RF2501

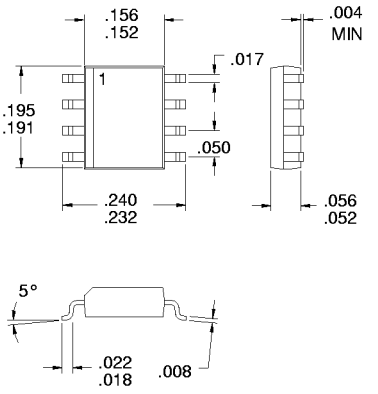
VCO/HIGH-ISOLATION BUFFER AMPLIFIER

Typical Applications

- 2-way Paging
- ISM Band Systems
- Wireless Local Loop Systems
- GPS Receivers
- Cellular Systems
- Wireless Modems

Product Description

The RF2501 is an integrated oscillator and buffer amplifier chain designed to achieve extremely low sensitivity to fluctuations in load impedance and power supply noise, thereby greatly reducing load pulling and pushing. The IC offers great flexibility, yet is easy to use. It has a power-down feature and is designed to operate from 700MHz to 1500MHz with the help of an external resonator. Frequency control is achieved with an external varactor diode. The IC's ease of use, reduced load pulling, small size, and low cost make it an ideal LO (Local Oscillator) for almost any wireless application



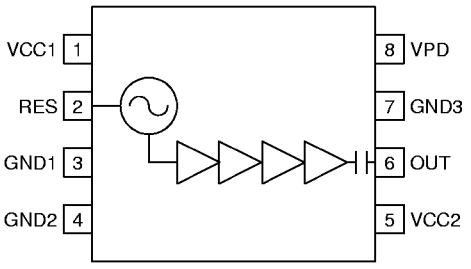
Package Style: SOP-8

Optimum Technology Matching® Applied

☑ Si BJT ☐ GaAs HBT ☐ GaAs MESFET
☐ Si Bi-CMOS

Features

- High-Isolation / Reduced Load Pulling
- Low Current Consumption
- -12dBm Output Power
- Digitally Controlled Power Down Mode
- 700MHz to 1500MHz Operating Range
- Single 5V Supply



Functional Block Diagram

Ordering Information

RF2501	VCO/High-Isolation Buffer Amplifier
RF2501 PCBA	Fully Assembled Evaluation Board

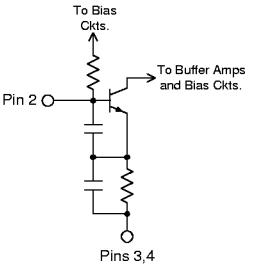
RF Micro Devices, Inc.
7625 Thorndike Road
Greensboro, NC 27409, USA
Tel (336) 664 1233
Fax (336) 664 0454
http://www.rfmd.com

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.5 to +5.8	V_{DC}
Power Down Voltage (V_{PD})	-0.5 to +5.8	V_{DC}
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C

Caution! ESD sensitive device.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Overall					
Operating Frequency		700 to 1500		MHz	
915MHz Operation					T=25 °C, V_{CC}=5.0V, Z_{LOAD}=50Ω, V_{PD}=5.0V, Chip Inductor Resonator
Output Power		-12		dBm	
2nd Harmonic		-15		dBc	
3rd Harmonic		-12		dBc	
Load Pulling		76		kHz	Into 1.67VSWR Load
V_{CC} Pushing		1.7		MHz/V	
Phase Noise		-102		dBc	100kHz Offset
		-89		dBc	25kHz Offset
		-81		dBc	10kHz Offset
1500MHz Operation					T=25 °C, V_{CC}=5.0V, Z_{LOAD}=50Ω, V_{PD}=5.0V, Chip Inductor Resonator
Output Power		-13		dBm	
2nd Harmonic		-16		dBc	
3rd Harmonic		-15		dBc	
Load Pulling		500		kHz	Into 1.67VSWR Load
V_{CC} Pushing		2		MHz/V	
Phase Noise		96		dBc	100kHz Offset
		83		dBc	25kHz Offset
		76		dBc	10kHz Offset
Power Supply					
Operating Voltage		3.6 to 5.5		V_{DC}	
Supply Current		3		mA	

