NEC

BIPOLAR ANALOG INTEGRATED CIRCUIT

μPC8112T

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 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_3 = –7 dBm@f_{RFin} = 1.9 GHz (reference)
  IM_3 = –88 dBm@P_{RFin} = –38 dBm, 1.9 GHz (reference); on test circuit
- Similar conversion gain to μPC2757T and lower noise figure than μPC2758T
- Minimized carrier leakage : RF_{IO} = –80 dB@f_{RFin} = 900 MHz (reference)
  RF_{IO} = –55 dB@f_{RFin} = 1.9 GHz (reference)
- High linearity : $P_{O(sat)}$ = –2.5 dBm TYP.@f_{RFin} = 900 MHz
  $P_{O(sat)}$ = –3 dBm TYP.@f_{RFin} = 1.9 GHz
- Low current consumption : I_{CC} = 8.5 mA TYP.
- Supply voltage : V_{CC} = 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	• Embossed tape 8 mm wide. • Pin 1, 2, 3 face to perforation side of the tape. • QTY 3k/reel.

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

Caution Electro-static sensitive devices

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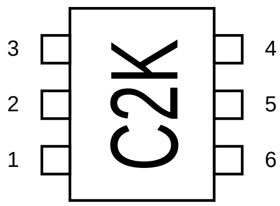
Printed in Japan

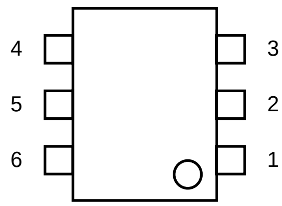
The mark ★ shows major revised points.

PIN CONNECTIONS

(Top View)



(Bottom View)



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

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

Items / Part No.	No RF I_{CC} (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_3 (dBm)	1.5 GHz IIP_3 (dBm)	1.9 GHz IIP_3 (dBm)
μPC2757T μPC2757TB	5.6	10	10	13	15	15	13	–14	–14	–12
μPC2758T μPC2758TB	11	9	10	13	19	18	17	–13	–12	–11
μPC8112T μPC8112TB	8.5	9	11	11	15	13	13	–10	–9	–7

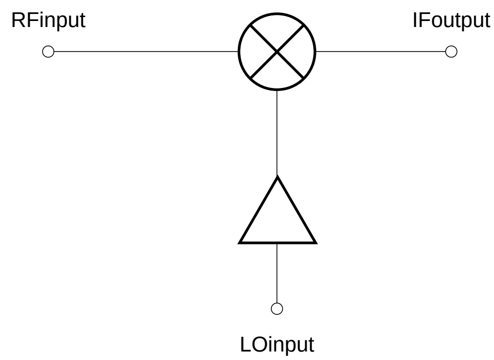
Items / Part No.	900 MHz $P_{O(sat)}$ (dBm)	1.5 GHz $P_{O(sat)}$ (dBm)	1.9 GHz $P_{O(sat)}$ (dBm)	900 MHz RF_{lo} (dB)	1.5 GHz RF_{lo} (dB)	1.9 GHz RF_{lo} (dB)	IF Output Configuration	Packages
μPC2757T	–3	–	–8	–	–	–	Emitter follower	6-pin minimold
μPC2757TB								6-pin super minimold
μPC2758T	+1	–	–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.

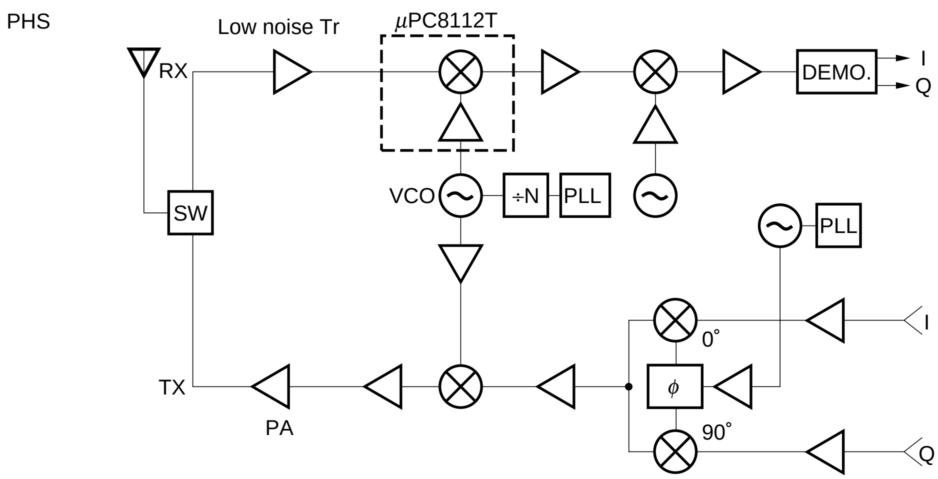
Cautions 1. μPC2757T, μPC2758T's IIP_3 are calculated with the same inclination of IM_3 as μPC8112T. μPC8112T IM_3's inclination at P_{RFin} = –38 dBm is close to 3rd order.(Refer to theoretical equation)

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.

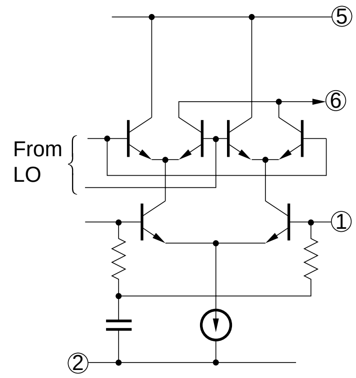
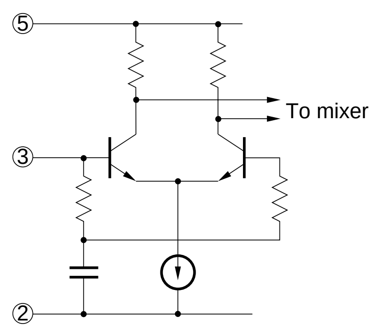
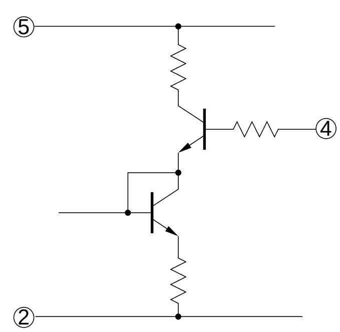
INTERNAL BLOCK DIAGRAM



