

## 2.1GHz / 1.9GHz / 900MHz Bands Application

### 3-1. Summary

The characteristics of Band1, 2, 8 have evaluated as follows. The evaluation circuit structure and measured data are reviewed.

### 3-2-1. Measurement data of assembled evaluation board

#### DC Characteristics

General condition :  $V_{DD}=2.8V$ ,  $T_a=+25^{\circ}C$

Parameter	Condition	Symbol	Measurement Data	Units
Supply Voltage		$V_{DD}$	2.8	V
Control Voltage 1 (High)		$V_{CTL1(H)}$	1.8	V
Control Voltage 1 (Low)		$V_{CTL1(L)}$	0	V
Control Voltage 2 (High)		$V_{CTL2(H)}$	1.8	V
Control Voltage 2 (Low)		$V_{CTL2(L)}$	0	V
Control Voltage 3 (High)		$V_{CTL3(H)}$	1.8	V
Control Voltage 3 (Low)		$V_{CTL3(L)}$	0	V
Operating Current 1 (Band1 High Gain Mode)	RF OFF, $V_{CTL1}=0V$ , $V_{CTL2}=0V$ , $V_{CTL3}=1.8V$	$I_{DD1}$	2.35	mA
Operating Current 2 (Band 8 High Gain Mode)	RF OFF, $V_{CTL1}=1.8V$ , $V_{CTL2}=0V$ , $V_{CTL3}=1.8V$	$I_{DD2}$	2.40	mA
Operating Current 3 (Band 4 High Gain Mode)	RF OFF, $V_{CTL1}=0V$ , $V_{CTL2}=1.8V$ , $V_{CTL3}=1.8V$	$I_{DD3}$	2.23	mA
Operating Current 4 (Low Gain mode)	RF OFF, $V_{CTL3}=0V$	$I_{DD7}$	31.9	uA
Control Current 1	$V_{CTL1}=1.8V$	$I_{CTL1}$	4.8	uA
Control Current 2	$V_{CTL2}=1.8V$	$I_{CTL2}$	4.9	uA
Control Current 3	$V_{CTL3}=1.8V$	$I_{CTL3}$	5.0	uA

## 3-2-2. Measurement data of assembled evaluation board

### RF Characteristics 1 (Band 1, High Gain Mode)

General condition :  $V_{DD}=2.7V$ ,  $V_{CTL1}=0V$ ,  $V_{CTL2}=0V$ ,  $V_{CTL3}=1.8V$ ,  $f_{RF}=2110\sim 2170MHz$ ,  
 $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Connector Losses (0.45dB)	Gain	15.8 ~ 16.0	dB
Noise Figure	Exclude PCB, Connector Losses (0.09dB)	NF	1.30 ~ 1.37	dB
Input Power 1dB Compression		P-1dB(IN)	-8.7 ~ -7.7	dBm
Input 3rd Order Intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ , $P_{in}=-30dBm$	IIP3	+0.4 ~ +0.9	dBm
RF IN VSWR		VSWR <sub>i</sub>	1.47 ~ 1.71	
RF OUT VSWR		VSWR <sub>o</sub>	1.84 ~ 1.93	

### RF Characteristics 2 (Band 1, Low Gain Mode)

General condition :  $V_{DD}=2.7V$ ,  $V_{CTL1}=0V$ ,  $V_{CTL2}=0V$ ,  $V_{CTL3}=0V$ ,  $f_{RF}=2110\sim 2170MHz$ ,  
 $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Connector Losses (0.45dB)	Gain	-3.6 ~ -3.4	dB
Noise Figure	Exclude PCB, Connector Losses (0.09dB)	NF	3.5 ~ 4.4	dB
Input Power 1dB Compression		P-1dB(IN)	+14.0 ~ +14.3	dBm
Input 3rd Order Intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ , $P_{in}=-16dBm$	IIP3	+11.9 ~ +12.8	dBm
RF IN VSWR		VSWR <sub>i</sub>	1.22 ~ 1.48	
RF OUT VSWR		VSWR <sub>o</sub>	1.72 ~ 1.91	

### 3-2-3. Measurement data of assembled evaluation board

#### RF Characteristics 3 (Band 8, High Gain Mode)

General condition :  $V_{DD}=2.7V$ ,  $V_{CTL1}=1.8V$ ,  $V_{CTL2}=0V$ ,  $V_{CTL3}=1.8V$ ,  $f_{RF}=925\sim 960MHz$ ,  
 $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Connector Losses (0.22dB)	Gain	15.9 ~ 16.2	dB
Noise Figure	Exclude PCB, Connector Losses (0.06dB)	NF	1.37 ~ 1.46	dB
Input Power 1dB Compression		P-1dB(IN)	-8.0 ~ -7.5	dBm
Input 3rd Order Intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ , $P_{in}=-30dBm$	IIP3	+1.6 ~ +2.0	dBm
RF IN VSWR		VSWR <sub>i</sub>	1.70 ~ 1.83	
RF OUT VSWR		VSWR <sub>o</sub>	1.49 ~ 1.80	

#### RF Characteristics 4 (Band 8, Low Gain Mode)

General condition :  $V_{DD}=2.7V$ ,  $V_{CTL1}=1.8V$ ,  $V_{CTL2}=0V$ ,  $V_{CTL3}=0V$ ,  $f_{RF}=925\sim 960MHz$ ,  
 $T_a=+25^{\circ}C$ ,  $Z_s=Z_l=50\Omega$ , with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Connector Losses (0.22dB)	Gain	-3.8 ~ -3.7	dB
Noise Figure	Exclude PCB, Connector Losses (0.06dB)	NF	2.6 ~ 4.6	dB
Input Power 1dB Compression		P-1dB(IN)	+17.1 ~ +17.5	dBm
Input 3rd Order Intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ , $P_{in}=-20dBm$	IIP3	+14.0 ~ +14.9	dBm
RF IN VSWR		VSWR <sub>i</sub>	1.70 ~ 1.80	
RF OUT VSWR		VSWR <sub>o</sub>	2.69 ~ 2.80	

### 3-2-4. Measurement data of assembled evaluation board

#### RF Characteristics 5 (Band 2 High Gain Mode)

General Condition:  $V_{DD}=2.7V$ ,  $V_{CTL1}=0V$ ,  $V_{CTL2}=1.8V$ ,  $V_{CTL3}=1.8V$ ,  $f_{RF}=1930\sim 1990MHz$ ,  $T_a=+25^{\circ}C$ ,  
 $Z_s=Z_l=50\text{ ohm}$ , with application circuit

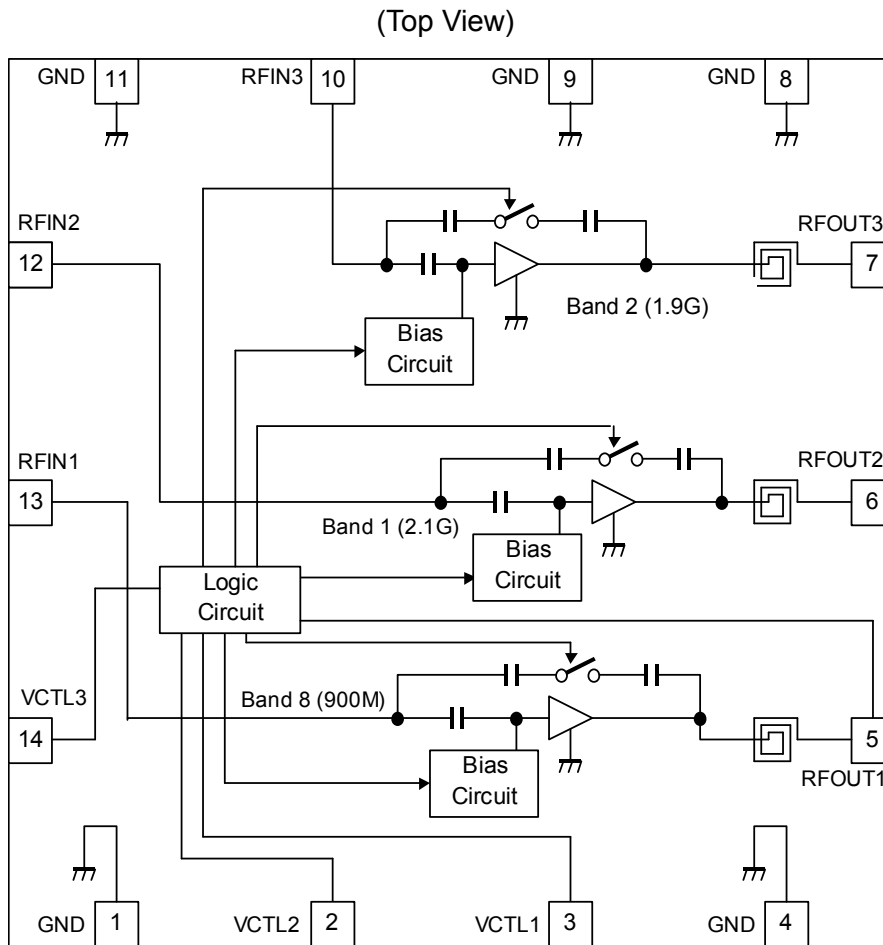
Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Conector Losses (0.41dB)	Gain	15.5~16.0	dB
Noise Figure	Exclude PCB, Connector Losses (0.10dB)	NF	1.36~1.38	dB
Input Power 1dB Compression		P1dB(IN)	-8.6~-8.1	dBm
Input 3rd Order intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ Pin=-30dBm	IIP3	+0.3~+1.0	dBm
RF IN VSWR		VSWRi	1.85~1.99	-
RF OUT VSWR		VSWRo	1.63~1.76	-

#### RF Characteristics 6 (Band 2 Low Gain Mode)

General Condition:  $V_{DD}=2.7V$ ,  $V_{CTL1}=0V$ ,  $V_{CTL2}=0V$ ,  $V_{CTL3}=1.8V$ ,  $f_{RF}=1930\sim 1990MHz$ ,  $T_a=+25^{\circ}C$ ,  
 $Z_s=Z_l=50\text{ ohm}$ , with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain	Exclude Input & Output PCB, Conector Losses (0.41dB)	Gain	-4.2~-4.1	dB
Noise Figure	Exclude PCB, Connector losses (0.10dB)	NF	3.8~4.7	dB
Input Power 1dB Compression		P1dB(IN)	+16.3~+16.8	dBm
Input 3rd Order intercept Point	$f_1=f_{RF}$ , $f_2=f_{RF}+100kHz$ Pin=-30dBm	IIP3	+14.1~+14.7	dBm
RF IN VSWR		VSWRi	1.56~1.61	-
RF OUT VSWR		VSWRo	2.22~2.26	-

## 3-3. Pin configuration



VCTL terminal function

VCTL1, VCTL2 : Band Select (Band 1 or 2 or 8)

VCTL3 : RX ATT Select (High Gain mode or Low Gain mode)

