1.9GHz / 900MHz /1.8GHz Bands Application

4-1 Summary

The characterisitics of Band1, 8, 3 have evaluated as follows. The evaluation circuit structure and measured data are reviewed.

4-2-1 Measurement data of assembled evaluation board

DC Characteristics
General conditions : V_{DD}=2.85V, Ta=+25°C

Parameter	Symbol	Condition	Measurement Data	Units
LNA Supply Voltage	V_{DD}		2.85	V
Control Voltage 1 (High)	$V_{CTL}1(H)$		1.8	V
Control Voltage 1 (Low)	$V_{CTL}1(L)$		0	V
Control Voltage 2 (High)	$V_{CTL}2(H)$		1.8	V
Control Voltage 2 (Low)	$V_{CTL}2(L)$		0	V
Control Voltage 3 (High)	$V_{CTL}3(H)$		1.8	V
Control Voltage 3 (Low)	$V_{CTL}3(L)$		0	V
LNA Operating Current 1 (1.9GHz Band High Gain Mode)	$I_{DD}1$	$V_{CTL}1$=0V, $V_{CTL}2$=0V, $V_{CTL}3$=1.8V	2.57	mA
LNA Operating Current 2 (900MHz Band High Gain Mode)	$I_{DD}2$	$V_{CTL}1$=1.8V, $V_{CTL}2$=0V, $V_{CTL}3$=1.8V	2.27	mA
LNA Operating Current 3 (1.8GHz Band High Gain Mode)	$I_{DD}3$	$V_{CTL}1$=0V, $V_{CTL}2$=1.8V, $V_{CTL}3$=1.8V	2.51	mA
LNA Operating Current 4 (Low Gain Mode)	$I_{DD}4$	$V_{CTL}3$=0V	34.5	uA
Control Current 1	$I_{CTL}1$	$V_{CTL}1$=1.8V	5.5	uA
Control Current 2	$I_{CTL}2$	$V_{CTL}2$=1.8V	5.6	uA
Control Current 3	$I_{CTL}3$	$V_{CTL}3$=1.8V	5.6	uA

4-2-2 Measurement data of assembled evaluation board

RF Characteristics 1 (1.9GHz Band High Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=1.8V, fRF=1920~1980MHz,
Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 1	Exclude Input&Output PCB, Connector Losses (0.45dB)	Gain 1	16.5 ~ 16.9	dB
Noise Figure 1	Exclude PCB, Connector Losses (0.09dB)	NF 1	1.13 ~ 1.39	dB
Input Power 1dB Compression 1		P-1dB(IN)_1	-9.3 ~ -9.1	dBm
Input 3rd Order Intercept Point 1	f1=fRF, f2=fRF+100kHz, Pin=-30dBm	IIP3_1	-1.3 ~ -0.9	dBm
RF IN VSWR 1		VSWRi_1	1.70 ~ 1.86	-
RF OUT VSWR 1		VSWRo_1	2.17 ~ 2.44	-

RF Characteristics 2 (1.9GHz Band Low Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=0V, fRF=1920~1980MHz,
Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 2	Exclude Input&Output PCB, Connector Losses (0.45dB)	Gain 2	-3.9 ~ -3.6	dB
Noise Figure 2	Exclude PCB, Connector Losses (0.09dB)	NF 2	3.8 ~ 4.4	dB
Input Power 1dB Compression 2		P-1dB(IN)_2	+15.2 ~ +15.7	dBm
Input 3rd Order Intercept Point 2	f1=fRF, f2=fRF+100kHz, Pin=-20dBm	IIP3_2	+12.3 ~ +12.6	dBm
RF IN VSWR 2		VSWRi_2	1.09 ~ 1.27	-
RF OUT VSWR 2		VSWRo_2	1.41 ~ 1.57	-

4-2-3 Measurement data of assembled evaluation board

RF Characteristics 3 (900MHz Band High Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=1.8V, fRF=925~960MHz,

Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 3	Exclude Input&Output PCB, Connector Losses (0.22dB)	Gain 3	16.1 ~ 16.2	dB
Noise Figure 3	Exclude PCB, Connector Losses (0.06dB)	NF 3	1.20 ~ 1.30	dB
Input Power 1dB Compression 3		P-1dB(IN)_3	-7.8 ~ -7.3	dBm
Input 3rd Order Intercept Point 3	f1=fRF, f2=fRF+100kHz, Pin=-30dBm	IIP3_3	+0.6 ~ +1.3	dBm
RF IN VSWR 3		VSWRi_3	1.78 ~ 1.96	-
RF OUT VSWR 3		VSWRo_3	1.48 ~ 1.66	-

RF Characteristics 4 (900MHz Band Low Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=0V, fRF=925~960MHz,

Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 4	Exclude Input&Output PCB, Connector Losses (0.22dB)	Gain 4	-4.0 ~ -3.9	dB
Noise Figure 4	Exclude PCB, Connector Losses (0.06dB)	NF 4	2.7 ~ 4.9	dB
Input Power 1dB Compression 4		P-1dB(IN)_4	+17.6 ~ +18.0	dBm
Input 3rd Order Intercept Point 4	f1=fRF, f2=fRF+100kHz, Pin=-20dBm	IIP3_4	+11.6 ~ +13.3	dBm
RF IN VSWR 4		VSWRi_4	1.75 ~ 1.81	-
RF OUT VSWR 4		VSWRo_4	2.72 ~ 2.81	-

4-2-4 Measurement data of assembled evaluation board

RF Characteristics 5 (1.8GHz Band High Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=1.8V, fRF=1805~1880MHz,
Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 5	Exclude Input&Output PCB, Connector Losses (0.41dB)	Gain 5	15.7 ~ 15.9	dB
Noise Figure 5	Exclude PCB, Connector Losses (0.10dB)	NF 5	1.35 ~ 1.41	dB
Input Power 1dB Compression 5		P-1dB(IN)_5	-7.8 ~ -7.1	dBm
Input 3rd Order Intercept Point 5	f1=fRF, f2=fRF+100kHz, Pin=-30dBm	IIP3_5	+1.0 ~ +1.8	dBm
RF IN VSWR 5		VSWRi_5	1.76 ~ 1.93	-
RF OUT VSWR 5		VSWRo_5	1.78 ~ 1.79	-

RF Characteristics 6 (1.8GHz Band Low Gain Mode)

General condition : V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=0V, fRF=1805~1880MHz,
Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Small Signal Gain 6	Exclude Input&Output PCB, Connector Losses (0.41dB)	Gain 6	-4.0 ~ -3.9	dB
Noise Figure 6	Exclude PCB, Connector Losses (0.10dB)	NF 6	3.9 ~ 4.7	dB
Input Power 1dB Compression 6		P-1dB(IN)_6	+17.4 ~ +17.7	dBm
Input 3rd Order Intercept Point 6	f1=fRF, f2=fRF+100kHz, Pin=-16dBm	IIP3_6	+13.3 ~ +14.1	dBm
RF IN VSWR 6		VSWRi_6	1.67 ~ 1.72	-
RF OUT VSWR 6		VSWRo_6	2.14 ~ 2.24	-

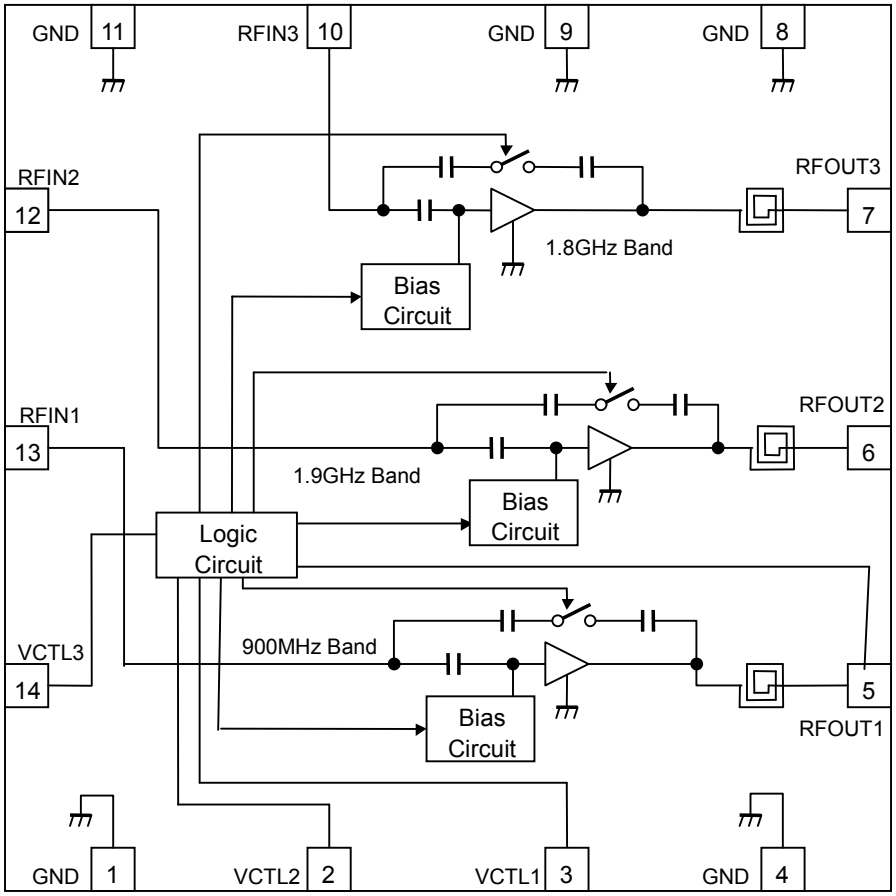
RF Characteristics 7

General condition : V_{DD}=2.85V, Ta=+25°C, Zs=Zl=50ohm, with application circuit

Parameter	Condition	Symbol	Measurement Data	Units
Gain Dynamic Range1 (1.9GHz Band)	(High Gain S21)-(Low Gain S21), f=1920~1950MHz, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=0V or 1.8V	GDR_1	20.1 ~ 20.5	dB
Gain Dynamic Range2 (900MHz Band)	(High Gain S21)-(Low Gain S21), f=925~960MHz, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=0V or 1.8V	GDR_2	20.0 ~ 20.2	dB
Gain Dynamic Range3 (1.8GHz Band)	(High Gain S21)-(Low Gain S21), f=1805~1880MHz, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=0V or 1.8V	GDR_3	19.6 ~ 19.8	dB

4-3 Pin configuration

(Top View)



VCTL terminal function

VCTL1, VCTL2：Band Select (1.9GHz Band or 900MHz Band or 1.8GHz Band)

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

4-4 Truth table

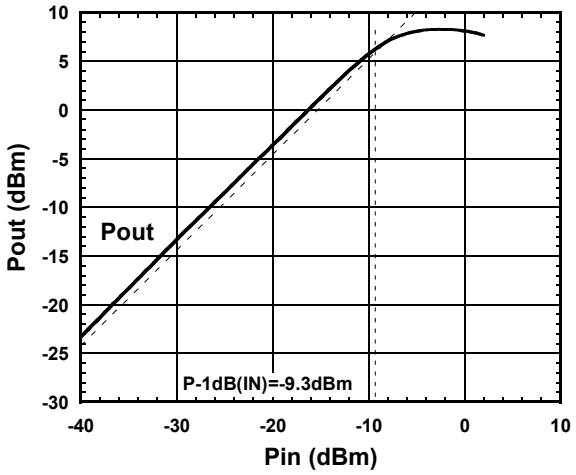
Control Voltage			State					
$V_{CTL}1$	$V_{CTL}2$	$V_{CTL}3$	1.9GHz Band		900MHz Band		1.8GHz Band	
(Band Sel1)	(Band Sel2)	(RX ATT)	LNA I_{DD}	Bypass	LNA I_{DD}	Bypass	LNA I_{DD}	Bypass
L	L	L	OFF	ON	OFF	ON	OFF	ON
L	L	H	ON	OFF	OFF	OFF	OFF	OFF
H	L	L	OFF	ON	OFF	ON	OFF	ON
H	L	H	OFF	OFF	ON	OFF	OFF	OFF
L	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”=0～0.3V、“H”=1.36～1.9V

