BFP843

BFP843 SiGe:C Ultra Low Noise RF Transistor in Dual-Band 2.4 - 2.5 GHz & 5 - 6 GHz WiFi / WLAN Application

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

Application Note AN312

Revision: Rev. 1.0
2013-03-14

RF and Protection Devices

Edition 2013-03-14

Published by
Infineon Technologies AG
81726 Munich, Germany

Legal Disclaimer

The information given in this document shall in no event be regarded as a guarantee of conditions or characteristics. With respect to any examples or hints given herein, any typical values stated herein and/or any information regarding the application of the device, Infineon Technologies hereby disclaims any and all warranties and liabilities of any kind, including without limitation, warranties of non-infringement of intellectual property rights of any third party.

Information

For further information on technology, delivery terms and conditions and prices, please contact the nearest Infineon Technologies Office (**www.infineon.com**).

Warnings

Due to technical requirements, components may contain dangerous substances. For information on the types in question, please contact the nearest Infineon Technologies Office.

Infineon Technologies components may be used in life-support devices or systems only with the express written approval of Infineon Technologies, if a failure of such components can reasonably be expected to cause the failure of that life-support device or system or to affect the safety or effectiveness of that device or system. Life support devices or systems are intended to be implanted in the human body or to support and/or maintain and sustain and/or protect human life. If they fail, it is reasonable to assume that the health of the user or other persons may be endangered.

Application Note AN312
Revision History: 2013-03-14

Previous Revision: No previous revision	
Page	**Subjects (major changes since last revision)**

Table of Content

List of Figures

List of Tables

1 Introduction

1.1 About Wi-Fi® /Wireless LAN (WLAN)

The Wi-Fi® function is one of the most important connectivity functions in notebooks, smart phones and tablet PCs. Wi-Fi is a registered trademark made of the Wi-Fi Alliance created to certify devices for wireless LAN (WLAN) applications based on the IEEE 802.11 standard. The WLAN standard has evolved over the years from its legacy systems known as 802.11-1997, through 802.11a, b, g, and n, to the newest 802.11ac. Today the trend is rapidly changing where Wi-Fi is not only used for high data rate access to internet but also for content consumption such as streaming music and High Definition video on TVs, smart phones, tablets, game consoles etc.

With the requirements on wireless data quality becoming more stringent than ever, the new Wireless LAN standards are being developed by using higher order modulation schemes, wider channels and multiple data streams.

Wi-Fi according to IEEE802.11b/g/n at 2.4 GHz widely implemented over years suffers from interference from other devices such as cordless phones, microwave ovens, Bluetooth devices etc. in the 2.4 GHz space. 802.11a/n operating at 5 GHz has less interference and can transmit data at greater speeds (54 Mbps) but at the cost of reduced range. 802.11n provides enhanced performance and range over prior 802.11 technologies by operating in both the 2.4 GHz and 5 GHz. It adds two significant technologies: MIMO (Multiple input-Multiple output) and 40 MHz channels. With this, data rates up to 600Mbps (for 4 streams) can be achieved in the 5GHz band. To cater to these high throughput requirements, major performance criteria have to be fulfilled: sensitivity, strong signal capability and interference immunity.

The **Figure 1** shows one example of general block diagram of a dual band WLAN system.

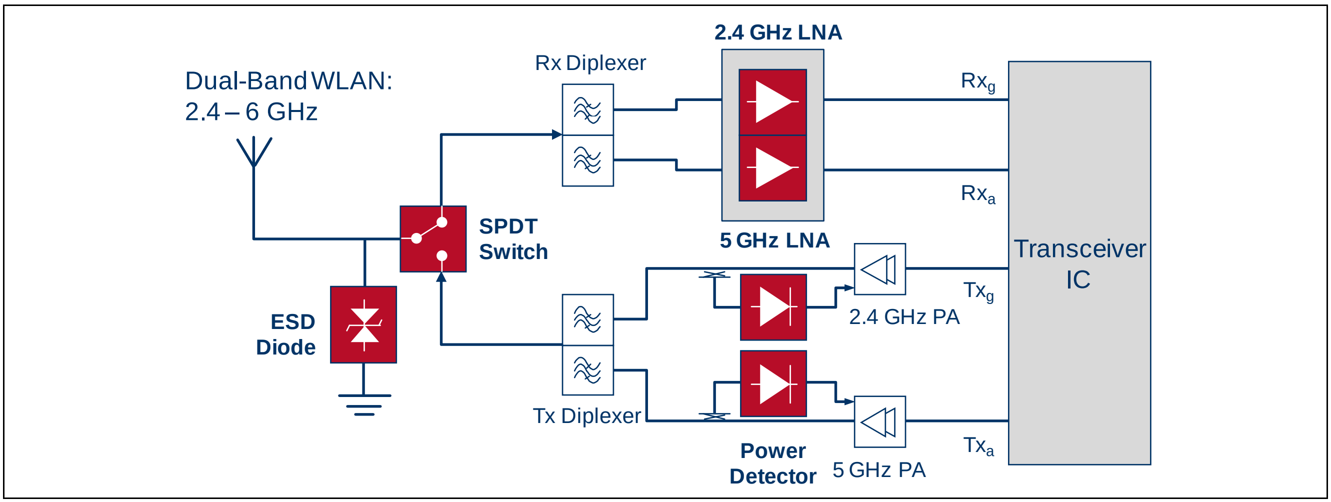

Figure 1 Dual-Band Wi-Fi® Wireless LAN at 2.4 - 2.5 GHz and 5 - 6 GHz

A Wi-Fi router has to receive relatively weak signals from Wi-Fi enabled devices such as mobile phones. Therefore, it should have high sensitivity to detect a weak signal in the presence of strong interfering signals. We can improve the sensitivity of the receiver by using a low noise amplifier (LNA) as a first block of the receiver front end to improve the signal-to-noise ratio (SNR) of the overall system. As an example, an increase in the sensitivity by 5 dB corresponds to nearly double link distance.

WLAN systems are subject to co-channel interference and also interference from strong co-existing cellular signals. High linearity characteristics such as 3rd-order intercept point (IP3) and 1dB compression point (P1dB) are required to improve an application's ability to distinguish between desired signals and spurious signals received close together. This avoids saturation, degradation of the gain and increased noise figure.

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 for WLAN.

