

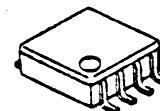
SPDT SWITCH GaAs MMIC

■GENERAL DESCRIPTION

NJG1507R is a GaAs SPDT switch IC which exhibits low loss and high isolation, and ideally suitable for T/R switch of the digital wireless phone.

This switch is operated in the wide frequency range from 50MHz to 3.0GHz at low operating voltage from +2.5V with small VSP8 package.

■PACKAGE OUTLINE



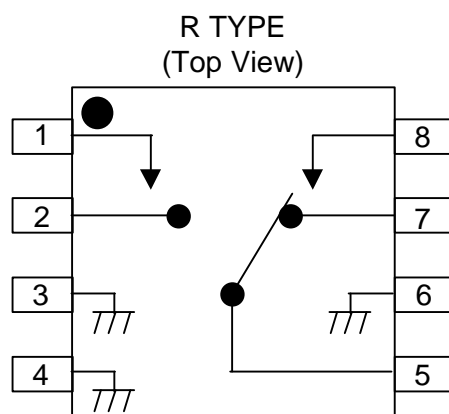
NJG1507R

■FEATURES

- Single and low positive supply voltage
- Low insertion loss
- Transmission power
- High isolation
- Low control current
- Package

+2.5~+5.5V
 0.5dB typ. @ f=2GHz, $P_{in}=22\text{dBm}$
 27dBm max. @ f=2GHz, $V_{CTL}=3.0\text{V}$
 33dB typ. @ f=2GHz, $P_{in}=22\text{dBm}$
 5uA typ. @ f=0.05~2.5GHz, $P_{in}=22\text{dBm}$
 VSP8 (Mount Size: 4.0x2.9x1.2mm)

■PIN CONFIGURATION



Pin Connection

1. V_{CTR2}
2. P2
3. GND
4. GND
5. PC
6. GND
7. P1
8. V_{CTR1}

■TRUTH TABLE

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

| | | | | |
|------------|-----|-----|---------------------------------------|---------------------------------------|
| V_{CTR1} | H | L | L | H |
| V_{CTR2} | L | H | L | H |
| P1-PC | OFF | ON | Loss =15dB P_1 Return Loss =-3dB | Loss =16dB P_1 Return Loss =-2dB |
| P2-PC | ON | OFF | Loss =15dB P_2 Return Loss =-3dB | Loss =16dB P_2 Return Loss =-2dB |

Note) The values of "Loss" and "Return Loss" are typical values at 2.0GHz.

NJG1507R

■ABSOLUTE MAXIMUM RATINGS

($T_a=25^{\circ}\text{C}$, $Z_s=Z_l=50\Omega$)

| PARAMETER | SYMBOL | RATINGS | UNITS |
|-------------------|-----------|----------|--------------------|
| Input power | P_{in} | 33 | dBm |
| Control voltage | V_{CTR} | 6.0 | V |
| Power dissipation | P_D | 320 | mW |
| Operating Temp. | T_{opr} | -30~+85 | $^{\circ}\text{C}$ |
| Storage Temp. | T_{stg} | -40~+150 | $^{\circ}\text{C}$ |

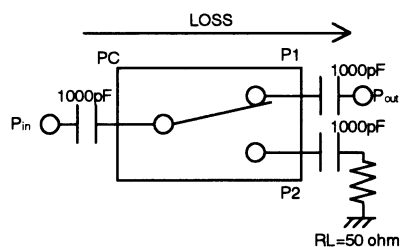
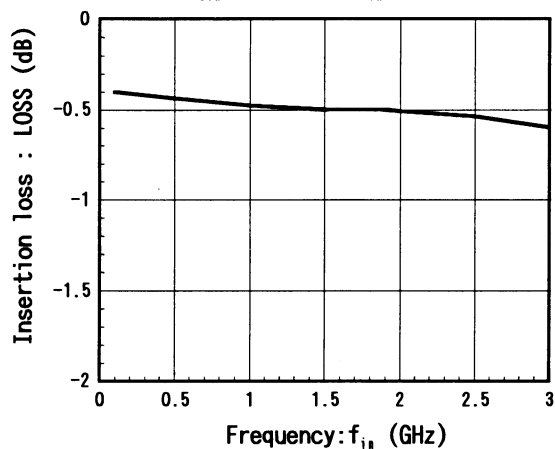
■ELECTRICAL CHARACTERISTICS

($V_{CTR(L)}=0\text{V}$, $V_{CTR(H)}=2.7\text{V}$, $Z_s=Z_o=50\Omega$, $T_a=25^{\circ}\text{C}$)

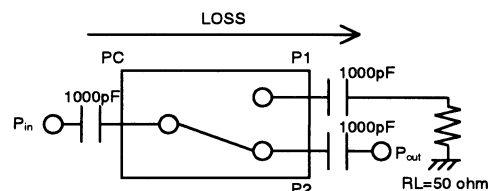
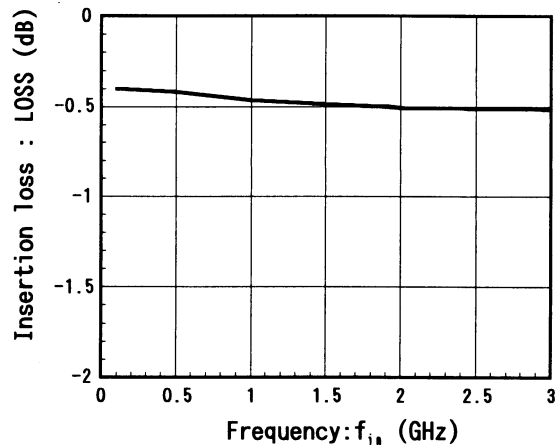
| PARAMETER | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|--------------------------------------|----------------------|--|------|-----|-----|---------------|
| Control voltage (L) | $V_{CTR(L)}$ | $f=0.05\sim 2.5\text{GHz}$, $P_{in}=22\text{dBm}$ | -0.2 | 0 | 0.2 | V |
| Control voltage (H) | $V_{CTR(H)}$ | $f=0.05\sim 2.5\text{GHz}$, $P_{in}=22\text{dBm}$ | 2.5 | 2.7 | 5.5 | V |
| Control current | I_{CTR} | $f=0.05\sim 2.5\text{GHz}$, $P_{in}=22\text{dBm}$ | - | 5.0 | 8.0 | μA |
| Insertion loss1 | LOSS1 | $f=1.0\text{GHz}$, $P_{in}=22\text{dBm}$ | - | 0.4 | 0.7 | dB |
| Insertion loss2 | LOSS2 | $f=2.0\text{GHz}$, $P_{in}=22\text{dBm}$ | - | 0.5 | 0.8 | dB |
| Isolation 1 (PC-P1, PC-P2, P1-P2) | ISL1 | $f=1.0\text{GHz}$, $P_{in}=22\text{dBm}$ | 25 | 31 | - | dB |
| Isolation 2 (PC-P1, PC-P2, P1-P2) | ISL2 | $f=2.0\text{GHz}$, $P_{in}=22\text{dBm}$ | 25 | 33 | - | dB |
| Pin at 1dB compression point 1 | $P_{-1\text{dB}(1)}$ | $f=2.0\text{GHz}$ | 26 | 28 | - | dBm |
| Pin at 1dB compression point 2 | $P_{-1\text{dB}(2)}$ | $V_{CTR(H)}=3.0\text{V}$, $f=2.0\text{GHz}$ | 27 | 30 | - | dBm |
| VSWR | VSWR | $f=0.05\sim 2.5\text{GHz}$, ON STATE | - | 1.2 | 1.5 | |
| Switching time | T_{SW} | $f=0.05\sim 2.5\text{GHz}$ | - | 15 | - | ns |

