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RF5745

2.4GHz TO 2.5GHz, 802.11b/g/n SINGLE-BAND FRONT END MODULE

Package Style: QFN, 16-pin, 3.0 x 3.0 x 0.5 mm

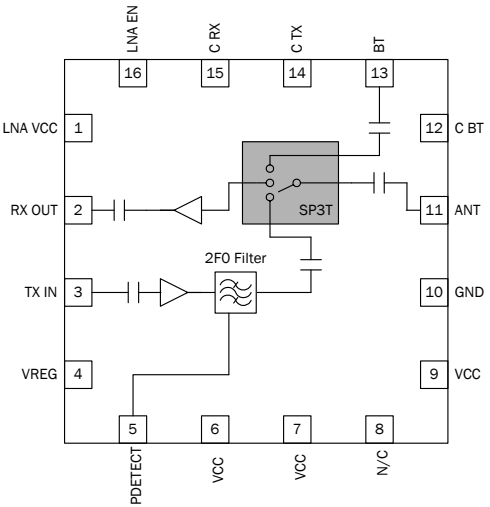
RoHS

Features

- Single Module Radio Front-End
- Single Supply Voltage 3.0V to 4.5V
- Integrated 2.4GHz to 2.5GHz PA, LNA, TX/RX Switch, P_{DETECT}
- 24dBm Output Power for Zigbee® Applications
- 20dBm Output Power for 11b Meeting Spectral Mask
- 17dBm Output Power for 11g, 54Mbps OFDM at <3% EVM

Applications

- ZigBee® Based Systems for Remote Monitoring and Control
- Smart Meters for Energy Management
- 802.11b/g WiFi Applications
- 2.5GHz ISM Band Applications
- Portable Battery-Powered Equipment
- Opt. *Bluetooth*™ Sharing of Single Antenna Port



Functional Block Diagram

Product Description

The RF5745 is a single-chip integrated front-end module (FEM) for high-performance ZigBee® and other WiFi applications in the 2.4GHz to 2.5GHz ISM band. The FEM addresses the need for aggressive size reduction for a typical IEEE802.15.4 and IEEE802.11b/g systems.

The RF5745 greatly reduces the number of external components by integrating all matching networks. The FEM has an integrated power amplifier, LNA, power detector, and some TX filtering. It is also capable of switching between WiFi RX, WiFi TX and *Bluetooth*™ RX/TX operations. The device is provided in a 3mmx3mmx0.45mm, 16-pin QFN package. This module meets or exceeds the front-end system requirements for and WiFi applications.

Ordering Information

RF5745	Standard 25 piece bag
RF5745SR	Standard 100 piece reel
RF5745TR7	Standard 2500 piece reel
RF5745PCK-410	Fully assembled evaluation board tuned for 2.4GHz to 2.5GHz and 5 piece loose samples

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
DC Supply Voltage	5.0	V
DC Supply Current	240	mA
Full Specification Temp Range (Full Spec. Compliant)	-15 to +65	°C
Extreme Operating (Reduced Performance)	+65 to +85 -40 to -15	°C
Storage Temperature	-40 to +150	°C
Antenna Port Nominal Impedance	50	Ω
Maximum TX Input Power for 11b/g/IEEE802.15.4 (No Damage)	+5	dBm
Moisture Sensitivity	MSL2	

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.		
2.4GHz Transmit Parameters					
Compliance					IEEE802.11b, IEEE802.11g, IEEE802.15.4, FCC CFG 15.247, .205, .209
Nominal Conditions					V_{CC}=4.0V, V_{REG}=2.85V pulsed at 1% to 100% duty cycle, Temp=+25°C, Freq=2.4GHz to 2.5GHz, unless otherwise noted
Frequency	2.4		2.5	GHz	
Output Power					
ZigBee® (IEEE802.15.4)		24		dBm	Measured with ZigBee® Waveform
11g	15	17		dBm	At rated 11g power, over Temp range, V_{CC}=4.0V, V_{REG}=2.85, over Frequency, and over Process. 54Mbps, OFDM, 64QAM
IEEE802.11b	19	20		dBm	Measured at 1Mbps meeting ACP1/ACP2 requirements
EVM*		3.0	4.0	%	RMS, mean, $P_{OUT(g)}$=17dBm
Adjacent Channel Power					
ACP1		-34	-30	dBc	At rated 11b power, over Temperature range, over V_{CC}, over Frequency, and over Process
ACP2		-53	-50	dBc	At rated 11b power, over Temperature range, over V_{CC}, over Frequency, and over Process
Gain	29	31		dB	
Gain Variation					
Frequency	-1		+1	dB	2.4GHz to 2.5GHz

