

# BIPOLAR ANALOG INTEGRATED CIRCUITS

# $\mu$ PC8106TB, $\mu$ PC8109TB

## SILICON MMIC 2.0 GHz FREQUENCY UP-CONVERTER FOR CELLULAR/CORDLESS TELEPHONES

### DESCRIPTION

The  $\mu$ PC8106TB and  $\mu$ PC8109TB are silicon monolithic integrated circuit designed as frequency up-converter for cellular/cordless telephone transmitter stage. The  $\mu$ PC8106TB features improved intermodulation and  $\mu$ PC8109TB features low current consumption. From these two version, you can chose either IC corresponding to your system design. These TB suffix ICs which are smaller package than conventional T suffix ICs contribute to reduce your system size.

The  $\mu$ PC8106TB and  $\mu$ PC8109TB are manufactured using NEC's 20 GHz fr NESAT<sup>TM</sup>III silicon bipolar process. This process uses a silicon nitride passivation film and gold electrodes. These materials can protect chip surface from external pollution and prevent corrosion/migration. Thus, this IC has excellent performance, uniformity and reliability.

### FEATURES

- Recommended operating frequency :  $f_{RFout} = 0.4 \text{ GHz to } 2.0 \text{ GHz}$ ,  $f_{iFin} = 100 \text{ MHz to } 400 \text{ MHz}$
- Supply voltage :  $V_{CC} = 2.7 \text{ to } 5.5 \text{ V}$
- High-density surface mounting : 6-pin super minimold package
- Low current consumption :  $I_{CC} = 9 \text{ mA TYP. @ } \mu\text{PC8106TB}$   
 $I_{CC} = 5 \text{ mA TYP. @ } \mu\text{PC8109TB}$
- Minimized carrier leakage : Due to double balanced mixer
- Built-in power save function

### APPLICATION

- Cellular/cordless telephone up to 2.0 GHz MAX (example: PHS, PDC, DCS1800 and so on)

### ORDERING INFORMATION

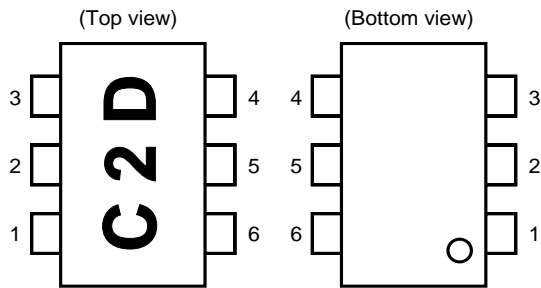
Part Number	Markings	Product Type	Package	Supplying Form
$\mu$ PC8106TB-E3	C2D	High IP <sub>3</sub>	6-pin super minimold	Embossed tape 8 mm wide. Pin 1, 2, 3 face to tape perforation side. QTY 3 kp/Reel.
$\mu$ PC8109TB-E3	C2G	Low current consumption		

**Remark** To order evaluation samples, please contact your local NEC sales office.  
(Part number for sample order:  $\mu$ PC8106TB,  $\mu$ PC8109TB)

**Caution Electro-static sensitive devices**

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 representative for availability and additional information.

**PIN CONNECTIONS**



Marking is an example of  $\mu$ PC8106TB.

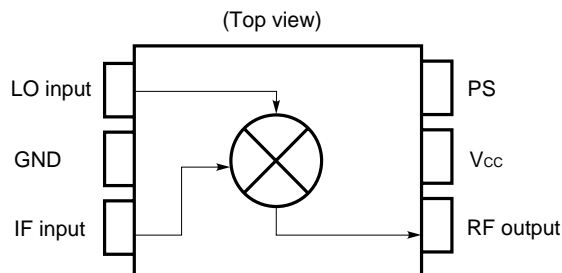
Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	PS
5	V <sub>cc</sub>
6	RFoutput

★ **SERIES PRODUCTS (T<sub>A</sub> = +25 °C, V<sub>CC</sub> = V<sub>PS</sub> = V<sub>RFout</sub> = 3.0 V, Z<sub>L</sub> = Z<sub>S</sub> = 50 Ω)**

TYPE	PRODUCT NAME	V <sub>CC</sub> (V)	I <sub>CC</sub> (mA)	CG1 (dB)	CG2 (dB)	P <sub>O(sat)1</sub> (dBm)	P <sub>O(sat)2</sub> (dBm)	OIP <sub>31</sub> (dBm)	OIP <sub>32</sub> (dBm)
High IP <sub>3</sub>	$\mu$ PC8106TB	2.7 to 5.5	9	9	7	-2	-4	+5.5	+2.0
Low power consumption	$\mu$ PC8109TB	2.7 to 5.5	5	6	4	-5.5	-7.5	+1.5	-1.0
Higher IP <sub>3</sub>	$\mu$ PC8163TB	2.7 to 3.3	16.5	9	5.5	0.5	-2	+9.5	+6

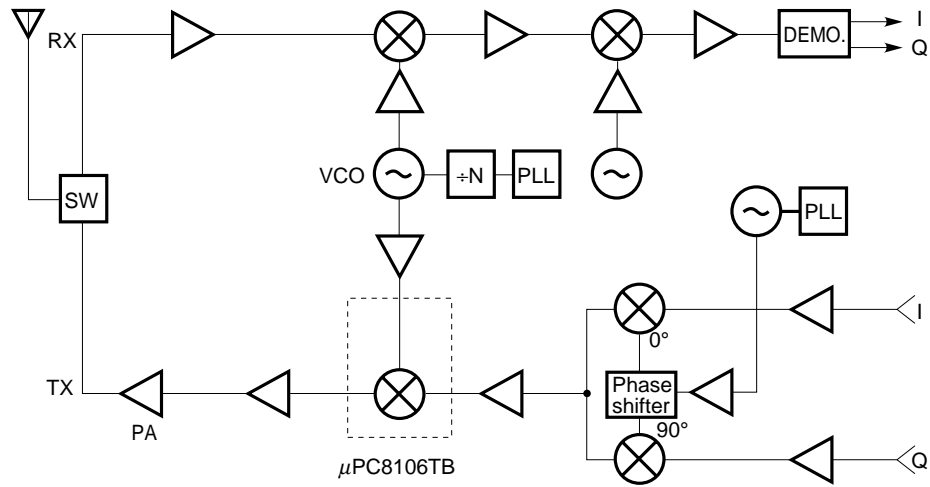
**Caution** The above table lists the typical performance of each model. See **ELECTRICAL CHARACTERISTICS** for the test conditions.

