



# AK1223

## 8500MHz High Linearity Mixer

### 1. Overview

The AK1223 is high linearity mixer. RF and Lo frequency range coverage is from 3000 to 8500MHz and IF coverage is from 20 to 3000MHz. The RF input provides single-ended 50Ω interface. Lo ports are 50Ω matched and complementary input should be decoupled to the ground. IF output ports are differential open collector outputs. The linearity and power consumption performances can be optimized by the resistance connected to the BIAS Pin.

### 2. Feature

- Operating Frequency: 3000MHz to 8500MHz
- Linearity vs. Power selectable architecture  
Power Consumption: 92mA, IIP3: +13dBm, Gain: -3dB, NF: 15dB
- Lo input level: 0dBm ±5dB
- Operating Supply Voltage: 4.75 to 5.25 V
- Package: 16pin UQFN (0.5mm pitch, 3mm × 3mm × 0.60mm)
- Operating Temperature Range: -40 to 85°C

### 3. Applications

- Microwave Radio Link
- Radar Systems

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5. System Diagram

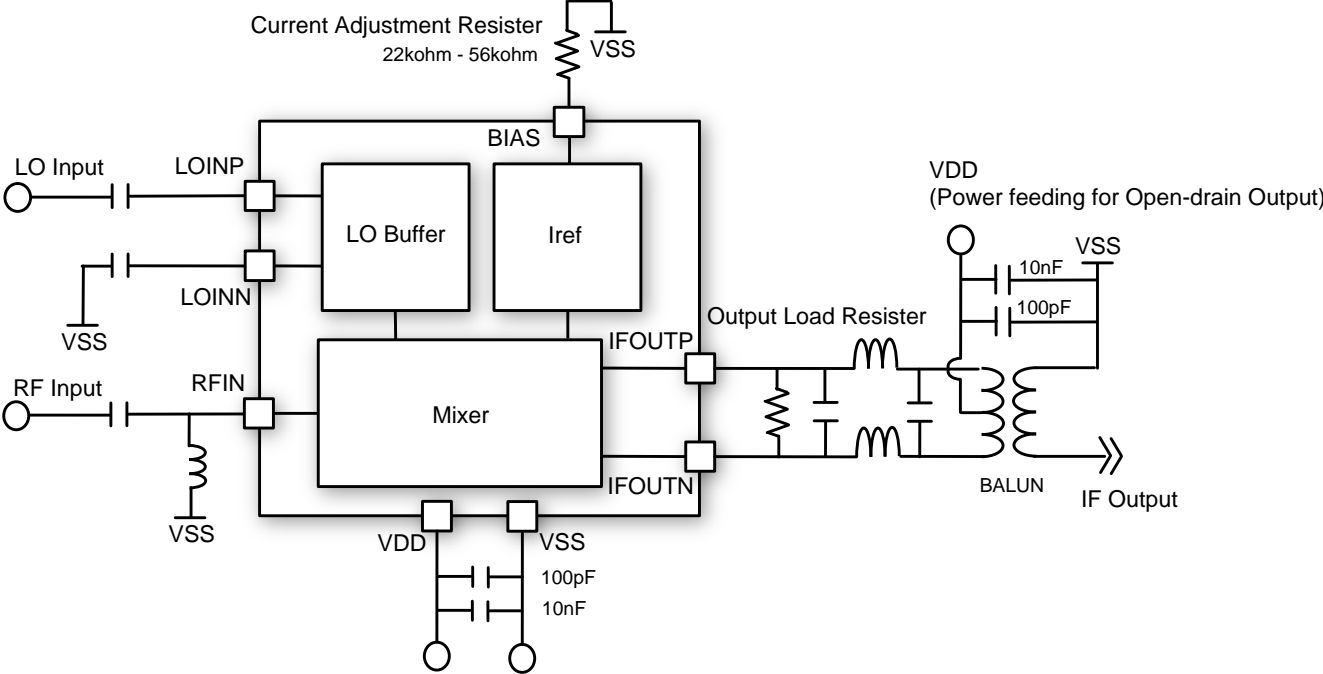


Figure 1. System Diagram

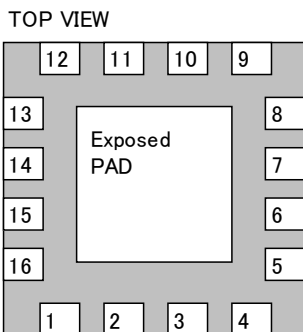
**6. Pin Functional Description**

**Table 1 Pin Function**

| No. | Name   | I/O | Pin Functions                         | Remarks   |
|-----|--------|-----|---------------------------------------|---|
| 1   | VSS    | G   | Ground pin                            |   |
| 2   | VSS    | G   | Ground pin                            |   |
| 3   | VSS    | G   | Ground pin                            |   |
| 4   | VSS    | G   | Ground pin                            |   |
| 5   | VSS    | G   | Ground pin                            |   |
| 6   | LOINN  | AI  | Lo Input Negative                     |   |
| 7   | LOINP  | AI  | Lo Input Positive                     |   |
| 8   | VDD    | P   | Power Supply                          |   |
| 9   | VDD    | P   | Power Supply                          |   |
| 10  | VDD    | P   | Power Supply                          |   |
| 11  | IFOUTN | AO  | IF Output Negative                    | This pin is open collector output.<br>It needs power feeding via an inductor. |
| 12  | IFOUTP | AO  | IF Output Positive                    | This pin is open collector output.<br>It needs power feeding via an inductor. |
| 13  | BIAS   | AIO | Resistance pin for current adjustment | Connecting a resistor between this pin and ground.                            |
| 14  | RFIN   | AI  | RF Input                              | Connecting an inductor between this pin and ground.                           |
| 15  | VSS    | G   | Ground pin                            |   |
| 16  | VSS    | G   | Ground pin                            |   |

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

|                      |                       |                     |
|----------------------|-----------------------|---------------------|
| AI: Analog input pin | AO: Analog output pin | AIO: Analog I/O pin |
| P: Power supply pin  | G: Ground pin         |                     |



**Figure 2. Package Pin Layout**

## 7. Absolute Maximum Ratings

**Table 2 Absolute Maximum Ratings**

| Parameter                    | Symbol | Min.    | Max. | Unit | Remarks |
|------------------------------|--------|---------|------|------|---------|
| Supply Voltage               | VDD    | -0.3    | 5.5  | V    |         |
| RF Input Power               | RFPOW  |         | 12   | dBm  |         |
| LO Input Power               | LOPOW  |         | 12   | dBm  |         |
| IFOUTP, IFOUTN<br>DC voltage | IFDC   | VDD-1.5 |      | V    |         |
| Storage Temperature          | Tstg   | -55     | 125  | °C   |         |

Exceeding these maximum ratings may result in damage to the AK1223. Normal operation is not guaranteed at these extremes. IFOUTP and IFOUTN should be connected to VDD via an inductor.

