

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC74HC4020AP, TC74HC4020AF TC74HC4040AP, TC74HC4040AF

## 1. Functional Description

TC74HC4020AP/AF 14-Stage Binary Counter  
TC74HC4040AP/AF 12-Stage Binary Counter

## 2. General

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<sup>st</sup> 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.

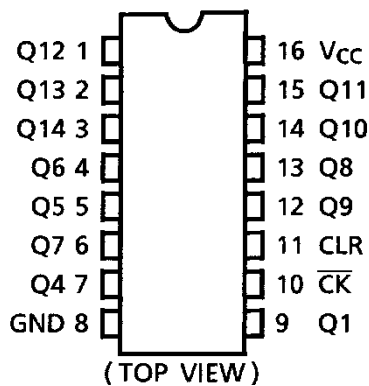
All inputs are equipped with protection circuits against static discharge or transient excess voltage.

## 3. Features

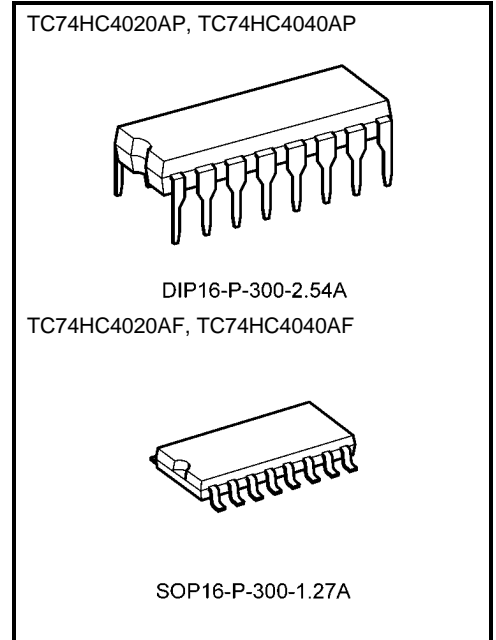
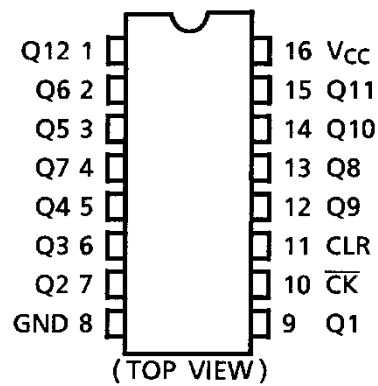
- High speed:  $f_{max} = 73 \text{ MHz (typ.)}$  at  $V_{CC} = 5 \text{ V}$
- Low power dissipation:  $I_{CC} = 4 \mu\text{A (max)}$  at  $T_a = 25^\circ\text{C}$
- High noise immunity:  $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min)}$
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: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

## 4. Pin Assignment

TC74HC4020A



TC74HC4040A

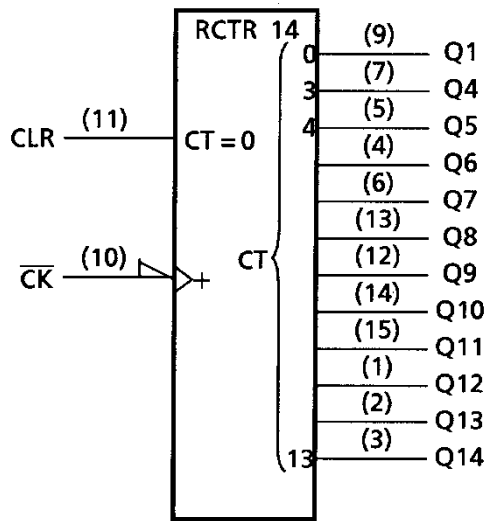


| Weight            |                 |
|-------------------|-----------------|
| DIP16-P-300-2.54A | : 1.00 g (typ.) |
| SOP16-P-300-1.27A | : 0.18 g (typ.) |

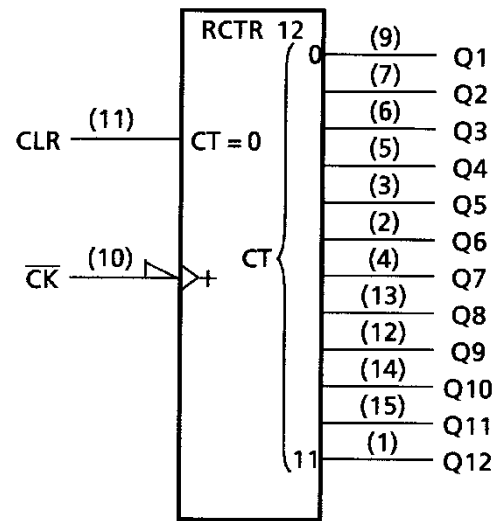
Start of commercial production  
1988-05