2 BFP843 Overview

2.1 Features

- Low noise broadband NPN RF transistor based on Infineon´s reliable, high volume SiGe:C bipolar technology
- High maximum RF input power and ESD robustness
- Unique combination of high RF performance, robustness and ease of use
- Low noise figure: NF_{min} = 1.0 dB at 2.4 GHz and 1.2 dB at 5.5 GHz, 1.8 V, 8 mA
- High gain $|S21|^2$ = 21.5 dB at 2.4 GHz and 15.5 dB at 5.5 GHz, 1.8 V, 15 mA
- *OIP*3 = 23 dBm at 2.4 GHz and 20 dBm at 5.5 GHz, 1.8 V, 15 mA
- Ideal for low voltage applications e.g. V_{CC} = 1.2 V and 1.8 V (2.85 V, 3.3 V, 3.6 V requires corresponding collector resistor)
- Low power consumption, ideal for mobile applications
- Thin small flat Pb-free (RoHS compliant) and halogen-free package
- Qualification report according to AEC-Q101 available

Figure 2 BFP843 in SOT343

2.2 Key Applications of BFP843

As Low Noise Amplifier (LNA) in:

- Wireless Communications: 2.4GHz Wireless LAN IEEE802.11b/g/n, 5-6 GHz Wireless LAN IEEE802.11a/n/ac, WiMAX
- Satellite navigation systems (e.g. GPS, GLONASS, COMPASS...) and satellite C-band LNB (1st and 2nd stage LNA)
- Broadband amplifiers: Dualband WLAN, multiband mobile phone, UWB up to 10 GHz
- ISM bands up to 10 GHz

3 BFP843 as Dual-Band LNA for 2.4 – 2.5 and 5.0 – 6.0 GHz Wireless LAN Applications

3.1 Description

BFP843 is a discrete SiGe:C hetero-junction bipolar transistor (HBT) specifically designed for high performance dual band 2- 6 GHz band low noise amplifier (LNA) solutions for Wi-Fi connectivity applications. This has been developed using Infineon's latest B9HFM technology. The key features of this technology are very high transition frequency (f_T = 80 GHz) and low parasitics, which enable to achieve higher gain and lower noise figure compared to the previous generation RF transistor BFR740L3RH. BFP843 features an integrated on-chip R-C feedback network. The negative feedback reduces the effects of performance variations of the amplifier. The design is therefore less sensitive to variations in PCB layout resulting in an amplifier with broader bandwidth, easier impedance matching and improved stability margin. However the price paid for using negative feedback is slight degradation of noise figure and decrease in gain.

The BFP843 is housed in low-height 1.1mm SOT343 package specially fitting into modules. It is also available in other packages, e.g. BFR843EL3 in TSLP-3-9 and BFP843F in TSFP-4-1 package.

The BFP843 has an integrated 1.5 kV HBM ESD protection which makes the device robust against electrostatic discharge and extreme RF input power. The device offers its high performance at low current and voltage and is especially well-suited for portable battery powered applications in which energy efficiency is a key requirement.

Figure 3 shows the pin assignment of package of BFP843 in the top view:

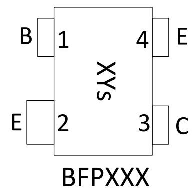

Figure 3 Package and pin connections of BFP843 in Topview

3.2 Performance Overview

Device: BFP843

Application: Dual-Band LNA for 2.4 - 6.0 GHz WLAN Applications

PCB Marking: BFP843 SOT343 **M130130**
(designed for 0402 SMD)

Table 1 Summary of Measurement Results

Parameter	Symbol	Value					Unit	Note/Test Condition
DC Voltage	V_{CC}	3.0					V	
DC Current	I_{CC}	13.8					mA	
Frequency Range	Freq	2400	2500	5100	5500	5900	MHz	
Gain (On Mode)	G_{ON}	19.6	19.4	15.3	14.7	14.2	dB	
Gain (Off Mode)	G_{OFF}	-21.6	-21.7	-27.3	-31.6	-41.5	dB	
Noise Figure	NF	1.06	1.08	1.34	1.36	1.35	dB	SMA and PCB losses (0.05 dB @ 2.4 GHz, 0.1 dB @ 5 GHz) are subtracted
Input Return Loss	RL_{in}	12.0	12.1	25.0	21.4	16.7	dB	
Output Return Loss	RL_{out}	18.1	17.5	28.4	21.0	15.8	dB	
Reverse Isolation	IRev	27.5	27.6	25.8	25.0	24.3	dB	
Input P1dB (On Mode)	$IP1dB_{ON}$	-12.3	-12.5	-8.4	-8.4	-7.4	dBm	
Output P1dB (On Mode)	$OP1dB_{ON}$	6.3	5.9	5.9	5.3	5.8	dBm	
Input IP3	IIP3	-2.1	-3.0	1.4	1.3	1.3	dBm	
Output IP3	OIP3	17.6	17.0	16.7	16.1	15.2	dBm	Power @ Input: -25 dBm
Stability	k	> 1					--	Stability measured from 10MHz to 15GHz

3.3 Schematics and Bill-of-Materials

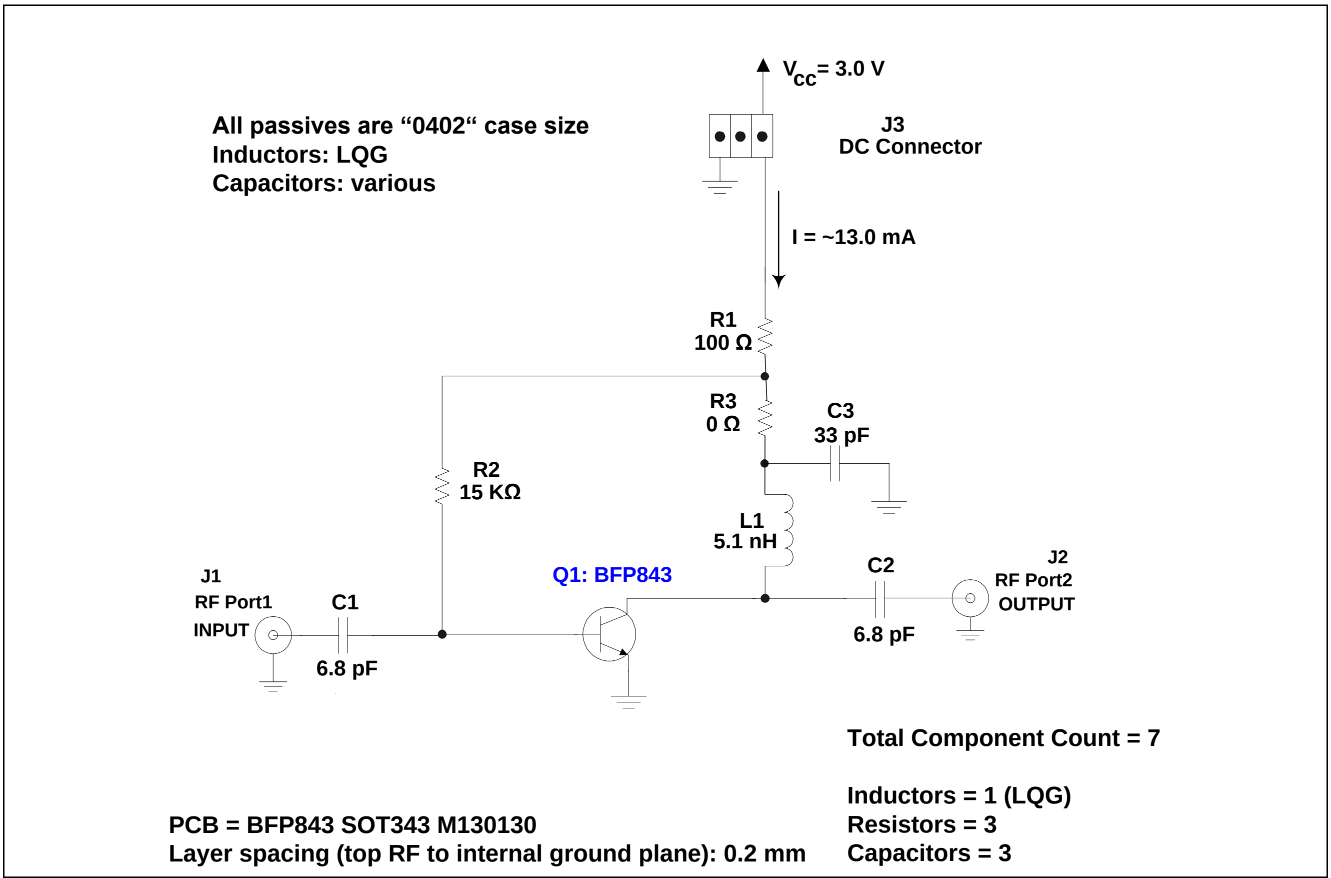

Figure 4 Schematic Diagram of the Application Circuit

Table 2 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	6.8	pF	0402	Various	Input DC block
C2	6.8	pF	0402	Various	Output DC block
C3	33	pF	0402	Various	RF decoupling / blocking cap
L1	5.1	nH	0402	LQG	RF decoupling / Output matching
R1	100	Ω	0402	Various	DC biasing
R2	15	kΩ	0402	Various	DC biasing
R3	0	Ω	0402	Various	Jumper
Q1			SOT343	Infineon Technologies	BFP843 SiGe:C Heterojunction Bipolar RF Transistor

