HD74HC4538

Dual Precision Retriggerable/Resettable Monostable Multivibrators

HITACHI

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 µA max
- Low Quiescent Supply Current

Function Table

Inputs			Outputs	
C_D	A	B	Q	$\overline{Q}$
L	X	X	L	H
H	L	↓	⊓	⊔
H	↑	H	⊓	⊔
H	H	↓	Not triggered	
H	↑	L	Not triggered	

X : Irrelevant

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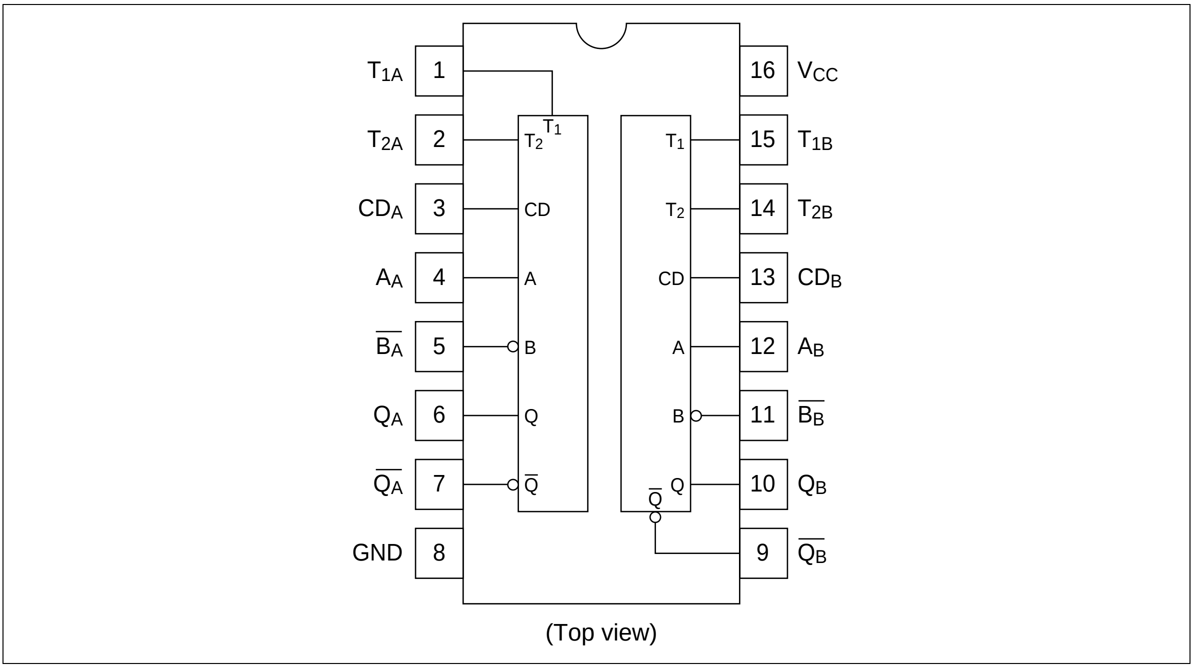
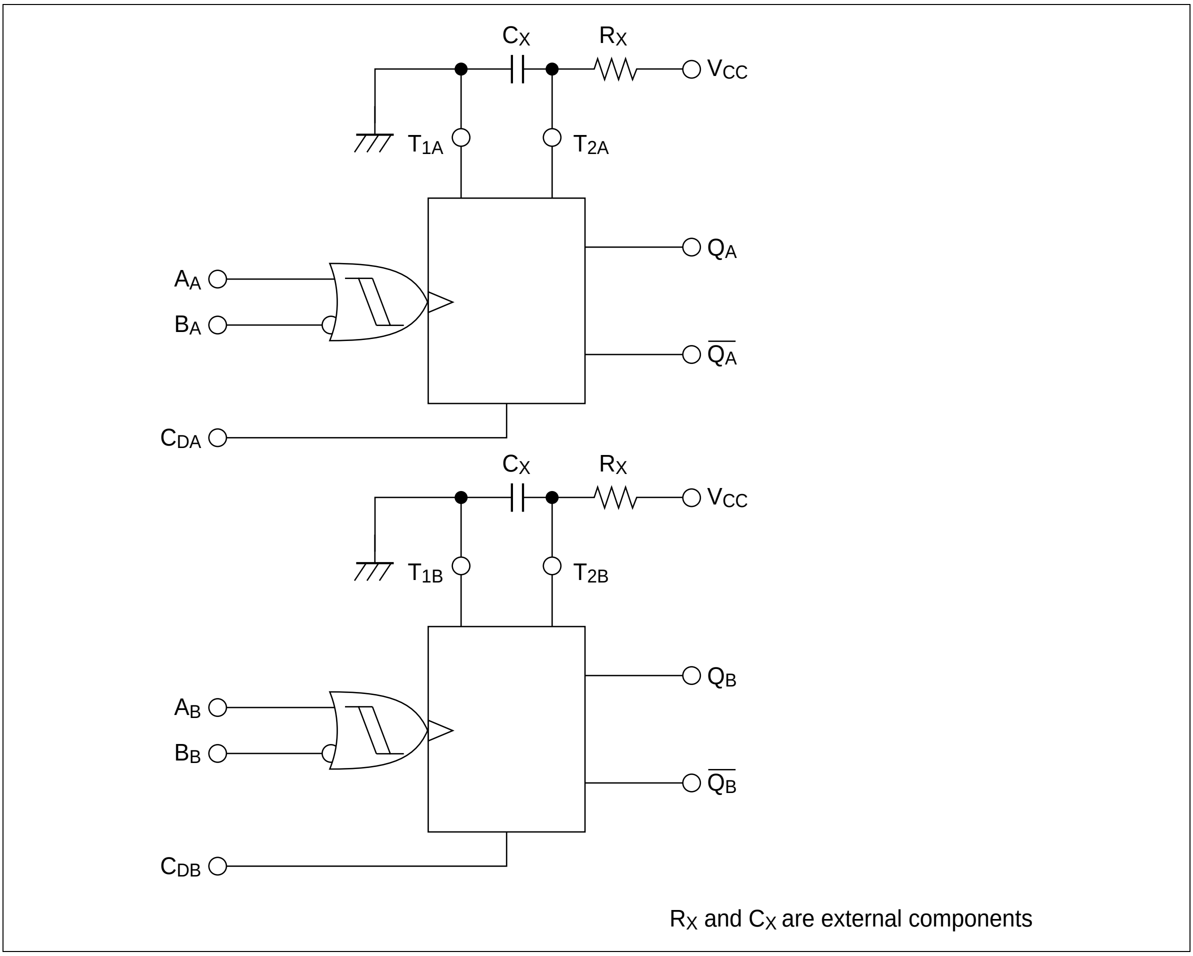
Pin Arrangement



