

To our customers,

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## Old Company Name in Catalogs and Other Documents

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April 1<sup>st</sup>, 2010  
Renesas Electronics Corporation

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## 5 V, SILICON MMIC WIDEBAND AMPLIFIER

### DESCRIPTION

The  $\mu$ PC3224TB is a silicon monolithic IC designed as IF amplifier for DBS tuners. This IC is manufactured using our 30 GHz  $f_{\max}$  UHS0 (Ultra High Speed Process) silicon bipolar process.

### FEATURES

- Wideband response :  $f_u = 3.2$  GHz TYP. @ 3 dB bandwidth
- Low current :  $I_{CC} = 9.0$  mA TYP.
- Power gain :  $G_P = 21.5$  dB TYP. @  $f = 1.0$  GHz  
:  $G_P = 21.5$  dB TYP. @  $f = 2.2$  GHz
- Supply voltage :  $V_{CC} = 4.5$  to  $5.5$  V
- Port impedance : input/output  $50\ \Omega$

### APPLICATION

- IF amplifiers in DBS converters etc.

### ORDERING INFORMATION

| Part Number       | Package              | Marking | Supplying Form                                                                                                                                         |
|-------------------|----------------------|---------|--------------------------------------------------------------------------------------------------------------------------------------------------------|
| $\mu$ PC3224TB-E3 | 6-pin super minimold | C3K     | <ul style="list-style-type: none"><li>Embossed tape 8 mm wide</li><li>1, 2, 3 pins face the perforation side of tape</li><li>Qty 3 kpcs/reel</li></ul> |

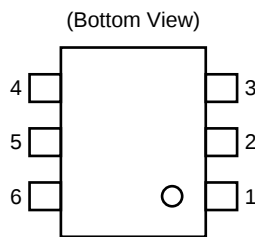
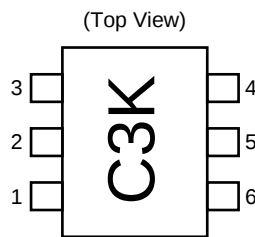
**Remark** To order evaluation samples, contact your nearby sales office.

Part number for sample order:  $\mu$ PC3224TB

**Caution** Observe precautions when handling because these devices are sensitive to electrostatic discharge.

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Not all devices/types available in every country. Please check with local NEC Compound Semiconductor Devices representative for availability and additional information.

PIN CONNECTIONS



| Pin No. | Pin Name        |
|---------|-----------------|
| 1       | INPUT           |
| 2       | GND             |
| 3       | GND             |
| 4       | OUTPUT          |
| 5       | GND             |
| 6       | V <sub>CC</sub> |

PRODUCT LINE-UP OF 5 V-BIAS SILICON MMIC MEDIUM WIDEBAND AMPLIFIER  
(T<sub>A</sub> = +25°C, f = 1 GHz, V<sub>CC</sub> = V<sub>out</sub> = 5.0 V, Z<sub>S</sub> = Z<sub>L</sub> = 50 Ω)

| Part No.                       | f <sub>u</sub><br>(GHz) | P <sub>O(sat)</sub><br>(dBm) | G <sub>P</sub><br>(dB) | NF<br>(dB) | I <sub>cc</sub><br>(mA) | Package              | Marking |
|--------------------------------|-------------------------|------------------------------|------------------------|------------|-------------------------|----------------------|---------|
| $\mu$ PC2711TB                 | 2.9                     | +1.0                         | 13                     | 5.0        | 12                      | 6-pin super minimold | C1G     |
| $\mu$ PC2712TB                 | 2.6                     | +3.0                         | 20                     | 4.5        | 12                      |                      | C1H     |
| $\mu$ PC3215TB <sup>Note</sup> | 2.9                     | +3.5                         | 20.5                   | 2.3        | 14                      |                      | C3H     |
| $\mu$ PC3224TB                 | 3.2                     | +4.0                         | 21.5                   | 4.3        | 9.0                     |                      | C3K     |

