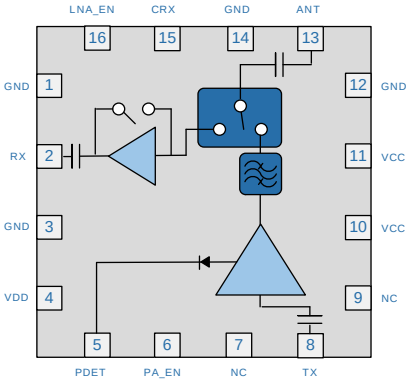
RFFM4501F

4.9GHz to 5.85GHz 802.11a/n/ac WiFi Front End Module

The RFFM4501F provides a complete integrated solution in a single front end module (FEM) for WiFi 802.11a/n/ac systems. The ultra-small factor and integrated matching minimizes layout area in the customer's application and greatly reduces the number of external components. Performance is focused on linear output power under a number of conditions including duty cycle and packet length while balancing power consumption needs of leading edge device platforms. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturing cost.

The RFFM4501F integrates a 5GHz power amplifier (PA), single pole two throw switch (SP2T) and an LNA with bypass. The device is provided in a 3mm x 3mm x 1.05mm, 16-pin laminate package. This module meets or exceeds the RF front end needs of IEEE 802.11a/n/ac WiFi RF systems.



Functional Block Diagram

Ordering Information

RFFM4501FSB	Standard 5-piece sample bag
RFFM4501FSQ	Standard 25-piece sample bag
RFFM4501FSR	Standard 100-piece reel
RFFM4501FTR7	Standard 2500-piece reel
RFFM4501FPCK-410	Fully assembled eval board w/ 5-piece sample bag

Package: Laminate, 16-pin, 3.0mm x 3.0mm x 1.05mm

Features

- 3.0V - 5.0V Operation
- P_{OUT} = +18.0dBm at 3.3V, 802.11ac MCS9 HT80 at 1.8% Dynamic EVM Compliance
- P_{OUT} = +19.5dBm at 3.3V, MCS0 HT20, HT40, and HT80 at Spectral Mask Compliance
- P_{OUT} = +19.5dBm at 5.0V, 802.11ac MCS9 HT80 at 1.8% Dynamic EVM Compliance
- P_{OUT} = +20.5dBm at 5.0V, MCS0 HT20, HT40, and HT80 at Spectral Mask Compliance
- High performance FEM in Small Package
- Input and Output Matched to 50Ω
- Integrated 5GHz PA, SP2T, LNA with Bypass and Power Detector Coupler

Applications

- Customer Premise Equipment
- Set-Top Boxes
- Netbooks/Notebooks
- Mobile Routers/Access Points
- Data Cards
- Consumer Electronics
- Gaming
- TV/Monitors/Video

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Absolute Maximum Ratings

Parameter	Rating	Unit
Control Voltage (VCTL, VEN)	6.0	V
Supply Voltage (VDD)	6.0	V
Maximum CW Input Power	+12	dBm
Operating Temperature Range	-40 to +85	°C
Storage Temperature Range	-40 to +150	°C
Maximum Junction Temperature	+150	°C
ESD Rating - Human Body Model (HBM)	250	V
Moisture Sensitivity Level	MSL3	

