

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC8112TB

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

#### DESCRIPTION

The  $\mu$ PC8112TB 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. The  $\mu$ PC8112TB features high impedance output of open collector. Similar ICs of the  $\mu$ PC2757TB and  $\mu$ PC2758TB feature low impedance output of emitter follower. These TB suffix ICs which are smaller package than conventional T suffix ICs contribute to reduce your system size.

The  $\mu$ PC8112TB is manufactured using NEC's 20 GHz  $f_T$  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)
- Similar conversion gain to  $\mu$ PC2757 and lower noise figure than  $\mu$ PC2758
- Minimized carrier leakage : RF<sub>LO</sub> = -80 dB@f<sub>RFIn</sub> = 900 MHz (reference)  
RF<sub>LO</sub> = -55 dB@f<sub>RFIn</sub> = 1.9 GHz (reference)
- High linearity : P<sub>O(sat)</sub> = -2.5 dBm TYP.@f<sub>RFIn</sub> = 900 MHz  
P<sub>O(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 super minimold package

#### APPLICATIONS

- 1.5 to 1.9 GHz cellular/cordless telephone (PHS, DECT, PDC1.5G and so on)
- 800 to 900 MHz cellular telephone (PDC800M and so on)

#### ORDER INFORMATION

Part Number	Package	Markings	Supplying Form
$\mu$ PC8112TB-E3	6-pin super minimold	C2K	Embossed tape 8 mm wide. Pin 1, 2, 3 face the tape perforation side. Qty 3kpcs/reel.

**Remark** To order evaluation samples, please contact your local NEC sales office (Part number for sample order:  $\mu$ PC8112TB).

#### 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.

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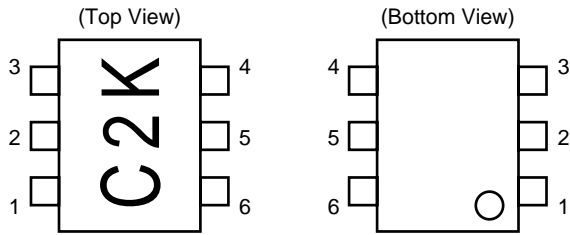
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1. PIN CONNECTIONS



Pin No.	Pin Name
1	RFinput
2	GND
3	LOinput
4	PS
5	Vcc
6	IFoutput

2. PRODUCT LINE-UP (TA = +25°C, VCC = VPS = 3.0 V, Zs = ZL = 50 Ω)

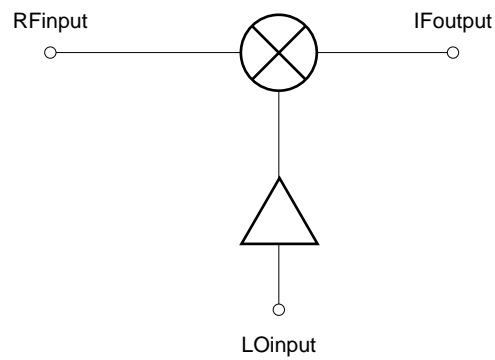
Part Number	Items	No RF Icc (mA)	900 MHz SSB · NF (dB)	1.5 GHz SSB · NF (dB)	1.9 GHz SSB · NF (dB)	900 MHz CG (dB)	1.5 GHz CG (dB)	1.9 GHz CG (dB)	900 MHz IIP <sub>3</sub> (dBm)	1.5 GHz IIP <sub>3</sub> (dBm)	1.9 GHz IIP <sub>3</sub> (dBm)
μPC2757T		5.6	10	10	13	15	15	13	-14	-14	-12
μPC2757TB											
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 Number	Items	900 MHz PO(sat) (dBm)	1.5 GHz PO(sat) (dBm)	1.9 GHz PO(sat) (dBm)	900 MHz RFLo (dB)	1.5 GHz RFLo (dB)	1.9 GHz RFLo (dB)	IF Output Configuration	Package
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.

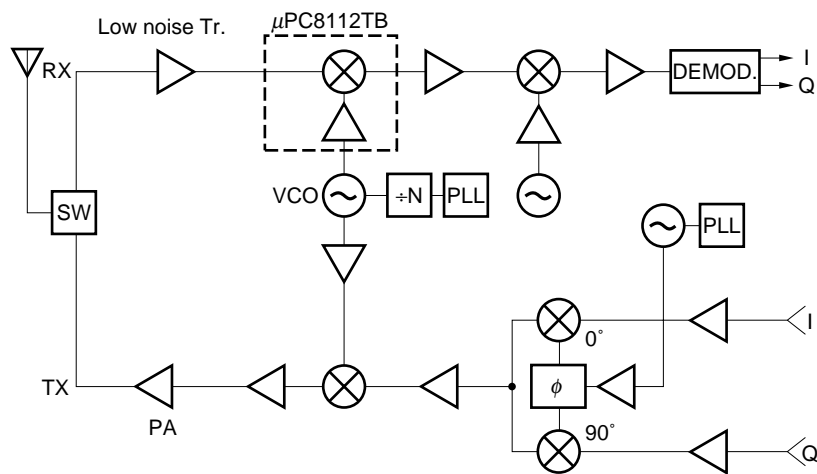
- Cautions**
- The μPC2757 and μPC2758's IIP<sub>3</sub> are calculated with ΔIM<sub>3</sub> = 3 which is the same IM<sub>3</sub> inclination as μPC8112. On the other hand, OIP<sub>3</sub> of Standard characteristics in page 7 is cross point IP.
  - This document is to be specified for μPC8112TB. The other part number mentioned in this document should be referred to the data sheet of each part number.

