

TC74HC193AP, TC74HC193AF

Synchronous Up/Down Binary Counter

The TC74HC193A are high speed CMOS SYNCHRONOUS 4-BIT UP/DOWN COUNTER fabricated with silicon gate C²MOS 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 (LOAD), load data inputs (A~D), two clock inputs (COUNT UP, COUNT DOWN), four count data outputs (QA~QD), and other outputs (CARRY, BORROW).

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

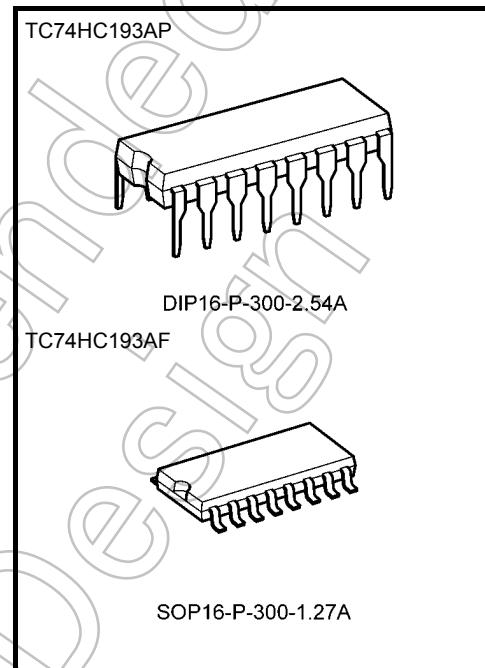
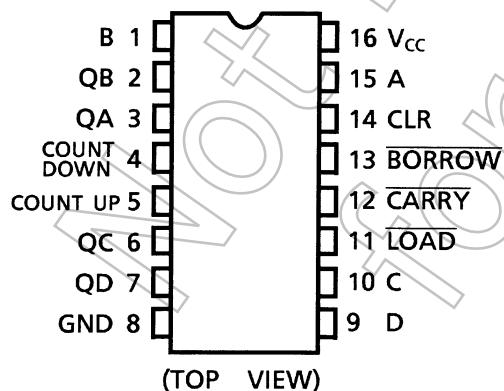
CARRY and BORROW outputs are provided in order to make a cascade connection without external circuitry.

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

Features

- High speed: $f_{max} = 54$ MHz (typ.) at $V_{CC} = 5$ V
- Low power dissipation: $I_{CC} = 4$ μ A (max) at $T_a = 25^\circ C$
- 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: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: V_{CC} (opr) = 2 to 6 V
- Pin and function compatible with 74LS193

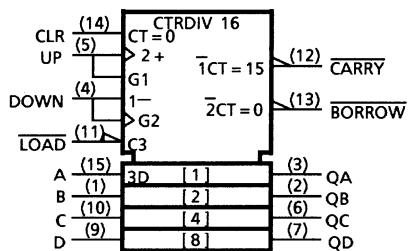
Pin Assignment



Weight
 DIP16-P-300-2.54A : 1.00 g (typ.)
 SOP16-P-300-1.27A : 0.18 g (typ.)

