

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

# TC4017BP, TC4017BF

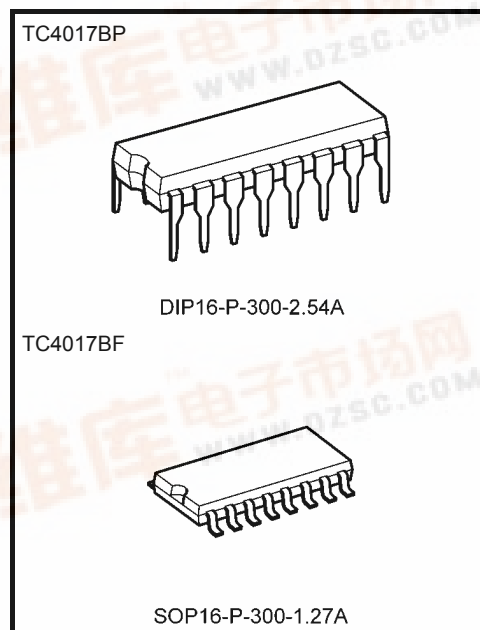
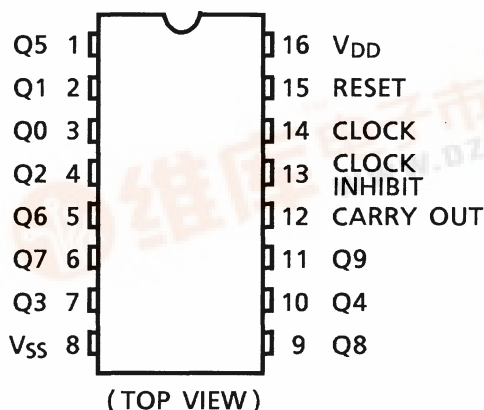
## TC4017BP/TC4017BF Decade Counter/Divider

TC4017BP/BF is decimal Johnson counter consisting of 5 stage D-type flip-flop equipped with the decoder to convert the output to decimal.

Depending on the number of count pulses fed to CLOCK or CLOCK INHIBIT one output among 10 output lines "Q0" through "Q9" becomes "H" level.

The counter advances its state at rising edge of CLOCK (CLOCK INHIBIT = "L") or falling edge of CLOCK INHIBIT (CLOCK = "H"). RESET input to "H" level resets the counter to Q0 = "H" and Q1 through Q9 = "L" regardless of CLOCK and CLOCK INHIBIT.

### Pin Assignment



Weight

DIP16-P-300-2.54A

: 1.00 g (typ.)

SOP16-P-300-1.27A

: 0.18 g (typ.)

### Truth Table

| Inputs         |                        |       | Selected Output |
|----------------|------------------------|-------|-----------------|
| CLOCK $\Delta$ | CLOCK INHIBIT $\Delta$ | RESET |                 |
| *              | *                      | H     | Q0              |
| *              | H                      | L     | Qn (NC)         |
| L              | *                      | L     | Qn (NC)         |
|                | L                      | L     | Qn + 1          |
|                | L                      | L     | Qn (NC)         |
| H              |                        | L     | Qn (NC)         |
| H              |                        | L     | Qn + 1          |

