

# MC74HC595A

## 8-Bit Serial-Input/Serial or Parallel-Output Shift Register with Latched 3-State Outputs

### High-Performance Silicon-Gate CMOS

The MC74HC595A consists of an 8-bit shift register and an 8-bit D-type latch with three-state parallel outputs. The shift register accepts serial data and provides a serial output. The shift register also provides parallel data to the 8-bit latch. The shift register and latch have independent clock inputs. This device also has an asynchronous reset for the shift register.

The HC595A directly interfaces with the SPI serial data port on CMOS MPUs and MCUs.

#### Features

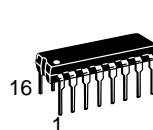
- Output Drive Capability: 15 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2.0 to 6.0 V
- Low Input Current: 1.0  $\mu$ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No. 7A
- Chip Complexity: 328 FETs or 82 Equivalent Gates
- Improvements over HC595
  - Improved Propagation Delays
  - 50% Lower Quiescent Power
  - Improved Input Noise and Latchup Immunity
- Pb-Free Packages are Available\*



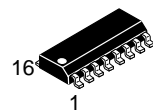
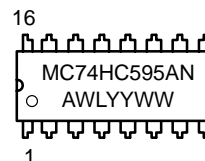
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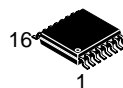
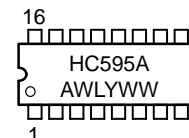
#### MARKING DIAGRAMS



PDIP-16  
N SUFFIX  
CASE 648



SOIC-16  
D SUFFIX  
CASE 751B



TSSOP-16  
DT SUFFIX  
CASE 948F



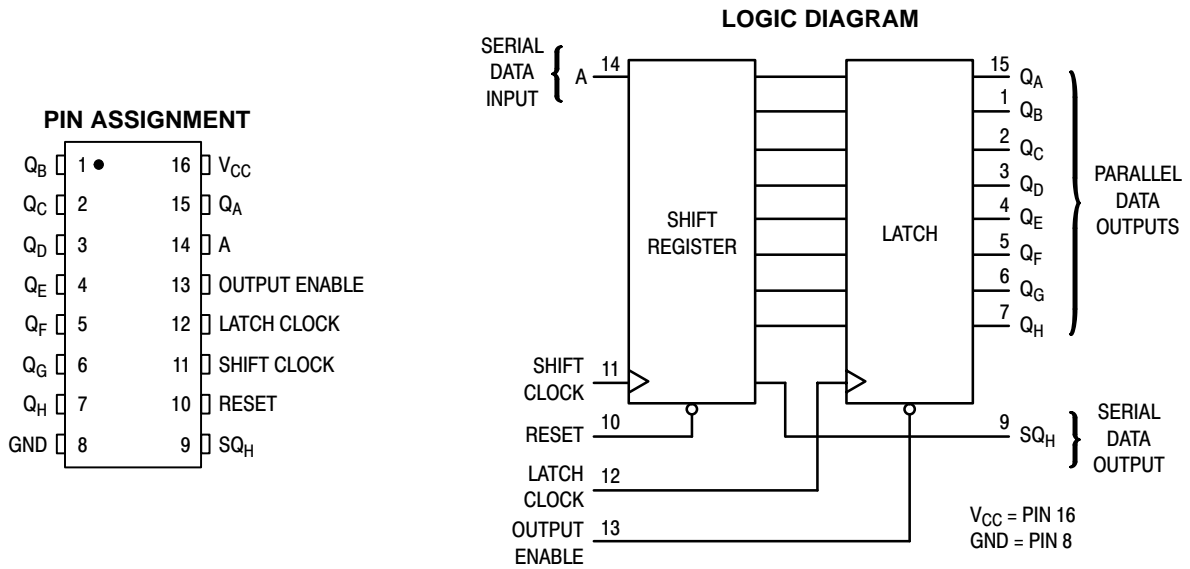
A = Assembly Location  
L, WL = Wafer Lot  
Y, YY = Year  
W, WW = Work Week

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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## ORDERING INFORMATION

Device	Package	Shipping†
MC74HC595AN	PDIP-16	500 Units / Rail
MC74HC595ANG	PDIP-16 (Pb-Free)	500 Units / Rail
MC74HC595AD	SOIC-16	48 Units / Rail
MC74HC595ADG	SOIC-16 (Pb-Free)	48 Units / Rail
MC74HC595ADR2	SOIC-16	2500 Tape & Reel
MC74HC595ADR2G	SOIC-16 (Pb-Free)	2500 Tape & Reel
MC74HC595ADT	TSSOP-16*	96 Units / Rail
MC74HC595ADTR2	TSSOP-16*	2500 Tape & Reel
MC74HC595AFEL	SOEIAJ-16	2000 Tape & Reel
MC74HC595AFELG	SOEIAJ-16 (Pb-Free)	2000 Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

\*This package is inherently Pb-Free.

