

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC8182TB

### 3 V, 2.9 GHz SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER FOR MOBILE COMMUNICATIONS

#### DESCRIPTION

The  $\mu$ PC8182TB is a silicon monolithic integrated circuit designed as amplifier for mobile communications. This IC operates at 3 V. The medium output power is suitable for RF-TX of mobile communications system.

This IC is manufactured using our 30 GHz  $f_{\max}$  UHS0 (Ultra High Speed Process) silicon bipolar process. This process uses direct silicon nitride passivation film and gold electrodes. These materials can protect the chip surface from pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

#### FEATURES

- Supply voltage :  $V_{CC} = 2.7$  to  $3.3$  V
- Circuit current :  $I_{CC} = 30$  mA TYP. @  $V_{CC} = 3.0$  V
- Medium output power :  $PO(1dB) = +9.5$  dBm TYP. @  $f = 0.9$  GHz  
 $PO(1dB) = +9.0$  dBm TYP. @  $f = 1.9$  GHz  
 $PO(1dB) = +8.0$  dBm TYP. @  $f = 2.4$  GHz
- Power gain :  $GP = 21.5$  dB TYP. @  $f = 0.9$  GHz  
 $GP = 20.5$  dB TYP. @  $f = 1.9$  GHz  
 $GP = 20.5$  dB TYP. @  $f = 2.4$  GHz
- Upper limit operating frequency :  $f_u = 2.9$  GHz TYP. @ 3 dB bandwidth
- High-density surface mounting : 6-pin super minimold package ( $2.0 \times 1.25 \times 0.9$  mm)

#### APPLICATION

- Buffer amplifiers on 1.9 to 2.4 GHz mobile communications system

#### ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
$\mu$ PC8182TB-E3	6-pin super minimold	C3F	<ul style="list-style-type: none"> <li>• Embossed tape 8 mm wide</li> <li>• Pin 1, 2, 3 face the perforation side of the tape</li> <li>• Qty 3 kpcs/reel</li> </ul>

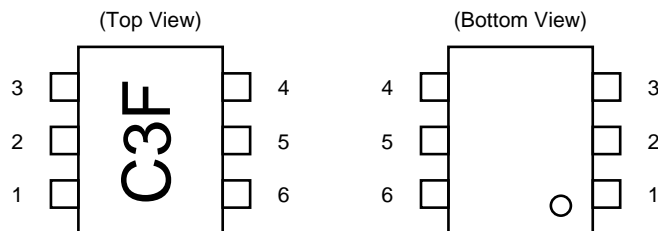
**Remark** To order evaluation samples, contact your nearby sales office.

Part number for sample order:  $\mu$ PC8182TB

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

The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.  
**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 (T<sub>A</sub> = +25°C, V<sub>CC</sub> = V<sub>out</sub> = 3.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)

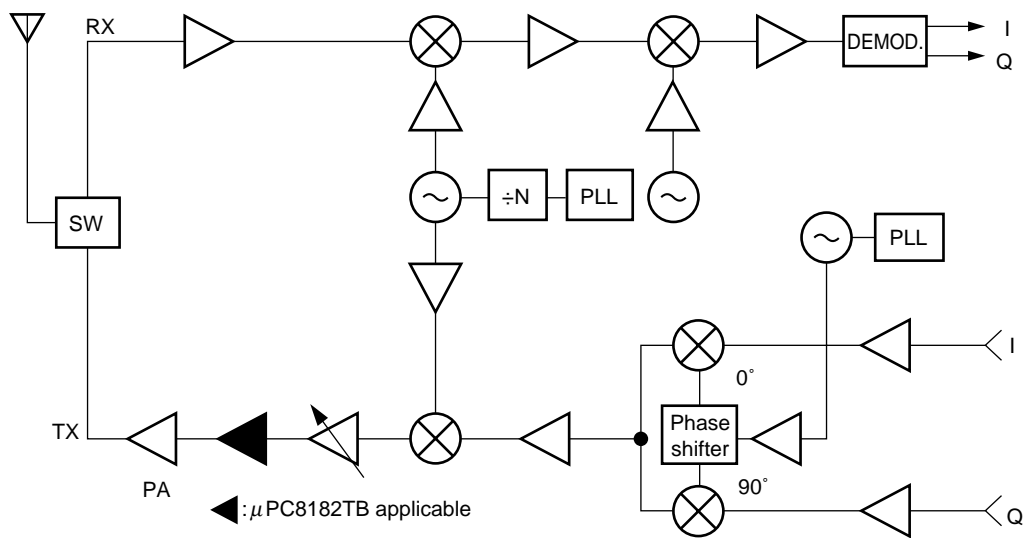
Part No.	f <sub>u</sub> (GHz)	P <sub>O</sub> (1 dB) (dBm)	GP (dB)	I <sub>CC</sub> (mA)	Package	Marking
μPC8182TB	2.9	+9.5 @ f = 0.9 GHz +9.0 @ f = 1.9 GHz +8.0 @ f = 2.4 GHz	21.5 @ f = 0.9 GHz 20.5 @ f = 1.9 GHz 20.5 @ f = 2.4 GHz	30.0	6-pin super minimold	C3F
μPC2762T	2.9	+8.0 @ f = 0.9 GHz	13.0 @ f = 0.9 GHz	26.5	6-pin minimold	C1Z
μPC2762TB		+7.0 @ f = 1.9 GHz	15.5 @ f = 1.9 GHz		6-pin super minimold	
μPC2763T	2.7	+9.5 @ f = 0.9 GHz	20.0 @ f = 0.9 GHz	27.0	6-pin minimold	C2A
μPC2763TB		+6.5 @ f = 1.9 GHz	21.0 @ f = 1.9 GHz		6-pin super minimold	
μPC2771T	2.2	+11.5 @ f = 0.9 GHz	21.0 @ f = 0.9 GHz	36.0	6-pin minimold	C2H
μPC2771TB		+9.5 @ f = 1.5 GHz	21.0 @ f = 1.5 GHz		6-pin super minimold	
★ μPC8181TB	4.0	+8.0 @ f = 0.9 GHz +7.0 @ f = 1.9 GHz +7.0 @ f = 2.4 GHz	19.0 @ f = 0.9 GHz 21.0 @ f = 1.9 GHz 22.0 @ f = 2.4 GHz	23.0	6-pin super minimold	C3E

