

# HD74LS85

## 4-bit Magnitude Comparator

REJ03D0421-0200

Rev.2.00

Feb.18.2005

This four bit magnitude comparator performs comparison of straight binary and straight BCD (8-4-2-1) codes. Three fully decoded decisions about two 4-bit words (A, B) are made and are externally available at three outputs. This device is fully expandable to any number of bits without external gates. Words of greater length may be compared by connecting comparators in cascade. The A > B, A < B, and A = B outputs of a stage handling less-significant bits. The stage handling the least- significant bits must have a high-level voltage applied to the A  $\beta$  B input. The cascading path is implemented with only a two-gate-level delay to reduce overall comparison times for long words.

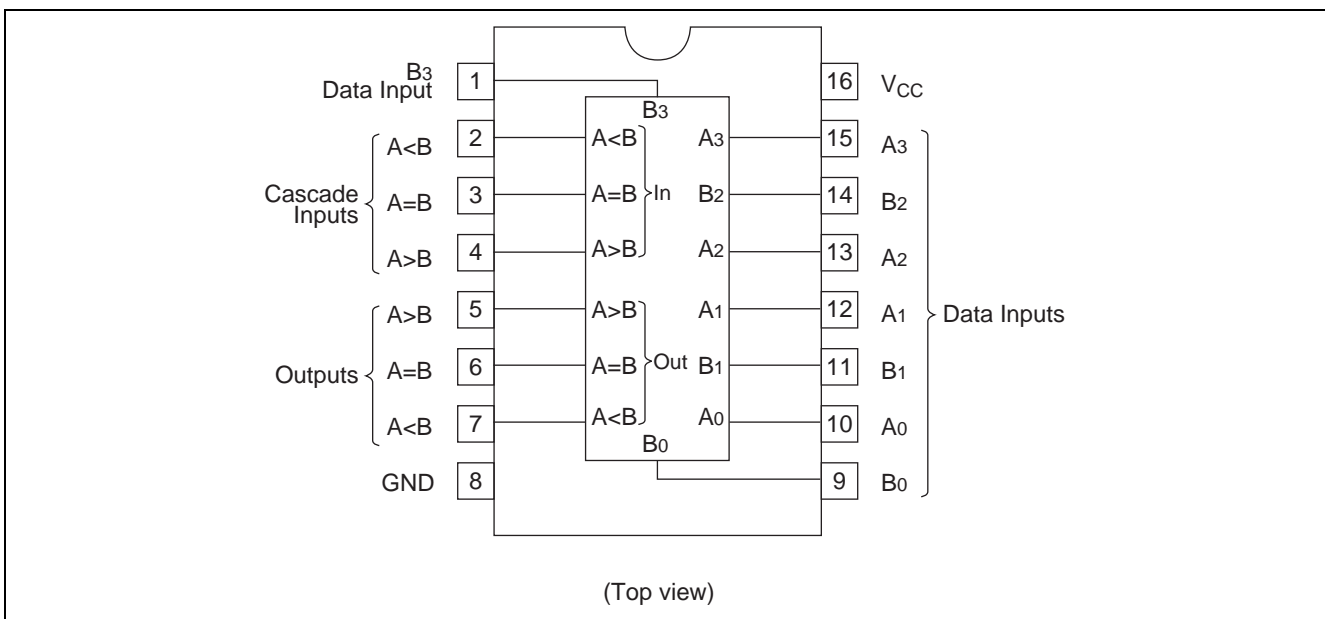
### Features

- Ordering Information

| Part Name    | Package Type       | Package Code (Previous Code) | Package Abbreviation | Taping Abbreviation (Quantity) |
|--------------|--------------------|------------------------------|----------------------|--------------------------------|
| HD74LS85P    | DILP-16 pin        | PRDP0016AE-B (DP-16FV)       | P                    | —                              |
| HD74LS85FPEL | SOP-16 pin (JEITA) | PRSP0016DH-B (FP-16DAV)      | FP                   | EL (2,000 pcs/reel)            |

Note: Please consult the sales office for the above package availability.

