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# SPF5189Z

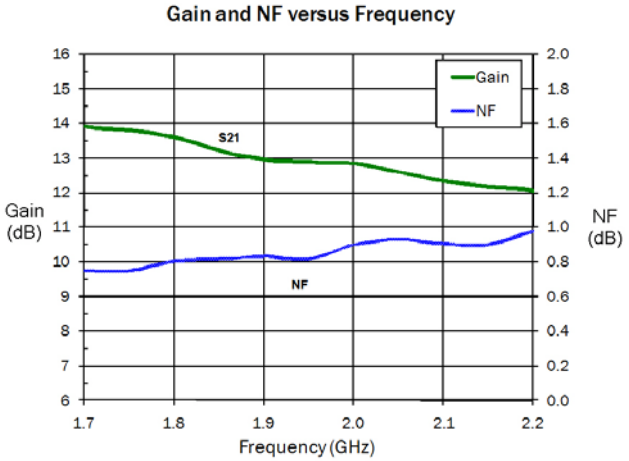
## 50MHz to 4000MHz, GaAs pHEMT LOW NOISE MMIC AMPLIFIER

## 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.

**Optimum Technology Matching® Applied**

- ☐ GaAs HBT
- ☐ GaAs MESFET
- ☐ InGaP HBT
- ☐ SiGe BiCMOS
- ☐ Si BiCMOS
- ☐ SiGe HBT
- ✓ GaAs pHEMT
- ☐ Si CMOS
- ☐ Si BJT
- ☐ GaN HEMT
- ☐ InP HBT
- ☐ RF MEMS
- ☐ LDMOS




## Features

- Ultra-Low Noise Figure=0.60dB at 900MHz
- Gain=18.7dB at 900MHz
- High Linearity: $OIP_3$=39.5dBm at 1960MHz
- $P_{1dB}$=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 |
|---|---|---|---|---|---|
| | Min. | Typ. | Max. | | |
| Small Signal Gain | | 18.7 | | dB | 0.9GHz |
| | 11.3 | 12.8 | 14.3 | dB | 1.96GHz |
| Output Power at 1dB Compression | | 22.4 | | dBm | 0.9GHz |
| | 20.7 | 22.7 | | dBm | 1.96GHz |
| Output Third Order Intercept Point | | 38.5 | | dBm | 0.9GHz |
| | 36.0 | 39.5 | | dBm | 1.96GHz |
| Noise Figure | | 0.55 | | dB | 0.9GHz |
| | | 0.8 | 1.1 | dB | 1.96GHz |
| Input Return Loss | | 17.5 | | dB | 0.9 GHz |
| | 14.5 | 18.5 | | dB | 1.96GHz |
| Output Return Loss | | 16.0 | | dB | 0.9GHz |
| | 11.0 | 15.0 | | dB | 1.96GHz |
| Reverse Isolation | | 24.0 | | dB | 0.9GHz |
| | | 18.0 | | dB | 1.96GHz |
| Device Operating Voltage | | 5 | 5.25 | V | |
| Device Operating Current | 75 | 90 | 105 | mA | Quiescent |
| Thermal Resistance | | 65 | | °C/W | Junction to lead |

Test Conditions: $V_D$=5V, $I_{DQ}$=90mA, TL=25°C, $OIP_3$ Tone Spacing=1MHz, $P_{OUT}$ per tone=0dBm
$Z_S$=$Z_L$=50Ω, 25°C, Application Circuit Data





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## Absolute Maximum Ratings

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

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:
$I_D V_D < (T_J - T_L)/R_{TH}$, j-l and $T_L = T_{LEAD}$

**Caution!** ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.



RFMD Green: RoHS compliant per EU Directive 2002/95/EC, halogen free per IEC 61249-2-21, < 1000 ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

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

| Parameter | Unit | 0.8 GHz | 0.9 GHz | 1.0 GHz | 1.7 GHz | 1.8 GHz | 1.9 GHz | 2.0 GHz | 2.1 GHz | 2.2 GHz |
|---|---|---|---|---|---|---|---|---|---|---|
| Small Signal Gain | dB | 19.6 | 18.7 | 17.9 | 13.8 | 13.5 | 12.9 | 12.7 | 12.2 | 11.9 |
| Noise Figure | dB | 0.52 | 0.55 | 0.79 | 0.75 | 0.81 | 0.83 | 0.90 | 0.91 | 0.98 |
| Output IP3 | dBm | 38.4 | 38.5 | 39.0 | 39.2 | 39.5 | 39.5 | 39.8 | 39.8 | 39.9 |
| Output P1dB | dBm | 22.3 | 22.4 | 22.5 | 22.6 | 22.6 | 22.7 | 22.7 | 22.7 | 22.7 |
| Input Return Loss | dB | 17.1 | 17.5 | 17.5 | 17.5 | 17.5 | 18.5 | 18.5 | 18.5 | 18.0 |
| Output Return Loss | dB | 16.0 | 16.0 | 15.5 | 14.0 | 14.0 | 14.5 | 15.0 | 15.5 | 16.0 |
| Reverse Isolation | dB | 24.5 | 24.0 | 23.0 | 18.5 | 18.5 | 18.0 | 18.0 | 17.5 | 17.0 |

