High Isolation X-SP4T (DP8T) SWITCH

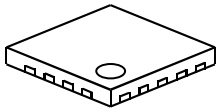
■ GENERAL DESCRIPTION

The NJG1695ME7 is a GaAs X (cross) - SP4T (DP8T) switch MMIC for switching of balanced (differential) mode filters. It features low insertion loss and very high isolation for balanced signal input.

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

The ultra-small and ultra-thin EQFN18-E7 package is adopted.

■ PACKAGE OUTLINE



NJG1695ME7

*) The X-SP4T is a paired SP4T switch that features two identical SP4T switches being integrated into one chip. The two SP4T switches are controlled synchronously, and their respective RF lines cross each other on the chip.

■ APPLICATIONS

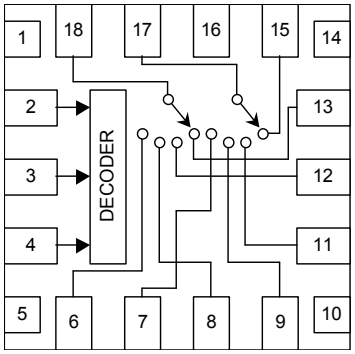
Switching of balanced type filters (Quad band) application
Suitable for 3G and LTE application

■ FEATURES

- Low operation voltage V_{DD}=+1.5~+4.5V
- Low control voltage $V_{CTL(H)}$=+1.35V min.
- High isolation (Balanced mode)
  43dB typ. @f=1.0GHz, P_{IN}=0dBm
  38dB typ. @f=2.0GHz, P_{IN}=0dBm
  35dB typ. @f=2.7GHz, P_{IN}=0dBm
- Low insertion loss
  0.45dB typ. @f=1.0GHz, P_{IN}=0dBm
  0.55dB typ. @f=2.0GHz, P_{IN}=0dBm
  0.80dB typ. @f=2.7GHz, P_{IN}=0dBm
- Small package EQFN18-E7 (Package size: 2.0mm x 2.0mm x 0.397mm typ.)
- RoHS compliant and Halogen Free
- MSL 1

■ PIN CONFIGURATION

(Top View)



1.	GND	10.	GND
2.	VDD	11.	P2B
3.	VCTL2	12.	P2A
4.	VCTL1	13.	P1A
5.	GND	14.	GND
6.	P4A	15.	P1B
7.	P4B	16.	GND(NC)
8.	P3A	17.	PCB
9.	P3B	18.	PCA

■ TRUTH TABLE

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

ON PATH	VCTL1	VCTL2
PCA-P1A, PCB-P1B	H	L
PCA-P2A, PCB-P2B	L	L
PCA-P3A, PCB-P3B	L	H
PCA-P4A, PCB-P4B	H	H

NOTE: The information on this datasheet is subject to change without notice.

■ ABSOLUTE MAXIMUM RATINGS

(T_a=+25°C, Z_s=Z_l=50Ω)

PARAMETERS	SYMBOL	CONDITIONS	RATINGS	UNITS
RF Input Power	P_{IN}	V_{DD} =2.7V, V_{CTL}=0V/1.8V ON state port	28	dBm
Supply Voltage	V_{DD}	VDD terminal	5.0	V
Control Voltage	V_{CTL}	VCTL terminal	5.0	V
Power Dissipation	P_D	Four-layer FR4 PCB with through-holes (74.2mmx74.2mm), T_j=150°C	1400	mW
Operating Temperature	T_{opr}		-40~+90	°C
Storage Temperature	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 circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Supply Voltage	V_{DD}		1.5	2.7	4.5	V
Operating Current	I_{DD}		-	30	60	μA
Control Voltage (LOW)	$V_{CTL(L)}$		0	0	0.45	V
Control Voltage (HIGH)	$V_{CTL(H)}$		1.35	1.8	4.5	V
Control Current	I_{CTL}		-	5	10	μA

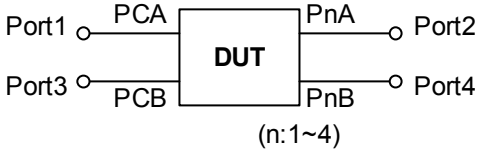
■ ELECTRICAL CHARACTERISTICS

(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 circuit)

PARAMETERS	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS
Insertion Loss 1	LOSS1	f=1.0GHz, P_{IN}=0dBm	-	0.40	0.60	dB
Insertion Loss 2	LOSS2	f=2.0GHz, P_{IN}=0dBm	-	0.45	0.65	dB
Insertion Loss 3	LOSS3	f=2.7GHz, P_{IN}=0dBm	-	0.80	1.0	dB
Balanced mode isolation 1 (Note1)	B-ISL1	f=1.0GHz, P_{IN}=0dBm PC-P1, P2, P3, P4	40	43	-	dB
Balanced mode Isolation 2 (Note1)	B-ISL2	f=2.0GHz, P_{IN}=0dBm PC-P1, P2, P3, P4	35	38	-	dB
Balanced mode isolation 3 (Note1)	B-ISL3	f=2.7GHz, P_{IN}=0dBm PC-P1, P2, P3, P4	32	35	-	dB
Isolation 1	ISL1	PCA-P1A, P2A, P3A, P4A PCB-P1B, P2B, P3B, P4B f=1.0GHz, P_{IN}=0dBm	26	28	-	dB
Isolation 2	ISL2	PCA-P1A, P2A, P3A, P4A PCB-P1B, P2B, P3B, P4B f=2.0GHz, P_{IN}=0dBm	23	26	-	dB
Isolation 3	ISL3	PCA-P1A, P2A, P3A, P4A PCB-P1B, P2B, P3B, P4B f=2.7GHz, P_{IN}=0dBm	18	20	-	dB
Isolation 4	ISL4	PCA-PCB port f=2.0GHz, P_{IN}=0dBm	17	19	-	dB
Input power at 0.2dB Compression Point	$P_{-0.2dB}$	f=2.0GHz	20	23	-	dBm
VSWR	VSWR	f=2.0GHz, On state port	-	1.2	1.4	-
Switching time	T_{SW}	50% V_{CTL} to 10/90% RF	-	2	5	μs

