

MC14538B

Dual Precision Retriggerable/Resetable Monostable Multivibrator

The MC14538B is a dual, retriggerable, resettable monostable multivibrator. It may be triggered from either edge of an input pulse, and produces an accurate output pulse over a wide range of widths, the duration and accuracy of which are determined by the external timing components, C_X and R_X . Output Pulse Width $T = R_X \cdot C_X$ (secs)

$$R_X = \Omega$$

$$C_X = \text{Farads}$$

Features

- Unlimited Rise and Fall Time Allowed on the A Trigger Input
- Pulse Width Range = 10 μ s to 10 s
- Latched Trigger Inputs
- Separate Latched Reset Inputs
- 3.0 Vdc to 18 Vdc Operational Limits
- Triggerable from Positive (A Input) or Negative-Going Edge (B-Input)
- Capable of Driving Two Low-Power TTL Loads or One Low-Power Schottky TTL Load Over the Rated Temperature Range
- Pin-for-pin Compatible with MC14528B and CD4528B (CD4098)
- Use the MC54/74HC4538A for Pulse Widths Less Than 10 μ s with Supplies Up to 6 V
- These Devices are Pb-Free and are 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	± 10	mA
P_D	Power Dissipation, per Package (Note 1)	500	mW
T_A	Operating Temperature Range	-55 to +125	$^{\circ}\text{C}$
T_{stg}	Storage Temperature Range	-65 to +150	$^{\circ}\text{C}$
T_L	Lead Temperature (8-Second Soldering)	260	$^{\circ}\text{C}$

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Temperature Derating:

Plastic "P and D/DW" Packages: - 7.0 mW/ $^{\circ}\text{C}$ From 65 $^{\circ}\text{C}$ To 125 $^{\circ}\text{C}$

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

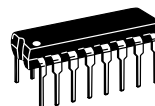
Unused inputs must always be tied to an appropriate logic voltage level (e.g., either V_{SS} or V_{DD}). Unused outputs must be left open.



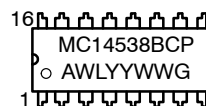
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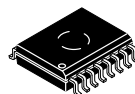
MARKING DIAGRAMS



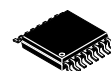
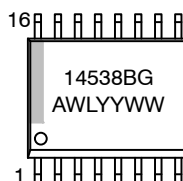
PDIP-16
P SUFFIX
CASE 648



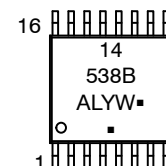
SOIC-16
D SUFFIX
CASE 751B



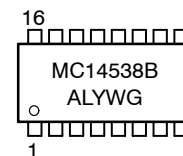
SOIC-16WB
DW SUFFIX
CASE 751G



TSSOP-16
DT SUFFIX
CASE 948F



SOEIAJ-16
F SUFFIX
CASE 966



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

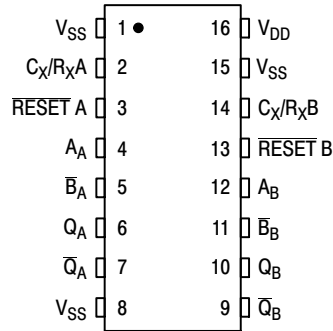
(Note: Microdot may be in either location)

ORDERING INFORMATION

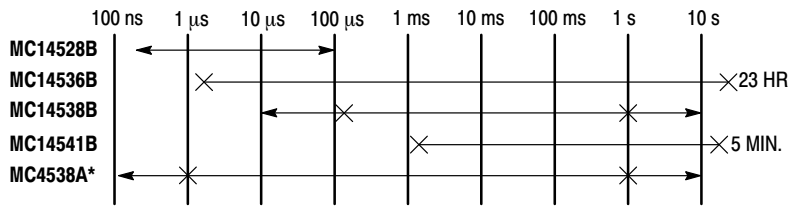
See detailed ordering and shipping information in the package dimensions section on page 2 of this data sheet.

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PIN ASSIGNMENT



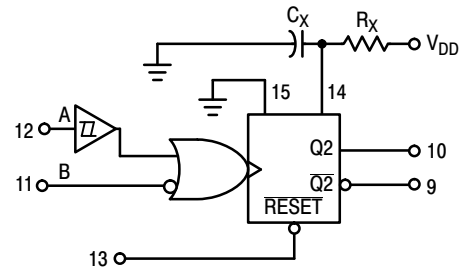
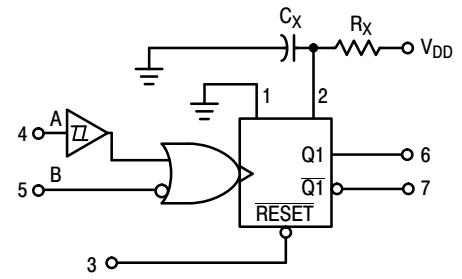
ONE-SHOT SELECTION GUIDE



*LIMITED OPERATING VOLTAGE (2 - 6 V)