**BLOCK DIAGRAM (FOR THE  $\mu$ PC8106TB AND  $\mu$ PC8109TB)**

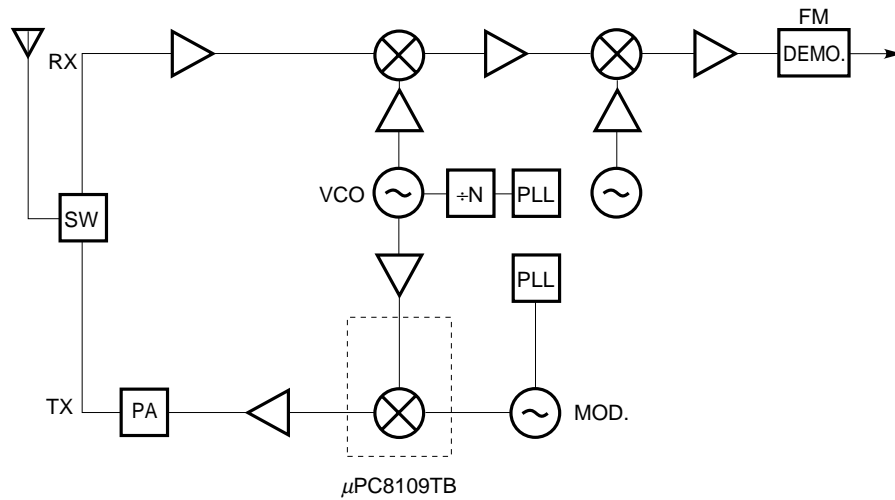


SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEMS)

PHS, DECT



Analog cellular telephone



**PIN FUNCTIONS (FOR THE μPC8106TB AND μPC8109TB)**

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) <sup>Note</sup>	Function and Explanation	Equivalent Circuit						
1	IFinput	–	1.3	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.							
2	GND	0	–	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.							
3	LOinput	–	2.4	Local input pin. Recommendable input level is –10 to 0 dBm.							
5	Vcc	2.7 to 5.5	–	Supply voltage pin.							
6	RFoutput	Same bias as Vcc through external inductor	–	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.							
4	PS	Vcc/GND	–	Power save control pin. Bias controls operation as follows. <table border="1" style="margin: 10px auto;"> <thead> <tr> <th>Pin bias</th> <th>Control</th> </tr> </thead> <tbody> <tr> <td>Vcc</td> <td>Operation</td> </tr> <tr> <td>GND</td> <td>Power Save</td> </tr> </tbody> </table>	Pin bias	Control	Vcc	Operation	GND	Power Save	
Pin bias	Control										
Vcc	Operation										
GND	Power Save										

**Note** Each pin voltage is measured with Vcc = VPS = VRFout = 3.0 V.

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25 °C, Pin 5 and 6	6.0	V
PS pin Input Voltage	V <sub>PS</sub>	T <sub>A</sub> = +25 °C	6.0	V
Power Dissipation of Package	P <sub>D</sub>	Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB T <sub>A</sub> = +85 °C	200	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C
Maximum Input Power	P <sub>in</sub>		+10	dBm

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Note
Supply Voltage	V <sub>CC</sub>	2.7	3.0	5.5	V	The same voltage should be supplied to pin 5 and 6
Operating Ambient Temperature	T <sub>A</sub>	-40	+25	+85	°C	
Local Input Level	P <sub>LOin</sub>	-10	-5	0	dBm	Z <sub>s</sub> = 50 Ω (without matching)
RF Output Frequency	f <sub>RFout</sub>	0.4	-	2.0	GHz	With external matching circuit
IF Input Frequency	f <sub>IFin</sub>	100	-	400	MHz	

**ELECTRICAL CHARACTERISTICS**

(T<sub>A</sub> = +25 °C, V<sub>CC</sub> = V<sub>RFout</sub> = 3.0 V, f<sub>IFin</sub> = 240 MHz, P<sub>LOin</sub> = -5 dBm, and V<sub>PS</sub> ≥ 2.7 V unless otherwise specified)

Parameter	Symbol	Conditions	$\mu$ PC8106TB			$\mu$ PC8109TB			Unit
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Circuit Current	I <sub>CC</sub>	No signal	4.5	9	13.5	2.5	5	8.0	mA
Circuit Current in Power-save Mode	I <sub>CC(PS)</sub>	V <sub>PS</sub> = 0 V	-	-	10	-	-	10	μA
Conversion Gain 1	CG1	f <sub>RFout</sub> = 0.9 GHz, P <sub>IFin</sub> = -30 dBm	6	9	12	3	6	9	dB
Conversion Gain 2	CG2	f <sub>RFout</sub> = 1.9 GHz, P <sub>IFin</sub> = -30 dBm	4	7	10	1	4	7	dB
Maximum RF Output Power 1	P <sub>O(sat)1</sub>	f <sub>RFout</sub> = 0.9 GHz, P <sub>IFin</sub> = 0 dBm	-4	-2	-	-7.5	-5.5	-	dBm
Maximum RF Output Power 2	P <sub>O(sat)2</sub>	f <sub>RFout</sub> = 1.9 GHz, P <sub>IFin</sub> = 0 dBm	-6.5	-4	-	-10	-7.5	-	dBm

**OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{CC} = V_{RFout} = 3.0\text{ V}$ ,  $P_{LOin} = -5\text{ dBm}$ , and  $V_{PS} \geq 2.7\text{ V}$  unless otherwise mentioned)

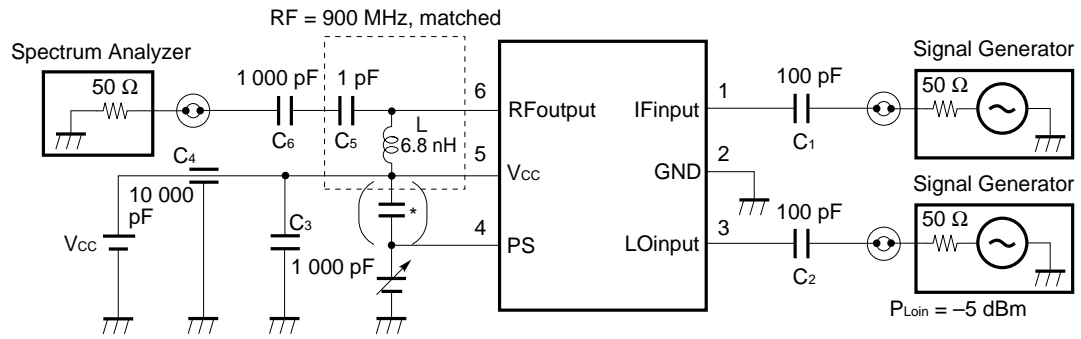
Parameter	Symbol	Conditions		Reference Value		Unit
				$\mu$ PC8106TB	$\mu$ PC8109TB	
Output Third-Order Distortion Intercept Point	OIP <sub>31</sub>	$f_{Fin1} = 240.0\text{ MHz}$	$f_{RFout} = 0.9\text{ GHz}$	+5.5	+1.5	dBm
	OIP <sub>32</sub>	$f_{Fin2} = 240.4\text{ MHz}$	$f_{RFout} = 1.9\text{ GHz}$	+2.0	-1.0	
Third-Order Intermodulation Distortion 1	IM <sub>31</sub>	$f_{Fint} = 240.0\text{ MHz}$ $f_{Fin2} = 240.4\text{ MHz}$	$f_{RFout} = 0.9\text{ GHz}$	-31	-29	dBc
Third-Order Intermodulation Distortion 2	IM <sub>32</sub>	$P_{Fin} = -20\text{ dBm}$	$f_{RFout} = 1.9\text{ GHz}$	-30	-28	dBc
SSB Noise Figure	SSBNF	$f_{RFout} = 0.9\text{ GHz}$ , $f_{Fin} = 240\text{ MHz}$		8.5	8.5	dB
Power Save Response Time	Rise time	$T_{PS(rise)}$	$V_{PS}: \text{GND} \rightarrow V_{CC}$	2.0	2.0	$\mu\text{s}$
	Fall time	$T_{PS(fall)}$	$V_{PS}: V_{CC} \rightarrow \text{GND}$	2.0	2.0	$\mu\text{s}$

**APPLICATION CIRCUIT EXAMPLE CHARACTERISTICS FOR REFERENCE PURPOSE ONLY**

( $T_A = +25\text{ }^\circ\text{C}$ ,  $V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$ ,  $f_{Fin} = 130\text{ MHz}$ ,  $f_{LOin} = 1630\text{ MHz}$ ,  $P_{LOin} = -5\text{ dBm}$ )

