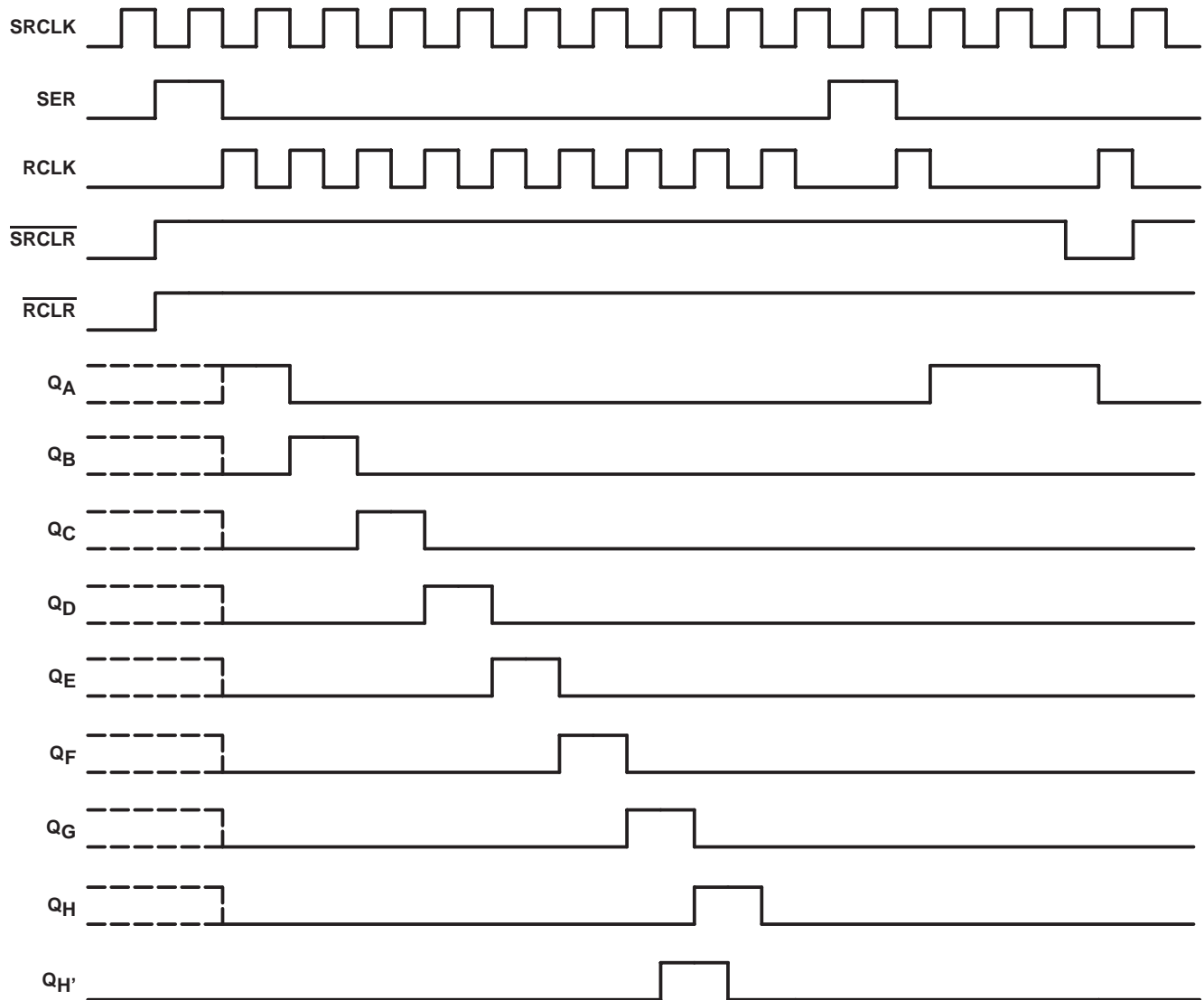
Pin numbers shown are for the D, DB, J, NS, PW, and W packages.



