

# MC74HC390A

## Dual 4-Stage Binary Ripple Counter with $\div 2$ and $\div 5$ Sections

### High-Performance Silicon-Gate CMOS

The MC74HC390A is identical in pinout to the LS390. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

This device consists of two independent 4-bit counters, each composed of a divide-by-two and a divide-by-five section. The divide-by-two and divide-by-five counters have separate clock inputs, and can be cascaded to implement various combinations of  $\div 2$  and/or  $\div 5$  up to a  $\div 100$  counter.

Flip-flops internal to the counters are triggered by high-to-low transitions of the clock input. A separate, asynchronous reset is provided for each 4-bit counter. State changes of the Q outputs do not occur simultaneously because of internal ripple delays. Therefore, decoded output signals are subject to decoding spikes and should not be used as clocks or strobes except when gated with the Clock of the HC390A.

#### Features

- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2.0 to 6.0 V
- Low Input Current: 1  $\mu$ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No 7 A
- Chip Complexity: 244 FETs or 61 Equivalent Gates
- 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

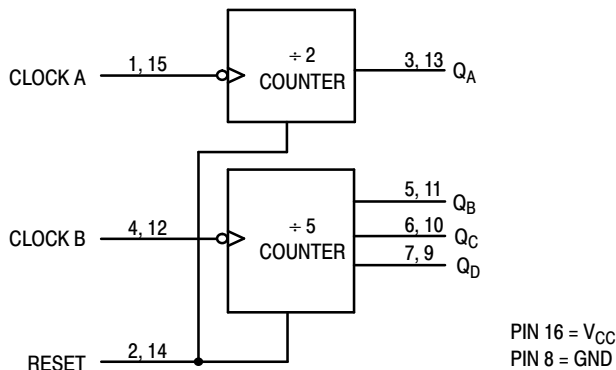
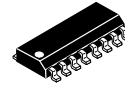


Figure 1. Logic Diagram



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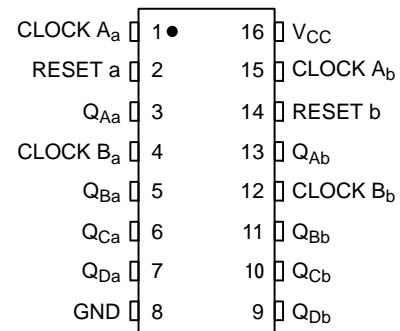


SOIC-16  
D SUFFIX  
CASE 751B

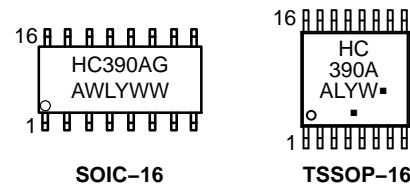


TSSOP-16  
DT SUFFIX  
CASE 948F

#### PIN ASSIGNMENT



#### MARKING DIAGRAMS



SOIC-16

TSSOP-16

- A = Assembly Location
- L, WL = Wafer Lot
- Y, YY = Year
- W, WW = Work Week
- G or  $\blacksquare$  = Pb-Free Package

(Note: Microdot may be in either location)

#### FUNCTION TABLE

Clock		Reset	Action
A	B		
X	X	H	Reset $\div 2$ and $\div 5$
$\sim$	X	L	Increment $\div 2$
X	$\sim$	L	Increment $\div 5$

#### ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 6 of this data sheet.

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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	$\pm 25$	mA
$I_{CC}$	DC Supply Current, $V_{CC}$ and GND Pins	$\pm 50$	mA
$P_D$	Power Dissipation in Still Air, SOIC Package† TSSOP Package†	500 450	mW
$T_{stg}$	Storage Temperature	-65 to +150	°C
$T_L$	Lead Temperature, 1 mm from Case for 10 Seconds 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.

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.

