BFP840FESD

Low Noise Amplifier for 3.4GHz-3.8GHz (Band 42/ 43)

Technical Report TR1129

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Revision History: 2013-06-05

Previous Revision:

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1 Application Circuit and Performance Overview

Device: BFP840FESD

Application: Low Noise Amplifier for 3.4GHz- 3.8GHz (Band 42/ 43)

PCB Marking: M13031106 0.6mmEDG TSFP-4-1 BFP840FESD

1.1 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	14.5			mA	
Frequency Range	Freq	3400	3600	3800	MHz	
Gain	G	18.2	17.7	17.2	dB	
Noise Figure	NF	1.11	1.06	1.11	dB	SMA and PCB losses (~0.05 dB) are subtracted
Input Return Loss	RLin	11.6	12.2	13.3	dB	
Output Return Loss	RLout	23.8	23.7	15.0	dB	
Reverse Isolation	IRev	29.6	29.2	29.0	dB	
Input P1dB	IP1dB	-12.6			dBm	Measured @ 3600MHz
Output P1dB	OP1dB	4.1			dBm	
Input IP3	IIP3	-3			dBm	Measured @ 3600MHz, Δf =1 MHz, Pin= - 30 dBm
Output IP3	OIP3	14.7			dBm	
Stability	k	> 1.0			--	Measured up to 15 GHz

1.2 High Gain Low Noise Amplifier using BFP840FESD for 3.4 – 3.8 GHz LTE Application

The BFP840FESD is a discrete hetero-junction bipolar transistor (HBT) specifically designed for high performance 3.4 – 3.8 GHz low noise amplifier (LNA) solutions for LTE connectivity applications. It combines the 80 GHz fT silicon-germanium:carbide (SiGe:C) B9HFM process with special device geometry engineering to reduce the parasitic capacitance between substrate and transistor that degrades high-frequency characteristics, resulting in an inherent input matching and a major improvement in power gain Band 42/43 together with a low noise figure performance that is industry's best.

The BFP840FESD has an integrated 1.5kV 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.

The BFP840FESD is housed in flat-leads TSFP-4-1 package. Further variants are available in industry standard visible-leads SOT343 package (BFP840ESD) and in the low-height 0.31mm TSLP-3-9 package (BFR840L3RHESD) specially fitting into modules.

Figure 1 shows the pin assignment of package of BFP840FESD in the top view:

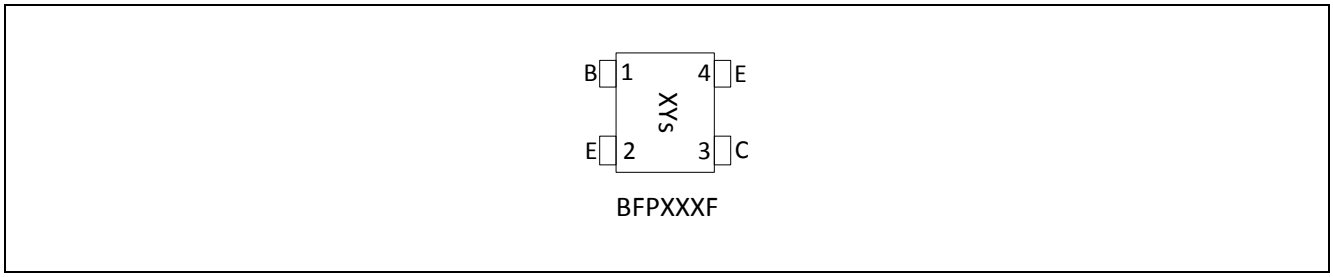

Figure 1 Package and pin connections of BFP840FESD in Topview

This application note presents the measurement results of the Low Noise Amplifier using BFP840FESD for 3400 MHz to 3800 MHz LTE applications. It requires 10 passive 0402 SMD components and can provide 17.7 dB gain at 3600 MHz. The noise figure varies from 1.03 dB to 1.08 dB (SMA and PCB losses are subtracted) over the frequency band.

The circuit achieves an input return loss of 12 dB and output return loss 24 dB. Furthermore, the circuit is unconditionally stable from 10 MHz to 15 GHz. However, Proper RF grounding on PCB has to be ensured in order to achieve stability k-factor > 1 (Figure 3111).

At 3600 MHz, using two tones spacing of 1 MHz, the output third order intercept point OIP3 reaches 14.7 dBm. Besides, we obtain input 1dB input compression point IP1dB of -12.6 dBm at 3600 MHz.

1.3 Schematics and Bill-of-Materials

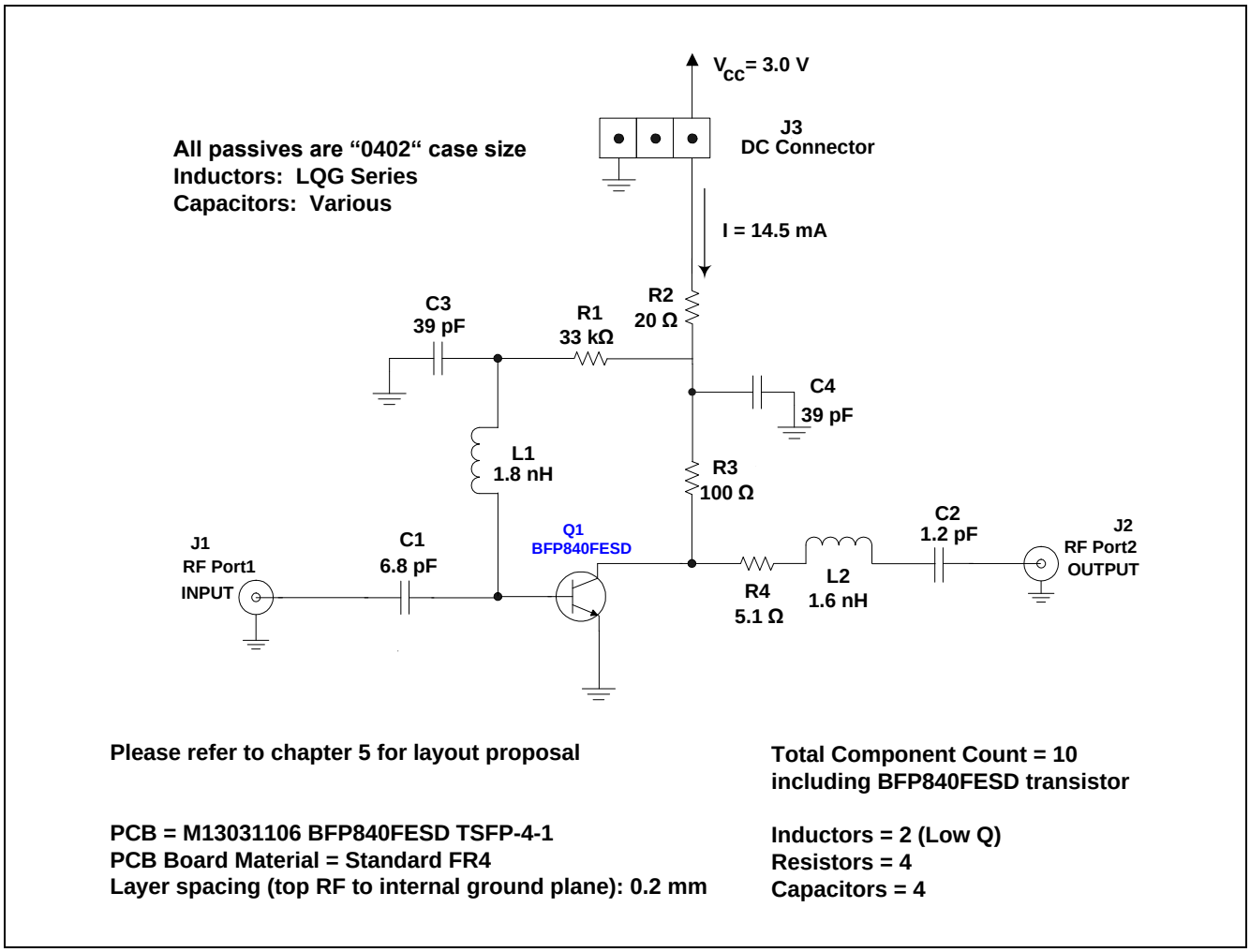

Figure 2 Schematics of BFP840FESD Low Noise Amplifier for 3.4 – 3.8 GHz Application

Table 2 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	6.8	pF	0402	Various	DC block & input matching
C2	1.2	pF	0402	Various	DC block & output matching
C3	39	pF	0402	Various	RF decoupling
C4	39	pF	0402	Various	RF decoupling
L1	1.8	nH	0402	LQG	Input matching
L2	1.6	nH	0402	LQG	Output matching and high frequency stability improvement
R1	33	kΩ	0402	Various	DC biasing
R2	20	Ω	0402	Various	DC biasing (provides DC negative feedback to stabilize DC operating point over temperature variation, transistor h_{FE} variation, etc.)
R3	100	Ω	0402	Various	Stability and input/output mathcing
R4	5.1	Ω	0402	Various	Output matching and stability improvement
Q1			TSLP-4-1	Infineon Technologies	BFP840FESD SiGe: C Heterojunction Bipolar RF Transistor

