

# 1.5/1.9GHz LOW NOISE AMPLIFIER

## GaAs MMIC

### ■GENERAL DESCRIPTION

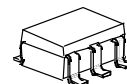
NJG1103F1 is a Low Noise Amplifier GaAs MMIC designed for 1.5GHz and 1.9GHz band digital cellular phone and Japanese PHS handsets.

This amplifier provides low noise figure, high gain and high IP3 operated by single low positive power supply.

This amplifier can be tuned to wide frequency point. (Best for 1.5GHz or 1.9GHz)

Small package of MTP6-1 is adopted.

### ■PACKAGE OUTLINE

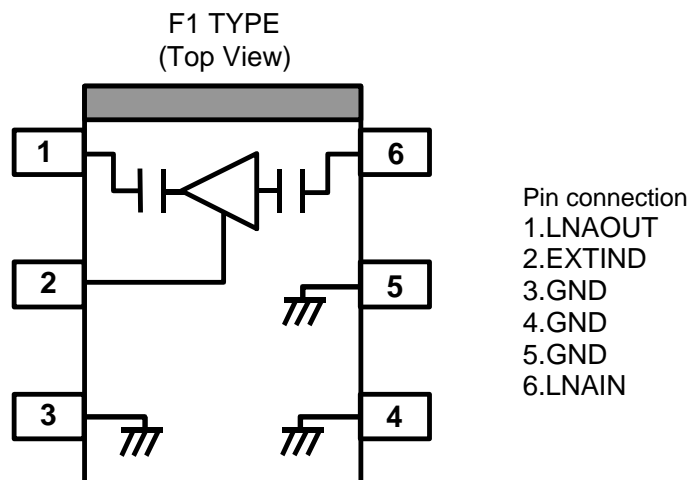


NJG1103F1

### ■FEATURES

- |                          |  |
|--------------------------|--|
| ●Low voltage operation   | +2.7V typ.   |
| ●Low current consumption | 3mA typ.   |
| ●High small signal gain  | 16dB typ. @f=1.489GHz<br>14dB typ. @f=1.9GHz                   |
| ●Low Noise Figure        | 1.2dB typ. @f=1.489GHz<br>1.4dB typ. @f=1.9GHz                 |
| ●High Input IP3          | -4dBm typ. @f=1.489+1.4891GHz<br>-3dBm typ. @f=1.9+1.9001GHz   |
| ●High Output IP3         | +12dBm typ. @f=1.489+1.4891GHz<br>+11dBm typ. @f=1.9+1.9001GHz |
| ●Package                 | MTP6-1 (Mount Size: 2.8 x 2.9 x 1.2mm)                         |

### ■PIN CONFIGURATION



Note: is package orientation mark.

# NJG1103F1

## ■ABSOLUTE MAXIMUM RATINGS

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

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Drain Voltage	$V_{DD}$		5.0	V
Input Power	$P_{in}$	$V_{DD}=2.7V$	+10	dBm
Power Dissipation	$P_D$		150	mW
Operating Temperature	$T_{opr}$		-40~+85	$^{\circ}\text{C}$
Storage Temperature	$T_{stg}$		-55~+125	$^{\circ}\text{C}$

## ■ELECTRICAL CHARACTERISTICS 1 (1.5GHz Band)

( $V_{DD}=2.7V$ ,  $f=1.489\text{GHz}$ ,  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ , Circuit: Application 1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Frequency	freq1		1.470	1.489	1.520	GHz
Drain Voltage	$V_{DD}$		2.5	2.7	4.5	V
Operating Current	$I_{DD}$	RF OFF	-	3.0	3.8	mA
Small Signal Gain	Gain		14.0	16.0	18.0	dB
Gain Flatness	$G_{flat}$	$f=1.47\sim 1.52\text{GHz}$	-	0.5	1.0	dB
Noise Figure	NF		-	1.2	1.4	dB
Pout at 1dB Gain Compression point	$P_{-1dB}$		-6.0	-2.0	-	dBm
Input 3rd Order Intercept Point	IIP3	$f=1.489+1.4891\text{GHz}$	-7.0	-4.0	-	dBm
LNAIN Port VSWR	$VSWR_i$		-	2.0	3.0	
LNAOUT Port VSWR	$VSWR_o$		-	2.0	3.0	

## ■ELECTRICAL CHARACTERISTICS 2 (1.9GHz Band)

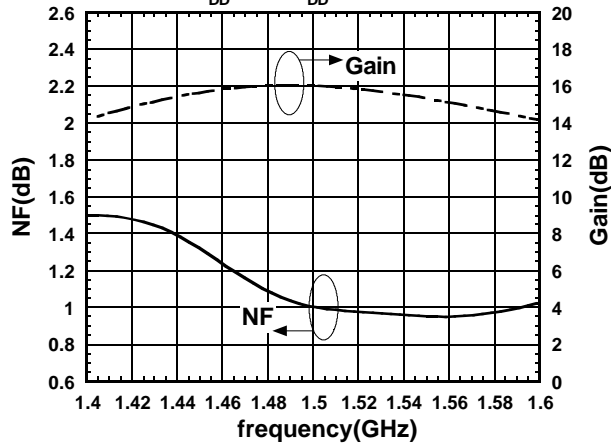
( $V_{DD}=2.7V$ ,  $f=1.9\text{GHz}$ ,  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ , Circuit: Application 2)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Frequency	freq2		1.89	1.90	1.92	GHz
Drain Voltage	$V_{DD}$		2.5	2.7	4.5	V
Operating Current	$I_{DD}$	RF OFF	-	3.0	3.8	mA
Small Signal Gain	Gain		12.0	14.0	16.0	dB
Gain Flatness	$G_{flat}$	$f=1.89\sim 1.92\text{GHz}$	-	0.5	1.0	dB
Noise Figure	NF		-	1.4	1.6	dB
Pout at 1dB Gain Compression point	$P_{-1dB}$		-4.5	-0.5	-	dBm
Input 3rd Order Intercept Point	IIP3	$f=1.9+1.9001\text{GHz}$	-6.0	-3.0	-	dBm
LNAIN Port VSWR	$VSWR_i$		-	2.0	3.0	
LNAOUT Port VSWR	$VSWR_o$		-	2.0	3.0	