### Pin Arrangement

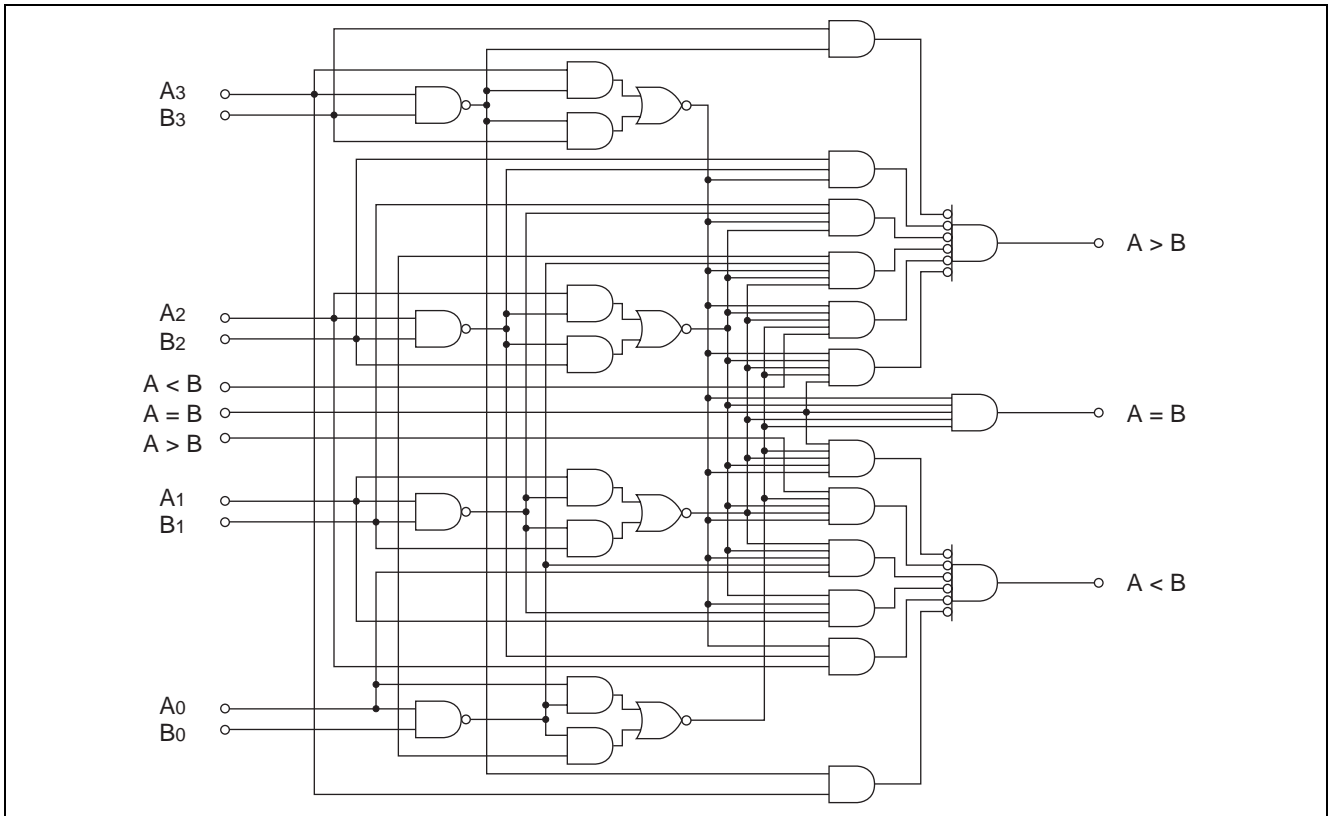


Function Table

| Inputs                          |                                 |                                 |                                 | Cascading Inputs |       |       | Outputs |       |       |
|---------------------------------|---------------------------------|---------------------------------|---------------------------------|------------------|-------|-------|---------|-------|-------|
| A <sub>3</sub> , B <sub>3</sub> | A <sub>2</sub> , B <sub>2</sub> | A <sub>1</sub> , B <sub>1</sub> | A <sub>0</sub> , B <sub>0</sub> | A > B            | A < B | A = B | A > B   | A < B | A = B |
| A <sub>3</sub> > B <sub>3</sub> | X                               | X                               | X                               | X                | X     | X     | H       | L     | L     |
| A <sub>3</sub> < B <sub>3</sub> | X                               | X                               | X                               | X                | X     | X     | L       | H     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> > B <sub>2</sub> | X                               | X                               | X                | X     | X     | H       | L     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> < B <sub>2</sub> | X                               | X                               | X                | X     | X     | L       | H     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> > B <sub>1</sub> | X                               | X                | X     | X     | H       | L     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> < B <sub>1</sub> | X                               | X                | X     | X     | L       | H     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> > B <sub>0</sub> | X                | X     | X     | H       | L     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> < B <sub>0</sub> | X                | X     | X     | L       | H     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> = B <sub>0</sub> | H                | L     | L     | H       | L     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> = B <sub>0</sub> | L                | H     | L     | L       | H     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> = B <sub>0</sub> | X                | X     | H     | L       | L     | H     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> = B <sub>0</sub> | H                | H     | L     | L       | L     | L     |
| A <sub>3</sub> = B <sub>3</sub> | A <sub>2</sub> = B <sub>2</sub> | A <sub>1</sub> = B <sub>1</sub> | A <sub>0</sub> = B <sub>0</sub> | L                | L     | L     | H       | H     | L     |

H; high level, L; low level, X; irrelevant

Block Diagram



Absolute Maximum Ratings

| Item                | Symbol           | Ratings     | Unit |
|---------------------|------------------|-------------|------|
| Supply voltage      | V <sub>CC</sub>  | 7           | V    |
| Input voltage       | V <sub>IN</sub>  | 7           | V    |