## 8. Recommended Operating Range

**Table 3 Recommended Operating Range**

| Parameter             | Symbol | Min. | Typ. | Max. | Unit | Remarks |
|-----------------------|--------|------|------|------|------|---------|
| Operating Temperature | Ta     | -40  |      | 85   | °C   |         |
| Supply Voltage        | VDD    | 4.75 | 5    | 5.25 | V    |         |

The specifications are applicable within the recommended operating range (supply voltage/operating temperature).

## 9. Electrical Characteristics

### 1. Analog Circuit Characteristics

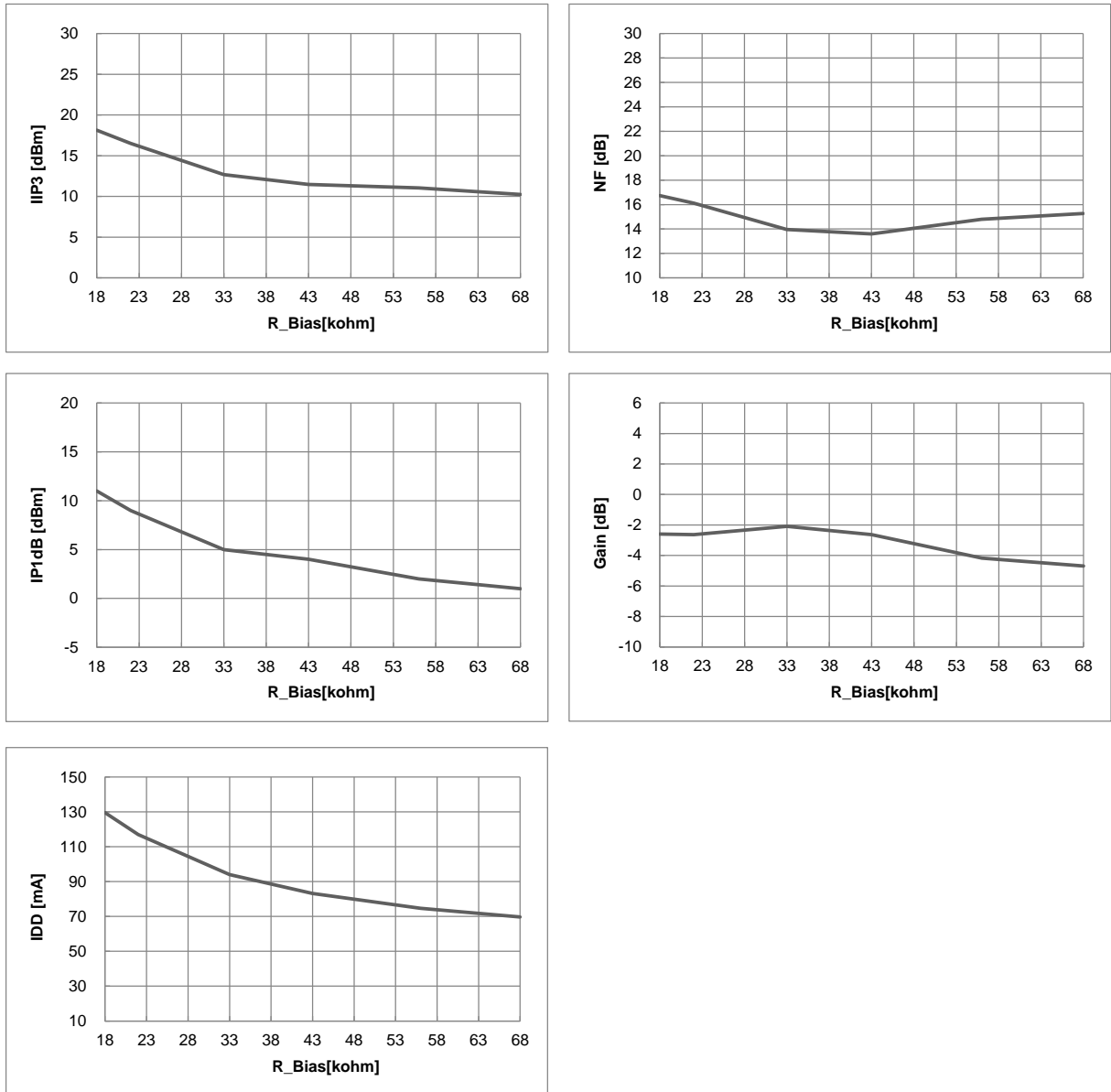
Unless otherwise noted IF output=1000MHz, Lo Input Level=-5dBm to +5dBm,  
Output Load Resistor (R<sub>Load</sub>)=270Ω, VDD=4.75 to 5.25V, T<sub>a</sub>=-40°C to 85°C

| Parameter  |           | Min. | Typ. | Max. | Unit | Remarks  |
|--|-----------|------|------|------|------|--|
| RF Input Frequency                                     |           | 3000 |      | 8500 | MHz  |  |
| Lo Input Frequency                                     |           | 3000 |      | 8500 | MHz  |  |
| IF output Frequency                                    |           | 20   |      | 3000 | MHz  |  |
| Lo Input Power   |           | -5   |      | +5   | dBm  | Lo Input Frequency≤6GHz                                  |
|  |           | 0    |      | +5   | dBm  | Lo Input Frequency>6GHz                                  |
| Current Adjustment Resistor(BIAS)                      |           | 22   |      | 56   | kΩ   |  |
| IDD  | BIAS=22kΩ |      | 114  | 174  | mA   | The total current of VDD pin, IFOUTP pin and IFOUTN pin. |
|  | BIAS=33kΩ |      | 92   | 144  | mA   |  |
|  | BIAS=56kΩ |      | 73   | 119  | mA   |  |
| <b>RFIN=6000MHz, Current Adjustment Resistor =33kΩ</b> |           |      |      |      |      |  |
| Conversion Gain  |           | -6   | -3   |      | dB   |  |
| SSB Noise Figure                                       |           |      | 15   | 18   | dB   | Design guarantee value                                   |
| IP1dB  |           | 2    | 5    |      | dBm  |  |
| IIP3   |           | 10   | 13   |      | dBm  | Design guarantee value                                   |

**10. Typical Performance**

Unless otherwise noted, RF input =6000MHz, LO input =5000MHz, IF output =1000MHz,  
Output Load Resistor (R<sub>Load</sub>)=270Ω

**1. Current Adjustment Resistor vs. IIP, NF, P1dB, Gain, IDD**



**Figure 3. Current Adjustment Resistor vs. IIP3, NF, P1dB, Gain, IDD**

Note ) A resistor with 5% tolerance are used.

