

**TC74HC4538AP, TC74HC4538AF, TC74HC4538AFN, TC74HC4538AFT**

**DUAL RETRIGGERABLE MONOSTABLE MULTIVIBRATOR**

The TC74HC4538A is a high speed CMOS MONOSTABLE MULTIVIBRATOR fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

There are two trigger inputs, A input (Positive edge input), and  $\overline{B}$  input (Negative edge input). These inputs are valid for a slow rise/fall time signal ( $t_r = t_f = 1\text{sec.}$ ) as they are schmitt trigger inputs.

After triggering, the output stays in a MONOSTABLE state for the time period determined by the external resistor and capacitor ( $R_x, C_x$ ). A low level at  $\overline{CD}$  input breaks this STABLE STATE. In the MONOSTABLE state, if a new trigger is applied, it makes the MONOSTABLE period longer (retrigger mode).

Limitations for  $C_x$  and  $R_x$  are as follows :

- External capacitor  $C_x$  ..... No limitation
- External resistor  $R_x$  .....  $V_{CC} = 2.0V$  more than  $5k\Omega$   
 $V_{CC} \geq 3.0V$  more than  $1k\Omega$

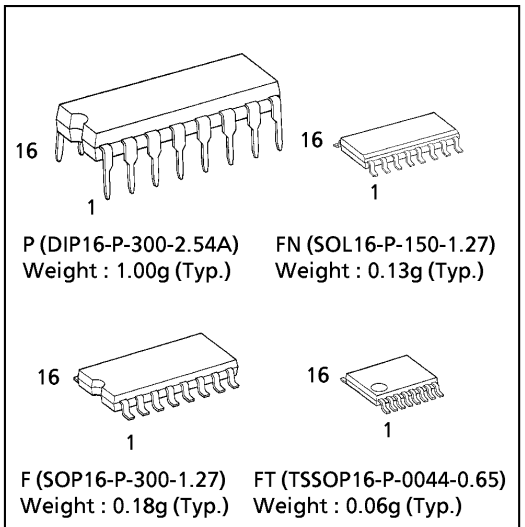
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

**FEATURES :**

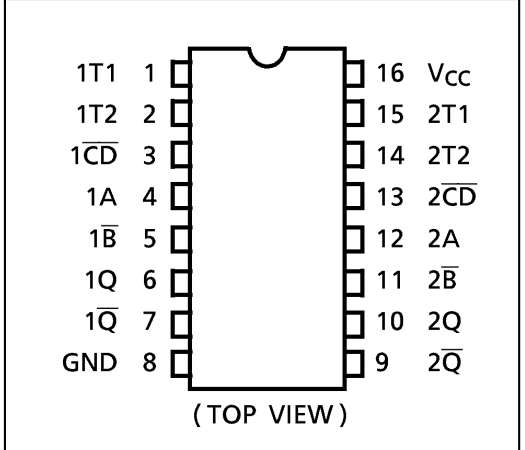
- High Speed..... $t_{pd} = 25\text{ns}$  (typ.) at  $V_{CC} = 5V$
- Low Power Dissipation  
 Stand by State..... $I_{CC} = 4\mu A$ (Max.) at  $T_a = 25^\circ C$   
 Active State ..... $I_{CC} = 300\mu A$ (Max.) at  $T_a = 25^\circ C$
- High Noise Immunity..... $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (Min.)
- Output Drive Capability..... 10 LSTTL Loads
- Symmetrical Output Impedance...  $|I_{OH}| = I_{OL} = 4\text{mA}$ (Min.)
- Balanced Propagation Delays..... $t_{pLH} \approx t_{pHL}$
- Wide Operating Voltage Range...  $V_{CC}$  (opr.) =  $2V \sim 6V$
- Pin and Function Compatible with 4538B

Note : In the case of using only one circuit,  $\overline{CD}$  should be tied to GND,  $T1 \cdot T2 \cdot Q \cdot \overline{Q}$  should be tied to OPEN, the other inputs should be tied to  $V_{CC}$  or GND.

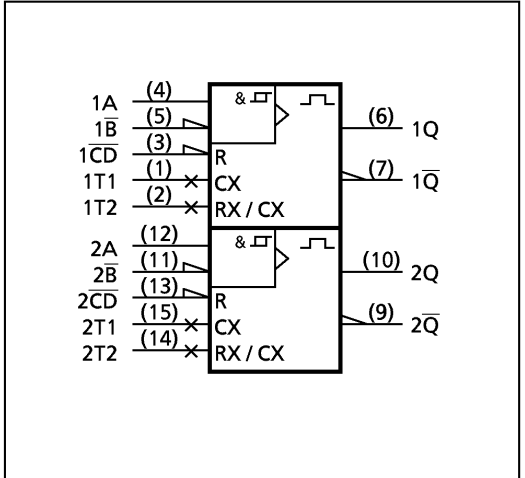
(Note) The JEDEC SOP (FN) is not available in Japan.



