# HIGH ISOLATION X-SPDT (DP4T) SWITCH GaAs MMIC

## ■ GENERAL DESCRIPTION

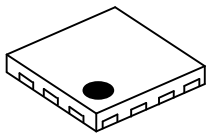
The NJG1690MD7 is a GaAs X (cross)-SPDT(DP4T) switch MMIC for switching of balanced (differential) dual band filters. It features low insertion loss and very high isolation for balanced signal input which makes it much suited for balanced filter switching.

The ESD protection circuit are integrated in the IC to achieve high ESD tolerance.

The ultra-small and ultra-thin EQFN14-D7 package is adopted.

*) X-SPDT is a paired SPDT switch controlled synchronously. The X-SPDT includes two SPDT switches whose RF lines have a crossing inside the chip.

## ■ PACKAGE OUTLINE



**NJG1690MD7**

## ■ APPLICATIONS

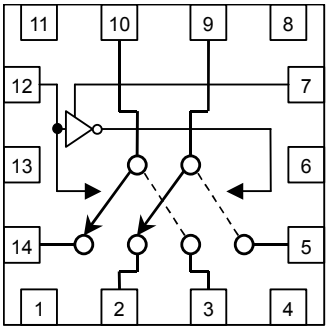
Balanced filter switching application
TDD/FDD LTE, UMTS, CDMA and GSM Multi-mode or Multi-band applications
Mobile phone, Tablet PC, Data card, Router and others mobile device applications

## ■ FEATURES

- Low operation voltage $V_{DD}$ =2.7V
- Low control voltage $V_{CTL(H)}$ =1.8V typ.
- High isolation
  - 37dB typ. @f=2.7GHz, $P_{IN}$=0dBm (with balanced mode operation)
  - 29dB typ. @f=1.0GHz, $P_{IN}$=0dBm
  - 24dB typ. @f=2.0GHz, $P_{IN}$=0dBm
  - 21dB typ. @f=2.7GHz, $P_{IN}$=0dBm
- Low insertion loss
  - 0.3dB typ. @f=1.0GHz, $P_{IN}$=0dBm
  - 0.4dB typ. @f=2.0GHz, $P_{IN}$=0dBm
  - 0.45dB typ. @f=2.7GHz, $P_{IN}$=0dBm
- Small and thin package EQFN14-D7 (Package size: 1.6x1.6x0.397mm typ.)
- RoHS compliant and Halogen Free
- MSL: 1

## ■ PIN CONFIGURATION

(Top View)




Pin connection

| | |
|---|---|
| 1. GND | 10. PC1 |
| 2. PA2 | 11. GND |
| 3. PB1 | 12. VCTL |
| 4. GND | 13. GND |
| 5. PB2 | 14. PA1 |
| 6. GND | |
| 7. VDD | |
| 8. GND | |
| 9. PC2 | |

## ■ TRUTH TABLE

"H"=$V_{CTL(H)}$, "L"=$V_{CTL(L)}$

| ON PATH | VCTL |
|---|---|
| PC1-PA1, PC2-PA2 | H |
| PC1-PB1, PC2-PB2 | L |

NOTE: Please note that any information on this catalog 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, VCTL=0V/1.8V | 28 | 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~+85 | °C |
| Storage temp. | $T_{stg}$ | | -55~+150 | °C |

## ■ ELECTRICAL CHARACTERISTICS

(General conditions: $T_a$=+25°C, $Z_s$=$Z_l$=50Ω, $V_{DD}$=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit1)

| PARAMETERS | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Supply voltage | $V_{DD}$ | | 1.5 | 2.7 | 4.5 | V |
| Operating current | $I_{DD}$ | $P_{IN}$=0dBm | - | 16 | 30 | μA |
| Control voltage (LOW) | $V_{CTL(L)}$ | | 0 | - | 0.4 | V |
| Control voltage (HIGH) | $V_{CTL(H)}$ | | 1.3 | 1.8 | 4.5 | V |
| Control current | $I_{CTL}$ | f=2GHz, $P_{IN}$=0dBm | - | 5 | 10 | μA |
| Insertion loss 1 | LOSS1 | f=1GHz, $P_{IN}$=0dBm | - | 0.30 | 0.45 | dB |
| Insertion loss 2 | LOSS2 | f=2GHz, $P_{IN}$=0dBm | - | 0.40 | 0.55 | dB |
| Insertion loss 3 | LOSS3 | f=2.7GHz, $P_{IN}$=0dBm | - | 0.45 | 0.65 | dB |
| Balanced mode isolation *Note1 | B-ISL | PC-PA (PC-PB ON)<br>PC-PB (PC-PA ON)<br>f=2.7GHz, $P_{IN}$=0dBm | 33 | 37 | - | dB |
| Isolation 1 | ISL1 | PC1-PA1, PC2-PA2<br>PC1-PB1, PC2-PB2<br>f=1GHz, $P_{IN}$=0dBm | 27 | 29 | - | dB |
| Isolation 2 | ISL2 | PC1-PA1, PC2-PA2<br>PC1-PB1, PC2-PB2<br>f=2GHz, $P_{IN}$=0dBm | 21 | 24 | - | dB |
| Isolation 3 | ISL3 | PC1-PA1, PC2-PA2<br>PC1-PB1, PC2-PB2<br>f=2.7GHz, $P_{IN}$=0dBm | 18 | 21 | - | dB |
| Isolation 4 | ISL4 | PC1-PC2 port<br>f=2GHz, $P_{IN}$=0dBm | 22 | 25 | - | dB |

Note1:

The balanced mode isolation is a unique specification for isolation defined under the condition where the X-SPDT switch is used in balanced mode operation as shown in application circuit2.

The NJG1690MD7 is designed so that the isolation in the balanced mode operation is much higher than the isolation in the single-ended mode operation.

