BFP842ESD

BFP842ESD SiGe:C Ultra Low Noise RF Transistor in Low Parts Count 2.4 – 2.5 GHz WLAN LNA Application

(For 802.11 b / g / n Wireless LAN Applications)

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Last Trademarks Update 2011-11-11

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1 Introduction

1.1 Wi-Fi®

The Wi-Fi® function is one of the most important connectivity functions in Access Point (AP) routers, notebooks, smart phones and tablet PCs. Wi-Fi® according to IEEE 802.11b/g/n at 2.4 GHz has been widely implemented over years. Different applications like home entertainment with wireless high-quality multimedia signal transmission, home networking notebooks, mass data storages and printers implement 2.4 – 2.5 GHz Wi-Fi® into their system to offer high-speed wireless connection.

For this kind of high-speed high data rate wireless communication standards it is essential to ensure the quality of the link path. Major performance criteria of these equipments have to be fulfilled: sensitivity, strong signal capability and interference immunity. Below a general application diagram of a WLAN system is shown.

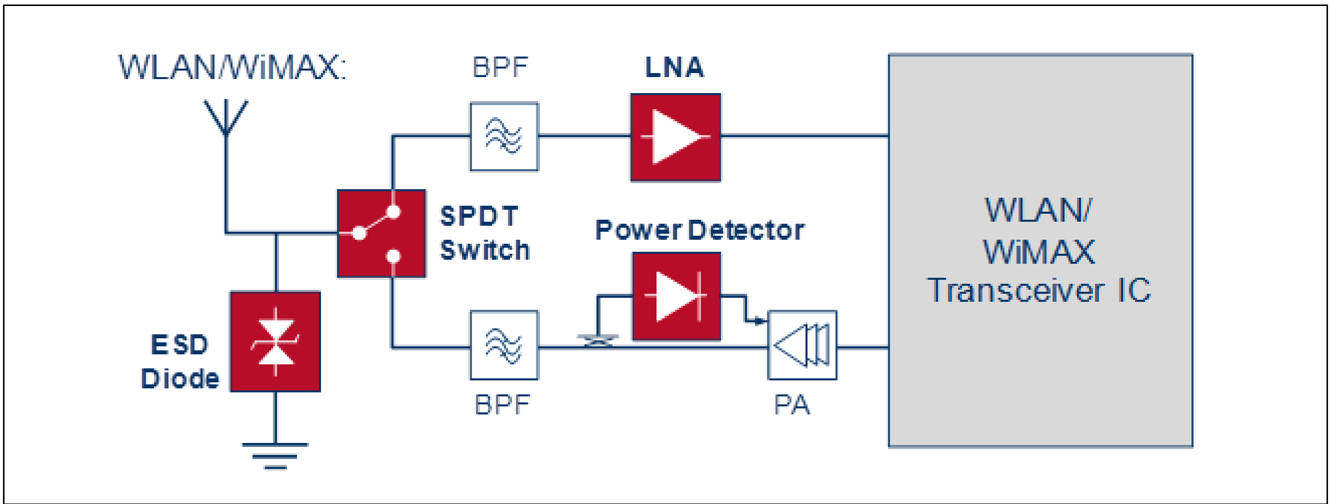

Figure 1 2.4 – 2.5 GHz Wi-Fi® Wireless LAN (WLAN, IEEE802.11b/g/n) Front-End

In order to increase the system sensitivity an excellent low noise amplifier (LNA) in front of the receiver is mandatory, especially in an environment with very weak signal strength and because of the insertion loss of the SPDT switch and the Bandpass Filter (BPF) or diplexer. The typical allowed overall system Noise Figure (NF) of the receiver chain of approx. 2 dB can only be achieved by using a high-gain low noise amplifier. As an example, to increase the sensitivity by 5 dB means doubled link distance.

In addition, strong signal environment can exist when the equipment is next to a transmitter. In that case, the LNA must be linear enough, i.e. have high 1dB compression point. This avoids saturation, degradation of the gain and increased noise figure.

The cloudy wireless environment nowadays makes the wireless system design more complicated. All kinds of interference might introduce signal distortion and reduce the real throughput data rate. To ensure that the low noise amplifier is not interfered by those signals good linearity characteristics like high IP3 are required.

This application note is focusing on the LNA block, but Infineon does also support with RF-switches, TVS-diodes for ESD protection and RF Schottky diodes for power detection.

2 About BFP842ESD

2.1 Device Overview

Infineon Technologies‟ BFP842ESD is a robust, high gain, ultra low noise Silicon-Germanium-Carbon (SiGe: C) HBT device suitable for a wide range of Low Noise Amplifier (LNA) applications. The BFP842ESD is specifically designed and optimized for the 2.4 – 2.5 GHz frequency range in order to reduce external parts count, ease design effort and speed the end-user‟s time-to-market. Unlike some earlier-generation devices of the same general type used for this frequency range, this transistor does not require any external inductive emitter degeneration for impedance matching or stability considerations. BFP842ESD has integrated protection structures to guard against Electro Static Discharge (ESD) events up to 1 kV per Human Body Model (HBM), and these same structures also protect the transistor against damage caused by excessive RF input power levels up to +16 dBm. The device is housed in the industry-standard SOT343 package, which is RoHS-compliant and Halogenfree.

2.2 Pin Assignment of BFP842ESD

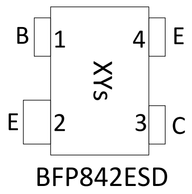

Figure 2 Package and pin Assignment of BFP842ESD

3 BFP842ESD as Ultra Low Noise Amplifier for 2.4GHz WLAN Applications

The circuit shown is a Low Noise Amplifier (LNA) targeted for applications in the 2.4 – 2.5 GHz ISM band, with particular emphasis on Wireless LAN (WLAN) 802.11 b / g / n applications where lowest possible cost, low external parts count, and high receiver sensitivity / long range are primary goals. "0402" case size passives are used in the applications circuit described herein. Potential target applications include Wireless LAN Access Points, laptop PCs, Tablets, Gaming Consoles, etc. Generally, LNA‟s for these applications must be able to switch on & off within about 1 microsecond or less. The charge storage (capacitance) used in this circuit is minimized to reduce on / off times, and this LNA achieves a Turn-On (OFF->ON) switching time of about 390 nanoseconds, and a turn-off (ON->OFF) time of about 40 nanoseconds. The LNA is unconditionally stable over the 10 MHz – 15 GHz frequency range. External parts count (not including BFP842ESD) is 10: 5 capacitors, 3 resistors, and 2 chip inductors. Please refer to schematic diagram, **Figure 3**. At 2.4 GHz, the amplifier achieves about 19.3 dB gain (On-Mode) with a Noise Figure of 0.76 dB. (PCB and SMA losses are subtracted.) The Off-Mode gain is about -17.6 dB.