μPC8112T LOCATION EXAMPLE IN THE SYSTEM



PIN EXPLANATION

<table>
<tr><th>Pin No.</th><th>Pin Name</th><th>Applied Voltage (V)</th><th>Pin Voltage (V)</th><th>Function and Application</th><th>Internal Equivalent Circuit</th></tr>
<tr><td>5</td><td>V_{CC}</td><td>2.7 to 3.3</td><td>–</td><td>Supply voltage pin.
This pin should be connected with bypass capacitor (example: 1 000 pf) to minimize ground imped-ance.</td><td rowspan="4">
</td></tr>
<tr><td>6</td><td>IFoutput</td><td>as same as V_{CC} voltage through external inductor</td><td>–</td><td>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.</td></tr>
<tr><td>1</td><td>RFinput</td><td>–</td><td>1.2</td><td>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.</td></tr>
<tr><td>2</td><td>GND</td><td>0</td><td>–</td><td>Ground pin. This pin must be connected to the system ground. Form the ground pattern as wide as possible and the truck length as short as possible to minimize ground impedance.</td></tr>
<tr><td>3</td><td>LOinput</td><td>–</td><td>1.4</td><td>Input pin of local amplifier. This amplifier is designed as differen-tial type.
This pin should be externally coupled to local signal source with DC cut capacitor.
Recommendable input level is –15 to 0 dBm.</td><td>
</td></tr>
<tr><td>4</td><td>PS</td><td>V_{CC} or GND</td><td>–</td><td>Power save control pin. This pin can control ON/OFF operation with bias as follows;<table><tr><th></th><th>Bias: V</th><th>Operation</th></tr><tr><td rowspan="2">V_{PS}</td><td>≥ 2.5</td><td>ON</td></tr><tr><td>0 - 0.5</td><td>OFF</td></tr></table></td><td>
</td></tr>
</table>

ABSOLUTE MAXIMUM RATINGS

Parameter	Symbol	Conditions	Ratings	Unit
Supply Voltage	V_{CC}	T_A = +25 °C, 5 pin and 6 pin	3.6	V
Total Circuit Current	I_{CC}	T_A = +25 °C	77.7	mA
Total Power Dissipation	P_D	Mounted on 50 × 50 × 1.6 mm epoxy glass PWB (T_A = +85 °C)	280	mW
Operating Ambient Temperature	T_A		–40 to +85	°C
Storage Temperature	T_{stg}		–55 to +150	°C

RECOMMENDED OPERATING CONDITIONS

Parameter	Symbol	MIN.	TYP.	MAX.	Unit	Remark
Supply Voltage	V_{CC}	2.7	3.0	3.3	V	5 pin and 6 pin should be applied to same voltage.
Operating Ambient Temperature	T_A	–40	+25	+85	°C	
LO Input Level	P_{LOin}	–15	–10	0	dBm	Z_s = 50 Ω
RF Input Frequency	f_{RFin}	0.8	1.9	2.0	GHz	
IF Output Frequency	f_{IFout}	100	250	300	MHz	With external matching

ELECTRICAL CHARACTERISTICS (Unless otherwise specified, T_A = +25 °C, $V_{CC} = V_{PS} = V_{IFout}$ = 3.0 V, P_{LOin} = –10 dBm, $Z_S = Z_L$ = 50 Ω)

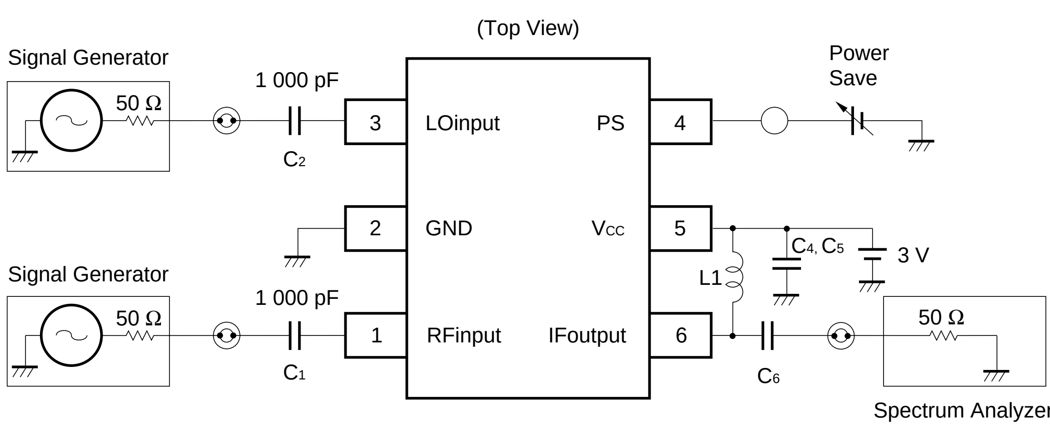
Parameter	Symbol	Test Conditions	MIN.	TYP.	MAX.	Unit
Circuit Current	I_{CC}	No signals	4.9	8.5	11.7	mA
Circuit Current at Power Save Mode	$I_{CC(PS)}$	V_{CC} = 3.0 V, V_{PS} = 0.5 V	–	–	0.1	μA
Conversion Gain	CG	f_{RFin} = 900 MHz, f_{LOin} = 1 000 MHz f_{RFin} = 1.9 GHz, f_{LOin} = 1.66 GHz	11.5 9.5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

STANDARD CHARACTERISTICS FOR REFERENCE (T_A = +25 °C, V_{CC} = V_{PS} = V_{IFout} = 3.0 V, P_{LOin} = –10 dBm, Z_S = Z_L = 50 Ω)

