TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74HC191AP,TC74HC191AF

4-Bit Binary Up/Down Counter

The TC74HC191A are high speed CMOS 4-BIT UP/DOWN COUNTERs fabricated with silicon gate C2MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

The TC74HC191A is 4-bit binary up/down counter.

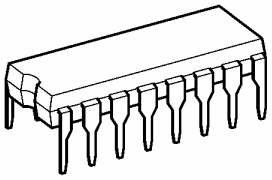
They have an asynchronous load input (LOAD) which is active low.

The direction of counting is determined by the level of DOWN/UP. When D/U is low, the counter counts up; when D/U is high, it counts down. Counting occurs on the positive going transition of the clock input.

Enable input (ENABLE) and two carry inputs (RIPPLE CLOCK OUT, MAX/MIN) are provided to permit easy cascading of the counters, which facilitates easy implementation of N-bit counters without using external gates.

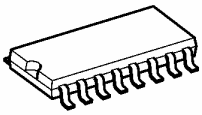
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC74HC191AP



DIP16-P-300-2.54A

TC74HC191AF



SOP16-P-300-1.27A

Weight

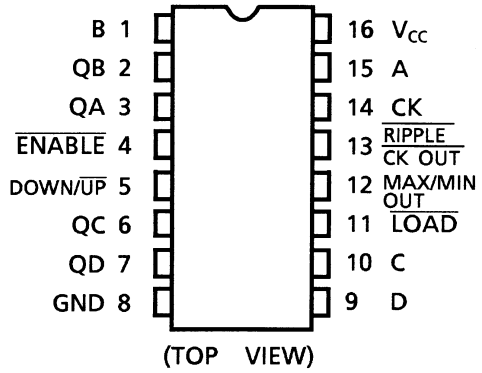
DIP16-P-300-2.54A : 1.00 g (typ.)

SOP16-P-300-1.27A : 0.18 g (typ.)

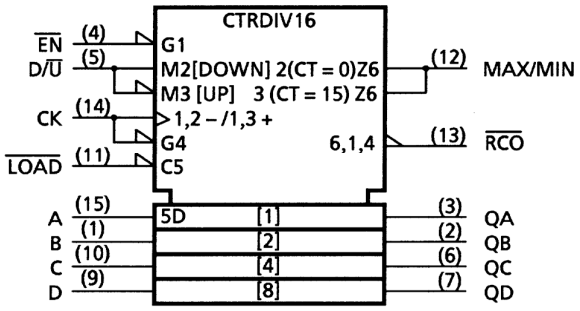
Features

- High speed: fmax = 48 MHz (typ.) at V_{CC} = 5 V
- Low power dissipation: I_{CC} = 4 μA (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} = 4 mA (min)
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Wide operating voltage range: V_{CC} (opr) = 2~6 V
- Pin and function compatible with 74LS191

