

# TC74HC165AP, TC74HC165AF

## 8-Bit Shift Register (P-IN, S-OUT)

The TC74HC165A is a high speed CMOS 8-BIT PARALLEL/SERIAL-IN, SERIAL-OUT SHIFT REGISTER fabricated with silicon gate C<sup>2</sup>MOS technology.

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

It consists of parallel-in or serial-in, serial-out 8-bit shift register with a gated clock inputs. When the  $\overline{\text{SHIFT/LOAD}}$  input is held high, the serial data input is enabled and the eight flip-flops perform serial shifting with each clock pulse.

When the  $\overline{\text{SHIFT/LOAD}}$  input is held low, the parallel data is loaded asynchronously into the register at positive going transition of the clock pulse.

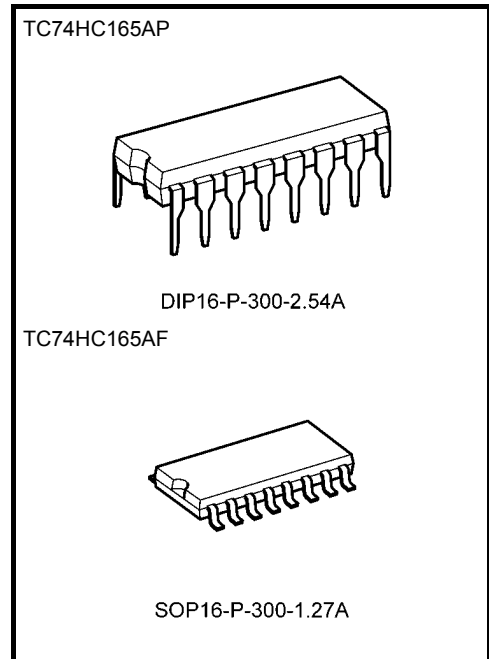
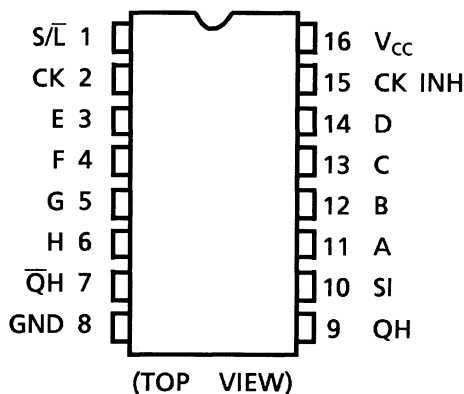
The CK-INH input should be shifted high only when the CK input is held high.

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

### Features

- High speed:  $f_{\text{max}} = 56 \text{ MHz}$  (typ.) at  $V_{\text{CC}} = 5 \text{ V}$
- Low power dissipation:  $I_{\text{CC}} = 4 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{\text{NIH}} = V_{\text{NIL}} = 28\% V_{\text{CC}}$  (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance:  $|I_{\text{OH}}| = I_{\text{OL}} = 4 \text{ mA}$  (min)
- Balanced propagation delays:  $t_{\text{pLH}} \approx t_{\text{pHL}}$
- Wide operating voltage range:  $V_{\text{CC}} (\text{opr}) = 2 \text{ to } 6 \text{ V}$
- Pin and function compatible with 74LS165

