



Preliminary

RF2472

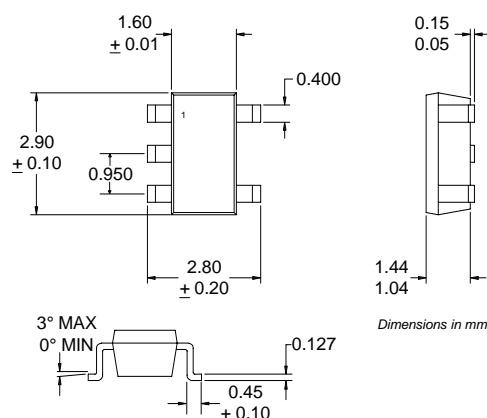
2.4GHZ LOW NOISE AMPLIFIER WITH ENABLE

Typical Applications

- TDMA/CDMA PCS LNA
- TDMA/CDMA/FM Cellular LNA
- ISM Band LNA/Driver
- Low Noise Transmit Driver Amplifier
- General Purpose Amplification
- Commercial and Consumer Systems

Product Description

The RF2472 is a general purpose, low-cost, high-performance amplifier designed for operation from a 2.7V to 4V supply with low current consumption. The device is optimized for 2.4GHz LNA applications, but is also useful for 1.9GHz PCS and K-PCS, 900MHz ISM, and 1.5GHz GPS applications. The RF2472 is available in a very small industry-standard SOT23 5-lead surface mount package, enabling compact designs which conserve board space.

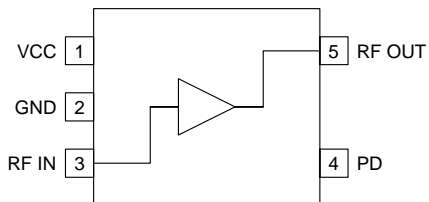


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GENERAL PURPOSE
AMPLIFIERS

Optimum Technology Matching® Applied

- | | | |
|-------------------------------------|--|--------------------------------------|
| <input type="checkbox"/> Si BJT | <input type="checkbox"/> GaAs HBT | <input type="checkbox"/> GaAs MESFET |
| <input type="checkbox"/> Si Bi-CMOS | <input checked="" type="checkbox"/> SiGe HBT | <input type="checkbox"/> Si CMOS |

Package Style: SOT 5 Lead



Functional Block Diagram

Features

- DC to >6GHz Operation
- 2.7V to 4.0V Single Supply
- High Input IP₃
- 1.5dB Noise Figure at 2400MHz
- 14dB Gain at 2400MHz
- Low Current Consumption of 6mA at 3V

Ordering Information

RF2472 2.4GHz Low Noise Amplifier with Enable
 RF2472 PCBA-410 Fully Assembled Evaluation Board, 2.4GHz
 RF2472 PCBA-411 Fully Assembled Evaluation Board, 1.9GHz

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.5 to 4.0	V
Input RF Level	0	dBm
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C



Caution! ESD sensitive device.

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall Frequency Range		DC to >6000		MHz	T=27°C, V _{CC} =3.0V
2.4 GHz LNA Operation Gain	13.0	14.6	17.0	dB	T=27°C, V _{CC} =3.0V, Freq=2440MHz Two tones at 1MHz spacing, -15dBm output
Noise Figure		1.5		dB	
Input IP3	+8.0	+10.0	+20.0	dBm	
Input P _{1dB}		-10		dBm	
PCS and K-PCS LNA Operation Gain		16.3		dB	T=27°C, V _{CC} =3.0V, Freq=1960MHz Two tones at 1MHz spacing, -12dBm output
Noise Figure		1.4		dB	
Input IP3		+8		dBm	
Input P _{1dB}		-12		dBm	
Power Supply Operating Voltage		2.7 to 3.6		V	V _{CC} =3.0V, PD=3.0V V _{CC} =3.0V, PD=0V
Operating Current	4.0	6.0	8.0	mA	
		<1.0	3.0	µA	

