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RF5565

2.4GHz TO 2.5GHz, 802.11b/g/n WiFi FRONT END MODULE

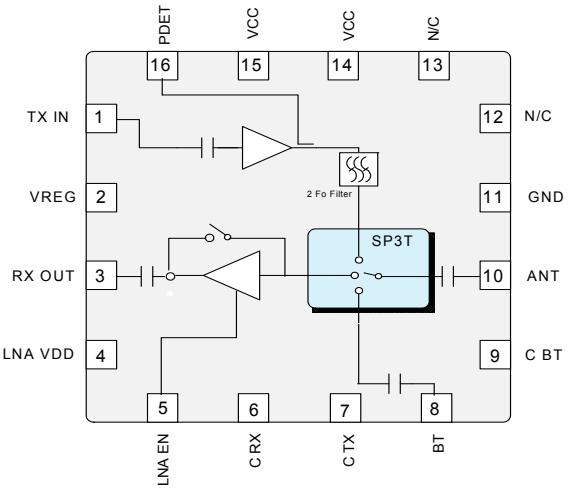
Package Style: QFN, 16-pin, 3mmx3mmx0.5mm

Features

- Integrated 2.4GHz to 2.5GHz b/g/n Amplifier, LNA, SP3T Switch, and Power Detector Coupler
- Single Supply Voltage 3.0V to 4.8V
- P_{OUT}=19.5dBm, 11g, OFDM at <3.3% EVM, 22dBm 11b Meeting 11b Spectral Mask
- Low Height Package, Suited for SiP and CoB Designs

Applications

- Cellular handsets
- Mobile devices
- Tablets
- Consumer electronics
- Gaming
- Netbooks/Notebooks
- TV/monitors/video
- SmartEnergy



Functional Block Diagram

Product Description

The RF5565 provides a complete integrated solution in a single Front End Module (FEM) for WiFi 802.11b/g/n and *Bluetooth*® systems. The ultra small form factor and integrated matching greatly reduces the number of external components and layout area in the customer application. This simplifies the total Front End solution by reducing the bill of materials, system footprint, and manufacturability cost. The RF5565 integrates a 2.4GHz Power Amplifier (PA), Low Noise Amplifier (LNA) with bypass mode, power detector coupler for improved accuracy, and some filtering for harmonic rejection. The device is provided in a 3mmx3mmx0.5mm, 16-pin package. This module meets or exceeds the RF Front End needs of IEEE 802.11b/g/n WiFi RF systems.

Ordering Information

RF5565SQ	Standard 25 pieces sample bag
RF5565SR	Standard 100 pieces reel
RF5565TR7	Standard 2500 pieces reel
RF5565PCK-410	Fully assembled evaluation board with 5-piece bag

Optimum Technology Matching® Applied

☐ GaAs HBT	☐ SiGe BiCMOS	☑ GaAs pHEMT	☐ GaN HEMT
☐ GaAs MESFET	☐ Si BiCMOS	☐ Si CMOS	☐ RF MEMS
☑ InGaP HBT	☐ SiGe HBT	☐ Si BJT	☐ LDMOS

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (Continuous with No Damage)	5.4	V
DC Supply Current	500	mA
Case Temperature (Full Spec. Compliant)	-10 to +70	°C
Extreme Operating Case Temperature (Reduced Performance)	-40 to -10 +70 to +85	°C
Storage Temperature	-40 to +150	°C
Maximum TX Input Power into 50Ω Load for 11b/g/n (No Damage)	0	dBm
Maximum RX Input Power (No Damage)	0	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).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247,.205,.209, EN, and JDEC
Nominal Conditions					V_{CC}=3.3V to 4.2V; V_{REG}=3V to 3.2V; Switch Control voltage=3V to 3.6V; Temp=-10°C to +70°C; Unless noted otherwise.
Frequency	2.4		2.5	GHz	
Power Supply	3.0	3.3	4.8	V	Voltage Supply Operating Range
V_{REG} Voltage					
ON	3.0	3.1	3.2	V	PA in "ON" state
OFF		0.00	0.20	V	PA in "OFF" state
Output Power					
11g	18	18.5		dBm	54Mbps, OFDM 54Mbps, V_{CC}≥3.0V
	18.5	19.5		dBm	54Mbps, OFDM 54Mbps, V_{CC}≥3.3V
11b	20	22		dBm	11Mbps, CCK, V_{CC}≥3.0V
EVM		3.3	4.0	%	$P_{OUT(g)}$=Rated Output Power, 54Mbps OFDM, 50Ω, see note 1
Adjacent Channel Power					$P_{OUT(b)}$=20dBm 11Mbps CCK, note 2
ACP1		-36	-33	dBc	Nominal conditions, meeting 11b spectral mask requirements
ACP2		-56	-51	dBc	
Gain	26	30	34.5	dB	
Gain Variation Slope					At rated power and a given supply voltage
Range	3.0		4.2	V	
V_{CC} (Average)			0.5	dB/V	
V_{CC} (Instantaneous)			1	dB/V	
Frequency	-0.5		+0.5	dB	2.4GHz to 2.5GHz

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters, cont.					
Typical Input Power					
11g		-9		dBm	
11b		-5		dBm	
Power Detect					
Power Range	0		23	dBm	
Voltage Range	0.1		1.5	V	
Resistance		10		kΩ	
Capacitance			10	pF	
Sensitivity					
$0<P_{OUT}<6$dBm	3			mV/dB	
$6<P_{OUT}<23$dBm	8		350	mV/dB	
Current Consumption					V_{CC}=3.3V, V_{REG}=3.1V, T=25°C
I_{CC}		170	200	mA	RF P_{OUT}=18.5dBm, 11g, 50Ω
		220	250	mA	RF P_{OUT}=20dBm, 11b, 50Ω
Quiescent Current		90		mA	RF="OFF"
I_{REG}			3	mA	V_{REG}>3.0V
V_{CC} Leakage Current		2	10	µA	V_{CC}=4.8V, V_{REG}=C_BT=C_RX=C_BWRX≤0.2V
Input Port Impedance		50		Ω	
Input Port Return Loss	10	15		dB	
Ruggedness					No Damage Conditions: max operating voltage, max input power, max temperature
Output VSWR			10:1		
Input Power			-5	dBm	
Stability					PA must be stable (no spurs above -43dBm) from 0 to 20dBm, All phase angles, no spurious or oscillations
Output VSWR	6:1				
Out-of-Band Emissions 2310MHz to 2390MHz and 2483.5MHz to 2500MHz			-41.25	dBm/MHz	P_{OUT}=16.5dBm, 54Mbps OFDM Modulation, 64QAM, RBW=1MHz, VBW=100kHz, V_{CC}=3.3V, V_{REG}=3.1V
			-41.25	dBm/MHz	P_{OUT}=20.5dBm, 11Mbps CCK Modulation, RBW=1MHz, VBW=100kHz, V_{CC}=3.3V, V_{REG}=3.1V
Thermal Resistance		20		°C/W	V_{CC} = 4.8, V_{REG} = 3.2V, P_{OUT}=20dBm, T_{REF}=85°C
Harmonics					11b modulation, 1Mbps, BW=1MHz, up to 3:1 load
Second			-23	dBm	4.80GHz to 5.00GHz
Third			-20	dBm	7.20GHz to 7.50GHz
Turn-on/off Time		0.5	1.0	µS	Output stable to within 90% of final gain, Note 1

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Receive Parameters					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247,.205,.209, EN, and JDEC
Frequency	2.4		2.5	GHz	
LNA Voltage Supply	3.0	3.3	4.8	V	LNA V_{DD} tied to V_{BATT} at all times
LNA Current	5	12	20	mA	LNA in "ON" state
	0		5	µA	LNA in "OFF" state (C_RX=low, LNA V_{DD}=ON)
LNA Input P1dB	-9	-5		dBm	
Gain					
WiFi RX Gain	11	14	16	dB	WiFi RX mode
Bypass Mode	-4			dB	WiFi Bypass Mode
Noise Figure					V_{CC}≥3.3V, including switch
WiFi RX		2.2	3.5	dB	
Bypass Mode		2.6	4	dB	
Passband Ripple	-0.5		+0.5	dB	WiFi RX Mode
	-0.5		+0.5	dB	WiFi Bypass Mode
WiFi RX Output Return Loss	9.6			dB	
WiFi RX Input Return Loss	5	7		dB	Measured at antenna port
WiFi RX Port Impedance		50		Ω	No external matching
Bluetooth Parameters					
Frequency	2.4		2.5	GHz	
Insertion Loss					
BT TX/RX		0.9	1.2	dB	Bluetooth mode (measured ANT to BT port)
Passband Ripple	-0.2		+0.2	dB	Bluetooth mode
Bluetooth Output Return Loss	9.6			dB	Switch in Bluetooth Mode
Input P1dB		28		dBm	
Other Requirements					
Antenna Port Impedance					
Output		50		Ω	
Return Loss	5	7		dB	
Isolation					
Antenna to Receive	20			dB	In BT Mode (measured from ANT to RX port)
Antenna to *Bluetooth*®	20			dB	In TX Mode (measured from ANT to BT port)
Antenna to Receive	20			dB	In TX Mode (measured from ANT to RX port)
Switch Control Voltage					C RX, C BT, and C_TX control lines
Low		0	0.2	V	Switch is in the low state (L)
High	3.0		3.6	V	Switch is in the high state (H)
Switch Control Current		2	10	µA	Per control line
LNA_EN Control Current		60	100	µA	Over V_{CC}, Frequency and Temperature.
Switch Control Speed			10	nsec	
Switch P1dB		28		dBm	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Other Requirements, cont.					
ESD					
Human Body Model	500			V	EIA/JESD22-114A RF pins
	1000			V	EIA/JESD22-114A DC pins
Charge Device Model	500			V	JESD22-C101C all pins

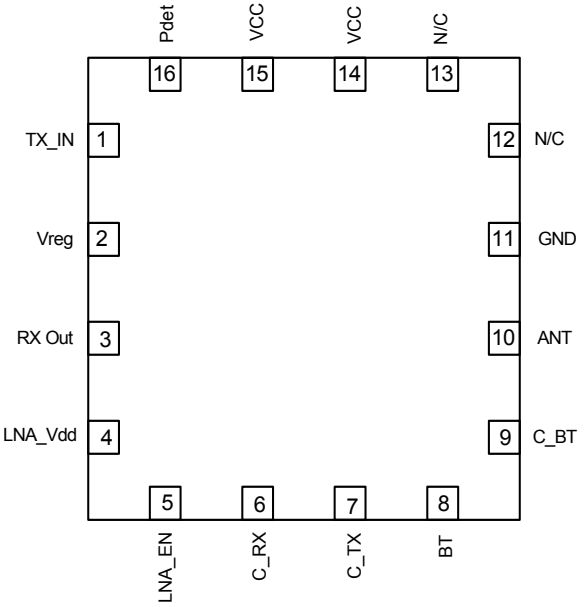
Note 1: The PA module must operate with gated bias voltage input at 1% to 99% duty cycle.
Note 2: The output power for channels 1 and 11 may be reduced to meet FCC restricted band requirements.

Switch Control Logic

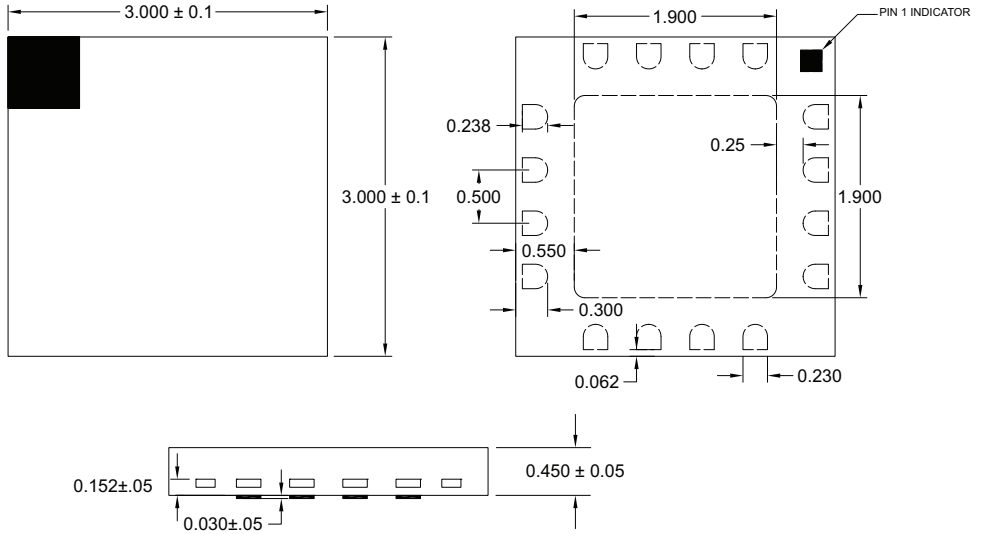
Mode	C_TX	C_RX	C_BT	VREG	LNA_EN
Transmit	H	L	L	H	L
Receive	L	H	L	L	H
Bypass	L	H	L	L	L
Bluetooth	L	L	H	L	L
Standby	L	L	L	L	L
Logic Voltage Levels	H	3.0V to 3.6V			
	L	<0.2V			

Pin	Function	Description
1	TX_IN	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.
2	VREG	Regulated voltage for the bias control circuit. An external bypass capacitor may be needed on the V_{REG} line for decoupling purposes.
3	RX OUT	Receive port for 802.11b/g band. Internally matched to 50Ω. DC block provided.
4	LNA VDD	Voltage supply for the LNA.
5	LNA_EN	Control voltage for the LNA. When this pin is set to a LOW logic state, the bypass mode is enabled.
6	C RX	Receive switch control pin. See switch truth table for proper level.
7	C_TX	Switch control voltage for the transmit branch. See logic control table for proper settings.
8	BT	RF bidirectional port for *Bluetooth*®. Input is matched to 50Ω and DC block is provided.
9	C_BT	*Bluetooth*® switch control pin. See truth table for proper level.
10	ANT	Port matched to 50Ω and is DC blocked internally.
11	GND	Ground.
12	N/C	No connect.
13	N/C	No connect.
14	VCC	Supply voltage for the PA.
15	VCC	Supply voltage for the PA.
16	PDETECT	Power detector voltage for TX section. PDET voltage varies with output power. May need external decoupling capacitor for noise bypassing. May need external circuitry to bring output voltage to desired level.

Pin Out

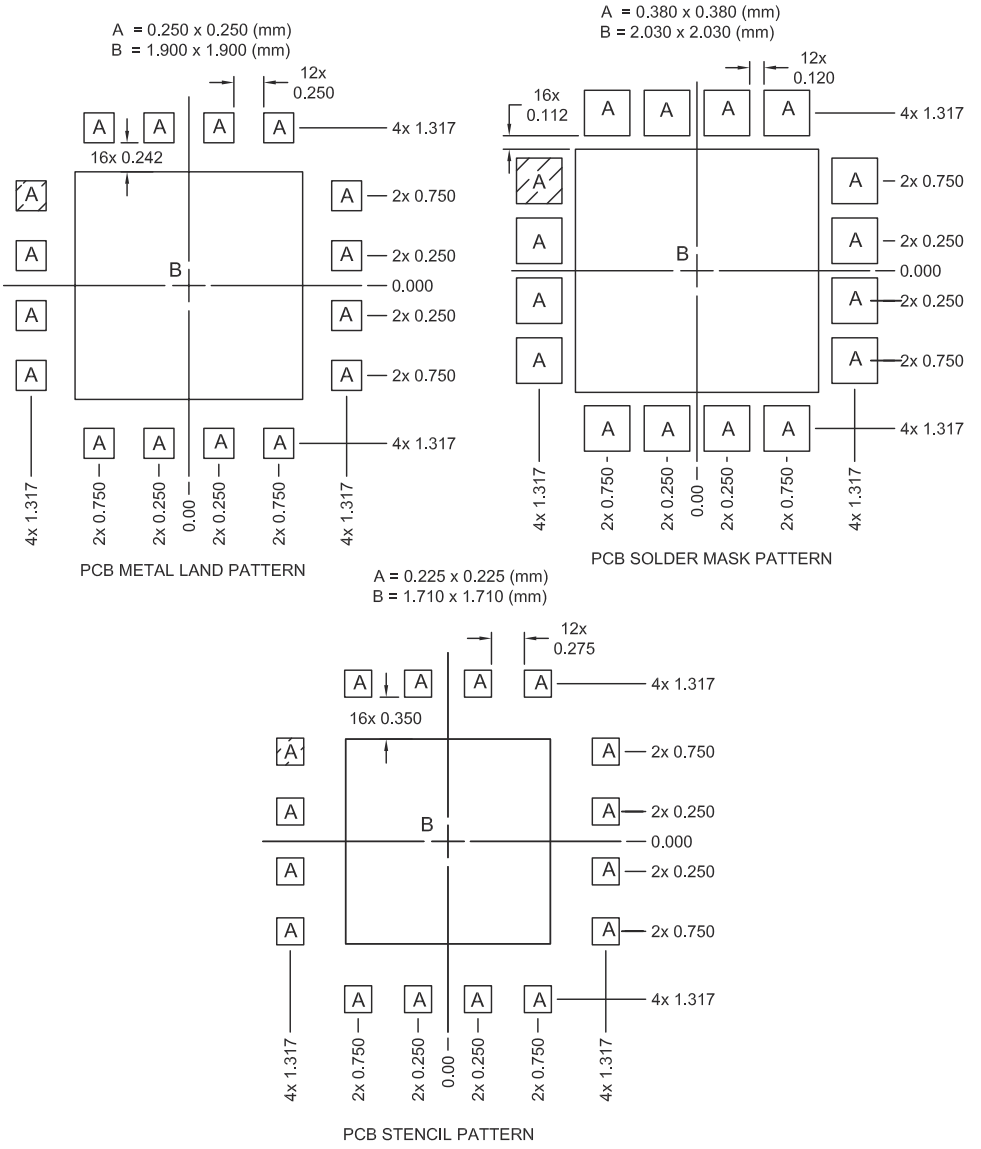


Package Drawing



NOTES:
1 Shaded Area is Pin 1 Indicator

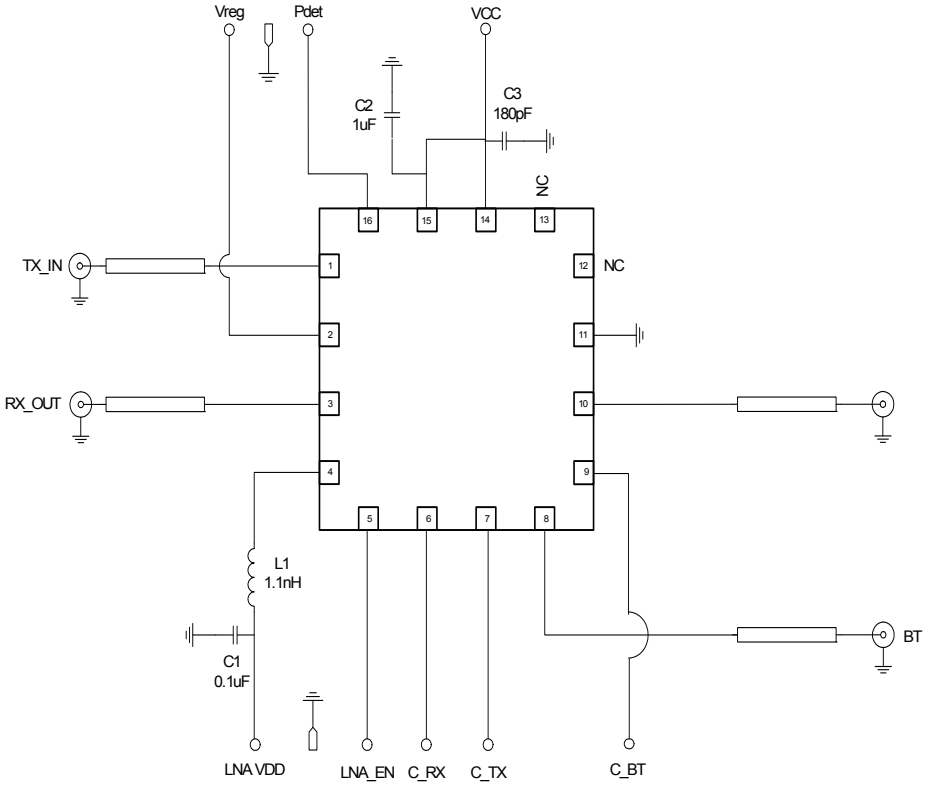
RF5565 PCB Footprint and Stencil Recommendations



Shaded are represents Pin 1 location.

Thermal vias for center slug “B” should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, the power dissipation, and the electrical requirements. Example of the number and size of vias can be found on the RFMD evaluation board layout.

Evaluation Board Schematic



Theory of Operation

The RF5565 Front End Module (FEM) is designed for WiFi applications in the 2.5GHz ISM band. It can be applied in many portable applications such as handsets, Personal Media Players, and portable battery power equipment. This highly integrated module can be connected directly to the battery without additional voltage regulators.

WiFi TRANSMIT MODE

The RF5565 requires a single positive supply (V_{CC}), a positive supply for switch controls, and a regulated supply for the V_{REG} to maintain nominal bias current. The RF5565 transmit path has a typical gain of 30dB from 2.4GHz to 2.5GHz, and delivers 20dBm typical output power under 54Mbps OFDM modulation and 22dBm under 1Mbps 11b modulation. The RF5565 contains basic filter components to produce a bandpass response for the transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles and additional filters may be required depending upon the end-user's application. While in transmit mode, the active components are the Power Amplifier (PA) and the TX branch of the SP3T switch. Refer to the logic control table for proper settings.

TX Biasing Instructions

- Connect the TX input to a signal generator and a spectrum analyzer at the Antenna output.
- Set V_{CC} to 3.3V with V_{REG} set to 0V.
- Turn V_{REG} ON and set voltage to 3.1V. V_{REG} controls the current drawn by the PA and it should quickly reach a quiescent current of approximately 90mA±20mA. Care must be exercised not to exceed 3.5V on the V_{REG} pin or the part may be damaged.
- Next set C_TX high. This pin controls the transmit branch of the SP3T.
- The SP3T controls for the off branches (C_RX and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance of the PA will degrade significantly. Likewise, unused RF Ports must be terminated in 50Ω to simulate actual system conditions and prevent RF signals from coupling back to the PA.
- Turn RF ON.

WiFi RECEIVE MODE

Within the frequency band of operation 2.4GHz to 2.5GHz, the RF5565 WiFi receive path has a typical gain of 14dB and a NF of 2.2dB with about 12mA of current. In RX mode, only the RX branch of the SP3T and the LNA are active. Refer to the logic control table for proper settings.

RX Biasing Instructions

- Connect the RX input (ANT/pin-10) to a signal generator and a spectrum analyzer at the RX output. A VNA may be used as well.
- Turn LNA voltage supply ON and set the voltage to 3.3V.
- Set C_RX and LNA_EN high. This turns the LNA and the receive branch of the SP3T ON.
- The SP3T controls for the off branches (C_TX and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Turn RF ON.

Bypass Mode for WiFi Receive Operation

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the RX output. A multiport VNA may be used as well.
- Set LNA_EN low. By applying a voltage <0.2V to this pin it enables the bypass switch of the LNA.
- Set C_RX high. This turns the receive branch of the SP3T ON.
- The SP3T controls for the off branches (C_TX and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Turn RF ON.

***BLUETOOTH®* MODE**

The RF765 *Bluetooth®* only mode is implemented through the SP3T switch by setting C_BT "high." Typical insertion loss is about 1dB.

Bluetooth® Biasing Instructions

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the BT (pin-8) RF port. A VNA may be used in place of the Sig Gen and SA.
- Set C_BT "high." This turns the *Bluetooth®* branch of the SP3T switch ON.
- The SP3T controls for the off branches (C_TX and C_RX) must be set to a logic "low" (0.2V max) or grounded. Do not leave floating.
- Terminate unused RF Ports in 50Ω
- Turn RF ON.

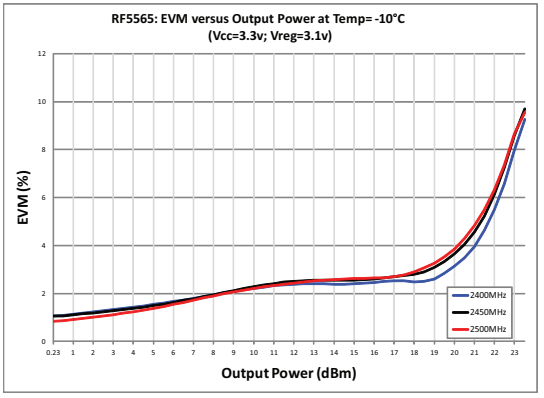
APPLICATION CIRCUIT AND LAYOUT RECOMMENDATIONS

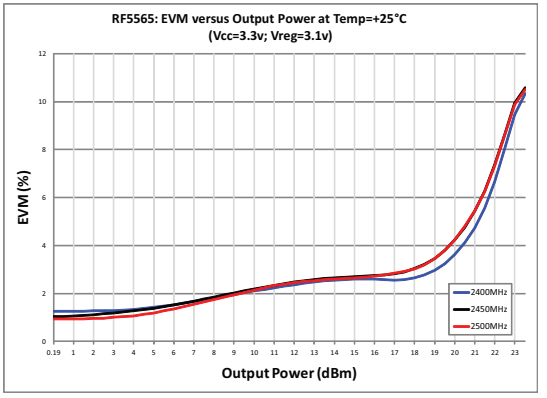
The RF5565 integrates the matching networks and DC blocking capacitors for all RF ports. This greatly reduces the number of external components and layout area needed to implement this FEM. Typically only a total of four external components are required to achieve nominal performance. However, depending on board layout and the many noise signals that could potentially couple to the RF5565, additional bypassing capacitors may be required to properly filter out unwanted signals that might degrade performance.

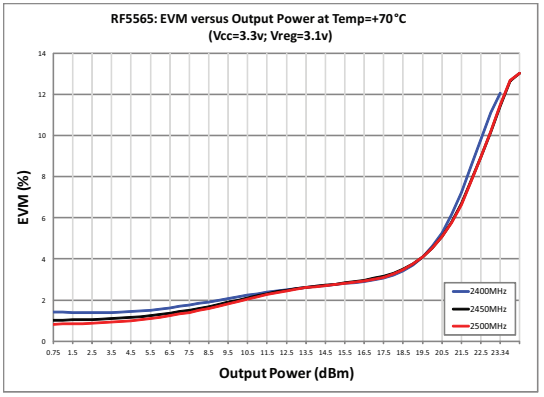
The LNA bias components consist of an inductor and a decoupling capacitor. The inductor value is critical to optimize NF and return loss at the RX output. For best performance and trade off between critical parameters such as NF, Gain, and IP3, the total inductance including board trace should be approximately 1.2nH. The last components needed in the application circuit are low frequency bypass capacitors on the VCC line. In general, it is good RF practice to have proper decoupling of supply lines to filter noise out. Occasionally, depending on the level of coupling or parasitics of the board, a high frequency bypass capacitor must be added as well.

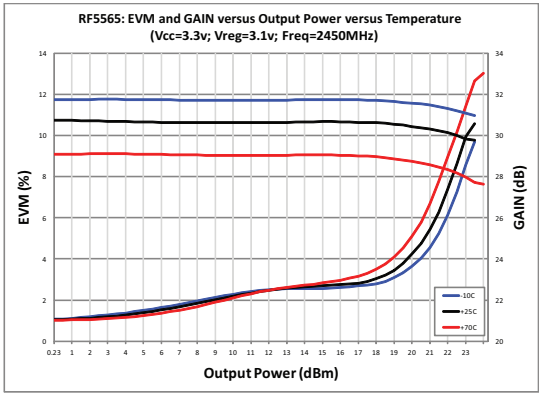
In order to optimize performance for both the Transmit and Receive paths, best known RF practices for PCB layout must be followed. All RF traces must be 50Ω. Adequate grounding along the RF traces and on the FEM ground slug must be exercised. This will minimize coupling and provide good thermal dissipation when the PA is operating at high power. For reference, RFMD evaluation board gerbers are available upon request.