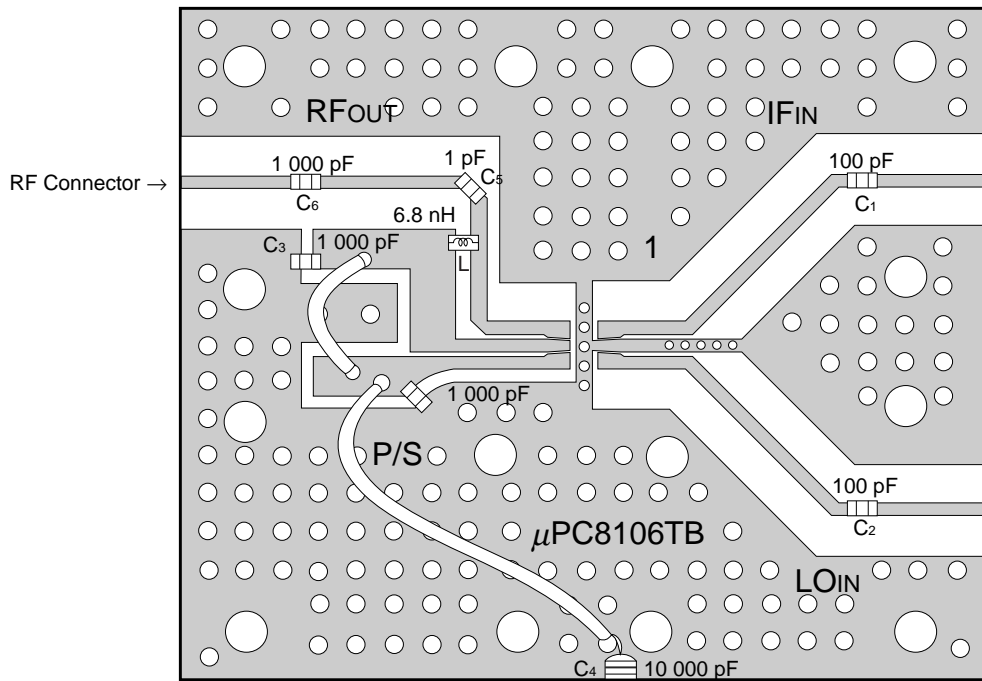
Parameter	Symbol	Conditions	Reference Value	Unit
			$\mu$ PC8106TB	
Conversion Gain	CG	$f_{RFout} = 1.5\text{ GHz}$ , with application circuit example	7	dB
Maximum RF Output Power	$P_{O(sat)}$	$f_{RFout} = 1.5\text{ GHz}$ , with application circuit example	-3.5	dBm

★ TEST CIRCUIT 1 (RF = 900 MHz, for the  $\mu$ PC8106TB and  $\mu$ PC8109TB)



\* In case of unstable operation, please connect capacitor 100 pF between 4 pin and 5 pin and adjust the matching circuit.

EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



## COMPONENT LIST

Form	Symbol	Value
Chip capacitor	C <sub>1</sub> , C <sub>2</sub>	100 pF
	C <sub>3</sub> , C <sub>6</sub>	1 000 pF
	C <sub>5</sub>	1 pF
Through capacitor	C <sub>4</sub>	10 000 pF
Chip inductor	L	6.8 nH <sup>Note</sup>

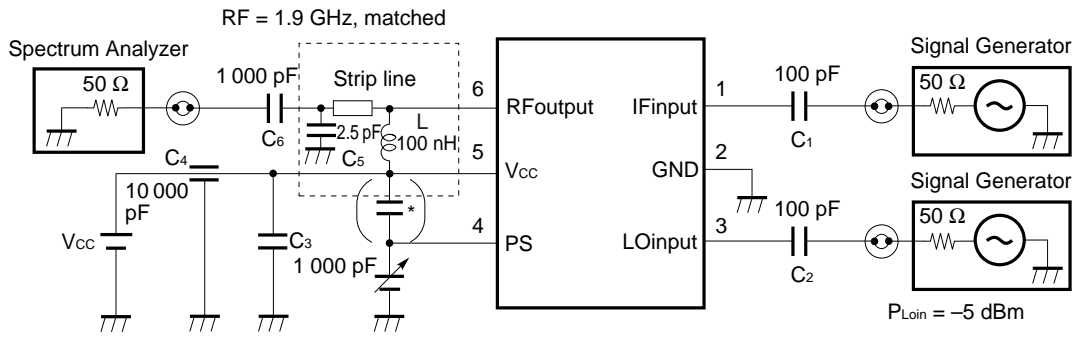
**Note** 6.8 nH: Murata Mfg. Co., Ltd. LQP31A6N8J04

**Notes on the board**

1. 35 × 42 × 0.4 mm polyimide board, 35  $\mu$ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes
5. C<sub>6</sub> is for RF short on the board pattern

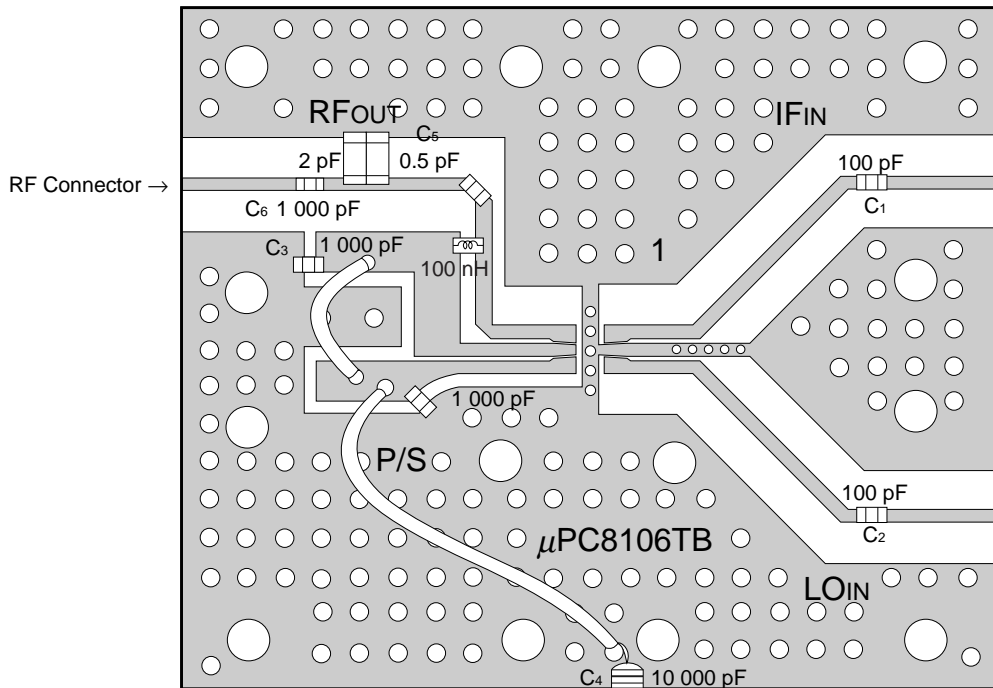


★ TEST CIRCUIT 2 (RF = 1.9 GHz, for the  $\mu$ PC8106TB and  $\mu$ PC8109TB)



\* In case of unstable operation, please connect capacitor 100 pF between 4 pin and 5 pin and adjust the matching circuit.

EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



## COMPONENT LIST

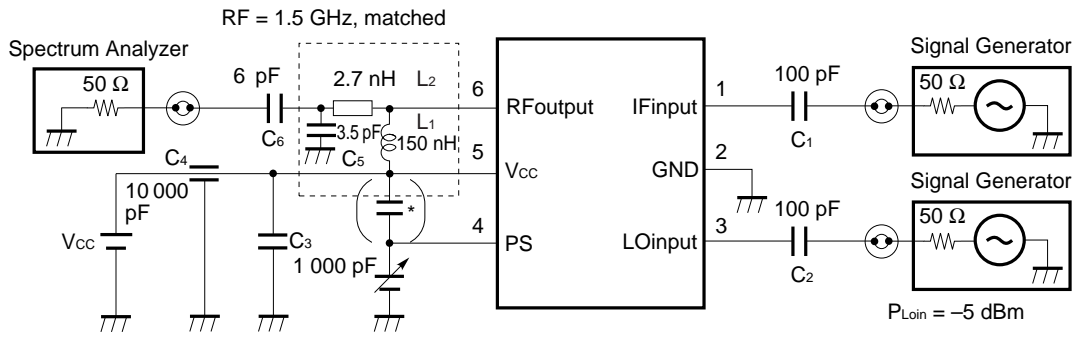
Form	Symbol	Value
Chip capacitor	C <sub>1</sub> , C <sub>2</sub>	100 pF
	C <sub>3</sub> , C <sub>6</sub>	1 000 pF
	C <sub>5</sub>	2.5 pF (2.0 pF, 0.5 pF parallel)
Through capacitor	C <sub>4</sub>	10 000 pF
Chip inductor	L	100 nH <sup>Note</sup>

**Note** 100 nH: Murata Mfg. Co., Ltd. LQN1AR10J(K)04

**Notes on the board**

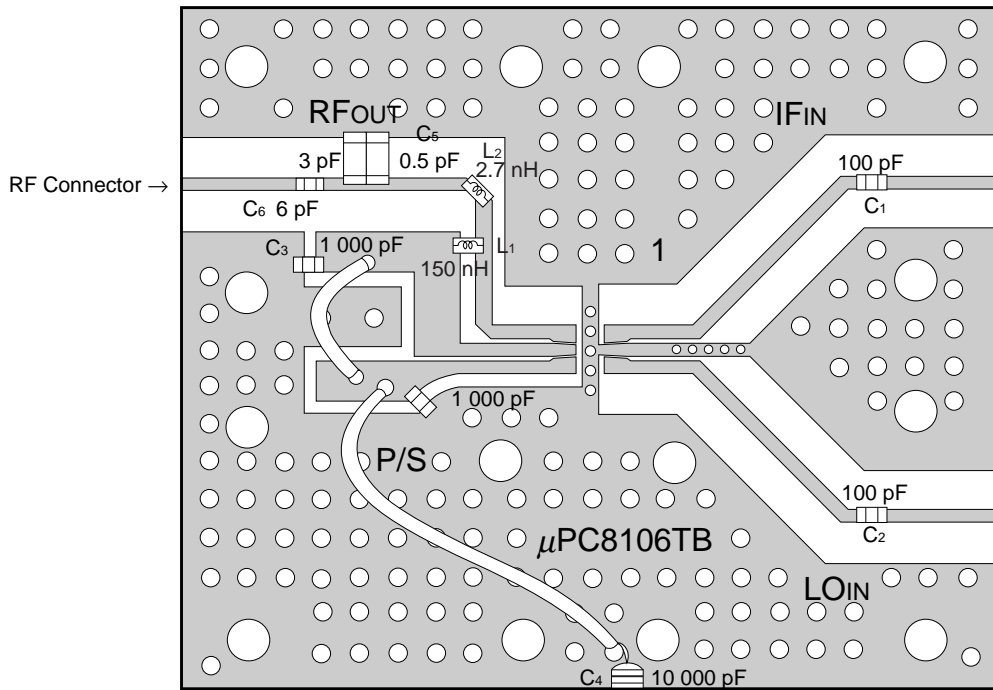
1. 35 × 42 × 0.4 mm polyimide board, 35  $\mu$ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes

★ APPLICATION CIRCUIT EXAMPLE (RF = 1.5 GHz, for the  $\mu$ PC8106TB and  $\mu$ PC8109TB)



\* In case of unstable operation, please connect capacitor 100 pF between 4 pin and 5 pin and adjust the matching circuit.

EXAMPLE OF APPLICATION CIRCUIT ASSEMBLED ON EVALUATION BOARD



**COMPONENT LIST**

Form	Symbol	Value
Chip capacitor	C <sub>1</sub> , C <sub>2</sub>	100 pF
	C <sub>3</sub>	1 000 pF
	C <sub>5</sub>	3.5 pF (3.0 pF, 0.5 pF parallel)
	C <sub>6</sub>	6 pF
Through capacitor	C <sub>4</sub>	10 000 pF
Chip inductor	L <sub>1</sub>	150 nH <sup>Note 1</sup>
	L <sub>2</sub>	2.7 nH <sup>Note 2</sup>

- Notes**
1. 150 nH: TOKO Co., Ltd. LL2012-FR15
  2. 2.7 nH : TOKO Co., Ltd. LL2012-F2N7S

**Notes on the board**

1. 35 × 42 × 0.4 mm polyimide board, 35  $\mu$ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes

