DATA SHEET

NEC

BIPOLAR ANALOG INTEGRATED CIRCUITS

μPC8106TB, μPC8109TB

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

DESCRIPTION

The μPC8106TB and μPC8109TB are silicon monolithic integrated circuits designed as frequency up-converter for cellular/cordless telephone transmitter stage. The μPC8106TB features improved intermodulation and μPC8109TB 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 μPC8106TB and μPC8109TB are manufactured using NEC's 20 GHz f_T 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 to 2.0 GHz, f_{IFin} = 100 to 400 MHz
- Supply voltage : V_{CC} = 2.7 to 5.5 V
- High-density surface mounting : 6-pin super minimold package
- Low current consumption : I_{CC} = 9 mA TYP. @ μPC8106TB
  I_{CC} = 5 mA TYP. @ μPC8109TB
- 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	Package	Marking	Supplying Form	Product Type
μPC8106TB-E3	6-pin super minimold	C2D	Embossed tape 8 mm wide. Pin 1, 2, 3 face the tape perforation side. Qty 3 kpcs/reel.	High IP_3
μPC8109TB-E3		C2G		Low current consumption

Remark To order evaluation samples, please contact your local NEC sales office (Part number for sample order: μPC8106TB, μPC8109TB).

Caution Electro-static sensitive devices

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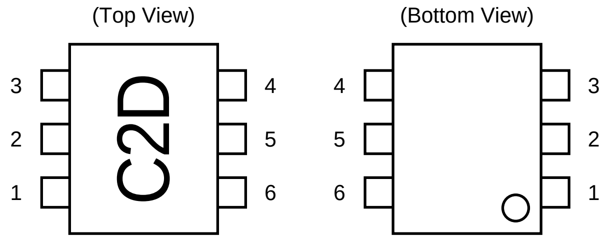
The mark ★ shows major revised points.

CONTENTS

1. PIN CONNECTIONS



Example marking is for μPC8106TB

μPC8106TB, μPC8109TB in common

Pin No.	Pin Name
1	IFinput
2	GND
3	LOinput
4	PS
5	V_{CC}
6	RFoutput

★ ## 2. PRODUCT LINE-UP (T_A = +25°C, V_{CC} = V_{PS} = V_{RFout} = 3.0 V, Z_S = Z_L = 50 Ω)

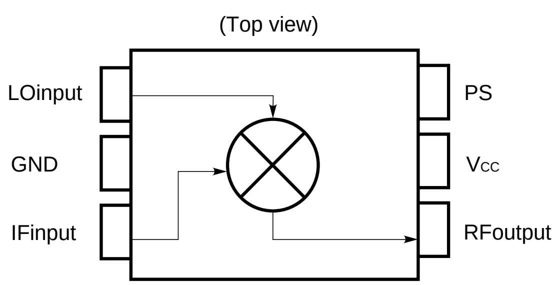
Part Number	I_{CC} (mA)	f_{RFout} (GHz)	CG (dB)		
			@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz
μPC8106TB	9	0.4 to 2.0	9	7	–
μPC8109TB	5	0.4 to.2.0	6	4	–
μPC8163TB	16.5	0.8 to 2.0	9	5.5	–
μPC8172TB	9	0.8 to 2.5	9.5	8.5	8.0
μPC8187TB	15	0.8 to 2.5	11	11	10

Part Number	$P_{O(sat)}$ (dBm)			OIP_3 (dBm)		
	@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz	@RF 0.9 GHz[Note]	@RF 1.9 GHz	@RF 2.4 GHz
μPC8106TB	–2	–4	–	+5.5	+2.0	–
μPC8109TB	–5.5	–7.5	–	+1.5	–1.0	–
μPC8163TB	+0.5	–2	–	+9.5	+6.0	–
μPC8172TB	+0.5	0	–0.5	+7.5	+6.0	+4.0
μPC8187TB	+4	+2.5	+1	+10	+10	+8.5

Note f_{RFout} = 0.83 GHz @ μPC8163TB and μPC8187TB

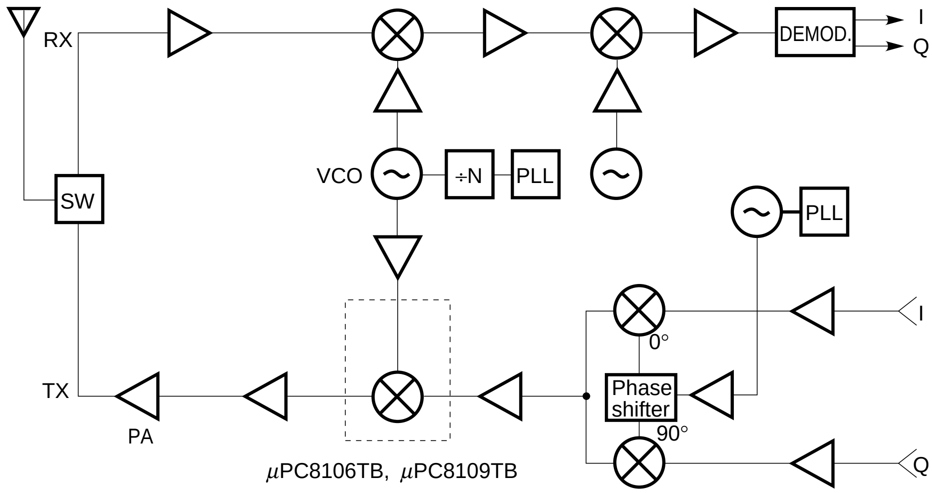
Remark Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

3. INTERNAL BLOCK DIAGRAM (for the μPC8106TB and μPC8109TB)

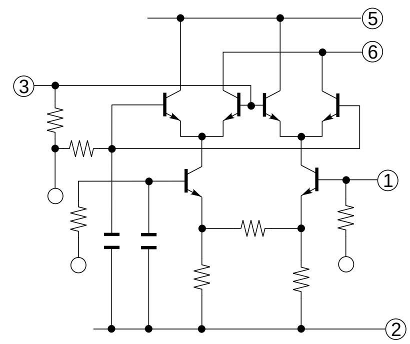
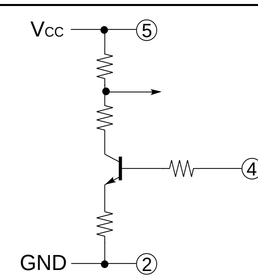


