

## Low Noise Amplifier with Bypass for LTE

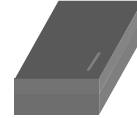
### ■ GENERAL DESCRIPTION

NJG1169UX2 is low noise amplifier with bypass switch for LTE which covers frequency from 728 to 960MHz.

The NJG1169UX2 has a LNA pass-through function to select LNA active mode or bypass mode, and this IC achieves high gain, low noise figure and high linearity. Integrated ESD protection device on each port achieves excellent ESD robustness.

A very small and ultra-thin package of EPFFP6-X2 is adopted.

### ■ PACKAGE OUTLINE



NJG1169UX2

### ■ APPLICATIONS

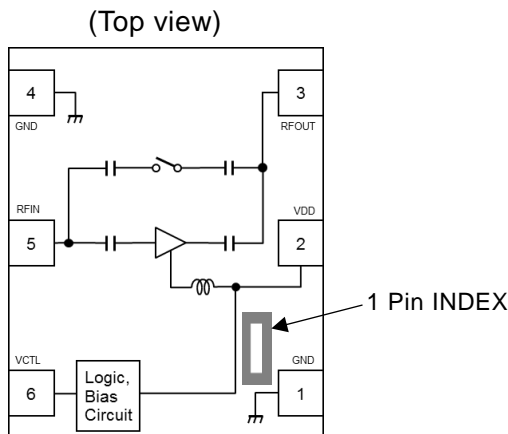
LTE receive application

RF front-end modules, smartphones, data cards and others mobile application

### ■ FEATURES

- Operating frequencies 728 to 960MHz
- Operating voltage 1.5 to 3.3V
- Low current consumption 4.8/4.0mA typ. @  $V_{DD}=2.8/1.8V$
- High Gain 12.5dB typ. @  $V_{DD}=2.8V, f=880MHz$
- Low Noise figure 0.8dB typ. @  $V_{DD}=2.8V, f=880MHz$
- High IIP3 0dBm typ. @  $V_{DD}=2.8V, f=880MHz$
- Insertion loss in bypass mode 2.5dB typ. @  $V_{DD}=2.8V, f=880MHz$
- Ultra Small package size EPFFP6-X2 (Package size: 1.1mm x 0.7mm x 0.37mm typ.)
- RoHS compliant and Halogen Free
- MSL1

### ■ PIN CONFIGURATION



#### Pin Connection

1. GND
2. VDD
3. RFOUT
4. GND
5. RFIN
6. VCTL

### ■ TRUTH TABLE

“H”= $V_{CTL}(H)$  “L”= $V_{CTL}(L)$

$V_{CTL}$	Mode
L	Bypass mode
H	LNA active mode

Note: Specifications and description listed in this datasheet are subject to change without notice

## ■ ABSOLUTE MAXIMUM RATINGS

General condition:  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Supply voltage	$V_{DD}$		5.0	V
Control voltage	$V_{CTL}$		5.0	V
Input power	$P_{in}$	$V_{DD}=2.8\text{V}$	+15	dBm
Power dissipation	$P_D$	4-layer FR4 PCB with through-hole (101.5x114.5mm), $T_j=150^{\circ}\text{C}$	430	mW
Operating temperature	$T_{opr}$		-40 to +105	$^{\circ}\text{C}$
Storage temperature	$T_{stg}$		-55 to +150	$^{\circ}\text{C}$

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

General condition:  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	$V_{DD}$		1.5	-	3.3	V
Control voltage (High)	$V_{CTL(H)}$		1.3	1.8	3.3	V
Control voltage (Low)	$V_{CTL(L)}$		0	0	0.3	V
Operating current 1	$I_{DD1}$	RF OFF, $V_{DD}=2.8\text{V}$ , $V_{CTL}=1.8\text{V}$	-	4.8	8.0	mA
Operating current 2	$I_{DD2}$	RF OFF, $V_{DD}=1.8\text{V}$ , $V_{CTL}=1.8\text{V}$	-	4.0	7.5	mA
Operating current 3	$I_{DD3}$	RF OFF, $V_{DD}=2.8\text{V}$ , $V_{CTL}=0\text{V}$	-	15	60	$\mu\text{A}$
Operating current 4	$I_{DD4}$	RF OFF, $V_{DD}=1.8\text{V}$ , $V_{CTL}=0\text{V}$	-	10	60	$\mu\text{A}$
Control current	$I_{CTL}$	RF OFF, $V_{CTL}=1.8\text{V}$	-	7	20	$\mu\text{A}$

## ■ ELECTRICAL CHARACTERISTICS 2 (LNA active mode)

General Condition:  $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 1	Gain1	Exclude PCB & connector losses(0.13dB)	10.0	12.5	15.0	dB
Noise figure 1	NF1	Exclude PCB & connector losses(0.06dB)	-	0.8	1.2	dB
Input power at 1dB gain compression point 1(1)	P-1dB (IN)1(1)		-10.0	+1.0	-	dBm
Input 3rd order intercept point 1(1)	IIP3_1(1)	$f1=f_{RF}$ , $f2=f_{RF}+1MHz$ , $P_{IN}=-24dBm$	-6.0	0	-	dBm
Gain settling time1(1)	Ts1(1)	Bypass to LNA active mode To be within 1dB of the final gain	-	2.0	5.0	$\mu s$
Gain settling time1(2)	Ts1(2)	LNA active to Bypass mode To be within 1dB of the final Insertion loss	-	1.0	4.0	$\mu s$
RF IN Return loss1(1)	RLi1(1)		6.0	11.0	-	dB
RF OUT Return loss1(1)	RLo1(1)		6.0	11.0	-	dB