TOTAL OUTPUT PULSE WIDTH RANGE
RECOMMENDED PULSE WIDTH RANGE

BLOCK DIAGRAM



R_X AND C_X ARE EXTERNAL COMPONENTS.
V_{DD} = PIN 16
V_{SS} = PIN 8, PIN 1, PIN 15

ORDERING INFORMATION

Device	Package	Shipping [†]
MC14538BCPG	PDIP-16 (Pb-Free)	500 Units / Rail
MC14538BDG	SOIC-16 (Pb-Free)	48 Units / Rail
MC14538BDR2G	SOIC-16 (Pb-Free)	2500 Units / Tape & Reel
MC14538BDWG	SOIC-16 WB	47 Units / Rail
MC14538BDWR2G	SOIC-16 WB (Pb-Free)	1000 Units / Tape & Reel
MC14538BDTR2G	TSSOP-16*	2500 Units / Tape & Reel
MC14538BFG	SOEIAJ-16 (Pb-Free)	50 Units / Rail
MC14538BFELG	SOEIAJ-16 (Pb-Free)	2000 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.

*This package is inherently Pb-Free.

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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 _{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 _{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, Pin 2 or 14	I _{in}	15	–	±0.05	–	±0.00001	±0.05	–	±0.5	μAdc
Input Current, Other Inputs	I _{in}	15	–	±0.1	–	±0.00001	±0.1	–	±1.0	μAdc
Input Capacitance, Pin 2 or 14	C _{in}	–	–	–	–	25	–	–	–	pF
Input Capacitance, Other Inputs (V _{in} = 0)	C _{in}	–	–	–	–	5.0	7.5	–	–	pF
Quiescent Current (Per Package) Q = Low, \bar{Q} = High	I _{DD}	5.0	–	5.0	–	0.005	5.0	–	150	μAdc
		10	–	10	–	0.010	10	–	300	
		15	–	20	–	0.015	20	–	600	
Quiescent Current, Active State (Both) (Per Package) Q = High, \bar{Q} = Low	I _{DD}	5.0	–	2.0	–	0.04	0.20	–	2.0	mAdc
		10	–	2.0	–	0.08	0.45	–	2.0	
		15	–	2.0	–	0.13	0.70	–	2.0	
Total Supply Current at an external load capacitance (C _L) and at external timing network (R _X , C _X) (Note 3)	I _T	5.0 10	$I_T = (3.5 \times 10^{-2}) R_X C_X f + 4 C_X f + 1 \times 10^{-5} C_L f$ $I_T = (8.0 \times 10^{-2}) R_X C_X f + 9 C_X f + 2 \times 10^{-5} C_L f$ $I_T = (1.25 \times 10^{-1}) R_X C_X f + 12 C_X f + 3 \times 10^{-5} C_L f$ where: I _T in μA (one monostable switching only), C _X in μF, C _L in pF, R _X in k ohms, and f in Hz is the input frequency.							μAdc

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.

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SWITCHING CHARACTERISTICS (Note 4) ($C_L = 50 \text{ pF}$, $T_A = 25^\circ\text{C}$)

Characteristic	Symbol	V_{DD} V_{dc}	All Types			Unit
			Min	Typ (Note 5)	Max	
Output Rise Time $t_{TLH} = (1.35 \text{ ns/pF}) C_L + 33 \text{ ns}$ $t_{TLH} = (0.60 \text{ ns/pF}) C_L + 20 \text{ ns}$ $t_{TLH} = (0.40 \text{ ns/pF}) C_L + 20 \text{ ns}$	t_{TLH}	5.0 10 15	– – –	100 50 40	200 100 80	ns
Output Fall Time $t_{THL} = (1.35 \text{ ns/pF}) C_L + 33 \text{ ns}$ $t_{THL} = (0.60 \text{ ns/pF}) C_L + 20 \text{ ns}$ $t_{THL} = (0.40 \text{ ns/pF}) C_L + 20 \text{ ns}$	t_{THL}	5.0 10 15	– – –	100 50 40	200 100 80	ns
Propagation Delay Time A or B to Q or \bar{Q} $t_{PLH}, t_{PHL} = (0.90 \text{ ns/pF}) C_L + 255 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.36 \text{ ns/pF}) C_L + 132 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.26 \text{ ns/pF}) C_L + 87 \text{ ns}$	$t_{PLH},$ t_{PHL}	5.0 10 15	– – –	300 150 100	600 300 220	ns
Reset to Q or \bar{Q} $t_{PLH}, t_{PHL} = (0.90 \text{ ns/pF}) C_L + 205 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.36 \text{ ns/pF}) C_L + 107 \text{ ns}$ $t_{PLH}, t_{PHL} = (0.26 \text{ ns/pF}) C_L + 82 \text{ ns}$		5.0 10 15	– – –	250 125 95	500 250 190	ns
Input Rise and Fall Times Reset	t_r, t_f	5 10 15	– – –	– – –	15 5 4	μs
B Input		5 10 15	– – –	300 1.2 0.4	1.0 0.1 0.05	ms
A Input		5 10 15	No Limit			–
Input Pulse Width A, B, or Reset	$t_{WH},$ t_{WL}	5.0 10 15	170 90 80	85 45 40	– – –	ns
Retrigger Time	t_{rr}	5.0 10 15	0 0 0	– – –	– – –	ns
Output Pulse Width — Q or \bar{Q} Refer to Figures 8 and 9 $C_X = 0.002 \text{ }\mu\text{F}$, $R_X = 100 \text{ k}\Omega$	T	5.0 10 15	198 200 202	210 212 214	230 232 234	μs
$C_X = 0.1 \text{ }\mu\text{F}$, $R_X = 100 \text{ k}\Omega$		5.0 10 15	9.3 9.4 9.5	9.86 10 10.14	10.5 10.6 10.7	ms
$C_X = 10 \text{ }\mu\text{F}$, $R_X = 100 \text{ k}\Omega$		5.0 10 15	0.91 0.92 0.93	0.965 0.98 0.99	1.03 1.04 1.06	s
Pulse Width Match between circuits in the same package. $C_X = 0.1 \text{ }\mu\text{F}$, $R_X = 100 \text{ k}\Omega$	100 [($T_1 - T_2$)/ T_1]	5.0 10 15	– – –	± 1.0 ± 1.0 ± 1.0	± 5.0 ± 5.0 ± 5.0	%

