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AK1291

IF Variable Gain Amplifier with RSSI

1. Overview

AK1291 is a variable gain amplifier with a power detector. It's operating frequency ranges from 90MHz to 300MHz. The gain control adopts an analog signal control, and the gain characteristic is dB linear. The gain control range is -9dB to +21dB and a dynamic range is 30dB. AK1291 has single-ended input and output, with impedance of 50 Ω. As a typical characteristic, NF is 7dB (at maximum gain) , and IMD3 is 70dBc at output power of -15dBm ,at frequency of 165MHz.The power supply voltage is 4.75V to 5.25V.

2. Feature

▪Operation Frequency Range	90MHz to 300MHz
▪Gain variable range	-9dB to 21dB
▪Noise Figure	7dB @max gain
▪IMD3	70dBc @output power -15dBm
▪Supply Voltage	4.75V to 5.25V
▪Operating Temperature	-40°C to +85°C
▪Package	24pin QFN0404

3. Block Diagram

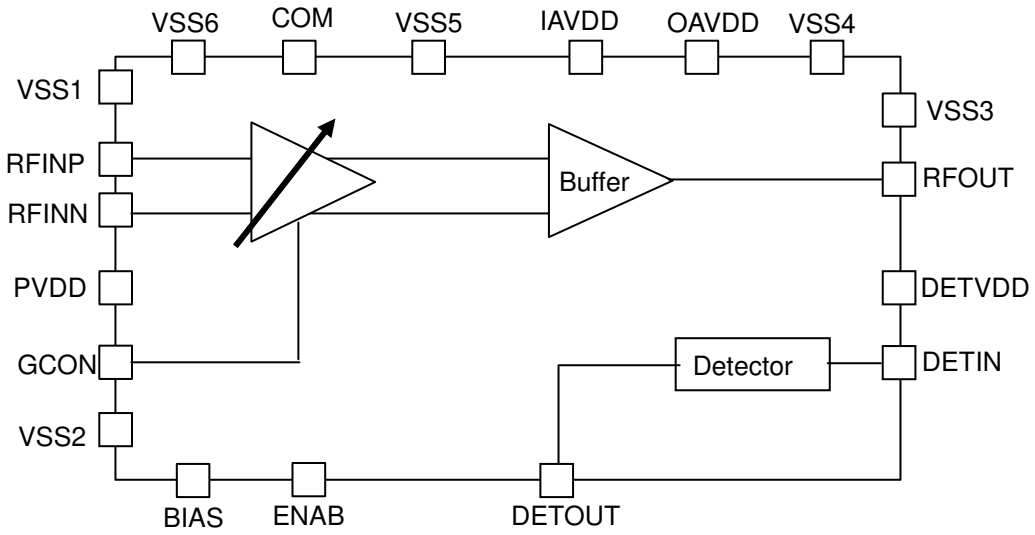


Figure. 1 Block Diagram

Contents

4. Pin Configuration

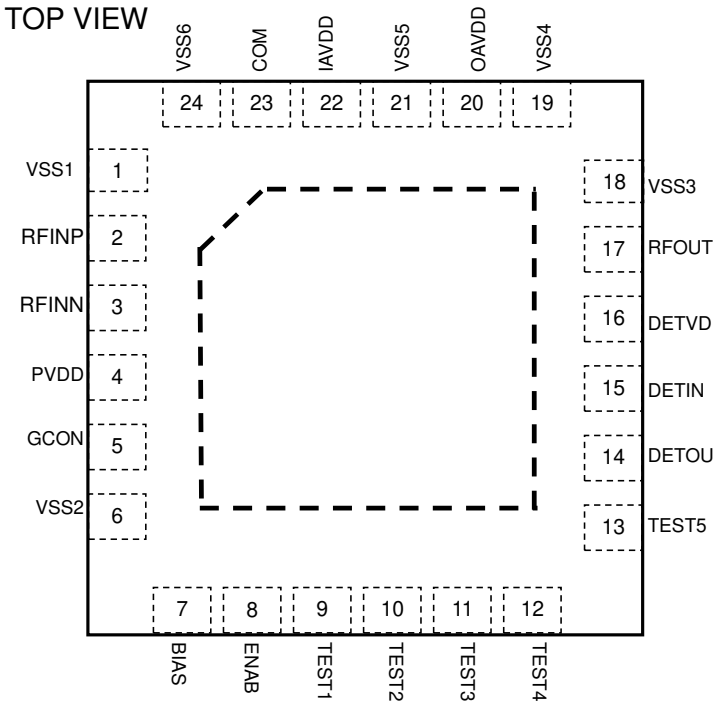


Figure. 2 Pin Configuration

5. Block Function

Block	Function
VGA	Variable Gain Amplifier which is controlled by the voltage of 0.2 to 2.5V
Power Detector	Power detector which detect power level of VGA output

6. Pin function Description

Pin No	Name	I/O	function	Remark
1	VSS1	G	Ground	
2	RFINP	AI	RF input Positive	
3	RFINN	AI	RF input Negative	
4	PVDD	P	Power Supply	
5	GCON	AI	Control voltage input	
6	VSS2	G	Ground	
7	BIAS	AIO	Resistance connection pin for current adjustment	No resistance is connected.
8	ENAB	DI	Power down control	ENAB=”High” Power on ENAB=”Low” Power down
9	TEST1	DI	Test pin	Connect to ground
10	TEST2	DI	Test pin	Connect to ground
11	TEST3	DI	Test pin	Connect to ground
12	TEST4	DI	Test pin	Connect to ground
13	TEST5	DO	Test pin	Connectionless
