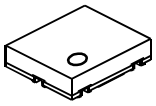
900MHz Band LNA GaAs MMIC

■ GENERAL DESCRIPTION

The NJG1138HA8 is a low noise amplifier designed for UMTS and LTE low band applications. The NJG1138HA8 has two gain state which are high gain mode and low gain mode. The NJG1138HA8 features high gain, low noise figure and high IP3.

An Ultra-small and thin USB6-A8 package is adopted.

■ PACKAGE OUTLINE



NJG1138HA8

■ APPLICATIONS

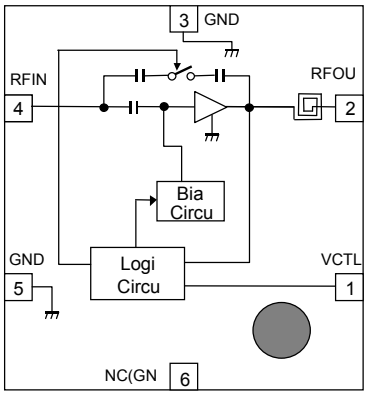
UMTS and LTE Low band applications
Mobile phone, Data card, modem and others mobile device applications
700MHz Band application*

*Note: Please check the Application Note for 700MHz Band

■ FEATURES

●Low operating voltage	+2.8V typ.	
●Low control voltage	+1.8V typ.	
●Low current consumption	2.3mA typ.	@V_{CTL}=1.8V
	10μA typ.	@V_{CTL}=0V
●High gain	16.0dB typ.	@V_{CTL}=1.8V, f_{RF} =942.5MHz
●Low noise figure	1.4dB typ.	@V_{CTL}=1.8V, f_{RF} =942.5MHz
●Input power at 1dB gain compression point	-8.5dBm typ.	@V_{CTL}=1.8V, f_{RF} =942.5MHz
	+16.0dBm typ.	@V_{CTL}=0V, f_{RF}=942.5MHz
●High input IP3	0dBm typ.	@V_{CTL}=1.8V, f_{RF} =942.5MHz
	+14dBm typ.	@V_{CTL}=0V, f_{RF}=942.5MHz
●Small package size	USB6-A8	(Package size: 1.0mmx1.2mmx0.38mm typ.)
●Lead-free and halogen-free		

■ PIN CONFIGURATION



Pin Connection
1. VCTL
2. RFOUT
3. GND
4. RFIN
5. GND
6. NC (GND)

■ TRUTH TABLE

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

VCTL	LNA Mode
H	High Gain Mode
L	Low Gain 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}		+15	dBm
Power dissipation	P_D	on PCB board, Tjmax=150°C	150	mW
Operating temperature	T_{opr}		-40~+85	°C
Storage temperature	T_{stg}		-55~+150	°C

■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General Conditions: V_{DD}=2.8V, Ta=+25°C)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	V_{DD}		2.5	2.8	3.6	V
Control voltage (High)	V_{CTL}(H)	VCTL terminal	1.36	1.8	3.6	V
Control voltage (Low)	V_{CTL}(L)	VCTL terminal	0	0	0.3	V
Operating current1 (High Gain Mode)	I_{DD}1	RF OFF, V_{CTL}=1.8V	-	2.3	4.0	mA
Operating current2 (Low Gain Mode)	I_{DD}2	RFOFF, V_{CTL}=0V	-	10	45	μA
Control current	I_{CTL}	RF OFF, V_{CTL}=1.8V	-	5.5	8.5	μA

■ ELECTRICAL CHARACTERISTICS 2 (High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 1	Gain1	Exclude PCB and connector losses (input: 0.07dB, output: 0.07dB)	14.5	16.0	17.5	dB
Noise figure 1	NF1	Exclude PCB and connector losses (input:0.07dB)	-	1.4	1.7	dB
Input power at 1dB gain compression point 1	$P_{-1dB(IN)}1$		-16.0	-8.5	-	dBm
3rd order Input Intercept Point 1	IIP3_1	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-30dBm	-7.0	0	-	dBm
RF IN VSWR 1	$VSWR_I$ 1		-	1.8	2.3	-
RF OUT VSWR 1	$VSWR_o$1		-	2.2	2.7	-

■ ELECTRICAL CHARACTERISTICS 3 (Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 2	Gain2	Exclude PCB and connector losses (input: 0.07dB, output: 0.07dB)	-4.5	-3.0	-2.0	dB
Noise figure 2	NF2	Exclude PCB and connector losses (input:0.07dB)	-	3.0	6.0	dB
Input power at 1dB gain compression point 1	$P_{-1dB(IN)}2$		+4.5	+16.0	-	dBm
3rd order Input Intercept Point 2	IIP3_2	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-20dBm	+2.0	+14.0	-	dBm
RF IN VSWR 2	$VSWR_I$ 2		-	1.4	2.0	-
RF OUT VSWR 2	$VSWR_o$2		-	1.6	2.2	-

■ TERMINAL INFORMATION

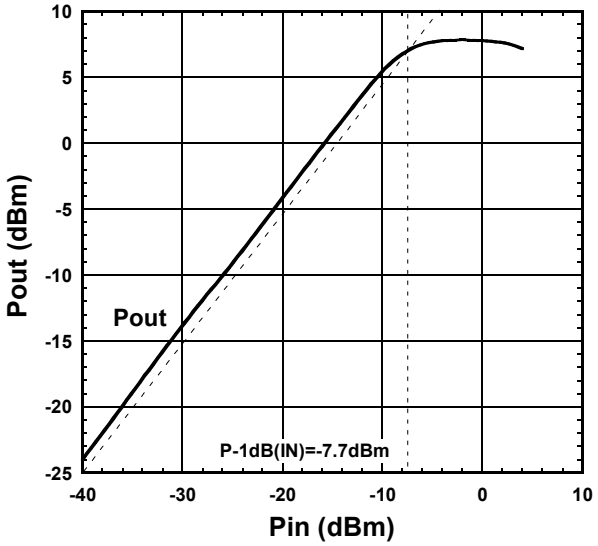
No.	SYMBOL	DESCRIPTION
1	VCTL	Gain control port. Inputting a logic-high, the LNA turn at high gain mode. Inputting a logic-low, the LNA turn at low gain mode.
2	RFOUT	RF output terminal. Requires an external matching components. This terminal should be connected a DC blocking capacitor C1.
3	GND	Ground terminal. Connect to the PCB ground plane.
4	RFIN	RF input terminal. Requires an external matching components.
5	GND	Ground terminal. Connect to the PCB ground plane.
6	NC (GND)	No connected terminal. This terminal is not connected with internal circuit. Connect to the PCB ground plane.

Notes: Ground terminal (No.3 and 5) and NC terminal (No.6) should be connected with the PCB ground for good RF performance.

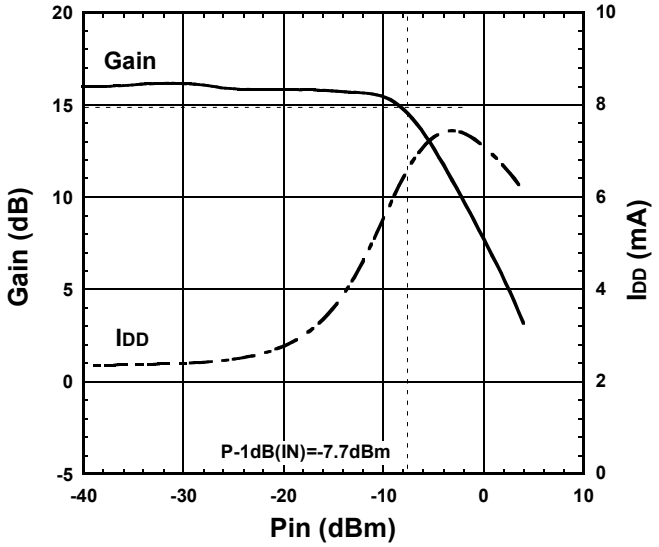
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

