

RoHS Compliant & Pb-Free Product  
Package Style: QFN, 16-Pin, 4 x 4

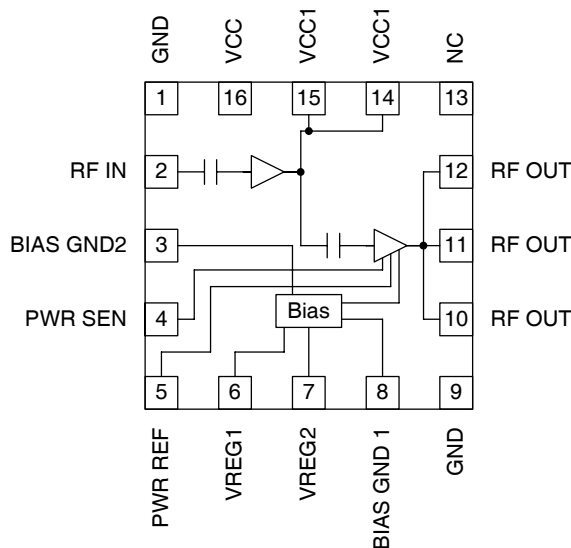


**Features**

- Single 3.3V Power Supply
- +30dBm Saturated Output Power
- 19dB Small Signal Gain
- High Power Added Efficiency
- Patent Pending Power Sense Technology
- 1800MHz to 2500MHz Frequency Range

**Applications**

- 2.5GHz ISM Band Applications
- PCS Communication Systems
- Wireless LAN Systems
- Commercial and Consumer Systems
- Portable Battery Powered Equipment
- Broadband Spread-Spectrum Systems



Functional Block Diagram

**Product Description**

The RF2163 is a linear, medium power, high efficiency amplifier IC designed specifically for low voltage operation. The device is manufactured on an advanced Gallium Arsenide Heterojunction Bipolar Transistor (HBT) process, and has been designed for use as the final RF amplifier in 2.5GHz spread-spectrum transmitters. The device is provided in a 16-pin leadless chip carrier with a backside ground and is self-contained with the exception of the output matching network and power supply feed line.

**Ordering Information**

RF2163                      3V, 2.5GHz Linear Power Amplifier  
 RF2163 PCBA            Fully Assembled Evaluation Board

**Optimum Technology Matching® Applied**

- GaAs HBT       SiGe BiCMOS       GaAs pHEMT       GaN HEMT
- GaAs MESFET       Si BiCMOS       Si CMOS
- InGaP HBT       SiGe HBT       Si BJT

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## Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.5 to +6.0	V <sub>DC</sub>
Power Control Voltage (V <sub>REG</sub> )	-0.5 to 3.3	V
DC Supply Current	1000	mA
Input RF Power	+15	dBm
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Moisture sensitivity	JEDEC Level 3	



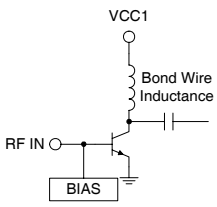
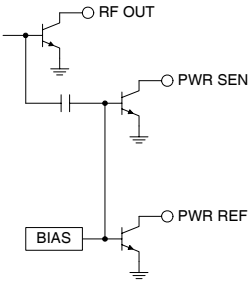
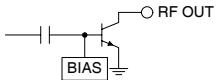
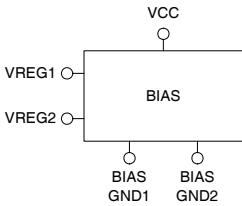
**Caution!** ESD sensitive device.

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.

