TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74HC221AP, TC74HC221AF

Dual Monostable Multivibrator

The TC74HC221A is a high speed CMOS MONOSTABLE MULTIVIBRATOR fabricated with silicon gate C^2MOS technology.

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

There are two trigger inputs, $\overline{A}$ input (negative edge), and B input (positive edge). These inputs are valid for a slow rise/fall time signal (tr = tf = 1 s) as they are schmitt trigger inputs. This device may also be triggered by using $\overline{CLR}$ input (positive edge).

After triggering, the output stays in a MONOSTABLE state for a time period determined by the external resistor and capacitor (Rx, Cx). A low level at the $\overline{CLR}$ input breaks this state.

Limits for Cx and Rx are:

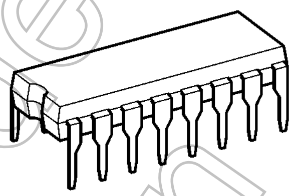
External capacitor, Cx: No limit

External resistor, Rx: V_{CC} = 2.0 V more than 5 kΩ

V_{CC} ≥ 3.0 V more than 1 kΩ

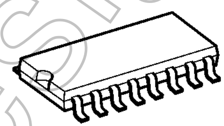
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC74HC221AP



DIP16-P-300-2.54A

TC74HC221AF



SOP16-P-300-1.27A

Weight

DIP16-P-300-2.54A : 1.00 g (typ.)

SOP16-P-300-1.27A : 0.18 g (typ.)

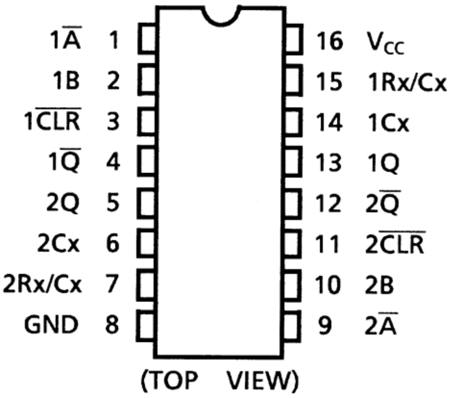
Features (Note)

- High speed: t_{pd} = 25 ns (typ.) at V_{CC} = 5 V
- Low power dissipation
  - Standy by State: I_{CC} = 4 μA (max) at Ta = 25°C
  - Active State: I_{CC} = 700 μA (max) at Ta = 25°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 mA (min)
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Wide operating voltage range: V_{CC} (opr) = 2 to 6 V
- Pin and function compatible with 74LS221

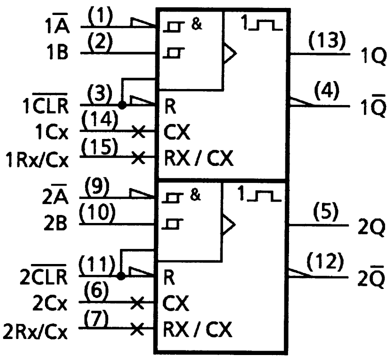
Note: In the case of using only one circuit, $\overline{CLR}$ should be tied to GND, Rx/Cx・Cx・Q・$\overline{Q}$ should be tied to OPEN, the other inputs should be tied to V_{CC} or GND.

Start of commercial production
1988-05

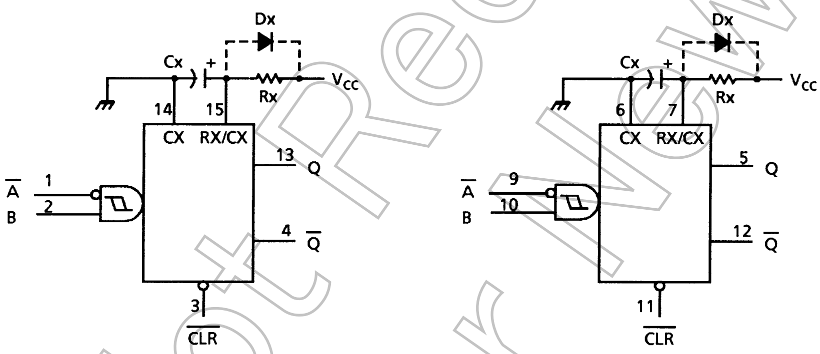
Pin Assignment



IEC Logic Symbol



Block Diagram (Note)



Note: Cx, Rx, Dx are external capacitor, resistor, and diode, respectively.

