

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

## TC74HC4020AP, TC74HC4020AF TC74HC4040AP, TC74HC4040AF

TC74HC4020AP/AF 14-Stage Binary Counter

TC74HC4040AP/AF 12-Stage Binary Counter

The TC74HC4020A/TC74HC4040A are high speed CMOS BINARY COUNTER/DIVIDERS fabricated with silicon gate C<sup>2</sup>MOS technology.

They achieve the high speed operation similar to equivalent LSTTL while maintaining the CMOS dissipation.

The TC74HC4020A is a 14-STAGE BINARY COUNTER, and the TC74HC4040A is a 12-STAGE BINARY COUNTER.

Setting CLR to high resets the counter to low.

A negative transition on the CK input brings one increment into the counter.

The TC74HC4020A provides 12 divided outputs: 1'st stage and stage 4 thru stage 14. At Q14, a 1/16384 divided frequency will be output.

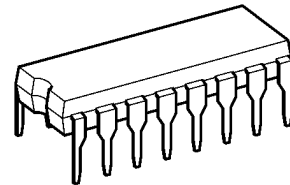
The TC74HC4040A provides all divided output stages, and at Q12, a 1/4096 divided frequency will be output.

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

### Features

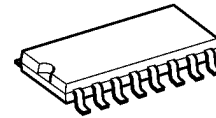
- High speed:  $f_{\max} = 73 \text{ MHz}$  (typ.) at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 4 \mu\text{A}$  (max) at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance:  $|I_{OH}| = I_{OL} = 4 \text{ mA}$  (min)
- Balanced propagation delays:  $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range:  $V_{CC} (\text{opr}) = 2 \sim 6 \text{ V}$
- Pin and function compatible with 4020B/4040B

TC74HC4020AP, TC74HC4040AP



DIP16-P-300-2.54A

TC74HC4020AF, TC74HC4040AF



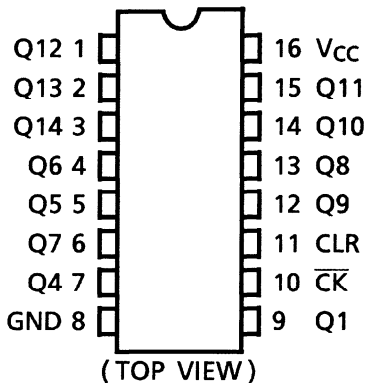
SOP16-P-300-1.27A

### Weight

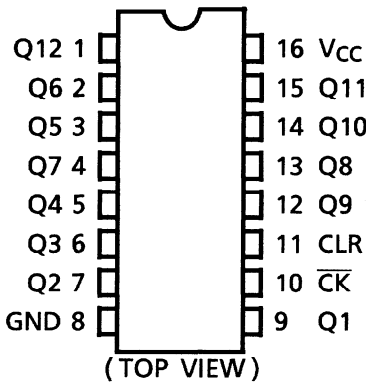
|                   |                 |
|-------------------|-----------------|
| DIP16-P-300-2.54A | : 1.00 g (typ.) |
| SOP16-P-300-1.27A | : 0.18 g (typ.) |

