



# BIPOLAR ANALOG INTEGRATED CIRCUIT

# $\mu$ PC8231TK

## SiGe:C LOW NOISE AMPLIFIER FOR GPS/MOBILE COMMUNICATIONS

### DESCRIPTION

The  $\mu$ PC8231TK is a silicon germanium carbon (SiGe:C) monolithic integrated circuit designed as low noise amplifier for GPS and mobile communications. This device exhibits low noise figure and high power gain characteristics. This device is enabled in the frequency range from 1.5 to 2.4 GHz by modifying the external matching circuit.

The package is 6-pin lead-less minimold, suitable for surface mount.

This IC is manufactured using our UHS4 (Ultra High Speed Process) SiGe:C bipolar process.

### FEATURES

- Low noise : NF = 0.8 dB TYP. @  $f_{in} = 1.575$  MHz
- High gain : GP = 20 dB TYP. @  $f_{in} = 1.575$  MHz
- Low current consumption :  $I_{CC} = 3.8$  mA TYP. @  $V_{CC} = 3.0$  V
- Built-in power-saving function
- High-density surface mounting : 6-pin lead-less minimold package (1.5 × 1.1 × 0.55 mm)
- Included very robust bandgap regulator (Small  $V_{CC}$  and  $T_A$  dependence)
- Included protection circuits for ESD

### APPLICATION

- Low noise amplifier for GPS and mobile communications

### ORDERING INFORMATION

| Part Number       | Order Number        | Package  | Marking | Supplying Form   |
|-------------------|---------------------|--|---------|--|
| $\mu$ PC8231TK-E2 | $\mu$ PC8231TK-E2-A | 6-pin lead-less minimold<br>(1511 PKG) (Pb-Free) | 6K      | <ul style="list-style-type: none"><li>• 8 mm wide embossed taping</li><li>• Pin 1, 6 face the perforation side of the tape</li><li>• Qty 5 kpcs/reel</li></ul> |

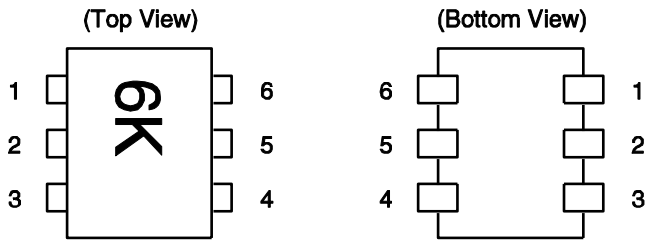
**Remark** To order evaluation samples, contact your nearby sales office.

Part number for sample order:  $\mu$ PC8231TK-A

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

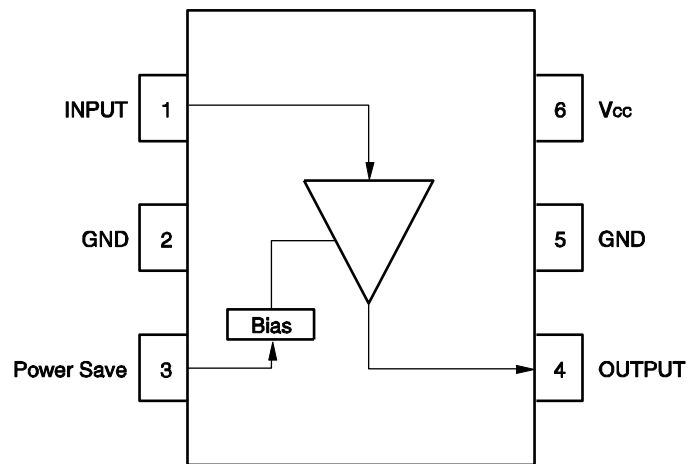
The information in this document is subject to change without notice. Before using this document, please confirm that this is the latest version.