**PIN ASSIGNMENT**



**IEC LOGIC SYMBOL**

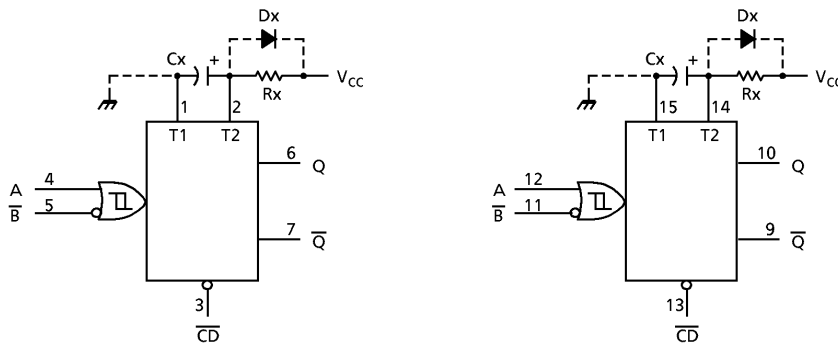


TRUTH TABLE

INPUT			OUTPUT		NOTE
A	$\bar{B}$	$\bar{CD}$	Q	$\bar{Q}$	
	H	H			OUTPUT ENABLE
X	L	H	L	H	INHIBIT
H	X	H	L	H	INHIBIT
L		H			OUTPUT ENABLE
X	X	L	L	H	RESET

X : Don't Care

BLOCK DIAGRAM



Notes : (1) Cx, Rx, Dx are external.  
Capacitor, Resistor, and Diode, respectively.

(2) External clamping diode, Dx

The external capacitor is charged to  $V_{CC}$  level in the wait state, i.e. when no trigger is applied. Supply voltage is turned off and Cx is discharged mainly through the internal (parasitic) diode. If Cx is sufficiently large and  $V_{CC}$  drops rapidly, there will be some possibility of damaging the IC by rush current or latch-up. If the capacitance of the supply voltage filter is large enough and  $V_{CC}$  drops slowly, the rush current is automatically limited and damage to the IC is avoided.

The maximum value of forward current through the parasitic diode is  $\pm 20\text{mA}$ .

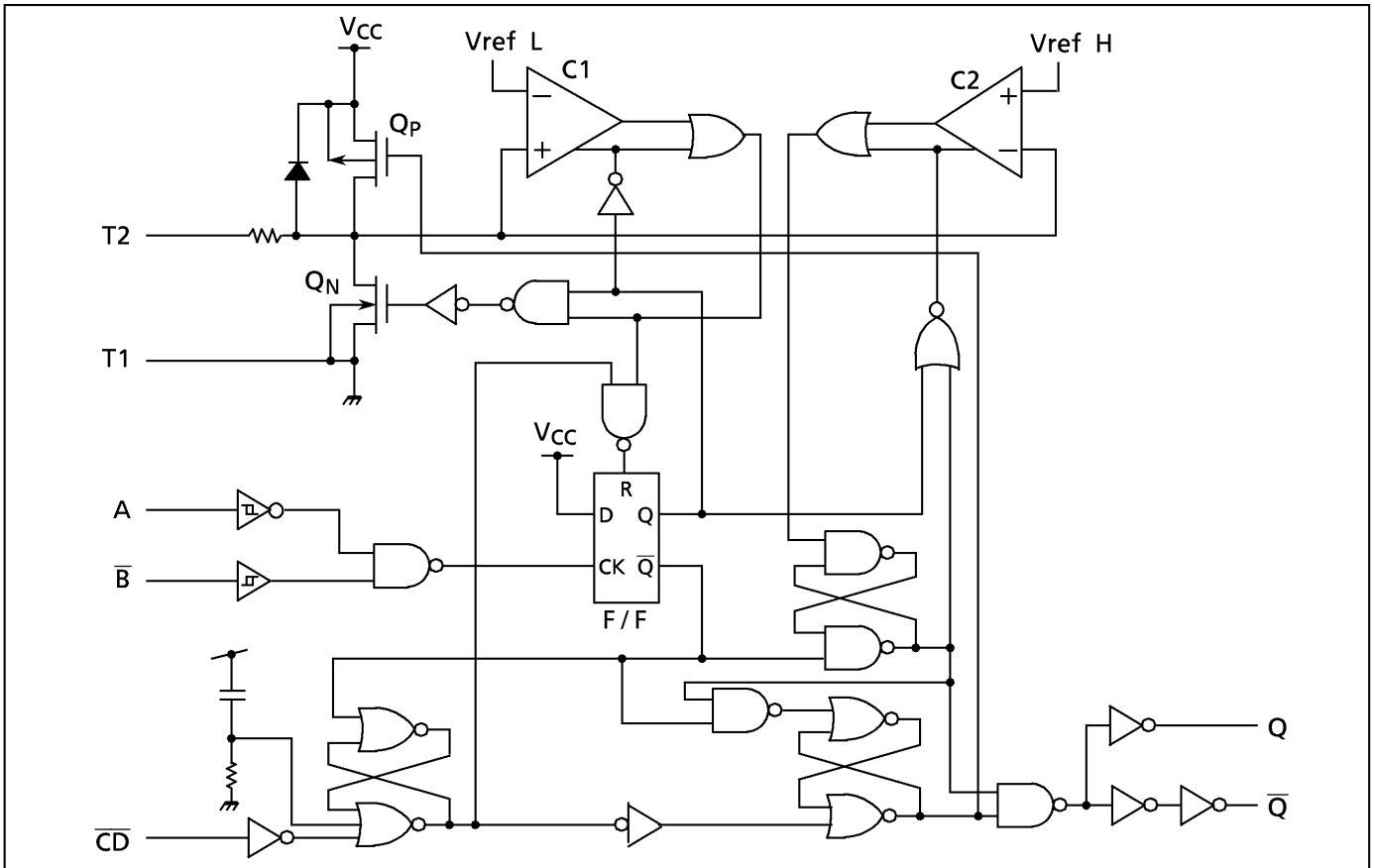
In the case of a large Cx, the limitation of fall time of the supply voltage is determined as follows :

