HIGH POWER SPDT SWITCH GaAs MMIC

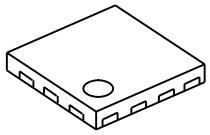
■ GENERAL DESCRIPTION

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

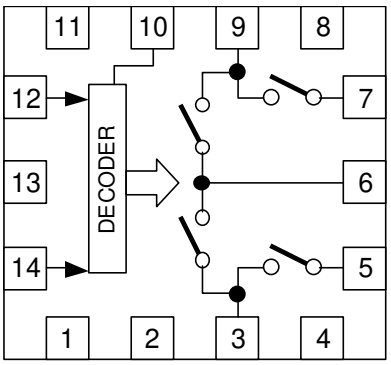
LTE, UMTS, CDMA, GSM applications
IEEE802.11p application
Antenna switching, bands switching, post PA switching applications

■ FEATURES

● Low voltage logic control	$V_{CTL(H)}$=1.8V typ.
● Low voltage operation	V_{DD}=2.7V typ.
● Low distortion	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
● P-0.1dB	+36dBm min.
● Low insertion loss	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
● Ultra small & ultra thin package	EQFN14-D7 (Package size: 1.6 x 1.6 x 0.397mm.)
● RoHS compliant and Halogen Free, MSL1	

■ PIN CONFIGURATION

(TOP VIEW)



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_a=+25°C, Z_s=Z_l=50Ω)

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
RF Input Power	P_{IN}	V_{DD} =2.7V	37	dBm
Supply Voltage	V_{DD}		5.0	V
Control Voltage	V_{CTL}		5.0	V
Power Dissipation	P_D	Four-layer FR4 PCB with through-hole (74.2x74.2mm), Tj=150°C	1300	mW
Operating Temp.	T_{opr}		-40 to +105	°C
Storage Temp.	T_{stg}		-55 to +150	°C

■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: T_a=+25°C, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{DD}		2.375	2.7	5.0	V
Operating Current	I_{DD}	No RF input, V_{DD}=2.7V	-	95	180	μA
Control Voltage (LOW)	$V_{CTL(L)}$		0	-	0.45	V
Control Voltage (HIGH)	$V_{CTL(H)}$		1.35	1.8	5.0	V
Control Current	I_{CTL}	$V_{CTL(H)}$=1.8V	-	4	10	μA

■ **ELECTRICAL CHARACTERISTICS 2 (RF)**

(General conditions: T_a=+25°C, Z_s=Z_l=50Ω, V_{DD}=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss 1	LOSS1	f=0.9GHz, P_{IN}=35dBm	-	0.18	0.33	dB
Insertion Loss 2	LOSS2	f=1.9GHz, P_{IN}=33dBm	-	0.20	0.40	dB
Insertion Loss 3	LOSS3	f=2.7GHz, P_{IN}=27dBm	-	0.23	0.43	dB
Insertion Loss 4	LOSS4	f=6.0GHz, P_{IN}=27dBm	-	0.45	0.65	dB
Isolation 1	ISL1	f=0.9GHz, P_{IN}=35dBm	40	45	-	dB
Isolation 2	ISL2	f=1.9GHz, P_{IN}=33dBm	30	35	-	dB
Isolation 3	ISL3	f=2.7GHz, P_{IN}=27dBm	25	30	-	dB
Isolation 4	ISL4	f=6.0GHz, P_{IN}=27dBm	16.5	20	-	dB
Input Power at 0.1dB Compression Point	$P_{-0.1dB}$	f=0.9GHz, f=1.9GHz, f=2.7GHz, f=6.0GHz	+36	-	-	dBm
2nd Harmonics 1	2fo(1)	f=0.9GHz, P_{IN}=35dBm	-	-85	-70	dBc
2nd Harmonics 2	2fo(2)	f=1.9GHz, P_{IN}=33dBm	-	-90	-70	dBc
2nd Harmonics 3	2fo(3)	f=2.7GHz, P_{IN}=27dBm	-	-90	-70	dBc
3rd Harmonics 1	3fo(1)	f=0.9GHz, P_{IN}=35dBm	-	-90	-70	dBc
3rd Harmonics 2	3fo(2)	f=1.9GHz, P_{IN}=33dBm	-	-80	-70	dBc
3rd Harmonics 3	3fo(3)	f=2.7GHz, P_{IN}=27dBm	-	-90	-70	dBc
Input 3rd order intercept point1	IIP3(1)	f=829+849MHz, P_{IN}=24dBm each	+65	+73	-	dBm
Input 3rd order intercept point2	IIP3(2)	f=1870+1910MHz, P_{IN}=24dBm 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	μs