The circuit achieves an input and output return loss more than 13 dB. At 2400 MHz, using two tones spacing of 1 MHz, the output third intercept point OIP3 reaches 21.9 dBm. Besides, we obtain 1dB input compression point IP1dB of -9.9 dBm at 2400 MHz.

4 Performance Overview

Device: BFP842ESD

Application: BFP842ESD Ultra Low Noise Amplifier for 2.4 GHz - 2.5 GHz WLAN Application

PCB Marking: BFP842ESD SOT343 **M130225**

(PCB designed for 0402 SMDs)

4.1 Summary of Measurement Results

Table 1 Summary of Measurement Results

Parameter	Symbol	Value		Unit	Note/Test Condition
DC Voltage	Vcc	3.0		V	
DC Current	Icc	11.9		mA	
Frequency Range	Freq	2400	2500	MHz	
Gain (On Mode)	G_{ON}	19.3	19.0	dB	
Gain (Off Mode)	G_{OFF}	-17.6	-17.5	dB	
Noise Figure	NF	0.76	0.76	dB	SMA and PCB losses (0.05 dB) are subtracted
Input Return Loss	RLin	13.2	16.6	dB	
Output Return Loss	Rlout	26.6	18.3	dB	
Reverse Isolation	Irev	23.5	23.5	dB	
Input P1dB (On Mode)	$IP1dB_{ON}$	-9.9	-9.0	dBm	
Input P1dB (Off Mode)	$IP1dB_{OFF}$	> 10	> 10	dBm	
Output P1dB (On Mode)	$OP1dB_{ON}$	8.4	9.0	dBm	
Output P1dB (Off Mode)	$OP1dB_{OFF}$	--	--	dBm	
Input IP3	IIP3	2,6	3,7	dBm	
Output IP3	OIP3	21.9	22,7	dBm	Power @ Input: -25 dBm f_1= 2400 MHz, f_2= 2401 MHz f_1' = 2500 MHz, f_2' = 2501 MHz
Stability	k	> 1		--	Stability measured from 10MHz to 15GHz

5 Schematics and Bill-of-Materials

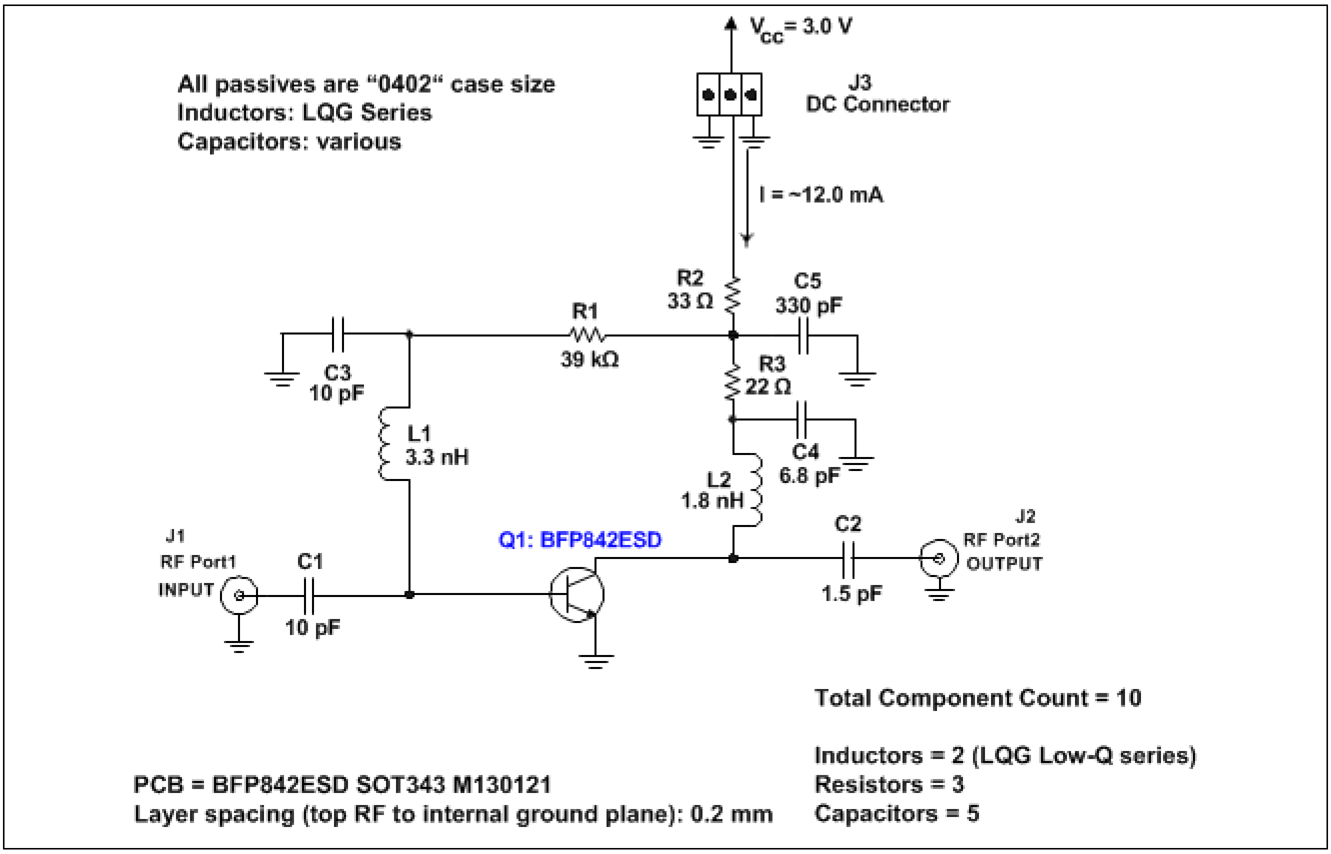

Figure 3 Schematic Diagram of the used Circuit

Table 2 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	10	pF	0402	Various	Input DC block
C2	1.5	pF	0402	Various	Output DC block, output matching
C3	10	pF	0402	Various	Input RF groud, input matching
C4	6.8	pF	0402	Various	RF decoupling / output matching
C5	330	pF	0402	Various	
L1	3.3	nH	0402	LQG	Input matching
R1	39	kΩ	0402	Various	DC biasing
R2	33	Ω	0402	Various	DC biasing
R3	22	Ω	0402	Various	Stability improvement
Q1			SOT 343	Infineon Technologies	BFP842ESD SiGe:C Heterojunction Bipolar RF Transistor