$$t_f \geq (V_{CC} - 0.7) C_x / 20\text{mA}$$

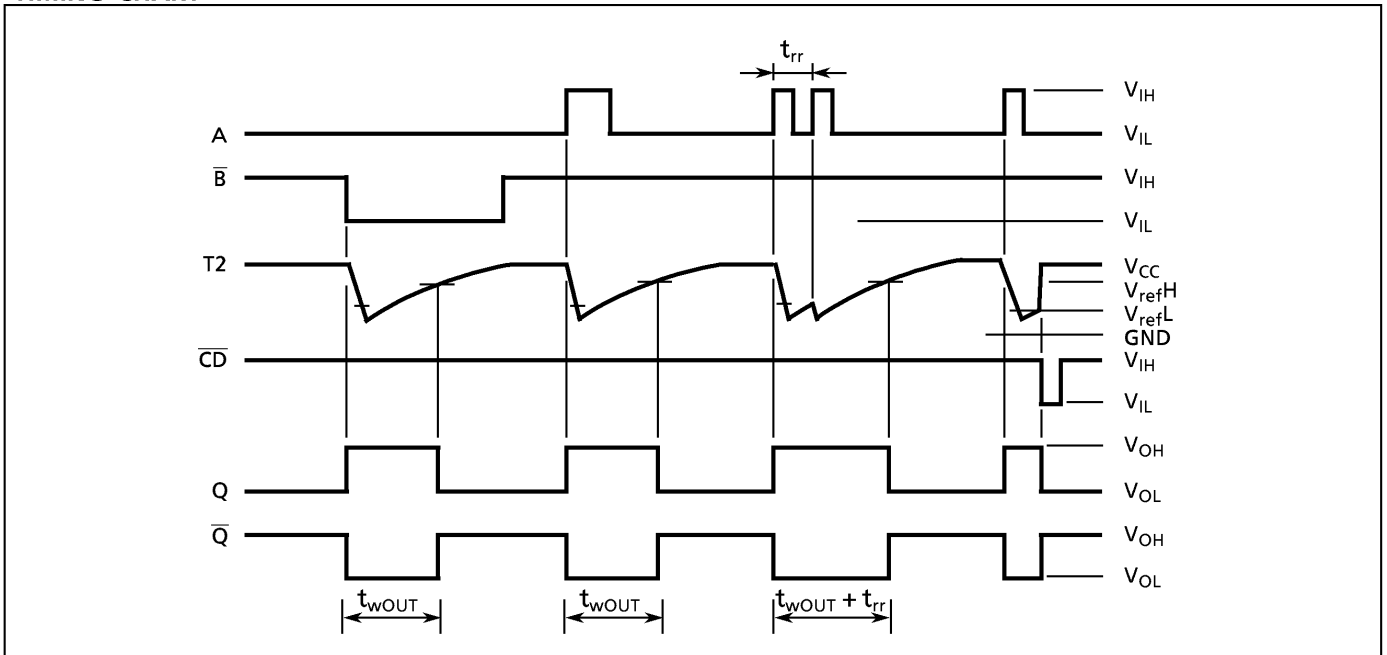
( $t_f$  is the time from the voltage supply turning off to the level of supply voltage reaching  $0.4 V_{CC}$ .)

