

MOTOROLA

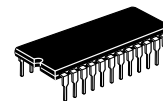
SEMICONDUCTOR TECHNICAL DATA

MC14534B

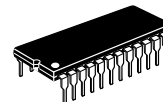
5 Cascaded BCD Counters

The MC14534B is composed of five BCD ripple counters that have their respective outputs multiplexed using an internal scanner. Outputs of each counter are selected by the scanner and appear on four (BCD) pins. Selection is indicated by a logic high on the appropriate digit select pin. Both BCD and digit select outputs have three-state controls providing an "open-circuit" when these controls are high and allowing multiplexing. Cascading may be accomplished by using the carry-out pin. The counters and scanner can be independently reset by applying a high to the counter master reset (MR) and the scanner reset (SR). The MC14534B was specifically designed for application in real time or event counters where continual updating and multiplexed displays are used.

- Four Operating Modes (See truth table)
- Input Error Detection Circuit
- Clock Conditioning Circuits for Slow Transition Inputs
- Counter Sequences on Positive Transition of Clock A
- 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



L SUFFIX
CERAMIC
CASE 623



P SUFFIX
PLASTIC
CASE 709



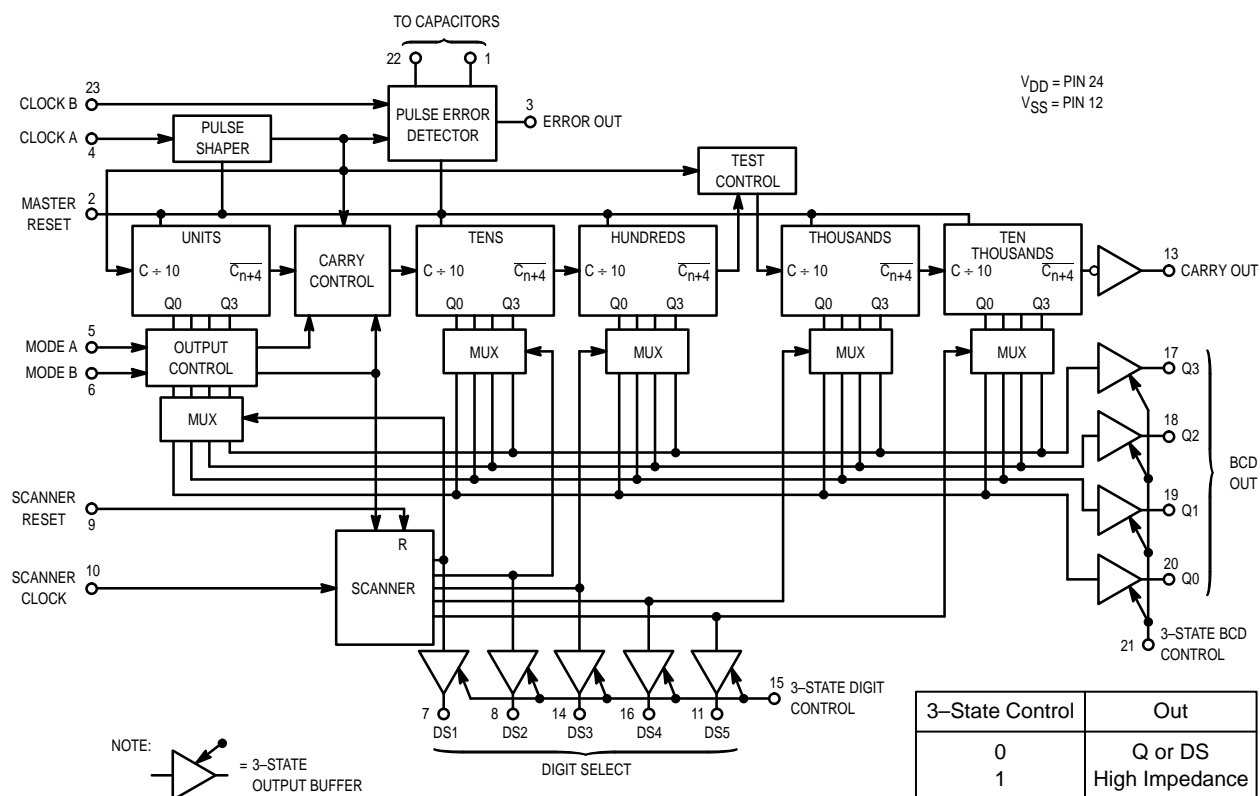
DW SUFFIX
SOIC
CASE 751E

ORDERING INFORMATION

MC14XXXBCP Plastic
MC14XXXBCL Ceramic
MC14XXXBDW SOIC

$T_A = -55^\circ$ to 125°C for all packages.