Block Diagram



Absolute Maximum Ratings

Item	Symbol	Rating	Unit
Supply voltage range	V_{CC}	–0.5 to +7.0	V
Input voltage	Vin	–0.5 to V_{CC} + 0.5	V
Output voltage	Vout	–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	Iout	±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	Tstg	–65 to +150	°C

DC Characteristics

Item	Symbol	V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ	Ta = 25°C Max	Ta = –40 to +85°C Min	Ta = –40 to +85°C Max	Unit	Test Conditions	
Input voltage	V_{IH}	2.0	1.5	—	—	1.5	—	V		
		4.5	3.15	—	—	3.15	—			
		6.0	4.2	—	—	4.2	—			
	V_{IL}	2.0	—	—	0.5	—	0.5	V		
		4.5	—	—	1.35	—	1.35			
		6.0	—	—	1.8	—	1.8			
Output voltage	V_{OH}	2.0	1.9	2.0	—	1.9	—	V	Vin = V_{IH} or V_{IL}	I_{OH} = –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_{OH} = –4 mA
		6.0	5.68	—	—	5.63	—			I_{OH} = –5.2 mA
	V_{OL}	2.0	—	0.0	0.1	—	0.1	V	Vin = V_{IH} or V_{IL}	I_{OL} = 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_{OL} = 4 mA
		6.0	—	—	0.26	—	0.33			I_{OL} = 5.2 mA
Input current	Iin	6.0	—	—	±0.1	—	±1.0	µA	Vin = V_{CC} or GND	
Quiescent supply current (standby state)	I_{CC}	6.0	—	—	130	—	220	µA	Vin = V_{CC} or GND, Q_A = Q_B = GND, Iout = 0 µA	
Current drain (active state)	I_{CC}	6.0	—	—	130	—	220	µA	Vin = V_{CC} or GND, Q_A = Q_B = V_{CC} Pin 2, 14 = 0.5 V_{CC}	

