

## 1.6 GHz Low Noise Amplifier

### GENERAL DESCRIPTION

The XC2401A8167R-G is an ultra-low-noise amplifier (LNA) with low operating voltage, low noise figure (NF), low power consumption using CMOS process.

The device offers easy output matching to 50  $\Omega$  for input and output with less external components.

An internal self bias function eliminates external bias setting.

The device operates at 1.2V. For higher power supplies such as 1.8V and 2.85V, the device can operate with a self bias of one adding resistor.

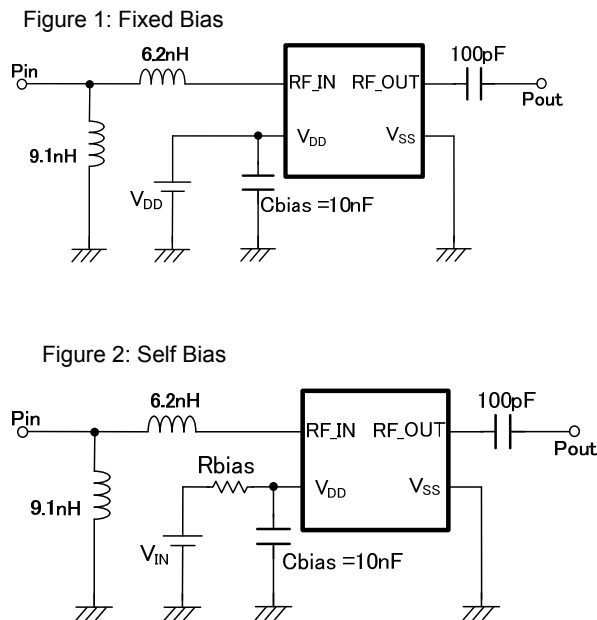
### APPLICATIONS

GPS RF module

### FEATURES

- Noise Figure : NF=0.69dB(TYP.) (@ 1.575GHz)
- Low Power Consumption : 6.6mW (TYP.) @  $V_{DD}$ =1.2V, Fixed Bias
- High Gain :  $S_{21}$  =15dB(TYP.) (@ 1.575GHz)
- Operation Voltage Range : 1.14V ~ 1.26V @ Fixed Bias
- Output : CMOS Output, 50  $\Omega$  driver built-in
- Operating Temperature Range : -40 ~ +85
- Ultra Small Package : USPN-4B02
- Environmentally Friendly : EU RoHS Compliant, Pb Free

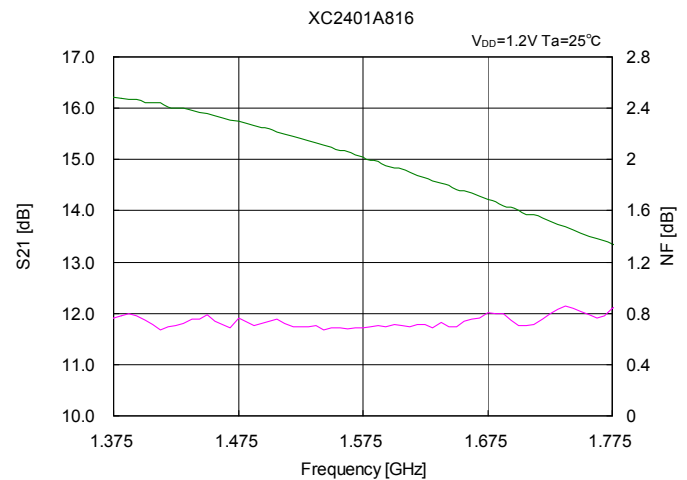
### TYPICAL APPLICATION CIRCUIT



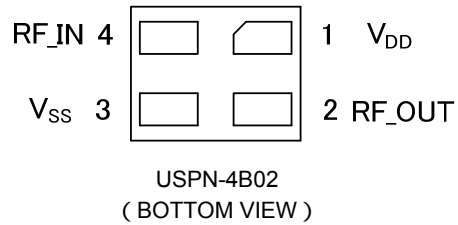
$V_{IN}$ [V]	$R_{bias}$ [ $\Omega$ ]
3.00	560
2.85	470
1.80	160

\*  $R_{BIAS}$  should be in  $\pm 1\%$  tolerance and  $\pm 200\text{ppm/}$  temperature stability.

### TYPICAL PERFORMANCE CHARACTERISTICS



## PIN CONFIGURATION



## PIN ASSIGNMENT

PIN NUMBER	PIN NAME	FUNCTION
USPN-4B02		
1	V <sub>DD</sub>	Power Supply RF
2	RF_OUT	RF Signal Output
3	V <sub>SS</sub>	Ground
4	RF_IN	RF Signal Input

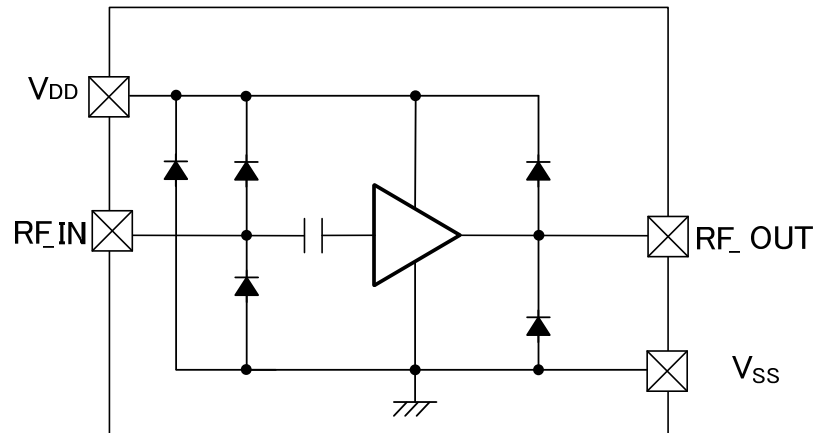
## PRODUCT CLASSIFICATION

### Ordering Information

PRODUCT NAME	PACKAGE	ORDER UNIT
XC2401A8167R-G <sup>(*)</sup>	USPN-4B02	5,000/Reel

<sup>(\*)</sup> The "-G" suffix indicates that the products are Halogen and Antimony free as well as being fully RoHS compliant.