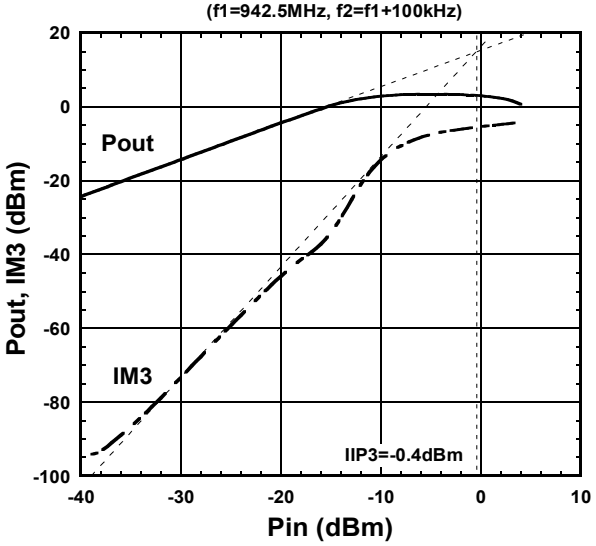
Pout vs. Pin
(f=942.5MHz)



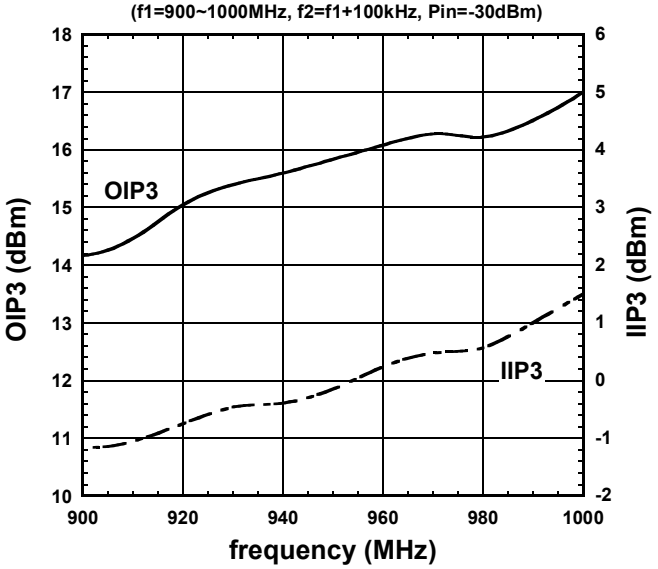
Gain, IDD vs. Pin
(f=942.5MHz)



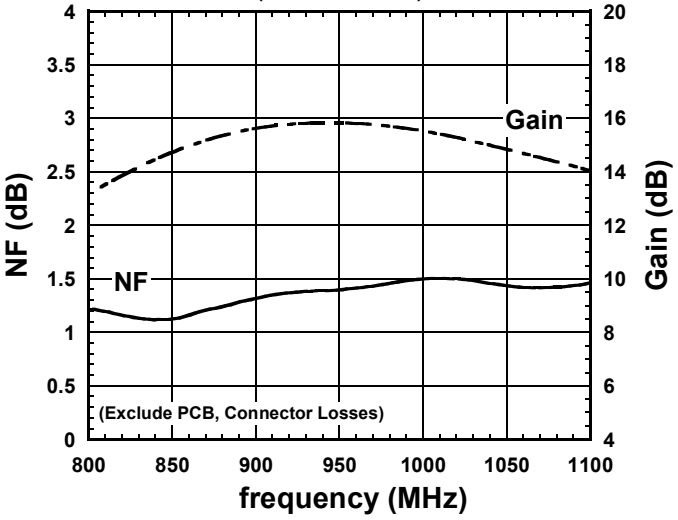
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



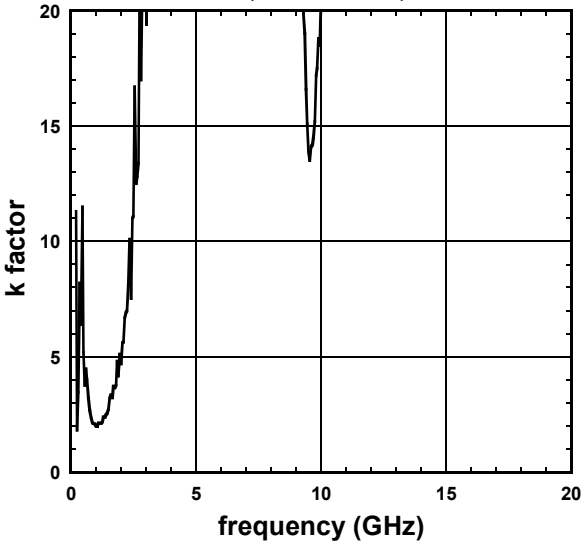
OIP3, IIP3 vs. frequency
(f1=900~1000MHz, f2=f1+100kHz, Pin=-30dBm)



NF, Gain vs. frequency
(f=800~1100MHz)



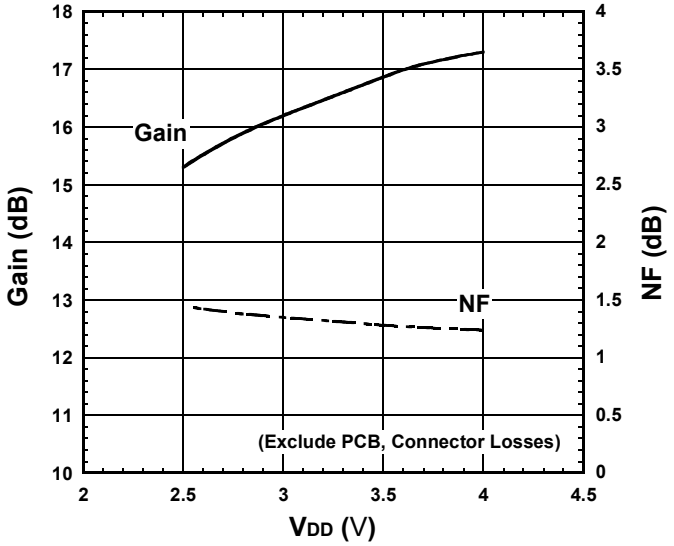
k factor vs. frequency
(f=50MHz~20GHz)



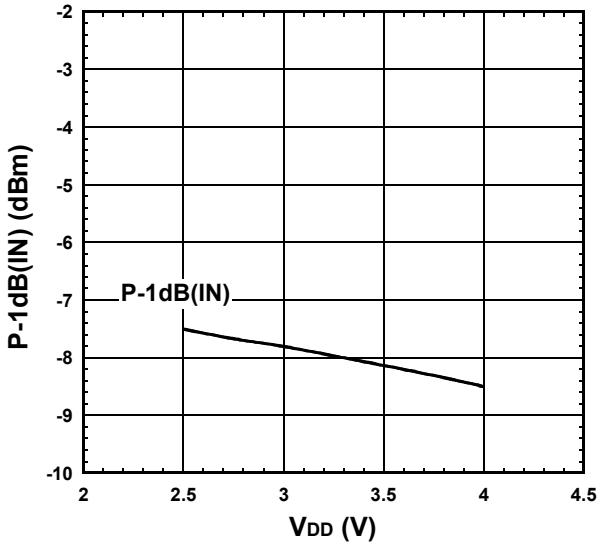
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

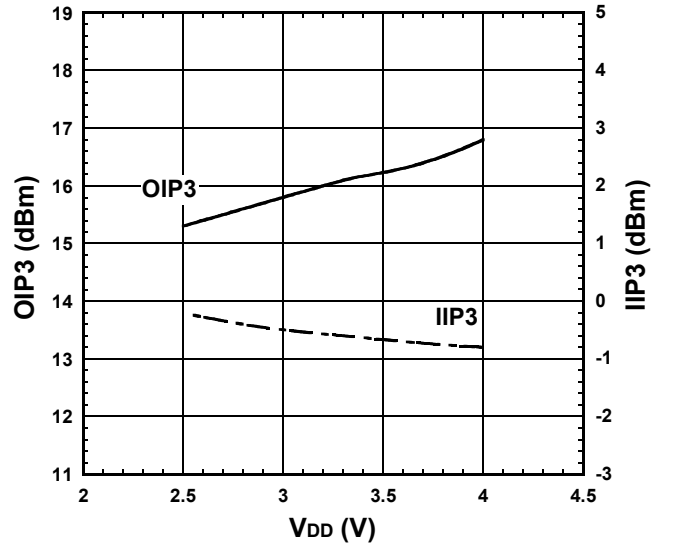
Gain, NF vs. VDD
(f=942.5MHz)



