To our customers,

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April 1st, 2010
Renesas Electronics Corporation



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DATA SHEET

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC3239TB

## 3.3 V, SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER

### DESCRIPTION

The μPC3239TB is a silicon monolithic integrated circuit designed as IF amplifier for DBS LNB.
This device exhibits low noise figure and high power gain characteristics.
This IC is manufactured using our UHS0 (Ultra High Speed Process) bipolar process.

### FEATURES

- Low current : $I_{CC}$ = 29.0 mA TYP.
- Medium output power : $P_{O\ (sat)}$ = +12.5 dBm TYP. @ f = 1.0 GHz
  : $P_{O\ (sat)}$ = +10 dBm TYP. @ f = 2.2 GHz
- High linearity : $P_{O\ (1dB)}$ = +10 dBm TYP. @ f = 1.0 GHz
  : $P_{O\ (1dB)}$ = +8 dBm TYP. @ f = 2.2 GHz
- Power gain : $G_P$ = 25 dB TYP. @ f = 1.0 GHz
  : $G_P$ = 25.5 dB TYP. @ f = 2.2 GHz
- Gain flatness : $\Delta G_P$ = 1.0 dB TYP. @ f = 1.0 to 2.2 GHz
- Noise Figure : NF = 4.0 dB TYP. @ f = 1.0 GHz
  : NF = 4.3 dB TYP. @ f = 2.2 GHz
- Supply voltage : $V_{CC}$ = 3.0 to 3.6 V
- Port impedance : input/output 50 Ω

### APPLICATIONS

- IF amplifiers in DBS LNB, other L-band amplifiers, etc.

### ORDERING INFORMATION

| Part Number | Order Number | Package | Marking | Supplying Form |
|---|---|---|---|---|
| μPC3239TB-E3 | μPC3239TB-E3-A | 6-pin super minimold (Pb-Free) | C3V | • Embossed tape 8 mm wide<br>• Pin 1, 2, 3 face the perforation side of the tape<br>• Qty 3 kpcs/reel |

**Remark** To order evaluation samples, please contact your nearby sales office
Part number for sample order: μPC3239TB



**Caution Observe precautions when handling because these devices are sensitive to electrostatic discharge.**



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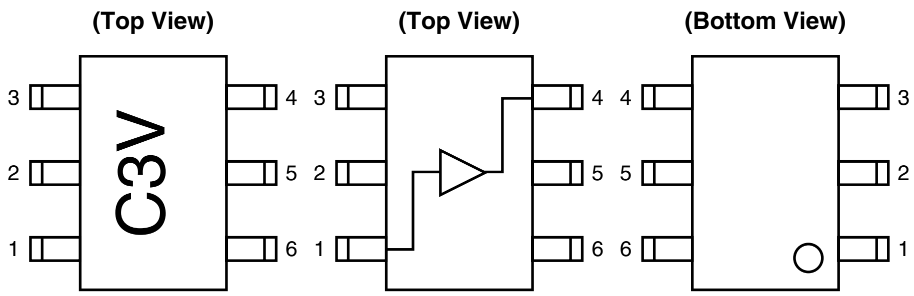
## PIN CONNECTIONS AND INTERNAL BLOCK DIAGRAM




| Pin No. | Pin Name |
|---|---|
| 1 | INPUT |
| 2 | GND |
| 3 | GND |
| 4 | OUTPUT |
| 5 | GND |
| 6 | $V_{CC}$ |

## PRODUCT LINE-UP OF 3 V or 3.3 V-BIAS SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER ($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 3.0 V or 3.3 V, $Z_S$ = $Z_L$ = 50 Ω)



| Part No. | $V_{CC}$ (V) | $I_{CC}$ (mA) | $G_P$ (dB) | NF (dB) | $P_{O\ (1\ dB)}$ (dBm) | $P_{O\ (sat)}$ (dBm) | Package | Marking |
|---|---|---|---|---|---|---|---|---|
| μPC2762TB | 3.0 | 26.5 | 13.0 (0.9 GHz)<br>15.5 (1.9 GHz) | 6.5 (0.9 GHz)<br>7.0 (1.9 GHz) | +8.0 (0.9 GHz)<br>+7.0 (1.9 GHz) | +9.0 (0.9 GHz)<br>+8.5 (1.9 GHz) | 6-pin super minimold | C1Z |
| μPC2763TB | | 27.0 | 20.0 (0.9 GHz)<br>21.0 (1.9 GHz) | 5.5 (0.9 GHz)<br>5.5 (1.9 GHz) | +9.5 (0.9 GHz)<br>+6.5 (1.9 GHz) | +11.0 (0.9 GHz)<br>+8.0 (1.9 GHz) | | C2A |
| μPC2771TB | | 36.0 | 21.0 (0.9 GHz)<br>21.0 (1.5 GHz) | 6.0 (0.9 GHz)<br>6.0 (1.5 GHz) | +11.5 (0.9 GHz)<br>+9.5 (1.5 GHz) | +12.5 (0.9 GHz)<br>+11.0 (1.5 GHz) | | C2H |
| μPC8181TB | | 23.0 | 19.0 (0.9 GHz)<br>21.0 (1.9 GHz)<br>22.0 (2.4 GHz) | 4.5 (0.9 GHz)<br>4.5 (1.9 GHz)<br>4.5 (2.4 GHz) | +8.0 (0.9 GHz)<br>+7.0 (1.9 GHz)<br>+7.0 (2.4 GHz) | +9.5 (0.9 GHz)<br>+9.0 (1.9 GHz)<br>+9.0 (2.4 GHz) | | C3E |
| μPC8182TB | | 30.0 | 21.5 (0.9 GHz)<br>20.5 (1.9 GHz)<br>20.5 (2.4 GHz) | 4.5 (0.9 GHz)<br>4.5 (1.9 GHz)<br>5.0 (2.4 GHz) | +9.5 (0.9 GHz)<br>+9.0 (1.9 GHz)<br>+8.0 (2.4 GHz) | +11.0 (0.9 GHz)<br>+10.5 (1.9 GHz)<br>+10.0 (2.4 GHz) | | C3F |
| μPC3239TB | 3.3 | 29.0 | 25 (1.0 GHz)<br>25.5 (2.2 GHz) | 4.0 (1.0 GHz)<br>4.3 (2.2 GHz) | +10 (1.0 GHz)<br>+8 (2.2 GHz) | +12.5 (1.0 GHz)<br>+10 (2.2 GHz) | | C3V |

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

## ABSOLUTE MAXIMUM RATINGS

| Parameter | Symbol | Conditions | Ratings | Unit |
|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | $T_A$ = +25°C, pin 4 and 6 | 4.0 | V |
| Total Circuit Current | $I_{CC}$ | $T_A$ = +25°C, pin 4 and 6 | 55 | mA |
| Power Dissipation | $P_D$ | $T_A$ = +85°C **Note** | 270 | mW |
| Operating Ambient Temperature | $T_A$ | | –40 to +85 | °C |
| Storage Temperature | $T_{stg}$ | | –55 to +150 | °C |
| Input Power | $P_{in}$ | $T_A$ = +25°C | +10 | dBm |

**Note** Mounted on double-sided copper-clad 50 × 50 × 1.6 mm epoxy glass PWB

## RECOMMENDED OPERATING RANGE

| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | The same voltage should be applied to pin 4 and 6. | 3.0 | 3.3 | 3.6 | V |
| Operating Ambient Temperature | $T_A$ | | –40 | +25 | +85 | °C |

## ELECTRICAL CHARACTERISTICS ($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 3.3 V, $Z_S$ = $Z_L$ = 50 Ω, unless otherwise specified)

