X-SP3T (DP6T) SWITCH GaAs MMIC

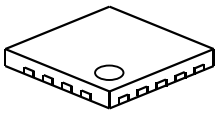
■ GENERAL DESCRIPTION

The NJG1655ME7 is a GaAs X (cross) - SP3T*(DP6T) switch MMIC, which is designed for switching of balanced signals. The NJG1655ME7 features very low phase error between on-state paths, low insertion loss, low control voltage and wide frequency coverage. The ESD protection circuit are integrated in the IC to achieve high ESD tolerance.

The NJG1655ME7 is available in a very small, lead-free, halogen-free, 2.0mm x 2.0mm x 0.397 mm, 18-pin EQFN18-E7 package.

*) X-SP3T is a paired SP3T switch controlled synchronously. The X-SP3T includes two SP3T switches whose RF lines have a crossing inside the chip.

■ PACKAGE OUTLINE



NJG1655ME7

■ APPLICATIONS

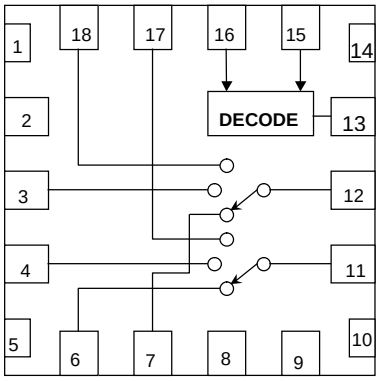
Switching of balanced type filters (Triple band) application
Suitable for 3G and LTE application

■ FEATURES

● Low voltage operation	V_{DD}=+1.5~+4.5V	
● Low voltage logic control	$V_{CTL(H)}$=+1.3V min.	
● Low insertion loss	0.40dB typ.	@ f=1.0GHz
	0.45dB typ.	@ f=2.0GHz
● Operating current consumption	20μA typ.	@ V_{DD}=2.7V
● Low phase error	±3 deg	@ f=2.0GHz
● Small package	EQFN18-E7	(Package size: 2.0mm x 2.0mm x 0.397mm typ.)
● Integrated ESD protection circuit		
● Lead-free, RoHs compliant and halogen-free		

■ PIN CONFIGURATION

(Top View)



Pin connection

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

■ 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

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

■ ABSOLUTE MAXIMUM RATINGS

(T_a=+25°C, Z_S=Z_I=50Ω)

PARAMETER	SYMBOL	CONDITIONS	RATINGS	UNITS
RF Input Power	P_{IN}	V_{DD} =2.7V, V_{CTL}=0V/1.8V	28	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 (74.2mmx74.2mm), T_j=150°C	1400	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_I=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}		-	20	40	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}		-	5	10	μA
Insertion Loss 1	LOSS1	f=1.0GHz, P_{IN}=0dBm	-	0.40	0.55	dB
Insertion Loss 2	LOSS2	f=2.0GHz, P_{IN}=0dBm	-	0.45	0.70	dB
Isolation 1	ISL1	f=1.0GHz, P_{IN}=0dBm PCA-P1A,P2A,P3A, PCB-P1B,P2B,P3B	24	27	-	dB
Isolation 2	ISL2	f=2.0GHz, P_{IN}=0dBm PCA-P1A,P2A,P3A, PCB-P1B,P2B,P3B	18	21	-	dB
Isolation 3	ISL3	f=2.0GHz, P_{IN}=0dBm PCA-PCB	15	18	-	dB
Phase Error	PE	f=2GHz	-3	-	3	deg
Input Power at 0.2dB Compression Point	$P_{-0.2dB}$	f=2GHz	18	23	-	dBm
VSWR	VSWR	f=2GHz, on state	-	1.1	1.3	
Switching Time	Tsw	50% V_{CTL} to 10%/90% RF	-	2	5	μs