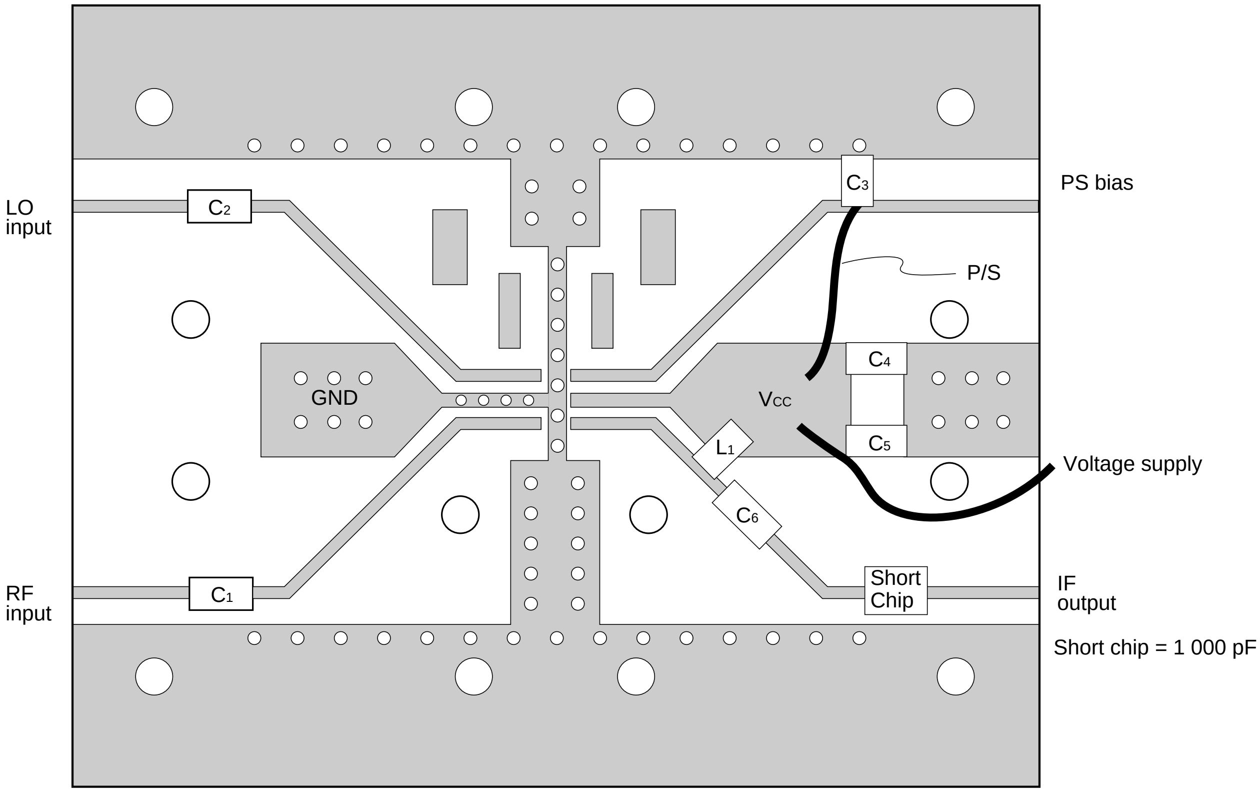
Parameter	Symbol	Test Conditions	Reference	Unit
Conversion Gain	CG	f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz	13	dB
Single Side Band Noise Figure	SSB NF	f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz	11	dB
LO Leakage at RF Pin	LO_{rf}	f_{RFin} = 900 MHz, f_{LOin} = 1 000 MHz f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz f_{RFin} = 1.9 GHz, f_{LOin} = 1.66 GHz	–45 –46 –45	dB
RF Leakage at LO Pin	RF_{lO}	f_{RFin} = 900 MHz, f_{LOin} = 1 000 MHz f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz f_{RFin} = 1.9 GHz, f_{LOin} = 1.66 GHz	–80 –57 –55	dB
LO Leakage at IF Pin	LO_{if}	f_{RFin} = 900 MHz, f_{LOin} = 1 000 MHz f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz f_{RFin} = 1.9 GHz, f_{LOin} = 1.66 GHz	–32 –33 –30	dB
Input 3rd Order Intercept Point[Note]	IIP_3	f_{RFin} = 900 MHz, f_{LOin} = 1 000 MHz f_{RFin} = 1.5 GHz, f_{LOin} = 1.6 GHz f_{RFin} = 1.9 GHz, f_{LOin} = 1.66 GHz	–10 –9 –7	dBm

Note IIP_3 is determined by comparing two method; theoretical calculation and cross point of IM_3 curve.
$IIP_3 = (\Delta IM_3 \times P_{in} + CG - IM_3) \div (\Delta IM_3 - 1)$ (dBm) [ΔIM_3: IM_3 curve inclination in linear range]
μPC8112T's ΔIM_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_1 to C_5	1 000 pF	1 000 pF	CHIP C
C_6	5 pF	2 pF	CHIP C
L_1	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_6, 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.

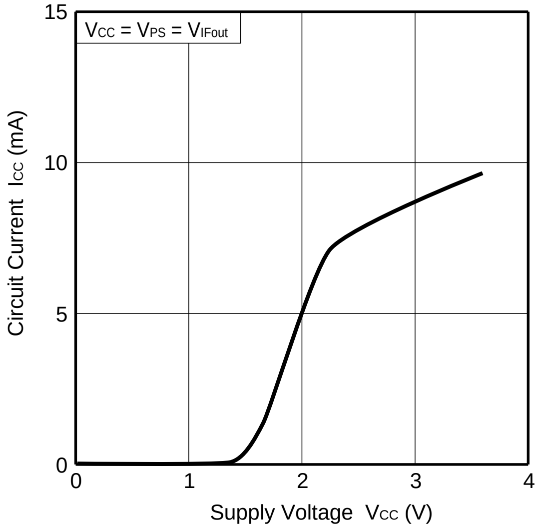
Remark External circuits of the IC can be referred to following application notes.

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

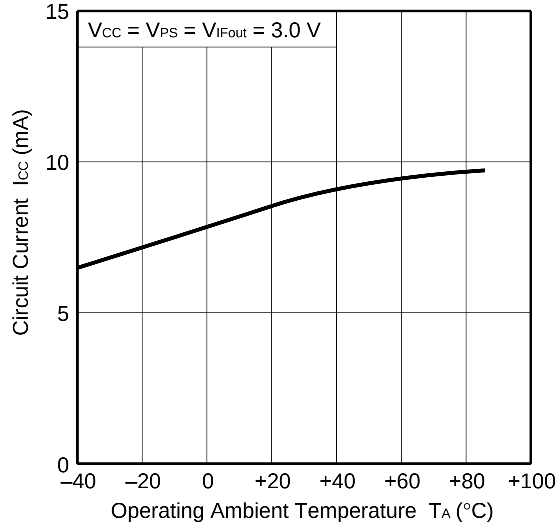
TYPICAL CHARACTERISTICS (TA = +25 °C, unless otherwise specified, measured on test circuits)

– Without Signals –

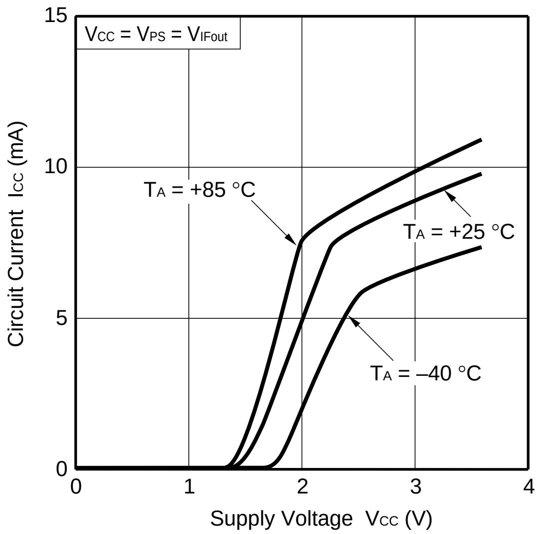
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