### 5. IEC Logic Symbol

TC74HC4020A



TC74HC4040A



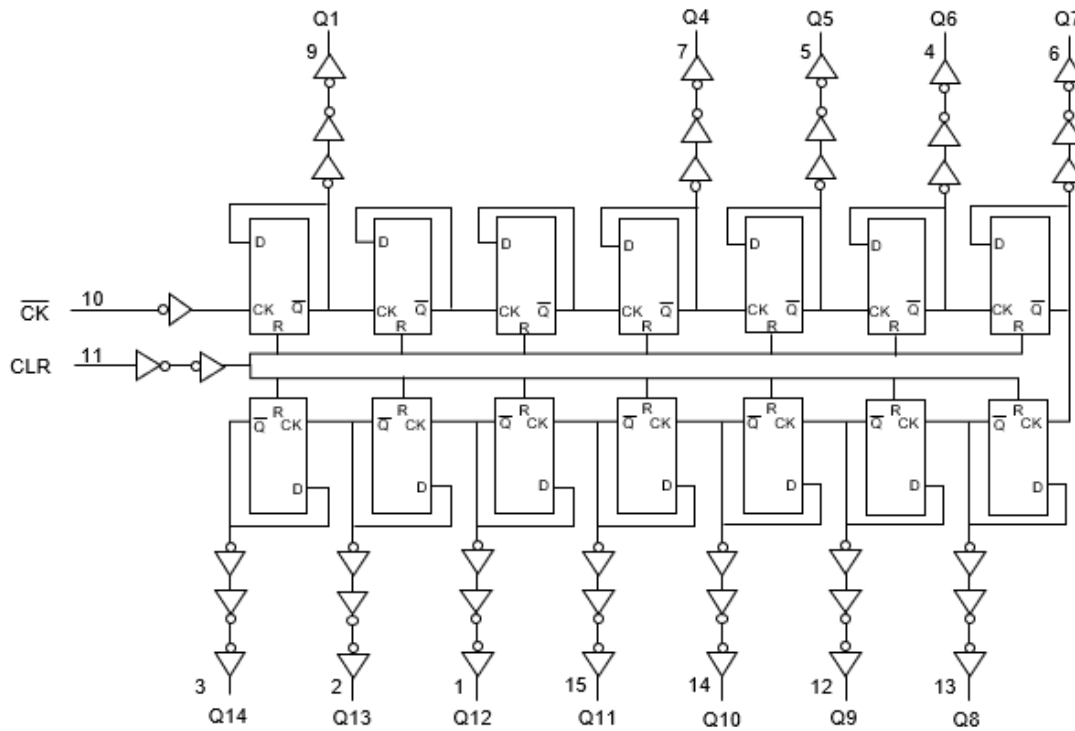
### 6. Truth Table

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

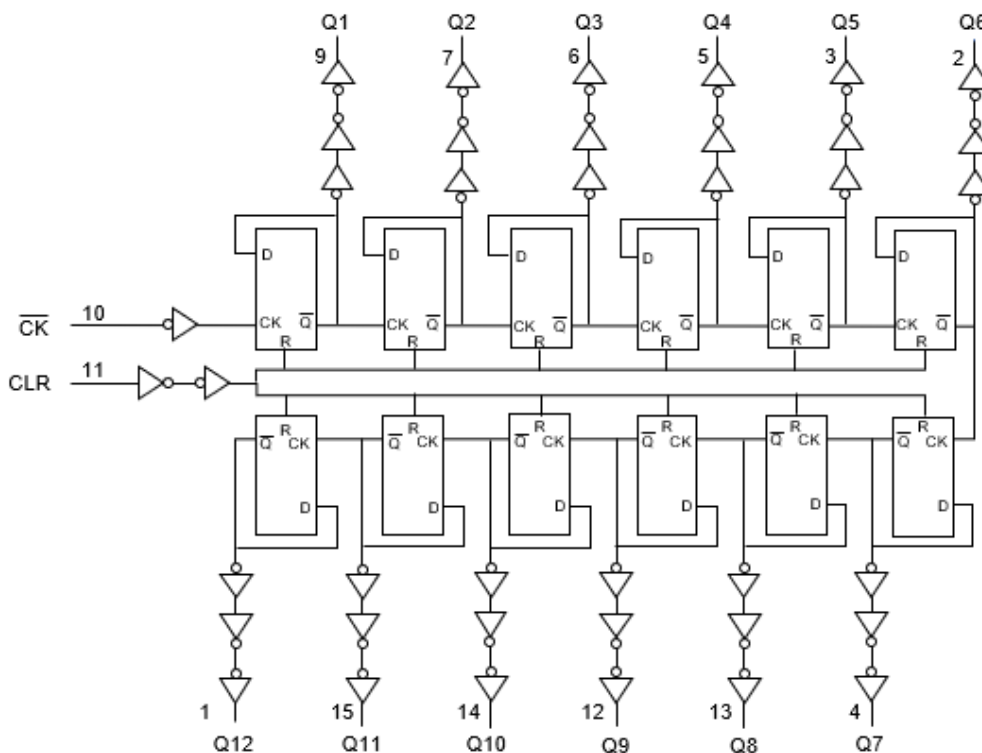
X: Don't care

### 7. System Diagram

#### TC74HC4020A



#### TC74HC4040A



### 8. Absolute Maximum Ratings (Note)

| Characteristics                    | Symbol           | Rating                        | Unit |
|------------------------------------|------------------|-------------------------------|------|
| Supply voltage range               | V <sub>CC</sub>  | -0.5 to 7                     | V    |
| DC input voltage                   | V <sub>IN</sub>  | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| DC output voltage                  | V <sub>OUT</sub> | -0.5 to V <sub>CC</sub> + 0.5 | V    |
| Input diode current                | I <sub>IK</sub>  | ±20                           | mA   |
| Output diode current               | I <sub>OK</sub>  | ±20                           | mA   |
| DC output current                  | I <sub>OUT</sub> | ±25                           | mA   |
| DC V <sub>CC</sub> /ground current | I <sub>CC</sub>  | ±50                           | mA   |
| Power dissipation                  | P <sub>D</sub>   | 500 (DIP) (Note 1)/180 (SOP)  | mW   |
| Storage temperature                | T <sub>stg</sub> | -65 to 150                    | °C   |

Note : 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 1: 500 mW in the range of T<sub>a</sub> = -40 to 65°C. From T<sub>a</sub> = 65 to 85°C a derating factor of -10 mW/°C shall be applied until 300 mW.

### 9. Operating Ranges (Note)

| Characteristics          | Symbol                          | Rating  | Unit |
|--------------------------|---------------------------------|---|------|
| Supply voltage           | V <sub>CC</sub>                 | 2 to 6  | V    |
| Input voltage            | V <sub>IN</sub>                 | 0 to V <sub>CC</sub>  | V    |
| Output voltage           | V <sub>OUT</sub>                | 0 to V <sub>CC</sub>  | V    |
| Operating temperature    | T <sub>opr</sub>                | -40 to 85   | °C   |
