

# BIPOLAR ANALOG INTEGRATED CIRCUITS

# $\mu$ PC2747TB, $\mu$ PC2748TB

### 3 V, SUPER MINIMOLD SILICON MMIC AMPLIFIER FOR MOBILE COMMUNICATIONS

#### DESCRIPTION

The  $\mu$ PC2747TB,  $\mu$ PC2748TB are silicon monolithic integrated circuits designed as amplifier for mobile communications. These ICs are packaged in super minimold package which is smaller than conventional minimold.

These ICs are manufactured using our 20 GHz fr NESAT III silicon bipolar process. This process uses silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, these ICs have excellent performance, uniformity and reliability.

#### FEATURES

- Supply voltage :  $V_{CC} = 2.7$  to  $3.3$  V
- Noise figure :  $\mu$ PC2747TB ; NF = 3.3 dB TYP. @  $f = 900$  MHz  
 $\mu$ PC2748TB ; NF = 2.8 dB TYP. @  $f = 900$  MHz
- Power gain :  $\mu$ PC2747TB ;  $G_P = 12$  dB TYP. @  $f = 900$  MHz  
 $\mu$ PC2748TB ;  $G_P = 19$  dB TYP. @  $f = 900$  MHz
- Operating frequency :  $\mu$ PC2747TB ; DC to 1.8 GHz  
 $\mu$ PC2748TB ; 0.2 to 1.5 GHz
- Isolation :  $\mu$ PC2747TB ; ISL = 40 dB TYP. @  $f = 900$  MHz  
 $\mu$ PC2748TB ; ISL = 40 dB TYP. @  $f = 900$  MHz
- High-density surface mounting : 6-pin super minimold package ( $2.0 \times 1.25 \times 0.9$  mm)

#### APPLICATION

- Buffer amplifiers for mobile telephones, etc. (PDC800M, GSM)

#### ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
$\mu$ PC2747TB-E3	6-pin super minimold	C1S	<ul style="list-style-type: none"> <li>• Embossed tape 8 mm wide</li> <li>• 1, 2, 3 pins face the perforation side of the tape</li> <li>• Qty 3 kpcs/reel</li> </ul>
$\mu$ PC2748TB-E3		C1T	

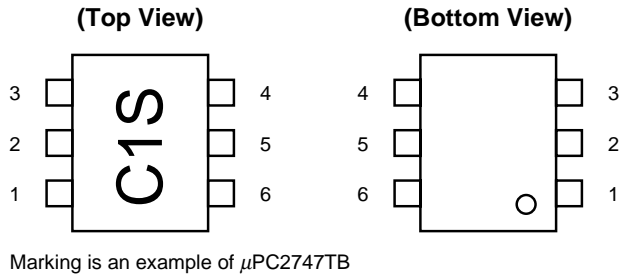
**Remark** To order evaluation samples, contact your nearby sales office.

Part number for sample order:  $\mu$ PC2747TB,  $\mu$ PC2748TB

**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> = 3.0 V, Z<sub>S</sub> = Z<sub>L</sub> = 50 Ω)**

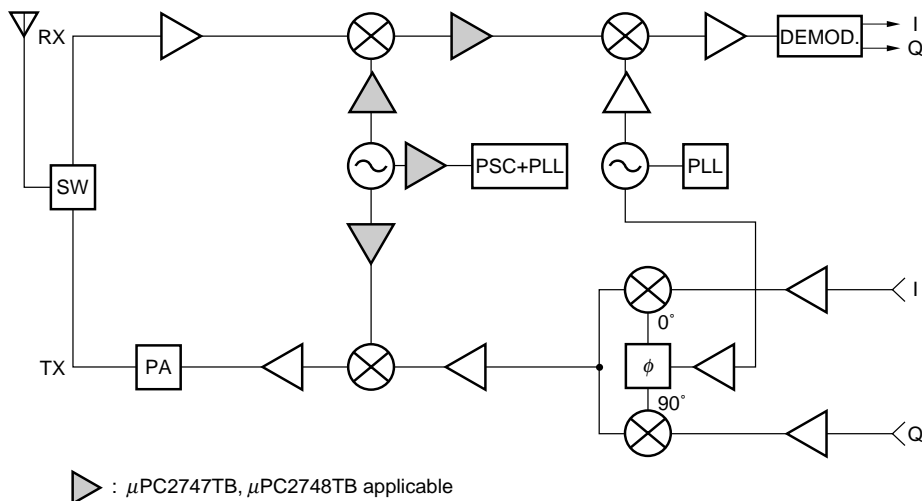
Part No.	f <sub>u</sub> (GHz)	P <sub>O (sat)</sub> (dBm)	G <sub>P</sub> (dB)	NF (dB)	I <sub>CC</sub> (mA)	Package	Marking
$\mu$ PC2745T	2.7	-1.0	12	6.0	7.5	6-pin minimold	C1Q
$\mu$ PC2745TB						6-pin super minimold	
$\mu$ PC2746T	1.5	0	19	4.0	7.5	6-pin minimold	C1R
$\mu$ PC2746TB						6-pin super minimold	
$\mu$ PC2747T	1.8	-7.0	12	3.3	5.0	6-pin minimold	C1S
$\mu$ PC2747TB						6-pin super minimold	
$\mu$ PC2748T	1.5	-3.5	19	2.8	6.0	6-pin minimold	C1T
$\mu$ PC2748TB						6-pin super minimold	
$\mu$ PC2749T	2.9	-6.0	16	4.0	6.0	6-pin minimold	C1U
$\mu$ PC2749TB						6-pin super minimold	

