BFP840ESD

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

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

Application Note AN309

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RF and Protection Devices

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Application Note AN309

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Previous Revision: No previous revision

Page	Subjects (major changes since last revision)

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Last Trademarks Update 2011-11-11

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1 Introduction

1.1 About Wi-Fi® /Wireless LAN (WLAN)

Wireless-Fidelity (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 Wi-Fi function is one of the most important connectivity functions in notebooks, smart phones and tablet PCs. 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.

In the 2.4 GHz frequeny band, the 802.11b/g/n wireless LAN devices suffer from interference from other devices operating in this ISM band, such as wireless keyboards or Bluetooth devices. In order 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. A general application diagram of 2.4 GHz wireless LAN system is shown in Error! Reference source not found..

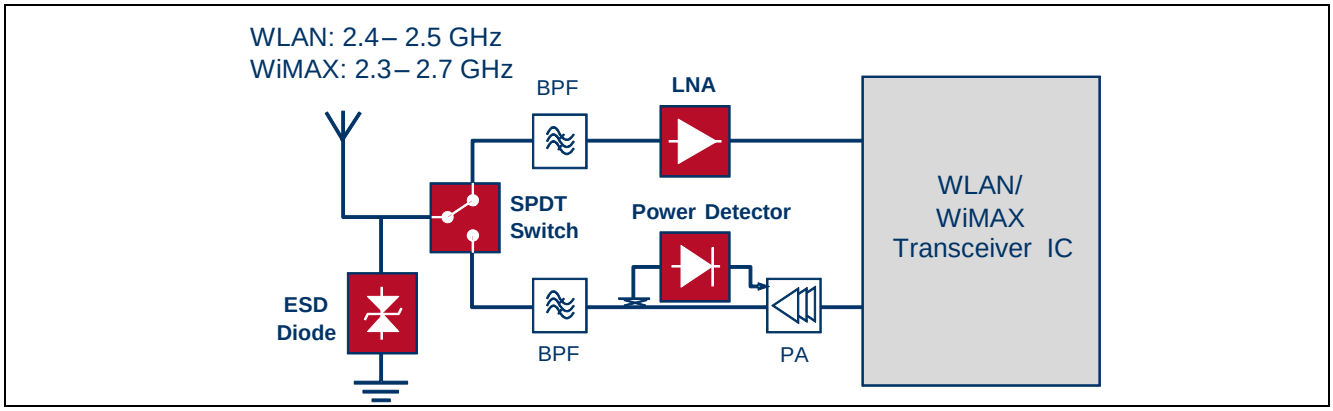

Figure 1 **General block diagram 2.4 GHz Wi-Fi Wireless LAN (WLAN, IEEE802.11b/g/n) and WiMAX (IEEE802.16e) Front-End**

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 receiver chain Noise Figure (NF) of approximately 2 dB can only be achieved by using a high-gain LNA.

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 BFP840ESD Overview

2.1 Features

- Robust very low noise amplifier based on Infineon´s reliable, high volume SiGe:C technology
- Unique combination of high end RF performance and robustness: 20 dBm maximum RF input power, 1.5 kV HBM ESD hardness
- Very high transition frequency *f*T = 80 GHz enables very low noise figure at high frequencies:

  NF_{min} = 0.85 dB at 5.5 GHz, 1.8 V, 6 mA
- High gain $|S21|^2$ = 18.5 dB at 5.5 GHz, 1.8 V, 10 mA
- OIP3 = 23 dBm at 5.5 GHz, 1.5 V, 6 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
- Easy to use Pb free (RoHS compliant) and halogen free industry standard package with visible leads
- Qualification report according to AEC-Q101 available

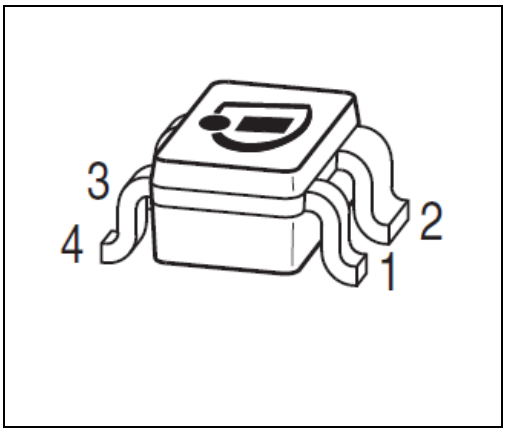

Figure 2 BFP840ESD in SOT343

2.2 Key Applications of BFP840ESD

As Low Noise Amplifier (LNA) in

- Mobile and fixed connectivity applications: WLAN 802.11, WiMAX and UWB
- Satellite communication systems: satellite radio (SDARs, DAB), navigation systems and C-band LNB (1st and 2nd stage LNA)
- Ku-band LNB front-end (2nd stage or 3rd stage LNA and active mixer)
- Ka-band oscillators (DROs)

3 BFP840ESD as LNA for 2.4 - 2.5 GHz Wireless LAN Applications

3.1 Description

BFP840ESD is a low noise SiGe:C HBT transistor. It provides inherently good input and output power match as well as noise match. Without lossy external matching components at the input leads to a low external parts count, to a very good noise figure and to a very high transducer gain in the 2.4 GHz and 5 GHz WLAN application. Integrated protection elements at in- and output make the device robust against ESD and excessive RF input power. The device offers its high performance at low current and voltage and is especially well-suited for portable battery powered applications. The BFP840ESD is housed in the SOT343 package with visible leads; other variants of this family are also available in flat-lead TSFP-4 package (BFP840FESD), and leadless TSLP-3 package (BFR840L3RHESD). **Figure 3** shows the pin assignment of package of BFP840ESD in the top view:

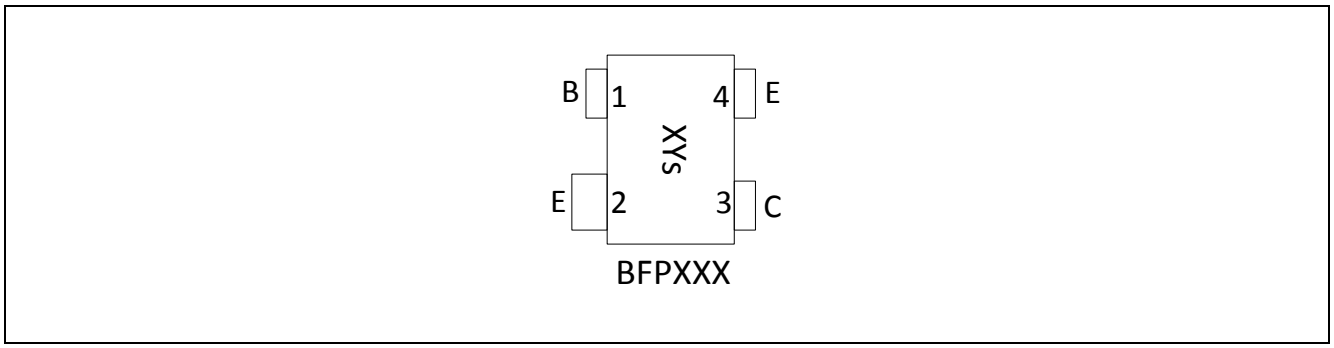

Figure 3 Package and pin connections of BFP840ESD in Topview

This application note presents the results of Low Noise Amplifer for the 2.4 GHz to 2.5 GHz Wireless LAN application using BFP840ESD. It achieves a Noise Figure level of approx. 1.1 dB, and the Gain ranges from 19.0 dB to 18.6 dB over this frequency band. The circuit achieves an Input Return Loss of approx. 12.0 dB and Output Return Loss of approx. 16.0 dB. The circuit requires ten passive 0402 SMD components, and it is unconditionally stable from 10 MHz to 15 GHz.

