DATA SHEET

CEL

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC8112TB

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

### DESCRIPTION

The μPC8112TB 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 μPC8112TB features high impedance output of open collector. Similar ICs of the μPC2757TB and μPC2758TB 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 μPC8112TB is manufactured using the 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)
- Similar conversion gain to μPC2757 and lower noise figure than μPC2758
- Minimized carrier leakage : $RF_{LO}$ = –80 dB@$f_{RFin}$ = 900 MHz (reference)
  $RF_{LO}$ = –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 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 |
|---|---|---|---|
| μPC8112TB-E3-A | 6-pin super minimold | C2K | Embossed tape 8 mm wide.<br>Pin 1, 2, 3 face the tape perforation side.<br>Qty 3kpcs/reel. |

**Remark** To order evaluation samples, please contact your local nearby sales office (Part number for sample order: μPC8112TB-A).

**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.

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**The mark ▲ shows major revised points.**

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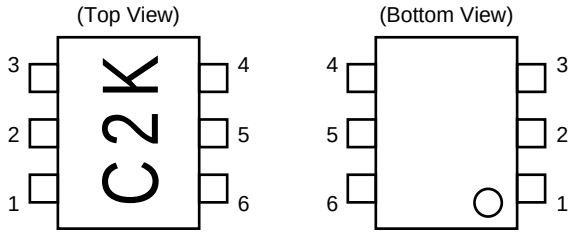
## 1. PIN CONNECTIONS




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

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

| Items / Part Number | 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 | 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 | | | | | | | | | | |

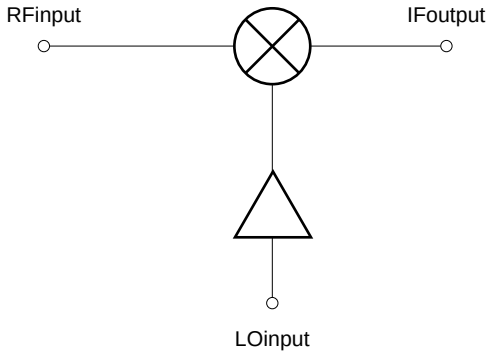
| Items / Part Number | 900 MHz $P_{O(sat)}$ (dBm) | 1.5 GHz $P_{O(sat)}$ (dBm) | 1.9 GHz $P_{O(sat)}$ (dBm) | 900 MHz $RF_{LO}$ (dB) | 1.5 GHz $RF_{LO}$ (dB) | 1.9 GHz $RF_{LO}$ (dB) | IF Output Configuration | Package |
|---|---|---|---|---|---|---|---|---|
| μPC2757T | –3 | – | –8 | – | – | – | Emitter 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 1. The μPC2757 and μPC2758's $IIP_3$ are calculated with $\Delta IM_3$ = 3 which is the same $IM_3$ inclination as μPC8112. On the other hand, $OIP_3$ of Standard characterisitcs in page 7 is cross point IP.**

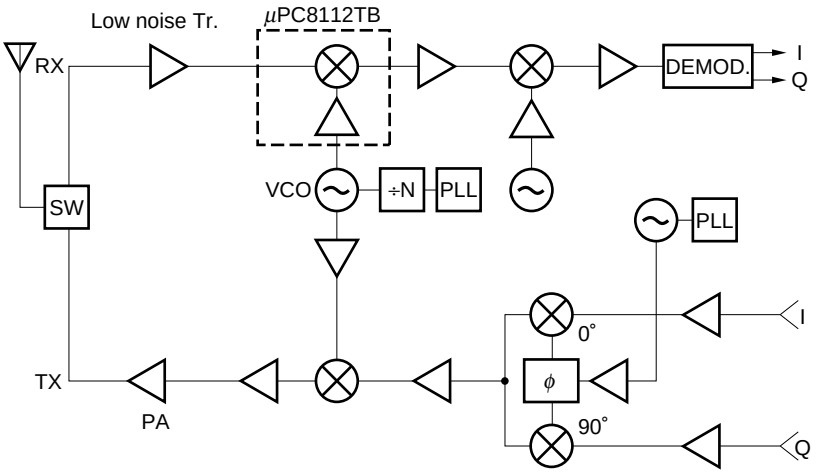
**2. This document is to be specified for μPC8112TB. The other part number mentioned in this document should be referred to the data sheet of each part number.**

## 3. INTERNAL BLOCK DIAGRAM

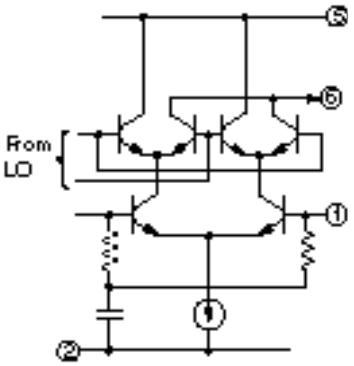
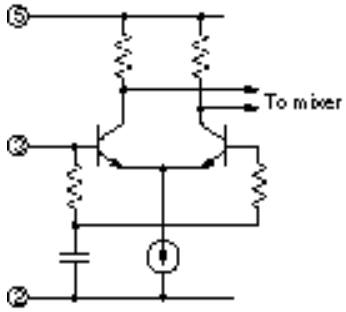
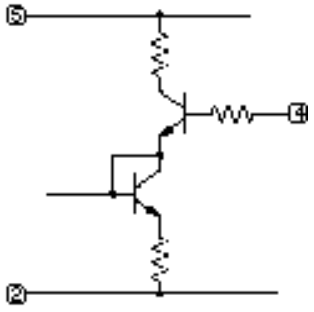



