DATA SHEET

NEC

# BIPOLAR ANALOG INTEGRATED CIRCUIT

# μPC3232TB

## 5 V, SILICON GERMANIUM MMIC MEDIUM OUTPUT POWER AMPLIFIER

### DESCRIPTION

The μPC3232TB is a silicon germanium (SiGe) monolithic integrated circuit designed as IF amplifier for DBS tuners. This IC is manufactured using our 50 GHz $f_{max}$ UHS2 (Ultra High Speed Process) SiGe bipolar process.

### FEATURES

- Low current : $I_{CC}$ = 26.0 mA TYP.
- Medium output power : $P_{O\ (sat)}$ = +15.5 dBm TYP. @ f = 1.0 GHz
  : $P_{O\ (sat)}$ = +12.0 dBm TYP. @ f = 2.2 GHz
- High linearity : $P_{O\ (1\ dB)}$ = +11.0 dBm TYP. @ f = 1.0 GHz
  : $P_{O\ (1\ dB)}$ = +8.5 dBm TYP. @ f = 2.2 GHz
- Power gain : $G_P$ = 32.8 dB MIN. @ f = 1.0 GHz
  : $G_P$ = 33.5 dB MIN. @ f = 2.2 GHz
- Gain flatness : $\Delta G_P$ = 1.0 dB TYP. @ f = 1.0 to 2.2 GHz
- Noise figure : NF = 4 dB TYP. @ f = 1.0 GHz
  : NF = 4.1 dB TYP. @ f = 2.2 GHz
- Supply voltage : $V_{CC}$ = 4.5 to 5.5 V
- Port impedance : input/output 50 Ω

### APPLICATIONS

- IF amplifiers in LNB for DBS converters etc.

### ORDERING INFORMATION

| Part Number | Order Number | Package | Marking | Supplying Form |
|---|---|---|---|---|
| μPC3232TB-E3 | μPC3232TB-E3-A | 6-pin super minimold (Pb-Free) | C3S | • 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: μPC3232TB

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



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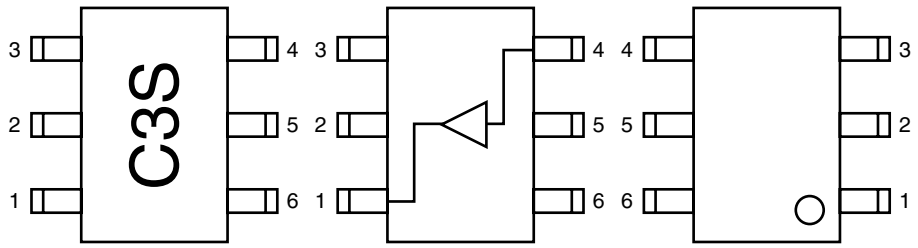
## PIN CONNECTIONS

(Top View) (Top View) (Bottom View)




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

## PRODUCT LINE-UP OF 5 V-BIAS SILICON MMIC MEDIUM OUTPUT POWER AMPLIFIER ($T_A$ = +25°C, f = 1 GHz, $V_{CC}$ = $V_{out}$ = 5.0 V, $Z_S$ = $Z_L$ = 50 Ω)

| Part No. | $P_{O\ (sat)}$ (dBm) | $G_P$ (dB) | NF (dB) | $I_{CC}$ (mA) | Package | Marking |
|---|---|---|---|---|---|---|
| μPC2708TB | +10.0 | 15.0 | 6.5 | 26 | 6-pin super minimold | C1D |
| μPC2709TB | +11.5 | 23.0 | 5.0 | 25 | | C1E |
| μPC2710TB | +13.5 | 33.0 | 3.5 | 22 | | C1F |
| μPC2776TB | +8.5 | 23.0 | 6.0 | 25 | | C2L |
| μPC3223TB | +12.0 | 23.0 | 4.5 | 19 | | C3J |
| μPC3225TB | +15.5 Note | 32.5 Note | 3.7 Note | 24.5 | | C3M |
| μPC3226TB | +13.0 | 25.0 | 5.3 | 15.5 | | C3N |
| μPC3232TB | +15.5 | 32.8 | 4.0 | 26 | | C3S |

**Note** μPC3225TB is f = 0.95 GHz

**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 | 6.0 | V |
| Total Circuit Current | $I_{CC}$ | $T_A$ = +25°C | 45 | 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 | 0 | dBm |