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

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

**SYSTEM APPLICATION EXAMPLE**

**EXAMPLE OF DIGITAL CELLULER TELEPHONE**



**PIN EXPLANATION**

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) <small>Note</small>	Function and Applications	Internal Equivalent Circuit
1	INPUT	–	0.80 ----- 0.80	Signal input pin. A internal matching circuit, configured with resistors, enables 50 $\Omega$ connection over a wide band. This pin must be coupled to signal source with capacitor for DC cut.	<p>The above diagram is for the <math>\mu</math>PC2747TB. The resistor marked with an asterisk does not exist in the <math>\mu</math>PC2748TB.</p>
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.	
4	OUTPUT	–	2.79 ----- 2.72	Signal output pin. A internal matching circuit, configured with resistors, enables 50 $\Omega$ connection over a wide band. This pin must be coupled to next stage with capacitor for DC cut.	
6	Vcc	2.7 to 3.3	–	Power supply pin. This pin should be externally equipped with bypass capacity to minimize ground impedance.	

**Note** Pin voltage is measured at Vcc = 3.0 V. Above:  $\mu$ PC2747TB, Below:  $\mu$ PC2748TB

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25°C	4.0	V
Circuit Current	I <sub>CC</sub>	T <sub>A</sub> = +25°C	15	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	0	dBm

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

**RECOMMENDED OPERATING RENGE**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit
Supply Voltage	V <sub>CC</sub>	2.7	3.0	3.3	V

**ELECTRICAL CHARACTERISTICS**

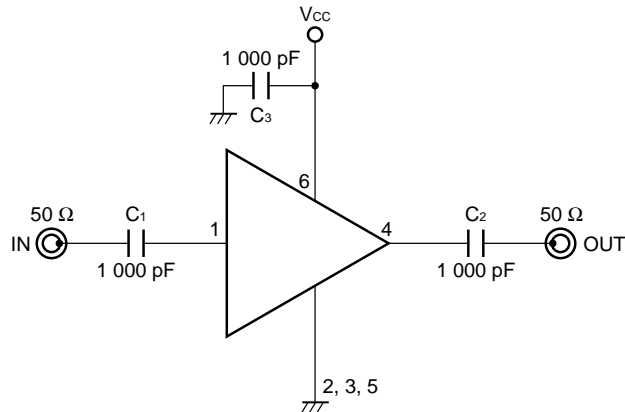
(T<sub>A</sub> = +25°C, V<sub>CC</sub> = 3.0 V, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω, unless otherwise specified)

Parameter	Symbol	Test Conditions	$\mu$ PC2747TB			$\mu$ PC2748TB			Unit
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Circuit Current	I <sub>CC</sub>	No Signal	3.8	5.0	7.0	4.5	6.0	8.0	mA
Power Gain	G <sub>P</sub>	f = 900 MHz	9	12	14	16	19	21	dB
Noise Figure	NF	f = 900 MHz	-	3.3	4.5	-	2.8	4.0	dB
Upper Limit Operating Frequency	f <sub>u</sub>	3 dB down below from gain at f = 0.9 GHz	1.5	1.8	-	1.2	1.5	-	GHz
Lower Limit Operating Frequency	f <sub>L</sub>	3 dB down below from gain at f = 0.9 GHz	-	-	-	-	0.2	0.4	GHz
Isolation	ISL	f = 900 MHz	35	40	-	35	40	-	dB
Input Return Loss	RL <sub>in</sub>	f = 900 MHz	11	14	-	8.5	11.5	-	dB
Output Return Loss	RL <sub>out</sub>	f = 900 MHz	7	10	-	5.5	8.5	-	dB
Saturated Output Power	P <sub>O (sat)</sub>	f = 900 MHz, P <sub>in</sub> = -8 dBm	-9.5	-7.0	-	-6.0	-3.5	-	dBm