## 4. SYSTEM APPLICATION EXAMPLE

**Digital cordless phone**



## 5. PIN EXPLANATION

<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>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.<br>This pin should be externally coupled to front stage with DC cut capacitor.</td><td rowspan="4">  </td></tr>
<tr><td>2</td><td>GND</td><td>GND</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>5</td><td>$V_{CC}$</td><td>2.7 to 3.3</td><td>–</td><td>Supply voltage pin.<br>This pin should be connected with bypass capacitor (example: 1 000 pf) to minimize ground impedance.</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>3</td><td>LOinput</td><td>–</td><td>1.4</td><td>Input pin of local amplifier. This amplifier is designed as differential type.<br>This pin should be externally coupled to local signal source with DC cut capacitor.<br>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;<br><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 to 0.5</td><td>OFF</td></tr></table></td><td>  </td></tr>
</table>

## 6. 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 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 |

## 7. RECOMMENDED OPERATING RANGE

| Parameter | Symbol | MIN. | TYP. | MAX. | Unit | Remarks |
|---|---|---|---|---|---|---|
| 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 Power | $P_{LOin}$ | –15 | –10 | 0 | dBm | Zs = 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 |

## 8. 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 input signal | 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<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | 11.5<br>9.5 | 15<br>13 | 17.5<br>15.5 | dB |
| SSB Noise Figure | SSB•NF | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | –<br>– | 9.0<br>11.2 | 11<br>13.2 | dB |
| Saturated Output Power | $P_{O(sat)}$ | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz<br>($P_{RFin}$ = –10 dBm each) | –6.5<br>–7 | –2.5<br>–3 | –<br>– | dBm |

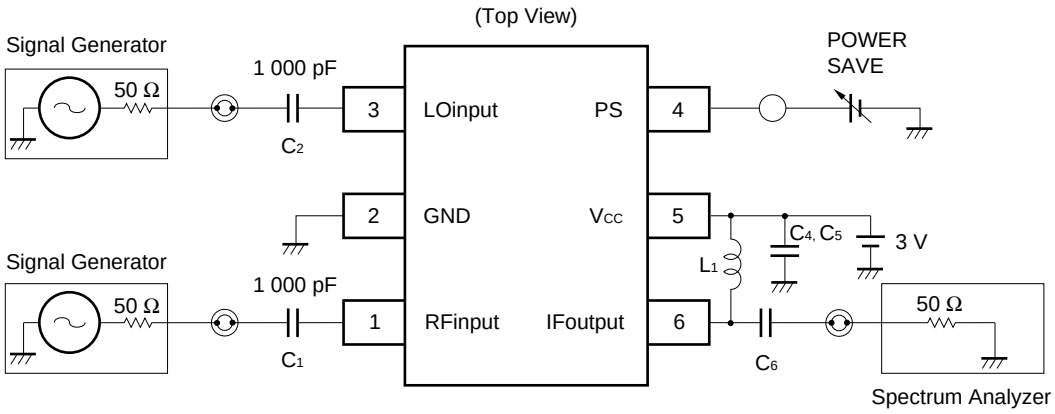
## 9. STANDARD CHARACTERISTICS FOR REFERENCE

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

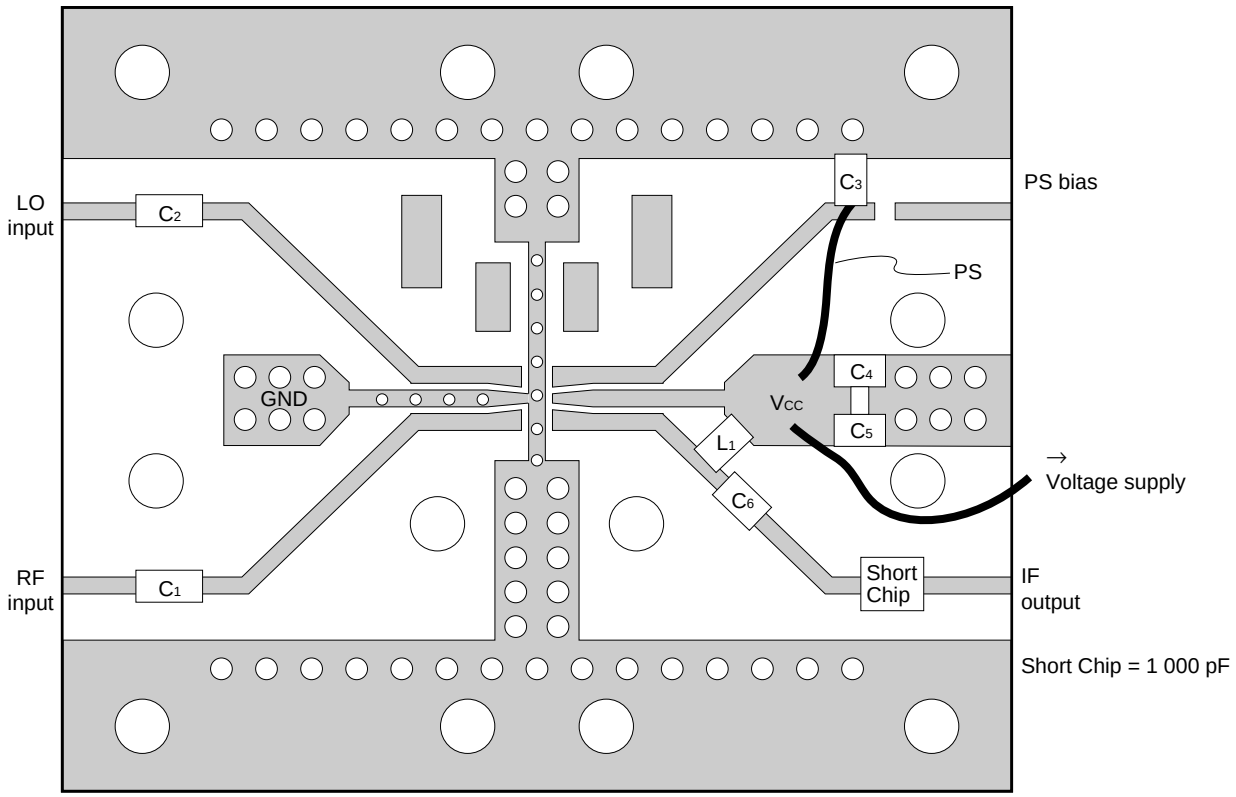
| Parameter | Symbol | Test Conditions | Reference | Unit |
|---|---|---|---|---|
| Conversion Gain | CG | $f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz | 13 | dB |
| SSB Noise Figure | SSB•NF | $f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz | 11 | dB |
| LO Leakage at RF pin | $LO_{RF}$ | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | –45<br>–46<br>–45 | dB |
| RF Leakage at LO pin | $RF_{LO}$ | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | –80<br>–57<br>–55 | dB |
| LO Leakage at IF pin | $LO_{if}$ | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | –32<br>–33<br>–30 | dB |
| 3rd Order Distortion Input Intercept Point[Note] | $IIP_3$ | $f_{RFin}$ = 900 MHz, $f_{LOin}$ = 1 000 MHz<br>$f_{RFin}$ = 1.5 GHz, $f_{LOin}$ = 1.6 GHz<br>$f_{RFin}$ = 1.9 GHz, $f_{LOin}$ = 1.66 GHz | –10<br>–9<br>–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) [$\Delta IM_3$: $IM_3$ 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 |
|---|---|---|---|
| $C_1$ 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.