Pin Assignment



IEC Logic Symbol



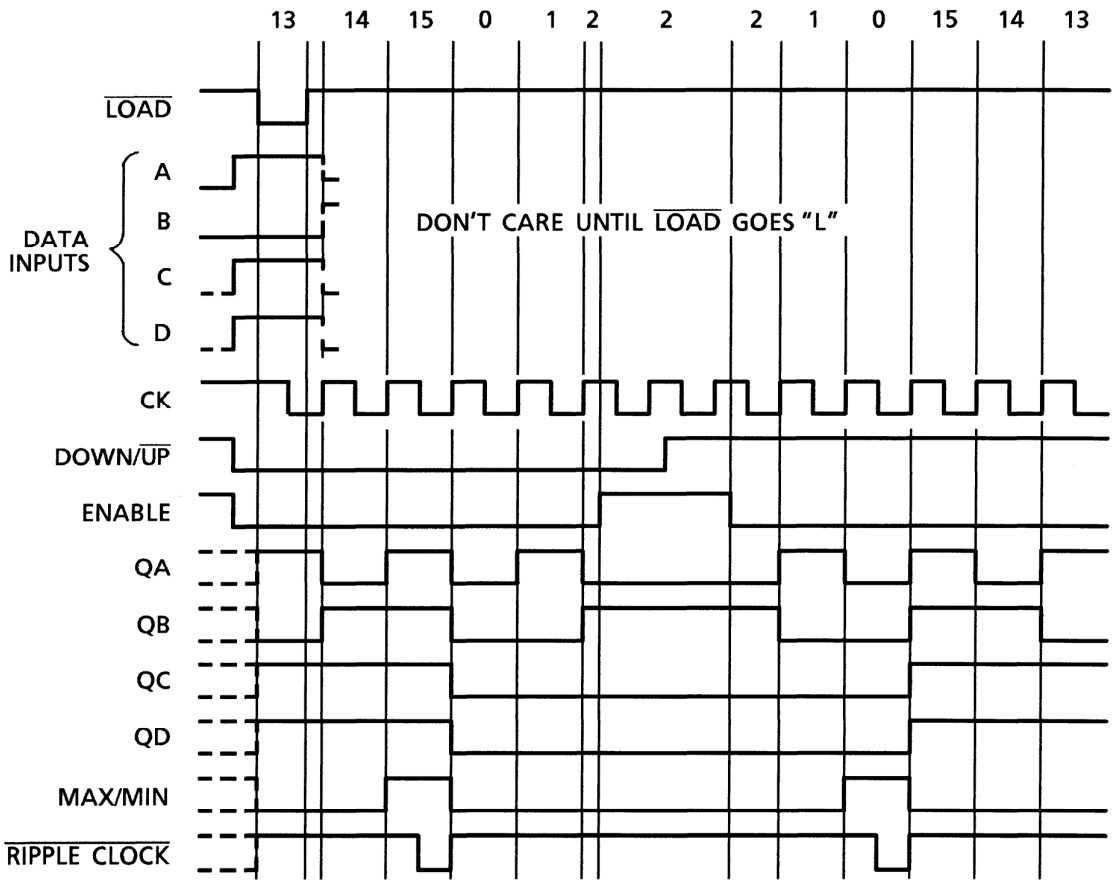
Truth Table

Inputs				Outputs				Function
$\overline{LOAD}$	$\overline{ENABLE}$	D/$\overline{U}$	CK	QA	QB	QC	QD	
L	X	X	X	a	b	c	d	Preset Data
H	L	L	↑	Up Count				Up Count
H	L	H	↑	Down Count				Down Count
H	H	X	↑	No Change				No Count
H	X	X	↓	No Change				No Count