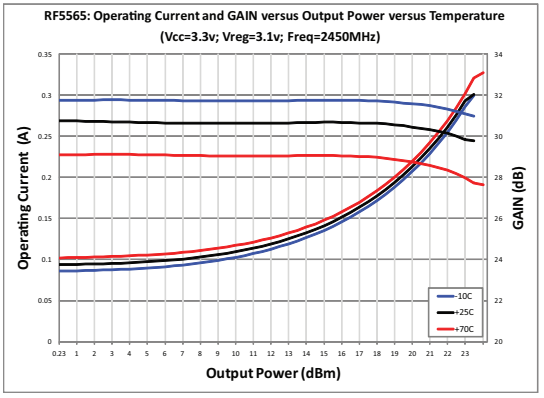
RF5565 WiFi Transmit Performance Plots

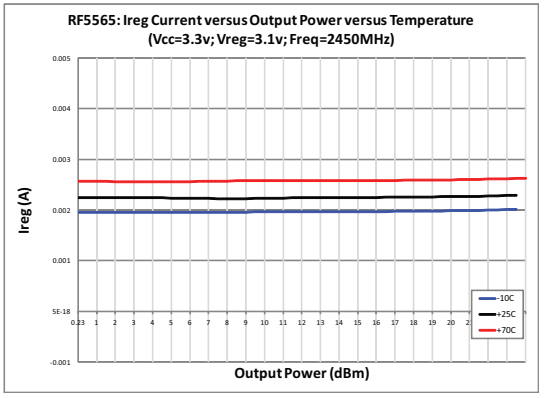




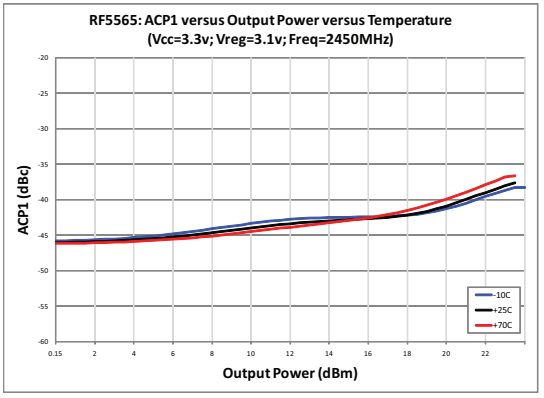


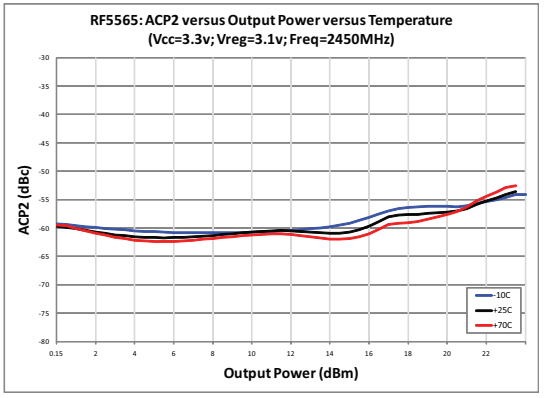




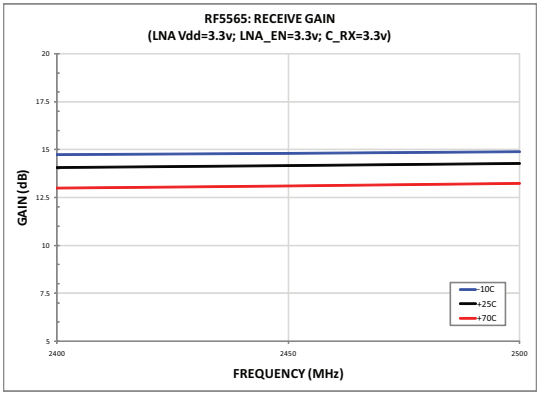


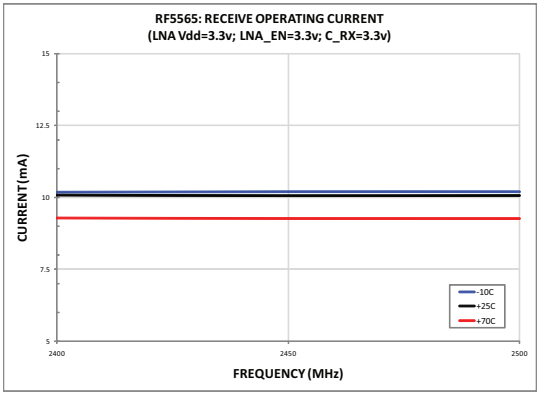
RF5565 WiFi Transmit Performance Plots (continued)

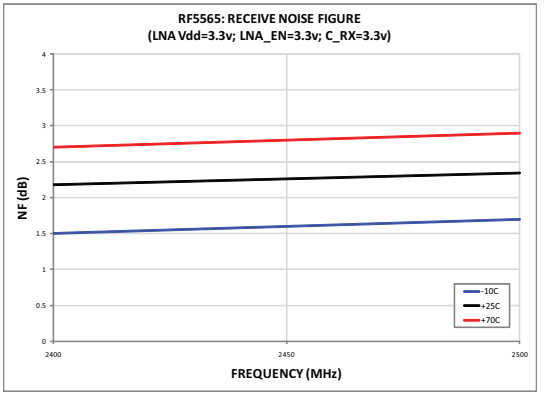


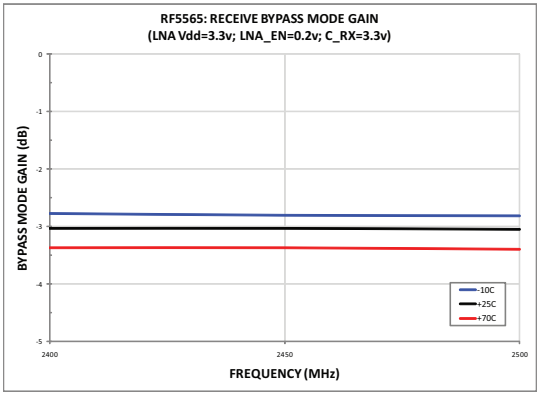


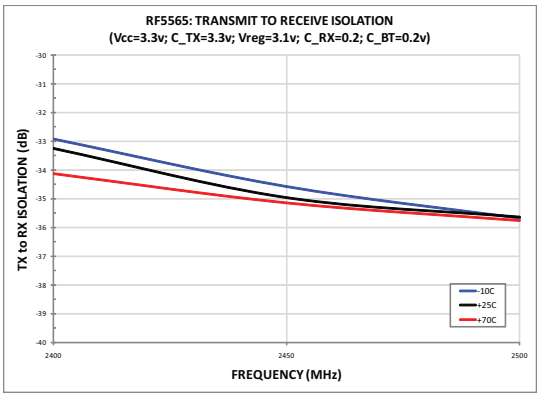
RF5565 WiFi Receive and BT Performance Plots

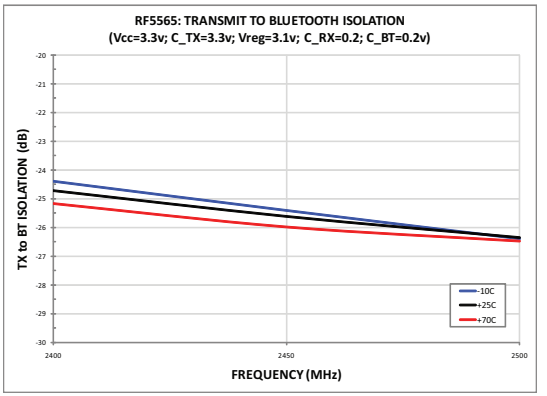












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RF5755

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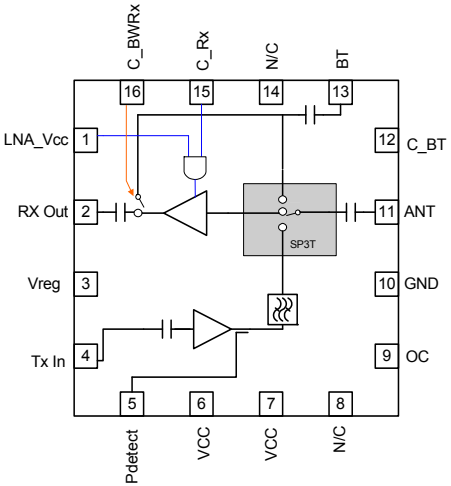

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Product Description

The RF5755 provides a complete integrated solution in a single Front End Module (FEM) for WiFi 802.11b/g/n and *Bluetooth*® systems. The ultra small form factor and integrated matching greatly reduces the number of external components and layout area in the customer application. This simplifies the total Front End solution by reducing the bill of materials, system footprint, and manufacturability cost. The RF5755 integrates a 2.4GHz Power Amplifier (PA), Low Noise Amplifier (LNA), power detector coupler for improved accuracy, and some filtering for harmonic rejection.

The RF5755 is capable of receiving WiFi and *Bluetooth*® simultaneously. The device is provided in a 3mmx3mmx0.5mm, 16-pin package. This module meets or exceeds the RF Front End needs of IEEE 802.11b/g/n WiFi RF systems.

Ordering Information

RF5755SQ	Standard 25 piece bag
RF5755SR	Standard 100 piece reel
RF5755TR7	Standard 2500 piece reel
RF5755PCK-410	Fully Assembled Evaluation Board with 5 loose sample pieces

Optimum Technology Matching® Applied

☐ GaAs HBT	☐ SiGe BiCMOS	☑ GaAs pHEMT	☐ GaN HEMT
☐ GaAs MESFET	☐ Si BiCMOS	☐ Si CMOS	☐ RF MEMS
☑ InGaP HBT	☐ SiGe HBT	☐ Si BJT	☐ LDMOS

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (Continuous with No Damage)	5.4	V
DC Supply Current	500	mA
Full Specification Temp Range (Full Spec. Compliant)	-10 to +70	°C
Extreme Operating (Reduced Performance)	-40 to -10 +70 to +85	°C
Storage Temperature	-40 to +150	°C
Antenna Port Nominal Impedance	50	Ω
Maximum Tx Input Power into 50Ω Load for 11b/g/n (No Damage)	0	dBm
Maximum Rx Input Power (No Damage)	0	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).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247, .205,.209, EN, and JDEC
Nominal Conditions					Specifications must be met across V_{CC}, V_{REG}, and Temperature; unless otherwise specified.
Frequency	2.4		2.5	GHz	
Power Supply	3.0	3.3	4.2	V	PA nominal voltage supply (V_{CC})
V_{REG} Voltage					
ON	3.0	3.1	3.2	V	PA in "ON" state
OFF		0.00	0.20	V	PA in "OFF" state
Output Power					
11g	18	18.5		dBm	54Mbps, OFDM 54Mbps, V_{CC}≥3.0V
	19	19.5		dBm	54Mbps, OFDM 54Mbps, V_{CC}≥3.3V
11b	20	22		dBm	11Mbps, CCK, V_{CC}≥3.0V
EVM		3.3	4.0	%	$P_{OUT(g)}$=Rated Output Power, 54Mbps OFDM, 50Ω, see note 1
Adjacent Channel Power					$P_{OUT(b)}$=20dBm 1Mbps CCK, note 2
ACP1		-36	-33	dBc	V_{CC}≥3.3V, meeting 11b spectral mask requirements
ACP2		-56	-51	dBc	
Gain	26	30	34	dB	
Gain Variation Slope					At rated power and a given supply voltage, room temp
Range	3.0		4.2	V	
V_{CC} (Average)			0.5	dB/V	
V_{CC} (Instantaneous)			1	dB/V	
Frequency	-0.5		+0.5	dB	2.4GHz to 2.5GHz
Over Temperature	-1.5		+1.5	dB	
Typical Input Power					
11g		-9		dBm	
11b		-5		dBm	

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters, cont.					
Power Detect					
Power Range	0		23	dBm	
Voltage Range	0.1		1.5	V	
Resistance		10		kΩ	
Capacitance			10	pF	
Sensitivity					
$0<P_{OUT}<6$dBm	3			mV/dB	
$6<P_{OUT}<23$dBm	8		350	mV/dB	
Current Consumption					V_{CC}=3.3V, V_{REG}=3.1V, T=25°C.
I_{CC}		170	200	mA	RF P_{OUT}=18.5dBm, 11g, 50Ω
		220	250	mA	RF P_{OUT}=20dBm, 11b, 50Ω
Quiescent Current		90		mA	RF="OFF"
I_{REG}			3	mA	V_{REG}>3.0V
V_{CC} Leakage Current		2	10	µA	V_{CC}=4.8V, V_{REG}=C_BT=C_RX=C_BWRx≤0.2V
Input Port Impedance		50		Ω	
Input Port Return Loss	10	15		dB	
Ruggedness					No Damage Conditions: max operating voltage, max input power, max temperature
Output VSWR			10:1		
Input Power			-5	dBm	
Stability					PA must be stable (no spurs above -43dBm) from 0 to 20dBm, All phase angles, no spurious or oscillations
Output VSWR	6:1				
Out-of-Band Emissions 2310MHz to 2390MHz and 2483.5MHz to 2500MHz			-41.25	dBm/MHz	P_{OUT}=16.5dBm, 54Mbps OFDM Modulation, 64QAM, RBW=1MHz, VBW=100kHz, V_{CC}=3.3V, V_{REG}=3.1V
			-43	dBm/MHz	P_{OUT}=20.5dBm, 11Mbps CCK Modulation, RBW=1MHz, VBW=100kHz, V_{CC}=3.3V, V_{REG}=3.1V
Thermal Resistance		20		°C/W	V_{CC}=4.8, V_{REG}=3.2, P_{OUT}=20dBm, T_{REF}=85°C
Harmonics					11b modulation, 1Mbps, BW=1MHz, P_{OUT}=20dBm
Second			-23	dBm	4.80GHz to 5.00GHz
Third			-20	dBm	7.20GHz to 7.50GHz
Turn-on/off Time		0.5	1.0	µS	Output stable to within 90% of final gain, Note 1
2.4GHz Receive Parameters					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247,.205,.209, EN, and JDEC
Frequency	2.4		2.5	GHz	
LNA Voltage Supply (LNA V_{CC})	3.0	3.3	4.2	V	LNA V_{CC} tied to V_{BATT} at all times
LNA Current		10	20	mA	LNA in "ON" state
	0		5	µA	LNA in "OFF" state (C_RX=low, LNA V_{CC}=ON)
LNA Input P1dB	-7			dBm	
Gain					
WiFi Rx Gain	16	18	20	dB	WiFi Rx mode
Simultaneous WiFi/BT Rx Mode	11	13	15	dB	WiFi Rx/BT Mode, LNA "ON"

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Receive Parameters, cont.					
Noise Figure					$V_{CC} \geq 3.3V$, including switch
WiFi Rx		2.1	3.5	dB	WiFi Rx mode (LNA "ON")
Simultaneous WiFi/BT Rx Mode		3	4	dB	WiFi Rx/BT Mode (LNA "ON")
Passband Ripple	-0.2		+0.2	dB	WiFi Rx Mode
	-0.5		+0.5	dB	WiFi Rx/BT Mode
WiFi Rx Port Return Loss	9.6			dB	Over temp and nominal bias conditions (V_{CC}=3.3V)
	5	7		dB	Switch in WiFi Rx/Bluetooth Mode
WiFi Rx Port Impedance		50		Ω	No external matching
Bluetooth Parameters					
Frequency	2.4		2.5	GHz	
Insertion Gain/Loss					
BT Tx/Rx only Loss		1.2	1.5	dB	Bluetooth mode
BT Rx* Gain	11	13	15	dB	WiFi Rx/BT Mode, LNA "ON"
Passband Ripple	-0.2		+0.2	dB	Bluetooth mode
	-0.5		+0.5	dB	WiFi Rx/BT mode
Bluetooth Port Return Loss	9.6			dB	Switch in Bluetooth Mode
	7			dB	Switch in WiFi Rx/Bluetooth Mode
Input P1dB	27	30		dBm	Over Temp, C_BT=3.3V to 3.6V
Other Requirements					
Antenna Port Impedance					
Output		50		Ω	
Return Loss		10		dB	
Isolation					
Antenna to Receive	20			dB	In BT Mode (measured from ANT to Rx port)
Antenna to *Bluetooth*®	20			dB	In Tx Mode (measured from ANT to BT port)
Antenna to Receive	20			dB	In Tx Mode (measured from ANT to Rx port)
Switch Control Voltage					C Rx, C BT, and C BW Rx control lines
Low		0	0.2	V	Switch is in the low state (L)
High	1.7		3.6	V	Switch is in the high state (H)
Switch Control Current		2	10	μA	Per control line (C_BT, C_BWRX)
C_Rx Current			100	μA	Over V_{CC}, Frequency and Temperature.
Switch Control Speed			100	nsec	
Switch P1dB		28		dBm	
ESD					
Human Body Model	500			V	EIA/JESD22-114A RF pins
	1000			V	EIA/JESD22-114A DC pins
Charge Device Model	500			V	JESD22-C101C all pins

Note 1: The PA module must operate with gated bias voltage input at 1% to 99% duty cycle.
Note 2: The output power for channels 1 and 11 may be reduced to meet FCC restricted band requirements.

Switch Control Logic

Mode	V_{REG}	C Rx	C BT	C BWRx
Standby	L	L	L	L
WiFi Tx	H	L	L	L
WiFi Rx	L	H	L	L
WiFi Rx/BT*	L	H	L	H
BT Rx	L	L	H	L
BT Tx	L	L	H	L

*The FEM can be placed in receive WiFi and *Bluetooth*® modes simultaneously with increased insertion loss.

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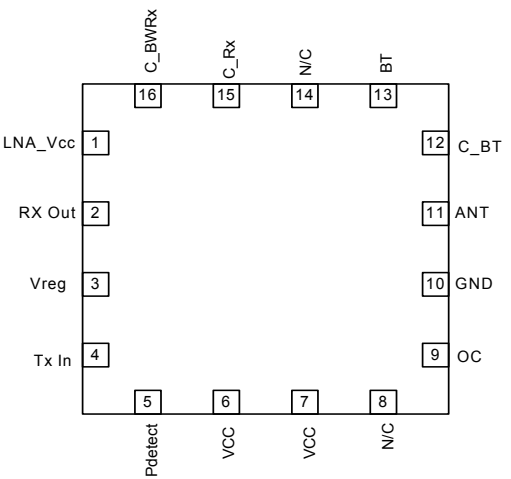
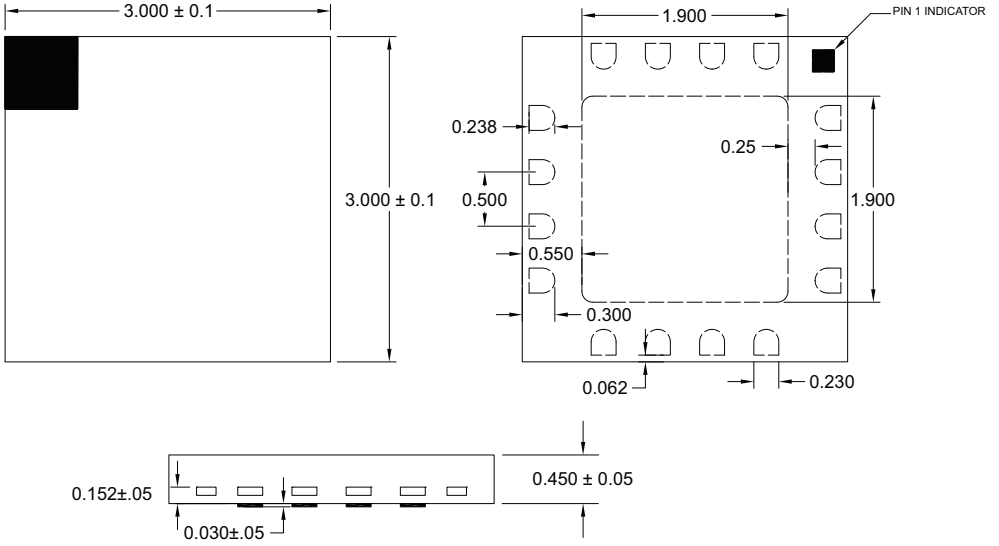
Pin	Function	Description
1	LNA VDD	Voltage supply for the LNA.
2	RX OUT	Receive port for 802.11b/g band. Internally matched to 50Ω. DC block provided.
3	VREG	Regulated voltage for the bias control circuit, and the Tx control port of the SP3T which is also tied to this pin. An external bypass capacitor may be needed on the V_{REG} line for decoupling purposes.
4	TX	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.
5	PDETECT	Power detector voltage for Tx section. PDET voltage varies with output power. May need external decoupling capacitor for noise bypassing. May need external circuitry to bring output voltage to desired level.
6	VCC	Supply voltage for the PA.
7	VCC	Supply voltage for the PA.
8	N/C	No connect.
9	OC	Open Circuit.
10	GND	Ground.
11	ANT	Port matched to 50Ω and is DC blocked internally.
12	C_BT	*Bluetooth*® switch control pin. See truth table for proper level.
13	BT	RF bidirectional port for *Bluetooth*®. Input is matched to 50Ω and DC block is provided.
14	N/C	No connect.
15	C RX	Receive switch control pin. See switch truth table for proper level.
16	C_BWRX	SPST switch control pin. (Simultaneous WiFi and BT receive.) See truth table for proper level.

Pin Out



Package Drawing



NOTES:
1 Shaded Area is Pin 1 Indicator

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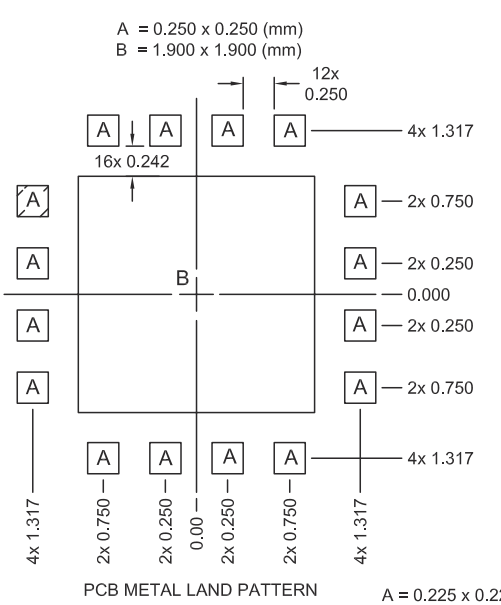
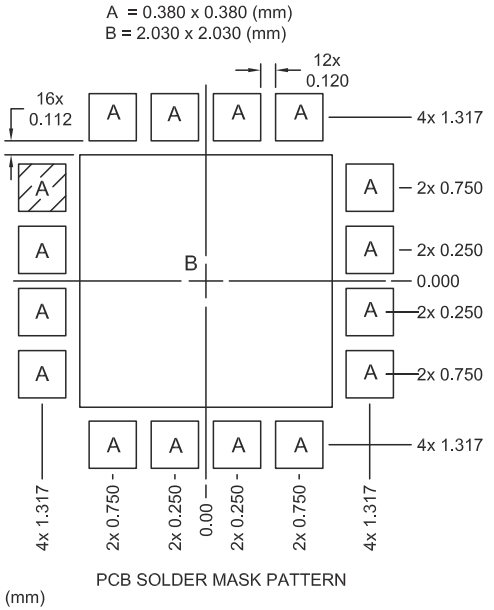
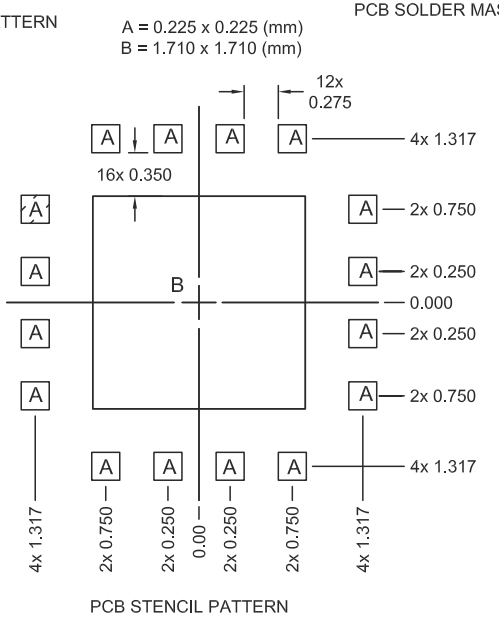
RF5755 PCB Footprint and Stencil Recommendations



PCB METAL LAND PATTERN



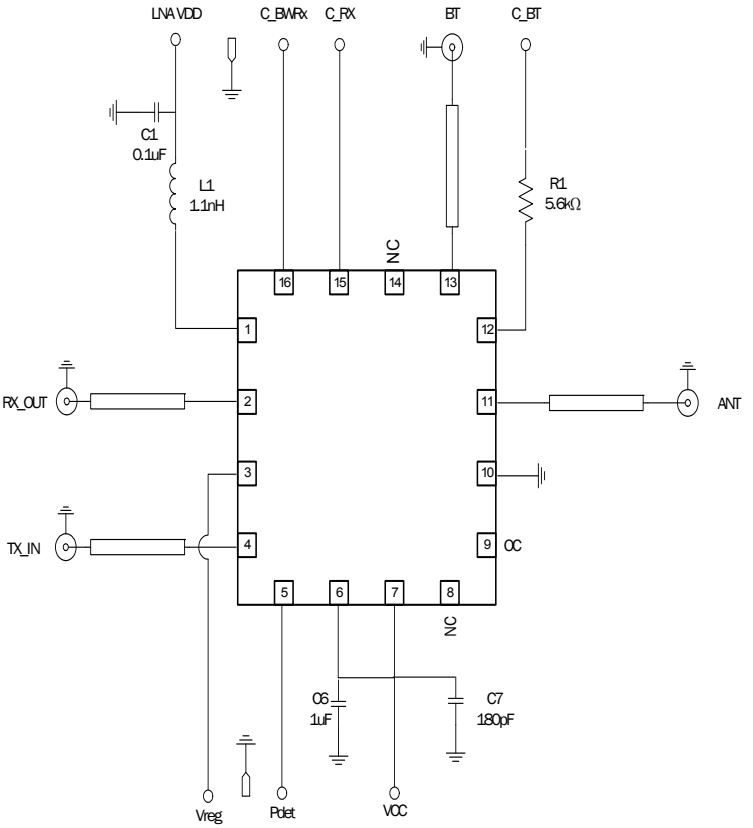
PCB SOLDER MASK PATTERN



PCB STENCIL PATTERN

Shaded are represents Pin 1 location.

Evaluation Board Schematic



Theory of Operation

The RF5755 Front End Module (FEM) is designed for WiFi applications in the 2.5GHz ISM band. It can be applied in many portable applications such as handsets, personal media players, and portable battery power equipment. This highly integrated module can be connected directly to the battery without additional voltage regulators.

WiFi TRANSMIT MODE

The RF5755 requires a single positive supply (V_{CC}), a positive supply for switch controls, and a regulated supply for the V_{REG} to maintain nominal bias current. The RF5755 transmit path has a typical gain of 27dB from 2.4GHz to 2.5GHz, and delivers 20dBm typical output power under 54Mbps OFDM modulation and 23dBm under 1Mbps 11b modulation. The RF5755 contains basic filter components to produce a bandpass response for the transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles and additional filters may be required depending upon the end-user's application. While in transmit mode, the active components are the power amplifier (PA) and the Tx branch of the SP3T switch. Refer to the logic control table for proper settings.

