

TOSHIBA CMOS DIGITAL INTEGRATED CIRCUIT SILICON MONOLITHIC

# TC4024BP, TC4024BF, TC4024BFN

## TC4024B 7 STAGE RIPPLE-CARRY BINARY COUNTER/DIVIDERS

TC4024B is 7 stage ripple carry type binary counter having asynchronous clear function.

The counter advances its counting state by falling edge of  $\overline{\text{CLOCK}}$  input.

When RESET input is placed at "H", all the internal flip-flop are reset making all the outputs Q1 through Q7 to be "L" regardless of  $\overline{\text{CLOCK}}$  input.

This is suitable for frequency divider circuits and control circuits.

(Note) The JEDEC SOP (FN) is not available in Japan.

### MAXIMUM RATINGS

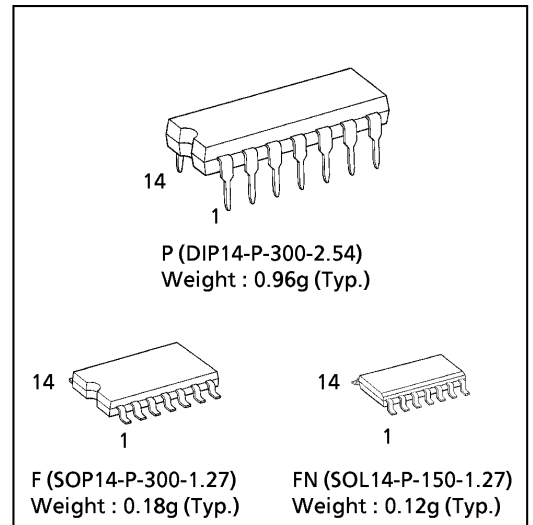
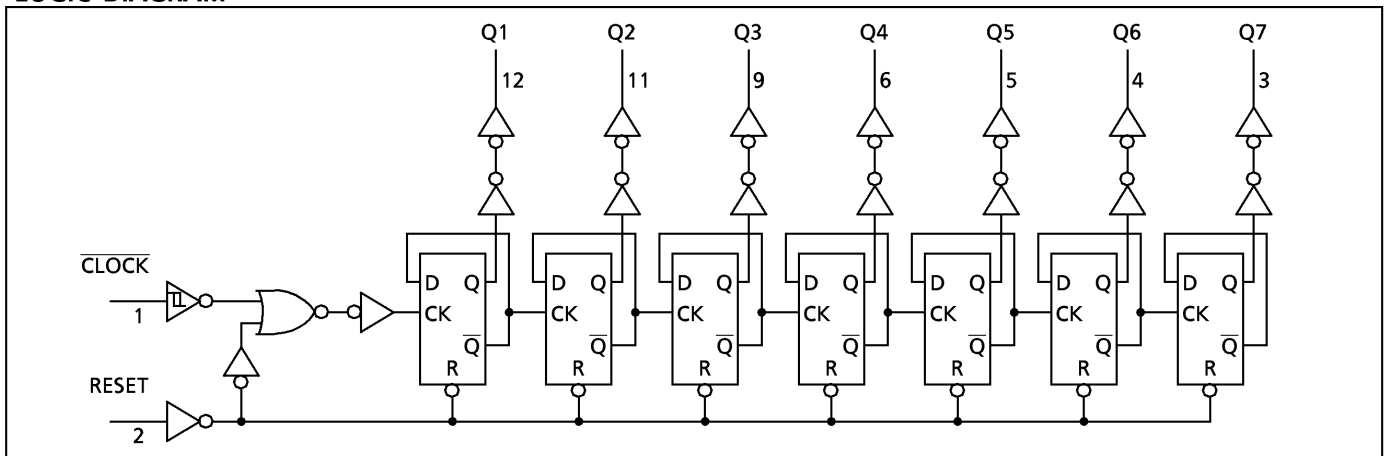
| CHARACTERISTIC              | SYMBOL    | RATING                           | UNIT               |
|-----------------------------|-----------|----------------------------------|--------------------|
| DC Supply Voltage           | $V_{DD}$  | $V_{SS} - 0.5 \sim V_{SS} + 20$  | V                  |
| 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 | $T_{opr}$ | $-40 \sim 85$                    | $^{\circ}\text{C}$ |
| Storage Temperature Range   | $T_{stg}$ | $-65 \sim 150$                   | $^{\circ}\text{C}$ |

