

# RFFM4293

3.0V to 5.0V, 2.4GHz to 2.5GHz 802.11b/g/n/ac WiFi Front End Module

The RFFM4293 provides a complete integrated 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 application. This simplifies the total front end solution by reducing the bill of materials, system footprint, and manufacturability cost. The RFFM4293 integrates a 2.4GHz to 2.5GHz 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 3mm x 3mm x 1.05mm, 16-pin package. This module meets or exceeds the RF front end needs of IEEE 802.11b/g/n/ac WiFi RF systems.



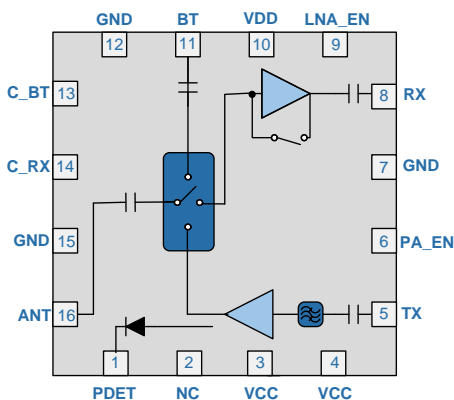
Package: Laminate, 16-pin, 3.0mm x 3.0mm x 1.05mm

## Features

- Integrated 2.4GHz to 2.5GHz b/g/n/ac Amplifier, LNA with bypass mode, SP3T Switch, and Power Detector Coupler
- Single Supply Voltage 3.0V to 5.0V  
 $P_{OUT} = 19\text{dBm}$ , 3.3V @ 3% Dynamic EVM.  
 $P_{OUT} = 21\text{dBm}$ , 5.0V @ 3% Dynamic EVM

## Applications

- IEEE802.11b/g/n/ac WiFi Applications
- 2.4GHz to 2.5GHz ISM Band Solutions
- Portable Battery-Powered Equipment
- WiFi Access Points, Gateways, and Set Top Boxes



Functional Block Diagram

## Ordering Information

RFFM4293SB	Standard 5-piece bag
RFFM4293SQ	Standard 25-piece bag
RFFM4293SR	Standard 100-piece reel
RFFM4293TR7	Standard 2500-piece reel
RFFM4293PCK-410	Fully assembled evaluation board w/5-piece bag

## Absolute Maximum Ratings

Parameter	Rating	Unit
DC Supply Voltage (Continuous with No Damage)	5.4	V
DC Supply Current	500	mA
Operating Case Temperature	-20 to +85	°C
Extended Temperature Range (with Reduced Performance)	-40 to -20	°C
Storage Temperature	-40 to +150	°C
Maximum Tx Input Power into 50Ω Load	+12	dBm
Maximum Rx Input Power (No Damage)	+12	dBm
Moisture Sensitivity	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		
<b>Typical Conditions 3.3V</b>					<b>Temperature = -10°C to +70°C, V<sub>CC</sub> = 3.3V, PA_EN = high, P<sub>OUT</sub> = 19dBm using an IEEE802.11n MCS7 waveform unless otherwise noted.</b>
Tx Performance - 11g/n/ac					Compliance with standard 802.11g/n/ac
Frequency	2412		2484	MHz	
802.11n Output Power	18.5	19.0		dBm	802.11n HT20 and HT40 MCS7 at 25°C
11n Dynamic EVM		2.5	3	%	
		-32.0	-30.5	dB	
802.11ac Output Power	16.5	17.0		dBm	802.11ac HT40 MCS9 at 25°C
11ac Dynamic EVM		1.5	1.8	%	
		-36.0	-35.0	dB	
Tx Performance - Spectral Mask					
802.11n Output Power		21		dBm	802.11n HT20 and HT40 MCS7 at 25°C
802.11b Output Power		24		dBm	Meet 802.11b DSSS 1Mbps Spectral Mask
General Tx Performance					
Second Harmonic		-24	-20	dBm/MHz	At P <sub>OUT</sub> = 19dBm
Third Harmonic		-50	-42	dBm/MHz	
Gain	25	27	29	dB	
Gain Variation Over Temp	-2		+2	dB	
Power Detect Voltage	0.11	0.125	0.14	V	RF = off
	0.7	0.8	0.9	V	At rated P <sub>OUT</sub>
Power Detect Accuracy	-2.0		+2.0	dB	Into 3:1 VSWR load at 25°C
Input Return Loss - Tx_in pin		-13	-10	dB	In specified frequency band
Output Return Loss at ANT pin		-15	-10	dB	
Operating Current		210	230	mA	At rated P <sub>OUT</sub> 19dBm
		195	215	mA	At rated P <sub>OUT</sub> 17dBm
Quiescent Current		170		mA	Nominal conditions; no RF applied
Leakage Current		2	10	μA	V <sub>CC</sub> = 3.3V, PA_EN = low, C_RX = low, LNA_EN = low
Power Added Efficiency		10.5		%	Nominal conditions
Power Supply - V <sub>CC</sub>	3.0	3.3	3.6	V	

