

## HIGH POWER SPDT SWITCH GaAs MMIC

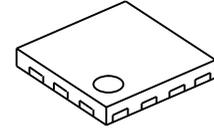
### ■ GENERAL DESCRIPTION

The NJG1681MD7 is a GaAs SPDT switch MMIC suitable for LTE/UMTS/CDMA/GSM applications.

The NJG1681MD7 features very low insertion loss, high isolation and excellent linearity performance down to 1.8V control voltage at high frequency up to 6GHz. In addition, this switch is able to handle high power signals.

The NJG1681MD7 has ESD protection devices to achieve excellent ESD performances. No DC Blocking capacitors are required for all RF ports unless DC is biased externally. And the ultra small & ultra thin EQFN14-D7 package is adopted.

### ■ PACKAGE OUTLINE



NJG1681MD7

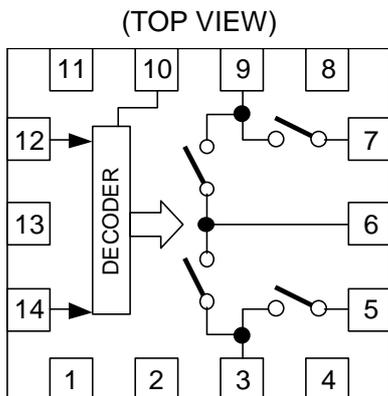
### ■ APPLICATIONS

- LTE, UMTS, CDMA, GSM applications
- IEEE802.11p application
- Antenna switching, bands switching, post PA switching applications

### ■ FEATURES

- Low voltage logic control
  - Low voltage operation
  - Low distortion
  
  - P-0.1dB
  - Low insertion loss
  
  - Ultra small & ultra thin package
  - RoHS compliant and Halogen Free, MSL1
- $V_{CTL(H)}=1.8V$  typ.  
 $V_{DD}=2.7V$  typ.  
 $IIP3=+73dBm$  typ. @ $f=829+849MHz$ ,  $P_{IN}=24dBm$   
 $IIP3=+71dBm$  typ. @ $f=1870+1910MHz$ ,  $P_{IN}=24dBm$   
 $2nd\ harmonics=-85dBc$  typ. @  $f=0.9GHz$ ,  $P_{IN}=35dBm$   
 $3rd\ harmonics=-90dBc$  typ. @  $f=0.9GHz$ ,  $P_{IN}=35dBm$   
 $+36dBm$  min.  
 $0.18dB$  typ. @ $f=0.9GHz$ ,  $P_{IN}=35dBm$   
 $0.20dB$  typ. @ $f=1.9GHz$ ,  $P_{IN}=33dBm$   
 $0.23dB$  typ. @ $f=2.7GHz$ ,  $P_{IN}=27dBm$   
 $0.45dB$  typ. @ $f=6.0GHz$ ,  $P_{IN}=27dBm$   
 EQFN14-D7 (Package size: 1.6 x 1.6 x 0.397mm.)

### ■ PIN CONFIGURATION



- Pin connection
- |            |             |
|------------|-------------|
| 1. GND     | 8. GND      |
| 2. NC(GND) | 9. P1       |
| 3. P2      | 10. GND     |
| 4. GND     | 11. GND     |
| 5. GND     | 12. VDD     |
| 6. PC      | 13. NC(GND) |
| 7. GND     | 14. VCTL    |
- Exposed PAD: GND

### ■ TRUTH TABLE

“H”= $V_{CTL(H)}$ , “L”= $V_{CTL(L)}$

VCTL	Path
H	PC-P1
L	PC-P2

NOTE: Please note that any information on this datasheet will be subject to change.

## ■ ABSOLUTE MAXIMUM RATINGS

(T<sub>a</sub>=+25°C, Z<sub>s</sub>=Z<sub>i</sub>=50Ω)

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
RF Input Power	P <sub>IN</sub>	V <sub>DD</sub> =2.7V	37	dBm
Supply Voltage	V <sub>DD</sub>		5.0	V
Control Voltage	V <sub>CTL</sub>		5.0	V
Power Dissipation	P <sub>D</sub>	Four-layer FR4 PCB with through-hole (74.2x74.2mm), T <sub>j</sub> =150°C	1300	mW
Operating Temp.	T <sub>opr</sub>		-40 to +105	°C
Storage Temp.	T <sub>stg</sub>		-55 to +150	°C

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: T<sub>a</sub>=+25°C, V<sub>DD</sub>=2.7V, V<sub>CTL(L)</sub>=0V, V<sub>CTL(H)</sub>=1.8V)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V <sub>DD</sub>		2.375	2.7	5.0	V
Operating Current	I <sub>DD</sub>	No RF input, V <sub>DD</sub> =2.7V	-	95	180	μA
Control Voltage (LOW)	V <sub>CTL(L)</sub>		0	-	0.45	V
Control Voltage (HIGH)	V <sub>CTL(H)</sub>		1.35	1.8	5.0	V
Control Current	I <sub>CTL</sub>	V <sub>CTL(H)</sub> =1.8V	-	4	10	μA