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## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	DC Supply Voltage (Referenced to GND)	- 0.5 to + 7.0	V
$V_{in}$	DC Input Voltage (Referenced to GND)	- 0.5 to $V_{CC} + 0.5$	V
$V_{out}$	DC Output Voltage (Referenced to GND)	- 0.5 to $V_{CC} + 0.5$	V
$I_{in}$	DC Input Current, per Pin	$\pm 20$	mA
$I_{out}$	DC Output Current, per Pin	$\pm 35$	mA
$I_{CC}$	DC Supply Current, $V_{CC}$ and GND Pins	$\pm 75$	mA
$P_D$	Power Dissipation in Still Air, Plastic DIP† SOIC Package† TSSOP Package†	750 500 450	mW
$T_{stg}$	Storage Temperature	- 65 to + 150	°C
$T_L$	Lead Temperature, 1 mm from Case for 10 Seconds (Plastic DIP, SOIC or TSSOP Package)	260	°C

This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $GND \leq (V_{in} \text{ or } V_{out}) \leq V_{CC}$ . Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or  $V_{CC}$ ). Unused outputs must be left open.

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

†Derating — Plastic DIP: - 10 mW/°C from 65° to 125°C  
SOIC Package: - 7 mW/°C from 65° to 125°C  
TSSOP Package: - 6.1 mW/°C from 65° to 125°C

For high frequency or heavy load considerations, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	DC Supply Voltage (Referenced to GND)	2.0	6.0	V
$V_{in}, V_{out}$	DC Input Voltage, Output Voltage (Referenced to GND)	0	$V_{CC}$	V
$T_A$	Operating Temperature, All Package Types	- 55	+ 125	°C
$t_r, t_f$	Input Rise and Fall Time (Figure 1)			ns
	$V_{CC} = 2.0 \text{ V}$	0	1000	
	$V_{CC} = 4.5 \text{ V}$	0	500	
	$V_{CC} = 6.0 \text{ V}$	0	400	

## DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	$V_{CC}$ V	Guaranteed Limit			Unit	
				- 55 to 25°C	$\leq 85^\circ\text{C}$	$\leq 125^\circ\text{C}$		
$V_{IH}$	Minimum High-Level Input Voltage	$V_{out} = 0.1 \text{ V or } V_{CC} - 0.1 \text{ V}$ $ I_{out}  \leq 20 \mu\text{A}$	2.0	1.5	1.5	1.5	V	
			3.0	2.1	2.1	2.1		
			4.5	3.15	3.15	3.15		
			6.0	4.2	4.2	4.2		
$V_{IL}$	Maximum Low-Level Input Voltage	$V_{out} = 0.1 \text{ V or } V_{CC} - 0.1 \text{ V}$ $ I_{out}  \leq 20 \mu\text{A}$	2.0	0.5	0.5	0.5	V	
			3.0	0.9	0.9	0.9		
			4.5	1.35	1.35	1.35		
			6.0	1.8	1.8	1.8		
$V_{OH}$	Minimum High-Level Output Voltage, $Q_A - Q_H$	$V_{in} = V_{IH} \text{ or } V_{IL}$ $ I_{out}  \leq 20 \mu\text{A}$	2.0	1.9	1.9	1.9	V	
			4.5	4.4	4.4	4.4		
			6.0	5.9	5.9	5.9		
		$V_{in} = V_{IH} \text{ or } V_{IL}$	$ I_{out}  \leq 2.4 \text{ mA}$	3.0	2.48	2.34		2.2
			$ I_{out}  \leq 6.0 \text{ mA}$	4.5	3.98	3.84		3.7
			$ I_{out}  \leq 7.8 \text{ mA}$	6.0	5.48	5.34		5.2