**PIN CONNECTIONS**



| Pin No. | Pin Name        |
|---------|-----------------|
| 1       | INPUT           |
| 2       | GND             |
| 3       | Power Save      |
| 4       | OUTPUT          |
| 5       | GND             |
| 6       | V <sub>cc</sub> |

**INTERNAL BLOCK DIAGRAM**



**ABSOLUTE MAXIMUM RATINGS**

| Parameter                     | Symbol           | Test Conditions                    | Ratings     | Unit |
|-------------------------------|------------------|------------------------------------|-------------|------|
| Supply Voltage                | V <sub>CC</sub>  | T <sub>A</sub> = +25°C             | 4.0         | V    |
| Power-Saving Voltage          | V <sub>PS</sub>  | T <sub>A</sub> = +25°C             | 4.0         | V    |
| Power Dissipation             | P <sub>D</sub>   | T <sub>A</sub> = +85°C <b>Note</b> | 232         | mW   |
| Operating Ambient Temperature | T <sub>A</sub>   |                                    | -40 to +85  | °C   |
| Storage Temperature           | T <sub>stg</sub> |                                    | -55 to +150 | °C   |
| Input Power                   | P <sub>in</sub>  |                                    | +10         | dBm  |

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

**RECOMMENDED OPERATING RANGE**

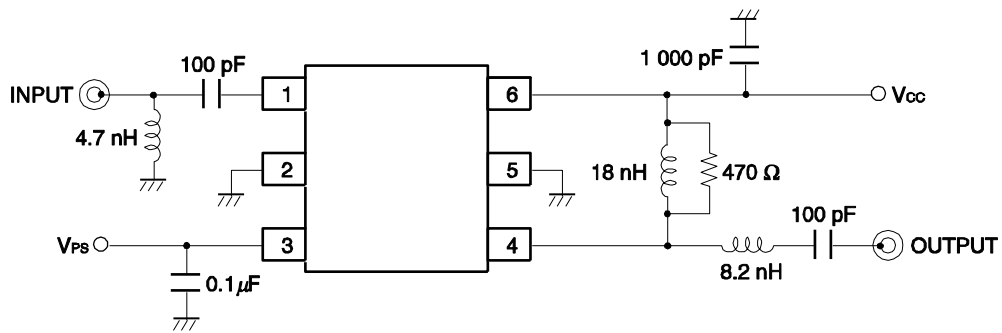
| Parameter                     | Symbol             | MIN. | TYP. | MAX.            | Unit |
|-------------------------------|--------------------|------|------|-----------------|------|
| Supply Voltage                | V <sub>CC</sub>    | 2.7  | 3.0  | 3.3             | V    |
| Operating Ambient Temperature | T <sub>A</sub>     | -40  | +25  | +85             | °C   |
| Power Save Turn-on Voltage    | V <sub>PSon</sub>  | 1.6  | -    | V <sub>CC</sub> | V    |
| Power Save Turn-off Voltage   | V <sub>PSoff</sub> | 0    | -    | 0.4             | V    |

**ELECTRICAL CHARACTERISTICS**

( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{PS} = 3.0\text{ V}$ ,  $f_{in} = 1\ 575\text{ MHz}$ , unless otherwise specified)