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

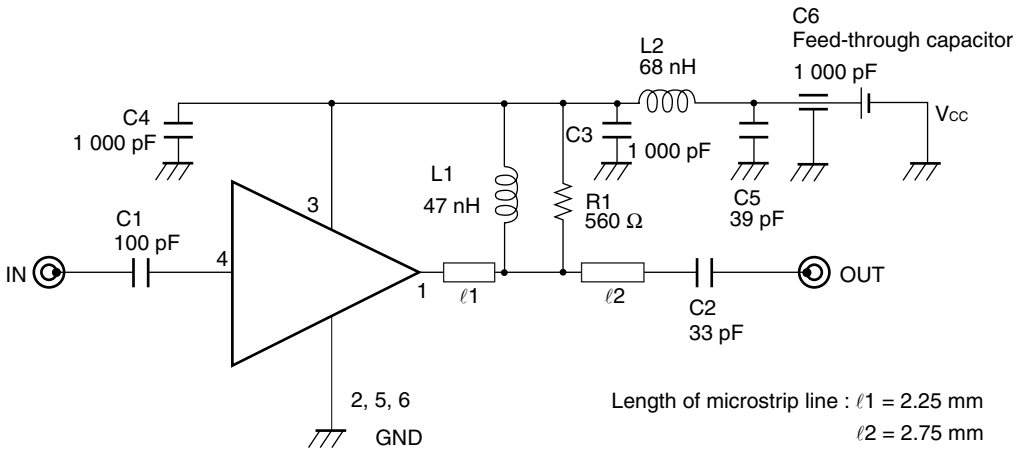
## RECOMMENDED OPERATING RANGE

| Parameter | Symbol | Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{CC}$ | | 4.5 | 5.0 | 5.5 | V |
| Operating Ambient Temperature | $T_A$ | | −40 | +25 | +85 | °C |

## ELECTRICAL CHARACTERISTICS ($T_A$ = +25°C, $V_{CC}$ = $V_{out}$ = 5.0 V, $Z_S$ = $Z_L$ = 50 Ω)

| Parameter | Symbol | Test Conditions | MIN. | TYP. | MAX. | Unit |
|---|---|---|---|---|---|---|
| Circuit Current | $I_{CC}$ | No input signal | 20 | 26 | 32 | mA |
| Power Gain 1 | $G_P1$ | f = 0.25 GHz, $P_{in}$ = –35 dBm | 29 | 31.5 | 34 | dB |
| Power Gain 2 | $G_P2$ | f = 1.0 GHz, $P_{in}$ = –35 dBm | 30 | 32.8 | 35.5 | |
| Power Gain 3 | $G_P3$ | f = 1.8 GHz, $P_{in}$ = –35 dBm | 31 | 33.8 | 37 | |
| Power Gain 4 | $G_P4$ | f = 2.2 GHz, $P_{in}$ = –35 dBm | 30.5 | 33.5 | 36.5 | |
| Power Gain 5 | $G_P5$ | f = 2.6 GHz, $P_{in}$ = –35 dBm | 29 | 32.2 | 35.5 | |
| Power Gain 6 | $G_P6$ | f = 3.0 GHz, $P_{in}$ = –35 dBm | 27 | 30.7 | 34 | |
| Gain Flatness | $\Delta G_P$ | f = 1.0 to 2.2 GHz, $P_{in}$ = –35 dBm | – | 1.0 | – | dB |
| K factor 1 | K1 | f = 1.0 GHz, $P_{in}$ = –35 dBm | – | 1.3 | – | – |
| K factor 2 | K2 | f = 2.2 GHz, $P_{in}$ = –35 dBm | – | 1.9 | – | – |
| Saturated Output Power 1 | $P_{O\,(sat)}1$ | f = 1.0 GHz, $P_{in}$ = 0 dBm | +13 | +15.5 | – | dBm |
| Saturated Output Power 2 | $P_{O\,(sat)}2$ | f = 2.2 GHz, $P_{in}$ = –5 dBm | +9.5 | +12 | – | |
| Gain 1 dB Compression Output Power 1 | $P_{O\,(1\,dB)}1$ | f = 1.0 GHz | +8 | +11 | – | dBm |
| Gain 1 dB Compression Output Power 2 | $P_{O\,(1\,dB)}2$ | f = 2.2 GHz | +6 | +8.5 | – | |
| Noise Figure 1 | NF1 | f = 1.0 GHz | – | 4 | 4.8 | dB |
| Noise Figure 2 | NF2 | f = 2.2 GHz | – | 4.1 | 4.9 | |
| Isolation 1 | ISL1 | f = 1.0 GHz, $P_{in}$ = –35 dBm | 36 | 41 | – | dB |
| Isolation 2 | ISL2 | f = 2.2 GHz, $P_{in}$ = –35 dBm | 38 | 45 | – | |
| Input Return Loss 1 | $RL_{in}1$ | f = 1.0 GHz, $P_{in}$ = –35 dBm | 9.5 | 13 | – | dB |
| Input Return Loss 2 | $RL_{in}2$ | f = 2.2 GHz, $P_{in}$ = –35 dBm | 10 | 14.5 | – | |
| Output Return Loss 1 | $RL_{out}1$ | f = 1.0 GHz, $P_{in}$ = –35 dBm | 12 | 15.5 | – | dB |
| Output Return Loss 2 | $RL_{out}2$ | f = 2.2 GHz, $P_{in}$ = –35 dBm | 12 | 15 | – | |
| Input 3rd Order Distortion Intercept Point 1 | $IIP_3$1 | f1 = 1 000 MHz, f2 = 1 001 MHz | – | –9 | – | dBm |
| Input 3rd Order Distortion Intercept Point 2 | $IIP_3$2 | f1 = 2 200 MHz, f2 = 2 201 MHz | – | –15.5 | – | |
| Output 3rd Order Distortion Intercept Point 1 | $OIP_3$1 | f1 = 1 000 MHz, f2 = 1 001 MHz | – | +23.5 | – | dBm |
| Output 3rd Order Distortion Intercept Point 2 | $OIP_3$2 | f1 = 2 200 MHz, f2 = 2 201 MHz | – | +18 | – | |
| 2nd Order Intermodulation Distortion | $IM_2$ | f1 = 1 000 MHz, f2 = 1 001 MHz, $P_{out}$ = –5 dBm/tone | – | 50 | – | dBc |
| 2nd Harmonic | 2f0 | f0 = 1.0 GHz, $P_{out}$ = –15 dBm | – | 70 | – | 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 |
|---|---|---|
| R1 | Chip Resistance | 560 Ω |
| L1 | Chip Inductor | 47 nH |
| L2 | Chip Inductor | 68 nH |
| C1 | Chip Capacitor | 100 pF |
| C2 | Chip Capacitor | 33 pF |
| C3, C4 | Chip Capacitor | 1 000 pF |
| C5 | Chip Capacitor | 39 pF |
| C6 | Feed-through Capacitor | 1 000 pF |