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

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

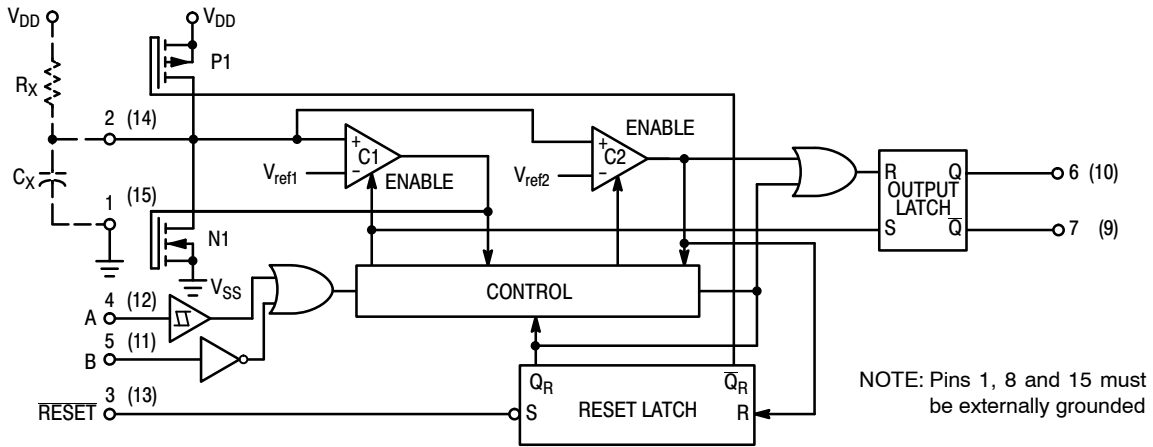
OPERATING CONDITIONS

External Timing Resistance	R_X	–	5.0	–	(Note 6)	$\text{k}\Omega$
External Timing Capacitance	C_X	–	0	–	No Limit (Note 7)	μF

6. The maximum usable resistance R_X is a function of the leakage of the capacitor C_X , leakage of the MC14538B, and leakage due to board layout and surface resistance. Susceptibility to externally induced noise signals may occur for $R_X > 1 \text{ M}\Omega$.