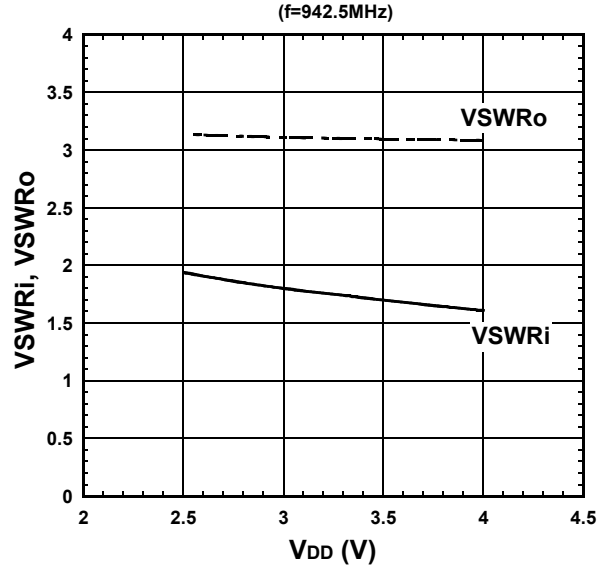
P-1dB(IN) vs. VDD
(f=942.5MHz)



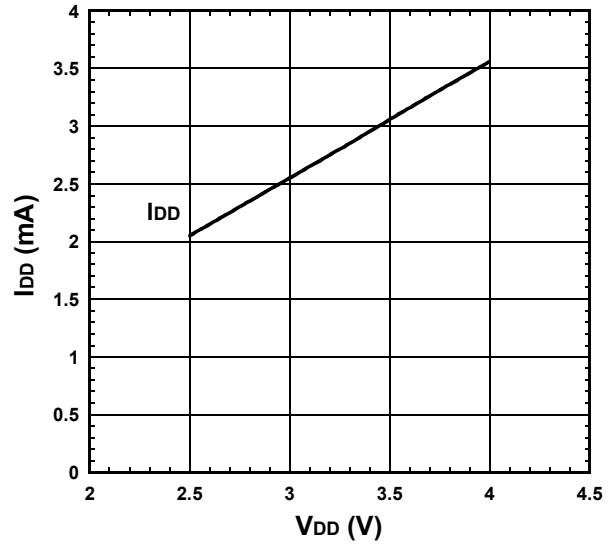
OIP3, IIP3 vs. VDD
(f1=942.5MHz, f2=f1+100kHz, Pin=-30dBm)



VSWRi, VSWRo vs. VDD
(f=942.5MHz)



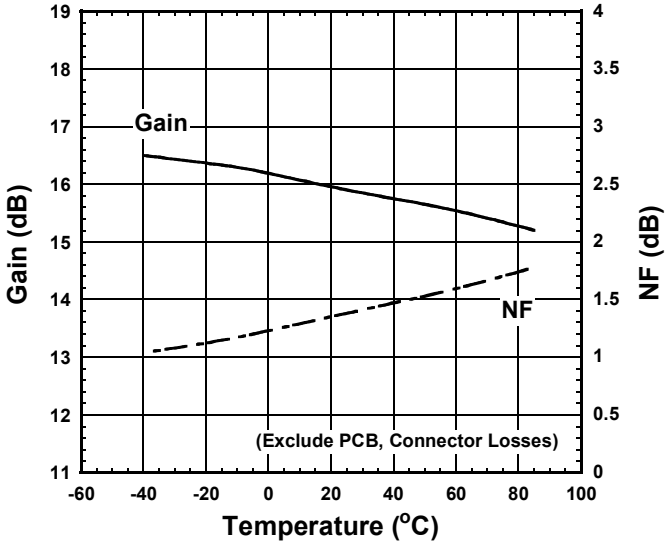
IDD vs. VDD
(RF OFF)



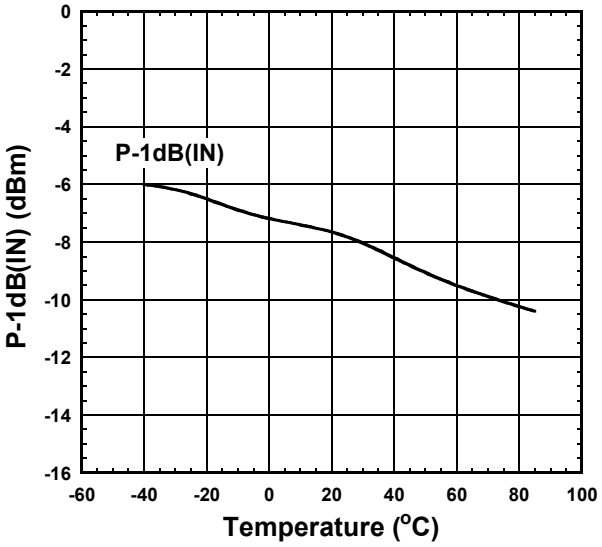
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, with application circuit)

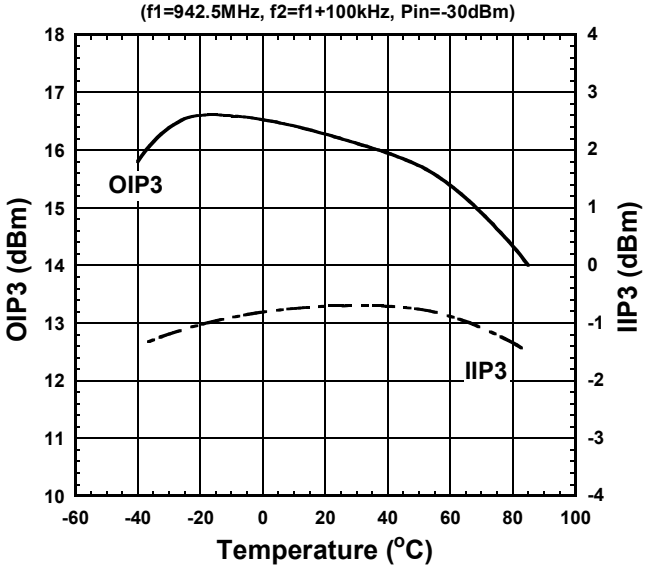
Gain, NF vs. Temperature
(f=942.5MHz)



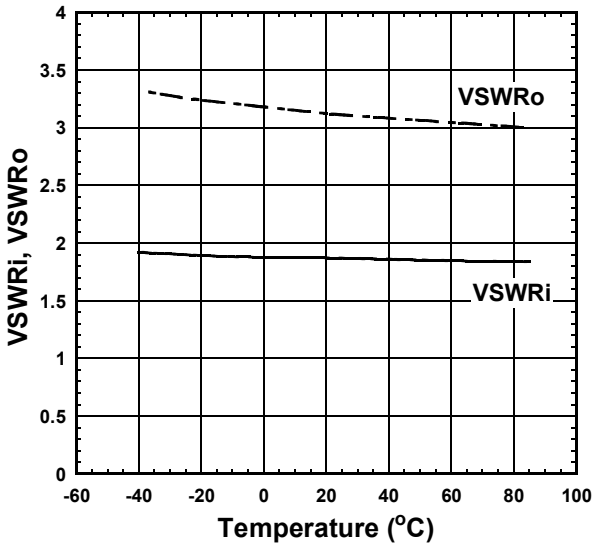
P-1dB(IN) vs. Temperature
(f=942.5MHz)



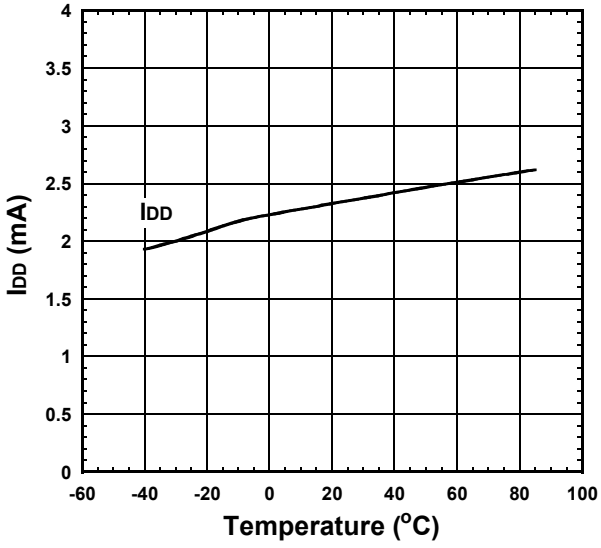
OIP3, IIP3 vs. Temperature
(f1=942.5MHz, f2=f1+100kHz, Pin=-30dBm)