14	DETOUT	AO	Detector output	connect a capacitor of 10pF to ground
15	DETIN	AI	Detector input	
16	DETVDD	P	Power supply	
17	RFOUT	AO	RF output	
18	VSS3	G	Ground	
19	VSS4	G	Ground	
20	OAVDD	P	Power supply	
21	VSS5	G	Ground	
22	IAVDD:	P	Power supply	
23	COM	AIO	Pin for input common voltage	connect a capacitor of 10nF to ground
24	VSS6	G	Ground	
25	EXPAD	G	Ground	The exposed pad at the center of the backside should be connected to ground.

Note) the exposed pad at the center of the backside should be connected to ground.

AI:Analog input pin	AO:Analog output pin	DI: Digital Input pin	DO:Digital Output pin
P: Power supply pin	G: Ground pin		

＊About power down control: The power down of the whole IC is done by ENAB (pin8). In the case that ENAB is “High”, VGA block and Detector block are power on state. In the case that let only Detector block power down, connect DETVDD to the ground.

7. Absolute Maximum Rating

Item	Symbol	Min.	Max.	unit	Remarks
Supply Voltage	VDD	-0.3	5.5	V	Applied to [PVDD],[IAVDD],[OAVDD],[DETVDD] note1)
Ground Level	VSS	0	0	V	Applied to[VSS1], [VSS2],[VSS3], [VSS4],[VSS5],[VSS6] and [EXPAD]
Analog input voltage	VAIN	-0.3	VDD+0.3	V	Applied to [RFINP],[RFINN], [GCON] and [DETIN]
	VDIN	-0.3	VDD+0.3	V	Applied to [ENAB] note1)
RFINP/RFINN Maximum input Level	Pmax		+10	dBm	
Storage Temperature	Tstg	-55	125	°C	

Note1) All voltage reference ground Level: 0V

Exceeding these maximum ratings may result in damage to the AK1291. Normal operation is not guaranteed at these extremes

8. Recommended operational condition

Item	Symbol	Min.	Typ.	Max.	unit	Remarks
Operating Temperature	Ta	-40		85	°C	
Supply Voltage	VDD	4.75	5	5.25	V	Applied to [PVDD],[IAVDD], [OAVDD],and [DETVDD]

Each specification is applied in the power supply voltage and the operating temperature applied to recommended operational condition.

