

# 8-Bit Shift Register with Output Register

## MC74VHC594

The MC74VHC594 is an 8-bit shift register designed for 2.0 V to 5.5 V  $V_{CC}$  operation. The device contains 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 ( $\overline{RCLR}$ ,  $\overline{SRCLR}$ ) inputs are provided on the shift and storage registers. A serial output ( $Q_H'$ ) is provided for cascading purposes.

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.

### Features

- 2.0 V to 5.5 V  $V_{CC}$  Operation
- High Speed:  $f_{max} = 185$  MHz (Typ) at  $V_{CC} = 5$  V
- Low Power Dissipation:  $I_{CC} = 4$   $\mu$ A (Max) at  $T_A = 25^\circ$ C
- High Noise Immunity:  $V_{NIH} = V_{NIL} = 28\%$   $V_{CC}$
- Power Down Protection Provided on Inputs
- Balanced Propagation Delays
- Low Noise:  $V_{OLP} = 1.0$  V (Max)
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- These Devices are Pb-Free, Halogen Free/BFR Free and are RoHS Compliant



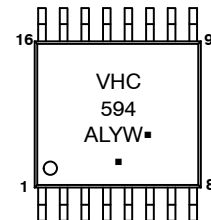
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### MARKING DIAGRAM



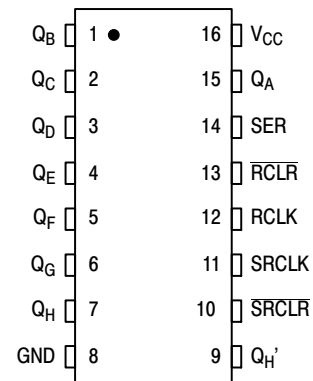
TSSOP-16  
DT SUFFIX  
CASE 948F



A = Assembly Location  
WL = Wafer Lot  
Y = Year  
W, WW = Work Week  
G or ■ = Pb-Free Package

(Note: Microdot may be in either location)

### PIN ASSIGNMENT



### ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
MC74VHC594DTR2G	TSSOP-16 (Pb-Free)	2500 Tape & Reel
NLV74VHC594DTR2G*	TSSOP-16 (Pb-Free)	2500 Tape & Reel

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

\*NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable

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## FUNCTION TABLE

INPUT					FUNCTION
SER	SRCLK	SRCLR	RCLK	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.