## ■ ELECTRICAL CHARACTERISTICS 2 (RF)

(General conditions:  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ ,  $V_{DD}=2.7\text{V}$ ,  $V_{CTL(L)}=0\text{V}$ ,  $V_{CTL(H)}=1.8\text{V}$ )

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss 1	LOSS1	f=0.9GHz, $P_{IN}=35\text{dBm}$	-	0.18	0.33	dB
Insertion Loss 2	LOSS2	f=1.9GHz, $P_{IN}=33\text{dBm}$	-	0.20	0.40	dB
Insertion Loss 3	LOSS3	f=2.7GHz, $P_{IN}=27\text{dBm}$	-	0.23	0.43	dB
Insertion Loss 4	LOSS4	f=6.0GHz, $P_{IN}=27\text{dBm}$	-	0.45	0.65	dB
Isolation 1	ISL1	f=0.9GHz, $P_{IN}=35\text{dBm}$	40	45	-	dB
Isolation 2	ISL2	f=1.9GHz, $P_{IN}=33\text{dBm}$	30	35	-	dB
Isolation 3	ISL3	f=2.7GHz, $P_{IN}=27\text{dBm}$	25	30	-	dB
Isolation 4	ISL4	f=6.0GHz, $P_{IN}=27\text{dBm}$	16.5	20	-	dB
Input Power at 0.1dB Compression Point	$P_{-0.1\text{dB}}$	f=0.9GHz, f=1.9GHz, f=2.7GHz, f=6.0GHz	+36	-	-	dBm
2nd Harmonics 1	2fo(1)	f=0.9GHz, $P_{IN}=35\text{dBm}$	-	-85	-70	dBc
2nd Harmonics 2	2fo(2)	f=1.9GHz, $P_{IN}=33\text{dBm}$	-	-90	-70	dBc
2nd Harmonics 3	2fo(3)	f=2.7GHz, $P_{IN}=27\text{dBm}$	-	-90	-70	dBc
3rd Harmonics 1	3fo(1)	f=0.9GHz, $P_{IN}=35\text{dBm}$	-	-90	-70	dBc
3rd Harmonics 2	3fo(2)	f=1.9GHz, $P_{IN}=33\text{dBm}$	-	-80	-70	dBc
3rd Harmonics 3	3fo(3)	f=2.7GHz, $P_{IN}=27\text{dBm}$	-	-90	-70	dBc
Input 3 <sup>rd</sup> order intercept point1	IIP3(1)	f=829+849MHz, $P_{IN}=24\text{dBm}$ each	+65	+73	-	dBm
Input 3 <sup>rd</sup> order intercept point2	IIP3(2)	f=1870+1910MHz, $P_{IN}=24\text{dBm}$ each	+65	+71	-	dBm
VSWR 1	VSWR 1	on-state ports, f=2.7GHz	-	1.1	1.4	
VSWR 2	VSWR 2	on-state ports, f=6.0GHz	-	1.1	1.4	
Switching time	$T_{SW}$	50% $V_{CTL}$ to 10/90% RF	-	1	5	$\mu\text{s}$

\*1: IIP3 are defined by the following equations.

$$IIP3=(3 \times P_{out-IM3})/2+LOSS$$

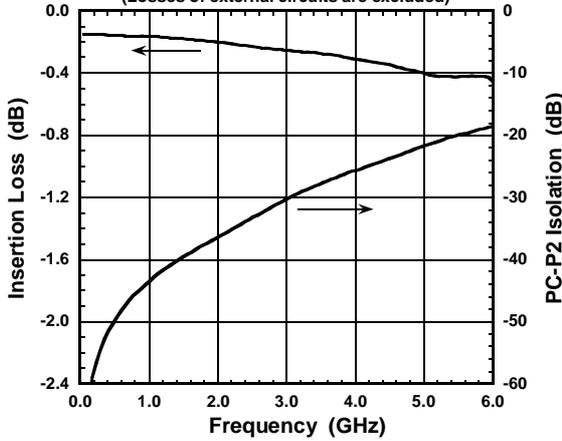
## ■ TERMINAL INFORMATION

No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
2	NC(GND)	No connected terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
3	P2	RF transmitting/receiving port. No DC blocking capacitor is required for this port unless DC is biased externally.
4	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
5	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
6	PC	RF transmitting/receiving port. No DC blocking capacitor is required for this port unless DC is biased externally. Please connect an inductor with GND terminal for ESD protection.
7	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
8	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
9	P1	RF transmitting/receiving port. No DC blocking capacitor is required for this port unless DC is biased externally.
10	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
11	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
12	VDD	Positive voltage supply terminal. The positive voltage (+2.375~+5V) has to be supplied. Please connect a bypass capacitor with GND terminal for excellent RF performance.
13	NC(GND)	No connected terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
14	VCTL	Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V).
Exposed Pad	GND	Ground terminal.