BLOCK DIAGRAM



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	± 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

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	"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		
$V_{in} = 0$ or V_{DD}	"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 ($V_O = 4.5$ 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	—	1.0	—	1.5	1.0	—	1.0	Vdc
		10	—	2.0	—	3.0	2.0	—	2.0	
		15	—	3.0	—	4.5	3.0	—	3.0	
	"1" Level V_{IH}	5.0	4.0	—	4.0	3.5	—	4.0	—	Vdc
		10	8.0	—	8.0	7.0	—	8.0	—	
		15	12	—	12	11	—	12	—	
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	—	
Output Drive Current — Pins 1 and 22 ($V_{OH} = 2.5$ Vdc) ($V_{OH} = 9.5$ Vdc) ($V_{OH} = 13.5$ Vdc)	Source I_{OH}	5.0	- 0.31	—	- 0.25	- 0.8	—	- 0.17	—	mAdc
		10	- 0.31	—	- 0.25	- 0.4	—	- 0.17	—	
		15	- 0.9	—	- 0.75	- 1.6	—	- 0.51	—	
	Sink I_{OL}	5.0	0.024	—	0.02	0.03	—	0.014	—	mAdc
		10	0.06	—	0.05	0.09	—	0.035	—	
		15	1.3	—	0.25	1.63	—	0.175	—	
Input Current	I_{in}	15	—	± 0.1	—	± 0.00001	± 0.1	—	± 1.0	μ Adc
Input Capacitance ($V_{in} = 0$)	C_{in}	—	—	—	—	5.0	7.5	—	—	pF

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

(continued)

ELECTRICAL CHARACTERISTICS (Voltages Referenced to V_{SS}) (continued)

Characteristic	Symbol	V_{DD} Vdc	- 55° C		25° C			125° C		Unit	
			Min	Max	Min	Typ #	Max	Min	Max		
Quiescent Current (Per Package)	I_{DD}	5.0	—	5.0	—	0.010	5.0	—	150	μ Adc	
		10	—	10	—	0.020	10	—	300		
		15	—	20	—	0.030	20	—	600		
Total Supply Current**† (Dynamic plus Quiescent, Per Package) ($C_L = 50$ pF on all outputs, all buffers switching)	I_T	5.0	$I_T = (0.5 \mu\text{A/kHz}) f + I_{DD}$ Scan Oscillator $I_T = (1.0 \mu\text{A/kHz}) f + I_{DD}$ Frequency = 1.0 kHz $I_T = (1.5 \mu\text{A/kHz}) f + I_{DD}$								μ Adc
		10									
		15									
Three-State Leakage Current	I_{TL}	15	—	± 0.1	—	± 0.0001	± 0.1	—	± 3.0	μ Adc	