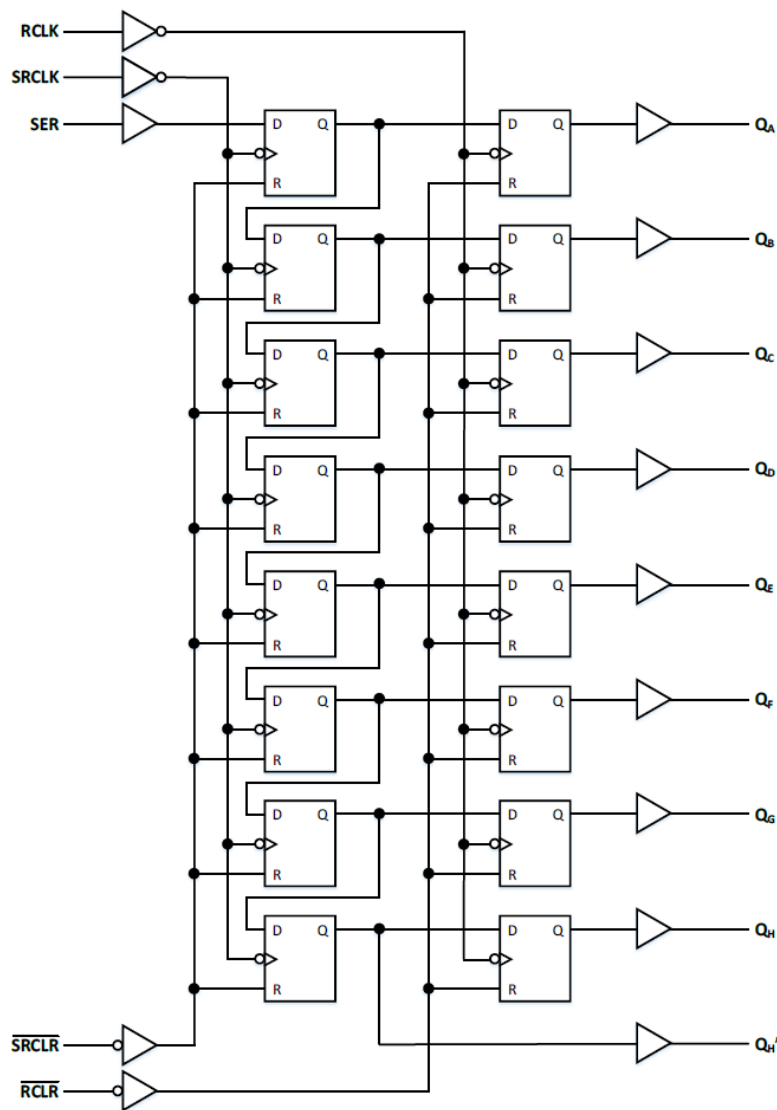


Figure 1. Logic Diagram

# MC74VHC594

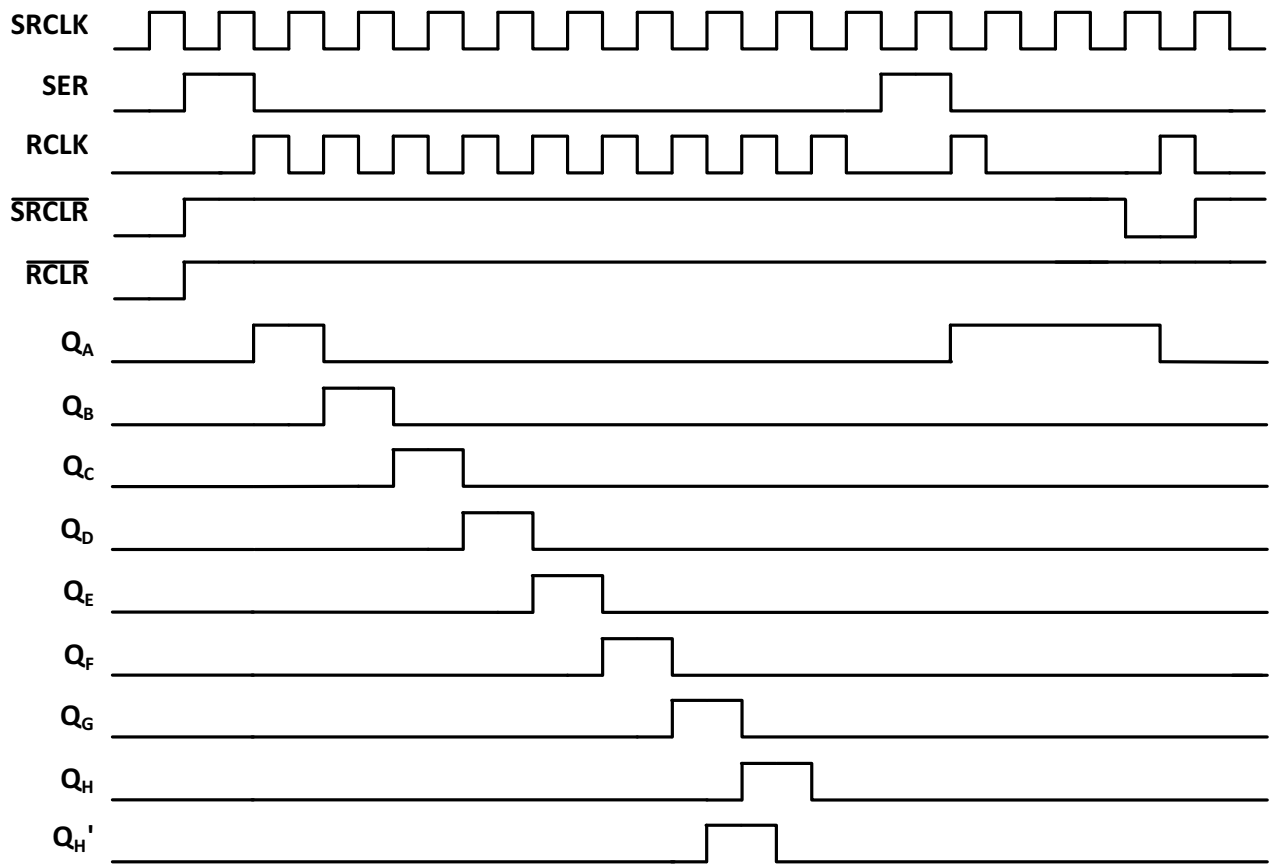


Figure 2. Timing Diagram

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## MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
$V_{CC}$	DC Supply Voltage	-0.5 to +6.5	V
$V_{IN}$	DC Input Voltage	-0.5 to +6.5	V
$V_O$	DC Output Voltage	-0.5 to $V_{CC} + 0.5$	V
$I_{IK}$	DC Input Clamp Current	-20	mA
$I_{OK}$	DC Output Clamp Current	$\pm 20$	mA
$I_{IN}$	DC Input Current	$\pm 20$	mA
$I_O$	DC Output Source / Sink Current	$\pm 25$	mA
$I_{CC}$	DC Supply Current per Supply Pin	$\pm 50$	mA
$I_{GND}$	DC Ground Current per Ground Pin	$\pm 50$	mA
$T_{STG}$	Storage Temperature Range	-65 to +150	$^{\circ}C$
$T_L$	Lead temperature, 1 mm from Case for 10 Seconds	260	$^{\circ}C$
$T_J$	Junction temperature under Bias	+150	$^{\circ}C$
$\theta_{JA}$	Thermal Resistance (Note 1)	62.2	$^{\circ}C/W$
$P_D$	Power Dissipation in Still Air	2	W
MSL	Moisture Sensitivity	Level 1	
$F_R$	Flammability Rating	Oxygen Index: 30% – 35% UL-94-V0 (0.125 in)	
$V_{ESD}$	ESD Withstand Voltage (Note 2)	Human Body Model 2000 Charged Device Model 1000	V
$I_{Latchup}$	Latchup Performance	Above $V_{CC}$ and Below GND at 125 $^{\circ}C$ (Note 3)	$\pm 100$ mA

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. Measured with minimum pad spacing on an FR4 board, using 254 mm<sup>2</sup>, 2 ounce copper trace no air flow per JESD51-7.
2. 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.
3. Tested to EIA/JESD78 Class II.

## RECOMMENDED OPERATING CONDITIONS (Note 4)

Symbol	Parameter	Min	Max	Unit
$V_{CC}$	DC Supply Voltage (Referenced to GND)	2.0	5.5	V
$V_{IN}$	DC Input Voltage (Referenced to GND)	0	5.5	V
$V_O$	DC Output Voltage (Referenced to GND)	0	$V_{CC}$	V
$T_A$	Operating Free-Air Temperature	-55	+125	$^{\circ}C$