### TRUTH TABLE

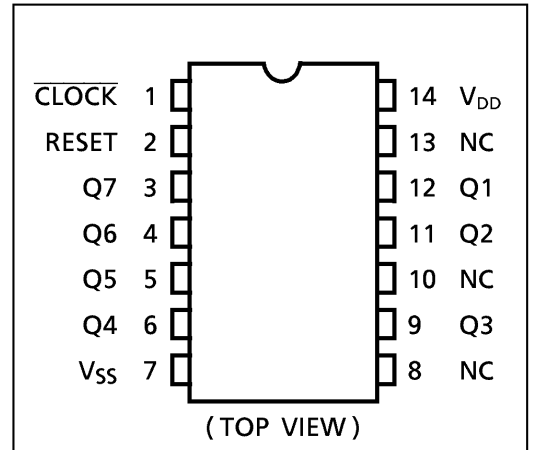
| $\overline{\text{CLOCK}} \Delta$ | RESET | OUTPUT STAGE          |
|----------------------------------|-------|-----------------------|
| *                                | H     | All Outputs = "L"     |
|                                  | L     | No Change             |
|                                  | L     | Advance to Next State |

$\Delta$  : Level Change, \* : Don't Care

### LOGIC DIAGRAM



### PIN ASSIGNMENT



**RECOMMENDED OPERATING CONDITIONS ( $V_{SS} = 0V$ )**

| CHARACTERISTIC    | SYMBOL   | TEST CONDITION | MIN. | TYP. | MAX.     | UNIT |
|-------------------|----------|----------------|------|------|----------|------|
| DC Supply Voltage | $V_{DD}$ |                | 3    | —    | 18       | V    |
| Input Voltage     | $V_{IN}$ |                | 0    | —    | $V_{DD}$ | V    |