Note: External clamping diode, Dx;

The external capacitor is charged to V_{CC} level in the wait state, i.e. when no trigger is applied.
If the supply voltage is turned off, Cx is discharges 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 through in rush current or latch-up. If the capacitance of the supply voltage filter is large enough and V_{CC} drops slowly, the in rush current is automatically limited and damage to the IC is avoided.
The maximum value of forward current through the parasitic diode is ±20 mA.
In the case of a large Cx, the limit of fall time of the supply voltage is determined as follows:

$t_f \geqq (V_{CC} - 0.7)$ Cx/20 mA

(t_f is the time between the supply voltage turn off and the supply voltage reaching 0.4 V_{CC}.)

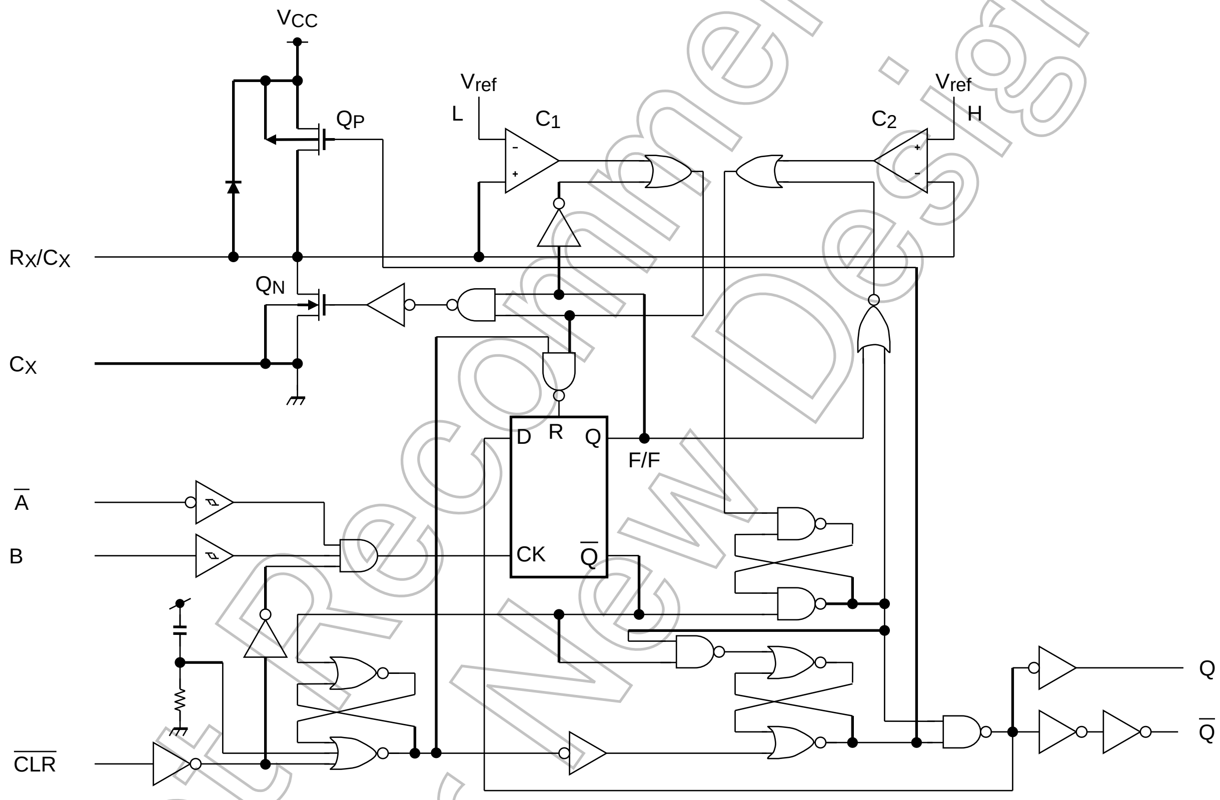
In the even a system does not satisfy the above condition, an external clamping diode (Dx) is needed to protect the IC from rush current.

