

# MC14029B

## Binary/Decade Up/Down Counter

The MC14029B Binary/Decade up/down counter is constructed with MOS P-channel and N-channel enhancement mode devices in a single monolithic structure. The counter consists of type D flip-flop stages with a gating structure to provide toggle flip-flop capability. The counter can be used in either Binary or BCD operation. This complementary MOS counter finds primary use in up/down and difference counting and frequency synthesizer applications where low power dissipation and/or high noise immunity is desired. It is also useful in A/D and D/A conversion and for magnitude and sign generation.

### Features

- Diode Protection on All Inputs
- Supply Voltage Range = 3.0 Vdc to 18 Vdc
- Internally Synchronous for High Speed
- Logic Edge-Clocked Design – Count Occurs on Positive Going Edge of Clock
- Asynchronous Preset Enable Operation
- 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 CD4029B
- 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	°C
$T_{stg}$	Storage Temperature Range	-65 to +150	°C
$T_L$	Lead Temperature (8-Second Soldering)	260	°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/°C From 65°C To 125°C

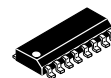
This device contains protection circuitry to guard against damage due to high static voltages or electric fields. However, precautions must be taken to avoid applications of any voltage higher than maximum rated voltages to this high-impedance circuit. For proper operation,  $V_{in}$  and  $V_{out}$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



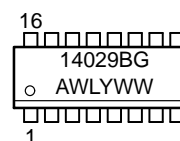
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SOIC-16  
D SUFFIX  
CASE 751B

### 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 2 of this data sheet.

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## PIN ASSIGNMENT

PE	1 ●	16	V <sub>DD</sub>
Q3	2	15	CLK
P3	3	14	Q2
P0	4	13	P2
$\overline{C}_{in}$	5	12	P1
Q0	6	11	Q1
$\overline{C}_{out}$	7	10	U/D
V <sub>SS</sub>	8	9	B/D

## TRUTH TABLE

Carry In	Up/Down	Preset Enable	Action
1	X	0	No Count
0	1	0	Count Up
0	0	0	Count Down
X	X	1	Preset

X = Don't Care

## ORDERING INFORMATION

Device	Package	Shipping†
MC14029BDR2G	SOIC-16 (Pb-Free)	2500 Units / Tape & Reel
NLV14029BDR2G*	SOIC-16 (Pb-Free)	2500 Units / 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.

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

Characteristic	Symbol	$V_{DD}$ Vdc	-55°C		25°C			125°C		Unit	
			Min	Max	Min	Typ (Note 2)	Max	Min	Max		
Output Voltage $V_{in} = V_{DD}$ or 0	"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 $V_{in} = 0$ or $V_{DD}$	$V_{OH}$	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 ( $V_O = 4.5$ or $0.5$ Vdc) ( $V_O = 9.0$ or $1.0$ Vdc) ( $V_O = 13.5$ or $1.5$ Vdc)	"0" Level $V_{IL}$	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		
	"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)	$V_{IH}$	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)	Source $I_{OH}$	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 $I_{OL}$	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	$I_{in}$	15	–	$\pm 0.1$	–	$\pm 0.00001$	$\pm 0.1$	–	$\pm 1.0$	$\mu$ Adc	
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	$\mu$ Adc	
		10	–	10	–	0.010	10	–	300		
		15	–	20	–	0.015	20	–	600		
Total Supply Current (Notes 3 & 4) (Dynamic plus Quiescent, Per Package) ( $C_L = 50$ pF on all outputs, all buffers switching)	$I_T$	5.0	$I_T = (0.58 \mu A/kHz) f + I_{DD}$								$\mu$ Adc
		10	$I_T = (1.20 \mu A/kHz) f + I_{DD}$								
		15	$I_T = (1.70 \mu A/kHz) f + I_{DD}$								

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.

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

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

4. 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  $\mu A$  (per package),  $C_L$  in pF,  $V = (V_{DD} - V_{SS})$  in volts,  $f$  in kHz is input frequency, and  $k = 0.001$ .