## 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 3) and output pin (pin 1). 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

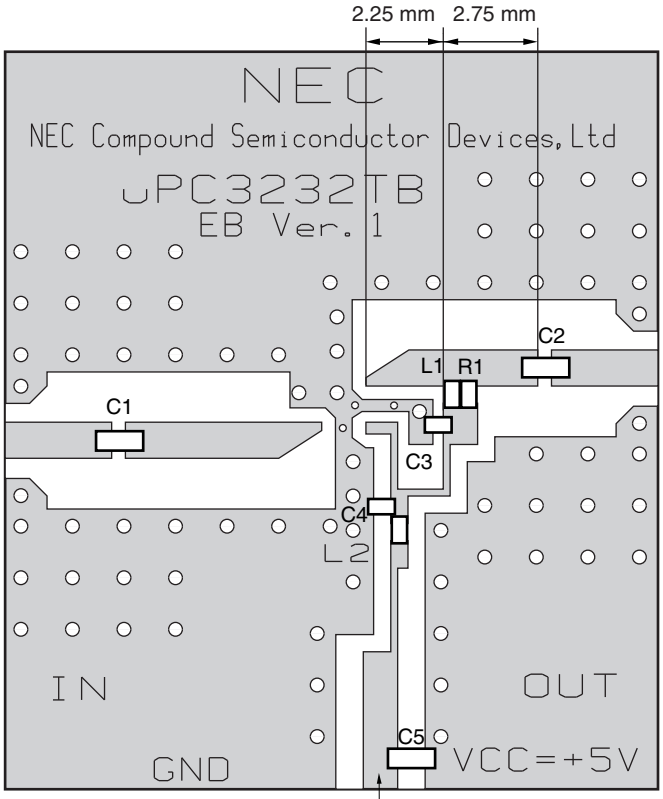
Capacitors of 1 000 pF are recommendable as the bypass capacitor for the $V_{CC}$ pin and the coupling capacitors for the input and output pins.