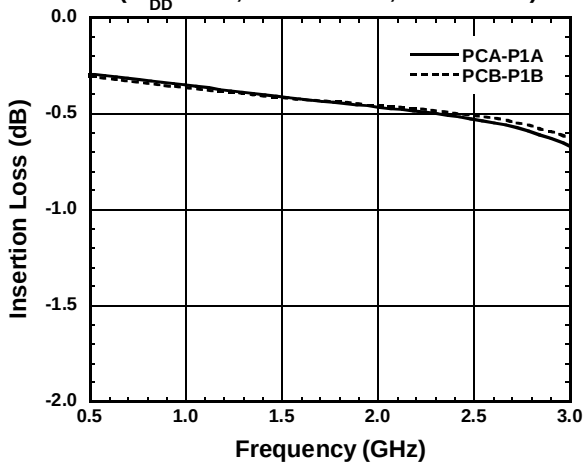
■ **TERMINAL INFORMATION**

No.	SYMBOL	DESCRIPTION
1, 5, 8 10, 14,	GND	Ground terminal. Connect to the PCB ground plane.
2, 9	NC(GND)	No connected terminal. This terminal is not connected with internal circuit. Connect to the PCB ground plane.
3	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.
4	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.
6	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.
7	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.
11	PCB	Common RF port of the 2nd switch. This port is connected with either of P1B, P2B, and P3B port. An external capacitor is required to block DC voltage.
12	PCA	Common RF port of the 1st switch. This port is connected with either of P1A, P2A, and P3A port. An external capacitor is required to block DC voltage.
13	VDD	Positive voltage supply terminal. The positive voltage (+1.5~+4.5V) should be supplied. Please connect a bypass capacitor with GND terminal for best RF performance.
15	VCTL2	Control signal input terminal. This terminal is set to High-Level (+1.3V~4.5V) or Low-Level (0~+0.4V).
16	VCTL1	Control signal input terminal. This terminal is set to High-Level (+1.3V~4.5V) or Low-Level (0~+0.4V).
17	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.
18	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.

■ **ELECTRICAL CHARACTERISTICS** (Losses of external circuit are excluded, with application circuit)

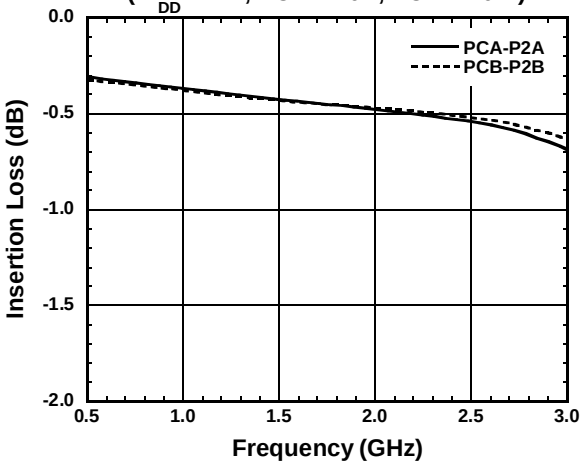
Insertion Loss vs. Frequency

(V_{DD}=2.7V, VCTL1=1.8V, VCTL2=0V)



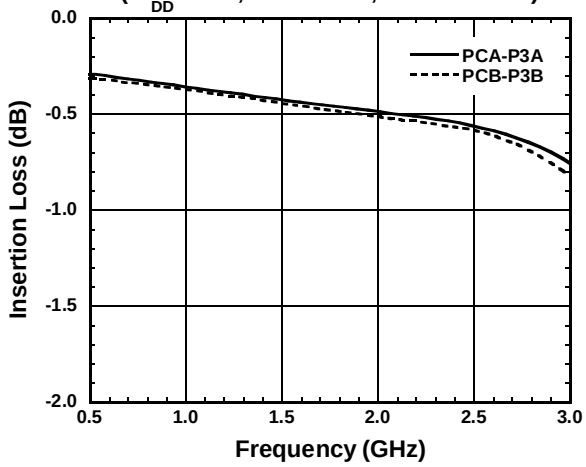
Insertion Loss vs. Frequency

(V_{DD}=2.7V, VCTL1=0V, VCTL2=0V)



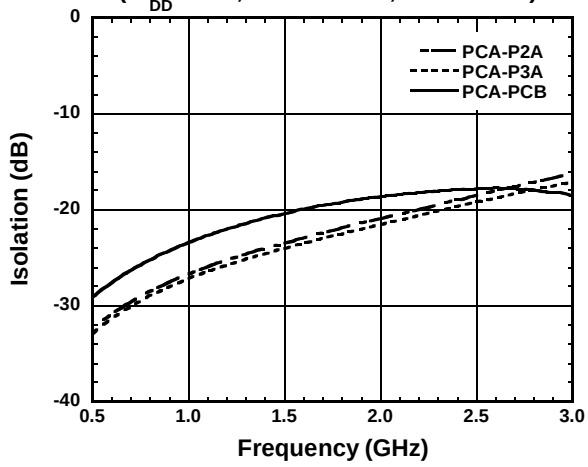
Insertion Loss vs. Frequency

(V_{DD}=2.7V, VCTL1=0V, VCTL2=1.8V)



