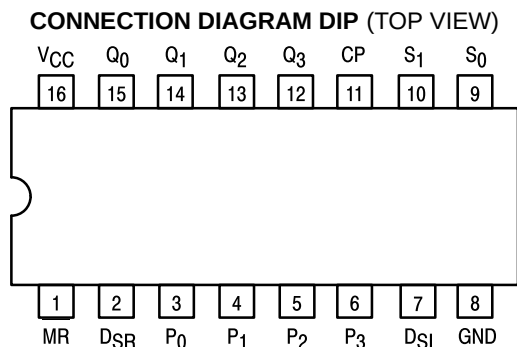




4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTER

The SN54/74LS194A is a High Speed 4-Bit Bidirectional Universal Shift Register. As a high speed multifunctional sequential building block, it is useful in a wide variety of applications. It may be used in serial-serial, shift left, shift right, serial-parallel, parallel-serial, and parallel-parallel data register transfers. The LS194A is similar in operation to the LS195A Universal Shift Register, with added features of shift left without external connections and hold (do nothing) modes of operation. It utilizes the Schottky diode clamped process to achieve high speeds and is fully compatible with all Motorola TTL families.

- Typical Shift Frequency of 36 MHz
- Asynchronous Master Reset
- Hold (Do Nothing) Mode
- Fully Synchronous Serial or Parallel Data Transfers
- Input Clamp Diodes Limit High Speed Termination Effects



PIN NAMES

S ₀ , S ₁	Mode Control Inputs
P ₀ –P ₃	Parallel Data Inputs
DSR	Serial (Shift Right) Data Input
DSL	Serial (Shift Left) Data Input
CP	Clock (Active HIGH Going Edge) Input
MR	Master Reset (Active LOW) Input
Q ₀ –Q ₃	Parallel Outputs (Note b)

LOADING (Note a)

HIGH	LOW
0.5 U.L.	0.25 U.L.
0.5 U.L.	0.25 U.L.
0.5 U.L.	0.25 U.L.
0.5 U.L.	0.25 U.L.
0.5 U.L.	0.25 U.L.
0.5 U.L.	0.25 U.L.
10 U.L.	5 (2.5) U.L.

NOTES:

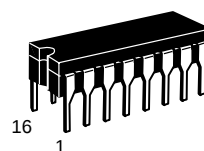
a. 1 TTL Unit Load (U.L.) = 40 μ A HIGH/1.6 mA LOW.

b. The Output LOW drive factor is 2.5 U.L. for Military (54) and 5 U.L. for Commercial (74) Temperature Ranges.