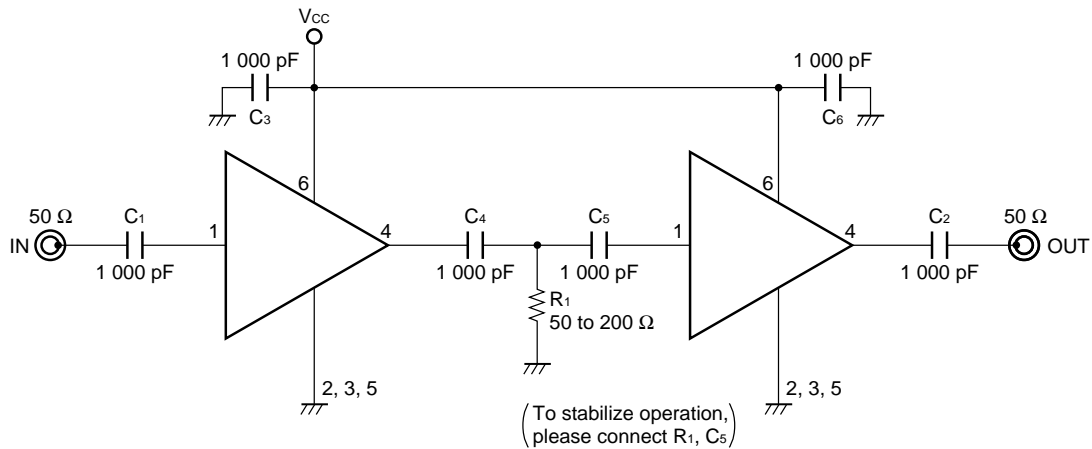
STANDARD CHARACTERISTICS FOR REFERENCE (T<sub>A</sub> = +25°C, Z<sub>S</sub> = Z<sub>L</sub> =50 Ω)

Parameter	Symbol	Test Conditions	Reference		Unit
			$\mu$ PC2747TB	$\mu$ PC2748TB	
Circuit Current	I <sub>CC</sub>	V <sub>CC</sub> = 1.8 V, No signal	3.0	3.5	mA
Power Gain	G <sub>P</sub>	V <sub>CC</sub> = 1.8 V, f = 900 MHz	5.5	11.5	dB
Noise Figure	NF	V <sub>CC</sub> = 1.8 V, f = 900 MHz	5.2	4.5	dB
Upper Limit Operating Frequency	f <sub>u</sub>	V <sub>CC</sub> = 1.8 V, 3 dB down below from gain at f = 0.9 GHz	1.8	1.5	GHz
Lower Limit Operating Frequency	f <sub>L</sub>	V <sub>CC</sub> = 1.8 V, 3 dB down below from gain at f = 0.9 GHz	–	0.2	GHz
Isolation	ISL	V <sub>CC</sub> = 1.8 V, f = 900 MHz	34	34	dB
Input Return Loss	RL <sub>in</sub>	V <sub>CC</sub> = 1.8 V, f = 900 MHz	11	10	dB
Output Return Loss	RL <sub>out</sub>	V <sub>CC</sub> = 1.8 V, f = 900 MHz	13	12	dB
Saturated Output Power	P <sub>O (sat)</sub>	V <sub>CC</sub> = 1.8 V, f = 900 MHz, P <sub>in</sub> = –8 dBm	–13.7	–10.0	dBm
3rd Order Intermodulation Distortion	IM <sub>3</sub>	V <sub>CC</sub> = 3.0 V, P <sub>out</sub> = –20 dBm, f <sub>1</sub> = 900 MHz, f <sub>2</sub> = 902 MHz	–34	–38	dBc
		V <sub>CC</sub> = 1.8 V, P <sub>out</sub> = –20 dBm, f <sub>1</sub> = 900 MHz, f <sub>2</sub> = 902 MHz	–20	–28	

TEST CIRCUIT



EXAMPLE OF APPLICATION CIRCUIT



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

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

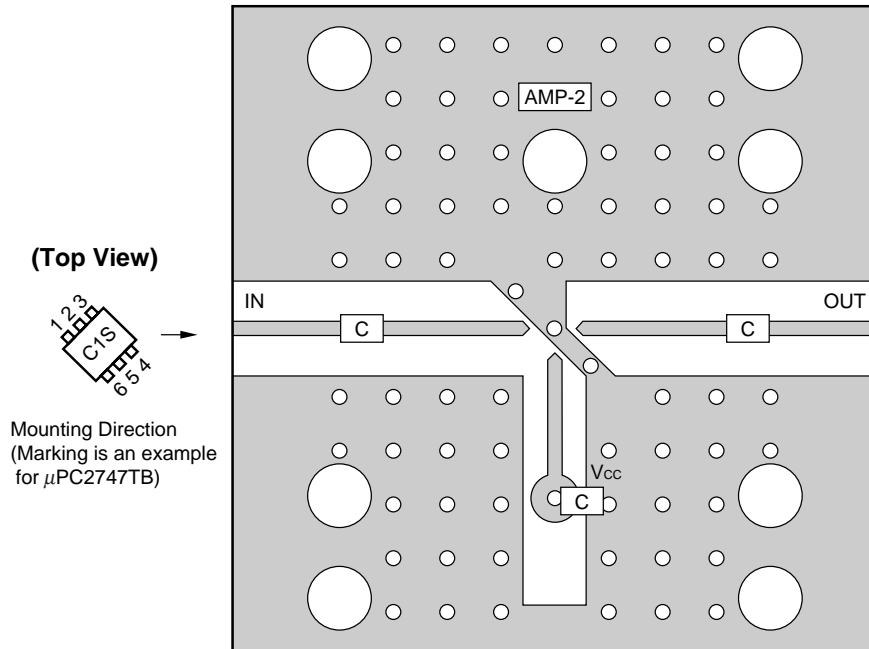
1 000 pF capacitors are recommendable as bypass capacitor for V<sub>CC</sub> pin and coupling capacitors for input/output pins.

