# HIGH POWER SP4T SWITCH GaAs MMIC

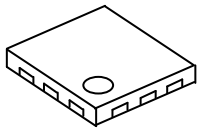
## ■ GENERAL DESCRIPTION

The NJG1684ME2 is a GaAs SP4T switch MMIC suitable for LTE/UMTS/CDMA/GSM applications.

The NJG1684ME2 features very low insertion loss, high isolation and excellent linearity performance down to 1.8V control voltage at high frequency up to 2.7GHz. In addition, this switch is able to handle high power signals.

The NJG1684ME2 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 EQFN12-E2 package is adopted.

## ■ PACKAGE OUTLINE



NJG1684ME2

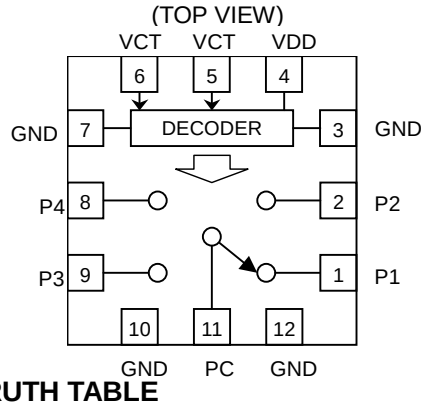
## ■ APPLICATIONS

LTE, UMTS, CDMA, GSM applications
Post PA Switching, Antenna Switching and Bands Switching applications
General Purpose Switching applications

## ■ FEATURES

| | |
|---|---|
| ● Low voltage logic control | $V_{CTL(H)}$=1.8V typ. |
| ● Low voltage operation | $V_{DD}$=2.7V typ. |
| ● Low distortion | IIP3=+70dBm typ. @f=829+849MHz, $P_{IN}$=24dBm |
| | IIP3=+69dBm typ. @f=1870+1910MHz, $P_{IN}$=24dBm |
| | 2nd harmonics=-80dBc typ. @f=0.9GHz, $P_{IN}$=35dBm |
| | 3rd harmonics=-77dBc typ. @f=0.9GHz, $P_{IN}$=35dBm |
| ● Low insertion loss | 0.25dB typ. @f=0.9GHz, $P_{IN}$=35dBm, $V_{DD}$=2.7V |
| | 0.30dB typ. @f=1.9GHz, $P_{IN}$=33dBm, $V_{DD}$=2.7V |
| | 0.35dB typ. @f=2.7GHz, $P_{IN}$=27dBm, $V_{DD}$=2.7V |
| ● $P_{-0.1dB}$ | 36dBm min. |
| ● Ultra small & ultra thin package | EQFN12-E2 (Package size: 1.8 x 1.8 x 0.397mm) |
| ● RoHS compliant and Halogen Free, MSL1 | |

## ■ PIN CONFIGURATION




Pin connection

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

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 catalog will be subject to change.

## ■ ABSOLUTE MAXIMUM RATINGS

$T_a$=+25℃, $Z_s$=$Z_l$=50ohm

| PARAMETER | SYMBOL | CONDITIONS | RATINGS | UNITS |
|---|---|---|---|---|
| RF Input Power | $P_{IN}$ | $V_{DD}$ =2.7V, $V_{CTL}$=0/1.8V | 37 | 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), Tj=150℃ | 1200 | mW |
| Operating Temp. | $T_{opr}$ | | -40~+85 | ℃ |
| Storage Temp. | $T_{stg}$ | | -55~+150 | ℃ |

## ■ ELECTRICAL CHARACTERISTICS 1 (DC)

(General conditions: $T_a$=+25℃, $Z_s$=$Z_l$=50ohm, $V_{DD}$=2.7V, $V_{CTL(H)}$=1.8V, $V_{CTL(L)}$=0V, with application circuit)

| PARAMETERS | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Supply Voltage | $V_{DD}$ | VDD Terminal | 2.375 | 2.7 | 5.0 | V |
| Operating Current | $I_{DD}$ | No RF input | - | 180 | 400 | μA |
| 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 | $I_{CTL}$ | $V_{CTL(H)}$=1.8V | - | 4 | 10 | μA |

## ■ ELECTRICAL CHARACTERISTICS 2 (RF)

(General conditions: $T_a$=+25℃, $Z_s$=$Z_l$=50ohm, $V_{DD}$=2.7V, $V_{CTL(H)}$=1.8V, $V_{CTL(L)}$=0V, with application circuit)

| PARAMETERS | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Insertion Loss 1 | LOSS1 | f=0.9GHz, $P_{IN}$=35dBm | - | 0.25 | 0.40 | dB |
| Insertion Loss 2 | LOSS2 | f=1.9GHz, $P_{IN}$=33dBm | - | 0.30 | 0.45 | dB |
| Insertion Loss 3 | LOSS3 | f=2.7GHz, $P_{IN}$=27dBm | - | 0.35 | 0.50 | dB |
| Isolation 1 | ISL1 | f=0.9GHz, $P_{IN}$=35dBm | 30 | 37 | - | dB |
| Isolation 2 | ISL2 | f=1.9GHz, $P_{IN}$=33dBm | 25 | 29 | - | dB |
| Isolation 3 | ISL3 | f=2.7GHz, $P_{IN}$=27dBm | 22 | 25 | - | dB |
| Input Power at 0.1dB Compression Point | $P_{-0.1dB}$ | f=0.9GHz, 1.9GHz, 2.7GHz | 36 | - | - | dBm |
| 2nd Harmonics 1 | 2fo(1) | f=0.9GHz, $P_{IN}$=35dBm | - | -80 | -70 | dBc |
| 2nd Harmonics 2 | 2fo(2) | f=1.9GHz, $P_{IN}$=33dBm | - | -80 | -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 | - | -77 | -70 | dBc |
| 3rd Harmonics 2 | 3fo(2) | f=1.9GHz, $P_{IN}$=33dBm | - | -77 | -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 *1 | +65 | +70 | - | dBm |
| Input 3rd order intercept point2 | IIP3(2) | f=1870+1910MHz, $P_{IN}$=24dBm each *1 | +63 | +69 | - | dBm |
| VSWR | VSWR | On-state ports, f=2.7GHz | - | 1.2 | 1.4 | |
| Switching time | $T_{SW}$ | 50% $V_{CTL}$ to 10/90% RF | - | 1.0 | 5.0 | μs |