SN54LV594A, SN74LV594A 8-BIT SHIFT REGISTERS WITH OUTPUT REGISTERS

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timing diagram



**SN54LV594A, SN74LV594A
8-BIT SHIFT REGISTERS
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absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage range, V_{CC}	-0.5 V to 7 V
Input voltage range, V_I (see Note 1)	-0.5 V to 7 V
Voltage range applied to any output in the high-impedance or power-off state, V_O (see Note 1)	-0.5 V to 7 V
Output voltage range, V_O (see Notes 1 and 2)	-0.5 V to $V_{CC} + 0.5$ V
Input clamp current, I_{IK} ($V_I < 0$)	-20 mA
Output clamp current, I_{OK} ($V_O < 0$ or $V_O > V_{CC}$)	± 50 mA
Continuous output current, I_O ($V_O = 0$ to V_{CC})	± 25 mA
Continuous current through V_{CC} or GND	± 50 mA
Package thermal impedance, θ_{JA} (see Note 3): D package	73°C/W
DB package	82°C/W
NS package	64°C/W
PW package	108°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. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 5.5 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51-7.



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recommended operating conditions (see Note 4)

		SN54LV594A		SN74LV594A		UNIT
		MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage	2	5.5	2	5.5	V
V_{IH}	High-level input voltage	$V_{CC} = 2\text{ V}$	1.5	1.5		V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$	$V_{CC} \times 0.7$	$V_{CC} \times 0.7$		
		$V_{CC} = 3\text{ V to }3.6\text{ V}$	$V_{CC} \times 0.7$	$V_{CC} \times 0.7$		
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$	$V_{CC} \times 0.7$	$V_{CC} \times 0.7$		
V_{IL}	Low-level input voltage	$V_{CC} = 2\text{ V}$		0.5	0.5	V
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$		$V_{CC} \times 0.3$	$V_{CC} \times 0.3$	
		$V_{CC} = 3\text{ V to }3.6\text{ V}$		$V_{CC} \times 0.3$	$V_{CC} \times 0.3$	
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$		$V_{CC} \times 0.3$	$V_{CC} \times 0.3$	
V_I	Input voltage	0	5.5	0	5.5	V
V_O	Output voltage	0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current	$V_{CC} = 2\text{ V}$		-50	-50	μA
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$		-2	-2	mA
		$V_{CC} = 3\text{ V to }3.6\text{ V}$		-6	-6	
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$		-12	-12	
I_{OL}	Low-level output current	$V_{CC} = 2\text{ V}$		50	50	μA
		$V_{CC} = 2.3\text{ V to }2.7\text{ V}$		2	2	mA
		$V_{CC} = 3\text{ V to }3.6\text{ V}$		6	6	
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$		12	12	
$\Delta t/\Delta v$	Input transition rise or fall rate	$V_{CC} = 2.3\text{ V to }2.7\text{ V}$		200	200	ns/V
		$V_{CC} = 3\text{ V to }3.6\text{ V}$		100	100	
		$V_{CC} = 4.5\text{ V to }5.5\text{ V}$		20	20	
T_A	Operating free-air temperature	-55	125	-40	85	$^{\circ}\text{C}$

NOTE 4: 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	V_{CC}	SN54LV594A			SN74LV594A			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
V_{OH}	$I_{OH} = -50\ \mu\text{A}$	2 V to 5.5 V	$V_{CC}-0.1$			$V_{CC}-0.1$			V
	$I_{OH} = -2\ \text{mA}$	2.3 V	2			2			
	$I_{OH} = -6\ \text{mA}$	3 V	2.48			2.48			
	$I_{OH} = -12\ \text{mA}$	4.5 V	3.8			3.8			
V_{OL}	$I_{OL} = 50\ \mu\text{A}$	2 V to 5.5 V				0.1			V
	$I_{OL} = 2\ \text{mA}$	2.3 V				0.4			
	$I_{OL} = 6\ \text{mA}$	3 V				0.44			
	$I_{OL} = 12\ \text{mA}$	4.5 V				0.55			
I_I	$V_I = 5.5\text{ V or GND}$	0 to 5.5 V				± 1			μA
I_{CC}	$V_I = V_{CC}\text{ or GND, } I_O = 0$	5.5 V				20			μA
I_{off}	$V_I\text{ or }V_O = 0\text{ to }5.5\text{ V}$	0				5			μA
C_i	$V_I = V_{CC}\text{ or GND}$	3.3 V	3.5			3.5			pF

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timing requirements over recommended operating free-air temperature range, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

		$T_A = 25^\circ\text{C}$		SN54LV594A		SN74LV594A		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	RCLK or SRCLK high or low		7	7.5	7.5		ns
		$\overline{\text{RCLR}}$ or $\overline{\text{SRCLR}}$ low		6	6.5	6.5		
t_{su}	Setup time	SER before SRCLK \uparrow		5.5	5.5	5.5		ns
		SRCLK \uparrow before RCLK \uparrow \dagger		8	9	9		
		$\overline{\text{SRCLR}}$ low before RCLK \uparrow		8.5	9.5	9.5		
		$\overline{\text{SRCLR}}$ high (inactive) before SRCLK \uparrow		6	6.8	6.8		
		$\overline{\text{RCLR}}$ high (inactive) before RCLK \uparrow		6.7	7.6	7.6		
t_h	Hold time	SER after SRCLK \uparrow		1.5	1.5	1.5		ns