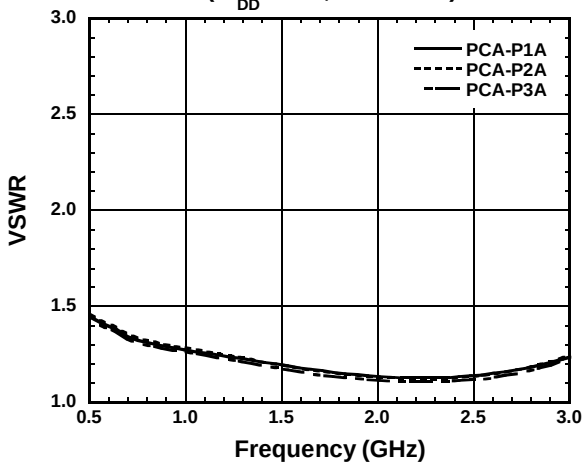
Isolation vs. Frequency

(V_{DD}=2.7V, VCTL1=1.8V, VCTL2=0V)



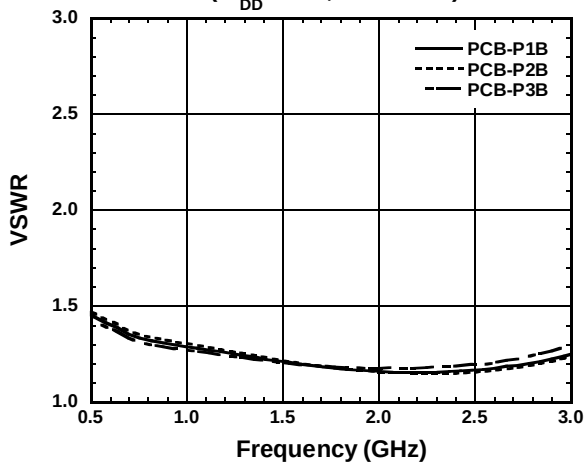
VSWR vs. Frequency

(V_{DD}=2.7V, PCA Port)



VSWR vs. Frequency

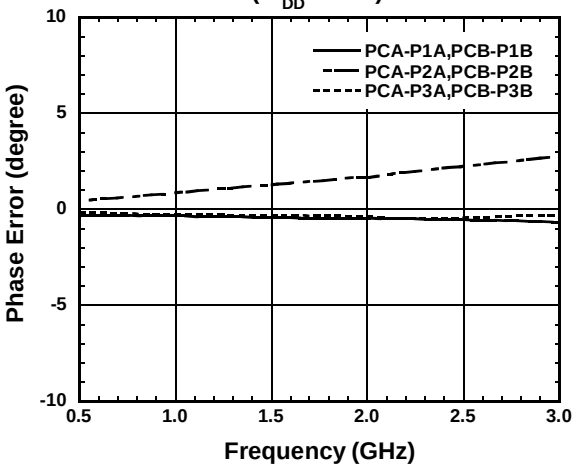
(V_{DD}=2.7V, PCB Port)



■ **ELECTRICAL CHARACTERISTICS** (Losses of external circuit are excluded, with application circuit)

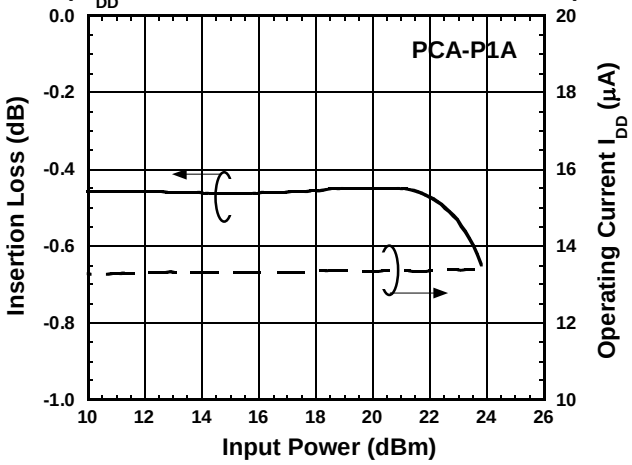
Phase Error vs. Frequency

(V_{DD}=2.7V)