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Ta=25

PARAMETER	SYMBOL	RATINGS	UNITS
Supply Voltage	$V_{DD}$	$V_{SS} - 0.3 \sim 1.60$	V
Supply Circuit	$I_{DD}$	30	mA
RF Input Power	$P_{IN}$	10	dBm
RF_IN Input Voltage	RF_IN	$V_{SS} - 0.3 \sim V_{DD} + 0.3$	V
RF_OUT Input Voltage	RF_OUT	$V_{SS} - 0.3 \sim V_{DD} + 0.3$	V
Power Dissipation	$P_d$	100	mW
Operating Temperature Range	$T_{opr}$	-40 ~ +85	°C
Storage Temperature Range	$T_{stg}$	-55 ~ +125	°C

## ELECTRICAL CHARACTERISTICS

### DC Characteristics

Fixed Bias (refer to TYPICAL APPLICATION CIRCUIT, Figure 1)

Ta=25

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Power Supply Pin Voltage	V <sub>DD</sub>	-	1.14	1.20	1.26	V	
Current Circuit	I <sub>DD</sub>	V <sub>DD</sub> =1.2V		5.5	10.5	mA	

Self Bias (refer to TYPICAL APPLICATION CIRCUIT, Figure 2)

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Input Power Supply Voltage 1	V <sub>IN1</sub>	R <sub>bias</sub> =560 ± 1% ± 200ppm/	2.850	3.000	3.150	V	
Input Power Supply Voltage 2	V <sub>IN2</sub>	R <sub>bias</sub> =470 ± 1%, ± 200ppm/	2.708	2.850	2.992	V	
Input Power Supply Voltage 3	V <sub>IN3</sub>	R <sub>bias</sub> =160 ± 1%, ± 200ppm/	1.710	1.800	1.890	V	
Power Supply Pin Voltage	V <sub>DD</sub>	V <sub>IN</sub> = V <sub>IN1</sub> , V <sub>IN2</sub> , V <sub>IN3</sub>	0.90	1.12	1.32	V	
Current Circuit	I <sub>DD</sub>	V <sub>IN</sub> = V <sub>IN1</sub> , V <sub>IN2</sub> , V <sub>IN3</sub>	-	4.25	5.50	mA	

\* When the device is used in self bias, please use the specified R<sub>BIAS</sub> and C<sub>BIAS</sub>.

## ELECTRICAL CHARACTERISTICS (Continued)

AC Characteristics

 $V_{DD}=1.2V$   $T_a=25$ 

PARAMETER	SYMBOL	CONDITIONS	MIN.	TYP.	MAX.	UNITS	CIRCUIT
Power Gain	S21	f=1.575 GHz	11.5	15.0	-	dB	
Input Return Loss	S11	f=1.575GHz	-	6	-	dB	
Output Return Loss	S22	f=1.575GHz	-	6	-	dB	
Isolation	S12	f=1.575GHz	-	-20	-	dB	
Noise Figure <sup>(*)</sup>	NF	f=1.575GHz	-	0.69	-	dB	
Input Power IP3	I <sub>IP3</sub>	f=1.575GHz, 1.576GHz P <sub>in</sub> = -30dBm	-	-1.0	-	dBm	
Input Power @ 1dB Gain Compression	P1dB	f=1.575GHz	-	-12	-	dBm	

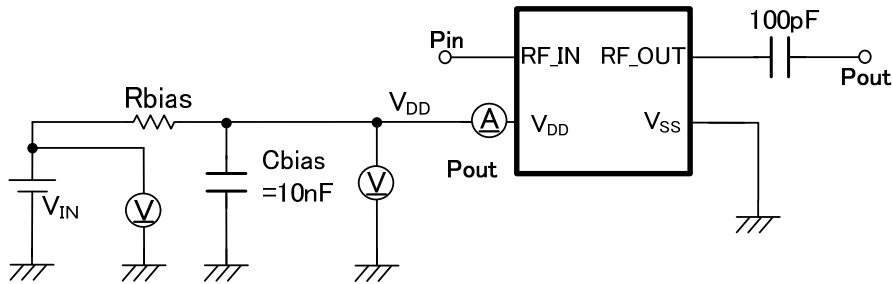
\*1: NF is the value excluding the PCB loss.

## Note

- In case symptoms of transient voltage drop and rise temporarily, please use this IC within the stated maximum ratings.  
The IC is liable to malfunction should the ratings be exceeded.
- Please eliminate static electricity from the operational table, people, and soldering iron.
- Please use noiseless power supply for stable operation.
- Please use  $\pm 1\%$  Rbias with  $\pm 200\text{ppm}/^\circ\text{C}$  temperature stability and 10nF Cbias.
- Please connect Cbias to  $V_{DD}$  pin as close as possible.
- Please ensure to use an external component which does not depend on bias or temperature too much.
- We will improve the product quality and improve reliability, however please make sure to design fail safe or pre-aging treatment on the system.