## ■ ELECTRICAL CHARACTERISTICS (With application circuit)

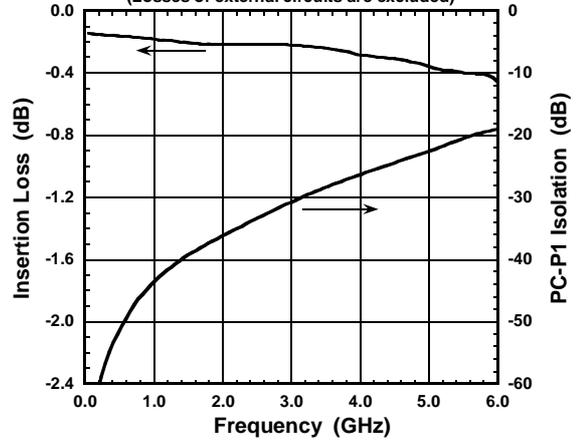
### Loss, ISL vs Frequency

(PC-P1 ON,  $V_{DD}=2.7V$ ,  $V_{CTL}=1.8V$ )  
(Losses of external circuits are excluded)



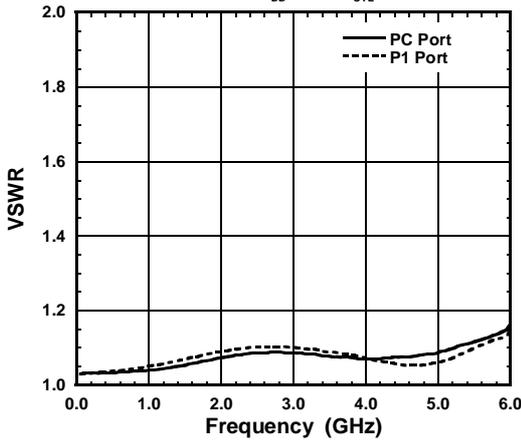
### Loss, ISL vs Frequency

(PC-P2 ON,  $V_{DD}=2.7V$ ,  $V_{CTL}=0V$ )  
(Losses of external circuits are excluded)



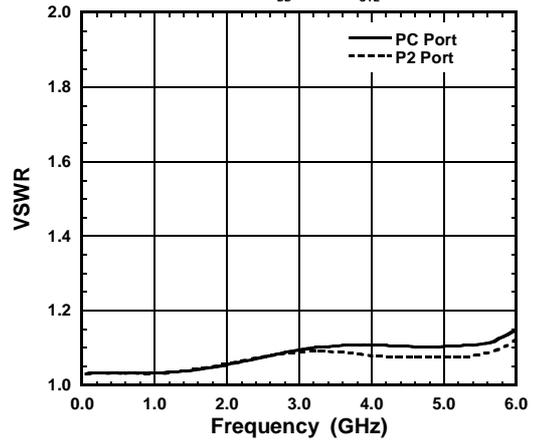
### VSWR vs Frequency

(PC-P1 ON,  $V_{DD}=2.7V$ ,  $V_{CTL}=1.8V$ )



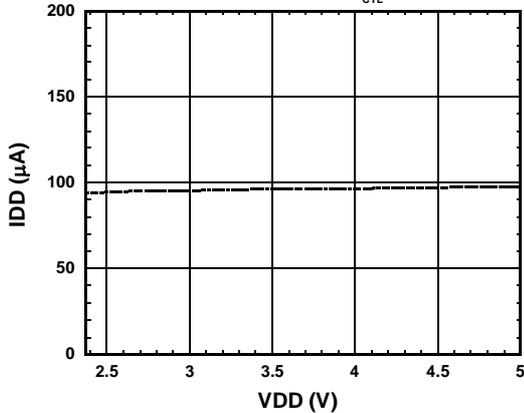
### VSWR vs Frequency

(PC-P2 ON,  $V_{DD}=2.7V$ ,  $V_{CTL}=0V$ )



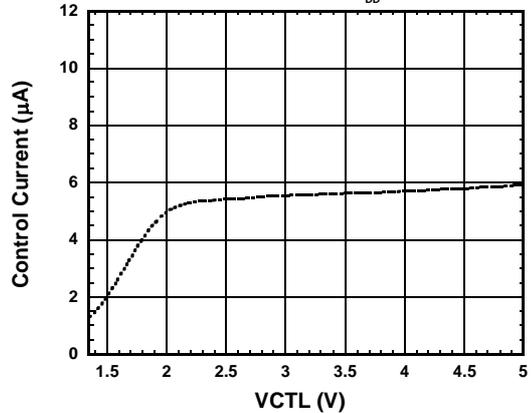
### IDD vs. VDD

(No RF input, PC-P1 ON,  $V_{CTL}=1.8V$ )



### Control Current vs. VCTL

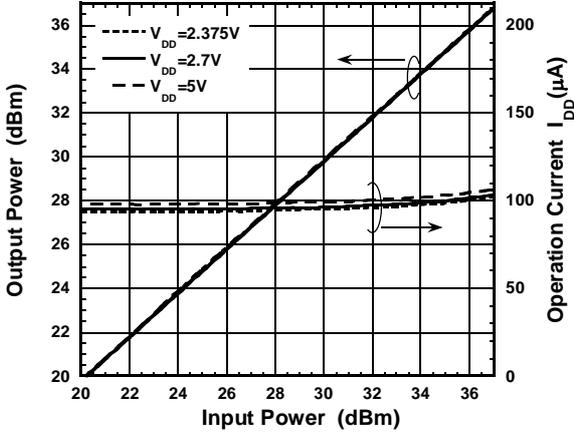
(No RF input, PC-P1 ON,  $V_{DD}=2.7V$ )



