

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC74HC590AP, TC74HC590AF

## 8 - BIT BINARY COUNTER/REGISTER WITH 3 - STATE OUTPUTS

The TC74HC590A is a high speed CMOS 8-BIT COUNTER/REGISTER 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.

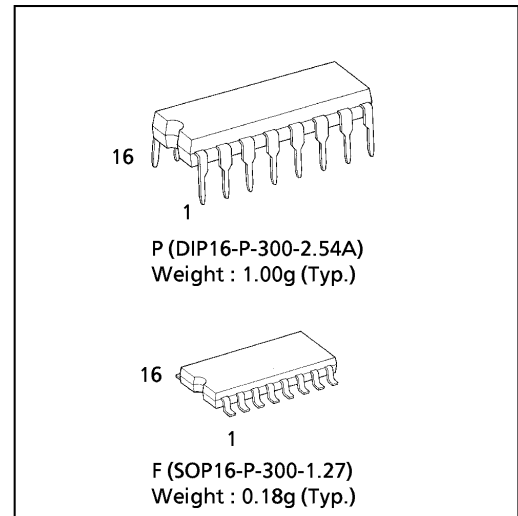
The internal counter counts on the positive going edge of Counter Clock (CCK) when Counter Clock Enable ( $\overline{\text{CCKEN}}$ ) is low. When Counter Clear ( $\overline{\text{CCLR}}$ ) is low, the internal counter is cleared asynchronously to the clock.

Data in the internal counter are loaded into the register at positive going edge of Register Clock (RCK), and the register outputs are controlled by enable input ( $\overline{\text{G}}$ ).

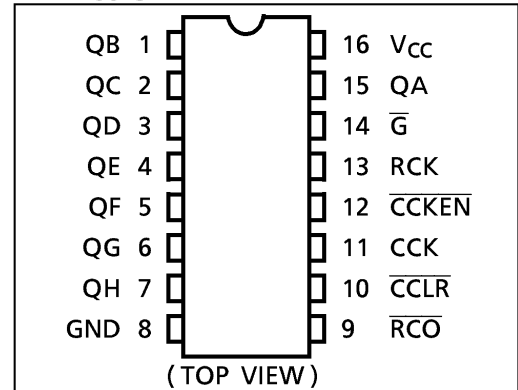
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

### FEATURES :

- High Speed..... $f_{\text{MAX}} = 62\text{MHz}(\text{typ.})$  at  $V_{\text{CC}} = 5\text{V}$
- Low Power Dissipation ..... $I_{\text{CC}} = 4\mu\text{A}(\text{Max.})$  at  $T_a = 25^\circ\text{C}$
- High Noise Immunity ..... $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (Min.)
- Output Drive Capability..... 15 LSTTL Loads For QA~QH  
10 LSTTL Loads For  $\overline{\text{RCO}}$
- Symmetrical Output Impedance...  
 $|I_{\text{OH}}| = I_{\text{OL}} = 6\text{mA}(\text{Min.})$  For QA~QH  
 $|I_{\text{OH}}| = I_{\text{OL}} = 4\text{mA}(\text{Min.})$  For  $\overline{\text{RCO}}$
- Balanced Propagation Delays..... $t_{\text{PLH}} \approx t_{\text{PHL}}$
- Wide Operating Voltage Range....  $V_{\text{CC}}(\text{opr.}) = 2\text{V} \sim 6\text{V}$
- Pin and Function Compatible with 74LS590



### PIN ASSIGNMENT



### TRUTH TABLE

INPUT					FUNCTION
G	RCK	$\overline{\text{CCLR}}$	$\overline{\text{CCKEN}}$	CCK	
H	X	X	X	X	Q OUTPUTS DISABLE
L	X	X	X	X	Q OUTPUTS ENABLE
X		X	X	X	COUNTER DATA IS STORED INTO REGISTER
X		X	X	X	REGISTER STATE IS NOT CHANGED
X	X	L	X	X	COUNTER CLEAR
X	X	H	L		ADVANCE ONE COUNT
X	X	H	L		NO COUNT
X	X	H	H	X	NO COUNT

