GNSS LOW NOISE AMPLIFIER

- GENERAL DESCRIPTION
  The NJG1144KA1 is a low noise amplifier GaAs MMIC designed for GNSS (Global Navigation Satellite Systems). This amplifier achieves high gain and a good balance between ultra-low noise figure and excellent VSWR, while low current consumption and high IP3, respectively.
  The NJG1144KA1 operates from +1.5V to +3.6V supply voltage range and current consumption is as low as 3.5mA.
  Also, the ESD protection circuit is integrated into the IC to achieve high ESD tolerance.
  An ultra-small and easy mounting package of FLP6-A1 is adopted.

- APPLICATIONS
  GNSS applications, like GPS, Galileo, GLONASS and COMPASS.

- FEATURES
  - Low supply voltage 1.8V/2.85V
  - Low current consumption
    - 3.5mA typ. @ V_{DD}=2.85V
    - 1.8mA typ. @ V_{DD}=1.8V
  - High gain
    - 21.0dB typ. @ f=1575MHz, V_{DD}=2.85V
  - Low noise figure
    - 0.65dB typ. @ f=1575MHz, V_{DD}=2.85V
  - High Input IP3
    - -2.0dBm typ. @ f=1575MHz, V_{DD}=2.85V
  - Small package
    - FLP6-A1 (Package size: 1.6mm x 1.6mm x 0.55mm typ.)
  - RoHS compliant and halogen free, MSL1

- PIN CONFIGURATION

   (Top View)

   - Pin connection
     1. RFIN
     2. GND
     3. GND
     4. RFOUT
     5. GND
     6. NC (GND)

   1 Pin INDEX

Note: Specifications and description listed in this datasheet are subject to change without notice.
### ABSOLUTE MAXIMUM RATINGS

Ta=+25°C, Zs=Zl=50Ω

<table>
<thead>
<tr>
<th>PARAMETERS</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>RATINGS</th>
<th>UNITS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_DD</td>
<td></td>
<td>5.0</td>
<td>V</td>
</tr>
<tr>
<td>Input power</td>
<td>P_IN</td>
<td>V_DD=2.85V</td>
<td>+15</td>
<td>dBm</td>
</tr>
<tr>
<td>Power dissipation</td>
<td>P_D</td>
<td>4-layer FR4 PCB with through-hole</td>
<td>580</td>
<td>mW</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(74.2mmx74.2mm), T_j=150°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating temp</td>
<td>T_opr</td>
<td>-40 to +105°C</td>
<td></td>
<td>°C</td>
</tr>
<tr>
<td>Storage temp</td>
<td>T_stg</td>
<td>-55 to +150°C</td>
<td></td>
<td>°C</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS 1 (DC CHARACTERISTICS)

General conditions: V_DD=2.85V, Ta=+25°C

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supply voltage</td>
<td>V_DD</td>
<td></td>
<td>1.5</td>
<td>-</td>
<td>3.6</td>
<td>V</td>
</tr>
<tr>
<td>Supply current 1</td>
<td>I_DD 1</td>
<td>RF OFF, V_DD=2.85V</td>
<td>-</td>
<td>3.5</td>
<td>5.5</td>
<td>mA</td>
</tr>
<tr>
<td>Supply current 2</td>
<td>I_DD 2</td>
<td>RF OFF, V_DD=1.8V</td>
<td>-</td>
<td>1.8</td>
<td>3.2</td>
<td>mA</td>
</tr>
</tbody>
</table>
### ELECTRICAL CHARACTERISTICS 2 (RF CHARACTERISTICS)

General conditions: $V_{DD}=2.85V$, $f_{RF}=1.575GHz$, $Ta=+25^\circ C$, $Z_s=Z_l=50\Omega$, with application circuit

