

BIPOLAR ANALOG INTEGRATED CIRCUITS

μ PC8106TB, μ PC8109TB

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

DESCRIPTION

The μ PC8106TB and μ PC8109TB are silicon monolithic integrated circuit designed as frequency up-converter for cellular/cordless telephone transmitter stage. The μ PC8106TB features improved intermodulation and μ 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 μ PC8106TB and μ PC8109TB are manufactured using NEC's 20 GHz fr NESAT™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

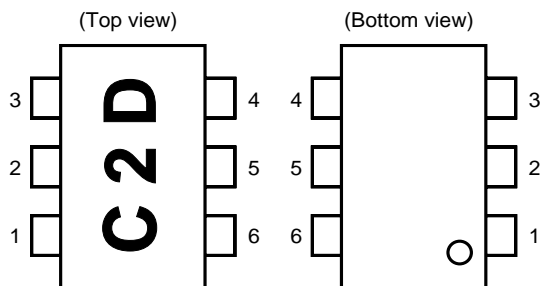
Part Number	Markings	Product Type	Package	Supplying Form
μ PC8106TB-E3	C2D	High IP ₃	6-pin super minimold	Embossed tape 8 mm wide. Pin 1, 2, 3 face to tape perforation side. QTY 3 kp/Reel.
μ PC8109TB-E3	C2G	Low current consumption		

Remark To order evaluation samples, please contact your local NEC sales office.
(Part number for sample order: μ PC8106TB, μ 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 μ PC8106TB.

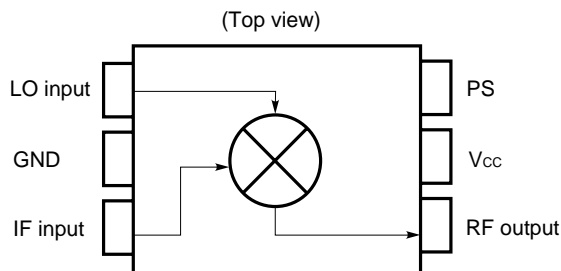
Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	PS
5	V _{cc}
6	RFoutput

★ **SERIES PRODUCTS (T_A = +25 °C, V_{CC} = V_{PS} = V_{RFout} = 3.0 V, Z_L = Z_S = 50 Ω)**

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

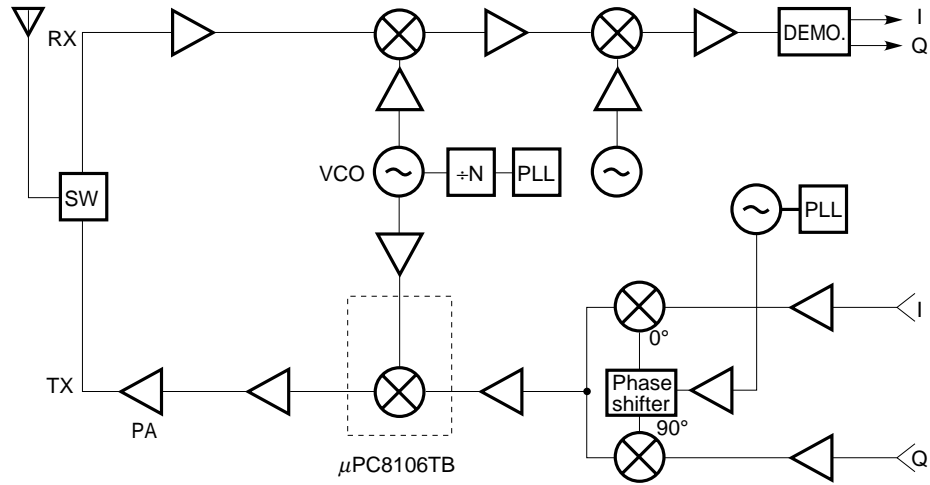
Caution The above table lists the typical performance of each model. See **ELECTRICAL CHARACTERISTICS** for the test conditions.

BLOCK DIAGRAM (FOR THE μ PC8106TB AND μ PC8109TB)

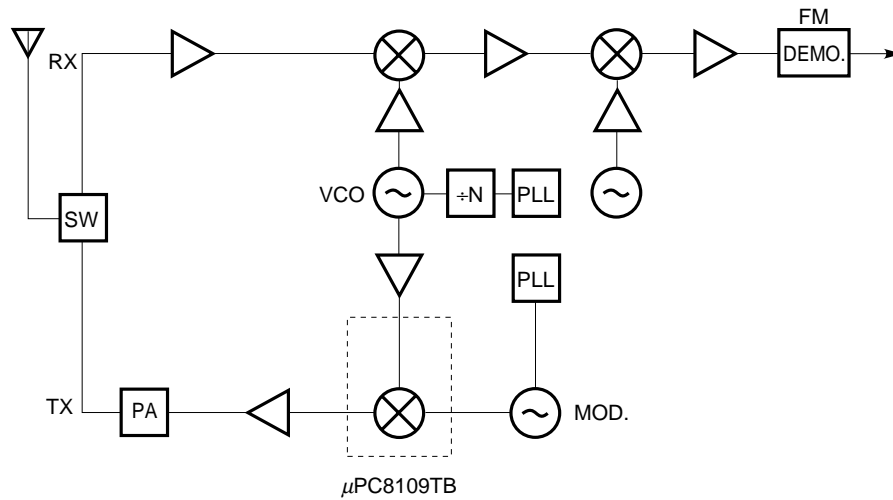


SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEMS)

PHS, DECT



Analog cellular telephone



PIN FUNCTIONS (FOR THE μPC8106TB AND μPC8109TB)

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V) ^{Note}	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 $V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$.

