TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74HC390AP, TC74HC390AF

Dual Decade Counter

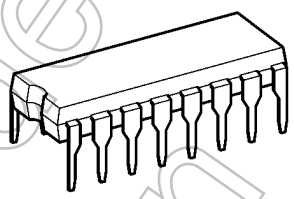
The TC74HC390A is a high speed CMOS DUAL DECADE COUNTER fabricated with silicon gate C^2MOS technology.

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

It consists of two independent 4-bit counters, each composed of a divide-by-two and a divide-by-five counter. The divide-by-two counter is incremented on the negative going transition of clock A ($\overline{CKA}$). The divided-by-five counter is incremented on the negative going transition of clock B ($\overline{CKB}$). The counter can be cascaded to form decade, bi-quinary, or various combinations up to a divide-by-100 counter. When the CLR input is set high, the Q outputs are set to low independent of the clock inputs.

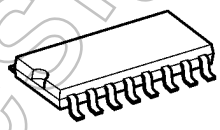
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC74HC390AP



DIP16-P-300-2.54A

TC74HC390AF



SOP16-P-300-1.27A

Weight

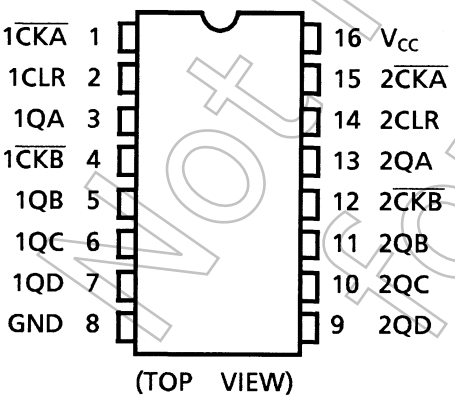
DIP16-P-300-2.54A : 1.00 g (typ.)

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

Features

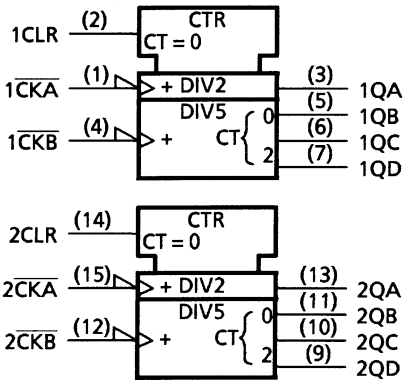
- High speed: f_{max} = 84 MHz (typ.) at V_{CC} = 5 V
- Low power dissipation: I_{CC} = 4 μA (max) at Ta = 25°C
- High noise immunity: $V_{NIH} = V_{NIL}$ = 28% V_{CC} (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: $|I_{OH}| = I_{OL}$ = 4 mA (min)
- Balanced propagation delays: $t_{pLH} \simeq t_{pHL}$
- Wide operating voltage range: V_{CC} (opr) = 2 to 6 V
- Pin and function compatible with 74LS390