X : Don't care

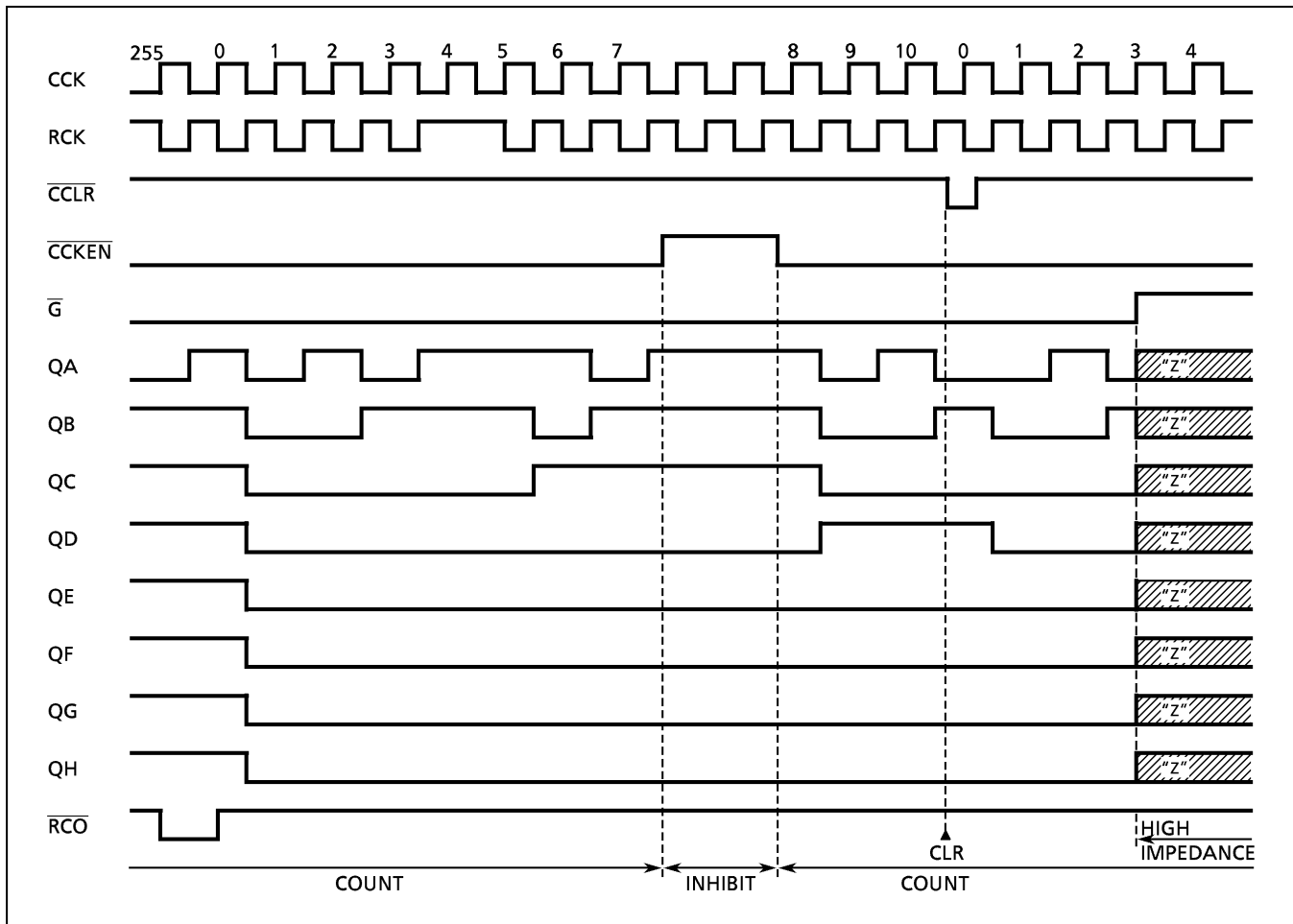
$$\overline{\text{RCO}} = \text{QA}' \cdot \text{QB}' \cdot \text{QC}' \cdot \text{QD}' \cdot \text{QE}' \cdot \text{QF}' \cdot \text{QG}' \cdot \text{QH}'$$

