# HD74AC138/HD74ACT138

## 1-of-8 Decoder/Demultiplexer

REJ03D0248–0200Z
(Previous ADE-205-368 (Z))
Rev.2.00
Jul.16.2004

## Description

The HD74AC138/HD74ACT138 is a high-speed 1-of-8 decoder/demultiplexer. This device is ideally suited for high-speed bipolar memory chip select address decoding. The multiple input enables allow parallel expansion to a 1-of-24 decoder using just three HD74AC138/HD74ACT138 devices or a 1-of-32 decoder using four HD74AC138/HD74ACT138 devices and one inverter.

## Features

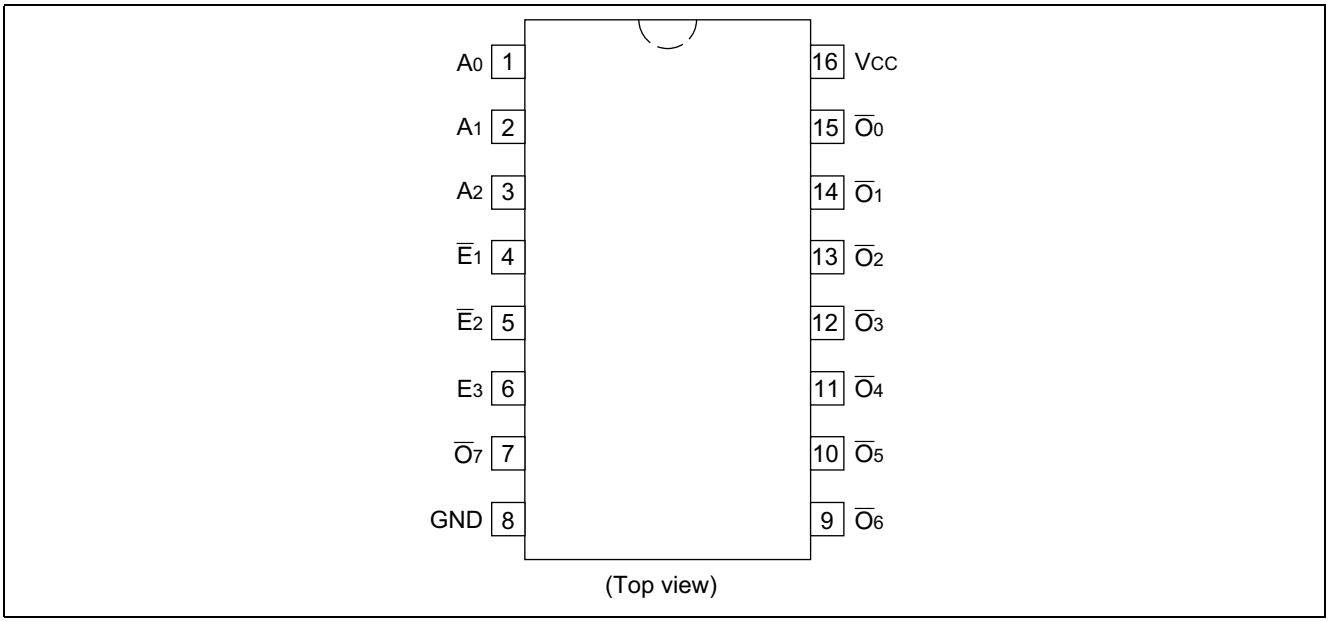
- Demultiplexing Capability
- Multiple Input Enable for Easy Expansion
- Active LOW Mutually Exclusive Outputs
- Outputs Source/Sink 24 mA
- HD74ACT138 has TTL-Compatible Inputs