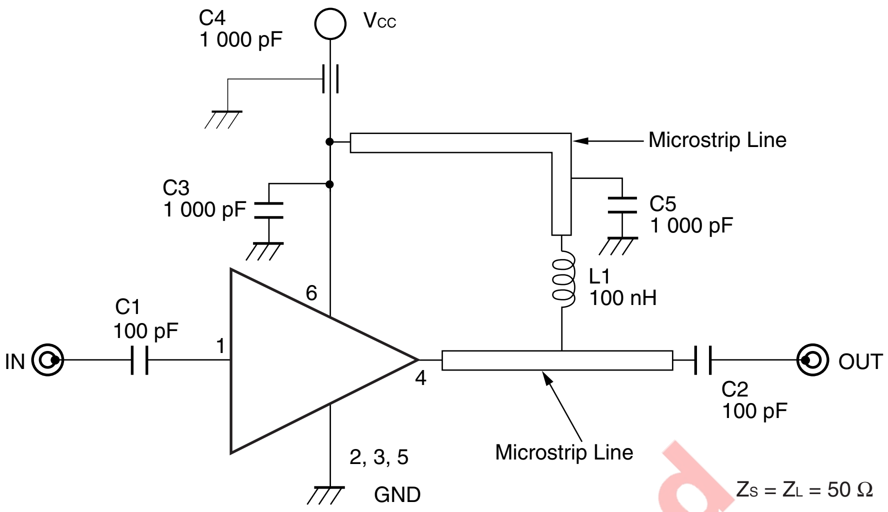
| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Circuit Current | $I_{CC}$ | No input signal | 23 | 29.0 | 36.5 | mA |
| Power Gain 1 | $G_P1$ | f = 0.25 GHz, $P_{in}$ = –30 dBm | 21.5 | 24.5 | 27.5 | dB |
| Power Gain 2 | $G_P2$ | f = 1.0 GHz, $P_{in}$ = –30 dBm | 22 | 25 | 28 | |
| Power Gain 3 | $G_P3$ | f = 1.8 GHz, $P_{in}$ = –30 dBm | 22.5 | 25.5 | 28.5 | |
| Power Gain 4 | $G_P4$ | f = 2.2 GHz, $P_{in}$ = –30 dBm | 22.5 | 25.5 | 28.5 | |
| Saturated Output Power 1 | $P_{O\ (sat)}$ 1 | f = 1.0 GHz, $P_{in}$ = –5 dBm | +10 | +12.5 | – | dBm |
| Saturated Output Power 2 | $P_{O\ (sat)}$ 2 | f = 2.2 GHz, $P_{in}$ = –10 dBm | +7 | +10 | – | |
| Gain 1 dB Compression Output Power 1 | $P_{O\ (1\ dB)}$ 1 | f = 1.0 GHz | +7.5 | +10 | – | dBm |
| Gain 1 dB Compression Output Power 2 | $P_{O\ (1\ dB)}$ 2 | f = 2.2 GHz | +5 | +8 | – | |
| Noise Figure 1 | NF1 | f = 1.0 GHz | – | 4.0 | 4.8 | dB |
| Noise Figure 2 | NF2 | f = 2.2 GHz | – | 4.3 | 5.1 | |
| Isolation 1 | ISL1 | f = 1.0 GHz, $P_{in}$ = –30 dBm | 28 | 35 | – | dB |
| Isolation 2 | ISL2 | f = 2.2 GHz, $P_{in}$ = –30 dBm | 28 | 35 | – | |
| Input Return Loss 1 | $RL_{in}1$ | f = 1.0 GHz, $P_{in}$ = –30 dBm | 10 | 25 | – | dB |
| Input Return Loss 2 | $RL_{in}2$ | f = 2.2 GHz, $P_{in}$ = –30 dBm | 10 | 15 | – | |
| Output Return Loss 1 | $RL_{out}1$ | f = 1.0 GHz, $P_{in}$ = –30 dBm | 15 | 25 | – | dB |
| Output Return Loss 2 | $RL_{out}2$ | f = 2.2 GHz, $P_{in}$ = –30 dBm | 15 | 25 | – | |

## STANDARD CHARACTERISTICS FOR REFERENCE

**($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 3.3 V, $Z_S$ = $Z_L$ = 50 Ω, unless otherwise specified)**

| Parameter | Symbol | Test Conditions | Reference Value | Unit |
|---|---|---|---|---|
| Power Gain 5 | $G_P5$ | f = 2.6 GHz, $P_{in}$ = –30 dBm | 24.5 | dB |
| Power Gain 6 | $G_P6$ | f = 3.0 GHz, $P_{in}$ = –30 dBm | 22.5 | |
| Gain Flatness | $\Delta G_P$ | f = 1.0 to 2.2 GHz, $P_{in}$ = –30 dBm | 1.0 | dB |
| K factor 1 | K1 | f = 1.0 GHz, $P_{in}$ = –30 dBm | 1.6 | – |
| K factor 2 | K2 | f = 2.2 GHz, $P_{in}$ = –30 dBm | 1.5 | – |
| Output 3rd Order Intercept Point 1 | $OIP_3 1$ | f1 = 1 000 MHz, f2 = 1 001 MHz | 21 | dBm |
| Output 3rd Order Intercept Point 2 | $OIP_3 2$ | f1 = 2 200 MHz, f2 = 2 201 MHz | 15.5 | |
| 2nd Order Intermodulation Distortion | $IM_2$ | f1 = 1 000 MHz, f2 = 1 001 MHz, $P_{out}$ = –5 dBm/tone | 37 | dBc |
| 2nd Harmonic | $2f_0$ | f0 = 1.0 GHz, $P_{out}$ = –15 dBm | 57 | dBc |

## TEST CIRCUIT




The application circuits and their parameters are for reference only and are not intended for use in actual design-ins.



### COMPONENTS OF TEST CIRCUIT FOR MEASURING ELECTRICAL CHARACTERISTICS

| | Type | Value |
|---|---|---|
| L1 Note | Chip Inductor | 100 nH |
| C1, C2 | Chip Capacitor | 100 pF |
| C3, C5 | Chip Capacitor | 1 000 pF |
| C4 | Feed-through Capacitor | 1 000 pF |

**Note** There is a case to show a dimple wave of characteristic by a chip inductor L1 part in the high frequency area. In that case, please reduce a value of L1.

## INDUCTOR FOR THE OUTPUT PIN

The internal output transistor of this IC, to output medium power. To supply current for output transistor, connect an inductor between the $V_{CC}$ pin (pin 6) and output pin (pin 4). Select inductance, as the value listed above.

The inductor has both DC and AC effects. In terms of DC, the inductor biases the output transistor with minimum voltage drop to output enable high level. In terms of AC, the inductor makes output-port impedance higher to get enough gain. In this case, large inductance and Q is suitable (Refer to the following page).

## CAPACITORS FOR THE $V_{CC}$, INPUT AND OUTPUT PINS

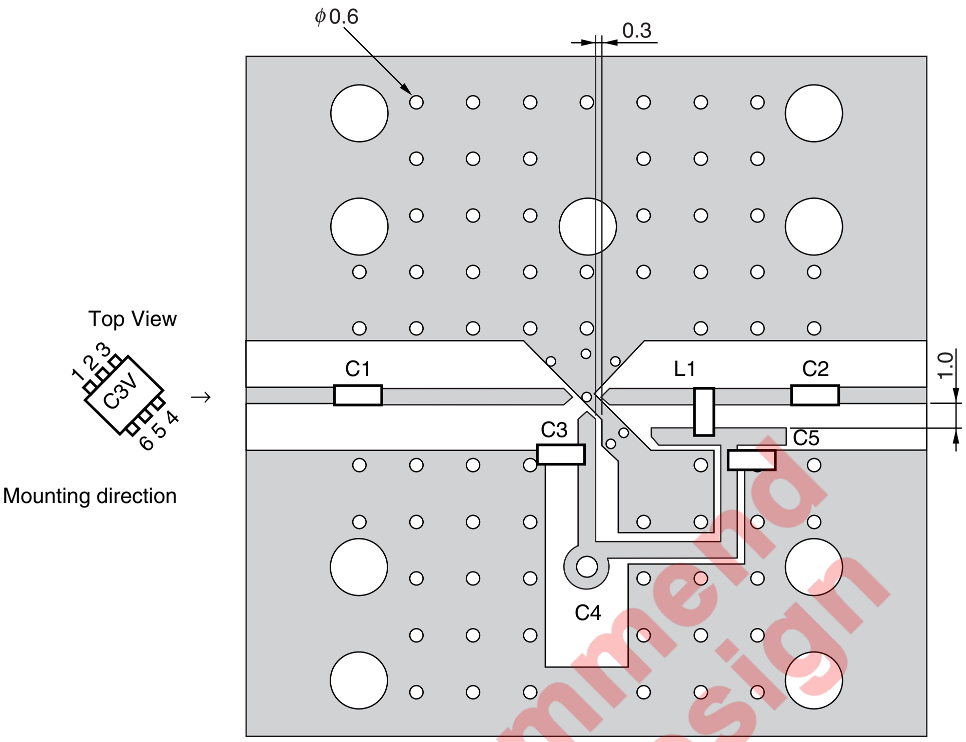
Capacitors of 1 000 pF are recommendable as the bypass capacitor for the $V_{CC}$ pin and the coupling capacitors for the input and output pins.

The bypass capacitor connected to the $V_{CC}$ pin is used to minimize ground impedance of $V_{CC}$ pin. So, stable bias can be supplied against $V_{CC}$ fluctuation.

The coupling capacitors, connected to the input and output pins, are used to cut the DC and minimize RF serial impedance. Their capacitances are therefore selected as lower impedance against a 50 Ω load. The capacitors thus perform as high pass filters, suppressing low frequencies to DC.