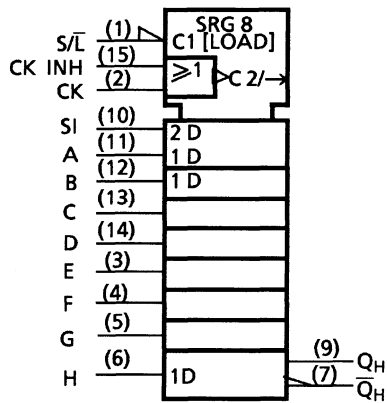
### Pin Assignment



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

Start of commercial production  
1988-05

**IEC Logic Symbol**



**Truth Table**

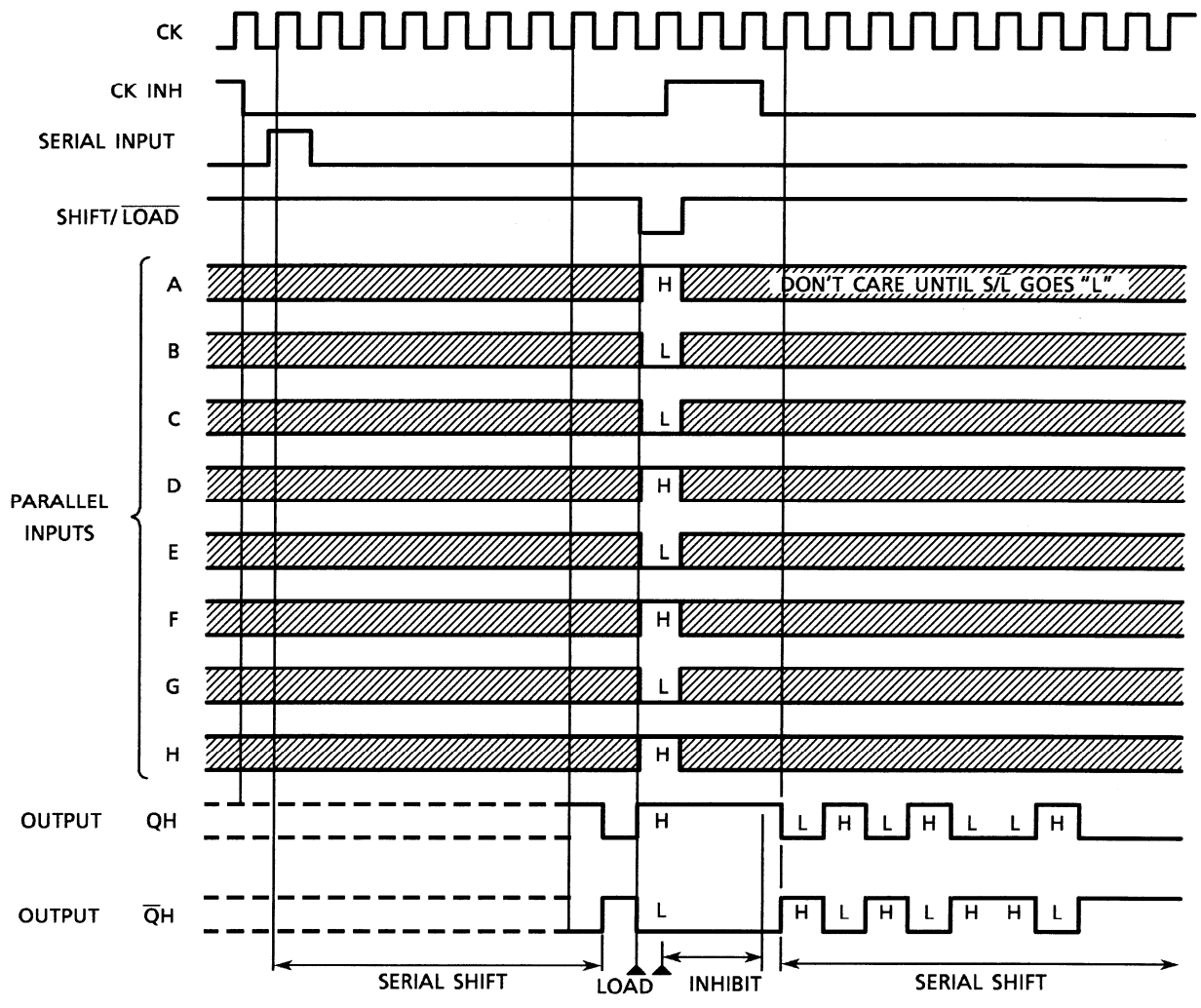
Inputs					Internal Outputs		Outputs	
SHIFT/LOAD	CLOCK INH	CLOCK	SERIAL IN	PARALLEL A·····h	QA	QB	QH	$\overline{QH}$
L	X	X	X	a·····h	a	b	h	$\overline{h}$
H	L	$\uparrow$	H	X	H	QAn	QGn	$\overline{QGn}$
H	L	$\uparrow$	L	X	L	QAn	QGn	$\overline{QGn}$
H	$\uparrow$	L	H	X	H	QAn	QGn	$\overline{QGn}$
H	$\uparrow$	L	L	X	L	QAn	QGn	$\overline{QGn}$
H	X	H	X	X	No Change			
H	H	X	X	X	No Change			