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

## 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)	$V_{CC} = 2.0 \text{ V}$ $V_{CC} = 3.0 \text{ V}$ $V_{CC} = 4.5 \text{ V}$ $V_{CC} = 6.0 \text{ V}$	0 0 0 0	1000 600 500 400	ns

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.

## DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND)

Symbol	Parameter	Test Conditions	$V_{CC}$ V	Guaranteed Limit			Unit
				-55 to 25°C	≤ 85°C	≤ 125°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	$V_{in} = V_{IH} \text{ or } V_{IL}$ $ 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	
	$ I_{out}  \leq 4.0 \text{ mA}$	4.5	3.98	3.84	3.70		
	$ I_{out}  \leq 5.2 \text{ mA}$	6.0	5.48	5.34	5.20		
$V_{OL}$	Maximum Low-Level Output Voltage	$V_{in} = V_{IH} \text{ or } V_{IL}$ $ I_{out}  \leq 20 \mu\text{A}$	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	
			$V_{in} = V_{IH} \text{ or } V_{IL}$ $ I_{out}  \leq 2.4 \text{ mA}$	3.0	0.26	0.33	
	$ I_{out}  \leq 4.0 \text{ mA}$	4.5	0.26	0.33	0.40		
	$ I_{out}  \leq 5.2 \text{ mA}$	6.0	0.26	0.33	0.40		

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## DC ELECTRICAL CHARACTERISTICS (Voltages Referenced to GND) (continued)

Symbol	Parameter	Test Conditions	V <sub>CC</sub> V	Guaranteed Limit			Unit
				-55 to 25°C	≤ 85°C	≤ 125°C	
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>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	40	160	μA

## AC ELECTRICAL CHARACTERISTICS (C<sub>L</sub> = 50 pF, Input t<sub>f</sub> = t<sub>r</sub> = 6 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 3)	2.0	10	9	8	MHz
		3.0	15	14	12	
		4.5	30	28	25	
		6.0	50	45	40	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Clock A to QA (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	24	30	36	
		6.0	20	26	31	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Clock A to QC (QA connected to Clock B) (Figures 1 and 3)	2.0	200	250	300	ns
		3.0	160	185	210	
		4.5	58	65	70	
		6.0	49	62	68	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Clock B to QB (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	26	33	39	
		6.0	22	28	33	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Clock B to QC (Figures 1 and 3)	2.0	90	105	180	ns
		3.0	56	70	100	
		4.5	37	46	56	
		6.0	31	39	48	
t <sub>PLH</sub> , t <sub>PHL</sub>	Maximum Propagation Delay, Clock B to QD (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	26	33	39	
		6.0	22	28	33	
t <sub>PHL</sub>	Maximum Propagation Delay, Reset to any Q (Figures 2 and 3)	2.0	80	95	110	ns
		3.0	48	65	75	
		4.5	30	38	44	
		6.0	26	33	39	
t <sub>TLH</sub> , t <sub>THL</sub>	Maximum Output Transition Time, Any Output (Figures 1 and 3)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	15	19	
C <sub>in</sub>	Maximum Input Capacitance	-	10	10	10	pF
C <sub>PD</sub>	Power Dissipation Capacitance (Per Counter)*	Typical @ 25°C, V <sub>CC</sub> = 5.0 V			pF	
		35				

\* 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>.

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## TIMING REQUIREMENTS (Input $t_r = t_f = 6$ ns)

Symbol	Parameter	$V_{CC}$ V	Guaranteed Limit			Unit
			-55 to 25°C	≤ 85°C	≤ 125°C	
$t_{rec}$	Minimum Recovery Time, Reset Inactive to Clock A or Clock B (Figure 3)	2.0	25	30	40	ns
		3.0	15	20	30	
		4.5	10	13	15	
		6.0	9	11	13	
$t_w$	Minimum Pulse Width, Clock A, Clock B (Figure 2)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	15	19	
$t_w$	Minimum Pulse Width, Reset (Figure 3)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	20	24	30	
		6.0	18	22	28	
$t_r, t_f$	Maximum Input Rise and Fall Times (Figure 2)	2.0	1000	1000	1000	ns
		3.0	800	800	800	
		4.5	500	500	500	
		6.0	400	400	400	

## PIN DESCRIPTIONS

### INPUTS

#### Clock A (Pins 1, 15) and Clock B (Pins 4, 15)

Clock A is the clock input to the ÷ 2 counter; Clock B is the clock input to the ÷ 5 counter. The internal flip-flops are toggled by high-to-low transitions of the clock input.