Tx Biasing Instructions

- Connect the Tx input (pin-4) to a signal generator and a spectrum analyzer at the antenna output (pin-11).
- Set V_{CC} to 3.3V with V_{REG} set to 0V.
- Turn V_{REG} on and set voltage to 3.1V. V_{REG} controls the current drawn by the PA and it should quickly reach a quiescent current of approximately 90mA±20mA. Care must be exercised not to exceed 3.5V on the V_{REG} pin or the part may be damaged.
- Control bias to the transmit branch of the SP3T switch is tied directly to V_{REG}.
- The SP3T controls for the off branches (C_RX and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance of the PA will degrade significantly. Likewise, unused RF ports must be terminated in 50Ω to simulate actual system conditions and prevent RF signals from coupling back to the PA.
- Turn RF on.

WiFi RECEIVE MODE

Within the frequency band of operation 2.4GHz to 2.5GHz, the RF5755 WiFi receive path has a typical gain of 16dB and a NF of 2.1dB with about 10mA of current. In Rx mode, only the Rx branch of the SP3T and the LNA are active. Refer to the logic control table for proper settings.

Rx Biasing Instructions

- Connect the Rx input (ANT/pin-11) to a signal generator and a spectrum analyzer at the Rx output (pin-2). A VNA may be used as well.
- Turn the LNA bias on (pin-1) and set the voltage to 3.3V.
- Set C_RX (pin-15) high. This turns on the receive branch of the SP3T.
- The SP3T controls for the off branches (V_{REG} and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Set the control bias for the SPST switch (C_BWRX/pin-16) "low" during WiFi Rx only mode.
- Turn RF on.

WiFi and *BLUETOOTH*® RECEIVE (SIMULTANEOUS MODE)

The RF755 WiFi and *Bluetooth*® receive circuits were specifically designed to address issues of simultaneous operation. In this mode both signals can be received at the same time when the C_BWRX (pin-16) is set high. The typical gain for each RF path is approximately 13dB and a NF of 3dB. During simultaneous mode the active components are the LNA, the SPST switch, and only the Rx branch of the SP3T. Refer to the logic control table for proper settings.

Simultaneous Mode Biasing Instructions

- Connect the RF input (ANT/pin-11) to a signal generator and a spectrum analyzer at the RX (pin-2) and BT (pin-13) RF ports. A multiport VNA may be used as well.
- Turn the LNA bias on (pin-1) and set the voltage to 3.3V.
- Set C_RX (pin-15) and C_BWRX (pin-16) high. This turns on the receive branch of the SP3T and the SPST switch.
- The SP3T controls for the off branches (V_{REG} and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Turn RF on.

BLUETOOTH® MODE

The RF755 *Bluetooth*® only mode is implemented through the SP3T switch by setting C_BT "high." Typical insertion loss is about 1.2dB.

Bluetooth® Biasing Instructions

- Connect the RF input (ANT/pin-11) to a signal generator and a spectrum analyzer at the BT (pin-13) RF port. A VNA may be used in place of the signal generator and SA.
- Set C_BT (pin-12) "high." This turns the *Bluetooth*® branch of the SP3T switch on.
- The SP3T controls for the off branches (V_{REG} and C_RX) must be set to a logic "low" (0.2V max) or grounded. Do not leave floating.
- Terminate unused RF Ports in 50Ω.
- Turn RF on.

APPLICATION CIRCUIT AND LAYOUT RECOMMENDATIONS

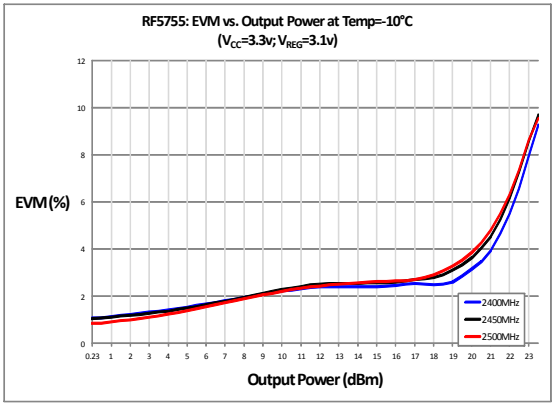
The RF5755 integrates the matching networks and DC blocking capacitors for all RF ports. This greatly reduces the number of external components and layout area needed to implement this FEM. Typically only a total of four external components are required to achieve nominal performance. However, depending on board layout and the many noise signals that could potentially couple to the RF5755, additional bypassing capacitors may be required to properly filter out unwanted signals that might degrade performance.

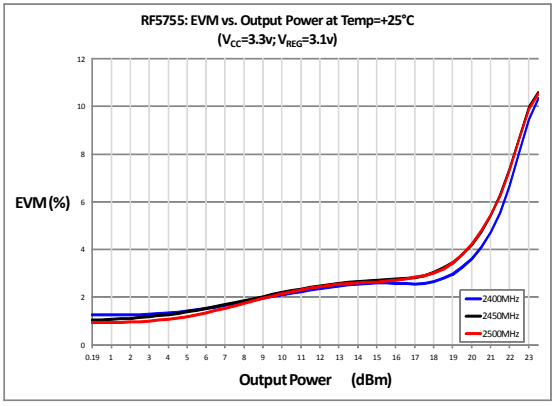
The LNA bias components consist of an inductor and a decoupling capacitor. The inductor value is critical to optimize NF and return loss at the Rx output. For best performance and trade off between critical parameters such as NF, Gain, and IP3, the total inductance including board trace should be approximately 1.2nH. The 5.6kΩ series resistor for the *Bluetooth*® control line helps to prevent unwanted signals from coupling to this pin. The resistor should be placed as close as possible to the package pin. The last component needed in the application circuit is a low frequency bypass capacitor on the V_{CC} line. In general, it is good RF practice to have proper decoupling of supply lines to filter out noise. Occasionally, depending on the level of coupling or parasitics of the board, a high frequency bypass capacitor must be added as well.

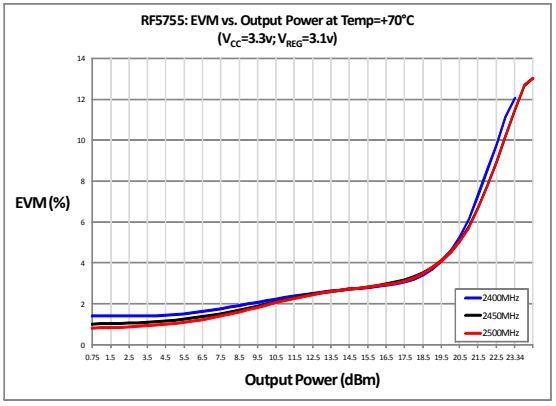
In order to optimize performance for both the Transmit and Receive paths, a good layout design must be implemented. As it is well know in the RF world, any mismatch and off port loading affects performance. To minimize this effect and have a more robust layout, all RF traces must be 50Ω. Adequate grounding along the RF traces and on the FEM ground slug must be exer-

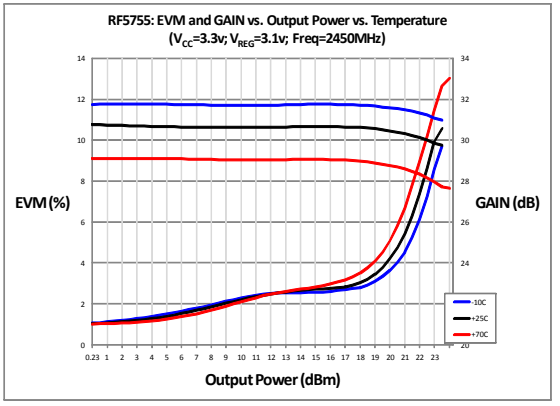
cised. This will minimize coupling and provide good thermal dissipation when the PA is operating at high power. For reference, the RFMD evaluation board uses 9 thermal ground vias (hole/capture pad 12/22mil) on the ground slug. Additionally, if space permitted, V_{CC} and control lines must be isolated from each other with ground vias in between them. RFMD evaluation board gerbers are available upon request.

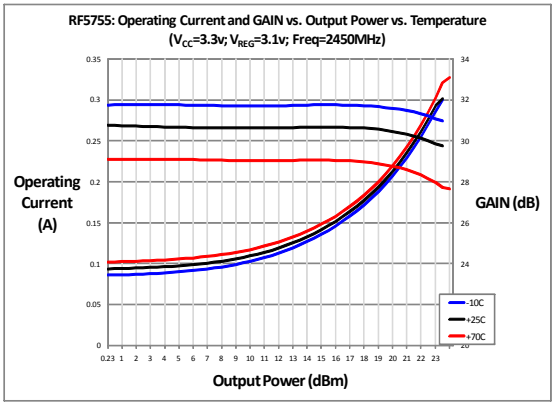
RF5755 Performance Graphs

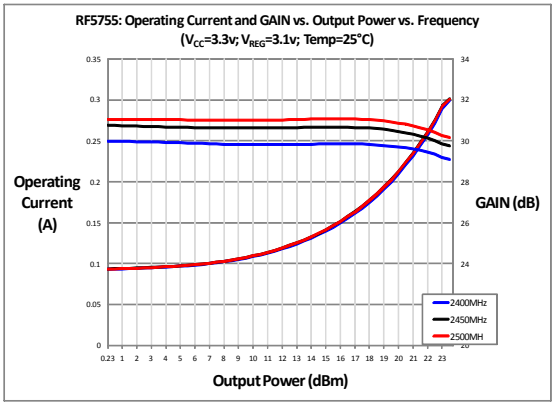




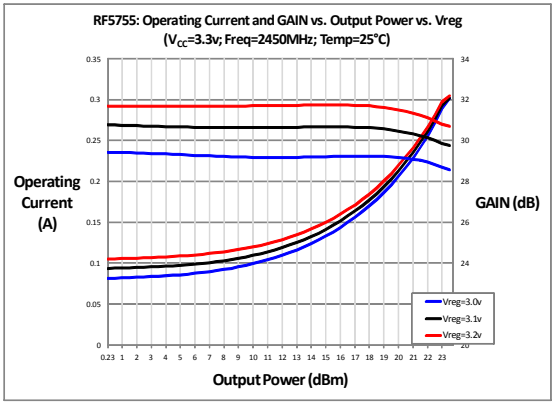


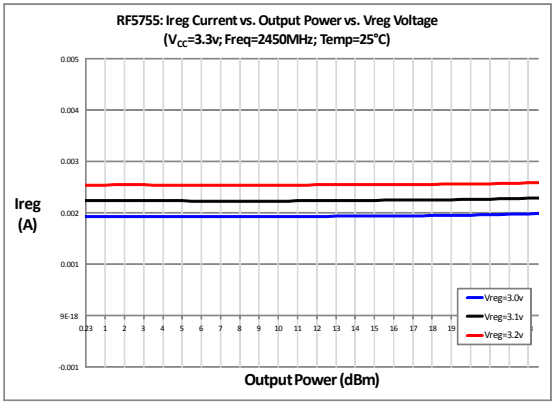


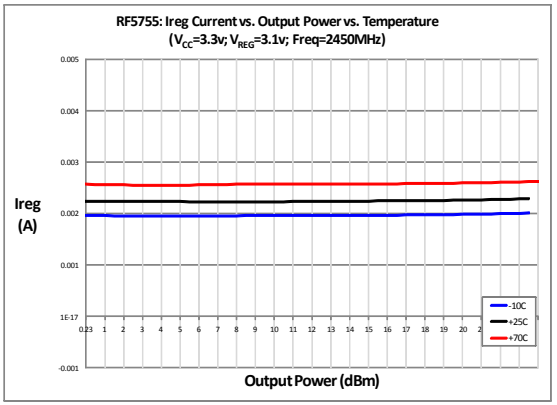


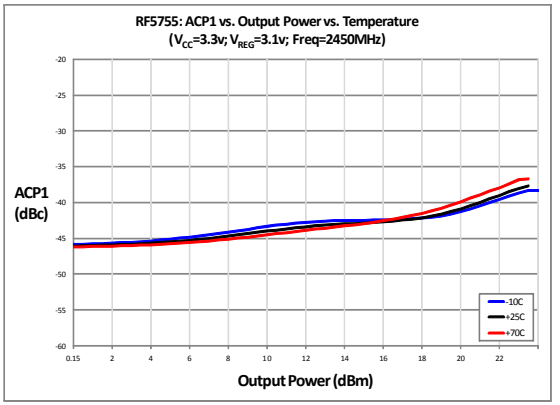


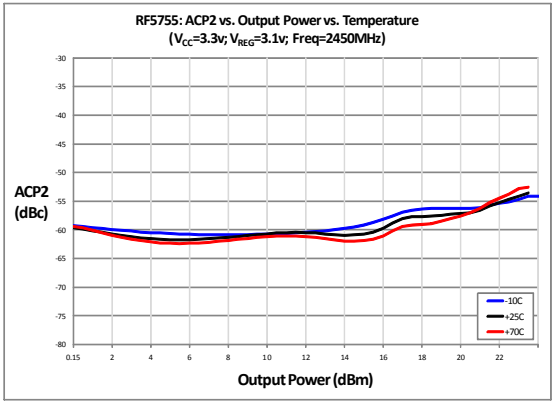
RF5755 Performance Graphs (cont.)



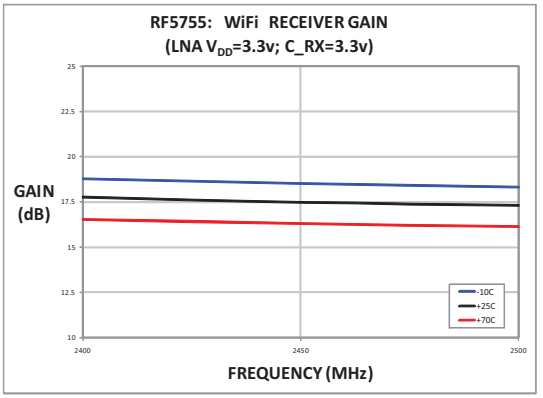


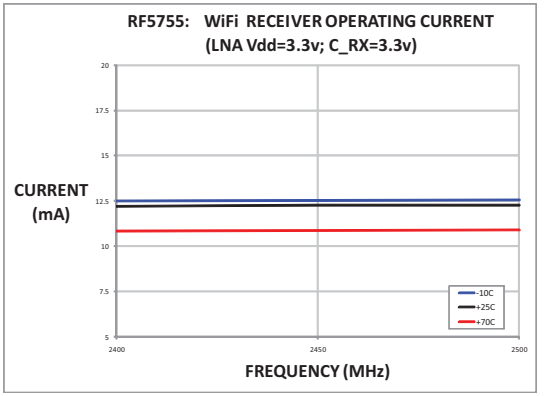


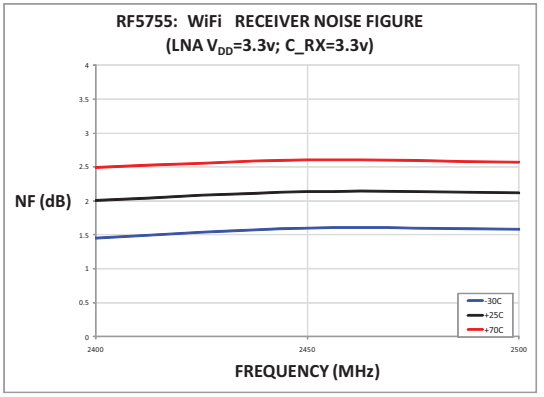


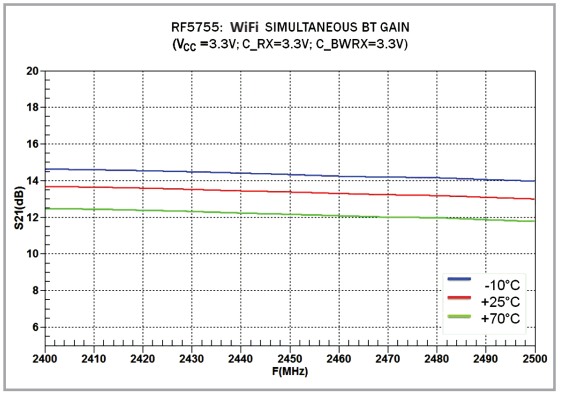


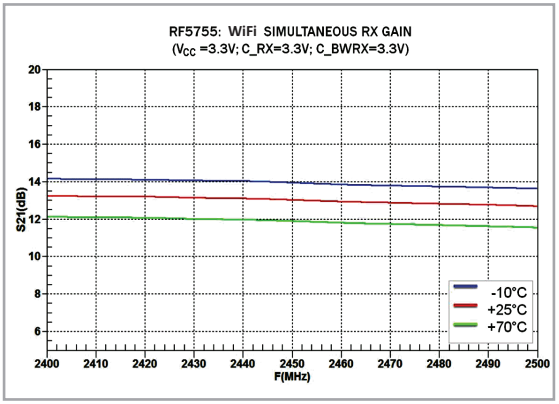
RF5755 Receiver Performance Graphs

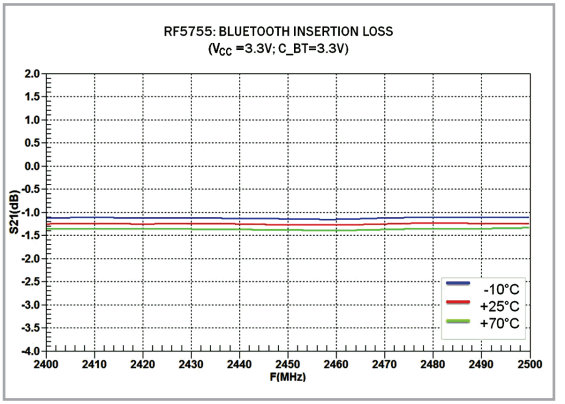












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RFFM3482Q

2.4GHz to 2.5GHz, Automotive WiFi Front End Module

Package Style: QFN, 16-pin, 3mm x 3mm x 0.45mm

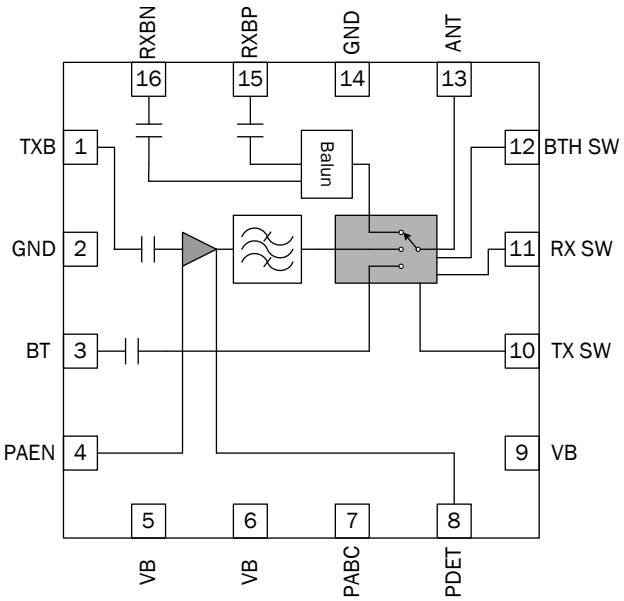
Features

- Single Voltage Supply 3.3V to 4.2V
- Integrated 2.5GHz b/g/n Amplifier, Rx Balun and Tx/Rx Switch and Directional Power Detector
- P_{OUT} = 17dBm, 11g, OFDM at ≤2.4% EVM and P_{OUT} = 21.5dBm, Meeting 11b Mask

Applications

Automotive WiFi

- Diagnostic
- Data
- Infotainment



Functional Block Diagram

Product Description

The RFFM3842Q FEM is a single-chip integrated front end module (FEM) for automotive WiFi. The FEM addresses the need for aggressive size reduction for a typical 802.11b/g/n front end design and greatly reduces the number of components outside of the core chipset. The front end module has integrated b/g/n power amplifier, directional power detector, Rx balun, and some Tx filtering. It is also capable of switching between WiFi Rx, WiFi Tx and BTH RX/TX operations. The device is provided in a 3mm x 3mm x 0.45mm, 16-pin package. This module meets or exceeds the RF front end needs of 802.11b/g/n WiFi RF systems.

Ordering Information

RFFM3482QTR13X	Standard 1 piece
RFFM3482QSQ	Standard 25 piece bag
RFFM3482QSR	Standard 100 piece bag
RFFM3482QTR7	Standard 2500 piece reel
RFFM3482QPCK-41X	Fully Assembled Evaluation Board and 5 loose sample pieces

7628 Thorndike Road, Greensboro, NC 27409-9421 · For sales or technical

ES France - Département RF & Hyperfréquences - 127 rue de Buzenval BP 26 - 92380 Garches
Tél. 01 47 95 99 60 - Fax. 01 47 01 16 22 - e-mail: hyper@es-france.com - Site Web: www.es-france.com

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage	5.6	V_{DC}
Full Specification Temp Range (Full Spec. Compliant)	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Maximum Tx Input Power for 11b (No Damage)	+10	dBm
Maximum Tx Input Power for 11g (No Damage)	+10	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.

RFMD Green: RoHS compliant per EU Directive 2002/95/EC, halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

Nominal Operating Parameters

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247, .205, .209
Nominal Conditions					V_{CC} = 3.6V, PAEN = 1.8V 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					
11g	15	17		dBm	54Mbps, OFDM, 64QAM meeting EVM requirement[1]
11b	19.5	21.5		dBm	Measured at 1Mbps meeting ACP1/ACP2 requirements
11n	13.5	16		dBm	MCS7, OFDM
EVM* 11g		2.4	3.5	%	RMS, mean, $P_{OUT(g)}$ = 15dBm
EVM* 11n		2.2	2.8	%	RMS, mean, $P_{OUT(n)}$ = 13.5dBm
ACP1		-36	-31	dBc	P_{OUT} = 19.5dBm, IEEE802.11b, 11Mbps CCK, 1Mbps BPSK modulation
ACP2		-56	-51	dBc	
Gain	26.5	33	38	dB	
Gain Variation	-3		+3	dB	Over temperature and voltage
Frequency	-1.0		+1.0	dB	2.4GHz to 2.5GHz

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

1. With V_{cc} >3.0V to 3.3V there will be a 0.5dB degradation in 11g linear output power.
2. The Typical parameters are at nominal conditions. Min/Max parameters are over all conditions.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Transmit Parameters (continued)					
Power Detect					
Voltage Detect	0		0.8	V	≤21dBm output power
P_{OUT} = 16dBm	0.260	0.31	0.380	V	IEEE802.11g, 54Mbps 64QAM modulation
Input Resistance		10		kΩ	
Input Capacitance			5	pF	
Bandwidth	800	1000		kHz	
Sensitivity					
0dBm to 7dBm	2			mV/dB	
8dBm to 15dBm	10			mV/dB	
>15dBm	20			mV/dB	
Current Consumption					
IEEE802.11g I_{CC}	140	160	180	mA	RF P_{OUT} = 15dBm, 54Mbps IEEE802.11g
IEEE802.11b I_{CC}	200	220	240	mA	RF P_{OUT} = 19.5dBm, 11Mbps IEEE802.11b
I_{PAEN}		240	400	µA	PA EN = High
Leakage		2	6	µA	V_B <4.0V all control inputs = “off”, no RF at 25°C
			25	µA	V_B <4.0V all control inputs = “off”, no RF at 85°C
Power Supply	3.3	3.6	4.2	V	
PA EN Voltage ON	1.6	1.8	2.0	V	PA is turned ON
PA EN Voltage OFF		0		V	PA is turned OFF
PABC Voltage	0		1.0	V	Used to drive the PABC current
PABC Current	0		1.8	mA	
Input/Output Impedance		50		Ω	
Output Load VSWR Ruggedness	No damage or permanent degradation to device				VSWR = 10:1; all phase angles (V_{RAMP} set for P_{OUT} ≤22dBm into 50Ω load; load switched to VSWR = 10:1)
Out of Band Gain (S_{21})					at 50Ω relative to minimal in-band gain
86MHz to 108MHz		30		dBr	
776MHz to 894MHz		20		dBr	
925MHz to 980MHz		20		dBr	
1570MHz to 1580MHz		20		dBr	
1805MHz to 1880MHz		20		dBr	
1930MHz to 1990MHz		20		dBr	
2110MHz to 2170MHz		15		dBr	
Harmonics					RBW = 1MHz. Measured in CW.
Second			-30	dBc	4.80GHz to 5.00GHz
Third			-50	dBc	7.20GHz to 7.50GHz
Fourth			-60	dBc	
2.4GHz Receive Parameters					
Frequency	2.4		2.5	GHz	
Insertion Loss		2.1	2.5	dB	Switch and Balun
Noise Figure			2.5	dB	
Passband Ripple			0.3	dB	
Output Return Loss			-9	dB	
Output Impedance		100		Ω	No external matching

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
2.4GHz Receive Parameters (continued)					
Balun					
Amplitude Balance	-1		1	dB	
Phase Balance	-10		10	°	Relative to 180°
Bluetooth Parameters					
Frequency	2.4		2.5	GHz	
Insertion Loss		1.0	1.5	dB	SP3T switch, all unused ports terminated into their nominal impedance
Passband Ripple	-0.3		+0.3	dB	
Input/Output Power P1dB	20			dBm	
Output Return Loss		-12	-10	dB	
Output Impedance		50		Ω	No external matching
General Characteristics					
Turn-On/Off Time			1.0	µS	Output stable to within 90% of final gain
Antenna Port Impedance					
Input		50		Ω	Receive
Output		50		Ω	Transmit
Switch Control Voltage					
Low	0		0.1	V	
High	1.6		2.0	V	
Switch Control Current			4	µA	Per control lines, TX, RX and BT
Switch Control Speed			100	nsec	Per control line TX
ESD					
Human Body Model		500		V	EIA/JESD22-114A
Charge Device Model		750		V	EIA/JESD22-C101

*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	22	29		dB
WiFi TX to BT RX/TX	22	25		dB
WiFi RX to WiFi TX	20	38		dB
ANT TX	25	45		dB
ANT RX	25	28		dB

Switch Control Logic

Mode	BTW_SW	RX_SW	TX_SW	PA_EN
Bluetooth	1	0	0	0
WiFi TX	0	0	1	1
WiFi RX	0	1	0	0
Simultation BT/RX	1	1	0	0
Calibration	0	1	0	1
	1	0	0	1
	1	1	0	1

Pin Names and Descriptions

Pin	Name	Description
1	TXB	RF input for the 802.11b/g/n PA. Input is matched to 50Ω and DC block is provided.
2	GND	Ground.
3	BT	RF bidirectional port for Bluetooth. Input is matched to 50Ω and DC block is provided.
4	PAEN	Digital enable pin for the 802.11b/g/n PA. This is an active high control. An external bypass capacitor may be needed on the PA EN line for decoupling purposes.
5	VB	Supply voltage for the 802.11b/g/n PA.
6	VB	Supply voltage for the 802.11b/g/n PA.
7	PABC	Linearity and Efficiency control pin, please see the Theory of Operation for more information.
8	PDET	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.
9	VB	Supply voltage for the 802.11b/g/n PA.
10	TX SW	Switch control port. See switch truth table for proper level.
11	RX SW	Switch control port. See switch truth table for proper level.
12	BTH SW	Switch control port. See switch truth table for proper level.
13	ANT	FEM connection to filter and antenna. Port is matched to 50Ω and DC block is provided.
14	GND	Ground.
15	RX+	Receive port for 802.11b/g/n band. Internally matched to 100Ω differential. DC block provided.
16	RX-	Receive port for 802.11b/g/n band. Internally matched to 100Ω differential. DC block provided.
Pkg Base	GND	The center metal base of the QFN package provides DC and RF ground as well as heat sink for the front end module.