4 Measurement Graphs

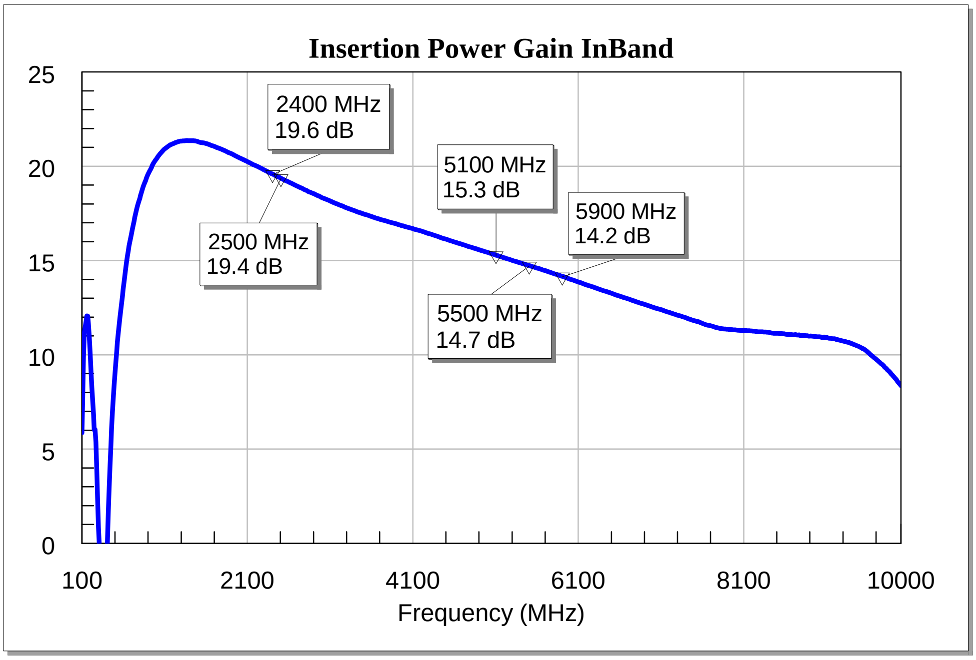

Figure 5 Wideband Insertion Power Gain of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843

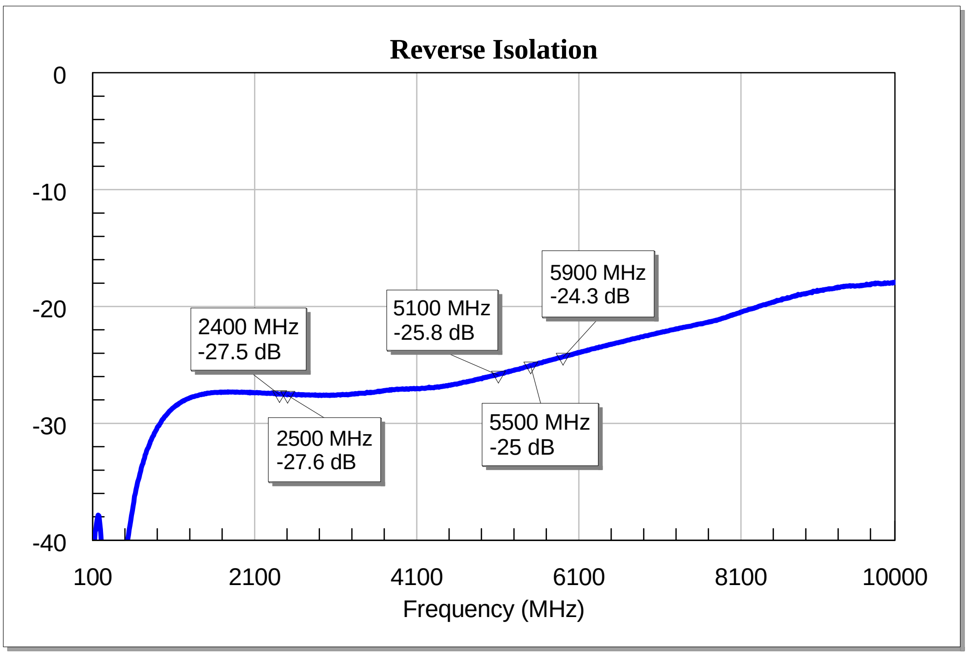

Figure 6 Reverse Isolation of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843

