

# HIGH POWER SP4T SWITCH GaAs MMIC

## ■ GENERAL DESCRIPTION

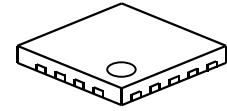
The NJG1809ME7 is a high power SP4T switch MMIC suitable for LTE-U / LAA, WLAN, and LTE applications.

This switch features very low insertion loss and high isolation up to 6GHz and excellent linearity performance with 1.8V control voltage. This switch achieves high speed switching time for WLAN application.

Integrated ESD protection device on each port achieves excellent ESD robustness. No DC Blocking capacitors are required for all RF ports unless DC is biased externally.

The small and thin EQFN18-E7 package is adopted.

## ■ PACKAGE OUTLINE



NJG1809ME7

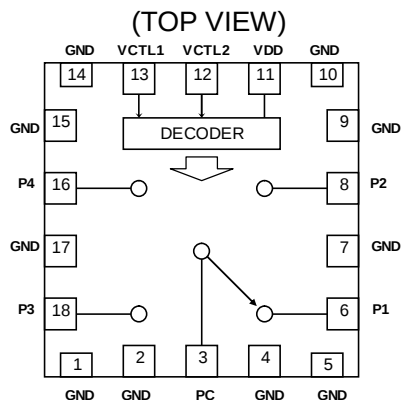
## ■ APPLICATIONS

LTE-U / LAA, WLAN (802.11a/b/g/n/ac), LTE multi-mode applications  
General purpose switching applications

## ■ FEATURES

- Low voltage logic control 1.35 to 5.0V
- Low insertion loss 0.40dB typ. @f=2.7GHz, 3.5GHz,  $P_{IN}=+27\text{dBm}$   
0.50dB typ. @f=5.85GHz,  $P_{IN}=+27\text{dBm}$
- High isolation 27dB typ. @f=2.7GHz,  $P_{IN}=+27\text{dBm}$   
25dB typ. @f=3.5GHz,  $P_{IN}=+27\text{dBm}$   
30dB typ. @f= 5.85GHz,  $P_{IN}=+27\text{dBm}$   
+32dBm min.
- $P_{-0.1\text{dB}}$  250ns typ.
- High speed switching time
- Small and thin package EQFN18-E7 (2.0x2.0x0.397mm typ.)
- RoHS compliant and Halogen Free, MSL1

## ■ PIN CONFIGURATION



### Pin connection

- |        |           |
|--------|-----------|
| 1. GND | 10. GND   |
| 2. GND | 11. VDD   |
| 3. PC  | 12. VCTL2 |
| 4. GND | 13. VCTL1 |
| 5. GND | 14. GND   |
| 6. P1  | 15. GND   |
| 7. GND | 16. P4    |
| 8. P2  | 17. GND   |
| 9. GND | 18. P3    |

Exposed PAD: GND

## ■ TRUTH TABLE

“H”= $V_{CTL(H)}$ , “L”= $V_{CTL(L)}$

| VCTL1 | VCTL2 | Path  |
|-------|-------|-------|
| L     | L     | PC-P1 |
| H     | L     | PC-P2 |
| L     | H     | PC-P3 |
| H     | H     | PC-P4 |

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

## ■ ABSOLUTE MAXIMUM RATINGS

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

| PARAMETER         | SYMBOL    | CONDITIONS                                                                      | RATINGS     | UNITS              |
|-------------------|-----------|---------------------------------------------------------------------------------|-------------|--------------------|
| RF Input Power    | $P_{IN}$  | $V_{DD}=2.75\text{V}$ , $V_{CTL}=0/1.8\text{V}$                                 | +33         | dBm                |
| Supply Voltage    | $V_{DD}$  | VDD terminal                                                                    | 5.0         | V                  |
| Control Voltage   | $V_{CTL}$ | VCTL1, VCTL2 terminal                                                           | 5.0         | V                  |
| Power Dissipation | $P_D$     | Four-layer FR4 PCB with through-hole (101.5x114.5mm), $T_j=150^{\circ}\text{C}$ | 1400        | mW                 |
| Operating Temp.   | $T_{opr}$ |                                                                                 | -40 to +105 | $^{\circ}\text{C}$ |
| Storage Temp.     | $T_{stg}$ |                                                                                 | -55 to +150 | $^{\circ}\text{C}$ |

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions:  $T_a=+25^{\circ}\text{C}$ ,  $V_{DD}=2.75\text{V}$ ,  $V_{CTL(H)}=1.8\text{V}$ ,  $V_{CTL(L)}=0\text{V}$ , with application circuit)

| PARAMETERS             | SYMBOL       | CONDITIONS               | MIN  | TYP  | MAX  | UNITS         |
|------------------------|--------------|--------------------------|------|------|------|---------------|
| Supply Voltage         | $V_{DD}$     | VDD Terminal             | 2.5  | 2.75 | 5.0  | V             |
| Operating Current      | $I_{DD}$     | No RF input              | -    | 350  | 700  | $\mu\text{A}$ |
| Control Voltage (LOW)  | $V_{CTL(L)}$ | VCTL1, VCTL2 Terminal    | 0    | -    | 0.45 | V             |
| Control Voltage (HIGH) | $V_{CTL(H)}$ | VCTL1, VCTL2 Terminal    | 1.35 | 1.8  | 5.0  | V             |
| Control Current        | $I_{CTL}$    | $V_{CTL(H)}=1.8\text{V}$ | -    | 4    | 10   | $\mu\text{A}$ |

## ■ ELECTRICAL CHARACTERISTICS 2 (RF)

(General conditions:  $T_a=+25^{\circ}\text{C}$ ,  $Z_s=Z_l=50\Omega$ ,  $V_{DD}=2.75\text{V}$ ,  $V_{CTL(H)}=1.8\text{V}$ ,  $V_{CTL(L)}=0\text{V}$ , with application circuit)