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

**Caution** The package size distinguishes between minimold and super minimold.

# SYSTEM APPLICATION EXAMPLE

## Digital cellular telephone



**Caution** The insertion point is different due to the specifications of conjunct devices.

# PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) <small>Note</small>	Function and Applications	Internal Equivalent Circuit
1	INPUT	—	0.99	Signal input pin. A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band. A multi-feedback circuit is designed to cancel the deviations of $h_{FE}$ and resistance. This pin must be coupled to signal source with capacitor for DC cut.	
4	OUTPUT	Voltage as same as $V_{CC}$ through external inductor	—	Signal output pin. The inductor must be attached between $V_{CC}$ and output pins to supply current to the internal output transistors.	
6	$V_{CC}$	2.7 to 3.3	—	Power supply pin, which biases the internal input transistor. This pin should be externally equipped with bypass capacitor to minimize its impedance.	
2 3 5	GND	0	—	Ground pin. This pin should be connected to system ground with minimum inductance. Ground pattern on the board should be formed as wide as possible. All the ground pins must be connected together with wide ground pattern to decrease impedance difference.	

**Note** Pin voltage is measured at  $V_{CC} = 3.0 \text{ V}$ .

# ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C, pin 4 and pin 6	3.6	V
Total Circuit Current	I <sub>CC</sub>	T <sub>A</sub> = +25°C	60	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

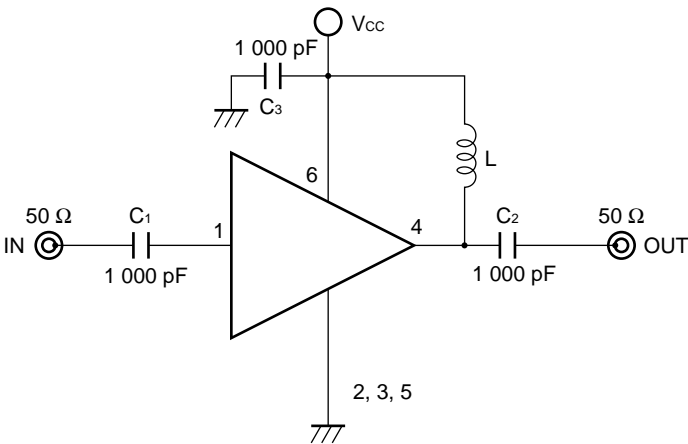
Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
Supply Voltage	V <sub>CC</sub>	2.7	3.0	3.3	V	Same voltage should be applied to pin 4 and pin 6.
Operating Ambient Temperature	T <sub>A</sub>	−40	+25	+85	°C	—

# ELECTRICAL CHARACTERISTICS

( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{out} = 3.0\text{ V}$ ,  $Z_s = Z_L = 50\ \Omega$ , unless otherwise specified)

Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	$I_{CC}$	No signal	–	30.0	38.0	mA
Power Gain	$G_P$	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	19.0 18.0 18.0	21.5 20.5 20.5	25.0 24.0 24.0	dB
Noise Figure	NF	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	– – –	4.5 4.5 5.0	6.0 6.0 6.5	dB
Upper Limit Operating Frequency	$f_u$	3 dB down below from gain at f = 0.1 GHz	2.6	2.9	–	GHz
Isolation	ISL	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	28 27 26	33 32 31	– – –	dB
Input Return Loss	$RL_{in}$	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	5 7 9	8 10 12	– – –	dB
Output Return Loss	$RL_{out}$	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	7 8 11	10 11 14	– – –	dB
Gain 1 dB Compression Output Power	$P_{O(1dB)}$	f = 0.9 GHz f = 1.9 GHz f = 2.4 GHz	+7.0 +6.5 +5.5	+9.5 +9.0 +8.0	– – –	dBm
Saturated Output Power	$P_{O(sat)}$	f = 0.9 GHz, $P_{in} = -5\text{ dBm}$ f = 1.9 GHz, $P_{in} = -5\text{ dBm}$ f = 2.4 GHz, $P_{in} = -5\text{ dBm}$	– – –	+11.0 +10.5 +10.0	– – –	dBm

TEST CIRCUITS



COMPONENTS OF TEST CIRCUIT  
FOR MEASURING ELECTRICAL  
CHARACTERISTICS

	Type	Value
C <sub>1</sub> , C <sub>2</sub>	Bias Tee	1 000 pF
C <sub>3</sub>	Capacitor	1 000 pF
L	Bias Tee	1 000 nH

EXAMPLE OF ACTUAL APPLICATION COMPONENTS

	Type	Value	Operating Frequency
C <sub>1</sub> to C <sub>3</sub>	Chip capacitor	1 000 pF	100 MHz or higher
L	Chip inductor	100 nH	100 MHz or higher
		10 nH	2.0 GHz or higher

INDUCTOR FOR THE OUTPUT PIN

The internal output transistor of this IC consumes 20 mA, to output medium power. To supply current for output transistor, connect an inductor between the Vcc pin (pin 6) and output pin (pin 4). Select large value inductance, as listed above.

The inductor has both DC and AC effects. In terms of DC, the inductor biases the output transistor with minimum voltage drop to output enable high level. In terms of AC, the inductor make output-port-impedance higher to get enough gain. In this case, large inductance and Q is suitable.

For above reason, select an inductance of 100 Ω or over impedance in the operating frequency. The gain is a peak in the operating frequency band, and suppressed at lower frequencies.

The recommendable inductance can be chosen from example of actual application components list as shown above.

CAPACITORS FOR THE Vcc, INPUT, AND OUTPUT PINS

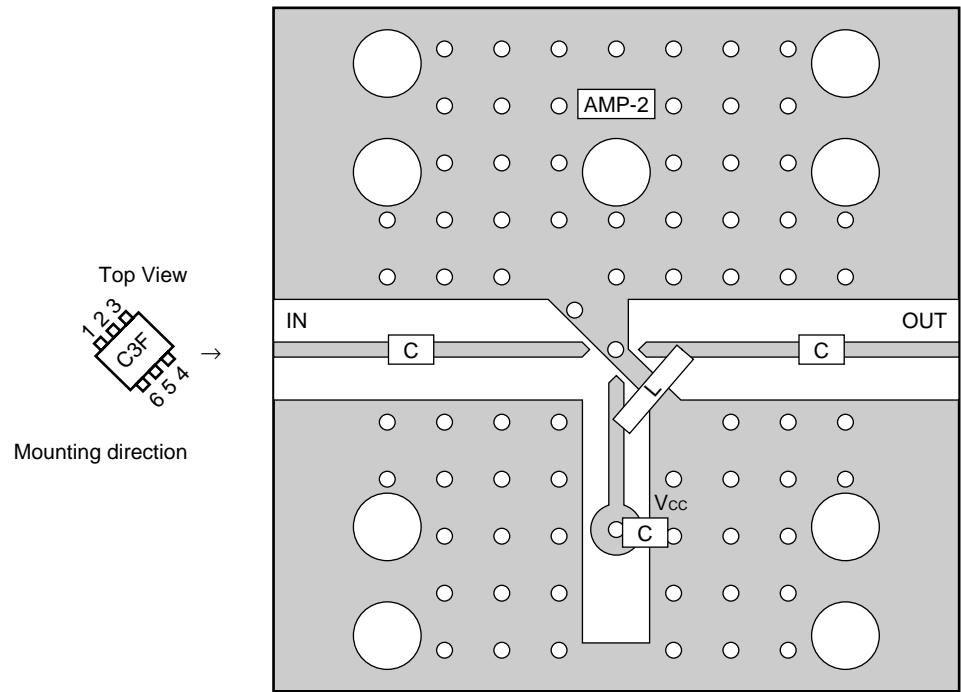
Capacitors of 1 000 pF are recommendable as the bypass capacitor for the Vcc pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the Vcc pin is used to minimize ground impedance of Vcc pin. So, stable bias can be supplied against Vcc fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitance 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,  $C = 1/(2\pi Rf_c)$ .