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

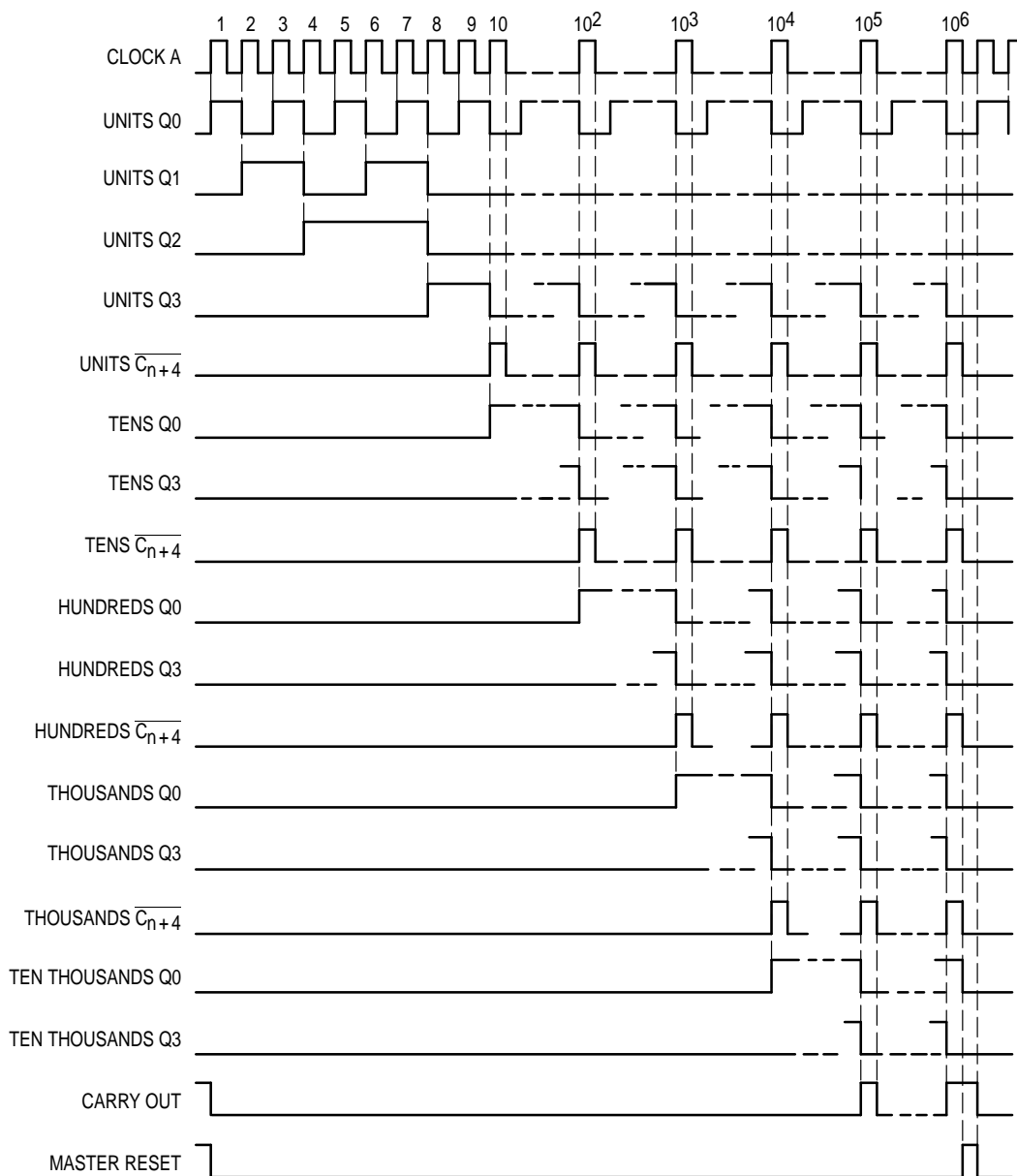
SWITCHING CHARACTERISTICS* ($C_L = 50$ pF, $T_A = 25^\circ\text{C}$, see Figure 1)