9. Electrical Characteristic

DC Characteristic

Item	Symbol	Condition	Min.	Typ.	Max.	Unit
High Level Input Voltage	VIH	Note1)	0.8*VDD			V
Low Level Input Voltage	VIL	Note1)	0.0		0.2*VDD	V
Input leak current	IIL	Note1)	-10		10	µA
Current consumption 1	ICC1	PVDD=OAVDD=IAVDD=DETVDD=VDD, ENAB=High		155	199	mA
Current consumption 2	ICC2	PVDD=OAVDD=IAVDD＝VDD, DETVDD=VSS, ENAB=High		151	195	mA
Current consumption 3	ICC3	PVDD=OAVDD=IAVDD＝VDD, DETVDD=VSS, ENAB=Low		10		µA

Note1) Applied to [ENAB] pin

AC Characteristic

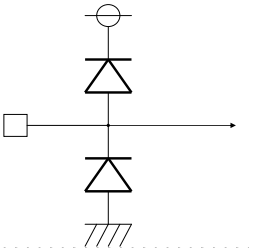
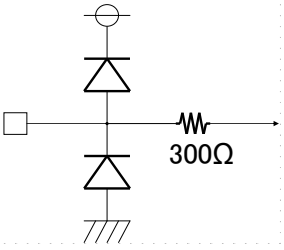
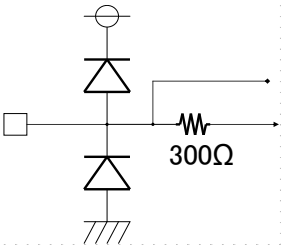
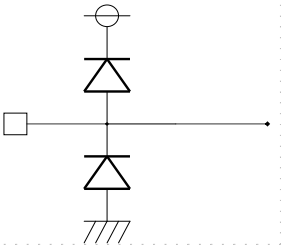
PVDD=OAVDD=IAVDD=4.75V～5.25V, Ta=-40°C～85°C f_0=165MHz, unless otherwise specified

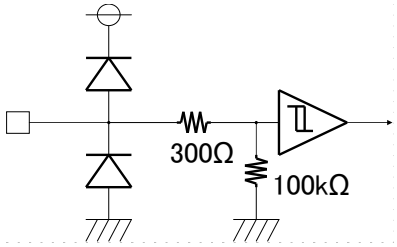
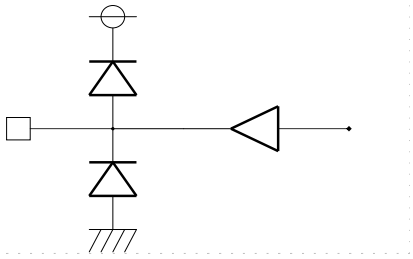
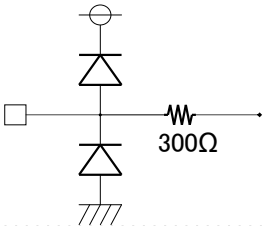
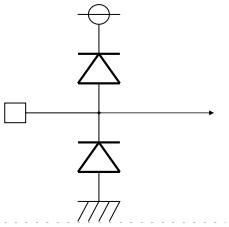
Item	Symbol	Condition	Min.	Typ.	Max.	Unit
VGA Block						
Input Frequency	F_{OP}		90		300	MHz
Input Impedance	I_{IMP}			50		Ω
Output Impedance	O_{IMP}			50		Ω
Gain control Range	G_{CONT}			30		dB
Max. Gain	G_{MAX}	GCON=2.5V	21			dB
Min. Gain	G_{MIN}	GCON=0.2V			-6.5	dB
Gain 1	Ga1	GCON=2V		21		dB
Gain 2	Ga2	GCON =0.5V		-9		dB
Gain control voltage range	V_{GT}		0.2		2.5	V
Gain curve slope note1)	G_{CS}	0.5V≦VGCONT≦2.0V	1	20	80	dB/V
Gain step response	G_{SR}			5		µS
<RFIN=90MHz>						
Noise Figure note2)	NF	Gain = 21 dB		7		dB
Output P1dB	OP1			5		dBm
IMD3	IMD3	Output Level = -15dBm	65	70		dBc
<RFIN=165MHz>						
Noise Figure note2)	NF	Gain = 21 dB		7		dB
Output P1dB	OP1			5		dBm
IMD3	IMD3	Output Level = -15dBm	65	70		dBc
<RFIN=300MHz>						
Noise Figure note2)	NF	Gain = 21 dB		7		dB
Output P1dB	OP1			5		dBm
IMD3	IMD3	Output Level = -15dBm	55	60		dBc