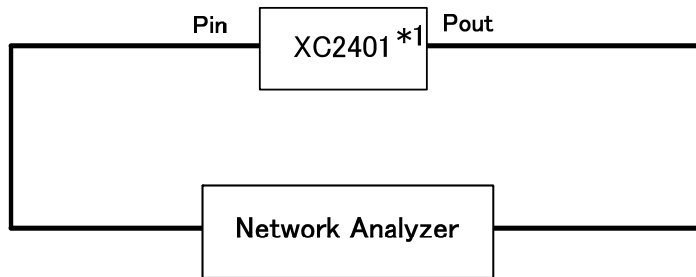
## TEST CIRCUITS

Circuit (DC Characteristics: Power Supply Pin Voltage, Circuit Current, Input Power Supply Voltage)



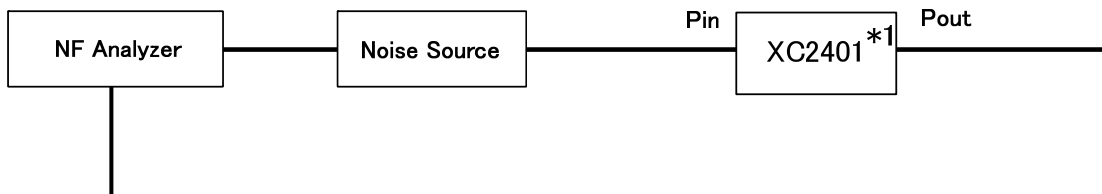
- \* Fixed Bias:  $R_{bias}=0\Omega$ ,  $V_{IN}=V_{DD}$
- \*\* Pin / Pout is  $50\Omega$

Circuit (Power Gain, Input Return Loss, Output Return Loss, Isolation, Input Power @ 1dB Gain Compression)



\*1: Refer to the circuit for the block detail.

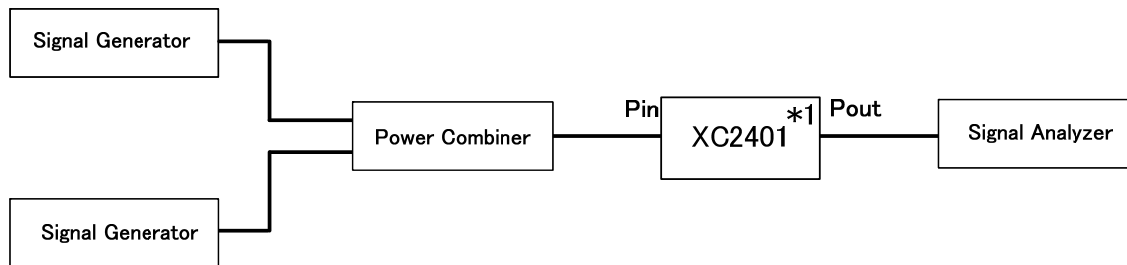
Circuit (Noise Figure)



\*1: Refer to the circuit for the block detail.

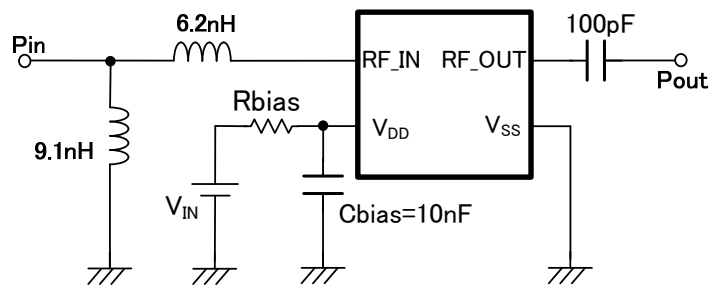
## TEST CIRCUITS (Continued)

Circuit (Input Power IIP3)



\*1: Refer to the circuit for the block detail.

Circuit (XC2401 series, the circuit of the block)

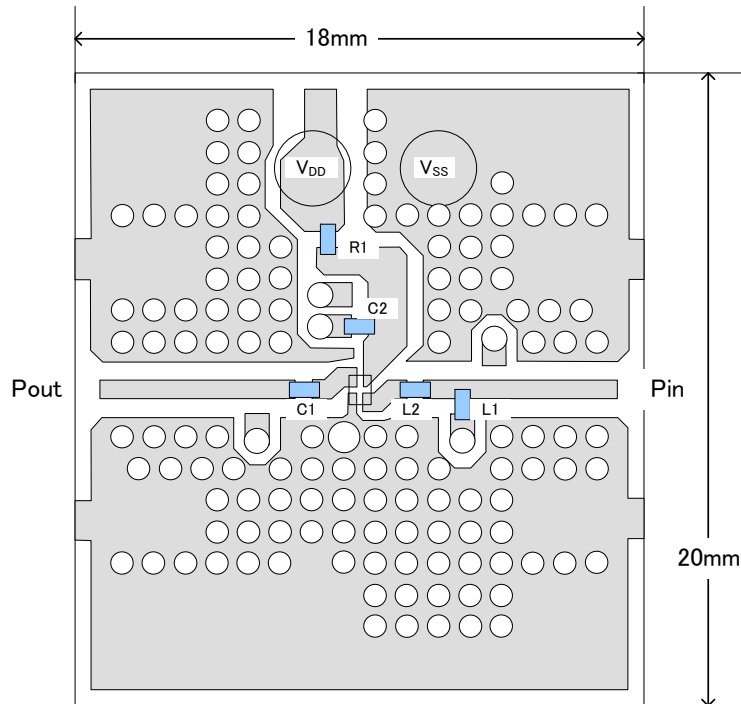


$V_{IN}(V)$	$R_{bias}(\Omega)$
3.00	560
2.85	470
1.80	160

\* Fixed Bias:  $R_{bias}=0\Omega$ ,  $V_{IN}=V_{DD}$

\*\*  $R_{bias}$ : Should be in  $\pm 1\%$  tolerance and  $\pm 200\text{ppm/}^\circ\text{C}$  temperature stability.