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		
Parameter					
Operating Frequency	5.150		5.850	GHz	
Extended Frequency	4.900		5.850	GHz	Functional with reduced performance
Operating Temperature	-20		+85	ºC	
Extended Operating Temperature	-40		-20	ºC	Functional with reduced performance
Power Supply V_{CC}	3.0	3.3	5.0	V	
Control Voltage-High	2.8	3.1	V_{CC}	V	PA_EN, LNA_EN, CRX
Control Voltage-Low		0	0.2	V	
Package Size	2.9 x 2.9 x 0.9	3.0 x 3.0 x 0.975	3.1 x 3.1 x 1.05	mm	Length x Width x Height
Transmit (TX-ANT)					**V_{CC} = 3.3V, *f* = 5.15 - 5.85 GHz, PA_EN = High, LNA_EN = Low, CRX = Low, T = +25ºC; Unless otherwise noted**
802.11ac MCS9 HT80 Output Power	17.5	18.0		dBm	T = 25ºC, V_{CC} = 3.3V
Dynamic EVM		1.5	1.8	%	
		-36.5	-35.0	dB	
802.11ac MCS9 HT80 Output Power	16.5	17.0		dBm	T = -20ºC to +85ºC, V_{CC} = 3.3V
Dynamic EVM		1.5	1.8	%	
		-36.5	-35.0	dB	
802.11n MCS7 HT20 Output Power		19.5		dBm	T = 25ºC, V_{CC} = 3.3V
Dynamic EVM		2.5	3.0	%	
		-32.0	-30.5	dB	
802.11n MCS7 HT20 Output Power		18		dBm	T = -20ºC to +85ºC, V_{CC} = 3.3V
Dynamic EVM		2.5	3	%	
		-32.0	-30.5	dB	
Spectral Mask Output Power		20		dBm	T = 25ºC, V_{CC} = 3.3V, 802.11ac MCS9 HT80
		21		dBm	T = 25ºC, V_{CC} = 3.3V, 802.11ac MCS0 HT20
Large Signal Gain		28		dB	T = 25ºC, V_{CC} = 3.3V
Large Signal Gain	25	28			T = -20ºC to +85ºC, V_{CC} = 3.3V
Gain Flatness Over Full Frequency band	-1.5		1.5		T = -25 ºC, V_{CC} = 3.3V
TX Port Return Loss	9	15		dB	

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Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Transmit (TX-ANT) (continued)					**V_{CC} = 3.3V, *f* = 5.15 - 5.85 GHz, PA_EN = High, LNA_EN = Low, CRX = Low, T = +25ºC; Unless otherwise noted**
ANT Port Return Loss	10	15		dB	
Operating Current		230		mA	P_{OUT} = 18dBm, 802.11ac MCS9 HT80
Operating Current		280		mA	P_{OUT} = 20dBm, 802.11ac MCS0 HT20 - HT80
PA Enable Current		30	50	uA	
Leakage Current		2	10	uA	RF OFF, PA_EN = Low, LNA_EN = Low, CRX = Low
Second Harmonic		-35		dBm	P_{OUT} = 20dBm, MCS0 HT20
Third Harmonic		-40		dBm	
Power Detector Voltage		0.25		V	P_{OUT} = RF OFF
Power Detector Voltage		0.85		V	P_{OUT} = 18dBm, 802.11ac MCS9 HT80
Transmit (TX-ANT)					**V_{CC} = 5.0V, *f* = 5.15 - 5.85 GHz, PA_EN = High, LNA_EN = Low, CRX = Low, T = +25ºC; Unless otherwise noted**
802.11ac MCS9 HT80 Output Power		19.5		dBm	T = 25ºC, V_{CC} = 5.0V
Dynamic EVM		1.5	1.8	%	
		-36.5	-35.0	dB	
802.11ac MCS9 HT80 Output Power		18		dBm	T = -20ºC to +85ºC, V_{CC} = 5.0V
Dynamic EVM		1.5	1.8	%	
		-36.5	-35.0	dB	
802.11n MCS7 HT20 Output Power		20.5		dBm	T = 25ºC, V_{CC} = 5.0V
Dynamic EVM		2.5	3.0	%	
		-32.0	-30.5	dB	
802.11n MCS7 HT20 Output Power		19		dBm	T = -20 to +85ºC, V_{CC} = 5.0V
Dynamic EVM		2.5	3	%	
		-32.0	-30.5	dB	
Spectral Mask Output Power		21		dBm	T = 25ºC, V_{CC} = 5.0V, 802.11ac MCS9 HT80
		22		dBm	T = 25ºC, V_{CC} = 5.0V, 802.11ac MCS0 HT20
Large Signal Gain		28		dB	
Large Signal Gain	24	28			T = -20ºC to +85ºC, V_{CC} = 5.0V
Gain Flatness Over Full Frequency band	-1.5		1.5		T = -25ºC, V_{CC} = 5.0V
TX Port Return Loss	9	15		dB	
ANT Port Return Loss	10	15	-	dB	
Operating Current		300		mA	P_{OUT} = 19.5dBm, 802.11ac MCS9 HT80
Operating Current		330		mA	P_{OUT} = 21.5dBm, 802.11ac MCS0 HT20 - HT80
PA Enable Current		30	50	uA	
Leakage Current		2	10	uA	RF OFF, PA_EN = Low, LNA_EN = Low, CRX = Low
Second Harmonic		-35		dBm	P_{OUT} = 21.5dBm, MCS0 HT20
Third Harmonic		-40		dBm	
Power Detector Voltage		0.25		V	P_{OUT} = RF OFF
Power Detector Voltage		0.9		V	P_{OUT} = 19.5dBm, 802.11ac MCS9 HT80

