

# TC74HC590AP, TC74HC590AF

## 8-Bit Binary Counter/Register with 3-State Outputs

The TC74HC590A is a high speed CMOS 8-BIT COUNTER/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.

The internal counter counts on the positive going edge of Counter Clock (CCK) when Counter Clock Enable ( $\overline{\text{CCKEN}}$ ) is low. When Counter Clear ( $\overline{\text{CCLR}}$ ) is low, the internal counter is cleared asynchronously to the clock.

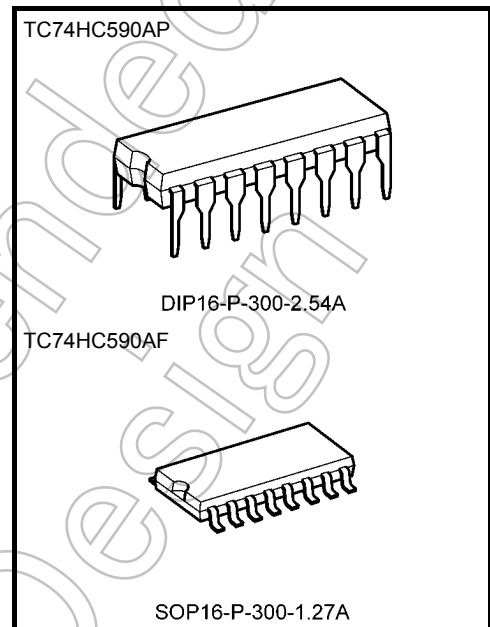
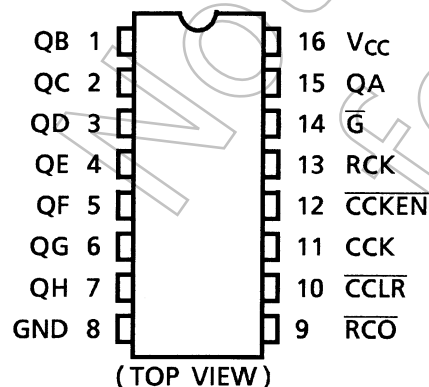
Data in the internal counter are loaded into the register at positive going edge of Register Clock (RCK), and the register outputs are controlled by enable input ( $\overline{\text{G}}$ ).

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

### Features

- High speed:  $f_{\text{max}} = 62 \text{ MHz}$  (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: 15 LSTTL loads for QA to QH  
10 LSTTL loads for  $\overline{\text{RCO}}$
- Symmetrical output impedance:  $|I_{\text{OH}}| = I_{\text{OL}} = 6 \text{ mA}$  (min)  
For QA to QH  
 $|I_{\text{OH}}| = I_{\text{OL}} = 4 \text{ mA}$  (min)  
For  $\overline{\text{RCO}}$
- 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 74LS590

### Pin Assignment

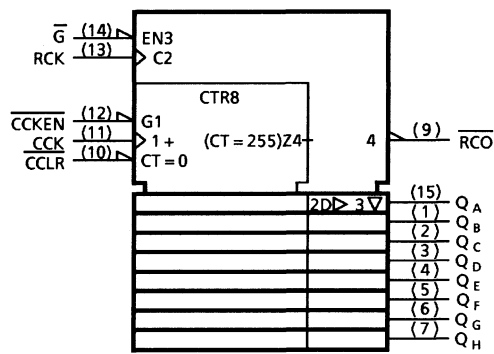


#### Weight

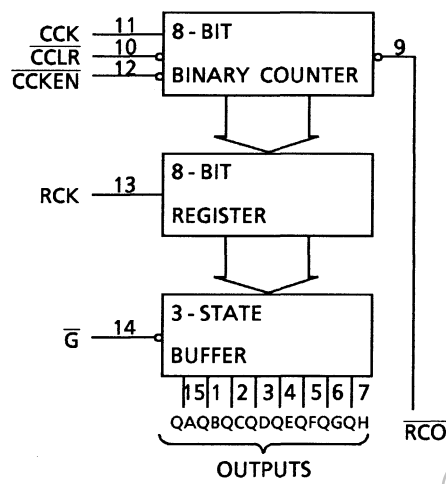
|                   |                 |
|-------------------|-----------------|
| DIP16-P-300-2.54A | : 1.00 g (typ.) |
| SOP16-P-300-1.27A | : 0.18 g (typ.) |

