

## TC4028BFN

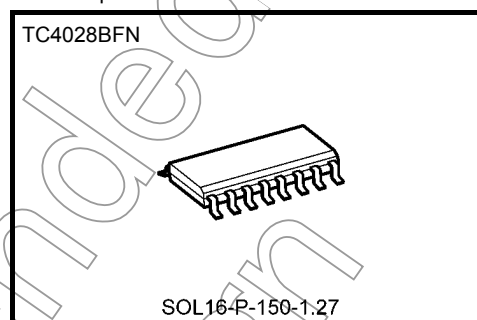
### TC4028B BCD-to-Decimal Decoder

TC4028B is a BCD-to-DECIMAL decoder which converts BCD signal into DECIMAL signal.

Of ten outputs from Q0 to Q9, one output corresponding to input BCD code goes to the "H" level and all the others remain at the "L" level.

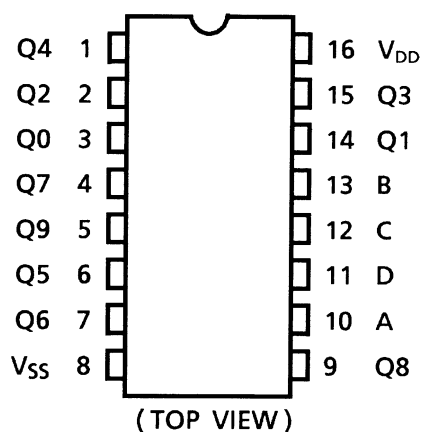
When D is used as inhibit input by use of three input lines from A to C, this decoder can be served as a BINARY-to-OCTAL decoder.

Note: xxxFN (JEDEC SOP) is not available in Japan.



Weight  
SOL16-P-150-1.27 : 0.13 g (typ.)