## EVALUATION BOARD



SYMBOL	SPEC	COMMENT
C1	100pF	MURATA (GRM1552C1H)
C2	10nF	-
L1	9.1nH	TDK (GLQ1005type)
L2	6.2nH	TDK (GLQ1005type)
R1 (Rbias) <sup>(*)</sup>	- <sup>(*)</sup>	Less than $\pm 1\%$ tolerance, Less than $\pm 200\text{ppm/}$ temperature stability

PCB(FR-4)

MICROSTRIPLINE WIDTH = 0.6mm

t = 0.018mm

PCB size = 20mm x 18mm

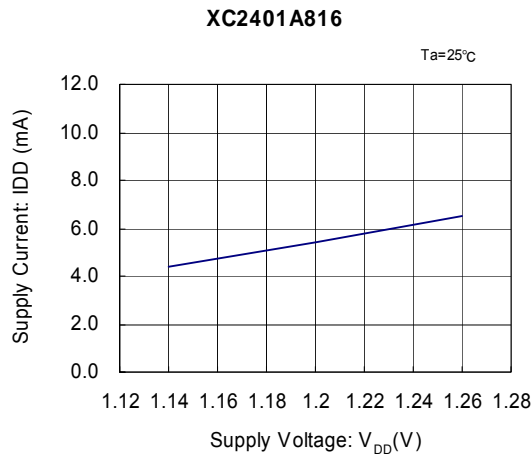
\*1: Fixed Bias: Rbias=0

\* Please use an external component which does not depend on bias or temperature too much.

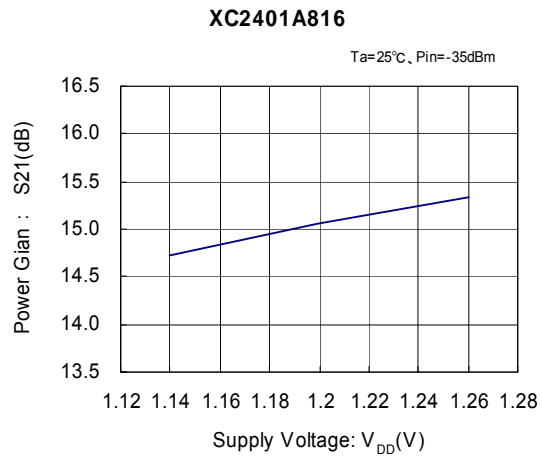


# TYPICAL PERFORMANCE CHARACTERISTICS

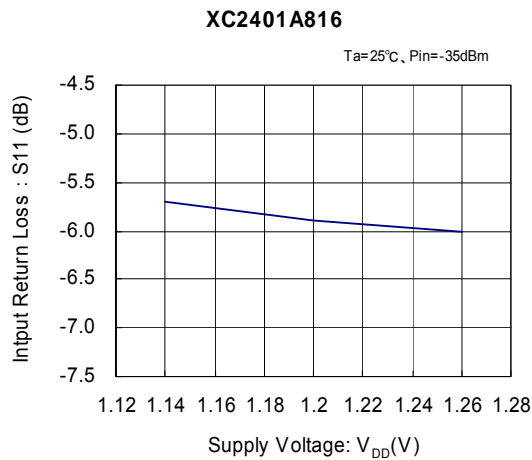
(1) Supply Circuit vs. Supply Voltage



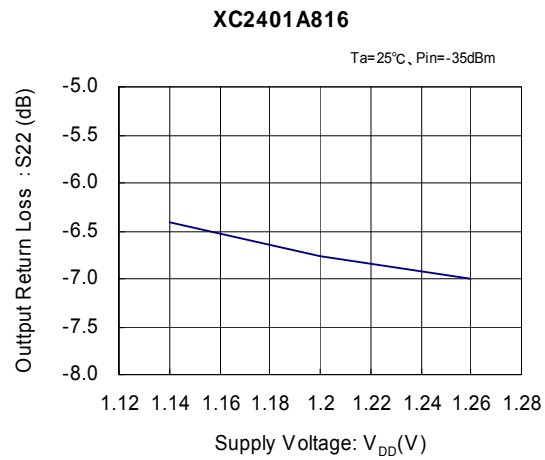
(2) Power Gain vs. Supply Voltage



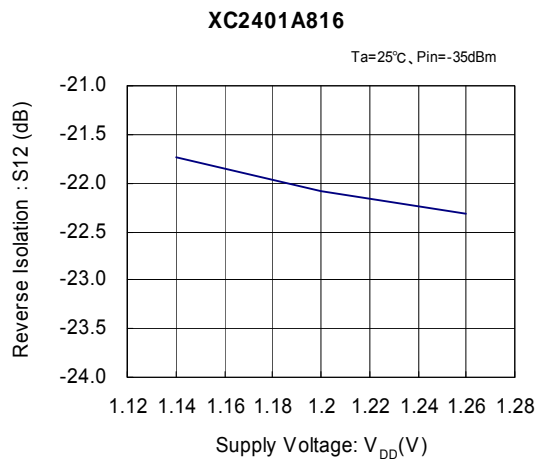
(3) Input Return Loss vs. Supply Voltage