2. Over temperature vs. IIP3, NF, P1dB, Gain, IDD

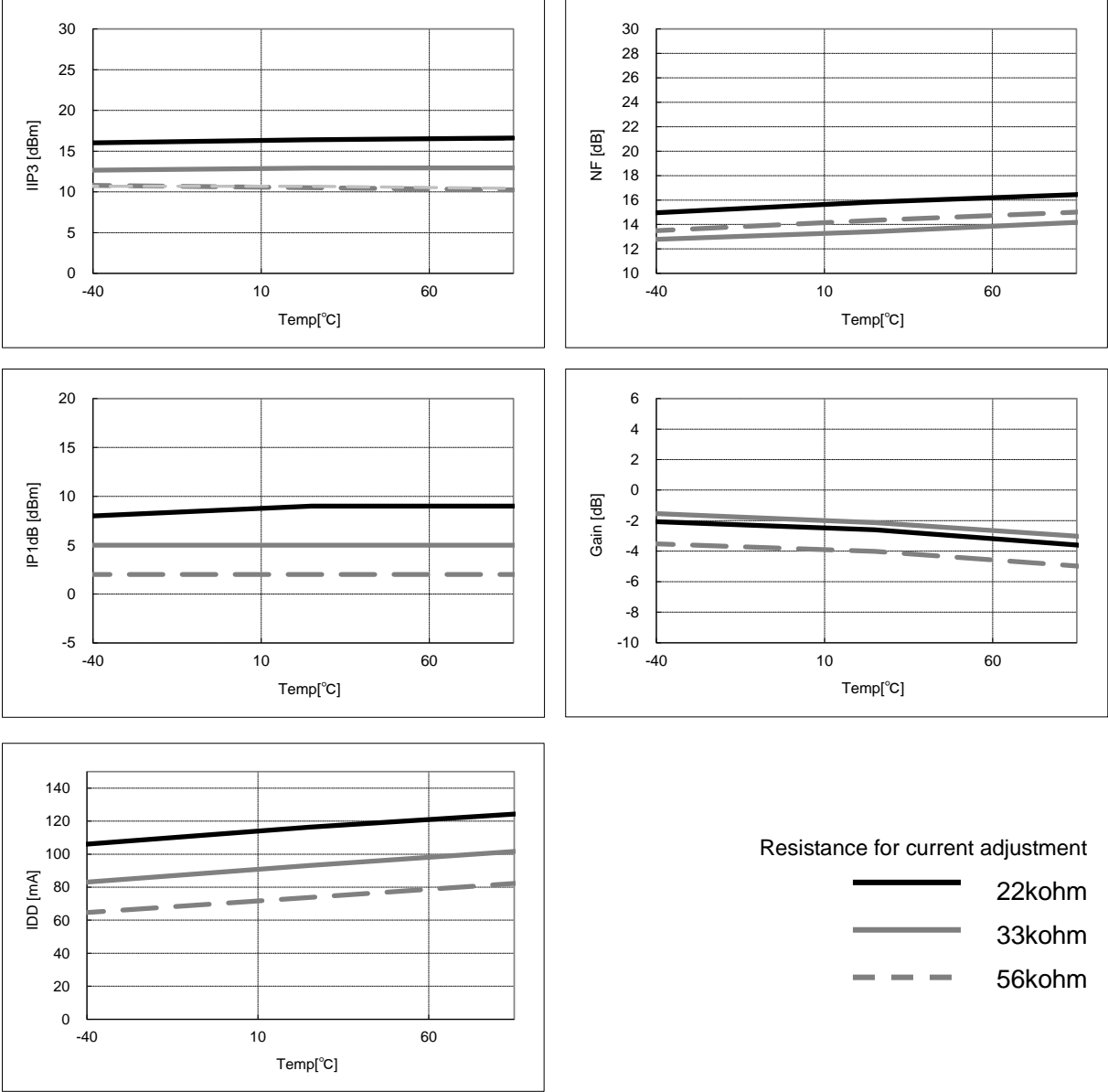


Figure 4. Over temperature vs. IIP3, NF, IP1dB, Gain, IDD



3. Over temperature vs. IIP3, NF, P1dB, Gain, IDD

