**Product Description**

The SPF-5189Z 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 SPF-5189Z 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 IDQ = 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

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<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
<th>Unit</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small Signal Gain</td>
<td>18.7</td>
<td>dB</td>
<td>0.9GHz</td>
</tr>
<tr>
<td></td>
<td>11.3 - 14.3</td>
<td>dB</td>
<td>1.96GHz</td>
</tr>
<tr>
<td>Output Power at 1dB Compression</td>
<td>22.4</td>
<td>dBm</td>
<td>0.9GHz</td>
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<tr>
<td></td>
<td>20.7 - 22.7</td>
<td>dBm</td>
<td>1.96GHz</td>
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<tr>
<td>Output Third Order Intercept Point</td>
<td>38.5</td>
<td>dBm</td>
<td>0.9GHz</td>
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<tr>
<td></td>
<td>36.0 - 39.5</td>
<td>dBm</td>
<td>1.96GHz</td>
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<tr>
<td>Noise Figure</td>
<td>0.55</td>
<td>dB</td>
<td>0.9GHz</td>
</tr>
<tr>
<td></td>
<td>0.8 - 1.1</td>
<td>dB</td>
<td>1.96GHz</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>17.5</td>
<td>dB</td>
<td>0.9GHz</td>
</tr>
<tr>
<td></td>
<td>14.5 - 16.0</td>
<td>dB</td>
<td>1.96GHz</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>15.0</td>
<td>dB</td>
<td>0.9GHz</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>24.0</td>
<td>dB</td>
<td>1.96GHz</td>
</tr>
<tr>
<td>Device Operating Voltage</td>
<td>5</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>Device Operating Current</td>
<td>90</td>
<td>mA</td>
<td>Quiescent</td>
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<tr>
<td>Thermal Resistance</td>
<td>65</td>
<td>°C/W</td>
<td>Junction to lead</td>
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</table>

Test Conditions: VDD = 5V, IDQ = 90mA, TL = 25°C, OIP3 Tone Spacing = 1MHz, POUT per tone = 0dBm, ZO = ZL = 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>
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<tr>
<td>Max Device Voltage (V_D)</td>
<td>5.5</td>
<td>V</td>
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<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:

\[ I_D V_D < \frac{(T_J - T_L)}{R_{TH,J}} \text{ and } T_L = T_{LEAD} \]

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>19.8</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>
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<tr>
<td>Noise Figure</td>
<td>dB</td>
<td>0.52</td>
<td>0.35</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>
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<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>22.8</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
<td>22.7</td>
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<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>
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<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>
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<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>17.5</td>
<td>17.0</td>
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</tbody>
</table>

Test Conditions: V_D = 5V, I_D = 90mA, OIP3 Tone Spacing = 1 MHz, P_OUT_per tone = 0 dBm, T_L = 25 °C, Z_S = Z_L = 50Ω
Typical RF Performance - 900MHz Application Circuit with $V_D = 5\text{V}$, $I_D = 90\text{mA}$

**Noise Figure versus Frequency**

- NF (dB) vs Frequency (GHz)
  - $+25°C$
  - $+85°C$

**OIP3 versus Frequency (0dBm tones)**

- OIP3 (dBm) vs Frequency (GHz)
  - $+25°C$
  - $40°C$
  - $+85°C$

**OIP3 versus Power (850MHz, 1MHz spacing)**

- OIP3 (dBm) vs Power Out Per Tone (dBm)
  - $+25°C$
  - $-40°C$
  - $+85°C$

**P1dB versus Frequency**

- P1dB (dBm) vs Frequency (GHz)
  - $+25°C$
  - $-40°C$
  - $+85°C$

**Pout versus Pin at 850MHz**

- Power out (dBm) vs Power in (dBm)
  - $P_{out_{-25C}}$
  - $P_{out_{-40C}}$
  - $P_{out_{85C}}$

**Device Current versus Voltage**

- $i_b$ (mA) vs $V_D$ (V)
  - $25°C$
  - $40°C$
  - $+85°C$
Typical RF Performance - 900MHz Application Circuit with $V_D=5\text{V}$, $I_D=90\text{mA}$

**S11 versus Frequency**

**S12 versus Frequency**

**S21 versus Frequency**

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

- **Noise Figure versus Frequency**
  - Frequency (GHz) range: 1.70 to 2.20
  - NF (dB) range: 0.0 to 2.0
  - Temperature conditions: $+25^\circ\text{C}$, $+85^\circ\text{C}$