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

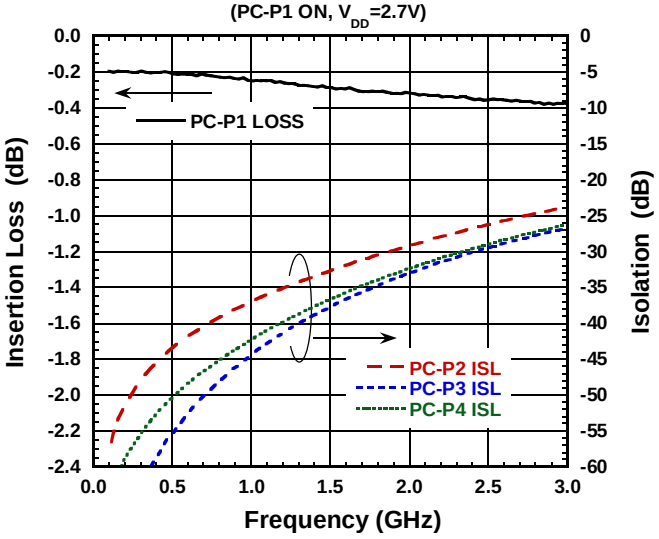
## ■ TERMINAL INFORMATION

| No. | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | P1 | RF transmitting/receiving port. |
| 2 | P2 | RF transmitting/receiving port. |
| 3 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance. |
| 4 | 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. |
| 5 | VCTL2 | Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V). |
| 6 | VCTL1 | Control signal input terminal. This terminal is set to High-Level (+1.35~+5.0V) or Low-Level (0~+0.45V). |
| 7 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance. |
| 8 | P4 | RF transmitting/receiving port. |
| 9 | P3 | RF transmitting/receiving port. |
| 10 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance. |
| 11 | PC | RF transmitting/receiving port. Please connect an inductor with GND terminal for ESD protection. |
| 12 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for excellent RF performance. |
| Exposed Pad | GND | Ground terminal. |

■ **ELECTRICAL CHARACTERISTICS** (With Application circuit, Loss of external circuit are excluded)