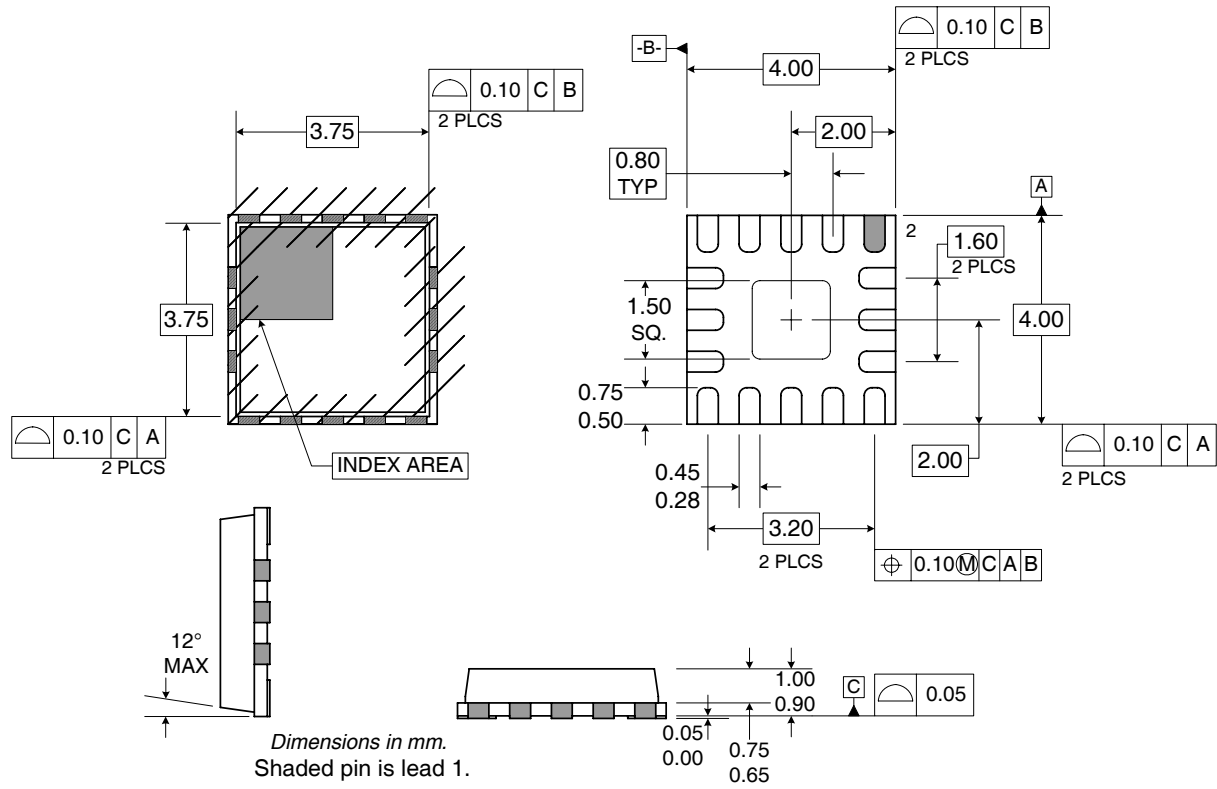
RoHS status based on EUDirective2002/95/EC (at time of this document revision).

