ESD-Robust BFP740FESD

2.3~2.7GHz WiFi/WiMAX LNA Applications

Application Note AN217

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RF and Protection Devices

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Page	Subjects (major changes since last revision)

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1 Introduction

The BFP740FESD is one of outstanding performance RF bipolar transistors intented to a wide range of wireless applications. It is based upon Infineon Technologies' B7HF 220 GHz fT Silicon Germanium Carbon (SiGe:C) technology, allowing for a cost-effective solution with excellent performance at low current consumption.
Besides RF bipolar transistor, Infineon Technologies Provides also an interesting range of components for WIFI/WIMAX systems like the Discretes switches, WIFI/WIMAX MMIC and Diodes for additive ESD protection.

1.1 Applications

The actual application note presents the performance of BFP740FESD protected by an ESD protection diode circuit (maximum peak voltage of 3kV). Using BFP740FESD on electronic applications offers the security to protect the devices by Electro Static Discharge. Therefore, the BFP740FESD avoids adding additional part in order to protect the system of ESD.

The BFP740FESD is presented here using external parts for WLAN & WiMAX configuration. (please refer to Figure 1).

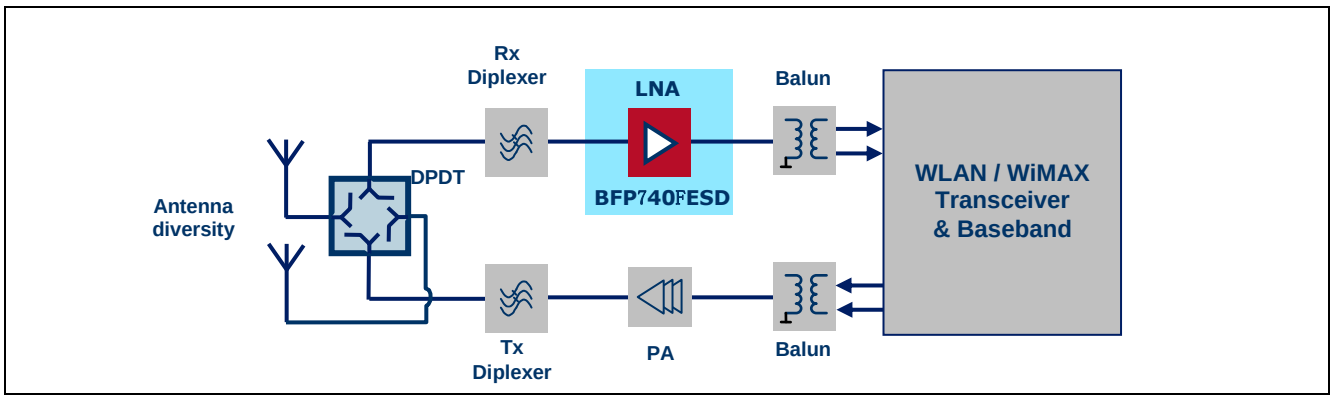

Figure 1 Application Diagra

2 Application Information

This amplifier for WIFI/WIMAX application shown in Figure2 is realized by using 11 pieces of external components. The resistors of R1,R2 and R3 make BFP740FESD working with 13.1 mA at 2.9 V. The microsrips of TL1 and TL2 in between emitter and ground can improve the input matching and IIP3. R2 makes big contribution to stability and RF matching. **In order to avoid unexpected feedback amoung the input, output, Vcc line and emitter grounding, the grounding positions of C2, C3/C4 and the microstrips M1 must be well separated.**

Table 1 shows the bill of materials used in this circuit.

