DATA SHEET

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC8172TB

## SILICON MMIC 2.5 GHz FREQUENCY UP-CONVERTER FOR WIRELESS TRANSCEIVER

### DESCRIPTION

The μPC8172TB is a silicon monolithic integrated circuit designed as frequency up-converter for wireless transceiver transmitter stage.

This IC is as same circuit current as conventional μPC8106TB, but operates at higher frequency, higher gain and lower distortion. Consequently this IC is suitable for mobile communications.

### FEATURES

- Recommended operating frequency : $f_{RFout}$ = 0.8 to 2.5 GHz
- Higher $IP_3$ : CG = 9.5 dB TYP., $OIP_3$ = +7.5 dBm TYP. @ $f_{RFout}$ = 0.9 GHz
- High-density surface mounting : 6-pin super minimold package
- Supply voltage : $V_{CC}$ = 2.7 to 3.3 V

### APPLICATIONS

- PCS1900M
- 2.4 GHz band transmitter/receiver system (wireless LAN etc.)

### ORDERING INFORMATION

| Part Number | Package | Marking | Supplying Form |
|---|---|---|---|
| μPC8172TB-E3 | 6-pin super minimold | C3A | • Embossed tape 8 mm wide.<br>• Pin 1, 2, 3 face the tape perforation side.<br>• Qty 3 kpcs/reel. |

**Remark** To order evaluation samples, please contact your nearby sales office.
(Part number for sample order: μPC8172TB-A)

**Caution Electro-static sensitive devices**



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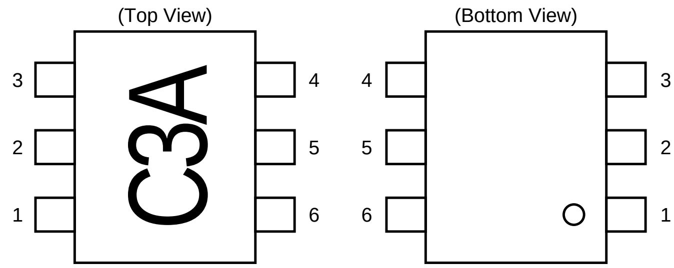
**The mark ★ shows major revised points.**

## PIN CONNECTIONS




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

## SERIES PRODUCTS ($T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$ = 3.0 V, $Z_S$ = $Z_L$ = 50 Ω)

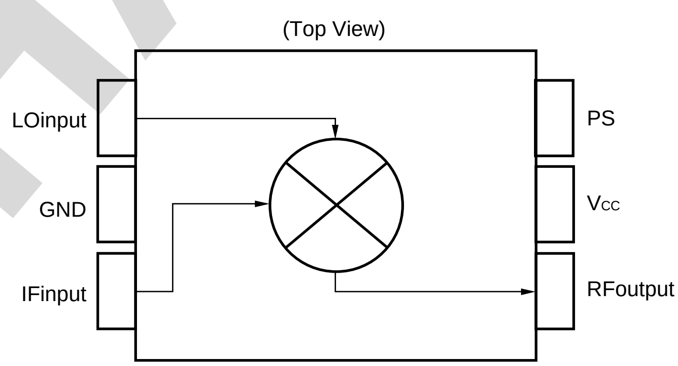
| Part Number | $I_{CC}$ (mA) | $f_{RFout}$ (GHz) | CG (dB) | | |
|---|---|---|---|---|---|
| | | | @RF 0.9 GHz[Note] | @RF 1.9 GHz | @RF 2.4 GHz |
| μPC8172TB | 9 | 0.8 to 2.5 | 9.5 | 8.5 | 8.0 |
| μPC8106TB | 9 | 0.4 to 2.0 | 9 | 7 | – |
| μPC8109TB | 5 | 0.4 to.2.0 | 6 | 4 | – |
| μPC8163TB | 16.5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

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

**Note** $f_{RFout}$ = 0.83 GHz @ μPC8163TB

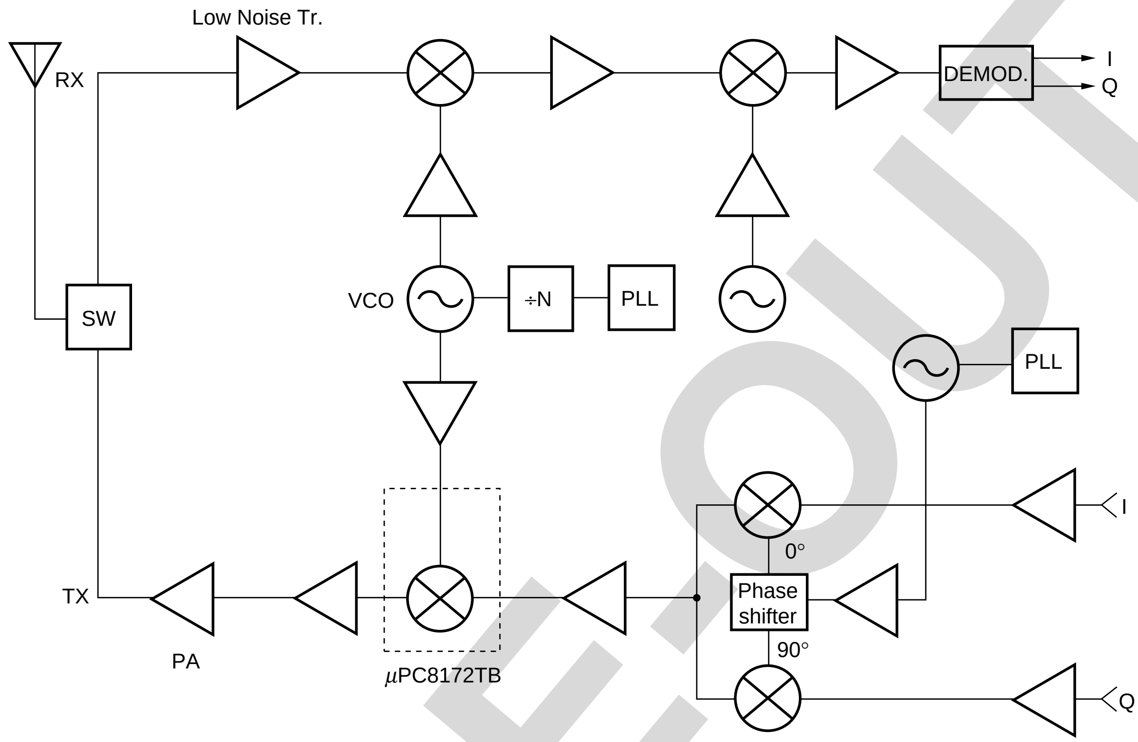
**Remark** Typical performance. Please refer to **ELECTRICAL CHARACTERISTICS** in detail.
To know the associated product, please refer to each latest data sheet.

## BLOCK DIAGRAM (FOR THE μPC8172TB)



## SYSTEM APPLICATION EXAMPLES (SCHEMATICS OF IC LOCATION IN THE SYSTEM)

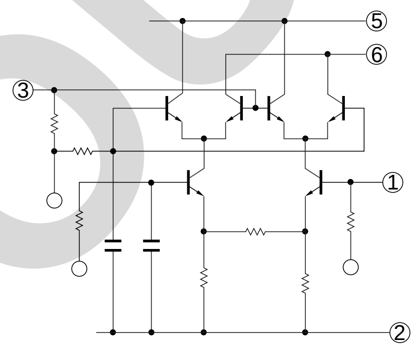
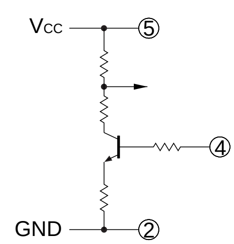
**Wireless Transceiver**




To know the associated products, please refer to each latest data sheet.

## CONTENTS

## 1. PIN EXPLANATION

| Pin No. | Pin Name | Applied Voltage (V) | Pin Voltage (V)[Note] | Function and Explanation | Equivalent Circuit |
|---|---|---|---|---|---|
| 1 | IFinput | – | 1.4 | This pin is IF input to double balanced mixer (DBM). The input is designed as high impedance. The circuit contributes to suppress spurious signal. Also this symmetrical circuit can keep specified performance insensitive to process-condition distribution. For above reason, double balanced mixer is adopted. |  |
| 2 | GND | GND | – | GND pin. Ground pattern on the board should be formed as wide as possible. Track Length should be kept as short as possible to minimize ground impedance. | |
| 3 | LOinput | – | 2.3 | Local input pin. Recommendable input level is –10 to 0 dBm. | |
| 5 | $V_{CC}$ | 2.7 to 3.3 | – | Supply voltage pin. | |
| 6 | RFoutput | Same bias as $V_{CC}$ through external inductor | – | This pin is RF output from DBM. This pin is designed as open collector. Due to the high impedance output, this pin should be externally equipped with LC matching circuit to next stage. | |
| 4 | PS | $V_{CC}$/GND | – | Power save control pin. Bias controls operation as follows.<br>Pin bias / Control:<br>$V_{CC}$ — Operation<br>GND — Power Save |  |

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

## ★ 2. ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Test Conditions | Rating | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | $T_A$ = +25°C | 3.6 | V |
| PS pin Input Voltage | $V_{PS}$ | $T_A$ = +25°C | 3.6 | V |
| Power Dissipation of Package | $P_D$ | Mounted on double-side copperclad 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 |
| Input Power | $P_{in}$ | | +10 | dBm |

## 3. RECOMMENDED OPERATING CONDITIONS

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | The same voltage should be applied to pin 5 and 6 | 2.7 | 3.0 | 3.3 | V |
| Operating Ambient Temperature | $T_A$ | | –40 | +25 | +85 | °C |
| Local Input Level | $P_{LOin}$ | $Z_S$ = 50 Ω (without matching) | –10 | –5 | 0 | dBm |
| RF Output Frequency | $f_{RFout}$ | With external matching circuit | 0.8 | – | 2.5 | GHz |
| IF Input Frequency | $f_{IFin}$ | | 50 | – | 400 | MHz |

## 4. ELECTRICAL CHARACTERISTICS

**($T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$ = 3.0 V, $f_{IFin}$ = 240 MHz, $P_{LOin}$ = –5 dBm, and $V_{PS}$ ≥ 2.7 V unless otherwise specified)**

| Parameter | Symbol | Test Conditions Note | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Circuit Current | $I_{CC}$ | No Signal | 5.5 | 9.0 | 13 | mA |
| Circuit Current In Power Save Mode | $I_{CC(PS)}$ | $V_{PS}$ = 0 V | – | – | 2 | μA |
| Conversion Gain | CG1 | $f_{RFout}$ = 0.9 GHz, $P_{IFin}$ = –30 dBm | 6.5 | 9.5 | 12.5 | dB |
| | CG2 | $f_{RFout}$ = 1.9 GHz, $P_{IFin}$ = –30 dBm | 5.5 | 8.5 | 11.5 | dB |
| | CG3 | $f_{RFout}$ = 2.4 GHz, $P_{IFin}$ = –30 dBm | 5 | 8.0 | 11.0 | dB |
| Saturated RF Output Power | $P_{O(sat)}1$ | $f_{RFout}$ = 0.9 GHz, $P_{IFin}$ = 0 dBm | –2.5 | +0.5 | – | dBm |
| | $P_{O(sat)}2$ | $f_{RFout}$ = 1.9 GHz, $P_{IFin}$ = 0 dBm | –3.5 | 0 | – | dBm |
| | $P_{O(sat)}3$ | $f_{RFout}$ = 2.4 GHz, $P_{IFin}$ = 0 dBm | –4 | –0.5 | – | dBm |