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

Characteristic	Symbol	$V_{DD}$	All Types			Unit
			Min	Typ (Note 6)	Max	
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 Clk to Q $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	– – –	200 100 90	400 200 180	ns
Clk to $\overline{C_{out}}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	– – –	250 130 85	500 260 190	ns
$\overline{C_{in}}$ to $\overline{C_{out}}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 95 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 47 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 35 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	– – –	175 50 50	360 120 100	ns
PE to Q $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 230 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 97 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 75 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	– – –	235 100 80	470 200 160	ns
PE to $\overline{C_{out}}$ $t_{PLH}, t_{PHL} = (1.7 \text{ ns/pF}) C_L + 465 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.66 \text{ ns/pF}) C_L + 192 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.5 \text{ ns/pF}) C_L + 125 \text{ ns}$	$t_{PLH},$ $t_{PHL}$	5.0 10 15	– – –	320 145 105	640 290 210	ns
Clock Pulse Width	$t_{W(cl)}$	5.0 10 15	180 80 60	90 40 30	– – –	ns
Clock Pulse Frequency	$f_{cl}$	5.0 10 15	– – –	4.0 8.0 10	2.0 4.0 5.0	MHz
Preset Removal Time The Preset Signal must be low prior to a positive-going transition of the clock.	$t_{rem}$	5.0 10 15	160 80 60	80 40 30	– – –	ns
Clock Rise and Fall Time	$t_{r(cl)}$ $t_{f(cl)}$	5.0 10 15	– – –	– – –	15 5 4	$\mu\text{s}$
Carry In Setup Time	$t_{su}$	5.0 10 15	150 60 40	75 30 20	– – –	ns
Up/Down Setup Time		5.0 10 15	340 140 100	170 70 50	– – –	ns
Binary/Decade Setup Time		5.0 10 15	320 140 100	160 70 50	– – –	ns
Preset Enable Pulse Width	$t_w$	5.0 10 15	130 70 50	65 35 25	– – –	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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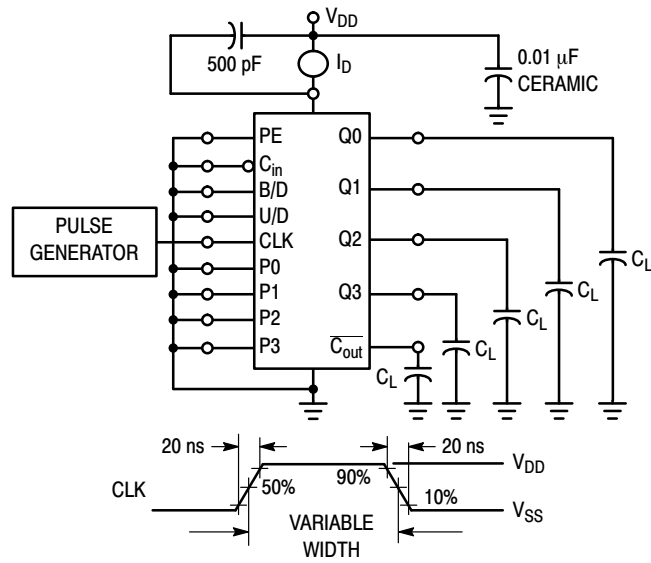


