WIDE BAND LOW NOISE AMPLIFIER GaAs MMIC

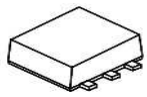
■ GENERAL DESCRIPTION

The NJG1142KA1 is a wide band low noise amplifier GaAs MMIC designed for mobile TV application. And this amplifier can be tuned to wide frequency (170MHz~900MHz).

The NJG1142KA1 has a LNA pass-through function to select high gain mode or low gain mode by low control voltage operation. The NJG1142KA1 features low current consumption, high linearity.

An ultra-small and ultra-thin package of FLP6-A1 is adopted.

■ PACKAGE OUTLINE



NJG1142KA1

■ APPLICATIONS

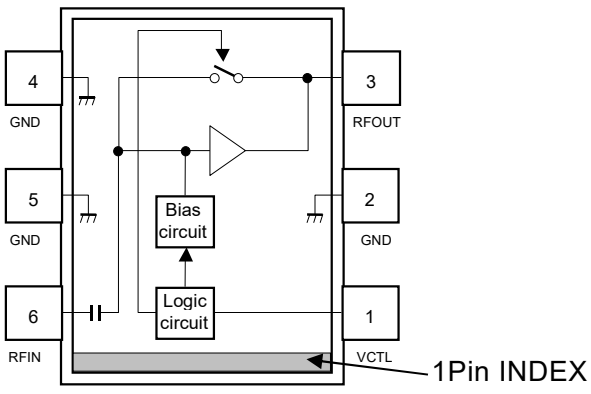
Wide band applications from 170MHz to 900MHz
Mobile TV and Digital TV applications
Mobile phone and tablet PC applications

■ FEATURES

● Wide operating frequency range	170MHz~900MHz	
● Low voltage operation	+2.8V/+1.8V typ.	
[High gain mode]		
● Low current consumption	6mA typ.	@Vdd=2.8V
● High gain	+14.0dB typ.	@Vdd=2.8V
● Low noise figure	1.5dB typ.	@Vdd=2.8V
● High $P_{-0.1dB}$ Compression	0dBm typ.	@Vdd=2.8V
● High input IP3	+2.0dBm typ.	@Vdd=2.8V
[Low gain mode]		
● Low current consumption	11μA typ.	@Vdd=2.8V
● Gain (Low loss)	-1.0dB typ.	@Vdd=2.8V
● High $P_{-0.1dB}$ Compression	+17dBm typ.	@Vdd=2.8V
● High input IP3	+22.0dBm typ.	@Vdd=2.8V
● External components count	3 pcs. (capacitor: 2pcs, inductor: 1pc)	
● Small package size	FLP6-A1 (package size: 1.6mm x 1.6mm x 0.55mm typ.)	
● RoHS compliant and Halogen Free		

■ PIN CONFIGURATION

(Top View)



■ PIN CONNECTION

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

■ TRUTH TABLE

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

V_{CTL}	LNA Mode
H	High Gain Mode
L	Low Gain Mode

NOTE: The information on this datasheet is subject to change without notice

■ ABSOLUTE MAXIMUM RATINGS

T_a=+25°C, Z_s=Z_l=50 ohm

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}=2.8V	+15	dBm
Power dissipation	P_D	4-layer FR4 PCB with through-hole (74.2mmx74.2mm), T_j=150°C	580	mW
Operating temperature	T_{opr}		-40~+85	°C
Storage temperature	T_{stg}		-55~+150	°C

■ ELECTRICAL CHARACTERISTICS 1
DC CHARACTERISTICS

General conditions: V_{DD}=2.8V, T_a=+25°C, Z_s=Z_l=50 ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	V_{DD}		2.3	2.8	3.6	V
Control voltage (High)	$V_{CTL(H)}$		1.3	1.8	3.6	V
Control voltage (Low)	$V_{CTL(L)}$		0.0	0.0	0.5	V
Operating current1	I_{DD1}	RF OFF, V_{CTL}=1.8V	-	6.0	9.5	mA
Operating current2	I_{DD2}	RF OFF, V_{CTL}=0V	-	11.0	25.0	μA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	6.0	10.0	μA

■ ELECTRICAL CHARACTERISTICS 1

RF CHARACTERISTICS1 (High Gain Mode)

Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=170~900MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain1	Gain1	Exclude PCB, connector losses*1	11.0	14.0	18.0	dB
Noise figure1	NF1	Exclude PCB & connector losses*2	-	1.5	1.9	dB
Input power 1dB gain compression1	$P_{-1dB(IN)}1$		-5.0	0.0	-	dBm
Input 3rd order intercept point1	IIP3_1	f1=f_{RF}, f2=f_{RF}+100kHz, P_{IN}=-26dBm	-3.0	+2.0	-	dBm
Isolation1	ISL1	Exclude PCB & connector losses*1	-	-19	-	dB
RF IN VSWR1	VSWRi1		-	1.5	2.3	-
RF OUT VSWR1	VSWRo1		-	1.5	2.2	-

*1 Input & output PCB and connector losses:
0.035dB(at 170MHz), 0.088dB(620MHz), 0.120dB(at 900MHz)

*2 Input PCB and connector losses:
0.018dB(170MHz), 0.044dB(620MHz), 0.060dB(900MHz)

■ ELECTRICAL CHARACTERISTICS 1

RF CHARACTERISTICS2 (Low Gain Mode)

Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=170~900MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain2	Gain2	Exclude PCB & connector losses*1	-2.5	-1.0	-	dB
Input power at 1dB gain compression2	$P_{-1dB(IN)}2$		+14.0	+17.0	-	dBm
Input 3rd order intercept point2	IIP3_2	f1=f_{RF}, f2=f_{RF}+100kHz, P_{IN}=-8dBm	+17.0	+22.0	-	dBm
RF IN VSWR2	VSWRi2		-	1.5	2.0	-
RF OUT VSWR2	VSWRo2		-	1.5	2.0	-

*1 Input & output PCB and connector losses:
0.035dB(at 170MHz), 0.088dB(620MHz), 0.120dB(at 900MHz)

■ ELECTRICAL CHARACTERISTICS 2
DC CHARACTERISTICS

General conditions: V_{DD}=1.8V, T_a=+25°C, Z_s=Z_l=50 ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	V_{DD}		-	1.8	-	V
Control voltage (High)	$V_{CTL(H)}$		-	1.8	-	V
Control voltage (Low)	$V_{CTL(L)}$		-	0.0	-	V
Operating current1	I_{DD1}	RF OFF, V_{CTL}=1.8V	-	4.2	-	mA
Operating current2	I_{DD2}	RF OFF, V_{CTL}=0V	-	6.4	-	μA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	5.6	-	μA

■ ELECTRICAL CHARACTERISTICS 2
RF CHARACTERISTICS1 (High Gain Mode)

Conditions: V_{DD}=1.8V, V_{CTL}=1.8V, f_{RF}=170~900MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain1	Gain1	Exclude PCB, connector losses*1	-	12.1	-	dB
Noise figure1	NF1	Exclude PCB & connector losses*2	-	1.75	-	dB
Input power 1dB gain compression1	$P_{-1dB(IN)}$1		-	-1.6	-	dBm
Input 3rd order intercept point1	IIP3_1	f1=f_{RF}, f2=f_{RF}+100kHz, P_{IN}=-26dBm	-	+2.0	-	dBm
Isolation1	ISL1	Exclude PCB & connector losses*1	-	-18.4	-	dB
RF IN VSWR1	VSWRi1		-	1.67	-	-
RF OUT VSWR1	VSWRo1		-	1.96	-	-

*1 Input and output PCB, connector losses :
0.035dB(at 170MHz), 0.088dB(at 620MHz), 0.120dB(at 900MHz)

*2 Input PCB, connector losses :
0.018dB(at 170MHz), 0.044dB(at 620MHz), 0.060dB(at 900MHz)

■ ELECTRICAL CHARACTERISTICS 2

RF CHARACTERISTICS2 (Low Gain Mode)

Conditions: V_{DD}=1.8V, V_{CTL}=0V, f_{RF}=170~900MHz, T_a=+25°C, Z_s=Z_l=50ohm, with application circuit

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain2	Gain2	Exclude PCB & connector losses*1	-	-1.1	-	dB
Input power at 1dB gain compression2	$P_{-1dB(IN)}2$		-	+18.9	-	dBm
Input 3rd order intercept point2	IIP3_2	f1=f_{RF}, f2=f_{RF}+100kHz, P_{IN}=-8dBm	-	+24.0	-	dBm
RF IN VSWR2	VSWRi2		-	1.33	-	-
RF OUT VSWR2	VSWRo2		-	1.15	-	-

*1 Input and output PCB, connector losses :
0.035dB(at 170MHz), 0.088dB(at 620MHz), 0.120dB(at 900MHz)

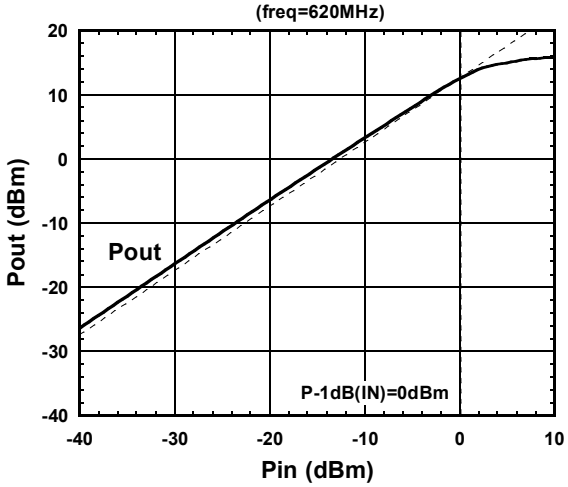
■TERMINAL INFORMATION

No.	SYMBOL	DESCRIPTION
1	VCTL	Control voltage supply terminal.
2	GND	Ground terminal. These terminals should be connected to the ground plane as close as possible for excellent RF performance.
3	RFOUT	RF output terminal. This terminal is also the power supply terminal of the LNA. please use inductor (L1) to connect power supply.
4	GND	Ground terminal. These terminals should be connected to the ground plane as close as possible for excellent RF performance.。
5	GND	Ground terminal. These terminals should be connected to the ground plane as close as possible for excellent RF performance.
6	RFIN	RF input terminal. This IC is integrated an input DC blocking capacitor.