To obtain a flat gain from 100 MHz upwards, 1 000 pF capacitors are used in the test circuit. In the case of under 10 MHz operation, increase the value of coupling capacitor such as 10 000 pF. Because the coupling capacitors are determined by equation, $C = 1/(2\pi Rfc)$.

## ILLUSTRATION OF THE TEST CIRCUIT ASSEMBLED ON EVALUATION BOARD




C4: Feed-through Capacitor

(Unit: mm)



### COMPONENT LIST

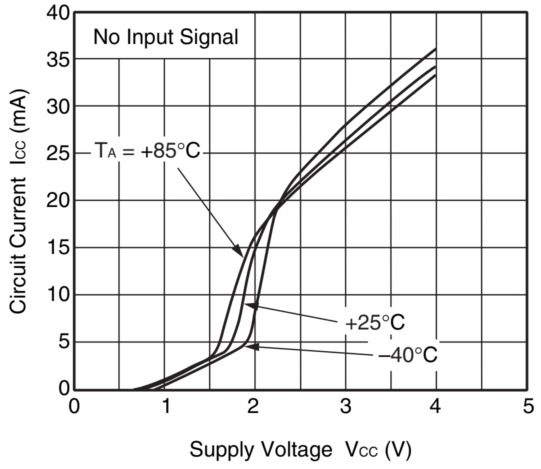
| | Value | Size |
|---|---|---|
| L1 | 100 nH | 1005 |
| C1, C2 | 100 pF | 1608 |
| C3, C5 | 1 000 pF | 1005 |
| C4 | 1 000 pF | Feed-through Capacitor |

**Notes**

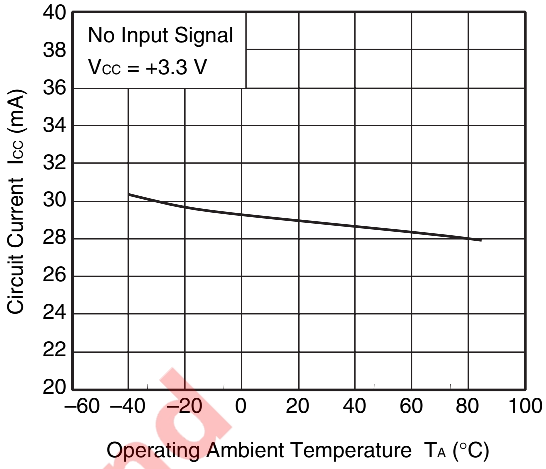
1. 30 × 30 × 0.4 mm double sided 35 μm copper clad polyimide board.
2. Back side: GND pattern
3. Au plated on pattern
4. ∘◯: Through holes

**TYPICAL CHARACTERISTICS ($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 3.3 V, $Z_S$ = $Z_L$ = 50 Ω, unless otherwise specified)**

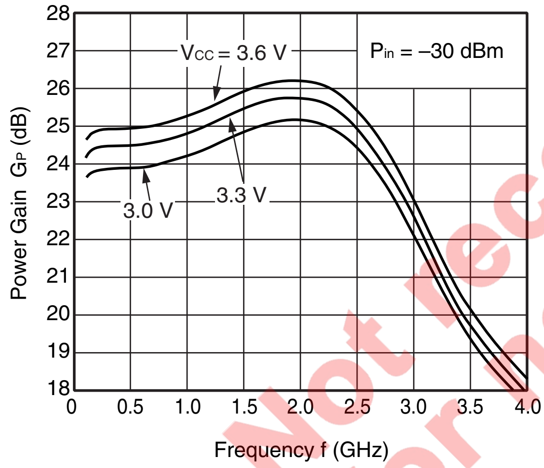
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