### CONTROL INPUTS

#### Reset (Pins 2, 14)

Asynchronous reset. A high at the Reset input prevents counting, resets the internal flip-flops, and forces  $Q_A$  through  $Q_D$  low.

### OUTPUTS

#### $Q_A$ (Pins 3, 13)

Output of the ÷ 2 counter.

#### $Q_B, Q_C, Q_D$ (Pins 5, 6, 7, 9, 10, 11)

Outputs of the ÷ 5 counter.  $Q_D$  is the most significant bit.  $Q_A$  is the least significant bit when the counter is connected for BCD output as in Figure 5.  $Q_B$  is the least significant bit when the counter is operating in the bi-quinary mode as in Figure 6.

## SWITCHING WAVEFORMS

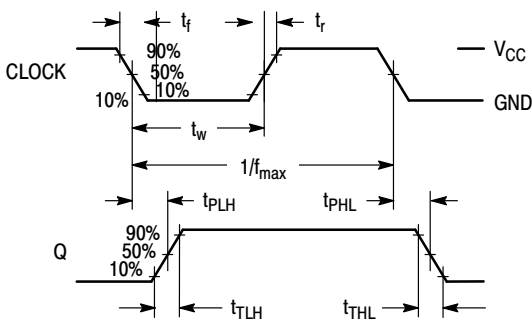


Figure 2.

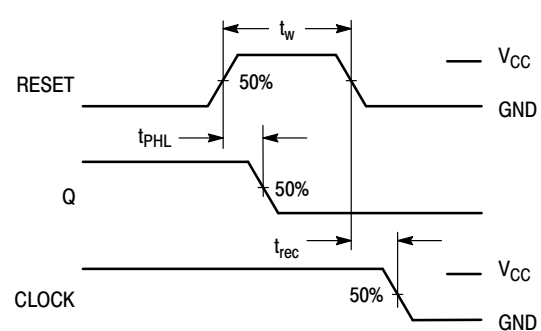
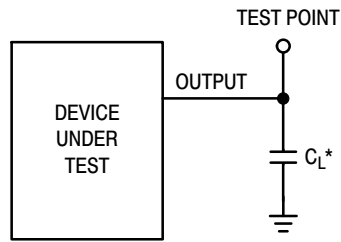


Figure 3.