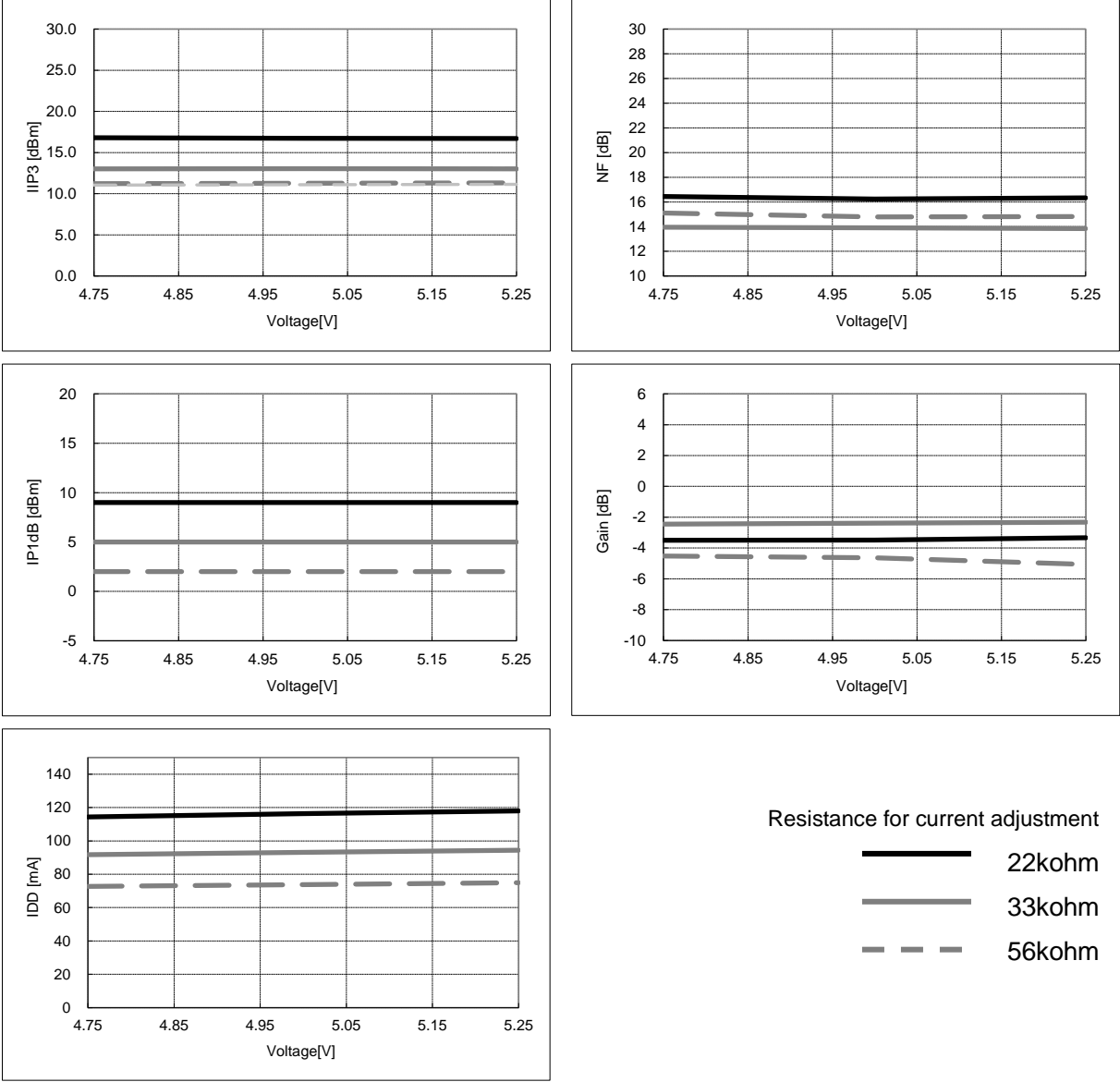
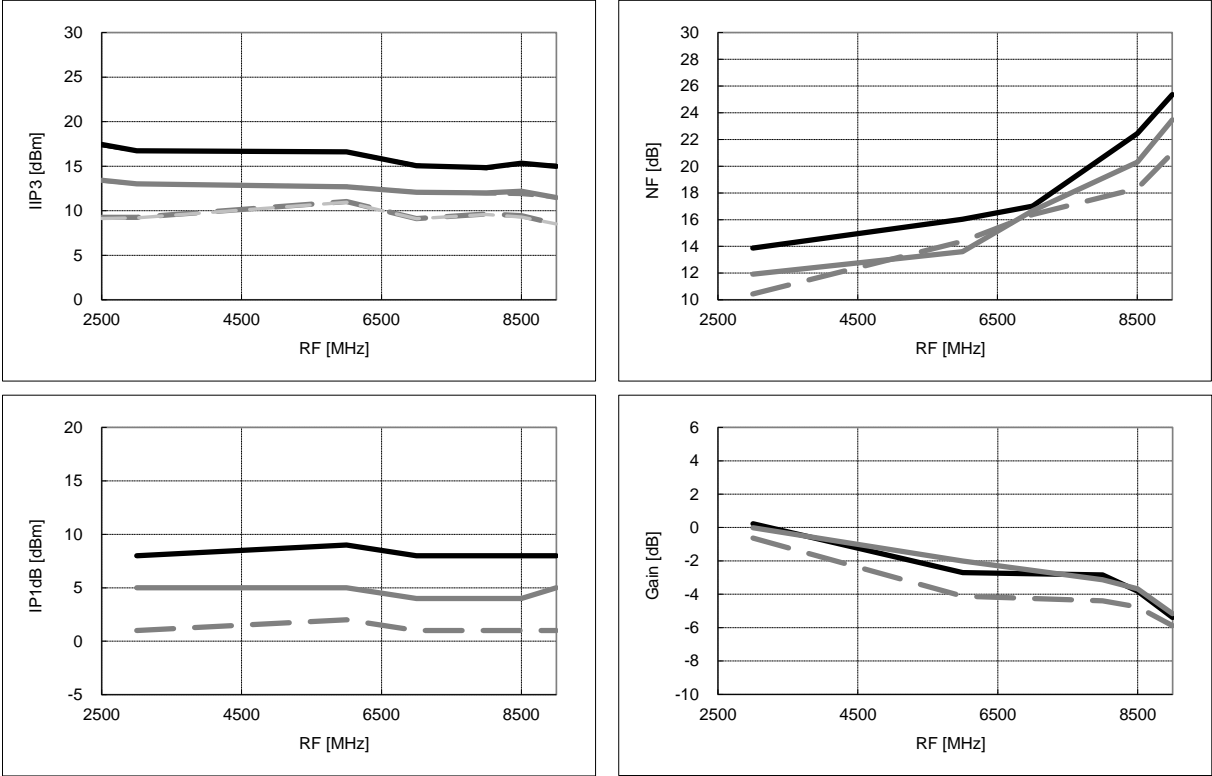


Figure 5. Supply voltage vs. IIP3, NF, IP1dB, Gain, IDD

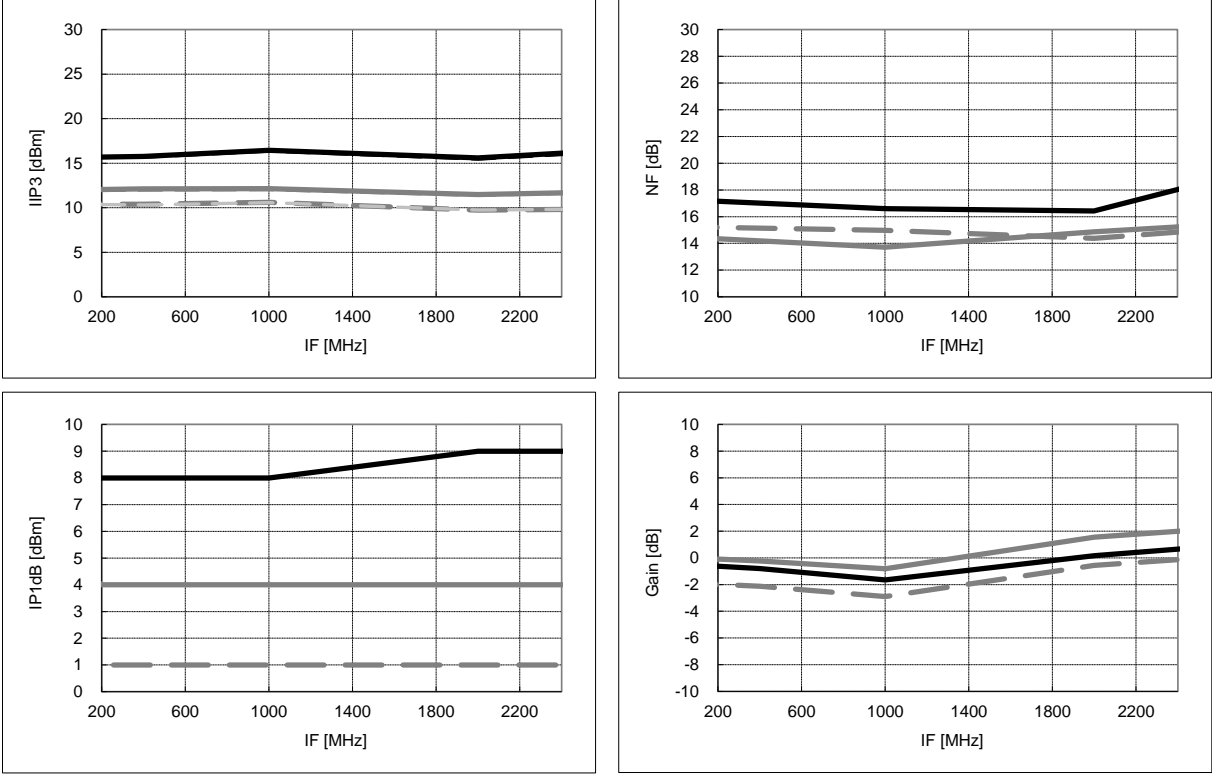
4. RF input frequency vs. IIP3, NF, Gain