3. INTERNAL BLOCK DIAGRAM



4. SYSTEM APPLICATION EXAMPLE

Digital cordless phone



5. PIN EXPLANATION

Pin No.	Pin Name	Applied Voltage (V)	Pin Voltage (V)	Function and Application	Internal Equivalent Circuit									
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	GND	–	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.										
5	Vcc	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 Vcc 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.										
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	Vcc 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 to 0.5</td> <td>OFF</td> </tr> </tbody> </table>		Bias: V	Operation	V <sub>PS</sub>	≥ 2.5	ON		0 to 0.5	OFF	
	Bias: V	Operation												
V <sub>PS</sub>	≥ 2.5	ON												
	0 to 0.5	OFF												

**6. 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 double sided copper clad 50 × 50 × 1.6 mm epoxy glass PWB (T <sub>A</sub> = +85°C)	270	mW
Operating Ambient Temperature	T <sub>A</sub>		-40 to +85	°C
Storage Temperature	T <sub>stg</sub>		-55 to +150	°C

**7. RECOMMENDED OPERATING RANGE**

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remarks
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 Power	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

**8. 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 input signal	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
SSB 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

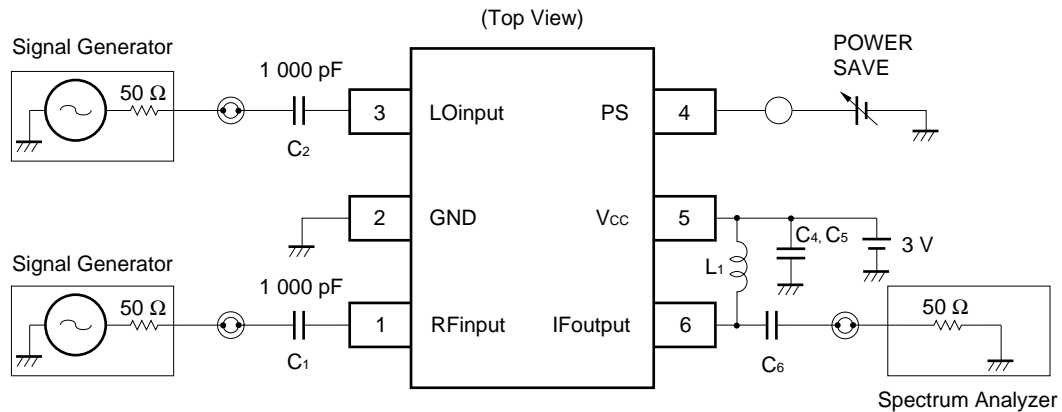
9. STANDARD CHARACTERISTICS FOR REFERENCE

( $T_A = +25^{\circ}\text{C}$ ,  $V_{CC} = V_{PS} = V_{IFout} = 3.0\text{ V}$ ,  $P_{LOin} = -10\text{ dBm}$ ,  $Z_s = Z_L = 50\ \Omega$ )

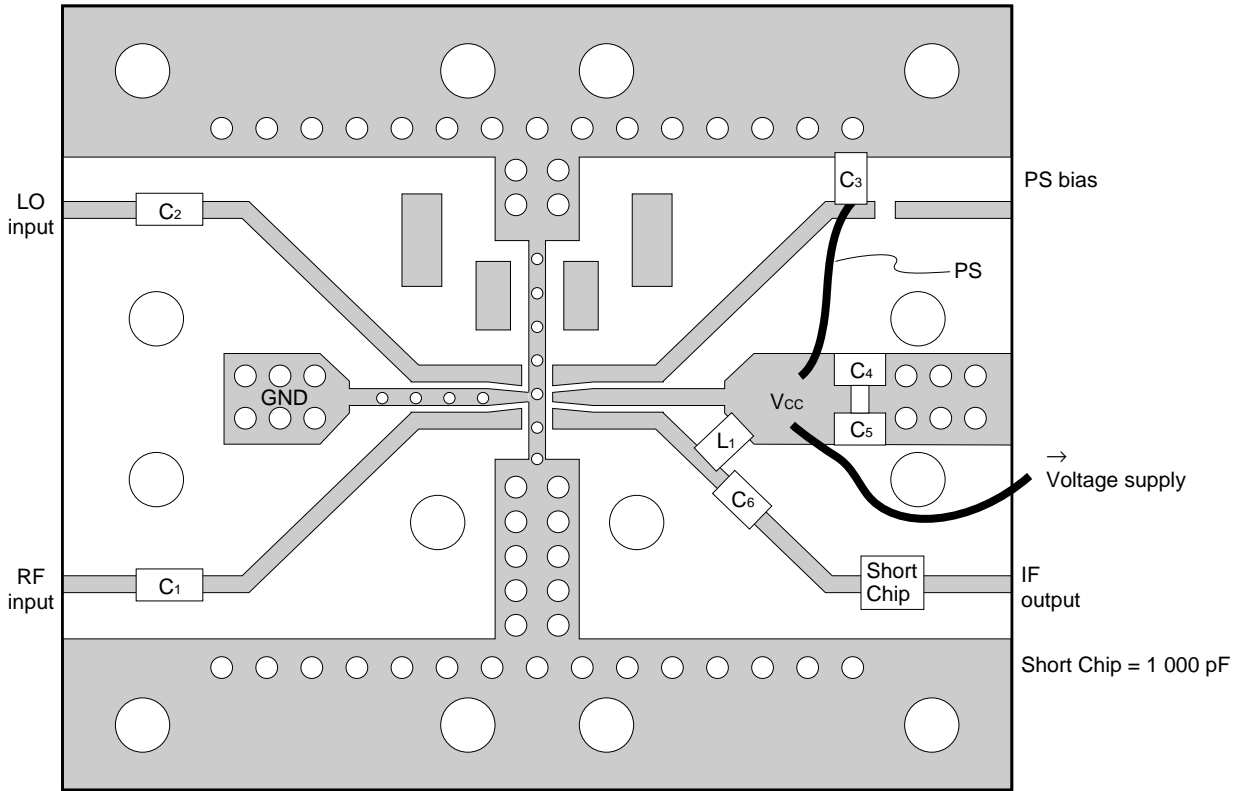
Parameter	Symbol	Test Conditions	Reference	Unit
Conversion Gain	CG	$f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$	13	dB
SSB Noise Figure	SSB·NF	$f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$	11	dB
LO Leakage at RF pin	LO <sub>RF</sub>	$f_{RFin} = 900\text{ MHz}$ , $f_{LOin} = 1\ 000\text{ MHz}$ $f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$ $f_{RFin} = 1.9\text{ GHz}$ , $f_{LOin} = 1.66\text{ GHz}$	-45 -46 -45	dB
RF Leakage at LO pin	RF <sub>LO</sub>	$f_{RFin} = 900\text{ MHz}$ , $f_{LOin} = 1\ 000\text{ MHz}$ $f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$ $f_{RFin} = 1.9\text{ GHz}$ , $f_{LOin} = 1.66\text{ GHz}$	-80 -57 -55	dB
LO Leakage at IF pin	LO <sub>if</sub>	$f_{RFin} = 900\text{ MHz}$ , $f_{LOin} = 1\ 000\text{ MHz}$ $f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$ $f_{RFin} = 1.9\text{ GHz}$ , $f_{LOin} = 1.66\text{ GHz}$	-32 -33 -30	dB
3rd Order Distortion Input Intercept Point <sup>Note</sup>	IIP <sub>3</sub>	$f_{RFin} = 900\text{ MHz}$ , $f_{LOin} = 1\ 000\text{ MHz}$ $f_{RFin} = 1.5\text{ GHz}$ , $f_{LOin} = 1.6\text{ GHz}$ $f_{RFin} = 1.9\text{ GHz}$ , $f_{LOin} = 1.66\text{ GHz}$	-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]  
 μPC8112's  $\Delta IM_3$  is closer to 3 (theoretical inclination) than μPC2757 and μPC2758 of conventional ICs.

