PRELIMINARY DATA SHEET

NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC8172TB

## SILICON MMIC 2.5 GHz FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

### DESCRIPTION

The μPC8172TB is a silicon monolithic integrated circuit designed as frequency up-converter for wireless transceiver transmitter stage. This IC is manufactured using NEC's 30 GHz $f_{max.}$ UHS0 (Ultra High Speed Process) silicon bipolar process.

This IC is as same circuit current as conventional μPC8106TB, but operates at higher frequency, higher gain and lower distortion. Consequently this IC is suitable for mobile communications.

### FEATURES

- Recommended operating frequency : $f_{RFout}$ = 0.8 to 2.5 GHz
- Higher $IP_3$ : CG = 9.5 dB TYP., $OIP_3$ = +7.5 dBm TYP. @ $f_{RFout}$ = 0.9 GHz
- High-density surface mounting : 6-pin super minimold package
- Supply voltage : $V_{CC}$ = 2.7 to 3.3 V

### APPLICATIONS

- PCS1900M
- 2.4 GHz band transmitter/receiver system (wireless LAN etc.)

### ORDERING INFORMATION

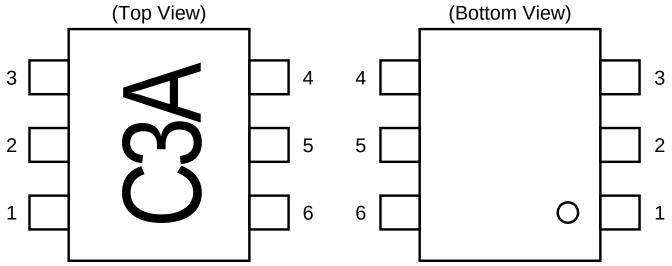
| Part Number | Package | Marking | Supplying Form |
|---|---|---|---|
| μPC8172TB-E3 | 6-pin super minimold | C3A | • Embossed tape 8 mm wide.<br>• Pin 1, 2, 3 face the tape perforation side.<br>• Qty 3 kpcs/reel. |

**Remark** To order evaluation samples, please contact your local NEC sales office.
(Part number for sample order: μPC8172TB)

**Caution Electro-static sensitive devices**

Document No. P14729EJ1V0DS00 (1st edition)
Date Published June 2000 N CP(K)
Printed in Japan

## PIN CONNECTIONS



| Pin No. | Pin Name |
|---|---|
| 1 | IFinput |
| 2 | GND |
| 3 | LOinput |
| 4 | PS |
| 5 | $V_{CC}$ |
| 6 | RFoutput |

## SERIES PRODUCTS ($T_A$ = +25°C, $V_{CC}$ = $V_{PS}$ = $V_{RFout}$ = 3.0 V, $Z_S$ = $Z_L$ = 50 Ω)

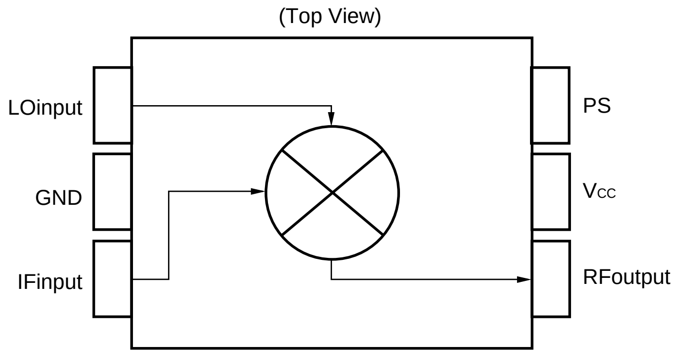
| Part Number | $I_{CC}$ (mA) | $f_{RFout}$ (GHz) | CG (dB) | | |
|---|---|---|---|---|---|
| | | | @RF 0.9 GHz$^{Note}$ | @RF 1.9 GHz | @RF 2.4 GHz |
| μPC8172TB | 9 | 0.8 to 2.5 | 9.5 | 8.5 | 8.0 |
| μPC8106TB | 9 | 0.4 to 2.0 | 9 | 7 | – |
| μPC8109TB | 5 | 0.4 to.2.0 | 6 | 4 | – |
| μPC8163TB | 16.5 | 0.8 to 2.0 | 9 | 5.5 | – |

| Part Number | $P_{O(sat)}$ (dBm) | | | $OIP_3$ (dBm) | | |
|---|---|---|---|---|---|---|
| | @RF 0.9 GHz$^{Note}$ | @RF 1.9 GHz | @RF 2.4 GHz | @RF 0.9 GHz$^{Note}$ | @RF 1.9 GHz | @RF 2.4 GHz |
| μPC8172TB | +0.5 | 0 | –0.5 | +7.5 | +6.0 | +4.0 |
| μPC8106TB | –2 | –4 | – | +5.5 | +2.0 | – |
| μPC8109TB | –5.5 | –7.5 | – | +1.5 | –1.0 | – |
| μPC8163TB | +0.5 | –2 | – | +9.5 | +6.0 | – |