Test Conditions: $V_D = 5V$, $I_{DQ} = 90mA$, $OIP_3$ Tone Spacing = 1MHz, $P_{OUT}$ per tone = 0dBm, $T_L = 25°C$, $Z_S = Z_L = 50\Omega$


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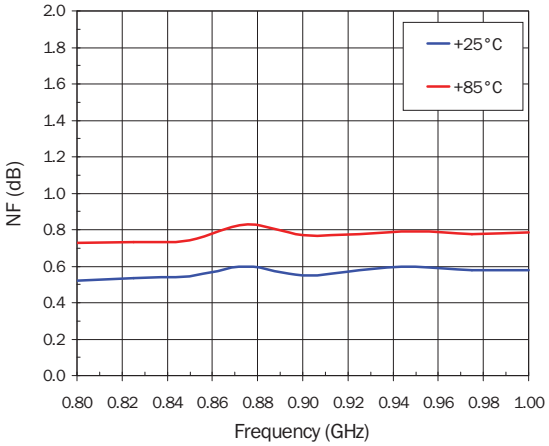
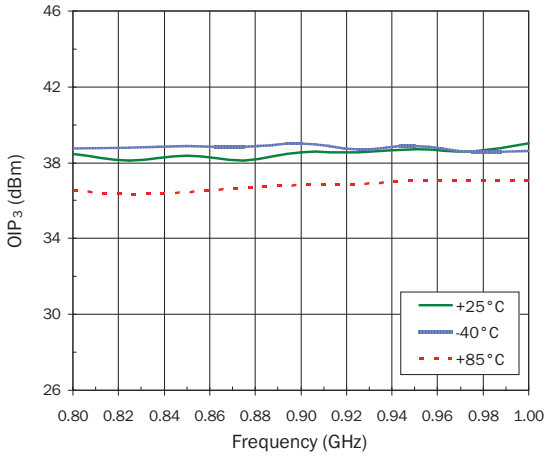
## Typical RF Performance - 900MHz Application Circuit with $V_D$=5V, $I_D$=90mA

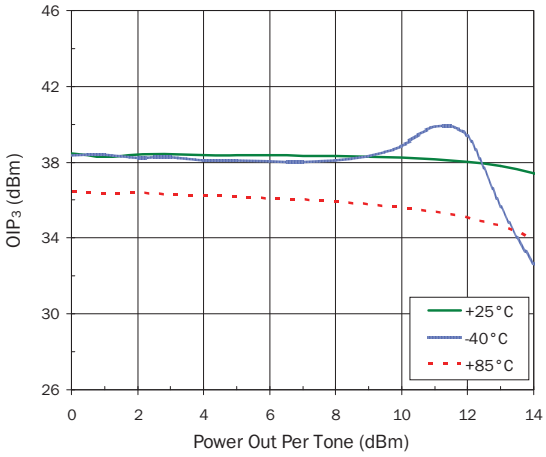
Noise Figure versus Frequency



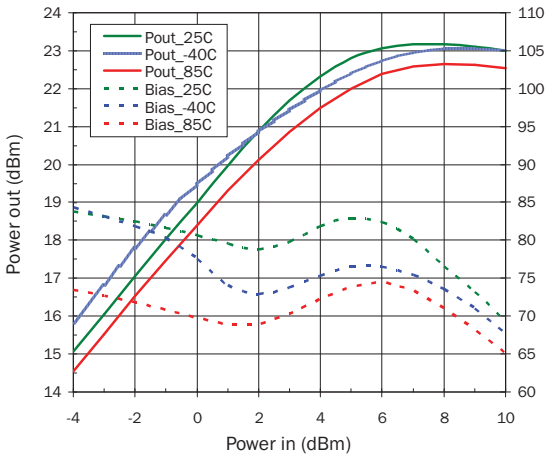

$OIP_3$ versus Frequency (0dBm tones)



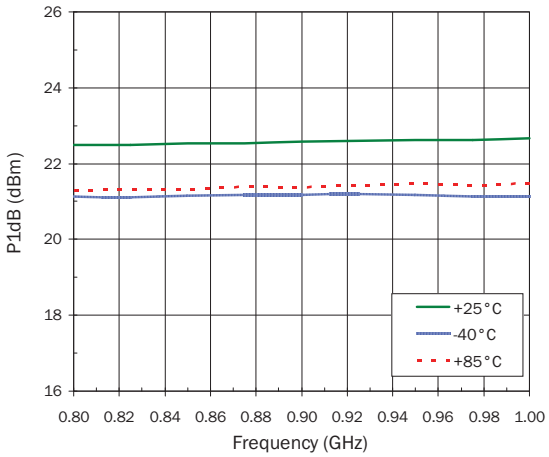

$OIP_3$ versus Power (850MHz, 1MHz spacing)



