TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# 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 $C^2MOS$ technology.

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

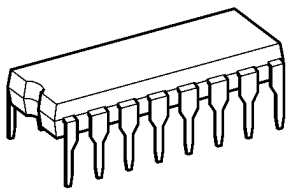
It consists of parallel-in or serial-in, serial-out 8-bit shift register with a gated clock inputs. When the SHIFT/$\overline{\text{LOAD}}$ input is held high, the serial data input is enabled and the eight frip-frops perform serial shifting with each clock pulse.

When the SHIFT/$\overline{\text{LOAD}}$ 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.

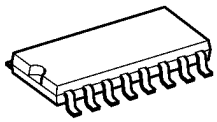
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

TC74HC165AP



DIP16-P-300-2.54A

TC74HC165AF



SOP16-P-300-1.27A

Weight

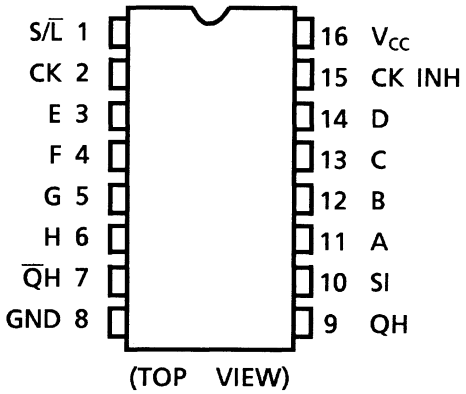
DIP16-P-300-2.54A : 1.00 g (typ.)

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

## Features

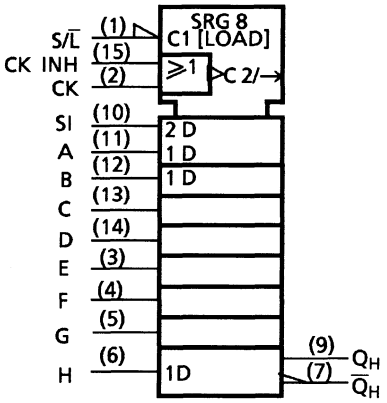
- High speed: $f_{max}$ = 56 MHz (typ.) at $V_{CC}$ = 5 V
- Low power dissipation: $I_{CC}$ = 4 μA (max) at Ta = 25°C
- High noise immunity: $V_{NIH} = V_{NIL}$ = 28% $V_{CC}$ (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: $|I_{OH}| = I_{OL}$ = 4 mA (min)
- Balanced propagation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