6 Measured Graphs

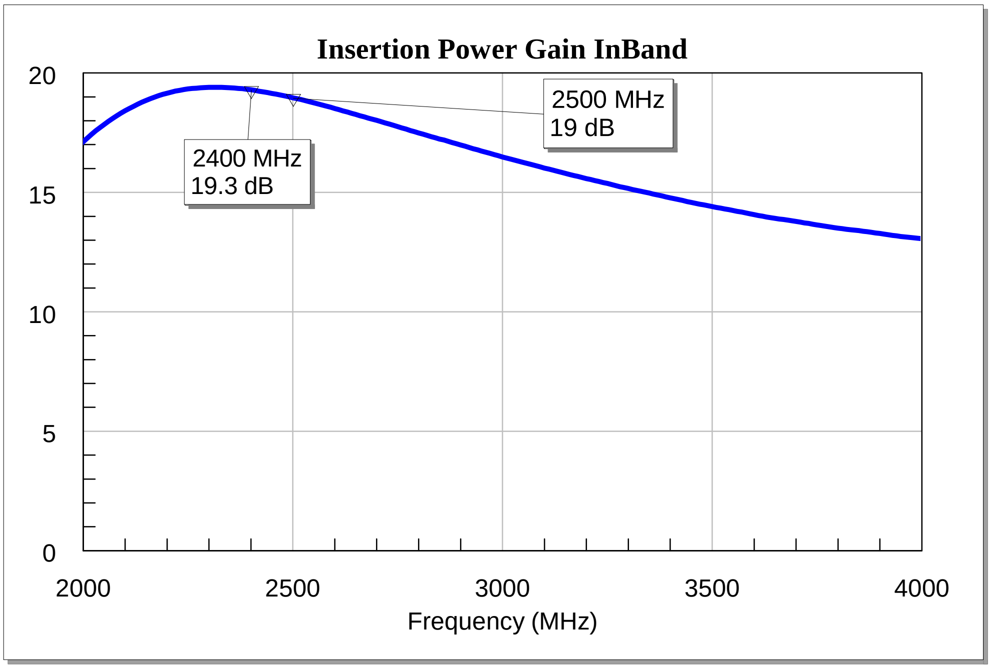

Figure 4 Insertion Power Gain of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

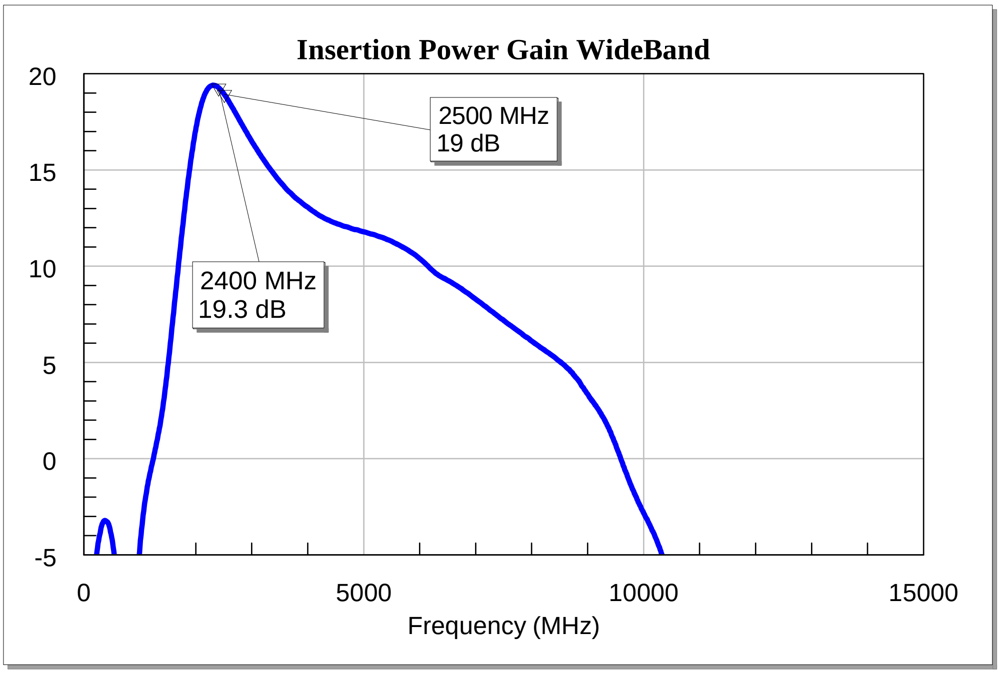

Figure 5 Wideband Insertion Power Gain of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

