

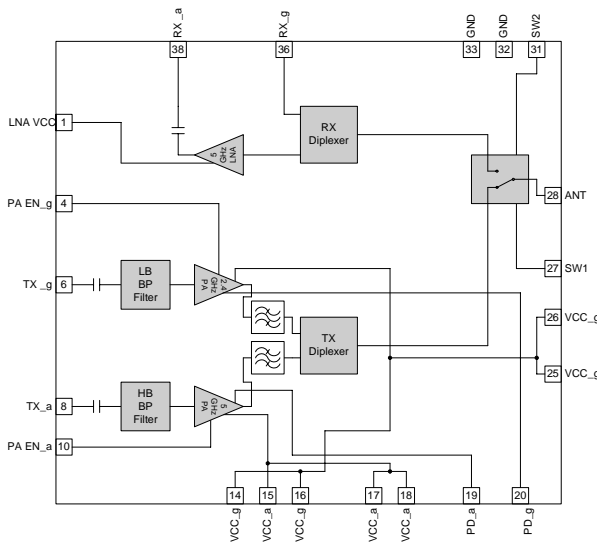


Features

- Single-Module Radio Front-End
- Single Supply Voltage 3.0V to 3.6V
- Integrated 2.5GHz & 5GHZ PA's, Diplexers, Filters & Switches for TX & RX
- P_{OUT}=18dBm, 11g, OFDM a 4% Typ EVM, P_{OUT}=16dBm, 11a, OFDM @ 4% Typ EVM

Applications

- IEEE802.11a/b/g/n WLAN Applications
- Single-Chip RF Front-End Module
- 2.5GHz and 5GHz ISM Bands Applications
- Wireless LAN Systems
- Portable Battery-Powered Equipment



Functional Block Diagram

Product Description

The RF5388 is a single-chip dual-band integrated front-end module (FEM) for high-performance WLAN applications in the 2.5GHz and 5GHz ISM bands. The RF5388 addresses the need for aggressive size reduction for a typical 802.11a/b/g RF front-end design and greatly reduces the number of components outside of the core chipset thus minimizing the footprint and assembly cost of the overall 802.11a/b/g/n solution. The RF5388 contains integrated PA's for 2.5GHz and 5GHz, diplexers, TX/RX switch, LNA for the 5.0GHz receive band, matching components, some bypass capacitors, built-in power detector for both bands, and filters for transmit and receive paths. The RF5388 is packaged in a 40-pin, 6mmx6mmx0.9mm QFN package with backside ground. Greatly minimizes next level board space and allows for simplified integration.

Ordering Information

RF5388 3.3V, Dual-Band Front-End Module
 RF5388PCBA-410 Fully Assembled Evaluation Board

Optimum Technology Matching® Applied

- | | | | |
|---|--------------------------------------|--|-----------------------------------|
| <input type="checkbox"/> GaAs HBT | <input type="checkbox"/> SiGe BiCMOS | <input checked="" type="checkbox"/> GaAs pHEMT | <input type="checkbox"/> GaN HEMT |
| <input type="checkbox"/> GaAs MESFET | <input type="checkbox"/> Si BiCMOS | <input type="checkbox"/> Si CMOS | |
| <input checked="" type="checkbox"/> InGaP HBT | <input type="checkbox"/> SiGe HBT | <input type="checkbox"/> Si BJT | |

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Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.3 to +5.5	V _{DC}
Power Control Voltage (PA EN)	-0.5 to +3.5	V
DC Supply Current	400	mA
Input RF Power	+10	dBm
Operating Ambient Temperature	-10 to +70	°C
Reduced Performance Temp	-30 to -10	°C
	+70 to +85	°C
Storage Temperature	-40 to +85	°C
Moisture Sensitivity	JEDEC Level MSL3	



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 EU Directive 2002/95/EC (at time of this document revision).

