



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

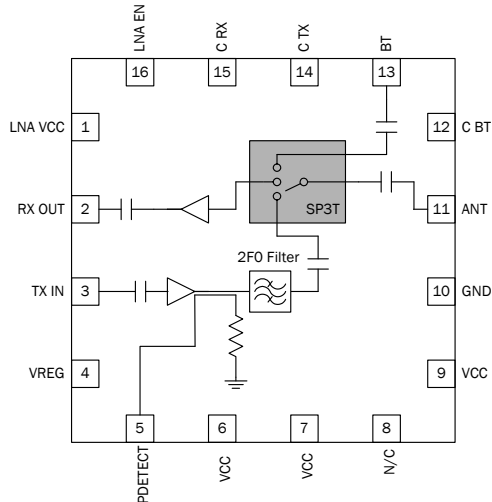


### Features

- Single Module Radio Front End
- Single Supply Voltage 3.0V to 5V
- Integrated 2.4GHz to 2.5GHz b/g Amplifier LNA, TX/RX Switch, P<sub>DETECT</sub> Coupler
- P<sub>OUT</sub> = 17 dBm, 11g, OFDM at <3% EVM, 21dBm 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 RF5725 is a single-chip integrated front-end module (FEM) for high performance WiFi applications in the 2.4GHz to 2.5GHz ISM band. This FEM greatly reduces the number of external components, minimizing footprint and assembly cost of the overall 802.11b/g solution. The RF5725 has an integrated b/g power amplifier, LNA, a Coupler Power detector, and TX filtering. It also is capable of switching between WiFi RX, WiFi TX, and BTH RX/TX operations. This device is manufactured using GaAs HBT and pHEMT processes on a 3mmx3mmx0.5mm 16-pin QFN package. This module meets or exceeds the RF front-end needs of 802.11b/g WiFi RF systems.

### Ordering Information

RF5725	Standard 25 piece bag
RF5725SR	Standard 100 piece reel
RF5725TR7	Standard 2500 piece reel
RF5725PCK-410	Fully assembled evaluation board tuned for 2.4GHz to 2.5GHz and 5 loose sample pieces

### Optimum Technology Matching® Applied

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

## Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage	5.0	V
DC Supply Current	240	mA
Full Specification Temp Range (Full Spec. Compliant)	-10 to +70	°C
Extreme Operating (Reduced Performance)	-40 to -10 +70 to +85	
Storage Temperature	-40 to +150	°C
Maximum TX Input Power for 11b/g (No Damage)	5	dBm
Moisture Sensitivity	MSL2	



**Caution!** ESD sensitive device.

Exceeding any one or a combination of the Absolute Maximum Rating conditions may cause permanent damage to the device. Extended application of Absolute Maximum Rating conditions to the device may reduce device reliability. Specified typical performance or functional operation of the device under Absolute Maximum Rating conditions is not implied.

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

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
<b>2.4GHz Transmit Parameters</b>					
Compliance					IEEE802.11b, IEEE802.11g, FCC CFG 15.247, .205, .209
Nominal Conditions					Specifications must be met across $V_{CC}$ , $V_{REG}$ , frequency, process, and temperature, unless otherwise specified.
Frequency	2.4		2.5	GHz	
Output Power					
11g	16	17		dBm	OFDM 54Mbps, $V_{CC}=3.3 \leq 4.2V$ , $T=10^\circ$ to $75^\circ C$
11g	15			dBm	Derated performance over Freq, Temp, and Process.
11b	20	21		dBm	11Mbps, CCK, $V_{CC}=3.3 \leq 4.2V$ , $T=10^\circ C$ to $+75^\circ C$ .
11b	18	19		dBm	Derated performance over Freq, Temp, and Process.
EVM*		3.0	4.0	%	54Mbps OFDM $V_{CC} \geq 3.6V$ , $50\Omega$ , see Note 1, 5.
Adjacent Channel Power					
ACP1		-38	-34	dBc	$P_{OUT(b)}=21dBm$ , 1Mbps CCK, Note 4. Meeting 11b spectral mask requirements with $\geq 3dB$ margin
ACP2		-56	-53	dBc	$P_{OUT(b)}=21dBm$ , 1Mbps CCK, Note 4. Meeting 11b spectral mask requirements with $\geq 3dB$ margin
Gain	24	26		dB	
Gain Variation					
$V_{CC}$			0.7	dB/V	
Frequency	-0.5		+0.5	dB	2.4GHz to 2.5GHz
Power Detect					
Voltage Detect	0.1		1.5	V	
$P_{OUT}=17dBm$		1.0		V	IEEE802.11g, 54Mbps 64QAM modulation
Input Resistance		10		k $\Omega$	
Input Capacitance			5	pF	
Bandwidth	800	1000		kHz	
$P_{DETECT}$ Accuracy	-1.5		+1.5	dB	$P_{OUT}=17dBm$

