

## W-CDMA FRONT-END GaAs MMIC for W-CDMA

### ■ GENERAL DESCRIPTION

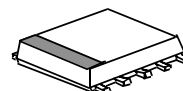
The NJG1715KC1 is a front-end GaAs MMIC including a LNA, a mixer with a local amplifier.

The main application is front-end of W-CDMA cellular phone handsets.

The NJG1715KC1 features low noise figure, high gain and high input IIP3.

The ultra small & ultra thin FLP10 package is applied.

### ■ PACKAGE OUTLINE

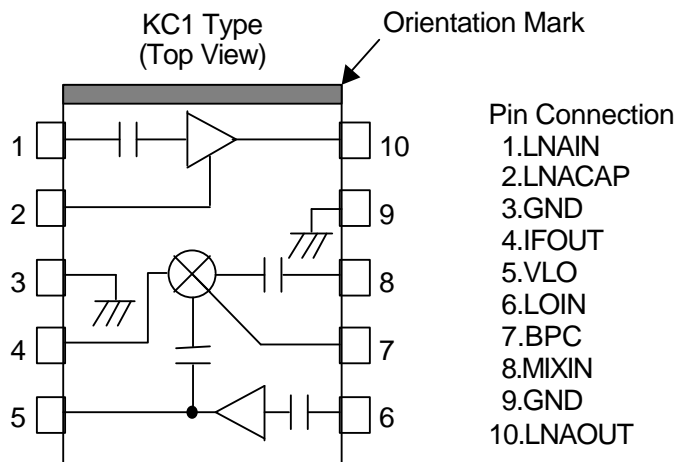


NJG1715KC1

### ■ FEATURES

- Low voltage operation +2.85V typ.
- Low current consumption
  - LNA 2.8mA typ.
  - Mixer 55mA typ. (with Local Amplifier operation current)
- Ultra small & ultra thin package FLP10-C1 (Package size: 3.0x2.8x0.75mm) [LNA]
- High small signal gain 15.0dB typ. @  $f_{RF}=2140\text{MHz}$
- Low noise figure 1.3dB typ. @  $f_{RF}=2140\text{MHz}$
- High input IP3 -2.0dBm typ. @  $f_{RF}=2140+2140.1\text{MHz}$  [Mixer]
- High conversion gain 11.5dB typ. @  $f_{RF}=2140\text{MHz}$ ,  $f_{LO}=2520\text{MHz}$ ,  $P_{LO}=-10\text{dBm}$
- Low noise figure 5.0dB typ. @  $f_{RF}=2140\text{MHz}$ ,  $f_{LO}=2520\text{MHz}$ ,  $P_{LO}=-10\text{dBm}$
- High input IP3 +1.0dBm typ. @  $f_{RF}=2140.0+2140.1\text{MHz}$ ,  $f_{LO}=2520\text{MHz}$ ,  $P_{LO}=-10\text{dBm}$

### ■ PIN CONFIGURATION



NOTE: Please note that any information on this catalog will be subject to change.

# NJG1715KC1

## ■ ABSOLUTE MAXIMUM RATINGS

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

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
LNA Voltage	$V_{LNA}$		5.0	V
Mixer Voltage	$V_{MIX}$		5.0	V
Local Amplifier Voltage	$V_{LO}$		5.0	V
Input Power 1	$P_{LNAIN}$	$V_{LNA}=V_{MIX}=V_{LO}=2.85\text{V}$	+15	dBm
Input Power 2	$P_{LOIN}$	$V_{LNA}=V_{MIX}=V_{LO}=2.85\text{V}$	+10	dBm
Power Dissipation	$P_D$		550	mW
Operating Temperature	$T_{opr}$		-40~+85	$^{\circ}\text{C}$
Storage Temperature	$T_{stg}$		-55~+125	$^{\circ}\text{C}$

## ■ ELECTRICAL CHARACTERISTICS 1 (LNA)

GENERAL CONDITIONS:  $T_a=+25^{\circ}\text{C}$ ,  $V_{LNA}=2.85\text{V}$ ,  $V_{MIX}=V_{LO}=0\text{V}$ ,  $f_{RF}=2140\text{MHz}$ ,  $P_{RF}=-36\text{dBm}$ ,  
 $Z_s=Z_l=50\Omega$ , with test circuit

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Frequency	freq		2110	2140	2170	MHz
LNA Voltage	$V_{LNA}$		2.5	2.85	4.5	V
LNA Operating Current	$I_{LNA}$	$P_{RF}$ , $P_{LO}=\text{OFF}$	-	2.8	3.5	mA
Small Signal Gain	Gain		13.0	15.0	17.0	dB
Gain Flatness	$G_{flat}$	$f_{RF}=2110\sim 2170\text{MHz}$	-	0.5	1.0	dB
Noise Figure	NF		-	1.3	1.5	dB
Pout at 1dB Gain Compression point	$P_{-1dB}$		-2.0	+1.0	-	dBm
Input 3rd order Intercept point	IIP3	$f_{RF}=2140.0+2140.1\text{MHz}$	-7.0	-2.0	-	dBm
RF IN VSWR	$VSWR_i$		-	2.0	-	
RF OUT VSWR	$VSWR_o$		-	2.0	-	

## ■ ELECTRICAL CHARACTERISTICS 2 (Mixer)

GENERAL CONDITIONS:  $T_a=+25^{\circ}\text{C}$ ,  $V_{LNA}=0\text{V}$ ,  $V_{MIX}=V_{LO}=2.85\text{V}$ ,  $f_{RF}=2140\text{MHz}$ ,  $f_{LO}=2520\text{MHz}$   
 $P_{RF}=-30\text{dBm}$ ,  $P_{LO}=-10\text{dBm}$ ,  $Z_s=Z_l=50\Omega$ , with test circuit

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Frequency	freq		2110	2140	2170	MHz
Mixer Voltage	$V_{MIX}$		2.5	2.85	4.5	V
Local Amplifier Voltage	$V_{LO}$		2.5	2.85	4.5	V
Mixer Operating Current	$I_{MIX}$	$P_{RF}$ , $P_{LO}=\text{OFF}$	-	4.6	6.0	mA
Local Amplifier Operating Current	$I_{LO}$	$P_{RF}$ , $P_{LO}=\text{OFF}$	-	0.9	1.3	mA
Conversion Gain	$G_c$		10.0	11.5	-	dB
Noise Figure	NF		-	5.0	7.0	dB
Input 3rd Order Intercept Point	IIP3	$f_{RF}=2140.0+2140.1\text{MHz}$	-3.0	+1.0	-	dBm
MIXER IN VSWR	$VSWR_M$		-	1.5	-	
LOCAL IN VSWR	$VSWR_L$		-	1.5	-	
IF OUT VSWR	$VSWR_i$		-	1.5	-	

