

## SILICON MMIC 1st FREQUENCY DOWN-CONVERTER FOR CELLULAR/CORDLESS TELEPHONE

### DESCRIPTION

The μPC8112T is a silicon monolithic integrated circuit designed as 1st frequency down-converter for cellular/cordless telephone receiver stage. This IC consists of mixer and local amplifier. Due to optimized circuit current, the μPC8112T improves RF performance such as intermodulation, leakage and linearity compared with conventional Si MMIC of the μPC2757T and μPC2758T. The μPC8112T features 3 V supply voltage and mini mold package which contribute to make system lower voltage, space decreased and fewer components.

The μPC8112T is manufactured using NEC's 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, this IC has excellent performance, uniformity and reliability.

### FEATURES

- Excellent RF performance : IIP<sub>3</sub> = -7 dBm@f<sub>RFIn</sub> = 1.9 GHz (reference)  
IM<sub>3</sub> = -88 dBm@P<sub>RFIn</sub> = -38 dBm, 1.9 GHz (reference); on test circuit
- Similar conversion gain to μPC2757T and lower noise figure than μPC2758T
- Minimized carrier leakage : RF<sub>IO</sub> = -80 dB@f<sub>RFIn</sub> = 900 MHz (reference)  
RF<sub>IO</sub> = -55 dB@f<sub>RFIn</sub> = 1.9 GHz (reference)
- High linearity : Po<sub>(sat)</sub> = -2.5 dBm TYP.@f<sub>RFIn</sub> = 900 MHz  
Po<sub>(sat)</sub> = -3 dBm TYP.@f<sub>RFIn</sub> = 1.9 GHz
- Low current consumption : I<sub>CC</sub> = 8.5 mA TYP.
- Supply voltage : V<sub>CC</sub> = 2.7 to 3.3 V
- High-density surface mounting : 6-pin minimold package

### APPLICATIONS

- 1.5 GHz to 1.9 GHz cellular/cordless telephone (example: PHS, DECT, PDC1. 5G)
- 800 MHz to 900 MHz cellular telephone (example: PDC 800 M)

### ORDERING INFORMATION

Part Number	Package	Marking	Supplying Form
μPC8112T-E3	6-pin minimold	C2K	<ul style="list-style-type: none"> <li>• Embossed tape 8 mm wide.</li> <li>• Pin 1, 2, 3 face to perforation side of the tape.</li> <li>• QTY 3k/reel.</li> </ul>

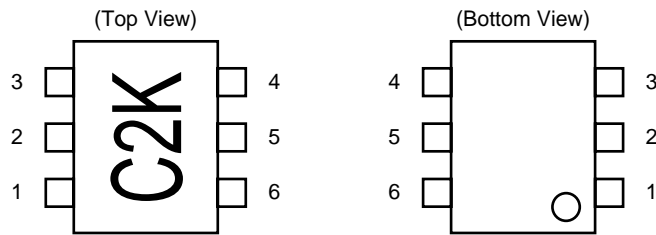
**Remark** To order evaluation samples, please contact your local NEC sales office. (Part number for sample order)

### 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**



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

★ **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)

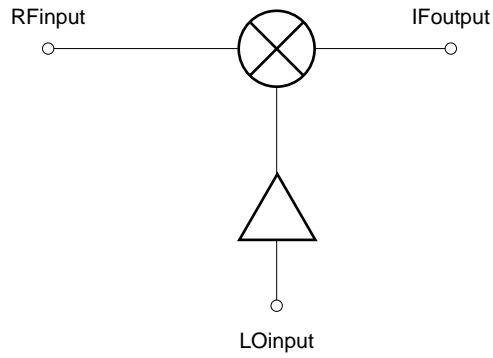
Part No.	Items	No RF I <sub>cc</sub> (mA)	900 MHz SSB NF (dB)	1.5 GHz SSB NF (dB)	1.9 GHz SSB NF (dB)	900 MHz CG (dB)	1.5 GHz CG (dB)	1.9 GHz CG (dB)	900 MHz IIP <sub>3</sub> (dBm)	1.5 GHz IIP <sub>3</sub> (dBm)	1.9 GHz IIP <sub>3</sub> (dBm)
μPC2757T		5.6	10	10	13	15	15	13	-14	-14	-12
μPC2757TB											
μPC2758T		11	9	10	13	19	18	17	-13	-12	-11
μPC2758TB											
μPC8112T		8.5	9	11	11	15	13	13	-10	-9	-7
μPC8112TB											

Part No.	Items	900 MHz P <sub>O(sat)</sub> (dBm)	1.5 GHz P <sub>O(sat)</sub> (dBm)	1.9 GHz P <sub>O(sat)</sub> (dBm)	900 MHz RF <sub>lo</sub> (dB)	1.5 GHz RF <sub>lo</sub> (dB)	1.9 GHz RF <sub>lo</sub> (dB)	IF Output Configuration	Packages
μPC2757T		-3	-	-8	-	-	-	Emitter follower	6-pin minimold
μPC2757TB									6-pin super minimold
μPC2758T	+1	-	-4	-	-	-	6-pin minimold		
μPC2758TB							6-pin super minimold		
μPC8112T		-2.5	-3	-3	-80	-57	-55	Open collector	6-pin minimold
μPC8112TB									6-pin super minimold

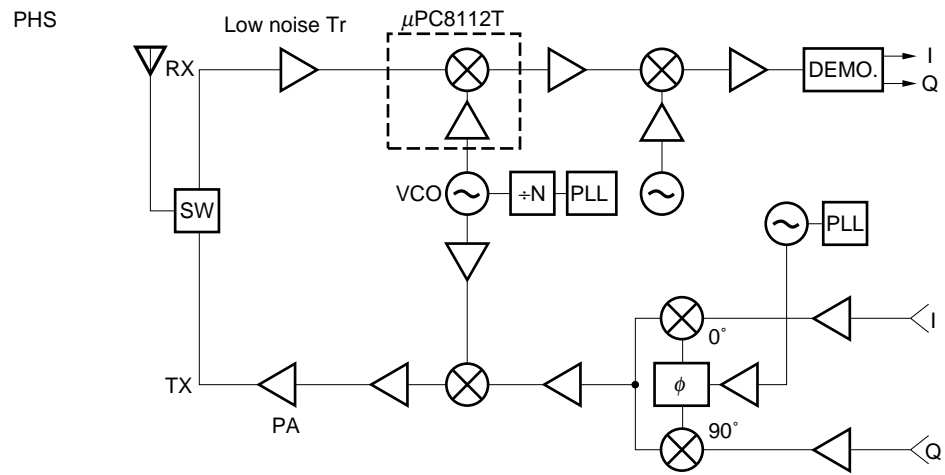
**Remark** Typical performance. Please refer to ELECTRICAL CHARACTERISTICS in detail.

- Cautions**
1. μPC2757T, μPC2758T's IIP<sub>3</sub> are calculated with the same inclination of IM<sub>3</sub> as μPC8112T. μPC8112T IM<sub>3</sub>'s inclination at P<sub>RFin</sub> = -38 dBm is close to 3rd order.(Refer to theoretical equation)
  2. This data sheet is to be specified for μPC8112T only. The other part numbers mentioned in this document should be referred to the data sheet of each part number.