Resistance for current adjustment  
—— 22kohm  
—— 33kohm  
- - - 56kohm

Figure 6. RF input frequency vs. IIP3, NF, Gain

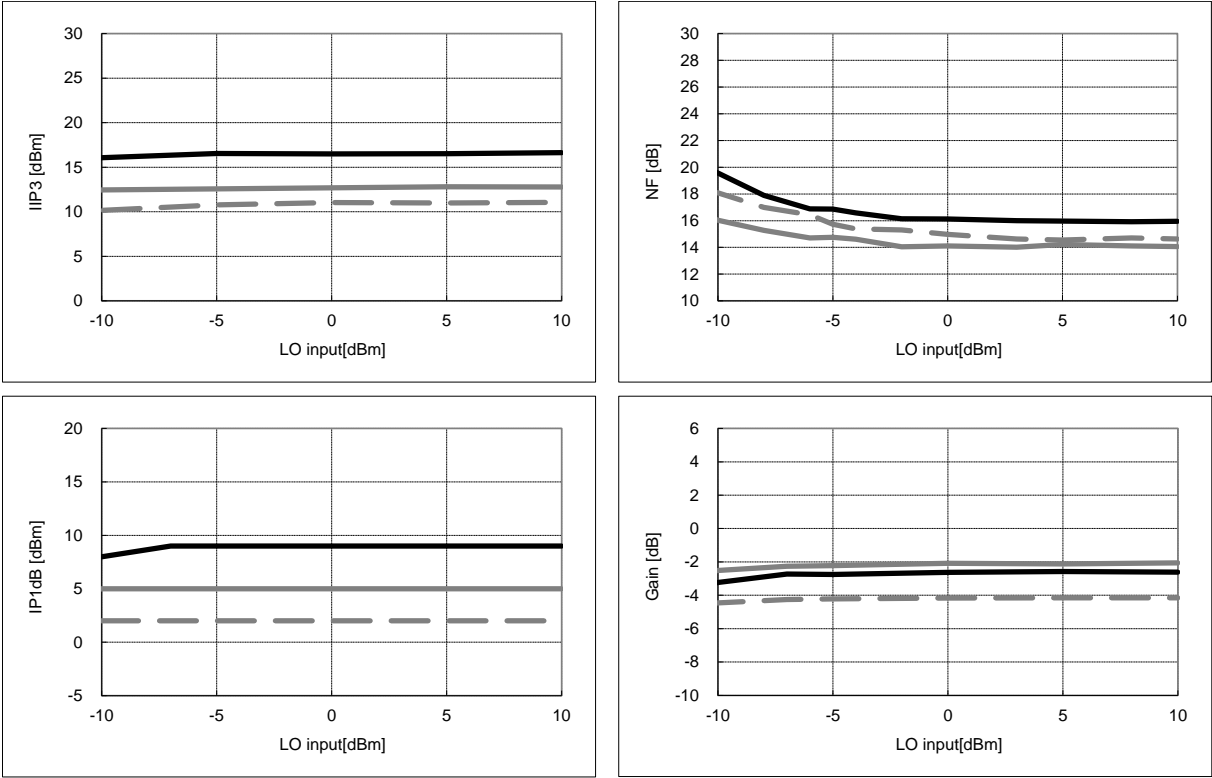
5. IF input frequency vs. IIP3, NF, Gain