Truth Table

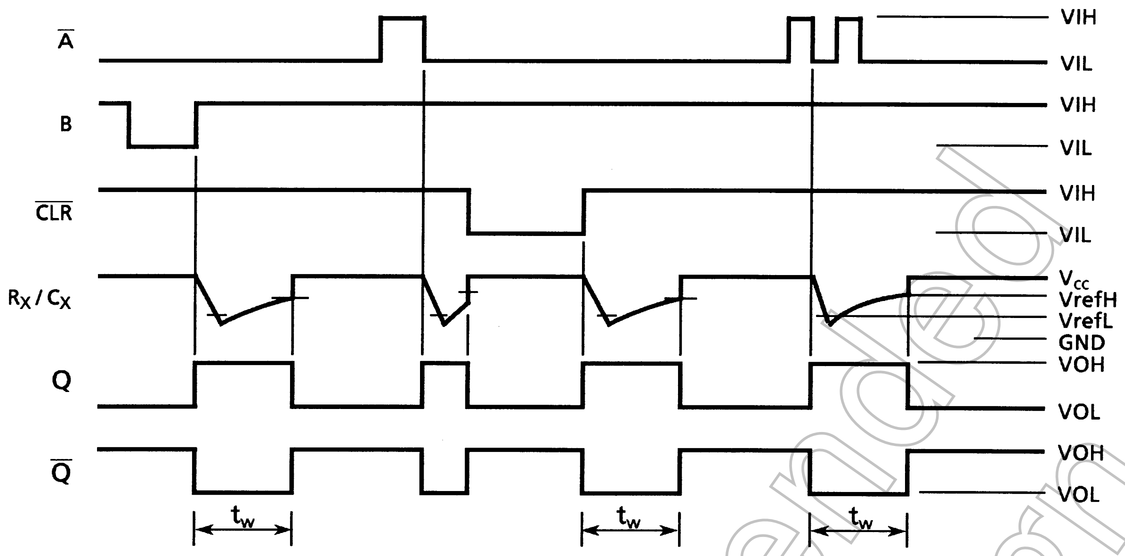
Inputs			Outputs		Note
$\overline{A}$	B	$\overline{CLR}$	Q	$\overline{Q}$	
↓	H	H	⊓	⊔	Output Enable
X	L	H	L	H	Inhibit
H	X	H	L	H	Inhibit
L	↑	H	⊓	⊔	Output Enable
L	H	↑	⊓	⊔	Output Enable
X	X	L	L	H	Reset

X: Don't care

System Diagram



Timing Chart



Functional Description

(1) Stand-by state

The external capacitor (Cx) is fully charged to V_{CC} in the stand-by state. That means, before triggering, the Q_P and Q_N transistors which are connected to the Rx/Cx node are in the off state. Two comparators that relate to the timing of the output pulse, and two reference voltage supplies turn off. The total supply current is only leakage current.

(2) Trigger operation

Trigger operation is effective in any of the following three cases. First the condition where the $\overline{A}$ input is low, and the B input has a rising signal; second, where the B input is high, and the $\overline{A}$ input has a falling signal; and third, where the $\overline{A}$ input is low and the B input is high, and the $\overline{CLR}$ input has a rising signal.

After a 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 Rx/Cx node drops. If the Rx/Cx voltage level falls to the internal reference voltage Vref 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 the Rx/Cx node starts rising at a rate determined by the time constant of external capacitor Cx and resistor Rx.