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Parameter	Specification			Unit	Condition
	Min	Typ	Max		
Receive (ANT-RX) LNA On Mode					**V_{CC} = 3.3V to 5.0V, *f* = 5.15 - 5.85 GHz, PA_EN = Low, LNA_EN = High; CRX = High, T = +25ºC; Unless otherwise noted**
Gain		12		dB	
Noise Figure		2.5		dB	
Rx Port Return Loss		10		dB	
ANT Port Return Loss		10		dB	
Input P_{1dB}	-13	-10		dBm	
Input IP3	-3	0		dBm	
Receive (ANT-RX) LNA Bypass Mode					**V_{CC} = 3.3V to 5.0V, *f* = 5.15 - 5.85 GHz, PA_EN = Low, LNA_EN = Low, CRX = High, T = +25ºC; Unless otherwise noted**
Bypass Loss		8		dB	
RX Port Return Loss	7			dB	
ANT Port Return Loss		6		dB	
Input P_{1dB}	5	10		dBm	
Input IP3	15	20		dBm	
Isolation ANT-TX: Rx Mode	20			dB	CRX = High, PA_EN = Low
Isolation ANT-RX: Tx Mode	25			dB	PA_EN = High, CRX = Low, LNA_EN = Low
General Specifications					**V_{CC} = 3.3V or 5.0V**
CRX Control Current		0.5	1	uA	
PA_EN Control Current		30	50	uA	
Switching Speed			100	nS	
ESD – Human Body Model		250		V	
ESD – Charge Device Model		500		V	
PA Turn-on Time		200	500	nS	10% to 90%
PA Stability					Unconditional into 4:1 VSWR, No spurious above -41.25dBm/MHz
Maximum Input Power			+12	dBm	Into 50 Ohms
Ruggedness			10:1	VSWR	At typical operating conditions

Switch Control Logic Table

Operating Mode	PA_EN	LNA_EN	CRX
Standby	Low	Low	Low
802.11a/n/ac TX	High	Low	Low
802.11a/n/ac RX Gain	Low	High	High
802.11a/n/ac RX Bypass	Low	Low	High

Notes:

- PA_EN and TX switch control are tied together internally.
- High = 2.8 to VCC. Low = 0V to 0.2V.