## ■ ELECTRICAL CHARACTERISTICS 3 (Bypass mode)

General Condition:  $V_{DD}=2.8V$ ,  $V_{CTL}=0V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss1	Loss1	Exclude PCB & connector losses(0.13dB)	-	2.5	4.0	dB
Input power at 1dB gain compression point 1(2)	P-1dB (IN)1(2)		0	+10.0	-	dBm
Input 3rd order intercept point 1(2)	IIP3_1(2)	$f1=f_{RF}$ , $f2=f_{RF}+1MHz$ , $P_{IN}=-5dBm$	0	+15.0	-	dBm
RF IN Return loss1(2)	RLi1(2)		6.0	10.0	-	dB
RF OUT Return loss1(2)	RLo1(2)		4.0	6.5	-	dB

## ■ ELECTRICAL CHARACTERISTICS 4 (LNA active mode)

General Condition:  $V_{DD}=1.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 2	Gain2	Exclude PCB & connector losses(0.13dB)	-	12.0	-	dB
Noise figure 2	NF2	Exclude PCB & connector losses(0.06dB)	-	0.8	-	dB
Input power at 1dB gain compression point 2(1)	P-1dB (IN)2(1)		-	-2.0	-	dBm
Input 3rd order intercept point 2(1)	IIP3_2(1)	$f1=f_{RF}$ , $f2=f_{RF}+1MHz$ , $P_{IN}=-24dBm$	-	-0.5	-	dBm
Gain settling time2(1)	Ts2(1)	Bypass to LNA active mode To be within 1dB of the final gain	-	2.0	-	$\mu s$
Gain settling time2(2)	Ts2(2)	LNA active to Bypass mode To be within 1dB of the final Insertion loss	-	1.0	-	$\mu s$
RF IN Return loss2(1)	RLi2(1)		-	10.0	-	dB
RF OUT Return loss2(1)	RLo2(1)		-	10.0	-	dB

## ■ ELECTRICAL CHARACTERISTICS 5 (Bypass mode)

General Condition:  $V_{DD}=1.8V$ ,  $V_{CTL}=0V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss2	Loss2	Exclude PCB & connector losses(0.13dB)	-	2.5	-	dB
Input power at 1dB gain compression point 2(2)	P-1dB (IN) 2(2)		-	+10.0	-	dBm
Input 3rd order intercept point 2(2)	IIP3_2(2)	$f1=f_{RF}$ , $f2=f_{RF}+1MHz$ , $P_{IN}=-5dBm$	-	+15.0	-	dBm
RF IN Return loss 2(2)	RLi2(2)		-	9.0	-	dB
RF OUT Return loss 2(2)	RLo2(2)		-	6.0	-	dB

## ■ TERMINAL INFORMATION

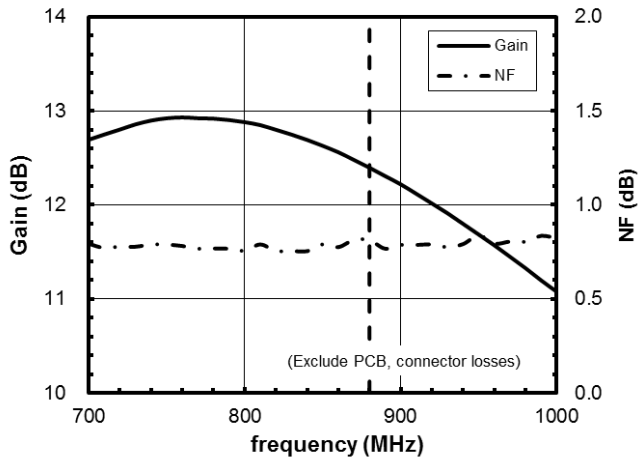
No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
2	VDD	Supply voltage terminal. Please connect bypass capacitor C1 with ground as close as possible.
3	RFOUT	RF output terminal. This terminal requires no DC blocking capacitor since this IC has internal output matching circuit including DC blocking capacitor.
4	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
5	RFIN	RF input terminal. This terminal requires only a matching inductor L1, and does not require DC blocking capacitor.
6	VCTL	Control voltage terminal.

## ■ ELECTRICAL CHARACTERISTICS (LNA active mode)

Conditions:  $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

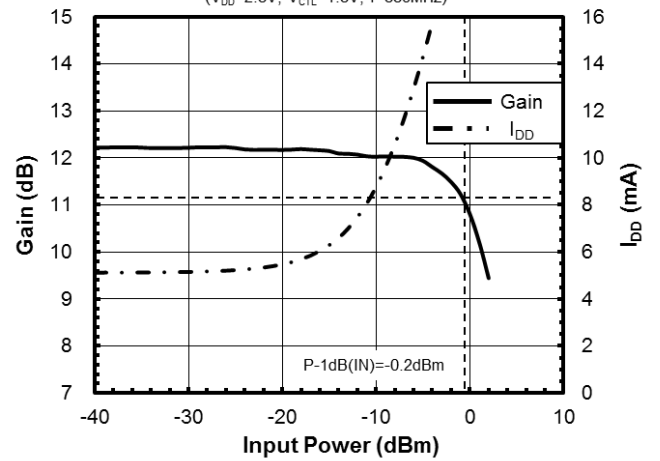
**Gain, NF vs. frequency**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ )