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

Item	Symbol	V_{CC} (V)	Ta = 25°C Min	Ta = 25°C Typ	Ta = 25°C Max	Ta = –40 to +85°C Min	Ta = –40 to +85°C Max	Unit	Test Conditions
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 kΩ, C_X = 12 pF
		5.0	—	100	—	—	—		
		3.0	—	—	—	—	—	µs	R_X = 10 kΩ, C_X = 100 pF
		5.0	—	1.3	—	—	—		
		3.0	—	—	—	—	—	µs	R_X = 10 kΩ, C_X = 1000 pF
		5.0	—	9	—	—	—		
		3.0	—	—	—	—	—	µs	R_X = 10 kΩ, C_X = 10000 pF
		5.0	—	70	—	—	—		
Pulse width match between circuits in the same package	Δt_{WQ}	5.0	—	±0.1	—	—	—	%	R_X = 10 kΩ, 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 references voltage (Vref Lower 1/3 V_{CC}). C_X then charges, through R_X, back up to the upper reference voltage (Vref Upper 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-flopw 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 $t = V_{CC} \bullet C_X/(30\ mA)$. For example, if V_{CC} = 5 V and C_X = 15 µF, the V_{CC} supply must turn off no faster than $t = (5\ V) \bullet (15\ \mu F)/30\ mA = 2.5\ ms$. 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.

