TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

TC74HC193AP, TC74HC193AF, TC74HC193AFN

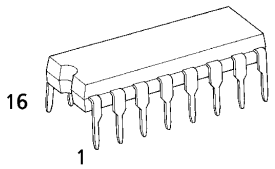
SYNCHRONOUS UP/DOWN BINARY COUNTER

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.

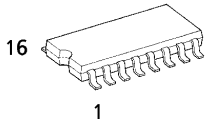
FEATURES :

- 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

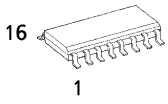
(Note) The JEDEC SOP (FN) is not available in Japan.



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

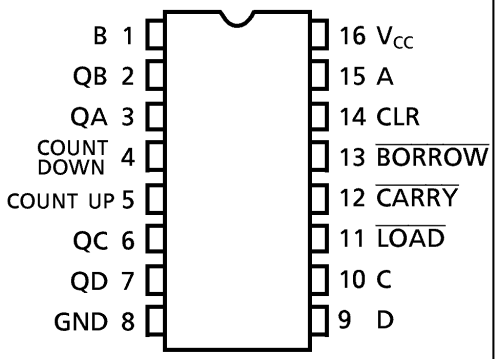


F (SOP16-P-300-1.27)
Weight : 0.18g (Typ.)



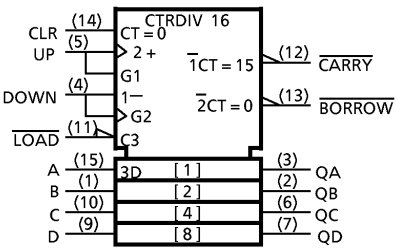
FN (SOL16-P-150-1.27)
Weight : 0.13g (Typ.)

PIN ASSIGNMENT



(TOP VIEW)