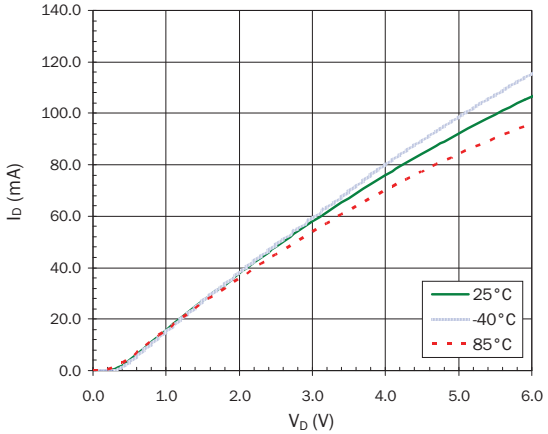

$P_{OUT}$ versus Pin at 850MHz




P1dB versus Frequency

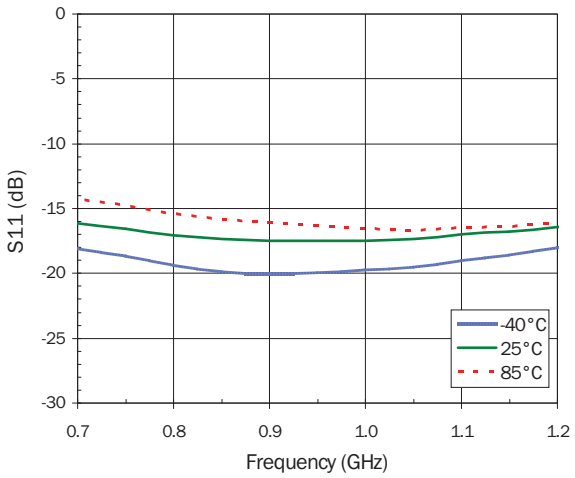



Device Current versus Voltage

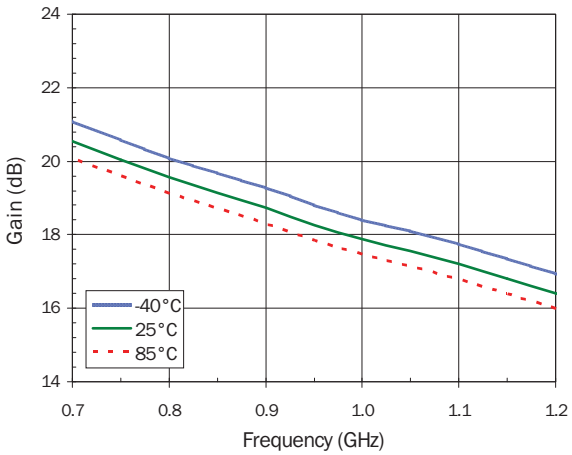


## Typical RF Performance - 900MHz Application Circuit with $V_D$=5V, $I_D$=90mA

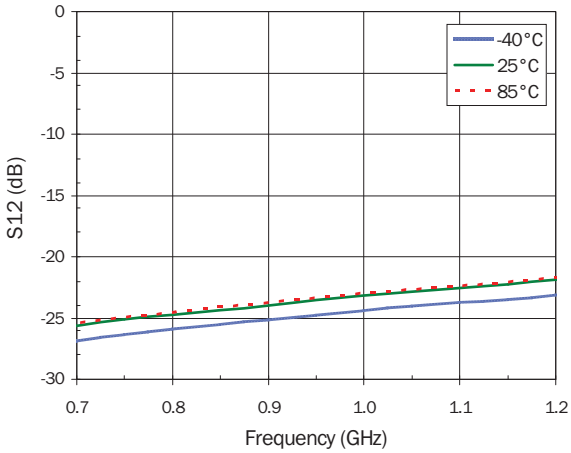
S11 versus Frequency



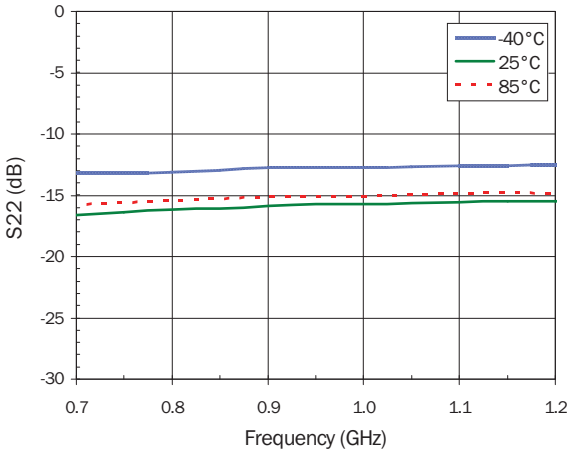

S21 versus Frequency




S12 versus Frequency




S22 versus Frequency



