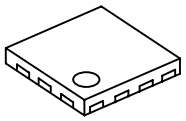
CDMA DUAL BAND LNA GaAs MMIC

■ GENERAL DESCRIPTION

The NJG1135MD7 is a GaAs LNA MMIC designed for CDMA2000 dual band (Cellular and PCS) application. The NJG1135MD7 has LNA pass-through function to select high gain mode or low gain. The NJG1135MD7 achieved high IIP3 and low noise figure at the high gain mode, and low current consumption at the low gain mode. An ultra-small and ultra-thin EQFN14-D7 package is adopted.

■ PACKAGE OUTLINE



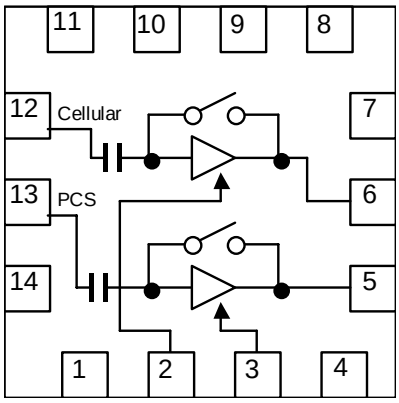
NJG1135MD7

■ FEATURES

●Low voltage operation	+2.8V typ.	
●Low control voltage operation	+1.8V min.	
[LNA high gain mode]		
●High input IP3	+10dBm typ.	@ f=880MHz
	+8dBm typ.	@ f=1960MHz
●High gain	+16dB typ.	@ f=880MHz / 1960MHz
●Low noise figure	1.4dB typ.	@ f=880MHz / 1960MHz
[LNA low gain mode]		
●Low current consumption	30uA typ.	
●High input IP3	+19dBm typ.	@ f=880MHz
	+17dBm typ.	@ f=1960MHz
● Ultra-small and ultra-thin package	EQFN14-D7	(Package size: 1.6x1.6x0.397mm typ., Lead and Halogen-Free)

■ PIN CONFIGURATION

(Top View)



Pin Connection

1. GND	8. GND
2. VCTL2	9. GND
3. VCTL1	10. GND
4. GND	11. GND
5. RFOUT1	12. RFIN2
6. RFOUT2	13. RFIN1
7. GND	14. GND

■ TRUETH TABLE

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

VCTL1	VCTL2	Cellular band		PCS band	
		LNA	Bypass	LNA	Bypass
L	L	OFF	ON	OFF	ON
L	H	ON	OFF	OFF	ON
H	L	OFF	ON	ON	OFF
H	H	ON	OFF	ON	OFF

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}	VCTL1, VCTL2 terminal	5.0	V
Input power	P_{in}	V_{DD}=2.8V	+15	dBm
Power dissipation	P_D	4-layer FR4 PCB with through-hole (74.2x74.2mm), T_j=150°C	1300	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=50Ω)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating voltage	V_{DD}		2.65	2.8	2.95	V
Control voltage (High)	V_{CTL}(H)		1.8	2.8	2.95	V
Control voltage (Low)	V_{CTL}(L)		-0.3	0	0.3	V
Operating current1 (Cellular Band High Gain mode)	I_{DD}1	RF OFF, V_{CTL}1=0V, V_{CTL}2=2.8V	-	10	14	mA
Operating current2 (PCS Band High Gain mode)	I_{DD}2	RF OFF, V_{CTL}1=2.8V, V_{CTL}2=0V	-	10	14	mA
Operating current3 (LNA all off mode)	I_{DD}3	RF OFF, V_{CTL}1=0V, V_{CTL}2=0V	-	30	60	μA
Control current1	I_{CTL}1	RF OFF, V_{CTL}1=2.8V	-	17	30	μA
Control current2	I_{CTL}2	RF OFF, V_{CTL}2=2.8V	-	17	30	μA

■ **ELECTRICAL CHARACTERISTICS 2 (Cellular Band: LNA High Gain Mode)**

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 1	Gain1	Exclude PCB, Connector Losses (input and output) 0.11dB	14.5	16.0	-	dB
Noise figure 1	NF1	Exclude PCB, Connector Losses (input) 0.06dB	-	1.4	1.8	dB
1dB gain compression input power 1	P-1dB_1		-8	-4	-	dBm
3rd order input intercept point 1	IIP3_1	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-25dBm	+7	+10	-	dBm
RF IN VSWR 1	$VSWR_i$_1		-	1.5	2.0	
RF OUT VSWR 1	$VSWR_o$_1		-	1.5	2.0	

■ **ELECTRICAL CHARACTERISTICS 3 (Cellular Band: LNA Low Gain Mode)**

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=0V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 2	Gain2	Exclude PCB, Connector Losses (input and output) 0.11dB	-4.0	-2.5	-	dB
Noise figure 2	NF2	Exclude PCB, Connector Losses (input and output) 0.11dB	-	2.5	5.0	dB
1dB gain compression input power 2	P-1dB_2		+3.5	+10.5	-	dBm
3rd order input intercept point 2	IIP3_2	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-12dBm	+15	+19	-	dBm
RF IN VSWR 2	$VSWR_i$_2		-	2.0	2.5	
RF OUT VSWR 2	$VSWR_o$_2		-	1.5	2.0	

■ ELECTRICAL CHARACTERISTICS 4 (PCS Band: LNA High Gain Mode)

(General Conditions: V_{DD}=2.8V, $V_{CTL}1$=2.8V, $V_{CTL}2$=0V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 3	Gain3	Exclude PCB, Connector Losses (input and output) 0.22dB	14.5	16.0	-	dB
Noise figure 3	NF3	Exclude PCB, Connector Losses (input) 0.12dB	-	1.4	1.8	dB
1dB gain compression input power 3	P-1dB_3		-10	-6	-	dBm
3rd order input intercept point 3	IIP3_3	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-25dBm	+5	+8	-	dBm
RF IN VSWR 3	$VSWR_i$_3		-	2.3	3.1	
RF OUT VSWR 3	$VSWR_o$_3		-	1.5	2.2	

■ ELECTRICAL CHARACTERISTICS 5 (PCS Band: LNA Low Gain Mode)

(General Conditions: V_{DD}=2.8V, $V_{CTL}1$=0V, $V_{CTL}2$=0V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Small signal gain 4	Gain4	Exclude PCB, Connector Losses (input and output) 0.22dB	-5.0	-3.5	-	dB
Noise figure 4	NF4	Exclude PCB, Connector Losses (input and output) 0.22dB	-	4.0	5.5	dB
1dB gain compression input power 4	P-1dB_4		+1.5	+8.5	-	dBm
3rd order input intercept point 4	IIP3_4	f1=f_{RF}, f2=f_{RF}+100kHz, Pin=-12dBm	+13	+17	-	dBm
RF IN VSWR 4	$VSWR_i$_4		-	2.3	2.9	
RF OUT VSWR 4	$VSWR_o$_4		-	1.5	2.0	

■ **TERMINAL INFOMATION**

No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal.
2	VCTL2	Control port 2. This terminal is set to more than +1.8V~+2.95V of logical high level for high gain mode of cellular band LNA, and set to –0.3V~+0.3V of logical low level for low gain mode of cellular band LNA.
3	VCTL1	Control port 1. This terminal is set to more than +1.8V~+2.95V of logical high level for high gain mode of PCS band LNA, and set to –0.3V~+0.3V of logical low level for low gain mode of PCS band LNA.
4	GND	Ground terminal.
5	RFOUT1	RF output terminal of PCS band signal. RF signal and DC power is input through external matching circuit connected to this terminal. External matching circuit and DC blocking capacitor are required.
6	RFOUT2	RF output terminal of cellular band signal. RF signal and DC power is input through external matching circuit connected to this terminal. External matching circuit and DC blocking capacitor are required.
7	GND	Ground terminal. This terminal is not connected with internal circuit.
8	GND	Ground terminal.
9	GND	Ground terminal. This terminal is not connected with internal circuit.
10	GND	Ground terminal. This terminal is not connected with internal circuit.
11	GND	Ground terminal.
12	RFIN2	RF input terminal of cellular band signal. RF signal is input through external matching circuit connected to this terminal. A DC blocking capacitor is not required.
13	RFIN1	RF input terminal of PCS band signal. RF signal is input through external matching circuit connected to this terminal. A DC blocking capacitor is not required.
14	GND	Ground terminal. This terminal is not connected with internal circuit.

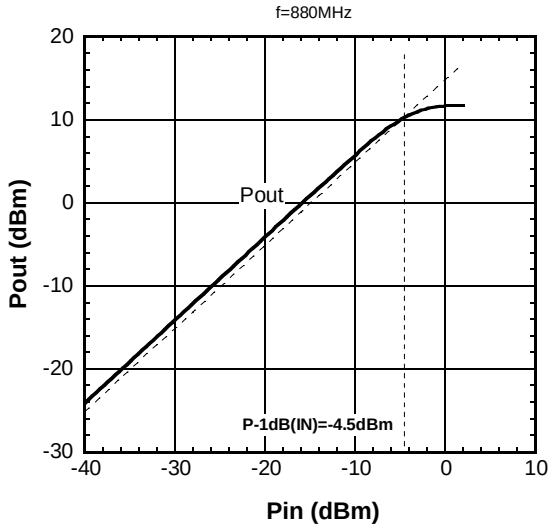
Notes:

1) Ground terminal (No.1, 4, 8, and 11) should be connected with the ground plane as close as possible for good RF performance, because distance to GND makes parasitic inductance.

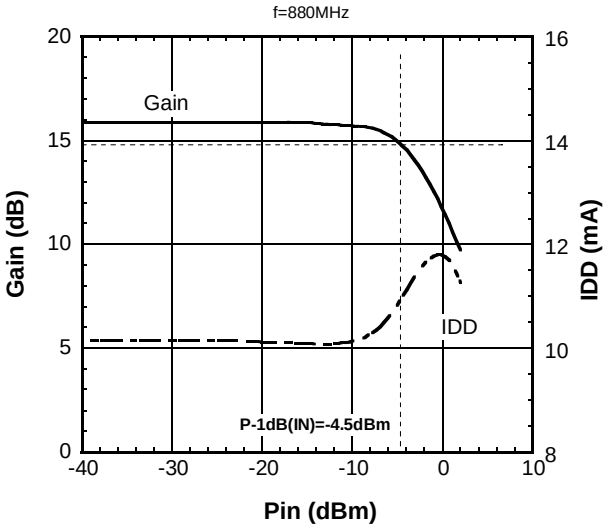
■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