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
<b>Typical Conditions 3.3V (continued)</b>					<b>Temperature = -10°C to +70°C, V<sub>CC</sub> = 3.3V, PA_EN = high, P<sub>OUT</sub> = 19dBm using an IEEE802.11n MCS7 waveform unless otherwise noted.</b>
VCONTROL High (PA_EN, C_RX, C_BT, LNA_EN)	2.8	3	V <sub>CC</sub>	V	
VCONTROL Low (PA_EN, C_RX, C_BT, LNA_EN)	0		0.2	V	
Turn-on time from PA_EN edge			500	ns	Output stable to within 90% of final gain
Turn-off time from PA_EN edge			500	ns	
Stability	-25		24	dBm	No spurs above -47dBm into 4:1 VSWR
CW P1dB	26	27		dBm	Tx mode in 50% Duty Cycle
<b>Rx Performance</b>					<b>Temperature = -10°C to +70°C, V<sub>DD</sub> = 3.3V, C_RX = high, LNA_EN = high</b>
Gain	11	13	15	dB	
NF		2.3	3	dB	In specified frequency band
RX Port Return Loss			-9.6	dB	
ANT Port Return Loss			-4	dB	
Input IP3	4	8		dBm	
Input P1dB	-6	-2		dBm	
I <sub>DD</sub>		10	15	mA	
LNA_EN Control Current		30	50	μA	
<b>Rx Bypass Mode</b>					<b>Temperature = -10°C to +70°C, V<sub>DD</sub> = 3.3V, C_RX = high, LNA_EN = low</b>
Insertion Loss	-8.5	-7.5	-6.5	dB	
RX Port Return Loss			-9.6	dB	
ANT Port Return Loss			-4	dB	
Input IP3	4	8		dB	
Input P1dB	-6	-2		dBm	
<b>Typical Conditions 5.0V</b>					<b>Temperature = -10°C to +70°C, V<sub>CC</sub> = 5.0V, PA_EN = high, P<sub>OUT</sub> = 21.5dBm using an IEEE802.11n MCS7 waveform unless otherwise noted.</b>
Tx Performance - 11g/n/ac					Compliance with standard 802.11g/n/ac
Frequency	2412		2484	MHz	
802.11n Output Power	21	21.5		dBm	802.11n HT20 and HT40 MCS7 at T=25°C, V <sub>CC</sub> = 5.0V
11n Dynamic EVM		2.5	3	%	
		-32	-30.5	dB	
802.11ac Output Power	17	18		dBm	802.11ac HT40 MCS9 at T=25°C, V <sub>CC</sub> = 5.0V
11ac Dynamic EVM		1.5	1.8	%	
		-36.0	-35.0	dB	
Tx Performance - Spectral Mask					
802.11n output power		22		dBm	802.11n HT20 and HT40 MCS7 T=25°C, V <sub>CC</sub> = 5.0V
802.11b output power		26		dBm	Meet 802.11b DSSS 1Mbps spectral mask