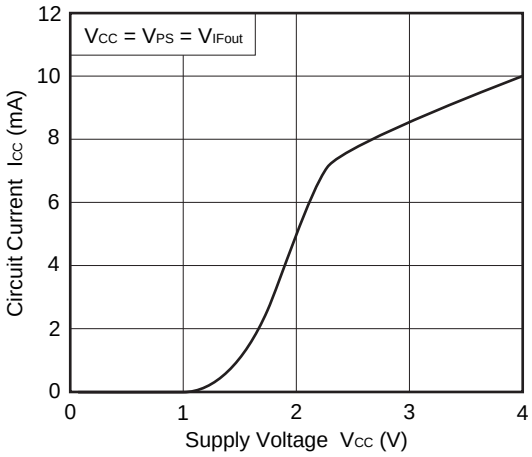
**Caution Test circuit or print pattern in this sheet is for testing IC characteristics. They are not an application circuit or recommended system circuit.**
**In the case of actual system application, external circuits including print pattern and matching circuit constant of output port should be designed in accordance with IC's S-parameters and environmental components.**

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

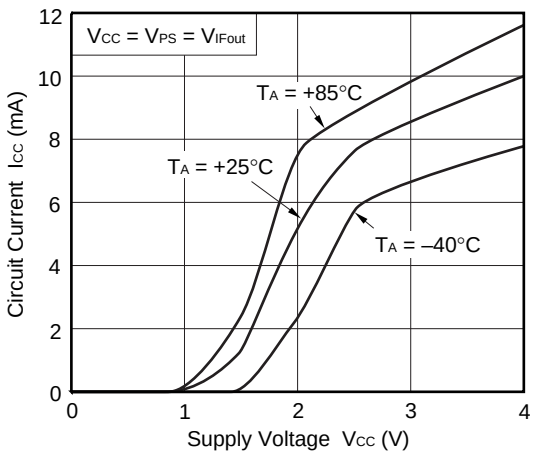
## 12. TYPICAL CHARACTERISTICS ($T_A$ = +25°C, unless otherwise specified, measured on test circuits)