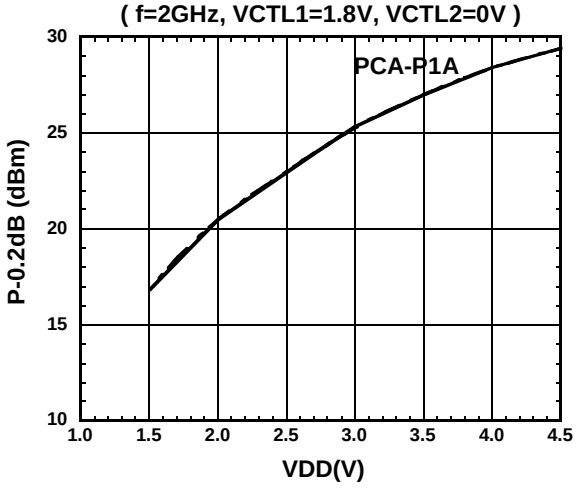
Insertion Loss, IDD vs. Input Power

(V_{DD}=2.7V, f=2GHz, VCTL1=1.8V, VCTL2=0V)



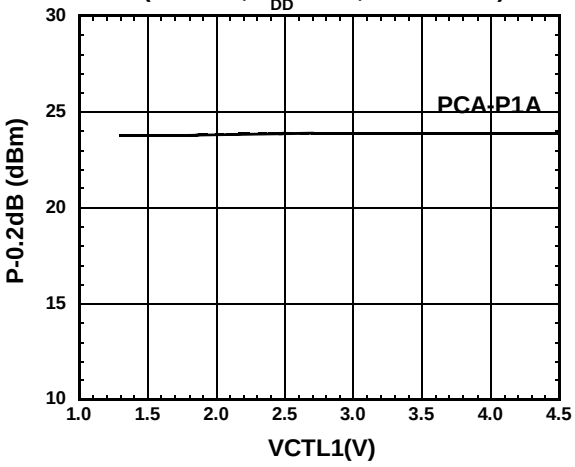
P-0.2dB vs. V_{DD}

(f=2GHz, VCTL1=1.8V, VCTL2=0V)



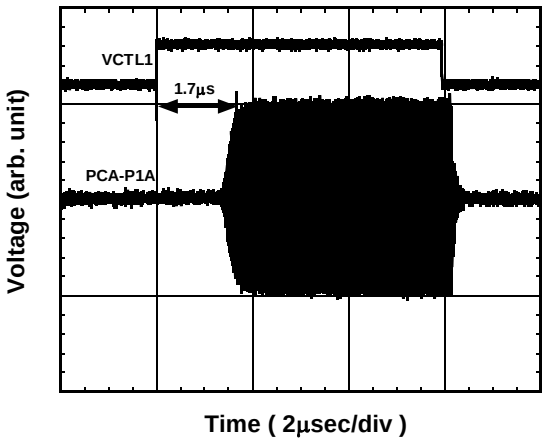
P-0.2dB vs. V_{CTL}

(f=2GHz, V_{DD}=2.7V, VCTL2=0V)



Switching Time

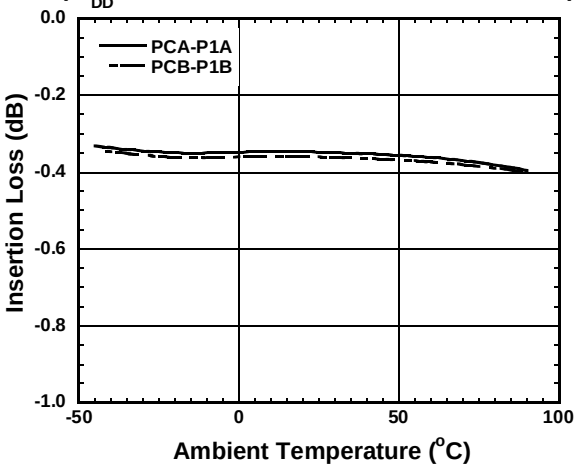
(V_{DD}=2.7V, VCTL2=0V)



■ **ELECTRICAL CHARACTERISTICS** (Losses of external circuit are excluded, with application circuit)

