

# 8-Bit Shift Register with Output Latches

## 74VHC595

### General Description

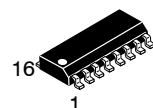
The VHC595 is an advanced high-speed CMOS Shift Register fabricated with silicon gate CMOS technology. It achieves the high-speed operation similar to equivalent Bipolar Schottky TTL while maintaining the CMOS low power dissipation.

This device contains an 8-bit serial-in, parallel-out shift register that feeds an 8-bit D-type storage register. The storage register has eight 3-STATE outputs. Separate clocks are provided for both the shift register and the storage register. The shift register has a direct-overriding clear, serial input, and serial output (standard) pins for cascading. Both the shift register and storage register use positive-edge triggered clocks. If both clocks are connected together, the shift register state will always be one clock pulse ahead of the storage register.

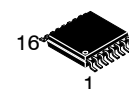
An input protection circuit insures that 0 V to 5.5 V can be applied to the input pins without regard to the supply voltage. This device can be used to interface 5 V to 3 V systems and two supply systems such as battery backup. This circuit prevents device destruction due to mismatched supply and input voltages.

### Features

- High Speed:  $t_{PD} = 5.4 \text{ ns}$  (Typ.) at  $V_{CC} = 5 \text{ V}$
- Low Power Dissipation:  $I_{CC} = 4 \mu\text{A}$  (Max.) at  $T_A = 25^\circ\text{C}$
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Power Down Protection is Provided on All Inputs
- Low Noise:  $V_{OLP} = 0.9 \text{ V}$  (Typ.)
- Pin and function compatible with 74HC595
- This is a Pb-Free Device

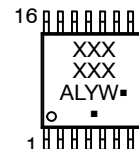
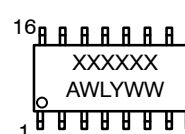


SOIC-16  
D SUFFIX  
CASE 751BG



TSSOP-16  
DT SUFFIX  
CASE 948AH

### MARKING DIAGRAMS



XXX = Specific Device Code  
A = Assembly Location  
WL, L = Wafer Lot  
Y = Year  
WW, W = Work Week  
G, ■ = Pb-Free Package

(Note: Microdot may be in either location)

### ORDERING INFORMATION

See detailed ordering and shipping information on page 9 of this data sheet.