| Input rise and fall time | t <sub>r</sub> , t <sub>f</sub> | 0 to 1000 (V <sub>CC</sub> = 2.0 V)<br>0 to 500 (V <sub>CC</sub> = 4.5 V)<br>0 to 400 (V <sub>CC</sub> = 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<sub>CC</sub> or GND.

### 10. Electrical Characteristics

#### DC Characteristics

| Characteristics           | Symbol          | Test Condition                                       |  | Ta = 25°C |      |      | Ta = -40 to 85°C |      | Unit |     |
|---------------------------|-----------------|--|--|-----------|------|------|------------------|------|------|-----|
|                           |                 |  |  | VCC (V)   | Min  | Typ. | Max              | Min  |      | Max |
| High-level input voltage  | V <sub>IH</sub> | —  |  | 2.0       | 1.50 | —    | —                | 1.50 | —    | V   |
|                           |                 |  |  | 4.5       | 3.15 | —    | —                | 3.15 | —    |     |
|                           |                 |  |  | 6.0       | 4.20 | —    | —                | 4.20 | —    |     |
| Low-level input voltage   | V <sub>IL</sub> | —  |  | 2.0       | —    | —    | 0.50             | —    | 0.50 | V   |
|                           |                 |  |  | 4.5       | —    | —    | 1.35             | —    | 1.35 |     |
|                           |                 |  |  | 6.0       | —    | —    | 1.80             | —    | 1.80 |     |
| High-level output voltage | V <sub>OH</sub> | V <sub>IN</sub> = V <sub>IH</sub> or 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 | 4.5       | 4.18 | 4.31 | —                | 4.13 | —    |     |
|                           |                 |  |  | 6.0       | 5.68 | 5.80 | —                | 5.63 | —    |     |
| Low-level output voltage  | V <sub>OL</sub> | V <sub>IN</sub> = V <sub>IH</sub> or 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   | 4.5       | —    | 0.17 | 0.26             | —    | 0.33 |     |
|                           |                 |  |  | 6.0       | —    | 0.18 | 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  |
| Quiescent supply 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<sub>r</sub> = t<sub>f</sub> = 6 ns)