### 12.1 Without Signals

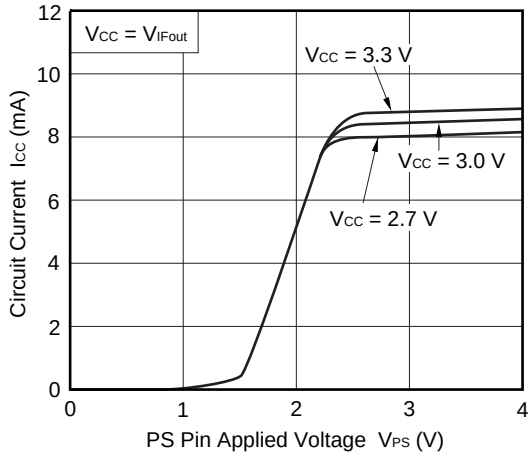
CIRCUIT CURRENT vs. SUPPLY VOLTAGE




CIRCUIT CURRENT vs. SUPPLY VOLTAGE

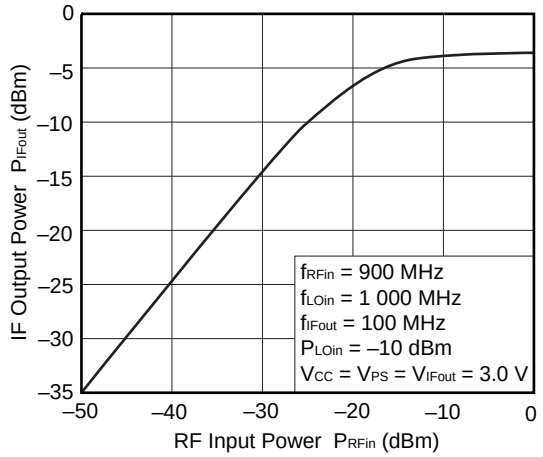



CIRCUIT CURRENT vs.
PS PIN APPLIED VOLTAGE

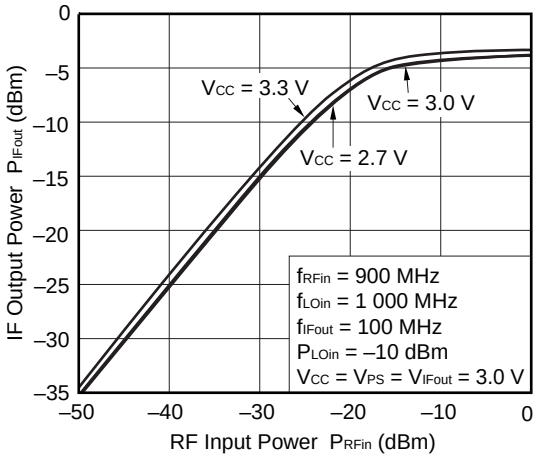


### 12.2 IF 100 MHz Matching ($f_{RFin}$ = 900 MHz)

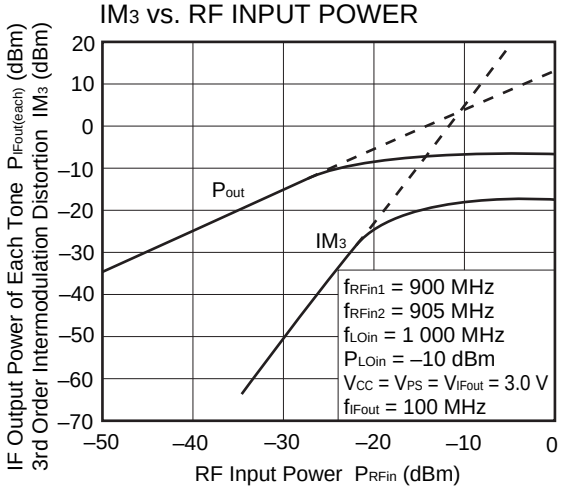
IF OUTPUT POWER vs. RF INPUT POWER



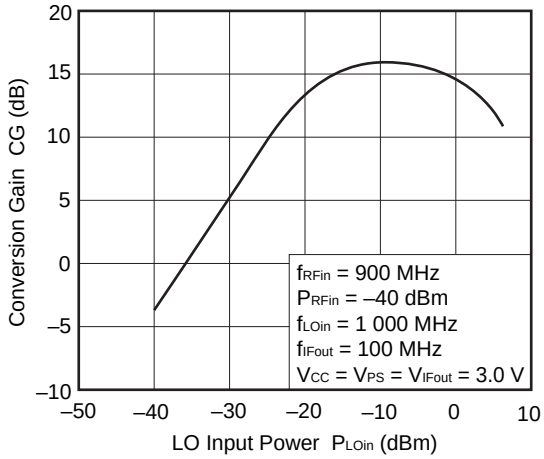

IF OUTPUT POWER vs. RF INPUT POWER



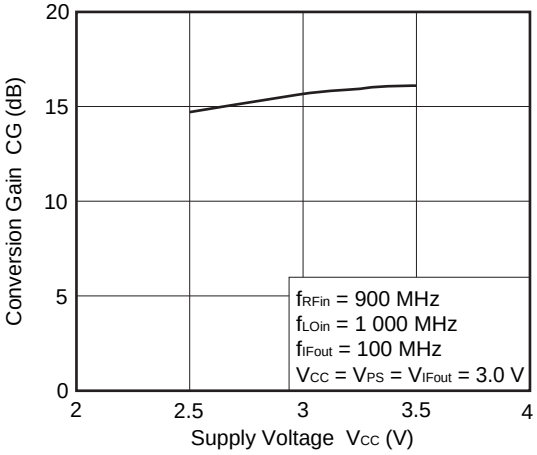

IF OUTPUT POWER OF EACH TONE, IM3 vs. RF INPUT POWER



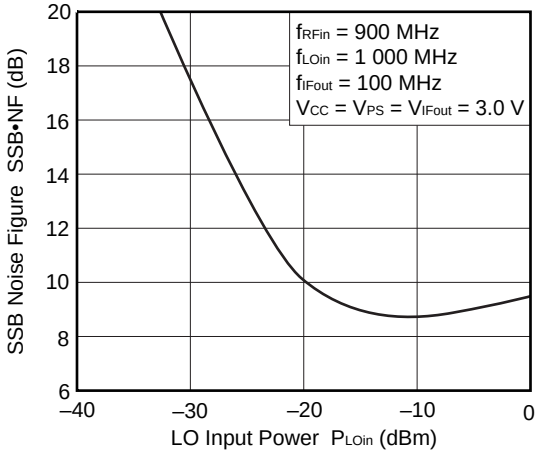

CONVERSION GAIN vs. LO INPUT POWER



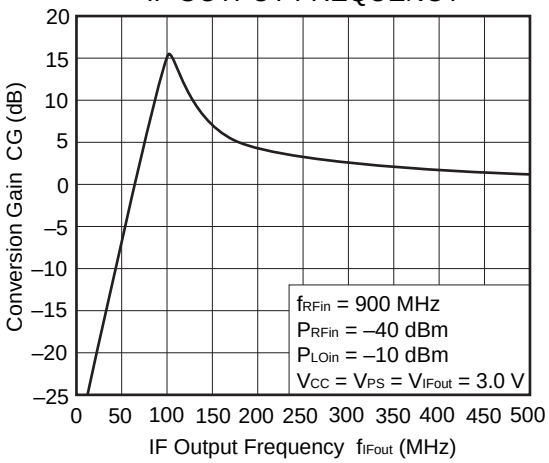
CONVERSION GAIN vs. SUPPLY VOLTAGE




SSB NOISE FIGURE vs. LO INPUT POWER

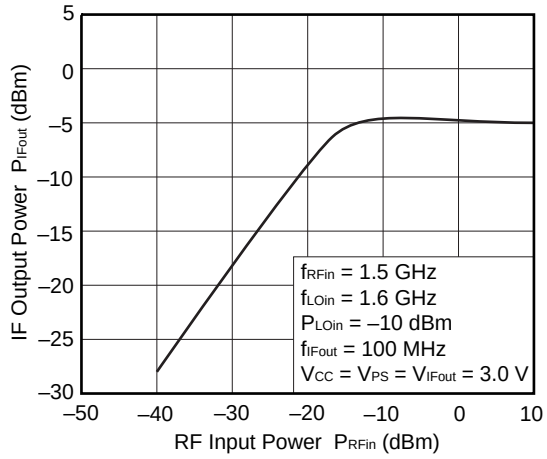



CONVERSION GAIN vs.
IF OUTPUT FREQUENCY

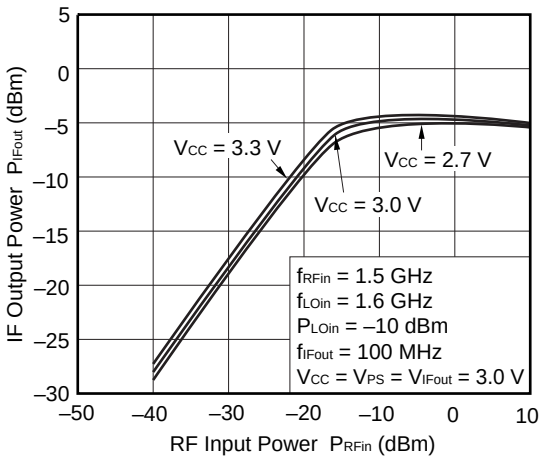