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small signal gain</td>
<td>Gain1</td>
<td></td>
<td>18.0</td>
<td>21.0</td>
<td>23.5</td>
<td>dB</td>
</tr>
<tr>
<td>Noise figure</td>
<td>NF1 Exclude PCB, Connector Losses(0.08dB)</td>
<td></td>
<td>-</td>
<td>0.65</td>
<td>0.95</td>
<td>dB</td>
</tr>
<tr>
<td>Input power at 1dB gain compression point 1</td>
<td>P-1dB(IN)1</td>
<td></td>
<td>-19.0</td>
<td>-16.5</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Input 3rd order intercept point 1</td>
<td>IIIP3_1 $f_1=f_{RF}, f_2=f_1+100kHz, Pin=-34dBm$</td>
<td></td>
<td>-5.0</td>
<td>-2.0</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>RF input VSWR 1</td>
<td>VSWRi1</td>
<td></td>
<td>-</td>
<td>1.5</td>
<td>2.0</td>
<td>-</td>
</tr>
<tr>
<td>RF output VSWR 1</td>
<td>VSWRo1</td>
<td></td>
<td>-</td>
<td>1.5</td>
<td>2.0</td>
<td>-</td>
</tr>
</tbody>
</table>

### ELECTRICAL CHARACTERISTICS 2 (RF CHARACTERISTICS)

General conditions: $V_{DD}=1.8V$, $f_{RF}=1.575GHz$, $Ta=+25^\circ C$, $Z_s=Z_l=50\Omega$, with application circuit

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SYMBOL</th>
<th>CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small signal gain 2</td>
<td>Gain2</td>
<td></td>
<td>-</td>
<td>18.0</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Noise figure 2</td>
<td>NF2 Exclude PCB, Connector Losses(0.08dB)</td>
<td></td>
<td>-</td>
<td>0.85</td>
<td>-</td>
<td>dB</td>
</tr>
<tr>
<td>Input power at 1dB gain compression point 2</td>
<td>P-1dB(IN)2</td>
<td></td>
<td>-</td>
<td>-18.5</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>Input 3rd order intercept point 2</td>
<td>IIIP3_2 $f_1=f_{RF}, f_2=f_1+100kHz, Pin=-34dBm$</td>
<td></td>
<td>-</td>
<td>-6.0</td>
<td>-</td>
<td>dBm</td>
</tr>
<tr>
<td>RF input VSWR 2</td>
<td>VSWRi2</td>
<td></td>
<td>-</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>RF output VSWR 2</td>
<td>VSWRo2</td>
<td></td>
<td>-</td>
<td>1.8</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
### TERMINAL INFORMATION

<table>
<thead>
<tr>
<th>No.</th>
<th>SYMBOL</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RFOUT</td>
<td>RF output and voltage supply terminal.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Ground terminal (0V), Connect to the PCB ground plane.</td>
</tr>
<tr>
<td>3</td>
<td>GND</td>
<td>Ground terminal (0V), Connect to the PCB ground plane.</td>
</tr>
<tr>
<td>4</td>
<td>RFIN</td>
<td>RF input terminal. DC blocking capacitor is not required. An external matching circuit is required.</td>
</tr>
<tr>
<td>5</td>
<td>GND</td>
<td>Ground terminal (0V), Connect to the PCB ground plane.</td>
</tr>
<tr>
<td>6</td>
<td>NC(GND)</td>
<td>No connected terminal. This terminal is not connected with internal circuit. Please connect to the PCB ground Plane.</td>
</tr>
</tbody>
</table>
**ELECTRICAL CHARACTERISTICS (\(V_{DD}=2.85\text{V}\))**

(Conditions: \(T_a=+25^\circ\text{C}, V_{DD}=2.85\text{V}, Z_s=Z_l=50\Omega\), with application circuit.)