*1: IIP3 are defined by the following equations.
IIP3=(3 x Pout-IM3)/2+LOSS

■ **TERMINAL INFORMATION**

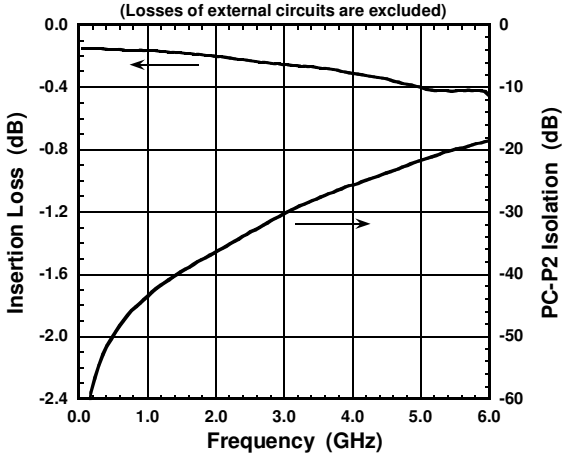
No.	SYMBOL	DESCRIPTION
1	GND	Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
2	NC(GND)	No connected terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.
3	P2	RF transmitting/receiving 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)

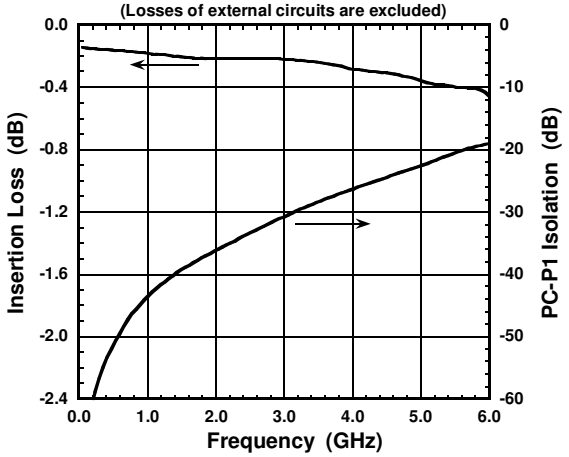
(Losses of external circuits are excluded)



Loss, ISL vs Frequency

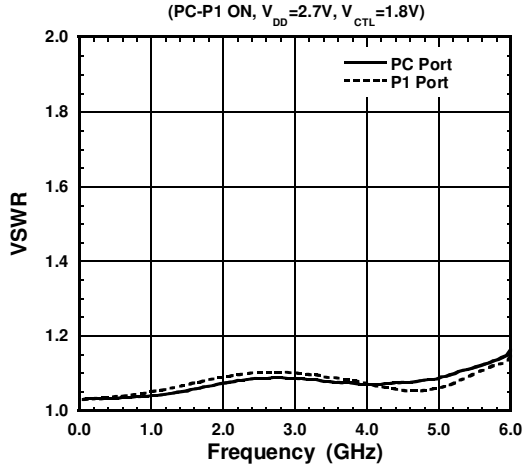
(PC-P2 ON, V_{DD}=2.7V, V_{CTL}=0V)

(Losses of external circuits are excluded)



