

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC4520BP, TC4520BF

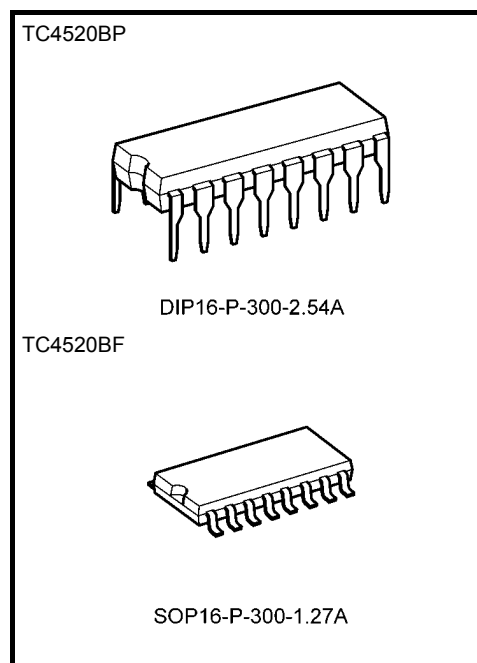
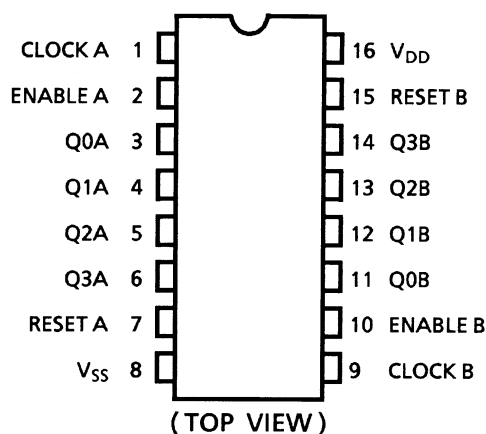
## TC4520B Dual Binary Up Counter

TC4520B is up counters of 4 bit binary.

Since both of TC4520B contain two independent circuits of counters with the same functions in one package, counting or frequency division of eight binary bits can be achieved with one IC. The counters can be reset to "0" ( $Q_0$  to  $Q_3 = "L"$ ) by giving "H" level signal to RESET input regardless of other inputs.

The counting condition is changed by the rising edge of CLOCK input if ENABLE = "H" or by the falling edge of ENABLE if CLOCK = "L".