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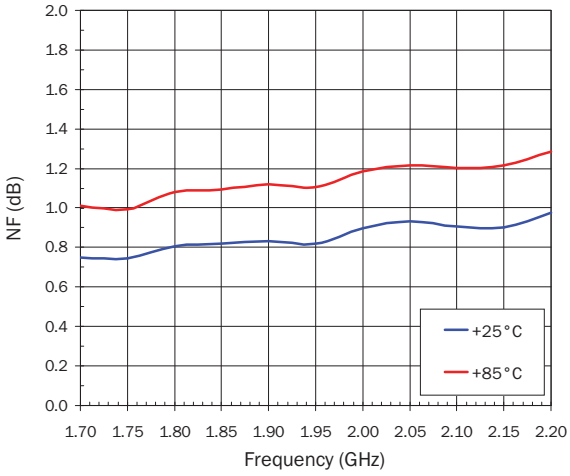
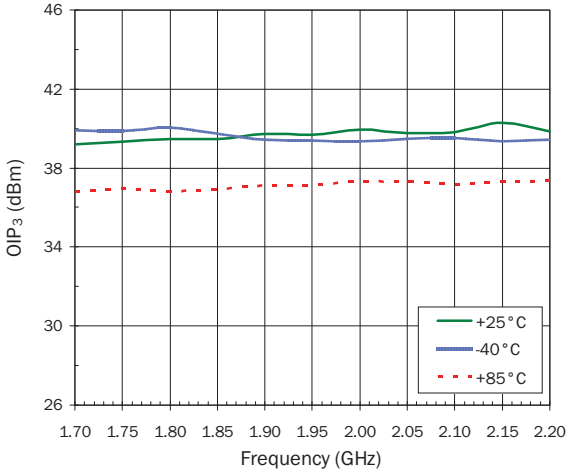
## Typical RF Performance - 1900MHz Application Circuit with $V_D$=5V, $I_D$=90mA

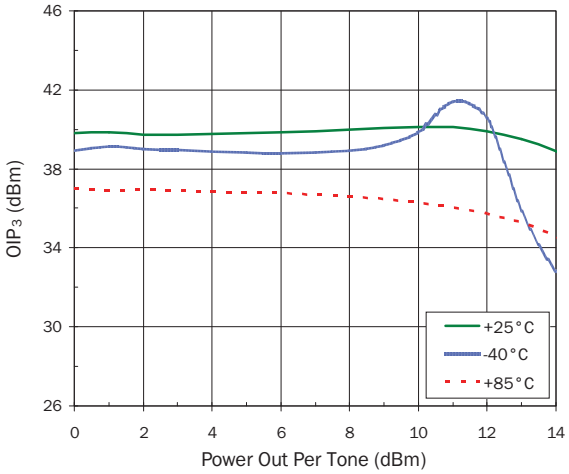
Noise Figure versus Frequency



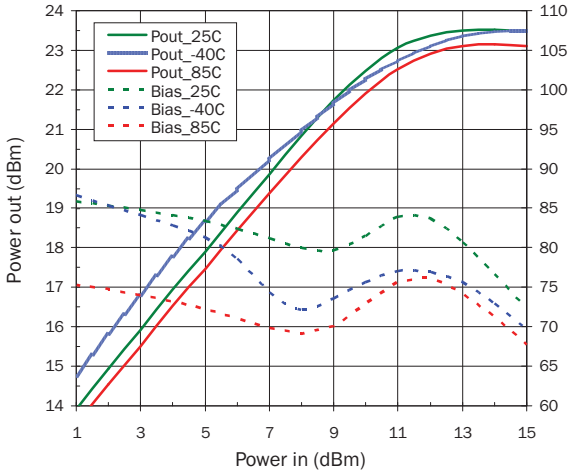

$OIP_3$ versus Frequency (0dBm tones)



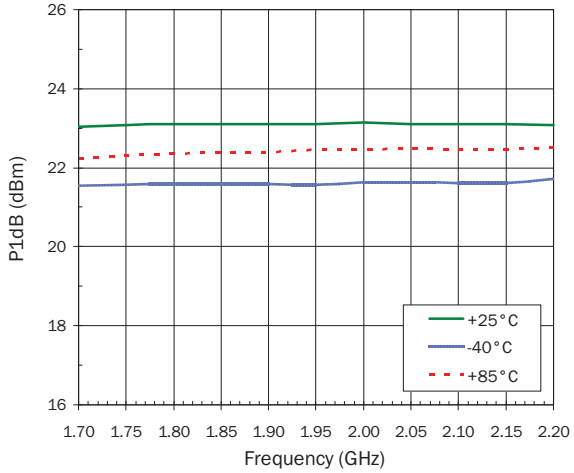

$OIP_3$ versus Power (1900MHz, 1MHz spacing)




