

Product Preview

Dual 4-Stage Binary Ripple Counter with $\div 2$ and $\div 5$ Sections High-Performance Silicon-Gate CMOS

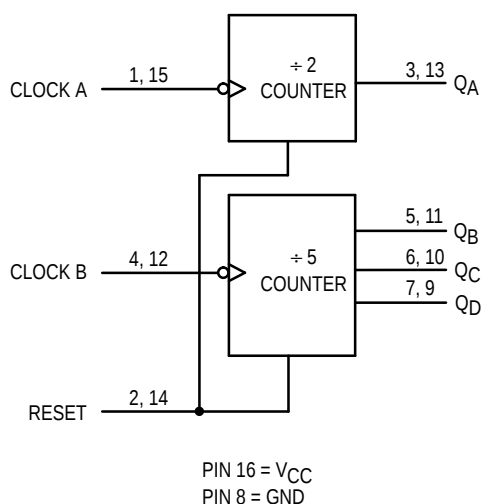
The MC54/74HC390A is identical in pinout to the LS390. The device inputs are compatible with standard CMOS outputs; with pullup resistors, they are compatible with LSTTL outputs.

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.

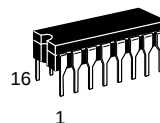
- Output Drive Capability: 10 LSTTL Loads
- Outputs Directly Interface to CMOS, NMOS, and TTL
- Operating Voltage Range: 2 to 6 V
- Low Input Current: 1 μ A
- High Noise Immunity Characteristic of CMOS Devices
- In Compliance with the Requirements Defined by JEDEC Standard No 7A
- Chip Complexity: 244 FETs or 61 Equivalent Gates

LOGIC DIAGRAM

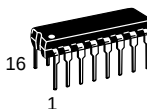


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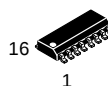
MC54/74HC390A



J SUFFIX
CERAMIC PACKAGE
CASE 620-10



N SUFFIX
PLASTIC PACKAGE
CASE 648-08



D SUFFIX
SOIC PACKAGE
CASE 751B-05



DT SUFFIX
TSSOP PACKAGE
CASE 948F-01

ORDERING INFORMATION

MC54HCXXXAJ	Ceramic
MC74HCXXXAN	Plastic
MC74HCXXXAD	SOIC
MC74HCXXXADT	TSSOP

PIN ASSIGNMENT

CLOCK A _a	1	16	V_{CC}
RESET a	2	15	CLOCK A _b
Q _{Aa}	3	14	RESET b
CLOCK B _a	4	13	Q _{Ab}
Q _{Ba}	5	12	CLOCK B _b
Q _{Ca}	6	11	Q _{Bb}
Q _{Da}	7	10	Q _{Cb}
GND	8	9	Q _{Db}

FUNCTION TABLE

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



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	± 20	mA
I_{out}	DC Output Current, per Pin	± 25	mA
I_{CC}	DC Supply Current, V_{CC} and GND Pins	± 50	mA
P_D	Power Dissipation in Still Air, Plastic or Ceramic 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 (Ceramic DIP)	260 300	°C

* Maximum Ratings are those values beyond which damage to the device may occur.
Functional operation should be restricted to the Recommended Operating Conditions.

† Derating — Plastic DIP: – 10 mW/°C from 65° to 125°C
Ceramic DIP: – 10 mW/°C from 100° 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 Motorola High-Speed CMOS Data Book (DL129/D).

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.

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 V 0 V _{CC} = 3.0 V 0 V _{CC} = 4.5 V 0 V _{CC} = 6.0 V 0	1000 600 500 400	ns

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 3.0 4.5 6.0	1.5 2.1 3.15 4.2	1.5 2.1 3.15 4.2	1.5 2.1 3.15 4.2	V
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 3.0 4.5 6.0	0.5 0.9 1.35 1.8	0.5 0.9 1.35 1.8	0.5 0.9 1.35 1.8	V
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}$ $ I_{out} \leq 4.0 \text{ mA}$ $ I_{out} \leq 5.2 \text{ mA}$	3.0 4.5 6.0	2.48 3.98 5.48	2.34 3.84 5.34	2.20 3.70 5.20	