Parameter	Specification			Unit	Condition
	Min	Typ	Max		
<b>Typical Conditions 5.0V (continued)</b>					<b>Temperature = -10°C to +70°C, V<sub>CC</sub> = 5.0V, PA_EN = high, P<sub>OUT</sub> = 21.5dBm using an IEEE802.11n MCS7 waveform unless otherwise noted.</b>
<b>General Tx Performance</b>					
Second Harmonic		-20	-18	dBm/MHz	P <sub>OUT</sub> = 21.5dBm, T=25°C, V <sub>CC</sub> = 5.0V
Third Harmonic		-43	-38	dBm/MHz	
Gain	25	27	29	dB	T=25°C, V <sub>CC</sub> = 5.0V
Gain variation over Temp	-2		+2	dB	
Power Detect Voltage	0.14	0.16	0.18	V	P <sub>OUT</sub> = 0dBm and also when RF = off
Power Detect Accuracy	-2		+2	dB	Into 3:1 VSWR load at T = 25°C
Power Detect Voltage	0.95	1.05	1.20	V	P <sub>OUT</sub> = 21.5dBm
Input Return Loss - Tx_IN pin		-13	-10	dB	In specified frequency band
Output Return Loss at ANT pin		-15	-10	dB	
Operating Current		260	290	mA	At rated 11n P <sub>OUT</sub> , T=25°C, V <sub>cc</sub> = 5.0V
		230	260	mA	At rated P <sub>OUT</sub> 19dBm, T=25°C, V <sub>cc</sub> = 5.0V
Quiescent Current		190		mA	Nominal conditions; no RF applied
Leakage Current		2	10	µA	V <sub>CC</sub> = 5V, PA_EN = low, C_RX = low, LNA_EN = low at 25°C
V <sub>CONTROL</sub> High (PA_EN, C_BT, C_RX, LNA_EN)	2.8	2.9	5.0	V	
V <sub>CONTROL</sub> Low (PA_EN, C_BT, C_RX, LNA_EN)	0		0.2	V	
Turn-on time from PA_EN edge			500	ns	Output stable to within 90% of final gain
Turn-off time from PA_EN edge			500	ns	
Stability	-25		24	dBm	No spurs above -47dBm into 4:1 VSWR
CW P1dB	28.5	29.5		dBm	Tx mode in 50% duty cycle
<b>Rx Performance</b>					<b>Temperature = -10°C to +70°C, V<sub>DD</sub> = 5.0V, C_RX = high, LNA_EN = high</b>
Gain	11.5	14	16	dB	T=25°C, V <sub>DD</sub> = 5.0V
NF		2.3	3.0	dB	In specified frequency band and T=25°C, V <sub>DD</sub> = 5.0V
RX Port Return Loss			-9.6	dB	T=25°C, V <sub>DD</sub> = 5.0V
ANT Port Return Loss			-4	dB	
Input IP3	4	8		dBm	
Input P1dB	-6	-2		dBm	
IDD		10	20	mA	
LNA_EN Control Current		30	50	µA	
<b>Rx Bypass Mode</b>					<b>Temperature = -10°C to +70°C, V<sub>DD</sub> = 5.0V, C_RX = high, LNA_EN = low</b>
Insertion Loss	-8.5	-7.5	-6.5	dB	T=25°C, V <sub>CC</sub> = 5.0V,
RX Port Return Loss			-9.6	dB	T=25°C, V <sub>CC</sub> = 5.0V,
ANT Port Return Loss			-4	dB	
Input IP3	4	8		dB	
Input P1dB	-6	-2		dBm	

