

**MC14022B**

**Octal Counter**

The MC14022B is a four-stage Johnson octal counter with built-in code converter. High-speed operation and spike-free outputs are obtained by use of a Johnson octal counter design. The eight decoded outputs are normally low, and go high only at their appropriate octal time period. The output changes occur on the positive-going edge of the clock pulse. This part can be used in frequency division applications as well as octal counter or octal decode display applications.

- Fully Static Operation
- DC Clock Input Circuit Allows Slow Rise Times
- Carry Out Output for Cascading
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Capable of Driving Two Low-power TTL Loads or One Low-power Schottky TTL Load Over the Rated Temperature Range
- Pin-for-Pin Replacement for CD4022B
- Triple Diode Protection on All Inputs

**MAXIMUM RATINGS\*** (Voltages Referenced to V<sub>SS</sub>)

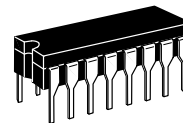
Symbol	Parameter	Value	Unit
V <sub>DD</sub>	DC Supply Voltage	- 0.5 to + 18.0	V
V <sub>in</sub> , V <sub>out</sub>	Input or Output Voltage (DC or Transient)	- 0.5 to V <sub>DD</sub> + 0.5	V
I <sub>in</sub> , I <sub>out</sub>	Input or Output Current (DC or Transient), per Pin	± 10	mA
P <sub>D</sub>	Power Dissipation, per Package†	500	mW
T <sub>stg</sub>	Storage Temperature	- 65 to + 150	°C
T <sub>L</sub>	Lead Temperature (8-Second Soldering)	260	°C

\* Maximum Ratings are those values beyond which damage to the device may occur.

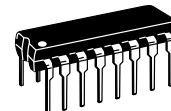
† Temperature Derating:

Plastic "P and D/DW" Packages: - 7.0 mW/°C From 65°C To 125°C

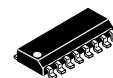
Ceramic "L" Packages: - 12 mW/°C From 100°C To 125°C



**L SUFFIX**  
CERAMIC  
CASE 620



**P SUFFIX**  
PLASTIC  
CASE 648



**D SUFFIX**  
SOIC  
CASE 751B

**ORDERING INFORMATION**

MC14XXXBCP Plastic  
MC14XXXBCL Ceramic  
MC14XXXBD SOIC

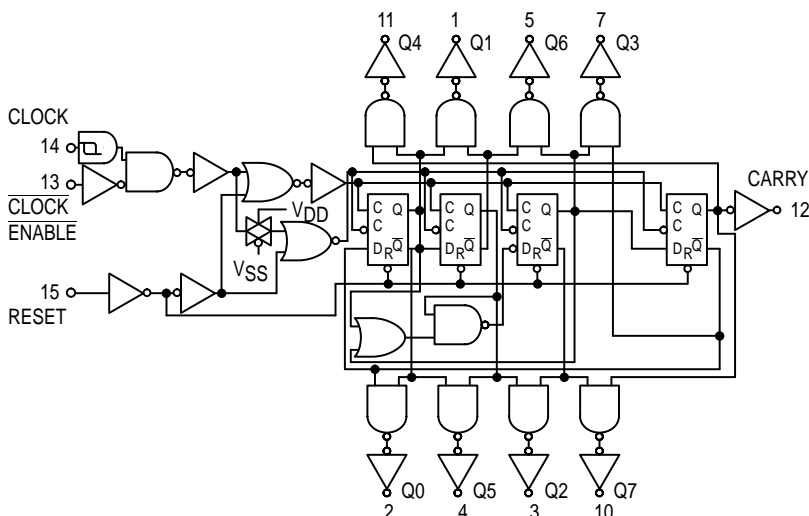
T<sub>A</sub> = - 55° to 125°C for all packages.

**FUNCTIONAL TRUTH TABLE**  
(Positive Logic)

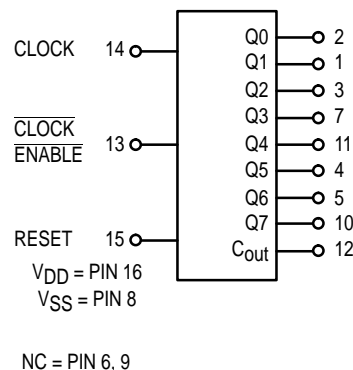
Clock	Clock Enable	Reset	Output=n
0	X	0	n
X	1	0	n
↗	0	0	n+1
↘	X	0	n
1	↗	0	n+1
X	↘	0	n
X	X	1	Q0

X = Don't Care. If n < 4 Carry = 1, Otherwise = 0.