*The EVM specification is obtained with a signal generator that has an EVM level <0.7%.

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters, cont'd					
Power Detect					
Voltage Detect	0.1		2.0	V	P_{OUT} 0dBm to 23dBm over all conditions
Input Resistance		10		kΩ	
Input Capacitance			5	pF	
Bandwidth	800	1000		kHz	
Current Consumption					
I_{CC}		150		mA	RF P_{OUT}=16dBm, 54Mbps IEEE802.11g
		190			At rated 11b power
		250		mA	RFPOUT=24dBm, 11b and ZigBee® waveform
Idle		110		mA	V_{CC}=4V, V_{REG}=2.85V, and RF=OFF
I_{REG}		3	5	mA	
Leakage		2	10	μA	
Power Supply	3.0	4	4.5	V	
V_{REG}	2.75	2.85	2.95	V	
Input/Output Impedance		50		Ω	
Ruggedness					
Output VSWR	10:1				No damage
Stability					
Output VSWR	5:1				No spurs above -45dBm/MHz
Thermal Resistance		79.25		°C/W	V_{CC} = 3.3, V_{REG} = 2.9V, C_TX = 3.3, C_RX = C_BT = GND, P_{OUT} = 17dBm, Modulation = On, Freq = 2.45GHz, DC = 100%, T = 85°C
Harmonics					RBW=1MHz. Measured at 1Mbps.
Second		-27	TBD	dBm	P_{OUT} at CF=20dBm, H2 Frequency is between 4.8GHz to 5.0GHz
Third		-48	TBD	dBm	P_{OUT} at CF=20dBm, H3 Frequency is between 7.2GHz to 7.5GHz
Turn-On/Off Time		0.5	1.0	μS	Output stable to within 90% of final gain
Antenna Port Impedance					Antenna port is a DC short to ground
Input		50		Ω	Receive
Output		50		Ω	Transmit
Switch Control Voltage					
Low		0	0.2	V	
High	2.30	2.85	V_{CC}	V	
Switch Control Current			10	μA	Per control line
Switch Control Speed		100		nsec	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Receive Parameters					
Frequency	2.4		2.5	GHz	
Receive Gain		12		dB	WiFi RX mode only
		8		dB	WiFi RX and BT RX mode
Noise Figure		2.5		dB	WiFi RX mode only
		8		dB	WiFi RX and BT RX mode
Passband Ripple	-1		+1	dB	
Output Return Loss	9.6			dB	
Output Impedance		50		Ω	No external matching
LNA Current		10	13	mA	
Input IP3		+9		dBm	
***Bluetooth*™ Parameters**					
Frequency	2.4		2.5	GHz	
Insertion Loss		1.2		dB	SP3T switch, all unused ports terminated into their nominal impedance. *Bluetooth*™ mode only
		5		dB	WiFi RX and BT RX mode
Passband Ripple	-0.2		+0.2	dB	
Input/Output Power			8	dBm	
Output Return Loss	9.6			dB	
Output Impedance		50		Ω	No external matching
Current Consumption			30	μA	Switch leakage current

*The EVM specification is obtained with a signal generator that has an EVM level <0.7%.

Isolation Table

Parameter	Min.	Typ.	Max.	Unit
WiFi RX to BT RX/TX	20			dB
WiFi TX to BT RX/TX	20			dB
WiFi RX to WiFi TX	20			dB
WiFi RX and BT RX Mode	9			dB

Switch Control Logic

Mode	C_RX	C_TX	C_BT
Bluetooth™	L	L	H
WiFi Tx	L	H	L
WiFi Rx	H	L	L
WiFi Rx/BT	H	L	H

*The FEM can simultaneously receive WiFi and *Bluetooth*™ in the WiFi RX and BT RX Mode.