**Note**  $\mu$ PC3215TB is f = 1.5 GHz

**Remark** Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.

# PIN EXPLANATIONS

| PIN No.     | Pin Name        | Applied Voltage (V) | Pin Voltage (V)<br><small>Note</small> | Function and Applications                                                                                                                                                                                                                                                                    |
|-------------|-----------------|---------------------|----------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | INPUT           | —                   | 0.91                                   | Signal input pin.<br>A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band.<br>A multi-feedback circuits is designed to cancel the deviations of $h_{FE}$ and resistance.<br>This pin must be coupled to signal source with capacitor for DC cut. |
| 4           | OUTPUT          | —                   | 4.42                                   | Signal output pin.<br>A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band.<br>This pin must be coupled to next stage with capacitor for DC cut.                                                                                                 |
| 6           | V <sub>CC</sub> | 4.5 to 5.5          | —                                      | Power supply pin.<br>This pin should be externally equipped with bypass capacitor to minimize its impedance.                                                                                                                                                                                 |
| 2<br>3<br>5 | GND             | 0                   | —                                      | Ground pin.<br>This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible.<br>All the ground pins must be connected together with wide ground pattern to decrease impedance difference.                         |

**Note** Pin Voltage is measured at V<sub>CC</sub> = 5.0 V

# ABSOLUTE MAXIMUM RATINGS

| Parameter                     | Symbol           | Conditions                         | Ratings     | Unit |
|-------------------------------|------------------|------------------------------------|-------------|------|
| Supply Voltage                | V <sub>CC</sub>  | T <sub>A</sub> = +25°C             | 6.0         | V    |
| Total Circuit Current         | I <sub>CC</sub>  | T <sub>A</sub> = +25°C             | 25          | mA   |
| Power Dissipation             | P <sub>D</sub>   | T <sub>A</sub> = +85°C <b>Note</b> | 270         | mW   |
| Operating Ambient Temperature | T <sub>A</sub>   |                                    | −40 to +85  | °C   |
| Storage Temperature           | T <sub>stg</sub> |                                    | −55 to +150 | °C   |
| Input Power                   | P <sub>in</sub>  | T <sub>A</sub> = +25°C             | +10         | dBm  |

**Note** Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

# RECOMMENDED OPERATING RANGE

| Parameter                     | Symbol          | Conditions | MIN. | TYP. | MAX. | Unit |
|-------------------------------|-----------------|------------|------|------|------|------|
| Supply Voltage                | V <sub>CC</sub> |            | 4.5  | 5.0  | 5.5  | V    |
| Operating Ambient Temperature | T <sub>A</sub>  |            | −40  | +25  | +85  | °C   |

# ELECTRICAL CHARACTERISTICS (T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5.0 V, Z<sub>S</sub> = Z<sub>L</sub> = 50 Ω)

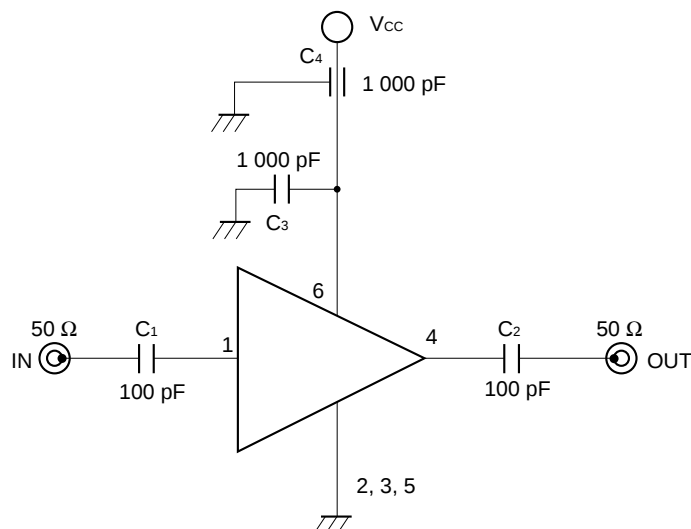
| Parameter                          | Symbol                | Test Conditions                          | MIN. | TYP. | MAX. | Unit |
|------------------------------------|-----------------------|------------------------------------------|------|------|------|------|
| Circuit Current                    | I <sub>CC</sub>       | No input signal                          | 7.0  | 9.0  | 12.0 | mA   |
| Power Gain                         | G <sub>P</sub>        | f = 1.0 GHz, P <sub>in</sub> = −30 dBm   | 19.0 | 21.5 | 24.0 | dB   |
|                                    |                       | f = 2.2 GHz, P <sub>in</sub> = −30 dBm   | 18.5 | 21.5 | 24.5 |      |
| Saturated Output Power             | P <sub>O (sat)</sub>  | f = 1.0 GHz, P <sub>in</sub> = −5 dBm    | +1.5 | +4.0 | −    | dBm  |
|                                    |                       | f = 2.2 GHz, P <sub>in</sub> = −5 dBm    | −1.5 | +1.5 | −    |      |
| Gain 1 dB Compression Output Power | P <sub>O (1 dB)</sub> | f = 1.0 GHz                              | −6.5 | −3.5 | −    | dBm  |
|                                    |                       | f = 2.2 GHz                              | −8.5 | −5.5 | −    |      |
| Noise Figure                       | NF                    | f = 1.0 GHz                              | −    | 4.3  | 5.8  | dB   |
|                                    |                       | f = 2.2 GHz                              | −    | 4.3  | 5.8  |      |
| Upper Limit Operating Frequency    | f <sub>u</sub>        | 3 dB down below flat gain at f = 0.1 GHz | 2.8  | 3.2  | −    | GHz  |
| Isolation                          | ISL                   | f = 1.0 GHz, P <sub>in</sub> = −30 dBm   | 35.0 | 40.0 | −    | dB   |
|                                    |                       | f = 2.2 GHz, P <sub>in</sub> = −30 dBm   | 37.0 | 42.0 | −    |      |
| Input Return Loss                  | RL <sub>in</sub>      | f = 1.0 GHz, P <sub>in</sub> = −30 dBm   | 9.0  | 12.0 | −    | dB   |
|                                    |                       | f = 2.2 GHz, P <sub>in</sub> = −30 dBm   | 10.0 | 14.0 | −    |      |
| Output Return Loss                 | RL <sub>out</sub>     | f = 1.0 GHz, P <sub>in</sub> = −30 dBm   | 11.0 | 17.0 | −    | dB   |
|                                    |                       | f = 2.2 GHz, P <sub>in</sub> = −30 dBm   | 8.0  | 12.0 | −    |      |
| Gain Flatness                      | ΔG <sub>P</sub>       | f = 0.1 to 2.2 GHz                       | −    | ±0.8 | −    | dB   |

OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

(T<sub>A</sub> = +25°C, V<sub>CC</sub> = 5.0 V, Z<sub>S</sub> = Z<sub>L</sub> = 50  $\Omega$ )

| Parameter              | Symbol           | Test Conditions | Reference Value | Unit |
|------------------------|------------------|-----------------|-----------------|------|
| Output Intercept Point | OIP <sub>3</sub> | f = 1.0 GHz     | +7.0            | dBm  |
|                        |                  | f = 2.2 GHz     | +5.5            |      |

## TEST CIRCUIT



The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.

### COMPONENTS OF TEST CIRCUIT FOR MEASURING ELECTRICAL CHARACTERISTICS

|                                 | Type                   | Value    |
|---------------------------------|------------------------|----------|
| C <sub>1</sub> , C <sub>2</sub> | Chip Capacitor         | 100 pF   |
| C <sub>3</sub>                  | Chip Capacitor         | 1 000 pF |
| C <sub>4</sub>                  | Feed-through Capacitor | 1 000 pF |

### CAPACITORS FOR THE V<sub>CC</sub>, INPUT AND OUTPUT PINS

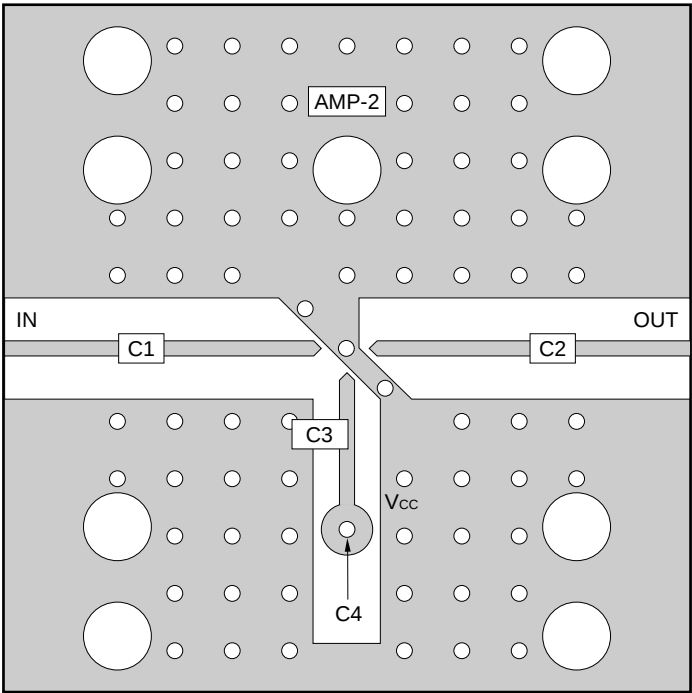
Capacitors of 1000 pF are recommendable as the bypass capacitor for the V<sub>CC</sub> pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the V<sub>CC</sub> pin is used to minimize ground impedance of V<sub>CC</sub> pin. So, stable bias can be supplied against V<sub>CC</sub> fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitances are therefore selected as lower impedance against a 50 Ω load. The capacitors thus perform as high pass filters, suppressing low frequencies to DC.