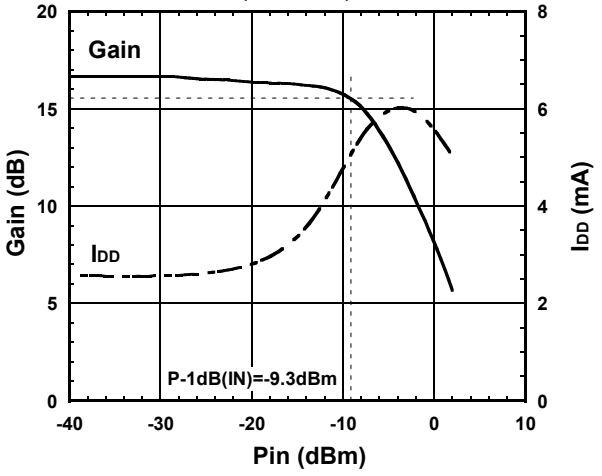
4-5-1 Typical characteristics (1.9GHz Band High Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=1.8V

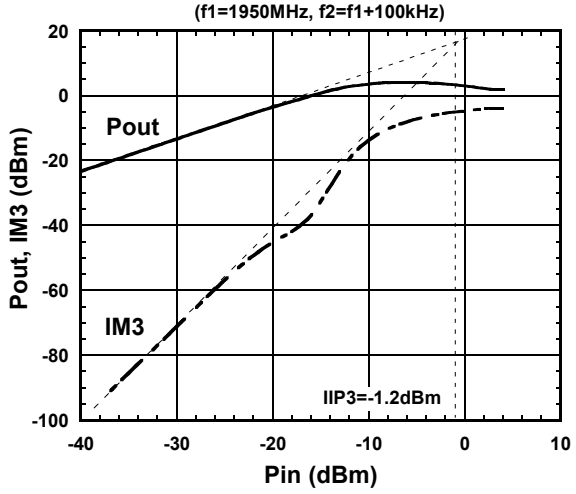
Band1(1.9GHz) @High Gain
Pout vs. Pin
(f=1950MHz)



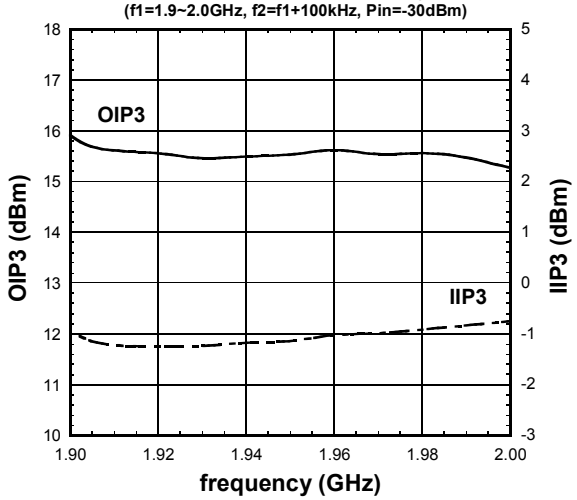
Band1(1.9GHz) @High Gain
Gain, I_{DD} vs. Pin
(f=1950MHz)



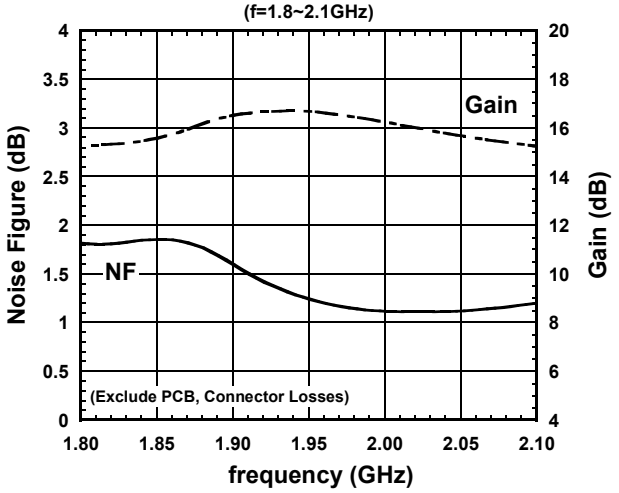
Band1(1.9GHz) @High Gain
Pout, IM3 vs. Pin
(f1=1950MHz, f2=f1+100kHz)



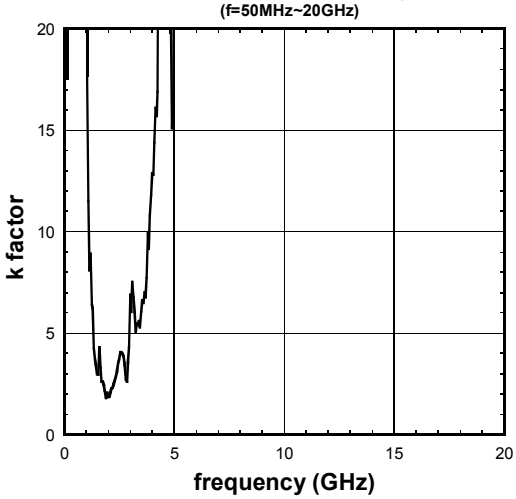
Band1(1.9GHz) @High Gain
OIP3, IIP3 vs. frequency
(f1=1.9~2.0GHz, f2=f1+100kHz, Pin=-30dBm)



Band1(1.9GHz) @High Gain
NF, Gain vs. frequency
(f=1.8~2.1GHz)

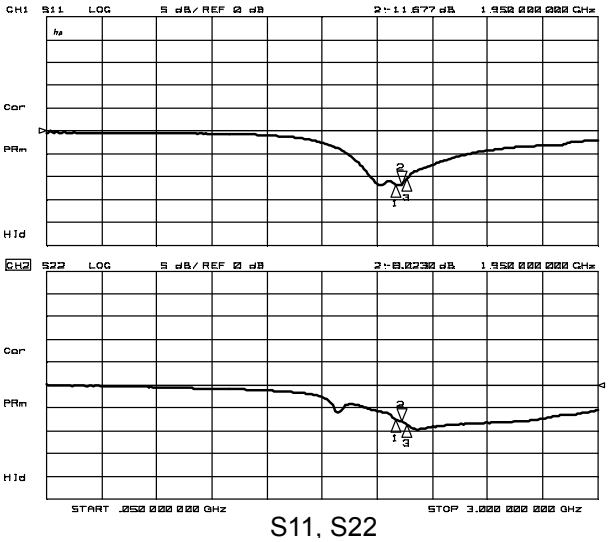


Band1(1.9GHz) @High Gain
k factor vs. frequency
(f=50MHz~20GHz)

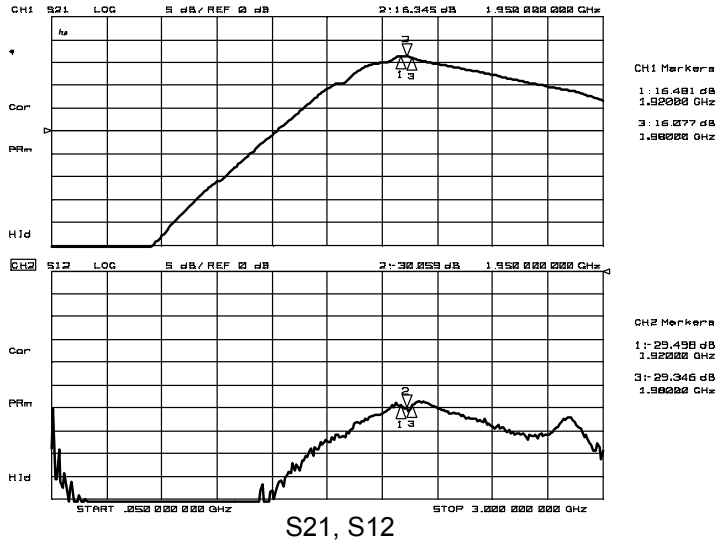


4-5-2 Typical characteristics (1.9GHz Band High Gain Mode)

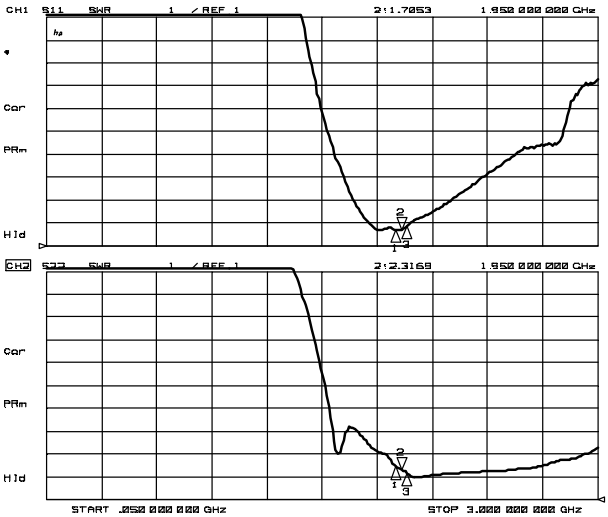
Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=1.8V



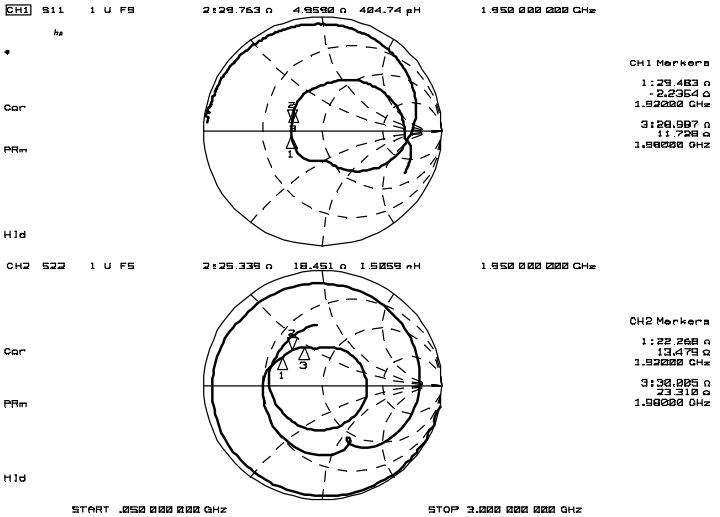
S11, S22



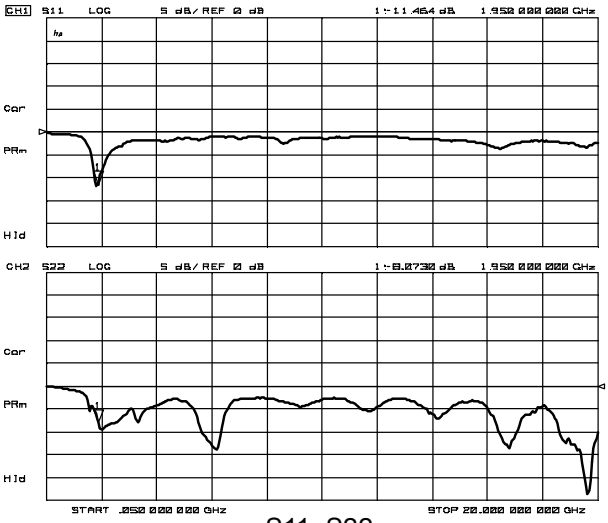
S21, S12



VSWR

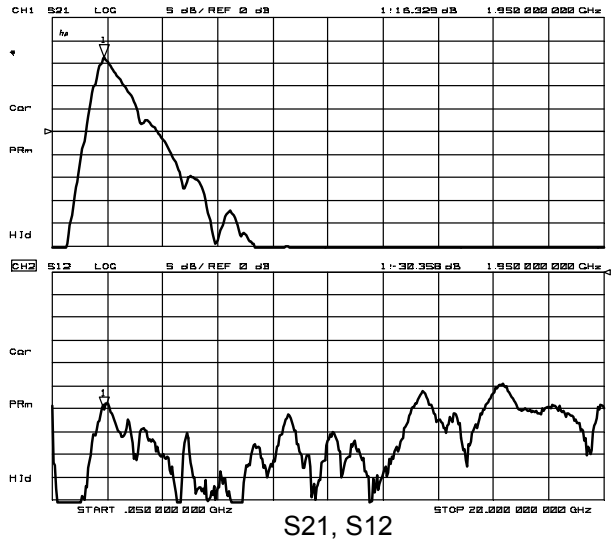


Zin, Zout



S11, S22

(f=50MHz~20GHz)



