

LNA IC for VHF and UHF Band (40 MHz to 900 MHz) Applications

FEATURES

- Low voltage operation +1.8 V to +2.5 V typ.
- Low current consumption
  - 5.5 mA typ. (High-Gain mode /  $V_{CC} = 1.8\text{ V}$ )
  - 1  $\mu\text{A}$  typ. (Low-Gain mode /  $V_{CC} = 1.8\text{ V}$ )
- High gain
  - 14.5 dB typ.  $f_{RX} = 470\text{ MHz}$  (High-Gain mode /  $V_{CC} = 1.8\text{ V}$ )
- Low noise figure
  - 1.36 dB typ.  $f_{RX} = 470\text{ MHz}$  (High-Gain mode /  $V_{CC} = 1.8\text{ V}$ )
- Low distortion (IIP3 +10 MHz offset)
  - 1.5 dBm typ.  $f_{RX} = 470\text{ MHz}$  (High-Gain mode /  $V_{CC} = 1.8\text{ V}$ )
- Small package 5 pin Plastic Small Surface Mount Package (SMINI Type)

DESCRIPTION

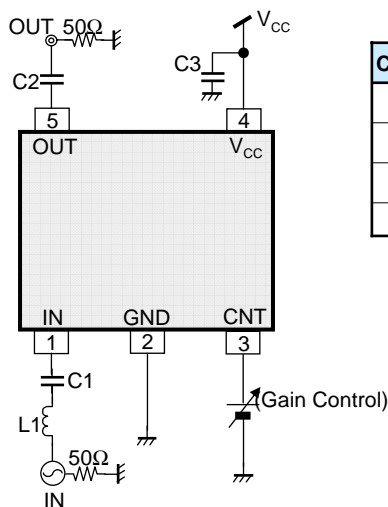
AN26072A is LNA-IC for VHF and UHF Band (40 MHz to 900 MHz) Applications. Realizing high performance by using SiGe Bi-CMOS process ( $f_T = 90\text{ GHz}$ ,  $f_{max} = 140\text{ GHz}$ ). High/Low Gain-mode is changeable, controlled by integrated CMOS logic circuit. Achieving miniaturization by using small size package.

APPLICATIONS

- DTV(VHF/UHF)

SIMPLIFIED APPLICATION

TOP VIEW



| Components | Size | Value    | Part Number       | Vendor |
|------------|------|----------|-------------------|--------|
| C1         | 0603 | 1 000 pF | GRM033B11C102KD01 | Murata |
| C2         | 0603 | 1 000 pF | GRM033B11C102KD01 | Murata |
| C3         | 0603 | 0.1 uF   | GRM033B30J104KE18 | Murata |
| L1         | 0603 | 6.8 nH   | LQP03T6N8H04      | Murata |

Notes) This application circuit is an example. The operation of mass production set is not guaranteed. You should perform enough evaluation and verification on the design of mass production set. You are fully responsible for the incorporation of the above application circuit and information in the design of your equipment.

**ABSOLUTE MAXIMUM RATINGS**

| Parameter                      | Symbol                 | Rating                     | Unit | Note |
|--------------------------------|------------------------|----------------------------|------|------|
| Supply voltage                 | $V_{CC}$               | 3.6                        | V    | *1   |
| Supply current                 | $I_{CC}$               | 18                         | mA   | —    |
| Operating ambient temperature  | $T_{opr}$              | -20 to 70                  | °C   | *2   |
| Operating junction temperature | $T_j$                  | -40 to +125                | °C   | *2   |
| Storage temperature            | $T_{stg}$              | -55 to +125                | °C   | *2   |
| Input Voltage Range            | IN (Pin No.1)          | —                          | V    | *3   |
|                                | CNT (Pin No.3)         | -0.3 to ( $V_{CC} + 0.3$ ) | V    | *4   |
|                                | OUT (Pin No.5)         | —                          | V    | *5   |
| ESD                            | HBM (Human Body Model) | 2                          | kV   | —    |
|                                | MM (Machine Model)     | 100                        | V    | —    |

Notes). This product may sustain permanent damage if subjected to conditions higher than the above stated absolute maximum rating. This rating is the maximum rating and device operating at this range is not guaranteeable as it is higher than our stated recommended operating range.

When subjected under the absolute maximum rating for a long time, the reliability of the product may be affected.

\*1: The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

\*2: Except for the power dissipation, operating ambient temperature, and storage temperature, all ratings are for  $T_a = 25^\circ\text{C}$ .

\*3: RF signal input pin. Do not apply DC current.

\*4: ( $V_{CC} + 0.3$ ) V must not be exceeded 3.6 V

\*5: RF signal output pin. Do not apply DC current.

**POWER DISSIPATION RATING**

| PACKAGE    | $\theta_{JA}$ | PD ( $T_a=25^\circ\text{C}$ ) | PD ( $T_a=70^\circ\text{C}$ ) |
|------------|---------------|-------------------------------|-------------------------------|
| SSMINI-5DC | 833.3°C/W     | 0.12W                         | 0.06W                         |

Note). For the actual usage, please refer to the PD- $T_a$  characteristics diagram in the package specification, supply voltage, load and ambient temperature conditions to ensure that there is enough margin follow the power and the thermal design does not exceed the allowable value.



