

## TC74HC85AP, TC74HC85AF, TC74HC85AFN

### 4-Bit Magnitude Comparator

The TC74HC85A is a high speed CMOS 4 BIT MAGNITUDE COMPARATOR fabricated with silicon gate C<sup>2</sup>MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

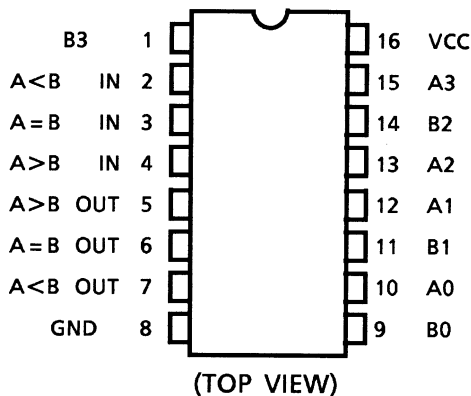
The TC74HC85A compares two 4-bit words applied to inputs A0-A3 and B0-B3, and provides a high voltage level on one of three outputs: A > B, A < B, or A = B.

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

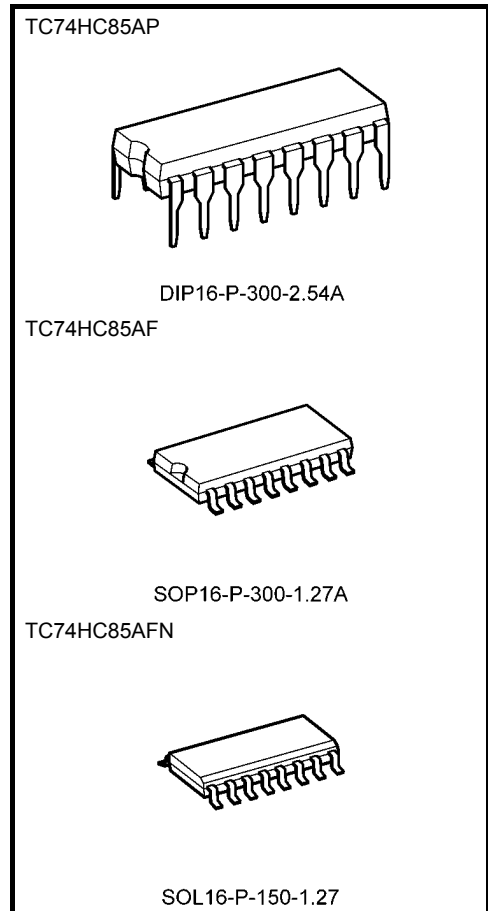
### Features

- High speed:  $t_{pd} = 22 \text{ ns}$  (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:  $V_{NIH} = V_{NIL} = 28\% V_{CC}$  (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:  $V_{CC} \text{ (opr)} = 2\sim 6 \text{ V}$
- Pin and function compatible with 74LS85

### Pin Assignment



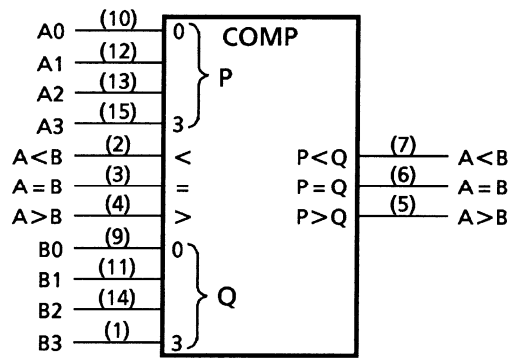
Note: xxxFN (JEDEC SOP) is not available in Japan.