**Note** $f_{RFout} < f_{Loin}$ @ $f_{RFout}$ = 0.9 GHz
$f_{Loin} < f_{RFout}$ @ $f_{RFout}$ = 1.9 GHz/2.4 GHz

## 5. OTHER CHARACTERISTICS, FOR REFERENCE PURPOSES ONLY

**($T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$ = 3.0 V, $P_{LOin}$ = –5 dBm, and $V_{PS}$ ≥ 2.7 V unless otherwise specified)**

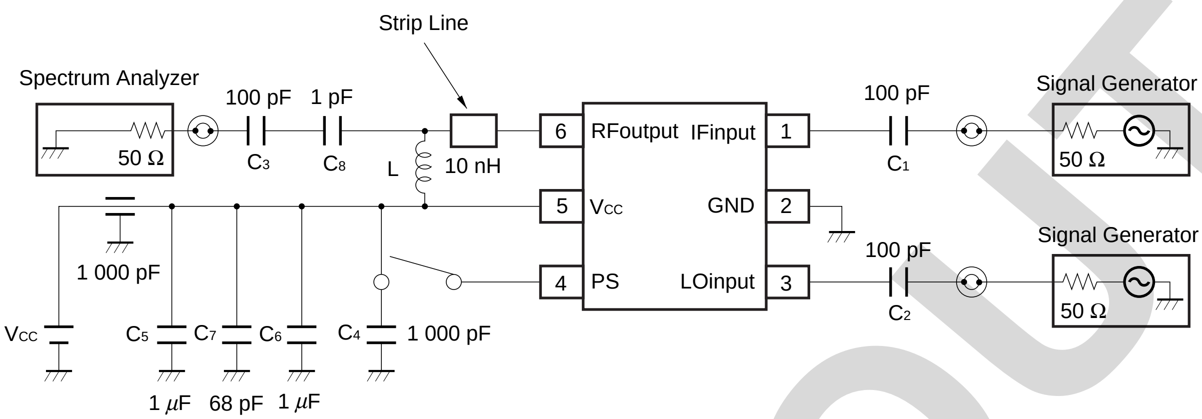
| Parameter | | Symbol | Test Conditions[Note] | | Data | Unit |
|---|---|---|---|---|---|---|
| Output Third-Order Distortion Intercept Point | | $OIP_3$1 | $f_{RFout}$ = 0.9 GHz | $f_{IFin}$1 = 240 MHz, $f_{IFin}$2 = 241 MHz | +7.5 | dBm |
| | | $OIP_3$2 | $f_{RFout}$ = 1.9 GHz | | +6.0 | dBm |
| | | $OIP_3$3 | $f_{RFout}$ = 2.4 GHz | | +4.0 | dBm |
| Input Third-Order Distortion Intercept Point | | $IIP_3$1 | $f_{RFout}$ = 0.9 GHz | $f_{IFin}$1 = 240 MHz, $f_{IFin}$2 = 241 MHz | –2.0 | dBm |
| | | $IIP_3$2 | $f_{RFout}$ = 1.9 GHz | | –2.5 | dBm |
| | | $IIP_3$3 | $f_{RFout}$ = 2.4 GHz | | –4.0 | dBm |
| SSB Noise Figure | | SSB•NF1 | $f_{RFout}$ = 0.9 GHz, $f_{IFin}$ = 240 MHz | | 9.5 | dB |
| | | SSB•NF2 | $f_{RFout}$ = 1.9 GHz, $f_{IFin}$ = 240 MHz | | 10.4 | dB |
| | | SSB•NF3 | $f_{RFout}$ = 2.4 GHz, $f_{IFin}$ = 240 MHz | | 10.6 | dB |
| Power Save Response Time | Rise time | $T_{PS(rise)}$ | $V_{PS}$: GND → $V_{CC}$ | | 1 | μs |
| | Fall time | $T_{PS(fall)}$ | $V_{PS}$: $V_{CC}$ → GND | | 1.5 | μs |

**Note** $f_{RFout}$ < $f_{LOin}$ @ $f_{RFout}$ = 0.9 GHz

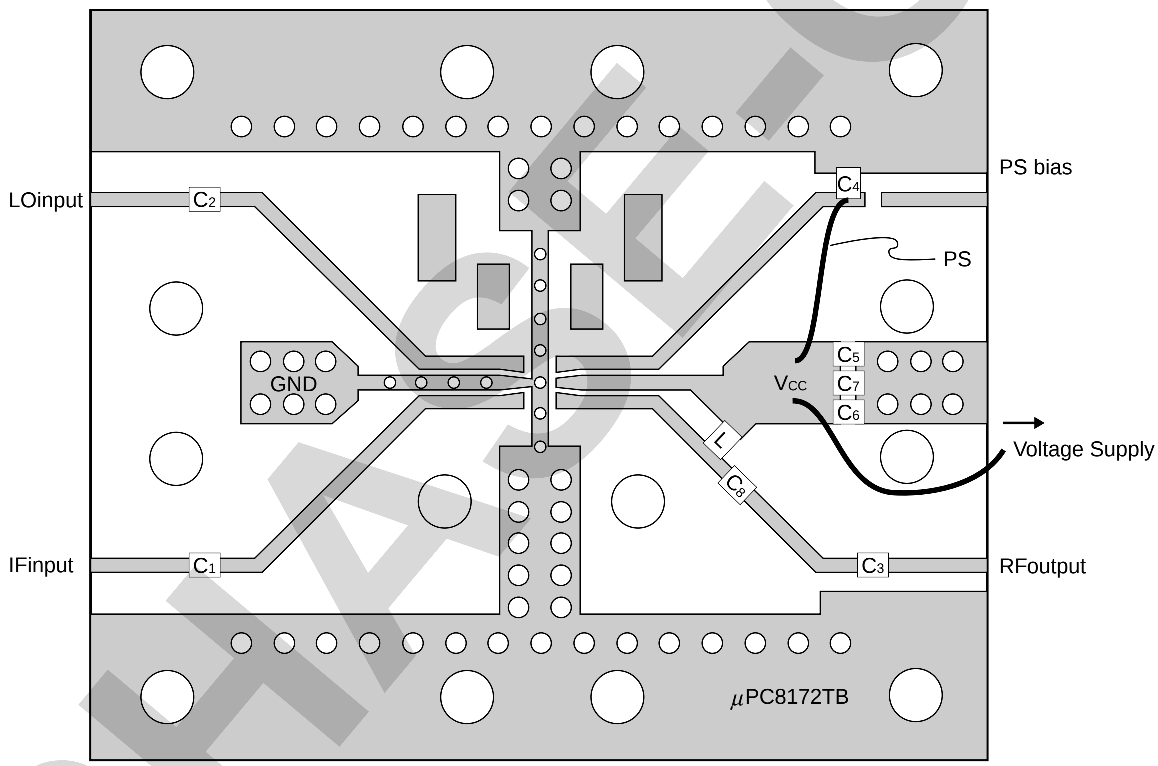
$f_{LOin}$ < $f_{RFout}$ @ $f_{RFout}$ = 1.9 GHz/2.4 GHz

## 6. TEST CIRCUIT

### ★ 6.1 TEST CIRCUIT 1 ($f_{RFout}$ = 900 MHz)




### EXAMPLE OF TEST CIRCUIT 1 ASSEMBLED ON EVALUATION BOARD



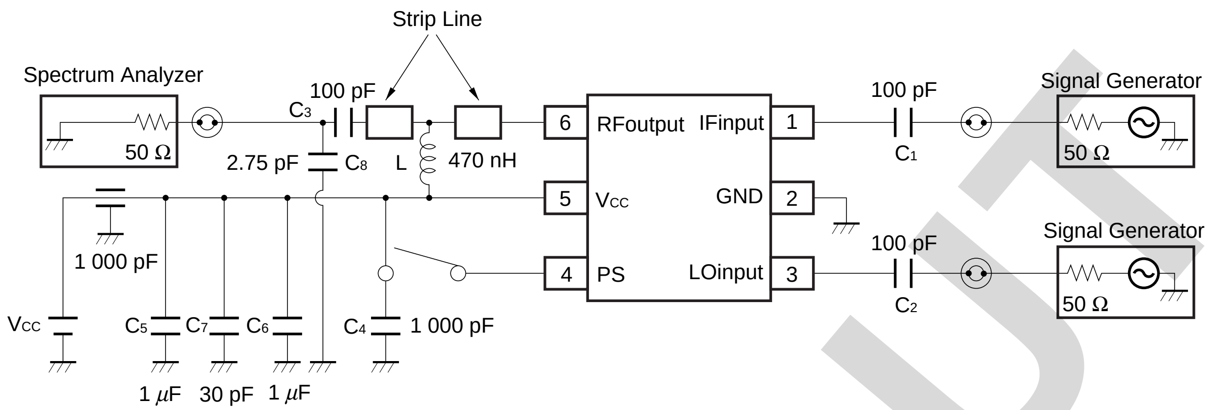

### COMPONENT LIST

| Form | Symbol | Value |
|---|---|---|
| Chip capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1 000 pF |
| | C5, C6 | 1 μF |
| | C7 | 68 pF |
| | C8 | 1 pF |
| Chip inductor | L | 10 nH Note |