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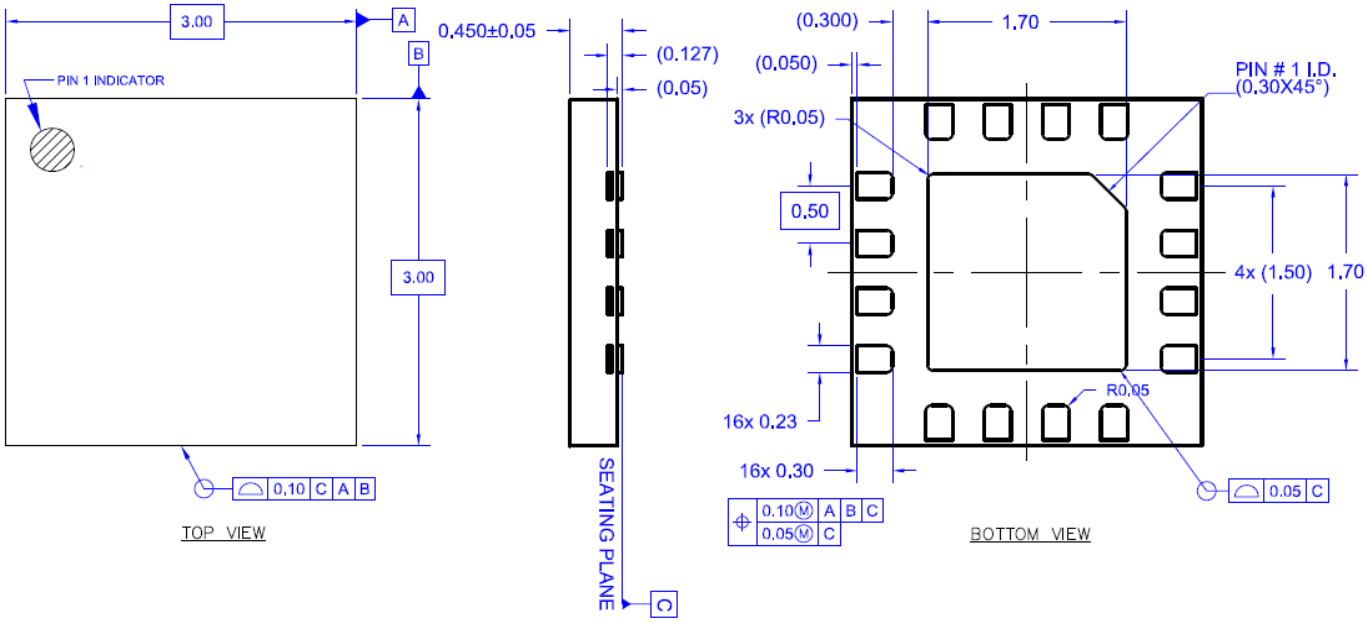
Package Drawing

QFN, 16-pin, 3mm x 3mm x 0.45mm



Notes:

1. Dimension applies to metallized terminal and is measured 0.25mm and 0.30mm from terminal tip.
2. Dimension represents terminal pull back from pacikage edge up to 0.1mm is acceptable.
3. Coplanarity applies to the exposed heat slug as well as hte terminal.

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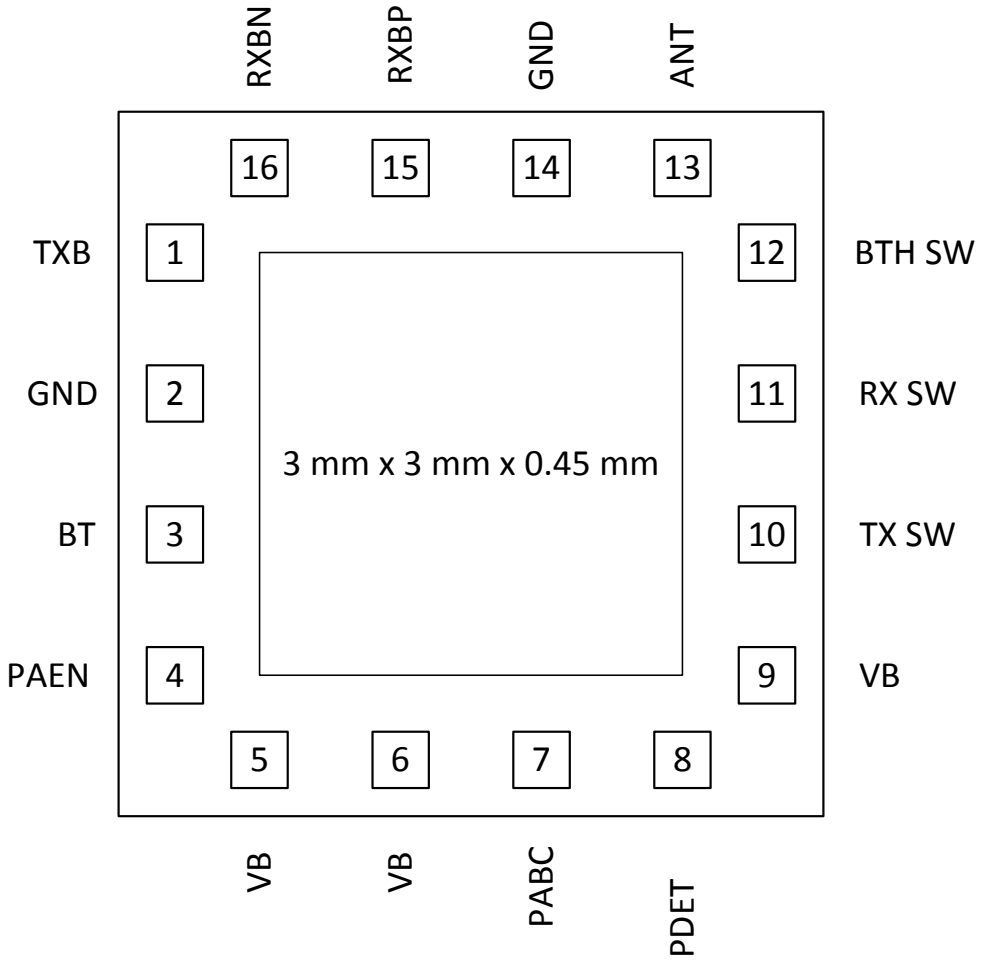
Pin Out



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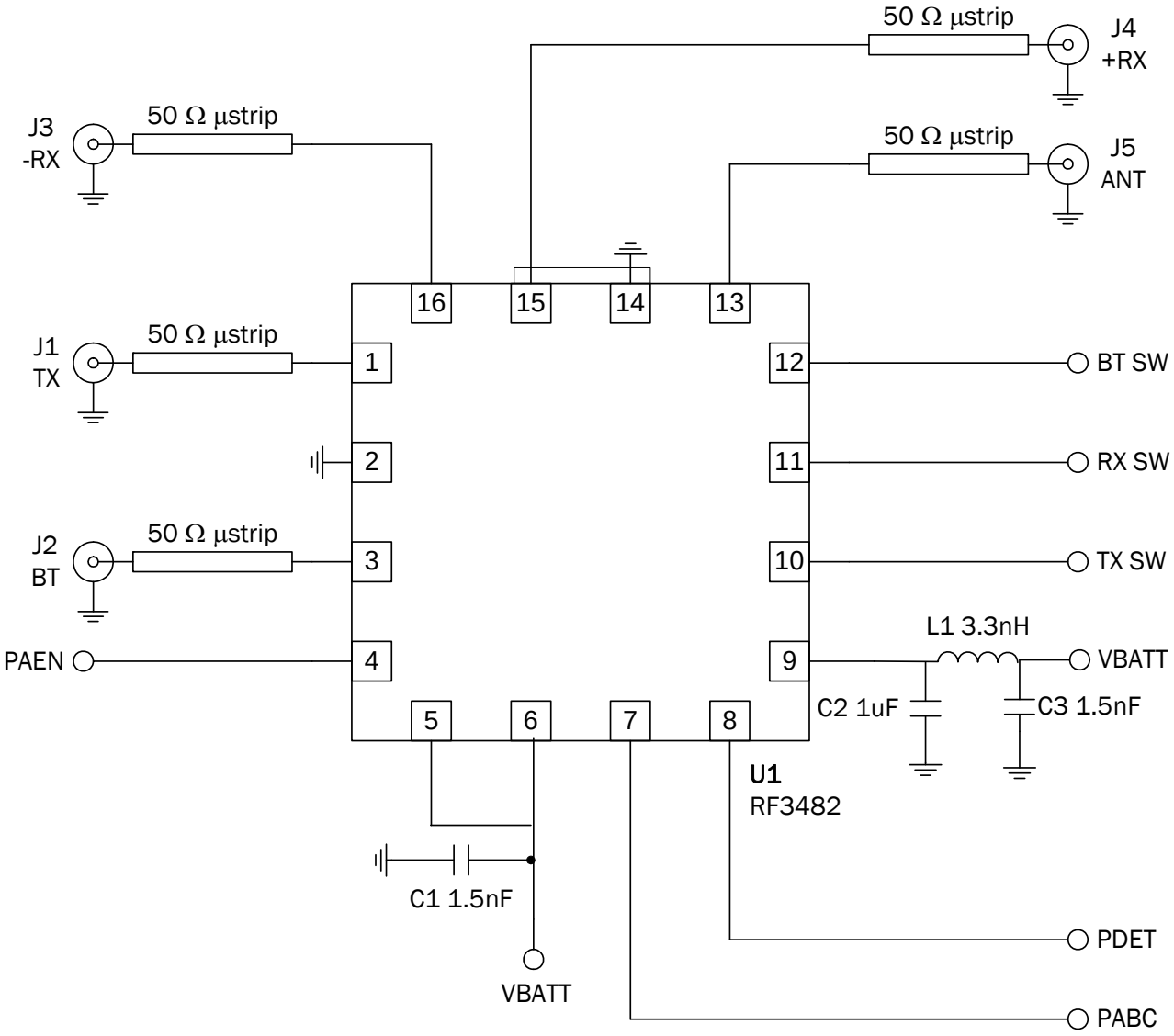
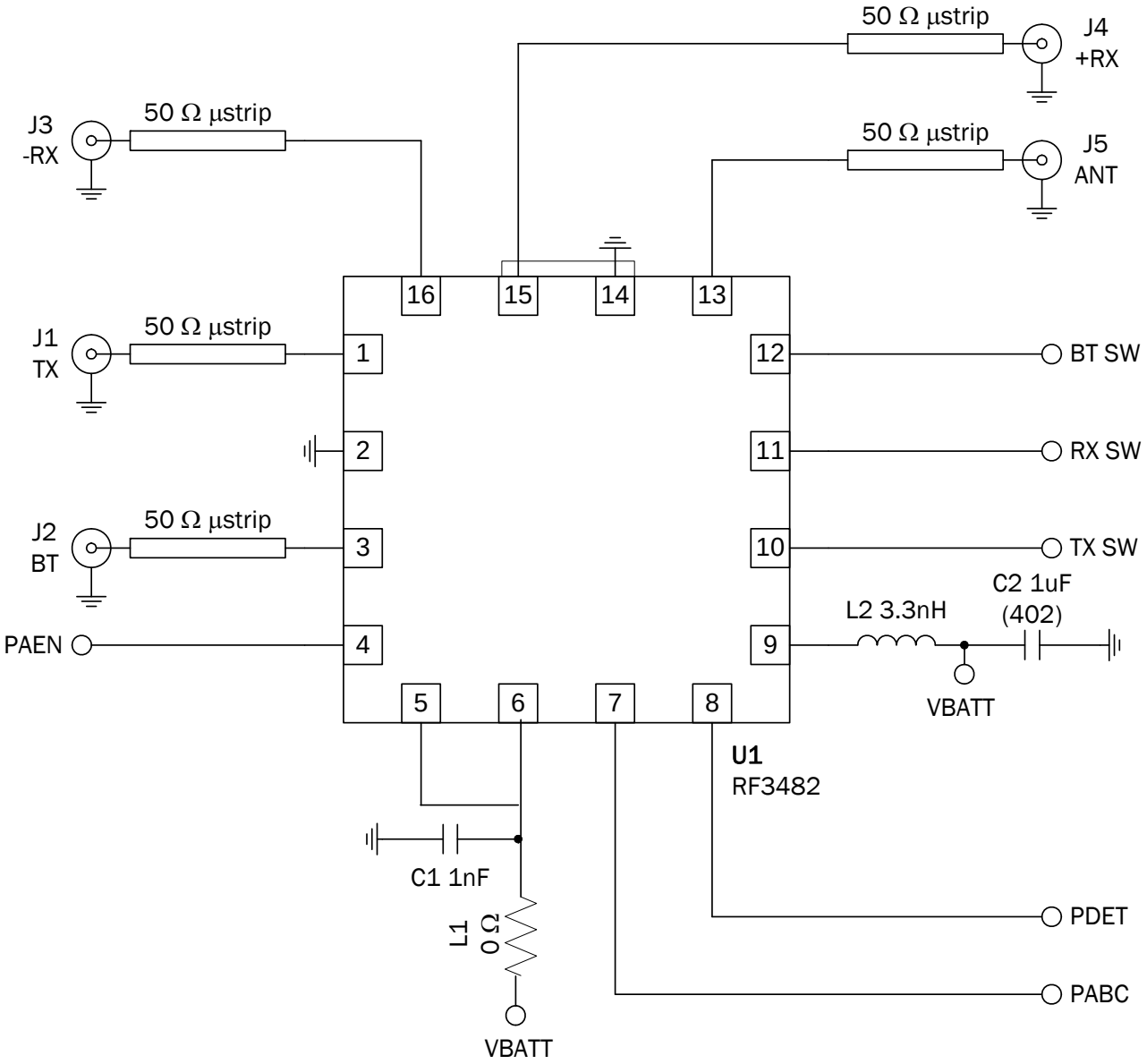
Application Schematic



Evaluation Board Schematic



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Theory of Operation

The RFFM3482Q FEM is a single-chip integrated front end module (FEM) for high performance WiFi applications in the 2.4GHz to 2.5GHz ISM band. The FEM addresses the need for aggressive size reduction for a typical 802.11b/g/n RF front end design, and greatly reduces the number of components outside of the core chipset. Therefore, the footprint and assembly cost of the overall 802.11b/g/n solution is minimized. The FEM has integrated b/g/n power amplifier, power detector, Rx balun, and Tx filtering. Also, it is capable of switching between WiFi Rx, WiFi Tx, and BTH RX/TX operations. It has low insertion loss at the 2.4GHz to 2.5GHz WiFi and BTH paths. The device is manufactured in a GaAs pHEMT processes, and provided in a 3mm x 3mm x 0.45mm, 16-pin package. This module meets or exceeds the RF front end needs of 802.11b/g/n WiFi RF systems.

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 RFFM3482Q evaluation board. There is an indicator pin labeled P1 ID that should be left as a no-connect on the PCB. This pin is directly connected to the ground pad of the IC. For the best performance, it is recommended that voltage and RF lines do not cross under this pin. Gerber files of RFMD PCBA designs can be provided on request. The supply voltage lines should present an RF short to the FEM by using bypass capacitors on the VB traces. The RFFM3482Q is a very easy part to implement, but care in circuit layout and component selection is always advisable when designing circuits to operate at 2.5GHz. Please contact RFMD Sales or Application Engineering for additional data and guidance.

The RFFM3482Q is designed primarily for IEEE802.11 b/g/n WiFi applications where the available supply voltage and current are limited. The RFFM3482Q requires a single positive supply voltage (VB), PA enable (PA_EN) supply, efficiency control (PABC), and a positive supply for switch control to simplify bias requirements. The RFFM3842Q FEM also has built in power detection. All inputs and outputs are internally matched to 50Ω except the WiFi receive path it is deferential with nominal impedance of 100Ω on each pin.

802.11b/g/n Transmit Path

The RFFM3482Q has a typical gain of 33dB from 2.4GHz to 2.5GHz, and delivers 16.5dBm typical output power under 54Mbps OFDM modulation, and 21dBm under 1Mbps 11b modulation. The RFFM3482Q requires a single positive supply of 3.3V to 4.2V to operate at full specifications. PA control for the 802.11b/g/n band is provided through one bias control input pin (PA_EN). The PA_EN pin requires a regulated supply to maintain nominal bias current. In general, the PABC pin controls acts as an efficiency and linearity control pin. The current or voltage applied at this pin may produce higher linear output power, higher operating current, and higher gain.

Out of Band Rejection

The RFFM3482Q contains basic filtering components to produce bandpass responses for the WiFi transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles on the RF path.

802.11b/g/n Receive Path

The 802.11b/g/n path has a100Ω differential impedance with a nominal insertion loss of 2.1dB. The RX port return loss is -9dB maximum. Depending on the application, if filtering is required beyond what the RFFM3482Q can achieve then additional external filters will need to be added outside of the RFFM3482Q.

RFFM3842Q Biasing Instructions:

- 802.11b/g/n Transmit (VB compliance = 5.5V, 400mA, PA EN compliance = 2V, ~450mA)
  - Connect the FEM to a signal generator at the input and a spectrum analyzer at the output.
  - Bias VB to 3.6V first with PA_EN = 0.0V
  - Refer to switch operational truth table to set the control lines at the proper levels for WiFi Tx.
- Turn on PA_EN to 1.8V (typ.). Be extremely careful not to exceed 3.0V on the PA_EN pin, or the part may exceed device current limits.
- Turn on PABC to 1.5mA (or 0.6V). For 11b operation Adjust PABC to 1.8mA. This controls the current drawn by the 802.11b/g/n power amplifier and the idle current should rise to ~115mA ± 20mA for a typical part, but it varies based on the output power desired.
- 802.11 b/g/n 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.

I_{BIAS} Table

WiFi PABC	Standard	Modulation	Units
IEEE 802.11b	CCK	1.8	mA
IEEE 802.11g	54OFDM	1.5	mA
IEEE 802.11n	MCS7	1.6	mA

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PCB Design Requirements

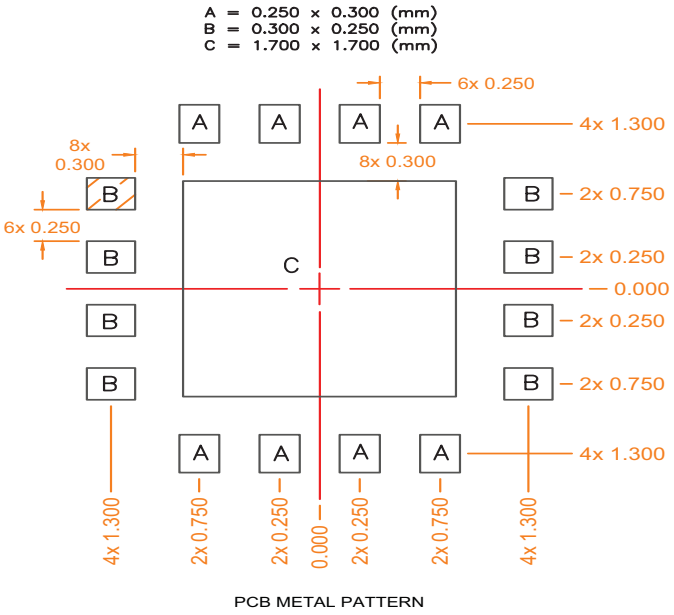
PCB Surface Finish

The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is 3 micro-inch to 8 micro-inch gold over 180 micro-inch nickel.

PCB Land Pattern Recommendation *

PCB land patterns for RFMD components are based on IPC-7351 standards and RFMD empirical data. The pad pattern shown has been developed and tested for optimized assembly at RFMD. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from company to company, careful process development is recommended.

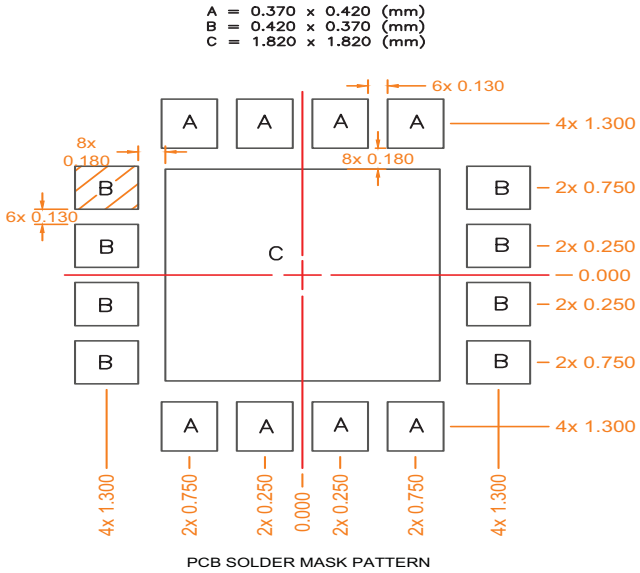
PCB Metal Land Pattern



PCB METAL PATTERN

PCB Solder Mask Pattern

Liquid Photo-Imageable (LPI) solder mask is recommended. The solder mask footprint will match what is shown for the PCB metal land pattern with a 2 mil to 3 mil expansion to accommodate solder mask registration clearance around all pads. The center-grounding pad shall also have a solder mask clearance. Expansion of the pads to create solder mask clearance can be provided in the master data or requested from the PCB fabrication supplier.



PCB SOLDER MASK PATTERN

Thermal Pad and Via Design

The PCB land pattern has been designed with a thermal pad that matches the die paddle size on the bottom of the device.

Thermal vias are required in the PCB layout to effectively conduct heat away from the package. The via pattern has been designed to address thermal, power dissipation and electrical requirements of the device as well as accommodating routing strategies.

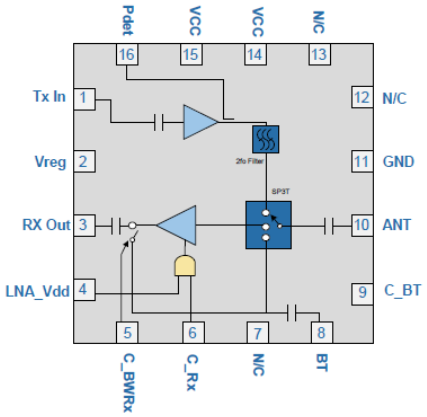
The via pattern used for the RFMD qualification is based on thru-hole vias with 0.203mm to 0.330mm finished hole size on a 0.5mm to 1.2mm grid pattern with 0.025mm plating on via walls. If micro vias are used in a design, it is suggested that the quantity of vias be increased by a 4:1 ratio to achieve similar results.

RFFM5765Q

Tested in Accordance with AEC-Q100
802.11b/g/n WiFi Front End Module

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

The RFFM5765Q provides a complete integrated solution in a single front end module (FEM) for automotive WiFi applications, 802.11b/g/n, and Bluetooth® systems. The ultra-small form factor and integrated matching greatly reduces the number of external components and layout area in the customer application. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturing cost. The RFFM5765Q integrates a 2.4GHz power amplifier (PA), low noise amplifier (LNA), power detector coupler for improved accuracy, and some filtering for harmonic rejection. The RFFM5765Q is capable of receiving WiFi and Bluetooth simultaneously and is tested in accordance with AEC-Q100 standard. The device is provided in a 3.0mm x 3.0mm x 0.5mm, 16-pin package. This module meets or exceeds the RF front end needs of IEEE 802.11b/g/n WiFi RF systems.



Functional Block Diagram

Features

- Single Supply Voltage 3.0V to 4.8V
- Input and Output Matched to 50Ω
- Gain = 30dB
- P_{OUT} = 19dBm, 11g, 64QAM at <4% Dynamic EVM
- P_{OUT} = 22dBm, 11b, CCK 11Mbps, Spectral Mask and ACPR compliant

Applications

- Automotive WiFi
- WiFi Direct
- Automotive Diagnostics
- WiFi Infotainment
- 2.5GHz ISM Band Solutions
- Portable Battery-Powered Equipment

Ordering Information

RFFM5765QSQ	Standard 25-piece bag
RFFM5765QSR	Standard 100-piece bag
RFFM5765QTR7	Standard 2500-piece reel
RFFM5765QPCK-410	Fully assembled evaluation board

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (Continuous with No Damage)	6.0	V
DC Supply Current	700	mA
Case Operating Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Maximum Tx Input Power into 50Ω Load for 11b/g/n (No Damage)	+5	dBm
Maximum Rx Input Power (No Damage)	+5	dBm
Moisture Sensitivity	MSL2	

Caution! ESD sensitive device.

RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

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.