Start of commercial production  
1988-05

IEC Logic Symbol



Block Diagram



Truth Table

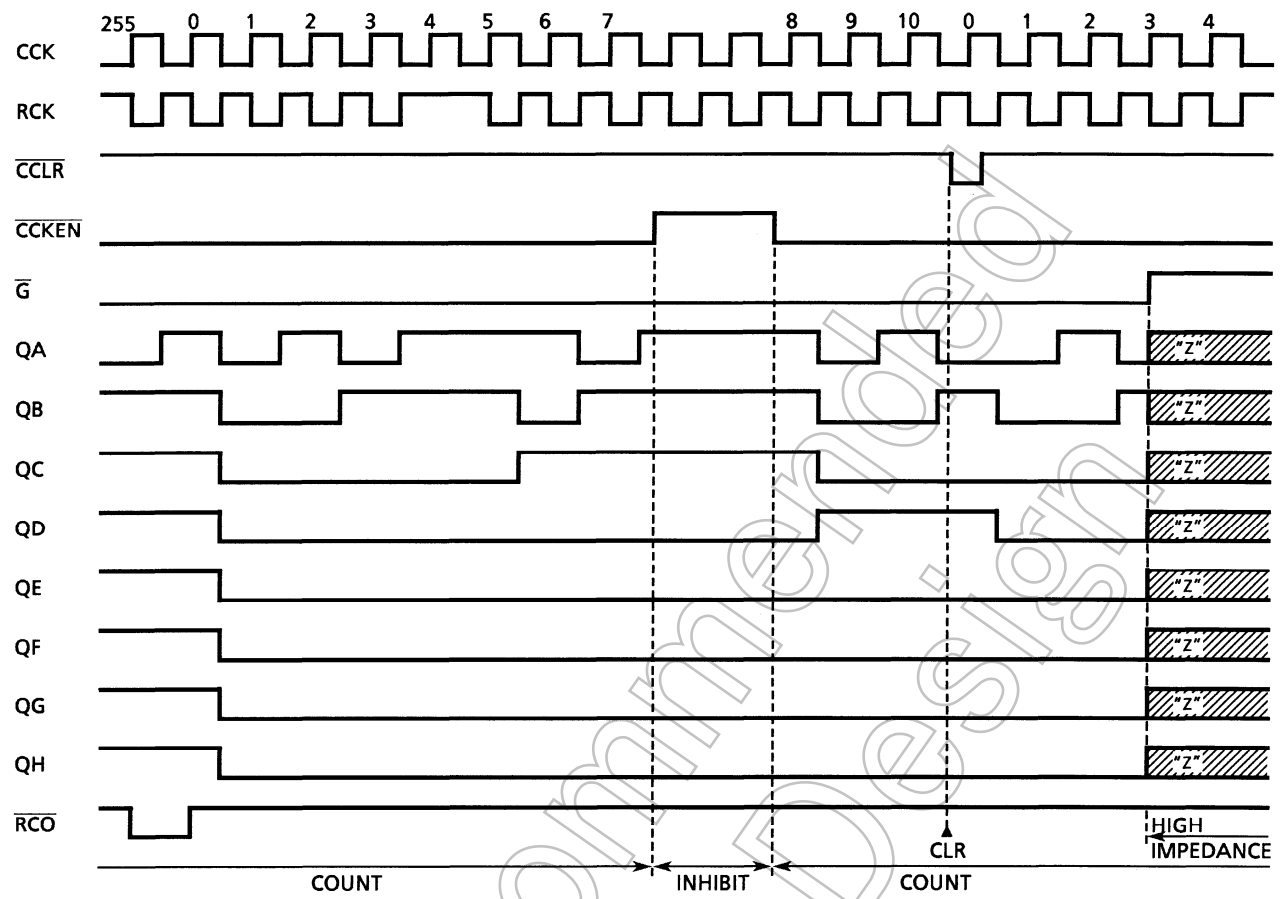
| Inputs |     |      |       |     | Function                             |
|--------|-----|------|-------|-----|--------------------------------------|
| G      | RCK | CCLR | CCKEN | CCK |                                      |
| H      | X   | X    | X     | X   | Q Outputs Disable                    |
| L      | X   | X    | X     | X   | Q Outputs Enable                     |
| X      |     | X    | X     | X   | Counter Data is Stored into Register |
| X      |     | X    | X     | X   | Register State is not Changed        |
| X      | X   | L    | X     | X   | Counter Clear                        |
| X      | X   | H    | L     |     | Advance One Count                    |
| X      | X   | H    | L     |     | No Count                             |
| X      | X   | H    | H     | X   | No Count                             |