Figure 1. Power Dissipation Test Circuit and Waveform

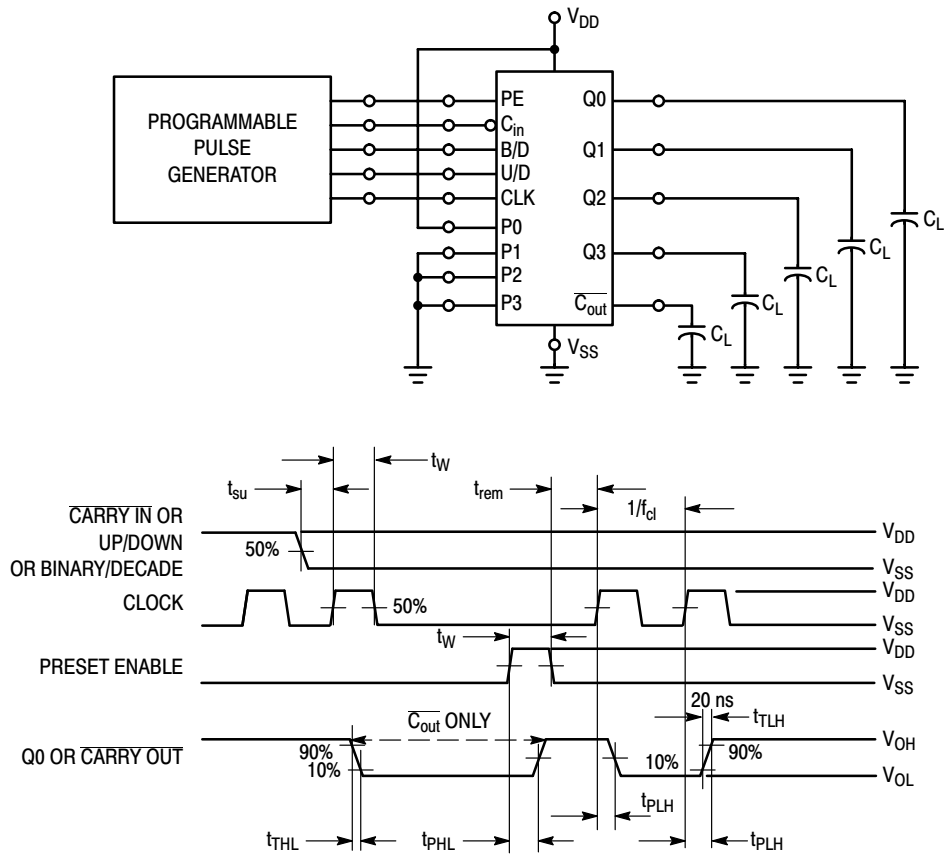