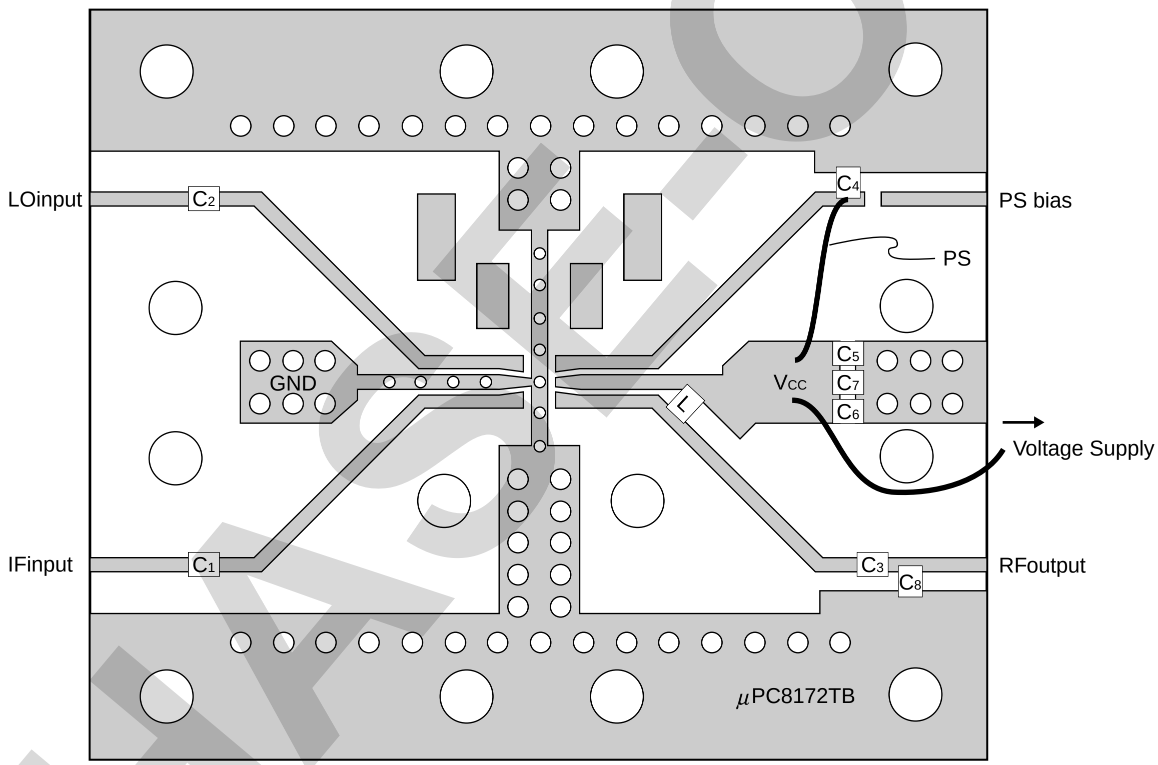
(∗1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Ground pattern on rear of the board
(∗3) Solder plated patterns
(∗4) ○○◯: Through holes

**Note** 10 nH: LL1608-FH10N (TOKO Co., Ltd.)

★ ## 6.2 TEST CIRCUIT 2 ($f_{RFout}$ = 1.9 GHz)




## EXAMPLE OF TEST CIRCUIT 2 ASSEMBLED ON EVALUATION BOARD



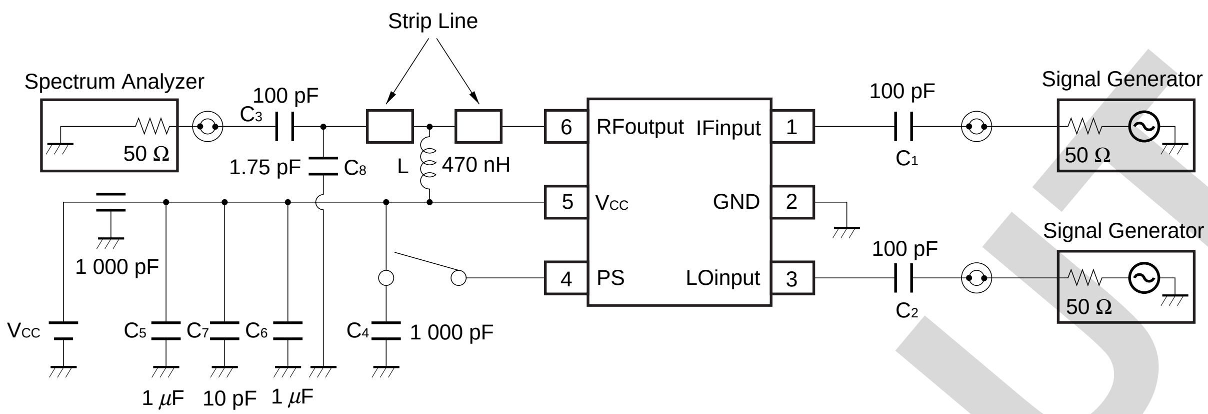

## COMPONENT LIST

| Form | Symbol | Value |
|---|---|---|
| Chip capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1 000 pF |
| | C5, C6 | 1 μF |
| | C7 | 30 pF |
| | C8 | 2.75 pF |
| Chip inductor | L | 470 nH[Note] |

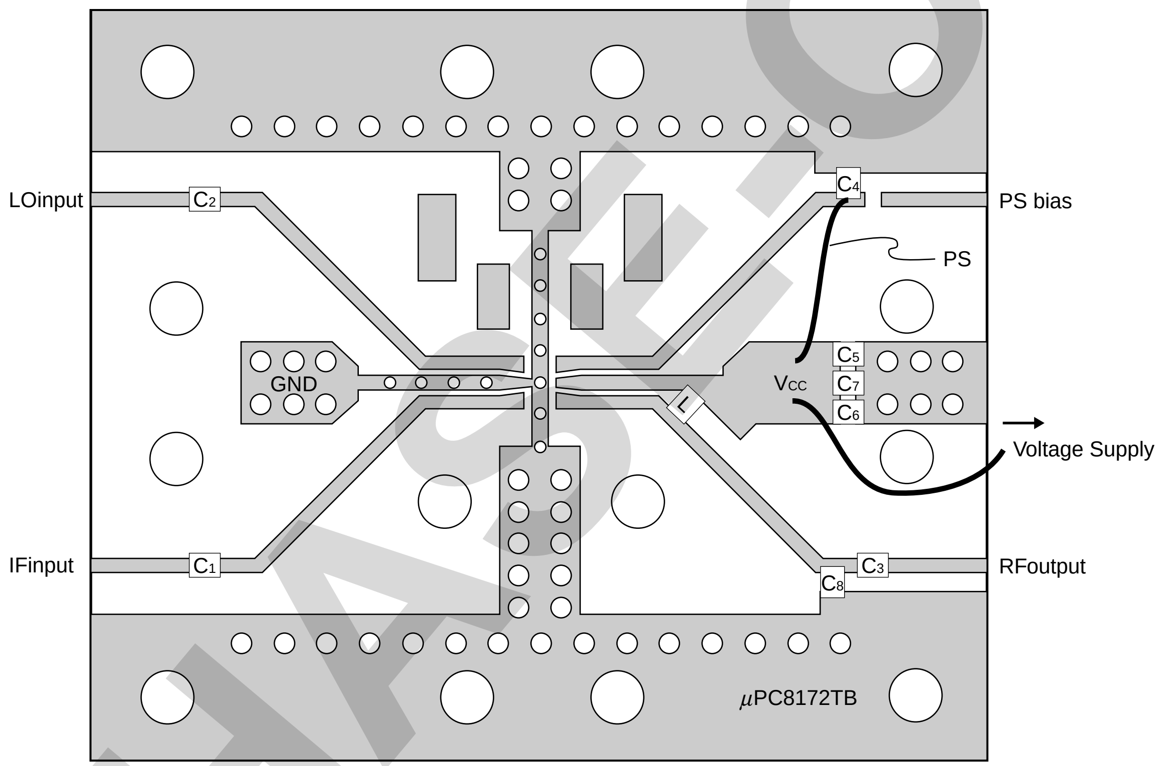
(∗1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Ground pattern on rear of the board
(∗3) Solder plated patterns
(∗4) ○○◯: Through holes

**Note** 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

## ★ 6.3 TEST CIRCUIT 3 ($f_{RFout}$ = 2.4 GHz)




## EXAMPLE OF TEST CIRCUIT 3 ASSEMBLED ON EVALUATION BOARD




## COMPONENT LIST

| Form | Symbol | Value |
|---|---|---|
| Chip capacitor | C1, C2, C3 | 100 pF |
| | C4 | 1 000 pF |
| | C5, C6 | 1 μF |
| | C7 | 10 pF |
| | C8 | 1.75 pF |
| Chip inductor | L | 470 nH[Note] |

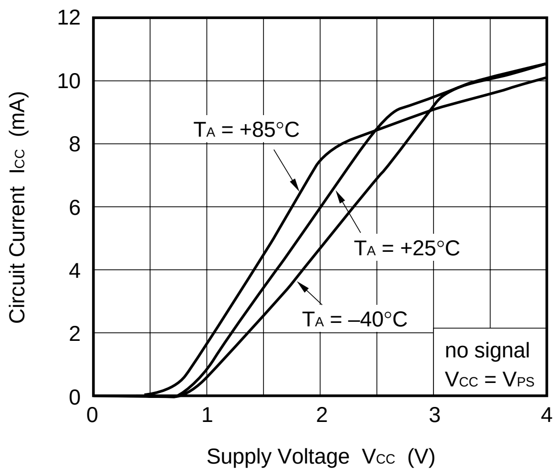
(∗1) 35 × 42 × 0.4 mm polyimide board, double-sided copper clad
(∗2) Ground pattern on rear of the board
(∗3) Solder plated patterns
(∗4) ◦ ○ ◯: Through holes

**Note** 470 nH: LL2012-FR47 (TOKO Co., Ltd.)

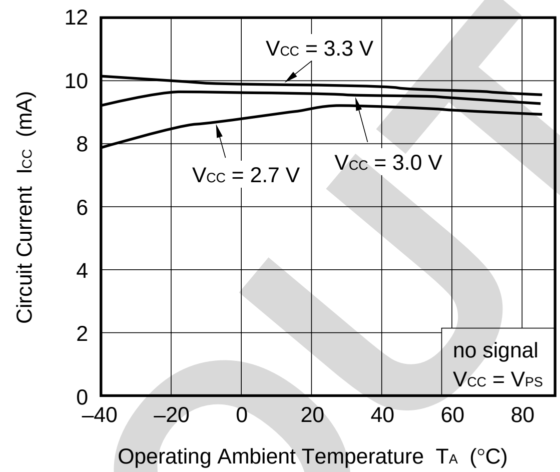
**Caution The test circuits and board pattern on data sheet are for performance evaluation use only (They are not recommended circuits). In the case of actual design-in, matching circuit should be determined using S-parameter of desired frequency in accordance to actual mounting pattern.**

## ★ 7. TYPICAL CHARACTERISTICS (Unless otherwise specified, $T_A$ = +25°C, $V_{CC}$ = $V_{RFout}$)

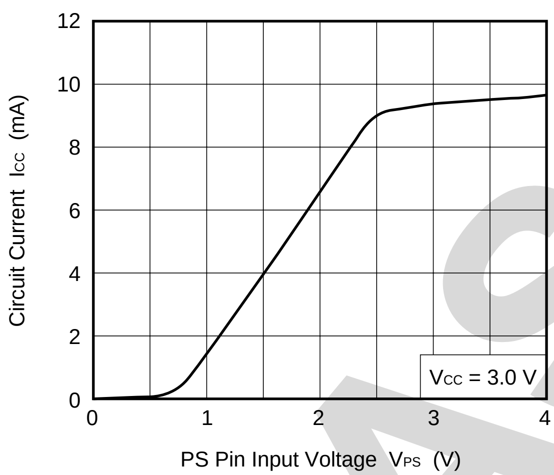
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



