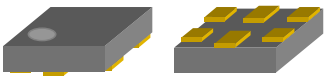
GNSS LOW NOISE AMPLIFIER GaAs MMIC

■ GENERAL DESCRIPTION

The NJG1150UA2 is a LNA GaAs MMIC designed for GNSS applications, like GPS, Galileo, GLONASS and COMPASS. The NJG1150UA2 is featured low noise figure and low distortion, and operates from 1.5V to 3.3V single voltage. The NJG1150UA2 has stand-by mode to save the supply current, has the on-chip ESD protection devices.

The NJG1150UA2 achieves very small mounting area by only two external components and very small package that is lead-free and halogen-free 6-pin EPFFP6-A2 package.

■ PACKAGE OUTLINE



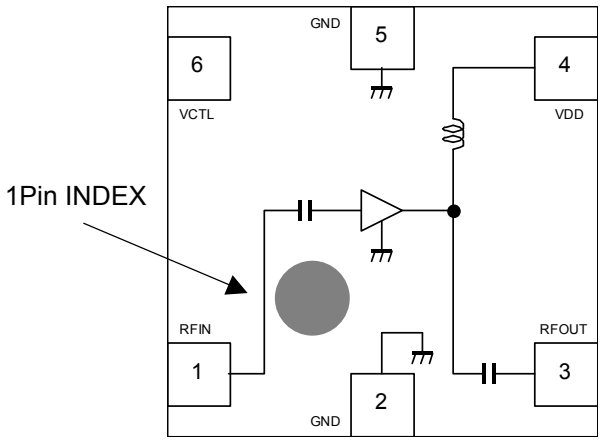
NJG1150UA2

■ FEATURES

● Low supply voltage	1.8/ 2.8V typ.	
● Low current consumption	4.2 / 4.9mA typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V
	0.1μA typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=0V (Stand-by mode)
● High gain	16.0dB typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1575MHz
● Low noise figure	0.6dB typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1575MHz
● High input IP3	-1 / +1dBm typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1575+1575.1MHz
● High out of band input IP3	+5 / +6dBm typ.	@V_{DD}=1.8/ 2.8V, V_{CTL}=1.8V, f=1712.7+1850MHz
● Small package	EPFFP6-A2	(Package size: 1.0mmx1.0mmx0.37mm typ.)
● RoHS compliant and Halogen Free		
● MSL 1		

■ PIN CONFIGURATION

(Top View)



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

■ TRUTH TABLE

"H"=V_{CTL}(H), "L"=V_{CTL}(L)

VCTL	LNA Mode
H	Active mode
L	Stand-by mode

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

■ ABSOLUTE MAXIMUM RATINGS

T_a=+25°C, Z_s=Z_l=50Ω

PARAMETERS	SYMBOL	CONDITIONS	RATINGS	UNITS
Supply voltage	V_{DD}		5.0	V
Control voltage	V_{CTL}		5.0	V
Input power	P_{IN}	V_{DD}=2.8V	+15	dBm
Power dissipation	P_D	4-layer FR4 PCB with through-hole (101.5mmx114.5mm), T_j=150°C	590	mW
Operating temperature	T_{opr}		-40~+85	°C
Storage temperature	T_{stg}		-55~+150	°C

■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: T_a=+25°C)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{DD}		1.5	-	3.3	V
Control Voltage (High)	$V_{CTL(H)}$		1.5	1.8	3.3	V
Control Voltage (Low)	$V_{CTL(L)}$		0	0	0.3	V
Supply Current1	I_{DD1}	Active mode, V_{DD}=2.8V, V_{CTL}=1.8V	-	4.9	8.0	mA
Supply Current2	I_{DD2}	Active mode, V_{DD}=1.8V, V_{CTL}=1.8V	-	4.2	7.0	mA
Supply Current3	I_{DD3}	Stand-by mode, V_{DD}=2.8V, V_{CTL}=0V	-	0.1	3.0	μA
Supply Current4	I_{DD4}	Stand-by mode, V_{DD}=1.8V, V_{CTL}=0V	-	0.1	3.0	μA
Control Current	I_{CTL}	V_{CTL}=1.8V	-	5.0	12.0	μA

■ ELECTRICAL CHARACTERISTICS 2 (RF)

General conditions: V_{DD}=2.8V, $V_{CTL=}$1.8V, f_{RF}=1555~1610MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit1)

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small Signal Gain1	Gain1	Exclude PCB and connector Losses (0.17dB)	14.5	16.0	17.0	dB
Noise Figure1	NF1	Exclude PCB and connector Losses (0.08dB)	-	0.6	0.9	dB
Input Power at 1dB Gain Compression Point1	$P\text{-}_{1dB}$ (IN)1		-12.0	-7.0	-	dBm
Input 3rd Order Intercept Point1	IIP3_1	f1=$f_{RF,}$ f2=f1+/- 1MHz, Pin=-30dBm	-1.0	+1.0	-	dBm
Out of Band Input 3rd Order Intercept Point1	IIP3_OB1	f_1 =1712.7MHz Pin =-20dBm, f_2 =1850MHz Pin =-65dBm	+2.0	+6.0	-	dBm
700MHz Harmonic1	2fo1	Input jammer tone: 787.76MHz at –25dBm Measure the harmonic tone at 1575.52MHz	-	-45.0	-	dBm
RF IN VSWR1	VSWRi1		-	1.9	2.4	-
RF OUT VSWR1	VSWRo1		-	1.8	2.3	-

■ ELECTRICAL CHARACTERISTICS 3 (RF)

General conditions: V_{DD}=1.8V, $V_{CTL=}$1.8V, f_{RF}=1555~1610MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit2)

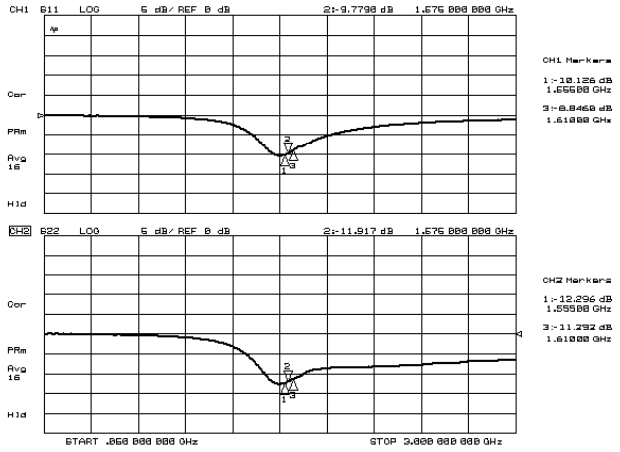
PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small Signal Gain2	Gain2	Exclude PCB and connector Losses (0.17dB)	14.0	16.0	17.0	dB
Noise Figure2	NF2	Exclude PCB and connector Losses (0.08dB)	-	0.6	0.95	dB
Input Power at 1dB Gain Compression Point2	$P\text{-}_{1dB}$ (IN)2		-14.0	-9.0	-	dBm
Input 3rd Order Intercept Point2	IIP3_2	f1=$f_{RF,}$ f2=f1+/- 1MHz, Pin=-30dBm	-6.0	-1.0	-	dBm
Out of Band Input 3rd Order Intercept Point2	IIP3_OB2	f_1 =1712.7MHz Pin =-20dBm, f_2 =1850MHz Pin =-65dBm	-1.0	+5.0	-	dBm
700MHz Harmonic2	2fo2	Input jammer tone: 787.76MHz at –25dBm Measure the harmonic tone at 1575.52MHz	-	-45.0	-	dBm
RF IN VSWR2	VSWRi2		-	1.9	2.6	-
RF OUT VSWR2	VSWRo2		-	1.8	2.5	-