# 74VHC595

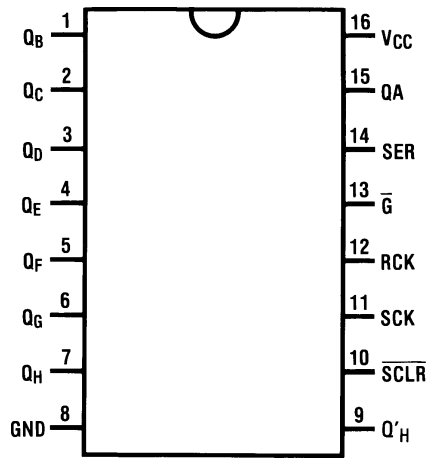


Figure 1. Connection Diagram

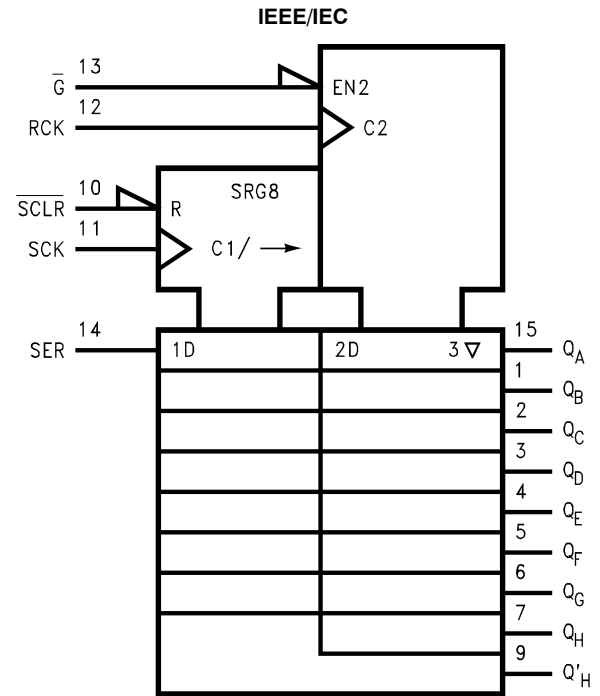


Figure 2. Logic Symbol

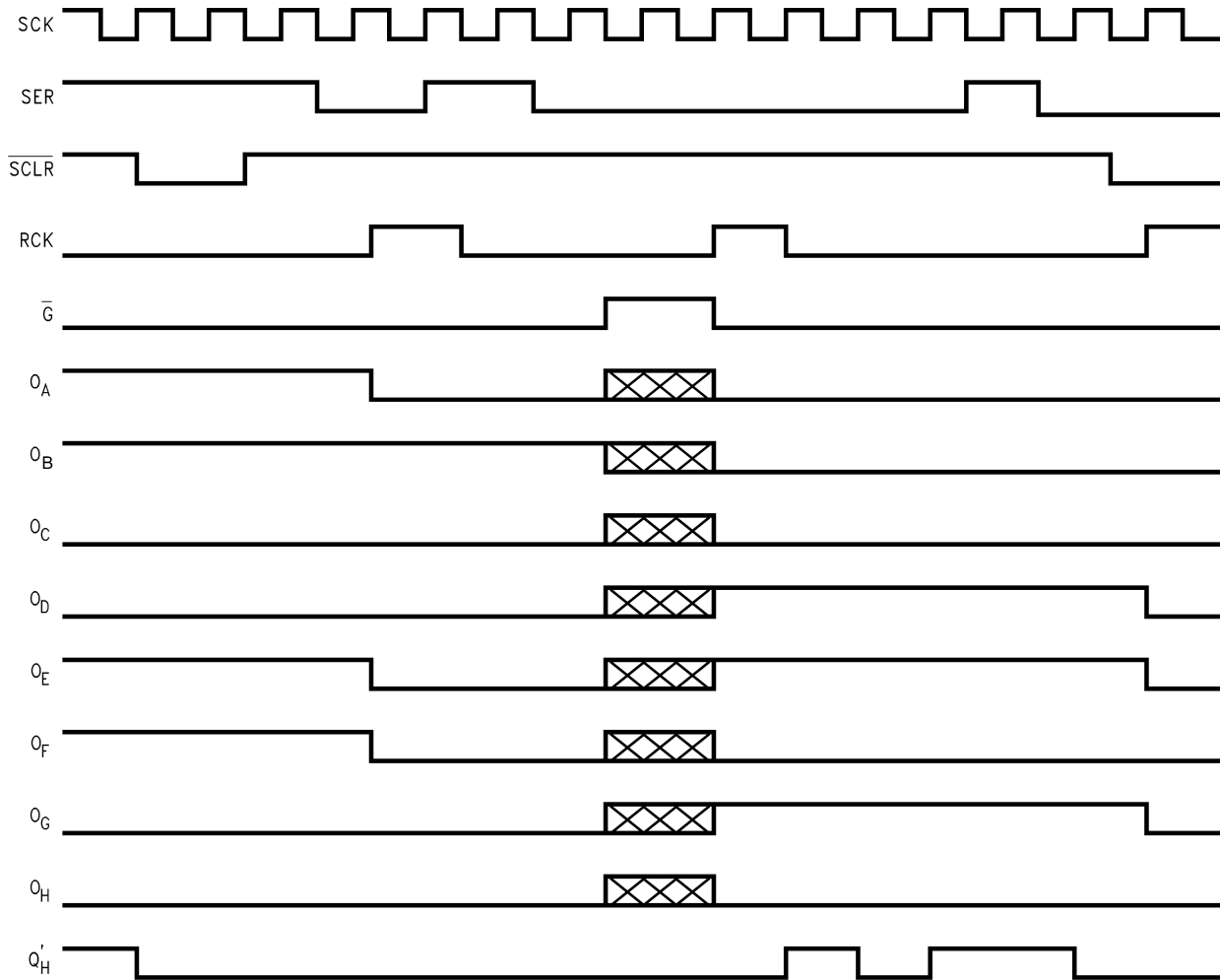
## PIN DESCRIPTIONS


Pin Names	Description
SER	Serial Data Input
SCK	Shift Register Clock Input (Active rising edge)
RCK	Storage Register Clock Input (Active rising edge)
SCLR	Reset Input
$\bar{G}$	3-STATE Output Enable Input (Active LOW)
$Q_A - Q_H$	Parallel Data Outputs
$Q'_H$	Serial Data Output