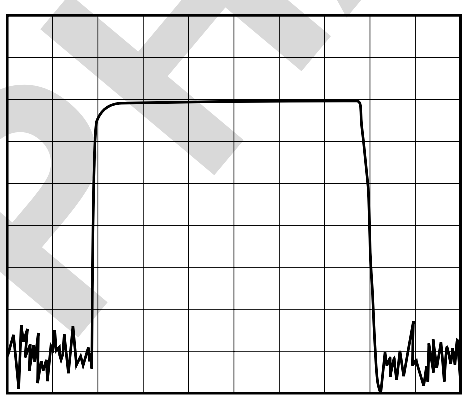

CIRCUIT CURRENT vs.
OPERATING AMBIENT TEMPERATURE




CIRCUIT CURRENT vs. PS PIN INPUT VOLTAGE



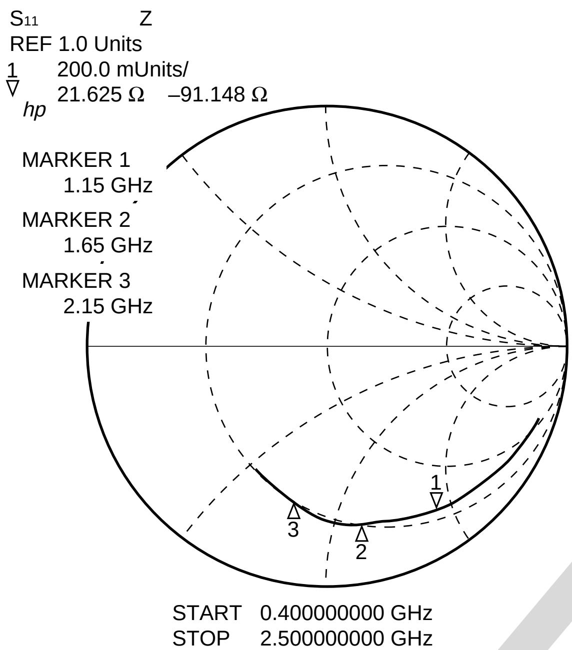

PS PIN CONTROL RESPONSE TIME



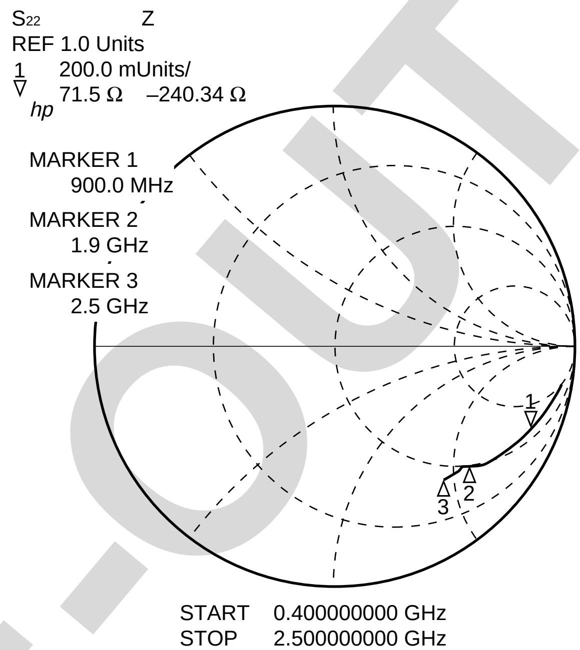
REF LVL = 0 dBm
ATT = 10 dB
10 dB/DIV (Vertical axis)
CENTER = 0.9 GHz
SPAN = 0 Hz
RBW = 3 MHz
VBW = 3 MHz
SWP = 50 μsec
5 μsec/DIV (Horizontal axis)

## ★ S-PARAMETERS FOR EACH PORT ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V)
**(The parameters are monitored at DUT pins)**

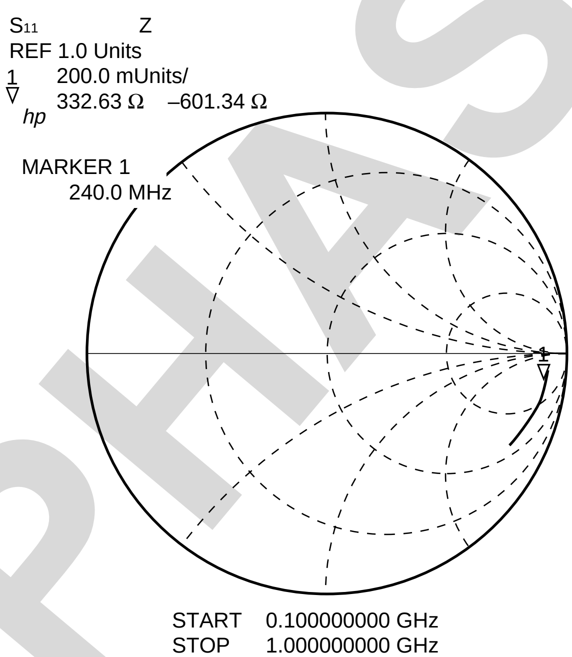
LO port




RF port (without matching)

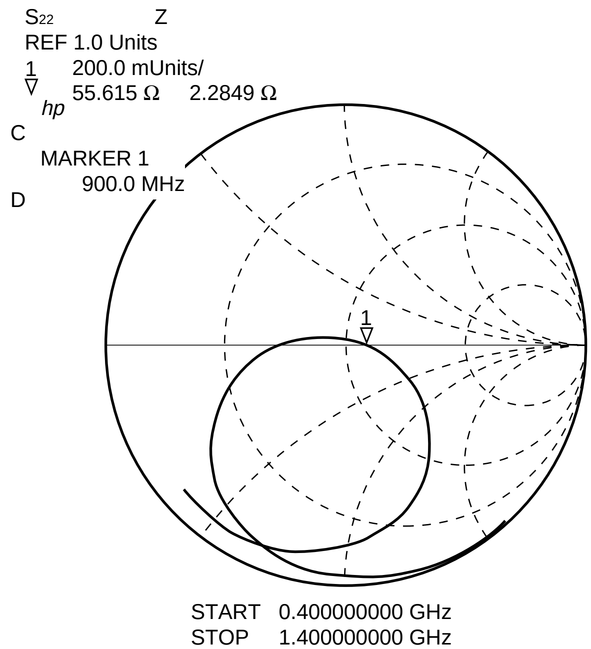



IF port

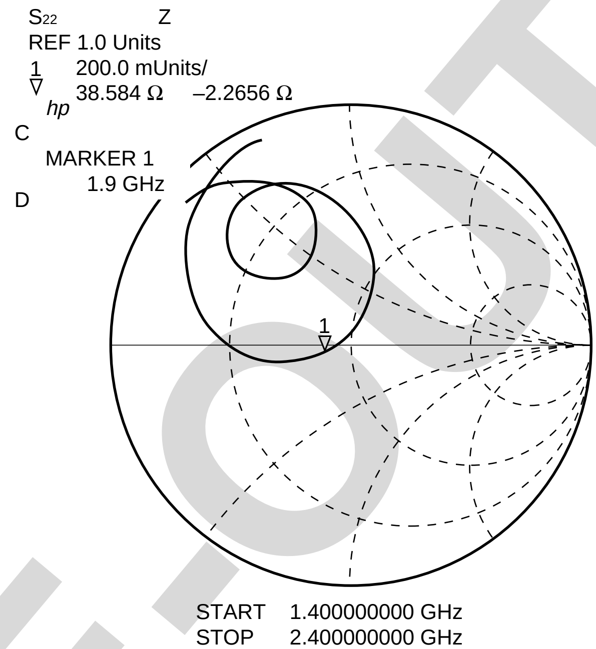


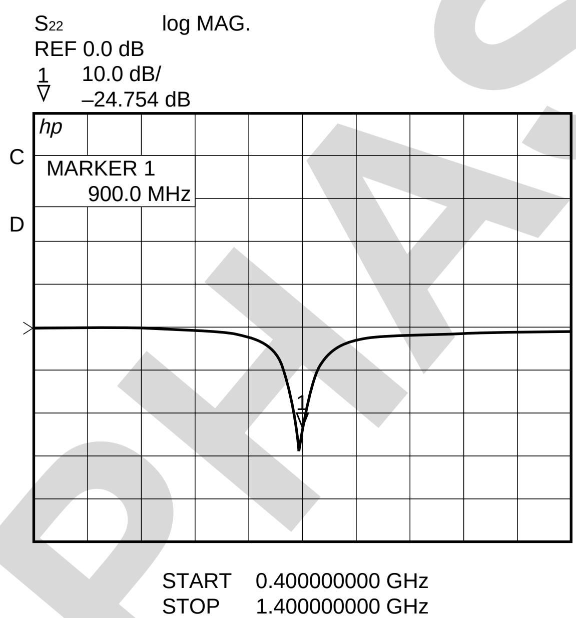
★ **S-PARAMETERS FOR MATCHED RF OUTPUT** ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V) **–ON EVALUATION BOARD–**
**($S_{22}$ data are monitored at RF connector on board)**

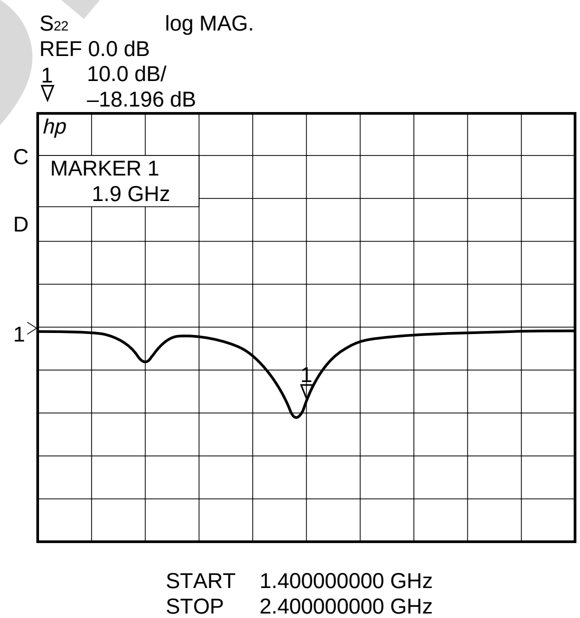
900 MHz (matched in test circuit 1)