X: Don't care

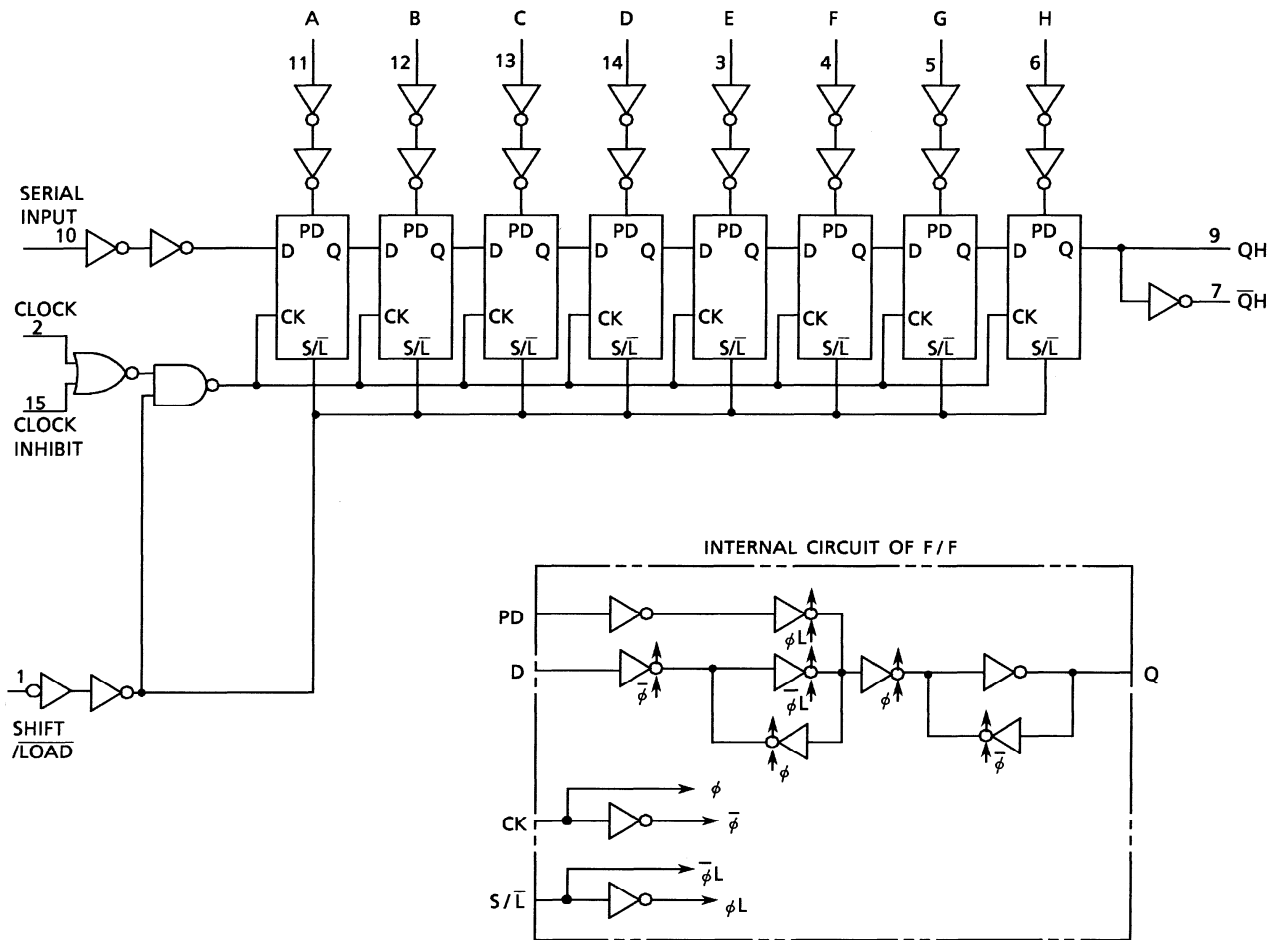
a·····h: The level of steady state input voltage at inputs A through H respectively

QAn~QGn: The level of QA~QG, respectively, before the most recent positive transition of the CK.