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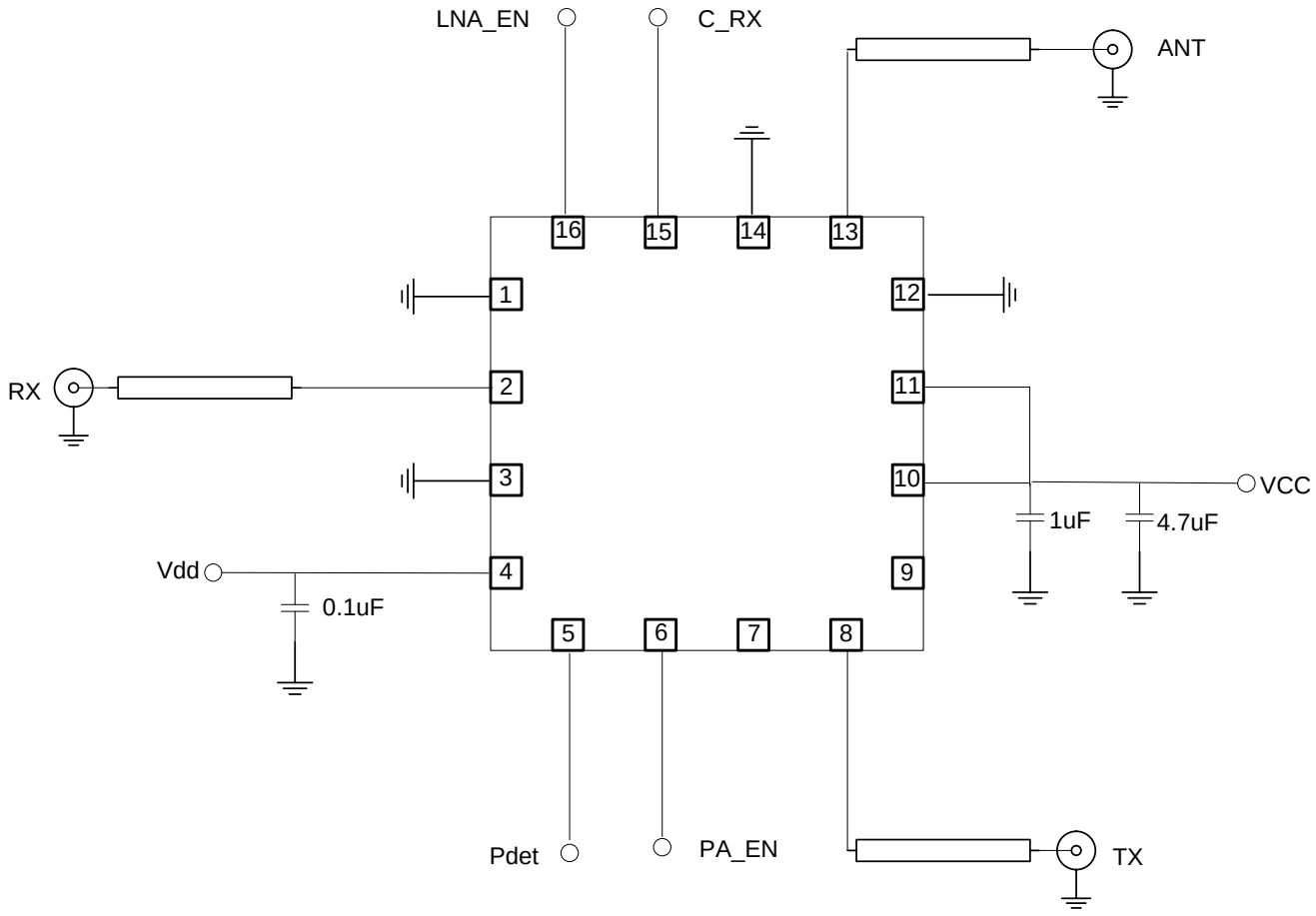
Applications Schematic 3.0V-4.2V Operation