| PARAMETERS                                  | SYMBOL              | CONDITIONS                                                                               |                     | MIN  | TYP  | MAX  | UNITS |
|---------------------------------------------|---------------------|------------------------------------------------------------------------------------------|---------------------|------|------|------|-------|
| Insertion Loss 1                            | LOSS1               | $f=0.7\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | -    | 0.35 | 0.55 | dB    |
| Insertion Loss 2                            | LOSS2               | $f=2.0\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | -    | 0.40 | 0.60 | dB    |
| Insertion Loss 3                            | LOSS3               | $f=2.7\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | -    | 0.40 | 0.60 | dB    |
| Insertion Loss 4                            | LOSS4               | $f=3.5\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | -    | 0.40 | 0.60 | dB    |
| Insertion Loss 5                            | LOSS5               | $f=5.85\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                              |                     | -    | 0.50 | 0.75 | dB    |
| Isolation 1                                 | ISL1                | $f=0.7\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | 32   | 36   | -    | dB    |
| Isolation 2                                 | ISL2                | $f=2.0\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | 25   | 28   | -    | dB    |
| Isolation 3                                 | ISL3                | $f=2.7\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | 24   | 27   | -    | dB    |
| Isolation 4                                 | ISL4                | $f=3.5\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                               |                     | 22   | 25   | -    | dB    |
| Isolation 5                                 | ISL5                | $f=5.85\text{GHz}$ , $P_{IN}=+27\text{dBm}$                                              | PC-Pn <sup>*1</sup> | 26   | 30   | -    | dB    |
|                                             |                     |                                                                                          | Pm-Pn <sup>*2</sup> | 20   | 23   | -    |       |
| Input Power at 0.1 dB Compression Point     | P <sub>-0.1dB</sub> | $f=5.85\text{GHz}$                                                                       |                     | +32  | -    | -    | dBm   |
| 2nd Harmonics 1                             | 2fo(1)              | $f=5.18\text{GHz}$ , $5.85\text{GHz}$ , $P_{IN}=+27\text{dBm}$                           |                     | -    | -    | -70  | dBc   |
| 2nd Harmonics 2                             | 2fo(2)              | $f=2.69\text{GHz}$ , $P_{IN}=0\text{dBm}$                                                |                     | -    | -    | -95  | dBc   |
| 3rd Harmonics 1                             | 3fo(1)              | $f=5.18\text{GHz}$ , $5.85\text{GHz}$ , $P_{IN}=+27\text{dBm}$                           |                     | -    | -    | -70  | dBc   |
| 3rd Harmonics 2                             | 3fo(2)              | $f=1.732\text{GHz}$ , $1.91\text{GHz}$ , $P_{IN}=0\text{dBm}$                            |                     | -    | -    | -95  | dBc   |
| 4th Harmonics                               | 4fo                 | $f=5.18\text{GHz}$ , $5.85\text{GHz}$ , $P_{IN}=+27\text{dBm}$                           |                     | -    | -    | -70  | dBc   |
| Input 2 <sup>nd</sup> order intercept point | IIP2                | $f=2.48+2.69\text{GHz}$ , $f_{\text{meas}}=5.17\text{GHz}$ , $P_{IN}=+10\text{dBm}$ each |                     | +100 | -    | -    | dBm   |
| Input 3 <sup>rd</sup> order intercept point | IIP3                | $f=1.71+2.40\text{GHz}$ , $f_{\text{meas}}=5.82\text{GHz}$ , $P_{IN}=+10\text{dBm}$ each |                     | +60  | -    | -    | dBm   |
| VSWR1                                       | VSWR1               | On-state ports, $f=2.7\text{GHz}$                                                        |                     | -    | 1.2  | 1.5  | -     |
| VSWR2                                       | VSWR2               | On-state ports, $f=5.85\text{GHz}$                                                       |                     | -    | 1.3  | 1.6  | -     |
| Switching time                              | T <sub>SW</sub>     | 50% V <sub>CTL</sub> to 10/90% RF                                                        |                     | -    | 250  | 400  | ns    |

\*1: Pn=P1, P2, P3, P4

\*2: Pm=P1, P2, P3, P4. Pn=P1, P2, P3, P4. m≠n

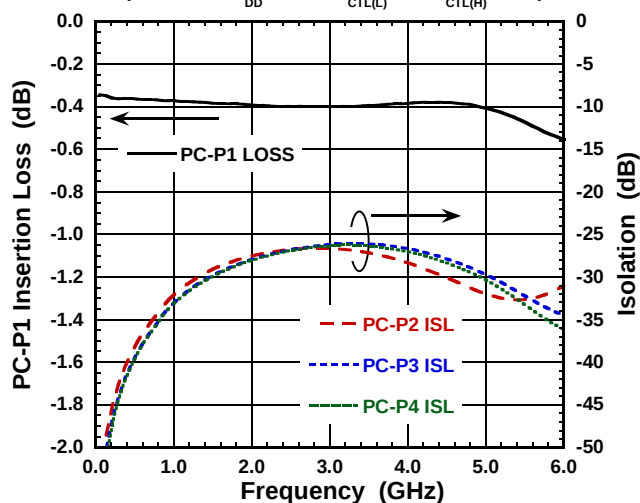
## ■ TERMINAL INFORMATION

| No.         | SYMBOL | DESCRIPTION                                                                                                                                                                |
|-------------|--------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1           | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 2           | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 3           | PC     | Common RF terminal. 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           | P1     | RF terminal. No DC blocking capacitor is required for this port unless DC is biased externally.                                                                            |
| 7           | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 8           | P2     | RF terminal. No DC blocking capacitor is required for this port unless DC is biased externally.                                                                            |
| 9           | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 10          | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 11          | VDD    | Positive voltage supply terminal. The positive voltage (+2.5 to +5V) has to be supplied. Please connect a bypass capacitor with ground plane for excellent RF performance. |
| 12          | VCTL2  | Control signal input terminal. This terminal is set to High-Level (+1.35 to +5.0V) or Low-Level (0 to +0.45V).                                                             |
| 13          | VCTL1  | Control signal input terminal. This terminal is set to High-Level (+1.35 to +5.0V) or Low-Level (0 to +0.45V).                                                             |
| 14          | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 15          | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 16          | P4     | RF terminal. No DC blocking capacitor is required for this port unless DC is biased externally.                                                                            |
| 17          | GND    | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance.                                                         |
| 18          | P3     | RF terminal. No DC blocking capacitor is required for this port unless DC is biased externally.                                                                            |
| Exposed Pad | GND    | Ground pad of IC bottom side. Please connect this pad with ground plane as close as possible for excellent RF performance.                                                 |

## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

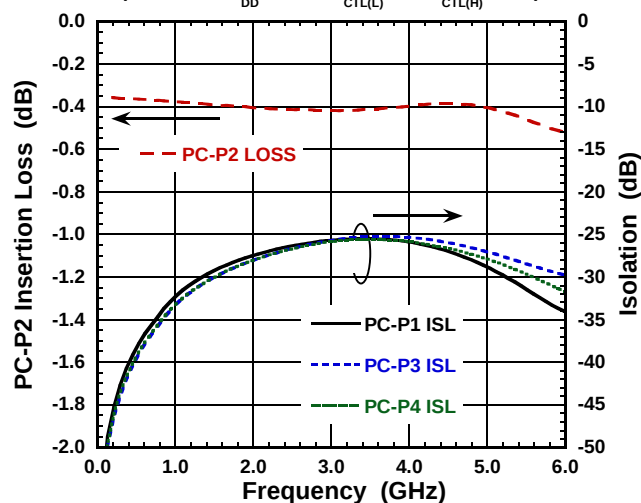
### LOSS, ISL vs Frequency

(PC-P1 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



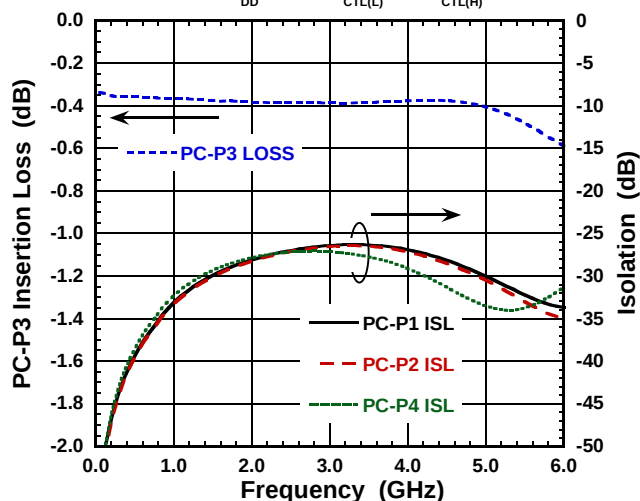
### LOSS, ISL vs Frequency

(PC-P2 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



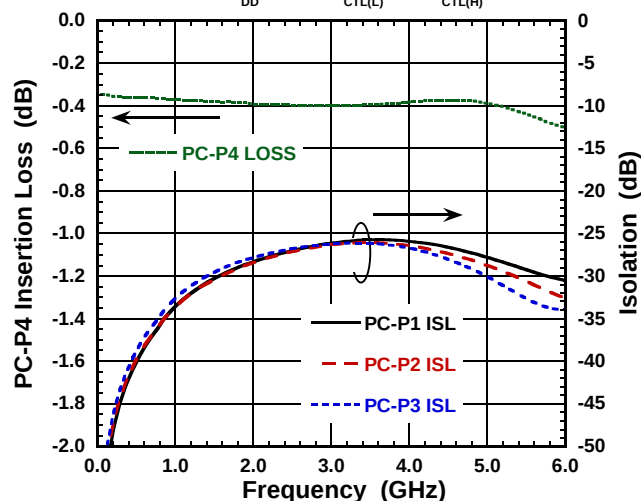
### LOSS, ISL vs Frequency

(PC-P3 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



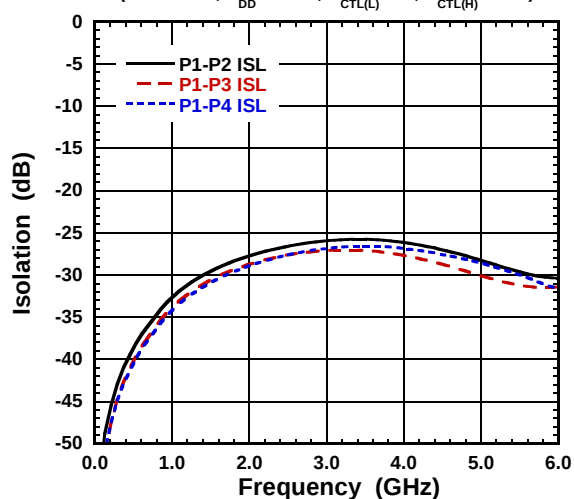
### LOSS, ISL vs Frequency

(PC-P4 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



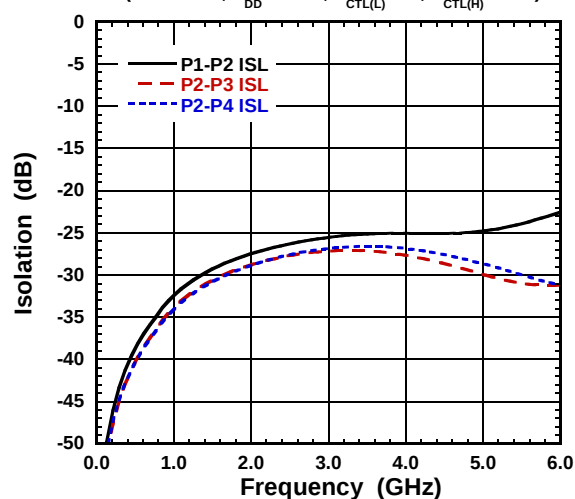
### ISL vs Frequency

(PC-P1 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



### ISL vs Frequency

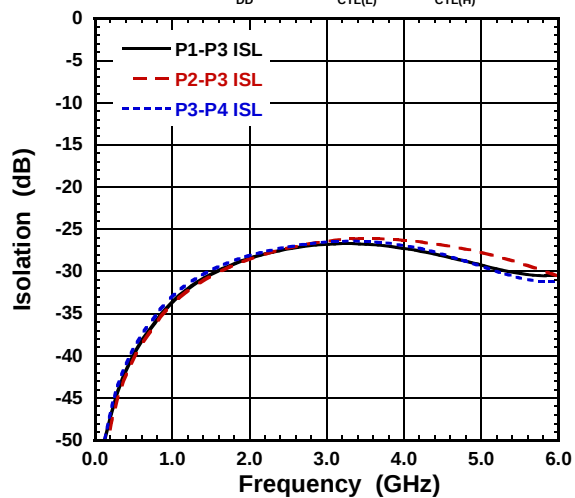
(PC-P2 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