## ■ ELECTRICAL CHARACTERISTICS

(General conditions: $T_a$=+25°C, $Z_s$=$Z_l$=50Ω, $V_{DD}$=2.7V, $V_{CTL(L)}$=0V, $V_{CTL(H)}$=1.8V, with application circuit1)

| PARAMETERS | SYMBOL | CONDITIONS | MIN | TYP | MAX | UNITS |
|---|---|---|---|---|---|---|
| Input power at 0.2dB compression point | $P_{-0.2dB}$ | f=2GHz | 20 | 24 | - | dBm |
| VSWR | VSWR | f=2GHz, On port | - | 1.2 | 1.4 | |
| Switching time | $T_{SW}$ | 50% CTL to 10%/90% RF | - | 1.5 | 5.0 | μs |

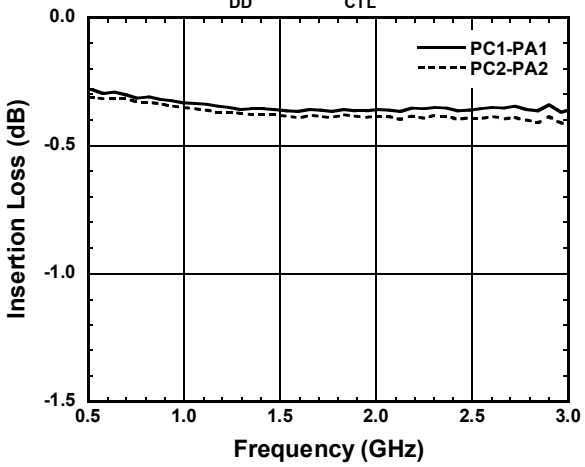
■ **TERMINAL INFORMATION**

| No. | SYMBOL | DESCRIPTION |
|---|---|---|
| 1 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 2 | PA2 | This port is connected to PC2 terminal by applying High-level (1.3~4.5V) at VCTL terminal. An external capacitor is required to block DC voltage of internal circuit. |
| 3 | PB1 | This port is connected to PC1 terminal by applying Low-level (0~0.4V) at VCTL terminal. An external capacitor is required to block DC voltage of internal circuit. |
| 4 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 5 | PB2 | This port is connected to PC2 terminal by applying Low-level (0~0.4V) at VCTL terminal. An external capacitor is required to block DC voltage of internal circuit. |
| 6 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 7 | VDD | A supply voltage terminal (1.5~4.5V). Please place a bypass capacitor between this terminal and GND for avoiding RF noise from outside. |
| 8 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 9 | PC2 | Common RF port. This port is connected with either of PA2 or PB2. An external capacitor is required to block DC voltage of internal circuit. |
| 10 | PC1 | Common RF port. This port is connected with either of PA1 or PB1. An external capacitor is required to block DC voltage of internal circuit. |
| 11 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 12 | VCTL | Control signal input terminal. This terminal is set to high-level (1.3V~4.5V) or low-level (0~0.4V). |
| 13 | GND | Ground terminal. Please connect this terminal with ground plane as close as possible for good RF performance. |
| 14 | PA1 | This port is connected to PC1 terminal by applying High-level (1.3~4.5V) at VCTL terminal. An external capacitor is required to block DC voltage of internal circuit. |

■ **ELECTRICAL CHARACTERISTICS** (With Application circuit1, Loss of external circuit are excluded)

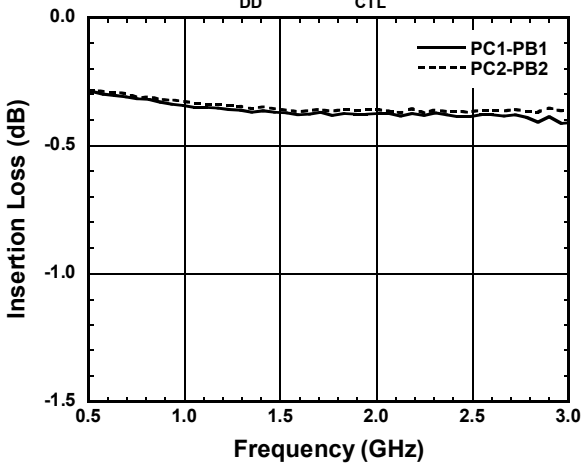
**Insertion Loss vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=1.8V )