## TYPICAL CHARACTERISTICS (1.5GHz Band)

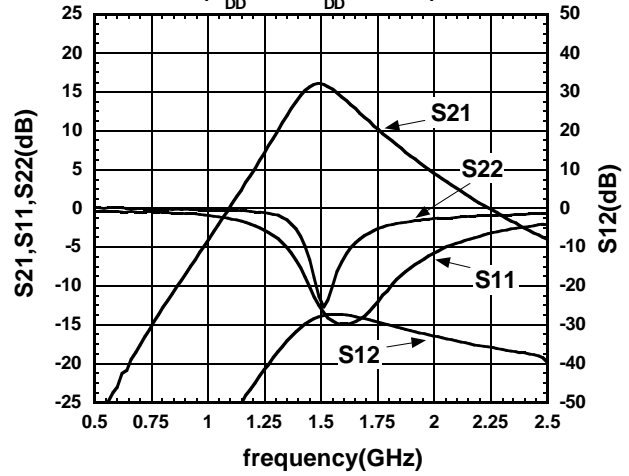
### NF, Gain vs. frequency

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



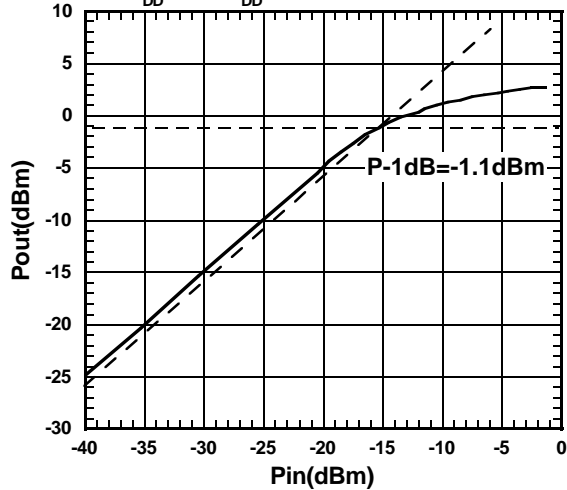
### S21, S11, S22, S12 vs. frequency

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



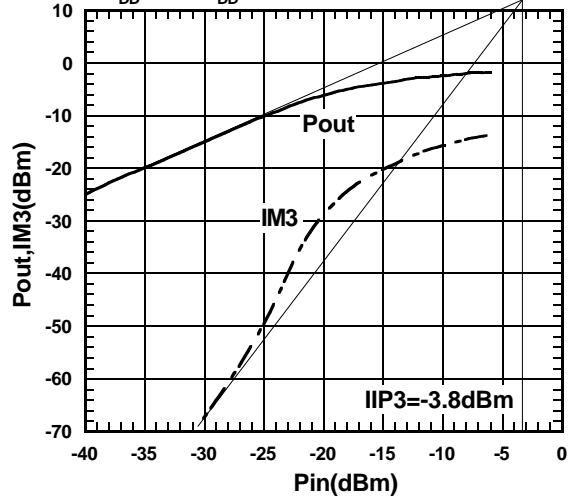
### Pin vs. Pout

( $V_{DD}=2.7V, I_{DD}=3.0mA, freq=1.489GHz$ )



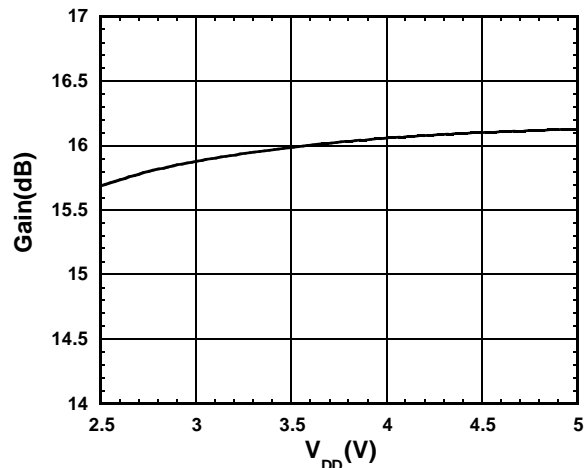
### Pin vs. Pout, IM3

( $V_{DD}=2.7V, I_{DD}=3.0mA, f=1489+1489.1MHz$ )



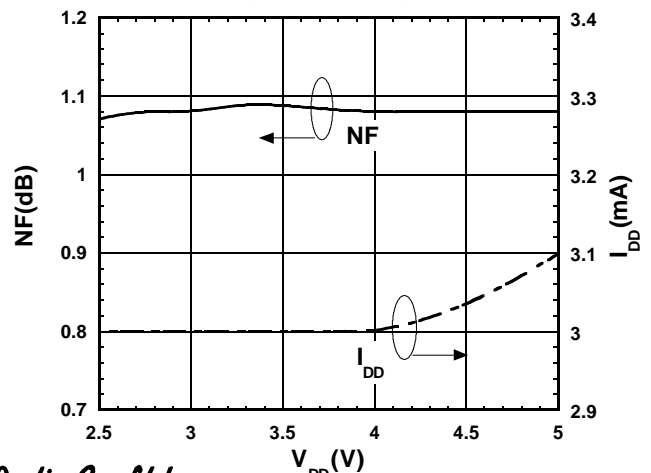
### Gain vs. $V_{DD}$

( $f=1.489GHz$ )