2.1 Schematics

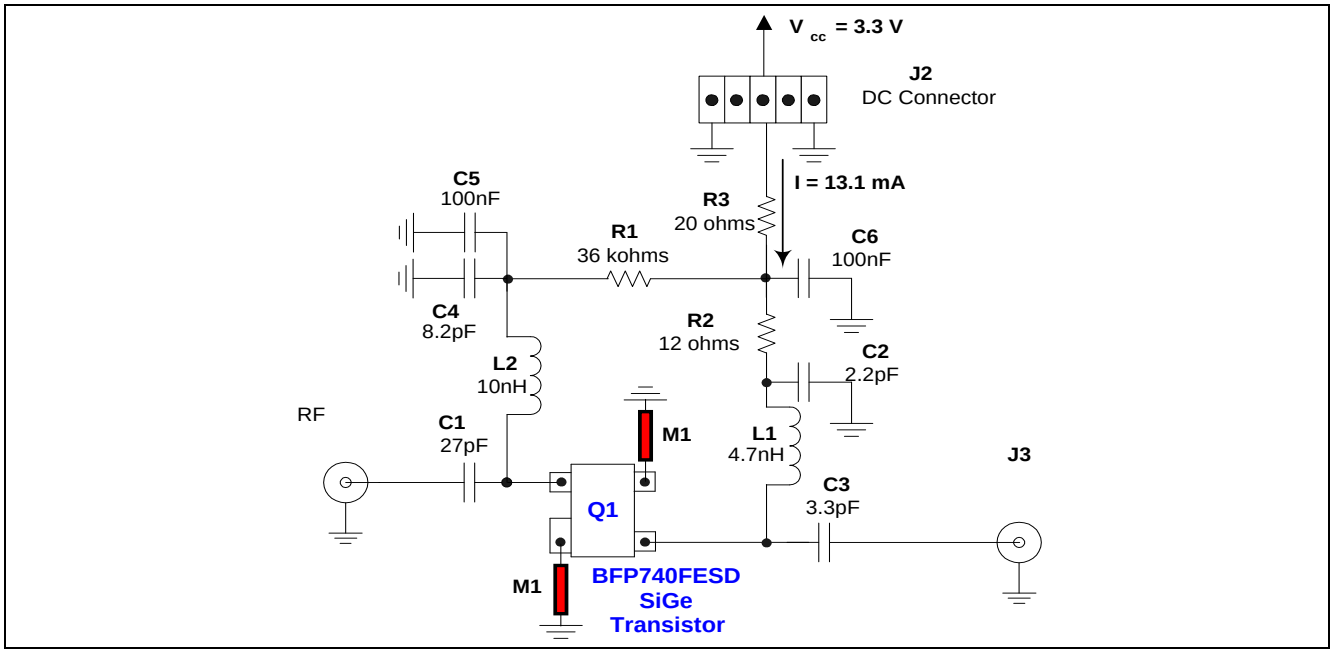

Figure 2 Schematics of the application circuit

Table 1 Bill-of-Materials

Symbol	Value	Unit	Size	Manufacturer	Comment
C1	27pF	pF	0402	various	DC block
C2	2.2	pF	0402	various	Out put matching
C3	3.3	pF	0402	various	Output matching/DC block
C4	8.2	pF	0402	various	RF short
C5	100	nF	0402	various	IP3 improvement
C6	100	nF	0402	various	RF short
L1	4.7	nH	0402	various	Output matching
L2	10	nH	0402	various	Input matching
R1	36	kΩ	0402	various	DC biasing
R2	12	Ω	0402	various	Stability impovement
R3	20	Ω	0402	various	DC biasing
Q1	BFP740FESD		TSFP-4-1	Infineon	Active device

3 Typical Measurement Results

The amplifier for WiFI/WIMAX application is covering 2.3~2.7GHz with a good matching. At typical frequency of 2.45GHz, The absolutely stable solution with BFP740FESD offers the Gain of 17.6dB and the Noise Figure of 0.78dB, featuring 13.6dBm of OIP3 and 9.4dB of OP1dB.

Table 2 Electrical Characteristics (at room temperature)

Text

Parameter	Symbol	Value	Unit	Comment/Test Condition
Frequency Range	Freq	2.3~2.7	GHz	
DC Voltage	Vcc	3.3	V	
DC Current	Icc	13.1	mA	
Gain	G	17.6	dB	f=2450MHz
Noise Figure	NF	0.78	dB	f=2450MHz
Input Return Loss	RLin	-12.9	dB	f=2450MHz
Output Return Loss	RLout	-15.7	dB	f=2450MHz
Reverse Isolation	IRev	-26	dB	f=2450MHz
Input P1dB	IP1dB	-7.5	dBm	F=2450MHz
Output P1dB	OP1dB	9.4	dBm	F=2450MHz
Input IP3	IIP3	-4	dBm	Tune1=-33dBm@2449.5MHz Tune2=-33dBm@2450.5MHz
Output IP3	OIP3	13.6	dBm	Tune1=-33dBm@2449.5MHz Tune2=-33dBm@2450.5MHz
Stability	k	>1	--	Over 0.1~6GHz