7. If $C_X > 15 \text{ }\mu\text{F}$, use discharge protection diode per Fig. 11.

MC14538B



**Figure 1. Logic Diagram
(1/2 of Device Shown)**

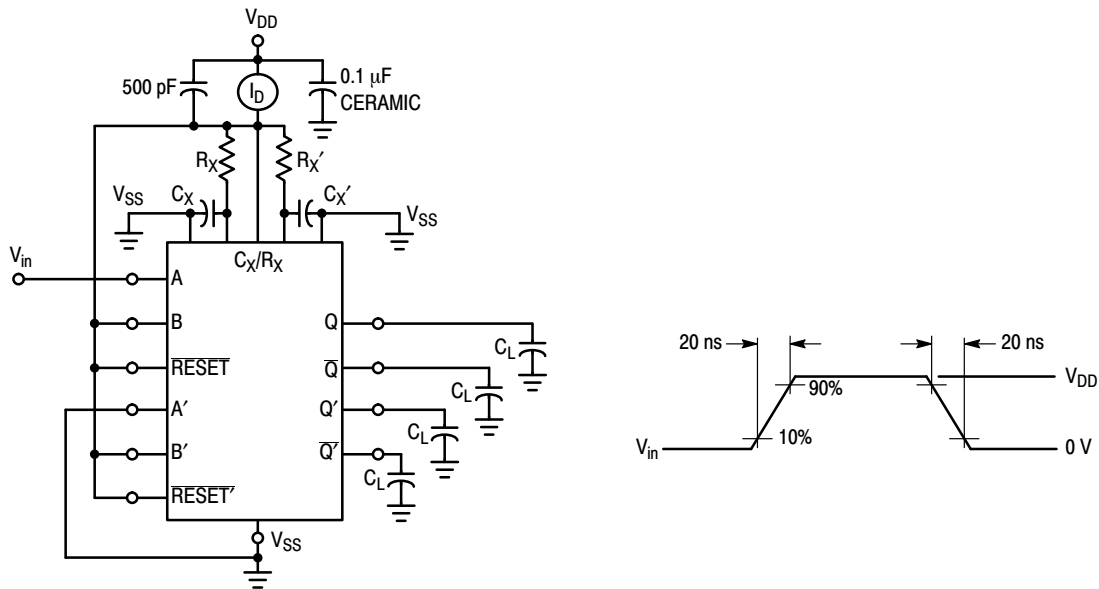
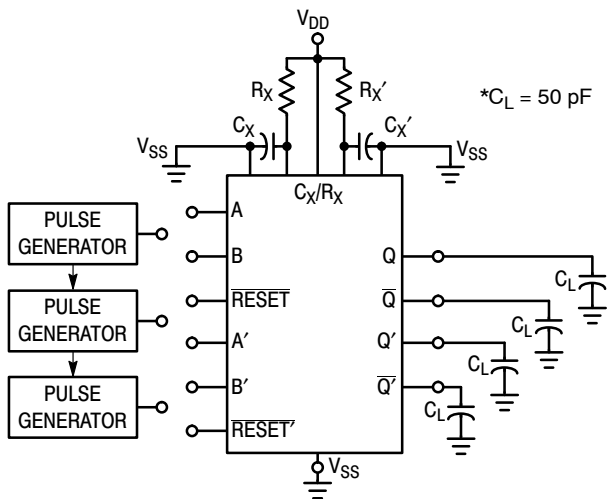


Figure 2. Power Dissipation Test Circuit and Waveforms



INPUT CONNECTIONS

Characteristics	Reset	A	B
t_{PLH} , t_{PHL} , t_{TLH} , t_{THL} , T , t_{WH} , t_{WL}	V_{DD}	PG1	V_{DD}
t_{PLH} , t_{PHL} , t_{TLH} , t_{THL} , T , t_{WH} , t_{WL}	V_{DD}	V_{SS}	PG2
$t_{PLH(R)}$, $t_{PHL(R)}$, t_{WH} , t_{WL}	PG3	PG1	PG2

*Includes capacitance of probes, wiring, and fixture parasitic.
NOTE: Switching test waveforms for PG1, PG2, PG3 are shown in Figure 4.

PG1 =

PG2 =

PG3 =

Figure 3. Switching Test Circuit

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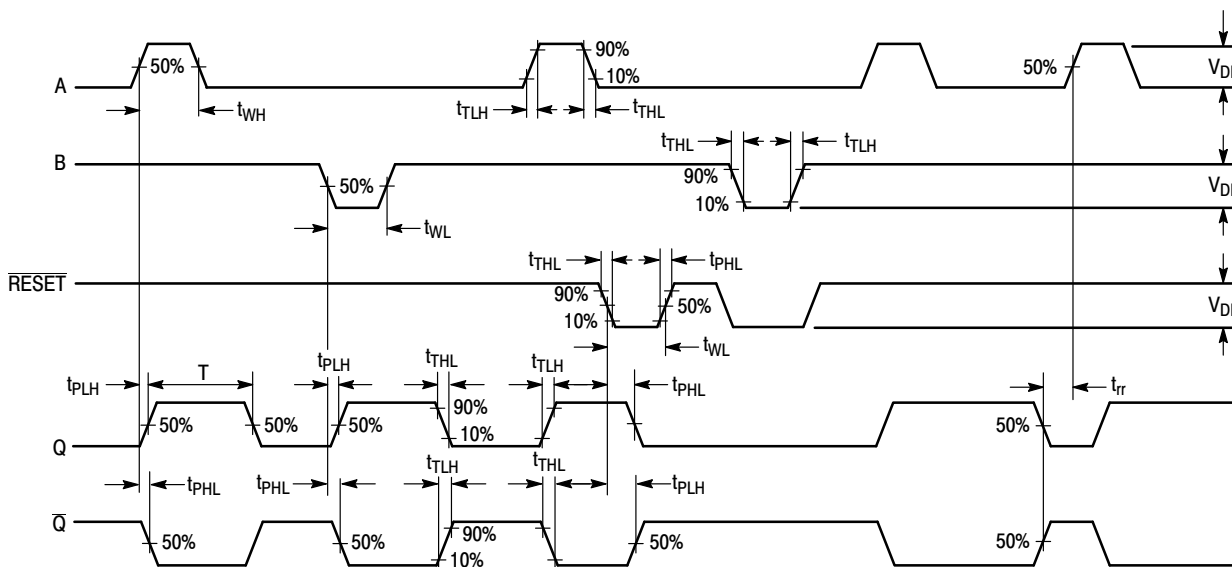