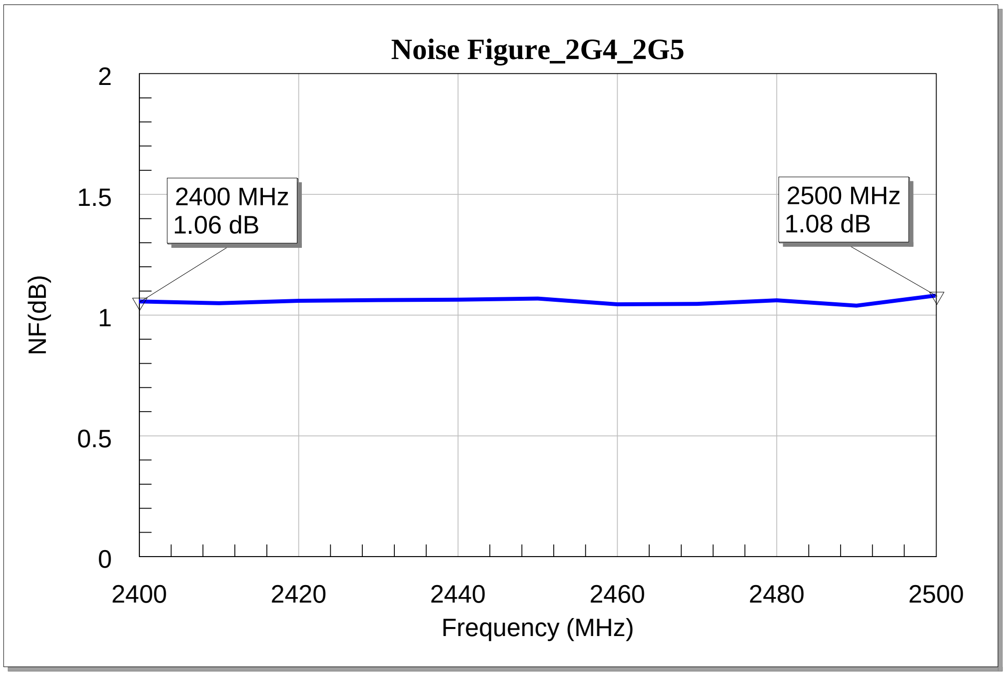

Figure 7 Noise Figure of BFP843 for 2.4 – 2.5 GHz

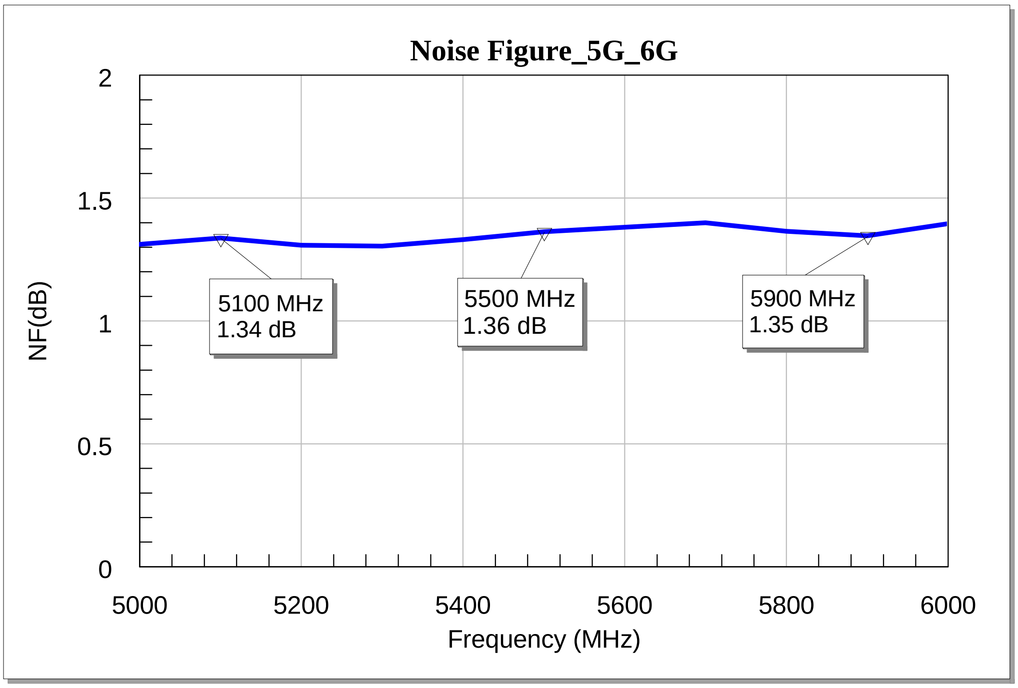

Figure 8 Noise Figure of BFP843 for 5 – 6 GHz

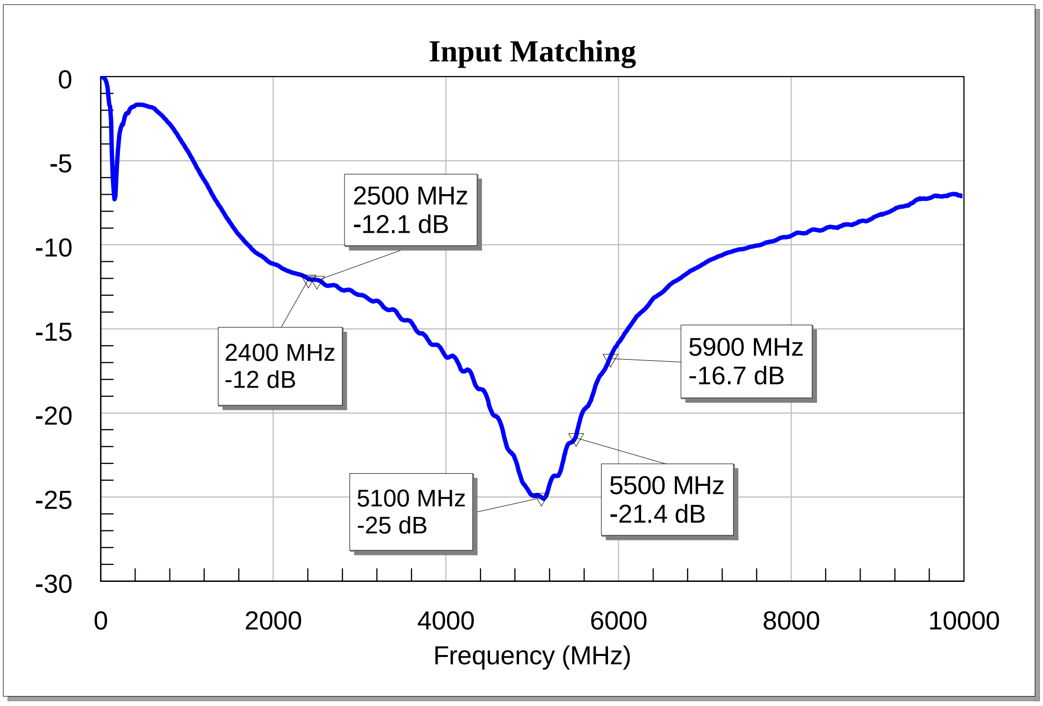

Figure 9 Input Matching of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843

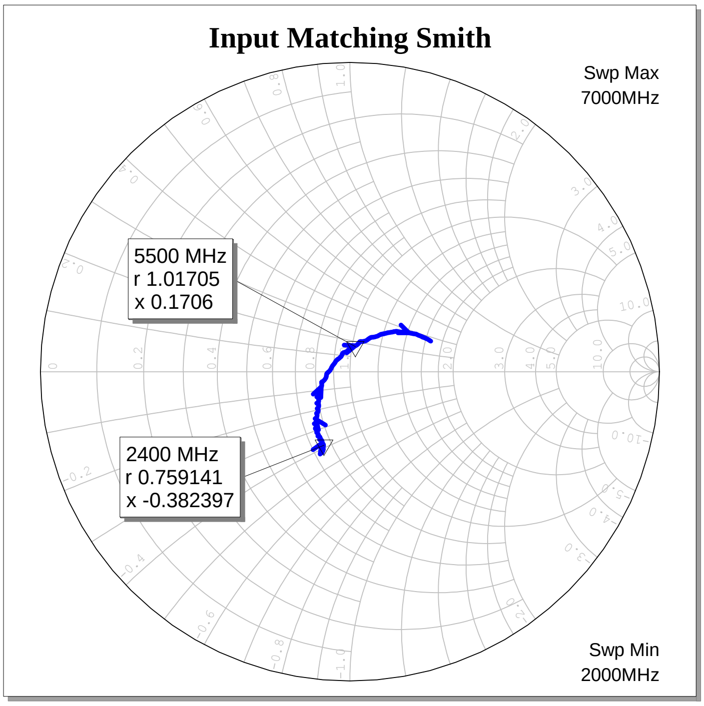

Figure 10 Input Matching of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843 (Smith Chart)