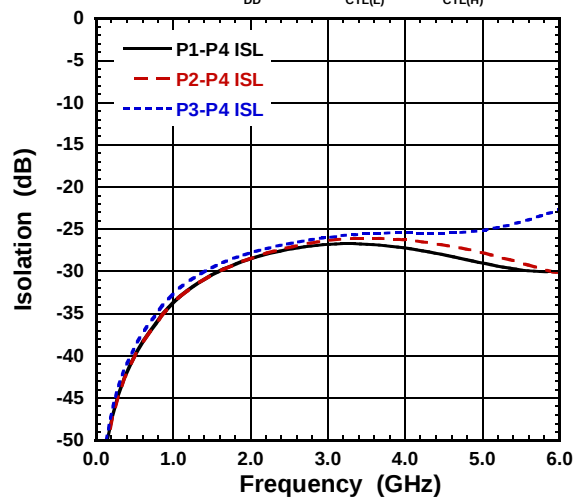
### ISL vs Frequency

(PC-P3 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



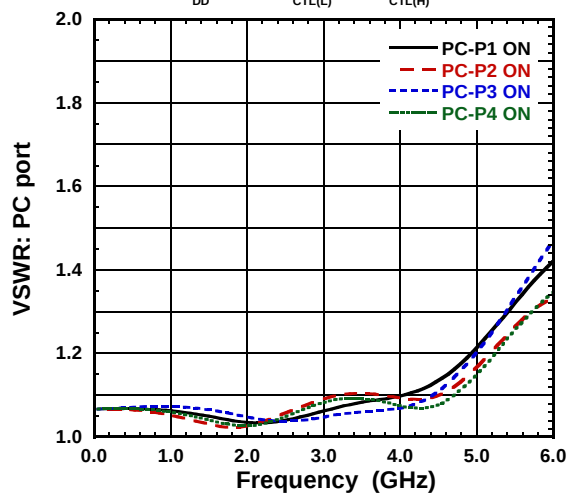
### ISL vs Frequency

(PC-P4 ON,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



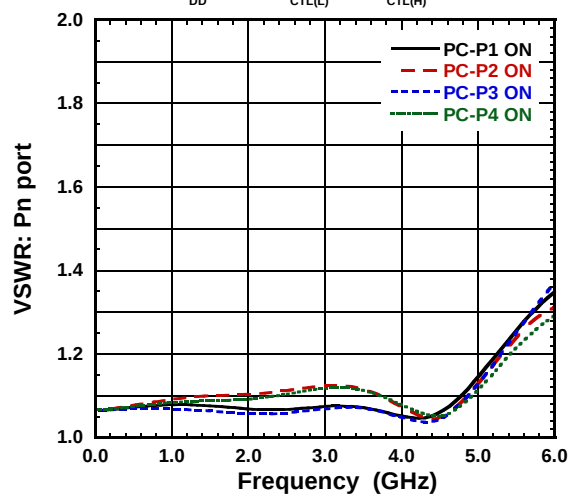
### VSWR vs Frequency

( $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



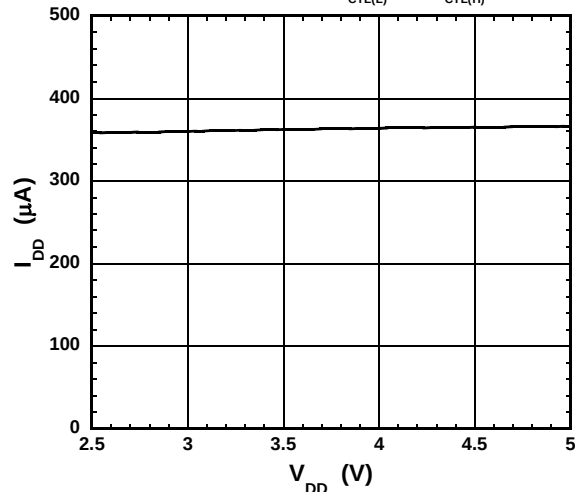
### VSWR vs Frequency

( $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



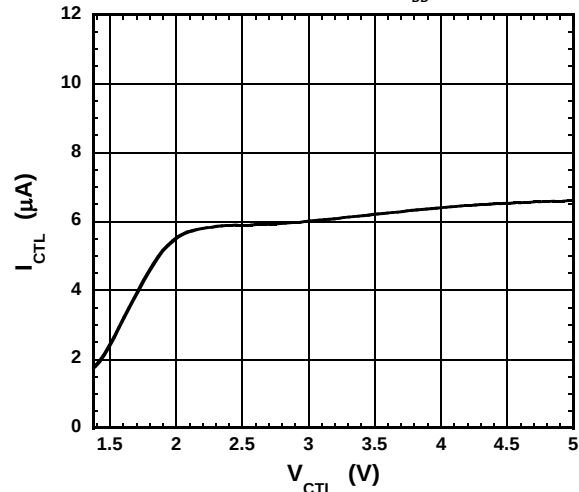
### $I_{DD}$ vs $V_{DD}$

(No RF input, PC-P1 ON,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )



### $I_{CTL}$ vs $V_{CTL}$

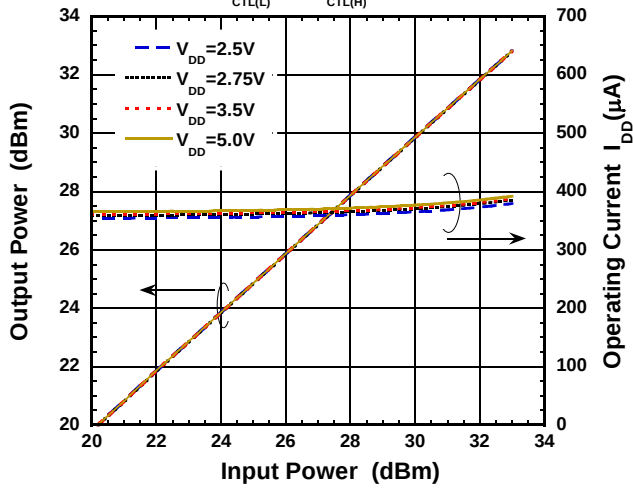
(No RF input, PC-P1 ON,  $V_{DD}=2.75V$ )



## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

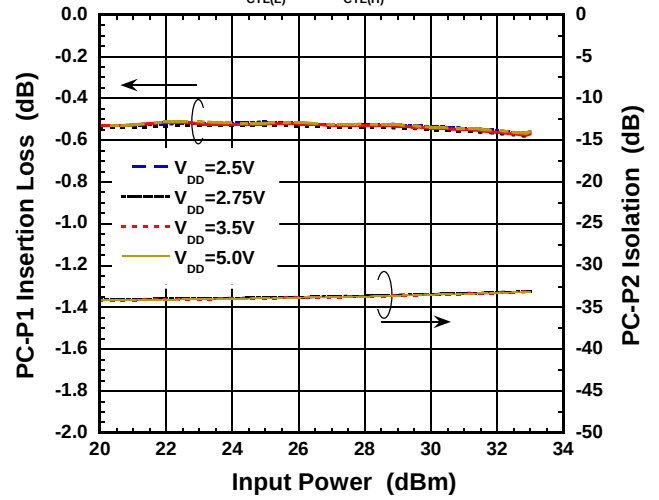
### Output Power, $I_{DD}$ vs Input Power

(PC-P1 ON,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=5.85GHz$ )



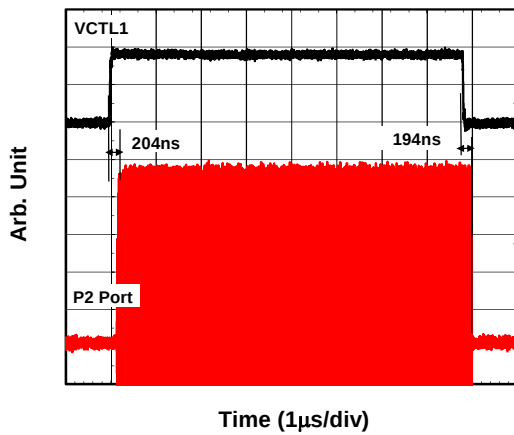
### Loss, ISL vs Input Power

(PC-P1 ON,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=5.85GHz$ )



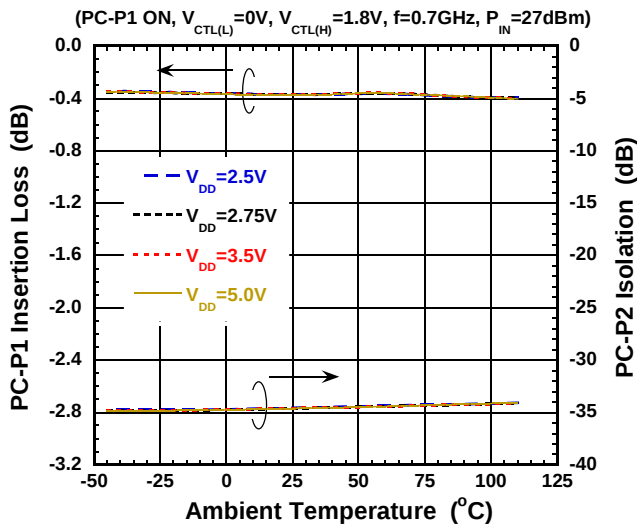
### Switching Time

(PC-P1/P2 path,  $V_{DD}=2.75V$ ,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ )

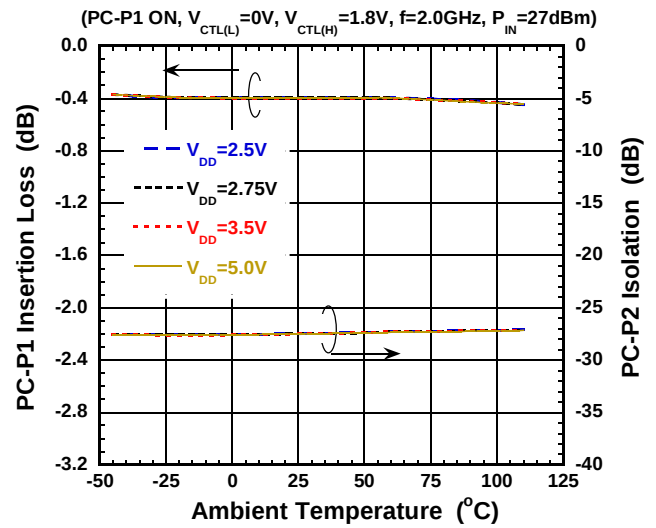


## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

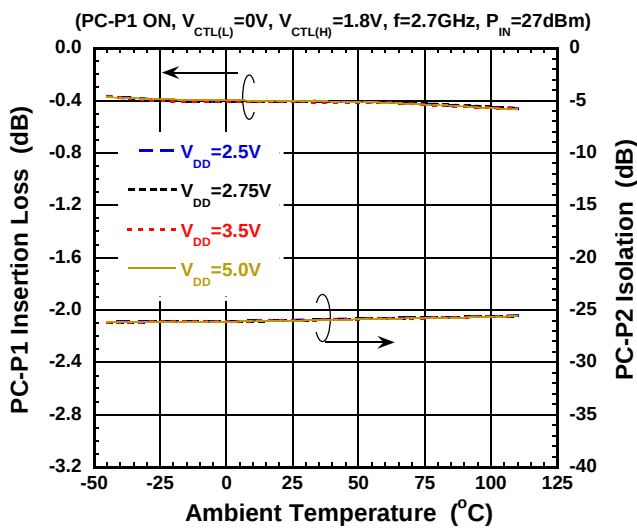
### Loss, ISL vs Temperature



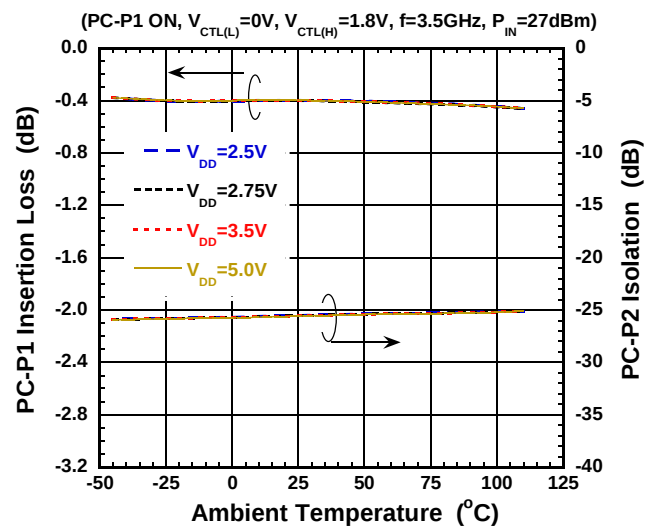
### Loss, ISL vs Temperature



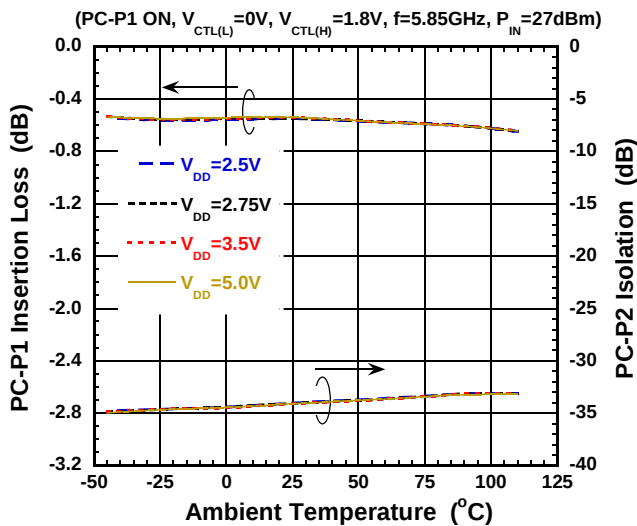
### Loss, ISL vs Temperature



### Loss, ISL vs Temperature



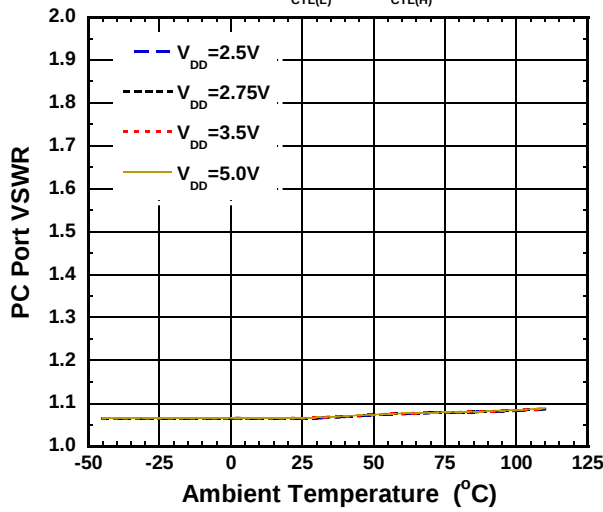
### Loss, ISL vs Temperature



## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

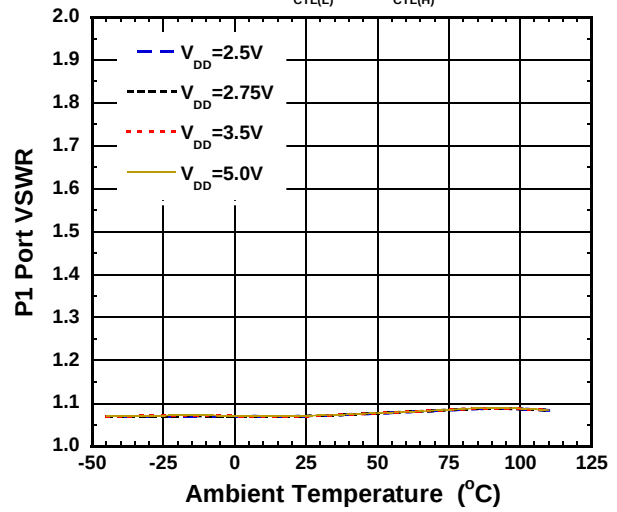
### VSWR vs Temperature

(PC-P1 ON, PC Port,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=2.7GHz$ )