Bypass capacitor for V<sub>CC</sub> pin is intended to minimize V<sub>CC</sub> pin's ground impedance. Therefore, stable bias can be supplied against V<sub>CC</sub> fluctuation.

Coupling capacitors for input/output pins are intended to minimize RF serial impedance and cut DC.

To get flat gain from 100 MHz up, 1 000 pF capacitors are assembled on the test circuit. [Actually, 1 000 pF capacitors give flat gain at least 10 MHz. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 2 200 pF. Because the coupling capacitors are determined by the equation of  $f_c = 1/(2 \pi RC)$ .]

ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



COMPONENT LIST

	Value
C	1 000 pF

Notes

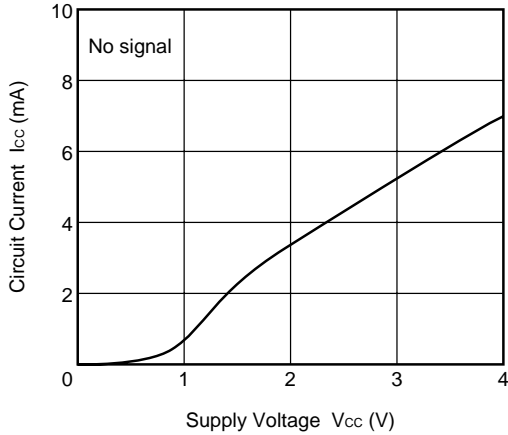
1. 30 × 30 × 0.4 mm double-sided copper-clad polyimide board.
2. Back side: GND pattern
3. Solder plated on pattern
4. ○ ○ : Through holes

For more information on the use of this IC, refer to the following application note: **USAGE AND APPLICATIONS OF 6-PIN MINI-MOLD, 6-PIN SUPER MINI-MOLD SILICON HIGH-FREQUENCY WIDEBAND AMPLIFIER MMIC (P11976E)**.

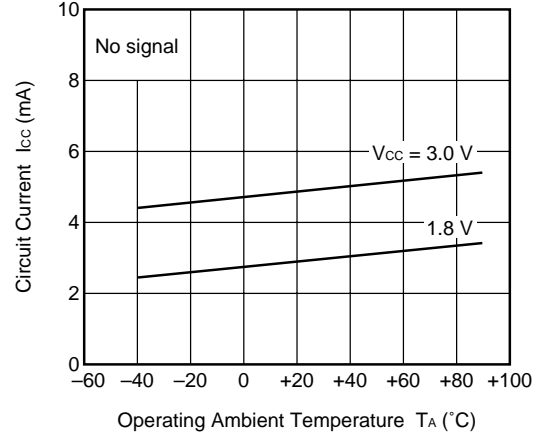
★ TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)

–  $\mu$ PC2747TB –

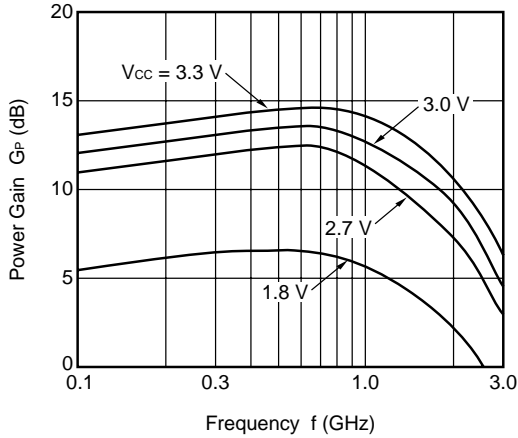
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



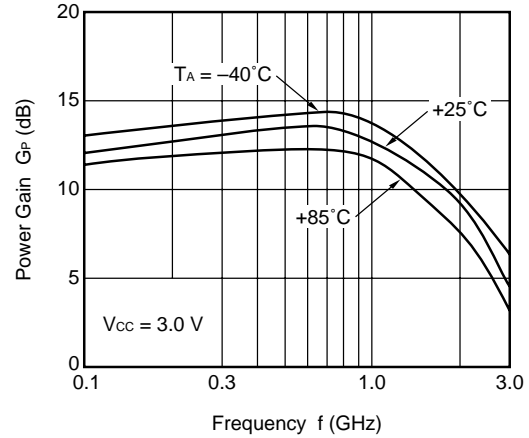
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



