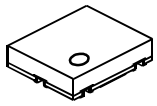
900MHz Band LNA GaAs MMIC

■ 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

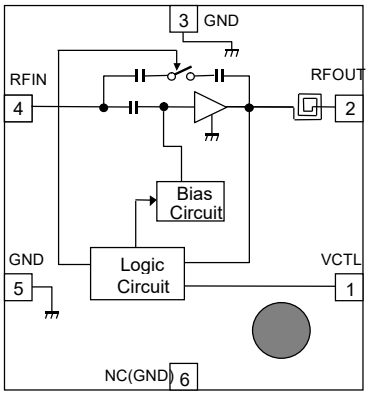
UMTS and LTE Low band applications
Mobile phone, Data card, modem and others mobile device applications
700MHz Band application*

*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**

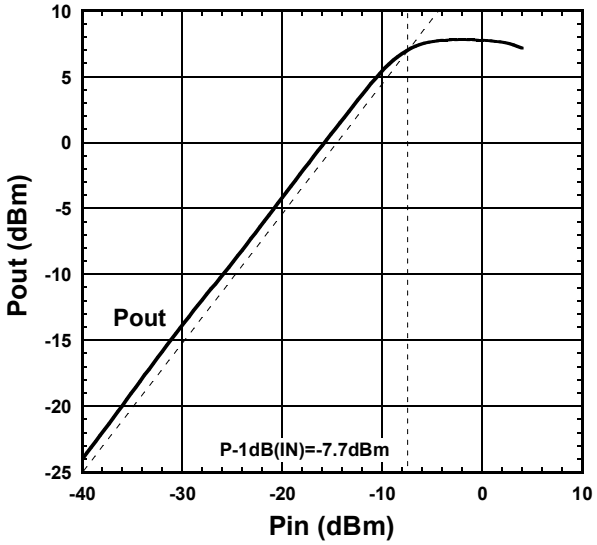
No.	SYMBOL	DESCRIPTION
1	VCTL	Gain control port. Inputting a logic-high, the LNA turn at high gain mode. Inputting a logic-low, the LNA turn at low gain mode.
2	RFOUT	RF output terminal. Requires an external matching components. This terminal should be connected a DC blocking capacitor C1.
3	GND	Ground 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.

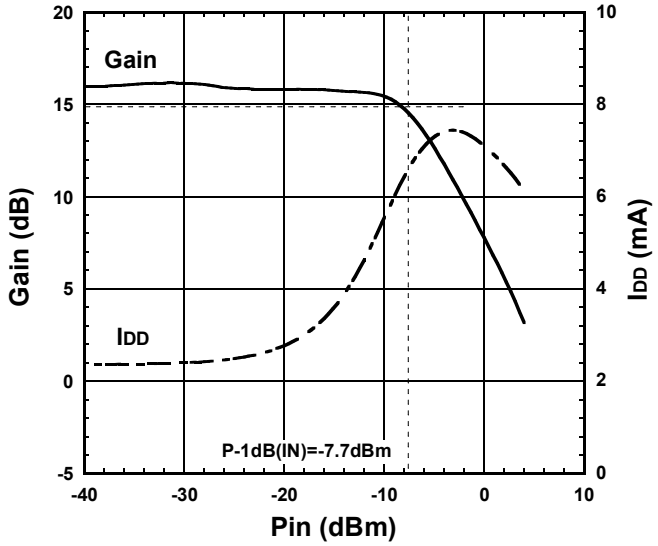
■ **ELECTRICAL CHARACTERISTICS (High Gain Mode)**

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

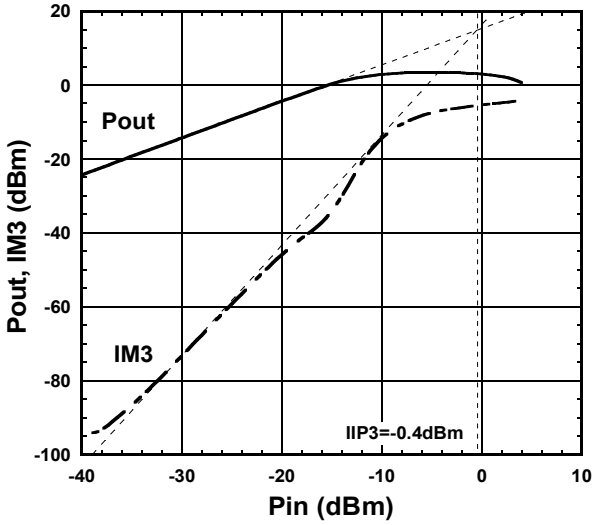
Pout vs. Pin
(f=942.5MHz)



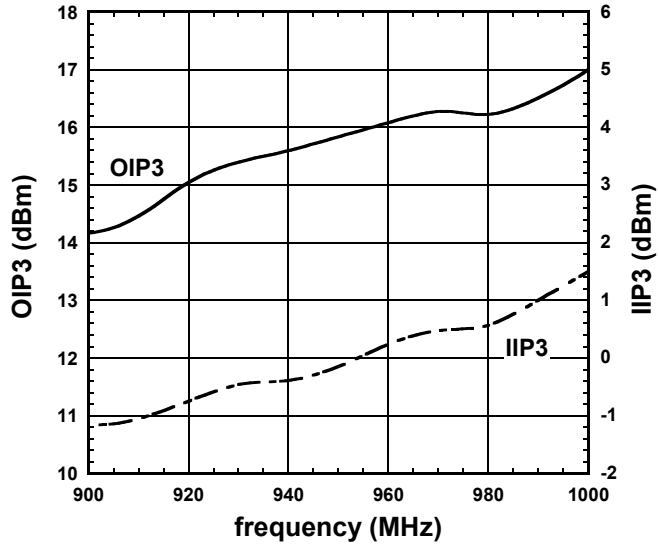
Gain, I_{DD} vs. Pin
(f=942.5MHz)



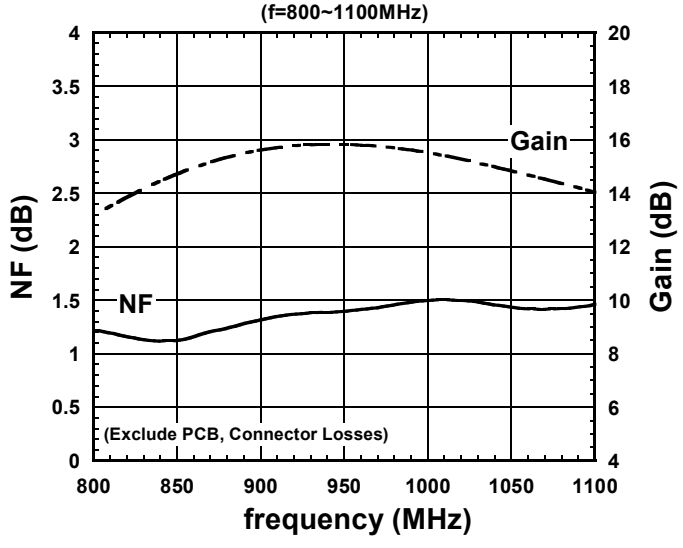
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



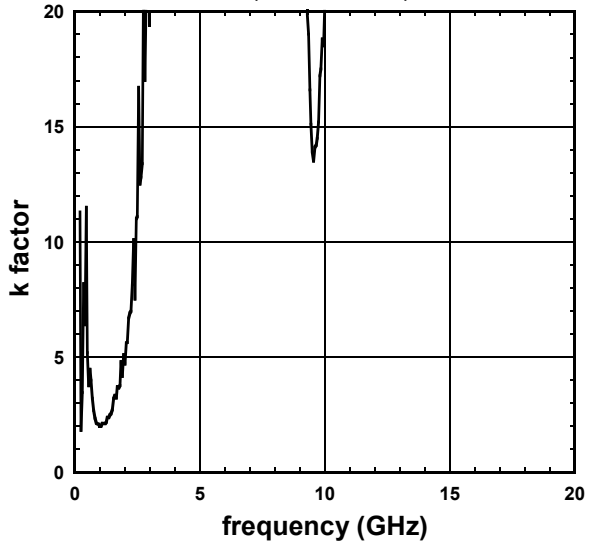
OIP3, IIP3 vs. frequency
(f1=900~1000MHz, f2=f1+100kHz, Pin=-30dBm)