4. SYSTEM APPLICATION EXAMPLE (schematics of IC location in the system)

WIRELESS TRANSCEIVER



5. PIN EXPLANATION (for the μPC8106TB and μPC8109TB)

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>Applied Voltage (V)</th><th>Pin Voltage (V)[Note]</th><th>Function and Explanation</th><th>Equivalent Circuit</th></tr>
<tr><td>1</td><td>IFinput</td><td>–</td><td>1.3</td><td>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.</td><td rowspan="5">
</td></tr>
<tr><td>2</td><td>GND</td><td>GND</td><td>–</td><td>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.</td></tr>
<tr><td>3</td><td>LOinput</td><td>–</td><td>2.4</td><td>Local input pin. Recommendable input level is –10 to 0 dBm.</td></tr>
<tr><td>5</td><td>V_{CC}</td><td>2.7 to 5.5</td><td>–</td><td>Supply voltage pin.</td></tr>
<tr><td>6</td><td>RFoutput</td><td>Same bias as V_{CC} through external inductor</td><td>–</td><td>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.</td></tr>
<tr><td>4</td><td>PS</td><td>V_{CC} or GND</td><td>–</td><td>Power save control pin. Bias controls operation as follows.<table><tr><th>Pin bias</th><th>Control</th></tr><tr><td>V_{CC}</td><td>Operation</td></tr><tr><td>GND</td><td>Power Save</td></tr></table></td><td>
</td></tr>
</table>

Note Each pin voltage is measured at $V_{CC} = V_{PS} = V_{RFout} = 3.0$ V.

6. ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Test Conditions	Rating	Unit
Supply Votage	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
★ Package Power Dissipation	P_D	Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB T_A = +85°C	270	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

7. RECOMMENDED OPERATING RANGE

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
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 Power	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	

8. 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	μPC8106TB			μPC8109TB			Unit
			MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
Circuit Current	I_{CC}	No input 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
Saturated Output Power 1	$P_{O(sat)}1$	f_{RFout} = 0.9 GHz, P_{IFin} = 0 dBm	–4	–2	–	–7.5	–5.5	–	dBm
Saturated Output Power 2	$P_{O(sat)}2$	f_{RFout} = 1.9 GHz, P_{IFin} = 0 dBm	–6.5	–4	–	–10	–7.5	–	dBm

9. OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY (T$_A$ = +25°C, V$_{CC}$ = V$_{RFout}$ = 3.0 V, P$_{LOin}$ = –5 dBm, and V$_{PS}$ ≥ 2.7 V unless otherwise mentioned)

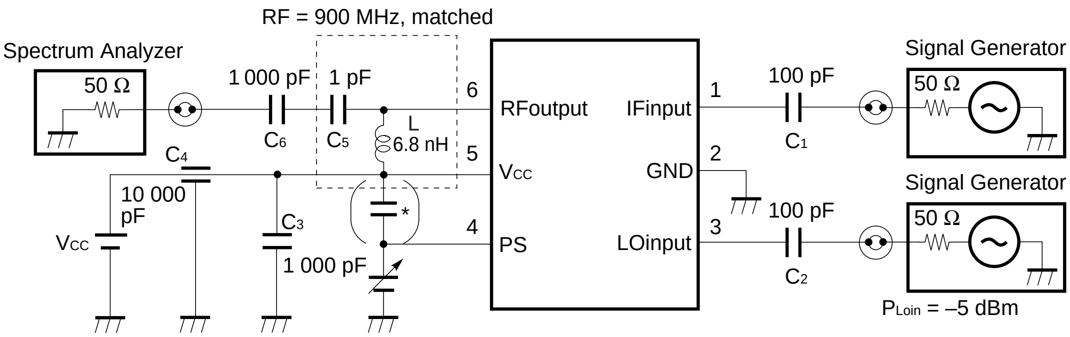
Parameter		Symbol	Conditions		Reference Value		Unit
					μPC8106TB	μPC8109TB	
3rd Order Distortion Output Intercept Point		OIP$_3$1	f$_{IFin}$1 = 240.0 MHz	f$_{RFout}$ = 0.9 GHz	+5.5	+1.5	dBm
		OIP$_3$2	f$_{IFin}$2 = 240.4 MHz	f$_{RFout}$ = 1.9 GHz	+2.0	–1.0	
3rd Order Intermodulation Distortion 1		IM$_3$1	f$_{IFin}$1 = 240.0 MHz f$_{IFin}$2 = 240.4 MHz P$_{IFin}$ = –20 dBm	f$_{RFout}$ = 0.9 GHz	–31	–29	dBc
3rd Order Intermodulation Distortion 2		IM$_3$2		f$_{RFout}$ = 1.9 GHz	–30	–28	dBc
SSB Noise Figure		SSB • NF	f$_{RFout}$ = 0.9 GHz, f$_{IFin}$ = 240 MHz		8.5	8.5	dB
Power Save Response Time	Rise time	T$_{PS(rise)}$	V$_{PS}$: GND → V$_{CC}$		2.0	2.0	μs
	Fall time	T$_{PS(fall)}$	V$_{PS}$: V$_{CC}$ → GND		2.0	2.0	μs

10. APPLICATION CIRCUIT EXAMPLE CHARACTERSISTICS FOR REFERENCE PURPOSES ONLY (T$_A$ = +25°C, V$_{CC}$ = V$_{PS}$ = V$_{RFout}$ = 3.0 V, f$_{IFin}$ = 130 MHz, f$_{LOin}$ = 1 630 MHz, P$_{LOin}$ = –5 dBm)

Parameter	Symbol	Conditions	Reference Value	Unit
			μPC8106TB	
Conversion Gain	CG	f$_{RFout}$ = 1.5 GHz, with application circuit example	7	dB
Saturated Output Power	P$_{O(sat)}$	f$_{RFout}$ = 1.5 GHz, with application circuit example	–3.5	dBm