- Ordering Information: Ex. HD74AC138

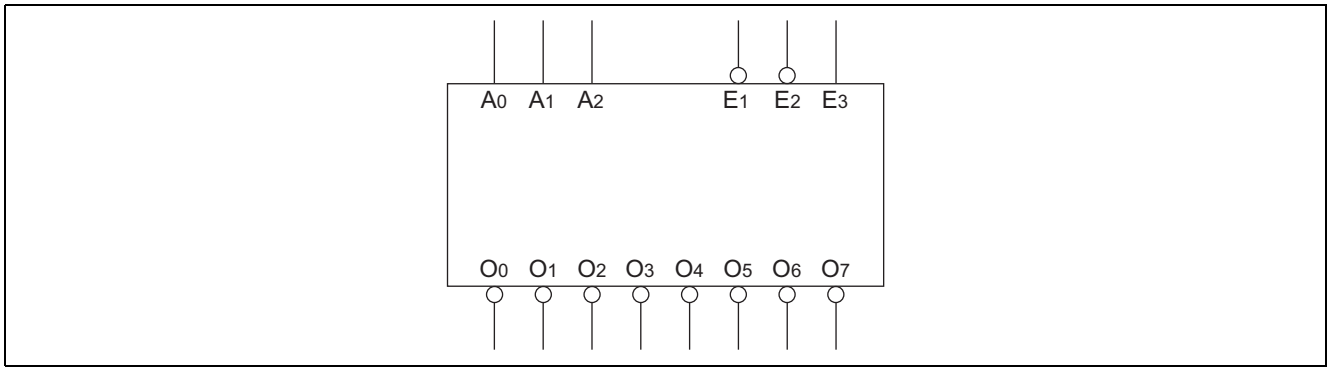
| Part Name | Package Type | Package Code | Package Abbreviation | Taping Abbreviation (Quantity) |
|---|---|---|---|---|
| HD74AC138AP | DIP-16 pin | DP-16E, -16FV | P | — |
| HD74AC138AFPEL | SOP-16 pin (JEITA) | FP-16DAV | FP | EL (2,000 pcs/reel) |
| HD74AC138ARPEL | SOP-16 pin (JEDEC) | FP-16DNV | RP | EL (2,500 pcs/reel) |
| HD74AC138TELL | TSSOP-16 pin | TTP-16DAV | T | ELL(2,000 pcs/reel) |

Notes: 1. Please consult the sales office for the above package availability.
2. The packages with lead-free pins are distinguished from the conventional products by adding V at the end of the package code.

## Pin Arrangement



## Logic Symbol




## Pin Names

| | |
|---|---|
| $A_0$ to $A_2$ | Address Inputs |
| $\overline{E}_1$ to $\overline{E}_2$ | Enable Inputs |
| $E_3$ | Enable Input |
| $\overline{O}_0$ to $\overline{O}_7$ | Outputs |

## Functional Description

The HD74AC138/HD74ACT138 high-speed 1-of-8 decoder/demultiplexer accepts three binary weighted inputs ($A_0$, $A_1$, $A_2$) and, when enabled, provides eight mutually exclusive active-LOW outputs ($\overline{O}_0$ to $\overline{O}_7$). The HD74AC138/HD74ACT138 features three Enable inputs, two active-Low ($\overline{E}_1$, $\overline{E}_2$) and one active-High ($E_3$). All outputs will be High unless $\overline{E}_1$ and $\overline{E}_2$ are Low and $E_3$ is High. This multiple enabled function allows easy parallel expansion of the device to a 1-of-32 (5 lines to 32 lines) decoder with just four HD74AC138/HD74ACT138 devices and one inverter (See Figure a). The HD74AC138/HD74ACT138 can be used as an 8-output demultiplexer by using one of the active Low Enable inputs as the data input and the other Enable inputs as strobes. The Enables inputs which are not used must be permanently tied to their appropriate active-High or active-Low state.