 $\Delta$ : Level change

\*: Don't care

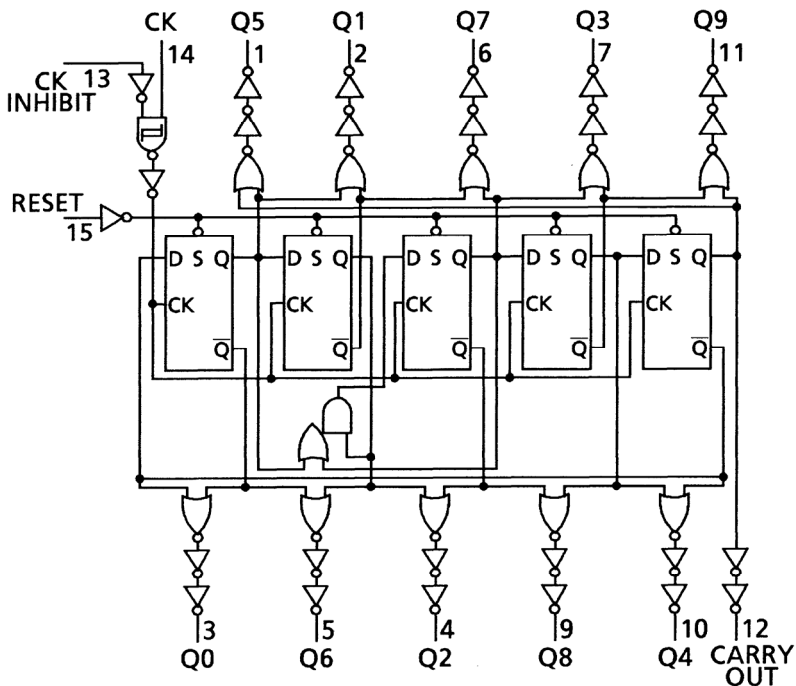
NC: No change

carry out

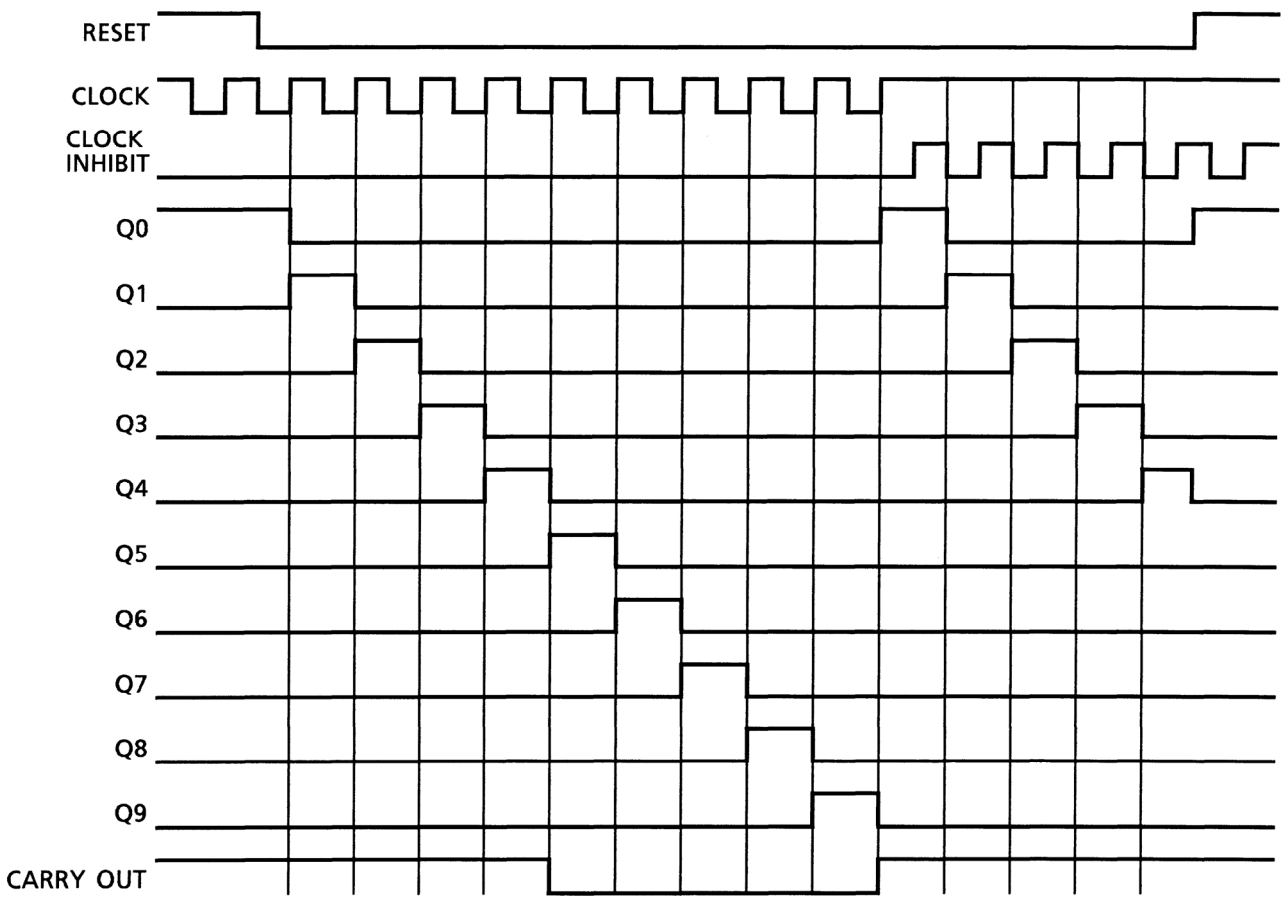
"H" ..... Q0~Q4 = "H"