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit					T = +25 °C, V _{CC(b/g)} = 3.3V, PAEN_g = 2.85V, Freq = 2.4GHz to 2.5GHz, unless otherwise noted.
Compliance					IEEE802.11b, IEEE802.11g FCC CFR 15.247, 0.205, 0.209
Frequency	2.4		2.5	GHz	
Output Power		14		dBm	
EVM		2		%	At 14dBm, 11g output power, RMS, Mean with a standard IEEE802.11g waveform, OFDM, 54Mbps, 64 QAM
Output Power		18		dBm	With a standard IEEE802.11g waveform at 54Mbps, 64 QAM
EVM*		4		%	At 18dBm, 11g output power, RMS, Mean with a standard IEEE802.11g waveform, OFDM, 54Mbps, 64 QAM
Output Power		20		dBm	With a standard IEEE802.11b waveform at 11Mbps, CCK
Gain	24	26		dB	
Gain Variance		±2.0		dB	Over Temperature and Frequency
Power Detect					
Voltage Range	0.1	1.8	TBD	V	For P _{OUT} = 0dBm to 20dBm in 11b mode.
Output Resistance		10		kΩ	
Output Capacitance		5		pF	
Bandwidth		8		MHz	
Sensitivity					
>10dBm	25			mV/dB	
0 < P _{OUT} < 10dBm	8			mV/dB	
Current Operating		140		mA	RF P _{OUT} = 18dBm with a standard IEEE802.11g waveform, OFDM, 54Mbps/s, 64 QAM
		180		mA	RF P _{OUT} = 20dBm with a standard IEEE802.11b waveform, CCK, 11Mbps/s
Idle Current		100		mA	V _{CC} = 3.3V, PA EN_g = 2.85V, RF = OFF
IPAEN_g		3		mA	V _{CC} = On, PAEN_g = ON, and RF = ON
Shutdown		5		uA	V _{CC} = On, PAEN_g = OFF, and RF = OFF

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit, cont.					
Power Supply	3.0	3.3	3.6	V	
PAEN_g Voltage	2.8	2.85	2.9	V	PAEN_a is in the high state (ON)
	-0.2		+0.2	V	PAEN_g is in the off state (OFF)
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.
Input Impedance		50		Ω	
Output Impedance		50		Ω	
Stability Output VSWR	4:1				Stable, max spurious -47 dBm
Ruggedness Output VSWR	10:1				No damage, conditions: max operating voltage, max input power
Second Harmonic	-43			dBm	Freq=2400MHz to 2500MHz at 18dBm P _{OUT} , RBW=1MHz, average detector tested with 1Mbps
IEEE802.11b/g Spectral Mask per FCC Part 15.205	-43			dBm	Amplifier set up for best IEEE802.11g performance; F _C =2412MHz; RF P _{OUT} =TBDdBm; IEEE802.11b CCK 11Mbps Modulation, T=+25°C, Measured at F _C -22MHz
IEEE802.11b/g Spectral Mask per FCC Part 15.205	-43			dBm	Amplifier set up for best IEEE802.11g performance; F _C =2462MHz; RF P _{OUT} =TBDdBm; IEEE802.11b CCK 11Mbps Modulation, T=+25°C, Measured at F _C +22MHz
Turn-On Time			1.0	μ Sec	Output stable to within 90% of final gain
Turn-Off Time			1.0	μ Sec	Output stable to within 90% of final gain
5.0GHz Transmit					
Compliance					T=+25°C, V _{CC(a)} =3.3V, PAEN_a=2.85V, Freq=4.9GHz to 5.85GHz, unless otherwise noted.
Frequency	4.9		5.85	GHz	IEEE802.11a IEEE802.11j FCC CFR 15.247, 0.205, 0.209
Output Power		16		dBm	With a standard IEEE802.11a waveform, OFDM, 54Mbits/s, 64 QAM
EVM*		4	6	%	At 16dBm output power, RMS, mean with a standard IEEE802.11a waveform, OFDM, 54Mbits/s, 64 QAM at rated output power
Output Power		13		dBm	At 13dBm, 11g output power, with a standard IEEE802.11a waveform, OFDM, 54Mbits/s, 64 QAM