$P_{OUT}$ versus Pin at 1900MHz

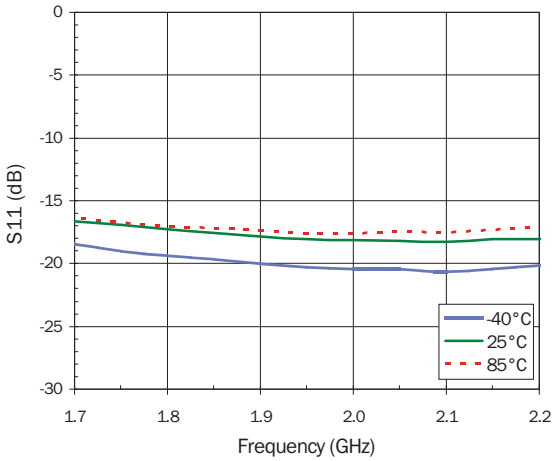



P1dB versus Frequency

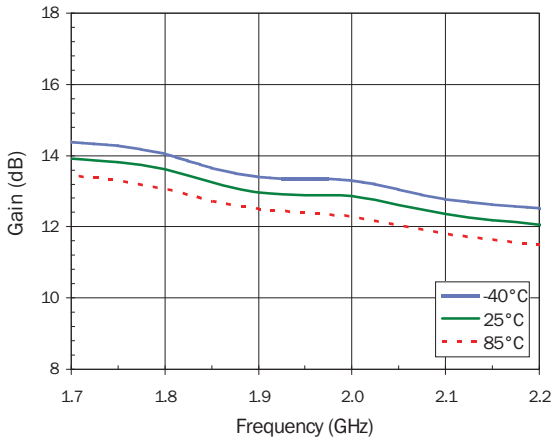


## Typical RF Performance - 1900MHz Application Circuit with $V_D$=3V, $I_D$=90mA

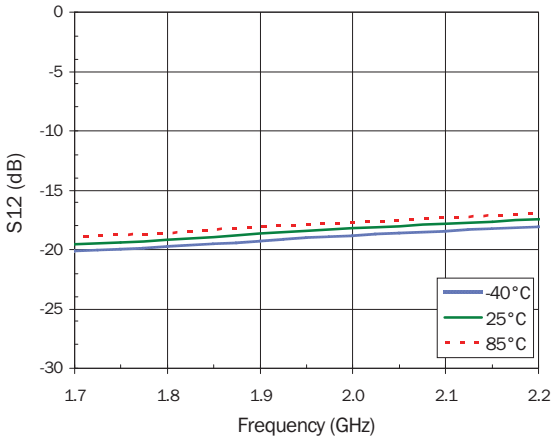
S11 versus Frequency



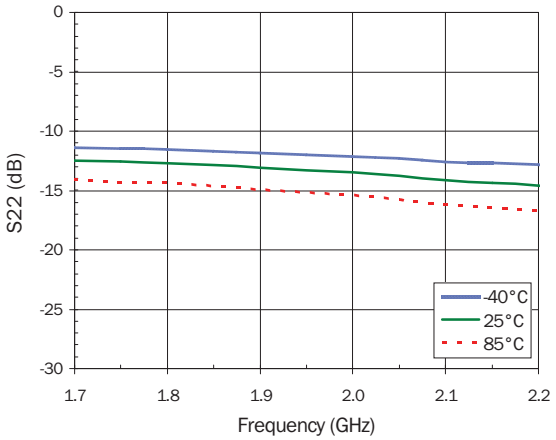

S21 versus Frequency




S12 versus Frequency




S22 versus Frequency