Note1:
The calculation of “Balanced Mode Isolation” uses the following formula.

$$\mathrm{B-ISL} = \frac{1}{2}\left(S_{21} - S_{23} - S_{41} + S_{43}\right)$$



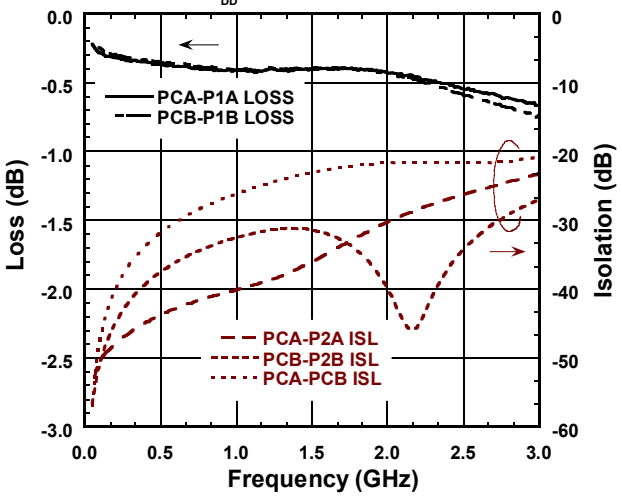
■ TERMINAL INFORMATION

No.	SYMBOL	DESCRIPTION
1, 5, 10, 14	GND	Ground terminal. Please connect to the PCB ground plane.
2	VDD	Positive voltage supply terminal (+1.5~+4.5V). Please place a bypass capacitor between this terminal and GND for best RF performance.
3	VCTL2	Control signal input terminal. This terminal is to be set to High-Level (+1.35V~4.5V) or Low-Level (0~+0.45V).
4	VCTL1	Control signal input terminal. This terminal is to be set to High-Level (+1.35V~4.5V) or Low-Level (0~+0.45V).
6	P4A	The 4th RF port of the 1st switch. This port is connected with PCA port. PCB port is connected with P4B port at the same time. An external capacitor is required to block DC voltage.
7	P4B	The 4th RF port of the 2nd switch. This port is connected with PCB port. PCA port is connected with P4A port at the same time. An external capacitor is required to block DC voltage.
8	P3A	The 3rd RF port of the 1st switch. This port is connected with PCA port. PCB port is connected with P3B port at the same time. An external capacitor is required to block DC voltage.
9	P3B	The 3rd RF port of the 2nd switch. This port is connected with PCB port. PCA port is connected with P3A port at the same time. An external capacitor is required to block DC voltage.
11	P2B	The 2nd RF port of the 2nd switch. This port is connected with PCB port. PCA port is connected with P2A port at the same time. An external capacitor is required to block DC voltage.
12	P2A	The 2nd RF port of the 1st switch. This port is connected with PCA port. PCB port is connected with P2B port at the same time. An external capacitor is required to block DC voltage.
13	P1A	The 1st RF port of the 1st switch. This port is connected with PCA port. PCB port is connected with P1B port at the same time. An external capacitor is required to block DC voltage.
15	P1B	The 1st RF port of the 2nd switch. This port is connected with PCB port. PCA port is connected with P1A port at the same time. An external capacitor is required to block DC voltage.
16	GND(NC)	Not connected terminal. This terminal is not connected with internal circuit. Please connect it to the PCB ground plane.
17	PCB	Common RF port of the 2nd switch. This port is connected to one RF port of the 2nd switch (P1B~P4B). An external capacitor is required to block DC voltage.
18	PCA	Common RF port of the 1st switch. This port is connected to one RF port of the 1st switch (P1A~P4A). An external capacitor is required to block DC voltage.