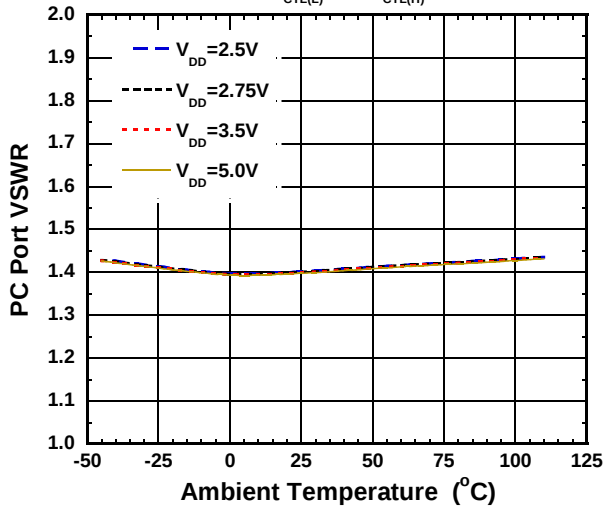
### VSWR vs Temperature

(PC-P1 ON, P1 Port,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=2.7GHz$ )



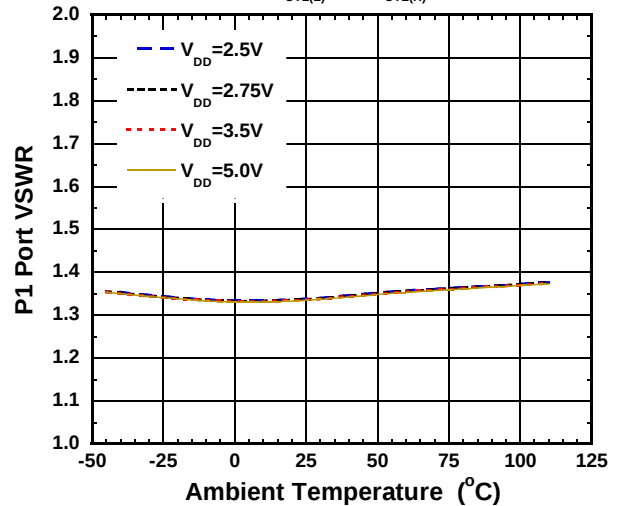
### VSWR vs Temperature

(PC-P1 ON, PC Port,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=5.85GHz$ )



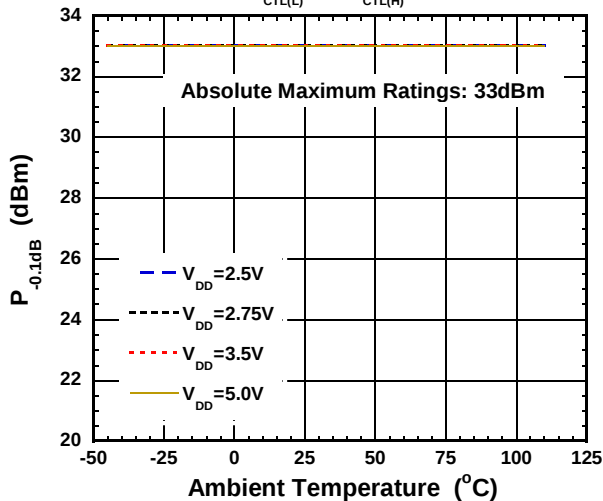
### VSWR vs Temperature

(PC-P1 ON, P1 Port,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=5.85GHz$ )



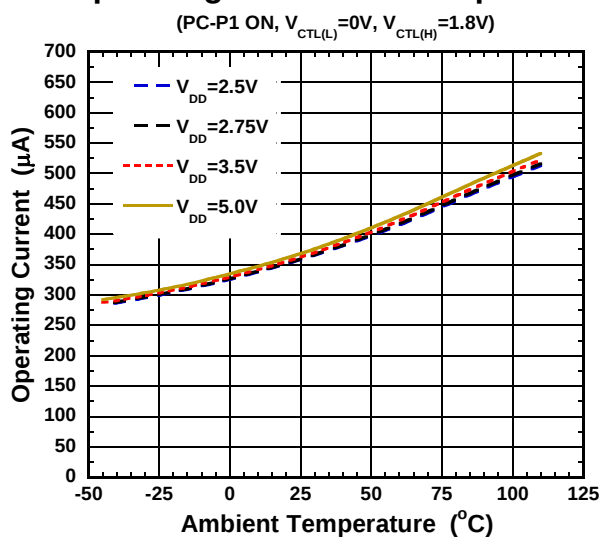
### P<sub>-0.1dB</sub> vs Temperature

(PC-P1 ON,  $V_{CTL(L)}=0V$ ,  $V_{CTL(H)}=1.8V$ ,  $f=5.85GHz$ )

