

## 9's Complementer

The MC14561B 9's complementer is a companion to the MC14560B NBCD adder to allow BCD subtraction. A BCD number (8-4-2-1 code) is applied to the inputs ( $A_1 = 2^0$ ,  $A_2 = 2^1$ ,  $A_3 = 2^2$ ,  $A_4 = 2^3$ ). If the complement control (Comp) is low, the BCD number appears at the outputs unmodified. The complement disable ( $\overline{\text{Comp}}$ ) allows the complement control to be gated, or an inverted control signal to be used. If the complement input is high and the disable input low, the 9's complement of the number is displayed at the outputs. The zero control (Z), when high, forces the outputs low regardless of the state of the other inputs.

When the MC14561B is used to perform BCD subtraction in conjunction with the MC14560B NBCD adder, the complement control becomes an add/subtract control.

- All Inputs Buffered
- 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

### MAXIMUM RATINGS\* (Voltages Referenced to $V_{SS}$ )

Symbol	Parameter	Value	Unit
$V_{DD}$	DC Supply Voltage	- 0.5 to + 18.0	V
$V_{in}$ , $V_{out}$	Input or Output Voltage (DC or Transient)	- 0.5 to $V_{DD} + 0.5$	V
$I_{in}$ , $I_{out}$	Input or Output Current (DC or Transient), per Pin	$\pm 10$	mA
$P_D$	Power Dissipation, per Package†	500	mW
$T_{stg}$	Storage Temperature	- 65 to + 150	°C
$T_L$	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

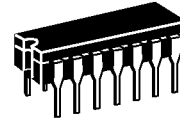
Ceramic "L" Packages: - 12 mW/°C From 100°C To 125°C

### TRUTH TABLE

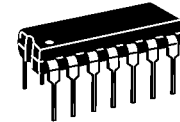
Z	Comp	$\overline{\text{Comp}}$	F1	F2	F3	F4	Mode
0	0	0	A1	A2	A3	A4	Straight-through
0	0	1					
0	1	1					
0	1	0	$\overline{A_1}$	A2	$A_2\overline{A_3} + \overline{A_2}A_3$	$\overline{A_2}A_3\overline{A_4}$	Complement
1	X	X	0	0	0	0	Zero

X = Don't Care.

## MC14561B



**L SUFFIX**  
CERAMIC  
CASE 632



**P SUFFIX**  
PLASTIC  
CASE 646



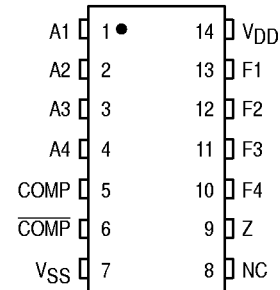
**D SUFFIX**  
SOIC  
CASE 751A

### ORDERING INFORMATION

MC14XXXBCP Plastic  
MC14XXXBCL Ceramic  
MC14XXXBD SOIC

$T_A = -55^\circ$  to  $125^\circ\text{C}$  for all packages.

### PIN ASSIGNMENT



NC = NO CONNECTION

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  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

Unused inputs must always be tied to an appropriate logic voltage level (e.g., either  $V_{SS}$  or  $V_{DD}$ ). Unused outputs must be left open.