EVM		2		%	At 13dBm, 11g output power, with a standard IEEE802.11a waveform, OFDM, 54Mbits/s, 64 QAM
Gain	23	25		dB	
Gain Variance		±2.0		dB	
Power Detect					
Voltage Range	0.7	1.5	TBD	V	At P _{OUT} range of 0dBm to 16dBm with a standard IEEE802.11a waveform.
Output Resistance		10		k Ω	
Output Capacitance		1		pF	
Bandwidth		8		MHz	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
5.0GHz Transmit, cont.					
Sensitivity					
>10dBm	25			mV/dB	
0 < P _{OUT} < 10dBm	8			mV/dB	
Current Operating		150		mA	RF P _{OUT} = +16dBm, RMS, mean with a standard IEEE802.11g waveform, OFDM, 54Mbps/s, 64 QAM at rated output power
Idle Current		90		mA	V _{CC} = 3.3V, PA EN_a = 2.85V, RF = OFF
IPAEN_a		8		mA	
Shutdown		5		μA	
PAEN_a Supply Voltage	3.0	3.3	3.6	V	
PA EN_a Voltage	2.8	2.85	2.9	V	PAEN_a is in the high state (ON)
	-0.2		+0.2	V	PAEN_a is in the off state (OFF)
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.
Input Impedance		50		Ω	
Output Impedance		50		Ω	
Stability Output VSWR	3:1				Stable, max spurious -47 dBm Conditions: max operating voltage, max input power
Ruggedness Output VSWR	10:1				No damage, conditions: max operating voltage, max input power
Second Harmonic	-30			dBm	At P _{OUT} = +16dBm, measured in 1MHz RBW with 6Mbps 11a signal, Fundamental Frequency is between 4.9GHz to 5.299GHz.
	-43			dBm	At P _{OUT} = +16dBm, measured in 1MHz RBW with 6Mbps 11a signal, Fundamental Frequency is between 5.3GHz to 5.85GHz.
IEEE802.11a Spectral Mask per FCC Part 15.205	-43			dBm	Amplifier set up for best IEEE802.11a performance; F _C = 5180MHz; RF P _{OUT} = +16dBm; T = +25 °C, Measured at 5150MHz
IEEE802.11a Spectral Mask per FCC Part 15.205	-43			dBm	Amplifier set up for best IEEE802.11a performance; F _C = 5320MHz; RF P _{OUT} = +16dBm; T = +25 °C, Measured at 5350MHz
Turn-On Time			1.0	μSec	Output stable to within 90% of final gain
Turn-Off Time			1.0	μSec	Output stable to within 90% of final gain
Antenna Port Impedance					
	Input		50	Ω	
Output		50		Ω	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Receive					
Compliance					IEEE802.11b IEEE802.11g FCC CFR 15.247, 0.205, 0.209
Frequency	2.4		2.5	GHz	
Insertion Loss		2.0		dB	SPDT switch + diplexer
Noise Figure		2.0		dB	SPDT switch + diplexer
Passband Ripple	-0.3		+0.3	dB	
Output Return Loss		-10		dB	
Current Consumption			30	μA	Switch leakage current
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.
5.0GHz Receive					
Compliance					IEEE802.11a IEEE802.11j FCC CFR 15.247, 0.205, 0.209
Frequency	4.9		5.85	GHz	
Insertion Gain		9		dB	
Noise Figure		4.5	4.9	dB	SPDT switch + diplexer
Input P1dB		TBD		dBm	
Input IP3		TBD		dBm	
Passband Ripple		±1		dB	
Output Return Loss		-10		dB	
Current Consumption		15		mA	
Switch Leakage Current			30	uA	
LNA V _{CC}	3.0		3.6	V	LNA V _{CC} is in the high state
	-0.2		+0.2	V	LNA V _{CC} is in the low state
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.