Pin	Function	Description	Interface Schematic
1	VCC	Supply connection. An external bypass capacitor may be required in some applications.	See pin 3.
2	GND	Ground connection. Keep traces physically short and connect immediately to ground plane for best performance.	
3	RF IN	RF input pin. This pin is DC coupled and matched to 50Ω at 2.4GHz.	
4	PD	Power down pin. This pin enables the bias to the amplifier. To turn the amplifier on, this pin should be connected to V _{CC} . Connecting this pin to ground, will turn the amplifier off and reduce the current draw to below 1 μA. This pin is a CMOS input. There is no DC current draw other than the transient current required to charge or discharge the gate capacitance (less than 5pF).	
5	RF OUT	LNA Output pin. This pin is an open-collector output. It must be biased to V _{CC} through a choke or matching inductor. This pin is typically matched to 50Ω with a shunt bias/matching inductor and series blocking/matching capacitor. Refer to application schematics.	See pin 3.

Theory of Operation

The RF2472 is a low-noise amplifier with internal bias circuitry. It is DC-coupled on the input and output; therefore, it can be used to arbitrarily low frequency. It has useful gain to above 6GHz. Its design is optimized for use at 2.4GHz. Because of the high-frequency gain, the designer must take care to ensure that the device will remain stable outside the desired operating frequency. The RF2472 is capable of providing outstanding linearity, but to achieve this high performance, the circuit designer must pay attention to the terminations that are presented to low-frequency intermodulation products.

Stability

The RF2472 must be stabilized for frequencies outside of the desired operating range. Ground connections should be kept as short as possible. Wherever practical, ground should be provided by a via hole directly to a continuous ground layer. Highly reflective terminations to the RF input and output pins should be avoided whenever possible. In most circumstances, a resistor in parallel with an inductor in the bias line on pin 5 will improve the stability of the circuit. See the application schematics for examples. The 10nH inductor in the bias line is part of an output impedance matching circuit. At higher frequencies, the impedance of the matching circuit, alone, would become highly inductive. The large reactive termination of the output port could cause the circuit to oscillate at a high frequency. The resistance in parallel with the inductor adds a real part to the high-frequency termination that will have a stabilizing effect on the circuit.

Linearity

The 22nF bypass and coupling capacitors in the application schematics may seem excessively large for circuits intended to operate at 1.9GHz and 2.4GHz. These large capacitors provide a low impedance path to ground for second-order mixing products that leads to improved third-order intermodulation performance. The effect is most easily seen for the input coupling capacitor. A 100pF capacitor would provide low enough impedance to couple a 2.4GHz signal into the input pin of the RF2472. However, low-frequency intermodulation products caused by second-order nonlinearities would be presented with a large reactive impedance at the input pin. Relatively large voltages for these low-frequency products would be allowed to mix with the fundamental signals at the input pin, resulting in relatively large, in-band, third-order products.

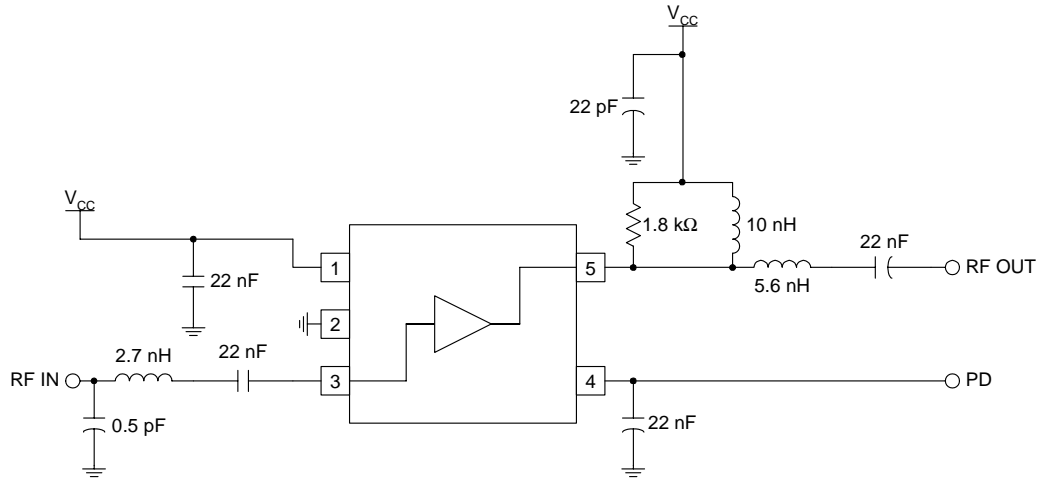
With a large coupling capacitor, the low-frequency products would be presented with a low impedance, via the input source impedance, resulting in a lower voltage at the input pin. These products, in turn, would mix at a lower level with the fundamental signals to produce lower in-band, third-order products.