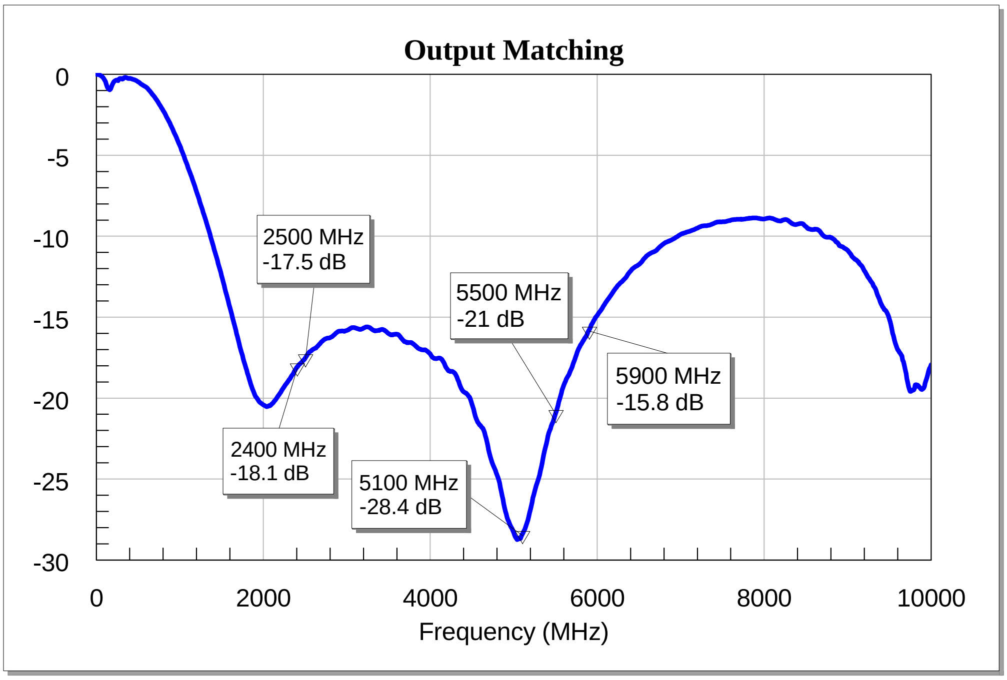

Figure 11 Output Matching of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843

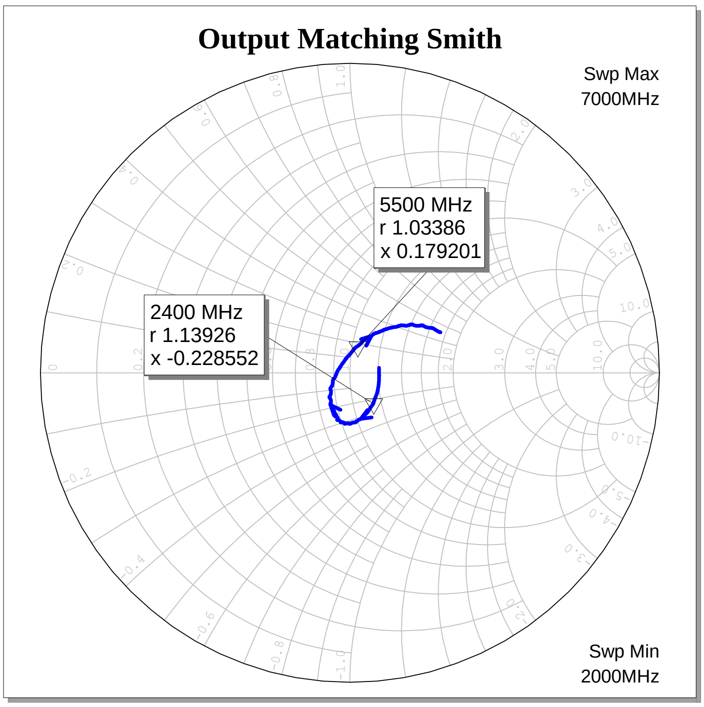

Figure 12 Output Matching of the 2.4 – 2.5 GHz & 5 – 6 GHz WLAN LNA with BFP843 (Smith Chart)

