Product Description

The SPF5189Z is a high performance pHEMT MMIC LNA designed for operation from 50MHz to 4000MHz. The on-chip active bias network provides stable current over temperature and process threshold voltage variations. The SPF5189Z offers ultra-low noise figure and high linearity performance in a gain block configuration. Its single-supply operation and integrated matching networks make implementation remarkably simple. A high maximum input power specification make it ideal for high dynamic range receivers.

Features

- Ultra-Low Noise Figure = 0.60dB at 900MHz
- Gain = 18.7dB at 900MHz
- High Linearity: OIP3 = 39.5dBm at 1960MHz
- P1dB = 22.7dBm at 1960MHz
- Single-Supply Operation: 5V at I(DQ) = 90mA
- Flexible Biasing Options: 3V to 5V, Adjustable Current
- Broadband Internal Matching

Applications

- Cellular, PCS, W-CDMA, ISM, WiMAX Receivers
- PA Driver Amplifier
- Low Noise, High Linearity Gain Block Applications

Parameter | Specification | Unit | Condition
--- | --- | --- | ---
Small Signal Gain | 11.3 | 12.8 | 14.3 dB | 1.96GHz
Output Power at 1dB Compression | 20.7 | 22.7 dBm | 1.96GHz
Output Third Order Intercept Point | 36.0 | 39.5 dBm | 1.96GHz
Noise Figure | 0.55 | 0.8 dB | 1.96GHz
Input Return Loss | 17.5 | 18.5 dB | 1.96GHz
Output Return Loss | 16.0 | 18.0 dB | 1.96GHz
Reverse Isolation | 24.0 | 24.0 dB | 1.96GHz
Device Operating Voltage | 5 | 5.25 V | Quiescent
Device Operating Current | 75 | 90 mA | Quiescent
Thermal Resistance | 65 | °C/W | Junction to lead

Test Conditions: VD = 5V, I(DQ) = 90mA, TL = 25°C, OIP3 Tone Spacing = 1MHz, P(OUT) per tone = 0dBm

Z(f) = Z(L) = 50Ω, 25°C, Application Circuit Data
### Absolute Maximum Ratings

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rating</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max Device Current ($I_D$)</td>
<td>120</td>
<td>mA</td>
</tr>
<tr>
<td>Max Device Voltage ($V_D$)</td>
<td>5.5</td>
<td>V</td>
</tr>
<tr>
<td>Max RF Input Power</td>
<td>27</td>
<td>dBm</td>
</tr>
<tr>
<td>Max Dissipated Power</td>
<td>660</td>
<td>mW</td>
</tr>
<tr>
<td>Max Junction Temperature ($T_J$)</td>
<td>150</td>
<td>°C</td>
</tr>
<tr>
<td>Operating Temperature Range ($T_L$)</td>
<td>-40 to +85</td>
<td>°C</td>
</tr>
<tr>
<td>Max Storage Temperature</td>
<td>-65 to +150</td>
<td>°C</td>
</tr>
<tr>
<td>ESD Rating - Human Body Model (HBM)</td>
<td>Class 1B</td>
<td></td>
</tr>
<tr>
<td>Moisture Sensitivity Level (MSL)</td>
<td>MSL 2</td>
<td></td>
</tr>
</tbody>
</table>

Operation of this device beyond any one of these limits may cause permanent damage. For reliable continuous operation, the device voltage and current must not exceed the maximum operating values specified in the table on page one. Bias Conditions should also satisfy the following expression:

$$I_DV_D < \left(\frac{T_J - T_L}{R_{TH, J}}\right)$$

### Typical RF Performance - Application Circuit Data with $V_D=5V$, $I_D=90mA$

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Unit</th>
<th>0.8 GHz</th>
<th>0.9 GHz</th>
<th>1.0 GHz</th>
<th>1.7 GHz</th>
<th>1.8 GHz</th>
<th>1.9 GHz</th>
<th>2.0 GHz</th>
<th>2.1 GHz</th>
<th>2.2 GHz</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain</td>
<td>dB</td>
<td>19.6</td>
<td>18.7</td>
<td>17.9</td>
<td>13.8</td>
<td>13.5</td>
<td>12.9</td>
<td>12.7</td>
<td>12.2</td>
<td>11.9</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>dB</td>
<td>0.52</td>
<td>0.55</td>
<td>0.79</td>
<td>0.75</td>
<td>0.81</td>
<td>0.83</td>
<td>0.90</td>
<td>0.91</td>
<td>0.98</td>
</tr>
<tr>
<td>Output IP3</td>
<td>dBm</td>
<td>38.4</td>
<td>38.5</td>
<td>39.0</td>
<td>39.2</td>
<td>39.5</td>
<td>39.5</td>
<td>39.8</td>
<td>39.8</td>
<td>39.9</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>dBm</td>
<td>22.3</td>
<td>22.4</td>
<td>22.5</td>
<td>22.6</td>
<td>22.6</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>dB</td>
<td>17.1</td>
<td>17.5</td>
<td>17.5</td>
<td>17.5</td>
<td>17.5</td>
<td>18.5</td>
<td>18.5</td>
<td>18.5</td>
<td>18.0</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>dB</td>
<td>16.0</td>
<td>16.0</td>
<td>15.5</td>
<td>14.0</td>
<td>14.0</td>
<td>14.5</td>
<td>15.0</td>
<td>15.5</td>
<td>16.0</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>dB</td>
<td>24.5</td>
<td>24.0</td>
<td>23.0</td>
<td>18.5</td>
<td>18.5</td>
<td>18.0</td>
<td>18.0</td>
<td>18.0</td>
<td>17.5</td>
</tr>
</tbody>
</table>

Test Conditions: $V_D=5V$, $I_{DQ}=90mA$, $Df=3$ tone spacing=1MHz, $P_{OUT}$ per tone=0dBm, $T_J=25^\circ C$, $Z_S=Z_L=50\Omega$
Typical RF Performance - 900MHz Application Circuit with \( V_D = 5V, I_D = 90mA \)

- **Noise Figure versus Frequency**
  - NF (dB) vs. Frequency (GHz)

- **OIP\(_3\) versus Frequency (0dBm tones)**
  - OIP\(_3\) (dBm) vs. Frequency (GHz)
  - Lines represent temperatures: +25°C, -40°C, +85°C

- **OIP\(_3\) versus Power (850MHz, 1MHz spacing)**
  - OIP\(_3\) (dBm) vs. Power Out Per Tone (dBm)
  - Lines represent temperatures: +25°C, -40°C, +85°C

- **P\(_{1dB}\) versus Frequency**
  - P\(_{1dB}\) (dBm) vs. Frequency (GHz)
  - Lines represent temperatures: +25°C, -40°C, +85°C

- **Device Current versus Voltage**
  - \( I_0 \) (mA) vs. \( V_D \) (V)
  - Lines represent temperatures: +25°C, -40°C, +85°C
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Typical RF Performance - 900MHz Application Circuit with $V_D=5V$, $I_D=90mA$

**S11 versus Frequency**

**S21 versus Frequency**

**S12 versus Frequency**

**S22 versus Frequency**
Typical RF Performance - 1900MHz Application Circuit with $V_D = 5V$, $I_D = 90mA$

- **Noise Figure versus Frequency**
  - NF (dB) vs Frequency (GHz) for $+25^\circ C$ and $+85^\circ C$

- **$OIP_3$ versus Frequency (0dBm tones)**
  - $OIP_3$ (dBm) vs Frequency (GHz) for $+25^\circ C$, $-40^\circ C$, and $+85^\circ C$

- **$OIP_3$ versus Power (1900MHz, 1MHz spacing)**
  - $OIP_3$ (dBm) vs Power Out Per Tone (dBm) for $+25^\circ C$, $40^\circ C$, and $+85^\circ C$

- **$P_{1dB}$ versus Frequency**
  - $P_{1dB}$ (dBm) vs Frequency (GHz) for $+25^\circ C$, $40^\circ C$, and $+85^\circ C$

- **$P_{OUT}$ versus Pin at 1900MHz**
  - Power out (dBm) vs Power in (dBm) for various temperatures and performance levels.
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Typical RF Performance - 1900MHz Application Circuit with \( V_D = 3 \text{V}, I_D = 90 \text{mA} \)