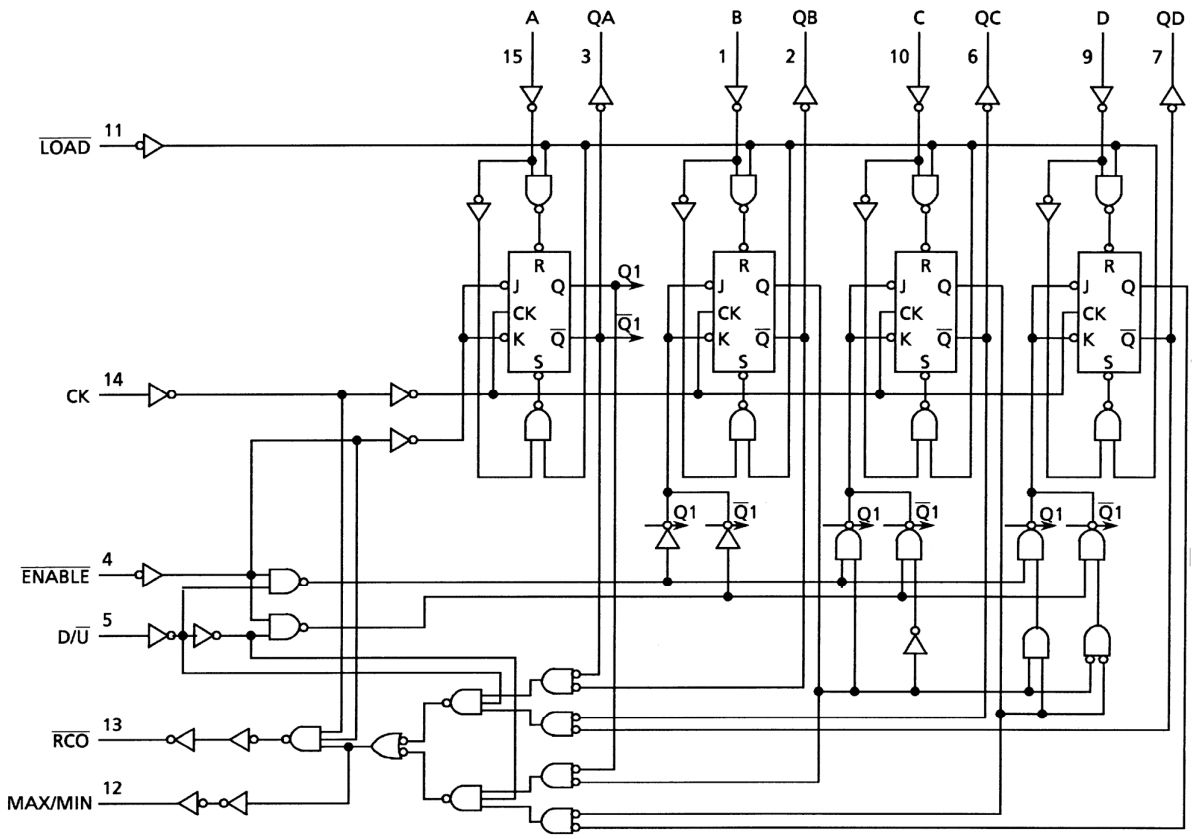
X: Don't care

a~d: Inputs level of A~D

Timing Chart



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}	±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) (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 Ta = −40 to 65°C. From Ta = 65 to 85°C a derating factor of −10 mW/°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 V) 0~500 (V_{CC} = 4.5 V) 0~400 (V_{CC} = 6.0 V)	ns

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either VCC or GND.

Electrical Characteristics

DC Characteristics

Characteristics	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	1.50	—	—	1.50	—	V
				4.5	3.15	—	—	3.15	—	
				6.0	4.20	—	—	4.20	—	
Low-level input voltage	V_{IL}	—		2.0	—	—	0.50	—	0.50	V
				4.5	—	—	1.35	—	1.35	
				6.0	—	—	1.80	—	1.80	
High-level output voltage	V_{OH}	V_{IN} = V_{IH} or V_{IL}	I_{OH} = –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	—	
			I_{OH} = –4 mA	4.5	4.18	4.31	—	4.13	—	
			I_{OH} = –5.2 mA	6.0	5.68	5.80	—	5.63	—	
Low-level output voltage	V_{OL}	V_{IN} = V_{IH} or V_{IL}	I_{OL} = 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	
			I_{OL} = 4 mA	4.5	—	0.17	0.26	—	0.33	
			I_{OL} = 5.2 mA	6.0	—	0.18	0.26	—	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	μA

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

Characteristics	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	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum set-up time ($\overline{ENABLE}$, D/$\overline{U}$)	t_s	—	2.0	—	150	190	ns
			4.5	—	30	38	
			6.0	—	26	33	
Minimum set-up time (DATA-$\overline{LOAD}$)	t_s	—	2.0	—	50	65	ns
			4.5	—	10	13	
			6.0	—	9	11	
Minimum hold time ($\overline{ENABLE}$, D/$\overline{U}$)	t_h	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum hold time (DATA-$\overline{LOAD}$)	t_h	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum removal time	t_{rem}	—	2.0	—	50	65	ns
			4.5	—	10	13	
			6.0	—	9	11	
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, Ta = 25°C, input: $t_r = t_f$ = 6 ns)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	t_{TLH} t_{THL}	—	—	4	8	ns
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	—	—	18	31	ns
Propagation delay time (CK-$\overline{RCO}$)	t_{pLH} t_{pHL}	—	—	10	20	ns
Propagation delay time (CK-MAX/MIN)	t_{pLH} t_{pHL}	—	—	23	42	ns
Propagation delay time ($\overline{LOAD}$-Q)	t_{pLH} t_{pHL}	—	—	21	35	ns
Propagation delay time (DATA-Q)	t_{pLH} t_{pHL}	—	—	17	30	ns
Propagation delay time ($\overline{ENABLE}$ - $\overline{RCO}$)	t_{pLH} t_{pHL}	—	—	11	17	ns
Propagation delay time (D/$\overline{U}$ - $\overline{RCO}$)	t_{pLH} t_{pHL}	—	—	17	31	ns
Propagation delay time (D/$\overline{U}$ -MAX/MIN)	t_{pLH} t_{pHL}	—	—	15	27	ns
Maximum clock frequency	f_{max}	—	27	48	—	MHz

