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April 1, 2003

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# HD74HC4538

## Dual Precision Retriggerable/Resetable Monostable Multivibrators



ADE-205-543 (Z)  
1st. Edition  
Sep. 2000

### Description









Each multivibrator features both a negative, A, and a positive, B, transition triggered input, either of which can be used as an inhibit input. Also included is a clear input that when taken low resets the one short. The HD74HC4538 is retriggerable. That is, it may be triggered repeatedly while their outputs are generating a pulse and the pulse will be extended.

Pulse width stability over a wide range of temperature. The output pulse equation is simply:  $t_w = 0.7 (R)(C)$ .

### Features

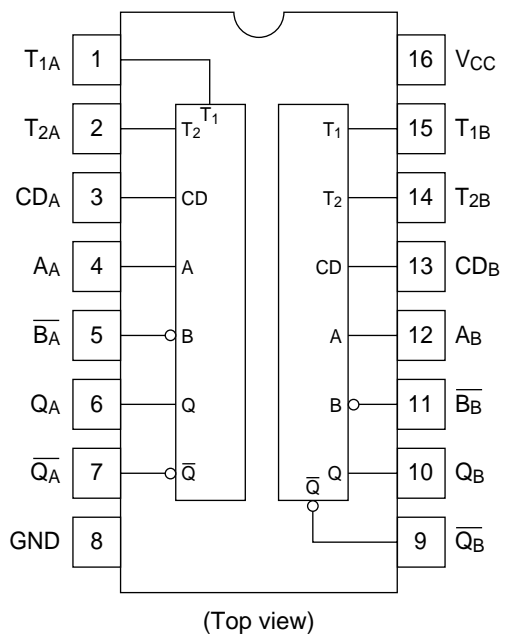
- High Speed Operation:  $t_{pd}$  (A or B to Y) = 22 ns typ ( $C_L = 50$  pF)
- High Output Current: Fanout of 10 LSTTL Loads
- Wide Operating Voltage:  $V_{CC} = 2$  to 6 V
- Low Input Current: 1  $\mu$ A max
- Low Quiescent Supply Current

### Function Table

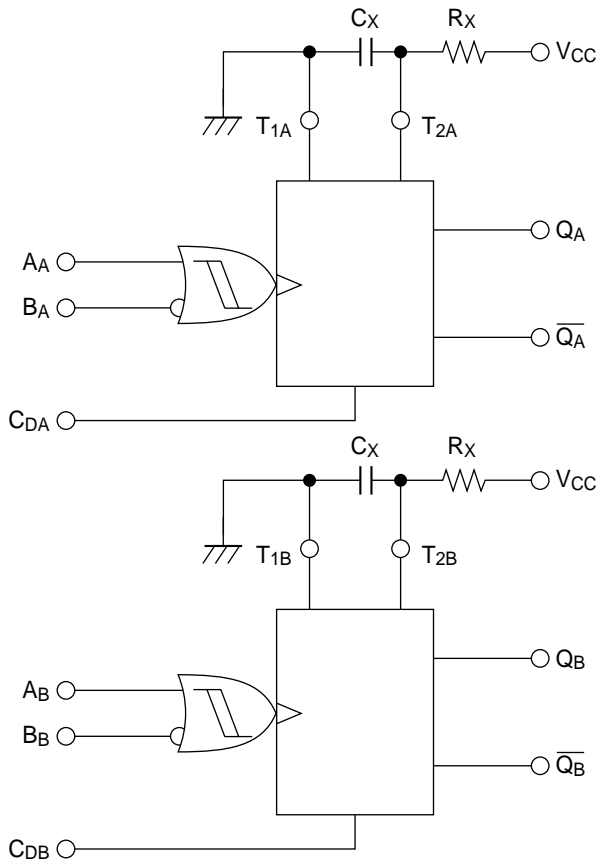
Inputs			Outputs	
$C_D$	A	B	Q	$\bar{Q}$
L	X	X	L	H
H	L			
H		H		
H	H		Not triggered	
H		L	Not triggered	