**ELECTRICAL CHARACTERISTICS** (Voltages Referenced to  $V_{SS}$ )

Characteristic	Symbol	$V_{DD}$ Vdc	-55°C		25°C			125°C		Unit
			Min	Max	Min	Typ #	Max	Min	Max	
Output Voltage $V_{in} = V_{DD}$ or 0  $V_{in} = 0$ or $V_{DD}$	"0" Level  $V_{OL}$	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  $V_{OH}$	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 ( $V_O = 4.5$ or $0.5$ Vdc) ( $V_O = 9.0$ or $1.0$ Vdc) ( $V_O = 13.5$ or $1.5$ Vdc)  "1" Level ( $V_O = 0.5$ or $4.5$ Vdc) ( $V_O = 1.0$ or $9.0$ Vdc) ( $V_O = 1.5$ or $13.5$ Vdc)	$V_{IL}$	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	
	$V_{IH}$	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 ( $V_{OH} = 2.5$ Vdc) ( $V_{OH} = 4.6$ Vdc) ( $V_{OH} = 9.5$ Vdc) ( $V_{OH} = 13.5$ Vdc)  ( $V_{OL} = 0.4$ Vdc) ( $V_{OL} = 0.5$ Vdc) ( $V_{OL} = 1.5$ Vdc)	Source  $I_{OH}$	5.0	-3.0	—	-2.4	-4.2	—	-1.7	—	mA <sub>dc</sub>
		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	—	
	Sink  $I_{OL}$	5.0	0.64	—	0.51	0.88	—	0.36	—	mA <sub>dc</sub>
		10	1.6	—	1.3	2.25	—	0.9	—	
15		4.2	—	3.4	8.8	—	2.4	—		
Input Current	$I_{in}$	15	—	±0.1	—	±0.00001	±0.1	—	±1.0	μA <sub>dc</sub>
Input Capacitance ( $V_{in} = 0$ )	$C_{in}$	—	—	—	—	5.0	7.5	—	—	pF
Quiescent Current (Per Package)	$I_{DD}$	5.0	—	5.0	—	0.005	5.0	—	150	μA <sub>dc</sub>
		10	—	10	—	0.010	10	—	300	
		15	—	20	—	0.015	20	—	600	
Total Supply Current**† (Dynamic plus Quiescent, Per Package) ( $C_L = 50$ pF on all outputs, all buffers switching)	$I_T$	5.0	$I_T = (1.5 \mu A/kHz) f + I_{DD}$							μA <sub>dc</sub>
		10	$I_T = (3.0 \mu A/kHz) f + I_{DD}$							
		15	$I_T = (4.5 \mu A/kHz) f + I_{DD}$							

#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:

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

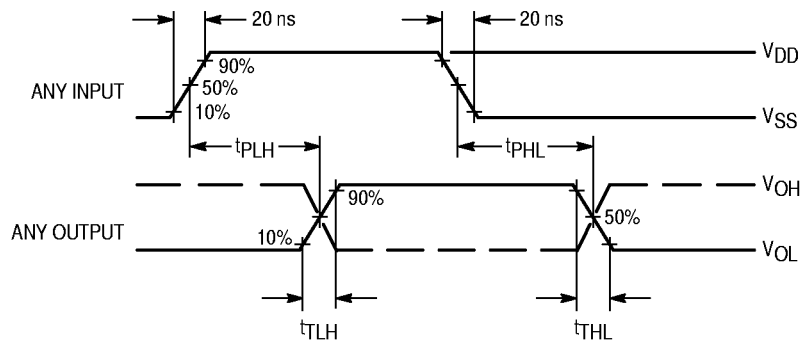
where:  $I_T$  is in μA (per package),  $C_L$  in pF,  $V = (V_{DD} - V_{SS})$  in volts,  $f$  in kHz is input frequency, and  $k = 0.004$ .

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

Characteristic	Symbol	V <sub>DD</sub>	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 $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 315 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 127 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 95 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	— — —	400 160 120	1000 400 300	ns

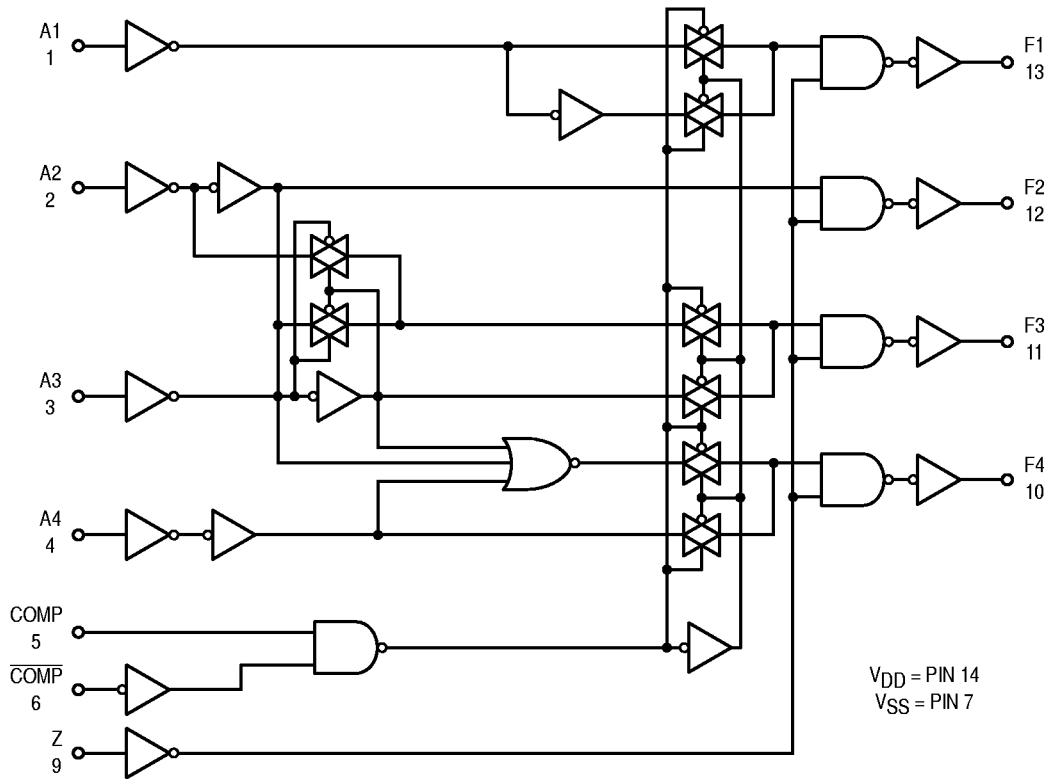
\* The formulas given are for the typical characteristics only at 25°C.