At 2450 MHz, using two tones spacing of 1 MHz, the Output Third Order Intercept Point (OIP3) reaches +13.2 dBm. Besides, we obtain Input 1 dB Compression Point (IP1dB) of -15.3 dBm at 2450 MHz.

4 Application Circuit and Performance Overview

Device: BFP840ESD

Application: LNA for 2.4 GHz WLAN Applications

PCB Marking: **M130124 (0.4mmx2)** BFP840ESD

4.1 Performance Overview

Table 1 Summary of Measurement Results (at room temperature)

Parameter	Symbol	Value		Unit	Note/Test Condition
DC Voltage	V_{CC}	3.0		V	
DC Current	I_{CC}	13.2		mA	
Frequency Range	Freq	2400	2500	MHz	
Gain	G	19.0	18.6	dB	
Noise Figure	NF	1.14	1.12	dB	SMA and PCB losses 0.09 dB are subtracted
Input Return Loss	RL_{in}	13.9	12.9	dB	
Output Return Loss	RL_{out}	17.6	16.1	dB	
Reverse Isolation	IRev	32.9	32.7	dB	
Input P1dB	IP1dB	-15.3		dBm	f=2450MHz
Output P1dB	OP1dB	+2.5		dBm	f=2450MHz
Input IP3	IIP3	-5.6		dBm	Power @ Input: -30 dBm each tone f1=2450MHz, f2=2451MHz
Output IP3	OIP3	+ 13.2		dBm	Power @ Input: -30 dBm each tone f1=2450MHz, f2=2451MHz
Stability	k	> 1		--	Stability measured from 10 MHz to 15 GHz

4.2 Schematics and Bill-of-Materials

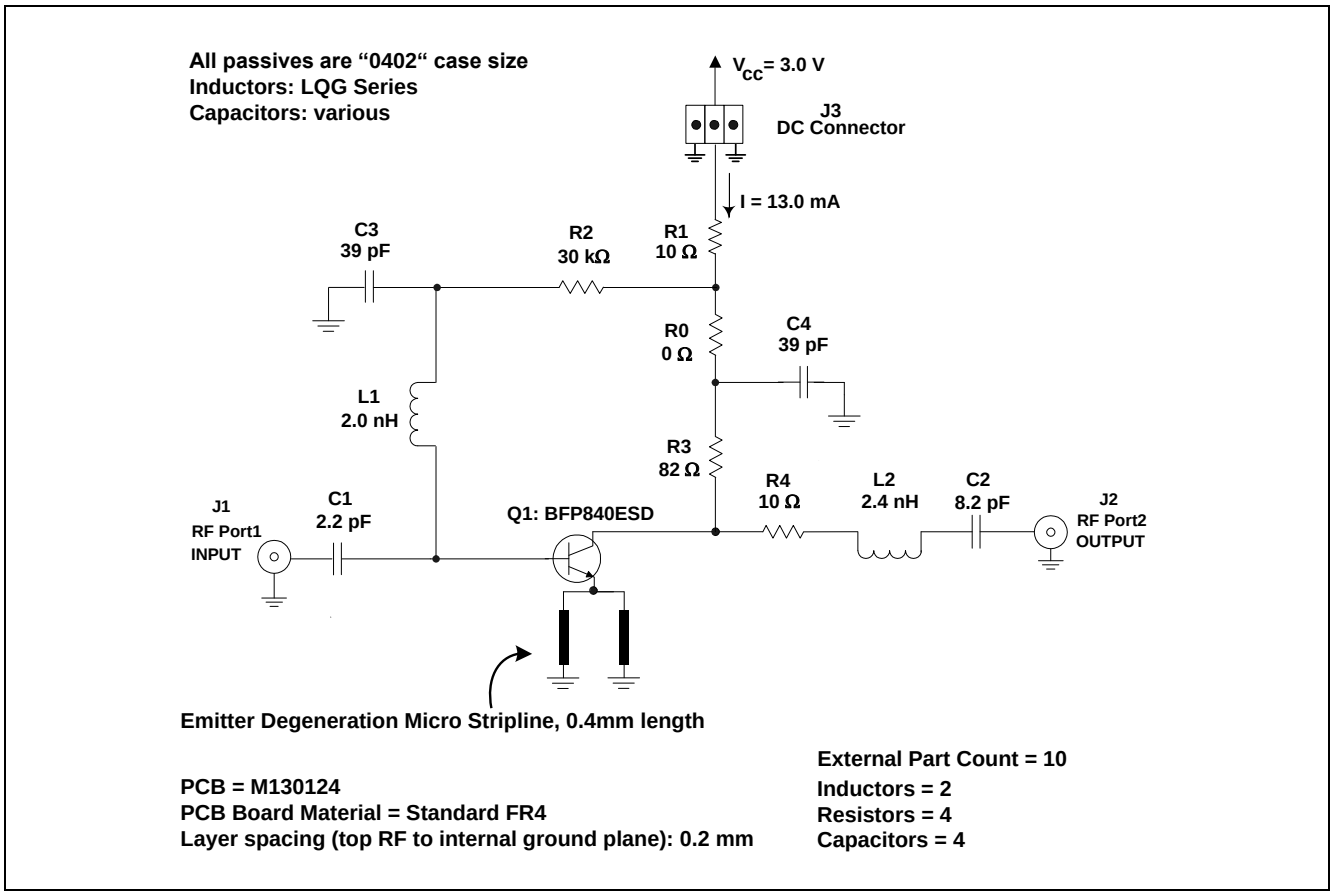

Figure 4 Schematic of the BFP840ESD Application Circuit

Table 2 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	2.2	pF	0402	Various	Input matching and RF blocking
C2	8.2	pF	0402	Various	Output matching
C3	39	pF	0402	Various	RF decoupling / DC blocking capacitor
C4	39	pF	0402	Various	RF decoupling / DC blocking capacitor
R0	0	Ω	0402	Various	Jumper
R1	10	Ω	0402	Various	DC biasing
R2	30	kΩ	0402	Various	DC biasing
R3	82	Ω	0402	Various	DC biasing
R4	10	Ω	0402	Various	Output matching and gain adjustment
L1	2.0	nH	0402	Murata LQG15A	Input matching
L2	2.4	nH	0402	Murata LQG15A	Output matching and RF blocking
Q1			SOT343	Infineon	BFP840ESD SiGe:C Heterojunction Bipolar RF Transistor

