

# GaAs SPDT SWITCH IC

## ■ GENERAL DESCRIPTION

NJG1506R is a GaAs SPDT switch IC featuring a low loss, a high isolation and a low control current.

In the wide frequency range from 100MHz to 3GHz, this IC operates at a low voltage from 2.5V.

A very small package is adopted.

It is suited for the switch in receiving circuit of RF frequency of cellular radio system.

## ■ PACKAGE OUTLINE



NJG1506R

## ■ FEATURES

- Single and low control voltage
- Low insertion loss
- High isolation
- Passing power
- Low control current
- Small package

+2.5~+5.5V

0.3dB Typ. @f=1GHz,  $P_{in}=0dBm$

28dB Typ. @f=1GHz,  $P_{in}=0dBm$

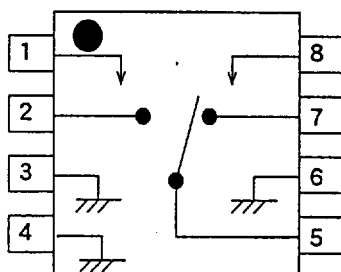
19dBm MAX. @f=2GHz,  $V_{CTR}=3.0V$

1uA Typ. @f=0.1~2.5GHz,  $P_{in}=10dBm$

VSP8

## ■ PIN CONFIGURATION

R TYPE  
(Top View)



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<br>$P_1$ Return Loss=-3dB | LOSS=16dB<br>$P_1$ Return Loss=-2dB |
| P2-PC      | ON  | OFF | LOSS=15dB<br>$P_2$ Return Loss=-3dB | LOSS=16dB<br>$P_2$ Return Loss=-2dB |

NOTE) The values of "LOSS" and "Return Loss" are typical values.


**■ ABSOLUTE MAXIMUM RATING**
 $(T_a=25^{\circ}\text{C})$ 

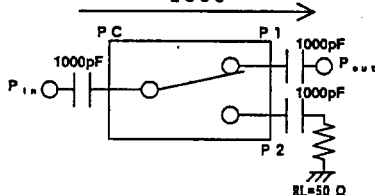
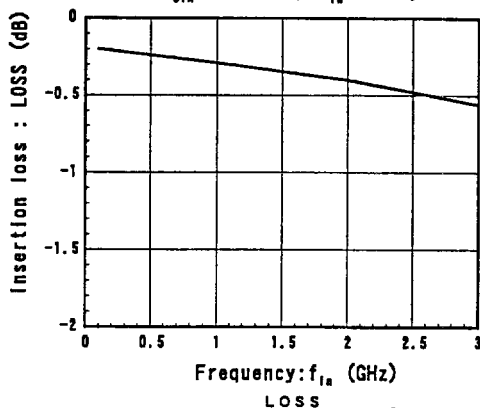
| PARAMETER         | SYMBOL    | RATINGS    | UNIT               |
|-------------------|-----------|------------|--------------------|
| Input power       | $P_{in}$  | 28         | dBm                |
| Control voltage   | $V_{CTR}$ | 6          | V                  |
| Power dissipation | $P_D$     | 320        | mW                 |
| Operating Temp.   | $T_{opr}$ | -30 ~ +85  | $^{\circ}\text{C}$ |
| Storage Temp.     | $T_{stg}$ | -40 ~ +150 | $^{\circ}\text{C}$ |

**■ ELECTRICAL CHARACTERISTICS**
 $(V_{CTR(L)}=0\text{V}, V_{CTR(H)}=2.7\text{V}, Z_S=Z_O=50\Omega, T_a=25^{\circ}\text{C})$ 