INTERNAL BLOCK DIAGRAM



$\mu$ PC8112T LOCATION EXAMPLE IN THE SYSTEM



PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit									
5	V <sub>CC</sub>	2.7 to 3.3	–	Supply voltage pin. This pin should be connected with bypass capacitor (example: 1 000 pf) to minimize ground impedance.										
6	IFoutput	as same as V <sub>CC</sub> voltage through external inductor	–	IF output pin. This output is configured with open collector of high impedance. This pin should be externally equipped with matching circuit of inductor should be selected as small resistance and high frequency use.										
1	RFinput	–	1.2	RF input pin of mixer. This mixer is designed as double balanced type. This pin should be externally coupled to front stage with DC cut capacitor.										
2	GND	0	–	Ground pin. This pin must be connected to the system ground. Form the ground pattern as wide as possible and the track length as short as possible to minimize ground impedance.										
3	LOinput	–	1.4	Input pin of local amplifier. This amplifier is designed as differential type. This pin should be externally coupled to local signal source with DC cut capacitor. Recommendable input level is –15 to 0 dBm.										
4	PS	V <sub>CC</sub> or GND	–	Power save control pin. This pin can control ON/OFF operation with bias as follows; <table border="1" style="margin: 10px auto;"> <thead> <tr> <th></th> <th>Bias: V</th> <th>Operation</th> </tr> </thead> <tbody> <tr> <td>V<sub>PS</sub></td> <td>≥ 2.5</td> <td>ON</td> </tr> <tr> <td></td> <td>0 - 0.5</td> <td>OFF</td> </tr> </tbody> </table>		Bias: V	Operation	V <sub>PS</sub>	≥ 2.5	ON		0 - 0.5	OFF	
	Bias: V	Operation												
V <sub>PS</sub>	≥ 2.5	ON												
	0 - 0.5	OFF												

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V <sub>CC</sub>	T <sub>A</sub> = +25 °C, 5 pin and 6 pin	3.6	V
Total Circuit Current	I <sub>CC</sub>	T <sub>A</sub> = +25 °C	77.7	mA
Total Power Dissipation	P <sub>D</sub>	Mounted on 50 × 50 × 1.6 mm epoxy glass PWB (T <sub>A</sub> = +85 °C)	280	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Supply Voltage	V <sub>CC</sub>	2.7	3.0	3.3	V	5 pin and 6 pin should be applied to same voltage.
Operating Ambient Temperature	T <sub>A</sub>	-40	+25	+85	°C	
LO Input Level	P <sub>LOin</sub>	-15	-10	0	dBm	Z <sub>s</sub> = 50 Ω
RF Input Frequency	f <sub>RFin</sub>	0.8	1.9	2.0	GHz	
IF Output Frequency	f <sub>IFout</sub>	100	250	300	MHz	With external matching

**ELECTRICAL CHARACTERISTICS (Unless otherwise specified, T<sub>A</sub> = +25 °C, V<sub>CC</sub> = V<sub>PS</sub> = V<sub>IFout</sub> = 3.0 V, P<sub>LOin</sub> = -10 dBm, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)**

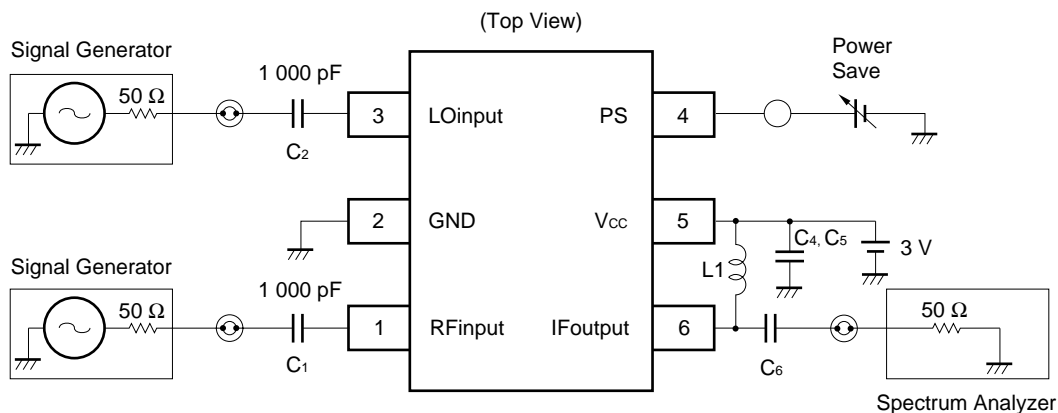
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I <sub>CC</sub>	No signals	4.9	8.5	11.7	mA
Circuit Current at Power Save Mode	I <sub>CC(PS)</sub>	V <sub>CC</sub> = 3.0 V, V <sub>PS</sub> = 0.5 V	-	-	0.1	μA
Conversion Gain	CG	f <sub>RFin</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFin</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	11.5 9.5	15 13	17.5 15.5	dB
Single Side Band Noise Figure	SSB NF	f <sub>RFin</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFin</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	- -	9.0 11.2	11 13.2	dB
Saturated Output Power	P <sub>O(sat)</sub>	f <sub>RFin</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFin</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz (P <sub>RFin</sub> = -10 dBm each)	-6.5 -7	-2.5 -3	- -	dBm

**STANDARD CHARACTERISTICS FOR REFERENCE (T<sub>A</sub> = +25 °C, V<sub>CC</sub> = V<sub>PS</sub> = V<sub>IFout</sub> = 3.0 V,  
P<sub>LOin</sub> = -10 dBm, Z<sub>s</sub> = Z<sub>L</sub> = 50 Ω)**