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## DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				- 55 to 25°C	≤ 85°C	≤ 125°C	
V <sub>OL</sub>	Maximum Low-Level Output Voltage, Q <sub>A</sub> – Q <sub>H</sub>	V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 20 μA	2.0	0.1	0.1	0.1	V
			4.5	0.1	0.1	0.1	
			6.0	0.1	0.1	0.1	
		V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 2.4 mA  I <sub>out</sub>   ≤ 6.0 mA  I <sub>out</sub>   ≤ 7.8 mA	3.0	0.26	0.33	0.4	
			4.5	0.26	0.33	0.4	
			6.0	0.26	0.33	0.4	
V <sub>OH</sub>	Minimum High-Level Output Voltage, SQ <sub>H</sub>	V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 20 μA	2.0	1.9	1.9	1.9	V
			4.5	4.4	4.4	4.4	
			6.0	5.9	5.9	5.9	
		V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 2.4 mA  I <sub>out</sub>   ≤ 4.0 mA  I <sub>out</sub>   ≤ 5.2 mA	3.0	2.98	2.34	2.2	
			4.5	3.98	3.84	3.7	
			6.0	5.48	5.34	5.2	
V <sub>OL</sub>	Maximum Low-Level Output Voltage, SQ <sub>H</sub>	V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 20 μA	2.0	0.1	0.1	0.1	V
			4.5	0.1	0.1	0.1	
			6.0	0.1	0.1	0.1	
		V <sub>in</sub> = V <sub>IH</sub> or V <sub>IL</sub>  I <sub>out</sub>   ≤ 2.4 mA  I <sub>out</sub>   ≤ 4.0 mA  I <sub>out</sub>   ≤ 5.2 mA	3.0	0.26	0.33	0.4	
			4.5	0.26	0.33	0.4	
			6.0	0.26	0.33	0.4	
I <sub>in</sub>	Maximum Input Leakage Current	V <sub>in</sub> = V <sub>CC</sub> or GND	6.0	± 0.1	± 1.0	± 1.0	μA
I <sub>OZ</sub>	Maximum Three-State Leakage Current, Q <sub>A</sub> – Q <sub>H</sub>	Output in High-Impedance State V <sub>in</sub> = V <sub>IL</sub> or V <sub>IH</sub> V <sub>out</sub> = V <sub>CC</sub> or GND	6.0	± 0.5	± 5.0	± 10	μA
I <sub>CC</sub>	Maximum Quiescent Supply Current (per Package)	V <sub>in</sub> = V <sub>CC</sub> or GND I <sub>out</sub> = 0 μA	6.0	4.0	40	160	μA

NOTE: Information on typical parametric values can be found in Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

## AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6.0 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			- 55 to 25°C	≤ 85°C	≤ 125°C	
f <sub>max</sub>	Maximum Clock Frequency (50% Duty Cycle) (Figures 1 and 7)	2.0	6.0	4.8	4.0	MHz
		3.0	15	10	8.0	
		4.5	30	24	20	
		6.0	35	28	24	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Shift Clock to SQ <sub>H</sub> (Figures 1 and 7)	2.0	140	175	210	ns
		3.0	100	125	150	
		4.5	28	35	42	
		6.0	24	30	36	
t <sub>PHL</sub>	Maximum Propagation Delay, Reset to SQ <sub>H</sub> (Figures 2 and 7)	2.0	145	180	220	ns
		3.0	100	125	150	
		4.5	29	36	44	
		6.0	25	31	38	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Latch Clock to Q <sub>A</sub> – Q <sub>H</sub> (Figures 3 and 7)	2.0	140	175	210	ns
		3.0	100	125	150	
		4.5	28	35	42	
		6.0	24	30	36	
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Maximum Propagation Delay, Output Enable to Q <sub>A</sub> – Q <sub>H</sub> (Figures 4 and 8)	2.0	150	190	225	ns
		3.0	100	125	150	
		4.5	30	38	45	
		6.0	26	33	38	
t <sub>PZL</sub> , t <sub>PZH</sub>	Maximum Propagation Delay, Output Enable to Q <sub>A</sub> – Q <sub>H</sub> (Figures 4 and 8)	2.0	135	170	205	ns
		3.0	90	110	130	
		4.5	27	34	41	
		6.0	23	29	35	

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## AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input t<sub>r</sub> = t<sub>f</sub> = 6.0 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			- 55 to 25°C	≤ 85°C	≤ 125°C	
t <sub>TLH</sub> , t <sub>THL</sub>	Maximum Output Transition Time, Q <sub>A</sub> – Q <sub>H</sub> (Figures 3 and 7)	2.0	60	75	90	ns
		3.0	23	27	31	
		4.5	12	15	18	
		6.0	10	13	15	
t <sub>TLH</sub> , t <sub>THL</sub>	Maximum Output Transition Time, SQ <sub>H</sub> (Figures 1 and 7)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	16	19	
C <sub>in</sub>	Maximum Input Capacitance	—	10	10	10	pF
C <sub>out</sub>	Maximum Three-State Output Capacitance (Output in High-Impedance State), Q <sub>A</sub> – Q <sub>H</sub>	—	15	15	15	pF

NOTE: For propagation delays with loads other than 50 pF, and information on typical parametric values, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

C <sub>PD</sub>	Power Dissipation Capacitance (Per Package)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V		pF
		300		

\* Used to determine the no-load dynamic power consumption: P<sub>D</sub> = C<sub>PD</sub> V<sub>CC</sub><sup>2</sup>f + I<sub>CC</sub> V<sub>CC</sub>. For load considerations, see Chapter 2 of the ON Semiconductor High-Speed CMOS Data Book (DL129/D).