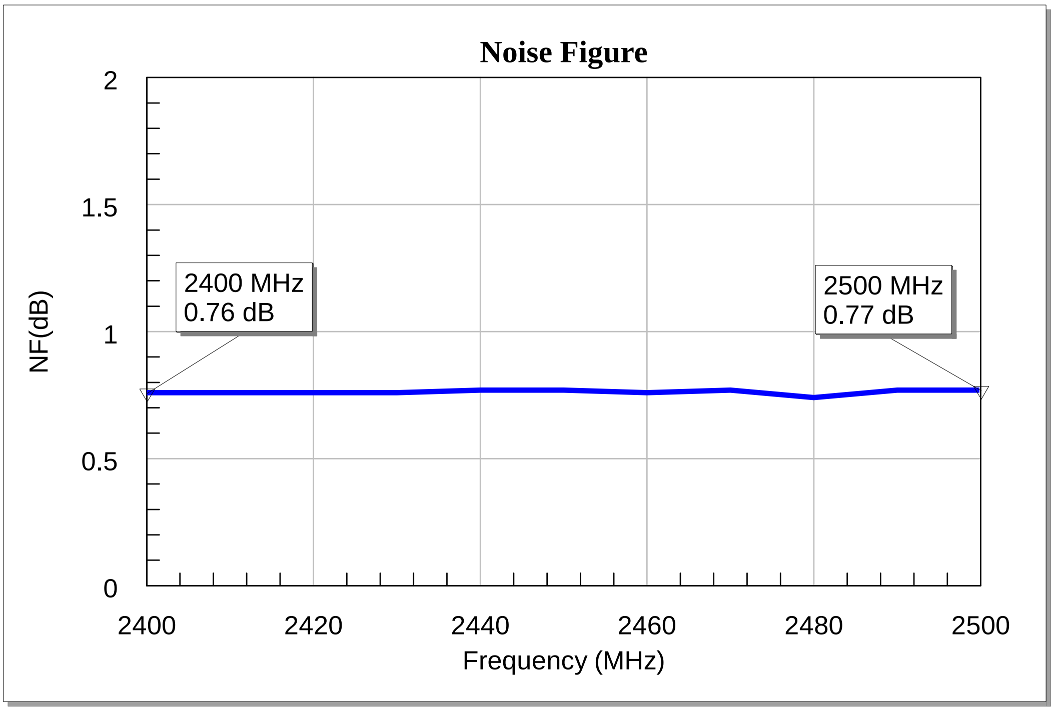

Figure 6 Noise figure of BFP842ESD for 2.4 – 2.5 GHz

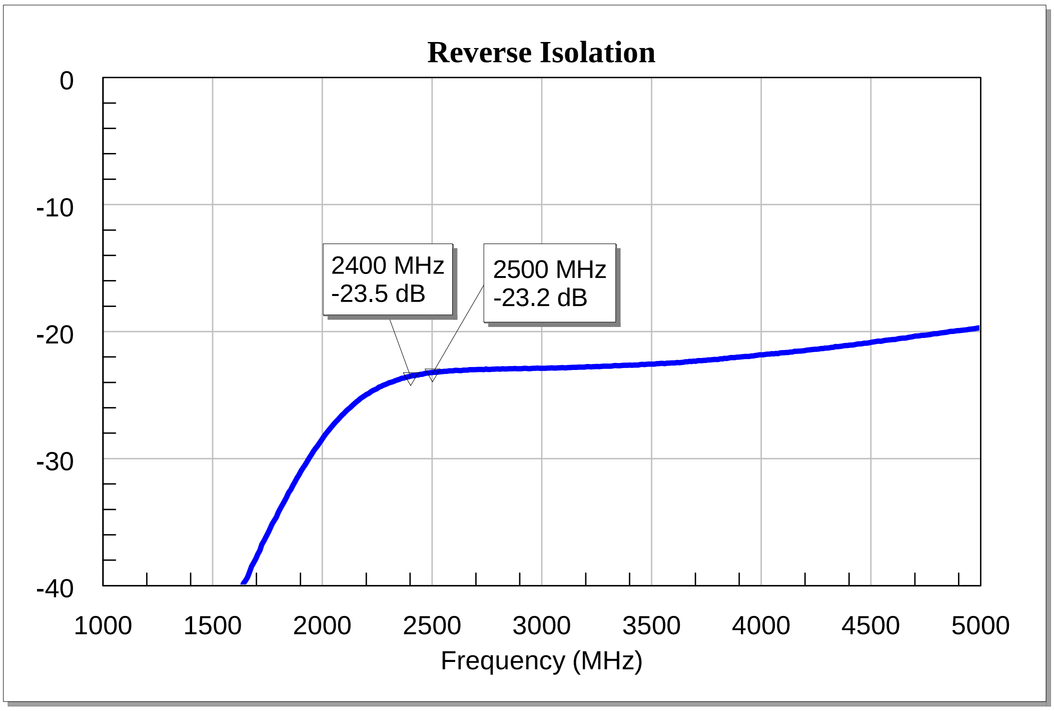

Figure 7 Reverse Isolation of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

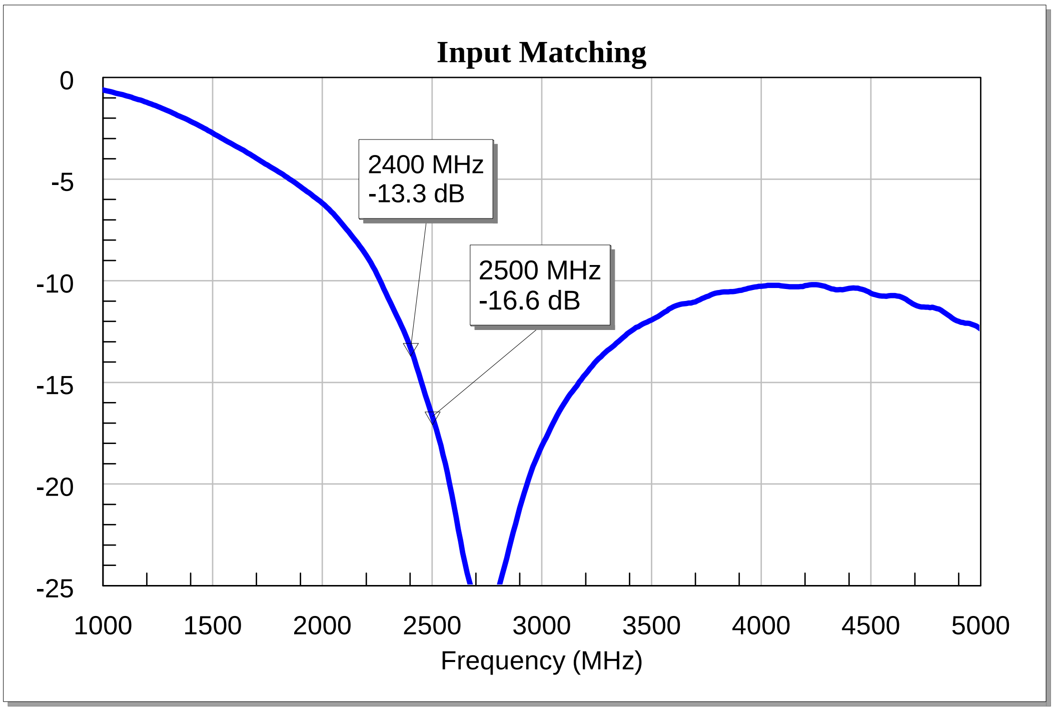

Figure 8 Input Matching of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

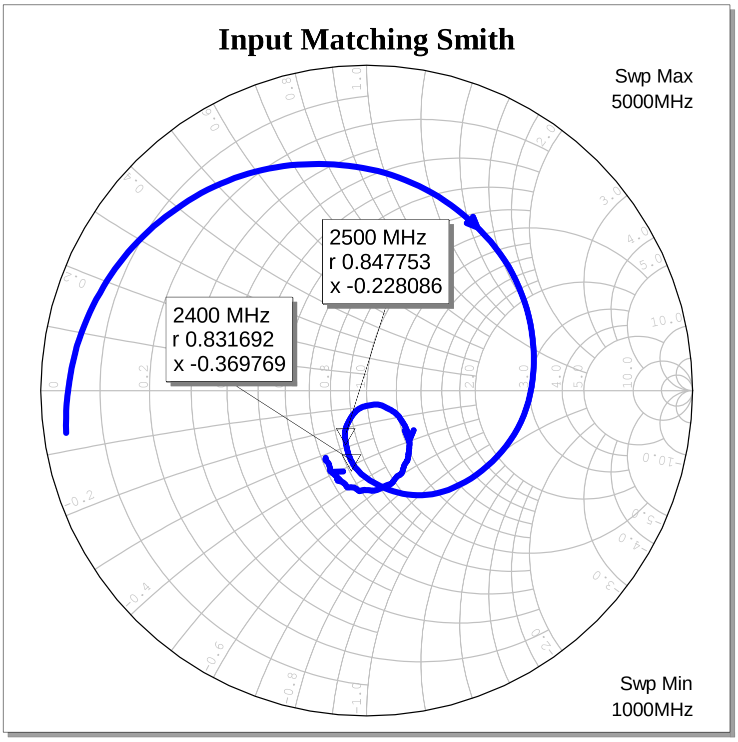

Figure 9 Input Matching of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD (Smith Chart)