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 _{OL}	Maximum Low-Level Output Voltage	V _{in} = V _{IH} or V _{IL} I _{out} ≤ 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 _{in} = V _{IH} or V _{IL} I _{out} ≤ 2.4 mA I _{out} ≤ 4.0 mA I _{out} ≤ 5.2 mA	3.0	0.26	0.33	0.40	
			4.5	0.26	0.33	0.40	
			6.0	0.26	0.33	0.40	
I _{in}	Maximum Input Leakage Current	V _{in} = V _{CC} or GND	6.0	± 0.1	± 1.0	± 1.0	μA
I _{CC}	Maximum Quiescent Supply Current (per Package)	V _{in} = V _{CC} or GND I _{out} = 0 μA	6.0	4	40	160	μA

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

AC ELECTRICAL CHARACTERISTICS (C_L = 50 pF, Input t_r = t_f = 6 ns)

Symbol	Parameter	V _{CC} V	Guaranteed Limit			Unit
			- 55 to 25°C	≤ 85°C	≤ 125°C	
f _{max}	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 _{PLH} , t _{PHL}	Maximum Propagation Delay, Clock A to QA (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	20	25	30	
		6.0	16	21	27	
t _{PLH} , t _{PHL}	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	35	45	60	
		6.0	30	40	50	
t _{PLH} , t _{PHL}	Maximum Propagation Delay, Clock B to QB (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	20	25	30	
		6.0	16	21	27	
t _{PLH} , t _{PHL}	Maximum Propagation Delay, Clock B to QC (Figures 1 and 3)	2.0	90	105	180	ns
		3.0	56	70	100	
		4.5	32	38	45	
		6.0	25	31	40	
t _{PLH} , t _{PHL}	Maximum Propagation Delay, Clock B to QD (Figures 1 and 3)	2.0	70	80	90	ns
		3.0	40	45	50	
		4.5	20	25	30	
		6.0	16	21	27	
t _{PHL}	Maximum Propagation Delay, Reset to any Q (Figures 2 and 3)	2.0	80	95	110	ns
		3.0	48	65	75	
		4.5	28	32	40	
		6.0	21	25	30	

MC54/74HC390A

AC ELECTRICAL CHARACTERISTICS ($C_L = 50$ pF, Input $t_f = t_r = 6$ ns)

Symbol	Parameter	V _{CC} V	Guaranteed Limit			Unit
			- 55 to 25°C	≤ 85°C	≤ 125°C	
t _{TLH} , t _{THL}	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 _{in}	Maximum Input Capacitance	—	10	10	10	pF

NOTES:

1. For propagation delays with loads other than 50 pF, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).
2. Information on typical parametric values can be found in Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

C _{PD}	Power Dissipation Capacitance (Per Counter)*	Typical @ 25°C, V _{CC} = 5.0 V	pF
		35	

* Used to determine the no-load dynamic power consumption: $P_D = C_{PD} V_{CC}^2 f + I_{CC} V_{CC}$. For load considerations, see Chapter 2 of the Motorola High-Speed CMOS Data Book (DL129/D).

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 2)	2.0	25	30	40	ns
		3.0	15	20	30	
		4.5	5	6	10	
		6.0	5	5	7	
t _w	Minimum Pulse Width, Clock A, Clock B (Figure 1)	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 2)	2.0	75	95	110	ns
		3.0	27	32	36	
		4.5	15	19	22	
		6.0	13	15	19	
t _r , t _f	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	

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

PIN DESCRIPTIONS

INPUTS

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

Clock A is the clock input to the $\div 2$ counter; Clock B is the clock input to the $\div 5$ 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 $\div 2$ counter.

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

Outputs of the $\div 5$ 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 4. Q_B is the least significant bit when the counter is operating in the bi-quinary mode as in Figure 5.

SWITCHING WAVEFORMS

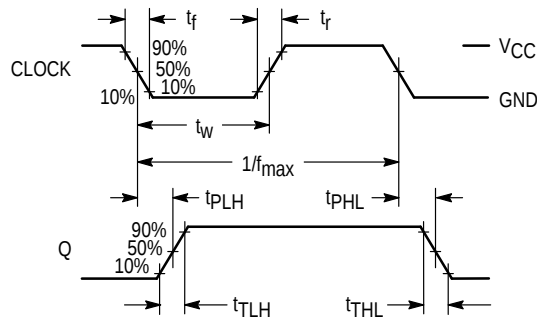


Figure 1.