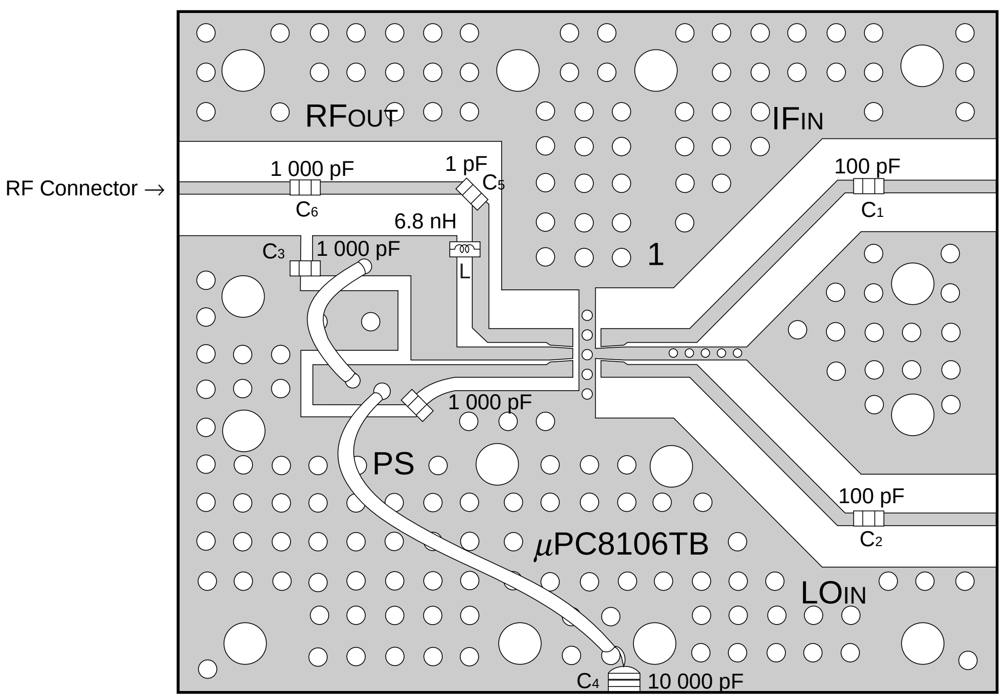
11. TEST CIRCUIT

11.1 Test Circuit 1 (f_{RFout} = 900 MHz, for the μPC8106TB and μPC8109TB)



* 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

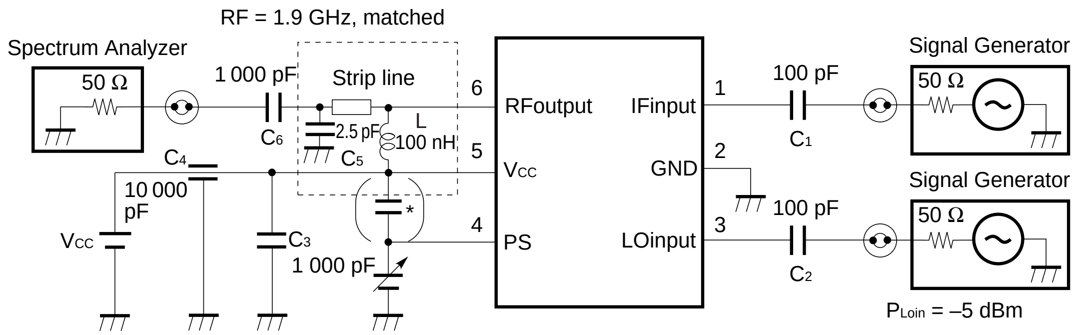
Form	Symbol	Value
Chip capacitor	C_1, C_2	100 pF
	C_3, C_6	1 000 pF
	C_5	1 pF
Through capacitor	C_4	10 000 pF
Chip inductor	L	6.8 nH[Note]

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

EVALUATION BOARD CHARACTERS

(1) Double-sided copper clad 35 × 42 × 0.4 mm polyimide board
(2) Back side: GND pattern
(3) Solder plated patterns
(4) ○◯◯: Through holes
(5) C_6 is for RF short on the board pattern

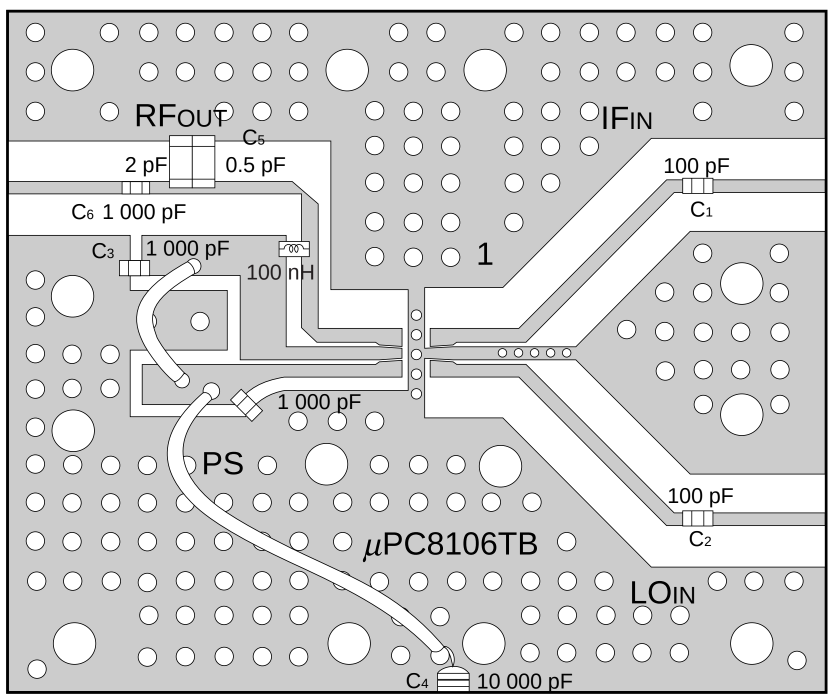
11.2 Test Circuit 2 (f_{RFout} = 1.9 GHz, for the μPC8106TB and μPC8109TB)



* 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

RF Connector →



COMPONENT LIST

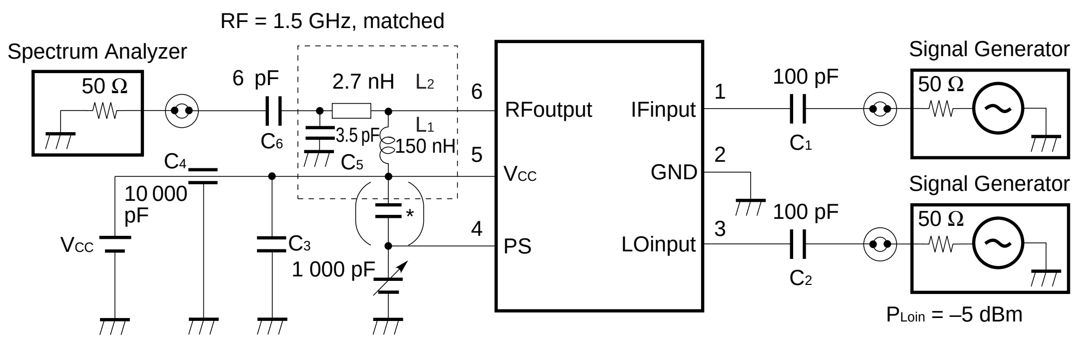
Form	Symbol	Value
Chip capacitor	C_1, C_2	100 pF
	C_3, C_6	1 000 pF
	C_5	2.5 pF (2.0 pF, 0.5 pF parallel)
Through capacitor	C_4	10 000 pF
Chip inductor	L	100 nH[Note]