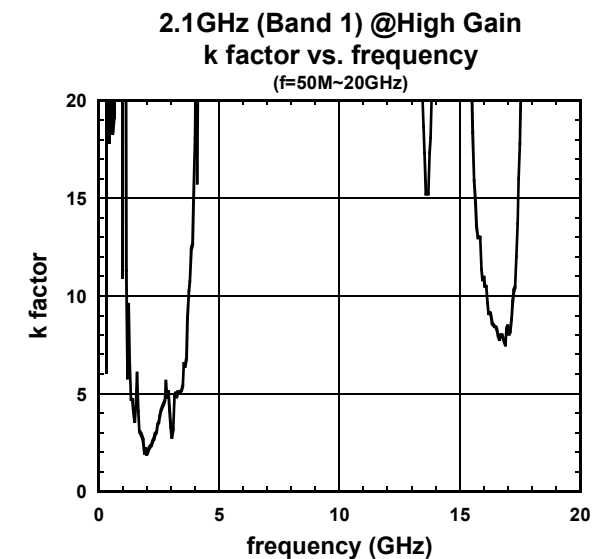
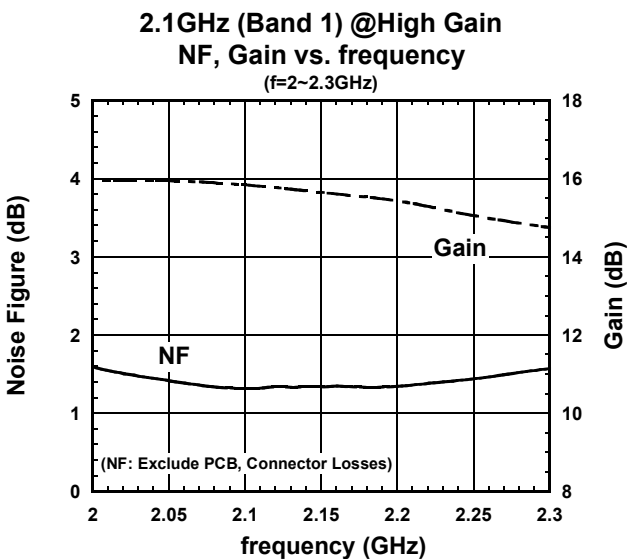
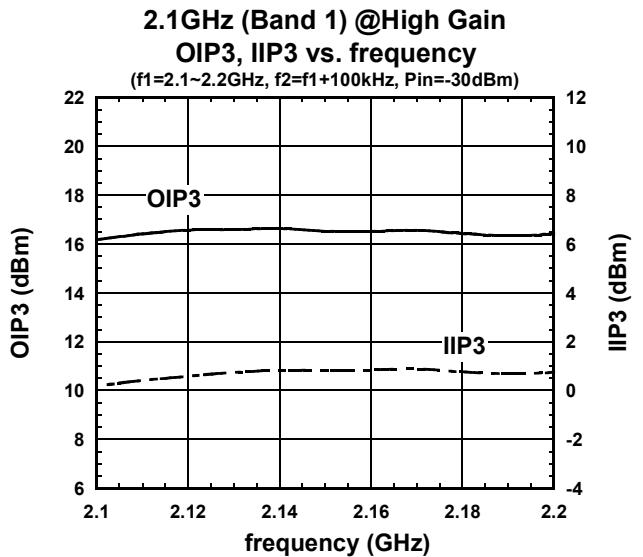
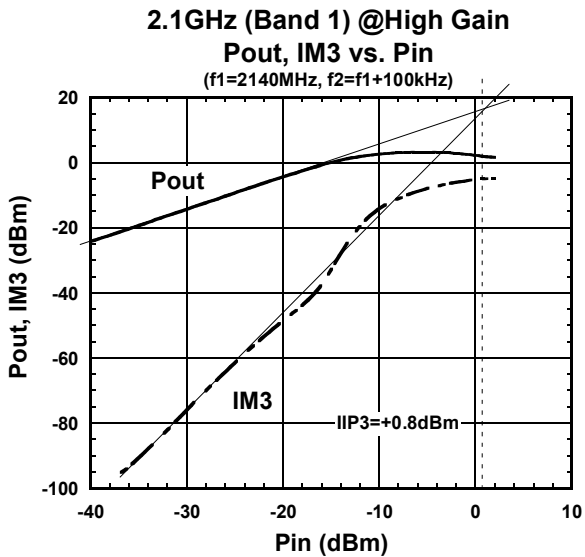
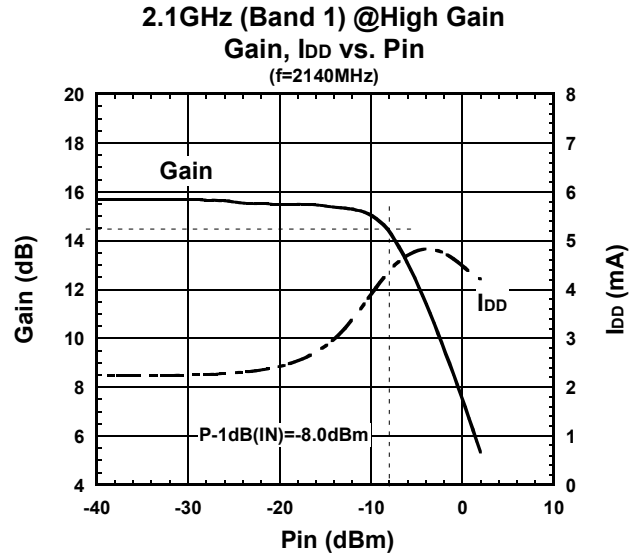
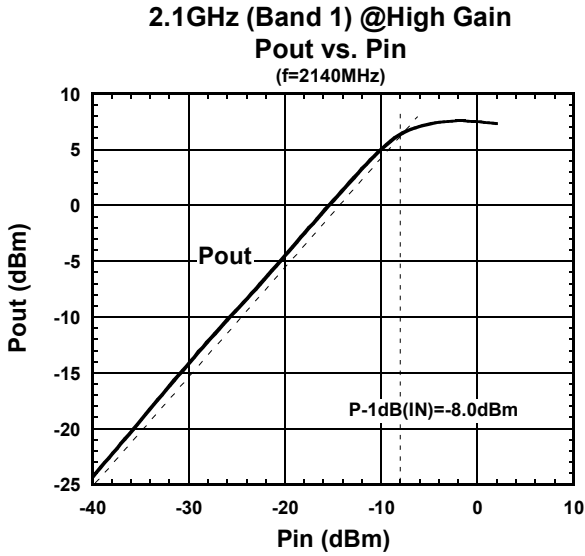
## 3-4. Truth table

Control voltage			Operating state					
V <sub>CTL1</sub> (Band Sel1)	V <sub>CTL2</sub> (Band Sel2)	V <sub>CTL3</sub> (Gain Sel1)	Band 1 (2.1G)		Band 8 (900M)		Band 2 (1.9G)	
			LNA	Bypass	LNA	Bypass	LNA	Bypass
L	L	L	OFF	ON	OFF	ON	OFF	ON
L	L	H	ON	OFF	OFF	OFF	OFF	OFF
H	L	L	OFF	ON	OFF	ON	OFF	ON
H	L	H	OFF	OFF	ON	OFF	OFF	OFF
L	H	L	OFF	ON	OFF	ON	OFF	ON
L	H	H	OFF	OFF	OFF	OFF	ON	OFF
H	H	L	OFF	ON	OFF	ON	OFF	ON
H	H	H	OFF	OFF	OFF	OFF	ON	OFF

“L”=0 ~ 0.30V, “H”=1.36 ~ 1.9 V

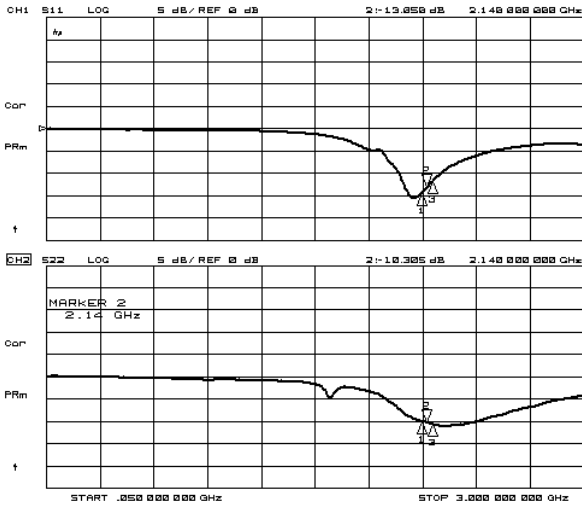
## 3-5-1. Typical characteristics (Band 1, High Gain Mode)

Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=0\text{V}$ ,  $V_{CTL2}=0\text{V}$ ,  $V_{CTL3}=1.8\text{V}$

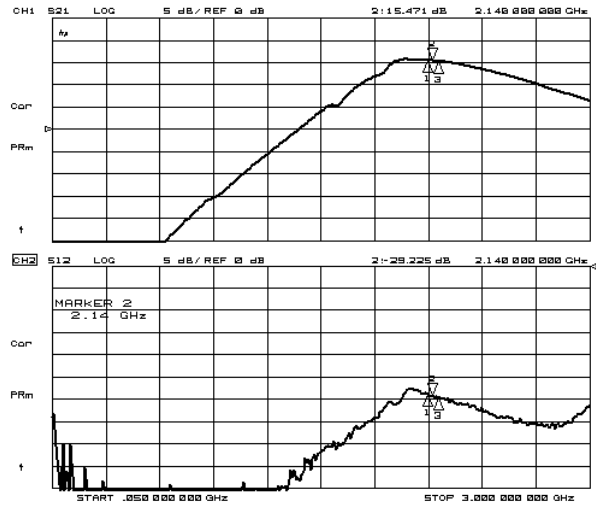


## 3-5-2. Typical characteristics (Band 1, High Gain Mode)

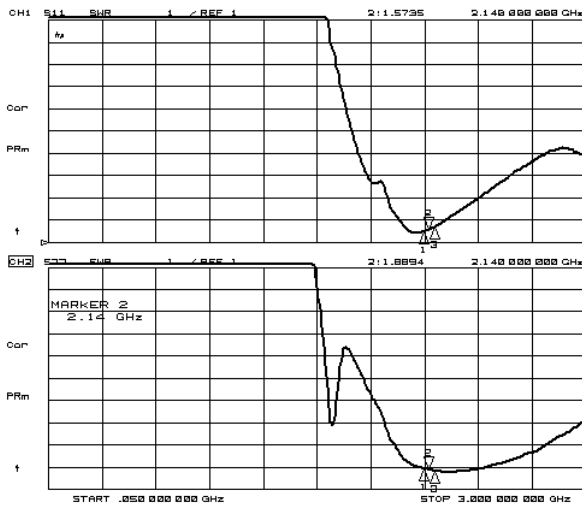
Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 0\text{V}$ ,  $V_{CTL2} = 0\text{V}$ ,  $V_{CTL3} = 1.8\text{V}$