Figure 4. Switching Test Waveforms

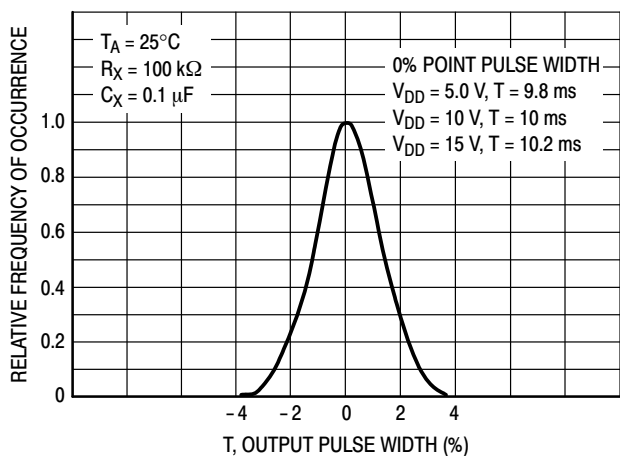


Figure 5. Typical Normalized Distribution of Units for Output Pulse Width

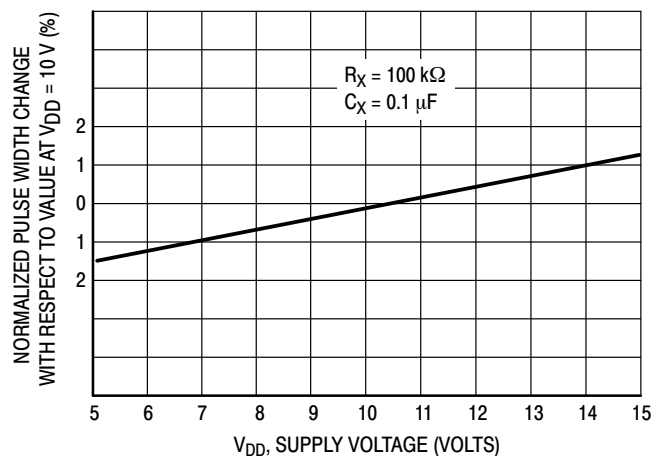


Figure 6. Typical Pulse Width Variation as a Function of Supply Voltage V_{DD}

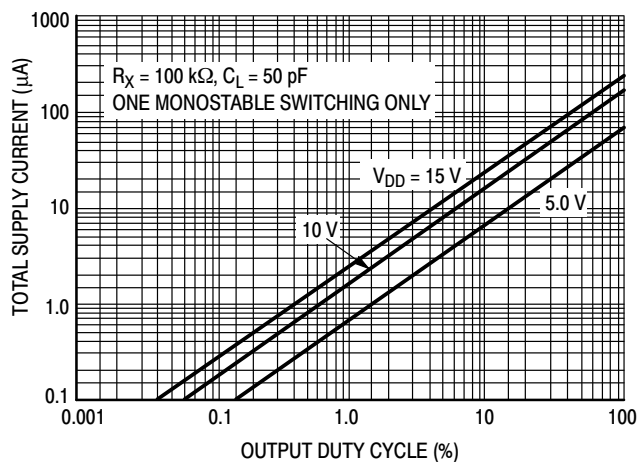











Figure 7. Typical Total Supply Current versus Output Duty Cycle

FUNCTION TABLE

Inputs			Outputs	
Reset	A	B	Q	\bar{Q}
H H		H 		
H H	 H	L 	Not Triggered	Not Triggered
H H	L, H,  L	H L, H, 	Not Triggered	Not Triggered
L 	X X	X X	L Not Triggered	H