\dagger This setup time allows the storage register to receive stable data from the shift register. The clocks can be tied together, in which case the shift register is one clock pulse ahead of the storage register.

timing requirements over recommended operating free-air temperature range, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 1)

		$T_A = 25^\circ\text{C}$		SN54LV594A		SN74LV594A		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	RCLK or SRCLK high or low		5.5	5.5	5.5		ns
		$\overline{\text{RCLR}}$ or $\overline{\text{SRCLR}}$ low		5	5	5		
t_{su}	Setup time	SER before SRCLK \uparrow		3.5	3.5	3.5		ns
		SRCLK \uparrow before RCLK \uparrow \dagger		8	8.5	8.5		
		$\overline{\text{SRCLR}}$ low before RCLK \uparrow		8	9	9		
		$\overline{\text{SRCLR}}$ high (inactive) before SRCLK \uparrow		4.2	4.8	4.8		
		$\overline{\text{RCLR}}$ high (inactive) before RCLK \uparrow		4.6	5.3	5.3		
t_h	Hold time	SER after SRCLK \uparrow		1.5	1.5	1.5		ns

\dagger This setup time allows the storage register to receive stable data from the shift register. The clocks can be tied together, in which case the shift register is one clock pulse ahead of the storage register.

timing requirements over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (unless otherwise noted) (see Figure 1)

		$T_A = 25^\circ\text{C}$		SN54LV594A		SN74LV594A		UNIT
		MIN	MAX	MIN	MAX	MIN	MAX	
t_w	Pulse duration	RCLK or SRCLK high or low		5	5	5		ns
		$\overline{\text{RCLR}}$ or $\overline{\text{SRCLR}}$ low		5.2	5.2	5.2		
t_{su}	Setup time	SER before SRCLK \uparrow		3	3	3		ns
		SRCLK \uparrow before RCLK \uparrow \dagger		5	5	5		
		$\overline{\text{SRCLR}}$ low before RCLK \uparrow		5	5	5		
		$\overline{\text{SRCLR}}$ high (inactive) before SRCLK \uparrow		2.9	3.3	3.3		
		$\overline{\text{RCLR}}$ high (inactive) before RCLK \uparrow		3.2	3.7	3.7		
t_h	Hold time	SER after SRCLK \uparrow		2	2	2		ns

\dagger This setup time allows the storage register to receive stable data from the shift register. The clocks can be tied together, in which case the shift register is one clock pulse ahead of the storage register.

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switching characteristics over recommended operating free-air temperature range, $V_{CC} = 2.5\text{ V} \pm 0.2\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	$T_A = 25^\circ\text{C}$			SN54LV594A		SN74LV594A		UNIT		
				MIN	TYP	MAX	MIN	MAX	MIN	MAX			
f_{max}			$C_L = 15\text{ pF}$	65*	80*		45*		45		MHz		
			$C_L = 50\text{ pF}$	60	70		40		40				
t_{PLH}	RCLK	Q_A-Q_H	$C_L = 15\text{ pF}$		6.4*	10.6*	1*	11.1*	1	11.1	ns		
t_{PHL}					6.3*	10.4*	1*	11.1*	1	11.1			
t_{PLH}	SRCLK	Q_H'			7.4*	12.1*	1*	12.8*	1	12.8			
t_{PHL}					7.2*	11.6*	1*	12.8*	1	12.8			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			7.9*	12.7*	1*	13.6*	1	13.6			
	$\overline{\text{SRCLR}}$	Q_H'			7.4*	11.9*	1*	13.1*	1	13.1			
t_{PLH}	RCLK	Q_A-Q_H		$C_L = 50\text{ pF}$		9.5	14.1	1	14.6	1		14.6	ns
t_{PHL}						10.8	15.5	1	17.2	1		17.2	
t_{PLH}	SRCLK	Q_H'			10.6	15.7	1	16.5	1	16.5			
t_{PHL}					11.3	16.1	1	18.6	1	18.6			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			12.1	17.4	1	19	1	19			
	$\overline{\text{SRCLR}}$	Q_H'			11.6	16.5	1	18.6	1	18.6			