## Truth Table

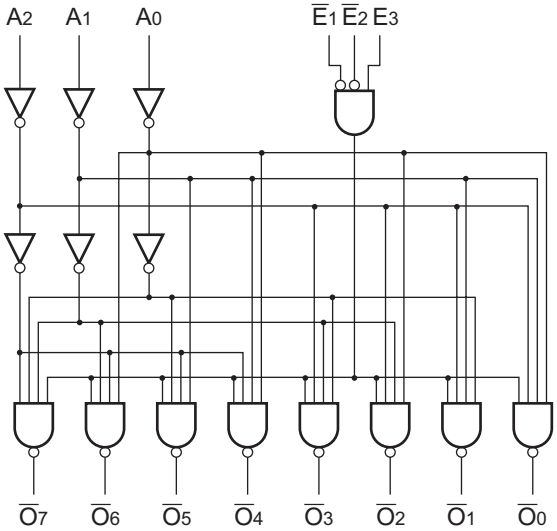
| Inputs | | | | | | Outputs | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\overline{E}_1$ | $\overline{E}_2$ | $E_3$ | $A_0$ | $A_1$ | $A_2$ | $\overline{O}_0$ | $\overline{O}_1$ | $\overline{O}_2$ | $\overline{O}_3$ | $\overline{O}_4$ | $\overline{O}_5$ | $\overline{O}_6$ | $\overline{O}_7$ |
| H | X | X | X | X | X | H | H | H | H | H | H | H | H |
| X | H | X | X | X | X | H | H | H | H | H | H | H | H |
| X | X | L | X | X | X | H | H | H | H | H | H | H | H |
| L | L | H | L | L | L | L | H | H | H | H | H | H | H |
| L | L | H | H | L | L | H | L | H | H | H | H | H | H |
| L | L | H | L | H | L | H | H | L | H | H | H | H | H |
| L | L | H | H | H | L | H | H | H | L | H | H | H | H |
| L | L | H | L | L | H | H | H | H | H | L | H | H | H |
| L | L | H | H | L | H | H | H | H | H | H | L | H | H |
| L | L | H | L | H | H | H | H | H | H | H | H | L | H |
| L | L | H | H | H | H | H | H | H | H | H | H | H | L |

H : High Voltage Level

L : Low Voltage Level

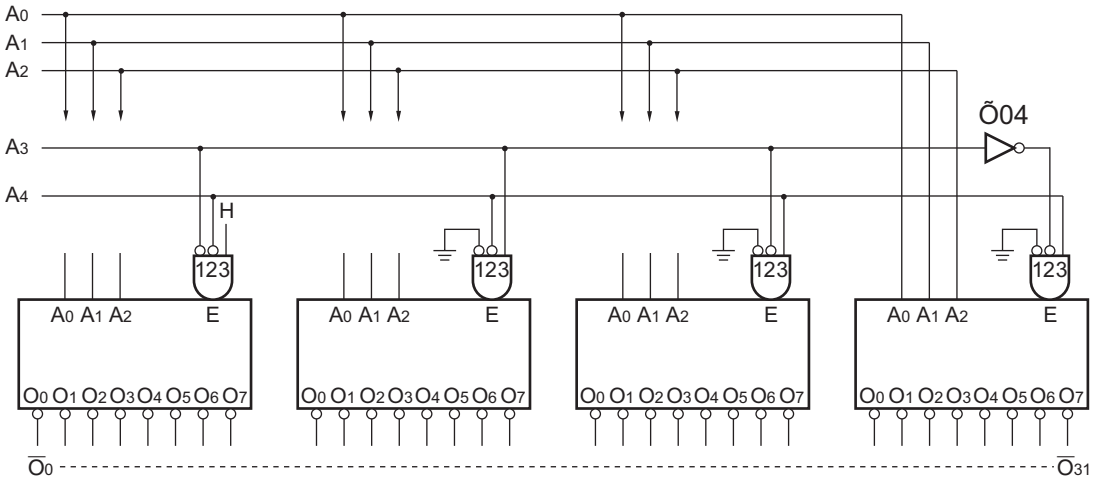
X : Immaterial

## Logic Diagram




Please note that this diagram is provided only for the understanding of logic operations and should not be used to estimate propagation delays.

## Figure a: Expansion of 1-of-32 Decoding




## Absolute Maximum Ratings

| Item | Symbol | Ratings | Unit | Condition |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | –0.5 to 7 | V | |
| DC input diode current | $I_{IK}$ | –20 | mA | $V_I$ = –0.5V |
| | | 20 | mA | $V_I$ = Vcc+0.5V |
| DC input voltage | $V_I$ | –0.5 to Vcc+0.5 | V | |
| DC output diode current | $I_{OK}$ | –50 | mA | $V_O$ = –0.5V |
| | | 50 | mA | $V_O$ = Vcc+0.5V |
| DC output voltage | $V_O$ | –0.5 to Vcc+0.5 | V | |
| DC output source or sink current | $I_O$ | ±50 | mA | |
| DC $V_{CC}$ or ground current per output pin | $I_{CC}$, $I_{GND}$ | ±50 | mA | |
| Storage temperature | Tstg | –65 to +150 | °C | |