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



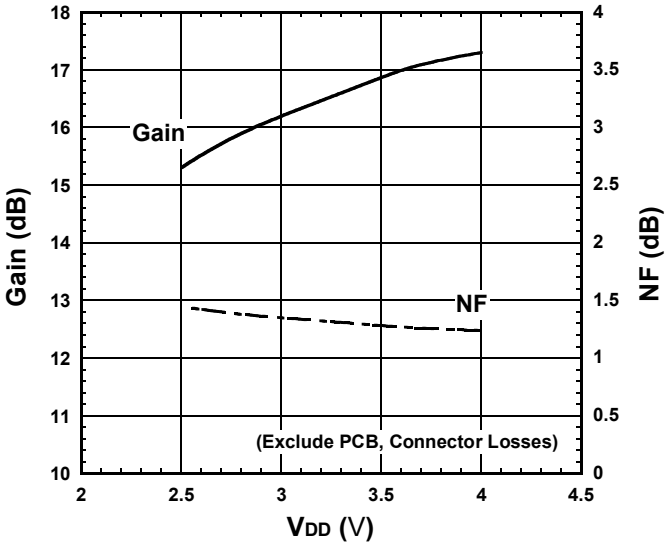
k factor vs. frequency
(f=50MHz~20GHz)



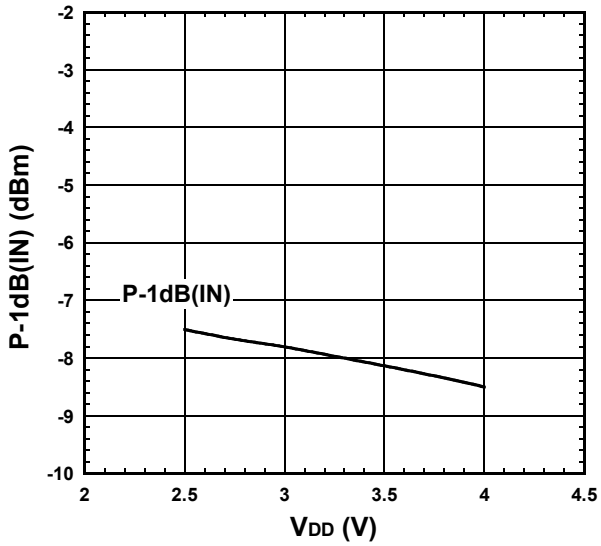
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

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

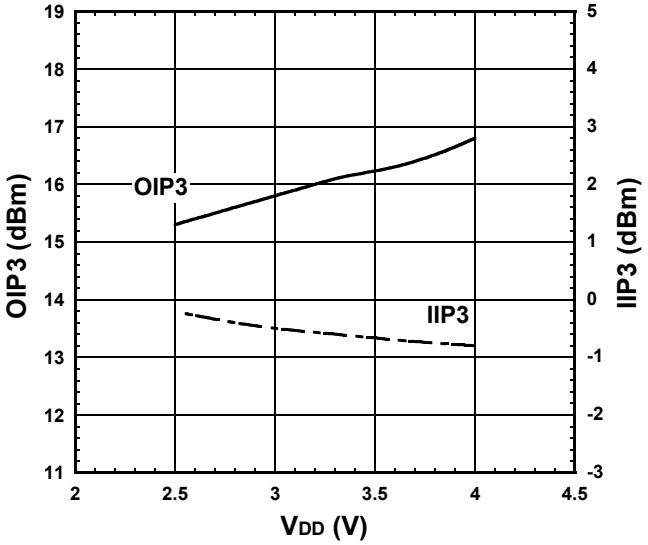
Gain, NF vs. V_{DD}
(f=942.5MHz)



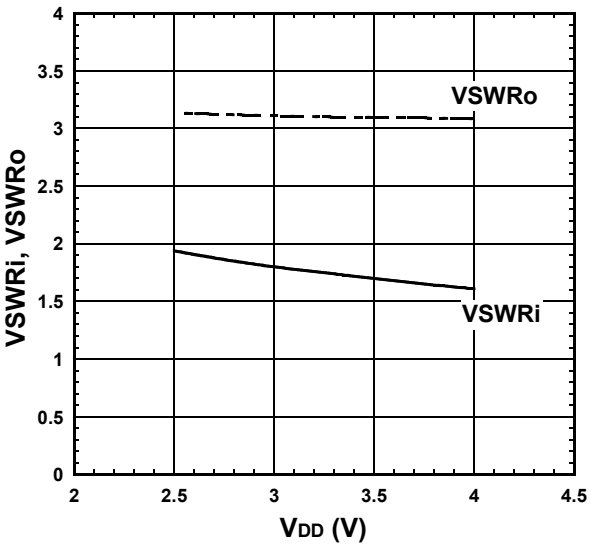
P-1dB(IN) vs. V_{DD}
(f=942.5MHz)



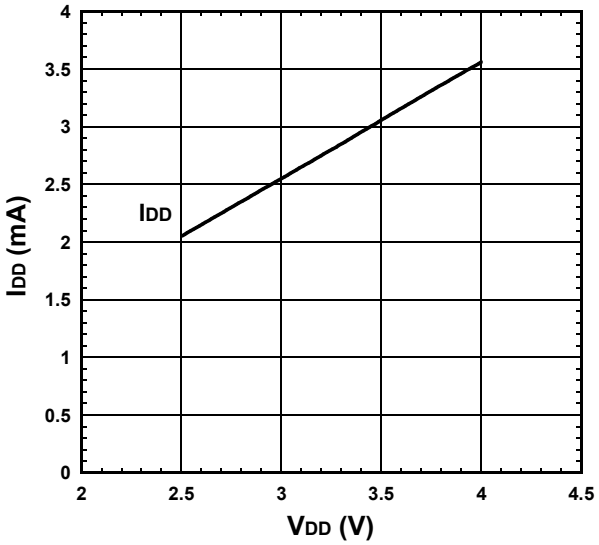
OIP3, IIP3 vs. V_{DD}
(f1=942.5MHz, f2=f1+100kHz, Pin=-30dBm)



VSWRi, VSWRo vs. V_{DD}
(f=942.5MHz)



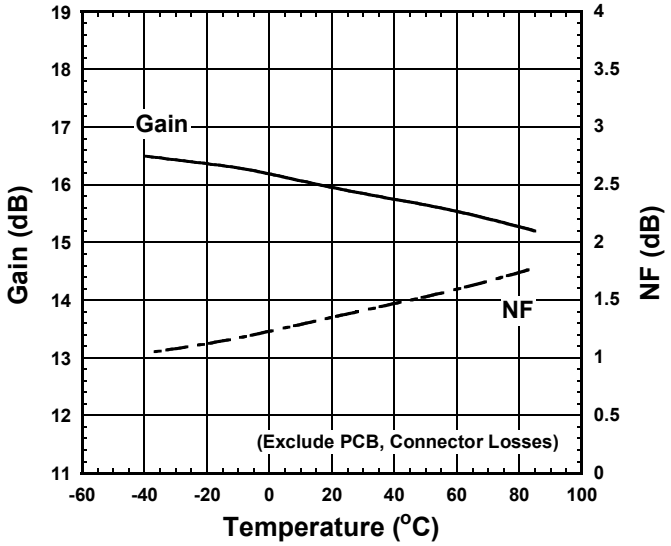
I_{DD} vs. V_{DD}
(RF OFF)