*The EVM specification includes a 0.5% to 0.7% source EVM floor.

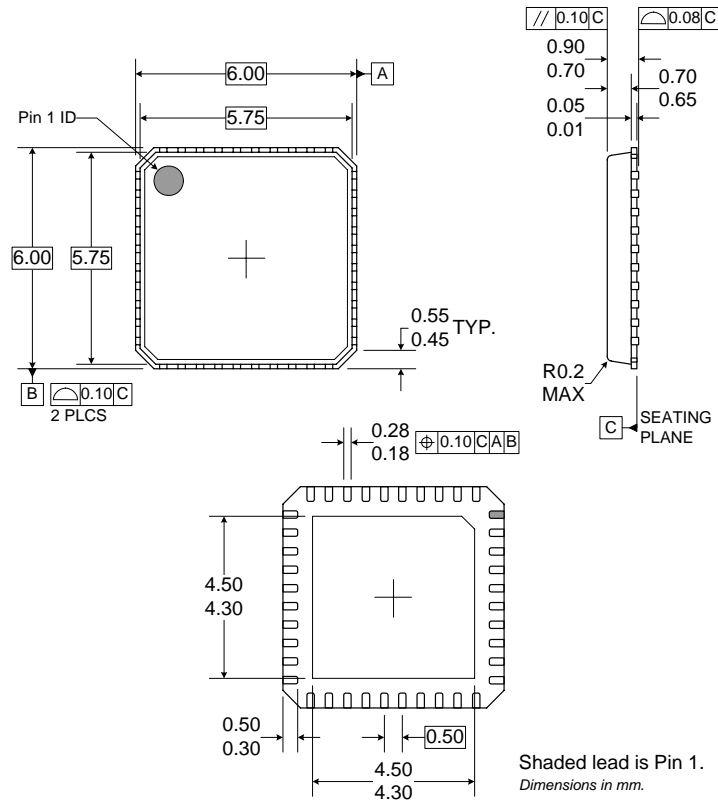
Pin	Function	Description	Interface Schematic
1	LNA VCC	5GHz LNA input voltage supply.	
2	GND	Ground connection.	
3	GND	Ground connection.	
4	PA EN_g	Bias voltage for the 802.11b/g PA. Internally decoupled port with approximately 100pF.	
5	GND	Ground connection.	
6	TX_g	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided internally.	
7	GND	Ground connection.	
8	TX_a	TX RF input for the 802.11a PA. Input is matched to 50Ω and DC block is provided internally.	
9	GND	Ground Connection.	
10	PA EN_a	Bias voltage for the 802.11a PA. Internally decoupled port with approximately 100pF.	
11	GND	Ground connection.	
12	GND	Ground connection.	
13	GND	Ground connection.	
14	VCC_g	Supply voltage for the 11b/g amplifier. Requires external decoupling capacitors for best performance.	
15	VCC_a	Supply voltage for the 11a amplifier. Requires external decoupling capacitors for best performance.	
16	VCC_g	Supply voltage for the 11b/g amplifier. Requires external decoupling capacitors for best performance.	
17	VCC_a	Supply voltage for the 11a amplifier. Requires external decoupling capacitors for best performance.	
18	VCC_a	Supply voltage for the 11a amplifier. Requires external decoupling capacitors for best performance.	
19	PDET_a	Power detector voltage for the 802.11a PA. Pdetect voltage varies with output power. May need external decoupling capacitor for module stability. May need resistive voltage divider to bring output voltage to desired level.	
20	PDET_g	Power detector voltage for the 802.11b/g PA. Pdetect voltage varies with output power. May need external decoupling capacitor for module stability. May need resistive voltage divider to bring output voltage to desired level.	
21	GND	Ground connection.	
22	GND	Ground connection.	
23	NC	No Connect.	
24	GND	Ground connection.	
25	VCC_g	Supply voltage for the 11b/g amplifier. Requires external decoupling capacitors for best performance.	
26	VCC_g	Supply voltage for the 11b/g amplifier. Requires external decoupling capacitors for best performance.	
27	SW1	Switch control port. (See Switch Truth table.)	
28	ANT	Antenna port. This port is matched to 50Ω and DC block is <i>not</i> provided internally.	
29	GND	Ground connection.	
30	NC	No Connect.	
31	SW2	Switch control port. (See Switch Truth table.)	
32	GND	Ground connection.	
33	GND	Ground connection.	
34	GND	Ground connection.	

Pin	Function	Description	Interface Schematic
35	GND	Ground connection.	
36	RX_g	Receive port for 802.11b/g band. Internally matched to 50Ω and DC block is not provided internally.	
37	GND	Ground connection.	
38	RX_a	Receive port for 802.11a band. Internally matched to 50Ω and DC block is provided internally.	
39	GND	Ground connection.	
40	GND	Ground connection.	
Pkg Base	GND	Ground connection. The back side of the package should be connected to ground plane through as short a connection as possible (e.g., PCB vias under the device are recommended).	