**CAUTION**

Although this has limited built-in ESD protection circuit, but permanent damage may occur on it. Therefore, proper ESD precautions are recommended to avoid electrostatic damage to the MOS gates

**RECOMMENDED OPERATING CONDITIONS**

| Parameter            | Symbol   | Min. | Typ. | Max. | Unit | Note |
|----------------------|----------|------|------|------|------|------|
| Supply voltage range | $V_{CC}$ | 1.70 | 2.50 | 3.00 | V    | *1   |

Note) \*1 : The values under the condition not exceeding the above absolute maximum ratings and the power dissipation.

**ELECTRICAL CHARACTERISTICS**

Vcc = 2.5 V    Ta = 25°C±2°C unless otherwise specified.

| Parameter                            | Symbol | Condition  | Limits |      |      | Unit | Note |
|--------------------------------------|--------|--|--------|------|------|------|------|
|                                      |        |  | Min    | Typ  | Max  |      |      |
| <b>DC electrical characteristics</b> |        |  |        |      |      |      |      |
| Supply current HG                    | IccHA  | Vcc current at High-Gain mode<br>No input signal | —      | 5.7  | 7.7  | mA   |      |
| Supply current LG                    | IccLA  | Vcc current at Low-Gain mode<br>No input signal  | —      | 1    | 10   | μA   |      |
| Input voltage<br>(High-Gain mode)    | VIHA   | —  | 1.40   | 2.50 | —    | V    |      |
| Input voltage<br>(Low-Gain mode)     | VILA   | —  | —      | 0.0  | 0.55 | V    |      |
| SW current (High)                    | IIHA   | Current at CNT pin<br>VIHA = Vcc                 | —      | 1    | 10   | μA   |      |

**ELECTRICAL CHARACTERISTICS (continued)**

V<sub>CC</sub> = 1.8 V    T<sub>a</sub> = 25°C±2°C unless otherwise specified.

| Parameter                            | Symbol            | Condition  | Limits |      |      | Unit | Note |
|--------------------------------------|-------------------|--|--------|------|------|------|------|
|                                      |                   |  | Min    | Typ  | Max  |      |      |
| <b>DC electrical characteristics</b> |                   |  |        |      |      |      |      |
| Supply current HG                    | I <sub>ccHB</sub> | V <sub>CC</sub> current at High-Gain mode<br>No input signal | —      | 5.5  | 7.5  | mA   | —    |
| Supply current LG                    | I <sub>ccLB</sub> | V <sub>CC</sub> current at Low-Gain mode<br>No input signal  | —      | 1    | 10   | μA   | —    |
| Input voltage<br>(High-Gain mode)    | V <sub>IHB</sub>  | —  | 1.40   | 2.50 | —    | V    | —    |
| Input voltage<br>(Low-Gain mode)     | V <sub>ILB</sub>  | —  | —      | 0.0  | 0.55 | V    | —    |

**ELECTRICAL CHARACTERISTICS (continued)**

Vcc = 2.5 V    Ta = 25°C±2°C, fRX = 470 MHz, PRX = -30 dBm, CW unless otherwise specified

| Parameter                                | Symbol  | Condition  | Limits |      |     | Unit | Note |
|--|---------|--|--------|------|-----|------|------|
|  |         |  | Min    | Typ  | Max |      |      |
| <b>LNA AC electrical characteristics</b> |         |  |        |      |     |      |      |
| Power Gain HG                            | GHSA    | High-Gain mode<br>f = fRX  | 13     | 15   | 17  | dB   | —    |
| Power Gain LG                            | GLSA    | Low-Gain mode<br>f = fRX, PRX = -20 dBm                            | -1.8   | -1.3 | —   | dB   | —    |
| IIP3<br>+10 MHz offset                   | IIP31SA | f1 = fRX + 10 MHz<br>f2 = fRX + 20 MHz<br>Input 2 signals (f1, f2) | -7.5   | -1.0 | —   | dBm  | —    |

**ELECTRICAL CHARACTERISTICS (continued)**

V<sub>CC</sub> = 1.8 V    T<sub>a</sub> = 25°C±2°C, f<sub>RX</sub> = 470 MHz, P<sub>RX</sub> = -30 dBm, CW unless otherwise specified

| Parameter                                | Symbol  | Condition  | Limits |      |      | Unit | Note |
|--|---------|--|--------|------|------|------|------|
|  |         |  | Min    | Typ  | Max  |      |      |
| <b>LNA AC electrical characteristics</b> |         |  |        |      |      |      |      |
| Power Gain HG                            | GHSB    | High-Gain mode<br>f = f <sub>RX</sub>  | 12.5   | 14.5 | 16.5 | dB   | —    |
| Power Gain LG                            | GLSB    | Low-Gain mode<br>f = f <sub>RX</sub> , P <sub>RX</sub> = -20 dBm                           | -2.0   | -1.5 | —    | dB   | —    |
| IIP3<br>+10 MHz offset                   | IIP31SB | f1 = f <sub>RX</sub> + 10 MHz<br>f2 = f <sub>RX</sub> + 20 MHz<br>Input 2 signals (f1, f2) | -8.0   | -1.5 | —    | dBm  | —    |