IEC LOGIC SYMBOL

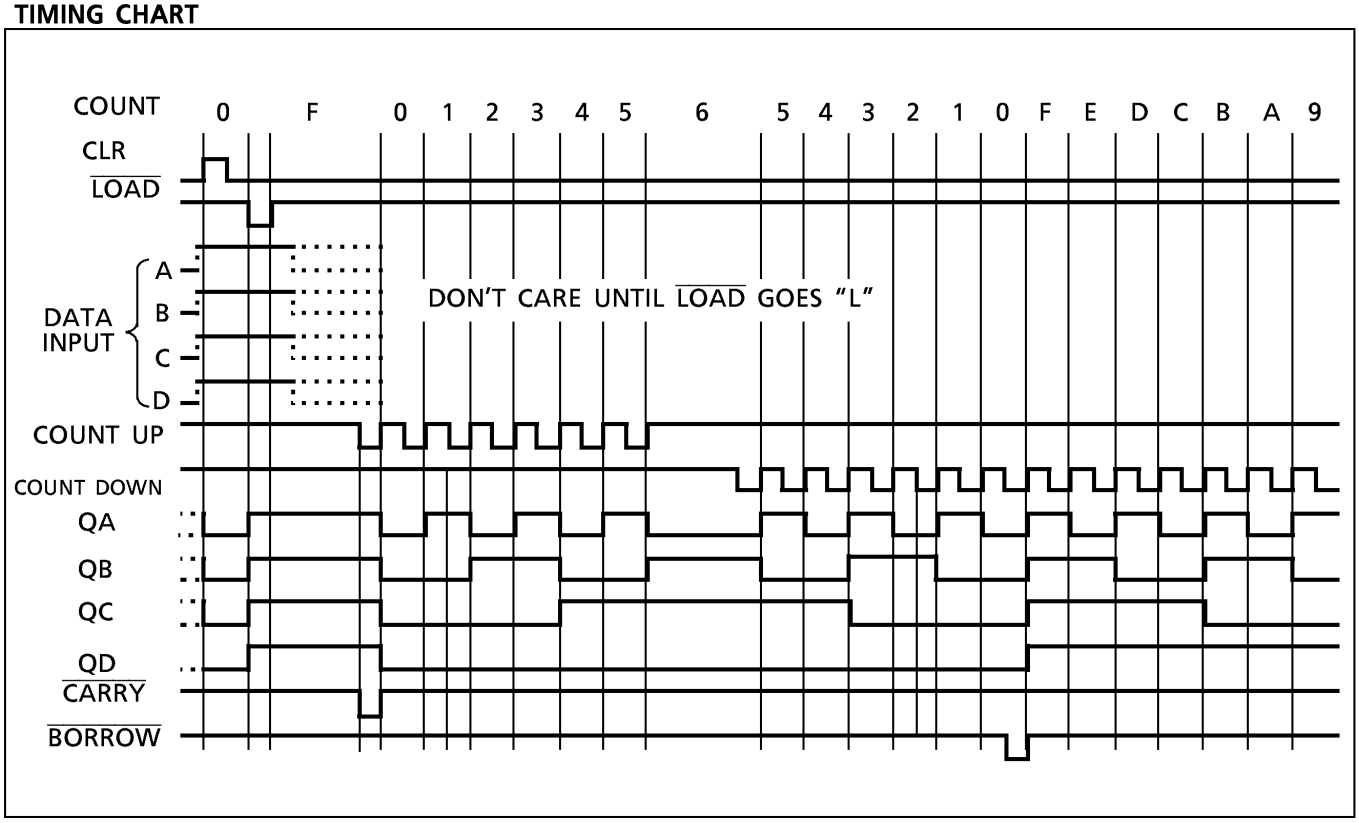


TRUTH TABLE

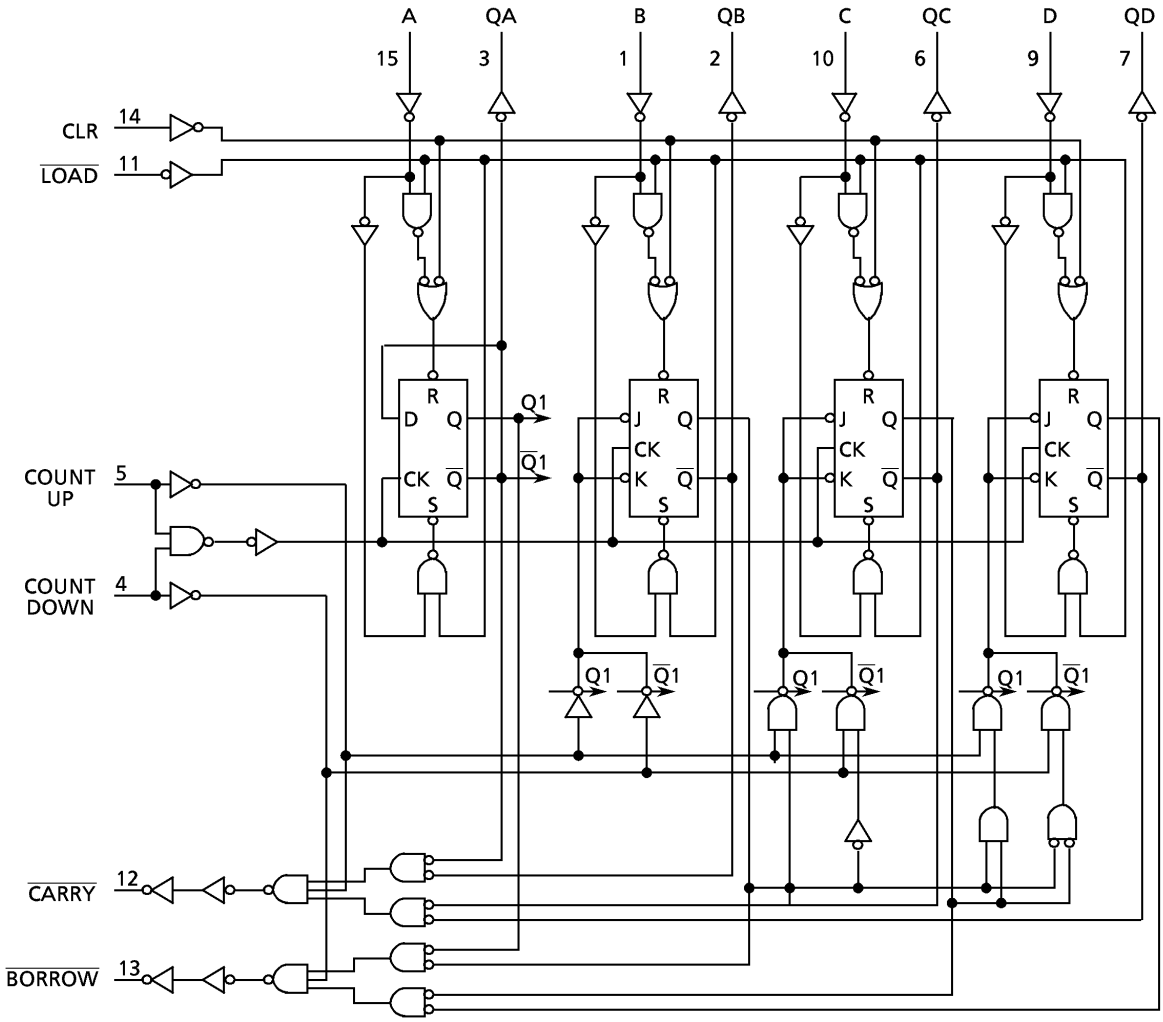
INPUTS				FUNCTION
COUNT UP	COUNT DOWN	$\overline{LOAD}$	CLR	
↑	H	H	L	COUNT UP
↓	H	H	L	NO COUNT
H	↑	H	L	COUNT DOWN
H	↓	H	L	NO COUNT
X	X	L	L	PRESET
X	X	X	H	RESET