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

	Value
C	1 000 pF
L	Example: 10 nH

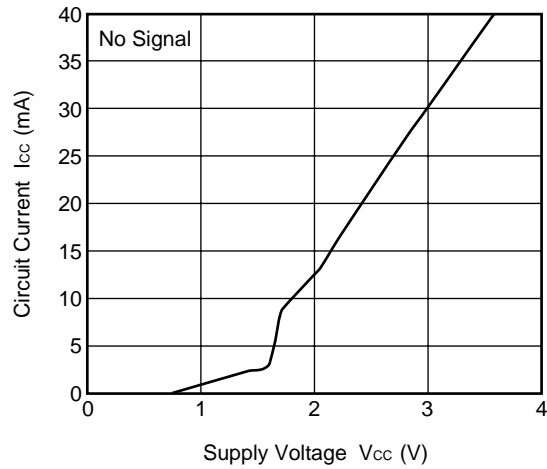
Notes

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

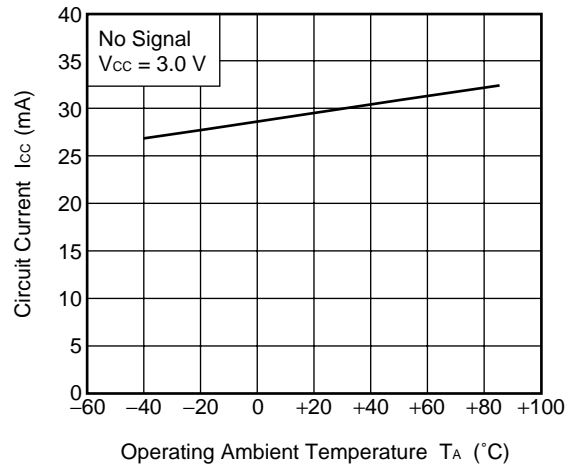


**TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)**

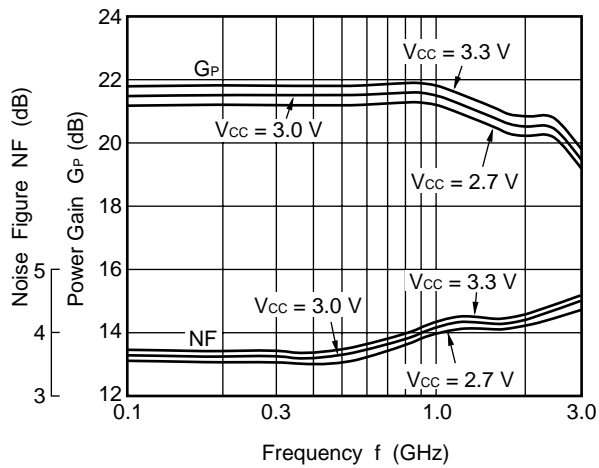
**CIRCUIT CURRENT vs. SUPPLY VOLTAGE**



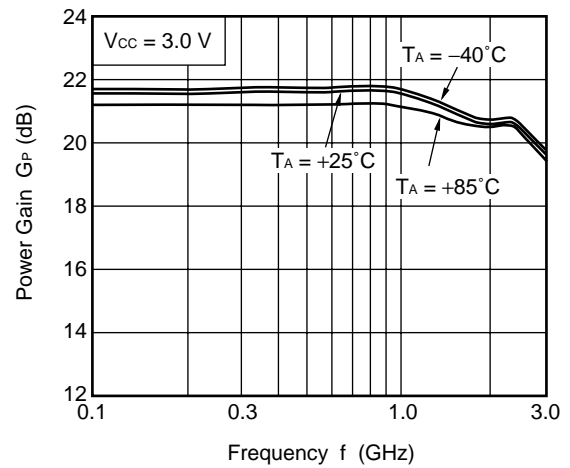
**CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE**