Pin Assignment

TC74HC4020A

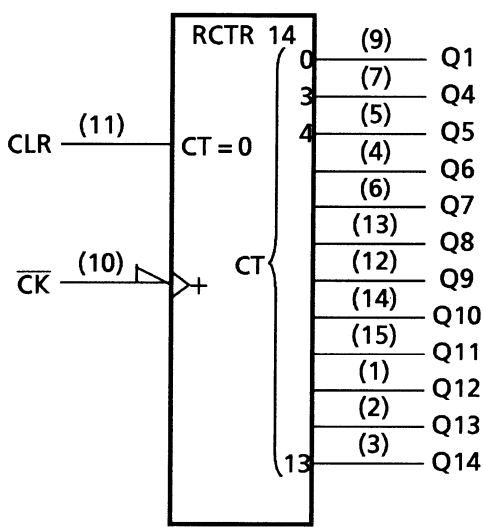


TC74HC4040A

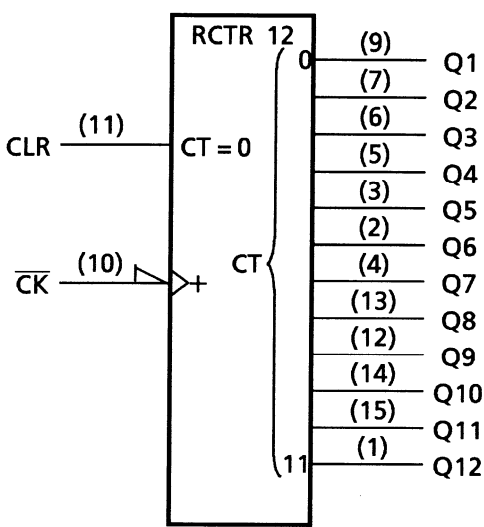


IEC Logic Symbol

TC74HC4020A



TC74HC4040A



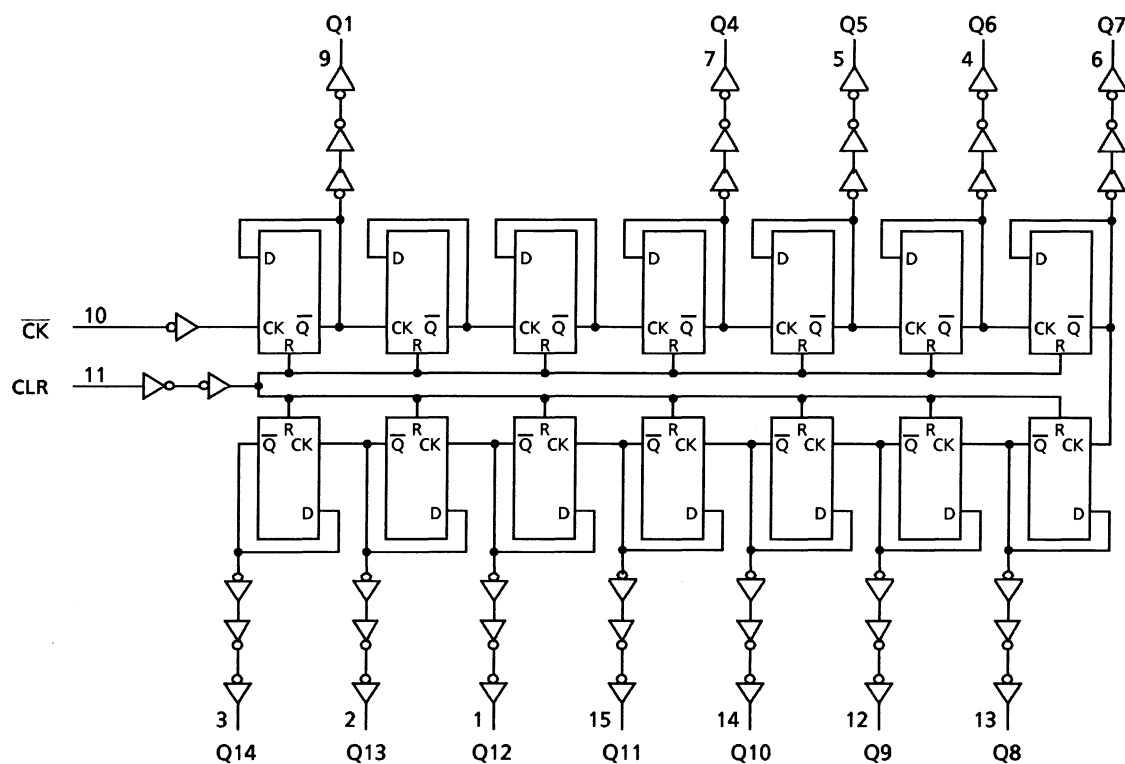
Truth Table

| $\overline{CK}$ | CLR | Output State          |
|-----------------|-----|-----------------------|
| X               | H   | All Output = "L"      |
|                 | L   | No Change             |
|                 | L   | Advance to Next State |

