



# AK1291

## IF Variable Gain Amplifier with RSSI

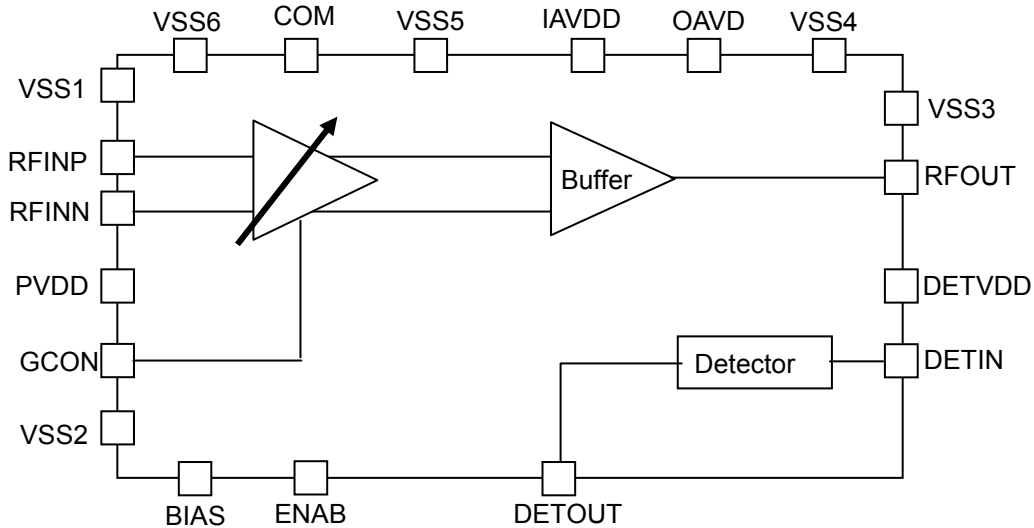
### 1. Overview

AK1291 is a variable gain amplifier with a power detector. It's operating frequency ranges from 100MHz 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 | 100MHz 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

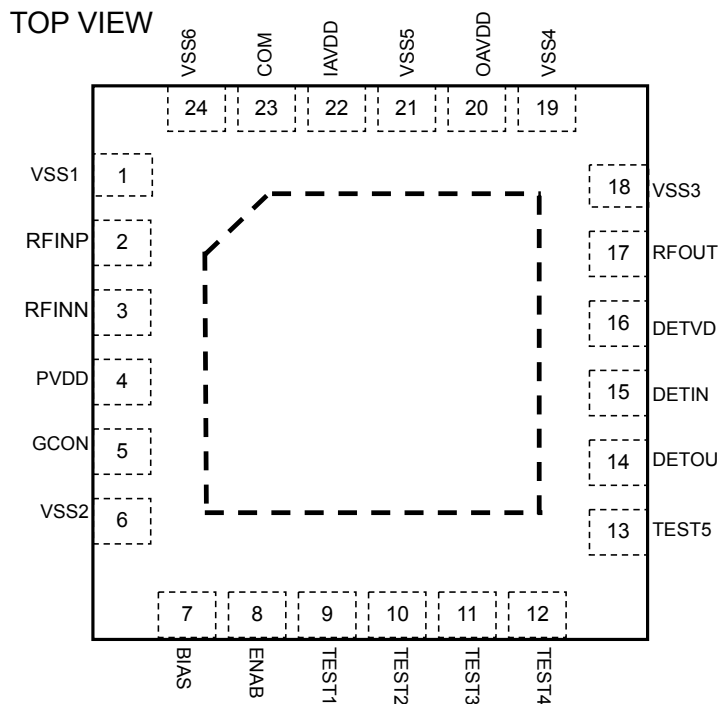


**Fig 1. Block Diagram**

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**4. Pin Configuration**



**Fig 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                     |

|                                    |
|------------------------------------|
| <b>6. Pin function Description</b> |
|------------------------------------|

Table 1. Pin function

| 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<br>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                                   | connect a resistor of 50Ω to ground  |
| 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

