

5 V, SILICON MMIC WIDEBAND AMPLIFIER

DESCRIPTION

The μ PC3224TB is a silicon monolithic IC designed as IF amplifier for DBS tuners. This IC is manufactured using our 30 GHz $f_{\max}$ UHSO (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
μ PC3224TB-E3	6-pin super minimold	C3K	• Embossed tape 8 mm wide • 1, 2, 3 pins face the perforation side of tape • Qty 3 kpcs/reel

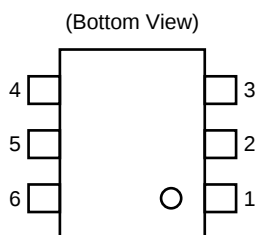
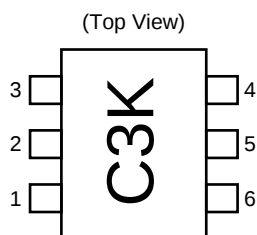
Remark To order evaluation samples, contact your nearby sales office.

Part number for sample order: μ PC3224TB

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 _{CC}

PRODUCT LINE-UP OF 5 V-BIAS SILICON MMIC MEDIUM WIDEBAND AMPLIFIER

(T_A = +25°C, f = 1 GHz, V_{CC} = V_{out} = 5.0 V, Z_S = Z_L = 50 Ω)

Part No.	f _u (GHz)	P _{O(sat)} (dBm)	G _P (dB)	NF (dB)	I _{cc} (mA)	Package	Marking
μ PC2711TB	2.9	+1.0	13	5.0	12	6-pin super minimold	C1G
μ PC2712TB	2.6	+3.0	20	4.5	12		C1H
μ PC3215TB ^{Note}	2.9	+3.5	20.5	2.3	14		C3H
μ PC3224TB	3.2	+4.0	21.5	4.3	9.0		C3K

Note μ 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) Note	Function and Applications
1	INPUT	—	0.91	Signal input pin. A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band. A multi-feedback circuits 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	—	4.42	Signal output pin. A internal matching circuit, configured with resistors, enables 50 Ω connection over a wide band. This pin must be coupled to next stage with capacitor for DC cut.
6	V _{CC}	4.5 to 5.5	—	Power supply pin. 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} = 5.0 V

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{CC}	$T_A = +25^{\circ}\text{C}$	6.0	V
Total Circuit Current	I_{CC}	$T_A = +25^{\circ}\text{C}$	25	mA
Power Dissipation	P_D	$T_A = +85^{\circ}\text{C}$ Note	270	mW
Operating Ambient Temperature	T_A		-40 to +85	$^{\circ}\text{C}$
Storage Temperature	T_{stg}		-55 to +150	$^{\circ}\text{C}$
Input Power	P_{in}	$T_A = +25^{\circ}\text{C}$	+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_{CC}		4.5	5.0	5.5	V
Operating Ambient Temperature	T_A		-40	+25	+85	$^{\circ}\text{C}$

ELECTRICAL CHARACTERISTICS ($T_A = +25^{\circ}\text{C}$, $V_{CC} = 5.0\text{ V}$, $Z_S = Z_L = 50\ \Omega$)