(QA'~QH' : Internal outputs of the counter)

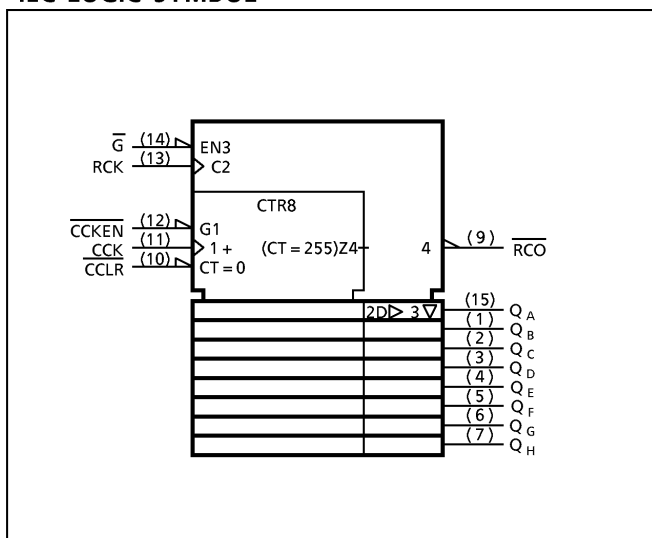
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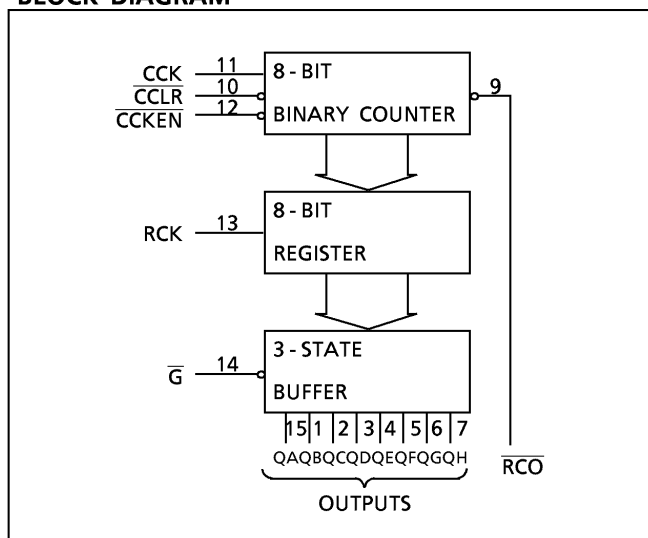
TIMING CHART