## ELECTRICAL CHARACTERISTICS (With application circuit)

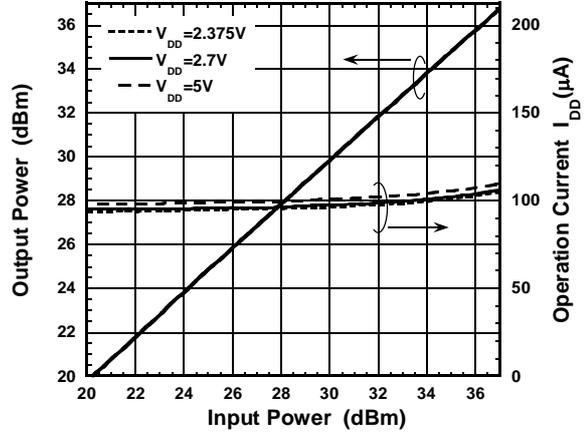
### Output Power, $I_{DD}$ vs Input Power

(f=0.9GHz, PC-P1 ON,  $V_{CT1}=1.8V$ )  
(Losses of external circuits are excluded)



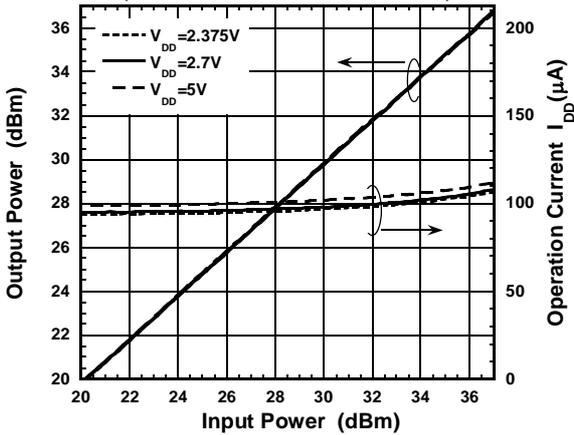
### Output Power, $I_{DD}$ vs Input Power

(f=1.9GHz, PC-P1 ON,  $V_{CT1}=1.8V$ )  
(Losses of external circuits are excluded)



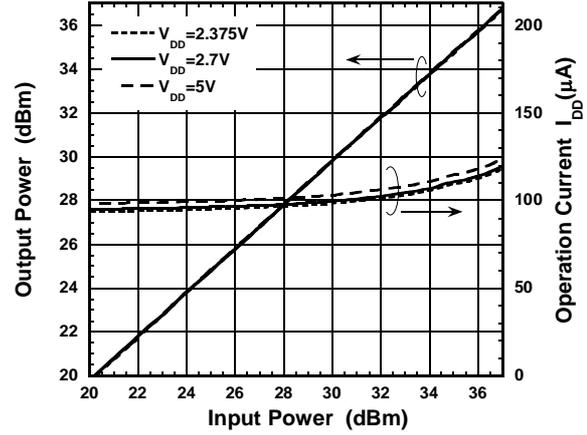
### Output Power, $I_{DD}$ vs Input Power

(f=2.7GHz, PC-P1 ON,  $V_{CT1}=1.8V$ )  
(Losses of external circuits are excluded)