X: Don't care

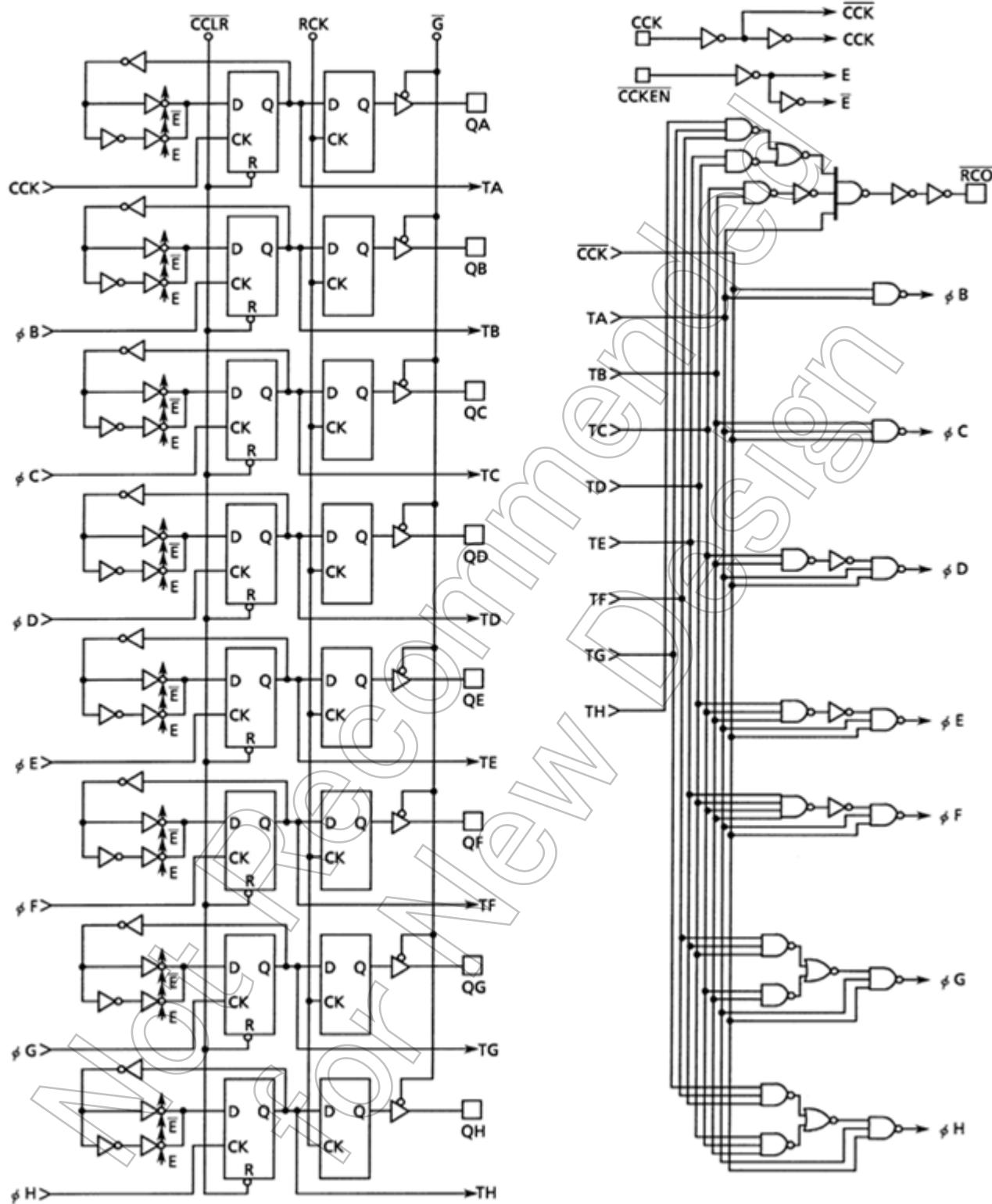
$$RCO = QA' \cdot QB' \cdot QC' \cdot QD' \cdot QE' \cdot QF' \cdot QG' \cdot QH'$$