IEC LOGIC SYMBOL



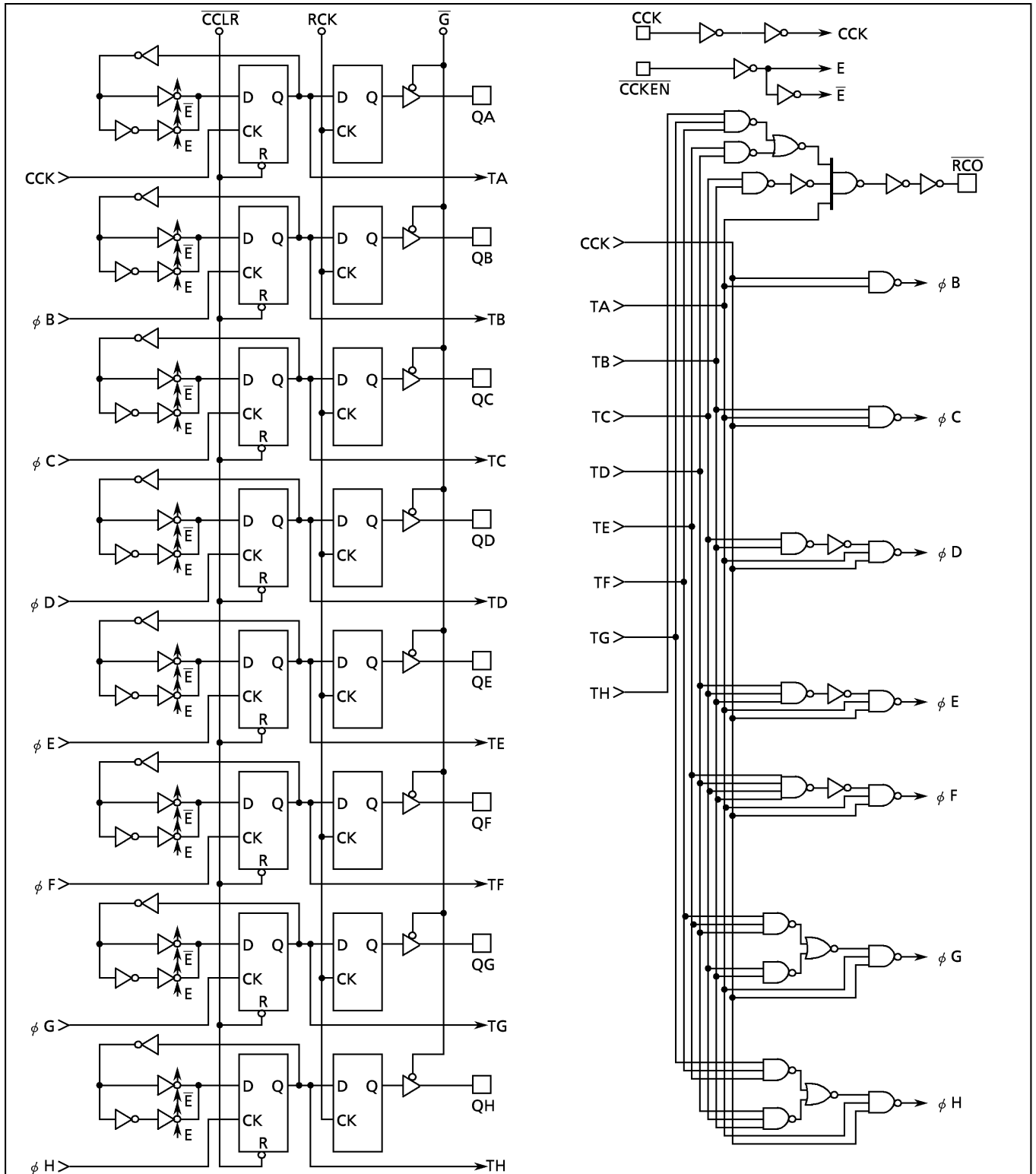
BLOCK DIAGRAM



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LOGIC DIAGRAM



## 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 (RCO) ( $Q_A \sim Q_H$ )	$I_{OUT}$	$\pm 25$ $\pm 35$	mA
DC $V_{CC}$ /Ground Current	$I_{CC}$	$\pm 75$	mA
Power Dissipation	$P_D$	500 (DIP)* / 180 (SOP)	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	$t_r, t_f$	$0 \sim 1000 (V_{CC} = 2.0\text{V})$ $0 \sim 500 (V_{CC} = 4.5\text{V})$ $0 \sim 400 (V_{CC} = 6.0\text{V})$	ns

**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 4.5 6.0	1.50 3.15 4.20	— — —	— — —	1.50 3.15 4.20	— — —	V
Low - Level Input Voltage	V <sub>IL</sub>		2.0 4.5 6.0	— — —	— — —	0.50 1.35 1.80	— — —	0.50 1.35 1.80	V
High - Level Output Voltage	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>   I <sub>OH</sub> = -20μA	2.0 4.5 6.0	1.9 4.4 5.9	2.0 4.5 6.0	— — —	1.9 4.4 5.9	— — —	V
		$\overline{\text{RCO}}$   I <sub>OH</sub> = -4 mA I <sub>OH</sub> = -5.2 mA	4.5 6.0	4.18 5.68	4.31 5.80	— —	4.13 5.63	— —	
		QA~QH   I <sub>OH</sub> = -6 mA I <sub>OH</sub> = -7.8 mA	4.5 6.0	4.18 5.68	4.31 5.80	— —	4.13 5.63	— —	
Low - Level Output Voltage	V <sub>OL</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>   I <sub>OL</sub> = 20μA	2.0 4.5 6.0	— — —	0.0 0.0 0.0	0.1 0.1 0.1	— — —	0.1 0.1 0.1	V
		$\overline{\text{RCO}}$   I <sub>OL</sub> = 4 mA I <sub>OL</sub> = 5.2 mA	4.5 6.0	— —	0.17 0.18	0.26 0.26	— —	0.33 0.33	
		QA~QH   I <sub>OL</sub> = 6 mA I <sub>OL</sub> = 7.8 mA	4.5 6.0	— —	0.17 0.18	0.26 0.26	— —	0.33 0.33	
3 - State Output Off - State Current	I <sub>OZ</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub> V <sub>OUT</sub> = V <sub>CC</sub> or GND	6.0	—	—	±0.5	—	±5.0	μA
Input Leakage Current	I <sub>IN</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	6.0	—	—	±0.1	—	±1.0	
Quiescent Supply Current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND	6.0	—	—	4.0	—	40.0	