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

EVALUATION BOAD CHARACTERS

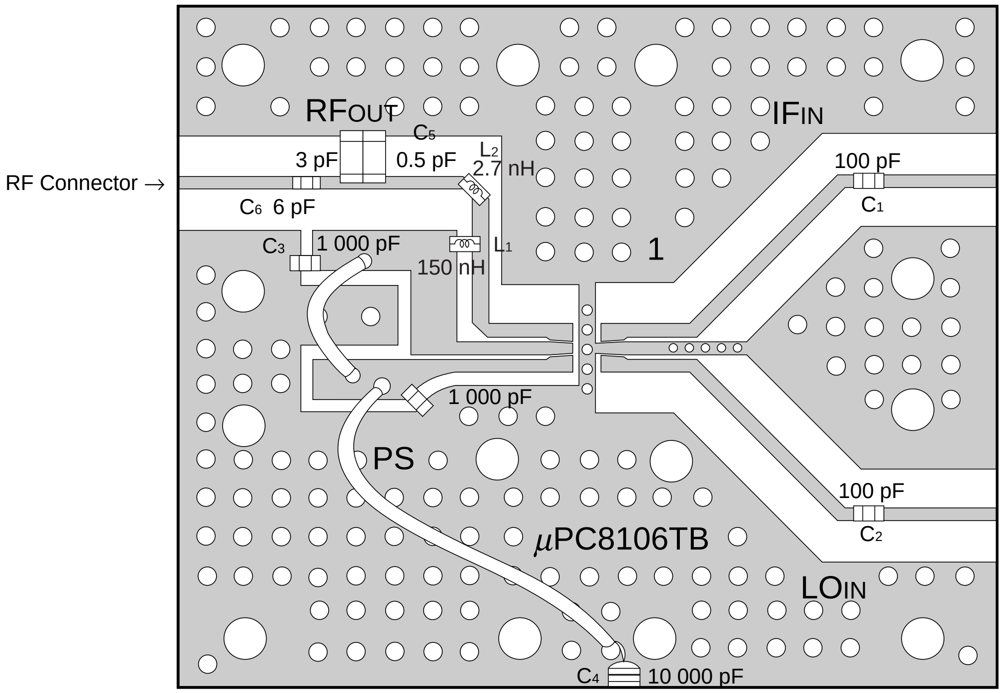
(1) Double-sided copper clad 35 × 42 × 0.4 mm polyimide board
(2) Back side: GND pattern
(3) Solder plated patterns
(4) ○◯◯ : Through holes

11.3 Application Circuit Example (f_{RFout} = 1.5 GHz, for the μPC8106TB and μPC8109TB)



* 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

EVALUATION BOARD CHARACTERS

(1) Double-sided copper clad 35 × 42 × 0.4 mm polyimide board
(2) Back side: GND pattern
(3) Solder plated patterns
(4) ○○◯ : Through holes

Caution

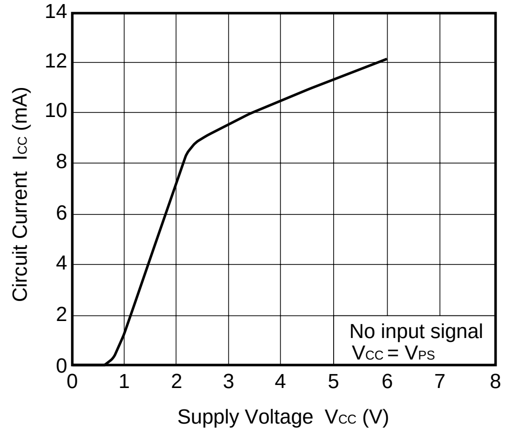
The test circuits and board pattern on data sheet are for performance evaluation use only. (They are not recommended circuits.) In the case of actual design-in, matching circuit should be determined using S parameter of desired frequency in accordance to actual mounting pattern.

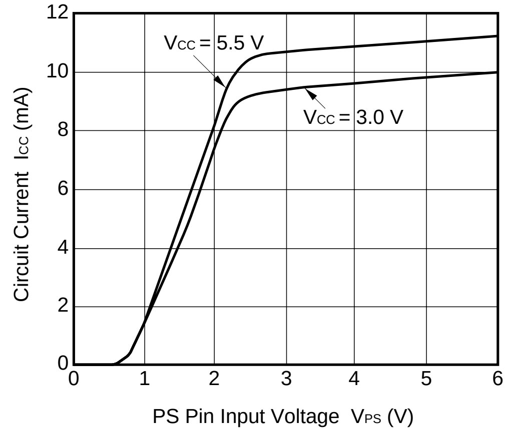
For external circuits of the ICs, following Application Note is also available.

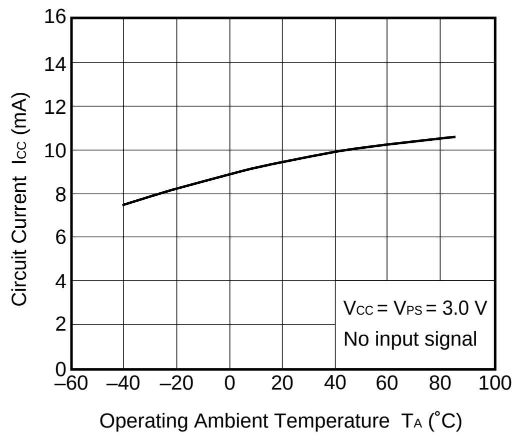
- μPC8106, μPC8109, μPC8163 Application Note (Document No. P13683E)

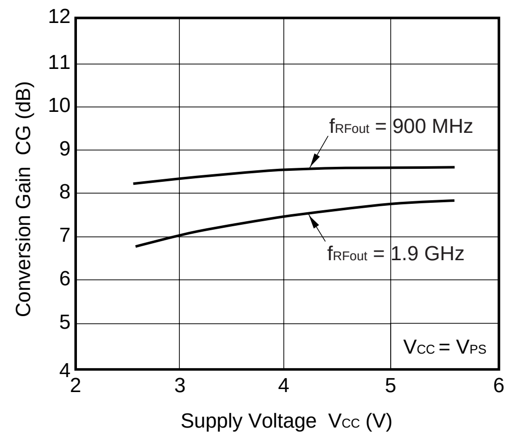
12. TYPICAL CHARACTERISTICS (T_A = +25°C, V_{CC} = V_{RFout}, with test circuit 1 or 2, according to the operating frequency, unless otherwise specified)