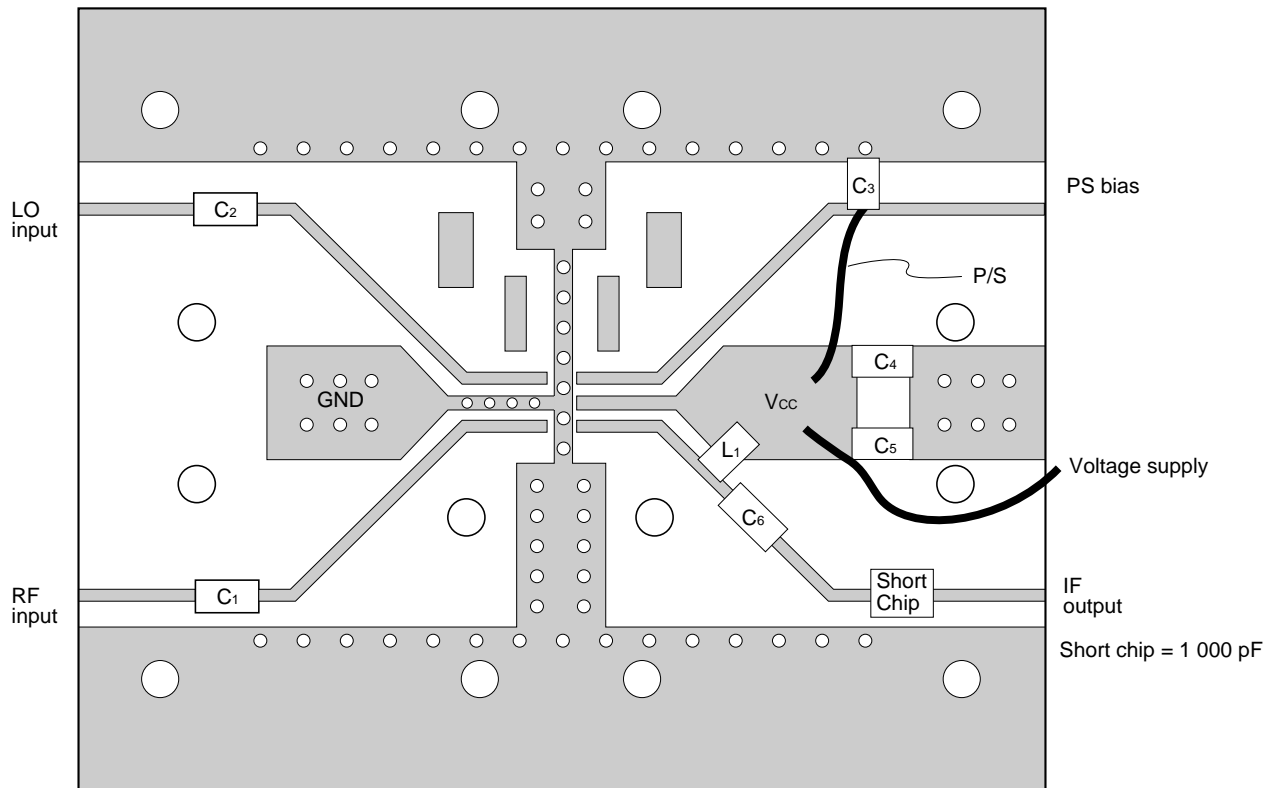
Parameter	Symbol	Test Conditions	Reference	Unit
Conversion Gain	CG	f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz	13	dB
Single Side Band Noise Figure	SSB NF	f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz	11	dB
LO Leakage at RF Pin	LO <sub>rf</sub>	f <sub>RFIn</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz f <sub>RFIn</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	-45 -46 -45	dB
RF Leakage at LO Pin	RF <sub>lo</sub>	f <sub>RFIn</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz f <sub>RFIn</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	-80 -57 -55	dB
LO Leakage at IF Pin	LO <sub>if</sub>	f <sub>RFIn</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz f <sub>RFIn</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	-32 -33 -30	dB
Input 3rd Order Intercept Point <sup>Note</sup>	IIP <sub>3</sub>	f <sub>RFIn</sub> = 900 MHz, f <sub>LOin</sub> = 1 000 MHz f <sub>RFIn</sub> = 1.5 GHz, f <sub>LOin</sub> = 1.6 GHz f <sub>RFIn</sub> = 1.9 GHz, f <sub>LOin</sub> = 1.66 GHz	-10 -9 -7	dBm

**Note** IIP<sub>3</sub> is determined by comparing two method; theoretical calculation and cross point of IM<sub>3</sub> curve.  
 $IIP_3 = (\Delta IM_3 \times P_{in} + CG - IM_3) \div (\Delta IM_3 - 1)$  (dBm) [ $\Delta IM_3$ : IM<sub>3</sub> curve inclination in linear range]  
 μPC8112T's  $\Delta IM_3$  is closer to 3 (theoretical inclination) than μPC2757T and μPC2758T of conventional ICs.

**TEST CIRCUIT**



★ ILLUSTRATION OF TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



Component Number	IF 100 MHz Matching	IF 200 MHz Matching	Remarks
C <sub>1</sub> to C <sub>5</sub>	1 000 pF	1 000 pF	CHIP C
C <sub>6</sub>	5 pF	2 pF	CHIP C
L <sub>1</sub>	330 nH	84 nH	CHIP L

**EVALUATION BOARD CHARACTERS AND NOTE**

- (1) 35 μm thick double-sided copper clad 35 × 42 × 0.4 mm polyimide board
- (2) Back side: GND pattern
- (3) Solder plated patterns
- (4) ○○: Through holes
- (5) To mount C<sub>6</sub>, pattern should be cut.

**Caution** Test circuit or print pattern in this sheet is for testing IC characteristics. They are not an application circuit or recommended system circuit.

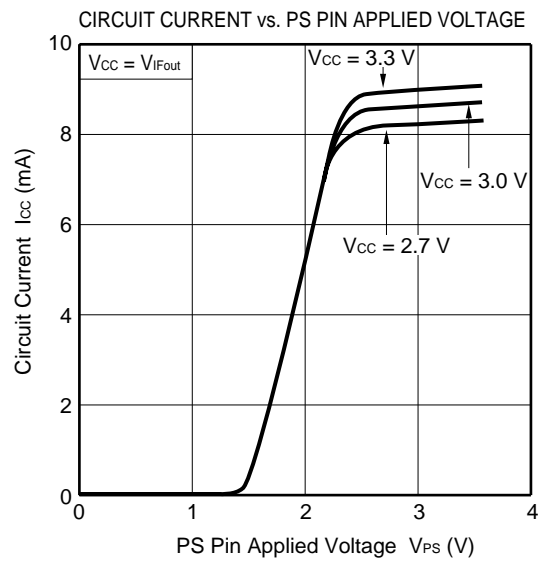
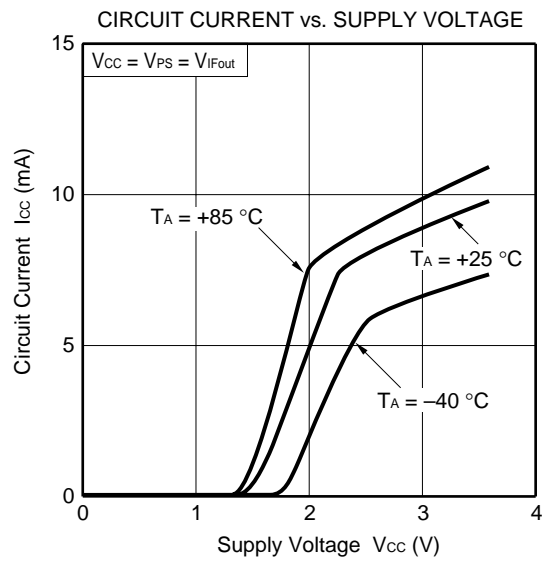
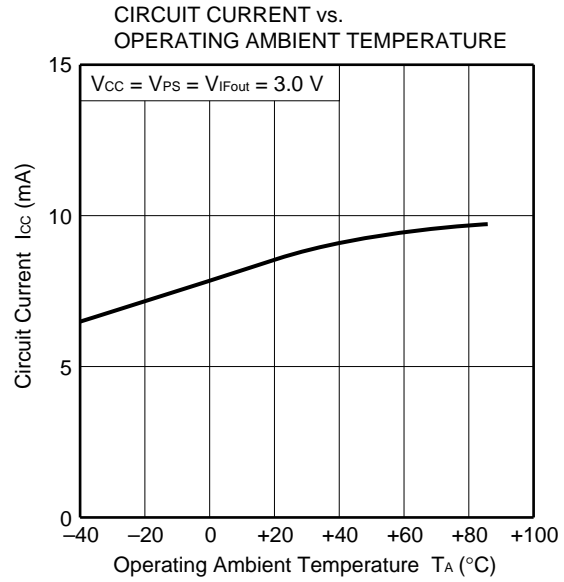
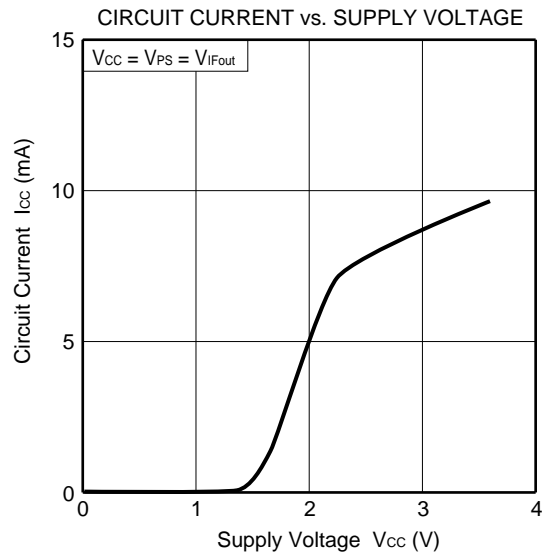
In the case of actual system application, external circuits including print pattern and matching circuit constant of output port should be designed in accordance with IC's S parameters and environmental components.