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




**COMPONENT LIST**

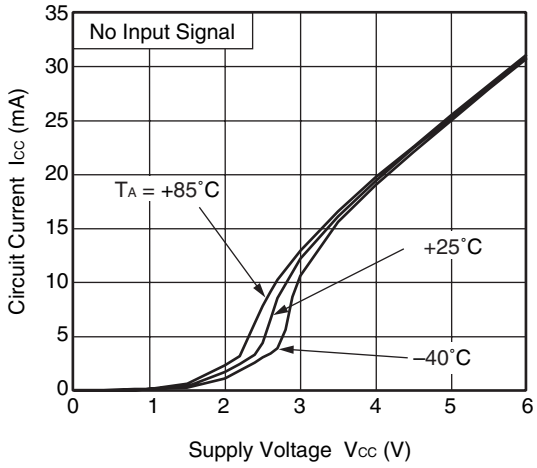
| | Value | Size |
|---|---|---|
| R1 | 560 Ω | 1005 |
| L1 | 47 nH | 1005 |
| L2 | 68 nH | 1005 |
| C1 | 100 pF | 1608 |
| C2 | 33 pF | 1608 |
| C3, C4 | 1 000 pF | 1005 |
| C5 | 39 pF | 1608 |
| C6 | 1 000 pF | Feed-through Capacitor |

**Notes**

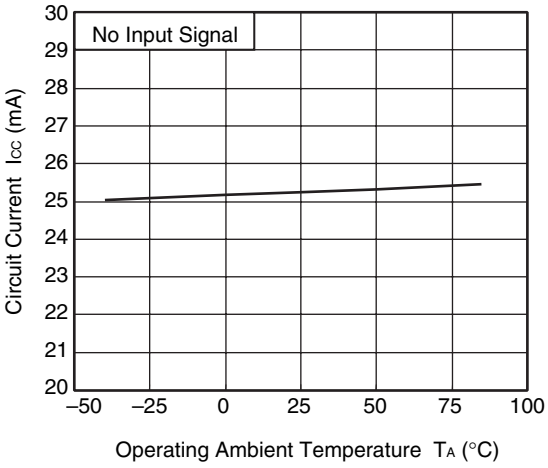
1. 19 × 21.46 × 0.51 mm double sided copper clad RO4003C (Rogers) board.
2. Back side: GND pattern
3. Au plated on pattern
4. ○: Through holes
5. L1, L2: FDK's products

**TYPICAL CHARACTERISTICS ($T_A$ = +25°C, $V_{CC}$ = 5.0 V, $Z_S$ = $Z_L$ = 50 Ω, unless otherwise specified)**

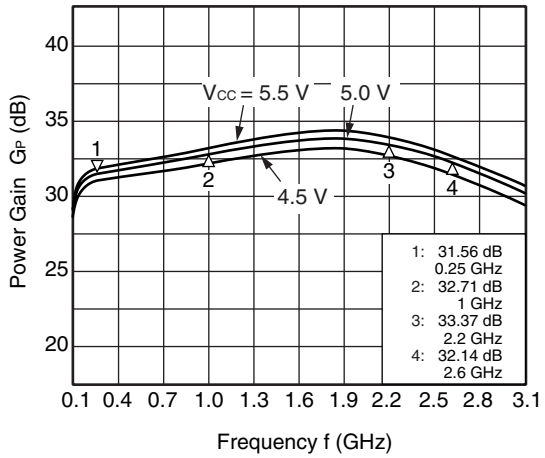
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