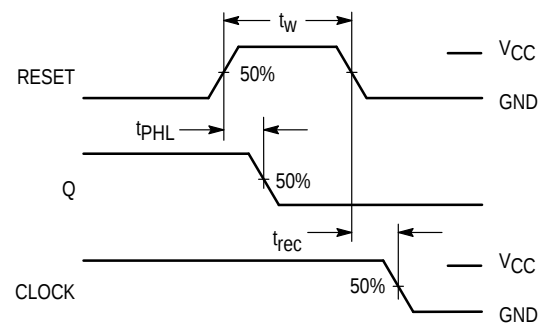
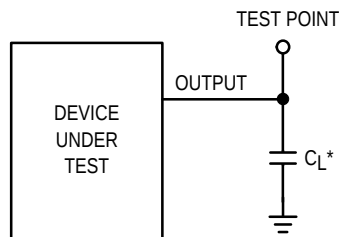


Figure 2.

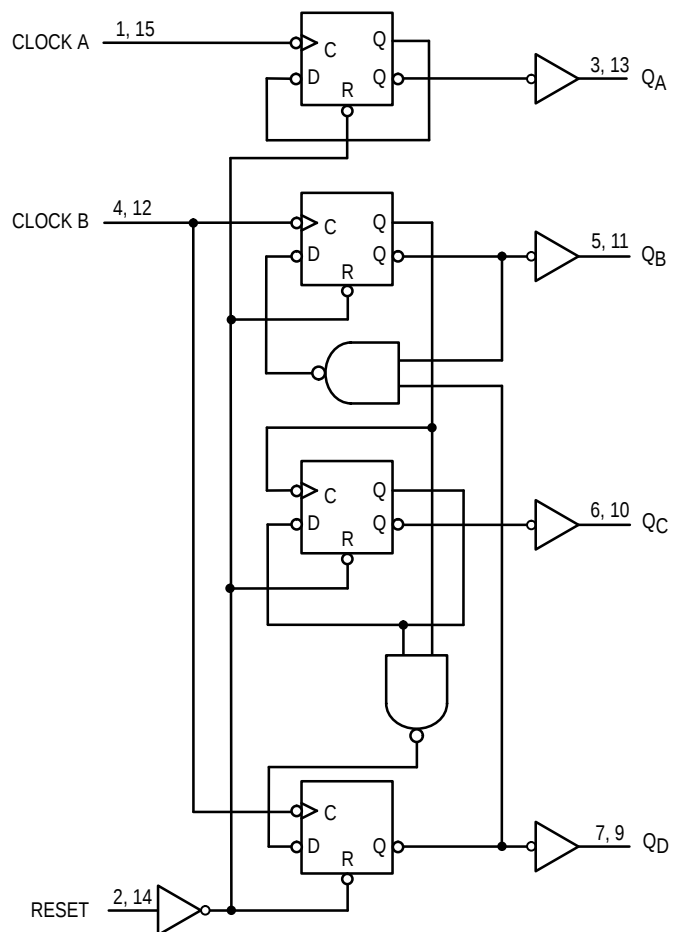
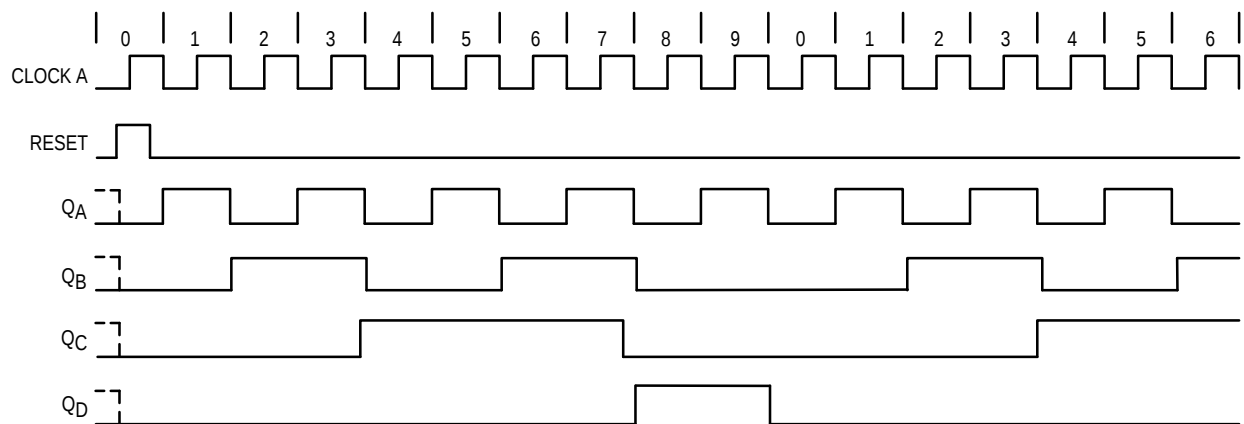
TEST CIRCUIT



* Includes all probe and jig capacitance

Figure 3.