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

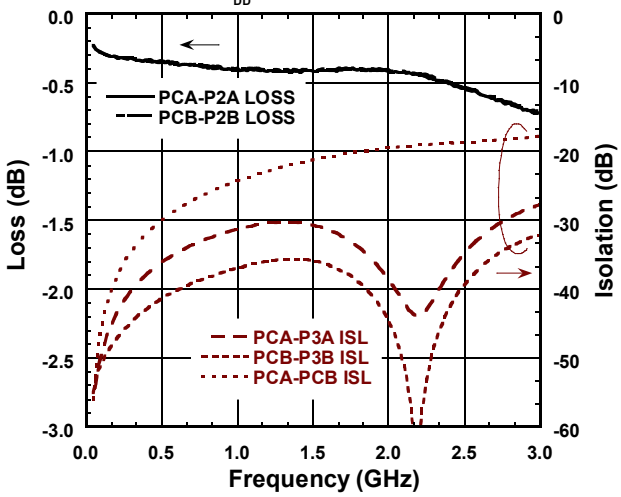
Insertion Loss vs. Frequency

PC-P1 ON, V_{DD}=2.7V, VCTL1=1.8V, VCTL2=0V



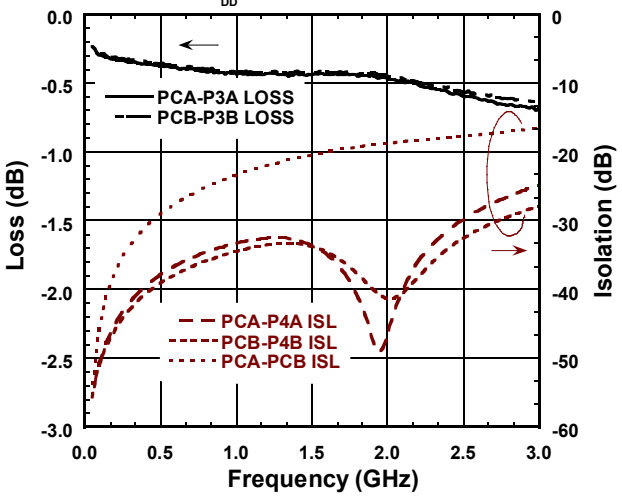
Insertion Loss vs. Frequency

PC-P2 ON, V_{DD}=2.7V, VCTL1=0V, VCTL2=0V



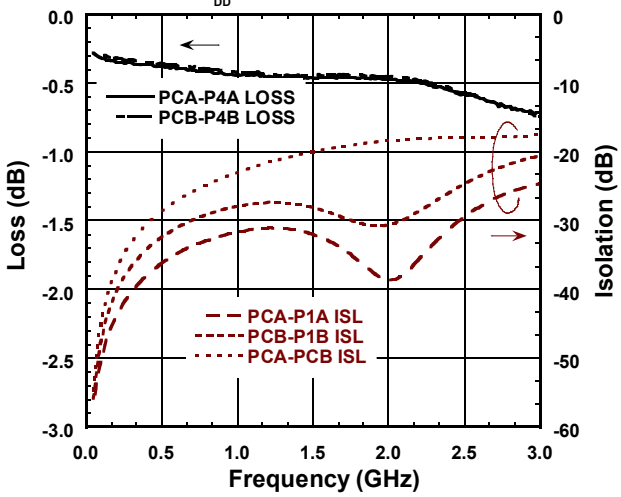
Insertion Loss vs. Frequency

PC-P3 ON, V_{DD}=2.7V, VCTL1=0V, VCTL2=1.8V



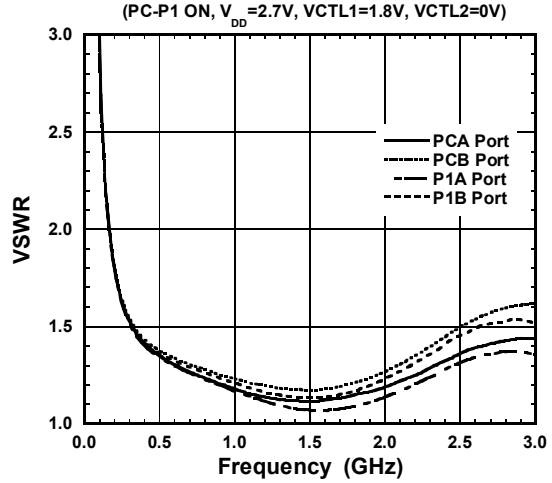
Insertion Loss vs. Frequency

PC-P4 ON, V_{DD}=2.7V, VCTL1=1.8V, VCTL2=1.8V



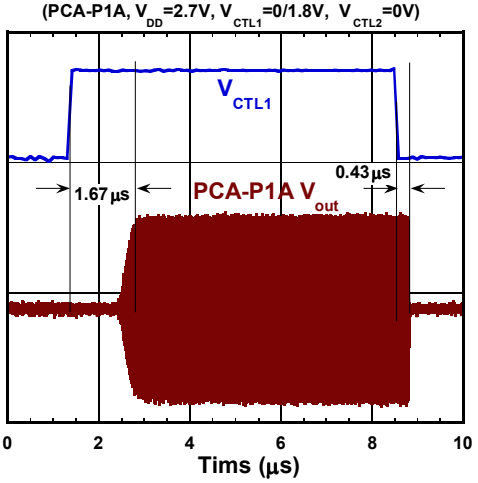
VSWR vs. Frequency

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



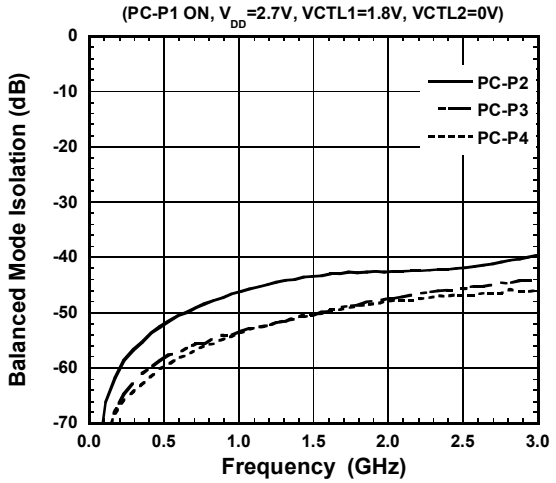
Switching Time

(PCA-P1A, V_{DD}=2.7V, V_{CTL1}=0/1.8V, V_{CTL2}=0V)

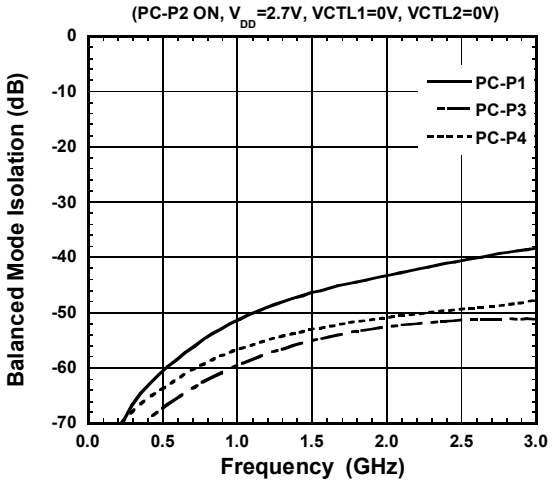


■ **ELECTRICAL CHARACTERISTICS** (With Application circuit, Loss of external circuit are excluded)