Pin	Function	Description	Interface Schematic
1	VCC1	Power supply connection for the VCO. This pin should be well bypassed close to the package with a capacitor suitable for the frequency of operation as well as a capacitor to minimize low frequency noise from the voltage supply. The ground side of the capacitors should connect immediately to ground plane.	
2	RES	Connection point for the resonator circuit. The resonator is an inductive element. Changing the effective inductance, either physically or with a varactor tuned circuit, will change the frequency of operation. Note that all parasitics on the circuit board will contribute to the effective inductance and will influence the frequency of operation. These effects become more pronounced at higher operating frequencies. This pin has DC bias present. A DC blocking capacitor, suitable for the frequency of operation, should be used if the external circuitry has DC present or presents a DC path to ground. See Application Example Schematic and Theory of Operation section of this data sheet for design details.	
3	GND1	Ground connection for the VCO. Keep traces physically short and connect immediately to ground plane for best performance. In order to minimize load pulling, it is recommended that pins 3 and 4 have different return paths to ground than pin 7 (i.e. separate vias to a common ground plane).	See pin 2
4	GND2	Same as pin 3.	See pin 2
5	VCC2	Power supply connection for the buffer amplifiers. This pin should be well bypassed close to the package with a capacitor suitable for the frequency of operation. The ground side of the capacitor should connect immediately to ground plane.	
6	RF OUT	RF output pin. This output is internally DC blocked.	
7	GND3	Ground connection for the buffer amplifiers. Keep traces physically short and connect immediately to ground plane for best performance. In order to minimize load pulling, it is recommended that pins 3 and 4 have different return paths to ground than pin 7 (i.e. separate vias to a common ground plane).	
8	VPD	Power Down pin for the VCO and buffer amplifiers. A logic "low" (0.0 to 0.7V) turns the entire device off and supply current drops to less than 1μA. A logic "high" (≥3.0V) turns the device on. Note that the voltage on this pin should never exceed 5.5V_{DC}.	

Application Notes

The RF2501 has two functional parts: an oscillator and buffer amplifier. The functional blocks have separate ground and VCC pins to increase the isolation and reduce load pulling, one of the key design objectives. An external resonator is used to add design flexibility, and the loaded Q of this resonator will affect the performance of the resulting oscillator.

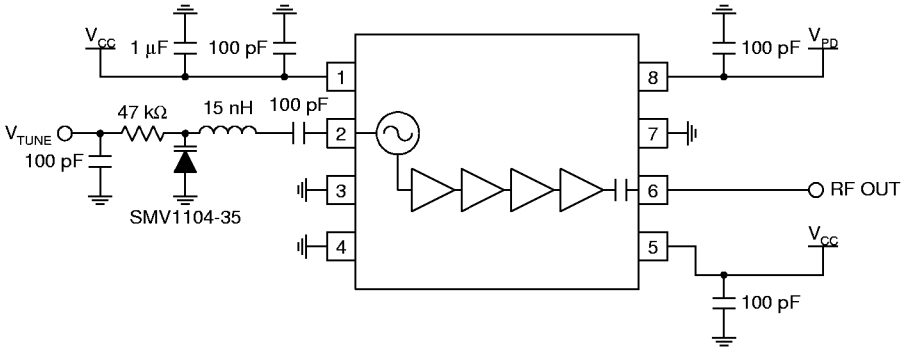
To create an oscillation, negative resistance is generated at pin 2 with a circuit similar to a Colpitts oscillator. The input impedance at pin 2, measured with a vector network analyzer, is shown here in the data sheet. In general, the impedance looks like a negative resistance in series with a capacitor. The negative resistance decays as the frequency increases. An oscillator is created when an inductive element is placed on pin 2 that is the conjugate of the capacitive reactance. A greater inductive element will create a lower frequency of oscillation.

The S11 looking into pin 2 is also shown here in the data sheet. It has return gain from 500 MHz to 2200 MHz at room temperature. The specified frequency range of 750 MHz to 1500 MHz defines the region where the output power is relatively flat. At lower and higher frequencies, the power will tend to roll off from the nominal value. The specified frequency range is conservatively set to ensure oscillation and maintain performance, but the RF2501 can be used over a broader frequency range with degraded performance.