Table 2. Absolute Maximum rating

| 項目                                 | 記号   | Min. | Max.    | 単位  | 備考  |
|------------------------------------|------|------|---------|-----|---|
| 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<br>Maximum input Level | Pmax |      | +10     | dBm |   |
| Storage<br>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

Table 3. Recommended operational condition

| 項目                       | 記号  | Min. | Typ. | Max. | 単位 | 備考  |
|--------------------------|-----|------|------|------|----|---|
| Operating<br>Temperature | Ta  | -40  |      | 85   | °C |   |
| Supply<br>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.

|                                     |
|-------------------------------------|
| <b>9. Electrical Characteristic</b> |
|-------------------------------------|

**DC Characteristic**

| Item                     | Symbol          | Condition                                   | Min.    | Typ. | Max.    | Unit |
|--------------------------|-----------------|---|---------|------|---------|------|
| High Level Input Voltage | V <sub>IH</sub> | Note1)                                      | 0.8*VDD |      |         | V    |
| Low Level Input Voltage  | V <sub>IL</sub> | Note1)                                      | 0.0     |      | 0.2*VDD | V    |
| Input leak current       | I <sub>IL</sub> | Note1)                                      | -10     |      | 10      | μA   |
| Current consumption 1    | ICC1            | PVDD=OAVDD=IAVDD=DET<br>VDD=VDD, ENAB=High  |         | 155  | 199     | mA   |
| Current consumption 2    | ICC2            | PVDD=OAVDD=IAVDD=VDD,<br>DET=VSS, ENAB=High |         | 151  | 195     | mA   |
| Current consumption 3    | ICC3            | PVDD=OAVDD=IAVDD=VDD,<br>DET=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<sub>0</sub>=165MHz, unless otherwise specified

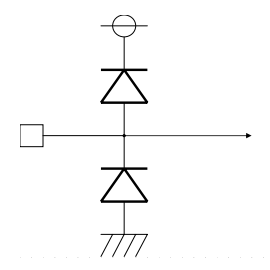
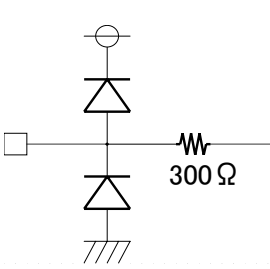
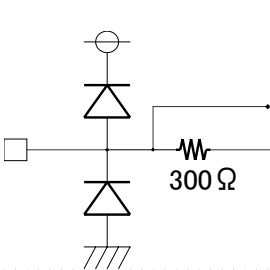
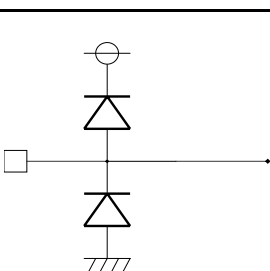
| Item                       | Symbol            | Condition             | Min. | Typ. | Max. | Unit |
|----------------------------|-------------------|-----------------------|------|------|------|------|
| <b>VGA Block</b>           |                   |                       |      |      |      |      |
| Input Frequency            | F <sub>OP</sub>   |                       | 100  |      | 300  | MHz  |
| Input Impedance            | I <sub>IMP</sub>  |                       |      | 50   |      | Ω    |
| Output Impedance           | O <sub>IMP</sub>  |                       |      | 50   |      | Ω    |
| Gain control Range         | G <sub>CONT</sub> |                       |      | 30   |      | dB   |
| Max. Gain                  | G <sub>MAX</sub>  | GCON=2.5V             | 21   |      |      | dB   |
| Min. Gain                  | G <sub>MIN</sub>  | 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 <sub>GT</sub>   |                       | 0.2  |      | 2.5  | V    |
| Gain curve slope note1)    | G <sub>CS</sub>   | 0.5V ≤ VGCONT ≤ 2.0V  | 1    | 20   | 80   | dB/V |
| Gain step response         | G <sub>SR</sub>   |                       |      | 5    |      | μS   |
| <b>&lt;RFIN=100MHz&gt;</b> |                   |                       |      |      |      |      |
| Noise Figure note2)        | NF                | Gain = 21 dB          |      | 7    |      | dB   |
| Output P1dB                | OP1               |                       |      | 5    |      | dBm  |
| IMD3                       | IMD3              | Output Level = -15dBm | 65   | 70   |      | dBc  |
| <b>&lt;RFIN=165MHz&gt;</b> |                   |                       |      |      |      |      |
| Noise Figure note2)        | NF                | Gain = 21 dB          |      | 7    |      | dB   |
| Output P1dB                | OP1               |                       |      | 5    |      | dBm  |
| IMD3                       | IMD3              | Output Level = -15dBm | 65   | 70   |      | dBc  |
| <b>&lt;RFIN=300MHz&gt;</b> |                   |                       |      |      |      |      |
| 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_H     | DETIN=-35dBm  | 0.5 | 0.9     |     | V   |
| Temperature dependency note 2) | Detvdev   | Refer to 25°C |     | $\pm 1$ |     | dB  |