■ TERMINAL INFORMATION

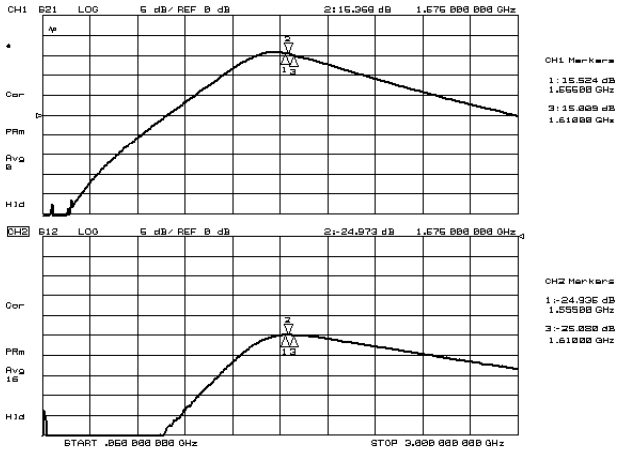
No.	SYMBOL	DESCRIPTION
1	RFIN	RF input terminal. This terminal requires only a matching inductor L1, and does not require DC blocking capacitor.
2	GND	Ground terminal. This terminal should be connected to the ground plane as close as possible for excellent RF performance.
3	RFOUT	RF output terminal.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

■ ELECTRICAL CHARACTERISTICS

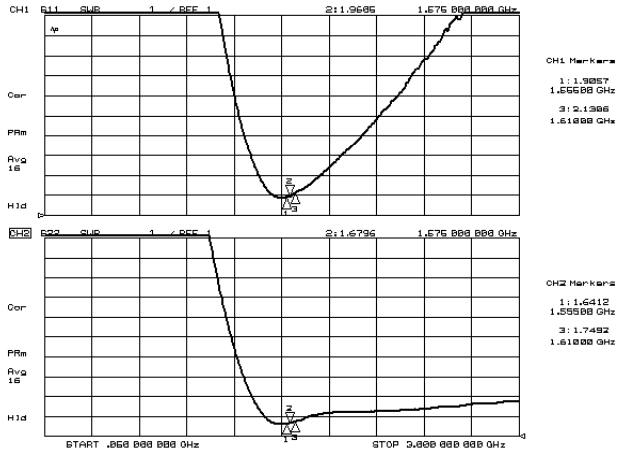
Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit1



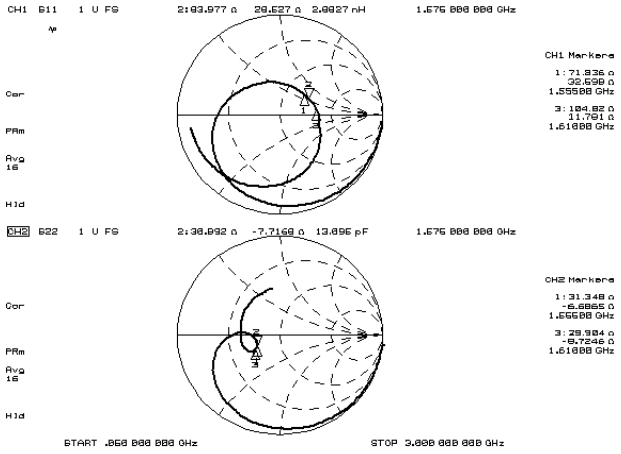
S11, S22



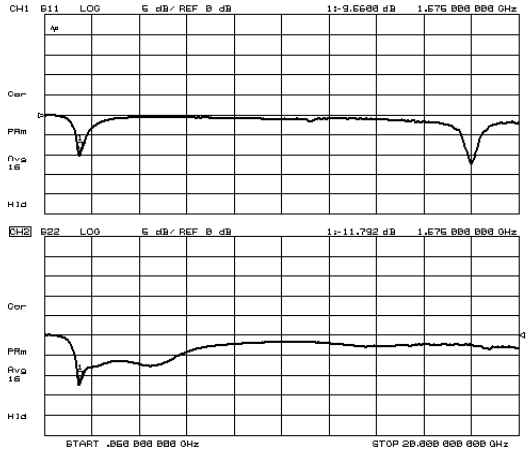
S21, S12



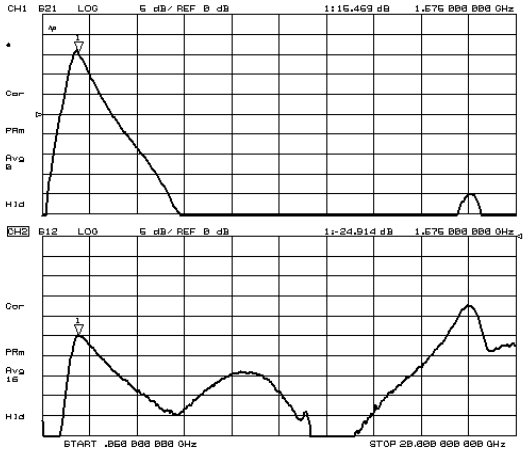
VSWRi, VSWRo



Zin, Zout



S11, S22 (50M~20GHz)

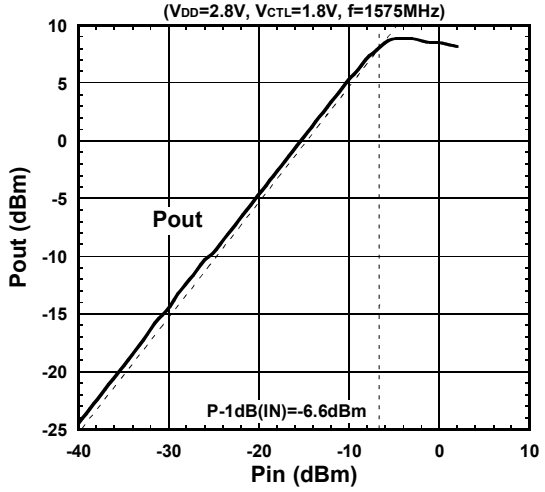


S21, S12 (50M~20GHz)

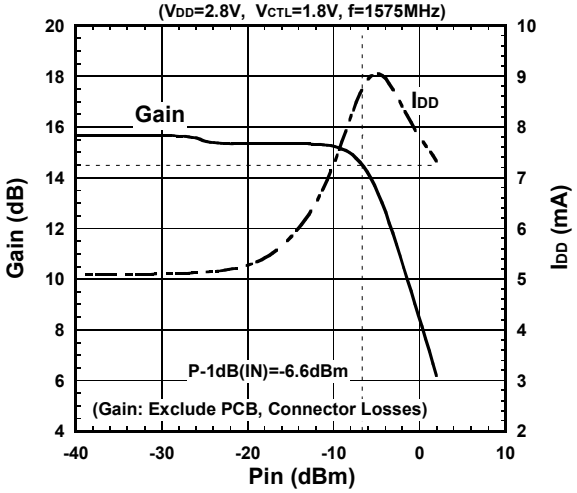
■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit1