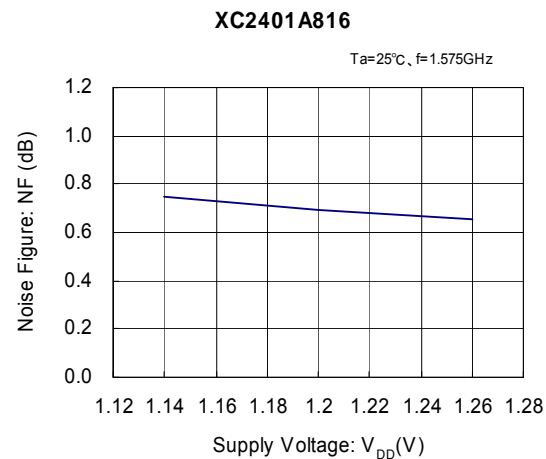
(4) Output Return Loss vs. Supply Voltage



(5) Reverse Isolation vs. Supply Voltage

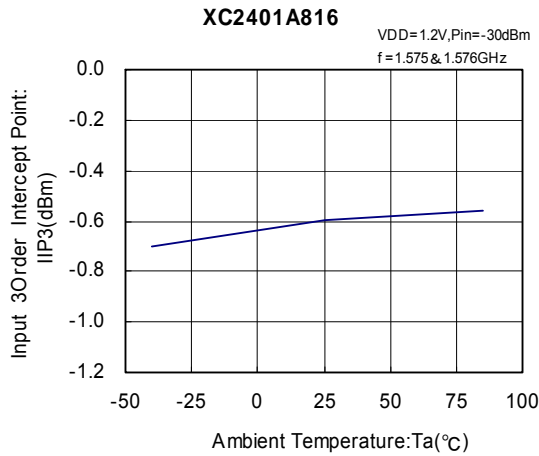


(6) Noise Figure vs. Supply Voltage

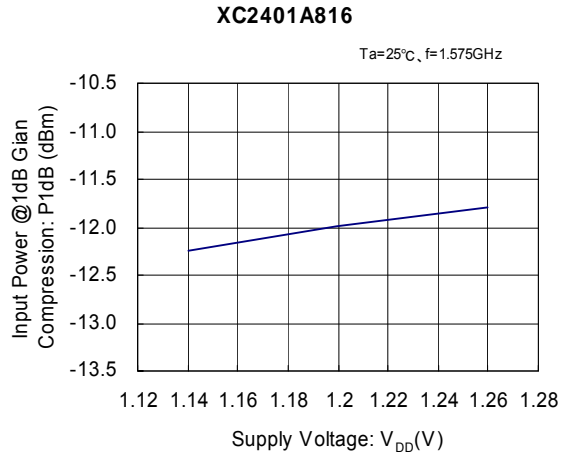


## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

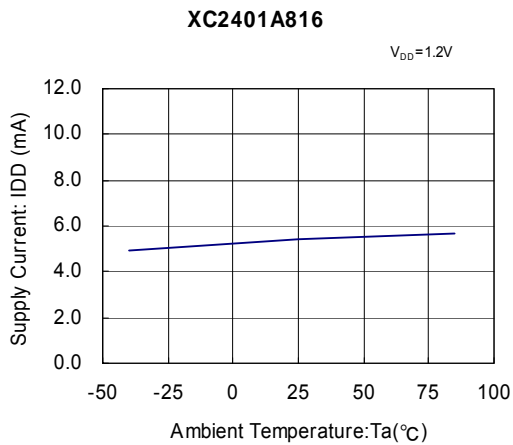
(7) Input 3 Order Intercept Point vs. Supply Voltage



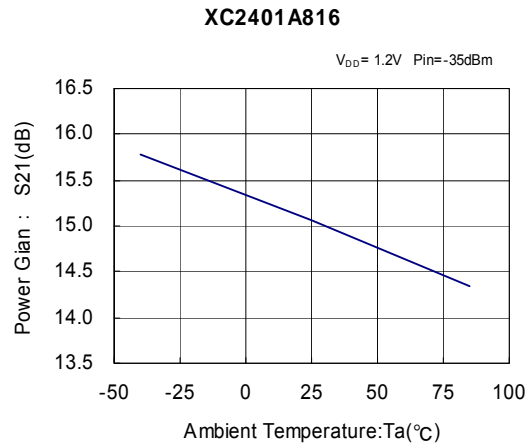
(8) Input Power @ 1dB Gain Compression vs. Power Supply Voltage



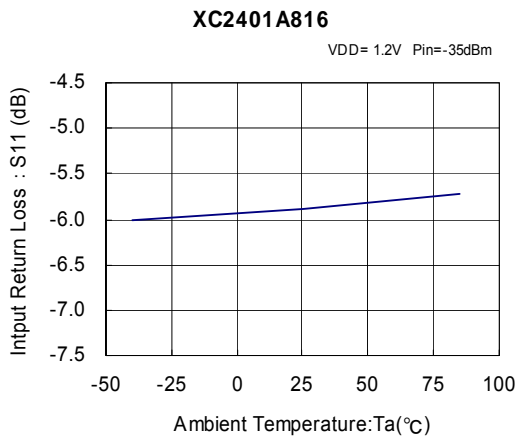
(9) Supply Current vs. Ambient Temperature