## TRUTH TABLE

Inputs					Function
SER	RCK	SCK	SCLR	$\bar{G}$	
X	X	X	X	H	$Q_A$ thru $Q_H$ 3-STATE
X	X	X	X	L	$Q_A$ thru $Q_H$ outputs enabled
X	X	X	L	L	Shift Register cleared: $Q'_H = 0$
L	X	$\uparrow$	H	L	Shift Register clocked: $Q_N = Q_{N-1}$ , $Q_0 = SER = L$
H	X	$\uparrow$	H	L	Shift Register clocked: $Q_N = Q_{N-1}$ , $Q_0 = SER = H$
X	$\uparrow$	X	H	L	Contents of Shift Register transferred to output latches

## Timing Diagram



NOTE:  Implies that the output is in 3-STATE mode.

**Figure 3. Timing Diagram**

# 74VHC595

## Logic Diagram (Positive Logic)

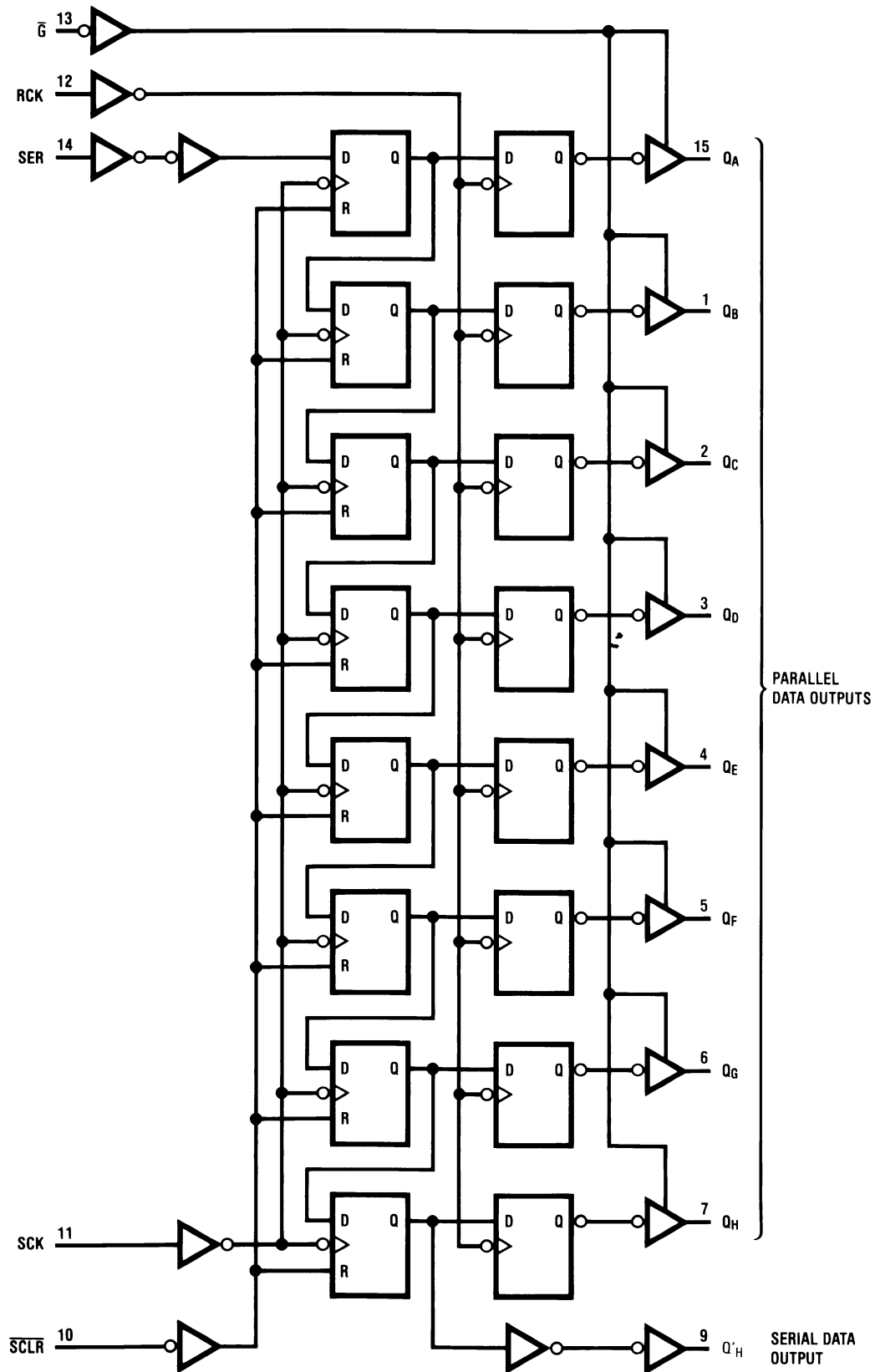


Figure 4. Logic Diagram

## MAXIMUM RATINGS

Symbol	Parameter		Value	Unit
V <sub>CC</sub>	DC Supply Voltage		–0.5 to +6.5	V
V <sub>IN</sub>	DC Input Voltage		–0.5 to +6.5	V
V <sub>OUT</sub>	DC Output Voltage		–0.5 to V <sub>CC</sub> +0.5	V
I <sub>IN</sub>	DC Input Current, per Pin		±20	mA
I <sub>OUT</sub>	DC Output Current, Per Pin		±25	mA
I <sub>CC</sub>	DC Supply Current, V <sub>CC</sub> and GND Pins		±75	mA
I <sub>IK</sub>	Input Clamp Current		–20	mA
I <sub>OK</sub>	Output Clamp Current		±20	mA
T <sub>STG</sub>	Storage Temperature Range		–65 to +150	°C
T <sub>L</sub>	Lead Temperature, 1 mm from Case for 10 secs		260	°C
T <sub>J</sub>	Junction Temperature Under Bias		+150	°C
θ <sub>JA</sub>	Thermal Resistance (Note 2)	SOIC–16	126	°C/W
		TSSOP–16	159	
P <sub>D</sub>	Power Dissipation in Still Air at 25°C	SOIC–16	995	mW