$t_r, t_f$	Input Rise or Fall Rate			nS/V
	$V_{CC} = 2.0 V$	0	20	
	$V_{CC} = 2.3 V$ to $2.7 V$	0	20	
	$V_{CC} = 3.0 V$ to $3.6 V$	0	10	
	$V_{CC} = 4.5 V$ to $5.5 V$	0	5	

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. All unused inputs of the device must be held at  $V_{CC}$  or GND to ensure proper device operation.

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## DC ELECTRICAL CHARACTERISTICS

Symbol	Parameter	Test Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> ≤ 85°C		T <sub>A</sub> ≤ 125°C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
V <sub>IH</sub>	Minimum High-Level Input Voltage		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		
			5.5	3.85			3.85		3.85		
V <sub>IL</sub>	Maximum Low-Level Input Voltage		2.0			0.59		0.59		0.59	V
			3.0			0.9		0.9		0.9	
			4.5			1.35		1.35		1.35	
			5.5			1.65		1.65		1.65	
V <sub>OH</sub>	Minimum High-Level Output Voltage	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -50 μA	2.0	1.9	2.0		1.9		1.9		V
			3.0	2.9	3.0		2.9		2.9		
		4.5	4.4	4.5		4.4		4.4			
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -4 mA I <sub>OH</sub> = -8 mA	3.0	2.58			2.48		2.34		
4.5	3.94				3.80		3.66				
V <sub>OL</sub>	Low-Level Output Voltage	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 50 μA	2.0		0.0	0.1		0.1		0.1	V
			3.0		0.0	0.1		0.1		0.1	
			4.5		0.0	0.1		0.1		0.1	
		V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 4 mA I <sub>OL</sub> = 8 mA	3.0			0.36		0.44		0.52	
4.5				0.36		0.44		0.52			
I <sub>IN</sub>	Input Leakage Current	V <sub>IN</sub> = 5.5 V or GND	2.0 to 5.5			± 0.1		± 1.0		± 1.0	μA
I <sub>OFF</sub>	Power Off Leakage Current	V <sub>IN</sub> = 5.5 V	0			± 0.1		± 1.0		± 1.0	μA
I <sub>CC</sub>	Maximum Supply Current	V <sub>I</sub> = V <sub>CC</sub> or GND, I <sub>O</sub> = 0 A	5.5			4.0		40.0		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.