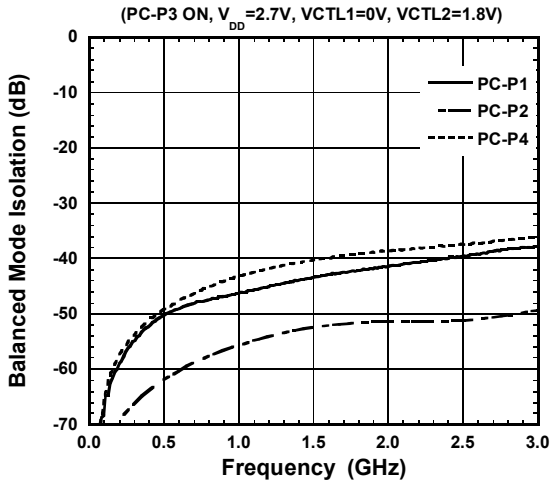
Balanced Mode Isolation vs. Frequency



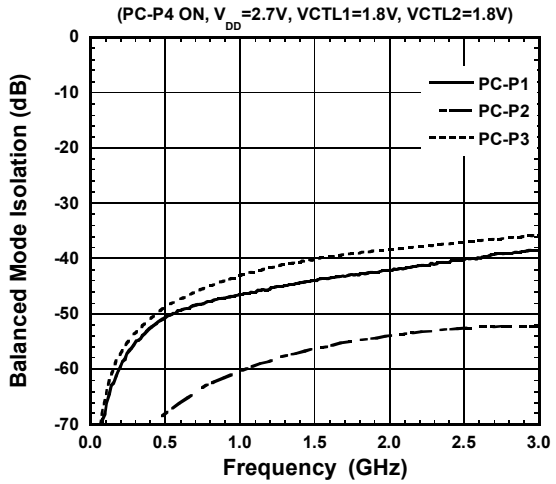
Balanced Mode Isolation vs. Frequency



Balanced Mode Isolation vs. Frequency



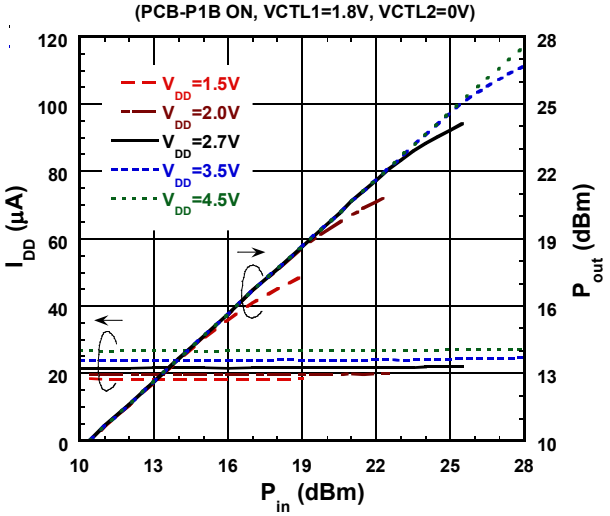
Balanced Mode Isolation vs. Frequency



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

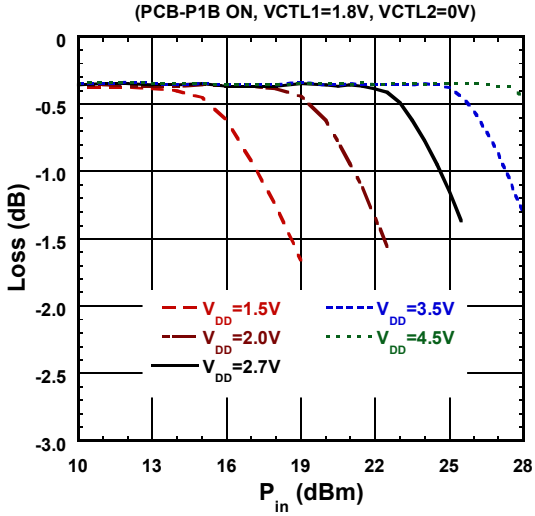
P_{out} & I_{DD} vs. P_{in} at 1.0GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)



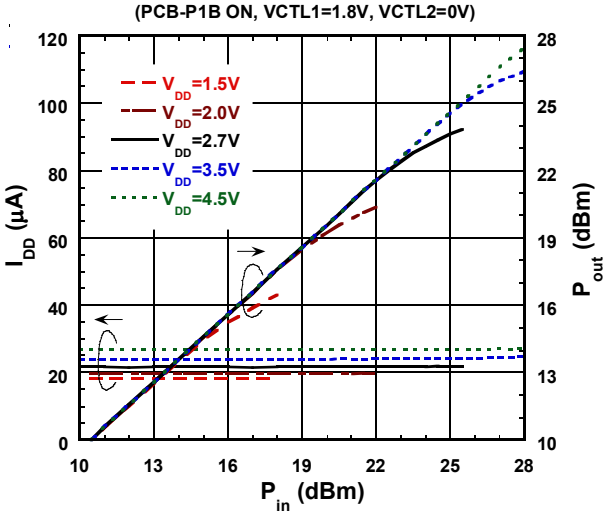
Loss vs. P_{in} at 1.0GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)



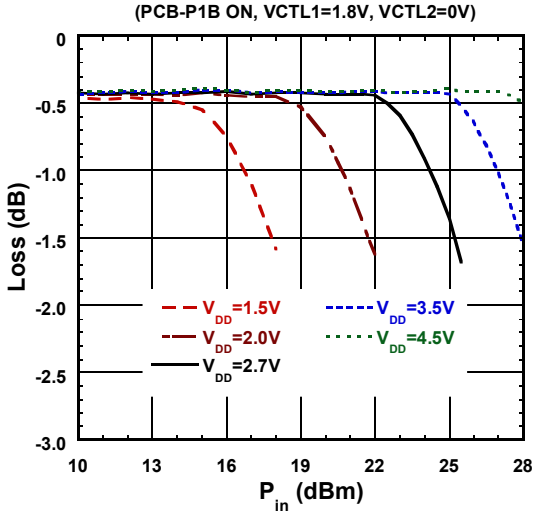
P_{out} & I_{DD} vs. P_{in} at 2.0GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)