"L" ..... Q5~Q9 = "H"

Logic Diagram



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 ambient temperature range | $T_{opr}$ | $-40 \sim 85$                    | $^{\circ}\text{C}$ |
| Storage temperature range           | $T_{stg}$ | $-65 \sim 150$                   | $^{\circ}\text{C}$ |

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 ( $V_{SS} = 0\text{ V}$ ) (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<sub>SS</sub> = 0 V)

| Characteristics              | Sym-<br>bol     | Test Condition   | V <sub>DD</sub><br>(V) | -40°C |      | 25°C  |       |                   | 85°C  |      | Unit |
|------------------------------|-----------------|--|------------------------|-------|------|-------|-------|-------------------|-------|------|------|
|                              |                 |  |                        | Min   | Max  | Min   | Typ.  | Max               | Min   | Max  |      |
| High-level output<br>voltage | V <sub>OH</sub> | I <sub>OUT</sub>   < 1 μA<br>V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub> | 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<br>voltage  | V <sub>OL</sub> | I <sub>OUT</sub>   < 1 μA<br>V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub> | 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 <sub>OH</sub> | V <sub>OH</sub> = 4.6 V  | 5                      | -0.61 | —    | -0.51 | -1.0  | —                 | -0.42 | —    | mA   |
|                              |                 | V <sub>OH</sub> = 2.5 V  | 5                      | -2.50 | —    | -2.10 | -4.0  | —                 | -1.70 | —    |      |
|                              |                 | V <sub>OH</sub> = 9.5 V  | 10                     | -1.50 | —    | -1.30 | -2.2  | —                 | -1.10 | —    |      |
|                              |                 | V <sub>OH</sub> = 13.5 V   | 15                     | -4.00 | —    | -3.40 | -9.0  | —                 | -2.80 | —    |      |
|                              |                 | V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>                              |                        |       |      |       |       |                   |       |      |      |
| Output low current           | I <sub>OL</sub> | V <sub>OL</sub> = 0.4 V  | 5                      | 0.61  | —    | 0.51  | 1.5   | —                 | 0.42  | —    | mA   |
|                              |                 | V <sub>OL</sub> = 0.5 V  | 10                     | 1.50  | —    | 1.30  | 3.8   | —                 | 1.10  | —    |      |
|                              |                 | V <sub>OL</sub> = 1.5 V  | 15                     | 4.00  | —    | 3.40  | 15.0  | —                 | 2.80  | —    |      |
|                              |                 | V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub>                              |                        |       |      |       |       |                   |       |      |      |
| Input high voltage           | V <sub>IH</sub> | V <sub>OUT</sub> = 0.5 V, 4.5 V  | 5                      | 3.5   | —    | 3.5   | 2.75  | —                 | 3.5   | —    | V    |
|                              |                 | V <sub>OUT</sub> = 1.0 V, 9.0 V  | 10                     | 7.0   | —    | 7.0   | 5.50  | —                 | 7.0   | —    |      |
|                              |                 | V <sub>OUT</sub> = 1.5 V, 13.5 V   | 15                     | 11.0  | —    | 11.0  | 8.25  | —                 | 11.0  | —    |      |
|                              |                 | I <sub>OUT</sub>   < 1 μA  |                        |       |      |       |       |                   |       |      |      |
| Input low voltage            | V <sub>IL</sub> | V <sub>OUT</sub> = 0.5 V, 4.5 V  | 5                      | —     | 1.5  | —     | 2.25  | 1.5               | —     | 1.5  | V    |
|                              |                 | V <sub>OUT</sub> = 1.0 V, 9.0 V  | 10                     | —     | 3.0  | —     | 4.50  | 3.0               | —     | 3.0  |      |
|                              |                 | V <sub>OUT</sub> = 1.5 V, 13.5 V   | 15                     | —     | 4.0  | —     | 6.75  | 4.0               | —     | 4.0  |      |
|                              |                 | I <sub>OUT</sub>   < 1 μA  |                        |       |      |       |       |                   |       |      |      |
| Input<br>current             | "H" level       | I <sub>IH</sub>  | V <sub>IH</sub> = 18 V | 18    | —    | 0.1   | —     | 10 <sup>-5</sup>  | 0.1   | —    | μA   |
|                              | "L" level       | I <sub>IL</sub>  | V <sub>IL</sub> = 0 V  | 18    | —    | -0.1  | —     | -10 <sup>-5</sup> | -0.1  | —    |      |
| Quiescent supply<br>current  | I <sub>DD</sub> | V <sub>IN</sub> = V <sub>SS</sub> , V <sub>DD</sub><br>(Note)                    | 5                      | —     | 5    | —     | 0.005 | 5                 | —     | 150  | μA   |
|                              |                 |  | 10                     | —     | 10   | —     | 0.010 | 10                | —     | 300  |      |
|                              |                 |  | 15                     | —     | 15   | —     | 0.015 | 20                | —     | 600  |      |