**STATIC ELECTRICAL CHARACTERISTICS ( $V_{SS} = 0V$ )**

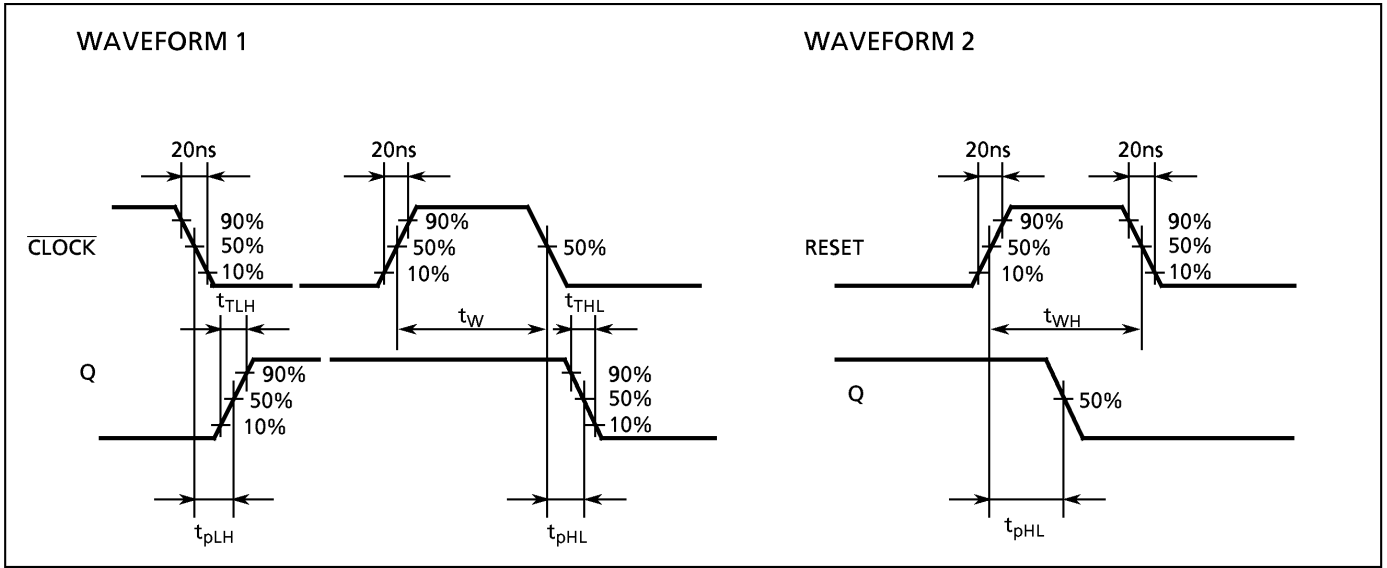
| CHARACTERISTIC            | SYM-BOL   | TEST CONDITION   | $V_{DD}$<br>(V) | - 40°C |      | 25°C  |       |            | 85°C  |      | UNIT    |         |
|---------------------------|-----------|--|-----------------|--------|------|-------|-------|------------|-------|------|---------|---------|
|                           |           |  |                 | MIN.   | MAX. | MIN.  | TYP.  | MAX.       | MIN.  | MAX. |         |         |
| High-Level Output Voltage | $V_{OH}$  | $ I_{OUT}  < 1\mu A$<br>$V_{IN} = V_{SS}$  | 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       | $I_{OH}$  | $V_{OH} = 4.6V$<br>$V_{OH} = 2.5V$<br>$V_{OH} = 9.5V$<br>$V_{OH} = 13.5V$<br>$V_{IN} = V_{SS}, V_{DD}$ | 5               | -0.61  | —    | -0.51 | -1.0  | —          | -0.42 | —    | mA      |         |
|                           |           |  | 5               | -2.50  | —    | -2.10 | -4.0  | —          | -1.70 | —    |         |         |
|                           |           |  | 10              | -1.50  | —    | -1.30 | -2.2  | —          | -1.10 | —    |         |         |
|                           |           |  | 15              | -4.00  | —    | -3.40 | -9.0  | —          | -2.80 | —    |         |         |
| Output Low Current        | $I_{OL}$  | $V_{OL} = 0.4V$<br>$V_{OL} = 0.5V$<br>$V_{OL} = 1.5V$<br>$V_{IN} = V_{SS}, V_{DD}$                     | 5               | 0.61   | —    | 0.51  | 1.2   | —          | 0.42  | —    | mA      |         |
|                           |           |  | 10              | 1.50   | —    | 1.30  | 3.2   | —          | 1.10  | —    |         |         |
|                           |           |  | 15              | 4.00   | —    | 3.40  | 12.0  | —          | 2.80  | —    |         |         |
|                           |           |  |                 |        |      |       |       |            |       |      |         |         |
| Input High Voltage        | $V_{IH}$  | $V_{OUT} = 0.5V, 4.5V$<br>$V_{OUT} = 1.0V, 9.0V$<br>$V_{OUT} = 1.5V, 13.5V$<br>$ I_{OUT}  < 1\mu A$    | 5               | 3.5    | —    | 3.5   | 2.75  | —          | 3.5   | —    | V       |         |
|                           |           |  | 10              | 7.0    | —    | 7.0   | 5.50  | —          | 7.0   | —    |         |         |
|                           |           |  | 15              | 11.0   | —    | 11.0  | 8.25  | —          | 11.0  | —    |         |         |
|                           |           |  |                 |        |      |       |       |            |       |      |         |         |
| Input Low Voltage         | $V_{IL}$  | $V_{OUT} = 0.5V, 4.5V$<br>$V_{OUT} = 1.0V, 9.0V$<br>$V_{OUT} = 1.5V, 13.5V$<br>$ I_{OUT}  < 1\mu A$    | 5               | —      | 1.5  | —     | 2.25  | 1.5        | —     | 1.5  | V       |         |
|                           |           |  | 10              | —      | 3.0  | —     | 4.50  | 3.0        | —     | 3.0  |         |         |
|                           |           |  | 15              | —      | 4.0  | —     | 6.75  | 4.0        | —     | 4.0  |         |         |
|                           |           |  |                 |        |      |       |       |            |       |      |         |         |
| Input Current             | "H" Level | $I_{IH}$   | $V_{IH} = 18V$  | 18     | —    | 0.1   | —     | $10^{-5}$  | 0.1   | —    | 1.0     | $\mu A$ |
|                           | "L" Level | $I_{IL}$   | $V_{IL} = 0V$   | 18     | —    | -0.1  | —     | $-10^{-5}$ | -0.1  | —    | -1.0    |         |
| Quiescent Supply Current  | $I_{DD}$  | $V_{IN} = V_{SS}, V_{DD}^*$  | 5               | —      | 5    | —     | 0.005 | 5          | —     | 150  | $\mu A$ |         |
|                           |           |  | 10              | —      | 10   | —     | 0.010 | 10         | —     | 300  |         |         |
|                           |           |  | 15              | —      | 15   | —     | 0.015 | 20         | —     | 600  |         |         |

\* All valid input combinations.

