

## 800MHz BAND LOW NOISE AMPLIFIER GaAs MMIC

### ■GENERAL DESCRIPTION

NJG1104KB2 is a variable gain low noise amplifier (LNA).

At 800MHz band, noise figure is 1.2dB, variable gain range is 21dB and input 3rd order intercept point is +6dBm. These characteristics are very suitable for CDMA cellular phone application.

The variable attenuators placed in front of LNA realize wide range of input power with low distortion.

An ultra small and ultra thin FLP6-B2 package is adopted.

### ■PACKAGE OUTLINE

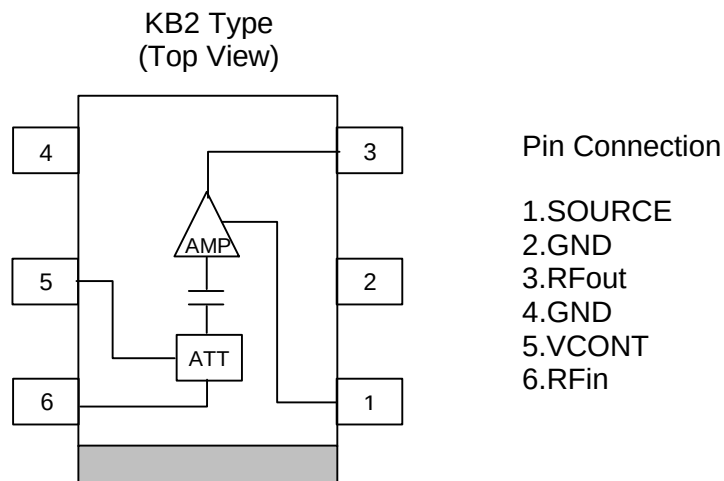


NJG1104KB2

### ■FEATURES

- |                                   |                                                 |
|-----------------------------------|-------------------------------------------------|
| ●Low voltage operation            | +2.8V typ.                                      |
| ●Low current consumption          | 6.0mA typ.                                      |
| ●High gain                        | 15dB typ. @f=865MHz                             |
| ●Low noise figure                 | 1.2dB typ. @f=865MHz                            |
| ●Variable gain control            | 21dB typ. @f=865MHz, $V_{CONT}=0.2$ to 1.7V     |
| ●High input IP3                   | +6dBm typ. @f=865.0+865.1MHz, $P_{in}=-30$ dBm  |
| ●High output IP3                  | +21dBm typ. @f=865.0+865.1MHz, $P_{in}=-30$ dBm |
| ●Ultra small & ultra thin package | FLP6-B2 (Mount Size: 2.1x2.0x0.75mm)            |

### ■PIN CONFIGURATION



Note: The  portion above shows orientation mark printed on the package surface.

# NJG1104KB2

## ■ABSOLUTE MAXIMUM RATINGS

( $T_a=25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ )

| PARAMETER             | SYMBOL     | CONDITIONS           | RATINGS  | UNITS              |
|-----------------------|------------|----------------------|----------|--------------------|
| Drain Voltage         | $V_{DD}$   |                      | 6.0      | V                  |
| Gain Control Voltage  | $V_{CONT}$ |                      | 4.0      | V                  |
| Input Power           | $P_{in}$   | $V_{DD}=2.8\text{V}$ | +20      | dBm                |
| Power Dissipation     | $P_D$      |                      | 450      | mW                 |
| Operating Temperature | $T_{opr}$  |                      | -40~+85  | $^{\circ}\text{C}$ |
| Storage Temperature   | $T_{stg}$  |                      | -55~+125 | $^{\circ}\text{C}$ |

## ■ELECTRICAL CHARACTERISTICS

( $V_{DD}=2.8\text{V}$ ,  $V_{CONT}=1.7\text{V}$ ,  $f=865\text{MHz}$ ,  $T_a=25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ )

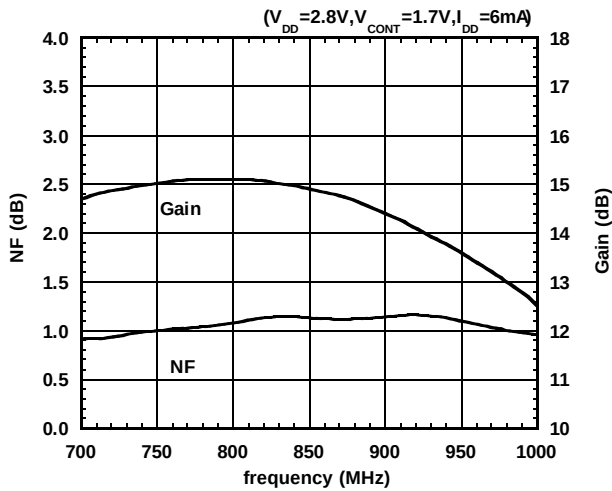
| PARAMETER                          | SYMBOL     | CONDITIONS                                                                    | MIN   | TYP   | MAX  | UNITS         |
|------------------------------------|------------|-------------------------------------------------------------------------------|-------|-------|------|---------------|
| Operating Frequency                | freq       |                                                                               | 830   | 865   | 900  | MHz           |
| Drain Voltage                      | $V_{DD}$   |                                                                               | 2.7   | 2.8   | 5.5  | V             |
| Gain Control Voltage               | $V_{CONT}$ |                                                                               | 0.2   | 1.7   | 3.0  | V             |
| Operating Current                  | $I_{DD}$   | No RF Signal                                                                  | -     | 6.0   | 7.5  | mA            |
| Gain Control Terminal Current      | $I_{CONT}$ | No RF Signal                                                                  | -     | 1.0   | 5.0  | $\mu\text{A}$ |
| Small Signal Gain                  | Gain       |                                                                               | 13.0  | 15.0  | 17.0 | dB            |
| Gain Flatness                      | $G_{flat}$ | $f=830\sim 900\text{MHz}$                                                     | -     | 0.5   | 1.0  | dB            |
| Gain Control Range                 | $G_{CONT}$ | $V_{CONT}=0.2\text{V}, 1.7\text{V}$                                           | 18.5  | 20.5  | 22.5 | dB            |
| Noise Figure                       | NF         |                                                                               | -     | 1.20  | 1.40 | dB            |
| Pout at 1dB Gain Compression point | $P_{-1dB}$ |                                                                               | -     | +8.0  | -    | dBm           |
| Output 3rd Order Intercept Point   | OIP3       | $f=865.0+865.1\text{MHz}$<br>$P_{in}=-30\text{dBm}$                           | +19.0 | +21.0 | -    | dBm           |
| Input 3rd Order Intercept Point 1  | IIP3-1     | $f=865.0+865.1\text{MHz}$<br>$P_{in}=-30\text{dBm}$                           | +4.0  | +6.0  | -    | dBm           |
| Input 3rd Order Intercept Point 2  | IIP3-2     | $f=865.0+865.1\text{MHz}$<br>$P_{in}=-10\text{dBm}$<br>$V_{CONT}=0.2\text{V}$ | +21.0 | +26.0 | -    | dBm           |
| RF Input Port VSWR                 | $VSWR_i$   |                                                                               | -     | 1.5   | 2.0  | -             |
| RF Output Port VSWR                | $VSWR_o$   |                                                                               | -     | 1.5   | 2.0  | -             |