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

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
<b>2.4 GHz Transmit Parameters, cont'd</b>					
Sensitivity					
>10dBm	25			mV/dB	
0 < P <sub>OUT</sub> < 10dBm	8			mV/dB	
Current Consumption					
I <sub>CC</sub>		130		mA	RFP <sub>OUT</sub> =17dBm, 54Mbps IEEE802.11g
		190			RFP <sub>OUT</sub> =21dBm, 11Mbps IEEE802.11b
Idle		95		mA	V <sub>CC</sub> =3.6V, V <sub>REG</sub> =2.85V, and RF=OFF
I <sub>REG</sub>		3	5	mA	
Leakage		2	10	μA	
Power Supply	3.0	3.6	4.5	V	
V <sub>REG</sub>	2.75	2.85	2.95	V	
Input/Output Impedance		50		Ω	
Ruggedness					No damage
Output VSWR	10:1				Maximum: operating voltage, input power, temperature
Stability					
Output VSWR	5:1				All phase angles, no spurious or oscillations.
Out of Band Performance					
S21 (DC to 960 MHz)			0	dB	
S21 (1570 MHz to 1580 MHz)			18	dB	
S21 (1805 MHz to 1990 MHz)			20	dB	
S21 (2110 MHz to 2170 MHz)			25	dB	All other ports terminated in their nominal impedances
Thermal Resistance		79.3		°C/W	V <sub>CC</sub> =3.3, V <sub>REG</sub> =2.9V, C <sub>TX</sub> =3.3, C <sub>RX</sub> =C <sub>BT</sub> =GND, P <sub>OUT</sub> =17dBm, Modulation=On, Freq=2.45GHz, D <sub>CC</sub> =100%, T=85 °C
		87.2		°C/W	V <sub>CC</sub> =4.8, V <sub>REG</sub> =3V, C <sub>TX</sub> =3.3, C <sub>RX</sub> =C <sub>BT</sub> =GND, P <sub>OUT</sub> =17dBm, Modulation=On, Freq=2.45GHz, D <sub>C</sub> =100%, T=85 °C
Harmonics					
Second		-35	-32	dBm	RBW=1MHz. Measured at 1Mbps.
Third		-45	-42	dBm	4.80GHz to 5.00GHz 7.20GHz to 7.50GHz
Turn-On/Off Time		0.5	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	0.2	V	
High	2.7	2.8	3.6	V	
Switch Control Current			10	μA	Per control line
Switch Control Speed			100	nsec	
ESD					
Human Body Model	1000			V	All pins unless otherwise stated. EIA/JESD22-114A
Charge Device Model	500			V	EIA/JESD22-C101C

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
<b>2.4GHz Receive Parameters</b>					
Frequency	2.4		2.5	GHz	
Receive Gain	10	13	16	dB	WiFi RX mode only
	7	10	13	dB	WiFi RX and BT RX mode
Noise Figure		2.1		dB	WiFi RX mode only
		5.5		dB	WiFi RX and BT RX mode
Passband Ripple	-1		+1	dB	
Output Return Loss			-9.6	dB	
Output Impedance		50		Ω	No external matching
Current Consumption			30	μA	
	LNA VCC	8		mA	LNA ON
	LNA enable	2		mA	
		5		uA	LNA OFF
<b>Bluetooth™ Parameters</b>					
Frequency	2.4		2.5	GHz	
Insertion Loss		0.8	1.2	dB	SP3T switch, all unused ports terminated into their nominal impedance. <i>Bluetooth™</i> mode only
		3.75	5.50	dB	WiFi RX and BT RX mode
Passband Ripple	-0.2		+0.2	dB	
Input/Output Power			8	dBm	
Output Return Loss			-10	dB	
Output Impedance		50		Ω	No external matching
Current Consumption			30	μA	Switch leakage current

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

Note 1. The PA module must operate with gated bias voltage input at 1% to 99% duty cycle.

