

# SN54AS194, SN74AS194 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

SDAS212A – DECEMBER 1983 – REVISED DECEMBER 1994

- Parallel-to-Serial, Serial-to-Parallel Conversions
- Left or Right Shifts
- Parallel Synchronous Loading
- Direct Overriding Clear
- Temporary Data-Latching Capability
- Package Options Include Plastic Small-Outline Packages (D), Ceramic Chip Carriers (FK), and Standard Plastic (N) and Ceramic (J) 300-mil DIPs

## description

These 4-bit bidirectional universal shift registers feature parallel outputs, right-shift and left-shift serial (SR SER, SL SER) inputs, operating-mode-control (S0, S1) inputs, and a direct overriding clear ( $\overline{\text{CLR}}$ ) line. The registers have four distinct modes of operation:

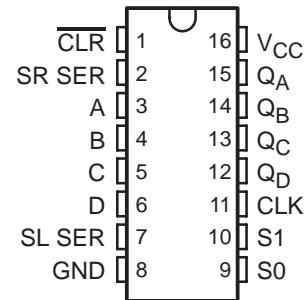
- Inhibit clock (temporary data latch/do nothing)
- Shift right (in the direction  $Q_A$  toward  $Q_D$ )
- Shift left (in the direction  $Q_D$  toward  $Q_A$ )
- Parallel (broadside) load

Parallel synchronous loading is accomplished by applying the four bits of data and taking both S0 and S1 high. The data is loaded into the associated flip-flops and appears at the outputs after the positive transition of the clock (CLK) input. During loading, serial data flow is inhibited.

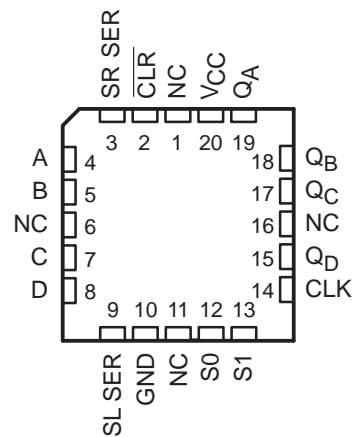
Shift right is accomplished synchronously with the rising edge of the clock pulse when S0 is high and S1 is low. Serial data for this mode is entered at the shift-right data input. When S0 is low and S1 is high, data shifts left synchronously and new data is entered at the shift-left serial inputs. Clocking of the flip-flop is inhibited when both mode-control inputs are low.

The SN54AS194 is characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN74AS194 is characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

SN54AS194 . . . J PACKAGE  
SN74AS194 . . . D OR N PACKAGE  
(TOP VIEW)



SN54AS194 . . . FK PACKAGE  
(TOP VIEW)



NC – No internal connection

# SN54AS194, SN74AS194

## 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

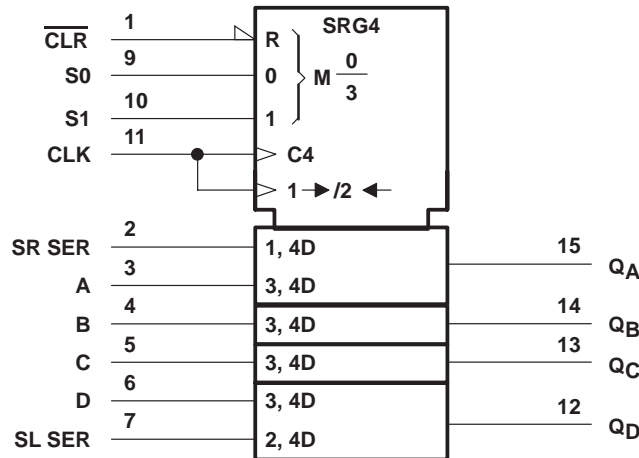
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FUNCTION TABLE

$\overline{\text{CLR}}$	MODE		CLK	INPUTS						OUTPUTS			
				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	H	↑	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.