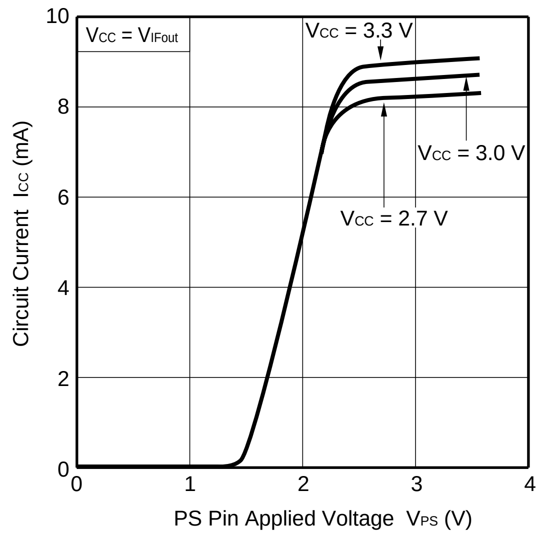
CIRCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



CIRCUIT CURRENT vs. SUPPLY VOLTAGE

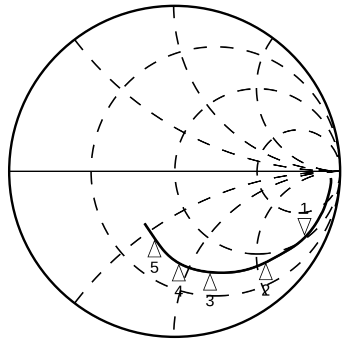


CIRCUIT CURRENT vs. PS PIN APPLIED VOLTAGE



★ – **S-PARAMETER** –

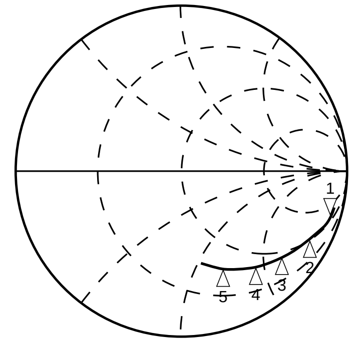
Calibrated on pin of DUT



RF port
$V_{CC} = V_{PS} = 3.0$ V

START 0.050000000 GHz
STOP 3.000000000 GHz

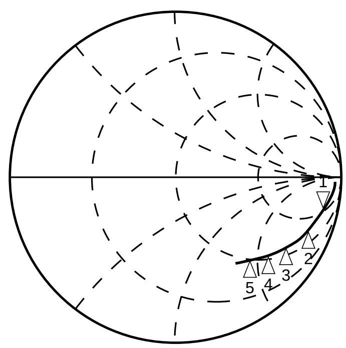
1: 500 MHz 53.961 Ω – j199.84 Ω
2: 900 MHz 37.164 Ω – j110.75 Ω
3: 1 500 MHz 30.703 Ω – j62.504 Ω
4: 1 900 MHz 28.742 Ω – j45.379 Ω
5: 2 500 MHz 29.257 Ω – j29.199 Ω



RF port
$V_{CC} = 3.0$ V V_{PS} = GND

START 0.050000000 GHz
STOP 3.000000000 GHz

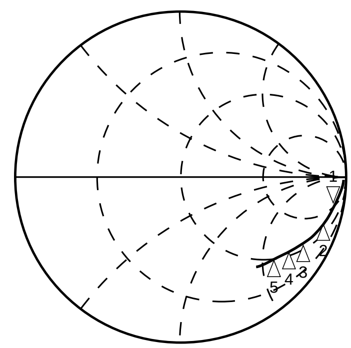
1: 500 MHz 70.25 Ω – j334.05 Ω
2: 900 MHz 53.289 Ω – j192.67 Ω
3: 1 500 MHz 41.633 Ω – j117.89 Ω
4: 1 900 MHz 36.133 Ω – j92.941 Ω
5: 2 500 MHz 32.621 Ω – j66.703 Ω



LO port
$V_{CC} = V_{PS} = 3.0$ V

START 0.050000000 GHz
STOP 3.000000000 GHz

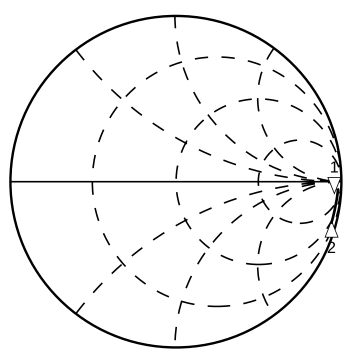
1: 500 MHz 147.34 Ω – j369.31 Ω
2: 900 MHz 90.164 Ω – j232.59 Ω
3: 1 500 MHz 61.602 Ω – j144.84 Ω
4: 1 900 MHz 59.125 Ω – j116.24 Ω
5: 2 500 MHz 50.164 Ω – j94.008 Ω



LO port
$V_{CC} = 3.0$ V V_{PS} = GND

START 0.050000000 GHz
STOP 3.000000000 GHz

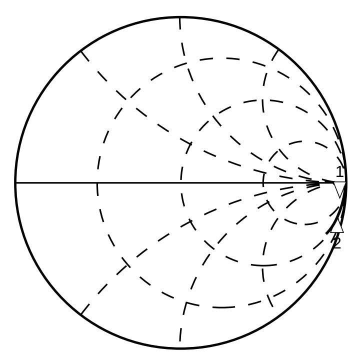
1: 500 MHz 126.91 Ω – j468.75 Ω
2: 900 MHz 84.906 Ω – j278.58 Ω
3: 1 500 MHz 58.266 Ω – j173.01 Ω
4: 1 900 MHz 57.07 Ω – j140.45 Ω
5: 2 500 MHz 47.453 Ω – j114.28 Ω



IF port
$V_{CC} = V_{PS} = 3.0$ 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