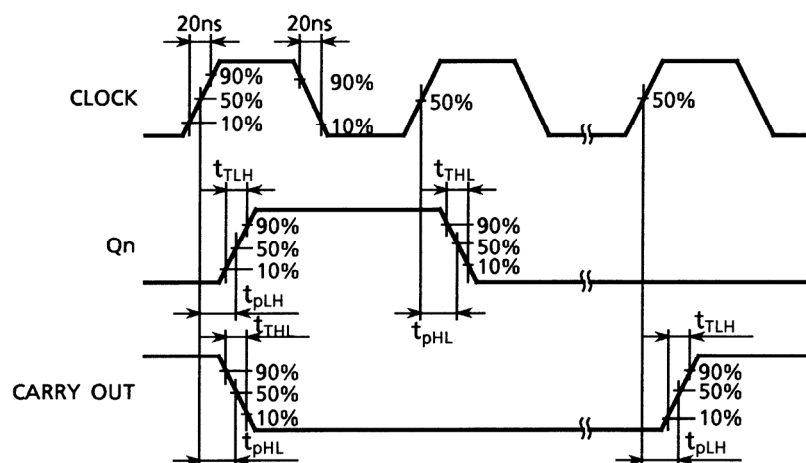
Note: All valid input combinations.

## Dynamic Electrical Characteristics (Ta = 25°C, VSS = 0 V, CL = 50 pF)

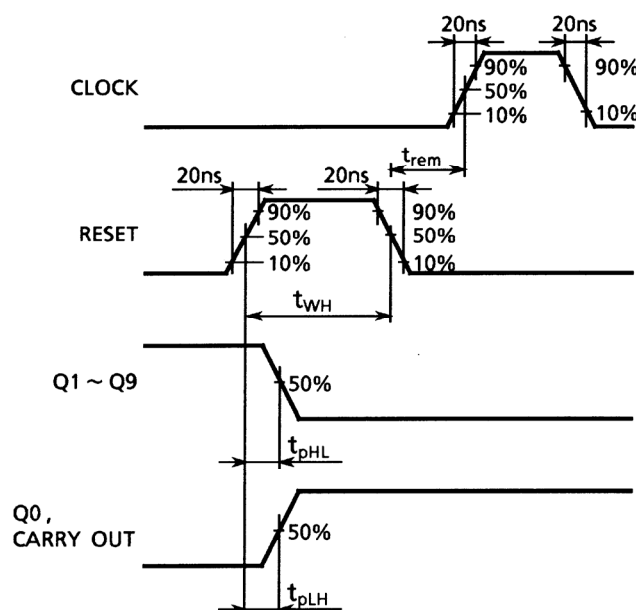
| Characteristics   | Symbol                               | Test Condition | VDD (V) | Min      | Typ. | Max | Unit |
|---|--------------------------------------|----------------|---------|----------|------|-----|------|
|   |                                      |                |         |          |      |     |      |
| Output transition time<br>(low to high)                 | t <sub>TLH</sub>                     | —              | 5       | —        | 80   | 200 | ns   |
|   |                                      |                | 10      | —        | 50   | 100 |      |
|   |                                      |                | 15      | —        | 40   | 80  |      |
| Output transition time<br>(high to low)                 | t <sub>THL</sub>                     | —              | 5       | —        | 80   | 200 | ns   |
|   |                                      |                | 10      | —        | 50   | 100 |      |
|   |                                      |                | 15      | —        | 40   | 80  |      |
| Propagation delay time<br>(CLOCK-Qn)                    | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | 5       | —        | 325  | 650 | ns   |
|   |                                      |                | 10      | —        | 135  | 270 |      |
|   |                                      |                | 15      | —        | 85   | 170 |      |
| Propagation delay time<br>(CLOCK-CARRY OUT)             | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | 5       | —        | 280  | 600 | ns   |
|   |                                      |                | 10      | —        | 110  | 250 |      |
|   |                                      |                | 15      | —        | 75   | 160 |      |
| Propagation delay time<br>(RESET-Qn<br>RESET-CARRY OUT) | t <sub>pLH</sub><br>t <sub>pHL</sub> | —              | 5       | —        | 265  | 530 | ns   |
|   |                                      |                | 10      | —        | 115  | 230 |      |
|   |                                      |                | 15      | —        | 85   | 170 |      |