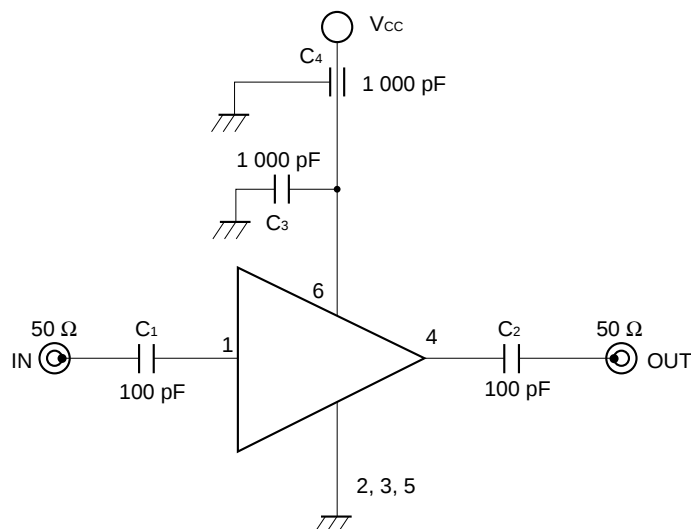
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No input signal	7.0	9.0	12.0	mA
Power Gain	G_P	$f = 1.0\text{ GHz}$, $P_{in} = -30\text{ dBm}$	19.0	21.5	24.0	dB
		$f = 2.2\text{ GHz}$, $P_{in} = -30\text{ dBm}$	18.5	21.5	24.5	
Saturated Output Power	$P_{O(sat)}$	$f = 1.0\text{ GHz}$, $P_{in} = -5\text{ dBm}$	+1.5	+4.0	—	dBm
		$f = 2.2\text{ GHz}$, $P_{in} = -5\text{ dBm}$	-1.5	+1.5	—	
Gain 1 dB Compression Output Power	$P_{O(1\text{ dB})}$	$f = 1.0\text{ GHz}$	-6.5	-3.5	—	dBm
		$f = 2.2\text{ GHz}$	-8.5	-5.5	—	
Noise Figure	NF	$f = 1.0\text{ GHz}$	—	4.3	5.8	dB
		$f = 2.2\text{ GHz}$	—	4.3	5.8	
Upper Limit Operating Frequency	f_u	3 dB down below flat gain at $f = 0.1\text{ GHz}$	2.8	3.2	—	GHz
Isolation	ISL	$f = 1.0\text{ GHz}$, $P_{in} = -30\text{ dBm}$	35.0	40.0	—	dB
		$f = 2.2\text{ GHz}$, $P_{in} = -30\text{ dBm}$	37.0	42.0	—	
Input Return Loss	RL_{in}	$f = 1.0\text{ GHz}$, $P_{in} = -30\text{ dBm}$	9.0	12.0	—	dB
		$f = 2.2\text{ GHz}$, $P_{in} = -30\text{ dBm}$	10.0	14.0	—	
Output Return Loss	RL_{out}	$f = 1.0\text{ GHz}$, $P_{in} = -30\text{ dBm}$	11.0	17.0	—	dB
		$f = 2.2\text{ GHz}$, $P_{in} = -30\text{ dBm}$	8.0	12.0	—	
Gain Flatness	ΔG_P	$f = 0.1\text{ to }2.2\text{ GHz}$	—	±0.8	—	dB

OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

(T_A = +25°C, V_{CC} = 5.0 V, Z_S = Z_L = 50 Ω)

Parameter	Symbol	Test Conditions	Reference Value	Unit
Output Intercept Point	OIP ₃	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 ₁ , C ₂	Chip Capacitor	100 pF
C ₃	Chip Capacitor	1 000 pF
C ₄	Feed-through Capacitor	1 000 pF

CAPACITORS FOR THE V_{CC}, INPUT AND OUTPUT PINS

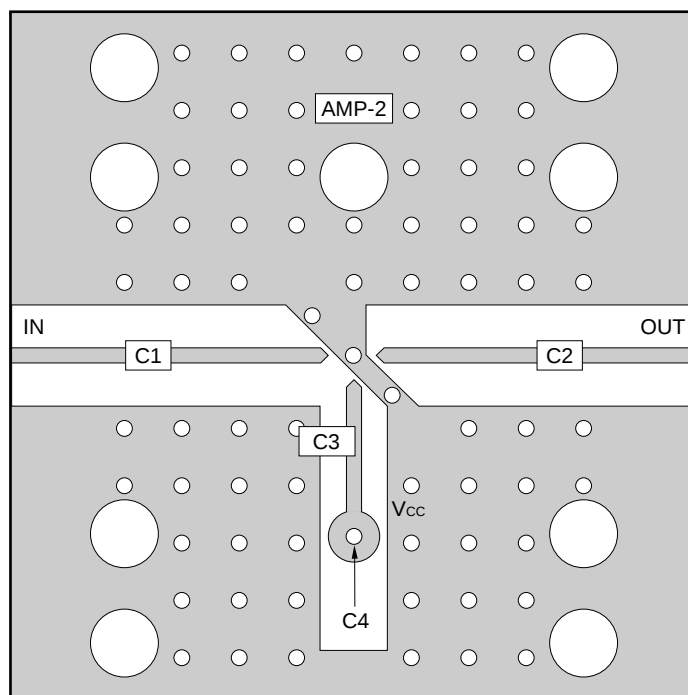
Capacitors of 1000 pF are recommendable as the bypass capacitor for the V_{CC} pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the V_{CC} pin is used to minimize ground impedance of V_{CC} pin. So, stable bias can be supplied against V_{CC} 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