## Recommended Operating Conditions: HD74AC138

| Item | Symbol | Ratings | Unit | Condition |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 2 to 6 | V | |
| Input and output voltage | $V_I$, $V_O$ | 0 to $V_{CC}$ | V | |
| Operating temperature | Ta | –40 to +85 | °C | |
| Input rise and fall time (except Schmitt inputs) $V_{IN}$ 30% to 70% $V_{CC}$ | tr, tf | 8 | ns/V | $V_{CC}$ = 3.0V |
| | | | | $V_{CC}$ = 4.5 V |
| | | | | $V_{CC}$ = 5.5 V |

## DC Characteristics: HD74AC138

| Item | Sym-bol | Vcc (V) | Ta = 25°C | | | Ta = –40 to +85°C | | Unit | Condition | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | min. | max. | | | |
| Input Voltage | $V_{IH}$ | 3.0 | 2.1 | 1.5 | — | 2.1 | — | V | $V_{OUT}$ = 0.1 V or $V_{CC}$ –0.1 V | |
| | | 4.5 | 3.15 | 2.25 | — | 3.15 | — | | | |
| | | 5.5 | 3.85 | 2.75 | — | 3.85 | — | | | |
| | $V_{IL}$ | 3.0 | — | 1.50 | 0.9 | — | 0.9 | | $V_{OUT}$ = 0.1 V or $V_{CC}$ –0.1 V | |
| | | 4.5 | — | 2.25 | 1.35 | — | 1.35 | | | |
| | | 5.5 | — | 2.75 | 1.65 | — | 1.65 | | | |
| Output voltage | $V_{OH}$ | 3.0 | 2.9 | 2.99 | — | 2.9 | — | V | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$I_{OUT}$ = –50 µA | |
| | | 4.5 | 4.4 | 4.49 | — | 4.4 | — | | | |
| | | 5.5 | 5.4 | 5.49 | — | 5.4 | — | | | |
| | | 3.0 | 2.58 | — | — | 2.48 | — | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$ | $I_{OH}$ = –12 mA |
| | | 4.5 | 3.94 | — | — | 3.80 | — | | | $I_{OH}$ = –24 mA |
| | | 5.5 | 4.94 | — | — | 4.80 | — | | | $I_{OH}$ = –24 mA |
| | $V_{OL}$ | 3.0 | — | 0.002 | 0.1 | — | 0.1 | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$I_{OUT}$ = 50 µA | |
| | | 4.5 | — | 0.001 | 0.1 | — | 0.1 | | | |
| | | 5.5 | — | 0.001 | 0.1 | — | 0.1 | | | |
| | | 3.0 | — | — | 0.32 | — | 0.37 | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$ | $I_{OL}$ = 12 mA |
| | | 4.5 | — | — | 0.32 | — | 0.37 | | | $I_{OL}$ = 24 mA |
| | | 5.5 | — | — | 0.32 | — | 0.37 | | | $I_{OL}$ = 24 mA |
| Input leakage current | $I_{IN}$ | 5.5 | — | — | ±0.1 | — | ±1.0 | µA | $V_{IN}$ = $V_{CC}$ or GND | |
| Dynamic output current* | $I_{OLD}$ | 5.5 | — | — | — | 86 | — | mA | $V_{OLD}$ = 1.1 V | |
| | $I_{OHD}$ | 5.5 | — | — | — | –75 | — | mA | $V_{OHD}$ = 3.85 V | |
| Quiescent supply current | $I_{CC}$ | 5.5 | — | — | 8.0 | — | 80 | µA | $V_{IN}$ = $V_{CC}$ or ground | |

*Maximum test duration 2.0 ms, one output loaded at a time.

## Recommended Operating Conditions: HD74ACT138

| Item | Symbol | Ratings | Unit | Condition |
|---|---|---|---|---|
| Supply voltage | $V_{CC}$ | 2 to 6 | V | |
| Input and output voltage | $V_I$, $V_O$ | 0 to $V_{CC}$ | V | |
| Operating temperature | Ta | –40 to +85 | °C | |
| Input rise and fall time (except Schmitt inputs) $V_{IN}$ 0.8 to 2.0 V | tr, tf | 8 | ns/V | $V_{CC}$ = 4.5V<br>$V_{CC}$ = 5.5V |