10. TEST CIRCUIT



★ 11. ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD



Component Number	IF 100 MHz Matching	IF 240 MHz Matching	Remarks
C1 to C5	1 000 pF	1 000 pF	CHIP C
C6	5 pF	2 pF	CHIP C
L1	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 C6, 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.

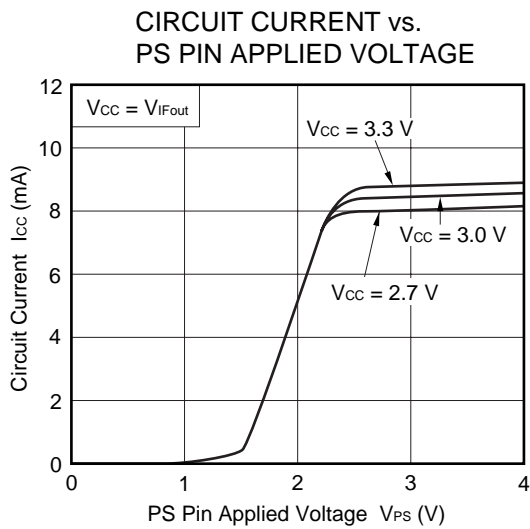
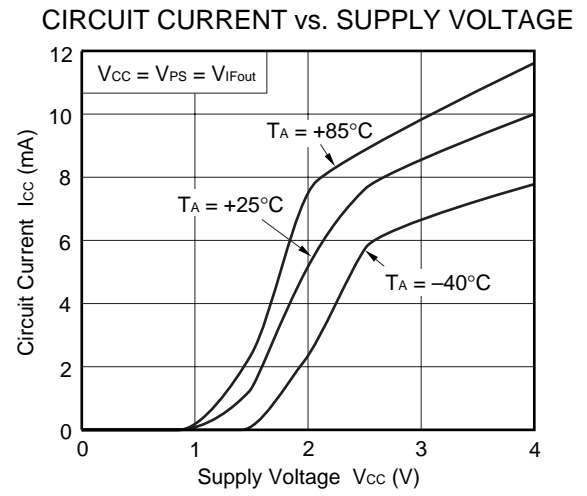
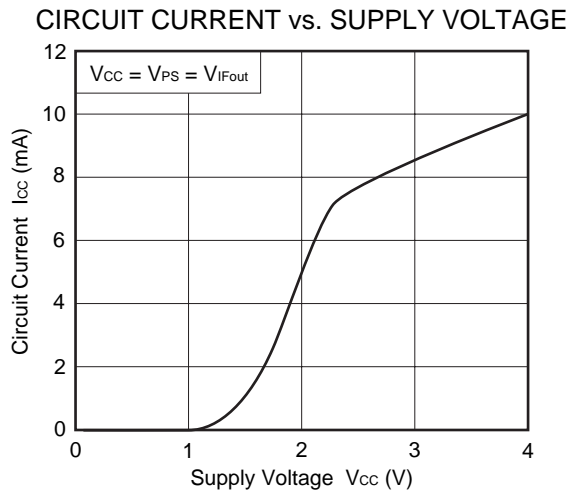
**Remark** External circuits of the IC can be referred to following application notes.

- USAGE AND APPLICATION CHARACTERISTICS OF μPC2757, μPC2758, AND μPC8112, 3-V POWER SUPPLY, 1.9-GHz FREQUENCY DOWN-CONVERTER ICS FOR MOBILE COMMUNICATION (Document No. P11997E)



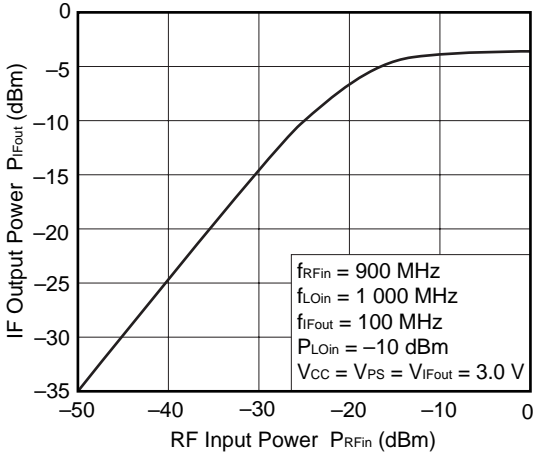
**12. TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified, measured on test circuits)**