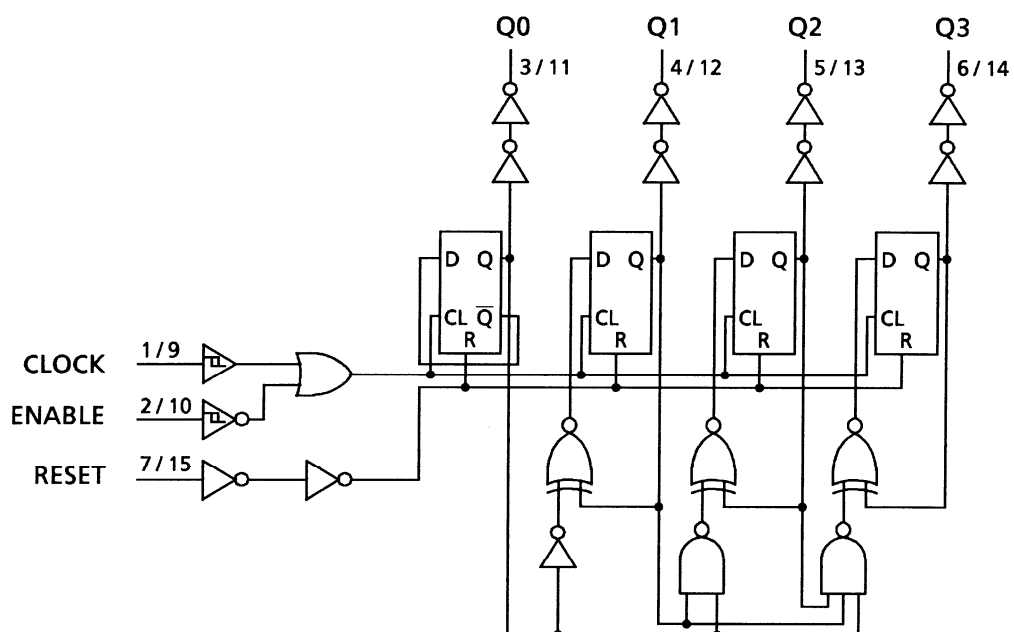
### Pin Assignment



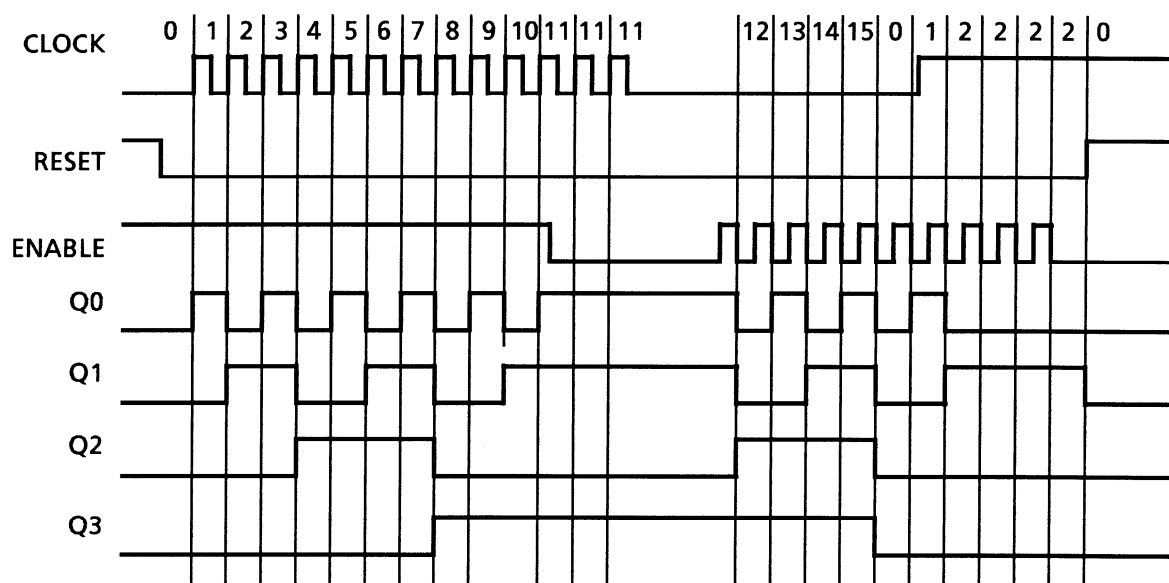
Weight  
 DIP16-P-300-2.54A : 1.00 g (typ.)  
 SOP16-P-300-1.27A : 0.18 g (typ.)

## Logic Diagram

1/2 TC4520B



## Timing Chart



## Absolute Maximum Ratings (Note)

| Characteristics             | Symbol    | Rating                           | Unit |
|-----------------------------|-----------|----------------------------------|------|
| DC supply voltage           | $V_{DD}$  | $V_{SS} - 0.5 \sim V_{SS} + 20$  | V    |
| Input voltage               | $V_{IN}$  | $V_{SS} - 0.5 \sim V_{DD} + 0.5$ | V    |
| Output voltage              | $V_{OUT}$ | $V_{SS} - 0.5 \sim V_{DD} + 0.5$ | V    |
| DC input current            | $I_{IN}$  | $\pm 10$                         | mA   |
| Power dissipation           | $P_D$     | 300 (DIP)/180 (SOIC)             | mW   |
| Operating temperature range | $T_{opr}$ | -40 to 85                        | °C   |
| Storage temperature range   | $T_{stg}$ | -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).

## Operating Ranges ( $V_{SS} = 0$ V) (Note)

| Characteristics   | Symbol   | Test Condition | Min | Typ. | Max      | Unit |
|-------------------|----------|----------------|-----|------|----------|------|
| DC supply voltage | $V_{DD}$ | —              | 3   | —    | 18       | V    |
| Input voltage     | $V_{IN}$ | —              | 0   | —    | $V_{DD}$ | V    |

Note: The operating ranges must be maintained to ensure the normal operation of the device.

Unused inputs must be tied to either  $V_{DD}$  or  $V_{SS}$ .