## DC Characteristics: HD74ACT138

| Item | Sym-bol | $V_{CC}$ (V) | Ta = 25°C | | | Ta = –40 to +85°C | | Unit | Condition | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | min. | typ. | max. | min. | max. | | | |
| Input voltage | $V_{IH}$ | 4.5 | 2.0 | 1.5 | — | 2.0 | — | V | $V_{OUT}$ = 0.1 V or Vcc–0.1 V | |
| | | 5.5 | 2.0 | 1.5 | — | 2.0 | — | | | |
| | $V_{IL}$ | 4.5 | — | 1.5 | 0.8 | — | 0.8 | | $V_{OUT}$ = 0.1 V or Vcc–0.1 V | |
| | | 5.5 | — | 1.5 | 0.8 | — | 0.8 | | | |
| Output voltage | $V_{OH}$ | 4.5 | 4.4 | 4.49 | — | 4.4 | — | V | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$I_{OUT}$ = –50 µA | |
| | | 5.5 | 5.4 | 5.49 | — | 5.4 | — | | | |
| | | 4.5 | 3.94 | — | — | 3.80 | — | | $V_{IN}$ = $V_{IL}$ | $I_{OH}$ = –24 mA |
| | | 5.5 | 4.94 | — | — | 4.80 | — | | | $I_{OH}$ = –24 mA |
| | $V_{OL}$ | 4.5 | — | 0.001 | 0.1 | — | 0.1 | | $V_{IN}$ = $V_{IL}$ or $V_{IH}$<br>$I_{OUT}$ = 50 µA | |
| | | 5.5 | — | 0.001 | 0.1 | — | 0.1 | | | |
| | | 4.5 | — | — | 0.32 | — | 0.37 | | $V_{IN}$ = $V_{IL}$ | $I_{OL}$ = 24 mA |
| | | 5.5 | — | — | 0.32 | — | 0.37 | | | $I_{OL}$ = 24 mA |
| Input current | $I_{IN}$ | 5.5 | — | — | ±0.1 | — | ±1.0 | µA | $V_{IN}$ = $V_{CC}$ or GND | |
| $I_{CC}$/input current | $I_{CCT}$ | 5.5 | — | 0.6 | — | — | 1.5 | mA | $V_{IN}$ = $V_{CC}$–2.1 V | |
| Dynamic output current* | $I_{OLD}$ | 5.5 | — | — | — | 86 | — | mA | $V_{OLD}$ = 1.1 V | |
| | $I_{OHD}$ | 5.5 | — | — | — | –75 | — | mA | $V_{OHD}$ = 3.85 V | |
| Quiescent supply current | $I_{CC}$ | 5.5 | — | — | 8.0 | — | 80 | µA | $V_{IN}$ = $V_{CC}$ or ground | |

*Maximum test duration 2.0 ms, one output loaded at a time.

## AC Characteristics: HD74AC138

| Item | Symbol | $V_{CC}$ (V)*[1] | Ta = +25°C $C_L$ = 50 pF | | | Ta = –40°C to +85°C $C_L$ = 50 pF | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | |
| Propagation delay $A_n$ to $\overline{O}_n$ | $t_{PLH}$ | 3.3 | 1.0 | 8.5 | 13.0 | 1.0 | 15.0 | ns |
| | | 5.0 | 1.0 | 6.5 | 9.5 | 1.0 | 10.5 | |
| Propagation delay $A_n$ to $\overline{O}_n$ | $t_{PHL}$ | 3.3 | 1.0 | 8.0 | 12.5 | 1.0 | 14.0 | ns |
| | | 5.0 | 1.0 | 6.0 | 9.0 | 1.0 | 10.5 | |
| Propagation delay $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | $t_{PLH}$ | 3.3 | 1.0 | 11.0 | 15.0 | 1.0 | 16.0 | ns |
| | | 5.0 | 1.0 | 8.0 | 11.0 | 1.0 | 12.0 | |
| Propagation delay $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | $t_{PHL}$ | 3.3 | 1.0 | 9.5 | 13.5 | 1.0 | 15.0 | ns |
| | | 5.0 | 1.0 | 7.0 | 9.5 | 1.0 | 10.5 | |
| Propagation delay $E_3$ to $\overline{O}_n$ | $t_{PLH}$ | 3.3 | 1.0 | 11.0 | 15.5 | 1.0 | 16.5 | ns |
| | | 5.0 | 1.0 | 8.0 | 11.0 | 1.0 | 12.5 | |
| Propagation delay $E_3$ to $\overline{O}_n$ | $t_{PHL}$ | 3.3 | 1.0 | 8.5 | 13.0 | 1.0 | 14.0 | ns |
| | | 5.0 | 1.0 | 6.0 | 8.0 | 1.0 | 9.5 | |