## DYNAMIC ELECTRICAL CHARACTERISTICS (Ta = 25°C, Vss = 0V, CL = 50pF)

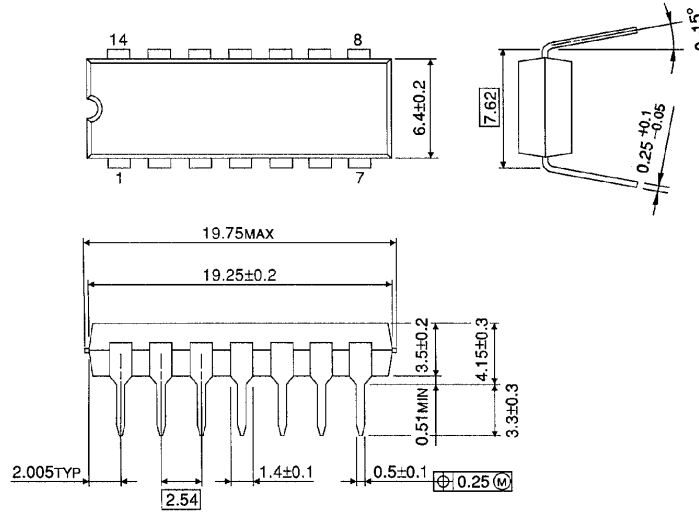
| CHARACTERISTIC  | SYMBOL                               | TEST CONDITION | V <sub>DD</sub> (V) | MIN.     | TYP. | MAX. | UNIT |
|---|--------------------------------------|----------------|---------------------|----------|------|------|------|
|   |                                      |                |                     |          |      |      |      |
| 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  |      |
|   |                                      |                | 10                  | —        | 35   | 100  |      |
|   |                                      |                | 15                  | —        | 30   | 80   |      |
| Propagation Delay Time<br>( $\overline{\text{CLOCK}}$ - Q1) | t <sub>pLH</sub>                     |                | 5                   | —        | 140  | 360  |      |
|   |                                      |                | 10                  | —        | 70   | 160  |      |
|   |                                      |                | 15                  | —        | 50   | 130  |      |
| Propagation Delay Time<br>( $\overline{\text{CLOCK}}$ - Q1) | t <sub>pHL</sub>                     |                | 5                   | —        | 140  | 360  |      |
|   |                                      |                | 10                  | —        | 70   | 160  |      |
|   |                                      |                | 15                  | —        | 50   | 130  |      |
| Propagation Delay Time<br>( $\overline{\text{CLOCK}}$ - Q7) | t <sub>pLH</sub>                     |                | 5                   | —        | 400  | 1200 |      |
|   |                                      |                | 10                  | —        | 160  | 520  |      |
|   |                                      |                | 15                  | —        | 115  | 430  |      |
| Propagation Delay Time<br>( $\overline{\text{CLOCK}}$ - Q7) | t <sub>pHL</sub>                     |                | 5                   | —        | 400  | 1200 |      |
|   |                                      |                | 10                  | —        | 160  | 520  |      |
|   |                                      |                | 15                  | —        | 115  | 430  |      |
| Propagation Delay Time<br>(RESET - Q)                       | t <sub>pHL</sub>                     |                | 5                   | —        | 140  | 280  |      |
|   |                                      |                | 10                  | —        | 70   | 120  |      |
|   |                                      |                | 15                  | —        | 50   | 100  |      |
| Max. Clock Frequency  | f <sub>CL</sub>                      |                | 5                   | 3.5      | 14   | —    | MHz  |
|   |                                      |                | 10                  | 8.0      | 30   | —    |      |
|   |                                      |                | 15                  | 12.0     | 40   | —    |      |
| Max. Clock Input Rise Time<br>Max. Clock Input Fall Time    | t <sub>rCL</sub><br>t <sub>fCL</sub> |                | 5                   | No Limit |      |      | μs   |
|   |                                      |                | 10                  |          |      |      |      |
|   |                                      |                | 15                  |          |      |      |      |
| Max. Clock Pulse Width                                      | t <sub>w</sub>                       |                | 5                   | —        | 40   | 140  | ns   |
|   |                                      |                | 10                  | —        | 20   | 60   |      |
|   |                                      |                | 15                  | —        | 15   | 40   |      |
| Max. Pulse Width (RESET)                                    | t <sub>WH</sub>                      |                | 5                   | —        | 40   | 200  |      |
|   |                                      |                | 10                  | —        | 20   | 80   |      |
|   |                                      |                | 15                  | —        | 15   | 60   |      |
| Minimum Removal Time  | t <sub>rem</sub>                     |                | 5                   | —        | 0    | 350  |      |
|   |                                      |                | 10                  | —        | 0    | 150  |      |
|   |                                      |                | 15                  | —        | 0    | 100  |      |
| Input Capacitance   | C <sub>IN</sub>                      |                |                     | —        | 5    | 7.5  |      |