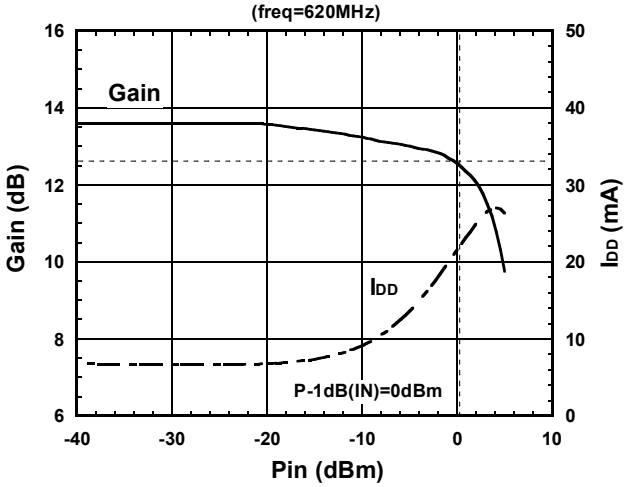
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=1.8V, Zs=Zl=50ohm, with application circuit)

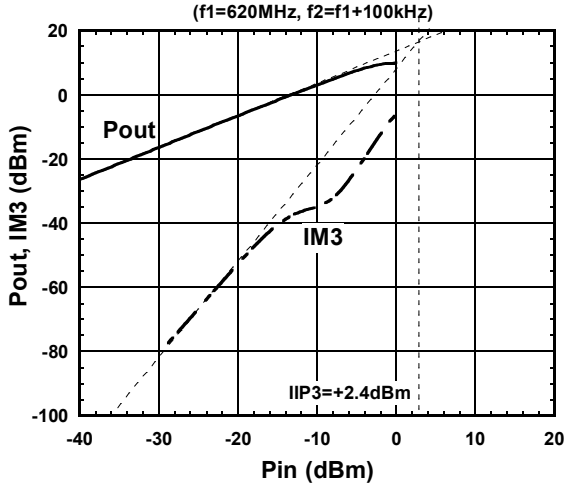
Pout vs. Pin
(freq=620MHz)



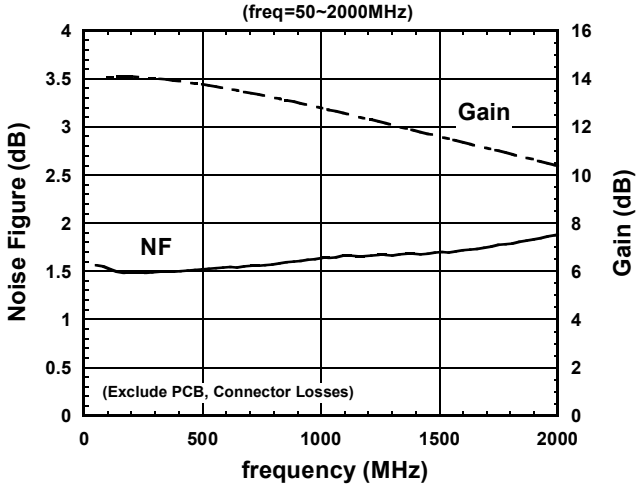
Gain, I_{DD} vs. Pin
(freq=620MHz)



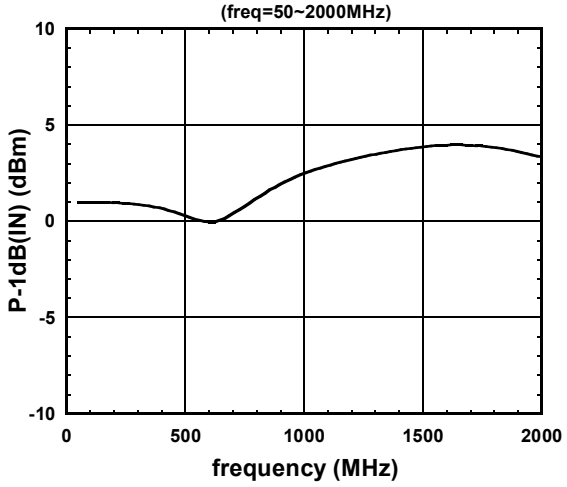
Pout, IM3 vs. Pin
(f1=620MHz, f2=f1+100kHz)



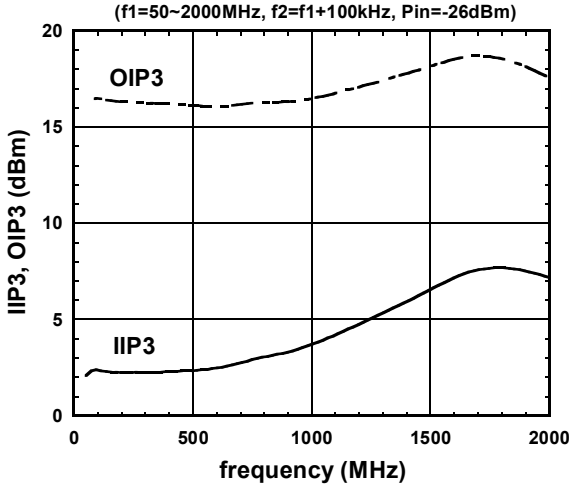
NF, Gain vs. frequency
(freq=50~2000MHz)



P-1dB(IN) vs. frequency
(freq=50~2000MHz)



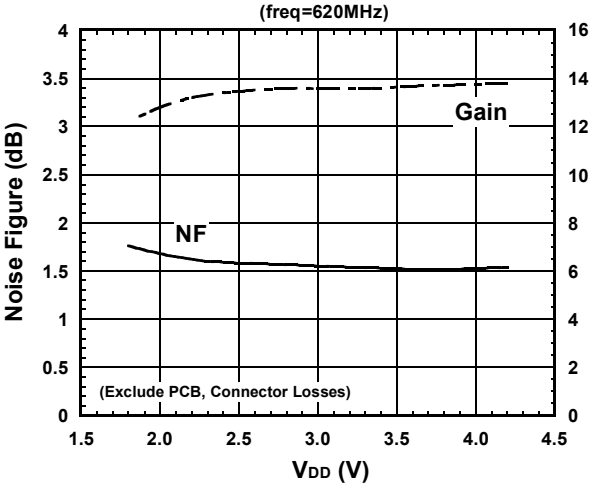
IIP3, OIP3 vs. frequency
(f1=50~2000MHz, f2=f1+100kHz, Pin=-26dBm)



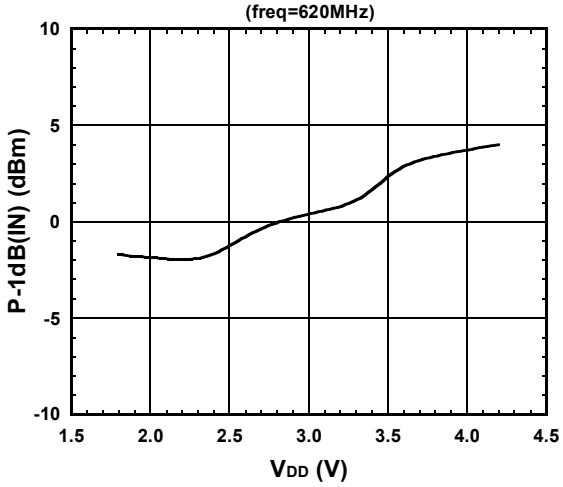
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(Condition :Ta=+25℃, V_{CTL}=1.8V, Zs=Zl=50ohm, with application circuit)

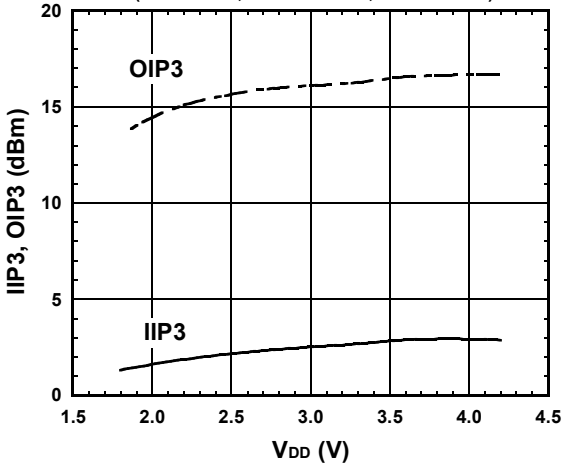
NF, Gain vs. V_{DD}
(freq=620MHz)



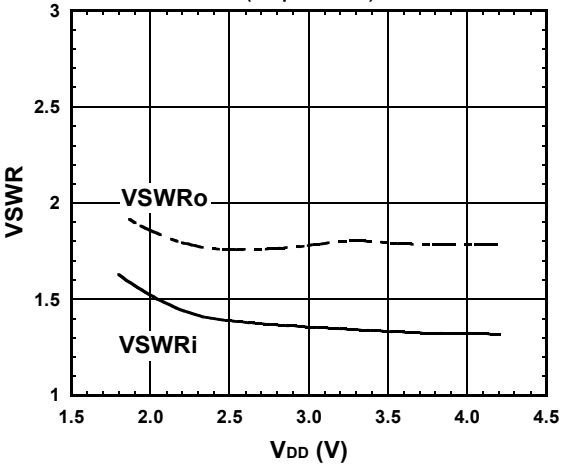
P-1dB(IN) vs. V_{DD}
(freq=620MHz)