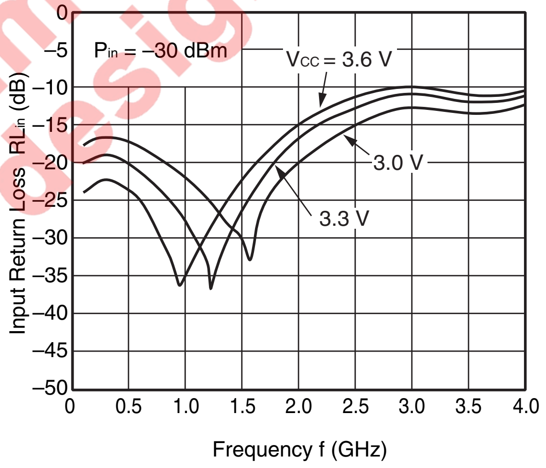

CURCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



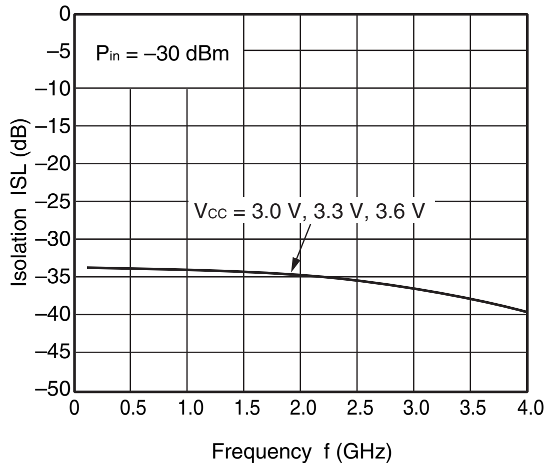

POWER GAIN vs. FREQUENCY



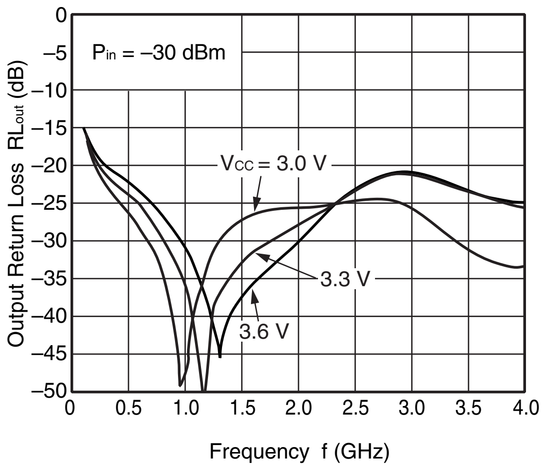

INPUT RETURN LOSS vs. FREQUENCY




ISOLATION vs. FREQUENCY

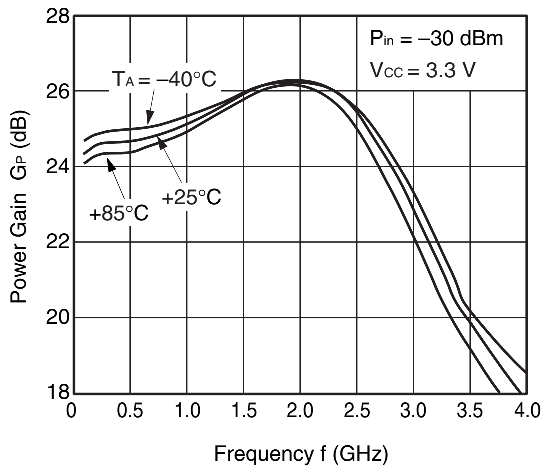



OUTPUT RETURN LOSS vs. FREQUENCY

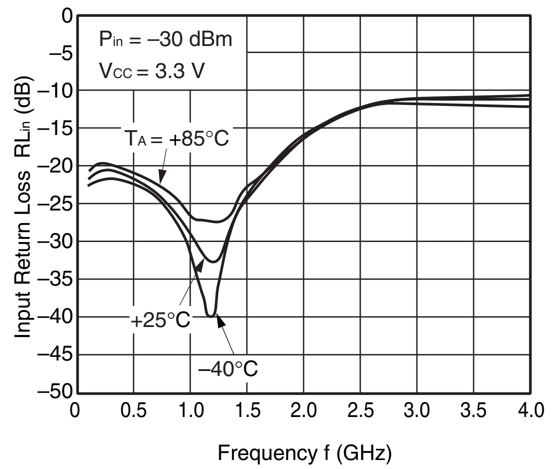



**Remark** The graphs indicate nominal characteristics.

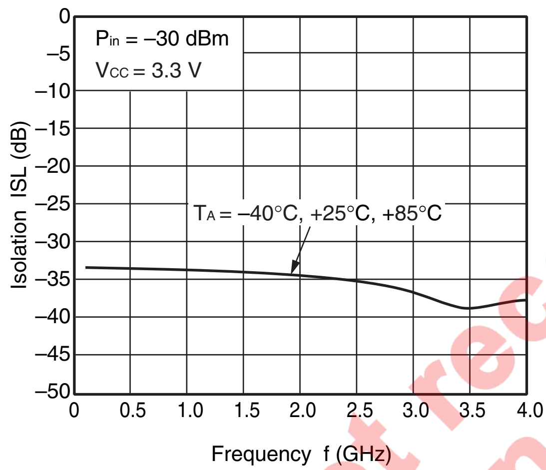
POWER GAIN vs. FREQUENCY



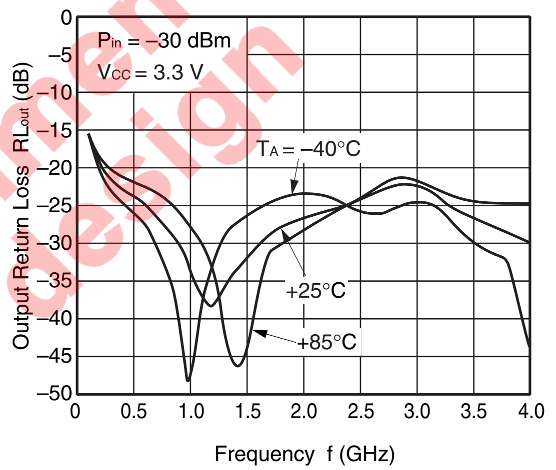

INPUT RETURN LOSS vs. FREQUENCY



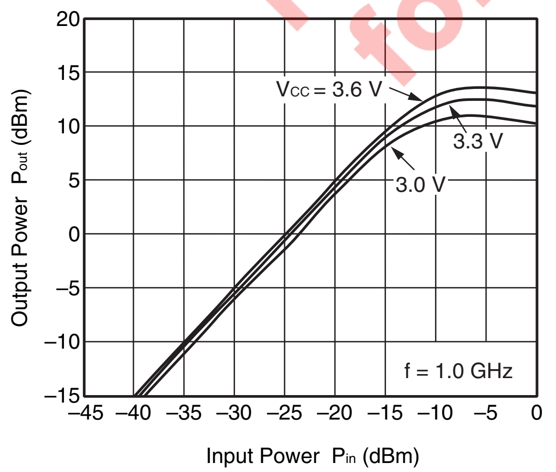