**LOGIC DIAGRAM**



**BLOCK DIAGRAM**



**ELECTRICAL CHARACTERISTICS** (Voltages Referenced to V<sub>SS</sub>)

Characteristic	Symbol	V <sub>DD</sub> Vdc	- 55°C		25°C			125°C		Unit
			Min	Max	Min	Typ #	Max	Min	Max	
Output Voltage V <sub>in</sub> = V <sub>DD</sub> or 0  V <sub>in</sub> = 0 or V <sub>DD</sub>	"0" Level V <sub>OL</sub>	5.0	—	0.05	—	0	0.05	—	0.05	Vdc
		10	—	0.05	—	0	0.05	—	0.05	
		15	—	0.05	—	0	0.05	—	0.05	
	"1" Level V <sub>OH</sub>	5.0	4.95	—	4.95	5.0	—	4.95	—	Vdc
		10	9.95	—	9.95	10	—	9.95	—	
		15	14.95	—	14.95	15	—	14.95	—	
Input Voltage "0" Level (V <sub>O</sub> = 4.5 or 0.5 Vdc) (V <sub>O</sub> = 9.0 or 1.0 Vdc) (V <sub>O</sub> = 13.5 or 1.5 Vdc)  "1" Level (V <sub>O</sub> = 0.5 or 4.5 Vdc) (V <sub>O</sub> = 1.0 or 9.0 Vdc) (V <sub>O</sub> = 1.5 or 13.5 Vdc)	V <sub>IL</sub>	5.0	—	1.5	—	2.25	1.5	—	1.5	Vdc
		10	—	3.0	—	4.50	3.0	—	3.0	
		15	—	4.0	—	6.75	4.0	—	4.0	
	V <sub>IH</sub>	5.0	3.5	—	3.5	2.75	—	3.5	—	Vdc
		10	7.0	—	7.0	5.50	—	7.0	—	
		15	11	—	11	8.25	—	11	—	
Output Drive Current Source (V <sub>OH</sub> = 2.5 Vdc) (V <sub>OH</sub> = 4.6 Vdc) (V <sub>OH</sub> = 9.5 Vdc) (V <sub>OH</sub> = 13.5 Vdc)  Sink (V <sub>OL</sub> = 0.4 Vdc) (V <sub>OL</sub> = 0.5 Vdc) (V <sub>OL</sub> = 1.5 Vdc)	I <sub>OH</sub>	5.0	-3.0	—	-2.4	-4.2	—	-1.7	—	mAdc
		5.0	-0.64	—	-0.51	-0.88	—	-0.36	—	
		10	-1.6	—	-1.3	-2.25	—	-0.9	—	
		15	-4.2	—	-3.4	-8.8	—	-2.4	—	
	I <sub>OL</sub>	5.0	0.64	—	0.51	0.88	—	0.36	—	mAdc
		10	1.6	—	1.3	2.25	—	0.9	—	
15	4.2	—	3.4	8.8	—	2.4	—	—		
Input Current	I <sub>in</sub>	15	—	± 0.1	—	± 0.00001	± 0.1	—	± 1.0	μAdc
Input Capacitance (V <sub>in</sub> = 0)	C <sub>in</sub>	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (Per Package)	I <sub>DD</sub>	5.0	—	5.0	—	0.005	5.0	—	150	μAdc
		10	—	10	—	0.010	10	—	300	
		15	—	20	—	0.015	20	—	600	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) (C <sub>L</sub> = 50 pF on all outputs, all buffers switching)	I <sub>T</sub>	5.0	I <sub>T</sub> = (0.28 μA/kHz)f + I <sub>DD</sub> I <sub>T</sub> = (0.56 μA/kHz)f + I <sub>DD</sub> I <sub>T</sub> = (0.85 μA/kHz)f + I <sub>DD</sub>							μAdc
10										
15										

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance.

\*\*The formulas given are for the typical characteristics only at 25°C.