Detector Block						
Input Frequency range	F_{OP2}		100		500	MHz
Output voltage Level 1	Det_H	DETIN=-15dBm		1.6	2.2	V
Output voltage Level 2	Det_L	DETIN=-35dBm	0.5	0.9		V
Temperature dependency note 2)	Detvdev	Refer to 25°C		±1		dB

Note1) guaranteed monotonicity
Note2) guaranteed by design

10. Interface circuit

Pin No	Pin Name	I/O	Interface circuit
2	RFINP	I	**RF input** 
3	RFINN		
5	GCON	I	**Analog Input** 
7	BIAS	I/O	**Analog Input/Output** 
23	COM		
17	RFOUT	O	**RF output** 

Pin No.	Pin Name	I/O	Interface Circuit
8	ENAB	I	**Digital input Pull-Down** 
9	TEST1		
10	TEST2		
11	TEST3		
12	TEST4		
13	TEST5	O	**Digital output** 
14	DETOUT	O	**Output** 
15	DETIN	I	**RF input** 

11. Evaluation Board Schimatic

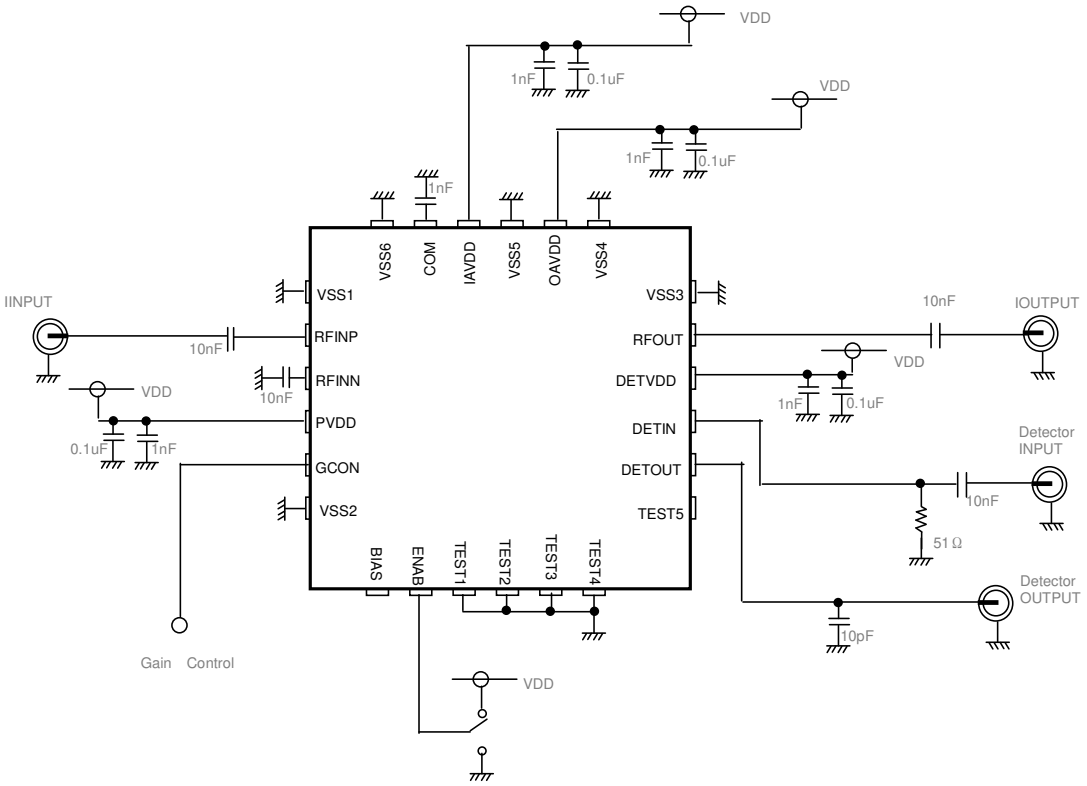
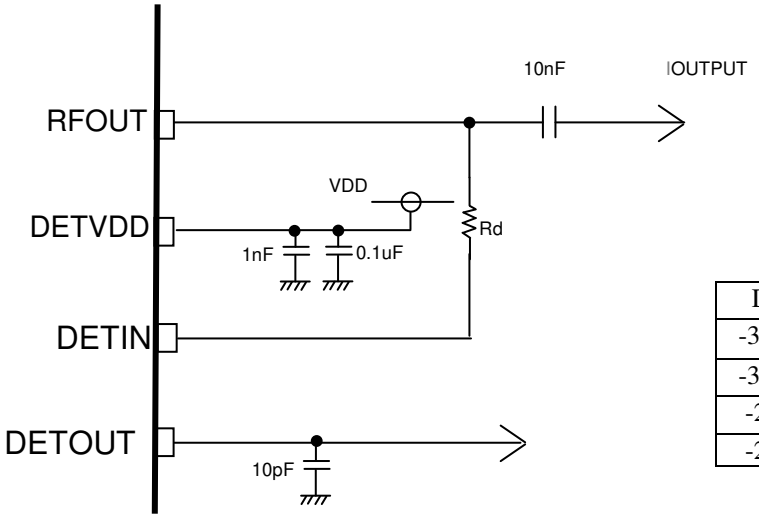