| Power dissipation   | P <sub>T</sub>   | 400         | mW   |
| Storage temperature | T <sub>stg</sub> | -65 to +150 | °C   |

Note: Voltage value, unless otherwise noted, are with respect to network ground terminal.

**Recommended Operating Conditions**

| Item                  | Symbol    | Min  | Typ  | Max  | Unit        |
|-----------------------|-----------|------|------|------|-------------|
| Supply voltage        | $V_{CC}$  | 4.75 | 5.00 | 5.25 | V           |
| Output current        | $I_{OH}$  | —    | —    | -400 | $\mu A$     |
|                       | $I_{OL}$  | —    | —    | 8    | mA          |
| Operating temperature | $T_{opr}$ | -20  | 25   | 75   | $^{\circ}C$ |

**Electrical Characteristics**

( $T_a = -20$  to  $+75^{\circ}C$ )

| Item                         | Symbol              | min.     | typ.*        | max. | Unit | Condition  |                                |
|------------------------------|---------------------|----------|--------------|------|------|--|--------------------------------|
| Input voltage                | $V_{IH}$            | 2.0      | —            | —    | V    |  |                                |
|                              | $V_{IL}$            | —        | —            | 0.8  | V    |  |                                |
| Output voltage               | $V_{OH}$            | 2.7      | —            | —    | V    | $V_{CC} = 4.75 V, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = -400 \mu A$ |                                |
|                              | $V_{OL}$            | —        | —            | 0.4  | V    | $I_{OL} = 4 mA, V_{CC} = 4.75 V, V_{IH} = 2 V, V_{IL} = 0.8 V$       |                                |
|                              |                     | —        | —            | 0.5  |      |  |                                |
| Input current                | A < B, A > B inputs | $I_{IH}$ | —            | —    | 20   | $\mu A$  | $V_{CC} = 5.25 V, V_I = 2.7 V$ |
|                              |                     |          | Other inputs | —    | —    |  |                                |
|                              | A < B, A > B inputs | $I_{IL}$ | —            | —    | -0.4 | mA   | $V_{CC} = 5.25 V, V_I = 0.4 V$ |
|                              |                     |          | Other inputs | —    | —    |  |                                |
|                              | A < B, A > B inputs | $I_I$    | —            | —    | 0.1  | mA   | $V_{CC} = 5.25 V, V_I = 7 V$   |
| Other inputs                 |                     |          | —            | —    | 0.3  |  |                                |
| Short-circuit output current | $I_{OS}$            | -20      | —            | -100 | mA   | $V_{CC} = 5.25 V$  |                                |
| Supply current**             | $I_{CC}$            | —        | 10.4         | 20   | mA   | $V_{CC} = 5.25 V$  |                                |
| Input clamp voltage          | $V_{IK}$            | —        | —            | -1.5 | V    | $V_{CC} = 4.75 V, I_{IN} = -18 mA$                                   |                                |