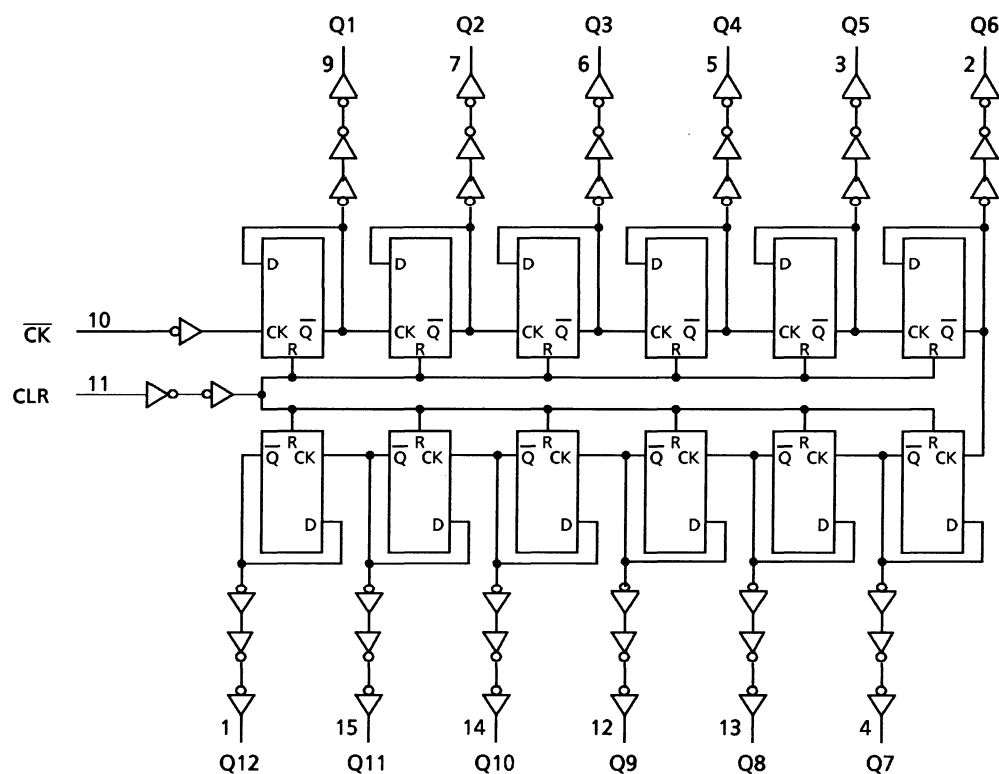
X: Don't care

## System Diagram

### TC74HC4020A



### TC74HC4040A



## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol    | Rating                       | Unit |
|-----------------------------|-----------|------------------------------|------|
| Supply voltage range        | $V_{CC}$  | -0.5~7                       | V    |
| DC input voltage            | $V_{IN}$  | -0.5~ $V_{CC} + 0.5$         | V    |
| DC output voltage           | $V_{OUT}$ | -0.5~ $V_{CC} + 0.5$         | 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         | $T_{stg}$ | -65~150                      | °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  $-10\text{ mW}/^{\circ}\text{C}$  shall be applied until 300 mW.

## Operating Ranges (Note)

| Characteristics          | Symbol     | Rating                                                                                                       | Unit |
|--------------------------|------------|--------------------------------------------------------------------------------------------------------------|------|
| Supply voltage           | $V_{CC}$   | 2~6                                                                                                          | V    |
| Input voltage            | $V_{IN}$   | 0~ $V_{CC}$                                                                                                  | V    |
| Output voltage           | $V_{OUT}$  | 0~ $V_{CC}$                                                                                                  | V    |
| Operating temperature    | $T_{opr}$  | -40~85                                                                                                       | °C   |
| Input rise and fall time | $t_r, t_f$ | 0~1000 ( $V_{CC} = 2.0\text{ V}$ )<br>0~500 ( $V_{CC} = 4.5\text{ V}$ )<br>0~400 ( $V_{CC} = 6.0\text{ V}$ ) | ns   |

Note: The operating ranges must be maintained to ensure the normal operation of the device. Unused inputs must be tied to either VCC or GND.