**APPLICATION INFORMATION**  
**REFERENCE VALUES FOR DESIGN**

Notes)  $V_{cc} = 2.5\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXa} = 40\text{ MHz}, 470\text{ MHz}, 900\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |       |      | Unit | Note  |
|--|----------|--|------------------|-------|------|------|-------|
|  |          |  | Min              | Typ   | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |       |      |      |       |
| Power Gain HG                            | GHAa     | High-Gain mode<br>$f = f_{RXa}$  | 12.5             | 15    | 17.5 | dB   | *1    |
| Power Gain LG                            | GLAa     | Low-Gain mode<br>$f = f_{RXa}$ , $PRX = -20\text{ dBm}$  | -3.3             | -1.3  | —    | dB   | *1    |
| Noise Figure HG                          | NFHAa    | High-Gain mode<br>$f = f_{RXa}$  | —                | 1.4   | 2.1  | dB   | *1,*2 |
| Noise Figure LG                          | NFLAa    | Low-Gain mode<br>$f = f_{RXa}$   | —                | 1.8   | 3.8  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Aa | High-Gain mode<br>$f_1 = f_{RXa} + 10\text{ MHz}$<br>$f_2 = f_{RXa} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -10.5            | -1    | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHAa | High-Gain mode<br>$f = f_{RXa}$  | -17.5            | -11.5 | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHAa   | High-Gain mode<br>$f = f_{RXa}$  | —                | -24   | -18  | dB   | *1    |
| Reverse Isolation LG                     | ISOAa    | Low-Gain mode<br>$f = f_{RXa}$   | —                | -1.3  | -0.4 | dB   | *1    |
| Input Return Loss HG                     | S11HAa   | High-Gain mode<br>$f = f_{RXa}$  | 5                | 16    | —    | dB   | *1    |
| Input Return Loss LG                     | S11LAa   | Low-Gain mode<br>$f = f_{RXa}$   | 7                | 23.5  | —    | dB   | *1    |
| Output Return Loss HG                    | S22HAa   | High-Gain mode<br>$f = f_{RXa}$  | 5                | 11    | —    | dB   | *1    |
| Output Return Loss LG                    | S22LAa   | Low-Gain mode<br>$f = f_{RXa}$   | 8                | 16    | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*2 : Connector & pattern (evaluation PCB) loss (0.01 dB at  $f_{RX} = 40\text{ MHz}$ , 0.04 dB at  $f_{RX} = 470\text{ MHz}$ , 0.08 dB at  $f_{RX} = 900\text{ MHz}$ ) included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 1.8\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXa} = 40\text{ MHz}, 470\text{ MHz}, 900\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |      |      | Unit | Note  |
|--|----------|--|------------------|------|------|------|-------|
|  |          |  | Min              | Typ  | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |      |      |      |       |
| Power Gain HG                            | GHBa     | High-Gain mode<br>$f = f_{RXa}$  | 12               | 14.5 | 17   | dB   | *1    |
| Power Gain LG                            | GLBa     | Low-Gain mode<br>$f = f_{RXa}$ , $PRX = -20\text{ dBm}$  | -3.5             | -1.5 | —    | dB   | *1    |
| Noise Figure HG                          | NFHBa    | High-Gain mode<br>$f = f_{RXa}$  | —                | 1.4  | 2.1  | dB   | *1,*2 |
| Noise Figure LG                          | NFLBa    | Low-Gain mode<br>$f = f_{RXa}$   | —                | 2    | 4    | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Ba | High-Gain mode<br>$f_1 = f_{RXa} + 10\text{ MHz}$<br>$f_2 = f_{RXa} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -11              | -1.5 | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHBa | High-Gain mode<br>$f = f_{RXa}$  | -18              | -12  | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHBa   | High-Gain mode<br>$f = f_{RXa}$  | —                | -24  | -18  | dB   | *1    |
| Reverse Isolation LG                     | ISOLBa   | Low-Gain mode<br>$f = f_{RXa}$   | —                | -1.5 | -0.6 | dB   | *1    |
| Input Return Loss HG                     | S11HBa   | High-Gain mode<br>$f = f_{RXa}$  | 5                | 14   | —    | dB   | *1    |
| Input Return Loss LG                     | S11LBa   | Low-Gain mode<br>$f = f_{RXa}$   | 7                | 26   | —    | dB   | *1    |
| Output Return Loss HG                    | S22HBa   | High-Gain mode<br>$f = f_{RXa}$  | 7                | 13   | —    | dB   | *1    |
| Output Return Loss LG                    | S22LBa   | Low-Gain mode<br>$f = f_{RXa}$   | 8                | 15   | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*2 : Connector & pattern (evaluation PCB) loss (0.01 dB at  $f_{RX} = 40\text{ MHz}$ , 0.04 dB at  $f_{RX} = 470\text{ MHz}$ , 0.08 dB at  $f_{RX} = 900\text{ MHz}$ ) included.