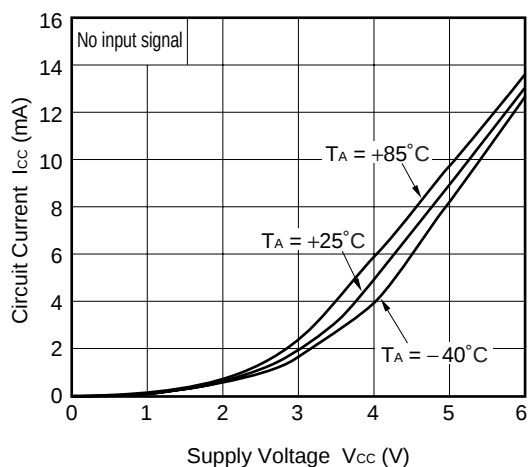
	Value
C ₁ , C ₂	100 pF
C ₃ , C ₄	1 000 pF

Notes

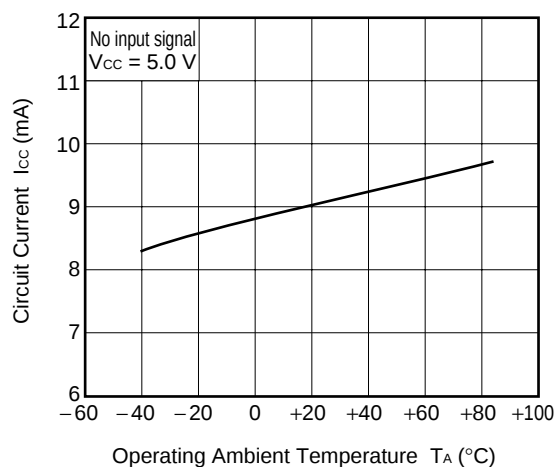
1. 30 × 30 × 0.4 mm double sided copper clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4. o○: Through holes

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

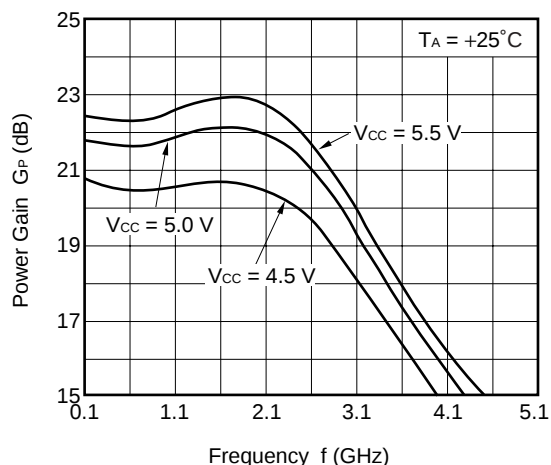
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



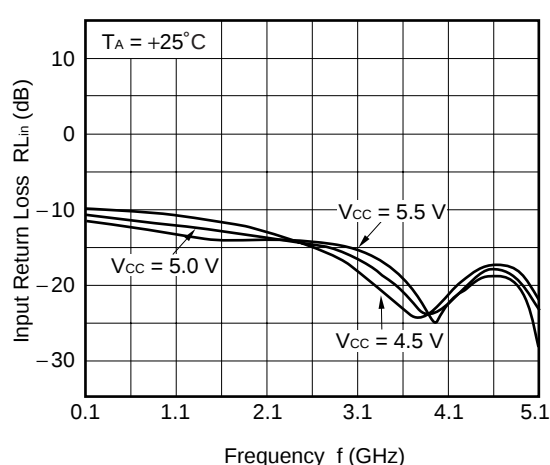
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