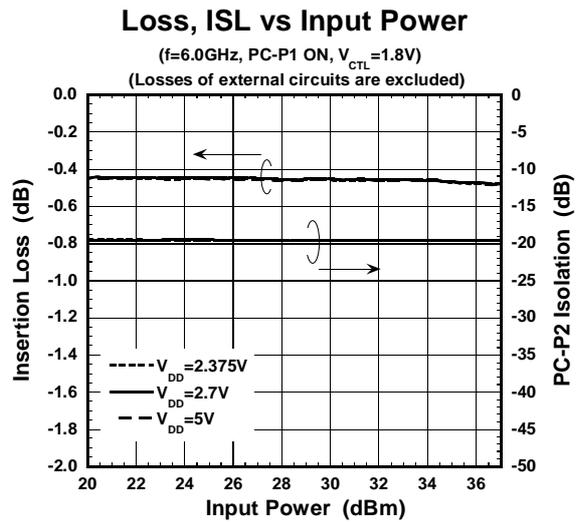
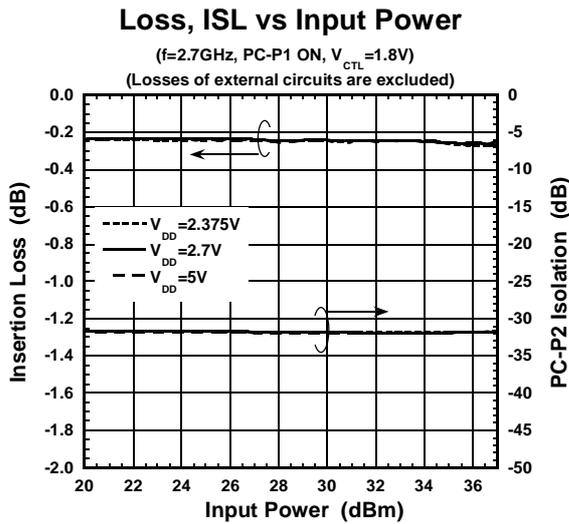
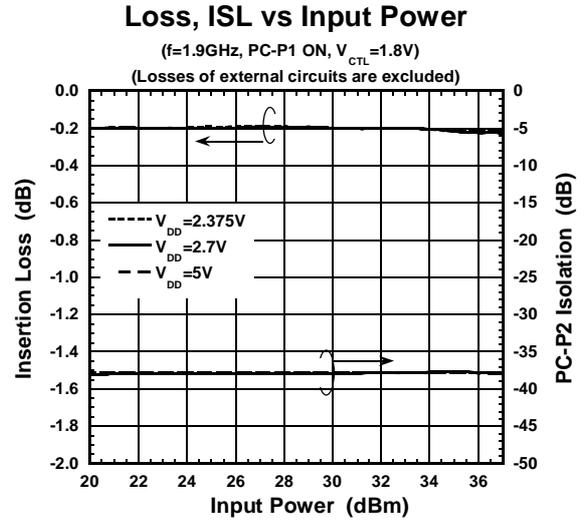
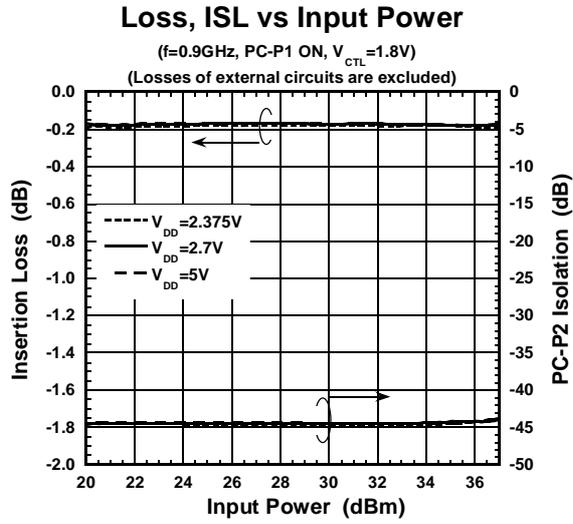


### Output Power, $I_{DD}$ vs Input Power

(f=6.0GHz, PC-P1 ON,  $V_{CT1}=1.8V$ )  
(Losses of external circuits are excluded)