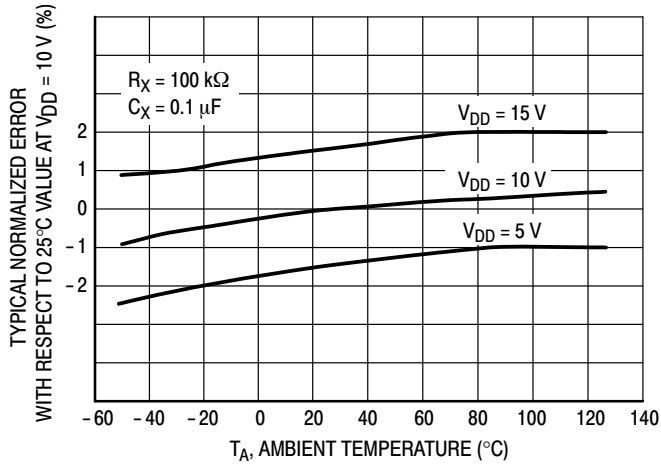


Figure 8. Typical Error of Pulse Width Equation versus Temperature

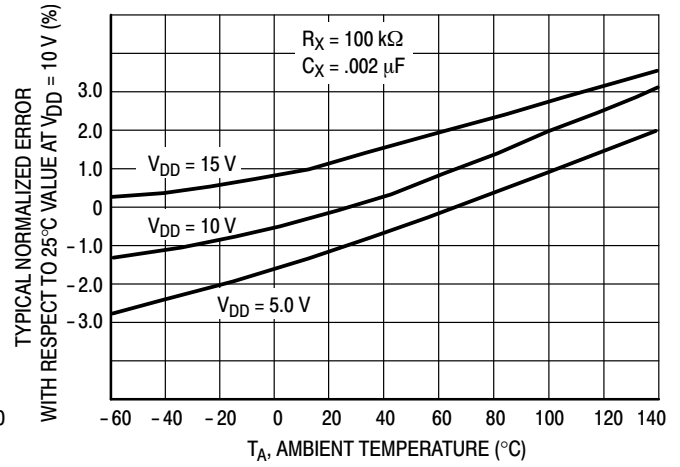


Figure 9. Typical Error of Pulse Width Equation versus Temperature

THEORY OF OPERATION

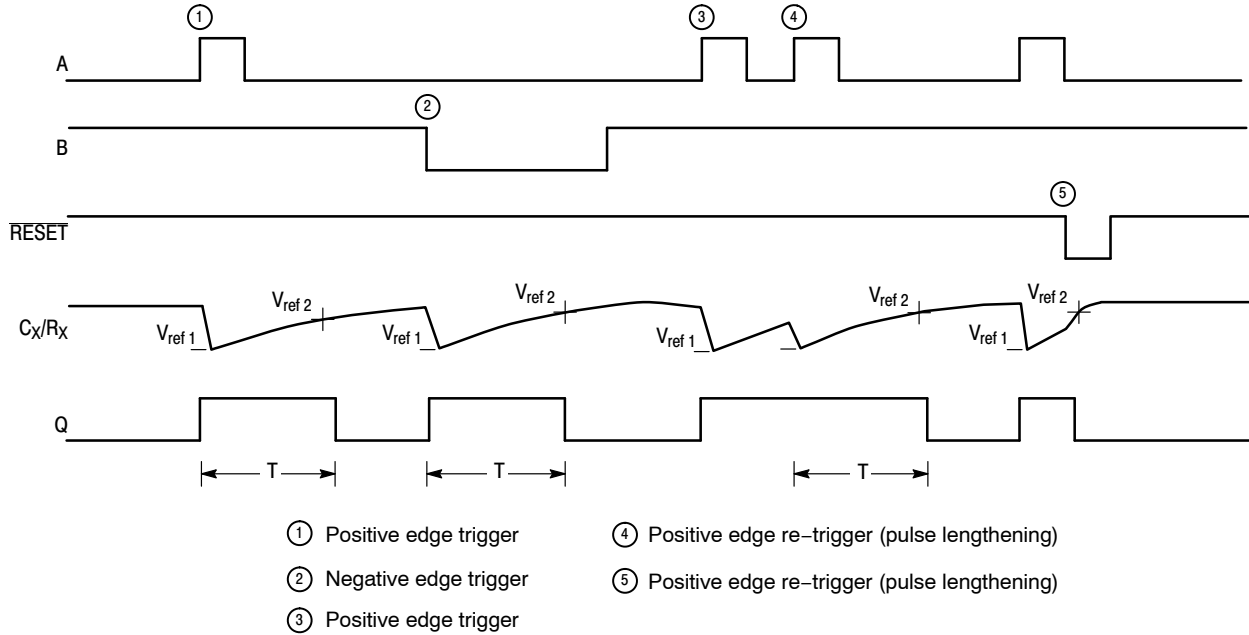


Figure 10. Timing Operation

TRIGGER OPERATION

The block diagram of the MC14538B is shown in Figure 1, with circuit operation following.

As shown in Figure 1 and 10, before an input trigger occurs, the monostable is in the quiescent state with the Q output low, and the timing capacitor C_X completely charged to V_{DD} . When the trigger input A goes from V_{SS} to V_{DD} (while inputs B and $\overline{\text{Reset}}$ are held to V_{DD}) a valid trigger is recognized, which turns on comparator C1 and N-channel transistor N1 ①. At the same time the output latch is set. With transistor N1 on, the capacitor C_X rapidly discharges toward V_{SS} until V_{ref1} is reached. At this point the output of comparator C1 changes state and transistor N1 turns off. Comparator C1 then turns off while at the same time comparator C2 turns on. With transistor N1 off, the capacitor C_X begins to charge through the timing resistor, R_X , toward V_{DD} . When the voltage across C_X equals V_{ref2} , comparator C2 changes state, causing the output latch to reset (Q goes low) while at the same time disabling comparator C2 ②. This ends at the timing cycle with the monostable in the quiescent state, waiting for the next trigger.

In the quiescent state, C_X is fully charged to V_{DD} causing the current through resistor R_X to be zero. Both comparators are “off” with total device current due only to reverse junction leakages. An added feature of the MC14538B is that the output latch is set via the input trigger without regard to the capacitor voltage. Thus, propagation delay from trigger to Q is independent of the value of C_X , R_X , or the duty cycle of the input waveform.