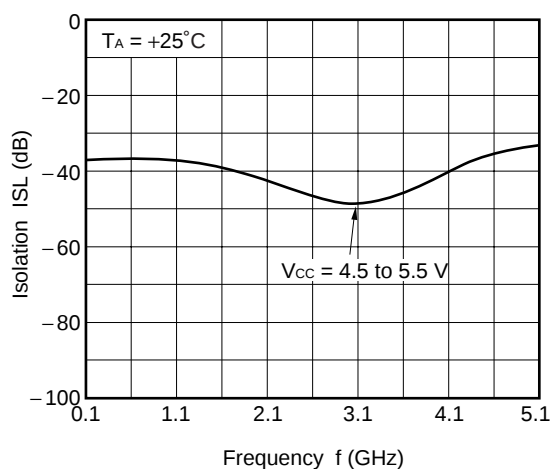
POWER GAIN vs. FREQUENCY



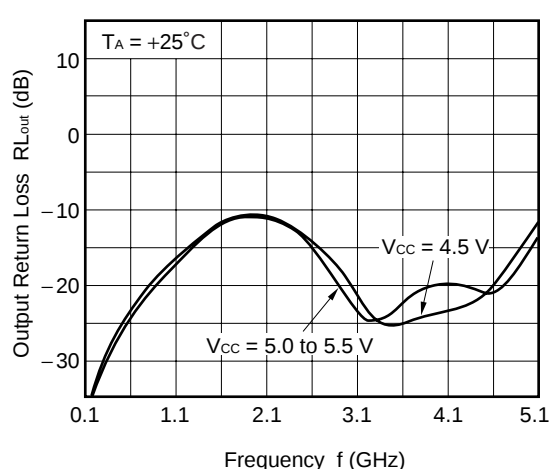
INPUT RETURN LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY

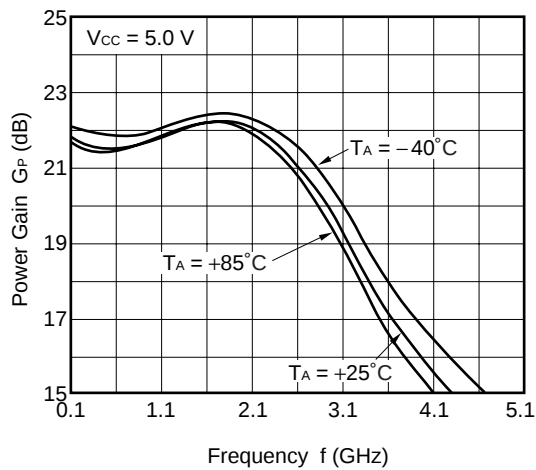


OUTPUT RETURN LOSS vs. FREQUENCY

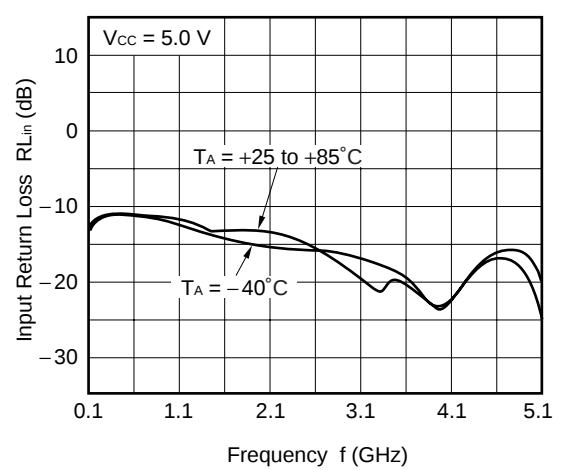


Remark The graphs indicate nominal characteristics.