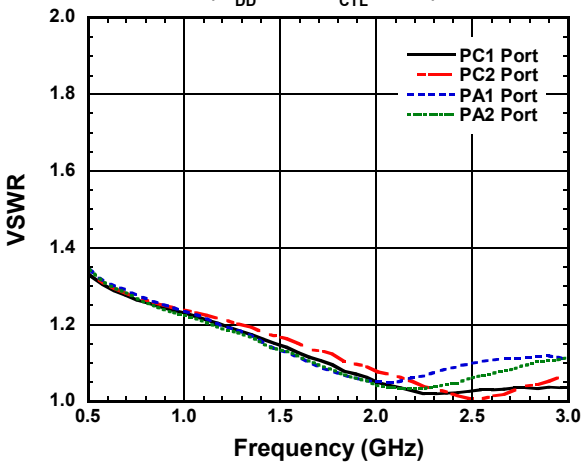

**Insertion Loss vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=0V )



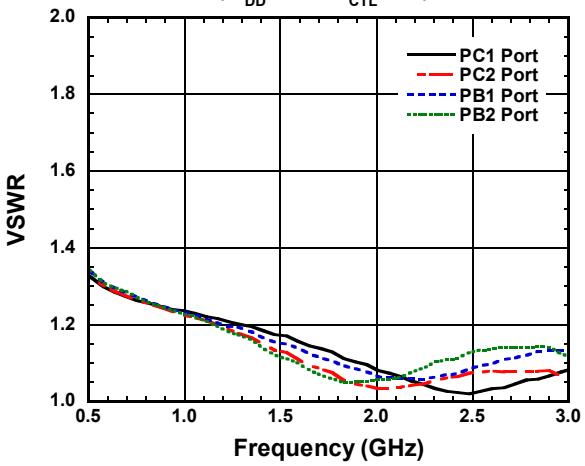

**VSWR vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=1.8V )



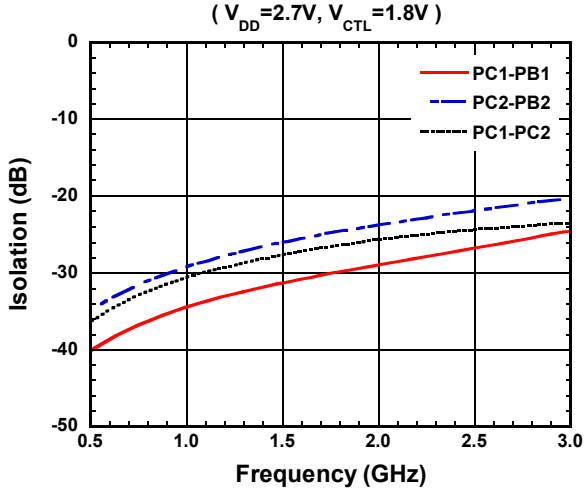

**VSWR vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=0V )



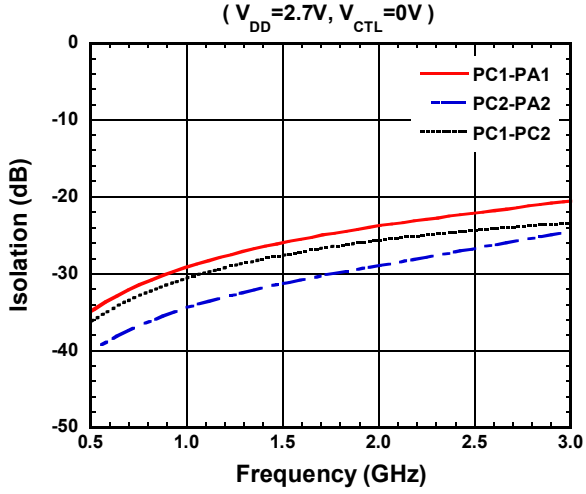

**Isolation vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=1.8V )




**Isolation vs. Frequency**

( $V_{DD}$=2.7V, $V_{CTL}$=0V )

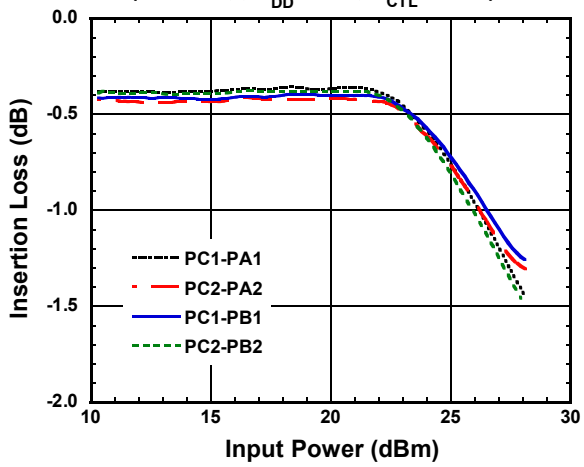


## ■ ELECTRICAL CHARACTERISTICS

(With Application circuit1 and 2, Loss of external circuit are excluded)