Some designers may be concerned about the self-resonant frequency of large coupling capacitors. A 22nF capacitor will probably pass through self resonance below 100MHz. Beyond resonance, the reactance of the capacitor will turn inductive, but the internal losses of the capacitor will usually prevent the component from exhibiting a large reactive impedance.

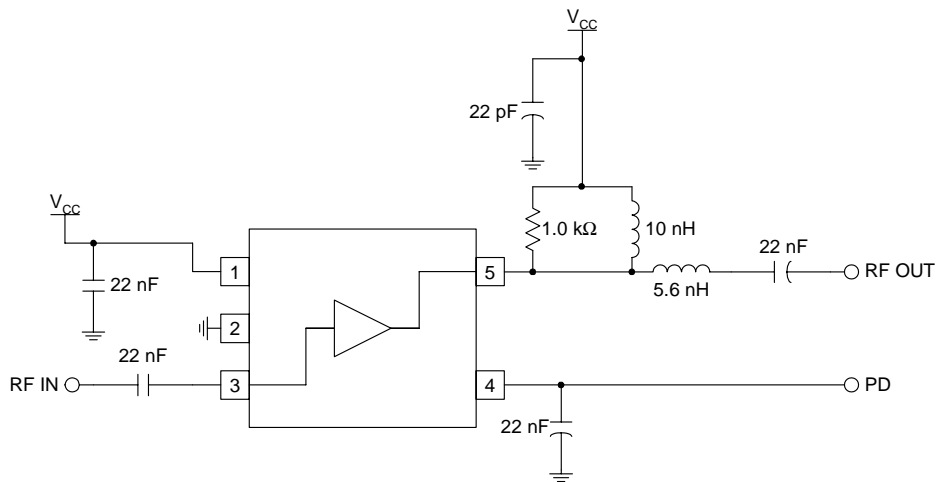
Third-Order Intercept versus 1-dB Compression Point

For many devices, the third-order intercept point is approximately 10dB higher than the 1-dB compression point. This rule of thumb does not apply for the RF2472. It is normal to find that the third-order intercept point is 20 dB higher than the 1-dB compression point. This behavior is common for SiGe devices. The reason for the difference is that the 10dB rule is based on a simple third-order polynomial model for device nonlinearities. For SiGe devices this simple model is not a good fit.