Note: 1. Voltage Range 3.3 is 3.3 V ± 0.3 V
Voltage Range 5.0 is 5.0 V ± 0.5 V

## AC Characteristics: HD74ACT138

| Item | Symbol | $V_{CC}$ (V)*[1] | Ta = +25°C $C_L$ = 50 pF | | | Ta = –40°C to +85°C $C_L$ = 50 pF | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | |
| Propagation delay An to $\overline{O}_n$ | $t_{PLH}$ | 5.0 | 1.0 | 7.0 | 10.5 | 1.0 | 11.5 | ns |
| Propagation delay An to $\overline{O}_n$ | $t_{PHL}$ | 5.0 | 1.0 | 6.5 | 10.5 | 1.0 | 11.5 | ns |
| Propagation delay $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | $t_{PLH}$ | 5.0 | 1.0 | 8.0 | 11.5 | 1.0 | 12.5 | ns |
| Propagation delay $\overline{E}_1$ or $\overline{E}_2$ to $\overline{O}_n$ | $t_{PHL}$ | 5.0 | 1.0 | 7.5 | 11.5 | 1.0 | 12.5 | ns |
| Propagation delay $E_3$ to $\overline{O}_n$ | $t_{PLH}$ | 5.0 | 1.0 | 8.0 | 12.0 | 1.0 | 13.0 | ns |
| Propagation delay $E_3$ to $\overline{O}_n$ | $t_{PHL}$ | 5.0 | 1.0 | 6.5 | 10.5 | 1.0 | 11.5 | ns |

Note: 1. Voltage Range 5.0 is 5.0 V ± 0.5 V

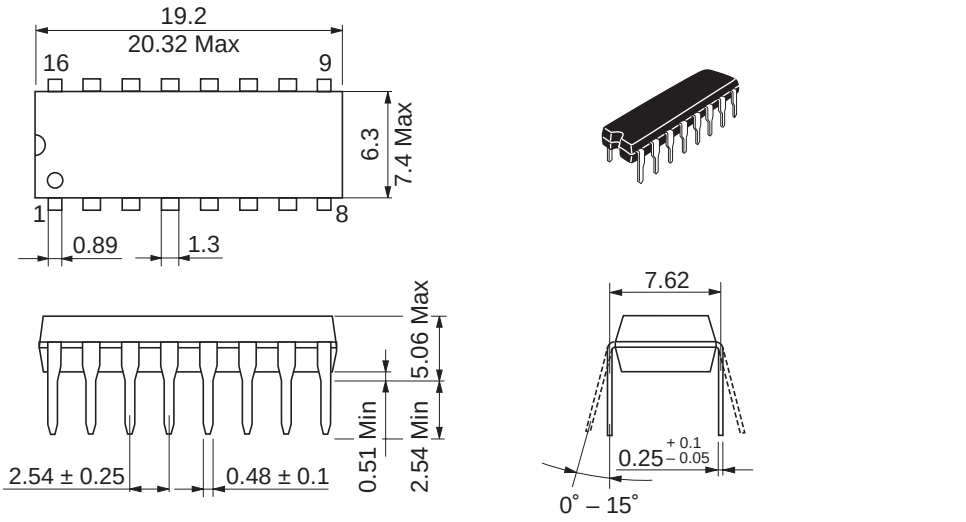
## Capacitance

| Item | Symbol | Typ | Unit | Condition |
|---|---|---|---|---|
| Input capacitance | $C_{IN}$ | 4.5 | pF | $V_{CC}$ = 5.5 V |
| Power dissipation capacitance | $C_{PD}$ | 60.0 | pF | $V_{CC}$ = 5.0 V |