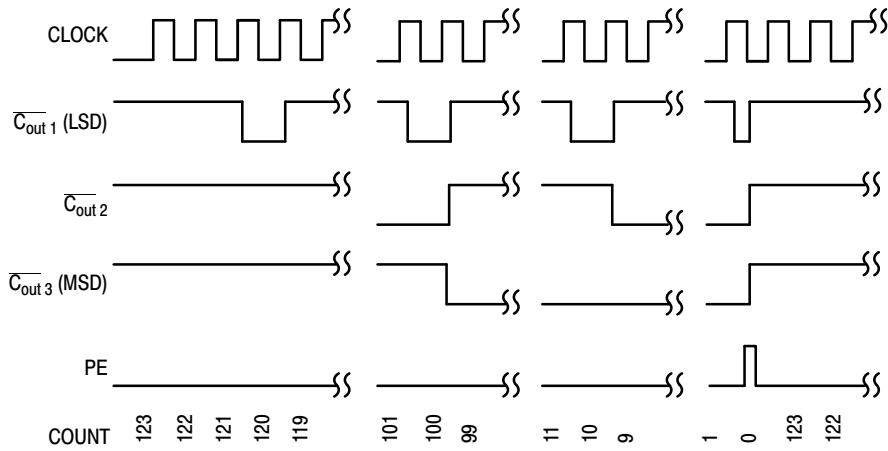
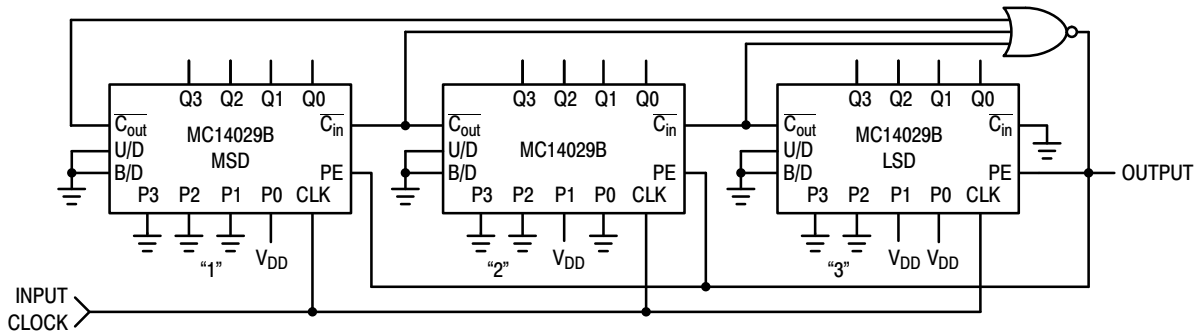
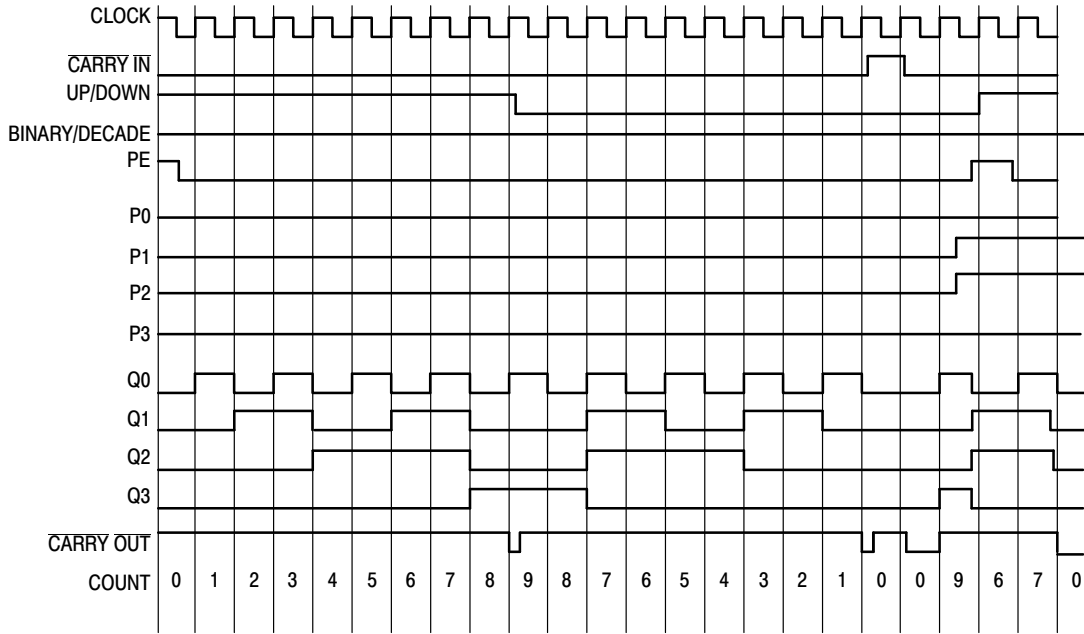