### logic symbol†

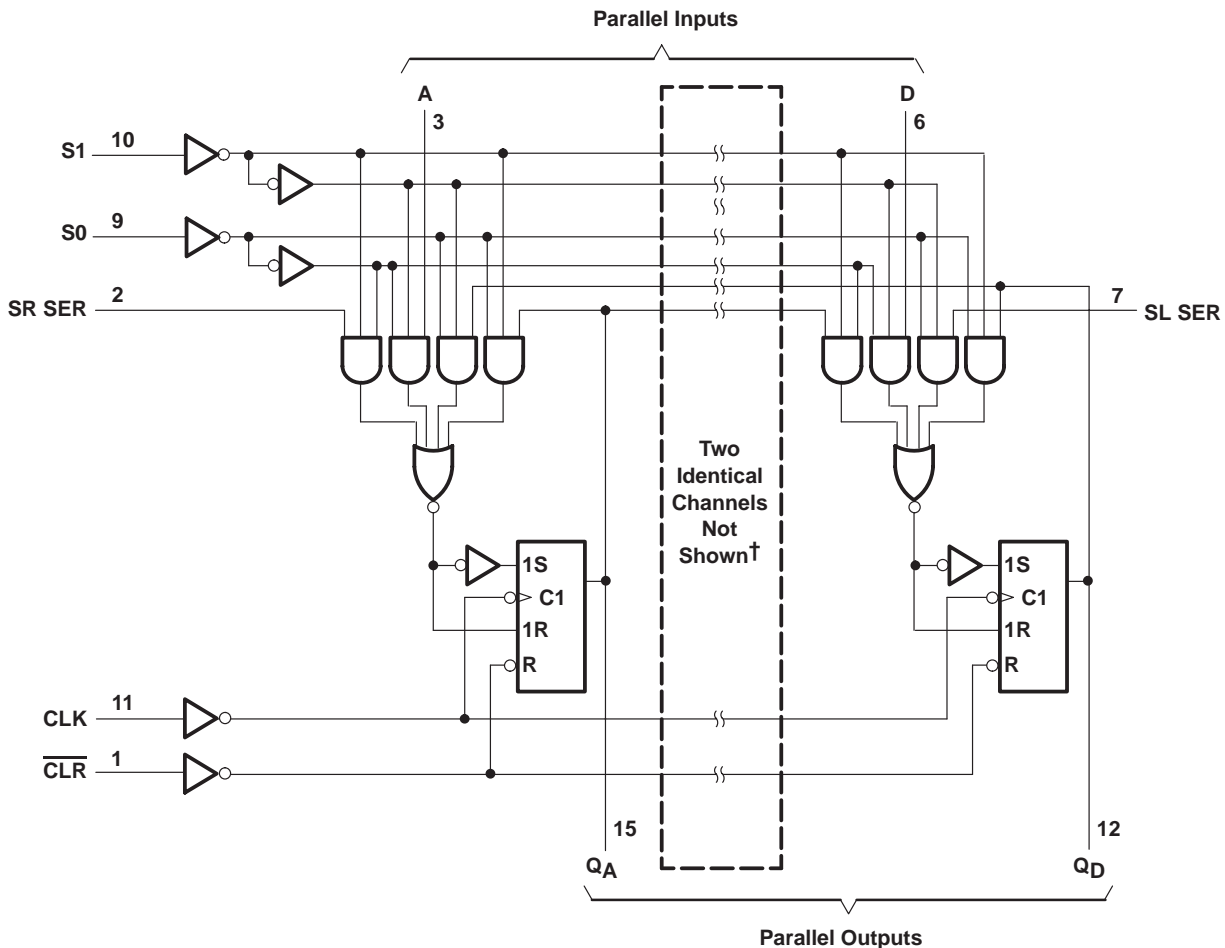


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.

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logic diagram (positive logic)



† I/O ports not shown: Q<sub>B</sub> (14) and Q<sub>C</sub> (13)  
Pin numbers shown are for the D, J, and N packages.



