

# 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.

### Features

- 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
- NLV Prefix for Automotive and Other Applications Requiring Unique Site and Control Change Requirements; AEC-Q100 Qualified and PPAP Capable
- This Device is Pb-Free and is RoHS Compliant

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

Symbol	Parameter	Value	Unit
$V_{DD}$	DC Supply Voltage Range	-0.5 to +18.0	V
$V_{in}, V_{out}$	Input or Output Voltage Range (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 (Note 1)	500	mW
$T_A$	Ambient Temperature Range	-55 to +125	$^{\circ}C$
$T_{stg}$	Storage Temperature Range	-65 to +150	$^{\circ}C$
$T_L$	Lead Temperature (8-Second Soldering)	260	$^{\circ}C$

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. Temperature Derating: "D/DW" Packages: -7.0 mW/ $^{\circ}C$  From 65 $^{\circ}C$  To 125 $^{\circ}C$

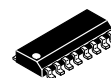
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$  should be constrained to the range  $V_{SS} \leq (V_{in} \text{ or } V_{out}) \leq V_{DD}$ .

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.



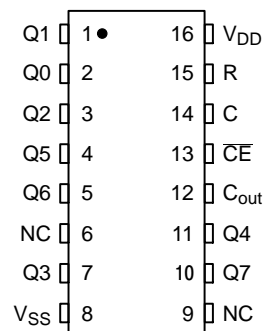
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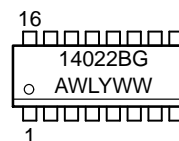
SOIC-16  
D SUFFIX  
CASE 751B

### PIN ASSIGNMENT



NC = NO CONNECTION

### MARKING DIAGRAM



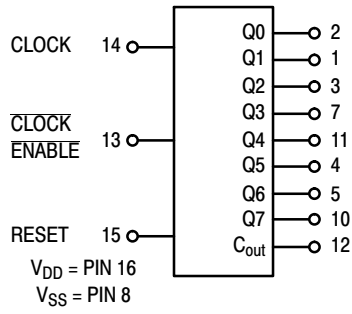
A = Assembly Location  
WL = Wafer Lot  
YY, Y = Year  
WW = Work Week  
G = Pb-Free Indicator

### ORDERING INFORMATION

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

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## BLOCK DIAGRAM



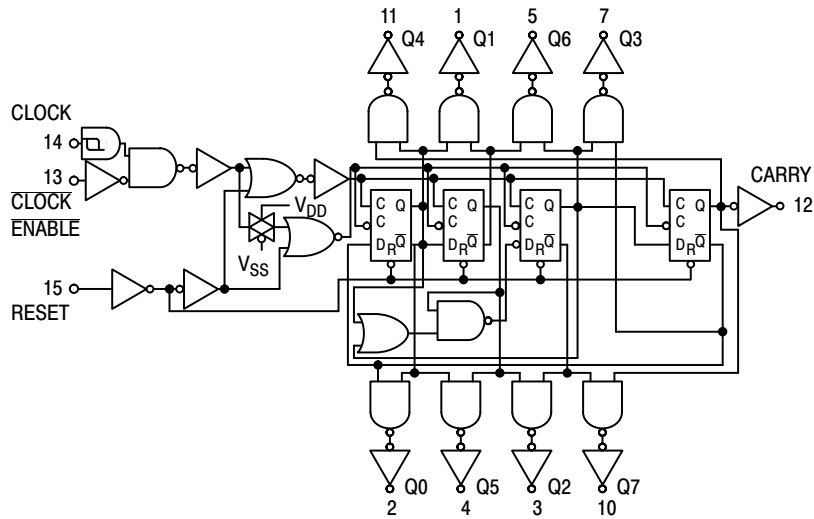
NC = PIN 6, 9

## 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



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## 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 (Note 2)	Max	Min	Max		
Output Voltage V <sub>in</sub> = V <sub>DD</sub> or 0	"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 (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)	"0" Level	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	
	"1" Level	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 (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)	Source	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	-	
	Sink	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 (Notes 3 & 4) (Dynamic plus Quiescent, Per Package) (C <sub>L</sub> = 50 pF on all outputs, all buffers switching)	I <sub>T</sub>	5.0 10 15	$I_T = (0.28 \mu\text{A}/\text{kHz})f + I_{DD}$ $I_T = (0.56 \mu\text{A}/\text{kHz})f + I_{DD}$ $I_T = (0.85 \mu\text{A}/\text{kHz})f + I_{DD}$							µAdc	

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.