## Electrical Characteristics

## DC Characteristics

| Characteristics           | Symbol          | Test Condition                                             |                                                      | Ta = 25°C              |                      |             |                      | Ta = -40~85°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 | —<br>—<br>—          | 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>—          | 0.50<br>1.35<br>1.80 | V    |
| High-level output voltage | V <sub>OH</sub> | V <sub>IN</sub><br>= V <sub>IH</sub> or<br>V <sub>IL</sub> | I <sub>OH</sub> = -20 μA                             | 2.0                    | 1.9                  | 2.0         | —                    | 1.9                  | —                    | V    |
|                           |                 |                                                            |                                                      | 4.5                    | 4.4                  | 4.5         | —                    | 4.4                  | —                    |      |
|                           |                 |                                                            | I <sub>OH</sub> = -4 mA<br>I <sub>OH</sub> = -5.2 mA | 6.0                    | 5.9                  | 6.0         | —                    | 5.9                  | —                    |      |
|                           |                 |                                                            |                                                      | 4.5                    | 4.18                 | 4.31        | —                    | 4.13                 | —                    |      |
| Low-level output voltage  | V <sub>OL</sub> | V <sub>IN</sub><br>= V <sub>IH</sub> or<br>V <sub>IL</sub> | I <sub>OL</sub> = 20 μA                              | 2.0                    | —                    | 0.0         | 0.1                  | —                    | 0.1                  | V    |
|                           |                 |                                                            |                                                      | 4.5                    | —                    | 0.0         | 0.1                  | —                    | 0.1                  |      |
|                           |                 |                                                            | I <sub>OL</sub> = 4 mA<br>I <sub>OL</sub> = 5.2 mA   | 6.0                    | —                    | 0.0         | 0.1                  | —                    | 0.1                  |      |
|                           |                 |                                                            |                                                      | 4.5                    | —                    | 0.17        | 0.26                 | —                    | 0.33                 |      |
| Input leakage current     | I <sub>IN</sub> | V <sub>IN</sub> = V <sub>CC</sub> or GND                   |                                                      | 6.0                    | —                    | —           | ±0.1                 | —                    | ±1.0                 | μA   |
|                           |                 |                                                            |                                                      | 6.0                    | —                    | —           | 4.0                  | —                    | 40.0                 | μA   |

Timing Requirements (input: t<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Characteristics                                   | Symbol           | Test Condition | Ta = 25°C |      | Ta =<br>−40<br>~85°C | Unit |       |
|---------------------------------------------------|------------------|----------------|-----------|------|----------------------|------|-------|
|                                                   |                  |                | VCC (V)   | Typ. | Limit                |      | Limit |
| Minimum pulse width<br>( $\overline{\text{CK}}$ ) | tW (L)<br>tW (H) | —              | 2.0       | —    | 75                   | 95   | ns    |
|                                                   |                  |                | 4.5       | —    | 15                   | 19   |       |
|                                                   |                  |                | 6.0       | —    | 13                   | 16   |       |
| Minimum pulse width<br>(CLR)                      | tW (H)           | —              | 2.0       | —    | 75                   | 95   | ns    |
|                                                   |                  |                | 4.5       | —    | 15                   | 19   |       |
|                                                   |                  |                | 6.0       | —    | 13                   | 16   |       |
| Minimum removal time                              | trem             | —              | 2.0       | —    | 25                   | 30   | ns    |
|                                                   |                  |                | 4.5       | —    | 5                    | 6    |       |
|                                                   |                  |                | 6.0       | —    | 5                    | 5    |       |
| Clock frequency                                   | f                | —              | 2.0       | —    | 6                    | 5    | MHz   |
|                                                   |                  |                | 4.5       | —    | 30                   | 24   |       |
|                                                   |                  |                | 6.0       | —    | 35                   | 28   |       |

## 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                             | $t_{TLH}$<br>$t_{THL}$ | —              | —   | 4    | 8   | ns   |
| Propagation delay time<br>( $\overline{CK} - Q1$ ) | $t_{pLH}$<br>$t_{pHL}$ | —              | —   | 16   | 24  | ns   |
| Propagation delay time<br>( $Q_n - Q_{n+1}$ )      | $\Delta t_{pd}$        | —              | —   | 5    | 14  | ns   |
| Propagation delay time<br>(CLR)                    | $t_{pHL}$              | —              | —   | 14   | 24  | ns   |
| Maximum clock frequency                            | $f_{max}$              | —              | 33  | 73   | —   | MHz  |