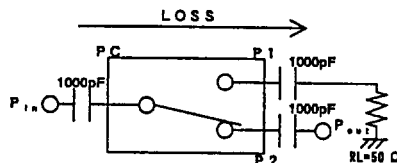
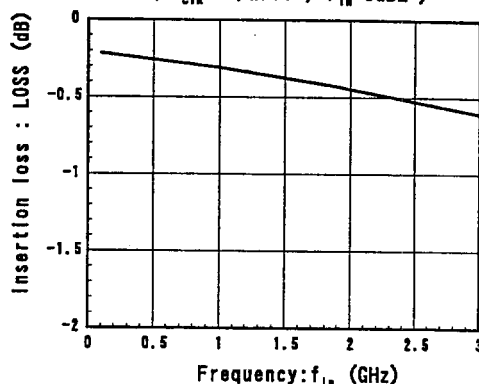
| PARAMETER                           | SYMBOL            | CONDITION                                      | MIN  | TYP | MAX | UNIT          |
|-------------------------------------|-------------------|------------------------------------------------|------|-----|-----|---------------|
| Control voltage(L)                  | $V_{CTR(L)}$      | $f=0.1\sim 2.5\text{GHz}, P_{in}=10\text{dBm}$ | -0.2 | 0   | 0.2 | V             |
| Control voltage(H)                  | $V_{CTR(H)}$      | $f=0.1\sim 2.5\text{GHz}, P_{in}=10\text{dBm}$ | 2.5  | 2.7 | 5.5 | V             |
| Control current                     | $I_{CTR}$         | $f=0.1\sim 2.5\text{GHz}, P_{in}=10\text{dBm}$ | —    | 1.0 | 2.0 | $\mu\text{A}$ |
| Insertion loss1                     | LOSS1             | $f=1\text{GHz}, P_{in}=0\text{dBm}$            | —    | 0.3 | 0.6 | dB            |
| Insertion loss2                     | LOSS2             | $f=2\text{GHz}, P_{in}=0\text{dBm}$            | —    | 0.5 | 0.8 | dB            |
| Isolation1<br>(PC-P1, PC-P2, P1-P2) | ISL1              | $f=1\text{GHz}, P_{in}=0\text{dBm}$            | 25   | 28  | —   | dB            |
| Isolation2<br>(PC-P1, PC-P2, P1-P2) | ISL2              | $f=2\text{GHz}, P_{in}=0\text{dBm}$            | 23   | 27  | —   | dB            |
| Input power at<br>1dB compression   | $P_{-1\text{dB}}$ | $f=2\text{GHz}$                                | 19   | 22  | —   | dBm           |
| VSWR<br>(PC, P1, P2)                | VSWR              | $f=0.1\sim 2.5\text{GHz}, \text{ON STATE}$     | —    | 1.2 | 1.5 |               |
| Switching Speed                     | $T_{sw}$          | $f=0.1\sim 2.5\text{GHz}$                      | —    | 15  | —   | ns            |

## ■ CHARACTERISTICS

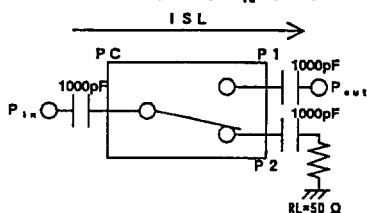
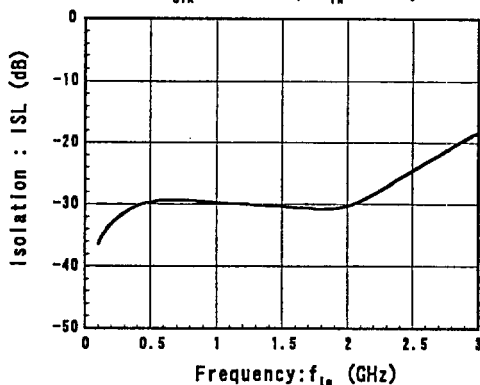
(PC-P1) Insertion loss vs. Frequency  
( $V_{CTR}=0V/2.7V$ ,  $P_{IN}=0dBm$ )



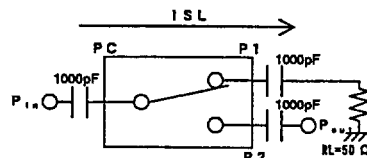
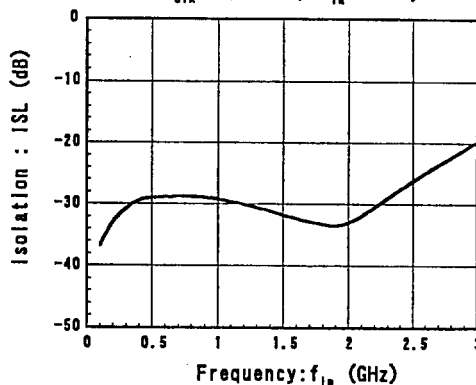
(PC-P2) Insertion loss vs. Frequency  
( $V_{CTR}=0V/2.7V$ ,  $P_{IN}=0dBm$ )



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



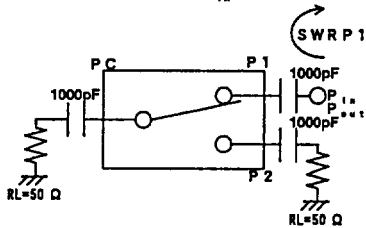
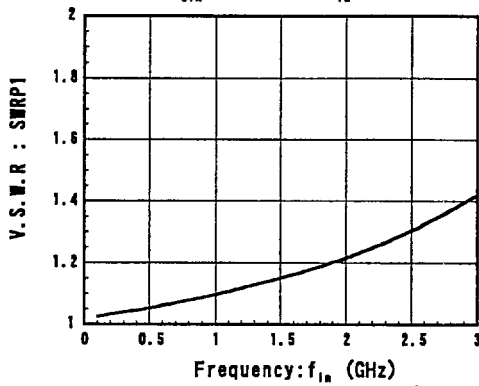
(PC-P2) Isolation vs. Frequency  
( $V_{CTR}=0V/2.7V$ ,  $P_{IN}=0dBm$ )