ABSOLUTE MAXIMUM RATINGS

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

RECOMMENDED OPERATING CONDITIONS

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

ELECTRICAL CHARACTERISTICS

(T_A = +25 °C, V_{CC} = V_{RFout} = 3.0 V, f_{IFin} = 240 MHz, P_{LOin} = -5 dBm, and V_{PS} ≥ 2.7 V unless otherwise specified)

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

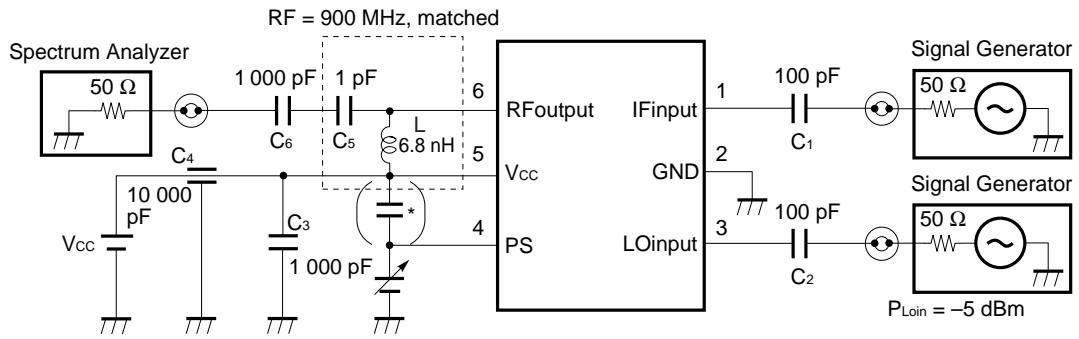
Parameter	Symbol	Conditions		Reference Value		Unit
				μ PC8106TB	μ PC8109TB	
Output Third-Order Distortion Intercept Point	OIP ₃₁	$f_{Fin1} = 240.0\text{ MHz}$	$f_{RFout} = 0.9\text{ GHz}$	+5.5	+1.5	dBm
	OIP ₃₂	$f_{Fin2} = 240.4\text{ MHz}$	$f_{RFout} = 1.9\text{ GHz}$	+2.0	-1.0	
Third-Order Intermodulation Distortion 1	IM ₃₁	$f_{Fint} = 240.0\text{ MHz}$ $f_{Fin2} = 240.4\text{ MHz}$	$f_{RFout} = 0.9\text{ GHz}$	-31	-29	dBc
Third-Order Intermodulation Distortion 2	IM ₃₂	$P_{Fin} = -20\text{ dBm}$	$f_{RFout} = 1.9\text{ GHz}$	-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	μs
	Fall time	$T_{PS(fall)}$	$V_{PS}: V_{CC} \rightarrow \text{GND}$	2.0	2.0	μs

APPLICATION CIRCUIT EXAMPLE CHARACTERISTICS FOR REFERENCE PURPOSE ONLY

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

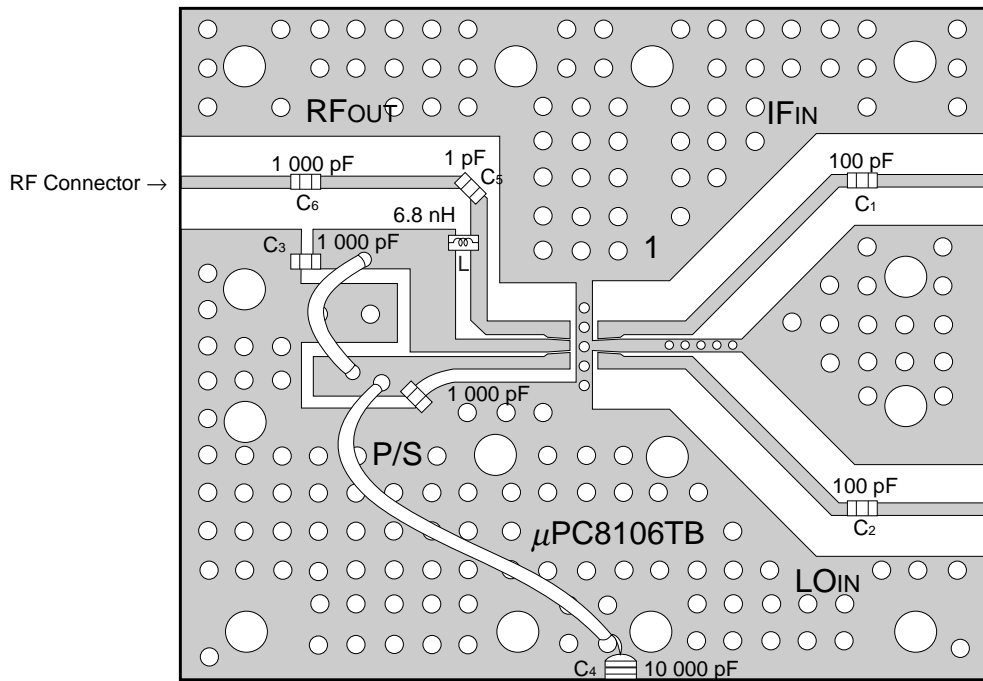
Parameter	Symbol	Conditions		Reference Value	Unit
				μ PC8106TB	
Conversion Gain	CG	$f_{RFout} = 1.5\text{ GHz}$, with application circuit example		7	dB
Maximum RF Output Power	$P_{O(sat)}$	$f_{RFout} = 1.5\text{ GHz}$, with application circuit example		-3.5	dBm

★ TEST CIRCUIT 1 (RF = 900 MHz, for the μ PC8106TB and μ 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

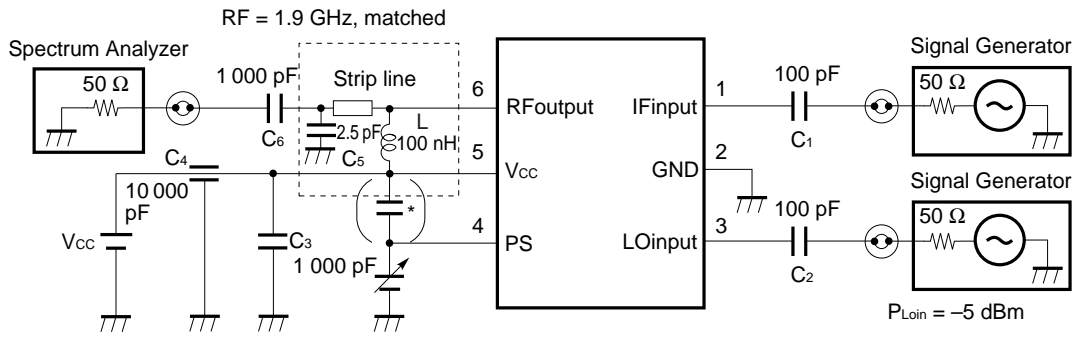
Form	Symbol	Value
Chip capacitor	C ₁ , C ₂	100 pF
	C ₃ , C ₆	1 000 pF
	C ₅	1 pF
Through capacitor	C ₄	10 000 pF
Chip inductor	L	6.8 nH ^{Note}