**Note** $f_{RFout}$ = 0.83 GHz @ μPC8163TB

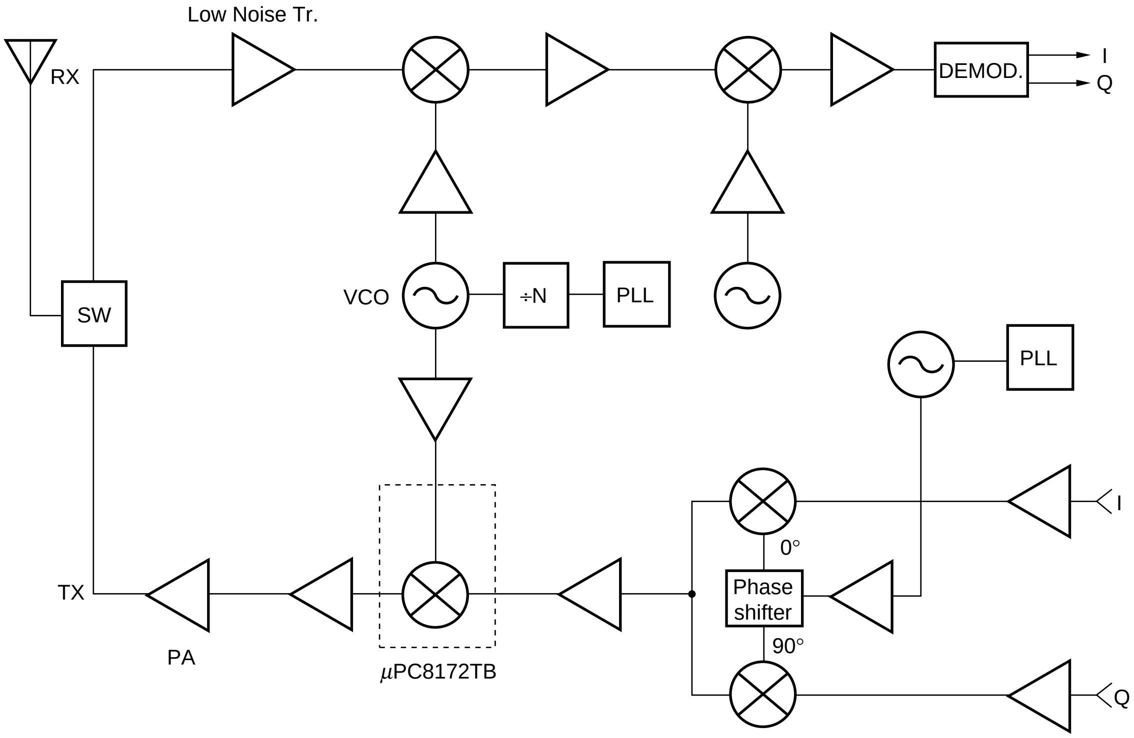
**Remark** Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

## BLOCK DIAGRAM (FOR THE μPC8172TB)



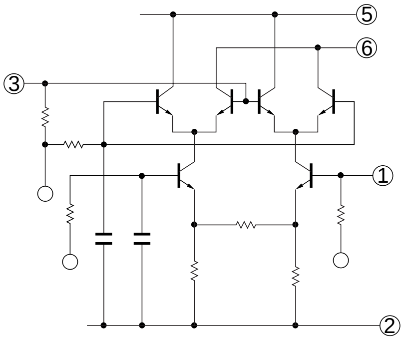
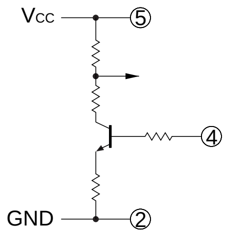
## SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEM)

### Wireless Transceiver



To know the associated products, please refer to each latest data sheet.