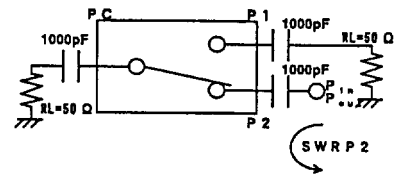
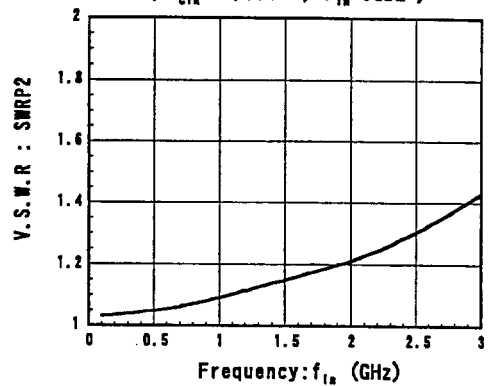


■ CHARACTERISTICS

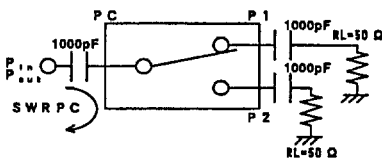
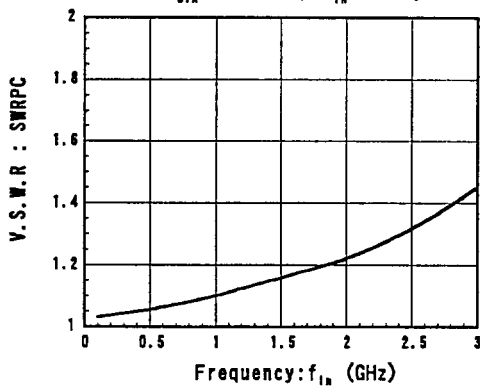
**P1-PC(ON) V.S.W.R vs. Frequency**  
(  $V_{CTR}=0V/2.7V$  ,  $P_{IN}=0dBm$  )