## ■TERMINAL INFORMATION

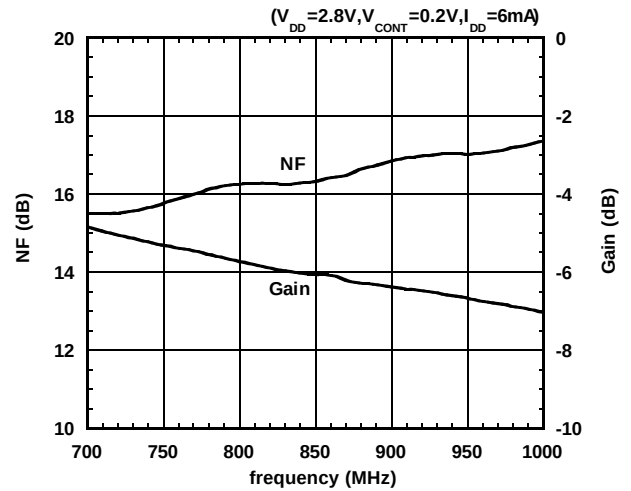
| Pin  | Function | Description                                                                                                                                                                                        |
|------|----------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1    | SOURCE   | This terminal is internally connected to FET's source of LNA. Please connect self-bias resistor (R1) and bypass capacitor (C3) through source inductor (L5). NF and IIP3 are tunable by C3 and L5. |
| 2, 4 | GND      | Ground (0V) terminal. Ground plane should be placed as close to the ground terminals. .                                                                                                            |
| 3    | RFout    | RF output and drain voltage supplies terminal. External matching circuit is required.                                                                                                              |
| 5    | VCONT    | Gain control voltage ( $V_{\text{CONT}}$ ) supplies terminal.                                                                                                                                      |
| 6    | RFin     | RF input terminal. External matching circuit and DC blocking capacitor are required.                                                                                                               |