| Characteristics           | Symbol                                   | Test Condition |  | Ta = 25°C |      | Ta = -40 to 85°C | Unit |       |
|---------------------------|--|----------------|--|-----------|------|------------------|------|-------|
|                           |  |                |  | VCC (V)   | Typ. | Limit            |      | Limit |
| Minimum pulse width (CK)  | t <sub>w</sub> (L)<br>t <sub>w</sub> (H) | —              |  | 2.0       | —    | 75               | 95   | ns    |
|                           |  |                |  | 4.5       | —    | 15               | 19   |       |
|                           |  |                |  | 6.0       | —    | 13               | 16   |       |
| Minimum pulse width (CLR) | t <sub>w</sub> (H)                       | —              |  | 2.0       | —    | 75               | 95   | ns    |
|                           |  |                |  | 4.5       | —    | 15               | 19   |       |
|                           |  |                |  | 6.0       | —    | 13               | 16   |       |
| Minimum removal time      | t <sub>rem</sub>                         | —              |  | 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 | $T_a = 25^\circ\text{C}$ |     |      | $T_a = -40 \text{ to } 85^\circ\text{C}$ |     | Unit |     |
|--|------------------------|----------------|--------------------------|-----|------|--|-----|------|-----|
|  |                        |                | $V_{CC} \text{ (V)}$     | 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                    | CPD<br>(Note 1)        | TC74HC4020A    | —                        | 27  | —    | —  | —   | pF   |     |
|  |                        | TC74HC4040A    | —                        | 37  | —    | —  | —   |      |     |

Note 1: CPD is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

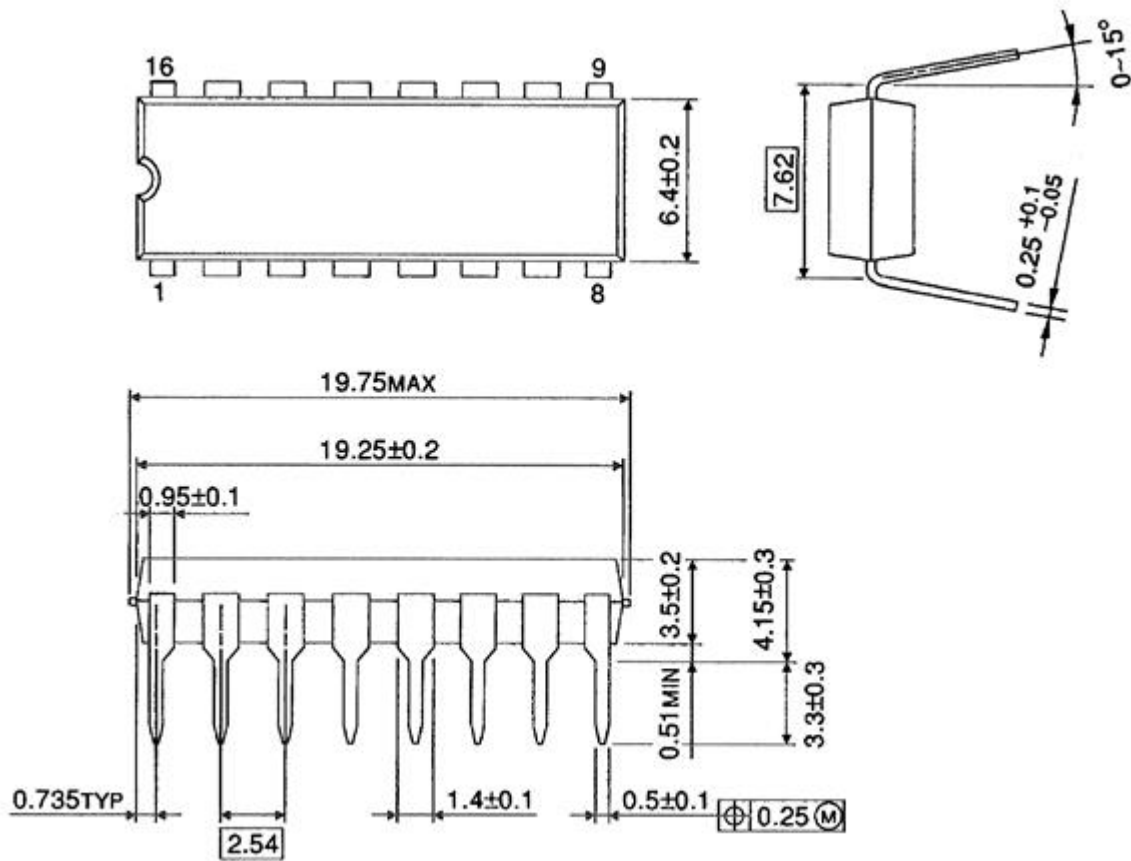
Average operating current can be obtained by the equation:

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

### Package Dimensions

DIP16-P-300-2.54A

Unit : mm

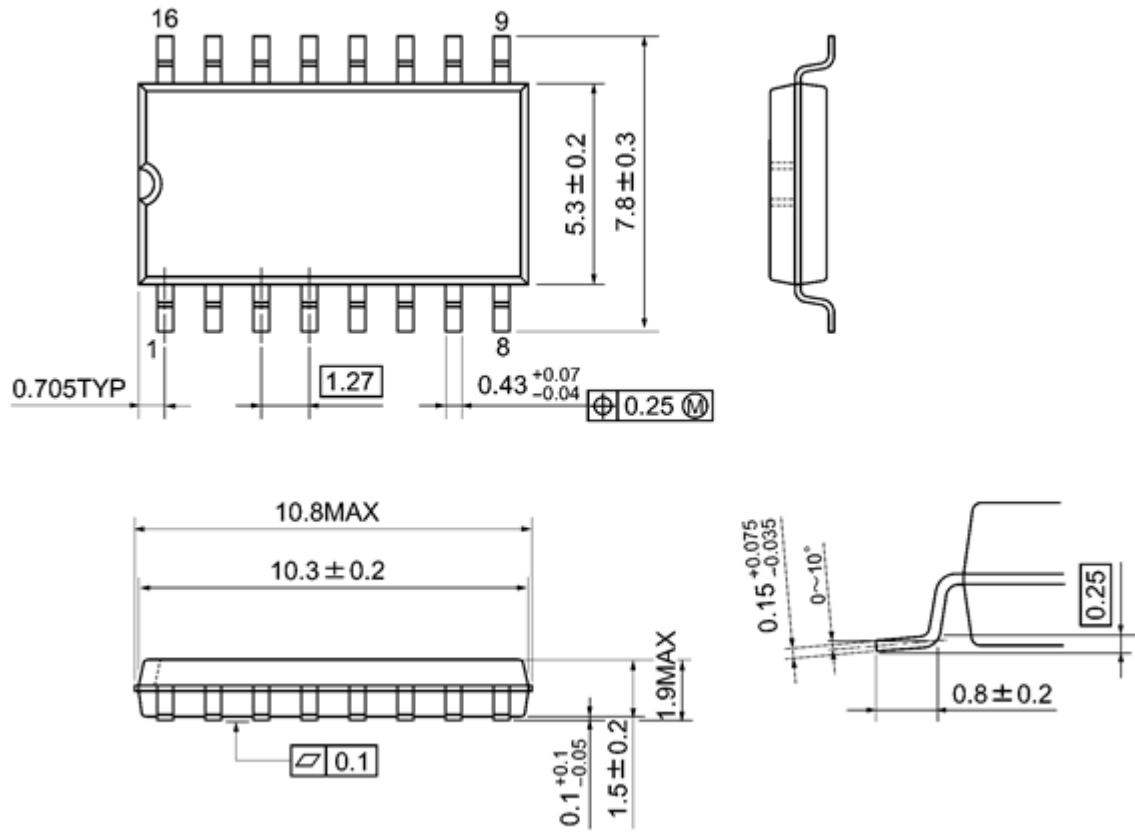


Weight: 1.00 g (typ.)

### Package Dimensions

SOP16-P-300-1.27A

Unit : mm



Weight: 0.18 g (typ.)

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