Characteristic	Symbol	V _{DD} Vdc	Min	Typ #	Max	Unit		
Output Rise and Fall Time	t_{TLH} , t_{THL}	5.0	—	100	200	ns		
		10	—	50	100			
		15	—	40	80			
Propagation Delay Time, Clock to Q t_{PLH} , $t_{PHL} = (1.8 \text{ ns/pF}) C_L + 4.0 \mu\text{s}$ t_{PLH} , $t_{PHL} = (0.8 \text{ ns/pF}) C_L + 1.5 \mu\text{s}$ t_{PLH} , $t_{PHL} = (0.6 \text{ ns/pF}) C_L + 1.0 \mu\text{s}$ Clock to Carry Out $t_{PLH} = (1.8 \text{ ns/pF}) C_L + 3.3 \mu\text{s}$ $t_{PLH} = (0.8 \text{ ns/pF}) C_L + 1.1 \mu\text{s}$ $t_{PLH} = (0.6 \text{ ns/pF}) C_L + 0.8 \mu\text{s}$ Master Reset to Q $t_{PHL} = (1.8 \text{ ns/pF}) C_L + 1.8 \mu\text{s}$ $t_{PHL} = (0.8 \text{ ns/pF}) C_L + 0.6 \mu\text{s}$ $t_{PHL} = (0.6 \text{ ns/pF}) C_L + 0.5 \mu\text{s}$ Master Reset to Error Out $t_{PHL} = (1.8 \text{ ns/pF}) C_L + 0.57 \mu\text{s}$ $t_{PHL} = (0.8 \text{ ns/pF}) C_L + 0.19 \mu\text{s}$ $t_{PHL} = (0.6 \text{ ns/pF}) C_L + 0.11 \mu\text{s}$ Scanner Clock to Q t_{PLH} , $t_{PHL} = (1.8 \text{ ns/pF}) C_L + 1.8 \mu\text{s}$ t_{PLH} , $t_{PHL} = (0.8 \text{ ns/pF}) C_L + 0.6 \mu\text{s}$ t_{PLH} , $t_{PHL} = (0.6 \text{ ns/pF}) C_L + 0.5 \mu\text{s}$ Scanner Clock to Digit Select t_{PHL} , $t_{PLH} = (1.8 \text{ ns/pF}) C_L + 1.5 \mu\text{s}$ t_{PHL} , $t_{PLH} = (0.8 \text{ ns/pF}) C_L + 0.5 \mu\text{s}$ t_{PHL} , $t_{PLH} = (0.6 \text{ ns/pF}) C_L + 0.4 \mu\text{s}$	t_{PLH} , t_{PHL}	5.0	—	4.0	8.0	μs		
		10	—	1.5	3.0			
		15	—	1.0	2.25			
	t_{PLH}	5.0	—	3.3	6.6	μs		
			10	—	1.1		2.2	
			15	—	0.8		1.7	
	t_{PHL}	5.0	—	1.8	3.6	μs		
			10	—	0.6		1.2	
			15	—	0.5		0.9	
	t_{PHL}	5.0	—	0.6	1.5	μs		
			10	—	0.2		.5	
			15	—	0.12		0.38	
	t_{PLH} , t_{PHL}	5.0	—	1.8	3.6	μs		
			10	—	0.6		1.2	
			15	—	0.5		0.9	
	t_{PLH} , t_{PLH}	5.0	—	1.5	3.0	μs		
			10	—	0.5		1.0	
			15	—	0.4		0.75	
	Propagation Delay Time 3-State Control to Q	t_{PHZ}	5.0	—	75	150	ns	
			10	—	45	90		
			15	—	40	80		
		t_{PZH}	5.0	—	120	240	ns	
				10	—	55		110
				15	—	40		80
t_{PLZ}		5.0	—	120	240	ns		
			10	—	55		110	
			15	—	45		90	
t_{PZL}		5.0	—	160	320	ns		
			10	—	70		140	
			15	—	45		90	
Clock Pulse Frequency	f_{cl}	5.0	—	1.0	0.5	MHz		
		10	—	3.0	1.0			
		15	—	5.0	1.2			
Clock or Scanner Clock Pulse Width	t_{WH}	5.0	1000	500	—	ns		
		10	500	190	—			
		15	375	125	—			
Scanner Reset Pulse Width	t_w	5.0	320	160	—	ns		
		10	130	65	—			
		15	80	40	—			
Scanner Reset Removal Time	t_{rem}	5.0	900	270	—	ns		
		10	150	80	—			
		15	100	50	—			
Master Reset Pulse Width	$t_{WH(R)}$	5.0	2000	900	—	ns		
		10	600	300	—			
		15	450	250	—			
Master Reset Removal Time	t_{rem}	5.0	1060	550	—	ns		
		10	350	205	—			
		15	250	140	—			

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

#Data labelled "Typ" is not to be used for design purposes but is intended as an indication of the IC's potential performance. www.DataSheet4U.com