**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	$I_{IK}$	$\pm 20$	mA
Output diode current	$I_{OK}$	$\pm 20$	mA
DC output current	$I_{OUT}$	$\pm 25$	mA
DC $V_{CC}$ /ground current	$I_{CC}$	$\pm 50$	mA
Power dissipation	$P_D$	500 (DIP) (Note 2)/180 (SOP)	mW
Storage temperature	$T_{stg}$	-65 to 150	$^{\circ}C$

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  $65^{\circ}C$ . From  $T_a = 65$  to  $85^{\circ}C$  a derating factor of  $-10$  mW/ $^{\circ}C$  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	$T_a = 25^\circ\text{C}$			$T_a = -40$ to $85^\circ\text{C}$		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 $V_{IL}$	$I_{OH} = -20 \mu\text{A}$	2.0	1.9	2.0	—	1.9	—	V
				4.5	4.4	4.5	—	4.4	—	
			$I_{OH} = -4 \text{ mA}$	4.5	4.18	4.31	—	4.13	—	
				6.0	5.68	5.80	—	5.63	—	
Low-level output voltage	$V_{OL}$	$V_{IN} = V_{IH}$ or $V_{IL}$	$I_{OL} = 20 \mu\text{A}$	2.0	—	0.0	0.1	—	0.1	V
				4.5	—	0.0	0.1	—	0.1	
			$I_{OL} = 4 \text{ mA}$	4.5	—	0.17	0.26	—	0.33	
				6.0	—	0.18	0.26	—	0.33	
Input leakage current	$I_{IN}$	$V_{IN} = V_{CC}$ or GND	6.0	—	—	$\pm 0.1$	—	$\pm 1.0$	$\mu\text{A}$	
Quiescent supply current	$I_{CC}$	$V_{IN} = V_{CC}$ or GND	6.0	—	—	4.0	—	40.0	$\mu\text{A}$	

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

Characteristics	Symbol	Test Condition	Ta = 25°C		Ta = -40 to 85°C		Unit
			V <sub>CC</sub> (V)	Typ.	Limit	Limit	
Minimum pulse width (CK, CK INH)	$t_W$ (H) $t_W$ (L)	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum pulse width ( $S/\bar{L}$ )	$t_W$ (L)	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum set-up time (PI- $S/\bar{L}$ )	$t_s$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum set-up time (SI-CK, CK INH)	$t_s$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum set-up time ( $S/\bar{L}$ -CK, CK INH)	$t_s$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Minimum hold time (PI- $S/\bar{L}$ )	$t_h$	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum hold time (SI-CK, CK INH)	$t_h$	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum hold time ( $S/\bar{L}$ -CK, CK INH)	$t_h$	—	2.0	—	0	0	ns
			4.5	—	0	0	
			6.0	—	0	0	
Minimum removal time (CK INH-CK) (CK-CK INH)	$t_{rem}$	—	2.0	—	75	95	ns
			4.5	—	15	19	
			6.0	—	13	16	
Clock frequency	f	—	2.0	—	7	6	MHz
			4.5	—	30	24	
			6.0	—	41	28	

### AC Characteristics ( $C_L = 15$ pF, $V_{CC} = 5$ V, $T_a = 25^\circ\text{C}$ , input: $t_r = t_f = 6$ ns)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	$t_{TLH}$	—	—	4	8	ns
	$t_{THL}$					
Propagation delay time (CK, CK INH-QH, $\bar{Q}H$ )	$t_{pLH}$	—	—	15	25	ns
	$t_{pHL}$					
Propagation delay time ( $S/\bar{L}$ -QH, $\bar{Q}H$ )	$t_{pLH}$	—	—	15	25	ns
	$t_{pHL}$					
Propagation delay time (H-QH, $\bar{Q}H$ )	$t_{pLH}$	—	—	14	26	ns
	$t_{pHL}$					
Maximum clock frequency	$f_{max}$	—	35	56	—	MHz