Note: \*  $V_{CC} = 5 V, T_a = 25^{\circ}C$

\*\*  $I_{CC}$  is measured with outputs open, A = B grounded, and all other inputs at 4.5 V.

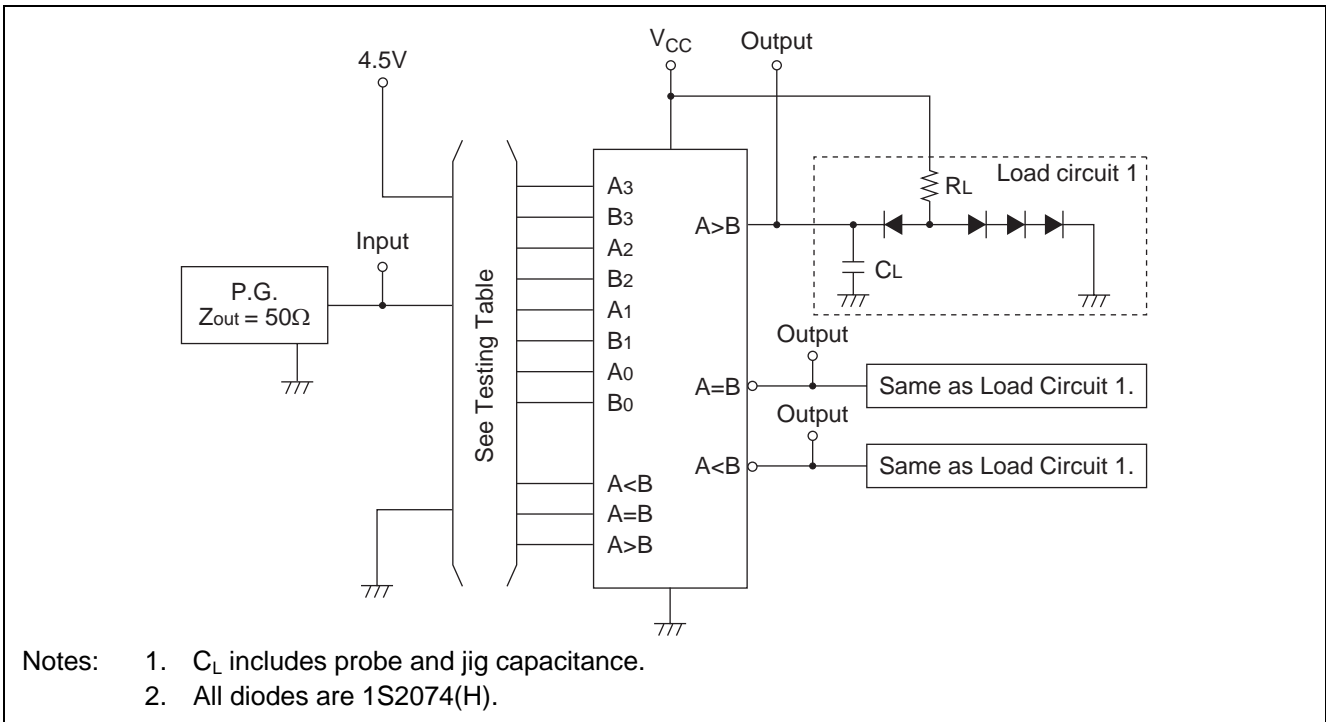
**Switching Characteristics**

( $V_{CC} = 5 V, T_a = 25^{\circ}C$ )