**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 2.5\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXb} = 470\text{ MHz}, 620\text{ MHz}, 770\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol               | Condition  | Reference values |      |      | Unit | Note  |
|--|----------------------|--|------------------|------|------|------|-------|
|  |                      |  | Min              | Typ  | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |                      |  |                  |      |      |      |       |
| Power Gain HG                            | GHA <sub>b</sub>     | High-Gain mode<br>$f = f_{RXb}$  | 12.8             | 14.8 | 17.2 | dB   | *1    |
| Power Gain LG                            | GLA <sub>b</sub>     | Low-Gain mode<br>$f = f_{RXb}$ , $PRX = -20\text{ dBm}$  | -2.7             | -1.5 | —    | dB   | *1    |
| Noise Figure HG                          | NFHA <sub>b</sub>    | High-Gain mode<br>$f = f_{RXb}$  | —                | 1.4  | 1.9  | dB   | *1,*3 |
| Noise Figure LG                          | NFLA <sub>b</sub>    | Low-Gain mode<br>$f = f_{RXb}$   | —                | 2.0  | 3.2  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1A <sub>b</sub> | High-Gain mode<br>$f_1 = f_{RXb} + 10\text{ MHz}$<br>$f_2 = f_{RXb} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -8.0             | 0    | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHA <sub>b</sub> | High-Gain mode<br>$f = f_{RXb}$  | -16              | -12  | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHA <sub>b</sub>   | High-Gain mode<br>$f = f_{RXb}$  | —                | -24  | -18  | dB   | *1    |
| Reverse Isolation LG                     | ISOA <sub>b</sub>    | Low-Gain mode<br>$f = f_{RXb}$   | —                | -1.5 | -0.9 | dB   | *1    |
| Input Return Loss HG                     | S11HA <sub>b</sub>   | High-Gain mode<br>$f = f_{RXb}$  | 8                | 17   | —    | dB   | *1    |
| Input Return Loss LG                     | S11LA <sub>b</sub>   | Low-Gain mode<br>$f = f_{RXb}$   | 9                | 16   | —    | dB   | *1    |
| Output Return Loss HG                    | S22HA <sub>b</sub>   | High-Gain mode<br>$f = f_{RXb}$  | 7                | 12   | —    | dB   | *1    |
| Output Return Loss LG                    | S22LA <sub>b</sub>   | Low-Gain mode<br>$f = f_{RXb}$   | 9                | 13   | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*3 : Connector & pattern (evaluation PCB) loss (0.04 dB at  $f_{RX} = 470\text{ MHz}$ , 0.05 dB at  $f_{RX} = 620\text{ MHz}$ , 0.06 dB at  $f_{RX} = 770\text{ MHz}$ ) included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 1.8\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXb} = 470\text{ MHz}, 620\text{ MHz}, 770\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |      |      | Unit | Note  |
|--|----------|--|------------------|------|------|------|-------|
|  |          |  | Min              | Typ  | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |      |      |      |       |
| Power Gain HG                            | GHBb     | High-Gain mode<br>$f = f_{RXb}$  | 12.3             | 14.3 | 16.7 | dB   | *1    |
| Power Gain LG                            | GLBb     | Low-Gain mode<br>$f = f_{RXb}$ , $PRX = -20\text{ dBm}$  | -2.9             | -1.7 | —    | dB   | *1    |
| Noise Figure HG                          | NFHBb    | High-Gain mode<br>$f = f_{RXb}$  | —                | 1.4  | 1.9  | dB   | *1,*3 |
| Noise Figure LG                          | NFLBb    | Low-Gain mode<br>$f = f_{RXb}$   | —                | 2.2  | 3.4  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Bb | High-Gain mode<br>$f_1 = f_{RXb} + 10\text{ MHz}$<br>$f_2 = f_{RXb} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -8.5             | -0.5 | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHBb | High-Gain mode<br>$f = f_{RXb}$  | -17              | -13  | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHBb   | High-Gain mode<br>$f = f_{RXb}$  | —                | -24  | -18  | dB   | *1    |
| Reverse Isolation LG                     | ISOLBb   | Low-Gain mode<br>$f = f_{RXb}$   | —                | -1.7 | -1.1 | dB   | *1    |
| Input Return Loss HG                     | S11HBb   | High-Gain mode<br>$f = f_{RXb}$  | 8                | 16   | —    | dB   | *1    |
| Input Return Loss LG                     | S11LBb   | Low-Gain mode<br>$f = f_{RXb}$   | 9.5              | 17   | —    | dB   | *1    |
| Output Return Loss HG                    | S22HBb   | High-Gain mode<br>$f = f_{RXb}$  | 7                | 13   | —    | dB   | *1    |
| Output Return Loss LG                    | S22LBb   | Low-Gain mode<br>$f = f_{RXb}$   | 8                | 12   | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*3 : Connector & pattern (evaluation PCB) loss (0.04 dB at  $f_{RX} = 470\text{ MHz}$ , 0.05 dB at  $f_{RX} = 620\text{ MHz}$ , 0.06 dB at  $f_{RX} = 770\text{ MHz}$ ) included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{CC} = 2.5\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXc} = 207.5\text{ MHz}$ ,  $215\text{ MHz}$ ,  $222\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |      |      | Unit | Note  |
|--|----------|--|------------------|------|------|------|-------|
|  |          |  | Min              | Typ  | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |      |      |      |       |
| Power Gain HG                            | GHAc     | High-Gain mode<br>$f = f_{RXc}$  | 12.7             | 14.5 | 17.3 | dB   | *1    |
| Power Gain LG                            | GLAc     | Low-Gain mode<br>$f = f_{RXc}$ , $PRX = -20\text{ dBm}$  | -1.5             | -1.0 | —    | dB   | *1    |
| Noise Figure HG                          | NFHAc    | High-Gain mode<br>$f = f_{RXc}$  | —                | 1.2  | 1.7  | dB   | *1,*4 |