## Package Dimensions

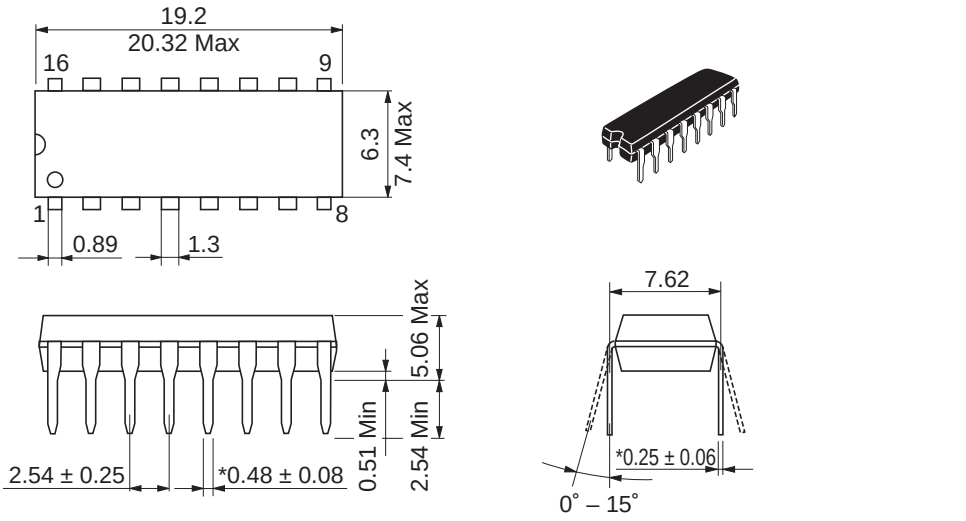
As of January, 2003

Unit: mm




| | |
|---|---|
| Package Code | DP-16E |
| JEDEC | Conforms |
| JEITA | Conforms |
| Mass (reference value) | 1.05 g |

Unit: mm

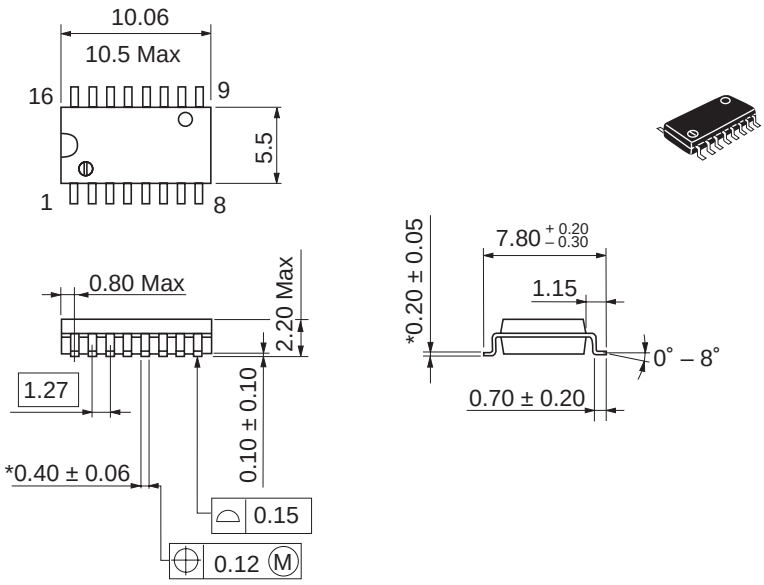



| | |
|---|---|
| Package Code | DP-16FV |
| JEDEC | Conforms |
| JEITA | Conforms |
| Mass (reference value) | 1.05 g |

*NI/Pd/AU Plating

As of January, 2003

Unit: mm

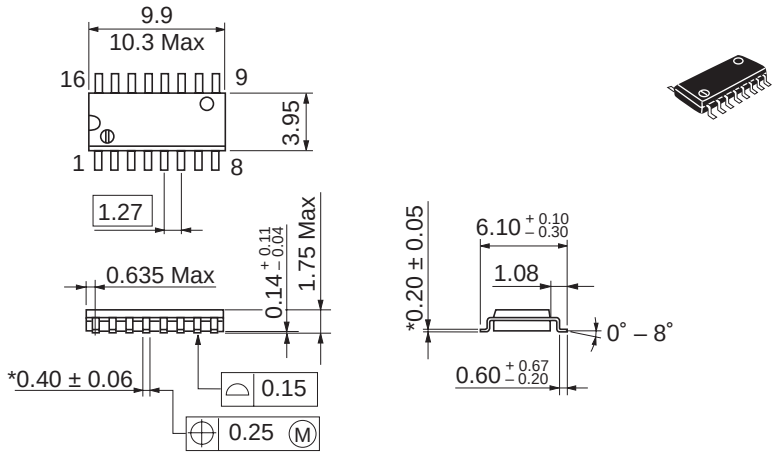



| Package Code | FP-16DAV |
|---|---|
| JEDEC | — |
| JEITA | Conforms |
| Mass (reference value) | 0.24 g |