### Pin Assignment



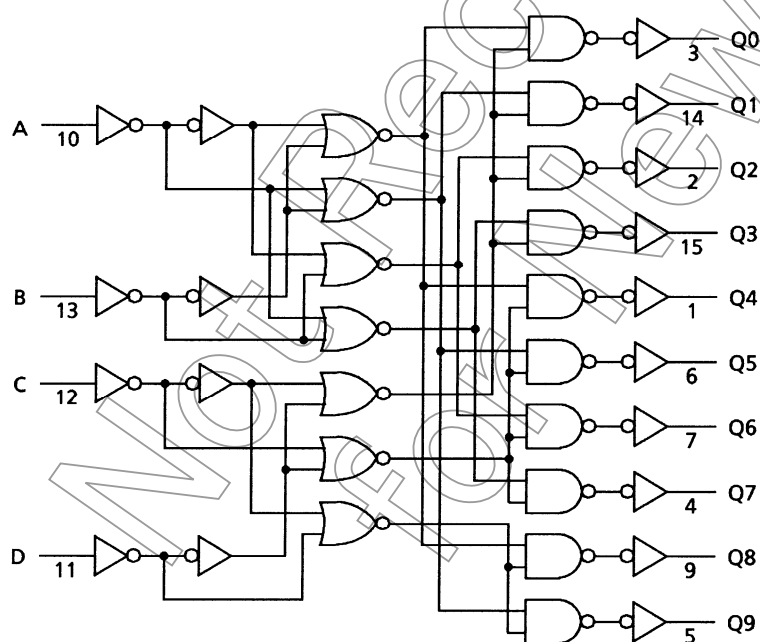
## Truth Table

| Inputs |   |   |   | Outputs |    |    |    |    |    |    |    |    |    |
|--------|---|---|---|---------|----|----|----|----|----|----|----|----|----|
| D      | C | B | A | Q0      | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 | Q7 | Q8 | Q9 |
| L      | L | L | L | H       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| L      | L | L | H | L       | H  | L  | L  | L  | L  | L  | L  | L  | L  |
| L      | L | H | L | L       | L  | H  | L  | L  | L  | L  | L  | L  | L  |
| L      | L | H | H | L       | L  | L  | H  | L  | L  | L  | L  | L  | L  |
| L      | H | L | L | L       | L  | L  | L  | H  | L  | L  | L  | L  | L  |
| L      | H | L | H | L       | L  | L  | L  | L  | H  | L  | L  | L  | L  |
| L      | H | H | L | L       | L  | L  | L  | L  | L  | H  | L  | L  | L  |
| L      | H | H | H | L       | L  | L  | L  | L  | L  | L  | H  | L  | L  |
| H      | L | L | L | L       | L  | L  | L  | L  | L  | L  | L  | H  | L  |
| H      | L | L | H | L       | L  | L  | L  | L  | L  | L  | L  | L  | H  |
| H      | L | H | L | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| H      | L | H | H | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| H      | H | L | L | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| H      | H | L | H | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| H      | H | H | L | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |
| H      | H | H | H | L       | L  | L  | L  | L  | L  | L  | L  | L  | L  |

H = High level

L = Low level

## Logic Diagram



**Absolute Maximum Ratings (Note)**

| Characteristics             | Symbol    | Rating                           | Unit |
|-----------------------------|-----------|----------------------------------|------|
| DC supply voltage           | $V_{DD}$  | $V_{SS} - 0.5$ to $V_{SS} + 20$  | V    |
| Input voltage               | $V_{IN}$  | $V_{SS} - 0.5$ to $V_{DD} + 0.5$ | V    |
| Output voltage              | $V_{OUT}$ | $V_{SS} - 0.5$ to $V_{DD} + 0.5$ | V    |
| DC input current            | $I_{IN}$  | $\pm 10$                         | mA   |
| Power dissipation           | $P_D$     | 180                              | 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 ( $V_{SS} = 0\text{ V}$ )