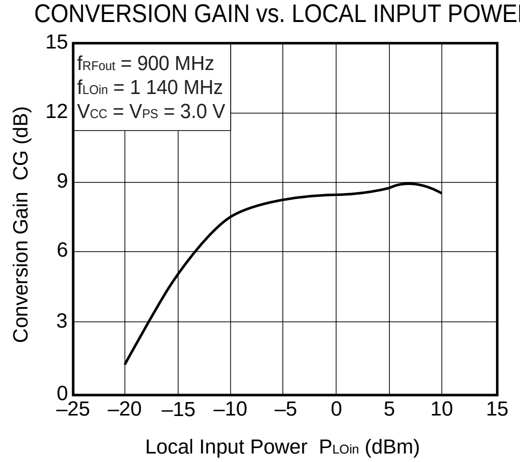
12.1 μPC8106TB

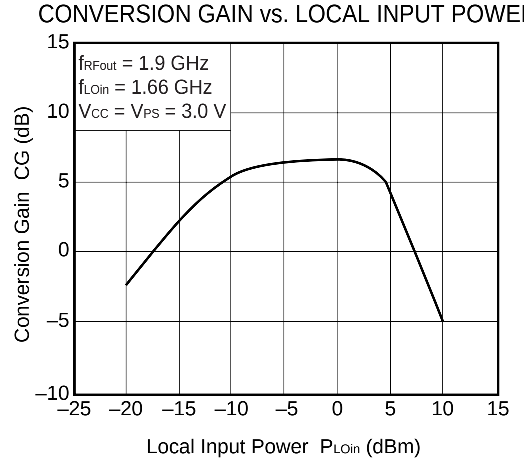




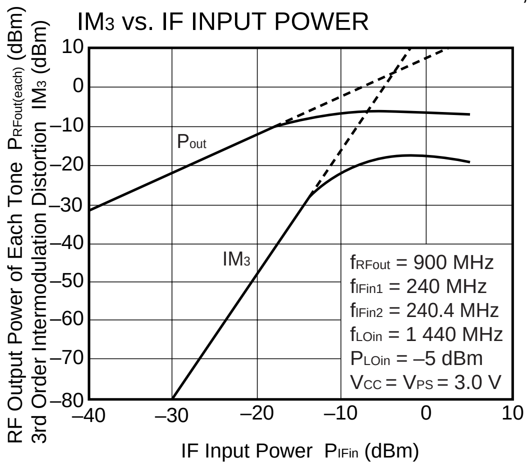




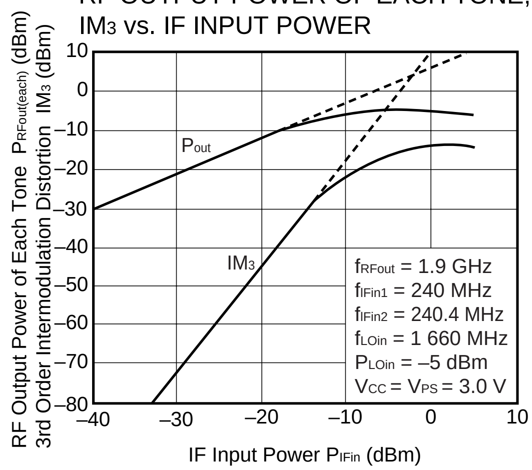




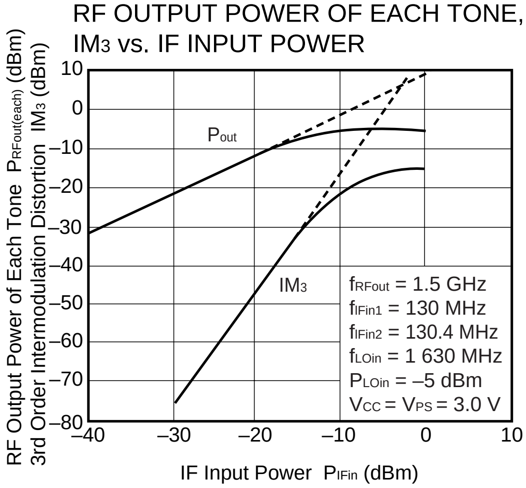
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



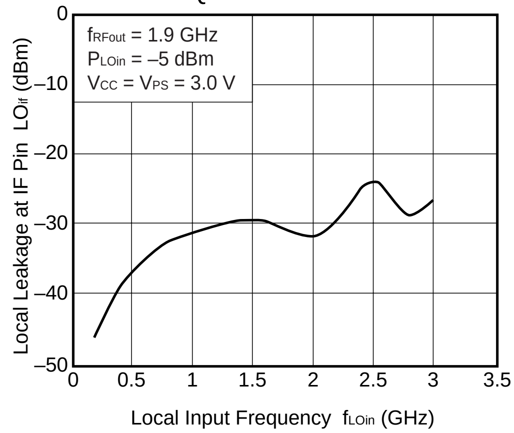
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



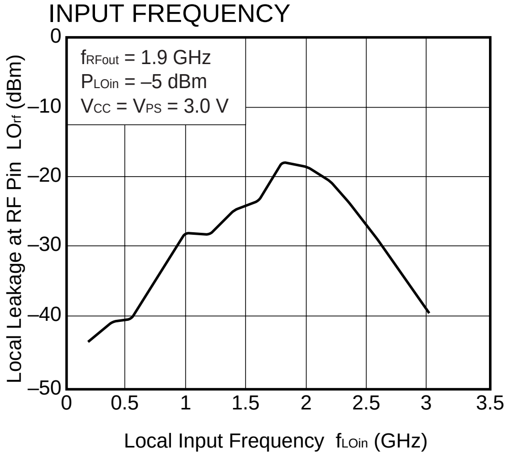
RF OUTPUT POWER OF EACH TONE, IM3 vs. IF INPUT POWER



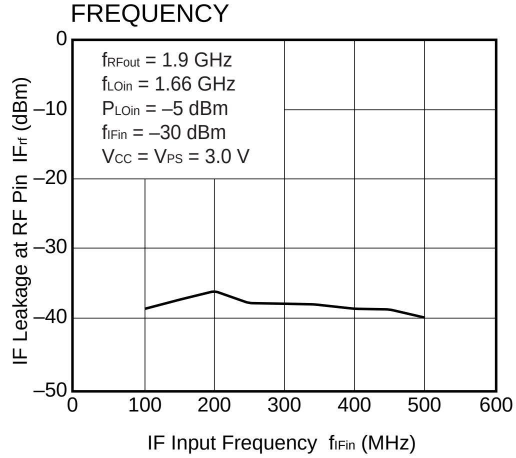
LOCAL LEAKAGE AT IF PIN vs. LOCAL INPUT FREQUENCY