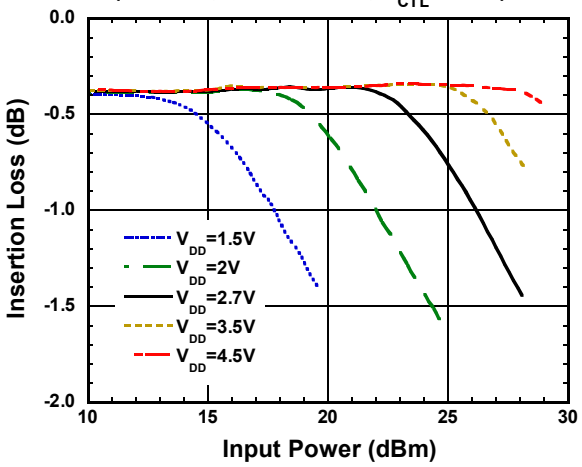
**Insertion Loss vs. Input Power**

**( f=2GHz, , $V_{DD}$=2.7V, $V_{CTL}$=1.8V )**



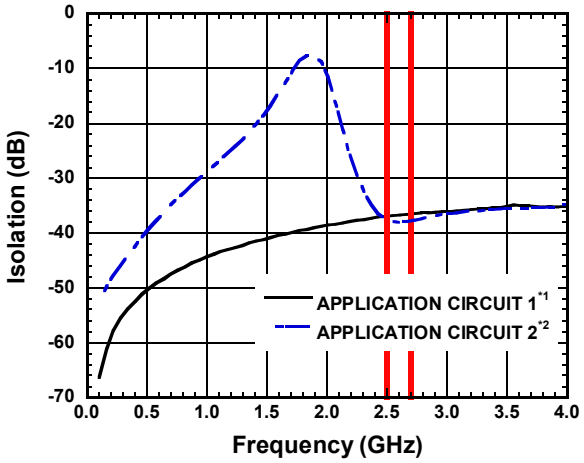

**Insertion Loss vs. Input Power**

**( f=2GHz, PC1-PA1 ON, $V_{CTL}$=1.8V )**



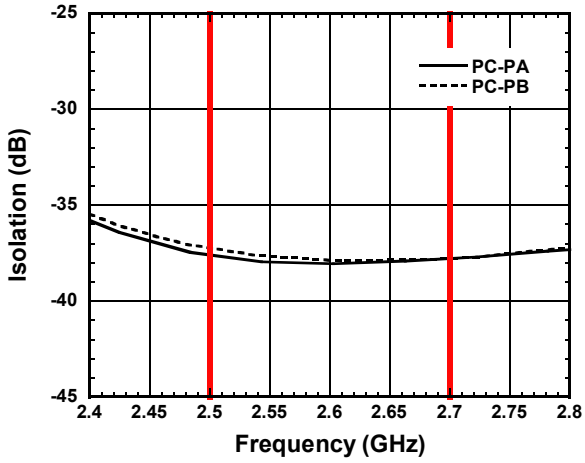

**Balanced Mode Isolation vs. Frequency**

**( Broad band )**




**Balanced Mode Isolation vs. Frequency**

**( With Application Circuit 2 )**



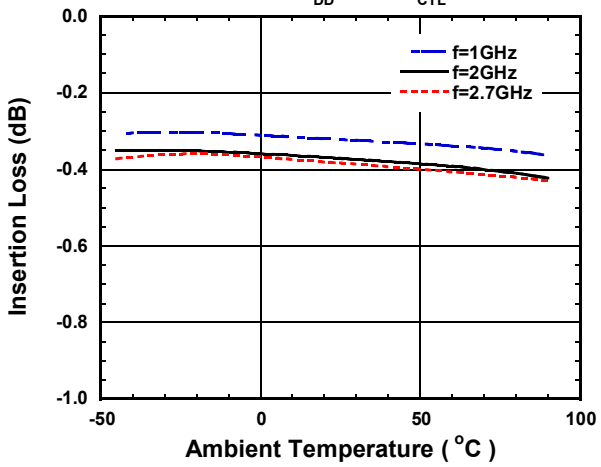

*1) The balanced mode isolation measured with the application circuit1.

*2) The balanced mode isolation measured with the application circuit2 having single-ended interfaces and baluns.

■ **ELECTRICAL CHARACTERISTICS** (With Application circuit1, Loss of external circuit are excluded)

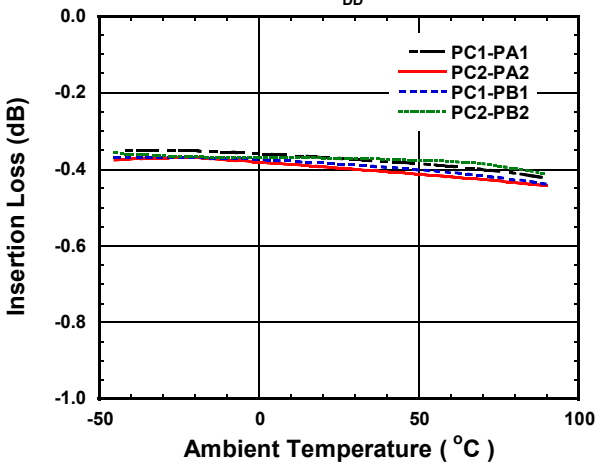
**Insertion Loss vs. Ambient Temperature**

( PC1-PA1 ON, $V_{DD}$=2.7V, $V_{CTL}$=1.8V )



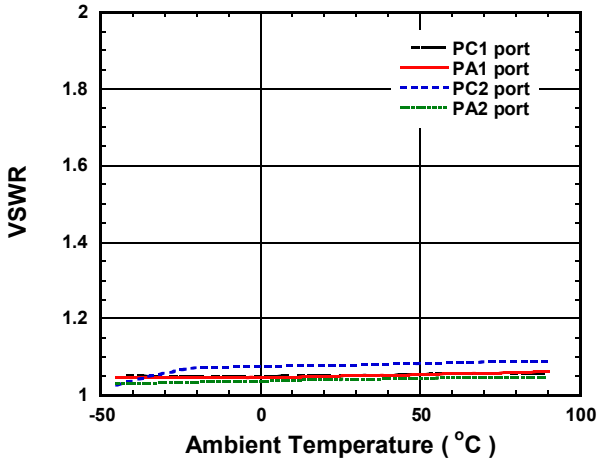

**Insertion Loss vs. Ambient Temperature**

( f=2GHz, $V_{DD}$=2.7V )



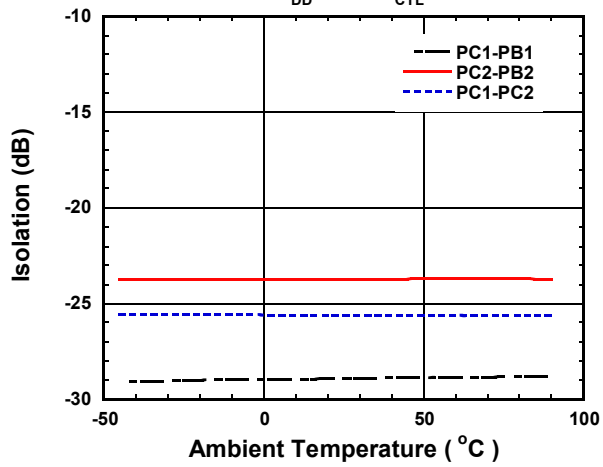

**VSWR vs. Ambient Temperature**

( f=2GHz, $V_{DD}$=2.7V, $V_{CTL}$=1.8V )




**Isolation vs. Ambient Temperature**

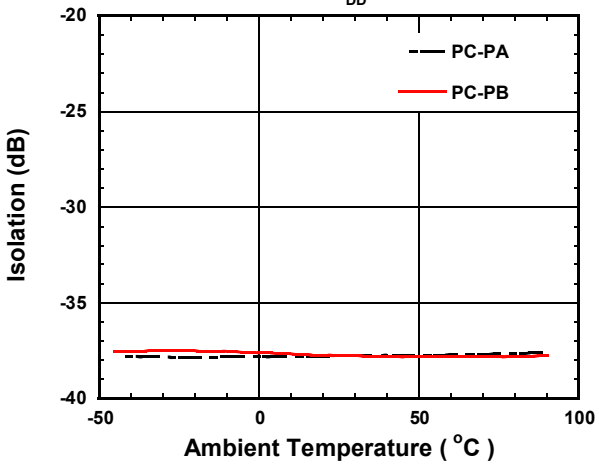
( f=2GHz, $V_{DD}$=2.7V, $V_{CTL}$=1.8V )