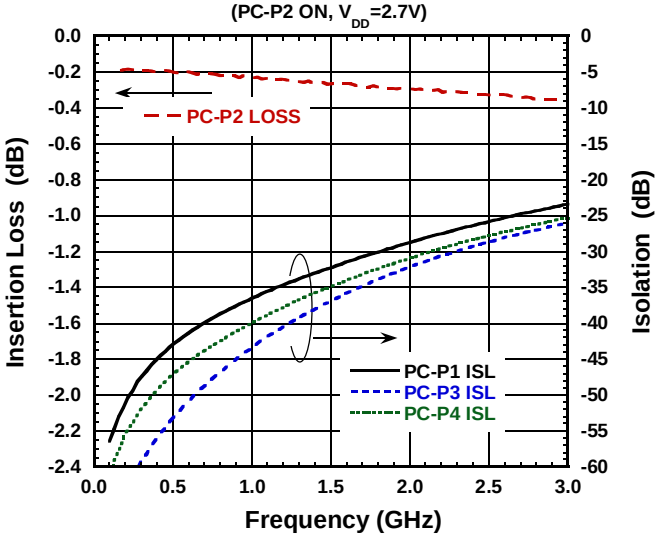
**Loss, ISL vs Frequency**

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



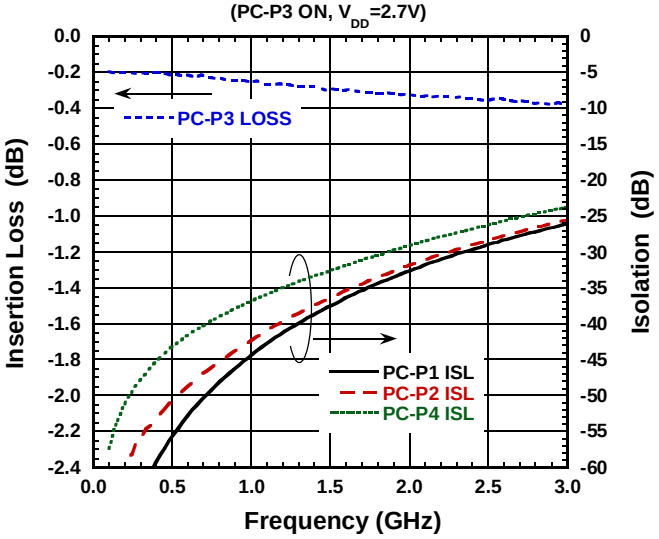

**Loss, ISL vs Frequency**

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



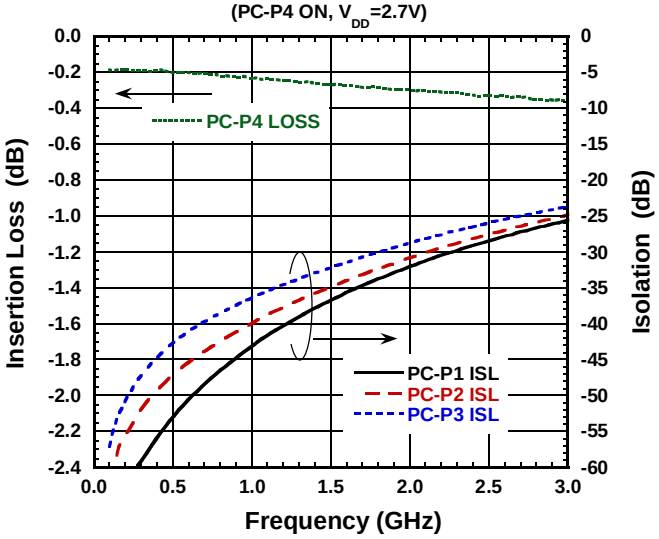

**Loss, ISL vs Frequency**

(PC-P3 ON, $V_{DD}$=2.7V)



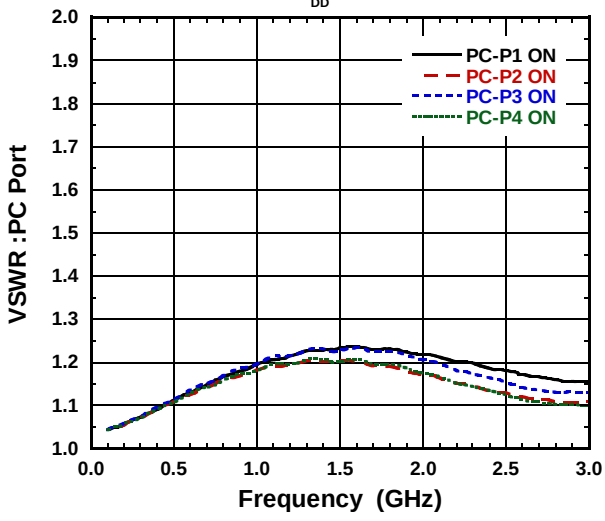

**Loss, ISL vs Frequency**

(PC-P4 ON, $V_{DD}$=2.7V)



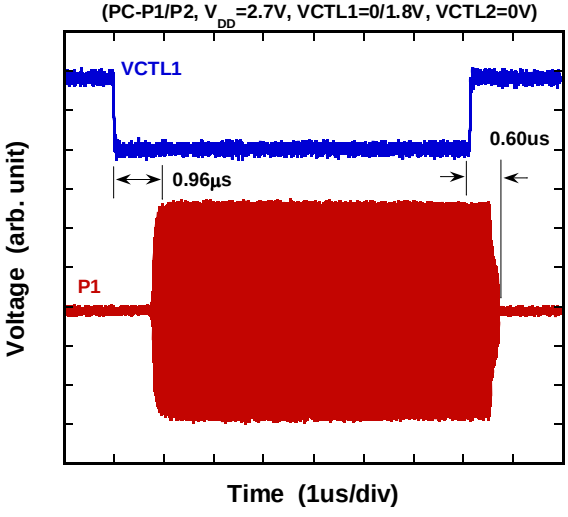

**VSWR vs Frequency**

($V_{DD}$=2.7V)




**Switching Time**

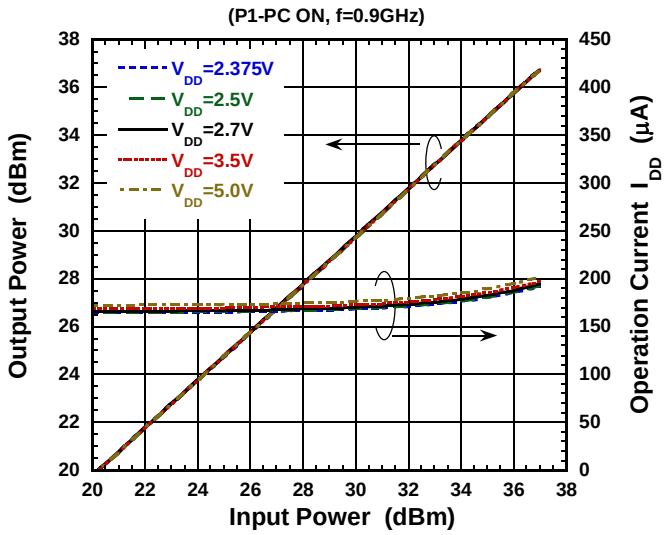
(PC-P1/P2, $V_{DD}$=2.7V, VCTL1=0/1.8V, VCTL2=0V)



■ **ELECTRICAL CHARACTERISTICS** (With Application circuit, Loss of external circuit are excluded)

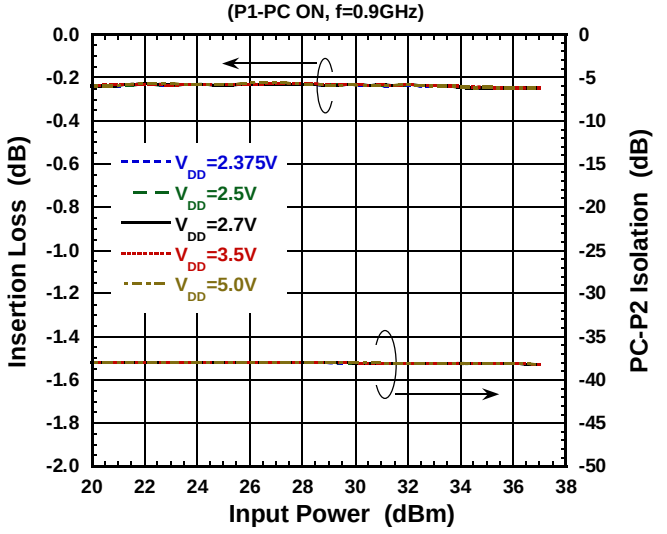
**Output Power, $I_{DD}$ vs Input Power**