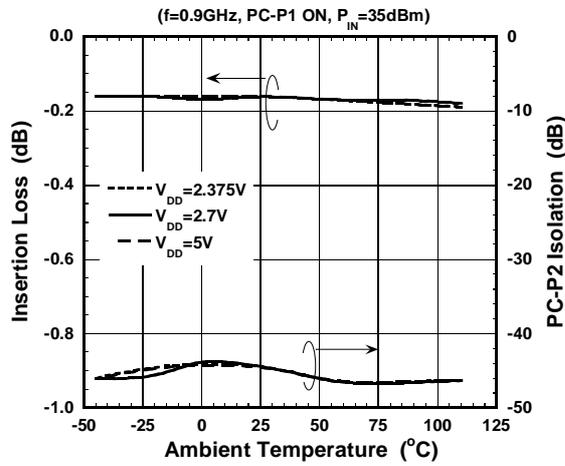


## ■ ELECTRICAL CHARACTERISTICS (With application circuit)

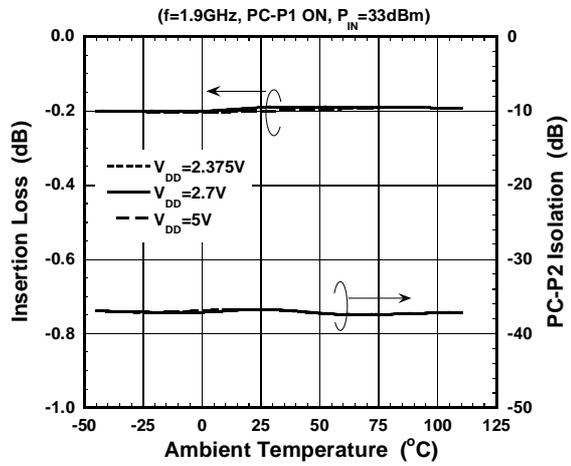


## ■ ELECTRICAL CHARACTERISTICS (With application circuit)

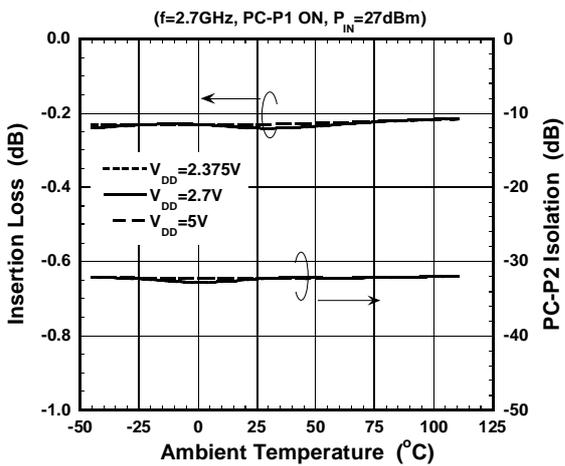
**Loss, ISL vs Ambient Temperature**



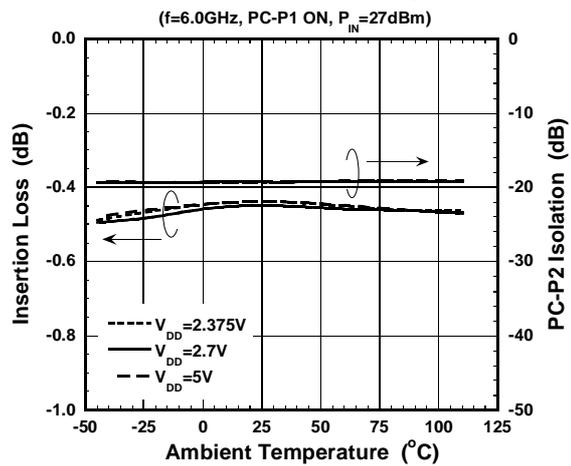
**Loss, ISL vs Ambient Temperature**



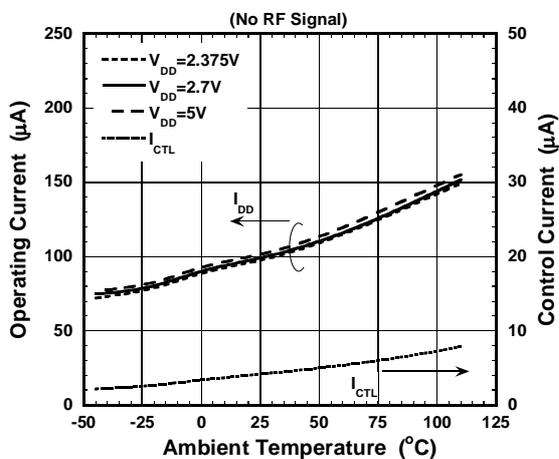
**Loss, ISL vs Ambient Temperature**



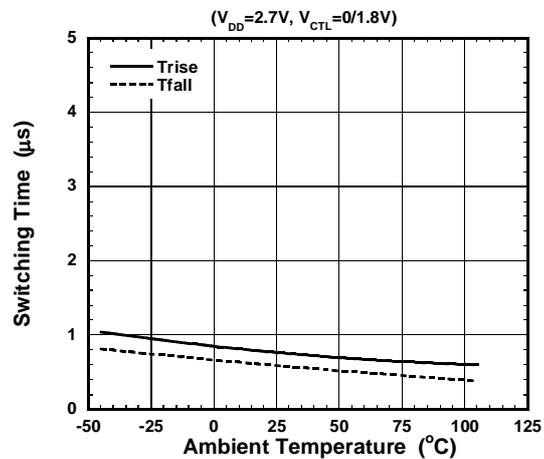
**Loss, ISL vs Ambient Temperature**



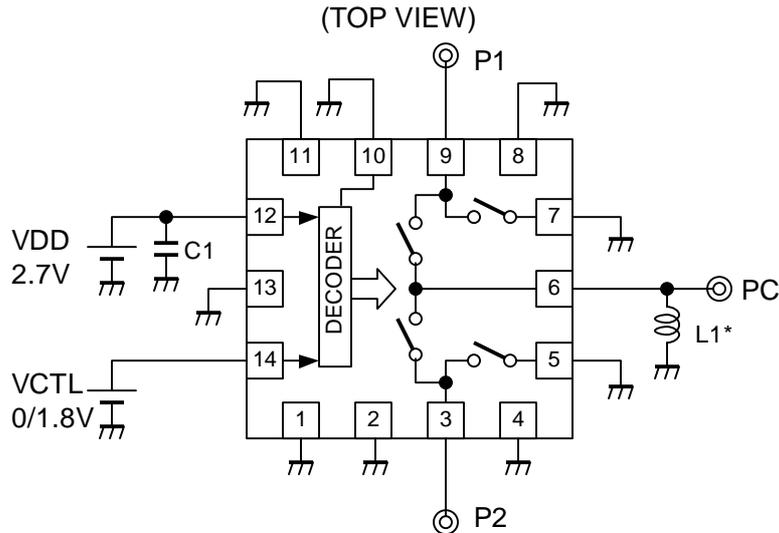
**DC Current vs Ambient Temperature**



**Switching Time vs Ambient Temperature**



## APPLICATION CIRCUIT



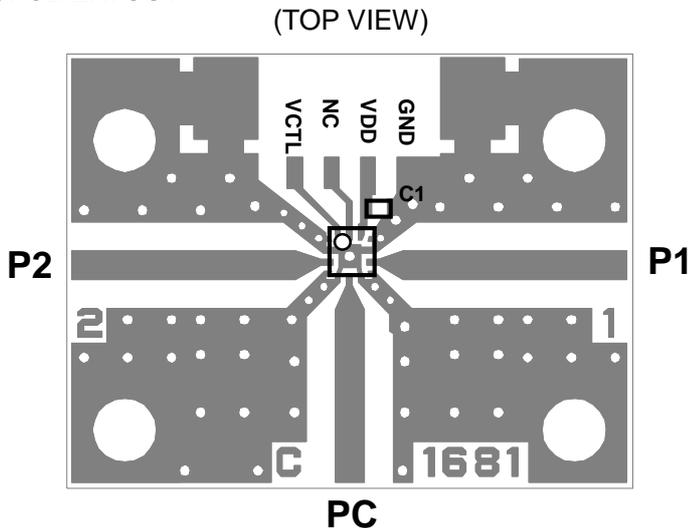
Note: No DC blocking capacitors are required on all RF ports, unless DC is biased externally.