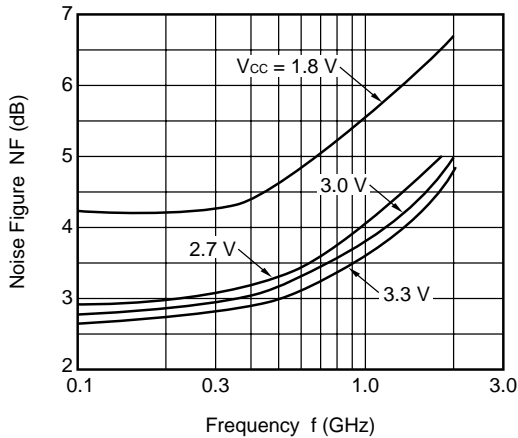
POWER GAIN vs. FREQUENCY



POWER GAIN vs. FREQUENCY



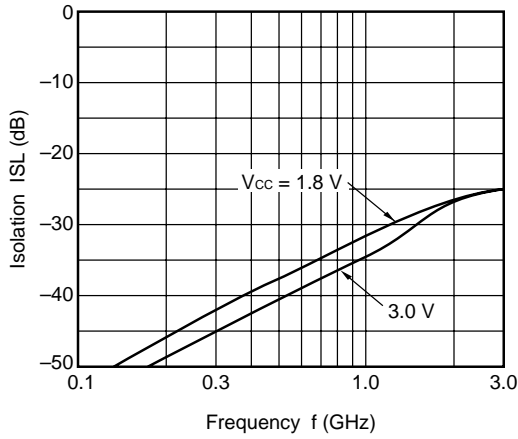
NOISE FIGURE vs. FREQUENCY



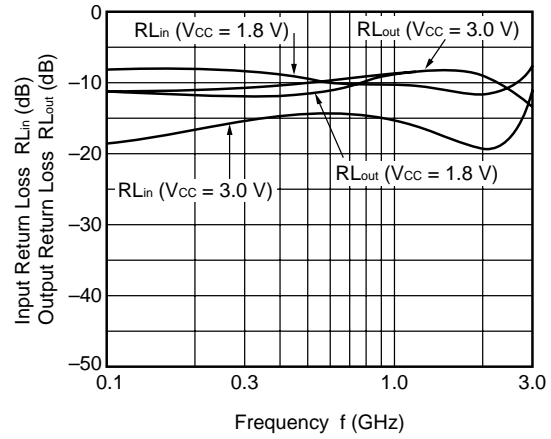


-  $\mu$ PC2747TB -

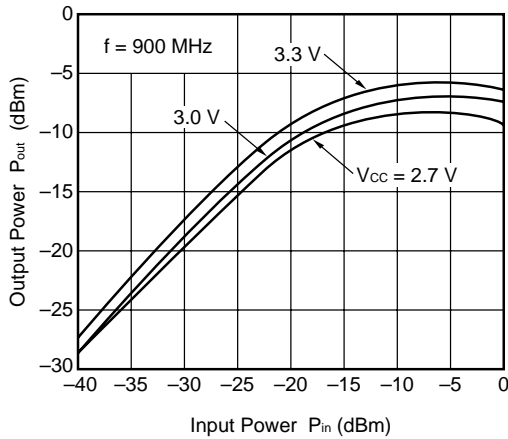
ISOLATION vs. FREQUENCY



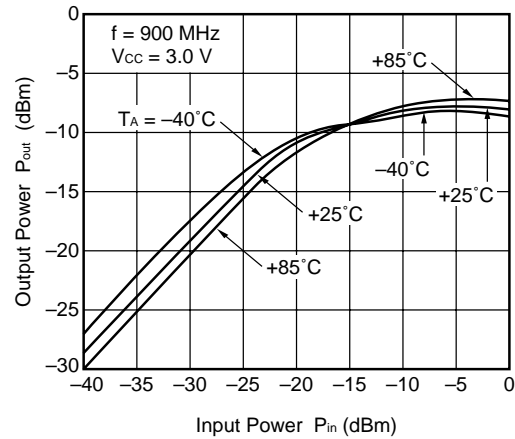
INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY



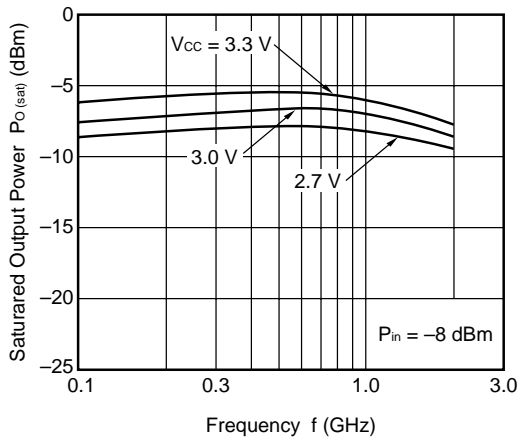
OUTPUT POWER vs. INPUT POWER



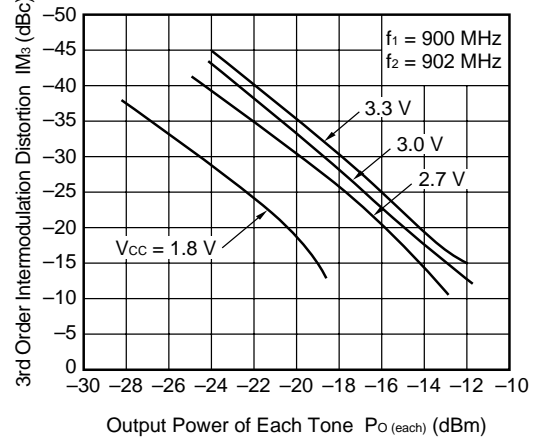
OUTPUT POWER vs. INPUT POWER



SATURATED OUTPUT POWER vs. FREQUENCY



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

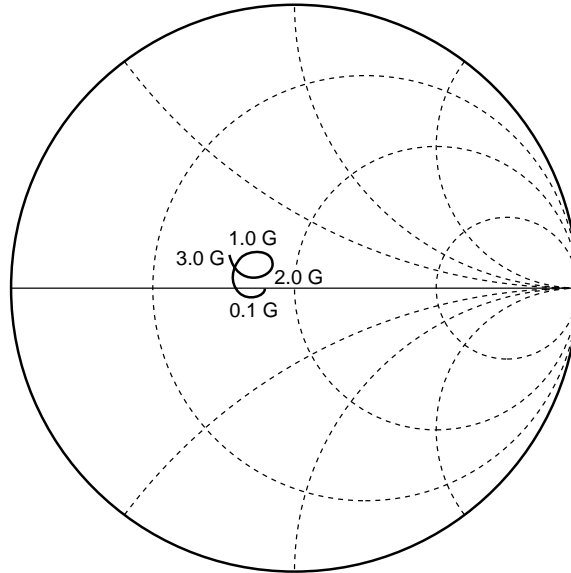


**Remark** The graphs indicate nominal characteristics.

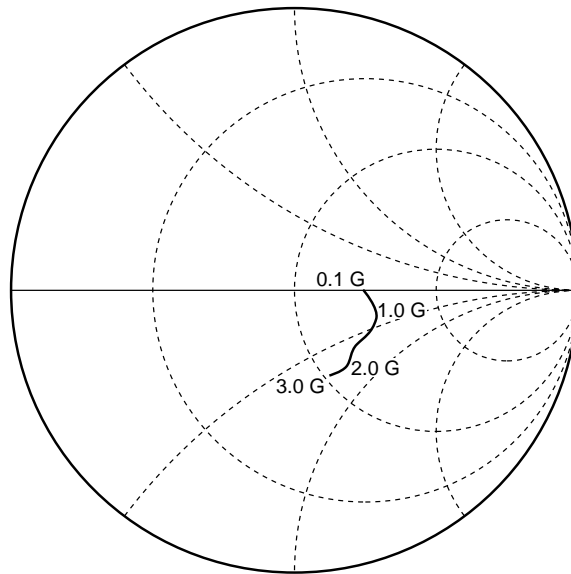
SMITH CHART ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = 3.0\text{ V}$ )

–  $\mu$ PC2747TB –

S<sub>11</sub>-FREQUENCY



S<sub>22</sub>-FREQUENCY



**S-PARAMETERS****–  $\mu$ PC2747TB –**

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.

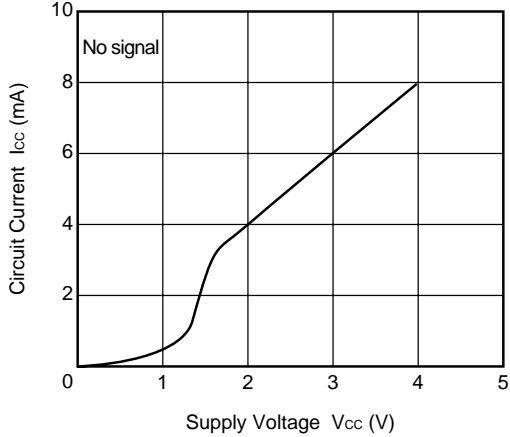
[RF and Microwave] → [Device Parameters]

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

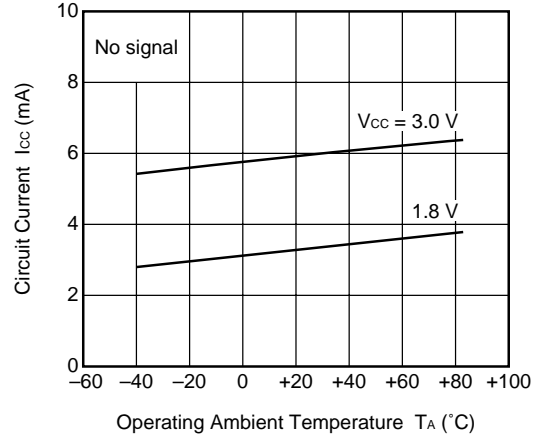
TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)

–  $\mu$ PC2748TB –

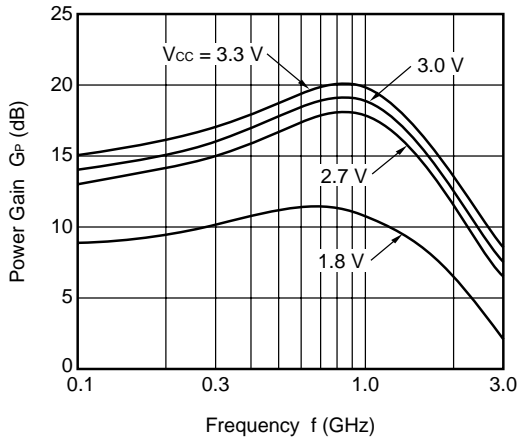
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