(QA' to QH': internal outputs of the counter)

Timing Chart



## Logic 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<br>(RCO)<br>(QA to QH) | $I_{OUT}$ | $\pm 25$<br>$\pm 35$         | mA   |
| DC $V_{CC}$ /ground current              | $I_{CC}$  | $\pm 75$                     | 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  $65^\circ\text{C}$ . From  $T_a = 65$  to  $85^\circ\text{C}$  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 =<br>-40 to 85°C                                |                                                                                                   | Unit |                   |              |              |              |              |
|-----------------------------|-----------------|---------------------------------------------------------|---------------------------------------------------------|-------------------------|------------------------------------------------------|------------------------------------------------------|----------------------------------------------------|---------------------------------------------------------------------------------------------------|------|-------------------|--------------|--------------|--------------|--------------|
|                             |                 |                                                         |                                                         | V <sub>CC</sub><br>(V)  | Min                                                  | Typ.                                                 | Max                                                | Min                                                                                               |      | Max               |              |              |              |              |
| High-level input voltage    | V <sub>IH</sub> | —                                                       |                                                         | 2.0<br>4.5<br>6.0       | 1.50<br>3.15<br>4.20                                 | —<br>—<br>—                                          | —<br>—<br>—                                        | 1.50<br>3.15<br>4.20                                                                              | V    |                   |              |              |              |              |
| Low-level input voltage     | V <sub>IL</sub> | —                                                       |                                                         | 2.0<br>4.5<br>6.0       | —<br>—<br>—                                          | —<br>—<br>—                                          | 0.50<br>1.35<br>1.80                               | —<br>—<br>1.80                                                                                    | V    |                   |              |              |              |              |
| High-level output voltage   | V <sub>OH</sub> | V <sub>IN</sub><br>= V <sub>IH</sub> or V <sub>IL</sub> | I <sub>OH</sub> = -20 μA                                | 2.0<br>4.5<br>6.0       | 1.9<br>4.4<br>5.9                                    | 2.0<br>4.5<br>6.0                                    | —<br>—<br>—                                        | 1.9<br>4.4<br>5.9                                                                                 | V    |                   |              |              |              |              |
|                             |                 |                                                         |                                                         | RCO                     | I <sub>OH</sub> = -4 mA<br>I <sub>OH</sub> = -5.2 mA | 4.5<br>6.0                                           | 4.18<br>5.68                                       | 4.31<br>5.80                                                                                      |      | —<br>—            | 4.13<br>5.63 |              |              |              |
|                             |                 |                                                         |                                                         |                         | QA to QH                                             | I <sub>OH</sub> = -6 mA<br>I <sub>OH</sub> = -7.8 mA | 4.5<br>6.0                                         | 4.18<br>5.68                                                                                      |      | 4.31<br>5.80      | —<br>—       | 4.13<br>5.63 |              |              |
|                             |                 | V <sub>OL</sub>                                         | V <sub>IN</sub><br>= V <sub>IH</sub> or V <sub>IL</sub> | I <sub>OL</sub> = 20 μA |                                                      | 2.0<br>4.5<br>6.0                                    | —<br>—<br>—                                        | 0.0<br>0.0<br>0.0                                                                                 |      | 0.1<br>0.1<br>0.1 | —<br>—<br>—  | V            |              |              |
|                             |                 |                                                         |                                                         |                         | RCO                                                  | I <sub>OL</sub> = 4 mA<br>I <sub>OL</sub> = 5.2 mA   | 4.5<br>6.0                                         | —<br>—                                                                                            |      | 0.17<br>0.18      | 0.26<br>0.26 |              | —<br>—       | 0.33<br>0.33 |
|                             |                 |                                                         |                                                         |                         |                                                      | QA to QH                                             | I <sub>OL</sub> = 6 mA<br>I <sub>OL</sub> = 7.8 mA | 4.5<br>6.0                                                                                        |      | —<br>—            | 0.17<br>0.18 |              | 0.26<br>0.26 | —<br>—       |
|                             |                 |                                                         |                                                         |                         | 3-state output<br>off-state current                  |                                                      | I <sub>OZ</sub>                                    | V <sub>IN</sub> = V <sub>IH</sub> or V <sub>IL</sub><br>V <sub>OUT</sub> = V <sub>CC</sub> or GND |      | 6.0               | —            |              | —            | ±0.5         |
| Input leakage<br>current    | I <sub>IN</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                |                                                         | 6.0                     | —                                                    | —                                                    | ±0.1                                               | —                                                                                                 | ±1.0 | μA                |              |              |              |              |
| Quiescent supply<br>current | I <sub>CC</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                |                                                         | 6.0                     | —                                                    | —                                                    | 4.0                                                | —                                                                                                 | 40.0 | μA                |              |              |              |              |