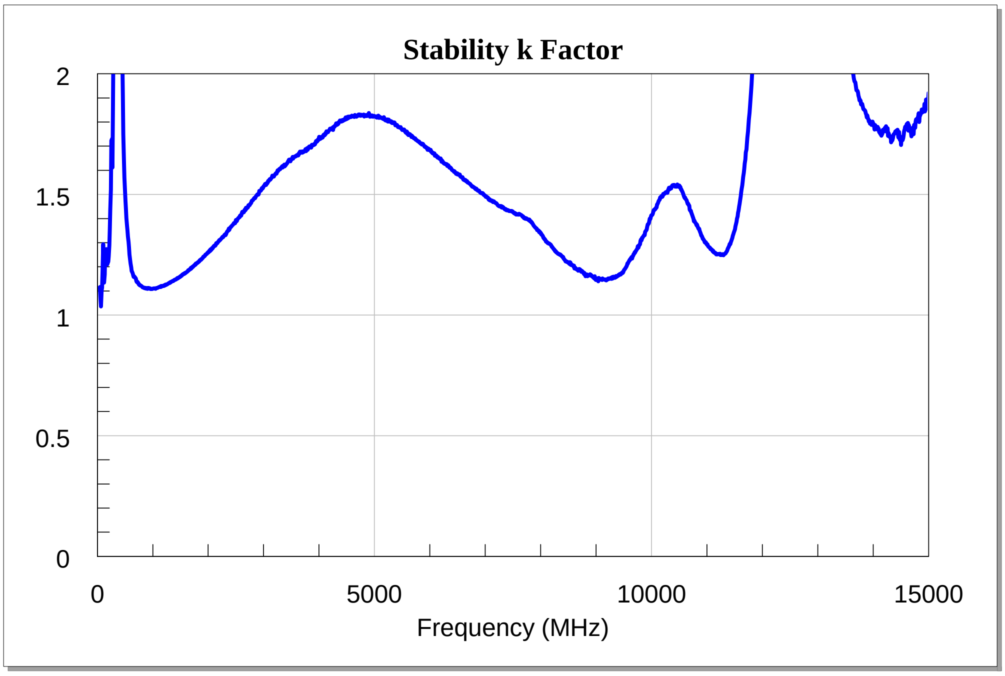

Figure 13 Plot of Broadband Stability k Factor

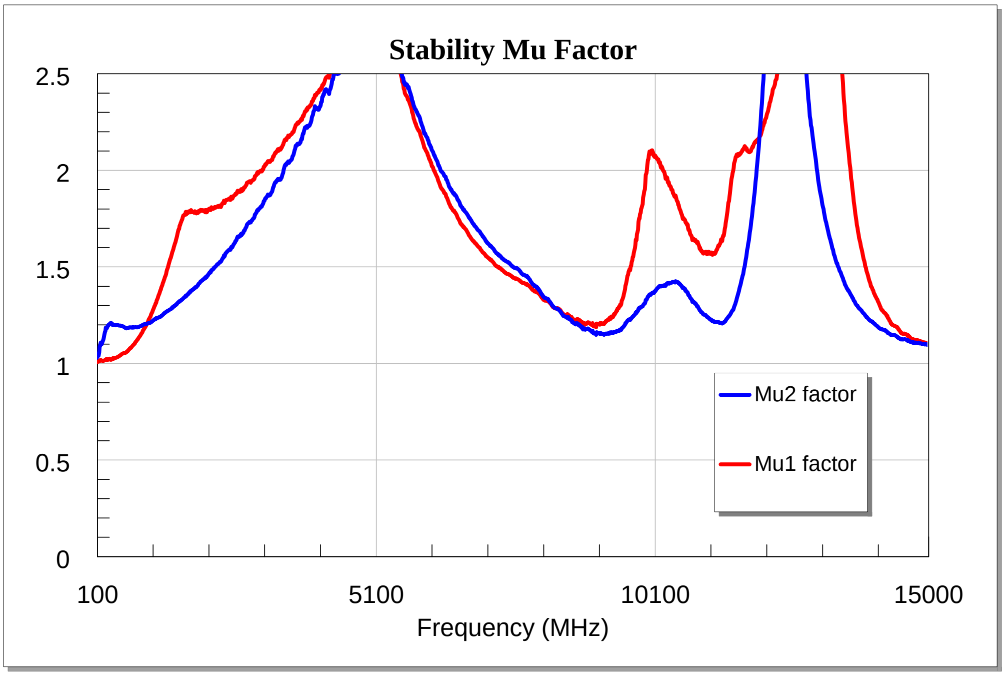

Figure 14 Plot of Broadband Stability μ Factor

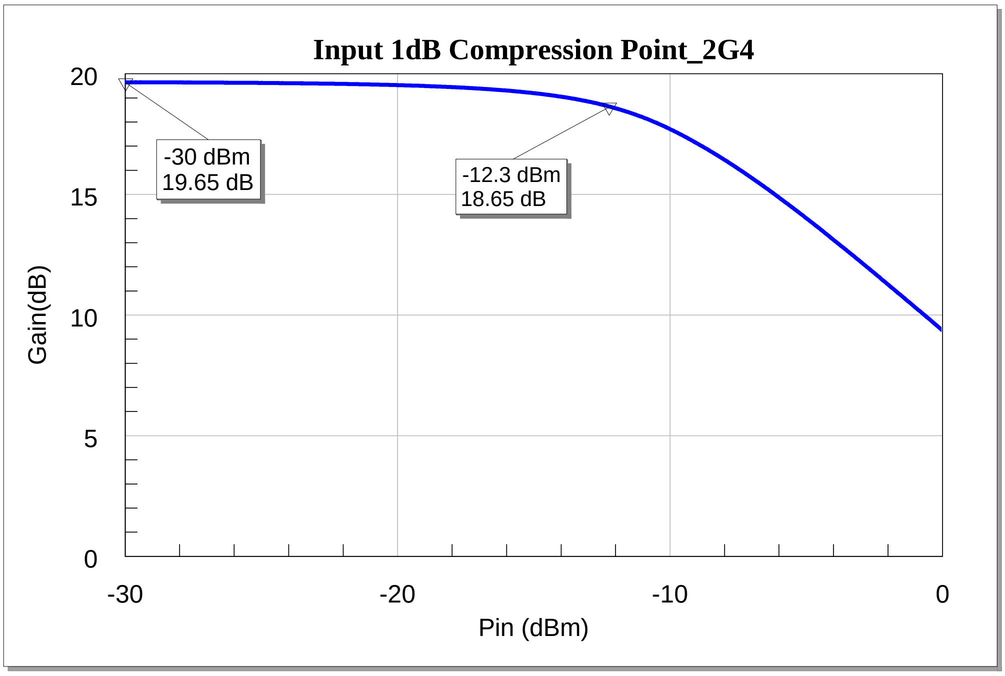

Figure 15 Input 1dB Compression Point of BFP843 Dual-Band WLAN LNA at 2400 MHz

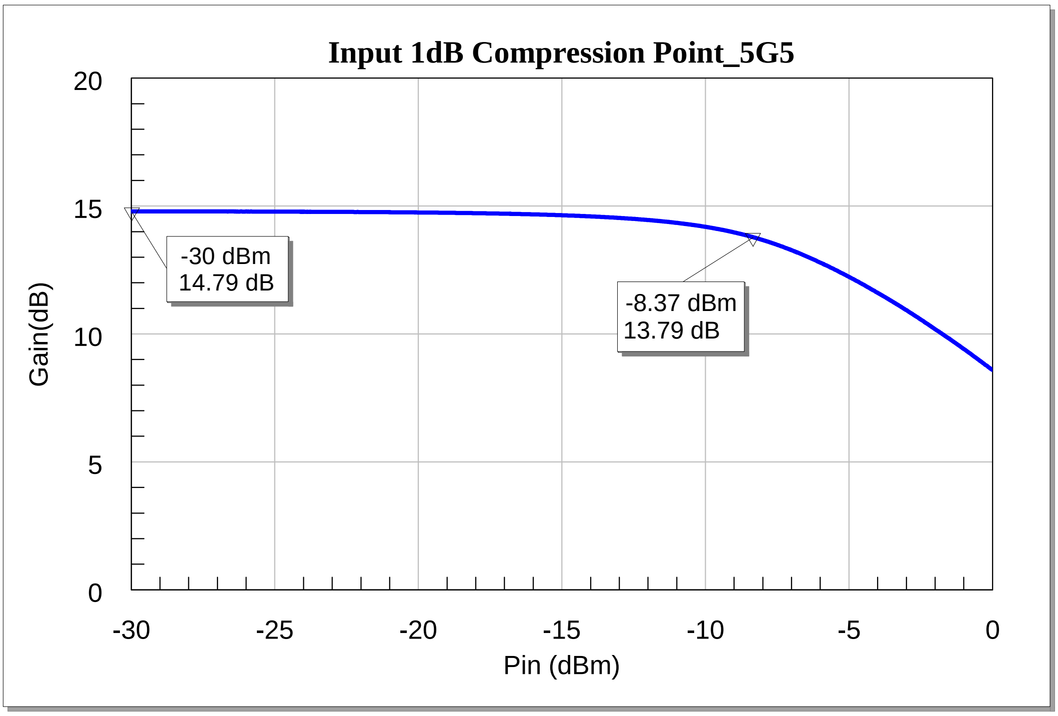

Figure 16 Input 1dB Compression Point of BFP843 Dual-Band WLAN LNA at 5500 MHz

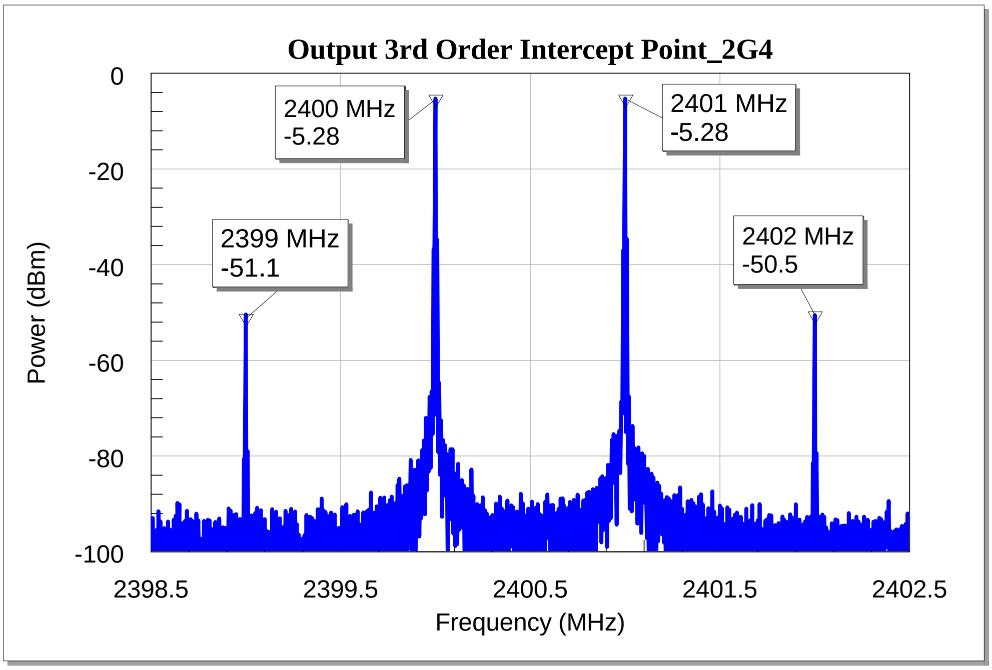

Figure 17 Output 3rd Order Intercept Point of Dual-Band WLAN LNA with BFP843 (at 2.4 GHz)