**Remark** External circuits of the IC can be referred to following application notes.

- To RF and IF port: μPC2757, μPC2758, μPC8112 application note (Document No. P11997E)

TYPICAL CHARACTERISTICS (T<sub>A</sub> = +25 °C, unless otherwise specified, measured on test circuits)

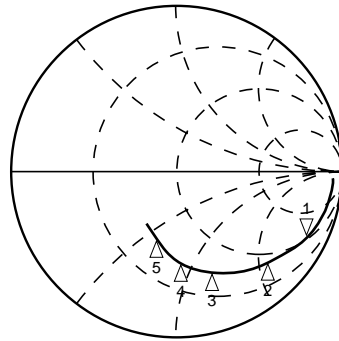
– Without Signals –





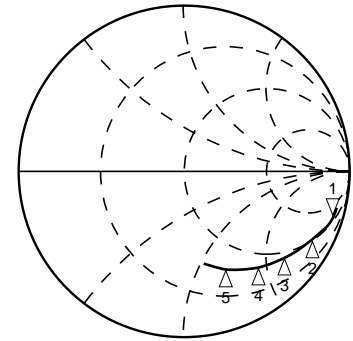
★ – S-PARAMETER –

Calibrated on pin of DUT



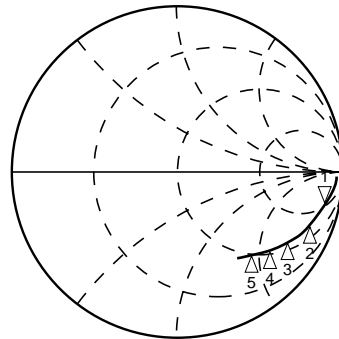
RF port  
 $V_{CC} = V_{PS} = 3.0\text{ V}$   
 START 0.050000000 GHz  
 STOP 3.000000000 GHz

1:	500 MHz	53.961 Ω	-j199.84 Ω
2:	900 MHz	37.164 Ω	-j110.75 Ω
3:	1 500 MHz	30.703 Ω	-j62.504 Ω
4:	1 900 MHz	28.742 Ω	-j45.379 Ω
5:	2 500 MHz	29.257 Ω	-j29.199 Ω



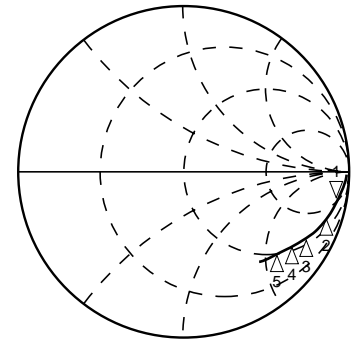
RF port  
 $V_{CC} = 3.0\text{ V}$   $V_{PS} = \text{GND}$   
 START 0.050000000 GHz  
 STOP 3.000000000 GHz

1:	500 MHz	70.25 Ω	-j334.05 Ω
2:	900 MHz	53.289 Ω	-j192.67 Ω
3:	1 500 MHz	41.633 Ω	-j117.89 Ω
4:	1 900 MHz	36.133 Ω	-j92.941 Ω
5:	2 500 MHz	32.621 Ω	-j66.703 Ω



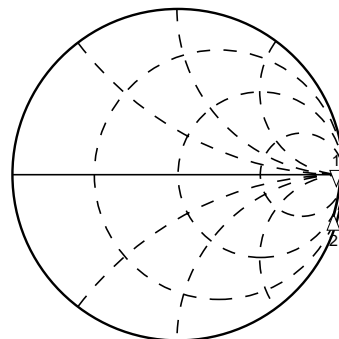
LO port  
 $V_{CC} = V_{PS} = 3.0\text{ V}$   
 START 0.050000000 GHz  
 STOP 3.000000000 GHz

1:	500 MHz	147.34 Ω	-j369.31 Ω
2:	900 MHz	90.164 Ω	-j232.59 Ω
3:	1 500 MHz	61.602 Ω	-j144.84 Ω
4:	1 900 MHz	59.125 Ω	-j116.24 Ω
5:	2 500 MHz	50.164 Ω	-j94.008 Ω



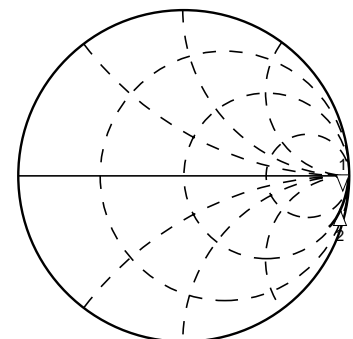
LO port  
 $V_{CC} = 3.0\text{ V}$   $V_{PS} = \text{GND}$   
 START 0.050000000 GHz  
 STOP 3.000000000 GHz

1:	500 MHz	126.91 Ω	-j468.75 Ω
2:	900 MHz	84.906 Ω	-j278.58 Ω
3:	1 500 MHz	58.266 Ω	-j173.01 Ω
4:	1 900 MHz	57.07 Ω	-j140.45 Ω
5:	2 500 MHz	47.453 Ω	-j114.28 Ω



IF port  
 $V_{CC} = V_{PS} = 3.0\text{ V}$   
 START 0.050000000 GHz  
 STOP 0.300000000 GHz

1:	100 MHz	159.75 Ω	-j1.2619 kΩ
2:	240 MHz	73.719 Ω	-j555.75 Ω



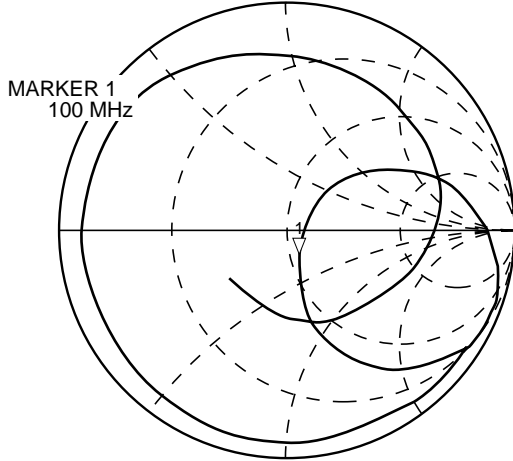
IF port  
 $V_{CC} = 3.0\text{ V}$   $V_{PS} = \text{GND}$   
 START 0.050000000 GHz  
 STOP 0.300000000 GHz

1:	100 MHz	81.25 Ω	-j1.3157 kΩ
2:	240 MHz	73.813 Ω	-j584.53 Ω

**S-PARAMETERS OF IF OUTPUT MATCHING ( $V_{CC} = V_{PS} = V_{IFout} = 3.0\text{ V}$ ) – ON TEST CIRCUIT –**  
 (This  $S_{22}$  is monitored at IF connector on test circuit fixture.)