Nominal Operating Parameters

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
2.4GHz Transmit Parameters					
Compliance					IEEE802.11b/g/n Standards, FCC CFG 15.247, .205, .209, EN, and JDEC
Operating Conditions					V_{CC} = 3.0V to 4.2V; V_{REG} = 3.0V to 3.2V; P_{OUT}(g/n) = 19dBm; Frequency 2412MHz to 2484MHz; Switch Control voltage: 3.0V to 3.6V; 11g 54Mbps and 11n MCS7 signals; Temp = -40°C to +85°C; Unless noted otherwise.
Frequency	2.4		2.5	GHz	
Voltage Supply	3.0	3.3	4.2	V	Power Amplifier Voltage Supply (V_{CC})
V_{REG} Voltage					
ON	3.0	3.1	3.2	V	PA in “ON” state
OFF		0.00	0.20	V	PA in “OFF” state
Output Power					
11g/n	17	18.5		dBm	V_{CC} > 3.0V
	18	19		dBm	V_{CC} > 3.3V
11b	19	22		dBm	11Mbps CCK signal, V_{CC} > = 3.3V
EVM		3.3	4	%	P_{OUT}(g/n) = Rated Output Power, 54Mbps OFDM, 50Ω, see note 1
Adjacent Channel Power					P_{OUT}(b) = 22dBm, 11Mbps CCK signal, V_{CC} > = 3.3V, see note 4
ACP1		-36	-33	dBc	+/- 11MHz Offset from carrier
ACP2		-56	-53	dBc	+/- 22MHz Offset from carrier
Gain	25.5	30	34.5	dB	
Gain Variation Slope					At rated power and a given supply voltage
Range	3.0		4.2	V	
V_{CC} (Average)			0.5	dB/V	
V_{CC} (Instantaneous)			1	dB/V	
Frequency	-0.5		+0.5	dB	2.4GHz to 2.5GHz
Over Temperature	-1.75		+1.75	dB	V_{CC} = 3.3V, V_{REG} = 3.1V, Freq = 2.45GHz
Typical Input Power					
11g/n		-9		dBm	
11b		-5		dBm	

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
2.4GHz Transmit Parameters (continued)					
Power Detect					
Power Range	0		23	dBm	
Voltage Range	0.1		1.5	V	
Resistance		10		kΩ	
Capacitance			10	pF	
Sensitivity					
$0 < P_{OUT} < 6dBm$	3			mV/dB	
$6 < P_{OUT} < 23dBm$	8		350	mV/dB	
Current Consumption (I_{CC})					
Quiescent Current		110	150	mA	Over V_{CC}, and Temp range
11g/n		215	250	mA	At rated power, over Freq, V_{CC}, and Temp range
11b		260	340	mA	At rated power, over Freq, V_{CC}, and Temp range
I_{REG}			5	mA	$V_{REG} > 3.0V$
V_{CC} Leakage Current		2	10	µA	$V_{CC} = 4.8V$, $V_{REG} = C\_BT = C\_RX = C\_BWRX < 0.2V$
Input Port Impedance		50		Ω	
Input Port Return Loss	10	15		dB	
Ruggedness					No Damage Conditions: max operating voltage, max input power, max temperature
Output VSWR			10:1		
Input Power			-5	dBm	
Stability					PA must be stable from 0dBm to 20dBm. No spurs above -41.25dBm for non-harmonic related signals.
Output VSWR	6:1				CW signal, $P_{OUT} = 20dBm$, all phases
Out-of-Band Emissions 2310MHz to 2390MHz and 2483.5MHz to 2500MHz (FCC restricted bands)			-41.25	dBm/MHz	$P_{OUT} = 16.5dBm$, 54Mbps OFDM Modulation, 64QAM, RBW = 1MHz, VBW = 100kHz, $V_{CC} = 3.3V$, $V_{REG} = 3.1V$, Note 4
			-41.25	dBm/MHz	$P_{OUT} = 20.5dBm$, 11Mbps CCK Modulation, BT = 0.45, RBW = 1MHz, VBW = 100kHz, $V_{CC} = 3.3V$, $V_{REG} = 3.1V$
Harmonics					11b modulation, 1Mbps, BW = 1MHz, up to 3:1 load, $P_{OUT} = 20dBm$
Second			-23	dBm	4.80GHz to 5.00GHz
Third			-20	dBm	7.20GHz to 7.50GHz
Turn-on/off Time		0.5	1.0	µs	Output stable to within 90% of final gain, Note 1

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
2.4GHz Receive Parameters					
Compliance					IEEE802.11b, IEEE802.11g/n, FCC CFG 15.247,.205,.209, EN, and JDEC
Nominal Conditions					V_{DD} = 3.0V to 4.2V; Switch Control: 3.0V to 3.6V; Freq = 2412MHz to 2484MHz; CW signal; Temp = -40°C to +85°C; Unless noted otherwise
Frequency	2.4		2.5	GHz	
LNA Voltage Supply (LNA V_{CC})	3.0	3.3	4.2	V	LNA V_{CC} can be tied to V_{BATT} at all times
LNA Current		16	18	mA	LNA in “ON” state
	0		5	µA	LNA in “OFF” state (C_RX = low, LNA V_{CC} = ON)
LNA Input P1dB	-10	-7	-4.5	dBm	
Gain					
WiFi Rx Gain	13	18	21	dB	WiFi Rx mode, V_{DD} > = 3.3V
Simultaneous WiFi/BT Rx Mode	9	13	16	dB	WiFi Rx/BT Mode, LNA “ON”, V_{DD} > = 3.3V
Noise Figure					V_{CC} > 3.3V, including switch
WiFi Rx		2.1	3.5	dB	WiFi Rx mode (LNA “ON”)
Simultaneous WiFi/BT Rx Mode		3	4	dB	WiFi Rx/BT Mode (LNA “ON”)
Passband Ripple	-0.2		+0.2	dB	WiFi Rx Mode
	-0.5		+0.5	dB	WiFi Rx/BT Mode
WiFi Rx Port Return Loss	8.5			dB	
	5			dB	Switch in WiFi Rx/Bluetooth Mode
WiFi Rx Port Impedance		50		Ω	No external matching
Bluetooth Parameters					
Frequency	2.4		2.5	GHz	
Insertion Loss					
BT Tx/Rx only		1.2	1.5	dB	Bluetooth mode
BT/WiFi Rx Gain (simultaneous mode)	9	13	16	dB	WiFi Rx/BT Mode, LNA “ON”
Passband Ripple	-0.2		+0.2	dB	Bluetooth mode
	-0.5		+0.5	dB	WiFi Rx/BT mode
Input P1dB	27	30		dB	BT Mode, over temp, C_BT = 3.3V to 3.6V
Bluetooth Port Return Loss	8.5			dB	Switch in Bluetooth Mode
	6			dB	Switch in WiFi Rx/Bluetooth Mode

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Other Requirements					
Antenna Port Impedance					
Output		50		Ω	
Return Loss		10		dB	
Isolation					
Antenna to Receive	20			dB	In BT Mode (measured from ANT to Rx port)
Antenna to Bluetooth	20			dB	In Tx Mode (measured from ANT to BT port)
Antenna to Receive	20			dB	In Tx Mode (measured from ANT to Rx port)
Switch Control Voltage					C RX, C BT, and C BW Rx control lines
Low		0	0.2	V	Switch is in the low state (L)
High	1.7	3.3	3.6	V	Switch is in the high state (H)
Switch Control Current		2	10	µA	Per control line (C_BT, C_BWRX)
C_RX Current		100	150	µA	Over V_{CC}, Frequency and Temperature.
Switch Control Speed			200	ns	
Switch P1dB		28		dBm	
ESD					
Human Body Model	500			V	EIA/JESD22-114A RF pins
	1000			V	EIA/JESD22-114A DC pins
Charge Device Model	500			V	JESD22-C101C all pins

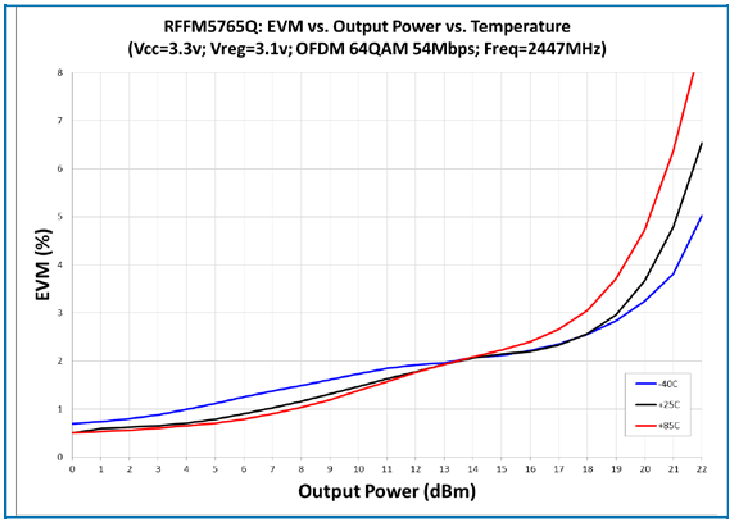
Note 1: The PA module must operate with gated bias voltage input at 1% to 99% duty cycle.
Note 3: Values to be agreed to upon characterization data review: current, gain, return loss, detector sensitivity and output power.
Note 4: The output power for channels 1 and 11 may be reduced to meet FCC restricted band requirements.

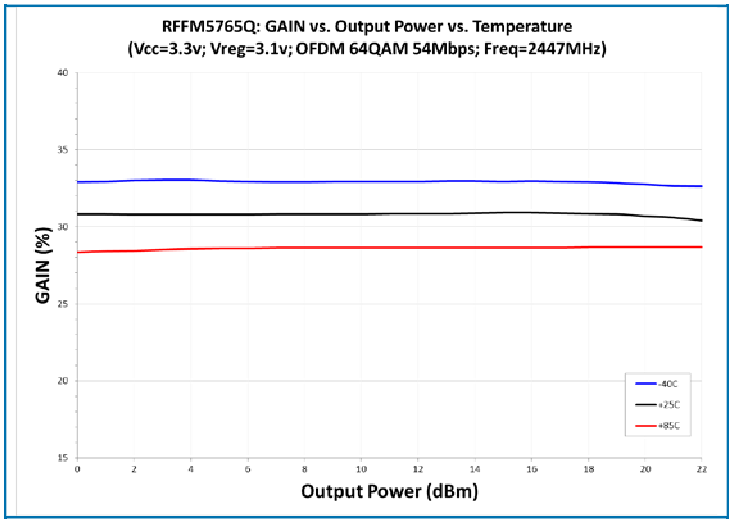
Switch Control Logic Table

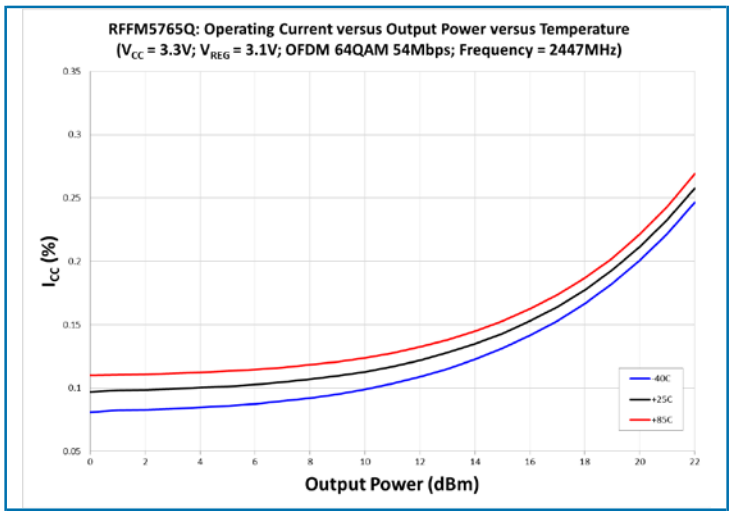
Mode	VREG	C_RX	C_BT	C_BWRX
Standby	Low	Low	Low	Low
WiFi Tx	High	Low	Low	Low
WiFi Rx	Low	High	Low	Low
WiFi Rx/BT*	Low	High	Low	High
BT Rx	Low	Low	High	Low
BT Tx	Low	Low	High	Low

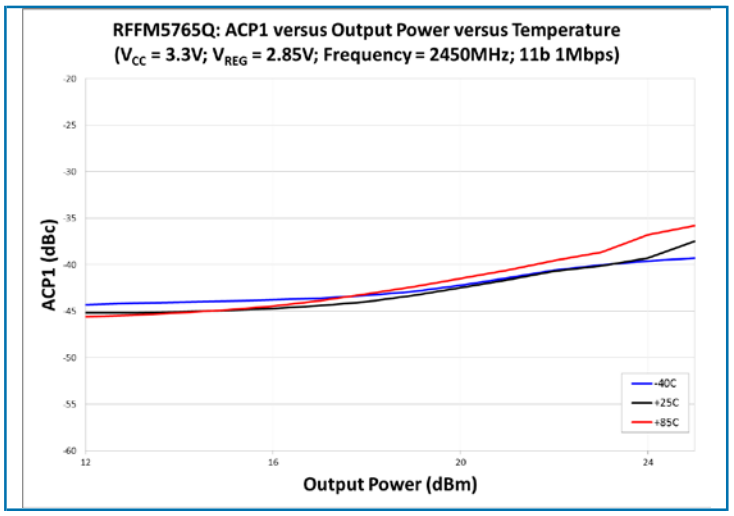
*The FEM can be placed in receive WiFi and Bluetooth modes simultaneously with increased insertion loss.

Transmit Performance Plots









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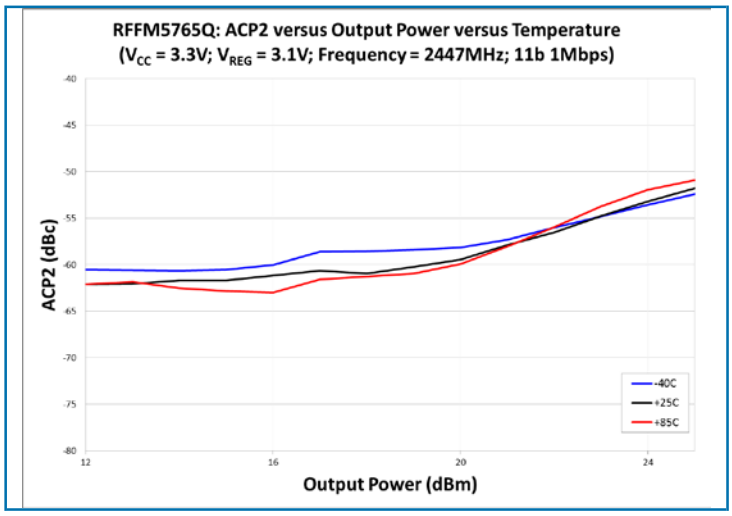

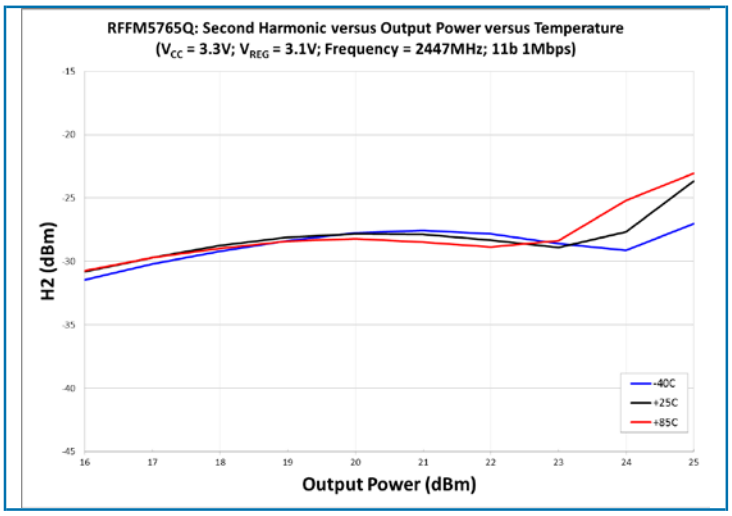

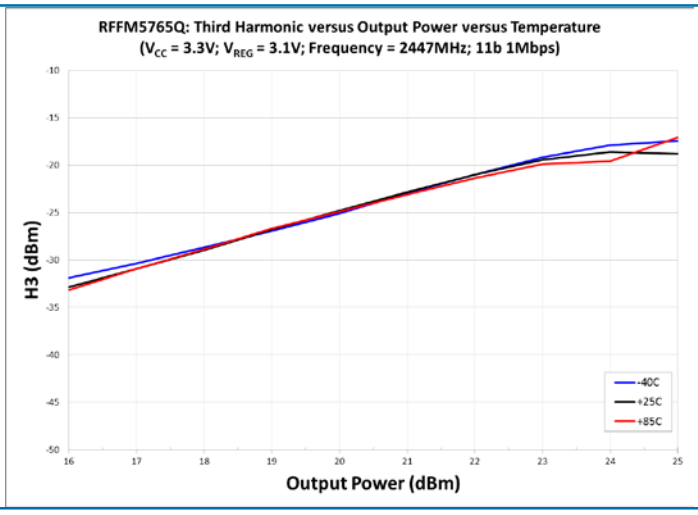

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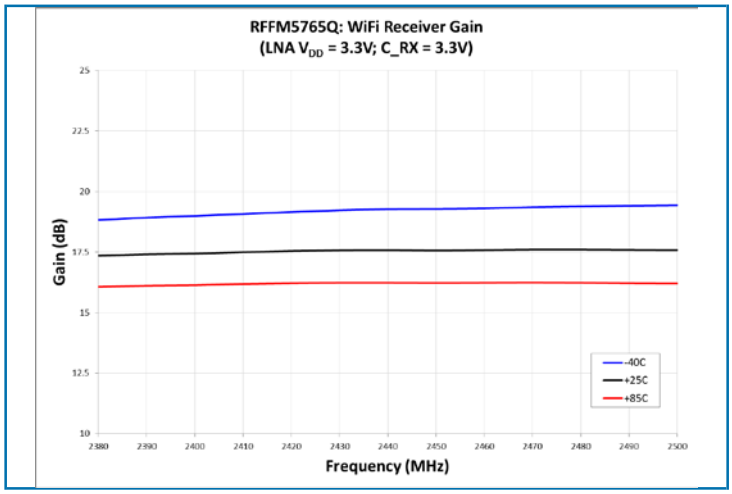
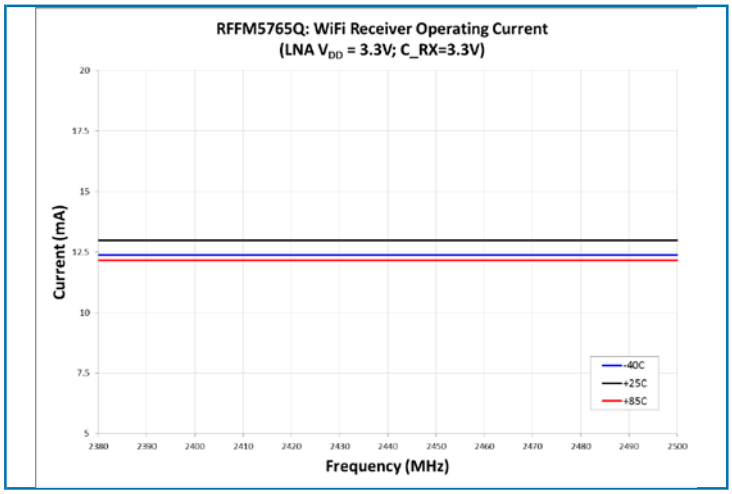
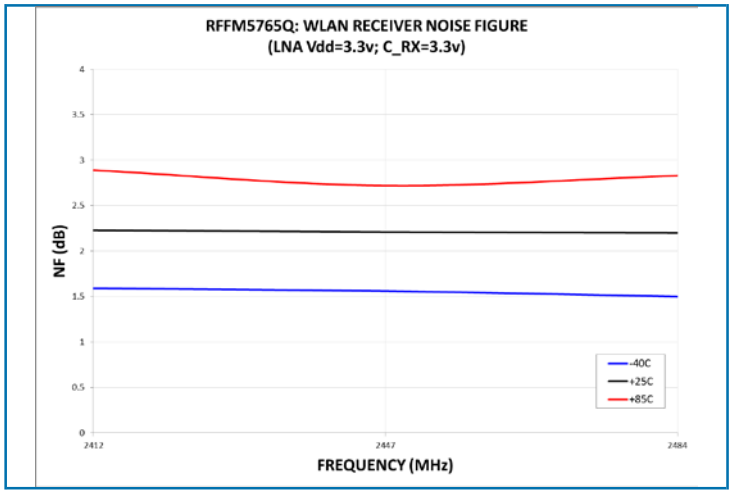
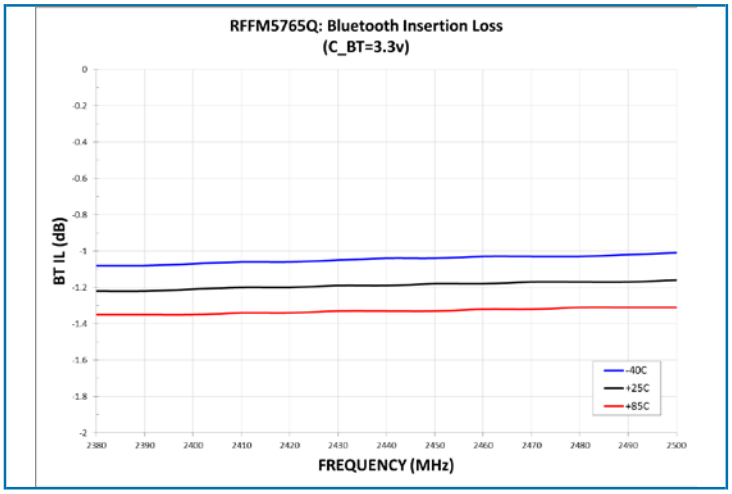
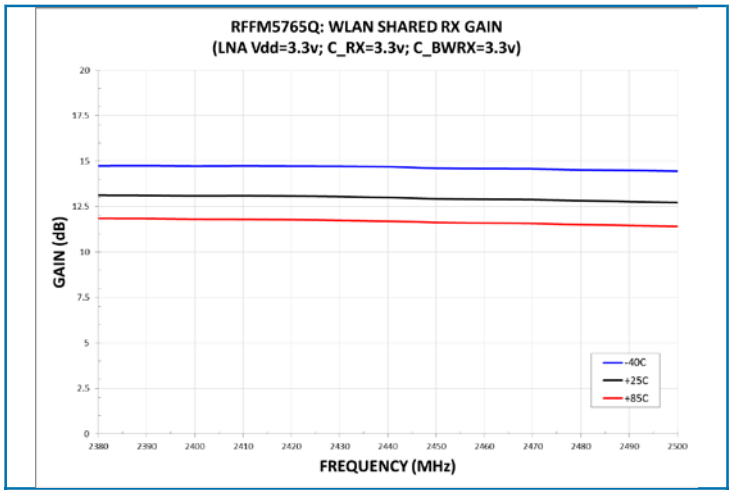
Receive Performance Plots

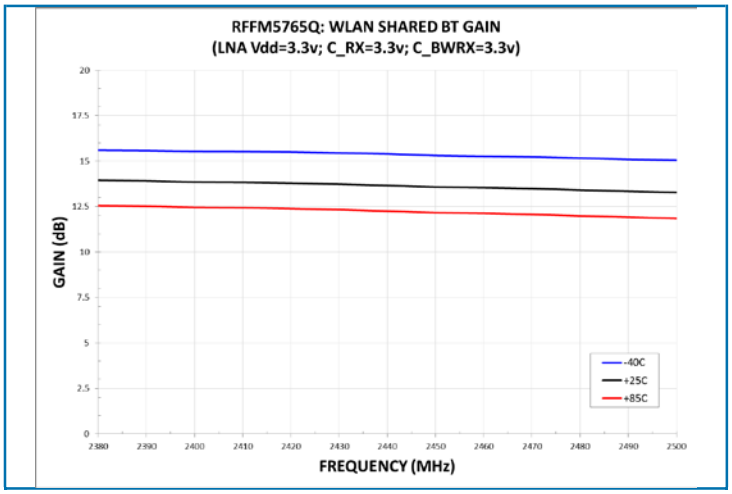












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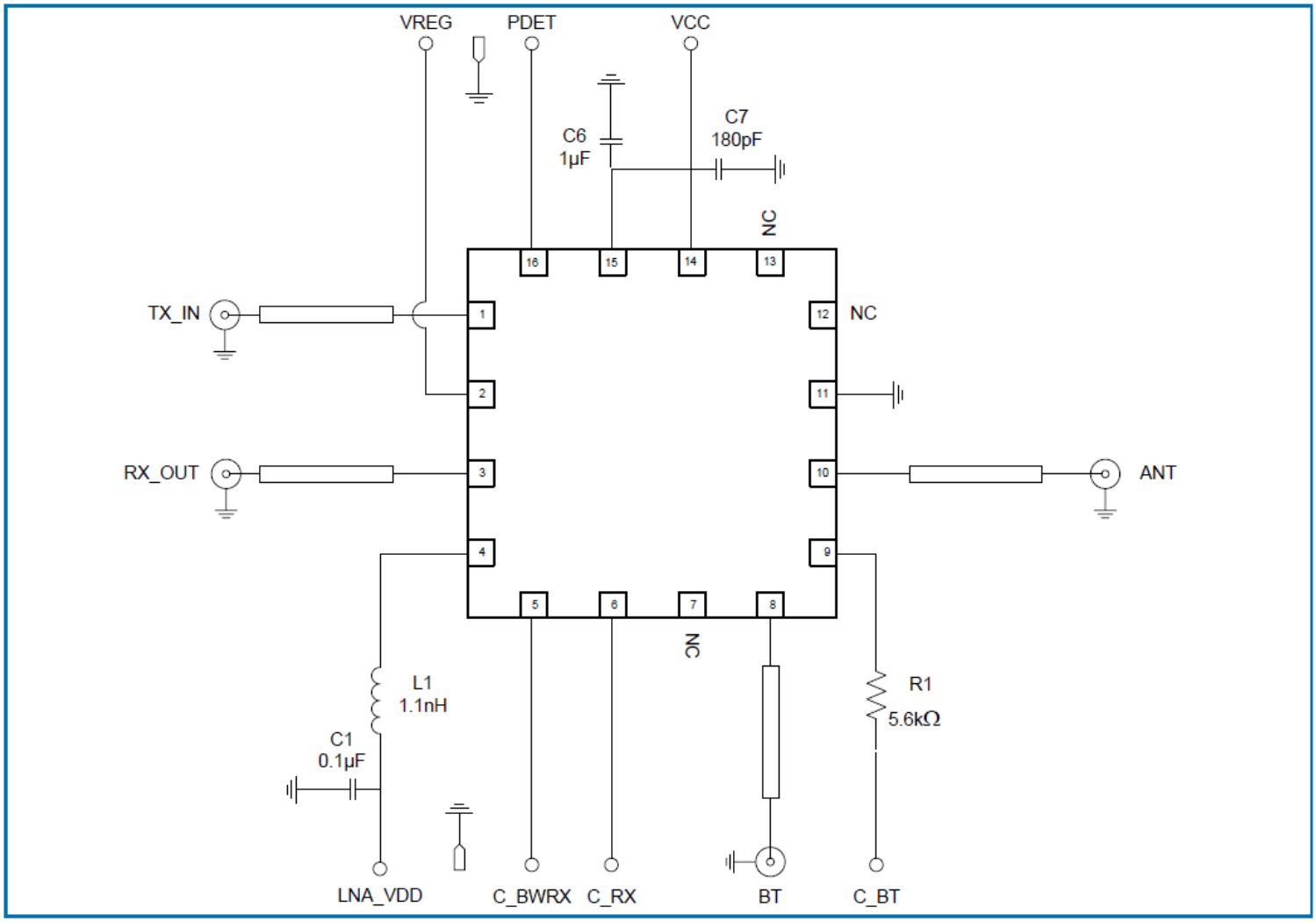
Application Schematic



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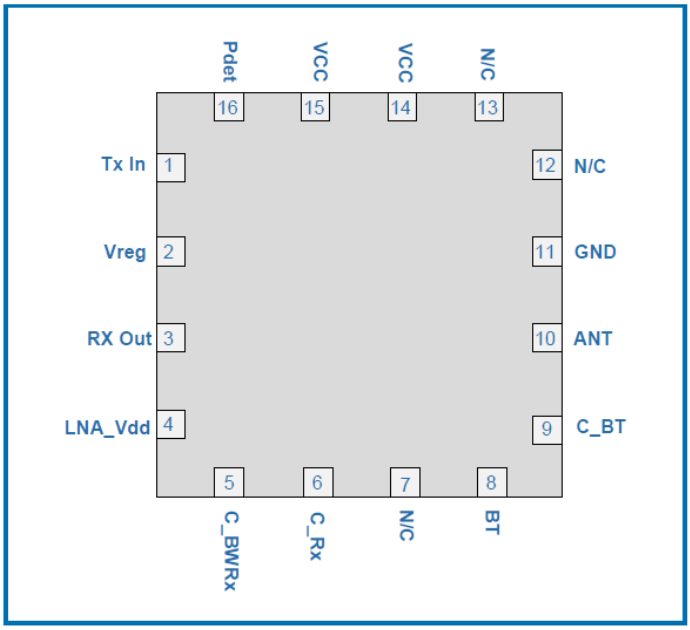
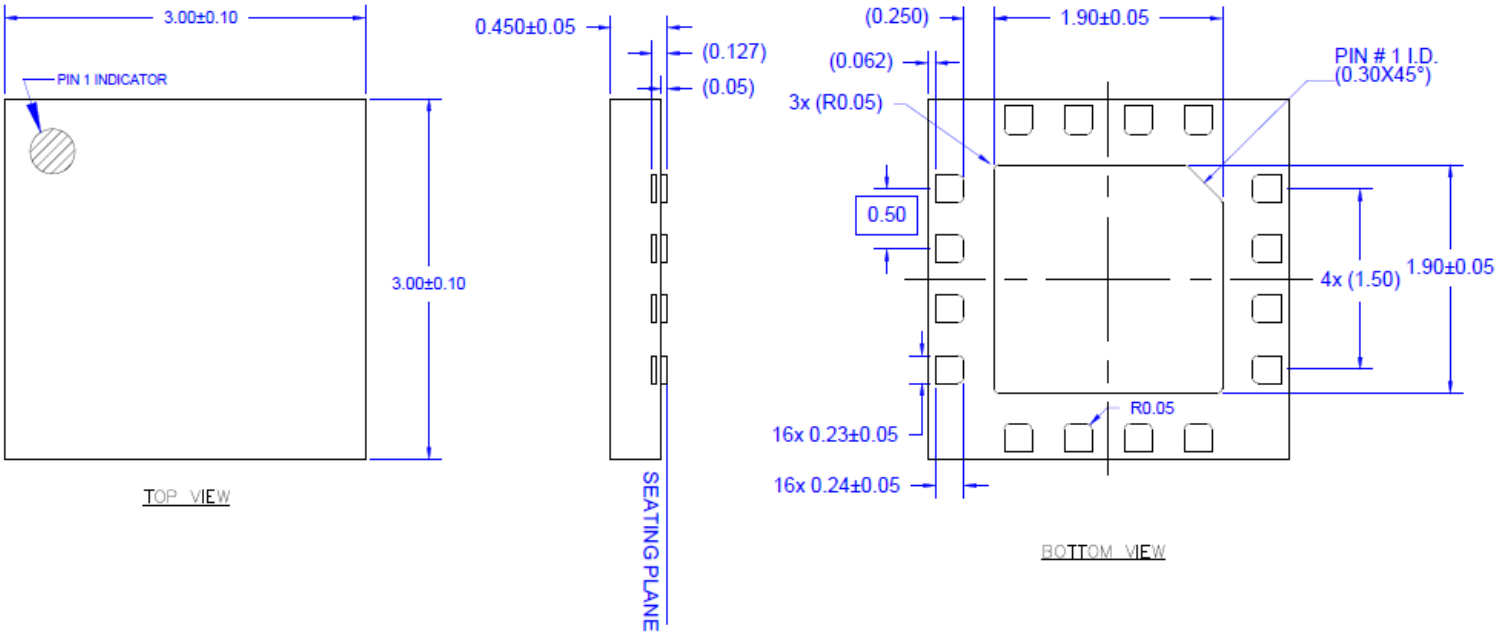
Pin Out