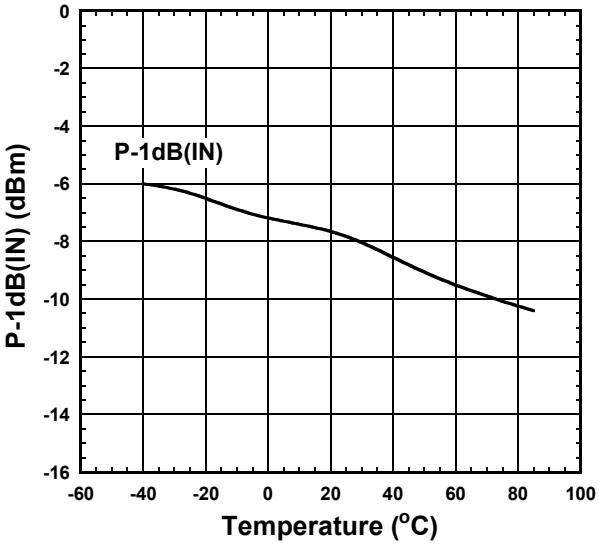
■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

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

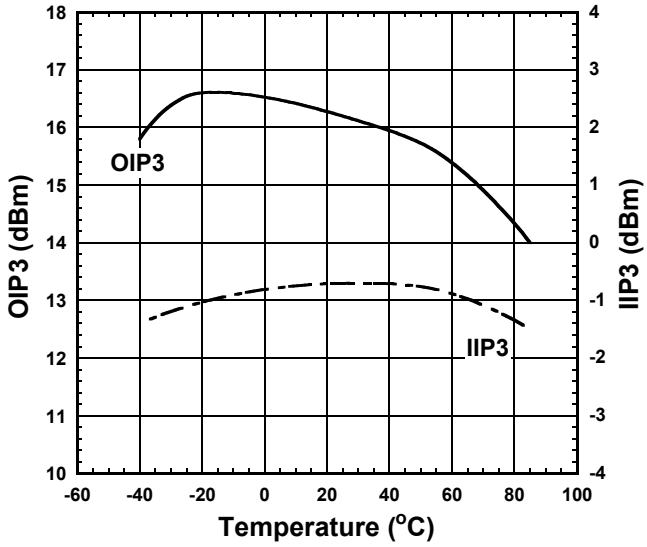
Gain, NF vs. Temperature
(f=942.5MHz)



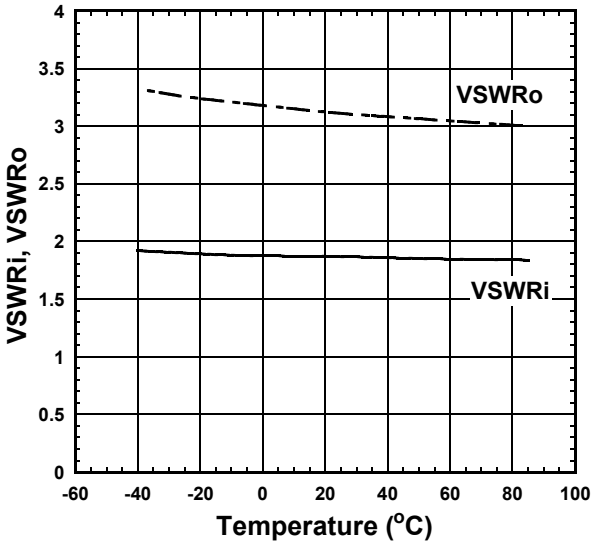
P-1dB(IN) vs. Temperature
(f=942.5MHz)



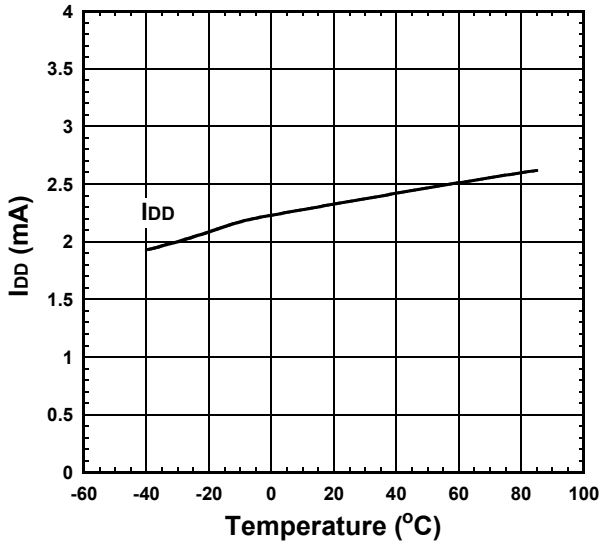
OIP3, IIP3 vs. Temperature
(f1=942.5MHz, f2=f1+100kHz, Pin=-30dBm)



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

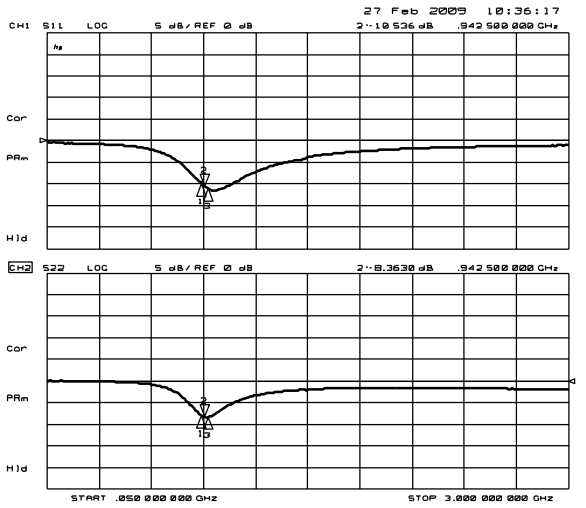


I_{DD} vs. Temperature
(RF OFF)

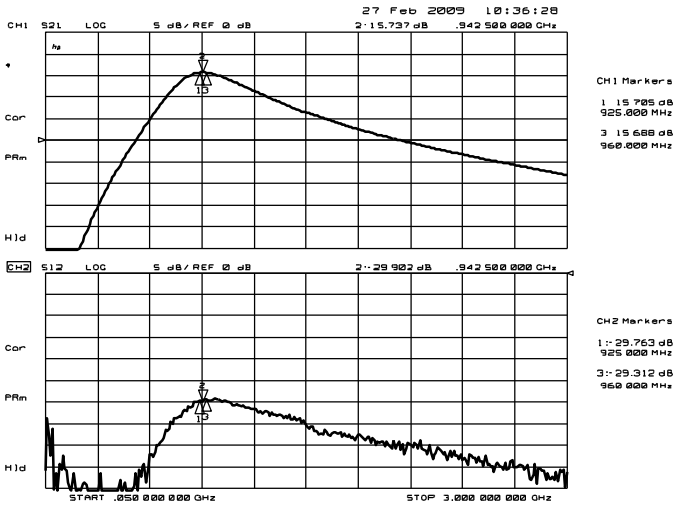


■ ELECTRICAL CHARACTERISTICS (High Gain Mode)

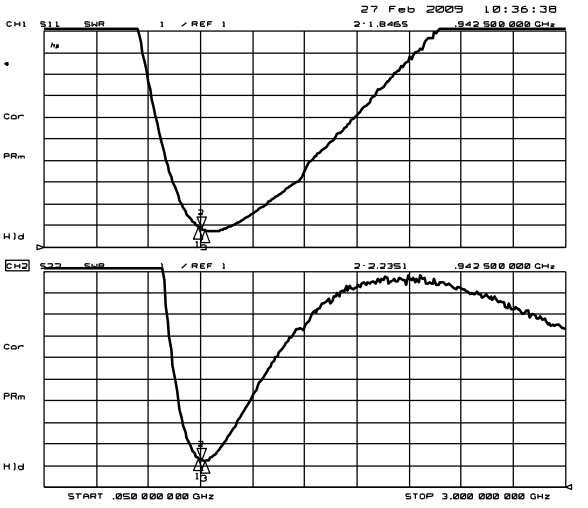
(General Conditions: V_{DD}=2.8V, V_{CTL}=1.8V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)