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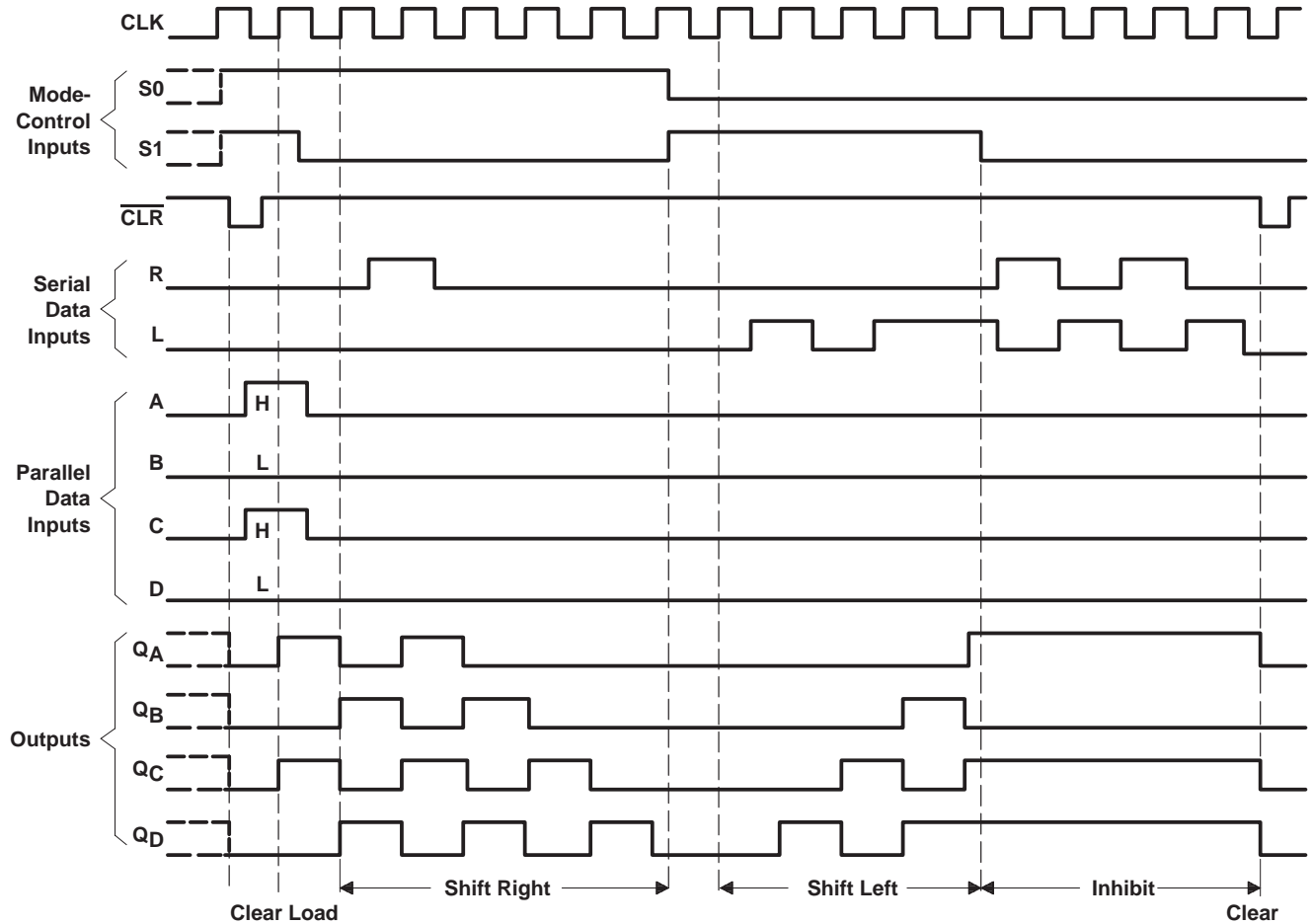


Figure 1. Typical Clear, Load, Right-Shift, and Clear Sequences

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

Supply voltage, $V_{CC}$ .....	7 V
Input voltage, $V_I$ .....	7 V
Operating free-air temperature range, $T_A$ : SN54AS194 .....	-55°C to 125°C
SN74AS194 .....	0°C to 70°C
Storage temperature range .....	-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.