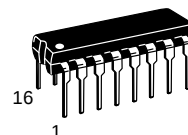
SN54/74LS194A

4-BIT BIDIRECTIONAL UNIVERSAL SHIFT REGISTER

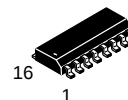
LOW POWER SCHOTTKY



J SUFFIX
CERAMIC
CASE 620-09



N SUFFIX
PLASTIC
CASE 648-08



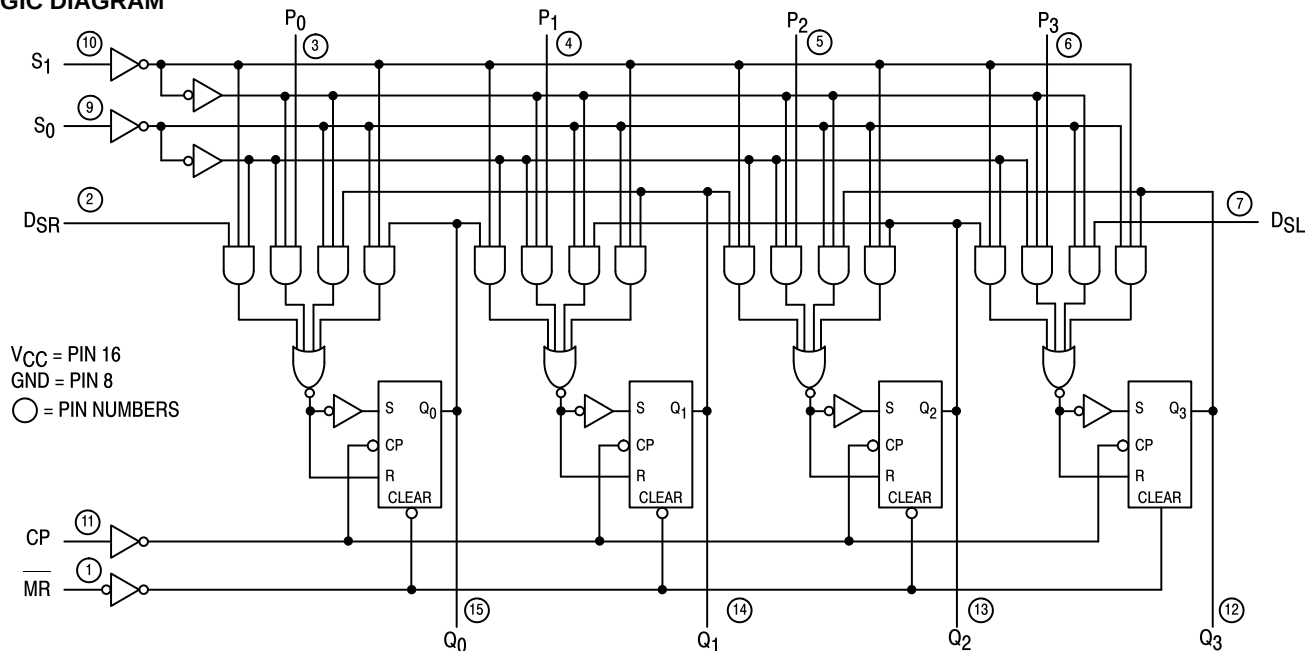
D SUFFIX
SOIC
CASE 751B-03

ORDERING INFORMATION

SN54LSXXXJ	Ceramic
SN74LSXXXN	Plastic
SN74LSXXXD	SOIC

SN54/74LS194A

LOGIC DIAGRAM



FUNCTIONAL DESCRIPTION

The Logic Diagram and Truth Table indicate the functional characteristics of the LS194A 4-Bit Bidirectional Shift Register. The LS194A is similar in operation to the Motorola LS195A Universal Shift Register when used in serial or parallel data register transfers. Some of the common features of the two devices are described below:

All data and mode control inputs are edge-triggered, responding only to the LOW to HIGH transition of the Clock (CP). The only timing restriction, therefore, is that the mode control and selected data inputs must be stable one set-up time prior to the positive transition of the clock pulse.

The register is fully synchronous, with all operations taking place in less than 15 ns (typical) making the device especially useful for implementing very high speed CPUs, or the memory buffer registers.

The four parallel data inputs (P₀, P₁, P₂, P₃) are D-type inputs. When both S₀ and S₁ are HIGH, the data appearing on P₀, P₁, P₂, and P₃ inputs is transferred to the Q₀, Q₁, Q₂, and

Q₃ outputs respectively following the next LOW to HIGH transition of the clock.

The asynchronous Master Reset (MR), when LOW, overrides all other input conditions and forces the Q outputs LOW.

Special logic features of the LS194A design which increase the range of application are described below:

Two mode control inputs (S₀, S₁) determine the synchronous operation of the device. As shown in the Mode Selection Table, data can be entered and shifted from left to right (shift right, Q₀ Q₁, etc.) or right to left (shift left, Q₃ Q₂, etc.), or parallel data can be entered loading all four bits of the register simultaneously. When both S₀ and S₁ are LOW, the existing data is retained in a "do nothing" mode without restricting the HIGH to LOW clock transition.

D-type serial data inputs (DSR, DSL) are provided on both the first and last stages to allow multistage shift right or shift left data transfers without interfering with parallel load operation.

MODE SELECT — TRUTH TABLE

OPERATING MODE	INPUTS						OUTPUTS			
	MR	S ₁	S ₀	DSR	DSL	P _n	Q ₀	Q ₁	Q ₂	Q ₃
Reset	L	X	X	X	X	X	L	L	L	L
Hold	H	I	I	X	X	X	q ₀	q ₁	q ₂	q ₃
Shift Left	H	h	I	X	I	X	q ₁	q ₂	q ₃	L
	H	h	I	X	h	X	q ₁	q ₂	q ₃	H
Shift Right	H	I	h	I	X	X	L	q ₀	q ₁	q ₂
	H	I	h	h	X	X	H	q ₀	q ₁	q ₂
Parallel Load	H	h	h	X	X	P _n	P ₀	P ₁	P ₂	P ₃

L = LOW Voltage Level

H = HIGH Voltage Level

X = Don't Care

I = LOW voltage level one set-up time prior to the LOW to HIGH clock transition

h = HIGH voltage level one set-up time prior to the LOW to HIGH clock transition

P_n (q_n) = Lower case letters indicate the state of the referenced input (or output) one set-up time prior to the LOW to HIGH clock transition.