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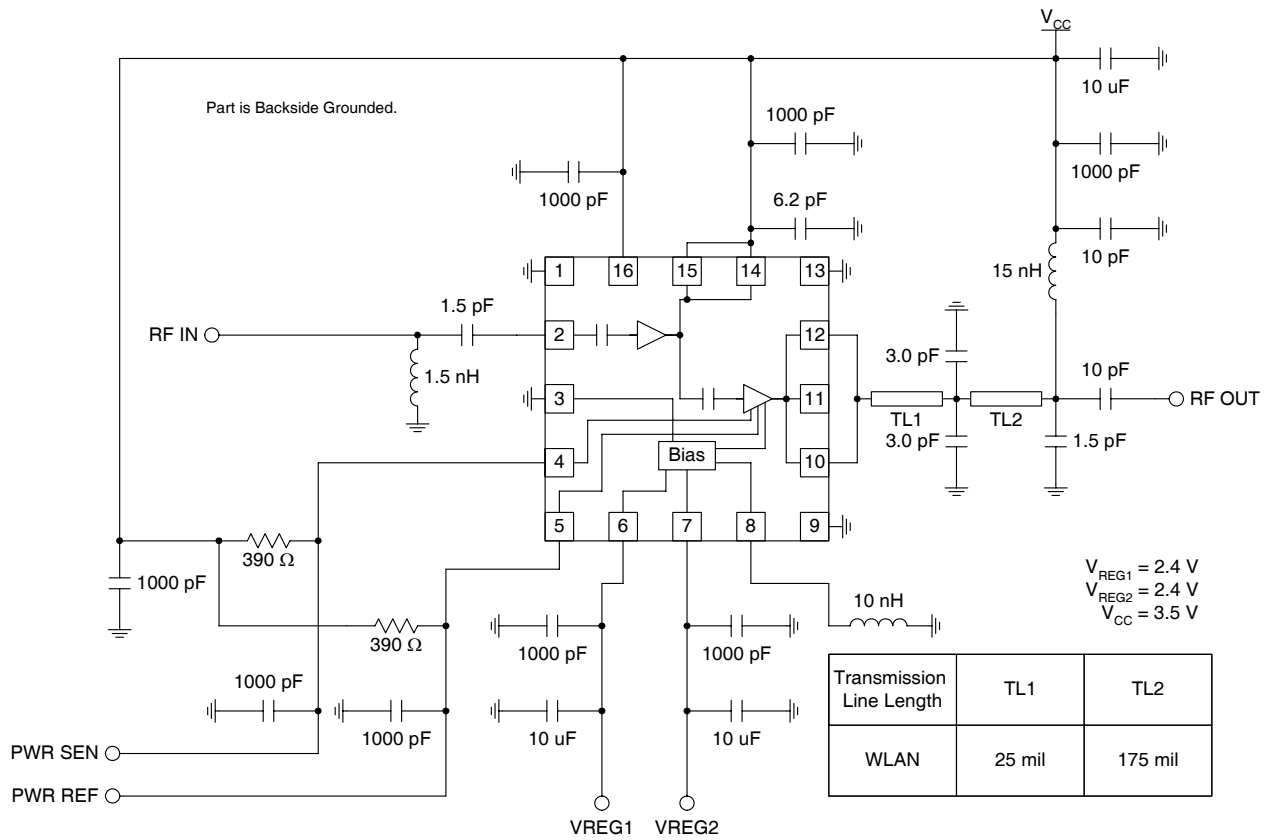
Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
<b>Overall</b>					T=25 °C, V <sub>CC</sub> =3.5V, V <sub>REG1</sub> =V <sub>REG2</sub> =2.3V, Freq=2450 MHz
Frequency Range		1800 to 2500		MHz	
Maximum Saturated Output Power	+29	+30	+32	dBm	P <sub>IN</sub> =+13 dBm
Efficiency at Max Output Power		26		%	
Maximum Linear Output Power		25		dBm	With 802.11 modulation (11Mbit/s) and meeting 802.11 spectral mask.
Linear Efficiency		25		%	
Small Signal Gain	16	19		dB	P <sub>IN</sub> =10dBm
Reverse Isolation		30		dB	In "ON" state
		30		dB	In "OFF" state
Second Harmonic		-35		dBc	Including second harmonic trap, see application circuit
Adjacent Channel Power		-35	-32	dBc	P <sub>OUT</sub> =24 dBm
Alternate Channel Power		-52	-50	dBc	P <sub>OUT</sub> =24 dBm
Isolation		TBD		dBm	In "OFF" state, P <sub>IN</sub> =TBD
Input Impedance		50		Ω	With external matching
Input VSWR		2:1			With external matching
<b>Power Down</b>					
V <sub>REG</sub> "ON"		2.3		V	Voltage supplied to control input; device is "ON"
V <sub>REG</sub> "OFF"		0	0.5	V	Voltage supplied to control input; device is "OFF"
<b>Power Supply</b>					
Operating Voltage		3.0 to 5.0		V	
Current Consumption		650		mA	Power Down "ON", at max output power
		350		mA	Power Down "ON", P <sub>OUT</sub> =25 dBm
		150	290	mA	Idle current