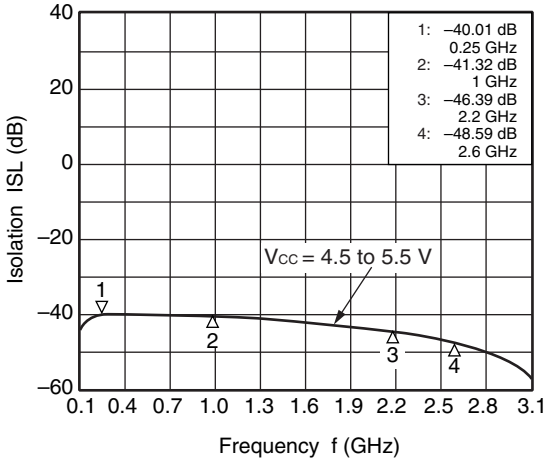

CURCUIT CURRENT vs. OPERATING AMBIENT TEMPERATURE



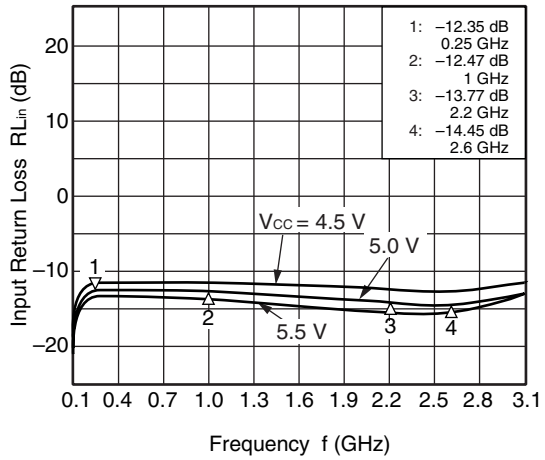

POWER GAIN vs. FREQUENCY



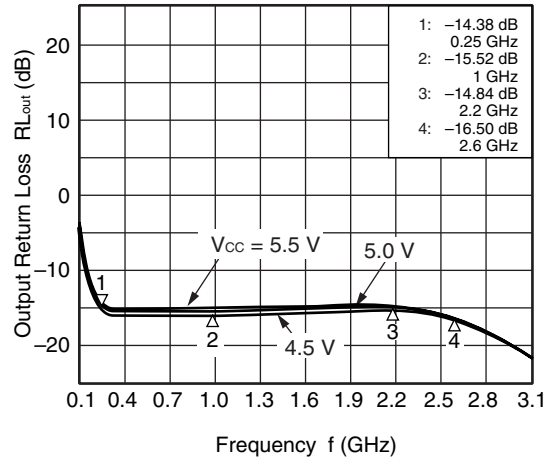

ISOLATION vs. FREQUENCY




INPUT RETURN LOSS vs. FREQUENCY

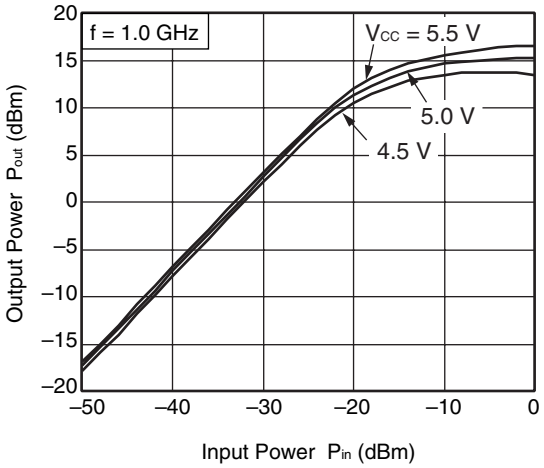



OUTPUT RETURN LOSS vs. FREQUENCY

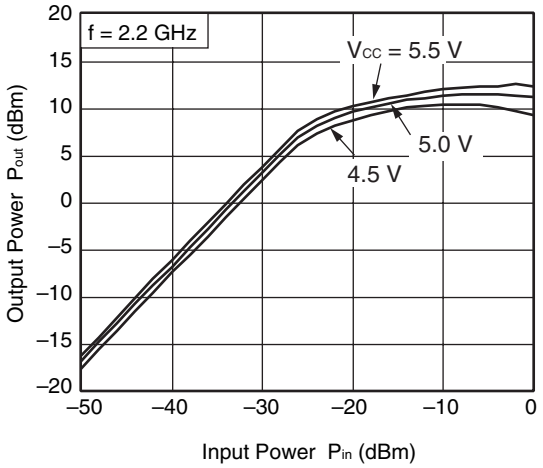



**Remark** The graphs indicate nominal characteristics.

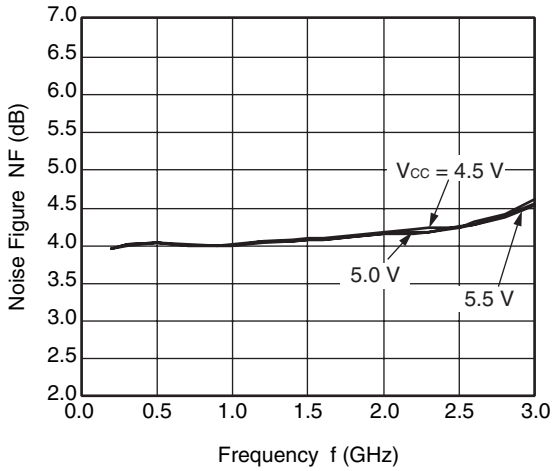
OUTPUT POWER vs. INPUT POWER