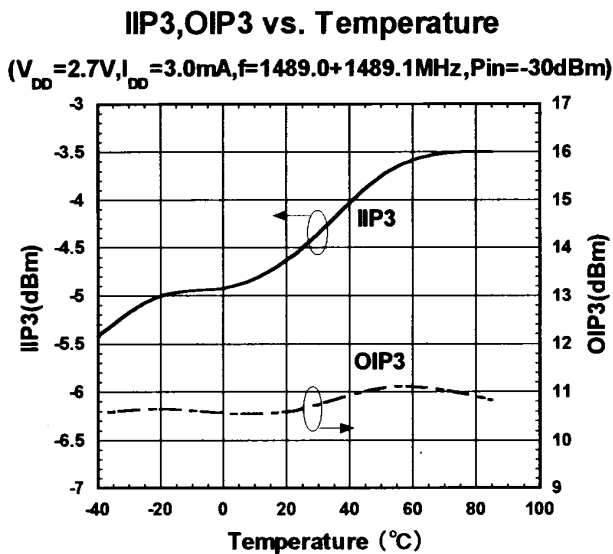
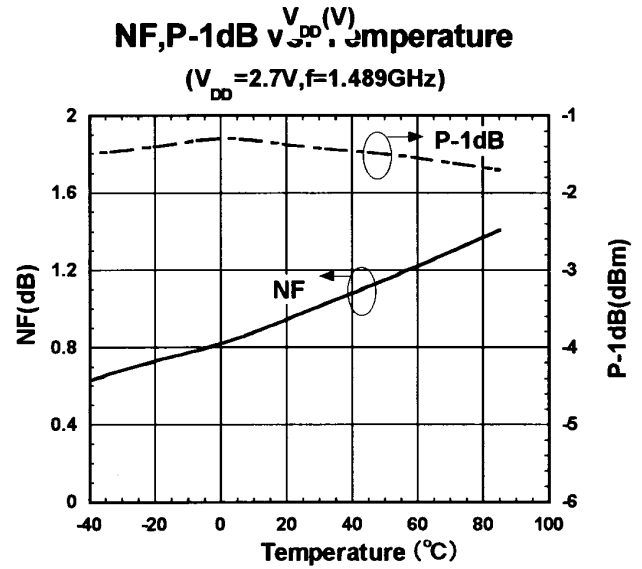
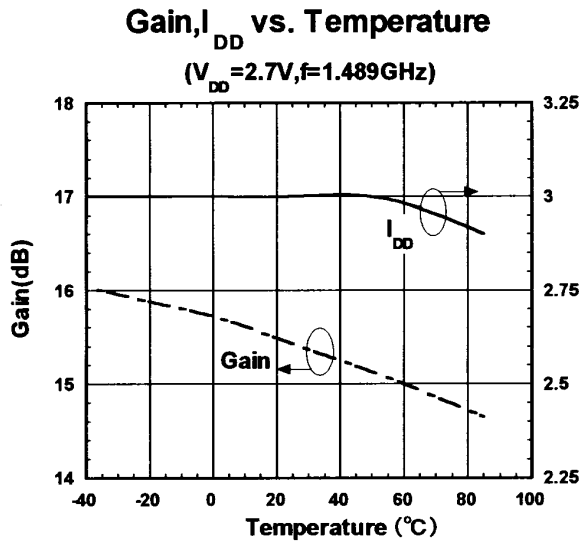
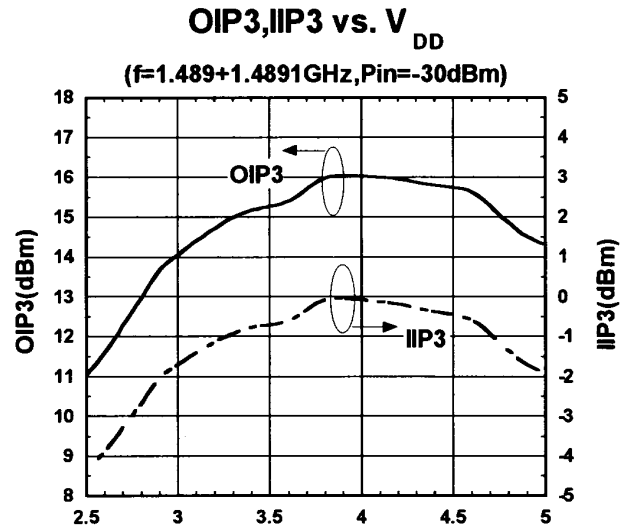
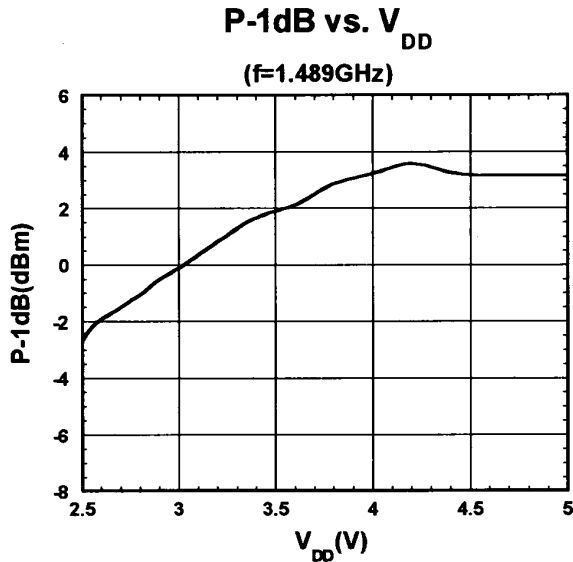
### NF, $I_{DD}$ vs. $V_{DD}$

( $f=1.489GHz$ )



# NJG1103F1

## TYPICAL CHARACTERISTICS (1.5GHz Band)



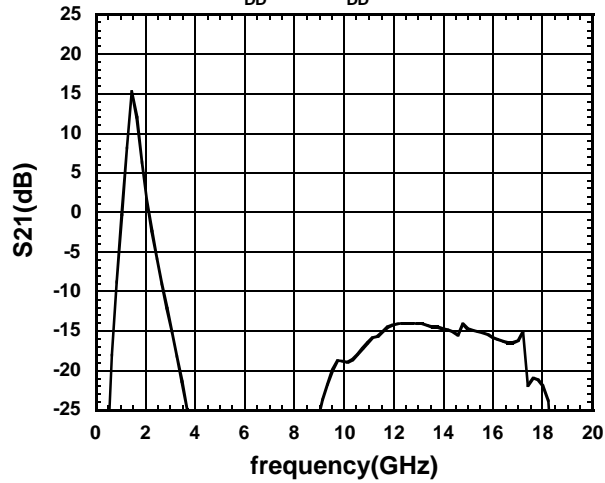
$$OIP3 = \frac{3 \times P_{out} - IM3}{2}$$