SN54/74LS194A

GUARANTEED OPERATING RANGES

Symbol	Parameter		Min	Typ	Max	Unit
V _{CC}	Supply Voltage	54 74	4.5 4.75	5.0 5.0	5.5 5.25	V
T _A	Operating Ambient Temperature Range	54 74	−55 0	25 25	125 70	°C
I _{OH}	Output Current — High	54, 74			−0.4	mA
I _{OL}	Output Current — Low	54 74			4.0 8.0	mA

DC CHARACTERISTICS OVER OPERATING TEMPERATURE RANGE (unless otherwise specified)

Symbol	Parameter		Limits			Unit	Test Conditions
			Min	Typ	Max		
V _{IH}	Input HIGH Voltage		2.0			V	Guaranteed Input HIGH Voltage for All Inputs
V _{IL}	Input LOW Voltage	54			0.7	V	Guaranteed Input LOW Voltage for All Inputs
		74			0.8		
V _{IK}	Input Clamp Diode Voltage			−0.65	−1.5	V	V _{CC} = MIN, I _{IN} = −18 mA
V _{OH}	Output HIGH Voltage	54	2.5	3.5		V	V _{CC} = MIN, I _{OH} = MAX, V _{IN} = V _{IH} or V _{IL} per Truth Table
		74	2.7	3.5		V	
V _{OL}	Output LOW Voltage	54, 74		0.25	0.4	V	I _{OL} = 4.0 mA
		74		0.35	0.5	V	I _{OL} = 8.0 mA
I _{IH}	Input HIGH Current				20	μA	V _{CC} = MAX, V _{IN} = 2.7 V
					0.1	mA	V _{CC} = MAX, V _{IN} = 7.0 V
I _{IL}	Input LOW Current				−0.4	mA	V _{CC} = MAX, V _{IN} = 0.4 V
I _{OS}	Short Circuit Current (Note 1)		−20		−100	mA	V _{CC} = MAX
I _{CC}	Power Supply Current				23	mA	V _{CC} = MAX

Note 1: Not more than one output should be shorted at a time, nor for more than 1 second.

AC CHARACTERISTICS (T_A = 25°C)

Symbol	Parameter	Limits			Unit	Test Conditions
		Min	Typ	Max		
f _{MAX}	Maximum Clock Frequency	25	36		MHz	V _{CC} = 5.0 V C _L = 15 pF
t _{PLH} t _{PHL}	Propagation Delay, Clock to Output		14 17	22 26	ns	
t _{PHL}	Propagation Delay, MR to Output		19	30	ns	

SN54/74LS194A

AC SETUP REQUIREMENTS ($T_A = 25^\circ\text{C}$)

Symbol	Parameter	Limits			Unit	Test Conditions
		Min	Typ	Max		
t_W	Clock or MR Pulse Width	20			ns	$V_{CC} = 5.0\text{ V}$
t_S	Mode Control Setup Time	30			ns	
t_S	Data Setup Time	20			ns	
t_h	Hold time, Any Input	0			ns	
t_{rec}	Recovery Time	25			ns	

DEFINITIONS OF TERMS

SETUP TIME (t_S) — is defined as the minimum time required for the correct logic level to be present at the logic input prior to the clock transition from LOW to HIGH in order to be recognized and transferred to the outputs.

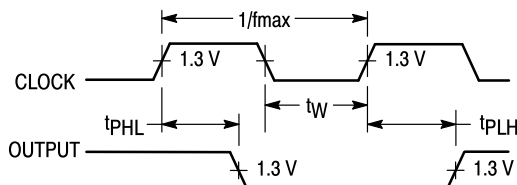
HOLD TIME (t_h) — is defined as the minimum time following the clock transition from LOW to HIGH that the logic level must be maintained at the input in order to ensure continued

recognition. A negative HOLD TIME indicates that the correct logic level may be released prior to the clock transition from LOW to HIGH and still be recognized.

RECOVERY TIME (t_{rec}) — is defined as the minimum time required between the end of the reset pulse and the clock transition from LOW to HIGH in order to recognize and transfer HIGH Data to the Q outputs.

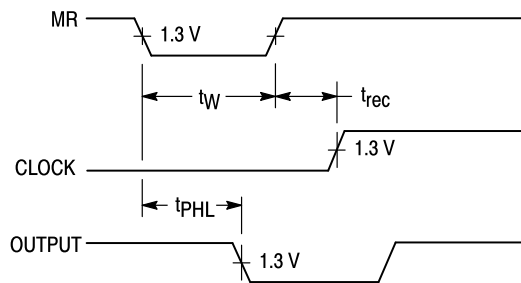
AC WAVEFORMS

The shaded areas indicate when the input is permitted to change for predictable output performance.



