SPDT SWITCH GaAs MMIC

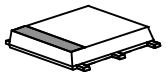
■GENERAL DESCRIPTION

NJG1516KC3 is a GaAs SPDT switch IC suited for antenna switch of cellular phone handset.

This switch features low loss, high isolation at high power, and exhibits wide operating frequency range from 50MHz to 3GHz at low voltage of 2.7V.

The ultra small & ultra thin FLP6-C3 package is applied.

■PACKAGE OUTLINE

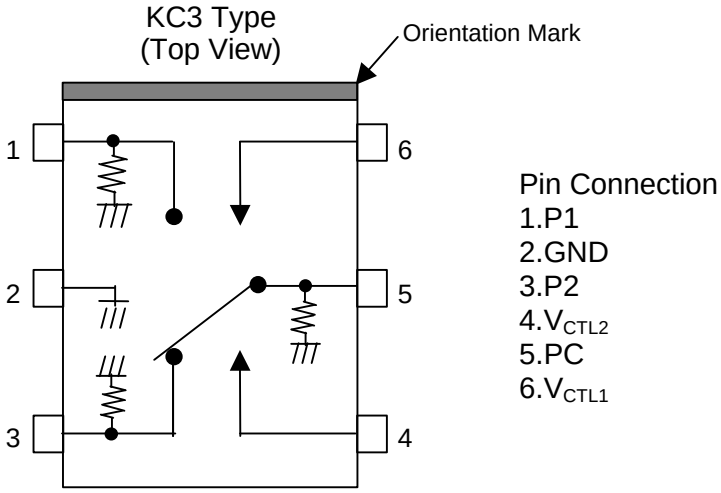


NJG1516KC3

■FEATURES

●Single, low voltage control	+2.7~+9V	
●Low insertion loss	0.4dB	typ. @f=1GHz, P_{in}=31dBm, V_{CTL}=3.0V
	0.5dB	typ.@f=1GHz, P_{in}=34.5dBm, V_{CTL}=3.0V
	0.4dB	typ. @f=1GHz, P_{in}=34.5dBm, V_{CTL}=3.5V
	0.7dB	typ.@f=2GHz, P_{in}=31.5dBm, V_{CTL}=3.0V
●High isolation	27dB	typ.@f=1GHz, P_{in}=34.5dBm, V_{CTL}=3.0V
	25dB	typ.@f=2GHz, P_{in}=31.5dBm, V_{CTL}=3.0V
●Handling power	36dBm	typ.@f=2GHz, V_{CTL}=3.0V
●Low current consumption	38uA	typ.@f=2GHz, P_{in}=34.5dBm, V_{CTL}=3.0V
●Ultra small & ultra thin package	FLP6-C3 (Mount size: 2.8x3.0x0.75mm)	

■PIN CONFIGURATION



Pin Connection
1.P1
2.GND
3.P2
4.V_{CTL2}
5.PC
6.V_{CTL1}

■TRUTH TABLE

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

V_{CTL1}	H	L
V_{CTL2}	L	H
PC - P1	ON	OFF
PC - P2	OFF	ON

■ABSOLUTE MAXIMUM RATINGS

(T_a=25°C)

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
Input Power	P_{in}	$V_{CTL(L)}$=0V, $V_{CTL(H)}$=3.0V	38	dBm
Control Voltage	V_{CTL}	$V_{CTL(H)}$-$V_{CTL(L)}$	12	V
Power Dissipation	P_D		500	mW
Operating Temp.	T_{opr}		-40~+85	°C
Storage Temp.	T_{stg}		-55~+125	°C

■ELECTRICAL CHARACTERISTICS

($V_{CTL(L)}$=0V, $V_{CTL(H)}$=3V, Z_S=Z_l=50Ω, T_a=25°C)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Operating Voltage (LOW)	$V_{CTL(L)}$		-0.2	0	0.2	V
Operating Voltage (HIGH)	$V_{CTL(H)}$	f=1GHz, P_{in}=34.5dBm	2.7	3.0	9.0	V
Control Current	I_{CTL}	f=1GHz, P_{in}=34.5dBm	-	38	55	uA
Insertion Loss 1	LOSS1	f=1GHz, P_{in}=31dBm	-	0.4	0.5	dB
Insertion Loss 2	LOSS2	f=1GHz, P_{in}=34.5dBm $V_{CTL(H)}$=3.5V, $V_{CTL(L)}$=0V	-	0.4	0.5	dB
Insertion Loss 3	LOSS3	f=1GHz, P_{in}=34.5dBm	-	0.5	0.6	dB
Insertion Loss 4	LOSS4	f=2GHz, P_{in}=31.5dBm	-	0.7	0.8	dB
Isolation 1 (PC-P1, PC-P2)	ISL1	f=1GHz, P_{in}=34.5dBm	26	27	-	dB
Isolation 2 (PC-P1, PC-P2)	ISL2	f=2GHz, P_{in}=31.5dBm	22	25	-	dB
Maximum Input Power 1 *1	P_{in1}	$V_{CTL(H)}$=2.7V, f=2GHz	-	-	33.5	dBm
Maximum Input Power 2 *1	P_{in2}	$V_{CTL(H)}$=3V, f=2GHz	-	-	34	dBm
Maximum Input Power 3 *1	P_{in3}	$V_{CTL(H)}$=4V, f=2GHz	-	-	37	dBm
Maximum Input Power 4 *1	P_{in4}	$V_{CTL(H)}$=6V, f=2GHz	-	-	38	dBm
Maximum Input Power 5 *1	P_{in5}	$V_{CTL(H)}$=9V, f=2GHz	-	-	34.5	dBm
Pout at 0.2dB Compression point	$P_{-0.2dB}$1	f=2GHz	34.5	36	-	dBm
VSWR 1 (PC, P1, P2)	VSWR	f=0.05~2.5GHz, ON State	-	1.45	1.55	
Switching Time	T_{SW}	f=0.05~2.5GHz	-	70	-	ns

*1: Maximum Input Power: This value is defined as maximum input power of linear operating region (such as Pout at 0.05dB Gain compression point) or damage free operating region.

■**ELECTRICAL CHARACTERISTICS** (Cellular Band)

($V_{CTL(L)}$=0V, $V_{CTL(H)}$=2.7V, Z_s=Z_l=50Ω, T_a=25°C)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Frequency range	f_{in}		800	-	1000	MHz
Control voltage (HIGH)	$V_{CTL(H)}$	P_{in}=25dBm	2.7	-	9	V
Insertion Loss 5	LOSS5	P_{in}=25dBm	-	0.4	0.5	dB
Isolation 3 (PC-P1, PC-P2)	ISL3	P_{in}=25dBm	26	27	-	dB
Pout at 0.2dB Compression point 2	$P_{-0.2dB}$(2)		33.5	35	-	dBm
Input 3rd Order Intercept Point 1	IIP3(1)	f=900+901MHz, P_{in}=25dBm, $V_{CTL(H)}$=3V, $V_{CTL(L)}$=0V *2	-	62	-	dBm
Input 3rd Order Intercept Point 2	IIP3(2)	f=900+901MHz, P_{in}=25dBm $V_{CTL(H)}$=2.7V, $V_{CTL(L)}$=0V *2	-	60	-	dBm
Second Harmonics	2fo	f=900MHz, P_{in}=25dBm 2nd Harmonics of Input Signal = -83dBc		-80	-	dBc
Third Harmonics	3fo	f=900MHz, P_{in}=25dBm 3rd Harmonics of Input Signal =-100dBc	-	-70	-	dBc
VSWR 2 (PC, P1, P2)	VSWR2	ON State	-	1.15	1.25	

*2: The input IP3 is defined as following equation.

IIP3 = (3 x Pout – IM3) / 2 + LOSS

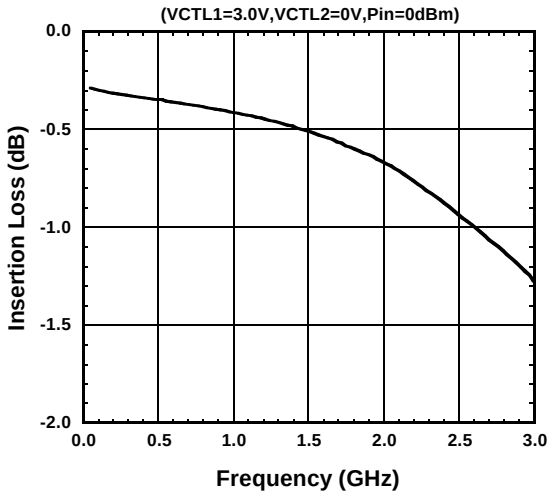
■TERMINAL INFORMATION

No.	SYMBOL	EXPLANATION
1	P1	RF port. This port is connected with PC port by controlling 6th pin ($V_{CTL(H)}$) to 2.7~9.0V and 4th pin ($V_{CTL(L)}$) to -0.2~+0.2V. An external capacitor is required to block the DC bias voltage of internal circuit. (50~100MHz: 0.01µF, 0.1~0.5GHz: 1000pF, 0.5~2.5GHz: 56pF)
2	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
3	P2	RF port. This port is connected with PC port by controlling 4th pin ($V_{CTL(H)}$) to 2.7~9.0V and 6th pin ($V_{CTL(L)}$) to -0.2~+0.2V. An external capacitor is required to block the DC bias voltage of internal circuit. (50~100MHz: 0.01µF, 0.1~0.5GHz: 1000pF, 0.5~2.5GHz: 56pF)
4	V_{CTL2}	Control port 2. The voltage of this port controls PC to P2 state. The 'ON' and 'OFF' state is toggled by controlling voltage of this terminal such as high-state (2.7~5.5V) or low-state (-0.2~+0.2V). The voltage of 6th pin have to be set to opposite state. The bypass capacitor has to be chosen to reduce switching speed delay from 10pF~1000pF range.
5	PC	Common RF port. In order to block the DC bias voltage of internal circuit, an external capacitor is required. (50~100MHz: 0.01uF, 0.1~0.5GHz: 1000pF, 0.5~2.5GHz: 56pF)
6	V_{CTL1}	Control port 1. The voltage of this port controls PC to P2 state. The 'ON' and 'OFF' state is toggled by controlling voltage of this terminal such as high-state (2.7–5.5V) or low-state (-0.2~+0.2V). The voltage of 4th pin have to be set to opposite state. The bypass capacitor has to be chosen to reduce switching speed delay from 10pF~1000pF range.

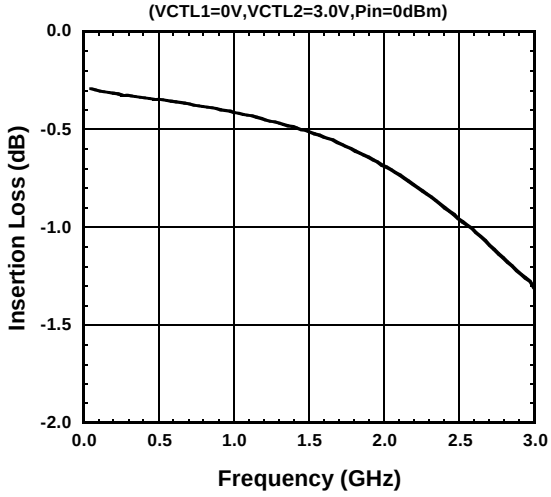
■ELECTRICAL CHARACTERISTICS

(f=50MHz~3.0GHz, with application circuit, losses of external circuit are excluded)