# SN54AS194, SN74AS194 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

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## recommended operating conditions

		SN54AS194			SN74AS194			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
$V_{CC}$	Supply voltage	4.5	5	5.5	4.5	5	5.5	V
$V_{IH}$	High-level input voltage	2			2			V
$V_{IL}$	Low-level input voltage			0.8			0.8	V
$I_{OH}$	High-level output current			-2			-2	mA
$I_{OL}$	Low-level output current			20			20	mA
$f_{clock}^*$	Clock frequency	0		75	0		80	MHz
$t_w^*$	Pulse duration	$\overline{CLR}$		4		4.5		ns
		CLK high		4		4		
		CLK low		6		7		
$t_{su}^*$	Setup time before CLK $\uparrow$	Select		9		9.5		ns
		Data		3.5		4		
		Clear inactive state		6		6		
$t_h^*$	Hold time, data after CLK $\uparrow$		0.5			0.5		ns
$T_A$	Operating free-air temperature		-55	125		0	70	$^{\circ}C$

\* On products compliant to MIL-STD-883, Class B, these parameters are based on characterization data, but are not production tested.

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

PARAMETER		TEST CONDITIONS		SN54AS194			SN74AS194			UNIT
				MIN	TYP $\dagger$	MAX	MIN	TYP $\dagger$	MAX	
$V_{IK}$		$V_{CC} = 4.5 V,$	$I_I = -18 mA$			-1.2			-1.2	V
$V_{OH}$		$V_{CC} = 4.5 V$ to $5.5 V,$	$I_{OH} = -2 mA$	$V_{CC}-2$			$V_{CC}-2$			V
$V_{OL}$		$V_{CC} = 4.5 V,$	$I_{OL} = 20 mA$		0.35	0.5		0.35	0.5	V
$I_I$	Data, CLK, $\overline{CLR}$	$V_{CC} = 5.5 V,$	$V_I = 7 V$			0.1		0.1		mA
	Mode, SL, SR					0.2		0.2		
$I_{IH}$	Data, CLK, $\overline{CLR}$	$V_{CC} = 5.5 V,$	$V_I = 2.7 V$			20		20		$\mu A$
	Mode, SL, SR					40		40		
$I_{IL}$	Data, CLK, $\overline{CLR}$	$V_{CC} = 5.5 V,$	$V_I = 0.4 V$			-0.5		-0.5		mA
	Mode, SL, SR					-1		-1		
$I_{O\ddagger}$		$V_{CC} = 5.5 V,$	$V_O = 2.25 V$	-30		-112	-30		-112	mA
$I_{CC}$		$V_{CC} = 5.5 V$	Outputs high		30	49		30	43	mA
			Outputs low		38	60		38	53	

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

$\ddagger$  The output conditions have been chosen to produce a current that closely approximates one half of the true short-circuit output current,  $I_{OS}.$



# SN54AS194, SN74AS194

## 4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTERS

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### switching characteristics (see Figure 2)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	V <sub>CC</sub> = 4.5 V to 5.5 V, C <sub>L</sub> = 50 pF, R <sub>L</sub> = 500 Ω, T <sub>A</sub> = MIN to MAX†				UNIT
			SN54AS194		SN74AS194		
			MIN	MAX	MIN	MAX	
f <sub>max</sub> *			75		80		MHz
t <sub>PLH</sub>	CLK	Any Q	2.5	8	3	7	ns
t <sub>PHL</sub>			2.5	8	3	7	
t <sub>PHL</sub>	CLR	Any Q	3.5	13	4	12	ns

\* On products compliant to MIL-STD-883, Class B, these parameters are based on characterization data, but are not production tested.