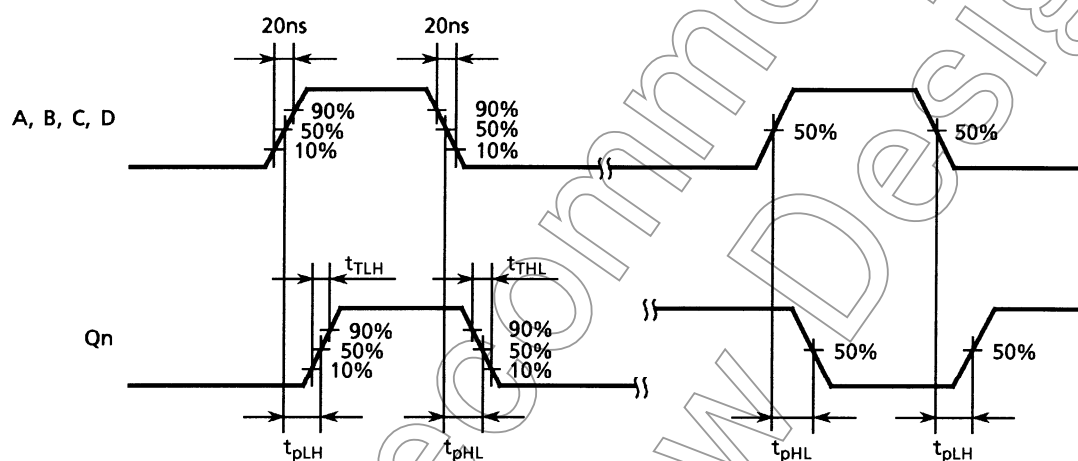
| Characteristics              | Sym-<br>bol | Test Condition                                                  | $V_{DD}$<br>(V) | -40°C |      | 25°C  |            |      | 85°C  |      | Unit          |
|------------------------------|-------------|-----------------------------------------------------------------|-----------------|-------|------|-------|------------|------|-------|------|---------------|
|                              |             |                                                                 |                 | Min   | Max  | Min   | Typ.       | Max  | Min   | Max  |               |
| High-level output<br>voltage | $V_{OH}$    | $ I_{OUT}  < 1\text{ }\mu\text{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<br>voltage  | $V_{OL}$    | $ I_{OUT}  < 1\text{ }\mu\text{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          | $I_{OH}$    | $V_{OH} = 4.6\text{ V}$                                         | 5               | -0.61 | —    | -0.51 | -1.0       | —    | -0.42 | —    | mA            |
|                              |             | $V_{OH} = 2.5\text{ V}$                                         | 5               | -2.50 | —    | -2.10 | -4.0       | —    | -1.70 | —    |               |
|                              |             | $V_{OH} = 9.5\text{ V}$                                         | 10              | -1.50 | —    | -1.30 | -2.2       | —    | -1.10 | —    |               |
|                              |             | $V_{OH} = 13.5\text{ V}$                                        | 15              | -4.00 | —    | -3.40 | -9.0       | —    | -2.80 | —    |               |
|                              |             | $V_{IN} = V_{SS}, V_{DD}$                                       |                 |       |      |       |            |      |       |      |               |
| Output low current           | $I_{OL}$    | $V_{OL} = 0.4\text{ V}$                                         | 5               | 0.61  | —    | 0.51  | 1.2        | —    | 0.42  | —    | mA            |
|                              |             | $V_{OL} = 0.5\text{ V}$                                         | 10              | 1.50  | —    | 1.30  | 3.2        | —    | 1.10  | —    |               |
|                              |             | $V_{OL} = 1.5\text{ V}$                                         | 15              | 4.00  | —    | 3.40  | 12.0       | —    | 2.80  | —    |               |
|                              |             | $V_{IN} = V_{SS}, V_{DD}$                                       |                 |       |      |       |            |      |       |      |               |
| Input high voltage           | $V_{IH}$    | $V_{OUT} = 0.5\text{ V}, 4.5\text{ V}$                          | 5               | 3.5   | —    | 3.5   | 2.75       | —    | 3.5   | —    | V             |
|                              |             | $V_{OUT} = 1.0\text{ V}, 9.0\text{ V}$                          | 10              | 7.0   | —    | 7.0   | 5.50       | —    | 7.0   | —    |               |
|                              |             | $V_{OUT} = 1.5\text{ V}, 13.5\text{ V}$                         | 15              | 11.0  | —    | 11.0  | 8.25       | —    | 11.0  | —    |               |
|                              |             | $ I_{OUT}  < 1\text{ }\mu\text{A}$                              |                 |       |      |       |            |      |       |      |               |
| Input low voltage            | $V_{IL}$    | $V_{OUT} = 0.5\text{ V}, 4.5\text{ V}$                          | 5               | —     | 1.5  | —     | 2.25       | 1.5  | —     | 1.5  | V             |
|                              |             | $V_{OUT} = 1.0\text{ V}, 9.0\text{ V}$                          | 10              | —     | 3.0  | —     | 4.50       | 3.0  | —     | 3.0  |               |
|                              |             | $V_{OUT} = 1.5\text{ V}, 13.5\text{ V}$                         | 15              | —     | 4.0  | —     | 6.75       | 4.0  | —     | 4.0  |               |
|                              |             | $ I_{OUT}  < 1\text{ }\mu\text{A}$                              |                 |       |      |       |            |      |       |      |               |
| Input<br>current             | "H" level   | $I_{IH}$ $V_{IH} = 18\text{ V}$                                 | 18              | —     | 0.1  | —     | $10^{-5}$  | 0.1  | —     | 1.0  | $\mu\text{A}$ |
|                              | "L" level   | $I_{IL}$ $V_{IL} = 0\text{ V}$                                  | 18              | —     | -0.1 | —     | $-10^{-5}$ | -0.1 | —     | -1.0 |               |
| Quiescent supply<br>current  | $I_{DD}$    | $V_{IN} = V_{SS}, V_{DD}$<br>(Note)                             | 5               | —     | 5    | —     | 0.005      | 5    | —     | 150  | $\mu\text{A}$ |
|                              |             |                                                                 | 10              | —     | 10   | —     | 0.010      | 10   | —     | 300  |               |
|                              |             |                                                                 | 15              | —     | 20   | —     | 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) | $t_{TLH}$              | —              | 5       | —   | 70   | 200 | ns   |
|                                         |                        |                | 10      | —   | 35   | 100 |      |
|                                         |                        |                | 15      | —   | 30   | 80  |      |
| Output transition time<br>(high to low) | $t_{THL}$              | —              | 5       | —   | 70   | 200 | ns   |
|                                         |                        |                | 10      | —   | 35   | 100 |      |
|                                         |                        |                | 15      | —   | 30   | 80  |      |
| Propagation delay time                  | $t_{PLH}$<br>$t_{PHL}$ | —              | 5       | —   | 110  | 350 | ns   |
|                                         |                        |                | 10      | —   | 55   | 160 |      |
|                                         |                        |                | 15      | —   | 40   | 120 |      |
| Input capacitance                       | $C_{IN}$               | —              | —       | —   | 5    | 7.5 | pF   |