## ■ TYPICAL CHARACTERISTICS

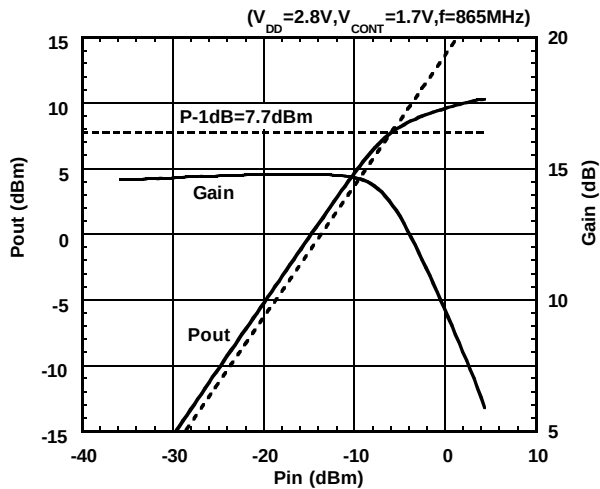
NF, Gain vs. frequency



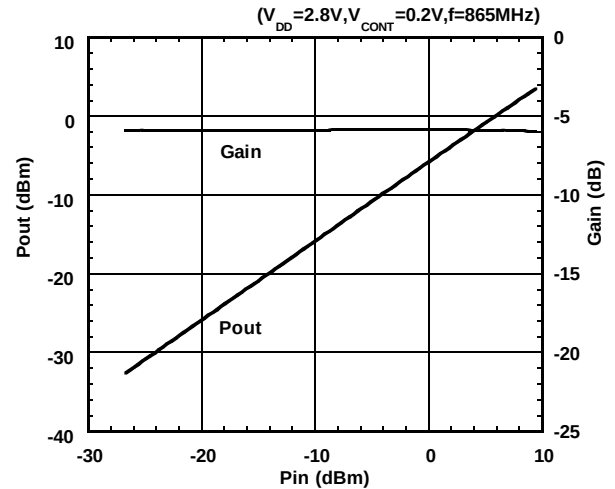
NF, Gain vs. frequency



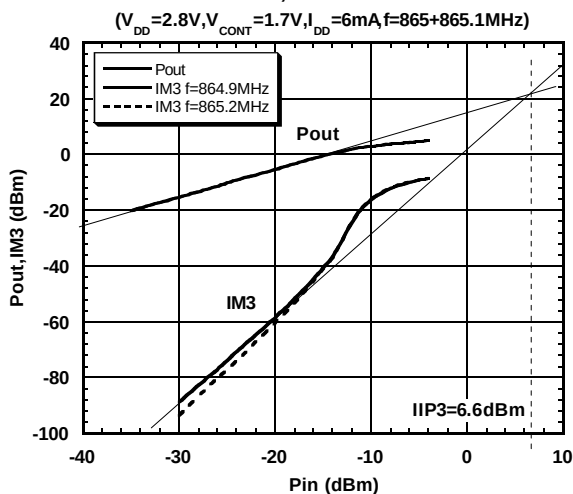
Pout, Gain vs. Pin



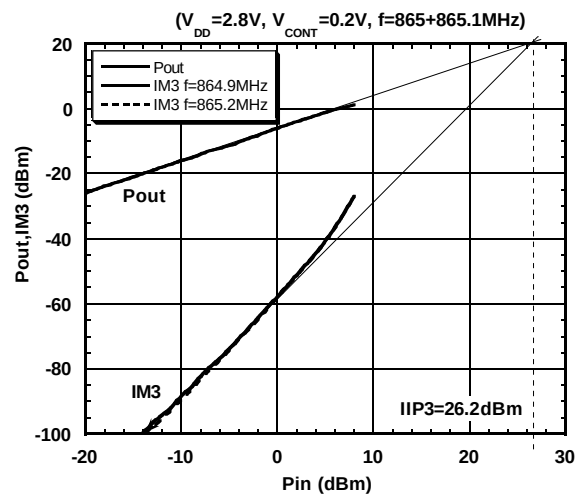
Pout, Gain vs. Pin



Pout, IM3 vs. Pin

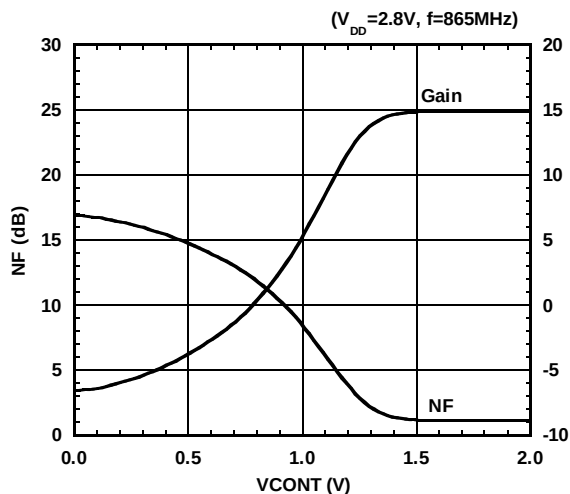


Pout, IM3 vs. Pin

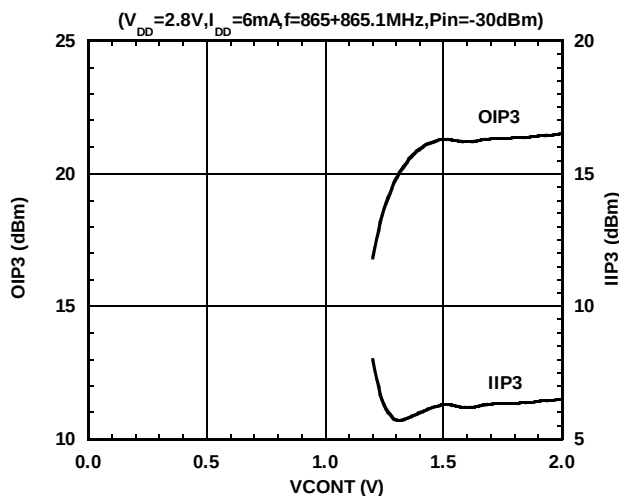


## TYPICAL CHARACTERISTICS

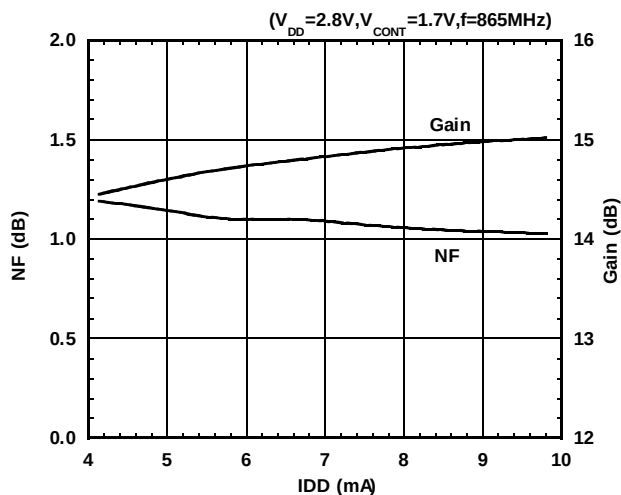
NF, Gain vs. VCONT



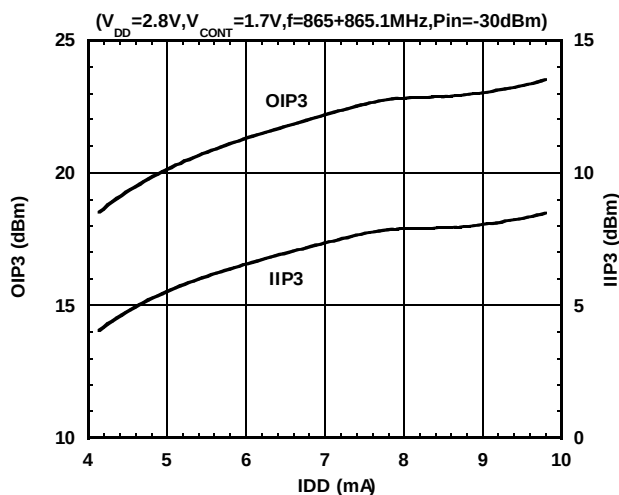
OIP3, IIP3 vs. VCONT



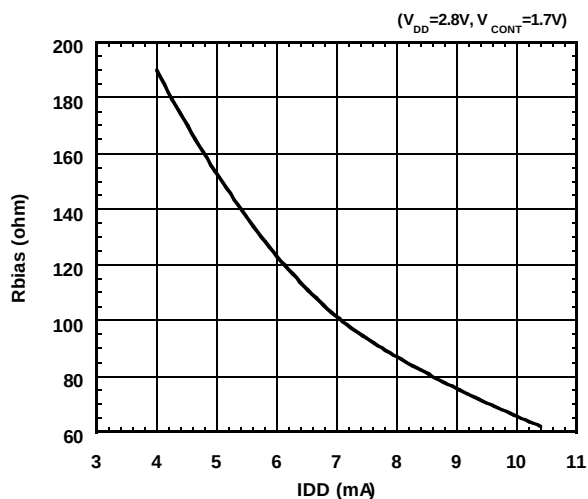
NF, Gain vs. IDD



OIP3, IIP3 vs. IDD



Rbias vs. IDD



Equations of OIP3 and IIP3

$$OIP3 = \frac{3 \times P_{out} - IM3}{2}$$

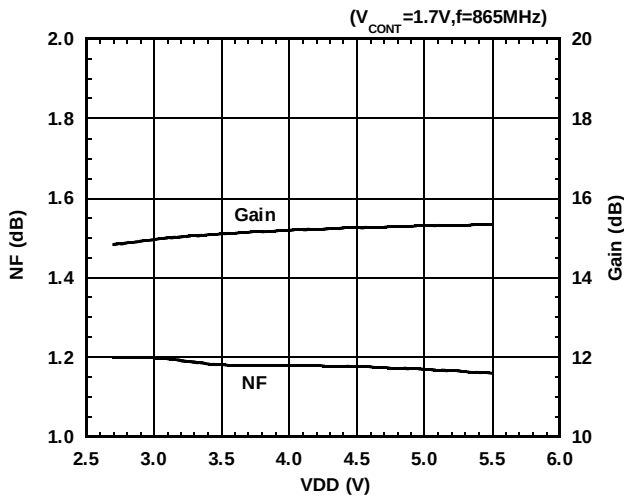
$$IIP3 = OIP3 - Gain$$

VCONT=1.7V@ Pin=-30dBm

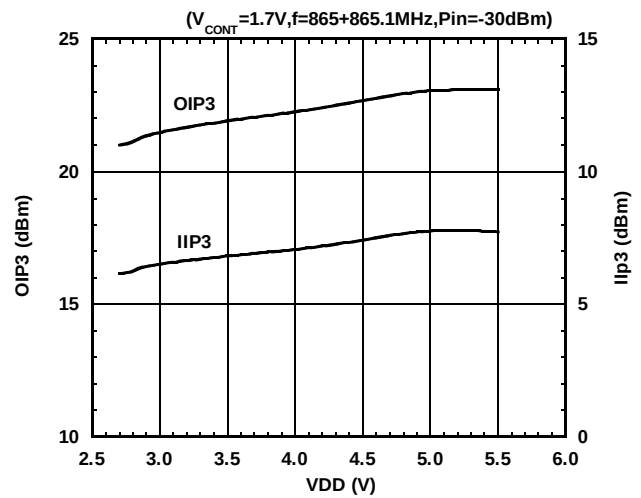
VCONT=0.2V@ Pin=-10dBm