■ TYPICAL CHARACTERISTICS

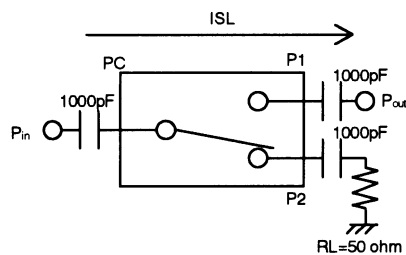
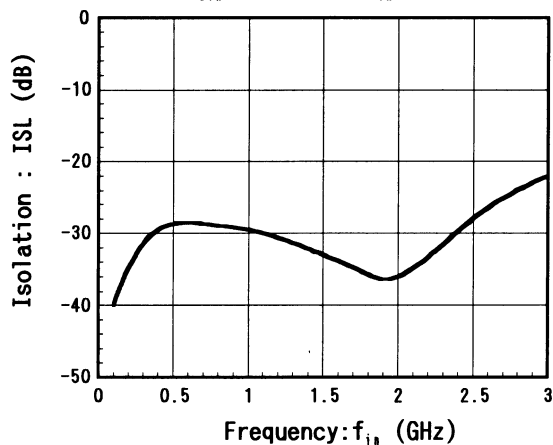
(PC-P1) Insertion loss vs. Frequency
($V_{CTX}=0V/2.7V$, $P_{iA}=22dBm$)



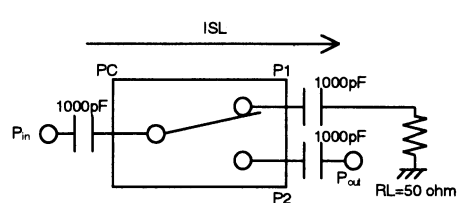
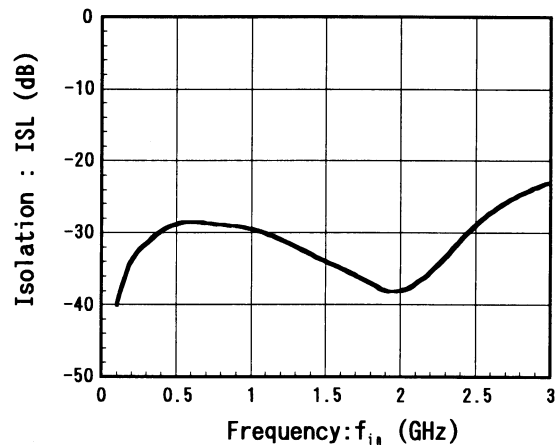
(PC-P2) Insertion loss vs. Frequency
($V_{CTX}=0V/2.7V$, $P_{iA}=22dBm$)



(PC-P1) Isolation vs. Frequency
($V_{CTX}=0V/2.7V$, $P_{iA}=22dBm$)



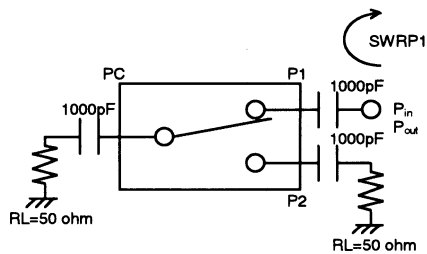
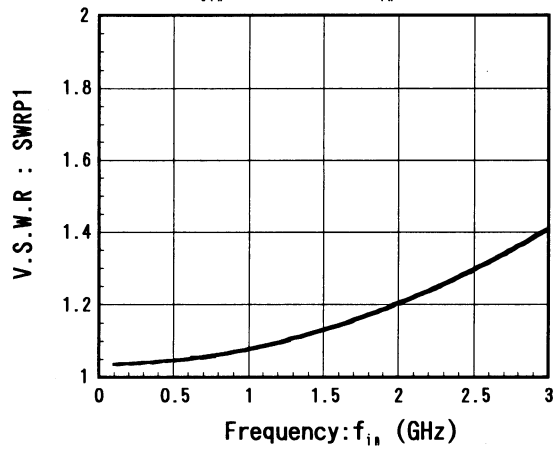
(PC-P2) Isoaltion vs. Frequency
($V_{CTX}=0V/2.7V$, $P_{iA}=22dBm$)