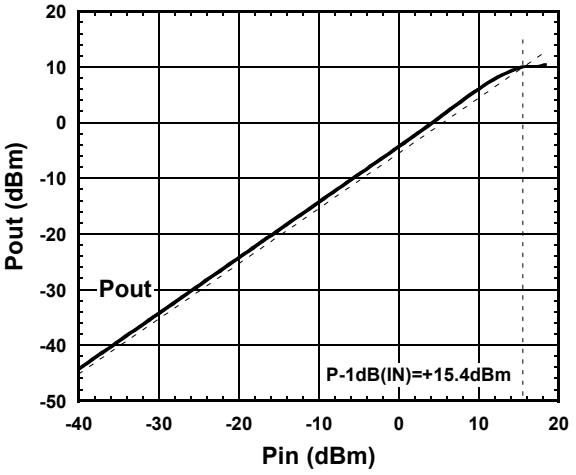
S21, S12

(f=50MHz~20GHz)

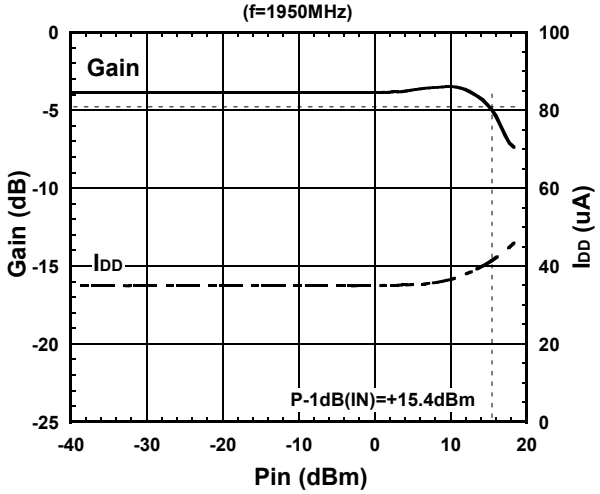
4-5-3 Typical characteristics (1.9GHz Band Low Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=0V

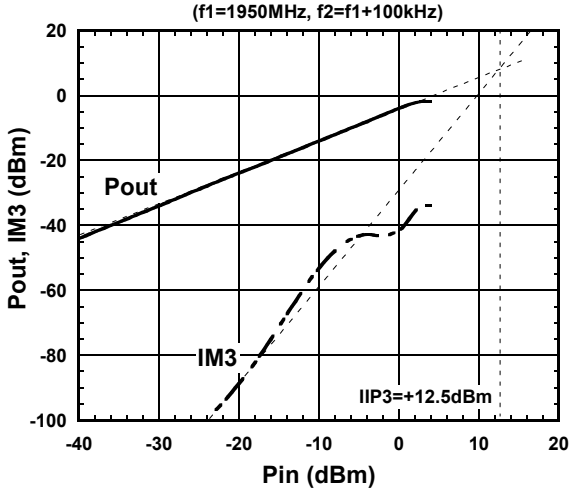
Band1(1.9GHz) @Low Gain
Pout vs. Pin
(f=1950MHz)



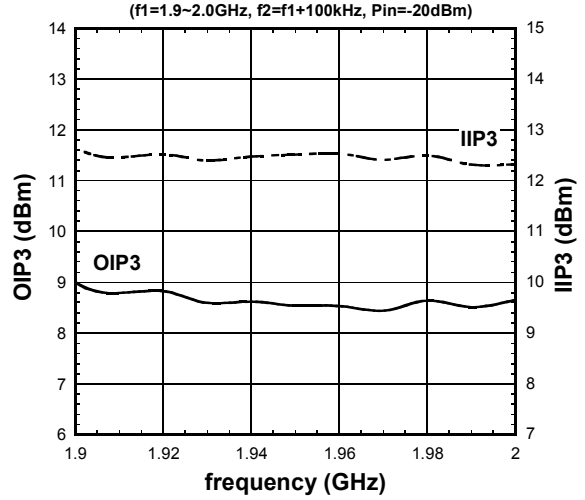
Band1(1.9GHz) @Low Gain
Gain, I_{DD} vs. Pin
(f=1950MHz)



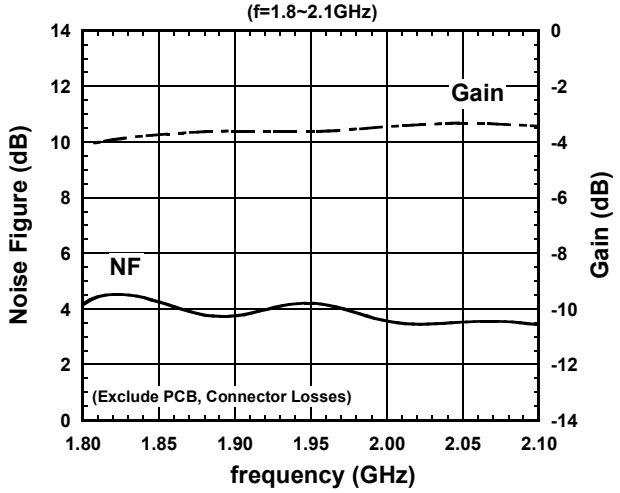
Band1(1.9GHz) @Low Gain
Pout, IM3 vs. Pin
(f1=1950MHz, f2=f1+100kHz)



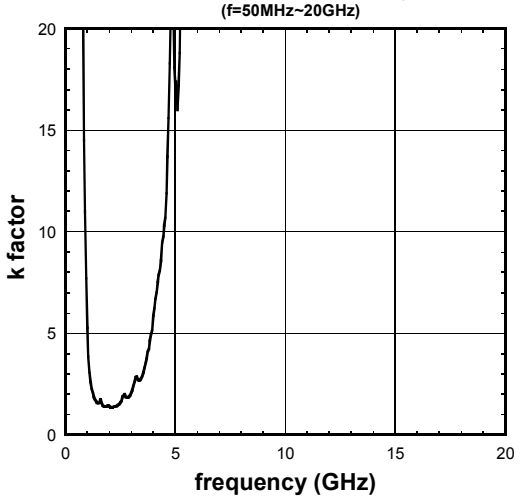
Band1(1.9GHz) @Low Gain
OIP3, IIP3 vs. frequency
(f1=1.9~2.0GHz, f2=f1+100kHz, Pin=-20dBm)



Band1(1.9GHz) @Low Gain
NF, Gain vs. frequency
(f=1.8~2.1GHz)

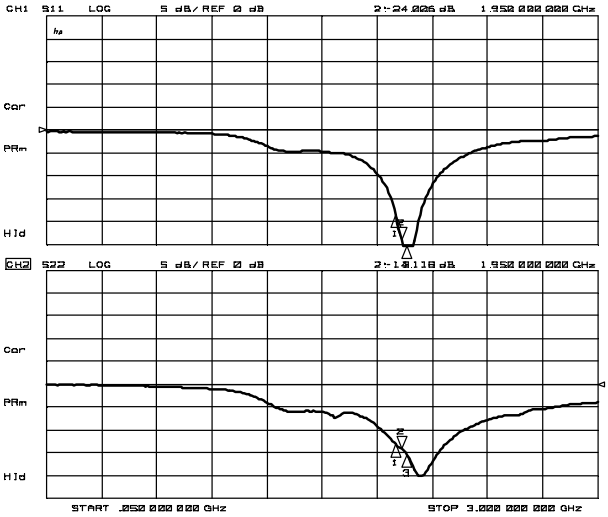


Band1(1.9GHz) @Low Gain
k factor vs. frequency
(f=50MHz~20GHz)

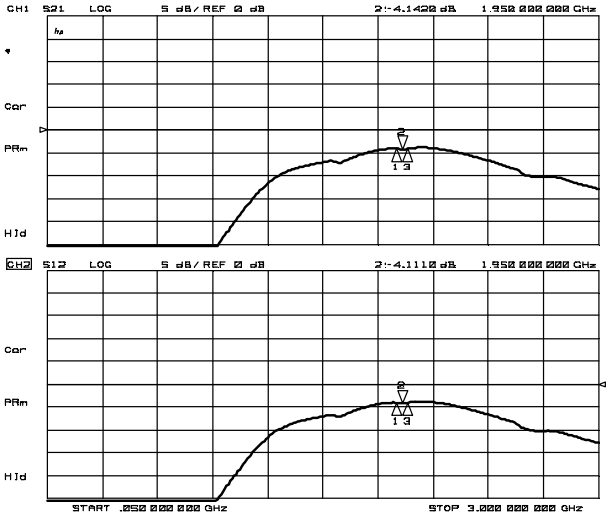


4-5-4 Typical characteristics (1.9GHz Band Low Gain Mode)

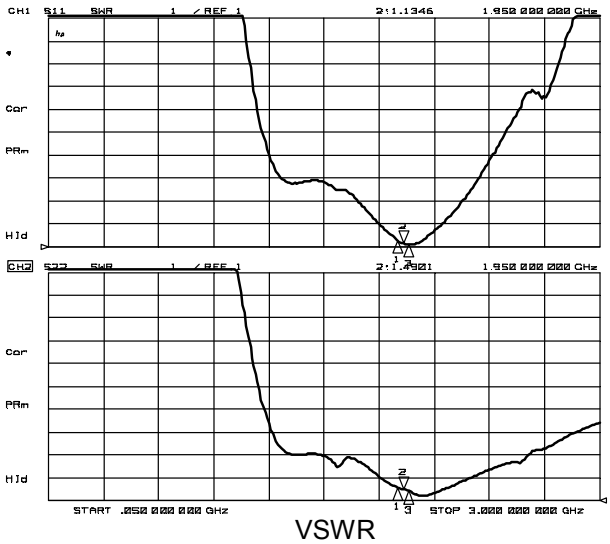
Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=0V, V_{CTL}3=0V



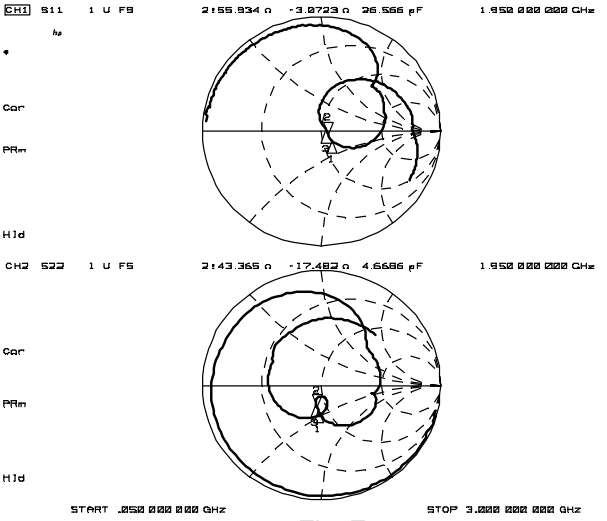
S11, S22



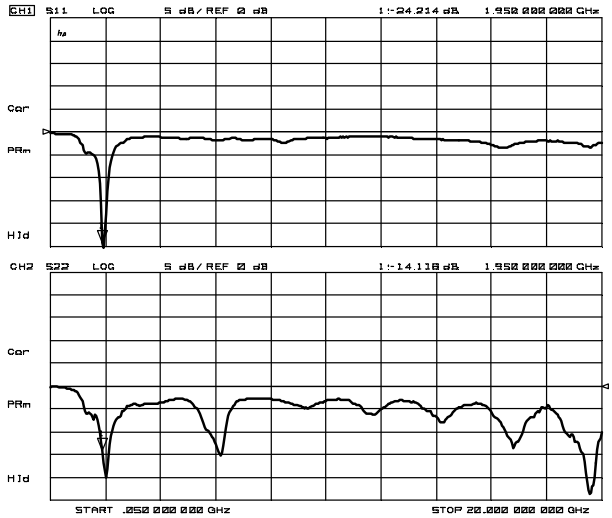
S21, S12



VSWR

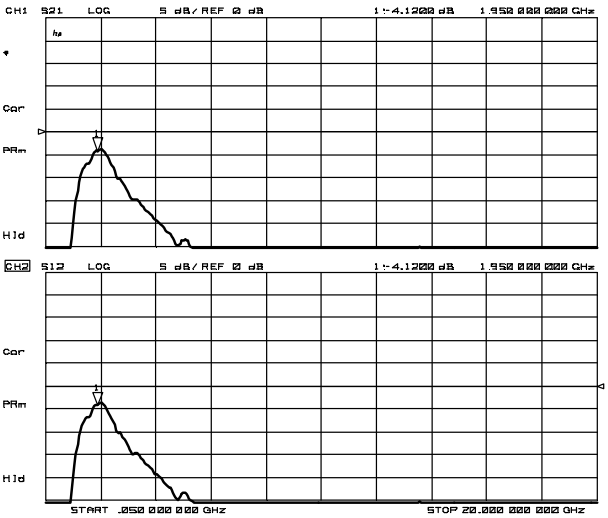


Zin, Zout



S11, S22

(f=50MHz~20GHz)