EXPANDED LOGIC DIAGRAM

TIMING DIAGRAM
(QA Connected to Clock B)

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.

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.

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 5). Q_A provides a 50% duty cycle output. The bi-quinary count sequence function table is given in Table 2.

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

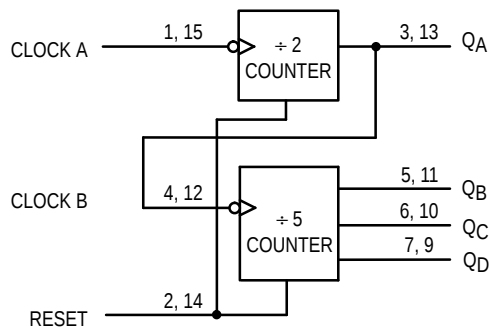


Figure 4. BCD Count

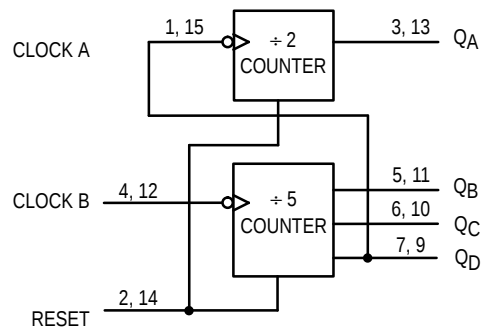
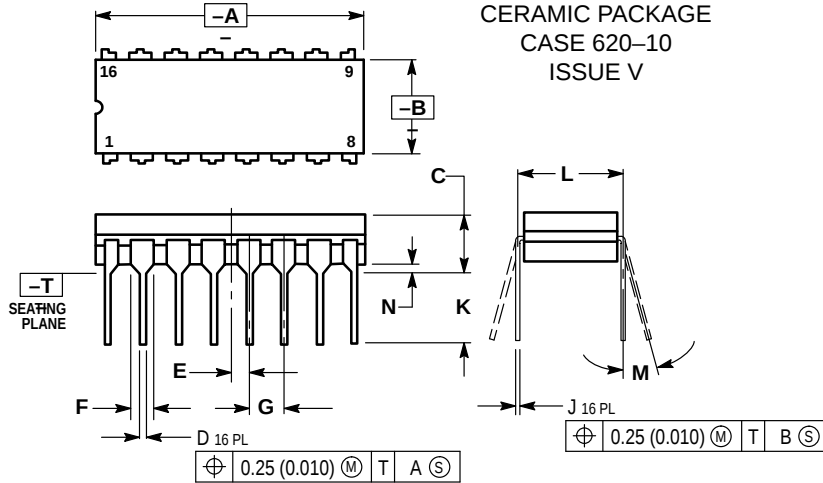


Figure 5. Bi-Quinary Count

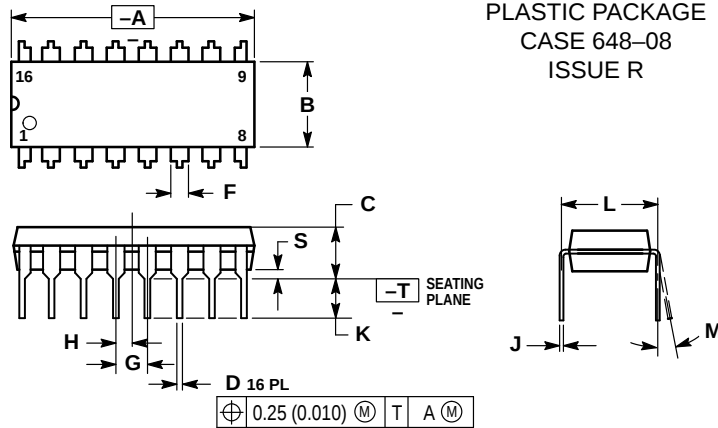
OUTLINE DIMENSIONS

J SUFFIX
 CERAMIC PACKAGE
 CASE 620-10
 ISSUE V


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.