■ TYPICAL CHARACTERISTICS

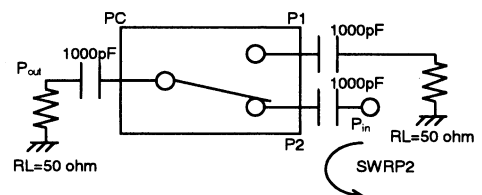
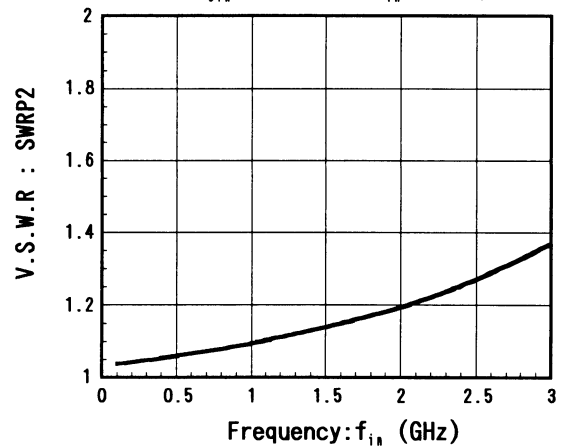
P1-PC(ON) V.S.W.R vs. Frequency

($V_{CTH}=0V/2.7V$, $P_{iA}=0dBm$)



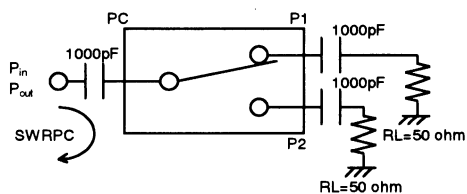
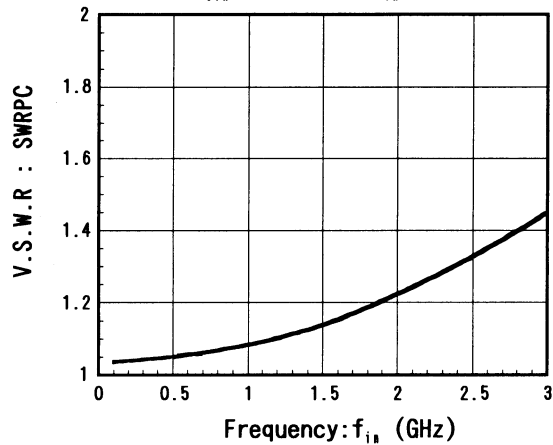
PC-P2(ON) V.S.W.R vs. Frequency

($V_{CTH}=0V/2.7V$, $P_{iA}=0dBm$)

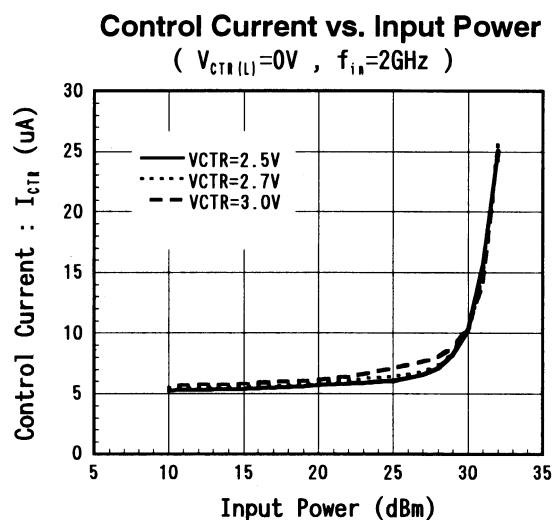
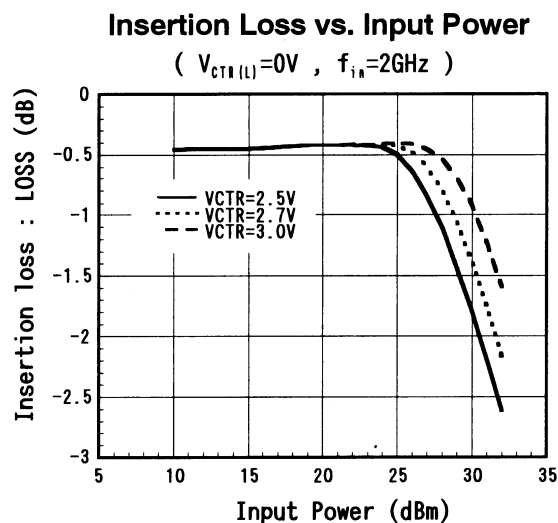
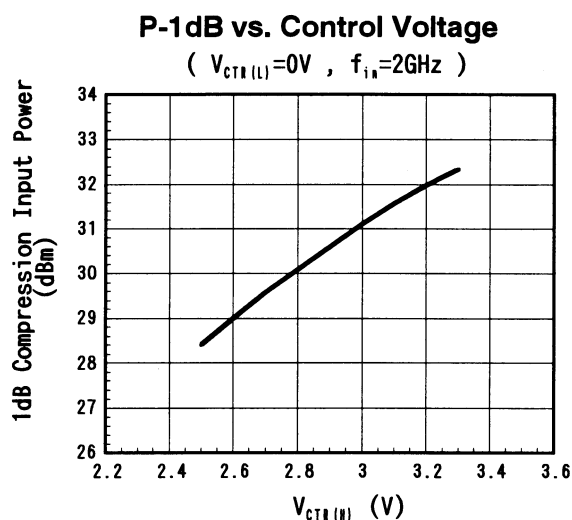
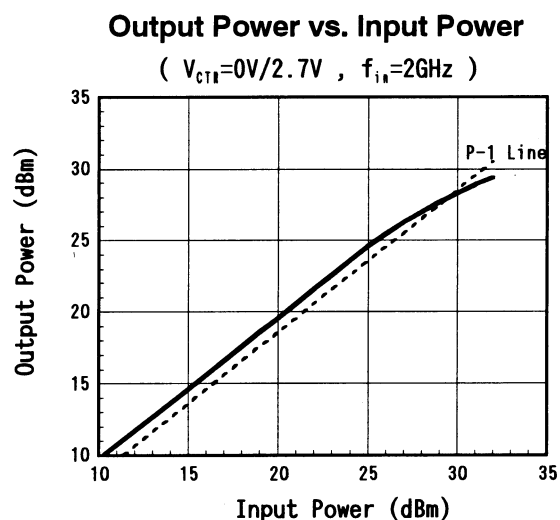
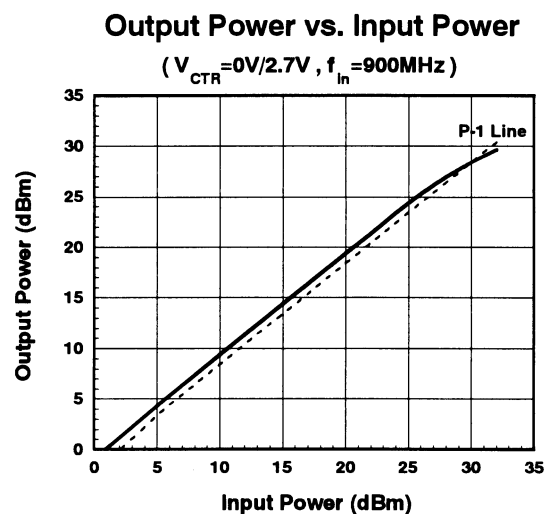
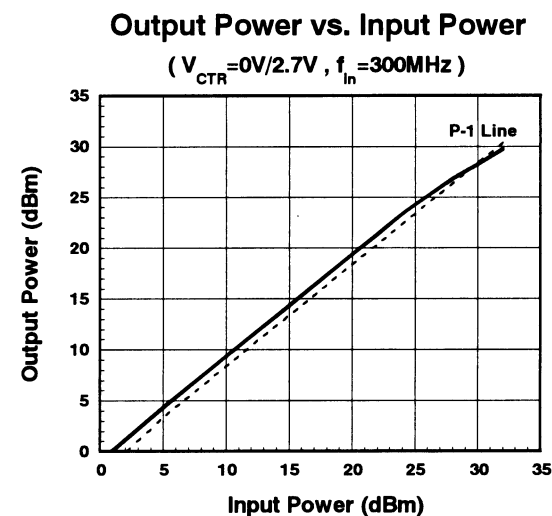