$$IIP3 = OIP3 - Gain \quad @P_{in} = -30dBm$$

**TYPICAL CHARACTERISTICS (1.5GHz Band)**

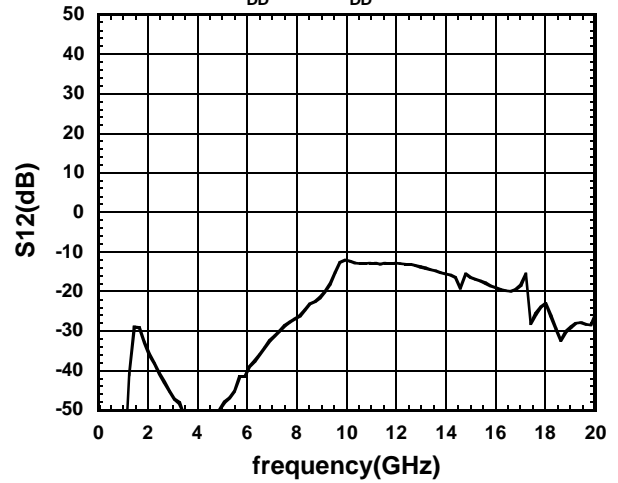
**S21 vs. frequency(~20GHz)**

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



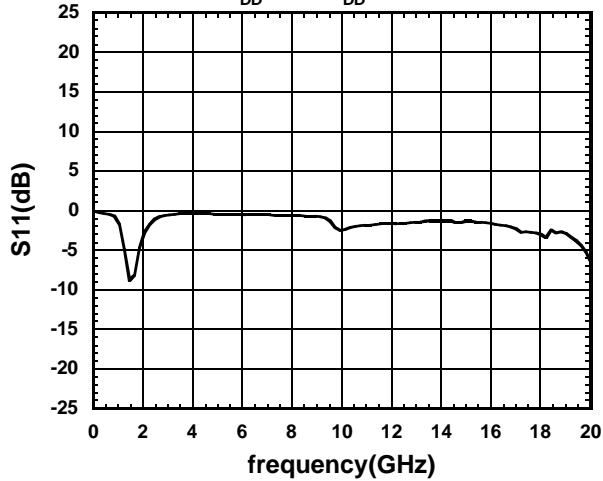
**S12 vs. frequency(~20GHz)**

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



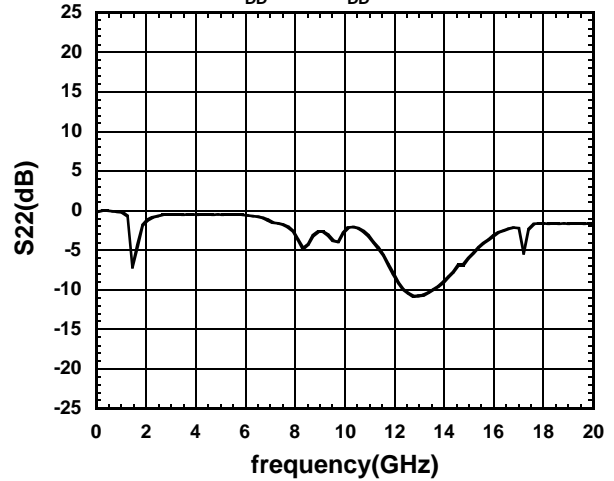
**S11 vs. frequency(~20GHz)**

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



**S22 vs. frequency(~20GHz)**

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



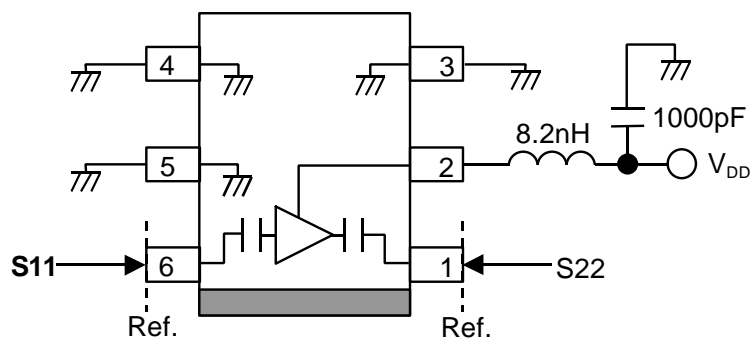
# NJG1103F1

## ■TYPICAL CHARACTERISTICS (1.5GHz Band)

Scattering Parameter Table 1

$V_{DD}=2.7V$ ,  $I_{DD}=3.0mA$ ,  $Z_0=50\Omega$

Freq (GHz)	S11		S21		S12		S22	
	mag (units)	ang (deg)	mag (units)	ang (deg)	mag (units)	ang (deg)	mag (units)	ang (deg)
0.1	1.000	-3.577	0.030	-96.974	0.000	-28.893	1.000	-3.994
0.2	1.000	-7.804	0.008	29.498	0.001	123.060	1.000	-8.157
0.3	1.000	-11.749	0.017	-17.030	0.001	90.574	1.000	-11.932
0.4	1.000	-15.677	0.039	-22.484	0.001	61.254	1.000	-15.939
0.5	1.000	-18.892	0.069	-35.493	0.002	70.970	1.000	-19.427
0.6	1.000	-22.855	0.105	-43.917	0.002	68.009	1.000	-23.659
0.7	0.989	-25.943	0.148	-52.340	0.002	71.027	0.999	-27.163
0.8	1.000	-29.192	0.211	-60.102	0.002	52.546	0.999	-31.190
0.9	0.967	-32.626	0.283	-68.097	0.001	54.258	0.993	-34.941
1.0	0.978	-34.942	0.384	-76.173	0.001	65.410	0.992	-39.139
1.1	0.952	-38.109	0.517	-84.022	0.001	-172.907	0.990	-43.543
1.2	0.958	-40.122	0.721	-92.837	0.001	-143.350	0.979	-48.600
1.3	0.939	-42.825	1.026	-103.156	0.004	-145.335	0.960	-55.801
1.4	0.944	-45.403	1.595	-118.935	0.008	-153.556	0.893	-67.092
1.5	0.912	-49.324	2.620	-147.296	0.017	-174.933	0.647	-88.575
1.6	0.848	-51.073	3.159	163.534	0.026	141.392	0.117	-8.962
1.7	0.835	-48.490	2.335	124.924	0.023	107.004	0.638	-2.204
1.8	0.854	-48.500	1.669	105.980	0.018	92.352	0.834	-16.766
1.9	0.859	-49.077	1.305	94.208	0.015	84.686	0.896	-24.947
2.0	0.856	-49.978	1.080	86.597	0.014	83.498	0.933	-30.122
2.1	0.858	-50.862	0.930	79.499	0.013	82.364	0.941	-33.659
2.2	0.843	-51.565	0.827	74.248	0.012	82.389	0.958	-36.464
2.3	0.843	-52.644	0.752	69.058	0.012	82.449	0.959	-38.653
2.4	0.825	-53.066	0.693	65.124	0.012	84.137	0.969	-40.685
2.5	0.823	-54.104	0.651	60.824	0.011	87.269	0.967	-42.276
2.6	0.806	-54.425	0.618	56.840	0.012	89.464	0.975	-44.085
2.7	0.805	-55.530	0.592	52.933	0.012	91.483	0.974	-45.755
2.8	0.793	-56.240	0.567	49.451	0.013	93.498	0.980	-47.284
2.9	0.783	-57.285	0.550	45.760	0.013	92.174	0.975	-48.847
3.0	0.778	-58.456	0.536	41.775	0.013	94.705	0.980	-50.377