## TIMING REQUIREMENTS (Input t<sub>r</sub> = t<sub>f</sub> = 6.0 ns)

Symbol	Parameter	V <sub>CC</sub> V	Guaranteed Limit			Unit
			25°C to -55°C	≤ 85°C	≤ 125°C	
t <sub>su</sub>	Minimum Setup Time, Serial Data Input A to Shift Clock (Figure 5)	2.0	50	65	75	ns
		3.0	40	50	60	
		4.5	10	13	15	
		6.0	9.0	11	13	
t <sub>su</sub>	Minimum Setup Time, Shift Clock to Latch Clock (Figure 6)	2.0	75	95	110	ns
		3.0	60	70	80	
		4.5	15	19	22	
		6.0	13	16	19	
t <sub>h</sub>	Minimum Hold Time, Shift Clock to Serial Data Input A (Figure 5)	2.0	5.0	5.0	5.0	ns
		3.0	5.0	5.0	5.0	
		4.5	5.0	5.0	5.0	
		6.0	5.0	5.0	5.0	
t <sub>rec</sub>	Minimum Recovery Time, Reset Inactive to Shift Clock (Figure 2)	2.0	50	65	75	ns
		3.0	40	50	60	
		4.5	10	13	15	
		6.0	9.0	11	13	
t <sub>w</sub>	Minimum Pulse Width, Reset (Figure 2)	2.0	60	75	90	ns
		3.0	45	60	70	
		4.5	12	15	18	
		6.0	10	13	15	
t <sub>w</sub>	Minimum Pulse Width, Shift Clock (Figure 1)	2.0	50	65	75	ns
		3.0	40	50	60	
		4.5	10	13	15	
		6.0	9.0	11	13	
t <sub>w</sub>	Minimum Pulse Width, Latch Clock (Figure 6)	2.0	50	65	75	ns
		3.0	40	50	60	
		4.5	10	13	15	
		6.0	9.0	11	13	
t <sub>r</sub> , t <sub>f</sub>	Maximum Input Rise and Fall Times (Figure 1)	2.0	1000	1000	1000	ns
		3.0	800	800	800	
		4.5	500	500	500	
		6.0	400	400	400	

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## FUNCTION TABLE

Operation	Inputs					Resulting Function			
	Reset	Serial Input A	Shift Clock	Latch Clock	Output Enable	Shift Register Contents	Latch Register Contents	Serial Output SQ <sub>H</sub>	Parallel Outputs Q <sub>A</sub> - Q <sub>H</sub>
Reset shift register	L	X	X	L, H, ↓	L	L	U	L	U
Shift data into shift register	H	D	↑	L, H, ↓	L	D → SR <sub>A</sub> ; SR <sub>N</sub> → SR <sub>N+1</sub>	U	SR <sub>G</sub> → SR <sub>H</sub>	U
Shift register remains unchanged	H	X	L, H, ↓	L, H, ↓	L	U	U	U	U
Transfer shift register contents to latch register	H	X	L, H, ↓	↑	L	U	SR <sub>N</sub> → LR <sub>N</sub>	U	SR <sub>N</sub>
Latch register remains unchanged	X	X	X	L, H, ↓	L	*	U	*	U
Enable parallel outputs	X	X	X	X	L	*	**	*	Enabled
Force outputs into high impedance state	X	X	X	X	H	*	**	*	Z

SR = shift register contents  
LR = latch register contents

D = data (L, H) logic level  
U = remains unchanged

↑ = Low-to-High  
↓ = High-to-Low

\* = depends on Reset and Shift Clock inputs  
\*\* = depends on Latch Clock input

## PIN DESCRIPTIONS

### INPUTS A (Pin 14)

Serial Data Input. The data on this pin is shifted into the 8-bit serial shift register.

### CONTROL INPUTS Shift Clock (Pin 11)

Shift Register Clock Input. A low-to-high transition on this input causes the data at the Serial Input pin to be shifted into the 8-bit shift register.

### Reset (Pin 10)

Active-low, Asynchronous, Shift Register Reset Input. A low on this pin resets the shift register portion of this device only. The 8-bit latch is not affected.

### Latch Clock (Pin 12)

Storage Latch Clock Input. A low-to-high transition on this input latches the shift register data.

### Output Enable (Pin 13)

Active-low Output Enable. A low on this input allows the data from the latches to be presented at the outputs. A high on this input forces the outputs (Q<sub>A</sub>-Q<sub>H</sub>) into the high-impedance state. The serial output is not affected by this control unit.

### OUTPUTS Q<sub>A</sub> - Q<sub>H</sub> (Pins 15, 1, 2, 3, 4, 5, 6, 7)

Noninverted, 3-state, latch outputs.

