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RF9500

UMTS RX TRI-BAND LNA/FILTER/SWITCH MODULE

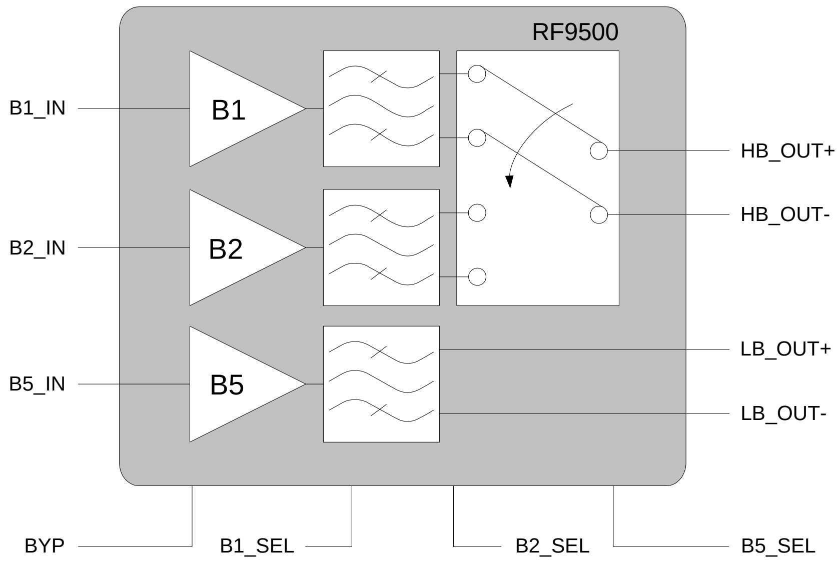
Package: Module, 28-Pin, 6.8mmx5mm x1.0mm

Features

- Tri-Band Support, Bands I, II, and V
- Lowest BOM Cost and Small Solution - No External DC-Blocking Capacitors
- Balanced Interface to RFIC
- LNA Bypass Mode
- Compact Footprint, 6.8mmx5mm x1.0mm, 28-Pin Module

Applications

- Cellular Handset and Data card Applications
- Multimode, GSM, EDGE, WCDMA Applications



Functional Block Diagram

Product Description

The RF9500 is a UMTS tri-band RX module containing an LNA + RX SAW filter for each supported band. Low insertion loss along with excellent linearity makes the RF9500 ideal for multi-mode GSM/EDGE/UMTS handset and data card applications. All external components normally associated with discrete RX front-end implementation have been integrated for ease of use. RF9500 is packaged in a compact 6.8mmx5mmx1mm, 28-pin module which allows for a small solution size and lowest BOM cost, as it does not require external DC-blocking capacitors.

Ordering Information

RF9500	UMTS Rx Tri-Band LNA/Filter/Switch Module
RF9500PCBA-410	Fully Assembled Evaluation Board

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
LB_VCC, HB_VCC	-0.3 to 3.5	V
B1_SEL, B2_SEL, B5_SEL, BYP	-0.3 to 3.5	V
Input RF Power	0	dBm
Operating Temperature	-30 to +85	°C
Storage Temperature	-55 to 125	°C

Caution! ESD sensitive device.

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

RoHS status based on EU Directive 2002/95/EC (at time of this document revision).

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band 1 **High Gain Mode**					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, B1_SEL=2.7V, B2_SEL=0V, B5_SEL=0V, BYP=1.8V, PIN=-30dBm
Frequency Range	2110		2170	MHz	
RF Input Power Range			-30	dBm	
Current Consumption		3.7	4.7	mA	
Insertion Gain					
	8.4		12.1	dB	f=2110MHz
	7.2		10.5	dB	f=2140MHz
	9.5		12.2	dB	f=2170MHz
		10.2		dB	Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=2110-2170MHz
Ripple		1		dB	Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=2110-2170MHz
Noise Figure		1.3	1.5	dB	
Input 3rd Order Intercept, 10MHz		-0.5		dBm	P_{IN}=-33dBm, 2-tone at 2140±10MHz offsets
Input 3rd Order Intercept, 2.4MHz		2.1		dBm	P_{IN}=-33dBm, 2-tone at 2140±2.4MHz offsets
Input 3rd Order Intercept, 0.8MHz		2.4		dBm	P_{IN}=-33dBm, 2-tone at 2140±0.8MHz offsets
Amplitude Balance	-1.5		1.5	dB	
Phase Balance	-10		10	deg	
Attenuation					
1920MHz to 1980MHz	-33.6			dB	
2400MHz to 2500MHz	-30.4			dB	

Note:
1. Typical performance with output of module terminated in equivalent transceiver impedance.

Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band 1 Bypass Mode					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, B1_SEL=2.7V, B2_SEL=0V, B5_SEL=0V, BYP=0V, PIN=-30dBm
Frequency Range	2110		2170	MHz	
RF Input Power Range			0	dBm	
Supply Current		145	157	μA	
Insertion Gain	-17.7	-16.1	-14.7	dB	
Band 2 High Gain Mode					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, BYP=1.8V, B1_SEL=0V, B2_SEL=2.7V, B5_SEL=0V, PIN=-30dBm
Frequency Range	1930		1990	MHz	
RF Input Power Range			-30	dBm	
Supply Current		3.7	4.7	mA	
Insertion Gain					
	5.7		10.9	dB	f=1930MHz
	7.5		11.6	dB	f=1960MHz
	5.1		9.9	dB	f=1990MHz
		9.4		dB	Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=1930MHz to f=1990MHz
Ripple		2.5			Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=1930MHz to f=1990MHz
Noise Figure		1.3	1.4	dB	
Input 3rd Order Intercept, 10MHz		-0.4		dBm	P_{IN}=-33dBm, 2-tone at 1960±10MHz offsets
Input 3rd Order Intercept, 2.4MHz		2.6		dBm	P_{IN}=-33dBm, 2-tone at 1960±2.4MHz offsets
Input 3rd Order Intercept, 0.8MHz		2.1		dBm	P_{IN}=-33dBm, 2-tone at 1960±0.8MHz offsets
Amplitude Balance	-1.8		1.8	dB	
Phase Balance	-10		10	deg	
Attenuation					
1850MHz to 1890MHz	-30.5			dB	
1890MHz to 1910MHz	-29.0			dB	
2400MHz to 2500MHz	-42.6			dB	

Note:
1. Typical performance with output of module terminated in equivalent transceiver impedance.

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
Band 2 Bypass Mode					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, BYP=0V, B1_SEL=0V, B2_SEL=2.7V, B5_SEL=0V, PIN=-30dBm
Frequency Range	1930		1990	MHz	
RF Input Power Range			0	dBm	
Supply Current		144	157.7	μA	
Insertion Gain	-18.3	-14.6	-10.9	dB	
Band 5 High Gain Mode					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, BYP=1.8V, B1_SEL=0V, B2_SEL=0V, B5_SEL=2.7V, PIN=-30dBm
Frequency Range	869		894	MHz	
RF Input Power Range			-30	dBm	
Supply Current		3.7	4.6	mA	
Insertion Gain					
	11.4		13.2	dB	f=869MHz
	9.8		13.6	dB	f=881MHz
	9.6		13.7	dB	f=894MHz
		13.9		dB	Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=869MHz to f=894MHz
Ripple		0.9			Z_{IN}=50Ω, Z_{OUT}=Z_{TXCR}[1], f=869MHz to f=894MHz
Noise Figure		1.2	1.4	dB	
Input 3rd Order Intercept 10MHz		-2		dBm	P_{IN}=-33dBm, 2-tone at 881±10MHz offsets
Input 3rd Order Intercept, 2.4MHz		-1.1		dBm	P_{IN}=-33dBm, 2-tone at 881±2.4MHz offsets
Input 3rd Order Intercept, 0.8MHz		-4.1		dBm	P_{IN}=-33dBmP_{IN}=33dBm, 2-tone at 881±0.8MHz offsets
Amplitude Balance	-0.5		0.5	dB	
Phase Balance	-5		+5	deg	
Attenuation					
824MHz to 849MHz	-46.7			dB	
2000MHz to 6000MHz	-43.0			dB	
Band 5 Bypass Mode					Nominal Test Conditions, unless otherwise noted: Ref Terminations: Z_{IN}=50Ω,Z_{OUT}=100Ω dfferential. Temp=25°C, HB_VCC=2.7V, LB_VCC=2.7V, BYP=0V, B1_SEL=0V, B2_SEL=0V, B5_SEL=2.7V, PIN=-30dBm
Frequency Range	869		894	MHz	
RF Input Power Range			0	dBm	
Supply Current		145	158.1	μA	
Insertion Gain	-20.2	-18.4	-16.6	dB	

Note:
1. Typical performance with output of module terminated in equivalent transceiver impedance.