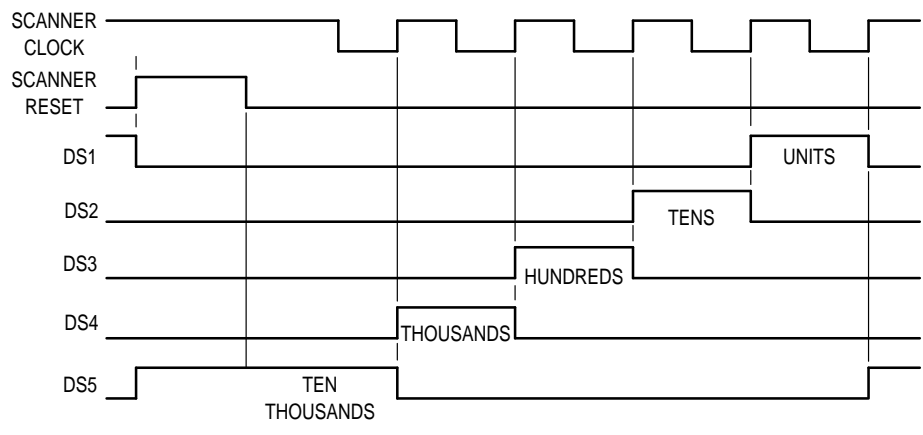
COUNTER TIMING DIAGRAM



MODE CONTROL TRUTH TABLE

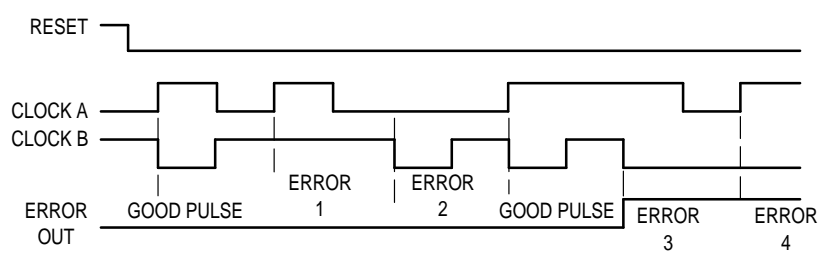
Mode A	Mode B	First Stage Output	Carry to Second Stage	Application
0	0	Normal Count and Display	At 9 to 0 transition of first stage	5-digit Counter
0	1	Inhibited	Input Clock	Test Mode: Clock directly into stages 1, 2, and 4.
1	1	Inhibited	At 4 to 5 transition of first stage	4-digit counter with $\div 10$ and roundoff at front end.
1	0	Counts 3, 4, 5, 6, 7 = 5 Counts 8, 9, 0, 1, 2 = 0	At 7 to 8 transition of first stage	4-digit counter with 1/2 pence capability.

SCANNER TIMING DIAGRAM



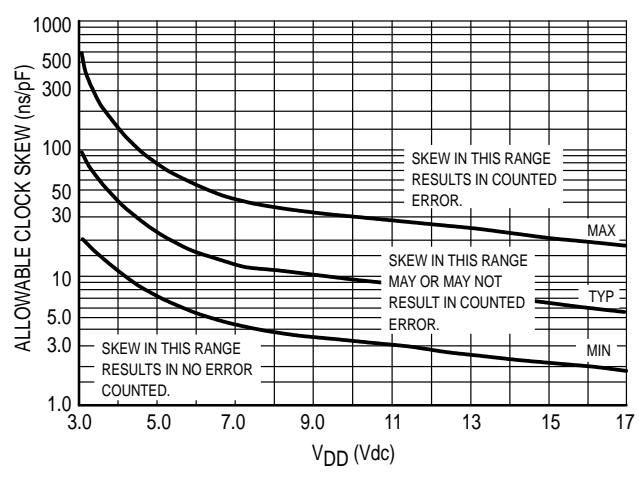
NOTE: If Mode B = 1, the first decade is inhibited and S1 will not go high, and the cycle will be shortened to four stages. DS5 is selected automatically when Scanner Reset goes high.

ERROR DETECTION TIMING DIAGRAM



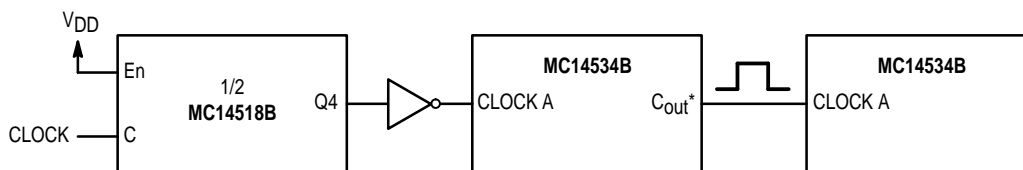
NOTE: Error detector looks for inverted pulse on Clock B. Whenever a positive edge at Clock A is not accompanied by a negative pulse at Clock B (or vice-versa) within a time period of the one-shots an error is counted. Three errors result in Error Out to go to a "1". If error detection is not needed, tie Clock B high or low and leave Pins 1 and 22 unconnected.