## Pin Assignment




Start of commercial production
1988-05

## IEC Logic Symbol




## Truth Table

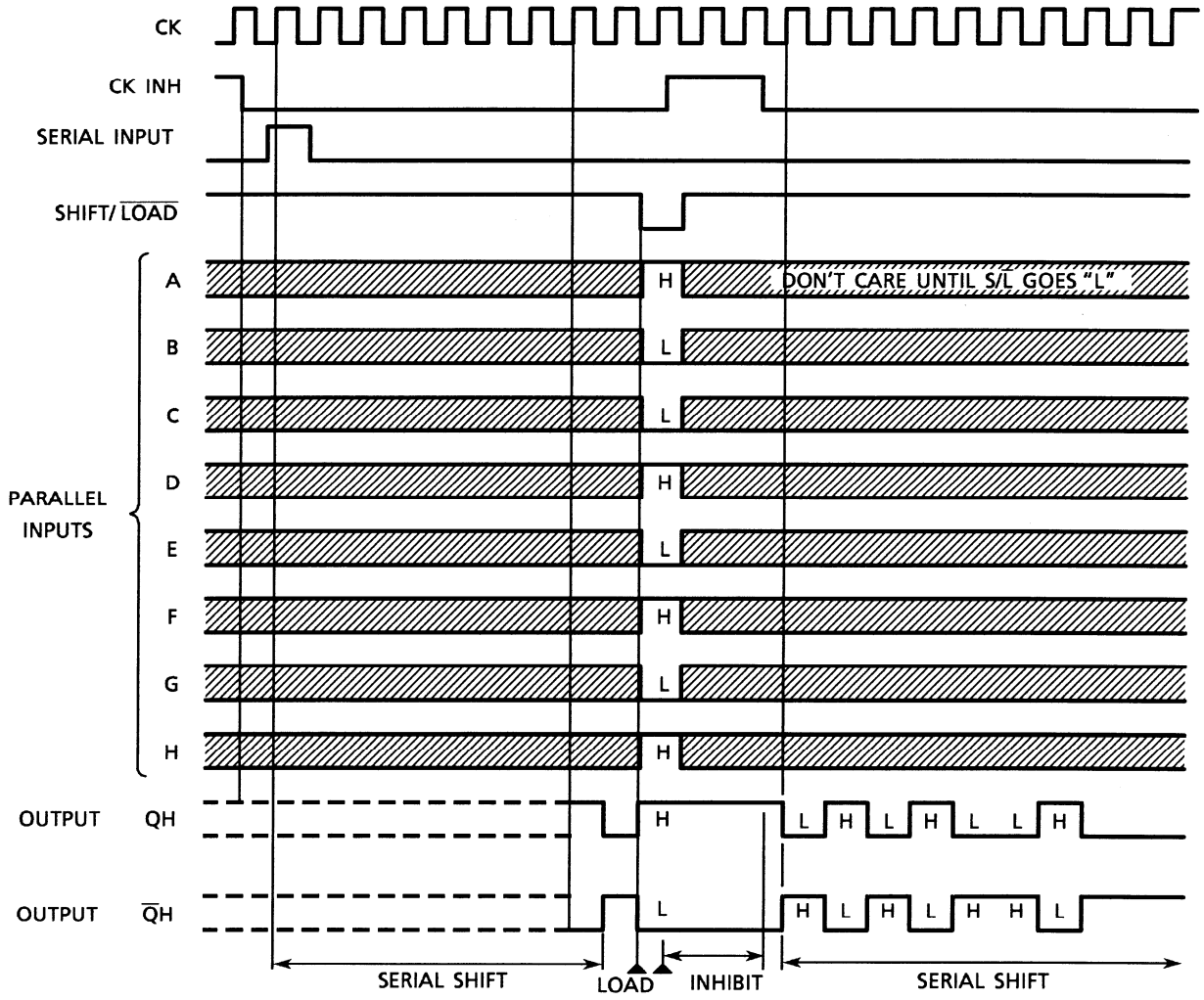
| Inputs | | | | | Internal Outputs | | Outputs | |
|---|---|---|---|---|---|---|---|---|
| SHIFT/$\overline{\text{LOAD}}$ | CLOCK INH | CLOCK | SERIAL IN | PARALLEL A·····H | QA | QB | QH | $\overline{\text{QH}}$ |
| L | X | X | X | a·····h | a | b | h | $\overline{\text{h}}$ |
| H | L | ↑ | H | X |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