5 Measurement Graphs

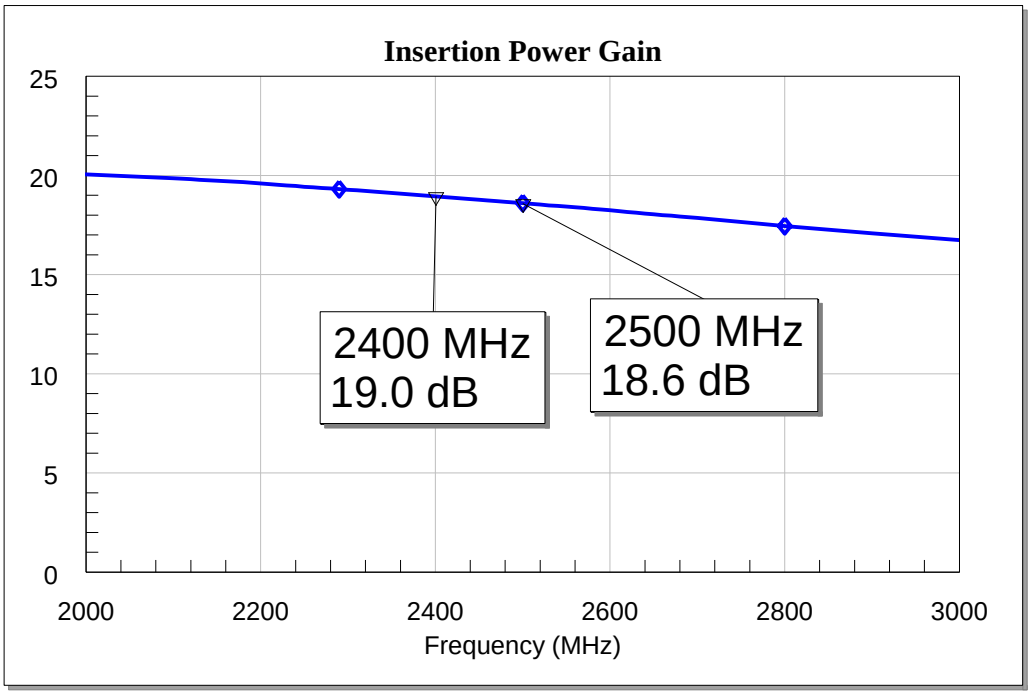

Figure 5 Narrowband Insertion Gain of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

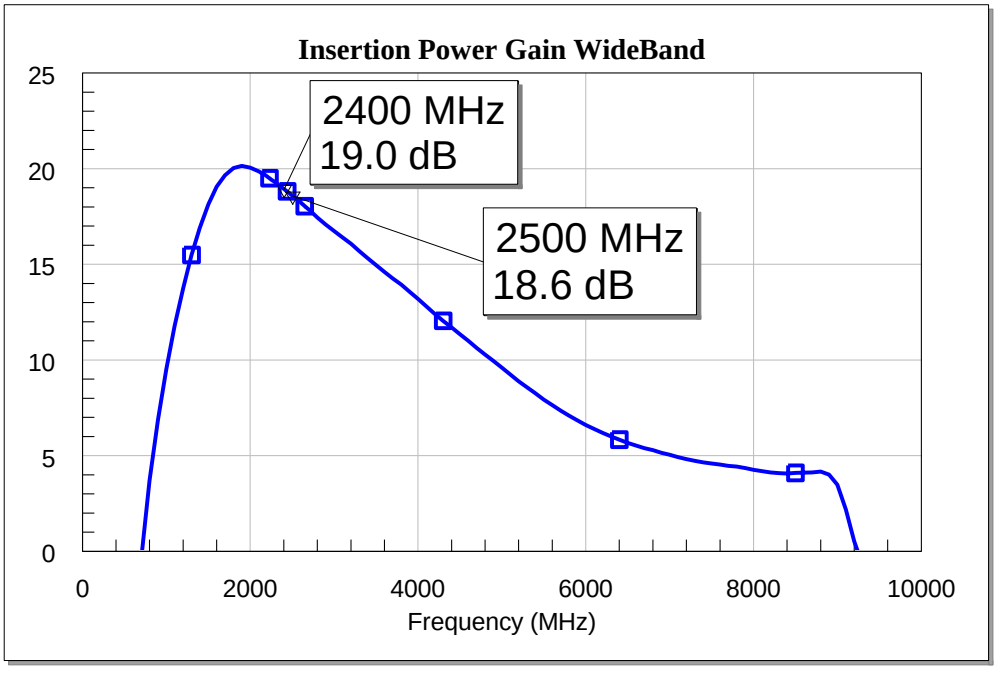

Figure 6 Wideband Insertion Gain of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