VSWRi, VSWRo vs. Temperature
(f=942.5MHz)

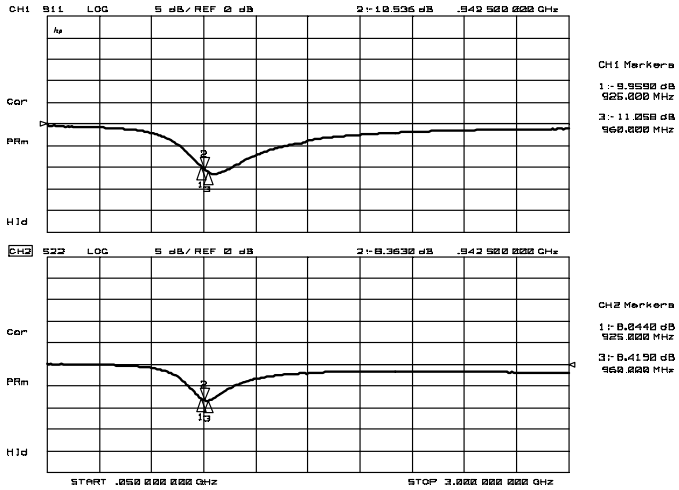


I_{DD} vs. Temperature
(RF OFF)

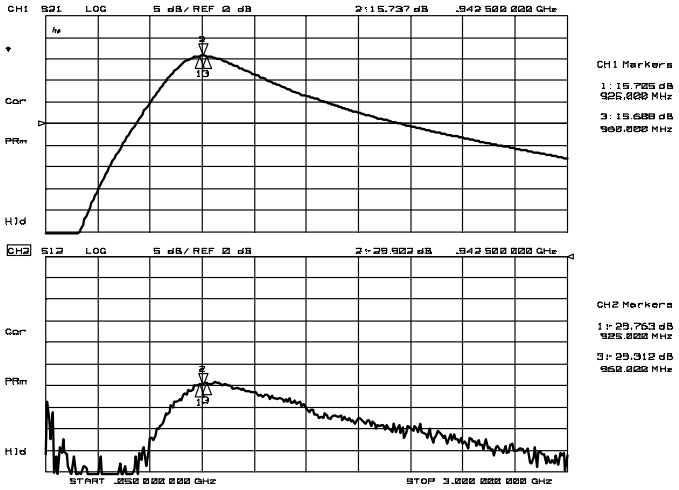


■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

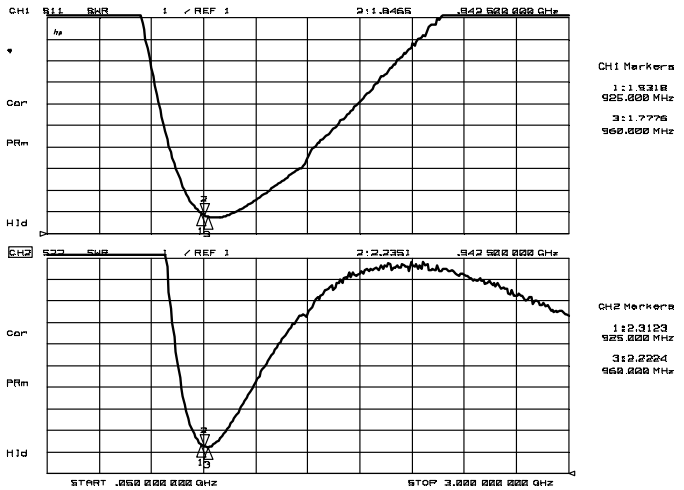
(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)



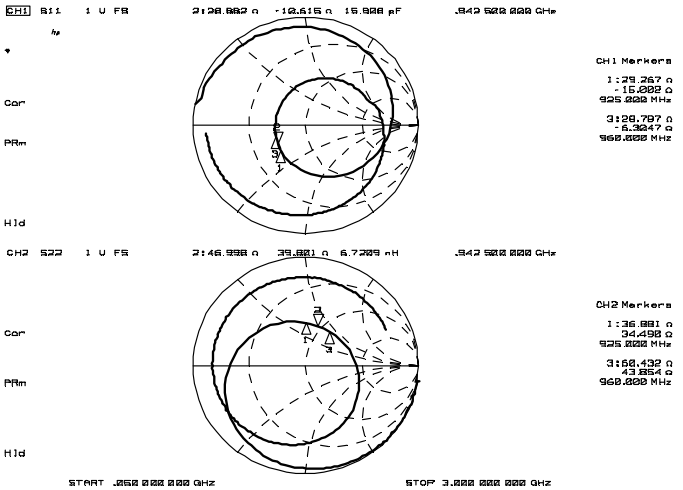
S11, S22



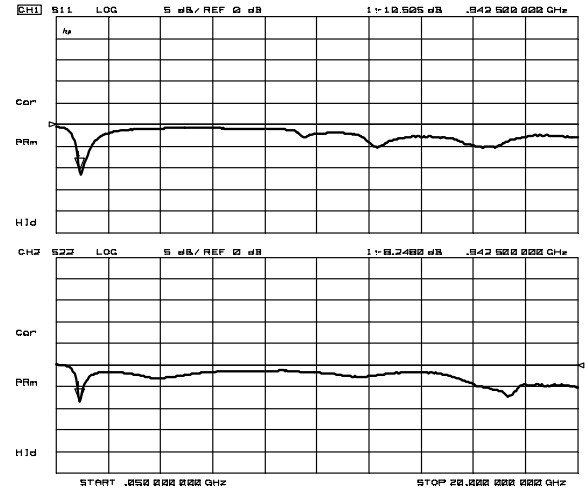
S21, S12



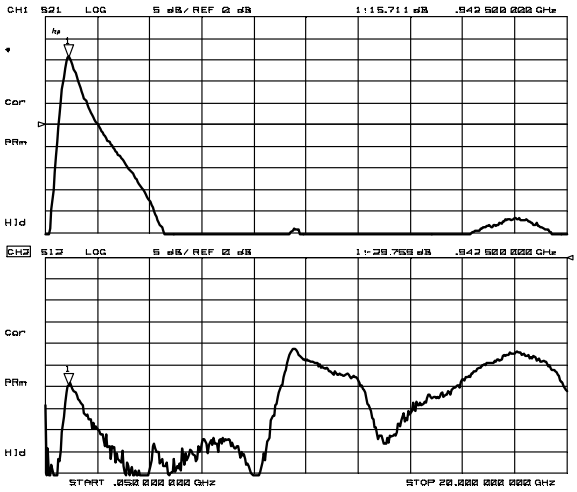
VSWR



Zin, Zout



S11, S22
(f=50MHz~20GHz)

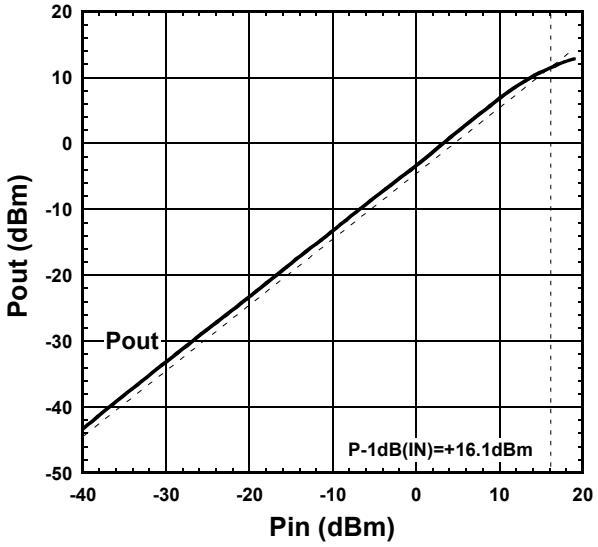


S21, S12
(f=50MHz~20GHz)