## PIN EXPLANATION

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>Applied Voltage (V)</th><th>Pin Voltage (V)[Note]</th><th>Function and Explanation</th><th>Equivalent Circuit</th></tr>
<tr><td>1</td><td>IFinput</td><td>–</td><td>1.4</td><td>This pin is IF input to double balanced mixer (DBM). The input is designed as high impedance. The circuit contributes to suppress spurious signal. Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution. For above reason, double balanced mixer is adopted.</td><td rowspan="5">
</td></tr>
<tr><td>2</td><td>GND</td><td>GND</td><td>–</td><td>GND pin. Ground pattern on the board should be formed as wide as possible. Track Length should be kept as short as possible to minimize ground impedance.</td></tr>
<tr><td>3</td><td>LOinput</td><td>–</td><td>2.3</td><td>Local input pin. Recommendable input level is –10 to 0 dBm.</td></tr>
<tr><td>5</td><td>$V_{CC}$</td><td>2.7 to 3.3</td><td>–</td><td>Supply voltage pin.</td></tr>
<tr><td>6</td><td>RFoutput</td><td>Same bias as $V_{CC}$ through external inductor</td><td>–</td><td>This pin is RF output from DBM. This pin is designed as open collector. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage.</td></tr>
<tr><td>4</td><td>PS</td><td>$V_{CC}$/GND</td><td>–</td><td>Power save control pin. Bias controls operation as follows.
<table>
<tr><th>Pin bias</th><th>Control</th></tr>
<tr><td>$V_{CC}$</td><td>Operation</td></tr>
<tr><td>GND</td><td>Power Save</td></tr>
</table></td><td>
</td></tr>
</table>

**Note** Each pin voltage is measured with $V_{CC} = V_{PS} = V_{RFout} = 3.0$ V.

## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | $T_A$ = +25°C | 3.6 | V |
| PS pin Input Voltage | $V_{PS}$ | $T_A$ = +25°C | 3.6 | V |
| Power Dissipation of Package | $P_D$ | Mounted on double-side copperclad 50 × 50 × 1.6 mm epoxy glass PWB ($T_A$ = +85°C) | 200 | mW |
| Operating Ambient Temperature | $T_A$ | | –40 to +85 | °C |
| Storage Temperature | $T_{stg}$ | | –55 to +150 | °C |
| Maximum Input Power | $P_{in}$ | | +10 | dBm |

## RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | The same voltage should be applied to pin 5 and 6 | 2.7 | 3.0 | 3.3 | V |
| Operating Ambient Temperature | $T_A$ | | –40 | +25 | +85 | °C |
| Local Input Level | $P_{LOin}$ | $Z_S$ = 50 Ω (without matching) | –10 | –5 | 0 | dBm |
| RF Output Frequency | $f_{RFout}$ | With external matching circuit | 0.8 | – | 2.5 | GHz |
| IF Input Frequency | $f_{IFin}$ | | 50 | – | 400 | MHz |

## ELECTRICAL CHARACTERISTICS

**($T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$ = 3.0 V, $f_{IFin}$ = 240 MHz, $P_{LOin}$ = –5 dBm, and $V_{PS}$ ≥ 2.7 V unless otherwise specified)**

| Parameter | Symbol | Test Conditions[Note] | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Circuit Current | $I_{CC}$ | No Signal | 5.5 | 9.0 | 13 | mA |
| Circuit Current In Power Save Mode | $I_{CC(PS)}$ | $V_{PS}$ = 0 V | – | – | 2 | $\mu$A |
| Conversion Gain | CG1 | $f_{RFout}$ = 0.9 GHz, $P_{IFin}$ = –30 dBm | 6.5 | 9.5 | 12.5 | dB |
| | CG2 | $f_{RFout}$ = 1.9 GHz, $P_{IFin}$ = –30 dBm | 5.5 | 8.5 | 11.5 | dB |
| | CG3 | $f_{RFout}$ = 2.4 GHz, $P_{IFin}$ = –30 dBm | 5 | 8.0 | 11.0 | dB |
| Saturated RF Output Power | $P_{O(sat)}1$ | $f_{RFout}$ = 0.9 GHz, $P_{IFin}$ = 0 dBm | –2.5 | +0.5 | – | dBm |
| | $P_{O(sat)}2$ | $f_{RFout}$ = 1.9 GHz, $P_{IFin}$ = 0 dBm | –3.5 | 0 | – | dBm |
| | $P_{O(sat)}3$ | $f_{RFout}$ = 2.4 GHz, $P_{IFin}$ = 0 dBm | –4 | –0.5 | – | dBm |