### Weight

|                   |                 |
|-------------------|-----------------|
| DIP16-P-300-2.54A | : 1.00 g (typ.) |
| SOP16-P-300-1.27A | : 0.18 g (typ.) |
| SOL16-P-150-1.27  | : 0.13 g (typ.) |

IEC Logic Symbol

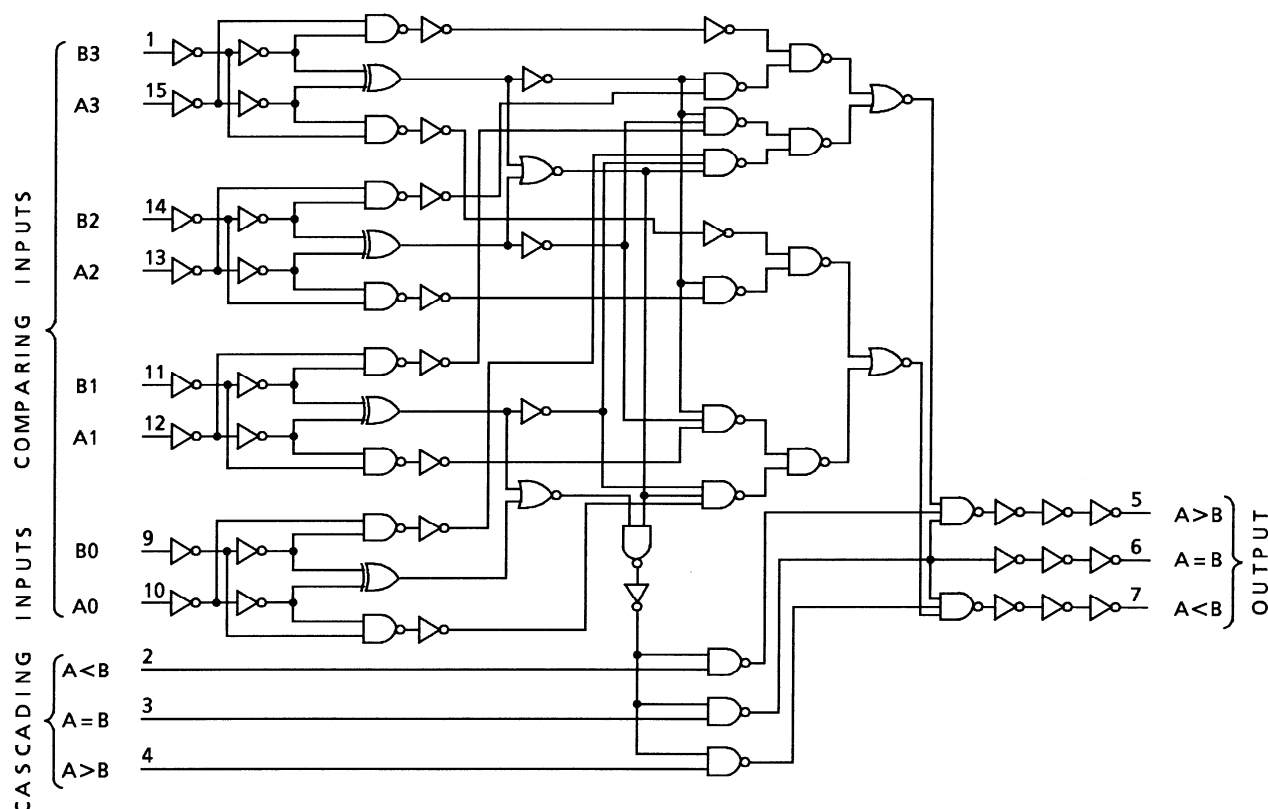


Truth Table

| Comparing Inputs                   |         |         |         | Cascading Inputs |       |       | Outputs |       |       |
|------------------------------------|---------|---------|---------|------------------|-------|-------|---------|-------|-------|
|                                    |         |         |         | A > B            | A < B | A = B | A > B   | A < B | A = B |
| A3 > B3                            | X       | X       | X       | X                | X     | X     | H       | L     | L     |
| A3 = B3                            | A2 > B2 | X       | X       | X                | X     | X     | H       | L     | L     |
| A3 = B3                            | A2 = B2 | A1 > B1 | X       | X                | X     | X     | H       | L     | L     |
| A3 = B3                            | A2 = B2 | A1 = B1 | A0 > B0 | X                | X     | X     | H       | L     | L     |
| A3 = B3, A2 = B2, A1 = B1, A0 = B0 |         |         |         | L                | L     | L     | H       | H     | L     |
|                                    |         |         |         | X                | X     | H     | L       | L     | H     |
|                                    |         |         |         | L                | H     | L     | L       | H     | L     |
|                                    |         |         |         | H                | L     | L     | H       | L     | L     |
|                                    |         |         |         | H                | H     | L     | L       | L     | L     |
| A3 = B3                            | A2 = B2 | A1 = B1 | A0 < B0 | X                | X     | X     | L       | H     | L     |
| A3 = B3                            | A2 = B2 | A1 < B1 | X       | X                | X     | X     | L       | H     | L     |
| A3 = B3                            | A2 < B2 | X       | X       | X                | X     | X     | L       | H     | L     |
| A3 < B3                            | X       | X       | X       | X                | X     | X     | L       | H     | L     |