Application Schematic - 1.9GHz

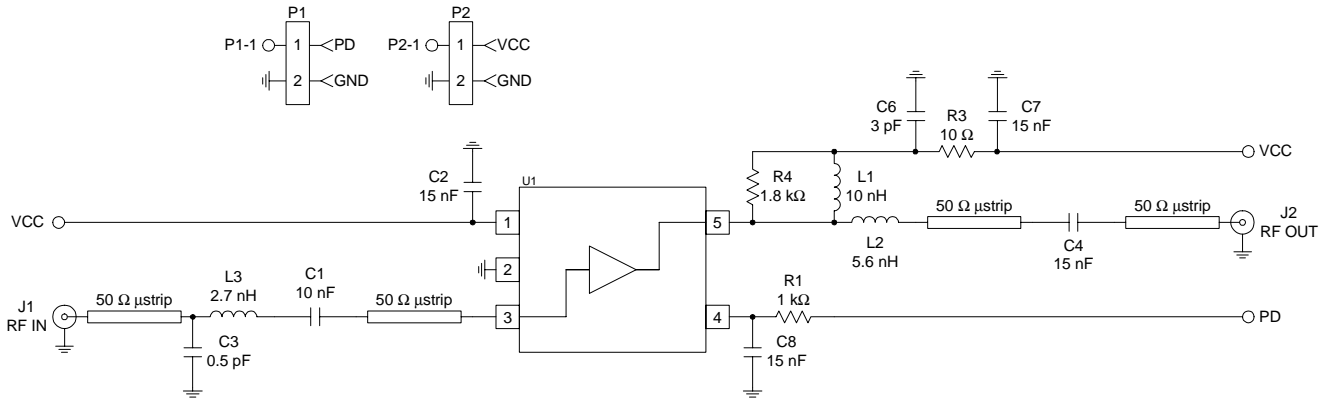


Application Schematic - 2.4GHz

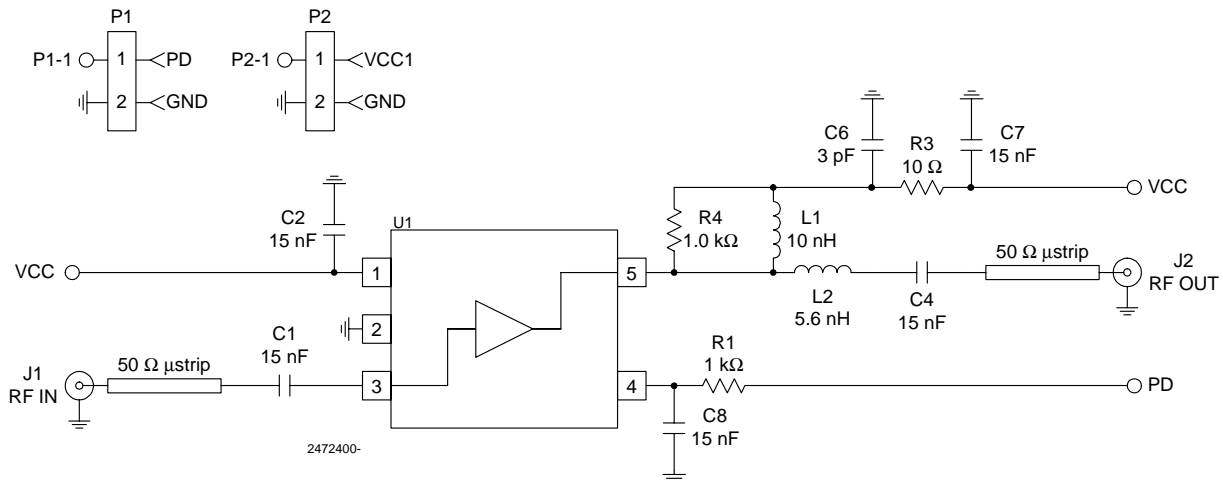


Evaluation Board Schematic - 1.9GHz

(Download [Bill of Materials](http://www.rfmd.com) from www.rfmd.com.)



Evaluation Board Schematic - 2.4GHz

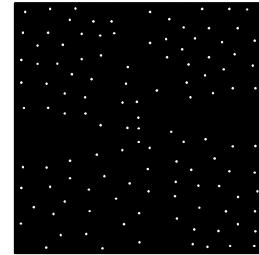
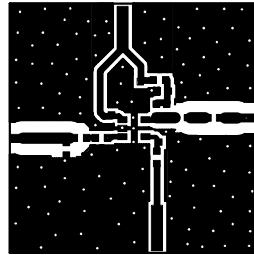
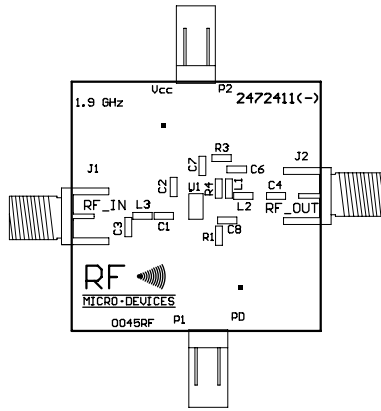