Package Drawing



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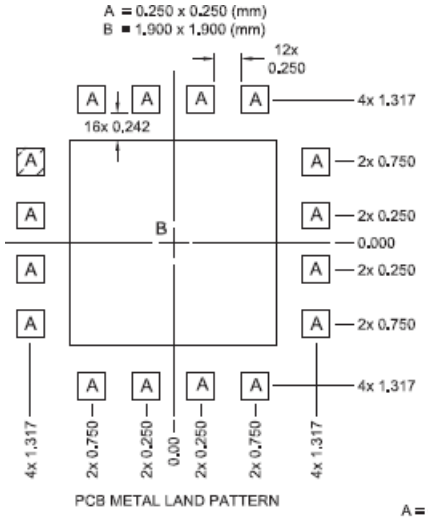
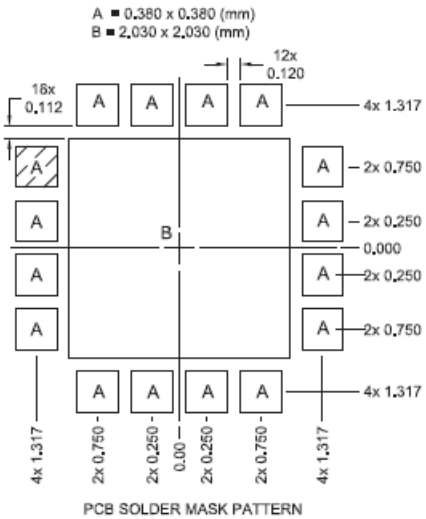
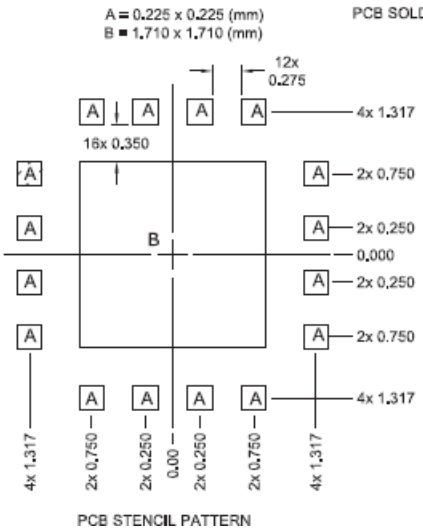
PCB Pattern



PCB METAL LAND PATTERN



PCB SOLDER MASK PATTERN



PCB STENCIL PATTERN

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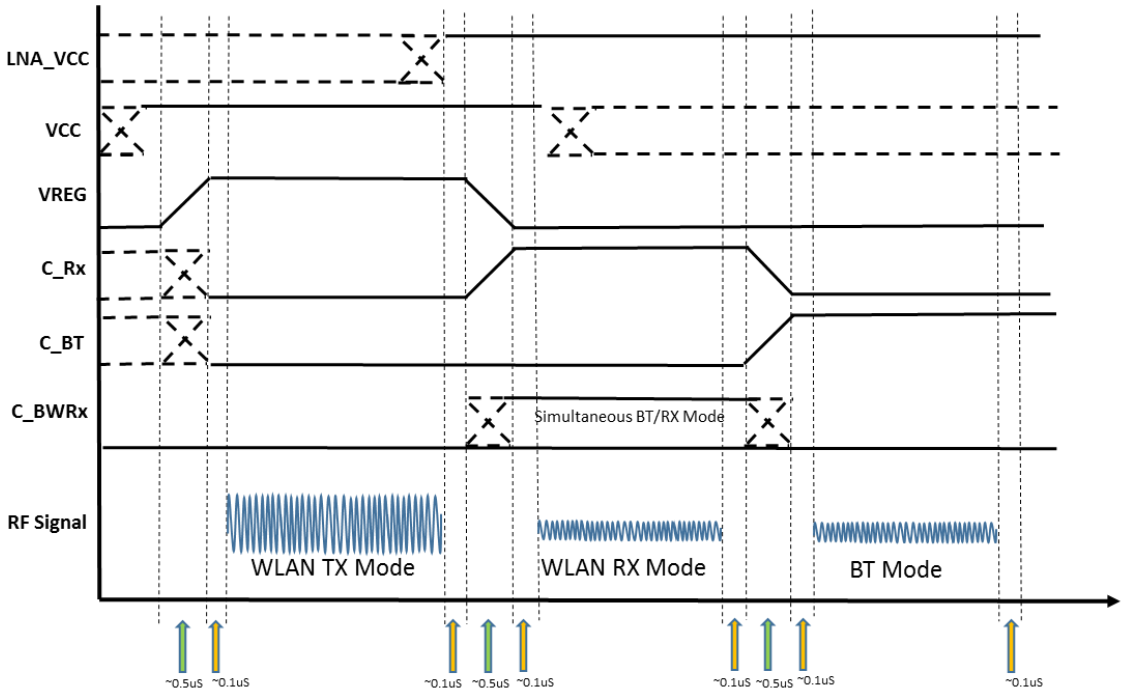
Pin Names and Descriptions

Pin	Name	Description
1	TX_IN	RF input for the PA. Input is matched to 50Ω and DC block is provided internally.
2	VREG	Supply voltage for the bias control circuit, and the Tx control port of the SP3T which is also tied to this pin. An external bypass capacitor may be needed on the V_{REG} line for decoupling purposes.
3	RX_OUT	Receive port output. Internally matched to 50Ω. DC block provided internally.
4	LNA_VDD	Supply voltage for the LNA.
5	C_BWRX	SPST switch control pin. (Simultaneous WiFi and BT receive.) See truth table for proper level.
6	C RX	Receive switch control pin. See switch truth table for proper level.
7	N/C	No connect.
8	BT	RF bidirectional port for Bluetooth. Input is matched to 50Ω and DC block is provided internally.
9	C_BT	Bluetooth switch control pin. See truth table for proper level.
10	ANT	Port matched to 50Ω and is DC blocked internally.
11	GND	Ground.
12	N/C	No connect.
13	N/C	No connect.
14	VCC	Supply voltage for the PA.
15	VCC	Supply voltage for the PA.
16	PDET	Power detector voltage for Tx section. PDET voltage varies with output power. May need external decoupling capacitor for noise bypassing. May need external circuitry to bring output voltage to desired level.

Timing Diagram



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Theory of Operation

The RFFM5765Q front end module (FEM) is designed for automotive WiFi applications in the 2.5GHz ISM band. It can be applied in many portable applications such as handsets, portable media players, and portable battery power equipment. This highly integrated module can be connected directly to the battery without additional voltage regulators.

WiFi Transmit Mode

The RFFM5765Q requires a single positive supply (V_{CC}), a positive supply for switch controls, and a regulated supply for the V_{REG} to maintain nominal bias current. The RFFM5765Q transmit path has a typical gain of 30dB from 2.4GHz to 2.5GHz, and delivers 19dBm typical output power under 54Mbps OFDM modulation and 22dBm under 1Mbps 11b modulation. The RFFM5765Q contains basic filter components to produce a bandpass response for the transmit path. Due to space constraints inside the module, filtering is limited to a few resonant poles and additional filters may be required depending upon the end-user's application. While in transmit mode, the active components are the power amplifier (PA) and the Tx branch of the SP3T switch. Refer to the logic control table for proper settings.

Tx Biasing Instructions

- Connect the Tx input (pin-1) to a signal generator and a spectrum analyzer at the antenna output (pin-10)
- Set V_{CC} to 3.3V with V_{REG} set to 0V
- Turn V_{REG} ON and set voltage to 3.1V. V_{REG} controls the current drawn by the PA and it should quickly reach a quiescent current of approximately 110mA ± 20mA. Care must be exercised not to exceed 3.5V on the V_{REG} pin or the part may be damaged.
- Control bias to the transmit branch of the SP3T switch is tied directly to V_{REG}
- The SP3T controls for the off branches (C_RX and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance of the PA will degrade significantly. Likewise, unused RF ports must be terminated in 50Ω to simulate actual system conditions and prevent RF signals from coupling back to the PA.
- Turn RF ON

WiFi Receive Mode

Within the frequency band of operation 2.4GHz to 2.5GHz, the RFFM5765Q WiFi receive path has a typical gain of 18dB and a NF of 2.1dB with about 10mA of current. In Rx mode, only the Rx branch of the SP3T and the LNA are active. Refer to the logic control table for proper settings.

Rx Biasing Instructions

- Connect the Rx input (ANT/pin-10) to a signal generator and a spectrum analyzer at the Rx output (pin-3). A VNA may be used as well.
- Turn the LNA bias ON (pin-4) and set the voltage to 3.3V.
- Set C_RX (pin-6) high. This turns ON the receive branch of the SP3T.
- The SP3T controls for the off branches (V_{REG} and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF ports in 50Ω.
- Set the control bias for the SPST switch (C_BWRX/pin-5) "low" during WiFi Rx only mode.
- Turn RF ON.

WiFi and Bluetooth Receive (Simultaneous Mode)

The RFFM5765Q WiFi and Bluetooth receive circuits were specifically designed to address issues of simultaneous operation. In this mode both signals can be received at the same time when the C_BWRX (pin-5) is set high. The typical gain for each RF path is approximately 13dB and a NF of 3dB. During simultaneous mode the active components are the LNA, the SPST switch, and only the Rx branch of the

SP3T. Refer to the logic control table for proper settings.

Simultaneous Mode Biasing Instructions

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the Rx (pin-3) and BT (pin-8) RF ports. A multiport VNA may be used as well.
- Turn the LNA bias ON (pin-4) and set the voltage to 3.3V.
- Set C_RX and C_BWRX high. This turns ON the receive branch of the SP3T and the SPST switch.
- The SP3T controls for the off branches (V_{REG} and C_BT) must be set to a logic "low" (0.2V max) or grounded. In the event that one of these branches is left floating or in a logic "high" the performance will degrade. It is recommended to terminate unused RF Ports in 50Ω.
- Turn RF ON.

Bluetooth Mode

The RFFM5765Q Bluetooth only mode is implemented through the SP3T switch by setting C_BT "high." Typical insertion loss is about 1.2dB.

Bluetooth Biasing Instructions

- Connect the RF input (ANT/pin-10) to a signal generator and a spectrum analyzer at the BT RF port. A VNA may be used in place of the Sig Gen and SA.
- Set C_BT (pin-9) "high." This turns the Bluetooth branch of the SP3T switch ON.
- The SP3T controls for the off branches (V_{REG} and C_RX) must be set to a logic "low" (0.2V max) or grounded. Do not leave floating.
- Terminate unused RF Ports in 50Ω.
- Turn RF ON

Application Circuit and Layout Recommendations

The RFFM5765Q integrates the matching networks and DC blocking capacitors for all RF ports. This greatly reduces the number of external components and layout area needed to implement this FEM. Typically only a total of four external components are required to achieve nominal performance. However, depending on board layout and the many noise signals that could potentially couple to the RFFM5765Q, additional bypassing capacitors may be required to properly filter out unwanted signals that might degrade performance.

The LNA bias components consist of an inductor and a decoupling capacitor. The inductor value is critical to optimize NF and return loss at the Rx output. For best performance and tradeoff between critical parameters such as NF, Gain, and IP3, the total inductance including board trace should be approximately 1.2nH. The 5.6kΩ series resistor for the Bluetooth control line helps to prevent unwanted signal from coupling to this pin. The resistor should be place as close as possible to the package pin. The last component needed in the application circuit is a low frequency bypass capacitor on the V_{CC} line. In general, it is good RF practice to have proper decoupling of supply lines to filter out noise. Occasionally, depending on the level of coupling or parasitics of the board, a high frequency bypass capacitor must be added as well.

In order to optimize performance for both the transmit and receive paths, a good layout design must be implemented. In addition to designing 50Ω RF lines, proper grounding along the RF traces and on the FEM ground slug must be exercised. This will minimize coupling and provide good thermal dissipation when the PA is operating at high power. For reference, the RFMD evaluation board uses 9 thermal ground vias (hole/capture pad 12/22mil) on the ground slug. Additionally, if space permitted, V_{CC} and control lines must be isolated from each other with ground vias in between them. RFMD evaluation board gerbers are available upon request.

Contact Information

For the latest specifications, additional product information, worldwide sales and distribution locations:
Web: www.qorvo.com
Tel: 1-844-890-8163
Email: customer.support@qorvo.com

Important Notice

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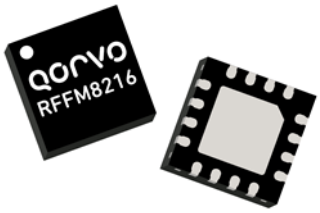
RFFM8216

2.4 GHz Integrated Wi-Fi Front-End Module

16 Pin 2.3 x 2.3 mm QFN Package



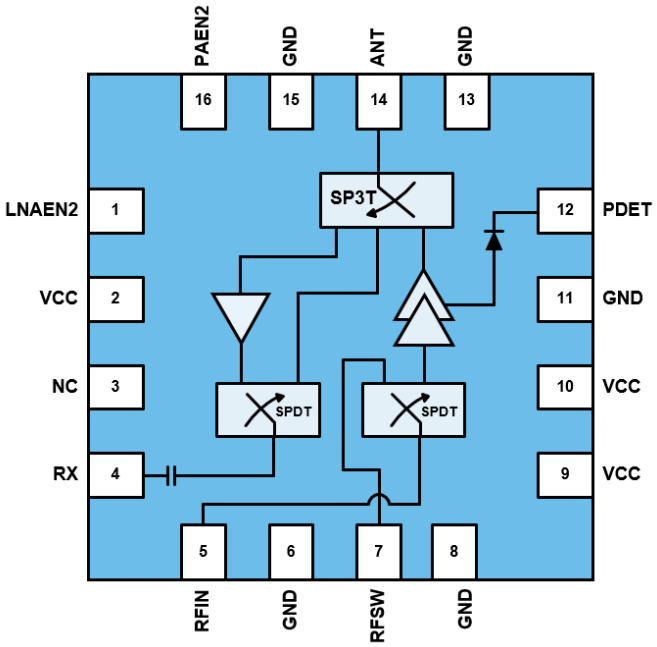
Product Overview

The RFFM8216 provides a complete integrated solution in a single front end module (FEM) for WiFi 802.11b/g/n/ac systems.Performance is focused on a balance of efficiency to enable long battery life and linear power that increases the range of connection. It is specifically designed to work with the RFFM8516 to greatly reduce BOM cost in dual band applications.

The RFFM8216 integrates a 2.4GHz power amplifier (PA), single pole triple throw switch (SP3T), LNA with bypass + BT/Rx switch (SP2T), harmonic filtering, a diversity switch (SP2T) and a power detector coupler for improved accuracy.

Functional Block Diagram

Top View



Key Features

- P_{OUT} = 20dBm, 802.11n 20MHz MCS7 @ 2.2% (-33dB) Dynamic EVM
- High efficiency
- Input and Output matched to 50 ohms
- Integrated 2.4GHz PA, SP3T, LNA with Bypass, 2xSPDT and P_{DET}
- Integrated Power Detector
- High Impedance PA Enable

Applications

- IEEE 802.11b/g/n/ac WLAN Applications
- Single-Placement RF Front-End Module
- Single-band and Dual-band Wireless LAN Systems
- Portable Battery-Powered Equipment

Ordering Information

PART NUMBER	DESCRIPTION
RFFM8216SB	5 piece sample bag
RFFM8216SQ	25 piece sample bag
RFFM8216SR	7” Reel with 100 pieces
RFFM8216TR7	7” Reel with 2500 pieces
RFFM8216TR7-5K	7” Reel with 5000 pieces
RFF8216PCK-410	Full assembled Evaluation Board w/ 5-piece bag

Absolute Maximum Ratings

PARAMETER	CONDITIONS	RATING
Storage Temperature		-40 to 150 °C
DC Supply Voltage	No RF Applied	−0.5 to +6.0 V
PA Enable Voltage		−0.5 to +5.0 V
DC Supply Current		800mA
RF Maximum Input Power (TX Mode)	CW, 50Ω, VCC = 3.6 V, T = 25ºC	+12 dBm
RF Maximum Input Power (RX LNA Mode)	CW, 50Ω, VCC = 3.6 V, T = 25ºC	0 dBm
RF Maximum Input Power (RX BYPASS Mode)	CW, 50Ω, VCC = 3.6 V, T = 25ºC	+30 dBm

Operation of this device outside the parameter ranges given above may cause permanent damage.

Recommended Operating Conditions

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating Temperature		−20	-	+60	ºC
Extended Operating Temperature	Functional with reduced performance	−40	-	+85	ºC
Operating Voltage V_{CC}		3.0	3.6	4.2	V
Extended Operating Voltage V_{CC}	Functional with reduced performance	3.0	-	4.8	V
Control Voltage (V-High)	PAEN2	2.75	2.9	Vcc	V
Control Voltage (V-High)	LNAEN2	2.75	3.3	Vcc	V
Control Voltage (V-Low)	PAEN2 / LNAEN2	0	0.1	0.4	V
Control Current (I-High)	PAEN2	-	100	1000	uA
Control Current (I-High)	LNAEN2	-	50	1000	uA
Control Current (I-Low)	PAEN2 / LNAEN2	-	0.1	10	uA
Leakage/Sleep/Bypass Mode Current	PAEN2/ LNAEN2 = LOW V_{CC} = 4.2 V	-	8	16	uA

Electrical specifications are measured at specified test conditions. Specifications are not guaranteed over all recommended operating conditions.

Logic Truth Table

SINGLE BAND CONFIGURATION		
MODE	**PAEN2**	**LNAEN2**
2.4 GHz TX Mode	High	Low
2.4 GHz RX LNA Mode	Low	High
2.4 GHz RX Bypass (Sleep)	Low	Low
RFSW	Low	High/Low

DUAL BAND CONFIGURATION					
	5 GHz FEM			2 GHz FEM	
MODE	**PAEN5**	**LNAEN5**	**SWCTL5**	**PAEN2**	**LNAEN2**
5 GHz TX Mode	High	Low	High	Low	Low
5 GHz RX LNA Mode	Low	High	Low	Low	Low
5 GHz Sleep/Bypass	Low	Low	Low	Low	Low
2.4 GHz TX Mode	N/A	N/A	N/A	High	Low
2.4 GHz RX LNA Mode	N/A	N/A	N/A	Low	High
2.4 GHz RX Bypass (Sleep)	N/A	N/A	N/A	Low	Low
RFSW	N/A	N/A	N/A	Low	High/Low

Electrical Specifications – Transmit

(V_{CC} = 3.6 V; Temp=25°C; unless noted otherwise)

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating Frequency		2412	-	2472	MHz
Small Signal Gain		24	28	-	dB
Gain flatness	For any 20 MHz bandwidth	−0.25	-	+0.25	dB
Gain flatness	For entire frequency band	−1	-	+1	dB
11g 54 Mbps	Output Power	+19.5	+20.5	-	dBm
	DEVM	-	−31	−28	dB
MCS7 20 MHz	Output Power	+19.0	+20.0	-	dBm
	DEVM	-	−33	−29	dB
MCS8 20 MHz	Output Power	+18.0	+19.0	-	dBm
	DEVM	-	-	−35	dB
Margin to Spectrum Emission Mask 11b 1 Mbps	Pout = 24.0 dBm	-	3.0	-	dB
Margin to Spectrum Emission Mask 11g 6 Mbps	Pout = 22.0 dBm	-	3.0	-	dB
Margin to Spectrum Emission Mask 11n, MCS0 HT20	Pout = 22.0 dBm	-	3.0	-	dB
Current 11b, 1 Mbps	Pout = 24.0 dBm	-	320	350	mA
Current 11n, MCS7 HT20	Pout = 20.0 dBm	-	230	260	mA
Return Loss RFIN Port		10	15	-	dB
Return Loss ANT Port		7	9	-	dB
Harmonics ($2f_0$)	802.11b 1Mbps; Pout = 22.0 dBm	-	-	−13	dBm/MHz
Harmonics ($3f_0$)	802.11b 1Mbps; Pout = 22.0 dBm	-	-	−30	dBm/MHz
Power Detector Voltage	Pout = 5.0 dBm	-	0.2	-	V
	Pout = 24.0 dBm	-	-	1.1	V
PA Switching Speed		-	400	-	nS
ANT to RX Isolation (TX Mode)		40	45	-	dB

Electrical Specifications – RFSW (RFIN-RFSW)

(V_{CC} = 3.6 V; Temp=25°C; unless noted otherwise)

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating Frequency		2412	-	2472	MHz
Insertion Loss	2.4 GHz to 6 GHz	-	0.7	1.5	dB
RFIN Port Return Loss		10	15	-	dB
RFSW Port Return Loss		10	15	-	dB
Input P0.1dB		20	-	-	dBm

Electrical Specifications – Receive

(V_{CC} = 3.6 V; Temp=25°C; unless noted otherwise)

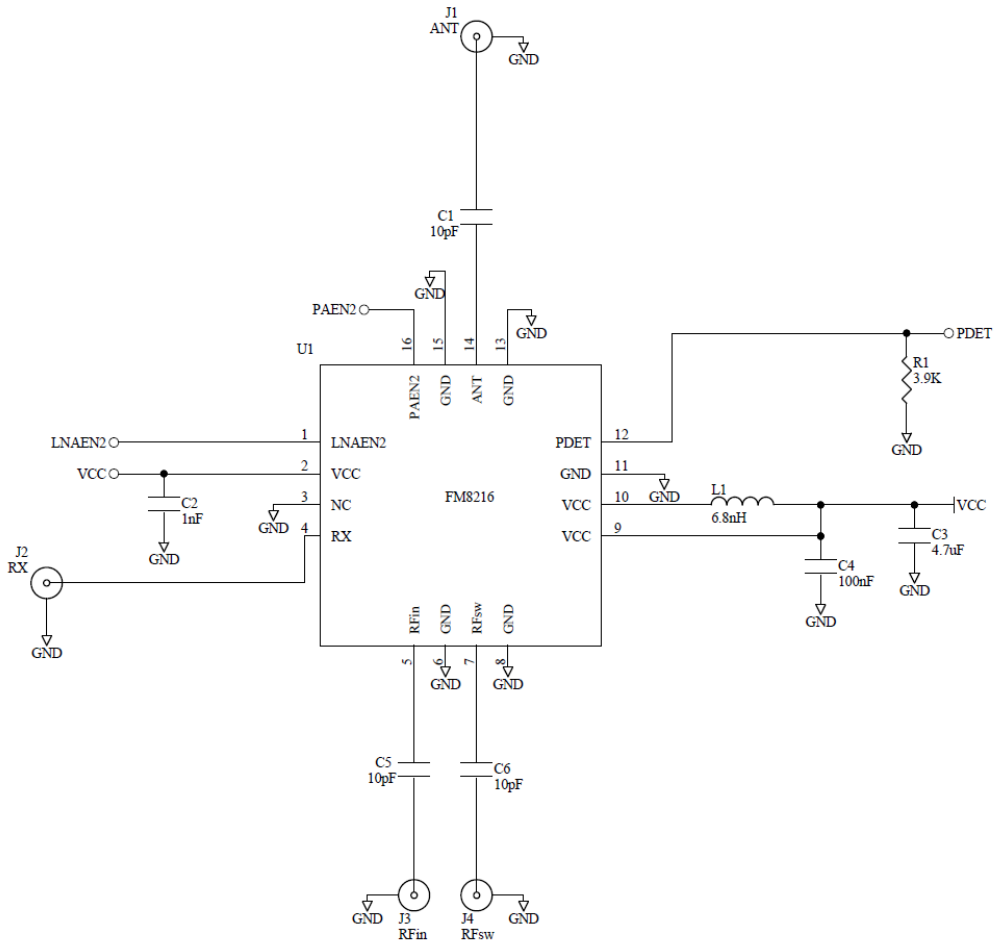
PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating Frequency		2412	-	2472	MHz
Gain		12	14	-	dB
Gain flatness	Over entire Frequency band	−1	-	+1	dB
Noise Figure		-	2.1	2.6	dB
Current		-	9	14	mA
Input P1dB		−10	−8	-	dBm
Return Loss RX Port		9	11	-	dB
Return Loss ANT Port		3	5	-	dB
LNA Switching Speed		-	400	-	nS

Electrical Specifications – RX Bypass

(V_{CC} = 3.6 V; Temp=25°C; unless noted otherwise)

PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNITS
Operating Frequency		2412	-	2472	MHz
Insertion Loss		-	1.2	2.0	dB
Return Loss RX Port		9	11	-	dB
Return Loss ANT Port		9	11	-	dB
Input P0.1dB		20	-	-	dBm

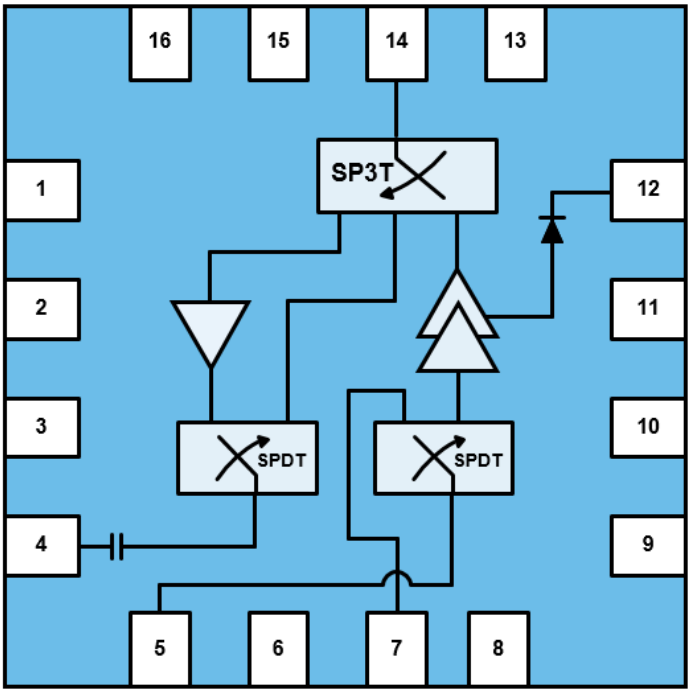
Application Circuit Schematic



Bill of Materials

REF. DES.	QTY	DESCRIPTION	MANUF.	PART NUMBER
PCB	1	PCB, FM8216	Performance Micro International	RFFM8216-410(B)
C3	1	CAP, 4.7uF, +80/-20%, 10V, Y5V, 0805	Taiyo Yuden	CE LMK212 F475ZG-T
C4	1	Cap, 0.1uF, 10%, 6.3V, X5R, 0201	Murata Electronics	GRM033R60J104KE19D
C2	1	CAP, 1000pF, 10%, 25V, X7R, 0201	Samsung	CL03B102KA3NNNC
C1, C5, C6	3	CAP, 10pF, +/-0.5pF, 25V, C0G, 0201	Taiyo Yuden	RM TMK063CG100DT-F
L1	1	IND, 6.8nH, 5%, M/L, 0201	Taiyo Yuden	LG HK06036N8J
R1	1	RES, 3.9K, 5%, 1/20W, 0201	Kamaya	RMC1/20-392JPA15
J1, J2, J3, J4	4	CONN, SMA, EL FLT VIPER, MAT-21-1038	Amphenol RF Asia Corp	901-10425
P1, P2	2	CONN, HDR, ST, PLRZD, 3-PIN, 0.100"	ITW Pancon	MPSS100-3-C