Figure. 3 Typical Evaluation Board Schimatic

12. Detection of the output signal level

To detect the output power , connect “RFOUT” to “DETIN” via register.
The value of register varies depending on the detection level.
Circuit schematic and the value of register are shown in figure 4.



Detect Rage	Rd
-35 to -15dBm	0Ω
-30 to -10dBm	820Ω
-25 to -5dBm	2.2kΩ
-20 to -0dBm	4.7kΩ

Figure. 4 Circuit schematic of VGA output and detector input

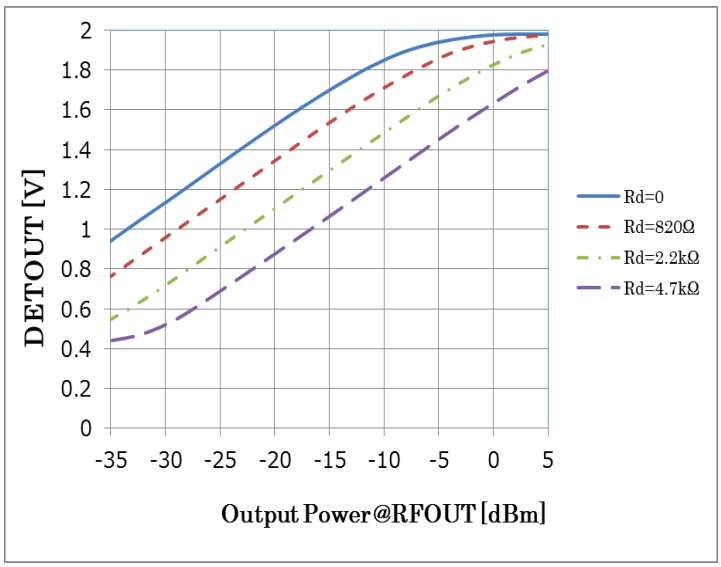


Figure. 5 DETOUT vs Output Power@RFOUT