In the care of a system that does not satisfy the above condition, an external clamping diode is needed to protect the IC from rush current.

SYSTEM DIAGRAM



TIMING CHART



## FUNCTIONAL DESCRIPTION

## (1)Stand-by State

The external capacitor is fully charge to  $V_{CC}$  in the stand-by state. That means, before triggering,  $Q_P$  and  $Q_N$  transistors which are connected to the T2 node are in the off state. Two comparators that relate to the timing of the output pulse, and two reference voltage supplies stop their operation. The total supply current is only leakage current.

## (2)Trigger operation

Trigger operation is effective in either of the following two cases. One is the condition where the A input is low, and the  $\overline{B}$  input has a falling signal. The other, where the  $\overline{B}$  input is high, and the A input has a rising signal.

After trigger becomes effective, comparators C1 and C2 start operating, and  $Q_N$  is turned on. The external capacitor discharges through  $Q_N$ . The voltage level at the T2 node drops. If the T2 voltage level falls to the internal reference voltage  $V_{ref L}$ , the output of C1 becomes low. The flip-flop is then reset and  $Q_N$  turns off. At that moment C1 stops but C2 continues operating.

After  $Q_N$  turns off, the voltage at T2 start rising at a rate determined by the time constant of external capacitor  $C_x$  and resistor  $R_x$ .

After the triggering, output Q becomes high, following some delay time of the internal F/F and gates. It stays high even if the voltage of T2 changes from falling to rising. When T2 reaches the internal reference voltage  $V_{ref H}$ , the output of C2 becomes low, the output Q goes low and C2 stops its operation. That means, after triggering, when the voltage level of T2 reaches  $V_{ref H}$ , the IC returns to its MONOSTABLE state.

In the case of large value of  $C_x$  and  $R_x$ , and ignoring the discharge time of the capacitor and internal delays of the IC, the width of the output pulse, ( $t_{WOUT}$ ), is as follows :

$$t_{WOUT} = 0.70 \cdot C_x \cdot R_x$$

## (3)Retrigger operation

When another new trigger is applied to input A or  $\overline{B}$  while in the MONOSTABLE state, it is effective only if the IC is charging  $C_x$ . The voltage level of T2 then falls to  $V_{ref L}$  level again. Therefore the Q output stays high if the next trigger comes in before the time period set by  $C_x$  and  $R_x$ .

If the 2nd trigger is very close to previous trigger, such as application during the discharge cycle, the 2nd trigger will not be effective.

The minimum time for effective 2nd trigger,  $t_{rr}(\text{Min})$ , depends on  $V_{cc}$  and  $C_x$ .

## (4)Reset operation

In normal operation,  $\overline{CD}$  input is held high. If  $\overline{CD}$  is low, a trigger has no effect because the Q output is held low and the trigger control F/F is reset. Also  $Q_P$  turns on and  $C_x$  is charged rapidly to  $V_{CC}$ .

This means if  $\overline{CD}$  input is set low, the IC goes into a wait state.

## ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage Range	$V_{CC}$	$-0.5 \sim 7$	V
DC Input Voltage	$V_{IN}$	$-0.5 \sim V_{CC} + 0.5$	V
DC Output Voltage	$V_{OUT}$	$-0.5 \sim V_{CC} + 0.5$	V
Input Diode Current	$I_{IK}$	$\pm 20$	mA
Output Diode Current	$I_{OK}$	$\pm 20$	mA
DC Output Current	$I_{OUT}$	$\pm 25$	mA
DC $V_{CC}$ / Ground Current	$I_{CC}$	$\pm 50$	mA
Power Dissipation	$P_D$	500 (DIP)* / 180 (SOP / TSSOP)	mW
Storage Temperature	$T_{stg}$	$-65 \sim 150$	$^{\circ}\text{C}$

\*500mW in the range of  $T_a = -40^{\circ}\text{C} \sim 65^{\circ}\text{C}$ . From  $T_a = 65^{\circ}\text{C}$  to  $85^{\circ}\text{C}$  a derating factor of  $-10\text{mW}/^{\circ}\text{C}$  shall be applied until 300mW.

## RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	UNIT
Supply Voltage	$V_{CC}$	$2 \sim 6$	V
Input Voltage	$V_{IN}$	$0 \sim V_{CC}$	V
Output Voltage	$V_{OUT}$	$0 \sim V_{CC}$	V
Operating Temperature	$T_{opr}$	$-40 \sim 85$	$^{\circ}\text{C}$
Input Rise and Fall Time (CD Only)	$t_r, t_f$	0~1000 ( $V_{CC} = 2.0\text{V}$ ) 0~500 ( $V_{CC} = 4.5\text{V}$ ) 0~400 ( $V_{CC} = 6.0\text{V}$ )	ns
External Capacitor	$C_x$	No Limitation *	F
External Resistor	$R_x$	$\geq 5\text{k}^*$ ( $V_{CC} = 2.0\text{V}$ ) $\geq 1\text{k}^*$ ( $V_{CC} \geq 3.0\text{V}$ )	$\Omega$

\* The maximum allowable values of  $C_x$  and  $R_x$  are a function of leakage of capacitor  $C_x$ , the leakage of TC74HC4538A, and leakage due to board layout and surface resistance. Susceptibility to externally induced noise signals may occur for  $R_x > 1\text{M}\Omega$ .

**DC ELECTRICAL CHARACTERISTICS**

PARAMETER	SYMBOL	TEST CONDITION	V <sub>CC</sub> (V)	Ta = 25°C			Ta = -40~85°C		UNIT	
				MIN.	TYP.	MAX.	MIN.	MAX.		
High - Level Input Voltage	V <sub>IH</sub>		2.0	1.50	—	—	1.50	—	V	
			4.5	3.15	—	—	3.15	—		
			6.0	4.20	—	—	4.20	—		
Low - Level Input Voltage	V <sub>IL</sub>		2.0	—	—	0.50	—	0.50	V	
			4.5	—	—	1.35	—	1.35		
			6.0	—	—	1.80	—	1.80		
High - Level Output Voltage (Q, $\bar{Q}$ )	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -20 $\mu$ A	2.0	1.9	2.0	—	1.9	—	V
				4.5	4.4	4.5	—	4.4	—	
			I <sub>OH</sub> = -4 mA I <sub>OH</sub> = -5.2 mA	4.5	4.18	4.31	—	4.13	—	
				6.0	5.68	5.80	—	5.63	—	
Low - Level Output Voltage (Q, $\bar{Q}$ )	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OL</sub> = 20 $\mu$ A	2.0	—	0.0	0.1	—	0.1	V
				4.5	—	0.0	0.1	—	0.1	
			I <sub>OL</sub> = 4 mA I <sub>OL</sub> = 5.2 mA	4.5	—	0.17	0.26	—	0.33	
				6.0	—	0.18	0.26	—	0.33	
Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	6.0	—	—	± 0.1	—	± 1.0	$\mu$ A	
T2 Terminal Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	6.0	—	—	± 0.5	—	± 5.0		
Quiescent Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	6.0	—	—	4.0	—	40.0		
Active - State * Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND T2 ext = 0.5 V <sub>CC</sub>	2.0	—	40	120	—	160	$\mu$ A	
			4.5	—	200	300	—	400		
			6.0	—	300	600	—	800		

\* : per circuit

**TIMING REQUIREMENTS ( Input t<sub>r</sub> = t<sub>f</sub> = 6ns )**

PARAMETER	SYMBOL	TEST CONDITION	V <sub>CC</sub> (V)	Ta = 25°C		Ta = -40~85°C	UNIT
				TYP.	LIMIT	LIMIT	
Minimum Pulse Width (A, B)	t <sub>w(L)</sub> t <sub>w(H)</sub>		2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Clear Width ( $\bar{CD}$ )	t <sub>w(L)</sub>		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Clear Removal Time	t <sub>rem</sub>		2.0	—	15	15	
			4.5	—	5	5	
			6.0	—	5	5	
Minimum Retrigger Time	t <sub>rr</sub>	Rx = 1k $\Omega$ Cx = 100pF	2.0	380	—	—	$\mu$ s
			4.5	92	—	—	
			6.0	72	—	—	
		Rx = 1k $\Omega$ Cx = 0.01 $\mu$ F	2.0	6.0	—	—	
			4.5	1.4	—	—	
			6.0	1.2	—	—	

**AC ELECTRICAL CHARACTERISTICS (  $C_L = 15\text{pF}$ ,  $V_{CC} = 5\text{V}$ ,  $T_a = 25^\circ\text{C}$ , Input  $t_r = t_f = 6\text{ns}$  )**

PARAMETER	SYMBOL	TEST CONDITION	MIN.	TYP.	MAX.	UNIT
Output Transition Time	$t_{TLH}$ $t_{THL}$		—	6	12	ns
Propagation Delay Time (A, $\overline{B}-Q, \overline{Q}$ )	$t_{pLH}$ $t_{pHL}$		—	25	44	
Propagation Delay Time ( $\overline{CD}-Q, \overline{Q}$ )	$t_{pLH}$ $t_{pHL}$		—	21	34	