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

Notes on the board

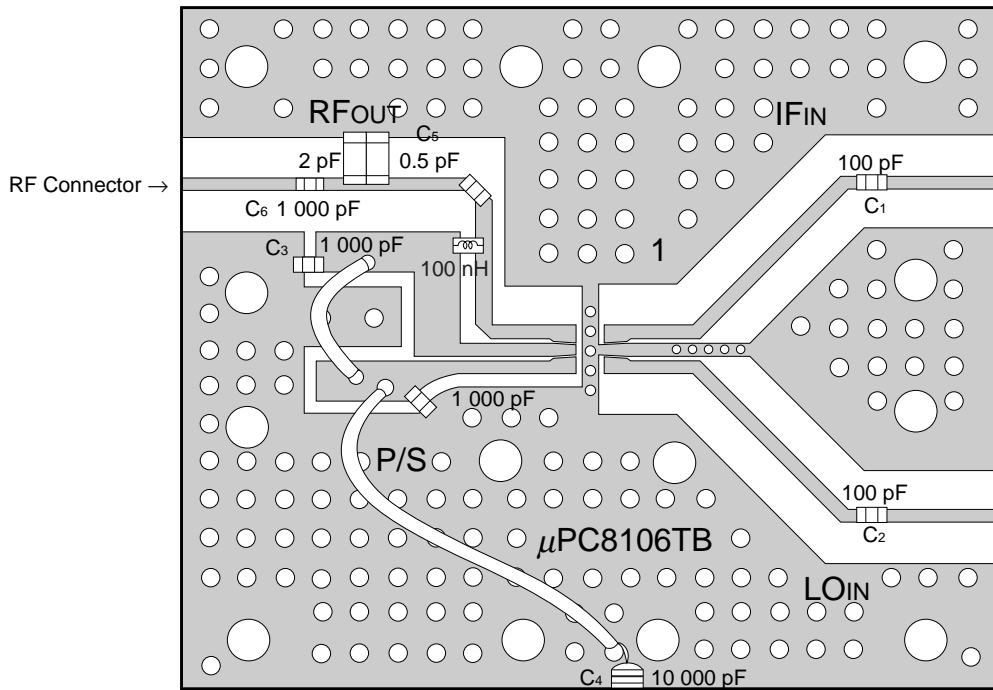
1. 35 × 42 × 0.4 mm polyimide board, 35 μ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes
5. C₆ is for RF short on the board pattern

★ TEST CIRCUIT 2 (RF = 1.9 GHz, for the μ PC8106TB and μ 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

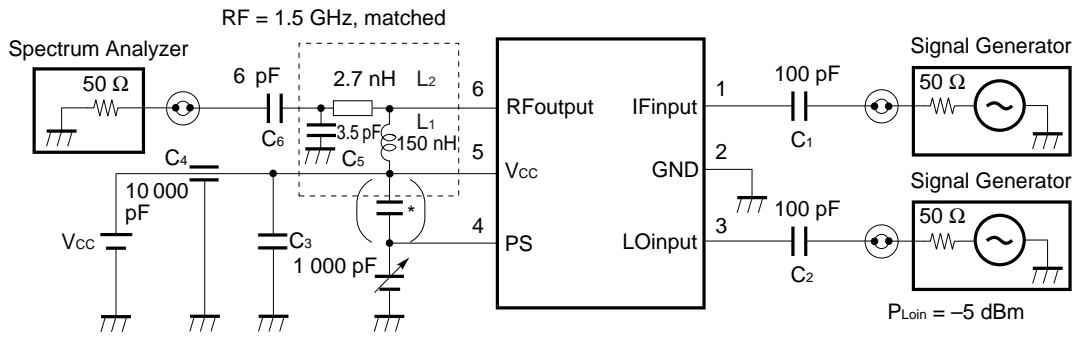
Form	Symbol	Value
Chip capacitor	C ₁ , C ₂	100 pF
	C ₃ , C ₆	1 000 pF
	C ₅	2.5 pF (2.0 pF, 0.5 pF parallel)
Through capacitor	C ₄	10 000 pF
Chip inductor	L	100 nH ^{Note}

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

Notes on the board

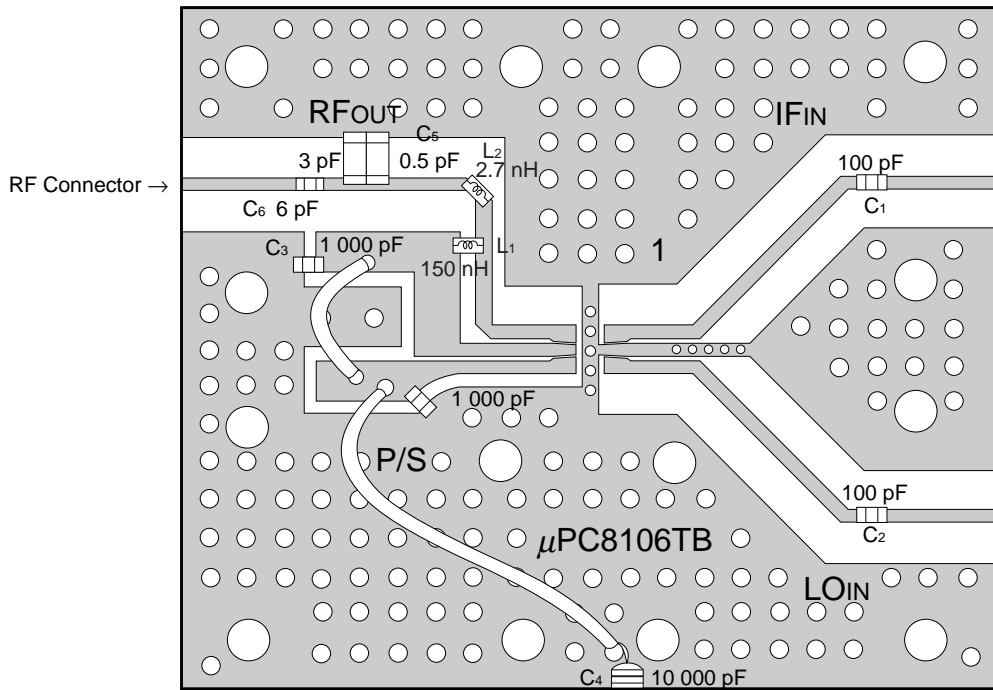
1. 35 × 42 × 0.4 mm polyimide board, 35 μ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes