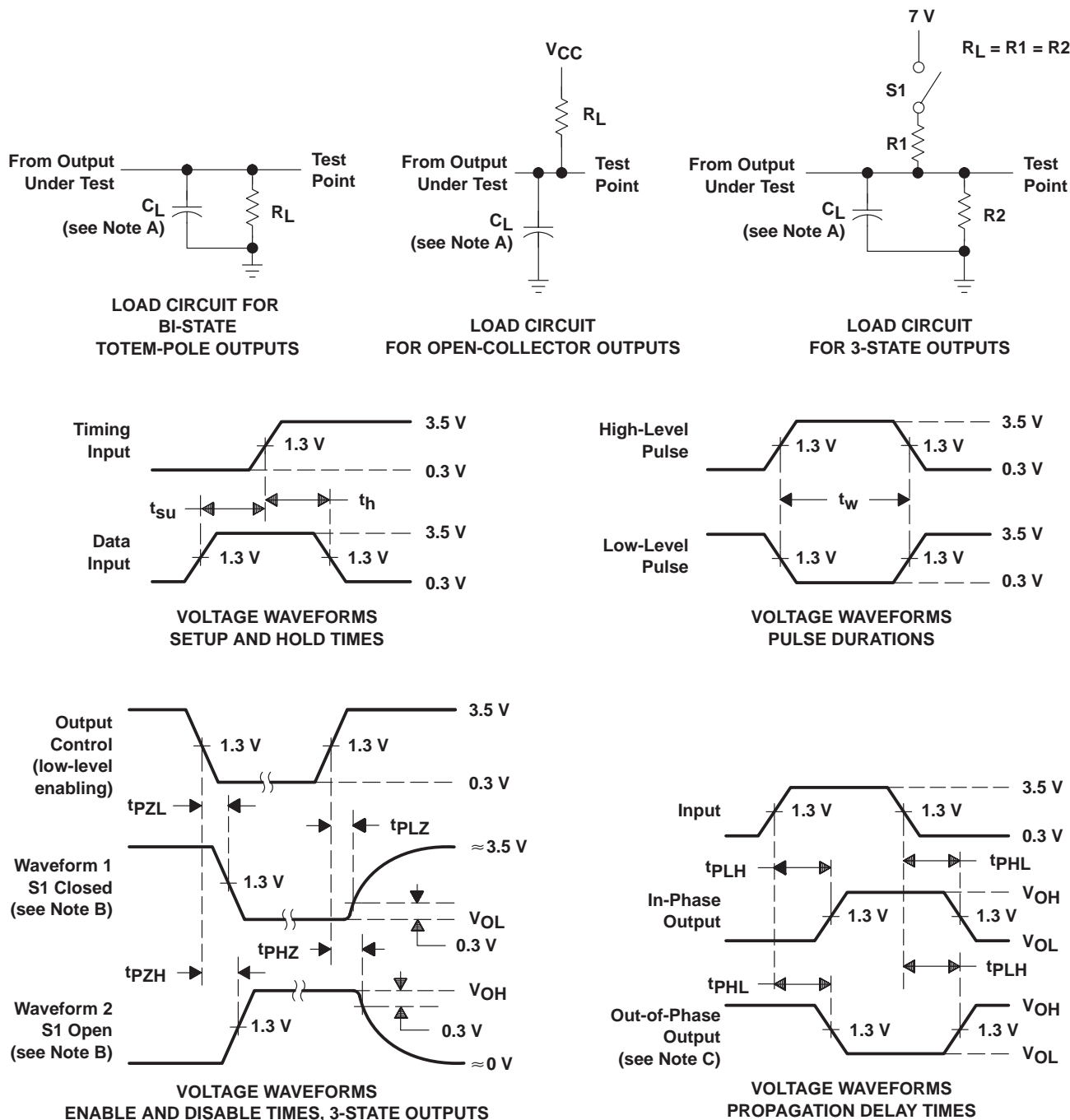
† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.



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## PARAMETER MEASUREMENT INFORMATION SERIES 54ALS/74ALS AND 54AS/74AS DEVICES



- NOTES: A.  $C_L$  includes probe and jig capacitance.  
 B. 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.  
 C. When measuring propagation delay items of 3-state outputs, switch S1 is open.  
 D. All input pulses have the following characteristics:  $PRR \leq 1$  MHz,  $t_r = t_f = 2$  ns, duty cycle = 50%.  
 E. The outputs are measured one at a time with one transition per measurement.

**Figure 2. Load Circuits and Voltage Waveforms**



**PACKAGING INFORMATION**

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead finish/ Ball material (6)	MSL Peak Temp (3)	Op Temp (°C)	Device Marking (4/5)	Samples
SN74AS194D	OBSOLETE	SOIC	D	16		TBD	Call TI	Call TI	0 to 70	AS194	
SN74AS194DR	ACTIVE	SOIC	D	16	2500	RoHS & Green	NIPDAU	Level-1-260C-UNLIM	0 to 70	AS194	Samples

(1) The marketing status values are defined as follows:

**ACTIVE:** Product device recommended for new designs.

**LIFEBUY:** TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

**NRND:** Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

**PREVIEW:** Device has been announced but is not in production. Samples may or may not be available.

**OBSOLETE:** TI has discontinued the production of the device.

(2) **RoHS:** TI defines "RoHS" to mean semiconductor products that are compliant with the current EU RoHS requirements for all 10 RoHS substances, including the requirement that RoHS substance do not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, "RoHS" products are suitable for use in specified lead-free processes. TI may reference these types of products as "Pb-Free".