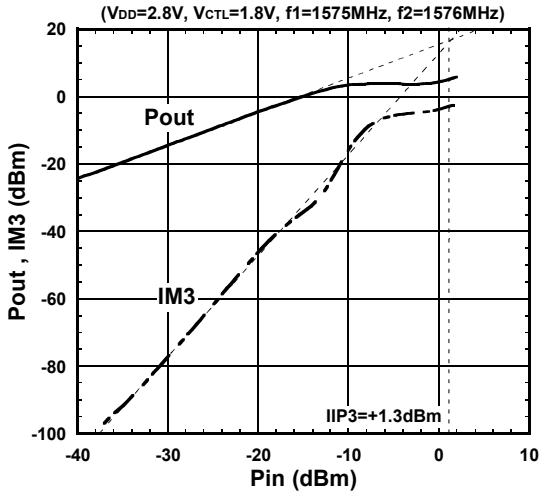
Pout vs. Pin



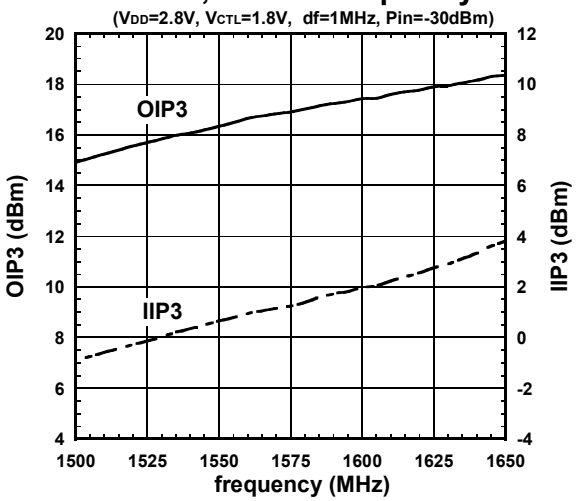
Gain, I_{DD} vs. Pin



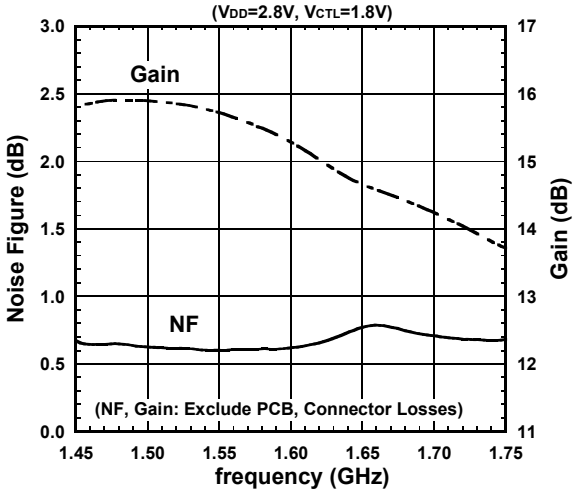
Pout, IM3 vs. Pin



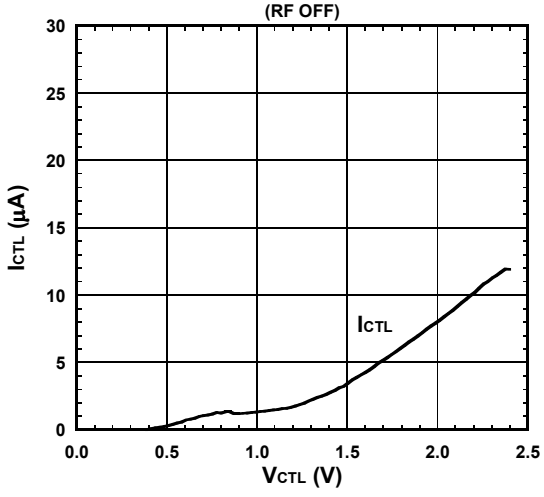
OIP3, IIP3 vs. frequency



NF, Gain vs. frequency



I_{CTL} vs. V_{CTL}

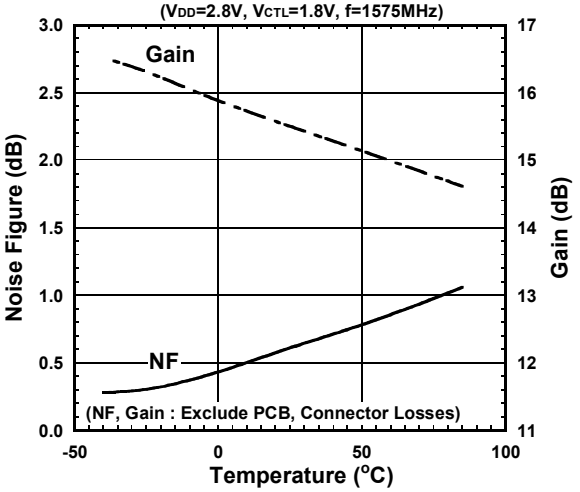


■ ELECTRICAL CHARACTERISTICS

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, Z_s=Z_l=50 ohm, with application circuit1

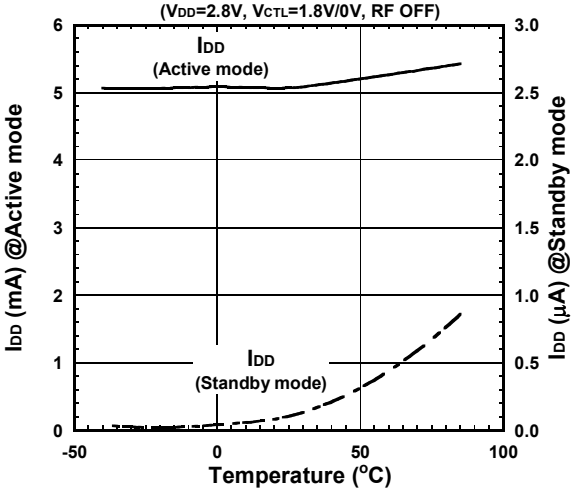
NF, Gain vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f=1575MHz)



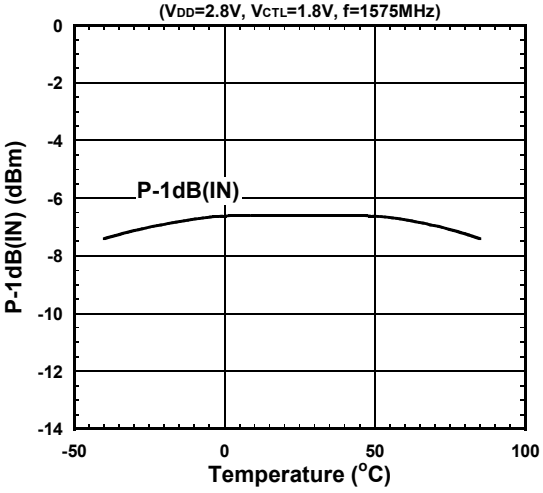
I_{DD} vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V/0V, RF OFF)



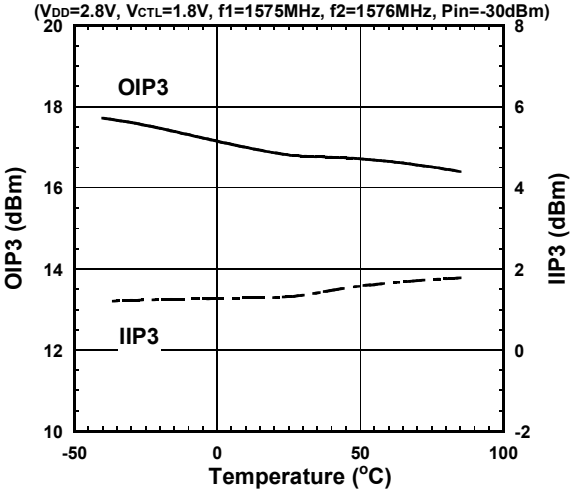
P-1dB(IN) vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f=1575MHz)



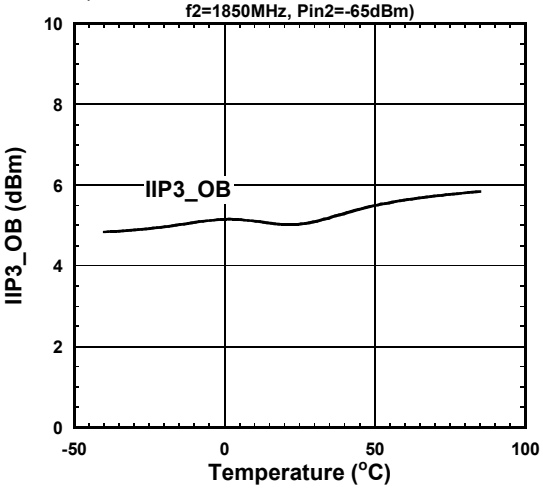
OIP3, IIP3 vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)



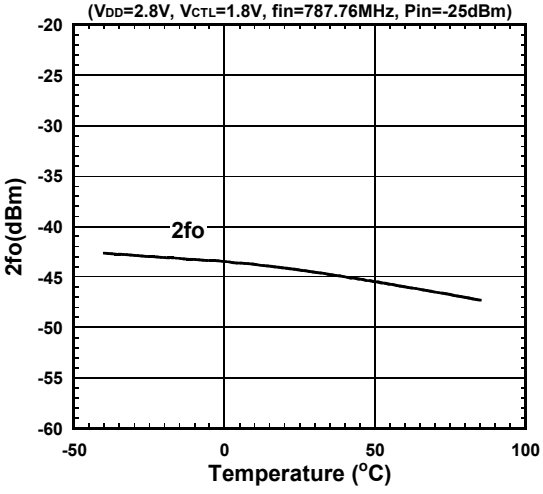
IIP3_OB vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, f1=1712.7MHz, Pin1=-20dBm, f2=1850MHz, Pin2=-65dBm)



2fo vs. Temperature

(V_{DD}=2.8V, V_{CTL}=1.8V, fin=787.76MHz, Pin=-25dBm)