**IF 100 MHz MATCHING**

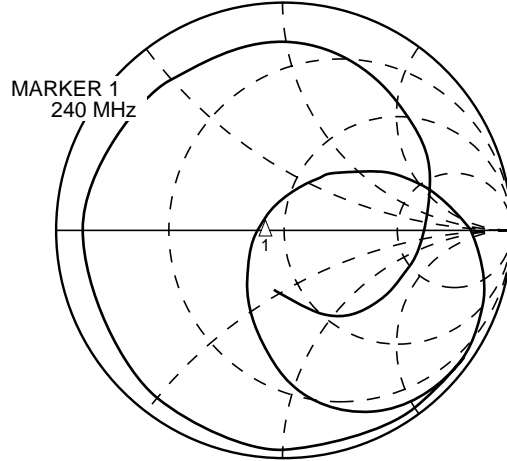
$S_{22}$  1 U FS 1; 54.432  $\Omega$  – 12.02  $\Omega$  129.58 pF  
 $\overline{hp}$  100.000 MHz



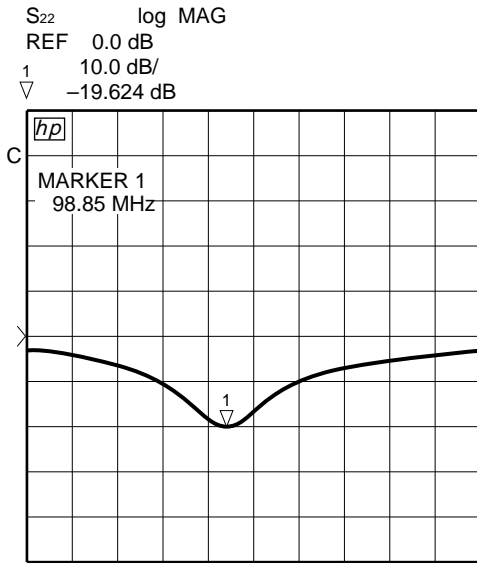
START 10.000000 MHz STOP 3000.000000 MHz

**IF 240 MHz MATCHING**

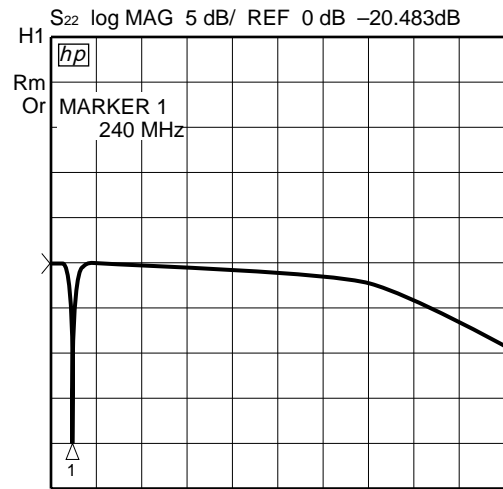
$S_{22}$  1U FS 1; 43.74  $\Omega$  5.4316  $\Omega$  3.6186 nH  
 $\overline{hp}$  240 MHz



START 100.000000 MHz STOP 3100.000000 MHz



START 0.090000000 GHz  
 STOP 0.110000000 GHz

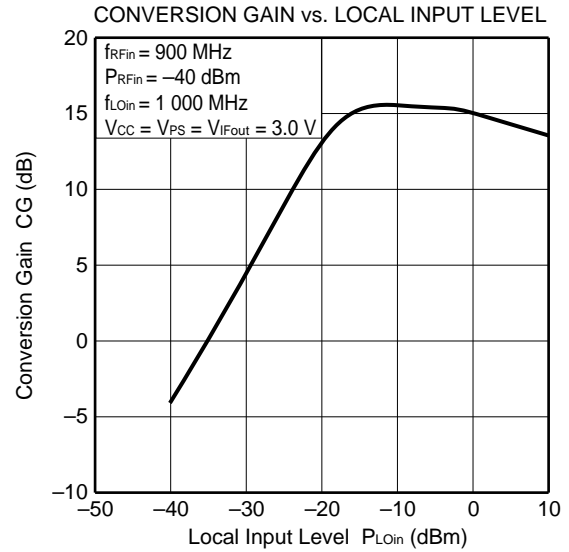
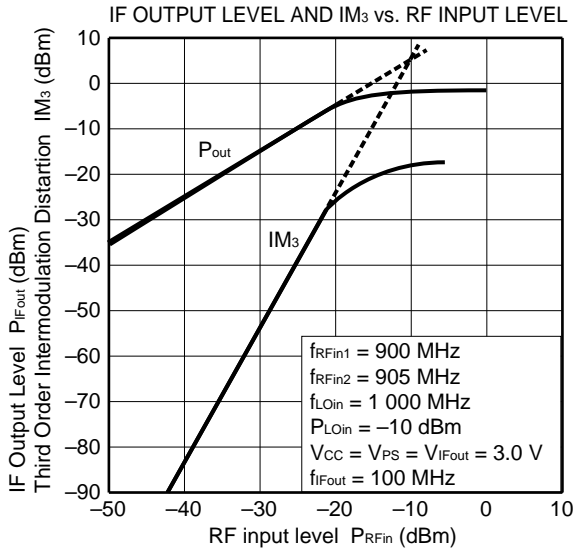
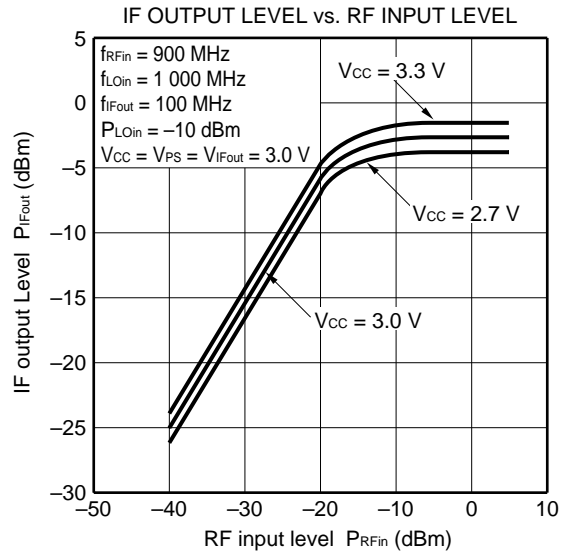
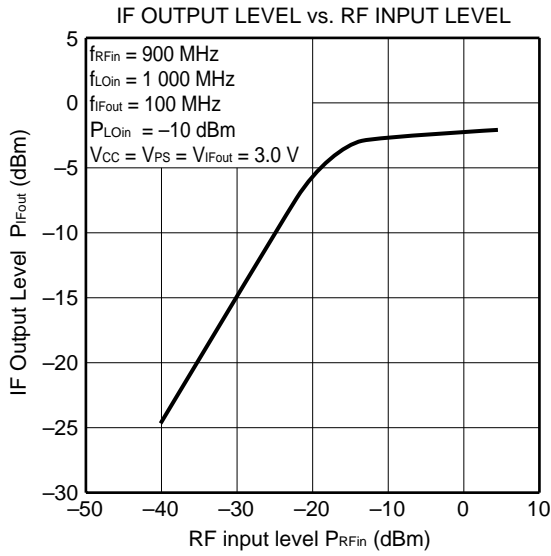