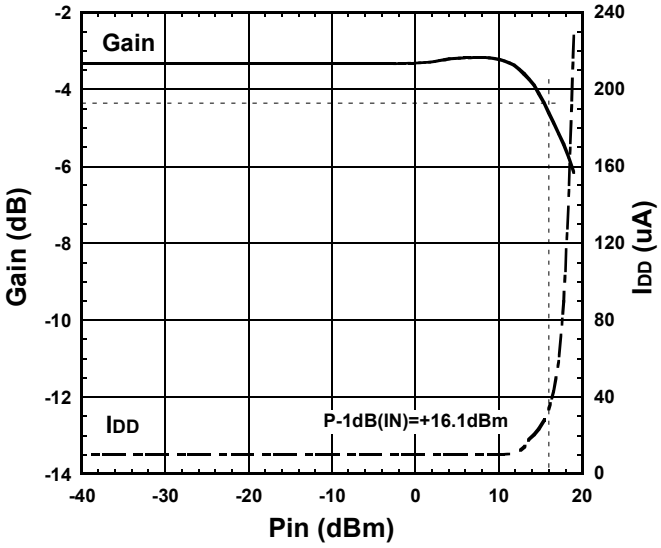
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

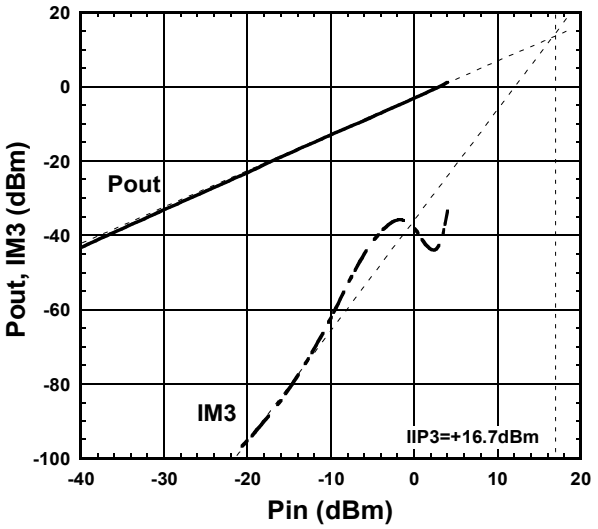
Pout vs. Pin
(f=942.5MHz)



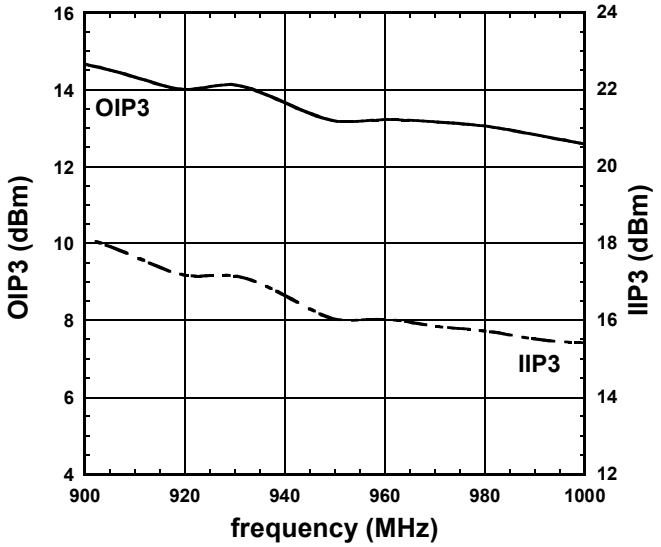
Gain, IDD vs. Pin
(f=942.5MHz)



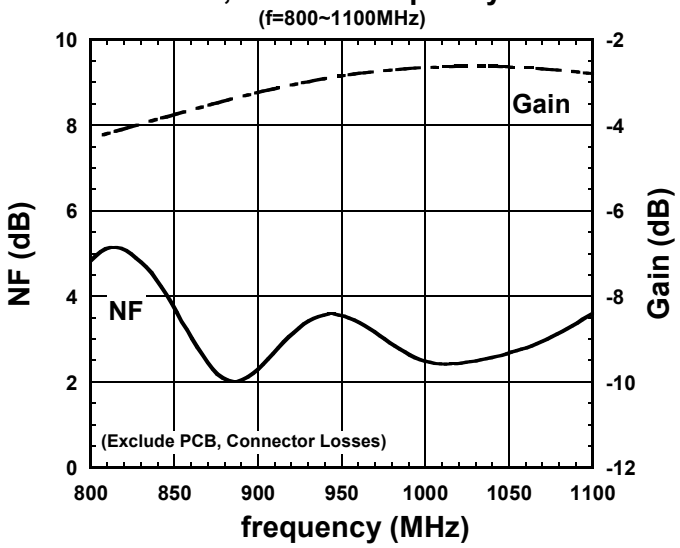
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



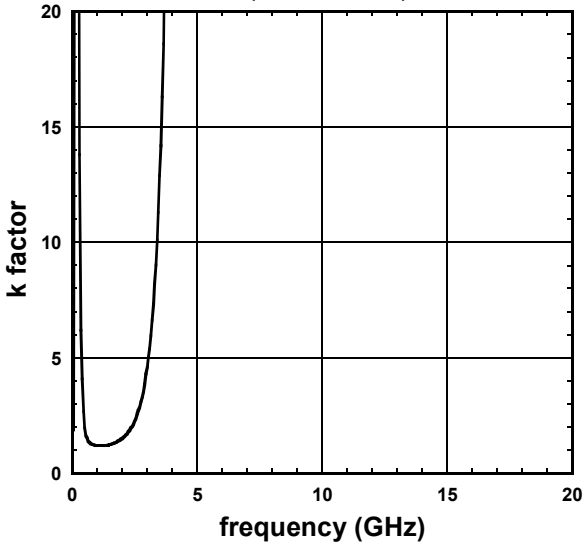
OIP3, IIP3 vs. Pin
(f1=900~1000MHz, f2=f1+100kHz, Pin=-20dBm)



NF, Gain vs. frequency
(f=800~1100MHz)



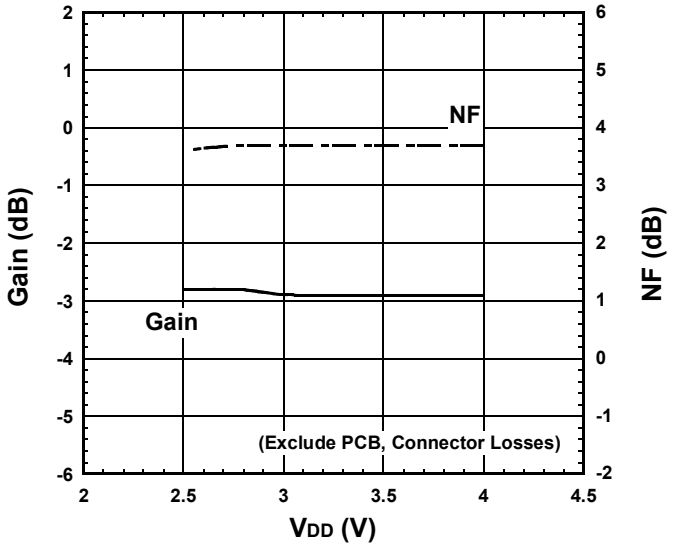
k factor vs. frequency
(f=50MHz~20GHz)



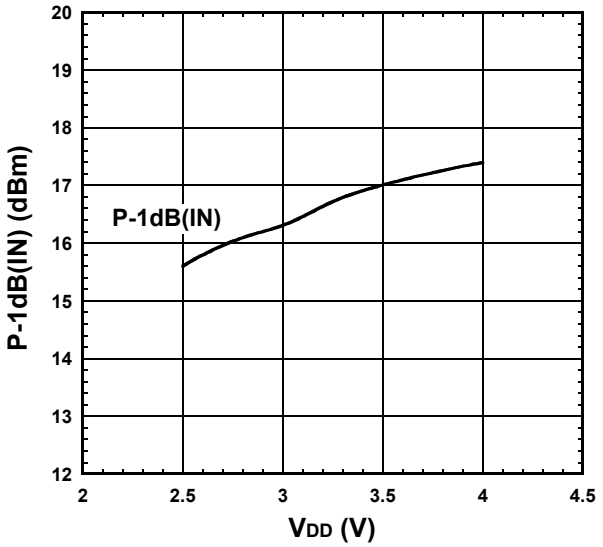
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)