**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 (CCK, RCK)	t <sub>W(H)</sub> t <sub>W(L)</sub>		2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Pulse Width ( $\overline{\text{CCLR}}$ )	t <sub>W(L)</sub>		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Set-up Time ( $\overline{\text{CCKEN}}$ - CCK)	t <sub>s</sub>		2.0	—	100	125	
			4.5	—	20	25	
			6.0	—	17	21	
Minimum Set-up Time (CCK - RCK)	t <sub>s</sub>		2.0	—	200	250	
			4.5	—	40	50	
			6.0	—	34	43	
Minimum Hold Time	t <sub>h</sub>		2.0	—	0	0	
			4.5	—	0	0	
			6.0	—	0	0	
Minimum Removal Time ( $\overline{\text{CCLR}}$ )	t <sub>rem</sub>		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Clock Frequency	f		2.0	—	6	5	MHz
			4.5	—	33	26	
			6.0	—	39	31	

**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 (RCO)	$t_{TLH}$ $t_{THL}$		—	4	8	ns
Propagation Delay Time (CCK-RCO)	$t_{pLH}$ $t_{pHL}$		—	18	28	
Propagation Delay Time (CCLR-RCO)	$t_{pLH}$		—	20	30	
Maximum Clock Frequency	$f_{MAX}$		32	62	—	MHz

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

PARAMETER	SYMBOL	TEST CONDITION	CL (pF)	V <sub>CC</sub> (V)	T <sub>a</sub> = 25°C			T <sub>a</sub> = -40~85°C		UNIT
					MIN.	TYP.	MAX.	MIN.	MAX.	
Output Transition Time (Qn)	$t_{TLH}$ $t_{THL}$		50	2.0	—	25	60	—	75	ns
				4.5	—	7	12	—	15	
				6.0	—	6	10	—	13	
Output Transition Time (RCO)	$t_{TLH}$ $t_{THL}$		50	2.0	—	30	75	—	95	
				4.5	—	8	15	—	19	
				6.0	—	7	13	—	16	
Propagation Delay Time (CCK-RCO)	$t_{pLH}$ $t_{pHL}$		50	2.0	—	75	163	—	205	
				4.5	—	22	33	—	41	
				6.0	—	17	28	—	35	
Propagation Delay Time (CCLR-RCO)	$t_{pLH}$		50	2.0	—	78	175	—	220	
				4.5	—	23	35	—	44	
				6.0	—	18	30	—	37	
Propagation Delay Time (RCK-Qn)	$t_{pLH}$ $t_{pHL}$		50	2.0	—	62	145	—	180	
				4.5	—	19	29	—	36	
				6.0	—	15	25	—	31	
			150	2.0	—	78	185	—	230	
				4.5	—	24	37	—	46	
				6.0	—	19	31	—	39	
Output Enable time	$t_{pZL}$ $t_{pZH}$	$R_L = 1\text{k}\Omega$	50	2.0	—	43	105	—	130	
				4.5	—	14	21	—	26	
				6.0	—	12	18	—	22	
			150	2.0	—	58	150	—	190	
				4.5	—	19	30	—	38	
				6.0	—	16	26	—	33	
Output Disable time	$t_{pLZ}$ $t_{pHZ}$	$R_L = 1\text{k}\Omega$	50	2.0	—	33	105	—	130	
				4.5	—	16	21	—	26	
				6.0	—	12	18	—	22	
Maximum Clock Frequency	$f_{MAX}$		50	2.0	6	12	—	5	—	
				4.5	30	51	—	24	—	
				6.0	35	80	—	28	—	
Input Capacitance	$C_{IN}$				—	5	10	—	10	pF
Power Dissipation Capacitance	$C_{PD} (1)$				—	34	—	—	—	