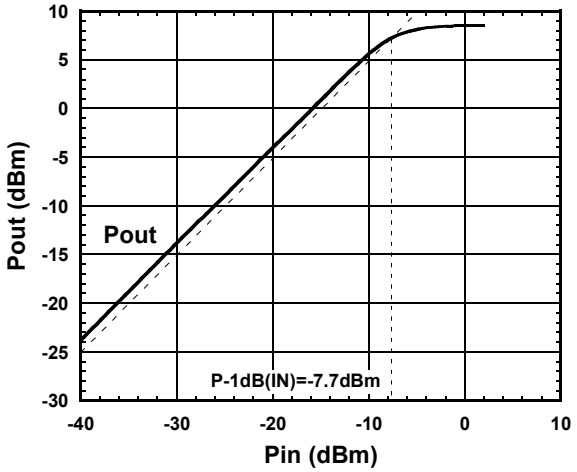
S21, S12

(f=50MHz~20GHz)

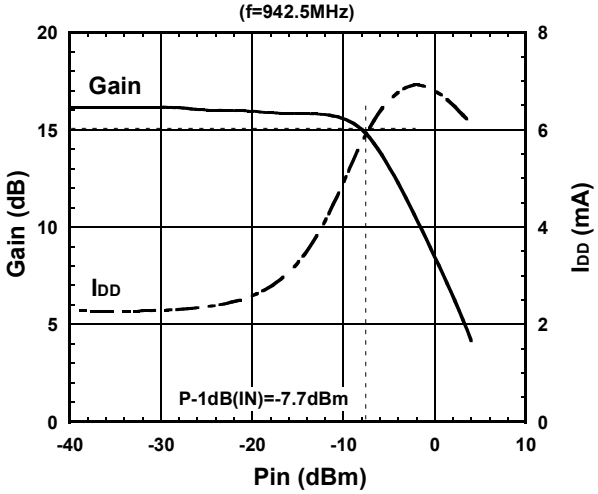
4-5-5 Typical characteristics (900MHz Band High Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=1.8V

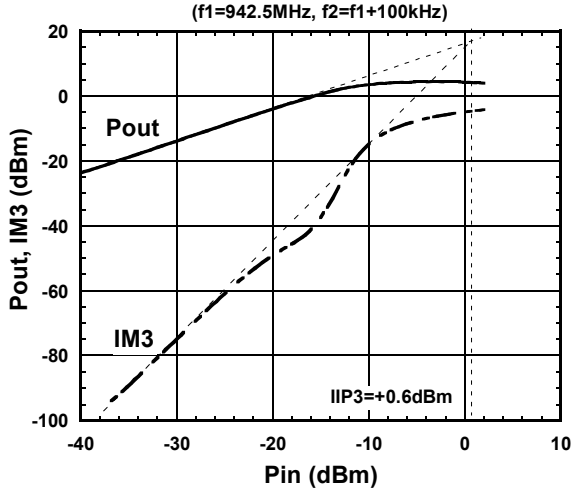
Band8(900MHz) @High Gain
Pout vs. Pin
(f=942.5MHz)



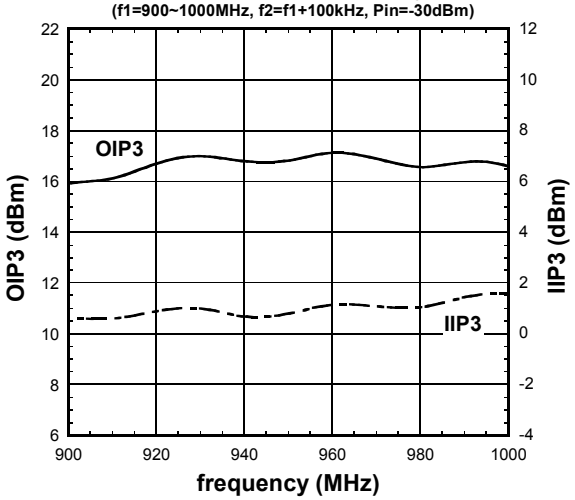
Band8(900MHz) @High Gain
Gain, I_{DD} vs. Pin
(f=942.5MHz)



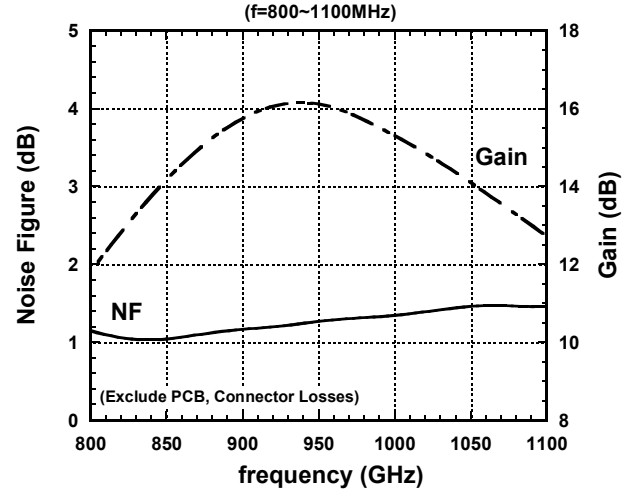
Band8(900MHz) @High Gain
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



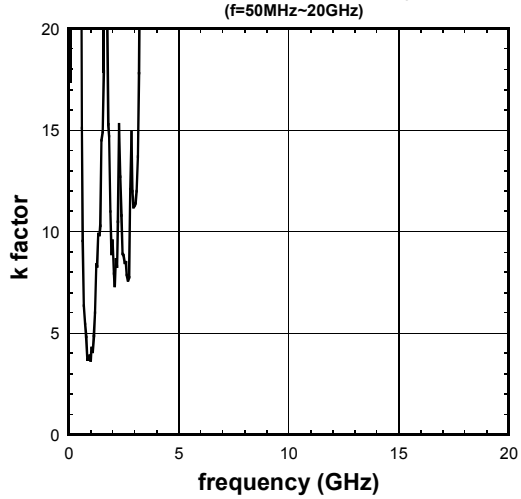
Band8(900MHz) @High Gain
OIP3, IIP3 vs. frequency
(f1=900~1000MHz, f2=f1+100kHz, Pin=-30dBm)



Band8(900MHz) @High Gain
NF, Gain vs. frequency
(f=800~1100MHz)

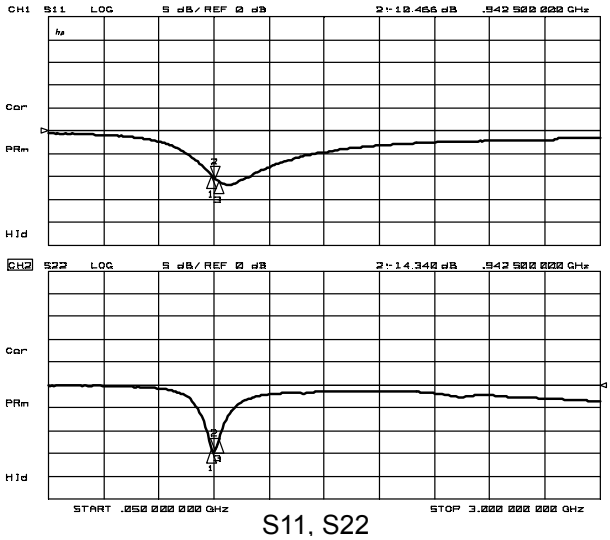


Band8(900MHz) @High Gain
k factor vs. frequency
(f=50MHz~20GHz)

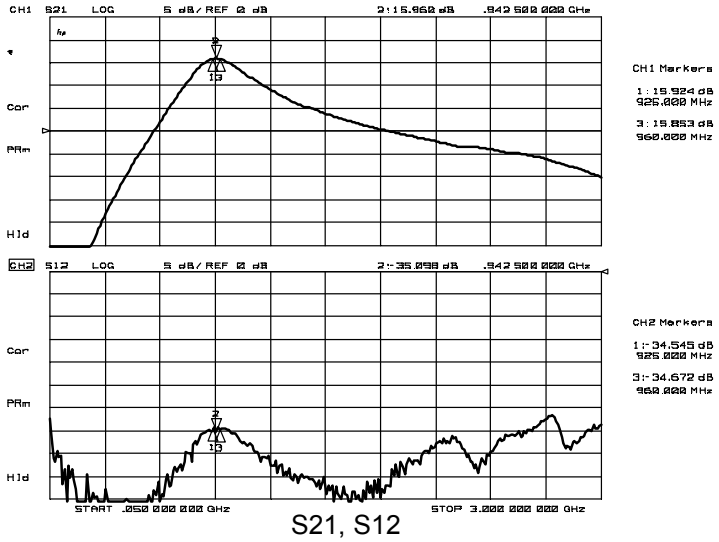


4-5-6 Typical characteristics (900MHz Band High Gain Mode)

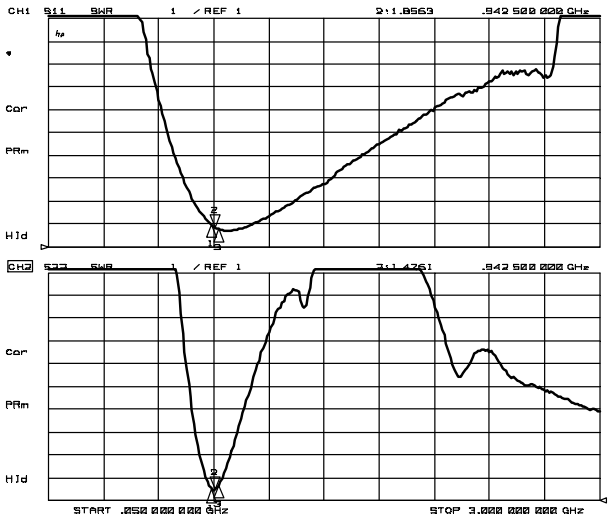
Condition: Ta=+25°C, V_{DD}=2.7V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=1.8V



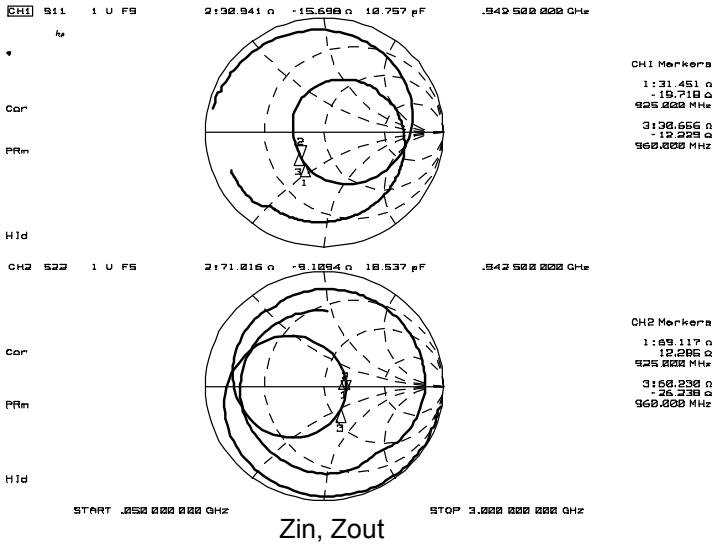
S11, S22



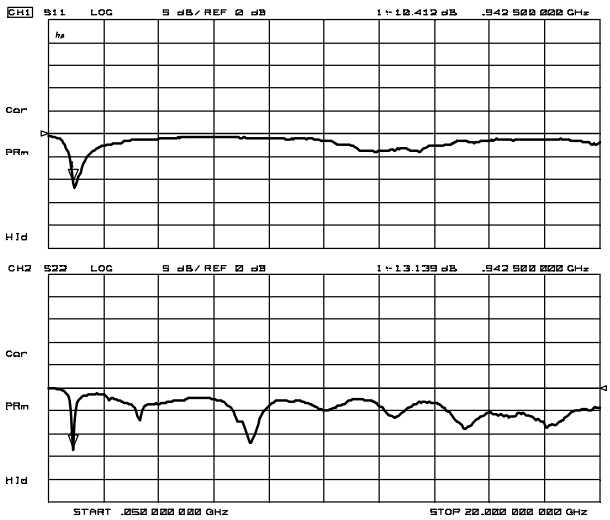
S21, S12



VSWR

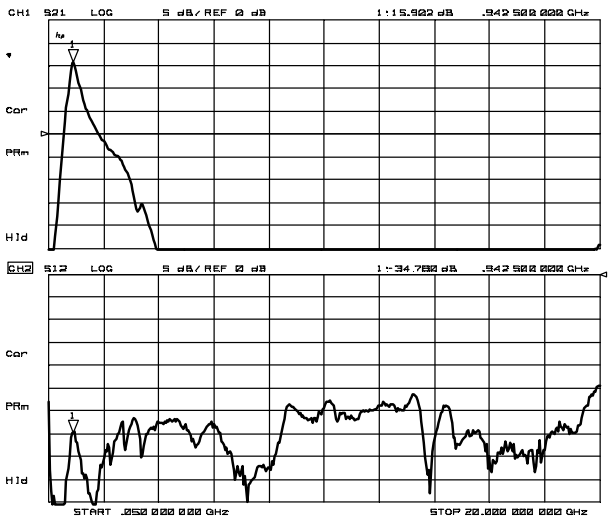


Zin, Zout



S11, S22

(f=50MHz~20GHz)