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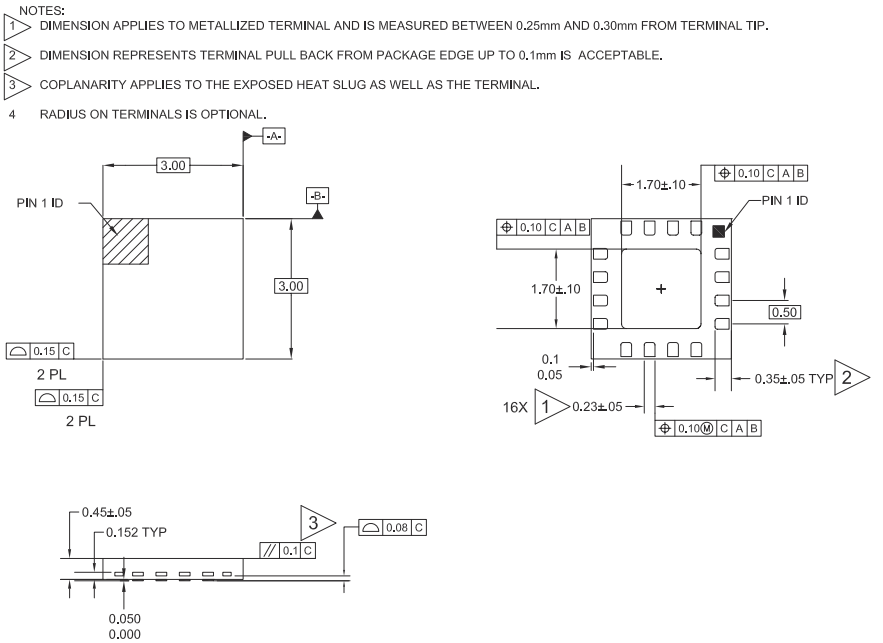
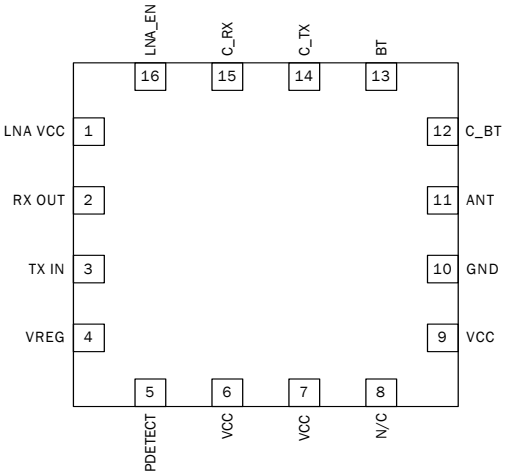
Pin	Function	Description
1	LNA VCC	Voltage supply for the LNA.
2	RX OUT	Receive port for 802.11b/g band. Internally matched to 50Ω. DC block provided.
3	TX	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.
4	VREG	Regulated voltage for the PA bias control circuit. An external bypass capacitor may be needed on the V_{REG} line for decoupling purposes.
5	PDETECT	Power detector voltage for TX section. PDET voltage varies with output power. May need external decoupling capacitor for module stability. May need external circuitry to bring output voltage to desired level.
6	VCC	Supply voltage for the bias circuit of the PA. Add an external 56pF bypass capacitor for low frequency decoupling.
7	VCC	Supply voltage for the first stage of the PA. Add an external 1nF capacitor for low frequency decoupling.
8	N/C	No connect.
9	VCC	Supply voltage for the second stage of the PA. Add an external 10nF capacitor for low frequency decoupling.
10	GND	Ground.
11	ANT	Port matched to 50Ω and is a DC short to ground.
12	C_BT	Switch control port. See truth table for proper level.
13	BT	RF bidirectional port for Bluetooth™. Input is matched to 50Ω and DC block is provided.
14	C_TX	Switch control port. See switch truth table for proper level.
15	C_RX	Switch control port. See switch truth table for proper level.
16	LNA_EN	LNA enable pin. This is an active high control. An external bypass capacitor may be needed on the LNA_EN line.