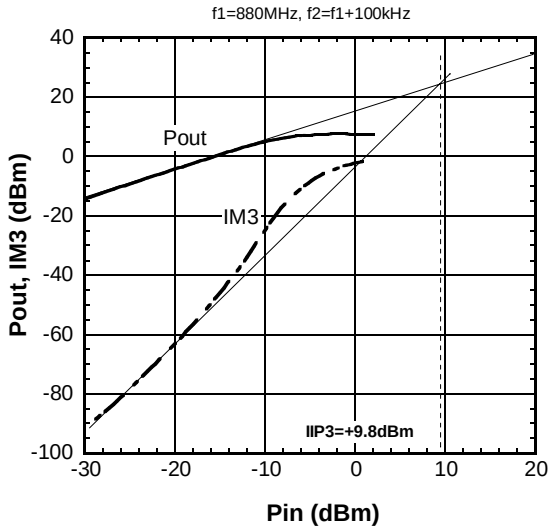
Pout vs. Pin



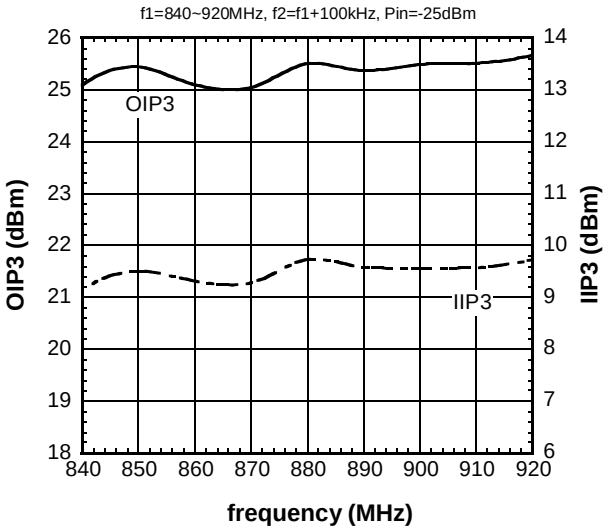
Gain, IDD vs. Pin



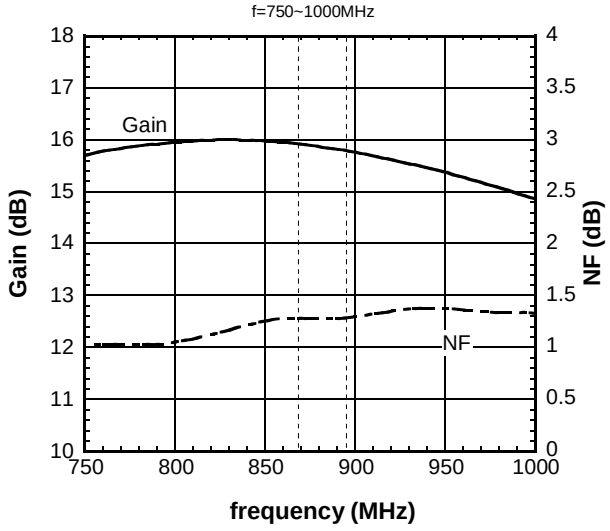
Pout, IM3 vs. Pin



OIP3, IIP3 vs. frequency

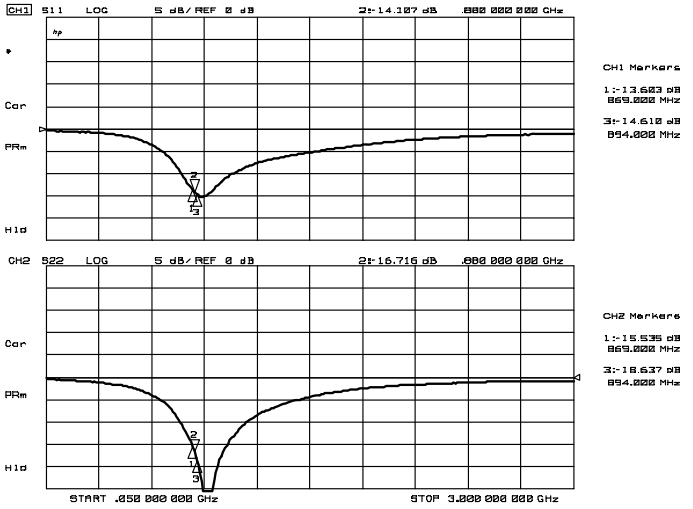


Gain, NF vs. frequency

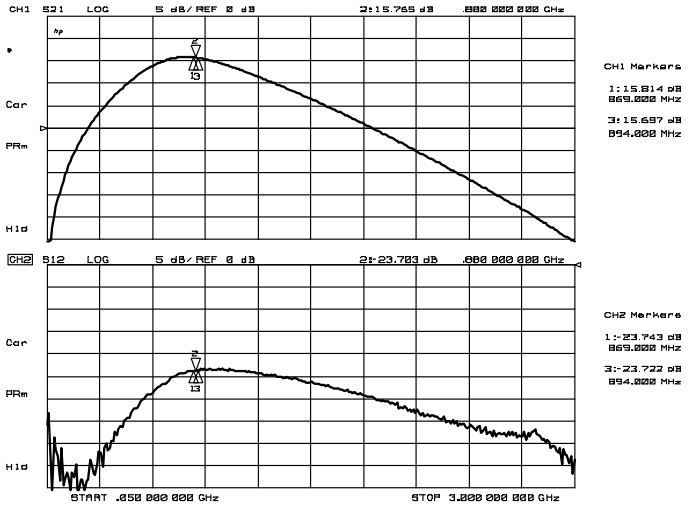


■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA High Gain Mode)

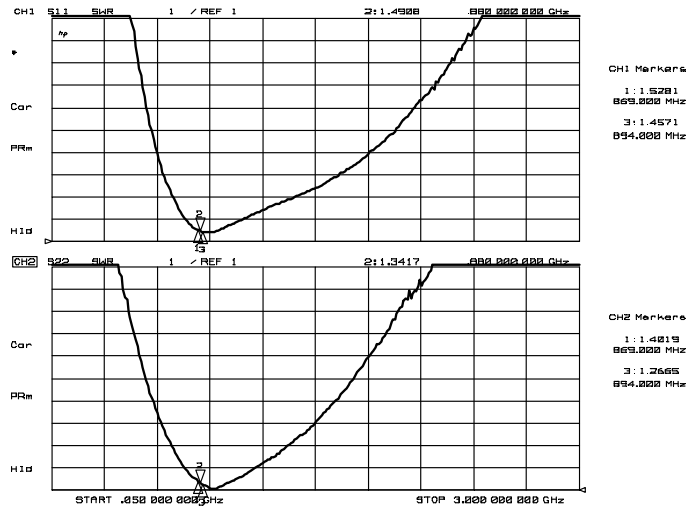
(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)



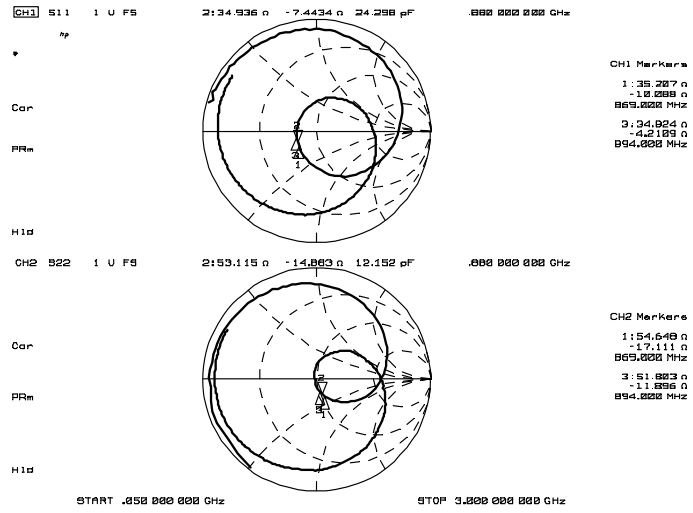
S11, S22



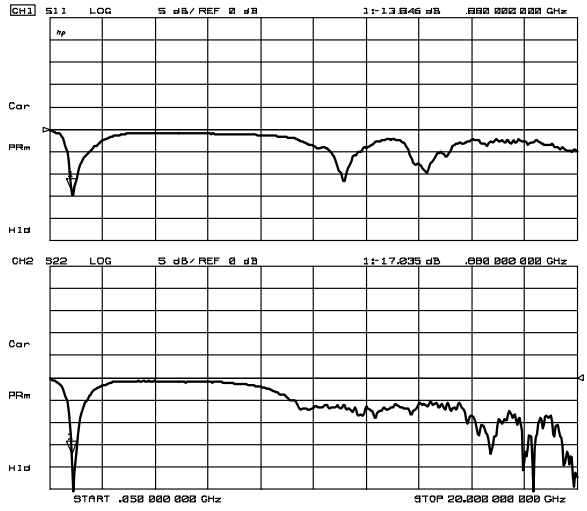
S21, S12



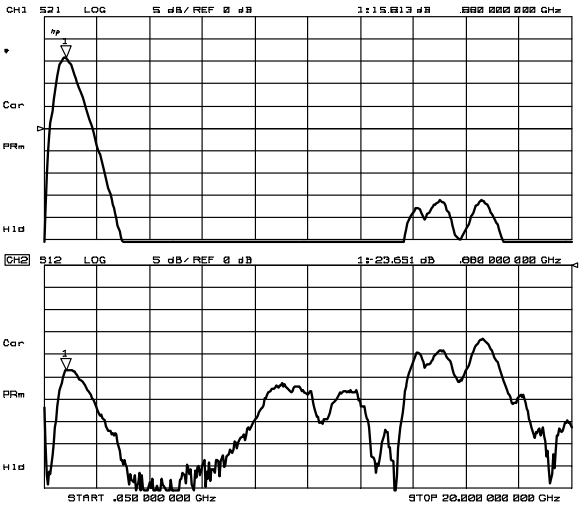
VSWR



Zin, Zout



S11, S22 (~20GHz)

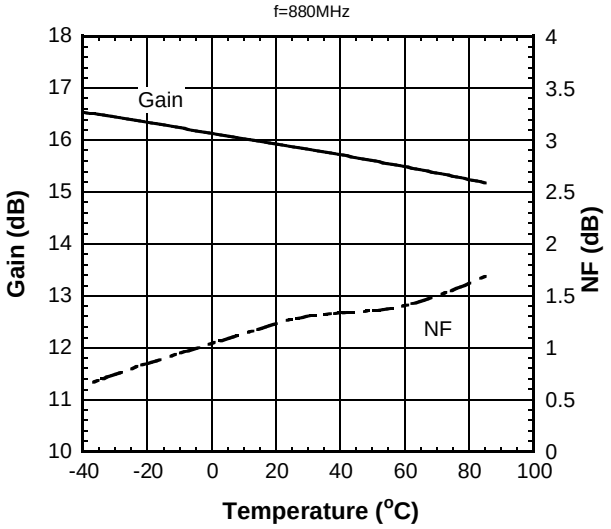


S21, S12 (~20GHz)

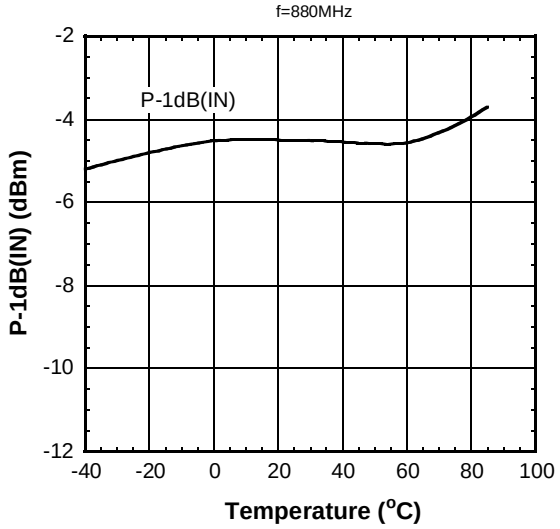
■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, Z_s=Z_l=50Ω, with application circuit)