To obtain a flat gain from 100 MHz upwards, 1 000 pF capacitors are used in the test circuit. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 10 000 pF. Because the coupling capacitors are determined by equation,  $C = 1/(2 \pi R f_c)$ .

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

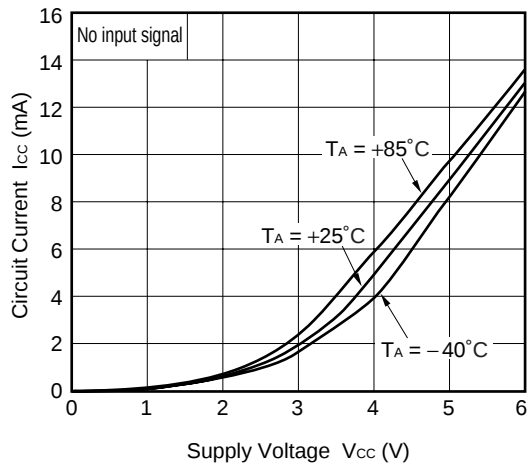
|                                 | Value    |
|---------------------------------|----------|
| C <sub>1</sub> , C <sub>2</sub> | 100 pF   |
| C <sub>3</sub> , C <sub>4</sub> | 1 000 pF |

Notes

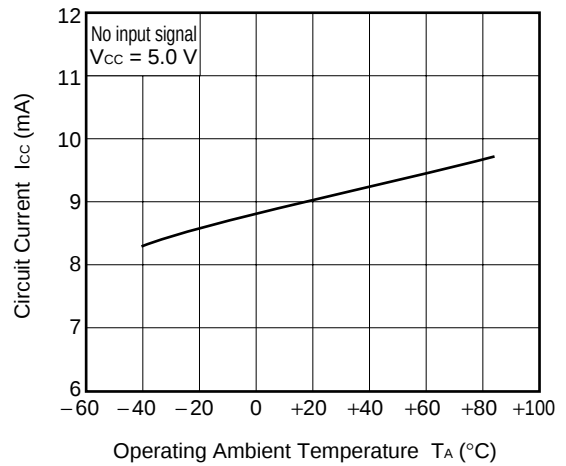
- 1. 30 × 30 × 0.4 mm double sided copper clad polyimide board.
- 2. Back side: GND pattern
- 3. Solder plated on pattern
- 4. ○○: Through holes

**TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)**

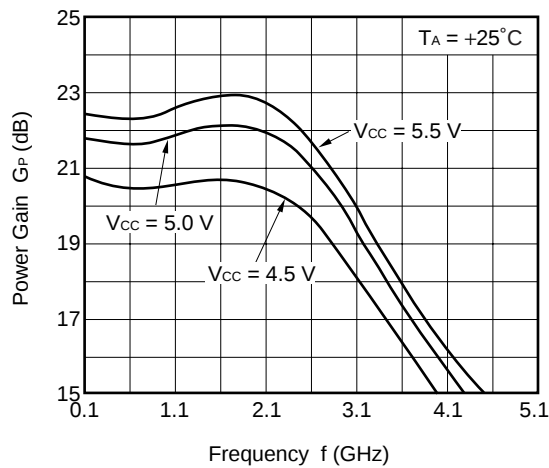
**CIRCUIT CURRENT vs. SUPPLY VOLTAGE**



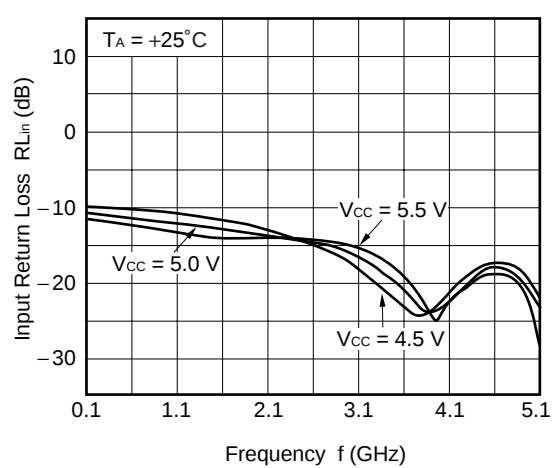
**CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE**