Upon 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 Rx/Cx changes from falling to rising. When Rx/Cx reaches the internal reference voltage Vref 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 the Rx/Cx node reaches Vref H, the IC returns to its MONOSTABLE state.

With large values of Cx and Rx, 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} = 1.0 Cx Rx

(3) Reset operation

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

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

Absolute Maximum Ratings (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	-0.5 to 7	V
DC input voltage	V_{IN}	-0.5 to V_{CC} + 0.5	V
DC output voltage	V_{OUT}	-0.5 to V_{CC} + 0.5	V
Input diode current	I_{IK}	±20	mA
Output diode current	I_{OK}	±20	mA
DC output current	I_{OUT}	±25	mA
DC V_{CC}/ground current	I_{CC}	±50	mA
Power dissipation	P_D	500 (DIP) (Note 1)/180 (SOP)	mW
Storage temperature	T_{stg}	-65 to 150	°C

Note: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.
Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.
Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 1: 500 mW in the range of Ta = -40 to 65°C. From Ta = 65 to 85°C a derating factor of -10 mW/°C shall be applied until 300 mW.

Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	2 to 6	V
Input voltage	V_{IN}	0 to V_{CC}	V
Output voltage	V_{OUT}	0 to V_{CC}	V
Operating temperature	T_{opr}	-40 to 85	°C
Input rise and fall time ($\overline{CLR}$ only)	t_r, t_f	0 to 1000 (V_{CC} = 2.0 V) 0 to 500 (V_{CC} = 4.5 V) 0 to 400 (V_{CC} = 6.0 V)	ns
External capacitor	Cx	No limitation (Note 1)	F
External resistor	Rx	≥ 5 k (V_{CC} = 2.0 V) (Note 1) ≥ 1 k (V_{CC} ≥ 3.0 V) (Note 1)	Ω

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either VCC or GND.

Note 1 The maximum allowable values of Cx and Rx are a function of leakage of capacitor Cx, the leakage of TC74HC221A, and leakage due to board layout and surface resistance.

Susceptibility to externally induced noise signals may occur for Rx > 1 MΩ.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		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
High-level input voltage	V_{IH}	—		2.0	1.50	—	—	1.50	—	V
				4.5	3.15	—	—	3.15	—	
				6.0	4.20	—	—	4.20	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	—	0.50	V
				4.5	—	—	1.35	—	1.35	
				6.0	—	—	1.80	—	1.80	
High-level output voltage (Q, $\overline{Q}$)	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = -20 μA	2.0	1.9	2.0	—	1.9	—	V
				4.5	4.4	4.5	—	4.4	—	
				6.0	5.9	6.0	—	5.9	—	
			I_{OH} = -4 mA	4.5	4.18	4.31	—	4.13	—	
			I_{OH} = -5.2 mA	6.0	5.68	5.80	—	5.63	—	
Low-level output voltage (Q, $\overline{Q}$)	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 20 μA	2.0	—	0.0	0.1	—	0.1	V
				4.5	—	0.0	0.1	—	0.1	
				6.0	—	0.0	0.1	—	0.1	
			I_{OL} = 4 mA	4.5	—	0.17	0.26	—	0.33	
			I_{OL} = 5.2 mA	6.0	—	0.18	0.26	—	0.33	
Input leakage current	I_{IN}	V_{IN} = V_{CC} or GND		6.0	—	—	±0.1	—	±1.0	μA
Rx/Cx terminal off-state current	I_{IN}	V_{IN} = V_{CC} or GND		6.0	—	—	±0.1	—	±1.0	μA
Quiescent supply current	I_{CC}	V_{IN} = V_{CC} or GND		6.0	—	—	4.0	—	40.0	μA
Active-state supply current (Note 1)	I_{CC}’	V_{IN} = V_{CC} or GND, Rx/Cx = 0.5 V_{CC}		2.0	—	45	200	—	260	μA
				4.5	—	400	500	—	650	
				6.0	—	700	1000	—	1300	