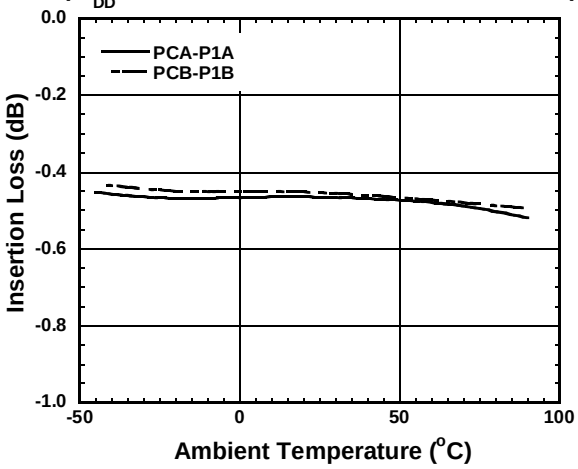
Insertion Loss vs. Ambient Temperature

(V_{DD}=2.7V, f=1GHz, VCTL1=1.8V, VCTL2=0V)



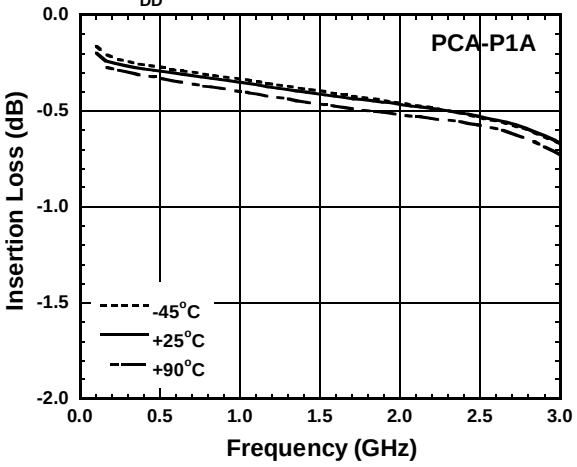
Insertion Loss vs. Ambient Temperature

(V_{DD}=2.7V, f=2GHz, VCTL1=1.8V, VCTL2=0V)



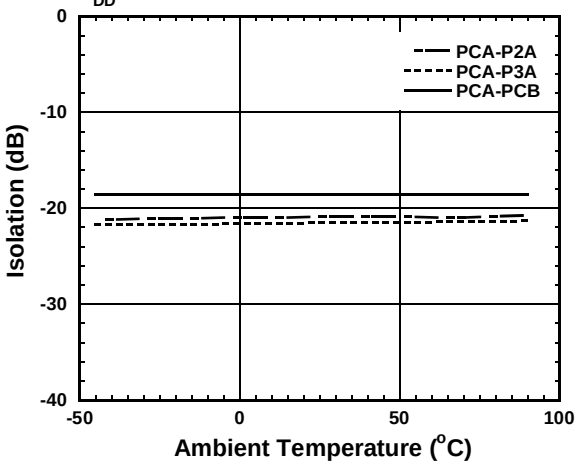
Insertion Loss vs. Frequency

(V_{DD}=2.7V, VCTL1=1.8V, VCTL2=0V)



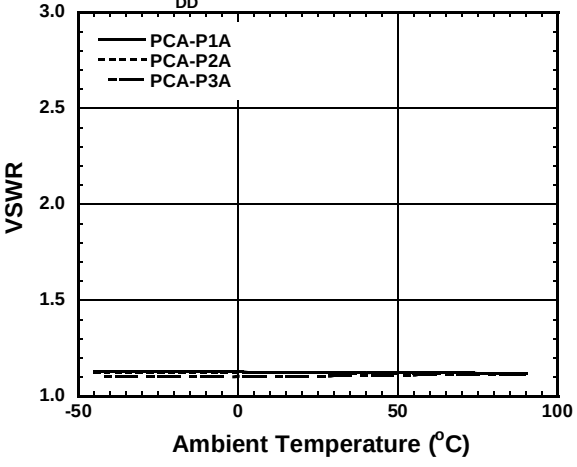
Isolation vs. Ambient Temperature

(V_{DD}=2.7V, f=2GHz, VCTL1=1.8V, VCTL2=0V)