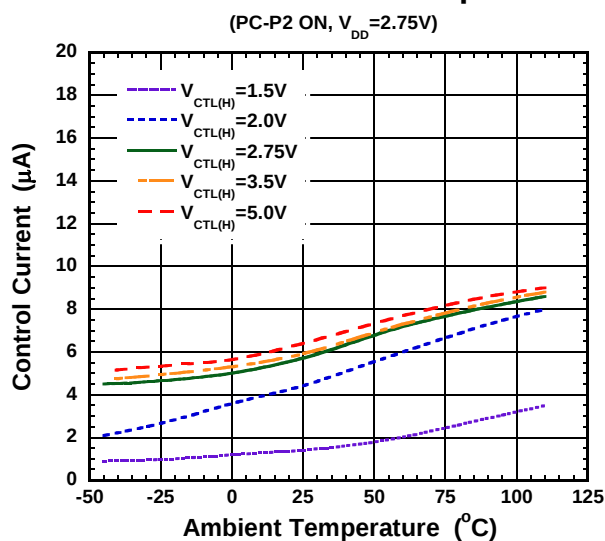


## ■ ELECTRICAL CHARACTERISTICS (With application circuit, loss of external circuit are excluded.)

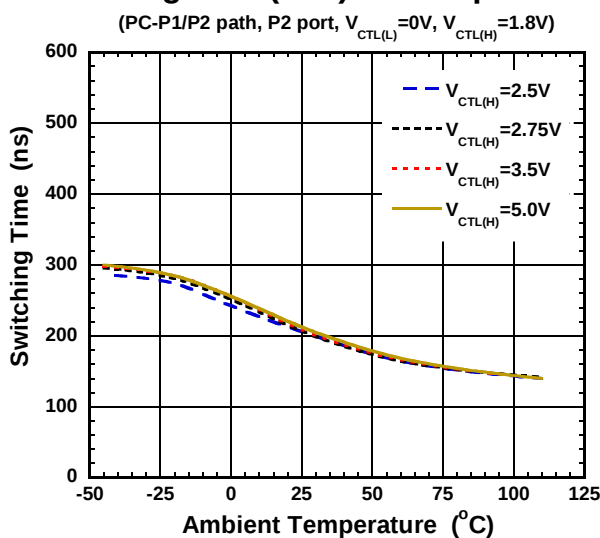
### Operating Current vs Temperature



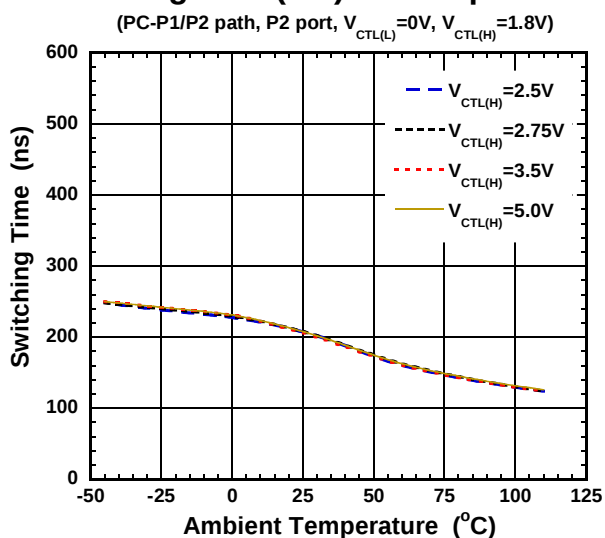
### Control Current vs Temperature



### Switching Time(rise) vs Temperature



### Switching Time(fall) vs Temperature

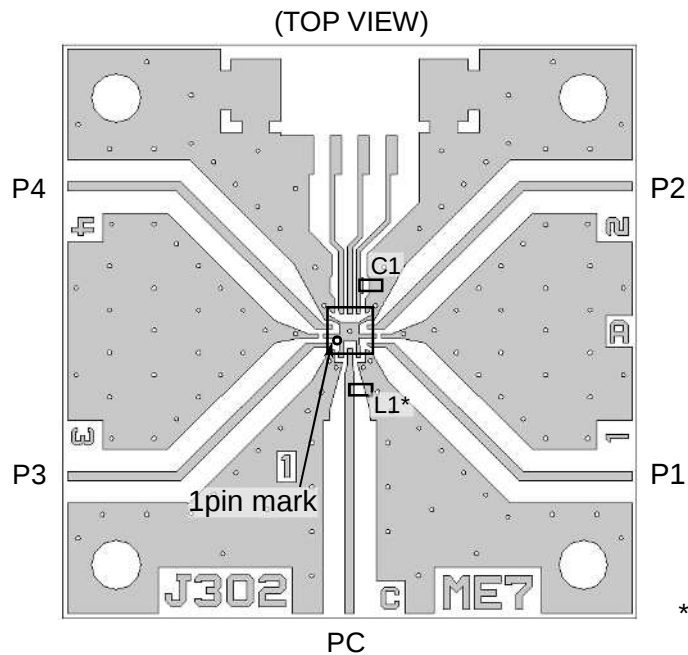




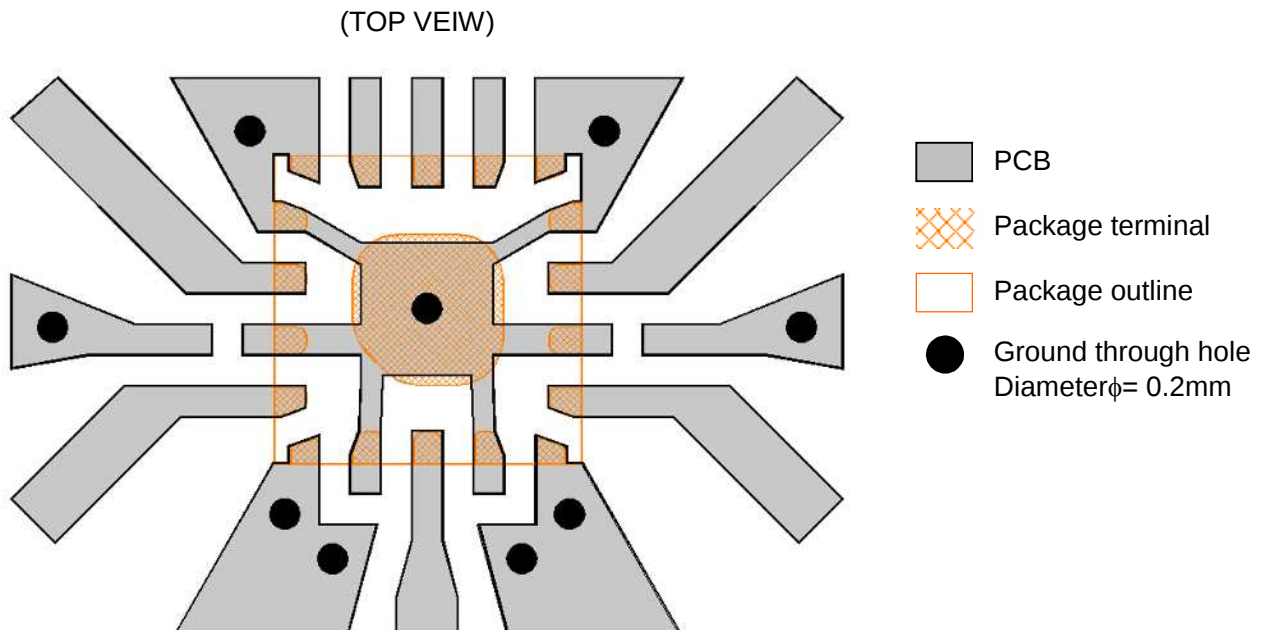
- [1] No DC blocking capacitors are required on all RF ports, unless DC is biased externally.  
[2] The inductor L1 is optional in order to achieve enhancing ESD protection level. L1 is also recommended in order to keep the DC bias level of each RF port at ground level tightly.

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

## PCB LAYOUT



## <PCB LAYOUT GUIDELINE>



## PRECAUTIONS

- [1] No DC block capacitors are required for RF ports unless DC is biased externally. When other device biased at certain voltage is connected to the NJG1809ME7, a DC block capacitor is required between the device and this switch IC. This is because the each RF port of this switch is biased at ground level.
- [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 near the IC.
- [4] Please connect Exposed PAD to PCB ground plane of substrate, and through holes for ground should be placed under the IC.