Pin Assignment

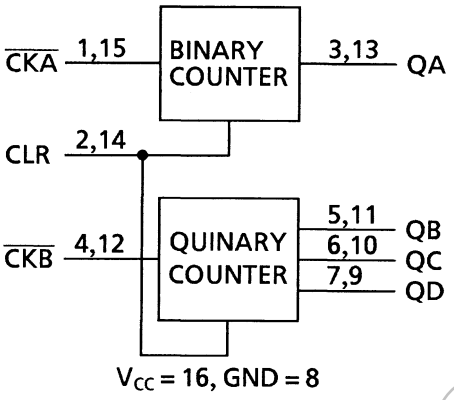


Start of commercial production
1986-11

IEC Logic Symbol



Block Diagram

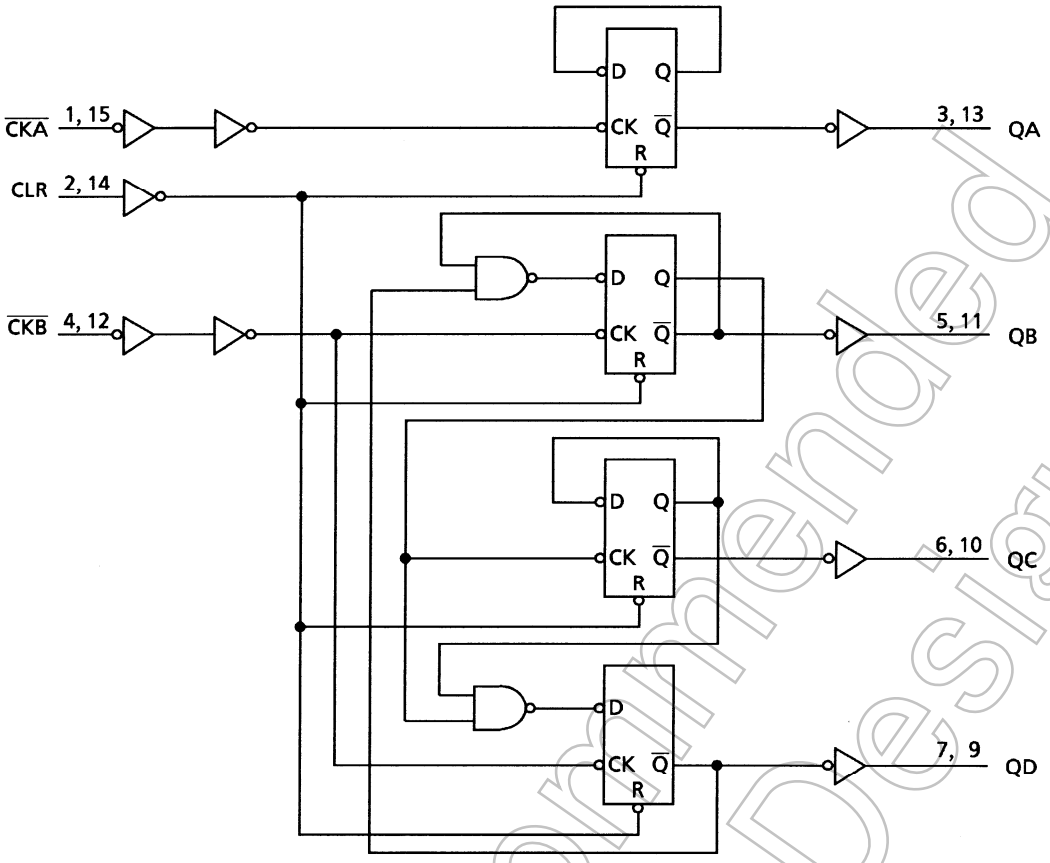


Truth Table

Inputs			Outputs			
$\overline{CKA}$	$\overline{CKB}$	CLR	QA	QB	QC	QD
X	X	H	L	L	L	L
↓	X	L	Binary Count Up			
X	↓	L	Quinary Count Up			

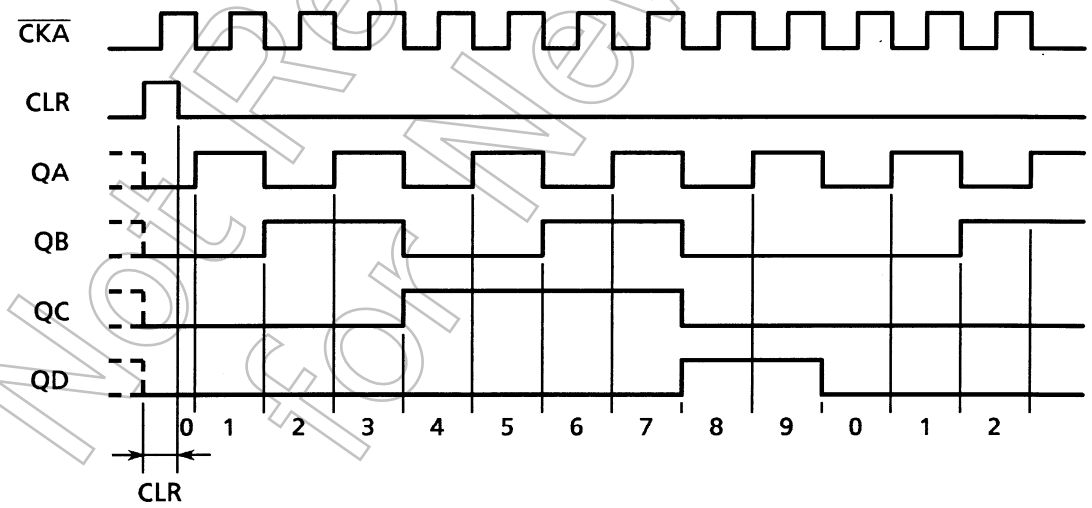
X: Don't care

System Diagram (1/2 package)