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Parameter	Specification			Unit	Condition
	Min.	Typ.	Max.		
DC Specifications					
Supply Voltage: LB_VCC, HB_VCC	2.55		3.0	V	
Switch Logic Level (HIGH): B1_SEL, B2_SEL, B5_SEL	2.55		3.0	V	
Switch Logic Level (LOW): B1_SEL, B2_SEL, B5_SEL	0		0.5	V	
LNA Logic Level (HIGH): BYP	1.5		3.0	V	
LNA Logic Level (LOW): BYP	0		0.5	V	

Control Signals

Signal Name	Comment	High	Low
B1_SEL	Selects B1 Path	Path Enabled	Path Disabled
B2_SEL	Selects B2 Path	Path Enabled	Path Disabled
B5_SEL	Selects B5 Path	Path Enabled	Path Disabled
BYP	Selects Bypass mode on all LNAs	High Gain Mode	Bypass (Low Gain) Mode

Pin	Function	Description
1	B1_IN	Band 1 RF Input
2	GND	Ground
3	B2_IN	Band 2 RF Input
4	GND	Ground
5	GND	Ground
6	B5_IN	Band 5 RF Input
7	GND	Ground
8	GND	Ground
9	GND	Ground
10	B5_SEL	Band 5 control
11	GND	Ground
12	LB_VCC	Low band power supply
13	BYP	Bypass mode control voltage
14	GND	Ground
15	GND	Ground
16	LB_OUT_P	Low band balanced output
17	LB_OUT_N	Low band balanced output
18	GND	Ground
19	HB_OUT_N	High balanced output
20	HB_OUT_P	High balanced output
21	GND	Ground
22	GND	Ground
23	GND	Ground
24	GND	Ground
25	HB_VCC	High band power supply
26	GND	Ground
27	B2_SEL	Band 2 control
28	B1_SEL	Band 1 control

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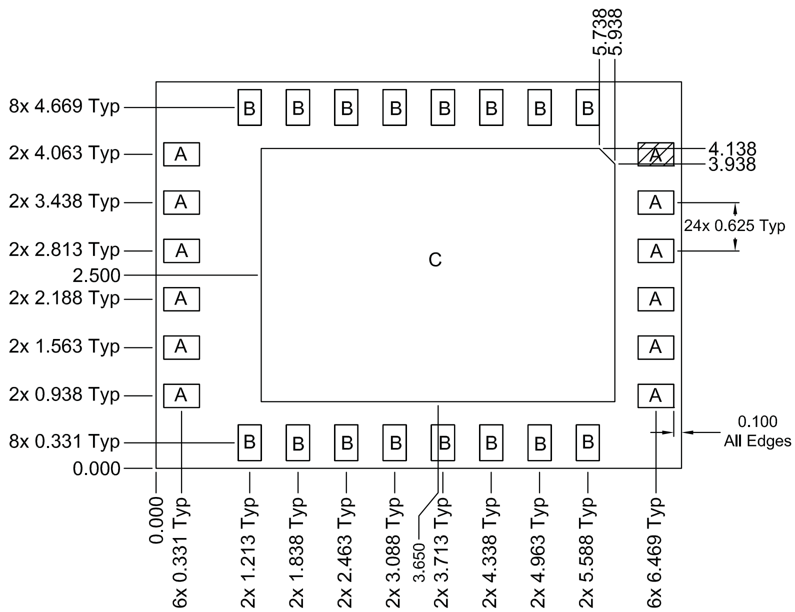
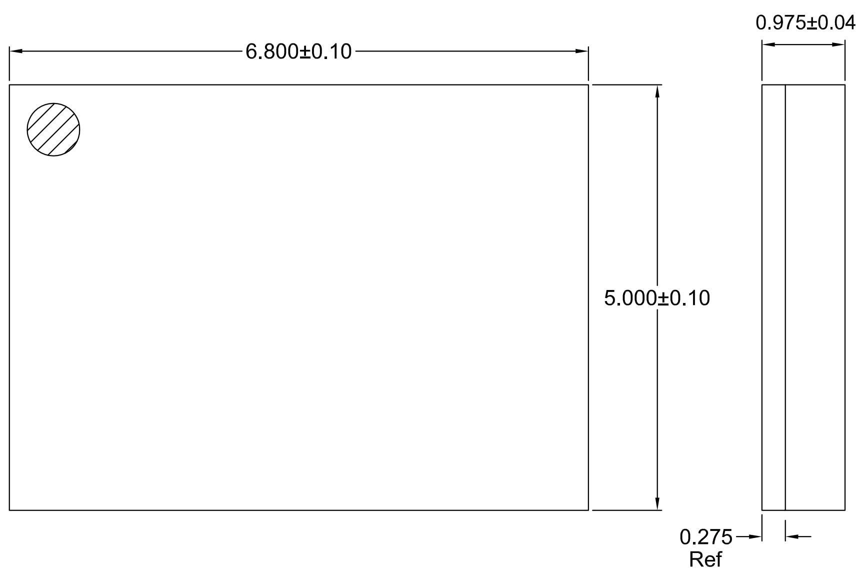
Package Drawing