**Note** $f_{RFout} < f_{Loin}$ @ $f_{RFout}$ = 0.9 GHz
$f_{Loin} < f_{RFout}$ @ $f_{RFout}$ = 1.9 GHz/2.4 GHz

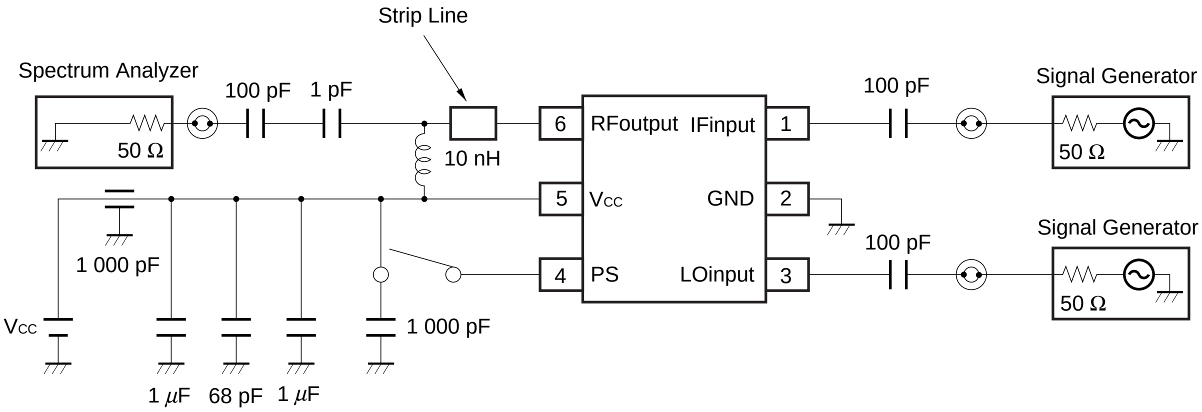
## OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

**($T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$ = 3.0 V, $P_{LOin}$ = –5 dBm, and $V_{PS} \geq$ 2.7 V unless otherwise specified)**

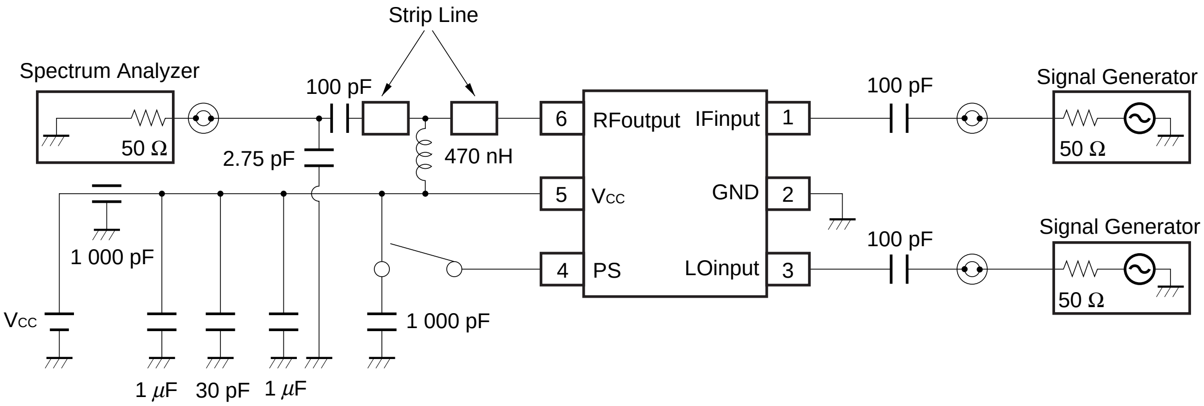
| Parameter | | Symbol | Test Conditions[Note] | | Data | Unit |
|---|---|---|---|---|---|---|
| Output Third-Order Distortion Intercept Point | | $OIP_3 1$ | $f_{RFout}$ = 0.9 GHz | $f_{IFin}1$ = 240 MHz<br>$f_{IFin}2$ = 241 MHz | +7.5 | dBm |
| | | $OIP_3 2$ | $f_{RFout}$ = 1.9 GHz | | +6.0 | dBm |
| | | $OIP_3 3$ | $f_{RFout}$ = 2.4 GHz | | +4.0 | dBm |
| Input Third-Order Distortion Intercept Point | | $IIP_3 1$ | $f_{RFout}$ = 0.9 GHz | $f_{IFin}1$ = 240 MHz<br>$f_{IFin}2$ = 241 MHz | –2.0 | dBm |
| | | $IIP_3 2$ | $f_{RFout}$ = 1.9 GHz | | –2.5 | dBm |
| | | $IIP_3 3$ | $f_{RFout}$ = 2.4 GHz | | –4.0 | dBm |
| SSB Noise Figure | | SSB•NF1 | $f_{RFout}$ = 0.9 GHz, $f_{IFin}$ = 240 MHz | | 9.5 | dB |
| | | SSB•NF2 | $f_{RFout}$ = 1.9 GHz, $f_{IFin}$ = 240 MHz | | 10.4 | dB |
| | | SSB•NF3 | $f_{RFout}$ = 2.4 GHz, $f_{IFin}$ = 240 MHz | | 10.6 | dB |
| Power Save Response Time | Rise time | $T_{PS(rise)}$ | $V_{PS}$: GND → $V_{CC}$ | | 1 | μs |
| | Fall time | $T_{PS(fall)}$ | $V_{PS}$: $V_{CC}$ → GND | | 1.5 | μs |