Timing Requirements (input:  $t_r = t_f = 6 \text{ ns}$ )

| Characteristics                                      | Symbol                 | Test Condition | Ta = 25°C           |      | Ta =<br>-40 to<br>85°C | Unit |
|------------------------------------------------------|------------------------|----------------|---------------------|------|------------------------|------|
|                                                      |                        |                | V <sub>CC</sub> (V) | Typ. | Limit                  |      |
| Minimum pulse width<br>(CCK, RCK)                    | $t_W$ (H)<br>$t_W$ (L) | —              | 2.0                 | —    | 75                     | ns   |
|                                                      |                        |                | 4.5                 | —    | 15                     |      |
|                                                      |                        |                | 6.0                 | —    | 13                     |      |
| Minimum pulse width<br>( $\overline{\text{CCLR}}$ )  | $t_W$ (L)              | —              | 2.0                 | —    | 75                     | ns   |
|                                                      |                        |                | 4.5                 | —    | 15                     |      |
|                                                      |                        |                | 6.0                 | —    | 13                     |      |
| Minimum set-up time<br>(CCKEN-CCK)                   | $t_s$                  | —              | 2.0                 | —    | 100                    | ns   |
|                                                      |                        |                | 4.5                 | —    | 20                     |      |
|                                                      |                        |                | 6.0                 | —    | 17                     |      |
| Minimum set-up time<br>(CCK-RCK)                     | $t_s$                  | —              | 2.0                 | —    | 200                    | ns   |
|                                                      |                        |                | 4.5                 | —    | 40                     |      |
|                                                      |                        |                | 6.0                 | —    | 34                     |      |
| Minimum hold time                                    | $t_h$                  | —              | 2.0                 | —    | 0                      | ns   |
|                                                      |                        |                | 4.5                 | —    | 0                      |      |
|                                                      |                        |                | 6.0                 | —    | 0                      |      |
| Minimum removal time<br>( $\overline{\text{CCLR}}$ ) | $t_{\text{rem}}$       | —              | 2.0                 | —    | 75                     | ns   |
|                                                      |                        |                | 4.5                 | —    | 15                     |      |
|                                                      |                        |                | 6.0                 | —    | 13                     |      |
| Clock frequency                                      | f                      | —              | 2.0                 | —    | 6                      | MHz  |
|                                                      |                        |                | 4.5                 | —    | 33                     |      |
|                                                      |                        |                | 6.0                 | —    | 39                     |      |