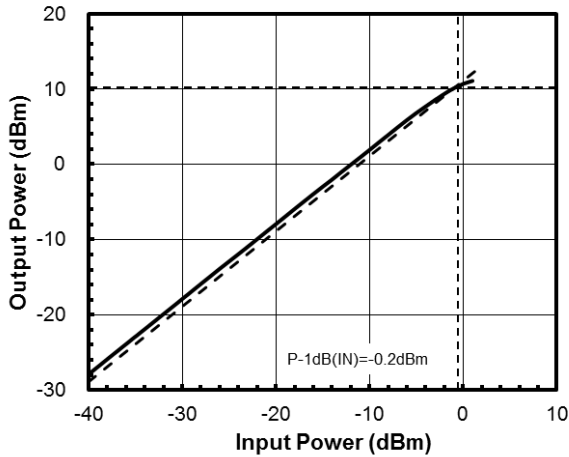
**Gain,  $I_{DD}$  vs. Pin**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f=880MHz$ )



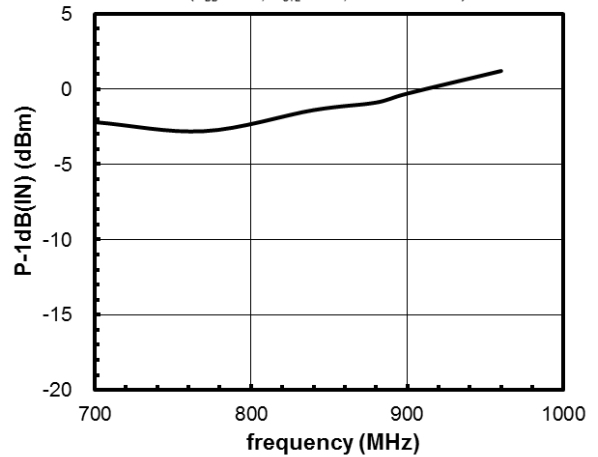
**Pout vs. Pin**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f=880MHz$ )



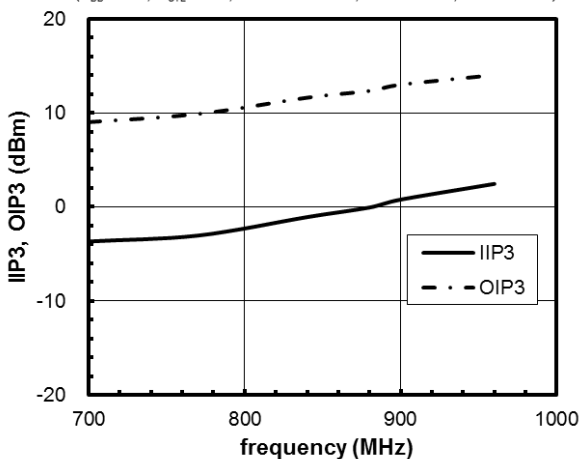
**P-1dB(IN) vs. frequency**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f=700\sim 960MHz$ )



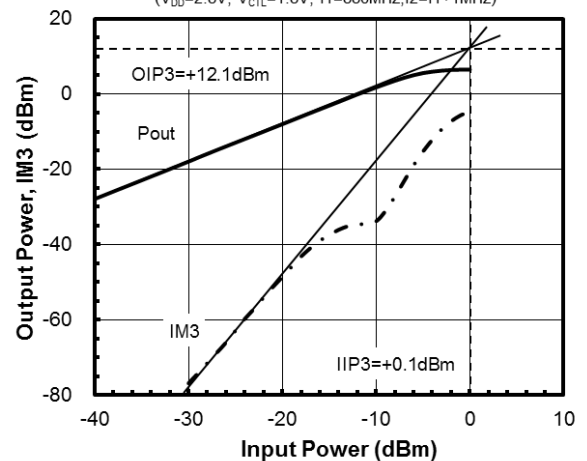
**IIP3, OIP3 vs. frequency**

( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_1=700\sim 960MHz$ ,  $f_2=f_1+1MHz$ ,  $Pin=-24dBm$ )



**Pout, IM3 vs. Pin**

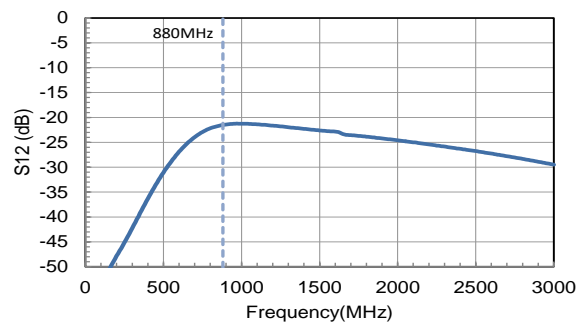
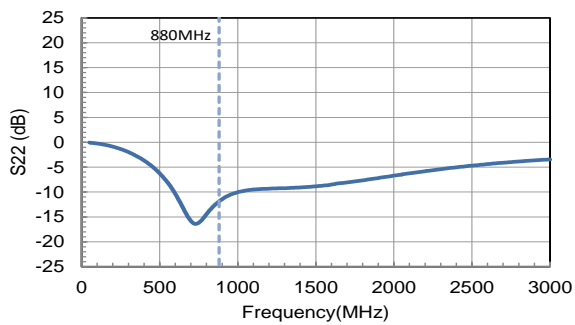
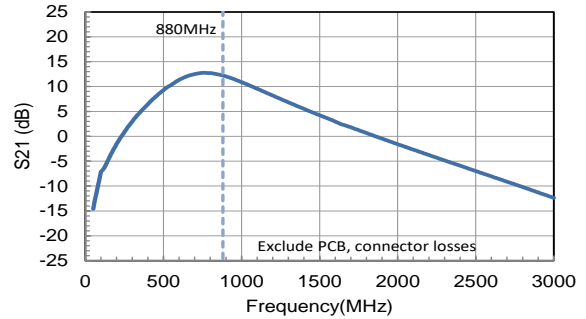
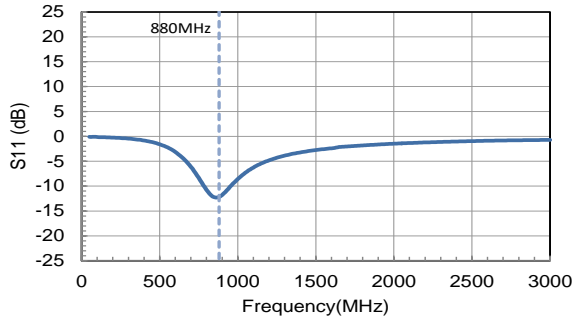
( $V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_1=880MHz$ ,  $f_2=f_1+1MHz$ )