A = 0.462 x 0.300 mm Typ
B = 0.300 x 0.462 mm Typ
C = 4.575 x 3.275 mm



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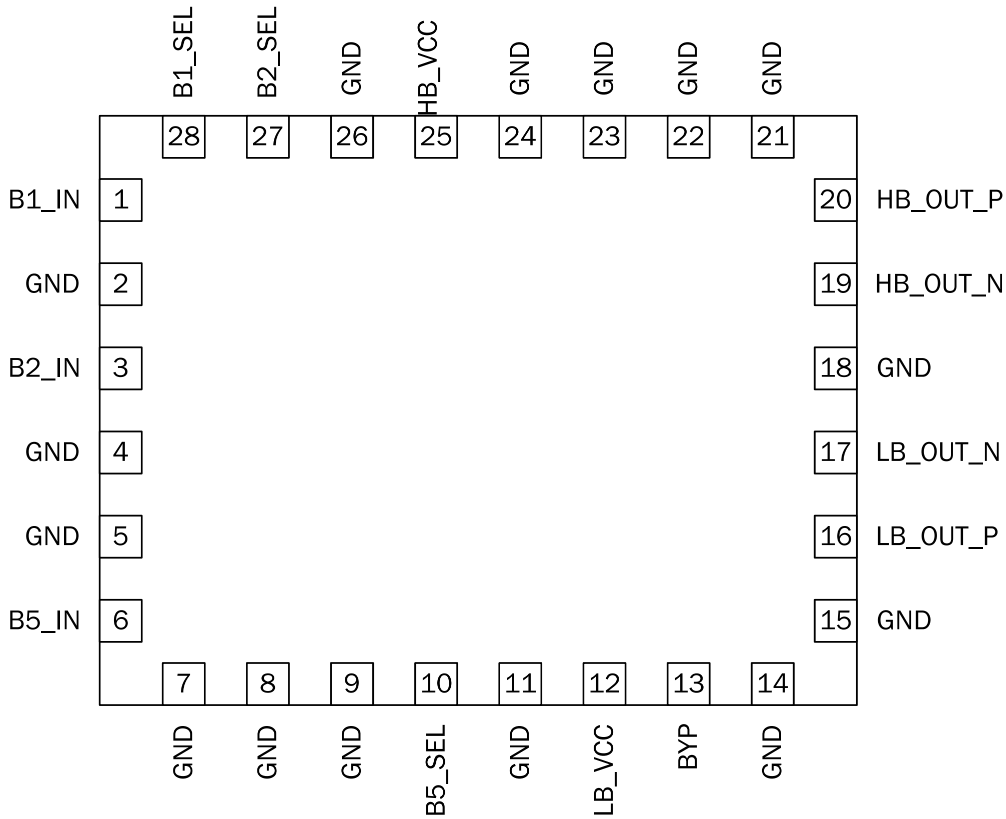
Pin Out