## ■ TERMINAL INFORMATION

No.	SYMBOL	FUNCTION
1	LNAIN	RF input terminal of LNA. An external matching circuit is required.
2	LNACAP	Terminal for the bypass capacitor of LNA. The bypass capacitor C1 shown in test circuits should be connected to this terminal as close as possible.
3	GND	Ground terminal (0V)
4	IFOUT	IF signal output terminal. The IF signal is output through external matching circuit connected to this terminal. Please connect inductances L7, L8 and power supply as shown in test circuits, since this terminal is also the terminal of mixer power supply.
5	VLO	Power supply terminal for local amplifier. Please place R1 and L11 shown in test circuits at very close to this terminal.
6	LOIN	Local signal input terminal to local amplifier. An external matching circuit is required.
7	BPC	Terminal for the bypass capacitor of mixer. The bypass capacitor C4 shown in test circuits should be connected to this terminal as close as possible.
8	MIXIN	RF signal input terminal to mixer. An external matching circuit is required.
9	GND	Ground terminal (0V)
10	LNAOUT	Signal output terminal of LNA. The RF signal from LNA goes out through external matching circuit connected to this terminal. Please connect inductances L3, L4 and power supply as shown in test circuits, since this terminal is also the terminal of LNA power supply.

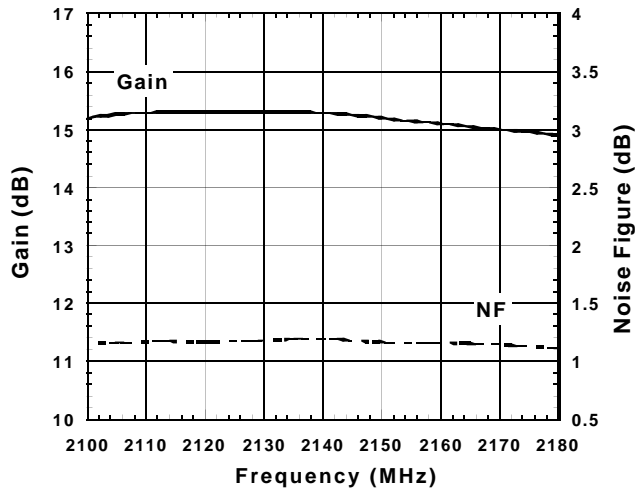
### CAUTION

- 1) Ground terminal (No.3, 9) should be connected to the ground plane as close as possible.

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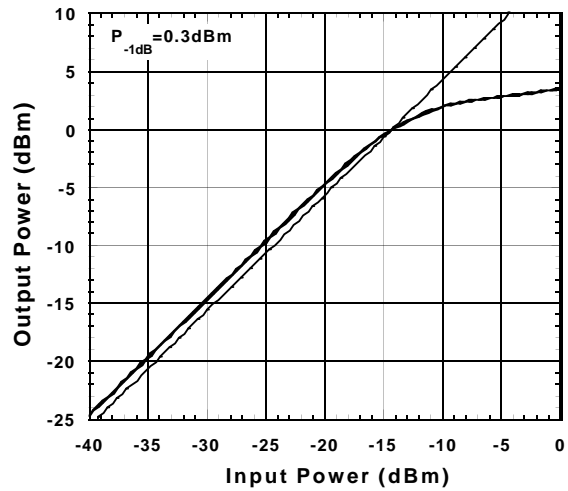
## ■ TYPICAL CHARACTERISTICS (LNA, with test circuit)

### Gain, Noise Figure vs. Frequency



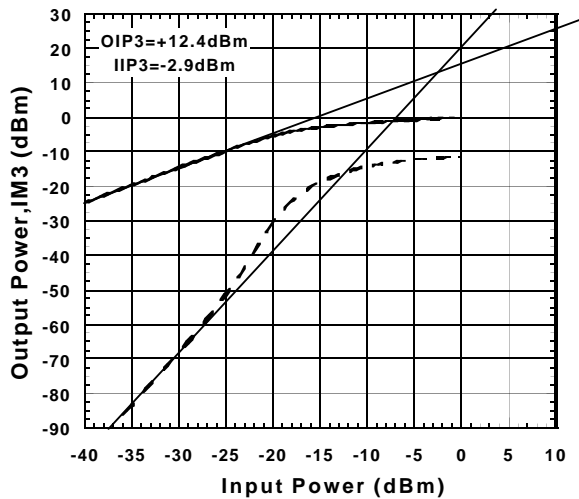
Condition  
 $f=2110\sim 2170\text{MHz}$   
 $V_{LNA}=2.85\text{V}$   
 $V_{MIX}=V_{LO}=0\text{V}$

### Output Power vs. Input Power



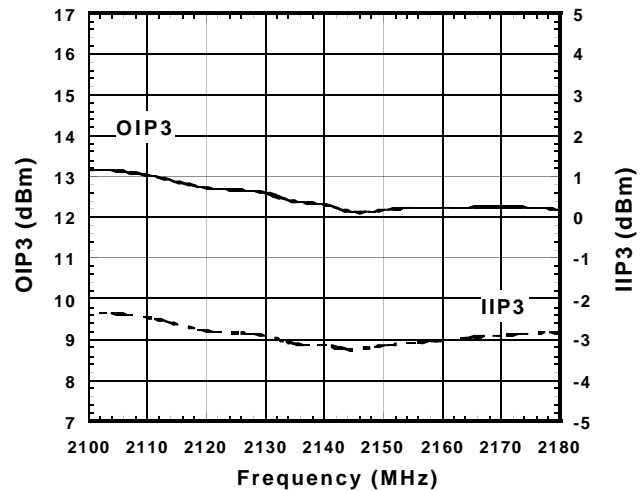
Condition  
 $f=2140\text{MHz}$   
 $V_{LNA}=2.85\text{V}$   
 $V_{MIX}=V_{LO}=0\text{V}$

### Output Power, IM3 vs. Input Power



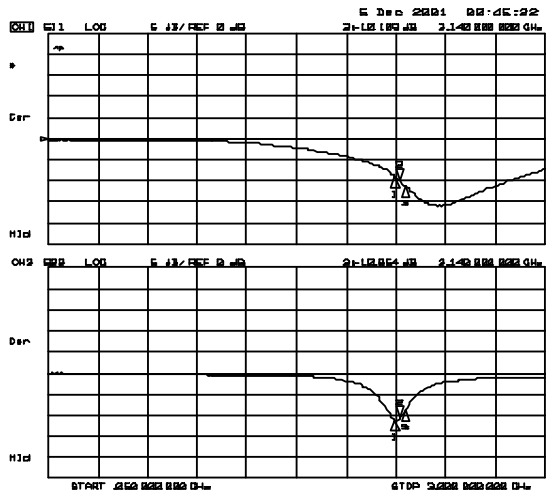
Condition  
 $f=2140+2140.1\text{MHz}$   
 $V_{LNA}=2.85\text{V}$   
 $V_{MIX}=V_{LO}=0\text{V}$