PC-P1(ON) V.S.W.R vs. Frequency

($V_{CTH}=0V/2.7V$, $P_{iA}=0dBm$)



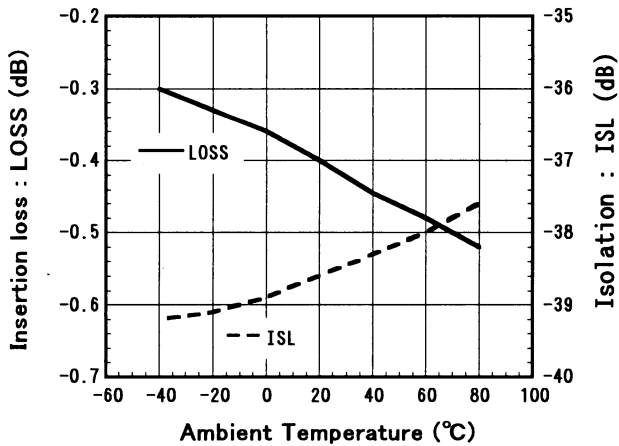
■ TYPICAL CHARACTERISTICS



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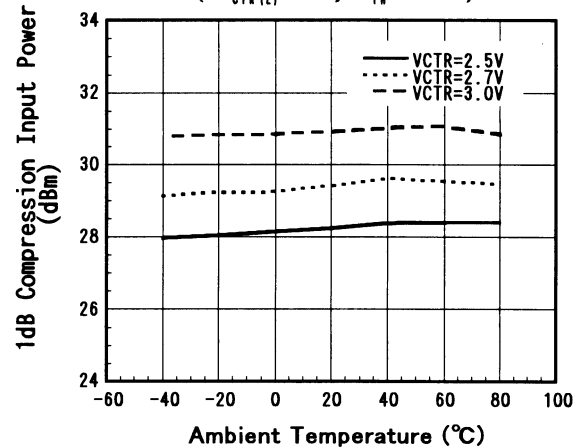
Loss/Isolation vs. Temperature

($V_{CTR}=0V/2.7V$, $f_{in}=2GHz$)



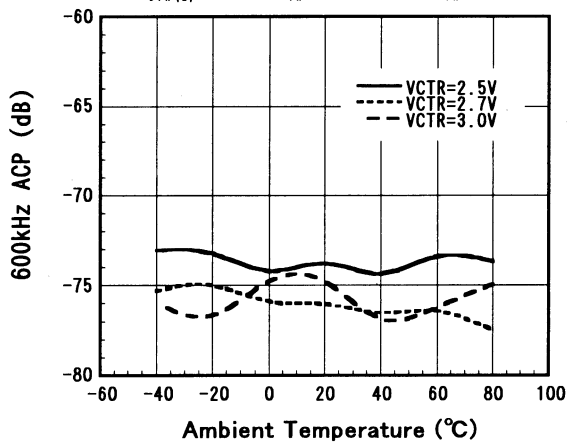
P-1dB vs. Temperature

($V_{CTR(L)}=0V$, $f_{in}=2GHz$)



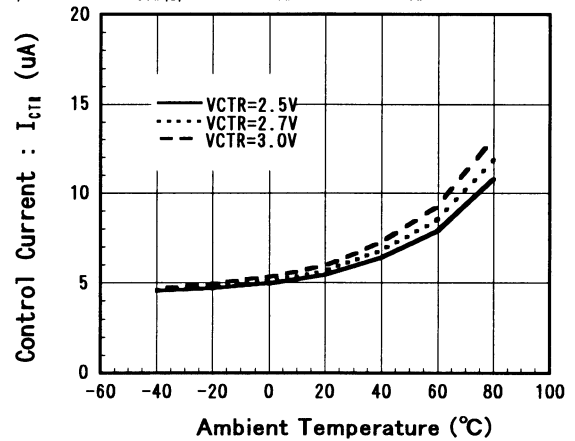
600kHz ACP vs. Temperature

($V_{CTR(L)}=0V$, $f_{in}=1.9GHz$, $P_{in}=22dBm$)



Control Current vs. Temperature

($V_{CTR(L)}=0V$, $f_{in}=2GHz$, $P_{in}=22dBm$)



TYPICAL CHARACTERISTICS

600kHz ACP (Ta=25°C)