# MC74HC390A

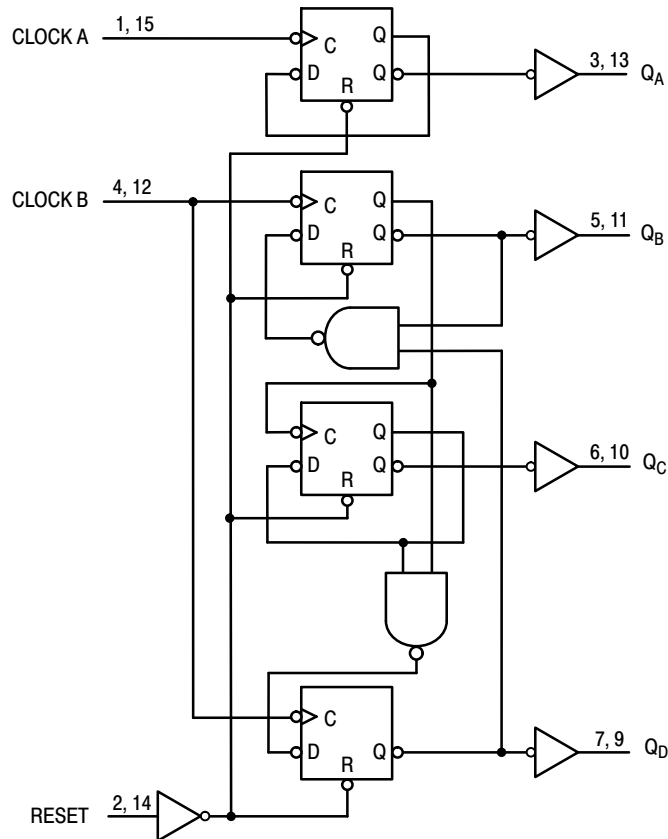
## TEST CIRCUIT



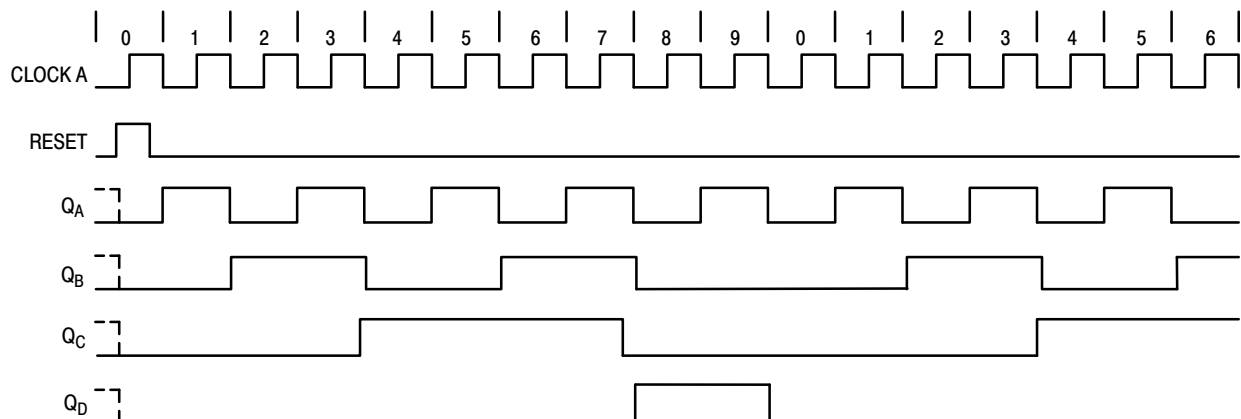
\*Includes all probe and jig capacitance

Figure 4.

## EXPANDED LOGIC DIAGRAM



## TIMING DIAGRAM (Q<sub>A</sub> Connected to Clock B)



# MC74HC390A

## APPLICATIONS INFORMATION

Each half of the MC54/74HC390A has independent  $\div 2$  and  $\div 5$  sections (except for the Reset function). The  $\div 2$  and  $\div 5$  counters can be connected to give BCD or bi-quinary (2–5) count sequences. If Output  $Q_A$  is connected to the Clock B input (Figure 4), a decade divider with BCD output is obtained. The function table for the BCD count sequence is given in Table 1.

To obtain a bi-quinary count sequence, the input signals connected to the Clock B input, and output  $Q_D$  is connected to the Clock A input (Figure 6).  $Q_A$  provides a 50% duty cycle output. The bi-quinary count sequence function table is given in Table 2.

**Table 1. BCD Count Sequence\***

Count	Output			
	$Q_D$	$Q_C$	$Q_B$	$Q_A$
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

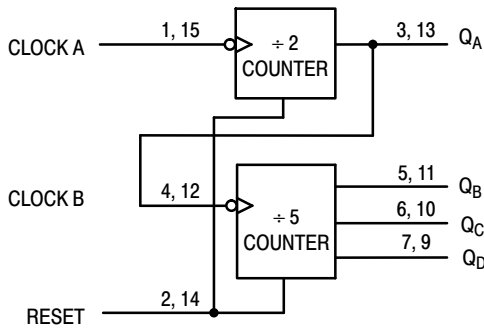
\* $Q_A$  connected to Clock B input.