X: Don't care

## System Diagram



## Absolute Maximum Ratings (Note 1)

| Characteristics             | Symbol    | Rating                       | Unit |
|-----------------------------|-----------|------------------------------|------|
| Supply voltage range        | $V_{CC}$  | -0.5~7                       | V    |
| DC input voltage            | $V_{IN}$  | -0.5~ $V_{CC}$ + 0.5         | V    |
| DC output voltage           | $V_{OUT}$ | -0.5~ $V_{CC}$ + 0.5         | V    |
| Input diode current         | $I_{IK}$  | ±20                          | mA   |
| Output diode current        | $I_{OK}$  | ±20                          | mA   |
| DC output current           | $I_{OUT}$ | ±25                          | mA   |
| DC $V_{CC}$ /ground current | $I_{CC}$  | ±50                          | mA   |
| Power dissipation           | $P_D$     | 500 (DIP) (Note 2)/180 (SOP) | mW   |
| Storage temperature         | $T_{stg}$ | -65~150                      | °C   |

Note 1: 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 2: 500 mW in the range of  $T_a = -40$  to  $65^\circ\text{C}$ . From  $T_a = 65$  to  $85^\circ\text{C}$  a derating factor of  $-10 \text{ mW}/^\circ\text{C}$  shall be applied until 300 mW.

## Operating Ranges (Note)

| Characteristics          | Symbol     | Rating                                                                               | Unit |
|--------------------------|------------|--------------------------------------------------------------------------------------|------|
| Supply voltage           | $V_{CC}$   | 2~6                                                                                  | V    |
| Input voltage            | $V_{IN}$   | 0~ $V_{CC}$                                                                          | V    |
| Output voltage           | $V_{OUT}$  | 0~ $V_{CC}$                                                                          | V    |
| Operating temperature    | $T_{opr}$  | -40~85                                                                               | °C   |
| Input rise and fall time | $t_r, t_f$ | 0~1000 ( $V_{CC} = 2.0$ V)<br>0~500 ( $V_{CC} = 4.5$ V)<br>0~400 ( $V_{CC} = 6.0$ V) | ns   |

Note: The operating ranges must be maintained to ensure the normal operation of the device.  
Unused inputs must be tied to either  $V_{CC}$  or GND.