Resistance for current adjustment  
— 22kohm  
— 33kohm  
- - 56kohm

Figure 7. IF input frequency vs. IIP3, NF, Gain

6. Lo input power vs. IIP3, NF, Gain

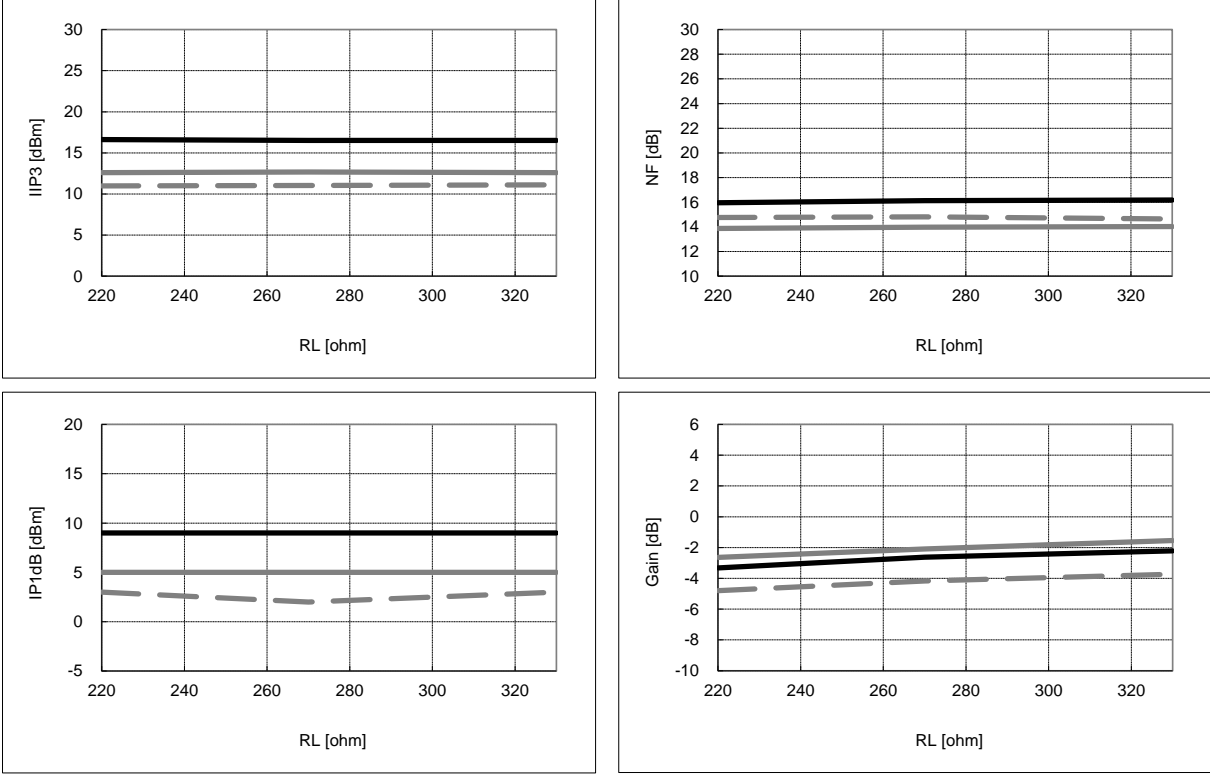


Resistance for current adjustment

- 22kohm
- 33kohm
- - - 56kohm

Figure 8. LO input power vs. IIP3, NF, Gain

7. Output Load Resistor (R<sub>Load</sub>) vs. IIP3, NF, Gain

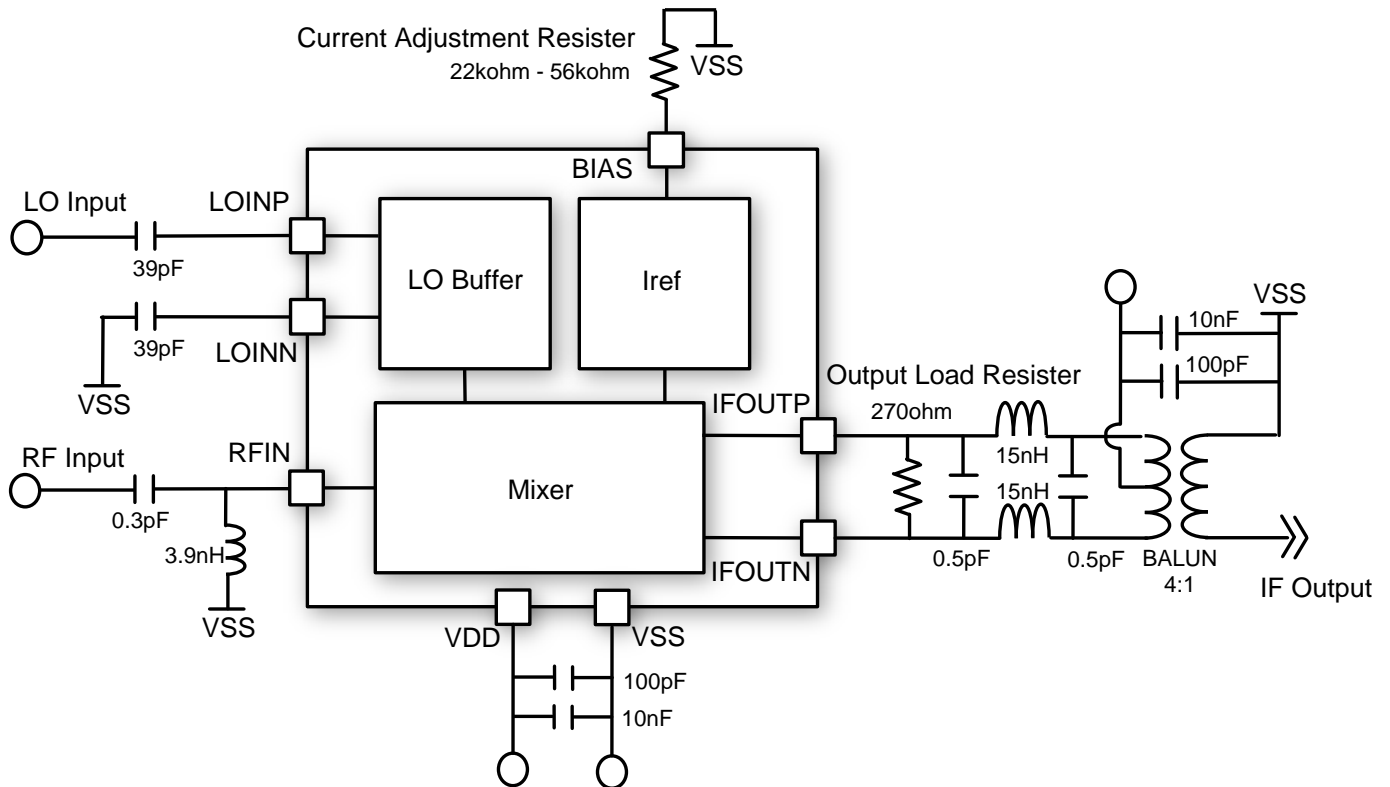


Resistance for current adjustment

- 22kohm
- 33kohm
- - - 56kohm

Figure 9. Output Load Resistor (R<sub>Load</sub>) vs. IIP3, NF, Gain

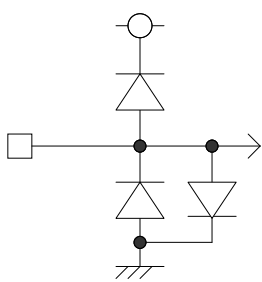
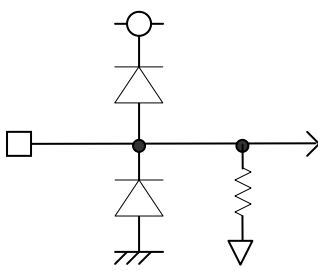
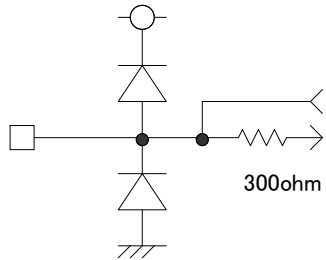
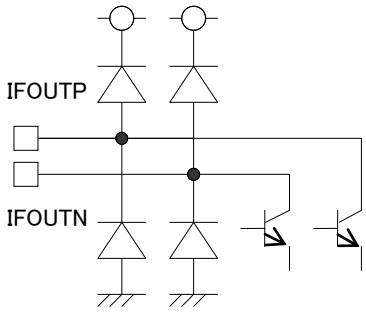
## 11. Typical Evaluation Board Schematic



**Figure 10. Typical Evaluation Board Schematic (RF:6GHz,IF:1GHz)**

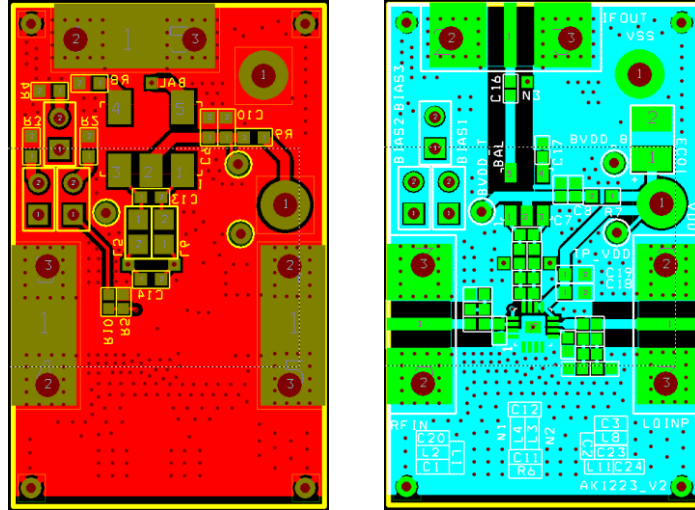
- Note 1) The exposed pad at the center of the backside should be connected to ground.
- Note 2) The collector drain output needs power feeding via a inductor. (IFOUTP pin and IFOUTN pin)
- Note 3) It is necessary to adjust impedance matching as to its setting frequency. (RF input and IF output)