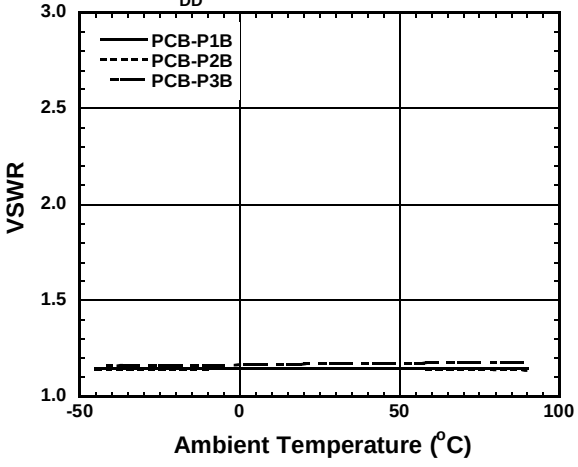
VSWR vs. Ambient Temperature

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



VSWR vs. Ambient Temperature

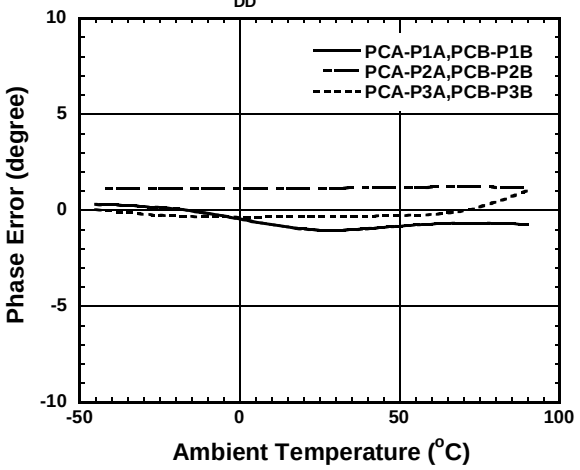
(V_{DD}=2.7V, f=2GHz, PCB Port)



■ **ELECTRICAL CHARACTERISTICS** (Losses of external circuit are excluded, with application circuit)

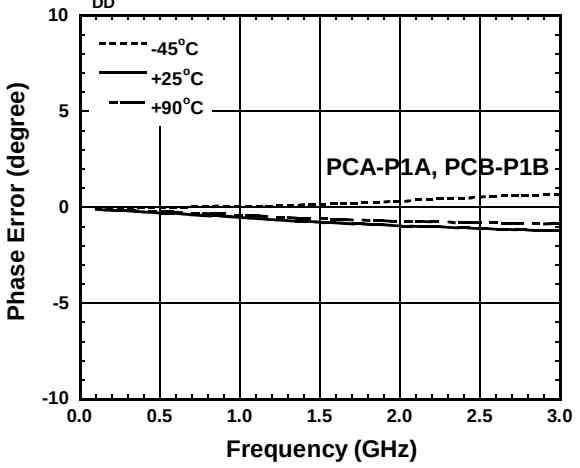
Phase Error vs. Ambient Temperature

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



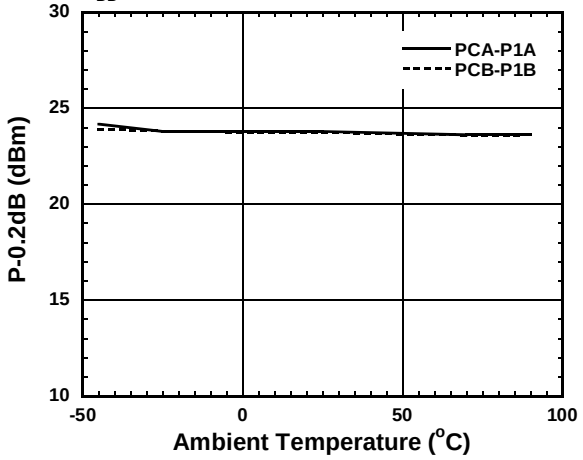
Phase Error vs. Frequency

(V_{DD}=2.7V, f=2GHz, VCTL1=1.8V, VCTL2=0V)



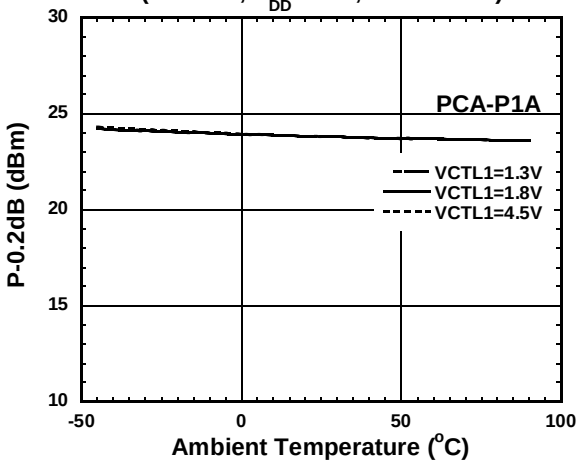
P-0.2dB vs. Ambient Temperature

(V_{DD}=2.7V, f=2GHz, VCTL1=1.8V, VCTL2=0V)