## ■ TYPICAL CHARACTERISTICS

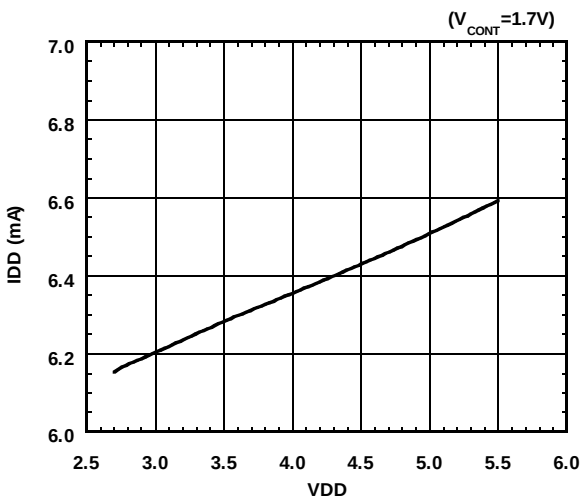
NF, Gain vs. VDD



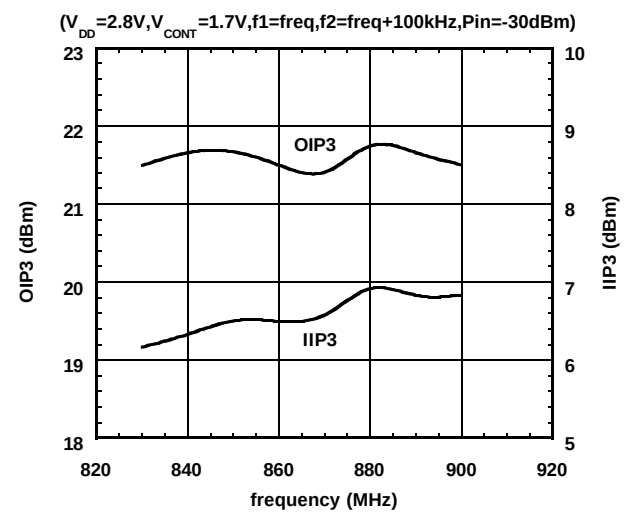
OIP3, IIP3 vs. VDD



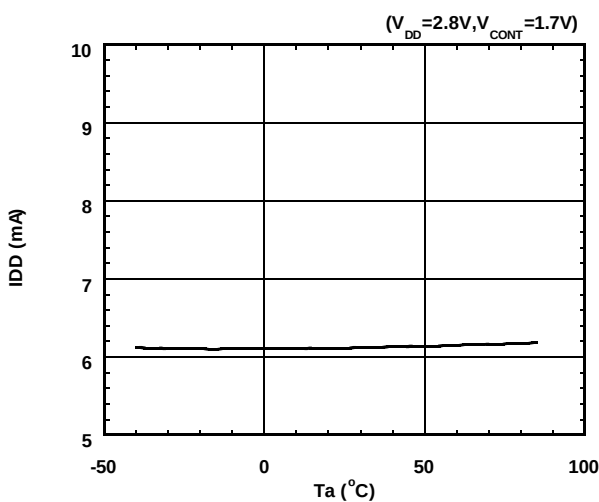
IDD vs. VDD



OIP3, IIP3 vs. frequency



IDD vs. Ta



Equations of OIP3 and IIP3

$$\text{OIP3} = \frac{3 \times \text{Pout} - \text{IM3}}{2}$$

$$\text{IIP3} = \text{OIP3} - \text{Gain}$$

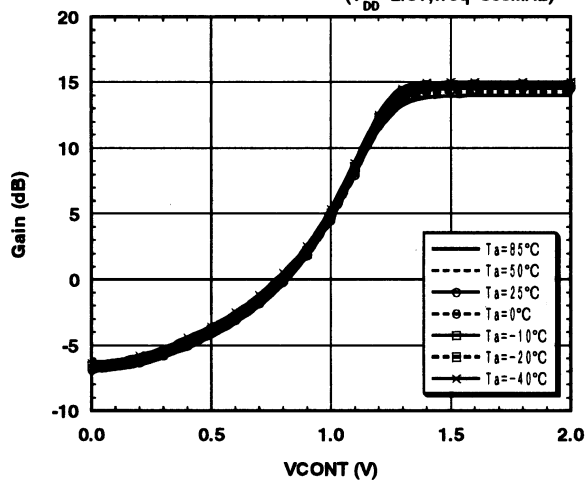
V<sub>CONT</sub> = 1.7V @ Pin = -30dBm

V<sub>CONT</sub> = 0.2V @ Pin = -10dBm

## TYPICAL CHARACTERISTICS

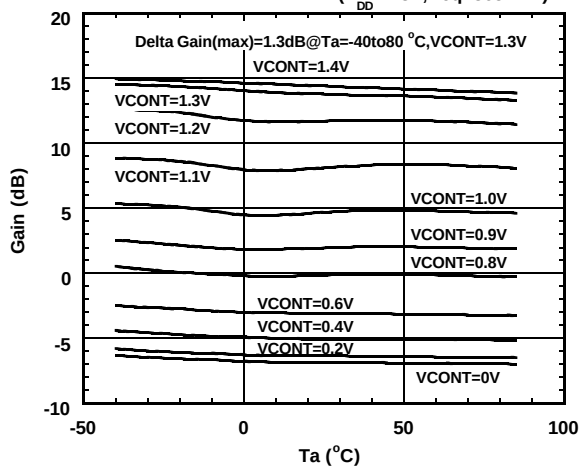
Gain vs. VCONT (Variable Ta)

(V<sub>DD</sub>=2.8V, freq=865MHz)



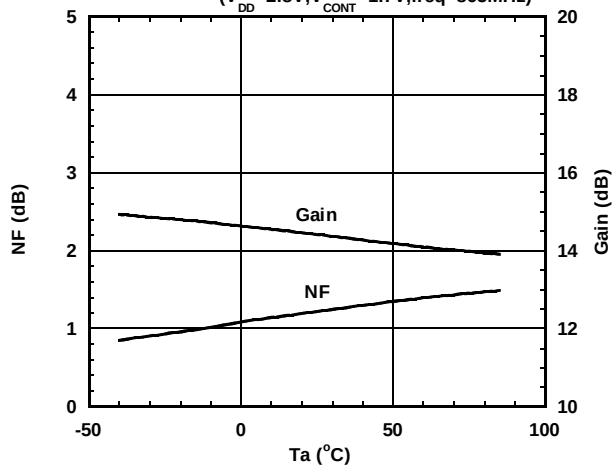
Gain vs. Ta (Variable VCONT)

(V<sub>DD</sub>=2.8V, freq=865MHz)



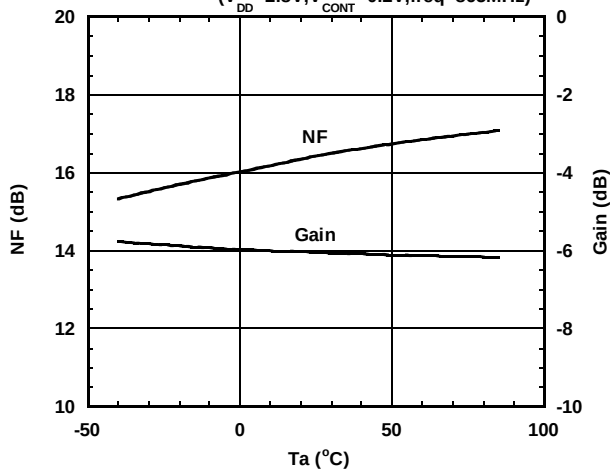
NF, Gain vs. Ta

(V<sub>DD</sub>=2.8V, V<sub>CONT</sub>=1.7V, freq=865MHz)