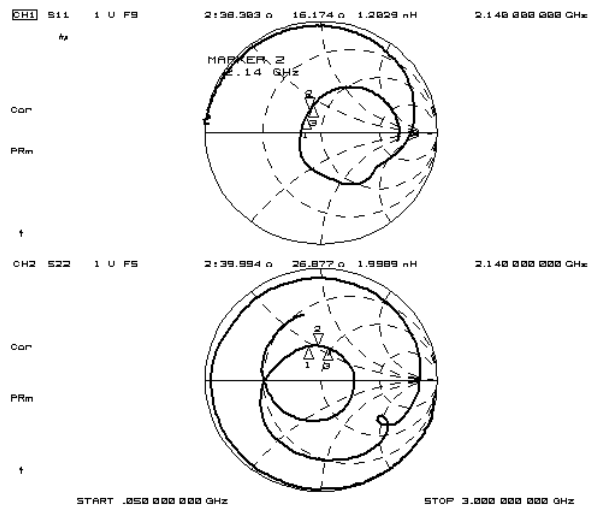
S11, S22



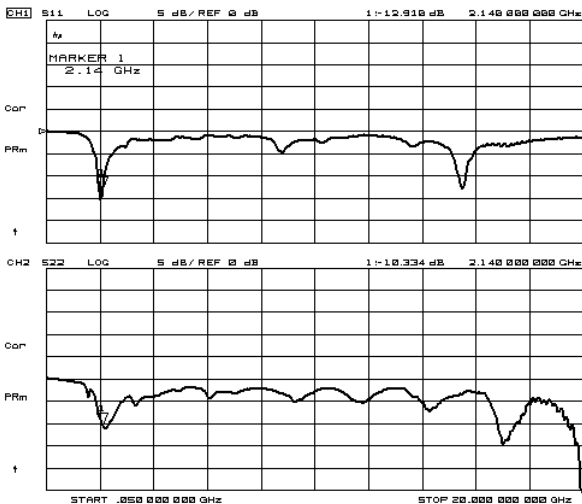
S21, S12



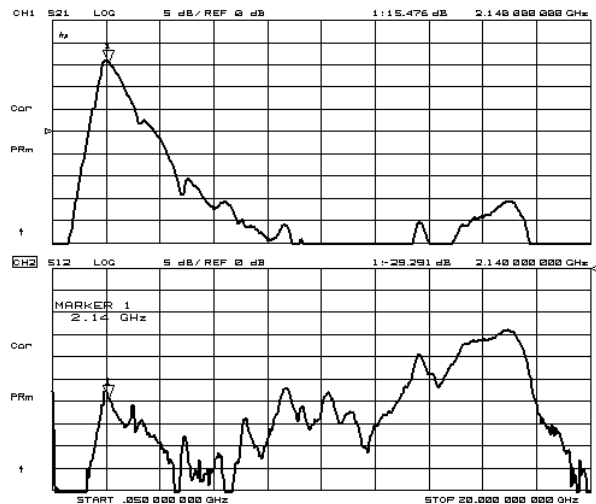
VSWR



Zin, Zout



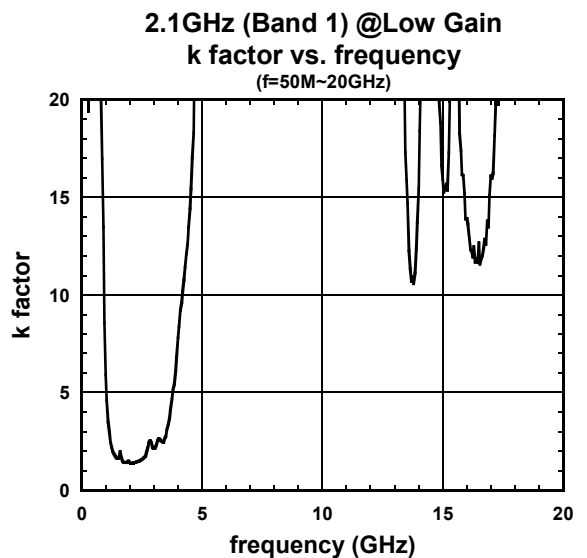
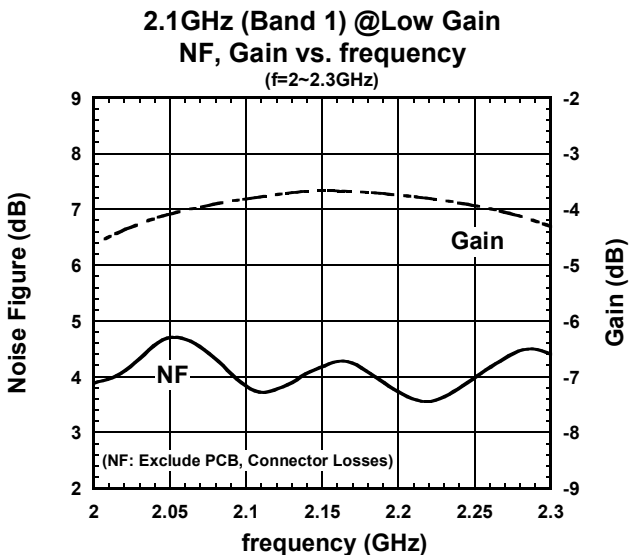
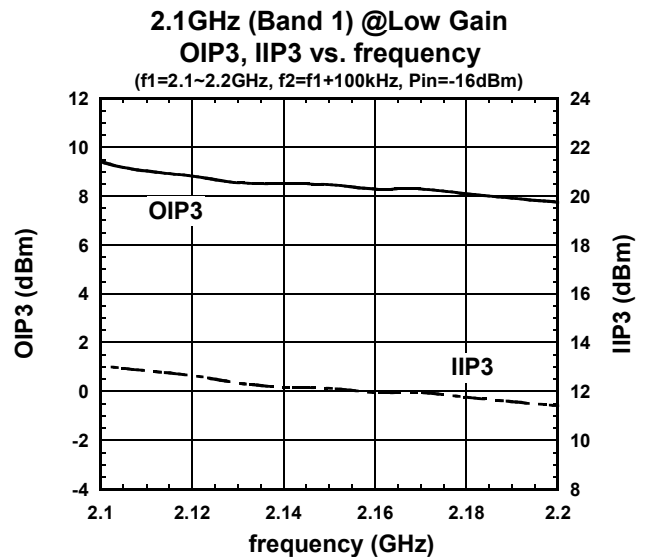
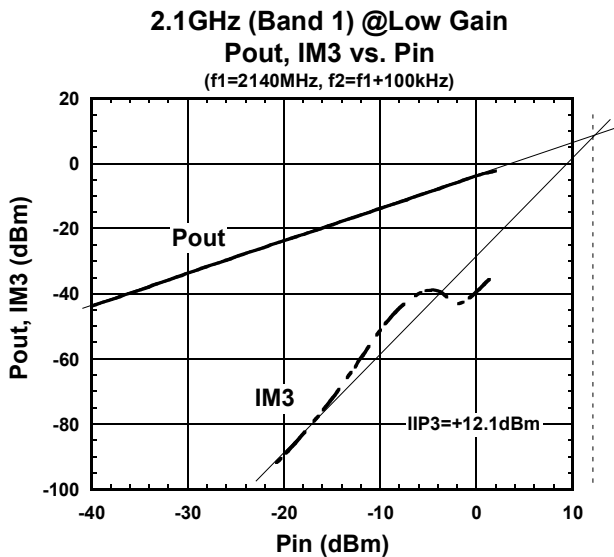
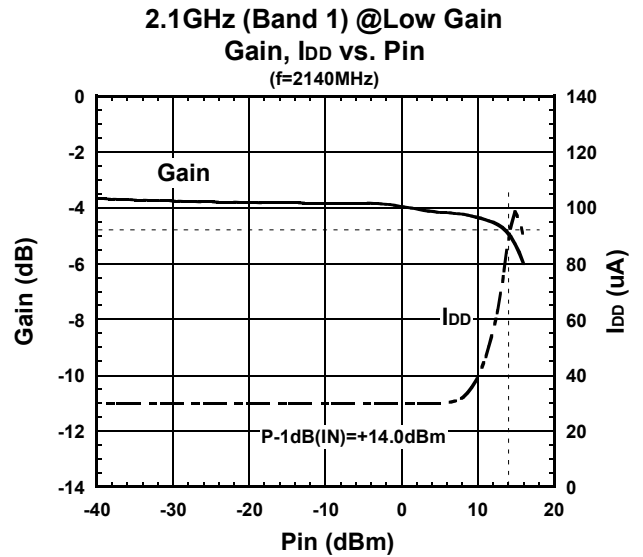
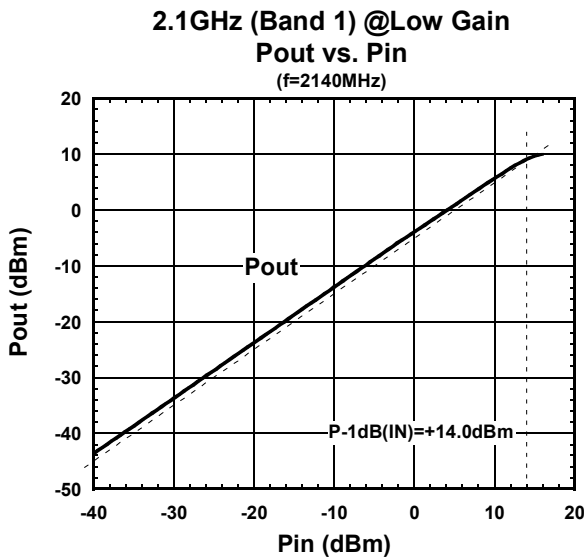
S11, S22 (50M~20GHz)



S21, S12 (50M~20GHz)

## 3-5-3. Typical characteristics (Band 1, Low Gain Mode)

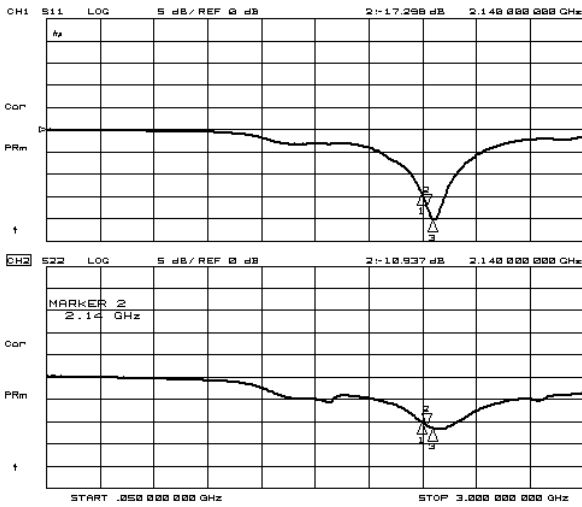
Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=0\text{V}$ ,  $V_{CTL2}=0\text{V}$ ,  $V_{CTL3}=0\text{V}$



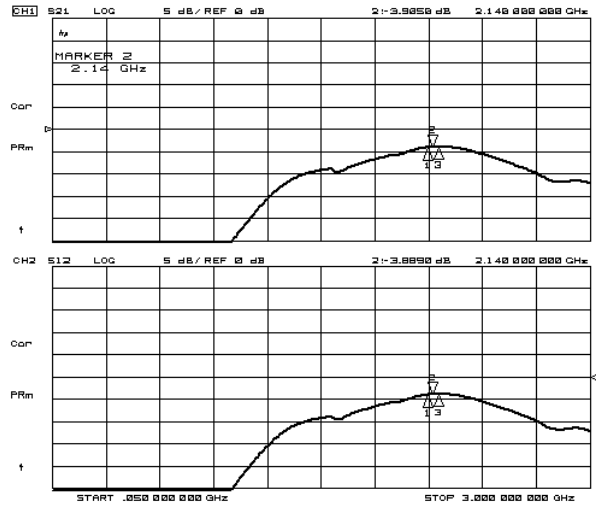


## 3-5-4. Typical characteristics (Band 1, Low Gain Mode)

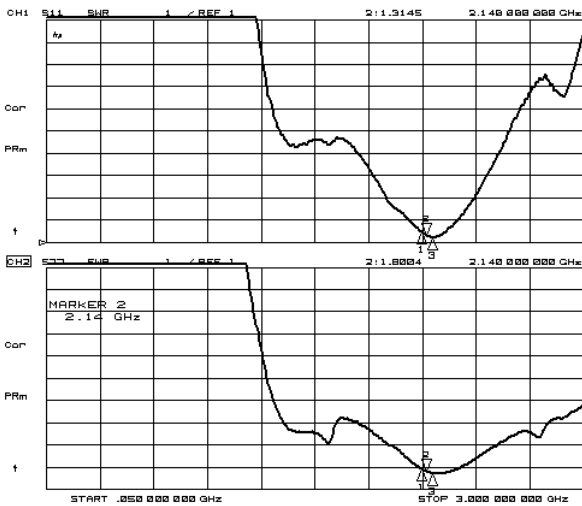
Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 0\text{V}$ ,  $V_{CTL2} = 0\text{V}$ ,  $V_{CTL3} = 0\text{V}$