980508EBA2

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 MIN.	Ta=25°C TYP.	Ta=25°C MAX.	Ta=−40~85°C MIN.	Ta=−40~85°C MAX.	UNIT
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

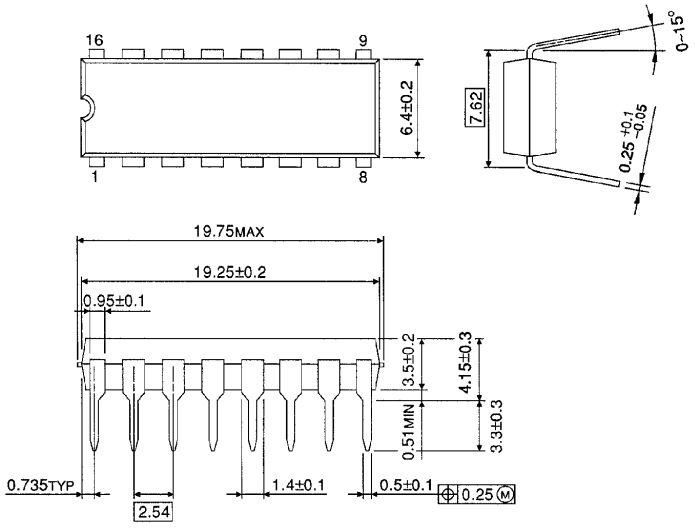
AC ELECTRICAL CHARACTERISTICS (C_L = 50pF, Input $t_r = t_f$ = 6ns)