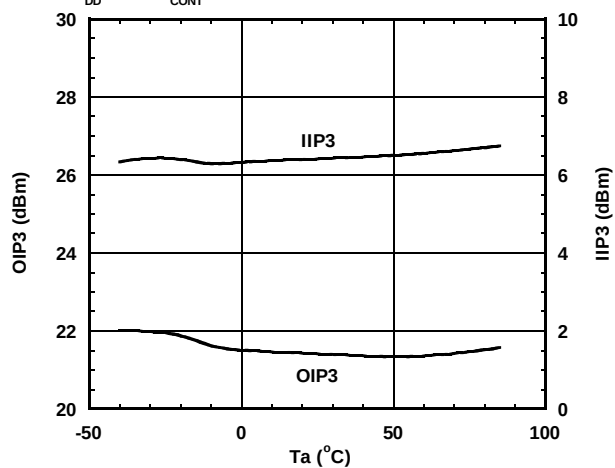
NF, Gain vs. Ta

(V<sub>DD</sub>=2.8V, V<sub>CONT</sub>=0.2V, freq=865MHz)



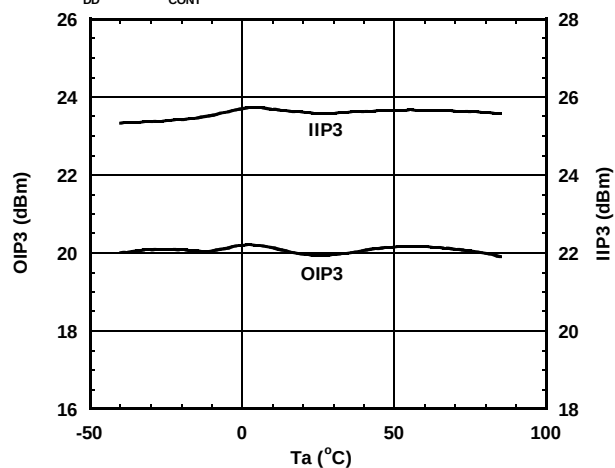
OIP3, IIP3 vs. Ta

(V<sub>DD</sub>=2.8V, V<sub>CONT</sub>=1.7V, freq=865+865.1MHz, Pin=-30dBm)



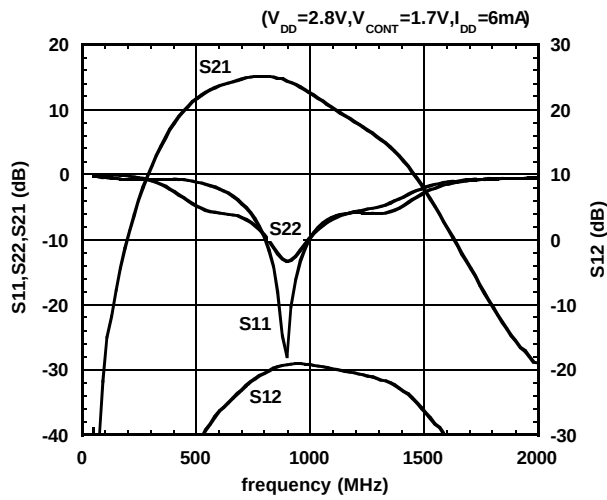
OIP3, IIP3 vs. Ta

(V<sub>DD</sub>=2.8V, V<sub>CONT</sub>=0.2V, freq=865+865.1MHz, Pin=-10dBm)