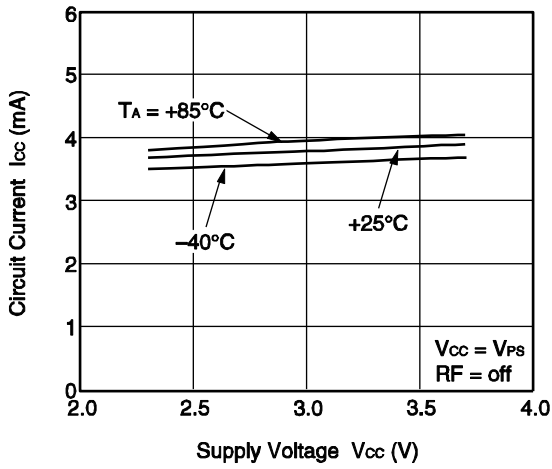
| Parameter                                  | Symbol                | Test Conditions   | MIN. | TYP. | MAX. | Unit          |
|--|-----------------------|---|------|------|------|---------------|
| Circuit Current                            | $I_{CC}$              | No Signal ( $V_{PS} = 3.0\text{ V}$ )                         | 2.8  | 3.8  | 5.1  | mA            |
|  |                       | At Power-Saving Mode ( $V_{PS} = 0\text{ V}$ )                | –    | –    | 1    | $\mu\text{A}$ |
| Power Gain                                 | $G_P$                 | $P_{in} = -35\text{ dBm}$                                     | 17.5 | 20   | 22.5 | dB            |
| Noise Figure                               | NF                    |   | –    | 0.8  | 1.1  | dB            |
| Input 3rd Order Distortion Intercept Point | IIP <sub>3</sub>      | $f_{in1} = 1\ 574\text{ MHz}$ , $f_{in2} = 1\ 575\text{ MHz}$ | –    | -10  | –    | dBm           |
| Input Return Loss                          | RL <sub>in</sub>      |   | 7    | 10   | –    | dB            |
| Output Return Loss                         | RL <sub>out</sub>     |   | 10   | 18   | –    | dB            |
| Isolation                                  | ISL                   |   | –    | 35   | –    | dB            |
| Gain 1 dB Compression Input Power          | $P_{in}(1\text{ dB})$ |   | –    | -22  | –    | dBm           |

**TEST CIRCUIT**

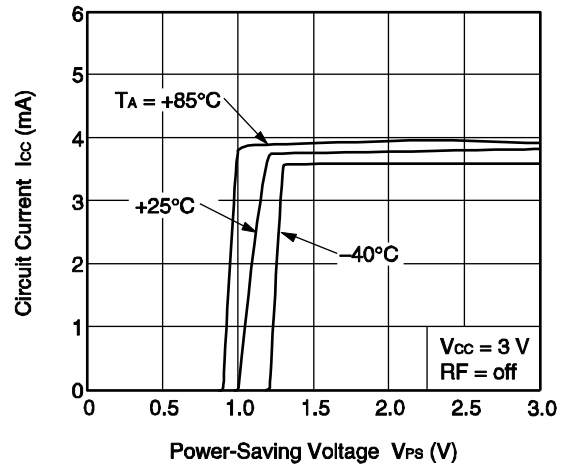


TYPICAL CHARACTERISTICS ( $T_A = +25^\circ\text{C}$ , unless otherwise specified)