Package Drawing



Pin Out



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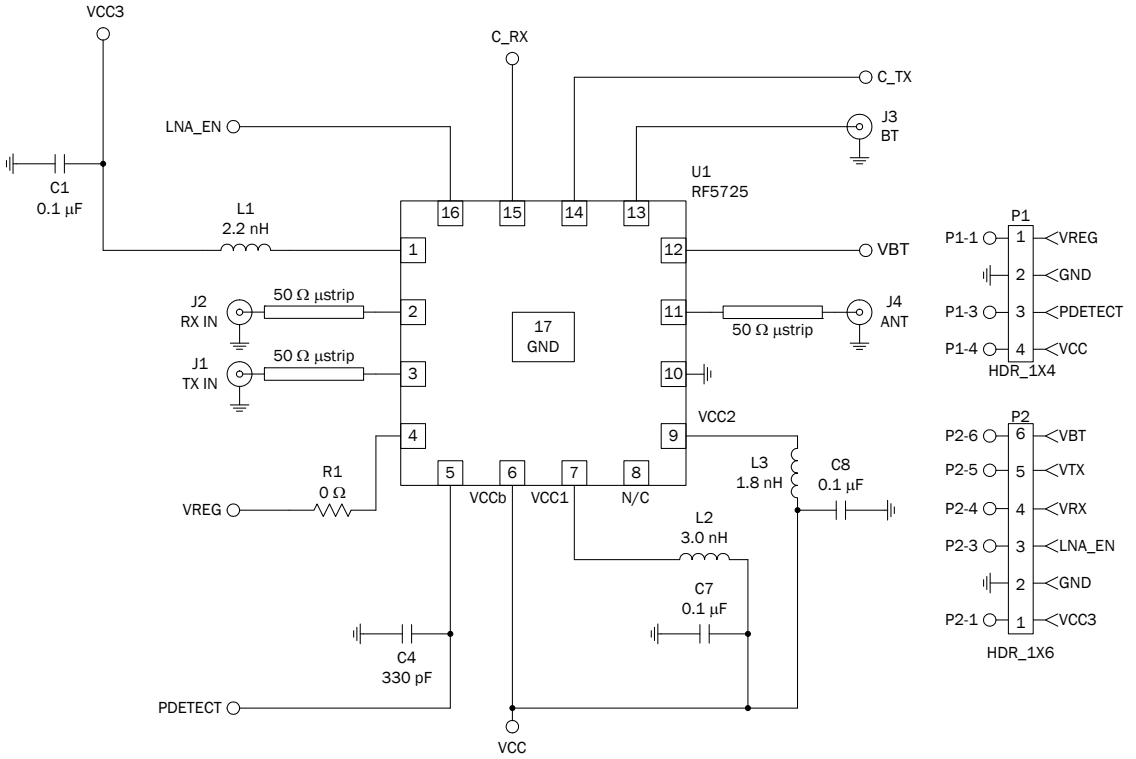
Evaluation Board Schematic



Theory of Operation

The RF5745 is an integrated front-end module (FEM) for high performance ZigBee® (802.15.4) and WiFi (802.11b/g) applications in the 2.4GHz to 2.5GHz ISM band. The FEM addresses the need for aggressive size reduction by integrating 50Ω matching networks to all RF ports and minimizing the number of external components. The FEM has integrated ZigBee® power amplifier, LNA, power detector, and some TX filtering. Also it is capable of switching between WiFi RX, WiFi TX, and simultaneous WiFi/BT Receive modes. The device is manufactured on GaAs HBT/pHEMT processes and is provided in a 3.00mmx3.00mmx0.45mm 16-pin QFN package. This module meets or exceeds the front-end system requirements for 802.15.4 and 802.11b/g applications.

For best performance, the evaluation board layout should be copied as close as possible in particular the ground vias and bypassing components. Other configurations may work, but the design process is much easier and quicker if this recommendation is followed. Gerber files of the evaluation board can be provided upon request. The supply voltage lines should present an RF short to the FEM by using bypass capacitors on the V_{CC} traces.