2 Measured Graphs

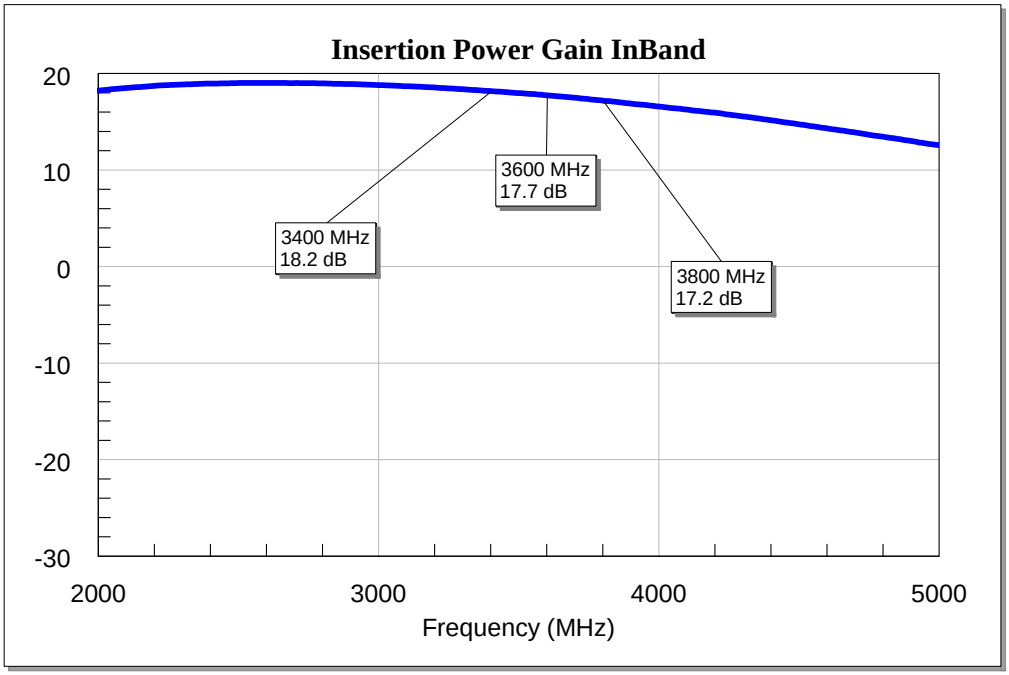

Figure 3 Insertion Power Gain of the 3.4 – 3.8 GHz LNA with BFP840FESD

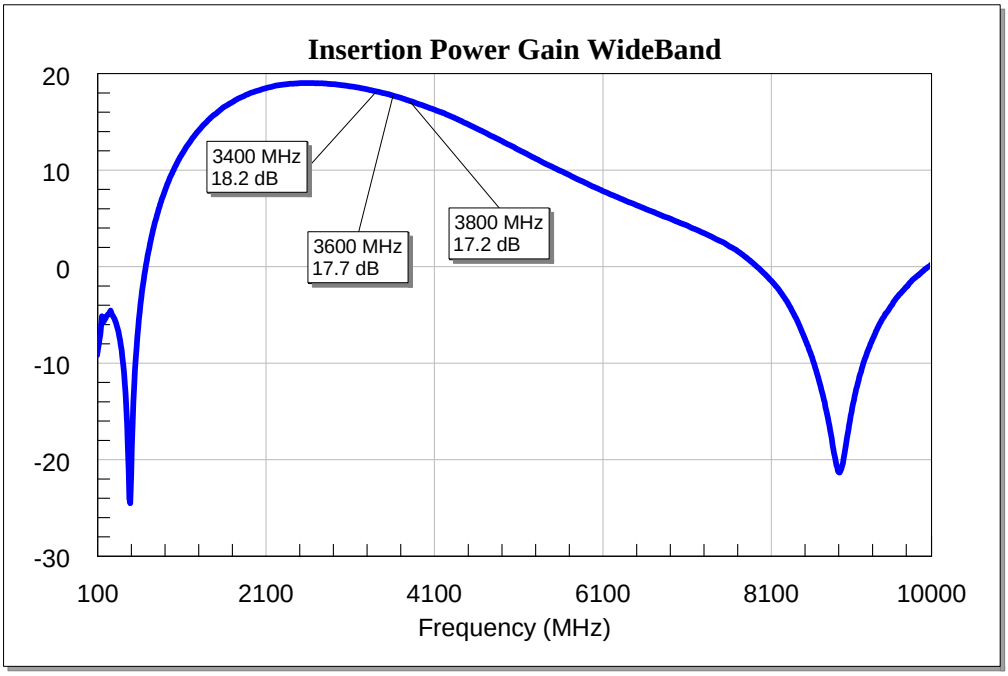

Figure 4 Wideband Insertion Power Gain of the 3.4 – 3.8 GHz LNA with BFP840FESD

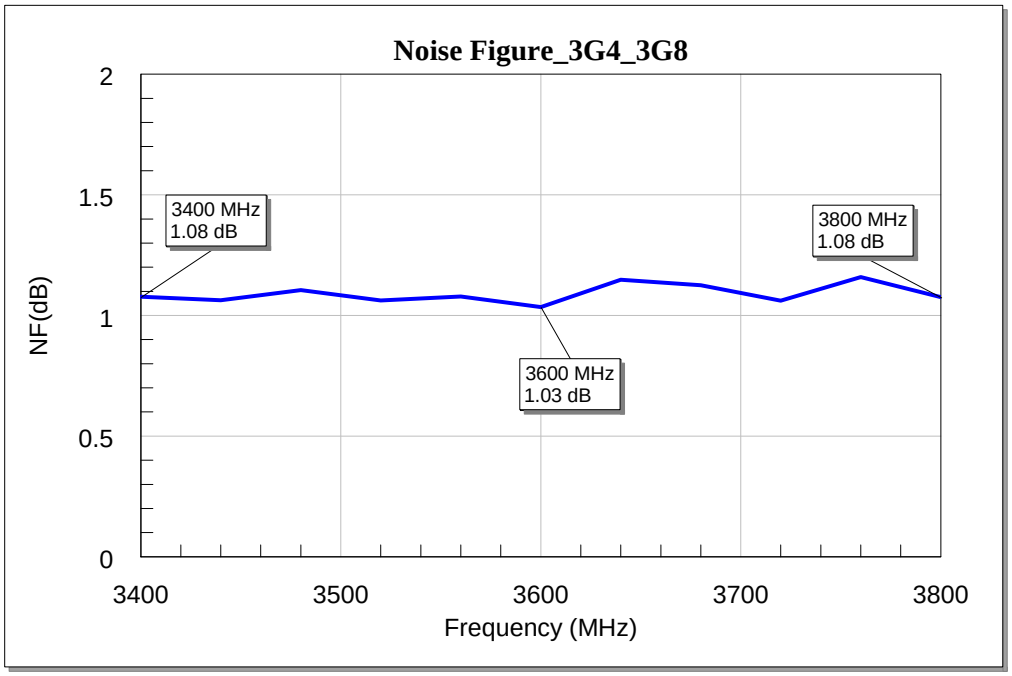

Figure 5 Noise Figure of BFP840FESD LNA for 3400 - 2500 MHz

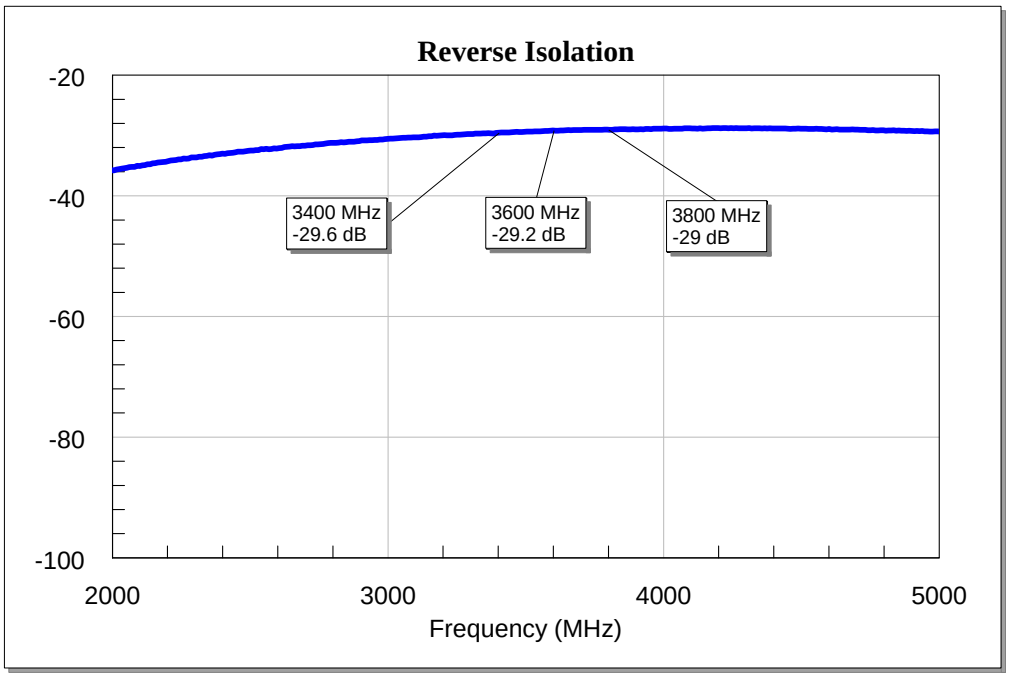

Figure 6 Reverse Isolation of the 3.4 – 3.8 GHz LNA with BFP840FESD