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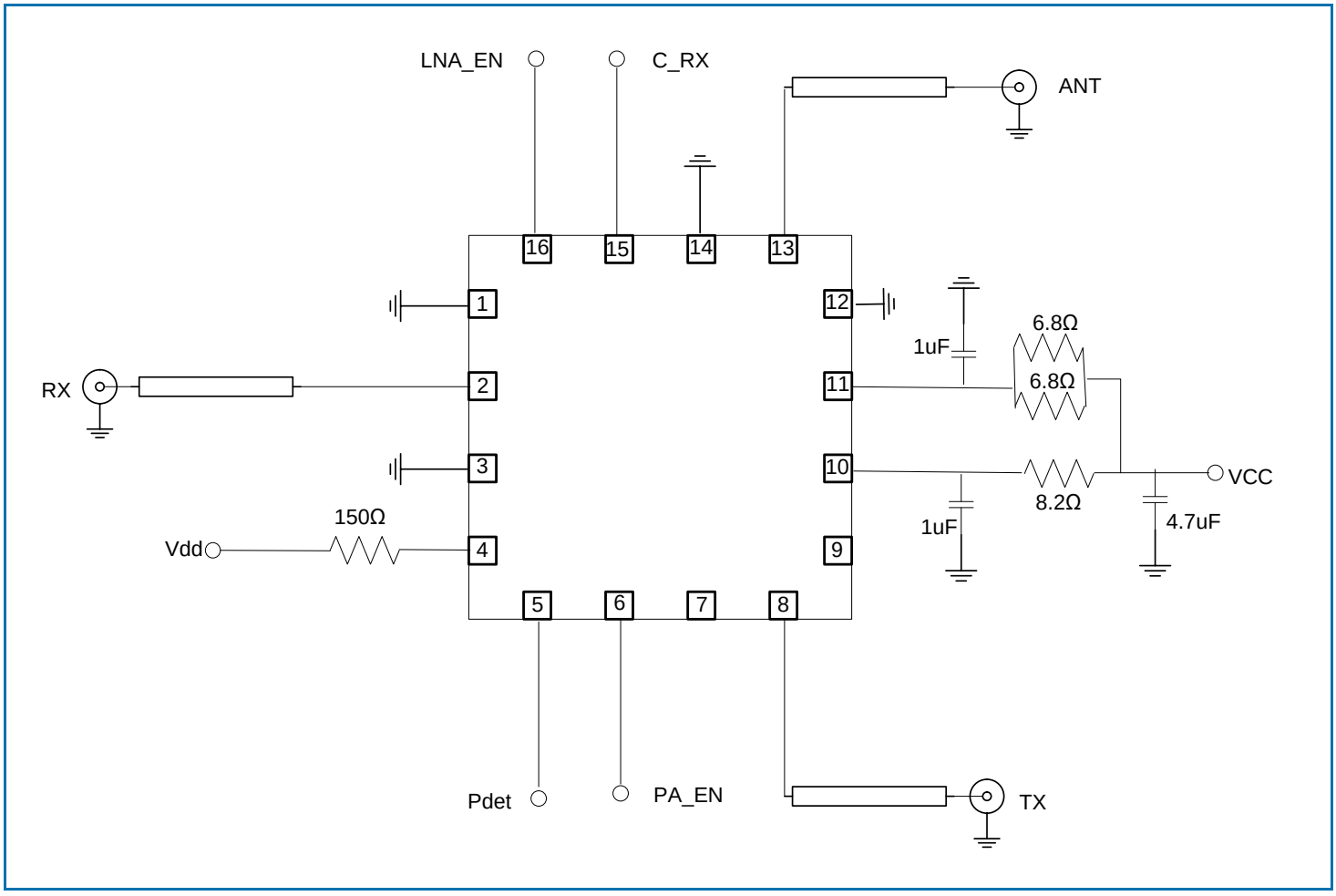
Applications Schematic 5.0V Operation