### SQ<sub>H</sub> (Pin 9)

Noninverted, Serial Data Output. This is the output of the eighth stage of the 8-bit shift register. This output does not have three-state capability.

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## SWITCHING WAVEFORMS

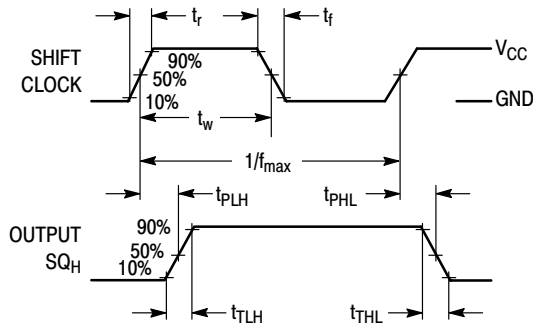


Figure 1.

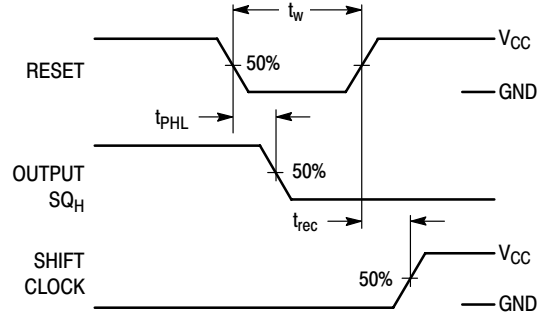


Figure 2.

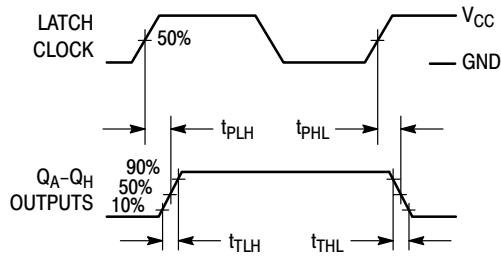


Figure 3.

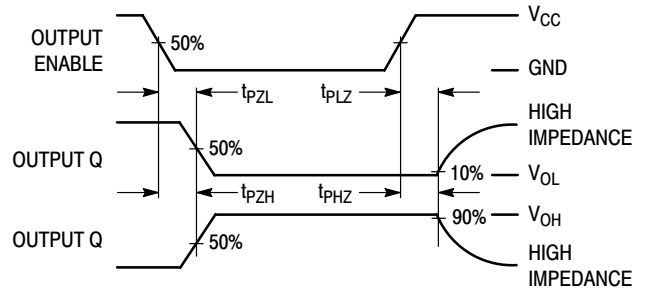


Figure 4.

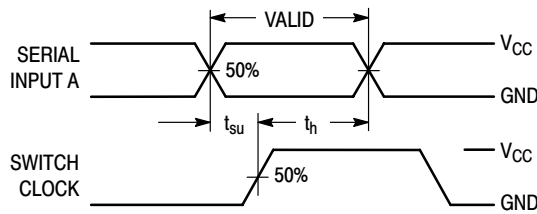


Figure 5.

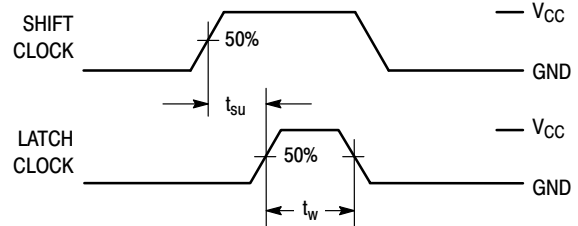
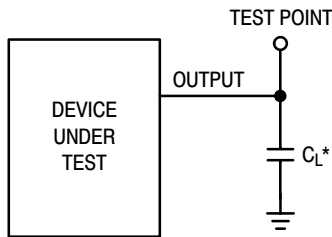


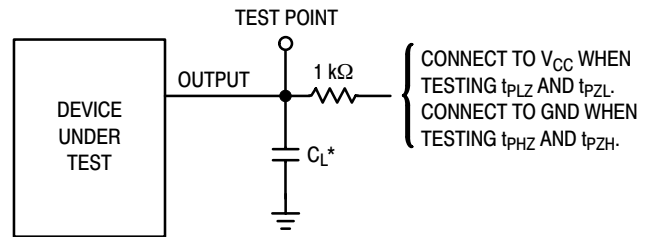
Figure 6.

## TEST CIRCUITS



\*Includes all probe and jig capacitance

Figure 7.