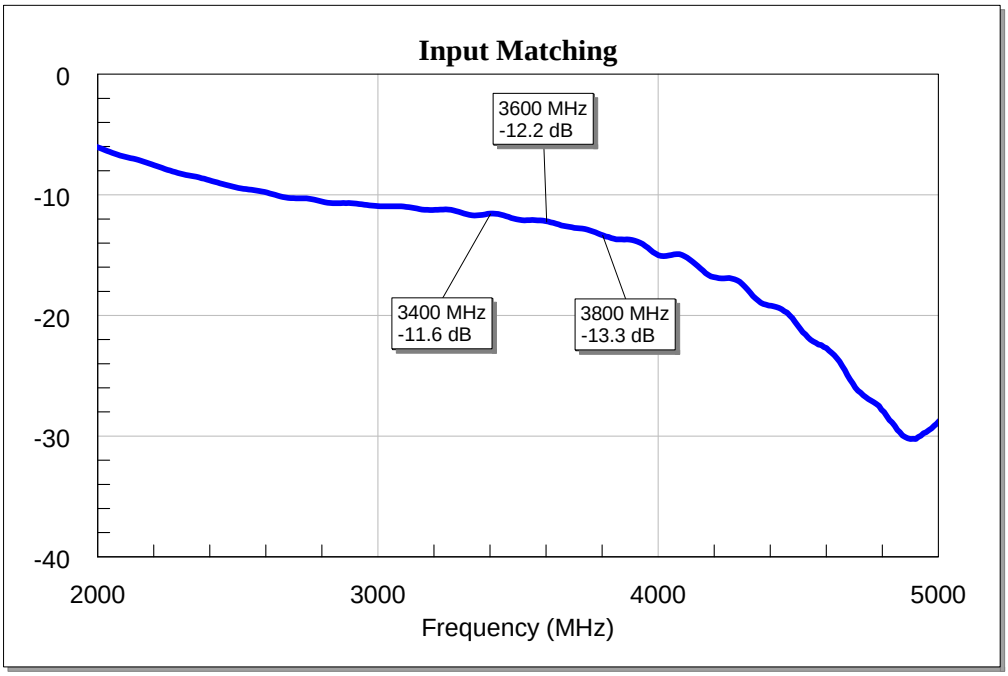

Figure 7 Input Matching of the 3.4 – 3.8 GHz LNA with BFP840FESD

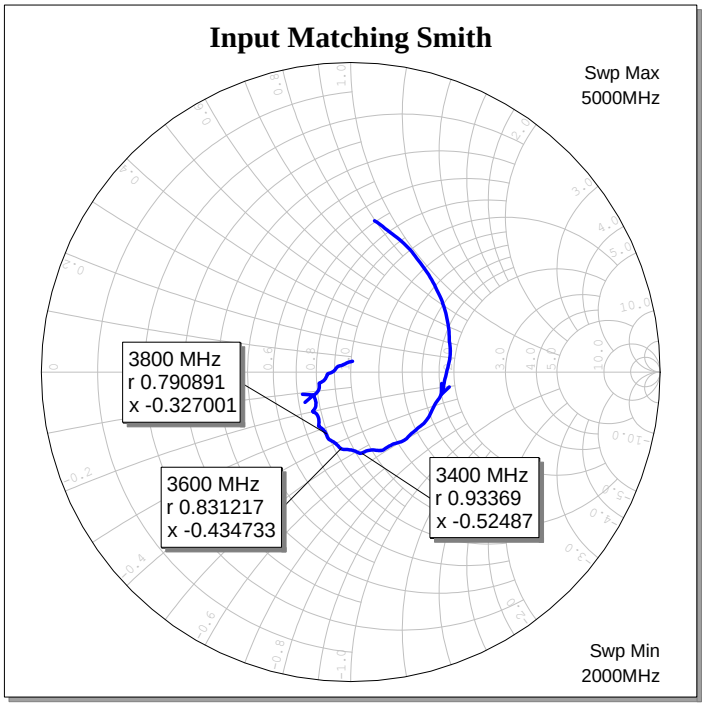

Figure 8 Input Matching of the 3.4 – 3.8 GHz LNA with BFP840FESD (Smith Chart)

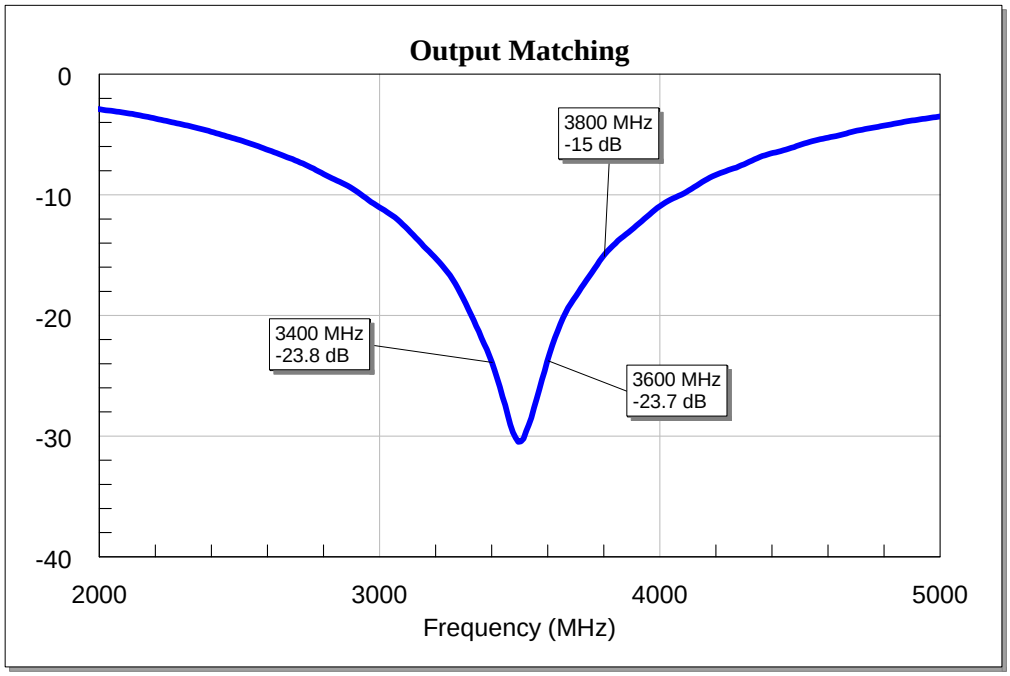

Figure 9 Output Matching of the 3.4 – 3.8 GHz LNA with BFP840FESD

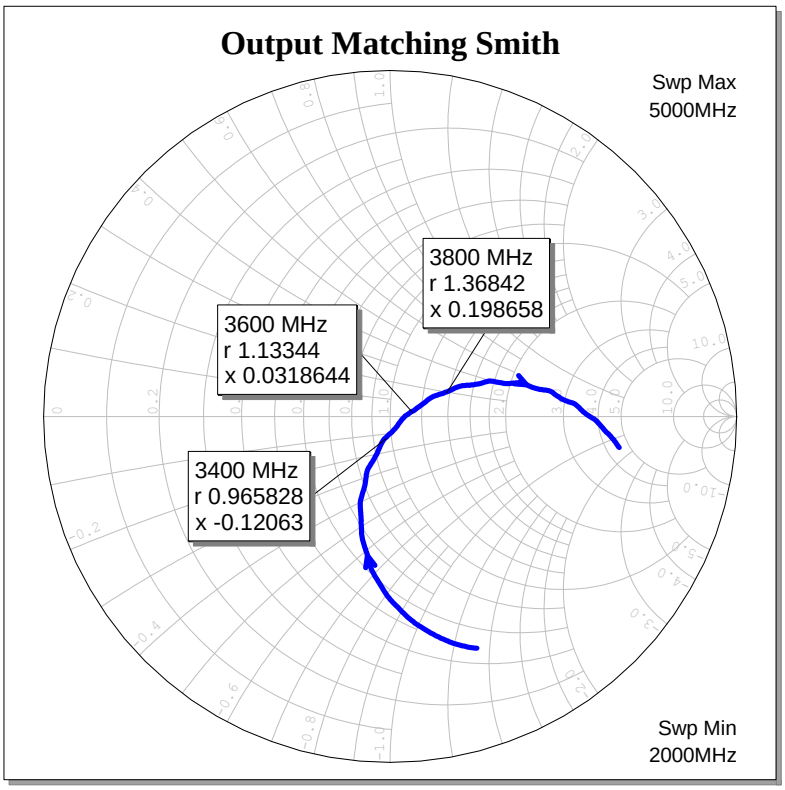

Figure 10 Output Matching of the 3.4 – 3.8 GHz LNA with BFP840FESD (Smith Chart)