Pin	Function	Description	Interface Schematic
1	GND	Ground connection. For best performance, keep traces physically short and connect immediately to ground plane.	
2	RF IN	RF input. This input is AC coupled, so an external blocking capacitor is not required if this pin is connected to a DC path.	
3	BIAS GND2	Ground for second stage bias circuit. For best performance, keep traces physically short and connect immediately to ground plane.	See pin 16.
4	PWR SEN	The PWR SEN and PWR REF pins can be used in conjunction with an external feedback path to provide an RF power control function for the RF2163. The power control function is based on sampling the RF drive to the final stage of the RF2163.	
5	PWR REF	Same as pin 4.	See pin 4.
6	VREG1	This pin requires a regulated supply to maintain the correct bias current.	See pin 16.
7	VREG2	Same as pin 6.	See pin 16.
8	BIAS GND1	Ground for first stage bias circuit. For best performance connect to ground with a 10nH inductor.	See pin 16.
9	GND	Same as pin 1.	
10	RF OUT	RF output and bias for the output stage. The power supply for the output transistor needs to be supplied to this pin. This can be done through a quarter-wave length microstrip line that is RF grounded at the other end, or through an RF inductor that supports the required DC currents.	
11	RF OUT	Same as pin 10.	See pin 10.
12	RF OUT	Same as pin 10.	See pin 10.
13	NC	Not connected.	
14	VCC1	Interstage match and bias for first stage output. Connect interstage matching capacitor to t pin with a short trace. Connect low-frequency bypass capacitors to this pin with a long trace. See evaluation board layout for details.	See pin 2.
15	VCC1	Same as pin 14.	See pin 2.
16	VCC	Power supply pin for the bias circuits. External low frequency bypass capacitors should be connected if no other low frequency decoupling is nearby.	
Pkg Base	GND	Ground connection. The backside of the package should be connected to the ground plane through a short path, i.e., vias under the device may be required.	See pin 1 and 2.