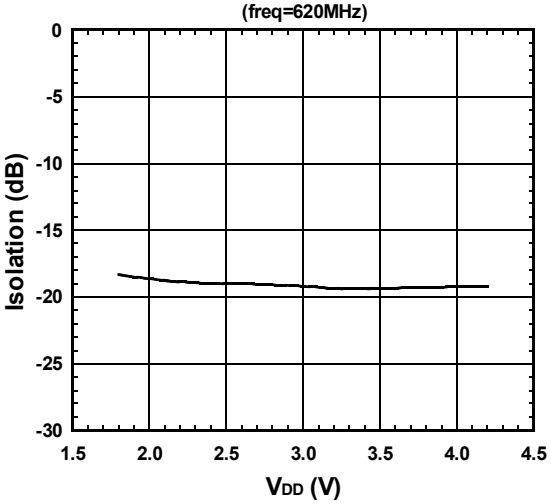
IIP3, OIP3 vs. V_{DD}
(f1=620MHz, f2=f1+100kHz, Pin=-26dBm)



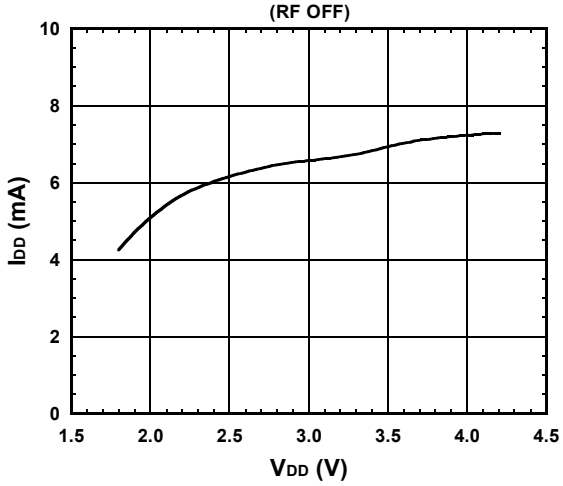
VSWR vs. V_{DD}
(freq=620MHz)



Isolation vs. V_{DD}
(freq=620MHz)



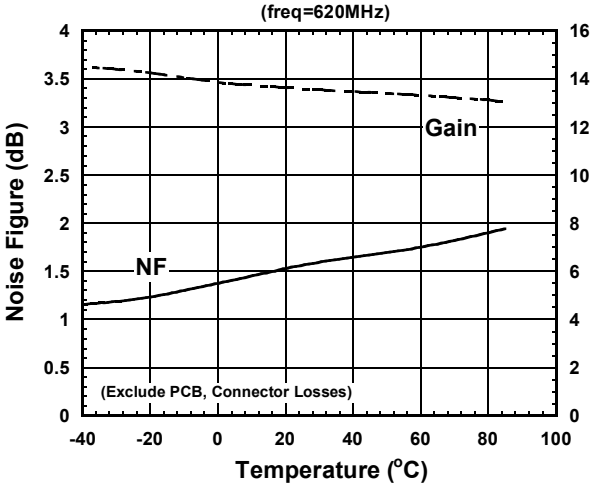
I_{DD} vs. V_{DD}
(RF OFF)



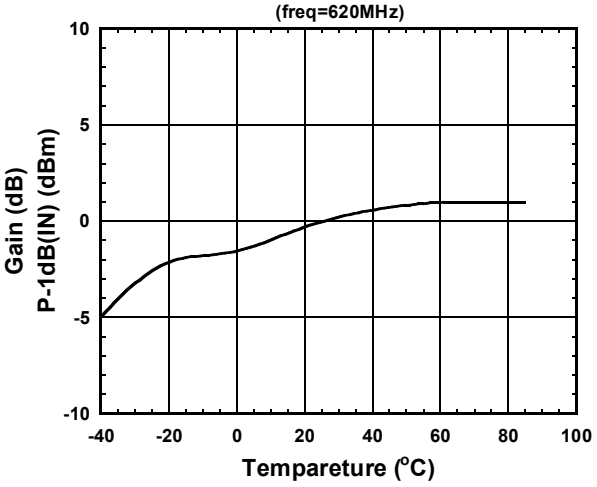
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(Condition : V_{DD}=2.8V, V_{CTL}=1.8V, Zs=Zl=50ohm, with application circuit)

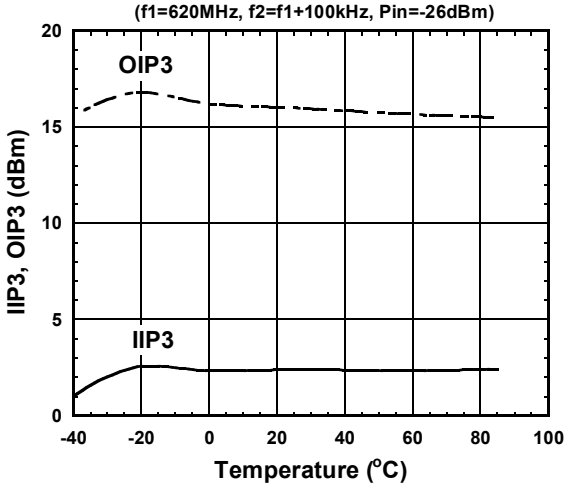
NF, Gain vs. Temperature
(freq=620MHz)



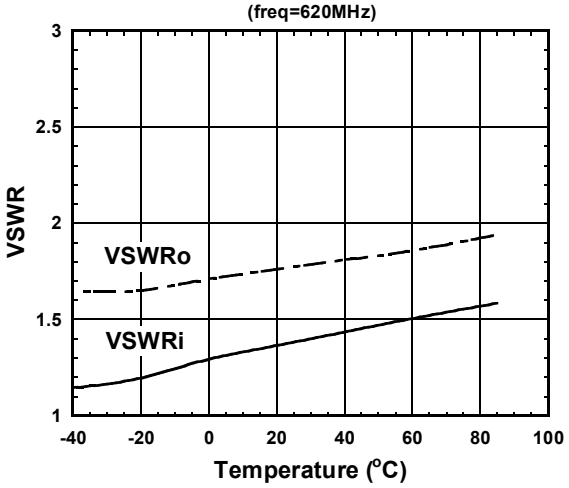
P-1dB(IN) vs. Tempareture
(freq=620MHz)



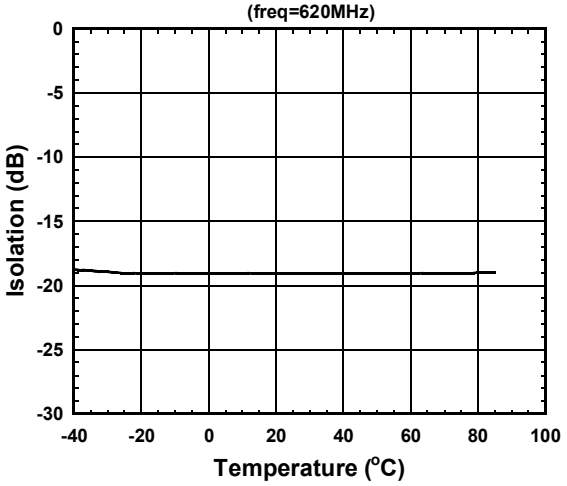
IIP3, OIP3 vs. Temperature
(f1=620MHz, f2=f1+100kHz, Pin=-26dBm)



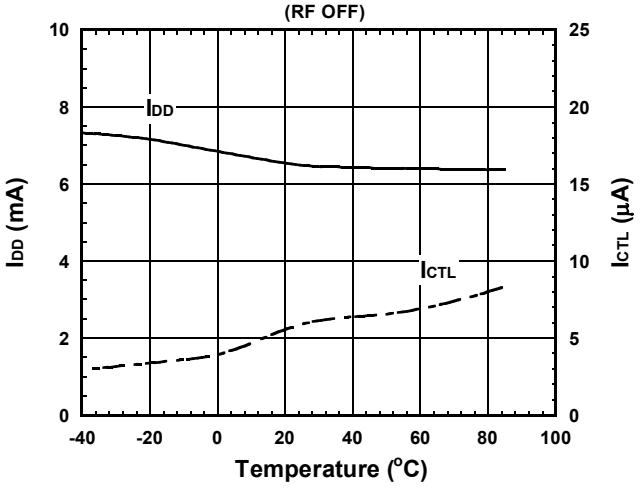
VSWR vs. Temperature
(freq=620MHz)



Isolation vs. Temperature
(freq=620MHz)

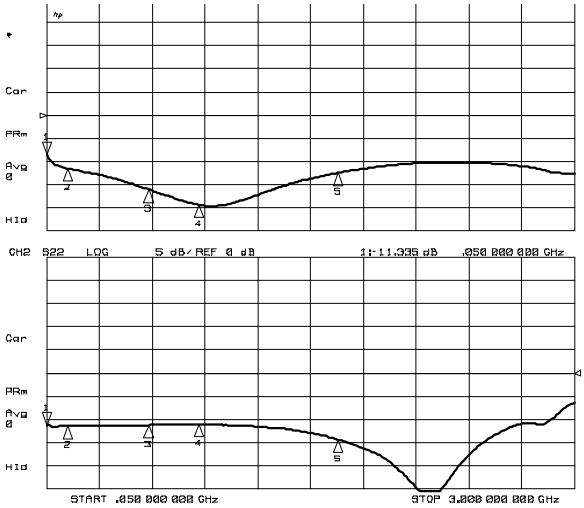


I_{DD}, I_{CTL} vs. Temperature
(RF OFF)