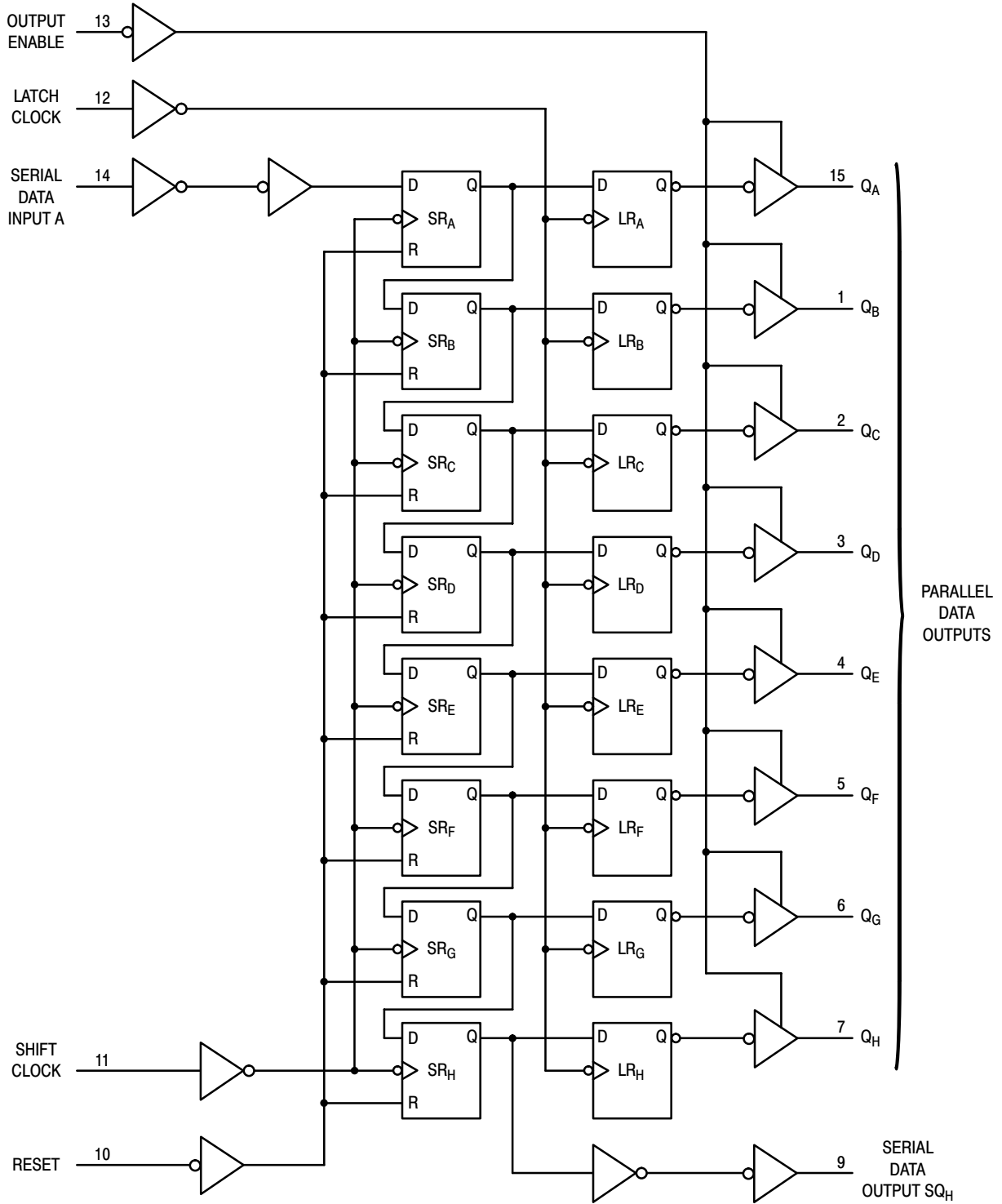


\*Includes all probe and jig capacitance

Figure 8.