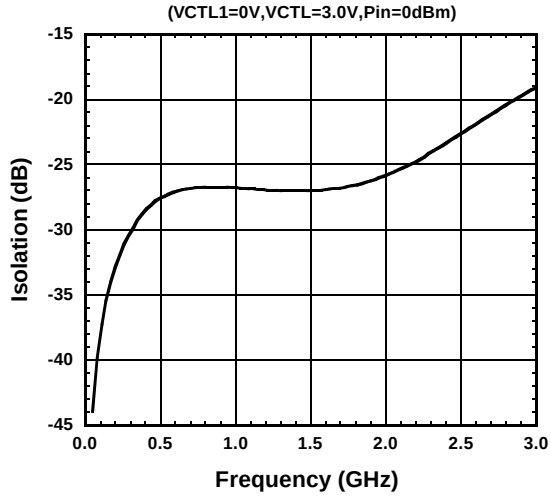
PC-P1 Insertion Loss vs. Frequency



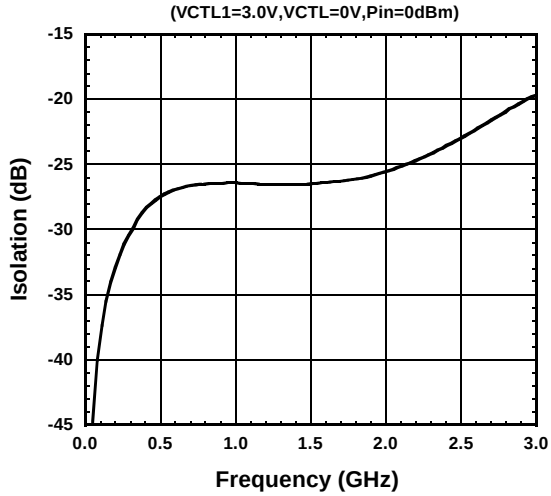
PC-P2 Insertion Loss vs. Frequency



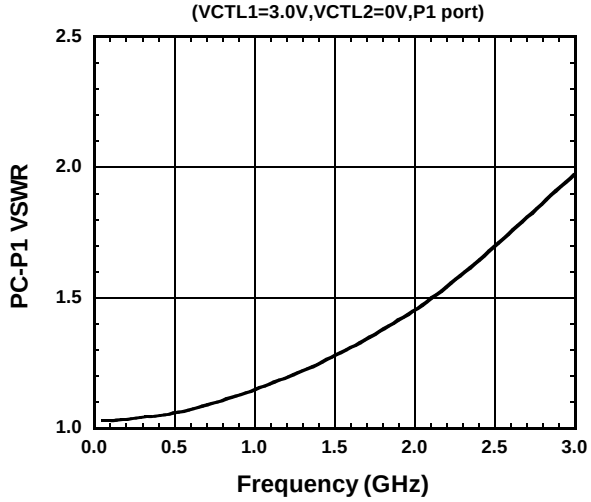
PC-P1 Isolation vs. Frequency



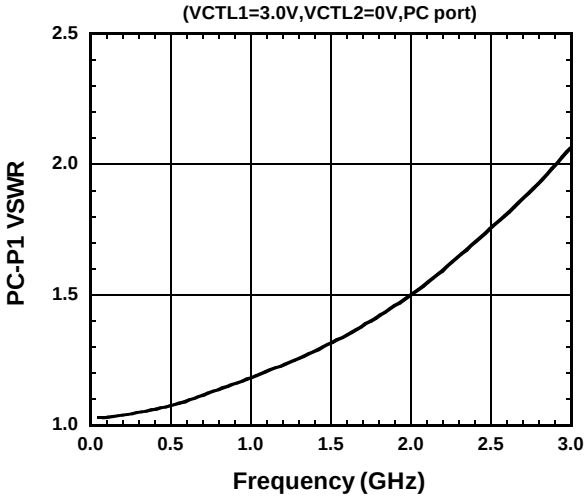
PC-P2 Isolation vs. Frequency



PC-P1 VSWR vs. Frequency



PC-P1 VSWR vs. Frequency

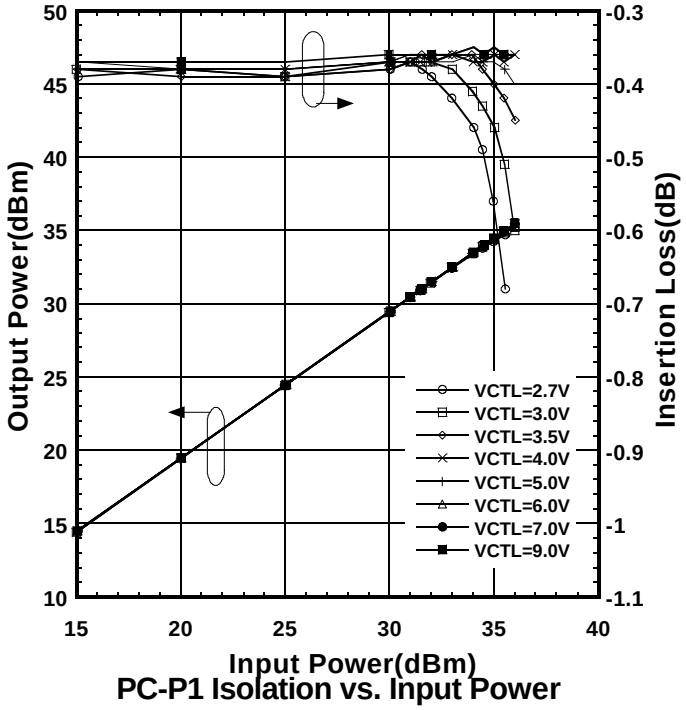


■ELECTRICAL CHARACTERISTICS

(f=0.8GHz, with application circuit 1 (Parts list 3), losses of PCB, DC blocking capacitor are excluded)

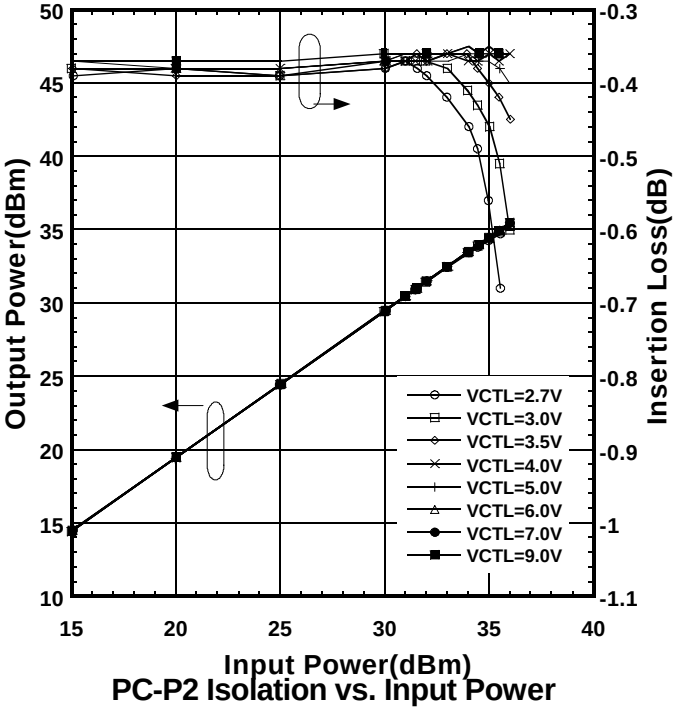
Output Power,Insertion Loss vs. Input power

(PC-P1,f=0.8GHz)



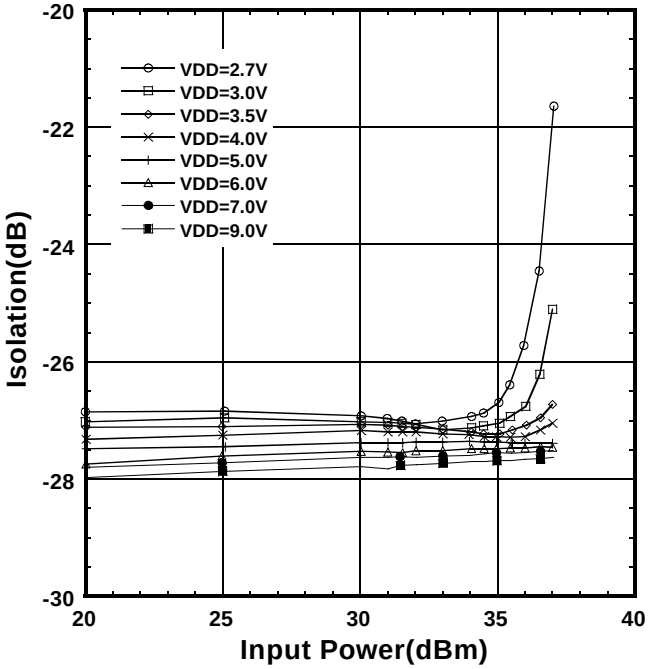
Output Power,Insertion Loss vs. Input power

(PC-P2,f=0.8GHz)



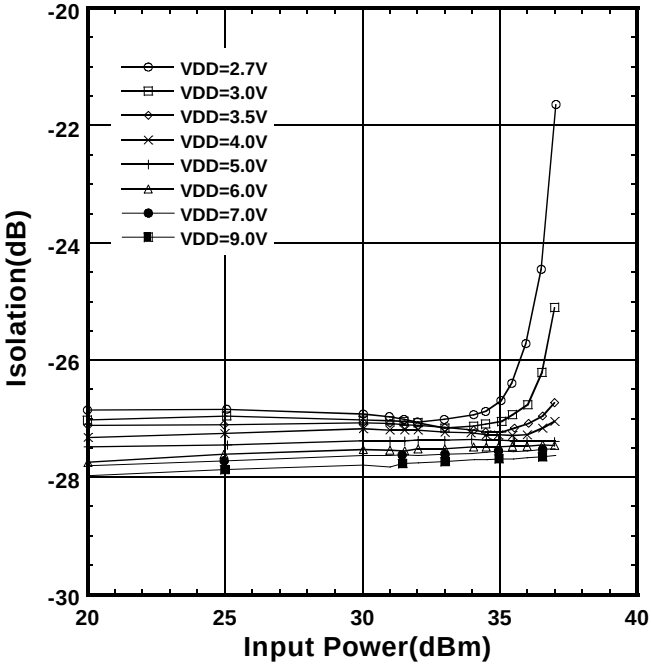
PC-P1 Isolation vs. Input Power

(PC-P1,f=0.8GHz)



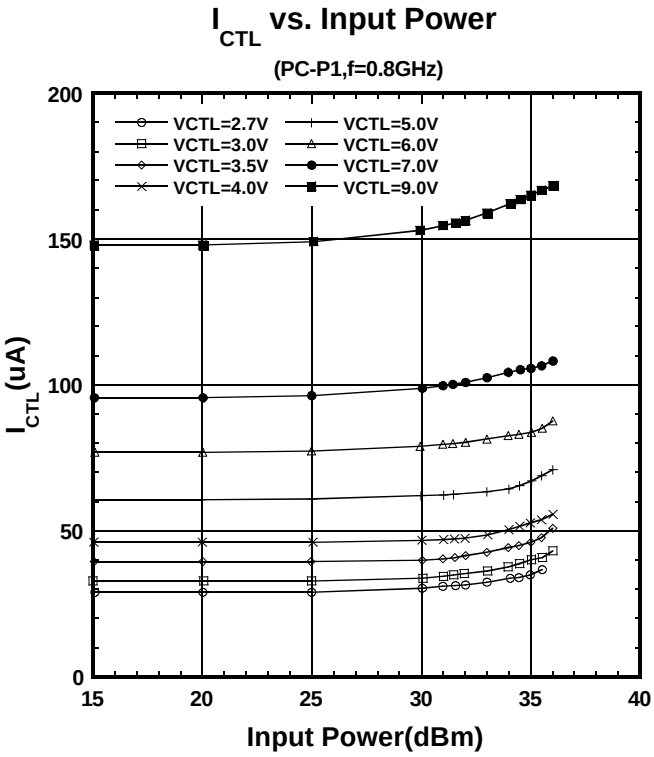
PC-P2 Isolation vs. Input Power

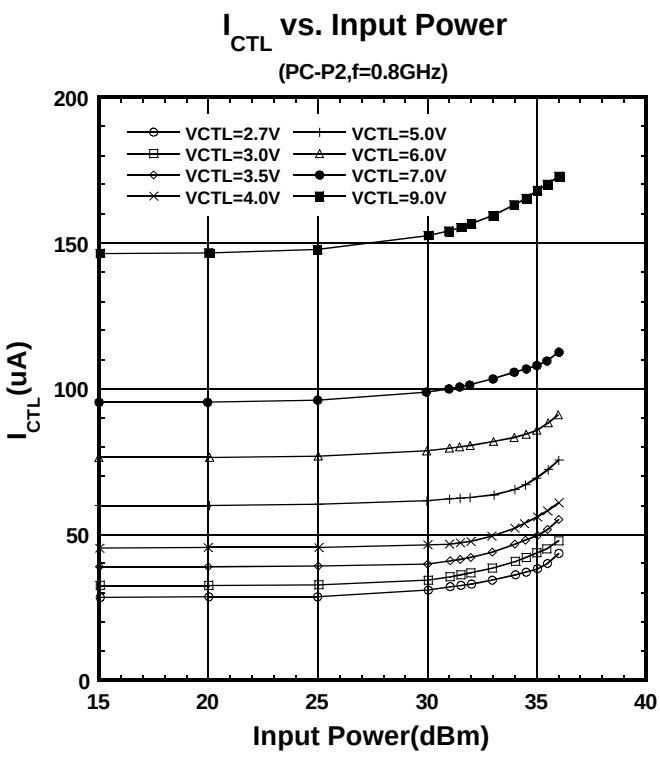
(PC-P2,f=0.8GHz)



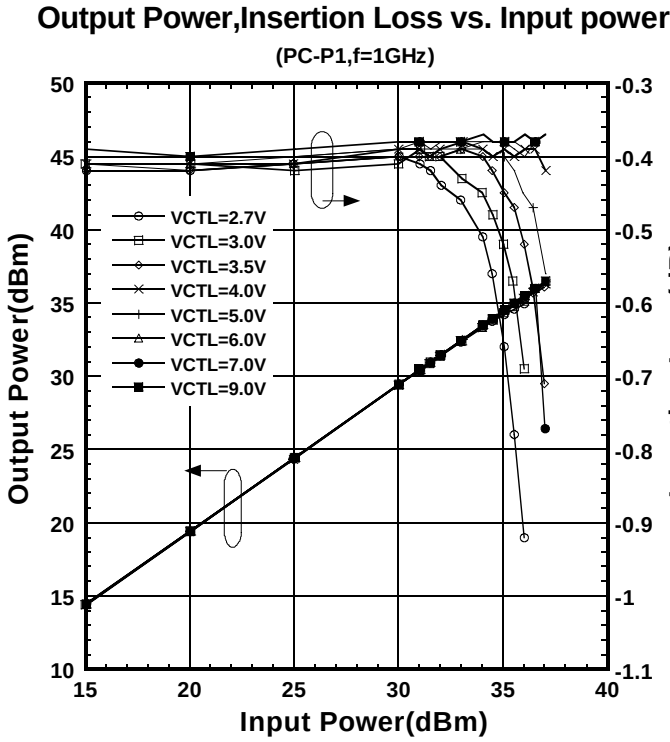
■ ELECTRICAL CHARACTERISTICS

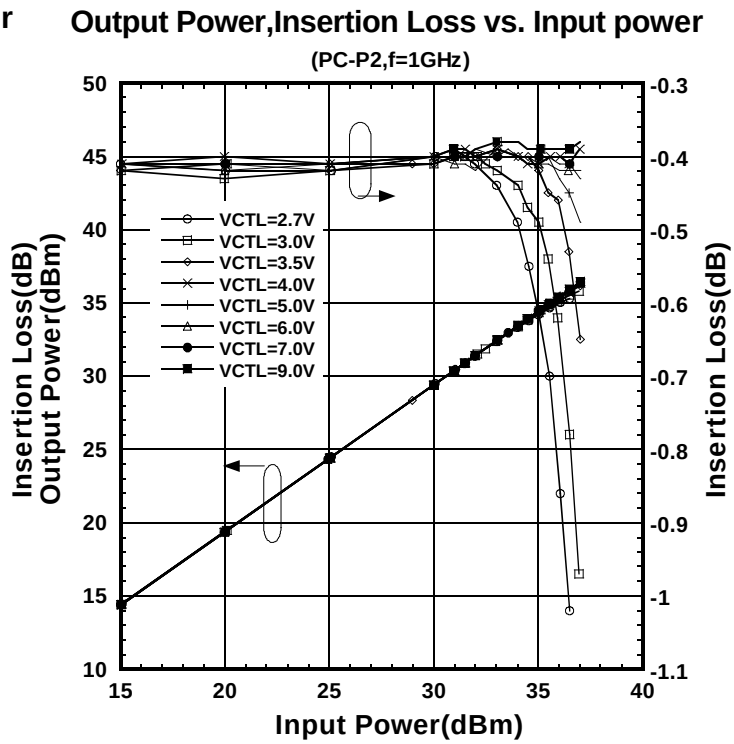
(f=0.8GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)