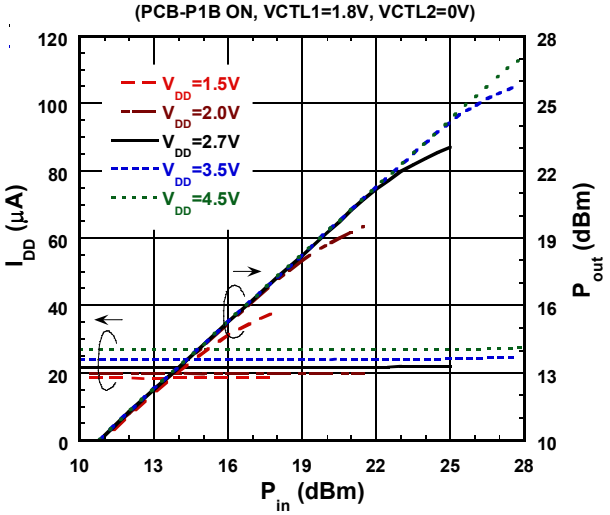
Loss vs. P_{in} at 2.0GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)



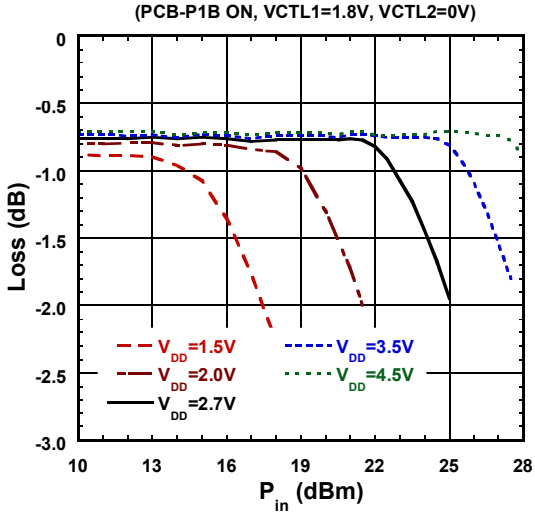
P_{out} & I_{DD} vs. P_{in} at 2.7GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)



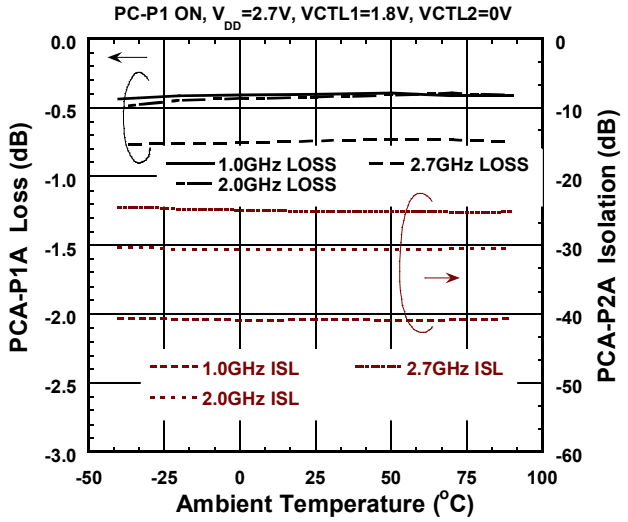
Loss vs. P_{in} at 2.7GHz

(PCB-P1B ON, VCTL1=1.8V, VCTL2=0V)

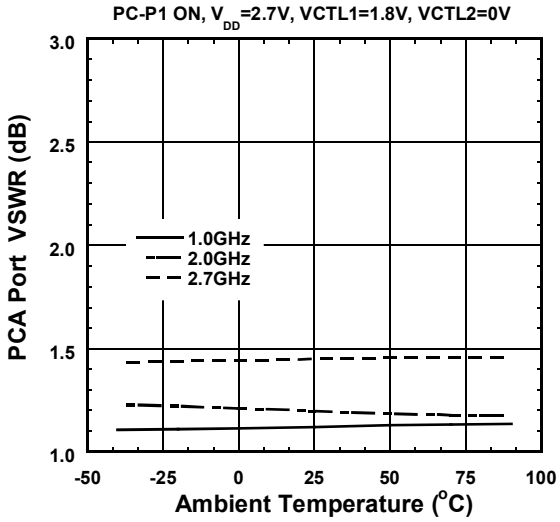


■ **ELECTRICAL CHARACTERISTICS** (With Application circuit, Loss of external circuit are excluded)