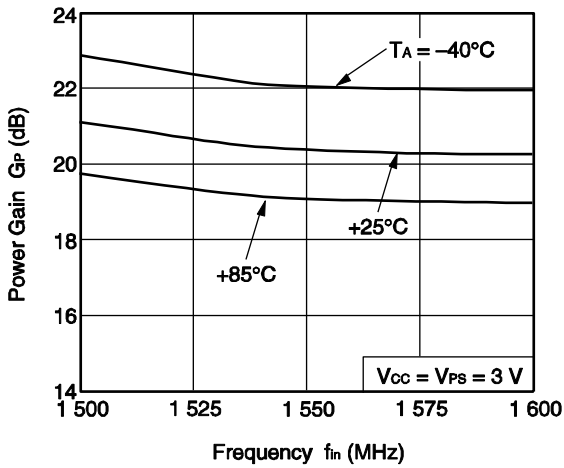
CIRCUIT CURRENT vs. SUPPLY VOLTAGE



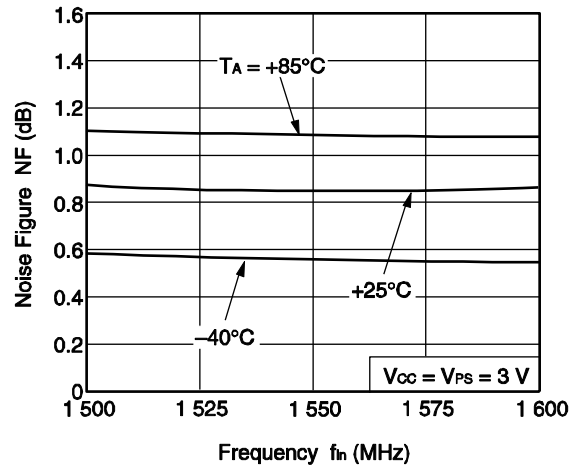
CIRCUIT CURRENT vs. POWER-SAVING VOLTAGE