(f=1.0GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)



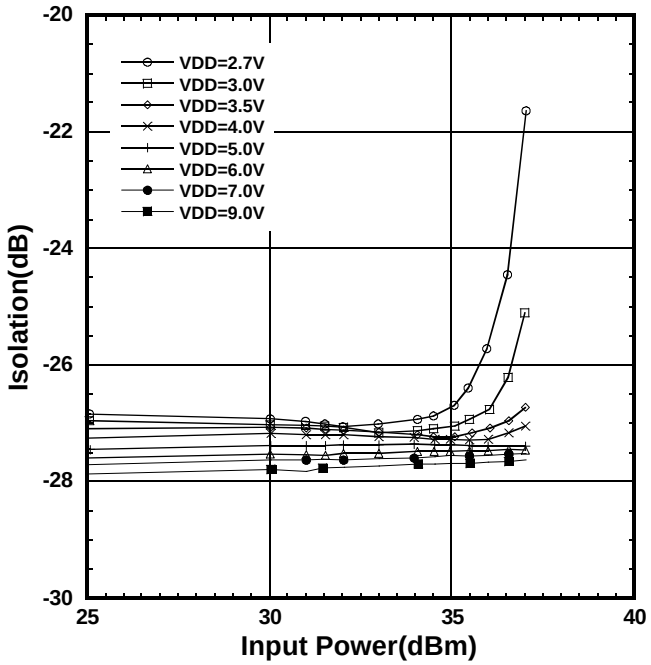


■ELECTRICAL CHARACTERISTICS

(f=1.0GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)

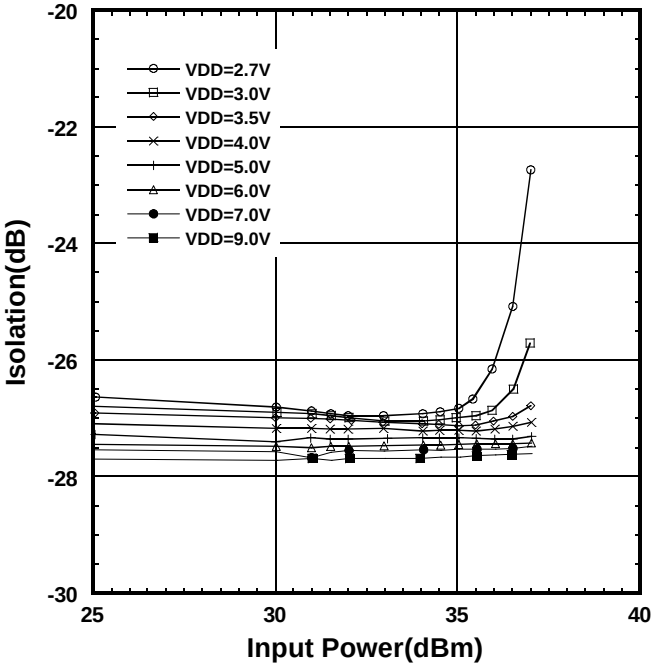
PC-P1 Isolation vs. Input Power

(PC-P1,f=1GHz)



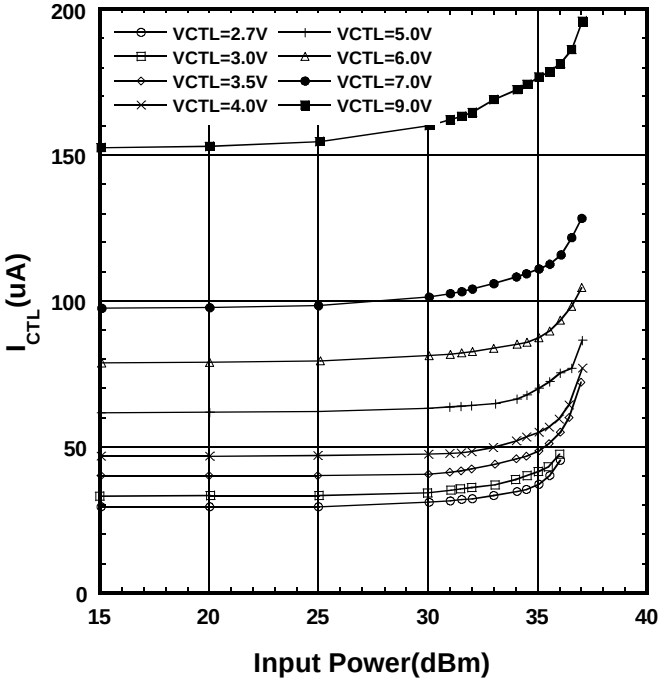
PC-P2 Isolation vs. Input Power

(PC-P2,f=1GHz)



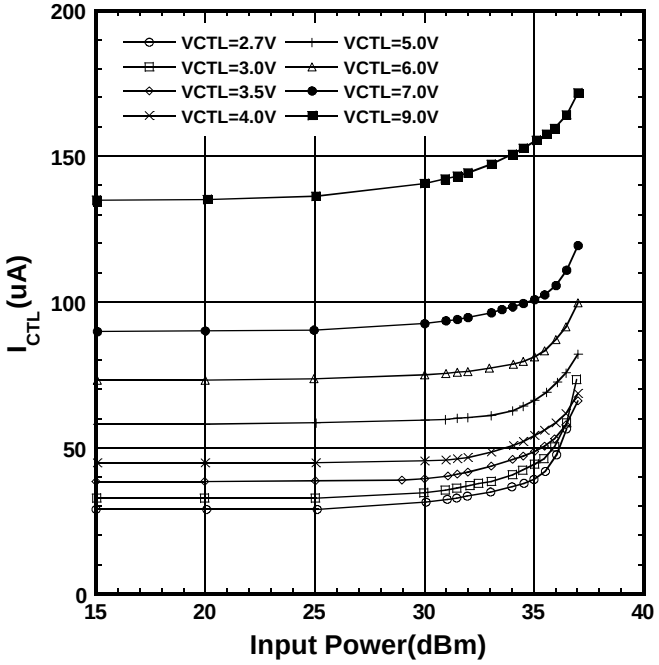
I_{CTL} vs. Input Power

(PC-P1,f=1GHz)



I_{CTL} vs. Input Power

(PC-P2,f=1GHz)

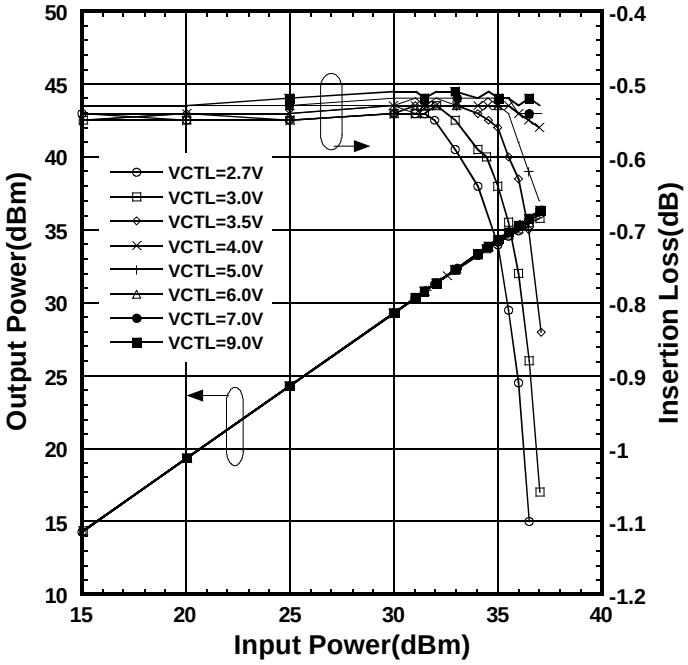


■ELECTRICAL CHARACTERISTICS

(f=1.5GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)

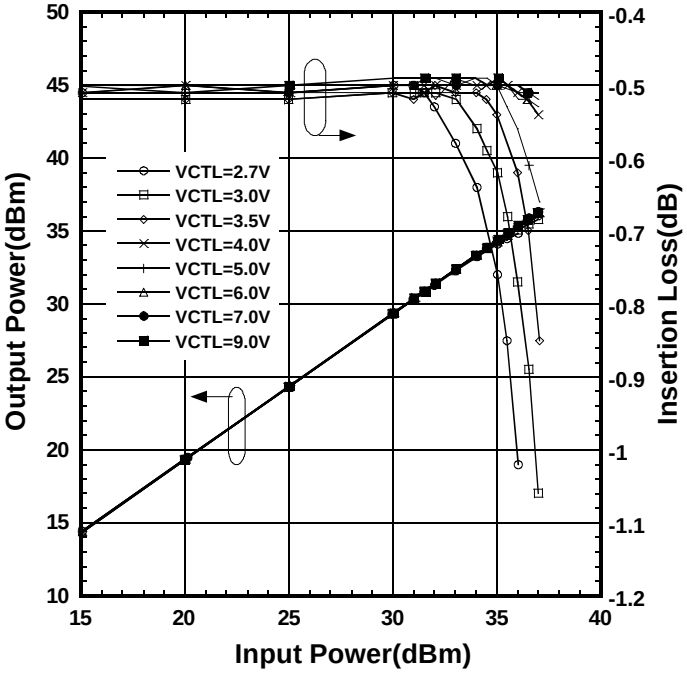
Output Power,Insertion Loss vs. Input power

(PC-P1,f=1.5GHz)



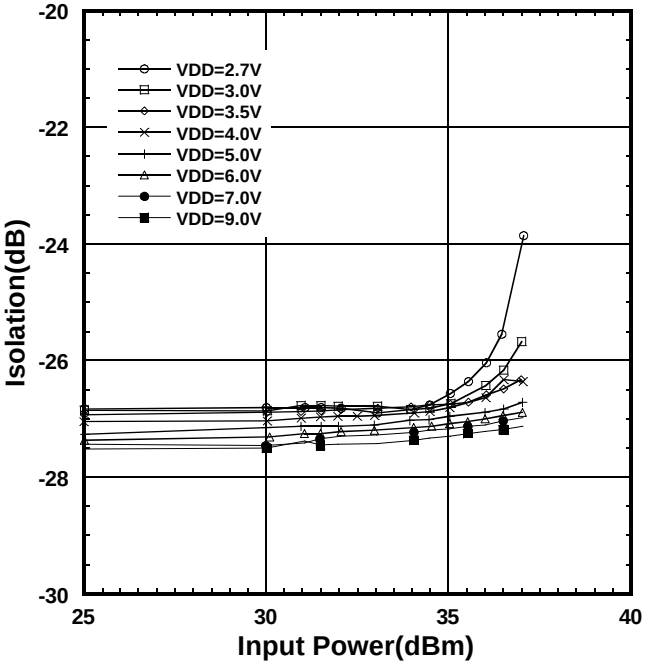
Output Power,Insertion Loss vs. Input power

(PC-P2,f=1.5GHz)



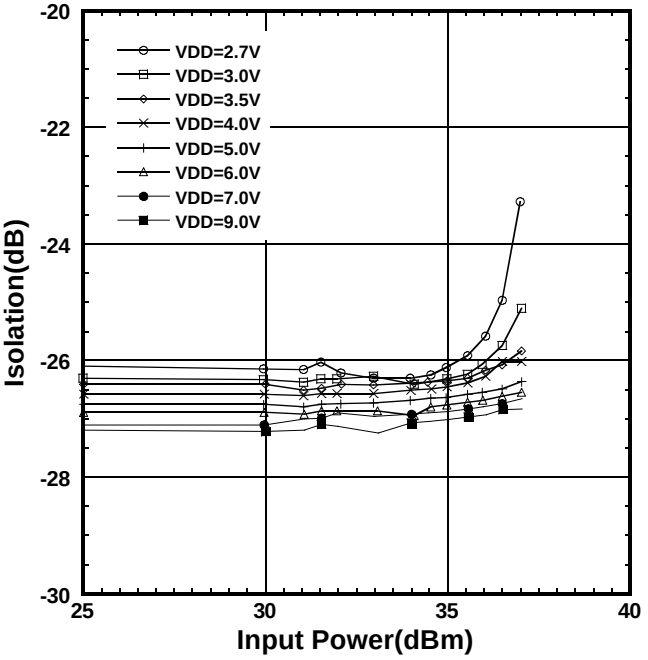
PC-P1 Isolation vs. Input Power

(PC-P1,f=1.5GHz)