CLOCK SKEW RANGE



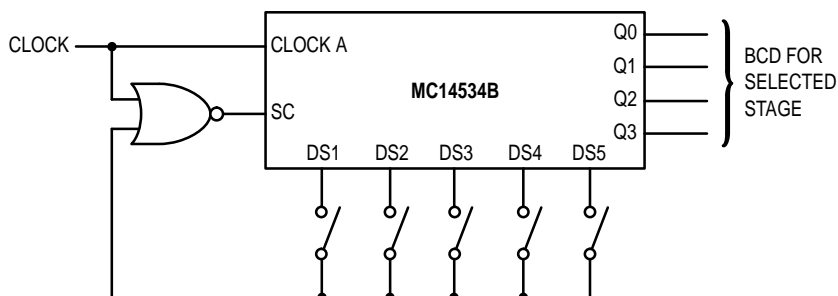
- NOTES:
1. The skew is the time difference between the low-to-high transition of C_A to the high-to-low transition of C_B or vice-versa. Capacitors C₁ = C₂₂ tied from pins 1 and 22 to V_{SS}.
 2. This graph is accurate for C₁ = C₂₂ ≥ 100 pF.
 3. When the error detection circuitry is not used, pins 1 and 22 are left open.

APPLICATIONS INFORMATION



* Carry Out is high for a single clock period when all five BCD stages go to zero. (Carry Out also goes high when MR is applied.)

Figure 1. Cascade Operation



When the Q outputs of a given stage are required, this configuration will lock up the selected stage within four clock cycles. The select line feedback can be hardwired or switched.

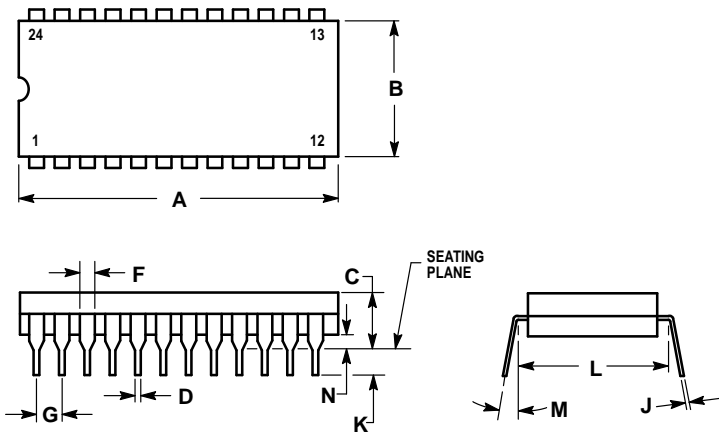
Figure 2. Forcing a BCD Stage to the Q Outputs

PIN ASSIGNMENT

C _{ext}	1	24	V _{DD}
MR	2	23	CLOCK B
E _{out}	3	22	C _{ext}
CLOCK A	4	21	3-ST BCD
MODE A	5	20	Q0
MODE B	6	19	Q1
DS1	7	18	Q2
DS2	8	17	Q3
SR	9	16	DS4
SC	10	15	3-ST DIG
DS5	11	14	DS3
V _{SS}	12	13	C _{out}

OUTLINE DIMENSIONS

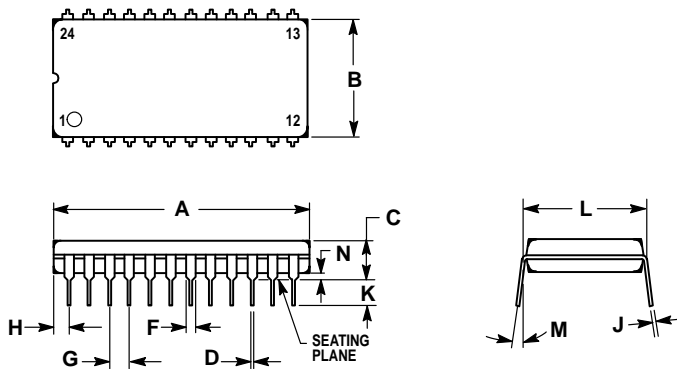
L SUFFIX CERAMIC DIP PACKAGE CASE 623-05 ISSUE M