**12.1 Without Signals**

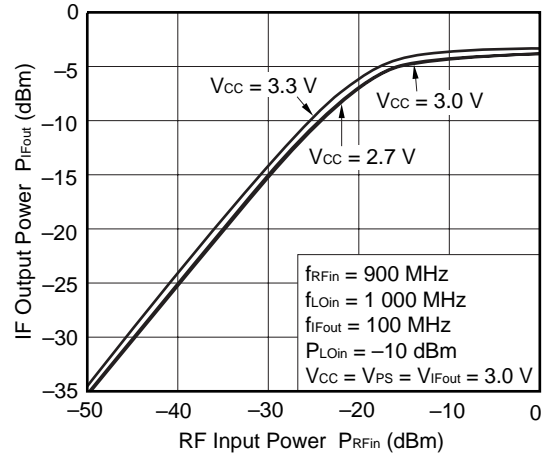


12.2 IF 100 MHz Matching ( $f_{RFin} = 900$  MHz)

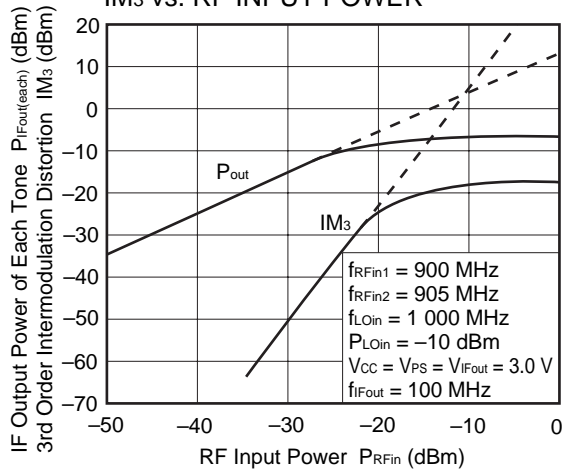
IF OUTPUT POWER vs. RF INPUT POWER



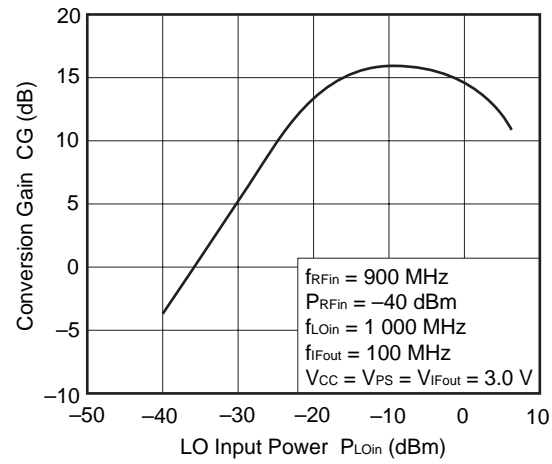
IF OUTPUT POWER vs. RF INPUT POWER



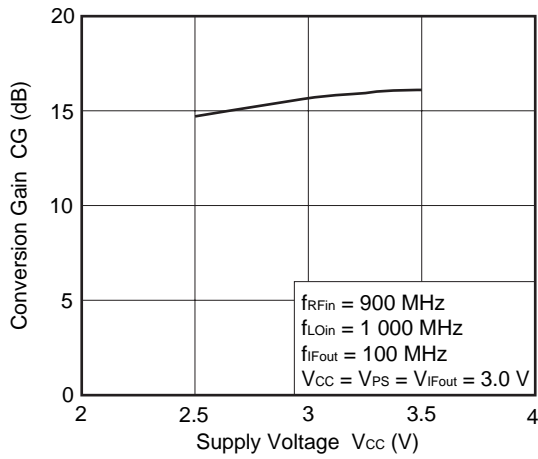
IF OUTPUT POWER OF EACH TONE,  $IM_3$  vs. RF INPUT POWER