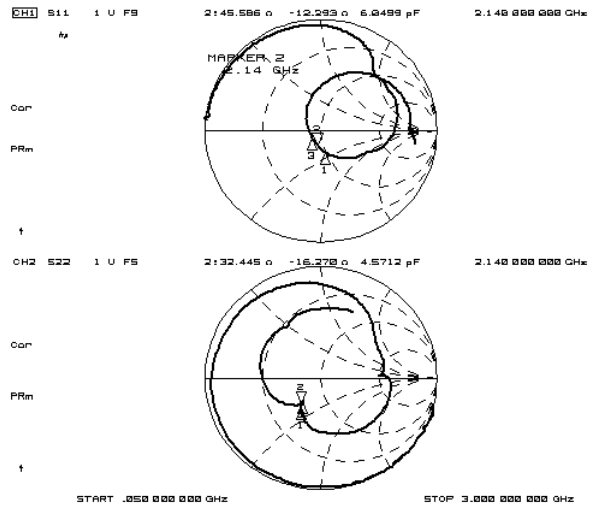
S11, S22



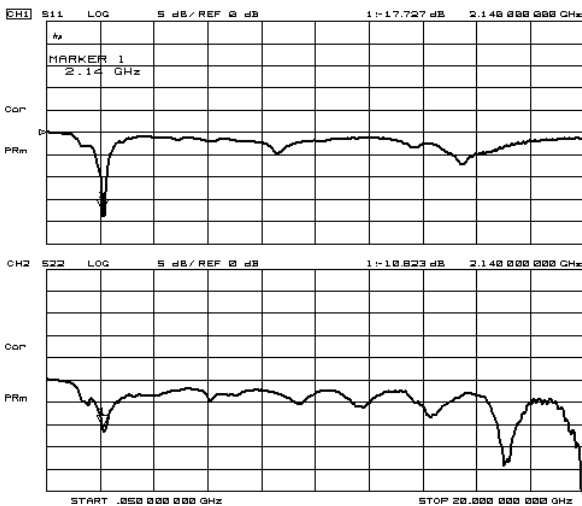
S21, S12



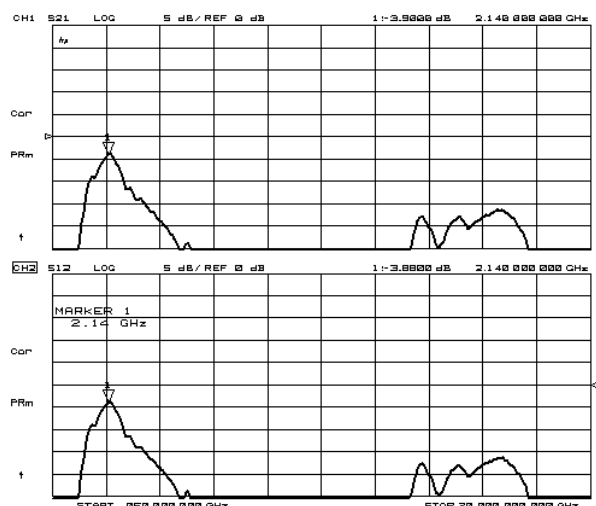
VSWR



Zin, Zout



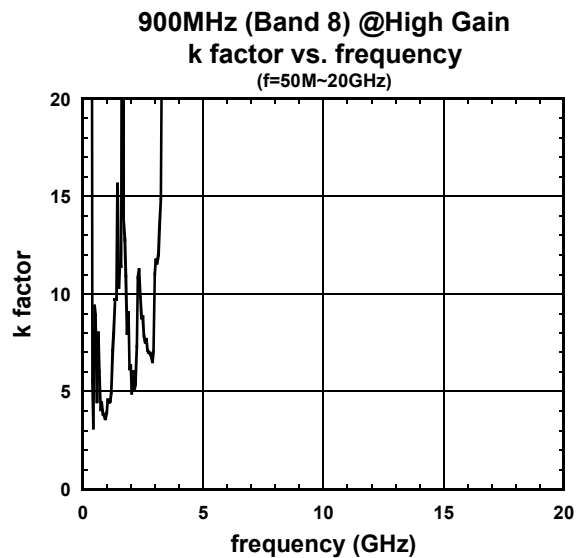
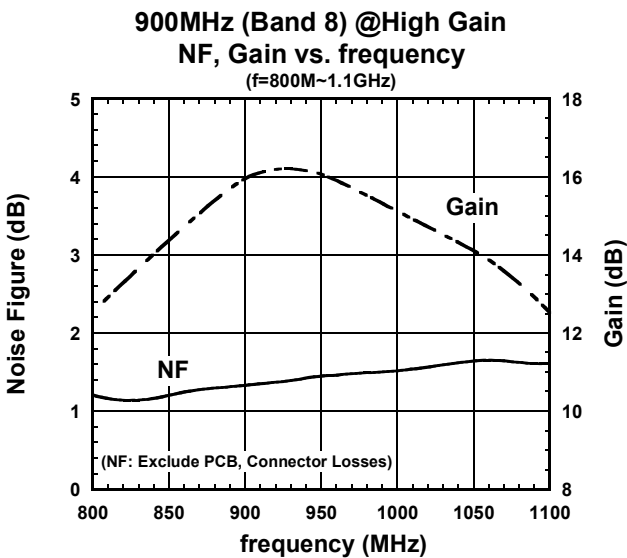
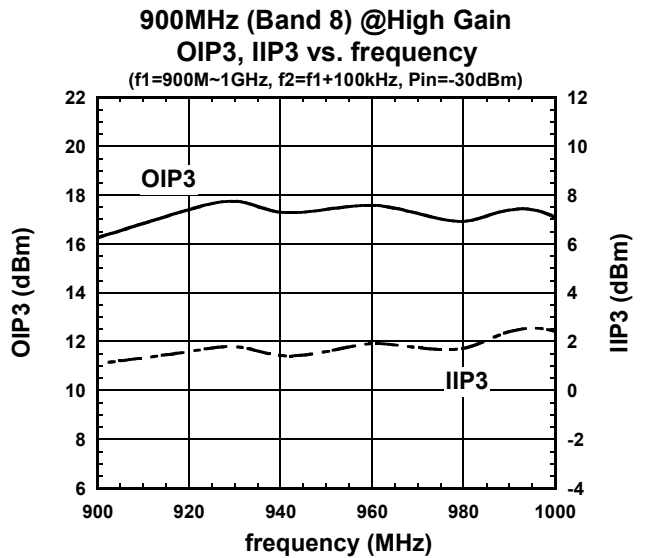
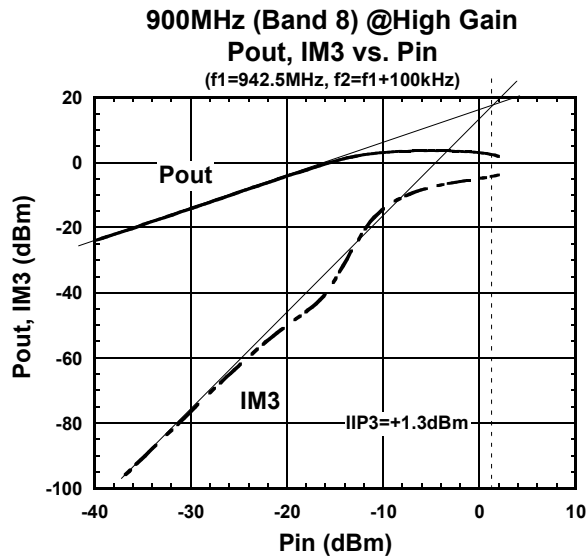
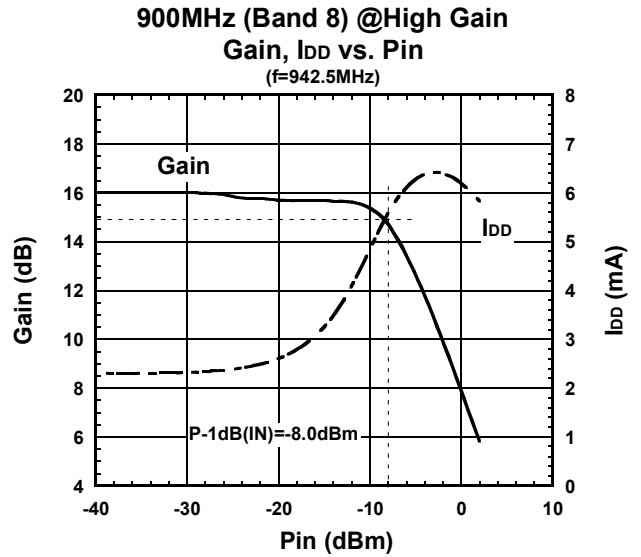
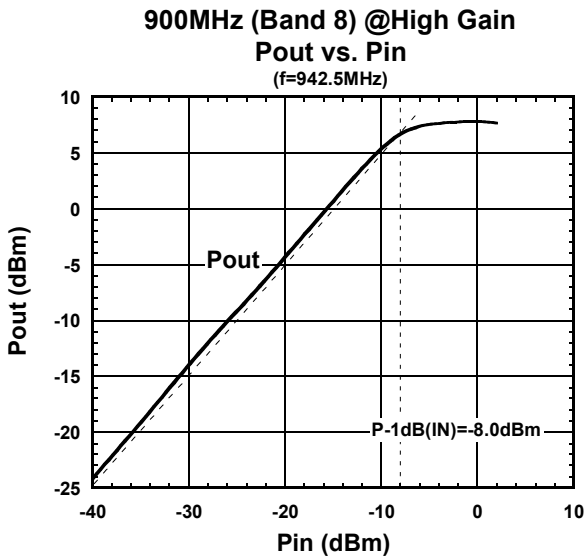
S11, S22 (50M~20GHz)



S21, S12 (50M~20GHz)

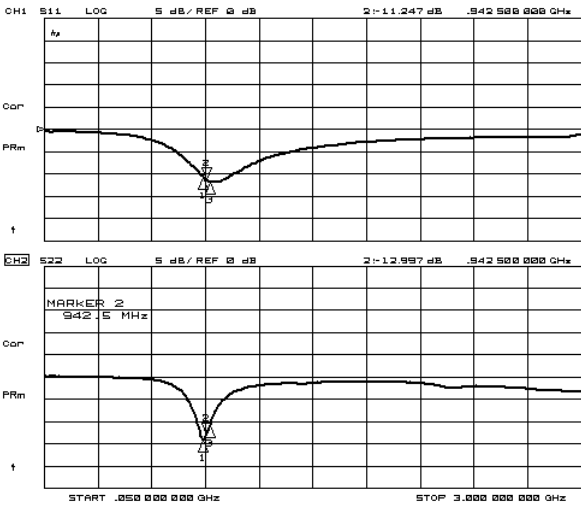
## 3-5-5. Typical characteristics (Band 8, High Gain Mode)

Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 1.8\text{V}$ ,  $V_{CTL2} = 0\text{V}$ ,  $V_{CTL3} = 1.8\text{V}$

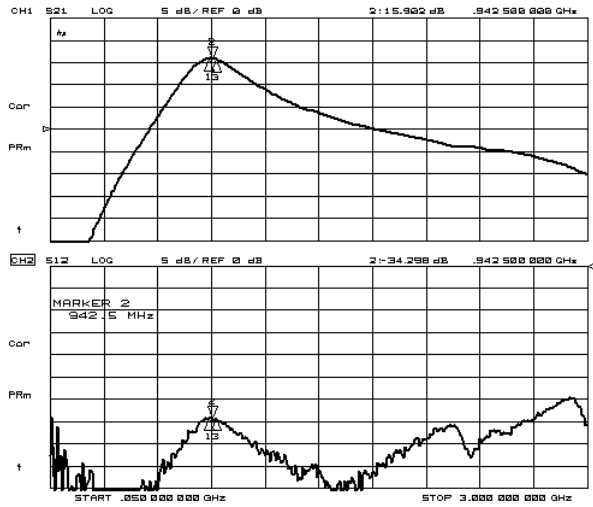


## 3-5-6. Typical characteristics (Band 8, High Gain Mode)

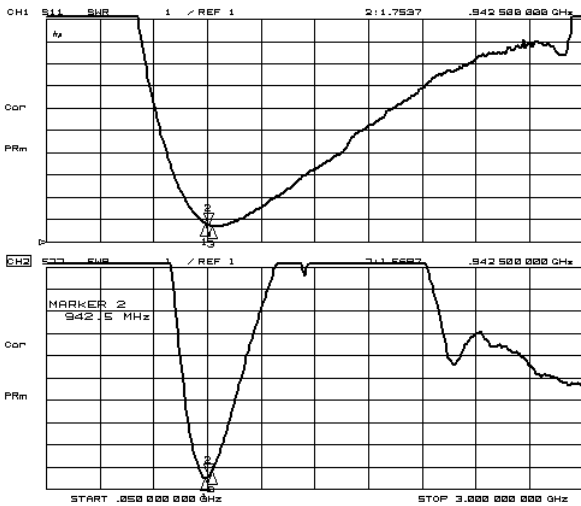
Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 1.8\text{V}$ ,  $V_{CTL2} = 0\text{V}$ ,  $V_{CTL3} = 1.8\text{V}$