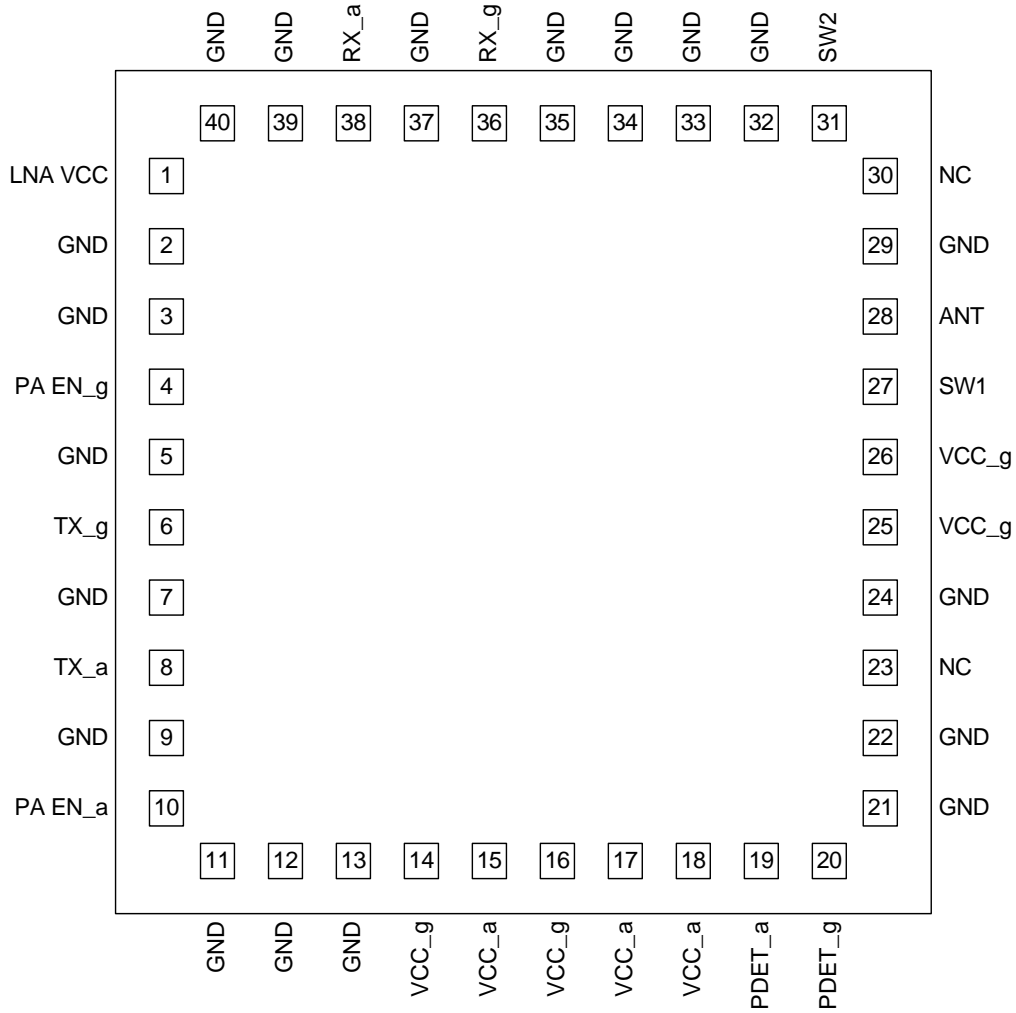
Switch Truth Table

Mode #	Description	SW1	SW2	PA EN_a	PA EN_g	LNA EN
1	Transmit, 2.4GHz	H	L	L	H	L
2	Receive, 2.4GHz	L	H	L	L	L
3	Transmit, 5.0GHz	H	L	H	L	L
4	Receive, 5.0GHz	L	H	L	L	H