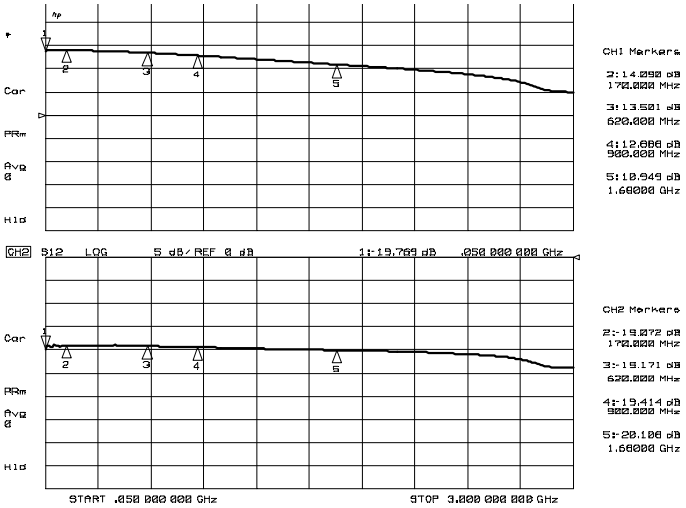


■ ELECTRICAL CHARACTERISTICS(High Gain Mode)

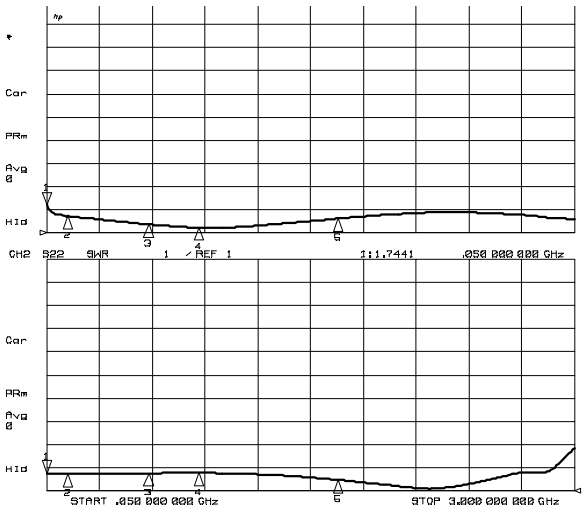
(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=1.8V, Zs=Zl=50ohm, with application circuit)



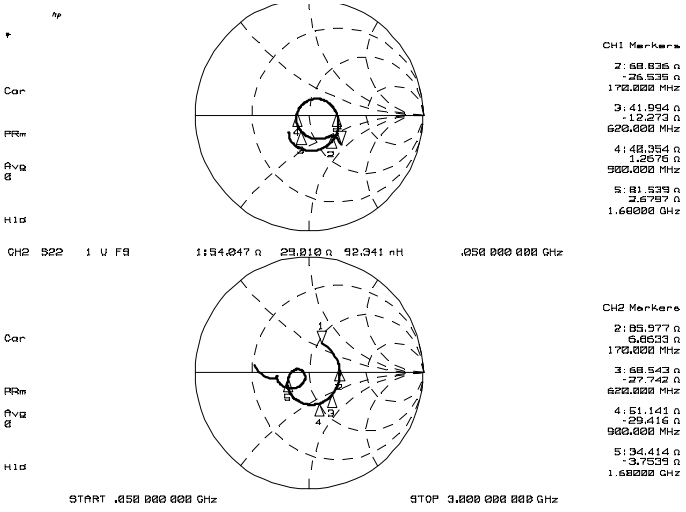
S11, S22



S21, S12



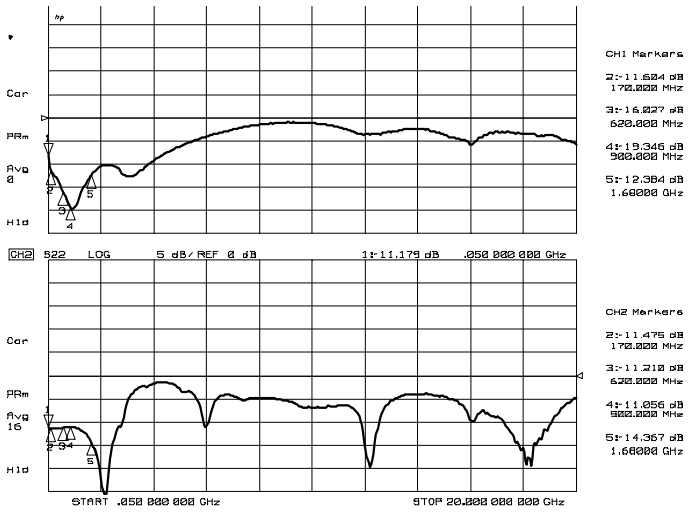
VSWRi, VSWRo



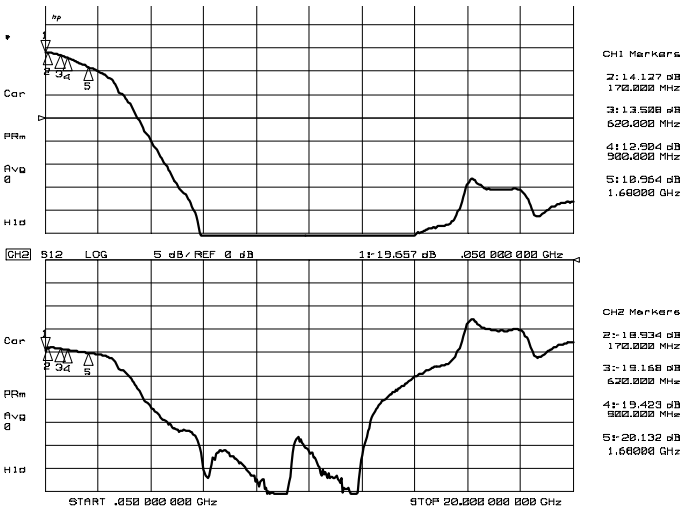
Zin, Zout

■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

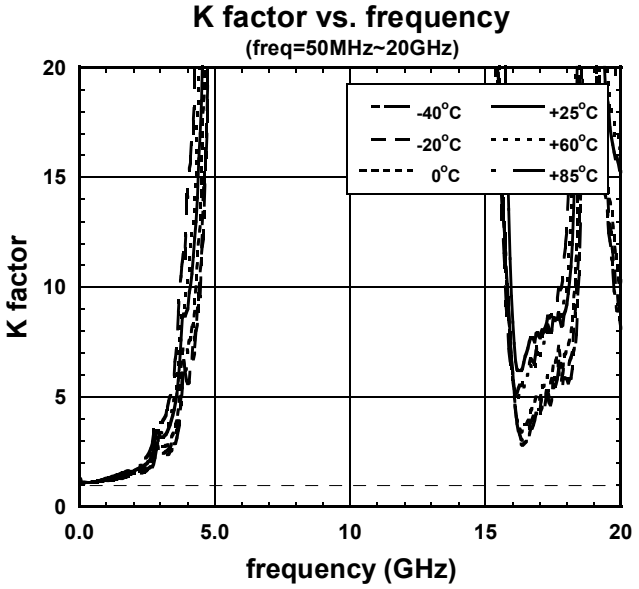
(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=1.8V, Zs=Zl=50ohm, with application circuit)



S11, S22 (50MHz~20GHz)



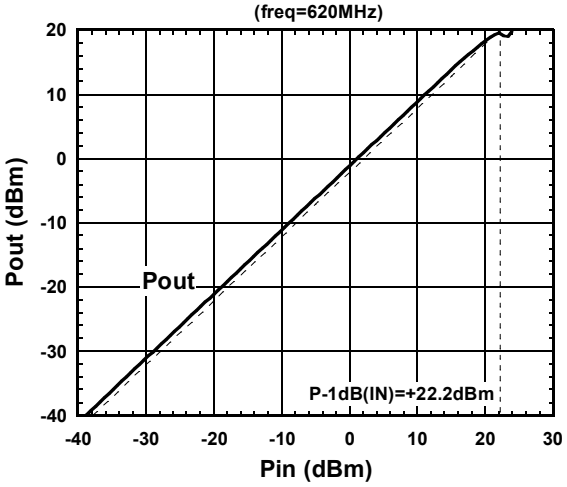
S21, S12 (50MHz~20GHz)



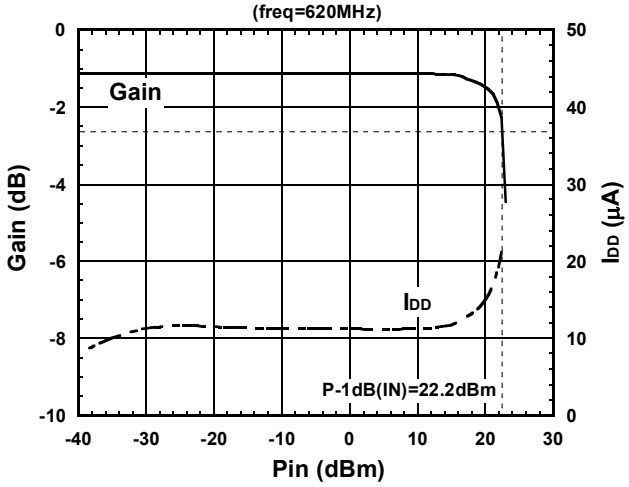
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=0V, Zs=Zl=50ohm, with application circuit)

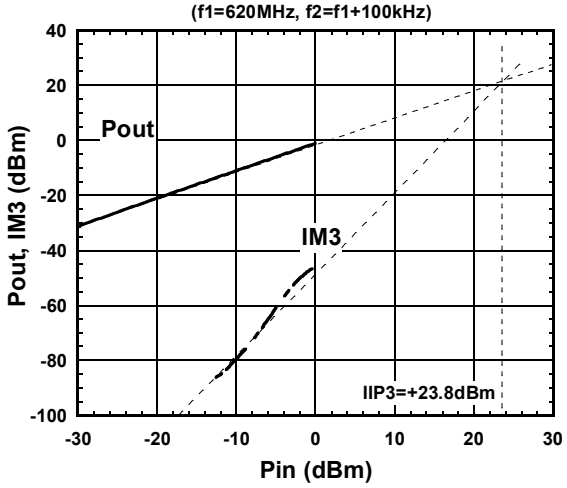
Pout vs. Pin
(freq=620MHz)