## AC Characteristics (C<sub>L</sub> = 50 pF, input: t<sub>r</sub> = t<sub>f</sub> = 6 ns)

Characteristics	Symbol	Test Condition	Ta = 25°C			Ta = -40 to 85°C		Unit	
			V <sub>CC</sub> (V)	Min	Typ.	Max	Min		Max
Output transition time	t <sub>TLH</sub>	—	2.0	—	25	75	—	95	ns
	t <sub>THL</sub>		4.5	—	8	15	—	19	
			6.0	—	7	13	—	16	
Propagation delay time (CK, CK INH-QH, $\overline{QH}$ )	t <sub>pLH</sub>	—	2.0	—	55	150	—	190	ns
	t <sub>pHL</sub>		4.5	—	18	30	—	38	
			6.0	—	15	26	—	33	
Propagation delay time (S/ $\overline{L}$ -QH, $\overline{QH}$ )	t <sub>pLH</sub>	—	2.0	—	60	165	—	205	ns
	t <sub>pHL</sub>		4.5	—	19	33	—	41	
			6.0	—	16	28	—	35	
Propagation delay time (H-QH, $\overline{QH}$ )	t <sub>pHL</sub>	—	2.0	—	52	135	—	170	ns
			4.5	—	17	27	—	34	
			6.0	—	14	23	—	29	
Maximum clock frequency	f <sub>max</sub>	—	2.0	7	14	—	6	—	MHz
			4.5	30	46	—	24	—	
			6.0	41	65	—	28	—	
Input capacitance	C <sub>IN</sub>	—	—	5	10	—	10	pF	
Power dissipation capacitance	C <sub>PD</sub> (Note)	—	—	55	—	—	—	pF	

Note: C<sub>PD</sub> is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

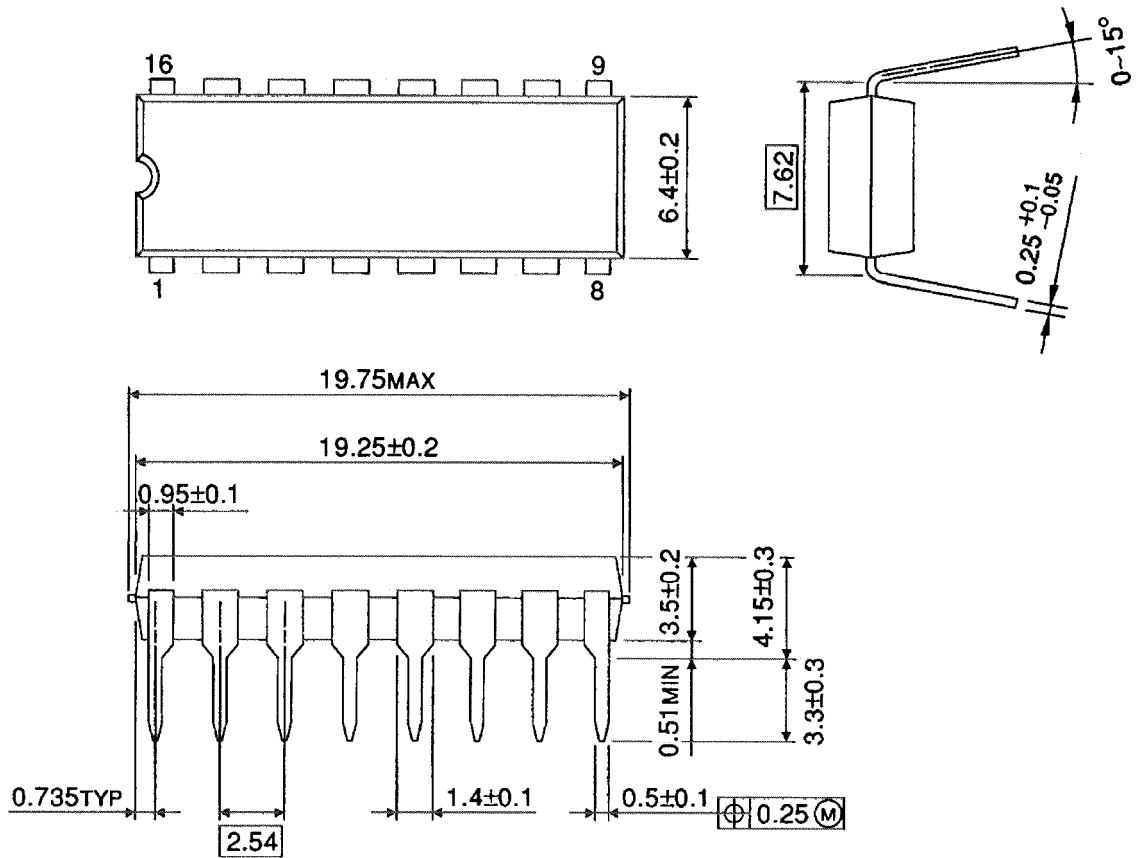
Average operating current can be obtained by the equation:

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

## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

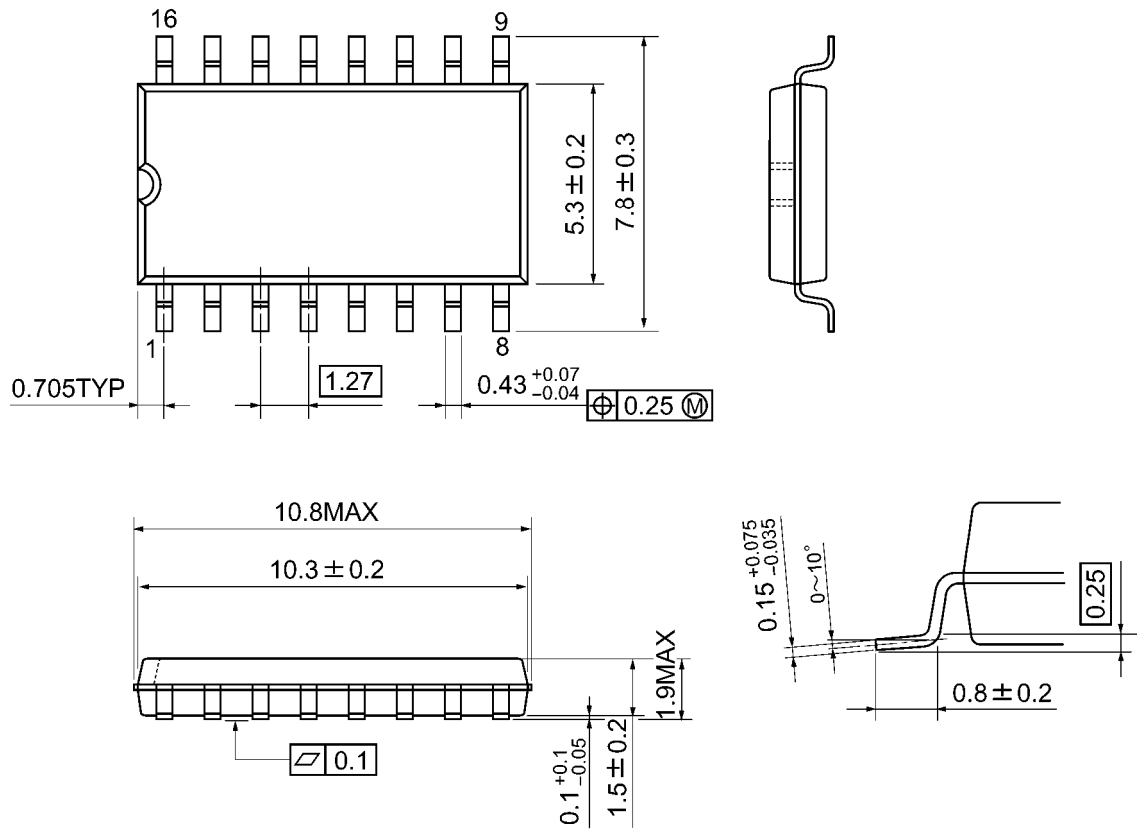


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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