**Table 2. Bi-Quinary Count Sequence\*\***

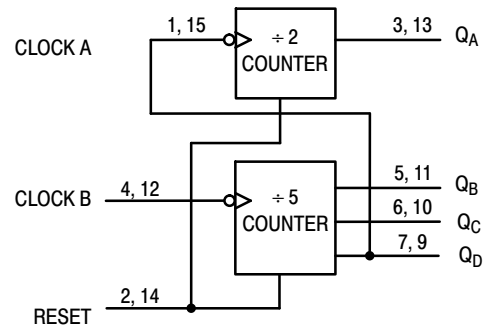
Count	Output			
	$Q_A$	$Q_D$	$Q_C$	$Q_B$
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L

\*\* $Q_D$  connected to Clock A input.

## CONNECTION DIAGRAMS



**Figure 5. BCD Count**



**Figure 6. Bi-Quinary Count**

## ORDERING INFORMATION

Device	Package	Shipping†
MC74HC390ADG	SOIC-16 (Pb-Free)	48 Units / Rail
MC74HC390ADR2G	SOIC-16 (Pb-Free)	2500 / Tape & Reel
MC74HC390ADTR2G	TSSOP-16 (Pb-Free)	2500 / Tape & Reel
NLV74HC390ADR2G*	SOIC-16 (Pb-Free)	2500 / Tape & Reel

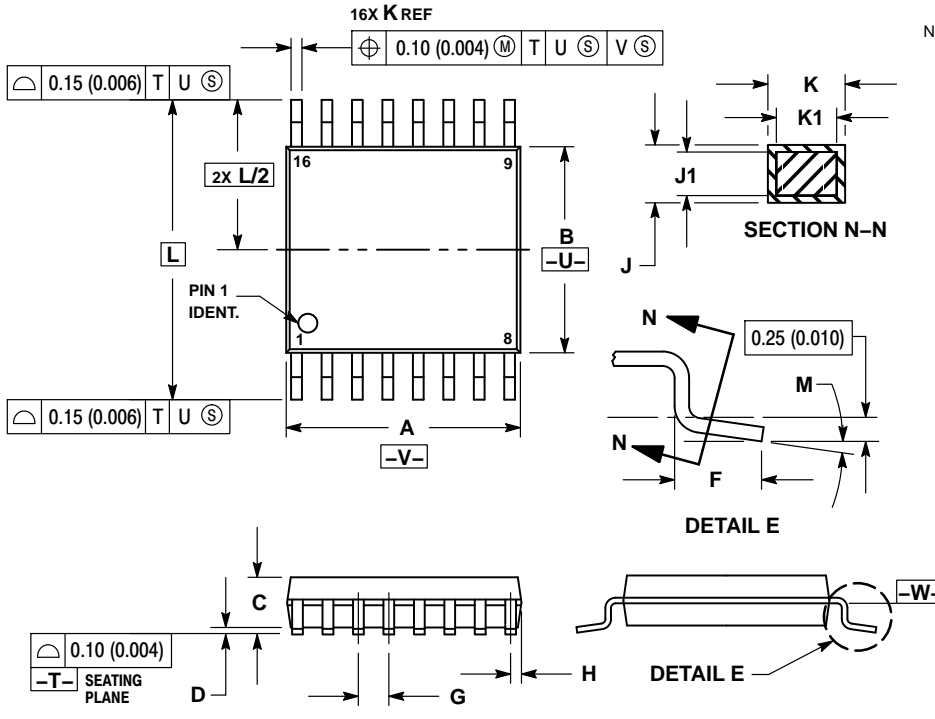
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