**Note** $f_{RFout} < f_{Loin}$ @ $f_{RFout}$ = 0.9 GHz
$f_{Loin} < f_{RFout}$ @ $f_{RFout}$ = 1.9 GHz/2.4 GHz

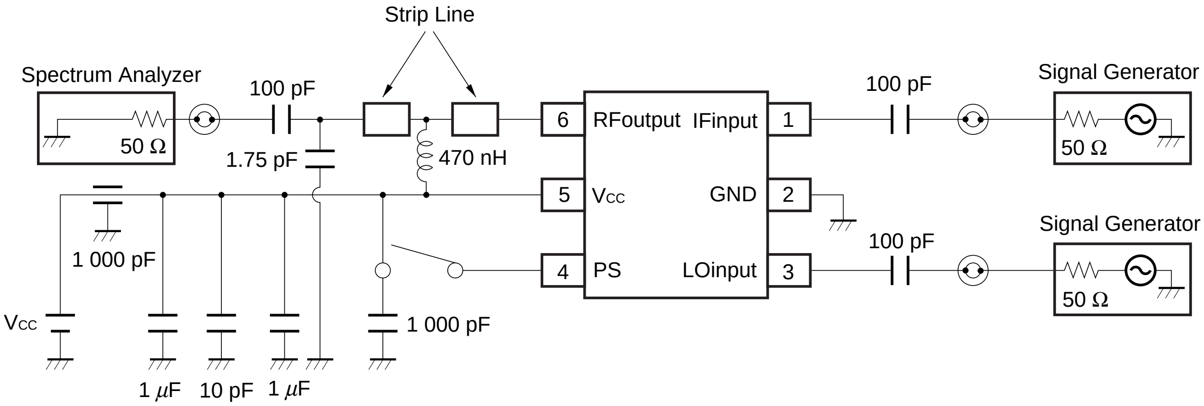
## TEST CIRCUIT 1 ($f_{RFout}$ = 900 MHz)



## TEST CIRCUIT 2 ($f_{RFout}$ = 1.9 GHz)

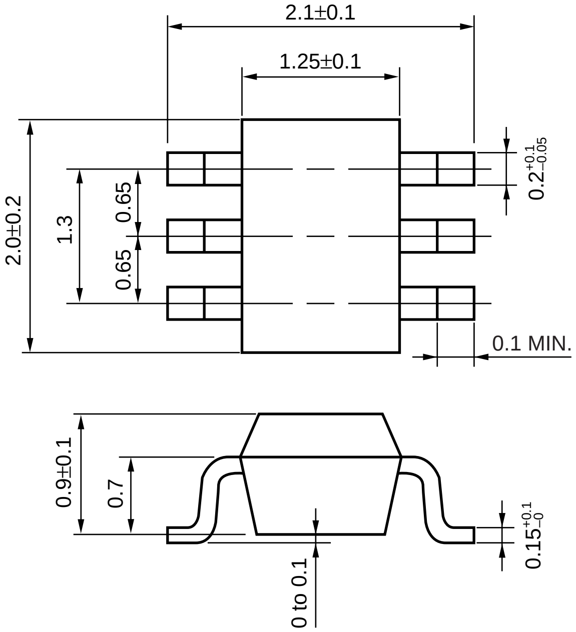


## TEST CIRCUIT 3 ($f_{RFout}$ = 2.4 GHz)



## PACKAGE DIMENSIONS

### 6-pin super minimold (Unit: mm)



## NOTE ON CORRECT USE

(1) Observe precautions for handling because of electrostatic sensitive devices.