Start of commercial production
 1986-05

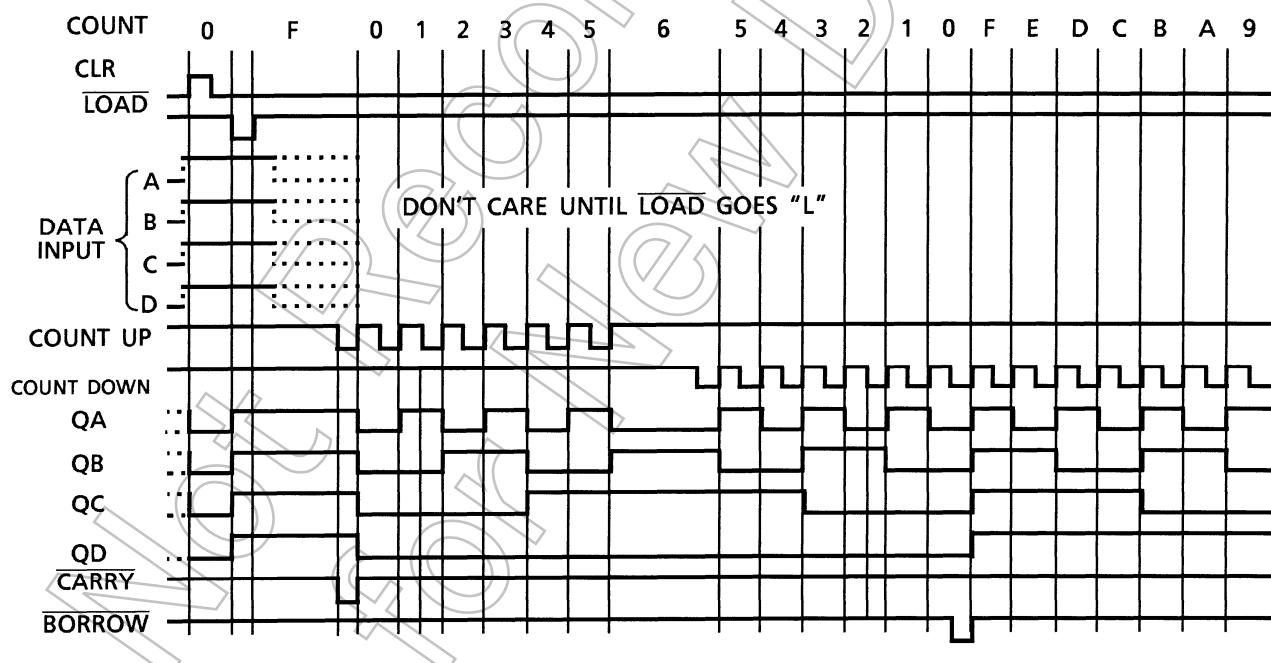
IEC Logic Symbol



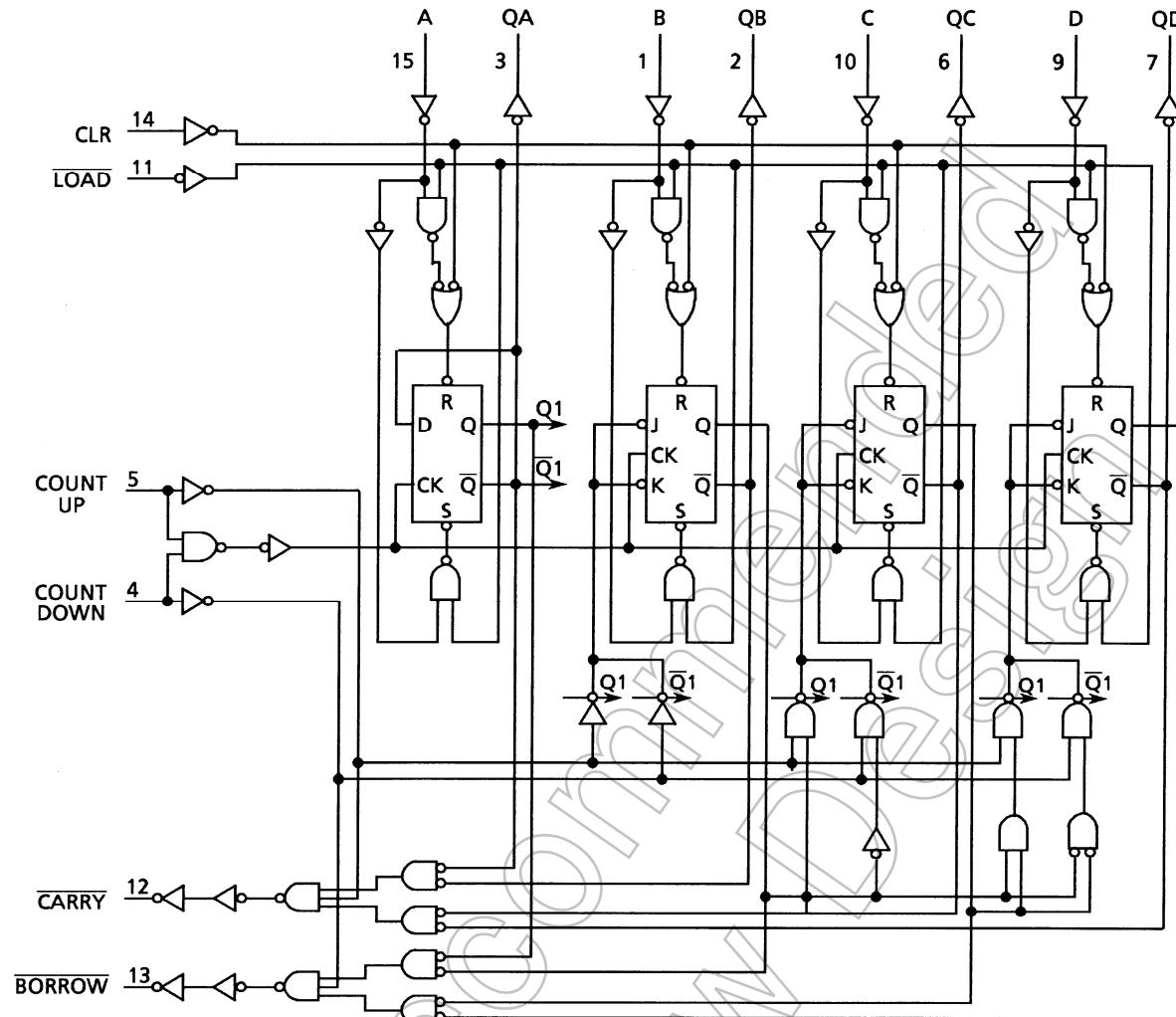
Truth Table

Inputs				Function
Count Up	Count Down	LOAD	CLR	
\uparrow	H	H	L	Count Up
\downarrow	H	H	L	No Count
H \uparrow	H	L	L	Count Down
H \downarrow	H	L	L	No Count
X	X	L	L	Preset
X	X	X	H	Reset

Timing Chart



System Diagram



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 $T_a = -40$ to 65°C . From $T_a = 65$ to 85°C a derating factor of $-10 \text{ mW}/^\circ\text{C}$ 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	$T_a = 25^\circ C$			$T_a = -40$ to $85^\circ C$		Unit		
			V_{CC} (V)	Min	Typ.	Max	Min			
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}	$I_{OH} = -20 \mu A$	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		
				6.0	5.68	5.80	—	5.63		
			$I_{OH} = -5.2 mA$	—	—	—	—	—		
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}		2.0	—	0.0	0.1	—	V	
				4.5	—	0.0	0.1	—		
				6.0	—	0.0	0.1	—		
		$I_{OL} = 20 \mu A$	—	—	—	—	—			
			—	—	—	—	—			
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND	$I_{OL} = 4 mA$	2.0	—	0.0	0.1	—	μA	
				4.5	—	0.0	0.1	—		
			$I_{OL} = 5.2 mA$	6.0	—	0.0	0.1	—		
				—	—	—	—	—		
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND	6.0	—	—	±0.1	—	±1.0	μA	