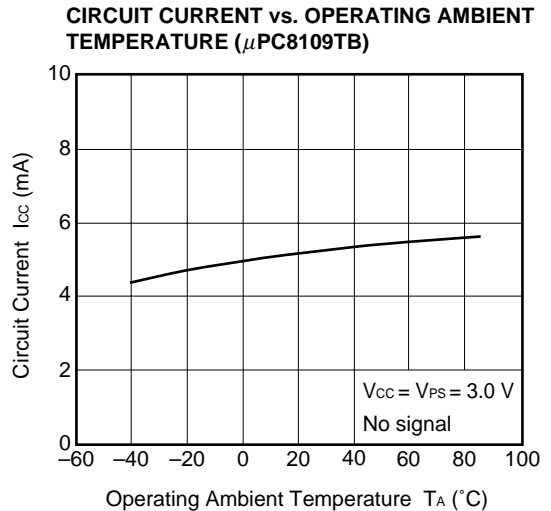
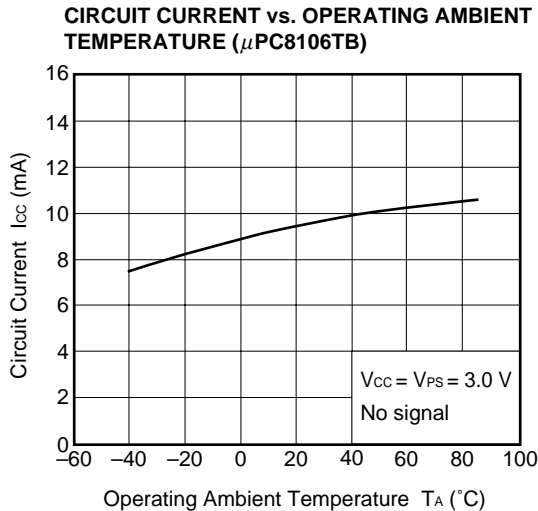
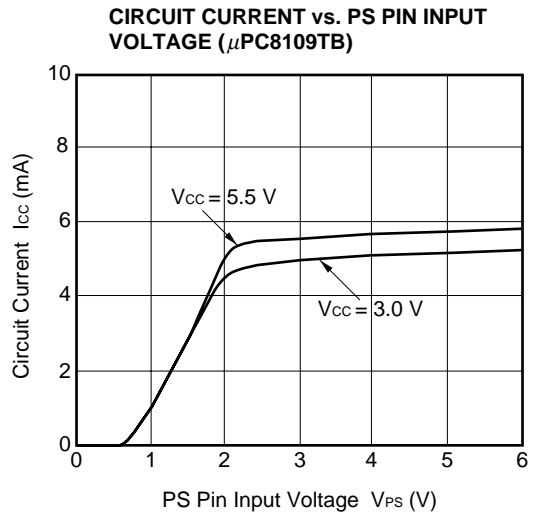
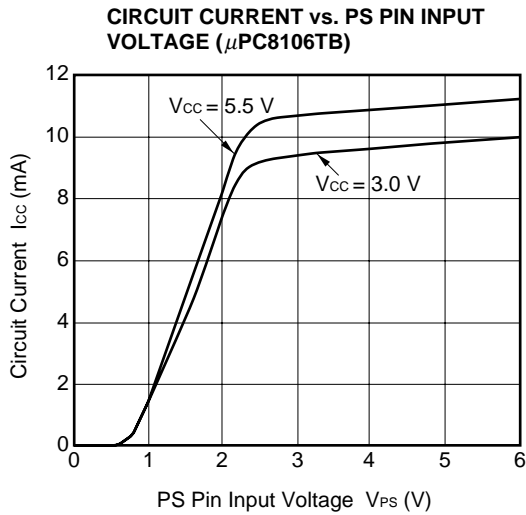
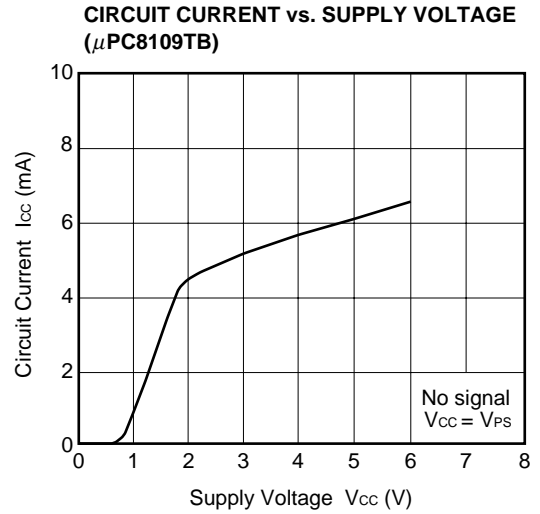
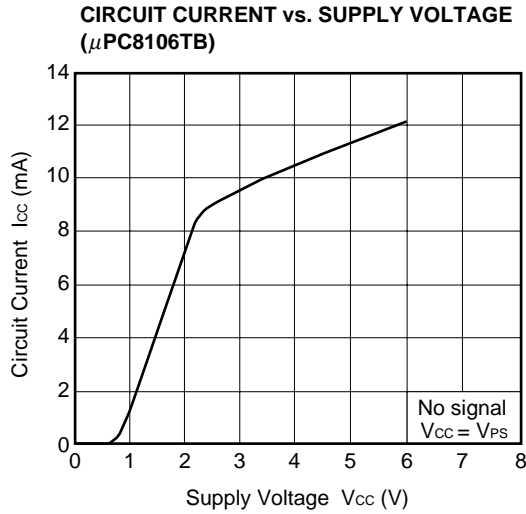
**NOTICE**

The test circuits and board pattern on data sheet are for performance evaluation use only. (They are not recommended circuits.) In the case of actual design-in, matching circuit should be determined using S parameter of desired frequency in accordance to actual mounting pattern.

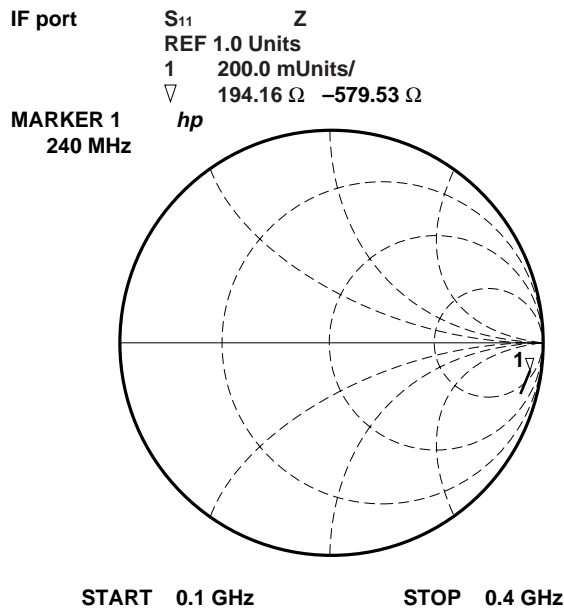
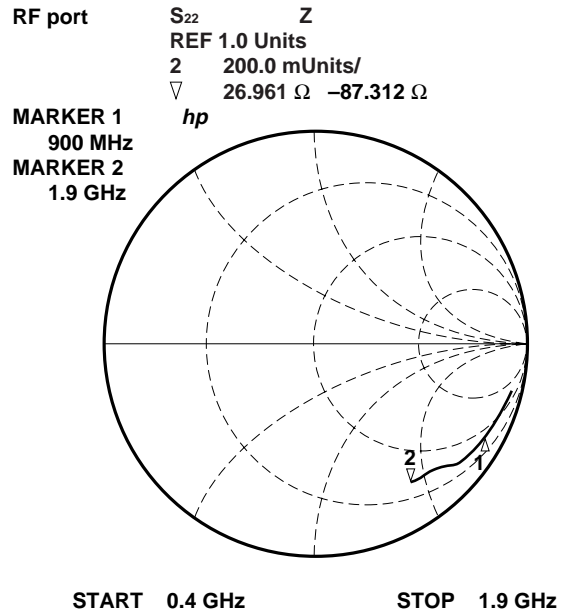
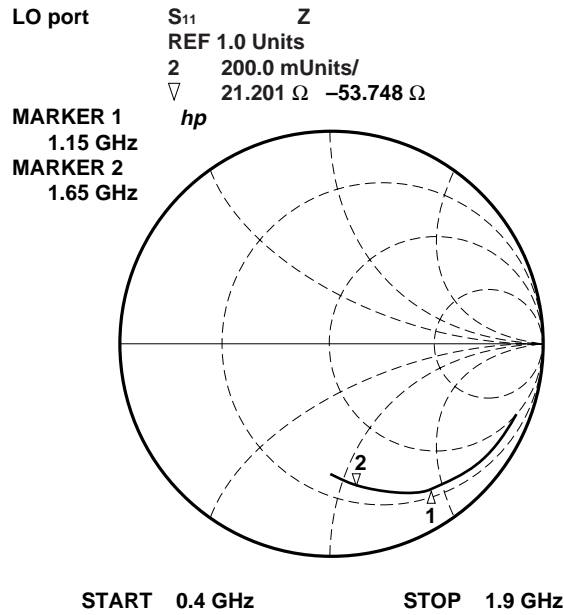
For external circuits of the ICs, following Application Note is also available.

- $\mu$ PC8106,  $\mu$ PC8109 Application Note (Document No. P13683E)

★ TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{RFout}$ ) with TEST CIRCUIT 1 or 2, according to the operating frequency, unless otherwise specified



S-PARAMETERS FOR EACH PORT ( $V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$ ) –  $\mu$ PC8106TB,  $\mu$ PC8109TB in common – (THE parameters are monitored at DUT pins.)