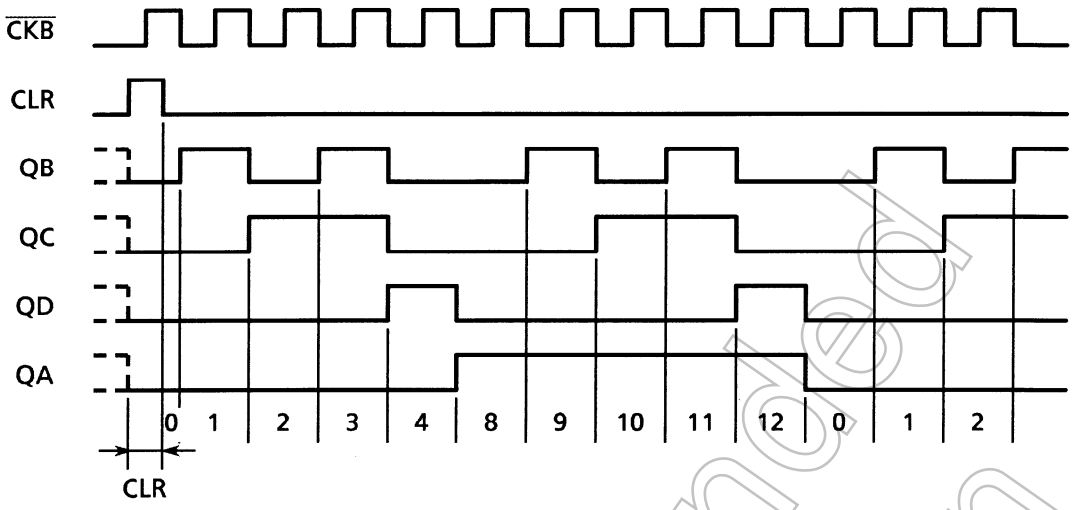
Timing Chart

(1) BCD count sequence (Note)



Note: QA connected to $\overline{CKB}$

(2) BI-quinary count sequence (Note)



Note: QD connected to $\overline{CKA}$

Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	−0.5 to 7	V
DC input voltage	V_{IN}	−0.5 to V_{CC} + 0.5	V
DC output voltage	V_{OUT}	−0.5 to 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 to 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 to 6	V
Input voltage	V_{IN}	0 to V_{CC}	V
Output voltage	V_{OUT}	0 to V_{CC}	V
Operating temperature	T_{opr}	−40 to 85	°C
Input rise and fall time	t_r, t_f	0 to 1000 (V_{CC} = 2.0 V) 0 to 500 (V_{CC} = 4.5 V) 0 to 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 V_{CC} or GND.

Electrical Characteristics

DC Characteristics

Characteristics	Symbol	Test Condition		Ta = 25°C				Ta = −40 to 85°C		Unit
			V_{CC} (V)	Min	Typ.	Max		Min	Max	
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}	2.0	1.9	2.0	—		1.9	—	V
		I_{OH} = −20 μA	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}	2.0	—	0.0	0.1		—	0.1	V
		I_{OL} = 20 μA	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 to 85°C	Unit
			V_{CC} (V)	Typ.	Limit	Limit	
Minimum pulse width ($\overline{CK}$)	$t_{W(H)}$ $t_{W(L)}$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum pulse width (CLR)	$t_{W(H)}$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum removal time	t_{rem}	—	2.0	—	25	30	ns
			4.5	—	5	6	
			6.0	—	5	5	
Clock frequency ($\overline{CKA}$)	f	—	2.0	—	6	5	MHz
			4.5	—	32	26	
			6.0	—	38	31	
Clock frequency ($\overline{CKB}$)	f	—	2.0	—	6	5	MHz
			4.5	—	31	25	
			6.0	—	36	29	

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 ($\overline{CKA}$ -QA)	t_{pLH} t_{pHL}	—	—	10	20	ns
Propagation delay time ($\overline{CKA}$ -QC)	t_{pLH} t_{pHL}	QA connected to $\overline{CKB}$	—	29	51	ns
Propagation delay time ($\overline{CKB}$ -QB, QD)	t_{pLH} t_{pHL}	—	—	12	22	ns
Propagation delay time ($\overline{CKB}$ -QC)	t_{pLH} t_{pHL}	—	—	17	32	ns
Propagation delay time (CLR-Qn)	t_{pHL}	—	—	12	26	ns
Maximum clock frequency ($\overline{CKA}$)	f_{max}	—	35	84	—	MHz
Maximum clock frequency ($\overline{CKB}$)	f_{max}	—	33	65	—	MHz