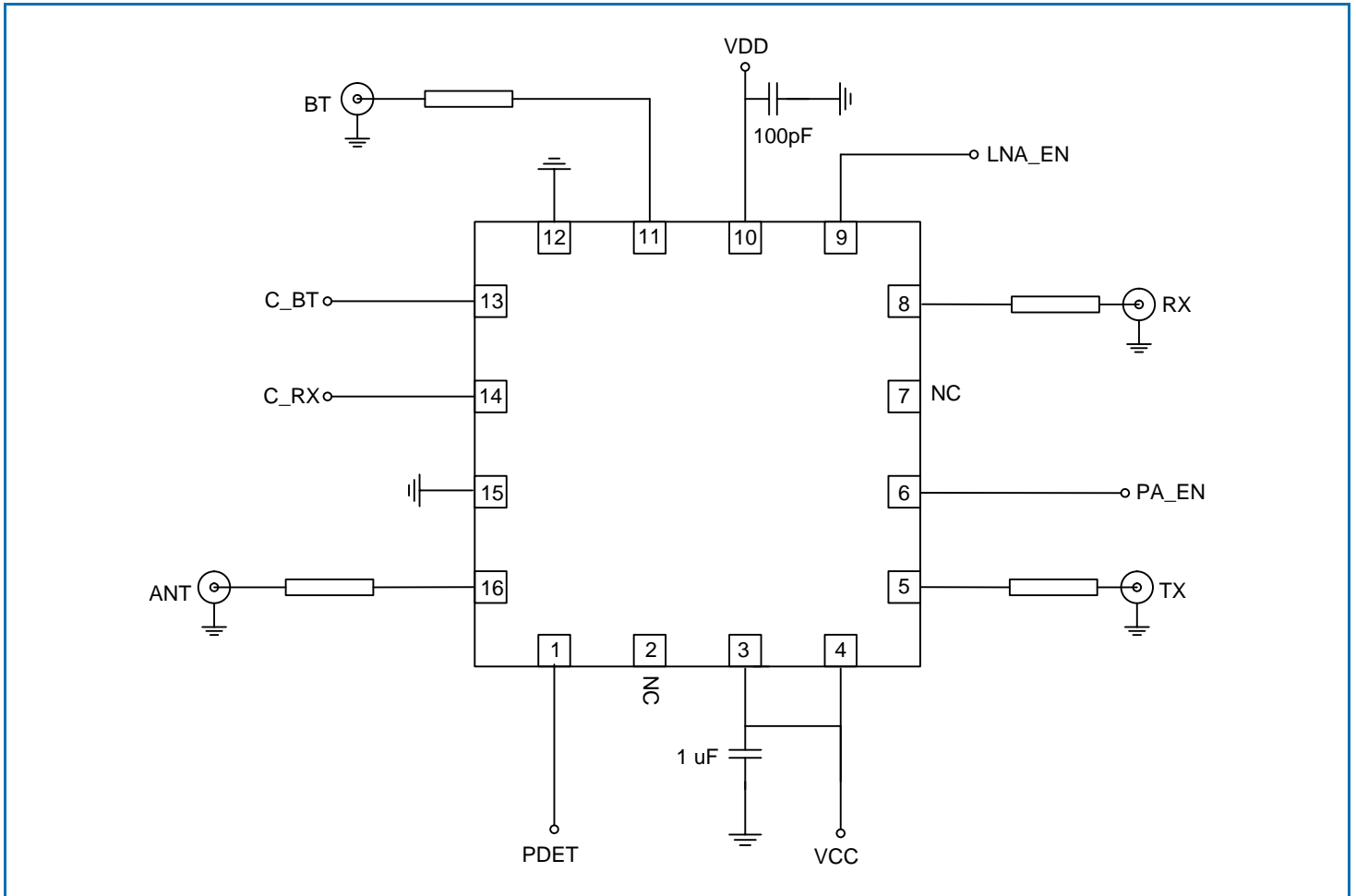
Parameter	Specification			Unit	Condition
	Min	Typ	Max		
<b>General Performance</b>					
Control Current					
C_RX and C_BT Current		0.5	1	μA	
PA_EN Current		30	50	μA	
Switch Control Speed			200	ns	
PA_EN Control Impedance		5.2		MΩ	
LNA_EN Control Impedance		7.4		MΩ	
C_RX Control Impedance		27		MΩ	
C_BT Control Impedance		27		MΩ	
<b>ESD</b>					
Human Body Model	500			V	EIA/JESD22-114A RF pins
	1000			V	EIA/JESD22-114A DC pins
Charge Device Model	250			V	JESD22-C101C all pins
<b>Thermal Resistance</b>					
R <sub>THJ</sub>		46		°C/W	
Junction Temperature T <sub>J</sub>		170		°C	MTTF > 30 years
Maximum Input Power			12	dBm	Into 50Ω, V <sub>CC</sub> = 3.3V, 25°C
			12	dBm	6:1 VSWR, V <sub>CC</sub> = 3.3V, 25°C
			5	dBm	10:1 VSWR, V <sub>CC</sub> = 3.3V, 25°C
<b>Bluetooth</b>					
<b>Temperature = -10°C to +70°C, V<sub>DD</sub> = 3.3 and 5.0V, C_BT = high, unless otherwise noted</b>					
Input/Output Power	25	30		dBm	
Insertion Loss		0.7	0.9	dB	T=25°C
BT Port Return Loss			-9.6	dB	
ANT Port Return Loss			-9.6	dB	
<b>Isolation</b>					
ANT-BT; Tx Mode		18		dB	PA_EN = High, C_BT = Low, C_RX = Low, LNA_EN = Low
ANT-BT; Rx Gain Mode		25		dB	PA_EN = Low, C_BT = Low, C_RX = High,
LNA_EN = High					
ANT-BT; Rx Bypass Mode		20		dB	PA_EN = Low, C_BT = Low, C_RX = High, LNA_EN = Low
ANT-RX; Tx Mode		35		dB	PA_EN = High, C_BT = Low, C_RX = Low, LNA_EN = Low
ANT-RX; BT Mode		25		dB	PA_EN = Low, C_BT = High, C_RX = Low,