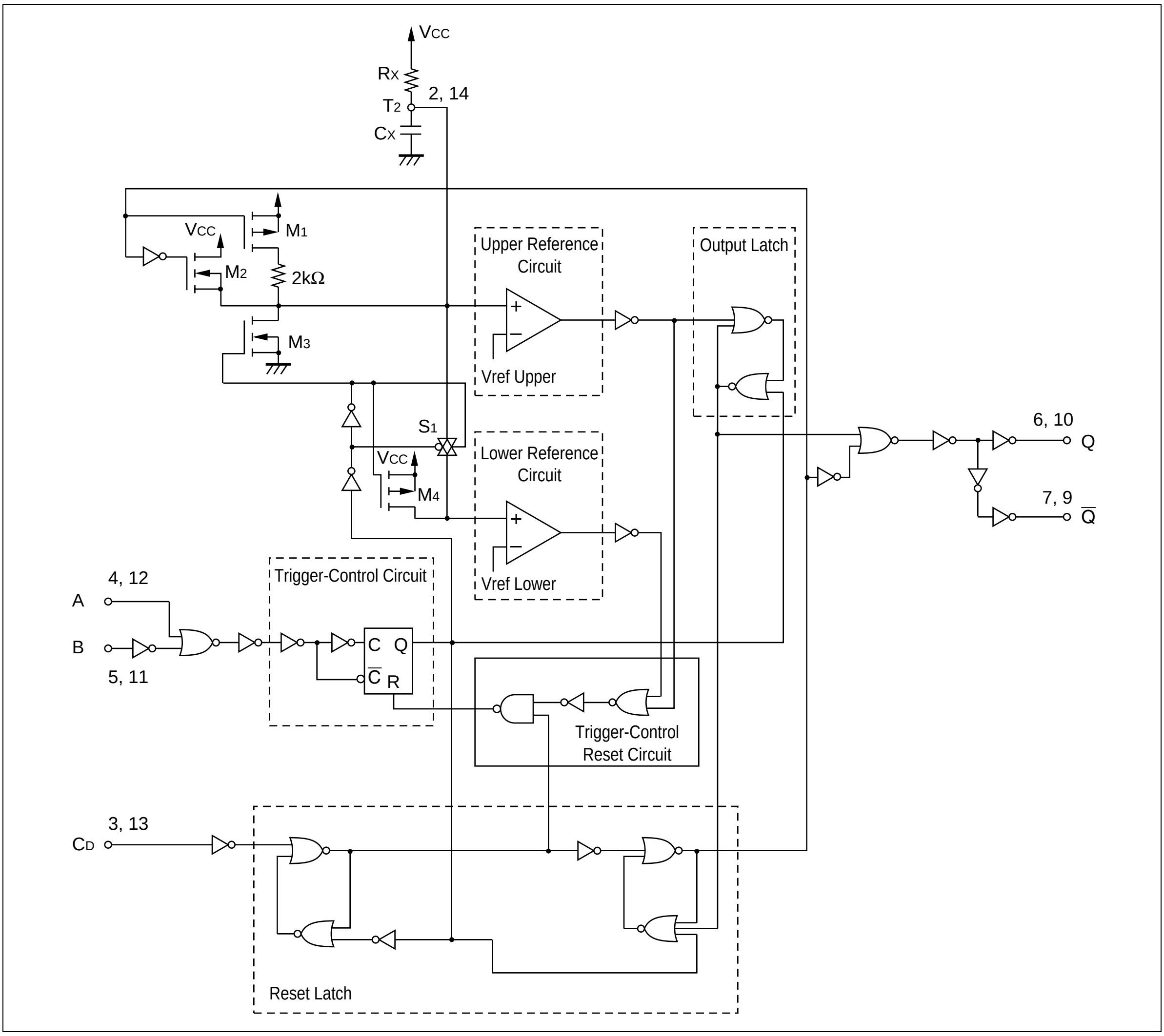


Fig. 1 Function Diagram