Figure 2. Switching Time Test Circuit and Waveforms

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## TIMING DIAGRAM

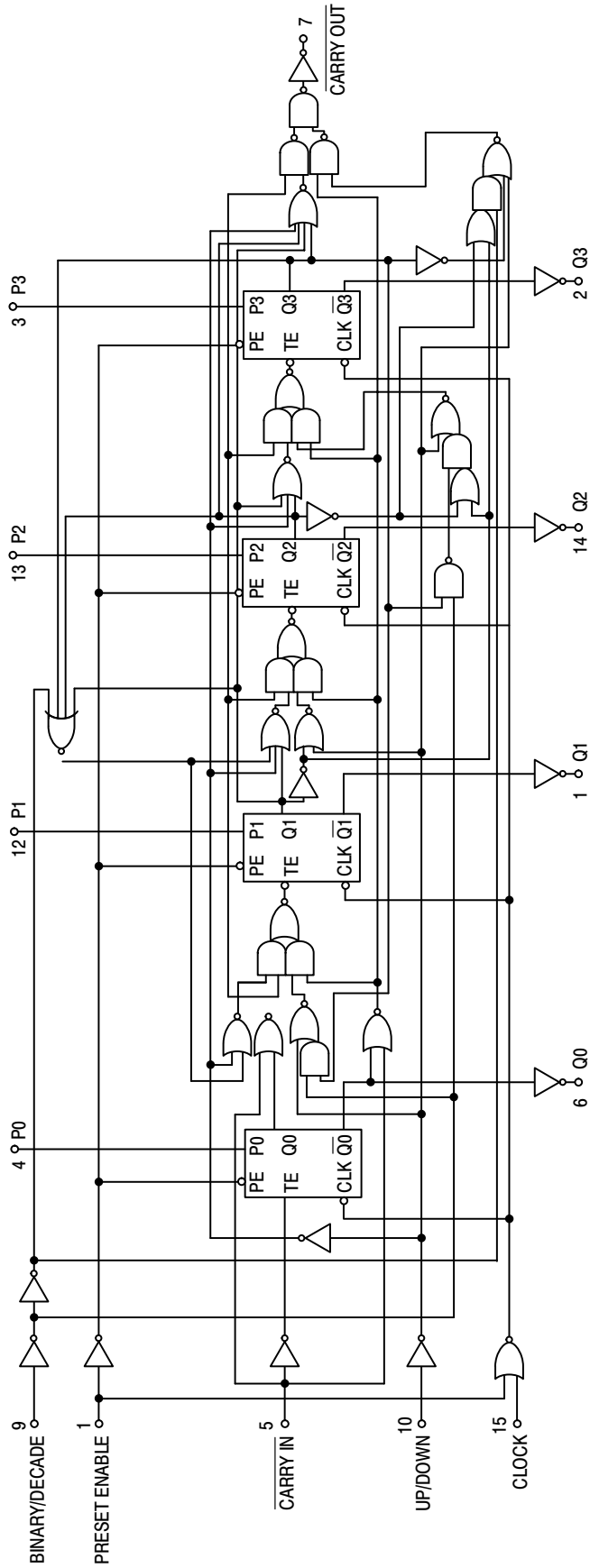


\* $t_{w} \cong 900 \text{ ns} @ V_{DD} = 5 \text{ V}$

Figure 3. Divide by N BCD Down Counter and Timing Diagram (Shown for N = 123)

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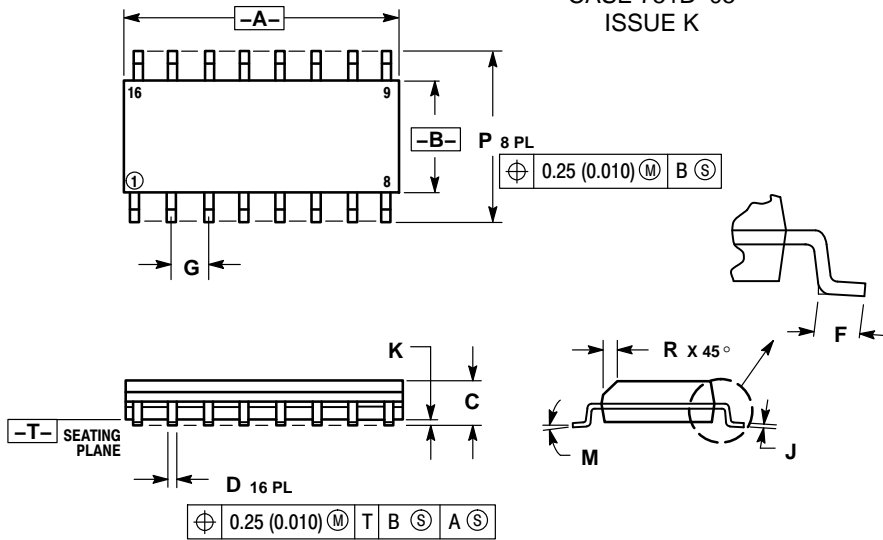
## LOGIC DIAGRAM



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## PACKAGE DIMENSIONS

SOIC-16  
D SUFFIX  
PLASTIC SOIC PACKAGE  
CASE 751B-05  
ISSUE K

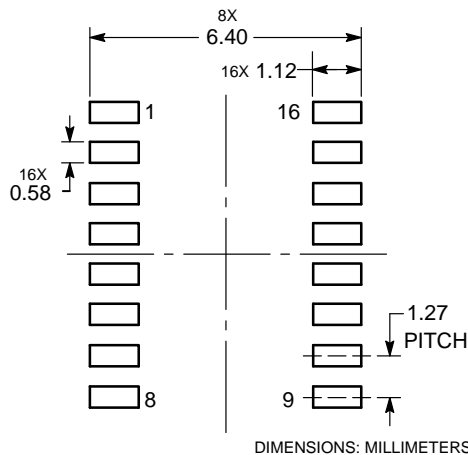


**NOTES:**

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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