**RoHS Exempt:** TI defines "RoHS Exempt" to mean products that contain lead but are compliant with EU RoHS pursuant to a specific EU RoHS exemption.

**Green:** TI defines "Green" to mean the content of Chlorine (Cl) and Bromine (Br) based flame retardants meet JS709B low halogen requirements of <=1000ppm threshold. Antimony trioxide based flame retardants must also meet the <=1000ppm threshold requirement.

(3) MSL, Peak Temp. - The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

(4) There may be additional marking, which relates to the logo, the lot trace code information, or the environmental category on the device.

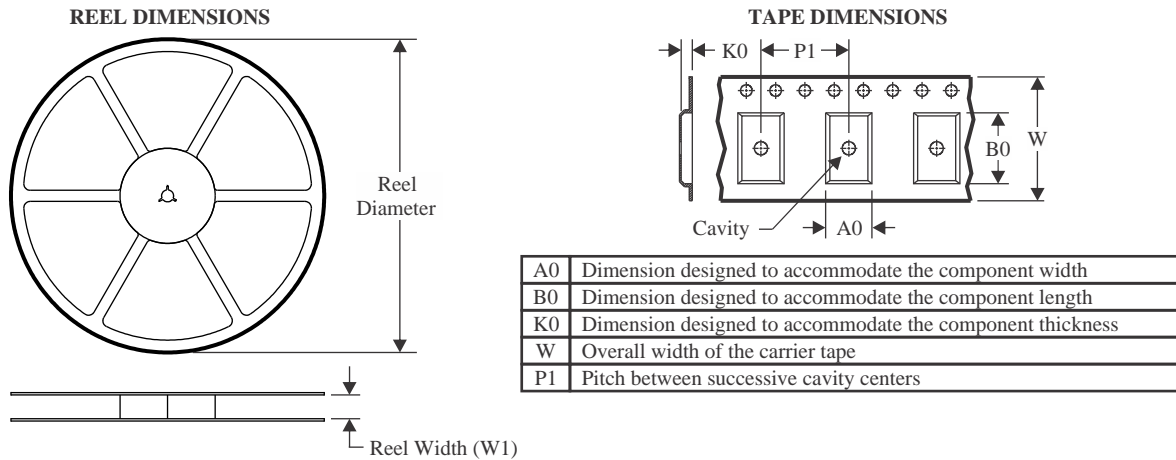
(5) Multiple Device Markings will be inside parentheses. Only one Device Marking contained in parentheses and separated by a "~" will appear on a device. If a line is indented then it is a continuation of the previous line and the two combined represent the entire Device Marking for that device.

(6) Lead finish/Ball material - Orderable Devices may have multiple material finish options. Finish options are separated by a vertical ruled line. Lead finish/Ball material values may wrap to two lines if the finish value exceeds the maximum column width.

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**TAPE AND REEL INFORMATION**

**QUADRANT ASSIGNMENTS FOR PIN 1 ORIENTATION IN TAPE**


\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Reel Diameter (mm)	Reel Width W1 (mm)	A0 (mm)	B0 (mm)	K0 (mm)	P1 (mm)	W (mm)	Pin1 Quadrant
SN74AS194DR	SOIC	D	16	2500	330.0	16.4	6.5	10.3	2.1	8.0	16.0	Q1