- \* The Inductor L1 is required for enhancing ESD protection level.  
 The inductor L1 is recommended in order to keep the DC bias level of each RF port at 0 V level tightly.

## PARTS LIST

No.	Parameters	Note
C1	1000pF	MURATA (GRM15)
L1	68nH	TAIYO-YUDEN (HK1005)

## PCB LAYOUT



PCB SIZE: 19.4 x 15.0 mm  
 PCB: FR-4, t=0.5mm  
 Capacitor size: 1005  
 MICROSTRIP LINE WIDTH: 0.98mm

Losses of PCB and connectors, Ta=+25°C

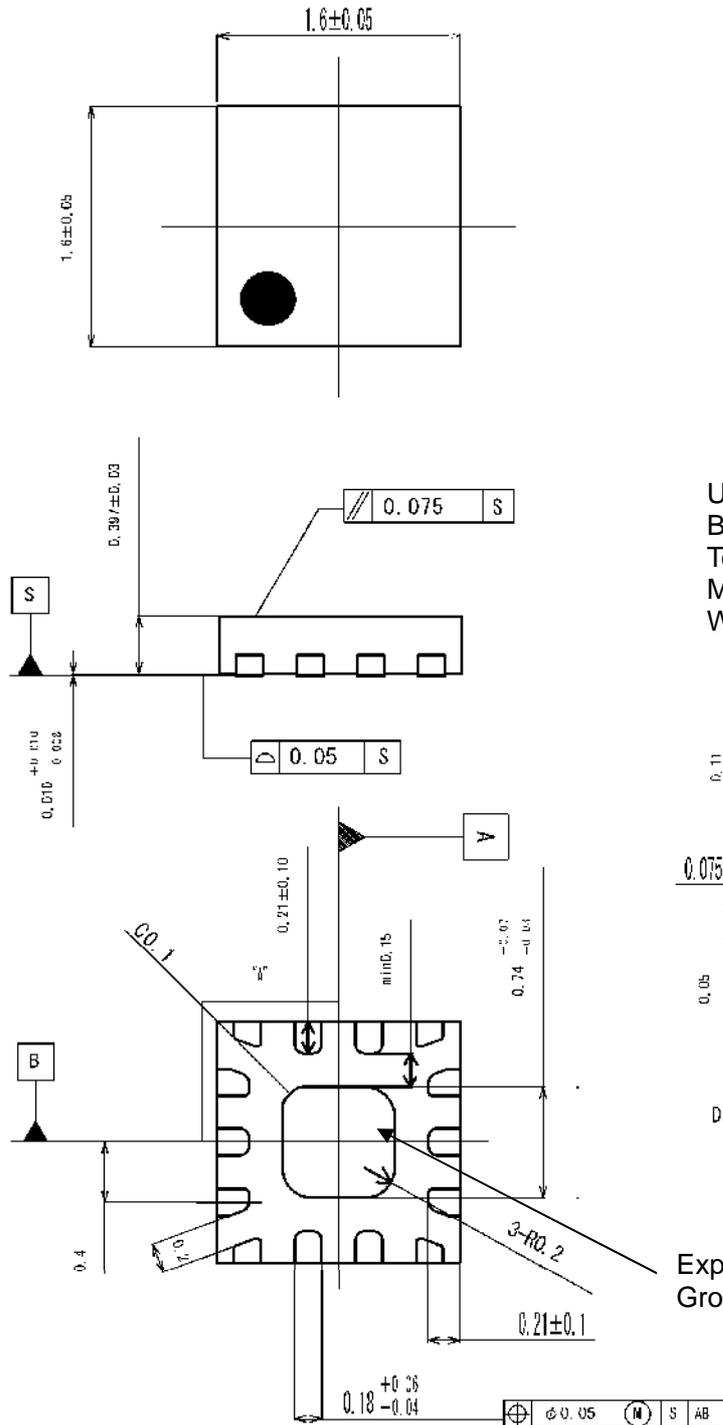
Frequency (GHz)	Loss (dB)
0.9	0.09
1.9	0.18
2.7	0.26
6.0	0.48

## PRECAUTIONS

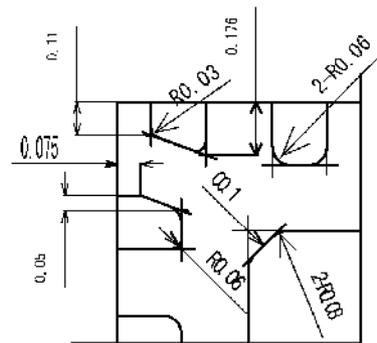
- [1] No DC blocking capacitors are required at each RF port normally. When the other device is biased at certain voltage and connected to the NJG1681MD7, a DC block capacitor is required between the device and the switch IC. This is because the each RF port of NJG1681MD7 is biased at 0 V (GND).
- [2] For avoiding the degradation of RF performance, the bypass capacitor (C1) should be placed as close as possible to VDD terminal
- [3] For good RF performance, all GND terminals are must be connected to PCB ground plane of substrate, and through - holes for GND should be placed the IC near.