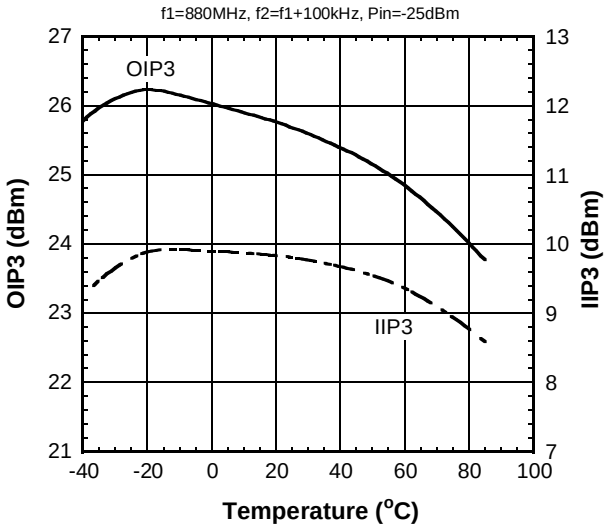
Gain, NF vs. Temperature



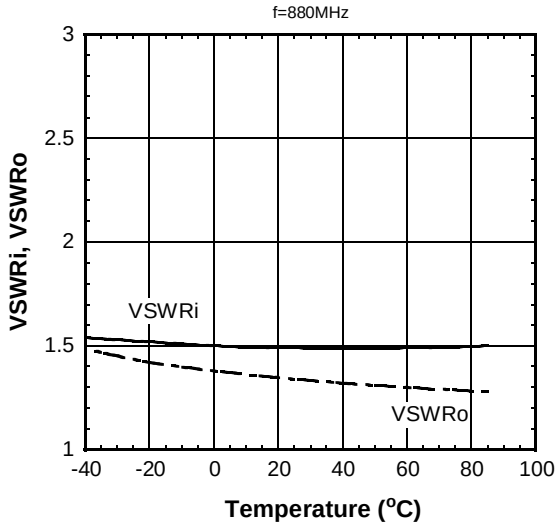
P-1dB(IN) vs. Temperature



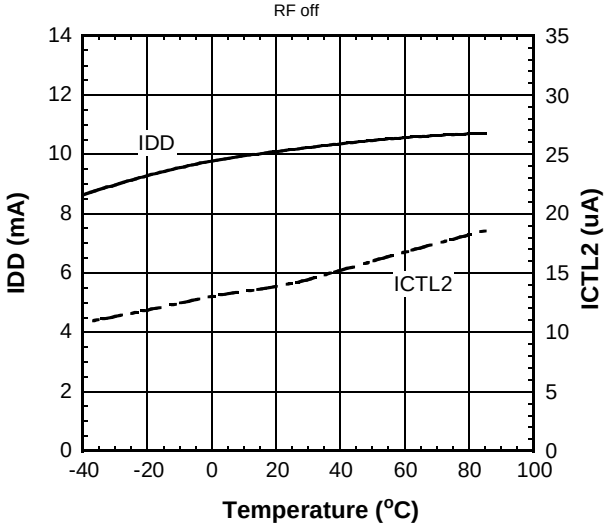
OIP3, IIP3 vs. Temperature



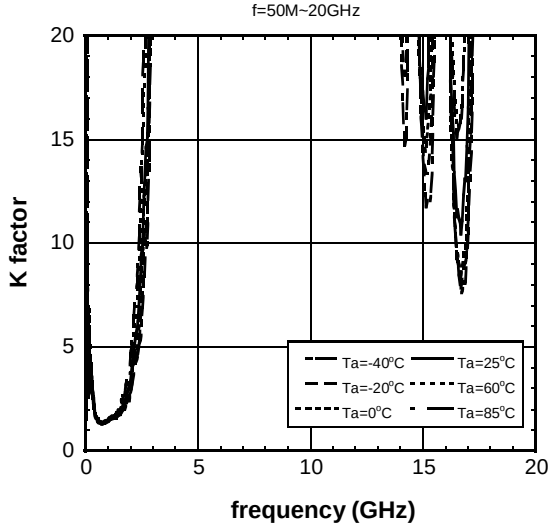
VSWRi, VSWRo vs. Temperature



IDD, ICTL2 vs. Temperature



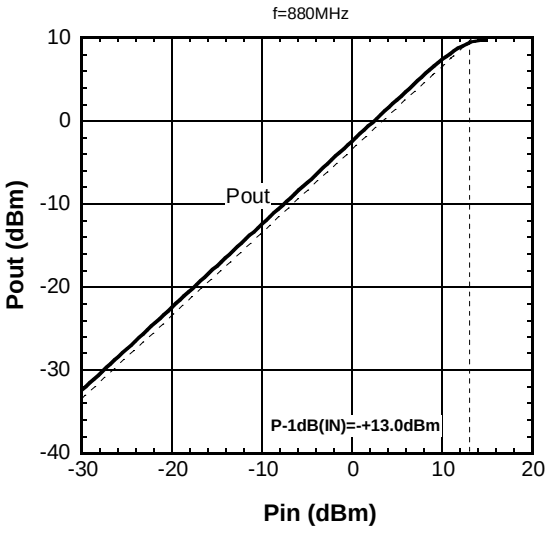
K factor vs. frequency



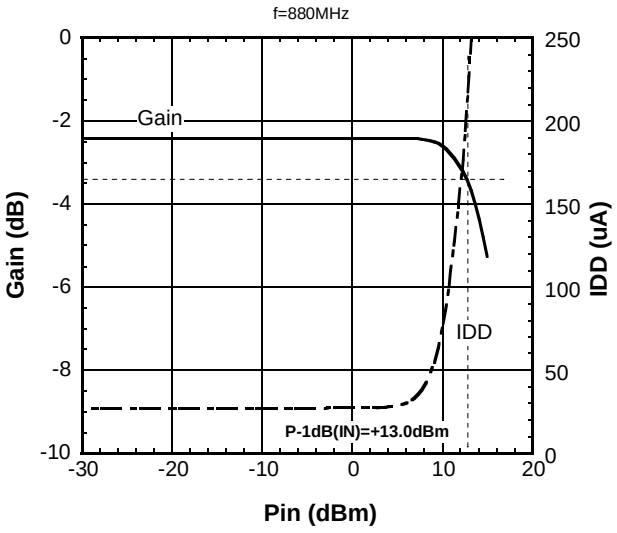
■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

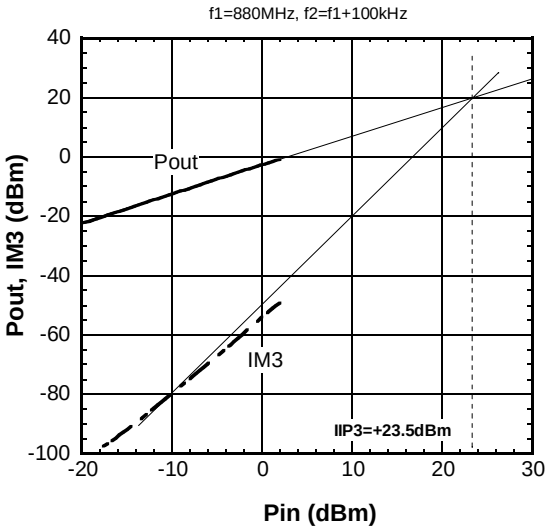
Pout vs. Pin



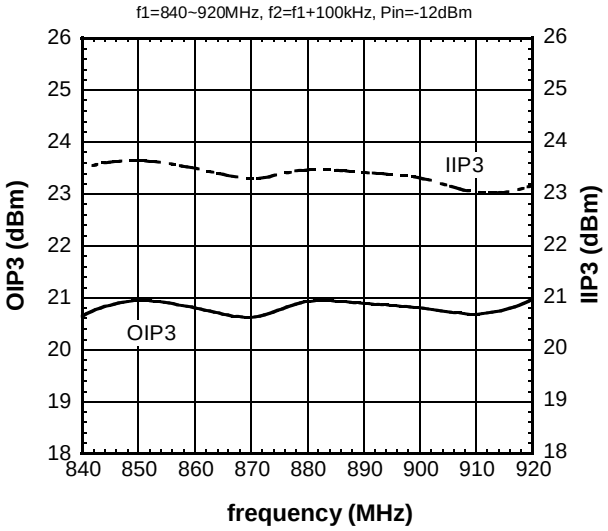
Gain, IDD vs. Pin



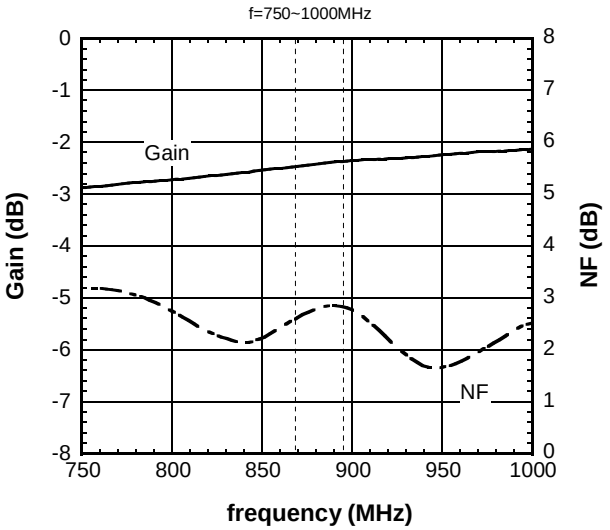
Pout, IM3 vs. Pin



OIP3, IIP3 vs. frequency

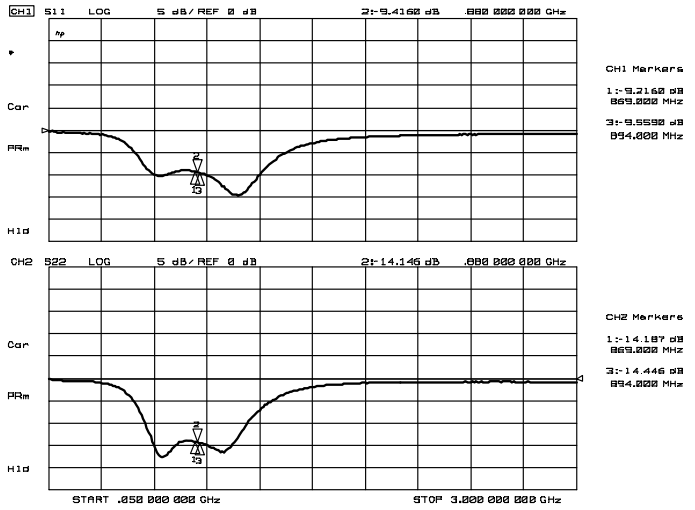


Gain, NF vs. frequency

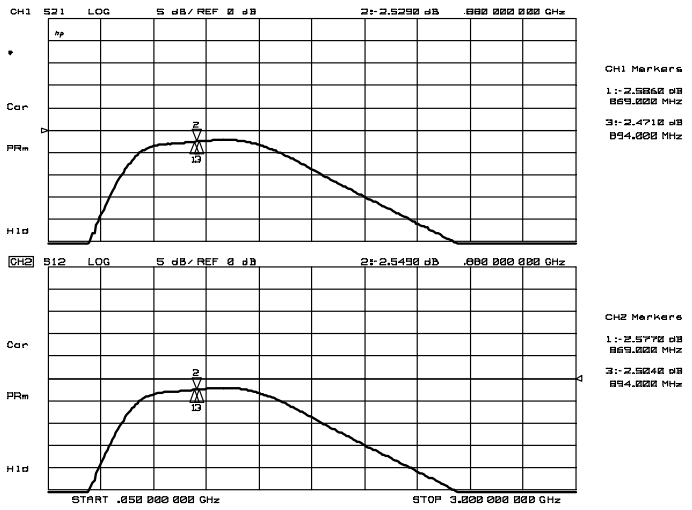


■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA Low Gain Mode)

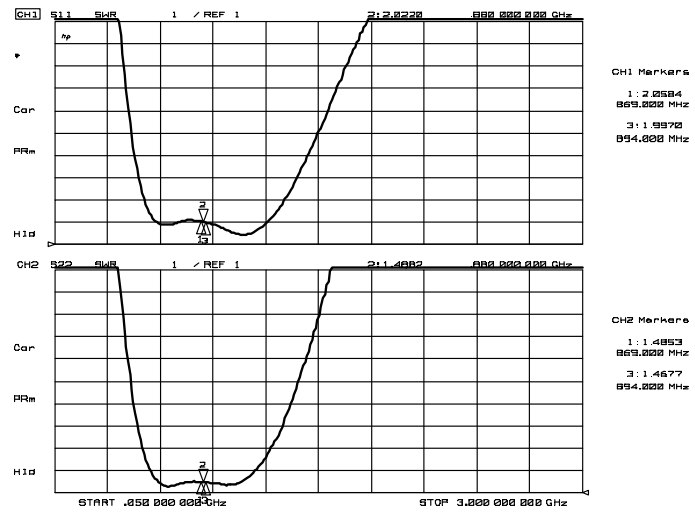
(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)