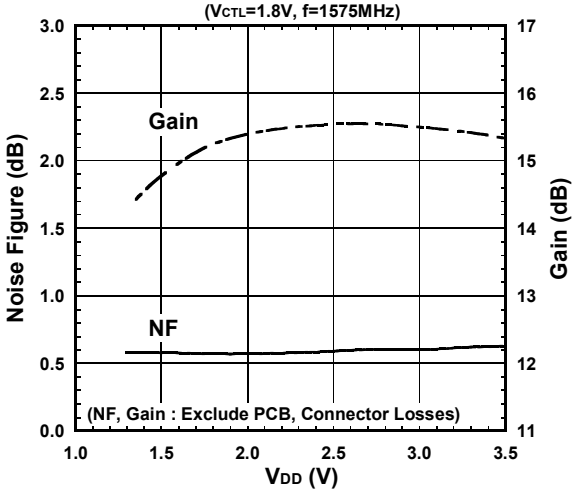


■ ELECTRICAL CHARACTERISTICS

Conditions: V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit1

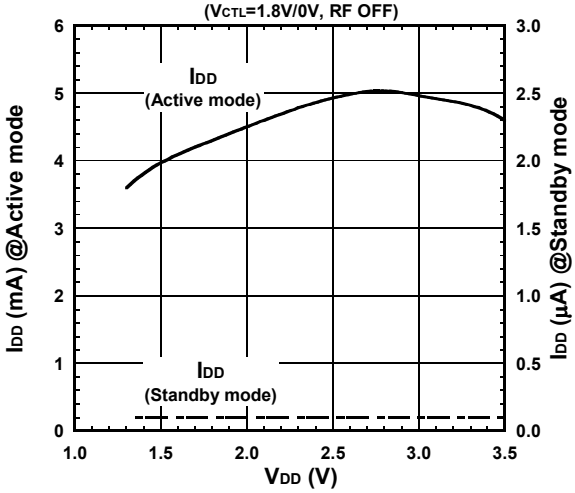
NF, Gain vs. V_{DD}

(V_{CTL}=1.8V, f=1575MHz)



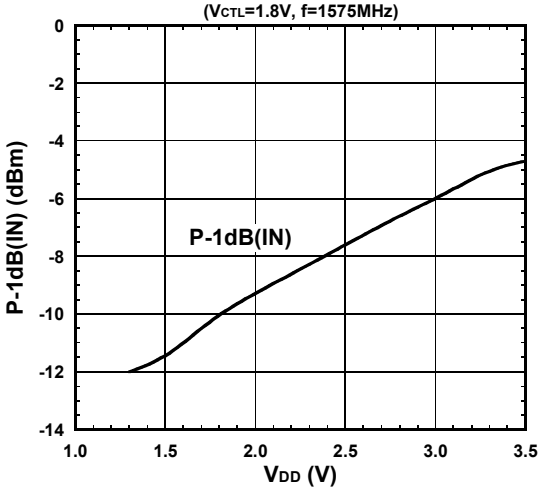
I_{DD} vs. V_{DD}

(V_{CTL}=1.8V/0V, RF OFF)



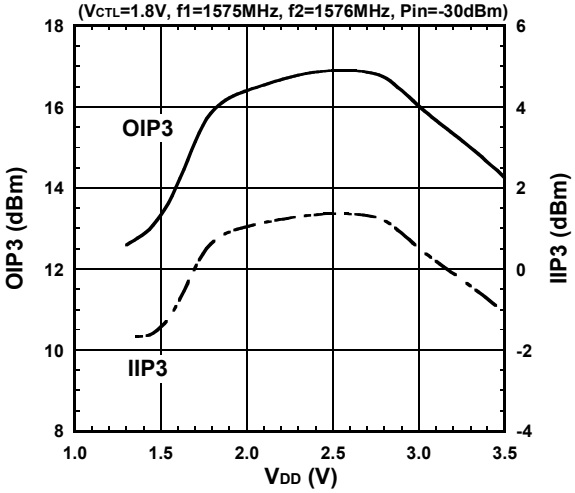
P-1dB(IN) vs. V_{DD}

(V_{CTL}=1.8V, f=1575MHz)



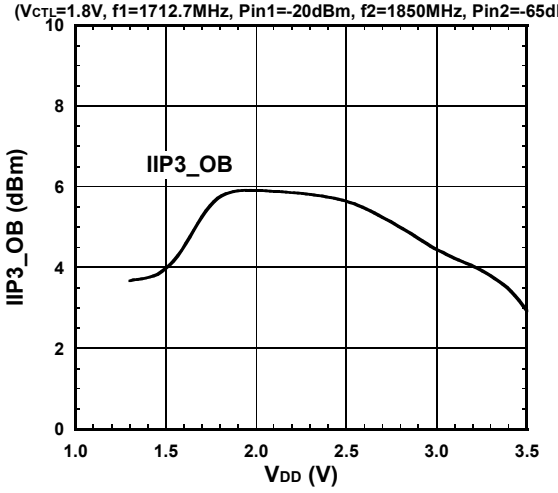
OIP3, IIP3 vs. V_{DD}

(V_{CTL}=1.8V, f1=1575MHz, f2=1576MHz, Pin=-30dBm)



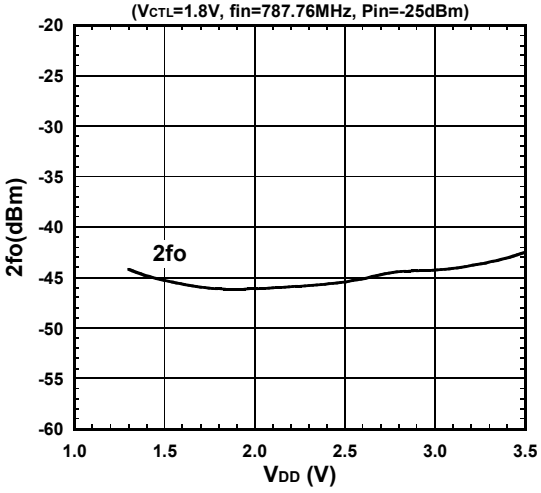
IIP3_OB vs. V_{DD}

(V_{CTL}=1.8V, f1=1712.7MHz, Pin1=-20dBm, f2=1850MHz, Pin2=-65dBm)



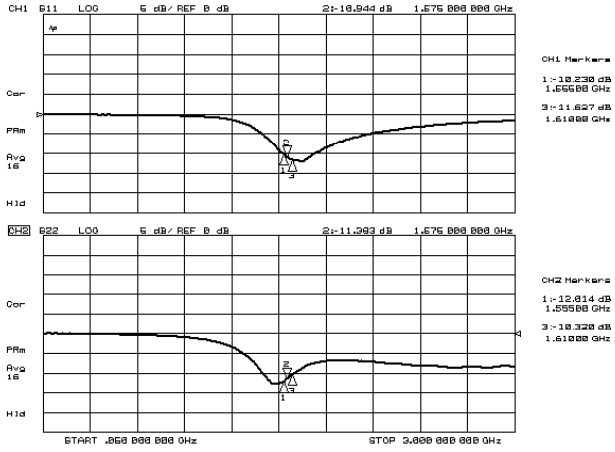
2fo vs. V_{DD}

(V_{CTL}=1.8V, fin=787.76MHz, Pin=-25dBm)

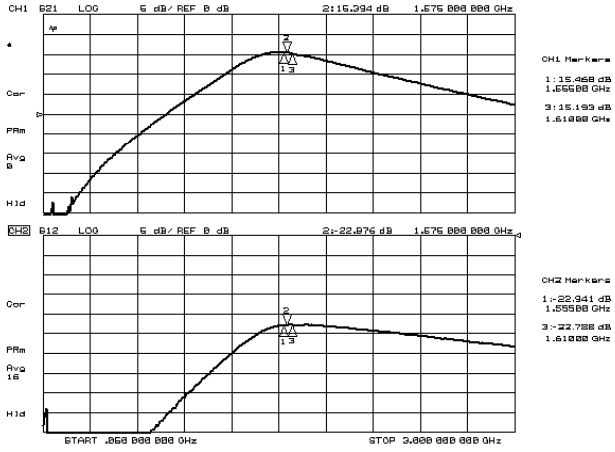


■ ELECTRICAL CHARACTERISTICS

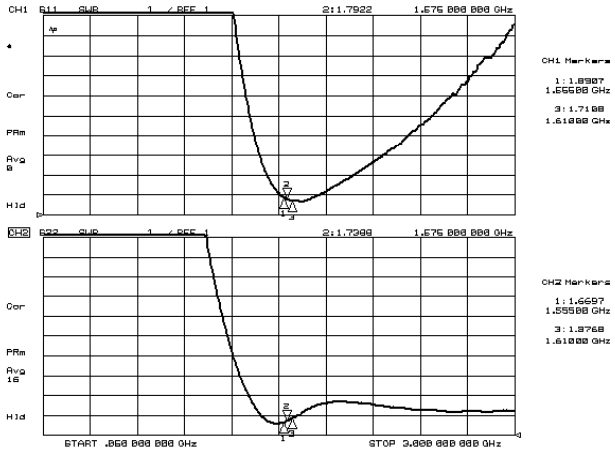
Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit2



