

# TC74HC193AP, TC74HC193AF, TC74HC193AFN

## SYNCHRONOUS UP/DOWN BINARY COUNTER

The TC74HC193A are high speed CMOS SYNCHRONOUS 4-BIT UP/DOWN COUNTER 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.

They have a clear input (CLR), a load input ( $\overline{\text{LOAD}}$ ), load data inputs (A ~ D), two clock inputs (COUNT UP, COUNT DOWN), four count data outputs (QA ~ QD), and other outputs ( $\overline{\text{CARRY}}$ ,  $\overline{\text{BORROW}}$ ).

CLEAR is active high and forces QA thru QD outputs low independent of the other inputs.

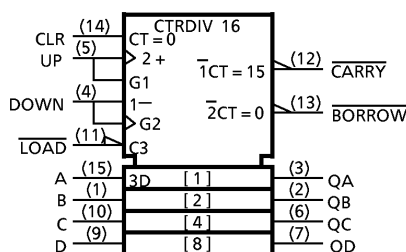
$\overline{\text{CARRY}}$  and  $\overline{\text{BORROW}}$  outputs are provided in order to make a cascade connection without external circuitry.

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

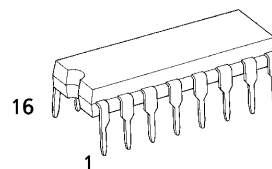
### FEATURES:

- High Speed..... $f_{\text{MAX}} = 54\text{MHz}$  (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.)
- Output drive Capability..... 10 LSTTL Loads
- Symmetrical Output Impedance...  $|I_{\text{OH}}| = |I_{\text{OL}}| = 4\text{mA}$  (Min.)
- Balanced Propagation Delays.....  $t_{\text{PLH}} \approx t_{\text{PHL}}$
- Wide Operating Voltage Range....  $V_{\text{CC}}$  (opr.) = 2V ~ 6V
- Pin and Function Compatible with 74LS193

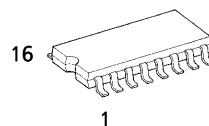
### IEC LOGIC SYMBOL



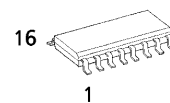
(Note) The JEDEC SOP (FN) is not available in Japan.



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

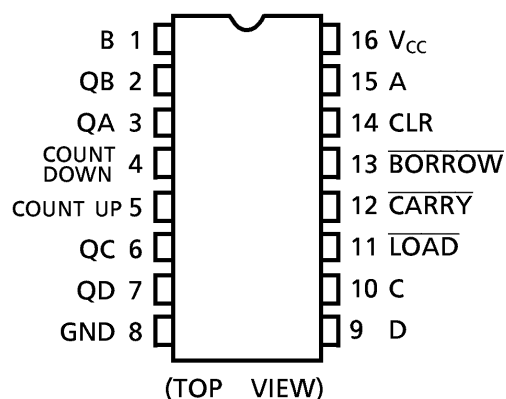


F (SOP16-P-300-1.27)  
Weight : 0.18g (Typ.)



FN (SOL16-P-150-1.27)  
Weight : 0.13g (Typ.)