(P1-PC ON, f=0.9GHz)



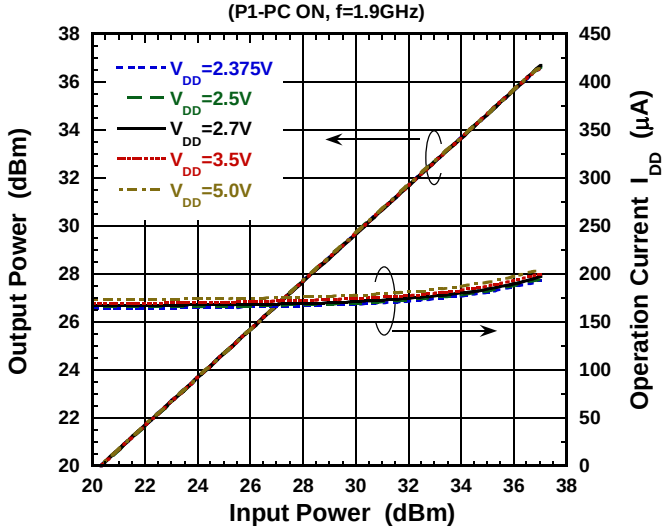

**Loss, ISL vs Input Power**

(P1-PC ON, f=0.9GHz)



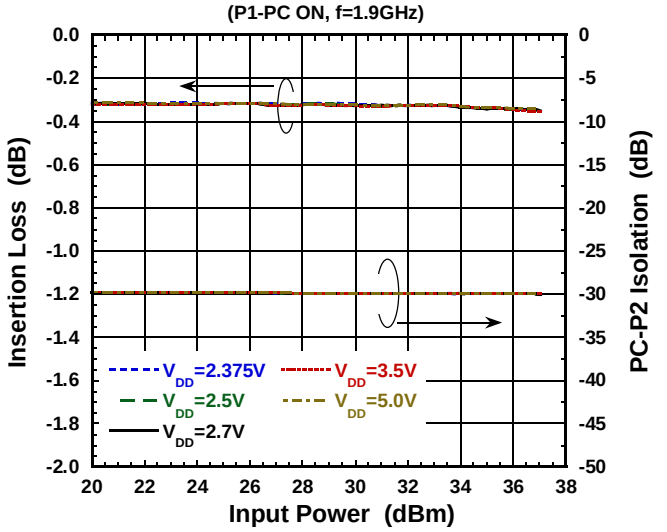

**Output Power, $I_{DD}$ vs Input Power**

(P1-PC ON, f=1.9GHz)



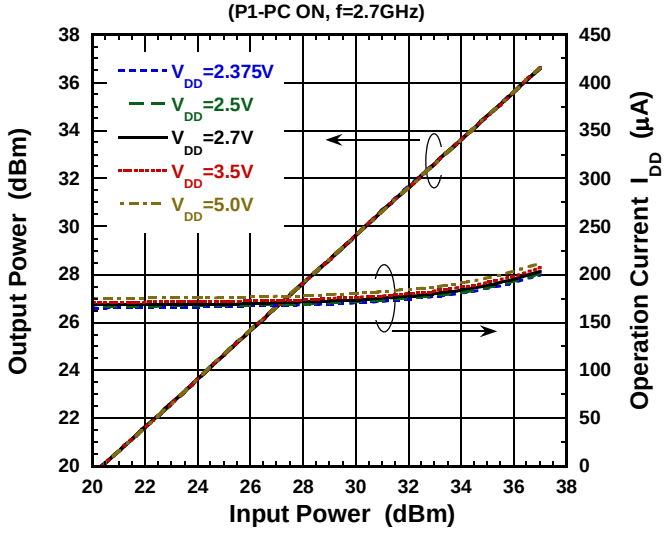

**Loss, ISL vs Input Power**

(P1-PC ON, f=1.9GHz)



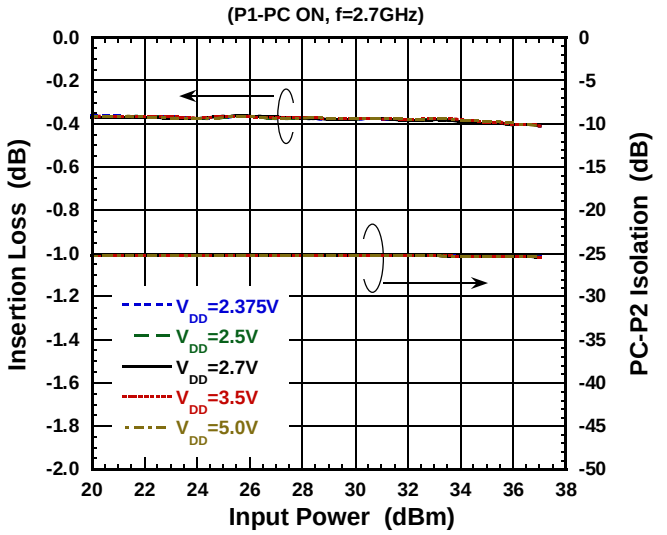

**Output Power, $I_{DD}$ vs Input Power**

(P1-PC ON, f=2.7GHz)