**AC ELECTRICAL CHARACTERISTICS (  $C_L = 50\text{pF}$ , Input  $t_r = t_f = 6\text{ns}$  )**

PARAMETER	SYMBOL	TEST CONDITION	$T_a = 25^\circ\text{C}$			$T_a = -40\sim 85^\circ\text{C}$		UNIT	
			$V_{CC}(\text{V})$	MIN.	TYP.	MAX.	MIN.		MAX.
Output Transition Time	$t_{TLH}$ $t_{THL}$		2.0	—	30	75	—	95	ns
			4.5	—	8	15	—	19	
			6.0	—	7	13	—	16	
Propagation Delay Time (A, $\overline{B}-Q, \overline{Q}$ )	$t_{pLH}$ $t_{pHL}$		2.0	—	120	250	—	315	ns
			4.5	—	30	50	—	63	
			6.0	—	25	43	—	54	
Propagation Delay Time ( $\overline{CD}-Q, \overline{Q}$ )	$t_{pLH}$ $t_{pHL}$		2.0	—	100	195	—	245	ns
			4.5	—	25	39	—	49	
			6.0	—	20	33	—	42	
Output Pulse Width	$tw_{OUT}$	Cx = 0F Rx = 5k $\Omega$ ( $V_{CC} = 2\text{V}$ ) Rx = 1k $\Omega$ ( $V_{CC} = 4.5\text{V}, 6\text{V}$ )	2.0	—	540	1200	—	1500	ns
			4.5	—	180	250	—	320	
			6.0	—	150	200	—	260	
		Cx = 0.01 $\mu\text{F}$ Rx = 10k $\Omega$	2.0	70	83	96	70	96	$\mu\text{s}$
			4.5	69	77	85	69	85	
			6.0	69	77	85	69	85	
Cx = 0.1 $\mu\text{F}$ Rx = 10k $\Omega$	2.0	0.67	0.75	0.83	0.67	0.83	ms		
	4.5	0.67	0.73	0.77	0.67	0.77			
	6.0	0.67	0.73	0.77	0.67	0.77			
Output Pulse Width Error Between Circuits (In same Package)	$\Delta tw_{OUT}$		—	$\pm 1$	—	—	—	%	
Input Capacitance	$C_{IN}$		—	5	10	—	10	pF	
Power Dissipation Capacitance	$C_{PD}$	Note (1)	—	70	—	—	—		

Note(1)  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

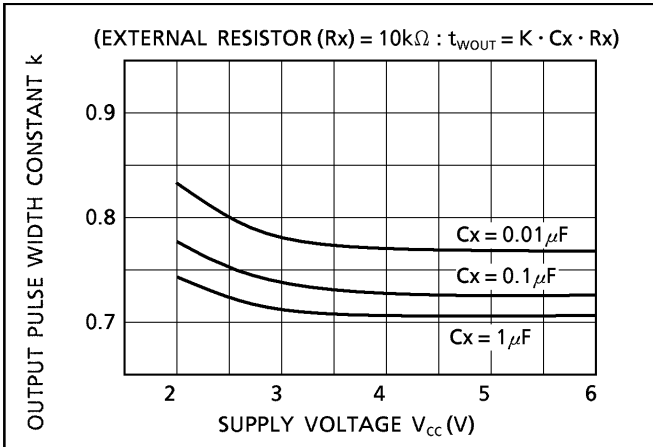
Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}' \cdot \text{Duty} / 100 + I_{CC} / 2 \text{ (per Circuit)}$$

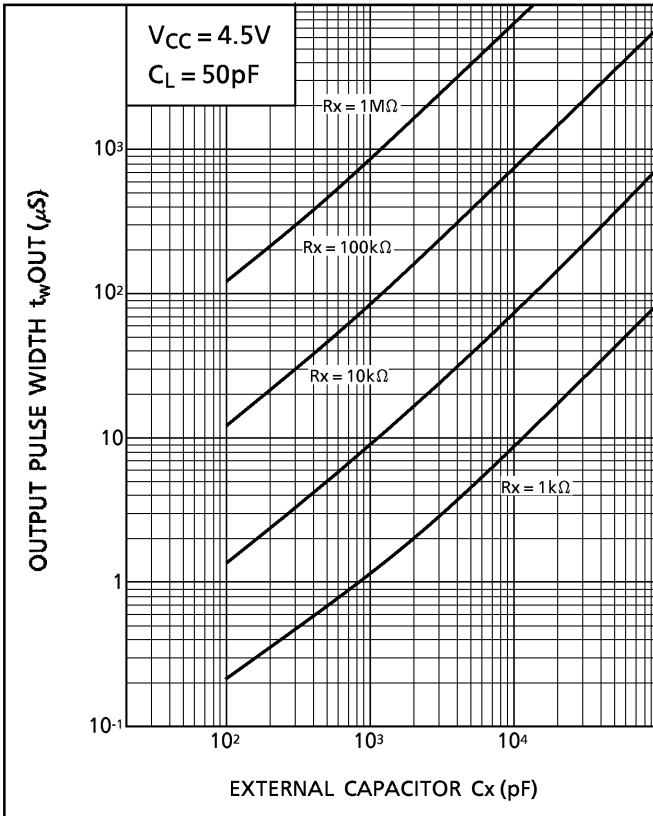
( $I_{CC}'$  : Active Supply Current)