LOCAL LEAKAGE AT RF PIN vs. LOCAL INPUT FREQUENCY

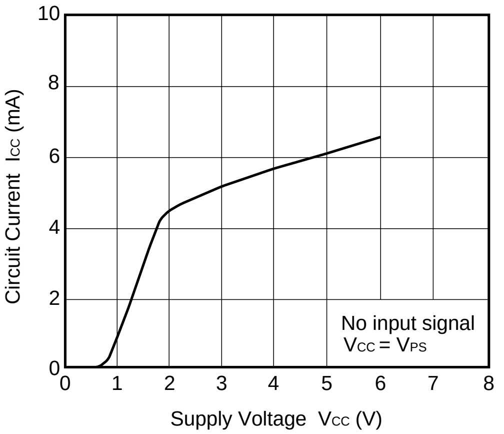


IF LEAKAGE AT RF PIN vs. IF INPUT FREQUENCY

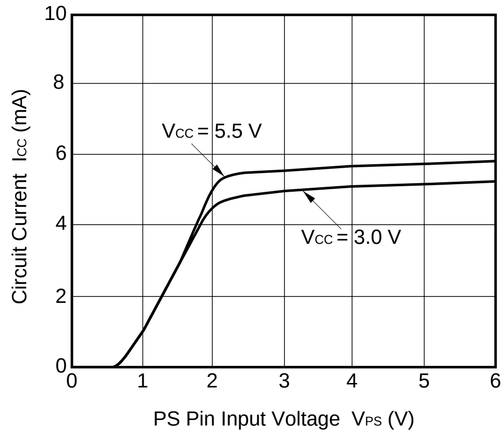


12.2 μPC8109TB

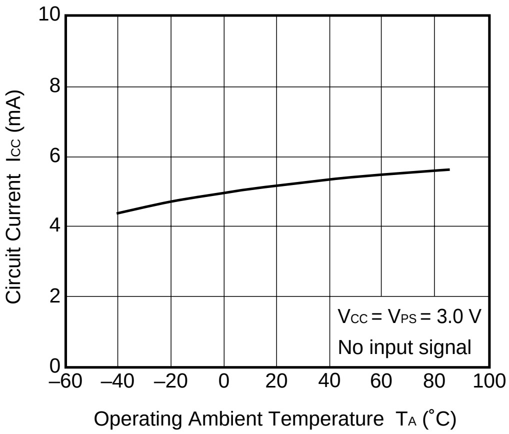
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



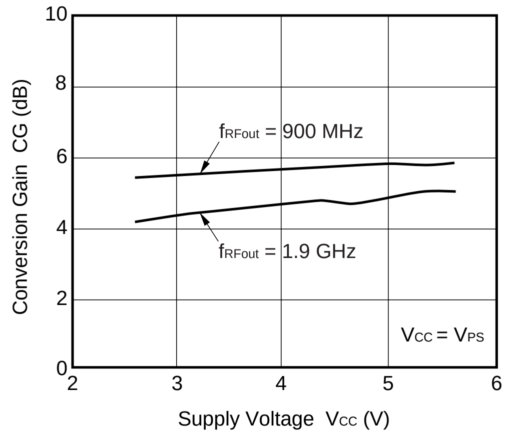
CIRCUIT CURRENT vs. PS PIN INPUT VOLTAGE



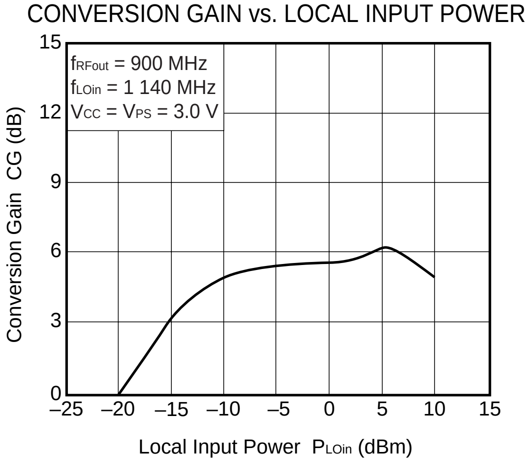
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