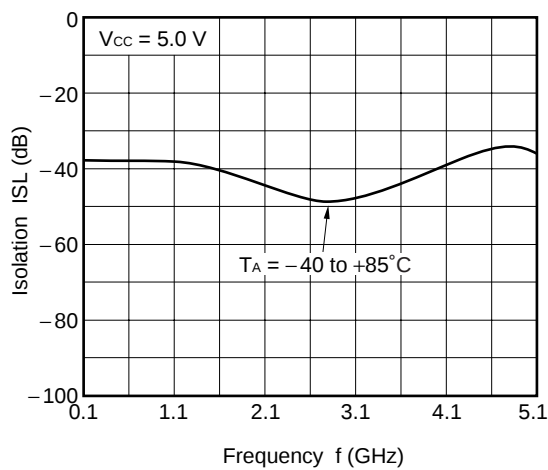
POWER GAIN vs. FREQUENCY



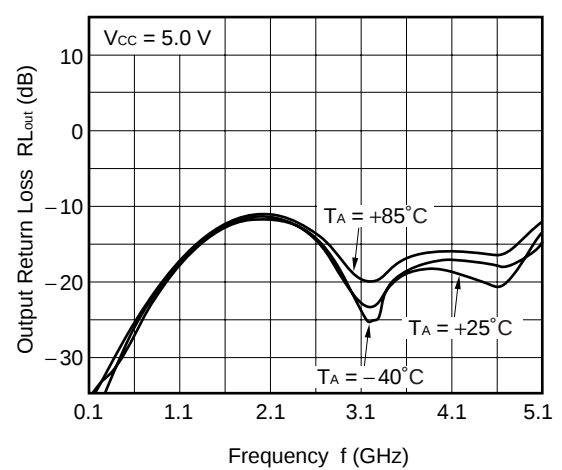
INPUT RETURN LOSS vs. FREQUENCY



ISOLATION vs. FREQUENCY

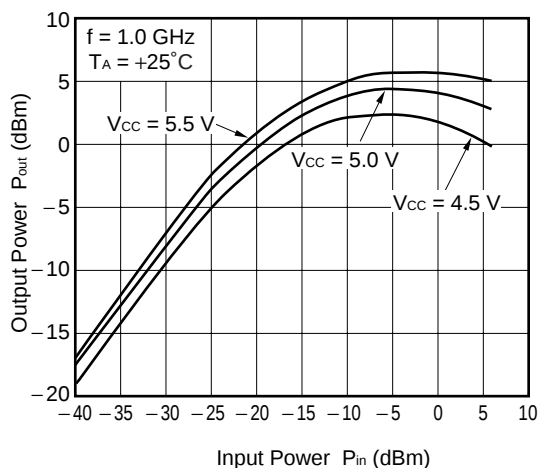


OUTPUT RETURN LOSS vs. FREQUENCY

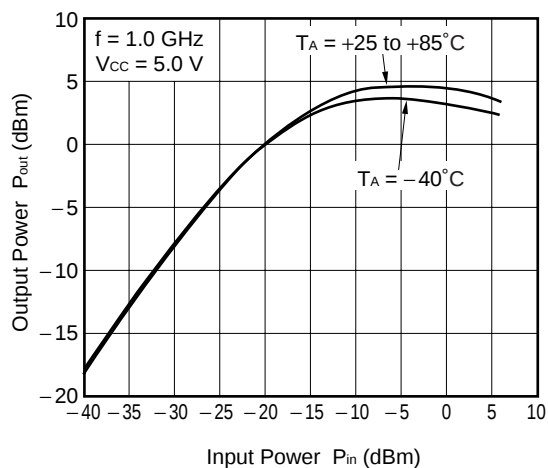


Remark The graphs indicate nominal characteristics.