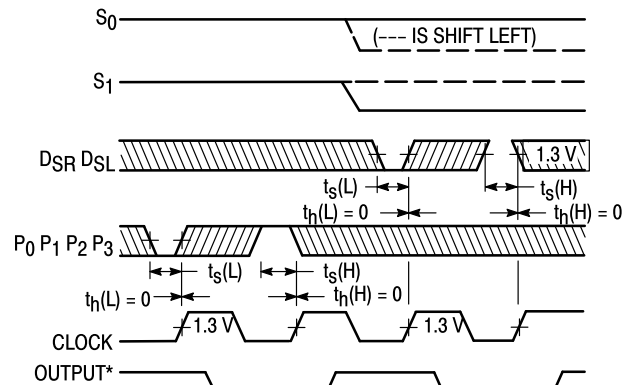
OTHER CONDITIONS: $S_1 = L$, $MR = H$, $S_0 = H$

Figure 1. Clock to Output Delays Clock Pulse Width and f_{max}



OTHER CONDITIONS: $S_0, S_1 = H$
 $P_0 = P_1 = P_2 = P_3 = H$

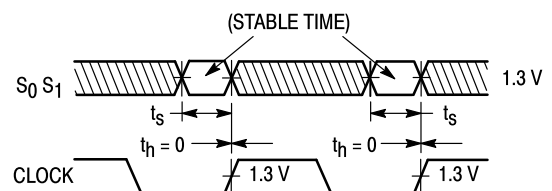
Figure 2. Master Reset Pulse Width, Master Reset to Output Delay and Master Reset to Clock Recovery Time



OTHER CONDITIONS: $MR = H$

* D_{SR} SET-UP TIME AFFECTS Q_0 ONLY
 D_{SL} SET-UP TIME AFFECTS Q_3 ONLY

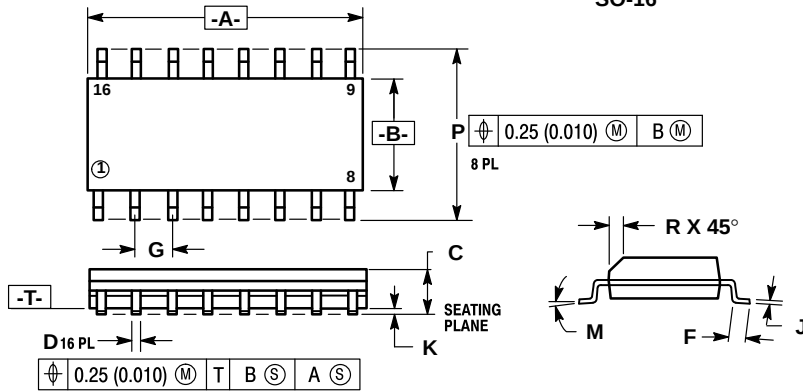
Figure 3. Setup (t_S) and Hold (t_h) Time for Serial Data (D_{SR} , D_{SL}) and Parallel Data (P_0 , P_1 , P_2 , P_3)



OTHER CONDITIONS: $MR = H$

Figure 4. Setup (t_S) and Hold (t_h) Time for S Input

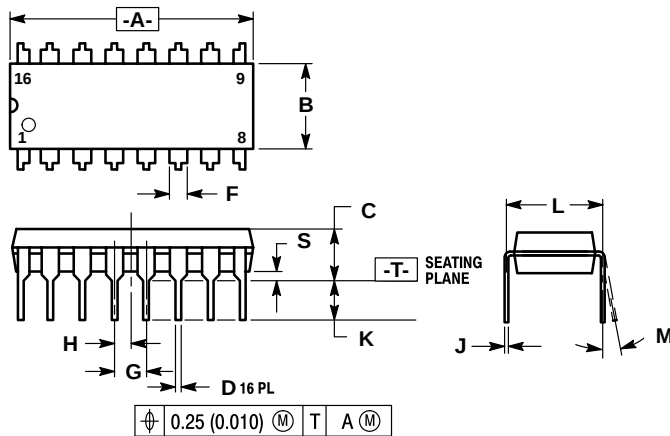
Case 751B-03 D Suffix
16-Pin Plastic
SO-16



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: MILLIMETER.
 3. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 5. 751B-01 IS OBSOLETE, NEW STANDARD 751B-03.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