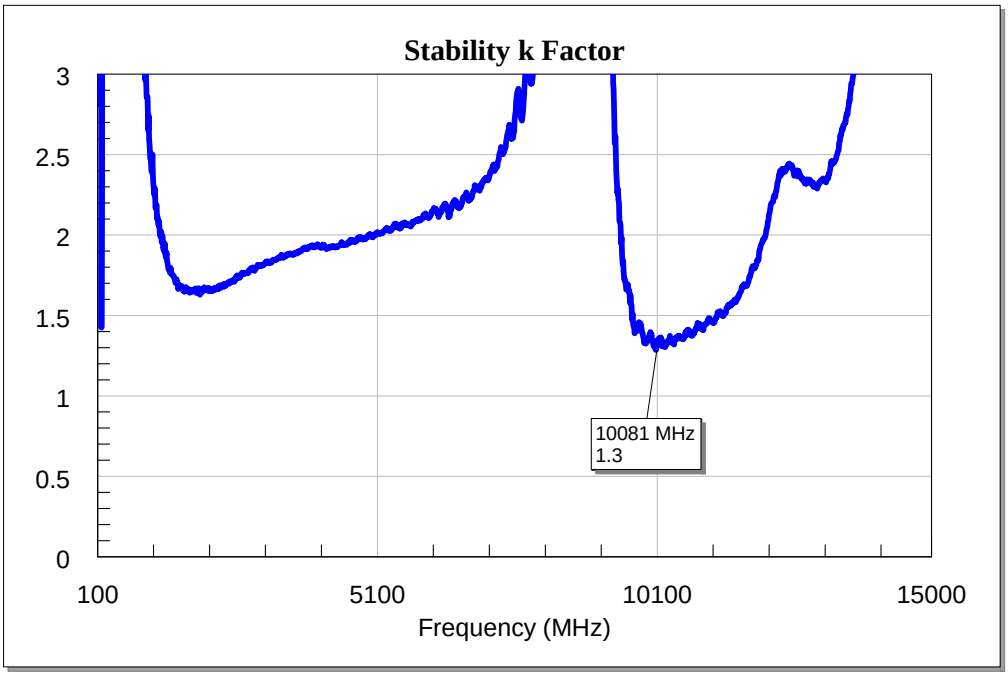

Figure 11 Wideband Stability k Factor of the 3.4 – 3.8 GHz LNA with BFP840FESD

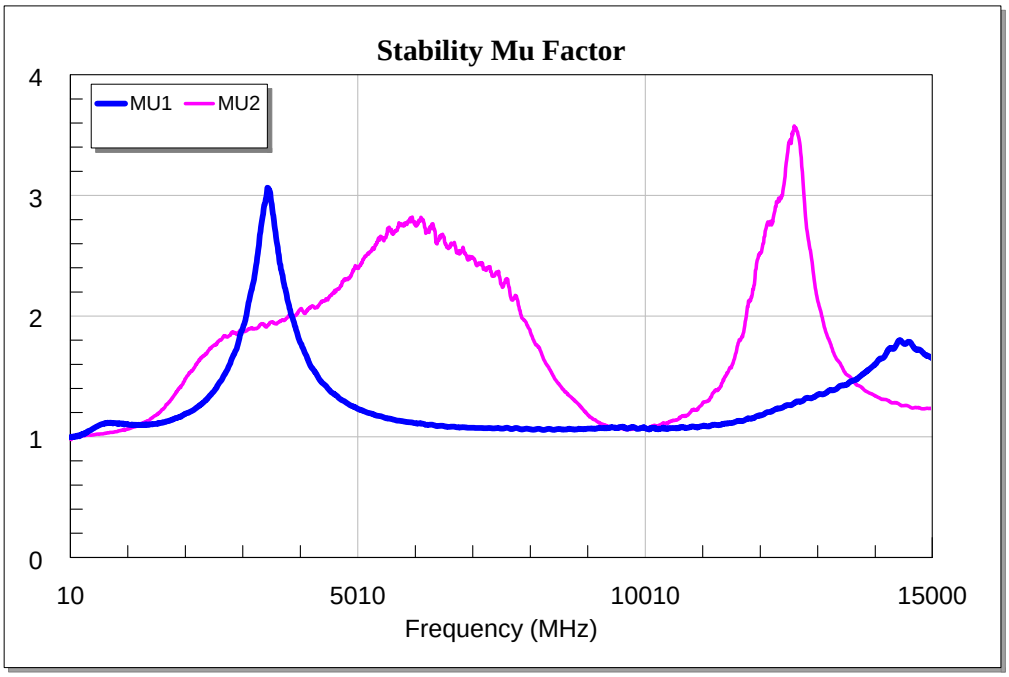

Figure 12 Wideband Stability Mu Factor of the 3.4 – 3.8 GHz LNA with BFP840FESD

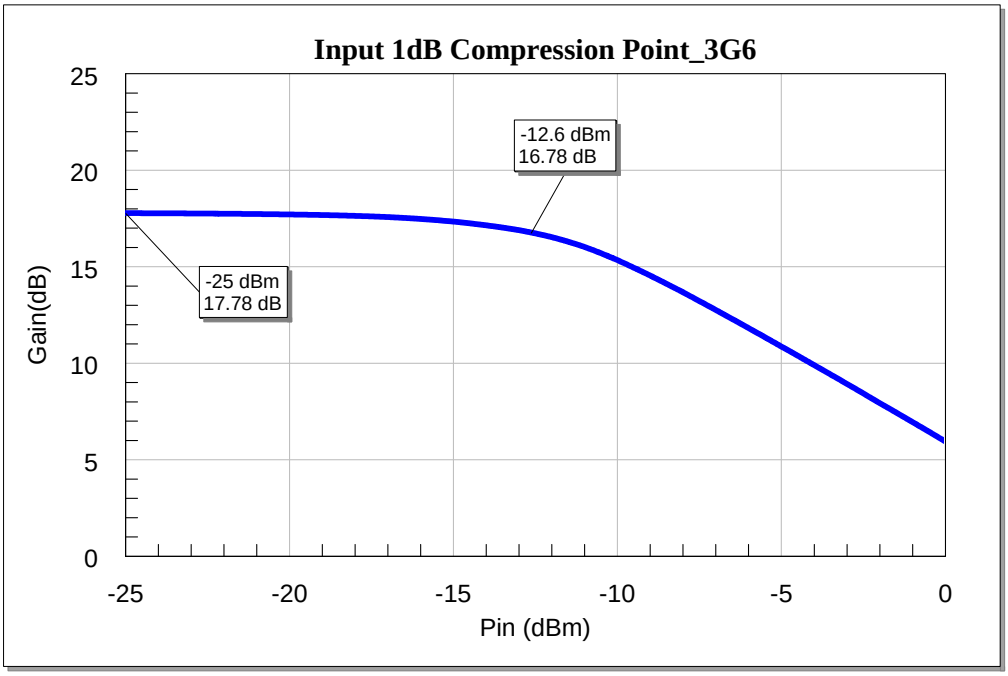

Figure 13 1dB Compression Point of the BFP840FESD Circuit at 3600 MHz

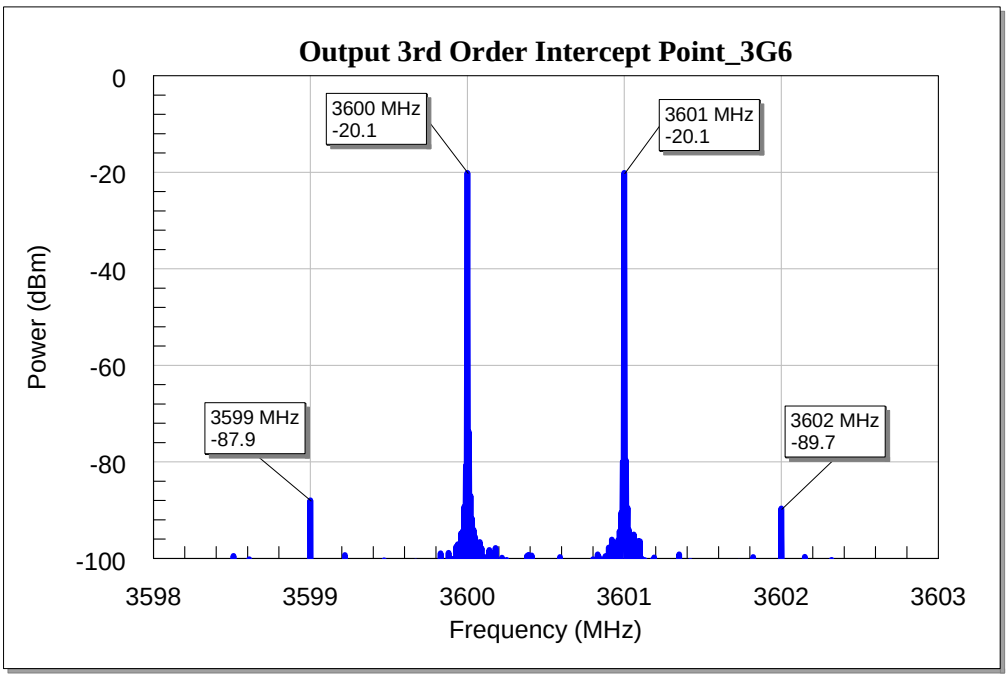

Figure 14 Output 3rd Order Intercept Point of BFP840FESD at 3600 MHz

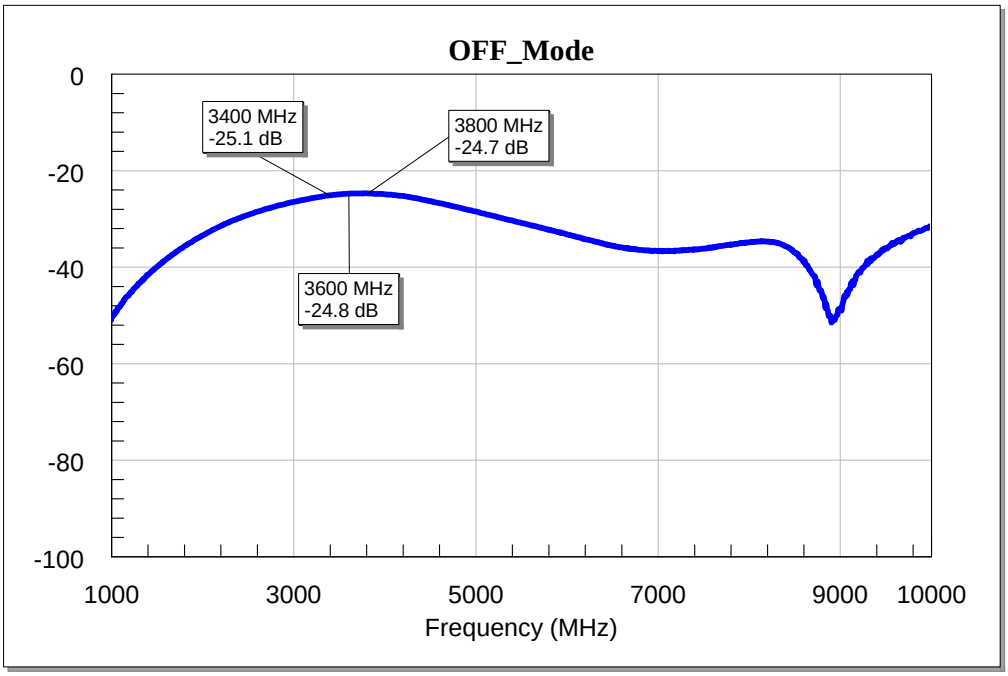

Figure 15 OFF-Mode (Vcc = 0V, Icc = 0mA) S21 of the 3.4 – 3.8 GHz LNA with BFP840FESD