Note 2. No external matching components. Antenna port is a DC short to GND.

Note 3. Values to be agreed upon characterization data review: current, gain, return loss, detector sensitivity, and output power.

Note 4. The output power for channels 1 and 13 may be reduced to meet FCC restricted band requirements.

Note 5: EVM at lower output power values will never exceed nominal operating power EVM. EVM should be monotonic from 0dBm to rated output power.

### Isolation Table

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

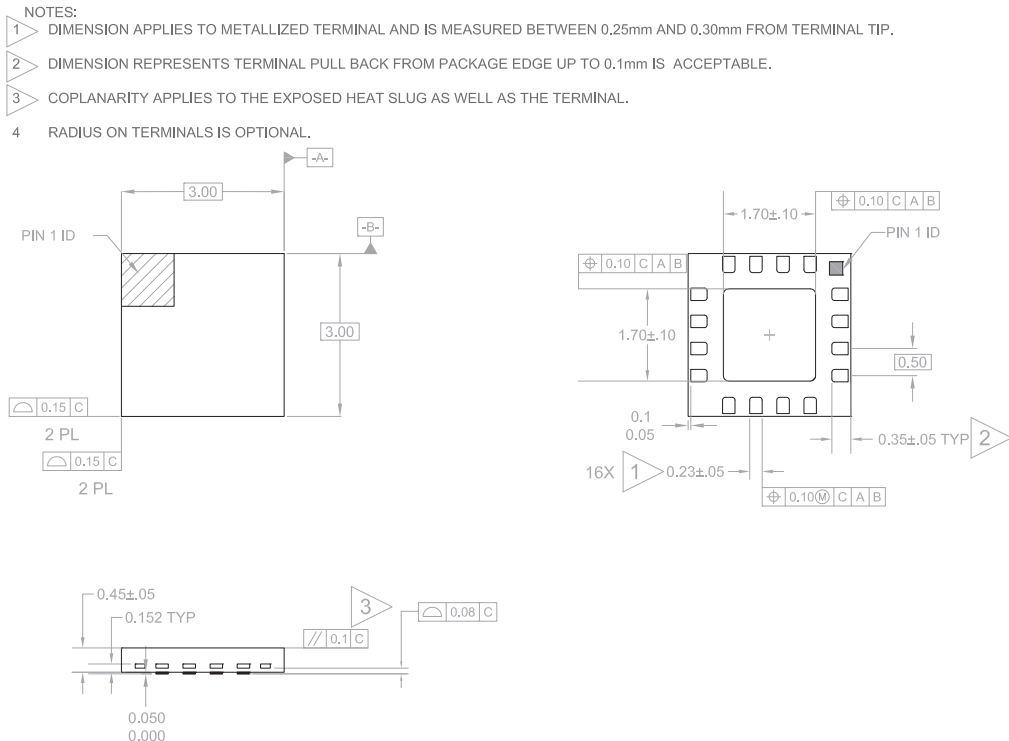
### Switch Control Logic

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

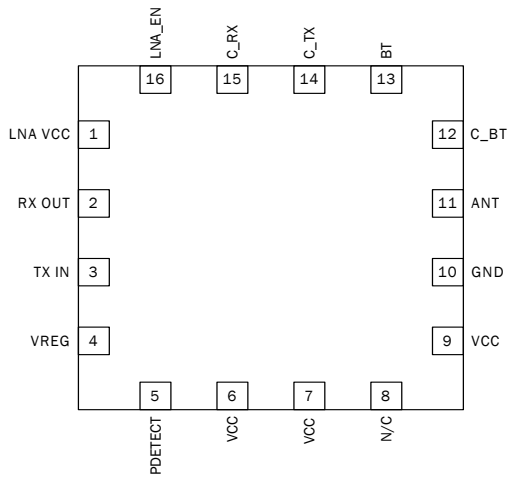
\*The FEM can simultaneously receive WiFi and *Bluetooth™* in the WiFi RX and BT RX Mode.