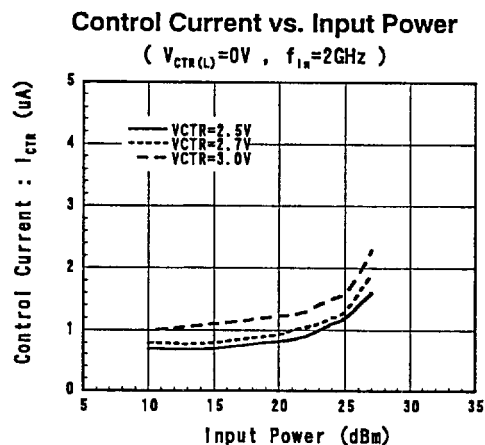
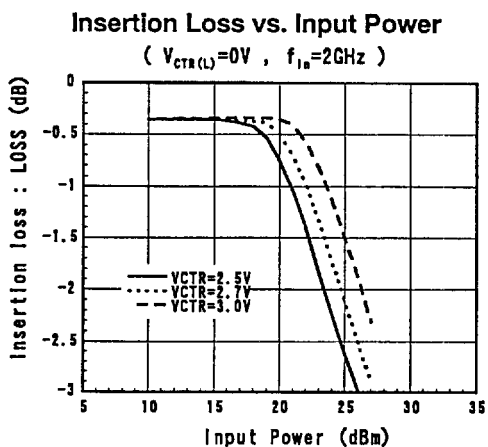
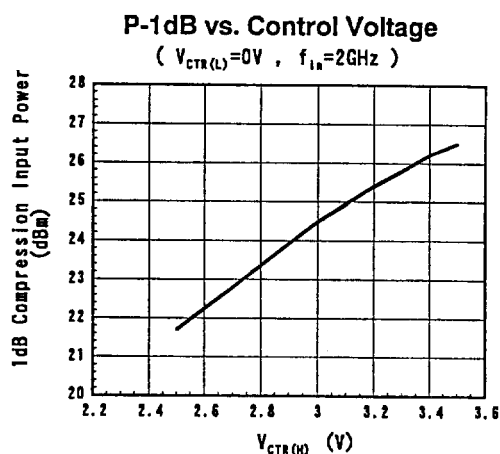
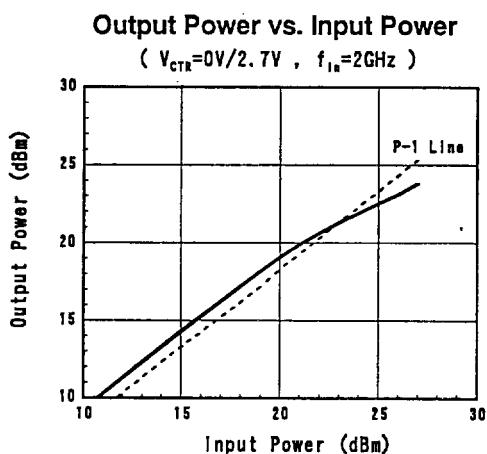
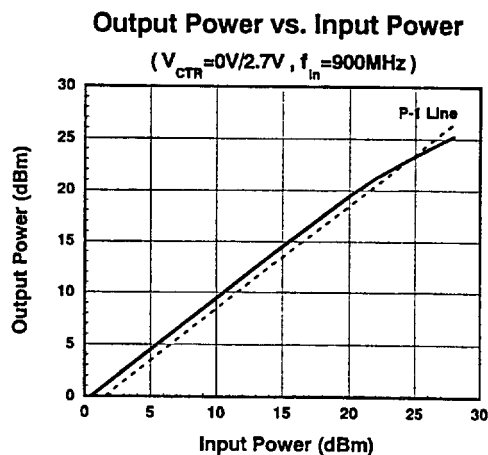
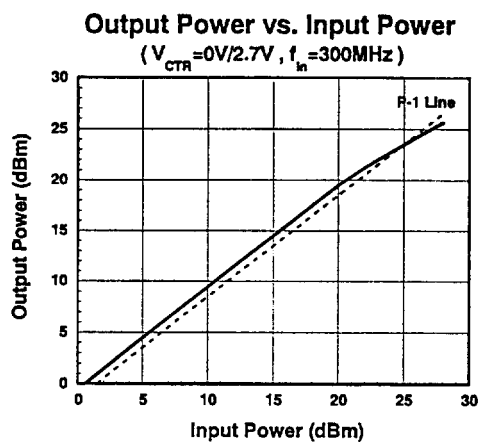
**P2-PC(ON) V.S.W.R vs. Frequency**  
(  $V_{CTR}=0V/2.7V$  ,  $P_{IN}=0dBm$  )



**PC-P1(ON) V.S.W.R vs. Frequency**  
(  $V_{CTR}=0V/2.7V$  ,  $P_{IN}=0dBm$  )



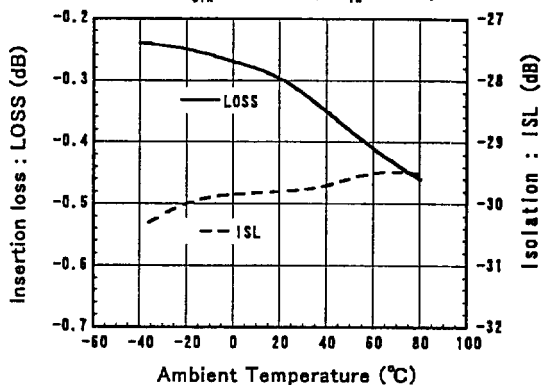
## ■ CHARACTERISTICS



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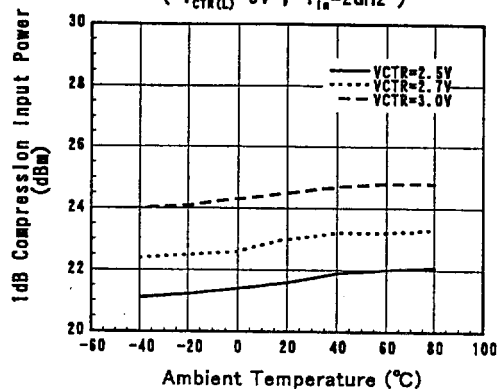
Loss/Isolation vs. Temperature