		TSSOP–16	787	
MSL	Moisture Sensitivity		Level 1	–
F <sub>R</sub>	Flammability Rating	Oxygen Index: 28 to 34	UL 94 V–0 @ 0.139 in	–
V <sub>ESD</sub>	ESD Withstand Voltage (Note 3)	Human Body Model	2000	V
		Charged Device Model	N/A	

Stresses exceeding those listed in the Maximum Ratings table may damage the device. If any of these limits are exceeded, device functionality should not be assumed, damage may occur and reliability may be affected.

1. Applicable to devices with outputs that may be tri–stated.
2. Measured with minimum pad spacing on an FR4 board, using 76 mm–by–114 mm, 2–ounce copper trace no air flow per JESD51–7.
3. HBM tested to EIA / JESD22–A114–A. CDM tested to JESD22–C101–A. JEDEC recommends that ESD qualification to EIA/JESD22–A115A (Machine Model) be discontinued.

## RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter		Min	Max	Unit
V <sub>CC</sub>	DC Supply Voltage		2.0	5.5	V
V <sub>IN</sub>	DC Input Voltage (Note 4)		0	5.5	V
V <sub>OUT</sub>	DC Output Voltage (Note 4)		0	V <sub>CC</sub>	V
T <sub>A</sub>	Operating Temperature		–40	+85	°C
t <sub>r</sub> , t <sub>f</sub>	Input Rise or Fall Rate	V <sub>CC</sub> = 3.0 V to 3.6 V	0	100	ns/V
		V <sub>CC</sub> = 4.5 V to 5.5 V	0	20	

Functional operation above the stresses listed in the Recommended Operating Ranges is not implied. Extended exposure to stresses beyond the Recommended Operating Ranges limits may affect device reliability.

4. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either GND or V<sub>CC</sub>). Unused outputs must be left open.

## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions		T <sub>A</sub> = 25°C			T <sub>A</sub> = -40°C to +85°C		Unit
					Min	Typ	Max	Min	Max	
V <sub>IH</sub>	HIGH Level Input Voltage	2.0			1.5			1.5		V
		3.0 – 5.5			0.7 × V <sub>CC</sub>			0.7 × V <sub>CC</sub>		
V <sub>IL</sub>	LOW Level Input Voltage	2.0					0.50		0.50	V
		3.0 – 5.5					0.3 × V <sub>CC</sub>		0.3 × V <sub>CC</sub>	
V <sub>OH</sub>	HIGH Level Output Voltage	2.0	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -50 μA	1.9	2.0		1.9		V
		3.0			2.9	3.0		2.9		
		4.5			4.4	4.5		4.4		
		3.0	I <sub>OH</sub> = -4 mA		2.58			2.48		
		4.5	I <sub>OH</sub> = -8 mA		3.94			3.80		
V <sub>OL</sub>	LOW Level Output Voltage	2.0	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 50 μA		0.0	0.1		0.1	V
		3.0				0.0	0.1		0.1	
		4.5				0.0	0.1		0.1	
		3.0	I <sub>OL</sub> = 4 mA				0.36		0.44	
		4.5	I <sub>OL</sub> = 8 mA				0.36		0.44	
I <sub>OZ</sub>	3-STATE Output Off-State Current	5.5	V <sub>IN</sub> = V <sub>CC</sub> or GND, V <sub>OUT</sub> = V <sub>CC</sub> or GND, V <sub>IN</sub> $\overline{G}$ = V <sub>IH</sub> or V <sub>IL</sub>				±0.25		±2.5	μA
I <sub>IN</sub>	Input Leakage Current	0 – 5.5	V <sub>IN</sub> = 5.5 V or GND				±0.1		±1.0	μA
I <sub>CC</sub>	Quiescent Supply Current	5.5	V <sub>IN</sub> = V <sub>CC</sub> or GND				4.0		40.0	μA

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

## NOISE CHARACTERISTICS

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions	T <sub>A</sub> = 25°C		Unit
				Typ	Limits	
V <sub>OLP</sub> (Note 5)	Quiet Output Maximum Dynamic V <sub>OL</sub>	5.0	C <sub>L</sub> = 50 pF	0.9	1.2	V
V <sub>OLV</sub> (Note 5)	Quiet Output Minimum Dynamic V <sub>OL</sub>	5.0	C <sub>L</sub> = 50 pF	-0.9	-1.2	V
V <sub>IHD</sub> (Note 5)	Minimum HIGH Level Dynamic Input Voltage	5.0	C <sub>L</sub> = 50 pF		3.5	V
V <sub>ILD</sub> (Note 5)	Maximum LOW Level Dynamic Input Voltage	5.0	C <sub>L</sub> = 50 pF		1.5	V