- **OIP3 versus Power (1900 MHz, 1 MHz spacing)**
  - Power Out Per Tone (dBm) range: 26 to 24
  - OIP3 (dBm) range: 26 to 46
  - Temperature conditions: $+25^\circ\text{C}$, $-40^\circ\text{C}$, $+85^\circ\text{C}$

- **OIP3 versus Frequency (0 dBm tones)**
  - Frequency (GHz) range: 1.70 to 2.20
  - OIP3 (dBm) range: 26 to 46
  - Temperature conditions: $+25^\circ\text{C}$, $40^\circ\text{C}$, $+85^\circ\text{C}$

- **P1dB versus Frequency**
  - Frequency (GHz) range: 1.70 to 2.20
  - P1dB (dBm) range: 16 to 26
  - Temperature conditions: $+25^\circ\text{C}$, $-40^\circ\text{C}$, $+85^\circ\text{C}$

- **Pout versus Pin at 1900 MHz**
  - Power in (dBm) range: 13 to 15
  - Power out (dBm) range: 60 to 110
  - Bias (mA) range: 60 to 110
  - Temperature conditions: $P_{out_{25^\circ\text{C}}}$, $P_{out_{-40^\circ\text{C}}}$, $P_{out_{85^\circ\text{C}}}$, $Bias_{25^\circ\text{C}}$, $Bias_{-40^\circ\text{C}}$, $Bias_{85^\circ\text{C}}$
Typical RF Performance - 1900MHz Application Circuit with \( V_D = 3\, \text{V} \), \( I_D = 90\, \text{mA} \)

- **S11 versus Frequency**
  - Frequency (GHz): 1.7, 1.8, 1.9, 2.0, 2.1, 2.2
  - S11 (dB):
    - -40°C
    - 25°C
    - 85°C

- **S21 versus Frequency**
  - Frequency (GHz): 1.7, 1.8, 1.9, 2.0, 2.1, 2.2
  - Gain (dB):
    - -40°C
    - 25°C
    - 85°C

- **S12 versus Frequency**
  - Frequency (GHz): 1.7, 1.8, 1.9, 2.0, 2.1, 2.2
  - S12 (dB):
    - -40°C
    - 25°C
    - 85°C

- **S22 versus Frequency**
  - Frequency (GHz): 1.7, 1.8, 1.9, 2.0, 2.1, 2.2
  - S22 (dB):
    - -40°C
    - 25°C
    - 85°C
SPF-5189Z

De-embedded Device S-parameters (Bias Tee Data)

G_{Max} versus Frequency
(5V, 90mA)

S11 versus Frequency (5V, 90mA)

S22 versus Frequency (5V, 90mA)
SPF-5189Z

900MHz Evaluation Board Layout

Bill of Materials (SPF-5189Z, 900MHz)

- C1: ECJ-1VB1C104, Panasonic, 0.1uF
- C2, C3, C4: ECJ-1VC1H101J, Panasonic, 100pF
- L1: LL1608-FSL1N5, Toko, 1.5nH
- L2: LL1608-FSR15J, Toko, 150nH
- PCB: 125763-B

900MHz Application Schematic

Note: Electrical lengths are determined from the center of shunt components and cuts on series transmission lines at 0.9GHz.
1900MHz Evaluation Board Layout

Bill of Materials (SPF-5189Z, 1900MHz)

C1  ECJ-1VB1C104, Panasonic, 0.1uF
C2, C4  ECJ-1VC1H101J, Panasonic, 100pF
C3  ECJ-1VC1H100, Panasonic, 10pF
L1  LL1608-FSL47N, Toko, 47nH
PCB  125763-B

1900MHz Application Schematic

Note: Electrical lengths are determined from the center of shunt components and cuts on series transmission lines at 2GHz.
**SPF-5189Z**

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

**Part Identification**

![Tracer Code](image)

**Suggested Pad Layout**

![Pad Layout](image)

**Package Drawing**

Dimensions in inches (millimeters)

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

![Package Drawing](image)

**Ordering Information**

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
<th>Reel Size</th>
<th>Devices/Reel</th>
</tr>
</thead>
<tbody>
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<td>SPF-5189Z</td>
<td>Lead Free, RoHS Compliant</td>
<td>7</td>
<td>1000</td>
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<tr>
<td>SPF-5189Z-EVB1</td>
<td>800MHz to 1000MHz Evaluation Board</td>
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<td>N/A</td>
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<tr>
<td>SPF-5189Z-EVB2</td>
<td>1700MHz to 2200MHz Evaluation Board</td>
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