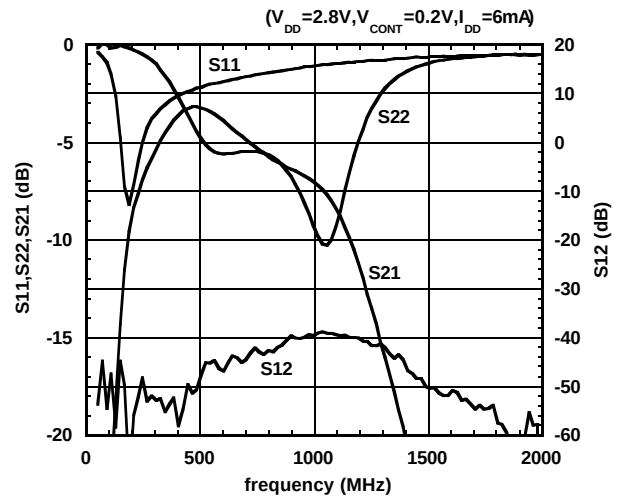


## TYPICAL CHARACTERISTICS

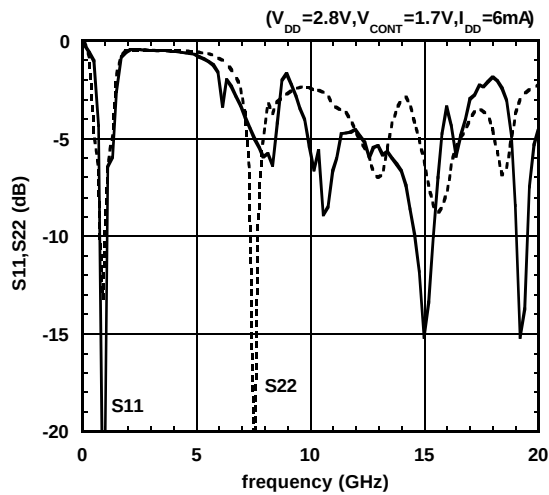
S11,S21,S12,S22 vs. frequency



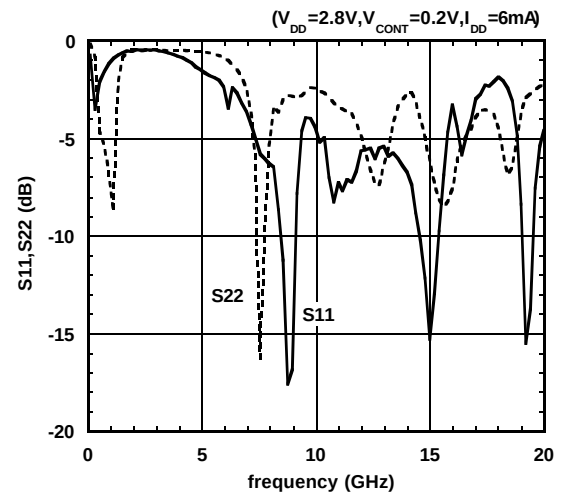
S11,S21,S12,S22 vs. frequency



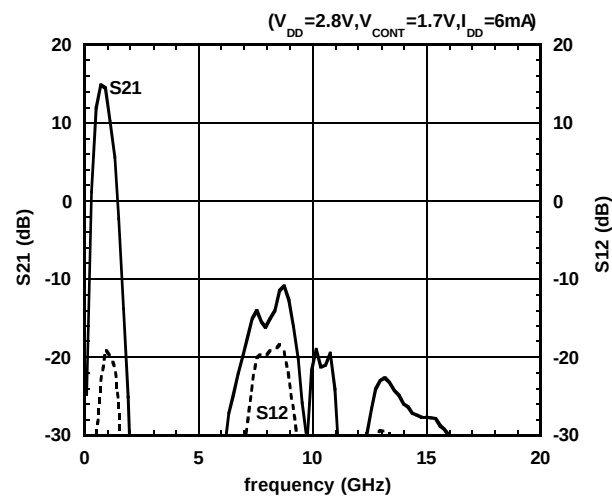
S11,S22 vs. frequency



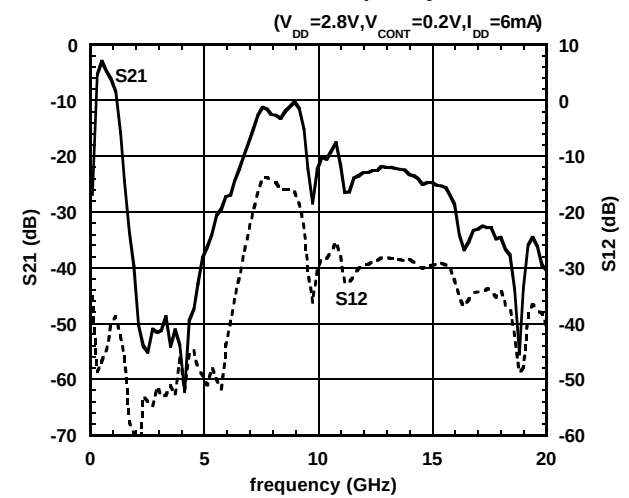
S11,S22 vs. frequency



S21,S12 vs. frequency



S21,S12 vs. frequency



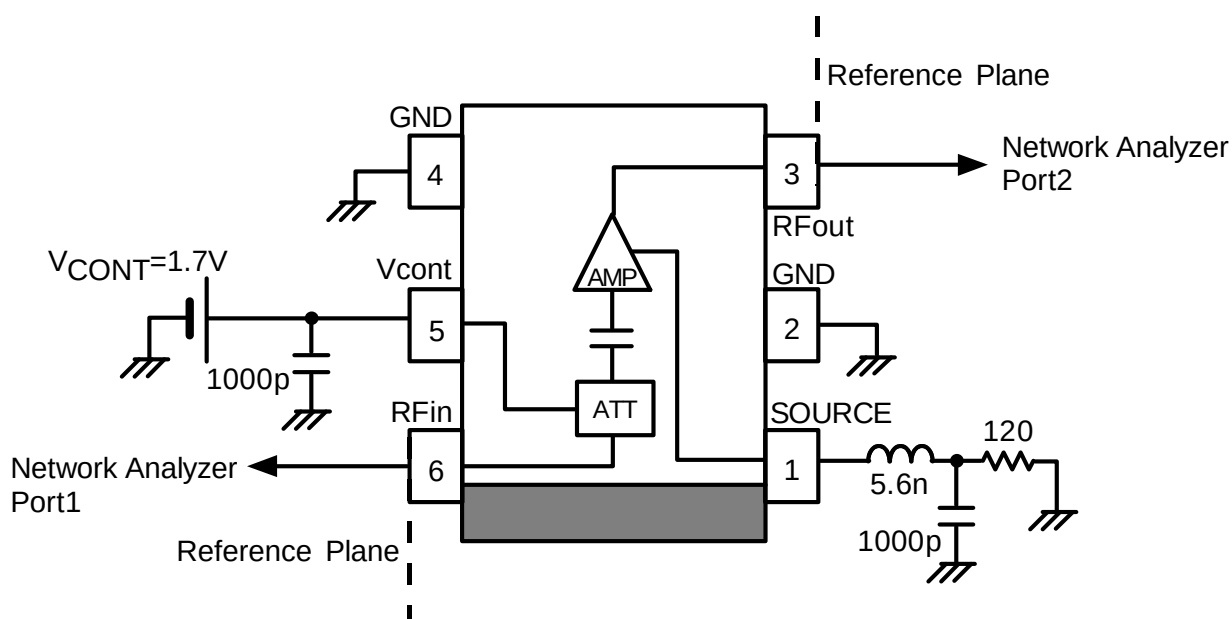


## ■TYPICAL CHARACTERISTICS

Scattering Parameter Table at Maximum Gain

$V_{DD}=2.8V$ ,  $V_{CONT}=1.7V$ ,  $I_{DD}=6.1mA$ ,  $Z_0=50\Omega$

| Freq<br>(MHz) | S11            |              | S21            |              | S12            |              | S22            |              |
|---------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|
|               | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) |
| 100           | 0.990          | -3.7         | 2.893          | -162.9       | 0.011          | 94.9         | 0.795          | -9.3         |
| 200           | 0.983          | -7.0         | 3.258          | 171.6        | 0.008          | 56.3         | 0.725          | -7.2         |
| 300           | 0.967          | -9.9         | 3.125          | 154.6        | 0.011          | 85.4         | 0.744          | -5.8         |
| 400           | 0.946          | -12.5        | 2.910          | 141.2        | 0.014          | 84.2         | 0.770          | -6.8         |
| 500           | 0.927          | -14.8        | 2.648          | 130.2        | 0.020          | 87.7         | 0.792          | -8.8         |
| 600           | 0.909          | -16.8        | 2.407          | 120.6        | 0.025          | 87.5         | 0.819          | -11.5        |
| 700           | 0.896          | -18.5        | 2.182          | 112.6        | 0.029          | 84.5         | 0.835          | -14.5        |
| 800           | 0.884          | -19.9        | 1.975          | 105.2        | 0.034          | 81.0         | 0.849          | -17.6        |
| 900           | 0.876          | -21.3        | 1.790          | 98.9         | 0.039          | 78.6         | 0.864          | -20.8        |
| 1000          | 0.871          | -22.7        | 1.624          | 92.9         | 0.044          | 77.3         | 0.874          | -24.0        |
| 1100          | 0.867          | -24.1        | 1.480          | 87.4         | 0.048          | 73.1         | 0.880          | -27.2        |
| 1200          | 0.864          | -25.3        | 1.349          | 82.2         | 0.054          | 71.6         | 0.884          | -30.5        |
| 1300          | 0.860          | -26.8        | 1.234          | 77.4         | 0.059          | 68.3         | 0.891          | -33.8        |
| 1400          | 0.861          | -28.1        | 1.129          | 72.7         | 0.063          | 66.2         | 0.897          | -37.1        |
| 1500          | 0.862          | -29.7        | 1.029          | 68.2         | 0.068          | 63.8         | 0.903          | -40.4        |
| 1600          | 0.862          | -31.3        | 0.942          | 63.8         | 0.072          | 61.0         | 0.907          | -43.8        |
| 1700          | 0.863          | -33.0        | 0.860          | 59.4         | 0.078          | 57.7         | 0.912          | -47.4        |
| 1800          | 0.867          | -34.7        | 0.783          | 55.2         | 0.083          | 55.4         | 0.916          | -50.6        |
| 1900          | 0.869          | -36.5        | 0.713          | 51.1         | 0.087          | 52.4         | 0.920          | -54.0        |
| 2000          | 0.874          | -38.4        | 0.650          | 47.3         | 0.091          | 50.5         | 0.921          | -57.6        |



Note

$V_{DD}$  (=2.8V) is supplied through "BIAS CONNECT (PORT2)" of Network Analyzer.