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

Characteristics	Symbol	Test Condition	$T_a = 25^\circ C$		$T_a = -40$ to $85^\circ C$		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 (LOAD)	t_W (L)	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum hold time (CLR)	t_W (H)	—	2.0	—	100	125	ns
			4.5	—	20	25	
			6.0	—	17	21	
Minimum set-up time (DATA-LOAD)	t_s	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum hold time (DATA-LOAD)	t_h	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum removal time (LOAD)	t_{rem}	—	2.0	—	50	65	ns
			4.5	—	10	13	
			6.0	—	9	10	
Minimum removal time (CLR)	t_{rem}	—	2.0	—	50	65	ns
			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 Characteristics ($C_L = 15 \text{ pF}$, $V_{CC} = 5 \text{ V}$, $T_a = 25^\circ\text{C}$, input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	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	ns
Propagation delay time (UP- CARRY)	t_{pLH} t_{pHL}	—	—	10	22	ns
Propagation delay time (DOWN- BORROW)	t_{pLH} t_{pHL}	—	—	10	22	ns
Propagation delay time (LOAD -Q)	t_{pLH} t_{pHL}	—	—	21	38	ns
Propagation delay time (LOAD - CARRY)	t_{pLH} t_{pHL}	—	—	25	44	ns
Propagation delay time (LOAD - BORROW)	t_{pLH} t_{pHL}	—	—	26	44	ns
Propagation delay time (DATA IN-Q)	t_{pLH} t_{pHL}	—	—	21	33	ns
Propagation delay time (DATA IN- CARRY)	t_{pLH} t_{pHL}	—	—	29	44	ns
Propagation delay time (DATA IN- BORROW)	t_{pLH} t_{pHL}	—	—	26	44	ns
Propagation delay time (CLR-Q)	t_{pHL}	—	—	25	39	ns
Propagation delay time (CLR- CARRY)	t_{pLH}	—	—	30	44	ns
Propagation delay time (CLR- BORROW)	t_{pHL}	—	—	30	44	ns
Maximum clock frequency	f_{max}	—	27	52	—	MHz

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

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit
			V _{CC} (V)	Min	Typ.	Max	Min	
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- $\overline{\text{CARRY}}$)	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 (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 - $\overline{\text{CARRY}}$)	t_{pLH} t_{pHL}	—	2.0	—	110	250	—	315
			4.5	—	30	50	—	63
			6.0	—	25	43	—	54
Propagation delay time (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	—
			4.5	25	48	—	20	—
			6.0	29	55	—	24	—
Input capacitance	C_{IN}	—	—	5	10	—	10	pF

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit
			V _{CC} (V)	Min	Typ.	Max	Min	
Power dissipation capacitance	C _{PD} (Note)	—	—	—	67	—	—	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:

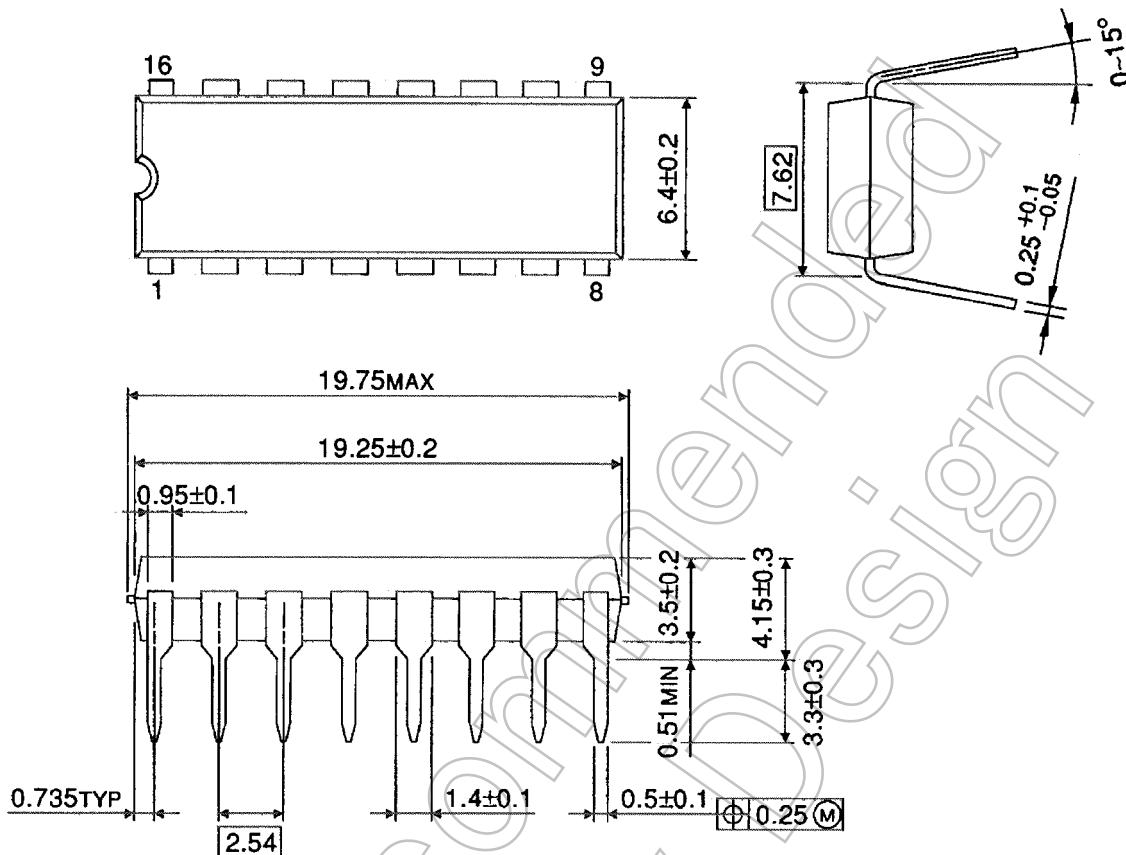
$$I_{CC\ (opr)} = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

