TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC74HC193AP, TC74HC193AF, TC74HC193AFN

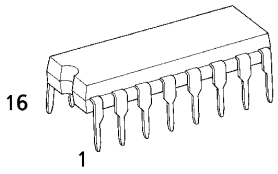
SYNCHRONOUS UP/DOWN BINARY COUNTER

The TC74HC193A are high speed CMOS SYNCHRONOUS 4-BIT UP/DOWN COUNTER fabricated with silicon gate C^2MOS 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 ($\overline{LOAD}$), load data inputs (A ~ D), two clock inputs (COUNT UP , COUNT DOWN), four count data outputs (QA ~ QD), and other outputs ($\overline{CARRY}$, $\overline{BORROW}$).
CLEAR is active high and forces QA thru QD outputs low independent of the other inputs.
$\overline{CARRY}$ and $\overline{BORROW}$ 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.

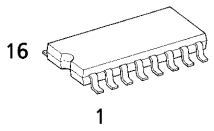
FEATURES :

- High Speed ····· f_{MAX} = 54MHz (typ.) at V_{CC} = 5V
- Low Power Dissipation ····· I_{CC} = 4μA(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 ··· $|I_{OH}| = I_{OL}$ = 4mA (Min.)
- Balanced Propagation Delays ····· $t_{pLH} \simeq t_{pHL}$
- Wide Operating Voltage Range ···· V_{CC} (opr.) = 2V ~ 6V
- Pin and Function Compatible with 74LS193

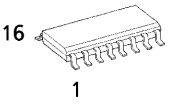
(Note) The JEDEC SOP (FN) is not available in Japan.



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

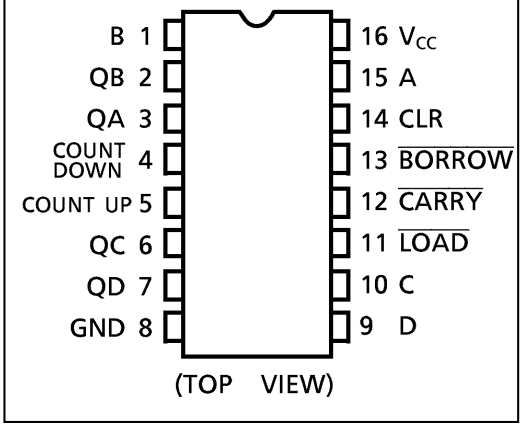


F (SOP16-P-300-1.27)
Weight : 0.18g (Typ.)

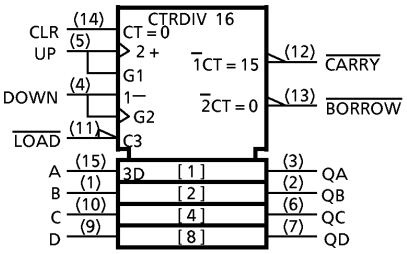


FN (SOL16-P-150-1.27)
Weight : 0.13g (Typ.)