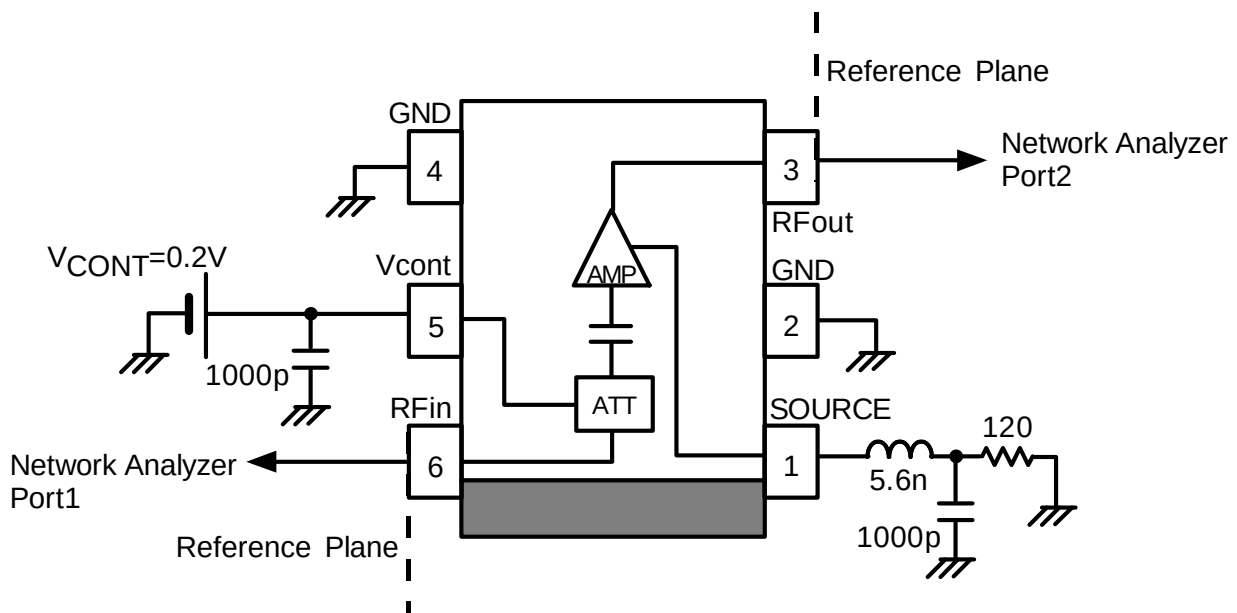
# NJG1104KB2

## ■TYPICAL CHARACTERISTICS

Scattering Parameter Table at Minimum Gain

$V_{DD}=2.8V$ ,  $V_{CONT}=0.2V$ ,  $I_{DD}=6.1mA$ ,  $Z_0=50\Omega$

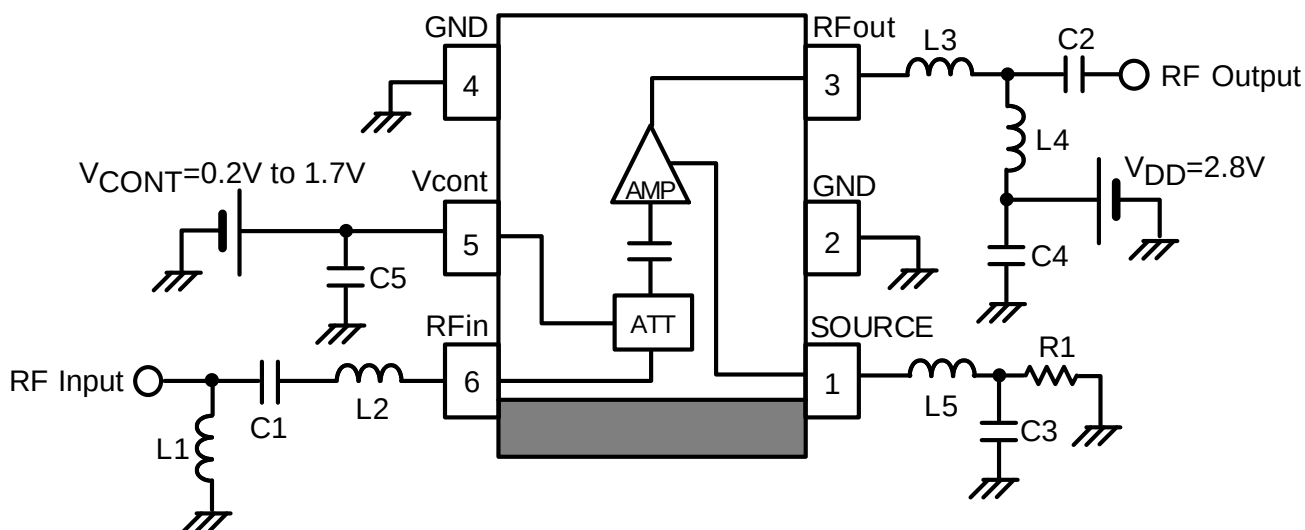
| Freq<br>(MHz) | S11            |              | S21            |              | S12            |              | S22            |              |
|---------------|----------------|--------------|----------------|--------------|----------------|--------------|----------------|--------------|
|               | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) | mag<br>(units) | ang<br>(deg) |
| 100           | 0.771          | -62.4        | 2.226          | 171.8        | 0.002          | -94.5        | 0.784          | -9.3         |
| 200           | 0.573          | -99.1        | 1.803          | 141.7        | 0.004          | 25.2         | 0.728          | -6.5         |
| 300           | 0.480          | -121.8       | 1.405          | 128.1        | 0.005          | 37.2         | 0.744          | -4.9         |
| 400           | 0.430          | -138.2       | 1.151          | 119.5        | 0.003          | 70.3         | 0.774          | -5.6         |
| 500           | 0.405          | -150.1       | 0.975          | 113.2        | 0.007          | 67.3         | 0.801          | -7.5         |
| 600           | 0.391          | -159.8       | 0.849          | 107.8        | 0.007          | 67.3         | 0.829          | -10.2        |
| 700           | 0.381          | -167.4       | 0.749          | 103.2        | 0.009          | 76.9         | 0.850          | -13.2        |
| 800           | 0.373          | -174.5       | 0.666          | 99.0         | 0.010          | 70.2         | 0.867          | -16.4        |
| 900           | 0.369          | 179.3        | 0.597          | 95.3         | 0.013          | 75.7         | 0.884          | -19.8        |
| 1000          | 0.366          | 173.4        | 0.538          | 91.7         | 0.014          | 73.3         | 0.897          | -23.1        |
| 1100          | 0.365          | 168.5        | 0.489          | 88.4         | 0.015          | 74.7         | 0.905          | -26.4        |
| 1200          | 0.365          | 163.1        | 0.443          | 84.9         | 0.017          | 73.9         | 0.910          | -29.8        |
| 1300          | 0.367          | 158.7        | 0.406          | 81.9         | 0.019          | 70.8         | 0.918          | -33.2        |
| 1400          | 0.369          | 154.2        | 0.371          | 78.8         | 0.020          | 68.7         | 0.923          | -36.7        |
| 1500          | 0.372          | 150.2        | 0.338          | 76.0         | 0.021          | 65.2         | 0.930          | -40.0        |
| 1600          | 0.374          | 146.3        | 0.310          | 73.1         | 0.023          | 63.8         | 0.932          | -43.4        |
| 1700          | 0.378          | 142.6        | 0.283          | 70.6         | 0.024          | 64.2         | 0.938          | -47.0        |
| 1800          | 0.384          | 139.1        | 0.257          | 67.8         | 0.026          | 63.6         | 0.942          | -50.4        |
| 1900          | 0.388          | 136.5        | 0.232          | 64.7         | 0.027          | 60.2         | 0.944          | -53.9        |
| 2000          | 0.388          | 133.1        | 0.211          | 62.7         | 0.029          | 59.5         | 0.947          | -57.6        |