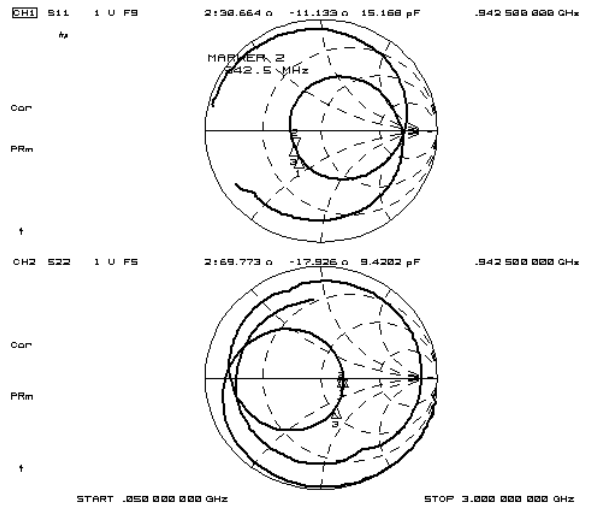
S11, S22



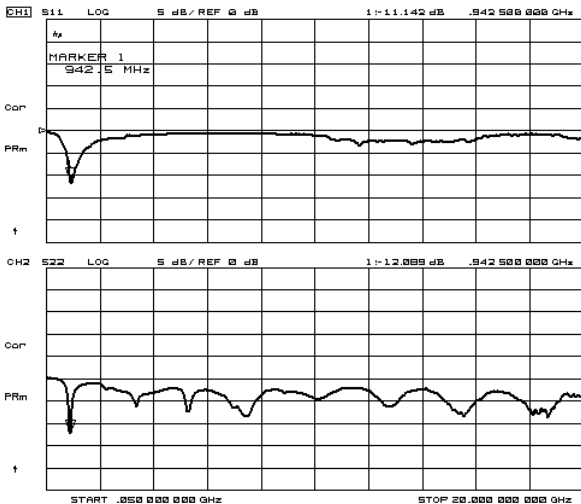
S21, S12



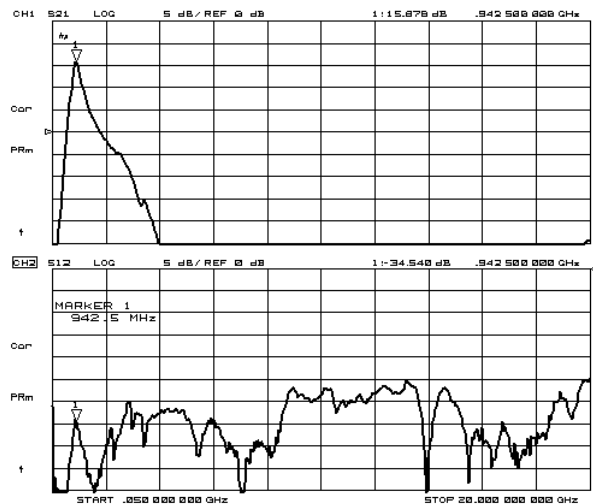
VSWR



Zin, Zout



S11, S22 (50M~20GHz)

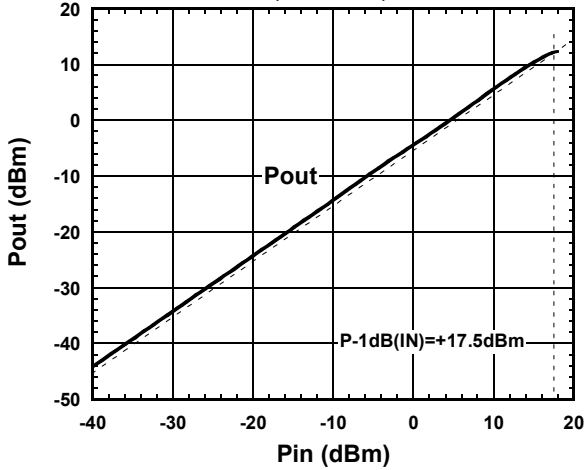


S21, S12 (50M~20GHz)

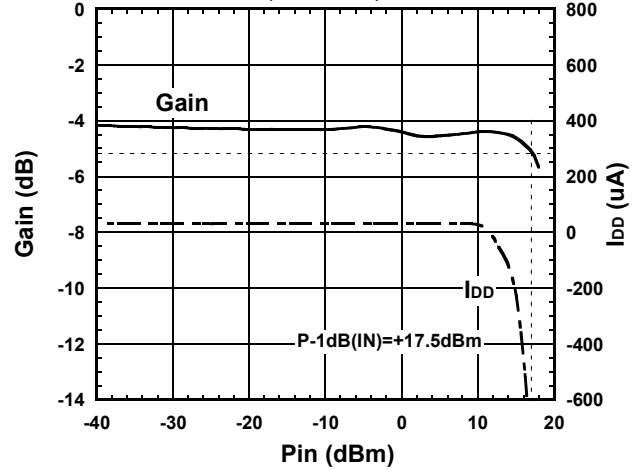
## 3-5-7. Typical characteristics (Band 8, Low Gain Mode)

Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 1.8\text{V}$ ,  $V_{CTL2} = 0\text{V}$ ,  $V_{CTL3} = 0\text{V}$

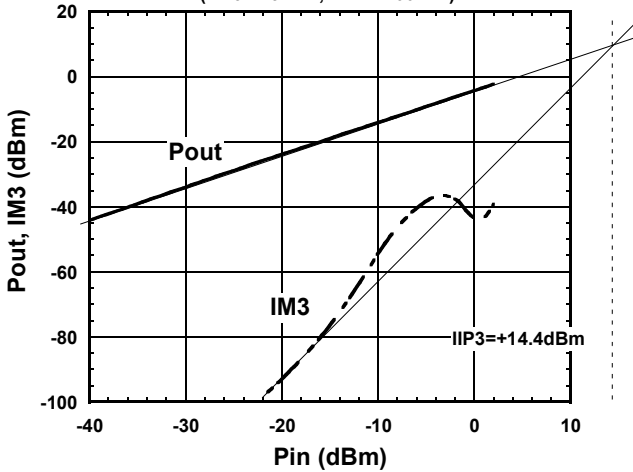
**900MHz (Band 8) @Low Gain**  
Pout vs. Pin  
(f=942.5MHz)



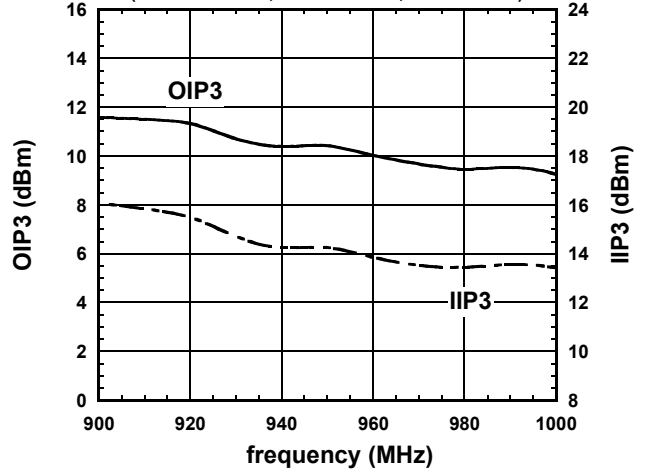
**900MHz (Band 8) @Low Gain**  
Gain, I<sub>DD</sub> vs. Pin  
(f=942.5MHz)



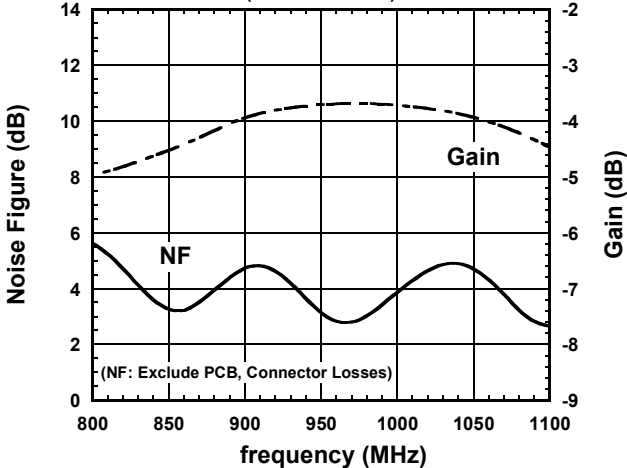
**900MHz (Band 8) @Low Gain**  
Pout, IM3 vs. Pin  
(f1=942.5MHz, f2=f1+100kHz)



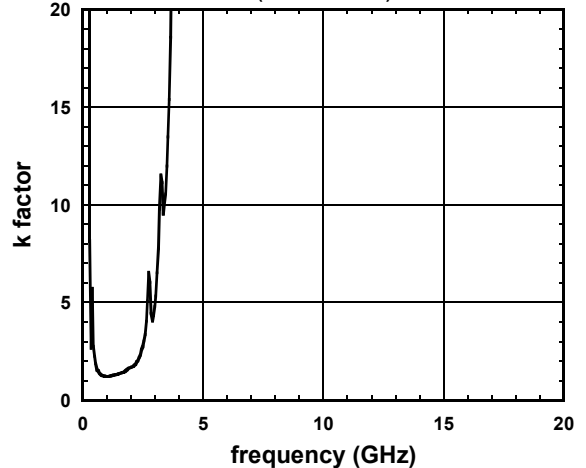
**900MHz (Band 8) @Low Gain**  
OIP3, IIP3 vs. frequency  
(f1=900M~1GHz, f2=f1+100kHz, Pin=-20dBm)



**900MHz (Band 8) @Low Gain**  
NF, Gain vs. frequency  
(f=800M~1.1GHz)

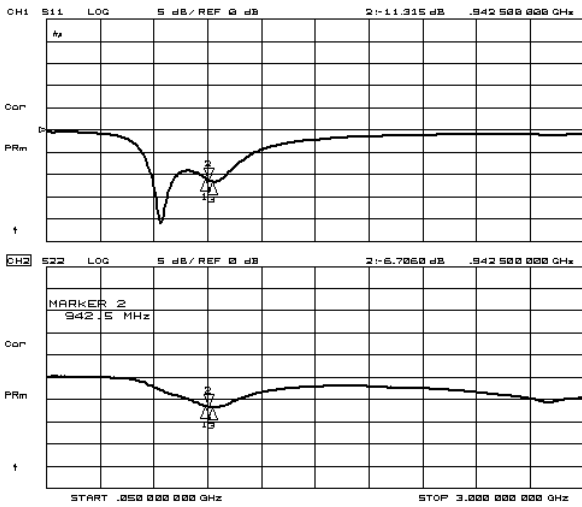


**900MHz (Band 8) @Low Gain**  
k factor vs. frequency  
(f=50M~20GHz)

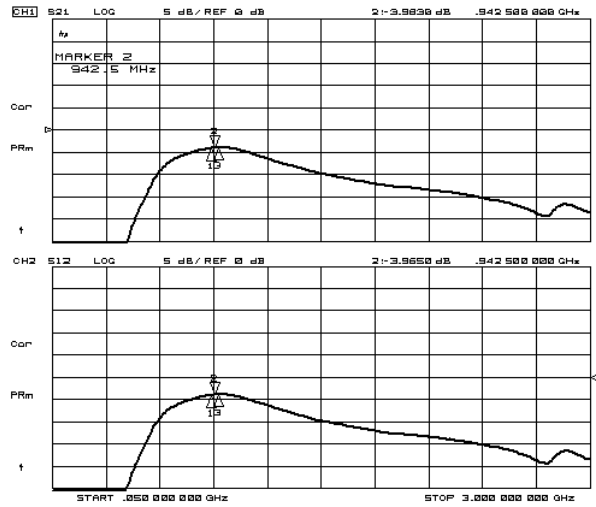


## 3-5-8. Typical characteristics (Band 8, Low Gain Mode)

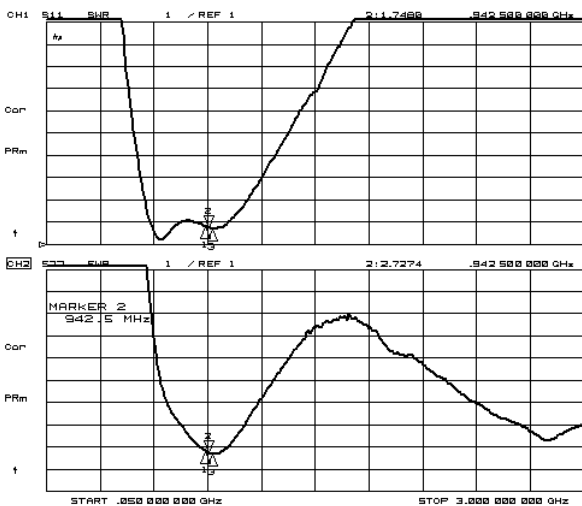
Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=1.8\text{V}$ ,  $V_{CTL2}=0\text{V}$ ,  $V_{CTL3}=0\text{V}$



