

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74HC697AP, TC74HC697AF

Synchronous Presettable 4-Bit Binary Up/Down Counter with Output Register (multiplexed 3-state outputs)

The TC74HC697A is high speed CMOS UP/DOWN COUNTERS 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.

It counts on the rising edge of the Counter Clock (CCK) input when "counter mode" is selected. If the up/down (U/D) input is held high, the internal counter counts up. Conversely, if U/D is held low, it counts down.

The internal counter outputs are latched into the output registers on the rising edge of the Register Clock (RCK) input.

The outputs (QA~QD) are selected as either internal counter or registered outputs by the output select (R/C) input. When high, the outputs are counter outputs and when low, they are registered outputs.

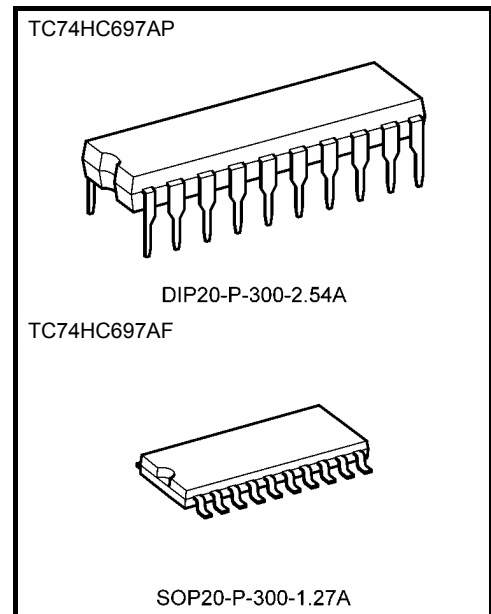
Two enable ( $\overline{\text{ENP}}$ ,  $\overline{\text{ENT}}$ ) inputs and a carry ( $\overline{\text{RCO}}$ ) output are provided to enable cascading of the counters.

This facilitates easy implementation of n-bit counters without using external gates.

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

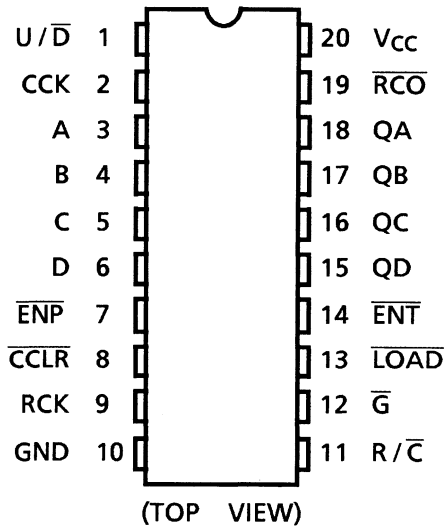
## Features

- High speed:  $f_{\text{max}} = 38 \text{ MHz (typ.)}$  at  $V_{\text{CC}} = 5 \text{ V}$
- Low power dissipation:  $I_{\text{CC}} = 4 \mu\text{A (max)}$  at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (min)
- Outputs drive capability: 15 LSTTL loads for QA~QD  
10 LSTTL loads for  $\overline{\text{RCO}}$
- Symmetrical output impedance:  
|IOH| = IOL = 6 mA (min) for QA~QD  
|IOH| = IOL = 4 mA (min) for  $\overline{\text{RCO}}$
- Balanced propagation delays:  $t_{\text{pLH}} \approx t_{\text{pHL}}$
- Wide operating voltage range:  $V_{\text{CC (opr)}} = 2\sim 6 \text{ V}$
- Pin and function compatible with 74LS697

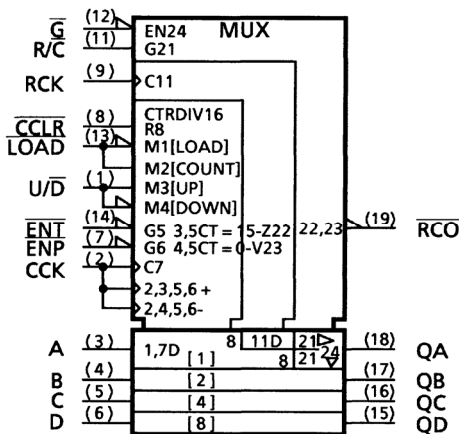


Weight	
DIP20-P-300-2.54A	: 1.30 g (typ.)
SOP20-P-300-1.27A	: 0.22 g (typ.)