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



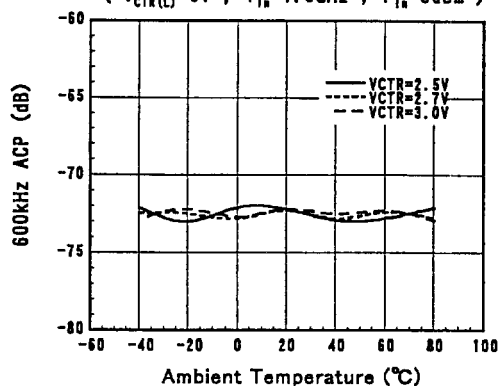
P-1dB vs. Temperature

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



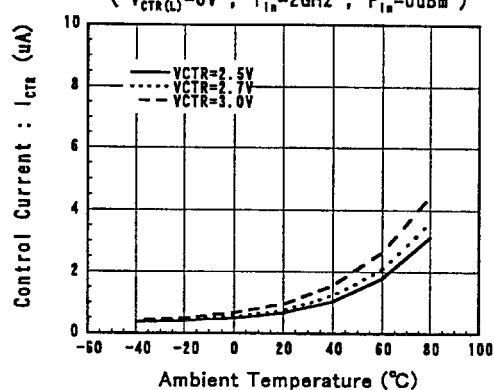
600kHz ACP vs. Temperature

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



Control Current vs. Temperature

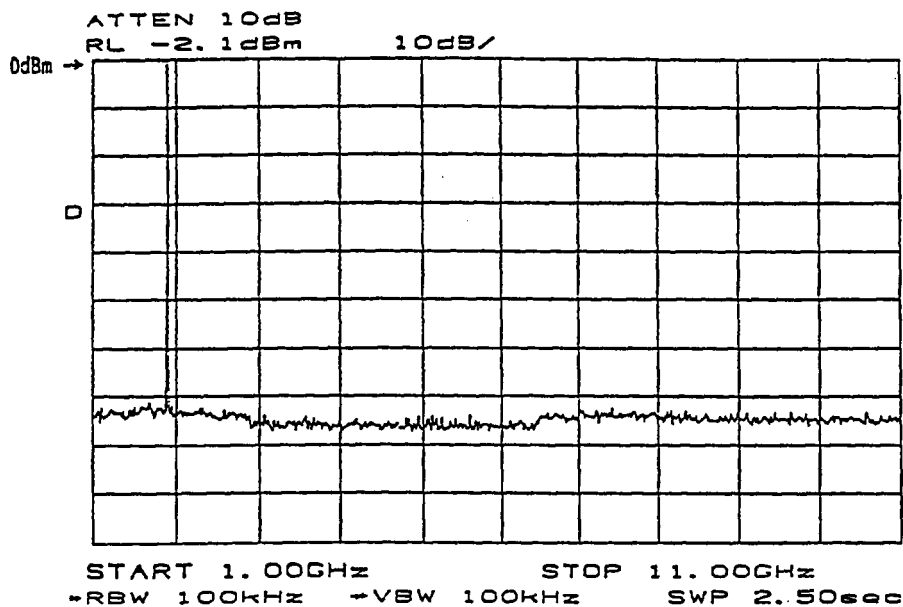
(  $V_{CTR(L)}=0V$  ,  $f_{in}=2GHz$  ,  $P_{in}=0dBm$  )



# ■ CHARACTERISTICS

Harmonics (Ta=25°C)

$f_{in}=1.9\text{GHz}$   $P_{in}=0\text{dBm}$   $V_{CTR(H)}=2.7\text{V}$

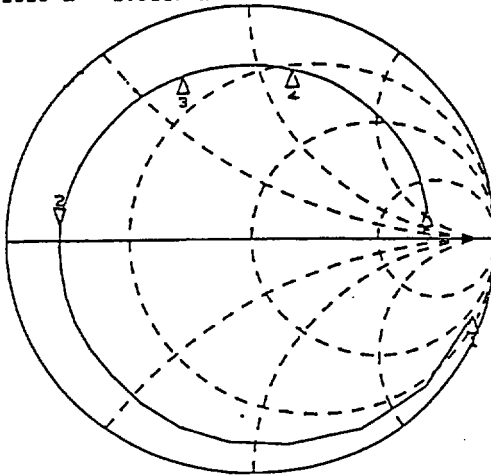




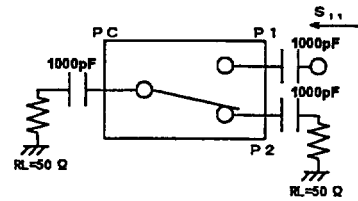
## ■ TYPICAL CHARACTERISTICS

### P1 PORT IMPEDANCE (OFF STATE)

REF 1.0 Units  
 2 200.0 mUnits/  
 ∇ 6.2329 Ω 2.0117 Ω



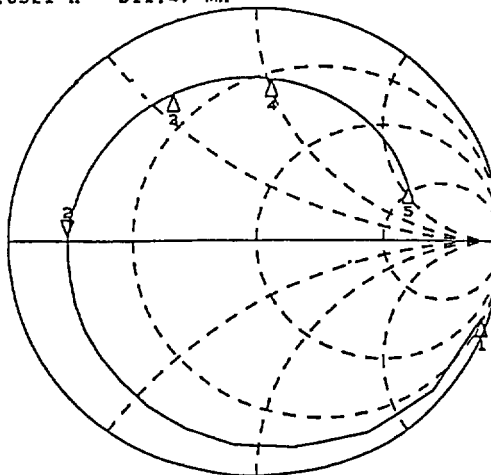
START 0.050000000 GHz  
 STOP 3.000000000 GHz