1.9 GHz (matched in test circuit 2)

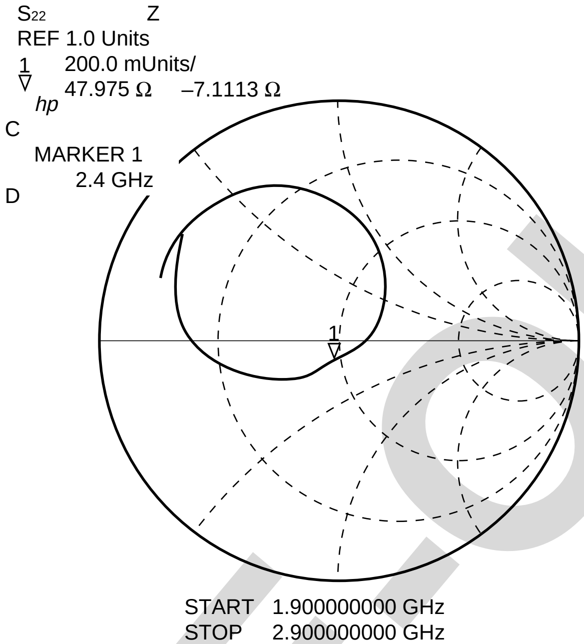


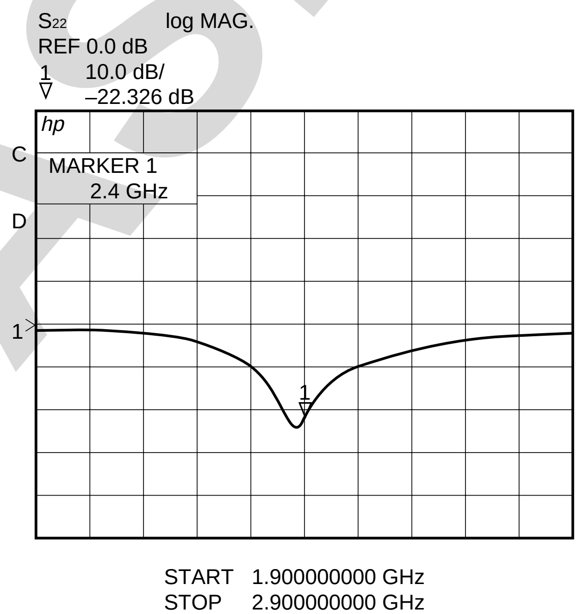



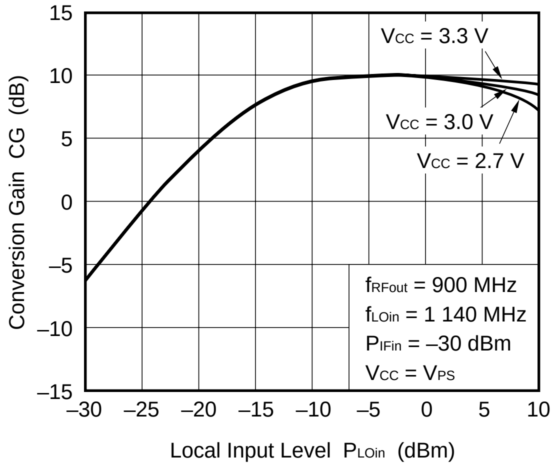
★ **S-PARAMETERS FOR MATCHED RF OUTPUT** ($V_{CC} = V_{PS} = V_{RFout} = 3.0$ V) **–ON EVALUATION BOARD–**
**($S_{22}$ data are monitored at RF connector on board)**