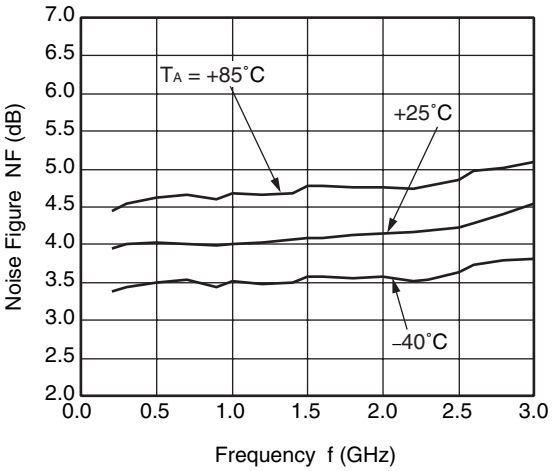

OUTPUT POWER vs. INPUT POWER




NOISE FIGURE vs. FREQUENCY

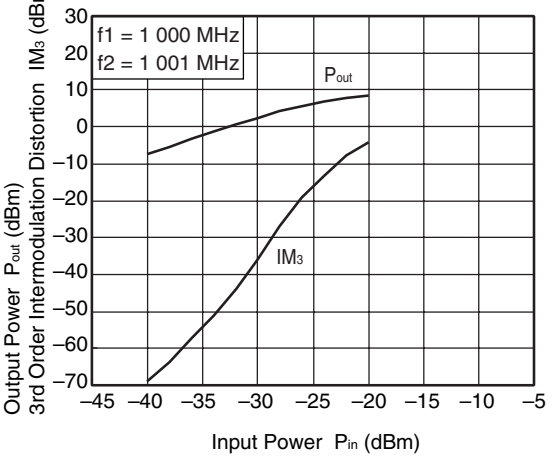



NOISE FIGURE vs. FREQUENCY

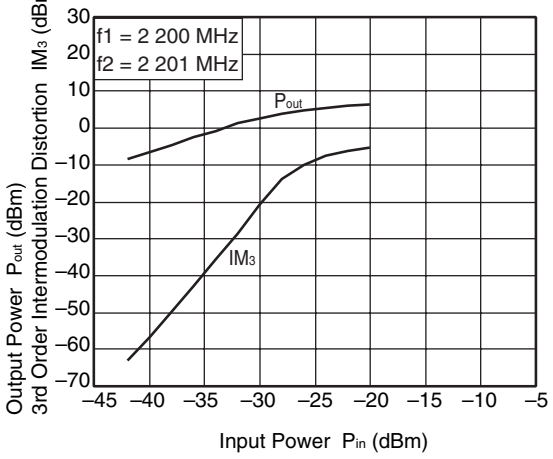



**Remark** The graphs indicate nominal characteristics.

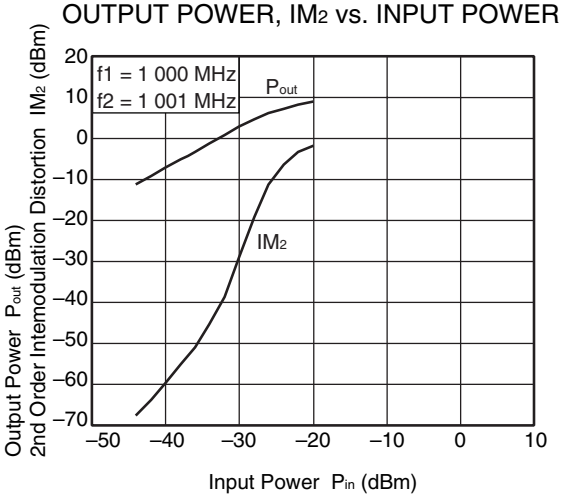
OUTPUT POWER, $IM_3$ vs. INPUT POWER



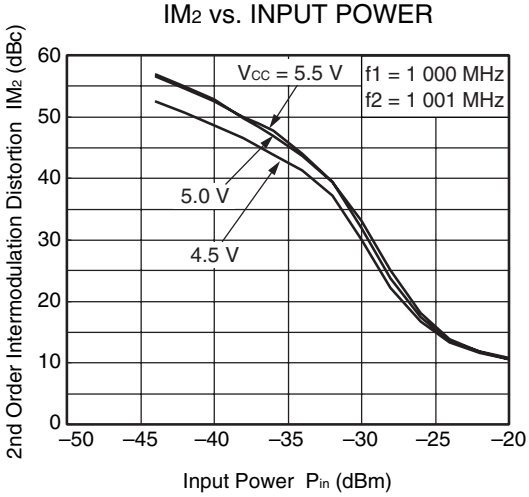

OUTPUT POWER, $IM_3$ vs. INPUT POWER



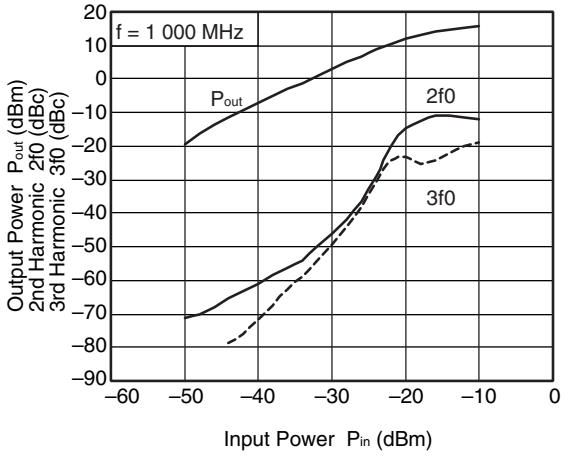

OUTPUT POWER, $IM_2$ vs. INPUT POWER