| Max clock frequency                                     | f <sub>CL</sub>                      | —              | 5       | 2.5      | 6.0  | —   | MHz  |
|   |                                      |                | 10      | 5.0      | 12.0 | —   |      |
|   |                                      |                | 15      | 6.7      | 13.5 | —   |      |
| Min clock pulse width                                   | t <sub>W</sub>                       | —              | 5       | —        | 85   | 200 | ns   |
|   |                                      |                | 10      | —        | 40   | 90  |      |
|   |                                      |                | 15      | —        | 35   | 60  |      |
| Min pulse width<br>(RESET)                              | t <sub>WH</sub>                      | —              | 5       | —        | 50   | 260 | ns   |
|   |                                      |                | 10      | —        | 20   | 110 |      |
|   |                                      |                | 15      | —        | 15   | 60  |      |
| Max clock rise time<br>Max clock fall time              | t <sub>rCL</sub><br>t <sub>fCL</sub> | —              | 5       | No limit |      |     | μs   |
|   |                                      |                | 10      |          |      |     |      |
|   |                                      |                | 15      |          |      |     |      |
| Min set-up time<br>(CLOCK INHIBIT-CLOCK)                | t <sub>SU</sub>                      | —              | 5       | —        | 30   | 230 | ns   |
|   |                                      |                | 10      | —        | 15   | 100 |      |
|   |                                      |                | 15      | —        | 10   | 70  |      |
| Min removal time<br>(RESET-CLOCK)                       | t <sub>rem</sub>                     | —              | 5       | —        | -55  | 400 | ns   |
|   |                                      |                | 10      | —        | -20  | 275 |      |
|   |                                      |                | 15      | —        | -15  | 150 |      |
| Input capacitance                                       | C <sub>IN</sub>                      | —              | —       | —        | 5    | 7.5 | pF   |