Pin Configuration and Description

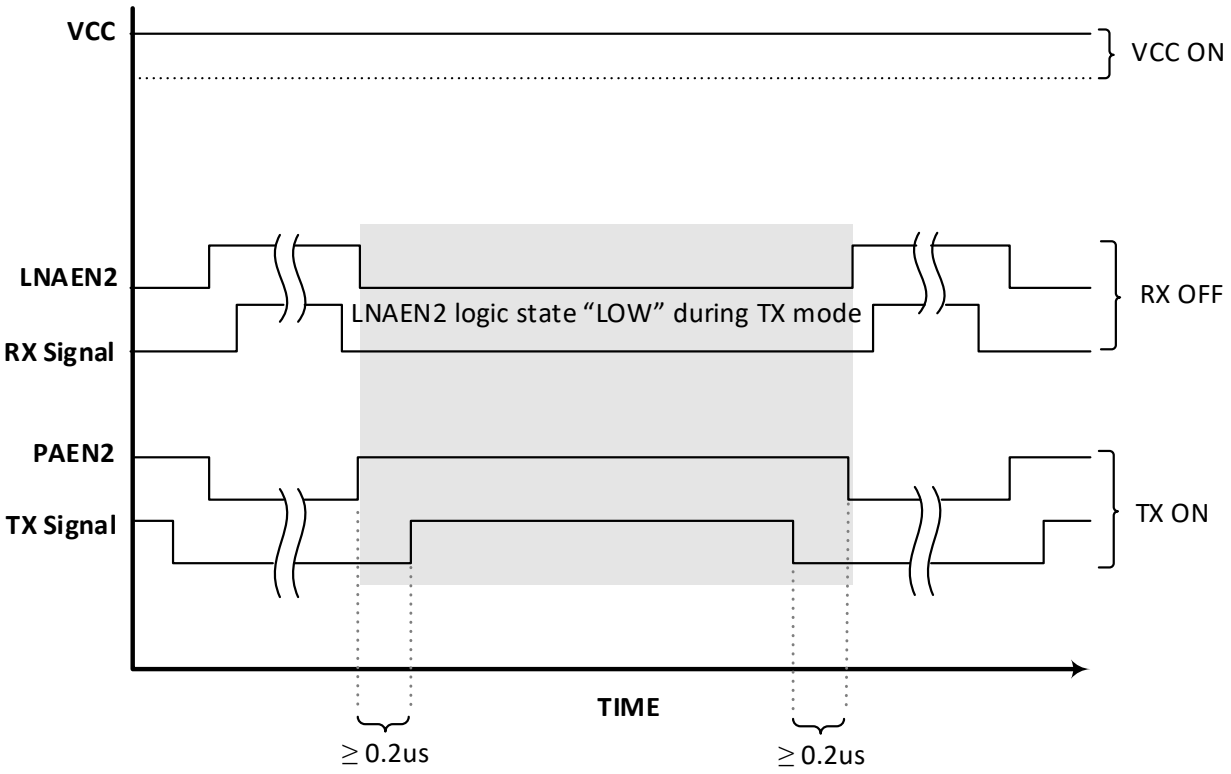


Top View

PIN NUMBER	LABEL	DESCRIPTION
1	LNAEN2	Logic Control voltage 2. See truth table for proper voltage settings.
2,9,10	VCC	DC Power Supply Voltage
3	NC	No Connection
4	RX	RF output port for the 802.11b/g/n/ac LNA. This port is matched to 50Ω and DC blocked internally.
5	RFIN	RF input port for the 802.11 diversity switch. This port is matched to 50Ω. An external DC block is required.
7	RFSW	RF output port for the 5GHz front end module. This port is matched to 50Ω. An external DC block is required.
12	PDET	Power Detector output. May need external series R/shunt C to adjust voltage level and to filter RF noise.
14	ANT	RF bidirectional antenna port matched to 50Ω. An external DC block is required.
16	PAEN2	Logic Control voltage 1. See truth table for proper voltage settings.
6, 8, 11, 13, 15	GND	RF and DC Ground
Backside Pad	GND	Ground connection. The back side of the package should be connected to the ground plan though as short of a connection as possible. PCB vias under the device are required.

Timing Diagram

RFFM8216 Transmit Mode
RF/DC Power ON/OFF Sequence



Note:
Observe the timing sequence shown in the diagram above and described below.
DC, RF, and ON/OFF Time signal levels per datasheet specifications.

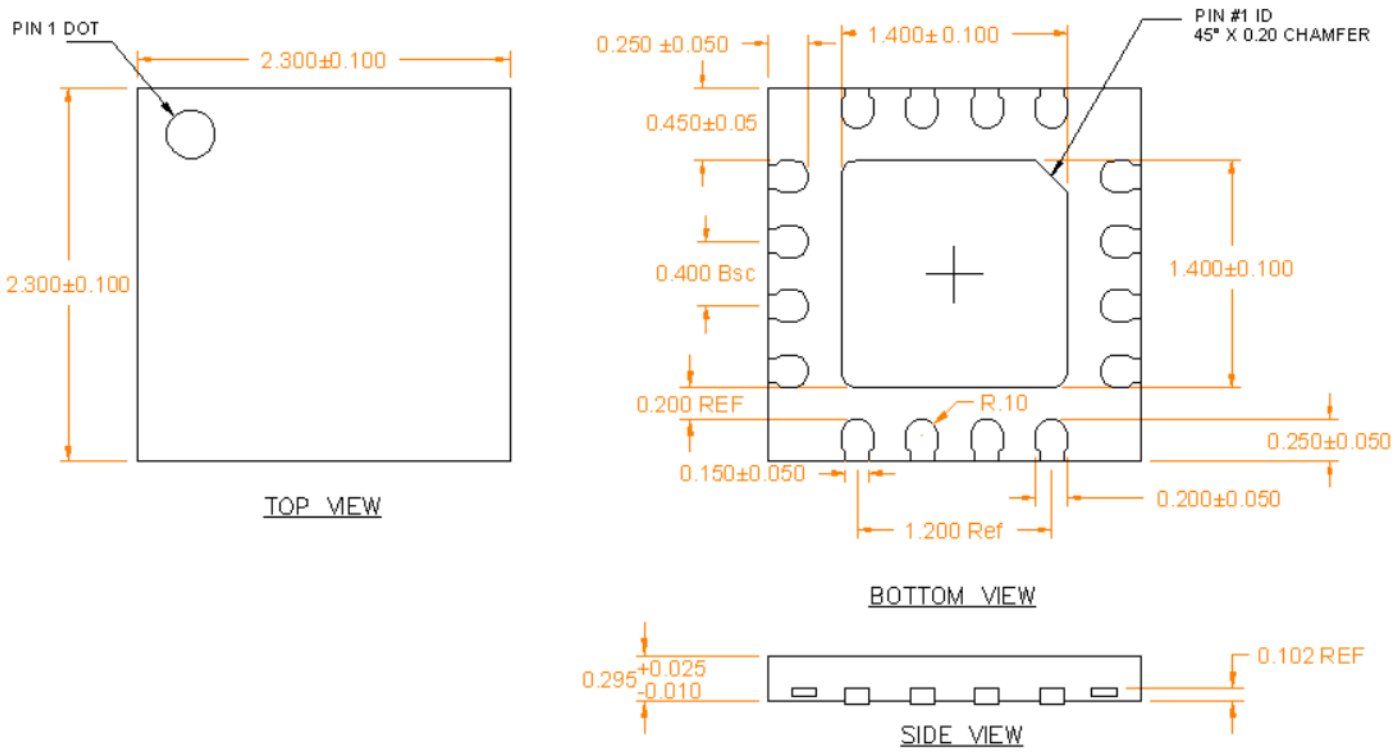
- Apply VCC prior to turning PA enable ON
- Turn PA enable ON prior to applying RF signal
- Turn RF signal OFF prior to turning PA enable OFF
- Turn PA enable OFF prior to turning VCC OFF
- TX/RX simultaneous transition is allowed

Package Outline Drawing

Package Marking and Dimensions

Marking: Part number – RFFM8216

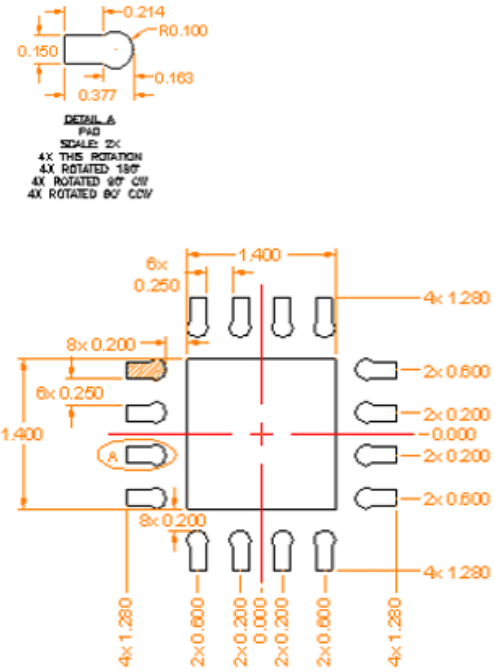
Trace code – XXXX



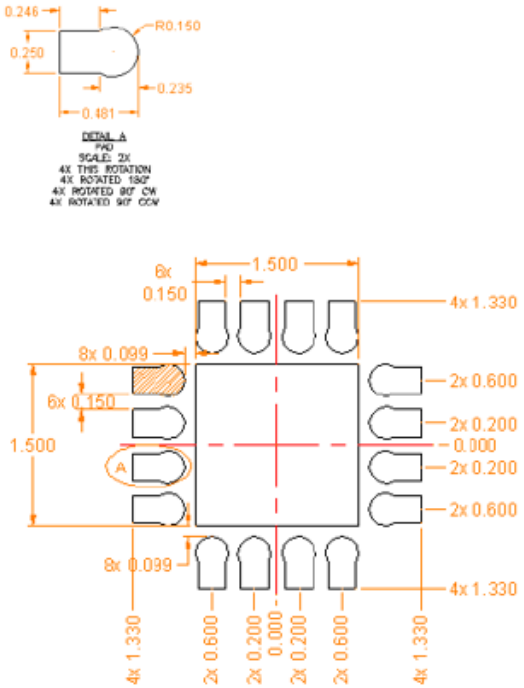
Notes:
1. All dimensions are in microns. Angles are in degrees.
2. Dimension and tolerance formats conform to ASME Y14.4M-1994.
3. The terminal #1 identifier and terminal numbering conform to JESD 95-1 SPP-012.

Recommended PCB Patterns

RECOMMENDED LAND PATTERN



RECOMMENDED SOLDER MASK PATTERN



Handling Precautions

PARAMETER	RATING	STANDARD
ESD – Human Body Model (HBM)	Class 1C	ESD/JEDEC JS-001-2012
ESD – Charged Device Model (CDM)	Class C3	JESD22-C101

Caution!

ESD sensitive device

Solderability

Compatible with both lead-free (260 °C max. reflow temperature) and tin/lead (245 °C max. reflow temperature) soldering processes.

Package lead plating: NiPdAu

RoHS Compliance

This part is compliant with the 2011/65/EU RoHS directive (Restrictions on the Use of Certain Hazardous Substances in Electrical and Electronic Equipment), as amended by Directive 2015/863/EU.

- Lead free
- Halogen Free (Chlorine, Bromine)
- Antimony Free
- TBBP-A ($C_{15}H_{12}Br_4O_2$) Free
- SVHC Free

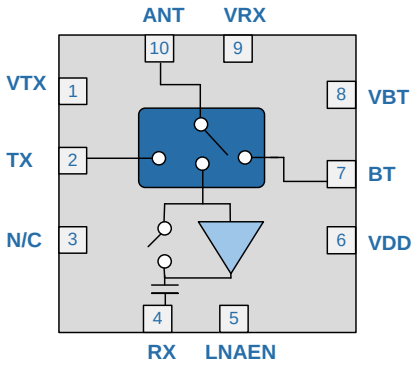
ES France - Département RF & Hyperfréquences - 127 rue de Buzenval BP 26 - 92380 Garches
Tél. 01 47 95 99 60 - Fax. 01 47 01 16 22 - e-mail: hyper@es-france.com - Site Web: www.es-france.com

RFFM8250

2.4GHz to 2.5GHz 802.11b/g/n/ac WiFi Switch + LNA Module

Package: QFN, 10-pin,
1.75mm x 1.75mm x 0.33mm

The RFFM8250 provides a complete integrated Switch + LNA solution in a single Front End Module (FEM) for WiFi 802.11b/g/n/ac and Bluetooth® systems. The ultra-small form factor and integrated matching greatly reduces the number of external components and layout area in the customer applications. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturing cost. The RFFM8250 integrates a Single Pole Three Throw (SP3T) Transmit/Receive (T/R) Switch and a 2.5GHz Low Noise Amplifier (LNA) with bypass mode. The device is provided in a 1.75mm x 1.75mm x 0.33mm 10-pin QFN package.



Functional Block Diagram

Features

- SP3T T/R Switch with Bluetooth Support
- LNA with Bypass Mode
- Input and Output Matched to 50Ω
- Wide Voltage Supply Range
- Supports WiFi chipsets with Integrated Power Amplifier (iPA)
- Low Profile Package for Module Designs

Applications

- Cellular Handsets
- Mobile Devices
- Tablets
- Consumer Electronics
- Gaming
- Netbooks/Notebooks
- TV/Monitors/Video

Ordering Information

RFFM8250SB	Standard 5-piece sample bag
RFFM8250SQ	Standard 25-piece sample bag
RFFM8250SR	Standard 100-piece reel
RFFM8250TR7	Standard 2500-piece reel
RFFM8250PCK-410	Fully assembled evaluation board w/ 5-piece bag

RF Micro Devices Inc. 7628 Thorndike Road, Greensboro, NC 27409-9421
For sales or technical support, contact RFMD at +1.336.678.5570 or customerservice@rfmd.com.

DS20180226

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (No RF Applied)	-0.5 to 6	V
DC Supply Current	100	mA
Operating Case Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Maximum TX Input Power into 50Ω Load for 11b/g/n/ac (No Damage)	+30	dBm
Maximum RX Input Power (No Damage)	+10	dBm
Bypass Mode Maximum RX input power (No damage)	+23	dBm
Moisture Sensitivity	MSL1	

Caution! ESD sensitive device.

RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

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.

Nominal Operating Parameters

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Compliance					**802.11b, 802.11g, 802.11n, 802.11ac**
Operating Frequency	2.412		2.484	GHz	
Operating Temperature	-40	25	85	°C	
Power Supply V_{DD}	3.0	3.6	5.0	V	
Control Voltage-High	2.8	3.1	V_{DD}	V	VTX, VRX, LNAEN, and VBT Should not exceed V_{CC} voltage
Control Voltage-Low		0	0.2	V	
Transmit (TX-ANT)					**V_{DD} = 3.6V over frequency, unless otherwise noted**
Insertion Loss		0.6	1.2	dB	T = 25°C, V_{DD} = 3.6V
TX Port Return Loss	12	20		dB	
ANT Port Return Loss	12	20		dB	
Input P1dB	27	30		dBm	T = 25°C, V_{DD} = 3.6V
ANT-Rx Isolation	28	35		dB	TX is enables and at Max power
Receive (ANT-RX)-LNA On					**V_{DD} = 3.6V, over frequency, unless otherwise noted**
Gain (S21)	11	13	16	dB	T =25°C, V_{DD} = 3.6V
	10	13	17	dB	T =-40 to +85C°, V_{DD} = 3.0V to 5V
Gain Flatness over any 20MHz BW	-0.25		+0.25	dB	
Gain Flatness across band	-0.5		+0.5	dB	
Noise Figure		2.3	2.7	dB	T = 25°C, V_{DD} = 3.6V
RX Port Return Loss		15	10	dB	
ANT Port Return Loss		5	3	dB	T = 25°C, V_{DD} = 3.6V
Input P1dB	-7	-5		dBm	
Current Consumption	6	9	13	mA	
LNA_EN Control Current		250	500	µA	
LNA Turn On Time		200	500	nS	

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Receive (ANT-RX)-Bypass Mode					**V_{DD} = 3.6V, unless otherwise noted**
Insertion Loss	5	7	10	dB	T= 25°C, V_{DD} = 3.6V
RX Port Return Loss		10	8	dB	
ANT Port Return Loss		10	8	dB	
Input P1dB	17	+21		dBm	
Bluetooth TX/RX					**V_{DD} = 3.6, unless otherwise noted**
Input P1dB	25	+27		dBm	T = 25°C, V_{DD} = 3.6V
Insertion Loss		0.6	1.3	dB	
BT Port Return Loss	12	20		dB	
ANT Port Return Loss	12	20		dB	
General Specifications					
Control Line Impedance - VTX		40		MΩ	
Control Line Impedance – LNAEN		65		KΩ	
Control Line Impedance - VRX		40		MΩ	
Control Line Impedance - VBT		40		MΩ	
V_{DD} Leakage Current		1	10	µA	
Switch Control Current-High-Each Line		1	10	µA	
Switch Control Current-Low-Each Line		0.1	1	µA	
Switching Speed		100	500	ns	
ESD-Human Body Model		1000		V	
ESD-Charge Device Model		1000		V	

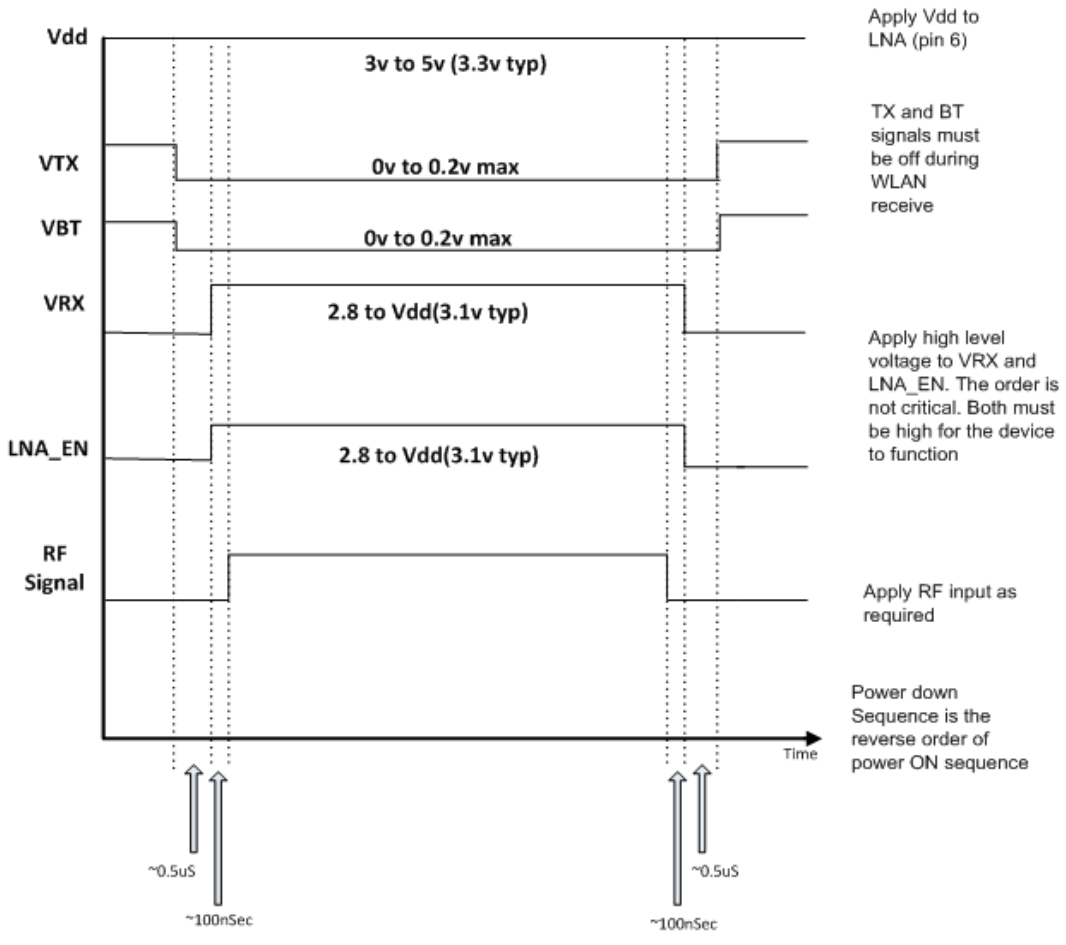
Switch Control Logic Truth Table

Operating Mode	VTX	LNAEN	VRX	VBT
Standby	Low	Low	Low	Low
802.11b/g/n/ac TX Mode	High	Low	Low	Low
802.11b/g/n/ac RX Gain	Low	High	High	Low
802.11b/g/n/ac RX Bypass	Low	Low	High	Low
BT RX/TX	Low	Low	Low	High

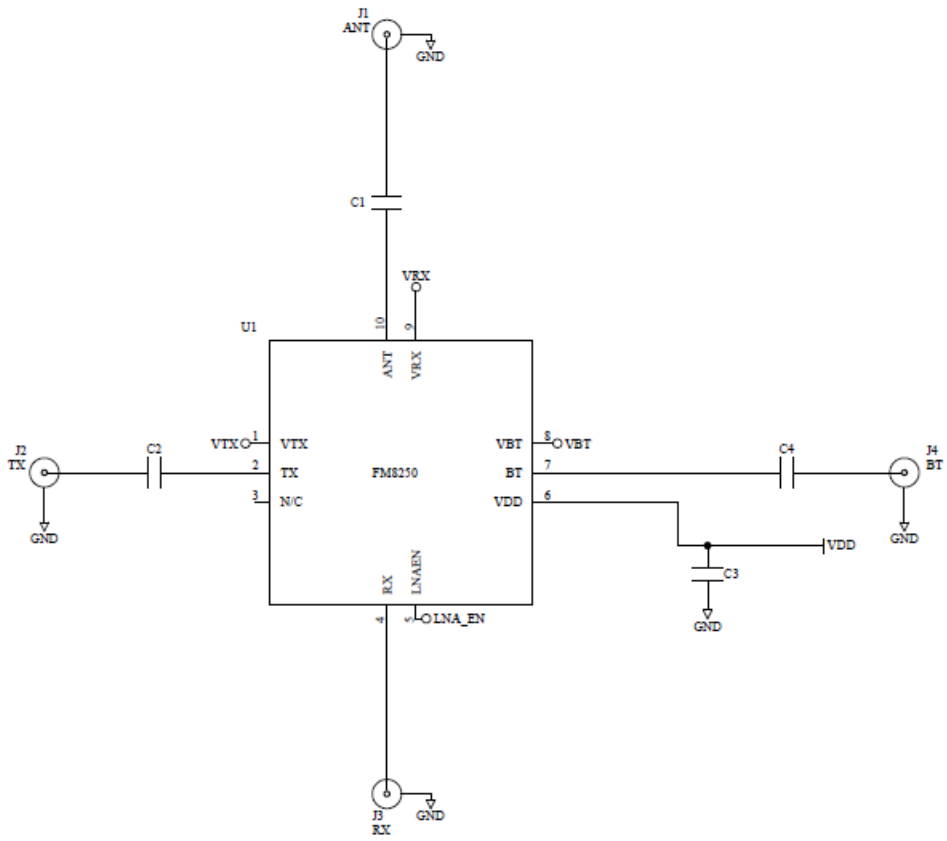
Notes:

- High = 2.8 to V_{CC}. Low = 0V to 0.2V.