START 100.000000 MHz STOP 3100.000000 MHz

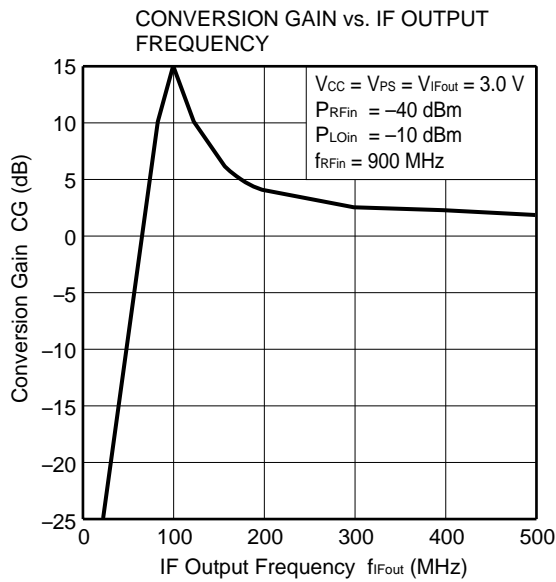
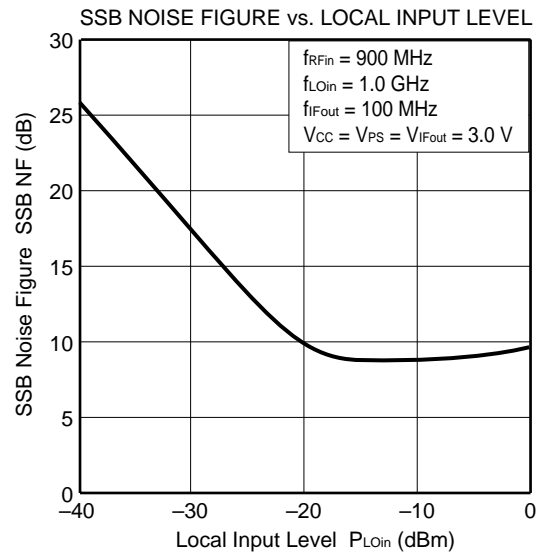
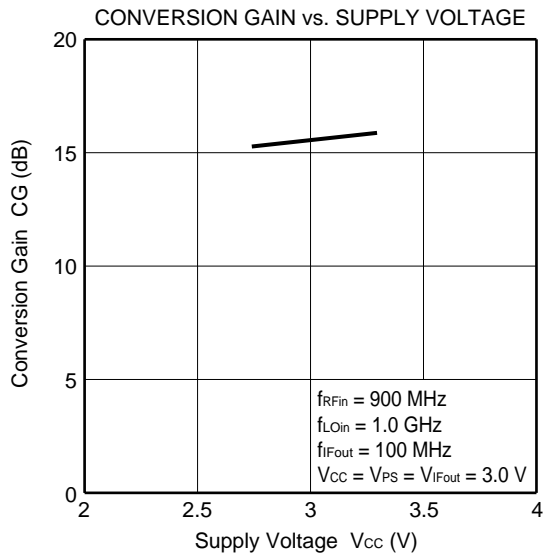
The data in this page are to make clear the test condition of impedance matched to next stage, not specify the recommended condition. The  $S_{22}$  smith charts of the test fixture setting IC are normalized to  $Z_0 = 50\ \Omega$ , because the IC's load is the measurement equipment of  $50\ \Omega$  impedance.

In your use, the output return loss value can be helpful information to adjust your circuit matching to next stage.

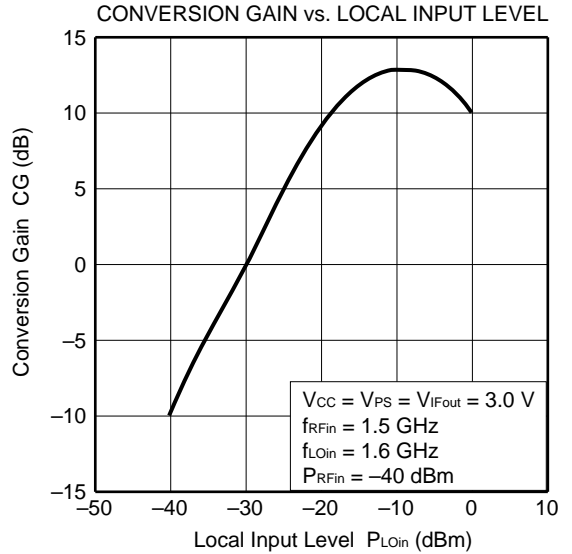
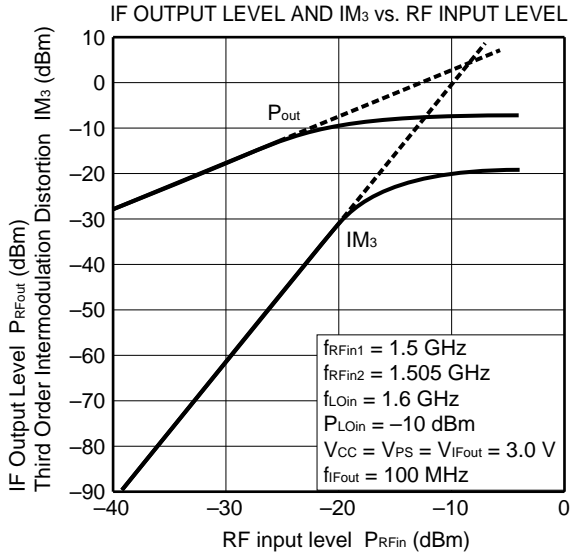
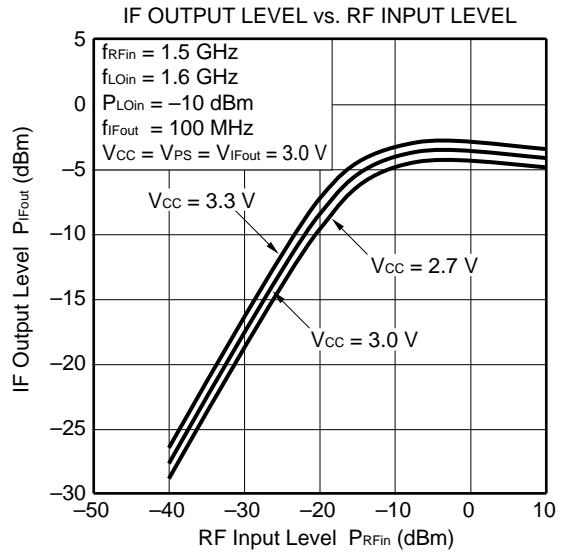
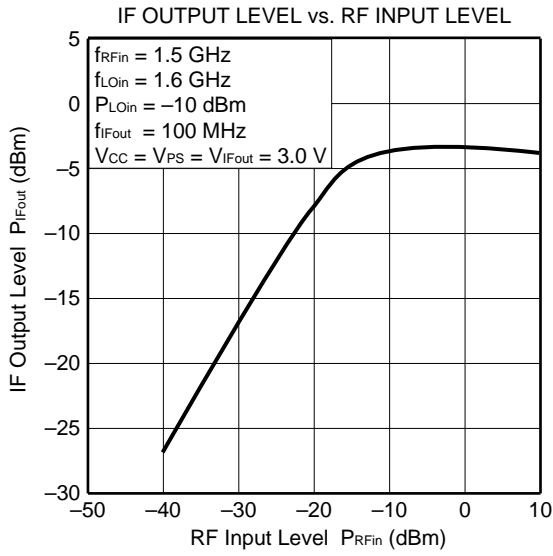
– IF 100 MHz MATCHING –