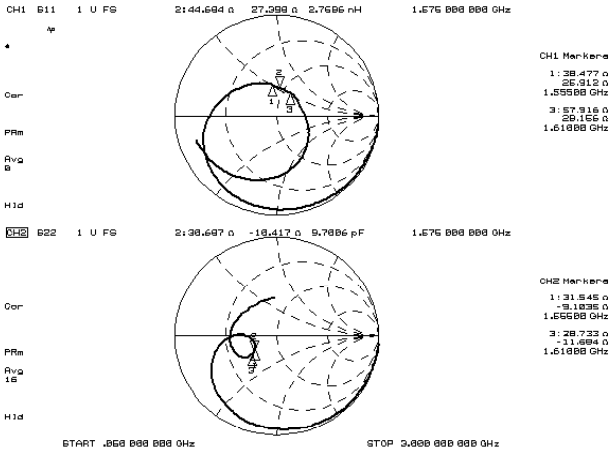
S11, S22



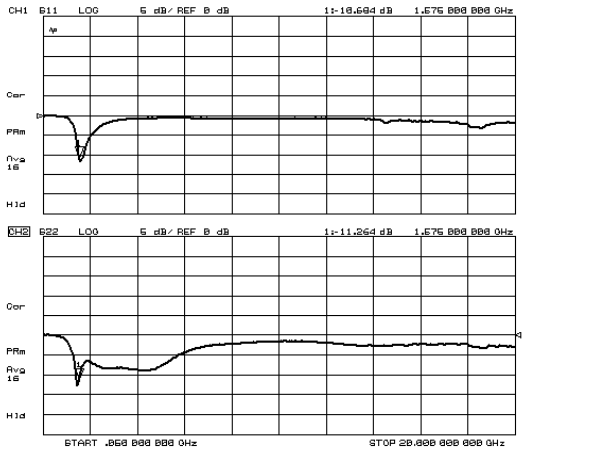
S21, S12



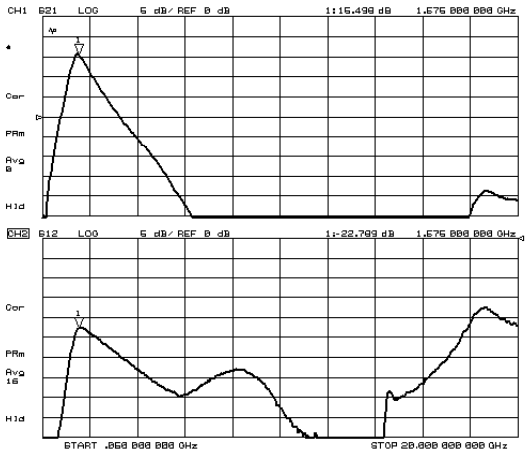
VSWRi, VSWRo



Zin, Zout



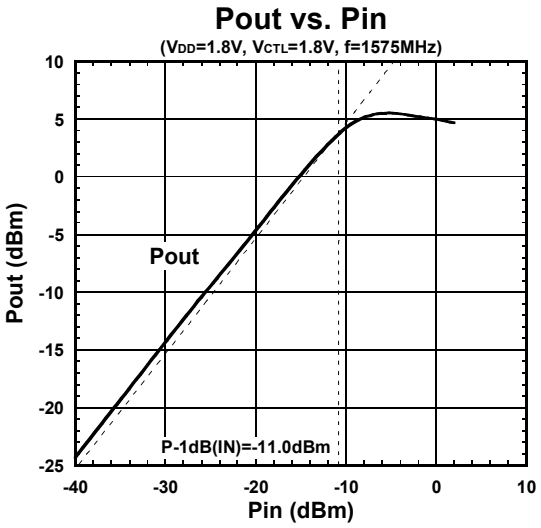
S11, S22 (50M~20GHz)

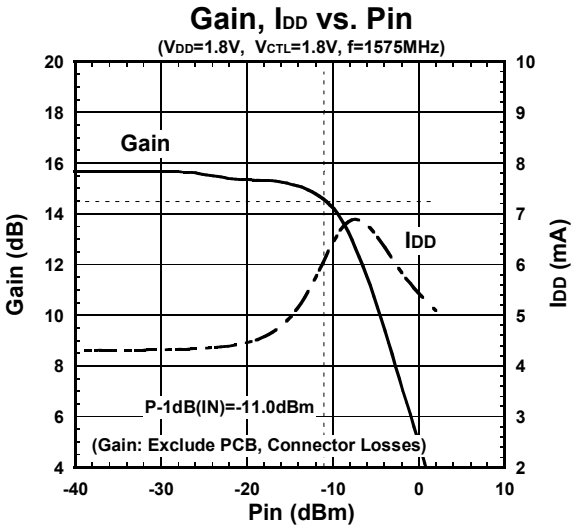


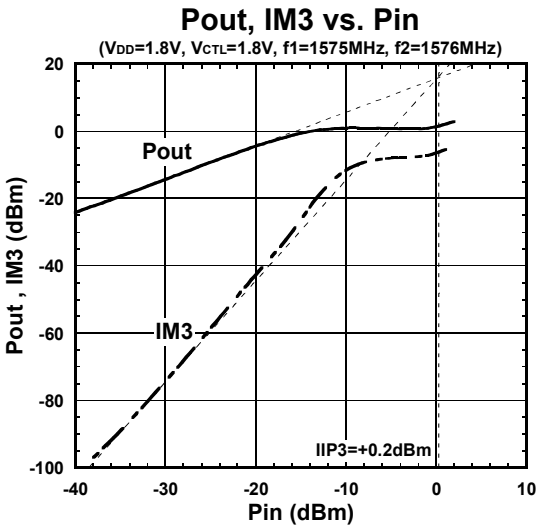
S21, S12 (50M~20GHz)

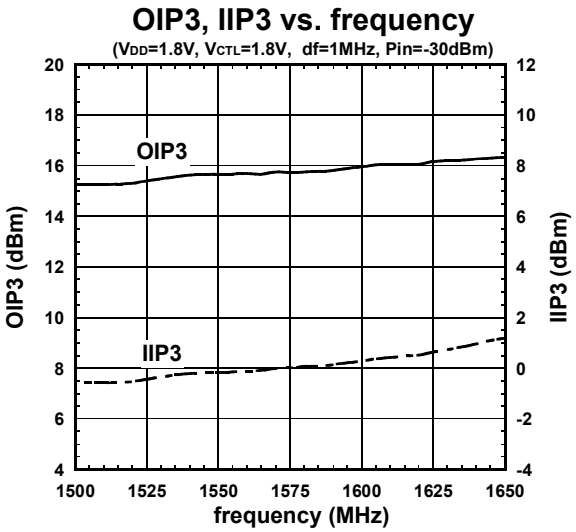
■ ELECTRICAL CHARACTERISTICS

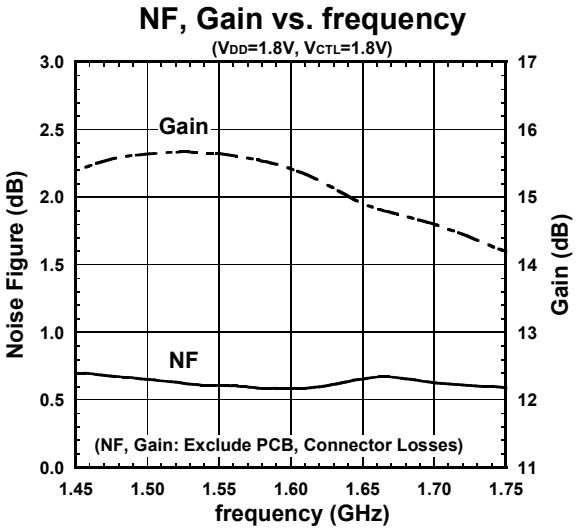
Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, Ta=25°C, Z_s=Z_l=50 ohm, with application circuit2