2.4 GHz (matched in test circuit 3)

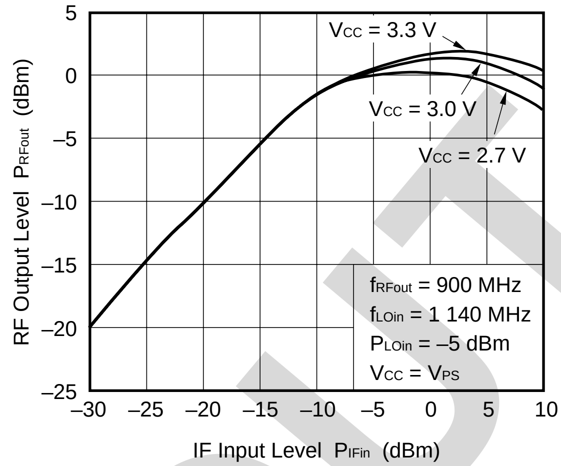


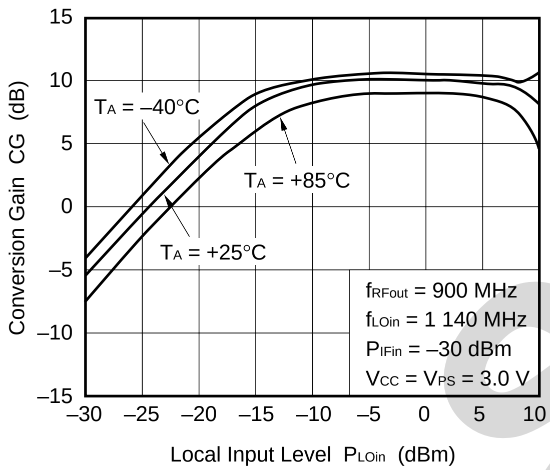
CONVERSION GAIN vs. LOCAL INPUT LEVEL



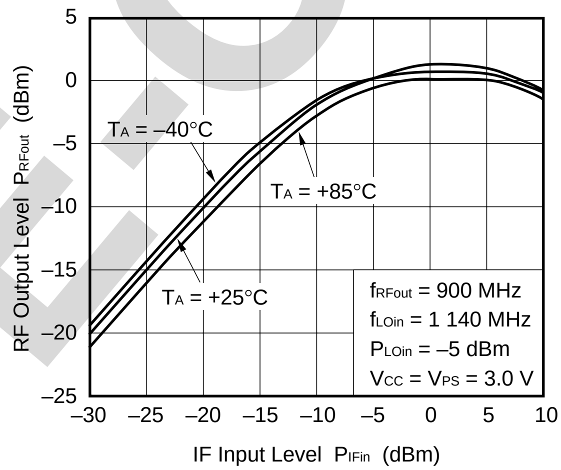

RF OUTPUT LEVEL vs. IF INPUT LEVEL



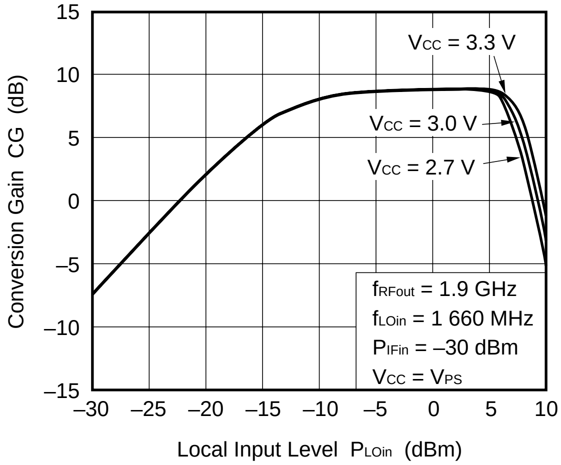

CONVERSION GAIN vs. LOCAL INPUT LEVEL



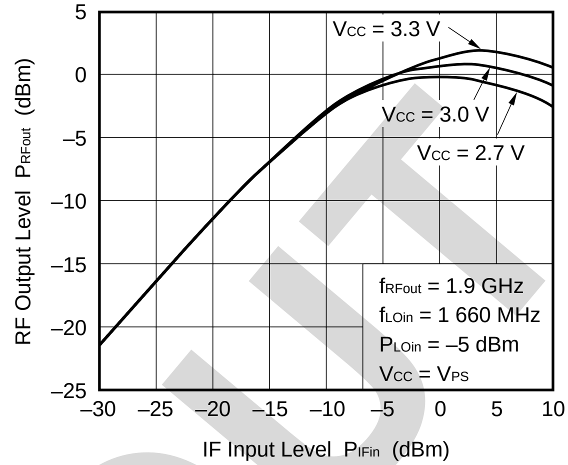

RF OUTPUT LEVEL vs. IF INPUT LEVEL



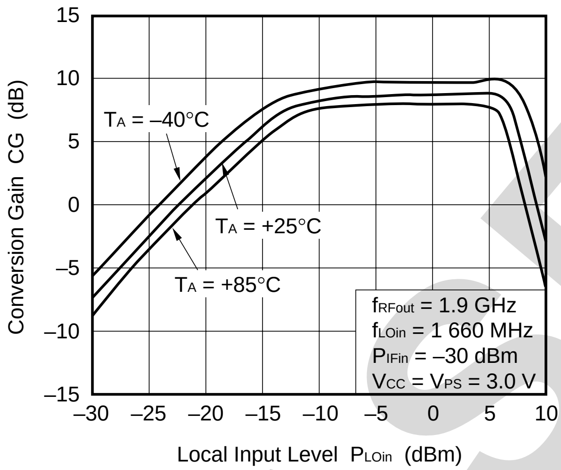
CONVERSION GAIN vs. LOCAL INPUT LEVEL



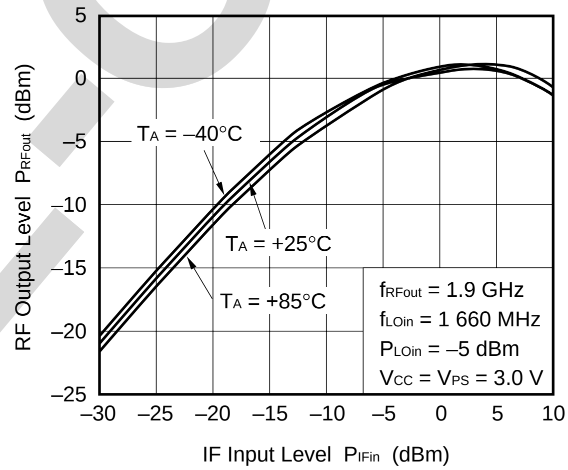

RF OUTPUT LEVEL vs. IF INPUT LEVEL



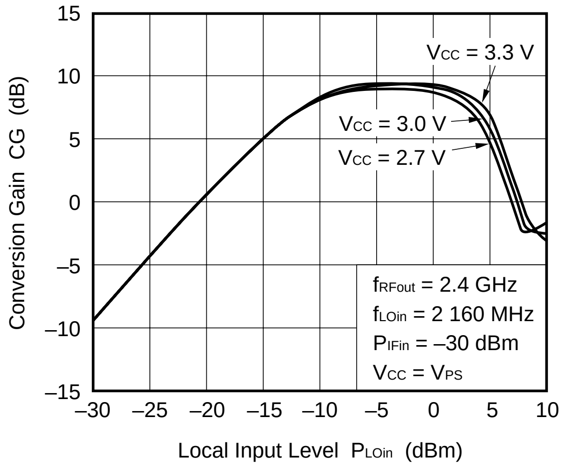

CONVERSION GAIN vs. LOCAL INPUT LEVEL



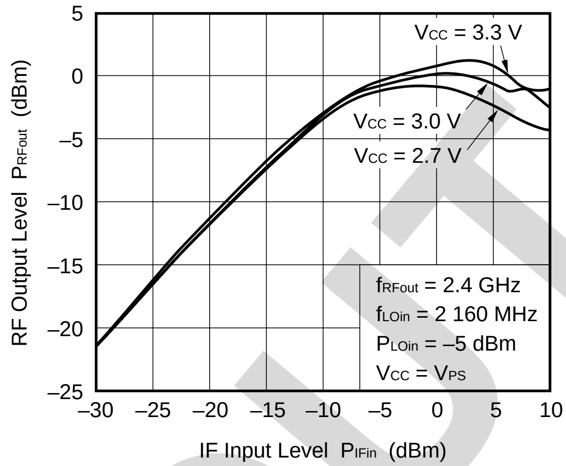

RF OUTPUT LEVEL vs. IF INPUT LEVEL



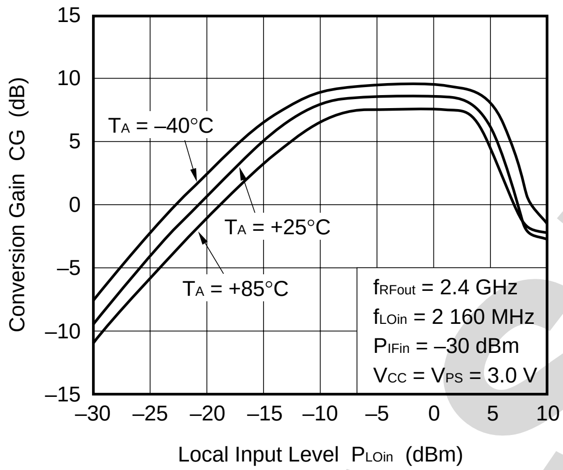
CONVERSION GAIN vs. LOCAL INPUT LEVEL



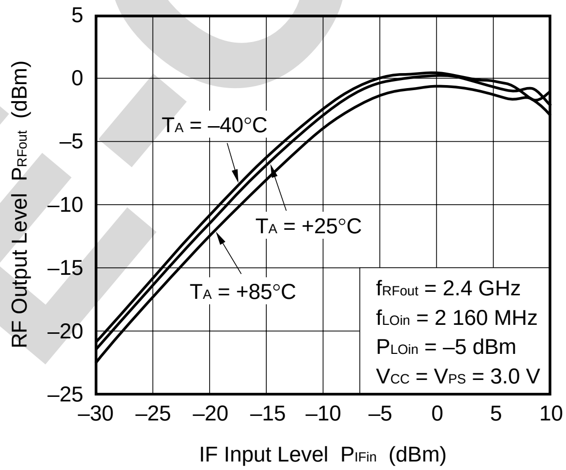

RF OUTPUT LEVEL vs. IF INPUT LEVEL

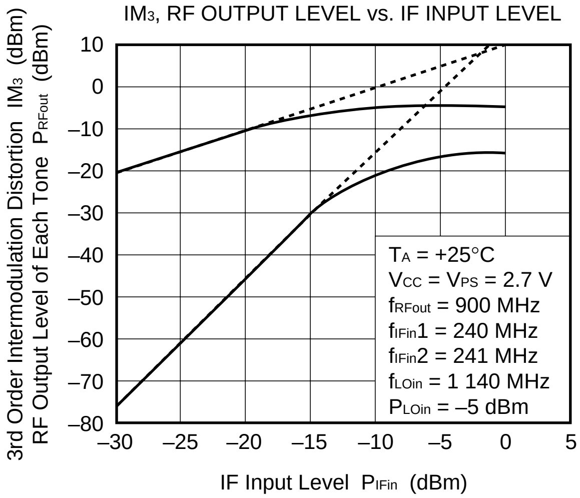


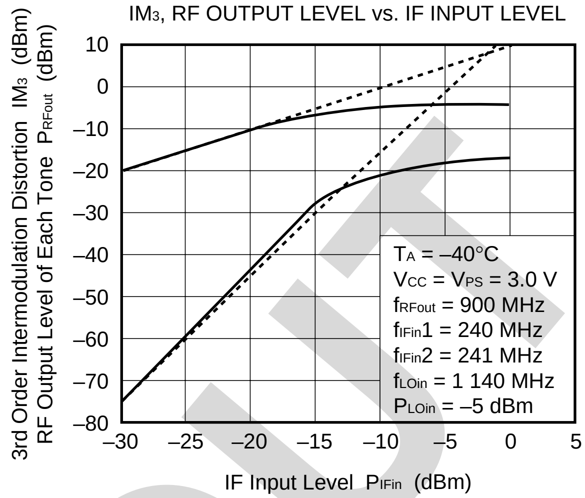

CONVERSION GAIN vs. LOCAL INPUT LEVEL

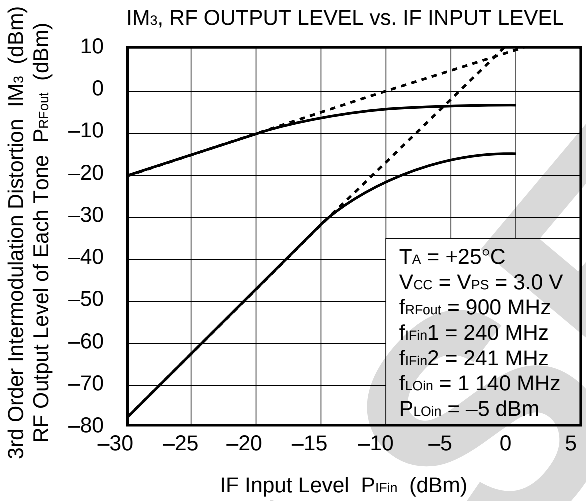



RF OUTPUT LEVEL vs. IF INPUT LEVEL




IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
IF Input Level PIFin (dBm)
TA = +25°C
VCC = VPS = 2.7 V
fRFout = 900 MHz
fIFin1 = 240 MHz
fIFin2 = 241 MHz
fLOin = 1 140 MHz
PLOin = –5 dBm


IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
IF Input Level PIFin (dBm)
TA = –40°C
VCC = VPS = 3.0 V
fRFout = 900 MHz
fIFin1 = 240 MHz
fIFin2 = 241 MHz
fLOin = 1 140 MHz
PLOin = –5 dBm


IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
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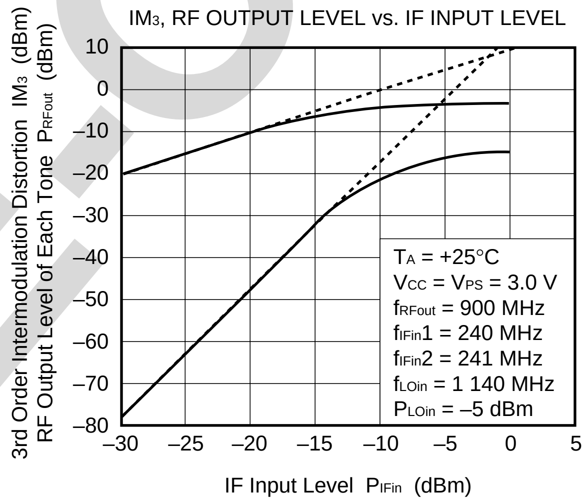
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RF Output Level of Each Tone PRFout (dBm)
IF Input Level PIFin (dBm)
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fRFout = 900 MHz
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fLOin = 1 140 MHz
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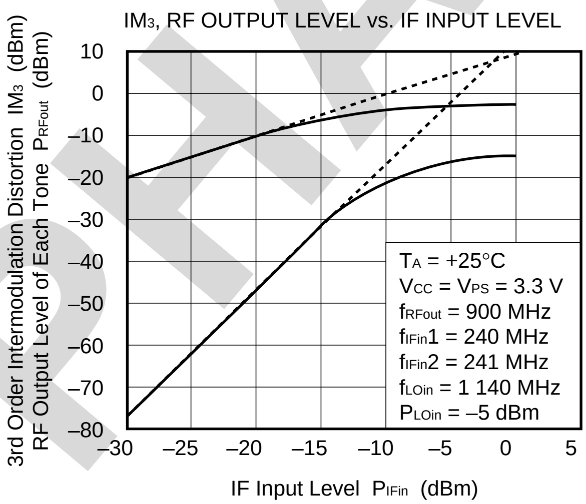
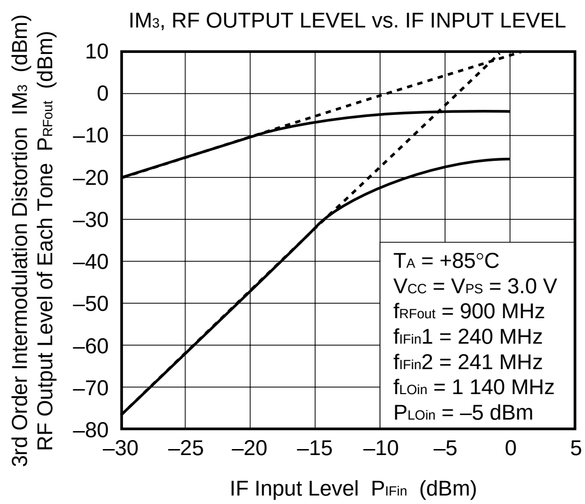
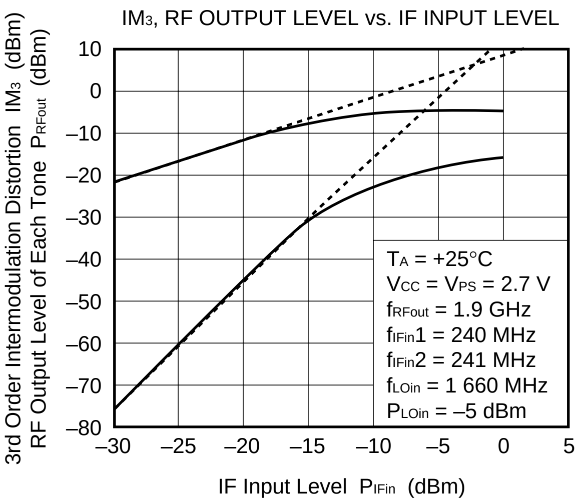

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
IF Input Level PIFin (dBm)
TA = +25°C
VCC = VPS = 3.3 V
fRFout = 900 MHz
fIFin1 = 240 MHz
fIFin2 = 241 MHz
fLOin = 1 140 MHz
PLOin = –5 dBm


IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
IF Input Level PIFin (dBm)
TA = +85°C
VCC = VPS = 3.0 V
fRFout = 900 MHz
fIFin1 = 240 MHz
fIFin2 = 241 MHz
fLOin = 1 140 MHz
PLOin = –5 dBm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3rd Order Intermodulation Distortion IM3 (dBm)
RF Output Level of Each Tone PRFout (dBm)
10
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–15
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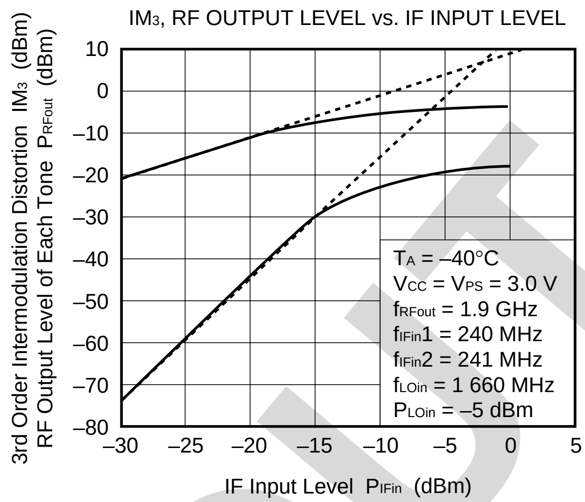
IF Input Level PIFin (dBm)
TA = +25°C
VCC = VPS = 2.7 V
fRFout = 1.9 GHz
fIFin1 = 240 MHz
fIFin2 = 241 MHz
fLOin = 1 660 MHz
PLOin = –5 dBm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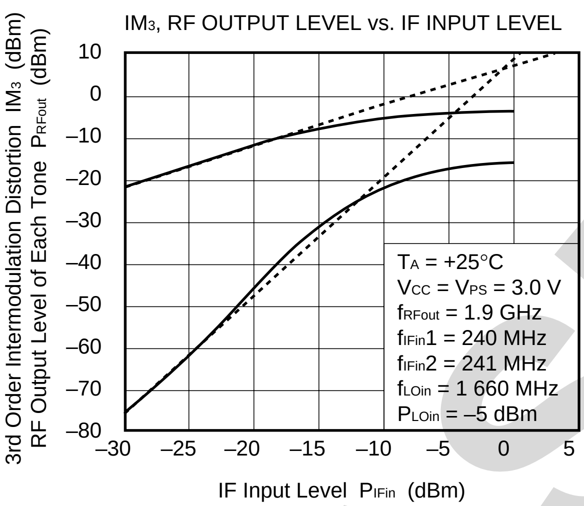
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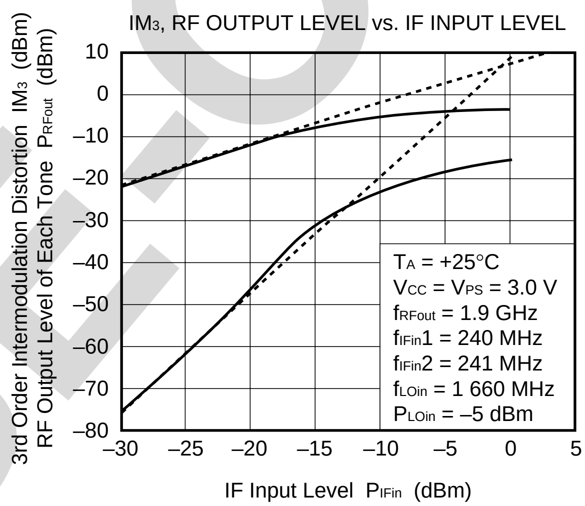
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fRFout = 1.9 GHz
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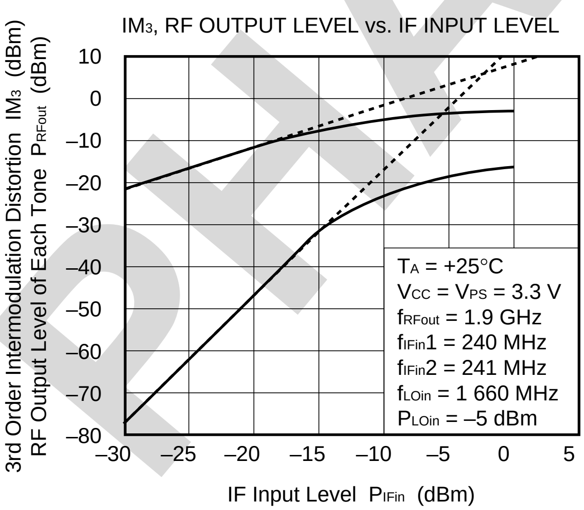
IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL
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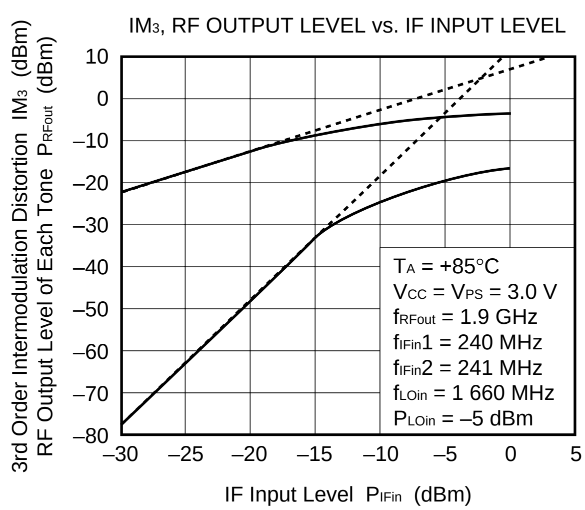
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IF Input Level PIFin (dBm)
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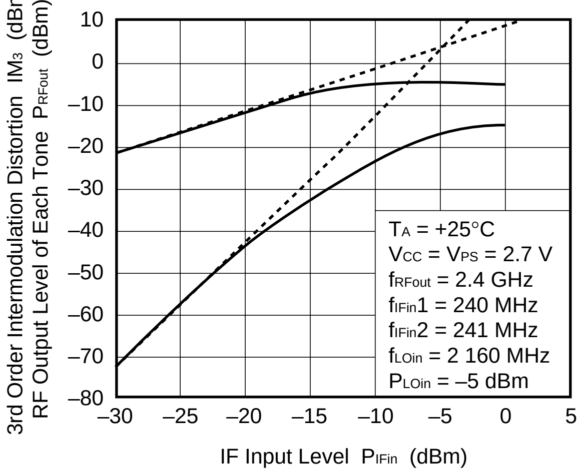
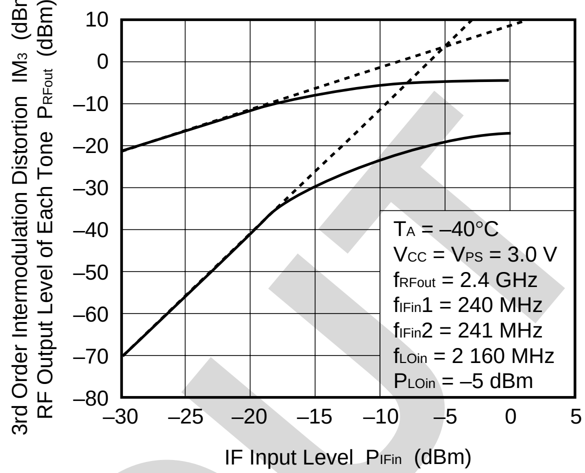
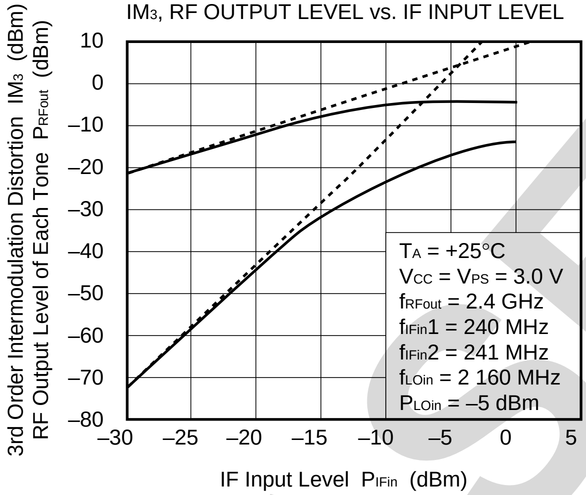
IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