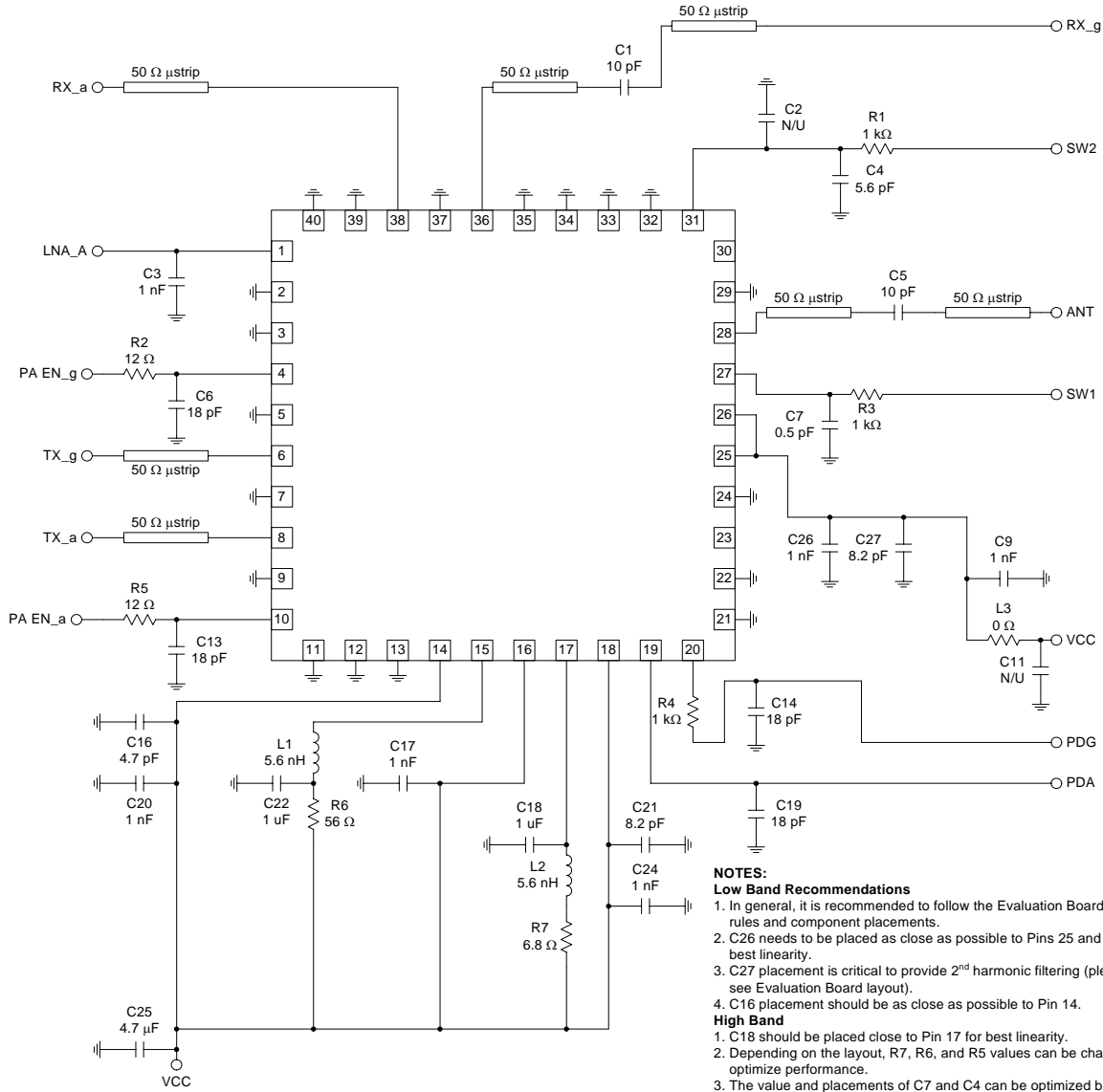
Package Drawing



Pin Out (Top View)