Pin	Function	Description
1	LNA VCC	Voltage supply for the LNA (labeled VCC3 on evaluation board).
2	RX OUT	Receive port for 802.11b/g band. Internally matched to 50Ω. DC block provided.
3	TX	RF input for the 802.11b/g PA. Input is matched to 50Ω and DC block is provided.
4	VREG	Regulated voltage for the bias control circuit. An external bypass capacitor may be needed on the V <sub>REG</sub> line for decoupling purposes.
5	PDETECT	Power detector voltage for TX section. PDET voltage varies with output power. May need external decoupling capacitor for module stability. May need external circuitry to bring output voltage to desired level.
6	VCC	Supply voltage for the bias circuit of the PA.
7	VCC	Supply voltage for the first stage of the PA. Add an external 0.1uF capacitor for low frequency decoupling.
8	N/C	No connect.
9	VCC	Supply voltage for the second stage of the PA. Add an external 0.1uF capacitor for low frequency decoupling.
10	GND	Ground.
11	ANT	Port matched to 50Ω and is a DC short to ground.
12	C_BT	Switch control port. See truth table for proper level.
13	BT	RF bidirectional port for Bluetooth™. Input is matched to 50Ω and DC block is provided.
14	C_TX	Switch control port. See switch truth table for proper level.
15	C_RX	Switch control port. See switch truth table for proper level.
16	LNA_EN	LNA enable pin. This is an active high control. A bypass capacitor may be needed for supply noise decoupling.