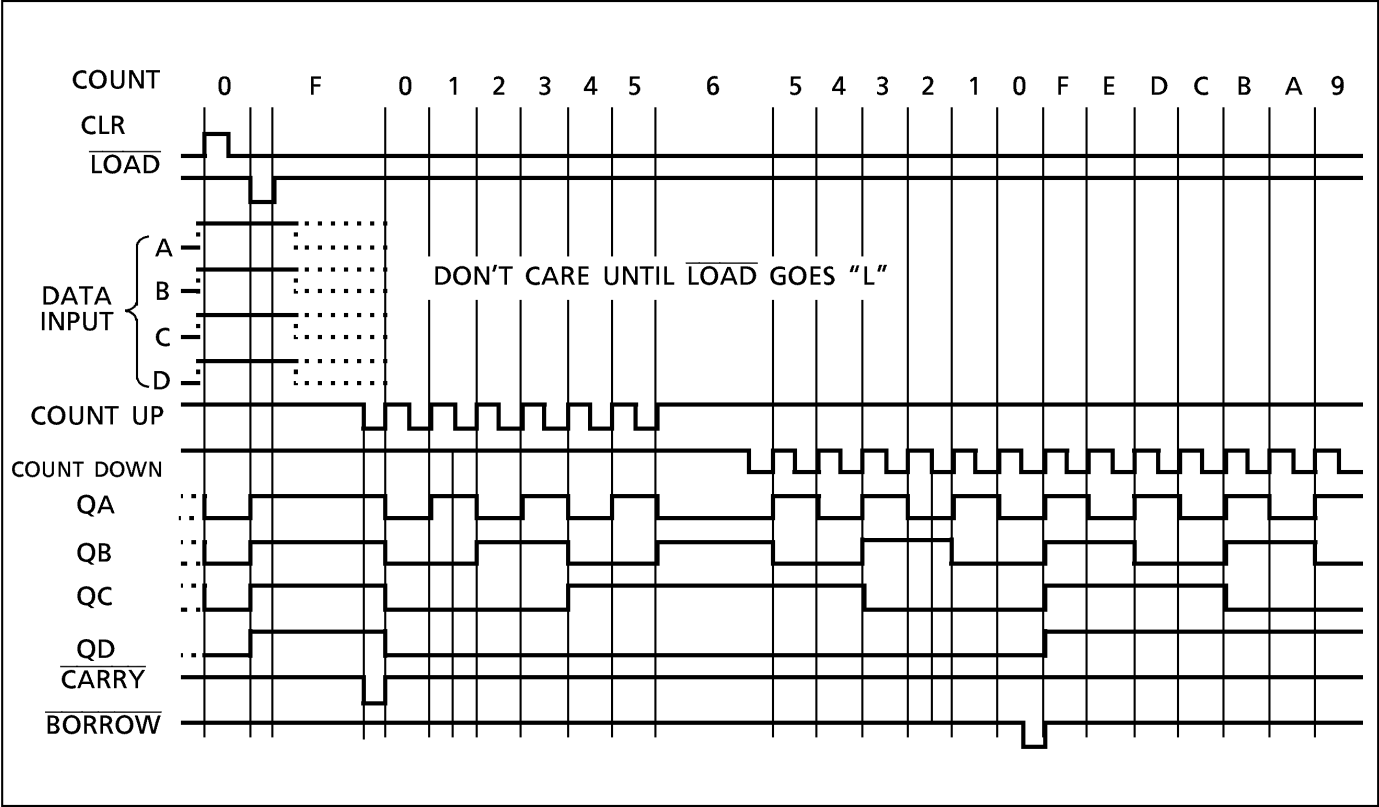
### PIN ASSIGNMENT



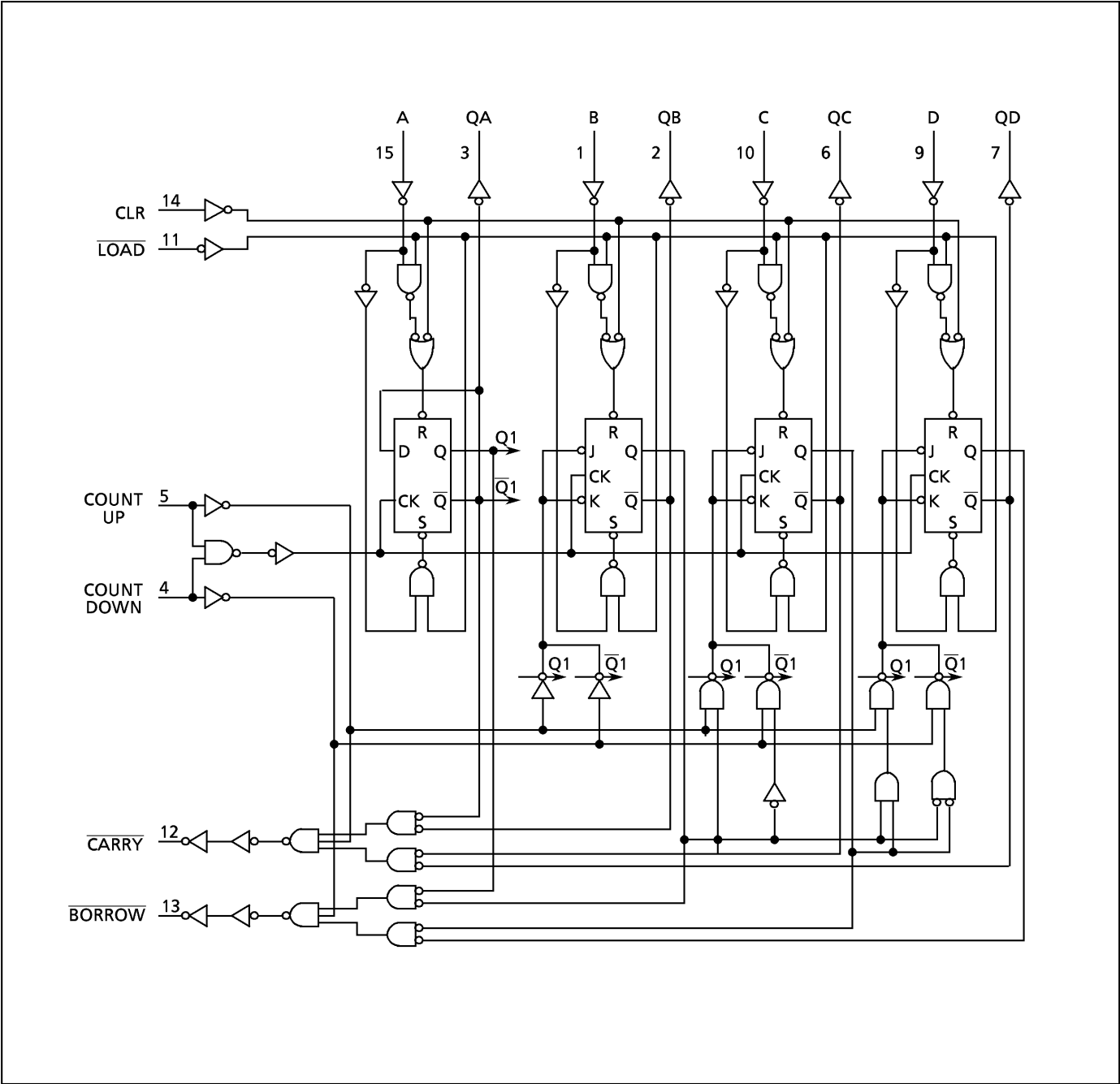
### TRUTH TABLE

INPUTS				FUNCTION
COUNT UP	COUNT DOWN	$\overline{\text{LOAD}}$	CLR	
	H	H	L	COUNT UP
	H	H	L	NO COUNT
H		H	L	COUNT DOWN
H		H	L	NO COUNT
X	X	L	L	PRESET
X	X	X	H	RESET