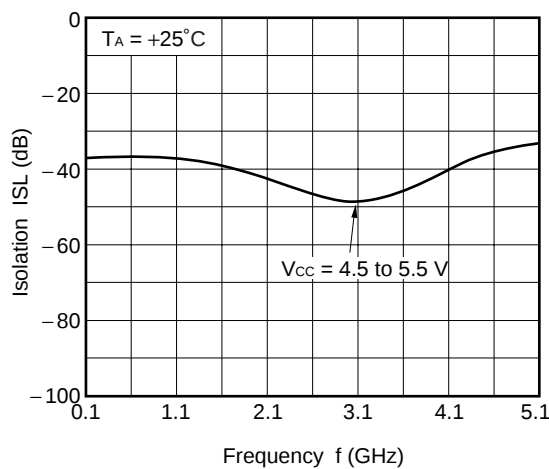
**POWER GAIN vs. FREQUENCY**



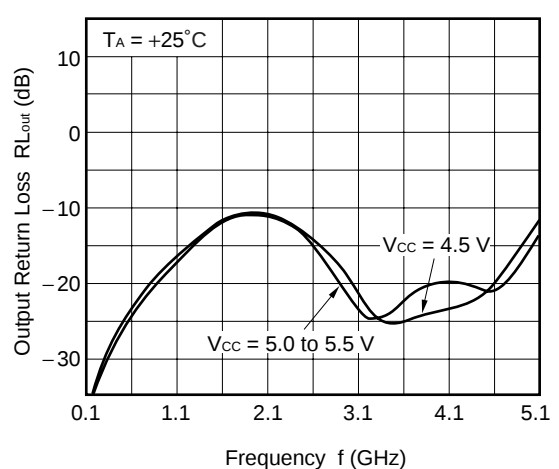
**INPUT RETURN LOSS vs. FREQUENCY**



**ISOLATION vs. FREQUENCY**

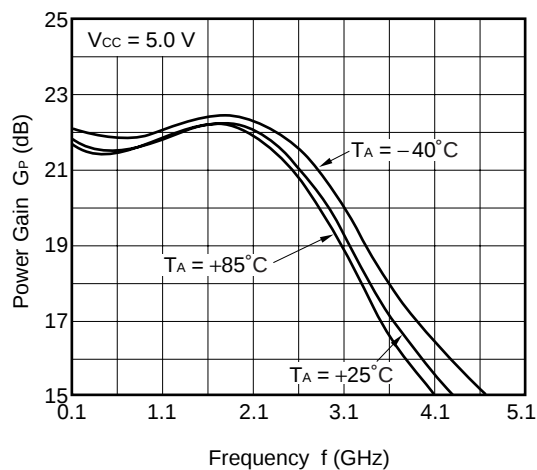


**OUTPUT RETURN LOSS vs. FREQUENCY**

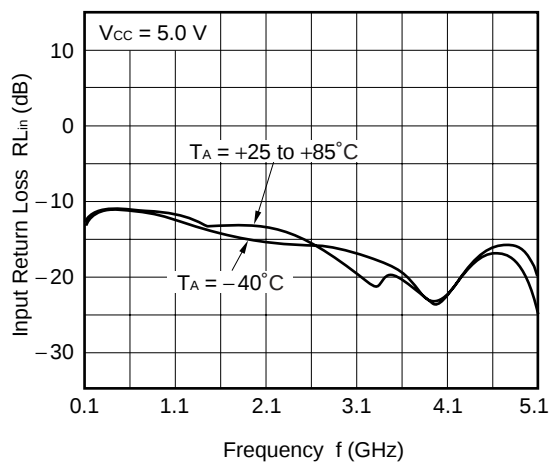


**Remark** The graphs indicate nominal characteristics.

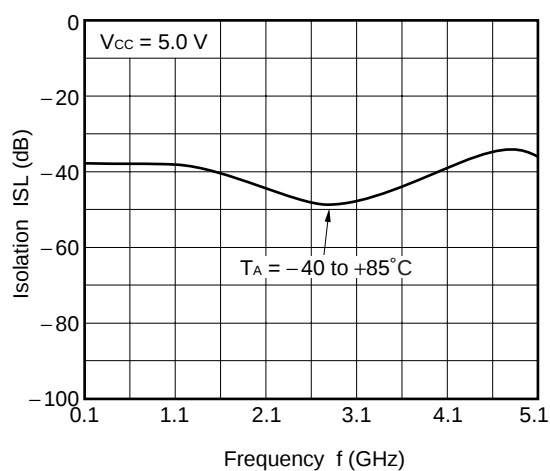
POWER GAIN vs. FREQUENCY



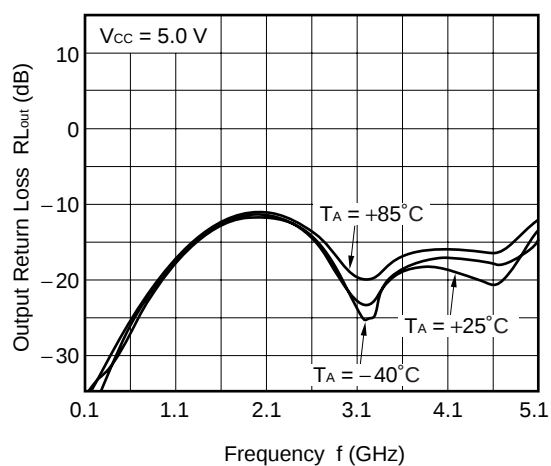
INPUT RETURN LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY

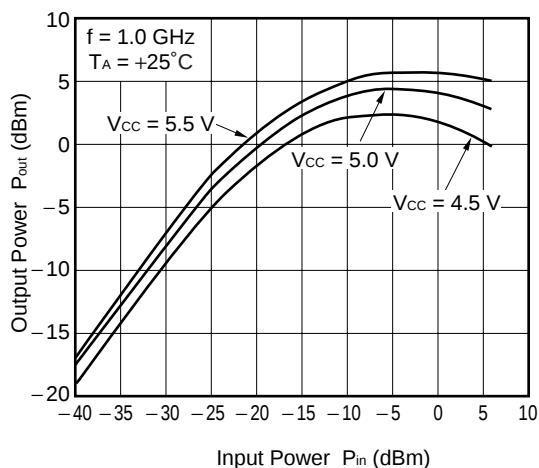


OUTPUT RETURN LOSS vs. FREQUENCY

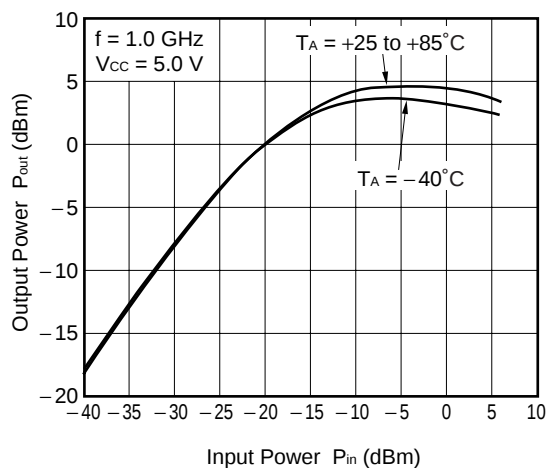


**Remark** The graphs indicate nominal characteristics.

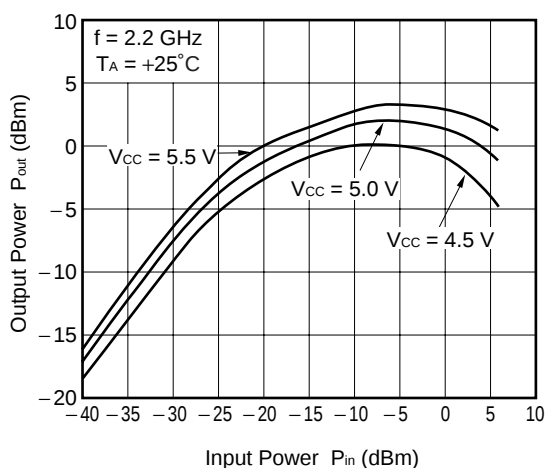
OUTPUT POWER vs. INPUT POWER



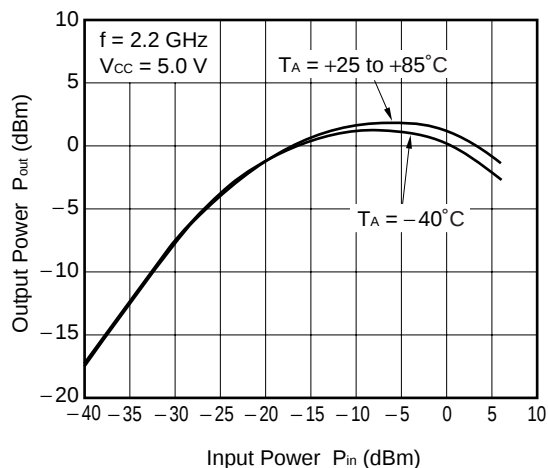
OUTPUT POWER vs. INPUT POWER