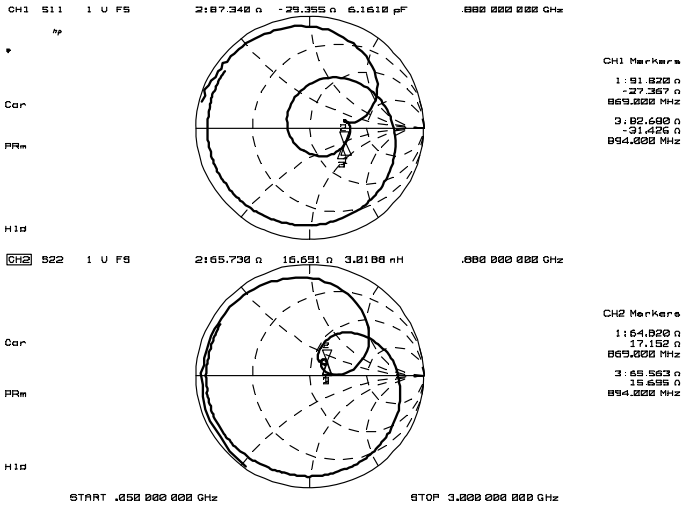
S11, S22



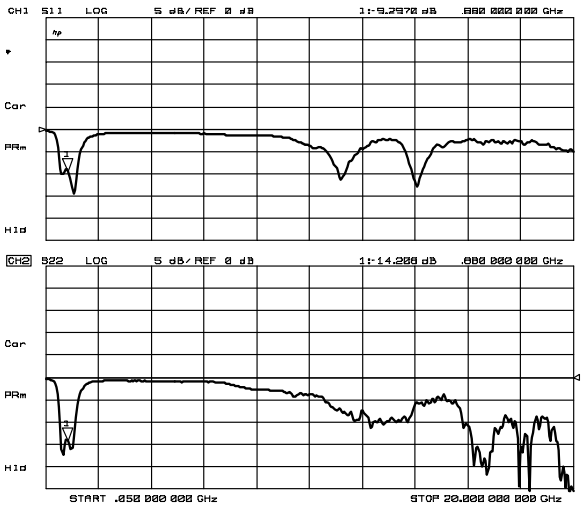
S21, S12



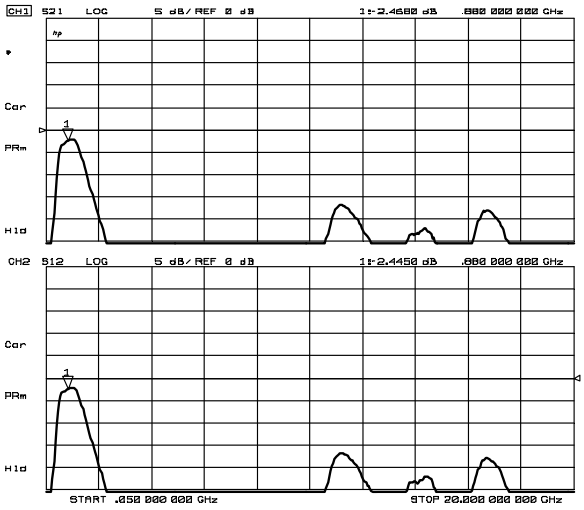
VSWR



Zin, Zout



S11, S22 (~20GHz)

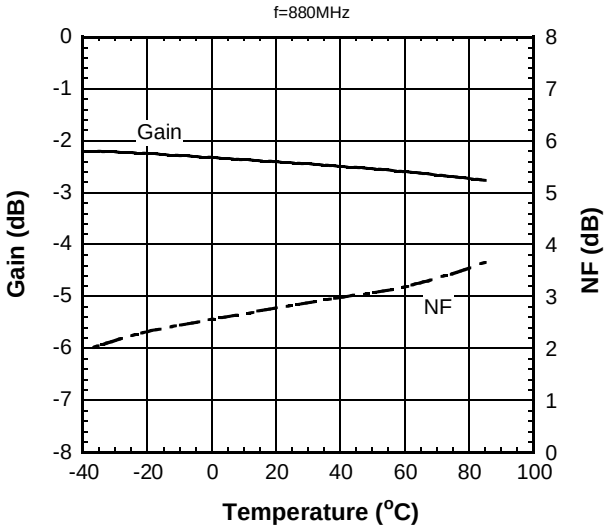


S21, S12 (~20GHz)

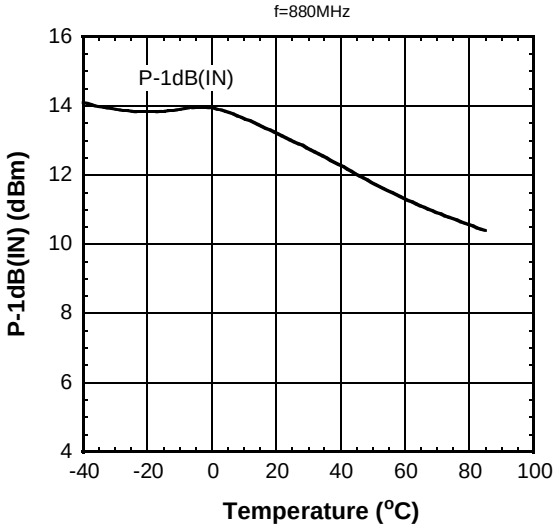
■ ELECTRICAL CHARACTERISTICS (Cellular Band: LNA Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=880MHz, Z_s=Z_l=50Ω, with application circuit)

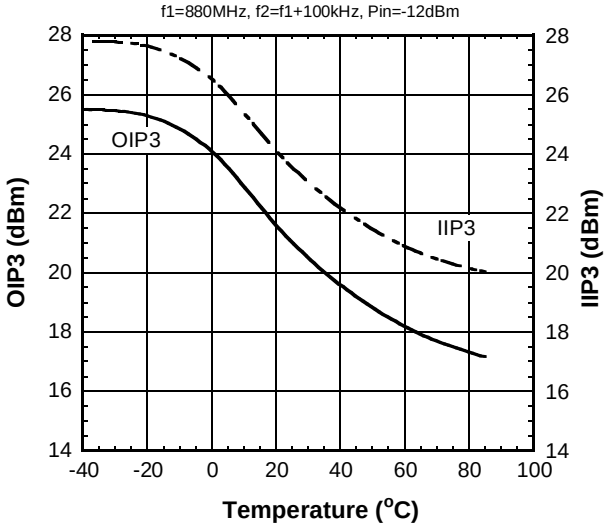
Gain, NF vs. Temperature



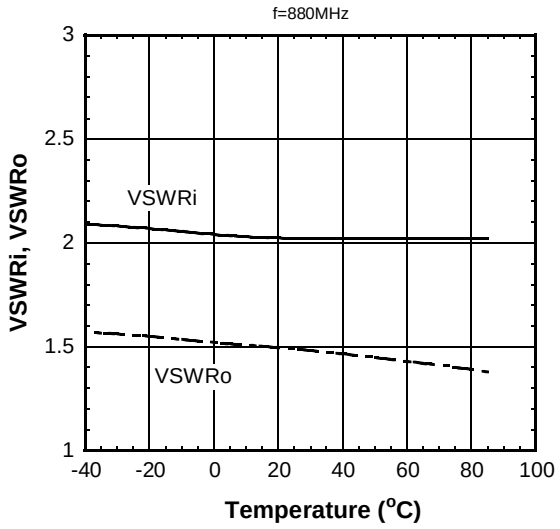
P-1dB(IN) vs. Temperature



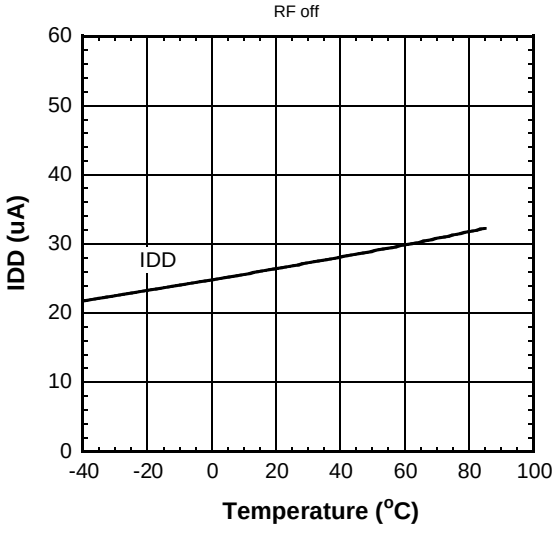
OIP3, IIP3 vs. Temperature



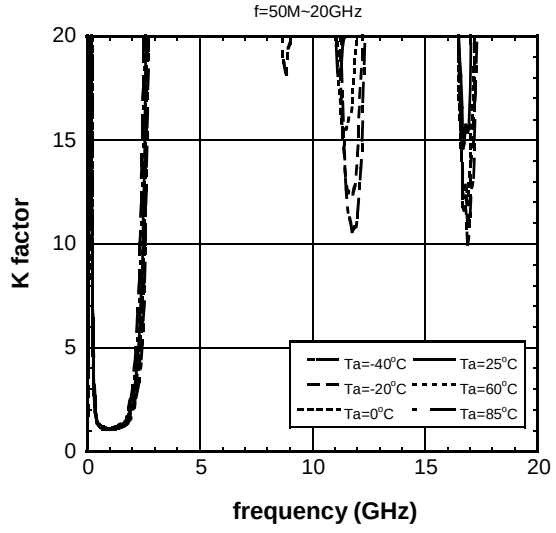
VSWRi, VSWRo vs. Temperature



IDD vs. Temperature



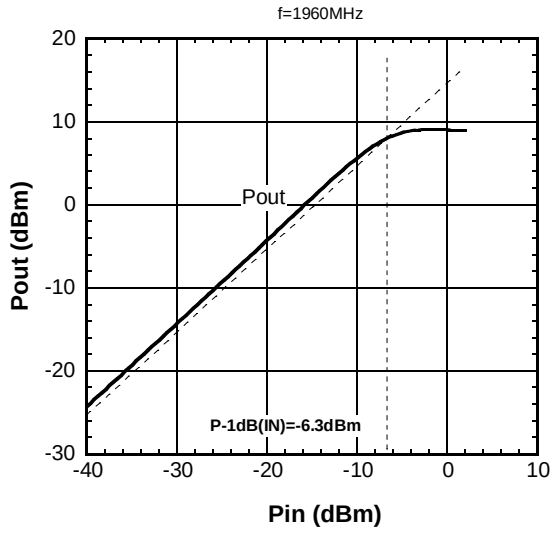
K factor vs. frequency



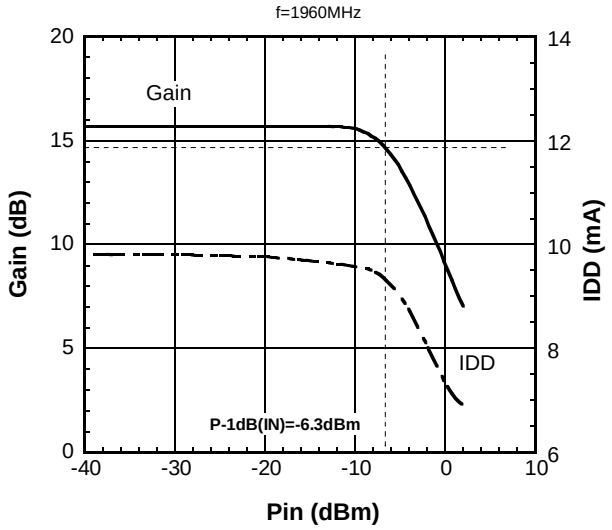
■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