PARAMETER	SYMBOL	TEST CONDITION	V_{CC} (V)	Ta = 25°C MIN.	TYP.	MAX.	Ta = −40~85°C MIN.	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 (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−$\overline{\text{CARRY}}$)	t_{pLH} t_{pHL}		2.0	−	40	130	−	165	
			4.5	−	13	26	−	33	
			6.0	−	11	22	−	28	
Propagation Delay Time (DOWN−$\overline{\text{BORROW}}$)	t_{pLH} t_{pHL}		2.0	−	40	130	−	165	
			4.5	−	13	26	−	33	
			6.0	−	11	22	−	28	
Propagation Delay Time ($\overline{\text{LOAD}}$−Q)	t_{pLH} t_{pHL}		2.0	−	85	220	−	275	
			4.5	−	25	44	−	55	
			6.0	−	20	37	−	47	
Propagation Delay Time ($\overline{\text{LOAD}}$−$\overline{\text{CARRY}}$)	t_{pLH} t_{pHL}		2.0	−	110	250	−	315	
			4.5	−	30	50	−	63	
			6.0	−	25	43	−	54	
Propagation Delay Time ($\overline{\text{LOAD}}$−$\overline{\text{BORROW}}$)	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−$\overline{\text{CARRY}}$)	t_{pLH} t_{pHL}		2.0	−	120	250	−	315	
			4.5	−	34	50	−	63	
			6.0	−	28	43	−	54	
Propagation Delay Time (DATA IN−$\overline{\text{BORROW}}$)	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−$\overline{\text{CARRY}}$)	t_{pLH}		2.0	−	120	250	−	315	
			4.5	−	35	50	−	63	
			6.0	−	29	43	−	54	
Propagation Delay Time (CLR−$\overline{\text{BORROW}}$)	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	−	MHz
			4.5	25	48	−	20	−	
			6.0	29	55	−	24	−	
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:

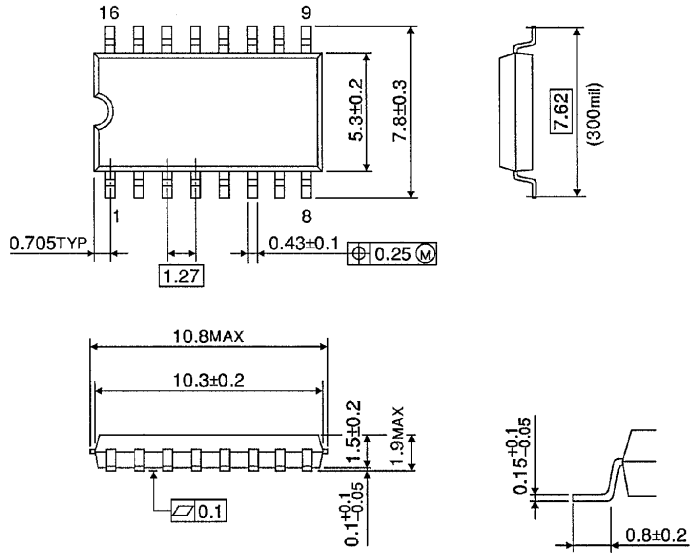
$$I_{CC}(opr) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

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



Weight : 1.00g (Typ.)

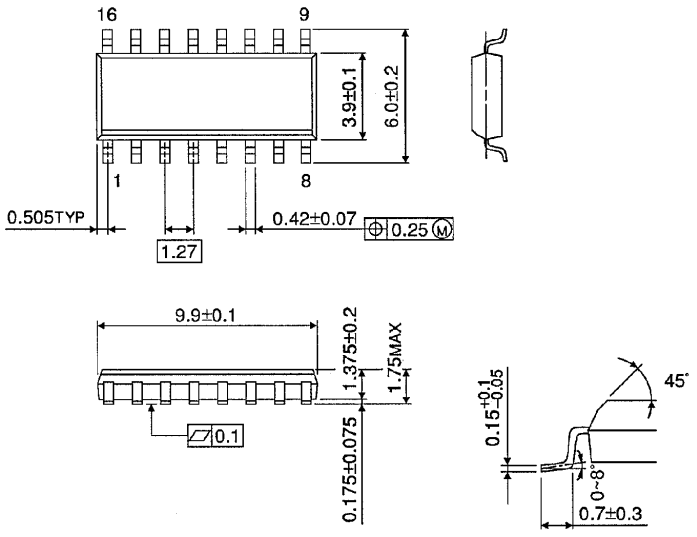
SOP 16PIN (200mil BODY) OUTLINE DRAWING (SOP16-P-300-1.27) Unit in mm



Weight : 0.18g (Typ.)

SOP 16PIN (150mil BODY) OUTLINE DRAWING (SOL16-P-150 -1.27) Unit in mm

(Note) This package is not available in Japan.



Weight : 0.13g (Typ.)