**S11 versus Frequency**

**S21 versus Frequency**

**S12 versus Frequency**

**S22 versus Frequency**
De-embedded Device S-parameters (Bias Tee Data)

**$G_{\text{MAX}}$ versus Frequency**

(5V, 90mA)

Gain, $G_{\text{MAX}}$ (dB)

- Frequency (GHz)
  - 0.0
  - 1.0
  - 2.0
  - 3.0
  - 4.0
  - 5.0
  - 6.0
  - 7.0
  - 8.0

- Gain

**S11 versus Frequency (5V, 90mA)**

**S22 versus Frequency (5V, 90mA)**
SPF5189Z

900MHz Evaluation Board Layout

Gnd  Vs

RF IN  RF OUT

RFMD 225134 REV. A

Bill of Materials (SPF5189Z, 900MHz)

<table>
<thead>
<tr>
<th>Component</th>
<th>Value</th>
<th>Manufacturer</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>ECJ-1VB1C104, Panasonic, 0.1uF</td>
<td></td>
</tr>
<tr>
<td>C2, C3, C4</td>
<td>ECJ-1VC1H101J, Panasonic, 100pF</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>LL1608-FSL1NS, Toko, 1.5nH</td>
<td></td>
</tr>
<tr>
<td>L2</td>
<td>LL1608-FSR15J, Toko, 150nH</td>
<td></td>
</tr>
</tbody>
</table>

900MHz Application Schematic

Note: Electrical lengths are determined from the center of shunt components and cuts on series transmission lines at 0.9GHz.

RF IN  100pF  1.5nH  100pF

1  SPF5189Z  4

Vs

100pF  150nH

RF OUT
1900MHz Evaluation Board Layout

Bill of Materials (SPF5189Z, 1900MHz)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>C1 ECJ-1VB1C104, Panasonic, 0.1uF</td>
<td></td>
</tr>
<tr>
<td>C2, C4</td>
<td>C2, C4 ECJ-1VC1H101J, Panasonic, 100pF</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>C3 ECJ-1VC1H100, Panasonic, 10pF</td>
<td></td>
</tr>
<tr>
<td>L1</td>
<td>L1 LL1608-FSL47N, Toko, 47nH</td>
<td></td>
</tr>
</tbody>
</table>

1900MHz Application Schematic

Note: Electrical lengths are determined from the center of shunt components and cuts on series transmission lines at 2GHz.
## Pin Names and Description

<table>
<thead>
<tr>
<th>Pin</th>
<th>Function</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>RF IN</td>
<td>RF input pin. This pin requires the use of an external DC-blocking capacitor chosen for the frequency of operation.</td>
</tr>
<tr>
<td>2</td>
<td>GND</td>
<td>Connection to ground. Use via holes as close to the device ground leads as possible to reduce ground inductance and achieve optimum RF performance.</td>
</tr>
<tr>
<td>3</td>
<td>RF OUT/DC BIAS</td>
<td>RF output and bias pin. This pin requires the use of an external DC-blocking capacitor chosen for the frequency of operation.</td>
</tr>
<tr>
<td>4</td>
<td>GND</td>
<td>Connection to ground. Use via holes as close to the device ground leads as possible to reduce ground inductance and achieve optimum RF performance.</td>
</tr>
</tbody>
</table>

### Part Identification

![Part Identification Diagram](image)

### Suggested Pad Layout

![Suggested Pad Layout Diagram](image)

### Package Drawing

Dimensions in inches (millimeters)

Refer to drawing posted at www.rfmd.com for tolerances.

![Package Drawing Diagram](image)
### Ordering Information

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SPF5189Z</td>
<td>7&quot; Reel with 1000 pieces</td>
</tr>
<tr>
<td>SPF5189ZSQ</td>
<td>Sample Bag with 25 pieces</td>
</tr>
<tr>
<td>SPF5189ZSR</td>
<td>7&quot; Reel with 100 pieces</td>
</tr>
<tr>
<td>SPF5189ZPCK1</td>
<td>800MHz to 1000MHz PCBA with 5-piece Sample Bag</td>
</tr>
<tr>
<td>SPF5189ZPCK2</td>
<td>1700MHz to 2200MHz PCBA with 5-piece Sample Bag</td>
</tr>
</tbody>
</table>