| Noise Figure LG                          | NFLAc    | Low-Gain mode<br>$f = f_{RXc}$   | —                | 1.5  | 3.3  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Ac | High-Gain mode<br>$f_1 = f_{RXc} + 10\text{ MHz}$<br>$f_2 = f_{RXc} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -9.5             | -2   | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHAc | High-Gain mode<br>$f = f_{RXc}$  | -14              | -10  | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHAc   | High-Gain mode<br>$f = f_{RXc}$  | —                | -25  | -19  | dB   | *1    |
| Reverse Isolation LG                     | ISOAc    | Low-Gain mode<br>$f = f_{RXc}$   | —                | -1.0 | -0.4 | dB   | *1    |
| Input Return Loss HG                     | S11HAc   | High-Gain mode<br>$f = f_{RXc}$  | 7                | 7.5  | —    | dB   | *1    |
| Input Return Loss LG                     | S11LAc   | Low-Gain mode<br>$f = f_{RXc}$   | 20               | 25   | —    | dB   | *1    |
| Output Return Loss HG                    | S22HAc   | High-Gain mode<br>$f = f_{RXc}$  | 7                | 11   | —    | dB   | *1    |
| Output Return Loss LG                    | S22LAc   | Low-Gain mode<br>$f = f_{RXc}$   | 15               | 20   | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*4 : Connector & pattern (evaluation PCB) loss 0.03dB included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 1.8\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXc} = 207.5\text{ MHz}$ ,  $215\text{ MHz}$ ,  $222\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |       |      | Unit | Note  |
|--|----------|--|------------------|-------|------|------|-------|
|  |          |  | Min              | Typ   | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |       |      |      |       |
| Power Gain HG                            | GHBc     | High-Gain mode<br>$f = f_{RXc}$  | 12.9             | 14.7  | 16.8 | dB   | *1    |
| Power Gain LG                            | GLBc     | Low-Gain mode<br>$f = f_{RXc}$ , $PRX = -20\text{ dBm}$  | -1.7             | -1.2  | —    | dB   | *1    |
| Noise Figure HG                          | NFHBc    | High-Gain mode<br>$f = f_{RXc}$  | —                | 1.2   | 1.6  | dB   | *1,*4 |
| Noise Figure LG                          | NFLBc    | Low-Gain mode<br>$f = f_{RXc}$   | —                | 1.7   | 3.5  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Bc | High-Gain mode<br>$f_1 = f_{RXc} + 10\text{ MHz}$<br>$f_2 = f_{RXc} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -10              | -2.5  | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHBc | High-Gain mode<br>$f = f_{RXc}$  | -16.5            | -12.5 | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHBc   | High-Gain mode<br>$f = f_{RXc}$  | —                | -25   | -19  | dB   | *1    |
| Reverse Isolation LG                     | ISOLBc   | Low-Gain mode<br>$f = f_{RXc}$   | —                | -1.2  | -0.6 | dB   | *1    |
| Input Return Loss HG                     | S11HBc   | High-Gain mode<br>$f = f_{RXc}$  | 7                | 8     | —    | dB   | *1    |
| Input Return Loss LG                     | S11LBc   | Low-Gain mode<br>$f = f_{RXc}$   | 17               | 22    | —    | dB   | *1    |
| Output Return Loss HG                    | S22HBc   | High-Gain mode<br>$f = f_{RXc}$  | 7                | 15    | —    | dB   | *1    |
| Output Return Loss LG                    | S22LBc   | Low-Gain mode<br>$f = f_{RXc}$   | 13               | 18    | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*4 : Connector & pattern (evaluation PCB) loss 0.03dB included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 2.5\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXd} = 90\text{ MHz}, 99\text{ MHz}, 108\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |      |      | Unit | Note  |
|--|----------|--|------------------|------|------|------|-------|
|  |          |  | Min              | Typ  | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |      |      |      |       |
| Power Gain HG                            | GHAd     | High-Gain mode<br>$f = f_{RXd}$  | 12.7             | 14.5 | 17.2 | dB   | *1    |
| Power Gain LG                            | GLAd     | Low-Gain mode<br>$f = f_{RXd}$ , $PRX = -20\text{ dBm}$  | -1.4             | -0.9 | —    | dB   | *1    |
| Noise Figure HG                          | NFHAd    | High-Gain mode<br>$f = f_{RXd}$  | —                | 1.2  | 1.7  | dB   | *1,*5 |
| Noise Figure LG                          | NFLAd    | Low-Gain mode<br>$f = f_{RXd}$   | —                | 1.4  | 3.1  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Ad | High-Gain mode<br>$f_1 = f_{RXd} + 10\text{ MHz}$<br>$f_2 = f_{RXd} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -10.5            | -1   | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHAd | High-Gain mode<br>$f = f_{RXd}$  | -13.5            | -9.5 | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHAd   | High-Gain mode<br>$f = f_{RXd}$  | —                | -25  | -19  | dB   | *1    |
| Reverse Isolation LG                     | ISOAd    | Low-Gain mode<br>$f = f_{RXd}$   | —                | -0.9 | -0.4 | dB   | *1    |
| Input Return Loss HG                     | S11HAd   | High-Gain mode<br>$f = f_{RXd}$  | 6                | 6.5  | —    | dB   | *1    |
| Input Return Loss LG                     | S11LAd   | Low-Gain mode<br>$f = f_{RXd}$   | 16               | 21   | —    | dB   | *1    |
| Output Return Loss HG                    | S22HAd   | High-Gain mode<br>$f = f_{RXd}$  | 7                | 11   | —    | dB   | *1    |
| Output Return Loss LG                    | S22LAd   | Low-Gain mode<br>$f = f_{RXd}$   | 15               | 20   | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*5 : Connector & pattern (evaluation PCB) loss 0.02dB included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 1.8\text{ V}$