(2) Form a ground pattern as wide as possible to keep the minimum ground impedance (to prevent undesired oscillation).

(3) Connect a bypass capacitor (example: 1 000 pF) to the $V_{CC}$ pin.

(4) Connect a matching circuit to the RF output pin.

(5) The DC cut capacitor must be each attached to the input and output pins.

## RECOMMENDED SOLDERING CONDITIONS

This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

| Soldering Method | Soldering Conditions | Recommended Condition Symbol |
|---|---|---|
| Infrared Reflow | Package peak temperature: 235°C or below<br>Time: 30 seconds or less (at 210°C)<br>Count: 3, Exposure limit: None$^{\text{Note}}$ | IR35-00-3 |
| VPS | Package peak temperature: 215°C or below<br>Time: 40 seconds or less (at 200°C)<br>Count: 3, Exposure limit: None$^{\text{Note}}$ | VP15-00-3 |
| Wave Soldering | Soldering bath temperature: 260°C or below<br>Time: 10 seconds or less<br>Count: 1, Exposure limit: None$^{\text{Note}}$ | WS60-00-1 |
| Partial Heating | Pin temperature: 300°C<br>Time: 3 seconds or less (per side of device)<br>Exposure limit: None$^{\text{Note}}$ | – |

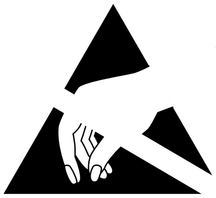
**Note** After opening the dry pack, keep it in a place below 25°C and 65% RH for the allowable storage period.

**Caution Do not use different soldering methods together (except for partial heating).**

For details of recommended soldering conditions for surface mounting, refer to information document SEMICONDUCTOR DEVICE MOUNTING TECHNOLOGY MANUAL (C10535E).

**[MEMO]**

**[MEMO]**



**ATTENTION**

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

- **The information in this document is current as of June, 2000. The information is subject to change without notice. For actual design-in, refer to the latest publications of NEC's data sheets or data books, etc., for the most up-to-date specifications of NEC semiconductor products. Not all products and/or types are available in every country. Please check with an NEC sales representative for availability and additional information.**
- No part of this document may be copied or reproduced in any form or by any means without prior written consent of NEC. NEC assumes no responsibility for any errors that may appear in this document.
- NEC does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from the use of NEC semiconductor products listed in this document or any other liability arising from the use of such products. No license, express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC or others.
- Descriptions of circuits, software and other related information in this document are provided for illustrative purposes in semiconductor product operation and application examples. The incorporation of these circuits, software and information in the design of customer's equipment shall be done under the full responsibility of customer. NEC assumes no responsibility for any losses incurred by customers or third parties arising from the use of these circuits, software and information.
- While NEC endeavours to enhance the quality, reliability and safety of NEC semiconductor products, customers agree and acknowledge that the possibility of defects thereof cannot be eliminated entirely. To minimize risks of damage to property or injury (including death) to persons arising from defects in NEC semiconductor products, customers must incorporate sufficient safety measures in their design, such as redundancy, fire-containment, and anti-failure features.
- NEC semiconductor products are classified into the following three quality grades:
  "Standard", "Special" and "Specific". The "Specific" quality grade applies only to semiconductor products developed based on a customer-designated "quality assurance program" for a specific application. The recommended applications of a semiconductor product depend on its quality grade, as indicated below. Customers must check the quality grade of each semiconductor product before using it in a particular application.

| | |
|---|---|
| "Standard": | Computers, office equipment, communications equipment, test and measurement equipment, audio and visual equipment, home electronic appliances, machine tools, personal electronic equipment and industrial robots |
| "Special": | Transportation equipment (automobiles, trains, ships, etc.), traffic control systems, anti-disaster systems, anti-crime systems, safety equipment and medical equipment (not specifically designed for life support) |
| "Specific": | Aircraft, aerospace equipment, submersible repeaters, nuclear reactor control systems, life support systems and medical equipment for life support, etc. |

The quality grade of NEC semiconductor products is "Standard" unless otherwise expressly specified in NEC's data sheets or data books, etc. If customers wish to use NEC semiconductor products in applications not intended by NEC, they must contact an NEC sales representative in advance to determine NEC's willingness to support a given application.

(Note)

(1) "NEC" as used in this statement means NEC Corporation and also includes its majority-owned subsidiaries.

(2) "NEC semiconductor products" means any semiconductor product developed or manufactured by or for NEC (as defined above).

M8E 00.4