## TIMING REQUIREMENTS (Input t<sub>r</sub> = t<sub>f</sub> = 3.0 ns, Figures 3 to 7)

Symbol	Parameter	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C		T <sub>A</sub> ≤ 85°C	T <sub>A</sub> ≤ 125°C	Unit	
			Typ	Limit	Limit	Limit		
t <sub>su</sub>	Setup Time, SER before SRCLK↑↓	3.3	-	3.5	3.5	3.5	ns	
		5.0	-	3.0	3.0	3.0		
	Setup Time, SRCLK↑ to RCLK↑	3.3	-	8.0	8.5	8.5	ns	
		5.0	-	5.0	5.0	5.0		
	Setup Time, SRCLR low to RCLK↑	3.3	-	8.0	9.0	9.0	ns	
		5.0	-	5.0	5.0	5.0		
t <sub>h</sub>	Hold Time, SER before SRCLK↑↓	3.3	-	2.0	2.0	2.0	ns	
		5.0	-	2.0	2.0	2.0		
	Hold Time, SRCLR low to RCLK↑	3.3	-	0.0	0.0	1.0	ns	
		5.0	-	0.0	0.0	1.0		
	t <sub>rec</sub>	Recovery Time, SRCLR high to SRCLK↑	3.3	-	3.0	3.0	3.0	ns
			5.0	-	2.5	2.5	2.5	
Recovery Time, RCLR high to RCLK↑		3.3	-	3.0	3.0	3.0	ns	
		5.0	-	2.5	2.5	2.5		
t <sub>w</sub>	Pulse Width, SRCLK or RCLK	3.3	-	5.0	5.0	5.0	ns	
		5.0	-	5.0	5.0	5.0		
	Pulse Width, SRCLR or RCLR	3.3	-	5.0	5.0	5.0	ns	
		5.0	-	5.0	5.0	5.0		

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## AC ELECTRICAL CHARACTERISTICS (Input $t_r = t_f = 3.0$ ns, Figures 3 to 8)

Symbol	Parameter	Conditions	V <sub>CC</sub> (V)	T <sub>A</sub> = 25°C			T <sub>A</sub> = ≤ 85°C		T <sub>A</sub> = ≤ 125°C		Unit
				Min	Typ	Max	Min	Max	Min	Max	
f <sub>max</sub>	Maximum Clock Frequency (50% Duty Cycle)		3.0 to 3.6	80	150		70		70		MHz
			4.5 to 5.5	135	185		115		115		
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay, SRCLK to Q <sub>H</sub> '	C <sub>L</sub> = 15pF	3.0 to 3.6		8.8	13.0	1.0	15.0	1.0	15.0	ns
		C <sub>L</sub> = 50pF			11.3	16.5	1.0	18.5	1.0	18.5	
t <sub>PLH</sub> , t <sub>PHL</sub>	Propagation Delay, RCLK to Q <sub>A</sub> -Q <sub>H</sub>	C <sub>L</sub> = 15pF	3.0 to 3.6		7.7	11.9	1.0	13.5	1.0	13.5	ns
		C <sub>L</sub> = 50pF			10.2	15.4	1.0	17.0	1.0	17.0	
t <sub>PHL</sub>	Propagation Delay, SRCLR to Q <sub>H</sub> '	C <sub>L</sub> = 15pF	3.0 to 3.6		8.4	12.8	1.0	13.7	1.0	13.7	ns
		C <sub>L</sub> = 50pF			10.9	16.3	1.0	17.2	1.0	17.2	
t <sub>PHL</sub>	Propagation Delay, RCLR to Q <sub>A</sub> -Q <sub>H</sub>	C <sub>L</sub> = 15pF	3.0 to 3.6		7.7	11.9	1.0	13.5	1.0	13.5	ns
		C <sub>L</sub> = 50pF			10.2	15.4	1.0	17.0	1.0	17.0	
C <sub>IN</sub>	Input Capacitance				4	10		10		10	pF

Symbol	Parameter	V <sub>CC</sub> (V)	Typ (T <sub>A</sub> = 25°C)	Unit
C <sub>PD</sub>	Power Dissipation Capacitance (Note 1)	5.0	87	pF

1. 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<sub>CC(OPR)</sub> = C<sub>PD</sub> • V<sub>CC</sub> • f<sub>in</sub> + I<sub>CC</sub>. C<sub>PD</sub> is 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<sub>in</sub> + I<sub>CC</sub> • V<sub>CC</sub>.