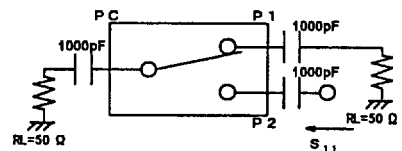
| MARKER | f (MHz) | Mag.  | Ang. (°) |
|--------|---------|-------|----------|
| 1      | 50      | 0.957 | -20.2    |
| 2      | 800     | 0.782 | 171.2    |
| 3      | 1500    | 0.759 | 102.0    |
| 4      | 2000    | 0.747 | 61.8     |
| 5      | 3000    | 0.710 | -11.3    |

### P2 PORT IMPEDANCE (OFF STATE)

REF 1.0 Units  
 2 200.0 mUnits/  
 ∇ 6.8921 Ω 511.47 mΩ



START 0.050000000 GHz  
 STOP 3.000000000 GHz



| MARKER | f (MHz) | Mag.  | Ang. (°) |
|--------|---------|-------|----------|
| 1      | 50      | 0.968 | -20.2    |
| 2      | 800     | 0.782 | 174.5    |
| 3      | 1500    | 0.749 | 108.2    |
| 4      | 2000    | 0.734 | 69.5     |
| 5      | 3000    | 0.690 | -1.2     |

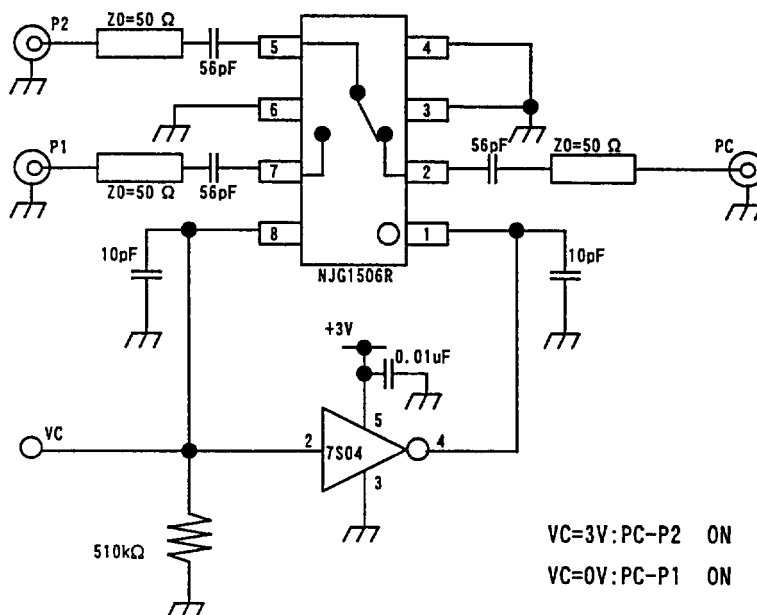


**Scattering Parameters : S11(OFF STATE)**  
( VCTR=0/2.7V , 50 $\Omega$  System )

| f(MHz) | P1 PORT |                        | P2 PORT |                        |
|--------|---------|------------------------|---------|------------------------|
|        | Mag.    | Ang.( $\angle^\circ$ ) | Mag.    | Ang.( $\angle^\circ$ ) |
| 50     | 0.957   | -20.2                  | 0.968   | -20.2                  |
| 100    | 0.942   | -39.5                  | 0.954   | -39.3                  |
| 200    | 0.902   | -74.0                  | 0.911   | -73.7                  |
| 300    | 0.866   | -102.8                 | 0.871   | -102.0                 |
| 400    | 0.836   | -126.1                 | 0.840   | -124.8                 |
| 500    | 0.815   | -145.4                 | 0.818   | -143.7                 |
| 600    | 0.800   | -161.8                 | 0.801   | -159.5                 |
| 700    | 0.791   | -176.1                 | 0.790   | -173.3                 |
| 800    | 0.782   | 171.2                  | 0.782   | 174.5                  |
| 900    | 0.778   | 159.6                  | 0.775   | 163.2                  |
| 1000   | 0.772   | 148.6                  | 0.769   | 152.8                  |
| 1100   | 0.758   | 138.0                  | 0.757   | 142.6                  |
| 1200   | 0.763   | 128.8                  | 0.758   | 133.9                  |
| 1300   | 0.762   | 119.6                  | 0.756   | 125.0                  |
| 1400   | 0.761   | 110.7                  | 0.752   | 116.5                  |
| 1500   | 0.759   | 102.0                  | 0.749   | 108.2                  |
| 1600   | 0.756   | 93.8                   | 0.747   | 100.3                  |
| 1700   | 0.753   | 85.7                   | 0.744   | 92.5                   |
| 1800   | 0.753   | 77.6                   | 0.741   | 84.7                   |
| 1900   | 0.750   | 69.6                   | 0.738   | 77.0                   |
| 2000   | 0.747   | 61.8                   | 0.734   | 69.5                   |
| 2100   | 0.744   | 54.4                   | 0.730   | 62.5                   |
| 2200   | 0.744   | 46.6                   | 0.730   | 55.0                   |
| 2300   | 0.740   | 39.1                   | 0.723   | 47.6                   |
| 2400   | 0.739   | 31.8                   | 0.720   | 40.5                   |
| 2500   | 0.733   | 24.4                   | 0.719   | 33.4                   |
| 2600   | 0.729   | 17.3                   | 0.711   | 26.3                   |
| 2700   | 0.727   | 10.3                   | 0.707   | 19.8                   |
| 2800   | 0.722   | 2.9                    | 0.701   | 12.5                   |
| 2900   | 0.715   | -4.2                   | 0.695   | 5.6                    |
| 3000   | 0.710   | -11.3                  | 0.690   | -1.2                   |