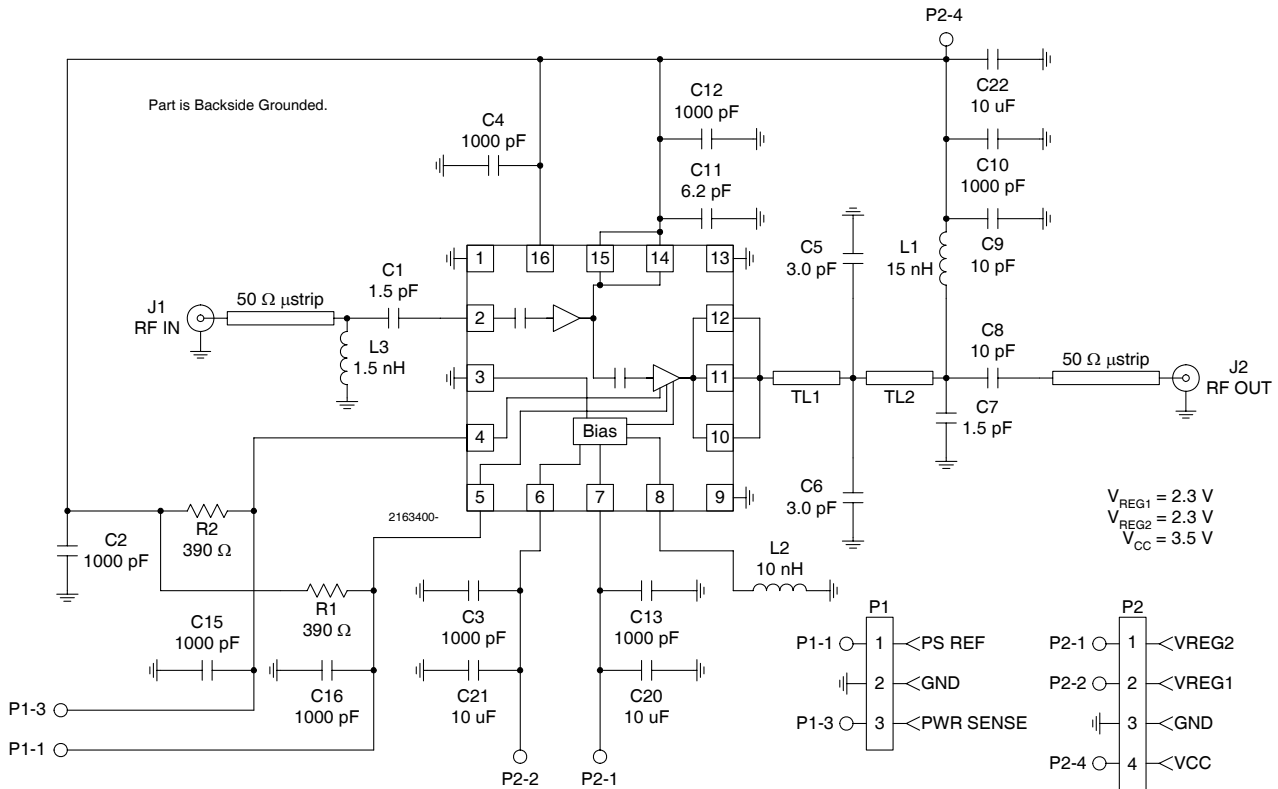
## Package Drawing



**Application Schematic  
2400MHz to 2483MHz**

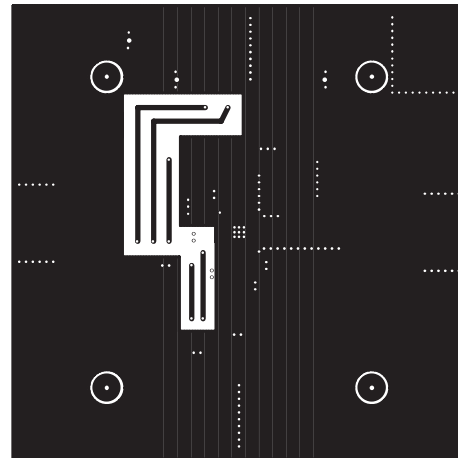
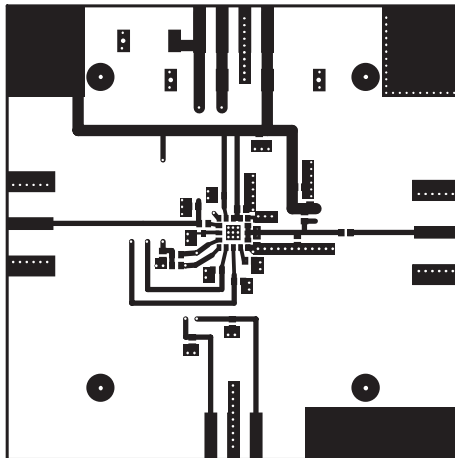
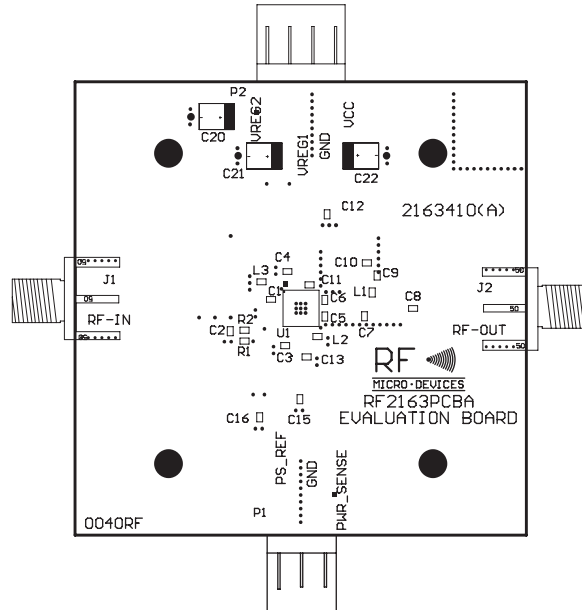


## Evaluation Board Schematic 2400 MHz to 2483 MHz



Transmission Line Length	TL1	TL2
WLAN	25 mil	175 mil

**Evaluation Board Layout**  
**Board Size 2.0" x 2.0"**  
**Board Thickness 0.028", Board Material FR-4**



## Theory of Operation and Application Information

The RF2163 is a two-stage device with a nominal gain of 19dB in the 2.4GHz to 2.5GHz ISM band. The RF2163 is designed primarily for IEEE802.11B WLAN applications where the available supply voltage and current are not limited. It will meet 802.11B spectral mask requirements at an output power of +24dBm. It is especially appropriate for WLAN access points and other base-station type equipment.