TIMING CHART



SYSTEM 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	$I_{OUT}$	$\pm 25$	mA
DC $V_{CC}$ / Ground Current	$I_{CC}$	$\pm 50$	mA
Power Dissipation	$P_D$	500 (DIP)* / 180 (SOP)	mW
Storage Temperature	$T_{stg}$	$-65 \sim 150$	°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	$T_{opr}$	$-40 \sim 85$	°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	$V_{CC}$ (V)	$T_a = 25^\circ\text{C}$			$T_a = -40 \sim 85^\circ\text{C}$		UNIT
				MIN.	TYP.	MAX.	MIN.	MAX.	
High - Level Input Voltage	$V_{IH}$		2.0 4.5 6.0	1.50 3.15 4.20	— — —	— — —	1.50 3.15 4.20	— — —	V
Low - Level Input Voltage	$V_{IL}$		2.0 4.5 6.0	— — —	— — —	0.50 1.35 1.80	— — —	0.50 1.35 1.80	V
High - Level Output Voltage	$V_{OH}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OH} = -20\mu\text{A}$	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
			$I_{OH} = -4 \text{ mA}$	4.5	4.18	4.31	—	4.13	
			$I_{OH} = -5.2 \text{ mA}$	6.0	5.68	5.80	—	5.63	
Low - Level Output Voltage	$V_{OL}$	$V_{IN} = V_{IH} \text{ or } V_{IL}$	$I_{OL} = 20\mu\text{A}$	2.0 4.5 6.0	— — —	0.0 0.0 0.0	— — —	0.1 0.1 0.1	V
			$I_{OL} = 4 \text{ mA}$	4.5	—	0.17	—	0.33	
			$I_{OL} = 5.2 \text{ mA}$	6.0	—	0.18	—	0.33	
Input Leakage Current	$I_{IN}$	$V_{IN} = V_{CC} \text{ or } \text{GND}$	6.0	—	—	$\pm 0.1$	—	$\pm 1.0$	$\mu\text{A}$
Quiescent Supply Current	$I_{CC}$	$V_{IN} = V_{CC} \text{ or } \text{GND}$	6.0	—	—	4.0	—	40.0	$\mu\text{A}$

TIMING REQUIREMENTS ( Input  $t_r = t_f = 6\text{ns}$  )

PARAMETER	SYMBOL	TEST CONDITION	$V_{CC}$ (V)	Ta = 25°C		Ta = -40~85°C	UNIT
				TYP.	LIMIT	LIMIT	
Minimum Pulse Width ( CK )	$t_{W(H)}$ $t_{W(L)}$		2.0	—	100	125	ns
			4.5	—	20	25	
			6.0	—	17	21	
Minimum Pulse Width ( LOAD )	$t_{W(L)}$		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Hold Time ( CLR )	$t_{W(H)}$		2.0	—	100	125	
			4.5	—	20	25	
			6.0	—	17	21	
Minimum Set-up Time ( DATA—LOAD )	$t_s$		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Hold Time ( DATA—LOAD )	$t_h$		2.0	—	0	0	
			4.5	—	0	0	
			6.0	—	0	0	
Minimum Removal Time ( LOAD )	$t_{rem}$		2.0	—	50	65	
			4.5	—	10	13	
			6.0	—	9	10	
Minimum Removal Time ( CLR )	$t_{rem}$		2.0	—	50	65	
			4.5	—	10	13	
			6.0	—	9	10	
Clock Frequency	f		2.0	—	5	4	MHz
			4.5	—	25	20	
			6.0	—	29	24	

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 (UP, DOWN—Q)	$t_{PLH}$ $t_{PHL}$		—	16	33	
Propagation Delay Time (UP— $\overline{\text{CARRY}}$ )	$t_{PLH}$ $t_{PHL}$		—	10	22	
Propagation Delay Time (DOWN— $\overline{\text{BORROW}}$ )	$t_{PLH}$ $t_{PHL}$		—	10	22	
Propagation Delay Time (LOAD—Q)	$t_{PLH}$ $t_{PHL}$		—	21	38	
Propagation Delay Time (LOAD— $\overline{\text{CARRY}}$ )	$t_{PLH}$ $t_{PHL}$		—	25	44	
Propagation Delay Time (LOAD— $\overline{\text{BORROW}}$ )	$t_{PLH}$ $t_{PHL}$		—	26	44	
Propagation Delay Time (DATA IN—Q)	$t_{PLH}$ $t_{PHL}$		—	21	33	
Propagation Delay Time (DATA IN— $\overline{\text{CARRY}}$ )	$t_{PLH}$ $t_{PHL}$		—	29	44	
Propagation Delay Time (DATA IN— $\overline{\text{BORROW}}$ )	$t_{PLH}$ $t_{PHL}$		—	26	44	
Propagation Delay Time (CLR—Q)	$t_{PHL}$		—	25	39	
Propagation Delay Time (CLR— $\overline{\text{CARRY}}$ )	$t_{PLH}$		—	30	44	
Propagation Delay Time (CLR— $\overline{\text{BORROW}}$ )	$t_{PHL}$		—	30	44	
Maximum Clock Frequency	$f_{MAX}$		27	52	—	MHz