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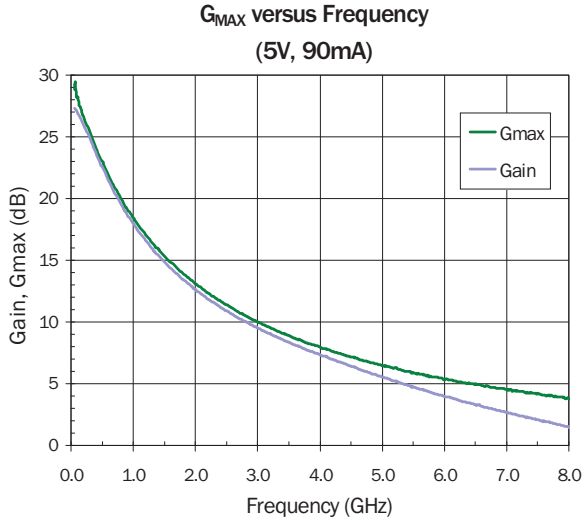
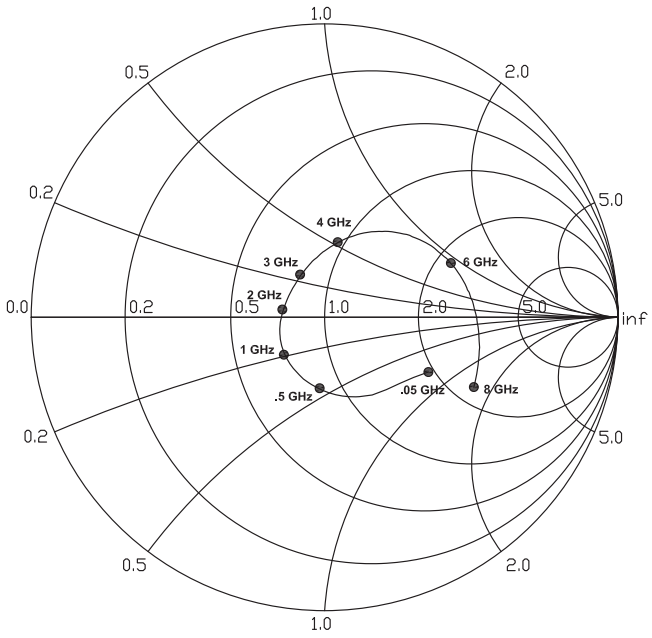
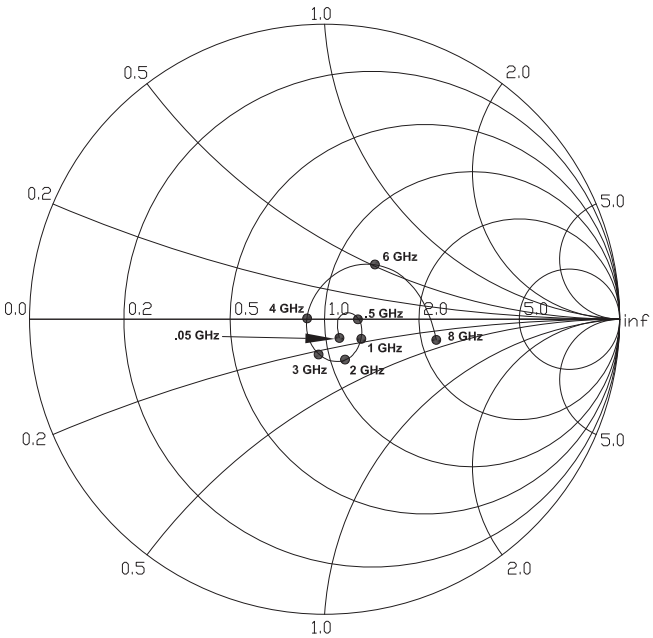
## De-embedded Device S-parameters (Bias Tee Data)




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




### S22 versus Frequency (5V, 90mA)





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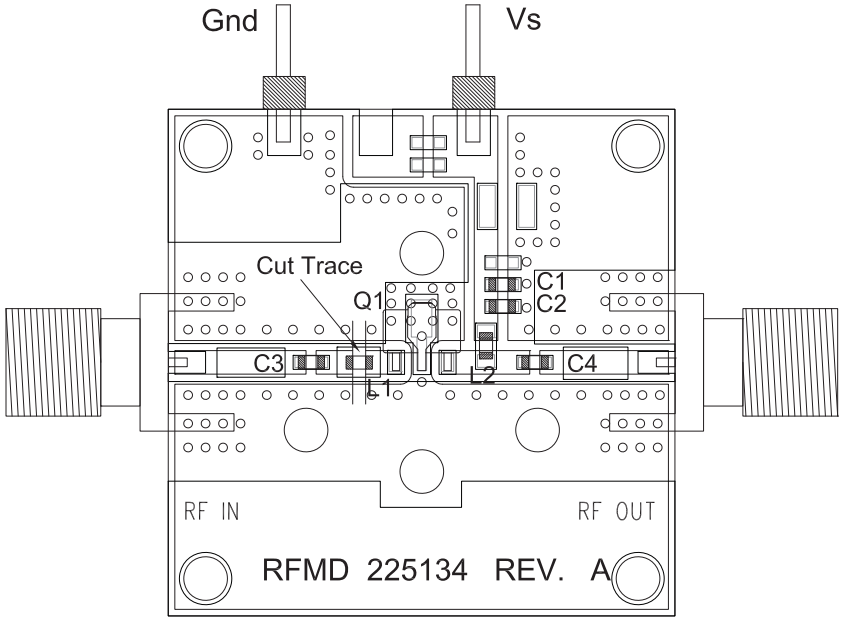
## 900MHz Evaluation Board Layout