4 Measured Graphs

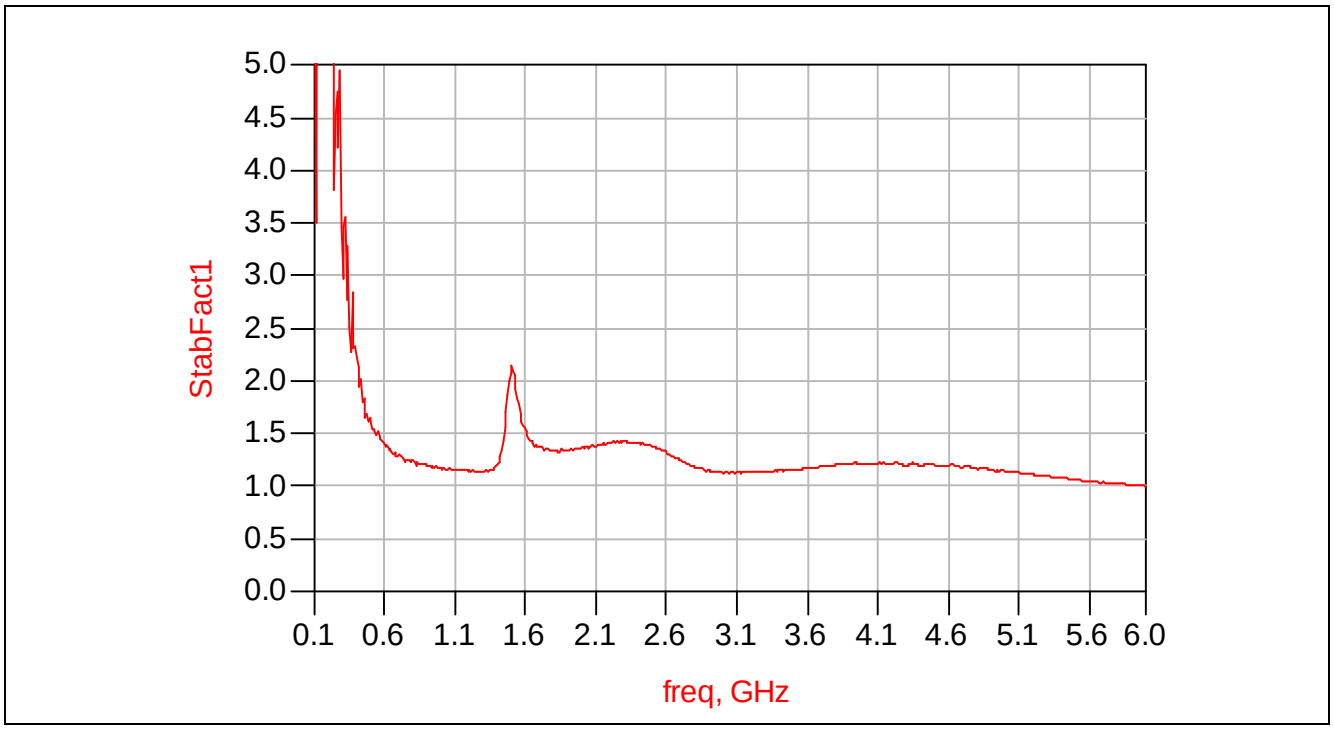

Figure 3 K Factor of stability