Not Recommended for New Design

Package Dimensions

DIP16-P-300-2.54A

Unit : mm

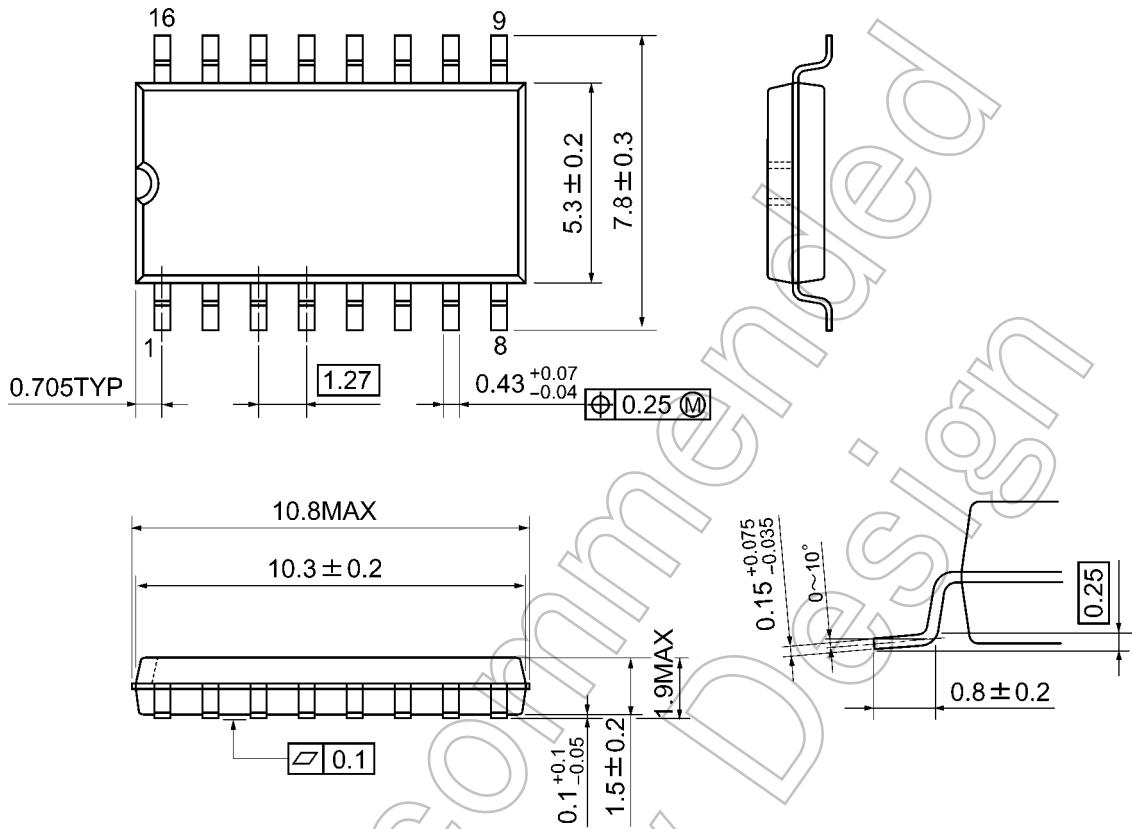


Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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