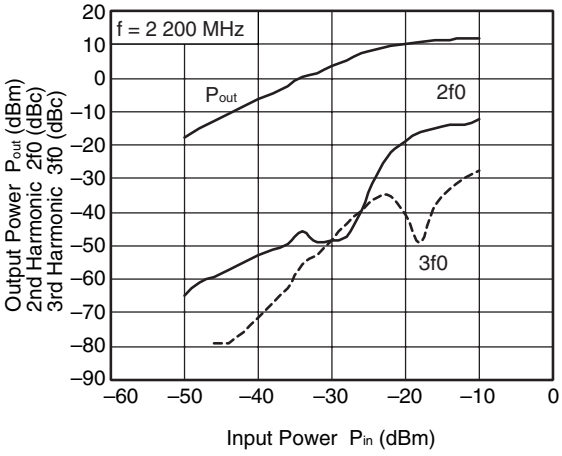

$IM_2$ vs. INPUT POWER




OUTPUT POWER, 2ND HARMONIC, 3RD HARMONIC vs. INPUT POWER



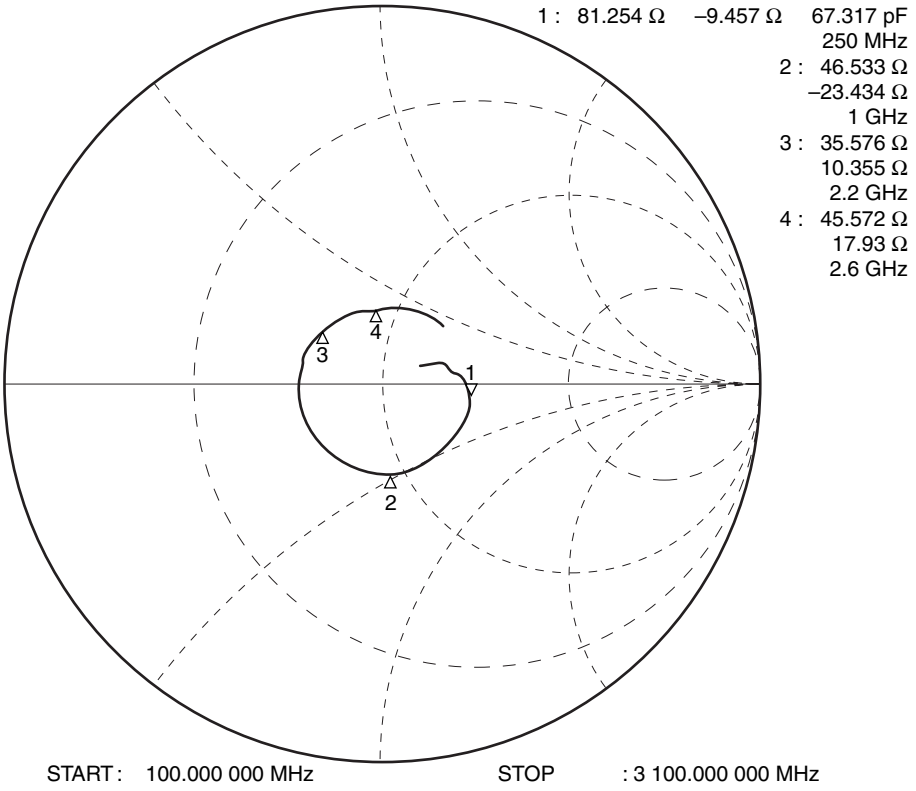

OUTPUT POWER, 2ND HARMONIC, 3RD HARMONIC vs. INPUT POWER



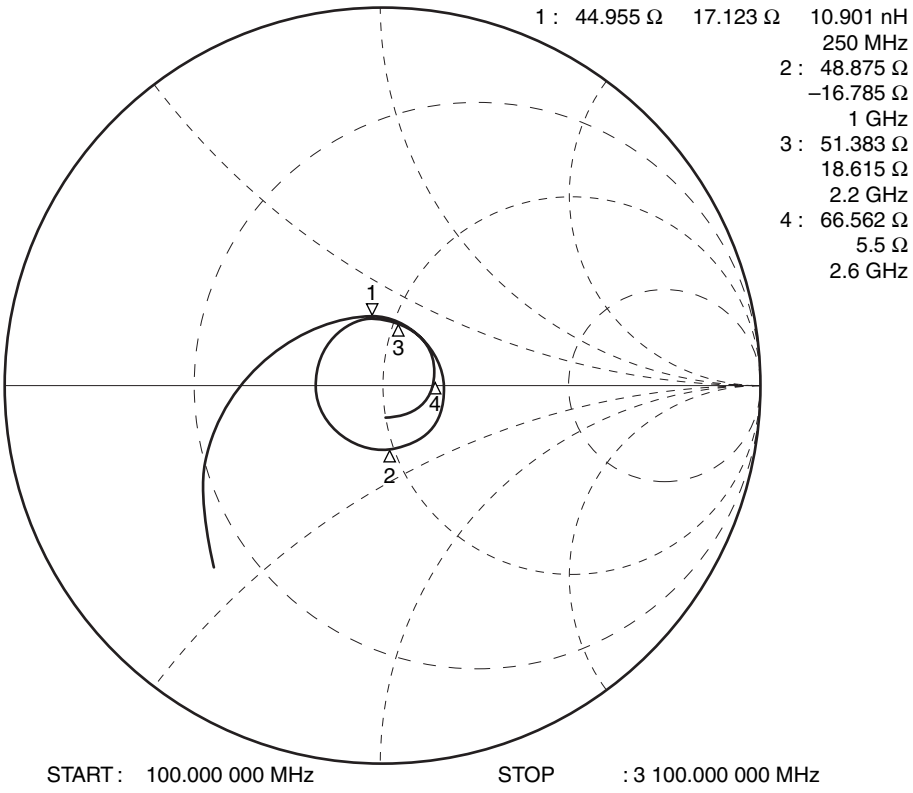

**Remark** The graphs indicate nominal characteristics.

## S-PARAMETERS ($T_A$ = +25°C, $V_{DD}$ = $V_{CC}$ = 5.0 V, $P_{in}$ = –35 dBm)

### $S_{11}$–FREQUENCY




### $S_{22}$–FREQUENCY



**S-PARAMETERS**

S-parameters/Noise parameters are provided on our web site in