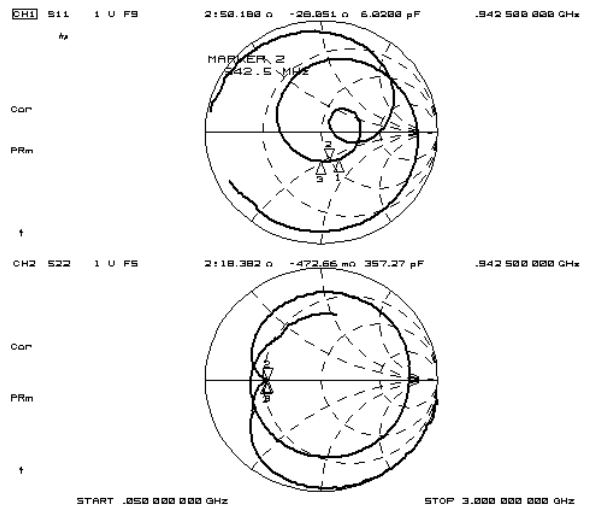
S11, S22



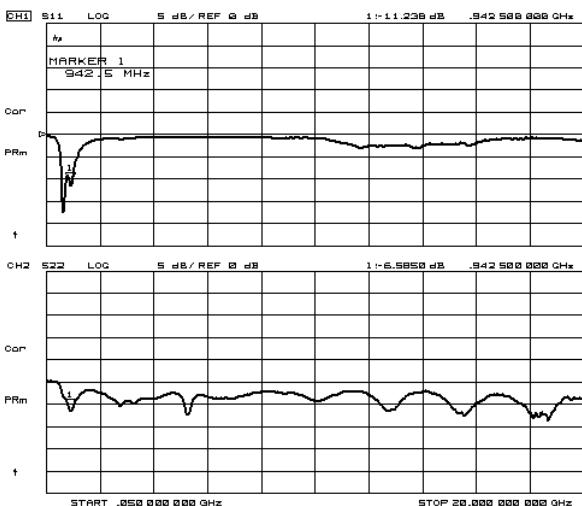
S21, S12



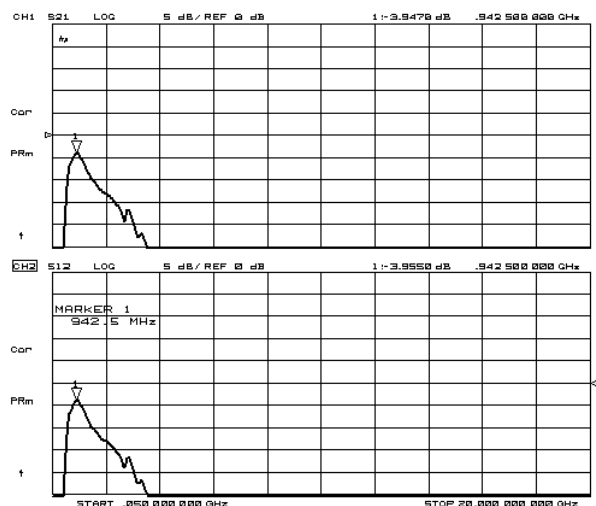
VSWR



Zin, Zout



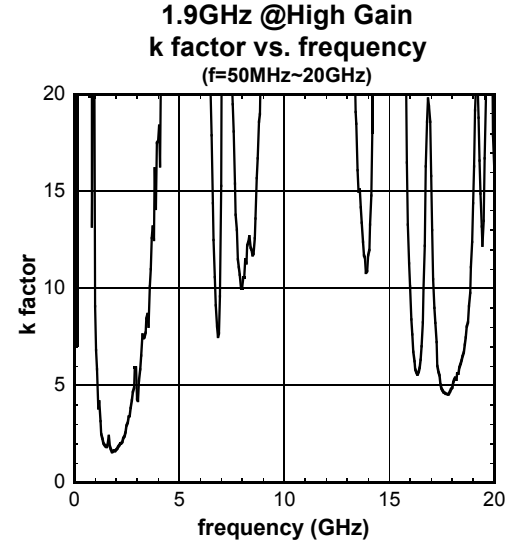
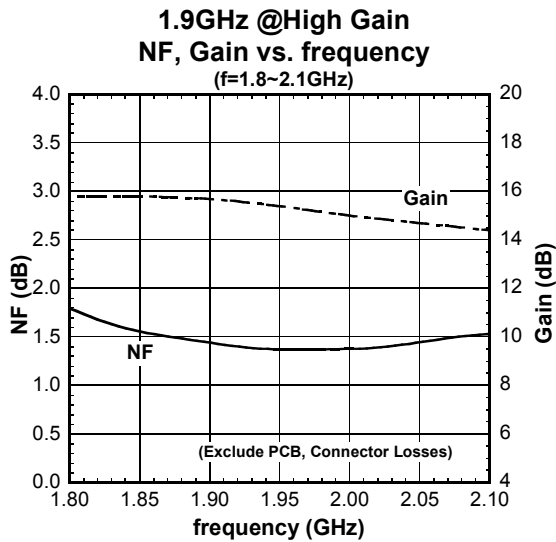
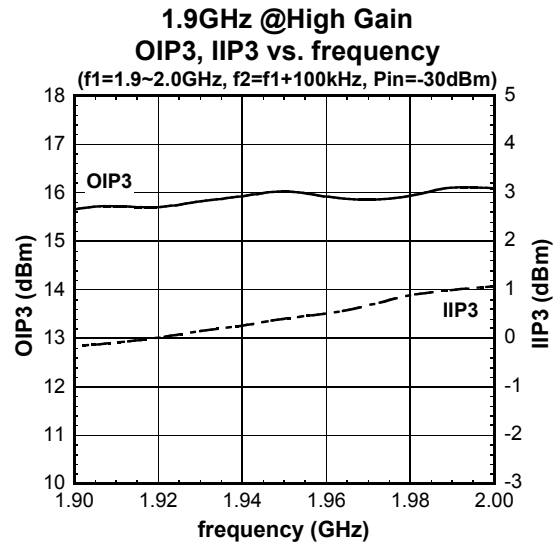
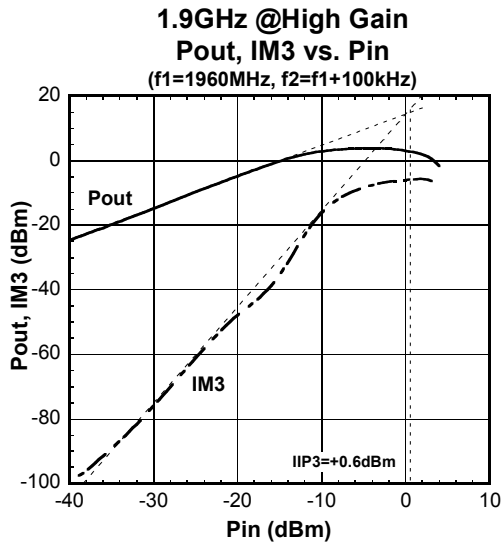
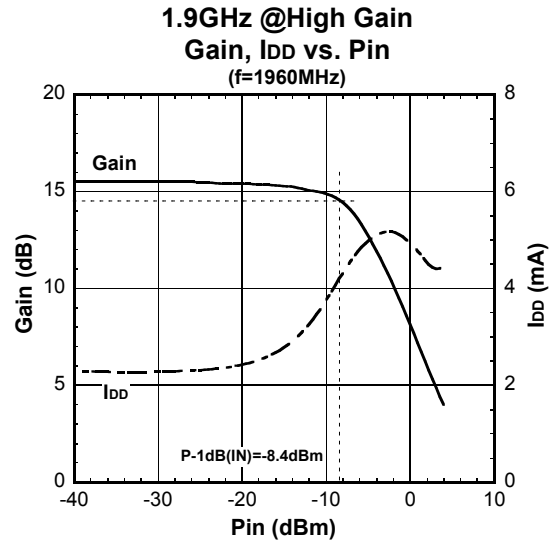
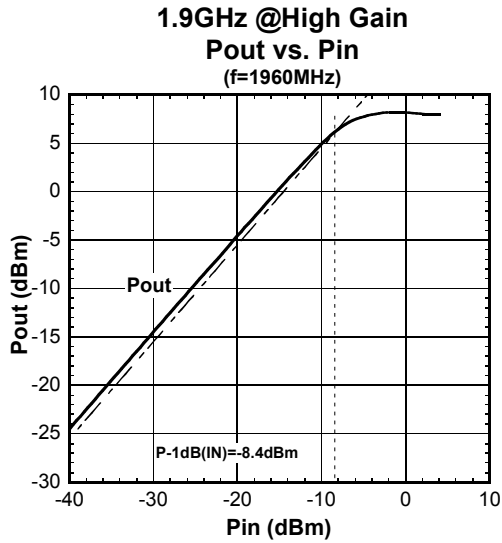
S11, S22 (50M~20GHz)



S21, S12 (50M~20GHz)

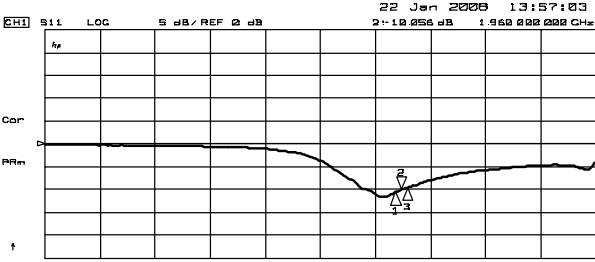
## 3-5-9. Typical characteristics (Band 2, High Gain Mode)

Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=0\text{V}$ ,  $V_{CTL2}=1.8\text{V}$ ,  $V_{CTL3}=1.8\text{V}$

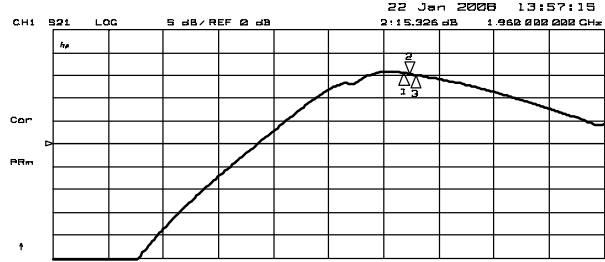


## 3-5-10. Typical characteristics (Band 2, High Gain Mode)

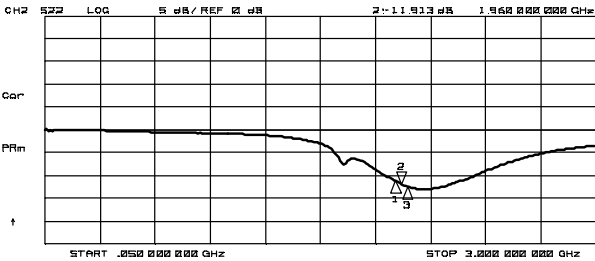
Condition:  $T_a = +25^\circ\text{C}$ ,  $V_{DD} = 2.7\text{V}$ ,  $V_{CTL1} = 0\text{V}$ ,  $V_{CTL2} = 1.8\text{V}$ ,  $V_{CTL3} = 1.8\text{V}$



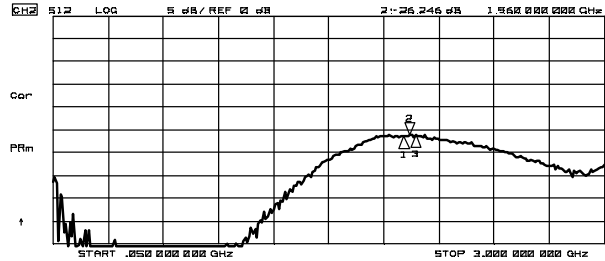
CH1 Markers  
 1: -10.566 dB  
 1.93000 GHz  
 3: -9.6400 dB  
 1.99000 GHz



CH1 Markers  
 1: 15.565 dB  
 1.93000 GHz  
 3: 15.275 dB  
 1.99000 GHz



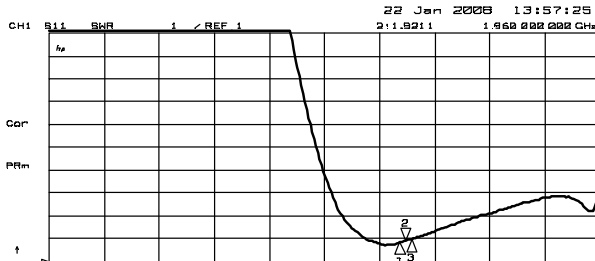
CH2 Markers  
 1: -11.189 dB  
 1.93000 GHz  
 3: -12.418 dB  
 1.99000 GHz