### Output Power, IM3 vs. Input Power

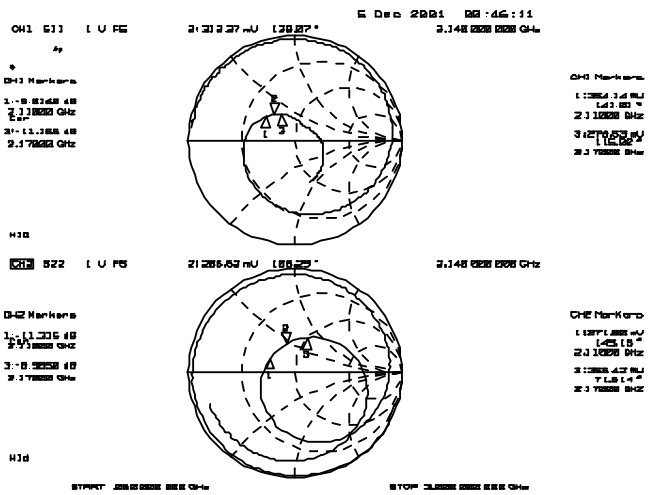


Condition  
 $f=2110\sim 2170\text{MHz}$   
 $f_{\text{OFFSET}}=100\text{kHz}$   
 $P_{\text{in}}=-30\text{dBm}$   
 $V_{LNA}=2.85\text{V}$   
 $V_{MIX}=V_{LO}=0\text{V}$

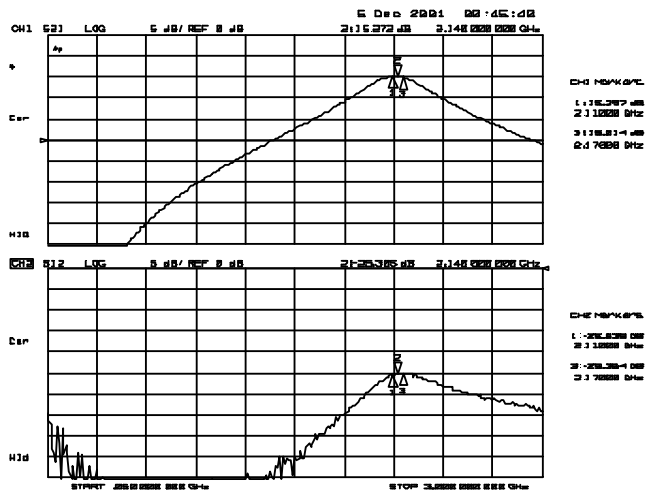
## TYPICAL CHARACTERISTICS (LNA, with test circuit)



S11 & S22  
 Condition  
 $V_{LNA}=2.85V$   
 $V_{MIX}=V_{LO}=0V$



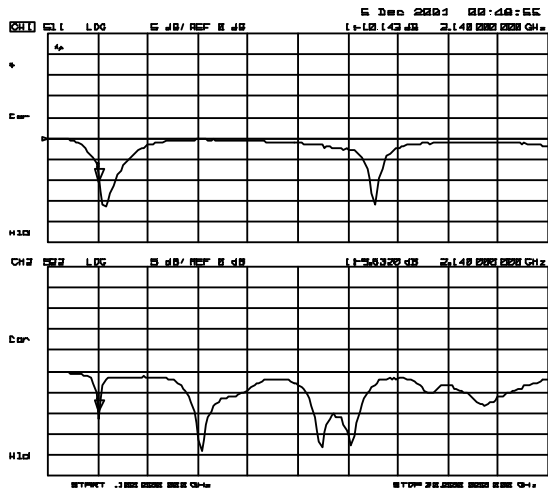
Z11 & Z22  
 Condition  
 $V_{LNA}=2.85V$   
 $V_{MIX}=V_{LO}=0V$



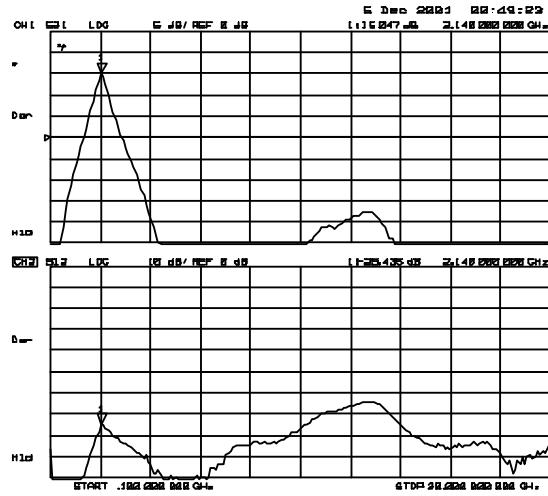
S21 & S12  
 Condition  
 $V_{LNA}=2.85V$   
 $V_{MIX}=V_{LO}=0V$

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## ■ TYPICAL CHARACTERISTICS (LNA, with test circuit )



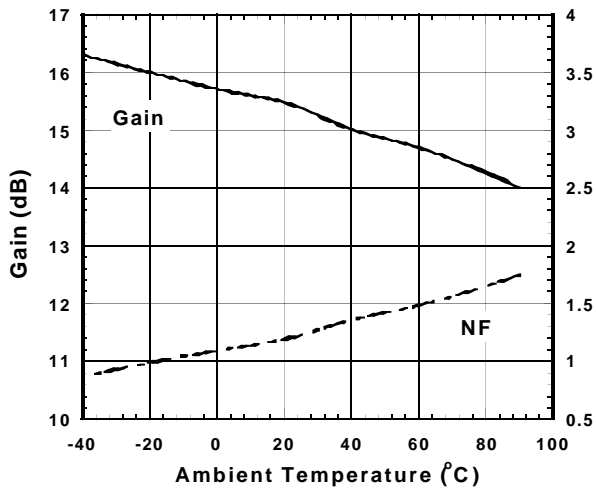
S11 & S22(~20GHz)  
Condition  
 $V_{LNA}=2.85V$   
 $V_{MIX}=V_{LO}=0V$



S21 & S12(~20GHz)  
Condition  
 $V_{LNA}=2.85V$   
 $V_{MIX}=V_{LO}=0V$

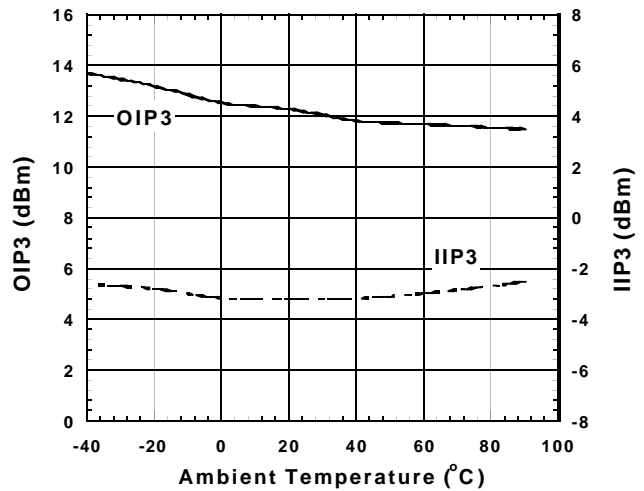
## ■ TYPICAL CHARACTERISTICS (LNA, with test circuit)