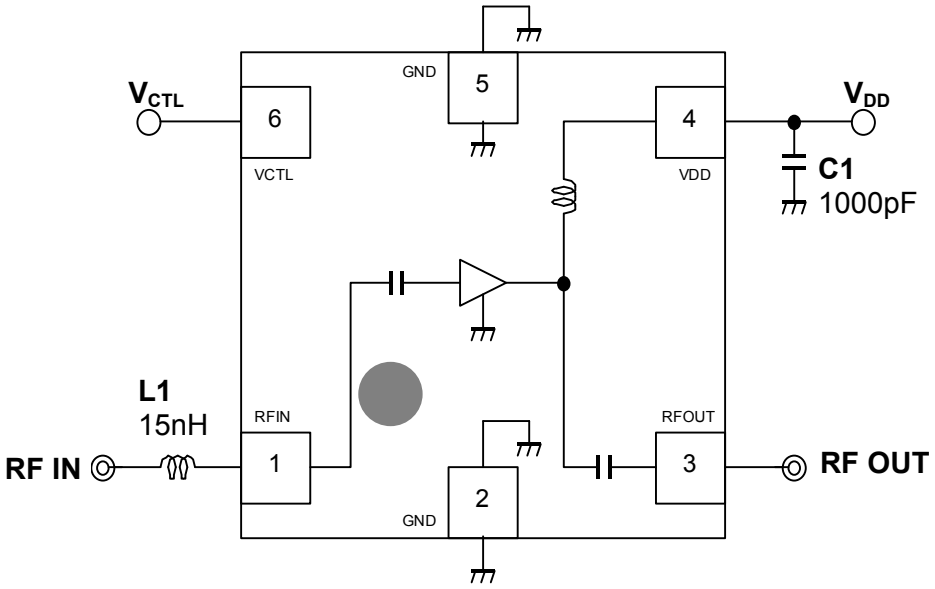






■ **APPLICATION CIRCUIT1 (V_{DD}=2.8V)**

(Top View)

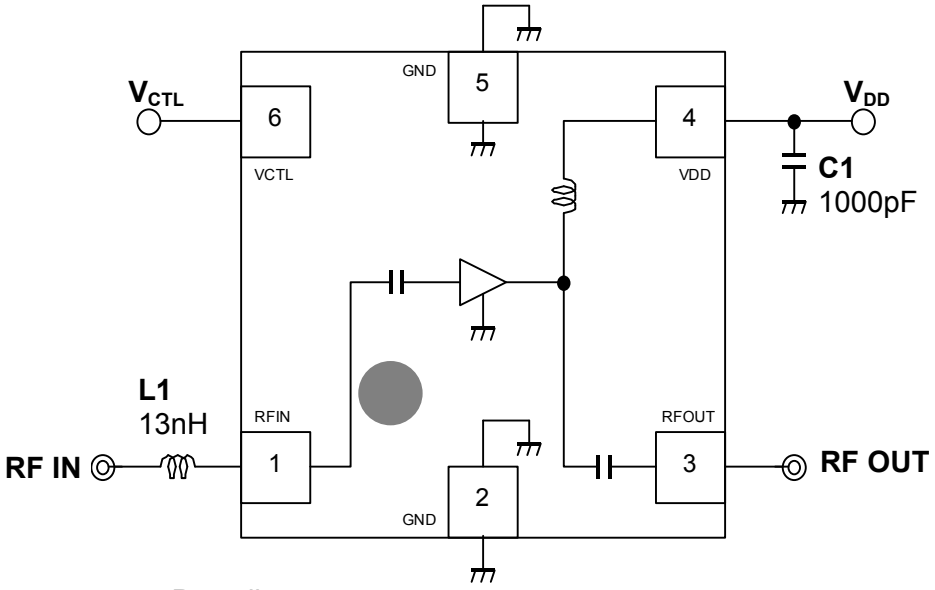


Parts list

Parts ID	Manufacture
L1	LQW15A Series (MURATA)
C1	GRM03 Series (MURATA)

■ **APPLICATION CIRCUIT2 (V_{DD}=1.8V)**

(Top View)

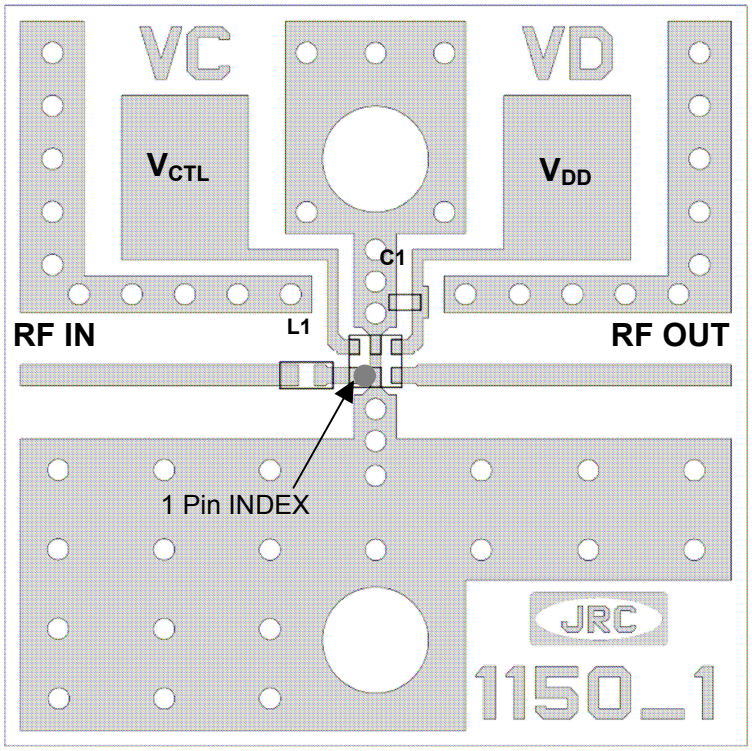


Parts list

Parts ID	Manufacture
L1	LQW15A Series (MURATA)
C1	GRM03 Series (MURATA)

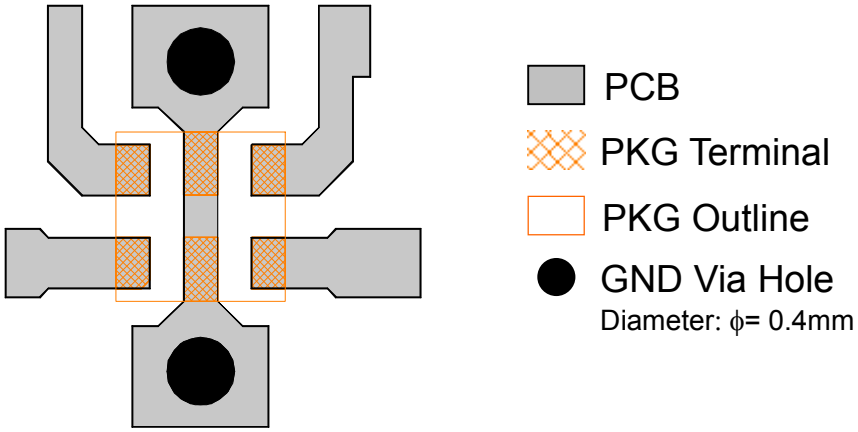
■ EVALUATION BOARD

(Top View)



PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.4mm (Z_0=50Ω)
PCB SIZE
=14.0mm x 14.0mm

<PCB LAYOUT GUIDELINE>



PRECAUTIONS

- Please layout ground pattern under this IC in order not to couple with terminal RFIN and RFOUT.
- 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.