**Loss, ISL vs Input Power**

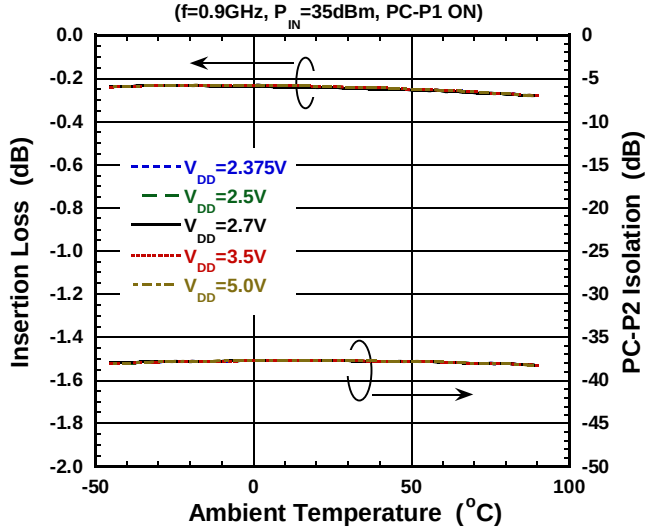
(P1-PC ON, f=2.7GHz)



■ **ELECTRICAL CHARACTERISTICS** (With Application circuit, Loss of external circuit are excluded)

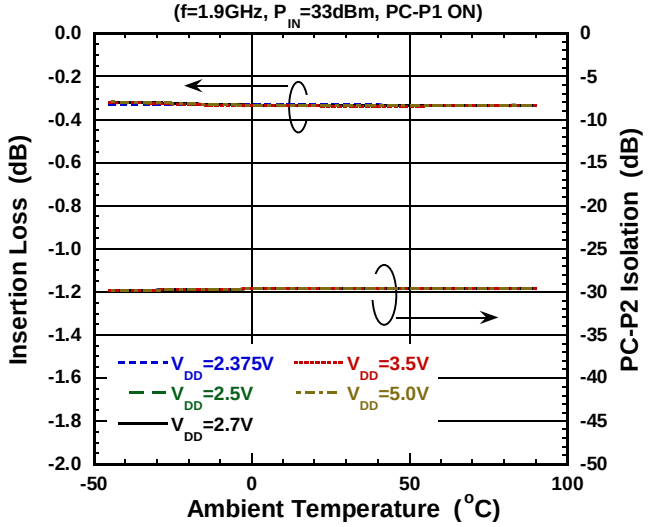
**Loss, ISL vs Temperature**

(f=0.9GHz, $P_{IN}$=35dBm, PC-P1 ON)



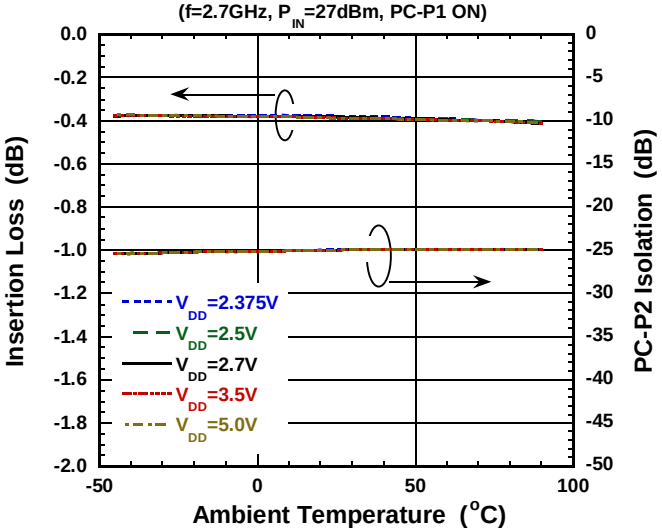

**Loss, ISL vs Temperature**

(f=1.9GHz, $P_{IN}$=33dBm, PC-P1 ON)



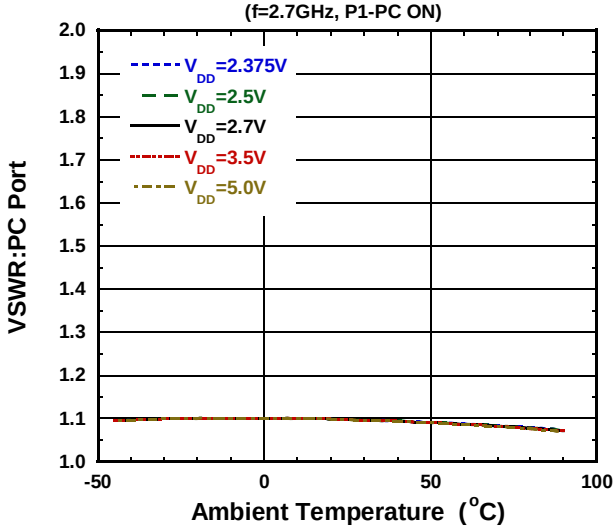

**Loss, ISL vs Temperature**

(f=2.7GHz, $P_{IN}$=27dBm, PC-P1 ON)