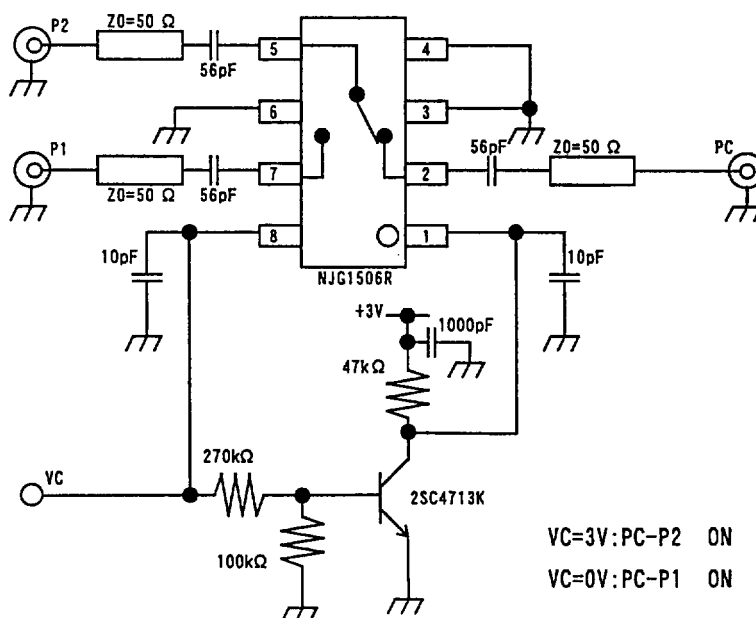


## ■ APPLICATION CIRCUIT1 : Single signal control circuit using C-MOS inverter



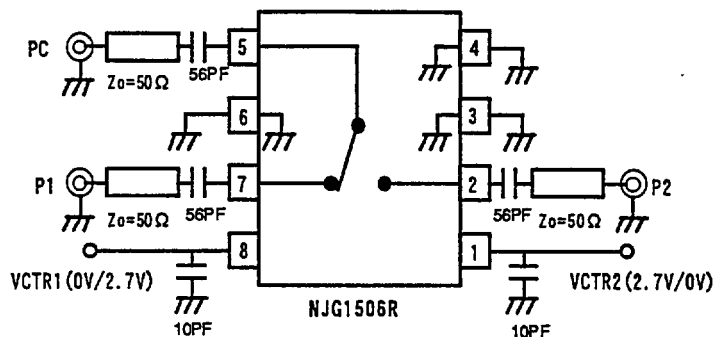
- [ 1 ] Please connect the bypass capacitor to C-MOS inverter supply terminal.
- [ 2 ] In order to the state of input impedance of inverter, please pull-down with 510k  $\Omega$  of resistor for C-MOS inverter input terminal.