5. Parameter guaranteed by design.

## AC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	V <sub>CC</sub> (V)	Conditions		T <sub>A</sub> = +25°C			T <sub>A</sub> = −40°C to +85°C		Unit
					Min	Typ	Max	Min	Max	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay Time, RCK to Q <sub>A</sub> –Q <sub>H</sub>	3.3 ± 0.3		C <sub>L</sub> = 15 pF		7.7	11.9	1.0	13.5	ns
				C <sub>L</sub> = 50 pF		10.2	15.4	1.0	17.0	
		5.0 ± 0.5		C <sub>L</sub> = 15 pF		5.4	7.4	1.0	8.5	ns
				C <sub>L</sub> = 50 pF		6.9	9.4	1.0	10.5	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay Time, SCK–Q'H	3.3 ± 0.3		C <sub>L</sub> = 15 pF		8.8	13.0	1.0	15.0	ns
				C <sub>L</sub> = 50 pF		11.3	16.5	1.0	18.5	
		5.0 ± 0.5		C <sub>L</sub> = 15 pF		6.2	8.2	1.0	9.4	ns
				C <sub>L</sub> = 50 pF		7.7	10.2	1.0	11.4	
t <sub>PHL</sub>	Propagation Delay Time, SCLR–Q'H	3.3 ± 0.3		C <sub>L</sub> = 15 pF		8.4	12.8	1.0	13.7	ns
				C <sub>L</sub> = 50 pF		10.9	16.3	1.0	17.2	
		5.0 ± 0.5		C <sub>L</sub> = 15 pF		5.9	8.0	1.0	9.1	ns
				C <sub>L</sub> = 50 pF		7.4	10.0	1.0	11.1	
t <sub>PZL</sub> , t <sub>PZH</sub>	Output Enable Time, $\bar{G}$ to Q <sub>A</sub> –Q <sub>H</sub>	3.3 ± 0.3	R <sub>L</sub> = 1 kΩ	C <sub>L</sub> = 15 pF		7.5	11.5	1.0	13.5	ns
				C <sub>L</sub> = 50 pF		9.0	15.0	1.0	17.0	
		5.0 ± 0.5		C <sub>L</sub> = 15 pF		4.8	8.6	1.0	10.0	ns
				C <sub>L</sub> = 50 pF		8.3	10.6	1.0	12.0	
t <sub>PLZ</sub> , t <sub>PHZ</sub>	Output Enable Time, $\bar{G}$ to Q <sub>A</sub> –Q <sub>H</sub>	3.3 ± 0.3	R <sub>L</sub> = 1 kΩ	C <sub>L</sub> = 50 pF		12.1	15.7	1.0	16.2	ns
		5.0 ± 0.5		C <sub>L</sub> = 50 pF		7.6	10.3	1.0	11.0	
f <sub>MAX</sub>	Maximum Clock Frequency	3.3 ± 0.3		C <sub>L</sub> = 15 pF	80	150		70		MHz
				C <sub>L</sub> = 50 pF	55	130		50		
		5.0 ± 0.5		C <sub>L</sub> = 15 pF	135	185		115		MHz
				C <sub>L</sub> = 50 pF	95	155		85		
t <sub>OSLH</sub> , t <sub>OSHL</sub>	Output to Output Skew	3.3 ± 0.3	(Note 6)	C <sub>L</sub> = 50 pF			1.5		1.5	ns
		5.0 ± 0.5		C <sub>L</sub> = 50 pF			1.0		1.0	
C <sub>IN</sub>	Input Capacitance		V <sub>CC</sub> = Open			5.0	10		10	pF
C <sub>OUT</sub>	Output Capacitance		V <sub>CC</sub> = 5.0 V			6.0				pF
C <sub>PD</sub>	Power Dissipation Capacitance		(Note 7)			87				pF

Product parametric performance is indicated in the Electrical Characteristics for the listed test conditions, unless otherwise noted. Product performance may not be indicated by the Electrical Characteristics if operated under different conditions.

6. Parameter guaranteed by design. t<sub>OSLH</sub> = |t<sub>PLH</sub> max - t<sub>PLH</sub> min|; t<sub>OSHL</sub> = |t<sub>PHL</sub> max - t<sub>PHL</sub> min|.

7. C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load. Average operating current can be obtained by the equation:

$$I_{CC}(\text{Opr.}) = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}$$

## AC OPERATING REQUIREMENTS

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C		T <sub>A</sub> = -40°C to +85°C	Unit
			Typ	Guaranteed Minimum		
t <sub>S</sub>	Minimum Setup Time (SER–SCK)	3.3 ± 0.3		3.5	3.5	ns
		5.0 ± 0.5		3.0	3.0	
t <sub>S</sub>	Minimum Setup Time (SCK–RCK)	3.3 ± 0.3		8.0	8.5	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>S</sub>	Minimum Setup Time (SCLR–RCK)	3.3 ± 0.3		8.0	9.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>H</sub>	Minimum Hold Time (SER–SCK)	3.3 ± 0.3		1.5	1.5	ns
		5.0 ± 0.5		2.0	2.0	
t <sub>H</sub>	Minimum Hold Time (SCK–RCK)	3.3 ± 0.3		0.0	0.0	ns
		5.0 ± 0.5		0.0	0.0	
t <sub>H</sub>	Minimum Hold Time (SCLR–RCK)	3.3 ± 0.3		0.0	0.0	ns
		5.0 ± 0.5		0.0	0.0	
t <sub>W(L)</sub>	Minimum Pulse Width (SCLR)	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>W(L)</sub> , t <sub>W(H)</sub>	Minimum Pulse Width (SCK)	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>W(L)</sub> , t <sub>W(H)</sub>	Minimum Pulse Width (RCK)	3.3 ± 0.3		5.0	5.0	ns
		5.0 ± 0.5		5.0	5.0	
t <sub>rem</sub>	Minimum Removal Time (SCLR–SCK)	3.3 ± 0.3		3.0	3.0	ns
		5.0 ± 0.5		2.5	2.5	



## 74VHC595

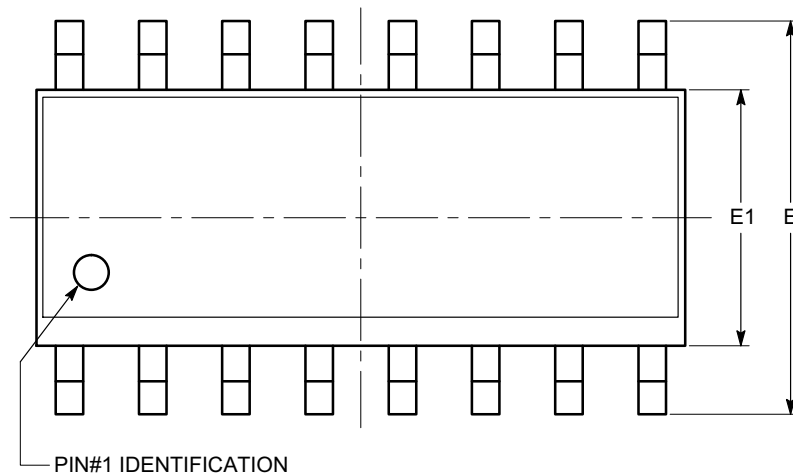
### ORDERING INFORMATION

Device	Marking	Package	Shipping†
74VHC595MX	VHC595G	SOIC-16	2500 Units / Tape & Reel
74VHC595MTCX	VHC 595	TSSOP-16	2500 Units / 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](#).

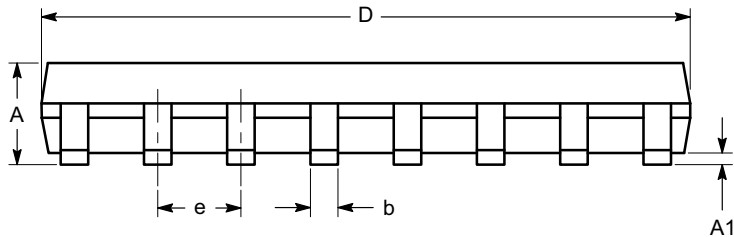
**SOIC-16, 150 mils**  
**CASE 751BG**  
**ISSUE O**

DATE 19 DEC 2008

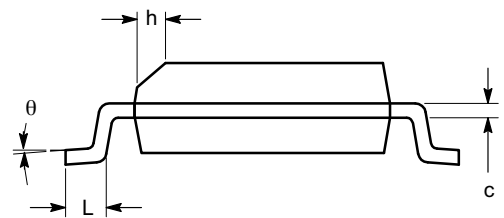


SYMBOL	MIN	NOM	MAX
A	1.35		1.75
A1	0.10		0.25
b	0.33		0.51
c	0.19		0.25
D	9.80	9.90	10.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e	1.27 BSC		
h	0.25		0.50
L	0.40		1.27
$\theta$	0°		8°