**Static Electrical Characteristics ( $V_{SS} = 0$  V)**

| Characteristics           | Sym-<br>bol | Test Condition                                     | $V_{DD}$<br>(V) | -40°C |      | 25°C  |       |            | 85°C  |      | Unit    |
|---------------------------|-------------|----------------------------------------------------|-----------------|-------|------|-------|-------|------------|-------|------|---------|
|                           |             |                                                    |                 | Min   | Max  | Min   | Typ.  | Max        | Min   | Max  |         |
| High-level output voltage | $V_{OH}$    | $ I_{OUT}  < 1 \mu A$<br>$V_{IN} = V_{SS}, V_{DD}$ | 5               | 4.95  | —    | 4.95  | 5.00  | —          | 4.95  | —    | V       |
|                           |             |                                                    | 10              | 9.95  | —    | 9.95  | 10.00 | —          | 9.95  | —    |         |
|                           |             |                                                    | 15              | 14.95 | —    | 14.95 | 15.00 | —          | 14.95 | —    |         |
| Low-level output voltage  | $V_{OL}$    | $ I_{OUT}  < 1 \mu A$<br>$V_{IN} = V_{SS}, V_{DD}$ | 5               | —     | 0.05 | —     | 0.00  | 0.05       | —     | 0.05 | V       |
|                           |             |                                                    | 10              | —     | 0.05 | —     | 0.00  | 0.05       | —     | 0.05 |         |
|                           |             |                                                    | 15              | —     | 0.05 | —     | 0.00  | 0.05       | —     | 0.05 |         |
| Output high current       | $I_{OH}$    | $V_{OH} = 4.6$ V                                   | 5               | -0.61 | —    | -0.51 | -1.0  | —          | -0.42 | —    | mA      |
|                           |             | $V_{OH} = 2.5$ V                                   | 5               | -2.5  | —    | -2.1  | -4.0  | —          | -1.7  | —    |         |
|                           |             | $V_{OH} = 9.5$ V                                   | 10              | -1.5  | —    | -1.3  | -2.2  | —          | -1.1  | —    |         |
|                           |             | $V_{OH} = 13.5$ V                                  | 15              | -4.0  | —    | -3.4  | -9.0  | —          | -2.8  | —    |         |
|                           |             | $V_{IN} = V_{SS}, V_{DD}$                          |                 |       |      |       |       |            |       |      |         |
| Output low current        | $I_{OL}$    | $V_{OL} = 0.4$ V                                   | 5               | 0.61  | —    | 0.51  | 1.2   | —          | 0.42  | —    | mA      |
|                           |             | $V_{OL} = 0.5$ V                                   | 10              | 1.5   | —    | 1.3   | 3.2   | —          | 1.1   | —    |         |
|                           |             | $V_{OL} = 1.5$ V                                   | 15              | 4.0   | —    | 3.4   | 12.0  | —          | 2.8   | —    |         |
|                           |             | $V_{IN} = V_{SS}, V_{DD}$                          |                 |       |      |       |       |            |       |      |         |
| Input high voltage        | $V_{IH}$    | $V_{OUT} = 0.5$ V, 4.5 V                           | 5               | 3.5   | —    | 3.5   | 2.75  | —          | 3.5   | —    | V       |
|                           |             | $V_{OUT} = 1.0$ V, 9.0 V                           | 10              | 7.0   | —    | 7.0   | 5.5   | —          | 7.0   | —    |         |
|                           |             | $V_{OUT} = 1.5$ V, 13.5 V                          | 15              | 11.0  | —    | 11.0  | 8.25  | —          | 11.0  | —    |         |
|                           |             | $ I_{OUT}  < 1 \mu A$                              |                 |       |      |       |       |            |       |      |         |
| Input low voltage         | $V_{IL}$    | $V_{OUT} = 0.5$ V, 4.5 V                           | 5               | —     | 1.5  | —     | 2.25  | 1.5        | —     | 1.5  | V       |
|                           |             | $V_{OUT} = 1.0$ V, 9.0 V                           | 10              | —     | 3.0  | —     | 4.5   | 3.0        | —     | 3.0  |         |
|                           |             | $V_{OUT} = 1.5$ V, 13.5 V                          | 15              | —     | 4.0  | —     | 6.75  | 4.0        | —     | 4.0  |         |
|                           |             | $ I_{OUT}  < 1 \mu A$                              |                 |       |      |       |       |            |       |      |         |
| Input current             | "H" level   | $I_{IH}$                                           | $V_{IH} = 18$ V | 18    | —    | 0.1   | —     | $10^{-5}$  | 0.1   | —    | $\mu A$ |
|                           | "L" level   | $I_{IL}$                                           | $V_{IL} = 0$ V  | 18    | —    | -0.1  | —     | $-10^{-5}$ | -0.1  | —    |         |
| Quiescent supply current  | $I_{DD}$    | $V_{IN} = V_{SS}, V_{DD}$<br>(Note)                | 5               | —     | 5    | —     | 0.005 | 5          | —     | 150  | $\mu A$ |
|                           |             |                                                    | 10              | —     | 10   | —     | 0.010 | 10         | —     | 300  |         |
|                           |             |                                                    | 15              | —     | 20   | —     | 0.015 | 20         | —     | 600  |         |