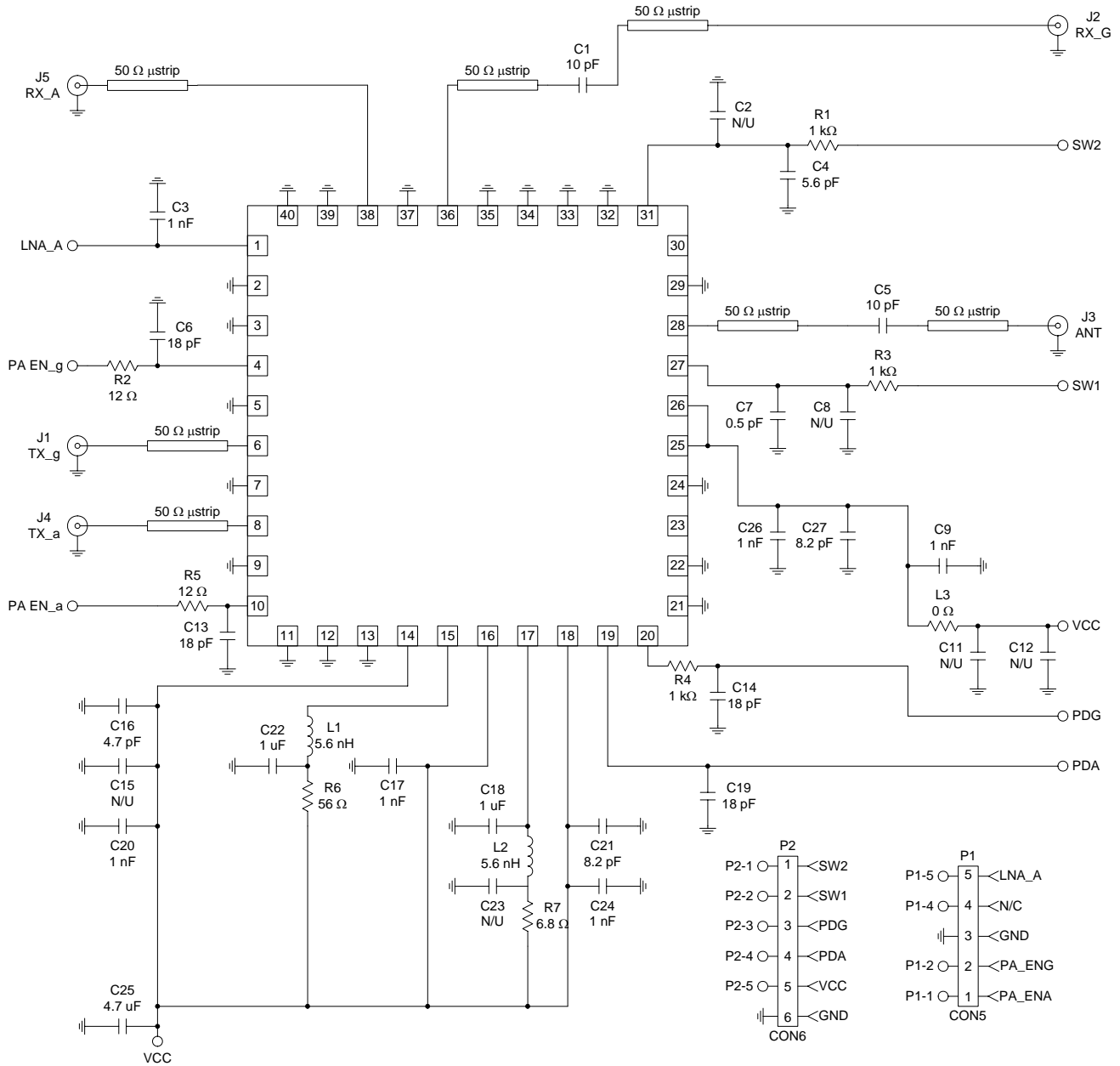


Application Schematic



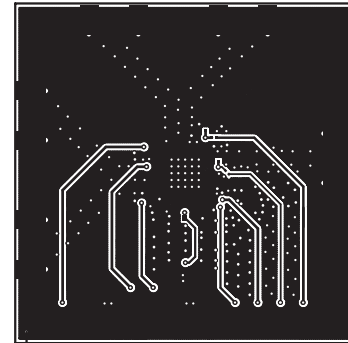
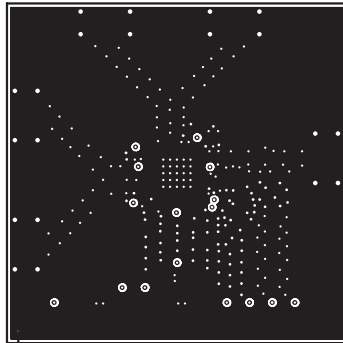
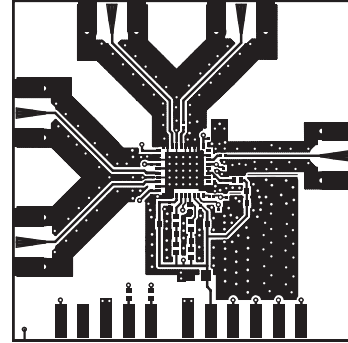
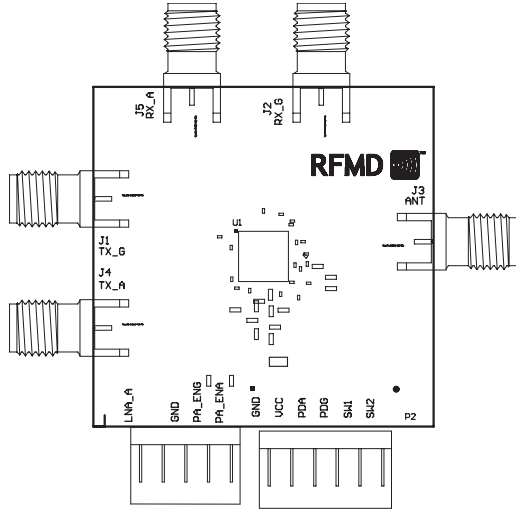
- NOTES:**
- Low Band Recommendations**
1. In general, it is recommended to follow the Evaluation Board layout rules and component placements.
 2. C26 needs to be placed as close as possible to Pins 25 and 26 for best linearity.
 3. C27 placement is critical to provide 2nd harmonic filtering (please see Evaluation Board layout).
 4. C16 placement should be as close as possible to Pin 14.
- High Band**
1. C18 should be placed close to Pin 17 for best linearity.
 2. Depending on the layout, R7, R6, and R5 values can be changed to optimize performance.
 3. The value and placements of C7 and C4 can be optimized based on the layout for best performance.