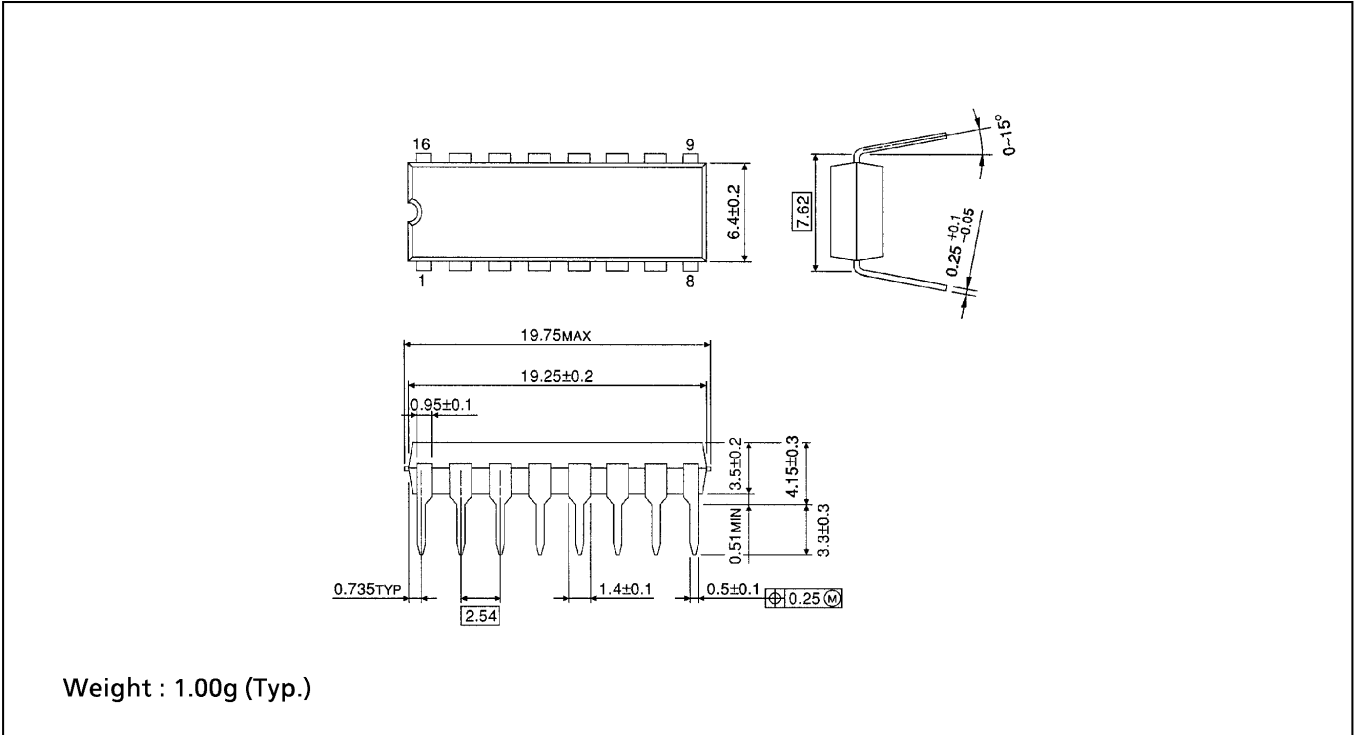
Note (1)  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation :

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

DIP 16PIN OUTLINE DRAWING (DIP16-P-300-2.54A)

Unit in mm



SOP 16PIN (200mil BODY) OUTLINE DRAWING (SOP16-P-300-1.27)

Unit in mm