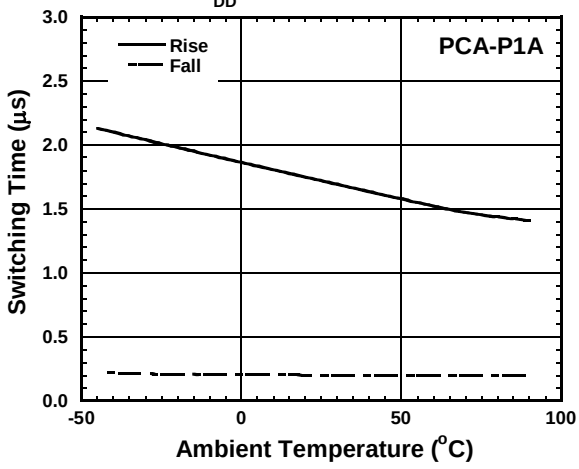
P-0.2dB vs. Ambient Temperature

(f=2GHz, V_{DD}=2.7V, VCTL2=0V)



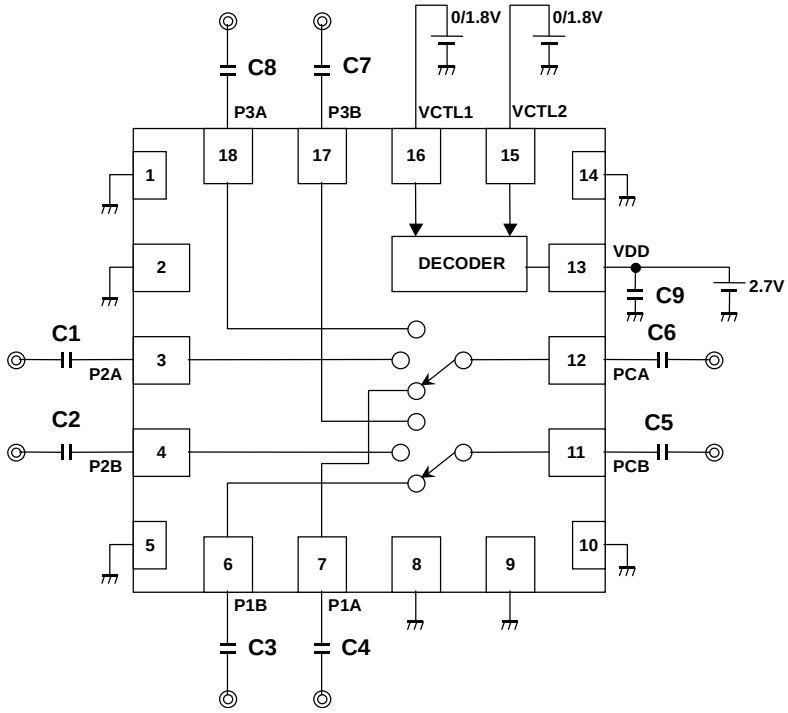
Switching Time vs. Ambient Temperature

(V_{DD}=2.7V, VCTL2=0V)



■ APPLICATION CIRCUIT

(TOP VIEW)

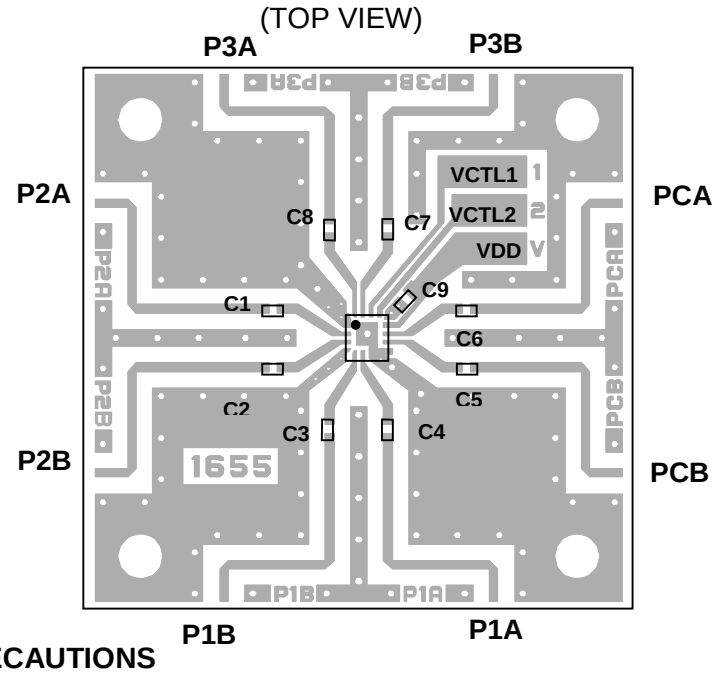


■ PARTS LIST

PART ID	Value	Notes
C1~C8	56pF	MURATA (GRM15)
C9	1000pF	

■ TEST PCB LAYOUT

(TOP VIEW)