★ APPLICATION CIRCUIT EXAMPLE (RF = 1.5 GHz, for the μ PC8106TB and μ 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 ₁ , C ₂	100 pF
	C ₃	1 000 pF
	C ₅	3.5 pF (3.0 pF, 0.5 pF parallel)
	C ₆	6 pF
Through capacitor	C ₄	10 000 pF
Chip inductor	L ₁	150 nH ^{Note 1}
	L ₂	2.7 nH ^{Note 2}

- 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 μ m double-sided copper clad
2. Ground pattern on rear of the board
3. Solder plated patterns
4. ○○○: Through holes

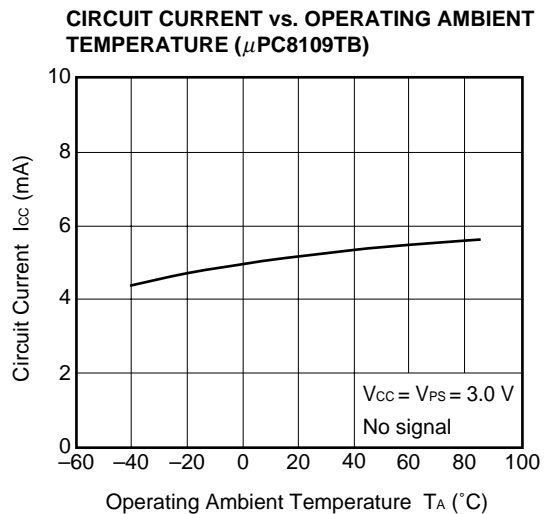
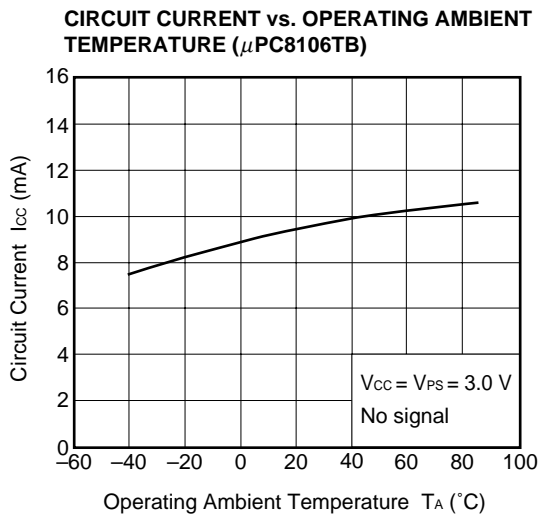
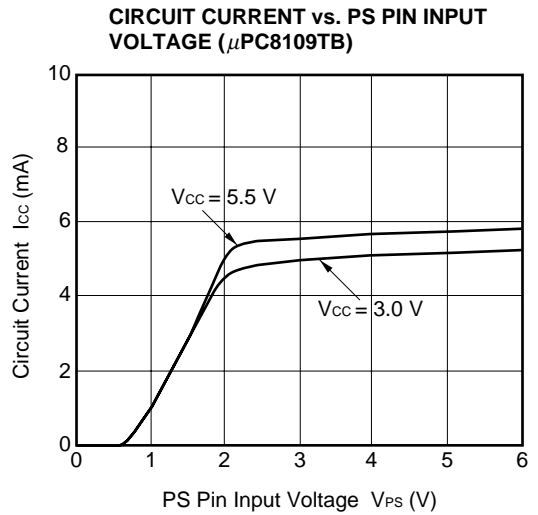
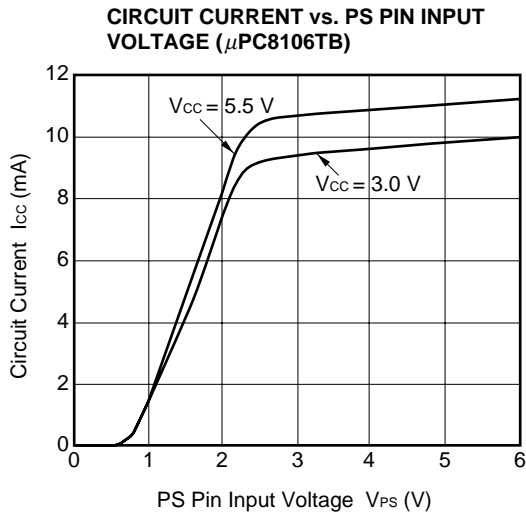
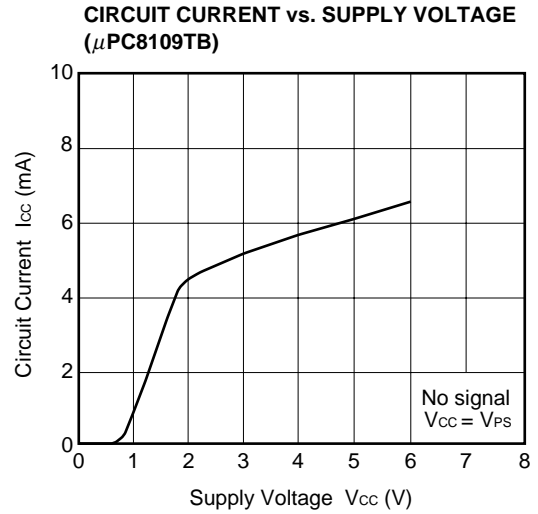
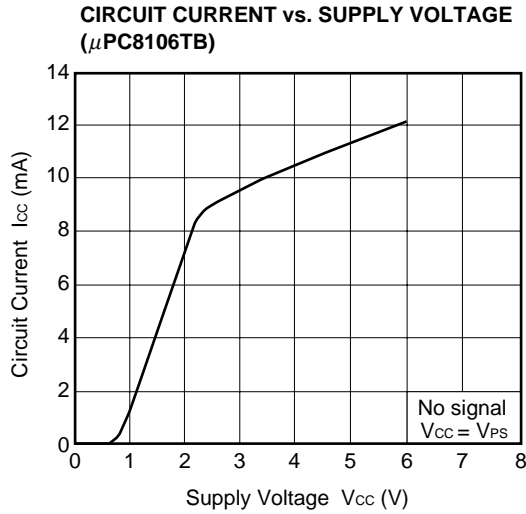
NOTICE

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.