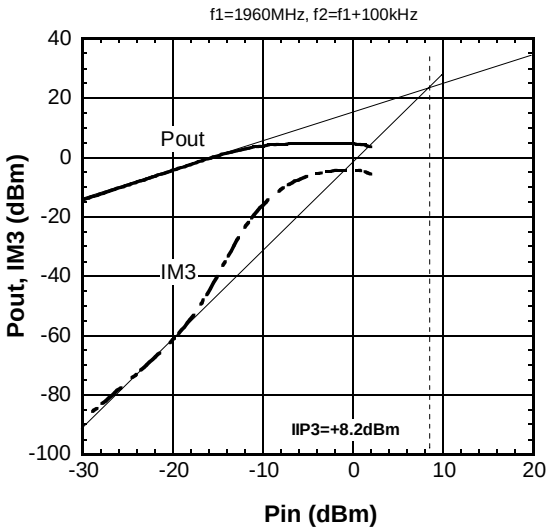
Pout vs. Pin



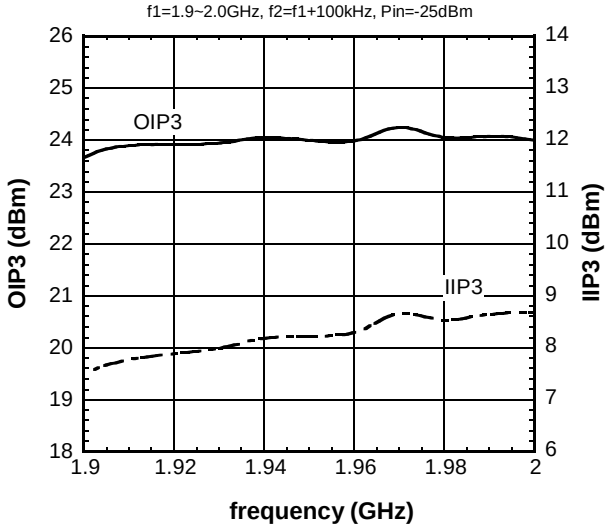
Gain, IDD vs. Pin



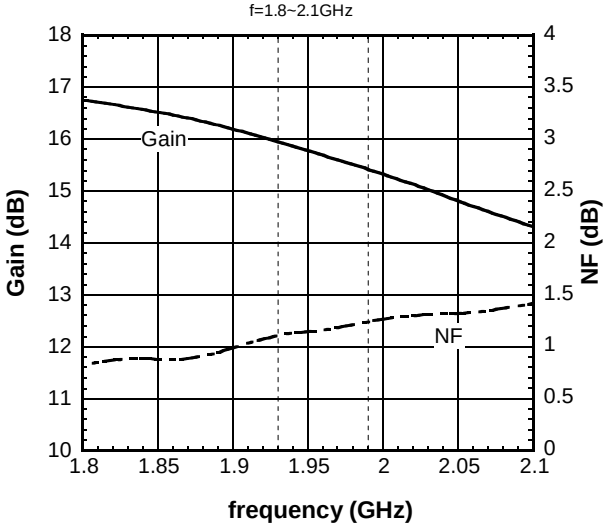
Pout, IM3 vs. Pin



OIP3, IIP3 vs. frequency

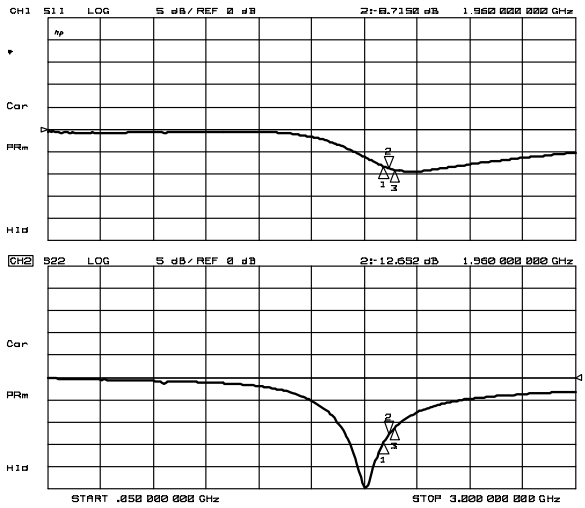


Gain, NF vs. frequency

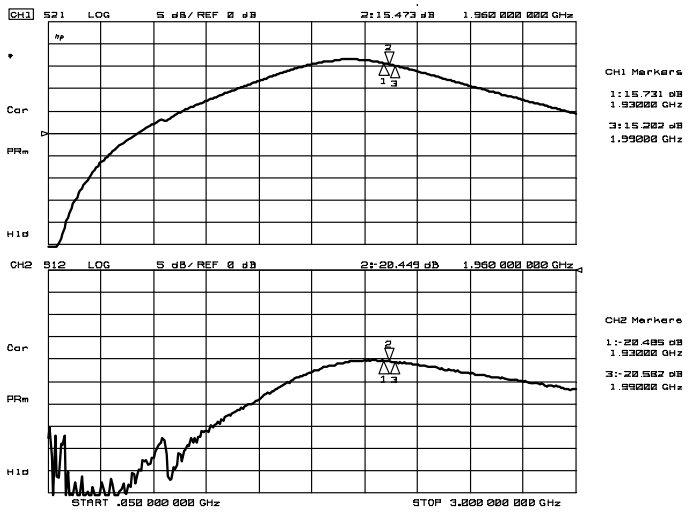


■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA High Gain Mode)

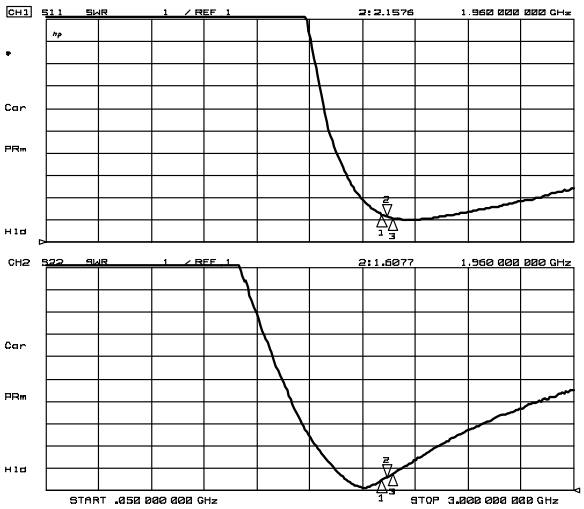
(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)



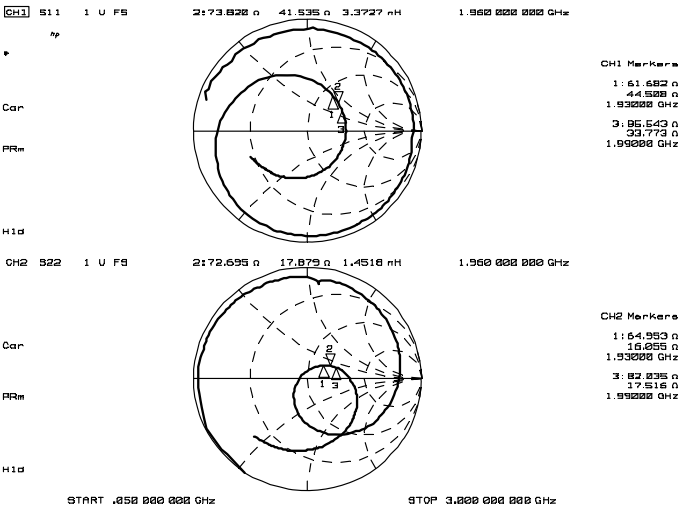
S11, S22



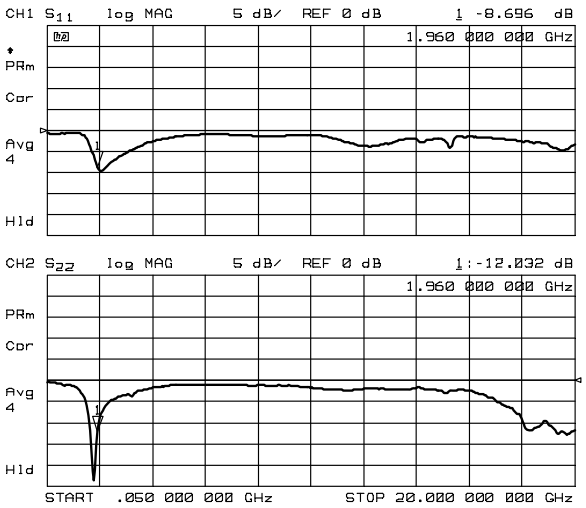
S21, S12



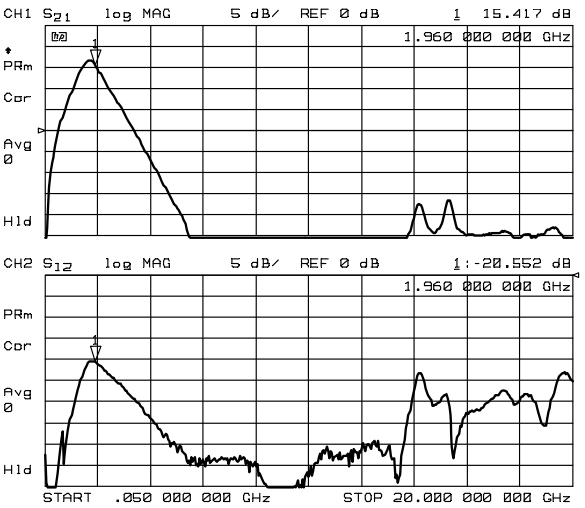
VSWR



Zin, Zout



S11, S22 (~20GHz)

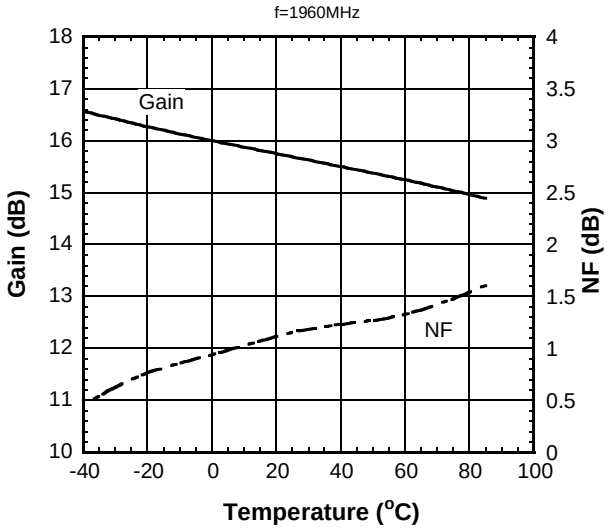


S21, S12 (~20GHz)