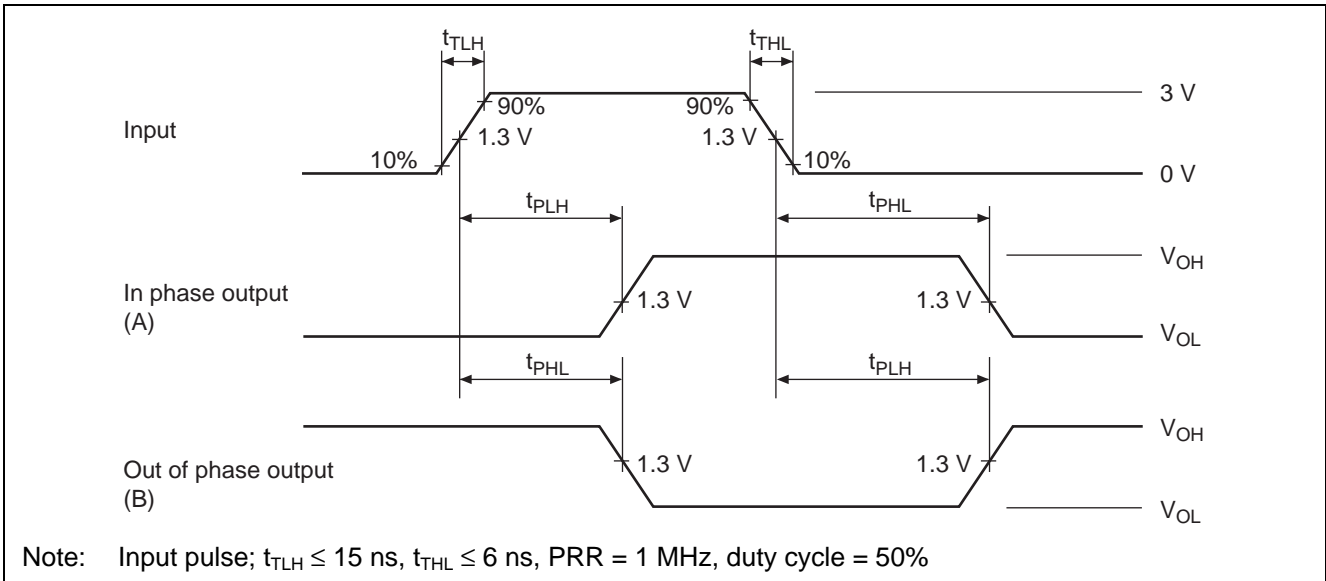
| Item                   | Symbol         | Inputs                | Outputs      | Number of gate levels | min. | typ. | max. | Unit | Condition                      |
|------------------------|----------------|-----------------------|--------------|-----------------------|------|------|------|------|--------------------------------|
| Propagation delay time | $t_{PLH}$      | Any A or B data input | A < B, A > B | 1                     | —    | 14   | —    | ns   | $C_L = 15 pF, R_L = 2 k\Omega$ |
|                        |                |                       |              | 2                     | —    | 19   | —    |      |                                |
|                        |                |                       | 3            | —                     | 24   | 36   |      |      |                                |
|                        |                |                       | A = B        | 4                     | —    | 27   | 45   |      |                                |
|                        | $t_{PHL}$      | Any A or B data input | A < B, A > B | 1                     | —    | 11   | —    |      |                                |
|                        |                |                       |              | 2                     | —    | 15   | —    |      |                                |
|                        |                |                       | 3            | —                     | 20   | 30   |      |      |                                |
|                        |                |                       | A = B        | 4                     | —    | 23   | 45   |      |                                |
|                        | $t_{PHL}$      | A < B or A = B        | A > B        | 1                     | —    | 14   | 22   |      |                                |
|                        | 1              |                       |              | —                     | 11   | 17   |      |      |                                |
|                        | $t_{PLH}$      | A = B                 | A = B        | 2                     | —    | 13   | 20   |      |                                |
|                        | 2              |                       |              | —                     | 13   | 26   |      |      |                                |
| $t_{PLH}$              | A > B or A = B | A < B                 | 1            | —                     | 14   | 22   |      |      |                                |
| 1                      |                |                       | —            | 11                    | 17   |      |      |      |                                |