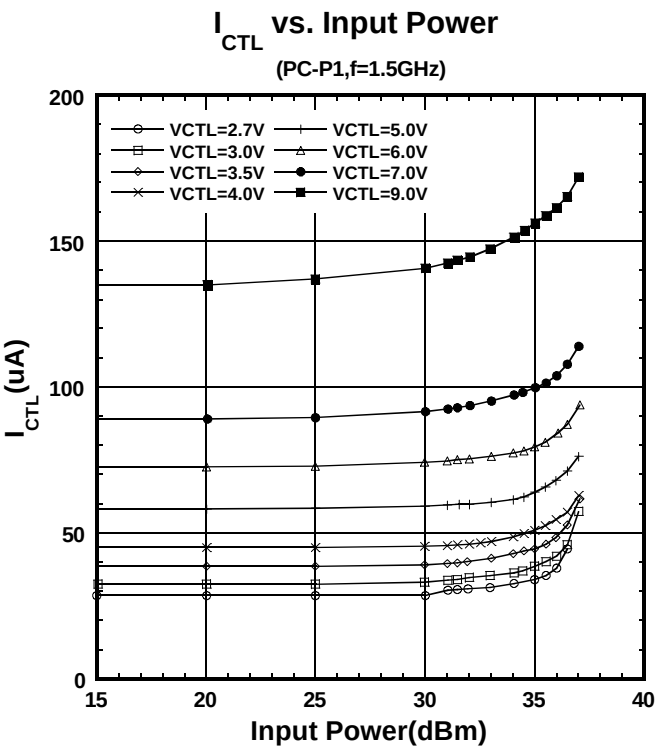
PC-P2 Isolation vs. Input Power

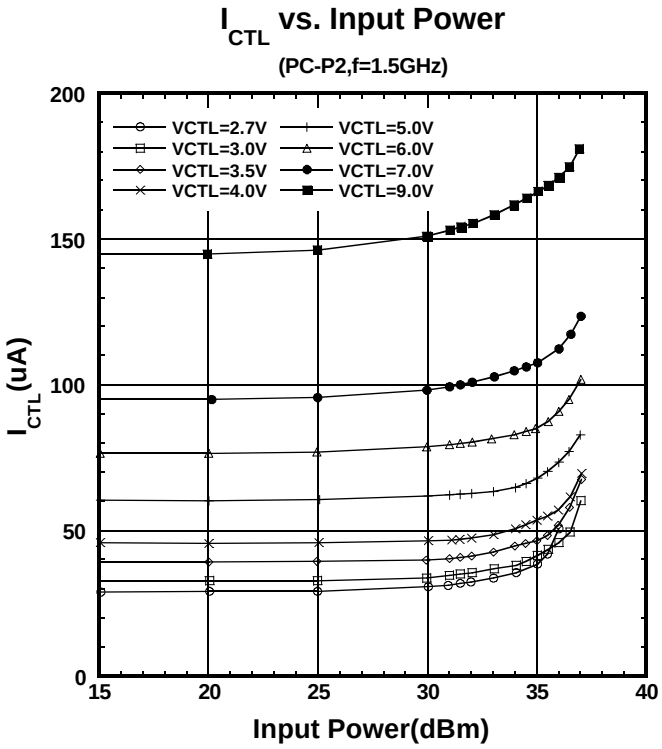
(PC-P2,f=1.5GHz)



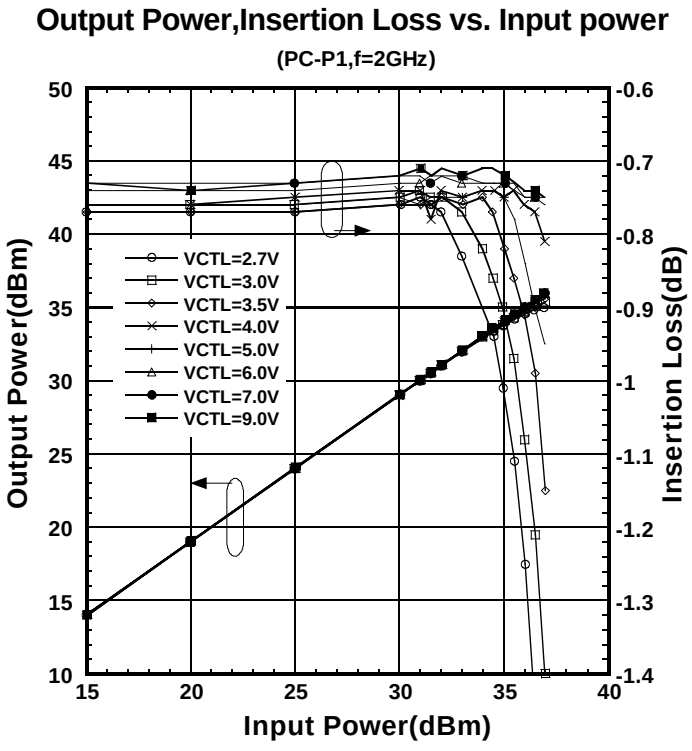
■ELECTRICAL CHARACTERISTICS

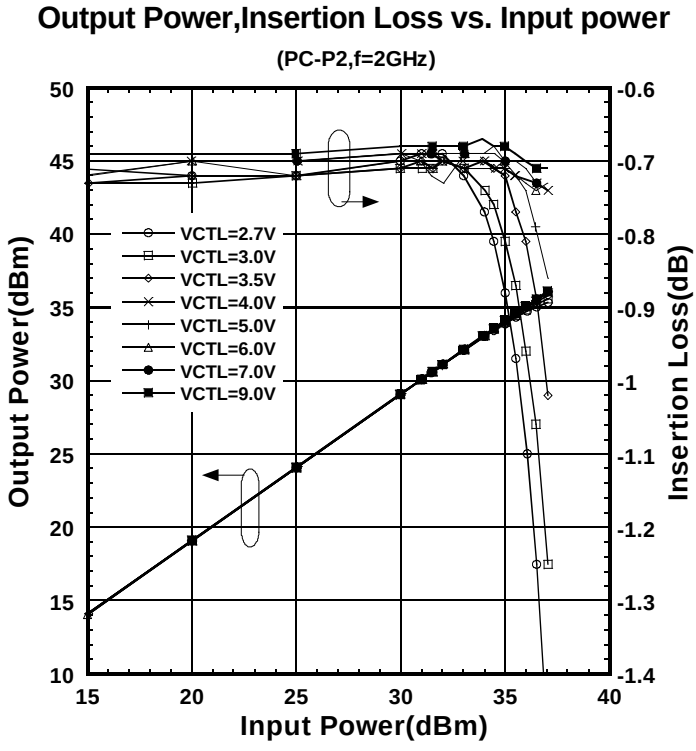
(f=1.5GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)





(f=2.0GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)



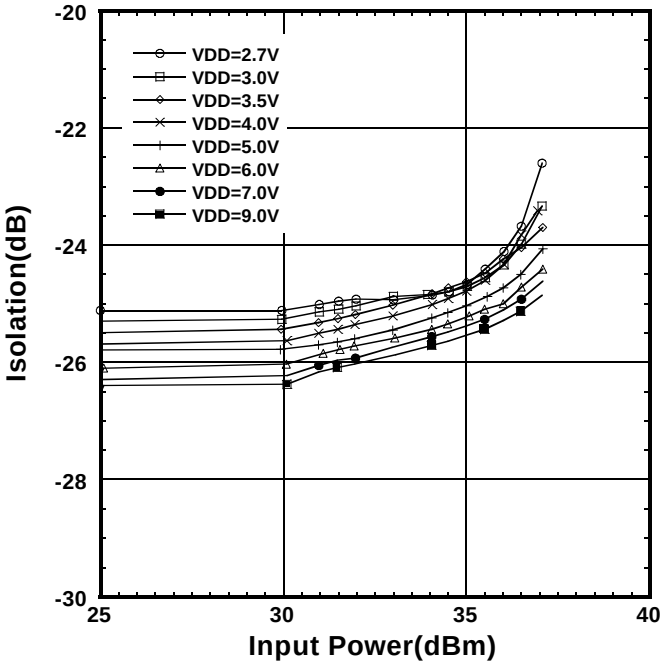


■ELECTRICAL CHARACTERISTICS

(f=2.0GHz, with application circuit 1 (Parts list 3), losses of PCB, connector and DC blocking capacitor are excluded)

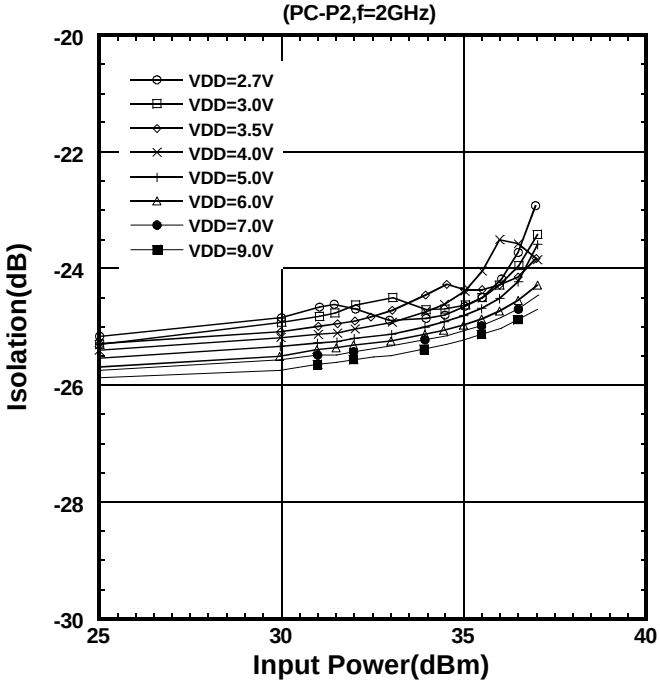
PC-P1 Isoration vs. Input Power

(PC-P1,f=2GHz)



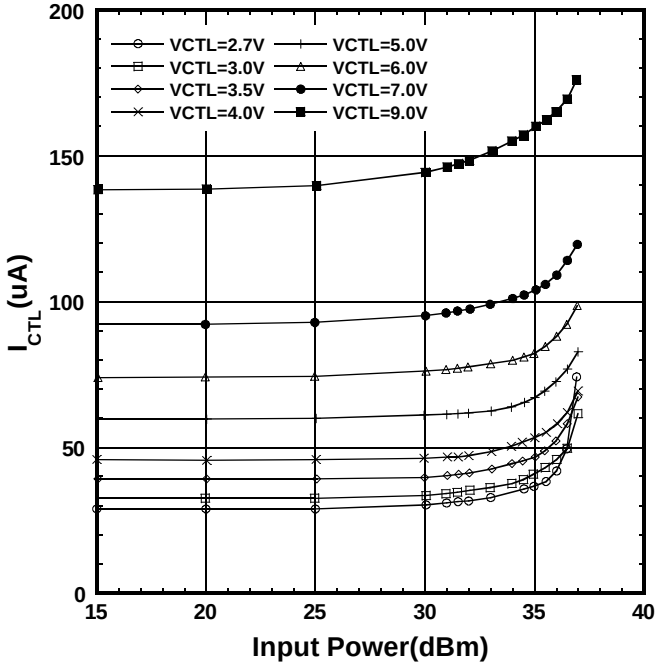
PC-P2 Isolation vs. Input Power

(PC-P2,f=2GHz)



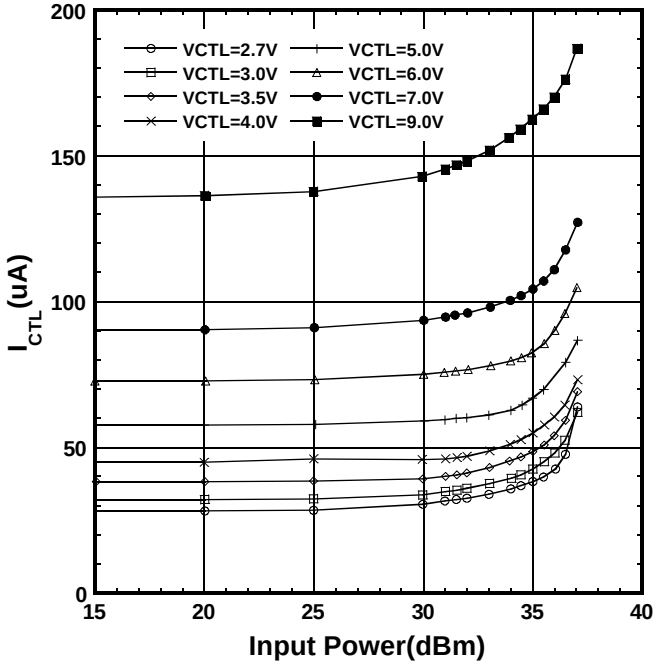
I_{CTL} vs. Input Power

(PC-P1,f=2GHz)



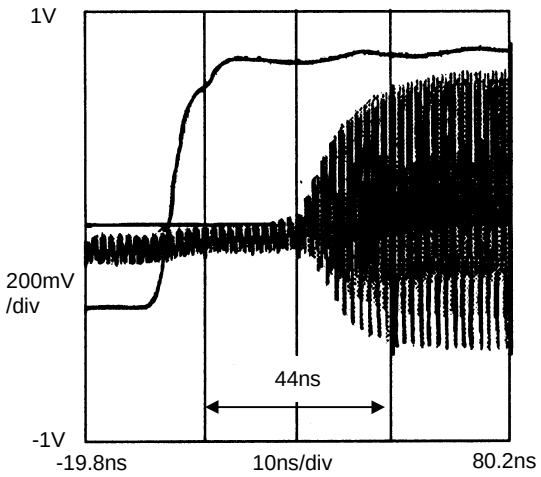
I_{CTL} vs. Input Power

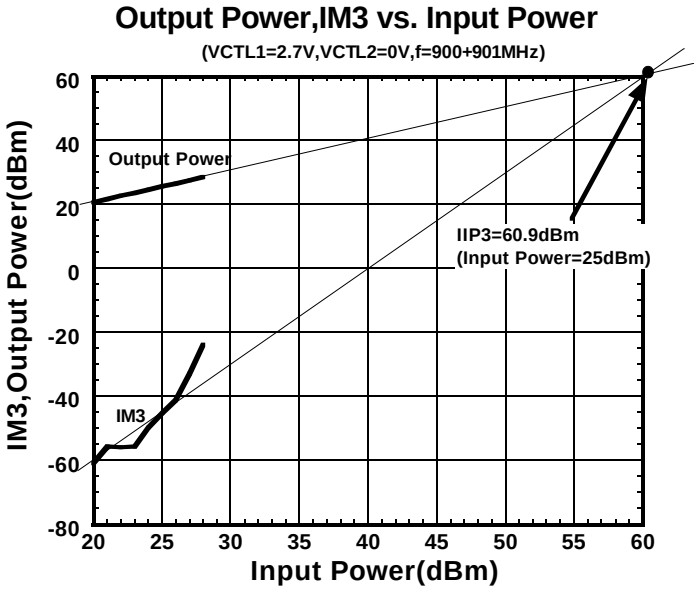
(PC-P2,f=2GHz)