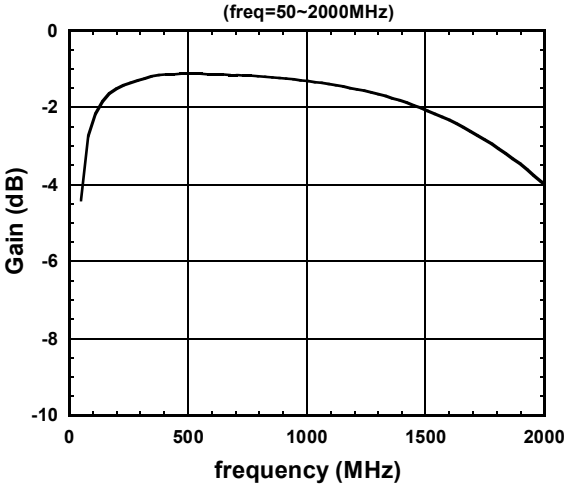
Gain, I_{DD} vs. Pin
(freq=620MHz)



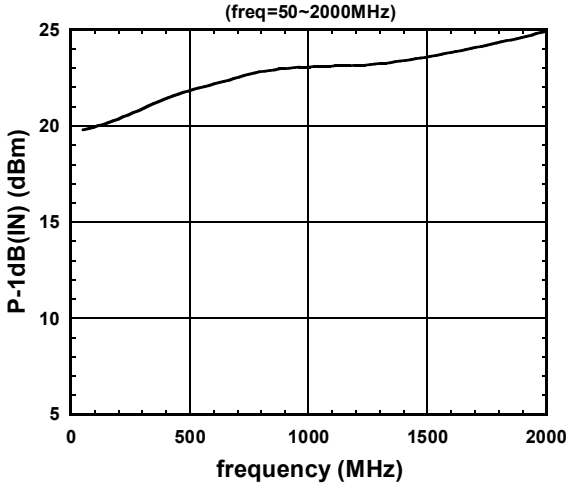
Pout, IM3 vs. Pin
(f1=620MHz, f2=f1+100kHz)



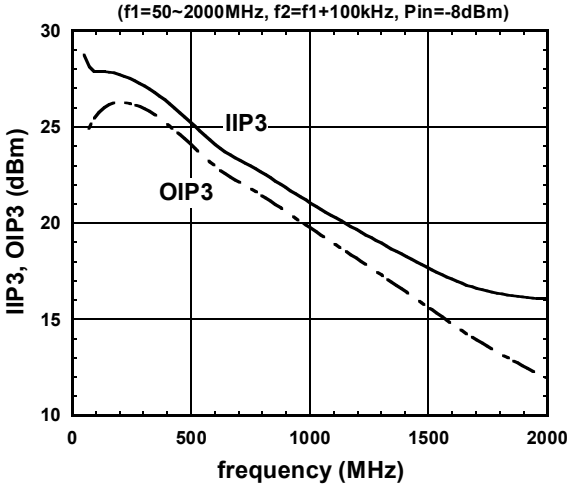
Gain vs. frequency
(freq=50~2000MHz)



P-1dB(IN) vs. frequency
(freq=50~2000MHz)



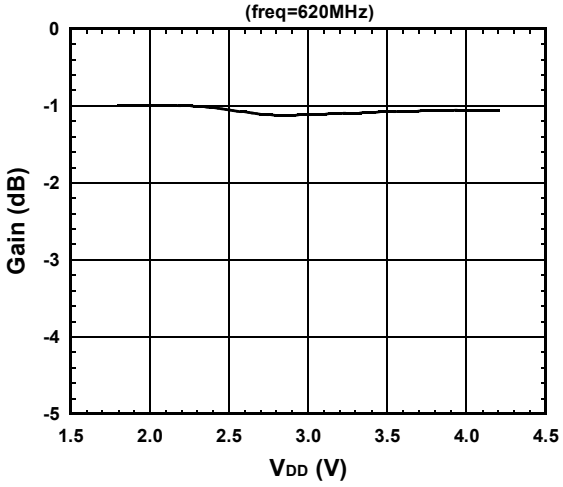
IIP3, OIP3 vs. frequency
(f1=50~2000MHz, f2=f1+100kHz, Pin=-8dBm)



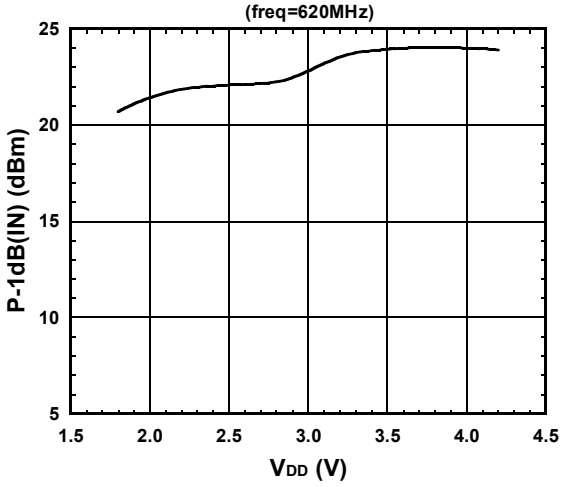
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(Condition :Ta=+25℃, V_{CTL}=0V, Zs=Zl=50ohm, with application circuit)

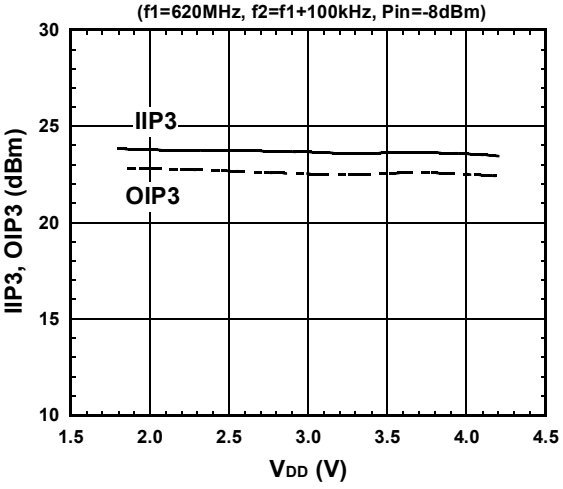
Gain vs. V_{DD}
(freq=620MHz)



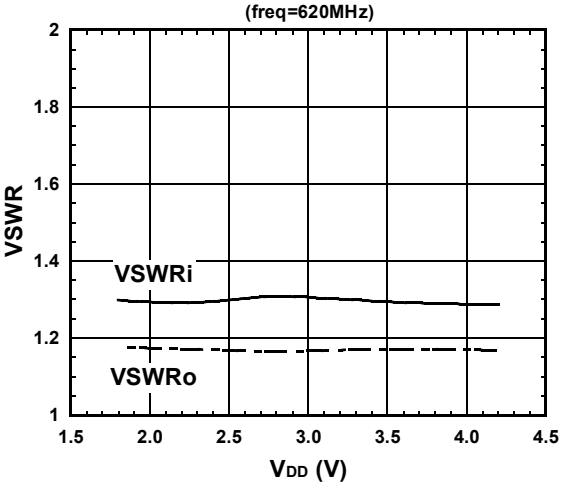
P-1dB(IN) vs. V_{DD}
(freq=620MHz)



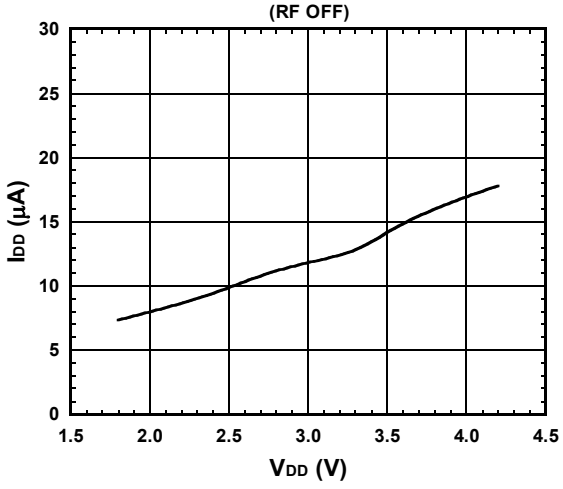
IIP3, OIP3 vs. V_{DD}
(f1=620MHz, f2=f1+100kHz, Pin=-8dBm)



VSWR vs. V_{DD}
(freq=620MHz)



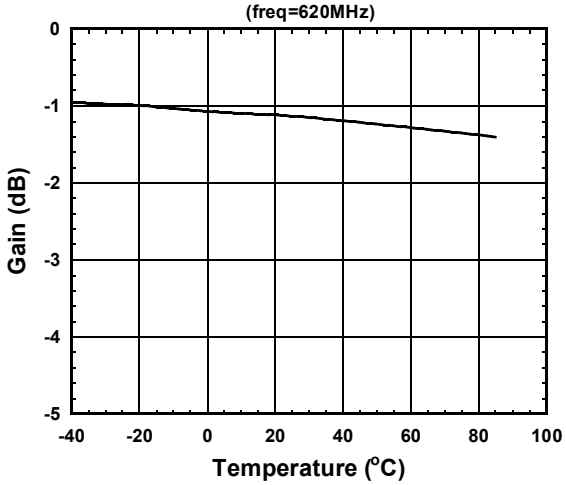
I_{DD} vs. V_{DD}
(RF OFF)



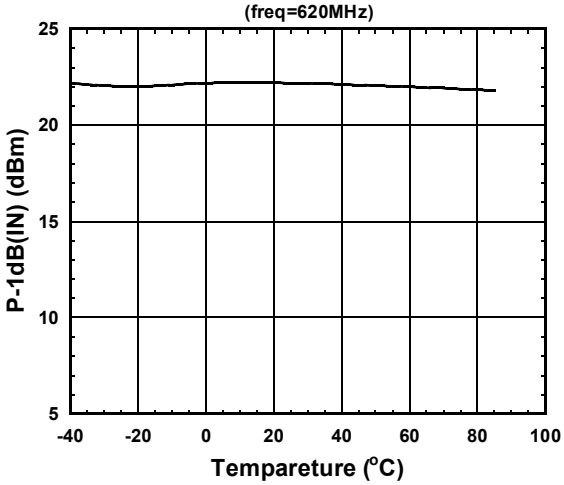
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(Condition : V_{DD}=2.8V, V_{CTL}=0V, Zs=Zl=50ohm, with application circuit)