RETRIGGER OPERATION

The MC14538B is retriggered if a valid trigger occurs ③ followed by another valid trigger ④ before the Q output has returned to the quiescent (zero) state. Any retrigger, after the timing node voltage at pin 2 or 14 has begun to rise from V_{ref1} , but has not yet reached V_{ref2} , will cause an increase in output pulse width T. When a valid retrigger is initiated ④, the voltage at C_X/R_X will again drop to V_{ref1} before progressing along the RC charging curve toward V_{DD} . The Q output will remain high until time T, after the last valid retrigger.

RESET OPERATION

The MC14538B may be reset during the generation of the output pulse. In the reset mode of operation, an input pulse

on $\overline{\text{Reset}}$ sets the reset latch and causes the capacitor to be fast charged to V_{DD} by turning on transistor P1 ⑤. When the voltage on the capacitor reaches V_{ref2} , the reset latch will clear, and will then be ready to accept another pulse. If the $\overline{\text{Reset}}$ input is held low, any trigger inputs that occur will be inhibited and the Q and \overline{Q} outputs of the output latch will not change. Since the Q output is reset when an input low level is detected on the $\overline{\text{Reset}}$ input, the output pulse T can be made significantly shorter than the minimum pulse width specification.

POWER-DOWN CONSIDERATIONS

Large capacitance values can cause problems due to the large amount of energy stored. When a system containing the MC14538B is powered down, the capacitor voltage may discharge from V_{DD} through the standard protection diodes at pin 2 or 14. Current through the protection diodes should be limited to 10 mA and therefore the discharge time of the V_{DD} supply must not be faster than $(V_{DD}) \cdot (C)/(10 \text{ mA})$. For example, if $V_{DD} = 10 \text{ V}$ and $C_X = 10 \mu\text{F}$, the V_{DD} supply should discharge no faster than $(10 \text{ V}) \times (10 \mu\text{F})/(10 \text{ mA}) = 10 \text{ ms}$. This is normally not a problem since power supplies are heavily filtered and cannot discharge at this rate.

When a more rapid decrease of V_{DD} to zero volts occurs, the MC14538B can sustain damage. To avoid this possibility use an external clamping diode, D_X , connected as shown in Fig. 11.