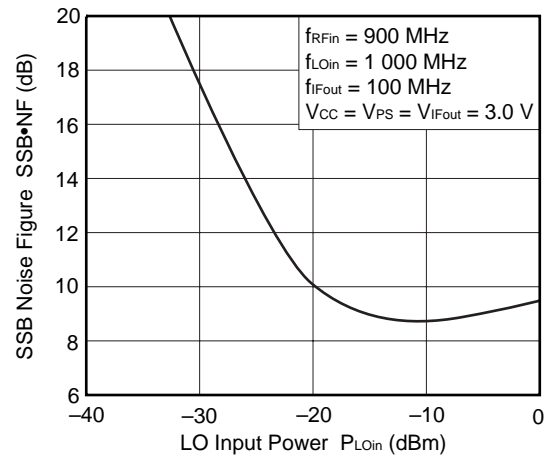
CONVERSION GAIN vs. LO INPUT POWER



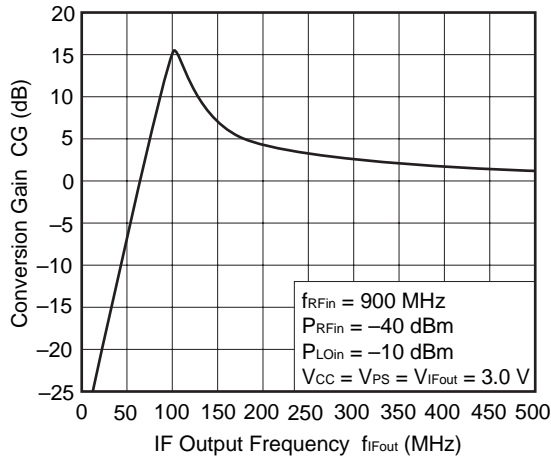
CONVERSION GAIN vs. SUPPLY VOLTAGE



SSB NOISE FIGURE vs. LO INPUT POWER

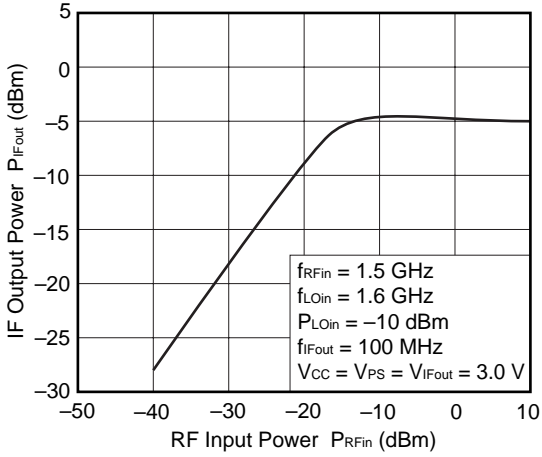


CONVERSION GAIN vs. IF OUTPUT FREQUENCY

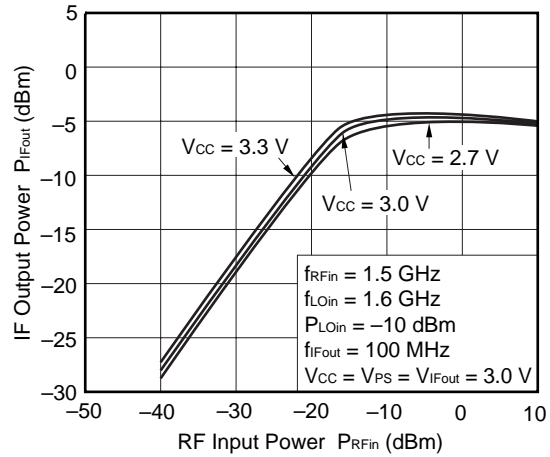


12.3 IF 100 MHz Matching ( $f_{RFin} = 1.5$  GHz)

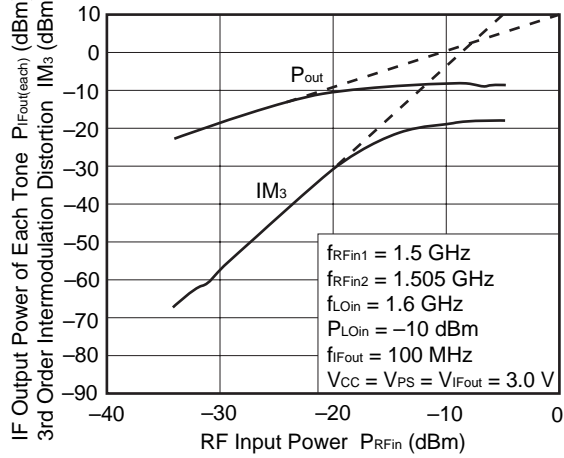
IF OUTPUT POWER vs. RF INPUT POWER



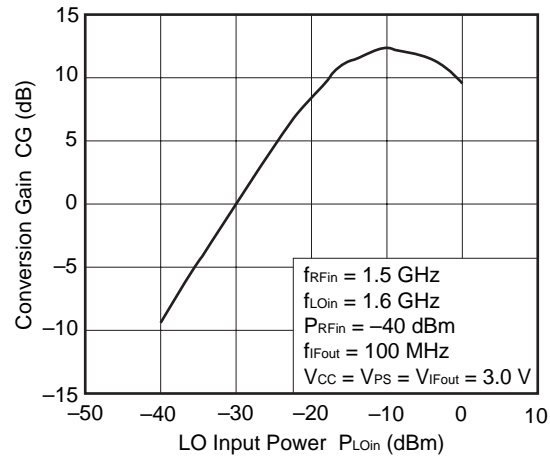
IF OUTPUT POWER vs. RF INPUT POWER

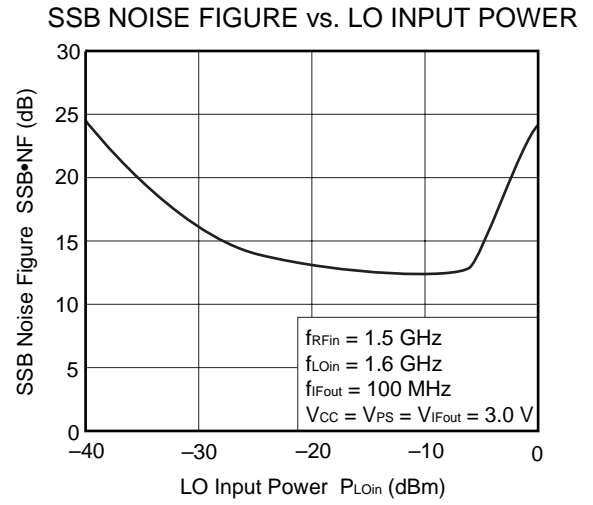
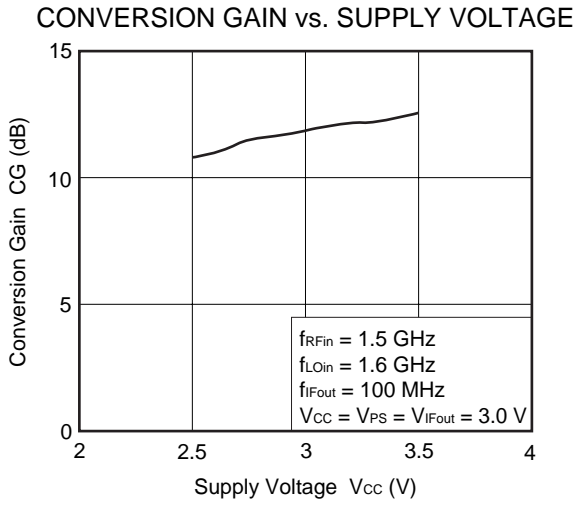