### Gain, Noise Figure vs. Temperature



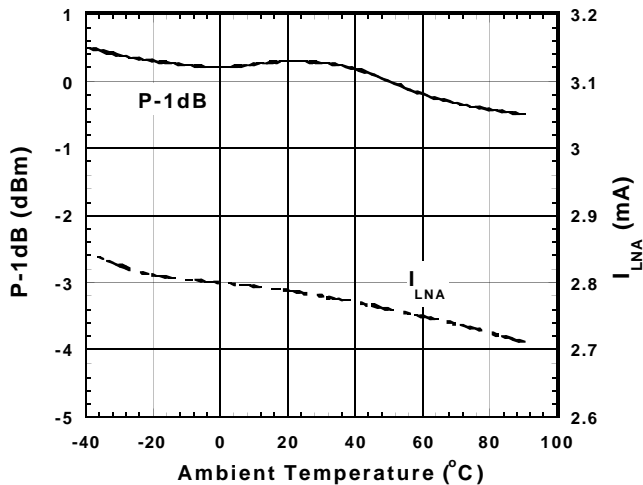
Condition  
 $f=2140\text{MHz}$   
 $V_{\text{LNA}}=2.85\text{V}$   
 $V_{\text{MIX}}=V_{\text{LO}}=0\text{V}$

### OIP3, IIP3 vs. Temperature



Condition  
 $f=2140+2140.1\text{MHz}$   
 $\text{Pin}=-30\text{dBm}$   
 $V_{\text{LNA}}=2.85$   
 $V_{\text{MIX}}=V_{\text{LO}}=0\text{V}$

### P-1dB, $I_{\text{LNA}}$ vs. Temperature

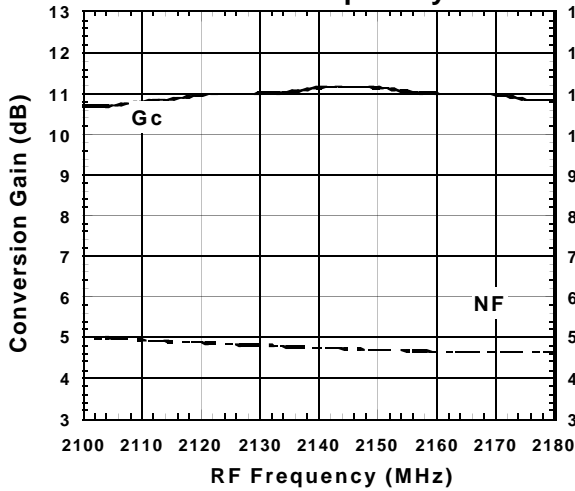


Condition  
 $f=2140\text{MHz}$   
 $V_{\text{LNA}}=2.85\text{V}$   
 $V_{\text{MIX}}=V_{\text{LO}}=0\text{V}$

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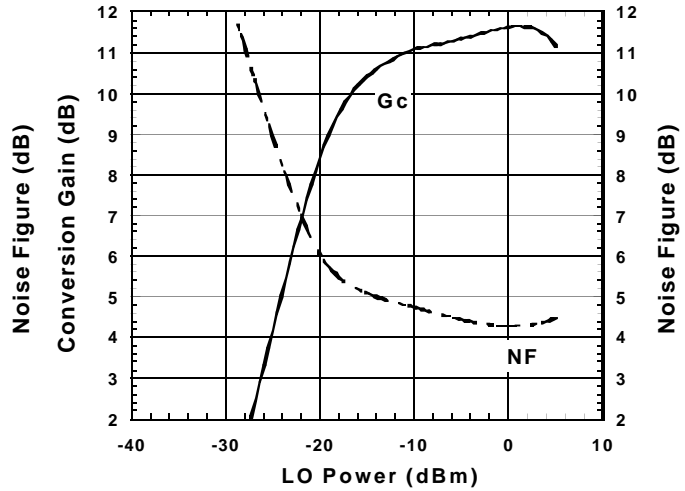
## ■ TYPICAL CHARACTERISTICS (MIXER, with test circuit)

**Conversion Gain, Noise Figure vs. RF Frequency**



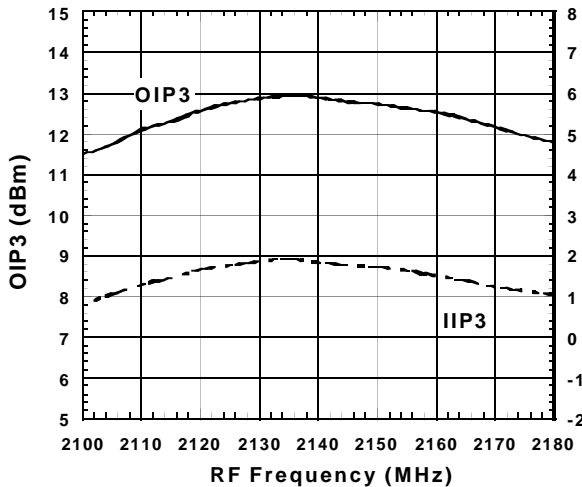
Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2110\sim 2170\text{MHz}, P_{RF}=-30\text{dBm}$   
 Upper LOCAL,  $P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

**Conversion Gain, Noise Figure vs. LO Power**



Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{LO}=2520\text{MHz}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

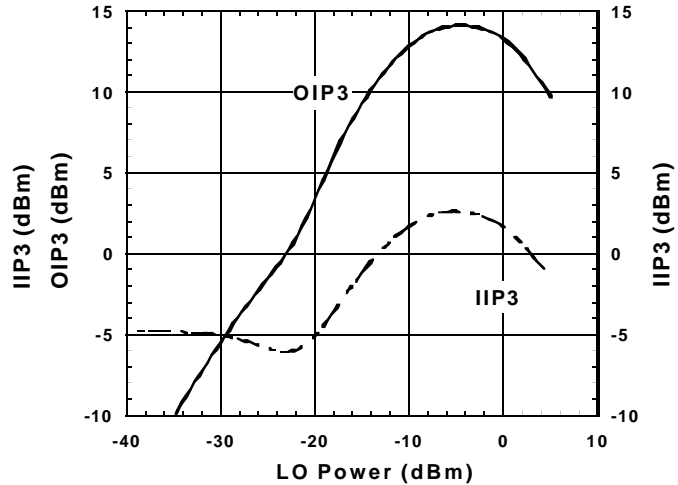
**OIP3, IIP3 vs. RF Frequency**



Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2110\sim 2170\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{RF\text{ OFFSET}}=100\text{kHz}$   
 Upper LOCAL,  $P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