**S-PARAMETERS FOR MATCHED RF OUTPUT ( $V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$ ) – with TEST CIRCUITS 1 and 2 ( $\mu$ PC8106TB,  $\mu$ PC8109TB in common) – ( $S_{22}$  data are monitored at RF connector on board.)**

900 MHz (LC-matched) in test circuit 1

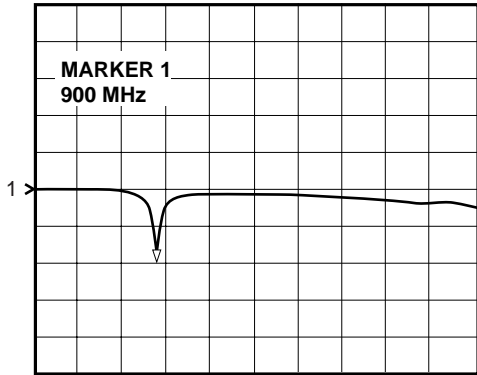
$S_{22}$  log MAG

REF 0.0 dB

1 10.0 dB/

$\nabla$  -19.567 dB

hp



START 100 MHz STOP 3 000 MHz

1.9 GHz (matched) in test circuit 2

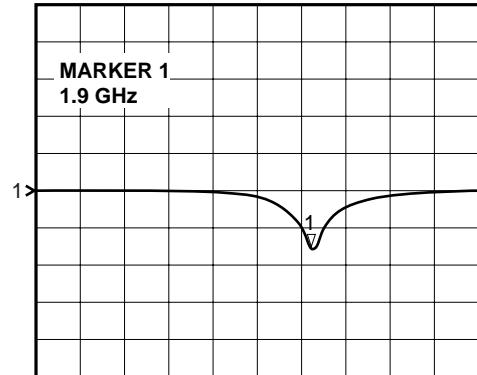
$S_{22}$  log MAG

REF 0.0 dB

1 10.0 dB/

$\nabla$  -15.213 dB

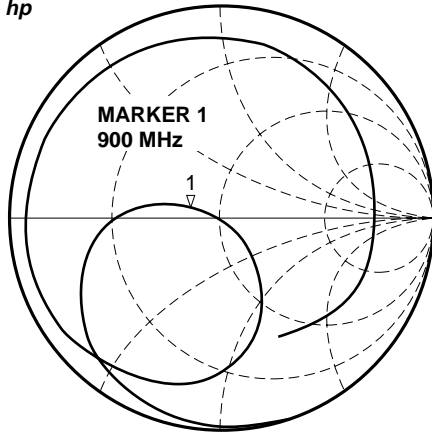
hp



START 100 MHz STOP 3 000 MHz

$S_{22}$   
REF 1.0 Units  
1 200.0 mUnits/  
 $\nabla$  36.59  $\Omega$  2.9355  $\Omega$

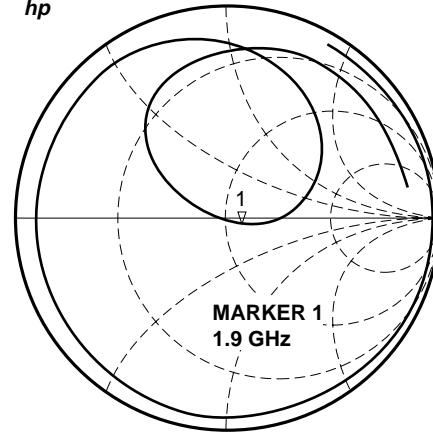
hp



START 100 MHz STOP 3 000 MHz

$S_{22}$   
REF 1.0 Units  
1 200.0 mUnits/  
 $\nabla$  58.191  $\Omega$  -4.1191  $\Omega$

hp



START 100 MHz STOP 3 000 MHz

**S-PARAMETERS FOR MATCHED RF OUTPUT ( $V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$ ) – with application circuit example – ( $S_{22}$  data are monitored at RF connector on board.)**