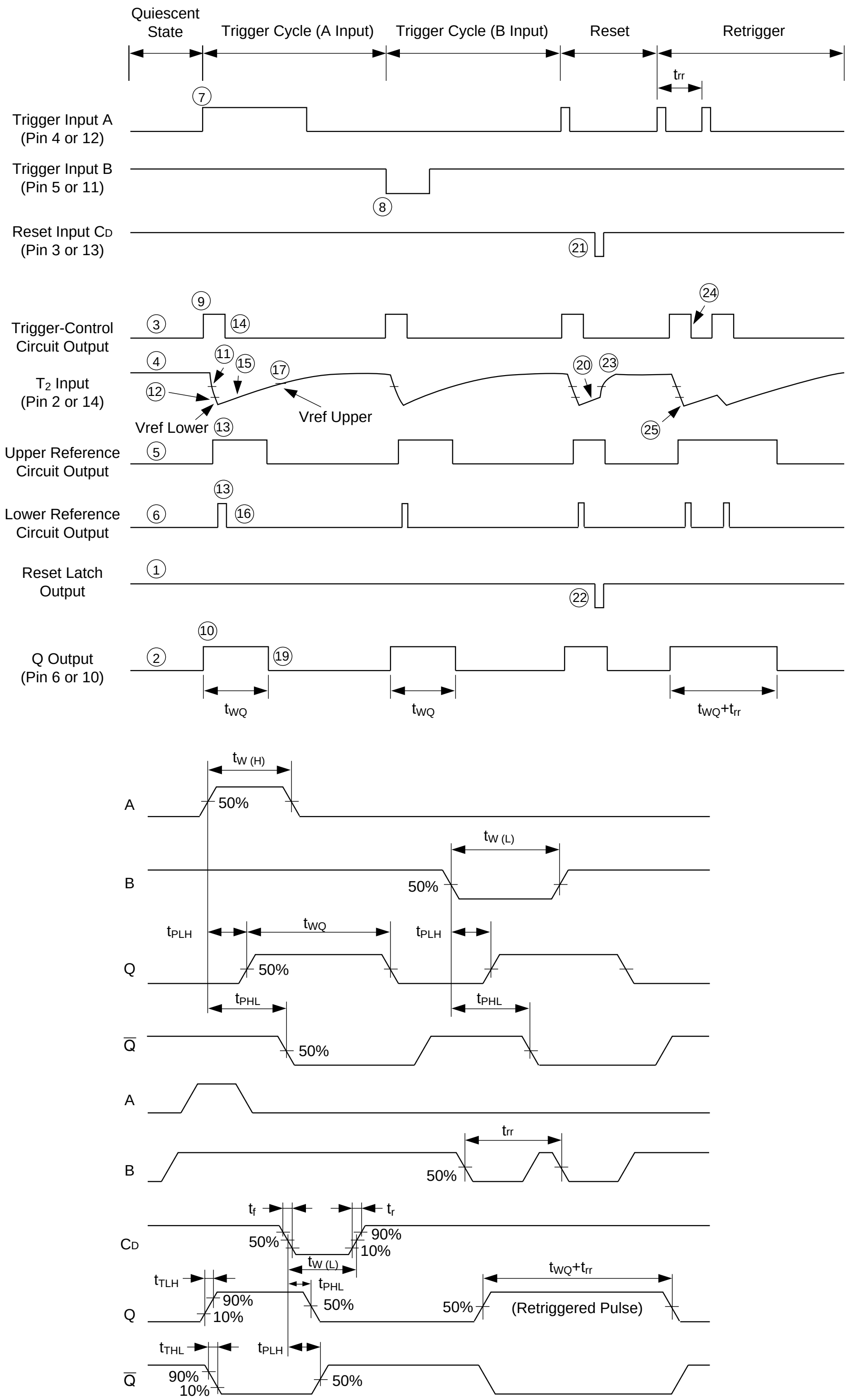


Fig. 2 Timing Diagram