The RF2163 requires only a single positive supply of 3.3V nominal (or greater) to operate to full specifications. Power control is provided through two bias control input pins ( $V_{REG1}$  and  $V_{REG2}$ ), but in most applications these are tied together and used as a single control input.

There is some external matching on the input and output of the part, thus allowing the part to be used in other applications outside the 2.4GHz to 2.5GHz ISM band (such as MMDS). Both the input and the output of the device need a series DC-blocking capacitor. In some cases, a capacitor used as a matching component can also serve as the blocking cap. The circuit used on the evaluation board is optimized for 3.5V nominal applications.

For best results, the PA circuit layout from the evaluation board should be copied as closely as possible, particularly the ground layout and ground vias. Other configurations may also work, but the design process is much easier and quicker if the layout is copied from the RF2163 evaluation board. Gerber files of our designs can be provided upon request.

The RF2163 is not a difficult part to implement, but care in circuit layout and component selection is always advisable when designing circuits to operate at 2.5GHz. The most critical passive components in the circuit are the input, interstage and output matching components (C1, C5, C6, C7, and C11). In these cases, high-Q capacitors suitable for RF applications are used on our evaluation board (a BOM is available on request). High-Q parts are not required in every design, but it is very strongly recommended that the original design be implemented with the same or similar parts used on our evaluation board. Then, less costly components can be substituted in their place, making it easy to test the impact of cheaper components on performance. General RFMD experience has indicated that the slightly higher cost of better quality passive components is more than offset by the significant improvements in production yields in large-volume manufacturing.

The interstage matching capacitor, C11, along with the combined inductance of the internal bond wire, the short length of circuit board trace, and the parasitic inductance of this capacitor, tunes the peak of the small-signal gain response. The trace length between C11 and pins 14 and 15 should be kept as short as possible.

In practice,  $V_{CC1}$ ,  $V_{CC}$ , and the supply for the output stage bias will be tied to this supply line. This can be accomplished using a suitably-long transmission line which is RF shorted on the other end. Ideally the length of this line will be a quarter wavelength, but it only needs to be long enough so that the effects of other supply bypass capacitors on the interstage match are minimized. If board space is a concern, this isolation can also be accomplished with an RF choke inductor or ferrite bead. Additionally, a higher-value capacitor than shown on the application schematic can be used if bypass capacitors must be closer. A Smith Chart can be used to provide initial guidance for value selection and parts placement. Be aware of the self-resonant frequency (SRF) of higher-valued capacitors. The SRF must be above the frequency of operation.

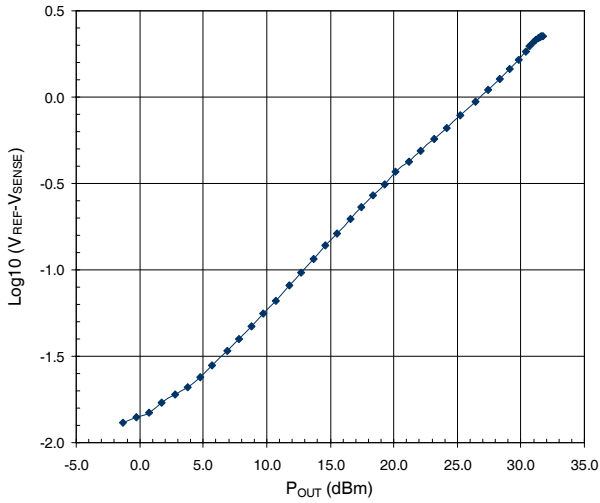
The output matching caps are C5, C6, and C7. These are tuned along with the 50 $\Omega$  transmission line segments TL1 and TL2, as shown on the evaluation board schematic. These segments should be duplicated as closely as possible. Due to variations in FR-4 characteristics and PCB manufacturer process variations, some benefit will be obtained from small adjustments to these transmission line lengths when the evaluation board layout is duplicated on another design. Prior to full rate manufacturing, the board layout of early prototypes should include some additional exposed ground areas around C5, C6, and C7 to optimize this part of the circuit. In order to reduce component count, the output can also be tuned with a single capacitor. A Smith Chart can help determine the desired value and transmission line length, which can be similarly adjusted on the board prior to production. This will result in a slightly lower-bandwidth and more sensitive match, but in most applications the bandwidth is still sufficient.