AC Characteristics (C_L = 50 pF, input: $t_r = t_f$ = 6 ns)

Characteristics	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	—	30	75	—	95	ns
			4.5	—	8	15	—	19	
			6.0	—	7	13	—	16	
Propagation delay time (CK-Q)	t_{pLH} t_{pHL}	—	2.0	—	88	180	—	225	ns
			4.5	—	22	36	—	45	
			6.0	—	19	31	—	38	
Propagation delay time (CK-$\overline{RCO}$)	t_{pLH} t_{pHL}	—	2.0	—	52	120	—	150	ns
			4.5	—	13	24	—	30	
			6.0	—	11	20	—	26	
Propagation delay time (CK-MAX/MIN)	t_{pLH} t_{pHL}	—	2.0	—	108	240	—	300	ns
			4.5	—	27	48	—	60	
			6.0	—	23	41	—	51	
Propagation delay time ($\overline{LOAD}$-Q)	t_{pLH} t_{pHL}	—	2.0	—	100	205	—	255	ns
			4.5	—	25	41	—	51	
			6.0	—	22	35	—	43	
Propagation delay time (DATA-Q)	t_{pLH} t_{pHL}	—	2.0	—	84	175	—	220	ns
			4.5	—	21	35	—	44	
			6.0	—	18	30	—	37	
Propagation delay time ($\overline{ENABLE}$ - $\overline{RCO}$)	t_{pLH} t_{pHL}	—	2.0	—	56	105	—	130	ns
			4.5	—	14	21	—	26	
			6.0	—	12	18	—	22	
Propagation delay time (D/$\overline{U}$ - $\overline{RCO}$)	t_{pLH} t_{pHL}	—	2.0	—	84	180	—	225	ns
			4.5	—	21	36	—	45	
			6.0	—	18	31	—	38	
Propagation delay time (D/$\overline{U}$ -MAX/MIN)	t_{pLH} t_{pHL}	—	2.0	—	72	160	—	200	ns
			4.5	—	18	32	—	40	
			6.0	—	15	27	—	34	
Maximum clock frequency	f_{max}	—	2.0	5	11	—	4	—	MHz
			4.5	25	44	—	20	—	
			6.0	29	52	—	24	—	
Input capacitance	C_{IN}	—		—	5	10	—	10	pF
Power dissipation capacitance	C_{PD} (Note)	—		—	101	—	—	—	pF

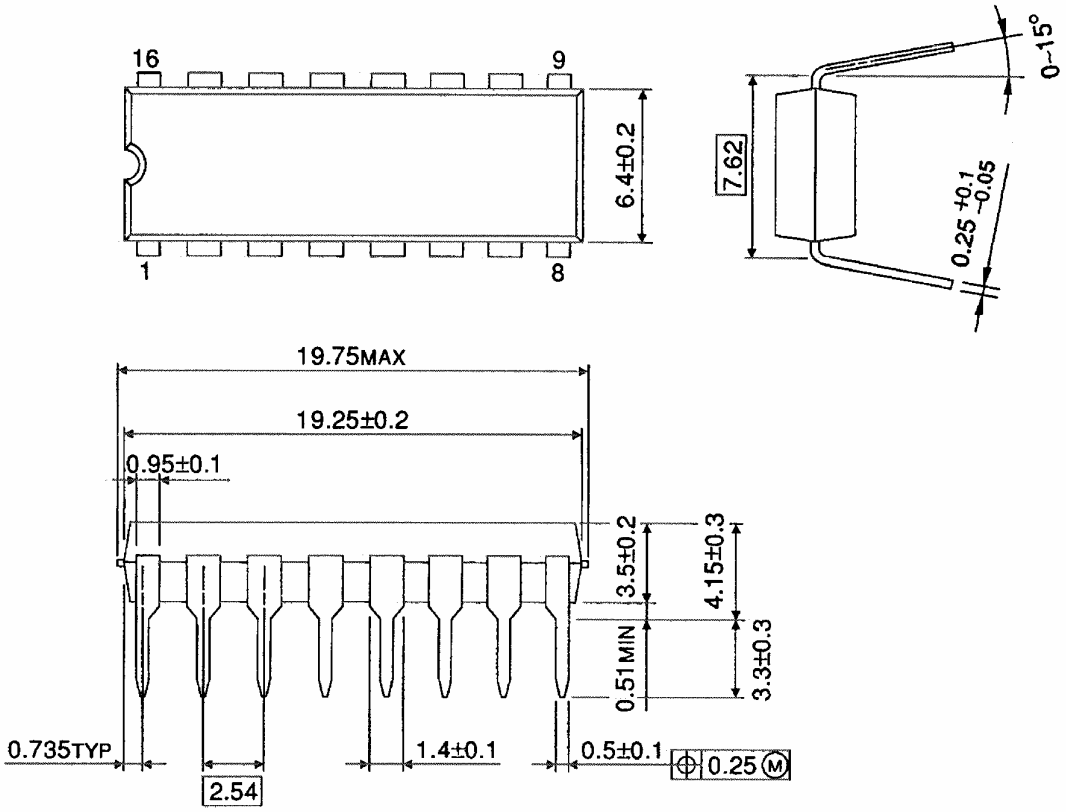
Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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