### 12.3 IF 100 MHz Matching ($f_{RFin}$ = 1.5 GHz)

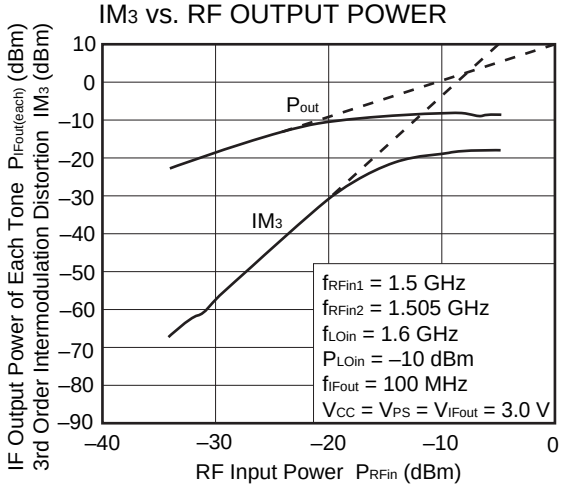
IF OUTPUT POWER vs. RF INPUT POWER



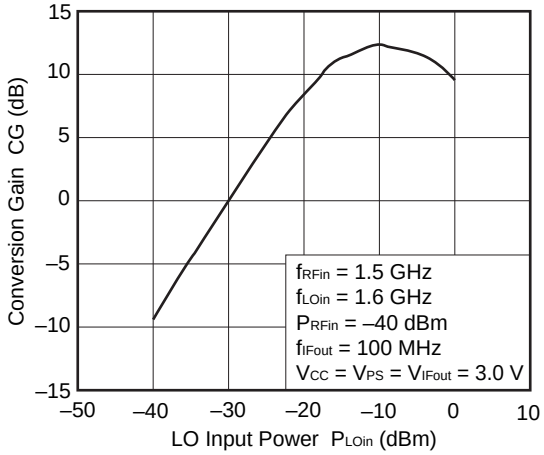

IF OUTPUT POWER vs. RF INPUT POWER



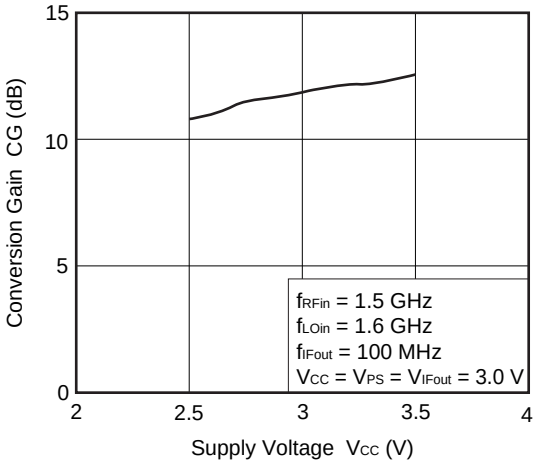

IF OUTPUT POWER OF EACH TONE, IM3 vs. RF OUTPUT POWER



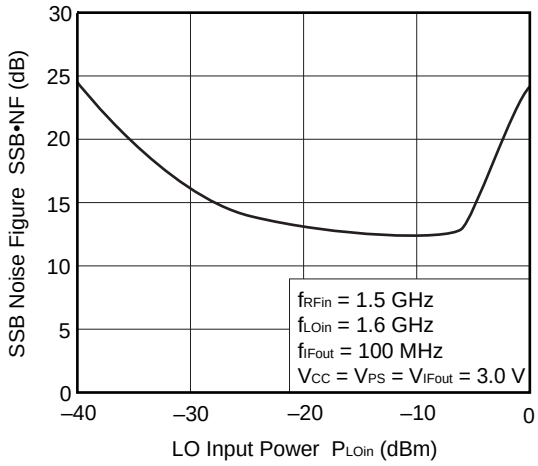

CONVERSION GAIN vs. LO INPUT POWER



CONVERSION GAIN vs. SUPPLY VOLTAGE

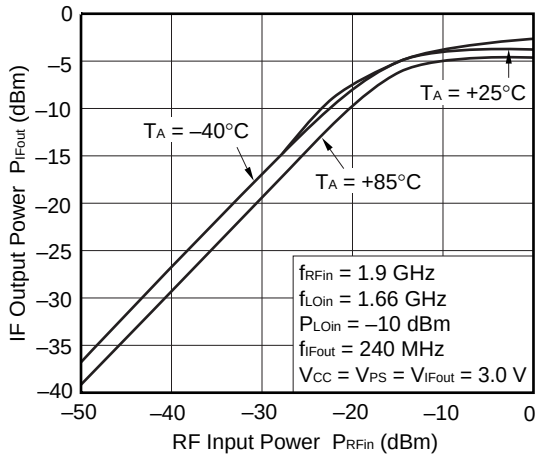



SSB NOISE FIGURE vs. LO INPUT POWER

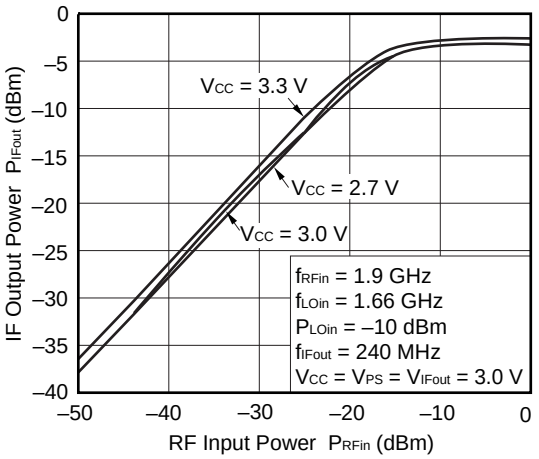


### 12.4 IF 240 MHz Matching

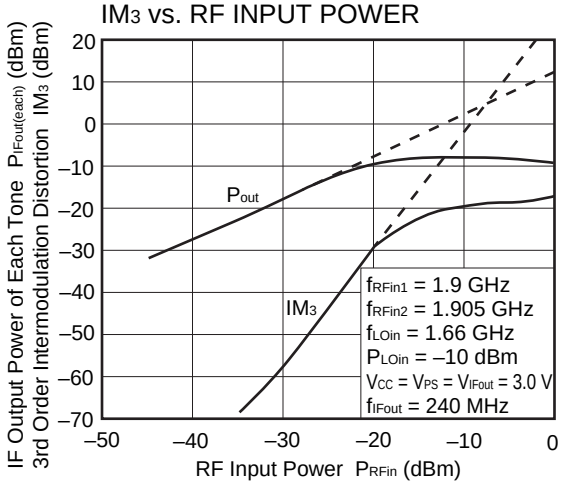
IF OUTPUT POWER vs. RF INPUT POWER



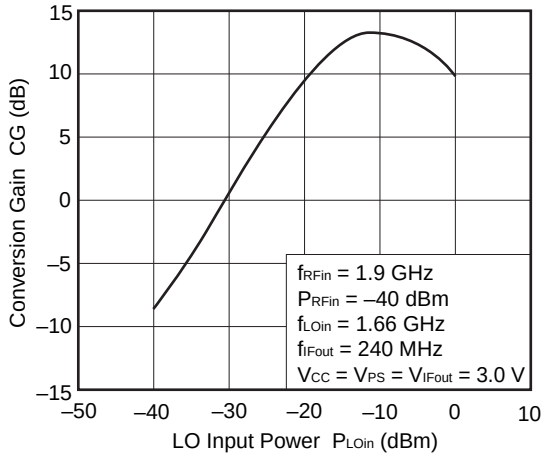

IF OUTPUT POWER vs. RF INPUT POWER



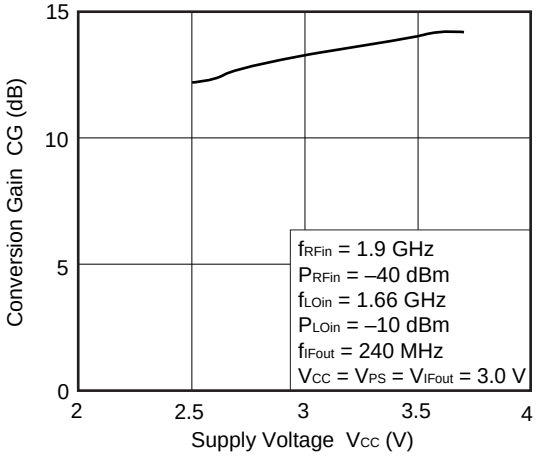

IF OUTPUT POWER OF EACH TONE, IM3 vs. RF INPUT POWER



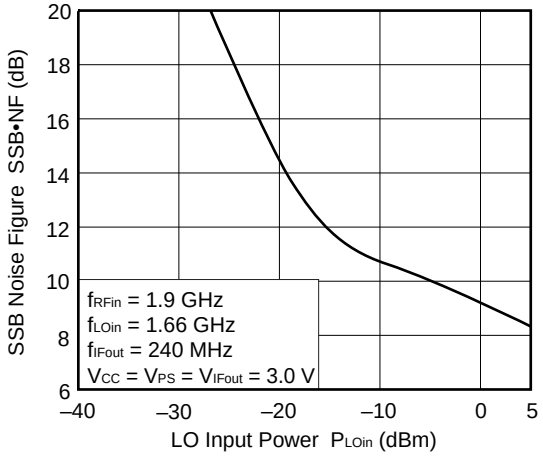

CONVERSION GAIN vs. LO INPUT POWER



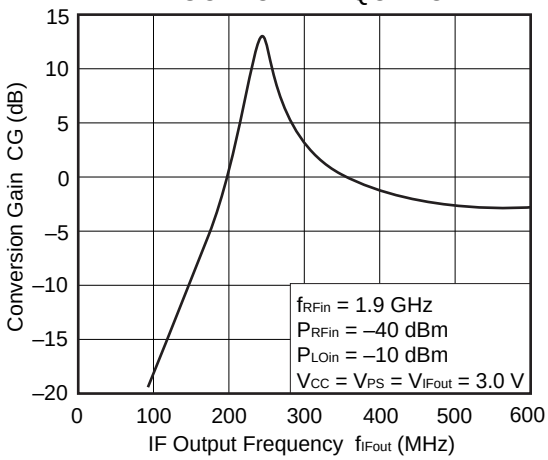