IF OUTPUT POWER OF EACH TONE,  $IM_3$  vs. RF OUTPUT POWER

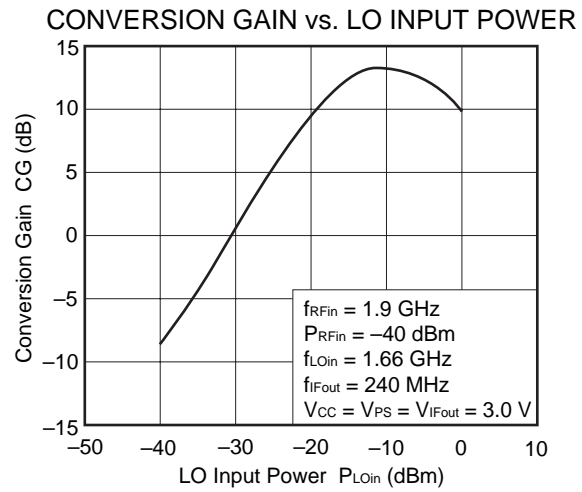
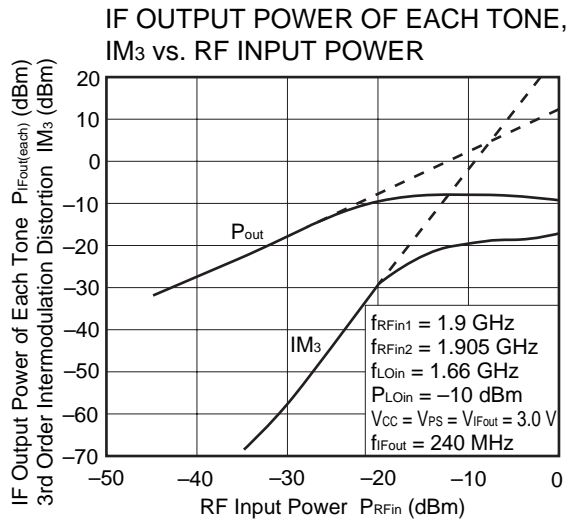
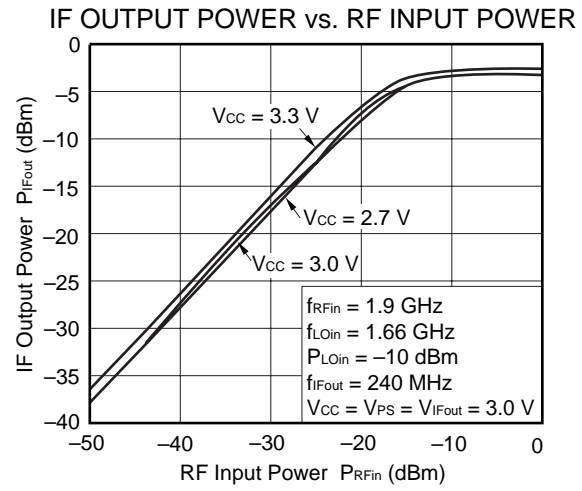
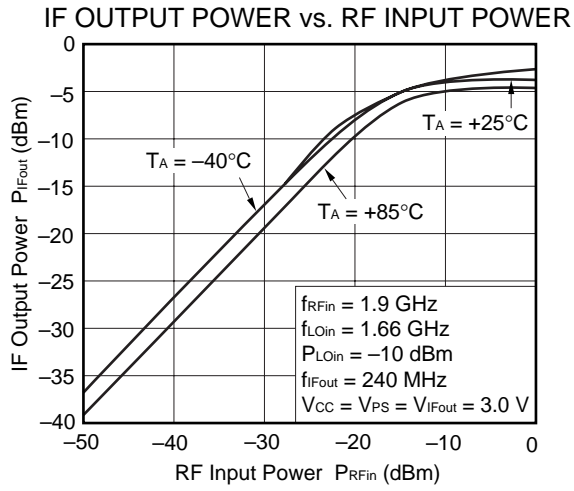


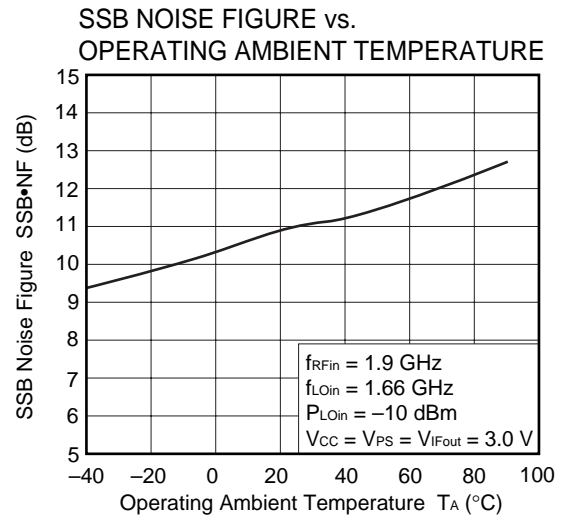
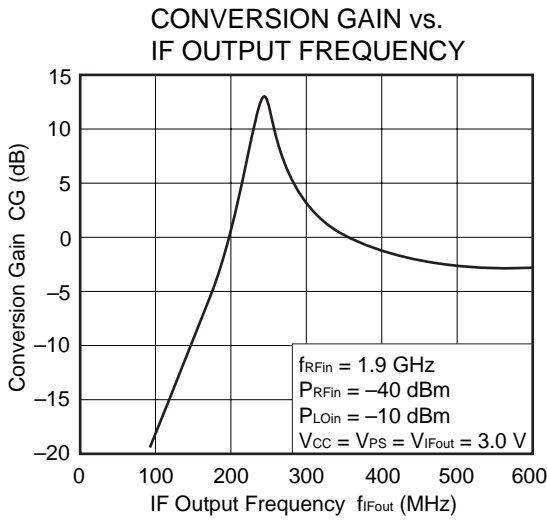
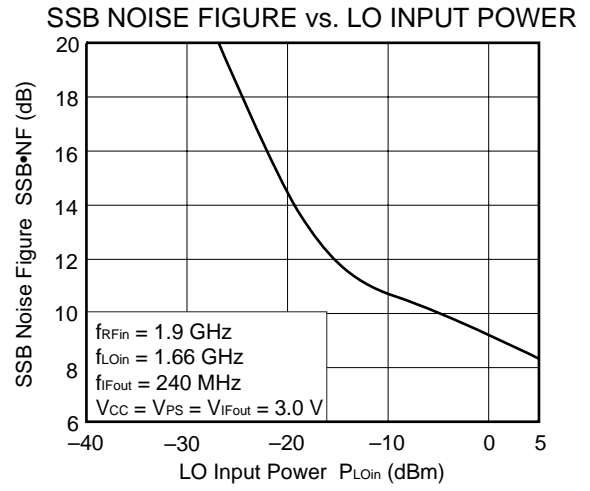
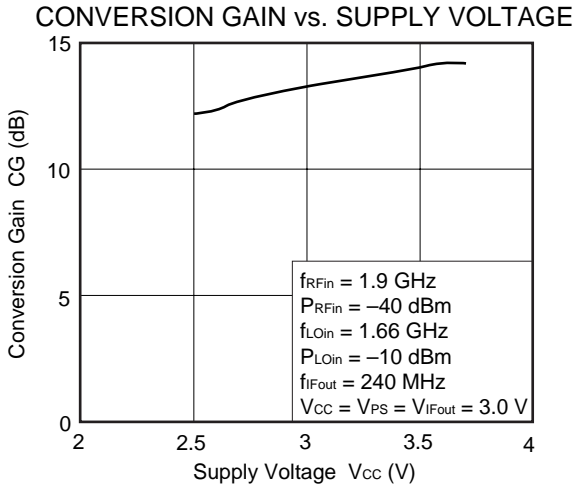
CONVERSION GAIN vs. LO INPUT POWER