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<br>( $\overline{\text{RCO}}$ )                            | $t_{\text{TLH}}$ | —              | —   | 4    | 8   | ns   |
|                                                                                  | $t_{\text{THL}}$ |                |     |      |     |      |
| Propagation delay time<br>(CCK- $\overline{\text{RCO}}$ )                        | $t_{\text{pLH}}$ | —              | —   | 18   | 28  | ns   |
|                                                                                  | $t_{\text{pHL}}$ |                |     |      |     |      |
| Propagation delay time<br>( $\overline{\text{CCLR}}$ - $\overline{\text{RCO}}$ ) | $t_{\text{pLH}}$ | —              | —   | 20   | 30  | ns   |
| Maximum clock frequency                                                          | $f_{\text{max}}$ | —              | 32  | 62   | —   | MHz  |

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

| Characteristics                                                    | Symbol                 | Test Condition            |         |         | Ta = 25°C |      |     | Ta = -40 to 85°C |     | Unit |
|--------------------------------------------------------------------|------------------------|---------------------------|---------|---------|-----------|------|-----|------------------|-----|------|
|                                                                    |                        |                           | CL (pF) | VCC (V) | Min       | Typ. | Max | Min              | Max |      |
| Output transition time<br>(Qn)                                     | $t_{TLH}$<br>$t_{THL}$ | —                         | 50      | 2.0     | —         | 25   | 60  | —                | 75  | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 7    | 12  | —                | 15  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 6    | 10  | —                | 13  |      |
| Output transition time<br>( $\overline{RCO}$ )                     | $t_{TLH}$<br>$t_{THL}$ | —                         | 50      | 2.0     | —         | 30   | 75  | —                | 95  | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 8    | 15  | —                | 19  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 7    | 13  | —                | 16  |      |
| Propagation delay time<br>(CCK- $\overline{RCO}$ )                 | $t_{pLH}$<br>$t_{pHL}$ | —                         | 50      | 2.0     | —         | 75   | 163 | —                | 205 | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 22   | 33  | —                | 41  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 17   | 28  | —                | 35  |      |
| Propagation delay time<br>( $\overline{CCLR}$ - $\overline{RCO}$ ) | $t_{pLH}$              | —                         | 50      | 2.0     | —         | 78   | 175 | —                | 220 | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 23   | 35  | —                | 44  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 18   | 30  | —                | 37  |      |
| Propagation delay time<br>(RCK-Qn)                                 | $t_{pLH}$<br>$t_{pHL}$ | —                         | 50      | 2.0     | —         | 62   | 145 | —                | 180 | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 19   | 29  | —                | 36  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 15   | 25  | —                | 31  |      |
|                                                                    |                        |                           | 150     | 2.0     | —         | 78   | 185 | —                | 230 |      |
|                                                                    |                        |                           |         | 4.5     | —         | 24   | 37  | —                | 46  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 19   | 31  | —                | 39  |      |
| Output enable time                                                 | $t_{pZL}$<br>$t_{pZH}$ | $R_L = 1 \text{ k}\Omega$ | 50      | 2.0     | —         | 43   | 105 | —                | 130 | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 14   | 21  | —                | 26  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 12   | 18  | —                | 22  |      |
|                                                                    |                        |                           | 150     | 2.0     | —         | 58   | 150 | —                | 190 |      |
|                                                                    |                        |                           |         | 4.5     | —         | 19   | 30  | —                | 38  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 16   | 26  | —                | 33  |      |
| Output disable time                                                | $t_{pLZ}$<br>$t_{pHZ}$ | $R_L = 1 \text{ k}\Omega$ | 50      | 2.0     | —         | 33   | 105 | —                | 130 | ns   |
|                                                                    |                        |                           |         | 4.5     | —         | 16   | 21  | —                | 26  |      |
|                                                                    |                        |                           |         | 6.0     | —         | 12   | 18  | —                | 22  |      |
| Maximum clock frequency                                            | $f_{\max}$             | —                         | 50      | 2.0     | 6         | 12   | —   | 5                | —   | MHz  |
|                                                                    |                        |                           |         | 4.5     | 30        | 51   | —   | 24               | —   |      |
|                                                                    |                        |                           |         | 6.0     | 35        | 80   | —   | 28               | —   |      |
| Input capacitance                                                  | $C_{IN}$               | —                         | —       | —       | —         | 5    | 10  | —                | 10  | pF   |
| Power dissipation capacitance                                      | $C_{PD}$<br>(Note)     | —                         | —       | —       | —         | 34   | —   | —                | —   | pF   |