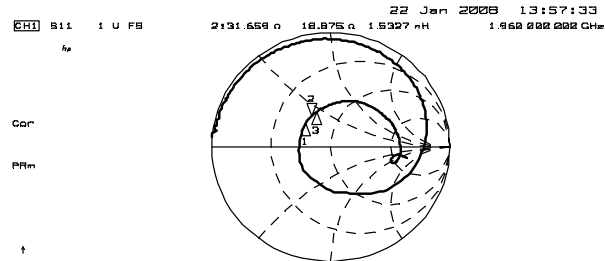
CH2 Markers  
 1: 25.468 dB  
 1.93000 GHz  
 3: 25.186 dB  
 1.99000 GHz

S11, S22

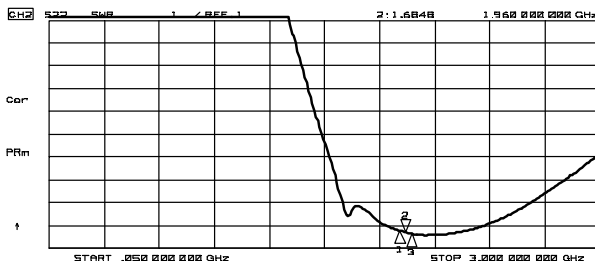
S21, S12



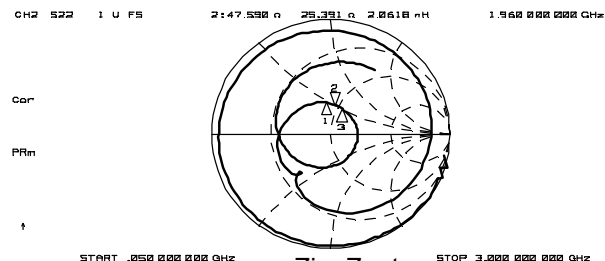
CH1 Markers  
 1: 1.8473  
 1.93000 GHz  
 3: 1.9853  
 1.99000 GHz



CH1 Markers  
 1: 38.255 n  
 14.068 n  
 1.93000 GHz  
 3: 33.170 n  
 23.049 n  
 1.99000 GHz



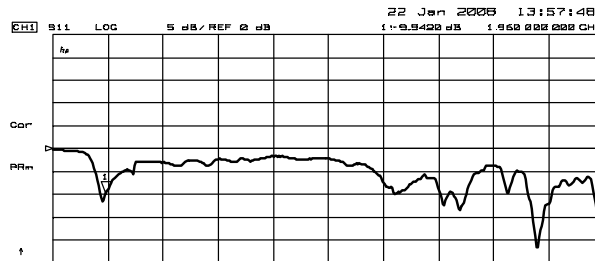
CH2 Markers  
 1: 1.7500  
 1.93000 GHz  
 3: 1.6200  
 1.99000 GHz



CH2 Markers  
 1: 48.555 n  
 24.045 n  
 1.93000 GHz  
 3: 54.523 n  
 28.141 n  
 1.99000 GHz

VSWR

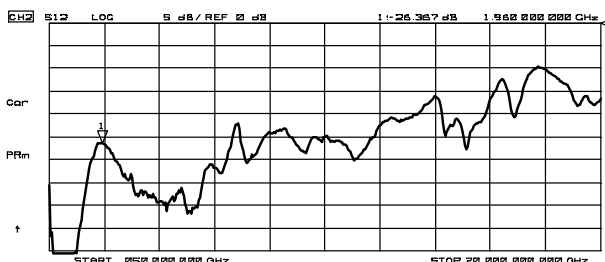
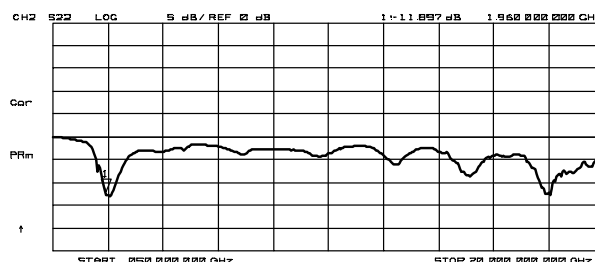
Zin, Zout



S11, S22 (50M~20GHz)

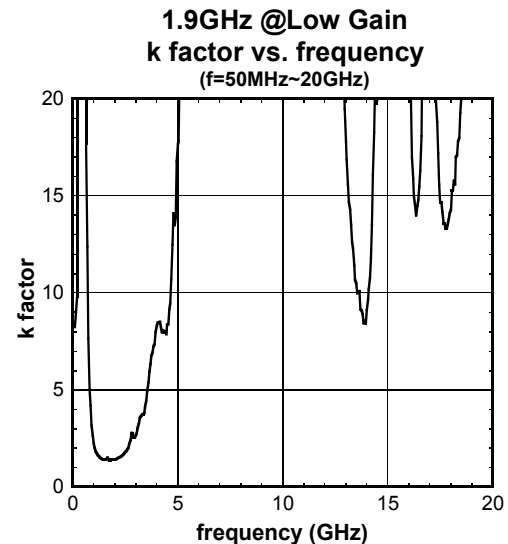
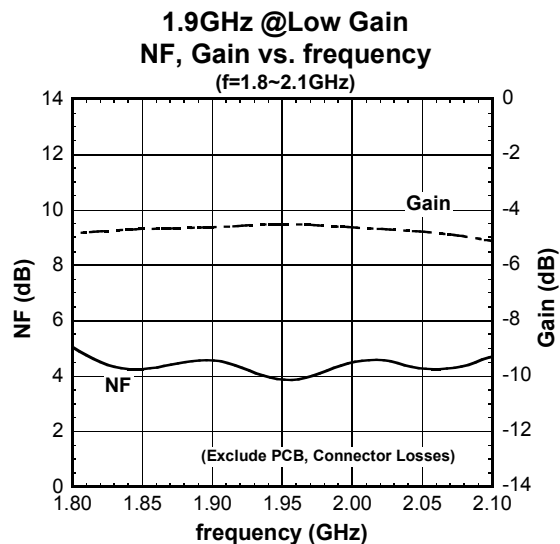
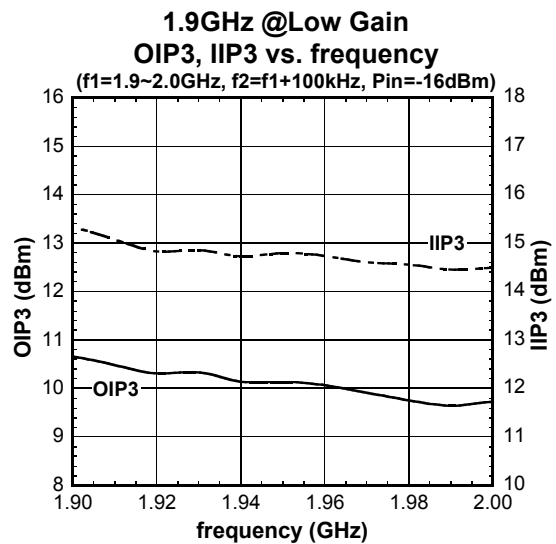
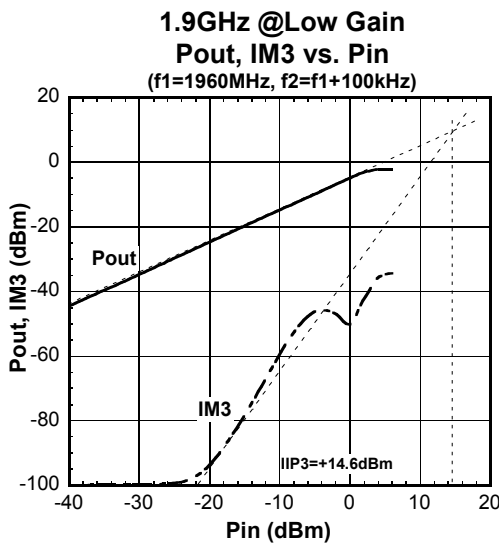
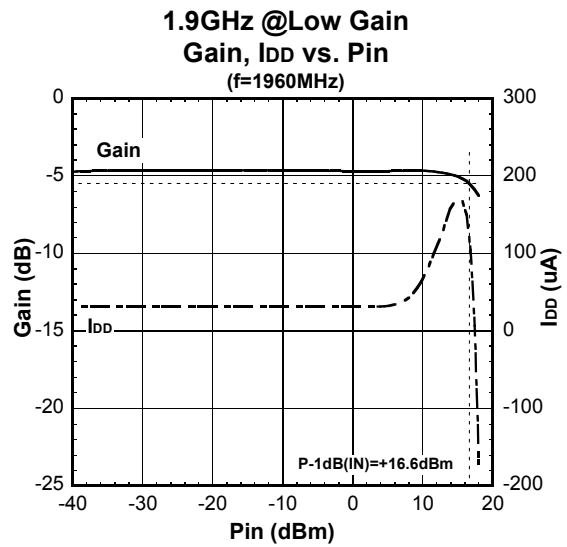
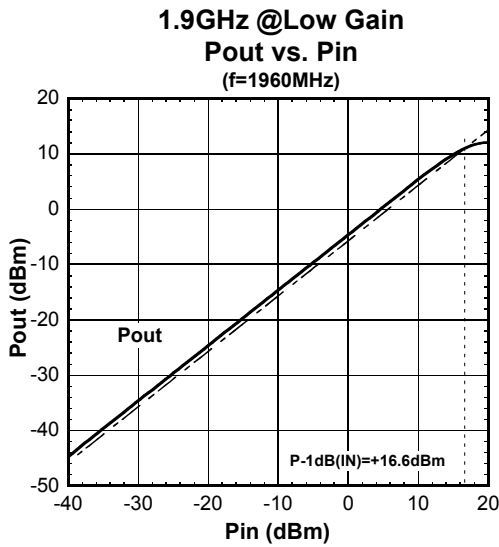


S21, S12 (50M~20GHz)



## 3-5-11. Typical characteristics (Band 2, Low Gain Mode)

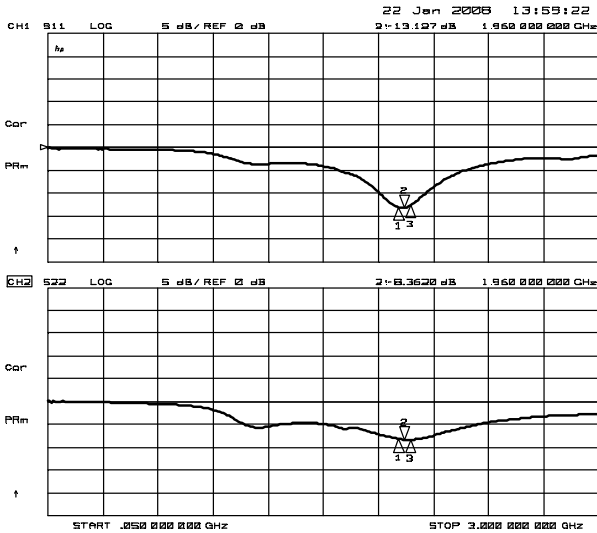
Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=0\text{V}$ ,  $V_{CTL2}=1.8\text{V}$ ,  $V_{CTL3}=0\text{V}$



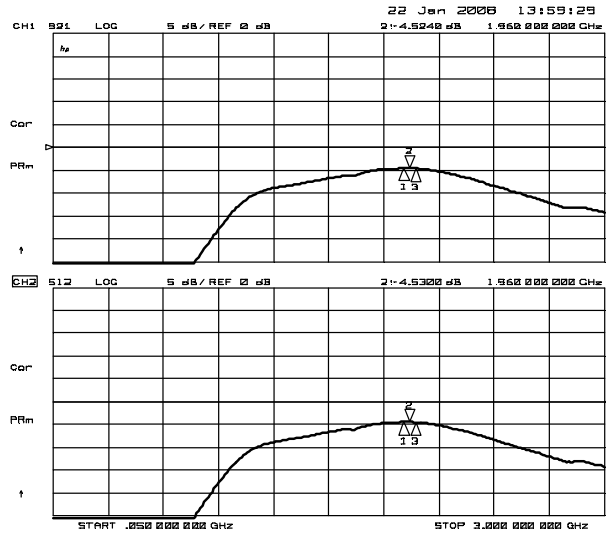


## 3-5-12. Typical characteristics (Band 2, Low Gain Mode)

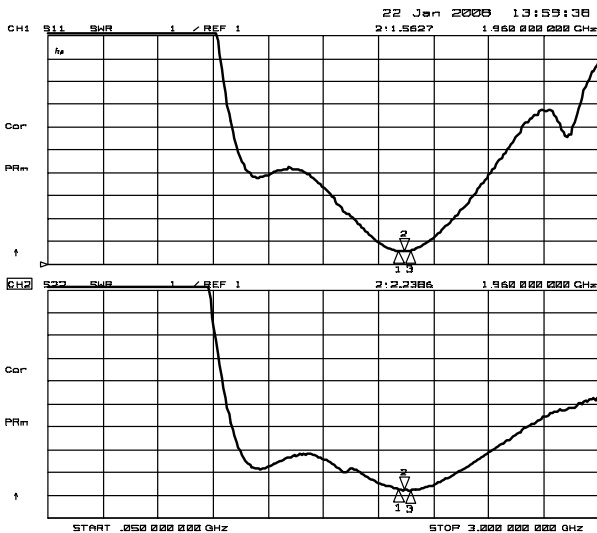
Condition:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL1}=0\text{V}$ ,  $V_{CTL2}=1.8\text{V}$ ,  $V_{CTL3}=0\text{V}$