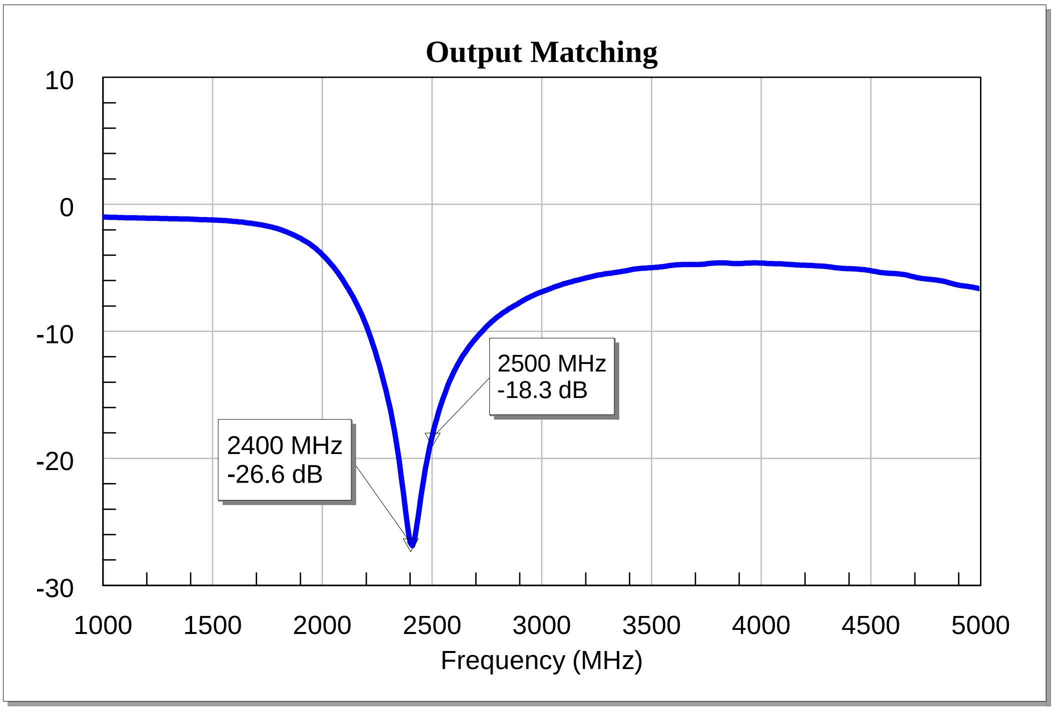

Figure 10 Output Matching of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

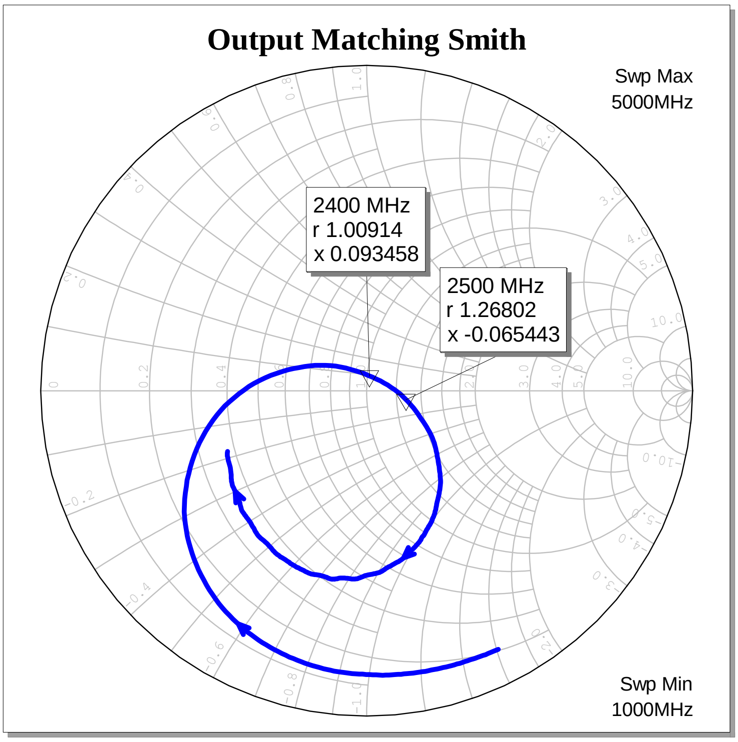

Figure 11 Output Matching of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD (Smith Chart)

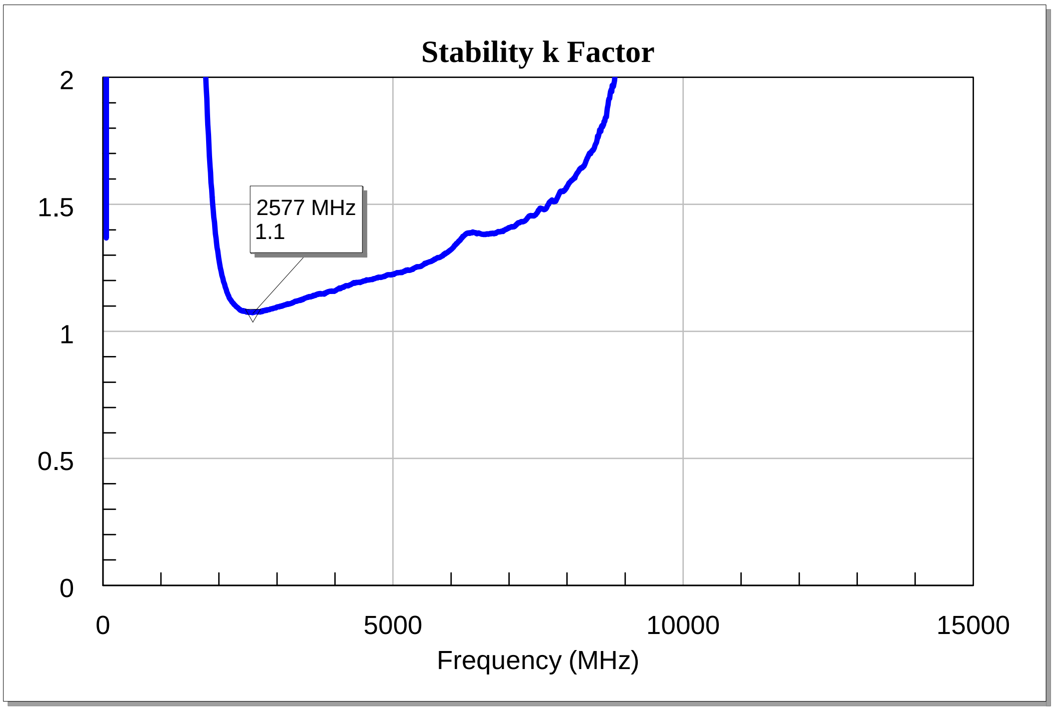

Figure 12 Wideband Stability K Factor of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