**12. LSI Interface Schematic**

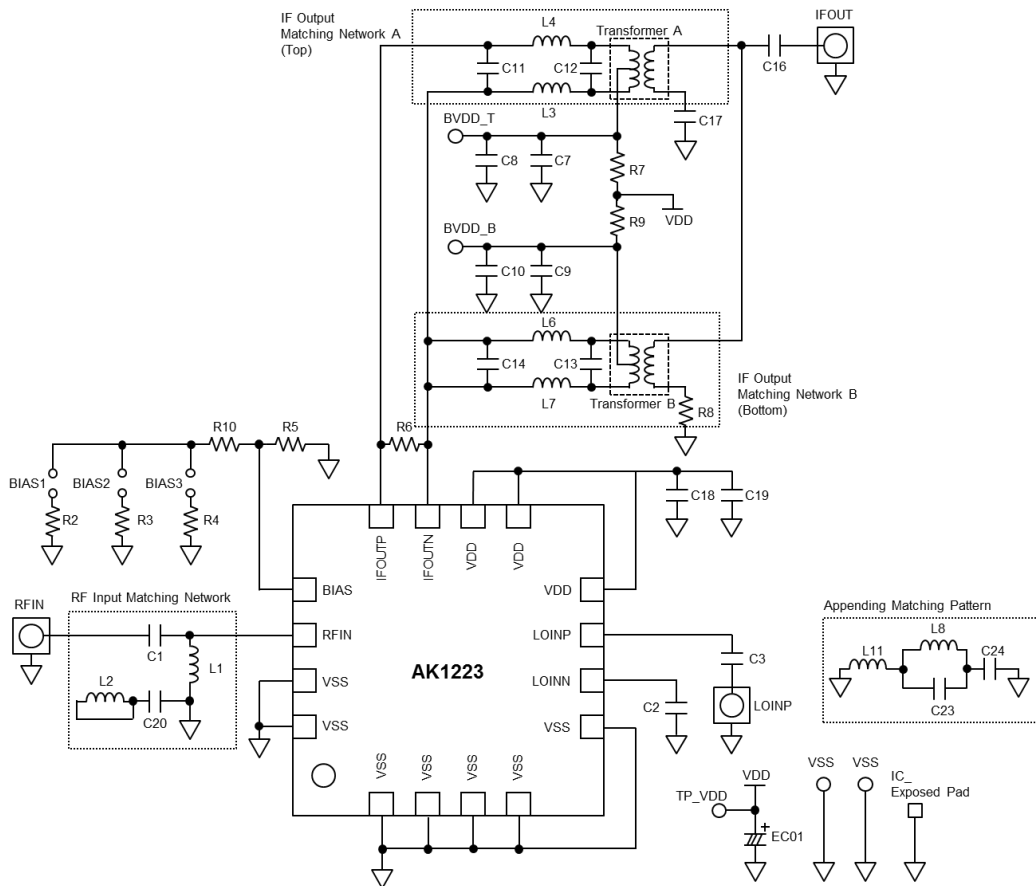
| Pin No. | Pin Name | I/O | Function  |
|---------|----------|-----|---|
| 14      | RFIN     | I   | <b>RF Input pin</b><br><br>     |
| 6       | LOINN    | I   | <b>LO Input pins</b><br><br>   |
| 7       | LOINP    |     |   |
| 13      | BIAS     | I/O | <b>Analog I/O pin</b><br><br> |
| 11      | IFOUTN   | O   | <b>IF Output pins</b><br><br> |
| 12      | IFOUTP   |     |   |

**13. Application Information**

•Evaluation Board



**Figure 11. AK1223 Evaluation Board**



**Figure 12. AK1223 Evaluation Board Schematic**



14. Outer Dimensions

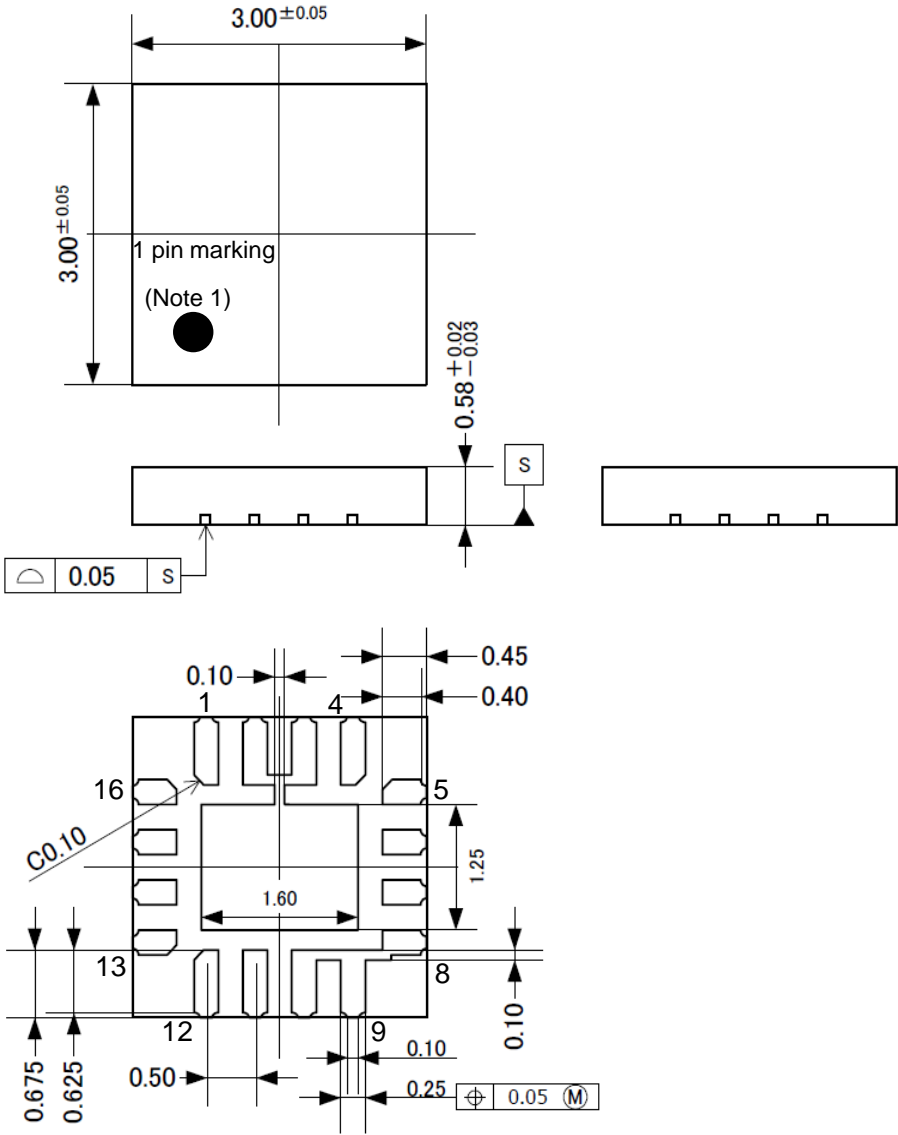
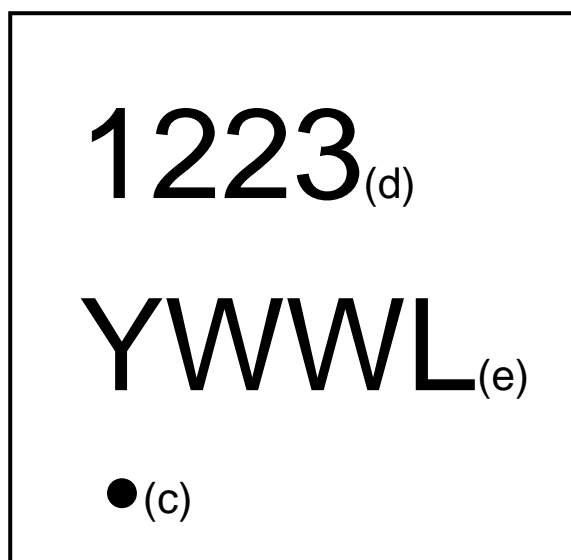