## Testing Method

### Test Circuit



### Waveform

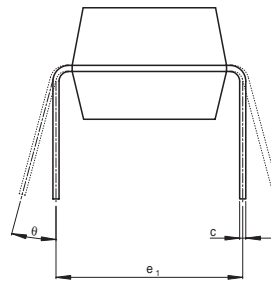
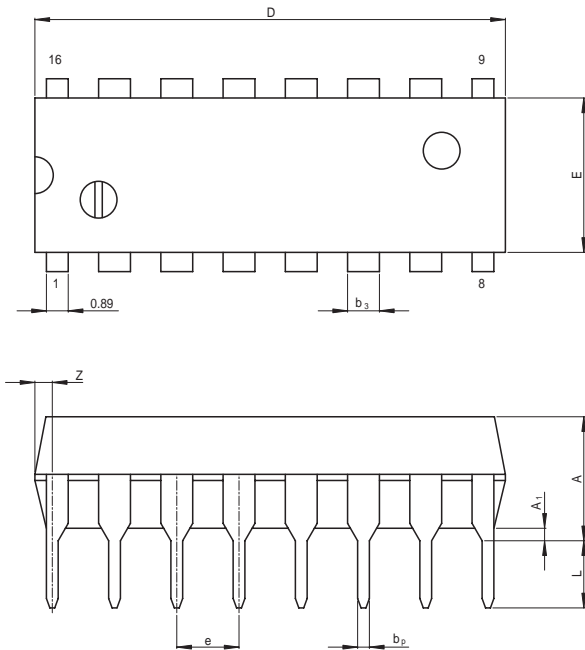


Testing Table

| Item                                 | Inputs         |                |                |                |                |                |                |                |       |       | Output waveforms |       |       |       |
|--------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|-------|-------|------------------|-------|-------|-------|
|                                      | A <sub>3</sub> | B <sub>3</sub> | A <sub>2</sub> | B <sub>2</sub> | A <sub>1</sub> | B <sub>1</sub> | A <sub>0</sub> | B <sub>0</sub> | A > B | A = B | A < B            | A > B | A = B | A < B |
| t <sub>PLH</sub><br>t <sub>PHL</sub> | IN             | 4.5 v          | 4.5 v          | GND            | GND            | GND            | GND            | GND            | GND   | GND   | GND              | A     | —     | B     |
|                                      | 4.5 v          | IN             | GND            | 4.5 v          | GND            | GND            | GND            | GND            | GND   | GND   | GND              | B     | —     | A     |
|                                      | GND            | GND            | IN             | 4.5 v          | 4.5 v          | GND            | GND            | GND            | GND   | GND   | GND              | A     | —     | B     |
|                                      | GND            | GND            | 4.5 v          | IN             | GND            | 4.5 v          | GND            | GND            | GND   | GND   | GND              | B     | —     | A     |
|                                      | GND            | GND            | GND            | GND            | IN             | 4.5 v          | 4.5 v          | GND            | GND   | GND   | GND              | A     | —     | B     |
|                                      | GND            | GND            | GND            | GND            | 4.5 v          | IN             | GND            | 4.5 v          | GND   | GND   | GND              | B     | —     | A     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | IN             | 4.5 v          | 4.5 v | GND   | GND              | A     | —     | B     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | 4.5 v          | IN             | GND   | GND   | 4.5 v            | B     | —     | A     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | IN             | 4.5 v          | GND   | 4.5 v | GND              | —     | A     | B     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | 4.5 v          | IN             | GND   | 4.5 v | GND              | B     | A     | —     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | GND            | GND            | IN    | GND   | GND              | —     | —     | B     |
|                                      | GND            | GND            | GND            | GND            | GND            | GND            | GND            | GND            | GND   | IN    | GND              | B     | A     | B     |
| GND                                  | GND            | GND            | GND            | GND            | GND            | GND            | GND            | GND            | GND   | IN    | B                | —     | —     |       |