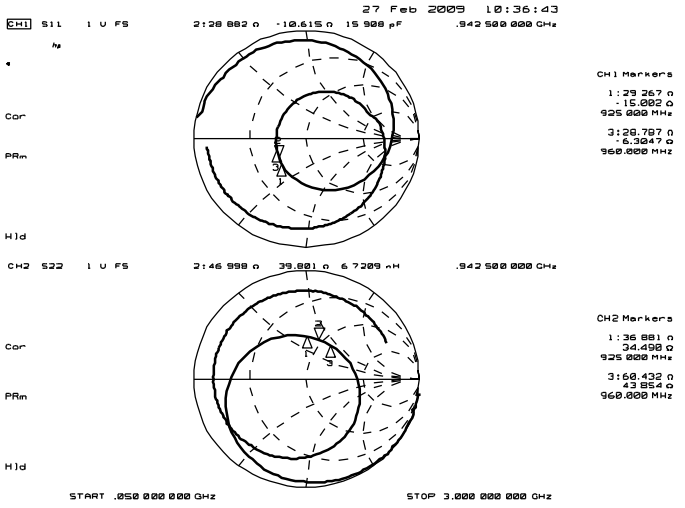
S11, S22



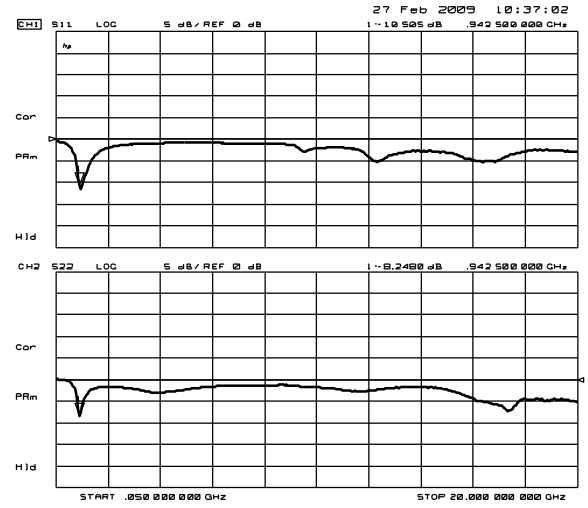
S21, S12



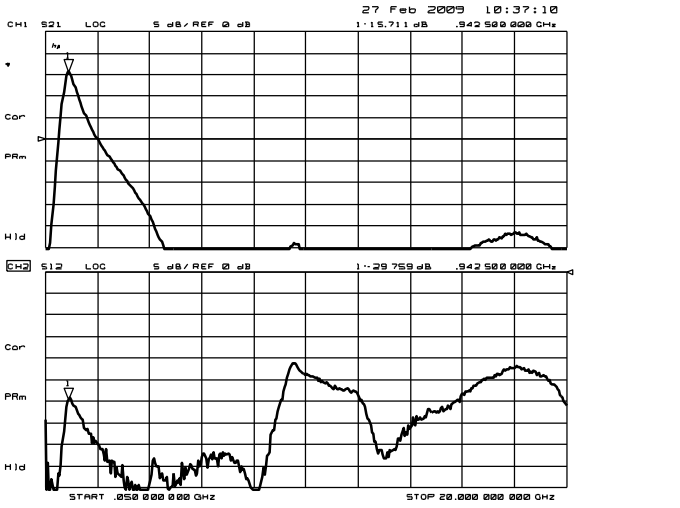
VSWR



Zin, Zout



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

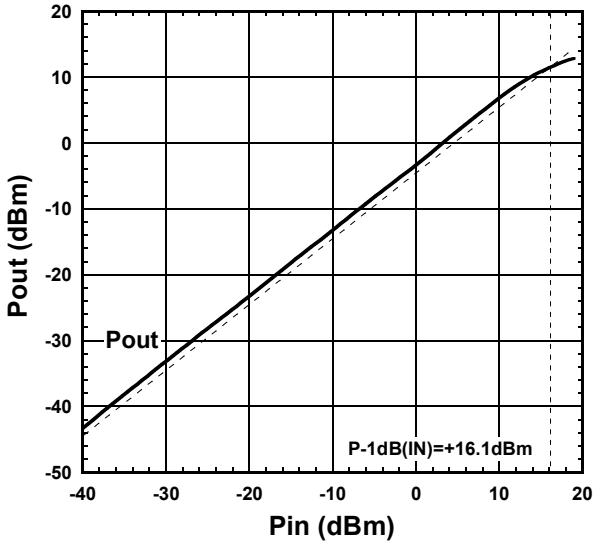


S21, S12
(f=50MHz~20GHz)

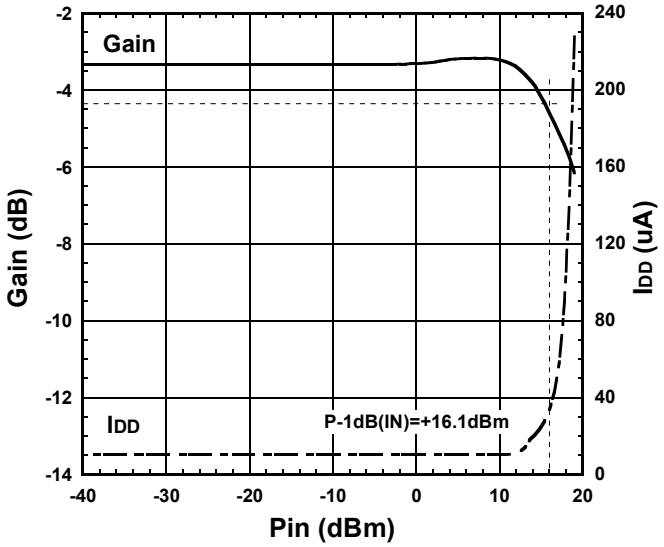
■ **ELECTRICAL CHARACTERISTICS (Low Gain Mode)**

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

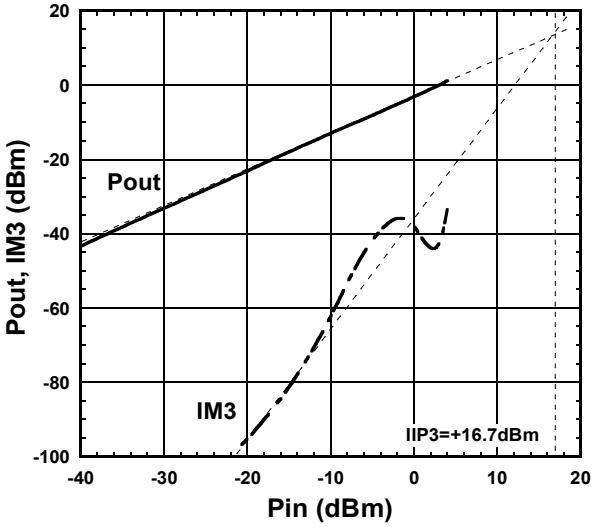
Pout vs. Pin
(f=942.5MHz)