X : Irrelevant

Pin Arrangement



# Block Diagram



$R_X$  and  $C_X$  are external components

**Absolute Maximum Ratings**

Item	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	−0.5 to +7.0	V
Input voltage	$V_{in}$	−0.5 to $V_{CC} + 0.5$	V
Output voltage	$V_{out}$	−0.5 to $V_{CC} + 0.5$	V
DC input diode current	$I_{IK}$	±20	mA
DC input diode current pin 2, 14	$I_{IK}$	±30	mA
DC output diode current	$I_{OK}$	±20	mA
DC current drain per pin	$I_{out}$	±25	mA
DC current drain per $V_{CC}$ , GND	$I_{CC}$ , $I_{GND}$	±50	mA
Power dissipation per package	$P_T$	500	mW
Storage temperature	$T_{stg}$	−65 to +150	°C

## DC Characteristics

Item	Symbol	V <sub>CC</sub> (V)	Ta = 25°C			Ta = -40 to +85°C		Unit	Test Conditions	
			Min	Typ	Max	Min	Max			
Input voltage	V <sub>IH</sub>	2.0	1.5	—	—	1.5	—	V		
		4.5	3.15	—	—	3.15	—			
		6.0	4.2	—	—	4.2	—			
	V <sub>IL</sub>	2.0	—	—	0.5	—	0.5	V		
		4.5	—	—	1.35	—	1.35			
		6.0	—	—	1.8	—	1.8			
Output voltage	V <sub>OH</sub>	2.0	1.9	2.0	—	1.9	—	V	Vin = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OH</sub> = -20 μA	
		4.5	4.4	4.5	—	4.4	—			
		6.0	5.9	6.0	—	5.9	—			
		4.5	4.18	—	—	4.13	—			I <sub>OH</sub> = -4 mA
		6.0	5.68	—	—	5.63	—			I <sub>OH</sub> = -5.2 mA
	V <sub>OL</sub>	2.0	—	0.0	0.1	—	0.1	V	Vin = V <sub>IH</sub> or V <sub>IL</sub> I <sub>OL</sub> = 20 μA	
		4.5	—	0.0	0.1	—	0.1			
		6.0	—	0.0	0.1	—	0.1			
		4.5	—	—	0.26	—	0.33			I <sub>OL</sub> = 4 mA
		6.0	—	—	0.26	—	0.33			I <sub>OL</sub> = 5.2 mA
Input current	I <sub>in</sub>	6.0	—	—	±0.1	—	±1.0	μA	Vin = V <sub>CC</sub> or GND	
Quiescent supply current (standby state)	I <sub>CC</sub>	6.0	—	—	130	—	220	μA	Vin = V <sub>CC</sub> or GND, Q <sub>A</sub> = Q <sub>B</sub> = GND, I <sub>out</sub> = 0 μA	
Current drain (active state)	I <sub>CC</sub>	6.0	—	—	130	—	220	μA	Vin = V <sub>CC</sub> or GND, Q <sub>A</sub> = Q <sub>B</sub> = V <sub>CC</sub> Pin 2, 14 = 0.5 V <sub>CC</sub>	