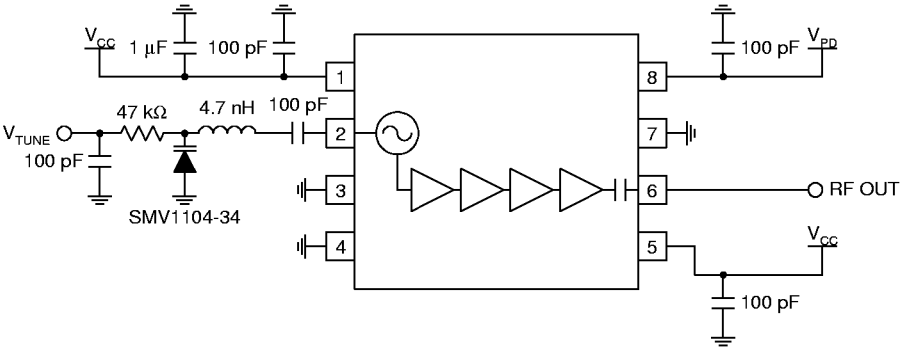
The overall Q of the external resonator will affect performance. Lower Q means lower power, higher phase noise, and more load pulling. If the Q is too low, the circuit will not oscillate. The IC is designed to oscillate into a resonator with Q>10. The performance is measured with a microstrip resonator or high quality inductor, which usually has a Q>50. These measurements define the best performance that can be expected from the ICs. Lower Q resonators, particularly those including a lossy varactor, might have degraded performance.

The specified output power is measured into a 50Ω load. The IC has a high output impedance, and if desired, output matching can be used to obtain more power by transforming 50Ω into a higher impedance. On the RF2501, this could be accomplished by adding an external output L-C matching network (shunt inductor and series capacitor).

Application Schematic
915MHz Operation



Application Schematic
1500MHz Operation



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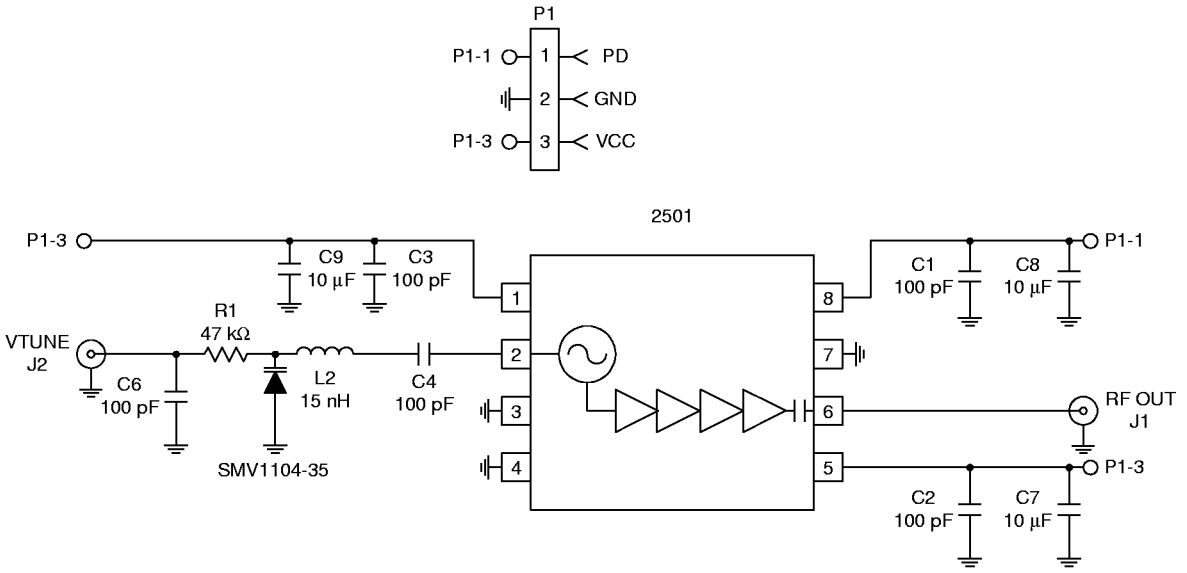
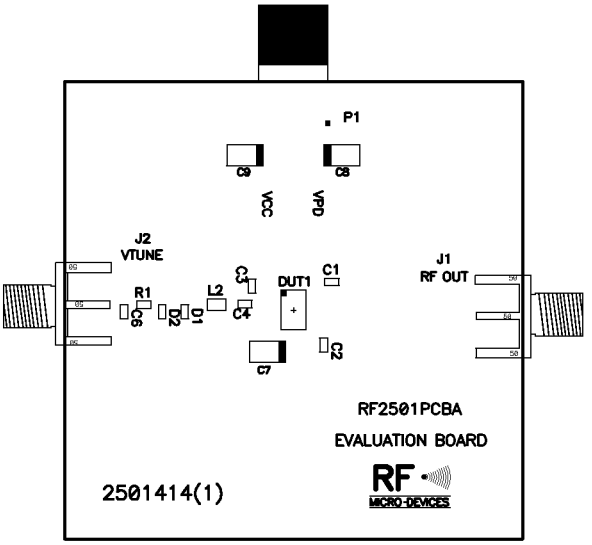
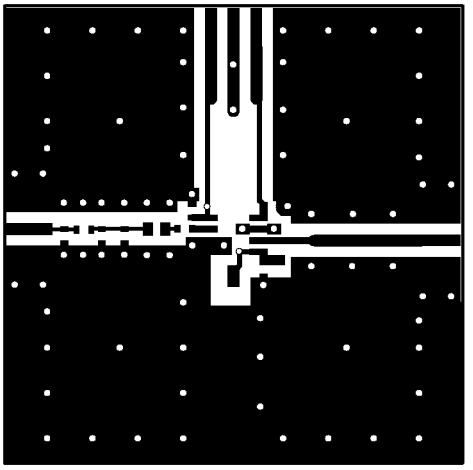
VCOs