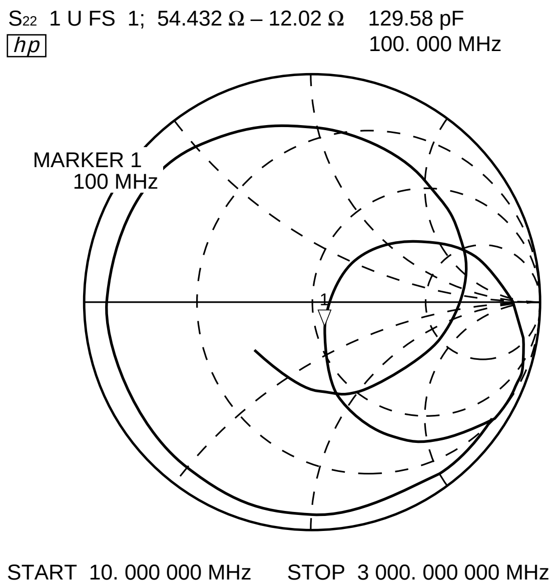
IF port
$V_{CC} = 3.0$ V V_{PS} = GND

START 0.050000000 GHz
STOP 0.300000000 GHz

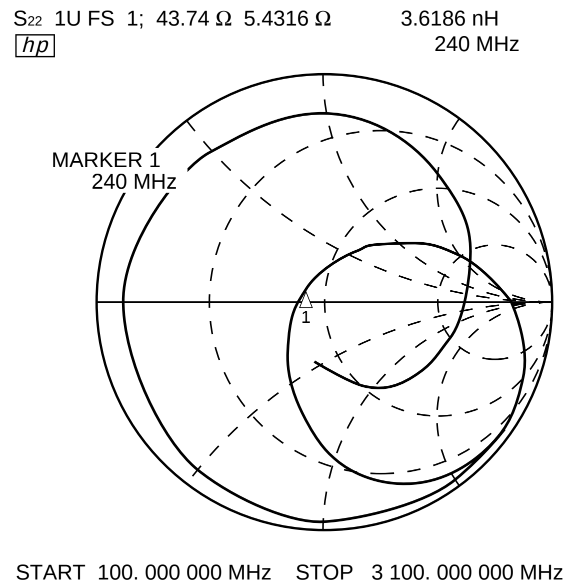
1: 100 MHz 81.25 Ω – j1.3157 kΩ
2: 240 MHz 73.813 Ω – j584.53 Ω

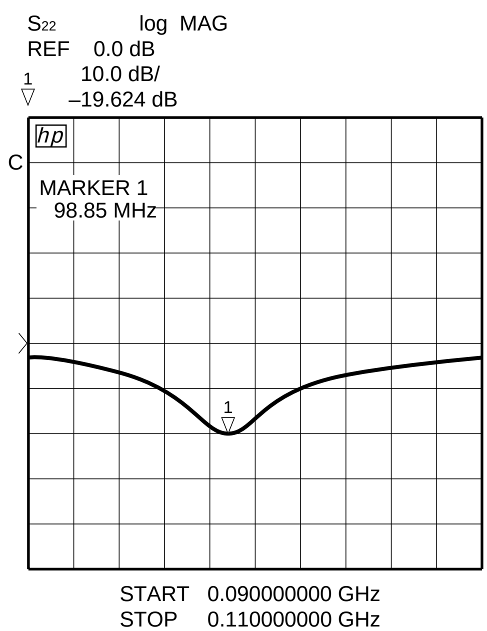
S-PARAMETERS OF IF OUTPUT MATCHING ($V_{CC} = V_{PS} = V_{IFout} = 3.0$ V) – ON TEST CIRCUIT –
(This S_{22} is monitored at IF connector on test circuit fixture.)

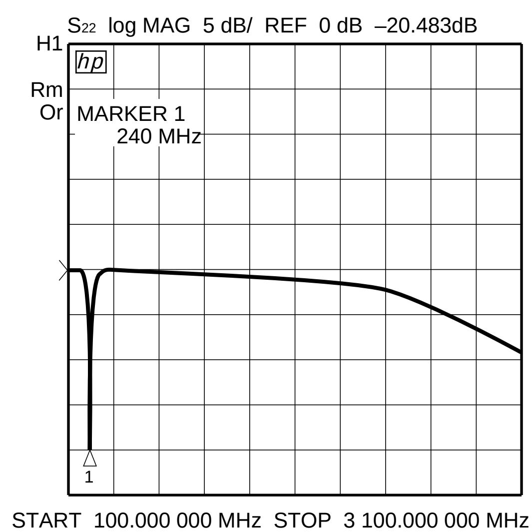
IF 100 MHz MATCHING



IF 240 MHz MATCHING



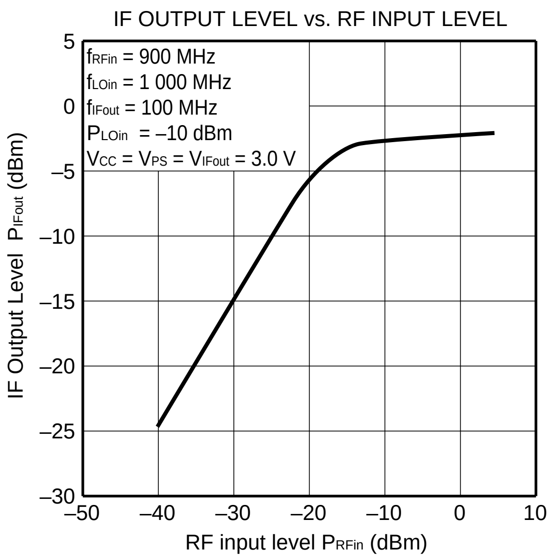


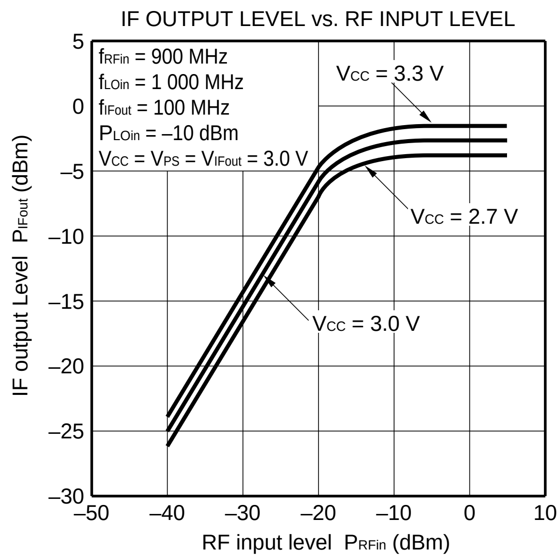


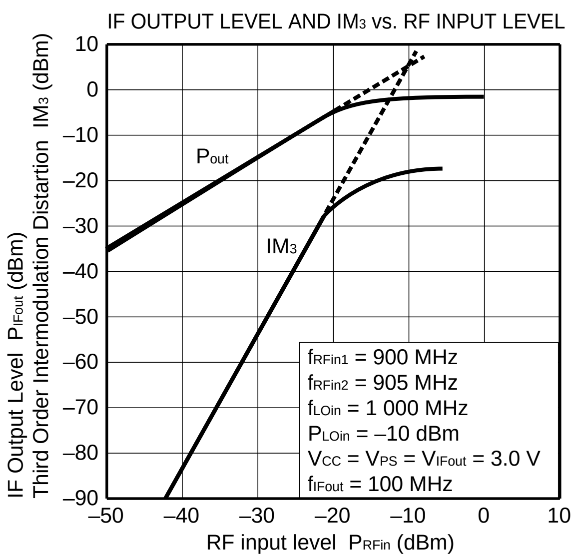
The data in this page are to make clear the test condition of impedance matched to next stage, not specify the recommended condition. The S_{22} smith charts of the test fixture setting IC are normalized to Zo = 50 Ω, because the IC's load is the measurement equipment of 50 Ω impedance.