## ■ APPLICATION CIRCUIT2 : Single signal control circuit using a transistor.



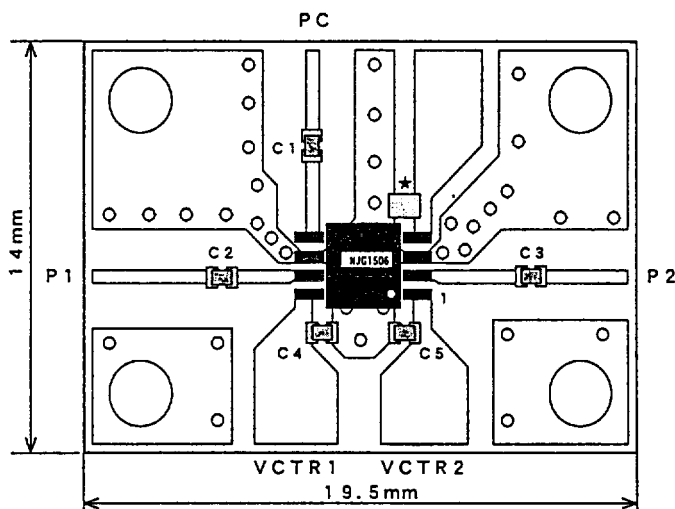


## ■ TEST CIRCUIT



## ■ RECOMMENDED PCB

(TOP VIEW)



PCB:FR-4  $t=0.2\text{mm}$

CAPACITOR:size 1005

STRIP LINE WIDTH=0.5mm

C1~C3:56pF

C4,C5:10pF

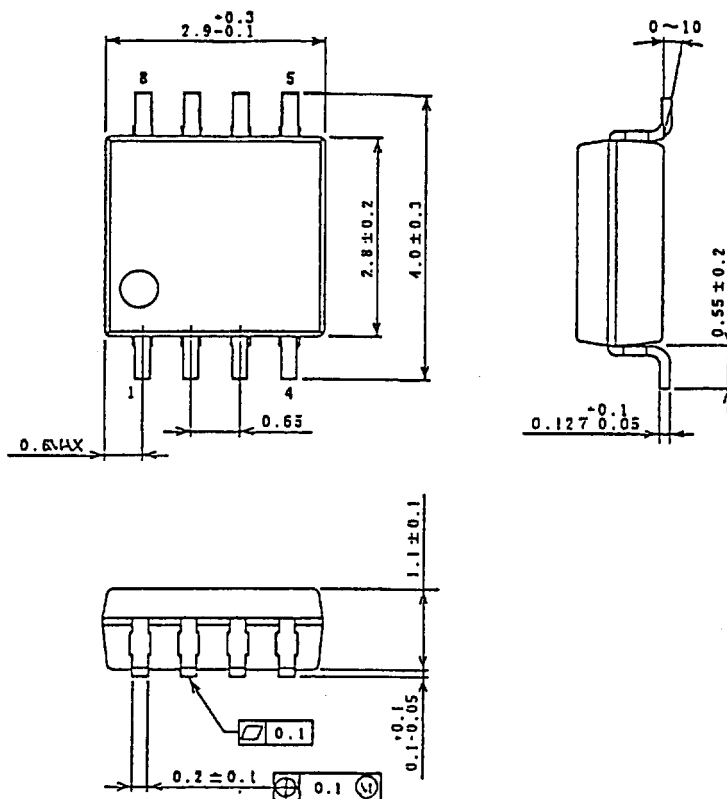
★:Please short between Pin4 and ground near IC

## Usage precaution on devices

- [ 1 ] Outer capacitors should be connected to the input and output RF frequency terminal(P1,P2,PC)to block the DC current. The above figure is a circuit's example to a frequency at 900MHz. Please use a capacitor from 10pF to 1000pF to be suited for using band.
- [ 2 ] Decoupling capacitors should be connected to the control terminals( $V_{CTR1}$ , $V_{CTR2}$ ) as near as possible. The values of these capacitors should be selected from 5pF to 100pF for using band. But take care of the switching time because the capacitor make the switching time late.
- [ 3 ] In order to keep good isolation characteristics, the ground terminal (3,4,6 pin)should be connected to ground pattern with relatively wide width as near as possible, and Though-hole in the ground plane should be placed as near as possible too.



## ■ PACKAGE OUTLINE



UNIT:mm

### Caution on using the products

A GaAs is used in this products. A GaAs is a harmful material.

- Don't eat or in the mouth.
- Don't dispose in fire or break up the products.
- Don't be make a gas or a powdered with the chemical reaction.
- In the case of wasting the products, please obey the relation rule in the each country.
- This products may be broken with static electric discharge or serge voltage. Therefore, please note a handling.

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- The product specifications and descriptions listed in this catalog are subject to change at any time, without notice.
  - It is to modify the details of this catalog without making any preliminary announcement.
  - We don't take upon ourselves the responsibilities that infringe on other people's rights of a patents bringing about the information and drawing in this catalog.
  - It is not purpose to be equipped with the system needs a high reliability as air system, submarine cable system, atomic energy control system and medical instrument for keeping life.
- If you think the above system, please ask for the sales office beforehand.

*New Japan Radio Co., Ltd.*