12.4 IF 240 MHz Matching





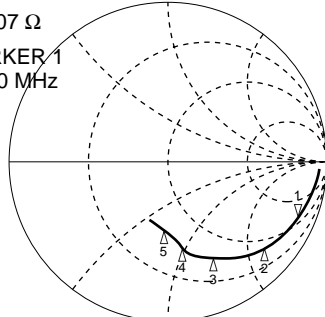
**Remark** The graphs indicate nominal characteristics.

13. S-PARAMETERS

13.1 Calibrated on pin of DUT

S<sub>11</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 62.711 Ω -224.07 Ω

MARKER 1  
 500.0 MHz



RF PORT

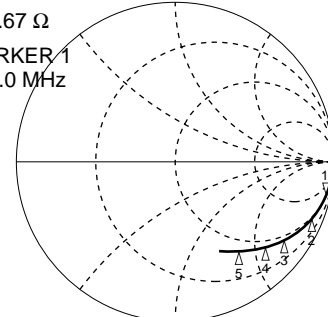
V<sub>CC</sub> = V<sub>PS</sub> = 3.0V

1:500 MHz 62.711 Ω-j224.07 Ω  
 2:900 MHz 48.977 Ω-j219.18 Ω  
 3:1 500 MHz 40.641 Ω-j129.94 Ω  
 4:1 900 MHz 37.422 Ω-j101.51 Ω  
 5:2 500 MHz 34.801 Ω-j74.141 Ω

START 0.050000000 GHz  
 STOP 3.000000000 GHz

S<sub>11</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 76.656 Ω -421.67 Ω

MARKER 1  
 500.0 MHz



RF PORT

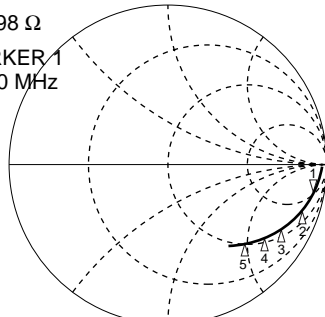
V<sub>CC</sub> = 3.0V V<sub>PS</sub> = GND

1:500 MHz 76.656 Ω-j421.67 Ω  
 2:900 MHz 53.102 Ω-j234.55 Ω  
 3:1 500 MHz 44.844 Ω-j140.82 Ω  
 4:1 900 MHz 40.898 Ω-j109.73 Ω  
 5:2 500 MHz 38.063 Ω-j80.547 Ω

START 0.050000000 GHz  
 STOP 3.000000000 GHz

S<sub>11</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 169.11 Ω -429.98 Ω

MARKER 1  
 500.0 MHz



LO PORT

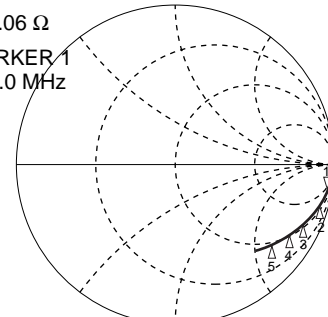
V<sub>CC</sub> = V<sub>PS</sub> = 3.0V

1:500 MHz 169.11 Ω-j429.98 Ω  
 2:900 MHz 91.875 Ω-j263.7 Ω  
 3:1 500 MHz 60.781 Ω-j162.56 Ω  
 4:1 900 MHz 56.789 Ω-j125.66 Ω  
 5:2 500 MHz 49.652 Ω-j97.602 Ω

START 0.050000000 GHz  
 STOP 3.000000000 GHz

S<sub>11</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 135.53 Ω -575.06 Ω

MARKER 1  
 500.0 MHz



LO PORT

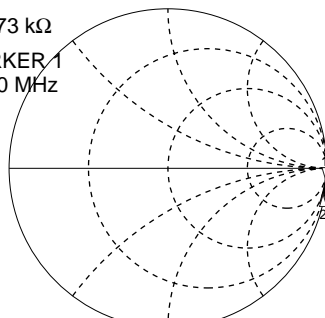
V<sub>CC</sub> = 3.0V V<sub>PS</sub> = GND

1:500 MHz 135.53 Ω-j575.06 Ω  
 2:900 MHz 78.266 Ω-j337.66 Ω  
 3:1 500 MHz 55.883 Ω-j201.43 Ω  
 4:1 900 MHz 52.734 Ω-j159.63 Ω  
 5:2 500 MHz 44.262 Ω-j122.66 Ω

START 0.050000000 GHz  
 STOP 3.000000000 GHz

S<sub>22</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 201.00 Ω -1.7173 kΩ