Note1) guaranteed monotonicity

Note2) guaranteed by design

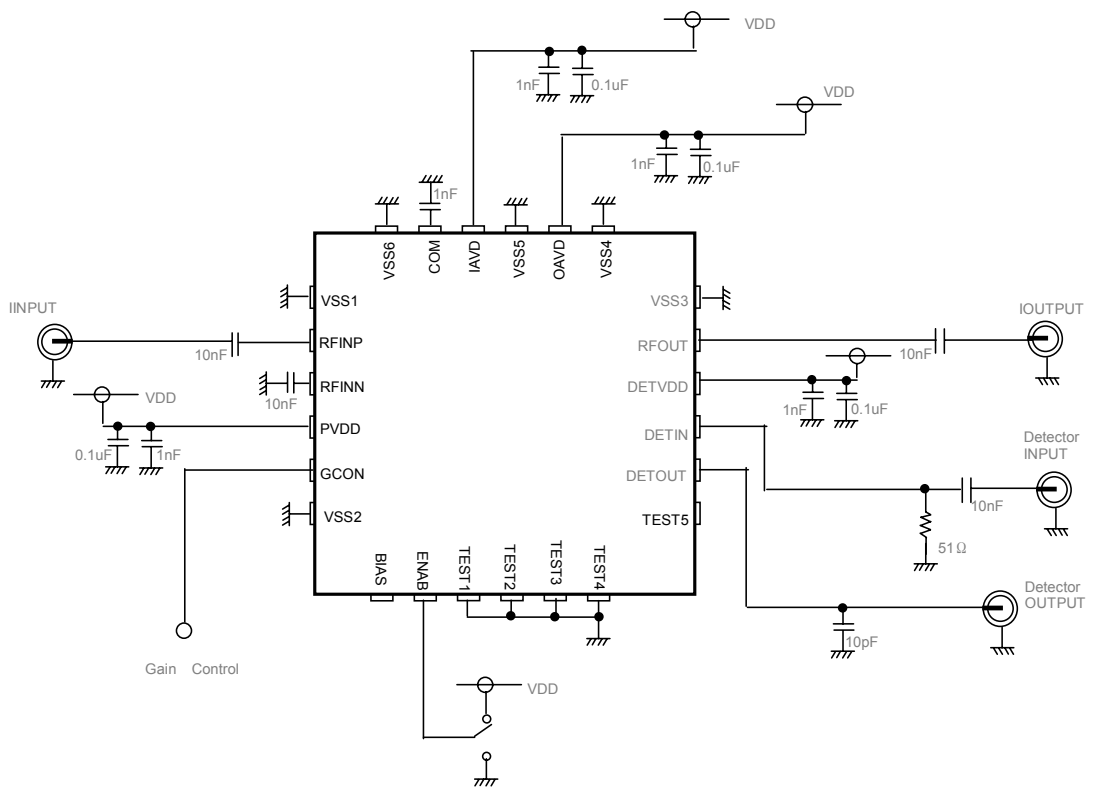
**10. Interface circuit**

| Pin No | Pin Name | I/O | Interface circuit   |
|--------|----------|-----|---|
| 2      | RFINP    | I   | <b>RF input</b><br>             |
| 3      | RFINN    |     |   |
| 5      | GCON     | I   | <b>Analog Input</b><br>         |
| 7      | BIAS     | I/O | <b>Analog Input/Output</b><br> |
| 23     | COM      |     |   |
| 17     | RFOUT    | O   | <b>RF output</b><br>          |