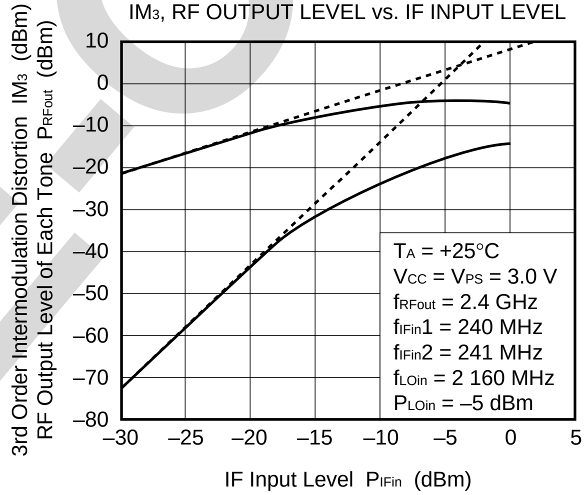

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



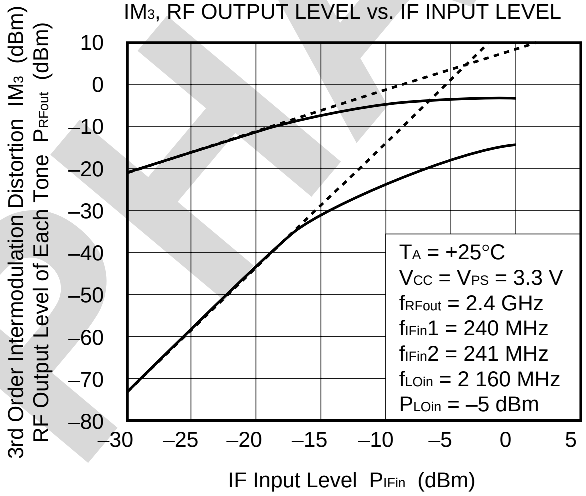

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



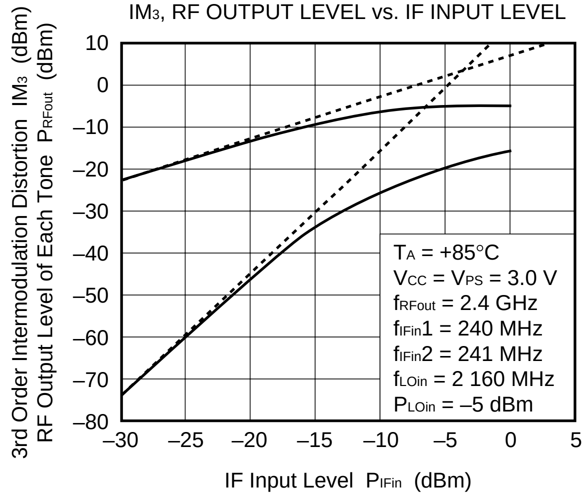

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



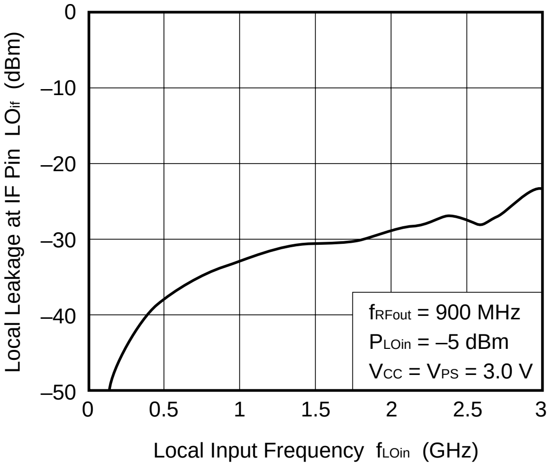

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



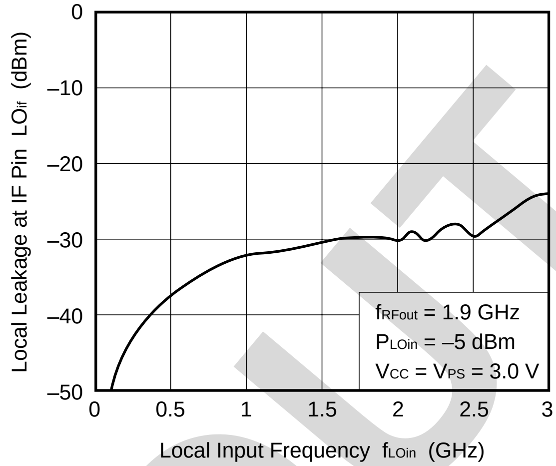

IM3, RF OUTPUT LEVEL vs. IF INPUT LEVEL



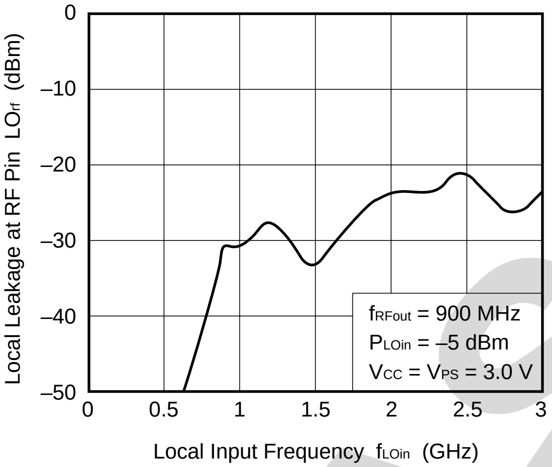
LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT FREQUENCY



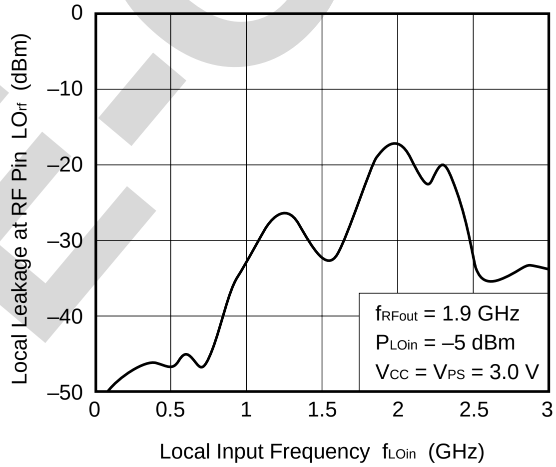

LOCAL LEAKAGE AT IF PIN vs.
LOCAL INPUT FREQUENCY



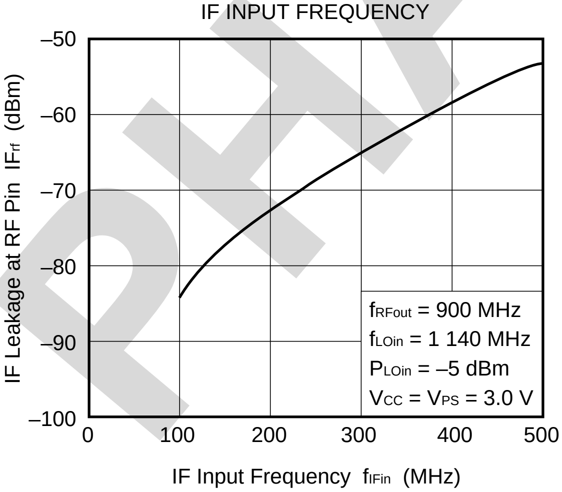

LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT FREQUENCY



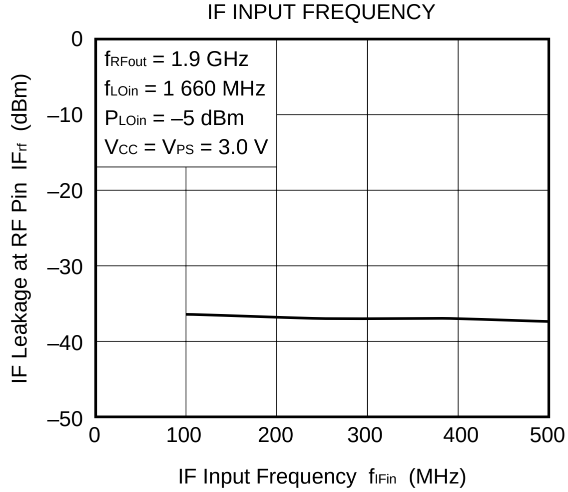

LOCAL LEAKAGE AT RF PIN vs.
LOCAL INPUT FREQUENCY

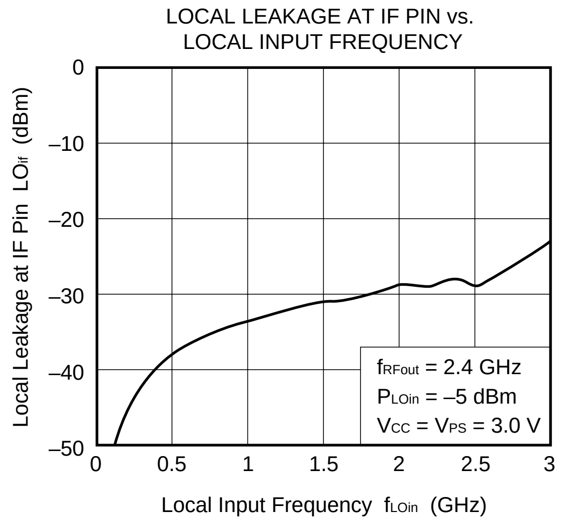


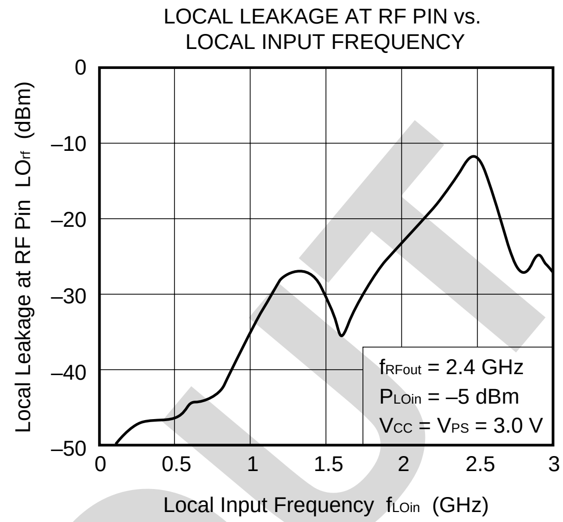

IF LEAKAGE AT RF PIN vs.
IF INPUT FREQUENCY

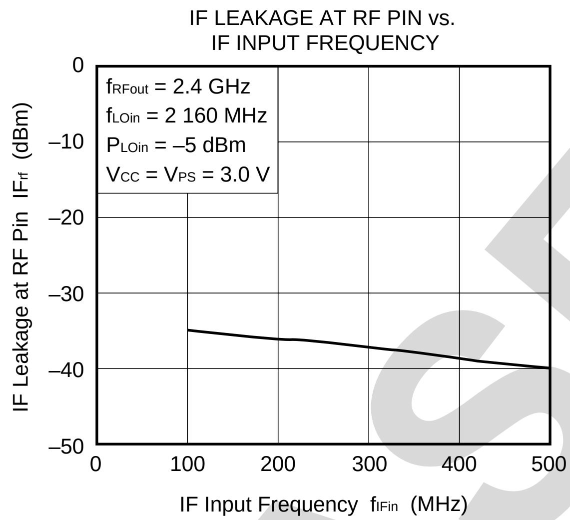



IF LEAKAGE AT RF PIN vs.
IF INPUT FREQUENCY





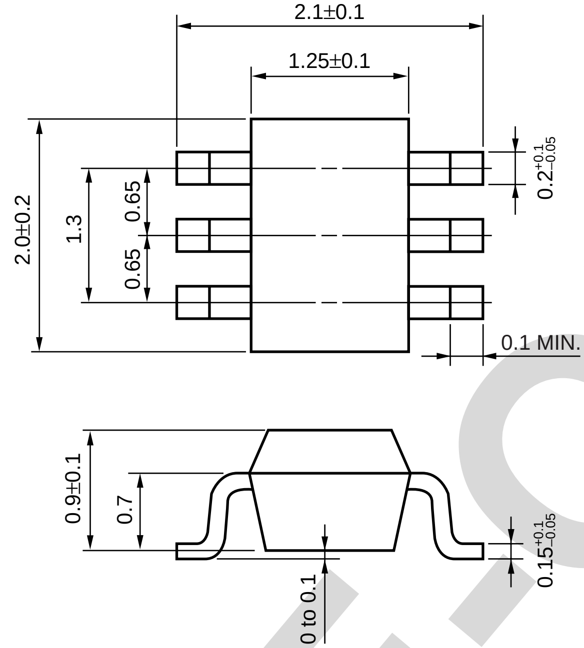




**Remark** The graphs indicate nominal characteristics.

## ★ 8. PACKAGE DIMENSIONS

**6-PIN SUPER MINIMOLD (UNIT: mm)**



## 9. NOTE ON CORRECT USE

(1) Observe precautions for handling because of electrostatic sensitive devices.
(2) Form a ground pattern as wide as possible to minimize ground impedance (to prevent undesired oscillation).
(3) Connect a bypass capacitor (example: 1 000 pF) to the $V_{CC}$ pin.
(4) Connect a matching circuit to the RF output pin.
(5) The DC cut capacitor must be each attached to the input and output pins.

## 10. RECOMMENDED SOLDERING CONDITIONS

This product should be soldered under the following recommended conditions.

| Soldering Method | Soldering Conditions | 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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