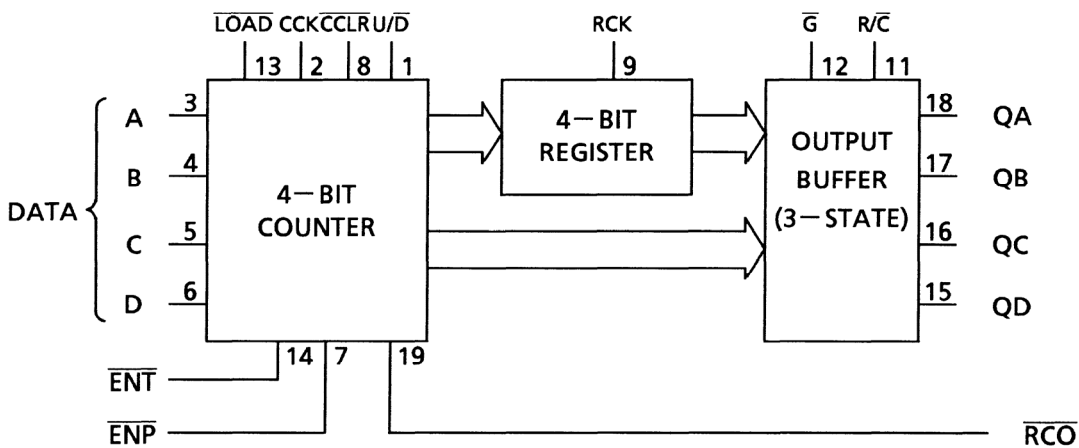
## Pin Assignment



## IEC Logic symbol



## Block Diagram



## Truth Table

Inputs									Outputs				Function
$\overline{\text{CCLR}}$	$\overline{\text{LOAD}}$	$\overline{\text{ENP}}$	$\overline{\text{ENT}}$	CCK	$\text{U}/\overline{\text{D}}$	RCK	$\text{R}/\overline{\text{C}}$	$\overline{\text{G}}$	QA	QB	QC	QD	
X	X	X	X	X	X	X	X	H	Z	Z	Z	Z	Z
L	X	X	X	X	X	X	L	L	L	L	L	L	Clear Counter
H	L	X	X		X	X	L	L	a	b	c	d	Load Counter
H	H	H	X		X	X	L	L	No Change				No Count
H	H	X	H		X	X	L	L					
H	H	L	L		H	X	L	L	Count Up				Count
H	H	L	L		L	X	L	L	Count Down				Count
H	X	X	X		X	X	L	L	No Change				No Count
X	X	X	X	X	X		H	L	a'	b'	c'	d'	Load Register
X	X	X	X	X	X		H	L	No Change				No Count