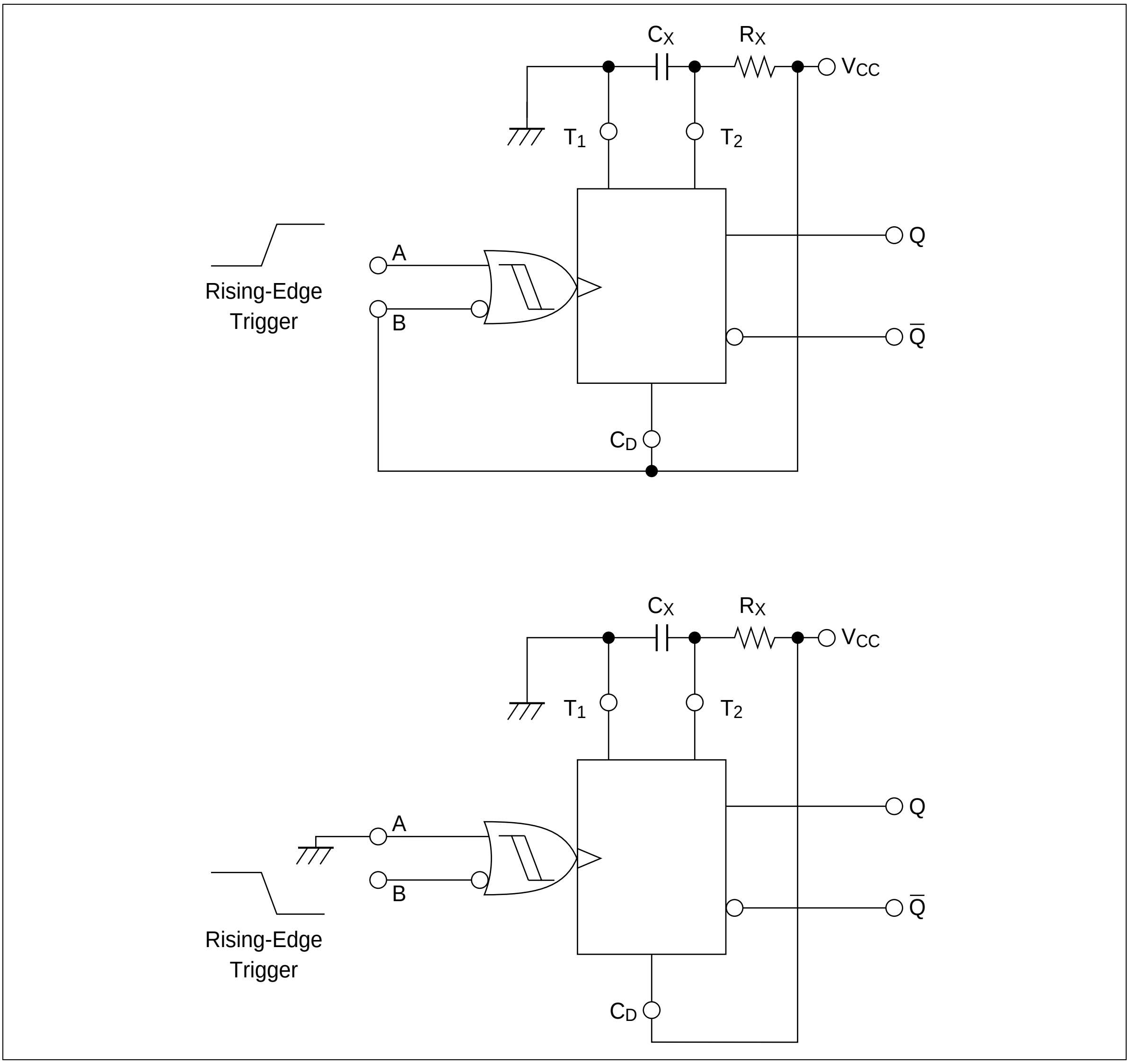


Fig. 3 Retriggerable Monostable Circuitry