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

**11. Evaluation Board Schimatic**

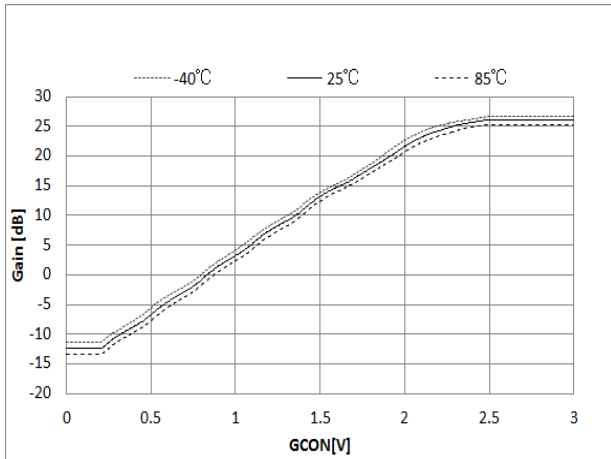


**Fig 3. Typical Evaluation Board Schimatic**

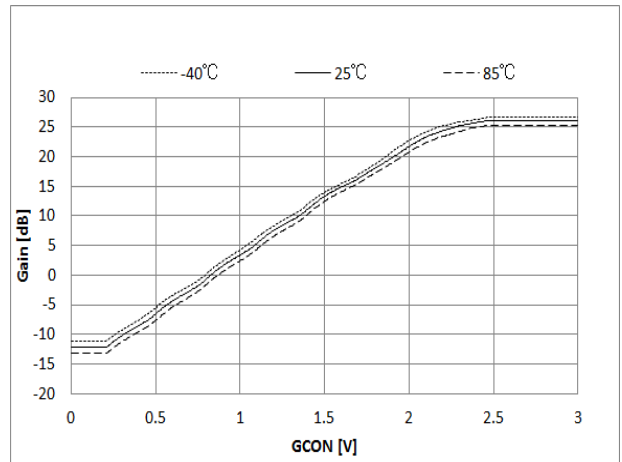
**12. Typical Performance**

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

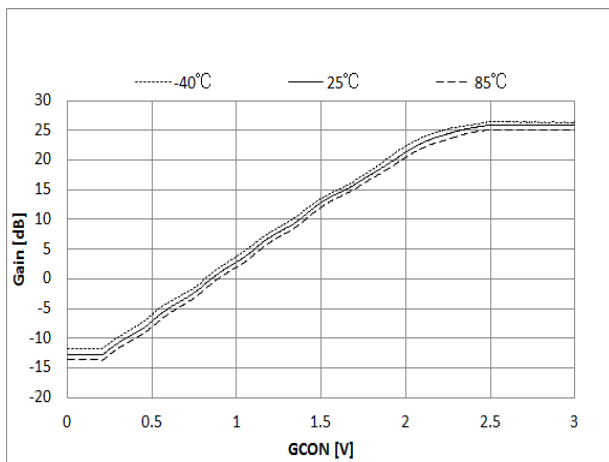
**1. Gain vs Analog Control Voltage**



**Fig.4-1 Gain VS Control Voltage(fo=100MHz)**