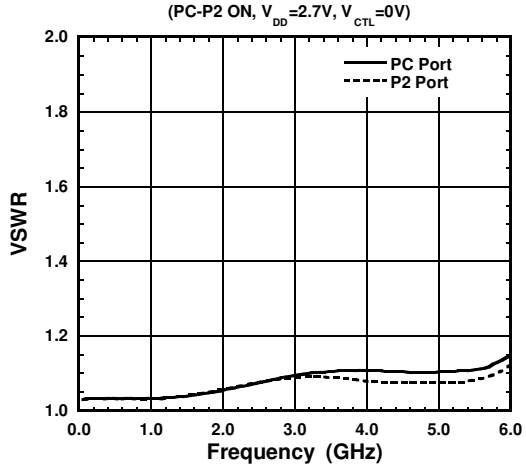
VSWR vs Frequency

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



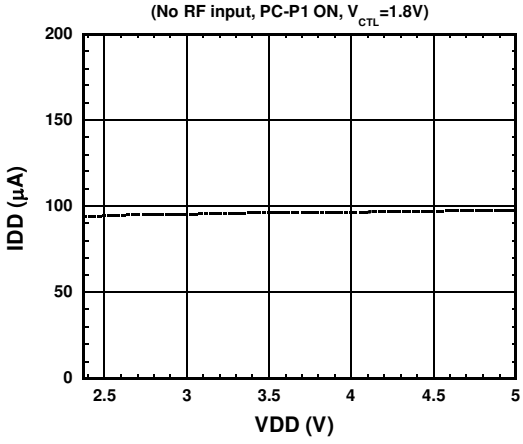
VSWR vs Frequency

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



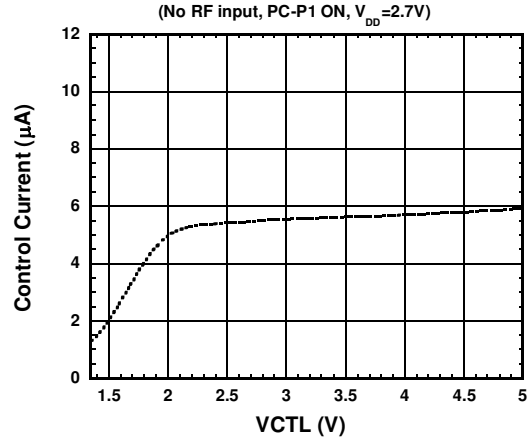
IDD vs. VDD

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



Control Current vs. VCTL

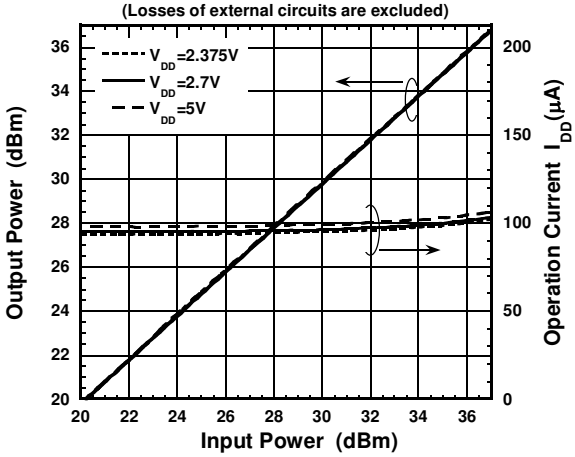
(No RF input, PC-P1 ON, V_{DD}=2.7V)



■ **ELECTRICAL CHARACTERISTICS** (With application circuit)