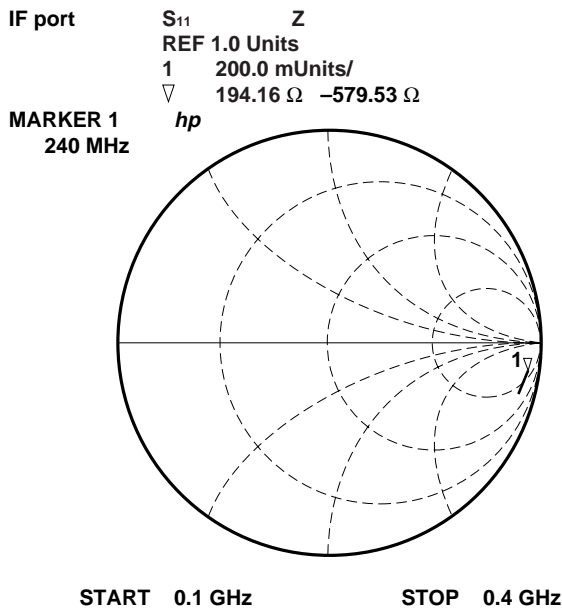
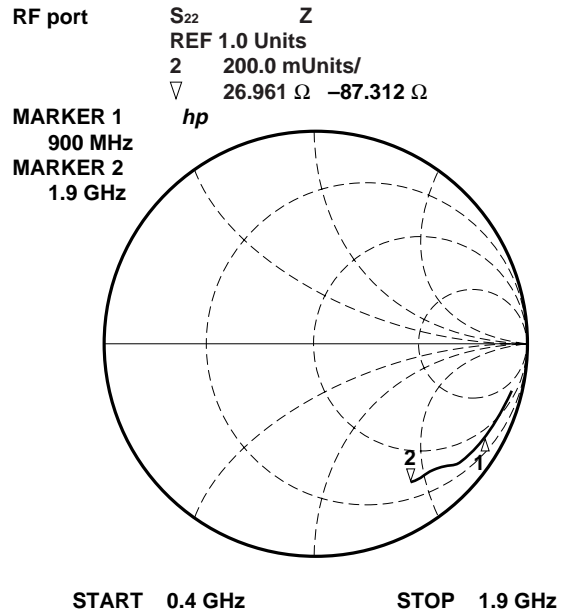
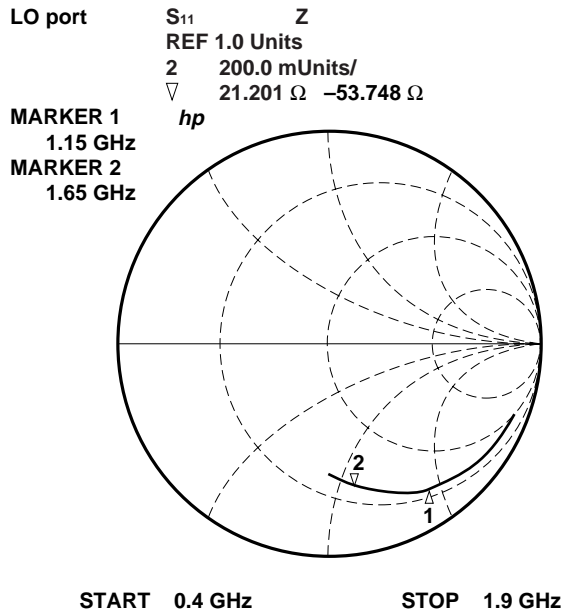
For external circuits of the ICs, following Application Note is also available.

- μ PC8106, μ 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 ($V_{CC} = V_{PS} = V_{RFout} = 3.0\text{ V}$) – μ PC8106TB, μ 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 (μ PC8106TB, μ PC8109TB in common) – (S_{22} data are monitored at RF connector on board.)