## ■ ELECTRICAL CHARACTERISTICS (LNA active mode)

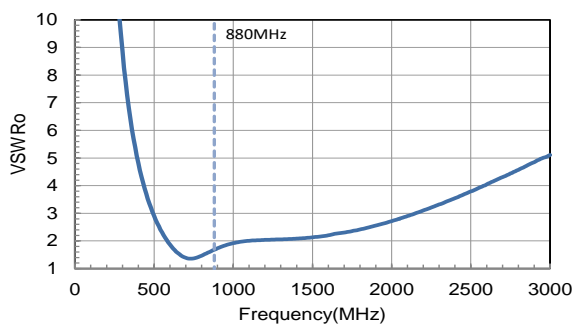
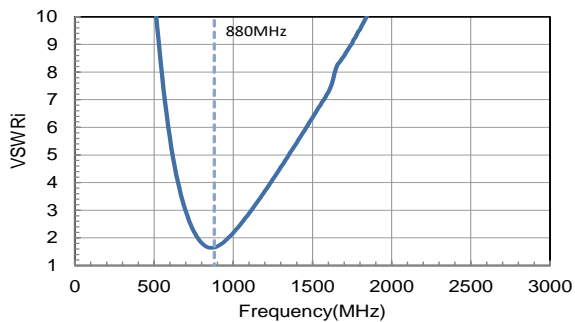
Conditions:

$V_{DD}=2.8V$ ,  $V_{CTL}=1.8V$ ,  $f_{RF}=50$  to  $3000MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