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

PARAMETER	SYMBOL	TEST CONDITION	Ta = 25°C			Ta = -40~85°C		UNIT
			V <sub>CC</sub> (V)	MIN.	TYP.	MAX.	MIN.	MAX.
Output Transition Time	$t_{TLH}$ $t_{THL}$		2.0	—	30	75	—	95
			4.5	—	8	15	—	19
			6.0	—	7	13	—	16
Propagation Delay Time (UP, DOWN—Q)	$t_{pLH}$ $t_{pHL}$		2.0	—	65	190	—	240
			4.5	—	20	38	—	48
			6.0	—	16	32	—	41
Propagation Delay Time (UP—CARRY)	$t_{pLH}$ $t_{pHL}$		2.0	—	40	130	—	165
			4.5	—	13	26	—	33
			6.0	—	11	22	—	28
Propagation Delay Time (DOWN—BORROW)	$t_{pLH}$ $t_{pHL}$		2.0	—	40	130	—	165
			4.5	—	13	26	—	33
			6.0	—	11	22	—	28
Propagation Delay Time (LOAD—Q)	$t_{pLH}$ $t_{pHL}$		2.0	—	85	220	—	275
			4.5	—	25	44	—	55
			6.0	—	20	37	—	47
Propagation Delay Time (LOAD—CARRY)	$t_{pLH}$ $t_{pHL}$		2.0	—	110	250	—	315
			4.5	—	30	50	—	63
			6.0	—	25	43	—	54
Propagation Delay Time (LOAD—BORROW)	$t_{pLH}$ $t_{pHL}$		2.0	—	110	250	—	315
			4.5	—	30	50	—	63
			6.0	—	25	43	—	54
Propagation Delay Time (DATA IN—Q)	$t_{pLH}$ $t_{pHL}$		2.0	—	80	190	—	240
			4.5	—	25	38	—	48
			6.0	—	20	32	—	41
Propagation Delay Time (DATA IN—CARRY)	$t_{pLH}$ $t_{pHL}$		2.0	—	120	250	—	315
			4.5	—	34	50	—	63
			6.0	—	28	43	—	54
Propagation Delay Time (DATA IN—BORROW)	$t_{pLH}$ $t_{pHL}$		2.0	—	110	250	—	315
			4.5	—	31	50	—	63
			6.0	—	25	43	—	54
Propagation Delay Time (CLR—Q)	$t_{pHL}$		2.0	—	100	225	—	280
			4.5	—	30	45	—	56
			6.0	—	25	38	—	48
Propagation Delay Time (CLR—CARRY)	$t_{pLH}$		2.0	—	120	250	—	315
			4.5	—	35	50	—	63
			6.0	—	29	43	—	54
Propagation Delay Time (CLR—BORROW)	$t_{pHL}$		2.0	—	120	250	—	315
			4.5	—	35	50	—	63
			6.0	—	29	43	—	54
Maximum Clock Frequency	$f_{MAX}$		2.0	5	12	—	4	—
			4.5	25	48	—	20	—
			6.0	29	55	—	24	—
Input Capacitance	$C_{IN}$			—	5	10	—	10
Power Dissipation Capacitance	$C_{PD} (1)$			—	67	—	—	—