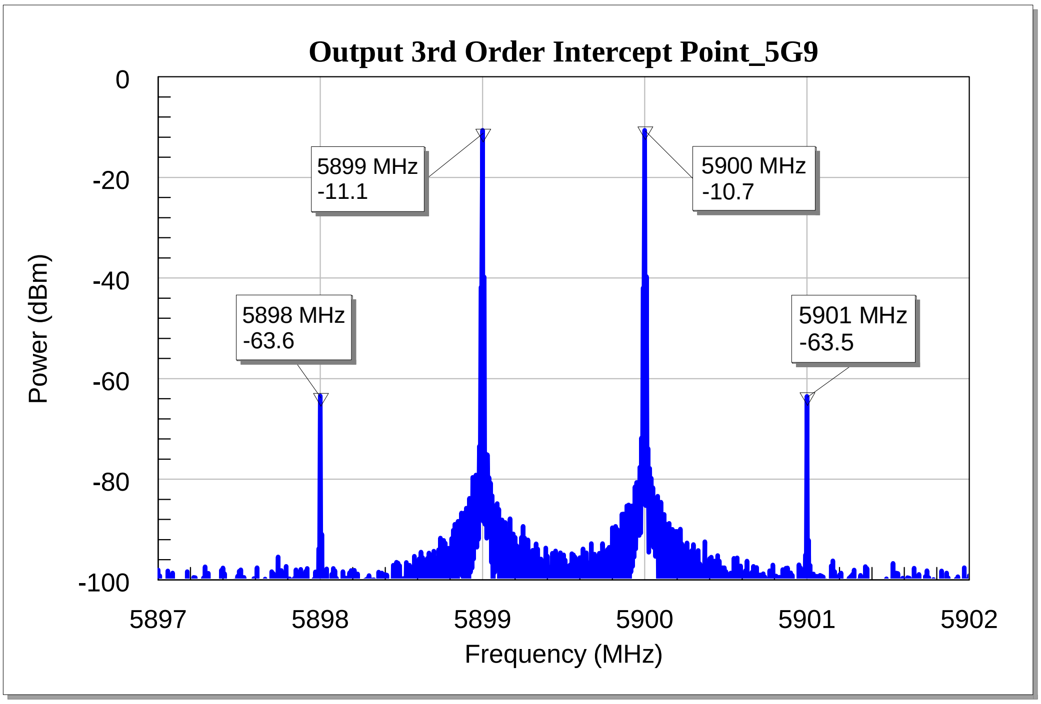

Figure 18 Output 3rd Order Intercept Point of Dual-Band WLAN LNA with BFP843 (at 5.5 GHz)