## AC Characteristics ( $C_L = 50$ pF, Input $t_r = t_f = 6$ ns)

Item	Symbol	$V_{CC}$ (V)	$T_a = 25^\circ\text{C}$			$T_a = -40$ to $+85^\circ\text{C}$		Unit	Test Conditions
			Min	Typ	Max	Min	Max		
Propagation delay time	$t_{PLH}$	2.0	—	—	235	—	295	ns	A or B to Q
		4.5	—	22	47	—	59		
		6.0	—	—	40	—	50		
	$t_{PHL}$	2.0	—	—	260	—	325	ns	A or B to $\overline{Q}$
		4.5	—	23	52	—	65		
		6.0	—	—	44	—	55		
	$t_{PHL}$	2.0	—	—	235	—	295	ns	$C_D$ to Q
		4.5	—	17	47	—	59		
		6.0	—	—	40	—	50		
	$t_{PLH}$	2.0	—	—	235	—	295	ns	$C_D$ to $\overline{Q}$
		4.5	—	—	47	—	59		
		6.0	—	—	40	—	50		
Pulse width	$t_w$	2.0	80	—	—	100	—	ns	A, B, $C_D$
		4.5	16	—	—	20	—		
		6.0	14	—	—	17	—		
Output pulse width	$t_{WQ}$	3.0	—	150	—	—	—	ns	$R_x = 1$ k $\Omega$ , $C_x = 12$ pF
		5.0	—	100	—	—	—		
		3.0	—	—	—	—	—	$\mu\text{s}$	$R_x = 10$ k $\Omega$ , $C_x = 100$ pF
		5.0	—	1.3	—	—	—		
		3.0	—	—	—	—	—	$\mu\text{s}$	$R_x = 10$ k $\Omega$ , $C_x = 1000$ pF
		5.0	—	9	—	—	—		
		3.0	—	—	—	—	—	$\mu\text{s}$	$R_x = 10$ k $\Omega$ , $C_x = 10000$ pF
		5.0	—	70	—	—	—		
Pulse width match between circuits in the same package	$\Delta t_{WQ}$	5.0	—	$\pm 0.1$	—	—	—	%	$R_x = 10$ k $\Omega$ , $C_x = 1000$ pF

Caution in use: In order to prevent any malfunctions due to noise, connect a high frequency performance capacitor between  $V_{CC}$  and GND, and keep the wiring between the External components and Cext, Rext/Cext pins as short as possible.



## Circuit Operation

Fig. 3 shows the HC4538 configured in the retriggerable mode. Briefly, the device operates as follows (refer to Fig. 1): In the quiescent state, the external timing capacitor,  $C_X$ , is charged to  $V_{CC}$ . When a trigger occurs, the Q output goes high and  $C_X$  discharges quickly to the lower reference voltage ( $V_{ref\ Lower} \approx 1/3 V_{CC}$ ).  $C_X$  then charges, through  $R_X$ , back up to the upper reference voltage ( $V_{ref\ Upper} \approx 2/3 V_{CC}$ ), at which point the one-shot has timed out and the Q output goes low.

The following, more detailed description of the circuit operation refers to both the function diagram (Fig. 1) and the timing diagram (Fig. 2)

### Quiescent State

In the quiescent state, before an input trigger appears; the output latch is high and the reset latch is high (1 in Fig. 2). Thus the Q output (pin 6 or 10) of the monostable multivibrator is low (2 Fig. 2).

The output of the trigger-control circuit is low (3), and transistors M1, M2, and M3 are turned off. The external timing capacitor,  $C_X$ , is charged to  $V_{CC}$  (4), and the upper reference circuit has a low output (5). Transistor M4 is turned on and analog switch S1 is turned off. Thus the lower reference circuit has  $V_{CC}$  at the noninverting input and a resulting low output (6).

In addition, the output of the trigger-control reset circuit is low.

### Trigger Operation

The HC4538 is triggered by either a rising-edge signal as input A (7) or a falling-edge signal at input B (8), with the unused trigger input and the Reset input held at the voltage levels shown in the Function Table. Either trigger signal will cause the output of the trigger-control circuit to go high (9). The trigger-control circuit going high simultaneously initiates three events. First, the output latch goes low, thus taking the Q output of the HC4538 to a high state (10). Second, transistor M3 is turned on, which allows the external timing capacitor,  $C_X$ , to rapidly discharge toward ground (11). (Note that the voltage across  $C_X$  appears at the input of the upper reference circuit comparator). Third, transistor M4 is turned off and analog switch S1 is turned on, thus allowing the voltage across  $C_X$  to also appear at the input of the lower reference circuit comparator.

When  $C_X$  discharges to the reference voltage of the lower reference circuit (12), the outputs of both reference circuits will be high (13). The trigger-control circuit flip-flop to a low state (14). This turns transistor M3 off again, allowing  $C_X$  to begin to charge back up toward  $V_{CC}$ , with a time constant  $t = R_X C_X$  (15). In addition, transistor M4 is turned on and analog switch S1 is turned off. Thus a high voltage level is applied to the input of the lower reference circuit comparator, causing its output to go low (16). The monostable multivibrator may be retriggered at any time after the trigger-control circuit goes low.