## Waveforms for Measurement of Dynamic Characteristics

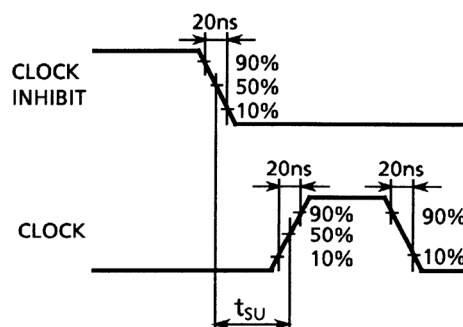
Waveform 1



Waveform 2



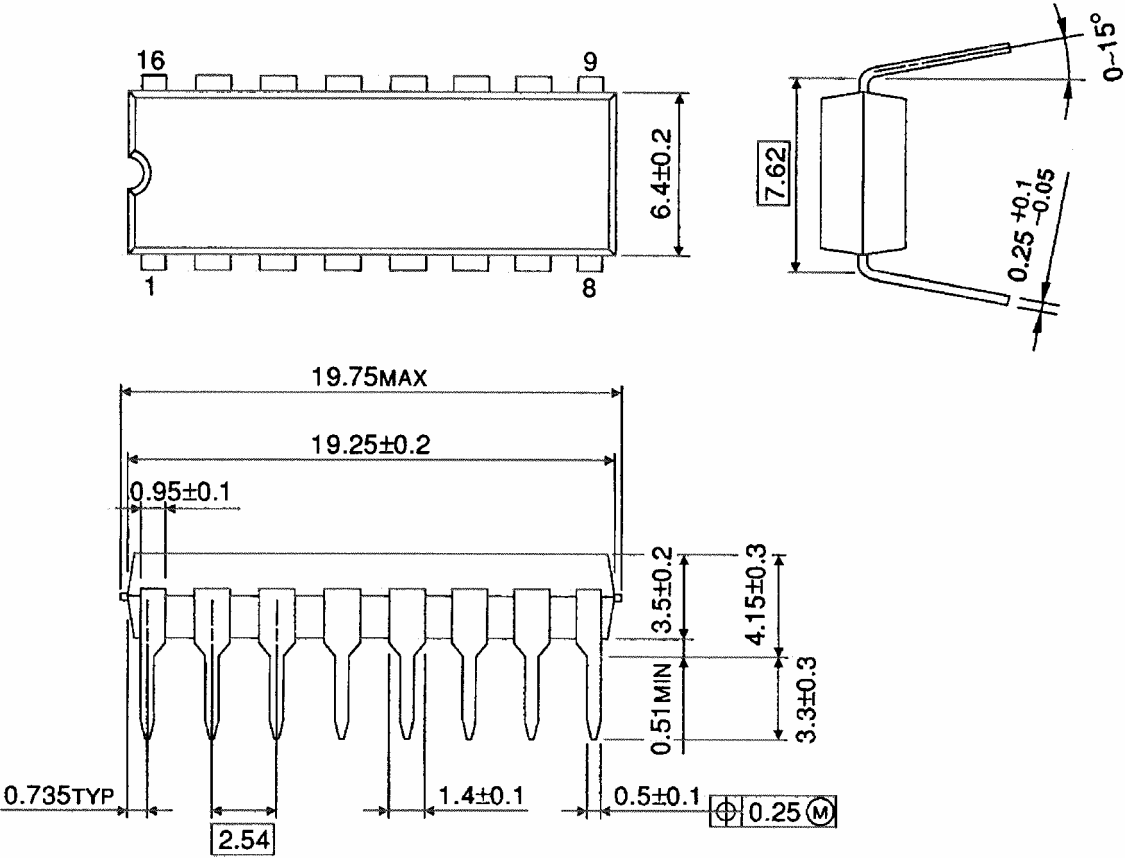
Waveform 3



Package Dimensions

DIP16-P-300-2.54A

Unit : mm