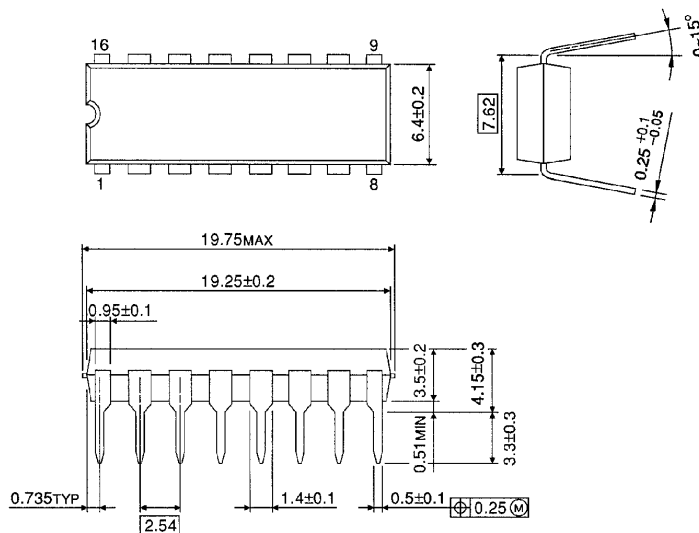
Note (1)  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

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 PACKAGE DIMENSIONS (DIP16-P-300-2.54A)

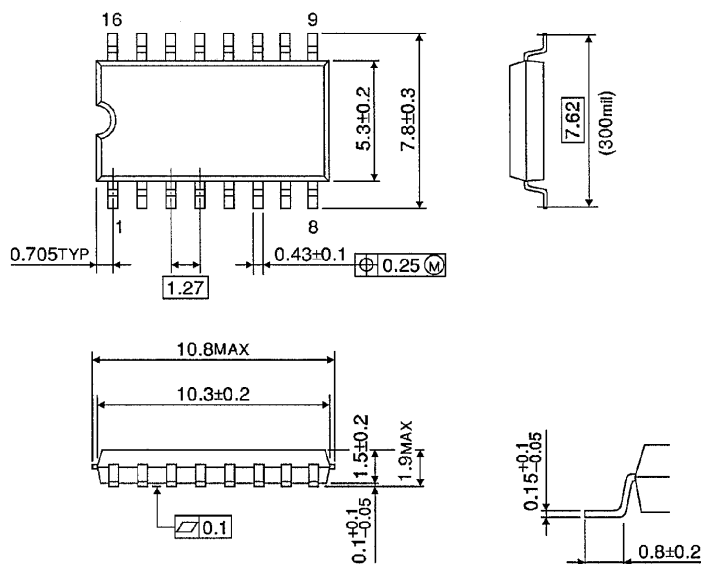
Unit in mm



Weight : 1.00g (Typ.)

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

Unit in mm



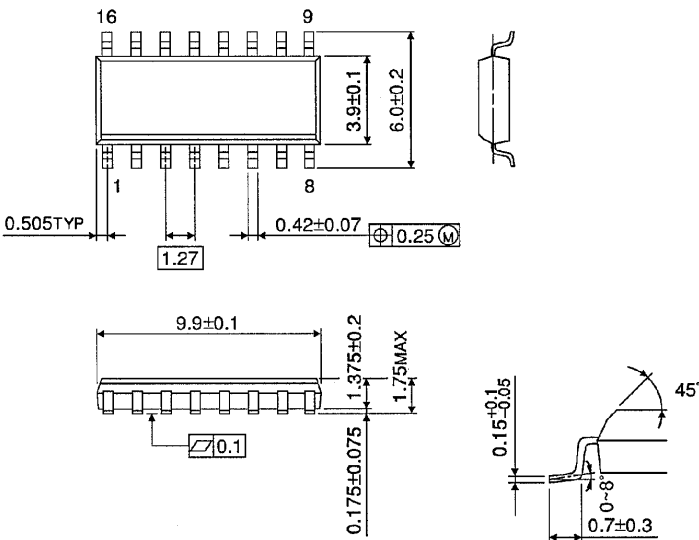
Weight : 0.18g (Typ.)



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.)

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000707EBA

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