The RF5745 is a very easy part to implement, but care on circuit layout and component selection is always advisable when designing circuits that operate at 2.5GHz. Please contact RFMD Sales or Application Engineering for additional data and guidance. The RF5745 requires a single supply voltage (V_{CC}), a regulated current control voltage (V_{REG}) supply, and a switch control supply to simplify bias requirements.

802.11b/g and ZigBee® Transmit Path

The RF5745 has a typical gain of 31dB from 2.4GHz to 2.5GHz. This FEM is capable of delivering a typical output power of 24dBm to 25dBm when operating under the IEEE802.15.4 conditions. It is also capable of delivering 17dBm typical output power with a standard IEEE802.11g waveform and 20dBm with a standard IEEE802.11b waveform. Current control optimization is provided through the V_{REG} pin which requires a regulated supply to maintain nominal current.

Out of Band Rejection

The RF5745 contains basic filtering components for the transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles. Additional filters may be needed outside the module depending upon the end-user's application.

Receive Path

While on receive mode, the RF5745 has a typical gain of 10dB and minimum insertion loss for the BT path. The RX port return loss is typically around 10dB. Depending on the application, if higher out of band rejection is needed beyond what the RF5745 can achieve, then additional external filters may be added. The RF5745 is designed so that the SP3T may act as a 3dB splitter when placed in WiFi RX and BT RX mode simultaneously. See logic control table for proper settings.

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RF5745 Biasing Instructions:

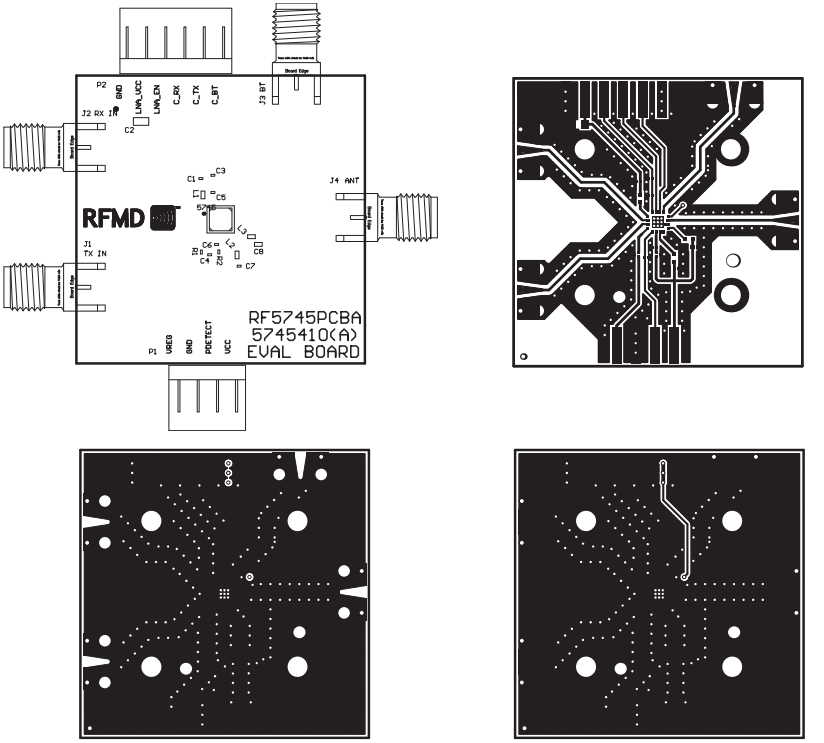
- 802.11b/g and ZigBee® Transmit
  - Connect the FEM to a signal generator at the input and a spectrum analyzer at the output.
  - Bias V_{CC} to 4.0V first with V_{REG}=0.0V
  - Refer to switch operational truth table to set the control lines at the proper levels for WiFi TX.
  - Turn on V_{REG} to 2.85V (typ.). V_{REG} controls the current drawn by the 802.11b/g and ZigBee® power amplifier and the current should quickly rise to ~100mA±20mA for a typical part but it varies based on the output power desired. Be extremely careful not to exceed 3.4V on the V_{REG} pin or the part may exceed device current limits.
- 802.11 b/g and ZigBee® Receive
  - To Receive WiFi set the switch control lines per the truth table below.
- *Bluetooth*™ Receive
  - To Receive *Bluetooth*™ set the switch control lines per the truth table below.