- NOTES:
1. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 2. LEADS WITHIN 0.13 (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION (WHEN FORMED PARALLEL).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.24	32.77	1.230	1.290
B	12.70	15.49	0.500	0.610
C	4.06	5.59	0.160	0.220
D	0.41	0.51	0.016	0.020
F	1.27	1.52	0.050	0.060
G	2.54 BSC		0.100 BSC	
J	0.20	0.30	0.008	0.012
K	3.18	4.06	0.125	0.160
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.27	0.020	0.050

P SUFFIX PLASTIC DIP PACKAGE CASE 709-02 ISSUE C

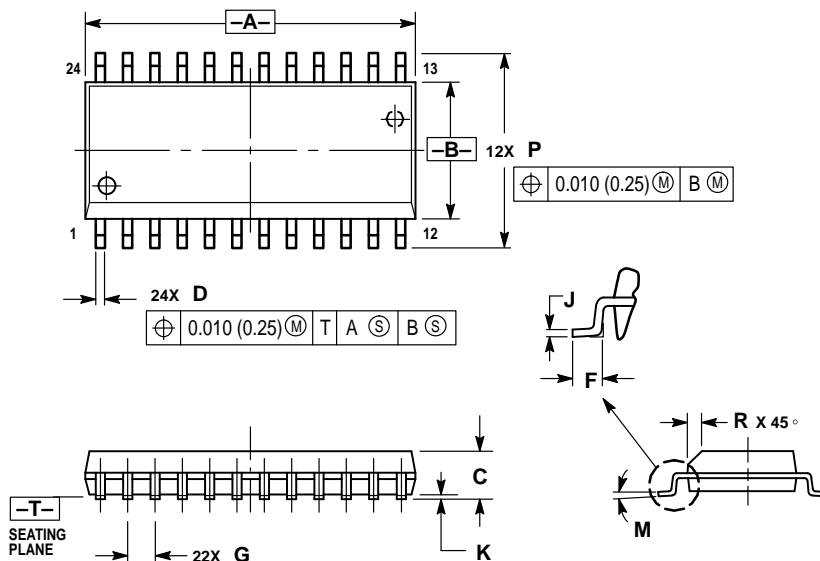


- NOTES:
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25 (0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
 2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	31.37	32.13	1.235	1.265
B	13.72	14.22	0.540	0.560
C	3.94	5.08	0.155	0.200
D	0.36	0.56	0.014	0.022
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	1.65	2.03	0.065	0.080
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	15.24 BSC		0.600 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

OUTLINE DIMENSIONS


DW SUFFIX PLASTIC SOIC PACKAGE CASE 751E-04 ISSUE E



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 0.13 (0.005) TOTAL IN EXCESS OF D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	15.25	15.54	0.601	0.612
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.41	0.90	0.016	0.035
G	1.27 BSC		0.050 BSC	
J	0.23	0.32	0.009	0.013
K	0.13	0.29	0.005	0.011
M	0°	8°	0°	8°
P	10.05	10.55	0.395	0.415
R	0.25	0.75	0.010	0.029

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USA/EUROPE/Locations Not Listed: Motorola Literature Distribution;
P.O. Box 20912; Phoenix, Arizona 85036. 1-800-441-2447 or 602-303-5454

MFAX: RMFAX0@email.sps.mot.com – TOUCHTONE 602-244-6609
INTERNET: <http://Design-NET.com>

JAPAN: Nippon Motorola Ltd.; Tatsumi-SPD-JLDC, 6F Seibu-Butsuryu-Center,
3-14-2 Tatsumi Koto-Ku, Tokyo 135, Japan. 03-81-3521-8315

ASIA/PACIFIC: Motorola Semiconductors H.K. Ltd.; 8B Tai Ping Industrial Park,
51 Ting Kok Road, Tai Po, N.T., Hong Kong. 852-26629298

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MC14534B/D