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

Characteristics	Symbol	Test Condition		Ta = 25°C			Ta = −40 to 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 ($\overline{CKA}$ -QA)	t_{pLH} t_{pHL}	—	2.0	—	39	120	—	150	ns
			4.5	—	13	24	—	30	
			6.0	—	11	20	—	26	
Propagation delay time ($\overline{CKA}$ -QC)	t_{pLH} t_{pHL}	QA connected to $\overline{CKB}$	2.0	—	102	290	—	365	ns
			4.5	—	34	58	—	73	
			6.0	—	29	49	—	62	
Propagation delay time ($\overline{CKB}$ -QB, QD)	t_{pLH} t_{pHL}	—	2.0	—	45	130	—	165	ns
			4.5	—	15	26	—	33	
			6.0	—	13	22	—	28	
Propagation delay time ($\overline{CKB}$ -QC)	t_{pLH} t_{pHL}	—	2.0	—	63	185	—	230	ns
			4.5	—	21	37	—	46	
			6.0	—	18	31	—	39	
Propagation delay time (CLR-Qn)	t_{pHL}	—	2.0	—	45	150	—	190	ns
			4.5	—	15	30	—	38	
			6.0	—	13	26	—	32	
Maximum clock frequency ($\overline{CKA}$)	f_{max}	—	2.0	6	20	—	5	—	MHz
			4.5	32	77	—	26	—	
			6.0	38	90	—	31	—	
Maximum clock frequency ($\overline{CKB}$)	f_{max}	—	2.0	6	15	—	5	—	MHz
			4.5	32	60	—	25	—	
			6.0	36	70	—	29	—	
Input capacitance	C_{IN}	—		—	5	10	—	10	pF
Power dissipation capacitance	C_{PD} (Note)	—		—	44	—	—	—	pF

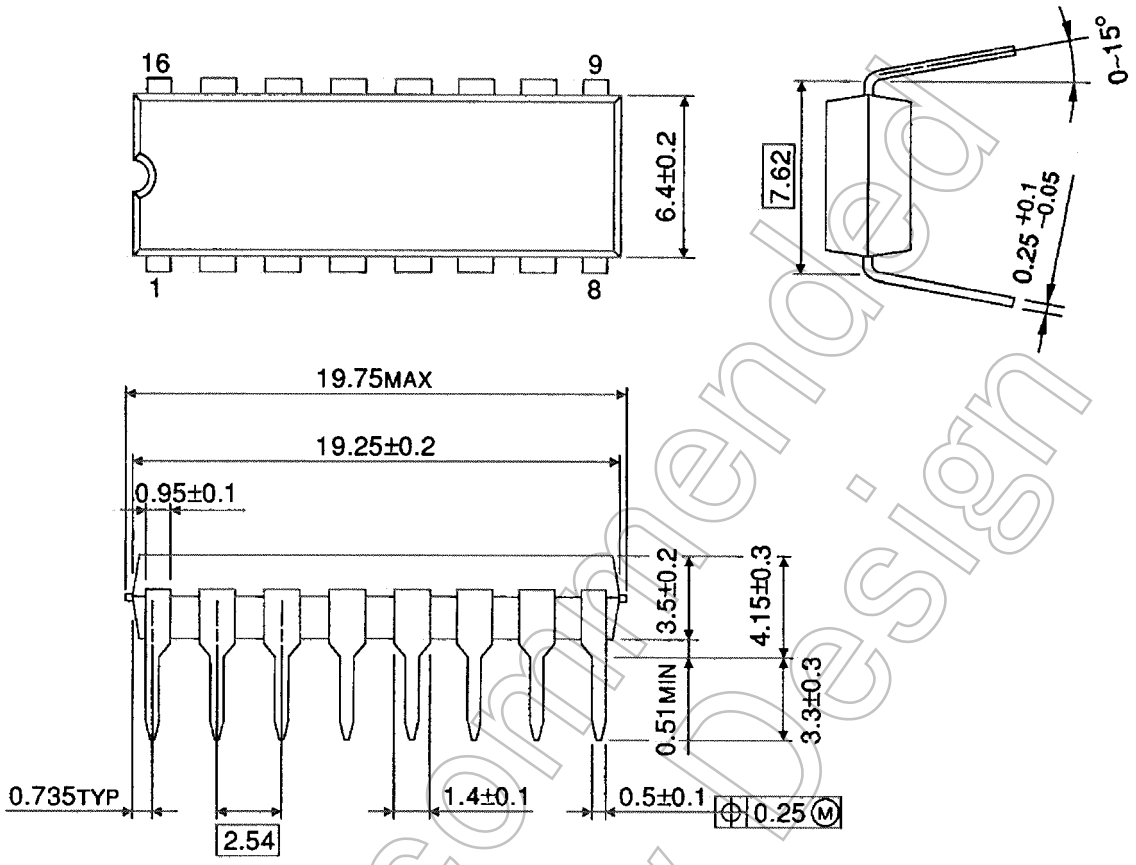
Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