a form (S2P) that enables direct import to a microwave circuit simulator without keyboard input.

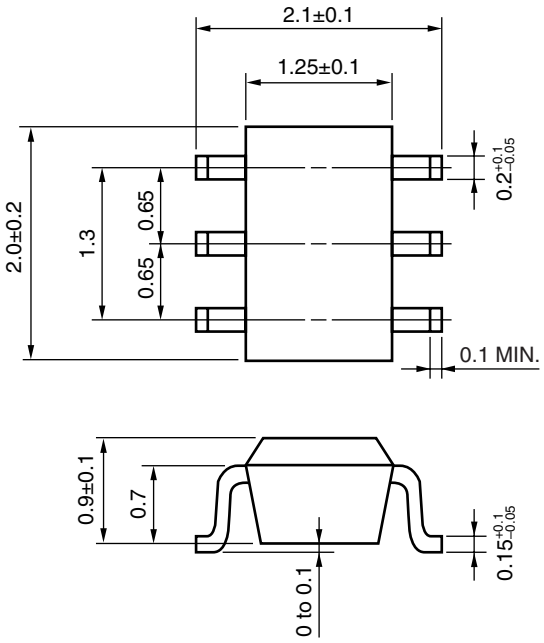
Click here to download S-parameters.

[RF and Microwave] → [Device Parameters]

URL http://www.ncsd.necel.com/microwave/index.html

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

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

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▶For further information, please contact

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