# MC74HC595A

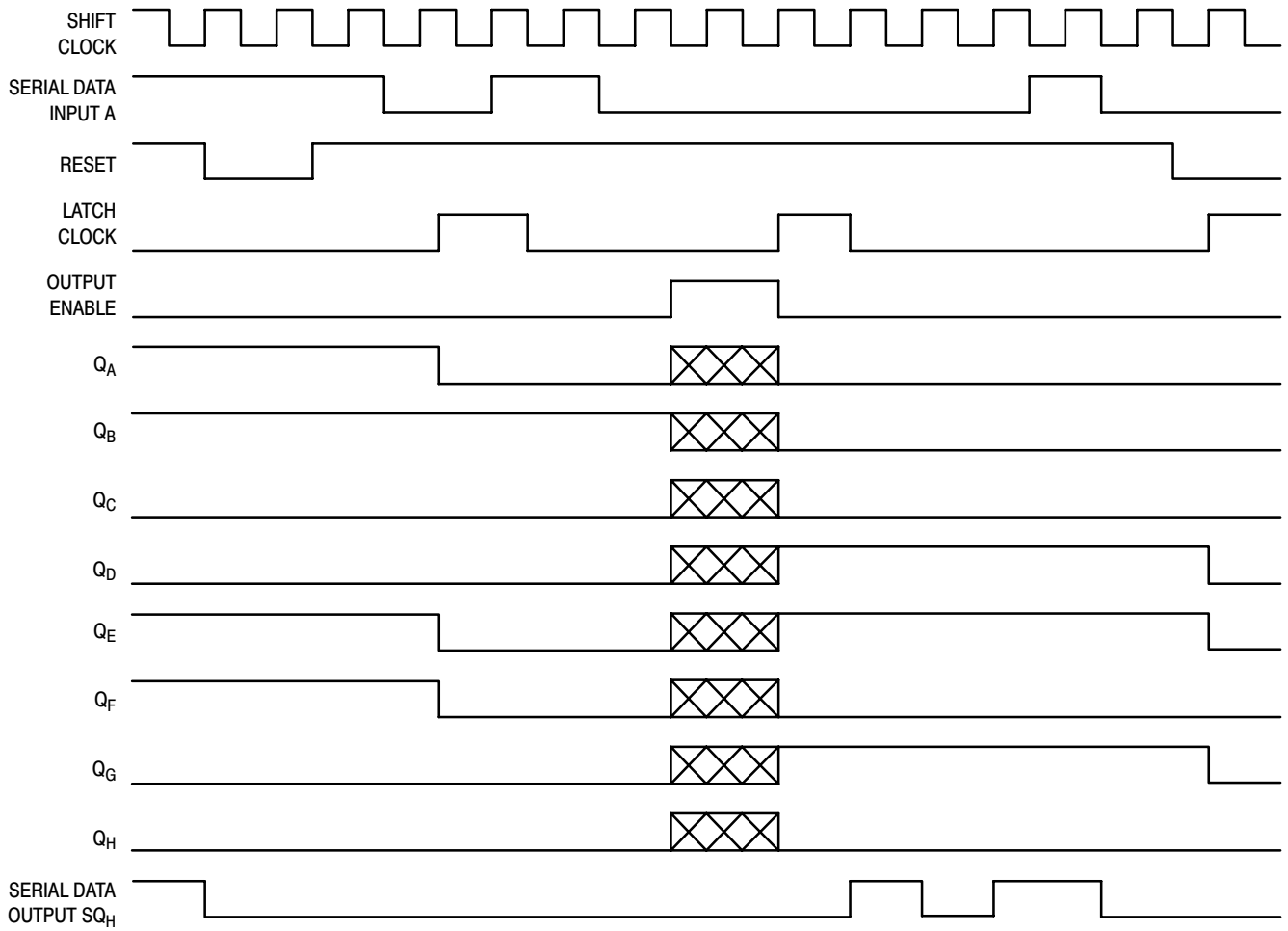
## EXPANDED LOGIC DIAGRAM






# MC74HC595A

## TIMING DIAGRAM

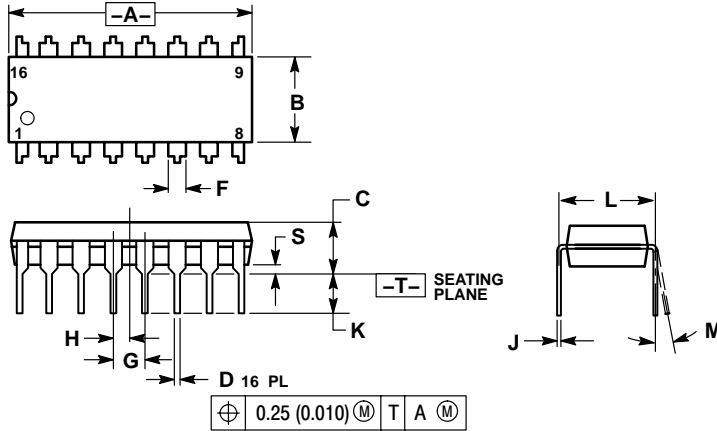


NOTE:  implies that the output is in a high-impedance state.