$T_a = 25^\circ\text{C} \pm 2^\circ\text{C}$ ,  $f_{RXd} = 90\text{ MHz}, 99\text{ MHz}, 108\text{ MHz}$ ,  $PRX = -30\text{ dBm}$ , CW unless otherwise specified.

| Parameter                                | Symbol   | Condition  | Reference values |       |      | Unit | Note  |
|--|----------|--|------------------|-------|------|------|-------|
|  |          |  | Min              | Typ   | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |          |  |                  |       |      |      |       |
| Power Gain HG                            | GHBd     | High-Gain mode<br>$f = f_{RXd}$  | 12.9             | 14.7  | 16.9 | dB   | *1    |
| Power Gain LG                            | GLBd     | Low-Gain mode<br>$f = f_{RXd}$ , $PRX = -20\text{ dBm}$  | -1.6             | -1.1  | —    | dB   | *1    |
| Noise Figure HG                          | NFHBd    | High-Gain mode<br>$f = f_{RXd}$  | —                | 1.2   | 1.7  | dB   | *1,*5 |
| Noise Figure LG                          | NFLBd    | Low-Gain mode<br>$f = f_{RXd}$   | —                | 1.6   | 3.3  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1Bd | High-Gain mode<br>$f_1 = f_{RXd} + 10\text{ MHz}$<br>$f_2 = f_{RXd} + 20\text{ MHz}$<br>Input 2 signals ( $f_1, f_2$ ) | -11              | -1    | —    | dBm  | *1    |
| Input P1dB                               | IP1dBHBd | High-Gain mode<br>$f = f_{RXd}$  | -16.5            | -12.5 | —    | dBm  | *1    |
| Reverse Isolation HG                     | ISOHBd   | High-Gain mode<br>$f = f_{RXd}$  | —                | -25   | -19  | dB   | *1    |
| Reverse Isolation LG                     | ISOLBd   | Low-Gain mode<br>$f = f_{RXd}$   | —                | -1.1  | -0.6 | dB   | *1    |
| Input Return Loss HG                     | S11HBd   | High-Gain mode<br>$f = f_{RXd}$  | 6                | 7     | —    | dB   | *1    |
| Input Return Loss LG                     | S11LBd   | Low-Gain mode<br>$f = f_{RXd}$   | 15               | 20    | —    | dB   | *1    |
| Output Return Loss HG                    | S22HBd   | High-Gain mode<br>$f = f_{RXd}$  | 7                | 16    | —    | dB   | *1    |
| Output Return Loss LG                    | S22LBd   | Low-Gain mode<br>$f = f_{RXd}$   | 14               | 19    | —    | dB   | *1    |

Note) \*1 : Checked by design, not production tested.

\*5 : Connector & pattern (evaluation PCB) loss 0.02dB included.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{cc} = 1.7\text{ V to }3.0\text{ V}$   
 $T_a = -20^\circ\text{C to }70^\circ\text{C}$

| Parameter                            | Symbol            | Condition  | Reference values |      |      | Unit | Note |
|--------------------------------------|-------------------|--|------------------|------|------|------|------|
|                                      |                   |  | Min              | Typ  | Max  |      |      |
| <b>DC electrical characteristics</b> |                   |  |                  |      |      |      |      |
| Supply current HG                    | I <sub>ccHT</sub> | V <sub>cc</sub> current at High-Gain mode<br>No input signal | —                | 5.7  | 8.2  | mA   | *1   |
| Supply current LG                    | I <sub>ccLT</sub> | V <sub>cc</sub> current at Low-Gain mode<br>No input signal  | —                | 1    | 11   | μA   | *1   |
| Input voltage<br>(High-Gain mode)    | V <sub>IHT</sub>  | —  | 1.50             | 2.50 | —    | V    | *1   |
| Input voltage<br>(Low-Gain mode)     | V <sub>ILT</sub>  | —  | —                | 0.0  | 0.40 | V    | *1   |
| SW current (High)                    | I <sub>IHT</sub>  | Current at CNT pin<br>V <sub>IHT</sub> = V <sub>cc</sub>     | —                | 1    | 11   | μA   | *1   |

Note) \*1 : Checked by design, not production tested.