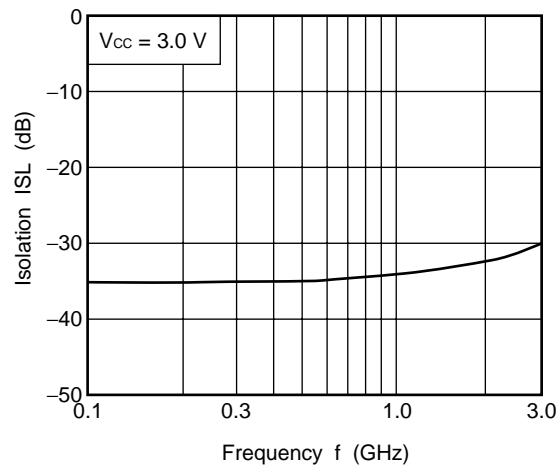
**NOISE FIGURE, POWER GAIN vs. FREQUENCY**



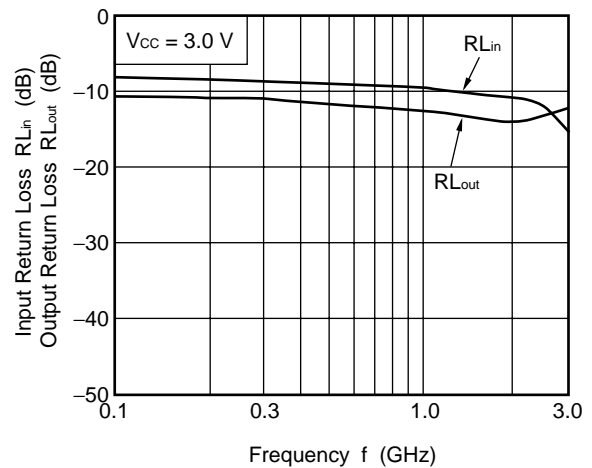
**POWER GAIN vs. FREQUENCY**



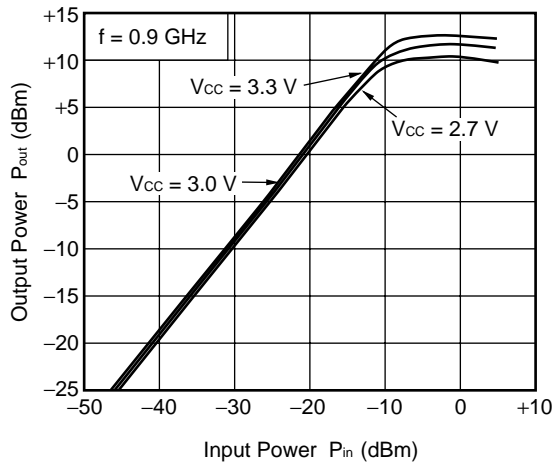
**ISOLATION vs. FREQUENCY**



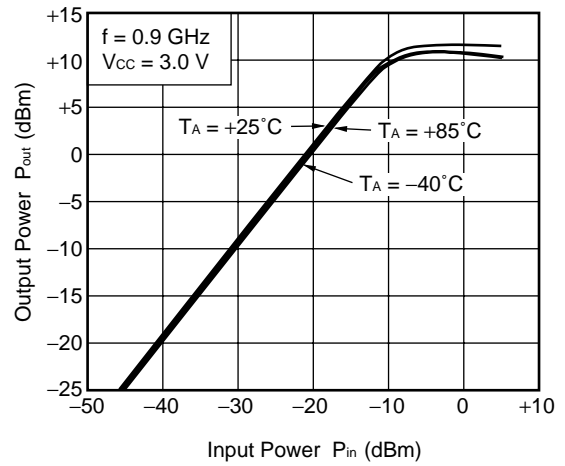
**INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY**