Evaluation Board Schematic
915MHz Operation

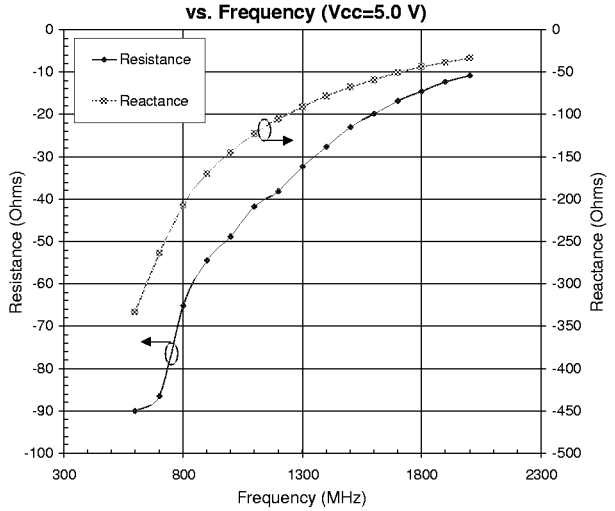


Evaluation Board Layout
915MHz Operation
2" x 2"

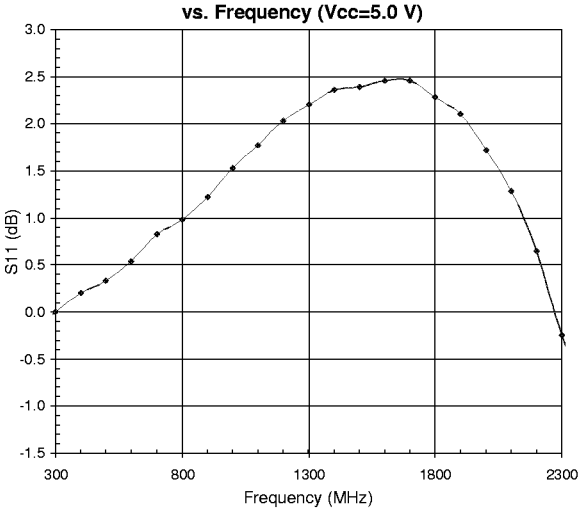




Resonator (Pin2) Input Impedance vs. Frequency (Vcc=5.0 V)



Resonator (Pin2) Input Return Loss vs. Frequency (Vcc=5.0 V)



Oscillating Freq. and Pout vs. Varactor Voltage (915 MHz Application Schematic; Vcc=5.0 V)