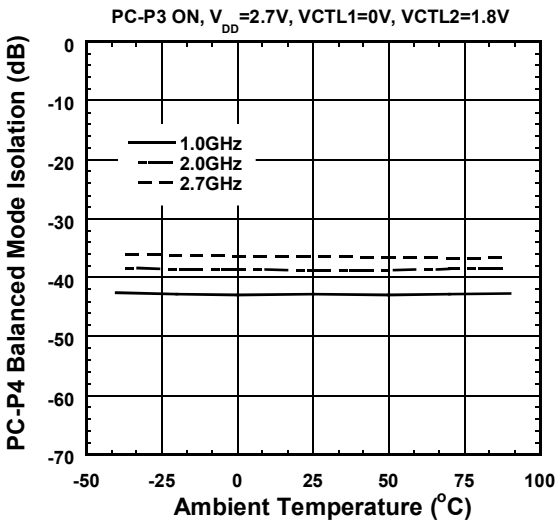
Insertion Loss vs. Temperature



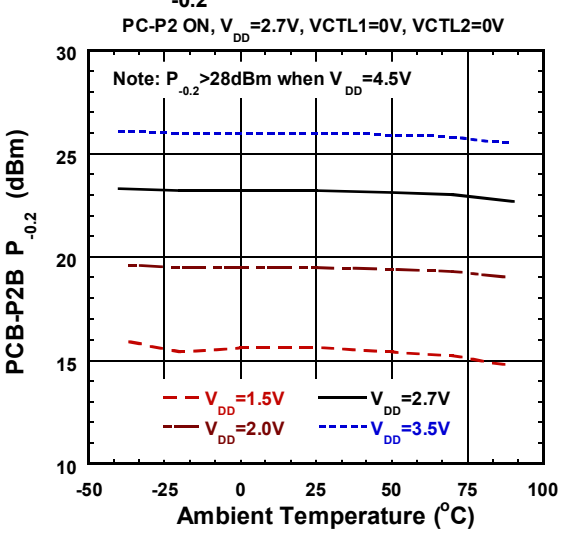
VSWR vs. Temperature



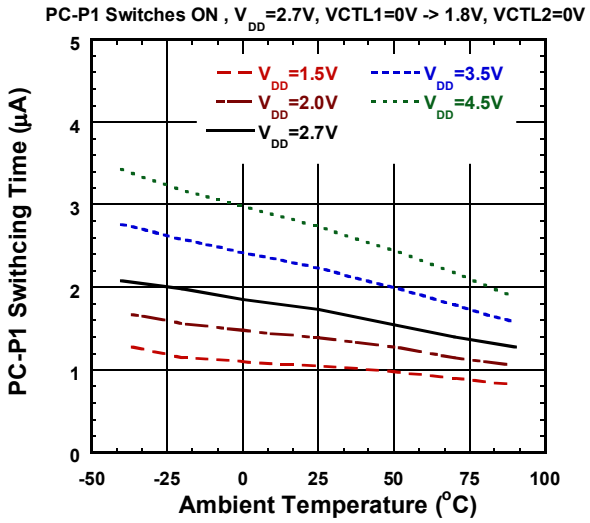
Balanced Mode Isolation vs. Temperature



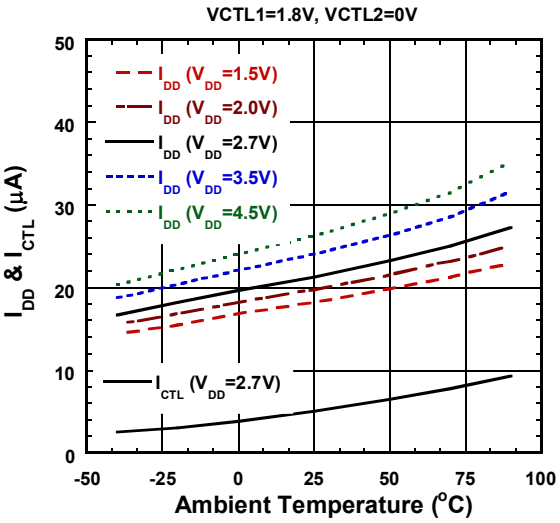
$P_{-0.2}$ vs. Temperature



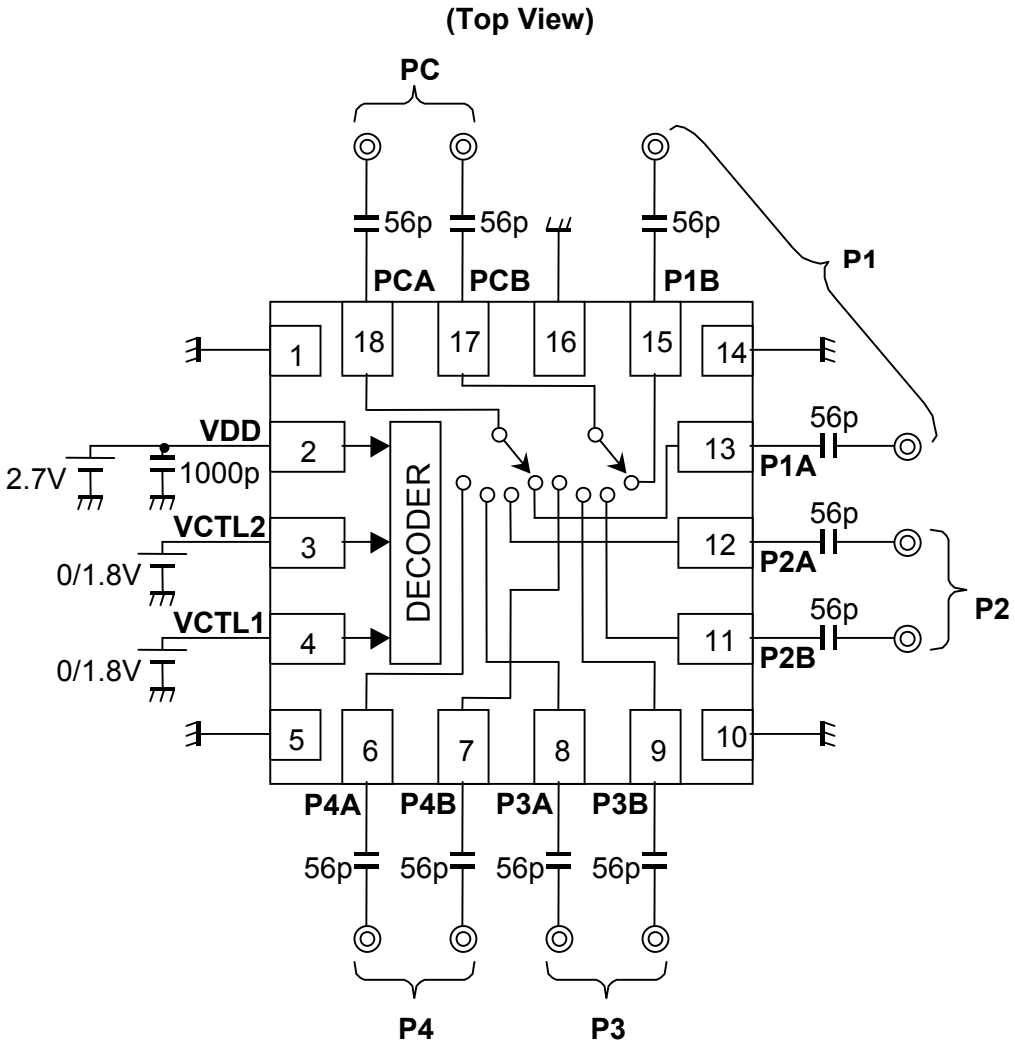
Switching Time vs. Temperature



I_{DD} & I_{CTL} vs. Temperature



■ APPLICATION CIRCUIT

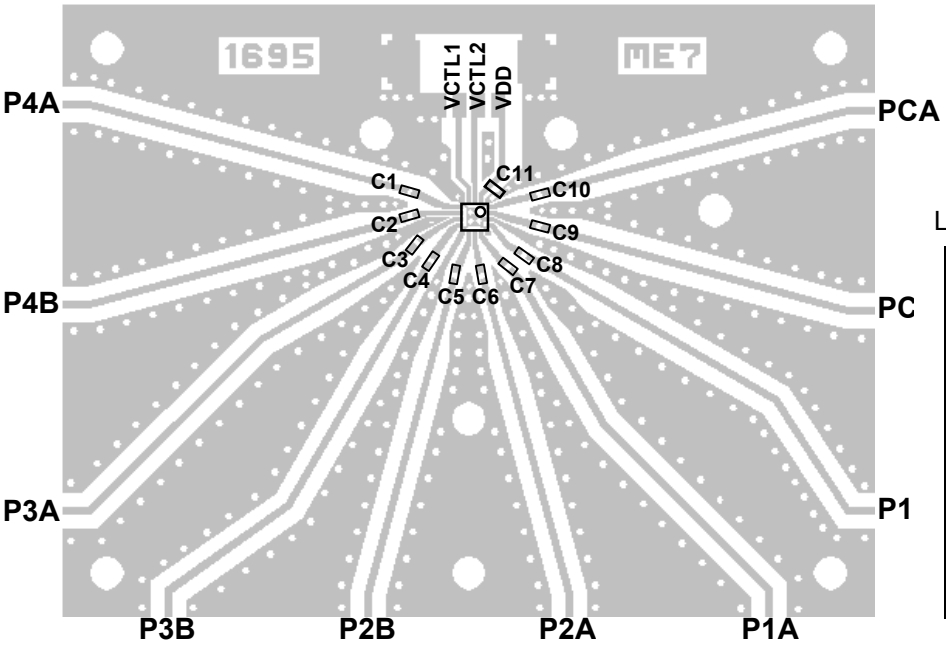


■ PARTS LIST

Part ID	Value	Notes
C1~C10	56pF	MURATA (GRM03)
C11	1000pF	MURATA (GRM15)

■ TEST PCB LAYOUT

(TOP VIEW)

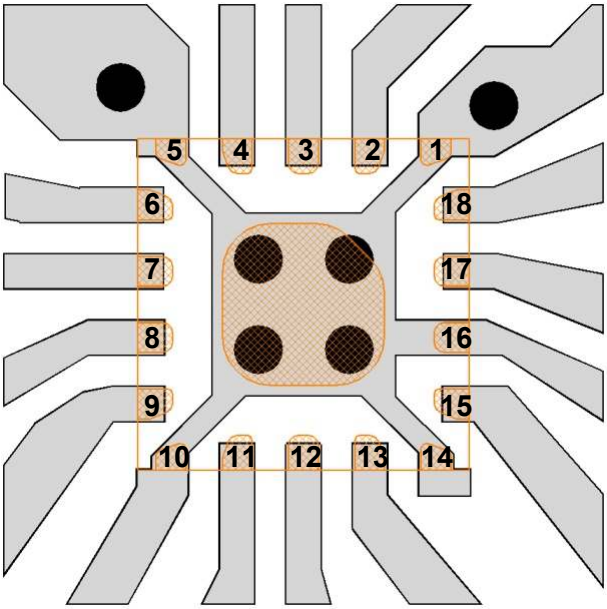


PCB:	FR-4, t=0.2mm
Capacitor Size:	0603, 1005
Strip Line Width:	0.4mm
PCB Size:	53 x 40mm

Losses of PCB, capacitors and connectors

Paths	Frequency (GHz)	Loss (dB)
PCA-P1A, PCB-P1B, PCA-P3A, PCB-P3B	1.0	0.50
	2.0	0.84
	2.7	1.10
PCA-P2A, PCB-P2B, PCA-P4A, PCB-P4B	1.0	0.46
	2.0	0.77
	2.7	0.97

<PCB LAYOUT GUIDELINE>



PCB Pattern

Through-hole (radius: 0.15mm)

Pin

Note2:

The ground plane and the through-holes under Tab, as shown in the picture, are not necessities. There is no problem in deleting them in the practical PCB design, though in such case beware that the GND terminals (pin 10 and 14 as for this particular design shown in the picture) still need through-holes being located in their vicinities.

PRECAUTIONS

[1] The DC current at RF ports must be equal to zero, which can be achieved with DC blocking capacitors (C1~C10).
(However, in case there is no possibility that DC current flows, the DC blocking capacitors are unnecessary, i.e. the RF signals are fed by SAW filters that block DC current by nature, etc.)

[2] To reduce stripline influence on RF characteristics, please locate the bypass capacitor (C11) close to VDD terminal.

[3] For good isolation, the GND terminals must be connected to the PCB ground plane of substrate, and the through-holes connecting the backside ground plane should be placed near by the pin connection.

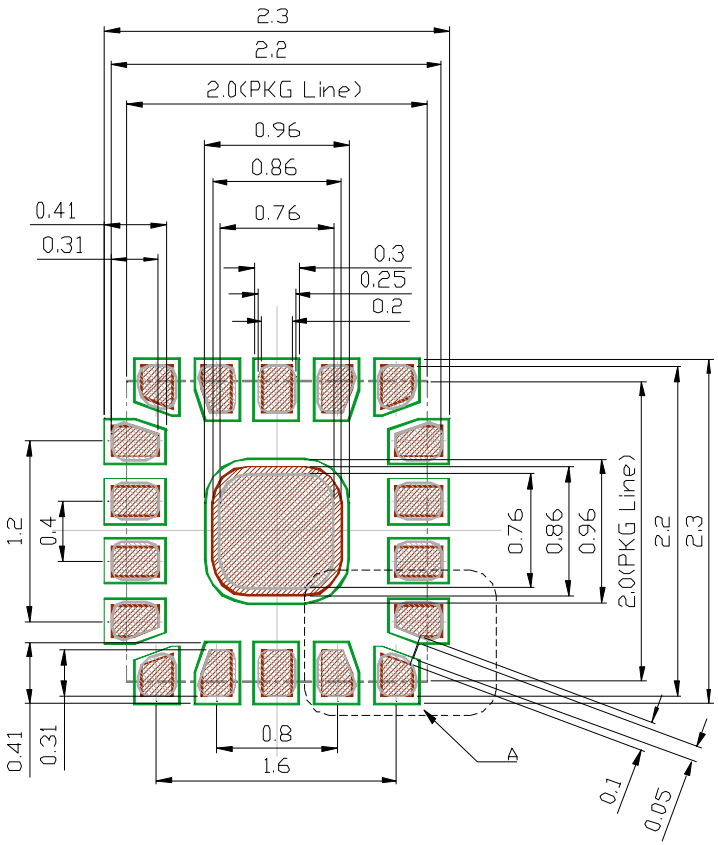
■ RECOMMENDED FOOTPRINT PATTERN (EQFN18-E7 PACKAGE REFERENCE)