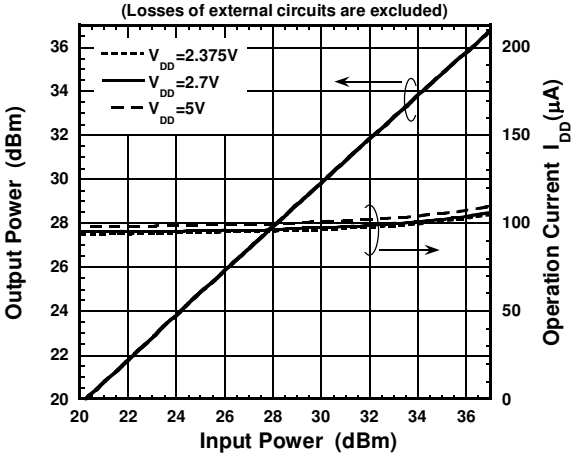
Output Power, I_{DD} vs Input Power

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



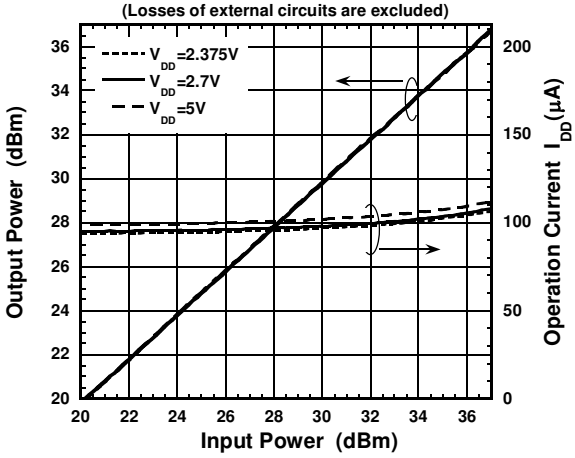
Output Power, I_{DD} vs Input Power

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



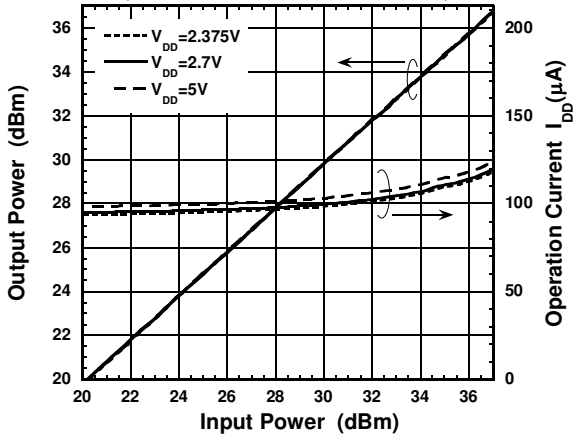
Output Power, I_{DD} vs Input Power

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

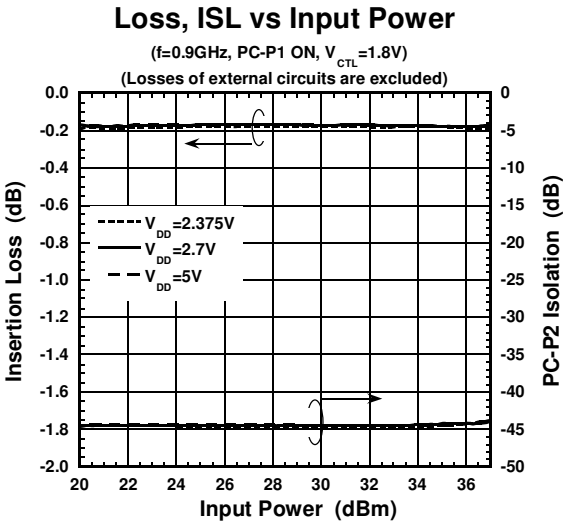


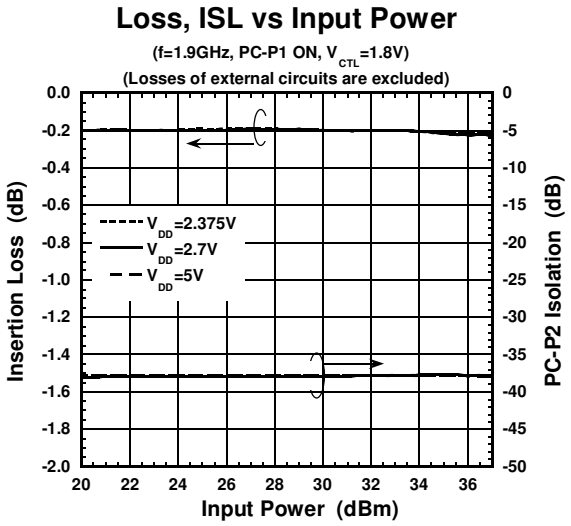
Output Power, I_{DD} vs Input Power

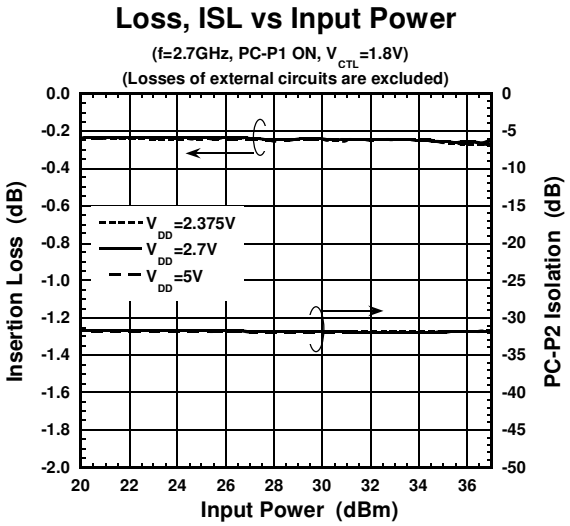
(f=6.0GHz, PC-P1 ON, V_{CTL}=1.8V)
(Losses of external circuits are excluded)