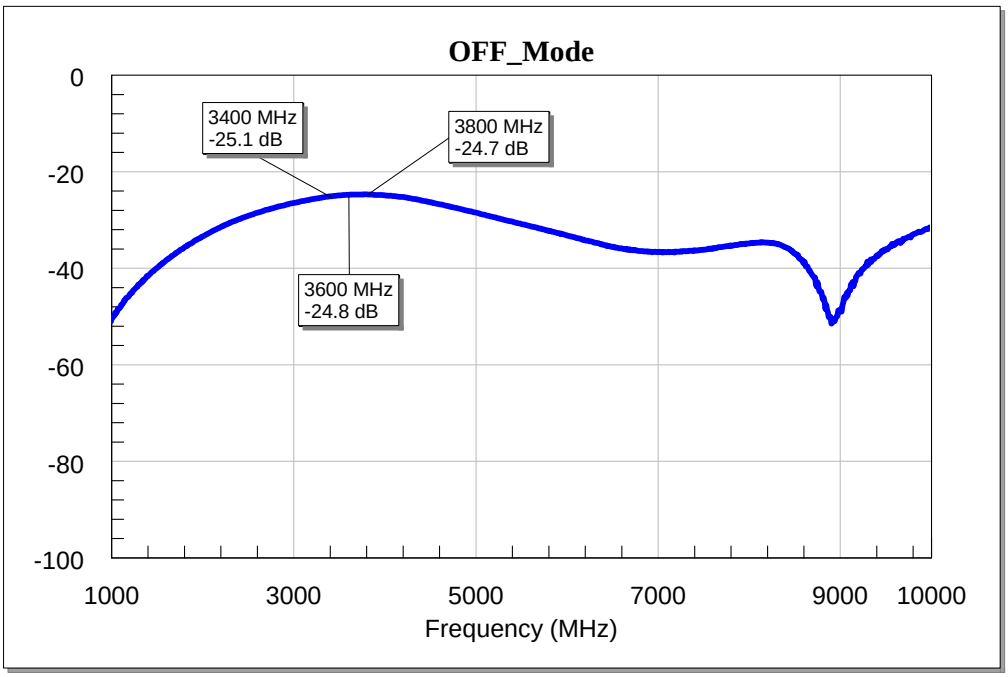

Figure 16 OFF-Mode (Vcc = 0V, Icc = 0mA) S21 of the 3.4 – 3.8 GHz LNA with BFP840FESD

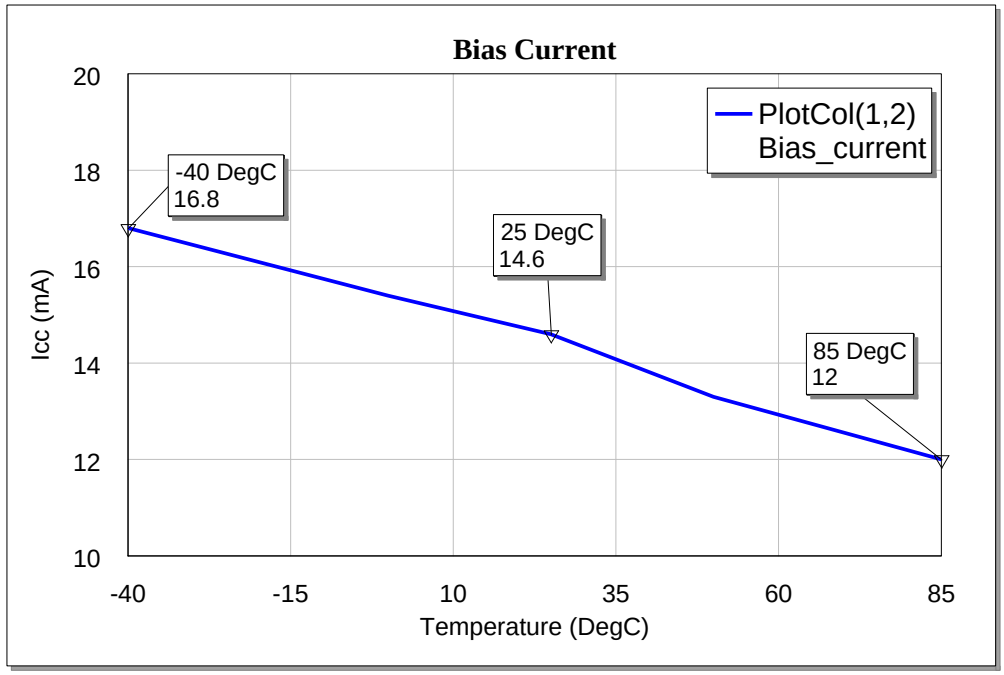

Figure 17 Bias current in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

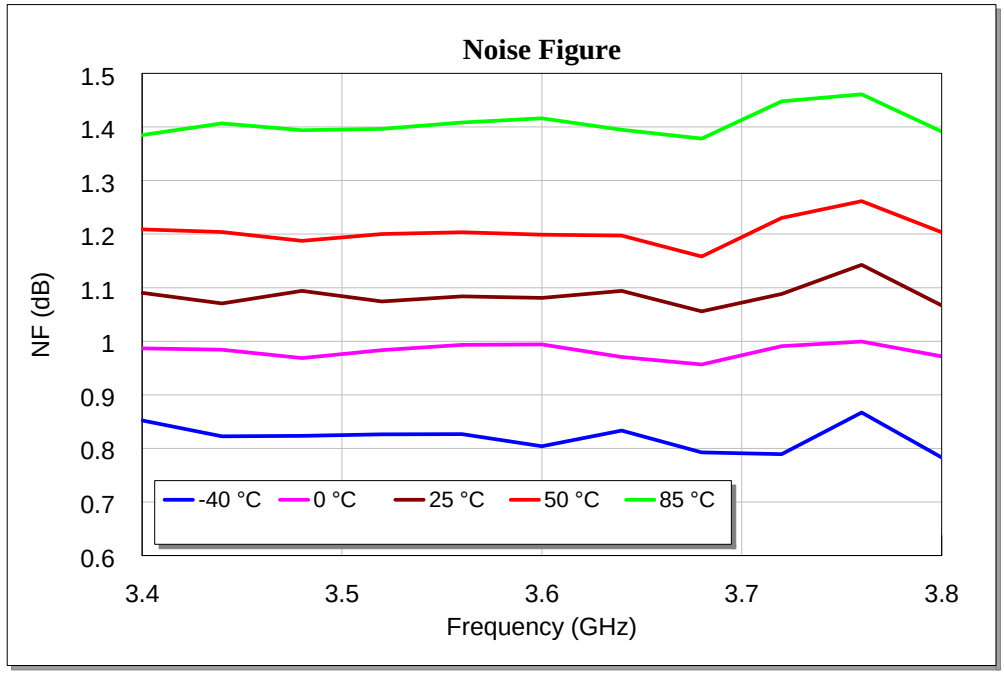

Figure 18 Noise Figure of BFP840FESD LNA in the Temperature Range from -40˚C to 85˚C (Vcc=3.0V)

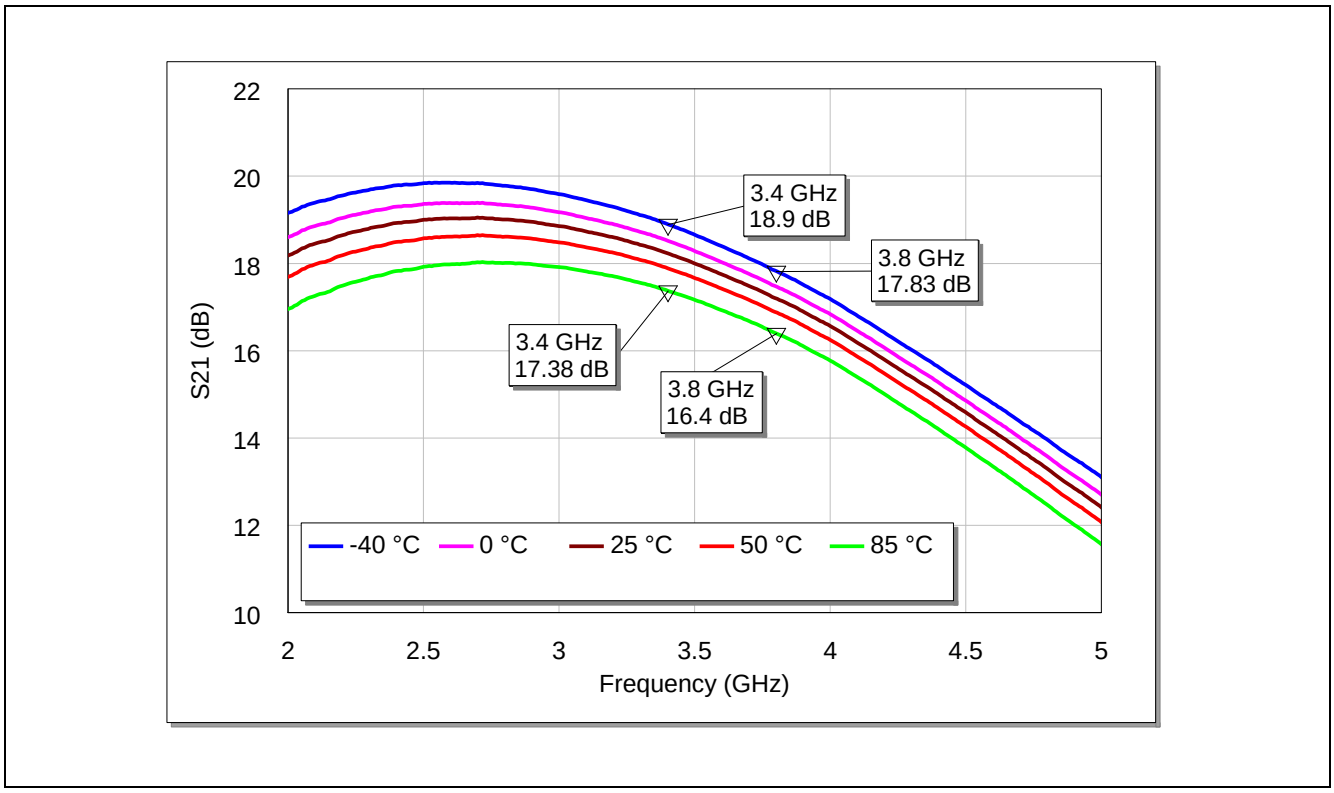

Figure 19 BFP840FESD LNA Insertion Power Gain in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