CONVERSION GAIN vs. SUPPLY VOLTAGE



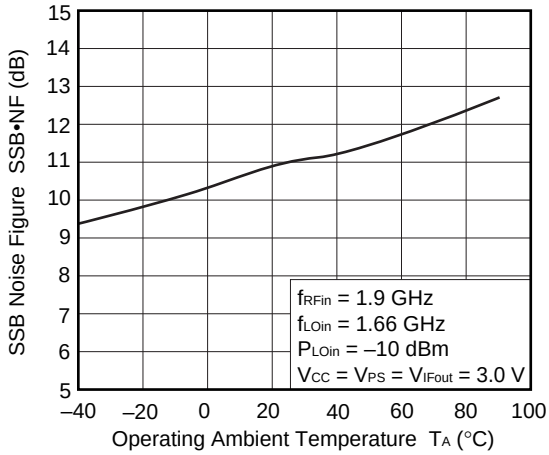

SSB NOISE FIGURE vs. LO INPUT POWER




CONVERSION GAIN vs.
IF OUTPUT FREQUENCY




SSB NOISE FIGURE vs.
OPERATING AMBIENT TEMPERATURE

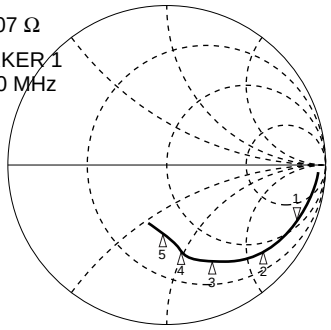



**Remark** The graphs indicate nominal characteristics.

## 13. S-PARAMETERS

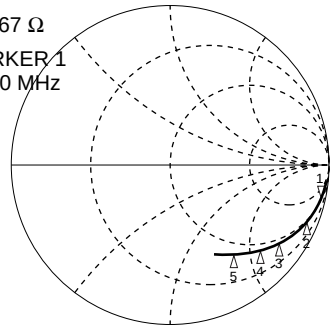
### 13.1 Calibrated on pin of DUT

S11 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 62.711 Ω –224.07 Ω
MARKER 1
500.0 MHz



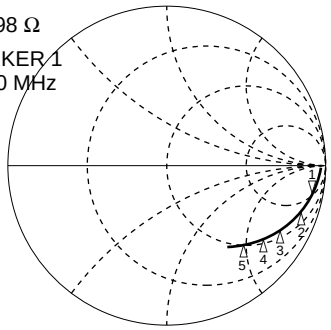

RF PORT
$V_{CC}$ = $V_{PS}$ = 3.0V
1:500 MHz 62.711 Ω-j224.07 Ω
2:900 MHz 48.977 Ω-j219.18 Ω
3:1 500 MHz 40.641 Ω-j129.94 Ω
4:1 900 MHz 37.422 Ω-j101.51 Ω
5:2 500 MHz 34.801 Ω-j74.141 Ω

S11 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 76.656 Ω –421.67 Ω
MARKER 1
500.0 MHz



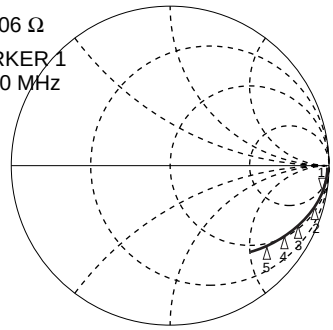

RF PORT
$V_{CC}$ = 3.0V $V_{PS}$ = GND