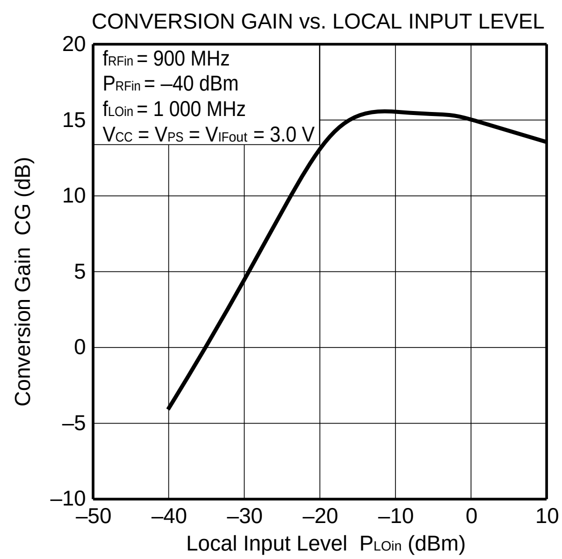
In your use, the output return loss value can be helpful information to adjust your circuit matching to next stage.

– IF 100 MHz MATCHING –

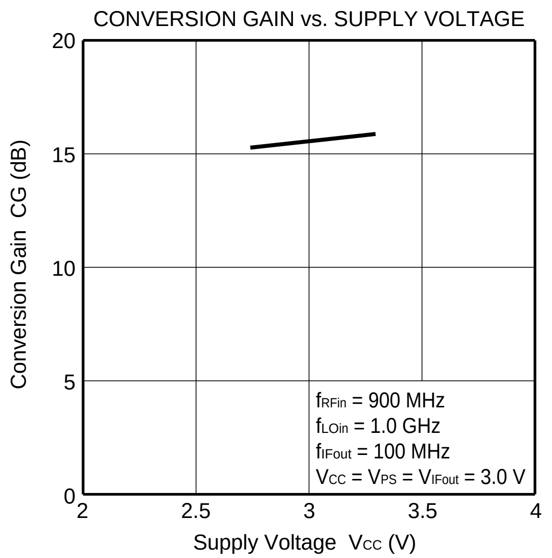


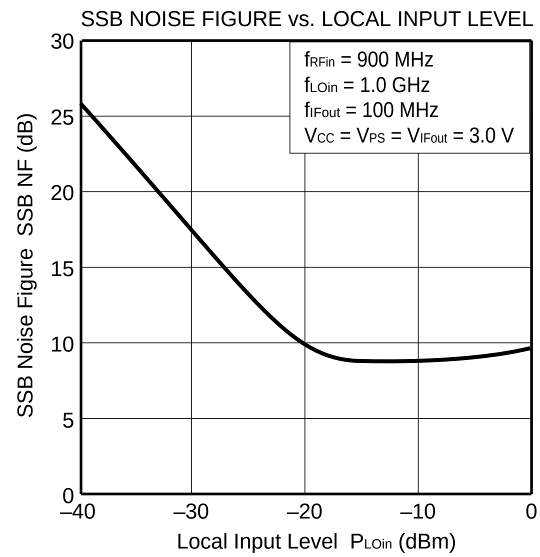


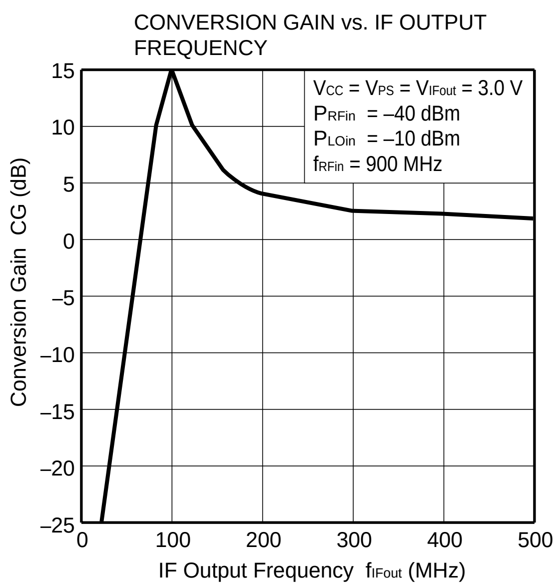




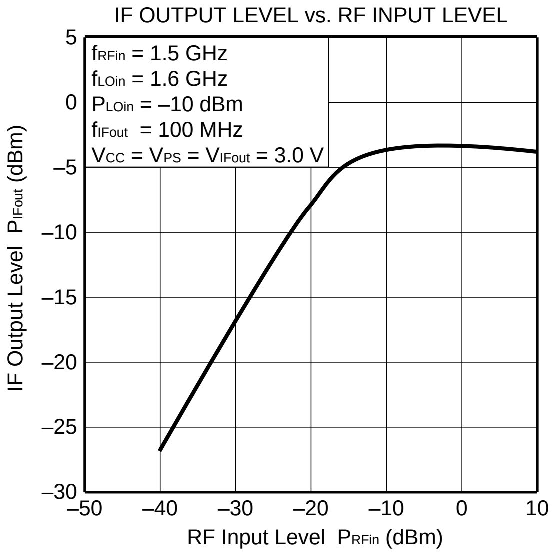
– IF 100 MHz MATCHING –

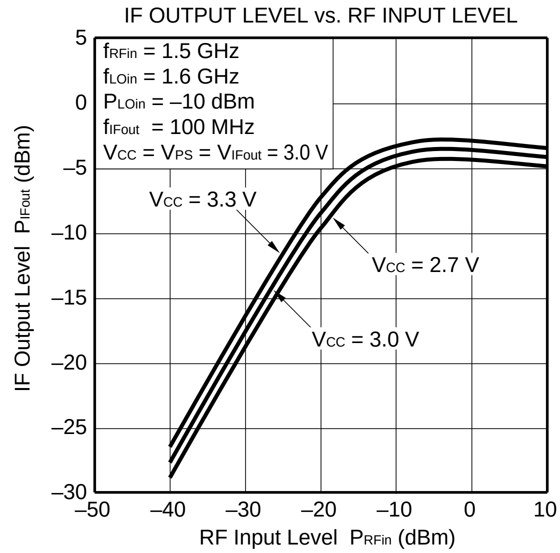


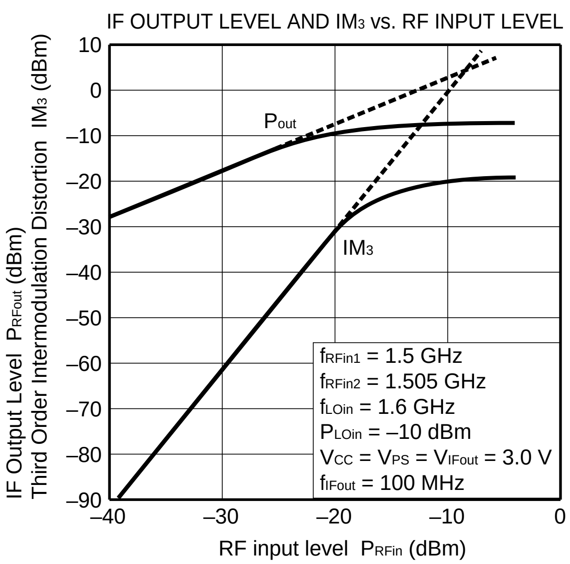


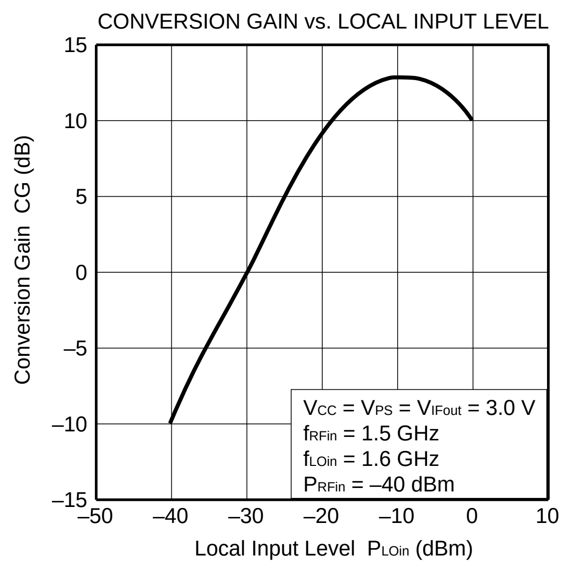


– IF 100 MHz MATCHING –