PIN ASSIGNMENT



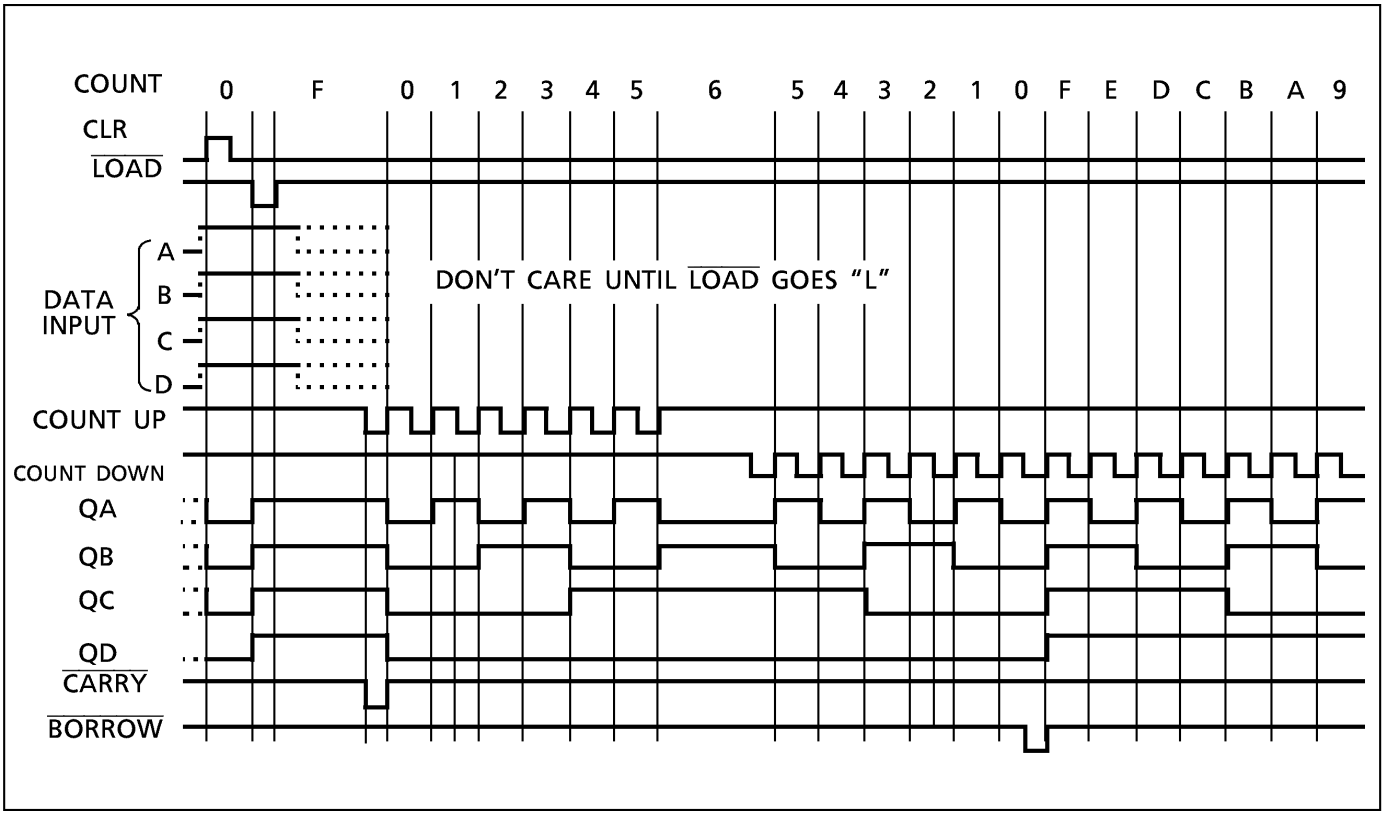
IEC LOGIC SYMBOL



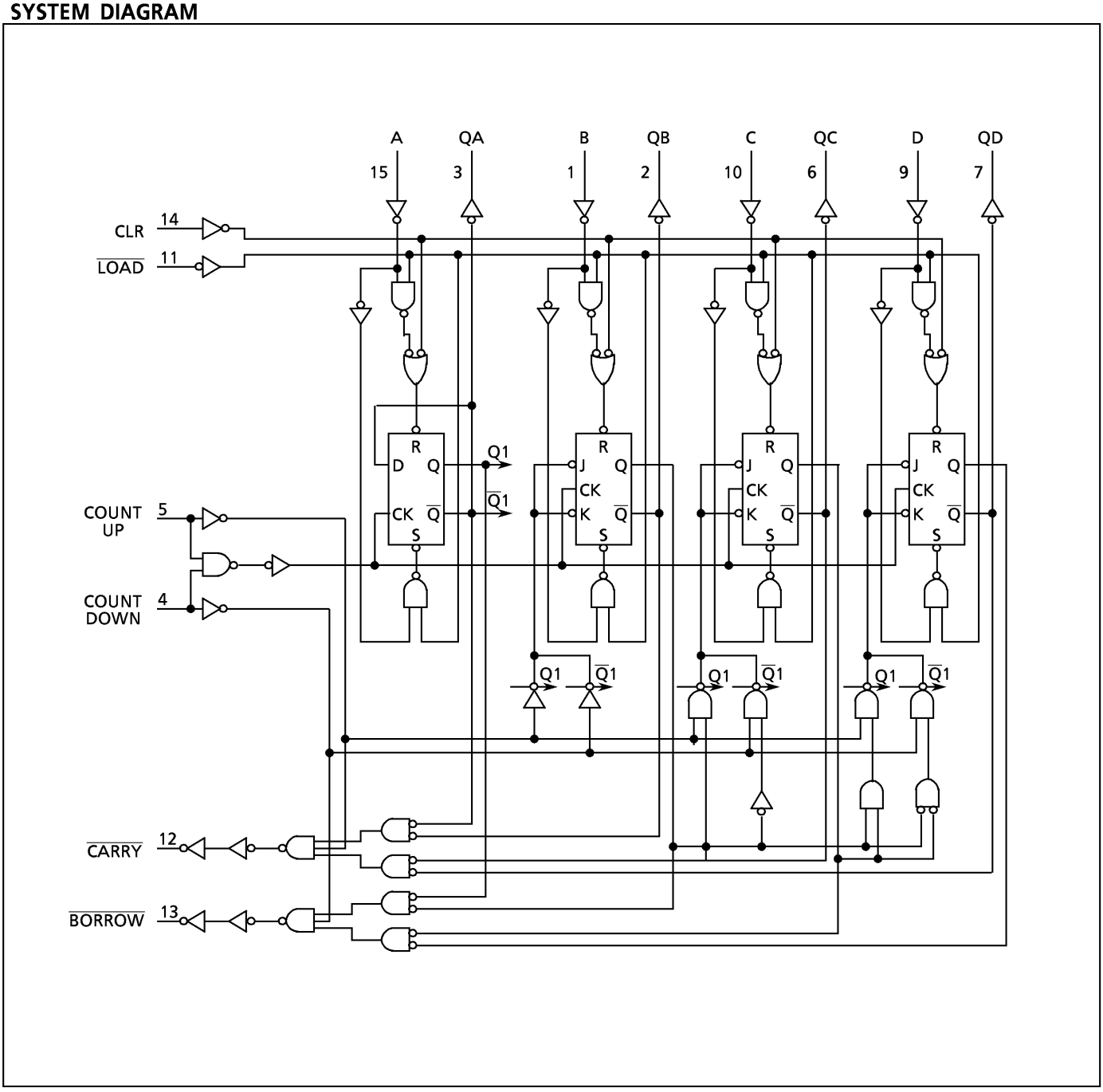
TRUTH TABLE

INPUTS				FUNCTION
COUNT UP	COUNT DOWN	$\overline{LOAD}$	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}	−0.5~7	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}	±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)* / 180 (SOP)	mW
Storage Temperature	T_{stg}	−65~150	°C

*500mW in the range of Ta= −40°C~65°C. From Ta=65°C to 85 °C a derating factor of −10mW/ °C shall be applied until 300mW.

RECOMMENDED OPERATING CONDITIONS

PARAMETER	SYMBOL	VALUE	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} = 2.0V) 0~ 500 (V_{CC} = 4.5V) 0~ 400 (V_{CC} = 6.0V)	ns

DC ELECTRICAL CHARACTERISTICS

PARAMETER	SYMBOL	TEST CONDITION		V_{CC} (V)	Ta = 25°C			Ta = −40~85°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} or V_{IL}	I_{OH} = −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
			I_{OH} = −4 mA I_{OH} = −5.2mA	4.5 6.0	4.18 5.68	4.31 5.80	— —	4.13 5.63	— —	
Low - Level Output Voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 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