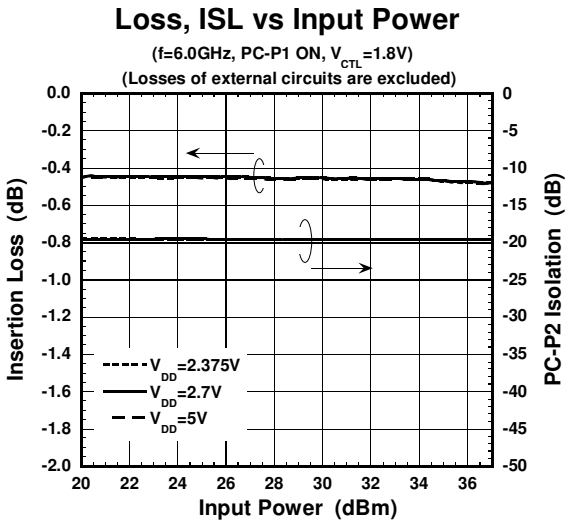


■ **ELECTRICAL CHARACTERISTICS** (With application circuit)



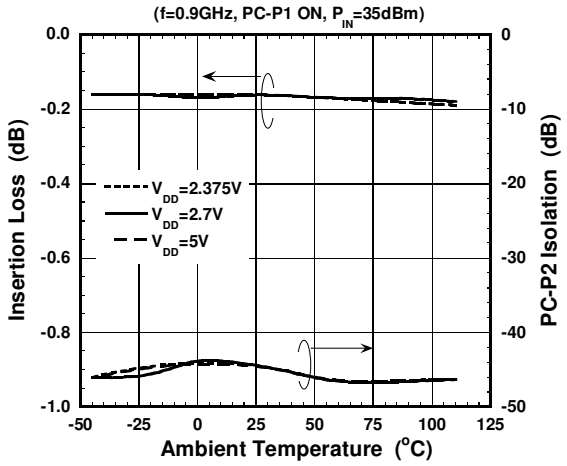




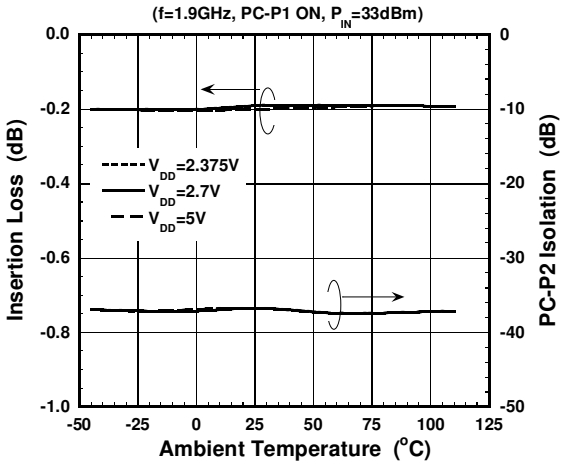


■ **ELECTRICAL CHARACTERISTICS** (With application circuit)