Losses of PCB, capacitors and connectors

Frequency	Loss
1GHz	0.36dB
2GHz	0.49dB

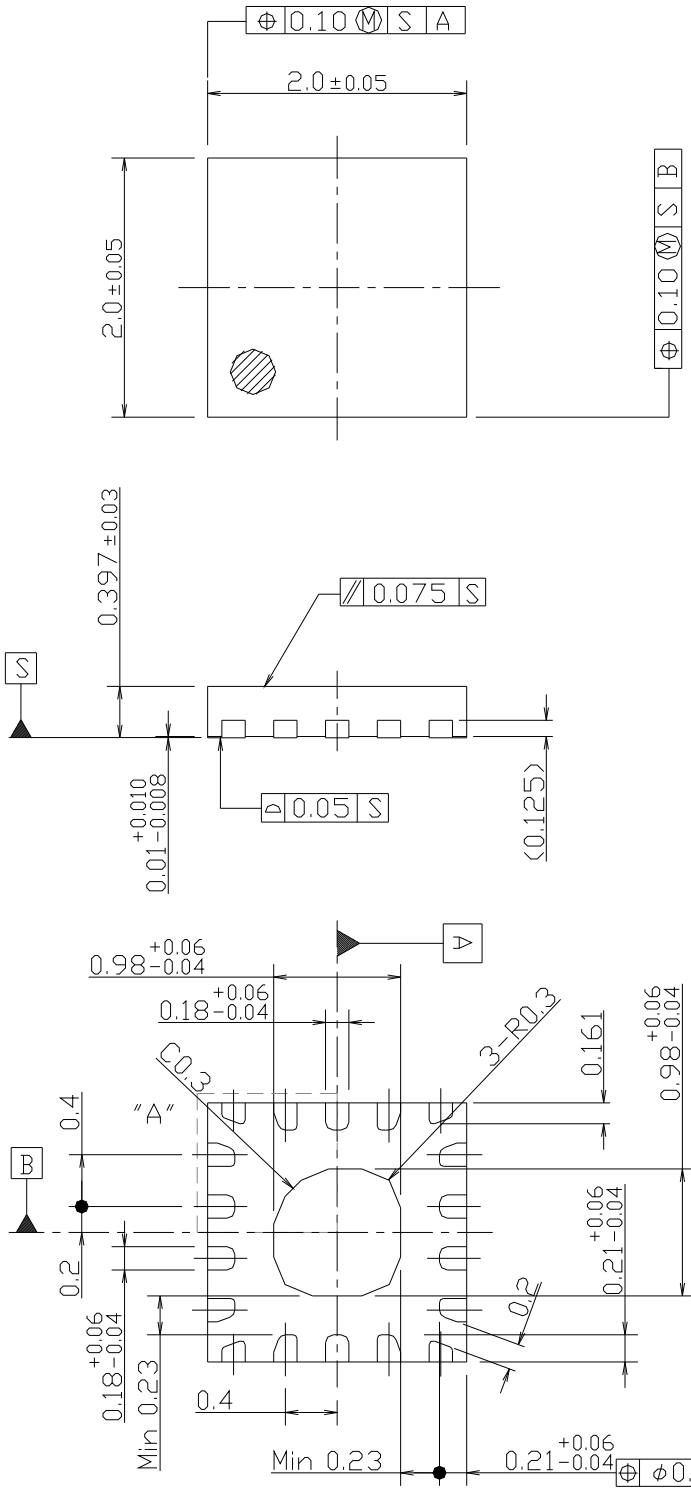
PRECAUTIONS

[1] The DC blocking capacitors (C1~C8) must be placed at all RF terminals (PCA, PCB, P1A, P1B, P2A, P2B, P3A and P3B).

[2] The bypass capacitor (C9) should be placed as close as VDD terminal.

[3] Please layout ground pattern right under this IC to avoid degradation of isolation or high power characteristics.

■ 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.

1. The products and the product specifications described in this document are subject to change or discontinuation of production without notice for reasons such as improvement. Therefore, before deciding to use the products, please refer to our sales representatives for the latest information thereon.
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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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