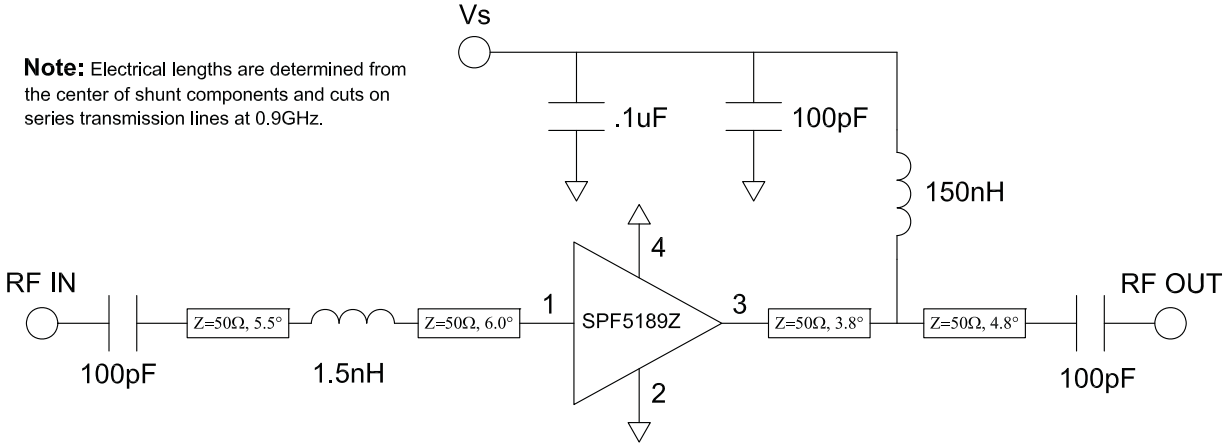



### Bill of Materials (SPF5189Z, 900MHz)

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

## 900MHz Application Schematic

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





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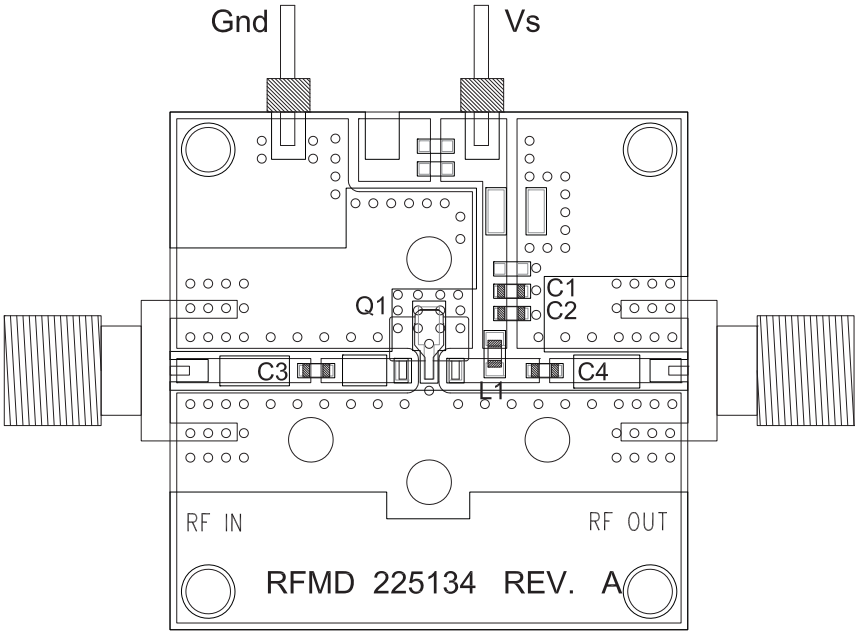
## 1900MHz Evaluation Board Layout