■ **ELECTRICAL CHARACTERISTICS** (With Application circuit1, Loss of external circuit are excluded)

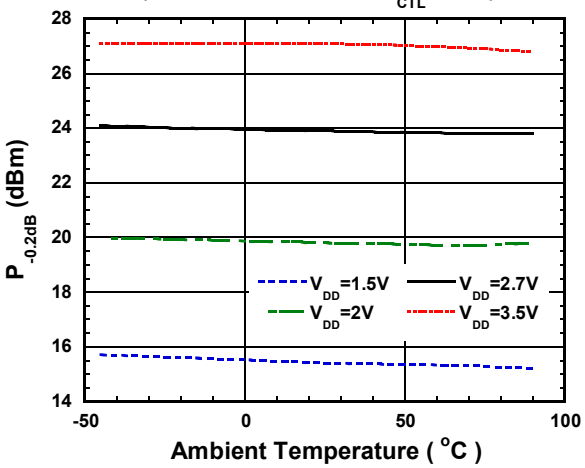
**Balanced Mode Isolation vs. Temperature**

( f=2.7GHz, $V_{DD}$=2.7V )



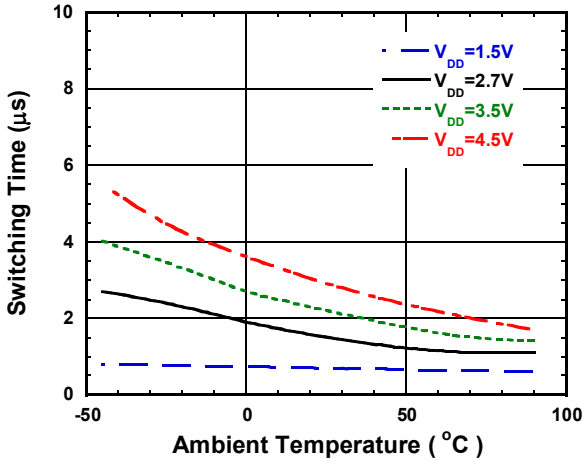

**$P_{-0.2dB}$ vs. Ambient Temperature**

( f=2GHz, PC1-PA1 ON, $V_{CTL}$=1.8V )



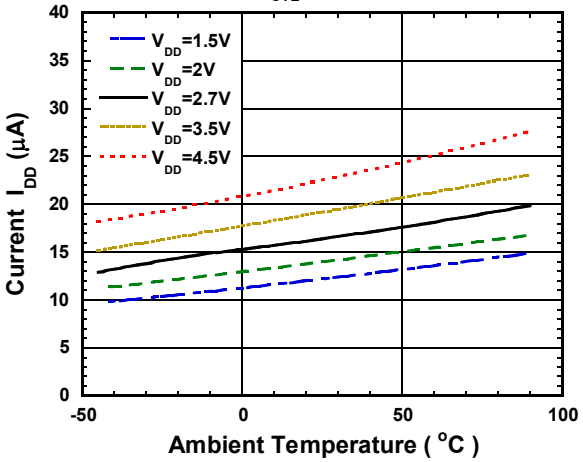

**Switching Time vs. Ambient Temperature**

( f=2GHz, PC1-PA1 ON )

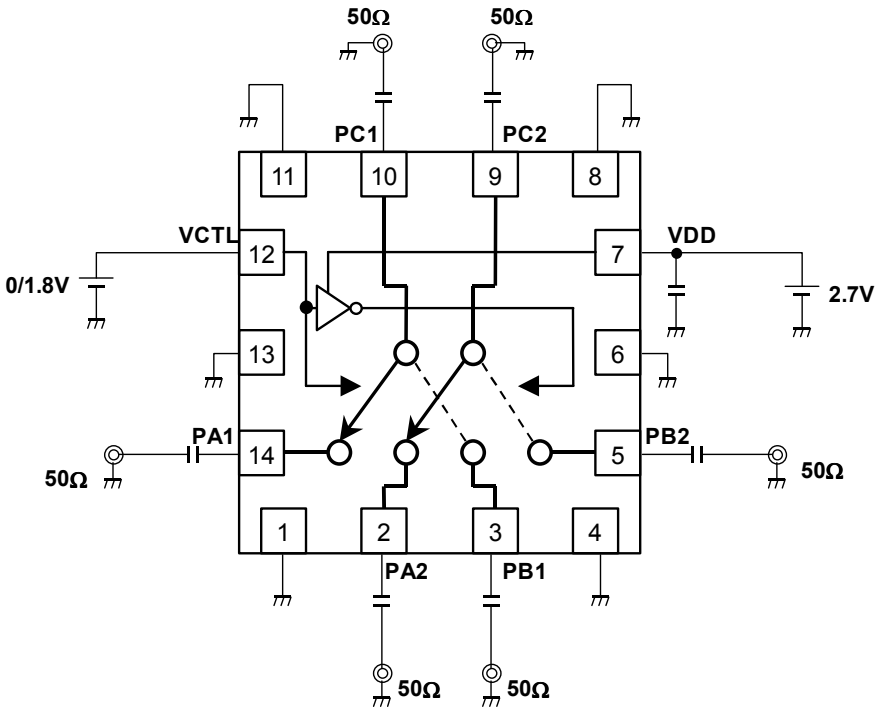



**Current $I_{DD}$ vs. Temperature**

( $V_{CTL}$=1.8V )