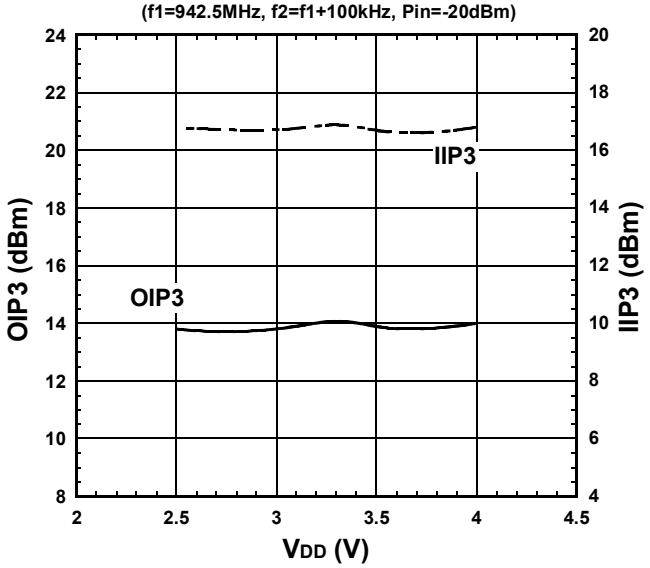
Gain, NF vs. VDD
(f=942.5MHz)



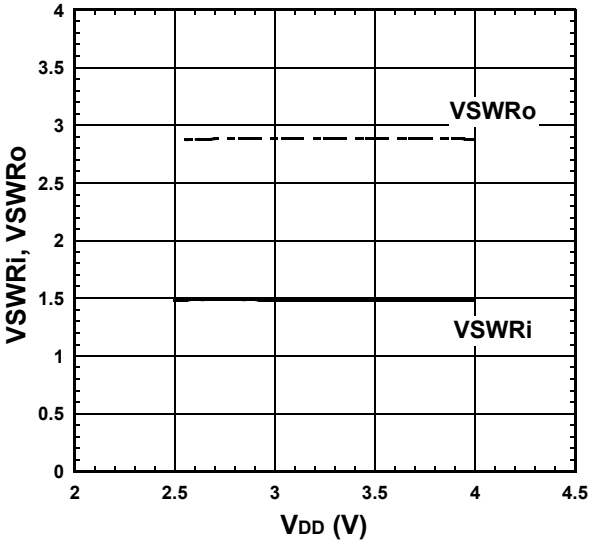
P-1dB(IN) vs. VDD
(f=942.5MHz)



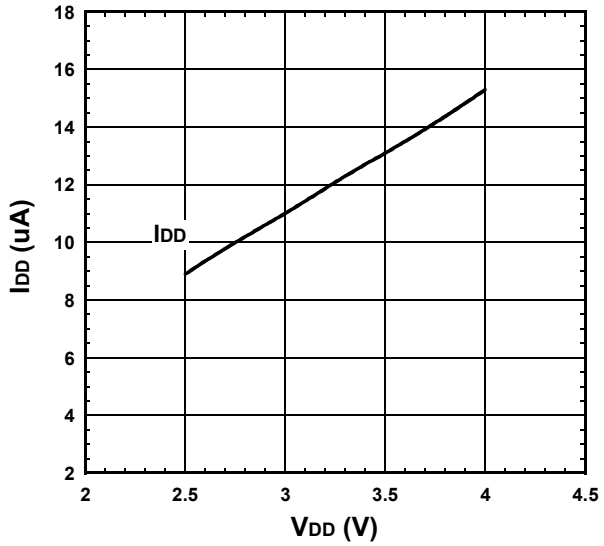
OIP3, IIP3 vs. VDD
(f1=942.5MHz, f2=f1+100kHz, Pin=-20dBm)



VSWRi, VSWRo vs. VDD
(f=942.5MHz)



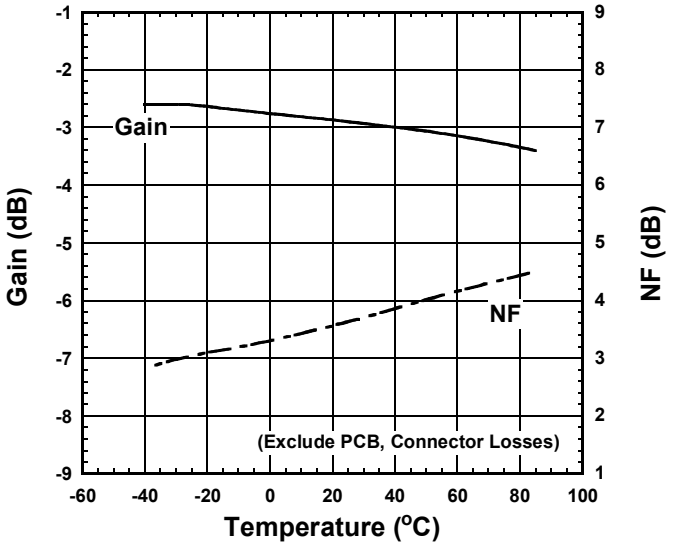
IDD vs. VDD
(RF OFF)



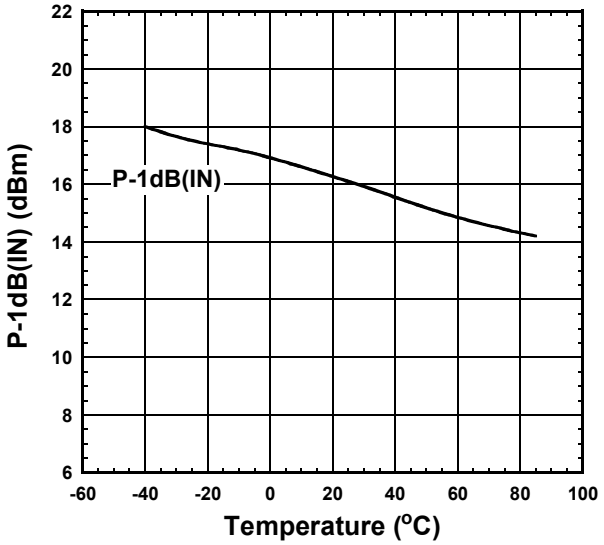
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, with application circuit)

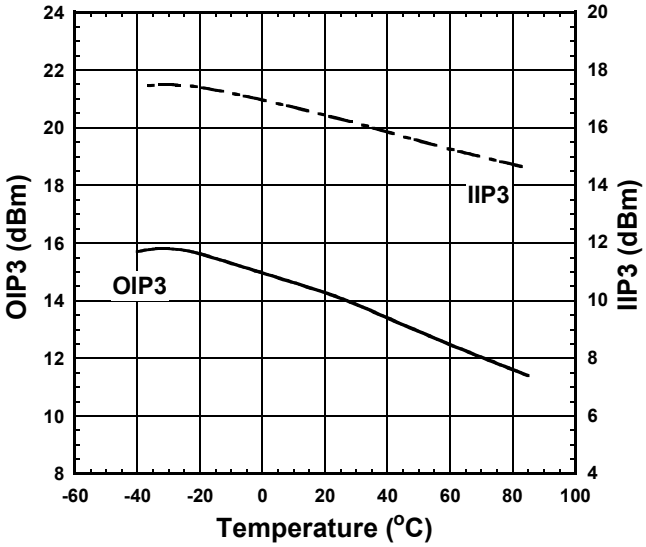
Gain, NF vs. Temperature
(f=942.5MHz)



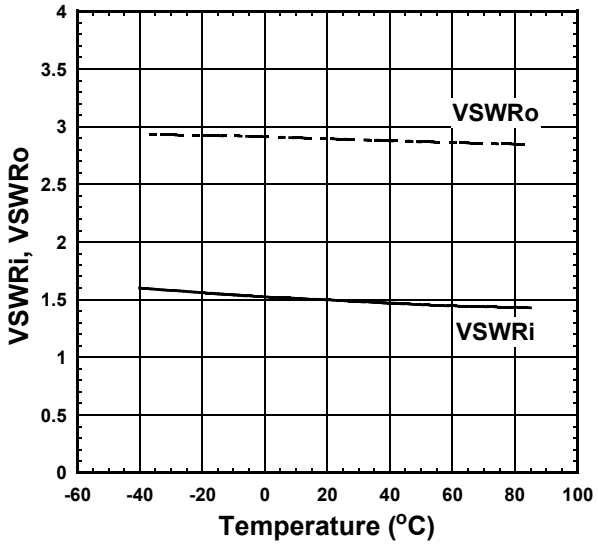
P-1dB(IN) vs. Temperature
(f=942.5MHz)



OIP3, IIP3 vs. Temperature
(f1=942.5MHz, f2=f1+100kHz, Pin=-20dBm)