$OIP3=(3 \times IF - IM3)/2$   
 $IIP3=OIP3-Gc$

**OIP3, IIP3 vs. LO Power**

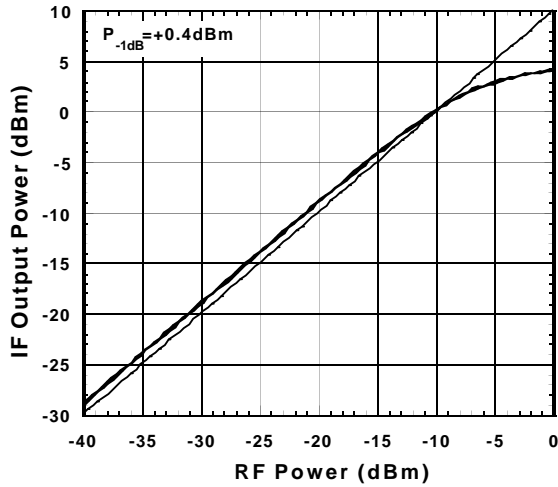


Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140+2140.1\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{LO}=2520\text{MHz}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$



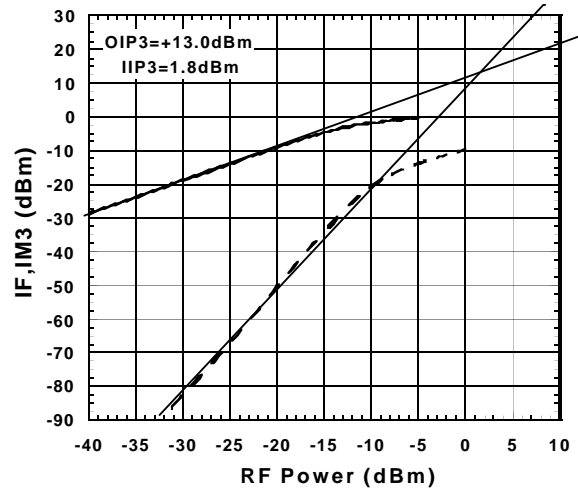
## ■ TYPICAL CHARACTERISTICS (MIXER, with test circuit )

### IF Output Power vs. RF Power



Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140\text{MHz}$   
 $f_{LO}=2520\text{MHz}, P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

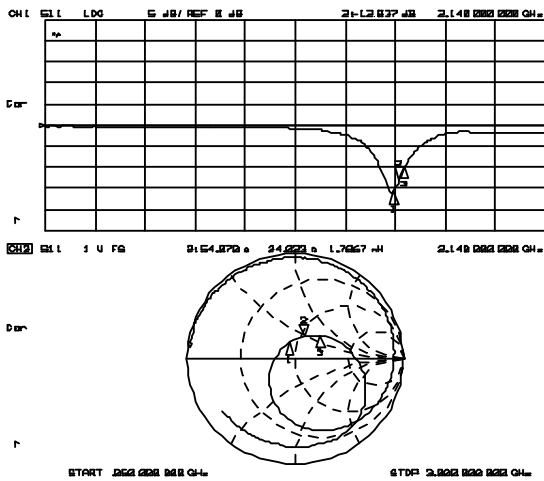
### IF, IM3 vs. RF Power



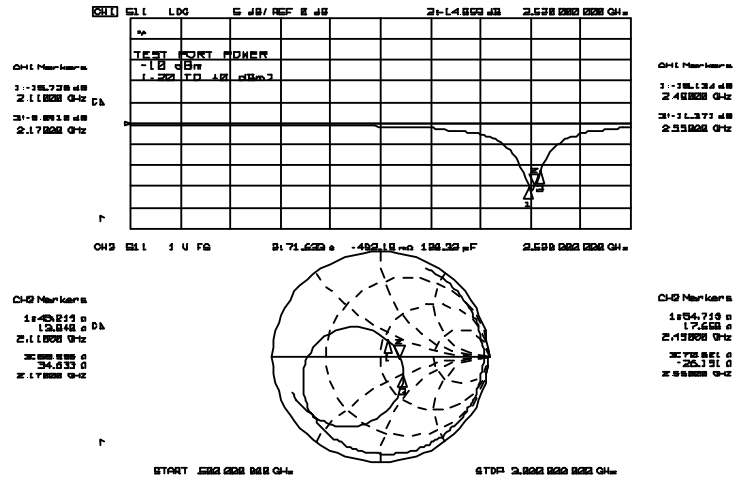
Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140+2140.1\text{MHz}$   
 $f_{LO}=2520\text{MHz}, P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

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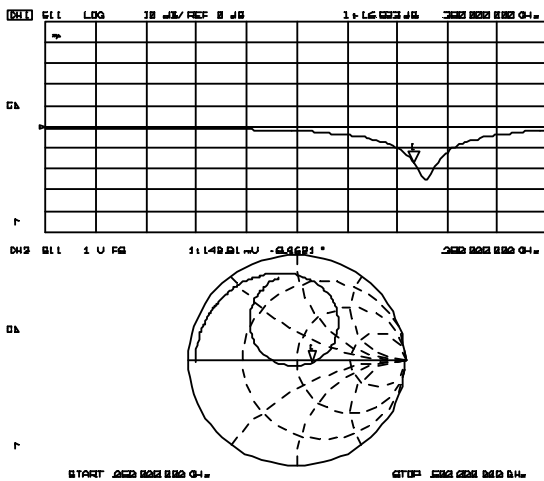
## TYPICAL CHARACTERISTICS (MIXER, with test circuit)



MIXER IN Impedance  
Condition  
LOCAL IN, IF OUT 50Ωterm.  
Source Power=-30dBm  
 $V_{LNA} = 0V$ ,  $V_{MIX} = V_{LO} = 2.85V$

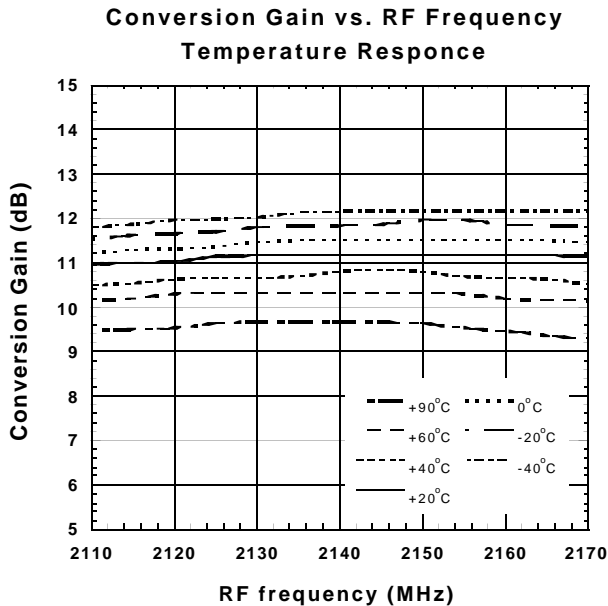


LOCAL IN Impedance  
Condition  
MIXER IN, IF OUT 50Ωterm.  
Source Power=-10dBm  
 $V_{LNA} = 0V$ ,  $V_{MIX} = V_{LO} = 2.85V$