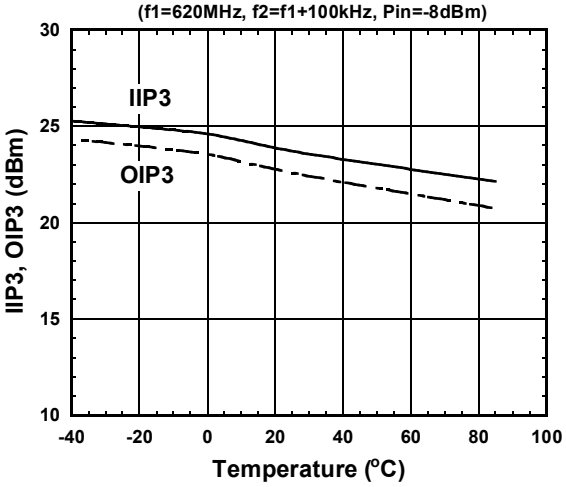
Gain vs. Temperature
(freq=620MHz)



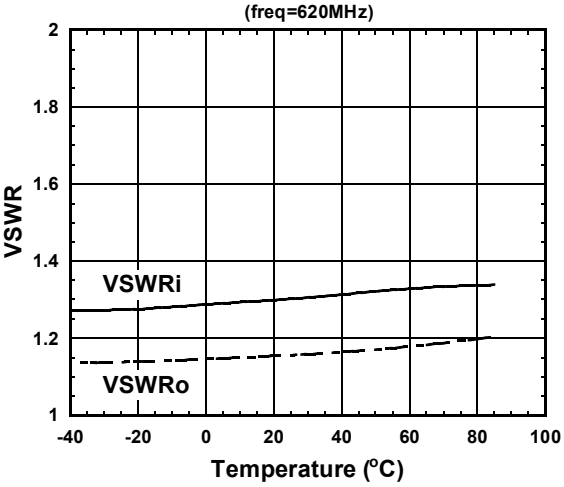
P-1dB(IN) vs. Tempareture
(freq=620MHz)



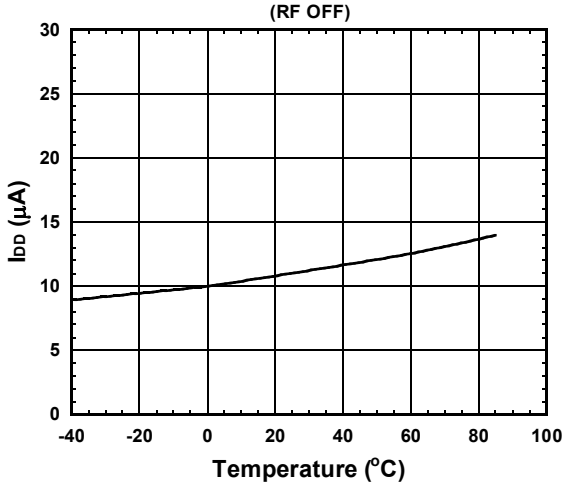
IIP3, OIP3 vs. Temperature
(f1=620MHz, f2=f1+100kHz, Pin=-8dBm)



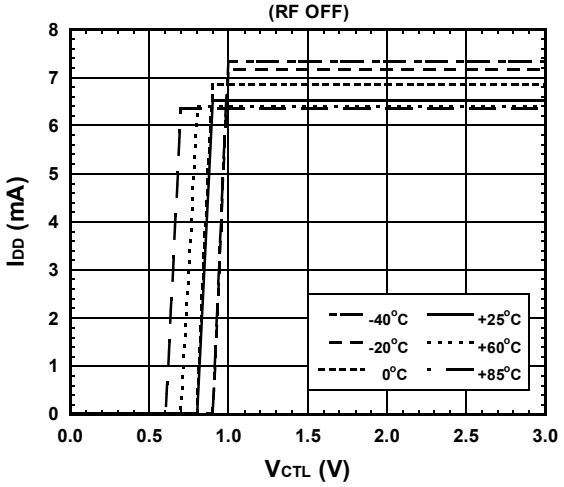
VSWR vs. Temperature
(freq=620MHz)



I_{DD} vs. Temperature
(RF OFF)

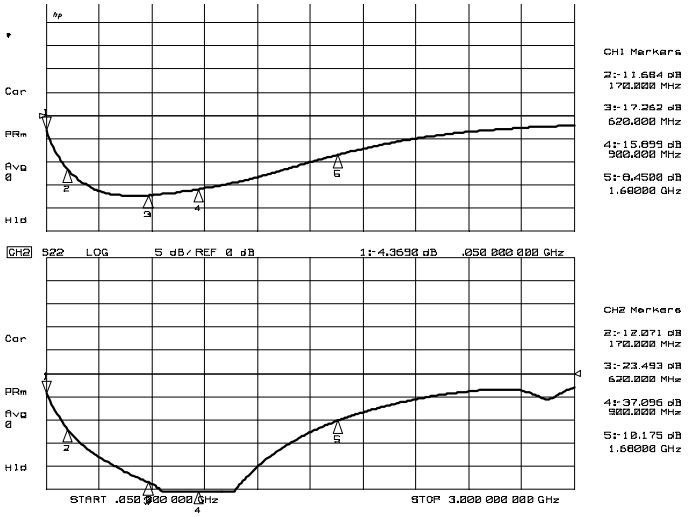


I_{DD} vs. V_{CTL}
(RF OFF)

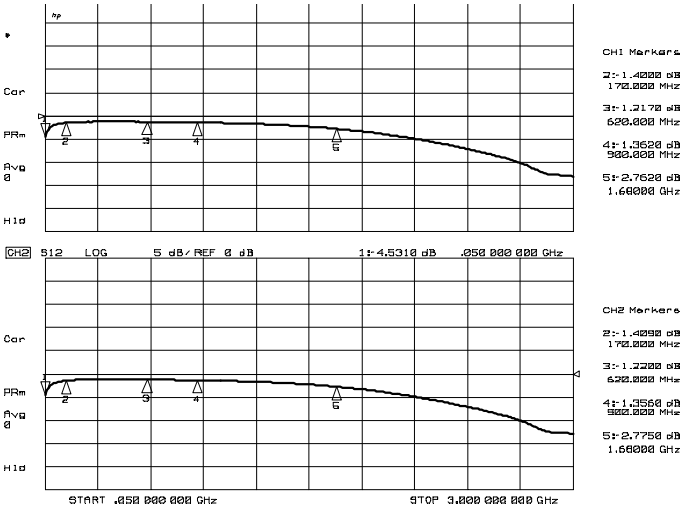


■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

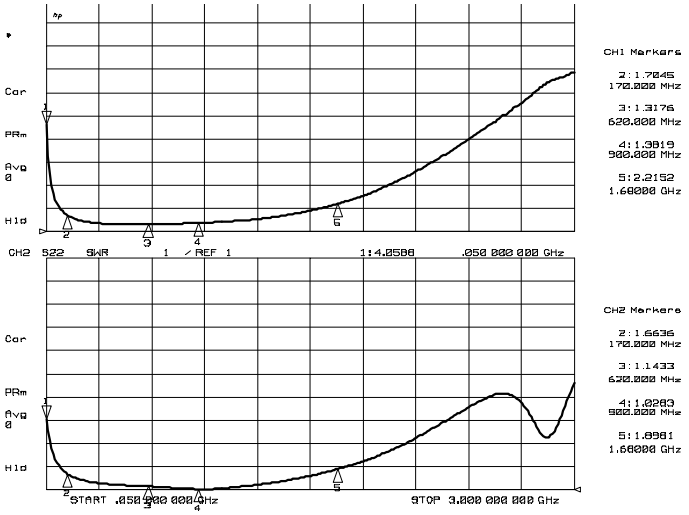
(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=0V, Zs=Zl=50ohm,with application circuit)