900 MHz (LC-matched) in test circuit 1

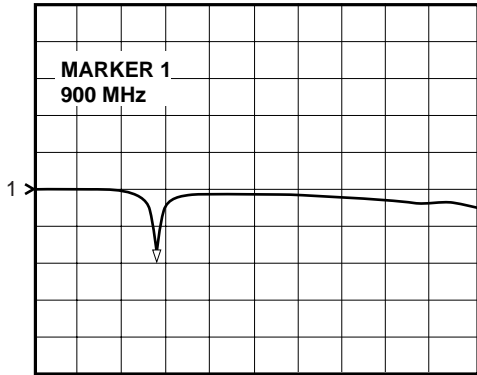
S_{22} log MAG

REF 0.0 dB

1 10.0 dB/

▽ -19.567 dB

hp



START 100 MHz STOP 3 000 MHz

1.9 GHz (matched) in test circuit 2

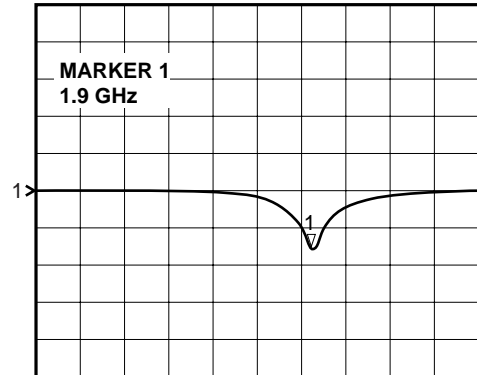
S_{22} log MAG

REF 0.0 dB

1 10.0 dB/

▽ -15.213 dB

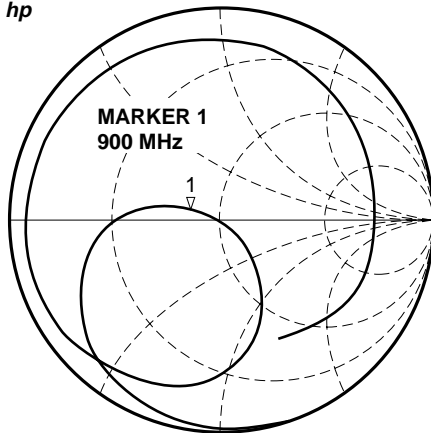
hp



START 100 MHz STOP 3 000 MHz

S_{22}
REF 1.0 Units
1 200.0 mUnits/
▽ 36.59 Ω 2.9355 Ω

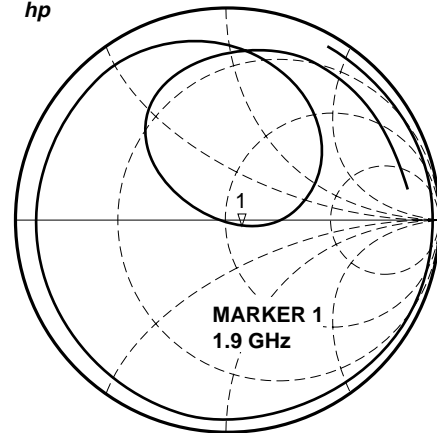
hp



START 100 MHz STOP 3 000 MHz

S_{22}
REF 1.0 Units
1 200.0 mUnits/
▽ 58.191 Ω -4.1191 Ω

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

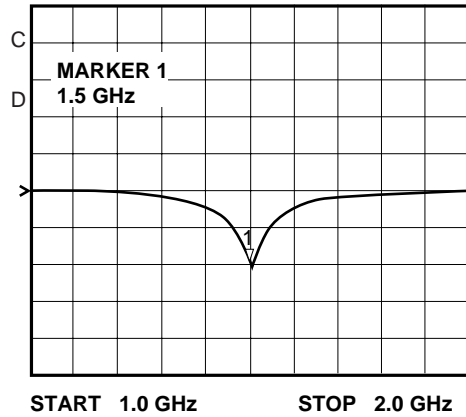
S_{22} log MAG

REF 0.0 dB

1 10.0 dB/

▽ -20.901 dB

hp



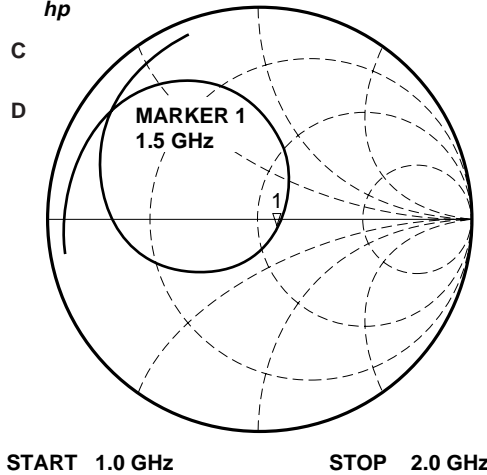
S_{22} Z

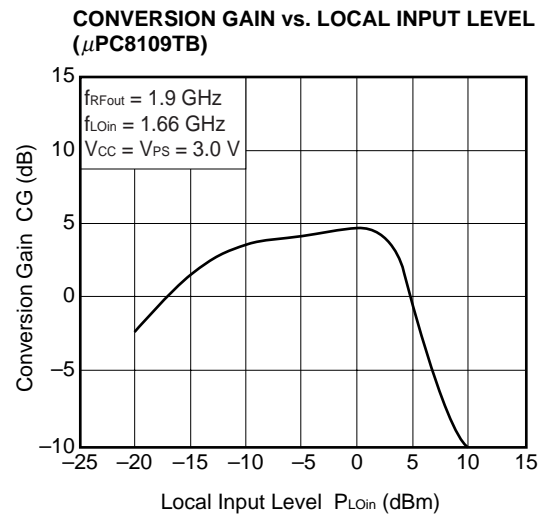
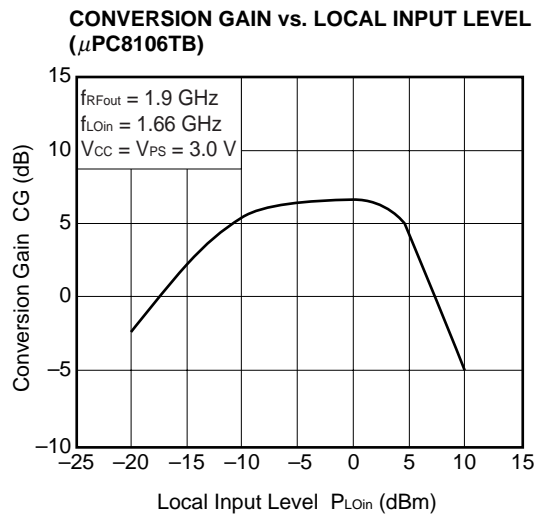
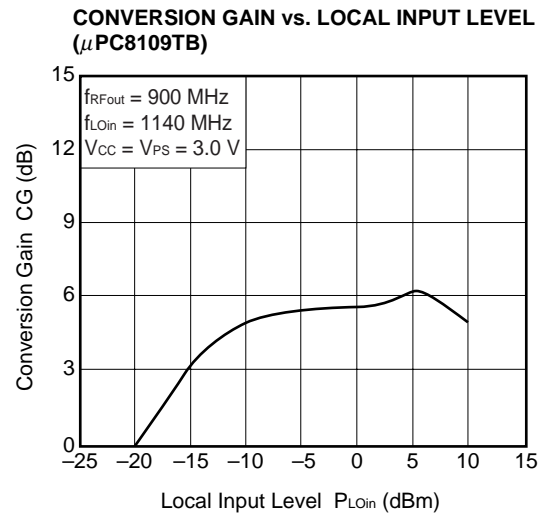
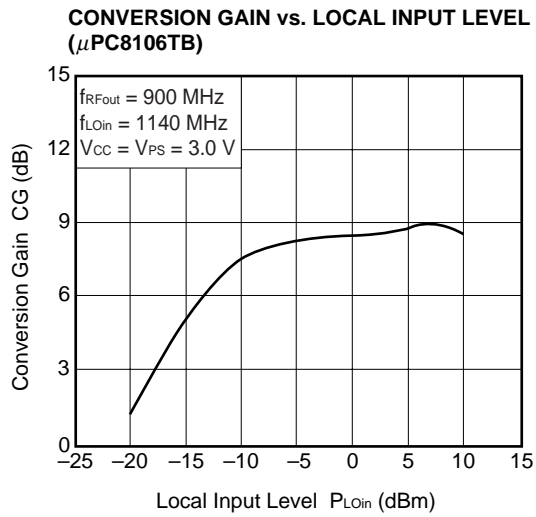
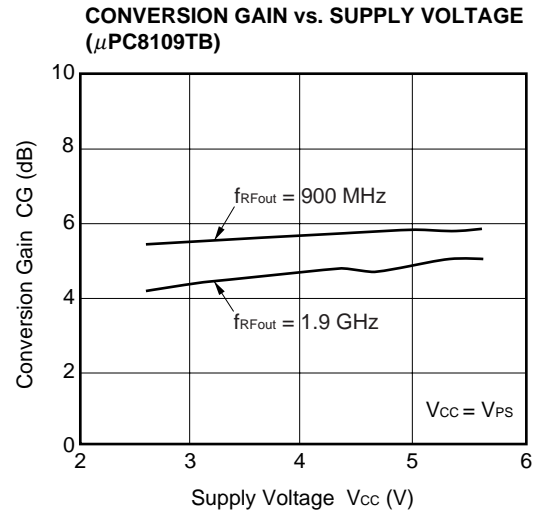
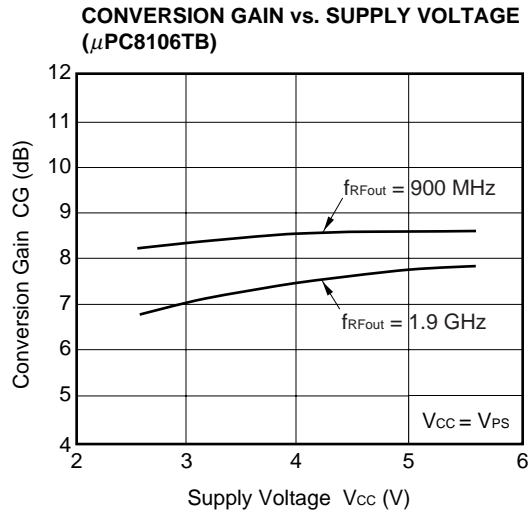
REF 1.0 Units