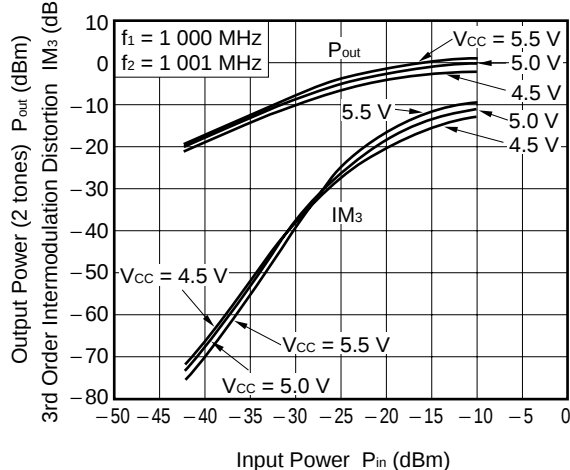
OUTPUT POWER vs. INPUT POWER



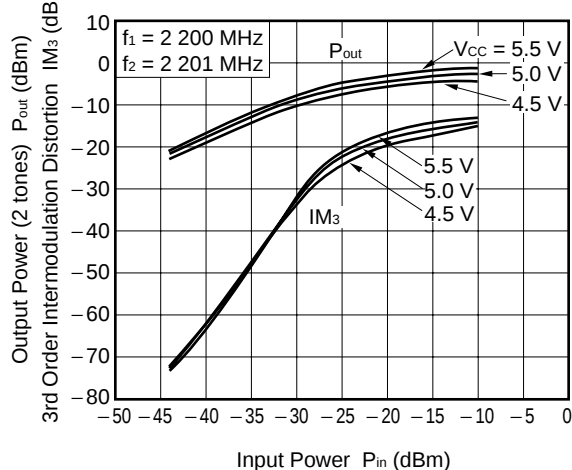
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER (2 tones),  $IM_3$  vs. INPUT POWER



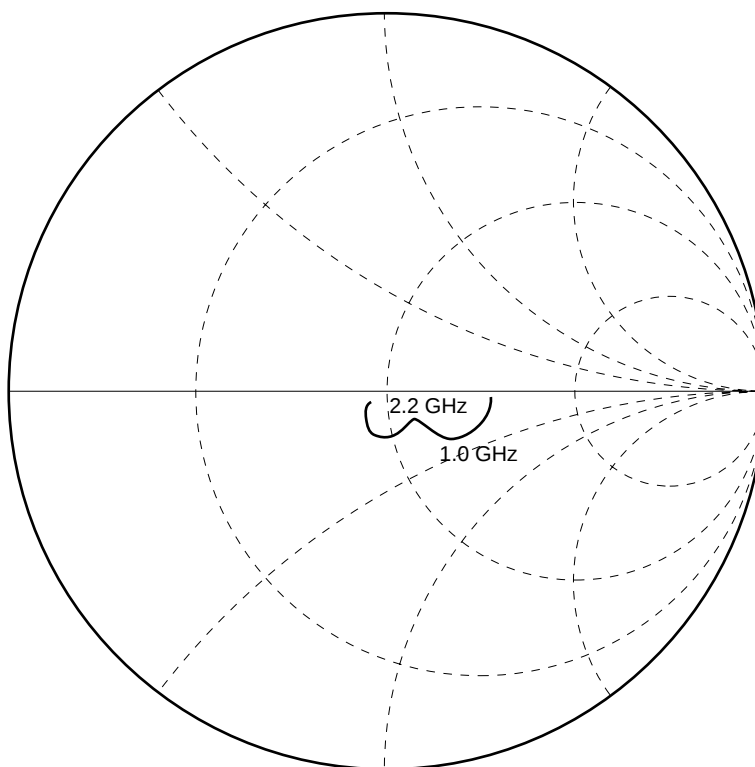
OUTPUT POWER (2 tones),  $IM_3$  vs. INPUT POWER