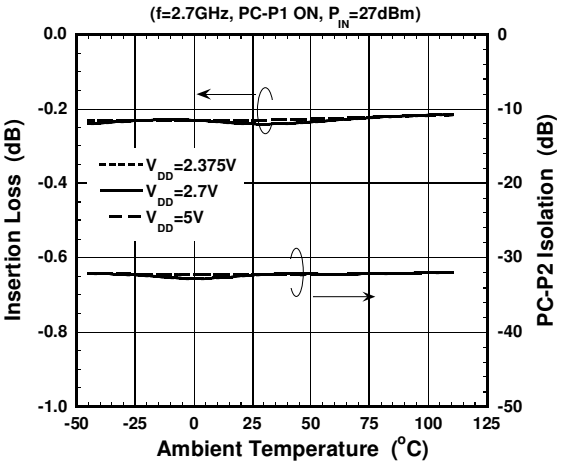
Loss, ISL vs Ambient Temperature



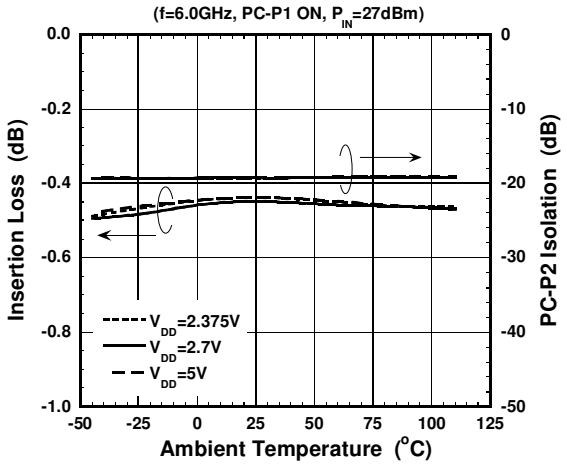
Loss, ISL vs Ambient Temperature



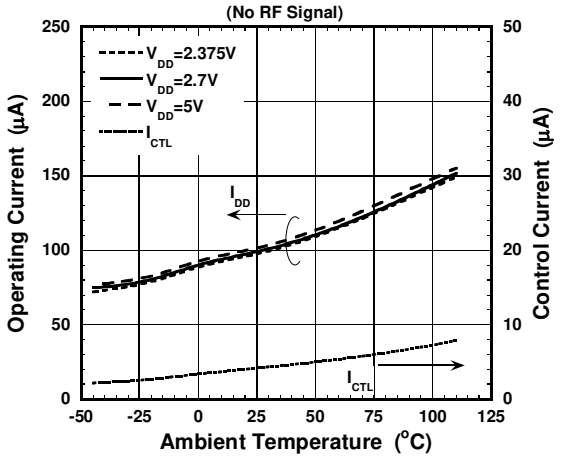
Loss, ISL vs Ambient Temperature



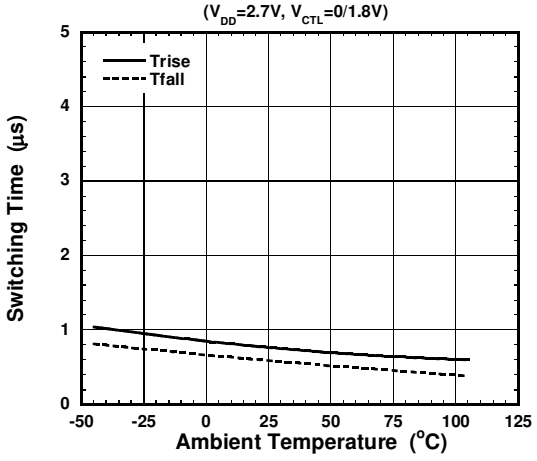
Loss, ISL vs Ambient Temperature



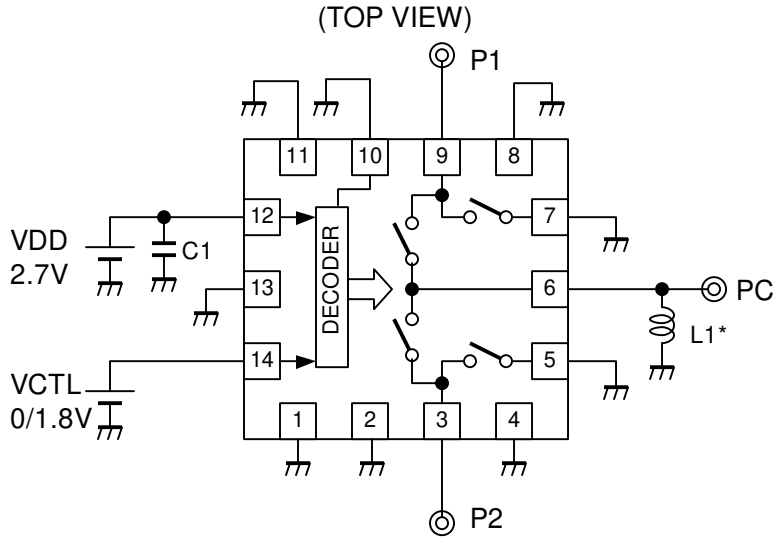
DC Current vs Ambient Temperature



Switching Time vs Ambient Temperature



■ APPLICATION CIRCUIT



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