## Electrical Characteristics

### DC Characteristics

| Characteristics           | Symbol   | Test Condition                |                             | $T_a = 25^\circ\text{C}$ |                      |                   | $T_a = -40\sim 85^\circ\text{C}$ |                      | Unit          |
|---------------------------|----------|-------------------------------|-----------------------------|--------------------------|----------------------|-------------------|----------------------------------|----------------------|---------------|
|                           |          |                               |                             | $V_{CC}$<br>(V)          | Min                  | Typ.              | Max                              | Min                  | Max           |
| High-level input voltage  | $V_{IH}$ | —                             |                             | 2.0<br>4.5<br>6.0        | 1.50<br>3.15<br>4.20 | —<br>—<br>—       | —<br>—<br>—                      | 1.50<br>3.15<br>4.20 | V             |
| Low-level input voltage   | $V_{IL}$ | —                             |                             | 2.0<br>4.5<br>6.0        | —<br>—<br>—          | —<br>—<br>—       | 0.50<br>1.35<br>1.80             | —<br>—<br>—          | V             |
| High-level output voltage | $V_{OH}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OH} = -20\ \mu\text{A}$ | 2.0<br>4.5<br>6.0        | 1.9<br>4.4<br>5.9    | 2.0<br>4.5<br>6.0 | —<br>—<br>—                      | 1.9<br>4.4<br>5.9    | V             |
|                           |          |                               | $I_{OH} = -4\ \text{mA}$    | 4.5<br>6.0               | 4.18<br>5.68         | 4.31<br>5.80      | —<br>—                           | 4.13<br>5.63         |               |
|                           |          |                               | $I_{OH} = -5.2\ \text{mA}$  | 6.0                      | 5.68                 | 5.80              | —                                | 5.63                 |               |
| Low-level output voltage  | $V_{OL}$ | $V_{IN} = V_{IH}$ or $V_{IL}$ | $I_{OL} = 20\ \mu\text{A}$  | 2.0<br>4.5<br>6.0        | —<br>—<br>—          | 0.0<br>0.0<br>0.0 | 0.1<br>0.1<br>0.1                | —<br>—<br>—          | V             |
|                           |          |                               | $I_{OL} = 4\ \text{mA}$     | 4.5<br>6.0               | —<br>—               | 0.17<br>0.18      | 0.26<br>0.26                     | —<br>—               | 0.33<br>0.33  |
|                           |          |                               | $I_{OL} = 5.2\ \text{mA}$   | 6.0                      | —                    | 0.18              | 0.26                             | —                    | 0.33          |
| Input leakage current     | $I_{IN}$ | $V_{IN} = V_{CC}$ or GND      |                             | 6.0                      | —                    | —                 | $\pm 0.1$                        | —                    | $\mu\text{A}$ |
| Quiescent supply current  | $I_{CC}$ | $V_{IN} = V_{CC}$ or GND      |                             | 6.0                      | —                    | —                 | 4.0                              | —                    | $\mu\text{A}$ |

## 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>(A, B-OUT)    | $t_{pLH}$<br>$t_{pHL}$ | —              | —   | 22   | 34  | ns   |
| Propagation delay time<br>(CASCADE-OUT) | $t_{pLH}$<br>$t_{pHL}$ | —              | —   | 10   | 18  | ns   |

## AC Characteristics ( $C_L = 50 \text{ pF}$ , input: $t_r = t_f = 6 \text{ ns}$ )

| Characteristics                         | Symbol                 | Test Condition | $T_a = 25^\circ\text{C}$ |     |      | $T_a = -40 \sim 85^\circ\text{C}$ |     | Unit |
|-----------------------------------------|------------------------|----------------|--------------------------|-----|------|-----------------------------------|-----|------|
|                                         |                        |                | $V_{CC}$<br>(V)          | Min | Typ. | Max                               | Min | Max  |
| Output transition time                  | $t_{TLH}$<br>$t_{THL}$ | —              | 2.0                      | —   | 30   | 75                                | —   | 95   |
|                                         |                        |                | 4.5                      | —   | 8    | 15                                | —   | 19   |
|                                         |                        |                | 6.0                      | —   | 7    | 13                                | —   | 16   |
| Propagation delay time<br>(A, B-OUT)    | $t_{pLH}$<br>$t_{pHL}$ | —              | 2.0                      | —   | 90   | 195                               | —   | 245  |
|                                         |                        |                | 4.5                      | —   | 26   | 39                                | —   | 49   |
|                                         |                        |                | 6.0                      | —   | 22   | 33                                | —   | 42   |
| Propagation delay time<br>(CASCADE-OUT) | $t_{pLH}$<br>$t_{pHL}$ | —              | 2.0                      | —   | 40   | 110                               | —   | 140  |
|                                         |                        |                | 4.5                      | —   | 13   | 22                                | —   | 28   |
|                                         |                        |                | 6.0                      | —   | 11   | 19                                | —   | 24   |
| Input capacitance                       | $C_{IN}$               | —              | —                        | 5   | 10   | —                                 | 10  | pF   |
| Power dissipation capacitance           | $C_{PD}$<br>(Note)     | —              | —                        | 25  | —    | —                                 | —   | pF   |