X: Don't care

Z: High impedance

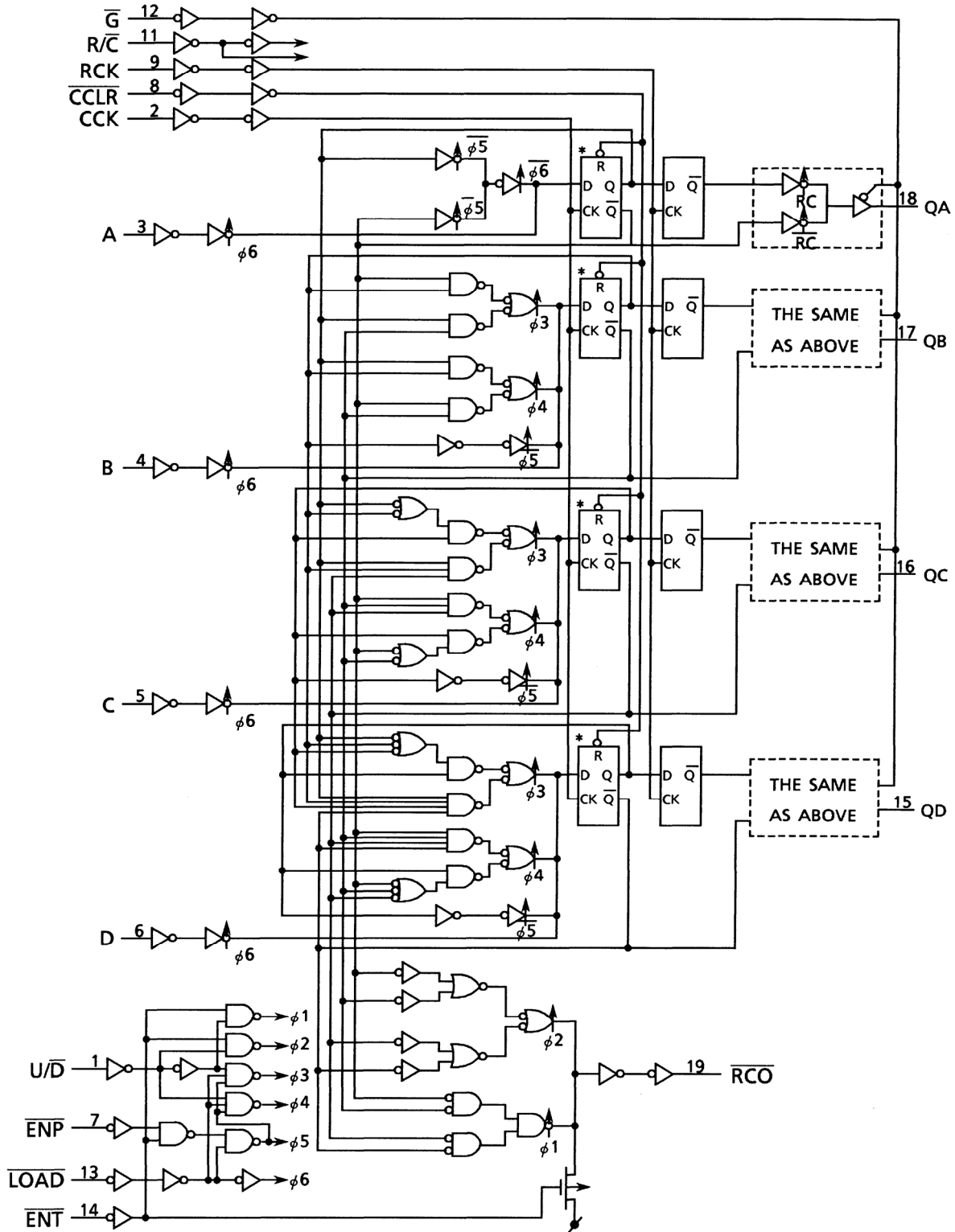
a~d: The level of steady state inputs at inputs A through D respectively.

a'~d': The level of steady state outputs at internal counter outputs QA' through QD' respectively.

$$\overline{\text{RCO}} = (\overline{\text{UP}} \cdot \text{QA} \cdot \text{QB} \cdot \text{QC} \cdot \text{QD} \cdot \overline{\text{ENT}} + \overline{\text{UP}} \cdot \overline{\text{QA}} \cdot \overline{\text{QB}} \cdot \overline{\text{QC}} \cdot \overline{\text{QD}} \cdot \overline{\text{ENT}})$$



**System Diagram**



## Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	$V_{CC}$	-0.5~7	V
DC input voltage	$V_{IN}$	-0.5~ $V_{CC} + 0.5$	V
DC output voltage	$V_{OUT}$	-0.5~ $V_{CC} + 0.5$	V
Input diode current	$I_{IK}$	$\pm 20$	mA
Output diode current	$I_{OK}$	$\pm 20$	mA
DC output current (RCO) (QA~QD)	$I_{OUT}$	$\pm 25$	mA
		$\pm 35$	
DC $V_{CC}$ /ground current	$I_{CC}$	$\pm 75$	mA
Power dissipation	$P_D$	500 (DIP) (Note 2)/180 (SOP)	mW
Storage temperature	$T_{stg}$	-65~150	°C

Note 1: 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 2: 500 mW in the range of  $T_a = -40$  to  $65^\circ\text{C}$ . From  $T_a = 65$  to  $85^\circ\text{C}$  a derating factor of  $-10 \text{ mW}/^\circ\text{C}$  shall be applied until 300 mW.

## Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	$V_{CC}$	2~6	V
Input voltage	$V_{IN}$	0~ $V_{CC}$	V
Output voltage	$V_{OUT}$	0~ $V_{CC}$	V
Operating temperature	$T_{opr}$	-40~85	°C
Input rise and fall time	$t_r, t_f$	0~1000 ( $V_{CC} = 2.0 \text{ V}$ )	ns
		0~500 ( $V_{CC} = 4.5 \text{ V}$ )	
		0~400 ( $V_{CC} = 6.0 \text{ V}$ )	

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either  $V_{CC}$  or GND.