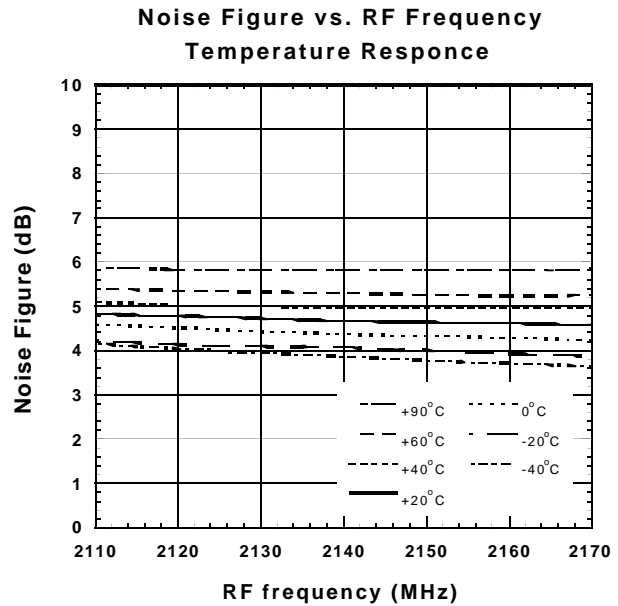


IF OUT Impedance  
Condition  
MIXER IN, LOCAL IN 50Ωterm.  
Source Power=-10dBm  
 $V_{LNA} = 0V$ ,  $V_{MIX} = V_{LO} = 2.85V$

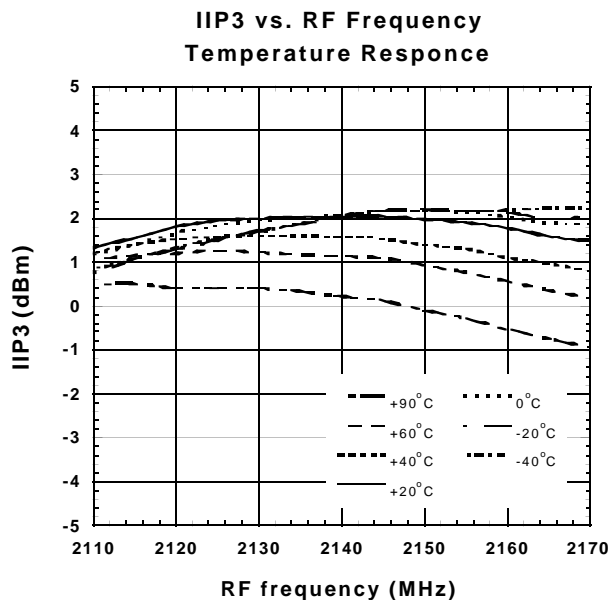
## ■ TYPICAL CHARACTERISTICS (MIXER, with test circuit)



Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2110\sim 2170\text{MHz}, P_{RF}=-30\text{dBm}$   
 Upper LOCAL,  $P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$



Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2110\sim 2170\text{MHz}, P_{RF}=-30\text{dBm}$   
 Upper LOCAL,  $P_{LO}=-10\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

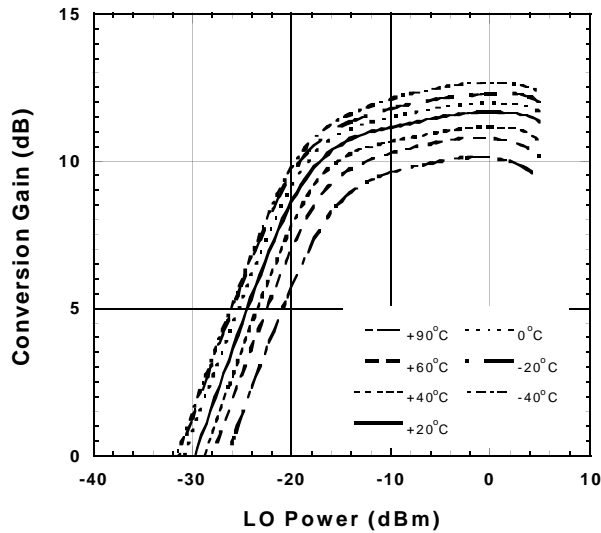


Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2110\sim 2170\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{RF\text{ OFFSET}}=100\text{kHz}$   
 Upper LOCAL,  $P_{LO}=-30\text{dBm}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

# NJG1715KC1

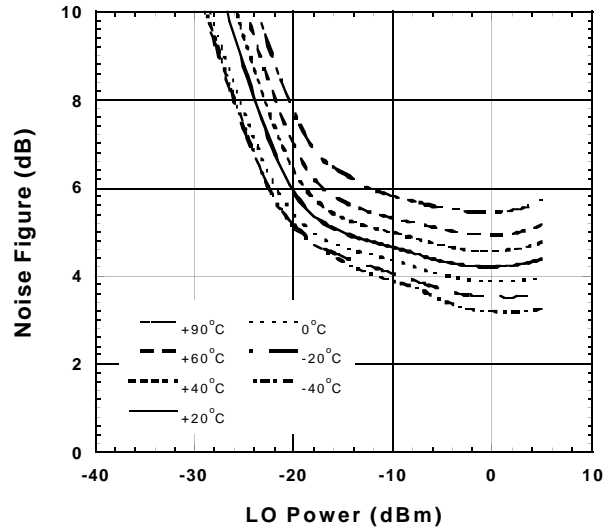
## TYPICAL CHARACTERISTICS (MIXER, with test circuit)

Conversion Gain vs. LO Power  
Temperature Response



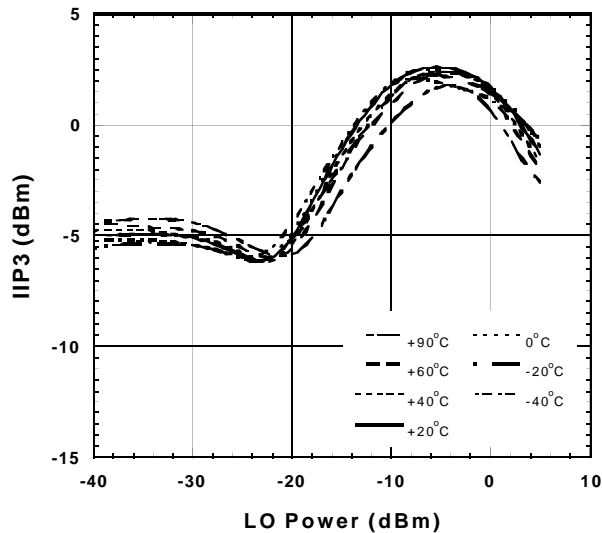
Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{LO}=2520\text{MHz}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