Note 1: Per circuit

Timing Requirements (input: t_r = t_f = 6 ns)

Characteristics	Symbol	Test Condition	V_{CC} (V)	Ta = 25°C Typ.	Ta = 25°C Limit	Ta = -40 to 85°C Limit	Unit
Minimum pulse width	$t_{W (L)}$, $t_{W (H)}$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum clear width	$t_{W (L)}$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	

AC Characteristics (C_L = 15 pF, V_{CC} = 5 V, Ta = 25°C, input: t_r = t_f = 6 ns)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	t_{TLH} t_{THL}	—	—	4	8	ns
Propagation delay time ($\overline{A}$, B-Q, $\overline{Q}$)	t_{pLH} t_{pHL}	—	—	25	36	ns
Propagation delay time ($\overline{CLR}$ TRIGGER-Q, $\overline{Q}$)	t_{pLH} t_{pHL}	—	—	25	41	ns
Propagation delay time ($\overline{CLR}$ -Q, $\overline{Q}$)	t_{pLH} t_{pHL}	—	—	16	27	ns

AC Characteristics (C_L = 50 pF, input: $t_r = t_f$ = 6 ns)

Characteristics	Symbol	Test Condition	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
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 ($\overline{A}$, B-Q, $\overline{Q}$)	t_{pLH}, t_{pHL}	—	2.0	—	102	210	—	265	ns
			4.5	—	30	42	—	53	
			6.0	—	24	36	—	45	
Propagation delay time ($\overline{CLR}$ TRIGGER-Q, $\overline{Q}$)	t_{pLH}, t_{pHL}	—	2.0	—	102	235	—	295	ns
			4.5	—	30	47	—	59	
			6.0	—	24	40	—	50	
Propagation delay time ($\overline{CLR}$-Q, $\overline{Q}$)	t_{pLH}, t_{pHL}	—	2.0	—	67	160	—	200	ns
			4.5	—	20	32	—	40	
			6.0	—	16	27	—	34	
Output pulse width	t_{wOUT}	Cx = 28 pF	2.0	—	700	2000	—	2500	ns
		Rx = 6 kΩ (V_{CC} = 2 V)	4.5	—	250	400	—	500	
		Rx = 2 kΩ (V_{CC} = 4.5 V, 6 V)	6.0	—	210	340	—	425	
		Cx = 0.01 μF, Rx = 10 kΩ	2.0	90	110	130	90	130	μs
			4.5	95	105	115	95	115	
			6.0	95	105	115	95	115	
		Cx = 0.1 μF, Rx = 10 kΩ	2.0	0.9	1.0	1.2	0.9	1.2	ms
			4.5	0.9	1.0	1.1	0.9	1.1	
			6.0	0.9	1.0	1.1	0.9	1.1	
Output pulse width error between circuits (in same package)	Δt_{wOUT}	—	—	—	±1	—	—	—	%
Input capacitance	C_{IN}	—		—	5	10	—	10	pF
Power dissipation capacitance	C_{PD}	(Note 1)		—	174	—	—	—	pF

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

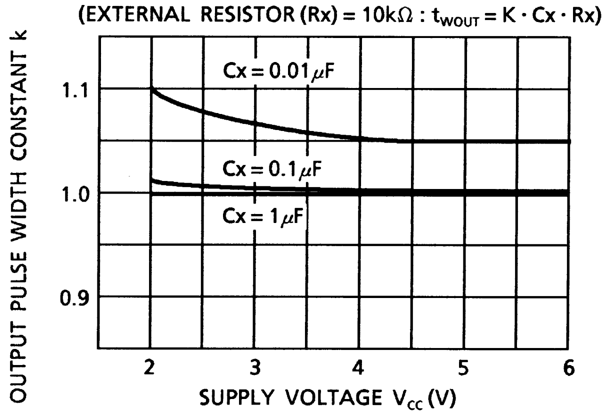
Average operating current can be obtained by the equation:

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

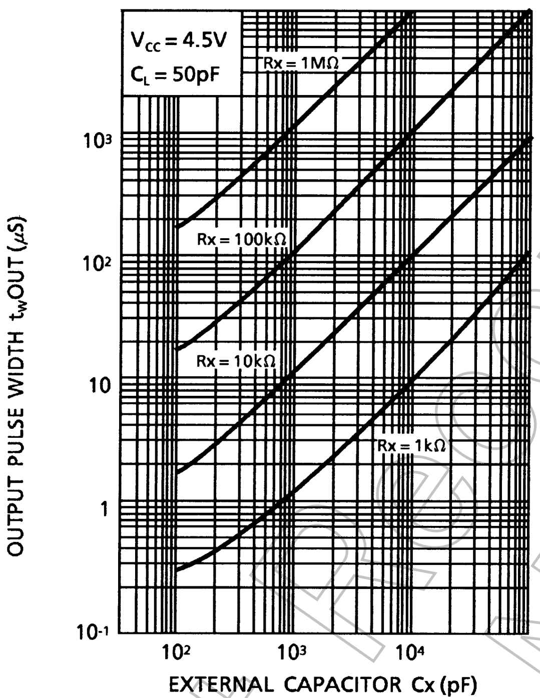
(I_{CC}': active supply current)

(duty: %)

Output Pulse Width Constant K – Supply Voltage (typ.)