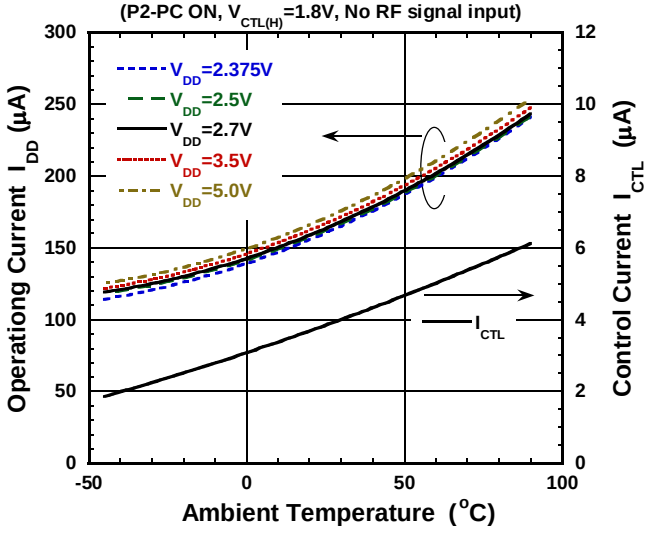

**VSWR vs Temperature**

(f=2.7GHz, P1-PC ON)



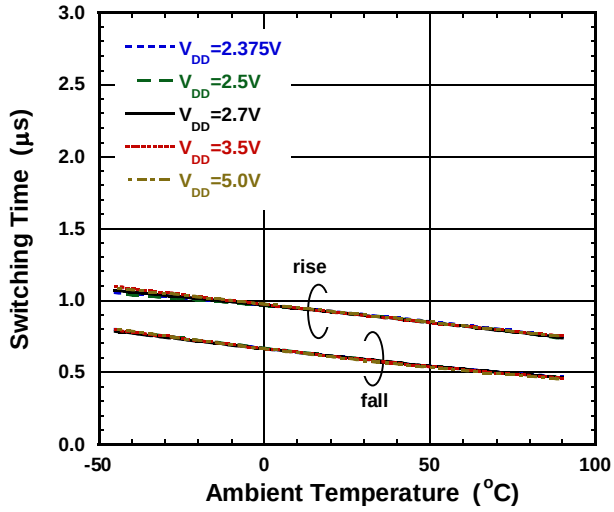

**$I_{DD}$, $I_{CTL}$ vs Temperature**

(P2-PC ON, $V_{CTL(H)}$=1.8V, No RF signal input)



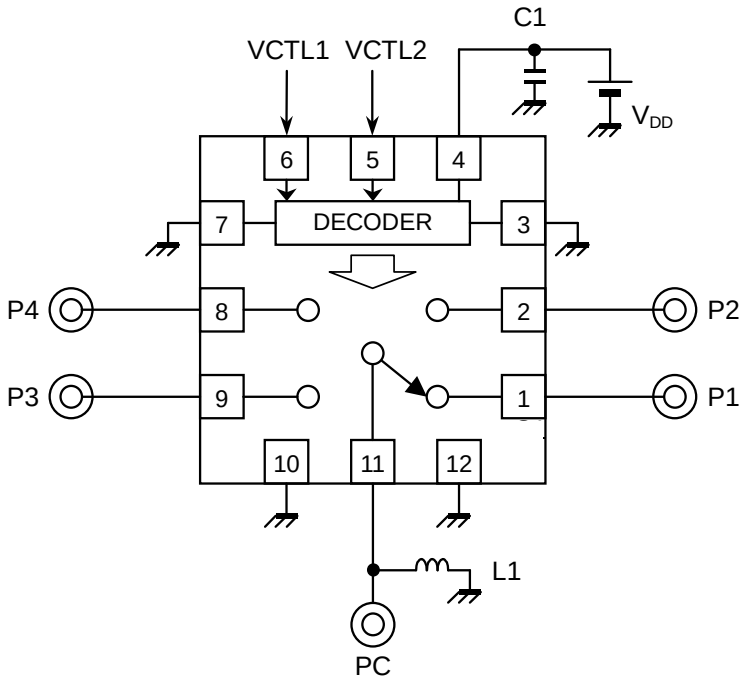

**Switching Time vs Temperature**

(PC-P1, VCTL1=H/L, VCTL2=L)



## ■ APPLICATION CIRCUIT

(TOP VIEW)



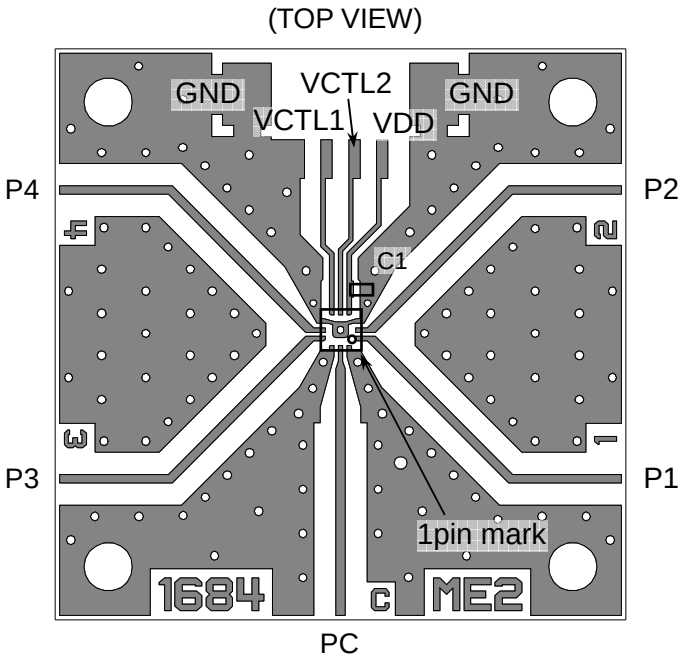

**PRECAUTIONS**

[1] The Inductor L1 is required for enhancing ESD protection level.
[2] All RF terminals are biased DC GND level.
[3] No DC block capacitors are required for RF ports unless DC is biased externally.