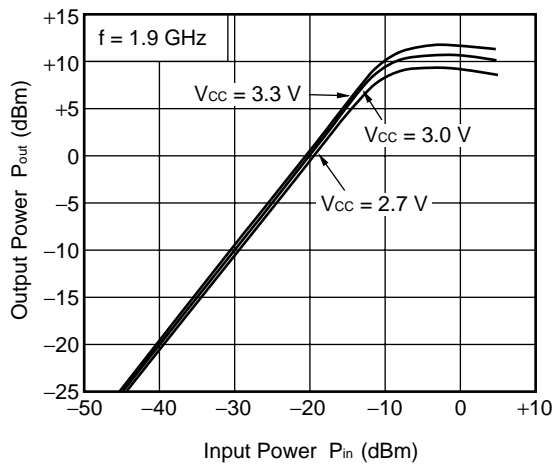
OUTPUT POWER vs. INPUT POWER



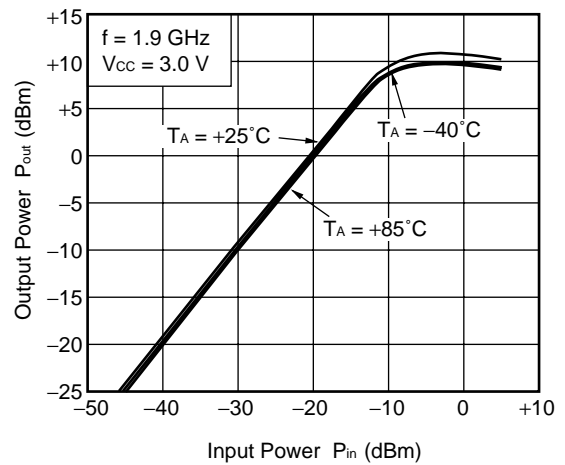
OUTPUT POWER vs. INPUT POWER



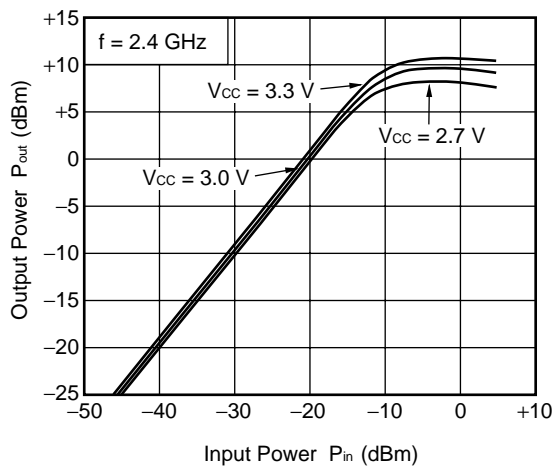
OUTPUT POWER vs. INPUT POWER



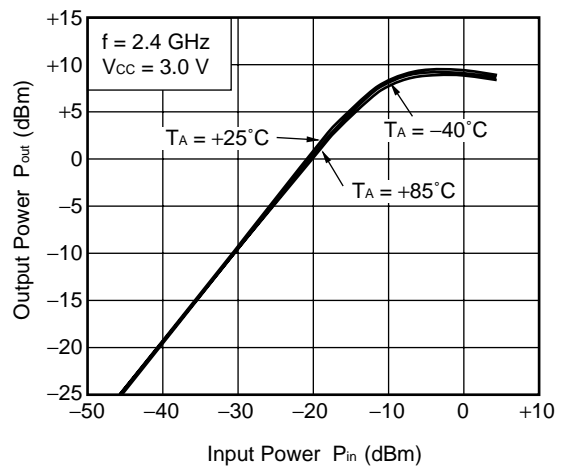
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER