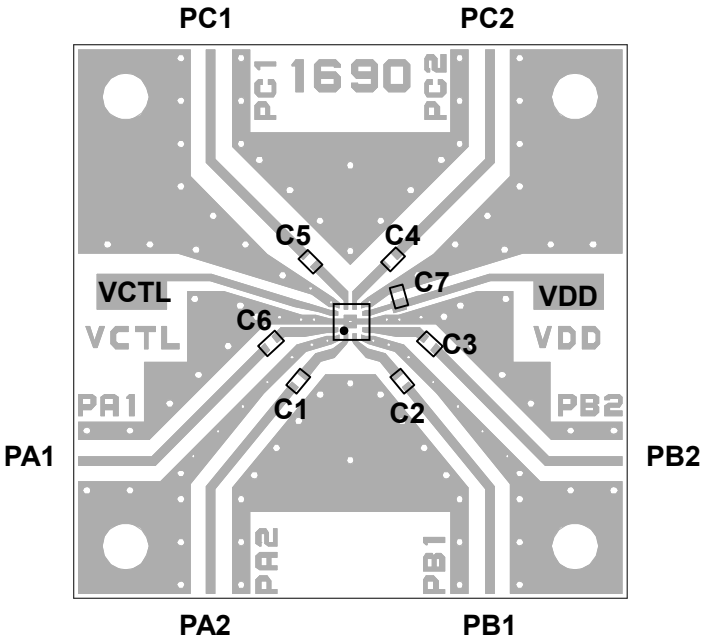


## ■ APPLICATION CIRCUIT 1 (Unbalanced mode)




## ■ PCB LAYOUT 1

(TOP VIEW)




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

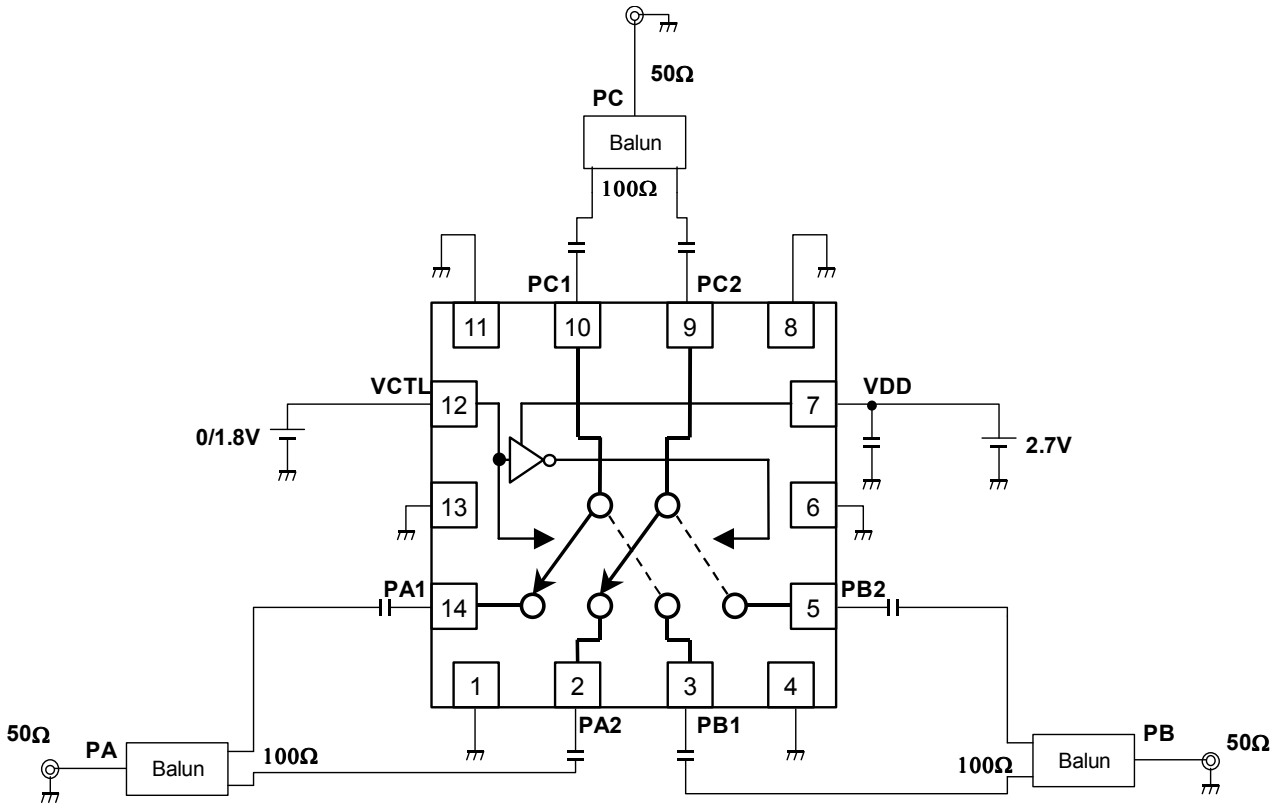
Losses of PCB, capacitors and connectors

| Frequency (GHz) | Loss (dB) |
|---|---|
| 1 | 0.35 |
| 2 | 0.54 |
| 2.7 | 0.68 |

## ■ PARTS LIST 1

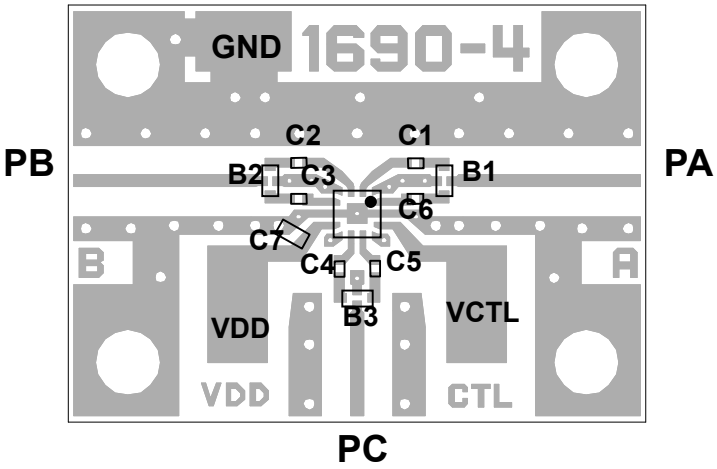
| PART ID | Value | COMMENT |
|---|---|---|
| C1~C6 | 56pF | MURATA (GRM15) |
| C7 | 1000pF | MURATA (GRM15) |