**TOP VIEW**



**SIDE VIEW**



**END VIEW**

**Notes:**

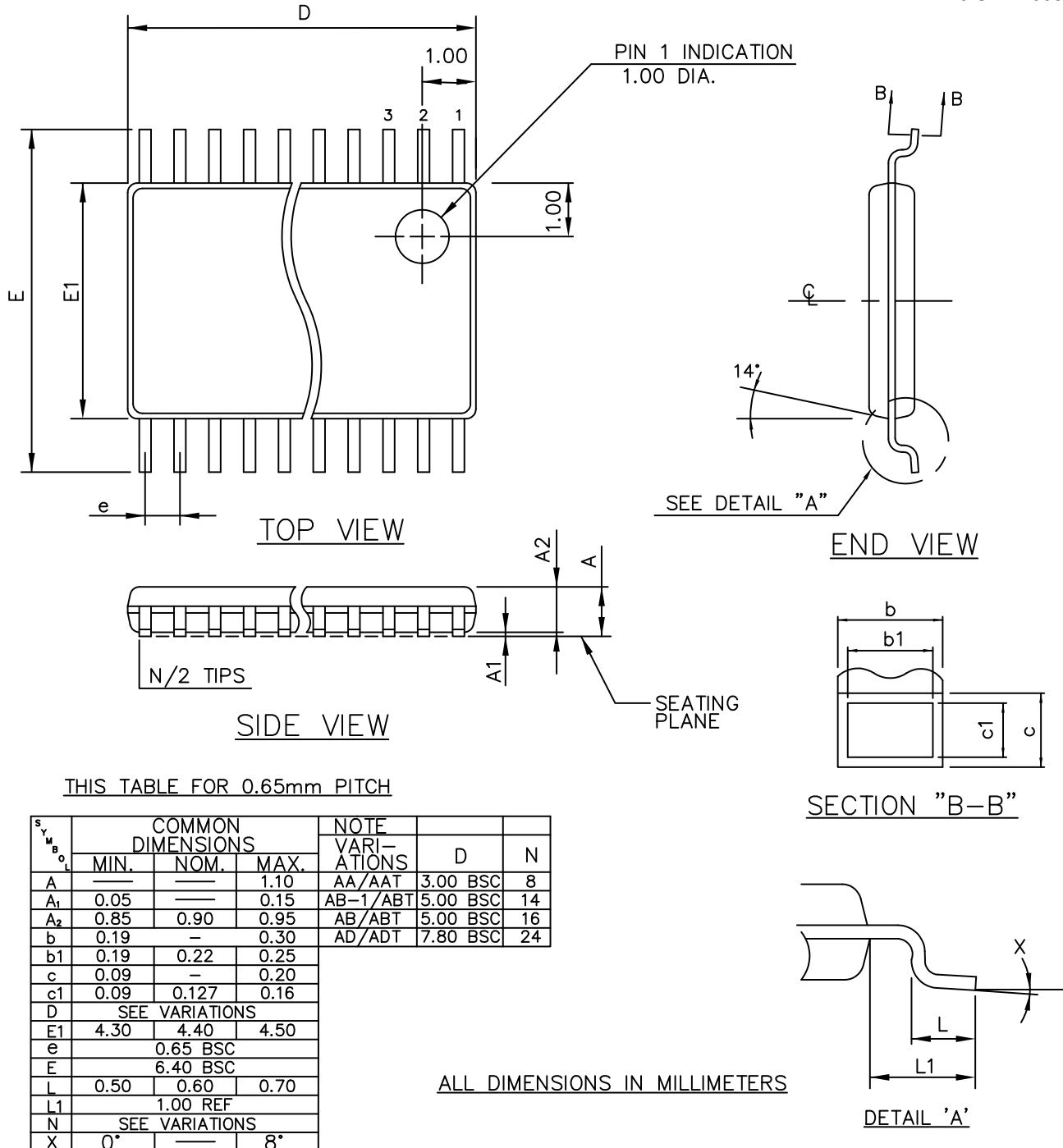
- (1) All dimensions are in millimeters. Angles in degrees.
- (2) Complies with JEDEC MS-012.

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