**Fig.4-1 Gain VS Control Voltage(fo=165MHz)**



**Fig.4-1 Gain VS Control Voltage(fo=300MHz)**

## 2. Noise Figure

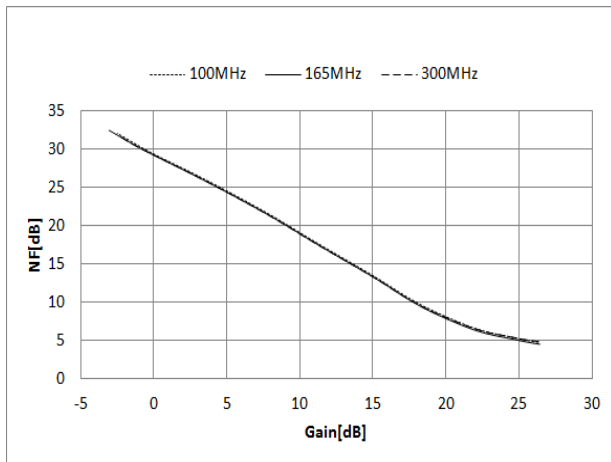


Fig.5-1 NF VS Gain (Temp =25°C)

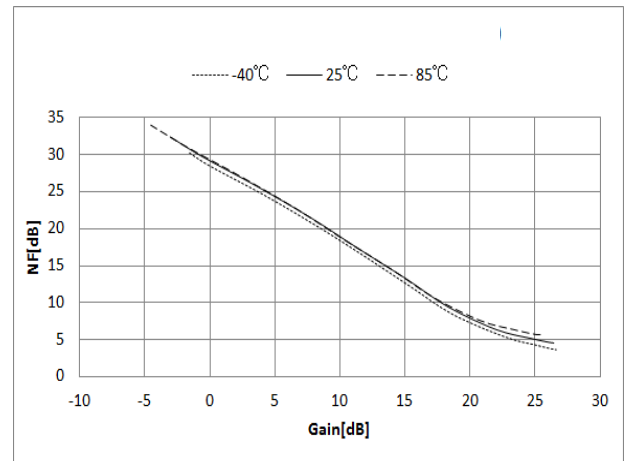


Fig.5-2 NF VS Gain (fo=165MHz)

## 3. IMD3

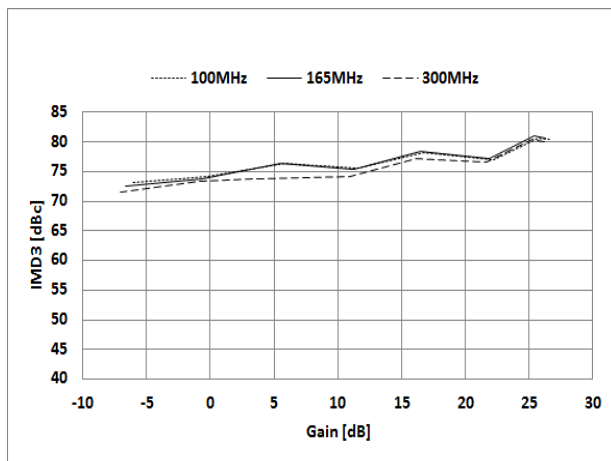


Fig.6-1 IMD3 VS Gain (Temp =25°C)

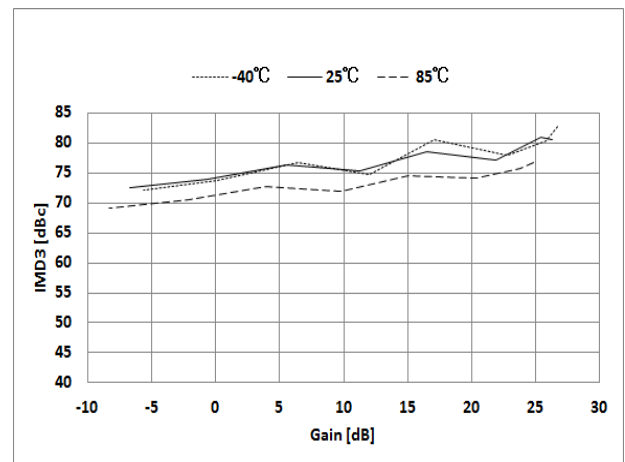
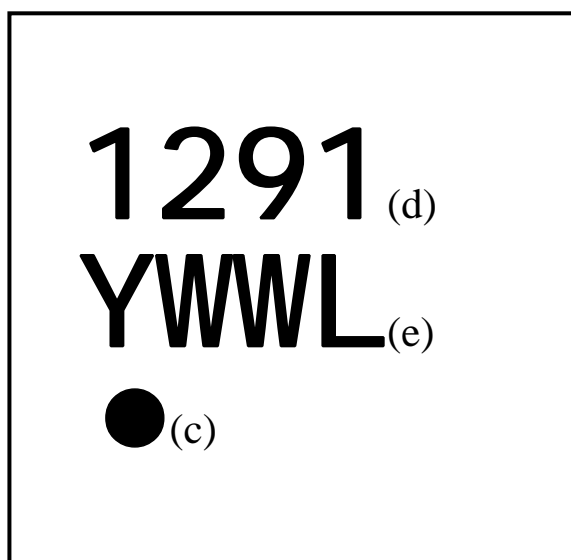