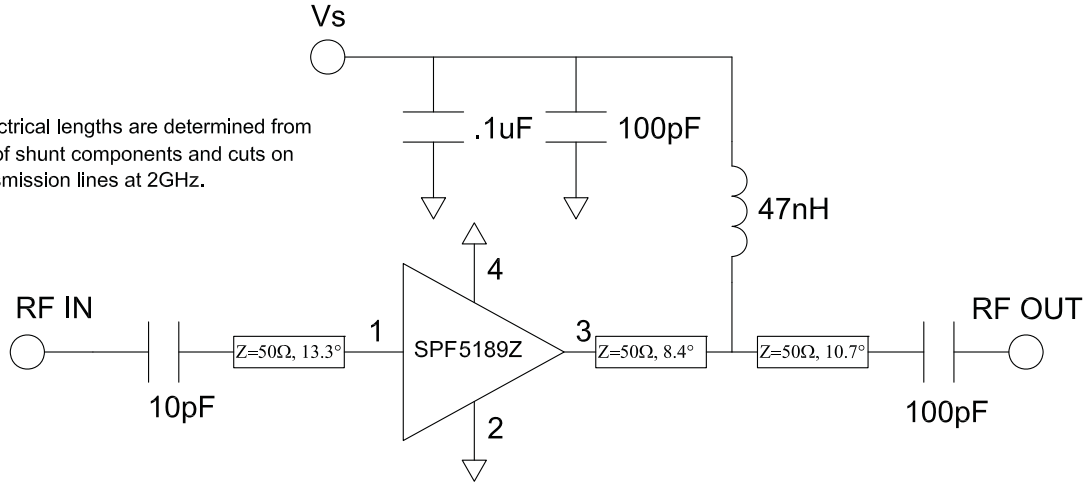



### Bill of Materials (SPF5189Z, 1900MHz)

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

## 1900MHz Application Schematic

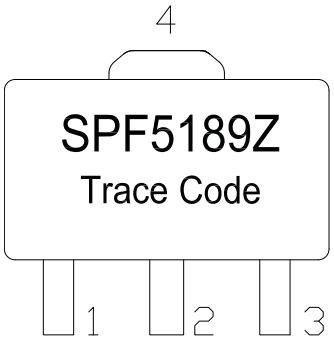
**Note:** Electrical lengths are determined from the center of shunt components and cuts on series transmission lines at 2GHz.



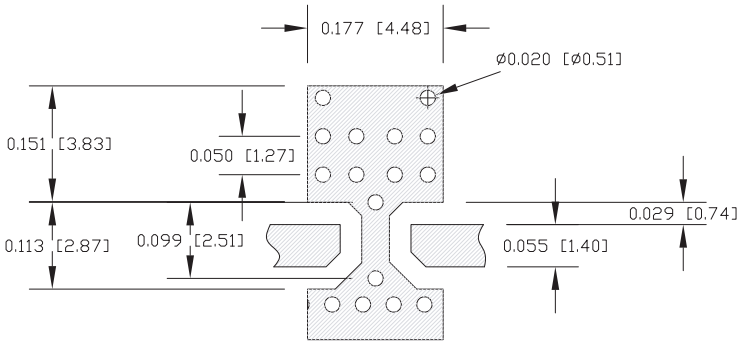
## Pin Names and Description

| 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 | 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. |
| 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. |

### Part Identification

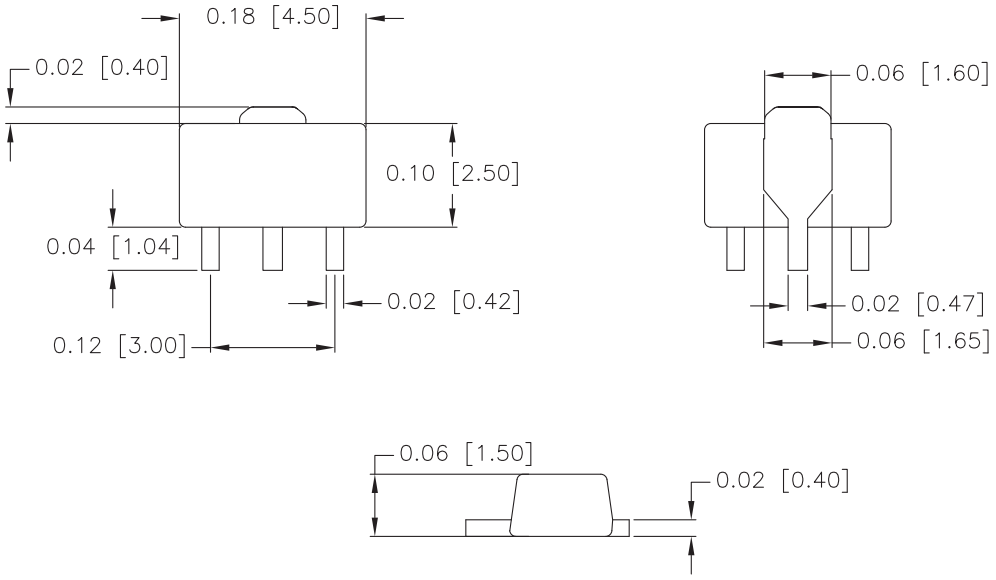



### Suggested Pad Layout




## Package Drawing

Dimensions in inches (millimeters)
Refer to drawing posted at www.rfmd.com for tolerances.





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## Ordering Information

| Part Number | Description |
|---|---|
| SPF5189Z | 7" Reel with 1000 pieces |
| SPF5189ZSQ | Sample Bag with 25 pieces |
| SPF5189ZSR | 7" Reel with 100 pieces |
| SPF5189ZPCK1 | 800MHz to 1000MHz PCBA with 5-piece Sample Bag |
| SPF5189ZPCK2 | 1700MHz to 2200MHz PCBA with 5-piece Sample Bag |


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