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Evaluation Board Layout - 1.9GHz

Board Size 1.0" x 1.0"

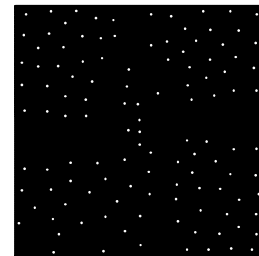
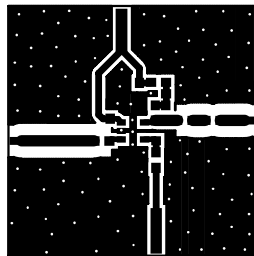
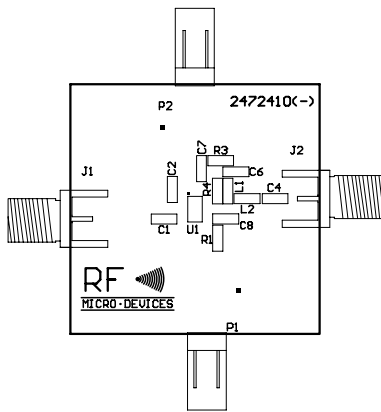
Board Thickness 0.031"; Board Material FR-4



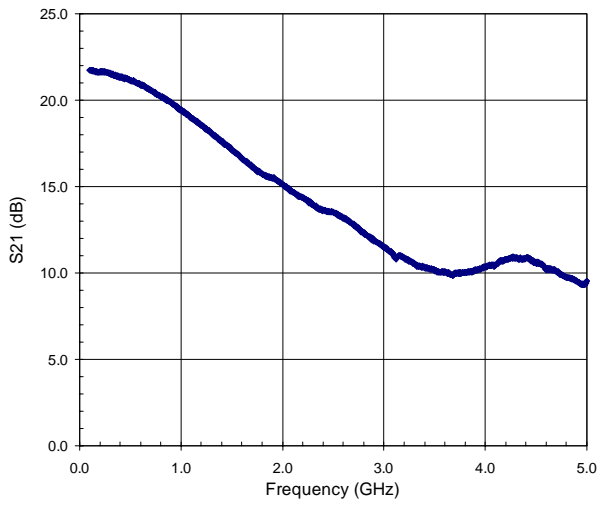
Evaluation Board Layout - 2.4GHz

Board Size 1.0" x 1.0"

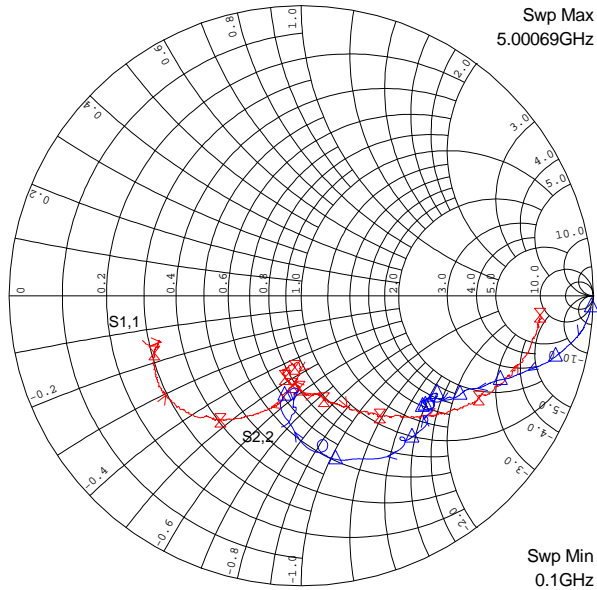
Board Thickness 0.031"; Board Material FR-4



Gain versus Frequency



Smith Chart



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