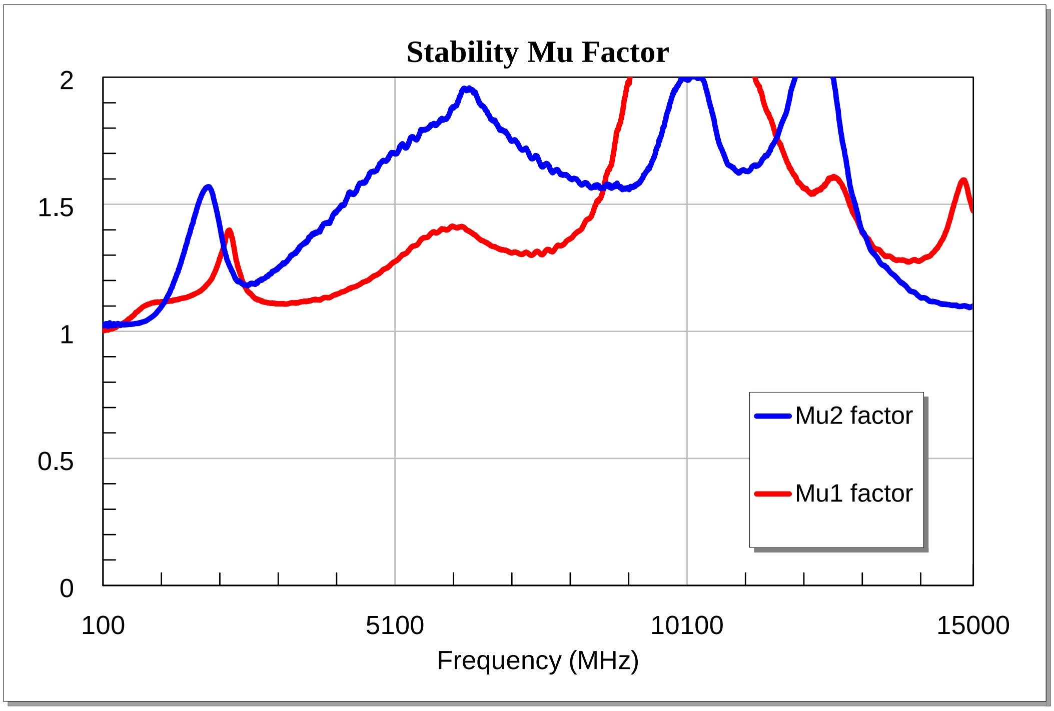

Figure 13 Wideband Stability Mu Factor of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