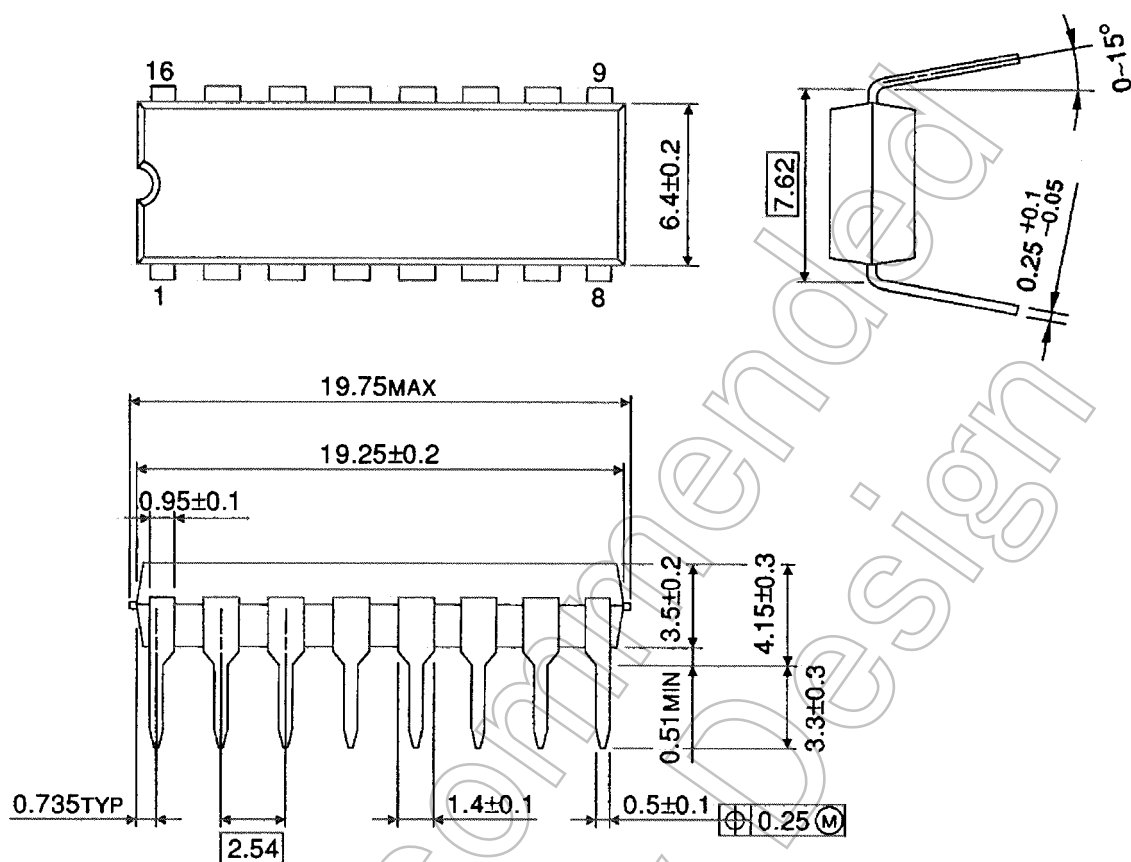
Note:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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