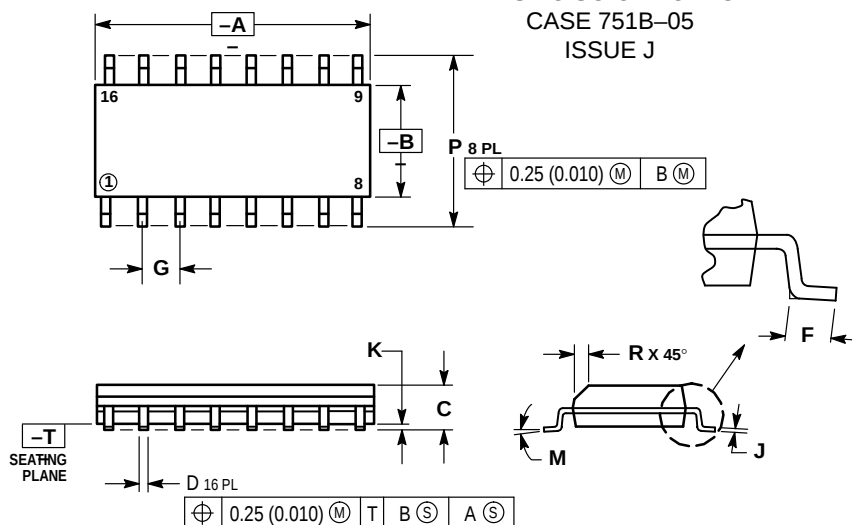
DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.750	0.785	19.05	19.93
B	0.240	0.295	6.10	7.49
C	—	0.200	—	5.08
D	0.015	0.020	0.39	0.50
E	0.050 BSC		1.27 BSC	
F	0.055	0.065	1.40	1.65
G	0.100 BSC		2.54 BSC	
J	0.008	0.015	0.21	0.38
K	0.125	0.170	3.18	4.31
L	0.300 BSC		7.62 BSC	
M	0°	15°	0°	15°
N	0.020	0.040	0.51	1.01

N SUFFIX
 PLASTIC PACKAGE
 CASE 648-08
 ISSUE R


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	0.070	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

D SUFFIX
 PLASTIC SOIC PACKAGE
 CASE 751B-05
 ISSUE J


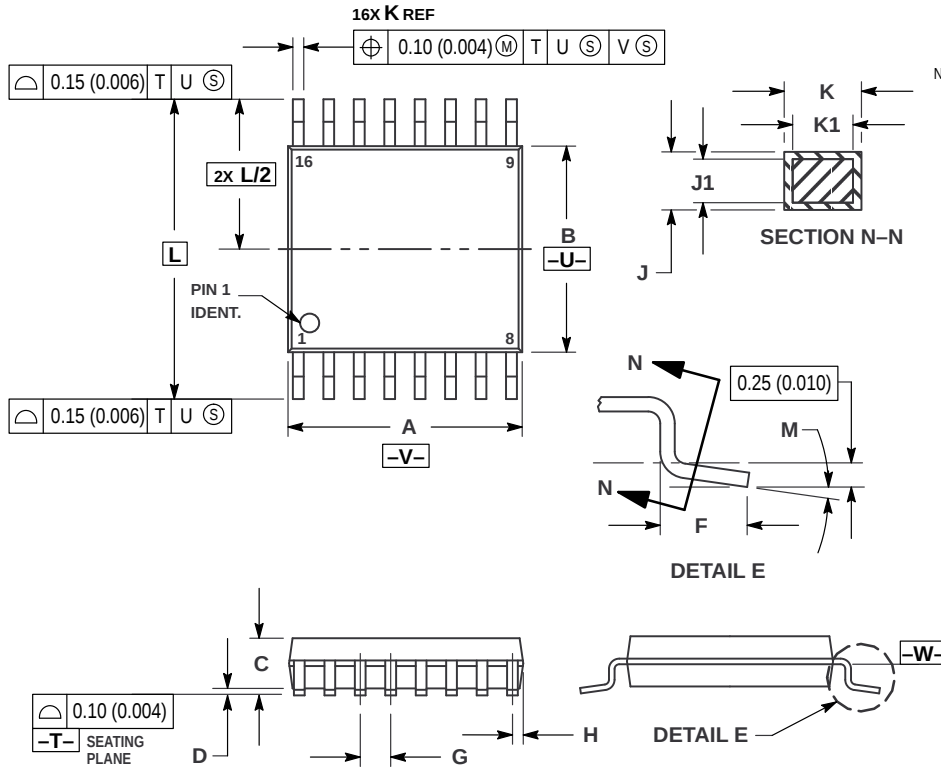
NOTES:

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

OUTLINE DIMENSIONS

DT SUFFIX
PLASTIC TSSOP PACKAGE
CASE 948F-01
ISSUE O



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°

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