## Electrical Characteristics

### DC Characteristics

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40~85°C		Unit		
				V <sub>CC</sub> (V)	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	V <sub>OH</sub>	V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub>	I <sub>OH</sub> = -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	—		
			$\overline{\text{RCO}}$	I <sub>OH</sub> = -4 mA	4.5	4.18	4.31	—	4.13		—
				I <sub>OH</sub> = -5.2 mA	6.0	5.68	5.80	—	5.63		—
				QA~QD	I <sub>OH</sub> = -6 mA	4.5	4.18	4.31	—		4.13
I <sub>OH</sub> = -7.8 mA	6.0	5.68	5.80		—	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> = 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		
			$\overline{\text{RCO}}$	I <sub>OL</sub> = 4 mA	4.5	—	0.17	0.26	—		0.33
				I <sub>OL</sub> = 5.2 mA	6.0	—	0.18	0.26	—		0.33
				QA~QD	I <sub>OL</sub> = 6 mA	4.5	—	0.17	0.26		—
I <sub>OL</sub> = 7.8 mA	6.0	—	0.18		0.26	—	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	μA	
Quiescent supply current	I <sub>CC</sub>	V <sub>IN</sub> = V <sub>CC</sub> or GND		6.0	—	—	4.0	—	40.0	μA	

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

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40 ~85°C	Unit	
			V <sub>CC</sub> (V)	Typ.	Limit		
Minimum pulse width (CCK, $\overline{RCK}$ )	$t_W$ (L) $t_W$ (H)	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum pulse width ( $\overline{CCLR}$ )	$t_W$ (L)	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum set-up time ( $\overline{LOAD}$ , $\overline{ENT}$ , $\overline{ENP}$ )	$t_s$	—	2.0	—	150	190	ns
			4.5	—	30	38	
			6.0	—	13	32	
Minimum set-up time (A, B, C, D)	$t_s$	—	2.0	—	50	65	ns
			4.5	—	10	13	
			6.0	—	9	11	
Minimum set-up time ( $U/\overline{D}$ )	$t_s$	—	2.0	—	100	125	ns
			4.5	—	20	25	
			6.0	—	17	21	
Minimum set-up time (CCK-RCK)	$t_s$	—	2.0	—	100	125	ns
			4.5	—	20	25	
			6.0	—	17	21	
Minimum hold time (A, B, C, D)	$t_h$	—	2.0	—	5	5	ns
			4.5	—	5	5	
			6.0	—	5	5	
Minimum hold time	$t_h$	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum removal time	$t_{rem}$	—	2.0	—	5	5	ns
			4.5	—	5	5	
			6.0	—	5	5	
Clock frequency	f	—	2.0	—	5	4	MHz
			4.5	—	25	20	
			6.0	—	29	24	

### AC Characteristics ( $C_L = 15$ pF, $V_{CC} = 5$ V, $T_a = 25^\circ\text{C}$ , input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time ( $\overline{RCO}$ )	$t_{TLH}$	—	—	4	8	ns
	$t_{THL}$					
Propagation delay time (CCK- $\overline{RCO}$ )	$t_{pLH}$	—	—	24	41	ns
	$t_{pHL}$					
Propagation delay time (ENT- $\overline{RCO}$ )	$t_{pLH}$	—	—	13	23	ns
	$t_{pHL}$					
Propagation delay time ( $\overline{CCLR}$ - $\overline{RCO}$ )	$t_{pLH}$	—	—	23	38	ns
Maximum clock frequency	$f_{max}$	—	25	38	—	MHz