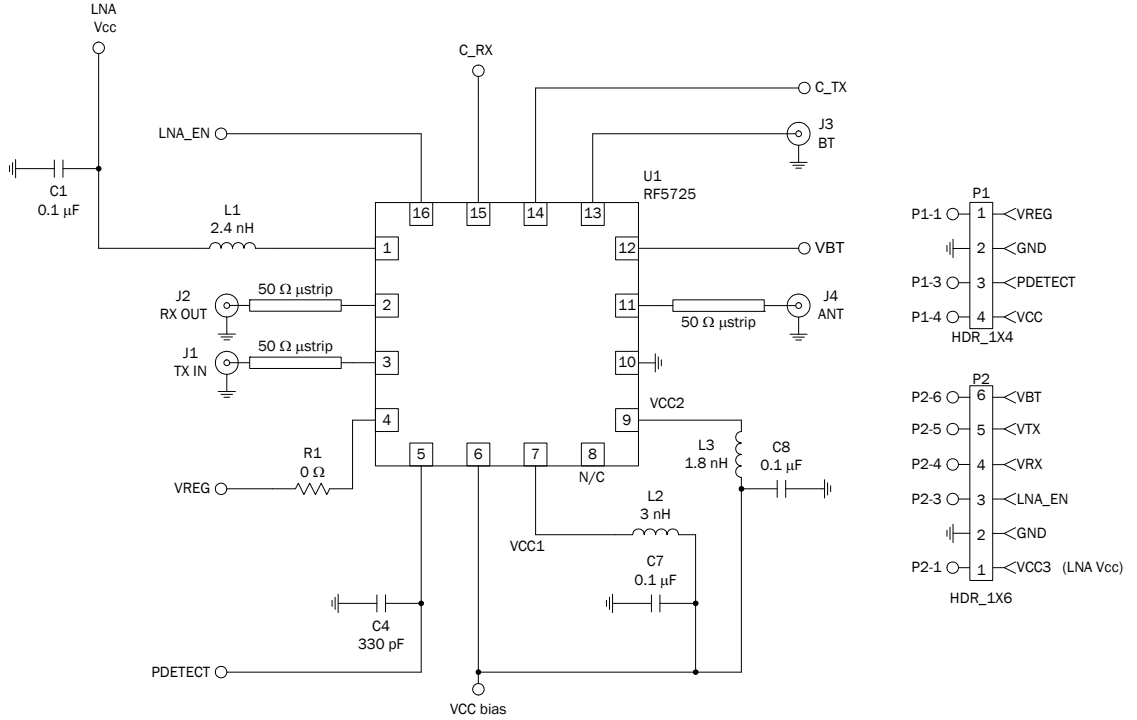
## Package Drawing



## Pin Out



**Evaluation Board Schematic**



## Theory of Operation

The RF5725 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 greatly reduces the number of external components minimizing footprint and assembly cost of the overall 802.11b/g solution. The RF5725 has an integrated b/g power amplifier, LNA, a Couple Power Detector, and TX filtering. It is also capable of switching between WiFi RX, WiFi TX, and BTH RX/TX operations. The device is manufactured using GaAs HBT and pHEMT processes on a 3mmx3mmx0.5mm 16-pin QFN package. The module meets or exceeds the RF front-end needs of the 802.11b/g WiFi RF systems.

The RF5725 is a very easy part to implement, but care in circuit layout and component selection is always advisable when designing circuits that operate at high frequencies. To reduce the design and optimization process on the customer application, the evaluation board layout should be copied as close as possible, in particular the ground and via configurations. Gerber files of RFMD PCBA designs can be provided upon request. The supply voltage lines should present an RF short to the FEM by using bypass capacitors on the VCC traces. Please contact RFMD Sales or Application Engineering for additional data and guidance.

To simplify bias conditions, the FR5725 requires a single positive supply voltage (VCC), a positive current control bias (VREG) supply, and a positive supply for switch control. The built in Coupler Power Detector of the FR5725 is very accurate and minimizes calibration time in the system. All inputs and outputs are internally matched to 50Ω.

### Transmit Path

The RF5725 has a typical gain of 28dB from 2.4GHz to 2.5GHz, and delivers 17dBm typical output power under 54Mbps OFDM modulation and 21dBm under 1Mbps 11b modulation. The RF5725 requires a single positive of 3.3V to 4.2V to operate at full specifications. Current control optimization for the 802.11b/g band is provided through one bias control input pin (VREG). The VREG pin requires a regulated supply to maintain nominal bias current.

### Out of Band Rejection

The RF5725 contains basic filtering 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. Depending upon the end-user's application, additional filters may be needed to meet the out of band rejection requirements of the system.

### Receive Path

The 802.11b/g path has a 50Ω single-ended port with a nominal gain of 10dB in WiFi RX mode and 6dB in WiFi RX/BT mode. The Receive port return loss is 9.6dB minimum. The RF5725 is designed so that the SP3T may act as a 3dB splitter when placed in the WiFi RX and BT RX mode. In this mode, the FEM can receive *Bluetooth*<sup>™</sup> and WiFi signals simultaneously with an additional 3dB of loss.



RF5275 Biasing Instructions:

- 802.11b/g Transmit:
  - Connect the FEM to a signal generator at the input and a spectrum analyzer at the output.
  - Bias  $V_{CC}$  to 3.6V first with  $V_{REG}=0.0V$ .
  - Refer to switch operational truth table to set the control lines at the proper levels for WiFi TX.
- Turn on  $V_{REG}$  to 2.85V (typ.).  $V_{REG}$  controls the current drawn by the 802.11b/g power amplifier and the current should quickly rise to  $\sim 100mA \pm 20mA$  for a typical part but it varies based on the output power desired. Be externally careful not to exceed 3.4V on the  $V_{REG}$  pin or the part may exceed device current limits.
- 802.11b/g Receive
  - To receive WiFi set the switch control lines per the truth table below.
- *Bluetooth*<sup>™</sup> Receive
  - To receive *Bluetooth*<sup>™</sup> set the switch control lines per the truth table below.

Switch Control Logic

Mode	C_RX	C_TX	C_BT
<i>Bluetooth</i> <sup>™</sup>	L	L	H
WiFi Tx	L	H	L
WiFi Rx	H	L	L
WiFi Rx/BT	H	L	H

\*The FEM can simultaneously receive WiFi and *Bluetooth*<sup>™</sup> in the WiFi RX and BT RX Mode.



**RF5725 Plots**