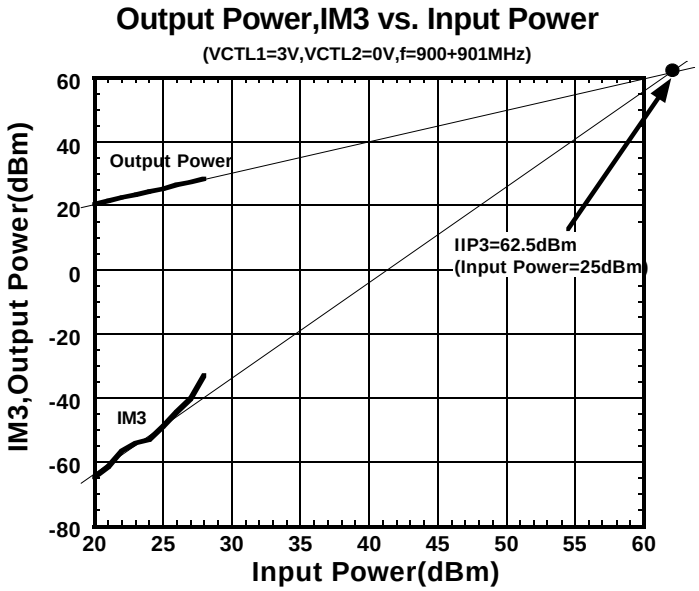


■**ELECTRICAL CHARACTERISTICS** (with application circuit 1, Parts list 3)

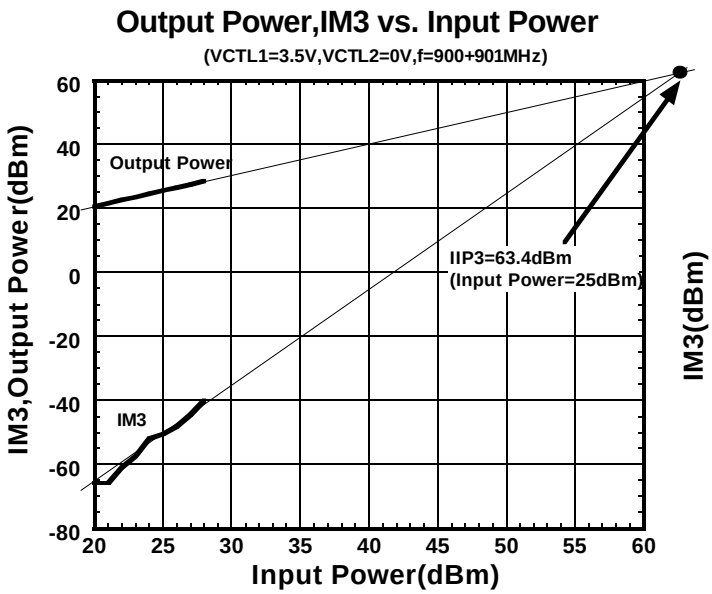
Switching speed
(V_{CTL1}=3.0V, V_{CTL2}=0V)

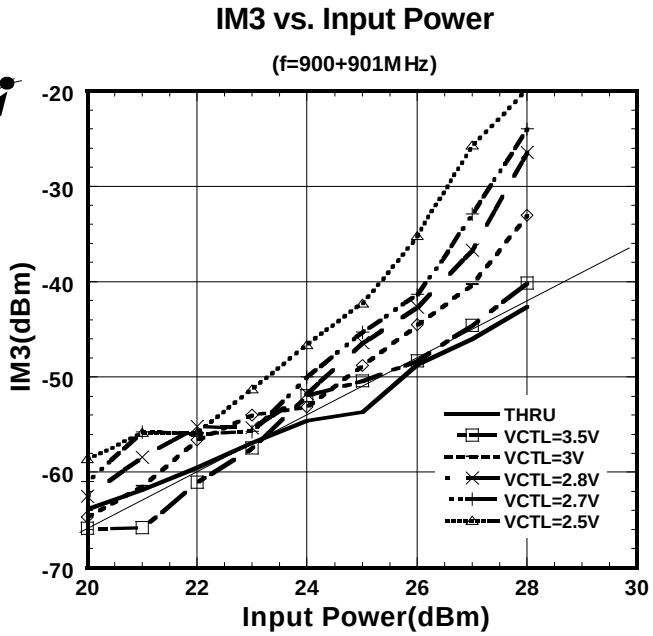


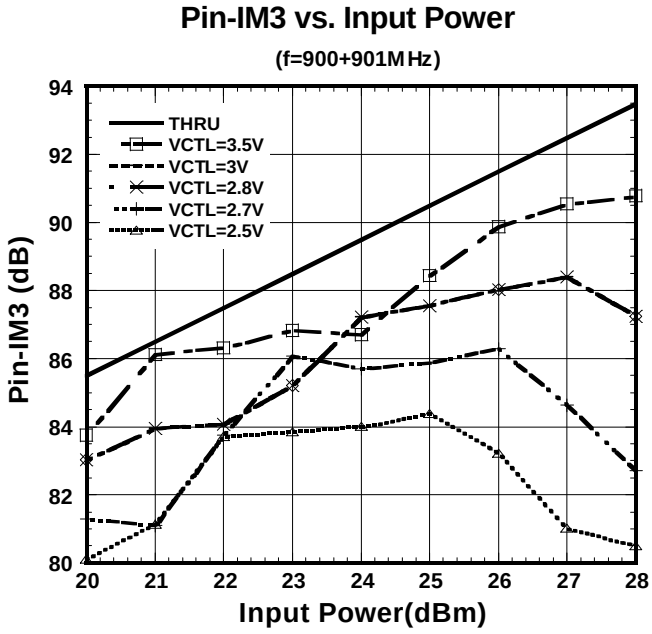




■**ELECTRICAL CHARACTERISTICS** (with application circuit 1, Parts list 3)



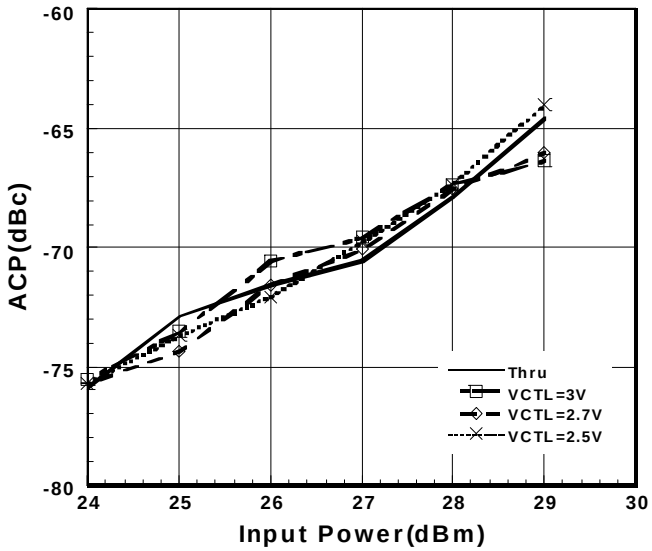




■**ELECTRICAL CHARACTERISTICS** (with application circuit 1, Parts list 3)

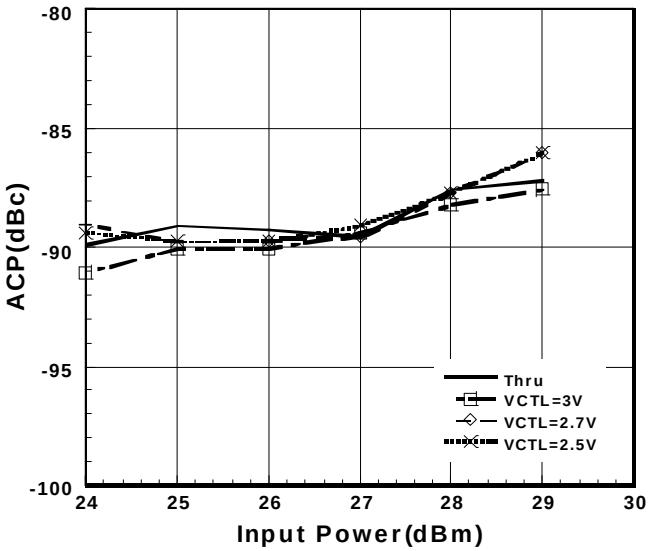
ACP vs. Input Power

(f=1GHz,offset=0.9MHz)



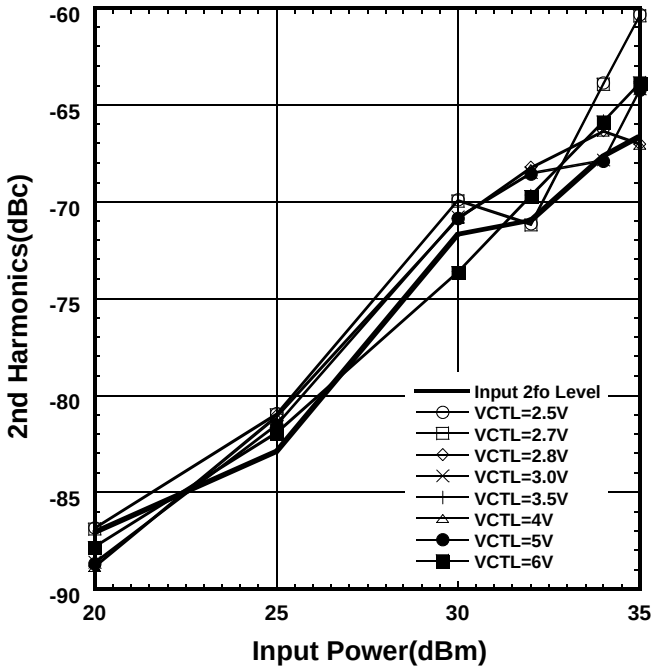
ACP vs. Input Power

(f=1GHz,offset=1.98MHz)



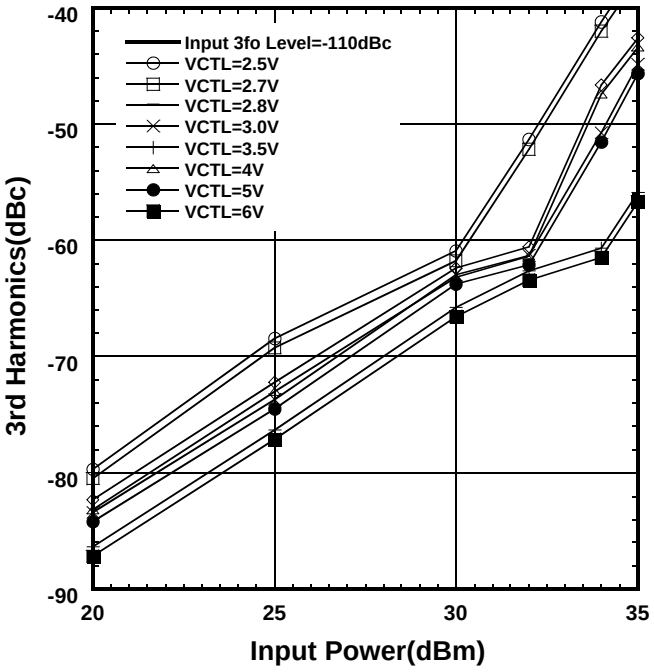
2nd Harmonics vs. Input Power

(f=900MHz)



3rd Harmonics vs. Input Power

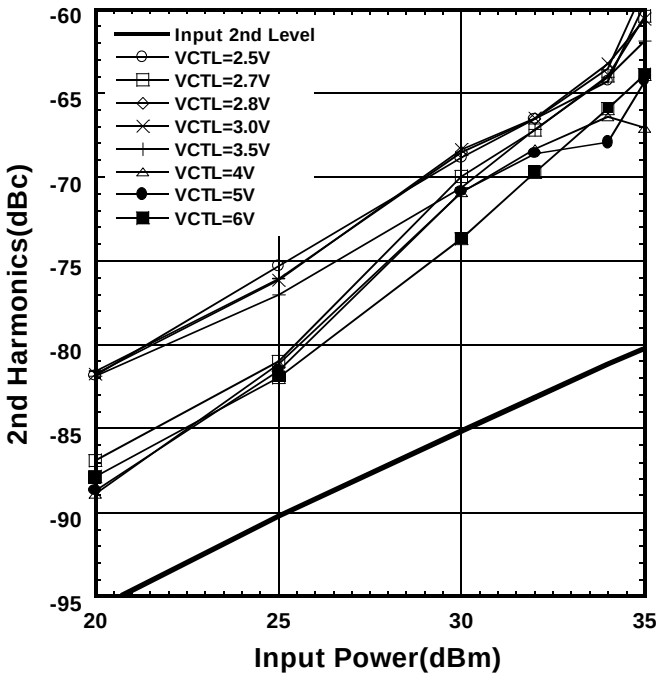
(f=900MHz)



■**ELECTRICAL CHARACTERISTICS** (with application circuit 1, Parts list 3)