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

| Characteristics                                    | Symbol                 | Test Condition | $V_{CC}$<br>(V) | $T_a = 25^\circ\text{C}$ |      |     | $T_a = -40 \sim 85^\circ\text{C}$ |     | Unit |
|----------------------------------------------------|------------------------|----------------|-----------------|--------------------------|------|-----|-----------------------------------|-----|------|
|                                                    |                        |                |                 | Min                      | Typ. | Max | Min                               | Max |      |
| Output transition time                             | $t_{TLH}$<br>$t_{THL}$ | —              | 2.0             | —                        | 30   | 75  | —                                 | 95  | ns   |
|                                                    |                        |                | 4.5             | —                        | 8    | 15  | —                                 | 19  |      |
|                                                    |                        |                | 6.0             | —                        | 7    | 13  | —                                 | 16  |      |
| Propagation delay time<br>( $\overline{CK} - Q1$ ) | $t_{pLH}$<br>$t_{pHL}$ | —              | 2.0             | —                        | 70   | 145 | —                                 | 180 | ns   |
|                                                    |                        |                | 4.5             | —                        | 20   | 29  | —                                 | 36  |      |
|                                                    |                        |                | 6.0             | —                        | 17   | 25  | —                                 | 31  |      |
| Propagation delay time<br>( $Q_n - Q_{n+1}$ )      | $\Delta t_{pd}$        | —              | 2.0             | —                        | 20   | 75  | —                                 | 95  | ns   |
|                                                    |                        |                | 4.5             | —                        | 6    | 15  | —                                 | 19  |      |
|                                                    |                        |                | 6.0             | —                        | 4    | 13  | —                                 | 16  |      |
| Propagation delay time<br>(CLR)                    | $t_{pHL}$              | —              | 2.0             | —                        | 55   | 140 | —                                 | 175 | ns   |
|                                                    |                        |                | 4.5             | —                        | 17   | 28  | —                                 | 35  |      |
|                                                    |                        |                | 6.0             | —                        | 14   | 24  | —                                 | 30  |      |
| Maximum clock frequency                            | $f_{max}$              | —              | 2.0             | 6                        | 17   | —   | 5                                 | —   | MHz  |
|                                                    |                        |                | 4.5             | 30                       | 66   | —   | 24                                | —   |      |
|                                                    |                        |                | 6.0             | 35                       | 78   | —   | 28                                | —   |      |
| Input capacitance                                  | $C_{IN}$               | —              | —               | 5                        | 10   | —   | 10                                | —   | pF   |
| Power dissipation capacitance                      | $C_{PD}$<br>(Note)     | TC74HC4020A    | —               | 27                       | —    | —   | —                                 | —   | pF   |
|                                                    |                        | TC74HC4040A    | —               | 37                       | —    | —   | —                                 | —   |      |

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

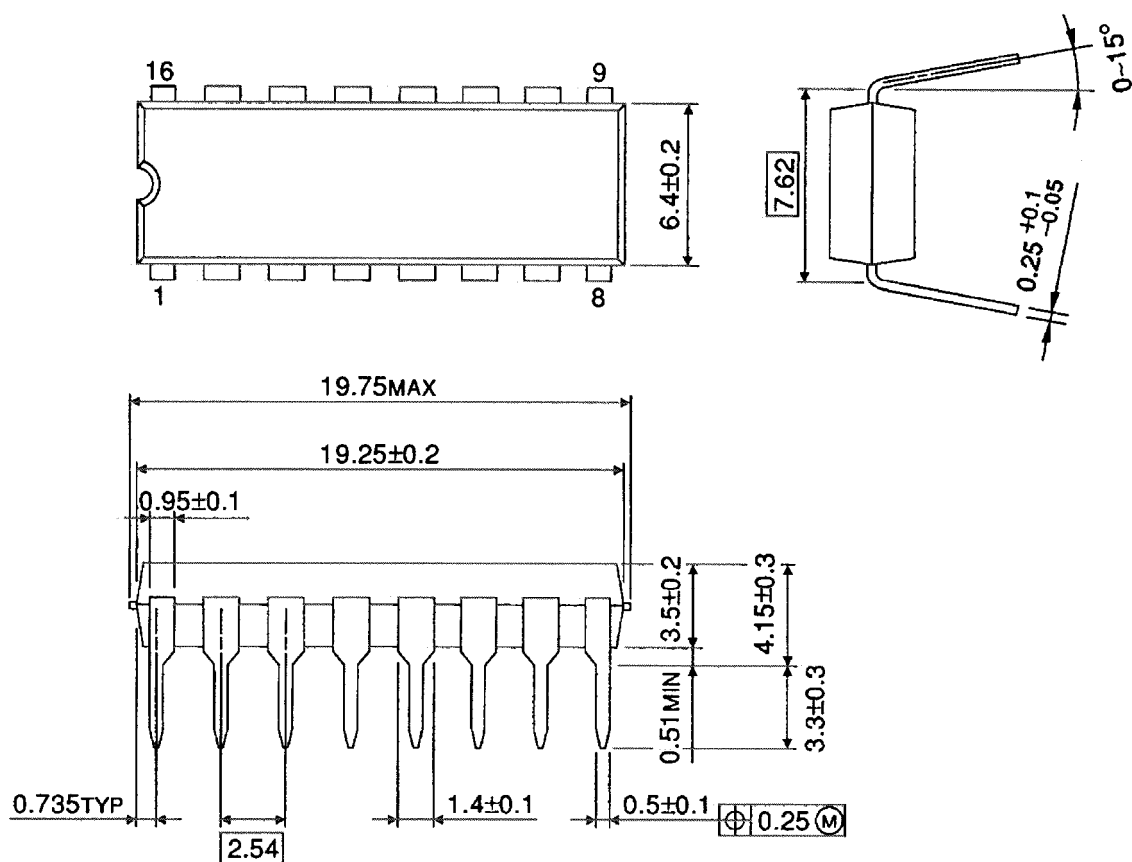
Average operating current can be obtained by the equation:

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

## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

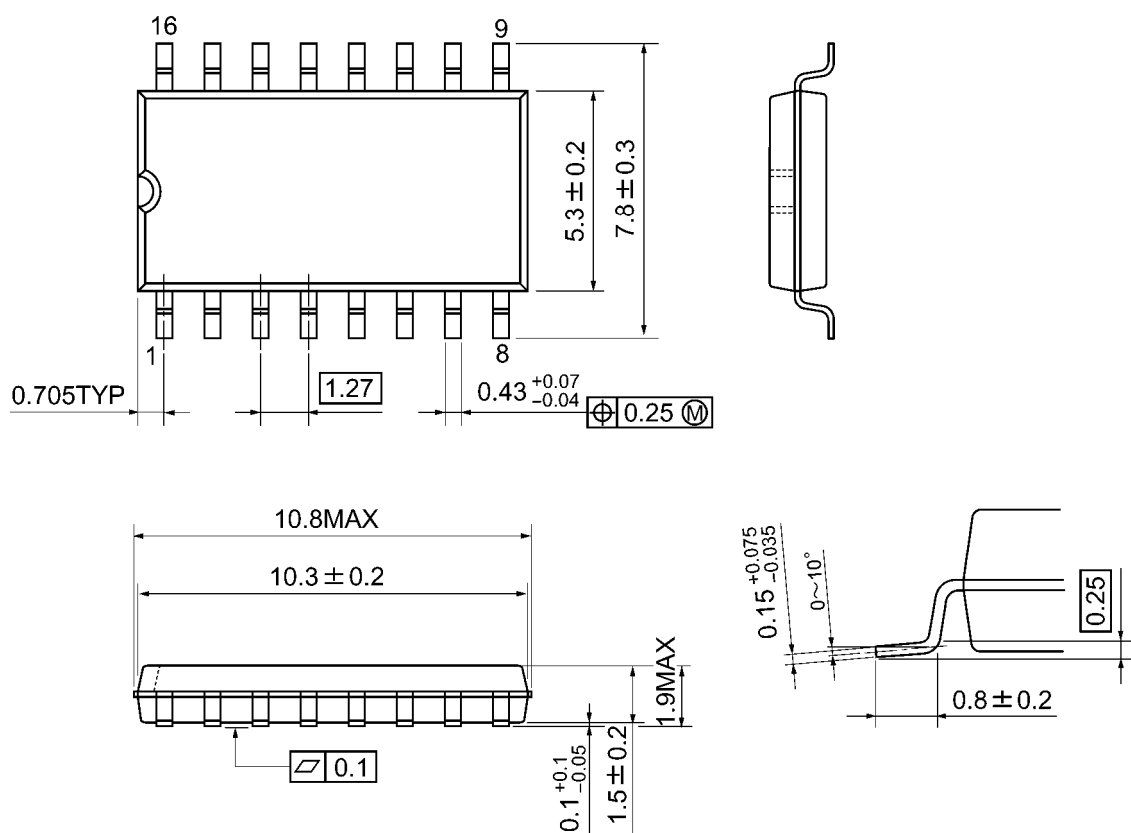


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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