

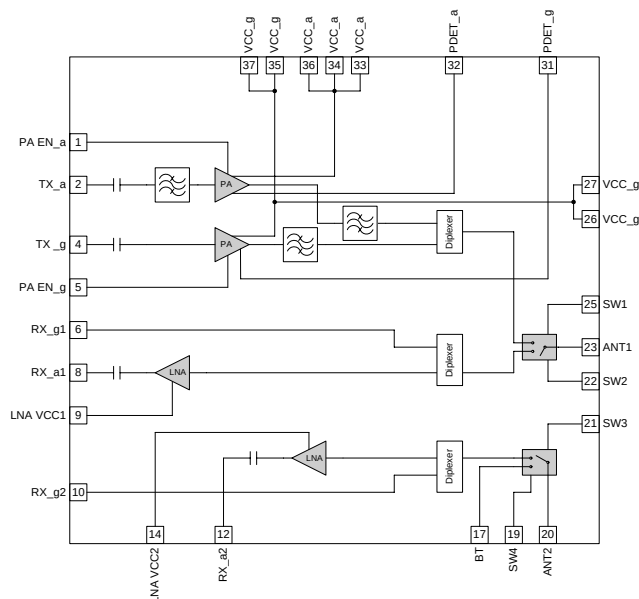


Features

- Single 1x2 11n MIMO FEM
- Single Supply Voltage 3.0V to 3.6V
- Integrated 2.5GHz & 5GHz PA's, Duplexers, Filters & Switches for TX & RX
- $P_{OUT} = 18\text{dBm}$, 11g, OFDM @ <4% EVM
 $P_{OUT} = 16\text{dBm}$, 11a, OFDM 4% Typ EVM

Applications

- IEEE802.11a/b/g/n Applications
- Single-Chip RF Front-End Module
- 2.5GHz and 5GHz ISM Bands Applications
- Wireless LAN Systems
- Portable Battery-Powered Equipment
- Supports 1x2 11n MIMO Applications



Functional Block Diagram

Product Description

The RF5389 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 RF5389 addresses the need for aggressive size reduction for typical 802.11a/b/g and 1x2 11n MIMO 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 and 11n solution. The RF5389 contains integrated PA's for 2.5GHz and 5GHz, duplexers, TX/RX switch, dual LNA's for high receive bands, matching components, some bypass capacitors, built-in power detector for both bands, and filtering for transmit and receive paths. The RF5389 is packaged in a 40-pin, 6mmx6mmx0.95mm QFN package with backside ground which greatly minimizes next level board space and allows for simplified integration.

Ordering Information

RF5389	3.3V, Dual-Band Front-End Module
RF5389PCBA-410	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 BIT

Absolute Maximum Ratings

Parameter	Rating	Unit
Supply Voltage	-0.3 to +4.0	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 EUDirective2002/95/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, Pulsed at 1% to 100% duty cycle, 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	With a standard IEEE802.11g waveform @ 54Mbps, 64 QAM
EVM*		2		%	At 14dBm, 11g output power, rated 11g P _{OUT} , RMS, Mean with a standard IEEE802.11g waveform, OFDM, 54Mbps, 64 QAM
Output Power		18		dBm	With a standard IEEE802.11g waveform @ 54Mbps, 64 QAM
EVM*		4		%	At rated 11g P _{OUT} , RMS, Mean with a standard IEEE802.11g waveform, OFDM, 54Mbps, 64 QAM
Output Power		20		dBm	With a standard IEEE802.11b waveform @ 11Mbps, CCK
Gain	24	26		dB	
Gain Variance		±2.0		dB	Over Temperature and Frequency
Power Detect					
P _{DET} Voltage Range	0.1	1.8	TBD	V	P _{OUT} =0dBm to 20dBm in 11b mode with 11Mbps
P _{DET} Output Resistance		10		kΩ	
P _{DET} Output Capacitance		5		pF	
P _{DET} Bandwidth		8		MHz	
P _{DET} 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