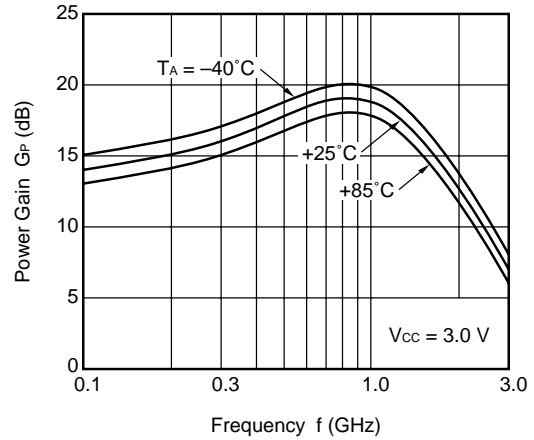
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



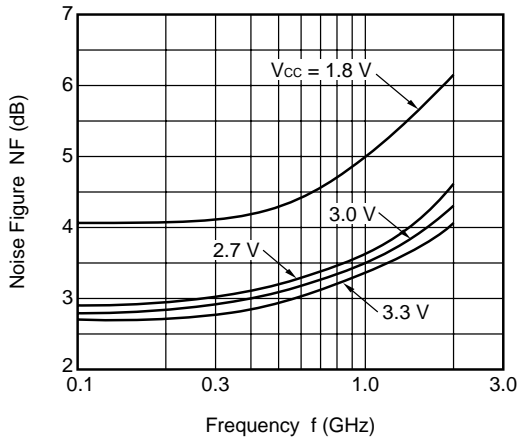
POWER GAIN vs. FREQUENCY



POWER GAIN vs. FREQUENCY

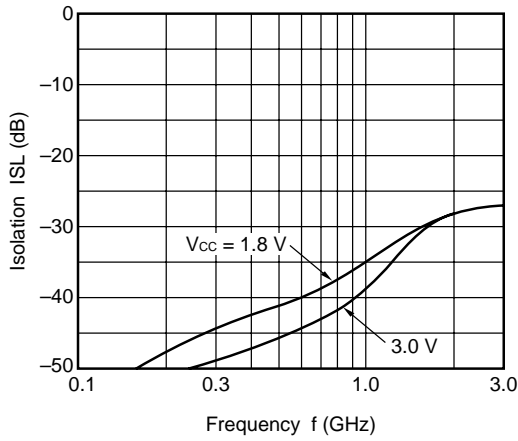


NOISE FIGURE vs. FREQUENCY

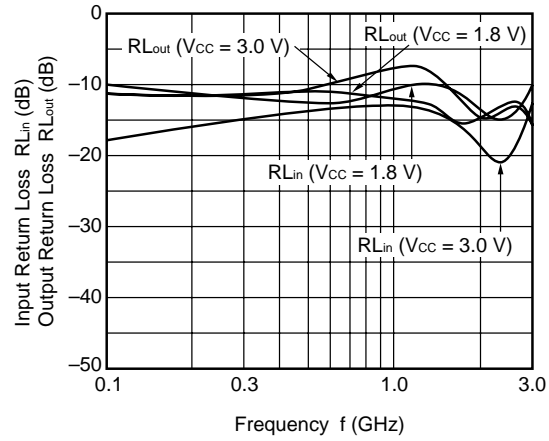


-  $\mu$ PC2748TB -

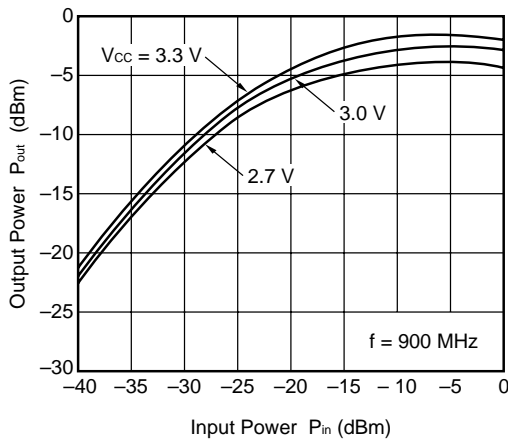
ISOLATION vs. FREQUENCY



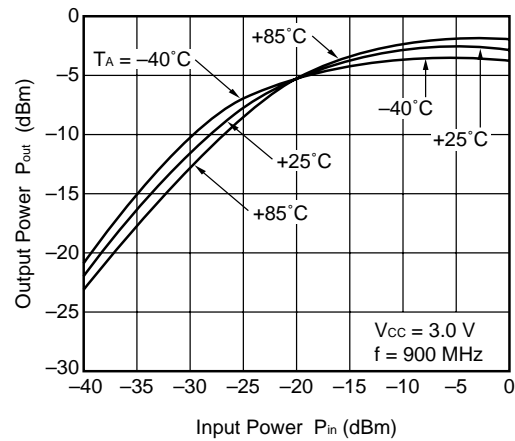
INPUT RETURN LOSS, OUTPUT RETURN LOSS vs. FREQUENCY