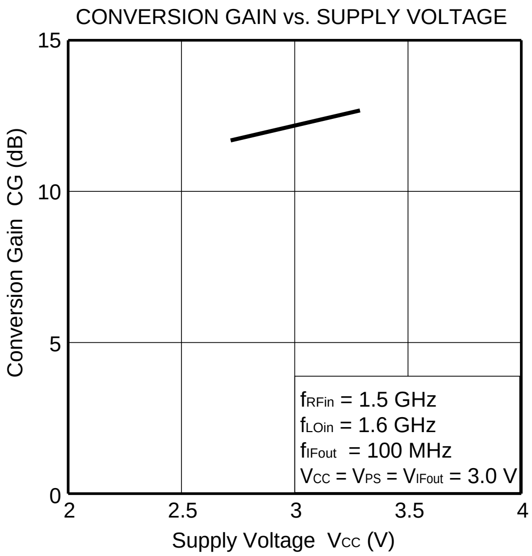


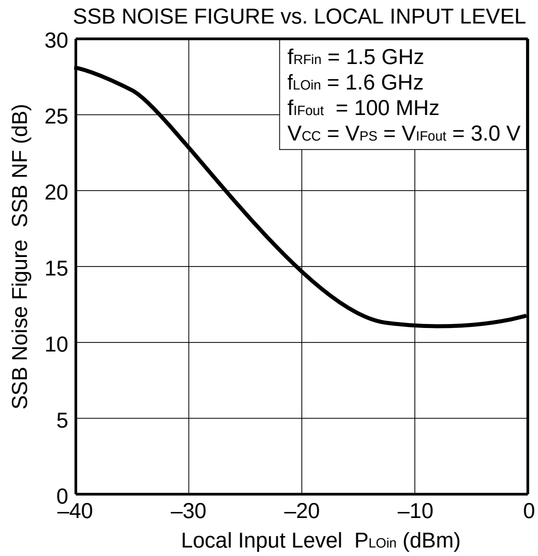




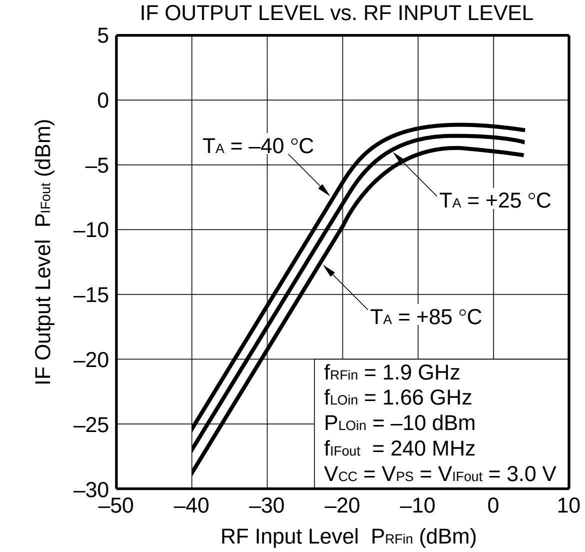


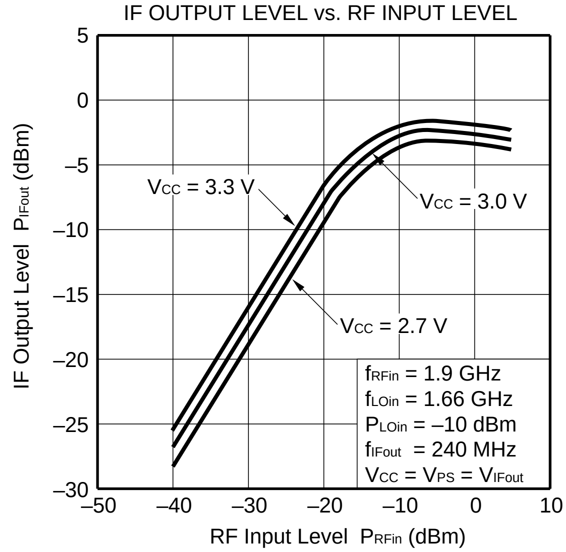
– IF 100 MHz MATCHING –

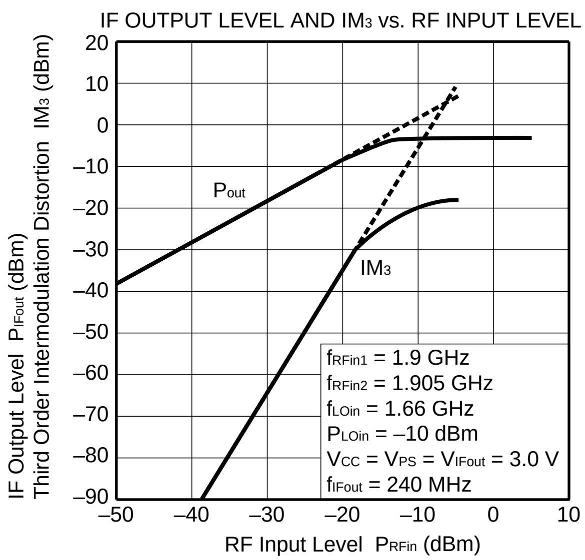


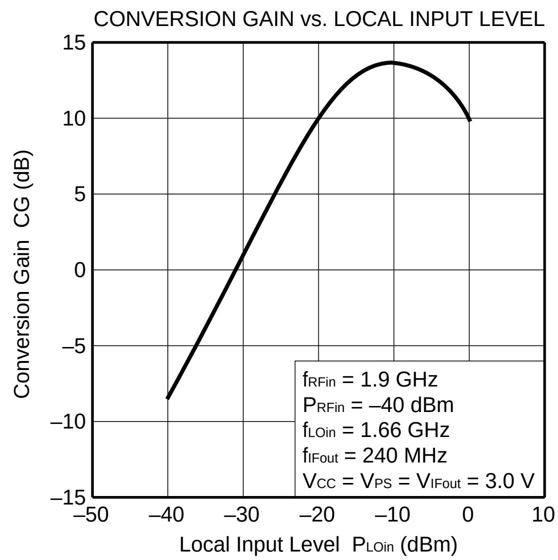


– IF 240 MHz MATCHING –

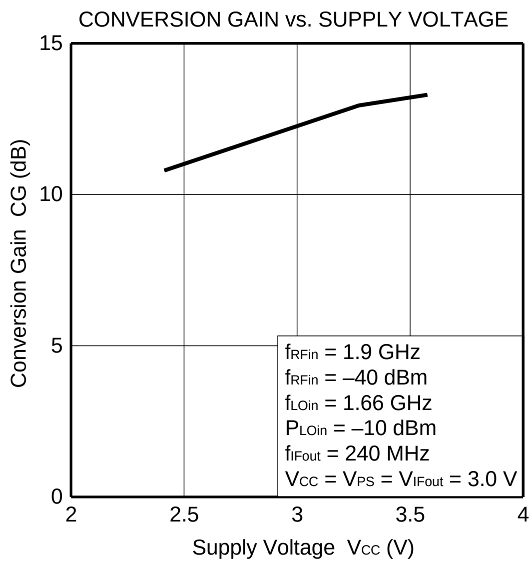


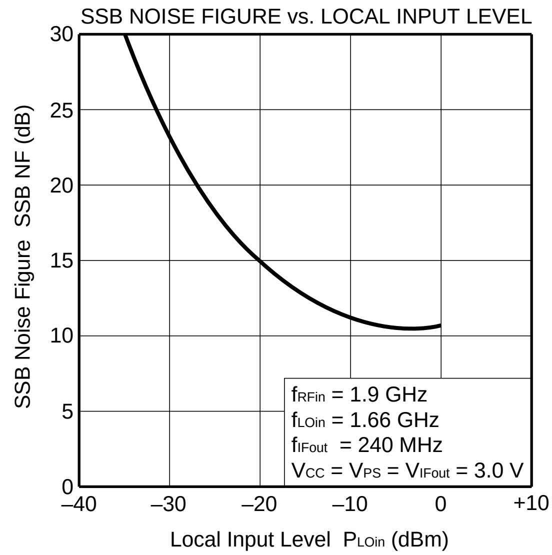


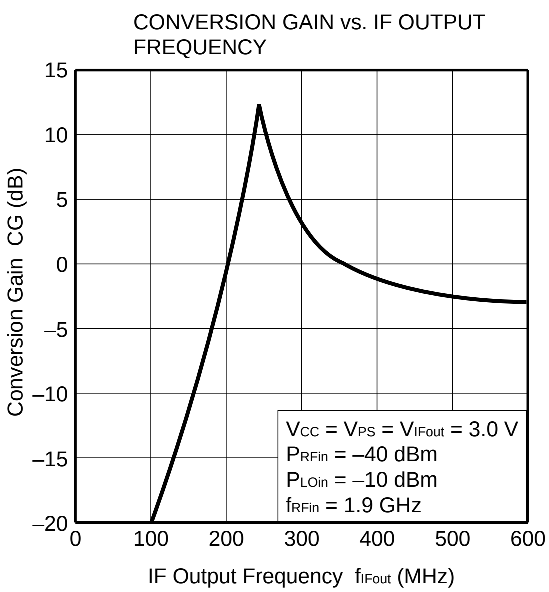


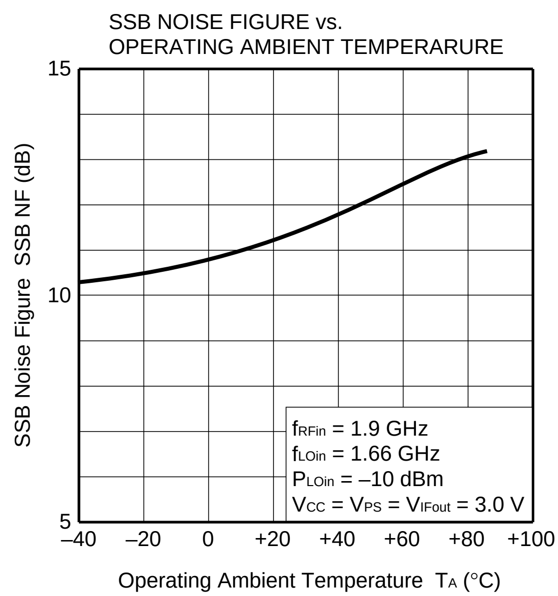


– IF 240 MHz MATCHING –



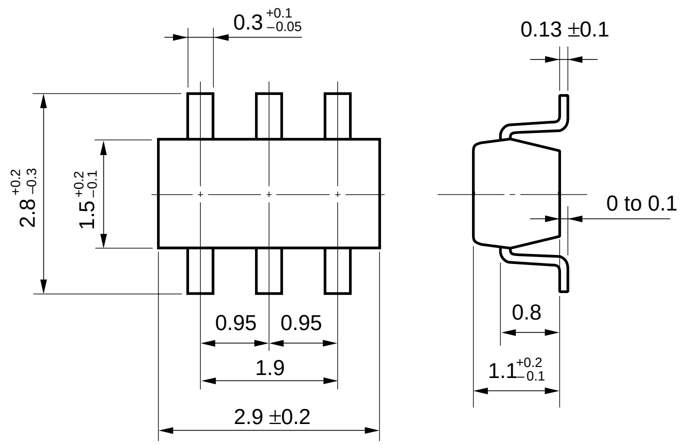






PACKAGE DIMENSIONS

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_{CC} 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.

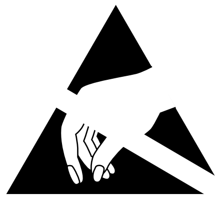
Soldering Method	Soldering Conditions	Recommended Condition Symbol
Infrared Reflow	Package peak temperature: 235 °C or below Time: 30 seconds or less (at 210 °C) Count: 3, Exposure limit: None[Note]	IR35-00-3
VPS	Package peak temperature: 215 °C or below Time: 40 seconds or less (at 200 °C) Count: 3,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