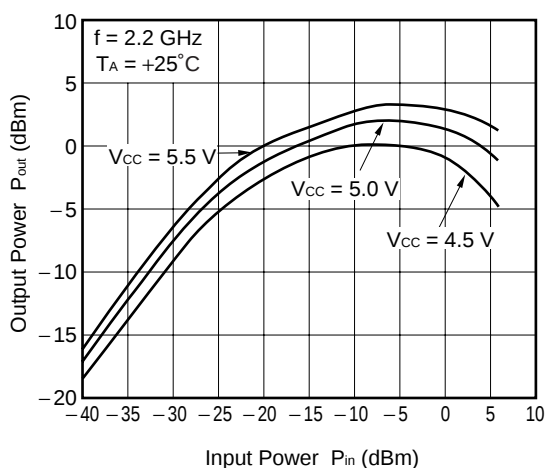
OUTPUT POWER vs. INPUT POWER



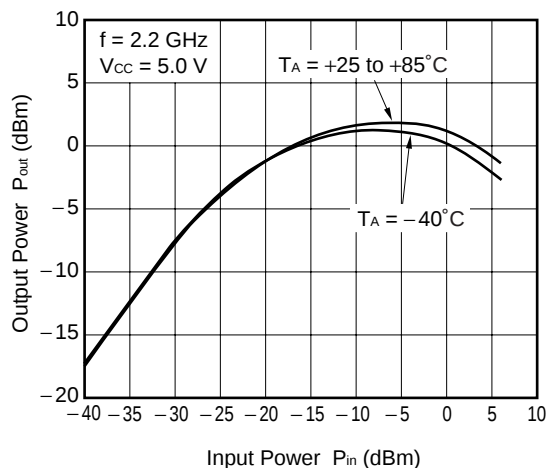
OUTPUT POWER vs. INPUT POWER



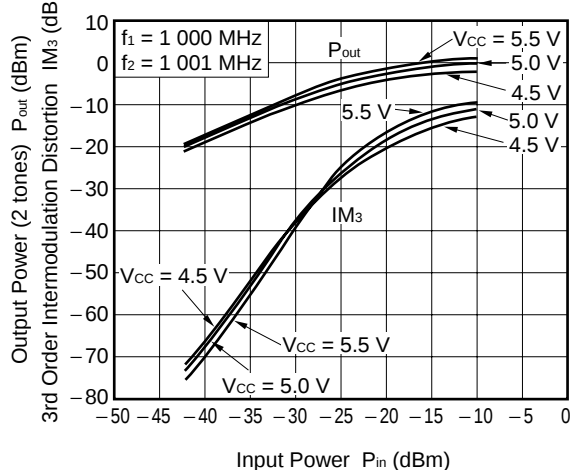
OUTPUT POWER vs. INPUT POWER



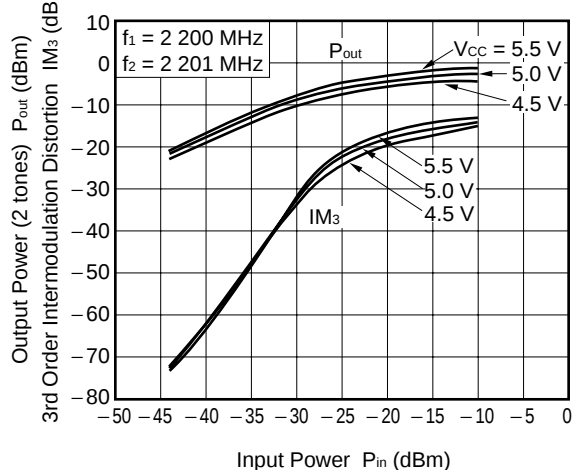
OUTPUT POWER vs. INPUT POWER



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



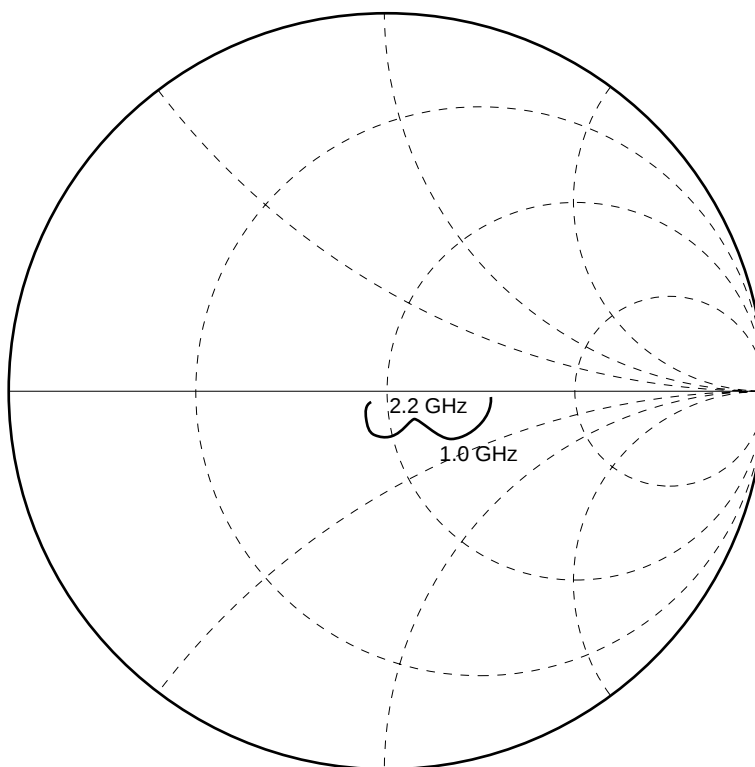
OUTPUT POWER (2 tones), IM_3 vs. INPUT POWER