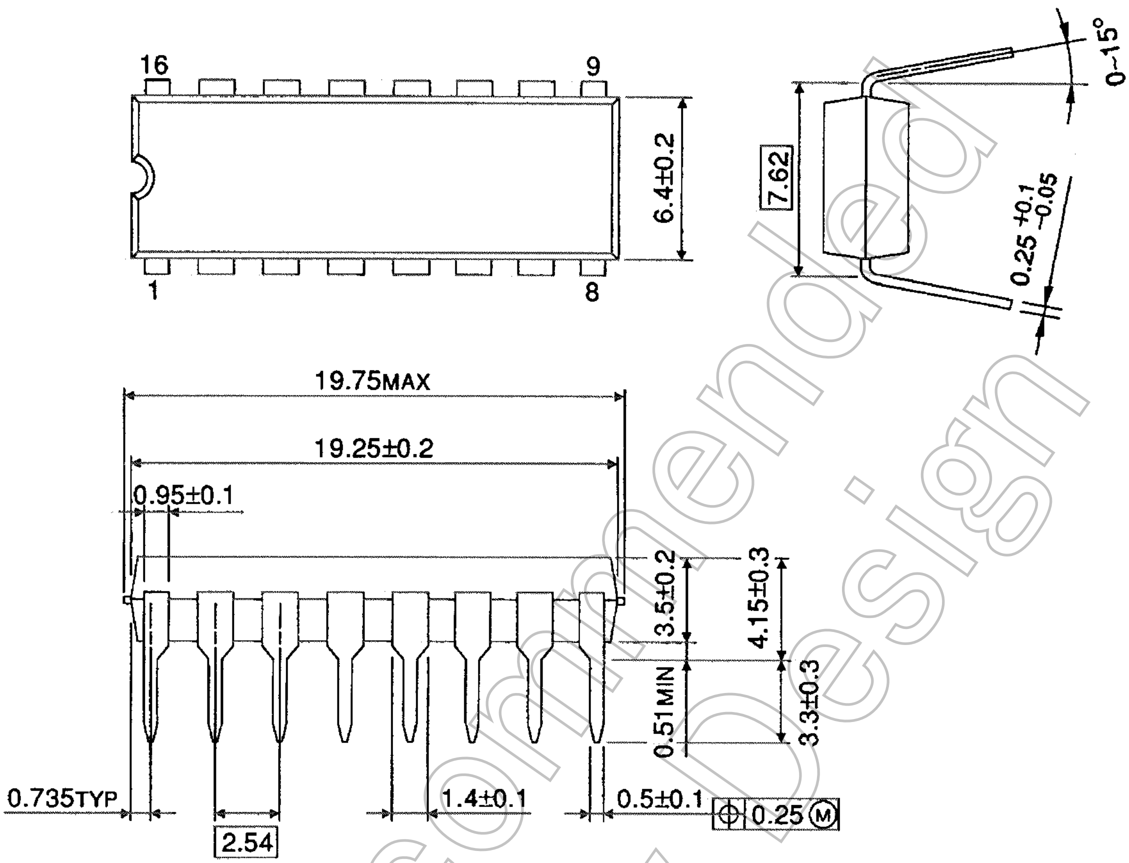


t_{WOUT} – Cx Characteristics (typ.)



Package Dimensions

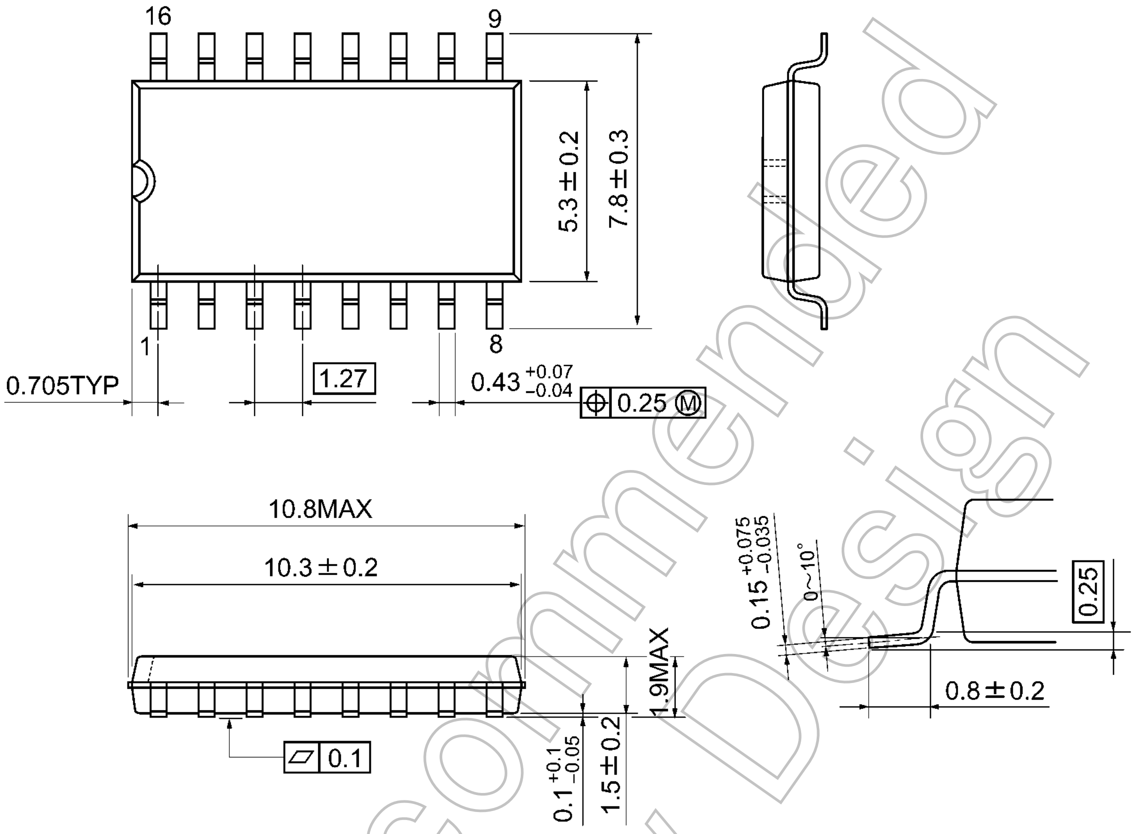
DIP16-P-300-2.54A Unit : mm



Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

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