- 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.

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## SWITCHING CHARACTERISTICS (Note 5) ( $C_L = 50 \text{ pF}$ , $T_A = 25^\circ\text{C}$ )

Characteristic	Symbol	$V_{DD}$ Vdc	Min	Typ (Note 6)	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 $C_{out}$ $t_{PLH}$ , $t_{PHL} = (1.7 \text{ ns/pF}) C_L + 315 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.66 \text{ ns/pF}) C_L + 142 \text{ ns}$ $t_{PLH}$ , $t_{PHL} = (0.5 \text{ ns/pF}) C_L + 100 \text{ ns}$	$t_{PLH}$ , $t_{PHL}$	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 $C_{out}$ $t_{PLH} = (1.7 \text{ ns/pF}) C_L + 315 \text{ ns}$ $t_{PLH} = (0.66 \text{ ns/pF}) C_L + 142 \text{ ns}$ $t_{PLH} = (0.5 \text{ ns/pF}) C_L + 100 \text{ ns}$	$t_{PLH}$	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

5. The formulas given are for the typical characteristics only at  $25^\circ\text{C}$ .

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

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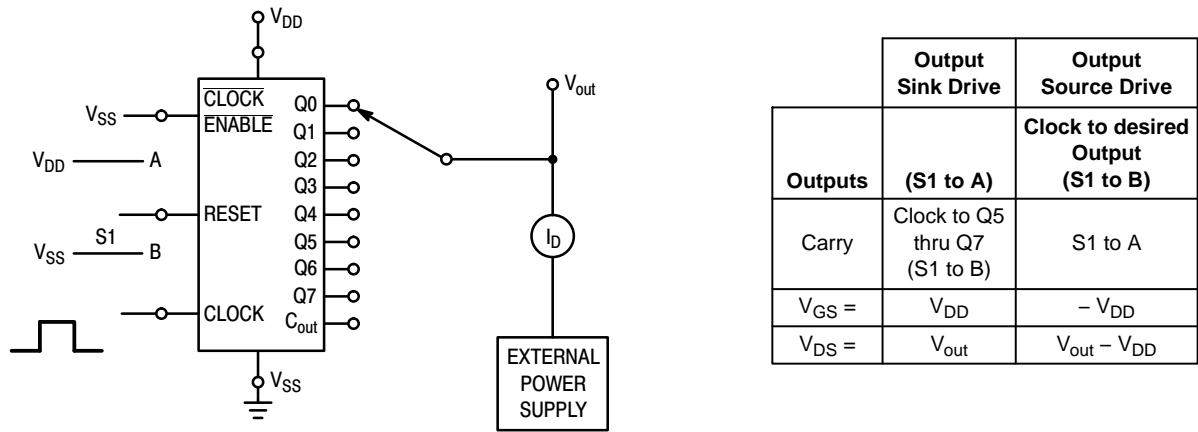