When  $C_X$  charges up to the reference voltage of the upper reference circuit (17), the output of the upper reference circuit goes low (18). This causes the output latch to toggle, taking the Q output of the HC4538 to a low state (19), and completing the time-out cycle.

## Reset Operation

A low voltage applied to the Reset pin always forces the Q output of the HC4538 to a low state.

The timing diagram illustrates the case in which reset occurs (20) while  $C_X$  is charging up toward the reference voltage of the upper reference circuit (21). When a reset occurs, the output of the reset latch goes low (22), turning on transistor M1. Thus  $C_X$  is allowed to quickly charge up to  $V_{CC}$  (23) to await the next trigger signal.

## Retrigger Operation

When used in the retriggerable mode (Fig. 3), the HC4538 may be retriggered during timing out of the output pulse at any time after the trigger-control circuit flip-flop has been reset (24). Because the trigger-control circuit flip-flop resets shortly after  $C_X$  has discharged to the reference voltage of the lower reference circuit (25), the minimum retrigger time,  $t_{rr}$  (Switching Waveform 1) is a function of internal propagation delays and the discharge time of  $C_X$ :

Fig. 4 shows the device configured in the non-retriggerable mode.

## Power-Down Considerations

Large values of  $C_X$  may cause problems when powering down the HC4538 because of the amount of energy stored in the capacitor. When a system containing this device is powered down, the capacitor may discharge from  $V_{CC}$  through the input protection diodes at pin 2 or pin 14. Current through the protection diodes must be limited to 30 mA; therefore, the turn-off time of the  $V_{CC}$  power supply must not be faster than  $t = V_{CC} \cdot C_X / (30 \text{ mA})$ . For example, if  $V_{CC} = 5 \text{ V}$  and  $C_X = 15 \text{ } \mu\text{F}$ , the  $V_{CC}$  supply must turn off no faster than  $t = (5 \text{ V}) \cdot (15 \text{ } \mu\text{F}) / 30 \text{ mA} = 2.5 \text{ ms}$ . This is usually not a problem because power supplies are heavily filtered and cannot discharge at this rate.

When a more rapid decrease of  $V_{CC}$  to zero voltage occurs, the HC4538 may sustain damage. To avoid this possibility, use an external clamping diode.