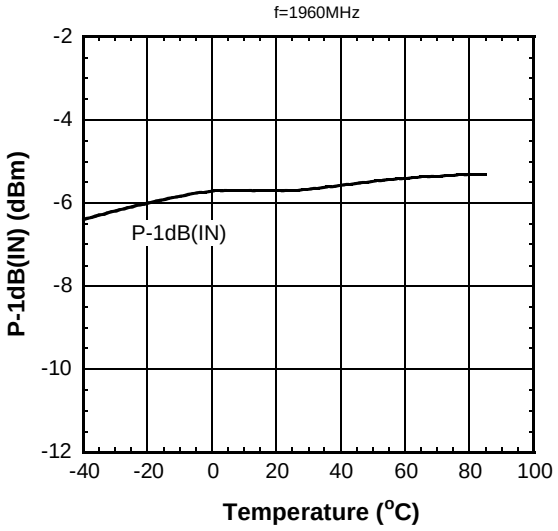
■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA High Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, Z_s=Z_l=50Ω, with application circuit)

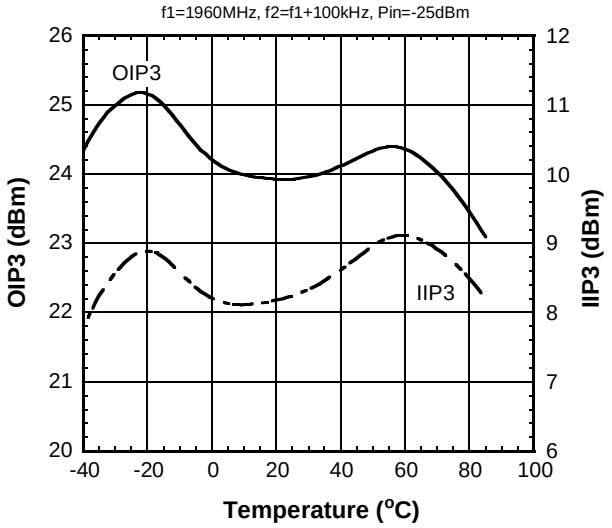
Gain, NF vs. Temperature



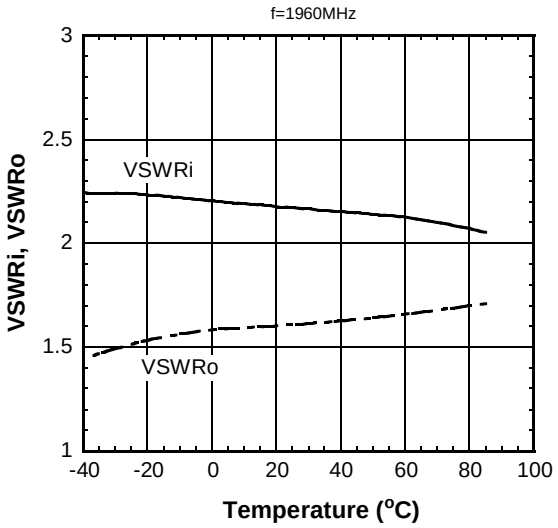
P-1dB(IN) vs. Temperature



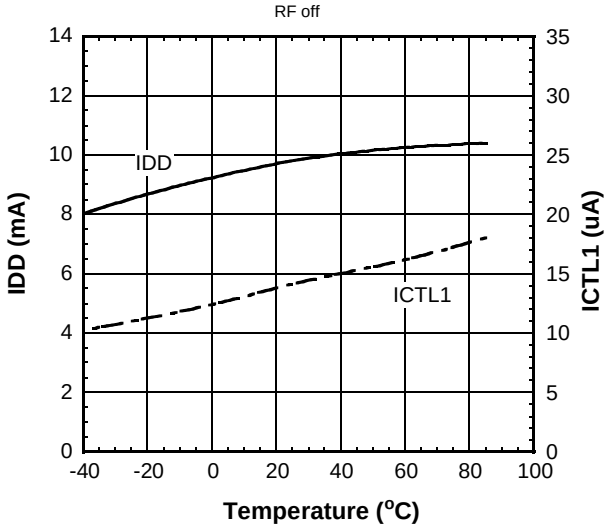
OIP3, IIP3 vs. Temperature



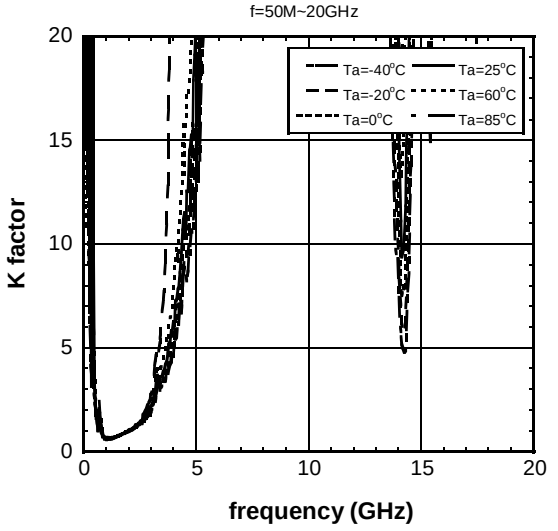
VSWRi, VSWRo vs. Temperature



IDD, ICTL1 vs. Temperature



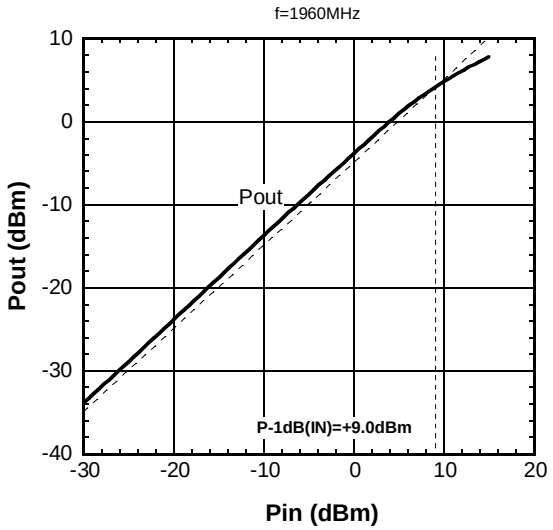
K factor vs. frequency



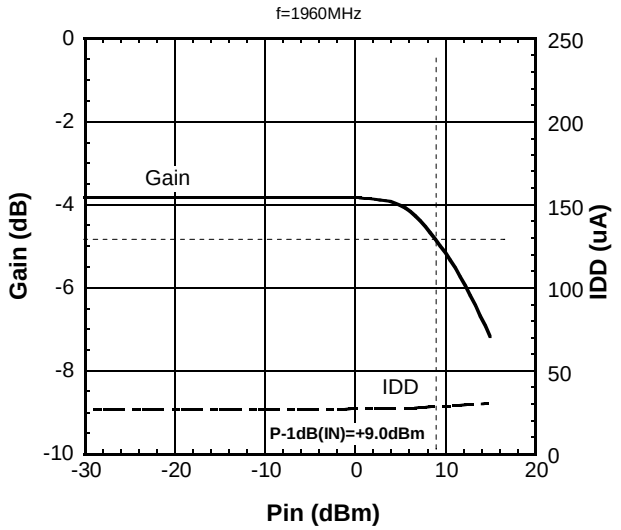
■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)

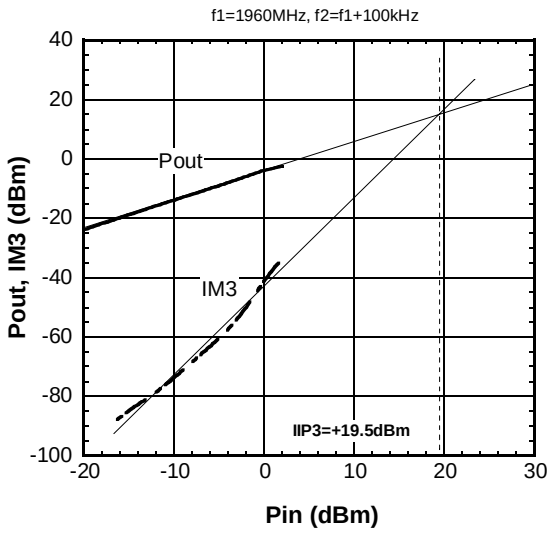
Pout vs. Pin



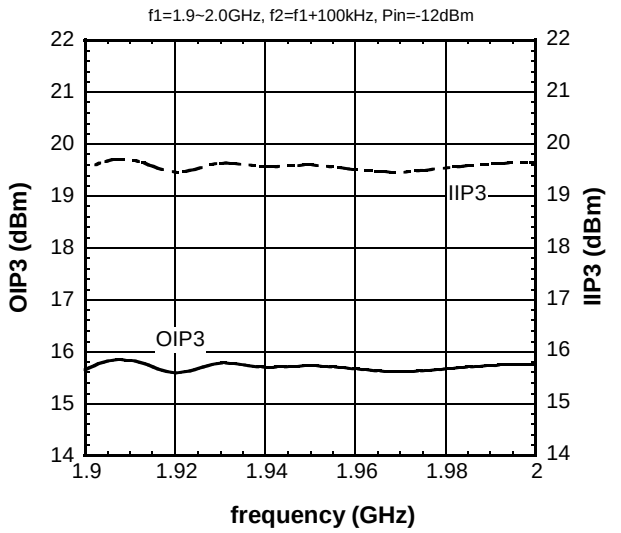
Gain, IDD vs. Pin



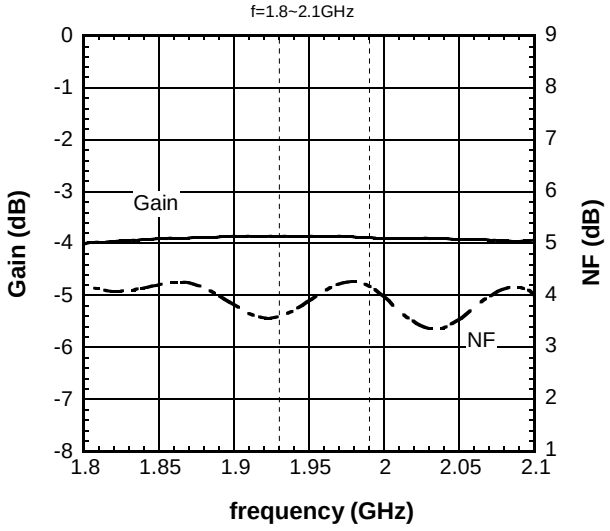
Pout, IM3 vs. Pin



OIP3, IIP3 vs. frequency

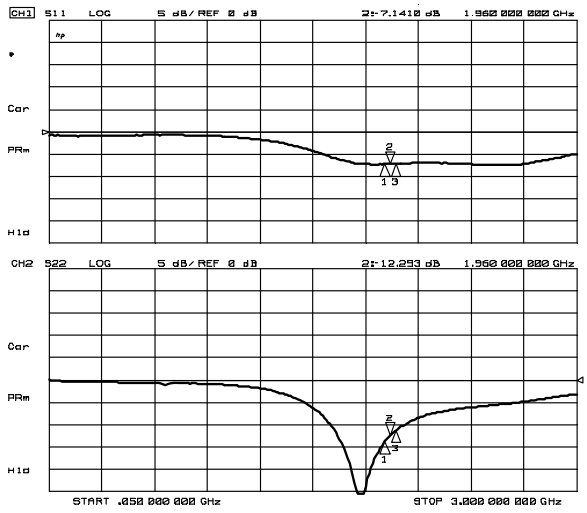


Gain, NF vs. frequency

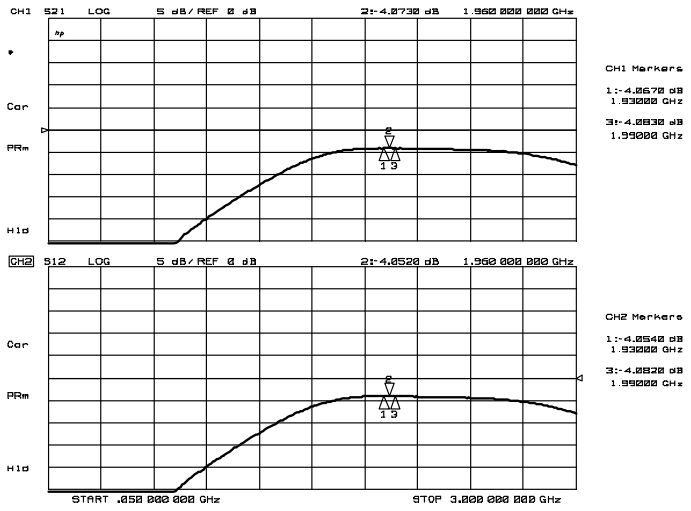


■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA Low Gain Mode)