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**Figure 1. Switching Time Waveforms**

LOGIC DIAGRAM



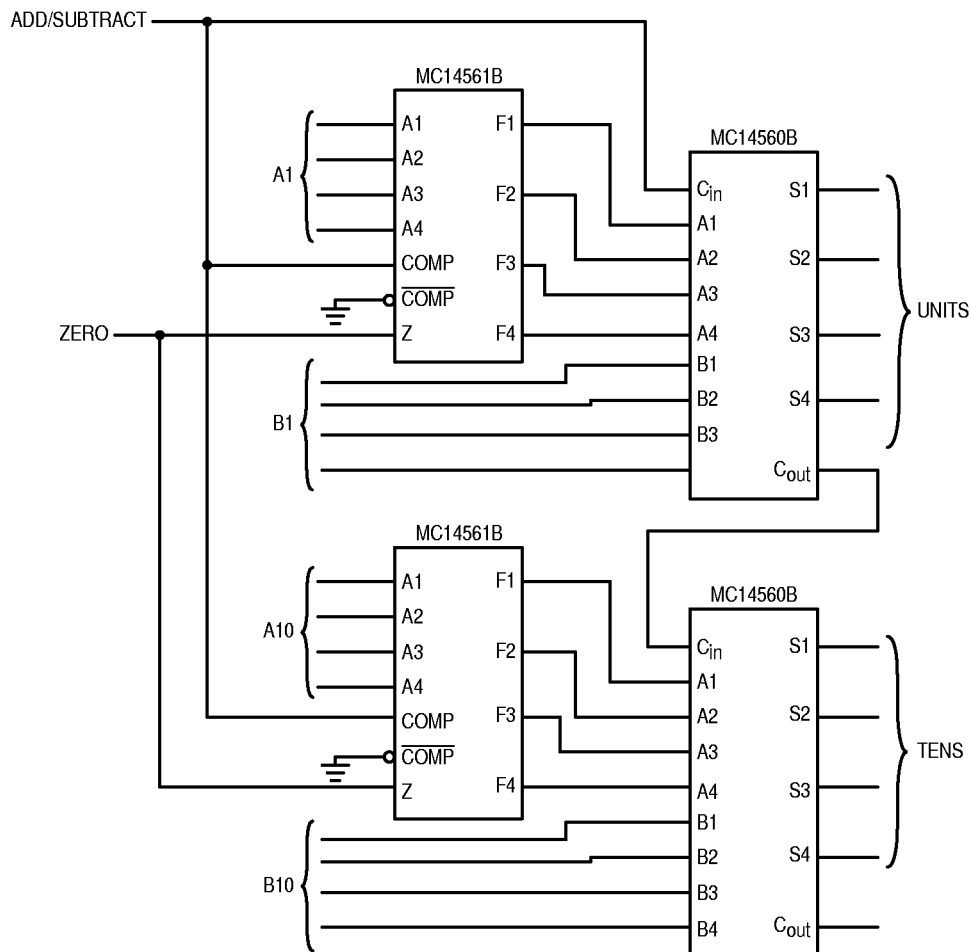
TRUTH TABLE – COMPLEMENT MODE  
(Z = 0, Comp = 1,  $\overline{\text{Comp}}$  = 0)