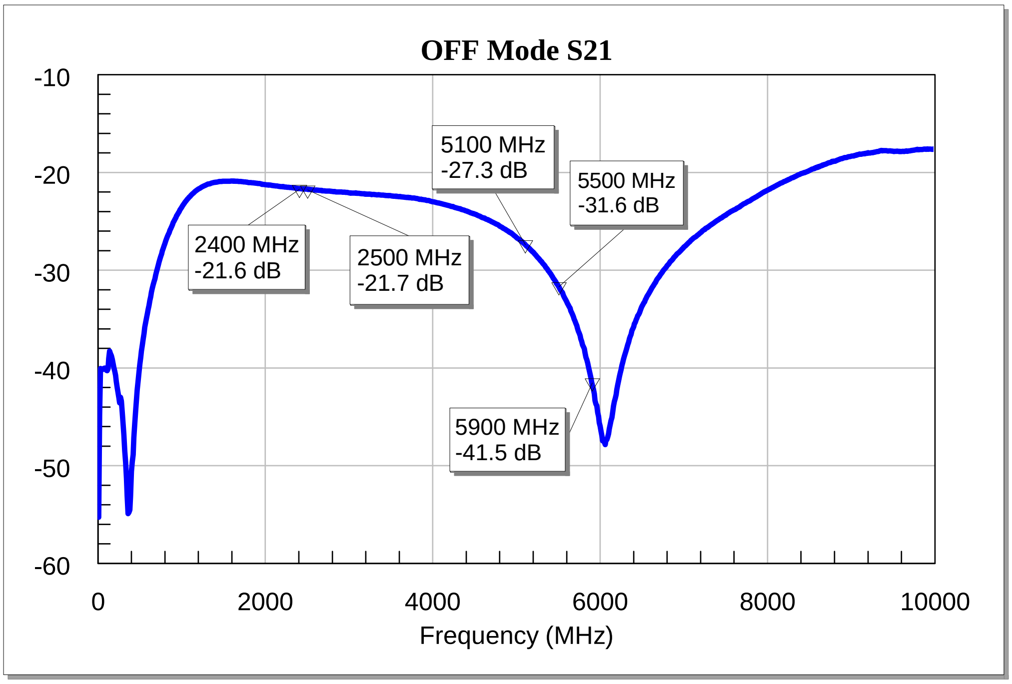

Figure 19 OFF-Mode (Vcc = 0V, Icc = 0mA) S21 of Dual-Band WLAN LNA with BFP843

5 Evaluation Board and Layout Information

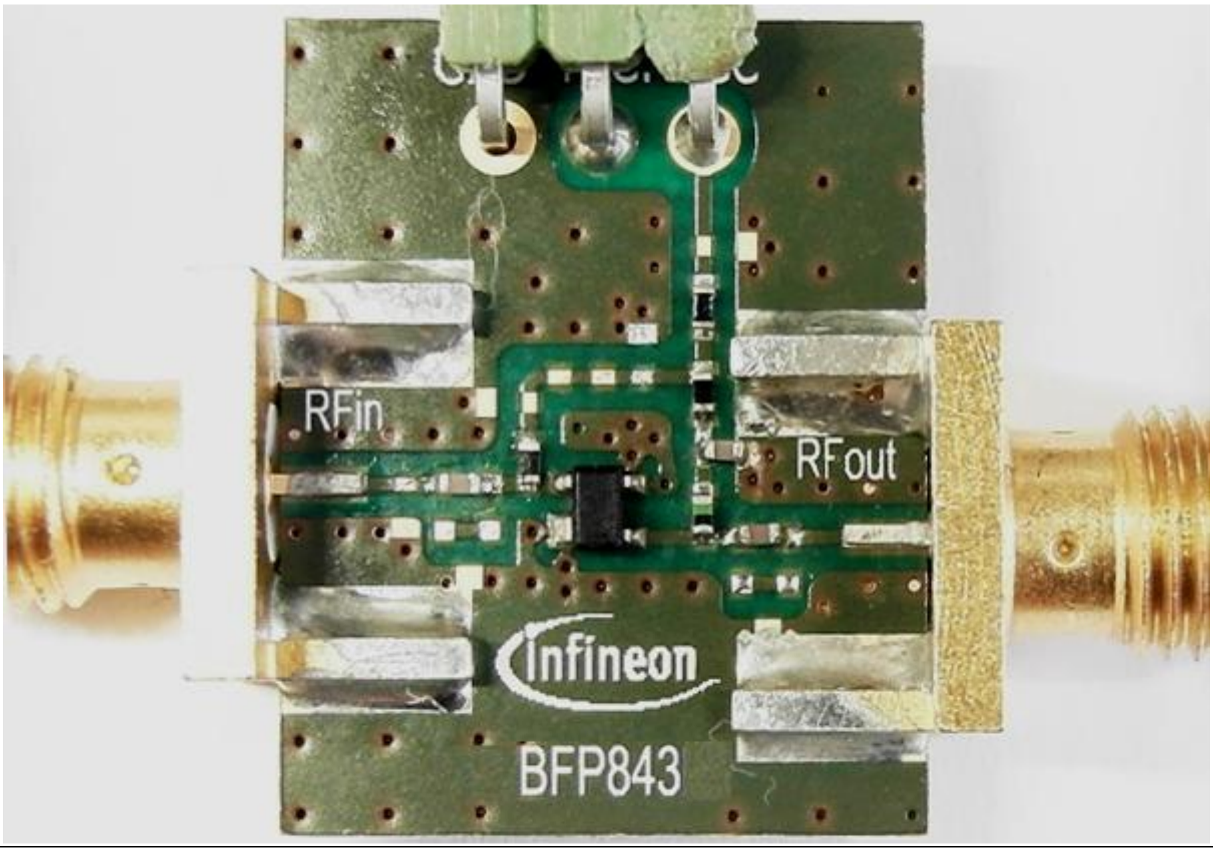

Figure 20 Photo Picture of Evaluation Board of Dual-Band WLAN LNA with BFP843

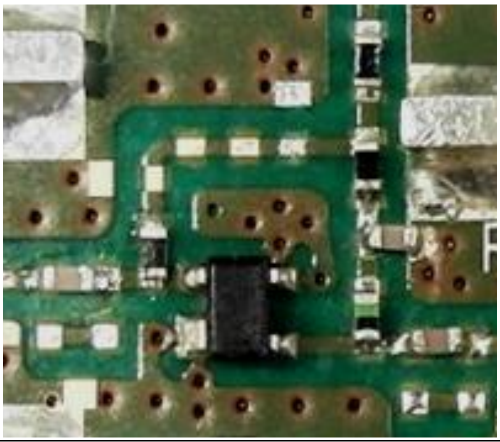

Figure 21 Zoom-In of Photo Picture

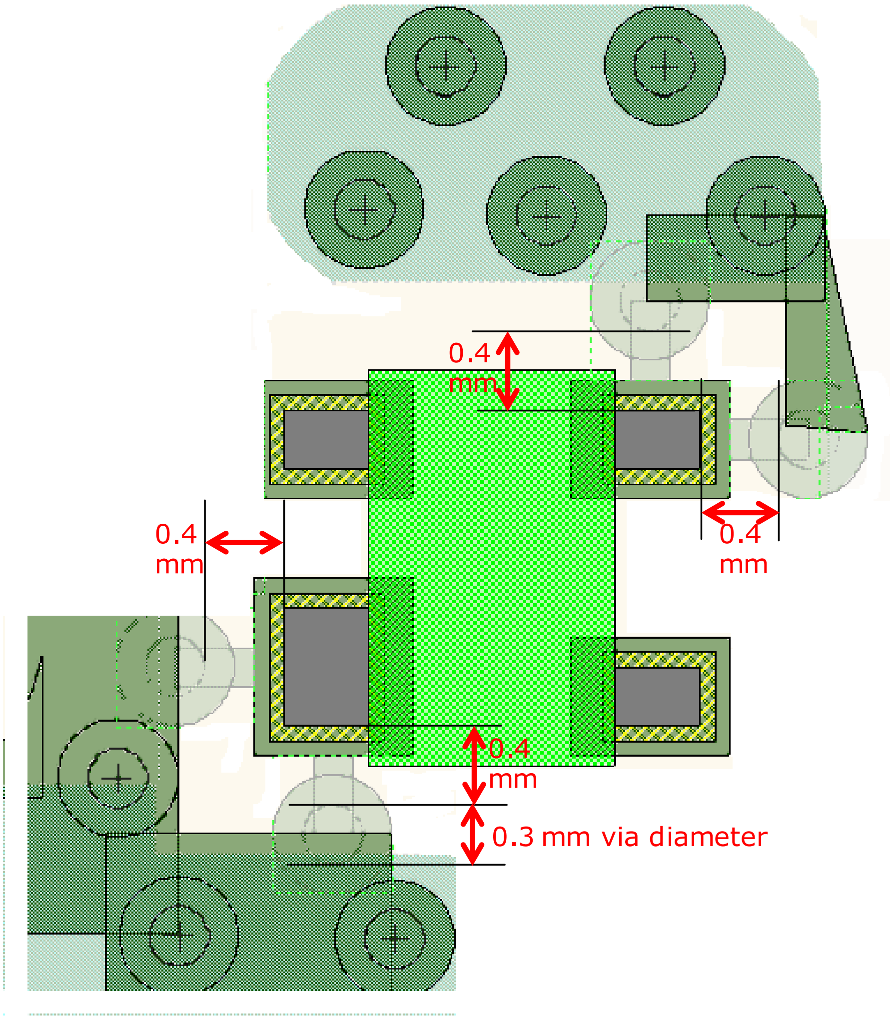

Figure 22 Layout Proposal for RF Grounding of the 2.4 – 6 GHz WLAN LNA with BFP843

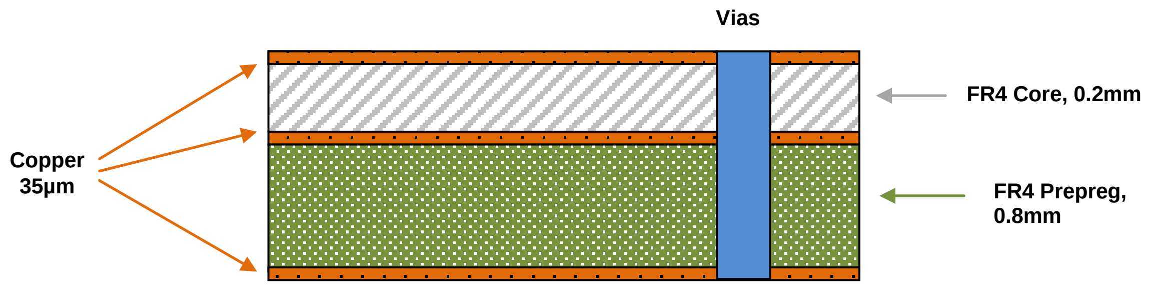

Figure 23 PCB Layer Information

6 Authors

Xi Chen, Internship Student of Application Engineering of Business Unit “RF and Protection Devices”

Ahmed Shamsuddin, Application Engineer of Business Unit “RF and Protection Devices”

w w w . i n f i n e o n . c o m

Published by Infineon Technologies AG AN312