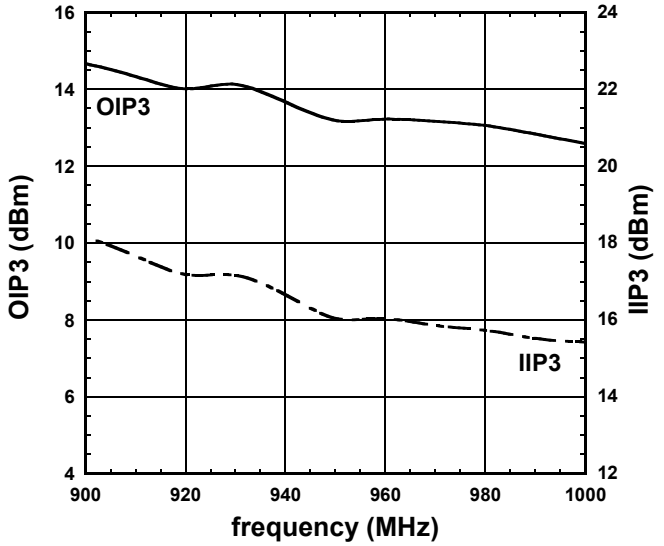
Gain, IDD vs. Pin
(f=942.5MHz)



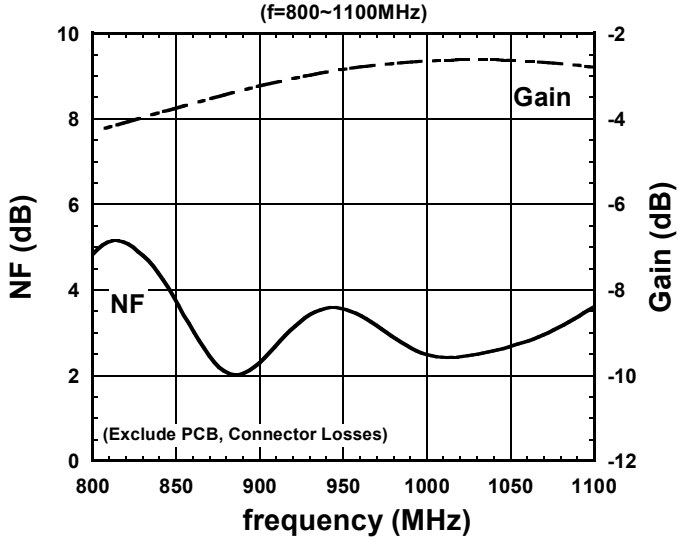
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



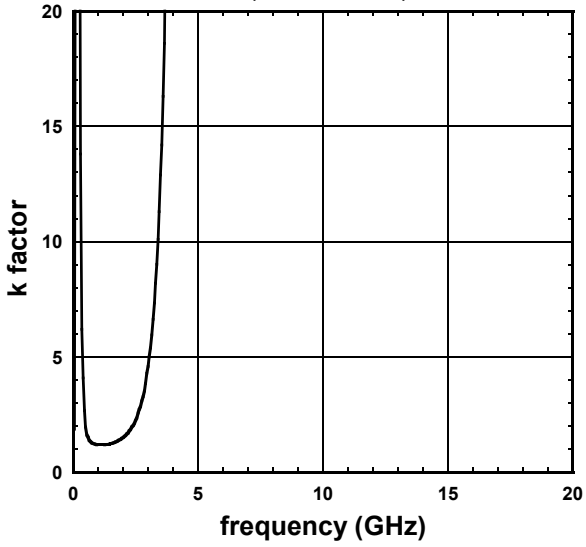
OIP3, IIP3 vs. Pin
(f1=900~1000MHz, f2=f1+100kHz, Pin=-20dBm)



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



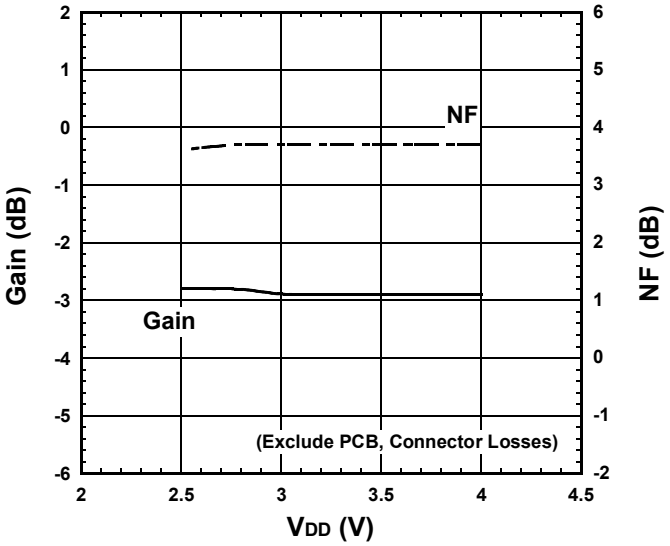
k factor vs. frequency
(f=50MHz~20GHz)



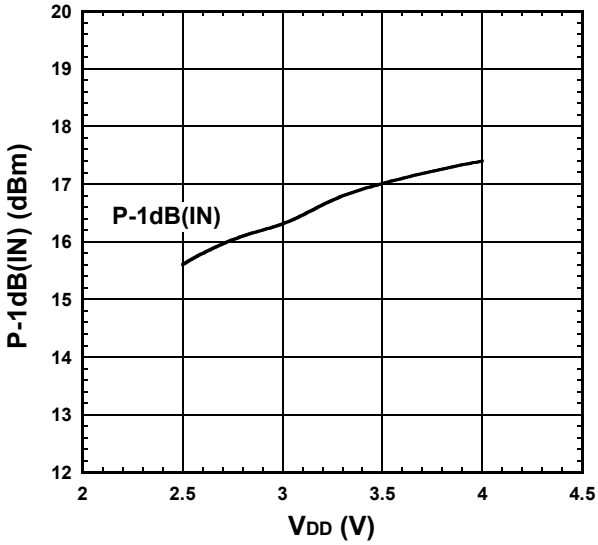
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

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

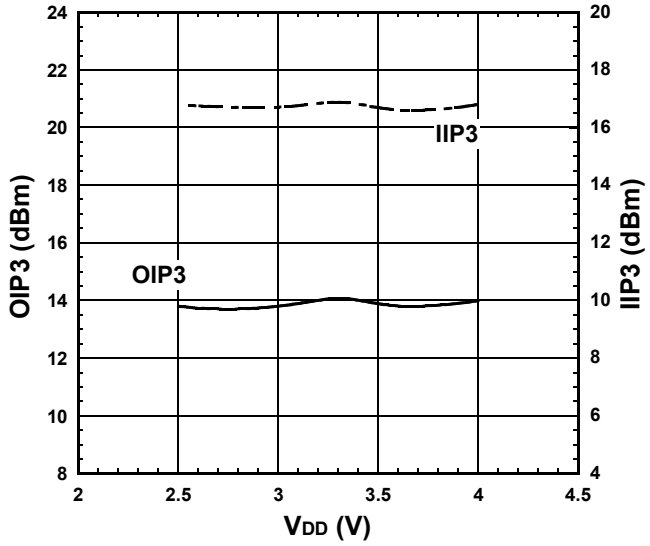
Gain, NF vs. V_{DD}
(f=942.5MHz)



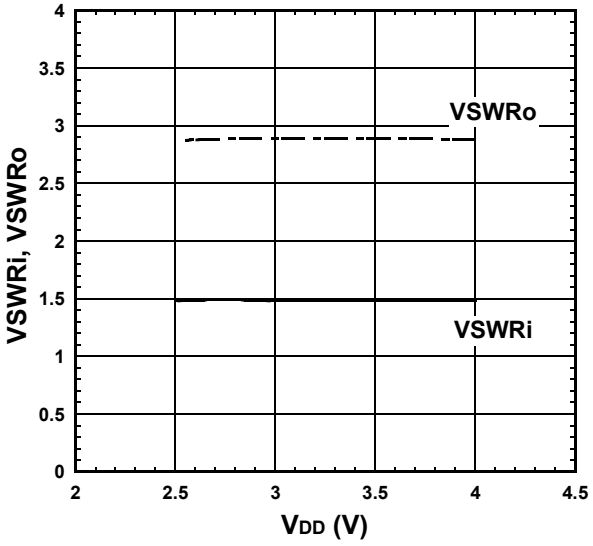
P-1dB(IN) vs. V_{DD}
(f=942.5MHz)