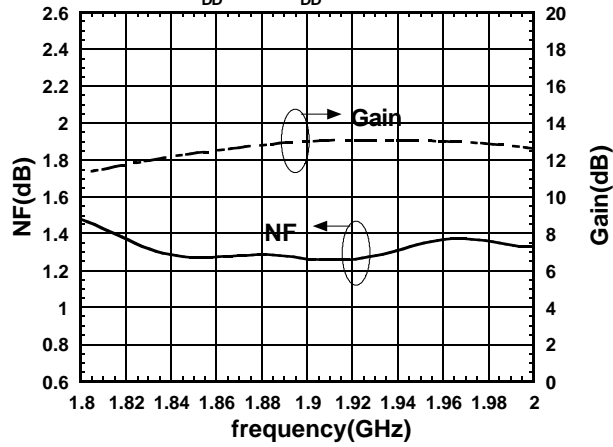


Scattering Parameter Evaluation Circuit

## TYPICAL CHARACTERISTICS (1.9GHz Band)

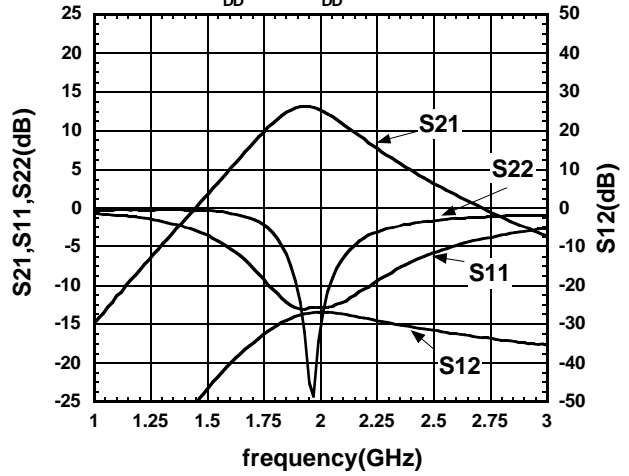
### NF, Gain vs. frequency

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



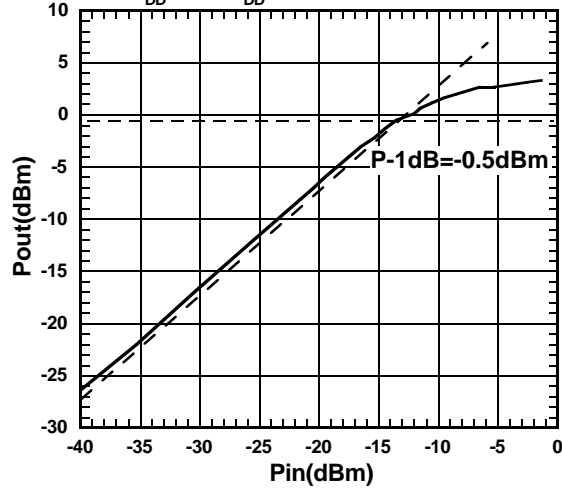
### S21, S11, S22, S12 vs. frequency

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



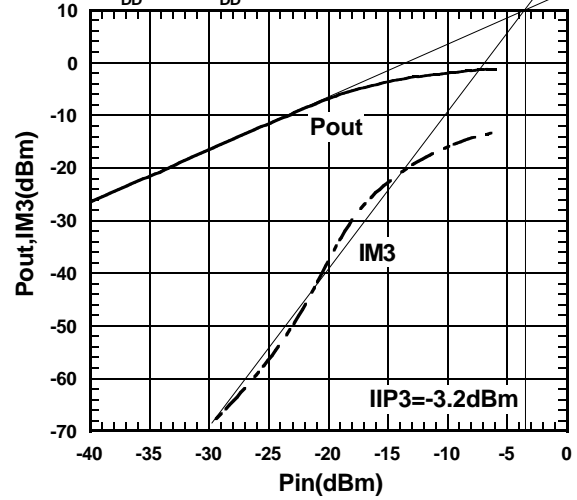
### Pin vs. Pout

( $V_{DD}=2.7V, I_{DD}=3.0mA, freq=1.9GHz$ )



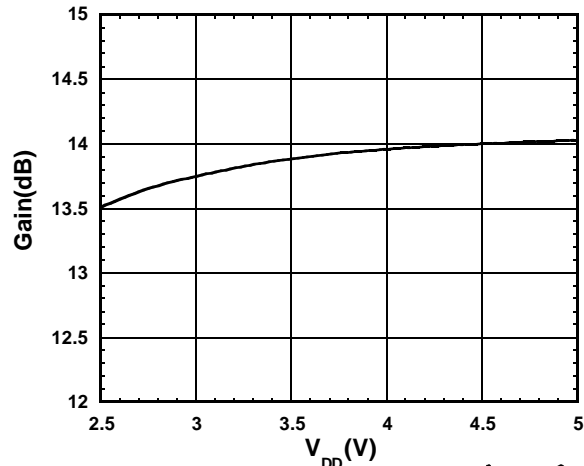
### Pin vs. Pout, IM3

( $V_{DD}=2.7V, I_{DD}=3.0mA, f=1900+1900.1MHz$ )



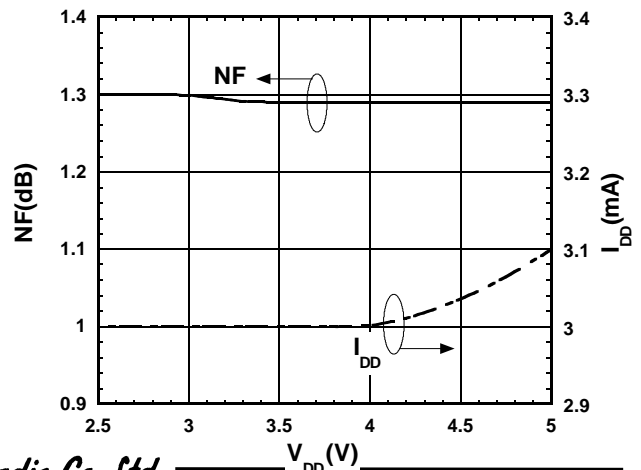
### Gain vs. $V_{DD}$

( $f=1.9GHz$ )