## ■ PARTS LIST

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

## ■ PCB LAYOUT

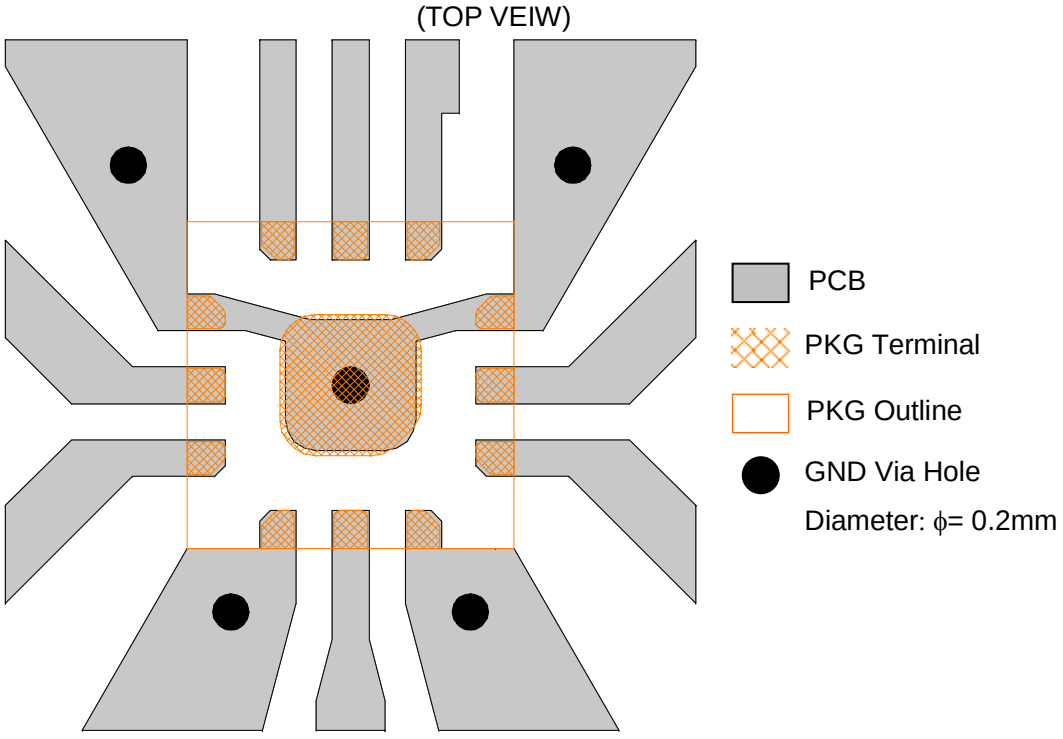



| | |
|---|---|
| PCB: | FR-4, t=0.2mm |
| Capacitor Size: | 1005 |
| Strip Line Width: | 0.4mm |
| PCB Size: | 26 x 26mm |

Losses of PCB and connectors, Ta=+25℃

| Frequency (GHz) | Loss (dB) |
|---|---|
| 0.9 | 0.27 |
| 1.9 | 0.50 |
| 2.7 | 0.61 |

**<PCB LAYOUT GUIDELINE>**




## ■ PRECAUTIONS

[1] No DC block capacitors are required for RF ports unless DC is biased externally. When the other device is biased at certain voltage and connected to the NJG1684ME2, a DC block capacitor is required between the device and the switch IC. This is because the each RF port of NJG1684ME2 is biased at 0 V (GND).

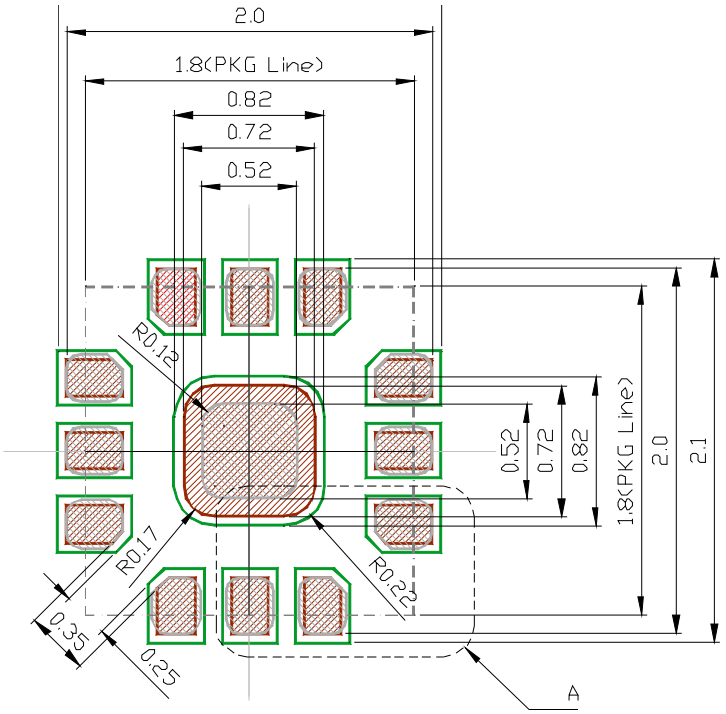
[2] For good RF performance, all GND terminals must be connected to PCB ground plane of substrate, and via-holes for GND should be placed near the IC.