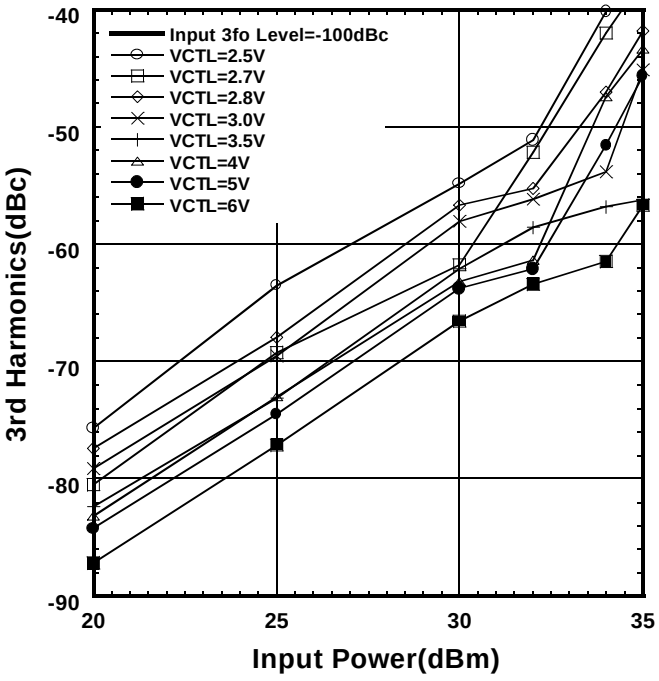
2nd Harmonics vs. Input Power

(f=1800MHz)



3rd Harmonics vs. Input Power

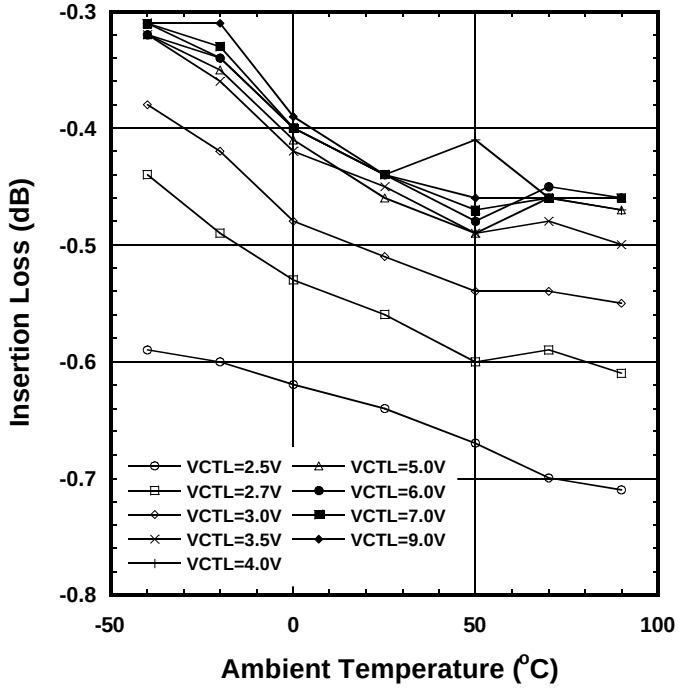
(f=1800MHz)



■ **TEMPERATURE CHARACTERISTICS** (with application circuit 1, Parts list 3)

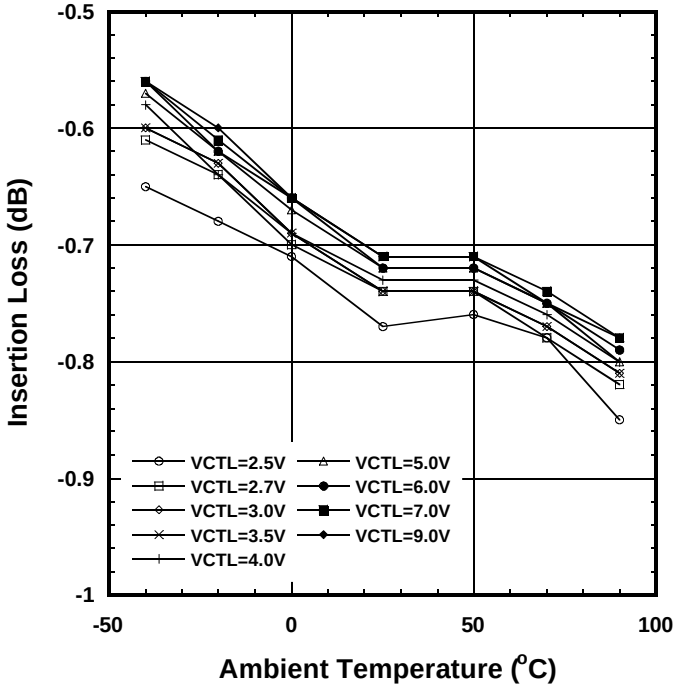
Insertion Loss vs. Ambient Temperature

(PC-P1,f=1GHz,Input Power=34.5dBm)



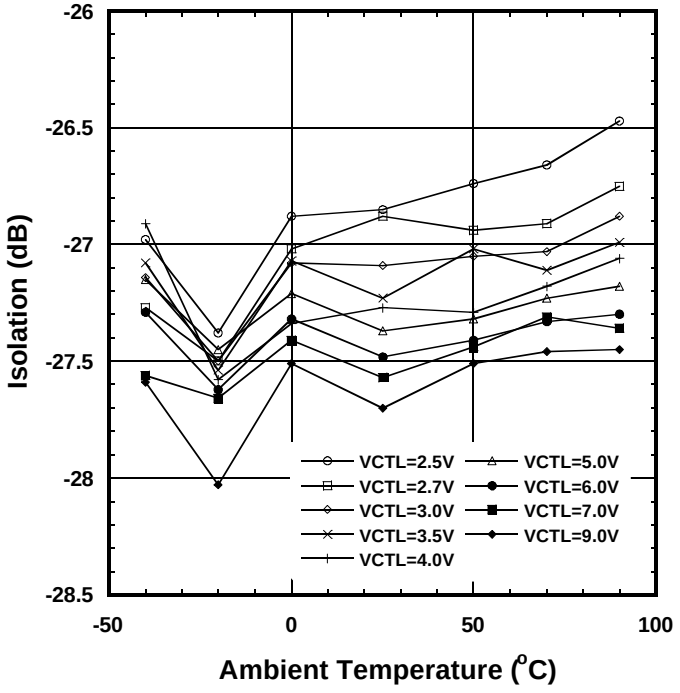
Insertion Loss vs. Ambient Temperature

(PC-P1,f=2GHz,Input Power=31.5dBm)



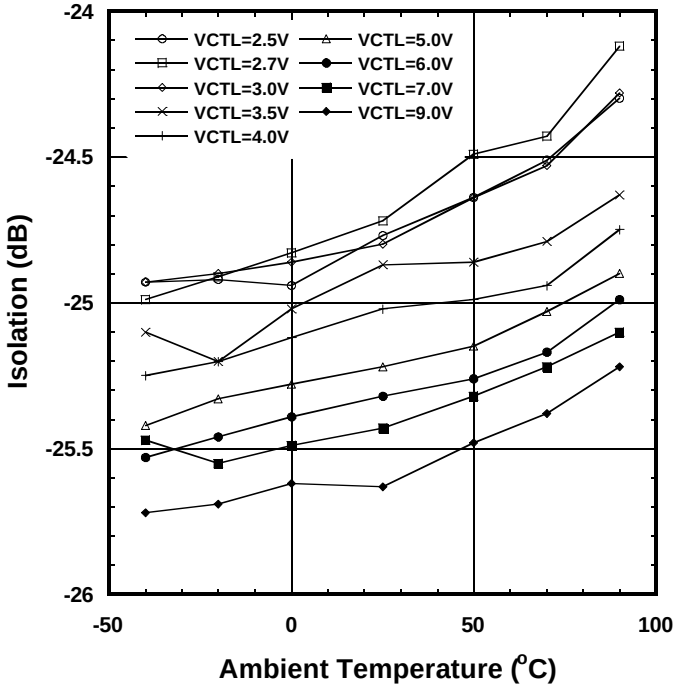
Isolation vs. Ambient Temperature

(PC-P1,f=1GHz,Input Power=34.5dBm)



Isolation vs. Ambient Temperature

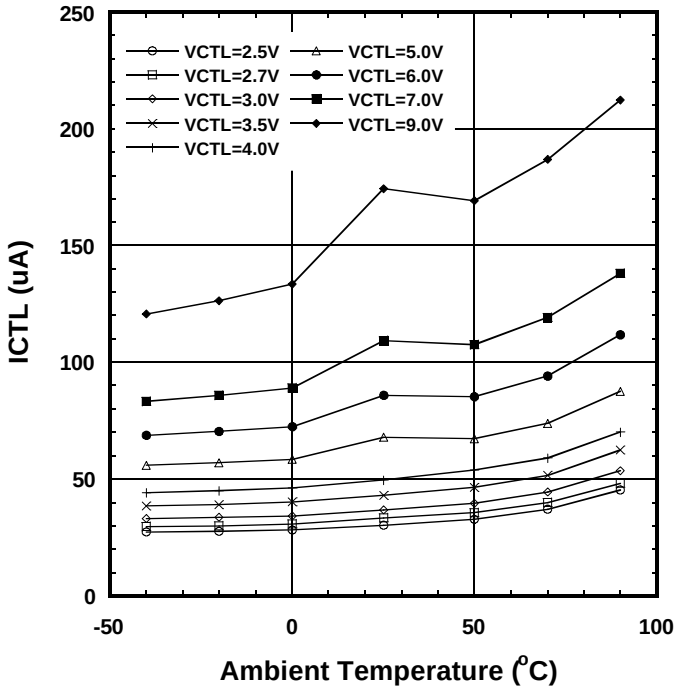
(PC-P1,f=2GHz,Input Power=31.5dBm)



■**TEMPERATURE CHARACTERISTICS** (with application circuit 1, Parts list 3)

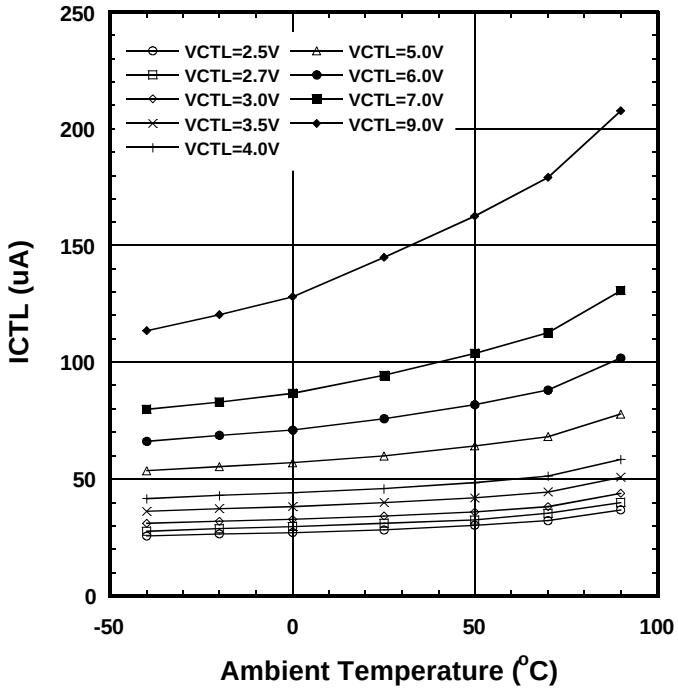
ICTL vs. Ambient Temperature

(PC-P1,f=1GHz,Input Power=34.5dBm)



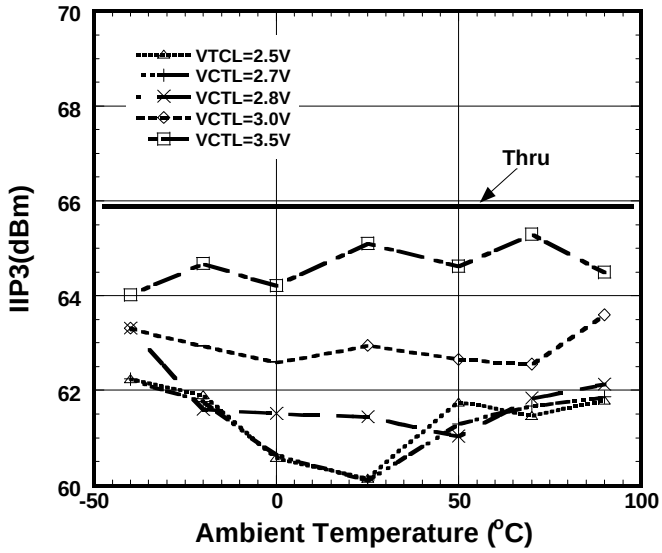
ICTL vs. Ambient Temperature

(PC-P1,f=2GHz,Input Power=31.5dBm)



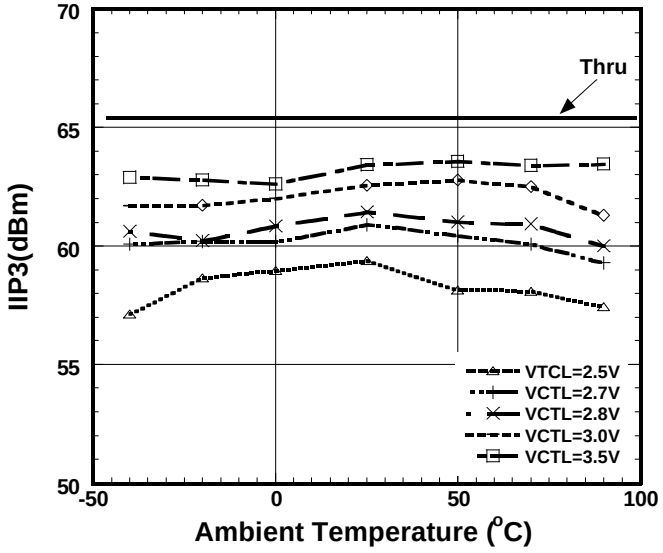
IIP3 vs. Ambient Temperature

(PC-P1,f=900+901MHz,Input Power=21dBm)