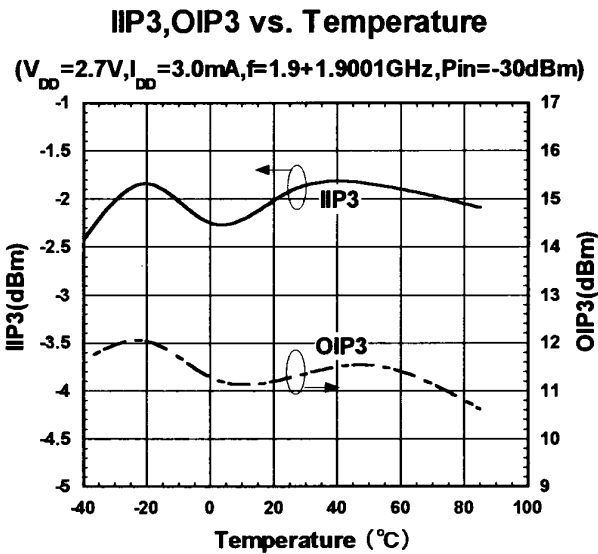
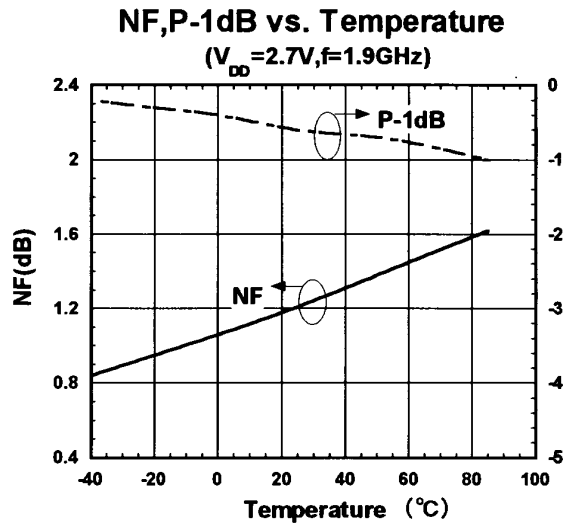
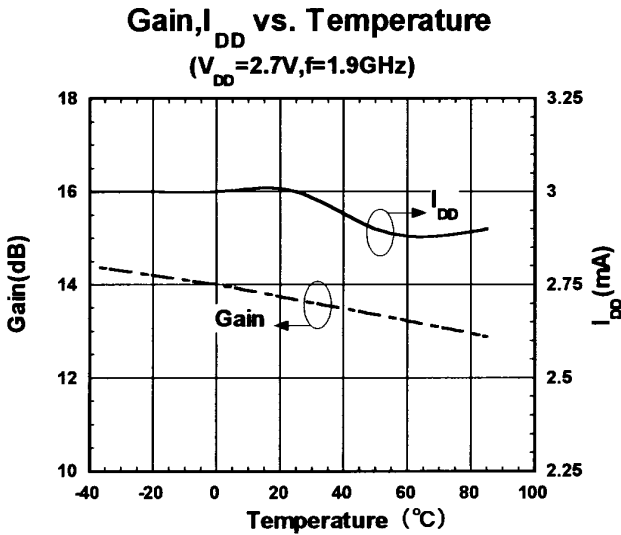
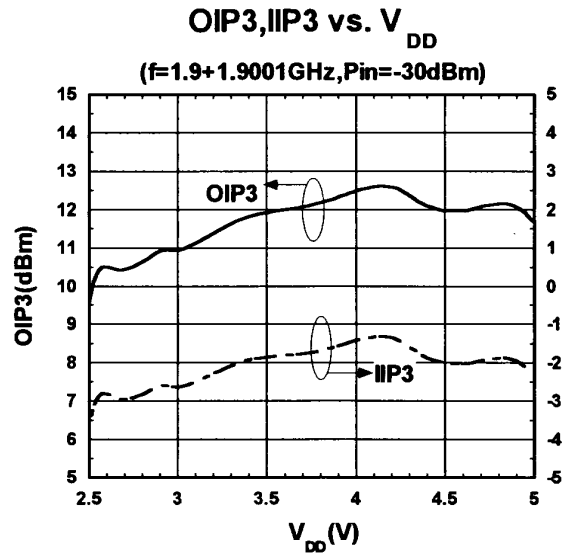
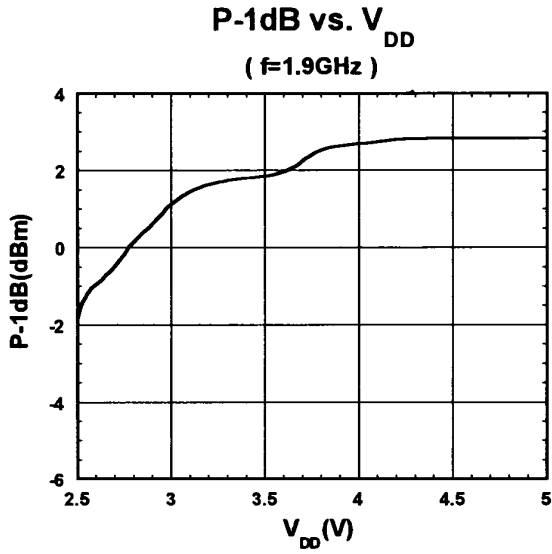
### NF, $I_{DD}$ vs. $V_{DD}$

( $f=1.9GHz$ )



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## TYPICAL CHARACTERISTICS (1.9GHz Band)



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

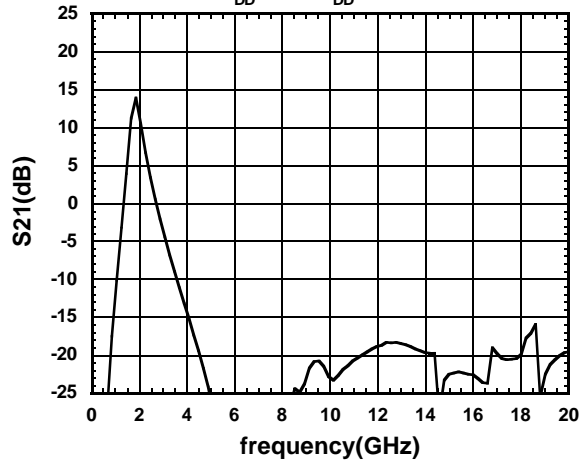
$$IIP3 = OIP3 - Gain \quad @P_{in} = -30dBm$$



## ■ TYPICAL CHARACTERISTICS (1.9GHz Band)

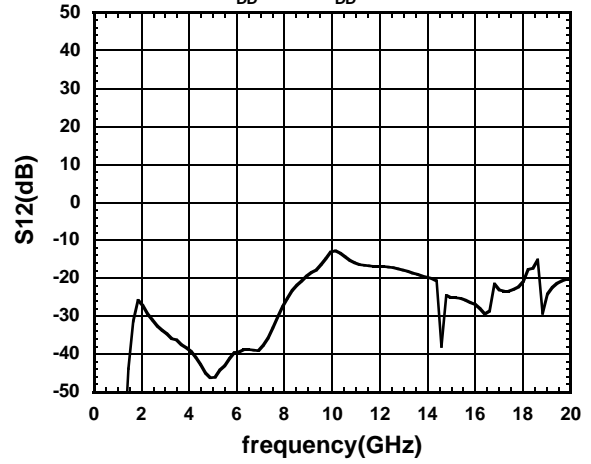
### S21 vs. frequency(~20GHz)