DIP16-P-300-2.54A

Unit : mm

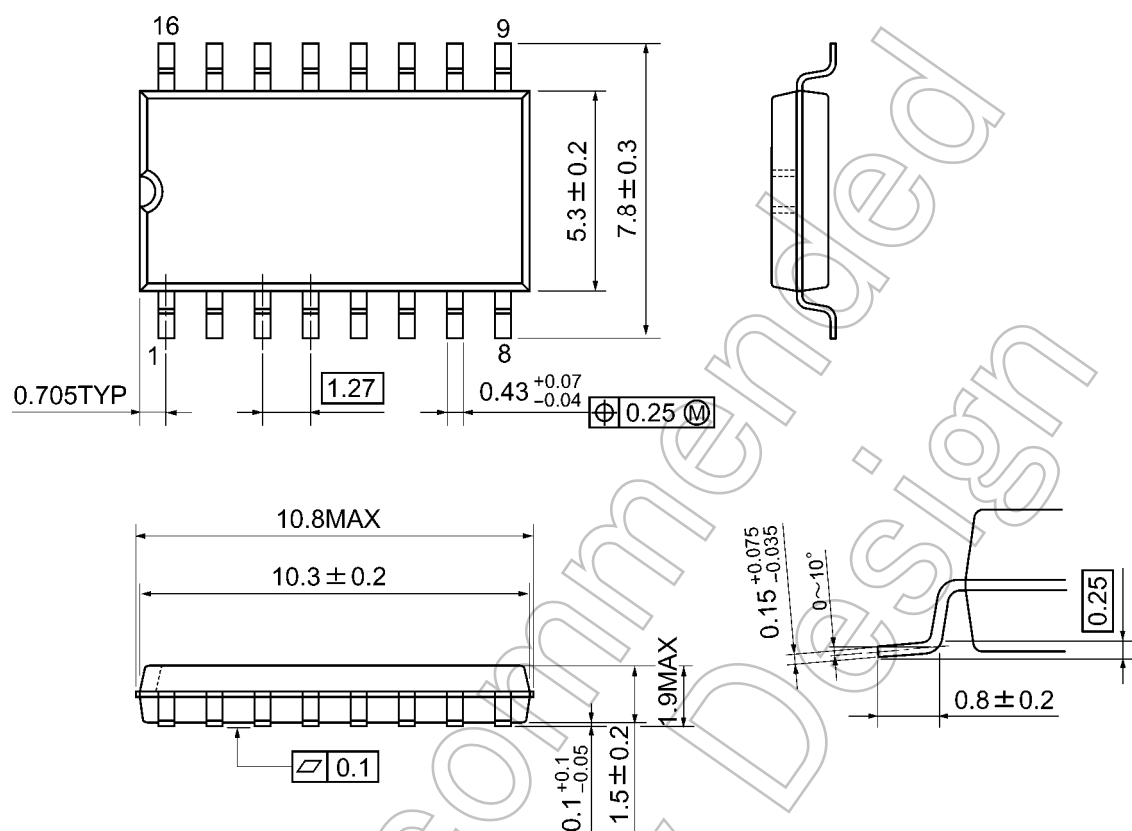


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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