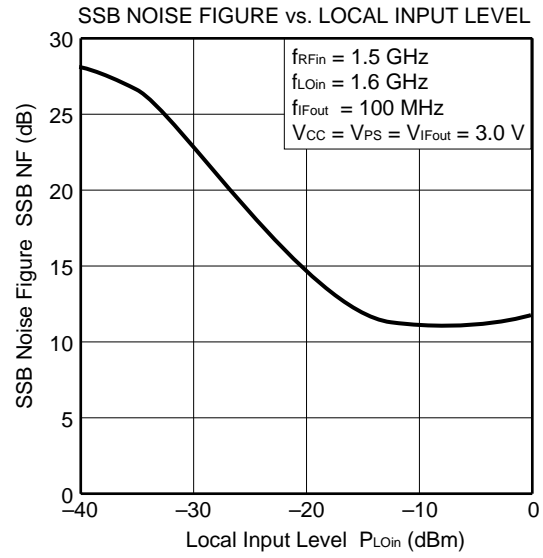
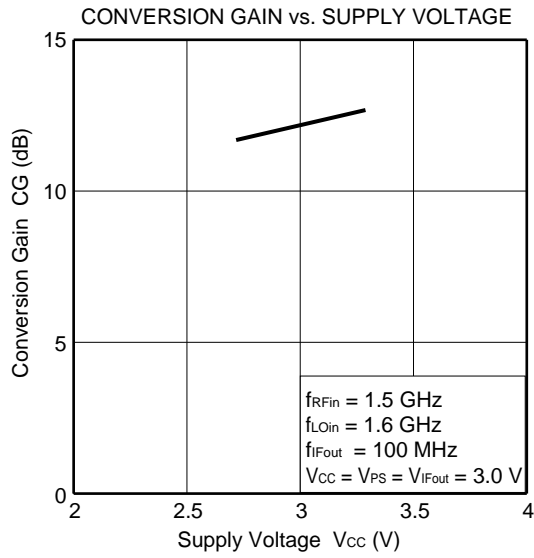
– IF 100 MHz MATCHING –



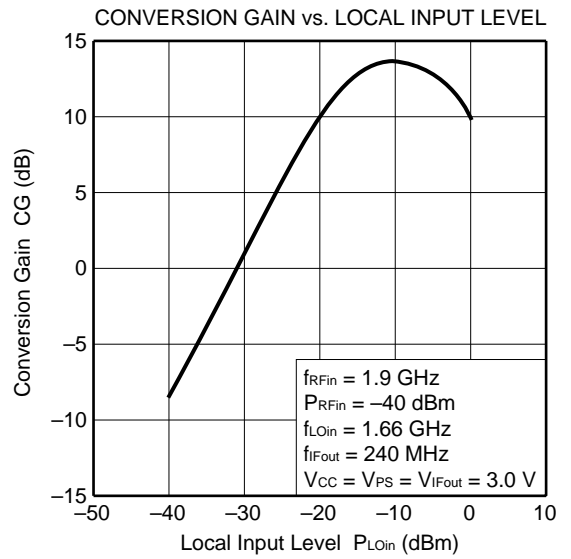
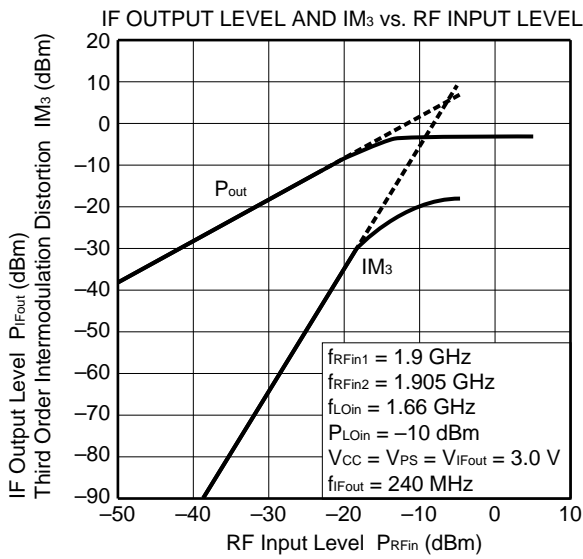
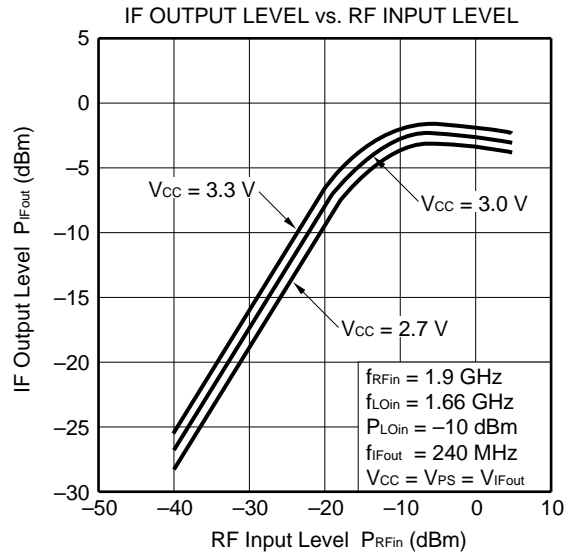
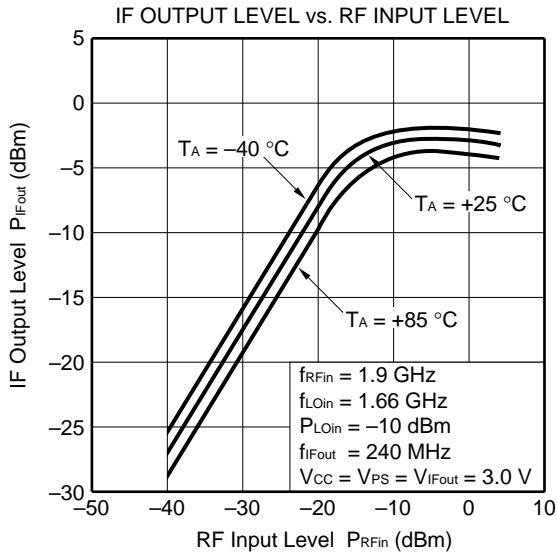
– IF 100 MHz MATCHING –