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

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit, cont.					
Idle Current		100		mA	
PAEN_g Current		3		mA	V _{CC} =ON, PAEN_g=ON, and RF=ON
Shutdown		5		uA	V _{CC} =ON, PAEN_g=OFF, and RF=OFF
V _{CC} (Power Supply)	3.0	3.3	3.6	V	
PA EN_g Voltage	2.8	2.85	2.9	V	PAEN_g 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@18dBm P _{OUT} , RBW=1MHz, average detector tested with 1Mbps
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
5.0GHz Transmit					T=+25 °C, V _{CC} (a)=3.3V, PAEN_a=2.85V, Pulsed at 1% to 100% duty cycle, Freq=4.9GHz to 5.85GHz, unless otherwise noted.
Compliance					IEEE802.11a IEEE802.11j FCC CFR 15.247, 0.205, 0.209
Frequency	4.9		5.85	GHz	
Output Power		16		dBm	With a standard IEEE802.11a waveform, OFDM, 54Mbps/s, 64 QAM
EVM*		4	6	%	RMS, mean with a standard IEEE802.11a waveform, OFDM, 54Mbps/s, 64 QAM at 16dBm output power
Output Power		13		dBm	With a standard IEEE802.11a waveform, OFDM, 54Mbps/s, 64 QAM
EVM*		2		%	RMS, mean with a standard IEEE802.11a waveform, OFDM, 54Mbps/s, 64 QAM at 13dBm output power
Gain	23	25		dB	
Gain Variance		±2.0		dB	
Power Detect					
P _{DET} Voltage Range	0.7	1.5	TBD	V	P _{OUT} =0dBm to 16dBm in 11a mode with 54Mbps
P _{DET} Output Resistance		10		kΩ	
P _{DET} Output Capacitance		5		pF	
P _{DET} Bandwidth		8		MHz	

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

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
5.0GHz Transmit, cont.					
P _{DET} 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	
PAEN_a Current		8		mA	V _{CC} =ON, PAEN_a=ON, and RF=ON
Shutdown		5		μA	V _{CC} =ON, PAEN_a=OFF, and RF=OFF
V _{CC} (Power Supply)	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	Fundamental frequency is between 4900MHz and 5299MHz at P _{OUT} = +16dBm measured with 6Mbps
			-43	dBm	Fundamental frequency is between 5300MHz and 5825MHz at P _{OUT} = +16dBm measured with 6Mbps
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 @ 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 @ 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, RX_g1 and RX_g2					
Compliance					IEEE802.11b IEEE802.11g IEEE802.11n FCC CFR 15.247, 0.205, 0.209
Frequency	2.4		2.5	GHz	
Insertion Loss		2.3		dB	SPDT switch + diplexer, 2.4GHz to 2.5GHz
Noise Figure		2.3		dB	SPDT switch + diplexer, 2.4GHz to 2.5GHz
Passband Ripple	-0.3		+0.3	dB	
Output Return Loss		-10		dB	
Current Consumption		15		μA	
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.
Switch Leakage			30	μA	
5.0GHz Receive, RX_a1 and RX_a2					
Compliance					IEEE802.11a IEEE802.11j FCC CFR 15.247, 0.205, 0.209
Frequency	4.9		5.9	GHz	
Insertion Gain		8		dB	
Noise Figure		4.9		dB	SPDT switch + diplexer + LNA
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
5.0GHz Receive, RX_a1 and RX_a2, cont.					
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.
Bluetooth					
Frequency	2.4		2.5	GHz	
Insertion Loss			1.0	dB	SPDT switch
Passband Ripple	-0.2		+0.2	dB	
Input/Output Power			8	dBm	
Output Return Loss		-10		dB	
Output Impedance		50		Ω	No external matching
Current Consumption		15		μA	
Switch Voltages	3.0		3.6	V	Switch voltage in the high state.
	0		0.2	V	Switch voltage in the low state.