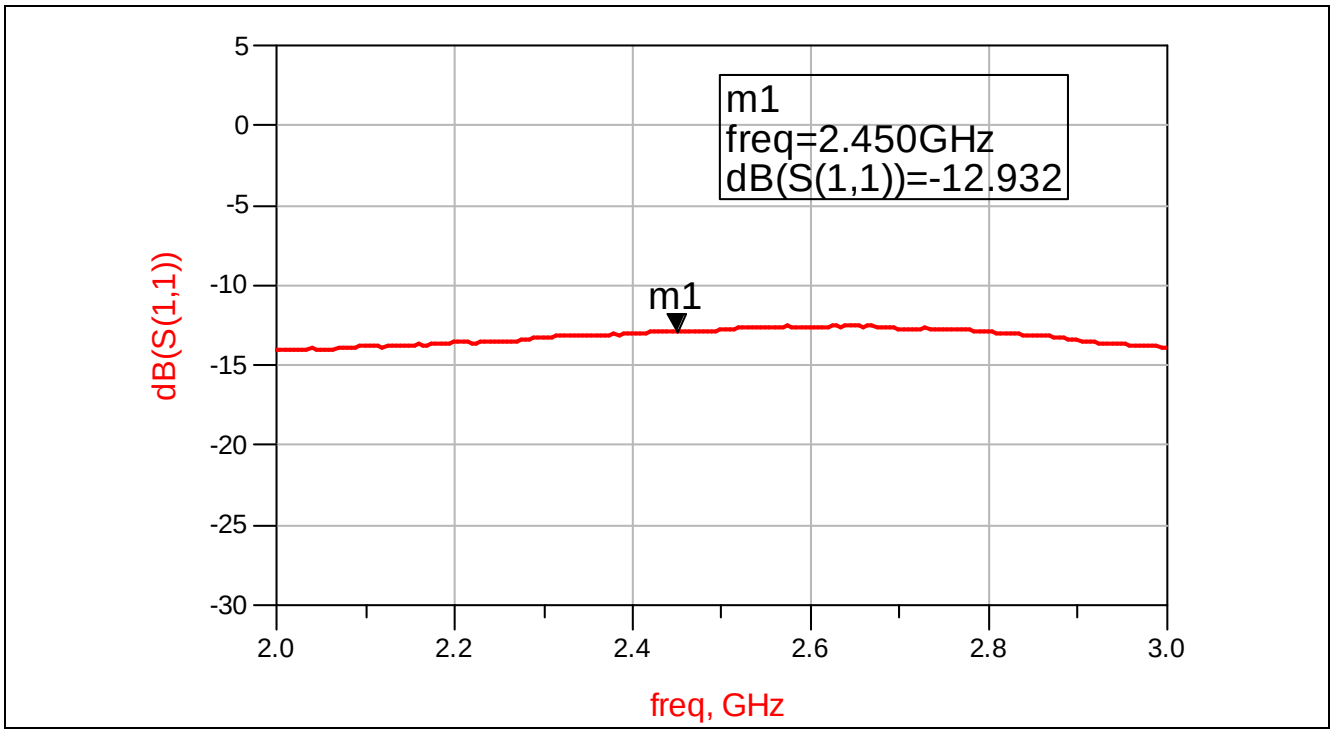

Figure 4 Input Return loss S11

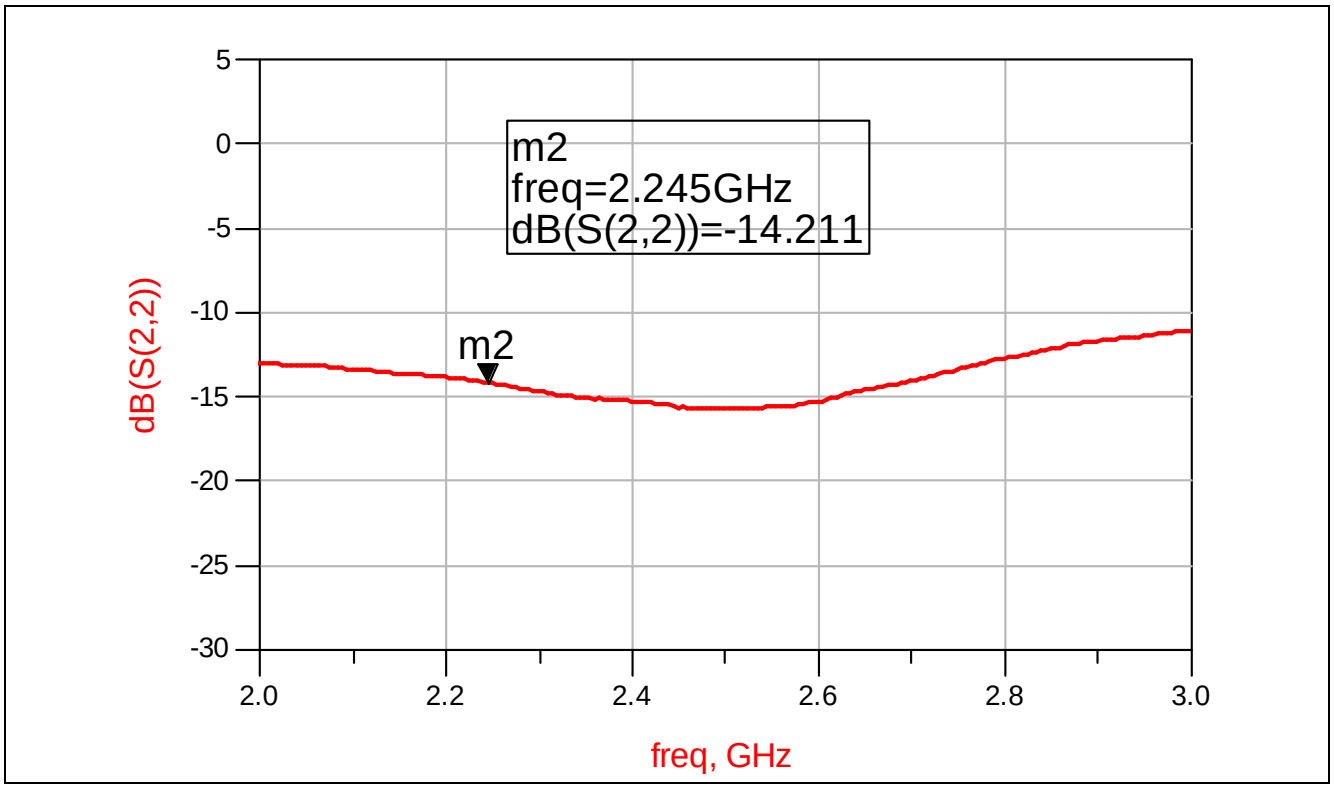