- **\(P_{out} \text{ vs. } P_{in}\)**
  - \(V_{DD}=2.85\text{V}, f_{RF}=1575\text{MHz}\)
  - \(P_{-1dB(IN)}=-16.5\text{dBm}\)

- **Gain, \(I_{dd} \) vs. \(P_{in}\)**
  - \(V_{DD}=2.85\text{V}, f_{RF}=1575\text{MHz}\)
  - \(P_{-1dB(IN)}=-16.5\text{dBm}\)

- **\(P_{out}, IM3 \) vs. \(P_{in}\)**
  - \(V_{DD}=2.85\text{V}, f_1=1575\text{MHz}, f_2=f_1+100\text{kHz}\)
  - \(I_{IP3}=-2.0\text{dBm}\)

- **OIP3, IIP3 vs. frequency**
  - \(V_{DD}=2.85\text{V}, f_1=1550\text{~}1600\text{MHz}, f_2=f_1+100\text{kHz}, P_{in}=-34\text{dBm}\)

- **NF, Gain vs. frequency**
  - \(V_{DD}=2.85\text{V}, f=1500\text{~}1650\text{MHz}\)
  - \(N\text{F: Exclude PCB, Connector Losses}\)
**ELECTRICAL CHARACTERISTICS (V_{DD} = 2.85V)**
(Conditions: V_{DD} = 2.85V, Z_{S}=Z_{L}=50\,\Omega, with application circuit.)

- **Gain, NF vs Temperature** (V_{DD}=2.85V, f=1575MHz)

- **P-1dB(IN) vs. Temperature** (V_{DD}=2.85V, f=1575MHz)

- **OIP3, IIP3 vs. Temperature** (V_{DD}=2.85V, f1=1575MHz, f2=f1+100kHz, P_{in}=-34dBm)

- **Gain, NF vs Temperature** (V_{DD}=2.85V, f=1575MHz)

- **Gain** vs. **Noise Figure** (dB)

- **IIP3 (dBm)** vs. **Temperature**

- **IIP3 (dBm)** vs. **Temperature**

- **OIP3 (dBm)** vs. **Temperature**

- **I_{DD} vs. Temperature** (V_{DD}=2.85V, RF OFF)

- **Gain, NF vs Temperature** (V_{DD}=2.85V, f=1575MHz)

- **Gain** (dB)

- **Noise Figure (dB)**

- **NF: Exclude PCB, Connector Losses**

- **k factor vs. Temperature** (V_{DD}=2.85V, f=50MHz ~ 20GHz)

- **k factor vs. Temperature**

- **VSWR vs. Temperature** (V_{DD}=2.85V, f=1575MHz)

- **V_{SWR}**

- **V_{SWR0}**

- **P-1dB(IN) vs. Temperature**

- **Temperature** (°C)

- **Gain** (dB)

- **k factor**

- **I_{DD} (mA)** vs. **Temperature**

- **Temperature** (°C)

- **Temperature** (°C)

- **Temperature** (°C)

- **Temperature** (°C)

- **Temperature** (°C)
ELECTRICAL CHARACTERISTICS ($V_{DD} = 1.8V$)

(Conditions: $T_a = +25^\circ C$, $V_{DD} = 1.8V$, $Z_s = Z_l = 50\Omega$, with application circuit.)

**Pout vs. Pin**
(Vcc=1.8V, fRF=1575MHz)

**Gain, Ioo vs. Pin**
(Vcc=1.8V, fRF=1575MHz)

**Pout, IM3 vs. Pin**
(Vcc=1.8V, f1=1575MHz, f2=f1+100kHz)

**OIP3, IIP3 vs. frequency**
(Vcc=1.8V, f1=1550~1600MHz, f2=f1+100kHz, Pin=-34dBm)

**NF, Gain vs. frequency**
(Vcc=1.8V, f=1500~1650MHz)

(NF: Exclude PCB, Connector Losses)
ELECTRICAL CHARACTERISTICS (V_{DD} = 1.8V)
(Conditions: V_{DD} = 1.8V, Z_s = Z_l = 50\,\Omega, with application circuit.)
ELECTRICAL CHARACTERISTICS
(Conditions: Ta=+25°C, Zs=Zl=50Ω, with application circuit.)