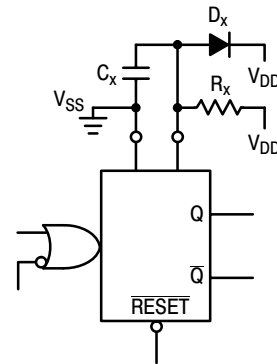


Figure 11. Use of a Diode to Limit Power Down Current Surge

TYPICAL APPLICATIONS

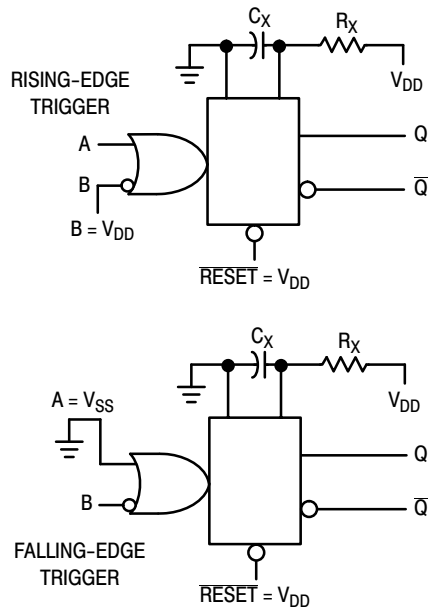


Figure 12. Retriggerable Monostables Circuitry

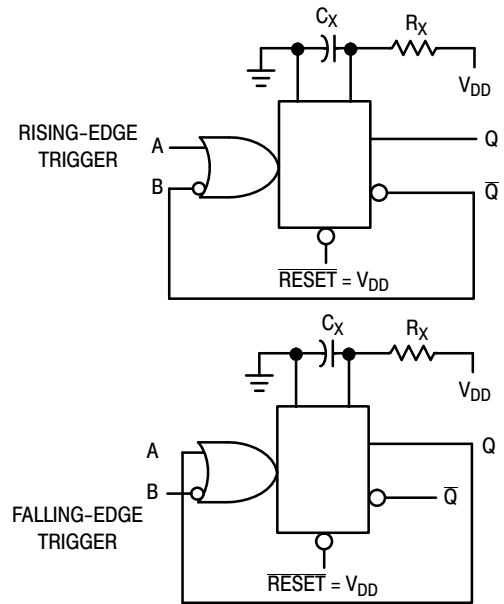


Figure 13. Non-Retriggerable Monostables Circuitry

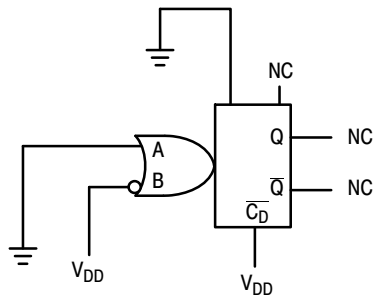
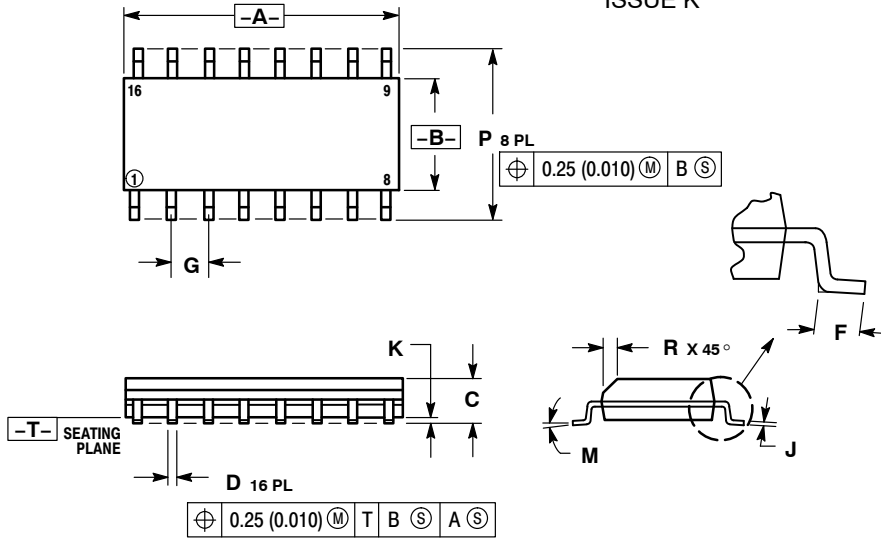


Figure 14. Connection of Unused Sections

MC14538B

PACKAGE DIMENSIONS

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

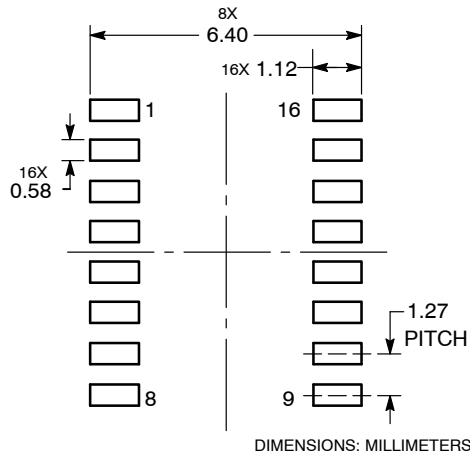


NOTES:

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

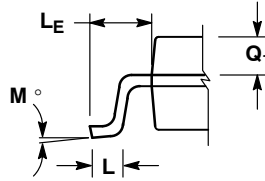
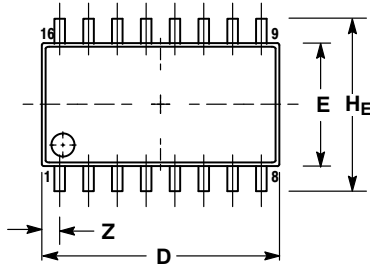
SOLDERING FOOTPRINT



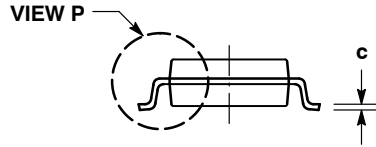
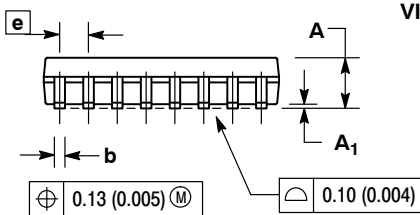
MC14538B

PACKAGE DIMENSIONS

SOEIAJ-16
CASE 966-01
ISSUE A




DETAIL P



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: MILLIMETER.
3. DIMENSIONS D AND E DO NOT INCLUDE MOLD FLASH OR PROTRUSIONS AND ARE MEASURED AT THE PARTING LINE. MOLD FLASH OR PROTRUSIONS SHALL NOT EXCEED 0.15 (0.006) PER SIDE.
4. TERMINAL NUMBERS ARE SHOWN FOR REFERENCE ONLY.
5. THE LEAD WIDTH DIMENSION (b) DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.08 (0.003) TOTAL IN EXCESS OF THE LEAD WIDTH DIMENSION AT MAXIMUM MATERIAL CONDITION. DAMBAR CANNOT BE LOCATED ON THE LOWER RADIUS OR THE FOOT. MINIMUM SPACE BETWEEN PROTRUSIONS AND ADJACENT LEAD TO BE 0.46 (0.018).

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	---	2.05	---	0.081
A ₁	0.05	0.20	0.002	0.008
b	0.35	0.50	0.014	0.020
c	0.10	0.20	0.007	0.011
D	9.90	10.50	0.390	0.413
E	5.10	5.45	0.201	0.215
e	1.27 BSC		0.050 BSC	
H _E	7.40	8.20	0.291	0.323
L	0.50	0.85	0.020	0.033
L _E	1.10	1.50	0.043	0.059
M	0°	10°	0°	10°
Q ₁	0.70	0.90	0.028	0.035
Z	---	0.78	---	0.031

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