Top View

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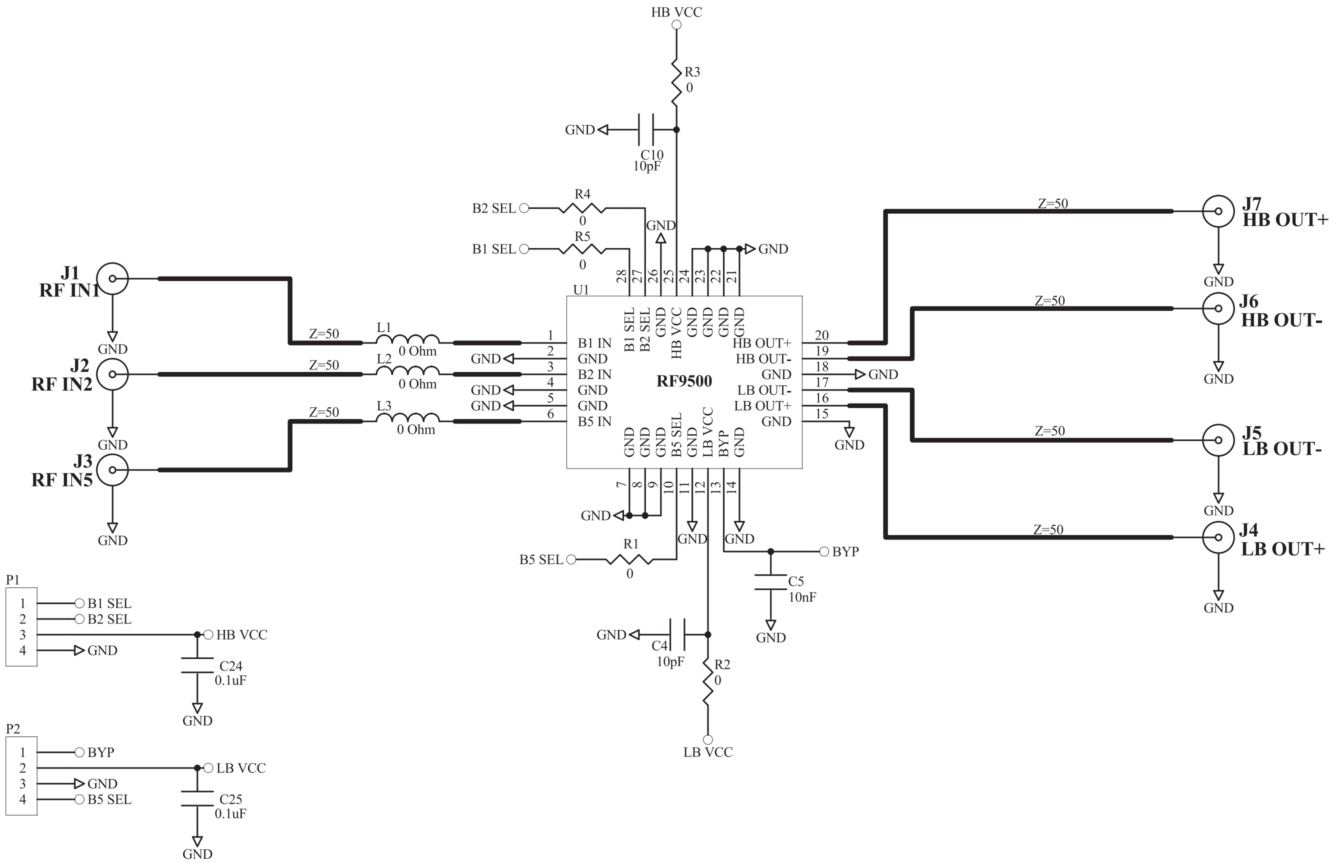
Evaluation Board Schematic



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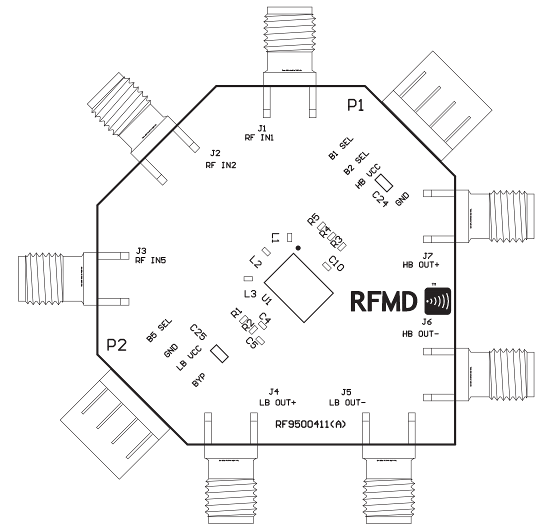
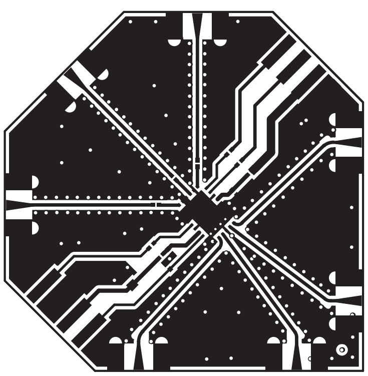
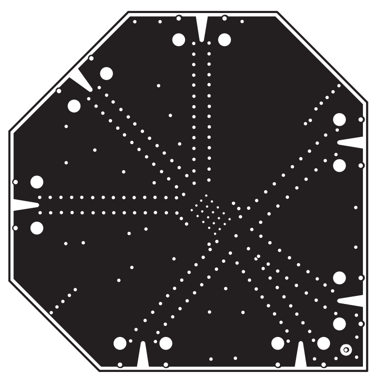
Evaluation Board Layout