Pin	Function	Description
1	PA EN_a	Bias voltage for the 802.11a PA. Internally decoupled port with approximately 100pF.
2	TX_a	TX RF input for the 802.11a PA. Input is matched to 50Ω and DC block is provided internally.
3	NC	Not connected.
4	TX_g	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.
5	PA ENG	Bias voltage for the 802.11b/g PA. Internally decoupled port with approximately 100pF.
6	RX_g1	Receive port for 802.11b/g band. Internally matched to 50Ω.
7	GND	Ground connection.
8	RX_a1	Receive port for 802.11a band. Internally matched to 50Ω and DC block is provided internally.
9	LNA VCC1	Voltage supply for the LNA.
10	RX_g2	Receive port for 802.11b/g band. Internally matched to 50Ω.
11	GND	Ground connection.
12	RX_a2	Receive port for 802.11a band. Internally matched to 50Ω and DC block is provided internally.
13	NC	Not connected.
14	LNA VCC2	Voltage supply for the LNA.
15	NC	Not connected.
16	GND	Ground connection.
17	BT	Bluetooth receive port.
18	GND	Ground connection.
19	SW4	Switch control port.
20	ANT2	RF output. This port is matched to 50Ω and DC block is provided internally.
21	SW3	Switch control port.
22	SW2	Switch control port.
23	ANT1	RF output. This port is matched to 50Ω and DC block is provided internally.
24	GND	Ground connection.
25	SW1	Switch control port. (See Switch Truth table for operation.)
26	VCC_g	Supply voltage for the IEEE802.11b/g PA. Requires external decoupling capacitors for best performance.
27	VCC_g	Supply voltage for the IEEE802.11b/g PA. Requires external decoupling capacitors for best performance.
28	GND	Ground connection.
29	GND	Ground connection.
30	GND	Ground connection.
31	PDET_g	Power detector voltage for the 802.11b/g PA. PDET 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.
32	PDET_a	Power detector voltage for the 802.11a PA. PDET 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.
33	VCC_a	Supply voltage for the IEEE802.11a PA. Requires external decoupling capacitors for best performance.
34	VCC_a	Supply voltage for the IEEE802.11a PA. Requires external decoupling capacitors for best performance.
35	VCC_g	Supply voltage for the IEEE802.11b/g PA. Requires external decoupling capacitors for best performance.
36	VCC_a	Supply voltage for the IEEE802.11a PA. Requires external decoupling capacitors for best performance.
37	VCC_g	Supply voltage for the bias reference circuit. Requires external decoupling capacitors for best performance.

Pin	Function	Description
38	GND	Ground connection.
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).

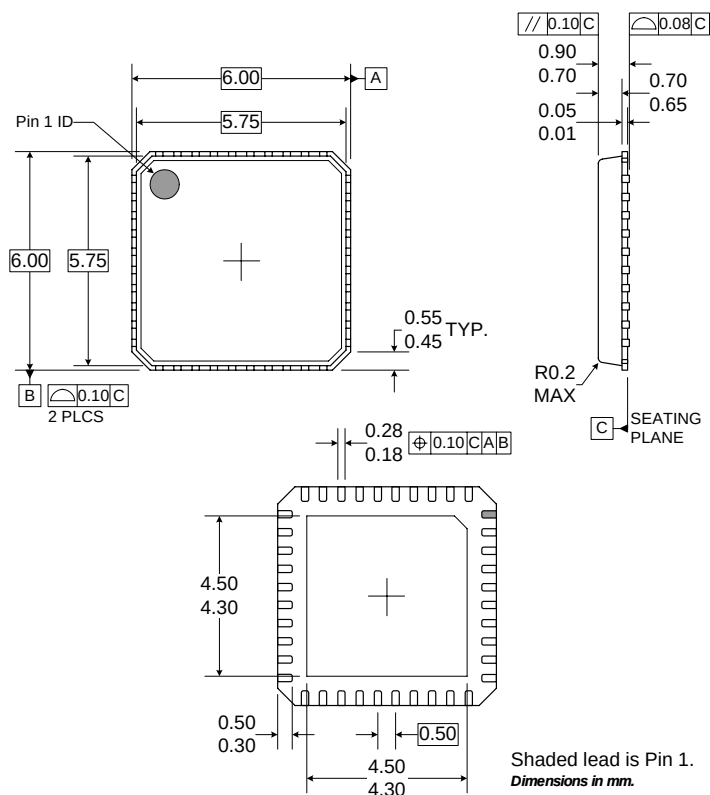
Switch Truth Table for Transmit and Receive Path 1 (ANT1)