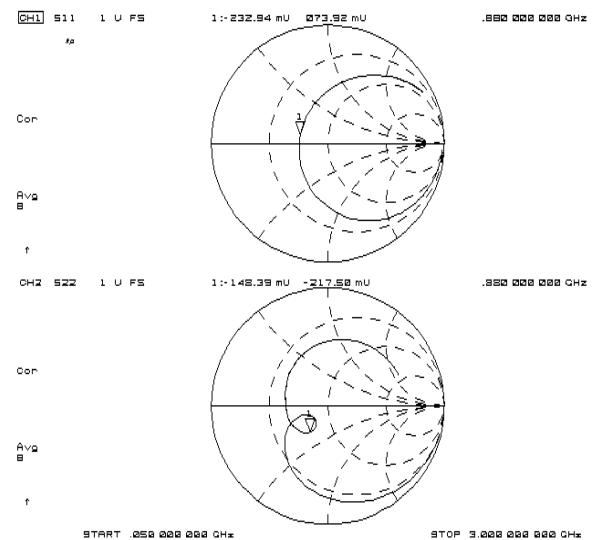


S11, S22

S21, S12



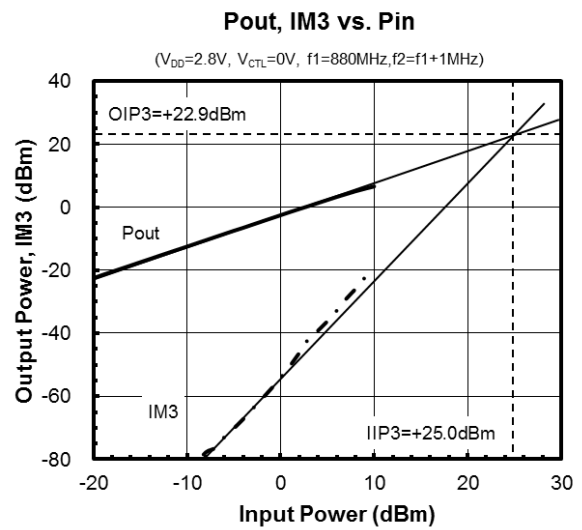
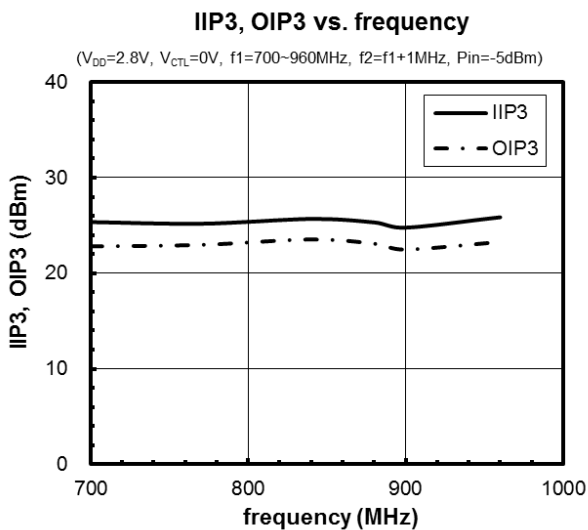
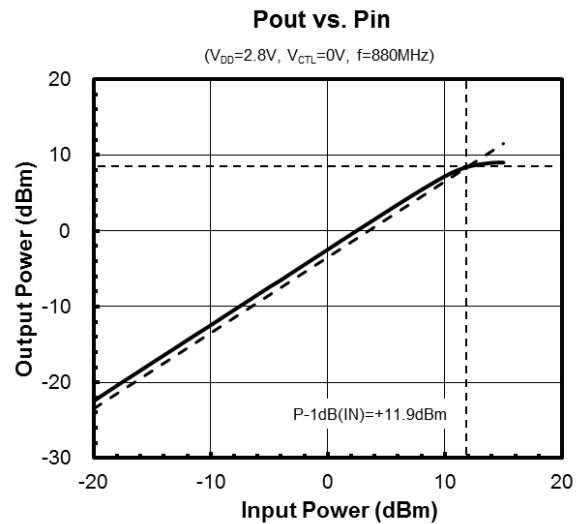
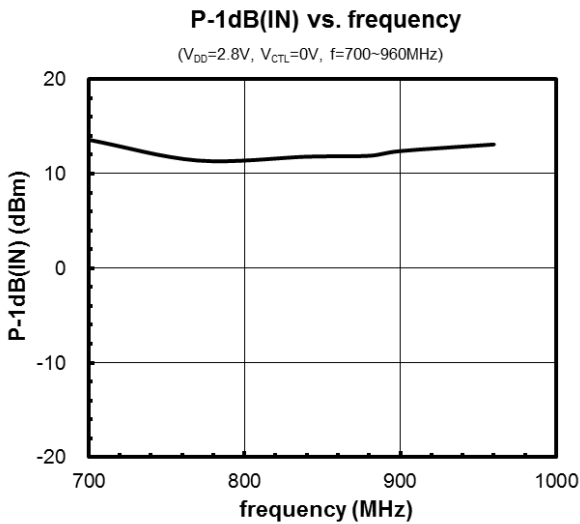
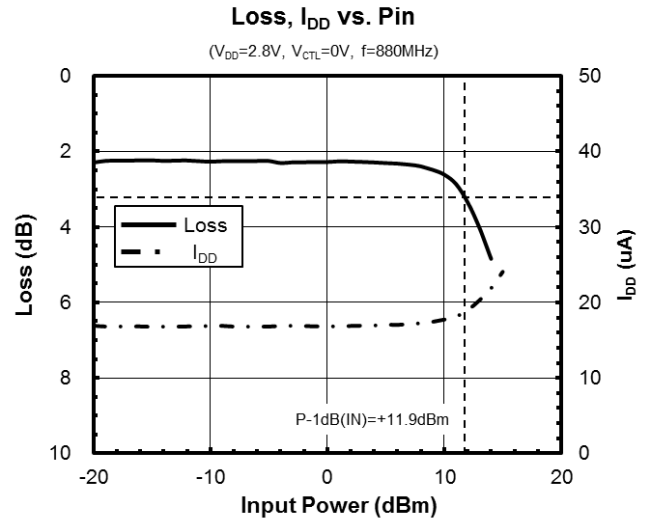
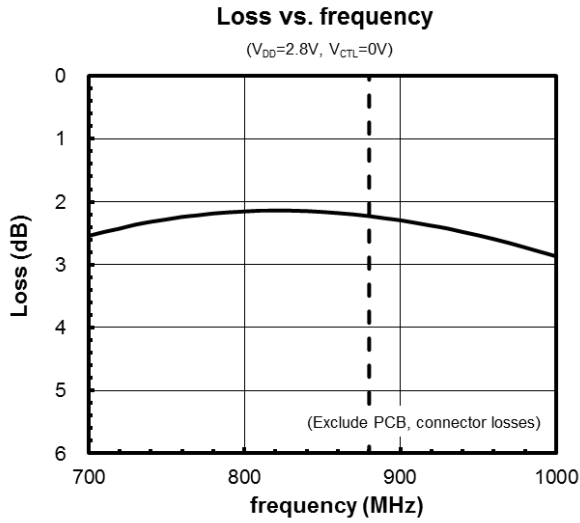
VSWRi, VSWRo



Zin, Zout

## ■ ELECTRICAL CHARACTERISTICS (Bypass mode)

Conditions:  $V_{DD}=2.8V$ ,  $V_{CTL}=0V$ ,  $f_{RF}=880MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