			I_{OL} = 4 mA I_{OL} = 5.2mA	4.5 6.0	— —	0.17 0.18	0.26 0.26	— —	0.33 0.33	
Input Leakage 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	

TIMING REQUIREMENTS (Input $t_r = t_f = 6ns$)

PARAMETER	SYMBOL	TEST CONDITION		Ta = 25°C		Ta = −40~85°C	UNIT
			V_{CC} (V)	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 ($\overline{LOAD}$)	$t_{W(L)}$		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−$\overline{LOAD}$)	t_s		2.0	—	75	95	
			4.5	—	15	19	
			6.0	—	13	16	
Minimum Hold Time (DATA−$\overline{LOAD}$)	t_h		2.0	—	0	0	
			4.5	—	0	0	
			6.0	—	0	0	
Minimum Removal Time ($\overline{LOAD}$)	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 = 15pF, V_{CC} = 5V, Ta = 25°C, Input $t_r = t_f$ = 6ns)

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 ($\overline{\text{LOAD}}$ − Q)	t_{pLH} t_{pHL}		—	21	38	
Propagation Delay Time ($\overline{\text{LOAD}}$ − $\overline{\text{CARRY}}$)	t_{pLH} t_{pHL}		—	25	44	
Propagation Delay Time ($\overline{\text{LOAD}}$ − $\overline{\text{BORROW}}$)	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