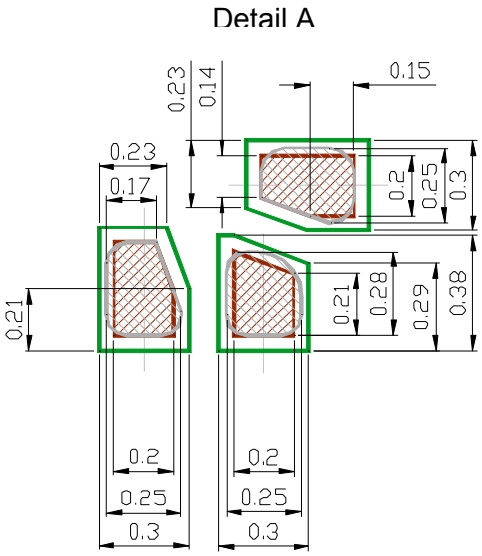
: Land

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

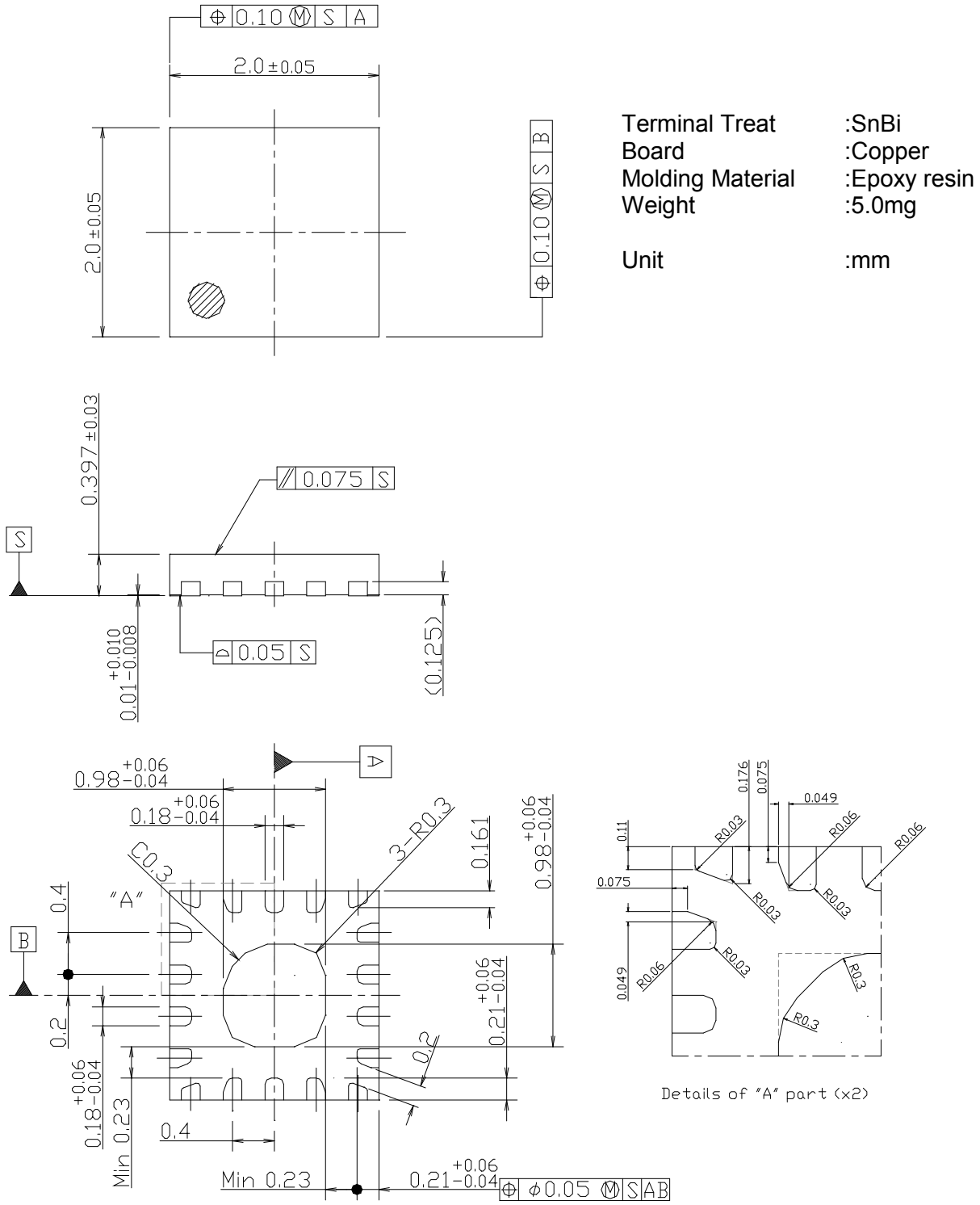
: Resist (Open area)

PKG : 2.0mm x 2.0mm





■ PACKAGE OUTLINE (EQFN18-E7)



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

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