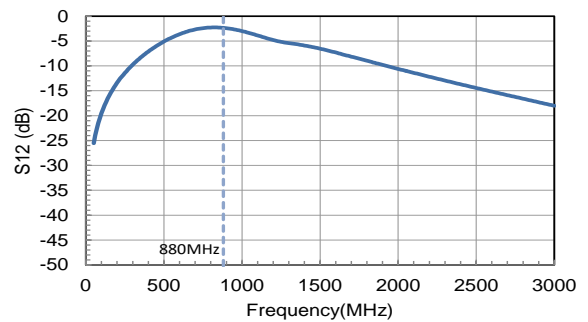
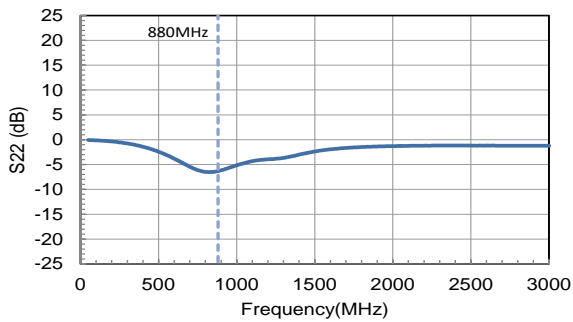
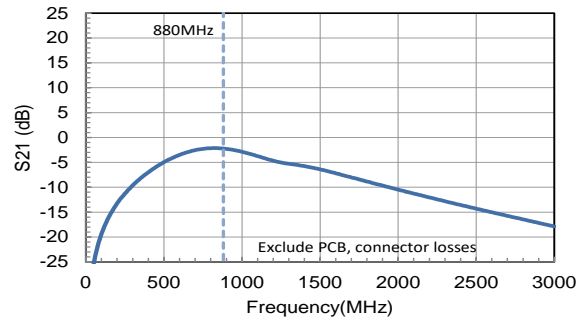
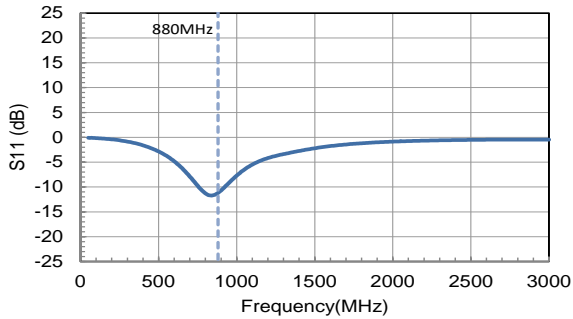




## ■ ELECTRICAL CHARACTERISTICS (Bypass mode)

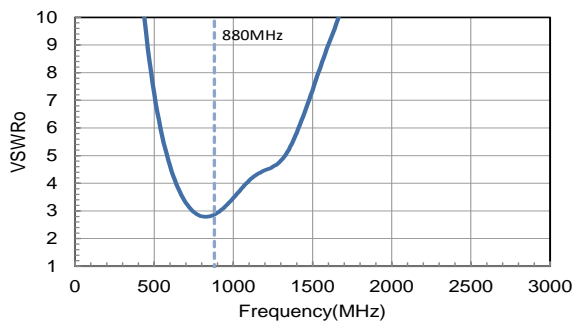
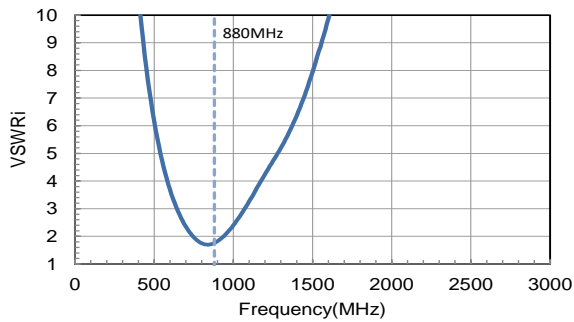
Conditions:

$V_{DD}=2.8V$ ,  $V_{CTL}=0V$ ,  $f_{RF}=50$  to  $3000MHz$ ,  $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

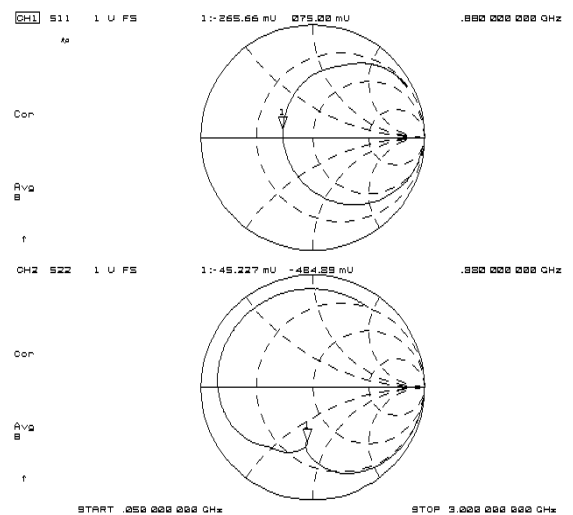


S11, S22

S21, S12



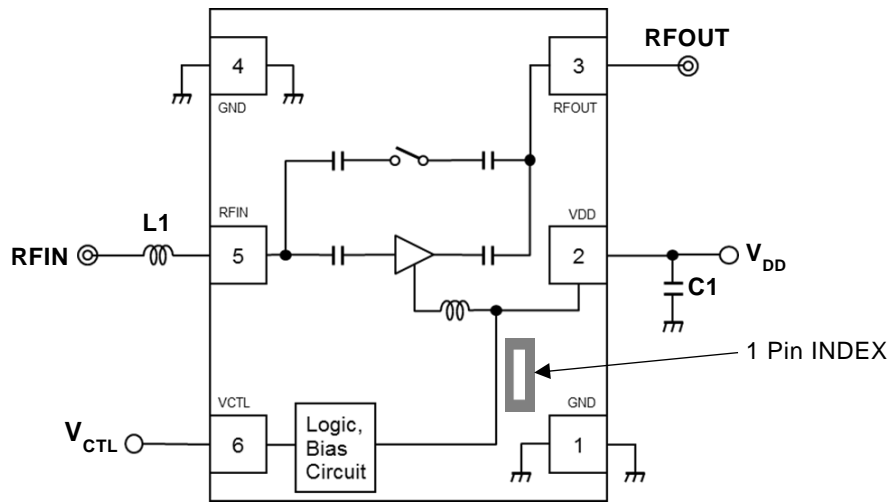
VSWRi, VSWRo



Zin, Zout

## APPLICATION CIRCUIT

(Top View)



## PARTS LIST

Parts ID	Value	Manufacture
L1	16nH	LQW15AN_00 Series (MURATA)
C1	1000pF	GRM03 Series (MURATA)