**APPLICATION INFORMATION (continued)**

**REFERENCE VALUES FOR DESIGN (continued)**

Notes)  $V_{CC} = 1.7\text{ V to }3.0\text{ V}$

$T_a = -20^\circ\text{C to }70^\circ\text{C}$ ,  $f_{RXa} = 40\text{ MHz, }470\text{ MHz, }900\text{ MHz}$ ,  $PRX = -30\text{ dBm, CW}$

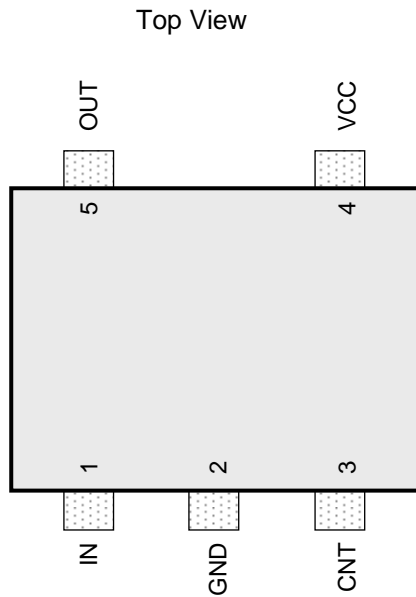
| Parameter                                | Symbol  | Condition  | Reference values |       |      | Unit | Note  |
|--|---------|--|------------------|-------|------|------|-------|
|  |         |  | Min              | Typ   | Max  |      |       |
| <b>LNA AC electrical characteristics</b> |         |  |                  |       |      |      |       |
| Power Gain HG                            | GHT     | High-Gain mode<br>$f = f_{RXa}$  | 11.5             | 15    | 18.5 | dB   | *1    |
| Power Gain LG                            | GLT     | Low-Gain mode<br>$f = f_{RXa}$ , $PRX = -20\text{ dBm}$  | -3.8             | -1.3  | —    | dB   | *1    |
| Noise Figure HG                          | NFHT    | High-Gain mode<br>$f = f_{RXa}$  | —                | 1.4   | 2.5  | dB   | *1,*2 |
| Noise Figure LG                          | NFLT    | Low-Gain mode<br>$f = f_{RXa}$   | —                | 1.8   | 4.3  | dB   | *1    |
| IIP3<br>+10 MHz offset HG                | IIP3H1T | High-Gain mode<br>$f1 = f_{RXa} + 10\text{ MHz}$<br>$f2 = f_{RXa} + 20\text{ MHz}$<br>Input 2 signals ( $f1, f2$ ) | -13.0            | -1.0  | —    | dBm  | *1    |
| Input P1dB HG                            | IP1dBHT | High-Gain mode<br>$f = f_{RXa}$  | -20              | -11.5 | —    | dBm  | *1    |

Note) \*1 : Checked by design, not production tested.

\*2 : Connector & pattern (evaluation PCB) loss (0.01 dB at  $f_{RX} = 40\text{ MHz}$ , 0.04 dB at  $f_{RX} = 470\text{ MHz}$ , 0.08 dB at  $f_{RX} = 900\text{ MHz}$ ) included.



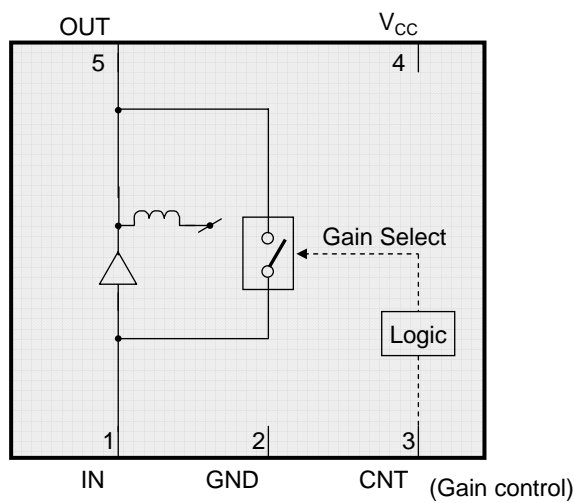
**PIN CONFIGURATION**



**PIN FUNCTIONS**

| Pin No. | Pin name | Type         | Description  |
|---------|----------|--------------|--|
| 1       | IN       | Input        | RF Input   |
| 2       | GND      | Ground       | GND  |
| 3       | CNT      | Input        | High-Gain / Low-Gain switch<br>L: Low-Gain Mode<br>H: High-Gain Mode |
| 4       | VCC      | Power Supply | V <sub>CC</sub>  |
| 5       | OUT      | Output       | RF Output  |