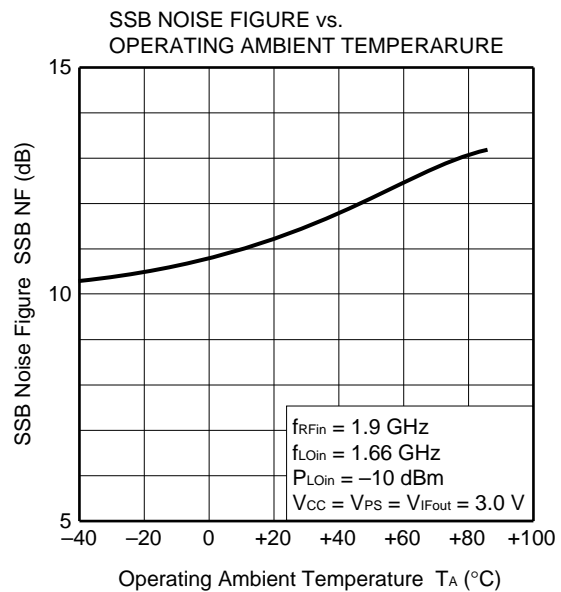
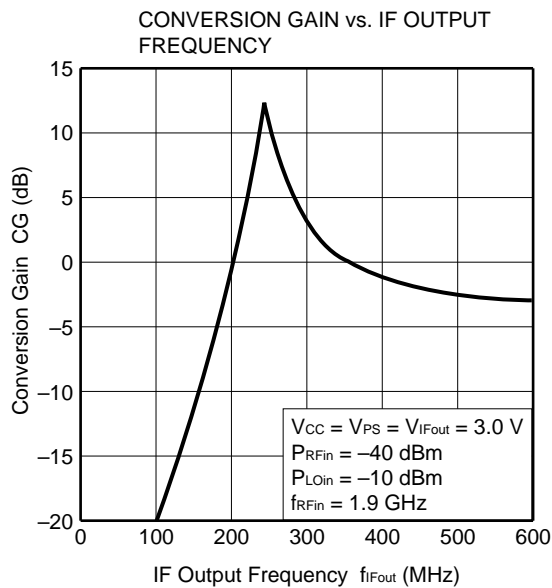
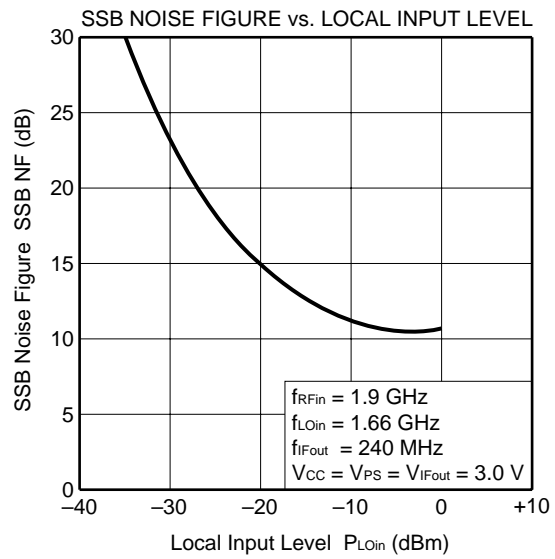
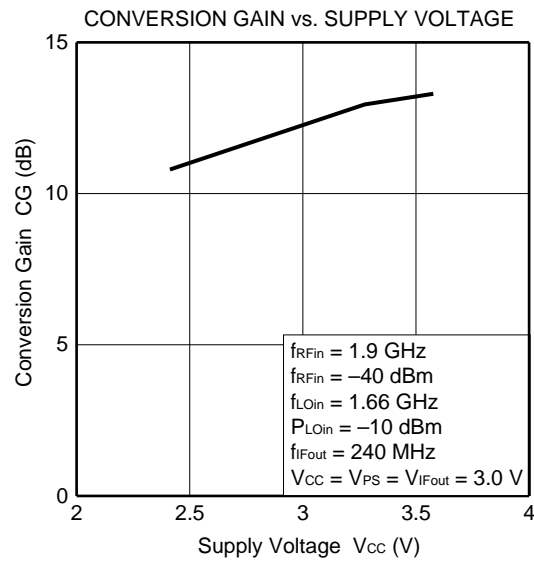
– IF 100 MHz MATCHING –



– IF 240 MHz MATCHING –



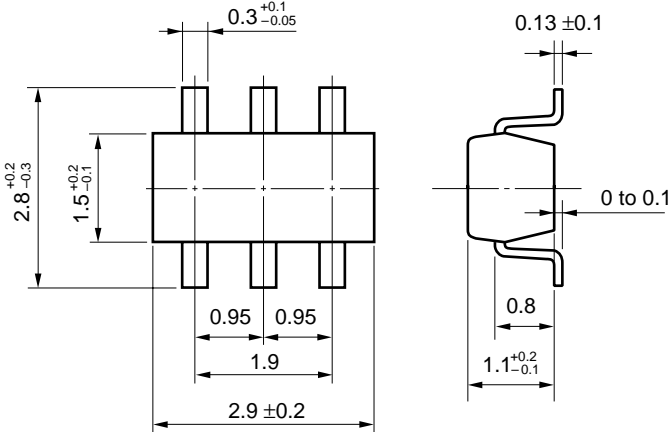
– IF 240 MHz MATCHING –





PACKAGE DIMENSIONS

6 PIN MINIMOLD (Unit: mm)



**NOTE ON CORRECT USE**

- (1) Observe precautions for handling because of electro-static sensitive devices.
- (2) Form a ground pattern as wide as possible to minimize ground impedance (to prevent undesired oscillation).
- (3) Keep the track length of the ground pins as short as possible.
- (4) The bypass capacitor (example: 1 000 pF) should be attached to the V<sub>cc</sub> pin.
- (5) The matching circuit should be externally attached to the IF output pin.
- (6) The DC cut capacitor must be each attached to the input and output pins.

**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.

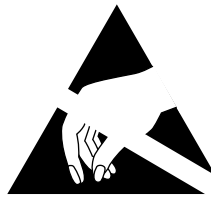
Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235 °C or below Time: 30 seconds or less (at 210 °C) Count: 3, Exposure limit: None <sup>Note</sup>	IR35-00-3
VPS	Package peak temperature: 215 °C or below Time: 40 seconds or less (at 200 °C)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



## ATTENTION

OBSERVE PRECAUTIONS  
FOR HANDLING  
ELECTROSTATIC  
SENSITIVE  
DEVICES

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    - 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.
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