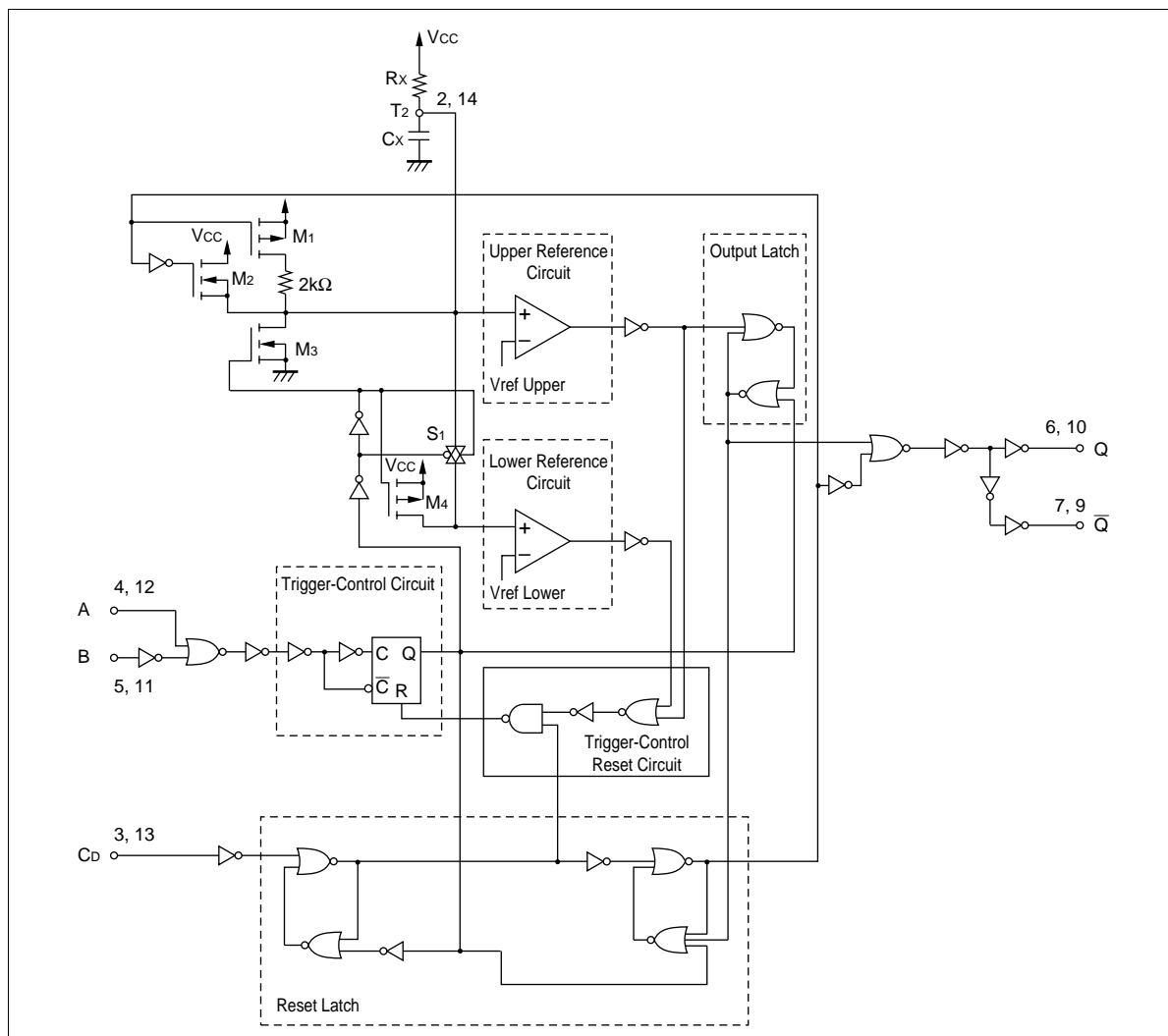


Fig. 1 Function Diagram