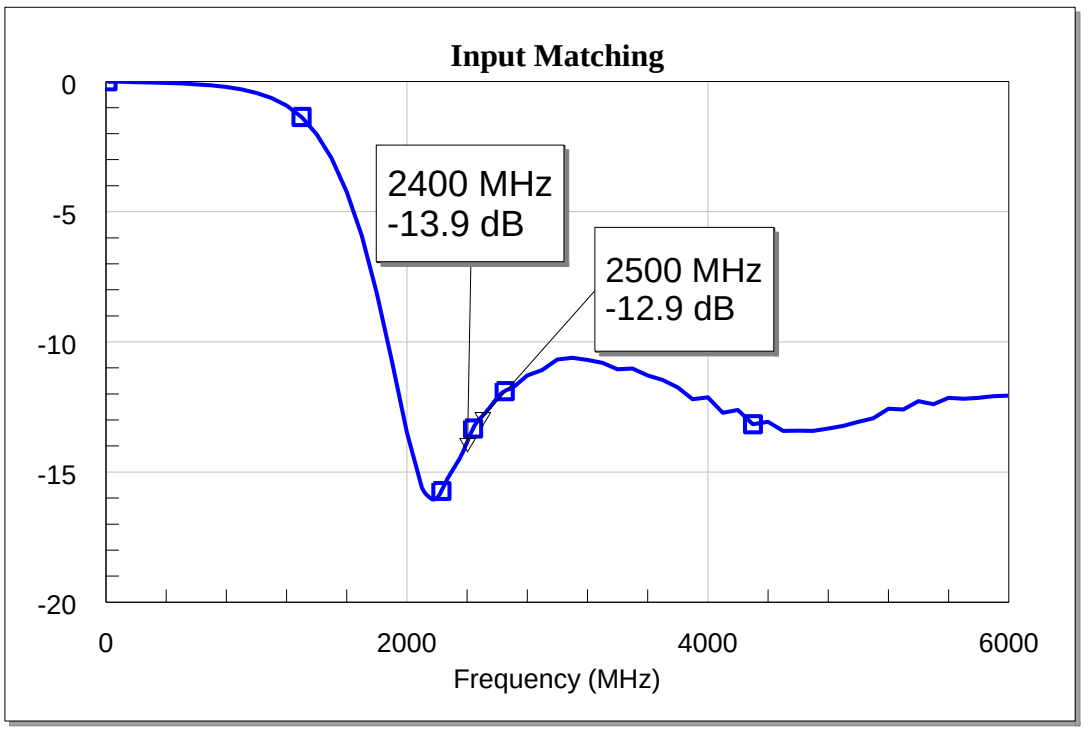

Figure 7 Input Matching of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

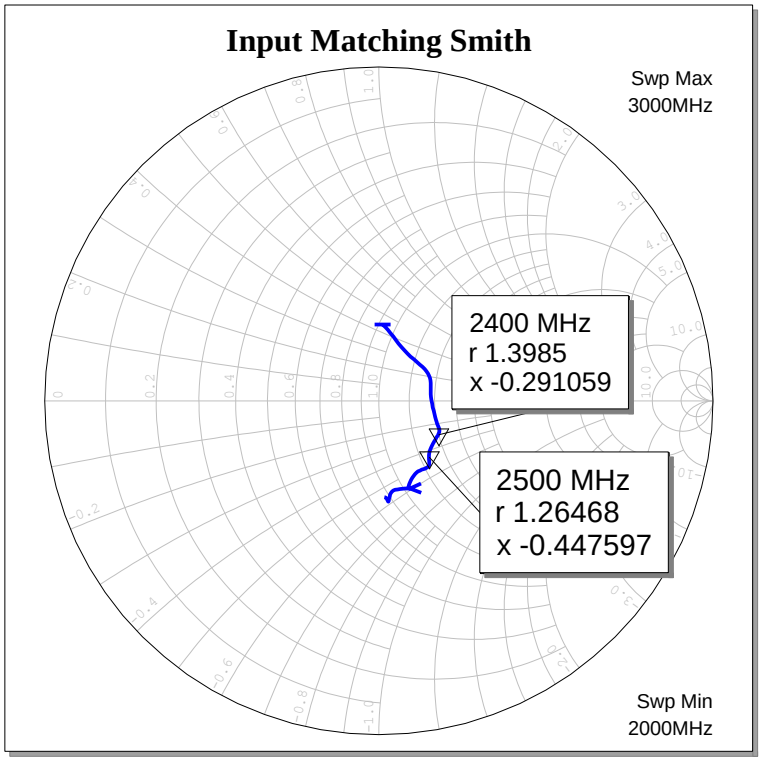

Figure 8 Input Matching (Smith Chart, Port Deembedded)

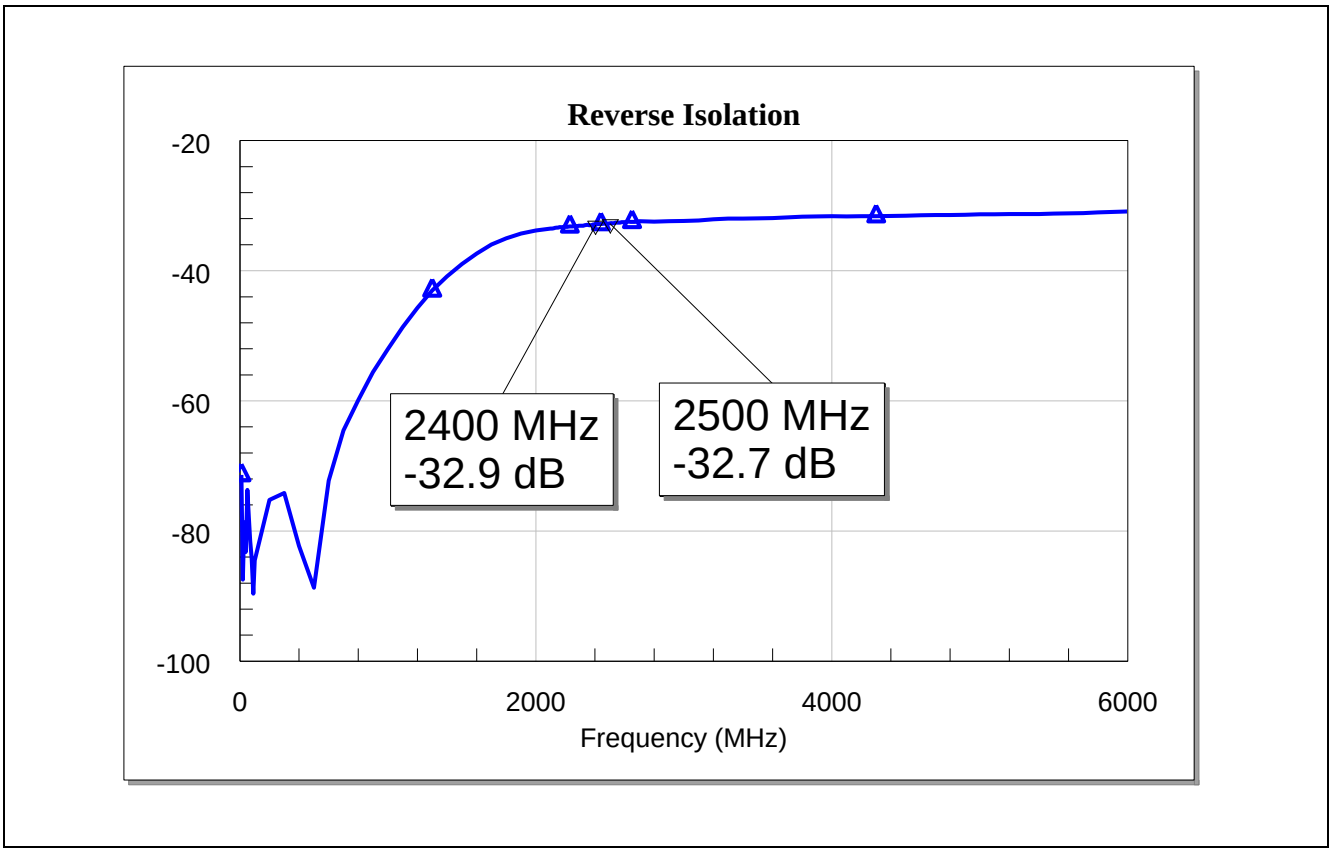

Figure 9 Reverse Isolation of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