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

# MC74HC390A

## PACKAGE DIMENSIONS

TSSOP-16  
CASE 948F  
ISSUE B

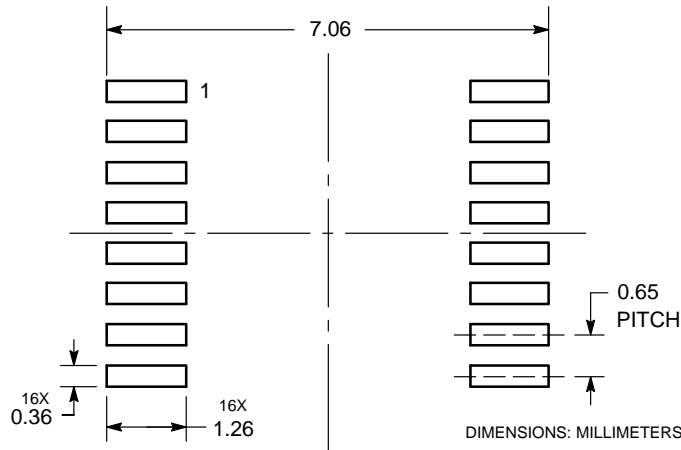


**NOTES:**

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°

### SOLDERING FOOTPRINT\*

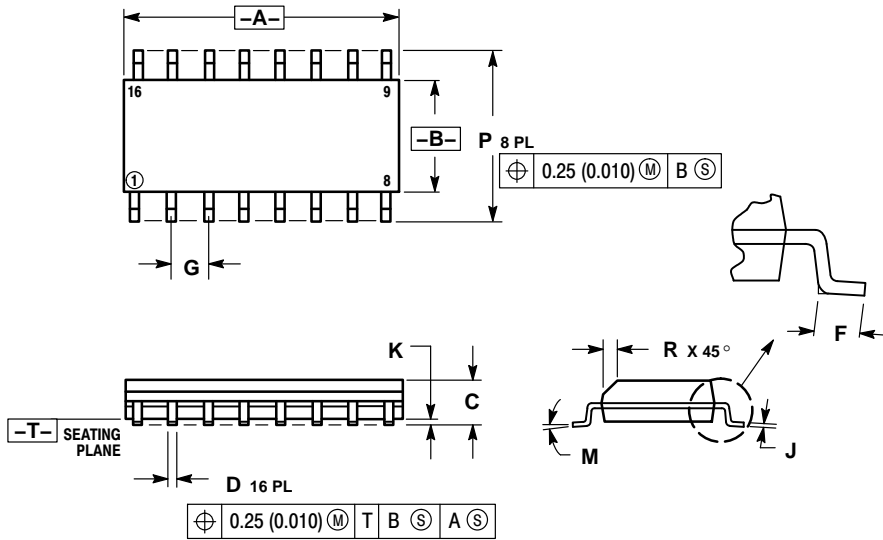


\*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

# MC74HC390A

## PACKAGE DIMENSIONS

SOIC-16  
CASE 751B-05  
ISSUE K

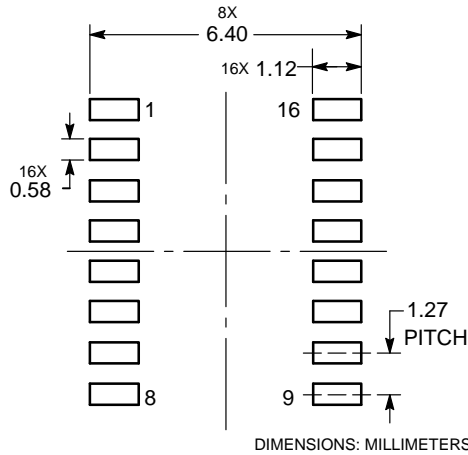


### NOTES:

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

### SOLDERING FOOTPRINT\*



\*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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