Figure 1. Typical Output Source and Output Sink Characteristics Test Circuit

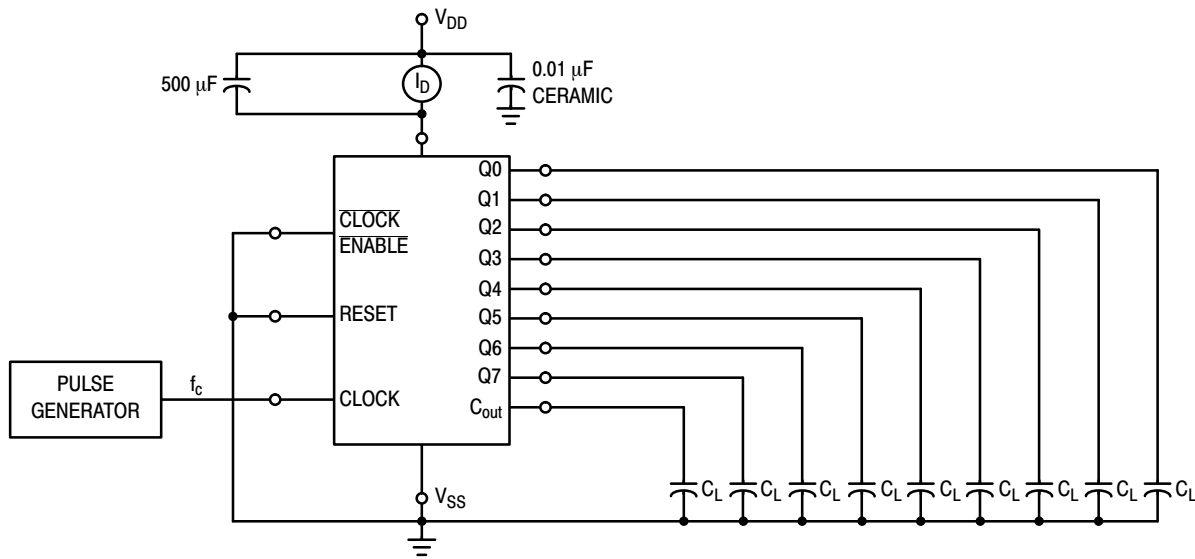


Figure 2. Typical Power Dissipation Test Circuit

## 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).

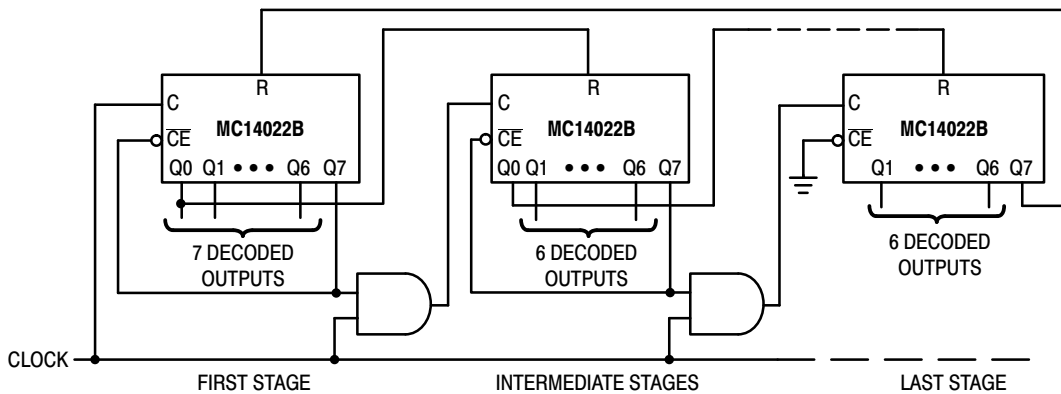


Figure 3. Counter Expansion

# MC14022B

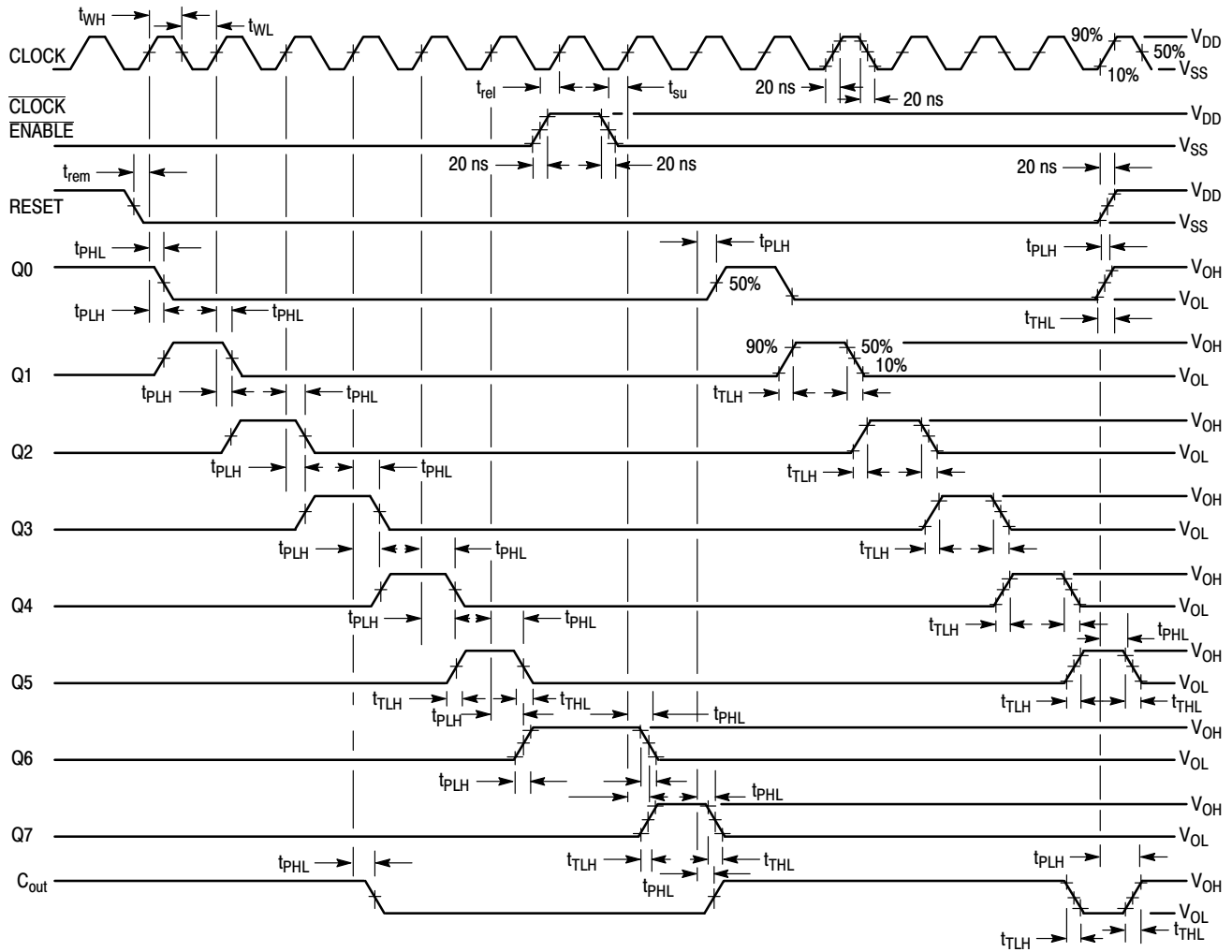


Figure 4. AC Measurement Definition and Functional Waveforms

## ORDERING INFORMATION

Device	Package	Shipping <sup>†</sup>