Fig.6-2 IMD3 VS Gain (fo=165MHz)

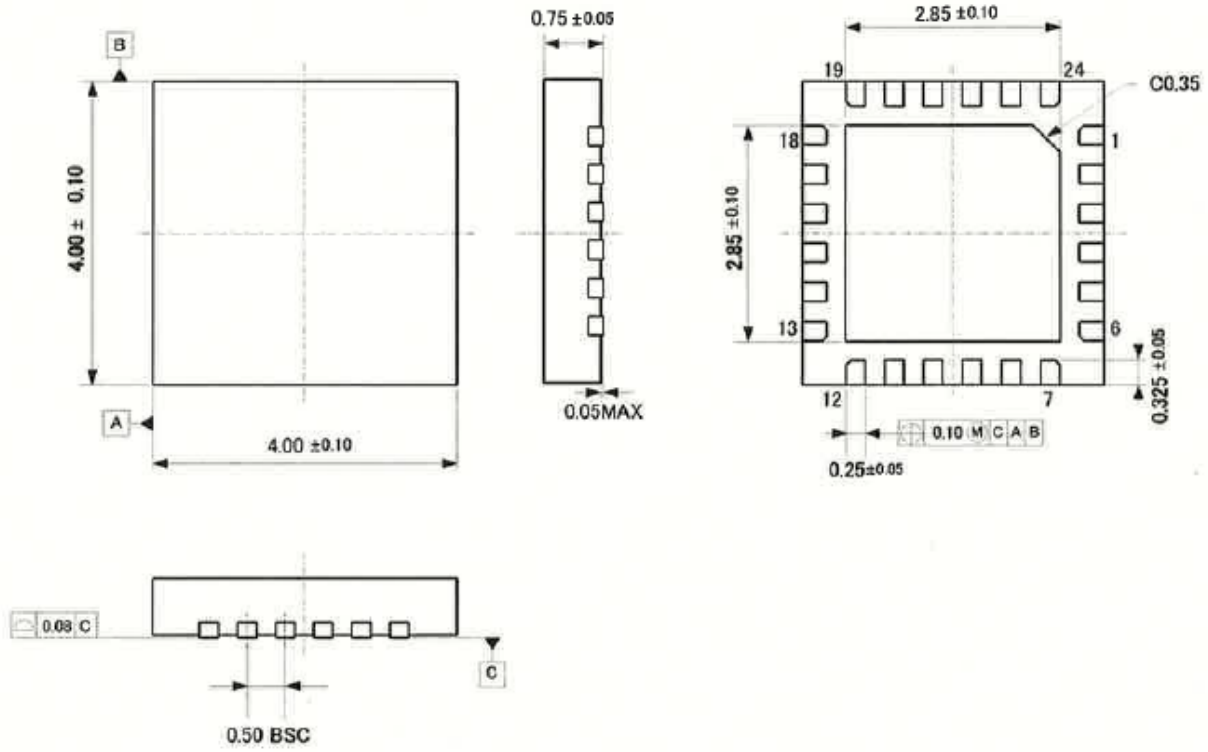
**13. Marking**

- (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...).



**14. 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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