X: Don't care

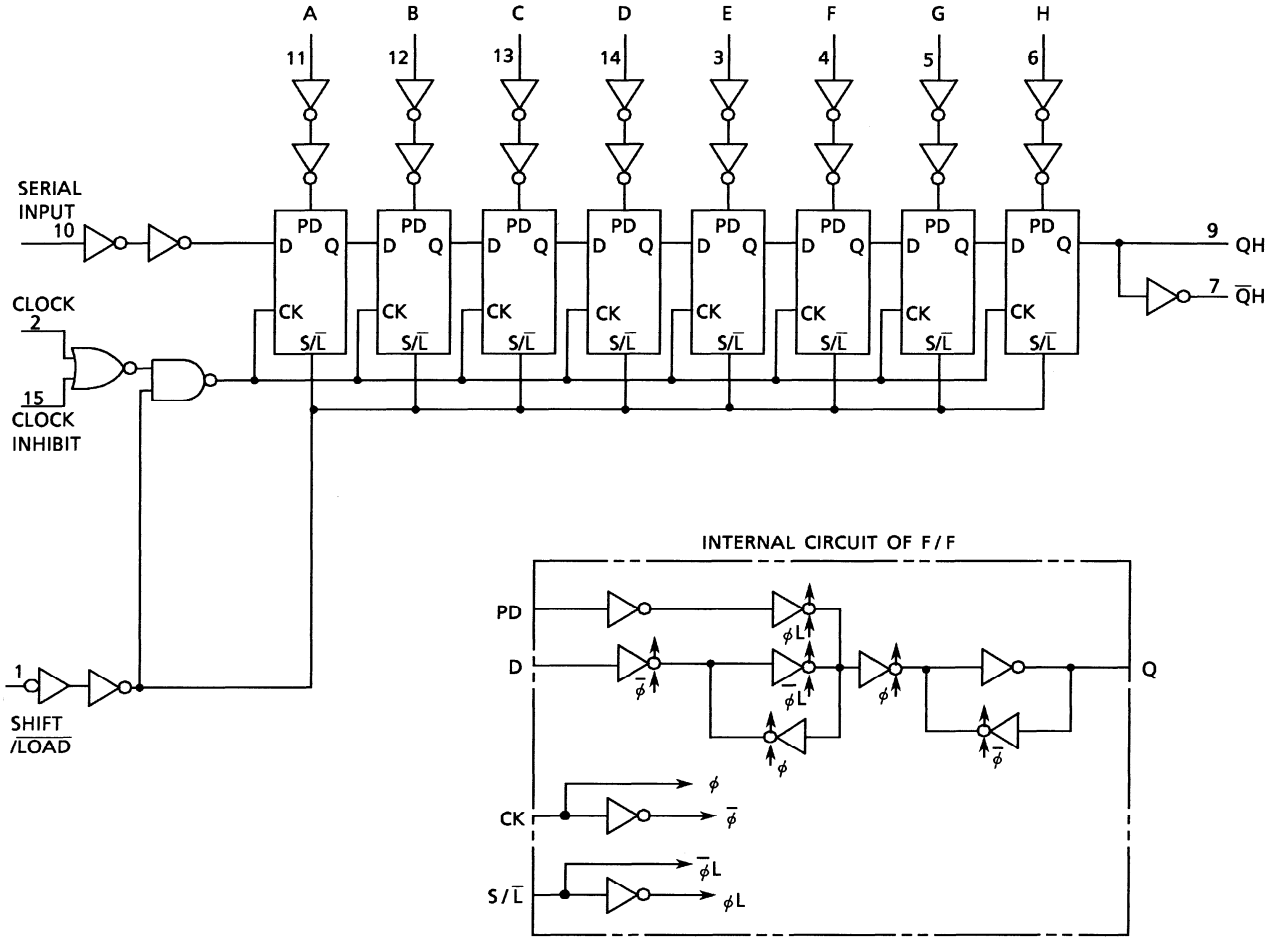
a·····h: The level of steady state input voltage at inputs A through H respectively