1.5 GHz (matched) in application circuit example

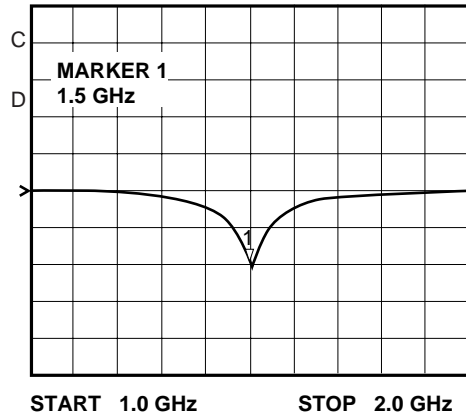
$S_{22}$  log MAG

REF 0.0 dB

1 10.0 dB/

▽ -20.901 dB

hp



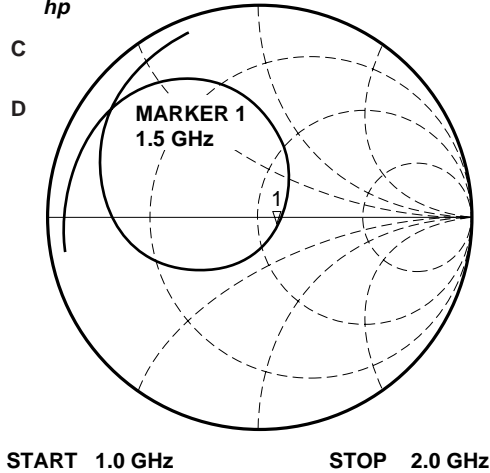
$S_{22}$  Z

REF 1.0 Units

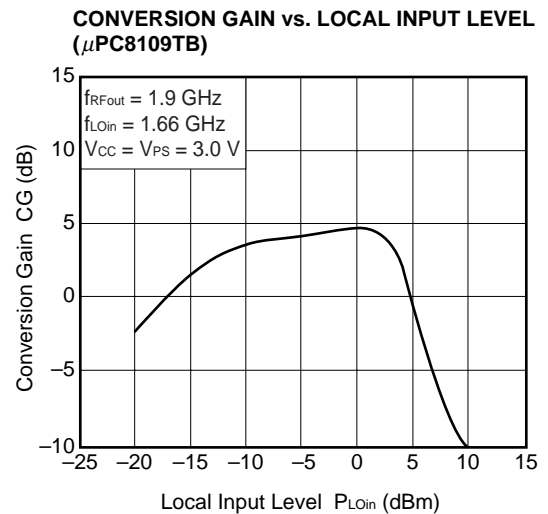
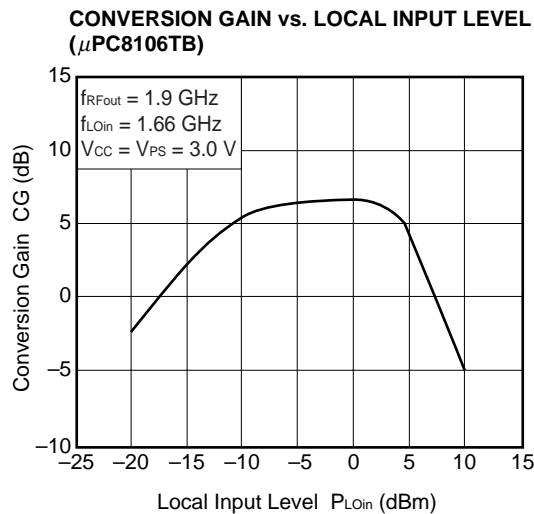
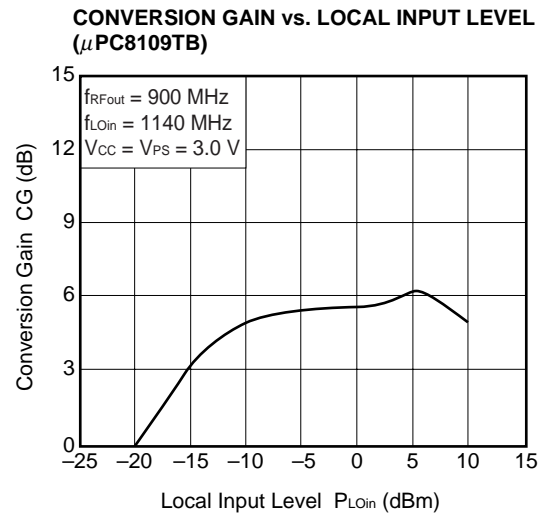
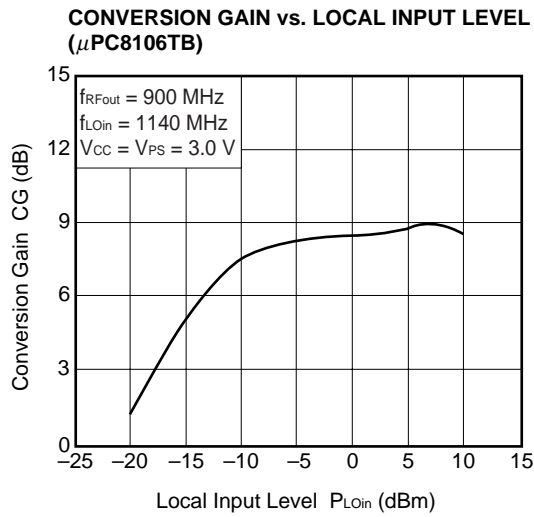
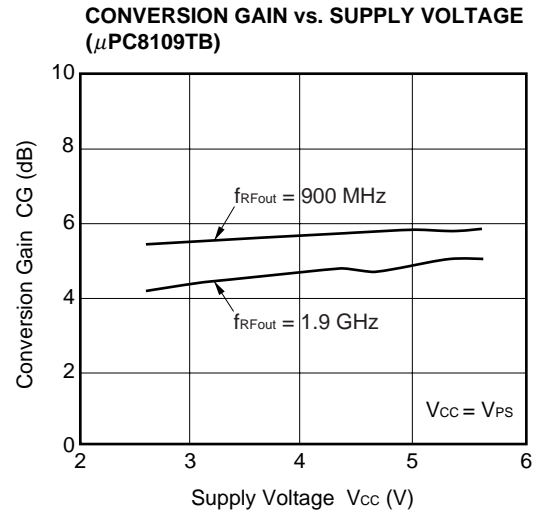
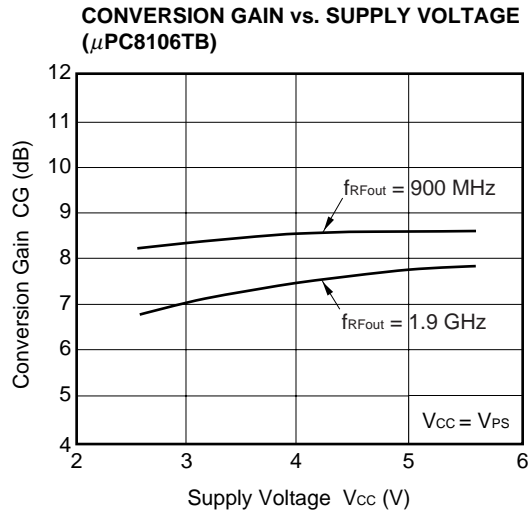
1 200.0 mUnits/

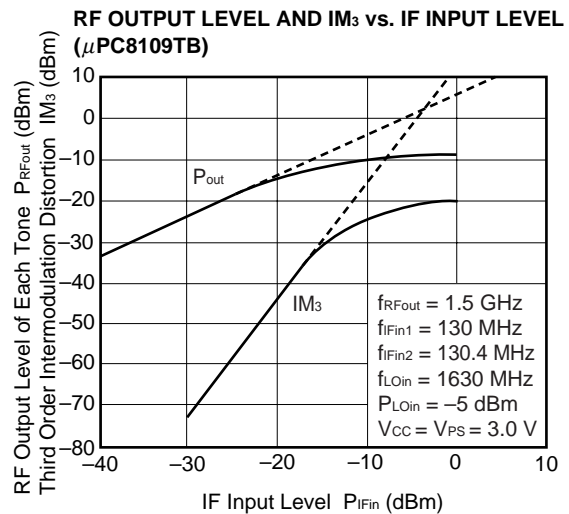
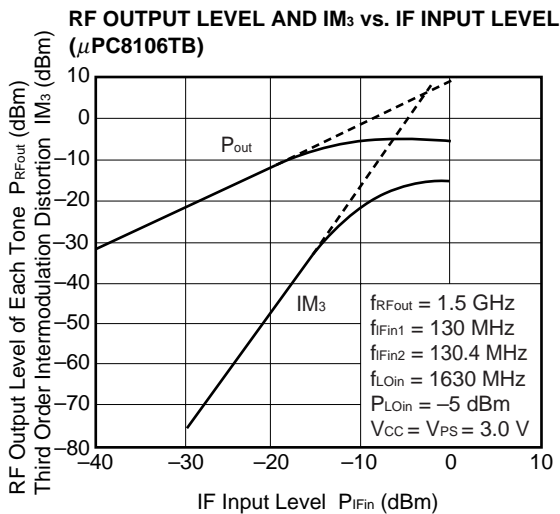
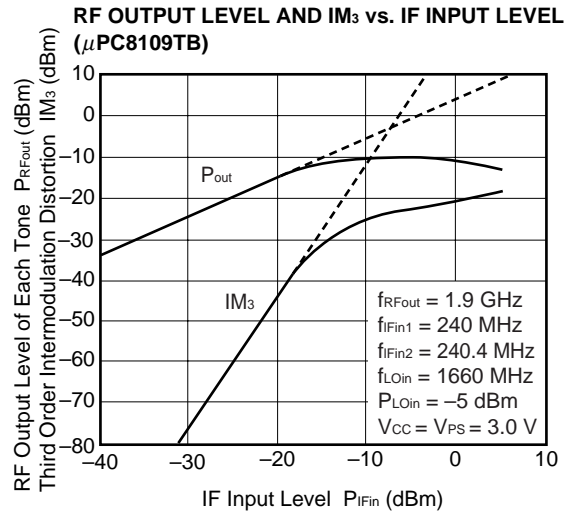
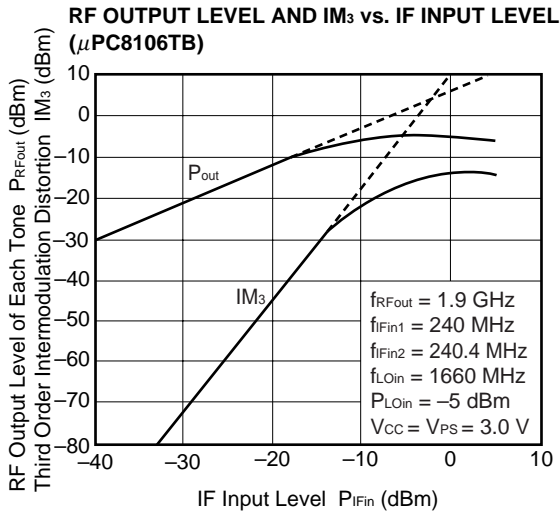
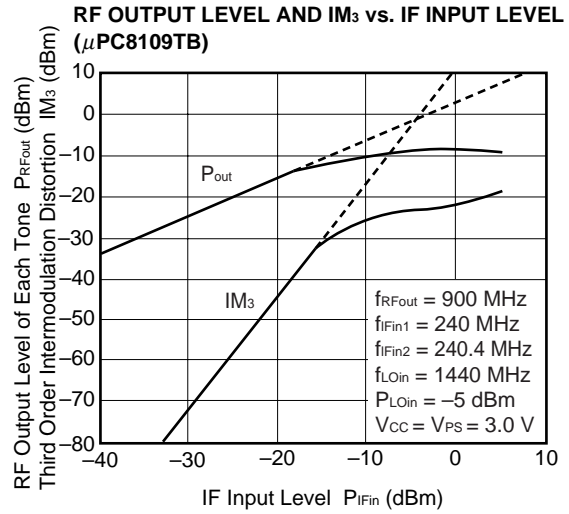
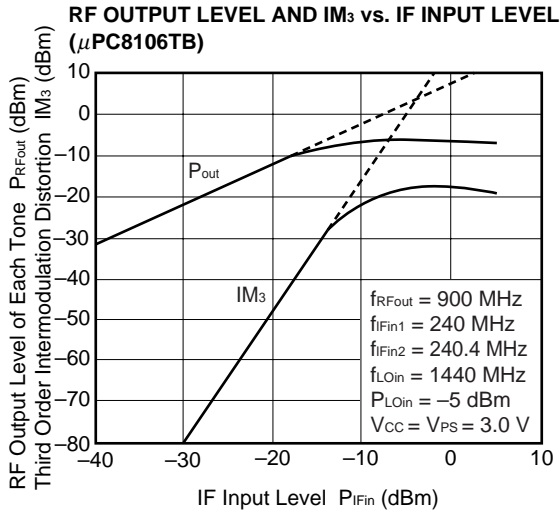
▽ 59.086  $\Omega$  -3.873  $\Omega$