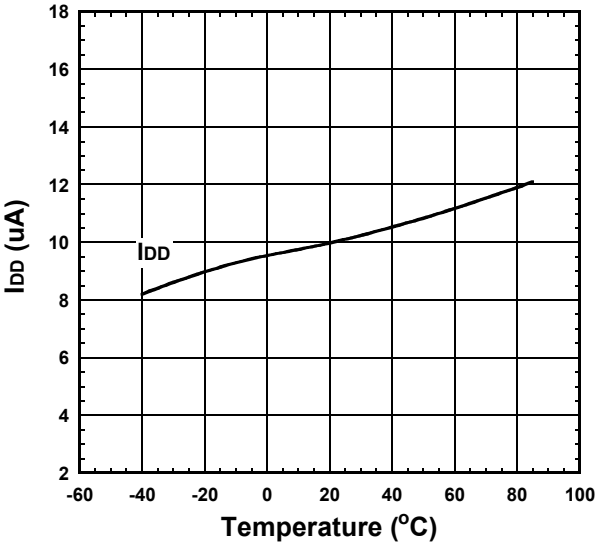


VSWRi, VSWRo vs. Temperature
(f=942.5MHz)



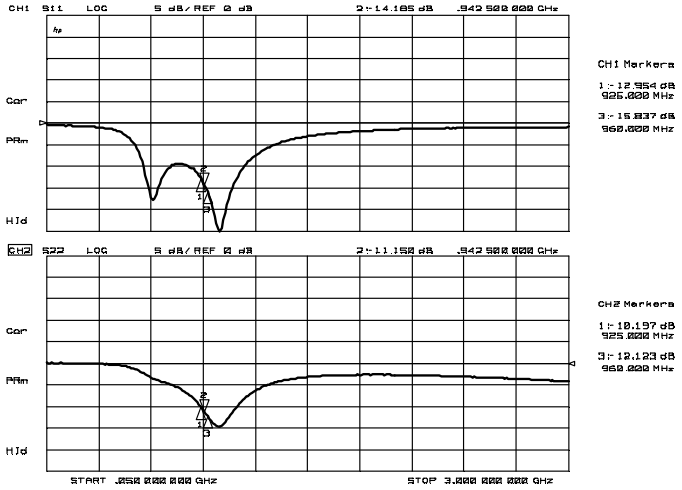
1

I_{DD} vs. Temperature
(RF OFF)

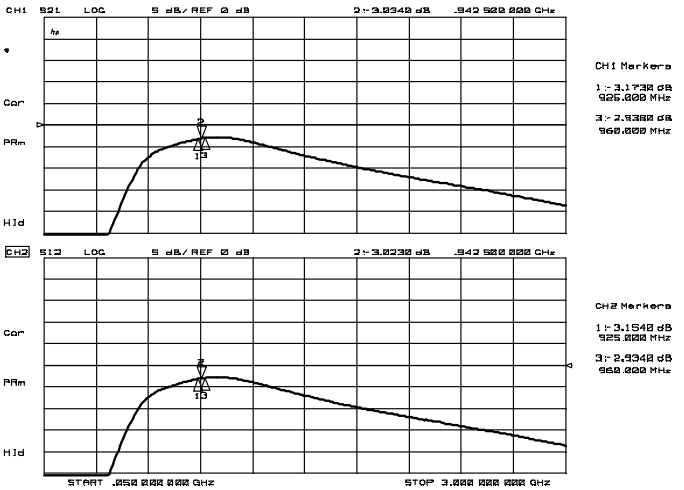


■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

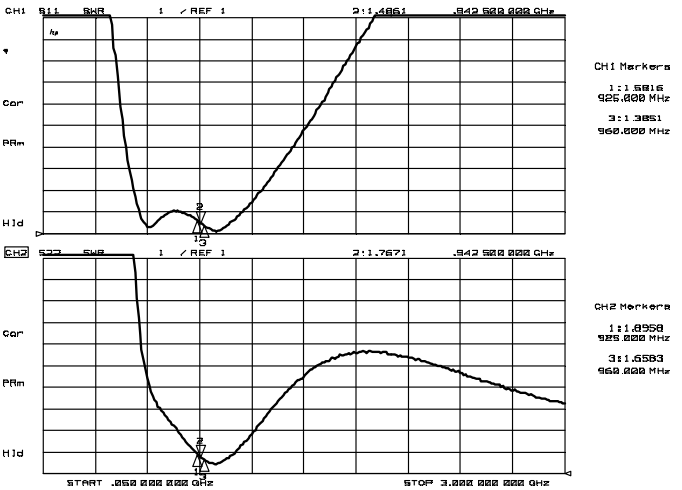
(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)