MARKER 1  
 100.0 MHz



IF PORT

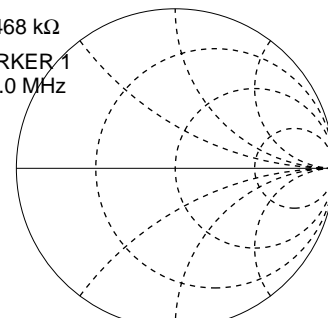
V<sub>CC</sub> = V<sub>PS</sub> = 3.0V

1:100 MHz 201.88 Ω-j1.7173 kΩ  
 2:240 MHz 92.094 Ω-j715.72 Ω

START 0.050000000 GHz  
 STOP 3.000000000 GHz

S<sub>22</sub> Z  
 REF 1.0 Units  
 1/V 200.0 mUnits/  
 hp 056.56 Ω -1.7468 kΩ

MARKER 1  
 100.0 MHz



IF PORT

V<sub>CC</sub> = 3.0V V<sub>PS</sub> = GND

1:100 MHz 56.56 Ω-j1.7468 kΩ  
 2:240 MHz 85.5 Ω-j722.22 Ω

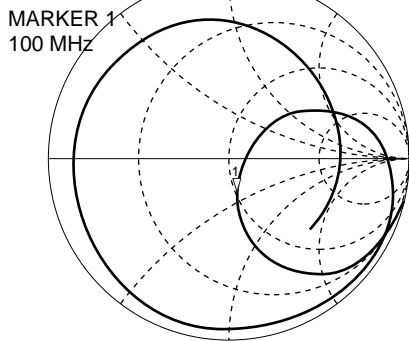
START 0.050000000 GHz  
 STOP 3.000000000 GHz



**13.2 IF Output Matching ( $V_{CC} = V_{PS} = V_{IFout} = 3.0\text{ V}$ ) –on Test Circuit–  
(This  $S_{11}$  is monitored at IF connector on test circuit fixture)**

**IF 100 MHz MATCHING**

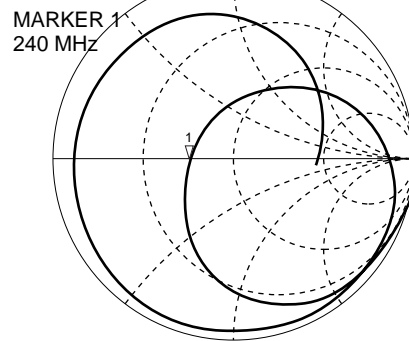
$S_{11}$  1 U FS 1: 50.277  $\Omega$  -22.559  $\Omega$  70.552 pF  
hp 100.000 000 MHz



START 50.000 000 MHz STOP 3 000.000 000 MHz

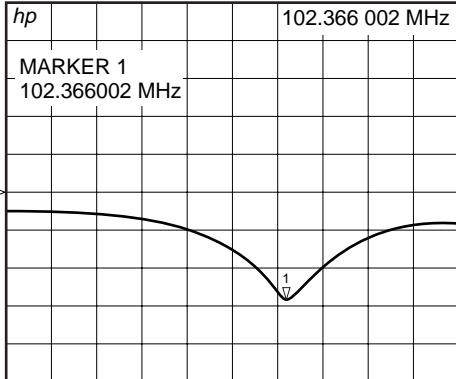
**IF 240 MHz MATCHING**

$S_{11}$  1 U FS 1: 31.052  $\Omega$  -84.961 m $\Omega$  7.8053 nF  
hp 240.000 000 MHz



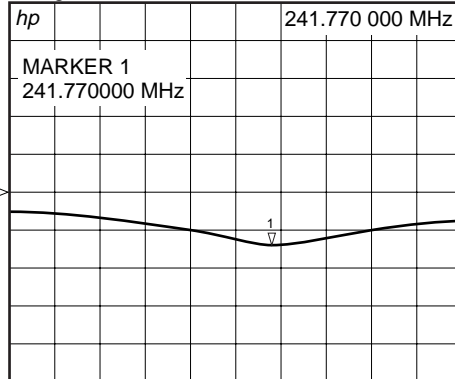
START 50.000 000 MHz STOP 3 000.000 000 MHz

$S_{11}$  log MAG. 10 dB/ REF 0 dB 1: -27.655 dB



START 90.000 000 MHz STOP 110.000 000 MHz

$S_{11}$  log MAG. 10 dB/ REF 0 dB 1: -13.556 dB



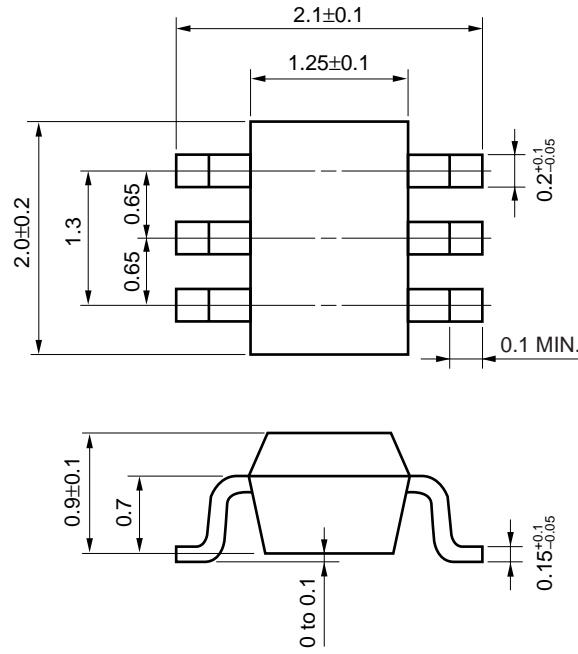
START 230.000 000 MHz STOP 250.000 000 MHz

The data in this page are to make clear the test condition of impedance matched to next stage, not specify the recommended condition. The  $S_{11}$  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.

14. PACKAGE DIMENSIONS

6-PIN SUPER MINIMOLD (UNIT: mm)



**15. NOTE ON CORRECT USE**

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

**16. RECOMMENDED SOLDERING CONDITIONS**

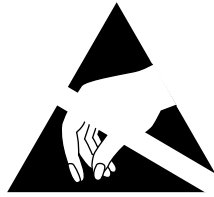
This product should be soldered under the following recommended conditions. For soldering methods and conditions other than those recommended below, contact your NEC sales representative.

Soldering Method	Soldering Condition	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).



**ATTENTION**  
 OBSERVE PRECAUTIONS  
 FOR HANDLING  
 ELECTROSTATIC  
 SENSITIVE  
 DEVICES

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