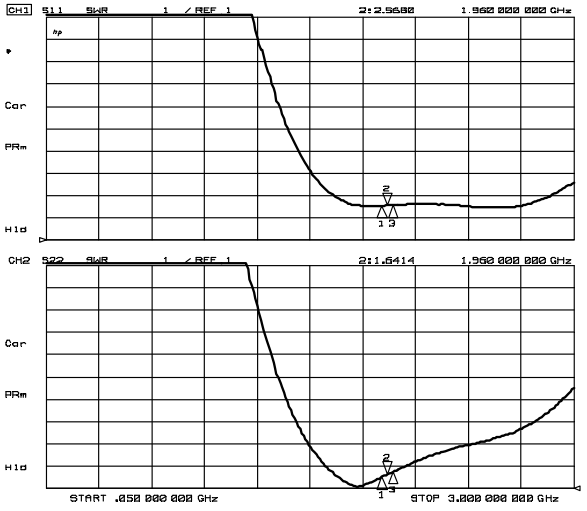
(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, T_a=+25°C, Z_s=Z_l=50Ω, with application circuit)



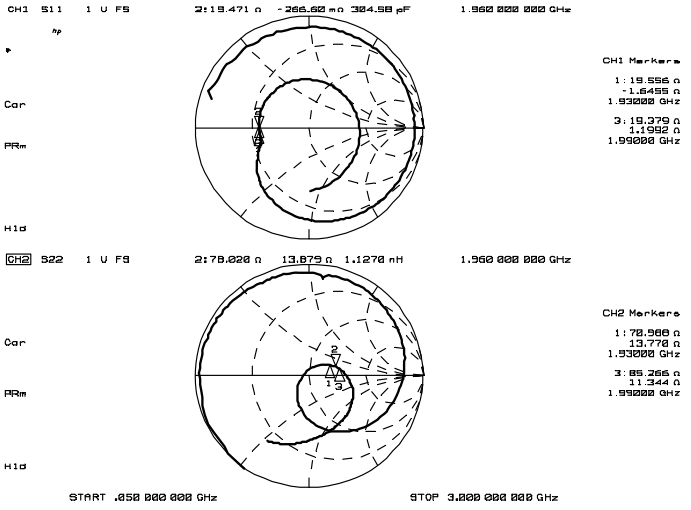
S11, S22



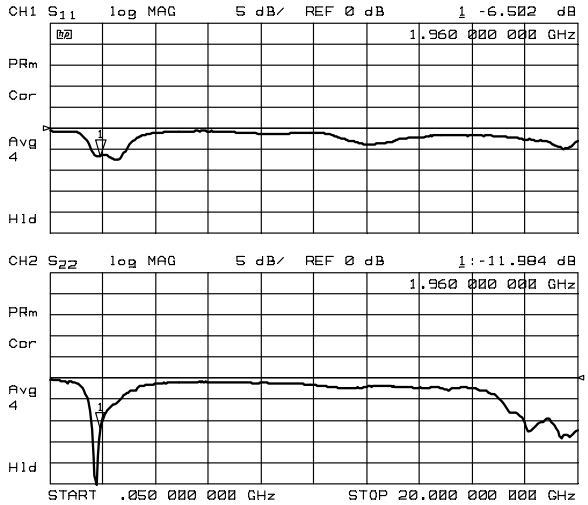
S21, S12



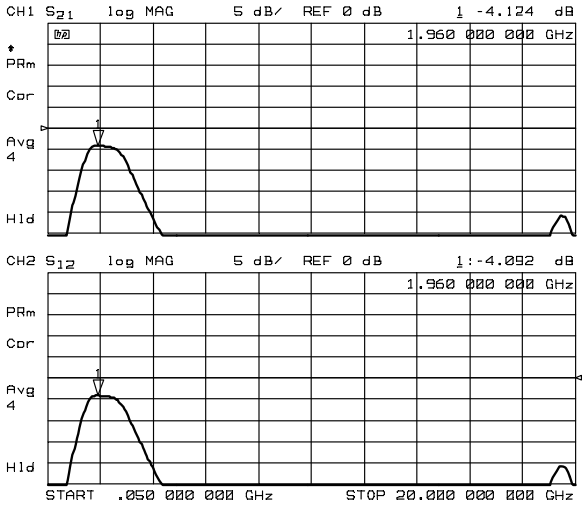
VSWR



Zin, Zout



S11, S22 (~20GHz)

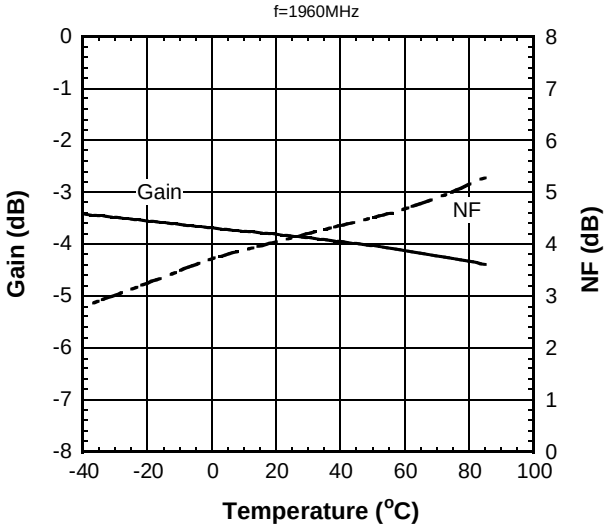


S21, S12 (~20GHz)

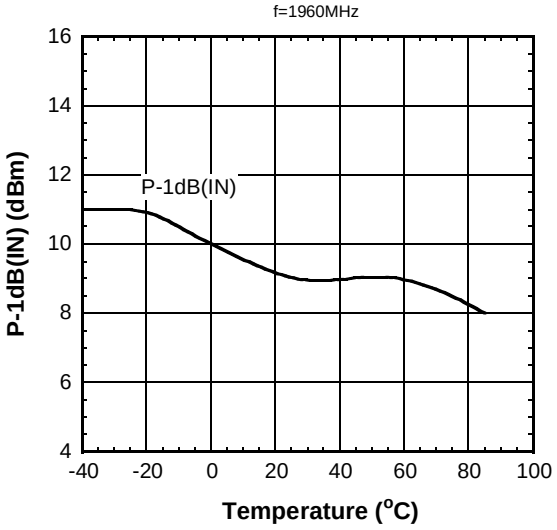
■ ELECTRICAL CHARACTERISTICS (PCS Band: LNA Low Gain Mode)

(General Conditions: V_{DD}=2.8V, V_{CTL}1=0V, V_{CTL}2=2.8V, f_{RF}=1960MHz, Z_s=Z_l=50Ω, with application circuit)