Package Dimensions

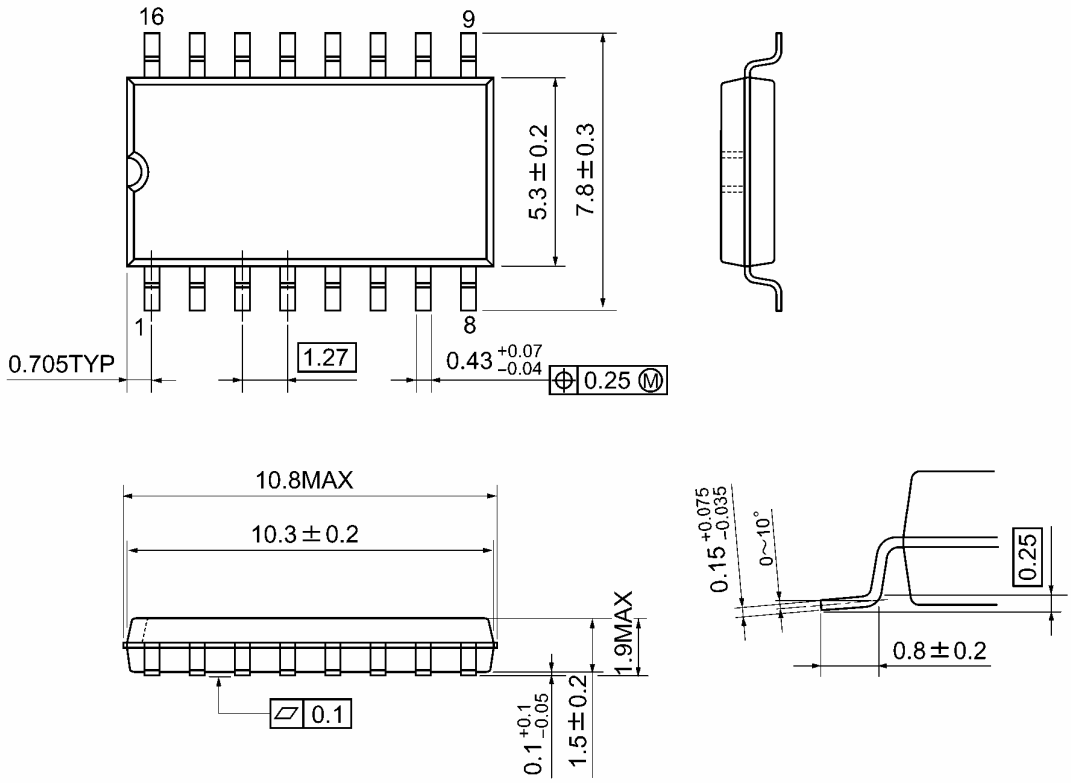
DIP16-P-300-2.54A Unit : mm



Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

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