ISOLATION vs. FREQUENCY



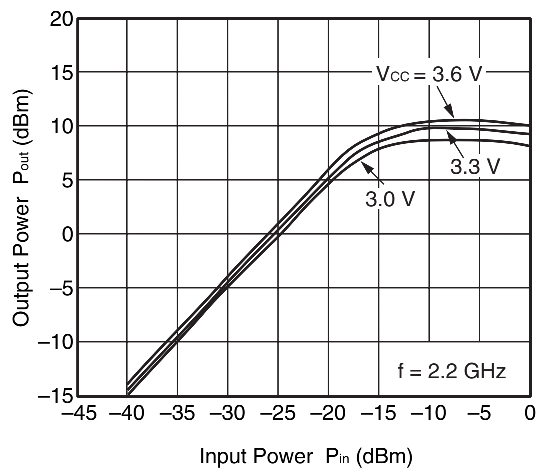

OUTPUT RETURN LOSS vs. FREQUENCY




OUTPUT POWER vs. INPUT POWER

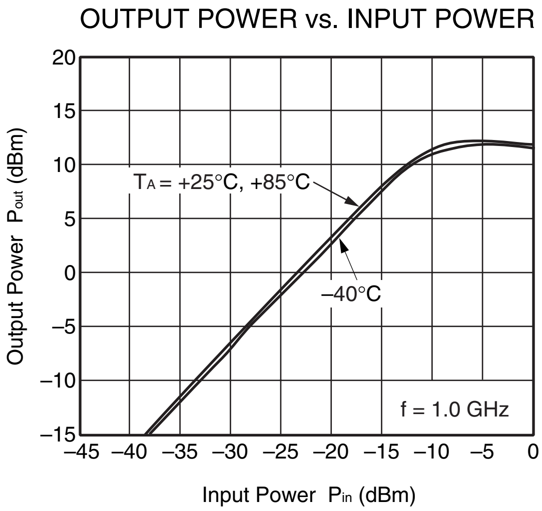


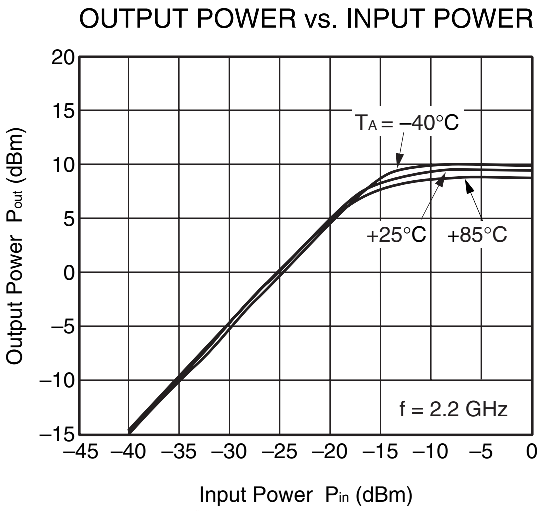

OUTPUT POWER vs. INPUT POWER

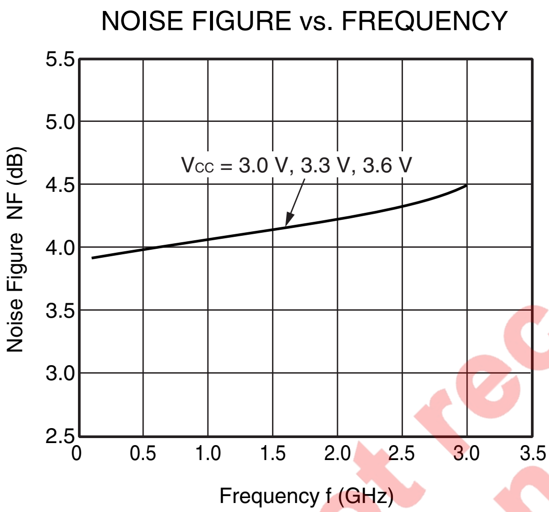


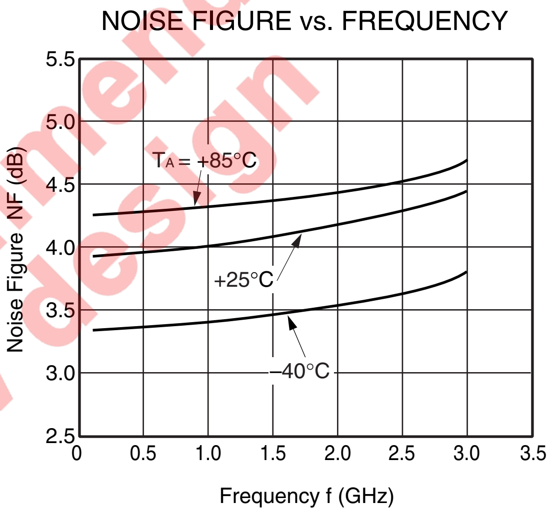



**Remark** The graphs indicate nominal characteristics.

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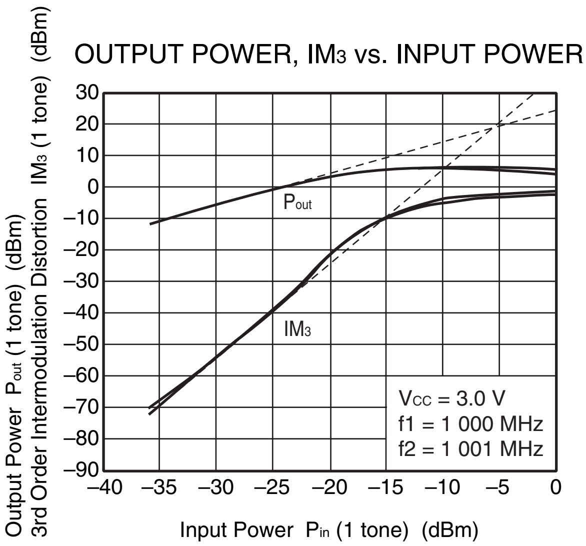
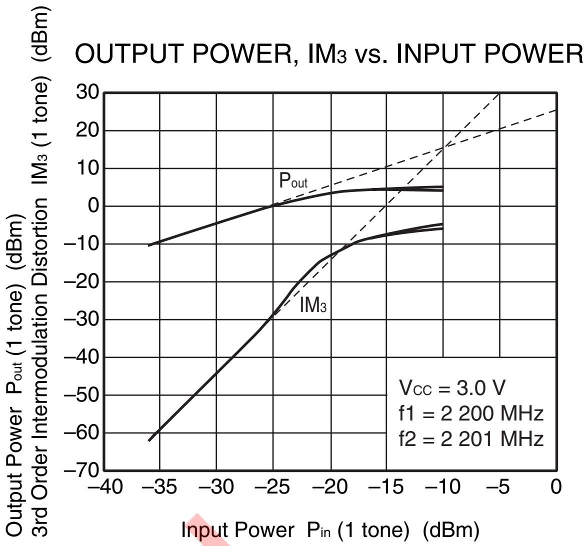
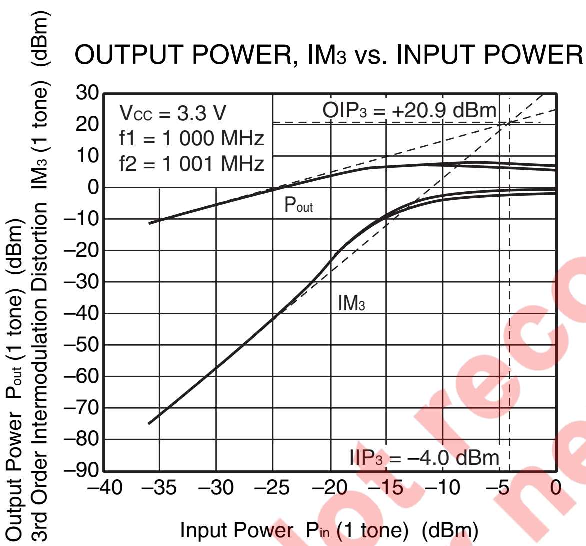
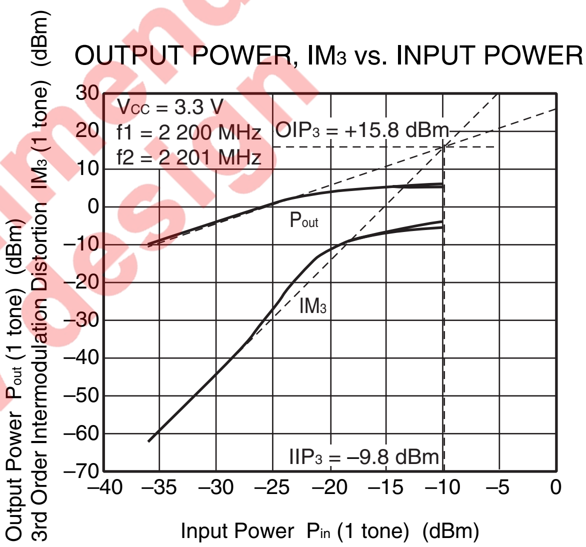
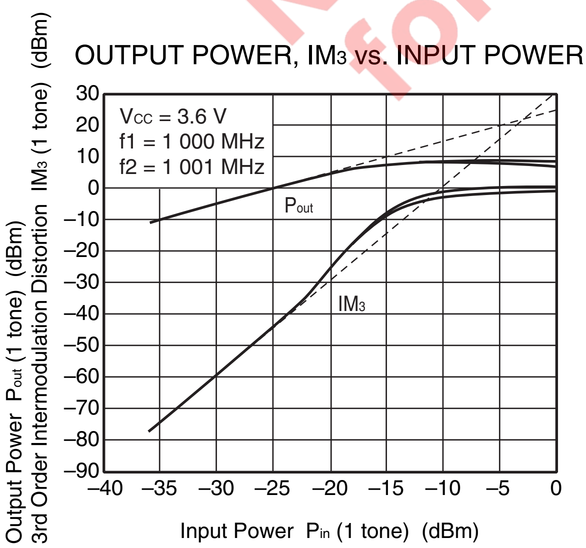