13. Typical Performance

Unless otherwise noted, PVDD=OAVDD=IAVDD=DETVDD=5V, Ta=25℃, Freq=165MHz

1. Gain vs Analog Controll Voltage

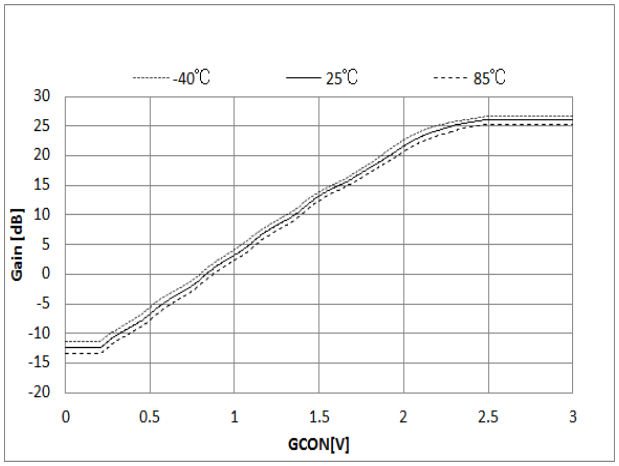


Figure.6-1 Gain VS Control Voltage(fo=100MHz)

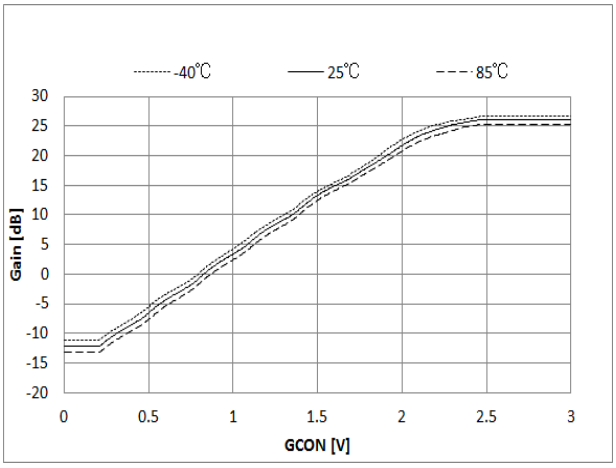


Figure.6-1 Gain VS Control Voltage(fo=165MHz)

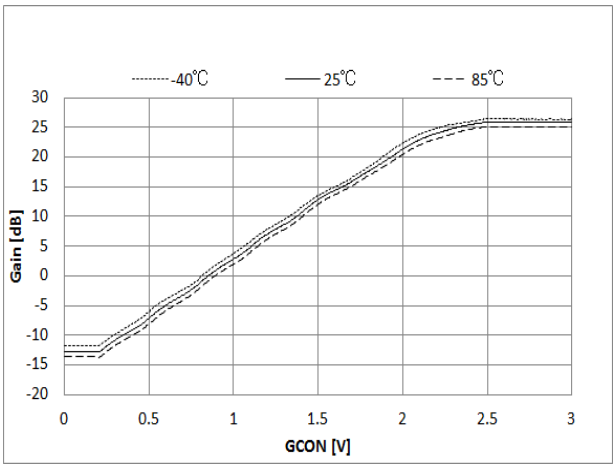


Figure.6-1 Gain VS Control Voltage(fo=300MHz)

2. Noise Figure

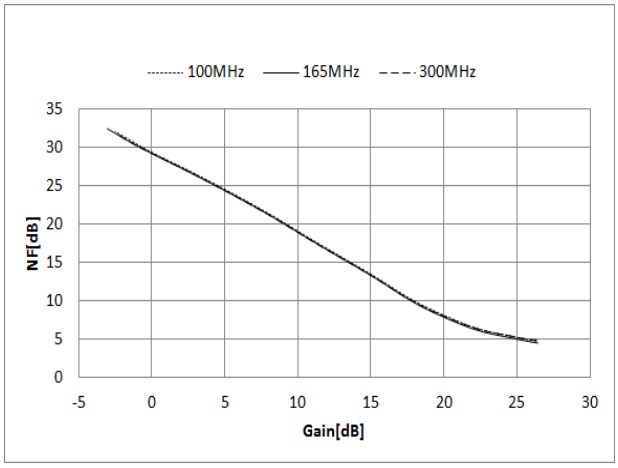


Figure.7-1 NF VS Gain (Temp =25°C)