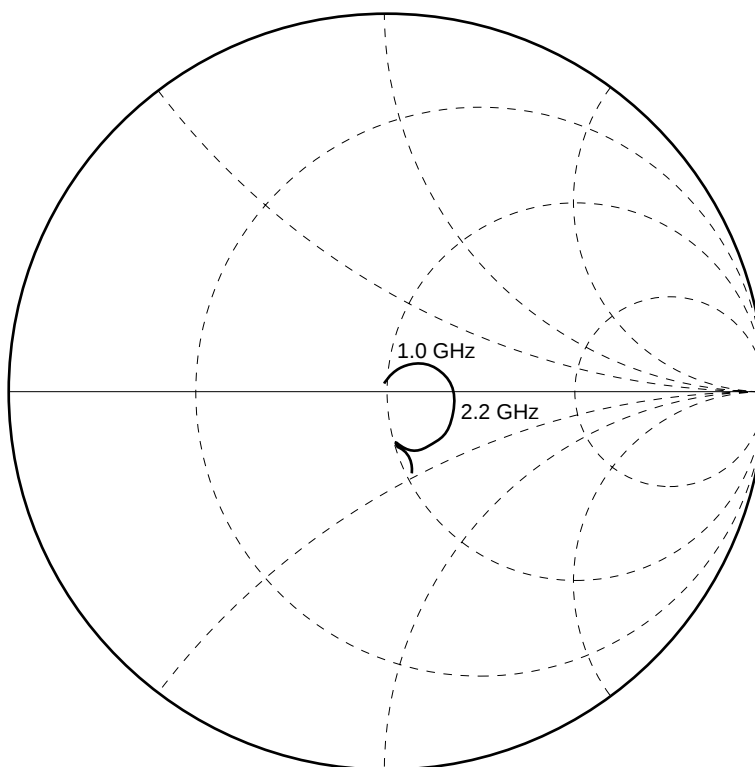
**Remark** The graphs indicate nominal characteristics.

S-PARAMETERS ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 5.0\text{ V}$ )

$S_{11}$ -FREQUENCY

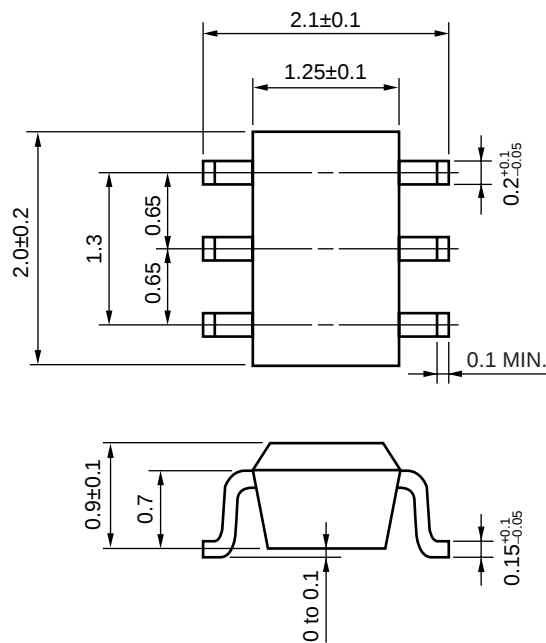


$S_{22}$ -FREQUENCY



PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



## NOTES ON CORRECT USE

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as widely as possible to minimize ground impedance (to prevent undesired oscillation).  
All the ground pins must be connected together with wide ground pattern to decrease impedance difference.
- (3) The bypass capacitor should be attached to V<sub>CC</sub> line.
- (4) The DC cut capacitor must be each attached to input and output pin.

## RECOMMENDED SOLDERING CONDITIONS

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

| Soldering Method | Soldering Conditions                                                                                                                                                                                                                                                                                                                                        | Condition Symbol |
|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------|
| Infrared Reflow  | Peak temperature (package surface temperature) : 260°C or below<br>Time at peak temperature : 10 seconds or less<br>Time at temperature of 220°C or higher : 60 seconds or less<br>Preheating time at 120 to 180°C : 120±30 seconds<br>Maximum number of reflow processes : 3 times<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | IR260            |
| Wave Soldering   | Peak temperature (molten solder temperature) : 260°C or below<br>Time at peak temperature : 10 seconds or less<br>Preheating temperature (package surface temperature) : 120°C or below<br>Maximum number of flow processes : 1 time<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below                                                | WS260            |
| Partial Heating  | Peak temperature (pin temperature) : 350°C or below<br>Soldering time (per side of device) : 3 seconds or less<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below                                                                                                                                                                      | HS350            |

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

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- 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, NEC Compound Semiconductor Devices, Ltd. 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).

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