hp

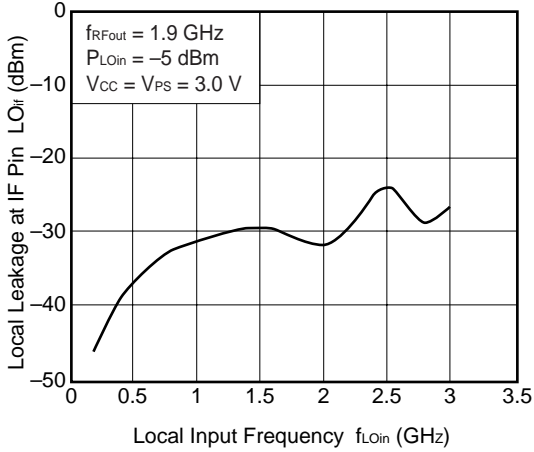




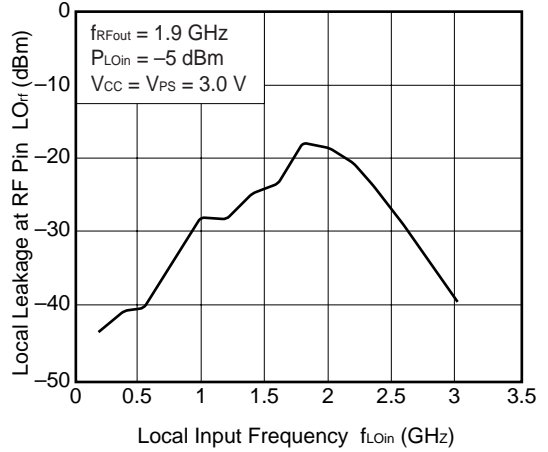




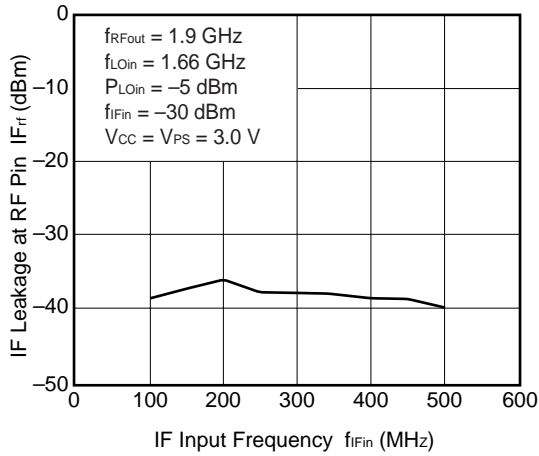
**LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY ( $\mu$ PC8106TB)**



**LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY ( $\mu$ PC8106TB)**

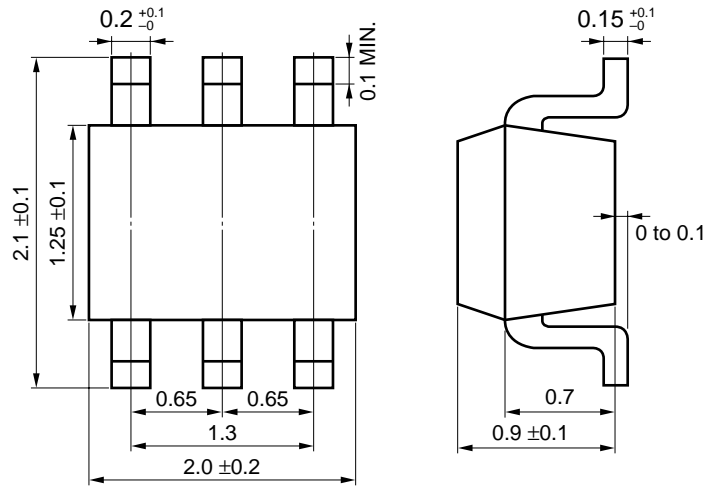


**IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY ( $\mu$ PC8106TB)**



PACKAGE DIMENSIONS

6 pin super minimold (Unit: mm)



**NOTES ON CORRECT USE**

- (1) Observe precautions for handling because of electrostatic sensitive devices.
- (2) Form a ground pattern wide as possible to minimize ground impedance (to prevent undesired oscillation).
- (3) Keep the wiring length of the ground pins as short as possible.
- (4) Connect a bypass capacitor to the Vcc pin.
- (5) Connect a matching circuit to the RF output pin.

**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 Time: 30 seconds or less (at 210°C) Count: 3, Exposure limit: None <sup>Note</sup>	IR35-00-3
VPS	Package peak temperature: 215°C or below Time: 40 seconds or less (at 200°C) Count: 3, Exposure limit: None <sup>Note</sup>	VP15-00-3
Wave Soldering	Soldering bath temperature: 260°C or below Time: 10 seconds or less Count: 1, Exposure limit: None <sup>Note</sup>	WS60-00-1
Partial Heating	Pin temperature: 300°C Time: 3 seconds or less (per side of device) Exposure limit: None <sup>Note</sup>	—

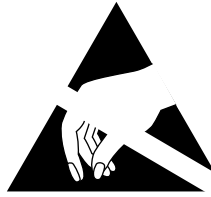
**Note** After opening the dry pack, keep it in a place below 25°C and 65% RH for the allowable storage period.

**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

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    - 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)
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