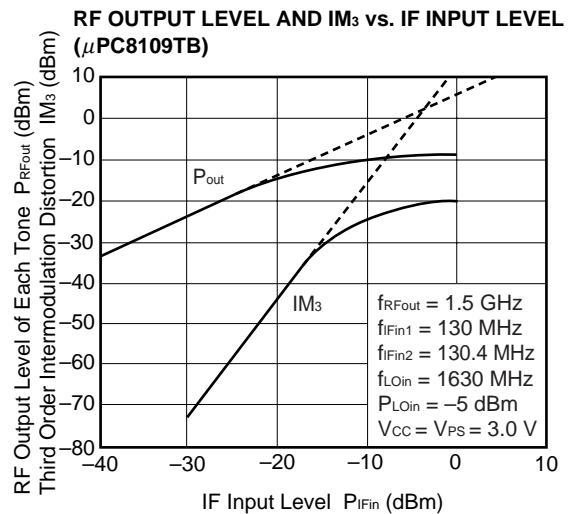
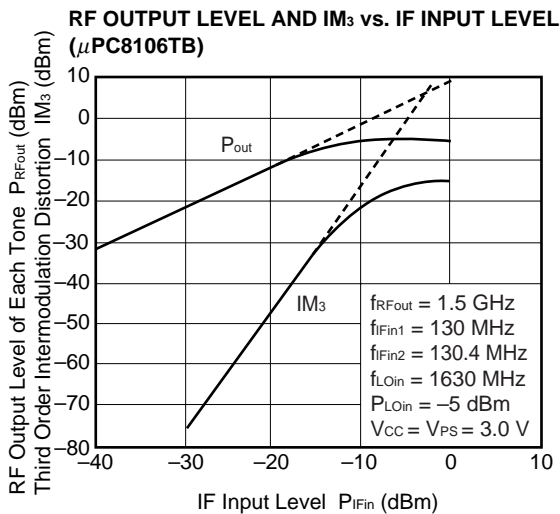
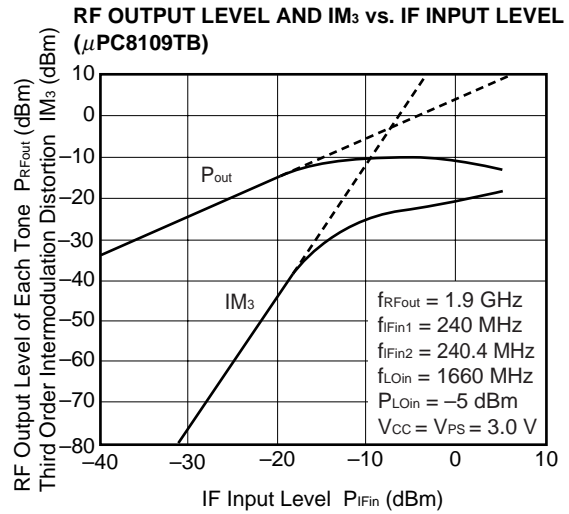
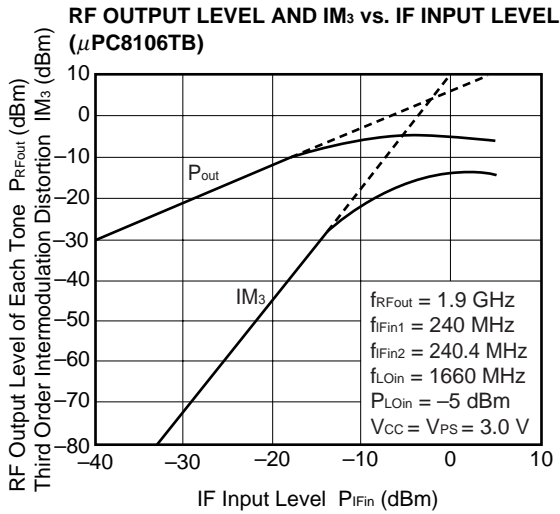
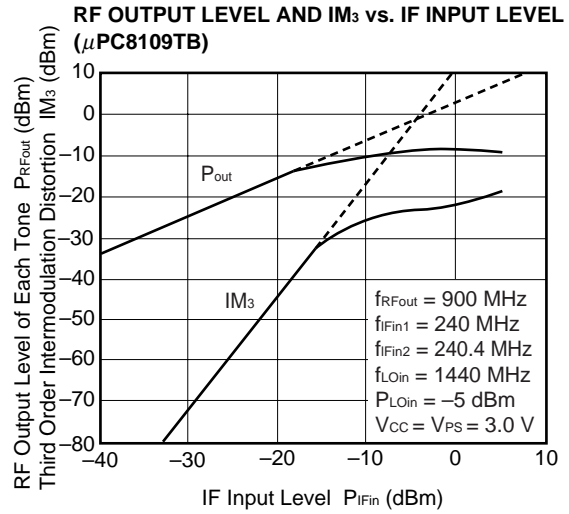
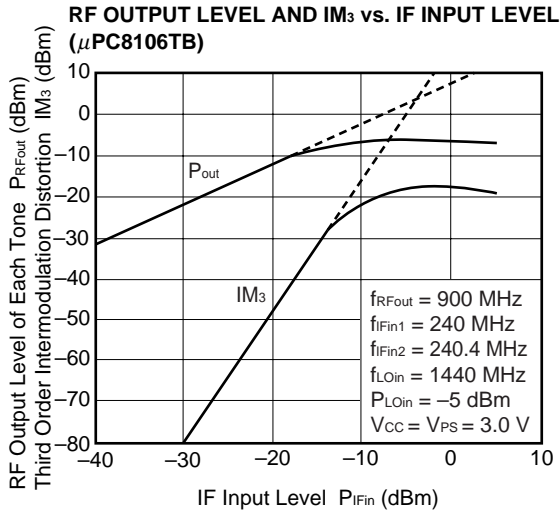
1 200.0 mUnits/