Noise Figure vs. LO Power  
Temperature Response



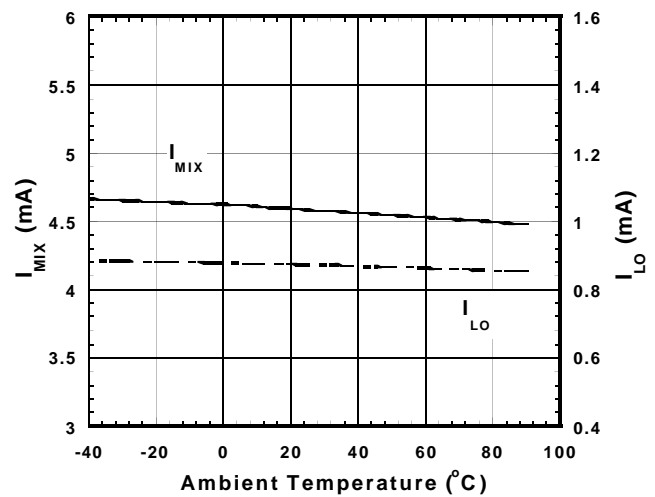
Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{LO}=2520\text{MHz}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

IIP3 vs. LO Power  
Temperature Response



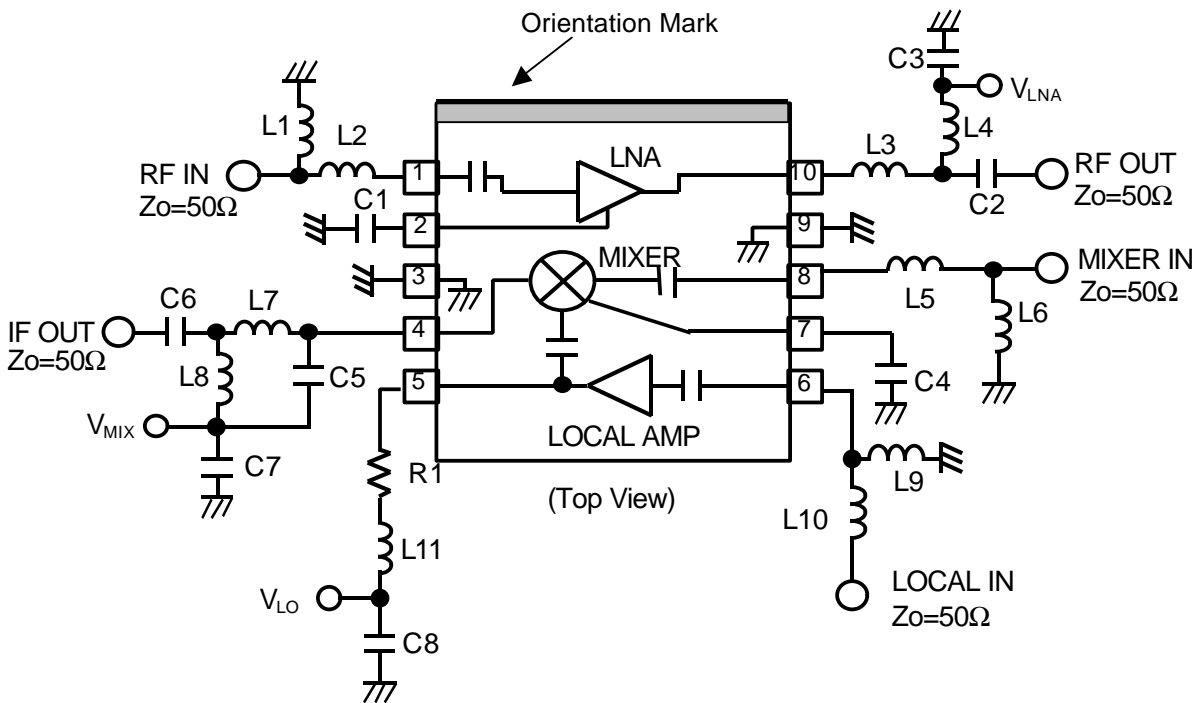
Condition  
 $f_{IF}=380\text{MHz}$   
 $f_{RF}=2140+2140.1\text{MHz}, P_{RF}=-30\text{dBm}$   
 $f_{LO}=2520\text{MHz}$   
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