Mode #	Description	SW1	SW2	PA EN_a	PA EN_g	LNA VCC1
1	Transmit, 2.4GHz	L	H	L	H	L
2	Receive, 2.4GHz	H	L	L	L	L
3	Transmit, 5.0GHz	L	H	H	L	L
4	Receive, 5.0GHz	H	L	L	L	H

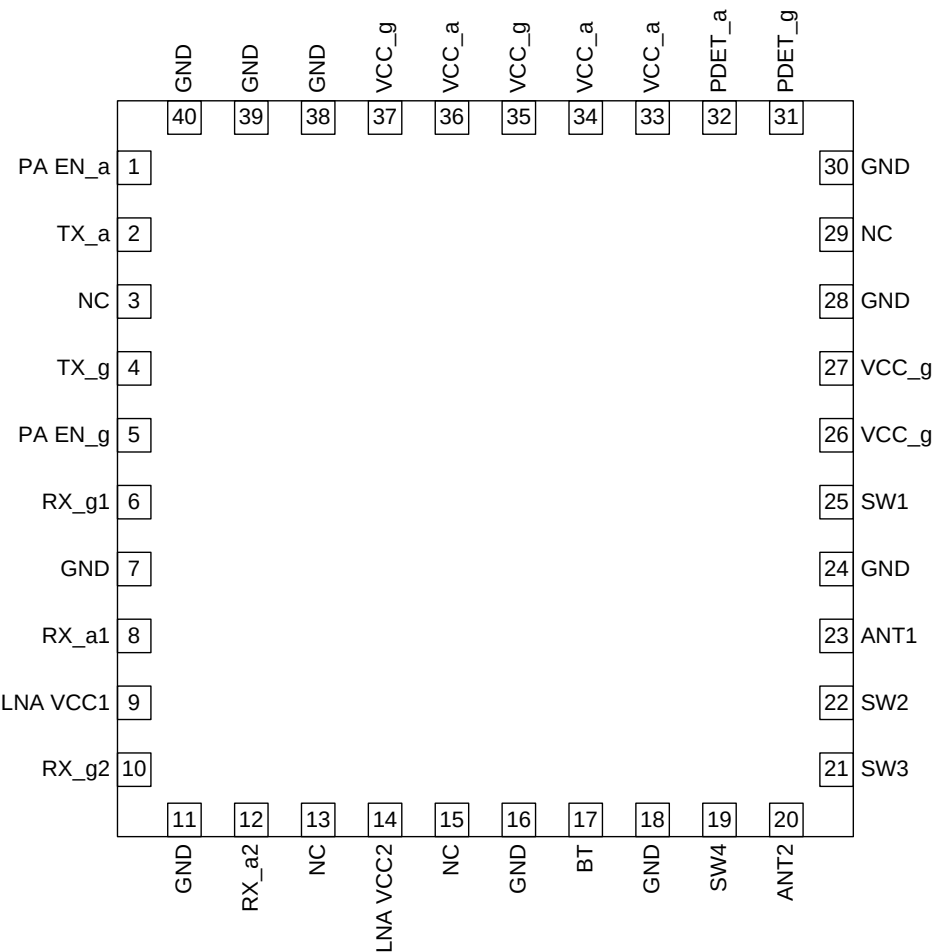
Switch Truth Table for Receive Path 2 (ANT2)

Mode #	Description	SW3	SW4	LNA VCC2
1	Receive, 2.4GHz	H	L	L
2	Receive, 5.0GHz	H	L	H
3	Receive, BT	L	H	L