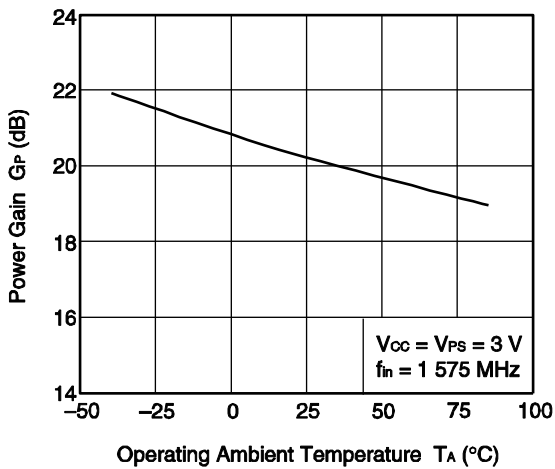
POWER GAIN vs. FREQUENCY



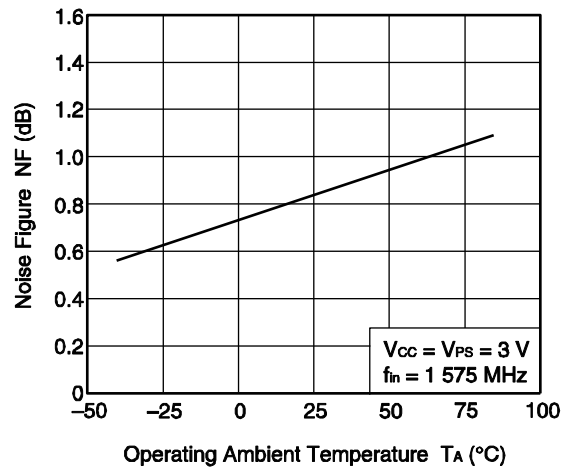
NOISE FIGURE vs. FREQUENCY



POWER GAIN vs. OPERATING AMBIENT TEMPERATURE

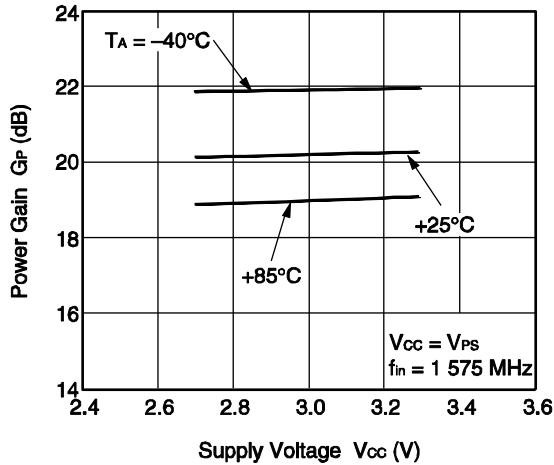


NOISE FIGURE vs. OPERATING AMBIENT TEMPERATURE

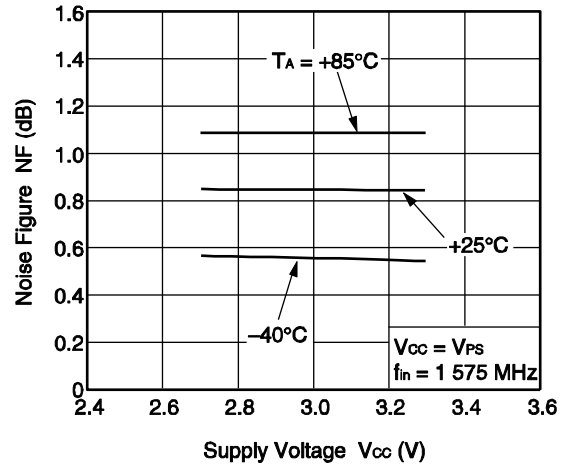


Remark The graphs indicate nominal characteristics.