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



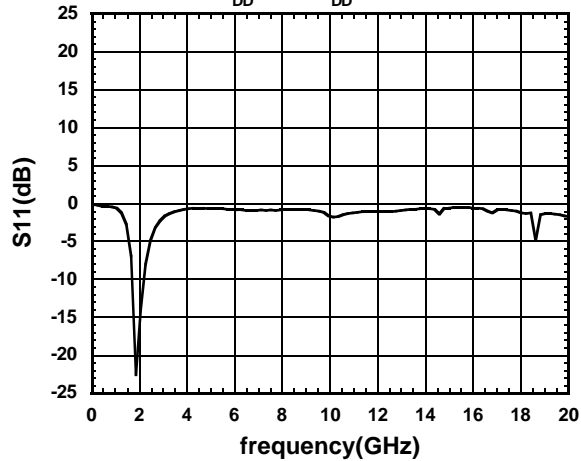
### S12 vs. frequency(~20GHz)

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



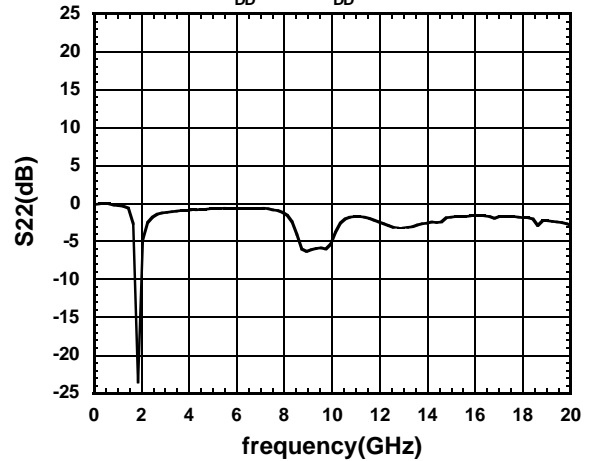
### S11 vs. frequency(~20GHz)

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



### S22 vs. frequency(~20GHz)

( $V_{DD}=2.7V, I_{DD}=3.0mA$ )



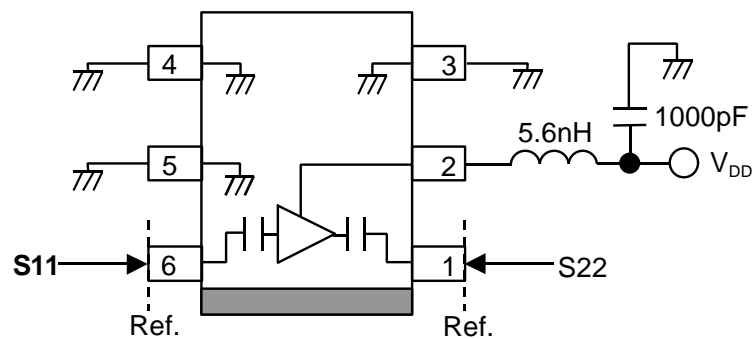
# NJG1103F1

## ■TYPICAL CHARACTERISTICS (1.9GHz Band)

Scattering Parameter Table 2

$V_{DD}=2.7V$ ,  $I_{DD}=3.0mA$ ,  $Z_0=50\Omega$

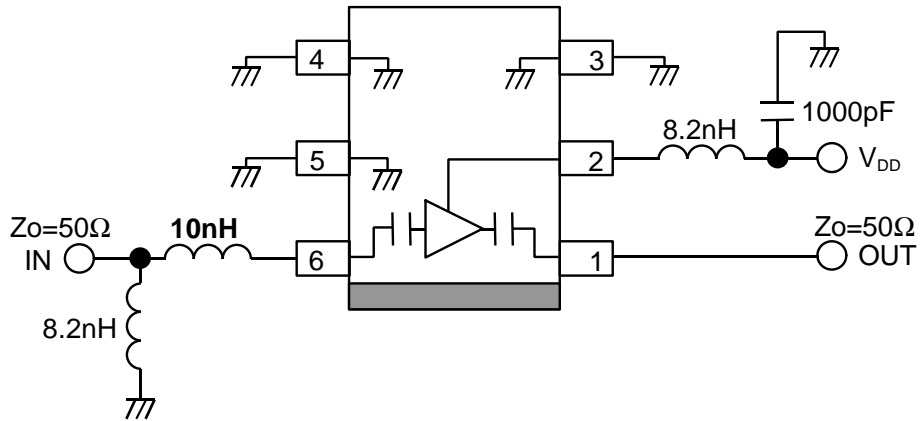
Freq (GHz)	S11		S21		S12		S22	
	mag (units)	ang (deg)	mag (units)	ang (deg)	mag (units)	ang (deg)	mag (units)	ang (deg)
0.1	1.000	-3.466	0.013	-99.853	0.001	-40.688	1.000	-3.792
0.2	1.000	-7.836	0.003	120.878	0.000	111.001	1.000	-7.797
0.3	1.000	-11.376	0.011	-23.230	0.001	77.901	1.000	-11.547
0.4	1.000	-15.369	0.024	-31.645	0.001	60.826	1.000	-15.222
0.5	1.000	-18.524	0.045	-34.983	0.002	73.639	1.000	-18.774
0.6	1.000	-22.254	0.068	-44.466	0.002	64.832	1.000	-22.517
0.7	0.987	-25.261	0.096	-51.466	0.002	59.880	0.998	-25.988
0.8	0.994	-28.510	0.134	-58.880	0.002	62.909	0.997	-29.586
0.9	0.962	-31.527	0.173	-65.887	0.002	62.762	0.994	-32.980
1.0	0.972	-33.806	0.227	-72.166	0.001	64.214	0.994	-36.537
1.1	0.946	-36.765	0.287	-80.123	0.001	59.903	0.993	-40.081
1.2	0.951	-38.499	0.370	-86.666	0.000	104.075	0.990	-43.600
1.3	0.931	-40.743	0.466	-93.543	0.001	-144.742	0.987	-47.623
1.4	0.936	-42.455	0.612	-101.148	0.002	-131.875	0.979	-52.301
1.5	0.922	-44.128	0.816	-109.855	0.004	-140.321	0.962	-58.048
1.6	0.927	-46.084	1.122	-120.983	0.007	-150.577	0.927	-66.488
1.7	0.915	-48.182	1.603	-137.240	0.012	-161.035	0.830	-79.157
1.8	0.900	-50.392	2.281	-162.468	0.018	-178.320	0.584	-100.354
1.9	0.853	-51.550	2.711	159.780	0.026	152.338	0.052	-128.112
2.0	0.829	-50.493	2.315	125.880	0.026	124.607	0.468	12.049
2.1	0.835	-49.844	1.803	104.689	0.023	107.196	0.718	-6.837
2.2	0.829	-49.732	1.426	91.557	0.020	99.244	0.827	-17.772
2.3	0.834	-50.427	1.192	82.277	0.018	94.680	0.876	-24.741
2.4	0.821	-50.628	1.027	75.650	0.017	92.857	0.906	-29.743
2.5	0.821	-51.483	0.922	69.553	0.016	91.557	0.920	-33.371
2.6	0.806	-51.476	0.841	64.184	0.015	91.315	0.934	-36.756
2.7	0.805	-52.354	0.782	59.683	0.015	91.885	0.939	-39.453
2.8	0.798	-52.928	0.731	55.213	0.014	91.583	0.947	-41.774
2.9	0.786	-53.597	0.692	51.129	0.015	95.367	0.945	-43.991
3.0	0.784	-54.637	0.665	46.939	0.015	101.051	0.955	-46.322