**TAPE AND REEL BOX DIMENSIONS**

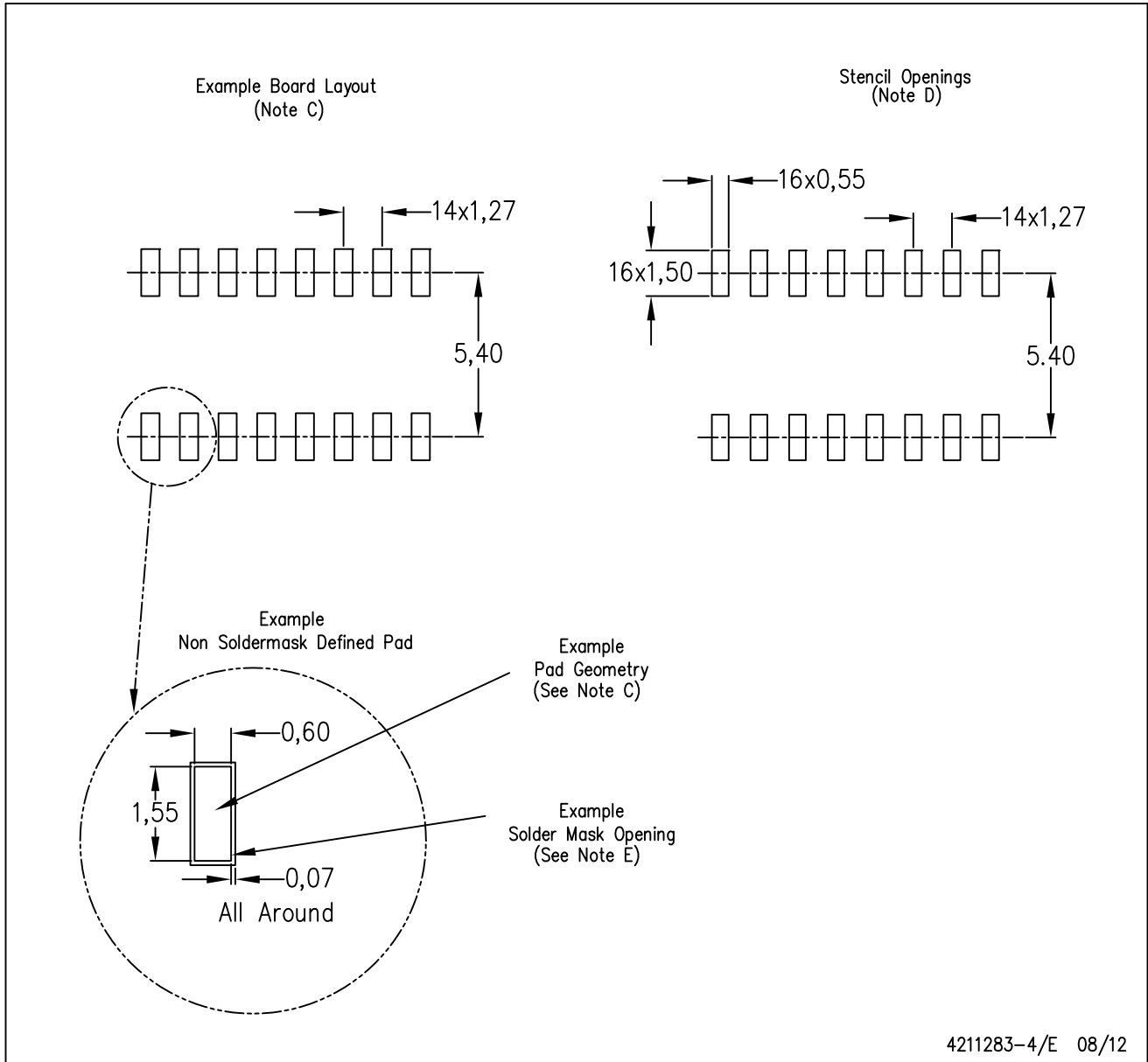

\*All dimensions are nominal

Device	Package Type	Package Drawing	Pins	SPQ	Length (mm)	Width (mm)	Height (mm)
SN74AS194DR	SOIC	D	16	2500	340.5	336.1	32.0



D (R-PDSO-G16)

PLASTIC SMALL OUTLINE



- NOTES:
- All linear dimensions are in millimeters.
  - This drawing is subject to change without notice.
  - Publication IPC-7351 is recommended for alternate designs.
  - Laser cutting apertures with trapezoidal walls and also rounding corners will offer better paste release. Customers should contact their board assembly site for stencil design recommendations. Refer to IPC-7525 for other stencil recommendations.
  - Customers should contact their board fabrication site for solder mask tolerances between and around signal pads.

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