Gain, NF vs. VDD
(\(f=1575\)MHz)

Gain
NF
(V: 1.0 1.5 2.0 2.5 3.0 3.5 4.0)

P-1dB(IN) vs. VDD
(\(f=1575\)MHz)

P-1dB(IN)
(V: 1.0 1.5 2.0 2.5 3.0 3.5 4.0)

OIP3, IIP3 vs. VDD
(\(f_1=1575\)MHz, \(f_2=f_1+100\)kHz, \(P_{in}=-34\)dBm)

OIP3
IIP3
(V: 1.0 1.5 2.0 2.5 3.0 3.5 4.0)

VSWR vs. VDD
(\(f=1575\)MHz)

VSWR
(V: 1.0 1.5 2.0 2.5 3.0 3.5 4.0)

I_DDD vs. VDD
(RF OFF)

I_DD
(V: 1.0 1.5 2.0 2.5 3.0 3.5 4.0)
ELECTRICAL CHARACTERISTICS ($V_{DD} = 2.85V$)
(Conditions: $T_a = +25°C$, $V_{DD} = 2.85V$, $Z_s = Z_l = 50\Omega$, with application circuit.)
ELECTRICAL CHARACTERISTICS (V_{DD}=1.8V)
(Conditions: Ta=+25°C, V_{DD}=1.8V, Zs=Zl=50Ω, with application circuit.)

- S11, S22
- Zin, Zout
- VSWR
- S21, S12
S11, S22 (50MHz to 20GHz)
S21, S12 (50MHz to 20GHz)
**APPLICATION CIRCUIT**

(Top View)

- L1 8.2nH
- RF IN
- RF OUT
- GND
- VDD
- L2 12nH
- C2 1000pF
- L3 5.1nH
- C1 1.6pF
- VDD
- 1 Pin INDEX

**TEST PCB LAYOUT**

(Top View)

Parts list:

<table>
<thead>
<tr>
<th>Parts ID</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1 to L3</td>
<td>MURATA LQP03T_02 Series</td>
</tr>
<tr>
<td>C1, C2</td>
<td>MURATA GRM03 Series</td>
</tr>
</tbody>
</table>

PCB (FR-4):
- t=0.2mm
- MICROSTRIP LINE WIDTH =0.34mm (Z0=50Ω)
- PCB SIZE=14.0mm x 14.0mm

Caution:
In order not to couple with terminal RFIN and RFOUT, please layout ground pattern under the IC.
**MEASUREMENT BLOCK DIAGRAM**

- S parameter Measurements

![S parameter Measurement Block Diagram](image)

- IIP3 Measurements

![IF and IM3 Measurement Block Diagram for IIP3](image)
Noise Figure Measurements

Measuring instruments
- NF Analyzer: Agilent 8973A, 8975A
- Noise Source: Agilent 346A

Setting the NF analyzer
- Measurement mode form:
  - Device under test: Amplifier
  - System downconverter: off
- Mode setup form:
  - Sideband: LSB
  - Averages: 16
  - Average mode: Point
  - Bandwidth: 4MHz
  - Loss comp: off
  - Tcold: setting the temperature of noise source (303.15K)

Calibration Setup
* Noise source and NF analyzer are connected directly.

Measurement Setup
* Noise source and DUT, DUT and NF analyzer are connected directly.
Cautions on using this product

- Do NOT eat or put into mouth.
- Do NOT dispose in fire or break up this product.
- Do NOT chemically make gas or powder with this product.
- To waste this product, please obey the relating law of your country.

This product may be damaged with electric static discharge (ESD) or spike voltage. Please handle with care to avoid these damages.

[CAUTION]

The specifications on this databook are only given for information, without any guarantee as regards either mistakes or omissions. The application circuits in this databook are described only to show representative usages of the product and not intended for the guarantee or permission of any right including the industrial rights.

Unit: mm