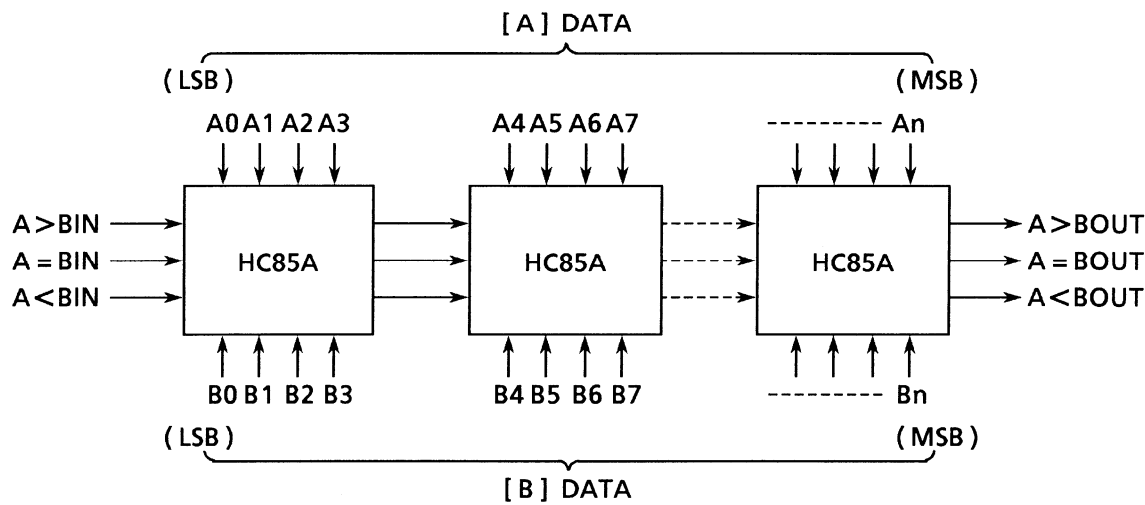
Note:  $C_{PD}$  is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