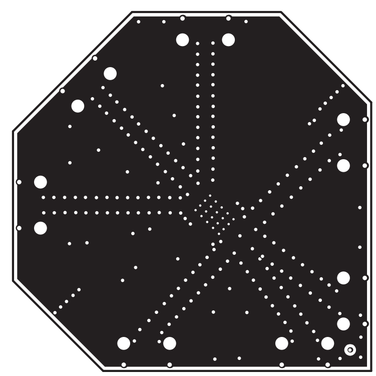
Assembly



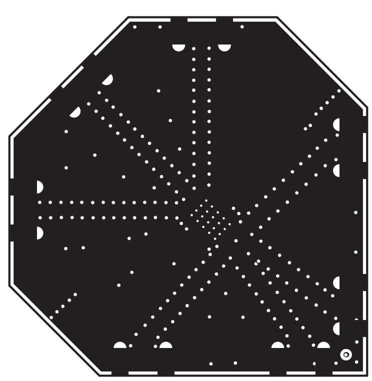
Top



In1



In2



Back

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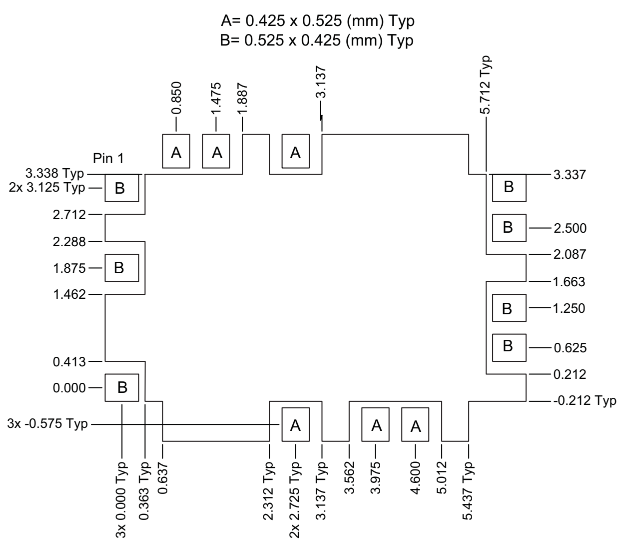
PCB Design Requirements

PCB Surface Finish

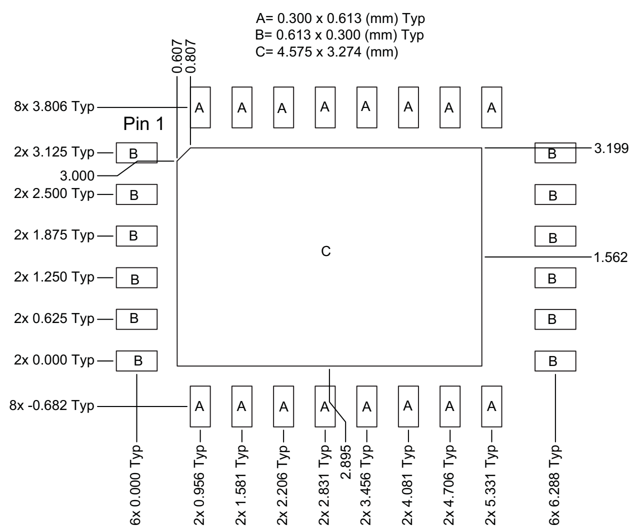
The PCB surface finish used for RFMD's qualification process is electroless nickel, immersion gold. Typical thickness is 3µinch to 8µinch gold over 180µinch nickel.