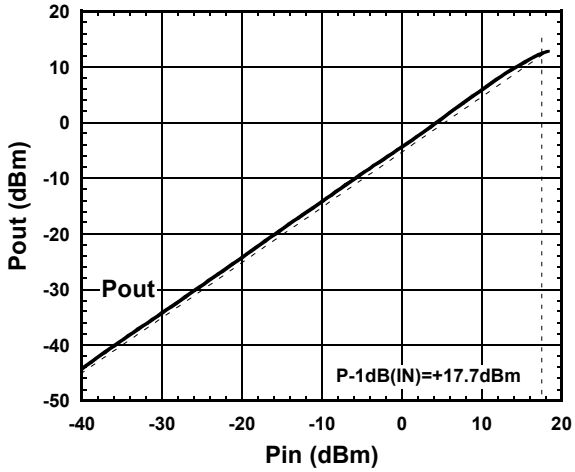
S21, S12

(f=50MHz~20GHz)

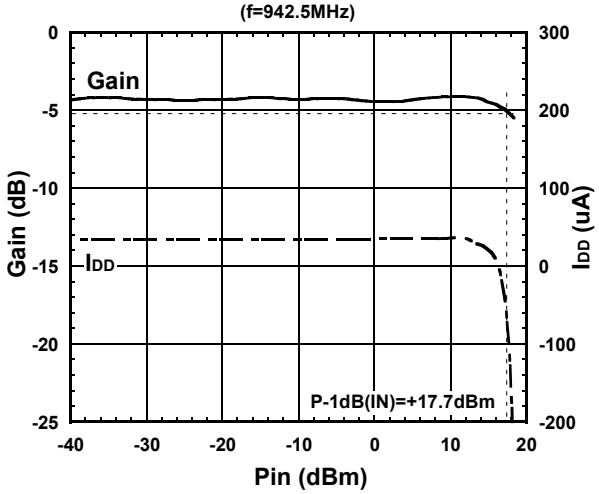
4-5-7 Typical characteristics (900MHz Band Low Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=0V

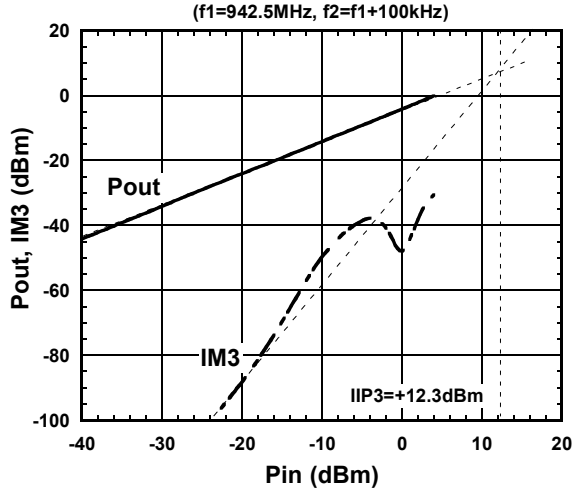
Band8(900MHz) @Low Gain
Pout vs. Pin
(f=942.5MHz)



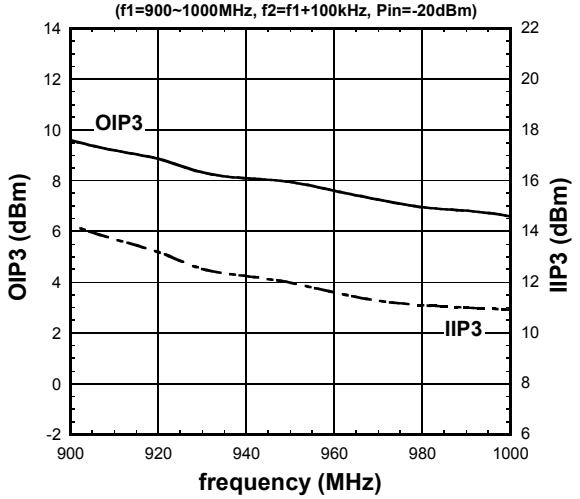
Band8(900MHz) @Low Gain
Gain, I_{DD} vs. Pin
(f=942.5MHz)



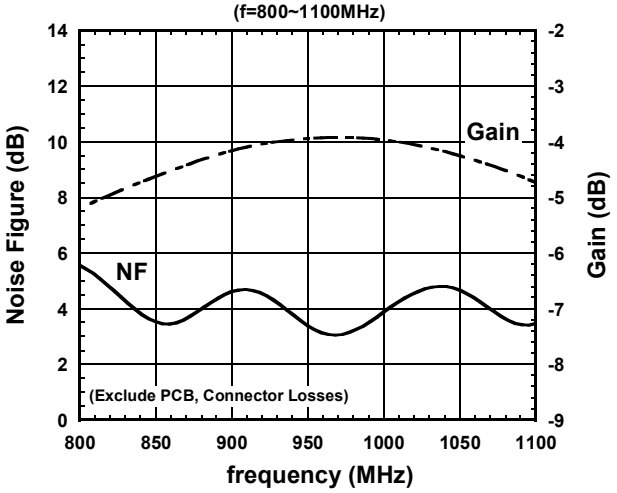
Band8(900MHz) @Low Gain
Pout, IM3 vs. Pin
(f1=942.5MHz, f2=f1+100kHz)



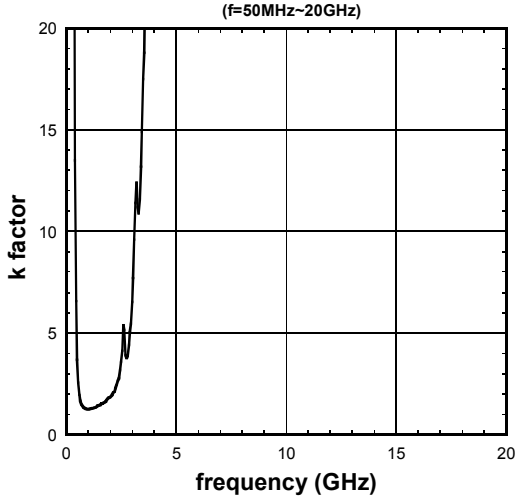
Band8(900MHz) @Low Gain
OIP3, IIP3 vs. frequency
(f1=900~1000MHz, f2=f1+100kHz, Pin=-20dBm)



Band8(900MHz) @Low Gain
NF, Gain vs. frequency
(f=800~1100MHz)

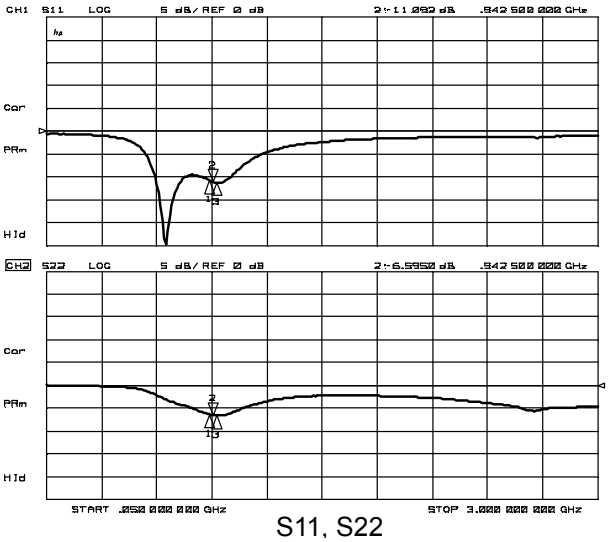


Band8(900MHz) @Low Gain
k factor vs. frequency
(f=50MHz~20GHz)

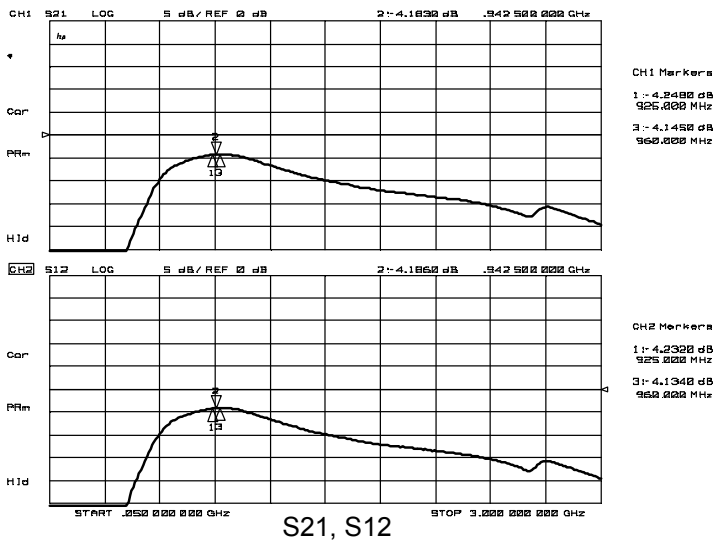


4-5-8 Typical characteristics (900MHz Band Low Gain Mode)

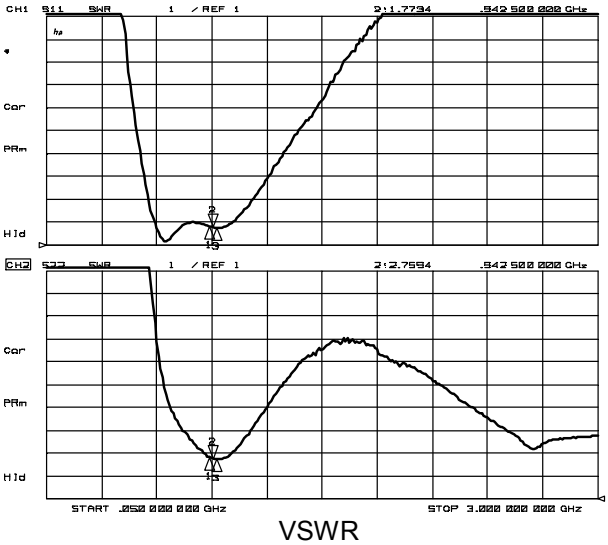
Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=1.8V, V_{CTL}2=0V, V_{CTL}3=0V