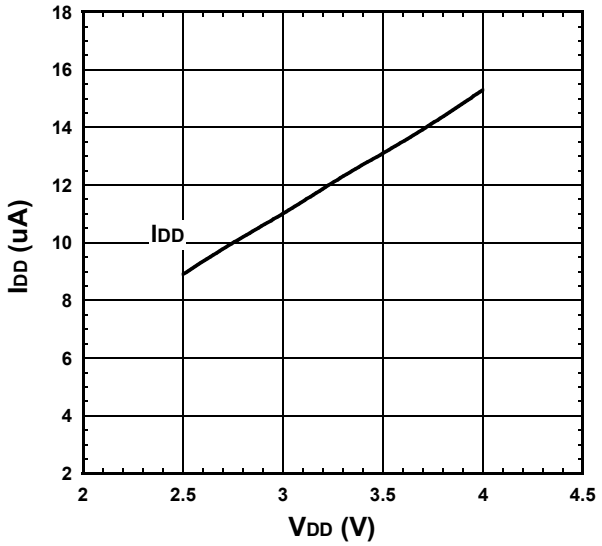
OIP3, IIP3 vs. V_{DD}
(f1=942.5MHz, f2=f1+100kHz, Pin=-20dBm)



VSWRi, VSWRo vs. V_{DD}
(f=942.5MHz)



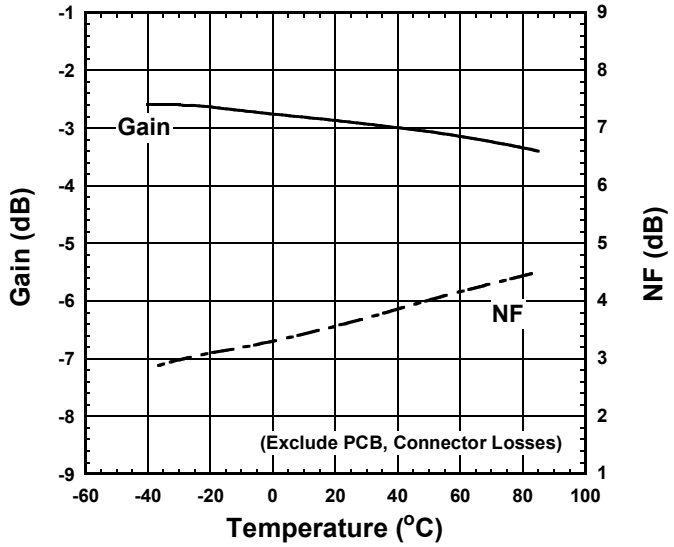
I_{DD} vs. V_{DD}
(RF OFF)



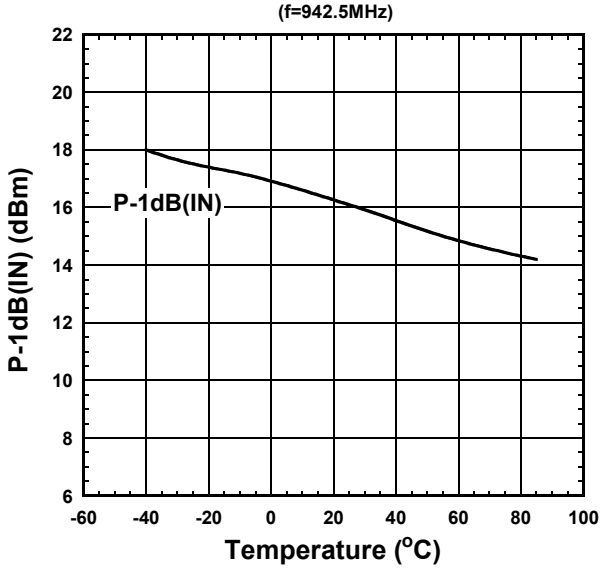
■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

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

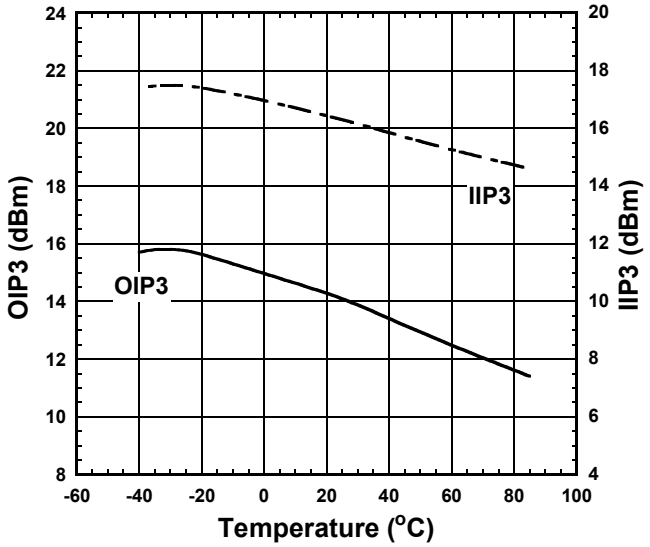
Gain, NF vs. Temperature
(f=942.5MHz)



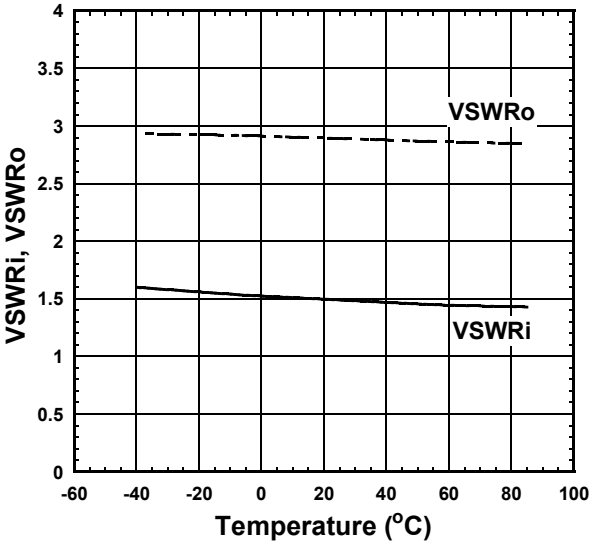
P-1dB(IN) vs. Temperature
(f=942.5MHz)



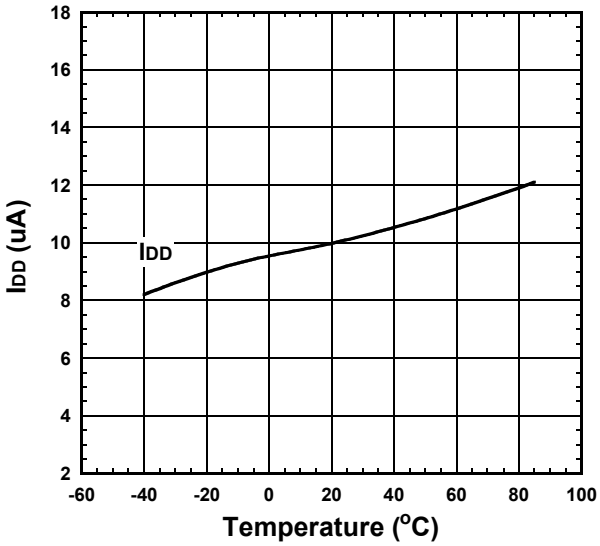
OIP3, IIP3 vs. Temperature
(f1=942.5MHz, f2=f1+100kHz, Pin=-20dBm)