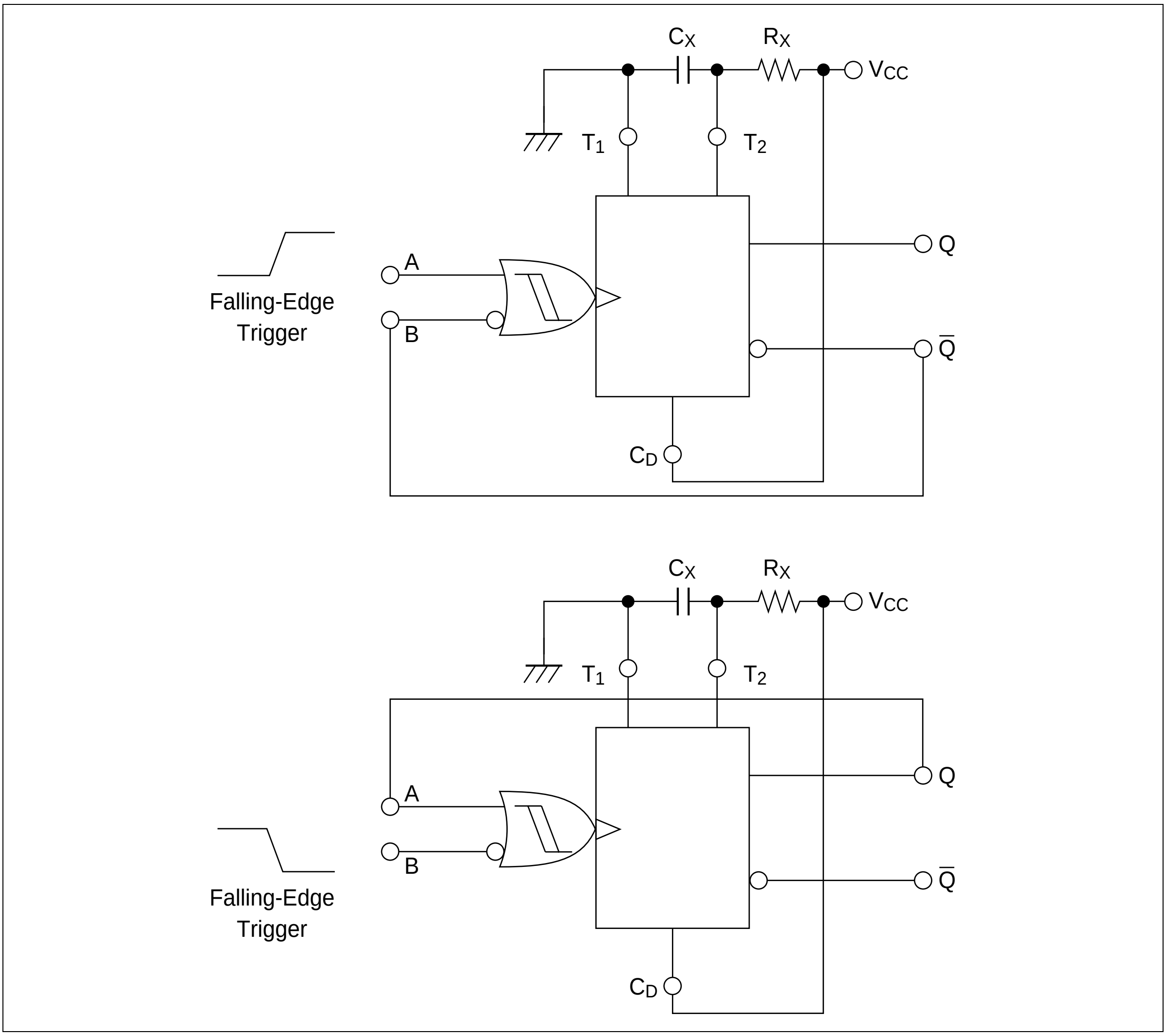
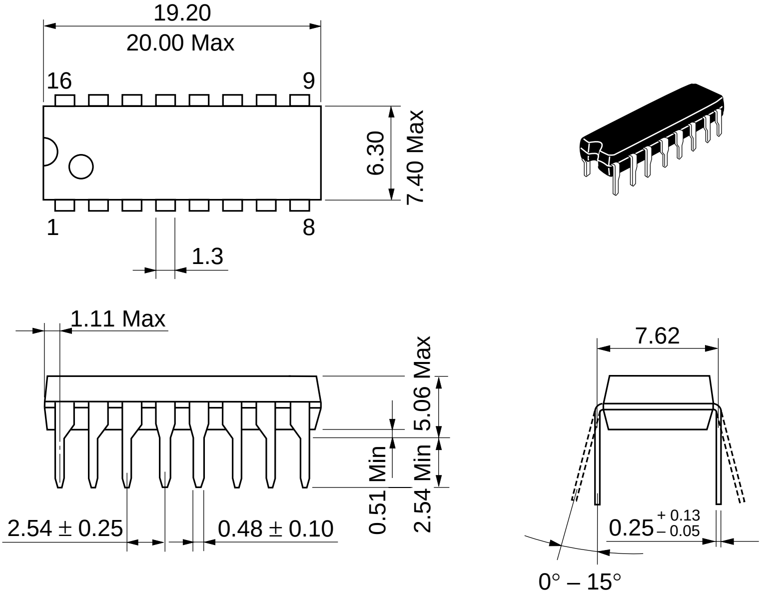