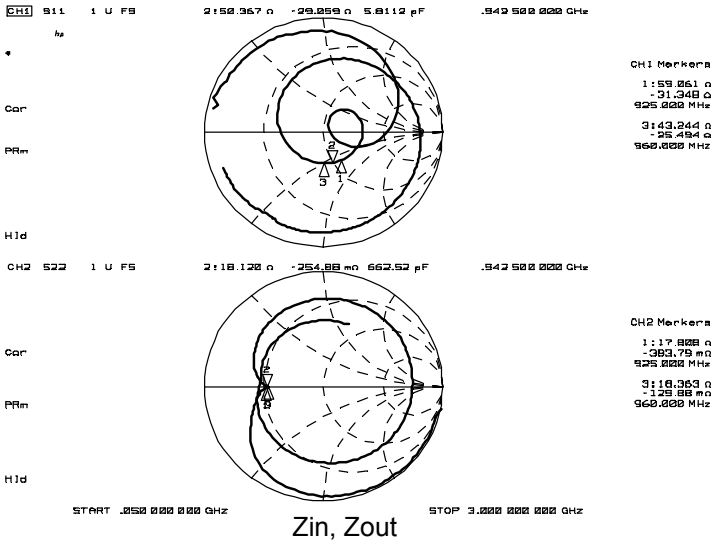
S11, S22



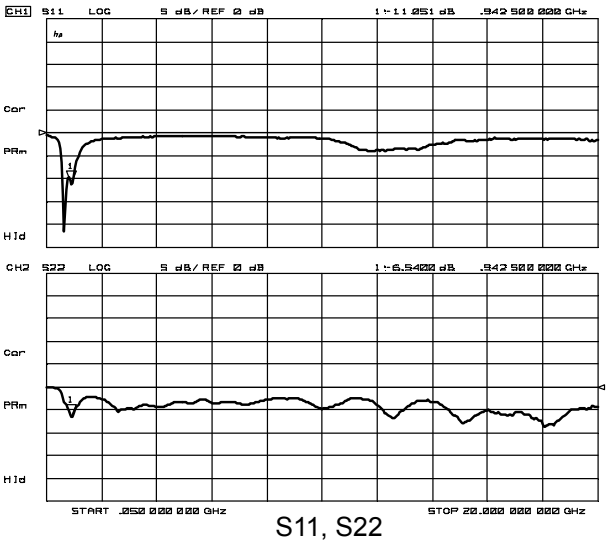
S21, S12



VSWR

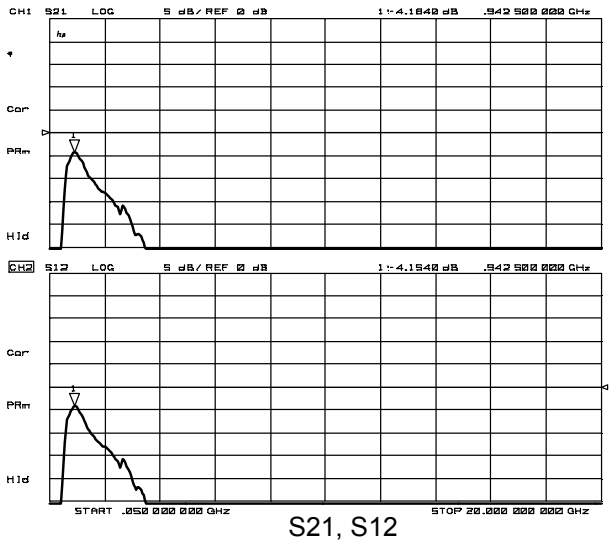


Zin, Zout



S11, S22

(f=50MHz~20GHz)



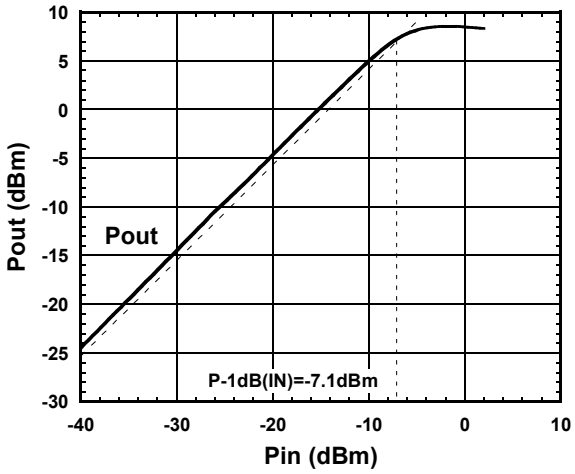
S21, S12

(f=50MHz~20GHz)

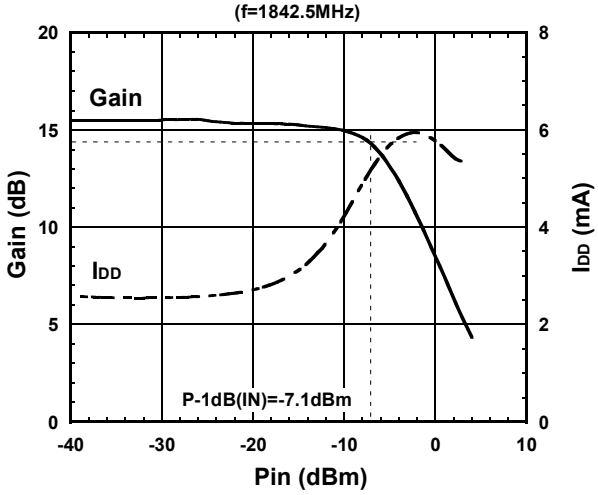
4-5-9 Typical characteristics (1.8GHz Band High Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=1.8V

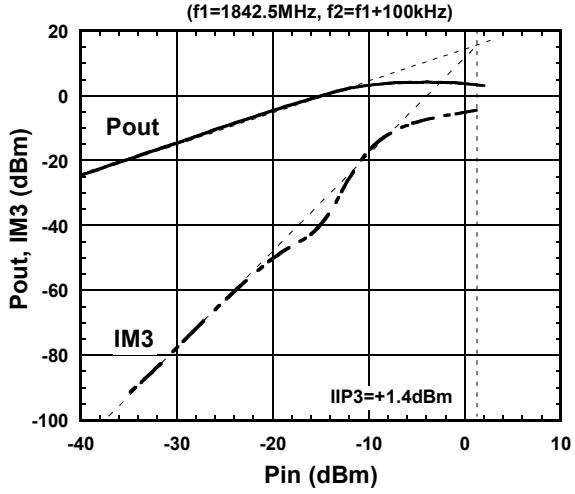
Band3(1.7GHz) @High Gain
Pout vs. Pin
(f=1842.5MHz)



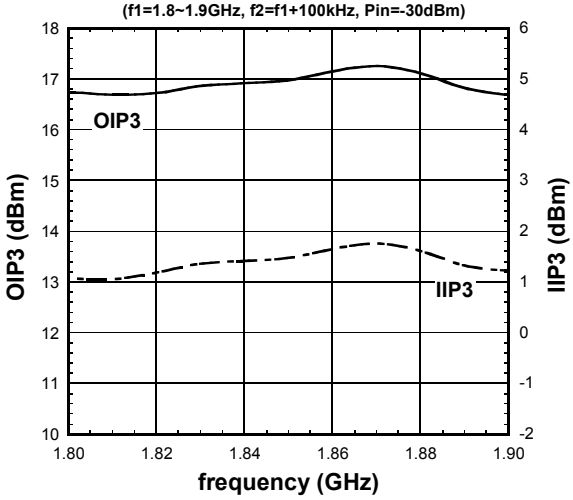
Band3(1.7GHz) @High Gain
Gain, I_{DD} vs. Pin
(f=1842.5MHz)



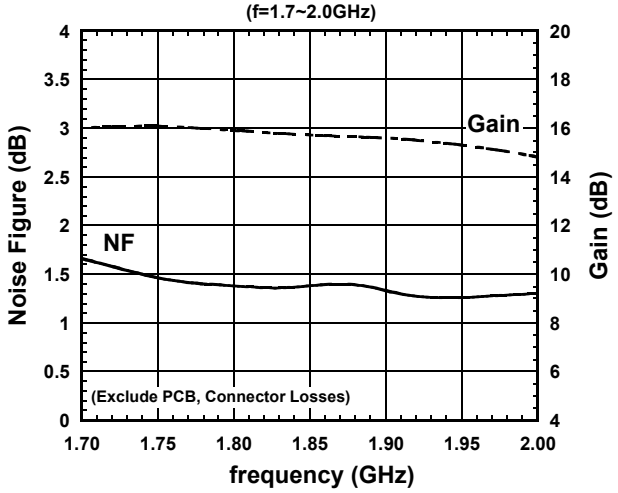
Band3(1.7GHz) @High Gain
Pout, IM3 vs. Pin
(f1=1842.5MHz, f2=f1+100kHz)



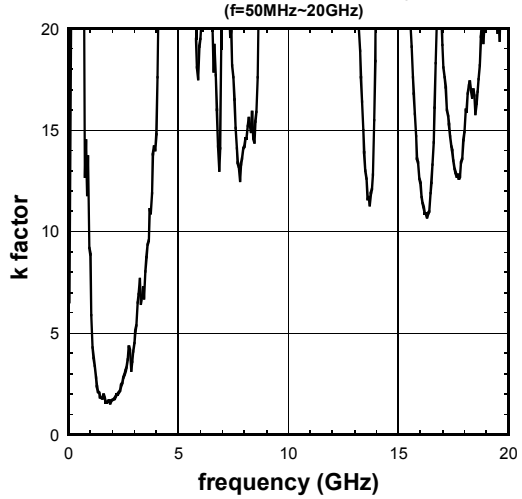
Band3(1.7GHz) @High Gain
OIP3, IIP3 vs. frequency
(f1=1.8~1.9GHz, f2=f1+100kHz, Pin=-30dBm)



Band3(1.7GHz) @High Gain
NF, Gain vs. frequency
(f=1.7~2.0GHz)

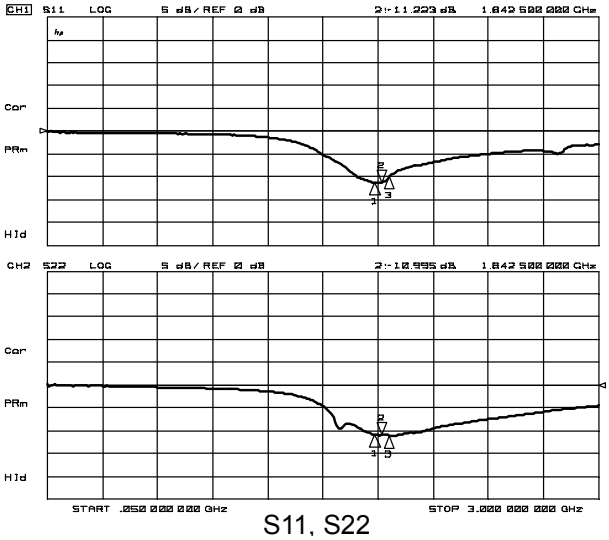


Band3(1.7GHz) @High Gain
k factor vs. frequency
(f=50MHz~20GHz)

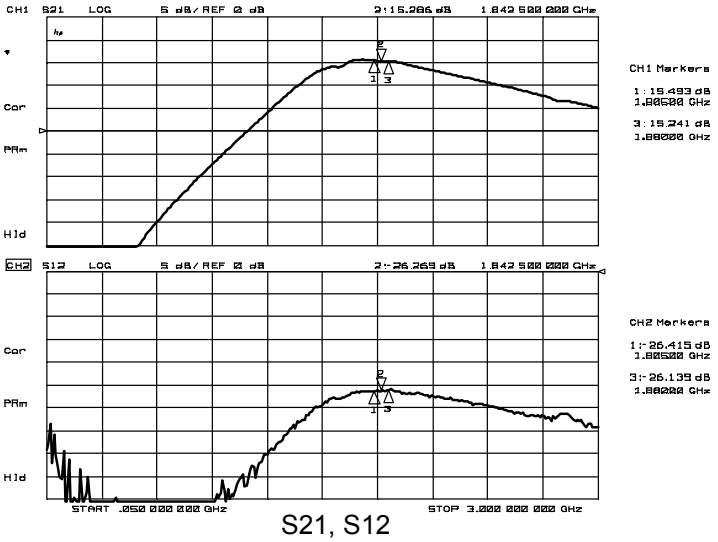


4-5-10 Typical characteristics (1.8GHz Band High Gain Mode)