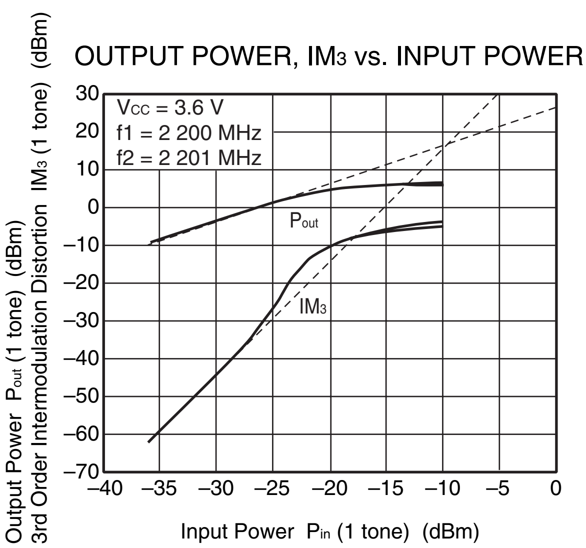



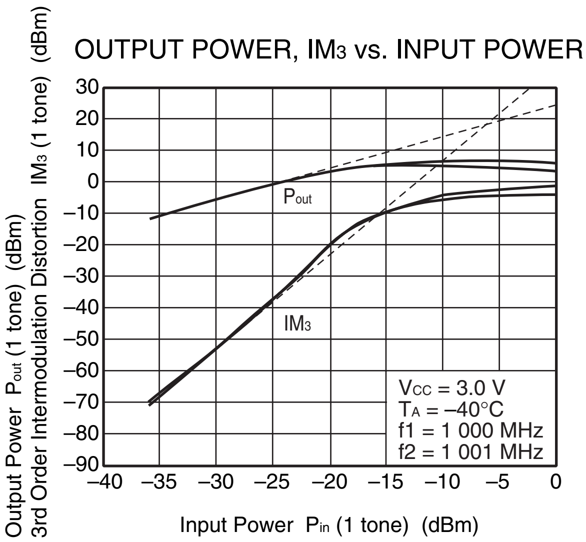



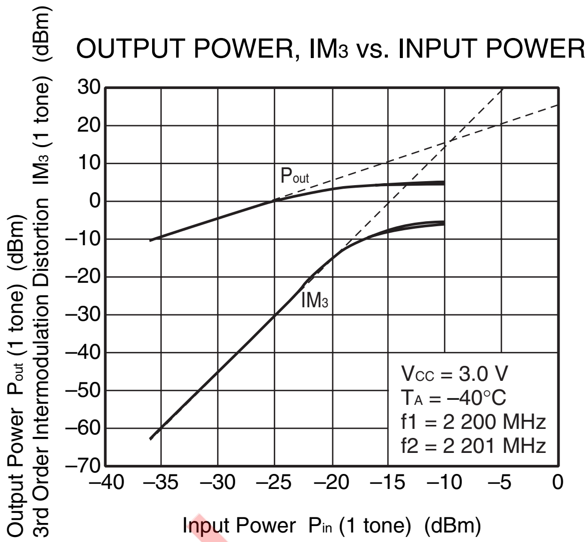


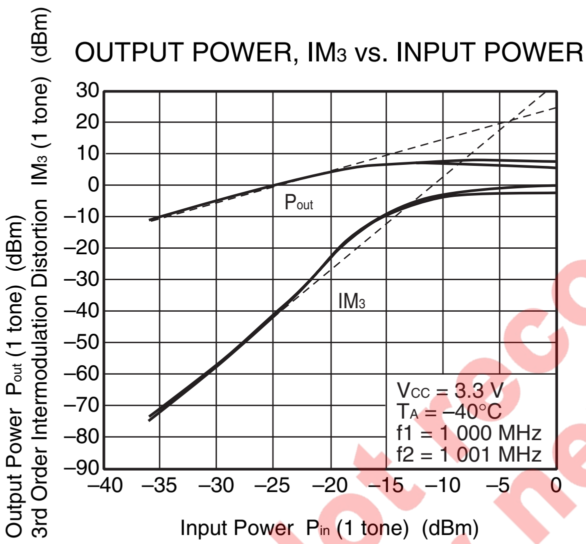



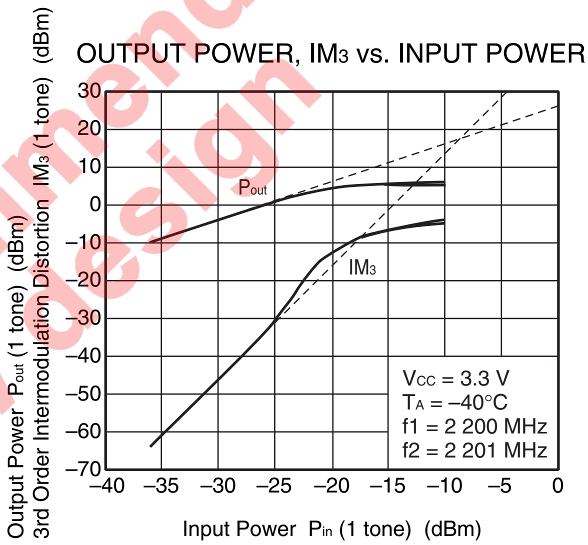




**Remark** The graphs indicate nominal characteristics.

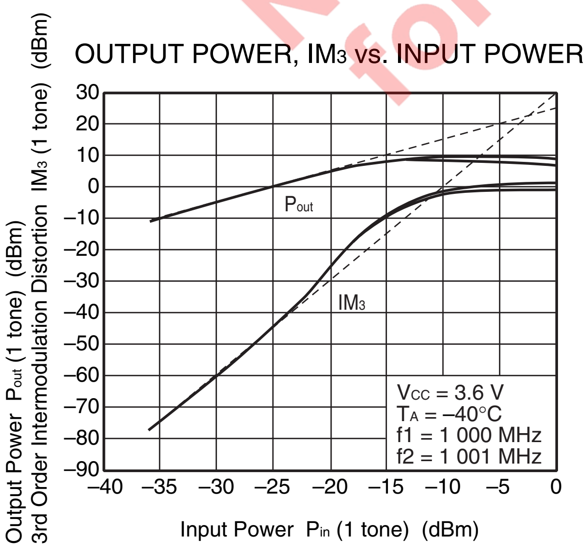


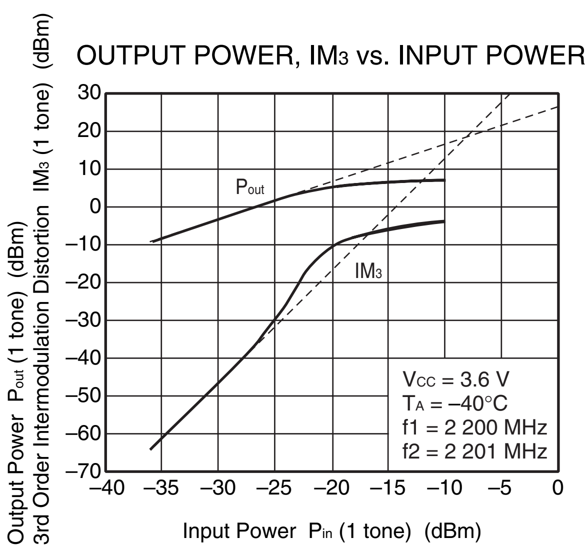



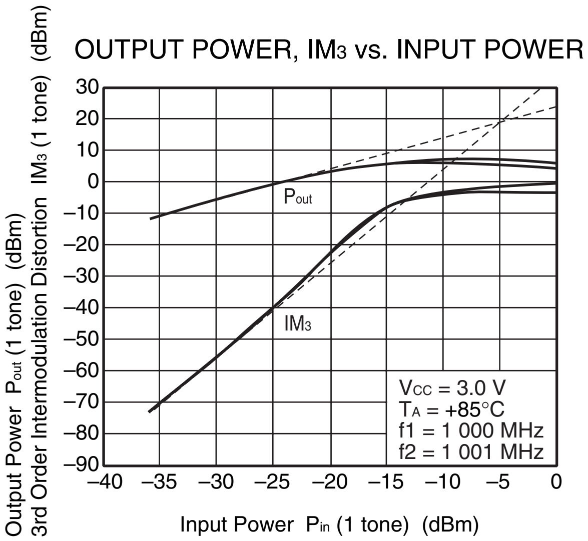



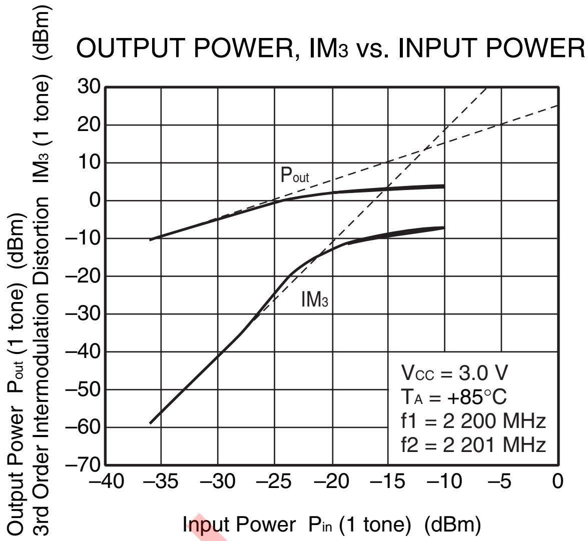


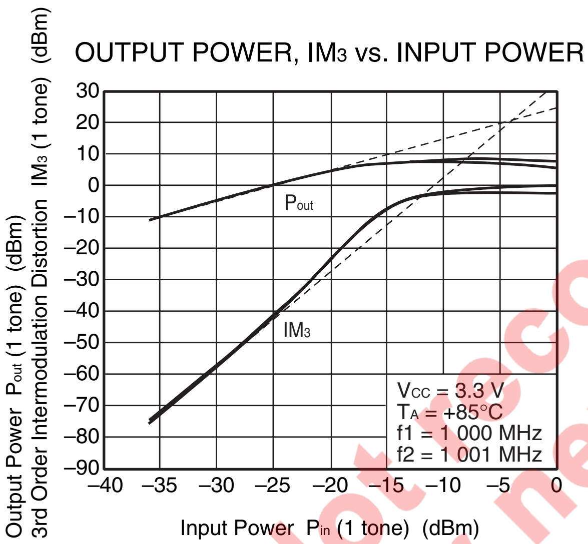



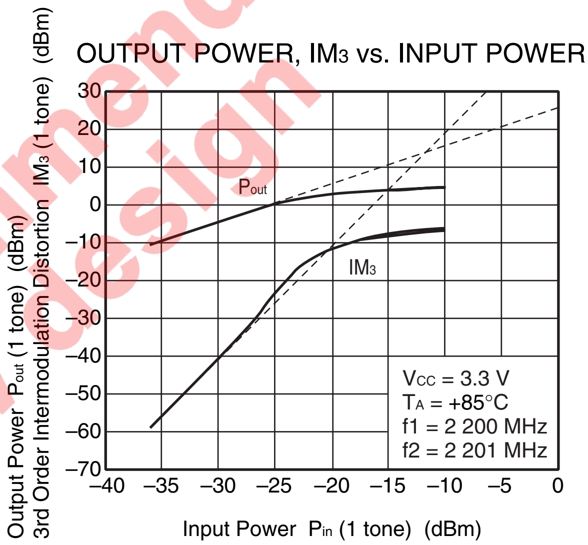




**Remark** The graphs indicate nominal characteristics.

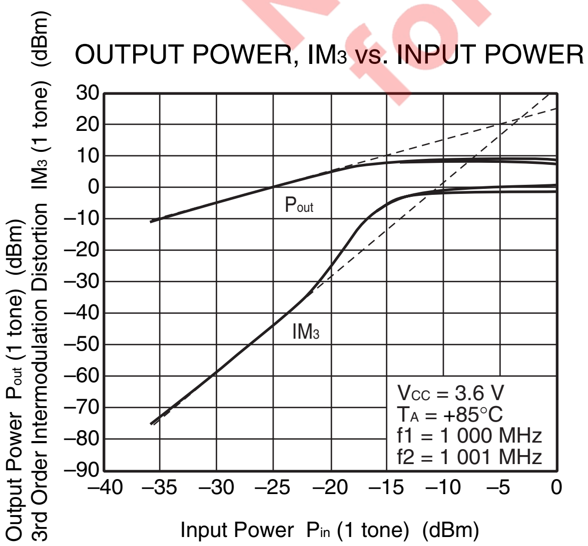


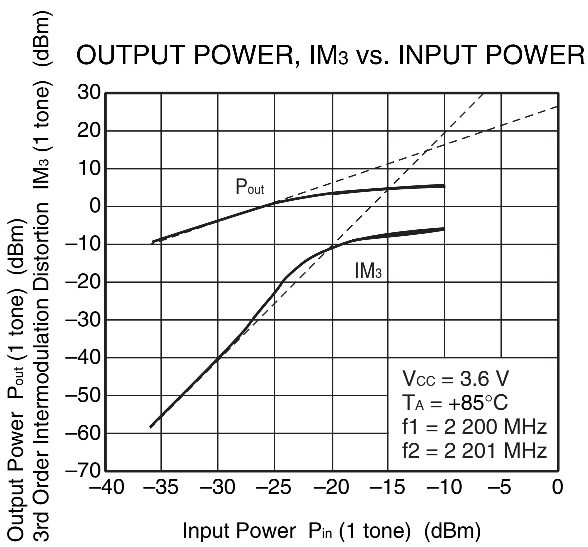



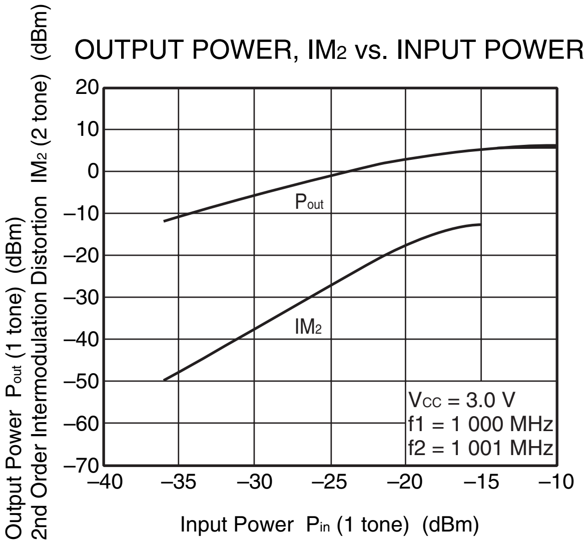



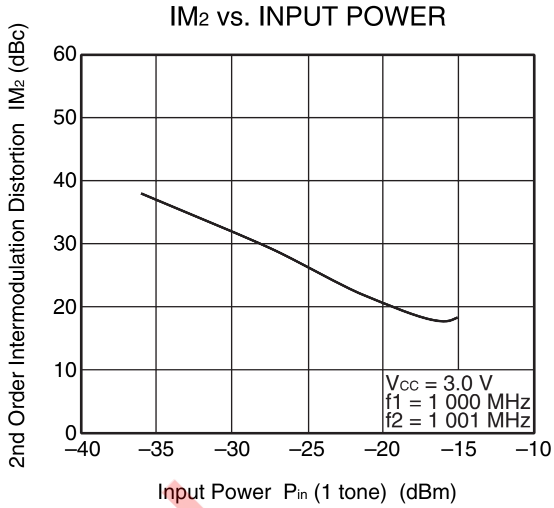


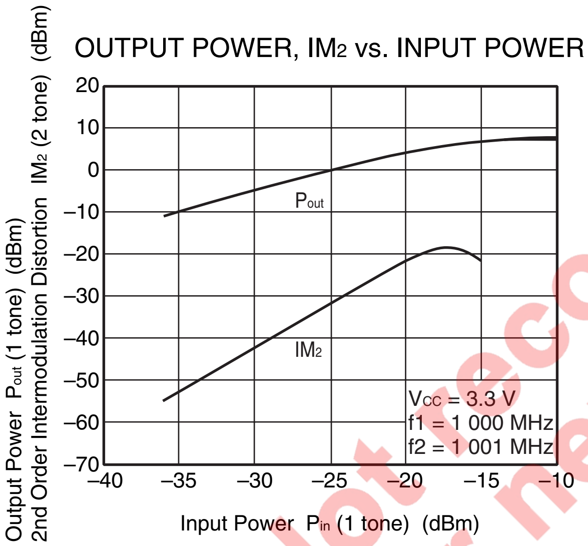



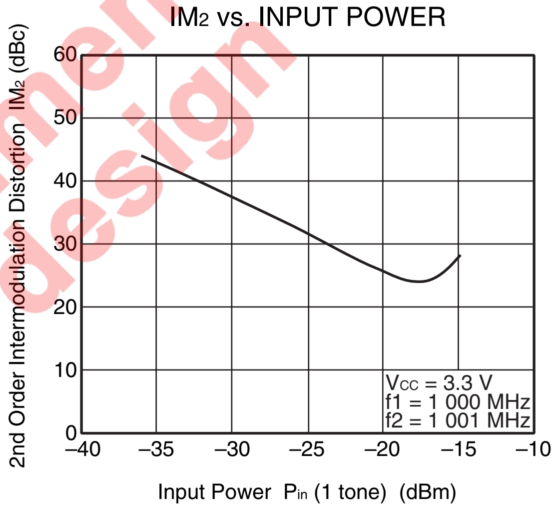




**Remark** The graphs indicate nominal characteristics.

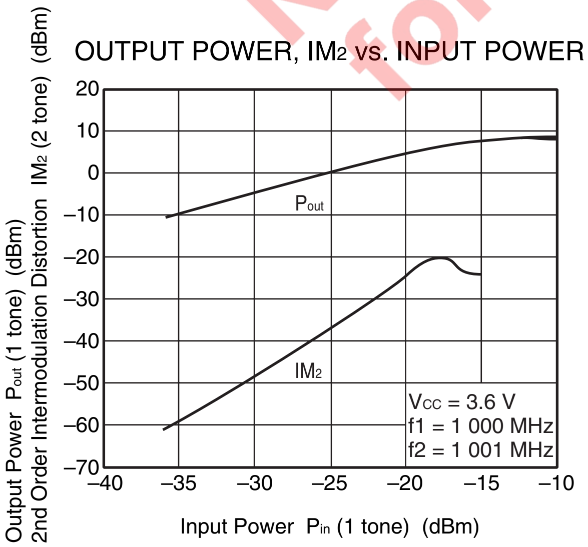


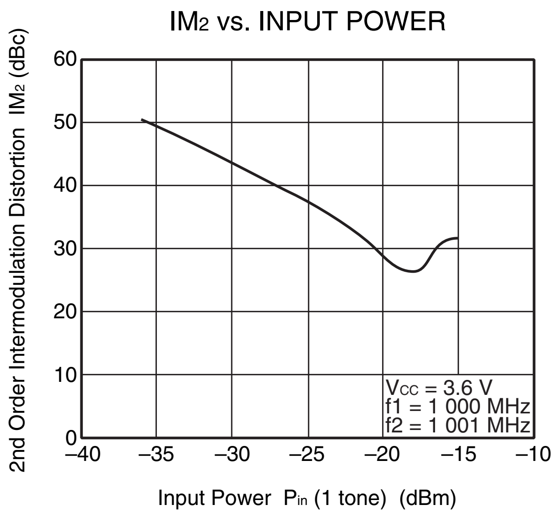



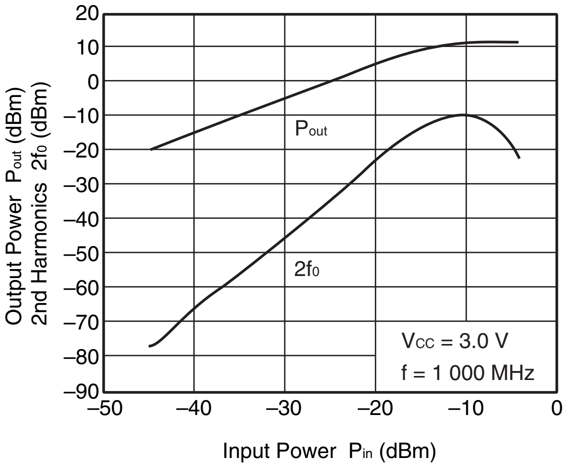


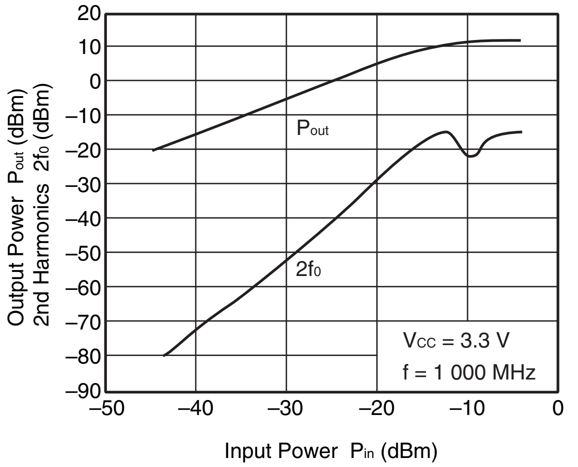




**Remark** The graphs indicate nominal characteristics.

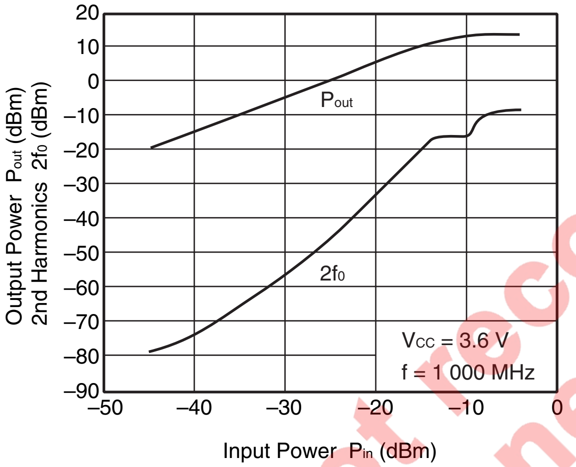
OUTPUT POWER, 2f0 vs. INPUT POWER



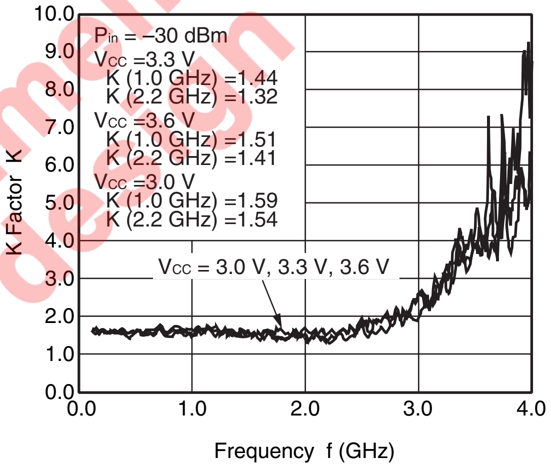

OUTPUT POWER, 2f0 vs. INPUT POWER