■ RECOMMENDED FOOTPRINT PATTERN (EPFFP6-A2 PACKAGE Reference)

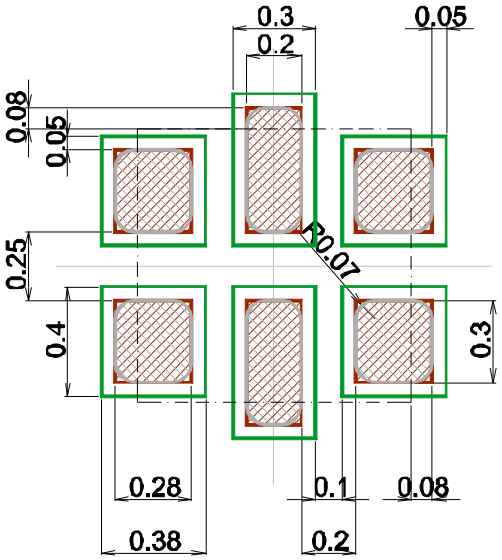
: Land

: Mask (Open area) *Metal mask thickness: 100um

: Resist (Open area)

Package: 1.0 x 1.0mm

Pin pitch: 0.4mm



APPLICATION NOTE FOR SMALLER MOUNTING AREA (using MLG0603P Series inductor)

This application note shows an example in order to achieve smaller mounting area using smaller size external inductor L1. MLG0603P (TDK-EPC) Series inductor is used for this application. The example of electrical characteristics are shown as follows:

■ ELECTRICAL CHARACTERISTICS 4 (DC)

(General conditions: T_a=+25°C)

PARAMETER	SYMBOL	CONDITIONS	MEASURED DATA	UNITS
Supply Voltage	V_{DD}		2.8 / 1.8	V
Control Voltage (High)	$V_{CTL(H)}$		1.8	V
Control Voltage (Low)	$V_{CTL(L)}$		0	V
Supply Current1	I_{DD1}	Active mode, V_{DD}=2.8V, V_{CTL}=1.8V	5.04	mA
Supply Current2	I_{DD2}	Active mode, V_{DD}=1.8V, V_{CTL}=1.8V	4.33	mA
Supply Current3	I_{DD3}	Stand-by mode, V_{DD}=2.8V, V_{CTL}=0V	0.1	μA
Supply Current4	I_{DD4}	Stand-by mode, V_{DD}=1.8V, V_{CTL}=0V	0.1	μA
Control Current	I_{CTL}	V_{CTL}=1.8V	6.0	μA

■ ELECTRICAL CHARACTERISTICS 5 (RF)

General conditions: V_{DD}=2.8V, $V_{CTL=}$1.8V, f_{RF}=1555~1610MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit3)

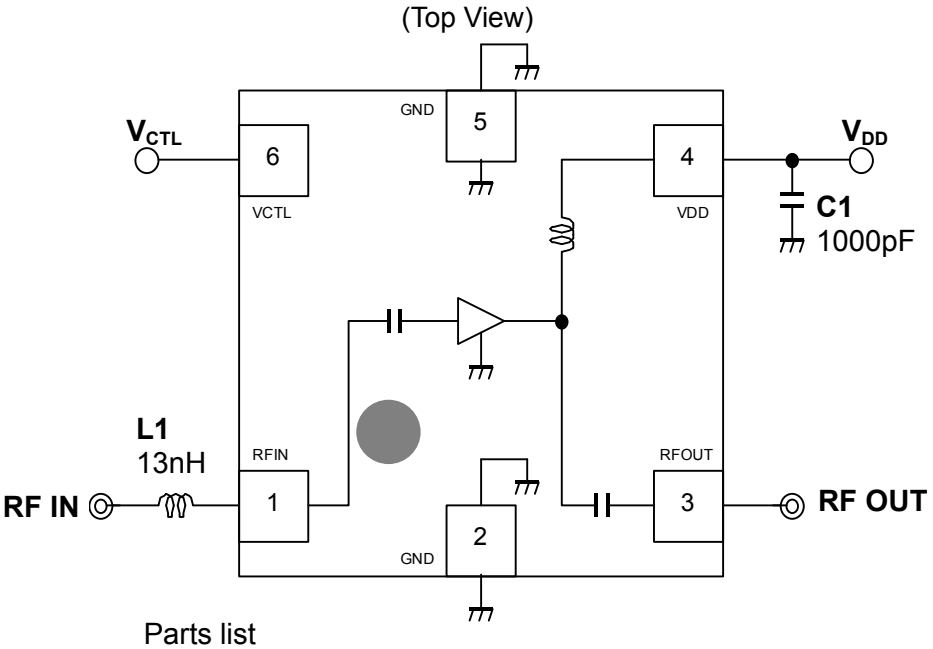
PARAMETER	SYMBOL	CONDITIONS	MEASURED DATA	UNITS
Small Signal Gain5	Gain5	Exclude PCB and connector Losses	15.3~15.7	dB
Noise Figure5	NF5	Exclude PCB and connector Losses	0.80~0.84	dB
Input Power at 1dB Gain Compression Point5	P_{-1dB} (IN)5		-8.6~-6.6	dBm
Input 3rd Order Intercept Point5	IIP3_5	f1=$f_{RF,}$ f2=f1+/- 1MHz, Pin=-30dBm	+0.2~+1.5	dBm
Out of Band Input 3rd Order Intercept Point5	IIP3_OB5	f_1 =1712.7MHz Pin =-20dBm, f_2 =1850MHz Pin =-65dBm	+4.3	dBm
700MHz Harmonic5	2fo5	Input jammer tone: 787.76MHz at –25dBm Measure the harmonic tone at 1575.52MHz	-44.8	dBm
RF IN VSWR5	VSWRi5		1.54~1.60	-
RF OUT VSWR5	VSWRo5		1.54~1.69	-

■ ELECTRICAL CHARACTERISTICS 6 (RF)

General conditions: V_{DD}=1.8V, $V_{CTL=}$1.8V, f_{RF}=1555~1610MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit3)

PARAMETER	SYMBOL	CONDITIONS	MEASURED DATA	UNITS
Small Signal Gain6	Gain6	Exclude PCB and connector Losses	14.9~15.4	dB
Noise Figure6	NF6	Exclude PCB and connector Losses	0.77~0.83	dB
Input Power at 1dB Gain Compression Point6	P_{-1dB} (IN)6		-10.5 ~ -10.0	dBm
Input 3rd Order Intercept Point6	IIP3_6	f1=$f_{RF,}$ f2=f1+/- 1MHz, Pin=-30dBm	+0.5 ~ +1.2	dBm
Out of Band Input 3rd Order Intercept Point6	IIP3_OB6	f_1 =1712.7MHz Pin =-20dBm, f_2 =1850MHz Pin =-65dBm	+5.8	dBm
700MHz Harmonic6	2fo6	Input jammer tone: 787.76MHz at –25dBm Measure the harmonic tone at 1575.52MHz	-45.5	dBm
RF IN VSWR6	VSWRi6		1.67~1.78	-
RF OUT VSWR6	VSWRo6		1.87~2.11	-

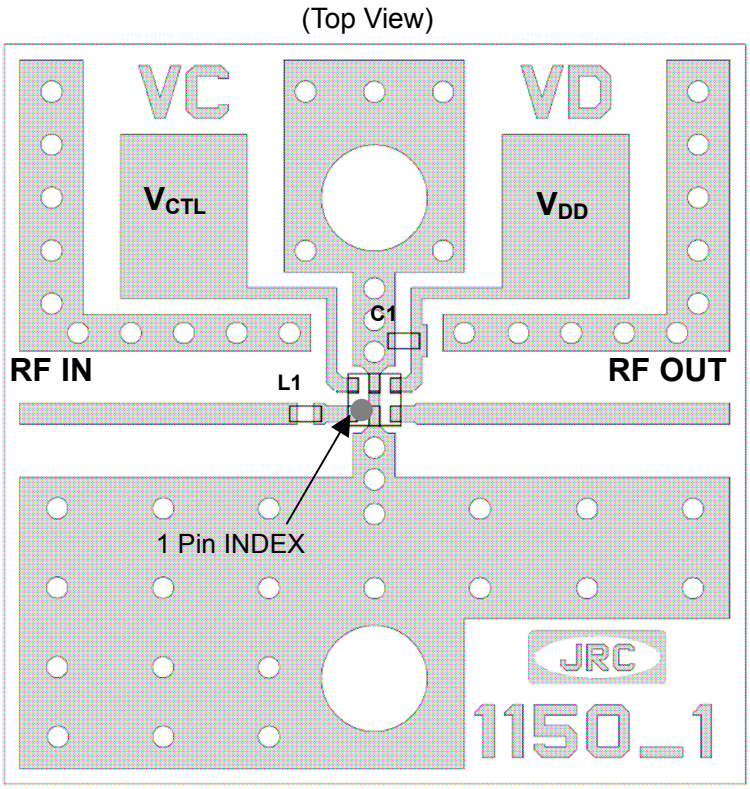
■ APPLICATION CIRCUIT3 (Using MLG0603P Series inductor)