$I_{MIX}, I_{LO}$  vs. Temperature



Condition  
 $V_{LNA}=0\text{V}$   
 $V_{MIX}=V_{LO}=2.85\text{V}$

## TEST CIRCUIT

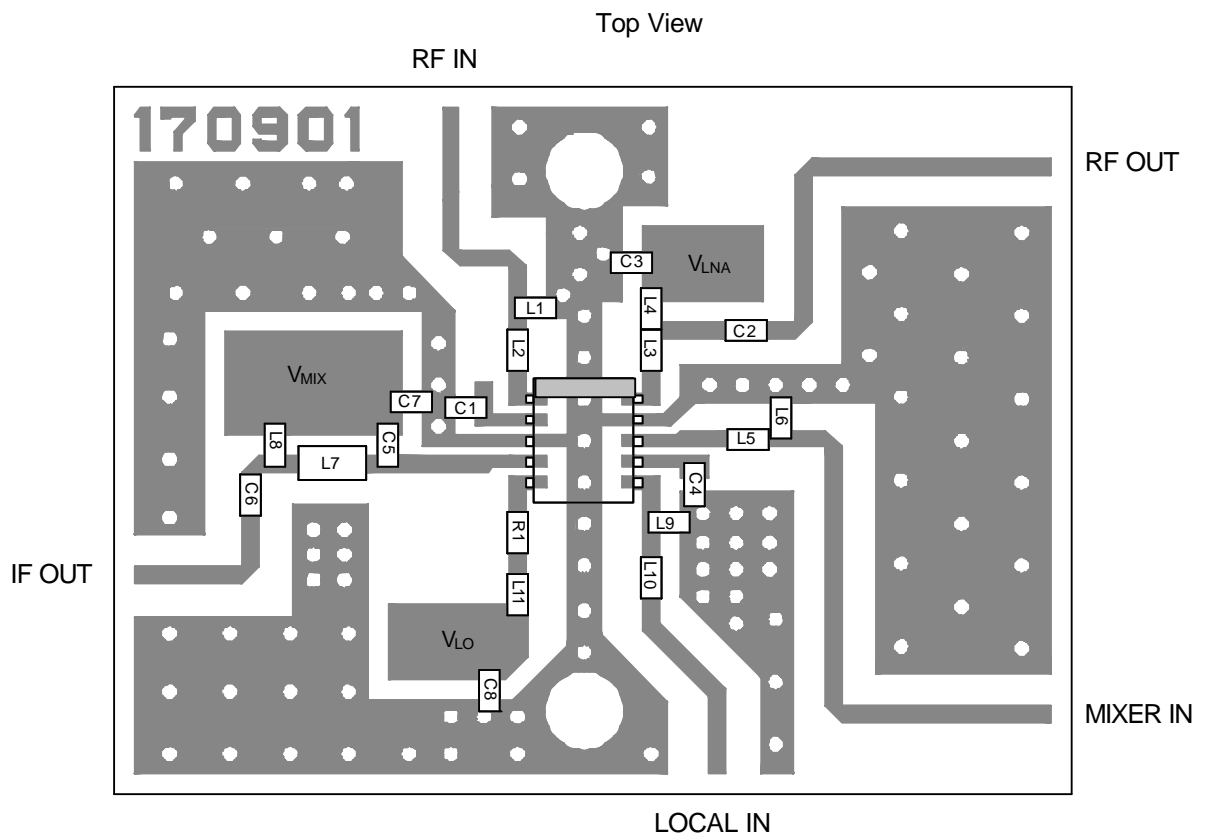


## PARTS LIST

PART ID	2.1GHz BAND		COMMENT
	Upper Local		
	$f_{RF}=2140\text{MHz}$ , $f_{LO}=2520\text{MHz}$ , $f_{IF}=380\text{MHz}$		
L1	5.6nH		TAIYO-YUDEN (HK1005)
L2	4.7nH		TAIYO-YUDEN (HK1005)
L3	5.6nH		TAIYO-YUDEN (HK1005)
L4	1.5nH		TAIYO-YUDEN (HK1005)
L5	2.7nH		TAIYO-YUDEN (HK1005)
L6	1.5nH		TAIYO-YUDEN (HK1005)
L7	39nH		TAIYO-YUDEN (HK1608)
L8	18nH		TAIYO-YUDEN (HK1005)
L9	6.8nH		TAIYO-YUDEN (HK1005)
L10	8.2nH		TAIYO-YUDEN (HK1005)
L11	2.7nH		TAIYO-YUDEN (HK1005)
C1	10pF		MURATA (GRM36)
C2	7pF		MURATA (GRM36)
C3	1000pF		MURATA (GRM36)
C4	470pF		MURATA (GRM36)
C5	2pF		MURATA (GRM36)
C6	470pF		MURATA (GRM36)
C7	0.01uF		MURATA (GRM36)
C8	0.01uF		MURATA (GRM36)
R1	5.1Ω		CHIP SIZE 1005

# NJG1715KC1

## RECOMMENDED PCB DESIGN

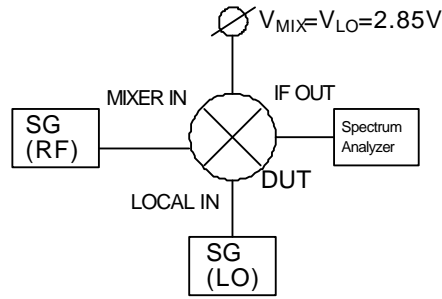


PCB (FR-4) :  $t = 0.2 \text{ mm}$

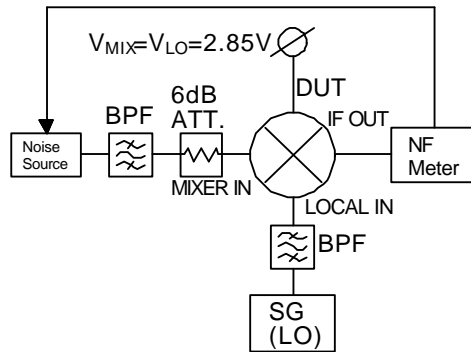
MICRO STRIPLINE WIDTH =  $0.4 \text{ mm}$  ( $Z_0 = 50\Omega$ )

PCB SIZE =  $23.0 \times 17.0 \text{ mm}$

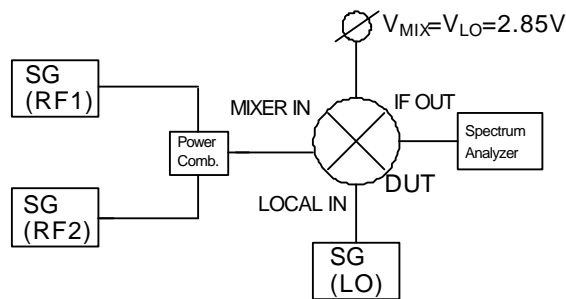
## MEASURING BLOCK DIAGRAM



Conversion Gain Measurement Block Diagram



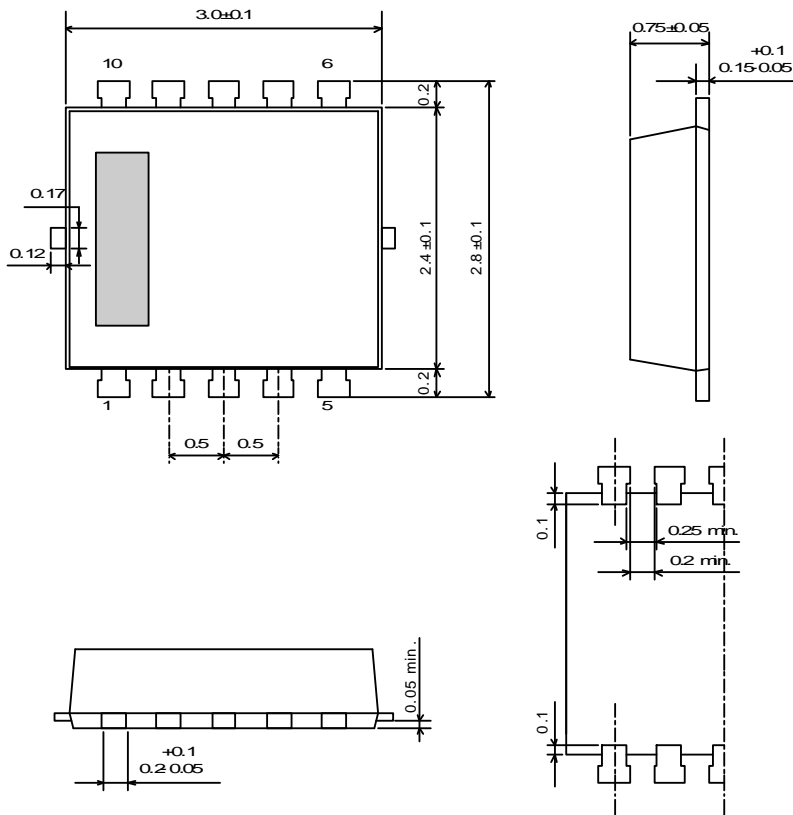
Noise Figure Measurement Block Diagram



IF,IM3 Measurement Block Diagram

# NJG1715KC1

## ■ PACKAGE OUTLINE (FLP10-C1)



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.