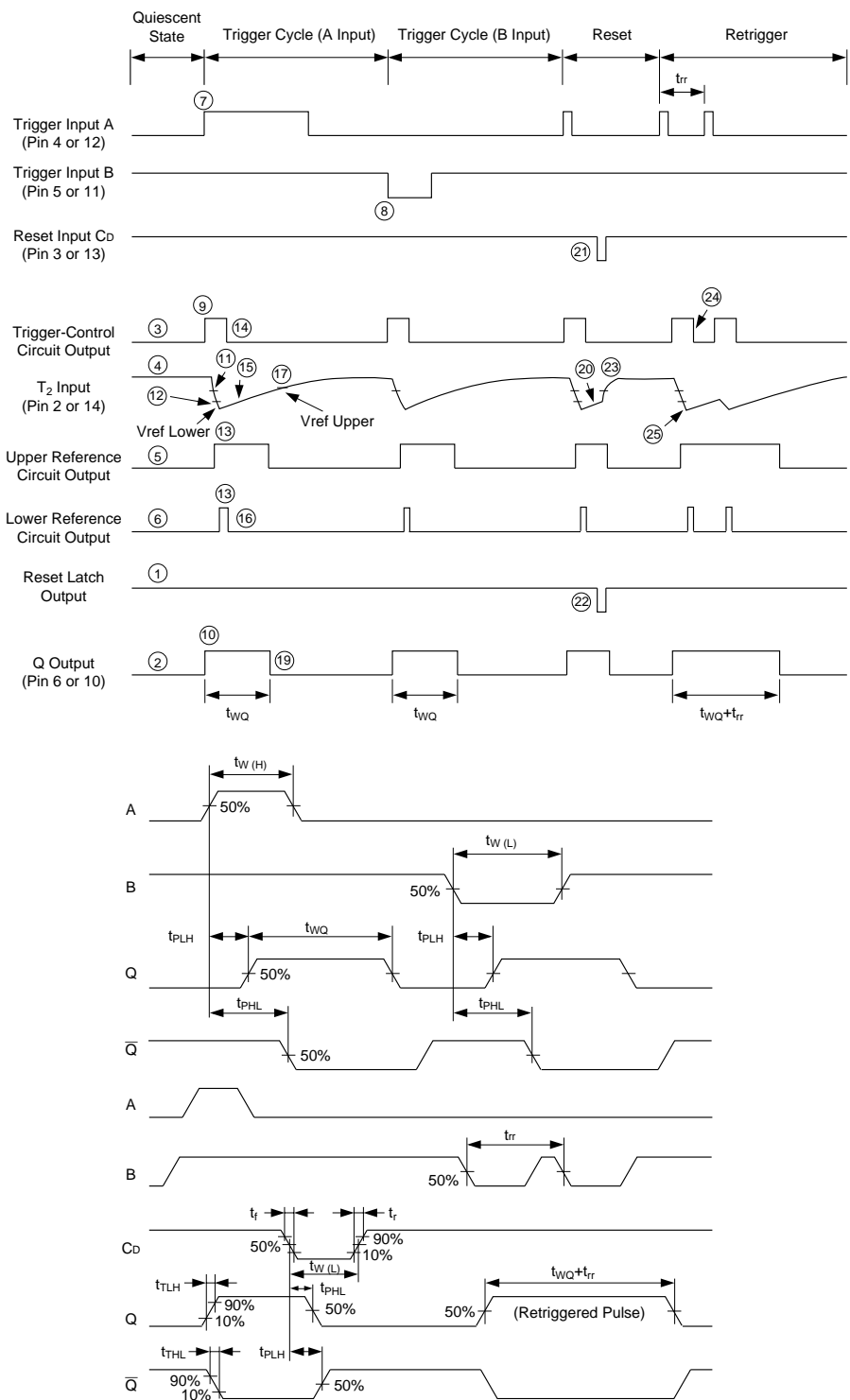
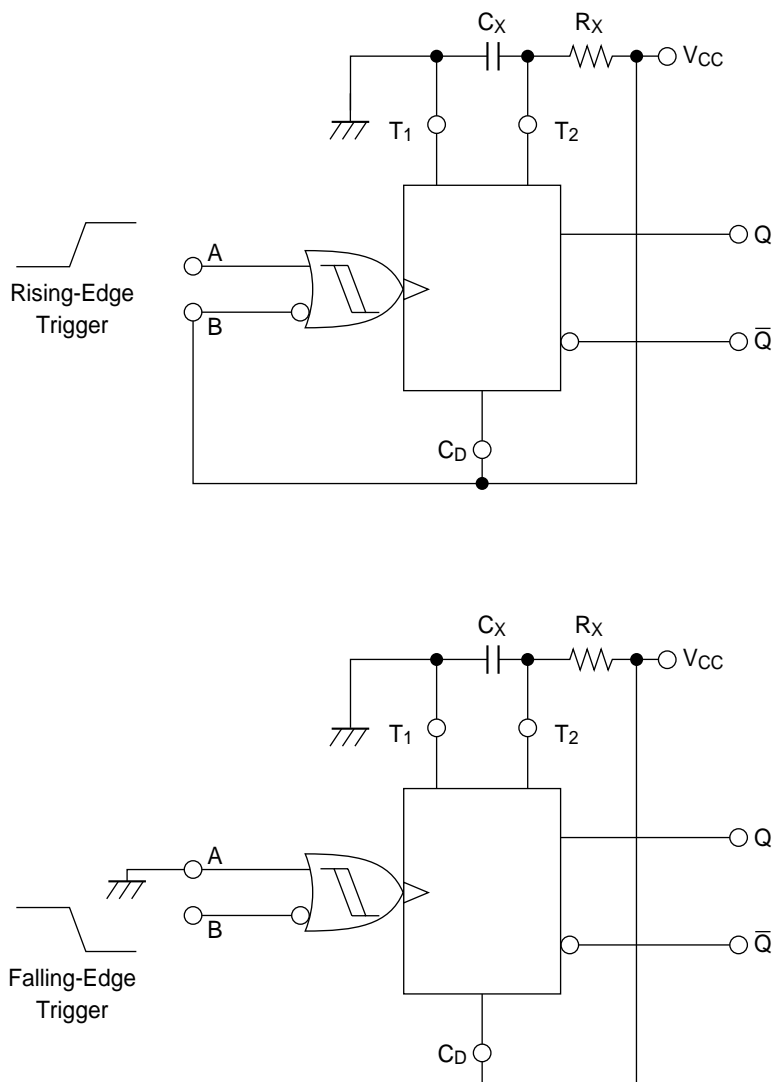