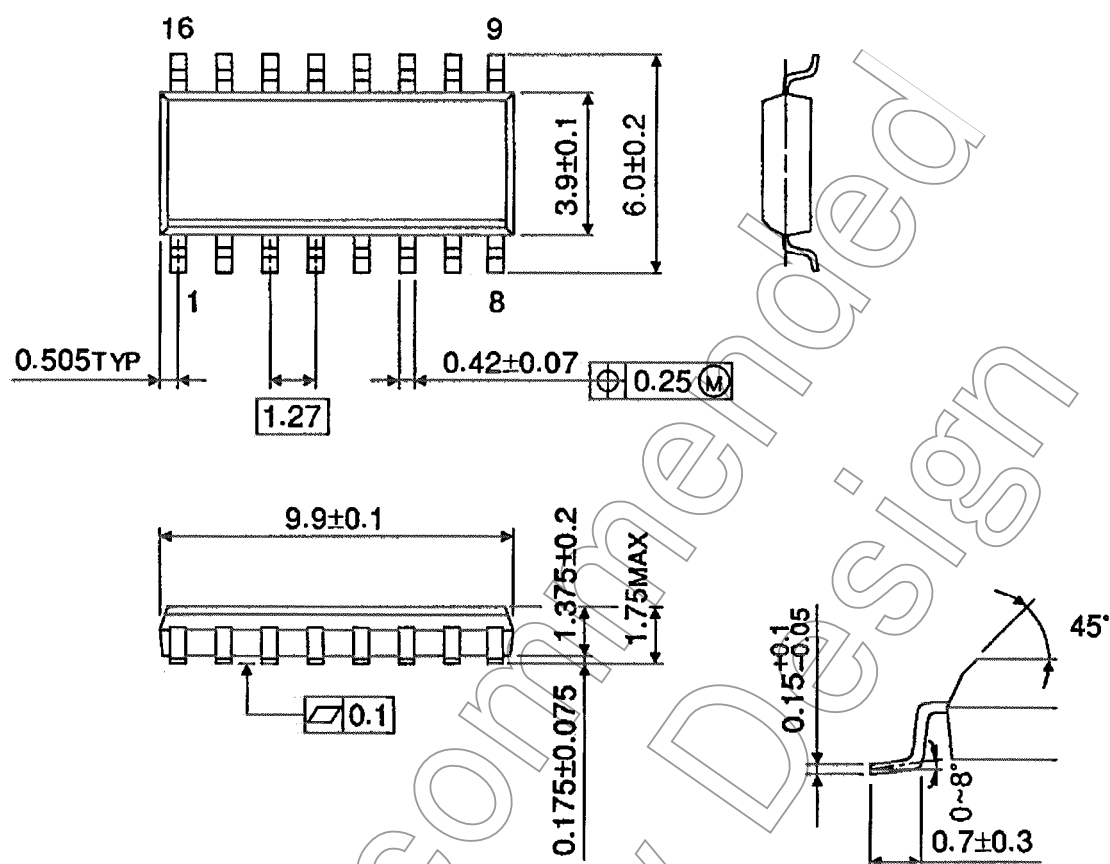
## Waveform for Measurement of Dynamic Characteristics



## Package Dimensions (Note)

SOL16-P-150-1.27

Unit : mm



Note: This package is not available in Japan.

Weight: 0.13 g (typ.)

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