PCB Land Pattern Recommendation

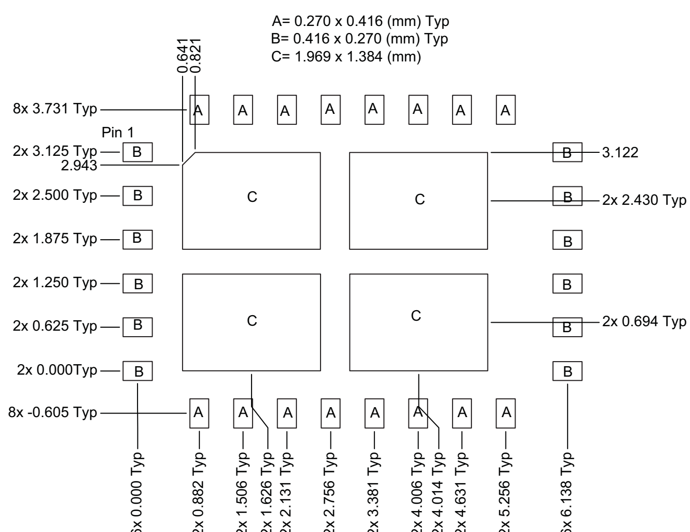
PCB land patterns for RFMD components are based on IPC-7351 standards and RFMD empirical data. The pad pattern shown has been developed and tested for optimized assembly at RFMD. The PCB land pattern has been developed to accommodate lead and package tolerances. Since surface mount processes vary from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



PCB METAL LAND PATTERN



PCB SOLDER MASK PATTERN



PCB STENCIL PATTERN

Theory of Operation

The RF9500 is a fully integrated tri-band + post LNA filter module. This module simplifies phone design by eliminating the need for discrete filters and LNAs as well as matching components. The burden of tuning excercises normally associated with discrete LNA design and PCB iterations is taken away from the handset designer, thus improving design cycles and reducing time to market.

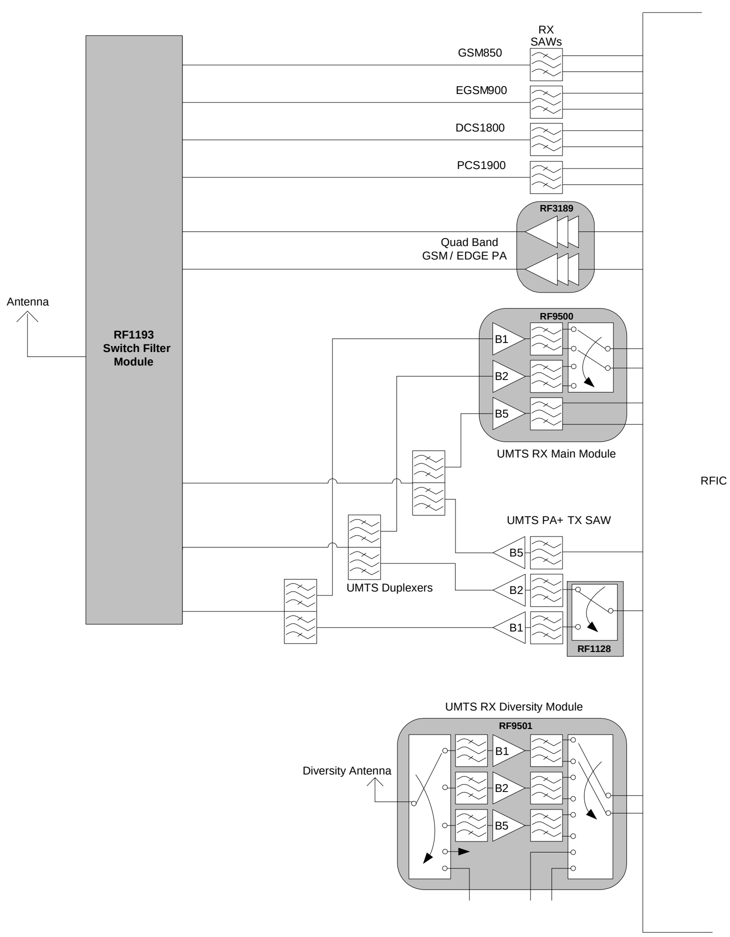
Power on sequence:

1. Apply VCC
2. Apply Bypass & Select Lines (B1_SEL, B2_SEL, B5_SEL, BYP)
3. Apply RF

For powering down the RF9500 module the above sequence should be followed in reverse.

When the RF9500 is used in conjunction with the RF9501 module (tri-band, with quad-band support, UMTS RX diversity path front end module) a complete tri-band RX front end solution with diversity can be realised. Typical block diagram of UMTS front end using the RF9500 and RF9501:

Functional Block Diagram of Typical Front End for Handset Application.