Fig. 2 Timing Diagram

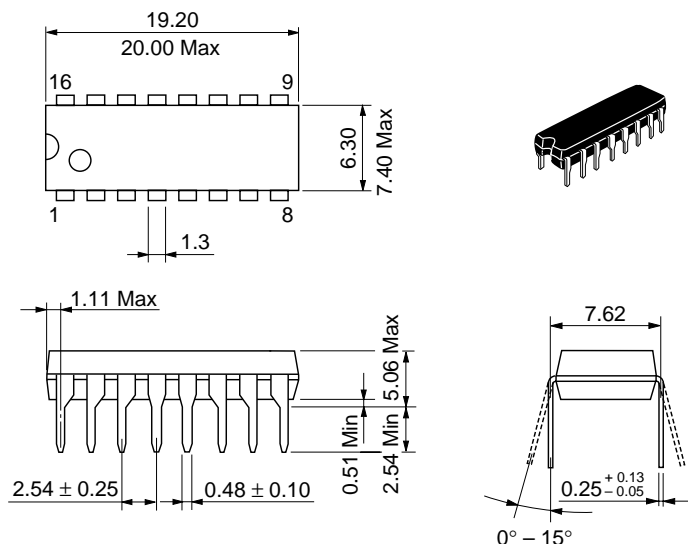


**Fig. 3 Retriggerable Monostable Circuitry**



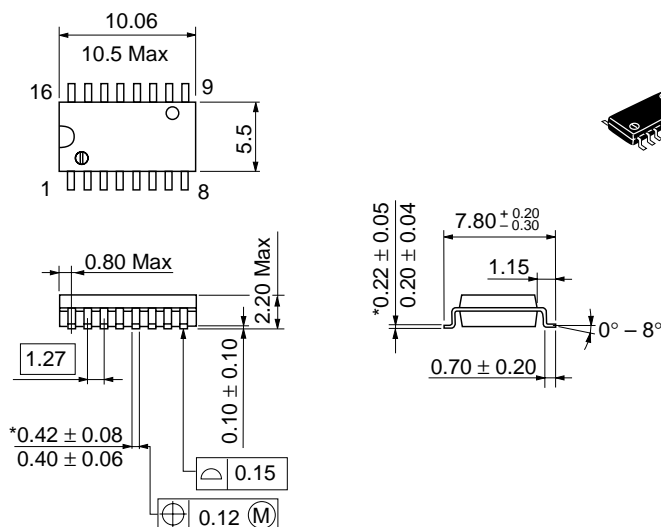
# Package Dimensions

Unit: mm



Hitachi Code	DP-16
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	1.07 g

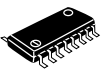
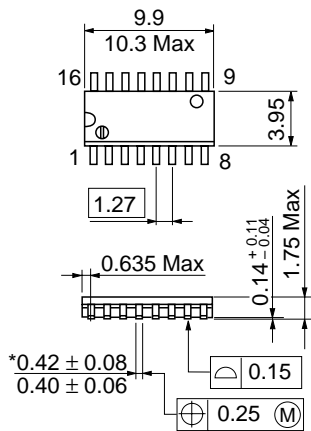
Unit: mm



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Mass (reference value)	0.24 g

Unit: mm



\*Dimension including the plating thickness  
Base material dimension

Hitachi Code	FP-16DN
JEDEC	Conforms
EIAJ	Conforms
Mass (reference value)	0.15 g



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