## ■ MEASUREMENT BLOCK DIAGRAM

### Measuring instruments

NF Analyzer : Keysight N8975A  
 Noise Source : Keysight 346A

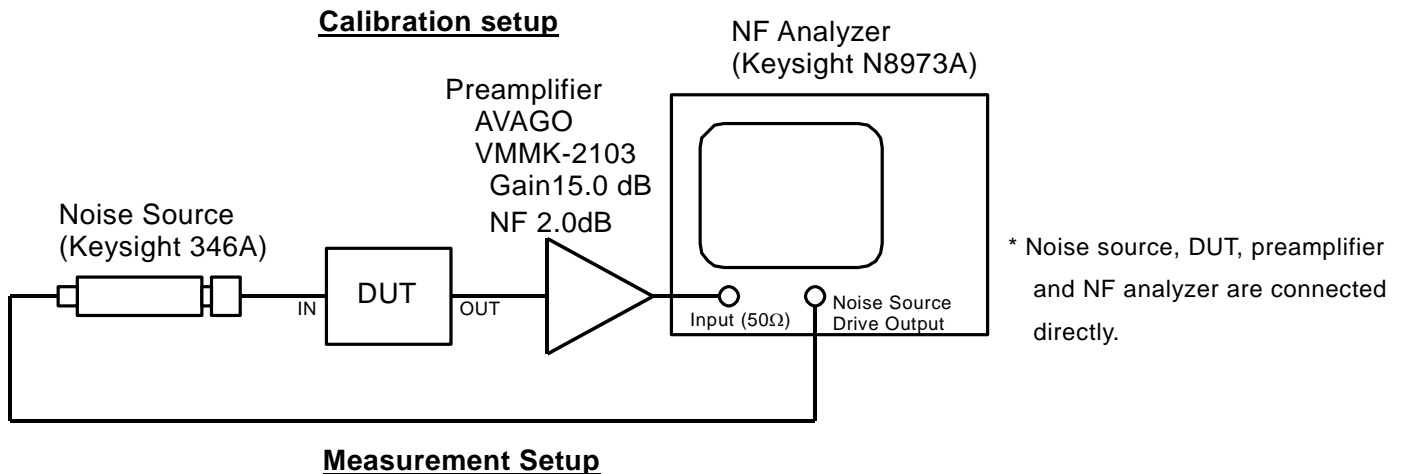
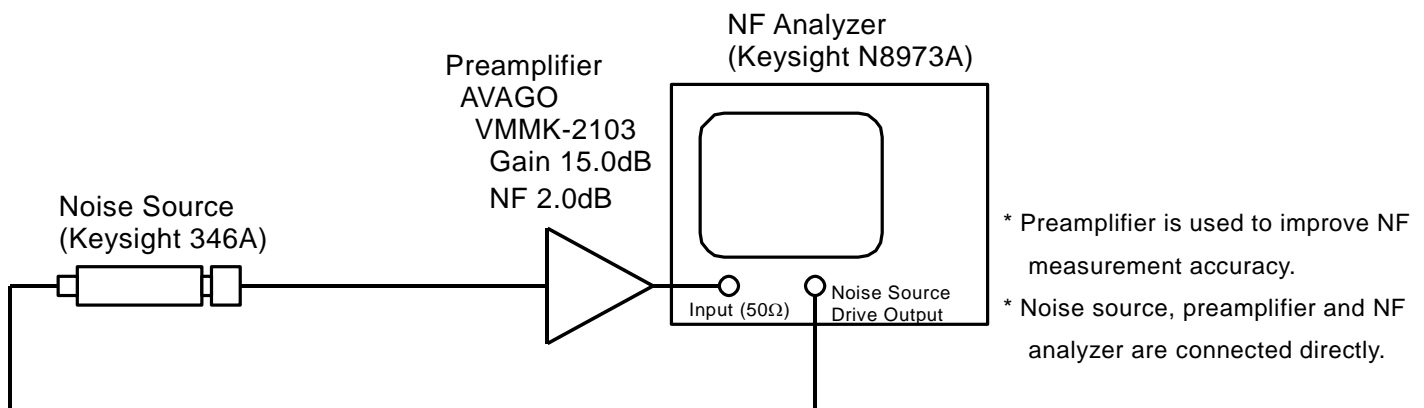
### Setting the NF analyzer