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

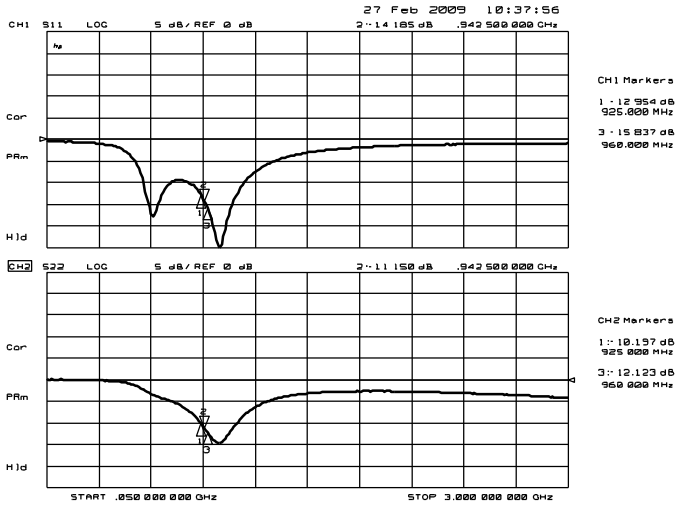


I_{DD} vs. Temperature
(RF OFF)

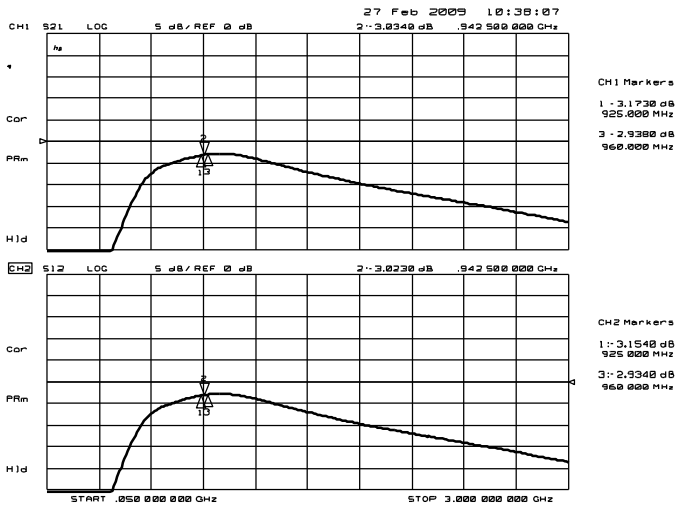


■ ELECTRICAL CHARACTERISTICS (Low Gain Mode)

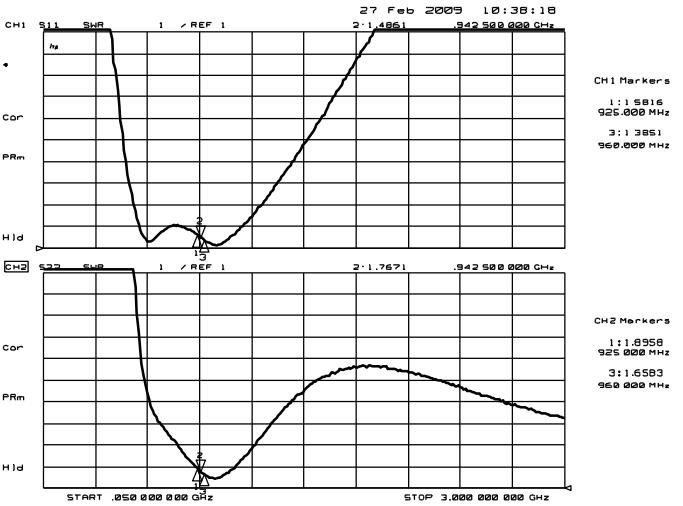
(General Conditions: V_{DD}=2.8V, V_{CTL}=0V, f_{RF}=942.5MHz, Zs=Zl=50 Ω, Ta=+25°C, with application circuit)