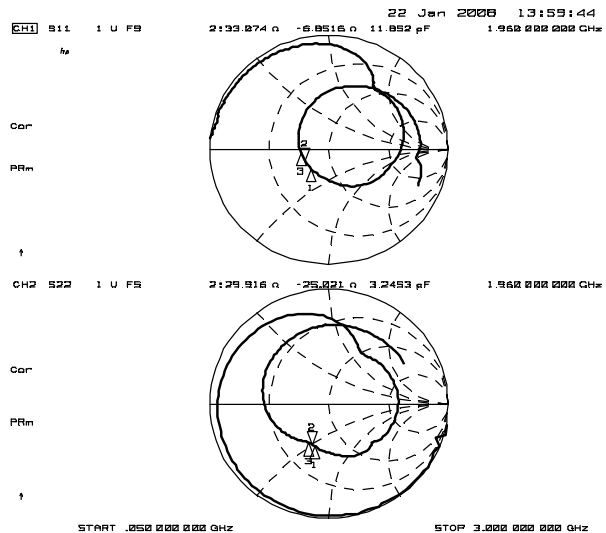
S11, S22



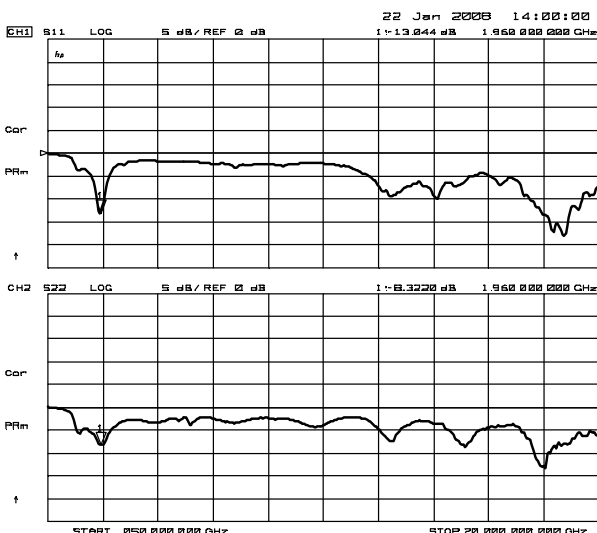
S21, S12



VSWR

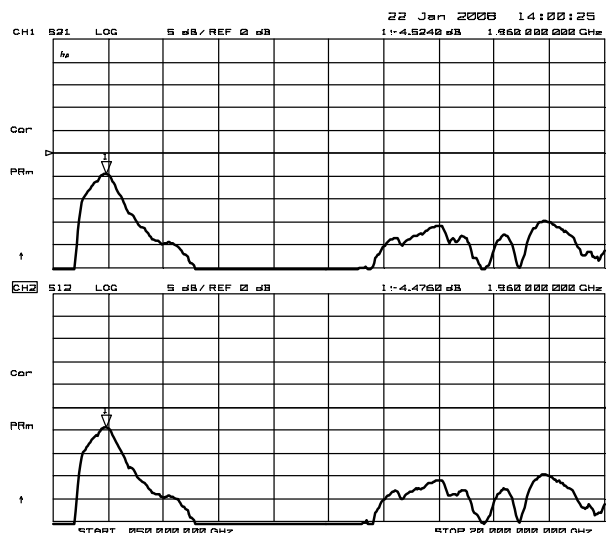


Zin, Zout



S11, S22

(f=50MHz~20GHz)

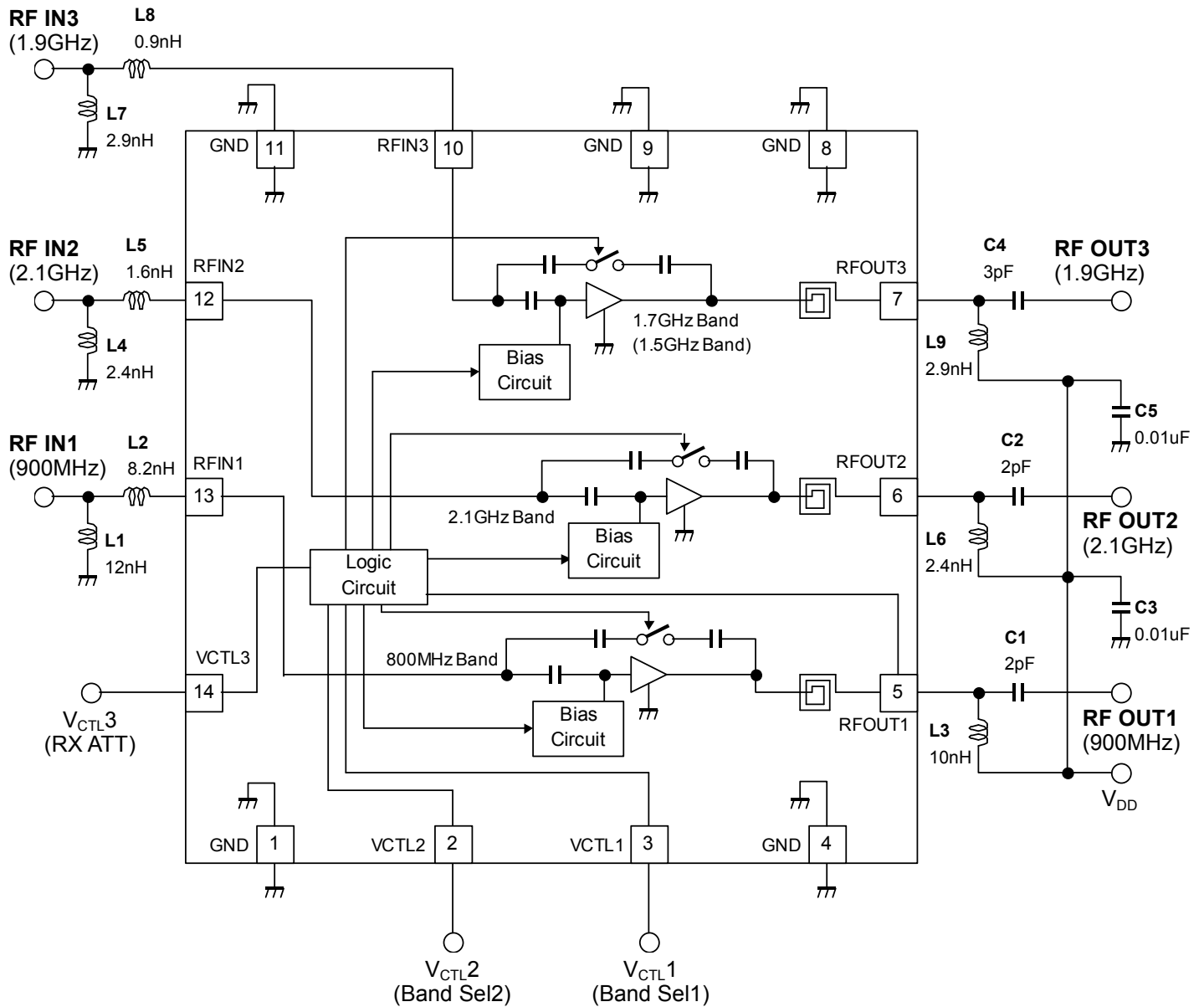


S21, S12

(f=50MHz~20GHz)

## 3-6. Application circuit

(Top View)

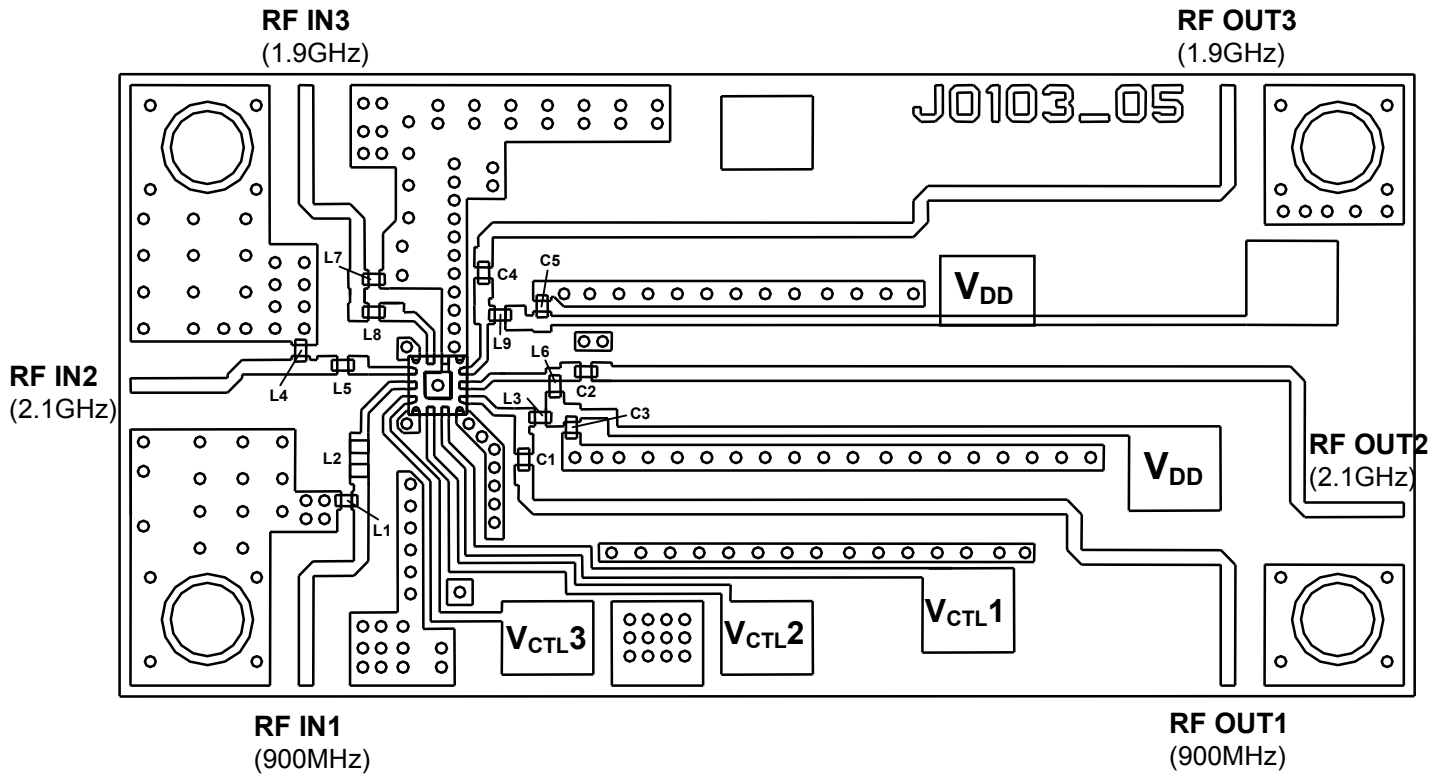


### Parts list

Parts ID	Comments
L1, L2, L4~L9	MURATA LQP03T Series
L3	TDK MLK0603 Series
C1~C5	MURATA GRM03 Series

## 3-7. Test PCB Layout

(Top View)



PCB (FR-4):  
 $t=0.2\text{mm}$   
 MICROSTRIP LINE WIDTH=0.4mm ( $Z_0=50\text{ohm}$ )  
 PCB SIZE=35.4mm x 17.0mm

### CAUTION

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