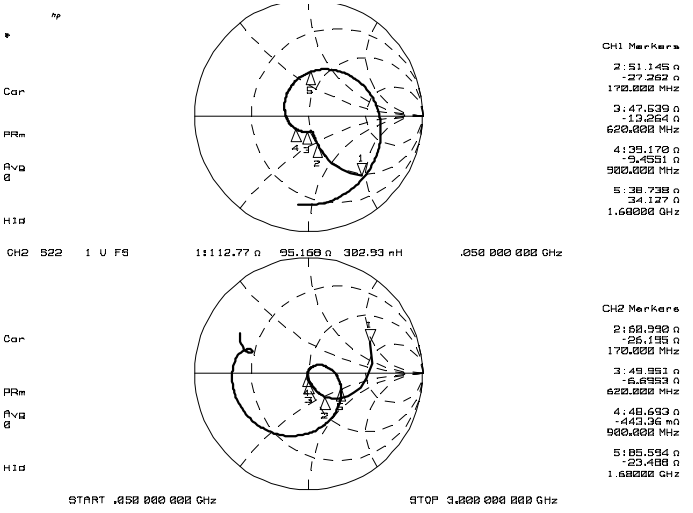
S11, S22



S21, S12



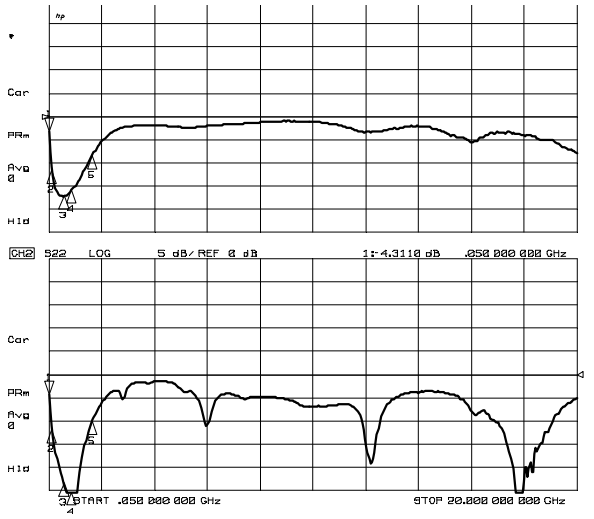
VSWRi, VSWRo



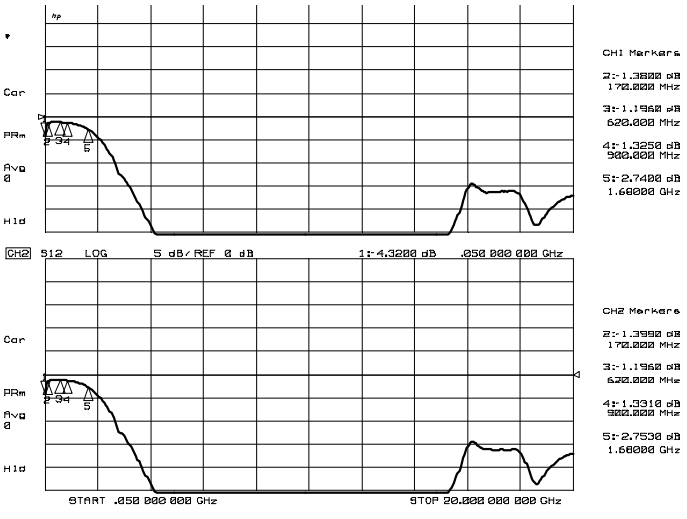
Zin, Zout

■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

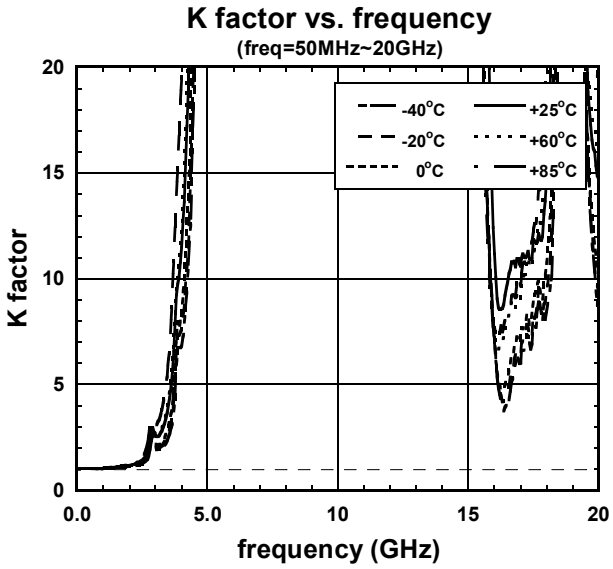
(Condition :Ta=+25℃, V_{DD}=2.8V, V_{CTL}=0V, Zs=Zl=50ohm,With application circuit)



S11, S22 (50MHz~20GHz)

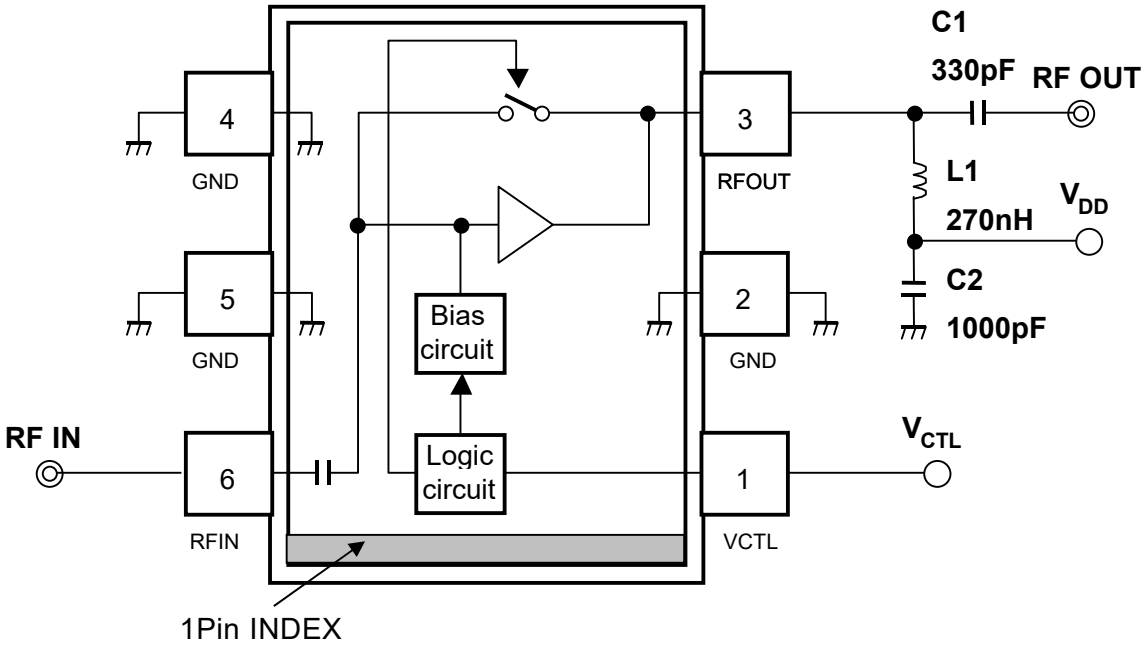


S21, S12 (50MHz~20GHz)



■ APPLICATION CIRCUIT

(Top View)

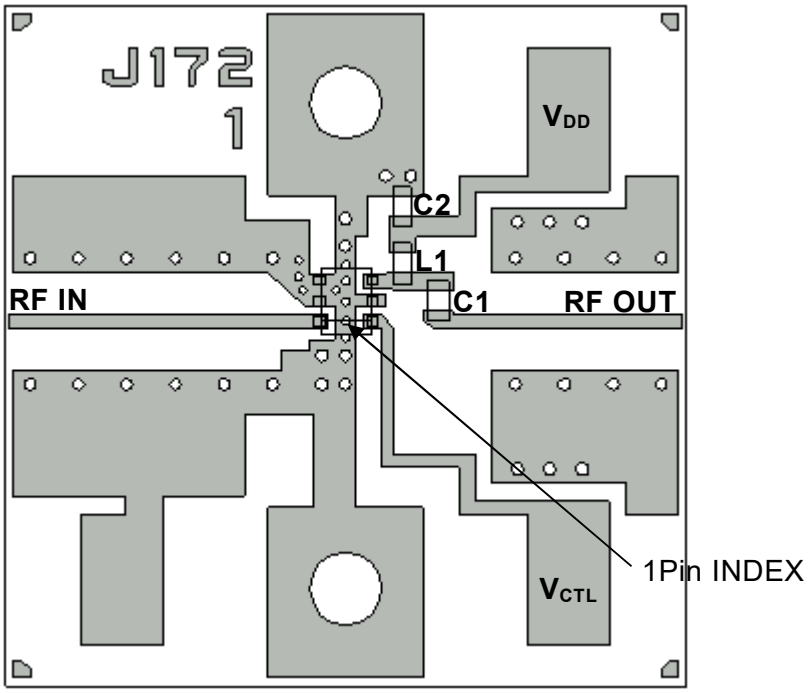


NOTES:

- L1 is an RF choke. (DC feed inductor)
- C1 is a coupling and DC blocking capacitor at the output.
- C2 is a bypass capacitor.

■ TEST PCB LAYOUT

(Top View)



■ PARTS LIST

Parts ID.	Notes
L1	TAIYO-YUDEN HK1005 Series
C1, C2	MURATA GRM15 Series

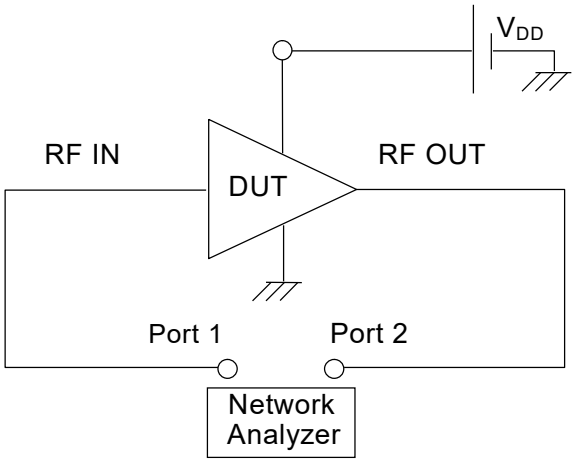
PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.40mm (Z_0=50Ω)
PCB SIZE=16.8mm x 16.8mm

PRECAUTION:

- In order not to couple with terminal RFIN and RFOUT, please layout ground pattern under the IC.