## AC Characteristics (input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = -40~85°C		Unit	
		CL (pF)	VCC (V)	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 ( $\overline{RCO}$ )	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	30	75	—	95	ns
				4.5	—	8	15	—	19	
				6.0	—	7	13	—	16	
Propagation delay time (CCK-Q)	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	90	195	—	245	ns
				4.5	—	26	39	—	49	
				6.0	—	19	33	—	42	
			150	2.0	—	103	235	—	295	
				4.5	—	31	47	—	59	
				6.0	—	23	40	—	50	
Propagation delay time (RCK-Q)	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	82	180	—	225	ns
				4.5	—	24	36	—	45	
				6.0	—	18	31	—	38	
			150	2.0	—	95	220	—	275	
				4.5	—	29	44	—	55	
				6.0	—	22	37	—	47	
Propagation delay time (R/ $\overline{C}$ -Q)	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	60	145	—	180	ns
				4.5	—	19	29	—	36	
				6.0	—	14	25	—	31	
			150	2.0	—	73	185	—	230	
				4.5	—	24	37	—	46	
				6.0	—	18	31	—	39	
Propagation delay time ( $\overline{CCLR}$ -Q)	$t_{pHL}$	—	50	2.0	—	89	195	—	245	ns
				4.5	—	26	39	—	49	
				6.0	—	20	33	—	42	
			150	2.0	—	102	235	—	295	
				4.5	—	31	47	—	59	
				6.0	—	24	40	—	50	
Propagation delay time (CCK- $\overline{RCO}$ )	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	108	235	—	295	ns
				4.5	—	31	47	—	59	
				6.0	—	23	40	—	50	
Propagation delay time ( $\overline{ENT}$ - $\overline{RCO}$ )	$t_{pLH}$ $t_{pHL}$	—	50	2.0	—	63	135	—	170	ns
				4.5	—	18	27	—	34	
				6.0	—	14	23	—	29	
Propagation delay time ( $\overline{CCLR}$ - $\overline{RCO}$ )	$t_{pLH}$	—	50	2.0	—	98	220	—	275	ns
				4.5	—	29	44	—	55	
				6.0	—	23	37	—	47	

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40~85°C		Unit				
			CL (pF)	VCC (V)	Min	Typ.	Max		Min	Max		
Output enable time ( $\bar{G}$ -Q)	t <sub>pZL</sub>	R <sub>L</sub> = 1 kΩ	50	2.0	—	45	115	—	145	ns		
				4.5	—	15	23	—	29			
				6.0	—	12	20	—	25			
	t <sub>pZH</sub>		150	2.0	—	58	155	—	195			
				4.5	—	20	31	—	39			
				6.0	—	16	26	—	33			
Output disable time ( $\bar{G}$ -Q)	t <sub>pLZ</sub>	R <sub>L</sub> = 1 kΩ	50	2.0	—	32	115	—	145	ns		
				4.5	—	17	23	—	29			
				6.0	—	14	20	—	25			
Maximum clock frequency	f <sub>max</sub>		—	50	2.0	5	11	—	4		—	MHz
					4.5	25	38	—	20		—	
					6.0	29	52	—	24		—	
Input capacitance	C <sub>IN</sub>	—		—	5	10	—	10	pF			
Output capacitance	C <sub>OUT</sub>	—		—	13	—	—	—	pF			
Power dissipation capacitance	C <sub>PD</sub> (Note)	—		—	72	—	—	—	pF			

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

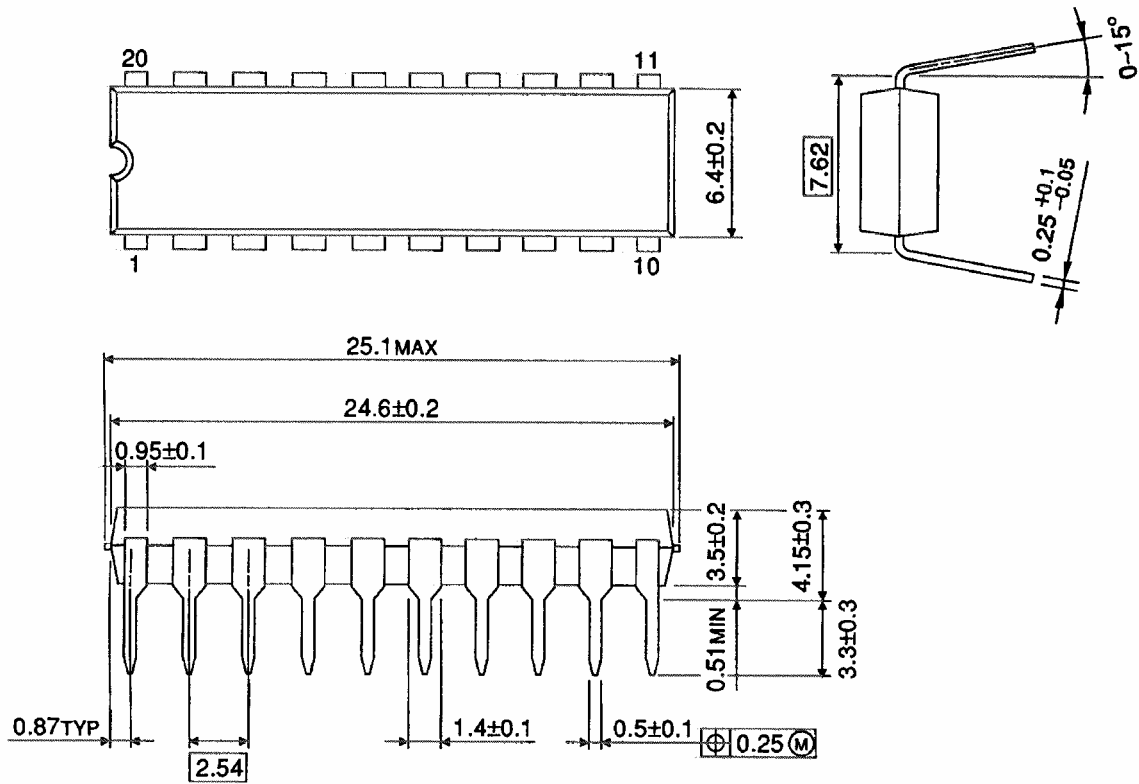
Average operating current can be obtained by the equation:

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

## Package Dimensions

DIP20-P-300-2.54A

Unit : mm

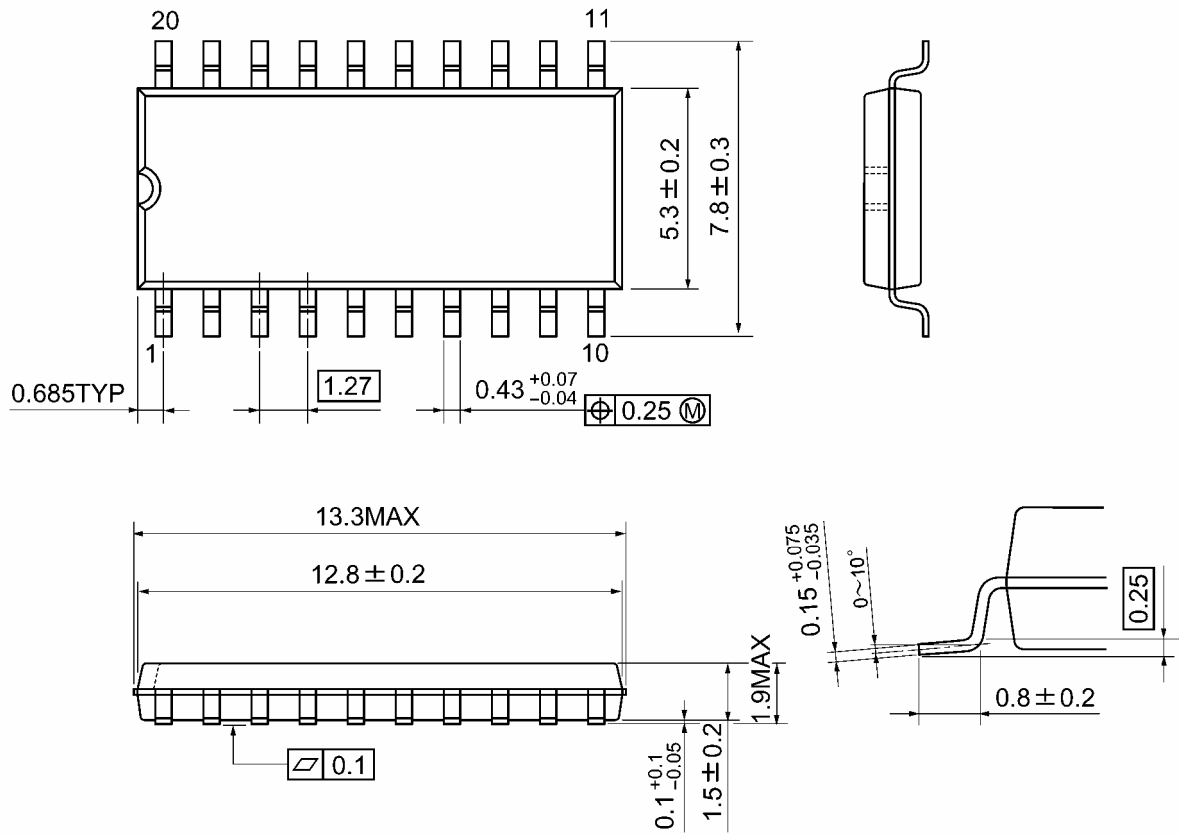


Weight: 1.30 g (typ.)

**Package Dimensions**

SOP20-P-300-1.27A

Unit: mm



Weight: 0.22 g (typ.)

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20070701-EN GENERAL

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