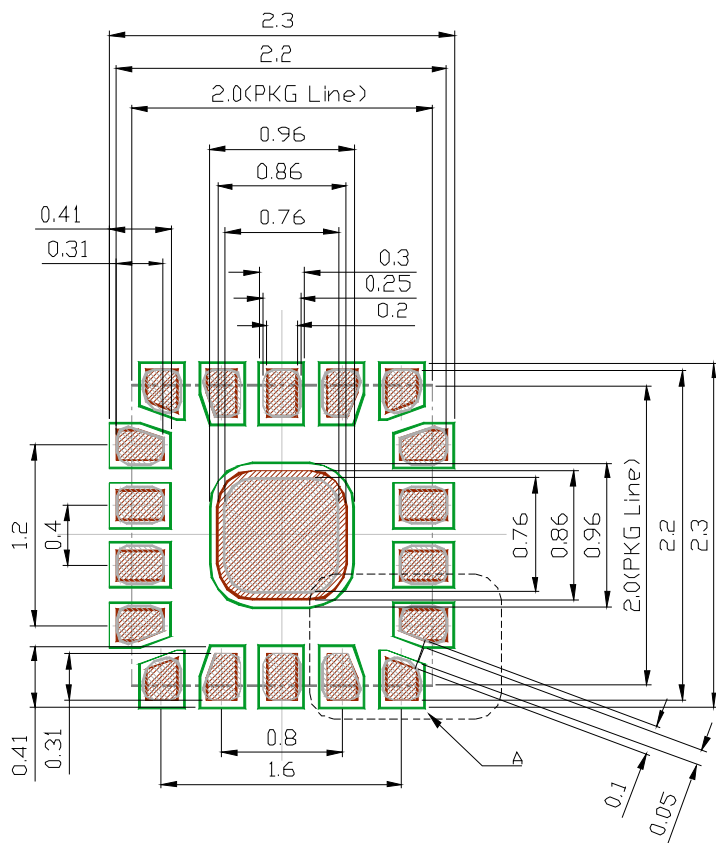
## RECOMMENDED FOOTPRINT PATTERN (EQFN18-E7 PACKAGE REFERENCE)

 : Land

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

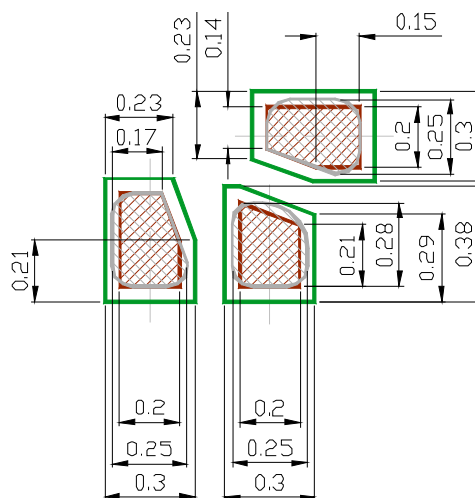
 : Resist (Open area)

PKG: 2.0x2.0mm<sup>2</sup>  
Pin pitch: 0.4mm

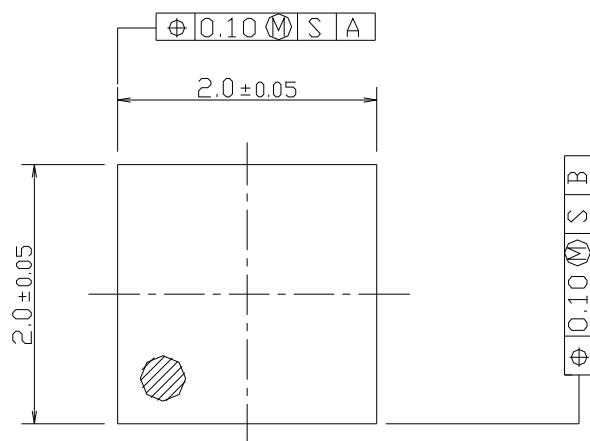


Unit: mm

Detail A

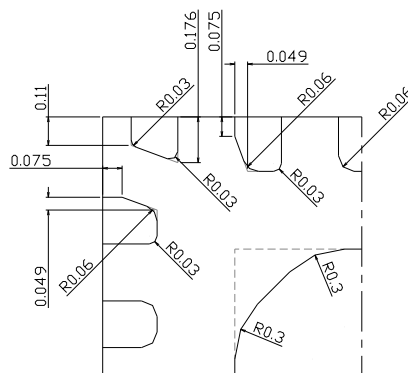
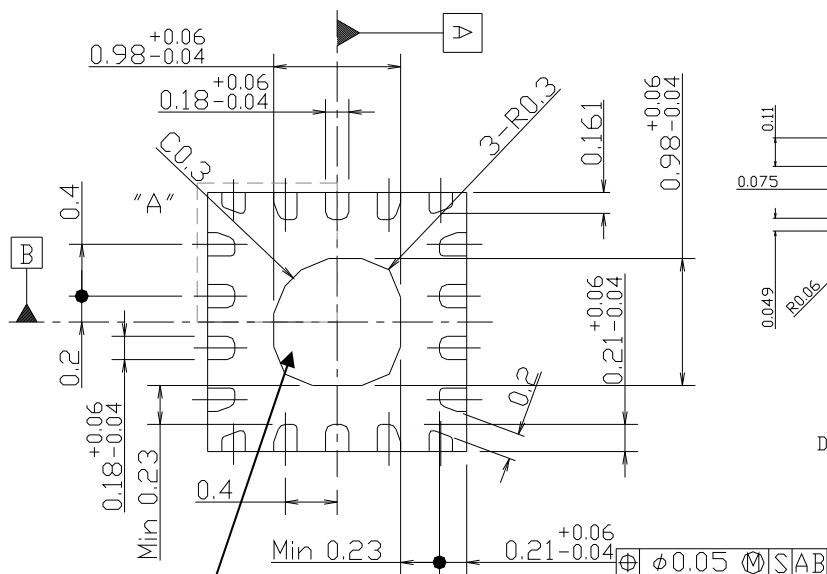
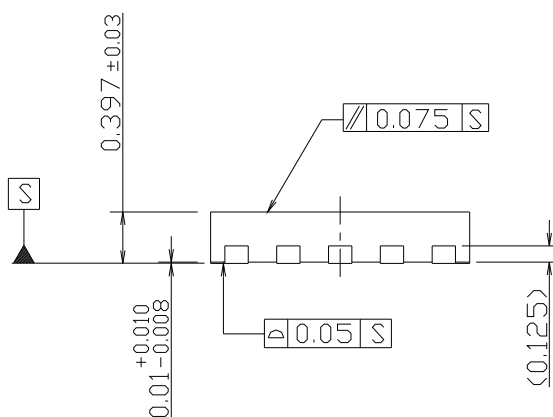


## ■ PACKAGE OUTLINE (EQFN18-E7)



Terminal Treat : SnBi  
Board : Copper  
Molding Material : Epoxy resin  
Weight : 5.0mg

Unit : mm



Details of "A" part (x2)

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.

### [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.

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