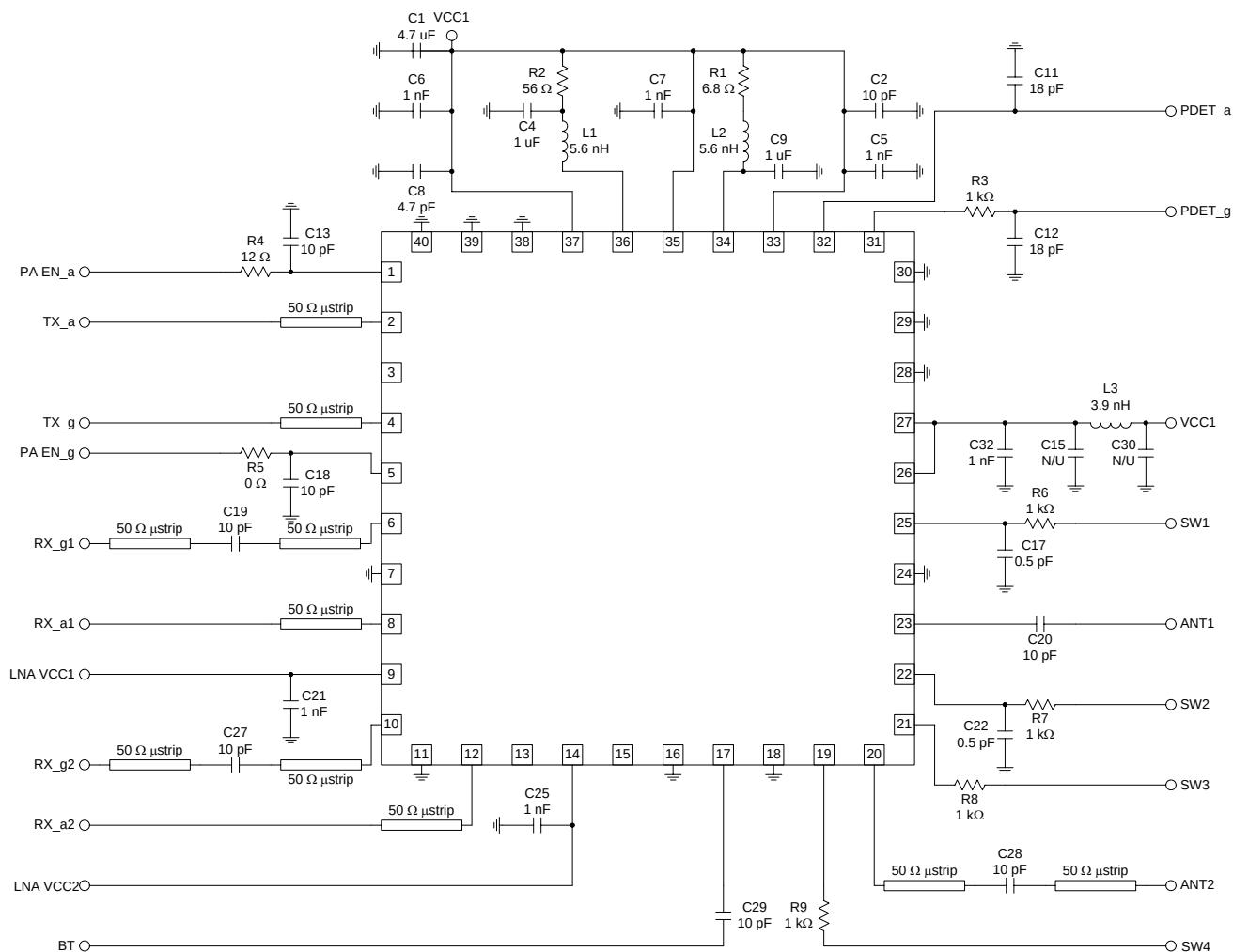
Package Drawing



Pin Out
(Top View)