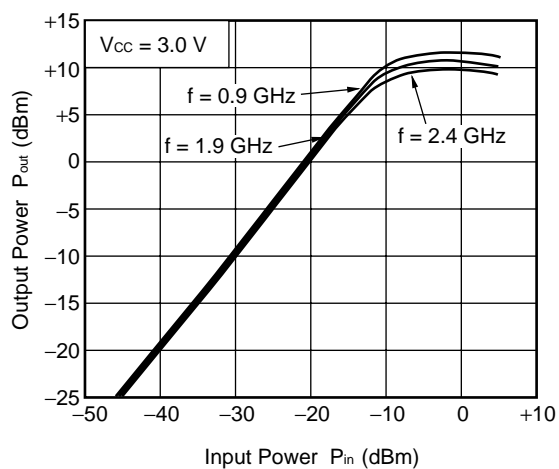


OUTPUT POWER vs. INPUT POWER

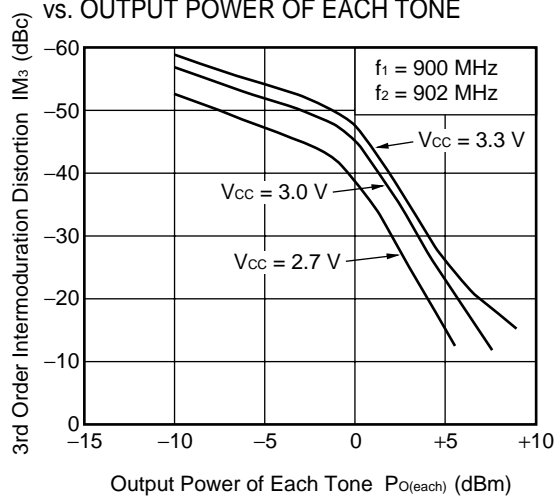


★

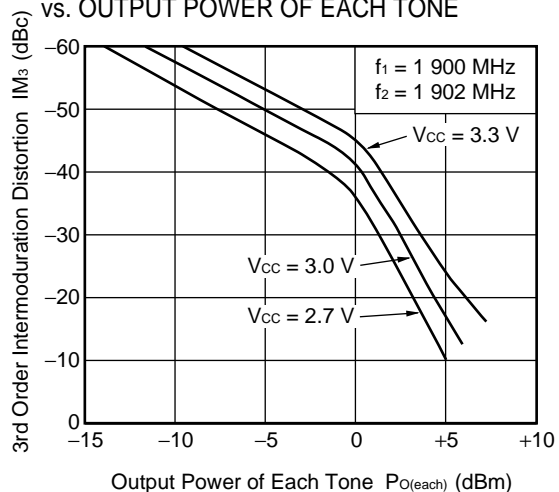
OUTPUT POWER vs. INPUT POWER



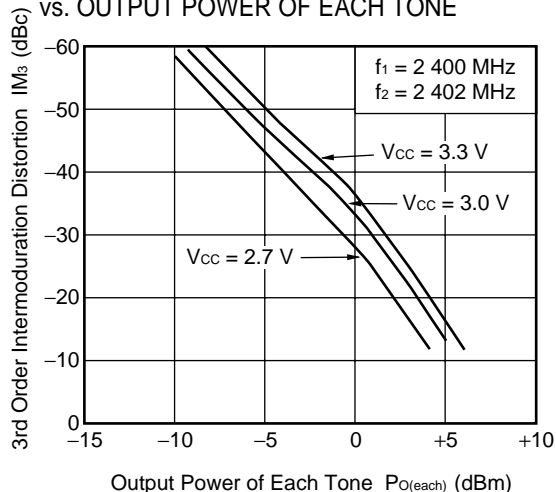
3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



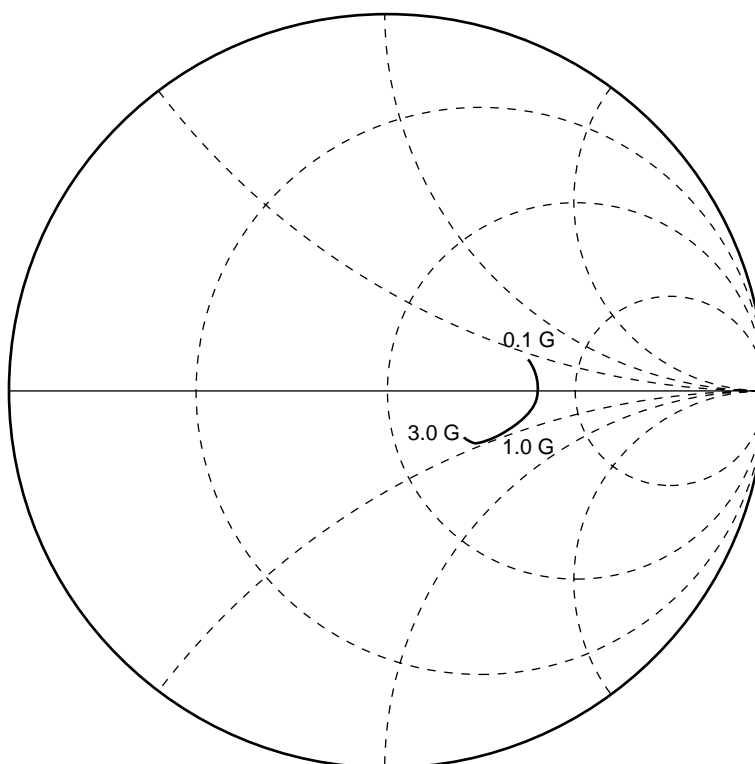
3RD ORDER INTERMODULATION DISTORTION vs. OUTPUT POWER OF EACH TONE



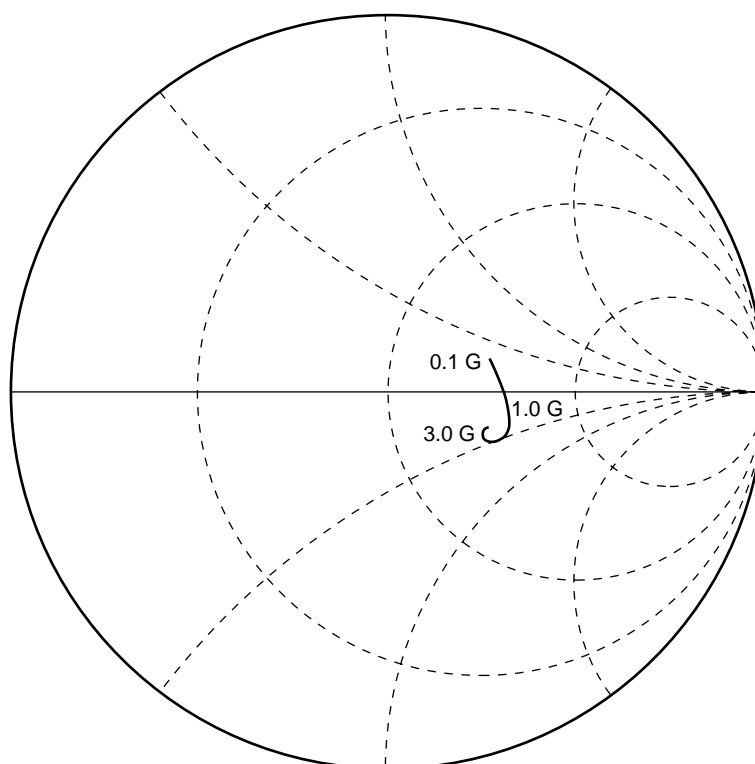
**Remark** The graphs indicate nominal characteristics.