**FUNCTIONAL BLOCK DIAGRAM**

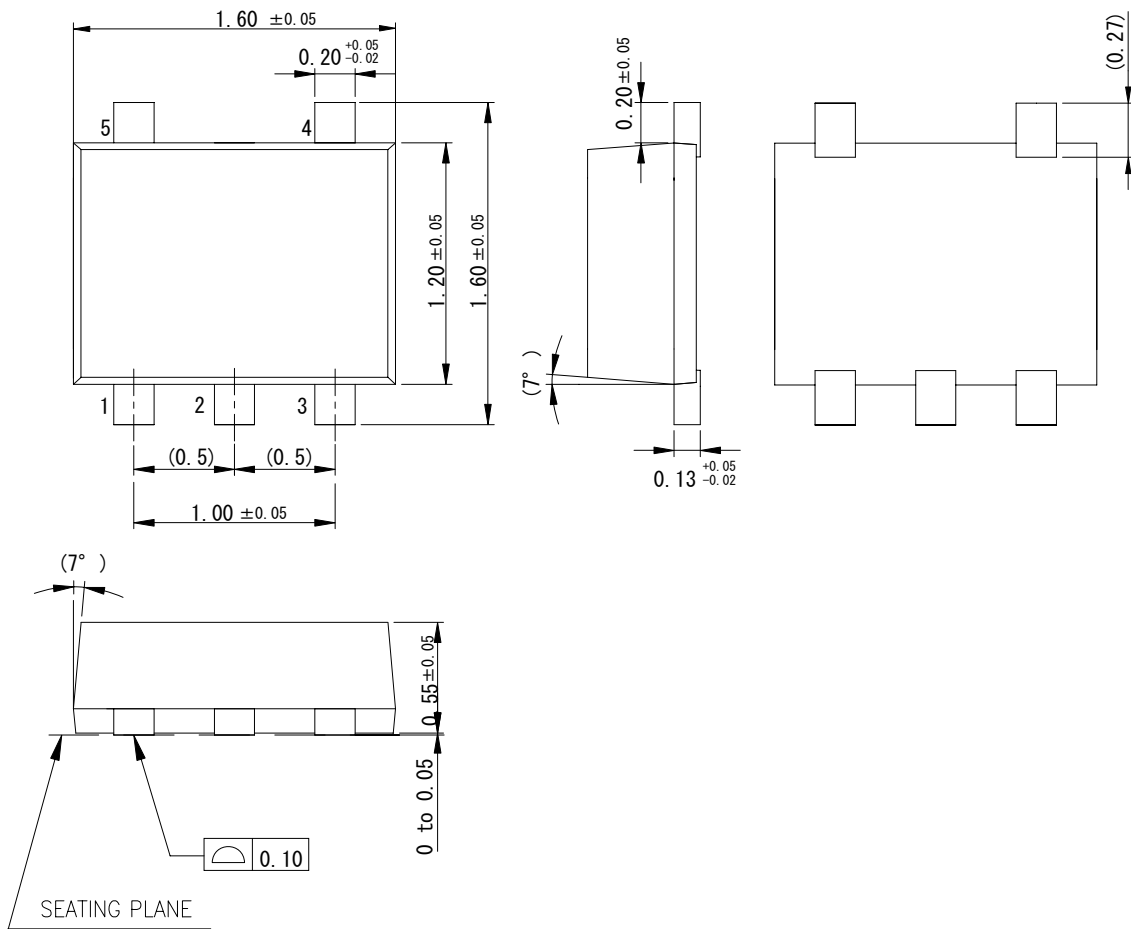


Notes) This circuit and these circuit constants show an example and do not guarantee the design as a mass-production set. This block diagram is for explaining functions. The part of the block diagram may be omitted, or it may be simplified.

PACKAGE INFORMATION ( Reference Data )

Package Code:SSMINI-5DC

Unit:mm



|                    |                               |
|--------------------|-------------------------------|
| Body Material      | : Br / Sb Free<br>Epoxy Resin |
| Lead Material      | : Cu Alloy                    |
| Lead Finish Method | : SnBi Plating                |

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Even when the products are used within the guaranteed values, take into the consideration of incidence of break down and failure mode, possible to occur to semiconductor products. Measures on the systems such as redundant design, arresting the spread of fire or preventing glitch are recommended in order to prevent physical injury, fire, social damages, for example, by using the products.

2. Comply with the instructions for use in order to prevent breakdown and characteristics change due to external factors (ESD, EOS, thermal stress and mechanical stress) at the time of handling, mounting or at customer's process. When using products for which damp-proof packing is required, satisfy the conditions, such as shelf life and the elapsed time since first opening the packages.
3. Pay attention to the direction of LSI. When mounting it in the wrong direction onto the PCB (printed-circuit-board), it might smoke or ignite.
4. Pay attention in the PCB (printed-circuit-board) pattern layout in order to prevent damage due to short circuit between pins. In addition, refer to the Pin Description for the pin configuration.
5. Perform a visual inspection on the PCB before applying power, otherwise damage might happen due to problems such as a solder-bridge between the pins of the semiconductor device. Also, perform a full technical verification on the assembly quality, because the same damage possibly can happen due to conductive substances, such as solder ball, that adhere to the LSI during transportation.
6. Take notice in the use of this product that it might break or occasionally smoke when an abnormal state occurs such as output pin-VCC short (Power supply fault), output pin-GND short (Ground fault), or output-to-output-pin short (load short) .

And, safety measures such as an installation of fuses are recommended because the extent of the above-mentioned damage and smoke emission will depend on the current capability of the power supply.

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