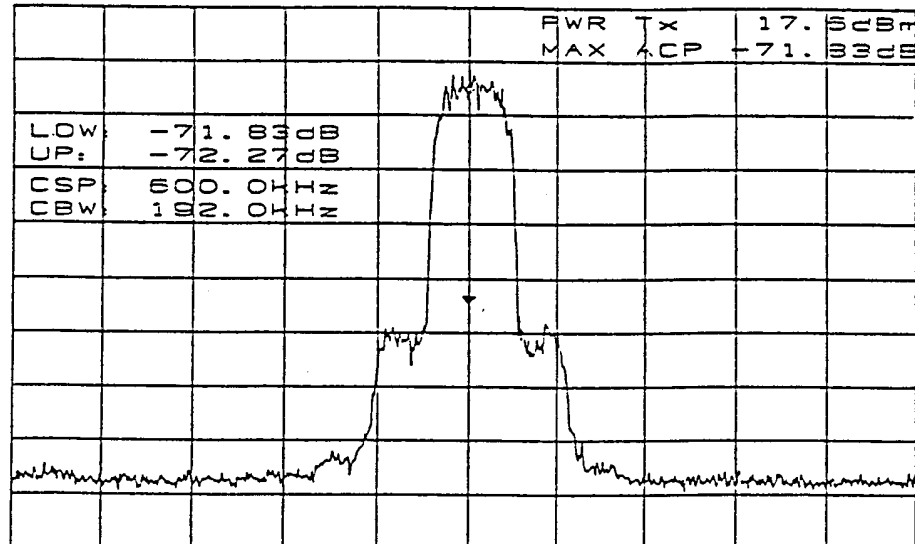
DQPSK Modulation Signal (without D.U.T)

$f_{in}=1.9\text{GHz}$ $P_{in}=22\text{dBm}$

MODULATION: 384Kbps RNYQ $\alpha=0.5$ $1/4 \pi$ DQPSK

→ATTEN 20dB

RL 10.0dBm 10dB/



CENTER 1.900000GHz SPAN 3.000MHz
→RBW 1.0KHz →VBW 10KHz →SWP 10.2sec

D.U.T Output Signal

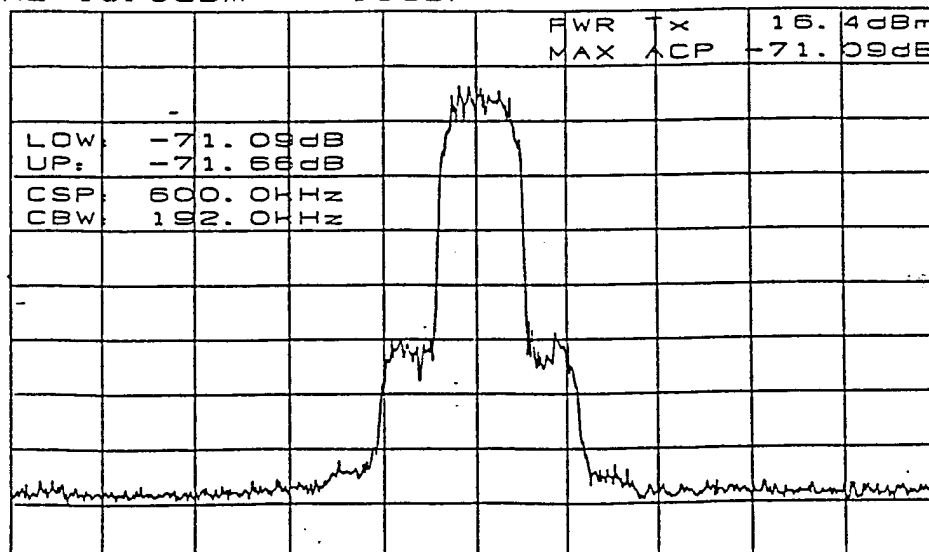
Insertion PORT: PC → P1

$f_{in}=1.9\text{GHz}$ $P_{in}=22\text{dBm}$ $V_{CTR}=0/2.7\text{V}$

MODULATION: 384Kbps RNYQ $\alpha=0.5$ $1/4 \pi$ DQPSK

→ATTEN 20dB

RL 10.0dBm 10dB/



CENTER 1.900000GHz SPAN 3.000MHz
→RBW 1.0KHz →VBW 10KHz SWP 7.50sec

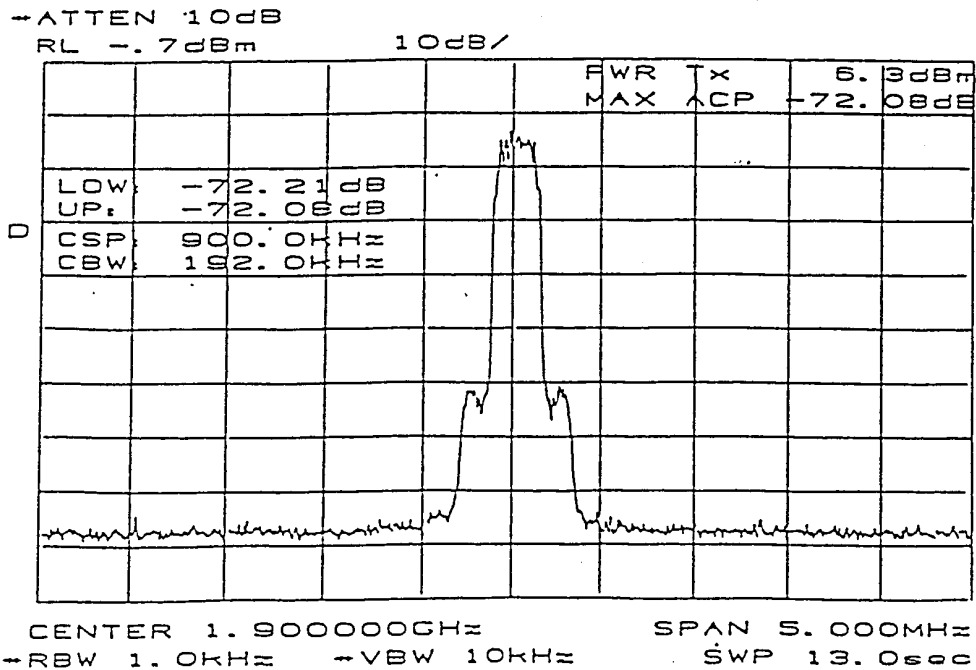
TYPICAL CHARACTERISTICS

900kHz ACP (Ta=25°C)