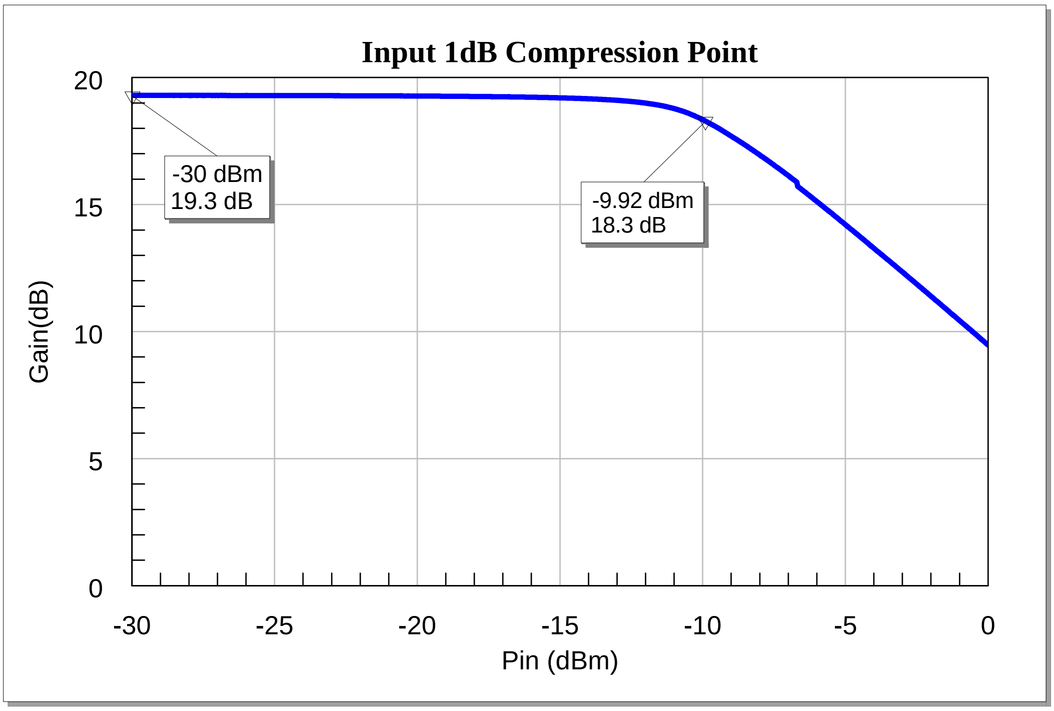

Figure 14 Input 1dB compression point of the BFP842ESD circuit at 2400 MHz

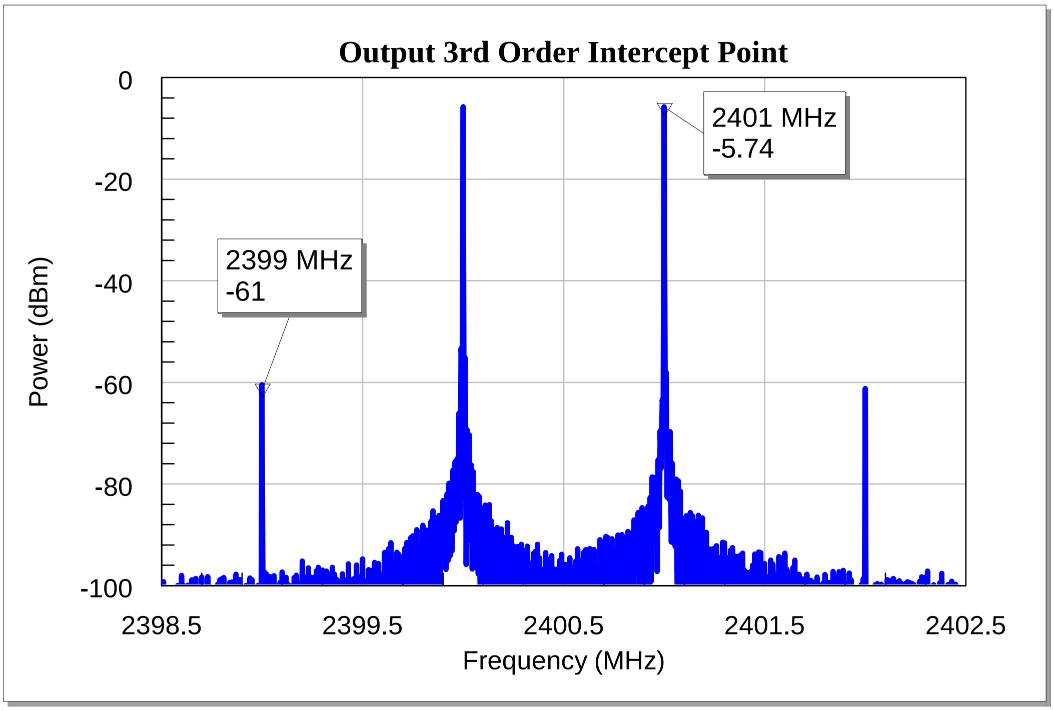

Figure 15 Output 3rd Order Intercept Point of 2.4 GHz WLAN LNA with BFP842ESD

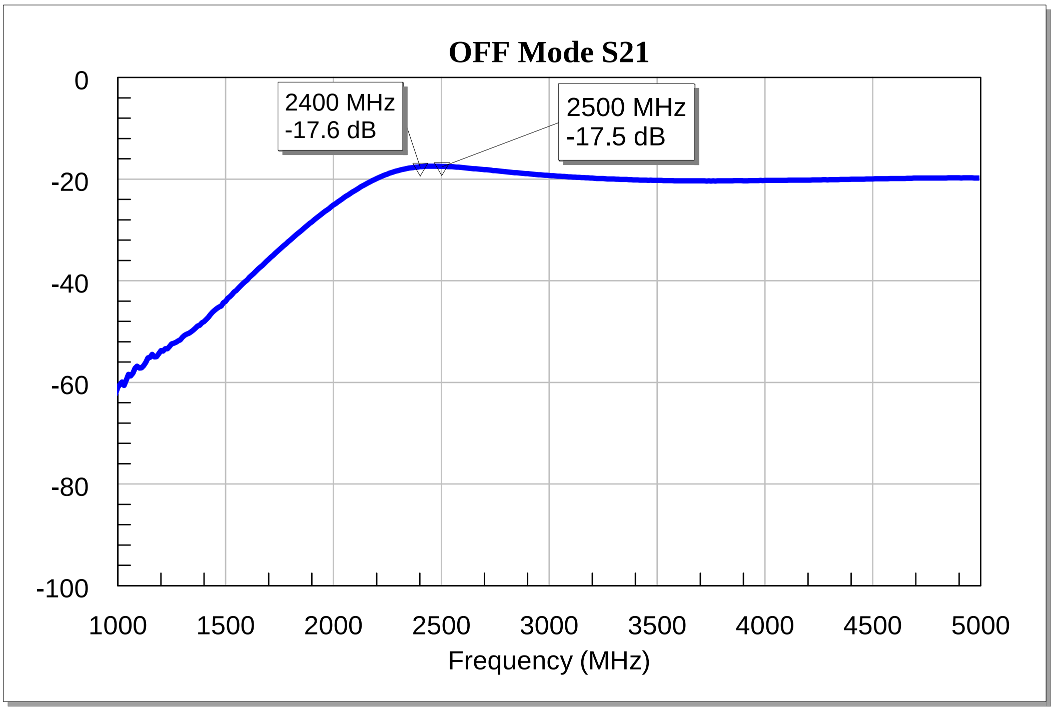

Figure 16 OFF-Mode (Vcc = 0V, Icc = 0mA) S21 of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

7 Evaluation Board and Layout Information

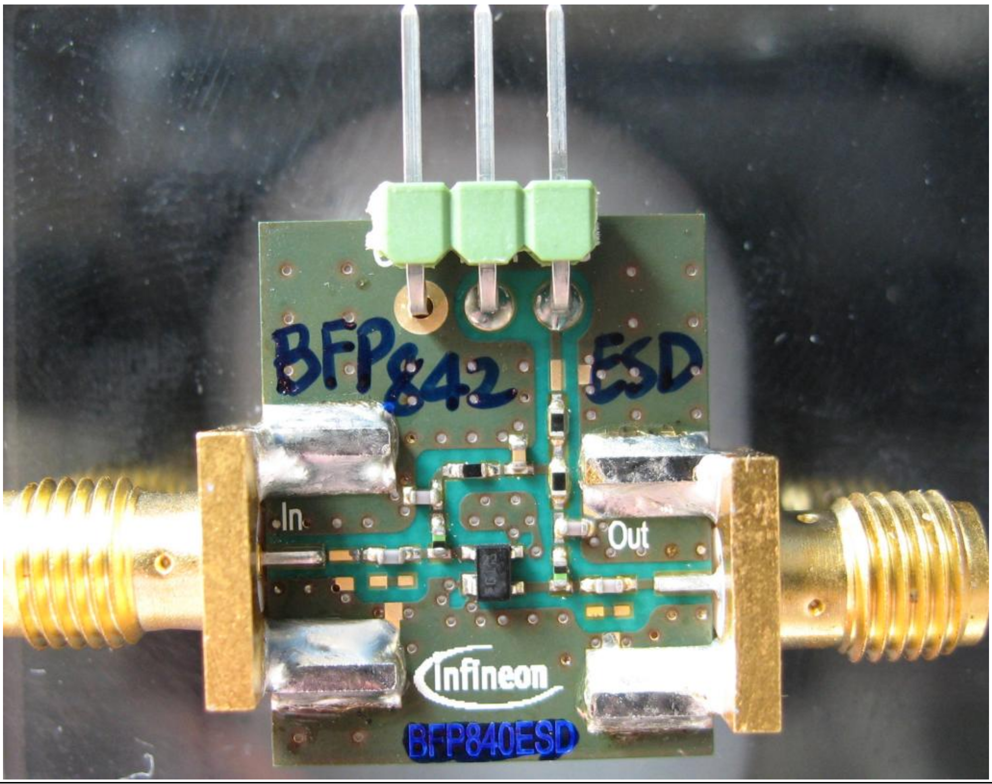

Figure 17 Photo Picture of Evaluation Board for 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