Evaluation Board Schematic

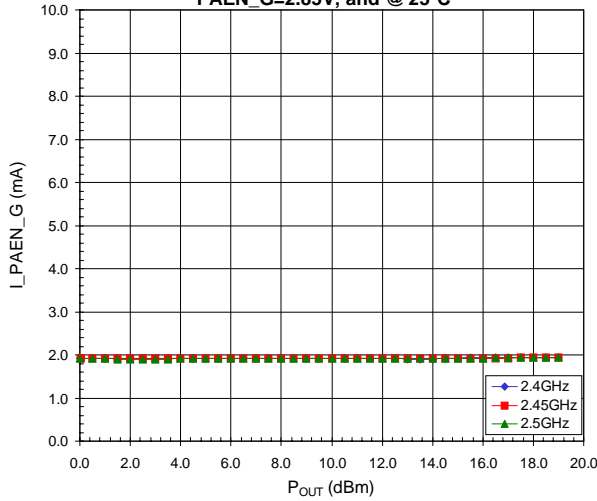


Evaluation Board Layouts
Board Size 1.5" x 1.5"

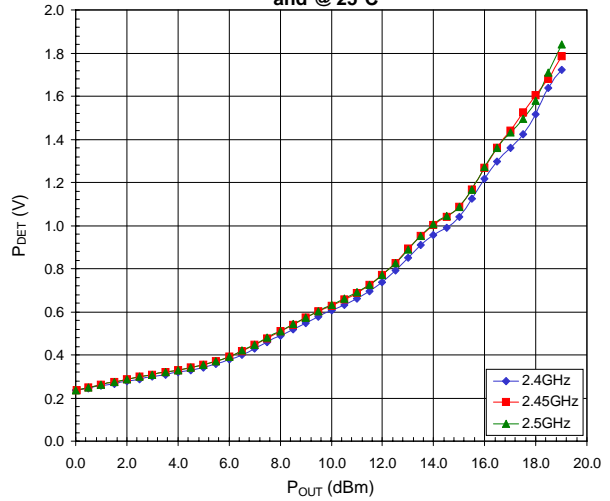
Board Thickness 0.032", Board Material FR-4, Multi-Layer



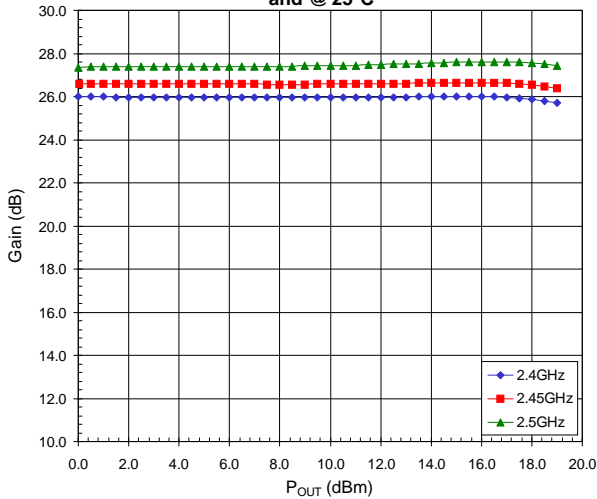
Typical I_{PAEN_G} versus P_{OUT} @ $V_{CC}=3.3V$, $PAEN_G=2.85V$, and @ $25^{\circ}C$



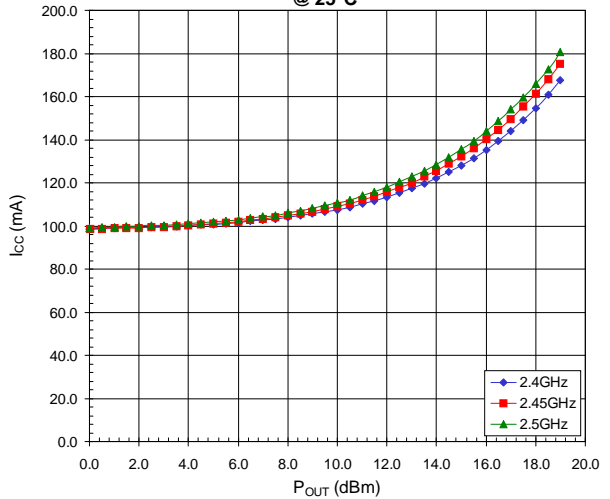
Typical P_{DET} versus P_{OUT} @ $V_{CC}=3.3V$, $PAEN_G=2.85V$ and @ $25^{\circ}C$



Typical Gain versus P_{OUT} @ $V_{CC}=3.3V$, $PAEN_G=2.85V$, and @ $25^{\circ}C$



Typical I_{CC} versus P_{OUT} @ $V_{CC}=3.3V$, $PAEN_G=2.85V$, and @ $25^{\circ}C$



Typical EVM versus P_{OUT} @ $V_{CC}=3.3V$, $PAEN_G=2.85V$, and @ $25^{\circ}C$