(Duty : %)

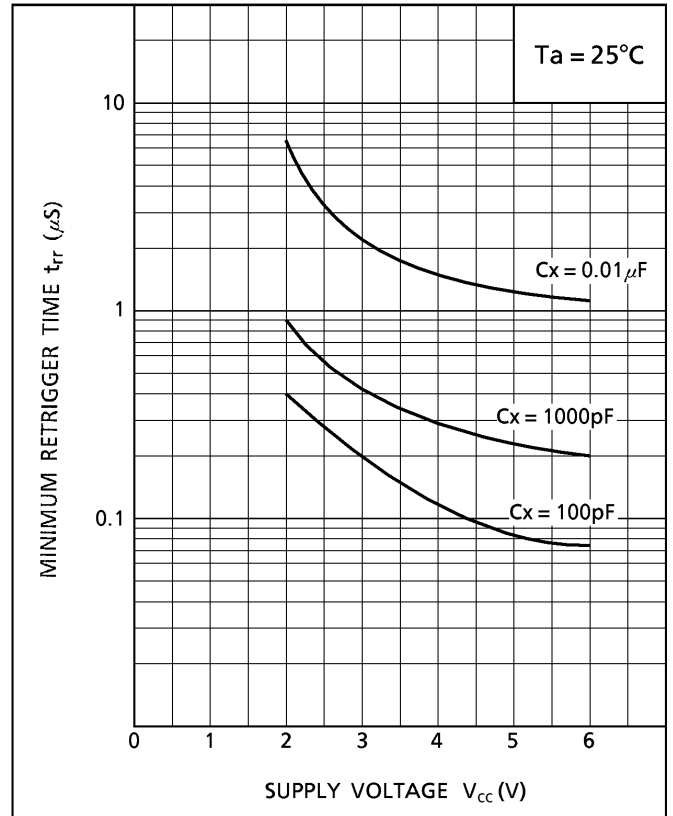
OUTPUT PULSE WIDTH CONSTANT K- SUPPLY VOLTAGE ( TYPICAL )



$t_{WOUT} - Cx$  CHARACTERISTICS ( TYPICAL )



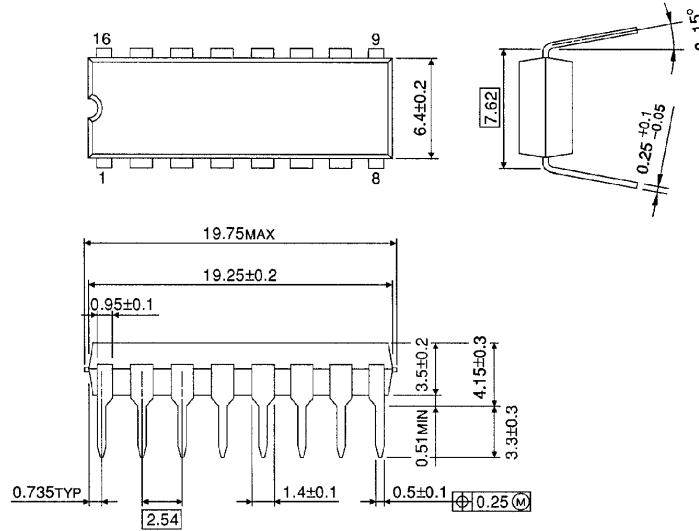
$t_{rr} - V_{CC}$  CHARACTERISTICS ( TYPICAL )