▽ 59.086 Ω -3.873 Ω

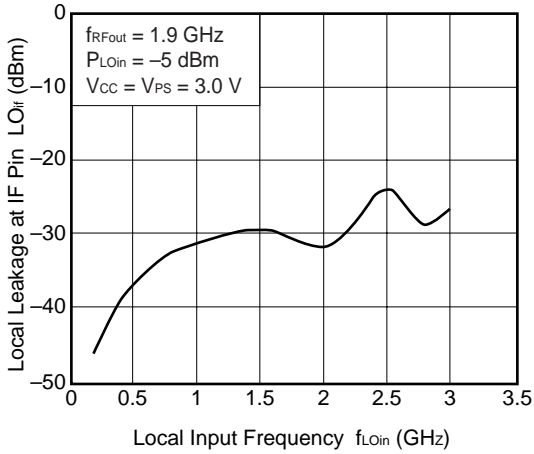
hp



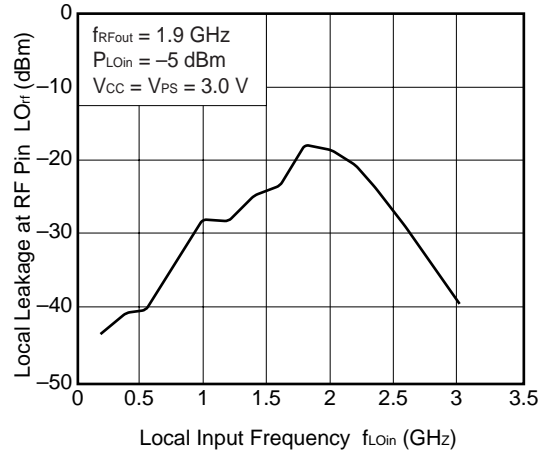




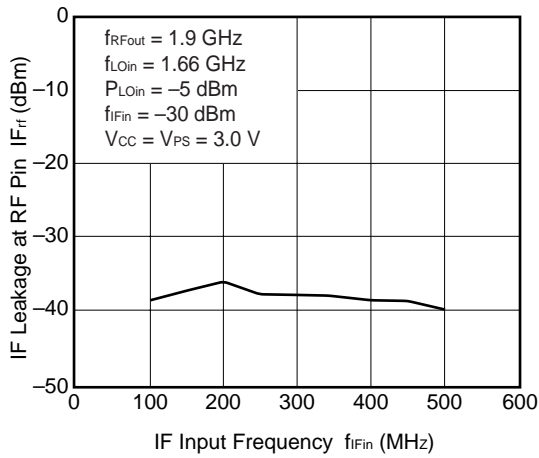
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY (μ PC8106TB)



LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY (μ PC8106TB)

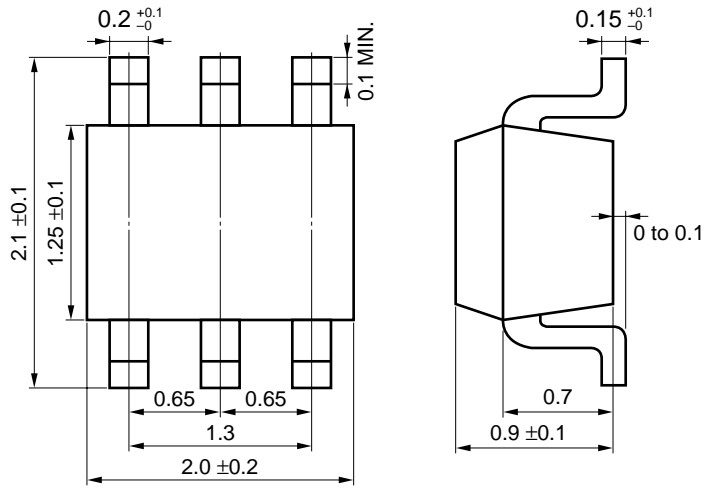


IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY (μ PC8106TB)



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

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

NESAT (NEC Silicon Advanced Technology) is a trademark of NEC Corporation.

- **The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.**
 - No part of this document may be copied or reproduced in any form or by any means without the prior written consent of NEC Corporation. NEC Corporation assumes no responsibility for any errors which may appear in this document.
 - NEC Corporation does not assume any liability for infringement of patents, copyrights or other intellectual property rights of third parties by or arising from use of a device described herein or any other liability arising from use of such device. No license, either express, implied or otherwise, is granted under any patents, copyrights or other intellectual property rights of NEC Corporation 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 the customer's equipment shall be done under the full responsibility of the customer. NEC Corporation assumes no responsibility for any losses incurred by the customer or third parties arising from the use of these circuits, software, and information.
 - While NEC Corporation has been making continuous effort to enhance the reliability of its semiconductor devices, the possibility of defects cannot be eliminated entirely. To minimize risks of damage or injury to persons or property arising from a defect in an NEC semiconductor device, customers must incorporate sufficient safety measures in its design, such as redundancy, fire-containment, and anti-failure features.
 - NEC devices are classified into the following three quality grades:
 "Standard", "Special", and "Specific". The Specific quality grade applies only to devices developed based on a customer designated "quality assurance program" for a specific application. The recommended applications of a device depend on its quality grade, as indicated below. Customers must check the quality grade of each device 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 or medical equipment for life support, etc.
- The quality grade of NEC devices is "Standard" unless otherwise specified in NEC's Data Sheets or Data Books. If customers intend to use NEC devices for applications other than those specified for Standard quality grade, they should contact an NEC sales representative in advance.