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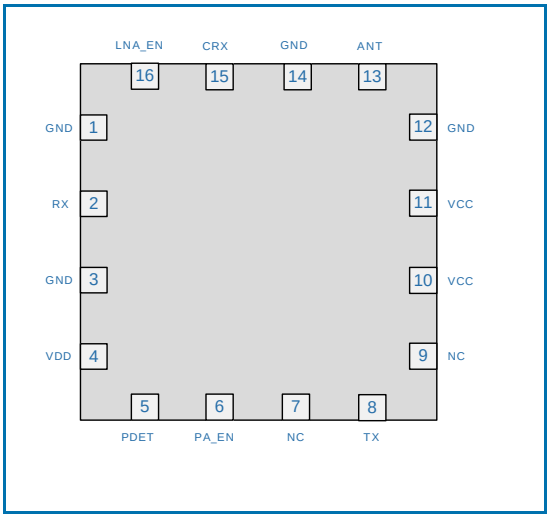
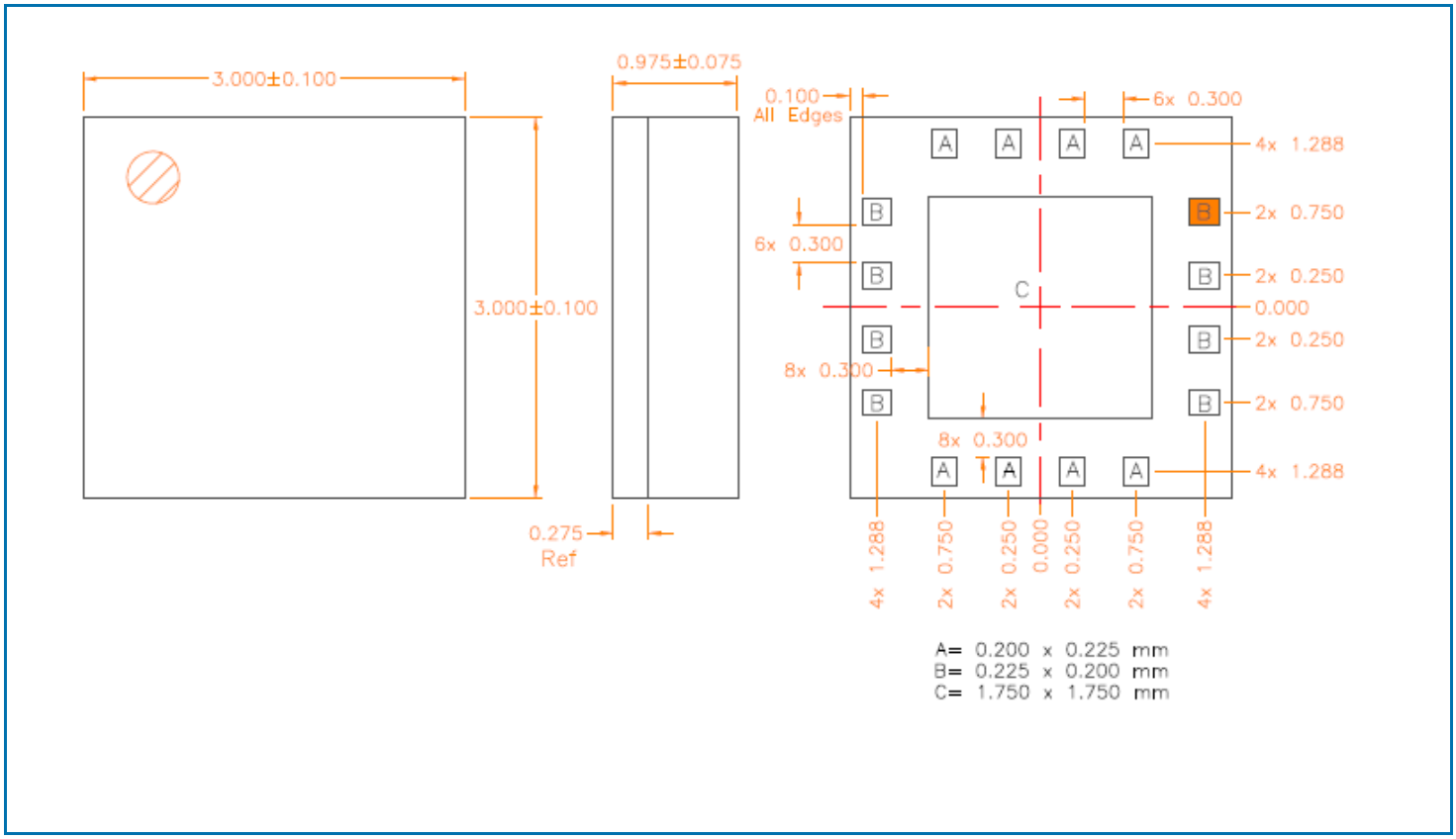
Pin Out