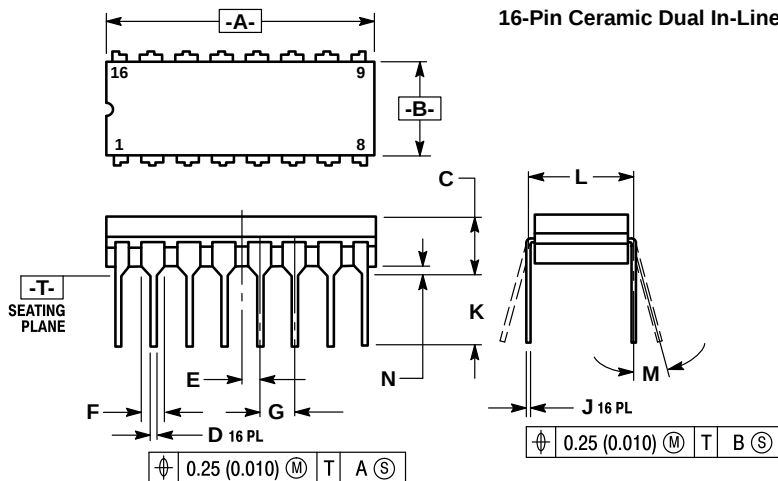
Case 648-08 N Suffix
16-Pin Plastic



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
 4. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
 5. ROUNDED CORNERS OPTIONAL.
 6. 648-01 THRU -07 OBSOLETE, NEW STANDARD 648-08.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	18.80	19.55	0.740	0.770
B	6.35	6.85	0.250	0.270
C	3.69	4.44	0.145	0.175
D	0.39	0.53	0.015	0.021
F	1.02	1.77	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.27 BSC		0.050 BSC	
J	0.21	0.38	0.008	0.015
K	2.80	3.30	0.110	0.130
L	7.50	7.74	0.295	0.305
M	0°	10°	0°	10°
S	0.51	1.01	0.020	0.040

Case 620-09 J Suffix
16-Pin Ceramic Dual In-Line



- NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
 4. DIM F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.
 5. 620-01 THRU -08 OBSOLETE, NEW STANDARD 620-09.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	19.05	19.55	0.750	0.770
B	6.10	7.36	0.240	0.290
C	—	4.19	—	0.165
D	0.39	0.53	0.015	0.021
E	1.27 BSC		0.050 BSC	
F	1.40	1.77	0.055	0.070
G	2.54 BSC		0.100 BSC	
J	0.23	0.27	0.009	0.011
K	—	5.08	—	0.200
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.39	0.88	0.015	0.035

Motorola reserves the right to make changes without further notice to any products herein. Motorola makes no warranty, representation or guarantee regarding the suitability of its products for any particular purpose, nor does Motorola assume any liability arising out of the application or use of any product or circuit, and specifically disclaims any and all liability, including without limitation consequential or incidental damages. "Typical" parameters can and do vary in different applications. All operating parameters, including "Typicals" must be validated for each customer application by customer's technical experts. Motorola does not convey any license under its patent rights nor the rights of others. Motorola products are not designed, intended, or authorized for use as components in systems intended for surgical implant into the body, or other applications intended to support or sustain life, or for any other application in which the failure of the Motorola product could create a situation where personal injury or death may occur. Should Buyer purchase or use Motorola products for any such unintended or unauthorized application, Buyer shall indemnify and hold Motorola and its officers, employees, subsidiaries, affiliates, and distributors harmless against all claims, costs, damages, and expenses, and reasonable attorney fees arising out of, directly or indirectly, any claim of personal injury or death associated with such unintended or unauthorized use, even if such claim alleges that Motorola was negligent regarding the design or manufacture of the part. Motorola and  are registered trademarks of Motorola, Inc. Motorola, Inc. is an Equal Opportunity/Affirmative Action Employer.

Literature Distribution Centers:

USA: Motorola Literature Distribution; P.O. Box 20912; Phoenix, Arizona 85036.

EUROPE: Motorola Ltd.; European Literature Centre; 88 Tanners Drive, Blakelands, Milton Keynes, MK14 5BP, England.

JAPAN: Nippon Motorola Ltd.; 4-32-1, Nishi-Gotanda, Shinagawa-ku, Tokyo 141, Japan.

ASIA PACIFIC: Motorola Semiconductors H.K. Ltd.; Silicon Harbour Center, No. 2 Dai King Street, Tai Po Industrial Estate, Tai Po, N.T., Hong Kong.



MOTOROLA