**WAVEFORMS FOR MEASUREMENT OF DYNAMIC CHARACTERISTICS**



DIP 14PIN PACKAGE DIMENSIONS (DIP14-P-300-2.54)

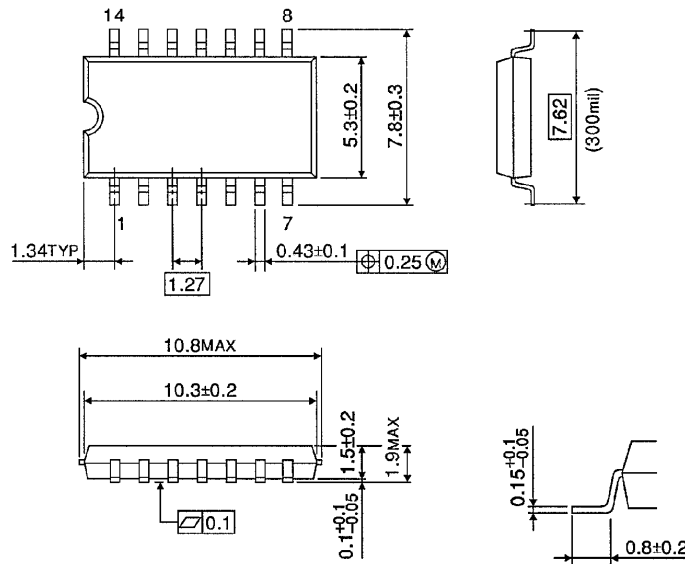
Unit in mm



Weight : 0.96g (Typ.)

SOP 14PIN (200mil BODY) PACKAGE DIMENSIONS (SOP14-P-300-1.27)

Unit in mm

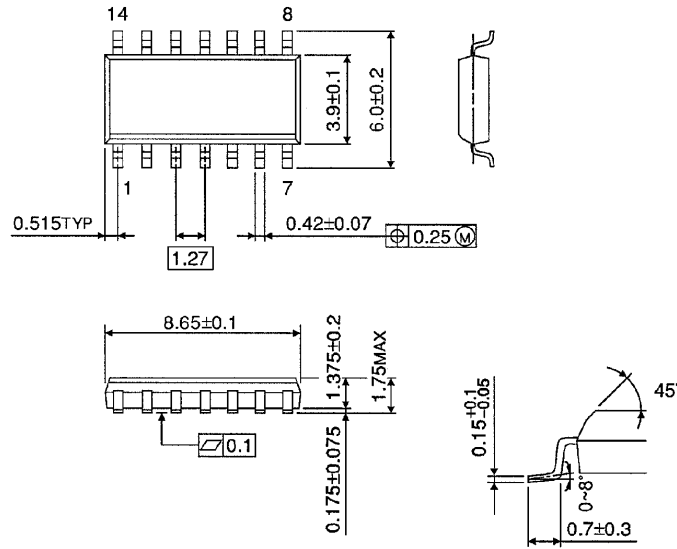


Weight : 0.18g (Typ.)

**SOP 14PIN (150mil BODY) PACKAGE DIMENSIONS (SOL14-P-150 -1.27)**

Unit in mm

(Note) This package is not available in Japan.



Weight : 0.12g (Typ.)

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