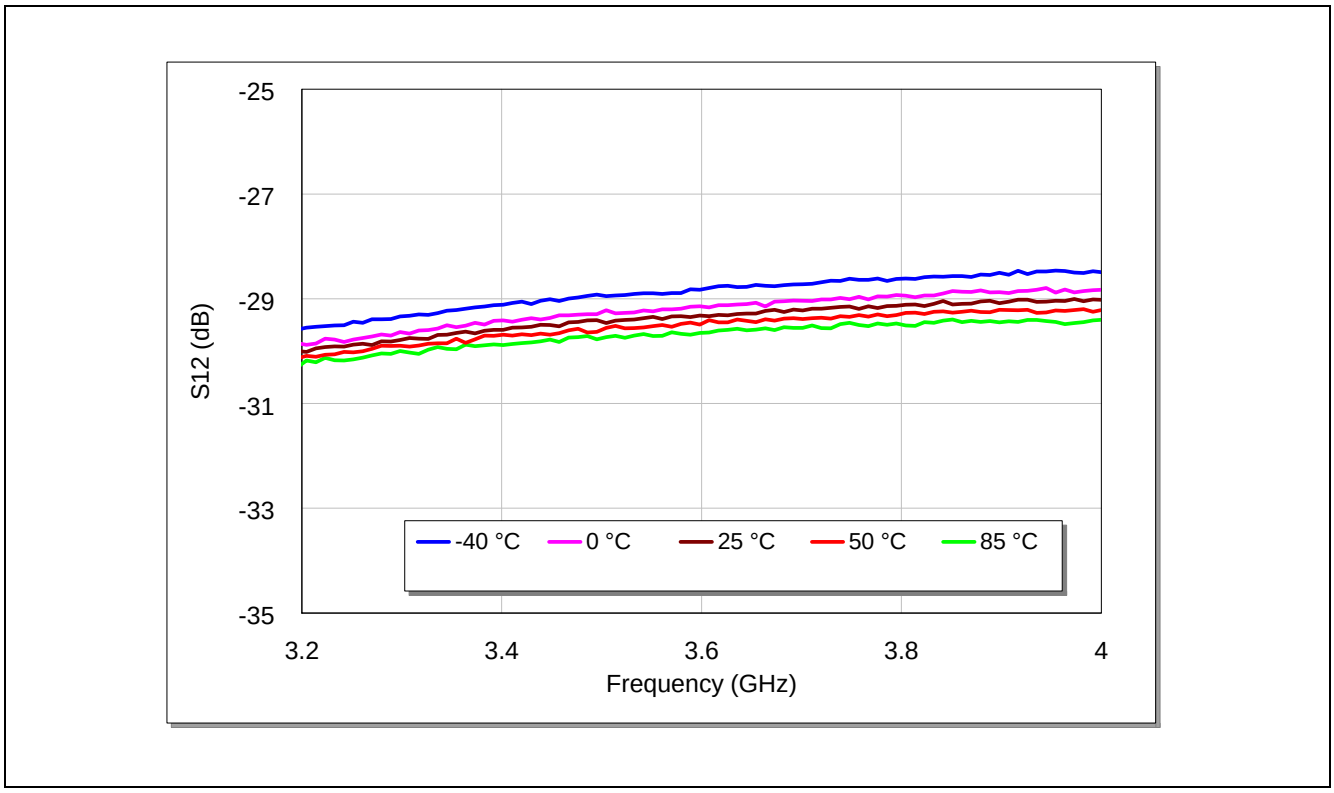

Figure 20 BFP840FESD LNA Reverse Isolation in the Temperature Range from -40˚C to 85˚C (Vcc=3.0V)

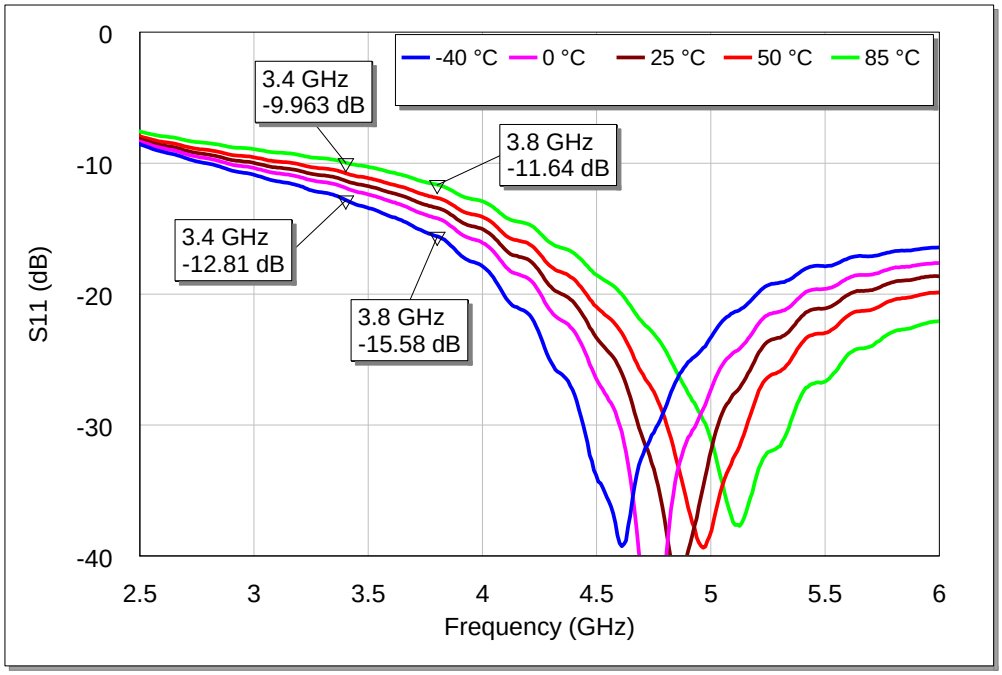

Figure 21 BFP840FESD LNA Input Matching in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

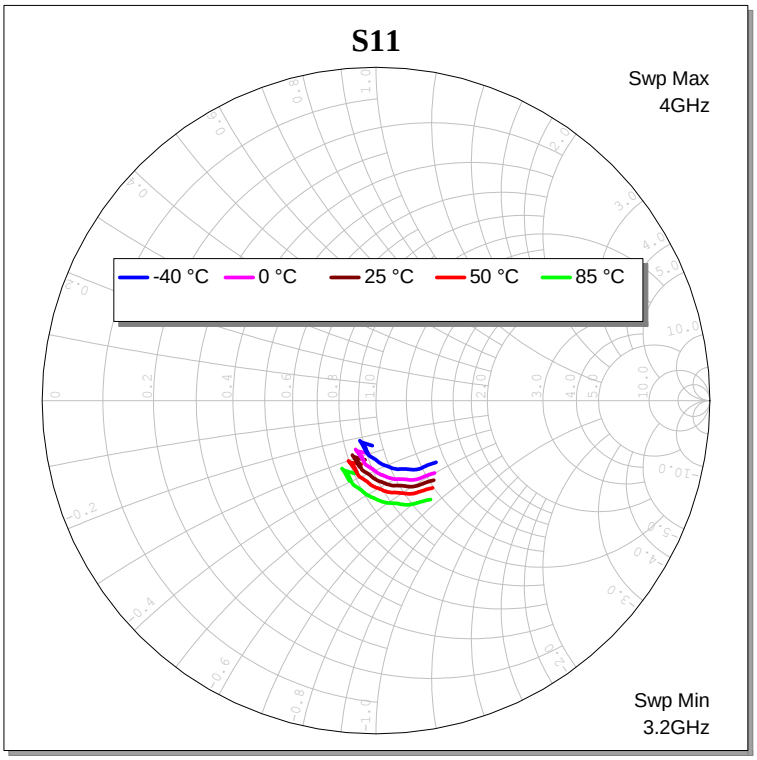

Figure 22 BFP840FESD LNA Input Matching in the Temperature Range from -40˚C to 85˚C (Smith Chart) (Vcc=3.0 V)

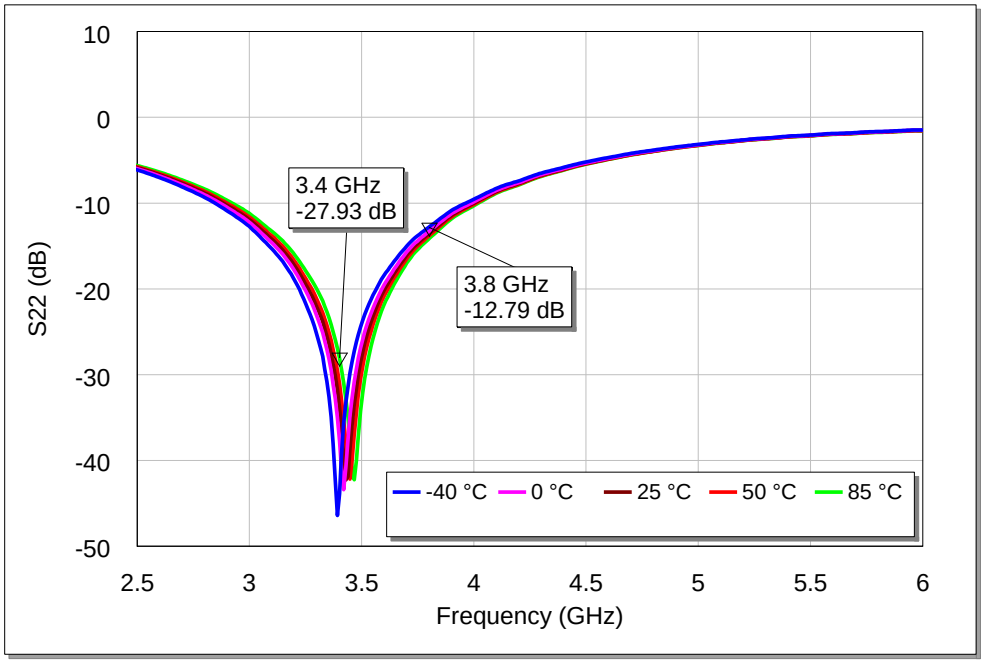

Figure 23 BFP840FESD LNA Output Matching in the Temperature Range from -40˚C to 85˚C (Vcc=3.0V)