SMITH CHART ( $V_{CC} = V_{out} = 3.0\text{ V}$ )

S<sub>11</sub>-FREQUENCY



S<sub>22</sub>-FREQUENCY



**★ S-PARAMETERS**

S-parameters/Noise parameters are provided on the NEC Compound Semiconductor Devices Web site in a form (S2P) that enables direct import to a microwave circuit simulator without keyboard input.

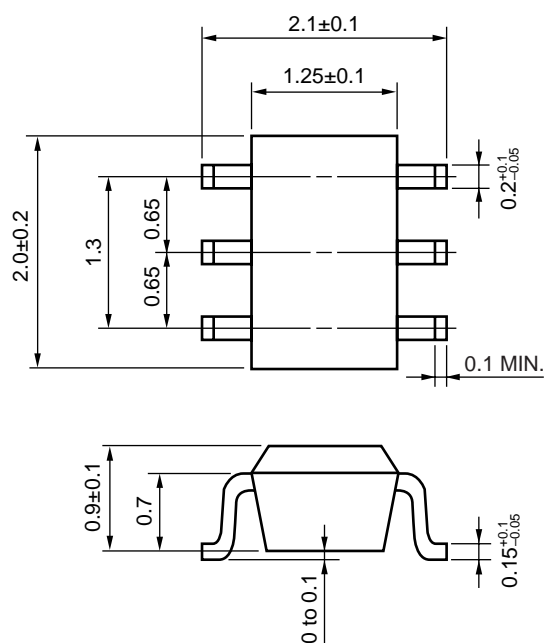
Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL <http://www.csd-nec.com/>

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 the V<sub>cc</sub> pin.
- (4) The inductor must be attached between V<sub>cc</sub> and output pins. The inductance value should be determined in accordance with desired frequency.
- (5) The DC cut capacitor must be 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 Time at peak temperature : 10 seconds or less Time at temperature of 220°C or higher : 60 seconds or less Preheating time at 120 to 180°C : 120±30 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	IR260
VPS	Peak temperature (package surface temperature) : 215°C or below Time at temperature of 200°C or higher : 25 to 40 seconds Preheating time at 120 to 150°C : 30 to 60 seconds Maximum number of reflow processes : 3 times Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	VP215
Wave Soldering	Peak temperature (molten solder temperature) : 260°C or below Time at peak temperature : 10 seconds or less Preheating temperature (package surface temperature) : 120°C or below Maximum number of flow processes : 1 time Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below	WS260
Partial Heating	Peak temperature (pin temperature) : 350°C or below Soldering time (per side of device) : 3 seconds or less 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).

- **The information in this document is current as of December 2002. 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, 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).

M8E 00.4-0110



---

► **Business issue**

**NEC Compound Semiconductor Devices, Ltd.**

5th Sales Group, Sales Division TEL: +81-3-3798-6372 FAX: +81-3-3798-6783 E-mail: salesinfo@csd-nec.com

**NEC Compound Semiconductor Devices Hong Kong Limited**

Hong Kong Head Office TEL: +852-3107-7303 FAX: +852-3107-7309

Taipei Branch Office TEL: +886-2-8712-0478 FAX: +886-2-2545-3859

Korea Branch Office TEL: +82-2-528-0301 FAX: +82-2-528-0302

**NEC Electronics (Europe) GmbH** <http://www.ee.nec.de/>

TEL: +49-211-6503-01 FAX: +49-211-6503-487

**California Eastern Laboratories, Inc.** <http://www.cel.com/>

TEL: +1-408-988-3500 FAX: +1-408-988-0279

► **Technical issue**

**NEC Compound Semiconductor Devices, Ltd.** <http://www.csd-nec.com/>

Sales Engineering Group, Sales Division

E-mail: techinfo@csd-nec.com FAX: +81-44-435-1918