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 | $I_{IK}$ | ±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)<br>0 to 500 ($V_{CC}$ = 4.5 V)<br>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 $V_{IL}$ | $I_{OH}$ = −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 to 85°C | Unit |
|---|---|---|---|---|---|---|---|
| | | | $V_{CC}$ (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 ( $S/\overline{L}$ ) | $t_{W(L)}$ | — | 2.0 | — | 75 | 95 | ns |
| | | | 4.5 | — | 15 | 19 | |
| | | | 6.0 | — | 13 | 16 | |
| Minimum set-up time (PI- $S/\overline{L}$ ) | $t_s$ | — | 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 ( $S/\overline{L}$ -CK, CK INH) | $t_s$ | — | 2.0 | — | 75 | 95 | ns |
| | | | 4.5 | — | 15 | 19 | |
| | | | 6.0 | — | 13 | 16 | |
| Minimum hold time (PI- $S/\overline{L}$ ) | $t_h$ | — | 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 ( $S/\overline{L}$ -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, 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, CK INH-QH, $\overline{Q}$H ) | $t_{pLH}$ $t_{pHL}$ | — | — | 15 | 25 | ns |
| Propagation delay time ( $S/\overline{L}$ -QH, $\overline{Q}$H ) | $t_{pLH}$ $t_{pHL}$ | — | — | 15 | 25 | ns |
| Propagation delay time (H-QH, $\overline{Q}$H ) | $t_{pLH}$ $t_{pHL}$ | — | — | 14 | 26 | ns |
| Maximum clock frequency | $f_{max}$ | — | 35 | 56 | — | 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 | — | 25 | 75 | — | 95 | ns |
| | | | 4.5 | — | 8 | 15 | — | 19 | |
| | | | 6.0 | — | 7 | 13 | — | 16 | |
| Propagation delay time (CK, CK INH-QH, $\overline{Q}$H) | $t_{pLH}$ $t_{pHL}$ | — | 2.0 | — | 55 | 150 | — | 190 | ns |
| | | | 4.5 | — | 18 | 30 | — | 38 | |
| | | | 6.0 | — | 15 | 26 | — | 33 | |
| Propagation delay time (S/$\overline{L}$-QH, $\overline{Q}$H) | $t_{pLH}$ $t_{pHL}$ | — | 2.0 | — | 60 | 165 | — | 205 | ns |
| | | | 4.5 | — | 19 | 33 | — | 41 | |
| | | | 6.0 | — | 16 | 28 | — | 35 | |
| Propagation delay time (H-QH, $\overline{Q}$H) | $t_{pHL}$ | — | 2.0 | — | 52 | 135 | — | 170 | ns |
| | | | 4.5 | — | 17 | 27 | — | 34 | |
| | | | 6.0 | — | 14 | 23 | — | 29 | |
| Maximum clock frequency | $f_{max}$ | — | 2.0 | 7 | 14 | — | 6 | — | MHz |
| | | | 4.5 | 30 | 46 | — | 24 | — | |
| | | | 6.0 | 41 | 65 | — | 28 | — | |
| Input capacitance | $C_{IN}$ | — | | — | 5 | 10 | — | 10 | pF |
| Power dissipation capacitance | $C_{PD}$ (Note) | — | | — | 55 | — | — | — | pF |

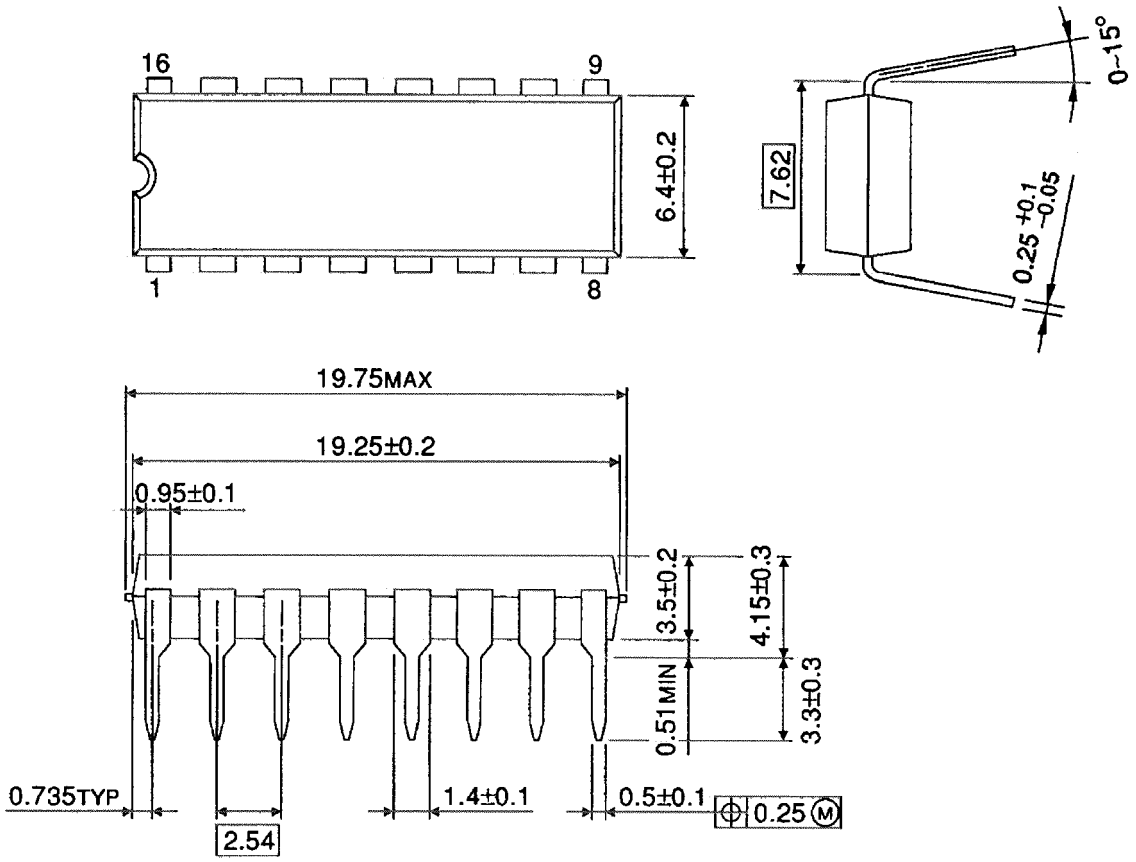
Note: $C_{PD}$ is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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