*Ni/Pd/Au plating

As of January, 2003

Unit: mm

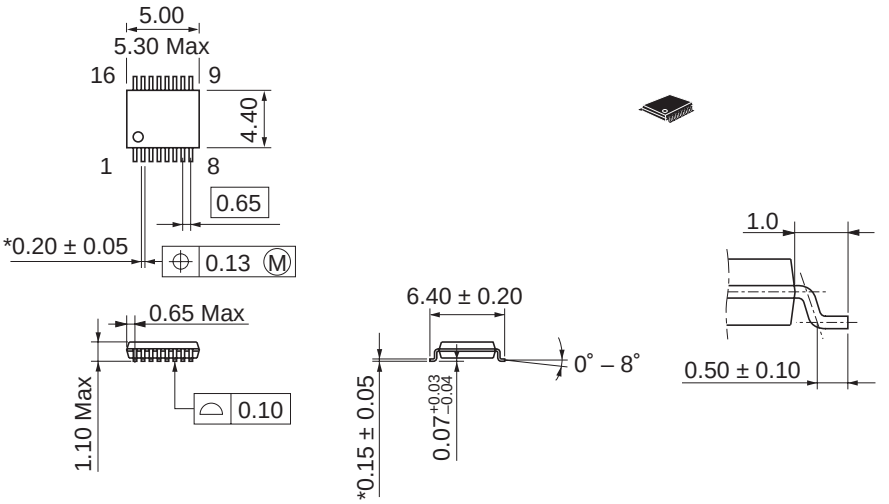



| Package Code | FP-16DNV |
|---|---|
| JEDEC | Conforms |
| JEITA | Conforms |
| Mass (reference value) | 0.15 g |

*Ni/Pd/Au plating

As of January, 2003

Unit: mm




| | |
|---|---|
| Package Code | TTP-16DAV |
| JEDEC | — |
| JEITA | — |
| Mass (reference value) | 0.05 g |

*Ni/Pd/Au plating

Renesas Technology Corp. Sales Strategic Planning Div. Nippon Bldg., 2-6-2, Ohte-machi, Chiyoda-ku, Tokyo 100-0004, Japan



## RENESAS SALES OFFICES

http://www.renesas.com

**Renesas Technology America, Inc.**
450 Holger Way, San Jose, CA 95134-1368, U.S.A
Tel: <1> (408) 382-7500 Fax: <1> (408) 382-7501

**Renesas Technology Europe Limited.**
Dukes Meadow, Millboard Road, Bourne End, Buckinghamshire, SL8 5FH, United Kingdom
Tel: <44> (1628) 585 100, Fax: <44> (1628) 585 900

**Renesas Technology Europe GmbH**
Dornacher Str. 3, D-85622 Feldkirchen, Germany
Tel: <49> (89) 380 70 0, Fax: <49> (89) 929 30 11

**Renesas Technology Hong Kong Ltd.**
7/F., North Tower, World Finance Centre, Harbour City, Canton Road, Hong Kong
Tel: <852> 2265-6688, Fax: <852> 2375-6836

**Renesas Technology Taiwan Co., Ltd.**
FL 10, #99, Fu-Hsing N. Rd., Taipei, Taiwan
Tel: <886> (2) 2715-2888, Fax: <886> (2) 2713-2999

**Renesas Technology (Shanghai) Co., Ltd.**
26/F., Ruijin Building, No.205 Maoming Road (S), Shanghai 200020, China
Tel: <86> (21) 6472-1001, Fax: <86> (21) 6415-2952

**Renesas Technology Singapore Pte. Ltd.**
1, Harbour Front Avenue, #06-10, Keppel Bay Tower, Singapore 098632
Tel: <65> 6213-0200, Fax: <65> 6278-8001



Colophon .1.0