## ■ APPLICATION CIRCUIT 2 (BALANCED MODE)




## ■ PCB LAYOUT 2

(TOP VIEW)




| | |
|---|---|
| PCB: | FR-4, t=0.2mm |
| Capacitor Size: | 0603, 1005 |
| Strip Line Width: | 0.4mm |
| PCB Size: | 19.4 x 14mm |

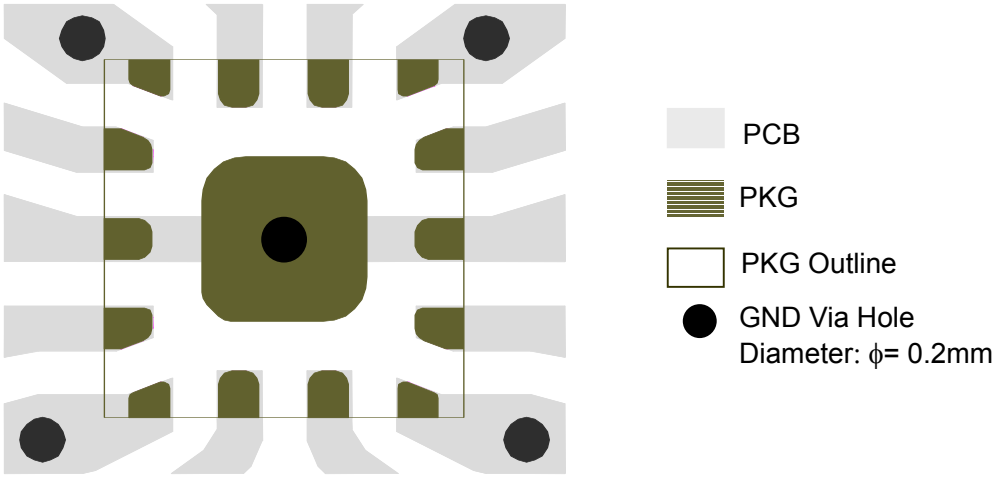
Losses of PCB, capacitors, connectors and baluns

| Frequency (GHz) | Loss (dB) |
|---|---|
| 2.7 | 0.93 |

## ■ PARTS LIST 2

| PART ID | Value | COMMENT |
|---|---|---|
| C1~C6 | 56pF | MURATA (GRM03) |
| C7 | 1000pF | MURATA (GRM15) |
| B1~B3 | 2500MHz band | TDK-EPC (HHM1903A1) |

## ■ PCB LAYOUT FOR EQFN14-D7




## ■ PRECAUTIONS

[1] 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.

[2] 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.

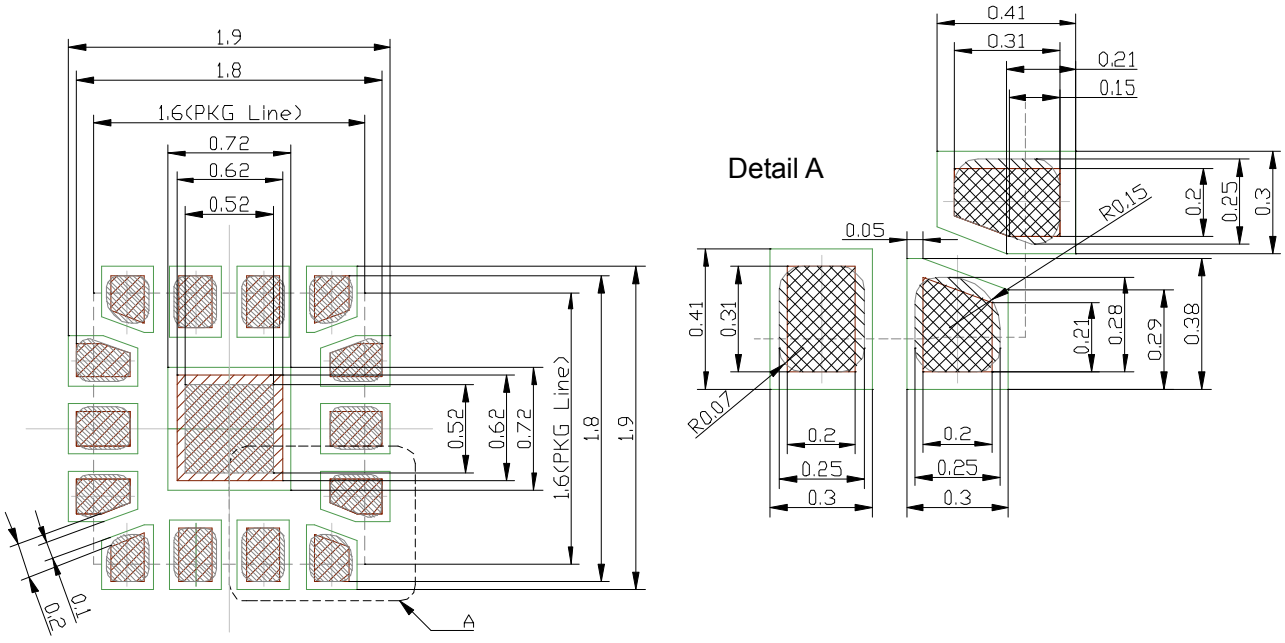
## ■ RECOMMENDED FOOTPRINT PATTERN (EQFN14-D7 PACKAGE Reference)