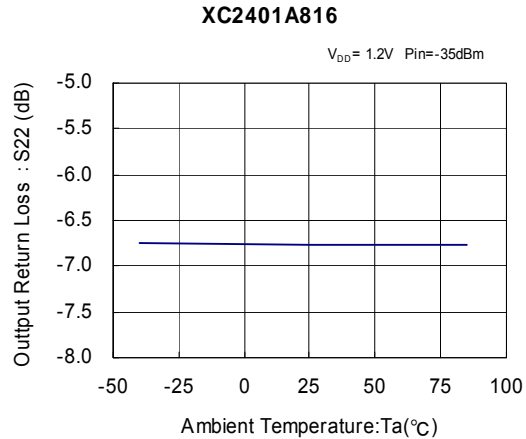
(10) Power Gain vs. Ambient Temperature



(11) Input Return Loss vs. Ambient Temperature

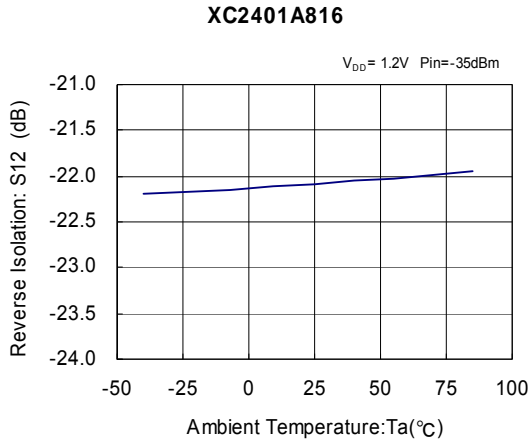


(12) Output Return Loss vs. Ambient Temperature

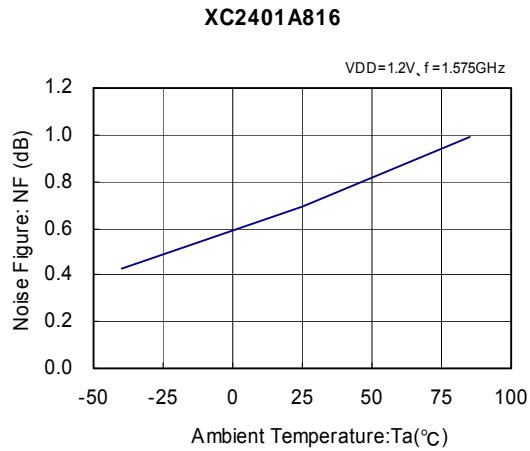


TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

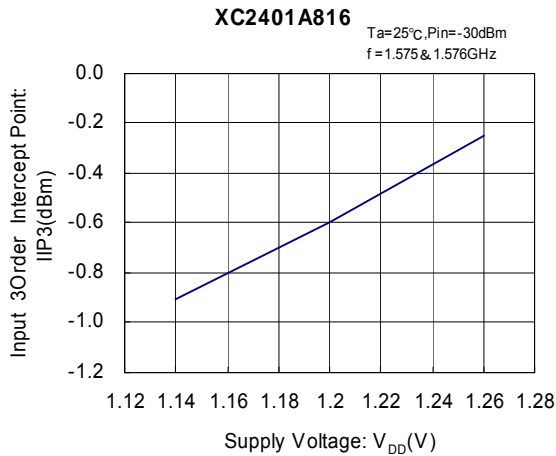
(13) Reverse Isolation vs. Ambient Temperature



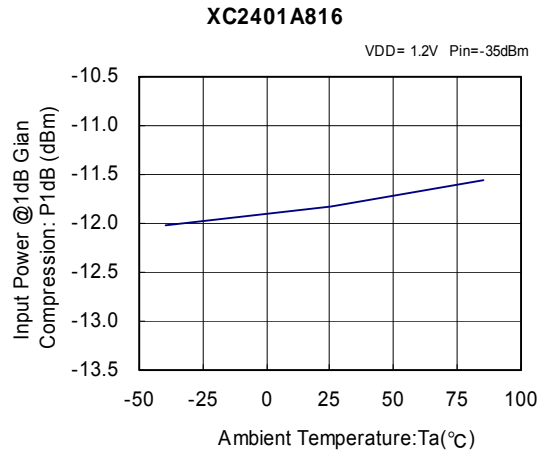
(14) Noise Figure vs. Ambient Temperature



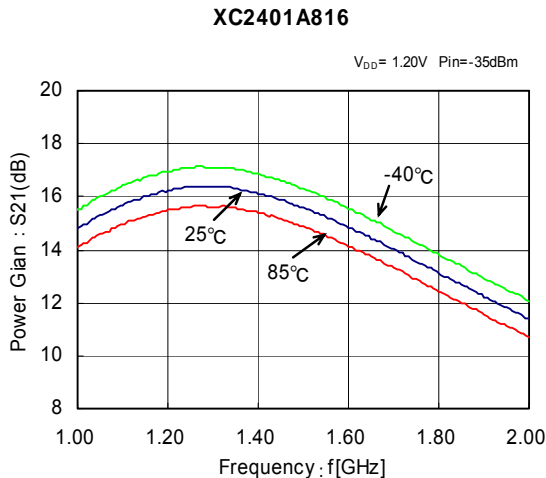
(15) Input 3 Order intercept point vs. Ambient Temperature



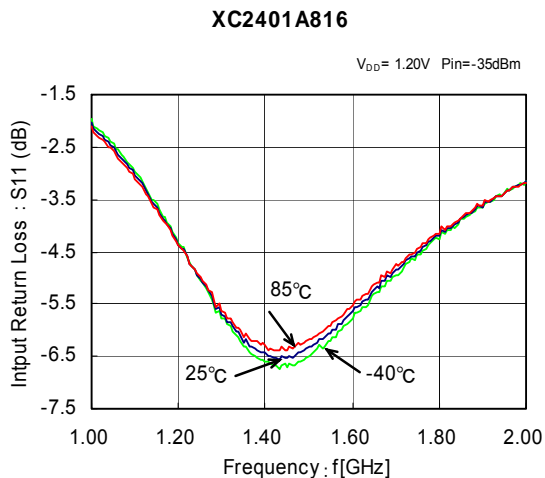
(16) Input Power @ 1dB Gain Compression vs. Ambient Temperature