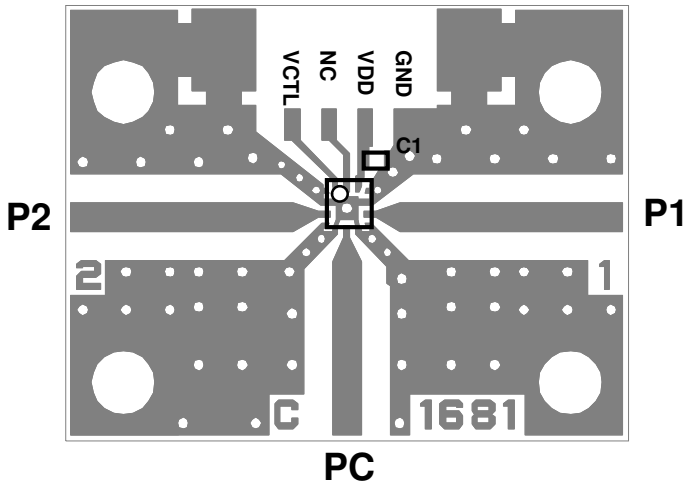
* The Inductor L1 is required for enhancing ESD protection level.
The inductor L1 is recommended in order to keep the DC bias level of each RF port at 0 V level tightly.

■ PARTS LIST

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

■ PCB LAYOUT

(TOP VIEW)



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.

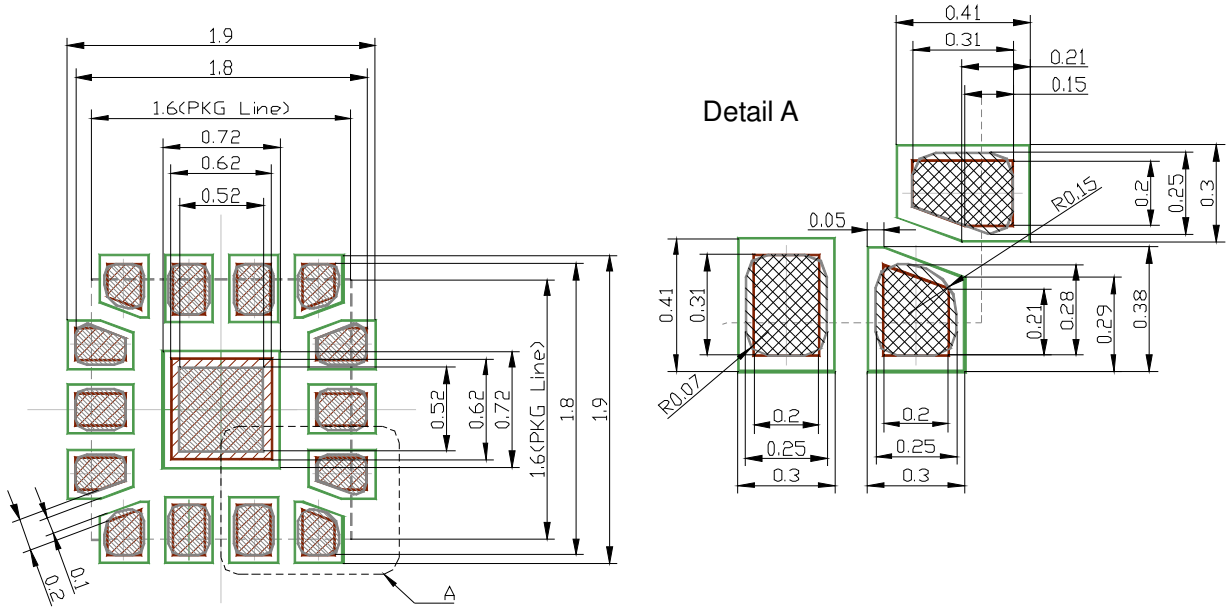
■ RECOMMENDED FOOTPRINT PATTERN (EQFN14-D7 PACKAGE Reference)