## Switch Logic Control Table

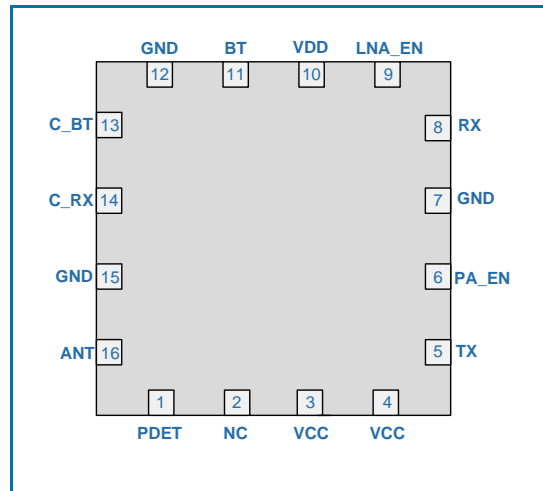
Operating Mode	PA_EN	LNA_EN	C_RX	C_BT
Standby	Low	Low	Low	Low
802.11b/g/n/ac Tx	High	Low	Low	Low
802.11b/g/n/ac Rx Gain	Low	High	High	Low
802.11b/g/n/ac Rx Bypass	Low	Low	High	Low
BT Rx/Tx	Low	Low	Low	High