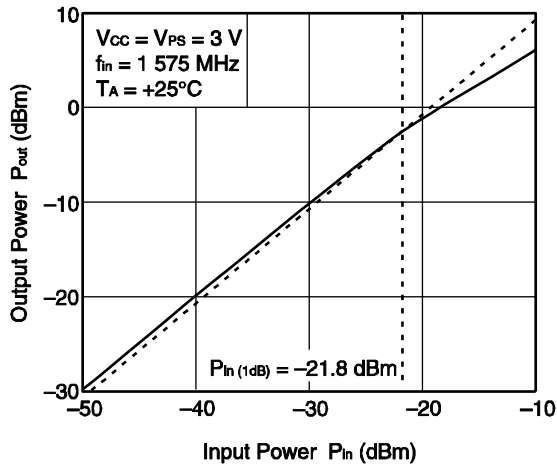
POWER GAIN vs. SUPPLY VOLTAGE



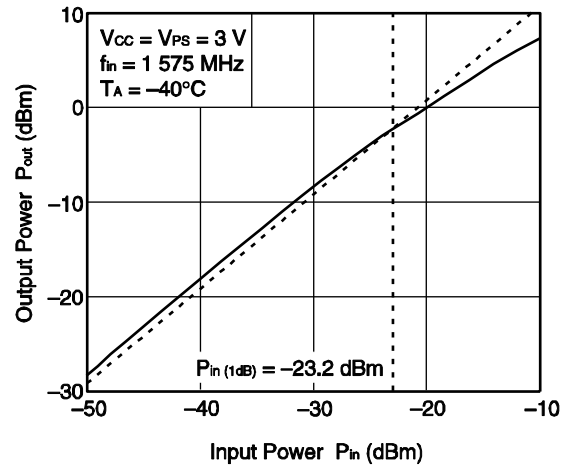
NOISE FIGURE vs. SUPPLY VOLTAGE



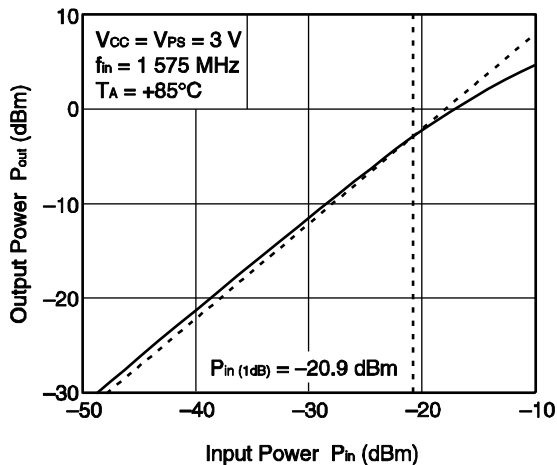
OUTPUT POWER vs. INPUT POWER



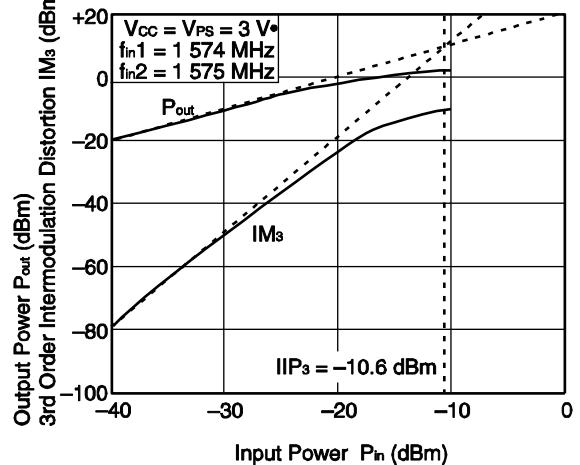
OUTPUT POWER vs. INPUT POWER



OUTPUT POWER vs. INPUT POWER



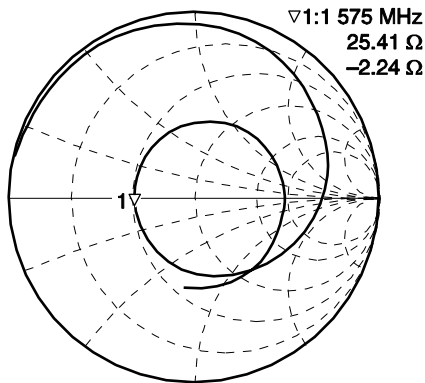
OUTPUT POWER, IM3 vs. INPUT POWER



Remark The graphs indicate nominal characteristics.

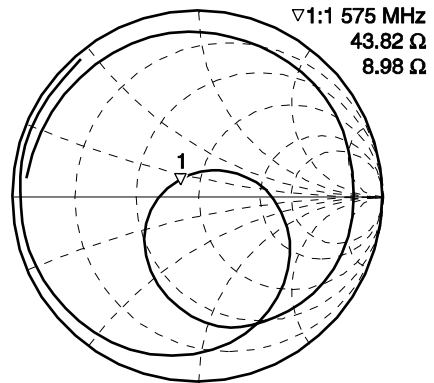
S-PARAMETERS ( $T_A = +25^\circ\text{C}$ ,  $V_{CC} = V_{PS} = 3.0\text{ V}$ , monitored at connector on board)

S<sub>11</sub>-FREQUENCY



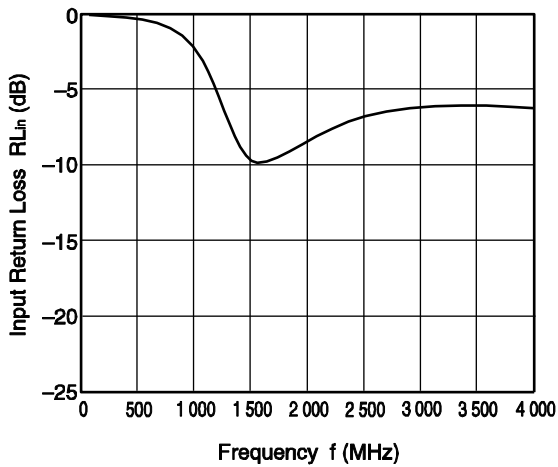
START 100.000 000 MHz STOP 4 000.000 000 MHz