1:500 MHz 76.656 Ω-j421.67 Ω
2:900 MHz 53.102 Ω-j234.55 Ω
3:1 500 MHz 44.844 Ω-j140.82 Ω
4:1 900 MHz 40.898 Ω-j109.73 Ω
5:2 500 MHz 38.063 Ω-j80.547 Ω

S11 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 169.11 Ω –429.98 Ω
MARKER 1
500.0 MHz



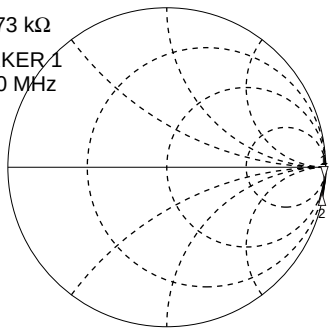

LO PORT
$V_{CC}$ = $V_{PS}$ = 3.0V
1:500 MHz 169.11 Ω-j429.98 Ω
2:900 MHz 91.875 Ω-j263.7 Ω
3:1 500 MHz 60.781 Ω-j162.56 Ω
4:1 900 MHz 56.789 Ω-j125.66 Ω
5:2 500 MHz 49.652 Ω-j97.602 Ω

S11 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 135.53 Ω –575.06 Ω
MARKER 1
500.0 MHz



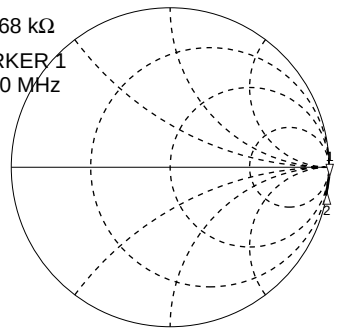

LO PORT
$V_{CC}$ = 3.0V $V_{PS}$ = GND
1:500 MHz 135.53 Ω-j575.06 Ω
2:900 MHz 78.266 Ω-j337.66 Ω
3:1 500 MHz 55.883 Ω-j201.43 Ω
4:1 900 MHz 52.734 Ω-j159.63 Ω
5:2 500 MHz 44.262 Ω-j122.66 Ω

S22 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 201.00 Ω –1.7173 kΩ
MARKER 1
100.0 MHz