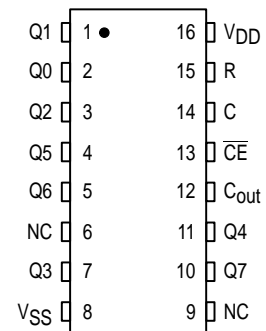
†To calculate total supply current at loads other than 50 pF:

$$I_T(C_L) = I_T(50 \text{ pF}) + (C_L - 50) Vfk$$

where: I<sub>T</sub> is in μA (per package), C<sub>L</sub> in pF, V = (V<sub>DD</sub> - V<sub>SS</sub>) in volts, f in kHz is input frequency, and k = 0.00125.

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<sub>in</sub> and V<sub>out</sub> should be constrained to the range V<sub>SS</sub> ≤ (V<sub>in</sub> or V<sub>out</sub>) ≤ V<sub>DD</sub>. Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V<sub>SS</sub> or V<sub>DD</sub>). Unused outputs must be left open.

**PIN ASSIGNMENT**



NC = NO CONNECTION

**SWITCHING CHARACTERISTICS\*** ( $C_L = 50 \text{ pF}$ ,  $T_A = 25^\circ\text{C}$ )

Characteristic	Symbol	V <sub>DD</sub> Vdc	Min	Typ #	Max	Unit
Output Rise and Fall Time $t_{TLH}$ , $t_{THL} = (1.5 \text{ ns/pF}) C_L + 25 \text{ ns}$ $t_{TLH}$ , $t_{THL} = (0.75 \text{ ns/pF}) C_L + 12.5 \text{ ns}$ $t_{TLH}$ , $t_{THL} = (0.55 \text{ ns/pF}) C_L + 9.5 \text{ ns}$	$t_{TLH}$ , $t_{THL}$	5.0 10 15	— — —	100 50 40	200 100 80	ns
Propagation Delay Time Reset to Decode Output $t_{PLH}$ , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 415 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 197 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 150 \text{ ns}$	$t_{PLH}$ , $t_{PHL}$	5.0 10 15	— — —	500 230 175	1000 460 350	ns
Propagation Delay Time Clock to C <sub>out</sub> $t_{PLH}$ , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 315 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 142 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 100 \text{ ns}$	$t_{PLH}$ , $t_{PHL}$	5.0 10 15	— — —	400 175 125	800 350 250	ns
Propagation Delay Time Clock to Decode Output $t_{PLH}$ , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 415 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 197 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 150 \text{ ns}$	$t_{PLH}$ , $t_{PHL}$	5.0 10 15	— — —	275 125 95	1000 460 350	ns
Turn-Off Delay Time Reset to C <sub>out</sub> $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 315 \text{ ns}$ $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 142 \text{ ns}$ $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 100 \text{ ns}$	$t_{PLH}$	5.0 10 15	— — —	400 175 125	800 350 250	ns
Clock Pulse Width	$t_{WH}$	5.0 10 15	250 100 75	125 50 35	— — —	ns
Clock Frequency	$f_{cl}$	5.0 10 15	— — —	5.0 12 16	2.0 5.0 6.7	MHz
Reset Pulse Width	$t_{WH}$	5.0 10 15	500 250 190	250 125 95	— — —	ns
Reset Removal Time	$t_{rem}$	5.0 10 15	750 275 210	375 135 105	— — —	ns
Clock Input Rise and Fall Time	$t_{TLH}$ , $t_{THL}$	5.0 10 15	No Limit			—
Clock Enable Setup Time	$t_{su}$	5.0 10 15	350 150 115	175 75 52	— — —	ns
Clock Enable Removal Time	$t_{rem}$	5.0 10 15	420 200 140	260 100 70	— — —	ns

\* The formulas given are for the typical characteristics only at 25°C.

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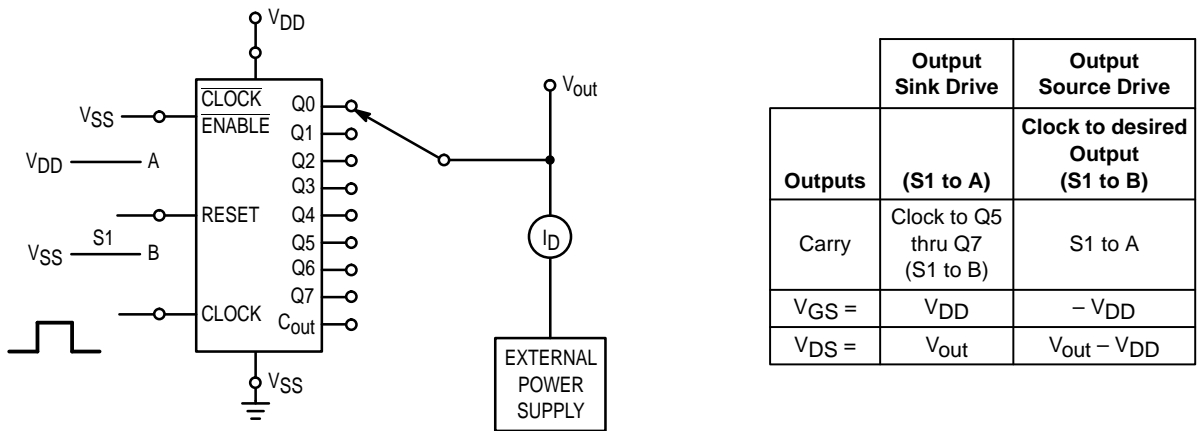