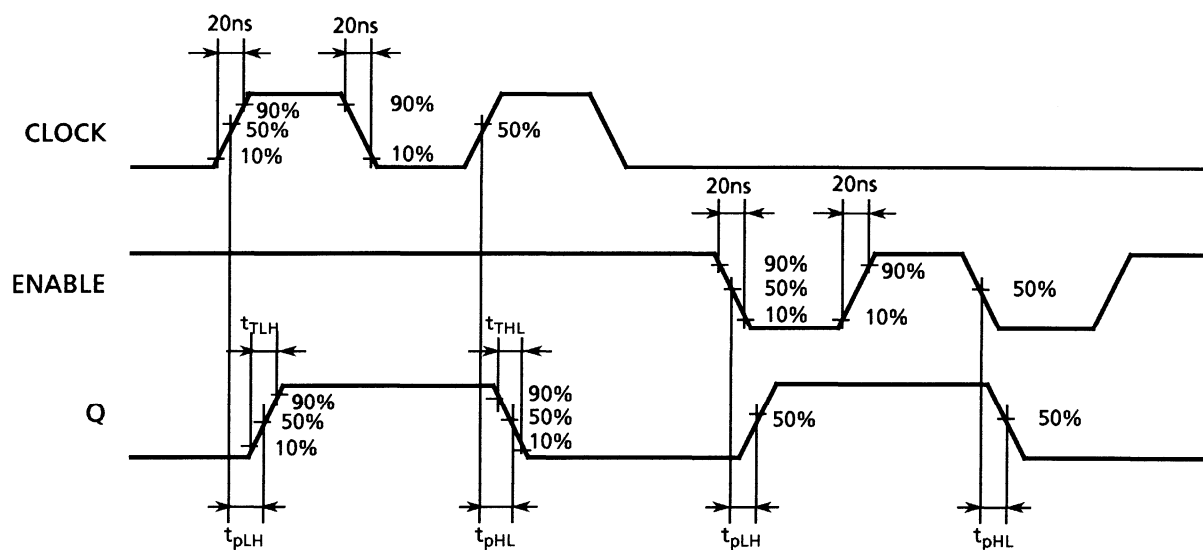
Note: All valid input combinations.