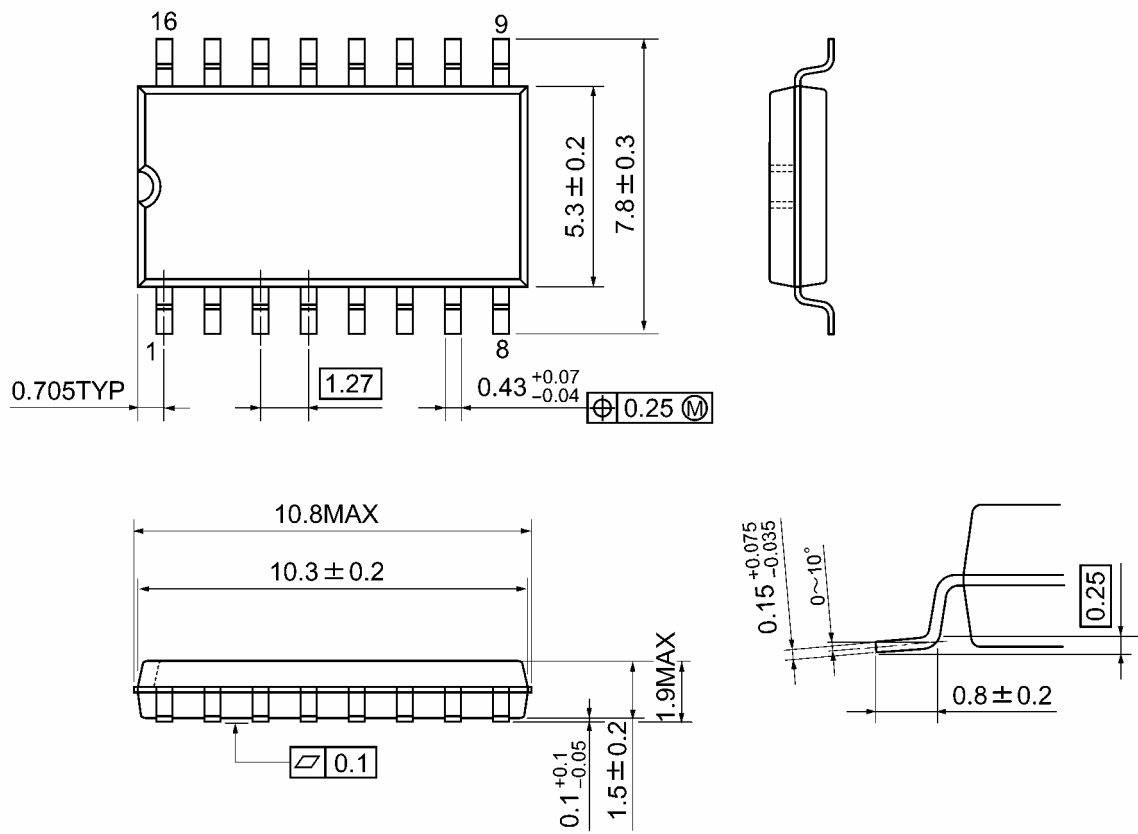


Weight: 1.00 g (typ.)

Package Dimensions

SOP16-P-300-1.27A

Unit: mm



Weight: 0.18 g (typ.)



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20070701-EN GENERAL

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