Figure 1. Typical Output Source and Output Sink Characteristics Test Circuit

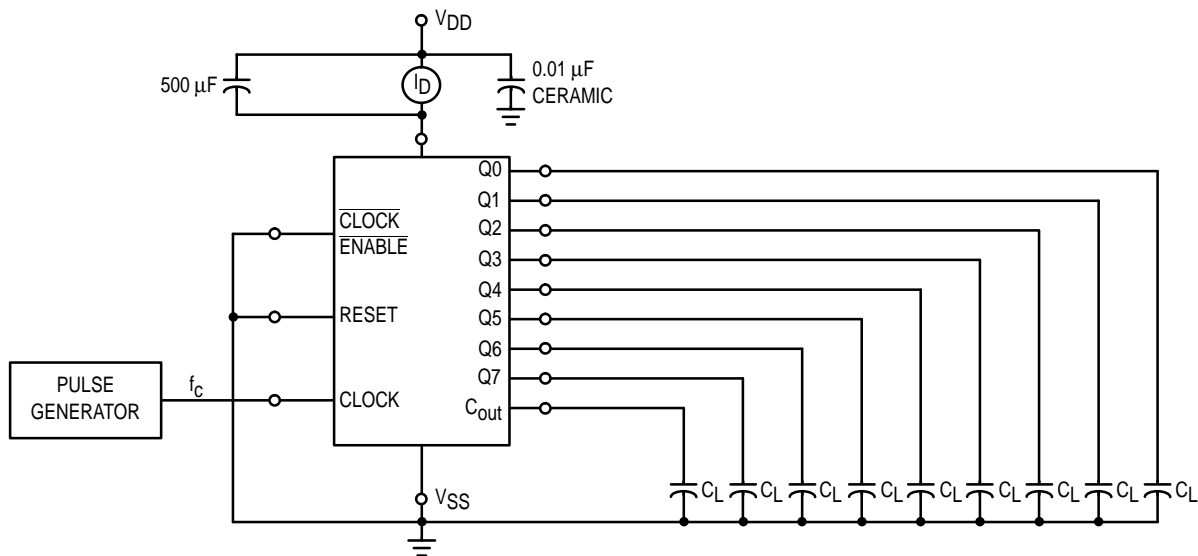


Figure 2. Typical Power Dissipation Test Circuit

### APPLICATIONS INFORMATION

Figure 3 shows a technique for extending the number of decoded output states for the MC14022B. Decoded outputs are sequential within each stage and from stage to stage, with no dead time (except propagation delay).