Measurement mode form

Device under test : Amplifier  
 System downconverter : off

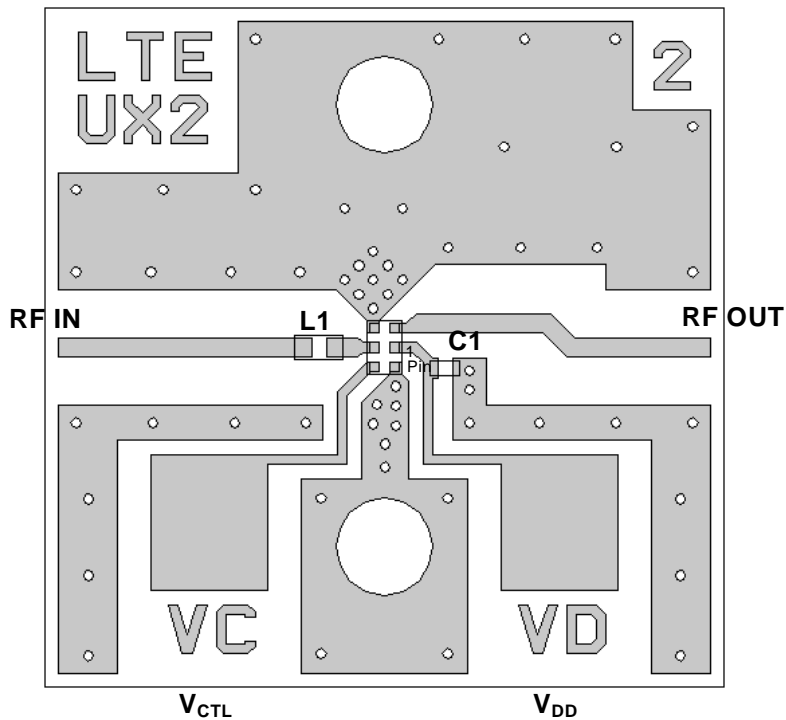
Mode setup form

Sideband : LSB  
 Averages : 8  
 Average mode : Point  
 Bandwidth : 4MHz  
 Loss comp : off  
 Tcold : setting the temperature of noise source (305.15K)



## ■ EVALUATION BOARD

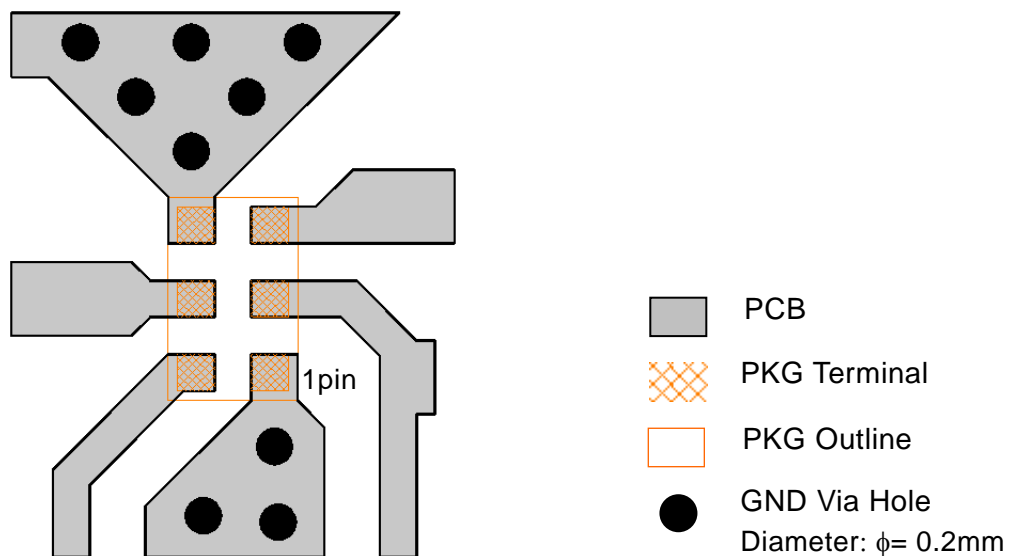
(Top View)



### PCB Information

Substrate:	FR-4
Thickness:	0.2mm
Microstrip line width:	0.4mm ( $Z_0=50\Omega$ )
Size:	14.0mm x 14.0mm

## ■ PCB LAYOUT GUIDELINE



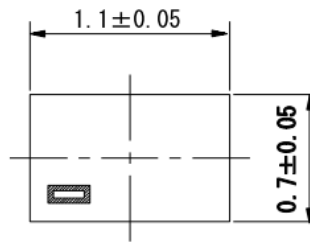
### PRECAUTIONS

- All external parts should be placed as close as possible to the IC.
- For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.

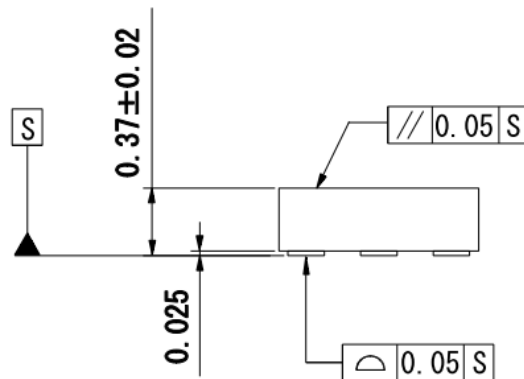


## PACKAGE OUTLINE (EPFFP6-X2)

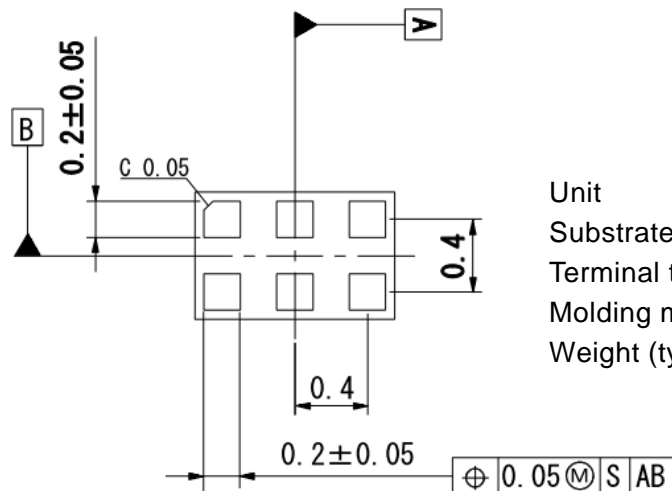
TOP VIEW



SIDE VIEW



BOTTOM VIEW



Unit	: mm
Substrate	: FR4
Terminal treat	: Ni/Pd/Au
Molding material	: Epoxy resin
Weight (typ.)	: 0.7mg

### 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.

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

### [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.