S<sub>22</sub>-FREQUENCY

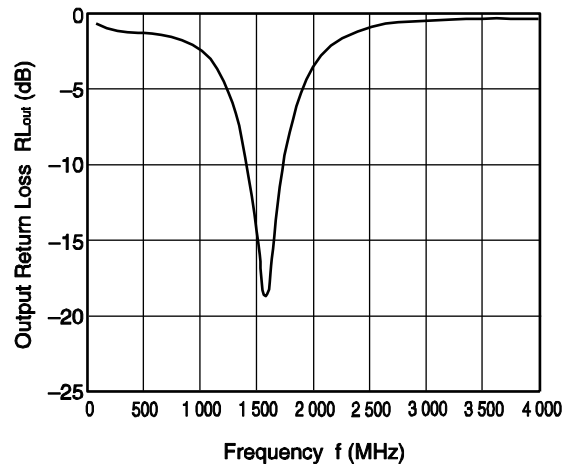


START 100.000 000 MHz STOP 4 000.000 000 MHz

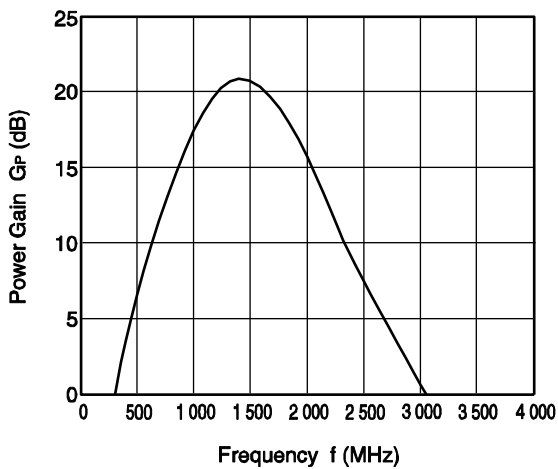
INPUT RETURN LOSS vs. FREQUENCY



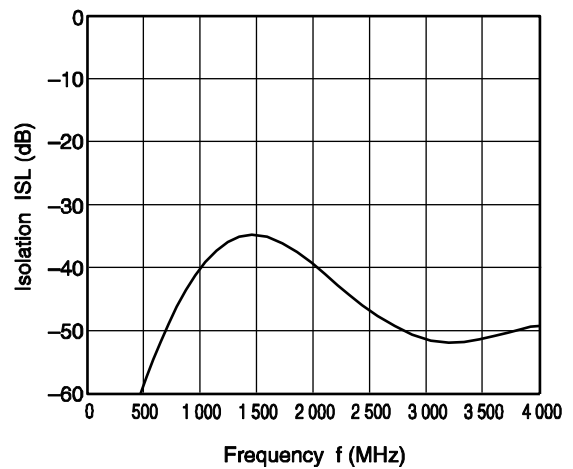
OUTPUT RETURN LOSS vs. FREQUENCY



POWER GAIN vs. FREQUENCY

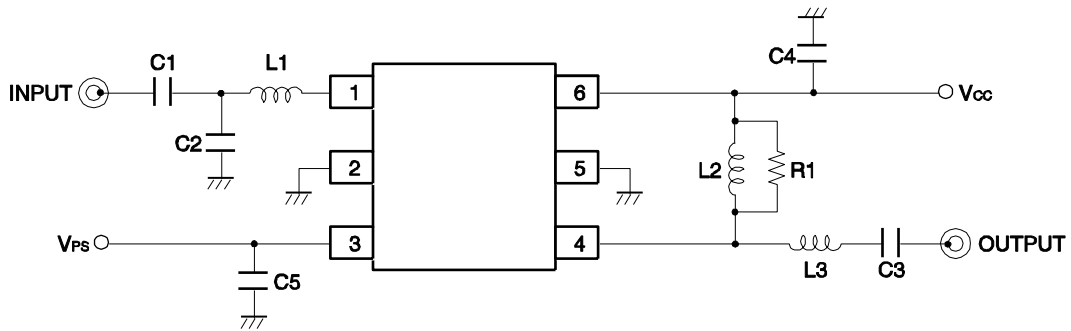


ISOLATION vs. FREQUENCY



**Remark** The graphs indicate nominal characteristics.

APPLIED CIRCUIT EXAMPLE



EXTERNAL PARTS CHART

| Symbol | Parts          | Value          |              |               |              | Unit |
|--------|----------------|----------------|--------------|---------------|--------------|------|
|        |                | 1.575 GHz Band | 1.9 GHz Band | 2.14 GHz Band | 2.4 GHz Band |      |
| L1     | Chip Inductor  | 5.6            | 3.9          | 3.3           | 2.7          | nH   |
| L2     | Chip Inductor  | 18             | 12           | 8.2           | 6.8          | nH   |
| L3     | Chip Inductor  | 10             | 8.2          | 6.8           | 5.6          | nH   |
| C1     | Chip Capacitor | 120            | 5.0          | 2.0           | 2.0          | pF   |
| C2     | Chip Capacitor | 1.3            | 0.7          | 0.5           | 0.3          | pF   |
| C3     | Chip Capacitor | 120            | 5.0          | 5.0           | 5.0          | pF   |
| C4     | Chip Capacitor | 1 000          | 1 000        | 1 000         | 1 000        | pF   |
| C5     | Chip Capacitor | 1 000          | 1 000        | 1 000         | 1 000        | pF   |
| R1     | Chip Resistor  | 470            | 470          | 470           | 470          | Ω    |

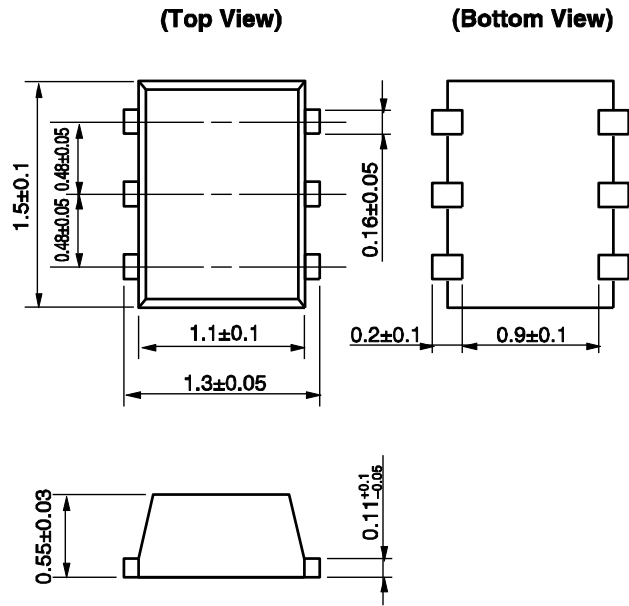
TYPICAL CHARACTERISTICS (TA = +25°C, VCC = VPS = 3.0 V, unless otherwise specified)