**DIP 16PIN PACKAGE DIMENSIONS (DIP16-P-300-2.54A)**

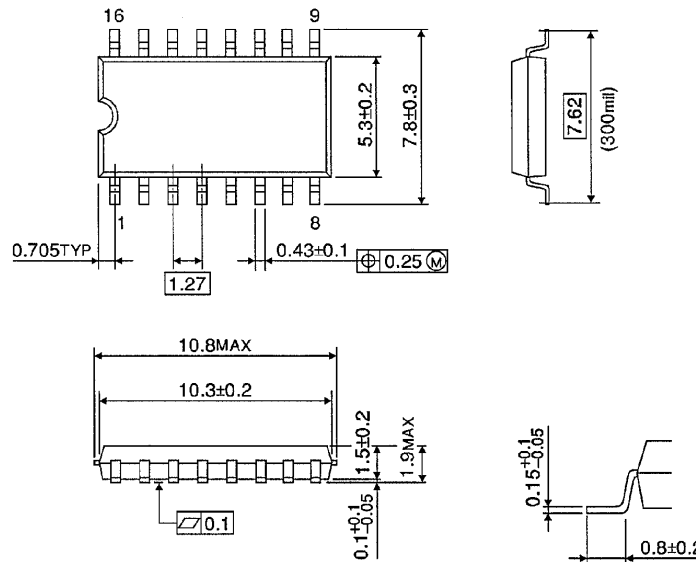
Unit in mm



Weight : 1.00g (Typ.)

**SOP 16PIN (200mil BODY) PACKAGE DIMENSIONS (SOP16-P-300-1.27)**

Unit in mm

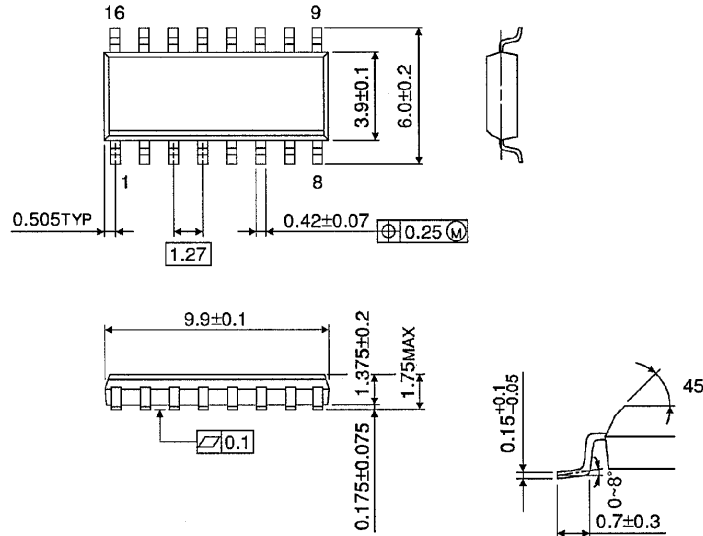


Weight : 0.18g (Typ.)

**SOP 16PIN (150mil BODY) PACKAGE DIMENSIONS (SOL16-P-150 -1.27)**

Unit in mm

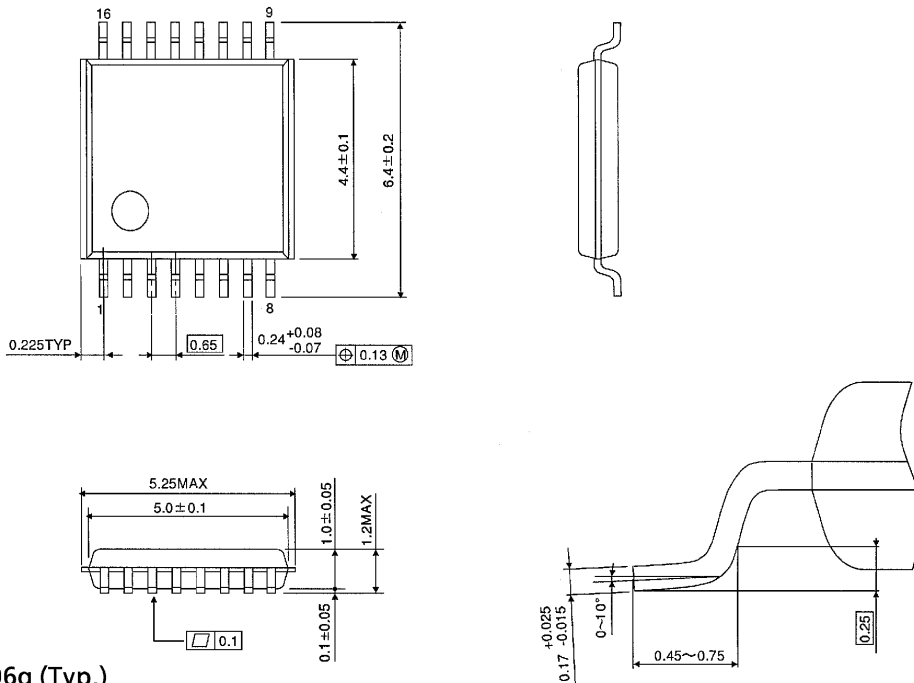
(Note) This package is not available in Japan.



Weight : 0.13g (Typ.)

**TSSOP 16PIN PACKAGE DIMENSIONS (TSSOP16-P-0044-0.65)**

Unit in mm



Weight : 0.06g (Typ.)

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000707EBA

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