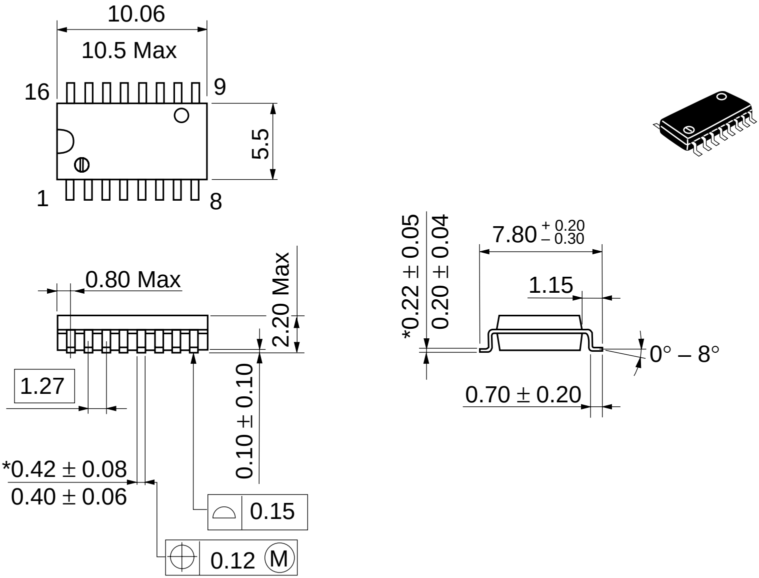
Fig. 4 Nonritriggerable Monostable Circuitry

Unit: mm



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

Unit: mm

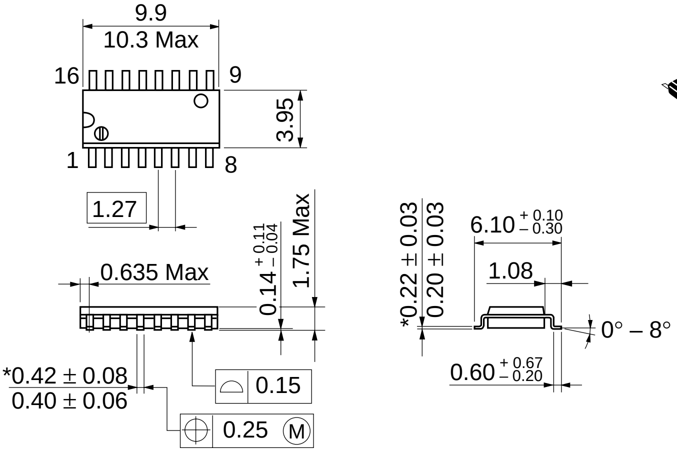


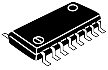
Hitachi Code	FP-16DA
JEDEC	—
EIAJ	Conforms
Weight (reference value)	0.24 g

*Dimension including the plating thickness

Base material dimension

Unit: mm





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

*Dimension including the plating thickness
Base material dimension

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Hitachi, Ltd.
Semiconductor & Integrated Circuits.
Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan
Tel: Tokyo (03) 3270-2111 Fax: (03) 3270-5109

URL	NorthAmerica	: http:semiconductor.hitachi.com/
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For further information write to:

Hitachi Semiconductor
(America) Inc.
179 East Tasman Drive,
San Jose,CA 95134
Tel: <1> (408) 433-1990
Fax: <1>(408) 433-0223

Hitachi Europe GmbH
Electronic components Group
Dornacher Stra§e 3
D-85622 Feldkirchen, Munich
Germany
Tel: <49> (89) 9 9180-0
Fax: <49> (89) 9 29 30 00

Hitachi Europe Ltd.
Electronic Components Group.
Whitebrook Park
Lower Cookham Road
Maidenhead
Berkshire SL6 8YA, United Kingdom
Tel: <44> (1628) 585000
Fax: <44> (1628) 778322

Hitachi Asia Pte. Ltd.
16 Collyer Quay #20-00
Hitachi Tower
Singapore 049318
Tel: 535-2100
Fax: 535-1533

Hitachi Asia Ltd.
Taipei Branch Office
3F, Hung Kuo Building. No.167,
Tun-Hwa North Road, Taipei (105)
Tel: <886> (2) 2718-3666
Fax: <886> (2) 2718-8180

Hitachi Asia (Hong Kong) Ltd.
Group III (Electronic Components)
7/F., North Tower, World Finance Centre,
Harbour City, Canton Road, Tsim Sha Tsui,
Kowloon, Hong Kong
Tel: <852> (2) 735 9218
Fax: <852> (2) 730 0281
Telex: 40815 HITEC HX