OUTPUT POWER, 2f0 vs. INPUT POWER



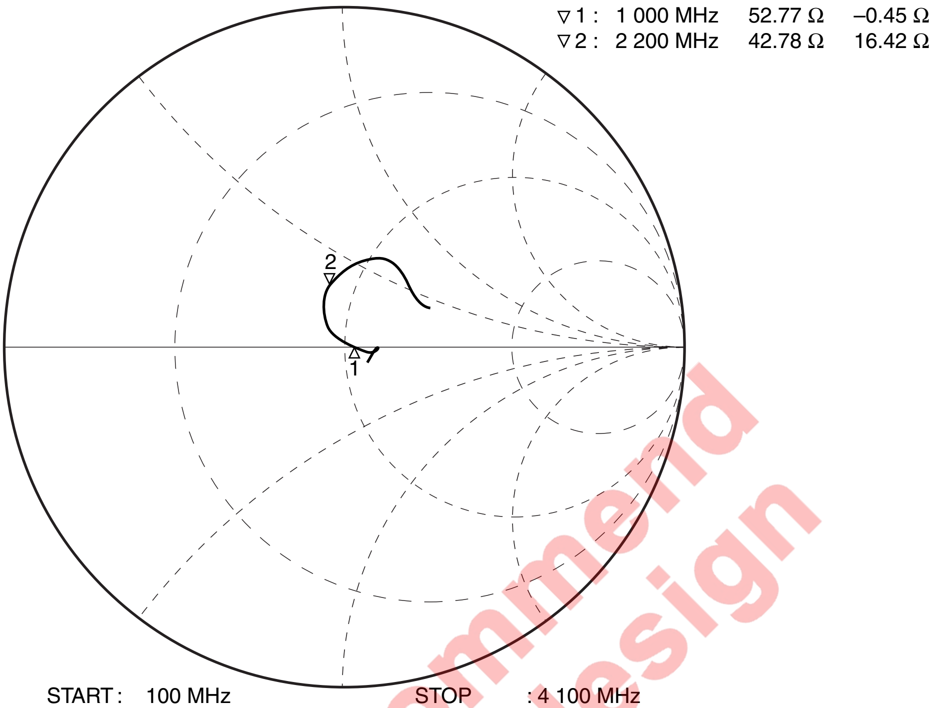

K FACTOR vs. FREQUENCY



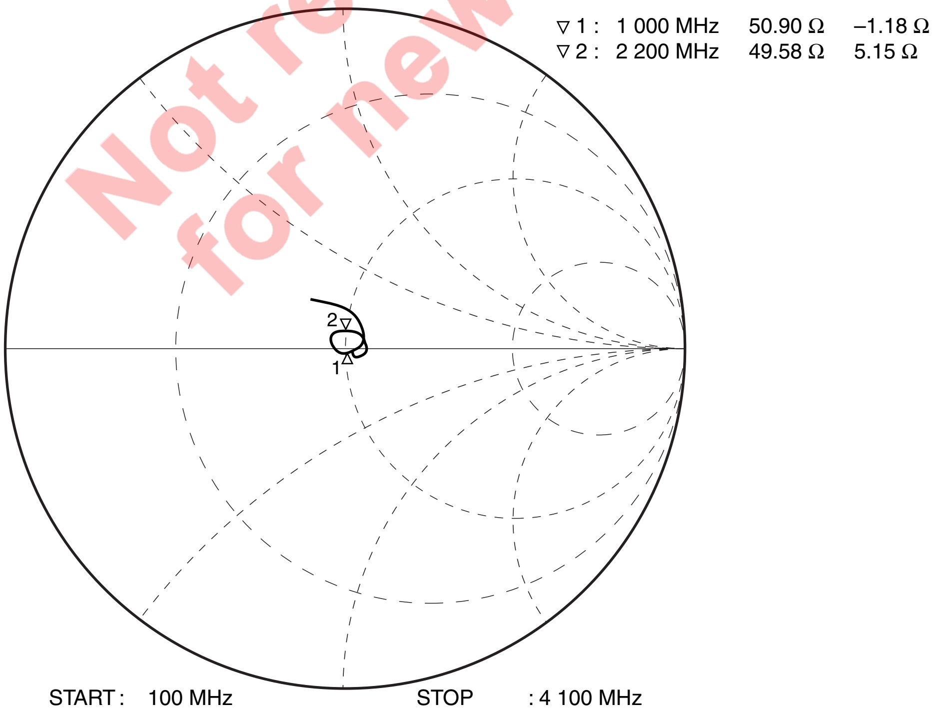

**Remark** The graphs indicate nominal characteristics.

## S-PARAMETERS ($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 3.3 V, $P_{in}$ = –30 dBm)

### $S_{11}$–FREQUENCY




### $S_{22}$–FREQUENCY




**Remarks 1.** Measured on the test circuit of evaluation board.

**2.** The graphs indicate nominal characteristics.

## S-PARAMETERS

S-parameters and noise parameters are provided on our Web site in a format (S2P) that enables the direct import of the parameters to microwave circuit simulators without the need for keyboard inputs.

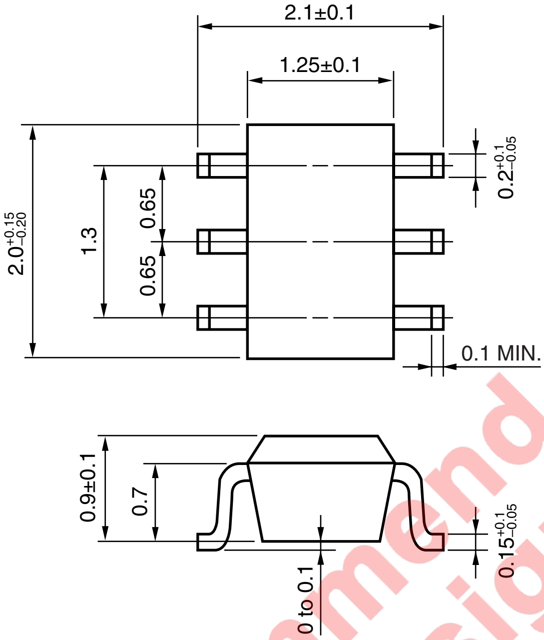
Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL http://www.necel.com/microwave/en/

## PACKAGE DIMENSIONS

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



## NOTES 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). All the ground terminals must be connected together with wide ground pattern to decrease impedance difference.

(3) The bypass capacitor should be attached to the $V_{CC}$ line.

(4) The inductor (L) must be attached between $V_{CC}$ and output pins. The inductance value should be determined in accordance with desired frequency.