IIP3 vs. Ambient Temperature

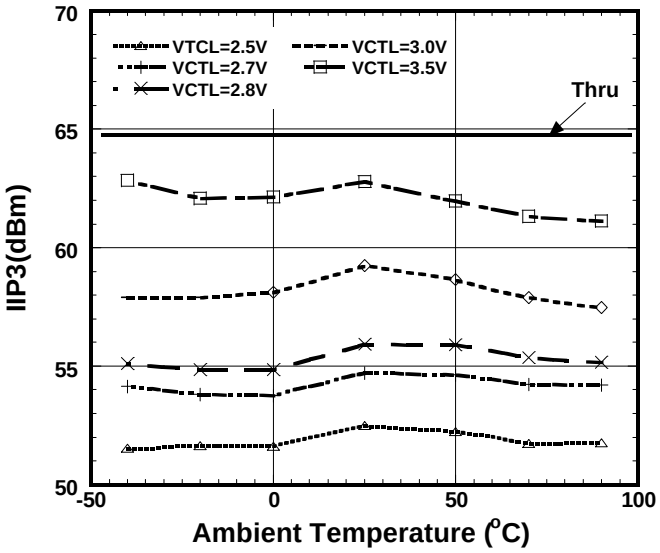
(PC-P1,f=900+901MHz,Input Power=25dBm)



■ **TEMPERATURE CHARACTERISTICS** (with application circuit 1, Parts list 3)

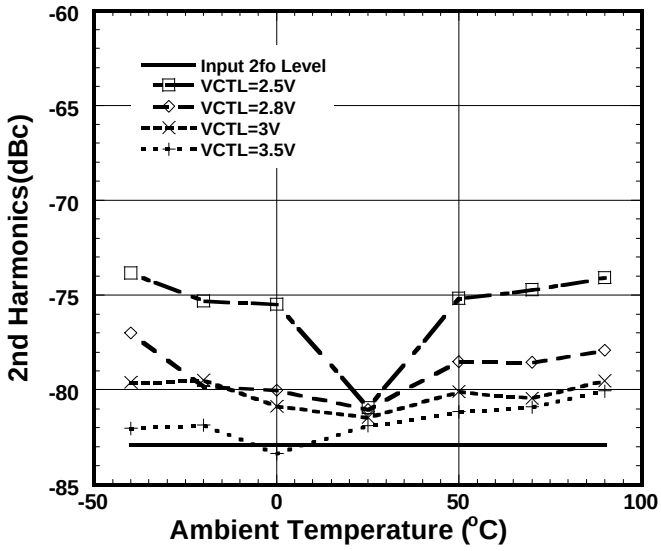
IIP3 vs. Ambient Temperature

(PC-P1,f=900+901MHz,Input Power=28dBm)



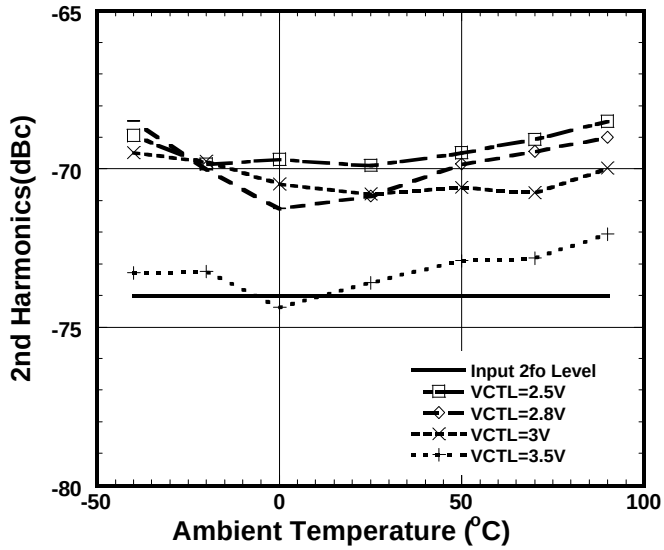
2nd Harmonics vs. Ambient Temperture

(f=900MHz,Input Power=25dBm)



2nd Harmonics vs. Ambient Temperture

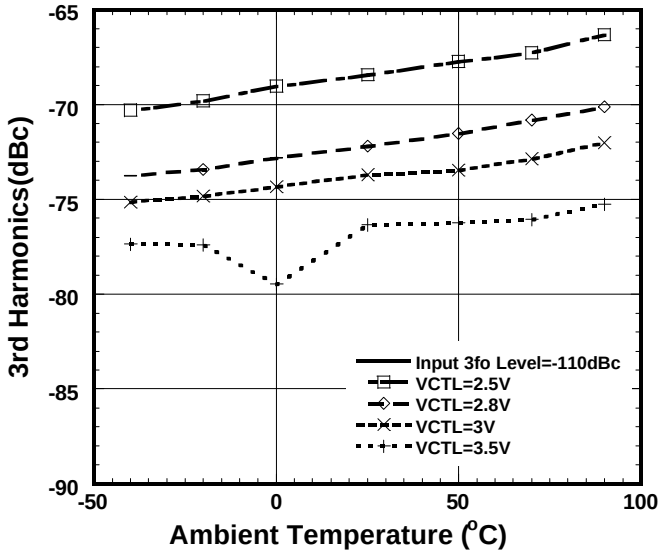
(f=900MHz,Input Power=30dBm)



■**TEMPERATURE CHARACTERISTICS** (with application circuit 1, Parts list 3)

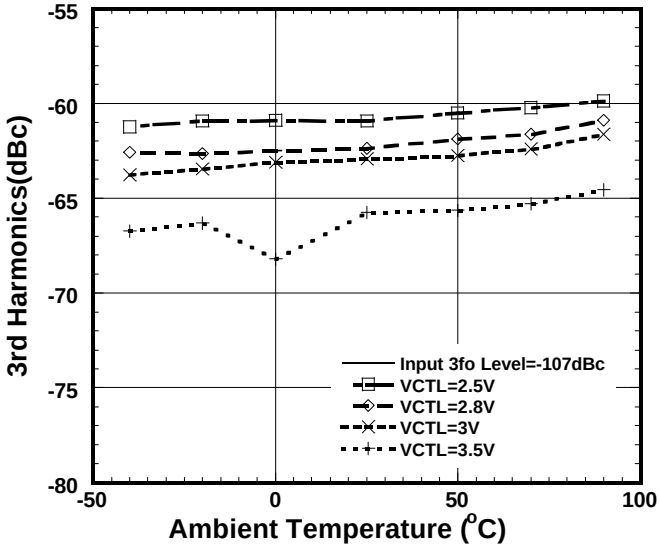
3rd Harmonics vs. Ambient Temperture

(f=900MHz,Input Power=25dBm)



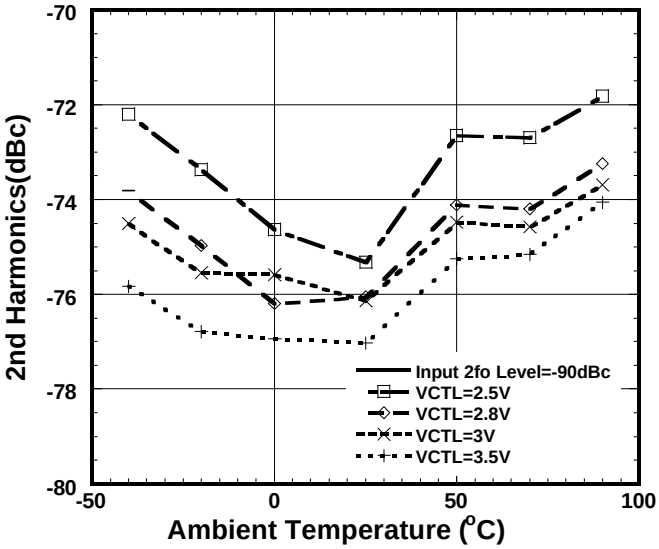
3rd Harmonics vs. Ambient Temperture

(f=900MHz,Input Power=30dBm)



2nd Harmonics vs. Ambient Temperture

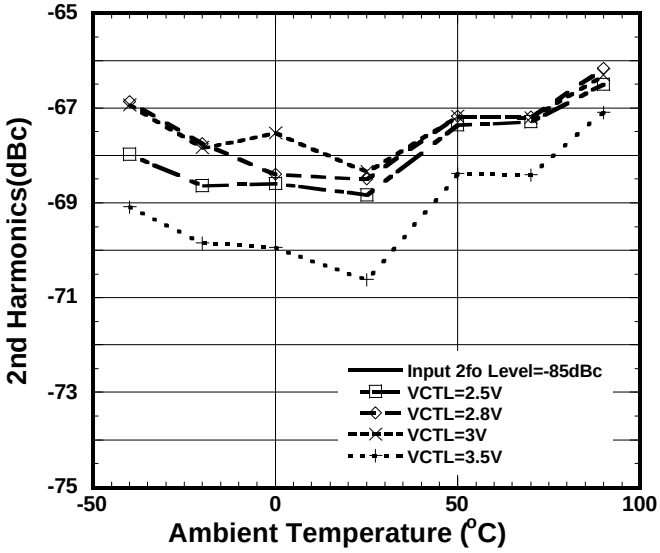
(f=1800MHz,Input Power=25dBm)



■**TEMPERATURE CHARACTERISTICS** (with application circuit 1, Parts list 3)

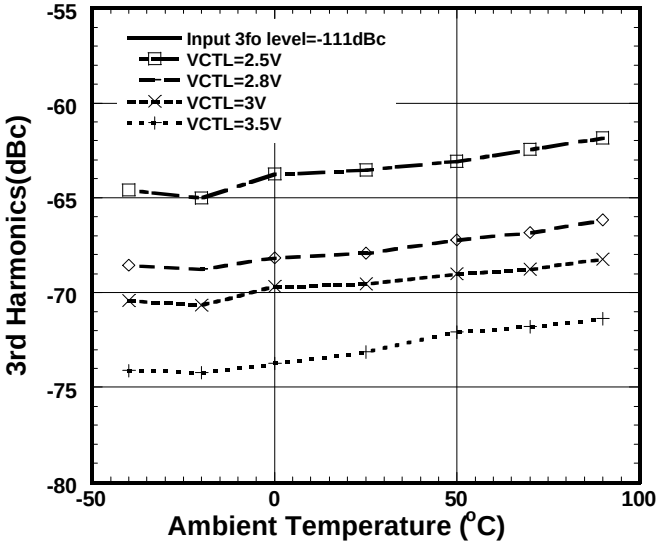
2nd Harmonics vs. Ambient Temperture

(f=1800MHz,Input Power=30dBm)



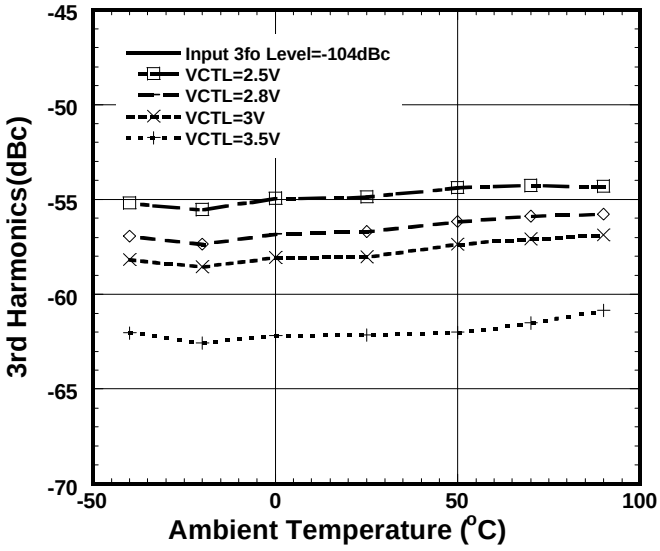
3rd Harmonics vs. Ambient Temperture

(f=1800MHz,Input Power=25dBm)



3rd Harmonics vs. Ambient Temperture

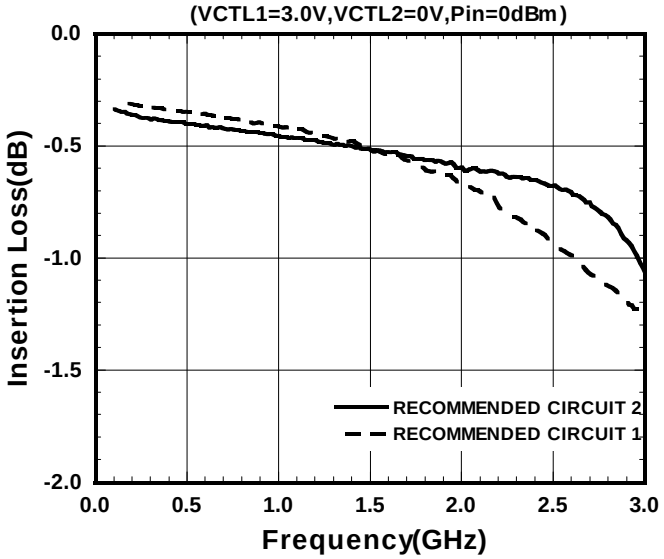
(f=1800MHz,Input Power=30dBm)