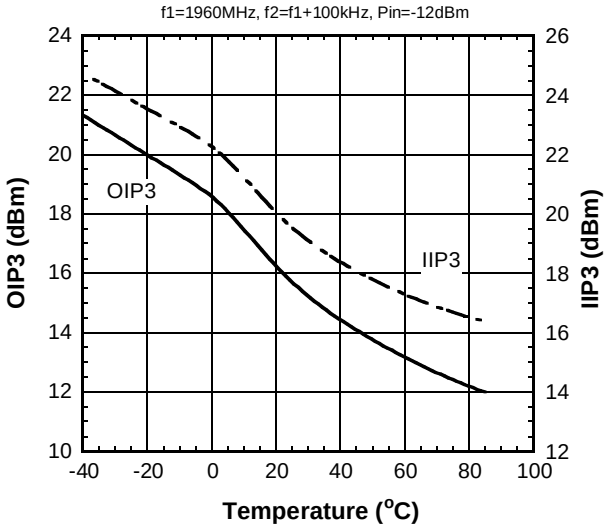
Gain, NF vs. Temperature



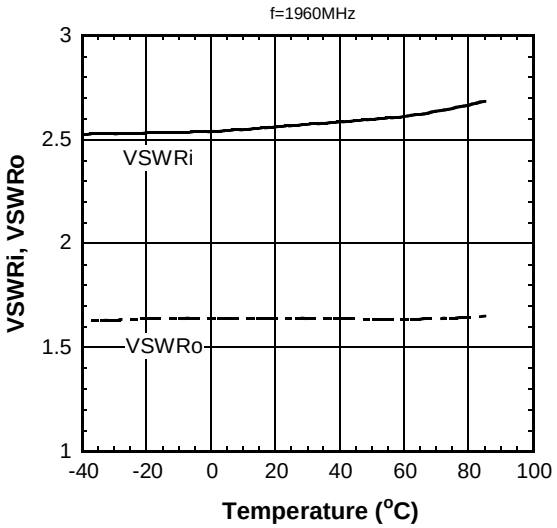
P-1dB(IN) vs. Temperature



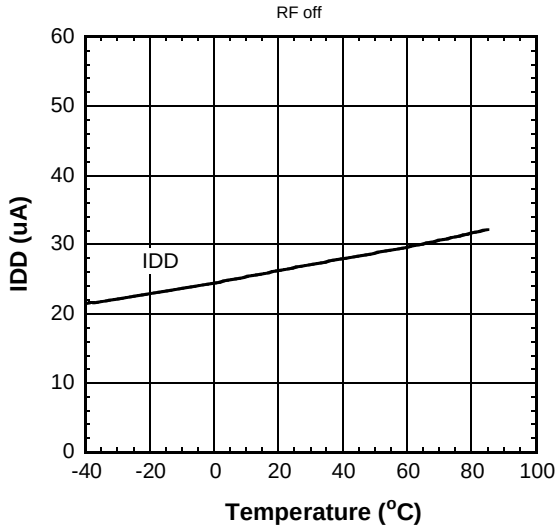
OIP3, IIP3 vs. Temperature



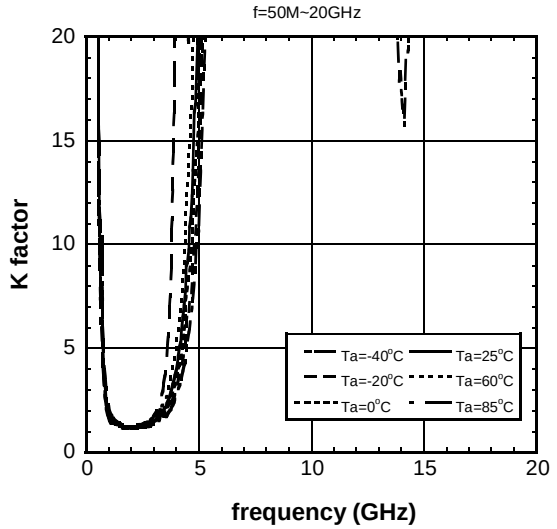
VSWRi, VSWRo vs. Temperature



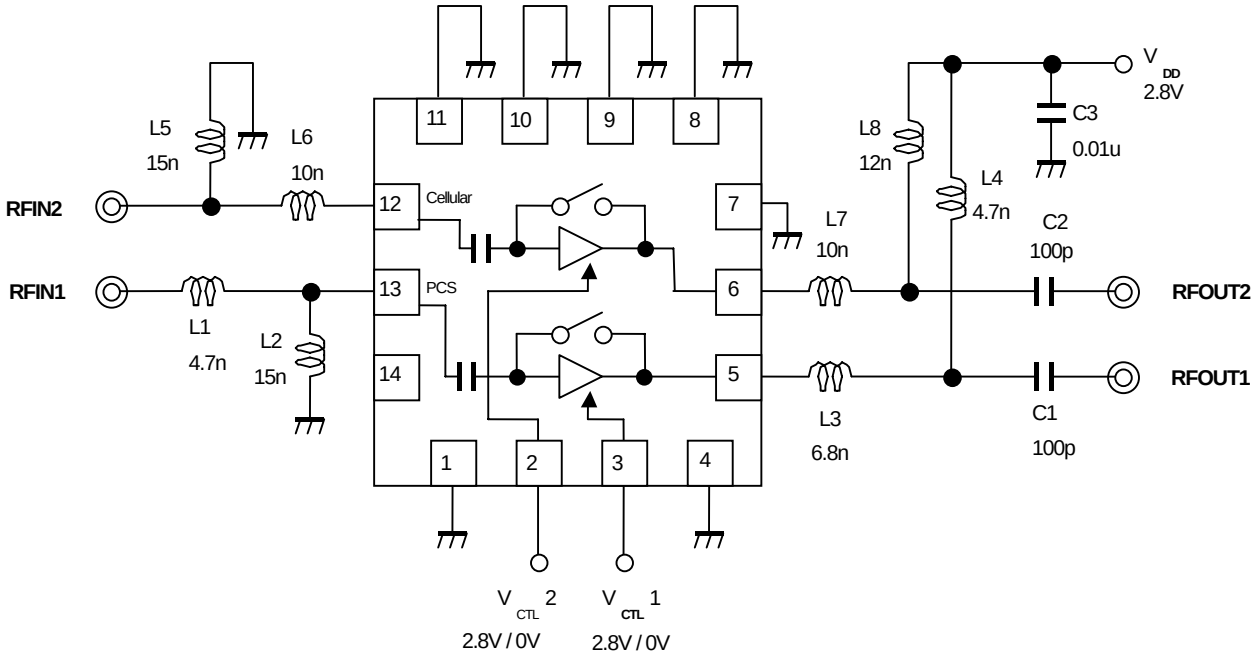
IDD vs. Temperature



K factor vs. frequency



■ APPLICATION CIRCUIT

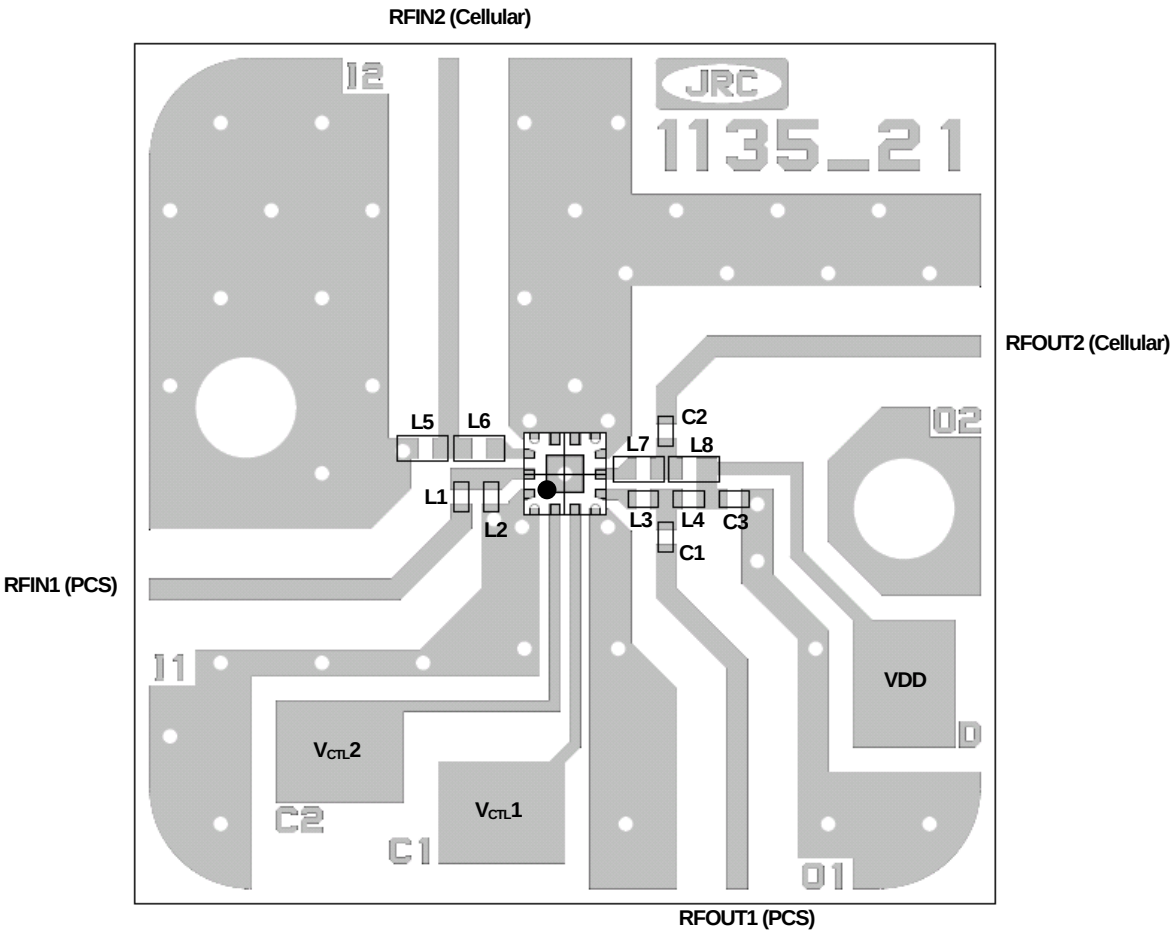


Parts list

Parts ID	Comments
L1, L2, L4	MURATA (LQP03T Series)
L3	TDK (MLK0603 Series)
L5~L8	TAIYO-YUDEN (HK1005 Series)
C1~C3	MURATA (GRM03 Series)

■ TEST PCB LAYOUT

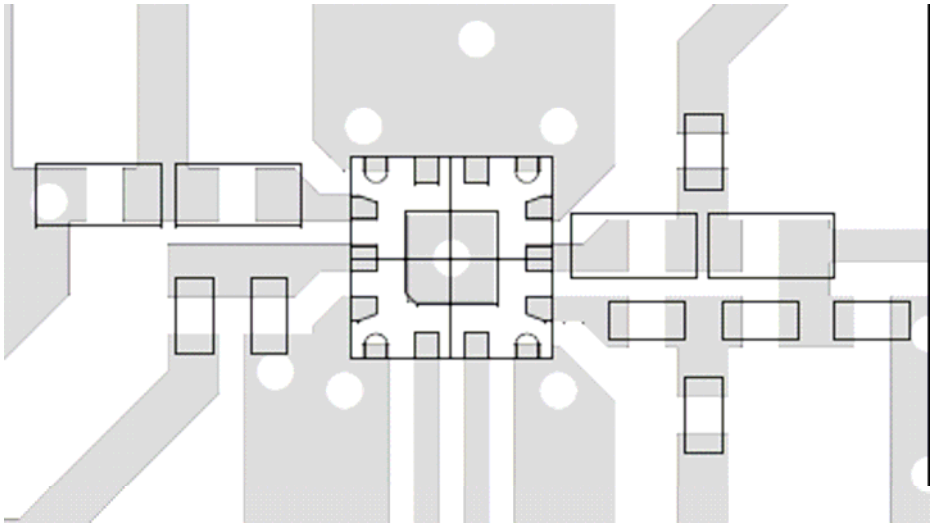
(TOP VIEW)



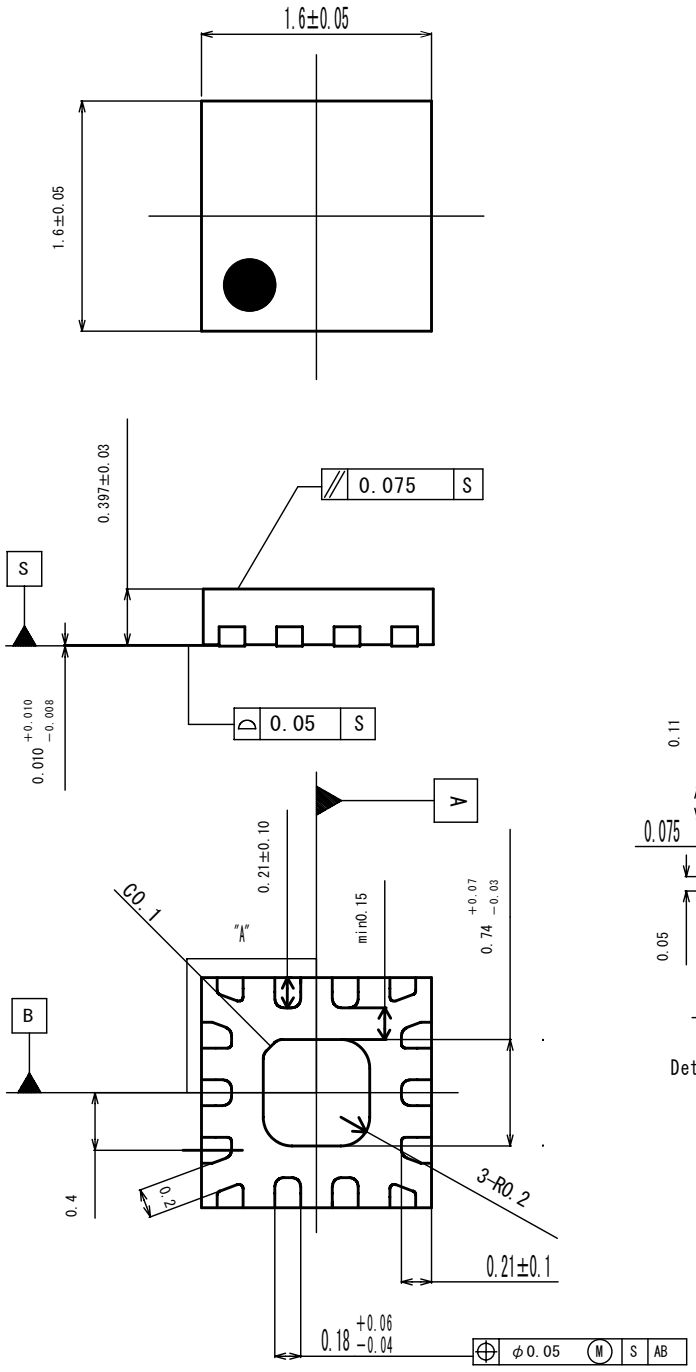
PCB (FR-4):
t=0.2mm
MICROSTRIP LINE WIDTH=0.4mm (Z_0=50ohm)
PCB SIZE=17.0mm x 17.0mm

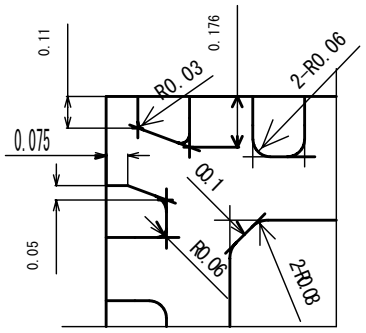
PRECAUTION:

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



■ PACKAGE OUTLINE (EQFN14-D7)





Details of"A" part (× 2)

UNIT : mm

SUBSTRATE MATERIAL : Copper
TERMINAL FINISH : Sn-Bi plating
MOLD MATERIAL : Epoxy resin
MASS (TYP.) : 0.0034 (g)

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.