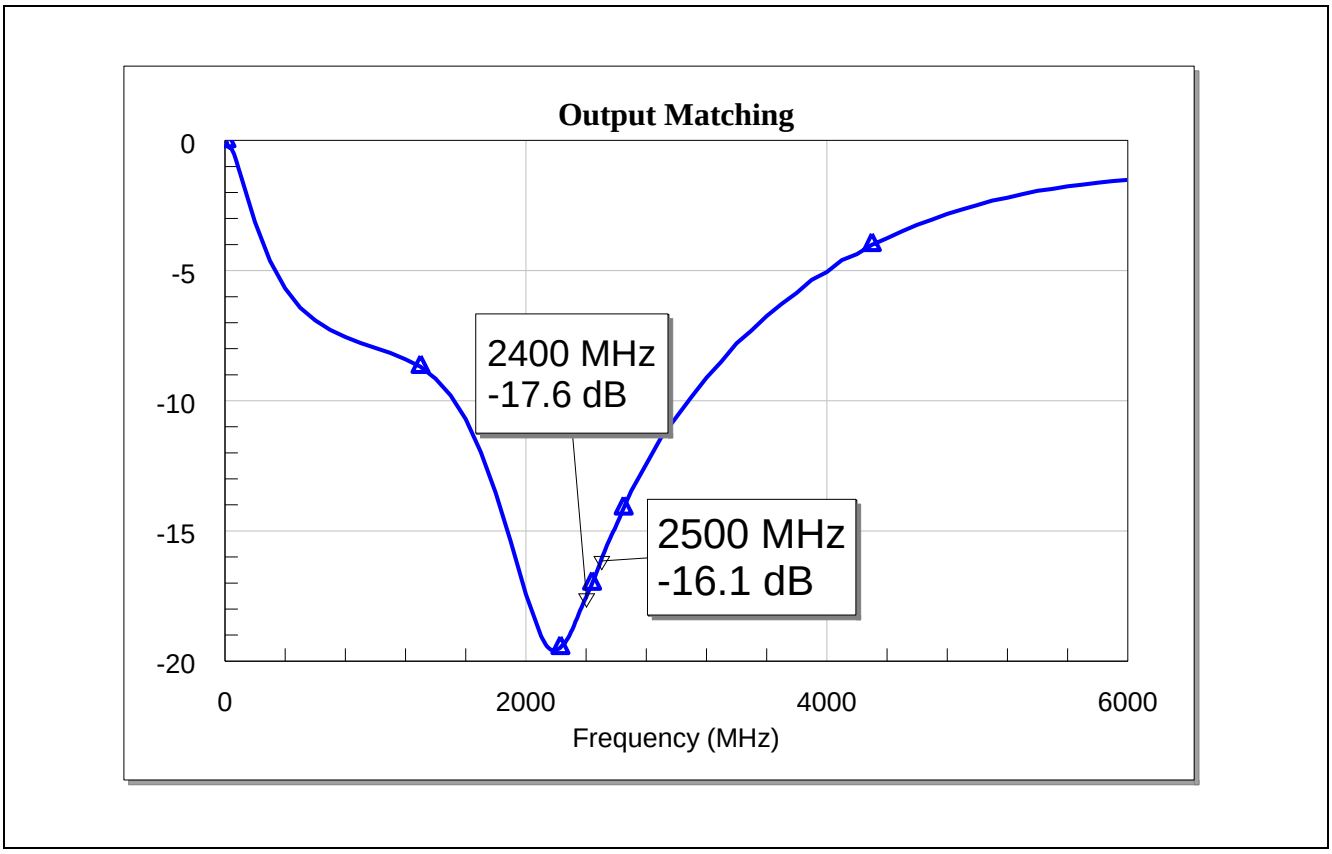

Figure 10 Output Matching of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

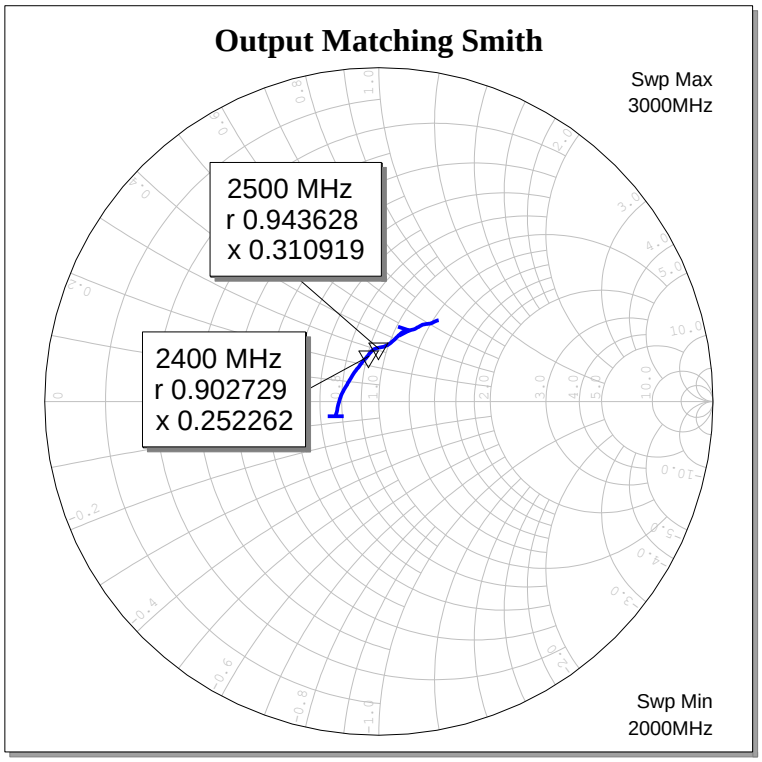

Figure 11 Output Matching (Smith Chart, Port Deembedded)