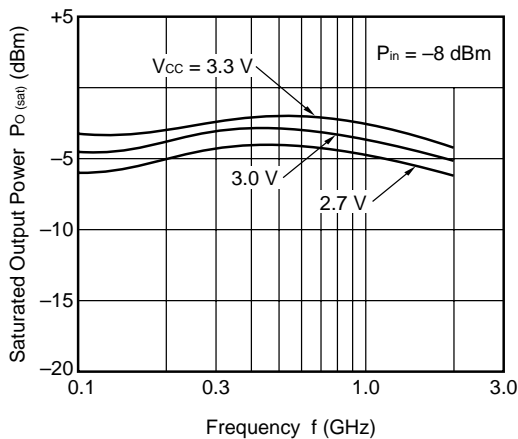
OUTPUT POWER vs. INPUT POWER



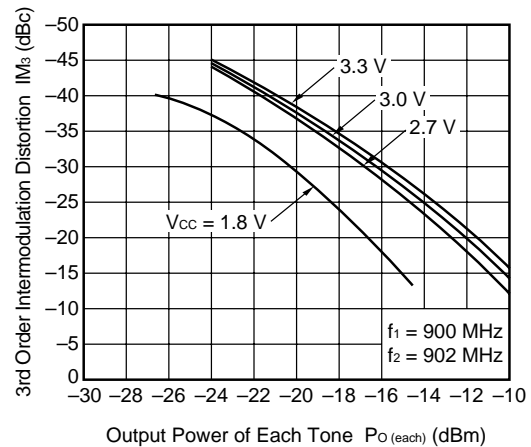
OUTPUT POWER vs. INPUT POWER



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

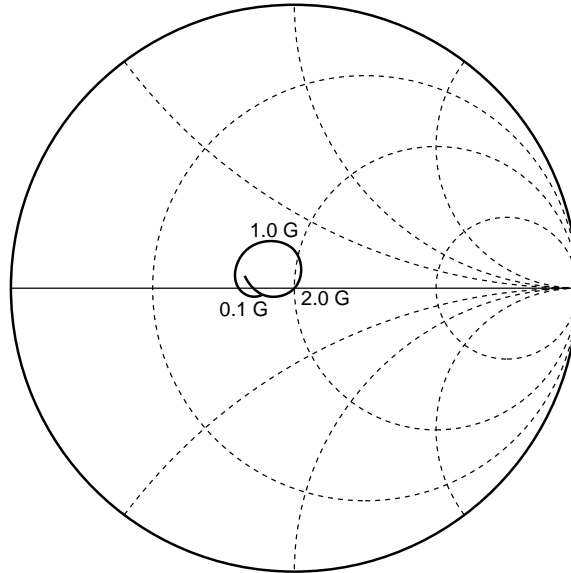


**Remark** The graphs indicate nominal characteristics.

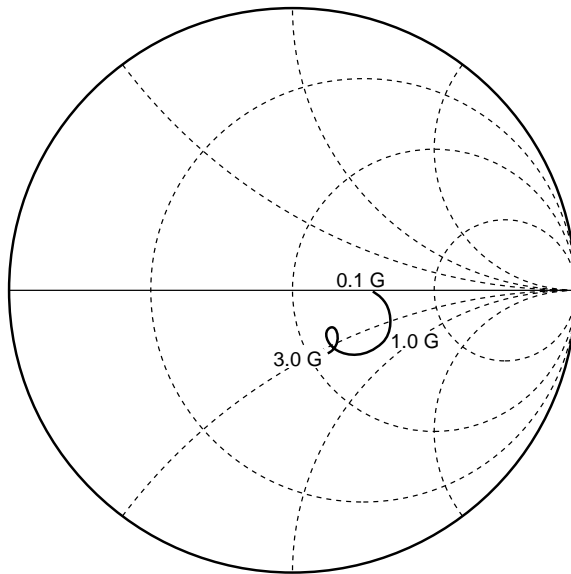
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–  $\mu$ PC2748TB –

S<sub>11</sub>-FREQUENCY



S<sub>22</sub>-FREQUENCY



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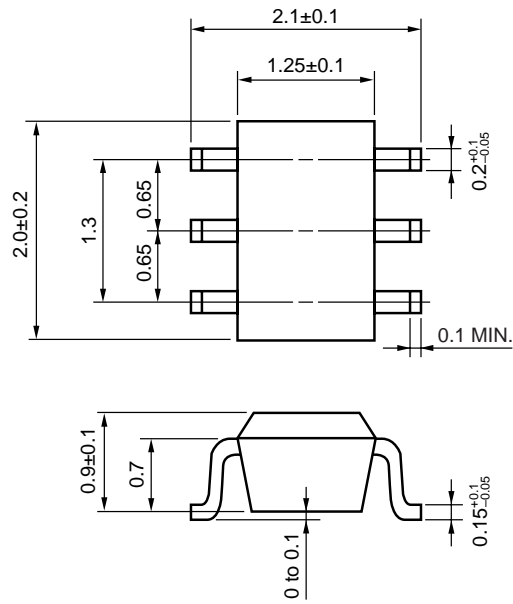
Click here to download S-parameters.

[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 Vcc line.
- (4) 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).**

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  - 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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