MC14022BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14022BDR2G	SOIC-16 (Pb-Free)	2500 Units / Tape & Reel
NLV14022BDR2G*	SOIC-16 (Pb-Free)	2500 Units / 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 Specifications Brochure, BRD8011/D.

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

# MECHANICAL CASE OUTLINE PACKAGE DIMENSIONS

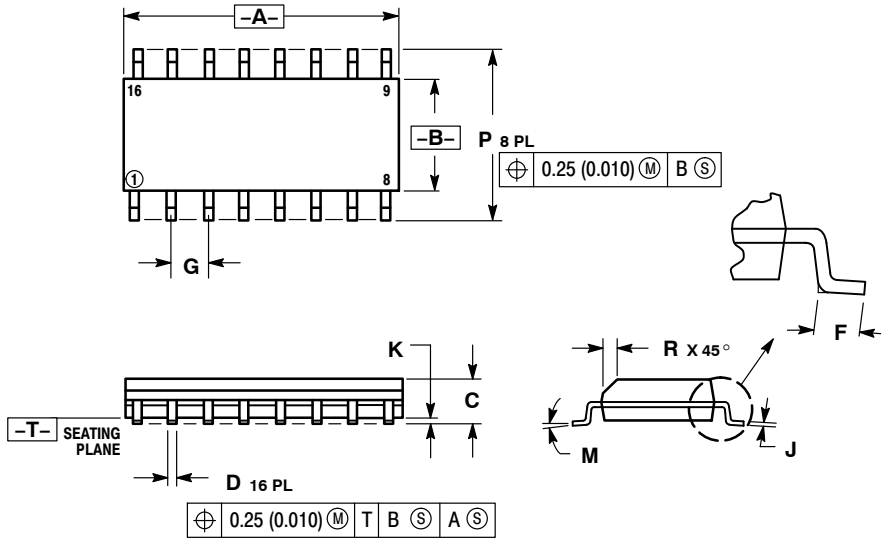
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SCALE 1:1