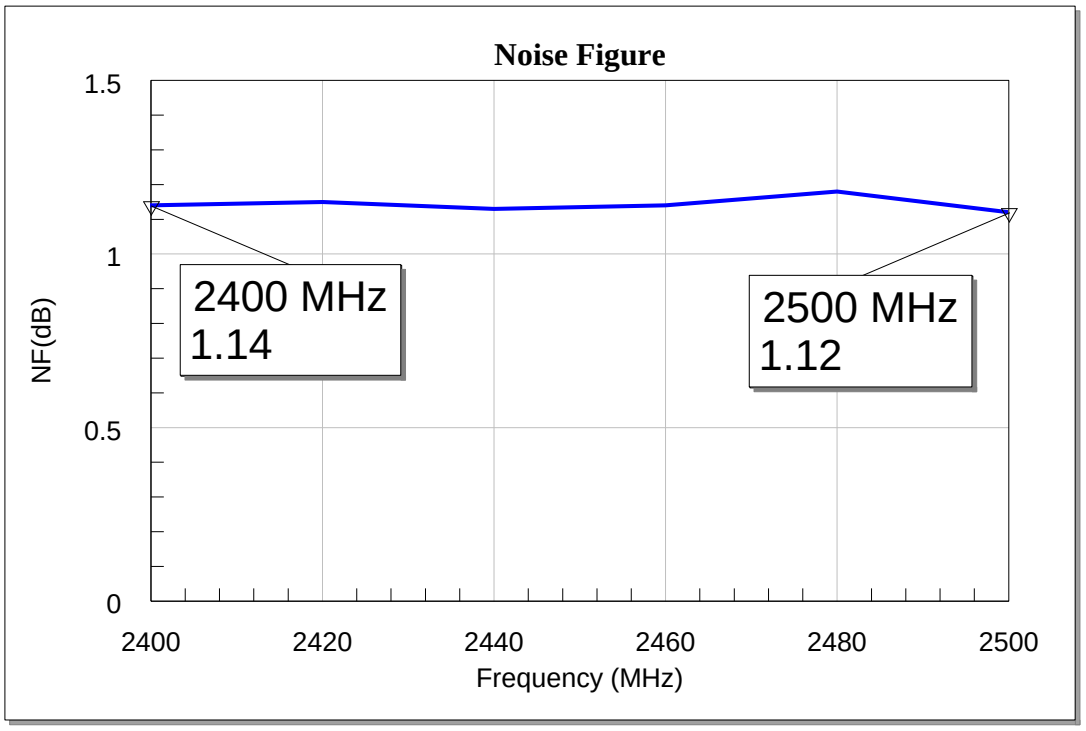

Figure 12 Noise Figure of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

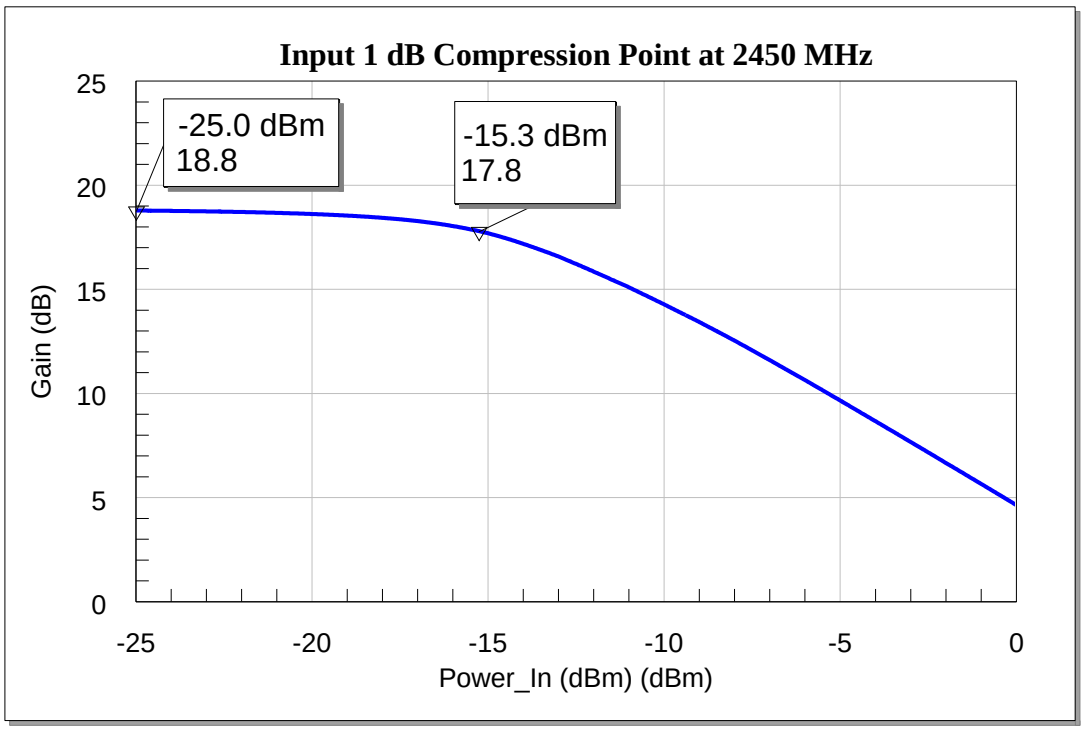

Figure 13 Input 1dB Compression Point (IP1dB) at 2450 MHz

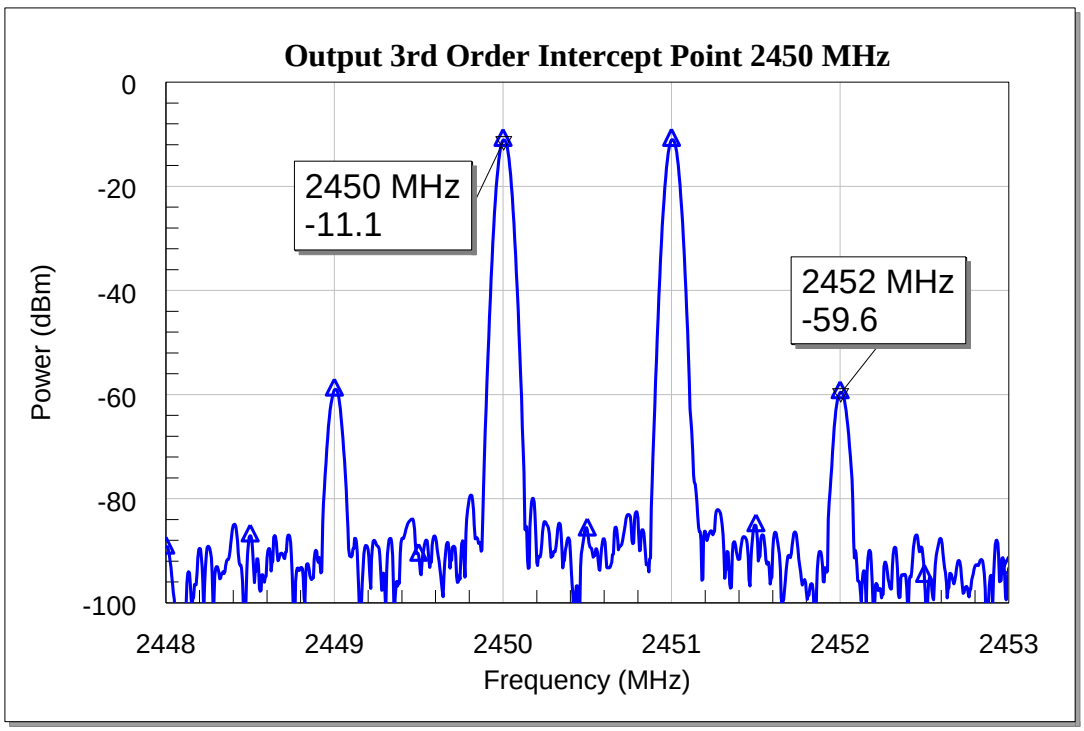

Figure 14 Output Third Order Intercept Point (OIP3) at 2450 MHz