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

Typical Application

N – BIT CASCADING CONNECTION

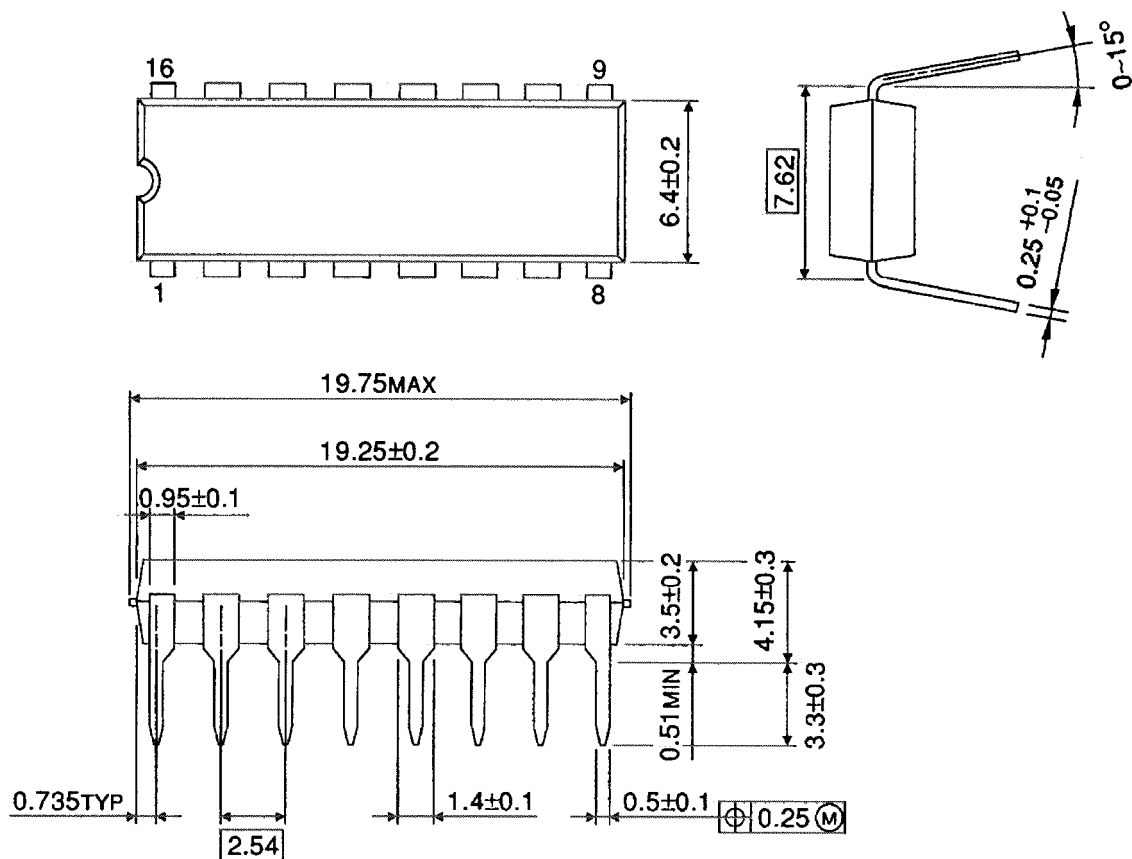


| Comparing Input | Cascading Inputs |       |       | Outputs |       |       |
|-----------------|------------------|-------|-------|---------|-------|-------|
|                 | A > B            | A = B | A < B | A > B   | A = B | A < B |
| [A] > [B]       | X                | X     | X     | H       | L     | L     |
| [A] = [B]       | H                | L     | L     | H       | L     | L     |
|                 | X                | H     | X     | L       | H     | L     |
|                 | L                | L     | H     | L       | L     | H     |
| [A] < [B]       | X                | X     | X     | L       | L     | H     |