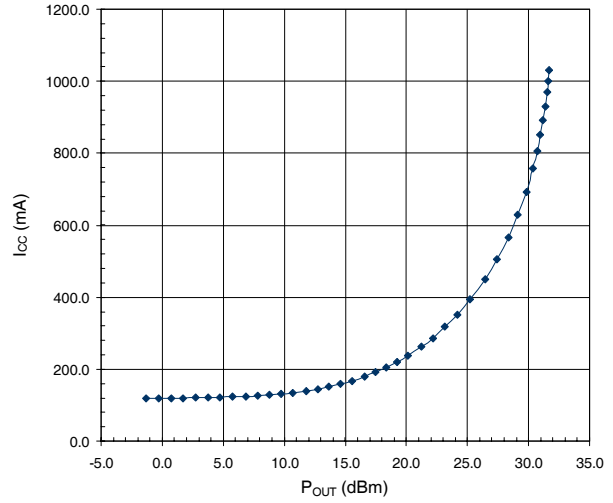
Power sensing is implemented with the PWR SEN and PWR REF lines. The outputs of these pins are transistor collectors and need to be pulled up to the supply through a resistor. PWR REF provides an output current proportional to the output stage bias current, and PWR SEN provides an output current proportional to the total (RF and bias) current of the output stage. The pull-up resistors convert these currents to voltages, and the voltage difference between these two pins is proportional to the RF current. See the graph, “ $V_{REF} - V_{SENSE}$  versus  $P_{OUT}$ ”, for the response of this signal. This difference signal can be fed to a power control circuit elsewhere in the end product, or it can be processed at the PA with additional circuitry and used to adjust the  $V_{REG}$  voltage(s) to implement automatic level control. Contact RFMD Sales or Applications Engineering for additional data and guidance in using this feature.

The RF2163 has primarily been characterized with a voltage on  $V_{REG1}$  and  $V_{REG2}$  of 2.4VDC. However, the RF2163 will operate from a wide range of control voltages. If you prefer to use a control voltage that is significantly different than 2.4VDC, contact RFMD Sales or Applications Engineering for additional data and guidance.

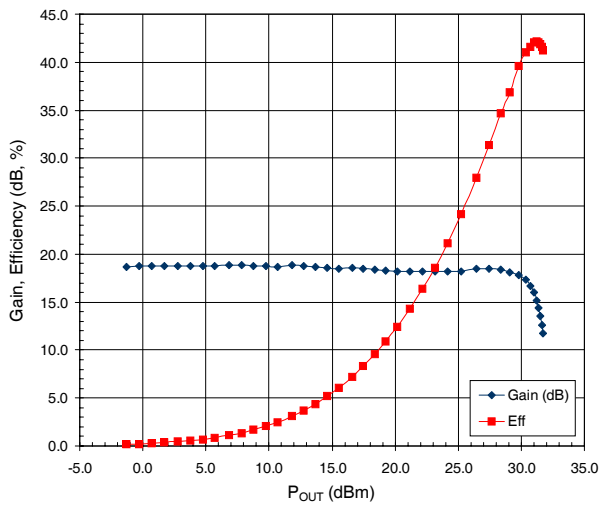
**V<sub>REF</sub> - V<sub>SENSE</sub> versus P<sub>OUT</sub>**



**I<sub>CC</sub> versus P<sub>OUT</sub>**



**Gain and Efficiency versus P<sub>OUT</sub> with 802.11 Modulation**





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**RF2163**