(5) The DC cut capacitor must be attached to input and output pin.

## RECOMMENDED SOLDERING CONDITIONS

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

| Soldering Method | Soldering Conditions | | Condition Symbol |
|---|---|---|---|
| Infrared Reflow | Peak temperature (package surface temperature) | : 260°C or below | IR260 |
| | Time at peak temperature | : 10 seconds or less | |
| | Time at temperature of 220°C or higher | : 60 seconds or less | |
| | Preheating time at 120 to 180°C | : 120±30 seconds | |
| | Maximum number of reflow processes | : 3 times | |
| | Maximum chlorine content of rosin flux (% mass) | : 0.2%(Wt.) or below | |
| Wave Soldering | Peak temperature (molten solder temperature) | : 260°C or below | WS260 |
| | Time at peak temperature | : 10 seconds or less | |
| | Preheating temperature (package surface temperature) | : 120°C or below | |
| | Maximum number of flow processes | : 1 time | |
| | Maximum chlorine content of rosin flux (% mass) | : 0.2%(Wt.) or below | |
| Partial Heating | Peak temperature (terminal temperature) | : 350°C or below | HS350 |
| | Soldering time (per side of device) | : 3 seconds or less | |
| | Maximum chlorine content of rosin flux (% mass) | : 0.2%(Wt.) or below | |

**Caution Do not use different soldering methods together (except for partial heating).**