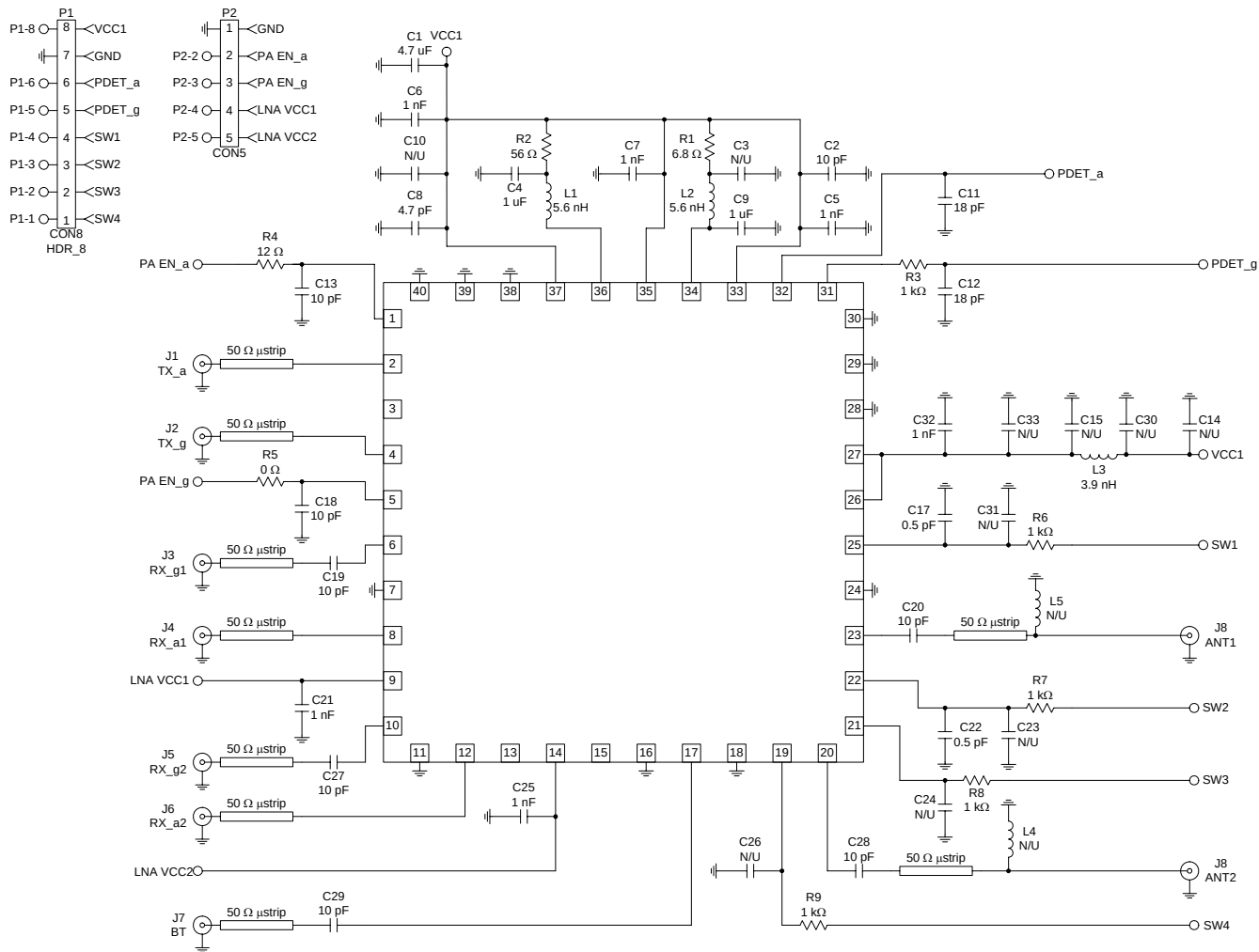
Application Schematic



NOTES:

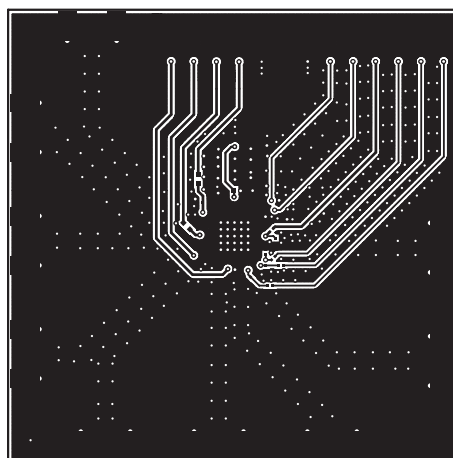
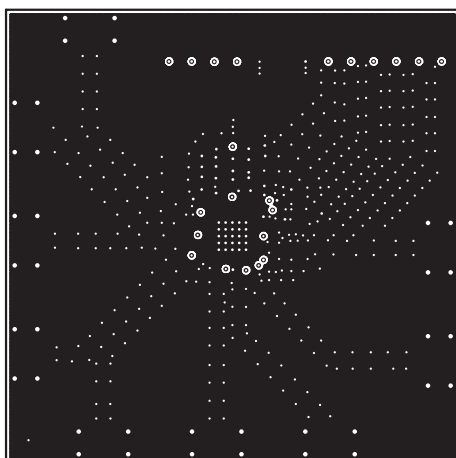
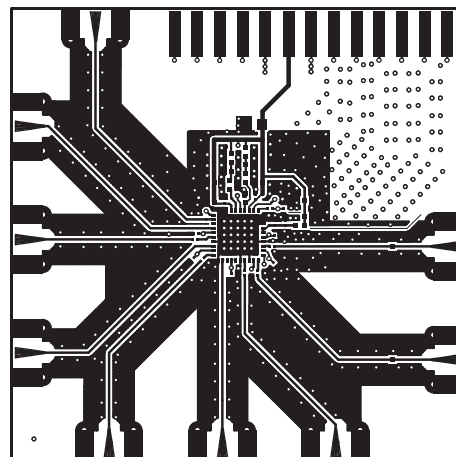
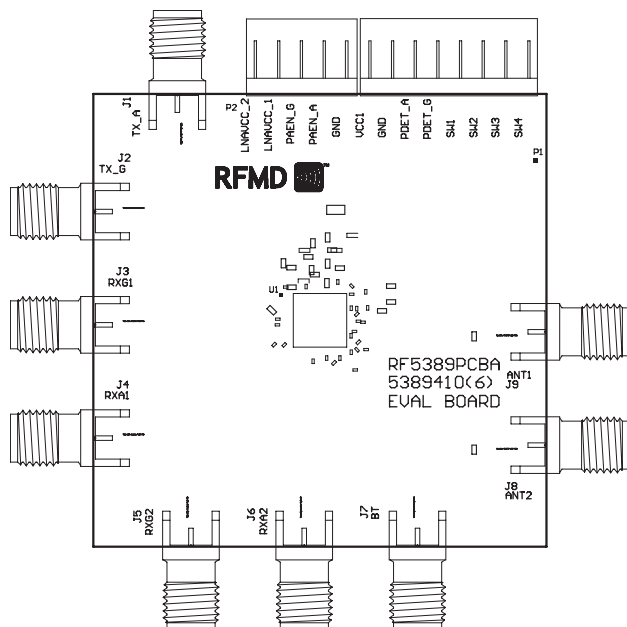
1. It is recommended that C32 is placed close to pins 26 and 27.
2. It is recommended that C9 is placed close to pin 34.
3. It is recommended that C8 is placed close to pin 37.
4. It is recommended that C17 is placed close to pin 25, and C22 placed close to pin 22.

Evaluation Board Schematic

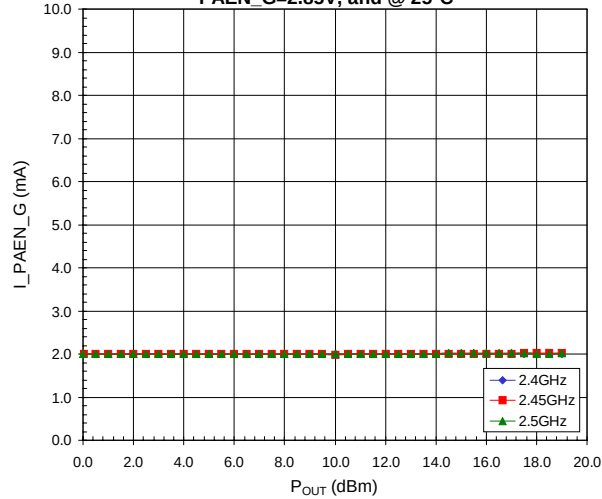


Evaluation Board Layouts Board Size 2.0" x 2.0"