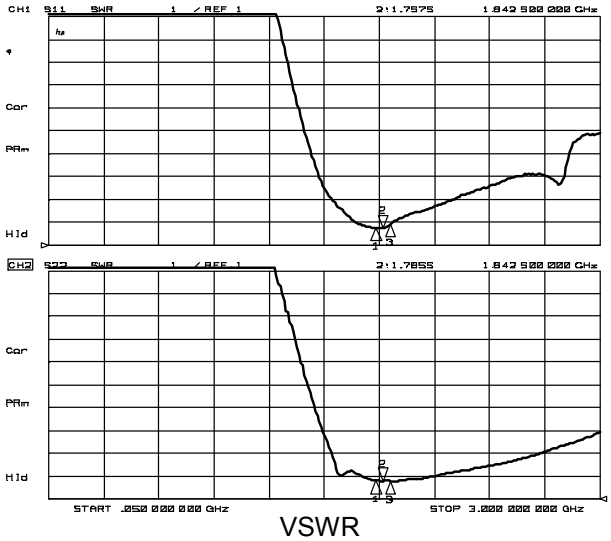
Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=1.8V



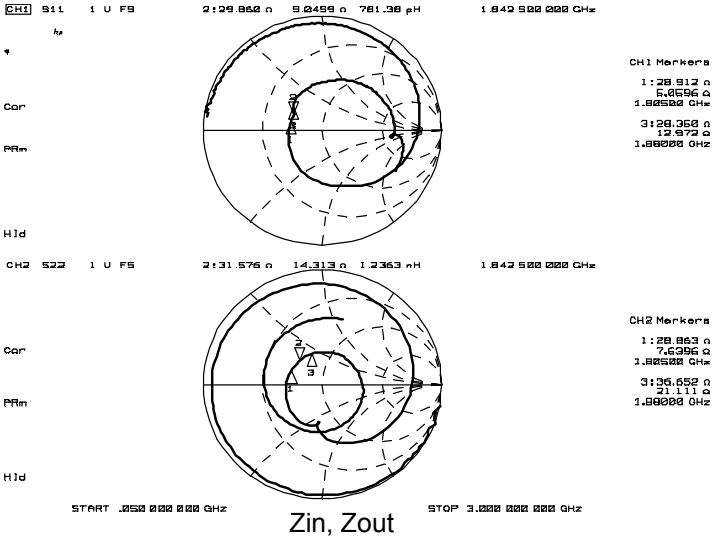
S11, S22



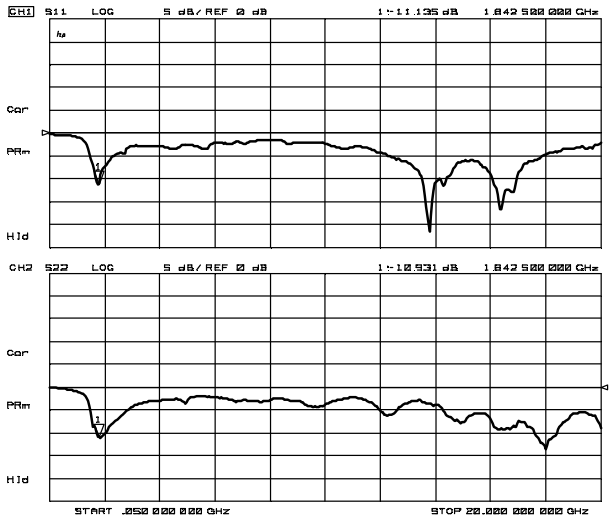
S21, S12



VSWR

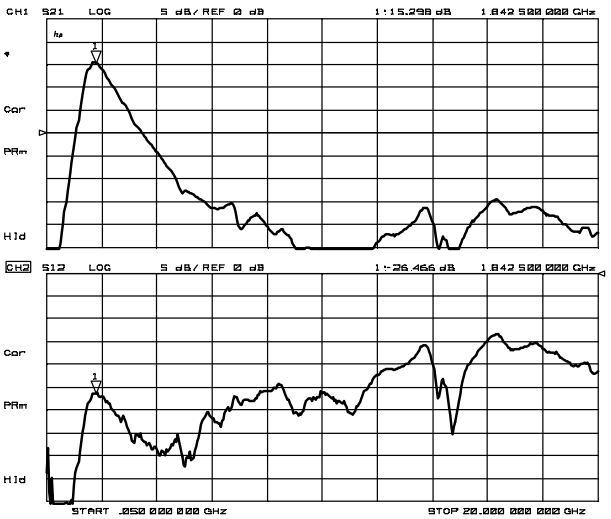


Zin, Zout



S11, S22

(f=50MHz~20GHz)



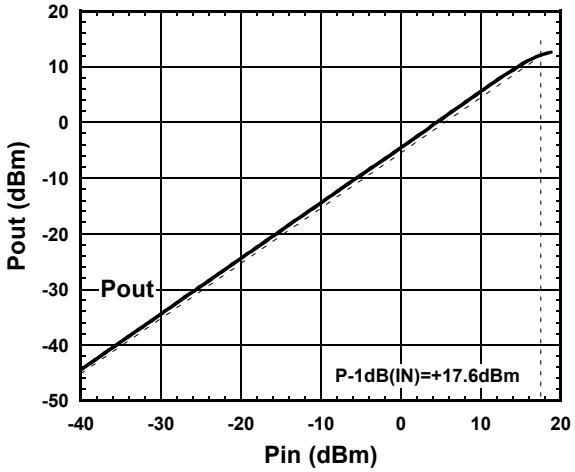
S21, S12

(f=50MHz~20GHz)

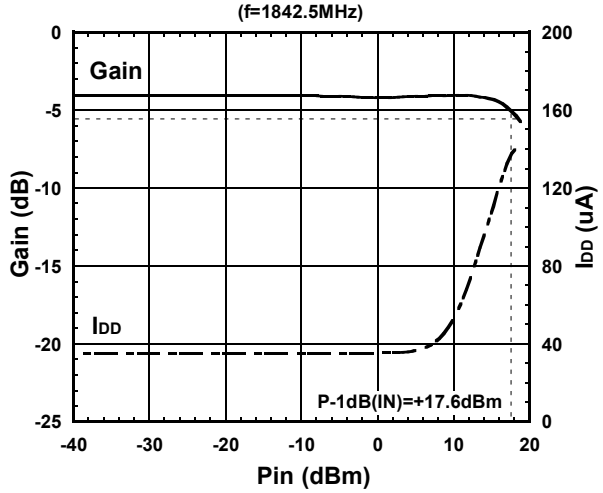
4-5-11 Typical characteristics (1.8GHz Band Low Gain Mode)

Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=0V

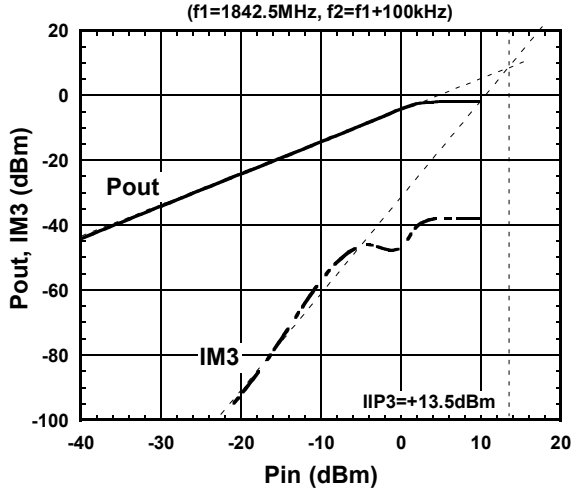
Band3(1.7GHz) @Low Gain
Pout vs. Pin
(f=1842.5MHz)



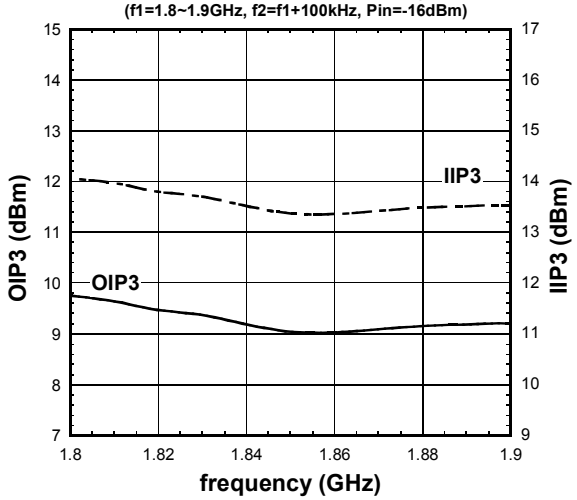
Band3(1.7GHz) @Low Gain
Gain, I_{DD} vs. Pin
(f=1842.5MHz)



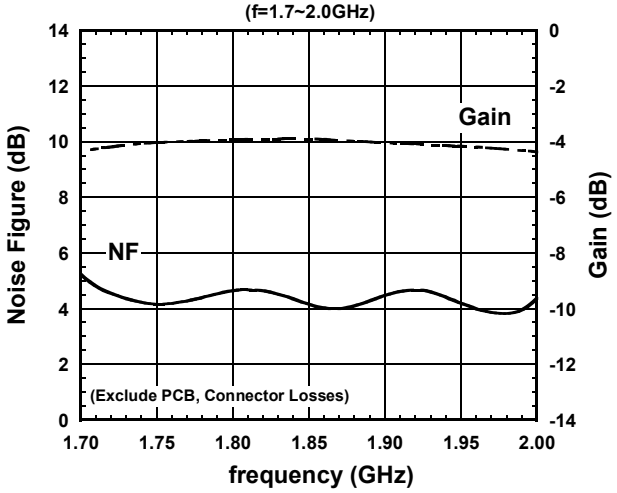
Band3(1.7GHz) @Low Gain
Pout, IM3 vs. Pin
(f1=1842.5MHz, f2=f1+100kHz)



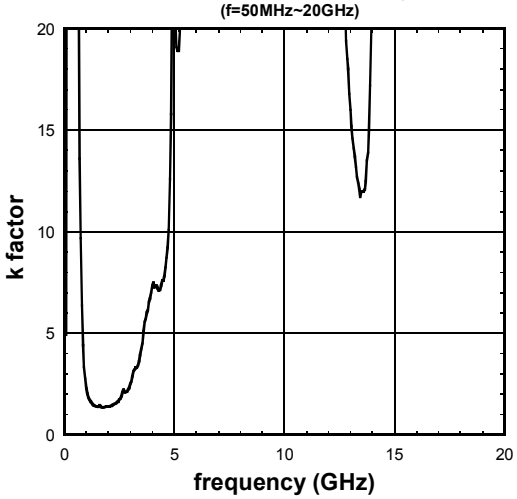
Band3(1.7GHz) @Low Gain
OIP3, IIP3 vs. frequency
(f1=1.8~1.9GHz, f2=f1+100kHz, Pin=-16dBm)



Band3(1.7GHz) @Low Gain
NF, Gain vs. frequency
(f=1.7~2.0GHz)

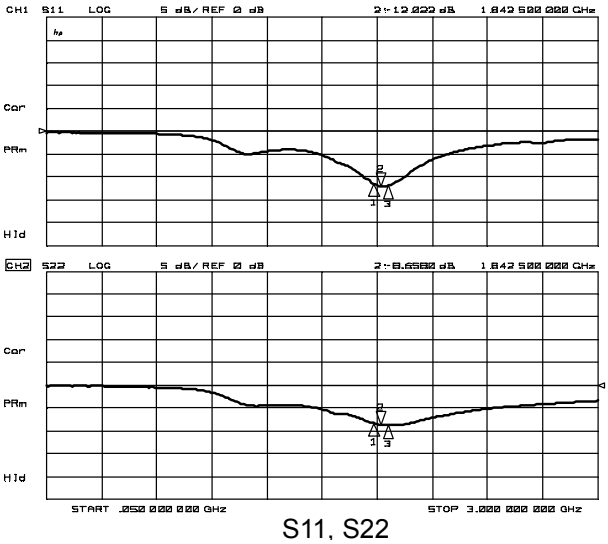


Band3(1.7GHz) @Low Gain
k factor vs. frequency
(f=50MHz~20GHz)