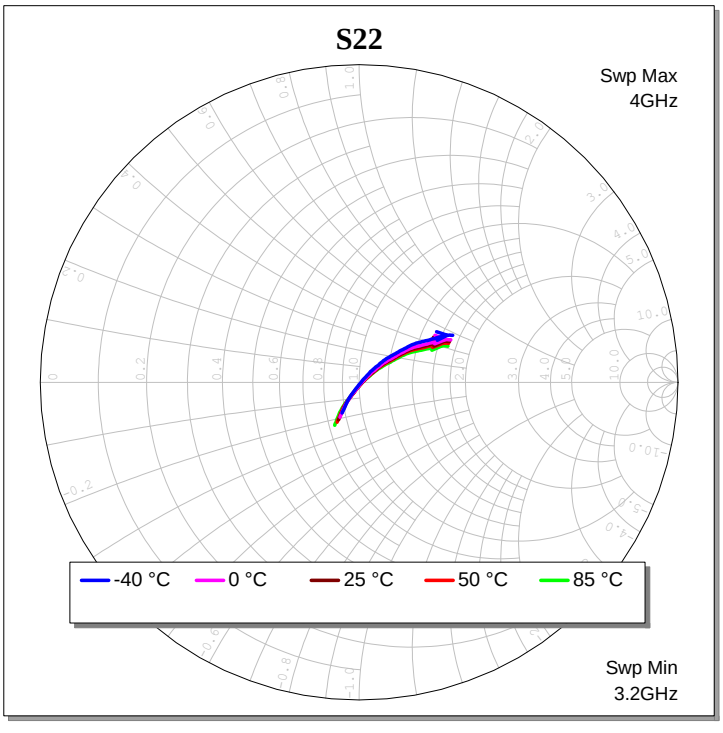

Figure 24 BFP840FESD LNA Output Matching in the temperature range from -40 ˚C to 85 ˚C (Smith Chart) (Vcc=3.0 V)

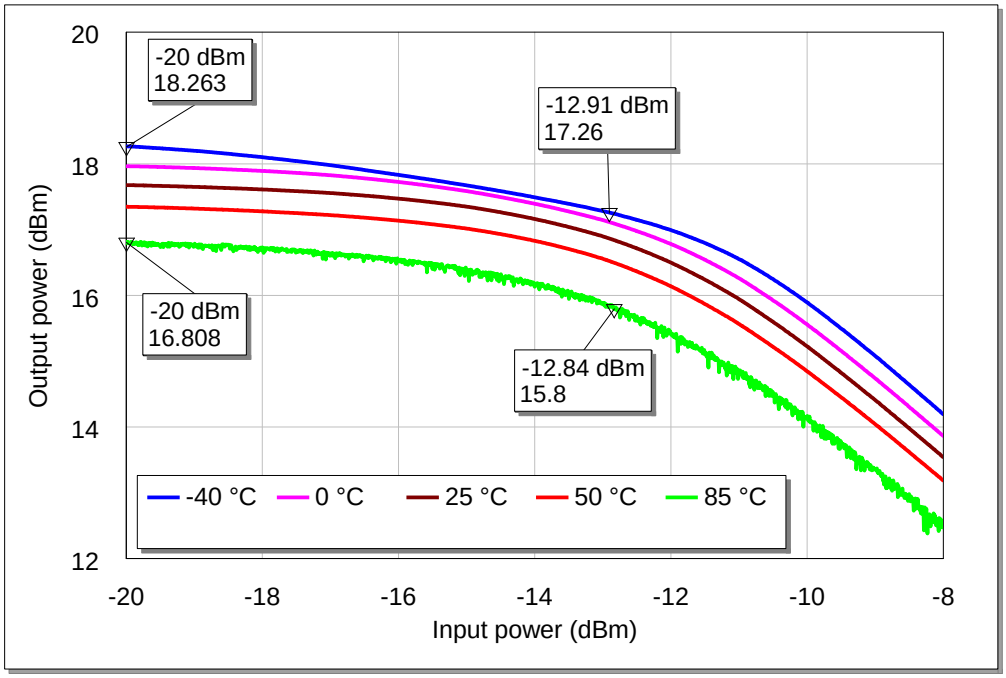

Figure 25 1dB Compression Point of the BFP840FESD LNA at 3.6 GHz in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

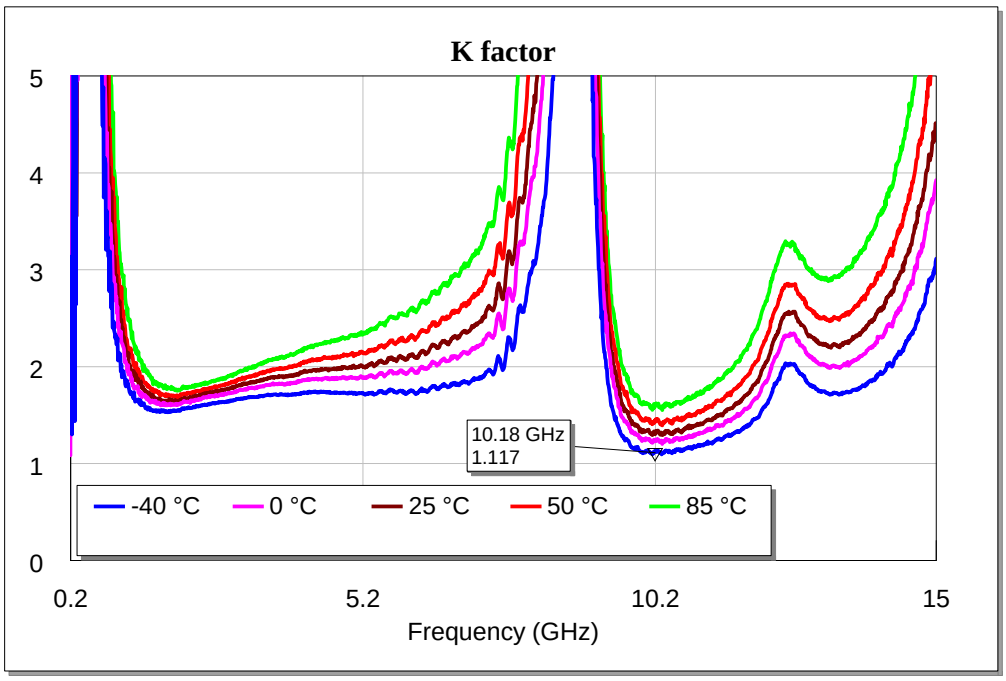

Figure 26 K Factor of the BFP840FESD LNA in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

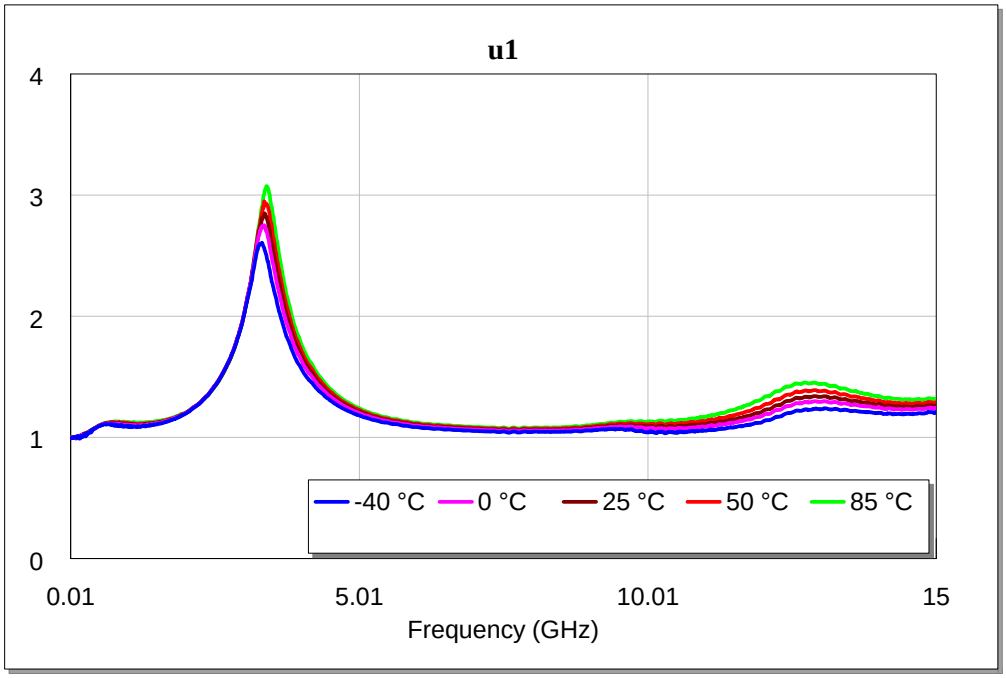

Figure 27 µ1 Factor of the BFP840FESD LNA in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

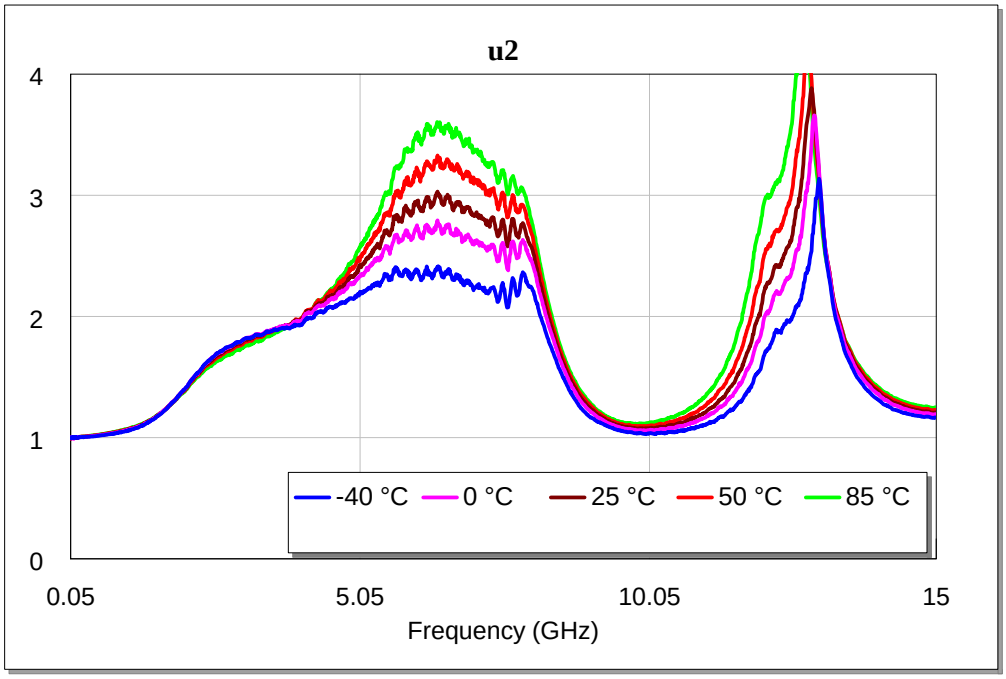

Figure 28 µ2 Factor of the BFP840FESD LNA in the Temperature Range from -40˚C to 85˚C (Vcc=3.0 V)