Decimal Equivalent Input	Inputs				Decimal Equivalent Output	Outputs				
	A4	A3	A2	A1		F4	F3	F2	F1	
0	0	0	0	0	9	1	0	0	1	
1	0	0	0	1	8	1	0	0	0	
2	0	0	1	0	7	0	1	1	1	
3	0	0	1	1	6	0	1	1	0	
4	0	1	0	0	5	0	1	0	1	
5	0	1	0	1	4	0	1	0	0	
6	0	1	1	0	3	0	0	1	1	
7	0	1	1	1	2	0	0	1	0	
8	1	0	0	0	1	0	0	0	1	
9	1	0	0	1	0	0	0	0	0	
Illegal BCD Input Codes	10	1	0	1	0	7	0	1	1	1
	11	1	0	1	1	6	0	1	1	0
	12	1	1	0	0	5	0	1	0	1
	13	1	1	0	1	4	0	1	0	0
	14	1	1	1	0	3	0	0	1	1
	15	1	1	1	1	2	0	0	1	0

## TYPICAL APPLICATIONS

One MC14560B and one MC14561B permit a BCD digit to be added to or subtracted from a second digit, such as in the typical configurations in Figures 2 and 3. A second

MC14561B permits either digit to be added to or subtracted from the other, or either word to appear unmodified at the output.



**TRUTH TABLE**

Zero	Add/Subtract	Result
0	0	B plus A
0	1	B minus A
1	X	B

X = Don't Care

**Figure 2. Parallel Add/Subtract Circuit (10's Complement)**

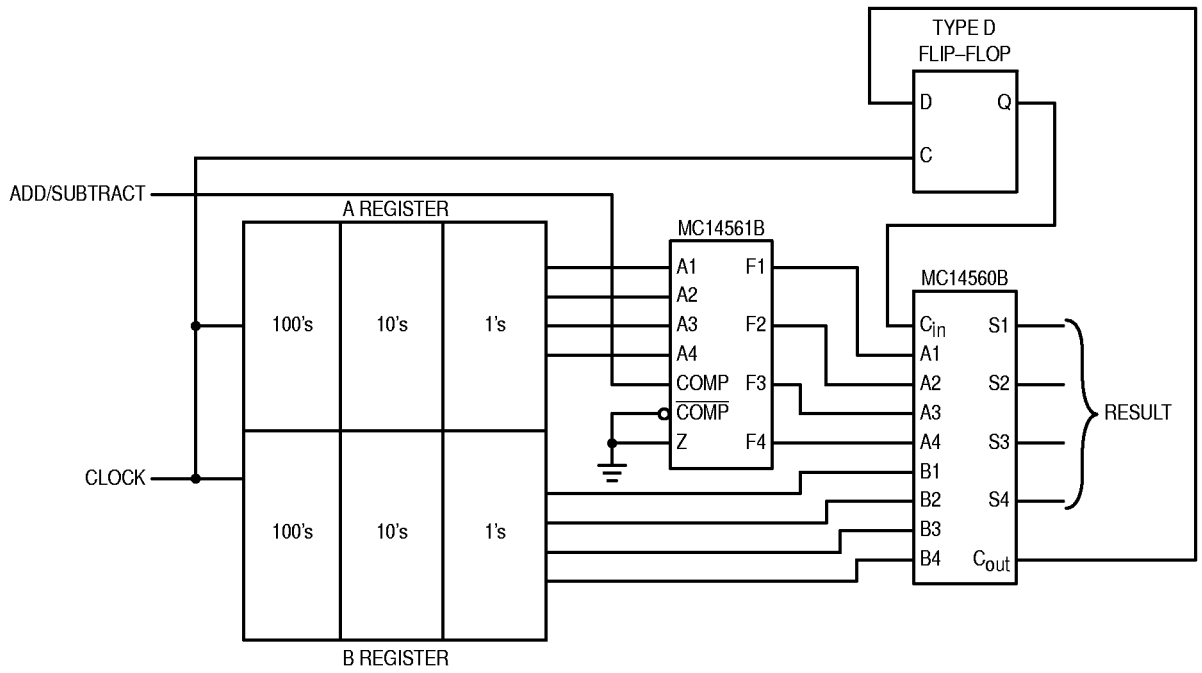
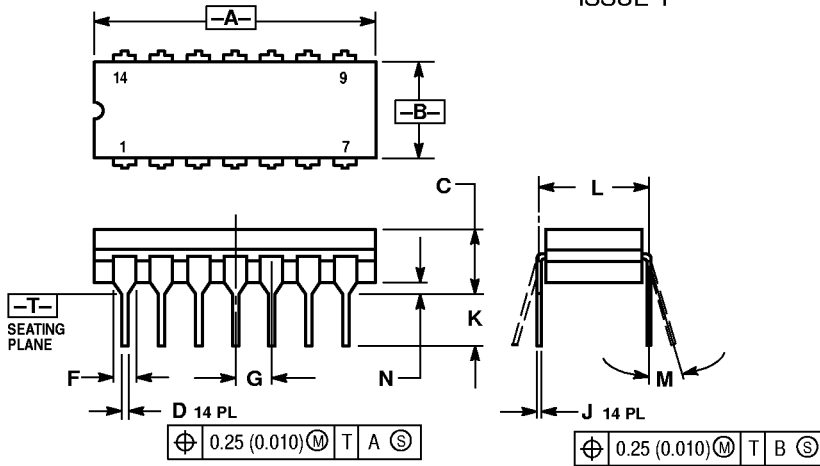