:Land

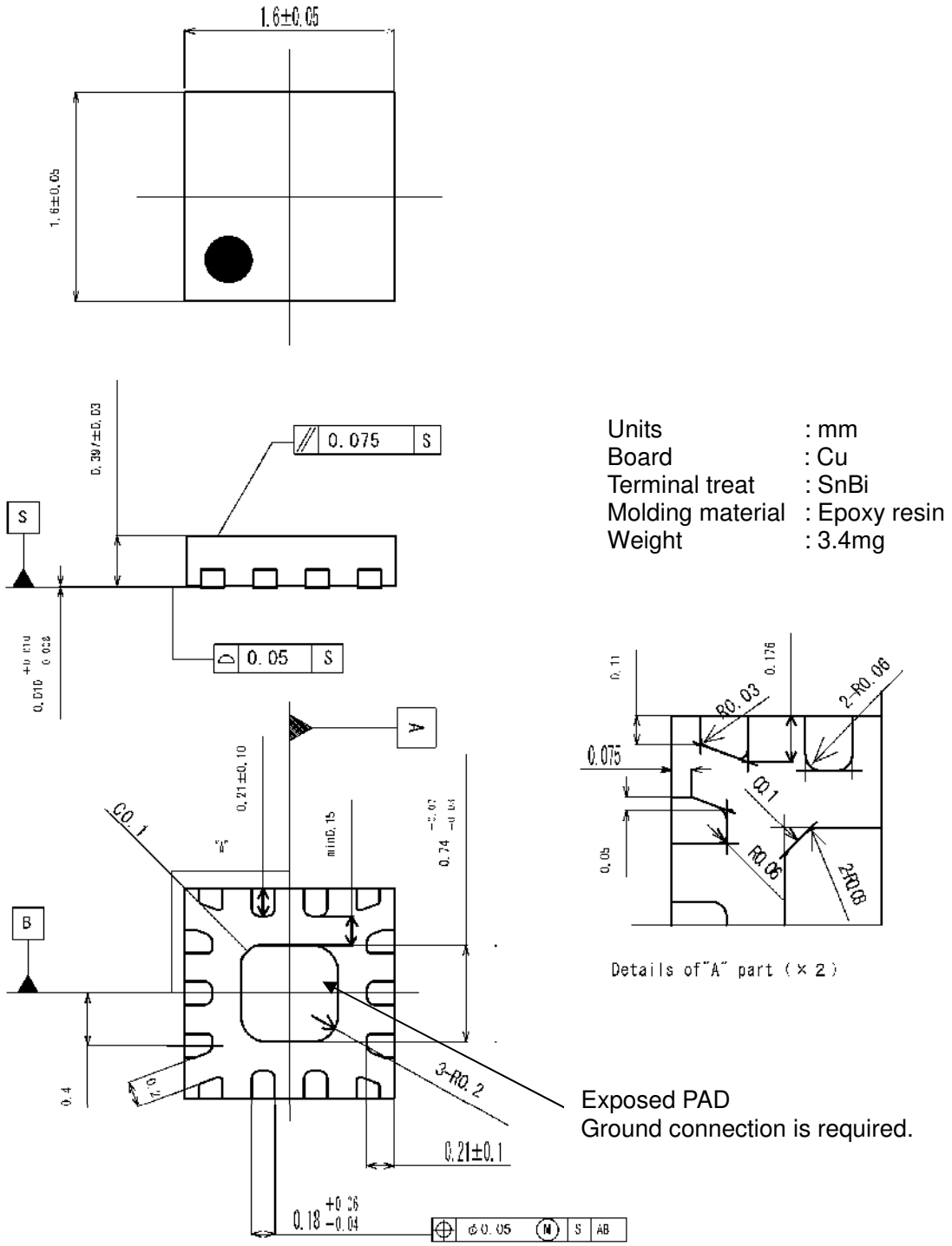
:Mask (Open area) *Metal mask thickness : 100μm

:Resist(Open area)

PKG: 1.6mm x 1.6mm
Pin pitch: 0.4mm



■ 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.

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    - 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.

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