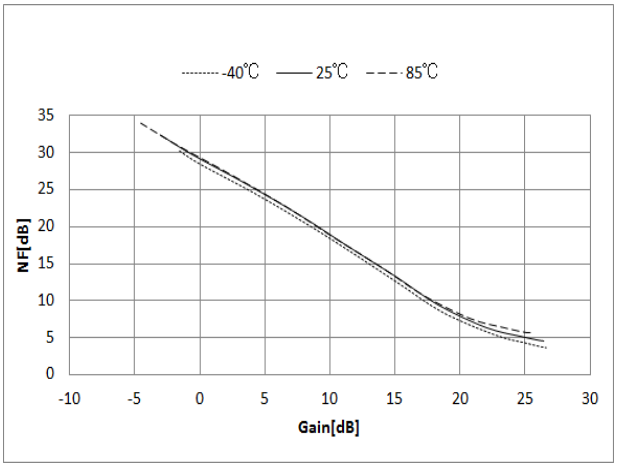


Figure.7-2 NF VS Gain (fo=165MHz)

3. IMD3

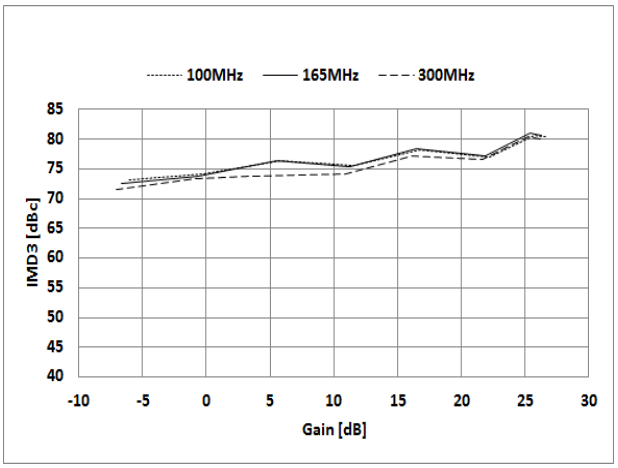


Figure.7-1 IMD3 VS Gain (Temp =25°C)

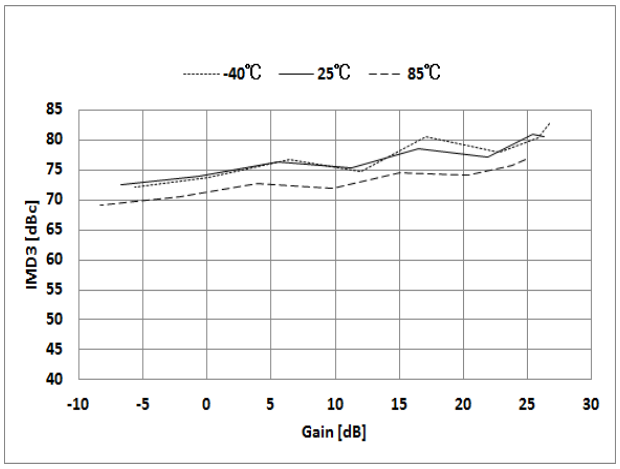
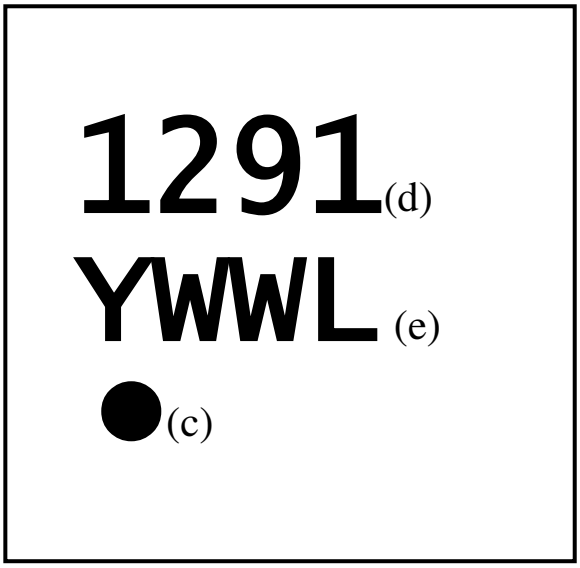