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

switching characteristics over recommended operating free-air temperature range, $V_{CC} = 3.3\text{ V} \pm 0.3\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	$T_A = 25^\circ\text{C}$			SN54LV594A		SN74LV594A		UNIT		
				MIN	TYP	MAX	MIN	MAX	MIN	MAX			
f_{max}			$C_L = 15\text{ pF}$	80*	120*		70*		70		MHz		
			$C_L = 50\text{ pF}$	55	105		50		50				
t_{PLH}	RCLK	Q_A-Q_H	$C_L = 15\text{ pF}$		4.6*	8*	1*	8.5*	1	8.5	ns		
t_{PHL}					4.9*	8.2*	1*	8.8*	1	8.8			
t_{PLH}	SRCLK	Q_H'			5.4*	9.1*	1*	9.7*	1	9.7			
t_{PHL}					5.5*	9.2*	1*	9.9*	1	9.9			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			6*	9.8*	1*	10.6*	1	10.6			
	$\overline{\text{SRCLR}}$	Q_H'			5.6*	9.2*	1*	10*	1	10			
t_{PLH}	RCLK	Q_A-Q_H		$C_L = 50\text{ pF}$		6.9	10.5	1	11.1	1		11.1	ns
t_{PHL}						8.1	11.9	1	13.1	1		13.1	
t_{PLH}	SRCLK	Q_H'			7.7	11.7	1	12.4	1	12.4			
t_{PHL}					8.4	12.5	1	13.9	1	13.9			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			9.1	13.1	1	14.4	1	14.4			
	$\overline{\text{SRCLR}}$	Q_H'			8.5	12.4	1	14	1	14			

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switching characteristics over recommended operating free-air temperature range, $V_{CC} = 5\text{ V} \pm 0.5\text{ V}$ (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	LOAD CAPACITANCE	$T_A = 25^\circ\text{C}$			SN54LV594A		SN74LV594A		UNIT		
				MIN	TYP	MAX	MIN	MAX	MIN	MAX			
f_{max}			$C_L = 15\text{ pF}$	135*	170*		115*		115		MHz		
			$C_L = 50\text{ pF}$	120	140		95		95				
t_{PLH}	RCLK	Q_A-Q_H	$C_L = 15\text{ pF}$		3.3*	6.2*	1*	6.5*	1	6.5	ns		
t_{PHL}					3.7*	6.5*	1*	6.9*	1	6.9			
t_{PLH}	SRCLK	$Q_{H'}$			3.7*	6.8*	1*	7.2*	1	7.2			
t_{PHL}					4.1*	7.2*	1*	7.6*	1	7.6			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			4.5*	7.6*	1*	8.2*	1	8.2			
	$\overline{\text{SRCLR}}$	$Q_{H'}$			4.1*	7.1*	1*	7.6*	1	7.6			
t_{PLH}	RCLK	Q_A-Q_H		$C_L = 50\text{ pF}$		4.9	7.8	1	8.3	1		8.3	ns
t_{PHL}						5.8	8.9	1	9.7	1		9.7	
t_{PLH}	SRCLK	$Q_{H'}$			5.5	8.6	1	9.1	1	9.1			
t_{PHL}					6	9.2	1	10.1	1	10.1			
t_{PHL}	$\overline{\text{RCLR}}$	Q_A-Q_H			6.6	10	1	10.7	1	10.7			
	$\overline{\text{SRCLR}}$	$Q_{H'}$			6	9.2	1	10.1	1	10.1			

* On products compliant to MIL-PRF-38535, this parameter is not production tested.

noise characteristics, $V_{CC} = 3.3\text{ V}$, $C_L = 50\text{ pF}$, $T_A = 25^\circ\text{C}$ (see Note 5)

PARAMETER		SN74LV594A			UNIT
		MIN	TYP	MAX	
$V_{OL(P)}$	Quiet output, maximum dynamic V_{OL}		0.5	0.8	V
$V_{OL(V)}$	Quiet output, minimum dynamic V_{OL}		-0.1	-0.8	V
$V_{OH(V)}$	Quiet output, minimum dynamic V_{OH}		2.8		V
$V_{IH(D)}$	High-level dynamic input voltage		2.31		V
$V_{IL(D)}$	Low-level dynamic input voltage			0.99	V

NOTE 5: Characteristics are for surface-mount packages only.