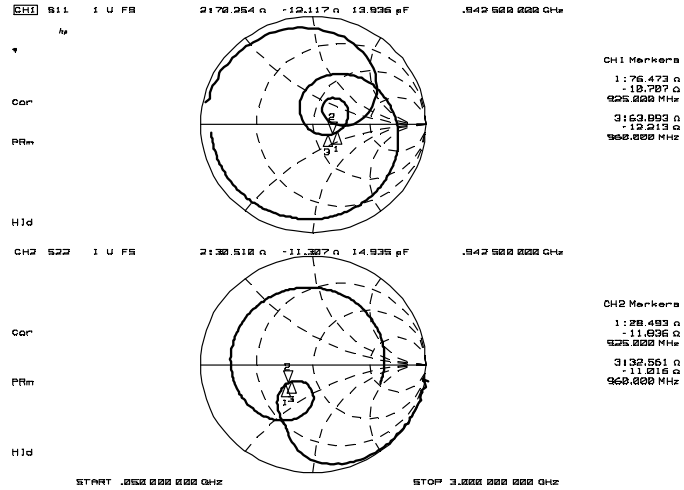
S11, S22



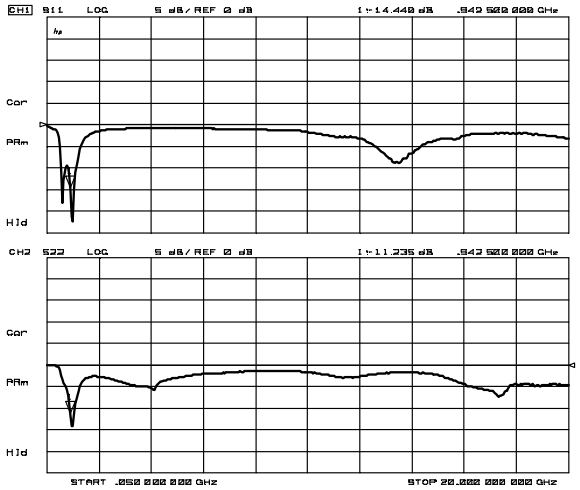
S21, S12



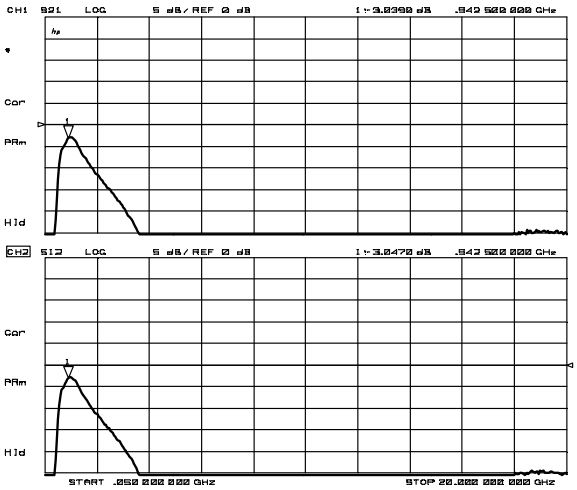
VSWR



Zin, Zout

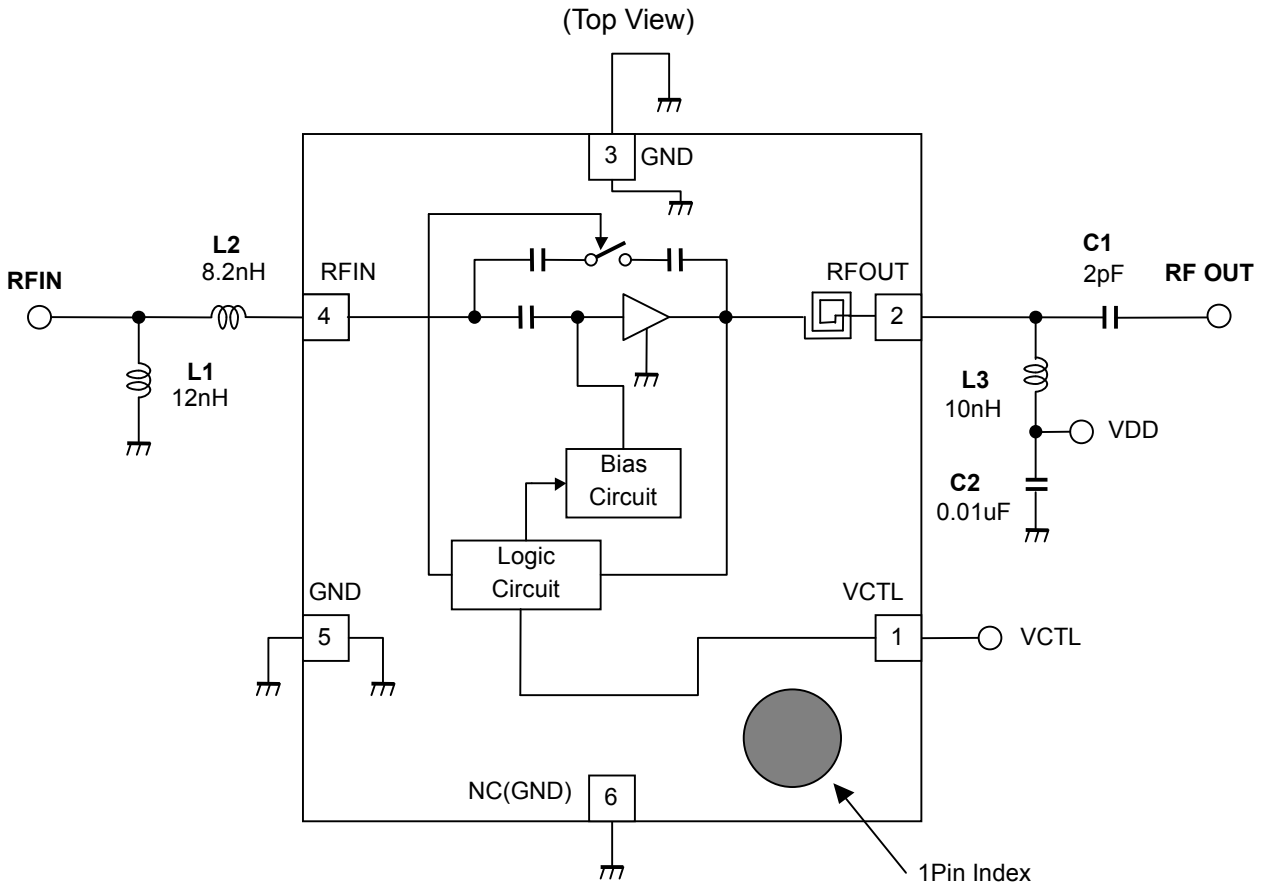


S11, S22
(f=50MHz~20GHz)



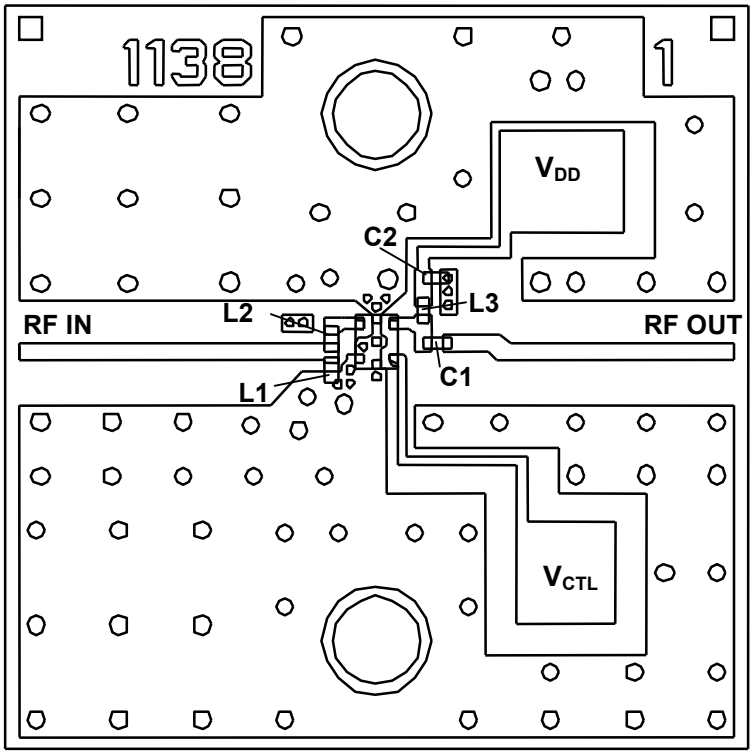
S21, S12
(f=50MHz~20GHz)

■ APPLICATION CIRCUIT



■ TEST PCB LAYOUT

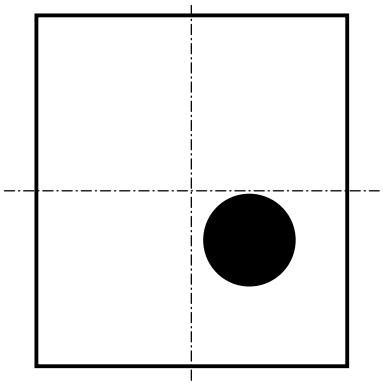
(Top View)

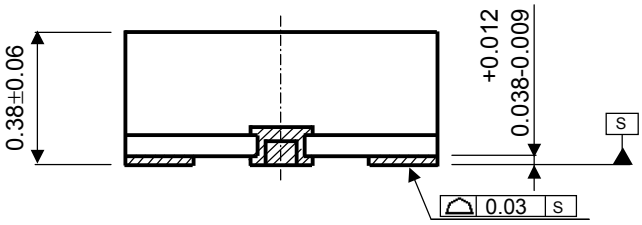


Parts ID	Comments
L1, L2	Murata LQP03T Series
L3	TDK MLK0603 Series
C1, C2	Murata GRM03 Series

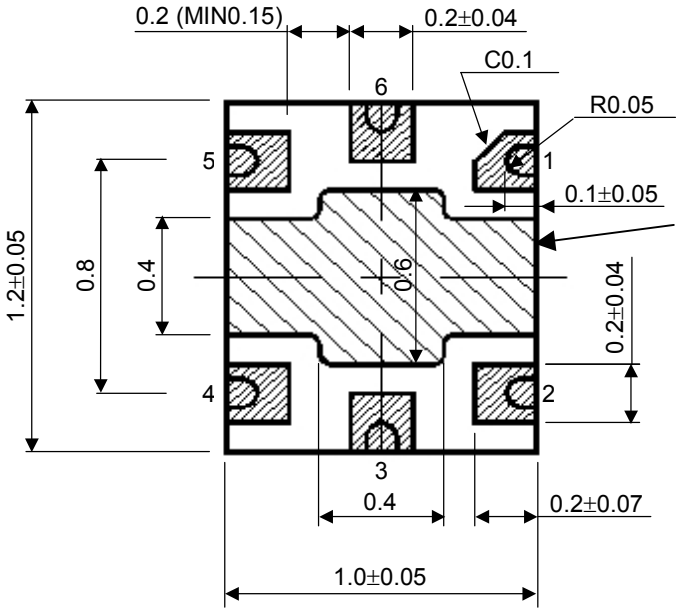
PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.4mm (Z_0=50ohm)
PCB SIZE=17.0mm x 17.0mm

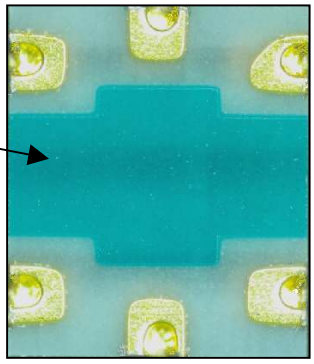
■ PACKAGE OUTLINE (USB6-A8)





TERMINAL TREAT	:Au
Substrate	:Glass epoxy
Molding material	:Epoxy resin
UNIT	:mm
WEIGHT	:1.1mg





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.

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NJR:

NJG1138HA8 NJG1138HA8-TE1

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