Package Dimensions

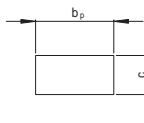
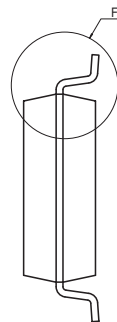
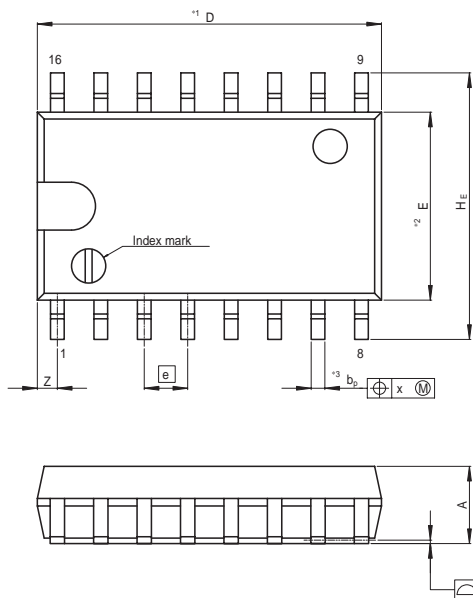
|                       |              |               |            |
|-----------------------|--------------|---------------|------------|
| JEITA Package Code    | RENESAS Code | Previous Code | MASS[Typ.] |
| P-DIP16-6.3x19.2-2.54 | PRDP0016AE-B | DP-16FV       | 1.05g      |



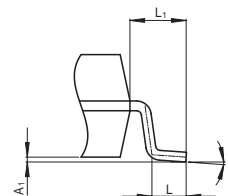
( Ni/Pd/Au plating )

| Reference Symbol | Dimension in Millimeters |      |       |
|------------------|--------------------------|------|-------|
|                  | Min                      | Nom  | Max   |
| e <sub>1</sub>   | —                        | 7.62 | —     |
| D                | —                        | 19.2 | 20.32 |
| E                | —                        | 6.3  | 7.4   |
| A                | —                        | —    | 5.06  |
| A <sub>1</sub>   | 0.51                     | —    | —     |
| b <sub>P</sub>   | 0.40                     | 0.48 | 0.56  |
| b <sub>3</sub>   | —                        | 1.30 | —     |
| c                | 0.19                     | 0.25 | 0.31  |
| θ                | 0°                       | —    | 15°   |
| e                | 2.29                     | 2.54 | 2.79  |
| Z                | —                        | —    | 1.12  |
| L                | 2.54                     | —    | —     |

|                        |              |               |            |
|------------------------|--------------|---------------|------------|
| JEITA Package Code     | RENESAS Code | Previous Code | MASS[Typ.] |
| P-SOP16-5.5x10.06-1.27 | PRSP0016DH-B | FP-16DAV      | 0.24g      |



Terminal cross section  
( Ni/Pd/Au plating )



Detail F

NOTE)  
1. DIMENSIONS\*1 (Nom)\*AND\*2\*  
DO NOT INCLUDE MOLD FLASH.  
2. DIMENSION\*3\*DOES NOT  
INCLUDE TRIM OFFSET.

| Reference Symbol | Dimension in Millimeters |       |      |
|------------------|--------------------------|-------|------|
|                  | Min                      | Nom   | Max  |
| D                | —                        | 10.06 | 10.5 |
| E                | —                        | 5.50  | —    |
| A <sub>2</sub>   | —                        | —     | —    |
| A <sub>1</sub>   | 0.00                     | 0.10  | 0.20 |
| A                | —                        | —     | 2.20 |
| b <sub>P</sub>   | 0.34                     | 0.40  | 0.46 |
| b <sub>1</sub>   | —                        | —     | —    |
| c                | 0.15                     | 0.20  | 0.25 |
| c <sub>1</sub>   | —                        | —     | —    |
| θ                | 0°                       | —     | 8°   |
| H <sub>E</sub>   | 7.50                     | 7.80  | 8.00 |
| e                | —                        | 1.27  | —    |
| x                | —                        | —     | 0.12 |
| y                | —                        | —     | 0.15 |
| Z                | —                        | —     | 0.80 |
| L                | 0.50                     | 0.70  | 0.90 |
| L <sub>1</sub>   | —                        | 1.15  | —    |

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