## NOISE CHARACTERISTICS (Input $t_r = t_f = 3.0$ ns, V<sub>CC</sub> = 5.0 V, C<sub>L</sub> = 50 pF, T<sub>A</sub> = 25°C)

Symbol	Characteristic	Min	Typ	Max	Unit
V <sub>OLP</sub>	Quiet Output, Dynamic V <sub>OL</sub>		0.8	1.0	V
V <sub>OLV</sub>	Quiet Output, Dynamic V <sub>OL</sub>	-1.0	-0.8		V
V <sub>IHD</sub>	High-Level Dynamic Input Voltage	3.5			V
V <sub>ILD</sub>	Low-Level Dynamic Input Voltage			1.5	V

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## SWITCHING WAVEFORMS

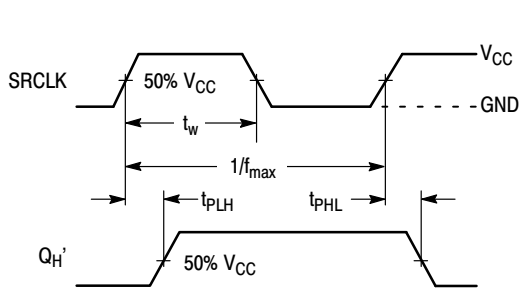


Figure 3.

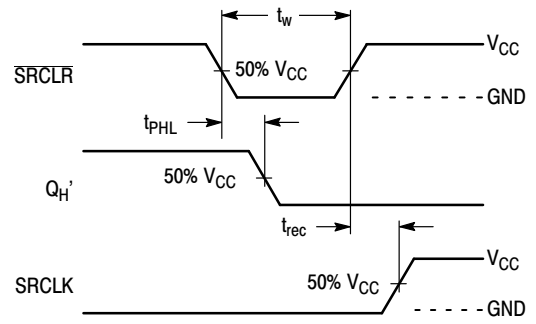


Figure 4.

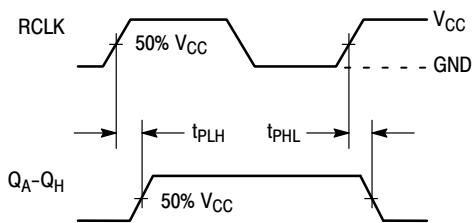


Figure 5.

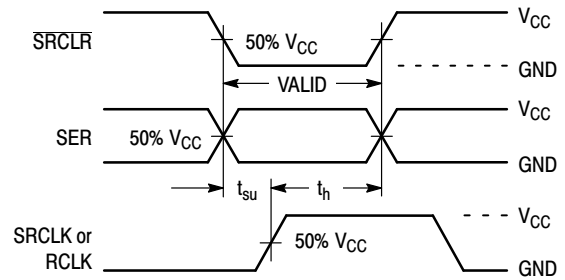


Figure 6.

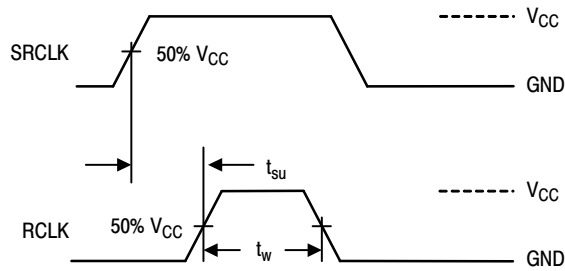
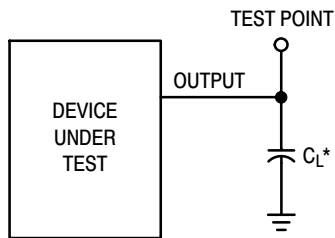


Figure 7.