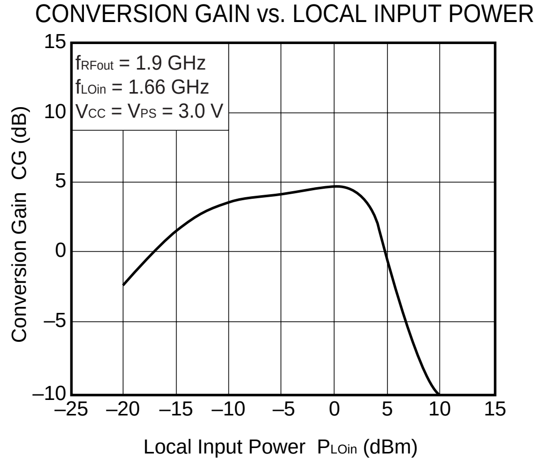
CONVERSION GAIN vs. SUPPLY VOLTAGE

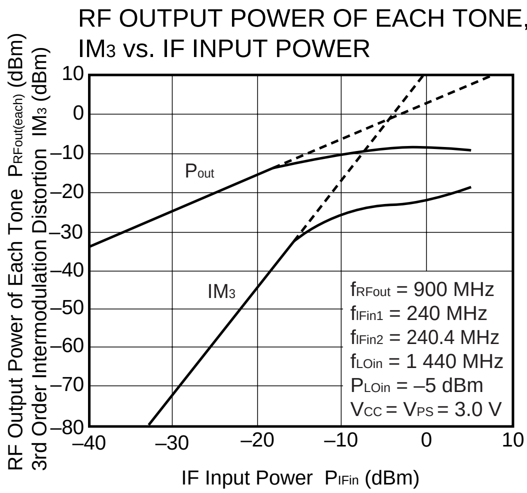


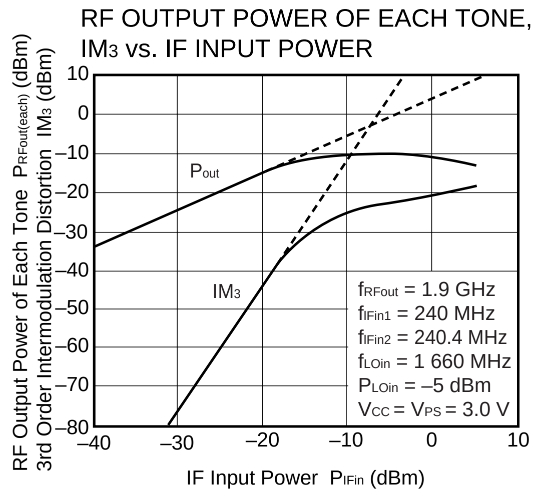
CONVERSION GAIN vs. LOCAL INPUT POWER

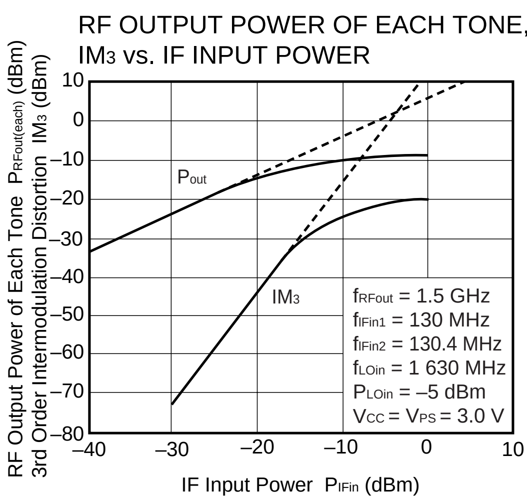


CONVERSION GAIN vs. LOCAL INPUT POWER





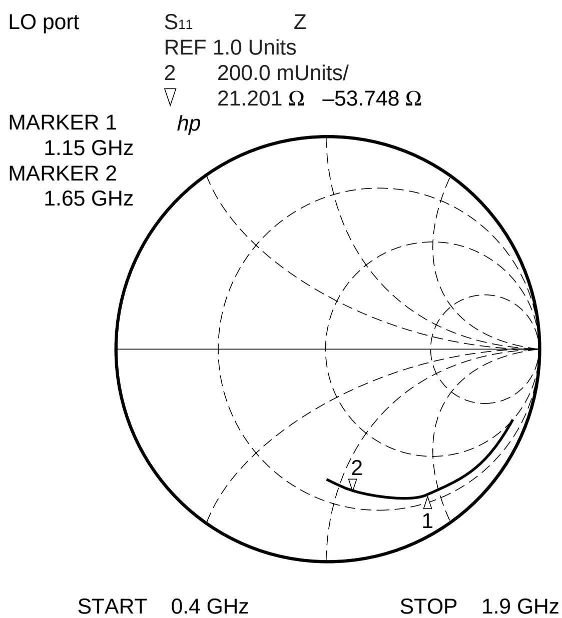


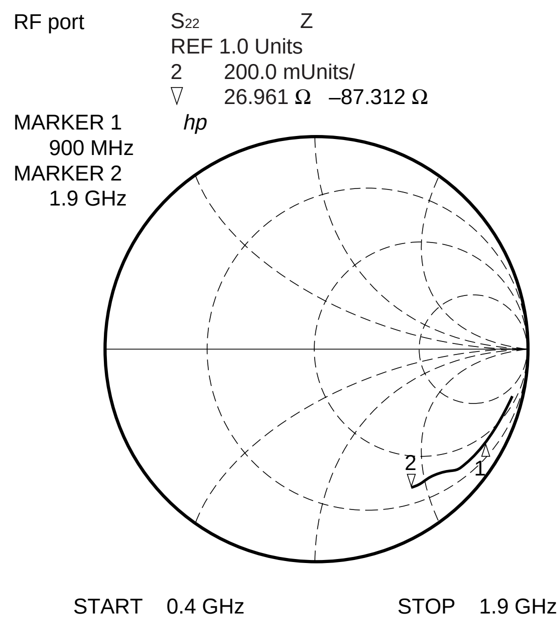


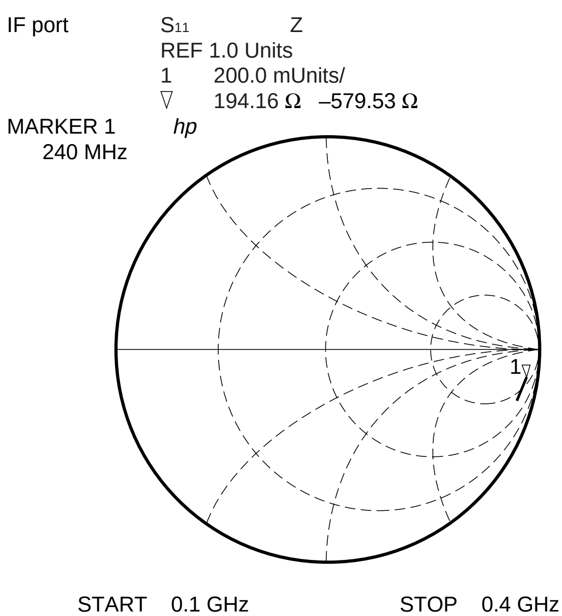
Remark The graphs indicate nominal characteristics.

13. S-PARAMETERS

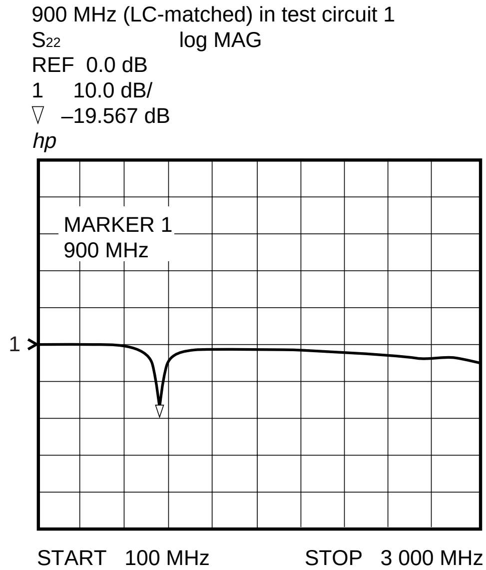
13.1 S-parameters for Each Port ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V) – μPC8106TB, μPC8109TB in common – (the parameters are monitored at DUT pins.)