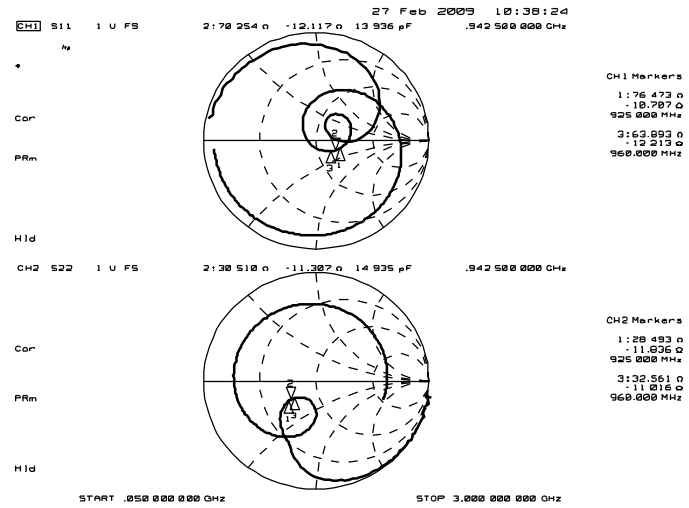
S11, S22



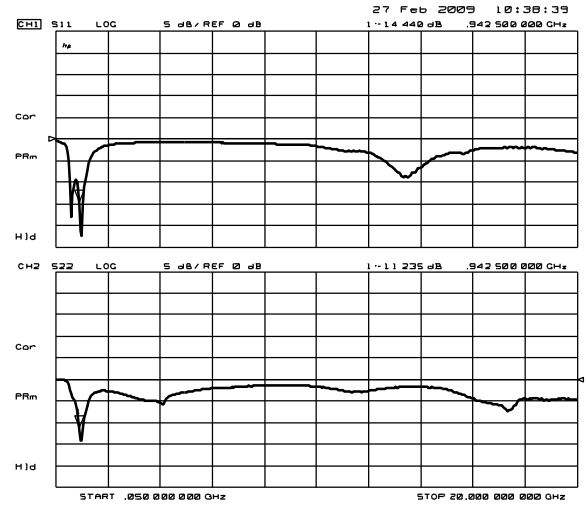
S21, S12



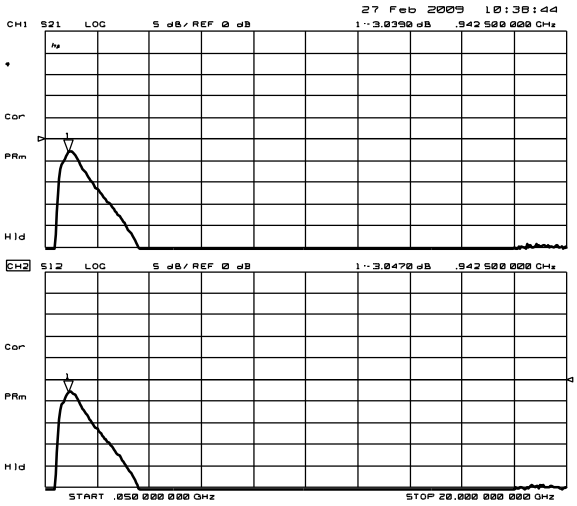
VSWR



Zin, Zout

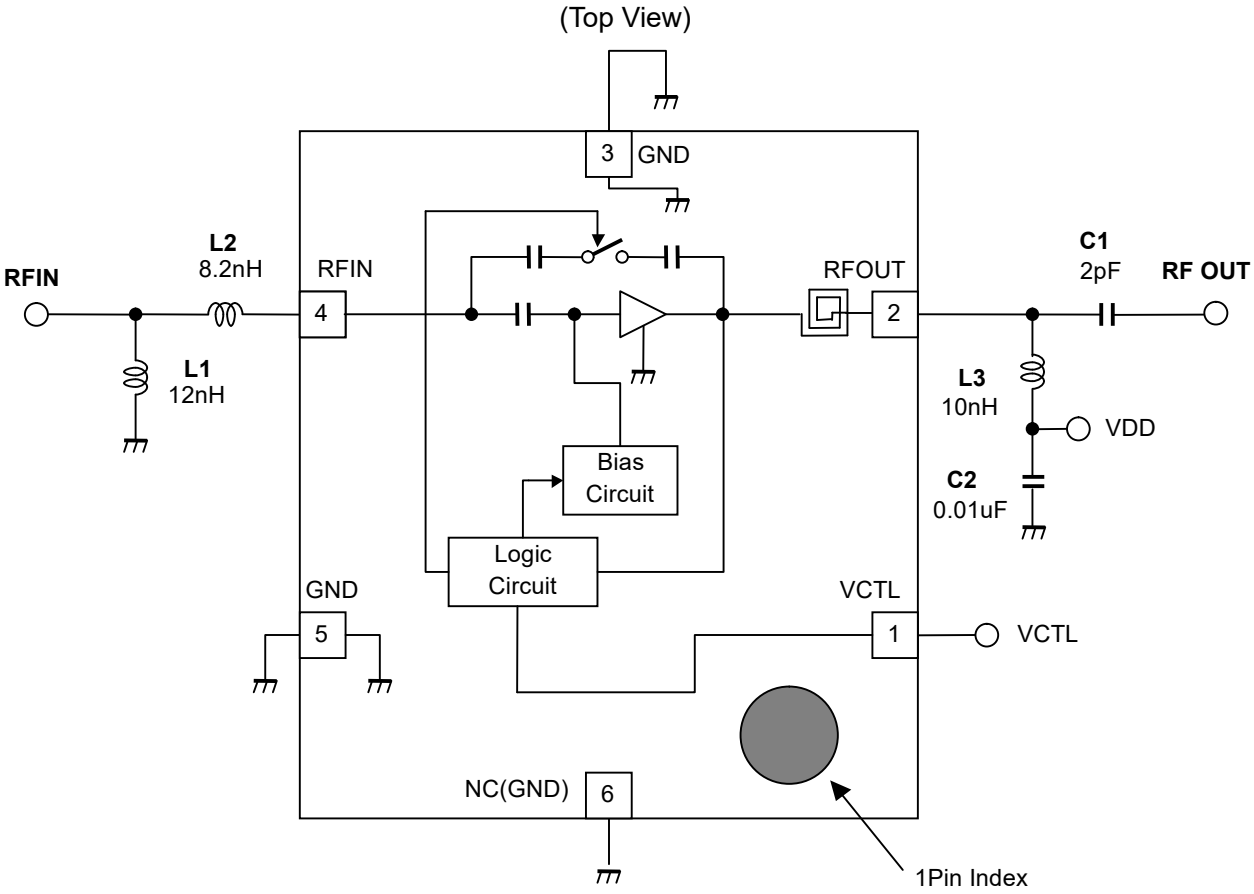


S11, S22
(f=50MHz~20GHz)

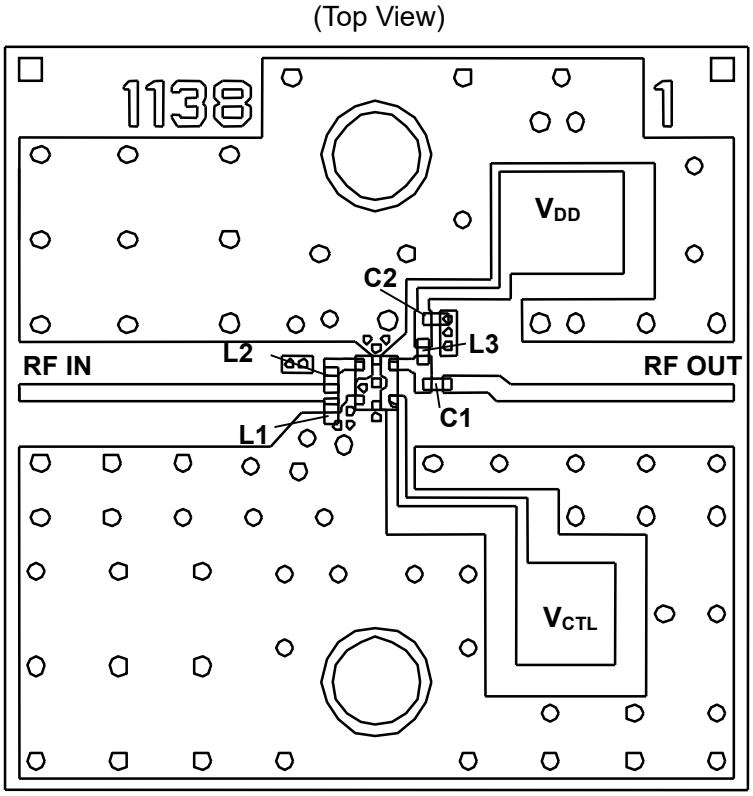


S21, S12
(f=50MHz~20GHz)

■ **APPLICATION CIRCUIT**



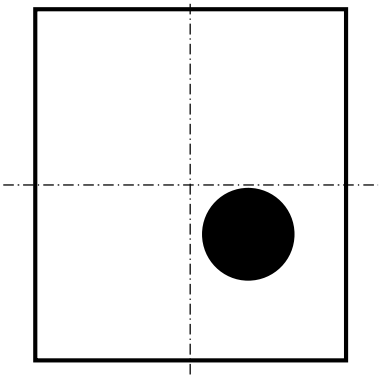
■ **TEST PCB LAYOUT**

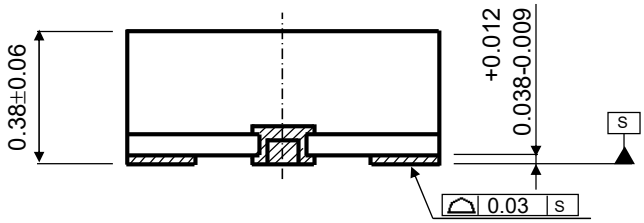


Parts ID	Comments
L1, L2	Murata LQP03T Series
L3	TDK MLK0603 Series
C1, C2	Murata GRM03 Series

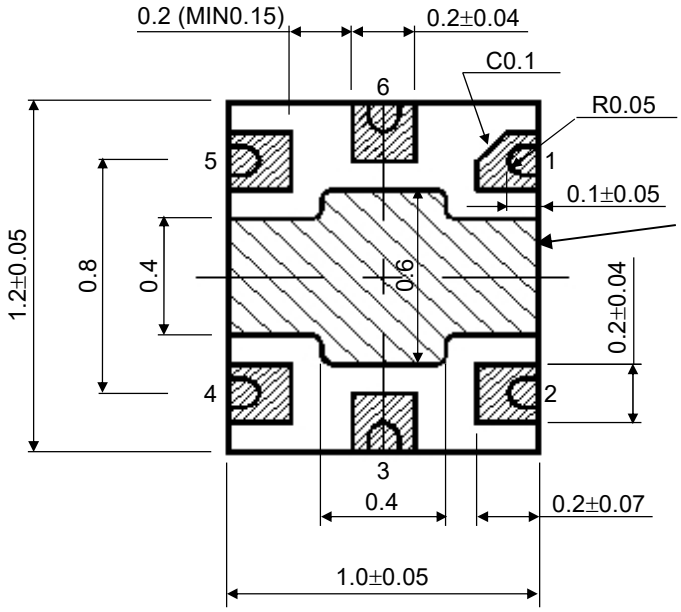
PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH
=0.4mm (Z_0=50ohm)
PCB SIZE=17.0mm x 17.0mm

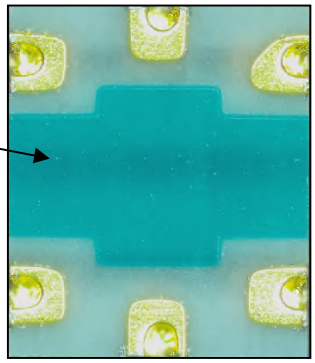
■ PACKAGE OUTLINE (USB6-A8)





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.

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4. The technical information described in this document shows typical characteristics and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our or any third party's intellectual property rights or any other rights.
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    - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
    - Life Maintenance Medical Equipment
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    - 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.
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10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
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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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