Insertion PORT: PC → P1

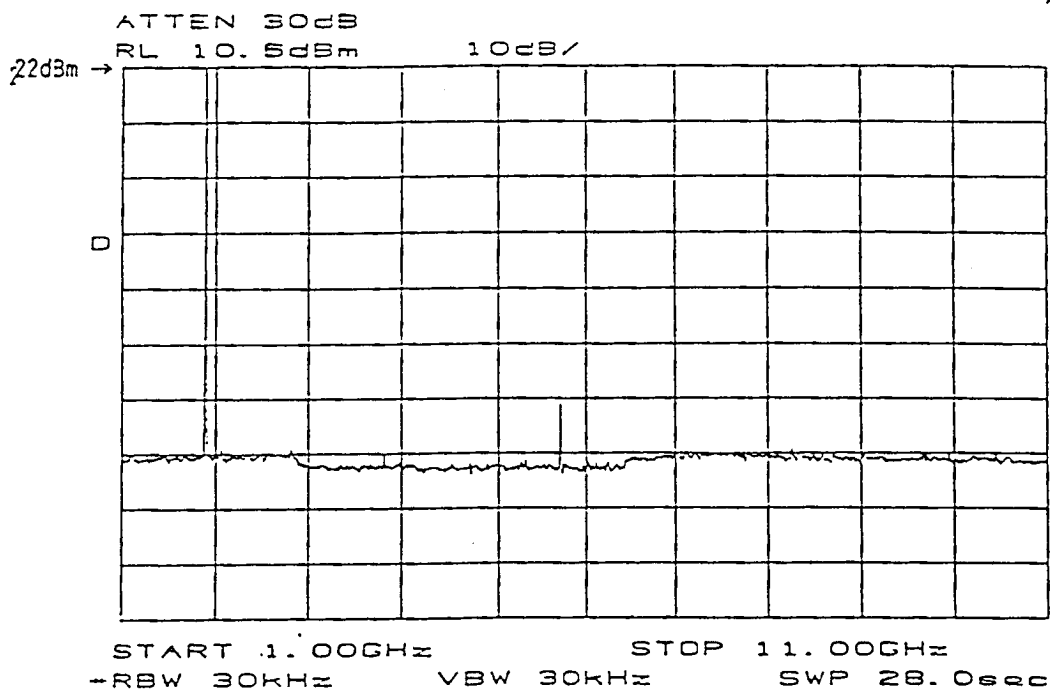
f_{in} =1.9GHz P_{in} =22dBm V_{CTR} =0/2.7V

MODULATION: 384Kbps RNYQ α =0.5 1/4 π DQPSK



Harmonics (Ta=25°C)

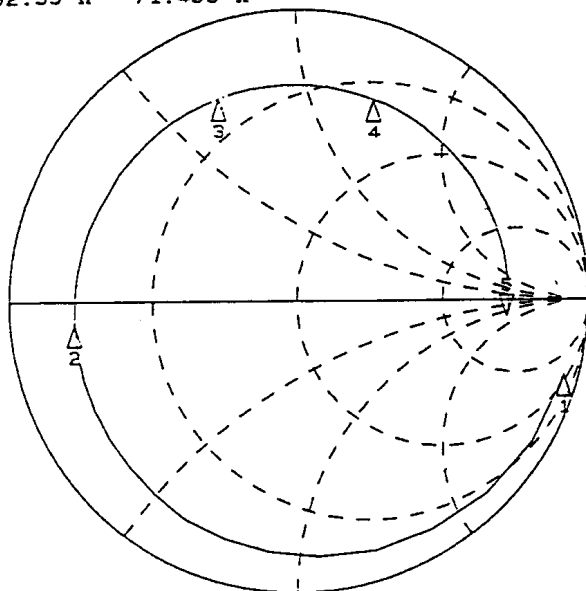
f_{in} =1.9GHz P_{in} =22dBm $V_{CTR(H)}$ =2.7V



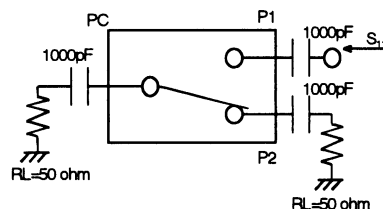
TYPICAL CHARACTERISTICS

P1 PORT IMPEDANCE (OFF STATE)

REF 1.0 Units
S 200.0 mUnits/
V 292.59 Ω -71.453 $^\circ$



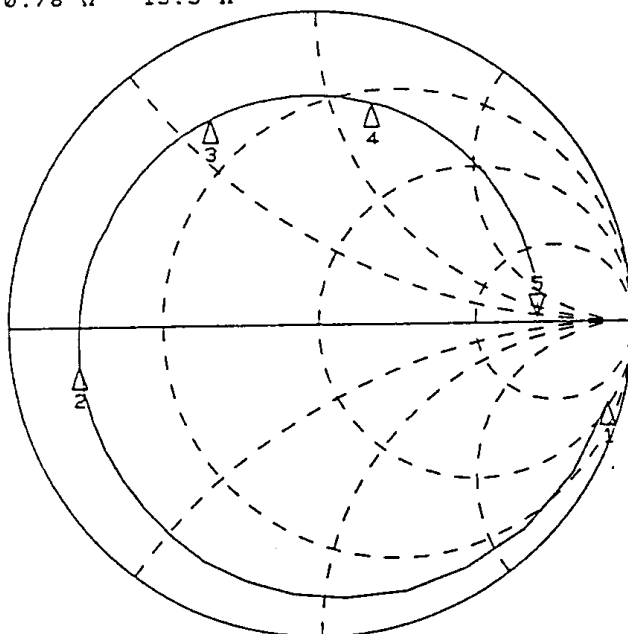
START 0.050000000 GHz
STOP 3.000000000 GHz