**Dynamic Electrical Characteristics (Ta = 25°C, V<sub>SS</sub> = 0 V, C<sub>L</sub> = 50 pF)**

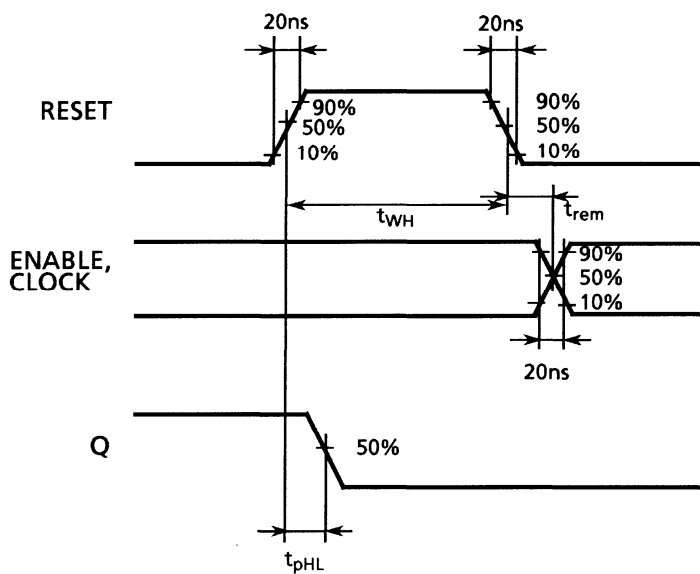
| Characteristics                             | Symbol                               | Test Condition | V <sub>DD</sub> (V) | Min      | Typ. | Max | Unit |
|---------------------------------------------|--------------------------------------|----------------|---------------------|----------|------|-----|------|
|                                             |                                      |                |                     |          |      |     |      |
| Output transition time<br>(low to high)     | t <sub>TLH</sub>                     | —              | 5                   | —        | 70   | 200 | ns   |
|                                             |                                      |                | 10                  | —        | 35   | 100 |      |
|                                             |                                      |                | 15                  | —        | 30   | 80  |      |
| Output transition time<br>(high to low)     | t <sub>THL</sub>                     | —              | 5                   | —        | 70   | 200 | ns   |
|                                             |                                      |                | 10                  | —        | 35   | 100 |      |
|                                             |                                      |                | 15                  | —        | 30   | 80  |      |
| Propagation delay time<br>(CLOCK, ENABLE-Q) | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | 5                   | —        | 160  | 560 | ns   |
|                                             |                                      |                | 10                  | —        | 75   | 230 |      |
|                                             |                                      |                | 15                  | —        | 60   | 160 |      |
| Propagation delay time<br>(RESET-Q)         | t <sub>pHL</sub>                     | —              | 5                   | —        | 110  | 560 | ns   |
|                                             |                                      |                | 10                  | —        | 55   | 230 |      |
|                                             |                                      |                | 15                  | —        | 40   | 160 |      |
| Max clock frequency                         | t <sub>CL</sub>                      | —              | 5                   | 1.5      | 6    | —   | MHz  |
|                                             |                                      |                | 10                  | 3        | 14   | —   |      |
|                                             |                                      |                | 15                  | 4        | 18   | —   |      |
| Max clock input rise/fall time              | t <sub>rCL</sub><br>t <sub>fCL</sub> | —              | 5                   | No limit |      |     | μs   |
|                                             |                                      |                | 10                  |          |      |     |      |
|                                             |                                      |                | 15                  |          |      |     |      |
| Max input rise/fall time<br>(ENABLE)        | t <sub>r</sub><br>t <sub>f</sub>     | —              | 5                   | No limit |      |     | μs   |
|                                             |                                      |                | 10                  |          |      |     |      |
|                                             |                                      |                | 15                  |          |      |     |      |
| Min clock pulse width                       | t <sub>W</sub>                       | —              | 5                   | —        | 30   | 200 | ns   |
|                                             |                                      |                | 10                  | —        | 15   | 100 |      |
|                                             |                                      |                | 15                  | —        | 10   | 70  |      |
| Min pulse width<br>(ENABLE)                 | t <sub>W</sub>                       | —              | 5                   | —        | 35   | 250 | ns   |
|                                             |                                      |                | 10                  | —        | 20   | 110 |      |
|                                             |                                      |                | 15                  | —        | 15   | 80  |      |
| Min pulse width<br>(RESET)                  | t <sub>WH</sub>                      | —              | 5                   | —        | 45   | 250 | ns   |
|                                             |                                      |                | 10                  | —        | 20   | 110 |      |
|                                             |                                      |                | 15                  | —        | 15   | 80  |      |
| Min removal time<br>(RESET-CLOCK, ENABLE)   | t <sub>rem</sub>                     | —              | 5                   | —        | —    | 0   | ns   |
|                                             |                                      |                | 10                  | —        | —    | 0   |      |
|                                             |                                      |                | 15                  | —        | —    | 0   |      |
| Input capacitance                           | C <sub>IN</sub>                      | —              | —                   | —        | 5    | 7.5 | pF   |