Note: High = 2.8V to V<sub>CC</sub>, Low = 0V to 0.2V

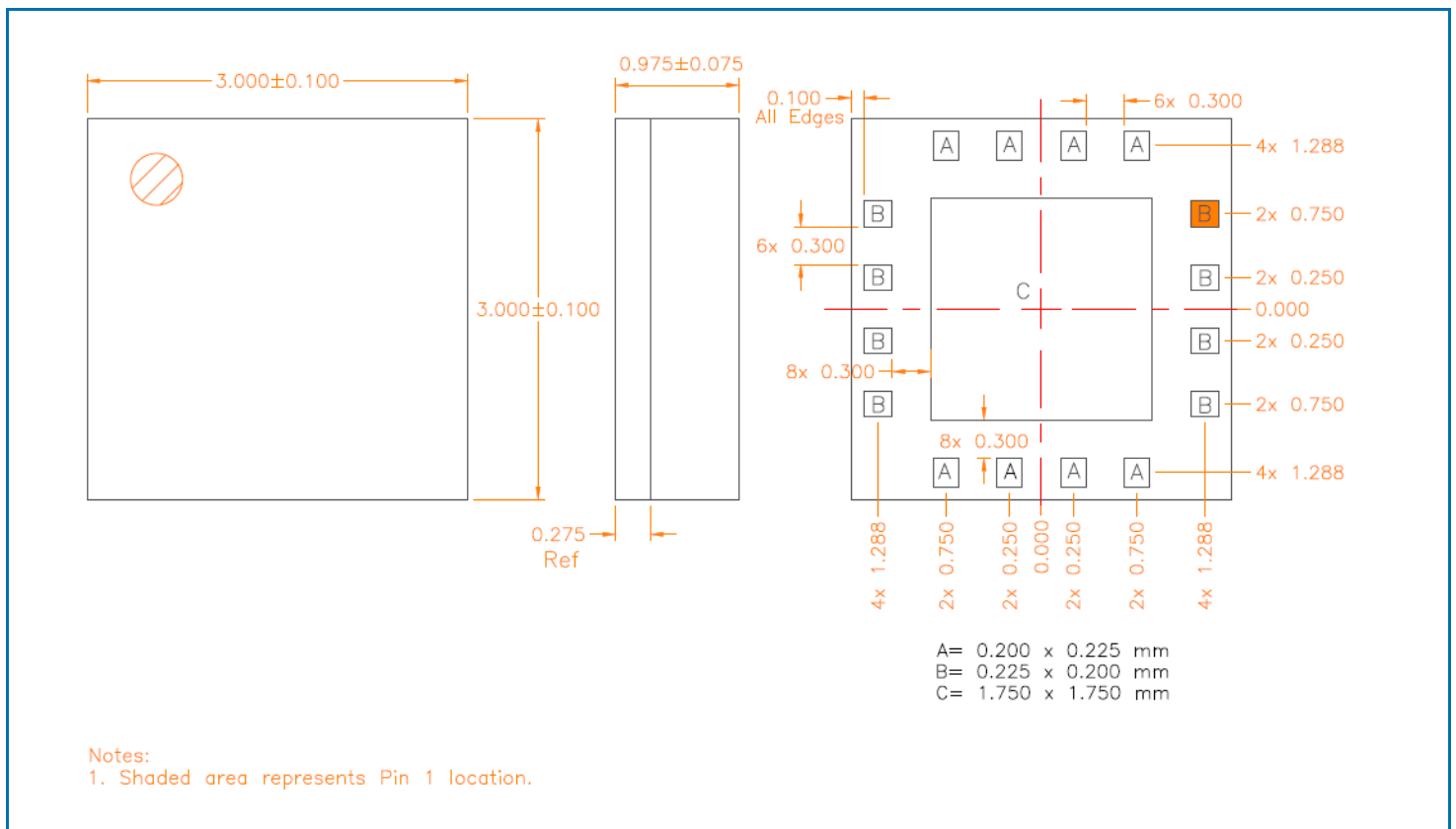
Evaluation Board Schematic



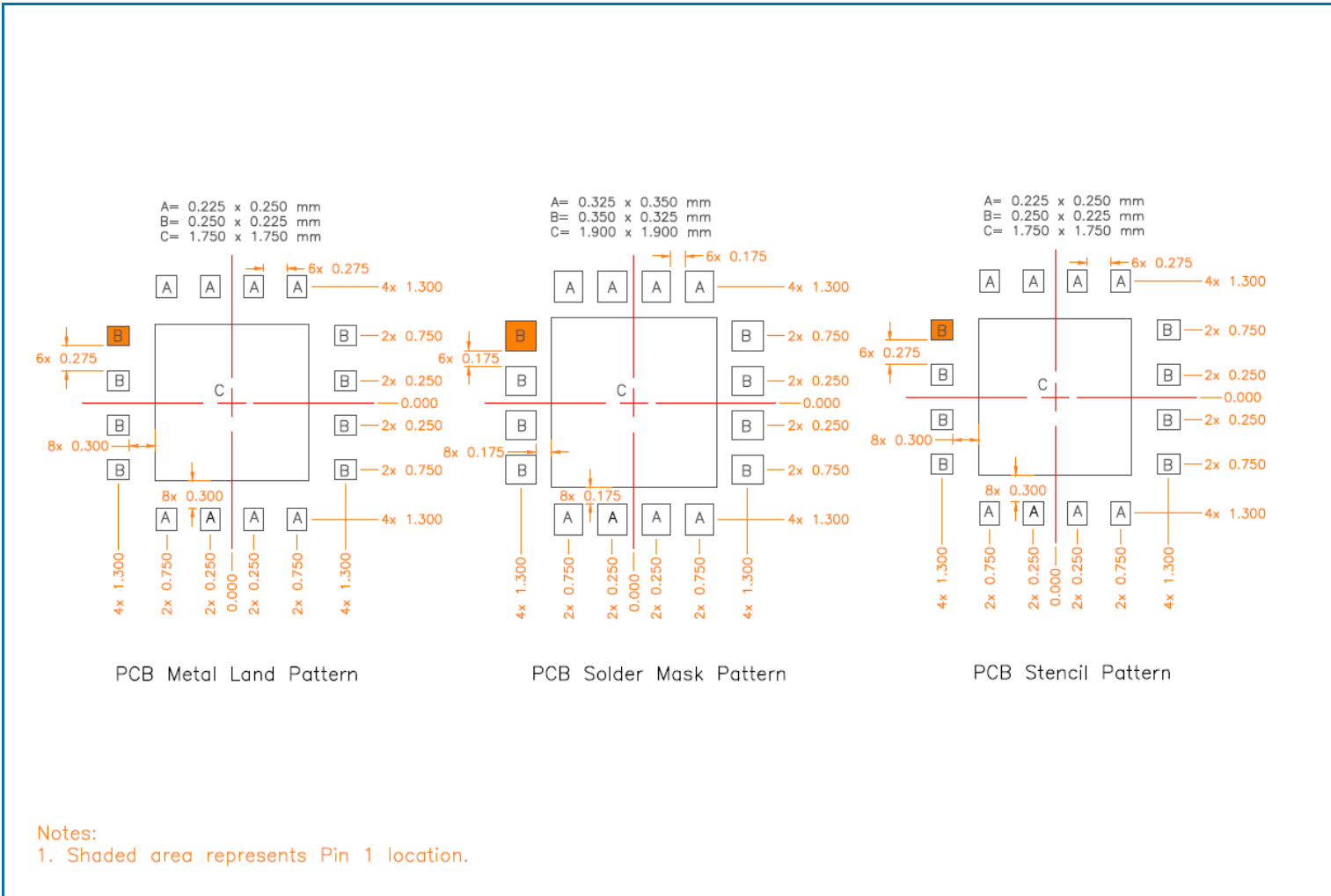
### Pin Out



### Package Drawing



PCB Pattern





## Pin Names and Descriptions

Pin	Name	Description
1	PDET	Power detector voltage for Tx section. PDET voltage varies with output power. May need external decoupling for noise decoupling.
2	NC	No connect pin.
3	VCC	Supply voltage for the PA. See applications schematic for biasing and bypassing components.
4	VCC	Supply voltage for the PA. See applications schematic for biasing and bypassing components.
5	TX	RF input port for the 802.11b/g/n/ac PA. Input is matched to 50Ω and DC block is provided internally.
6	PA_EN	Control voltage for the PA and Tx switch. See truth table for proper settings.
7	NC	No connect pin.
8	RX	RF output port for the 802.11b/g/n/ac LNA. Input is matched to 50Ω and DC block is provided internally.
9	LNA_EN	Control voltage for the LNA. When this pin is set to a LOW logic state, the bypass mode is enabled.
10	VDD	Supply voltage for the LNA. See applications schematic for biasing and bypassing components.
11	BT	RF Bidirectional port for Bluetooth®. Input is matched to 50Ω and DC block is provided internally.
12	GND	Ground connection.
13	C_BT	Bluetooth® switch control pin. See Truth Table for proper level.
14	C_RX	Receive switch control pin. See Switch Truth Table for proper level.
15	GND	Ground connection.
16	ANT	RF bidirectional antenna port matched to 50Ω and is DC blocked internally.
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.