Figure 13. Outer Dimensions

Note 1. 1 pin marking is only a reference for the 1 pin location on the top of package.

**15. Marking**

- (a) Style : UQFN  
(b) Number of pins : 16  
(c) 1 pin marking: : ○  
(d) Product number : 1223  
(e) Date code : YWWL (4 digits)  
Y : Lower 1 digit of calendar year (Year 2012 → 2, 2013 → 3 ...)  
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...).

**Figure 14. Marking**

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### ●Related Parts

| Part#   | Discription   | Comments                              |
|---|---|---------------------------------------|
| <b>Mixer</b>  |   |                                       |
| AK1220  | 100MHz~900MHz High Linearity Down Conversion Mixer                                  | IIP3:+22dBm                           |
| AK1222  | 100MHz~900MHz Low Power Down Conversion Mixer                                       | IDD:2.9mA                             |
| AK1224  | 100MHz~900MHz Low Noise, High Liniarity Down Conversion Mixer                       | NF:8.5dB, IIP3:+18dBm                 |
| AK1228  | 10MHz~2GHz Up/Down Conversion Mixer   | 3V Supply, NF:8.5dB                   |
| AK1221  | 0.7GHz~3.5GHz High Linearity Down Conversion Mixer                                  | IIP3:+25dBm                           |
| AK1223  | 3GHz~8.5GHz High Linearity Down Conversion Mixer                                    | IIP3:+13dB, NF:15dB                   |
| <b>PLL Synthesizer</b>                                |   |                                       |
| AK1541  | 20MHz~600MHz Low Power Fractional-N Synthesizer                                     | IDD:4.6mA                             |
| AK1542A   | 20MHz~600MHz Low Power Integer-N Synthesizer  | IDD:2.2mA                             |
| AK1543  | 400MHz~1.3GHz Low Power Fractional-N Synthesizer                                    | IDD:5.1mA                             |
| AK1544  | 400MHz~1.3GHz Low Power Integer-N Synthesizer                                       | IDD:2.8mA                             |
| AK1590  | 60MHz~1GHz Fractional-N Synthesizer   | IDD:2.5mA                             |
| AK1545  | 0.5GHz~3.5GHz Integer-N Synthesizer   | 16-TSSOP                              |
| AK1546  | 0.5GHz~3GHz Low Phase Noise Integer-N Synthesizer                                   | Normalized C/N:-226dBc/Hz             |
| AK1547  | 0.5GHz~4GHz Integer-N Synthesizer   | 5V Supply                             |
| AK1548  | 1GHz~8GHz Low Phase Noise Integer-N Synthesizer                                     | Normalized C/N:-226dBc/Hz             |
| <b>IFVGA</b>  |   |                                       |
| AK1291  | 100~300MHz Analog Signal Control IF VGA w/ RSSI                                     | Dynamic Range:30dB                    |
| <b>integrated VCO</b>                                 |   |                                       |
| AK1572  | 690MHz~4GHz Down Conversion Mixer with Frac.-N PLL and VCO                          | IIP3:24dBm, -111dBc/Hz@100kHz         |
| AK1575  | 690MHz~4GHz Up Conversion Mixer with Frac.-N PLL and VCO                            | IIP3:24dBm, -111dBc/Hz@100kHz         |
| <b>IF Reciever (2nd Mixer + IF BPF + FM Detector)</b> |   |                                       |
| AK2364  | Built-in programmable AGC+BPF, FM detector IC                                       | IFBPF:±10kHz ~ ±4.5kHz                |
| AK2365A   | Built-in programmable AGC+BPF, IFIC   | IFBPF:±7.5kHz ~ ±2kHz                 |
| <b>Analog BB for PMR/LMR</b>                          |   |                                       |
| AK2345  | CTCSS Filter, Encoder, Decoder  | 24-VSOP                               |
| AK2360/<br>AK2360A                                    | Inverted frequency(3.376kHz/3.020kHz) scrambler                                     | 8-SON                                 |
| AK2363  | MSK Modem/DTMF Receiver   | 24-QFN                                |
| AK2346B   | 0.3-2.55/3.0kHz Analog audio filter,<br>Emphasis, Compandor, scrambler, MSK Modem   | 24-VSOP                               |
| AK2346A   |   | 24-QFN                                |
| AK2347B   | 0.3-2.55/3.0kHz Analog audio filter<br>Emphasis, Compandor, scrambler, CTCSS filter | 24-VSOP                               |
| AK2347A   |   | 24-QFN                                |
| <b>Function IC</b>                                    |   |                                       |
| AK2330  | 8-bit 8ch Electronic Volume   | VREF can be selected for each channel |
| AK2331  | 8-bit 4ch Electronic Volume   | VREF can be selected for each channel |

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