(17) Power Gain vs. Frequency



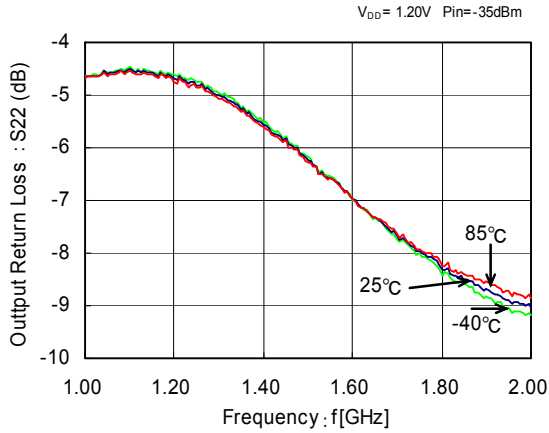
(18) Input Return Loss vs. Frequency



## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

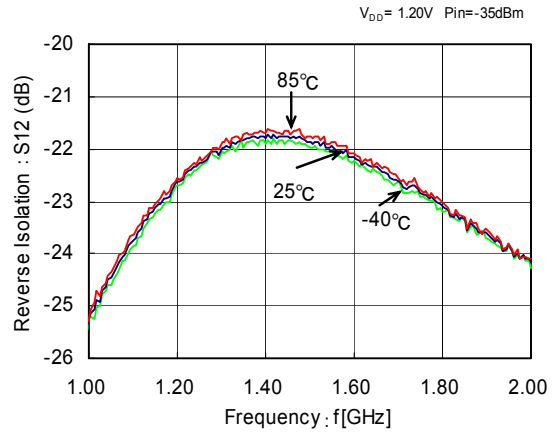
(19) Output Return Loss vs. Frequency

**XC2401A816**



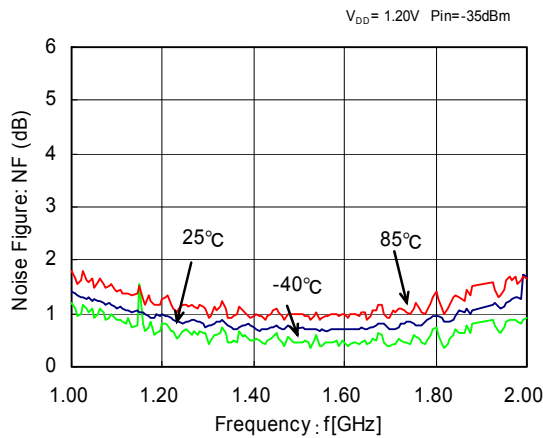
(20) Isolation vs. Frequency

**XC2401A816**



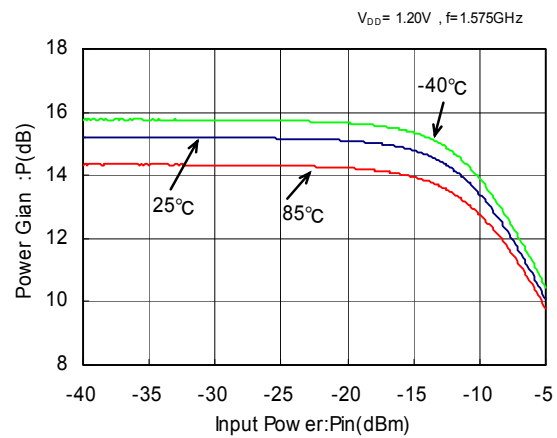
(21) Noise Figure vs. Frequency

**XC2401A816**



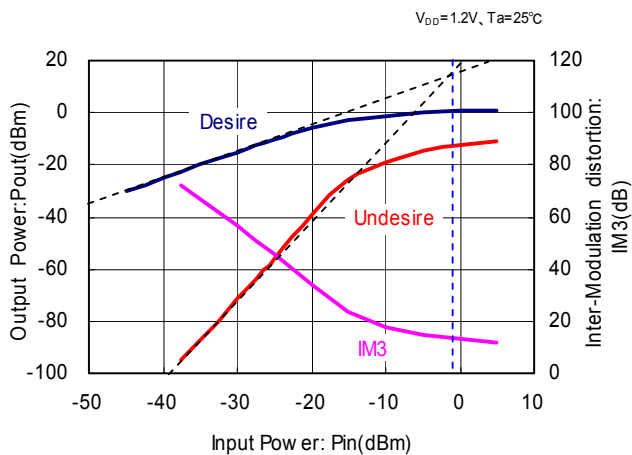
(22) Power Gain vs. Input Power

**XC2401A816**



(23) Output Power / IM3 vs. Input Power

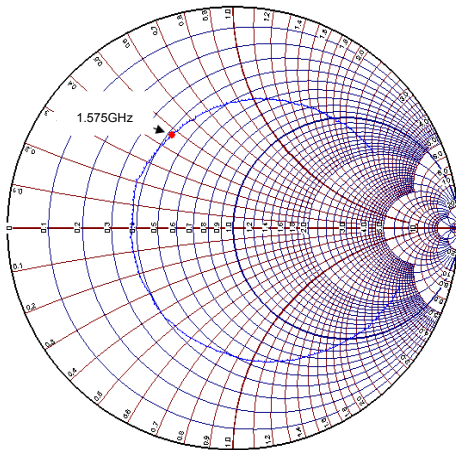
**XC2401A816**



## TYPICAL PERFORMANCE CHARACTERISTICS (Continued)

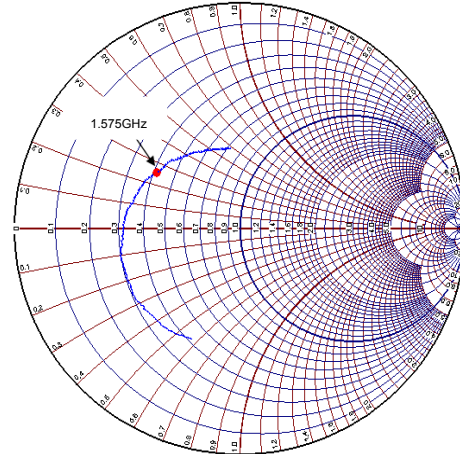
(24) Input Return Loss vs. Frequency (Smith Chart)