Switch Control Logic

Mode	C_RX	C_TX	C_BT
Bluetooth™	L	L	H
WiFi Tx	L	H	L
WiFi Rx	H	L	L
WiFi Rx/BT	H	L	H

*The FEM can simultaneously receive WiFi and *Bluetooth*™ in the WiFi RX and BT RX Mode.

Evaluation Board Layout
Board Size 1.5” x 1.5”
Board Thickness 0.032”, Board Material FR-4, Multi-Layer



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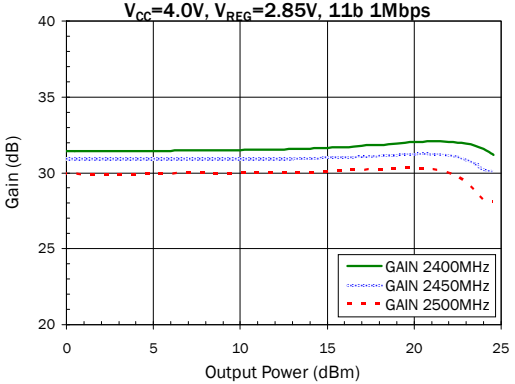
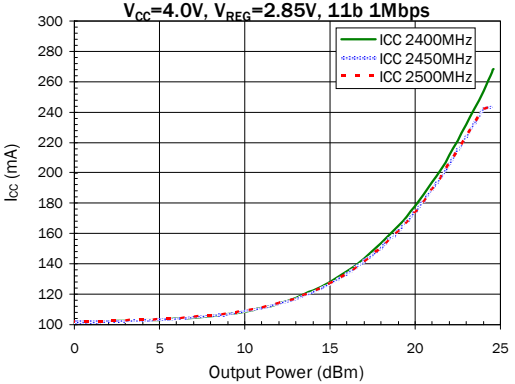
RF5745 Plots for IEEE802.11b

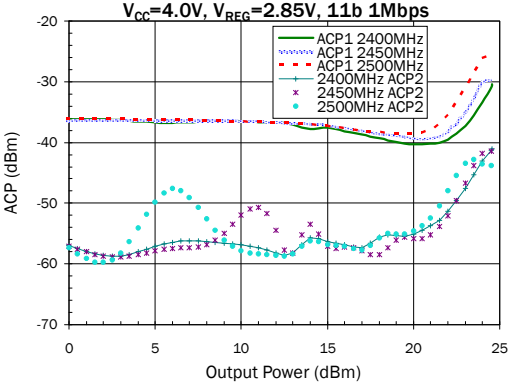
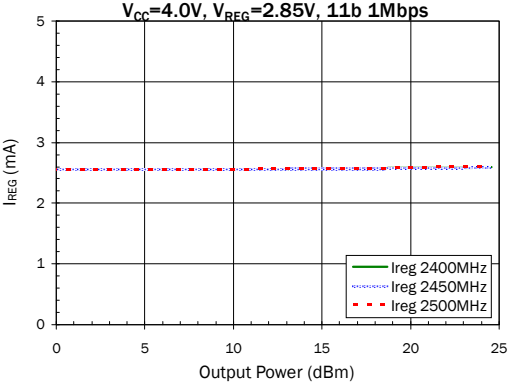
Gain versus P_{OUT}
V_{CC}=4.0V, V_{REG}=2.85V, 11b 1Mbps



Operating Current versus P_{OUT}
V_{CC}=4.0V, V_{REG}=2.85V, 11b 1Mbps



ACP versus P_{OUT}
V_{CC}=4.0V, V_{REG}=2.85V, 11b 1Mbps



I_{REG} versus P_{OUT}
V_{CC}=4.0V, V_{REG}=2.85V, 11b 1Mbps