Package Drawing



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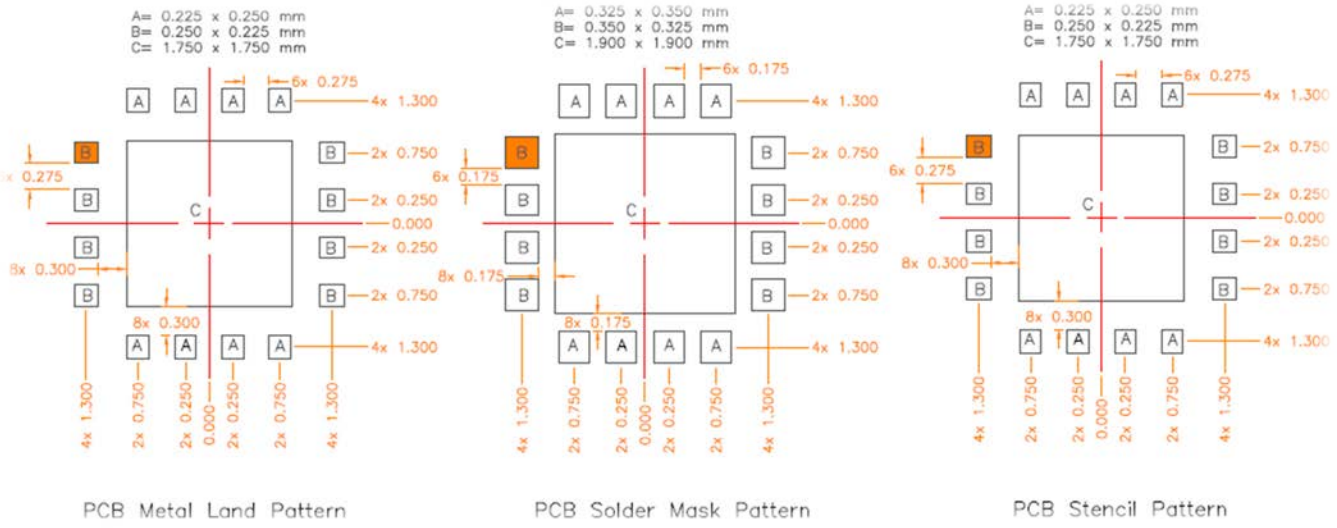
PCB Patterns



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Pin Names and Descriptions

Pin	Name	Description
1	GND	Ground connection
2	RX	RF output port for the 802.11a/n/ac LNA. This port is matched to 50Ω and DC blocked internally.
3	GND	Ground connection
4	VDD	Supply voltage for the LNA and PA regulator. See applications schematic for biasing and bypassing components.
5	PDET	Power detector voltage for the TX path. May need external series R/shunt C to adjust voltage level and to filter RF noise.
6	PA_EN	Control voltage for the PA and TX switch. See truth table for proper settings.
7	NC	This pin is not connected internally and can be left floating or connected to ground.
8	TX	RF input port for the 802.11a/n PA. Input is matched to 50Ω and DC blocked internally
9	NC	This pin is not connected internally and can be left floating or connected to ground.
10	VCC	Supply voltage for the PA stage 1 and 2. See applications schematic for biasing and bypassing components.
11	VCC	Supply voltage for the PA stage 3. See applications schematic for biasing and bypassing components.
12	GND	Ground connection
13	ANT	RF bi-directional antenna port matched to 50Ω. An internal DC block is integrated in device.
14	GND	Ground connection
15	CRX	Receive switch control pin. See truth table
16	LNA-EN	Control voltage for the LNA. When this pin is set to a LOW logic state, the bypass mode is enabled.
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.

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