| Parameter          | Symbol | Reference Value |         |          |         | Unit |
|--------------------|--------|-----------------|---------|----------|---------|------|
|                    |        | 1.575 GHz       | 1.9 GHz | 2.14 GHz | 2.4 GHz |      |
| Power Gain         | GP     | 20.0            | 19.0    | 18.0     | 17.0    | dB   |
| Noise Figure       | NF     | 0.78            | 0.95    | 1.10     | 1.27    | dB   |
| Input Return Loss  | RLin   | 10.4            | 10.2    | 10.2     | 10.5    | dB   |
| Output Return Loss | RLout  | 21.0            | 30.0    | 32.2     | 23.0    | dB   |



**PACKAGE DIMENSIONS**

**6-PIN LEAD-LESS MINIMOLD (1511 PKG) (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 Vcc line.
- (4) Do not supply DC voltage to INPUT 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<br>Time at peak temperature : 10 seconds or less<br>Time at temperature of 220°C or higher : 60 seconds or less<br>Preheating time at 120 to 180°C : 120±30 seconds<br>Maximum number of reflow processes : 3 times<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below | IR260            |
| Wave Soldering   | Peak temperature (molten solder temperature) : 260°C or below<br>Time at peak temperature : 10 seconds or less<br>Preheating temperature (package surface temperature) : 120°C or below<br>Maximum number of flow processes : 1 time<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below  | WS260            |
| Partial Heating  | Peak temperature (terminal temperature) : 350°C or below<br>Soldering time (per side of device) : 3 seconds or less<br>Maximum chlorine content of rosin flux (% mass) : 0.2%(Wt.) or below   | HS350            |

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