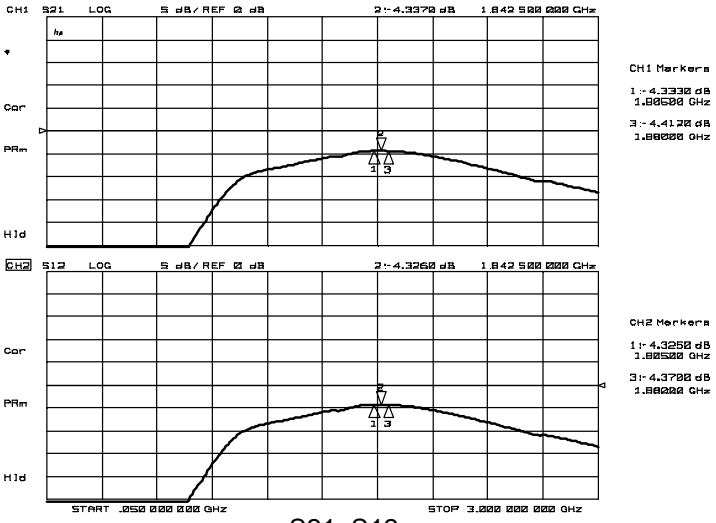


4-5-12 Typical characteristics (1.8GHz Band Low Gain Mode)

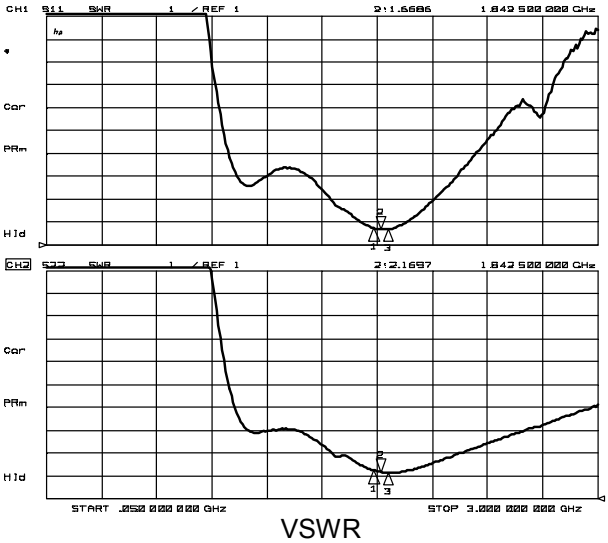
Condition: Ta=+25°C, V_{DD}=2.85V, V_{CTL}1=0V, V_{CTL}2=1.8V, V_{CTL}3=0V



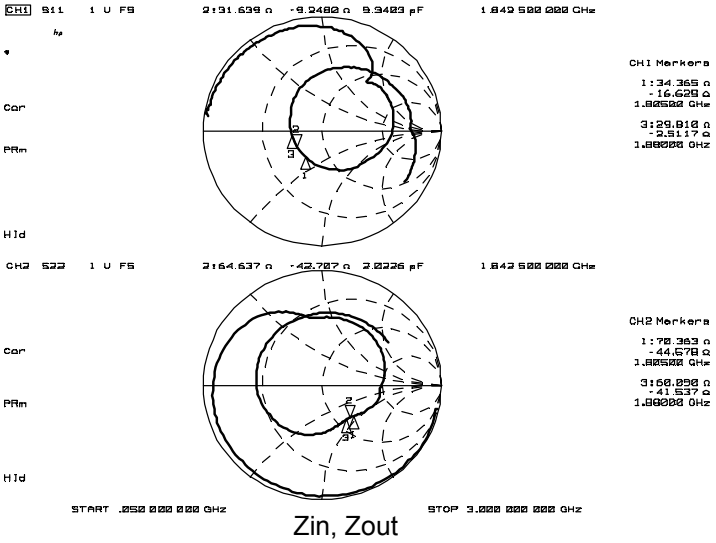
S11, S22



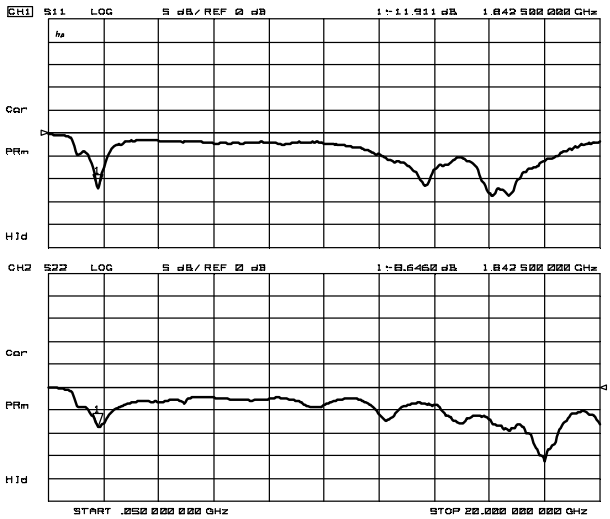
S21, S12



VSWR

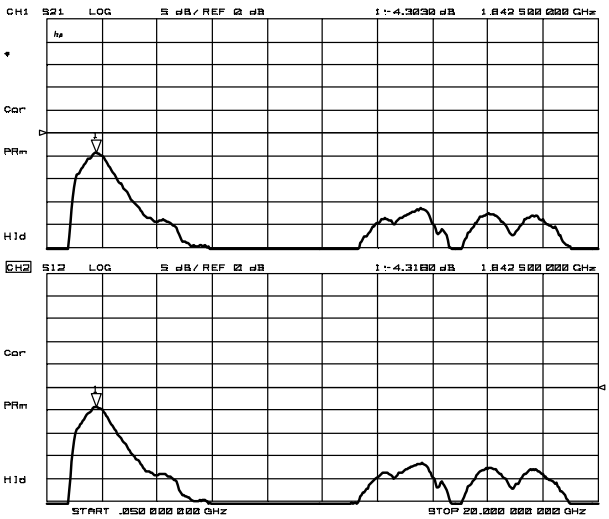


Zin, Zout



S11, S22

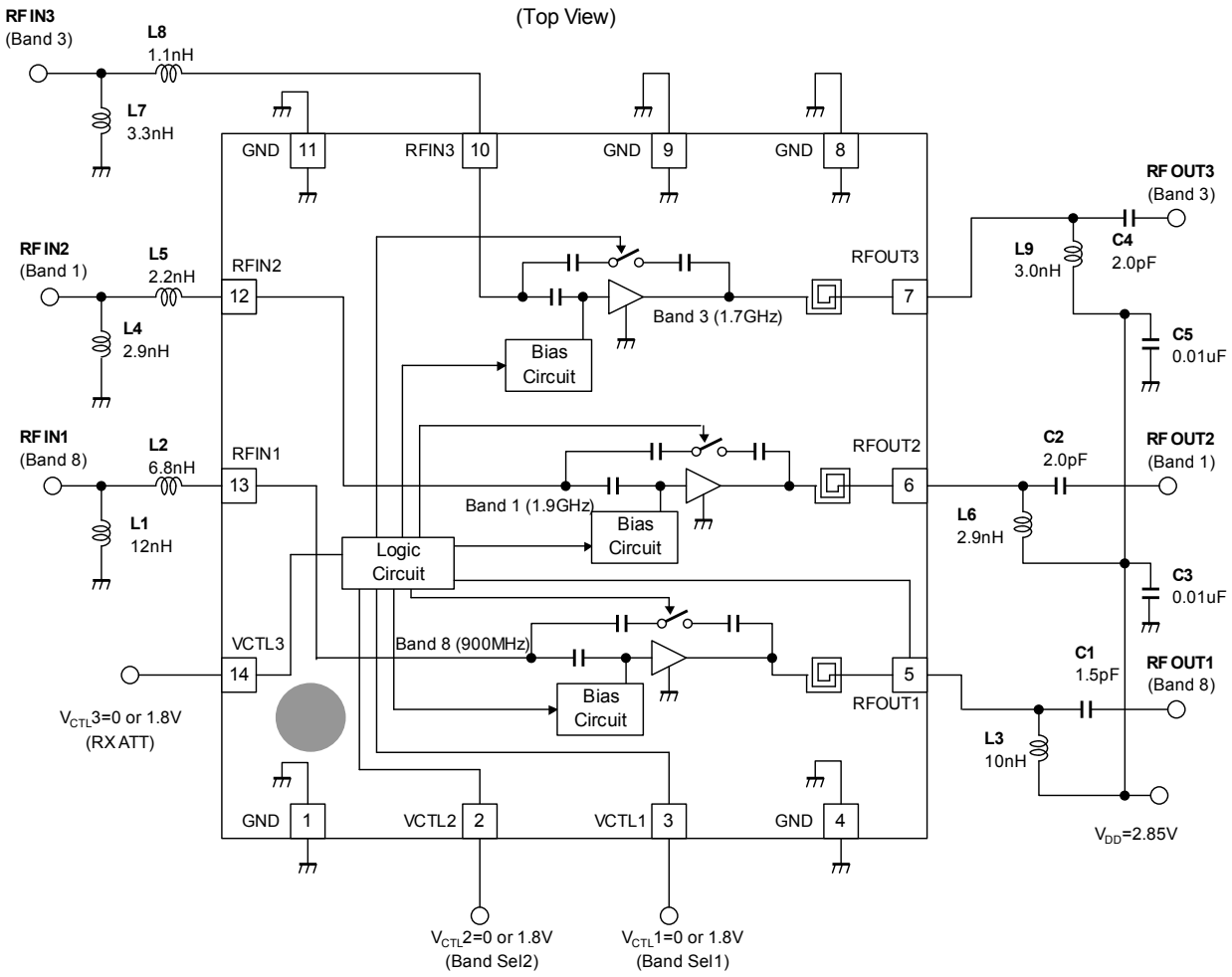
(f=50MHz~20GHz)



S21, S12

(f=50MHz~20GHz)

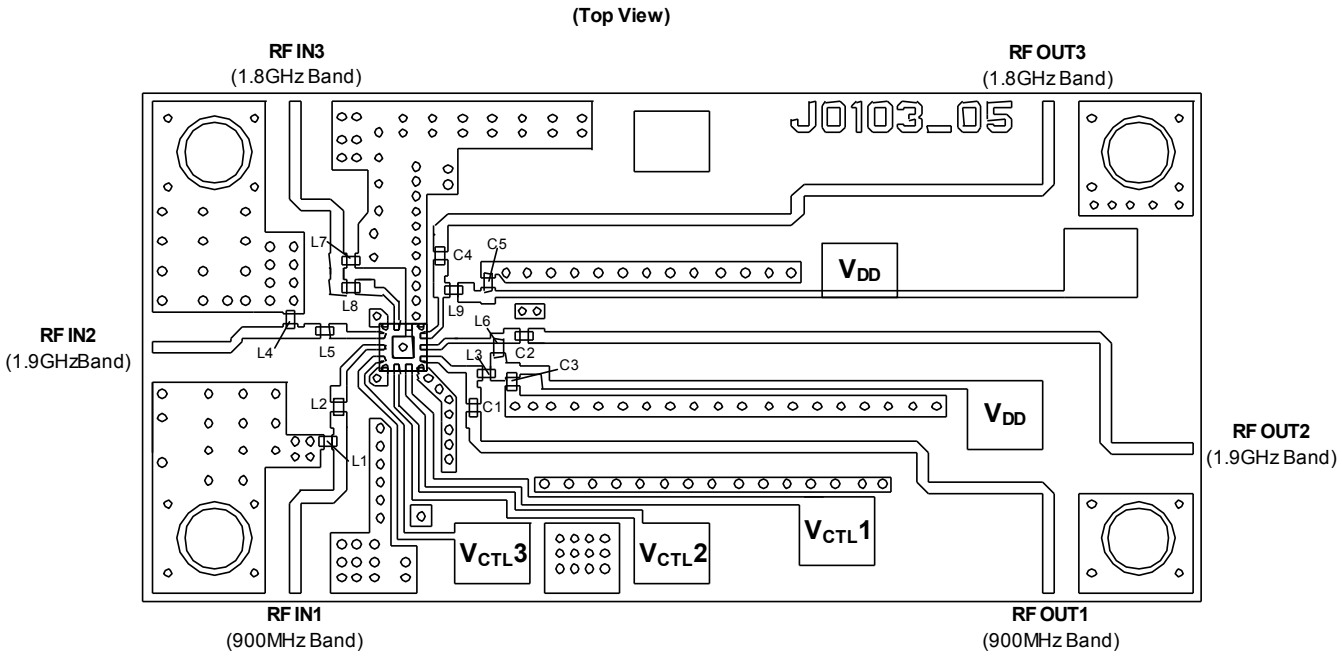
4-6 Block diagram, Application circuit



Parts List

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

4-7 Evaluation board



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