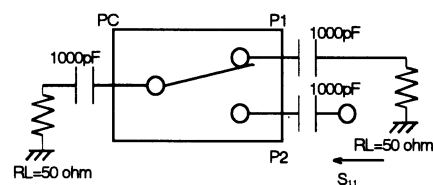
| MARKER | f(MHz) | Mag. | Ang. ($^\circ$) |
|--------|--------|-------|-------------------|
| 1 | 50 | 0.952 | -15.9 |
| 2 | 800 | 0.780 | -171.0 |
| 3 | 1500 | 0.740 | 117.0 |
| 4 | 2000 | 0.726 | 75.8 |
| 5 | 3000 | 0.698 | 1.2 |

P2 PORT IMPEDANCE (OFF STATE)

REF 1.0 Units
S 200.0 mUnits/
V 280.78 Ω 15.5 $^\circ$



START 0.050000000 GHz
STOP 3.000000000 GHz



| MARKER | f(MHz) | Mag. | Ang. ($^\circ$) |
|--------|--------|-------|-------------------|
| 1 | 50 | 0.952 | -15.9 |
| 2 | 800 | 0.780 | -171.0 |
| 3 | 1500 | 0.740 | 117.0 |
| 4 | 2000 | 0.726 | 75.8 |
| 5 | 3000 | 0.698 | 1.2 |

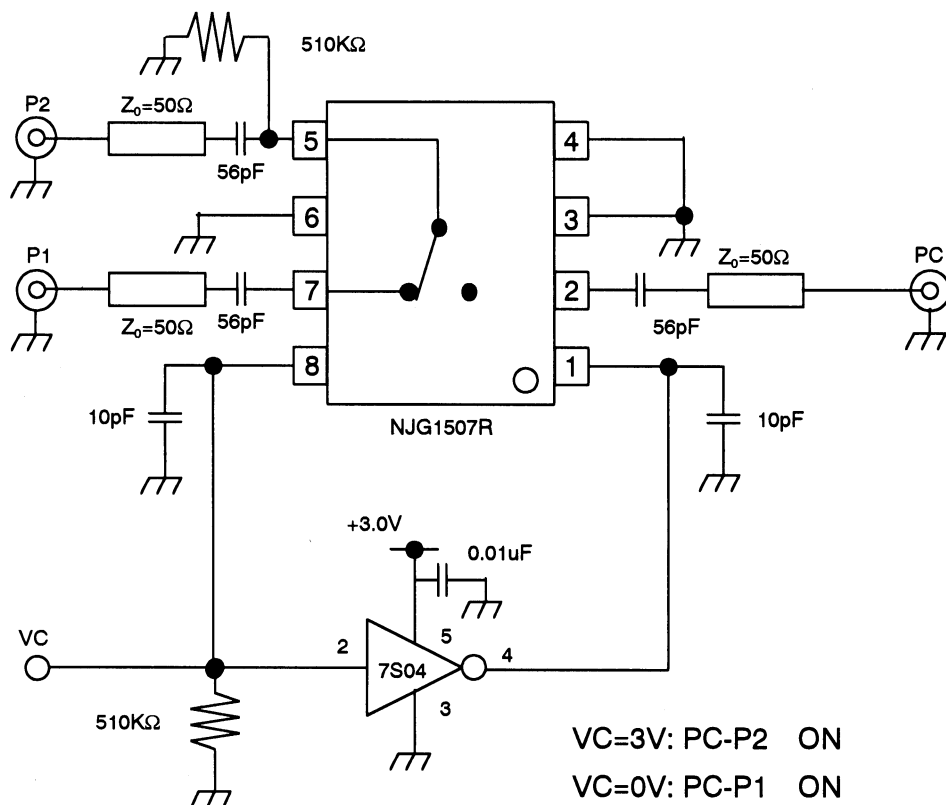
■TYPICAL CHARACTERISTICS

Scattering Parameters: S11 (OFF STATE)

($V_{CTR}=0/2.7V$, 50Ω System)

| f(MHz) | P1 PORT | | P2 PORT | |
|--------|---------|------------------------|---------|------------------------|
| | Mag. | Ang.(\angle°) | Mag. | Ang.(\angle°) |
| 50 | 0.951 | -15.8 | 0.952 | -15.9 |
| 100 | 0.941 | -30.9 | 0.938 | -31.0 |
| 200 | 0.911 | -59.2 | 0.911 | -59.2 |
| 300 | 0.879 | -84.9 | 0.877 | -84.6 |
| 400 | 0.849 | -107.4 | 0.850 | -106.7 |
| 500 | 0.823 | -127.2 | 0.824 | -126.0 |
| 600 | 0.803 | -144.6 | 0.805 | -142.8 |
| 700 | 0.787 | -160.1 | 0.791 | -157.6 |
| 800 | 0.777 | -174.1 | 0.780 | -171.0 |
| 900 | 0.768 | 173.1 | 0.770 | 176.8 |
| 1000 | 0.761 | 161.2 | 0.763 | 165.5 |
| 1100 | 0.750 | 149.6 | 0.749 | 154.2 |
| 1200 | 0.751 | 139.8 | 0.749 | 144.7 |
| 1300 | 0.748 | 129.7 | 0.745 | 135.1 |
| 1400 | 0.748 | 120.1 | 0.744 | 125.9 |
| 1500 | 0.745 | 110.9 | 0.740 | 117.0 |
| 1600 | 0.746 | 102.1 | 0.737 | 108.5 |
| 1700 | 0.743 | 93.6 | 0.732 | 100.3 |
| 1800 | 0.742 | 85.1 | 0.732 | 91.9 |
| 1900 | 0.740 | 76.9 | 0.728 | 83.7 |
| 2000 | 0.739 | 68.9 | 0.726 | 75.8 |
| 2100 | 0.740 | 61.3 | 0.725 | 68.3 |
| 2200 | 0.739 | 53.3 | 0.723 | 60.5 |
| 2300 | 0.735 | 45.8 | 0.718 | 52.7 |
| 2400 | 0.735 | 38.4 | 0.717 | 45.2 |
| 2500 | 0.736 | 30.8 | 0.714 | 37.7 |
| 2600 | 0.732 | 23.8 | 0.711 | 30.5 |
| 2700 | 0.734 | 17.0 | 0.708 | 23.4 |
| 2800 | 0.729 | 9.5 | 0.706 | 15.8 |
| 2900 | 0.727 | 2.5 | 0.703 | 8.6 |
| 3000 | 0.721 | -4.6 | 0.698 | 1.2 |