## SOIC-16 CASE 751B-05 ISSUE K

DATE 29 DEC 2006



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

- |  |  |  |  |
|--|--|--|--|
| <p>STYLE 1:</p> <p>PIN 1. COLLECTOR</p> <p>2. BASE</p> <p>3. EMITTER</p> <p>4. NO CONNECTION</p> <p>5. EMITTER</p> <p>6. BASE</p> <p>7. COLLECTOR</p> <p>8. COLLECTOR</p> <p>9. BASE</p> <p>10. EMITTER</p> <p>11. NO CONNECTION</p> <p>12. EMITTER</p> <p>13. BASE</p> <p>14. COLLECTOR</p> <p>15. EMITTER</p> <p>16. COLLECTOR</p>                           | <p>STYLE 2:</p> <p>PIN 1. CATHODE</p> <p>2. ANODE</p> <p>3. NO CONNECTION</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. NO CONNECTION</p> <p>7. ANODE</p> <p>8. CATHODE</p> <p>9. CATHODE</p> <p>10. ANODE</p> <p>11. NO CONNECTION</p> <p>12. CATHODE</p> <p>13. CATHODE</p> <p>14. NO CONNECTION</p> <p>15. ANODE</p> <p>16. CATHODE</p> | <p>STYLE 3:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. BASE, #1</p> <p>3. EMITTER, #1</p> <p>4. COLLECTOR, #1</p> <p>5. COLLECTOR, #2</p> <p>6. BASE, #2</p> <p>7. EMITTER, #2</p> <p>8. COLLECTOR, #2</p> <p>9. COLLECTOR, #3</p> <p>10. BASE, #3</p> <p>11. EMITTER, #3</p> <p>12. COLLECTOR, #3</p> <p>13. COLLECTOR, #4</p> <p>14. BASE, #4</p> <p>15. EMITTER, #4</p> <p>16. COLLECTOR, #4</p>   | <p>STYLE 4:</p> <p>PIN 1. COLLECTOR, DYE #1</p> <p>2. COLLECTOR, #1</p> <p>3. COLLECTOR, #2</p> <p>4. COLLECTOR, #2</p> <p>5. COLLECTOR, #3</p> <p>6. COLLECTOR, #3</p> <p>7. COLLECTOR, #4</p> <p>8. COLLECTOR, #4</p> <p>9. BASE, #4</p> <p>10. EMITTER, #4</p> <p>11. BASE, #3</p> <p>12. EMITTER, #3</p> <p>13. BASE, #2</p> <p>14. EMITTER, #2</p> <p>15. BASE, #1</p> <p>16. EMITTER, #1</p> |
| <p>STYLE 5:</p> <p>PIN 1. DRAIN, DYE #1</p> <p>2. DRAIN, #1</p> <p>3. DRAIN, #2</p> <p>4. DRAIN, #2</p> <p>5. DRAIN, #3</p> <p>6. DRAIN, #3</p> <p>7. DRAIN, #4</p> <p>8. DRAIN, #4</p> <p>9. GATE, #4</p> <p>10. SOURCE, #4</p> <p>11. GATE, #3</p> <p>12. SOURCE, #3</p> <p>13. GATE, #2</p> <p>14. SOURCE, #2</p> <p>15. GATE, #1</p> <p>16. SOURCE, #1</p> | <p>STYLE 6:</p> <p>PIN 1. CATHODE</p> <p>2. CATHODE</p> <p>3. CATHODE</p> <p>4. CATHODE</p> <p>5. CATHODE</p> <p>6. CATHODE</p> <p>7. CATHODE</p> <p>8. CATHODE</p> <p>9. ANODE</p> <p>10. ANODE</p> <p>11. ANODE</p> <p>12. ANODE</p> <p>13. ANODE</p> <p>14. ANODE</p> <p>15. ANODE</p> <p>16. ANODE</p>                                 | <p>STYLE 7:</p> <p>PIN 1. SOURCE N-CH</p> <p>2. COMMON DRAIN (OUTPUT)</p> <p>3. COMMON DRAIN (OUTPUT)</p> <p>4. GATE P-CH</p> <p>5. COMMON DRAIN (OUTPUT)</p> <p>6. COMMON DRAIN (OUTPUT)</p> <p>7. COMMON DRAIN (OUTPUT)</p> <p>8. SOURCE P-CH</p> <p>9. SOURCE P-CH</p> <p>10. COMMON DRAIN (OUTPUT)</p> <p>11. COMMON DRAIN (OUTPUT)</p> <p>12. COMMON DRAIN (OUTPUT)</p> <p>13. GATE N-CH</p> <p>14. COMMON DRAIN (OUTPUT)</p> <p>15. COMMON DRAIN (OUTPUT)</p> <p>16. SOURCE N-CH</p> |  |

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