Figure.7-2 IMD3 VS Gain (fo=165MHz)

14. Marking

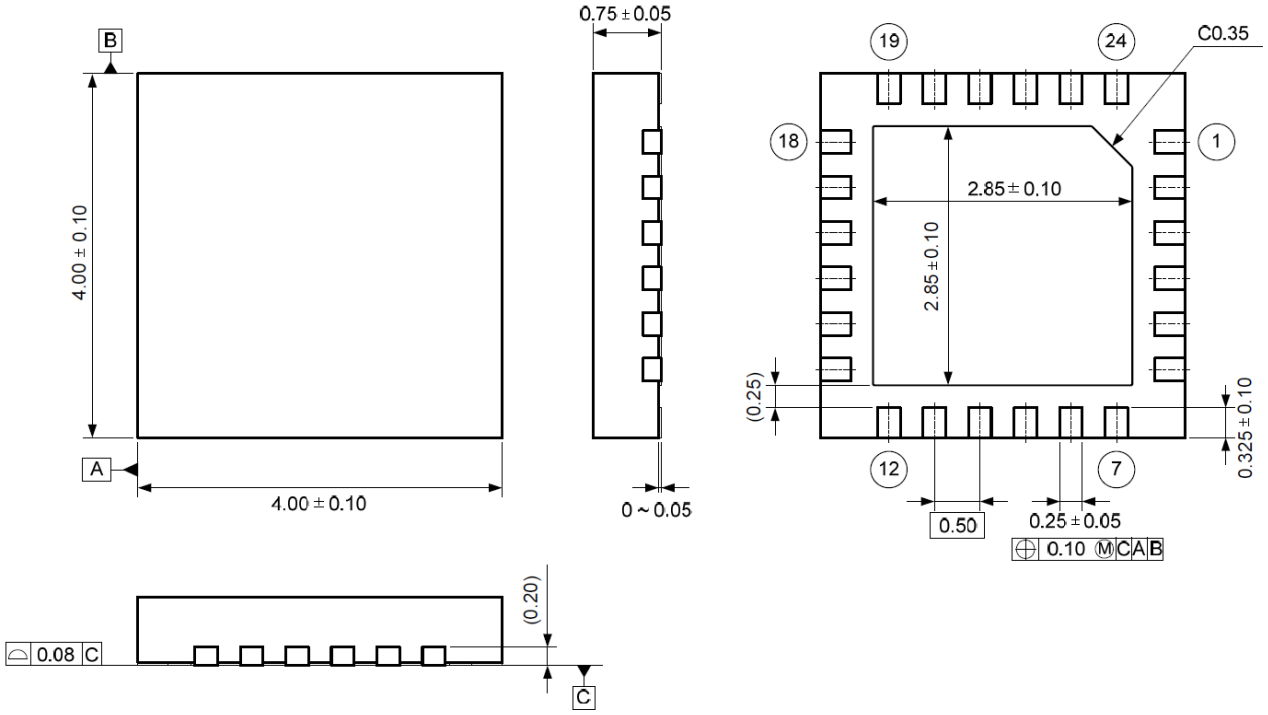
(a) Style : QFN
(b) Number of pins : 24
(c) 1 pin marking: ○
(d) Product number : 1291
(e) Date code : YWWL (4 digits)

Y:	Lower 1 digit of calendar year (Year 2013 → 3, 2014 → 4 ...)
WW:	Week
L:	Lot identification, given to each product lot which is made in a week
	→ LOT ID is given in alphabetical order (A, B, C…).



15. Outer Dimensions

HWQFN24-4×4-0.5



Note) The exposed pad at the center of the backside should be connected to ground.

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