:Land

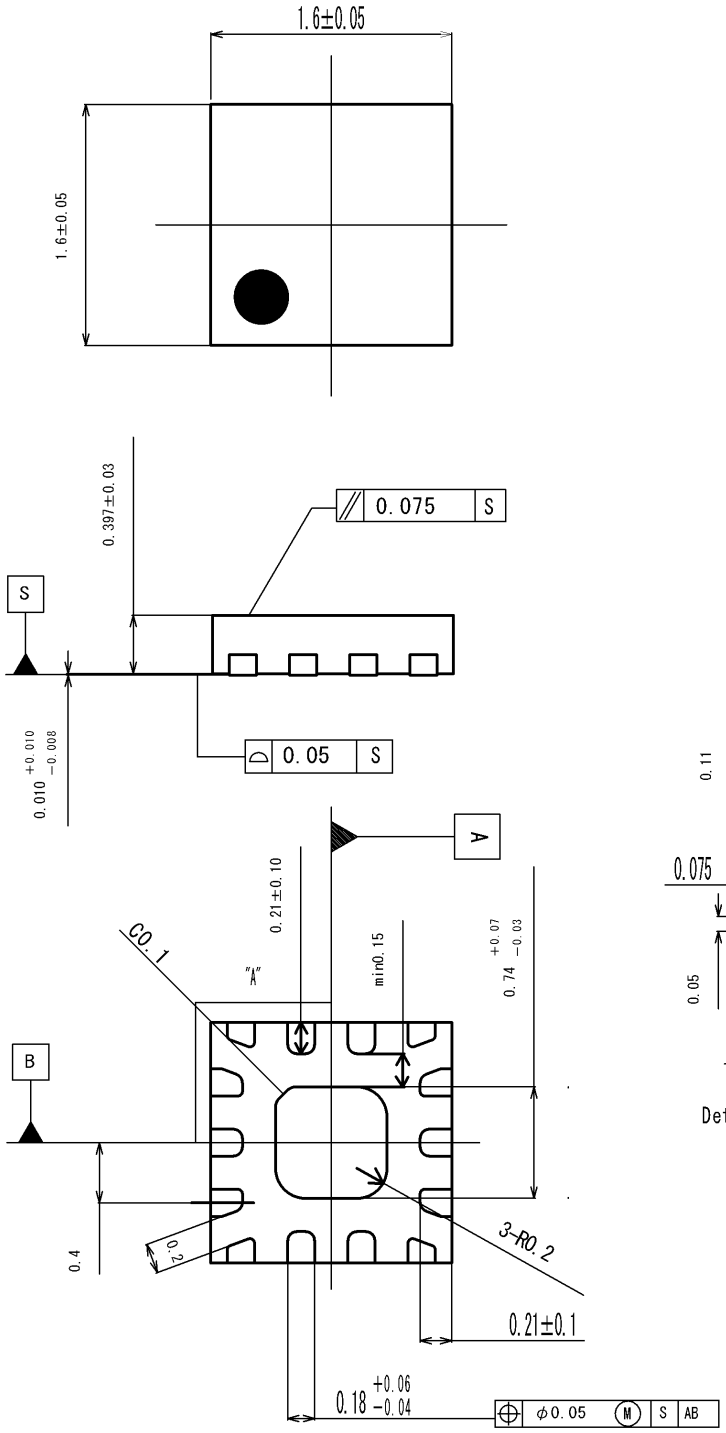
:Mask (Open area) *Metal mask thickness : 100μm

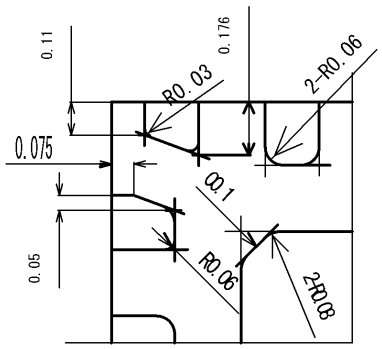
:Resist(Open area)

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



## ■ PACKAGE OUTLINE (EQFN14-D7)




Details of"A" part (× 2)

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

**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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NJG1690MD7-TE1

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## Океан Электроники
## Поставка электронных компонентов

Компания «Океан Электроники» предлагает заключение долгосрочных отношений при поставках импортных электронных компонентов на взаимовыгодных условиях!

Наши преимущества:

- Поставка оригинальных импортных электронных компонентов напрямую с производств Америки, Европы и Азии, а так же с крупнейших складов мира;
- Широкая линейка поставок активных и пассивных импортных электронных компонентов (более 30 млн. наименований);
- Поставка сложных, дефицитных, либо снятых с производства позиций;
- Оперативные сроки поставки под заказ (от 5 рабочих дней);
- Экспресс доставка в любую точку России;
- Помощь Конструкторского Отдела и консультации квалифицированных инженеров;
- Техническая поддержка проекта, помощь в подборе аналогов, поставка прототипов;
- Поставка электронных компонентов под контролем ВП;
- Система менеджмента качества сертифицирована по Международному стандарту ISO 9001;
- При необходимости вся продукция военного и аэрокосмического назначения проходит испытания и сертификацию в лаборатории (по согласованию с заказчиком);
- Поставка специализированных компонентов военного и аэрокосмического уровня качества (Xilinx, Altera, Analog Devices, Intersil, Interpoint, Microsemi, Actel, Aeroflex, Peregrine, VPT, Syfer, Eurofarad, Texas Instruments, MS Kennedy, Miteq, Cobham, E2V, MA-COM, Hittite, Mini-Circuits, General Dynamics и др.);

Компания «Океан Электроники» является официальным дистрибьютором и эксклюзивным представителем в России одного из крупнейших производителей разъемов военного и аэрокосмического назначения «**JONHON**», а так же официальным дистрибьютором и эксклюзивным представителем в России производителя высокотехнологичных и надежных решений для передачи СВЧ сигналов «**FORSTAR**».

AVIC JONHON

**«JONHON»** (основан в 1970 г.)

Разъемы специального, военного и аэрокосмического назначения:

(Применяются в военной, авиационной, аэрокосмической, морской, железнодорожной, горно- и нефтедобывающей отраслях промышленности)

**«FORSTAR»** (основан в 1998 г.)

ВЧ соединители, коаксиальные кабели, кабельные сборки и микроволновые компоненты:

(Применяются в телекоммуникациях гражданского и специального назначения, в средствах связи, РЛС, а так же военной, авиационной и аэрокосмической отраслях промышленности).

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