XC2401A816

 $V_{DD}=1.2V, P_{in}=-35dBm$ 

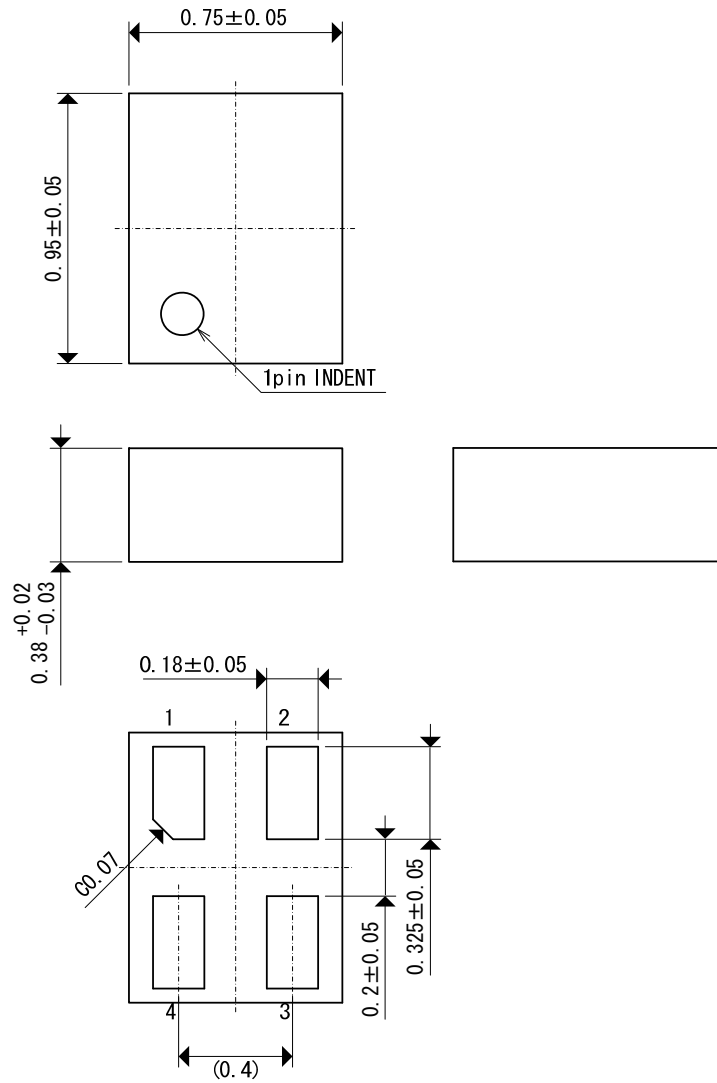
(25) Output Return Loss vs. Frequency (Smith Chart)

XC2401A816

 $V_{DD}=1.2V, P_{in}=-35dBm$ 

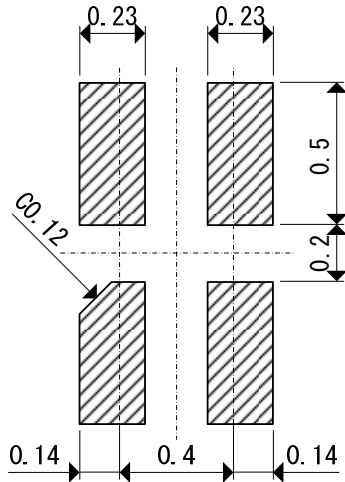
## PACKAGING INFORMATION

USPN-4B02

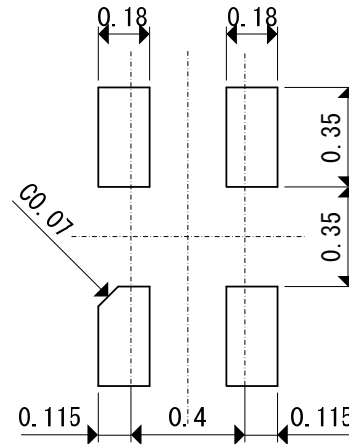


## PACKAGING INFORMATION (Continued)

USPN-4B02 Reference Pattern Layout

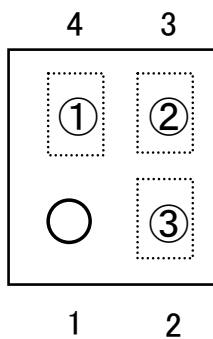


USPN-4B02 Reference Metal Mask Design



## MARKING RULE

USPN-4B02



represents product series.

MARK	PRODUCT SERIES
8	XC2401*****-G

represents product.

MARK	PRODUCT SERIES
A	XC2401A816**-G

represents production lot number.

01 to 09, 0A to 0Z, 11 to 9Z, A1 to A9, AA to Z9, ZA to ZZ in order.

(G, I, J, O, Q, W excepted)

\*No character inversion used.

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