## Waveforms for Measurement of Dynamic Characteristics

Waveform 1

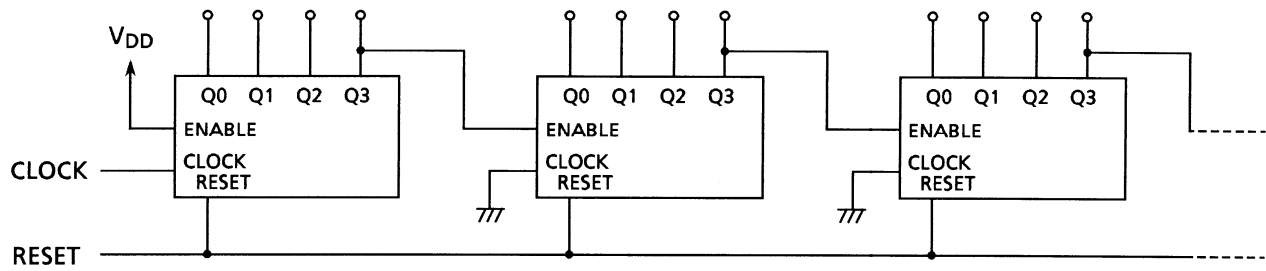


Waveform 2

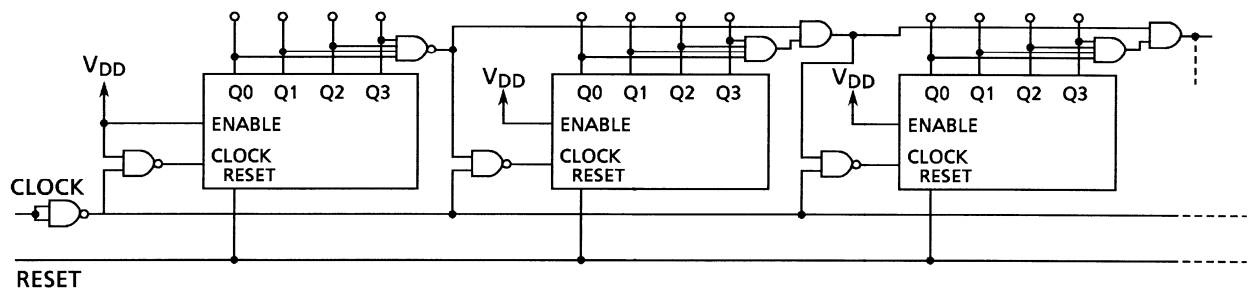


## Application Circuit

Ripple carry counter



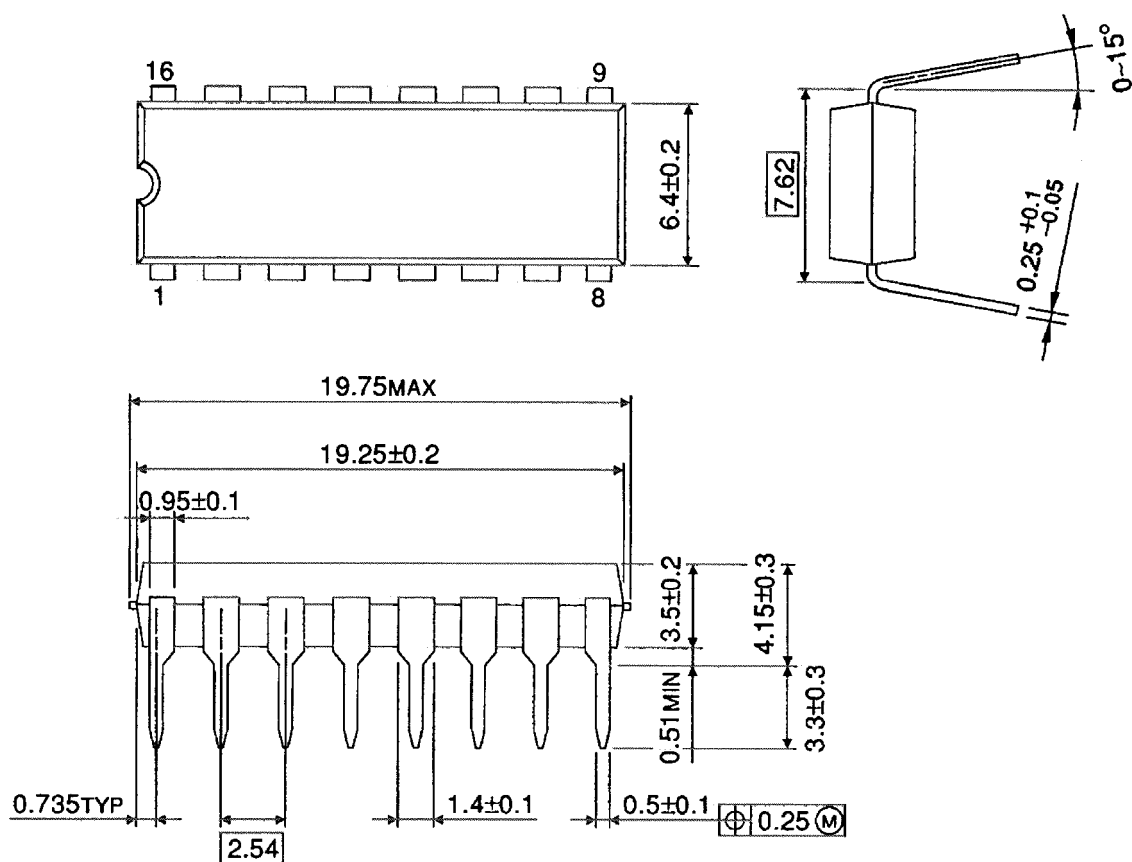