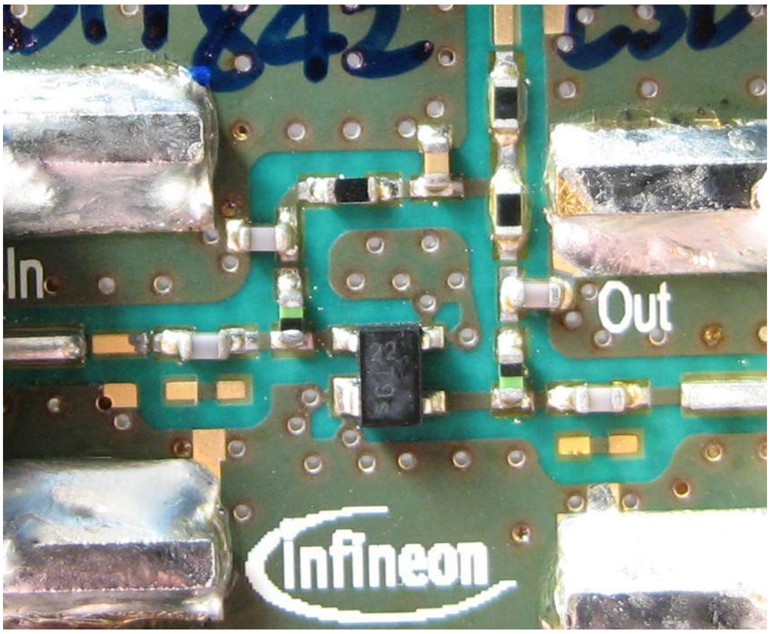

Figure 18 Zoom-In of Photo Picture of Evaluation Board for 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

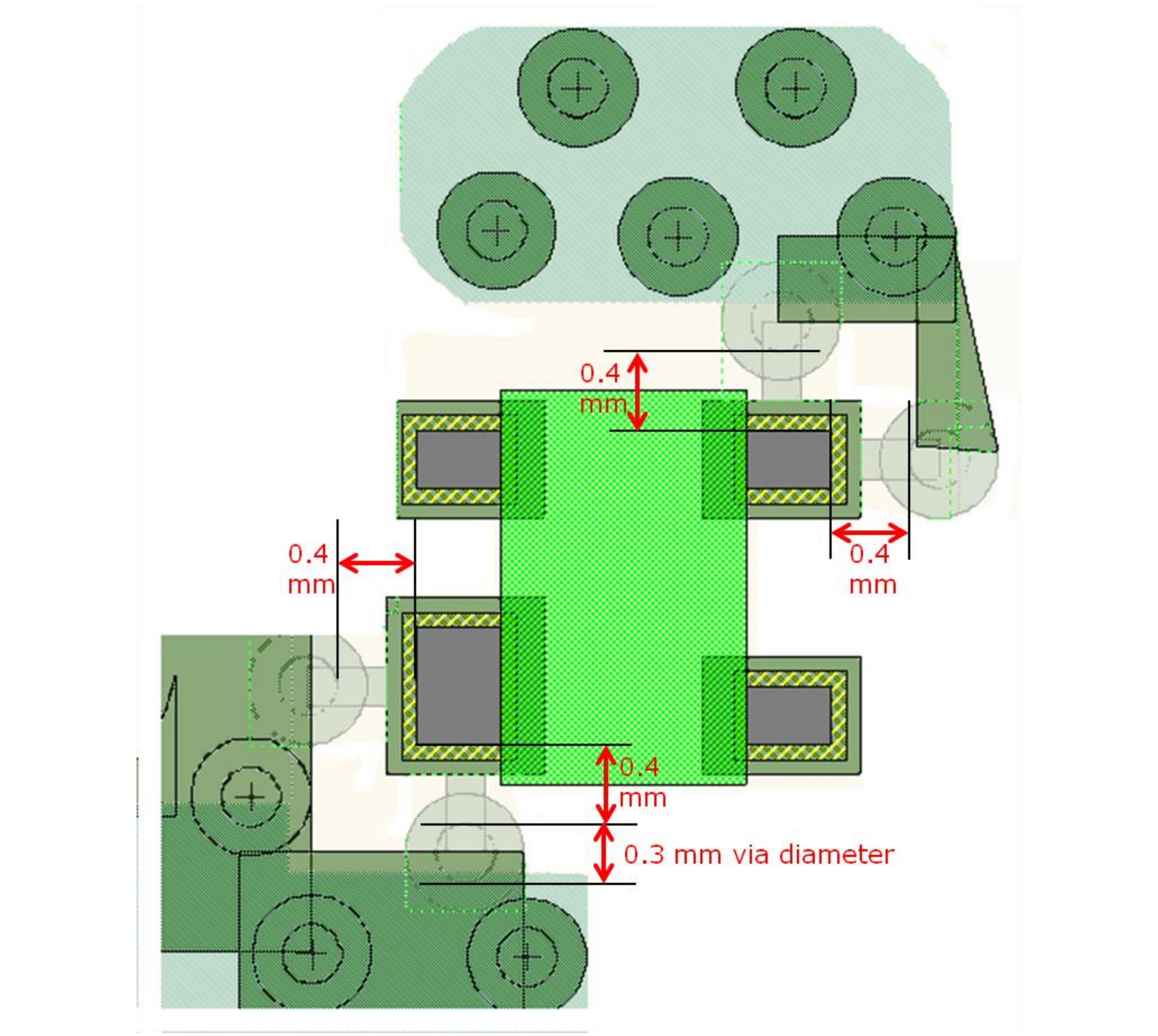

Figure 19 Layout Proposal for RF Grounding of the 2.4 – 2.5 GHz WLAN LNA with BFP842ESD

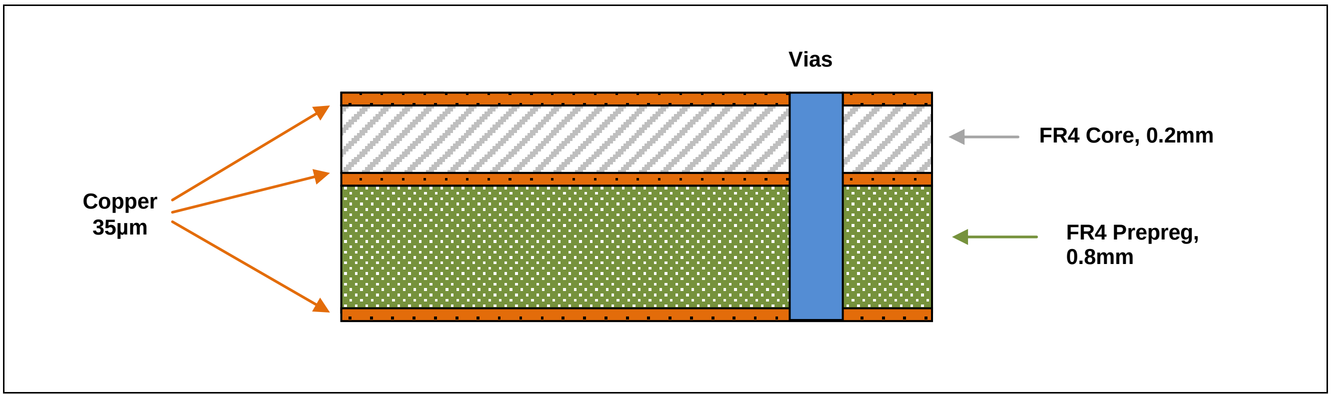

Figure 20 PCB Layer Information

8 Authors

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