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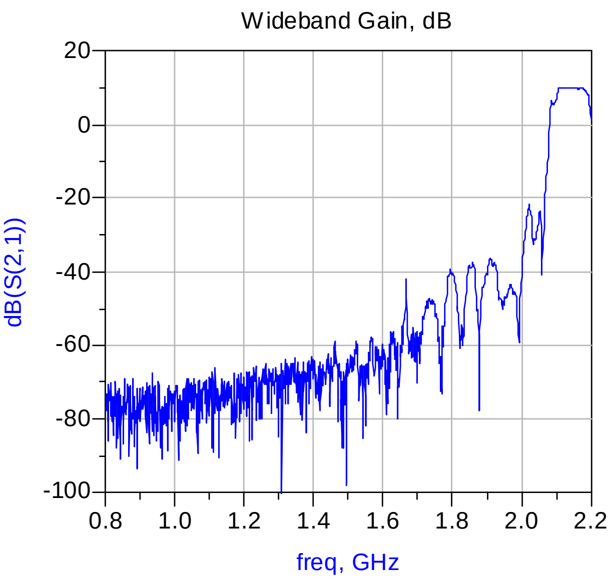
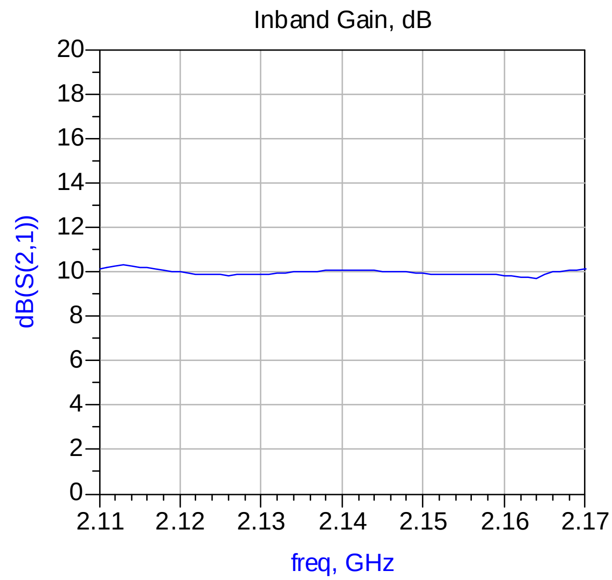
Typical Performance in System

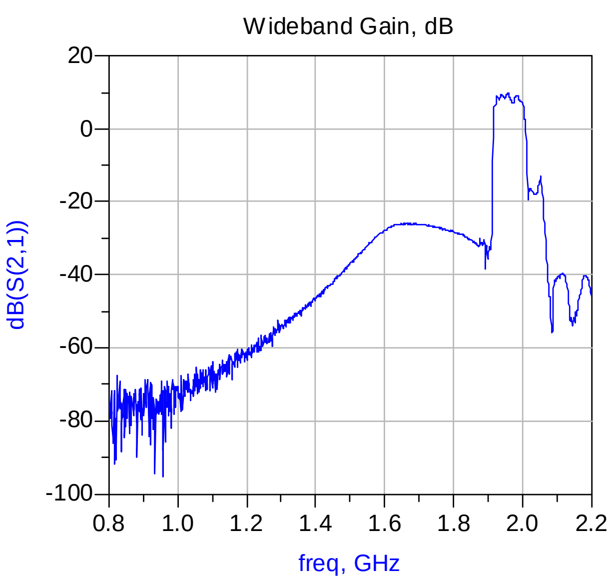
The following graphs show the typical gain response of the Rx module when terminated in the equivalent transceiver output impedance.

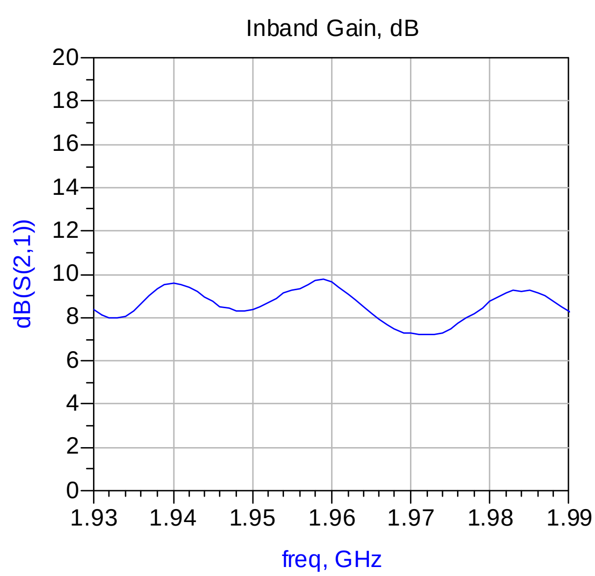
Band 1 (2110MHz to 2170MHz)





Band 2 (1930MHz to 1990MHz)





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Band 5 (869 MHz to 894 MHz)