## Package Dimensions

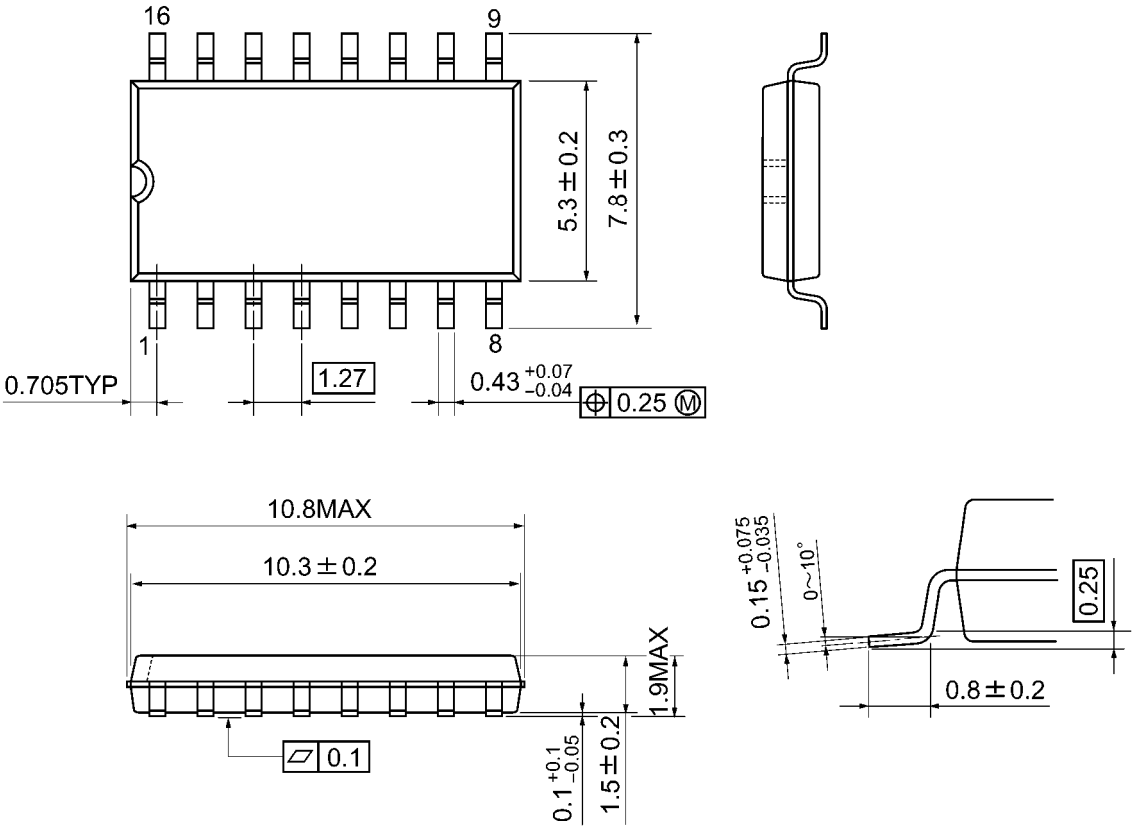
DIP16-P-300-2.54A Unit : mm




Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A Unit: mm




Weight: 0.18 g (typ.)

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