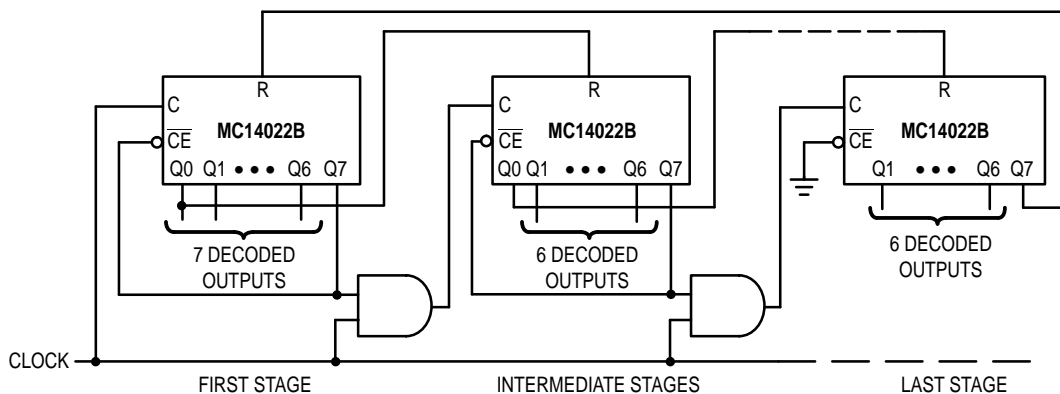


Figure 3. Counter Expansion

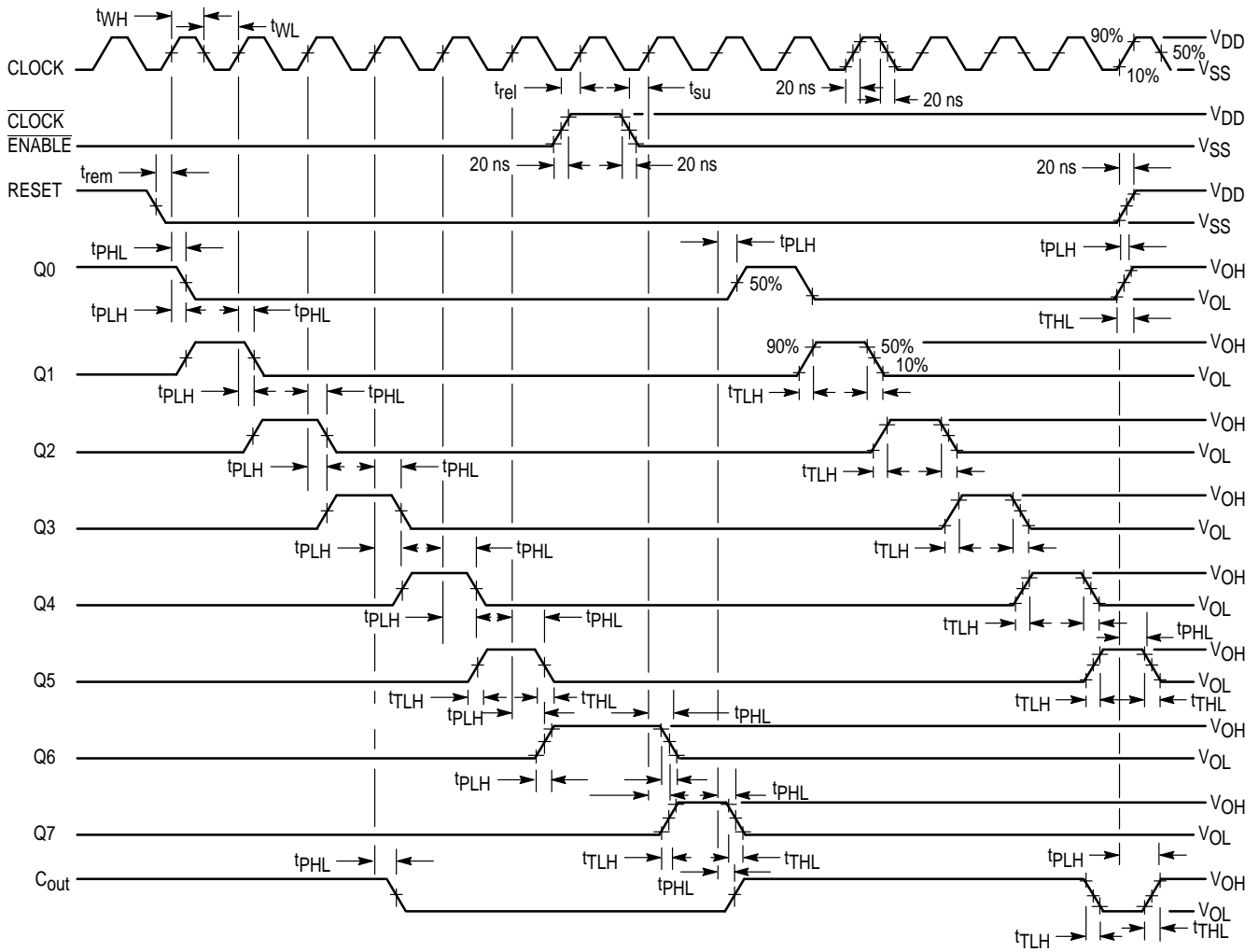
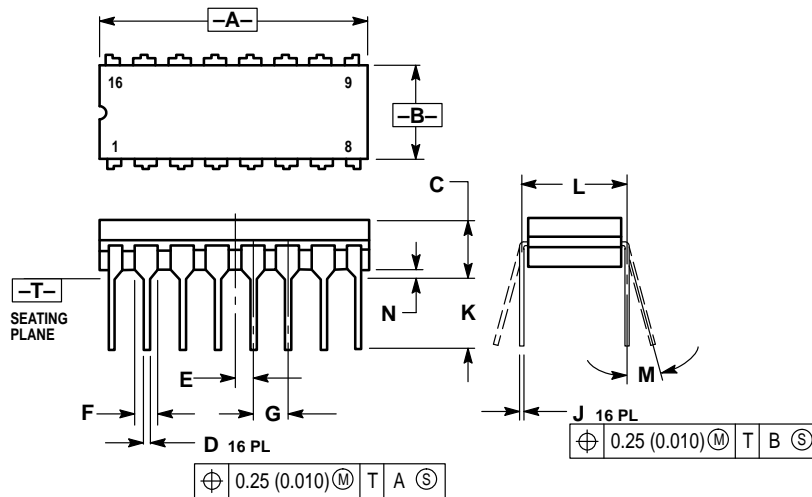