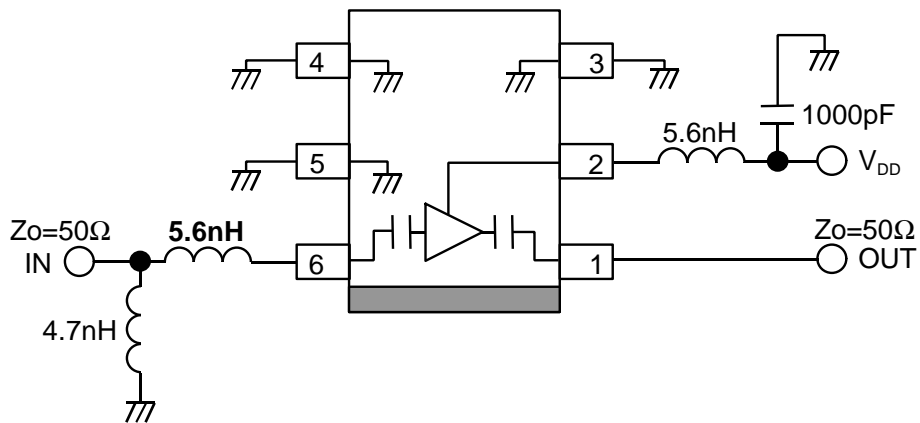
Scattering Parameter Evaluation Circuit

*New Japan Radio Co., Ltd.*

## RECOMMEND CIRCUIT 1 (1.5GHz Band)

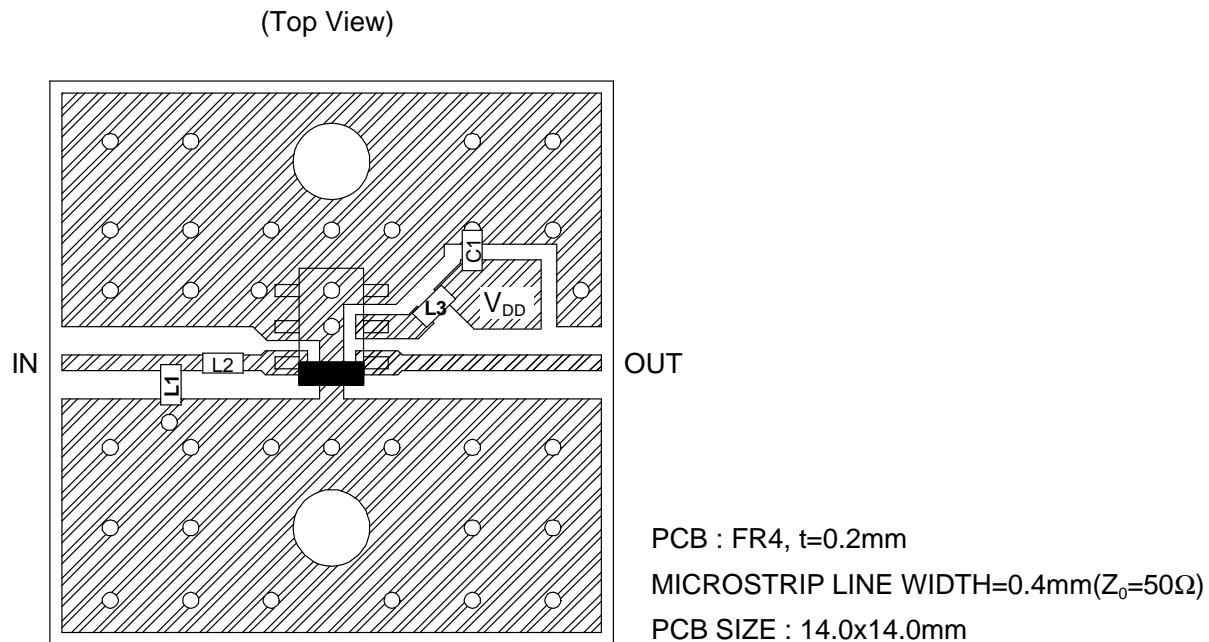


## RECOMMEND CIRCUIT 2 (1.9GHz Band)



# NJG1103F1

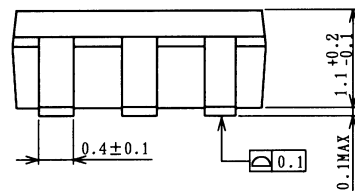
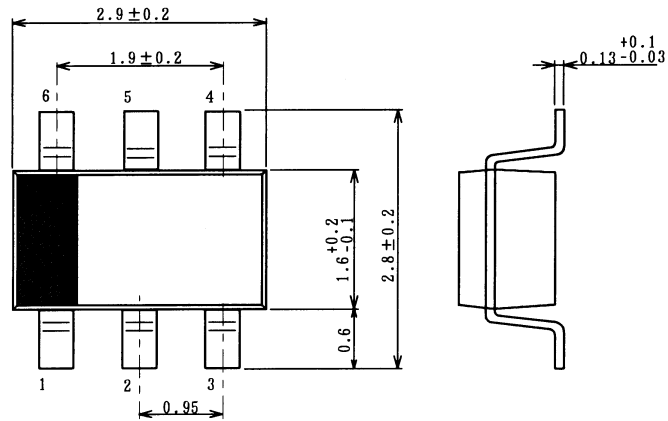
## RECOMMENDED PCB DESIGN



### PARTS LIST

PARTS ID	1.5GHz	1.9GHz	COMMENT
L1	8.2nH	4.7nH	TAIYO-YUDEN (HK1005)
L2	10nH	5.6nH	TAIYO-YUDEN (HK1005)
L3	8.2nH	5.6nH	TAIYO-YUDEN (HK1005)
C1	1000pF	1000pF	MURATA (GRM36)

## PACKAGE OUTLINE (MTP6-1)



Lead material : Copper  
 Lead surface finish : Solder plating  
 Molding material : Epoxy resin  
 UNIT : mm  
 Weight : 15mg

### 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.