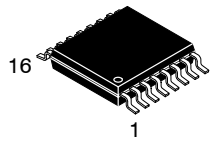
## TEST CIRCUIT



\*Includes all probe and jig capacitance

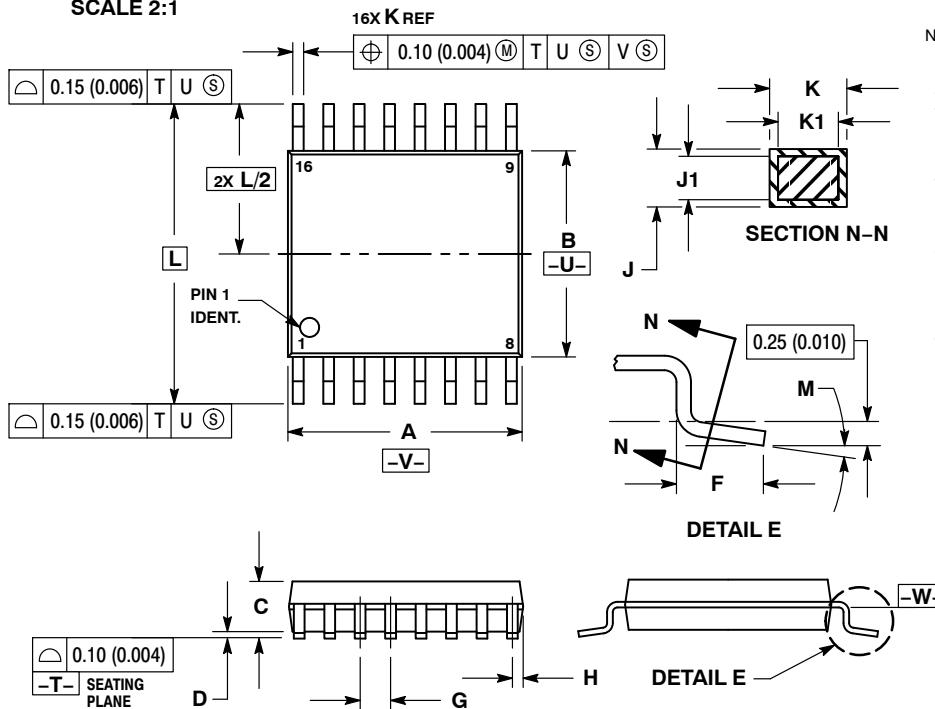
Figure 8. Test Circuit

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS



TSSOP-16 WB  
CASE 948F  
ISSUE B

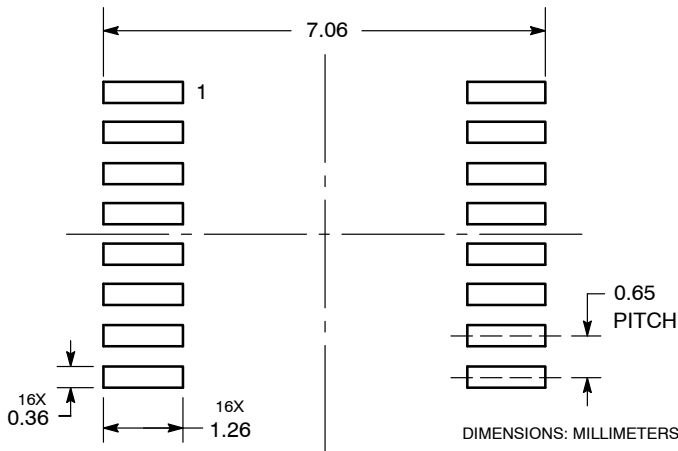
DATE 19 OCT 2006



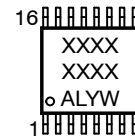
- NOTES:
- DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
  - CONTROLLING DIMENSION: MILLIMETER.
  - DIMENSION A DOES NOT INCLUDE MOLD FLASH, PROTRUSIONS OR GATE BURRS. MOLD FLASH OR GATE BURRS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
  - DIMENSION B DOES NOT INCLUDE INTERLEAD FLASH OR PROTRUSION. INTERLEAD FLASH OR PROTRUSION SHALL NOT EXCEED 0.25 (0.010) PER SIDE.
  - 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.
  - TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
  - 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°

### RECOMMENDED SOLDERING FOOTPRINT\*



### GENERIC MARKING DIAGRAM\*



- XXXX = Specific Device Code  
A = Assembly Location  
L = Wafer Lot  
Y = Year  
W = Work Week  
G or ■ = Pb-Free Package

\*This information is generic. Please refer to device data sheet for actual part marking. Pb-Free indicator, "G" or microdot "■", may or may not be present. Some products may not follow the Generic Marking.

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

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