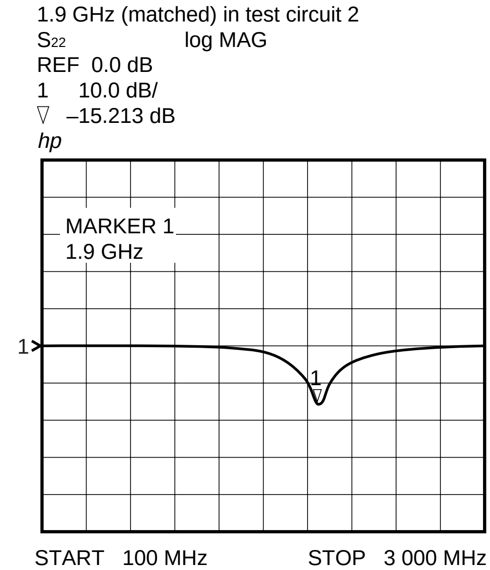


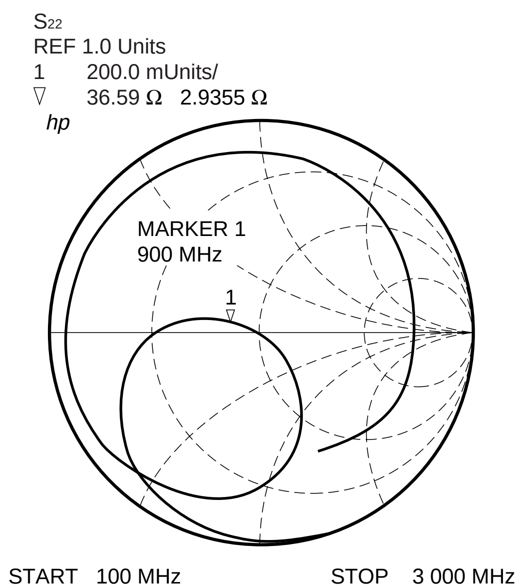


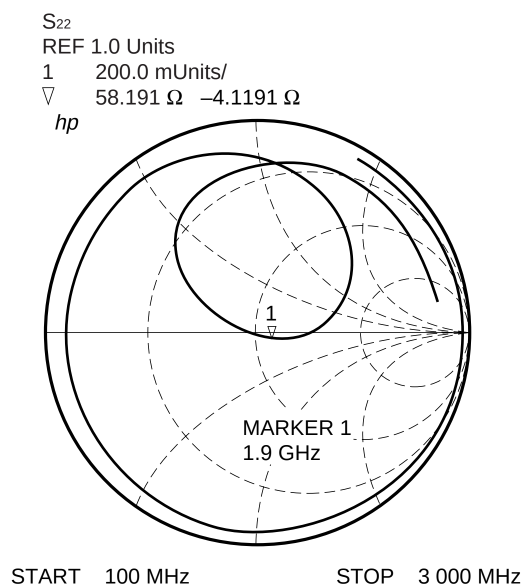


13.2 S-parameters for Matched RF Output ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V) – with test circuits 1 and 2 (μPC8106TB, μPC8109TB in common) – (S_{22} data are monitored at RF connector on board.)



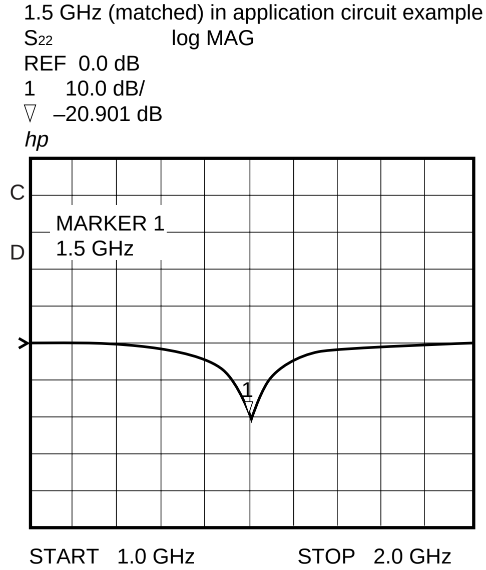


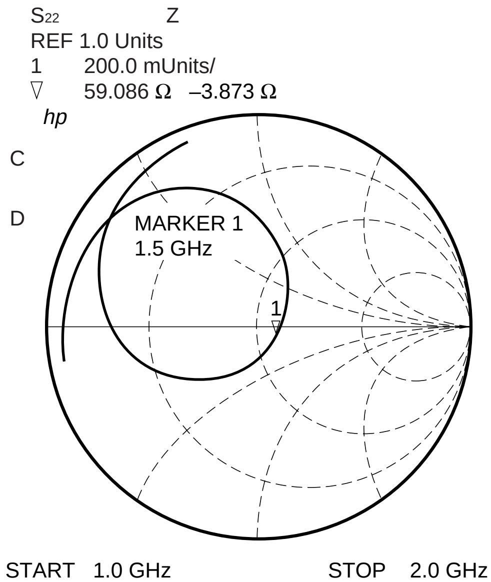




13.3 S-parameters for Matched RF Output ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V) – with application circuit example – (S_{22} data are monitored at RF connector on board.)

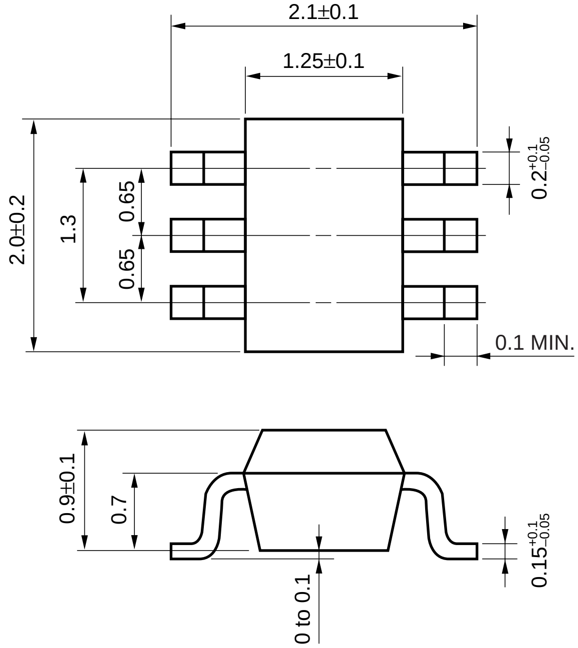
1.5 GHz (matched) in application circuit example





★ ## 14. PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



15. NOTE ON CORRECT USE

(1) Observe precutions for handling because of electrostatic sensitive devices.
(2) Form a ground pattern as widely 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 V_{CC} pin.
(5) Connect a matching circuit to the RF output pin.

16. 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.

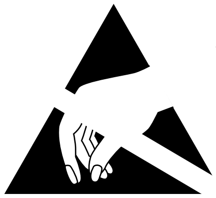
Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235°C or below Time: 30 seconds or less (at 210°C) Count: 3, Exposure limit: None[Note]	IR35-00-3
VPS	Package peak temperature: 215°C or below Time: 40 seconds or less (at 200°C) Count: 3, Exposure 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]



ATTENTION

OBSERVE PRECAUTIONS
FOR HANDLING
ELECTROSTATIC
SENSITIVE
DEVICES

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