Parts list

Parts ID	Manufacture
L1	MLG0603P (TDK-EPC)
C1	GRM03 Series (MURATA)

■ EVALUATION BOARD (Using MLG0603P Series)



PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.4mm (Z_0=50Ω)
PCB SIZE
=14.0mm x 14.0mm

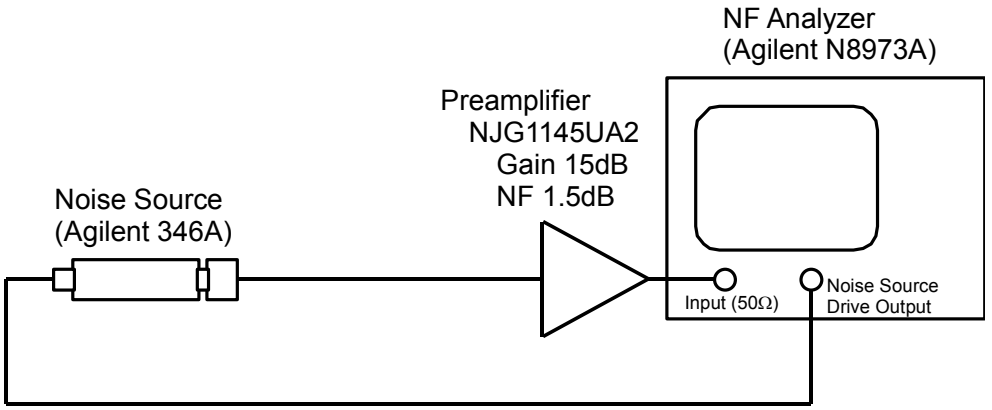
■ NOISE FIGURE MEASUREMENT BLOCK DIAGRAM

Measuring instruments

NF Analyzer : Agilent N8973A
Noise Source : Agilent 346A

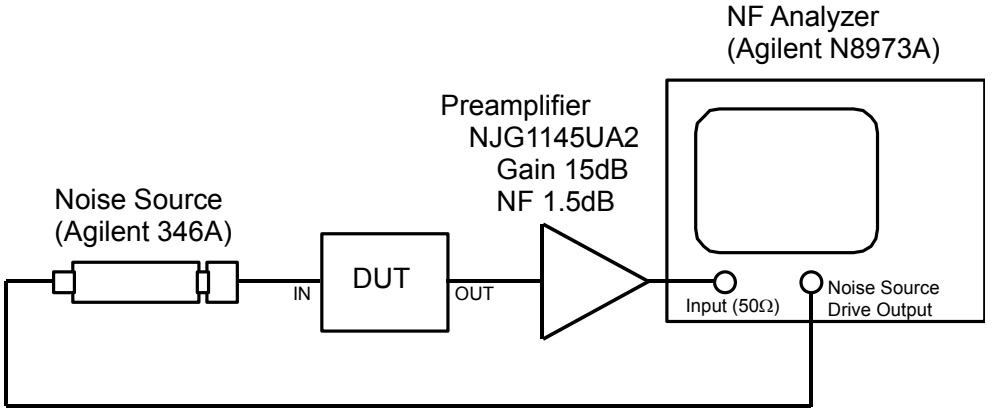
Setting the NF analyzer

Measurement mode form
Device under test : Amplifier
System downconverter : off
Mode setup form
Sideband : LSB
Averages : 16
Average mode : Point
Bandwidth : 4MHz
Loss comp : off
Tcold : setting the temperature of noise source (303.15K)



* Preamplifier is used to improve NF measurement accuracy.
* Noise source, preamplifier and NF analyzer are connected directly.

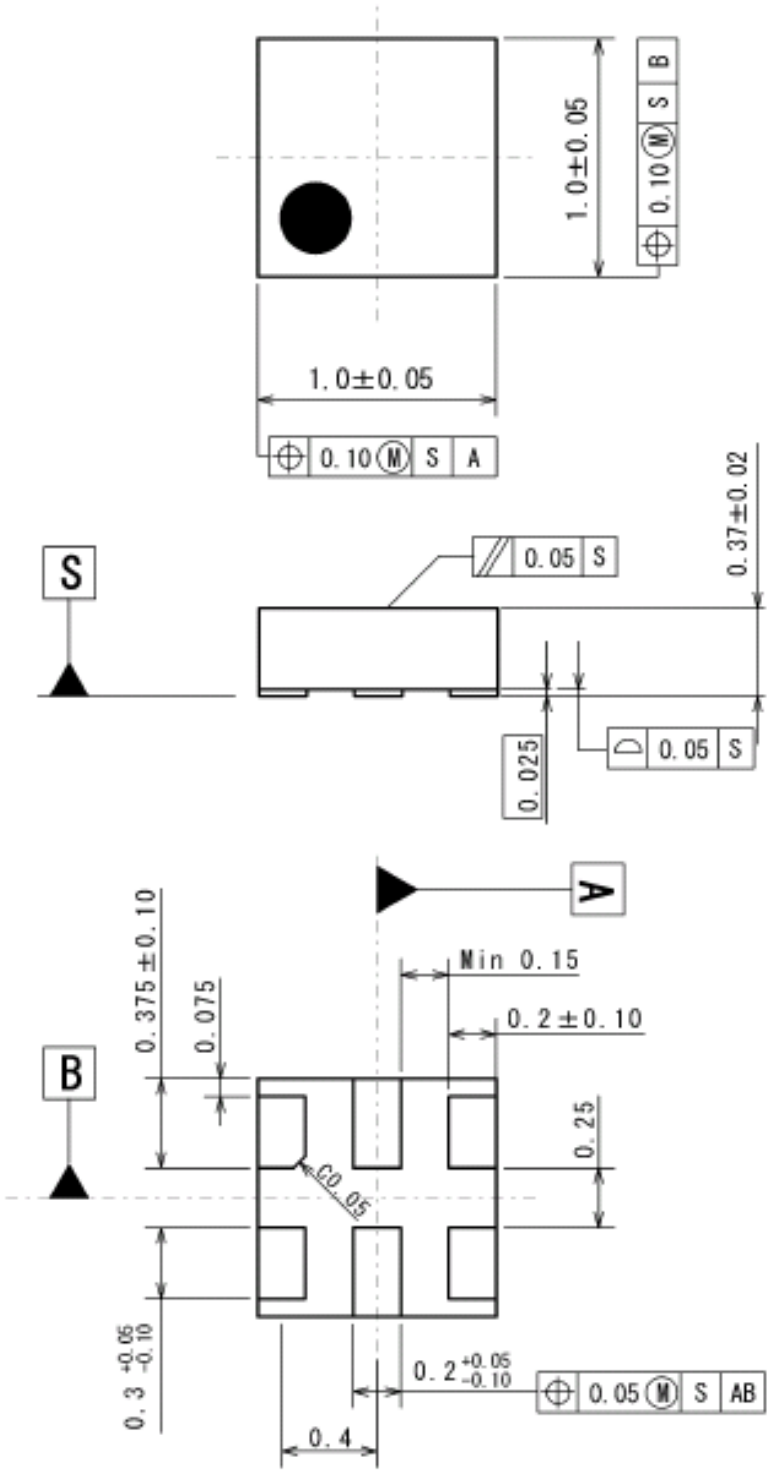
Calibration setup



* Noise source, DUT, preamplifier and NF analyzer are connected directly.

Measurement Setup

■ PACKAGE OUTLINE (EPFFP6-A2)



Unit	: mm
Substrate	: FR4
Terminal treat	: Au
Molding material	: Epoxy resin
Weight (typ.)	: 0.855mg

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.