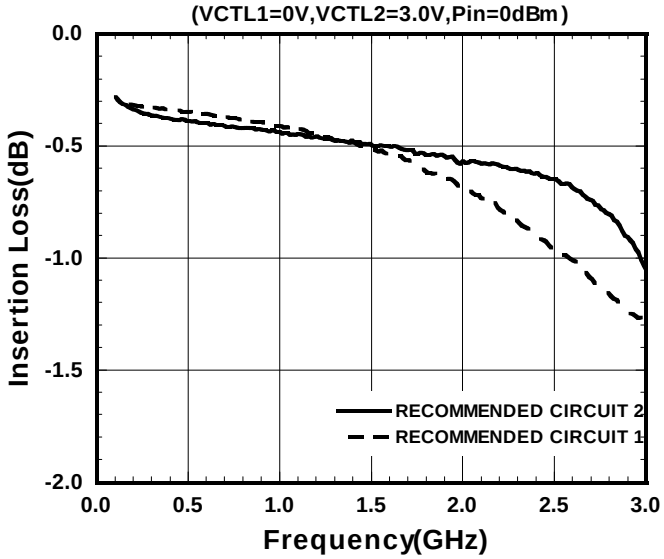
■ELECTRICAL CHARACTERISTICS

(f=50MHz~3.0GHz, with application circuit 2, losses of PCB, connector and DC blocking capacitor are excluded)

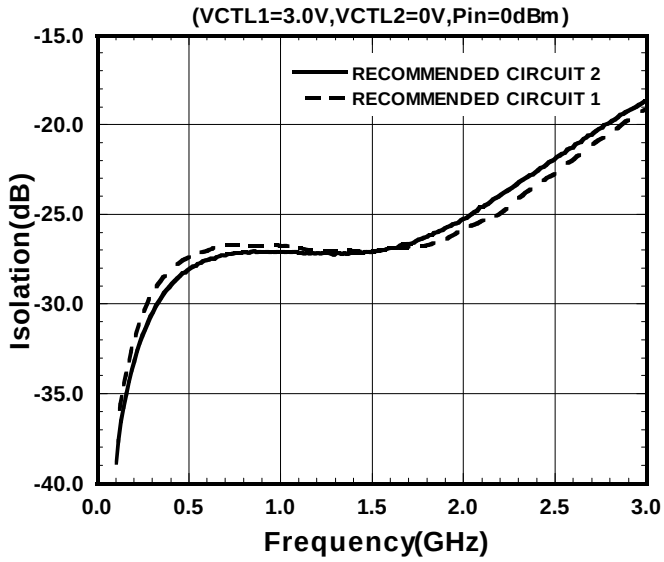
PC-P1 Insertion Loss vs. Frequency



PC-P2 Insertion Loss vs. Frequency



PC-P1 Isolation vs. Frequency

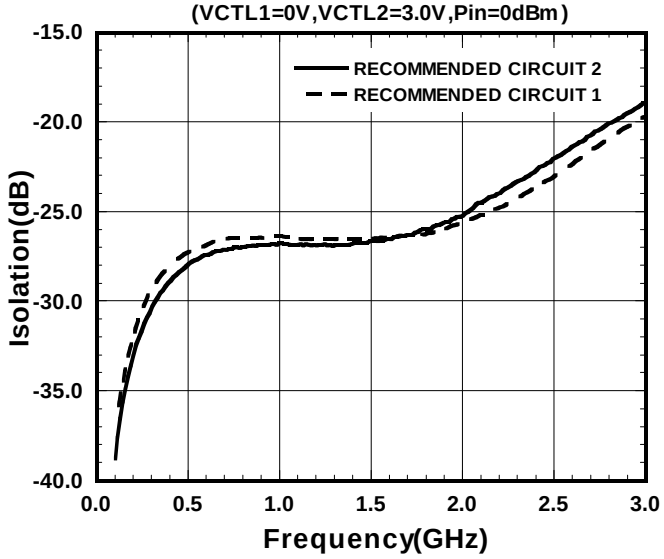


■ELECTRICAL CHARACTERISTICS

(f=50MHz~3.0GHz, with application circuit 2, losses of PCB, connector and DC blocking capacitor are excluded)

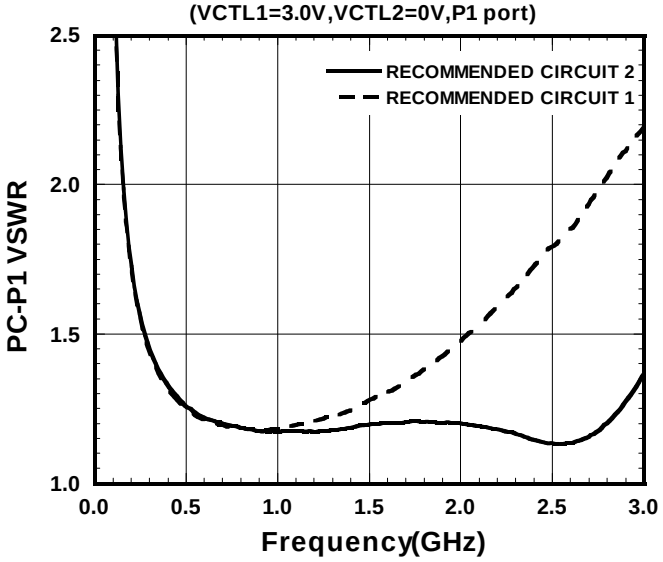
PC-P2 Isolation vs. Frequency

(VCTL1=0V,VCTL2=3.0V,Pin=0dBm)



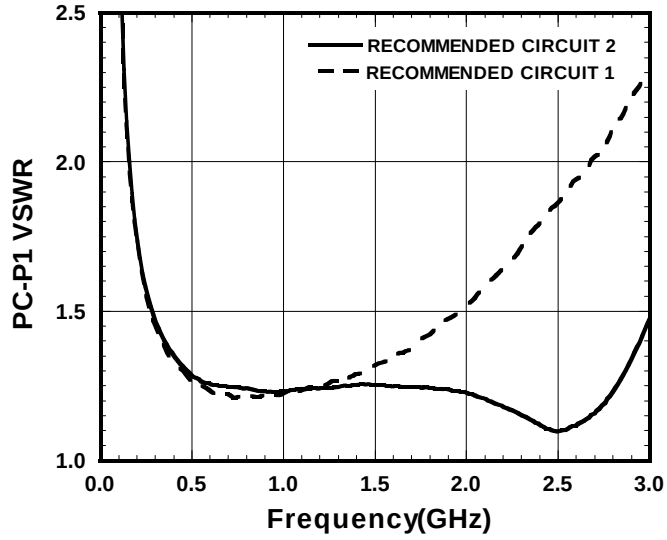
PC-P1 VSWR vs. Frequency

(VCTL1=3.0V,VCTL2=0V,P1 port)

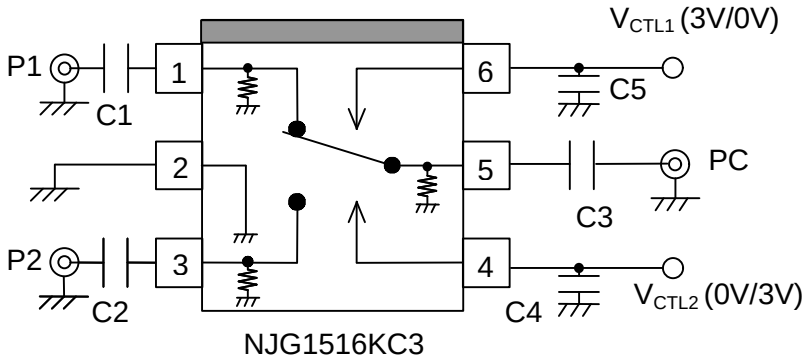


PC-P1 VSWR vs. Frequency

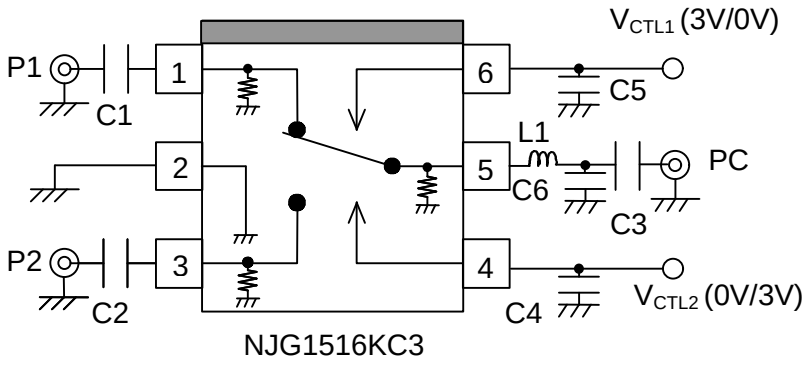
(VCTL1=3.0V,VCTL2=0V,DC cut=56pF,PC port)



■**APPLICATION CIRCUIT 1** (Parts list 1~3)



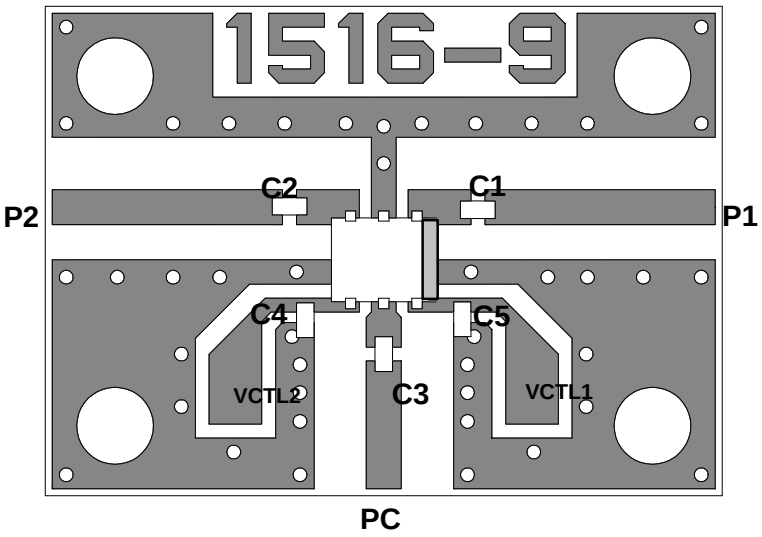
■**APPLICATION CIRCUIT 2** (for 2GHz or above, Parts list 4)



No.	List 1	List 2	List 3	List 4
	fin=50 ~100MHz	fin=0.1 ~0.5GHz	fin=0.5 ~2.0GHz	fin=2.0 ~2.5GHz
C1~C3	0.01uF	1000pF	56pF	56pF
C4, C5	10pF	10pF	10pF	10pF
C6	-	-	-	0.75pF
L1	-	-	-	2.2nH

■RECOMMENDED PCB DESIGN

(TOP VIEW)



PCB: FR-4, t=0.5mm
Capacitor: size 1005
Strip Line Width=1.0mm
PCB SIZE: 14.0x19.4mm

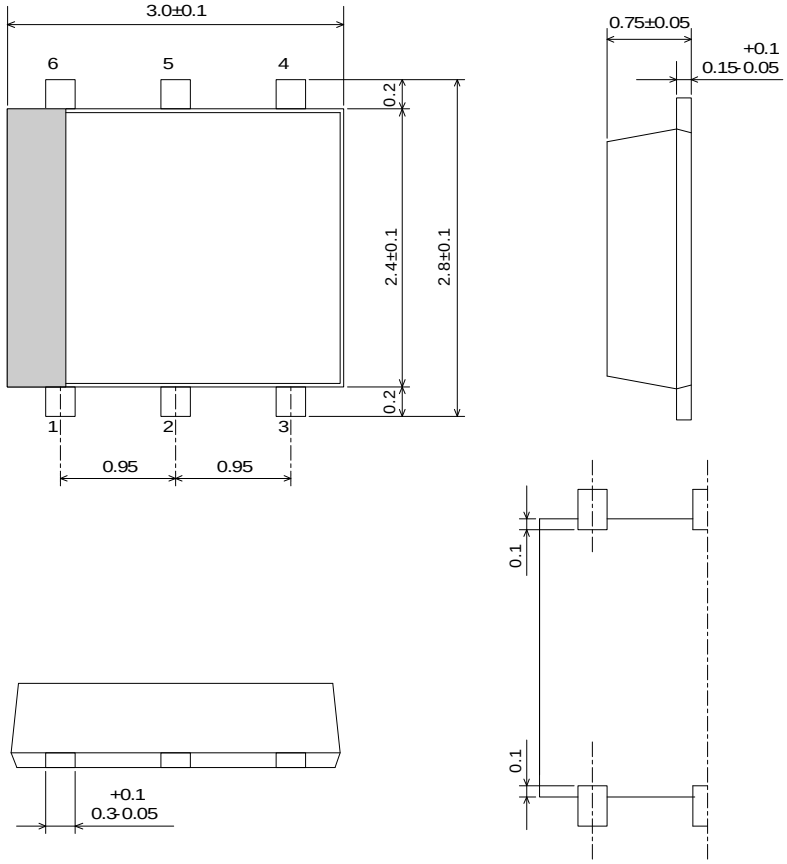
Circuit losses including losses of capacitors and connectors

freq[GHz]	LOSS[dB]
0.8	0.11
1.0	0.13
1.5	0.16
1.8	0.20
2.0	0.22
2.5	0.26

PRECAUTIONS

[1]The DC blocking capacitors have to be placed at RF terminal of P1, P2 and PC.
[2]Bypass capacitors (C4, C5) should be placed close to terminals of V_{CTL1}, V_{CTL2} to reduce stripline influence of RF characteristics.
[3]For good isolation, the GND terminal (2nd pin) must be placed possibly close to ground plane of substrate, and through holes for GND should be placed near by the pin connection.

■PACKAGE OUTLINE



Lead material : Copper
Lead surface finish : Solder plating
Molding material : Epoxy resin
UNIT : mm
Weight : 14mg

Cautions on using this product

This product contains Gallium-Arsenide (GaAs) which is a harmful material.

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.

[CAUTION]
The specifications on this databook are only given for information , without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.