[3] For good RF performance, through-holes for GND should be placed close to the GND pin 6 and pin 13. One of the ways to do this is to place a via-hole at the TAB pad under this IC.

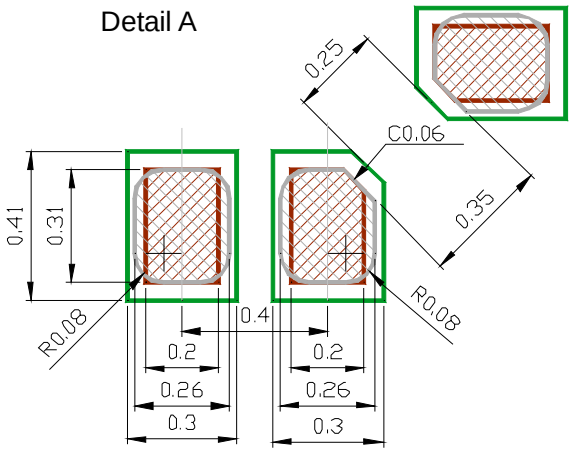
## ■ RECOMMENDED FOOTPRINT PATTERN (EQFN12-E2 PACKAGE Reference)

: Land
: Mask (Open area) *Metal mask thickness : 100um
: Resist(Open area)

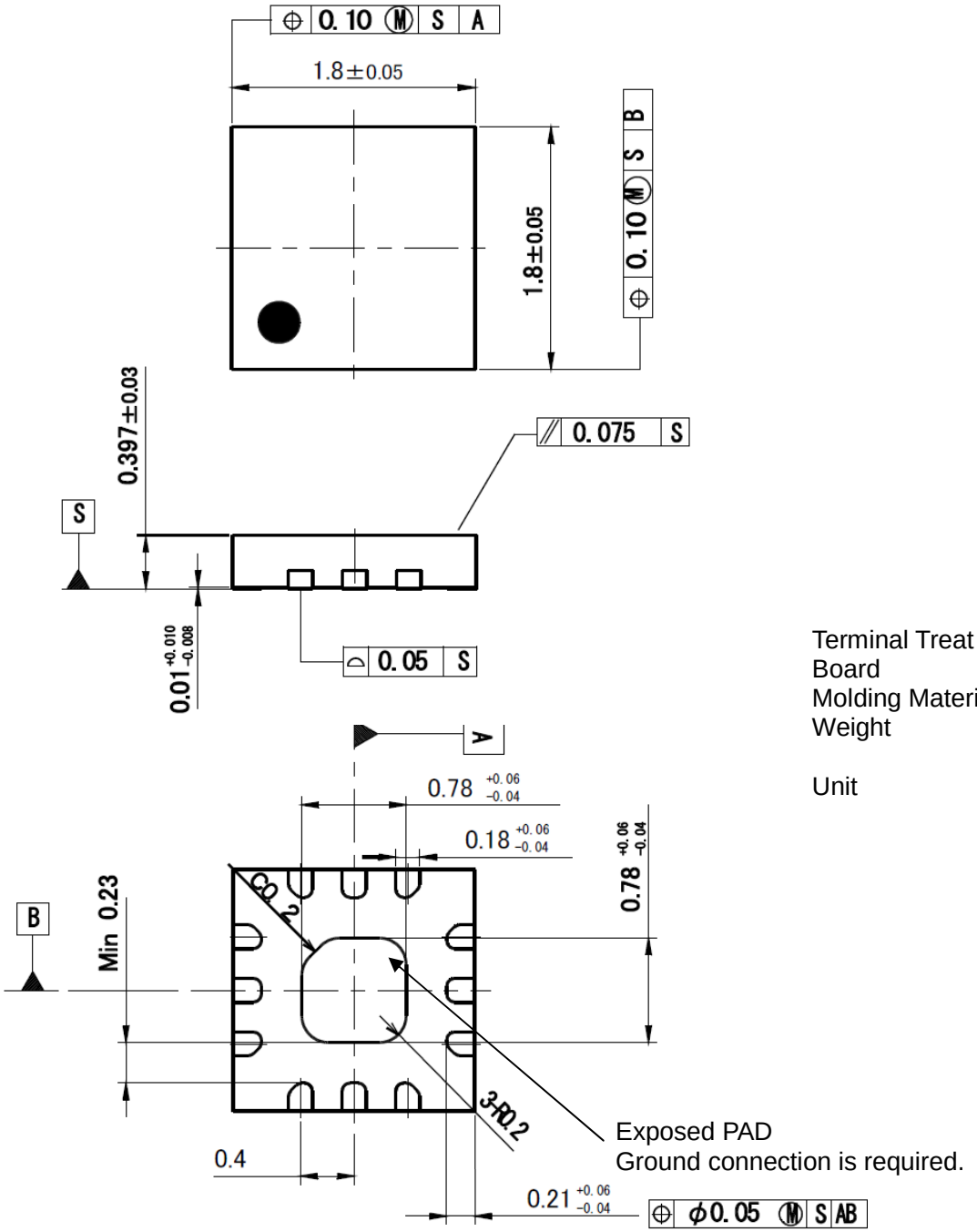
PKG : 1.8mm x 1.8mm
Pin pitch : 0.4mm




Detail A



## ■ PACKAGE OUTLINE (EQFN12-E2)




| | |
|---|---|
| Terminal Treat | : SnBi |
| Board | : Copper |
| Molding Material | : Epoxy resin |
| Weight | : 3.7mg |
| Unit | : mm |

**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.