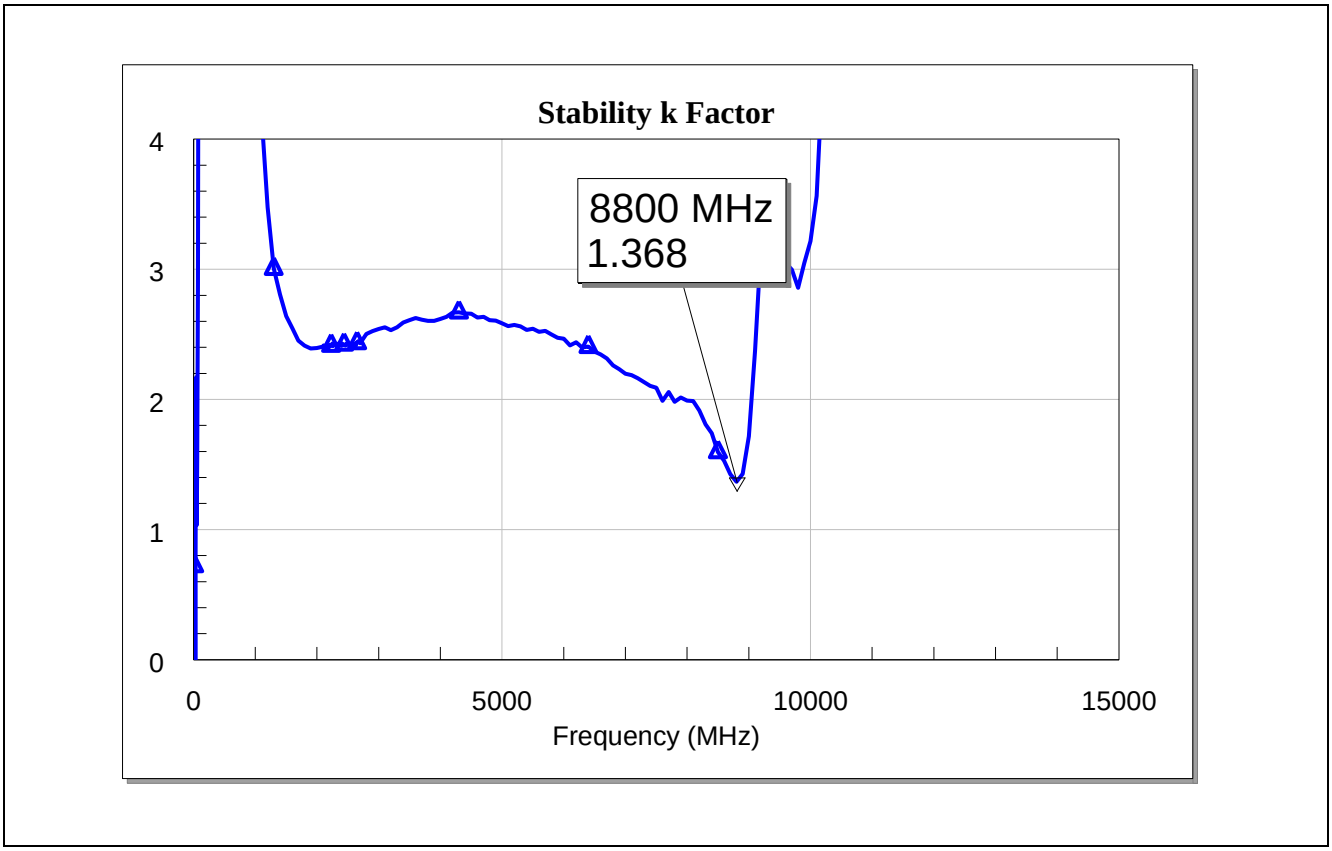

Figure 15 Stability k Factor of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

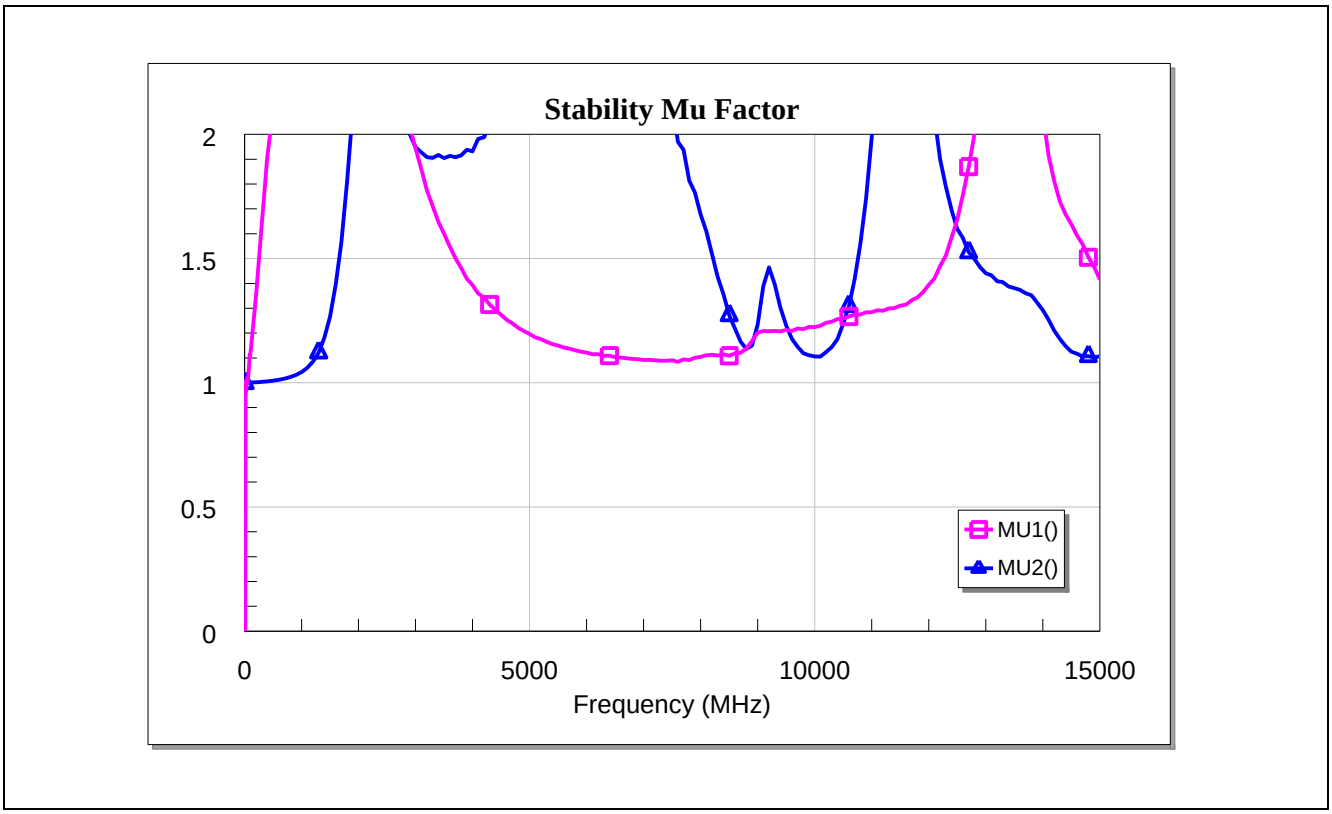

Figure 16 Stability Mu Factors of of the 2.4 - 2.5 GHz WLAN LNA with BFP840ESD

6 Evaluation Board

In this application note, the following PCB is used:

PCB Marking: **M130124 (0.4mmx2)** BFP840ESD

PCB material: <FR4>

ε_r of PCB material: <4.3>

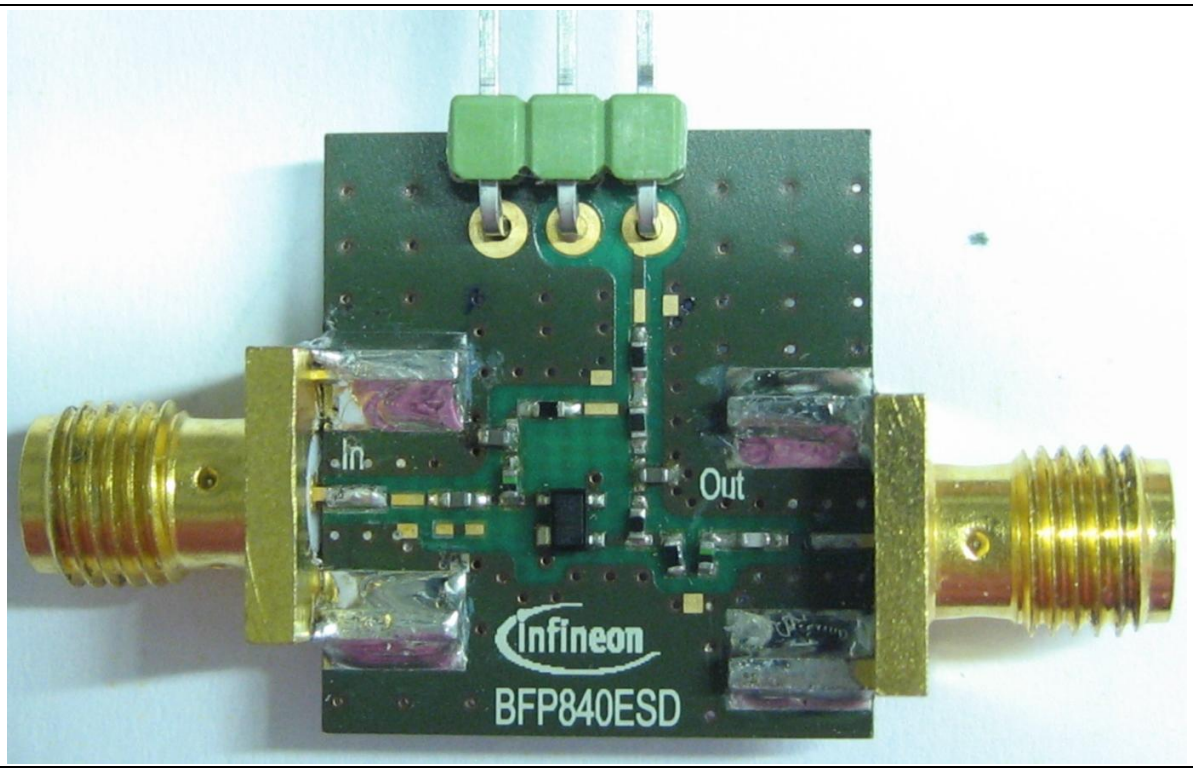

Figure 17 Photo Picture of Evaluation Board (overview) <M130124>

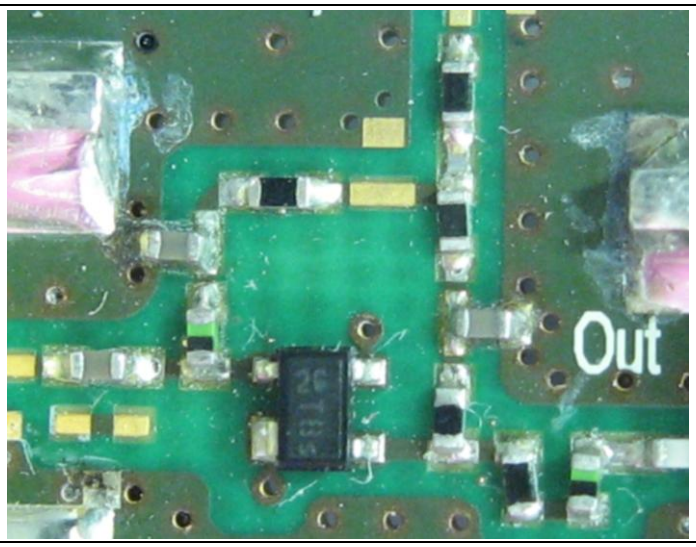

Figure 18 Photo Picture of Evaluation Board (detailed view)

7 Layout Information

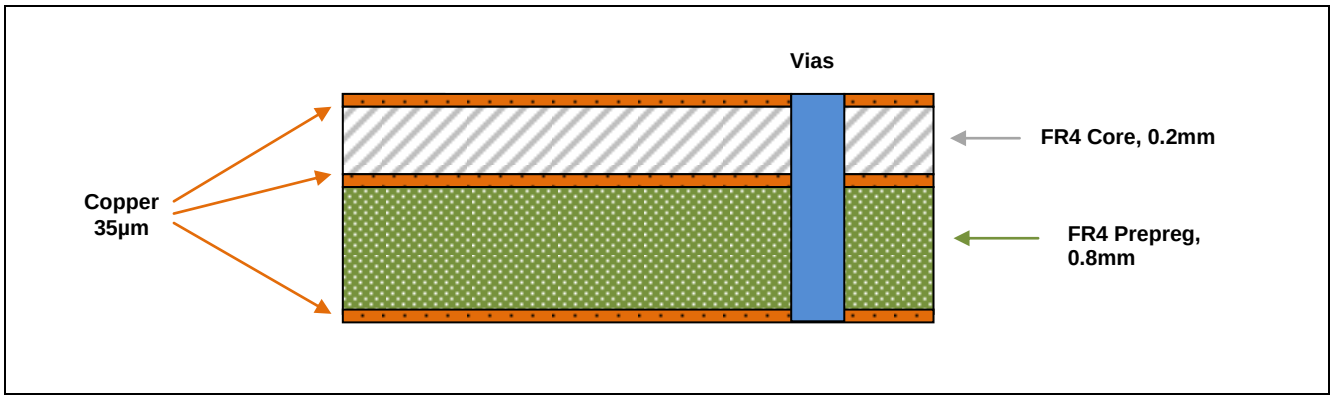

Figure 19 PCB Layer Information

8 Authors

Xiang Li, Application Engineer of Business Unit “RF and Protection Devices”

Jie Fang, Application Engineer of Business Unit “RF and Protection Devices”

9 Remark

The graphs are generated with the simulation program AWR Microwave Office®.

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