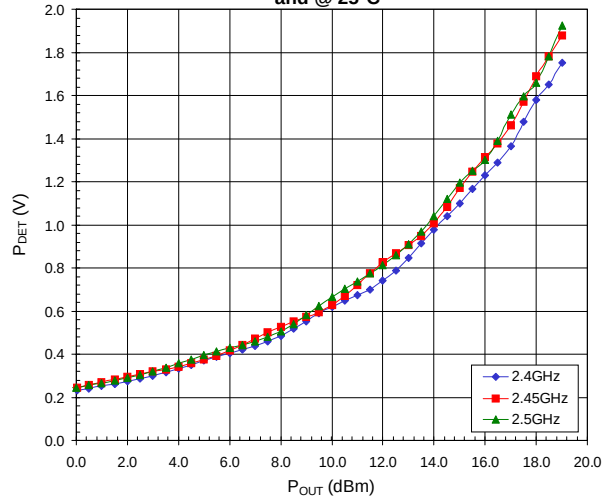
Board Thickness 0.032", Board Material FR-4, Multi-Layer



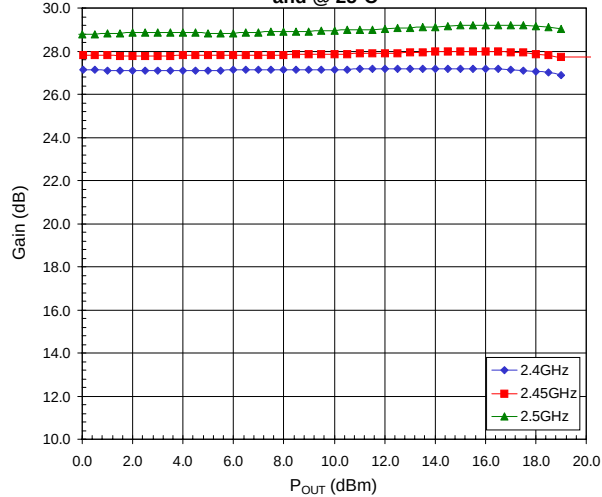
Typical I_{PAEN_G} versus P_{OUT} @ V_{CC}=3.3V,
PAEN_G=2.85V, and @ 25°C



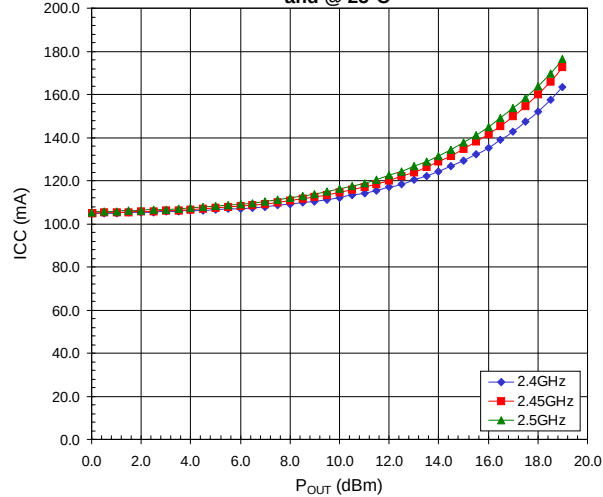
Typical P_{DET} versus P_{OUT} @ V_{CC}=3.3V, PAEN_G=2.85V,
and @ 25°C



Typical Gain versus P_{OUT} @ V_{CC}=3.3V PAEN_G=2.85V,
and @ 25°C



Typical ICC versus P_{OUT} @ V_{CC}=3.3V, PAEN_G=2.85V,
and @ 25°C



Typical EVM versus P_{OUT} @ V_{CC}=3.3V, PAEN_G=2.85V,
and @ 25°C