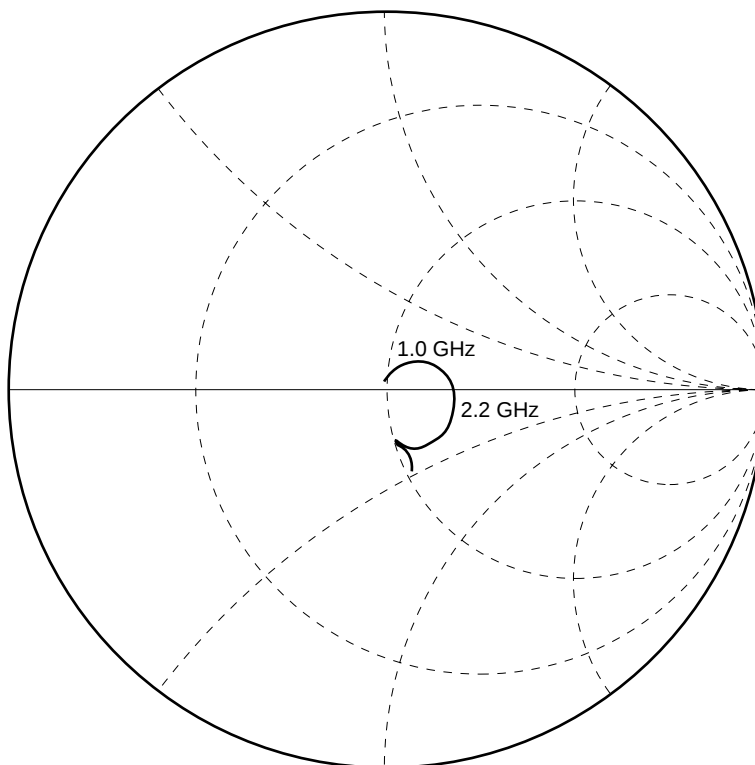
Remark The graphs indicate nominal characteristics.

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

S_{11} -FREQUENCY

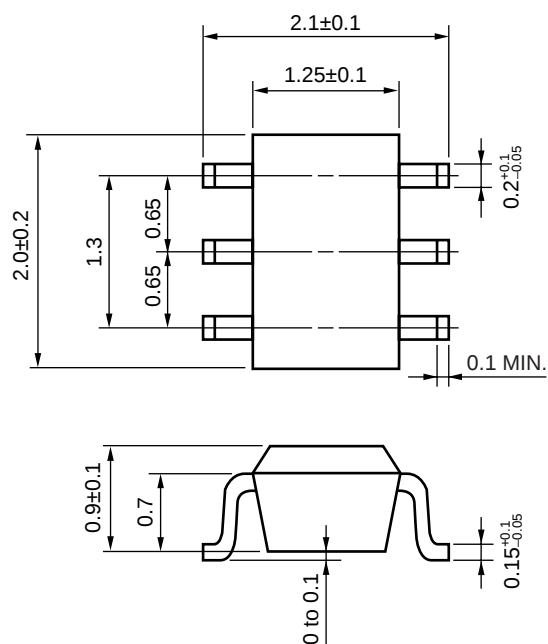


S_{22} -FREQUENCY



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_{CC} 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 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
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 May, 2004. 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

► For further information, please contact

NEC Compound Semiconductor Devices, Ltd. <http://www.ncsd.necel.com/>

E-mail: salesinfo@ml.ncsd.necel.com (sales and general)

techinfo@ml.ncsd.necel.com (technical)

5th Sales Group, Sales Division TEL: +81-44-435-1588 FAX: +81-44-435-1579

NEC Compound Semiconductor Devices Hong Kong Limited

E-mail: ncsd-hk@elhk.nec.com.hk (sales, technical and general)

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: +82-2-558-2120 FAX: +82-2-558-5209

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

TEL: +49-211-6503-0 FAX: +49-211-6503-1327

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

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