Ripple carry counter



## Package Dimensions

DIP16-P-300-2.54A

Unit : mm

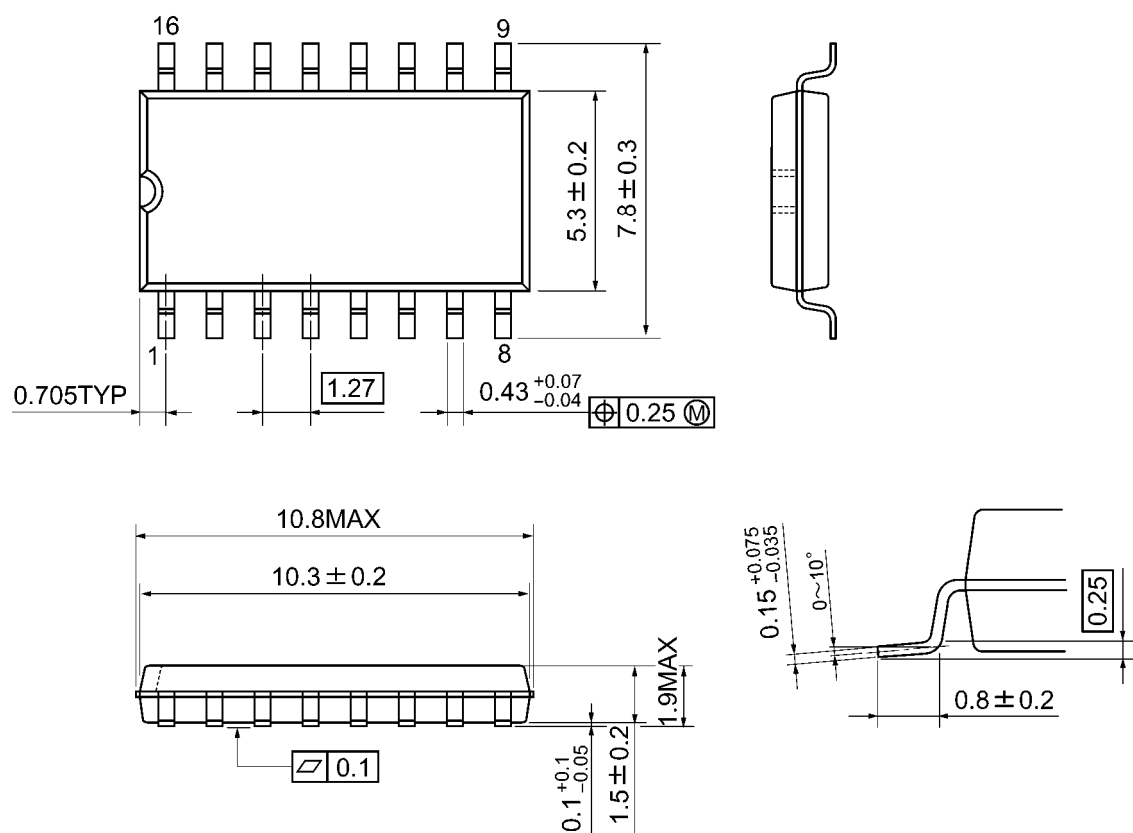


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)

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