# MC74HC595A

## PACKAGE DIMENSIONS

PDIP-16  
N SUFFIX  
CASE 648-08  
ISSUE T

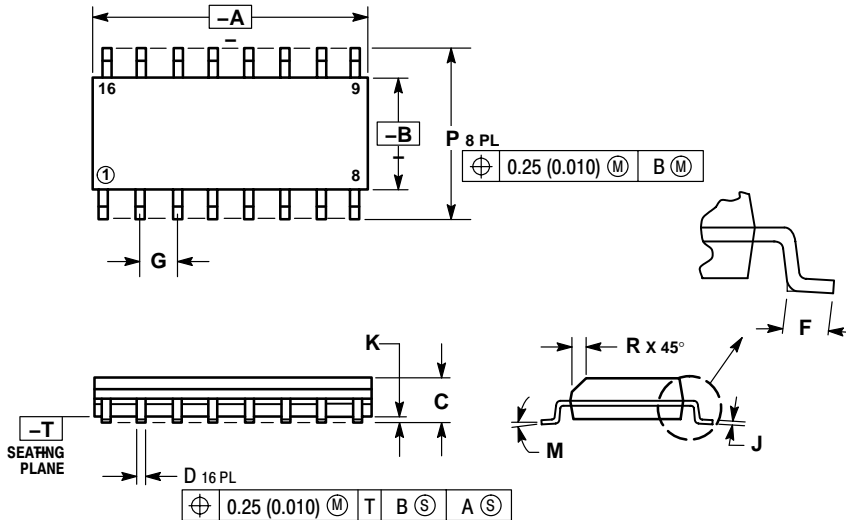


NOTES:

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.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.740	0.770	18.80	19.55
B	0.250	0.270	6.35	6.85
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.040	0.70	1.02	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.130	2.80	3.30
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
S	0.020	0.040	0.51	1.01

SOIC-16  
D SUFFIX  
CASE 751B-05  
ISSUE J



NOTES:

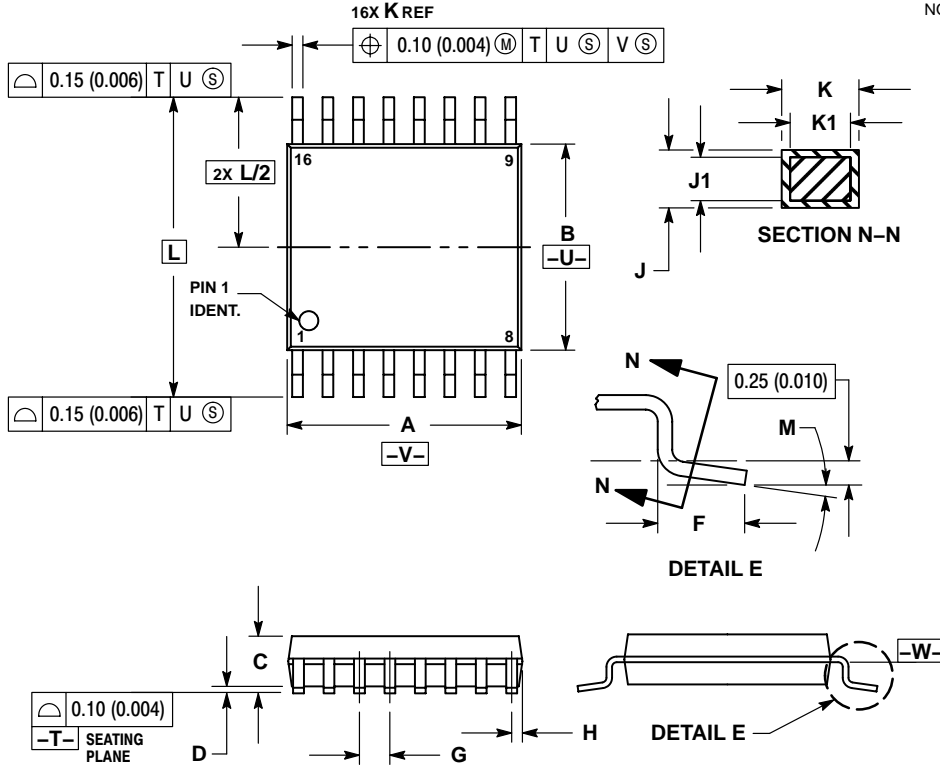
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

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

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## PACKAGE DIMENSIONS

TSSOP-16  
DT SUFFIX  
CASE 948F-01  
ISSUE A



### NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSION A DOES NOT INCLUDE MOLD FLASH. PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
5. DIMENSION K DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE K DIMENSION AT MAXIMUM MATERIAL CONDITION.
6. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
7. DIMENSION A AND B ARE TO BE DETERMINED AT DATUM PLANE -W-.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.90	5.10	0.193	0.200
B	4.30	4.50	0.169	0.177
C	---	1.20	---	0.047
D	0.05	0.15	0.002	0.006
F	0.50	0.75	0.020	0.030
G	0.65 BSC		0.026 BSC	
H	0.18	0.28	0.007	0.011
J	0.09	0.20	0.004	0.008
J1	0.09	0.16	0.004	0.006
K	0.19	0.30	0.007	0.012
K1	0.19	0.25	0.007	0.010
L	6.40 BSC		0.252 BSC	
M	0°	8°	0°	8°

# MC74HC595A

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