3 Evaluation Board and layout Information

In this Technical Report, the following PCB is used:

PCB Marking: M13031106 0.6mmEDG TSFP-4-1 BFP840FESD

PCB Board Material: Standard FR4

ε_r of PCB Material: 4.3 (FR4)

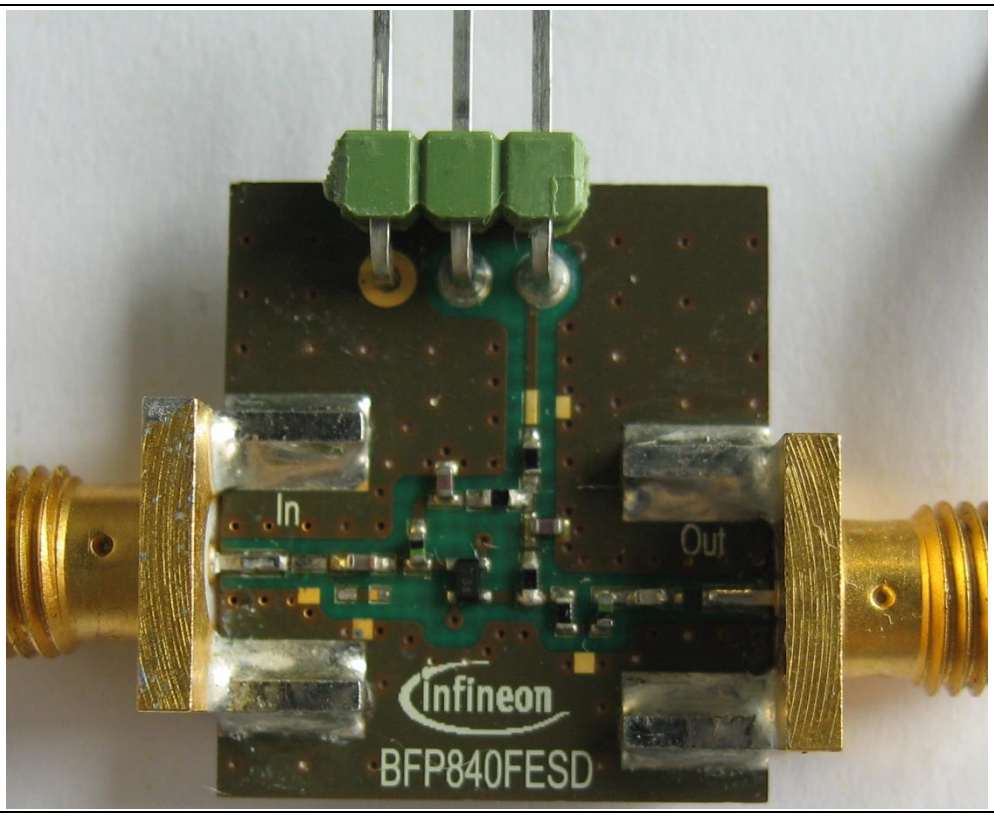

Figure 29 Photo Picture of Evaluation Board

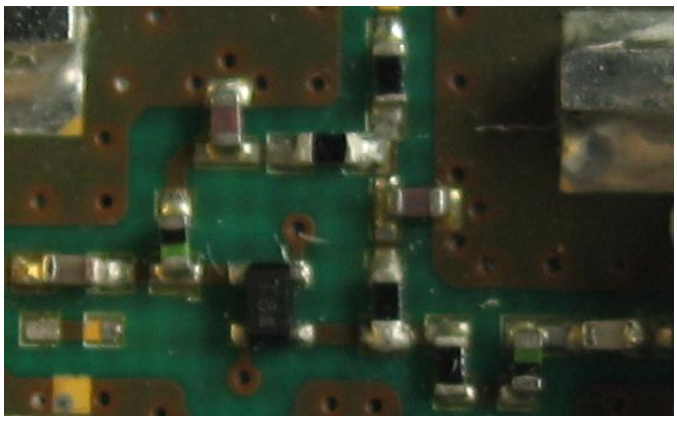

Figure 30 Zoom-In Picture of the BFP840FESD 3.4 – 3.8 GHz LNA Evaluation Board

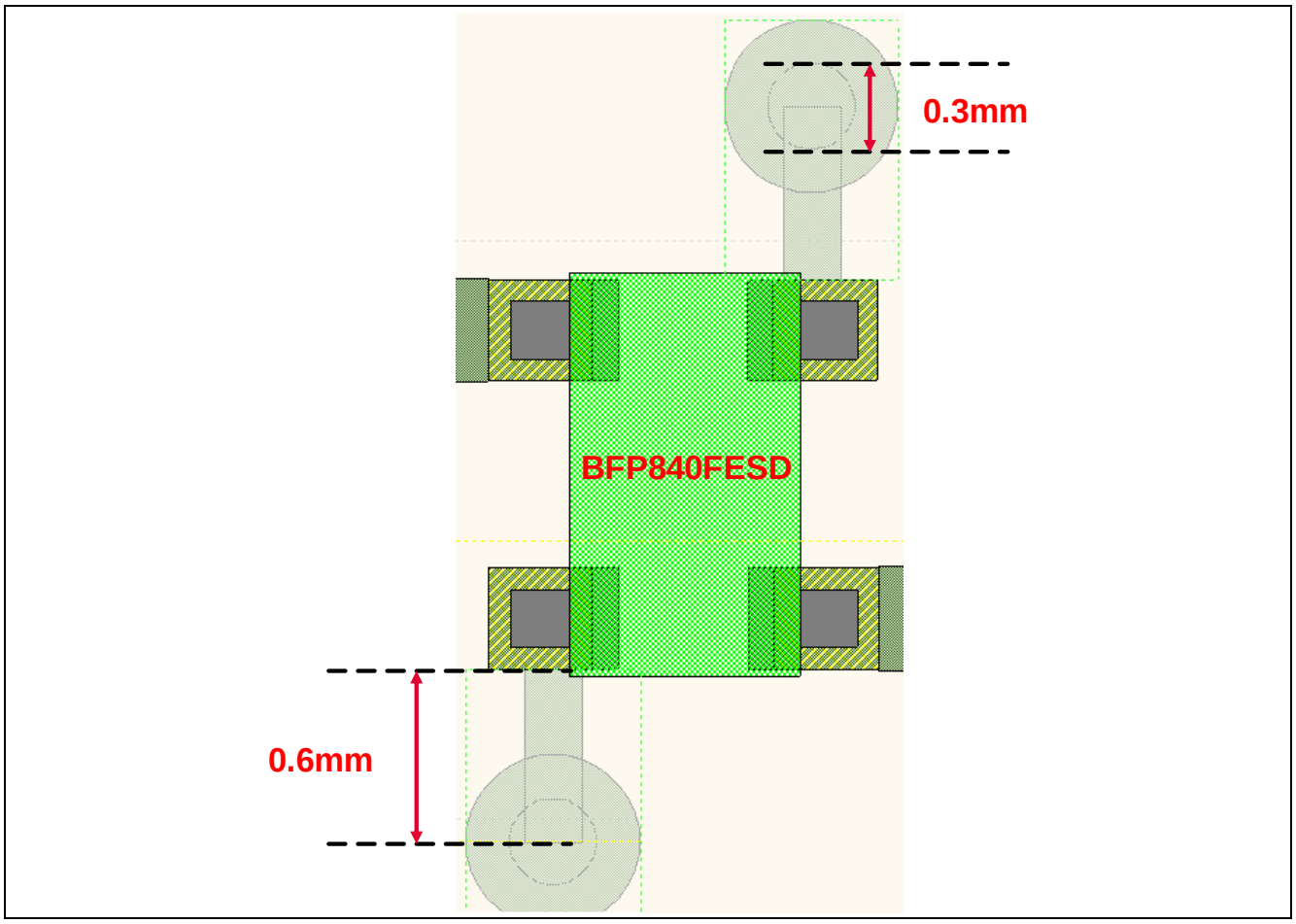

Figure 31 Layout Proposal for RF Grounding of the 3.4 – 3.8 GHz LNA with BFP840FESD

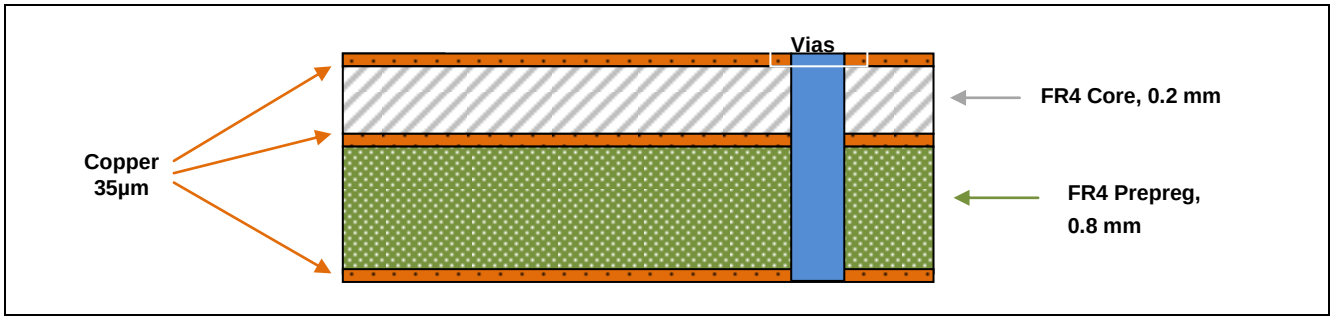

Figure 32 PCB Layer Information

4 Authors

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

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