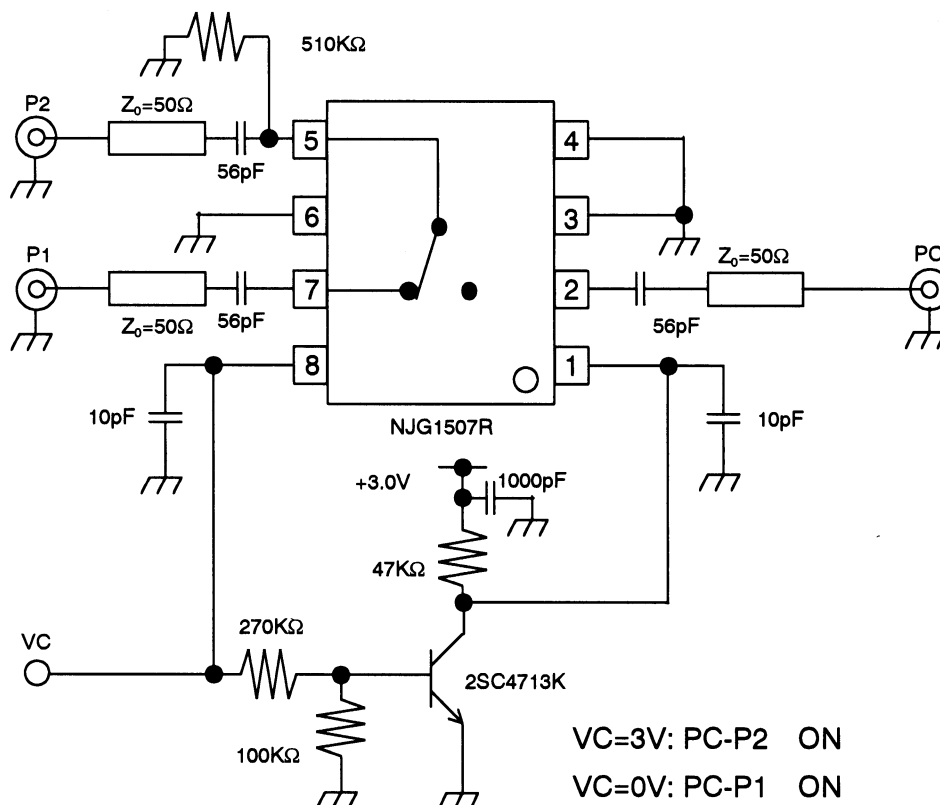
■APPLICATION CIRCUIT 1: Single control signal operation by using C-MOS inverter.



[1] Please connect bypass capacitors to the supply terminals of the C-MOS inverter.

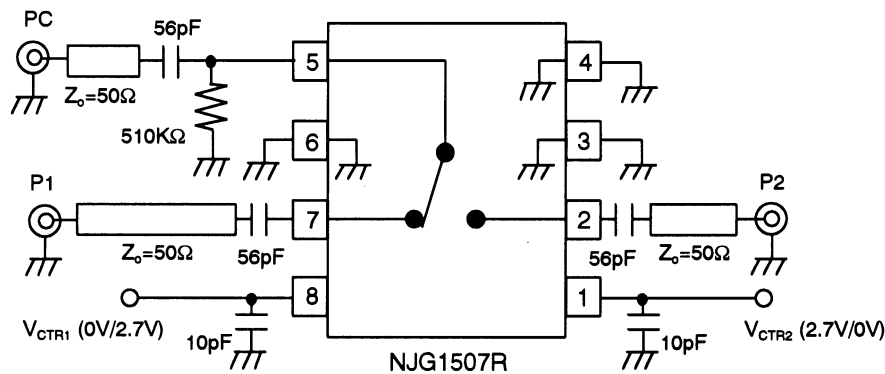
[2] In order to stabilize input impedance of inverter, please pull down using 510KΩ resistor from the input terminal of the C-MOS inverter to the ground plane.

■APPLICATION CIRCUIT 2: Single control signal operation by using a transistor.

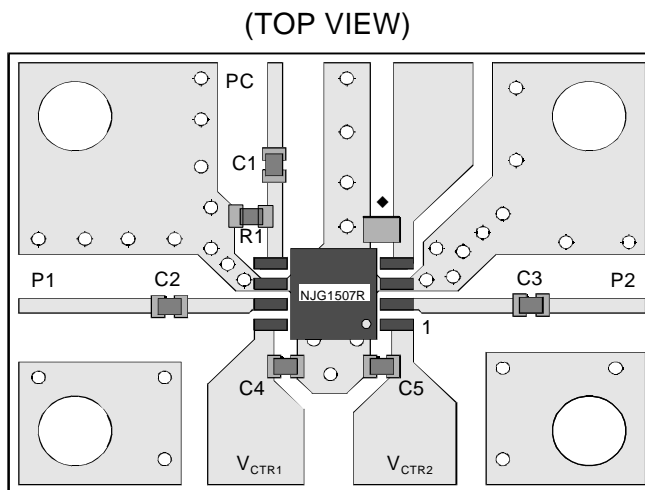


NJG1507R

■TEST CIRCUIT



■RECOMMENDED PCB DESIGN



PCB SIZE=19.5x14.0mm

PCB: FR-4, t=0.2mm

CAPACITOR: size 1005

STRIPLINE WIDTH=0.5mm

C1~C3: 56pF

C4, C5: 10pF

R1: 510KΩ

◆: Please short between Pin4 and ground plane directly as close as possible.

Precautions

- [1] External capacitors should be connected to the input and output RF terminals (P1, P2, PC) to block the DC current. The above example is a circuit at 1.9GHz. Please select the capacitor value suitable for actual frequency from 10pF to 1000pF.
- [2] Decoupling capacitors should be connected to the control terminals (V_{CTR1} , V_{CTR2}) as close as possible. The values of these capacitors should be selected from 5pF to 100pF range. Please consider that these values are very effective to switching time (Larger capacitor gives longer switching time).
- [3] In order to keep good isolation characteristics, the ground terminals (3, 4, 6pin) should be connected to the ground pattern with wider width as close as possible, and through-hole in the ground plane should also be placed as close as possible.