IF PORT
$V_{CC}$ = $V_{PS}$ = 3.0V
1:100 MHz 201.88 Ω-j1.7173 kΩ
2:240 MHz 92.094 Ω-j715.72 Ω

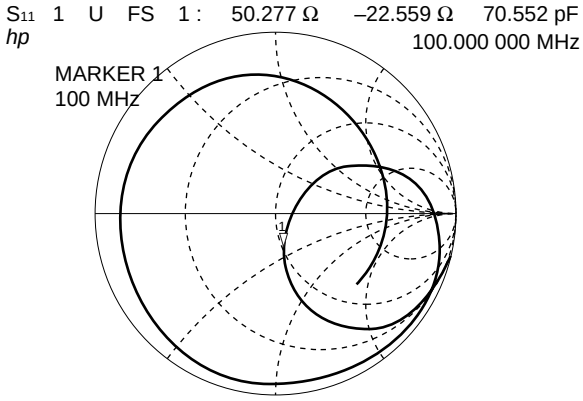
S22 Z
REF 1.0 Units
1/▽ 200.0 mUnits/
*hp* 056.56 Ω –1.7468 kΩ
MARKER 1
100.0 MHz

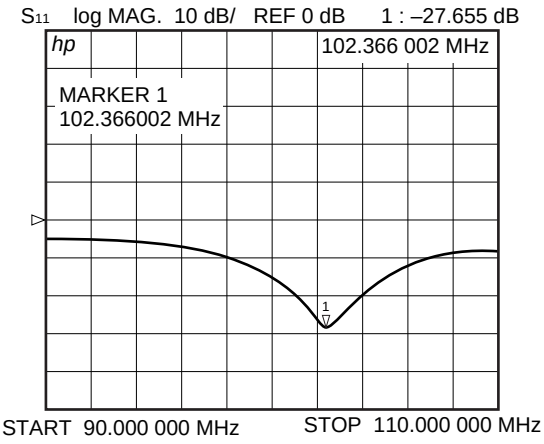



IF PORT
$V_{CC}$ = 3.0V $V_{PS}$ = GND
1:100 MHz 56.56 Ω-j1.7468 kΩ
2:240 MHz 85.5 Ω-j722.22 Ω

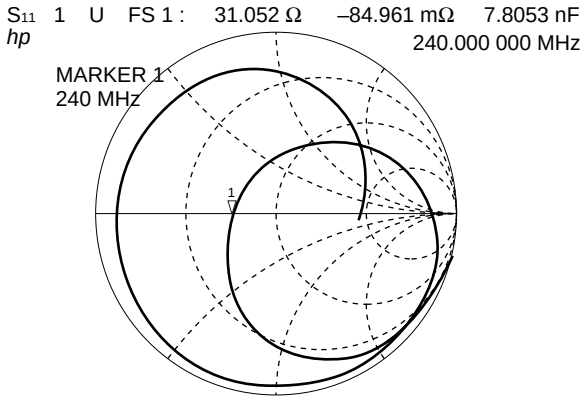
### 13.2 IF Output Matching ($V_{CC}$ = $V_{PS}$ = $V_{IFout}$ = 3.0 V) –on Test Circuit– (This $S_{11}$ is monitored at IF connector on test circuit fixture)

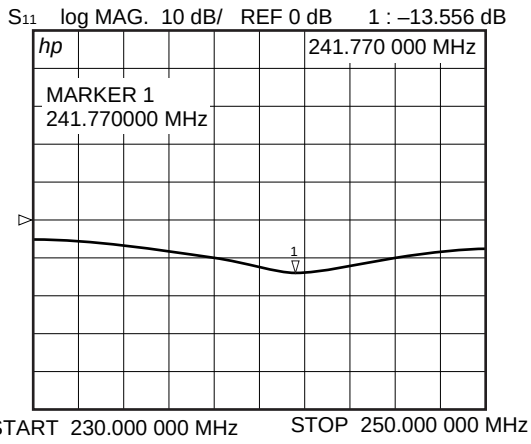
**IF 100 MHz MATCHING**




**IF 240 MHz MATCHING**



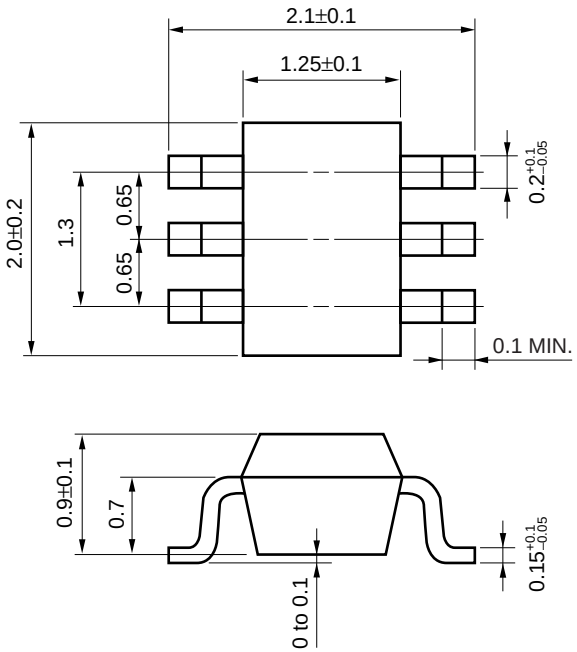




The data in this page are to make clear the test condition of impedance matched to next stage, not specify the recommended condition. The $S_{11}$ smith charts of the test fixture setting IC are normalized to $Z_O$ = 50 Ω, because the IC's load is the measurement equipment of 50 Ω impedance.

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

## 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 $V_{CC}$ 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 nearby sales office.

| Soldering Method | Soldering Condition | Recommended Condition Symbol |
|---|---|---|
| Infrared Reflow | Package peak temperature: 235°C or below<br>Time: 30 seconds or less (at 210°C)<br>Count: 3, Exposure limit: None[Note] | IR35-00-3 |
| VPS | Package peak temperature: 215°C or below<br>Time: 40 seconds or less (at 200°C)<br>Count: 3, Exposure limit: None[Note] | VP15-00-3 |
| Wave Soldering | Soldering bath temperature: 260°C or below<br>Time: 10 seconds or less<br>Count: 1, Exposure limit: None[Note] | WS60-00-1 |
| Partial Heating | Pin temperature: 300°C<br>Time: 3 seconds or less (per side of device)<br>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).

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