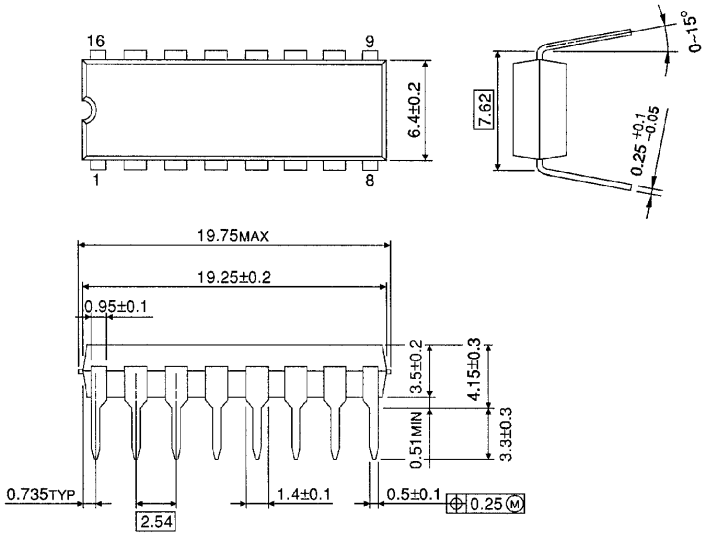
AC ELECTRICAL CHARACTERISTICS (C_L = 50pF, Input $t_r = t_f$ = 6ns)

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

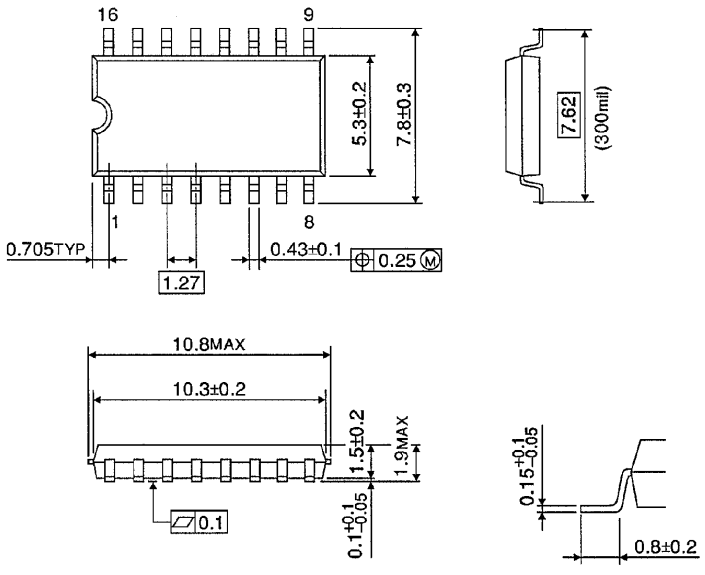
$$I_{CC}(opr) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

DIP 16PIN PACKAGE DIMENSIONS (DIP16-P-300-2.54A) Unit in mm



Weight : 1.00g (Typ.)

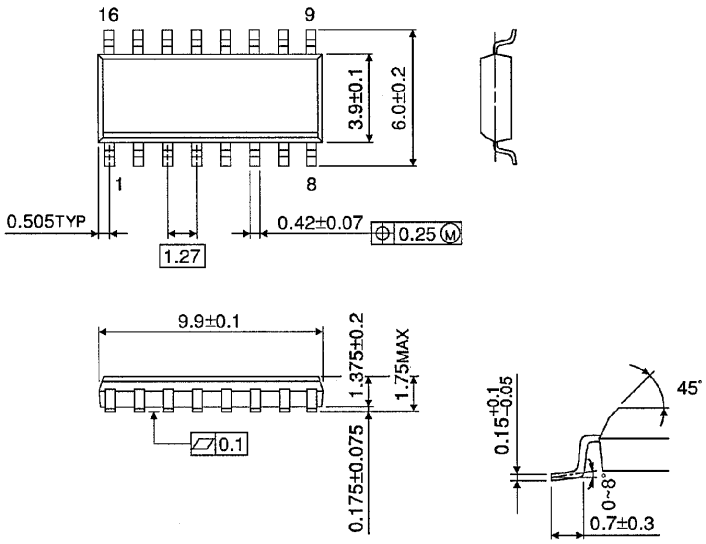
SOP 16PIN (200mil BODY) PACKAGE DIMENSIONS (SOP16-P-300-1.27) Unit in mm



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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