Figure 4. AC Measurement Definition and Functional Waveforms

## OUTLINE DIMENSIONS

### L SUFFIX CERAMIC DIP PACKAGE CASE 620-10 ISSUE V

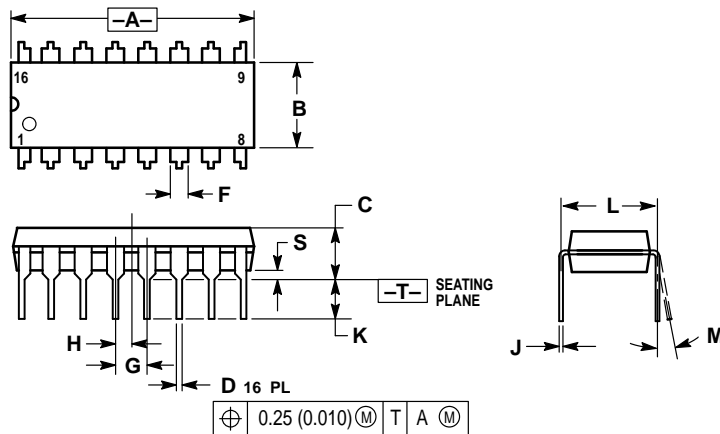


**NOTES:**

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIMENSION 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	
H	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

### P SUFFIX PLASTIC DIP PACKAGE CASE 648-08 ISSUE R



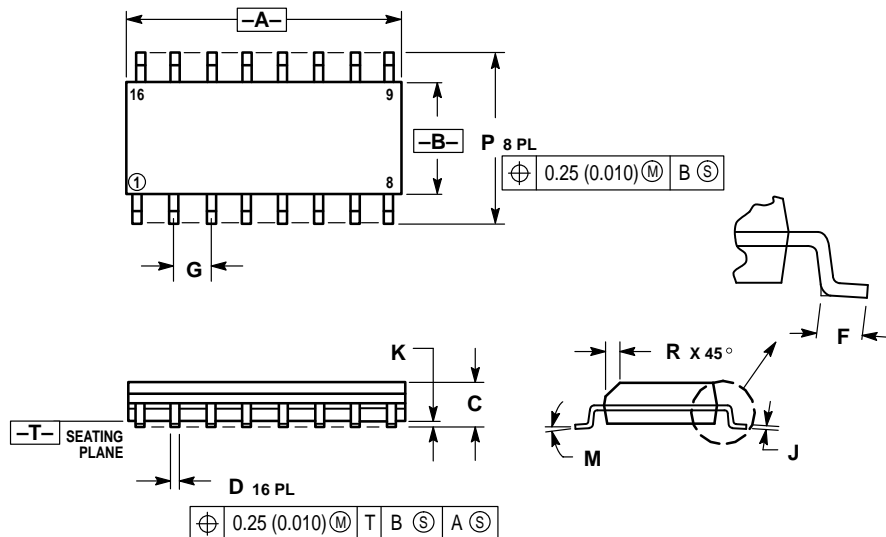
**NOTES:**

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	0.70	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

## OUTLINE DIMENSIONS

### 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

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3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

**MFAX:** RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609  
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51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



MC14022B/D