## PACKAGE OUTLINE (EQFN14-D7)



Units : mm  
 Board : Cu  
 Terminal treat : SnBi  
 Molding material : Epoxy resin  
 Weight : 3.4mg



Details of "A" part (× 2)

Exposed PAD  
 Ground connection is required.

### 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.

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
2. The materials in this document may not be copied or otherwise reproduced in whole or in part without the prior written consent of us.
3. This product and any technical information relating thereto are subject to complementary export controls (so-called KNOW controls) under the Foreign Exchange and Foreign Trade Law, and related politics ministerial ordinance of the law. (Note that the complementary export controls are inapplicable to any application-specific products, except rockets and pilotless aircraft, that are insusceptible to design or program changes.) Accordingly, when exporting or carrying abroad this product, follow the Foreign Exchange and Foreign Trade Control Law and its related regulations with respect to the complementary export controls.
4. The technical information described in this document shows typical characteristics and example application circuits for the products. The release of such information is not to be construed as a warranty of or a grant of license under our or any third party's intellectual property rights or any other rights.
5. The products listed in this document are intended and designed for use as general electronic components in standard applications (office equipment, telecommunication equipment, measuring instruments, consumer electronic products, amusement equipment etc.). Those customers intending to use a product in an application requiring extreme quality and reliability, for example, in a highly specific application where the failure or misoperation of the product could result in human injury or death should first contact us.
  - Aerospace Equipment
  - Equipment Used in the Deep Sea
  - Power Generator Control Equipment (nuclear, steam, hydraulic, etc.)
  - Life Maintenance Medical Equipment
  - Fire Alarms / Intruder Detectors
  - Vehicle Control Equipment (automotive, airplane, railroad, ship, etc.)
  - Various Safety Devices
  - Traffic control system
  - Combustion equipment

In case your company desires to use this product for any applications other than general electronic equipment mentioned above, make sure to contact our company in advance. Note that the important requirements mentioned in this section are not applicable to cases where operation requirements such as application conditions are confirmed by our company in writing after consultation with your company.

6. We are making our continuous effort to improve the quality and reliability of our products, but semiconductor products are likely to fail with certain probability. In order to prevent any injury to persons or damages to property resulting from such failure, customers should be careful enough to incorporate safety measures in their design, such as redundancy feature, fire containment feature and fail-safe feature. We do not assume any liability or responsibility for any loss or damage arising from misuse or inappropriate use of the products.
7. The products have been designed and tested to function within controlled environmental conditions. Do not use products under conditions that deviate from methods or applications specified in this datasheet. Failure to employ the products in the proper applications can lead to deterioration, destruction or failure of the products. We shall not be responsible for any bodily injury, fires or accident, property damage or any consequential damages resulting from misuse or misapplication of the products.
8. **Quality Warranty**
  - 8-1. **Quality Warranty Period**

In the case of a product purchased through an authorized distributor or directly from us, the warranty period for this product shall be one (1) year after delivery to your company. For defective products that occurred during this period, we will take the quality warranty measures described in section 8-2. However, if there is an agreement on the warranty period in the basic transaction agreement, quality assurance agreement, delivery specifications, etc., it shall be followed.
  - 8-2. **Quality Warranty Remedies**

When it has been proved defective due to manufacturing factors as a result of defect analysis by us, we will either deliver a substitute for the defective product or refund the purchase price of the defective product.

Note that such delivery or refund is sole and exclusive remedies to your company for the defective product.
  - 8-3. **Remedies after Quality Warranty Period**

With respect to any defect of this product found after the quality warranty period, the defect will be analyzed by us. On the basis of the defect analysis results, the scope and amounts of damage shall be determined by mutual agreement of both parties. Then we will deal with upper limit in Section 8-2. This provision is not intended to limit any legal rights of your company.
9. Anti-radiation design is not implemented in the products described in this document.
10. The X-ray exposure can influence functions and characteristics of the products. Confirm the product functions and characteristics in the evaluation stage.
11. WLCSP products should be used in light shielded environments. The light exposure can influence functions and characteristics of the products under operation or storage.
12. Warning for handling Gallium and Arsenic (GaAs) products (Applying to GaAs MMIC, Photo Reflector). These products use Gallium (Ga) and Arsenic (As) which are specified as poisonous chemicals by law. For the prevention of a hazard, do not burn, destroy, or process chemically to make them as gas or power. When the product is disposed of, please follow the related regulation and do not mix this with general industrial waste or household waste.
13. Please contact our sales representatives should you have any questions or comments concerning the products or the technical information.



**Nisshinbo Micro Devices Inc.**

**Official website**

<https://www.nisshinbo-microdevices.co.jp/en/>

**Purchase information**

<https://www.nisshinbo-microdevices.co.jp/en/buy/>