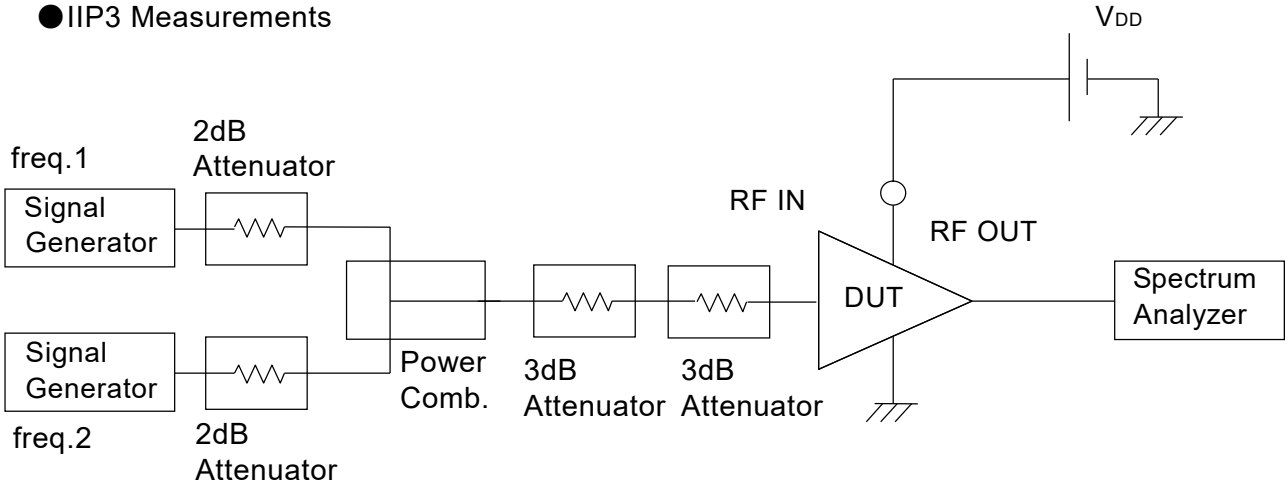
■ MEASUREMENT BLOCK DIAGRAM

●S parameter Measurements

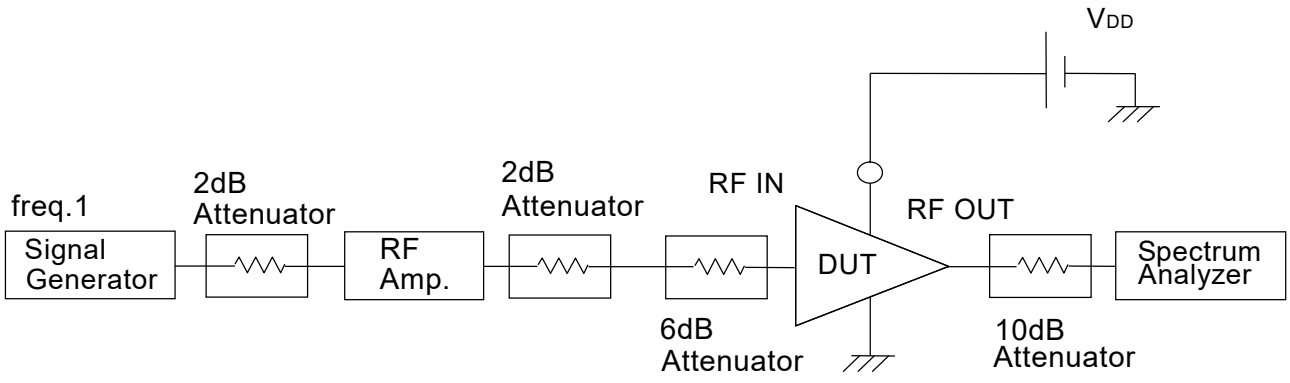


S parameter Measurement Block Diagram

●IIP3 Measurements



IF and IM3 Measurement Block Diagram for IIP3（High Gain Mode）



IF and IM3 Measurement Block Diagram for IIP3（Low Gain Mode）

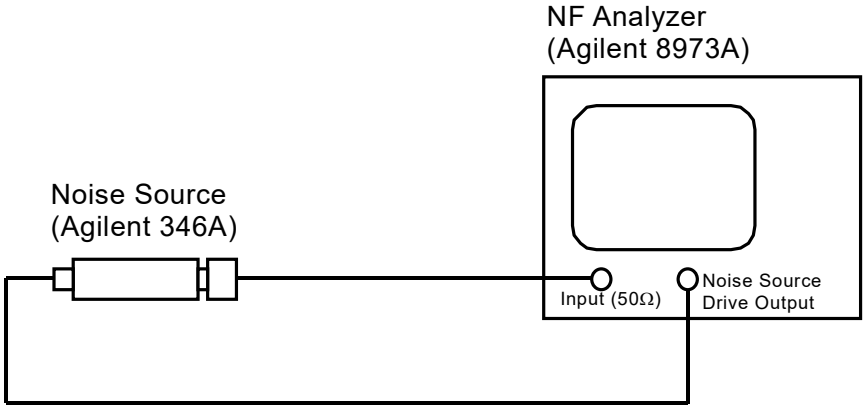
● Noise Figure Measurements

Measuring instruments

NF Analyzer : Agilent 8973A
Noise Source : Agilent 346A

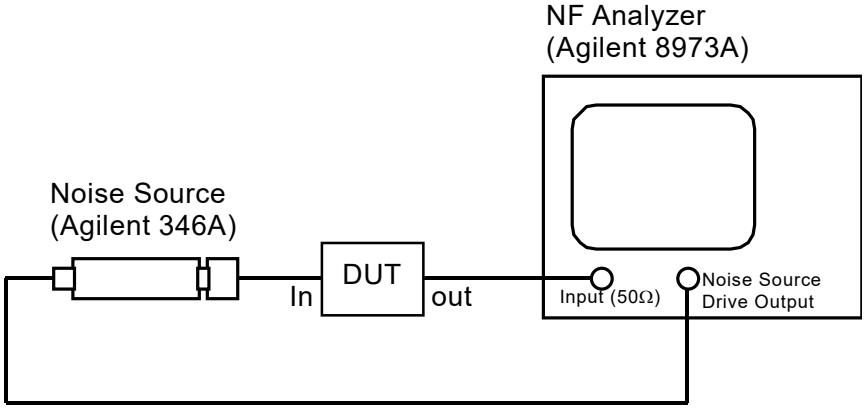
Setting the NF analyzer

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 (300.0K)



* Noise source and NF analyzer are connected directly.

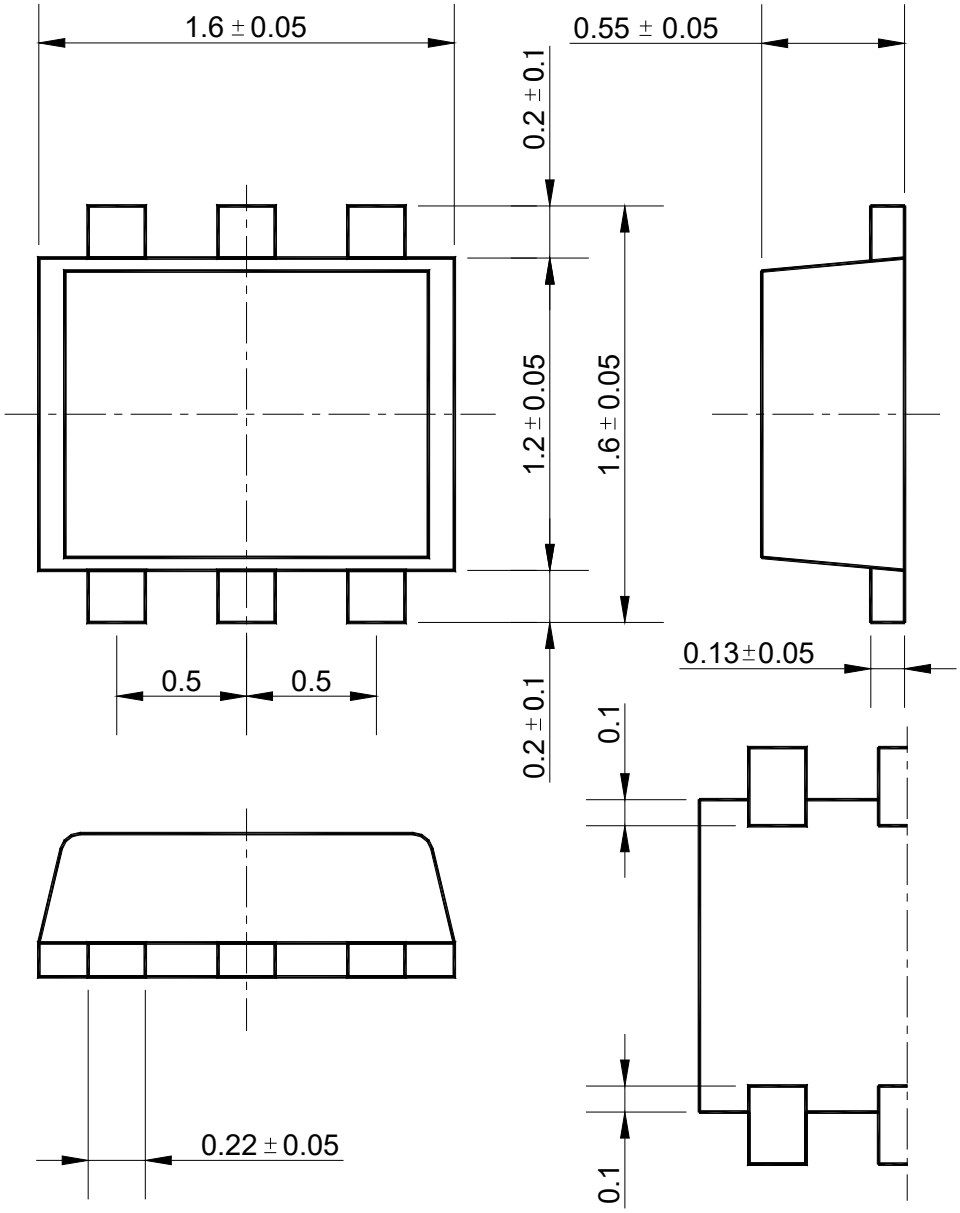
Calibration Setup



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

Measurement Setup

■ PACKAGE OUTLINE (FLP6-A1)



Unit: mm

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.

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    - Equipment Used in the Deep Sea
    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
    - Fire Alarms / Intruder Detectors
    - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
    - Various Safety Devices
    - Traffic control system
    - Combustion equipment

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8. Quality Warranty
    8-1. Quality Warranty Period
    In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
    8-2. Quality Warranty Remedies
    When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.
    Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
    8-3. Remedies after Quality Warranty Period
    With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.

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