Figure 3. Serial Add/Subtract Circuit

## OUTLINE DIMENSIONS

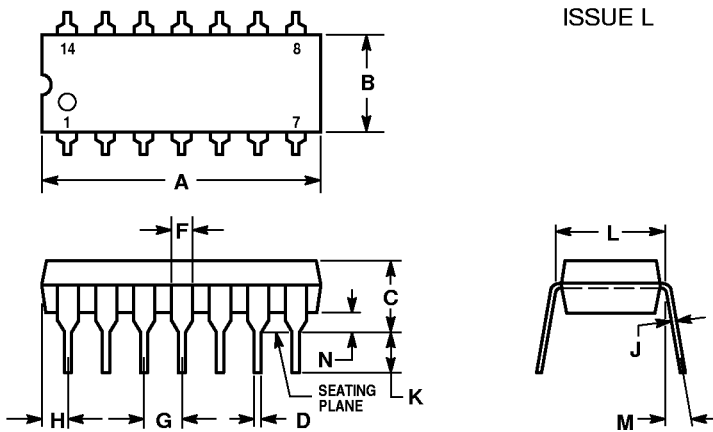
### L SUFFIX CERAMIC DIP PACKAGE CASE 632-08 ISSUE Y



- 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	19.94
B	0.245	0.280	6.23	7.11
C	0.155	0.200	3.94	5.08
D	0.015	0.020	0.39	0.50
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

### P SUFFIX PLASTIC DIP PACKAGE CASE 646-06 ISSUE L

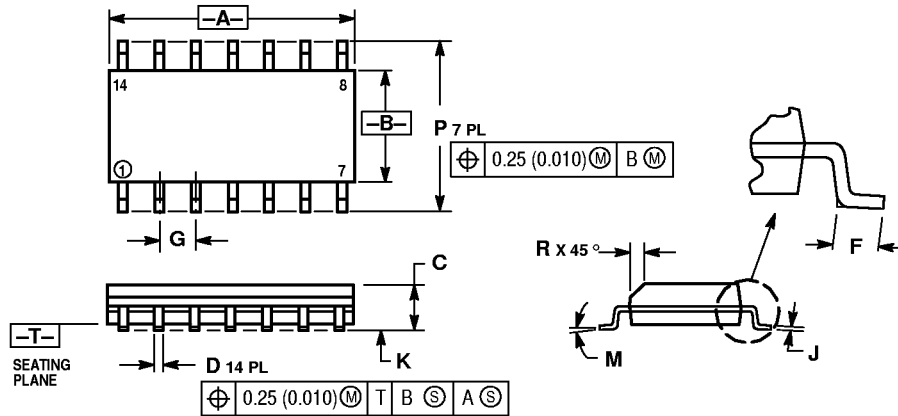


- NOTES:
1. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
  2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
  3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
  4. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.715	0.770	18.16	19.56
B	0.240	0.260	6.10	6.60
C	0.145	0.185	3.69	4.69
D	0.015	0.021	0.38	0.53
F	0.040	0.070	1.02	1.78
G	0.100 BSC		2.54 BSC	
H	0.052	0.095	1.32	2.41
J	0.008	0.015	0.20	0.38
K	0.115	0.135	2.92	3.43
L	0.300 BSC		7.62 BSC	
M	0° 10°		0° 10°	
N	0.015	0.039	0.39	1.01

## OUTLINE DIMENSIONS

### D SUFFIX PLASTIC SOIC PACKAGE CASE 751A-03 ISSUE F



- 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	8.55	8.75	0.337	0.344
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	0.228	0.244
R	0.25	0.50	0.010	0.019

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51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298



MC14561B/D