I_{CC} (opr) = $C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}/2$ (per counter)

Package Dimensions

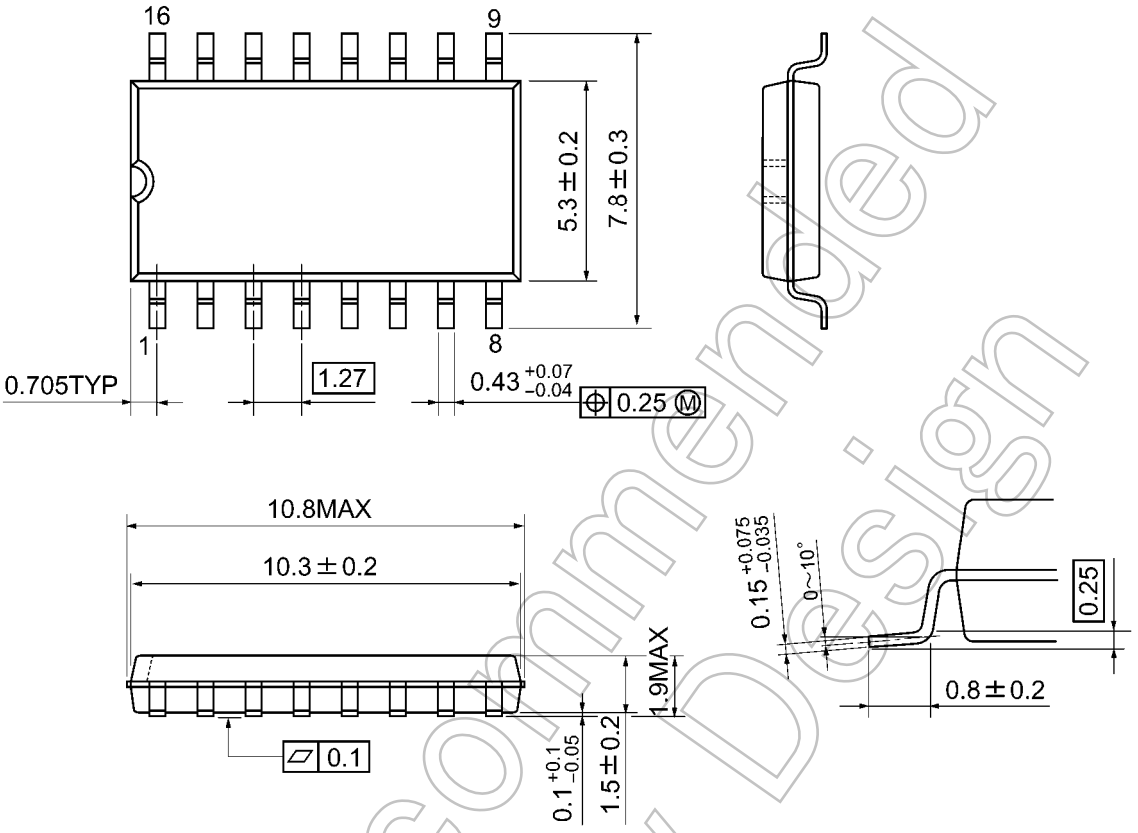
DIP16-P-300-2.54A Unit : mm



Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A Unit: mm



Weight: 0.18 g (typ.)

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