operating characteristics, $T_A = 25^\circ\text{C}$

PARAMETER		TEST CONDITIONS	V_{CC}	TYP	UNIT
C_{pd}	Power dissipation capacitance	$f = 10\text{ MHz}$	3.3 V	93	pF
			5 V	112	

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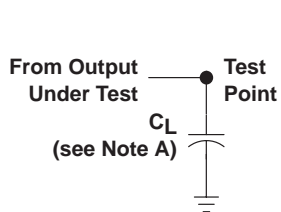


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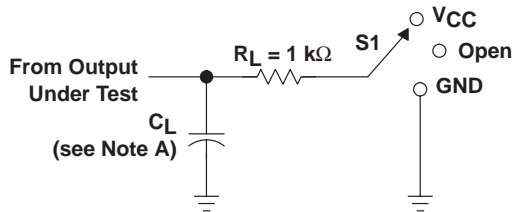
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PARAMETER MEASUREMENT INFORMATION

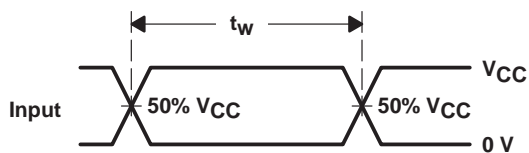


LOAD CIRCUIT FOR
TOTEM-POLE OUTPUTS

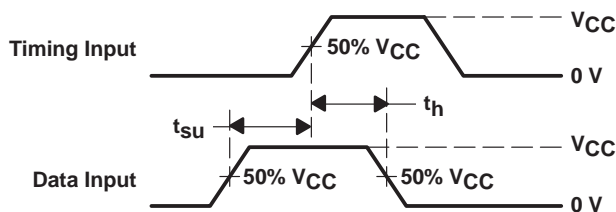


LOAD CIRCUIT FOR
3-STATE AND OPEN-DRAIN OUTPUTS

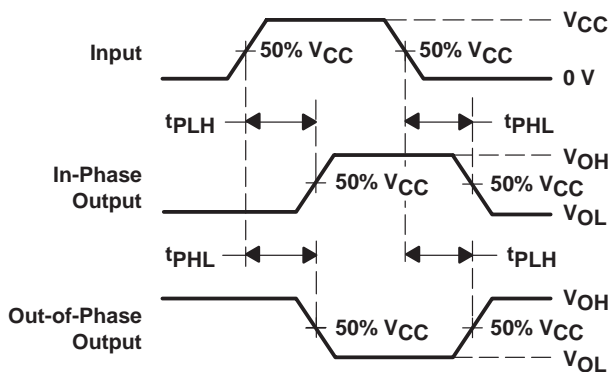
TEST	S1
t_{PLH}/t_{PHL}	Open
t_{PLZ}/t_{PZL}	V_{CC}
t_{PHZ}/t_{PZH}	GND
Open Drain	V_{CC}



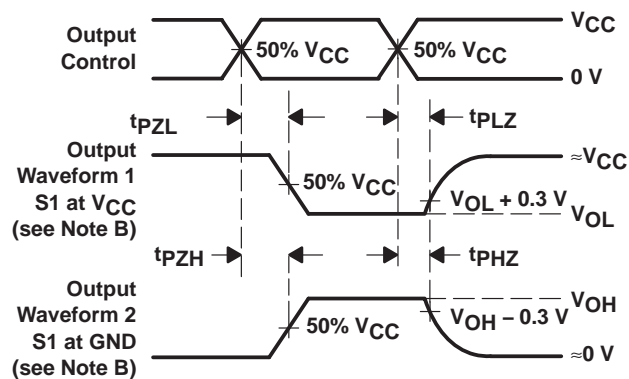
VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES



VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES
INVERTING AND NONINVERTING OUTPUTS



VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES
LOW- AND HIGH-LEVEL ENABLING

- NOTES:
- C_L includes probe and jig capacitance.
 - 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.
 - All input pulses are supplied by generators having the following characteristics: $PRR \leq 1\text{ MHz}$, $Z_O = 50\ \Omega$, $t_r \leq 3\text{ ns}$, $t_f \leq 3\text{ ns}$.
 - The outputs are measured one at a time with one input transition per measurement.
 - t_{PLZ} and t_{PHZ} are the same as t_{dis} .
 - t_{PZL} and t_{PZH} are the same as t_{en} .
 - t_{PHL} and t_{PLH} are the same as t_{pd} .
 - All parameters and waveforms are not applicable to all devices.

Figure 1. Load Circuit and Voltage Waveforms

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

PW (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14 PINS SHOWN



4040064/F 01/97

- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-153

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