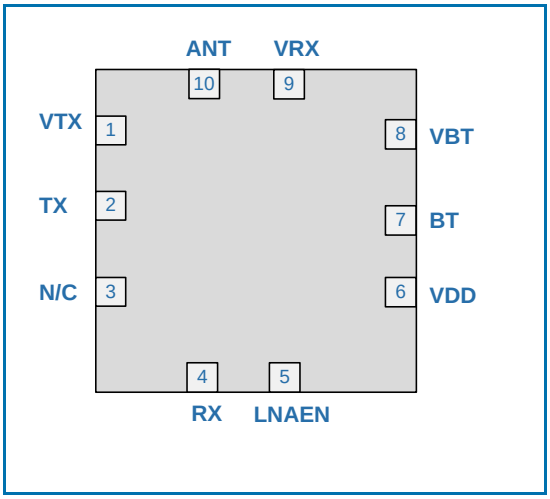
Timing Diagram



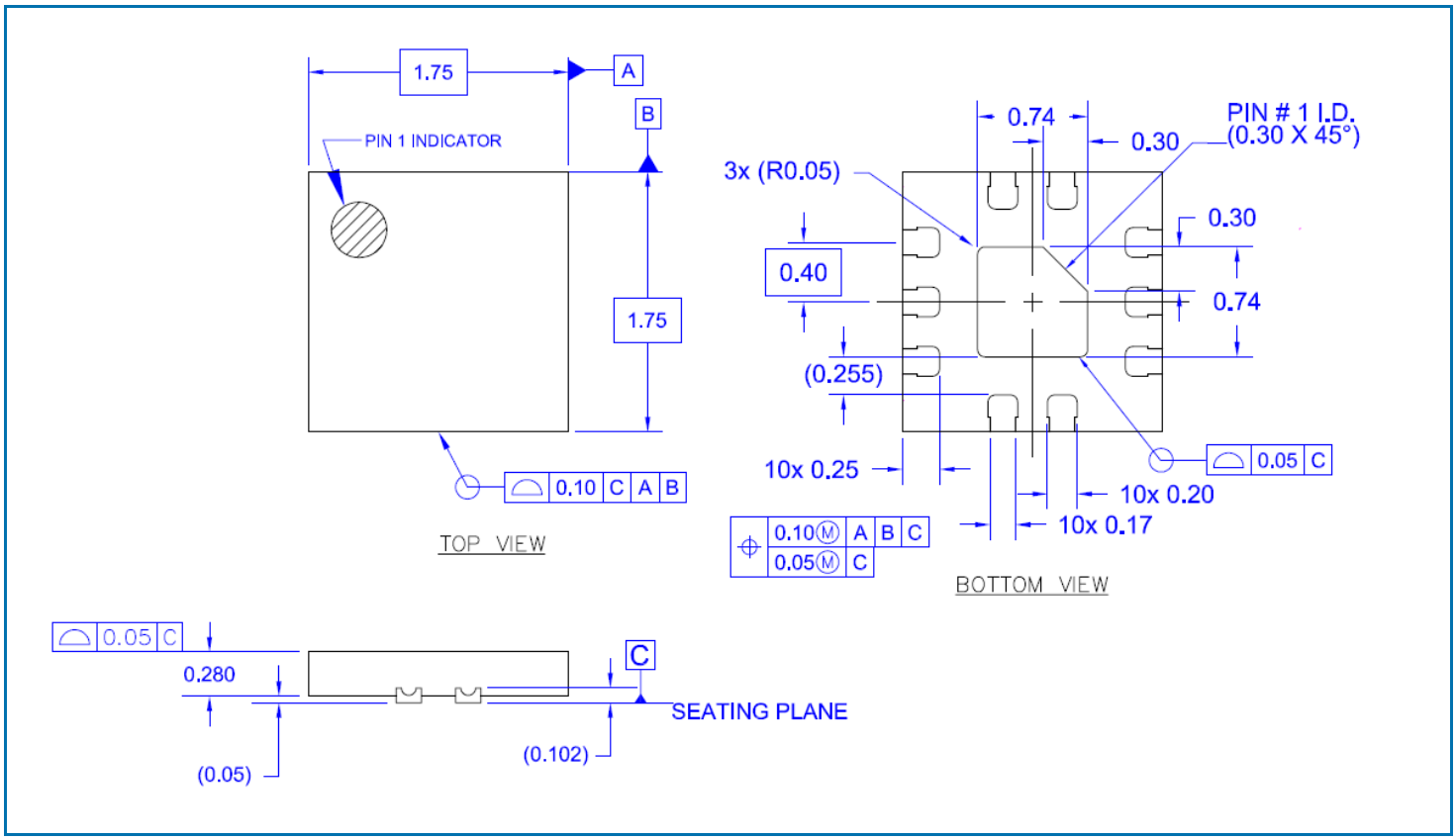
Applications Schematic



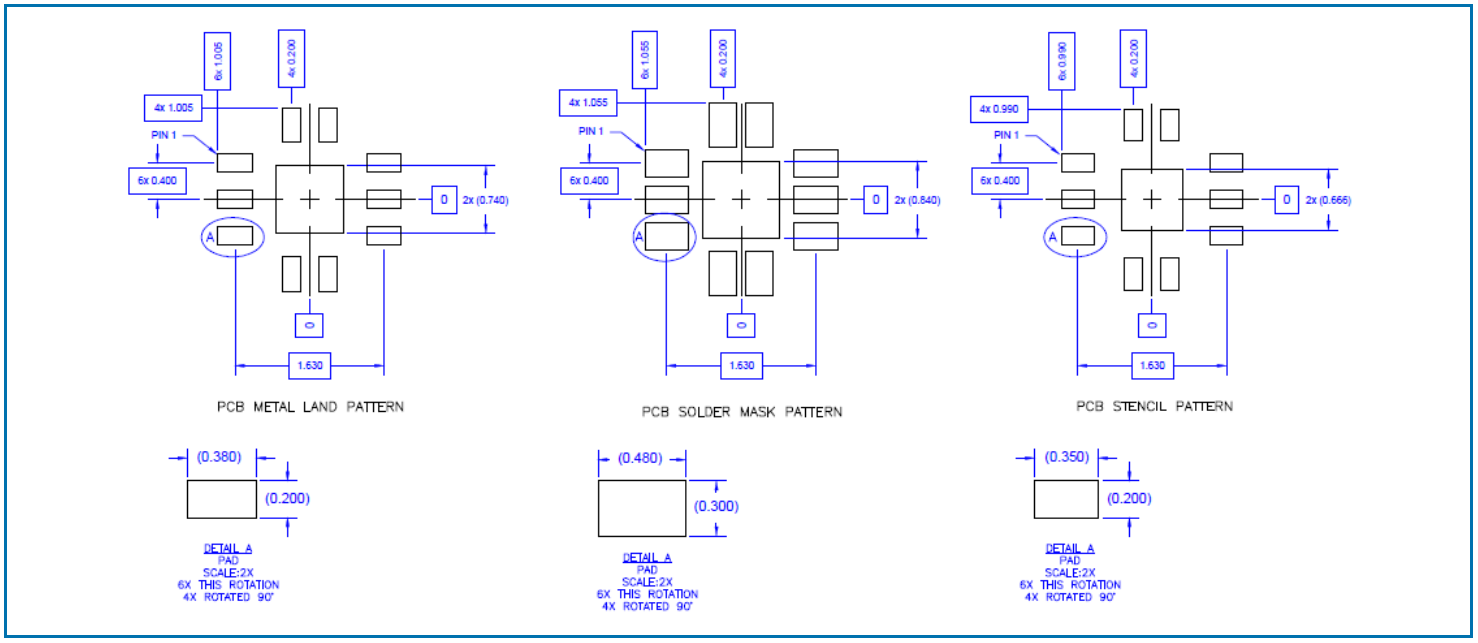
Pin Out



Package Drawing



PCB Patterns



Note:

Thermal vias for center slug “C” should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, power, dissipation and electrical requirements. Example of the number and size of vias can be found on the RFMD evaluation board layout (gerber files are available upon request)

Pin Names and Descriptions

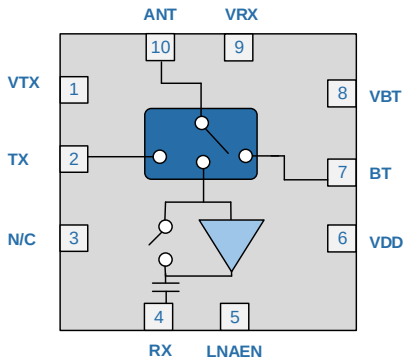
Pin	Name	Description
1	VTX	Transmit switch control pin. See switch truth table for proper level.
2	TX	RF input port for the 802.11b/g/n PA. Input is matched to 50Ω. An external DC block is required.
3	N/C	No connect. This pin is not connected internally and can be left floating or connected to ground.
4	RX	RF output port for the 802.11b/g/n LNA. Port is matched to 50Ω. This pin is DC blocked internally.
5	LNAEN	Control voltage for the LNA. When this pin is set to a LOW logic state, the bypass mode is enabled.
6	VDD	Supply voltage for the LNA. See applications schematic for biasing and bypassing components.
7	BT	RF bidirectional port for Bluetooth®. Input is matched to 50Ω. An external DC block is required.
8	VBT	Bluetooth® switch control pin. See truth table for proper level.
9	VRX	Receive switch control pin. See switch truth table for proper level.
10	ANT	RF bidirectional antenna port matched to 50Ω. An external DC block is required.
Pkg Base	GND	Ground connection. The backside of the package should be connected to the ground plane through a short path, i.e., PCB vias under the device are recommended.

RFFM8250Q

WiFi Switch + LNA Module
2.4GHz to 2.5GHz
Tested in Accordance with AEC-Q100

Package: QFN, 10-pin,
1.75mm x 1.75mm x 0.5mm

The RFFM8250Q provides an integrated Switch + LNA solution in a single Front End Module (FEM) for automotive WiFi 802.11b/g/n/ac and Bluetooth systems. The ultra-small form factor and integrated matching greatly reduces the number of external components and layout area in the customer applications. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturing cost. The RFFM8250Q integrates a Single Pole 3-Throw (SP3T) switch and a Low Noise Amplifier (LNA) with bypass mode. The device is tested in accordance with AEC-Q100 and is provided in a 1.75mm x 1.75mm x 0.5mm 10-pin QFN package.



Functional Block Diagram

Features

- SP3T T/R Switch with Bluetooth Support
- LNA with Bypass Mode
- Input and Output Matched to 50Ω
- Wide Voltage Supply Range
- Supports WiFi chipsets with Integrated Power Amplifier (iPA)
- Low Profile Package for Module Designs

Applications

- Automotive WiFi
- WiFi Direct
- Automotive Diagnostics
- WiFi Infotainment
- 2.5GHz ISM Band Solutions for Automotive

Ordering Information

RFFM8250QSB	Standard 5-piece sample bag
RFFM8250QSQ	Standard 25-piece sample bag
RFFM8250QSR	Standard 100-piece reel
RFFM8250QTR7	Standard 2500-piece reel
RFFM8250QPCK-410	Fully assembled evaluation board w/ 5-piece bag

Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (No RF Applied)	-0.5 to 6	V
DC Supply Current	100	mA
Operating Ambient Temperature	-40 to +85	°C
Storage Temperature	-40 to +150	°C
Maximum TX Input Power into 50Ω Load for 11b/g/n/ac (No Damage)	+30	dBm
Maximum RX Input Power (No Damage)	+10	dBm
Bypass Mode Maximum RX input power (No damage)	+23	dBm
Moisture Sensitivity	MSL1	

Caution! ESD sensitive device.

RFMD Green: RoHS status based on EU Directive 2011/65/EU (at time of this document revision), halogen free per IEC 61249-2-21, < 1000ppm each of antimony trioxide in polymeric materials and red phosphorus as a flame retardant, and <2% antimony in solder.

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.

Nominal Operating Parameters

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Compliance					**802.11b, 802.11g, 802.11n, 802.11ac**
Operating Frequency	2.412		2.484	GHz	
Operating Ambient Temperature	-40	25	85	°C	
Power Supply V_{DD}	3.0	3.6	5.0	V	
Control Voltage-High	2.8	3.1	4.8	V	VTX, VRX, LNAEN, and VBT Should not exceed V_{CC} voltage
Control Voltage-Low		0	0.2	V	
Transmit (TX-ANT)					**Over all conditions unless otherwise noted**
Insertion Loss		0.6	1.2	dB	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
		0.6	1.8	dB	
TX Port Return Loss	10	18		dB	
ANT Port Return Loss	10	18		dB	
Input P1dB	27	30		dBm	T = 25°C, Control voltage = 3.1V; V_{DD} = 3.6V; CW signal
ANT-Rx Isolation	28	35		dB	TX mode
Receive (ANT-RX)-LNA On					**Over all conditions unless otherwise noted**
Gain (S21)	11	13	16	dB	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
	10	13	17	dB	
Gain Flatness	-0.25		+0.25	dB	over any 20MHz BW
Gain Flatness across band	-0.5		+0.5	dB	
Noise Figure		2.3	2.7	dB	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
		2.5	3.5	dB	
RX Port Return Loss	10	15		dB	
ANT Port Return Loss	3	5		dB	
Input P1dB	-7	-5		dBm	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
Current Consumption	5	10		mA	
LNA_EN Control Current		250	500	µA	
LNA Turn On Time		200	500	nS	

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Receive (ANT-RX)-Bypass Mode					**Over all conditions unless otherwise noted**
Insertion Loss		7	9	dB	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
		7	10	dB	
RX Port Return Loss	8	10		dB	
ANT Port Return Loss	8	10		dB	
Input P1dB	17	21		dBm	
Bluetooth TX/RX					**Over all conditions unless otherwise noted**
Input P1dB	25	+27		dBm	Temp = 25°C; V_{DD} = 3.6V; Control Voltage = 3.1V
Insertion Loss		0.6	1.2	dB	
		0.6	1.5	dB	
BT Port Return Loss	12	18		dB	
ANT Port Return Loss	12	18		dB	
General Specifications					
V_{DD} Leakage Current		1	10	µA	
Switch Control Current-High-Each Line		1	10	µA	
Switch Control Current-Low-Each Line		0.1	1	µA	
Switching Speed		100	500	ns	
ESD-Human Body Model		1000		V	
ESD-Charge Device Model		1000		V	

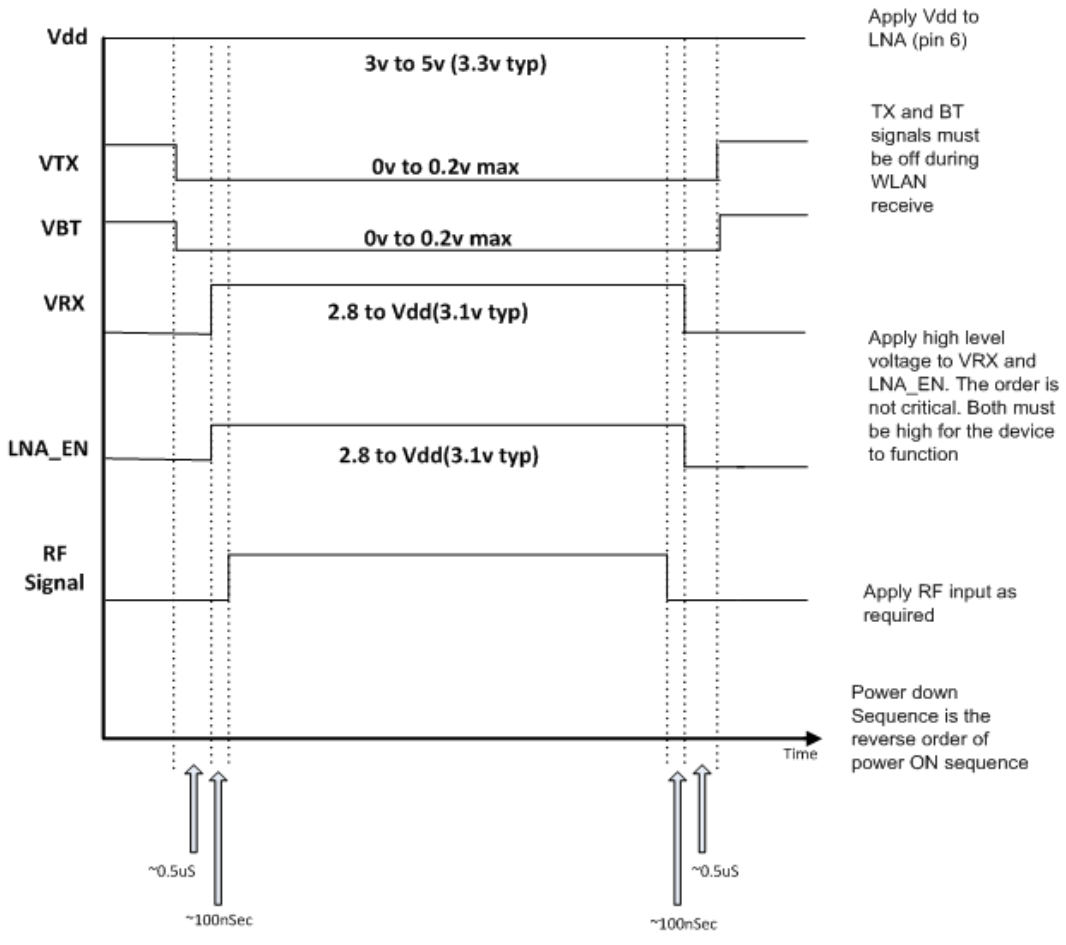
Switch Control Logic Truth Table

Operating Mode	VTX	LNAEN	VRX	VBT
Standby	Low	Low	Low	Low
802.11b/g/n/ac TX Mode	High	Low	Low	Low
802.11b/g/n/ac RX Gain	Low	High	High	Low
802.11b/g/n/ac RX Bypass	Low	Low	High	Low
BT RX/TX	Low	Low	Low	High

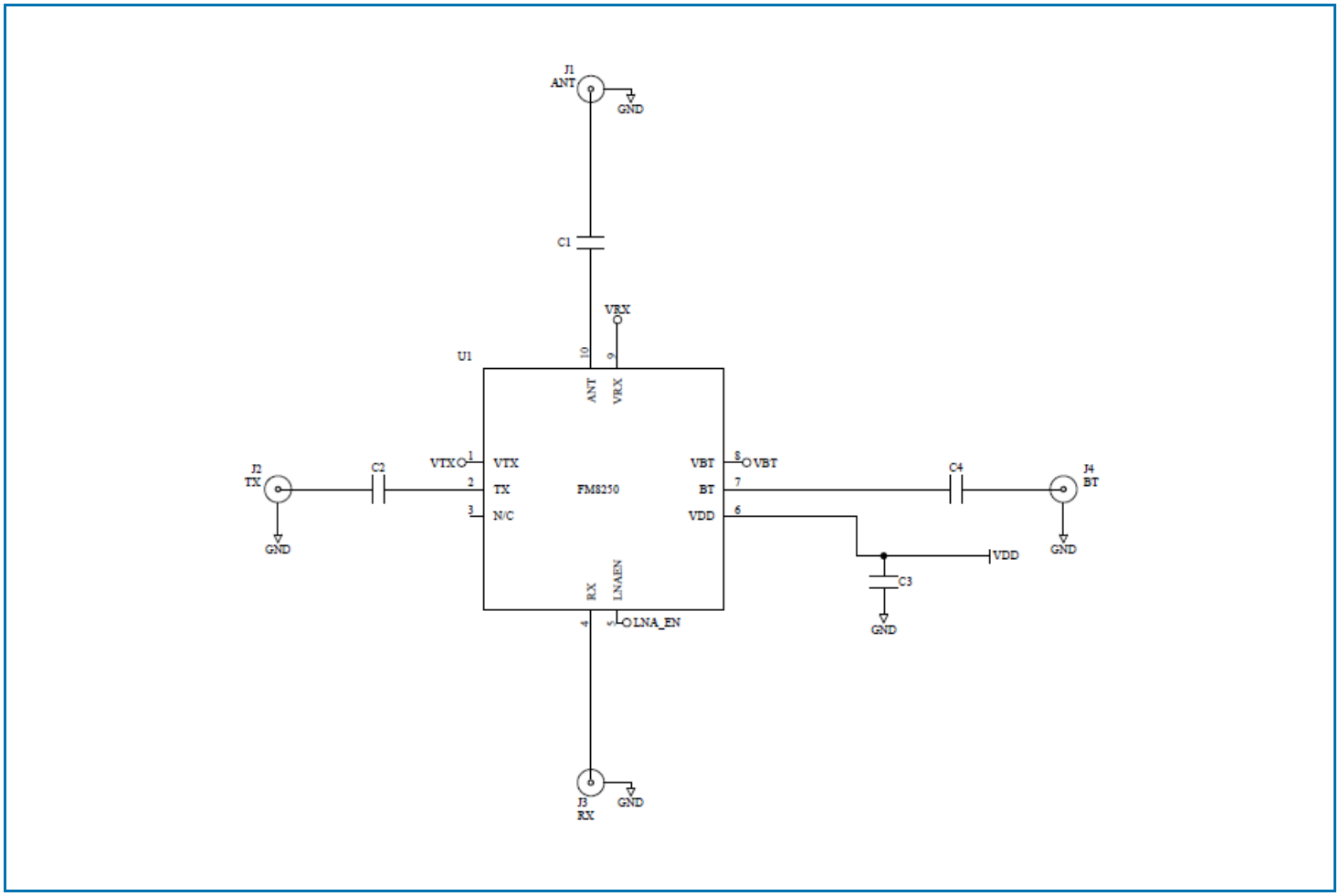
Notes:

- High = 2.8 to V_{CC}. Low = 0V to 0.2V.

Timing Diagram



Applications Schematic



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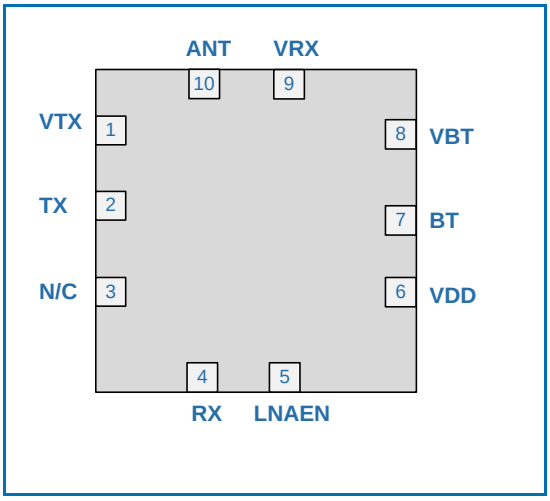
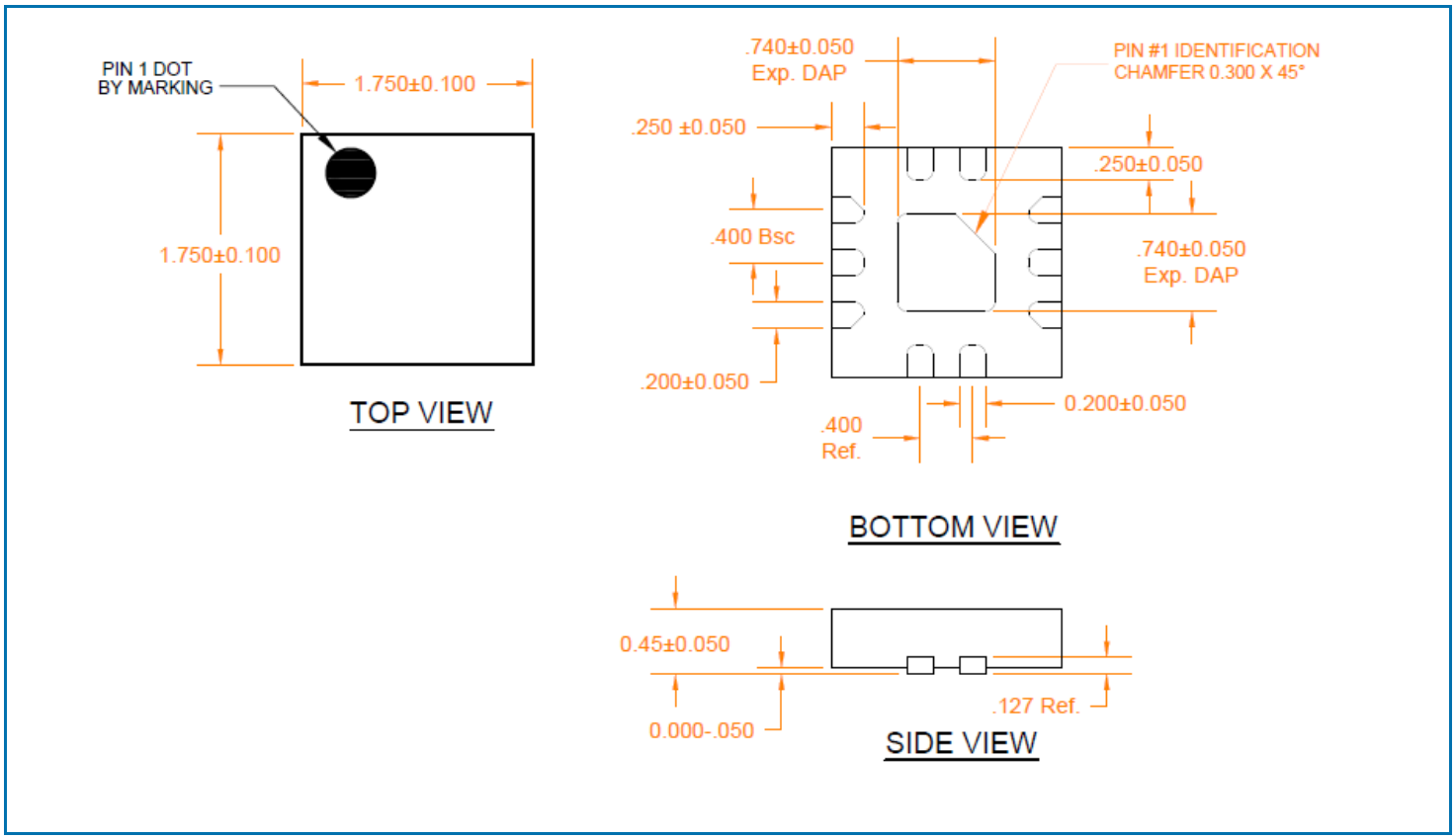
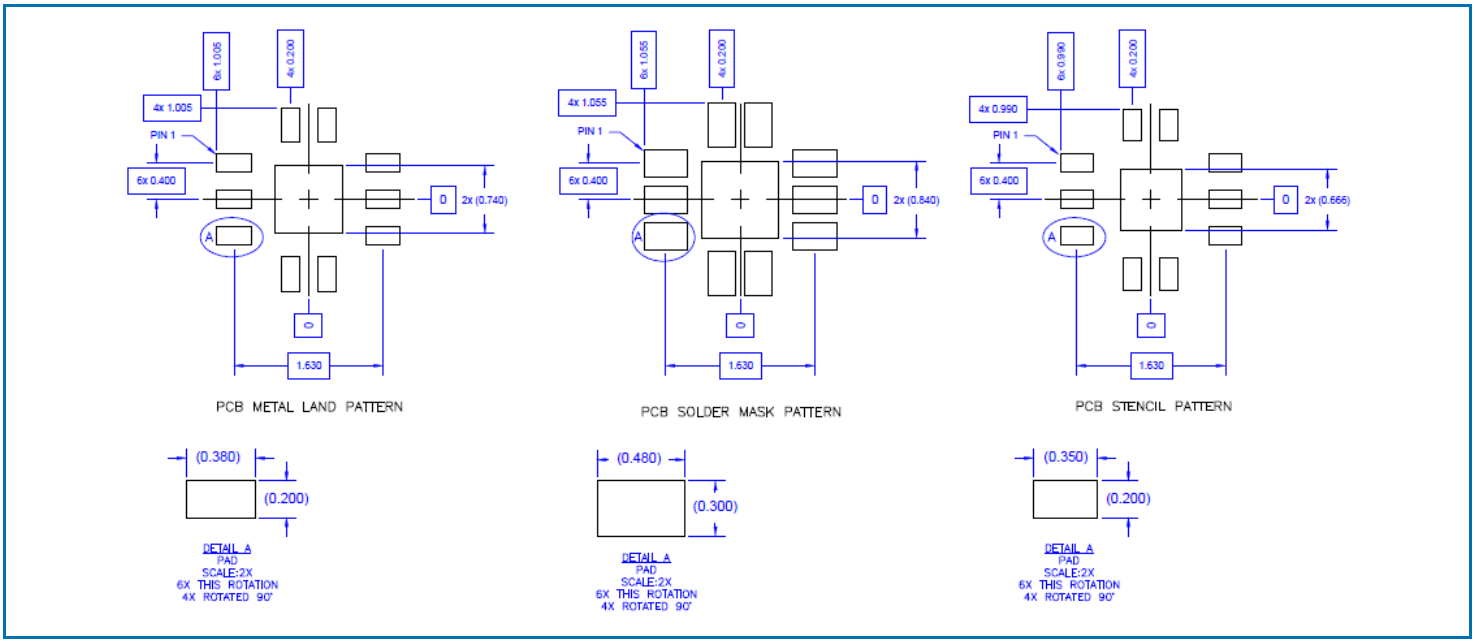
Pin Out



Package Drawing (dimensions in mm)



PCB Patterns (dimensions in mm)



Note:

Thermal vias for center slug “C” should be incorporated into the PCB design. The number and size of thermal vias will depend on the application, power, dissipation and electrical requirements. Example of the number and size of vias can be found on the RFMD evaluation board layout (gerber files are available upon request)

Pin Names and Descriptions

Pin	Name	Description
1	VTX	Transmit switch control pin. See switch truth table for proper level.
2	TX	RF input port for the 802.11b/g/n PA. Input is matched to 50Ω. An external DC block is required.
3	N/C	No connect. This pin is not connected internally and can be left floating or connected to ground.
4	RX	RF output port for the 802.11b/g/n LNA. Port is matched to 50Ω. This pin is DC blocked internally.
5	LNAEN	Control voltage for the LNA. When this pin is set to a LOW logic state, the bypass mode is enabled.
6	VDD	Supply voltage for the LNA. See applications schematic for biasing and bypassing components.
7	BT	RF bidirectional port for Bluetooth®. Input is matched to 50Ω. An external DC block is required.
8	VBT	Bluetooth® switch control pin. See truth table for proper level.
9	VRX	Receive switch control pin. See switch truth table for proper level.
10	ANT	RF bidirectional antenna port matched to 50Ω. An external DC block is required.
Pkg Base	GND	Ground connection. The backside of the package should be connected to the ground plane through a short path, i.e., PCB vias under the device are recommended.

Contact Information

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