X: Don't care

DIP16-P-300-2.54A

Unit : mm

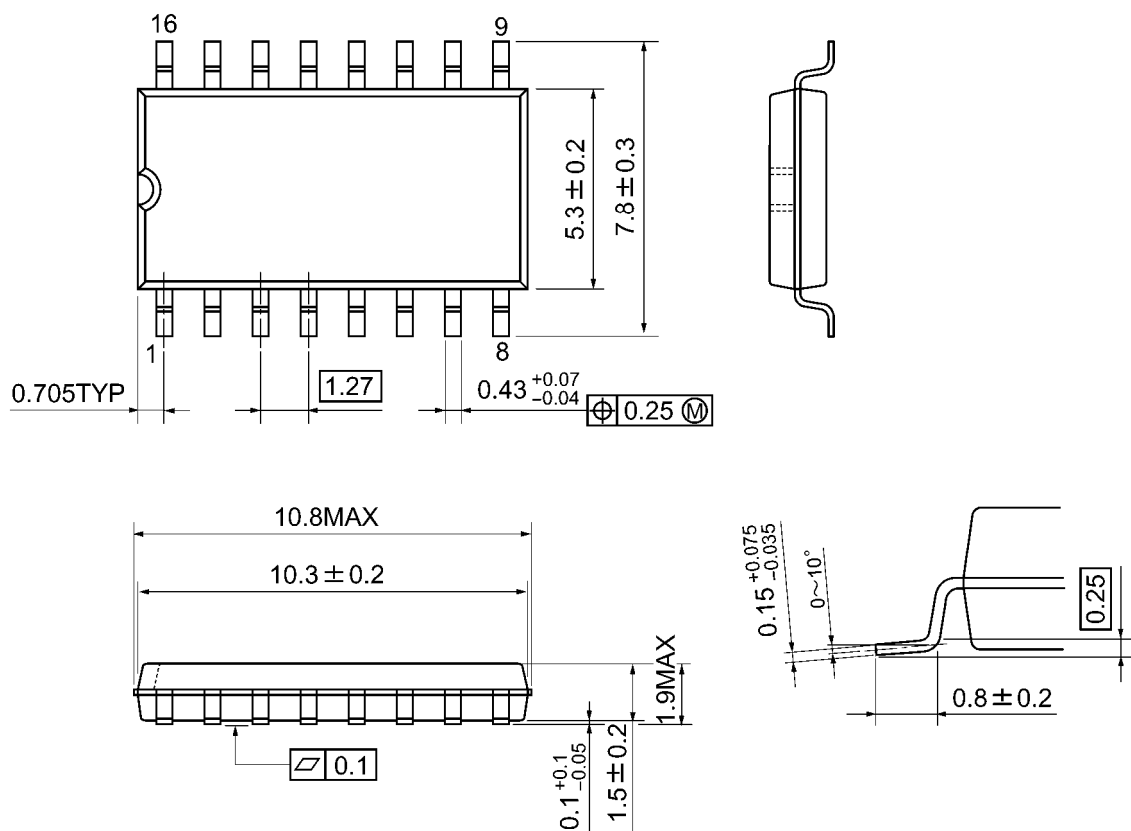


Weight: 1.00 g (typ.)

## Package Dimensions

SOP16-P-300-1.27A

Unit: mm

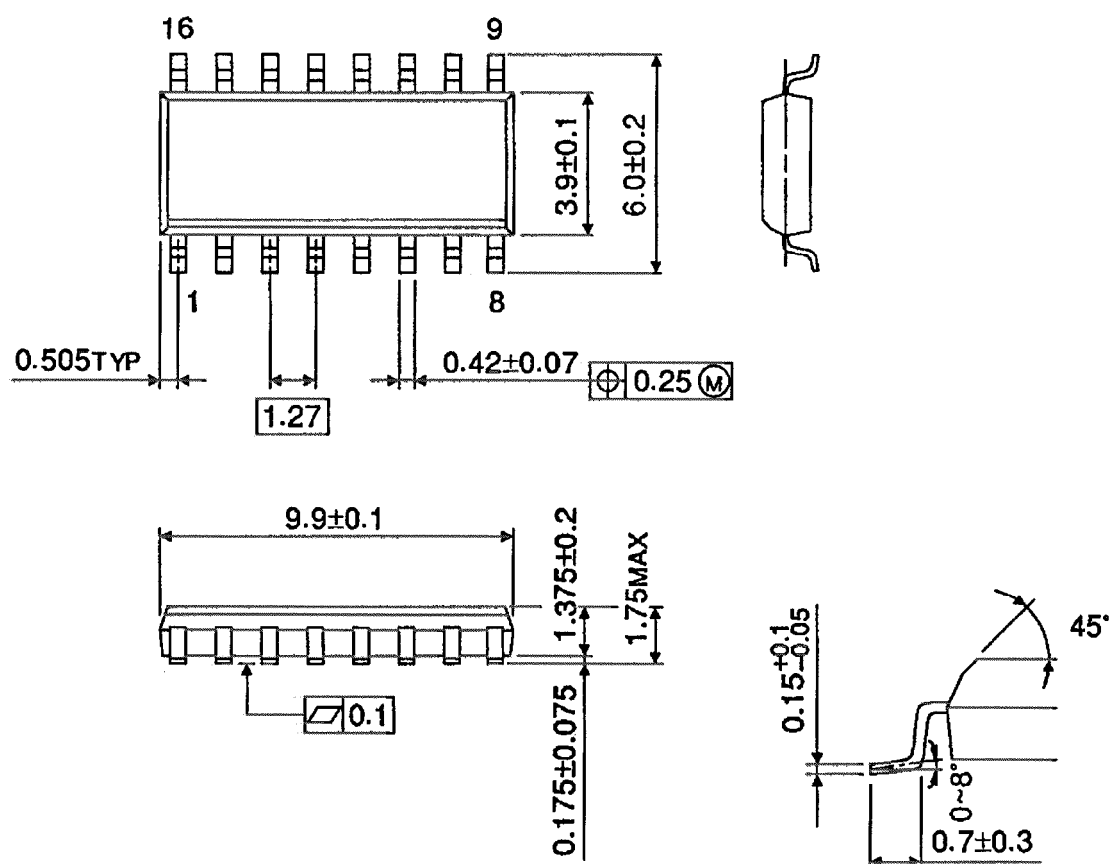


Weight: 0.18 g (typ.)

## 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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