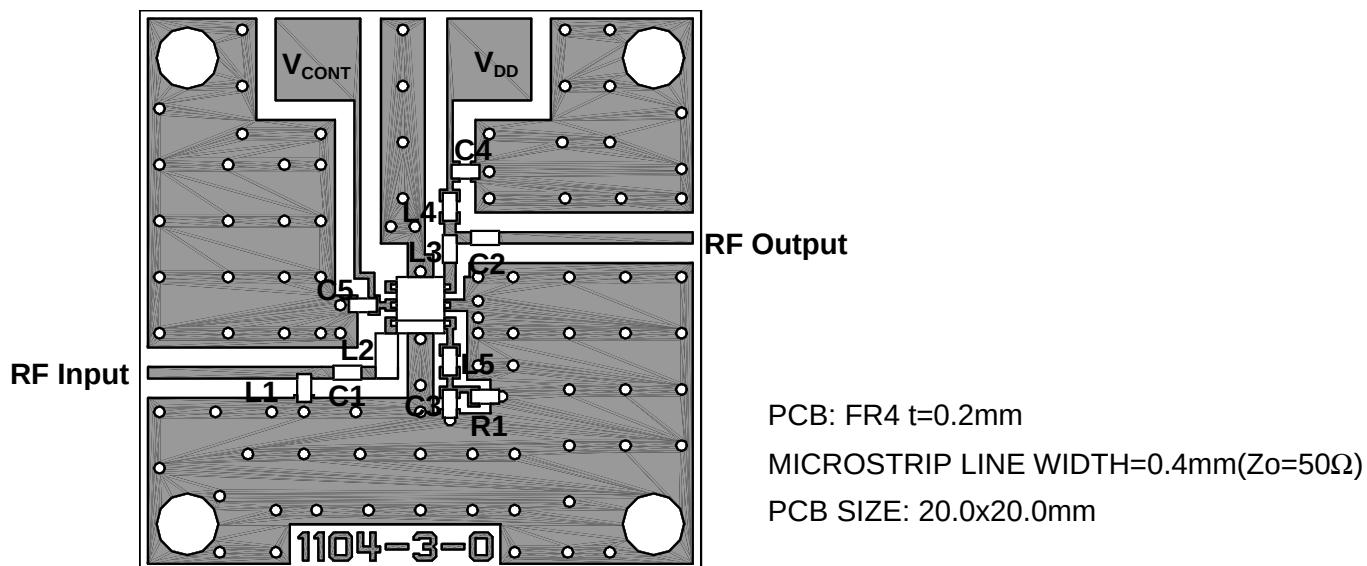
Note

$V_{DD}$  (=2.8V) is supplied through "BIAS CONNECT (PORT2)" of Network Analyzer.

## RECOMMENDED CIRCUIT



## RECOMMENDED PCB DESIGN



Parts List (f=830~900MHz)

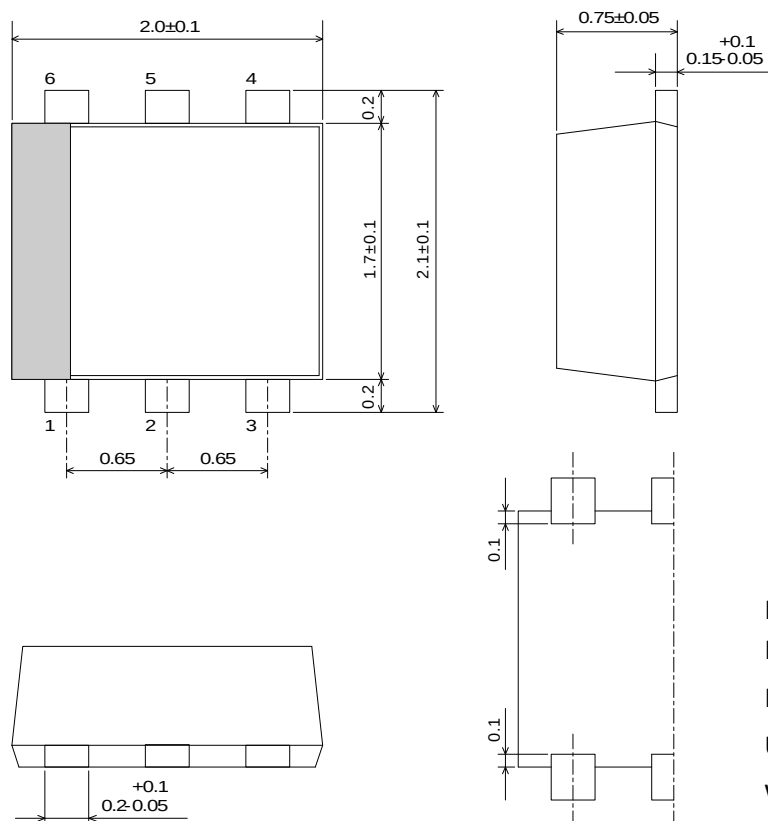
| PARTS ID   | Constant | Comment                   |
|------------|----------|---------------------------|
| L1         | 22nH     | TAIYO-YUDEN HK1005 Series |
| L2         | 22nH     | TAIYO-YUDEN HK1608 Series |
| L3         | 22nH     | TAIYO-YUDEN HK1005 Series |
| L4         | 15nH     | TAIYO-YUDEN HK1005 Series |
| L5         | 5.6nH    | TAIYO-YUDEN HK1005 Series |
| C1, C4, C5 | 1000pF   | MURATA GRM36 Series       |
| C2         | 6pF      | MURATA GRM36 Series       |
| C3         | 100pF    | MURATA GRM36 Series       |
| R1         | 120Ω     | -                         |

## PRECAUTIONS

- 1) The inductor of 1608 size is recommended for NF characteristics.
- 2) The value of C3 is selected to get lower gain and higher output IP3.

# NJG1104KB2

## ■PACKAGE OUTLINE (FLP6-B2)



Lead material : Copper  
Lead surface finish: Solder plating  
Molding material : Epoxy resin  
UNIT : mm  
Weight : 6.5mg

### Cautions on using this product

This product contains Gallium-Arsenide (GaAs) which is a harmful material.

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

### [CAUTION]

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.

This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.