Figure 5 Output Return Loss S22

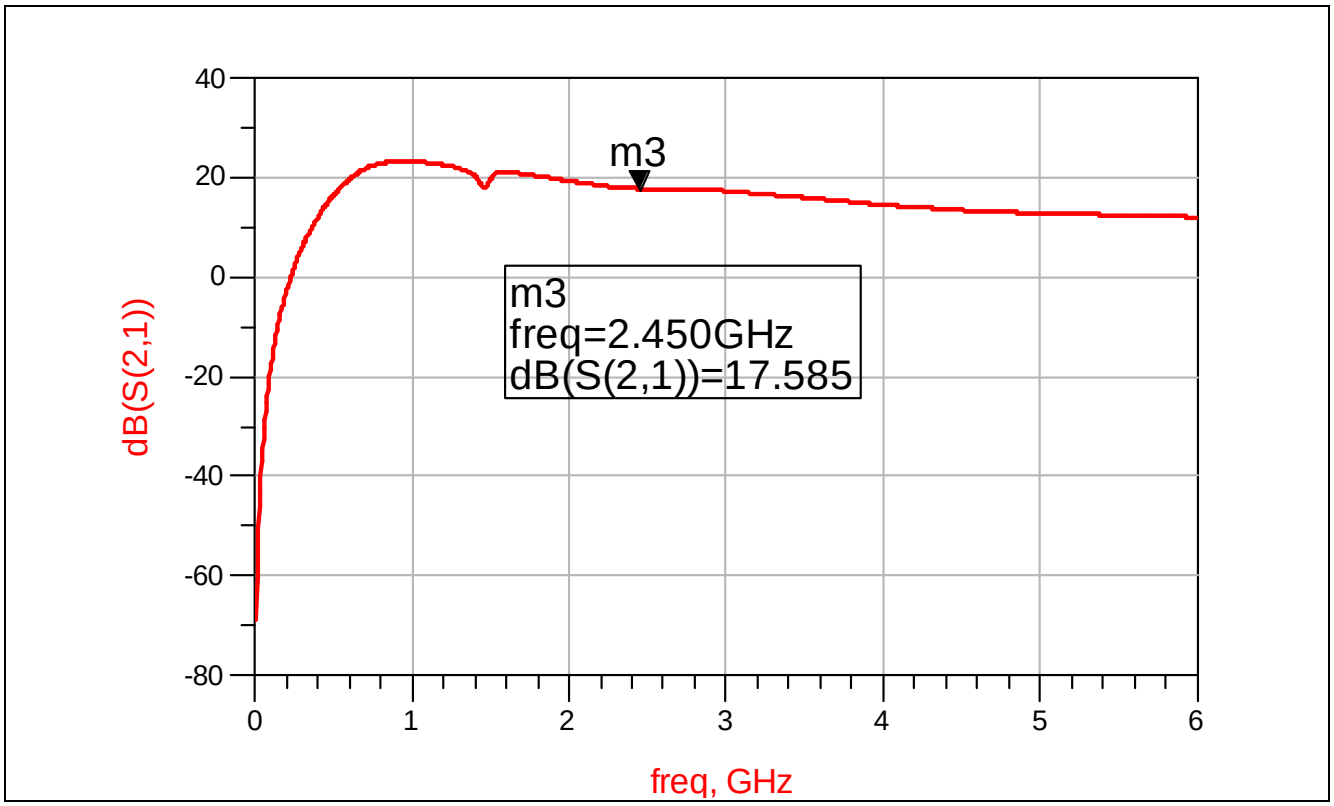

Figure 6 Forward Gain S21

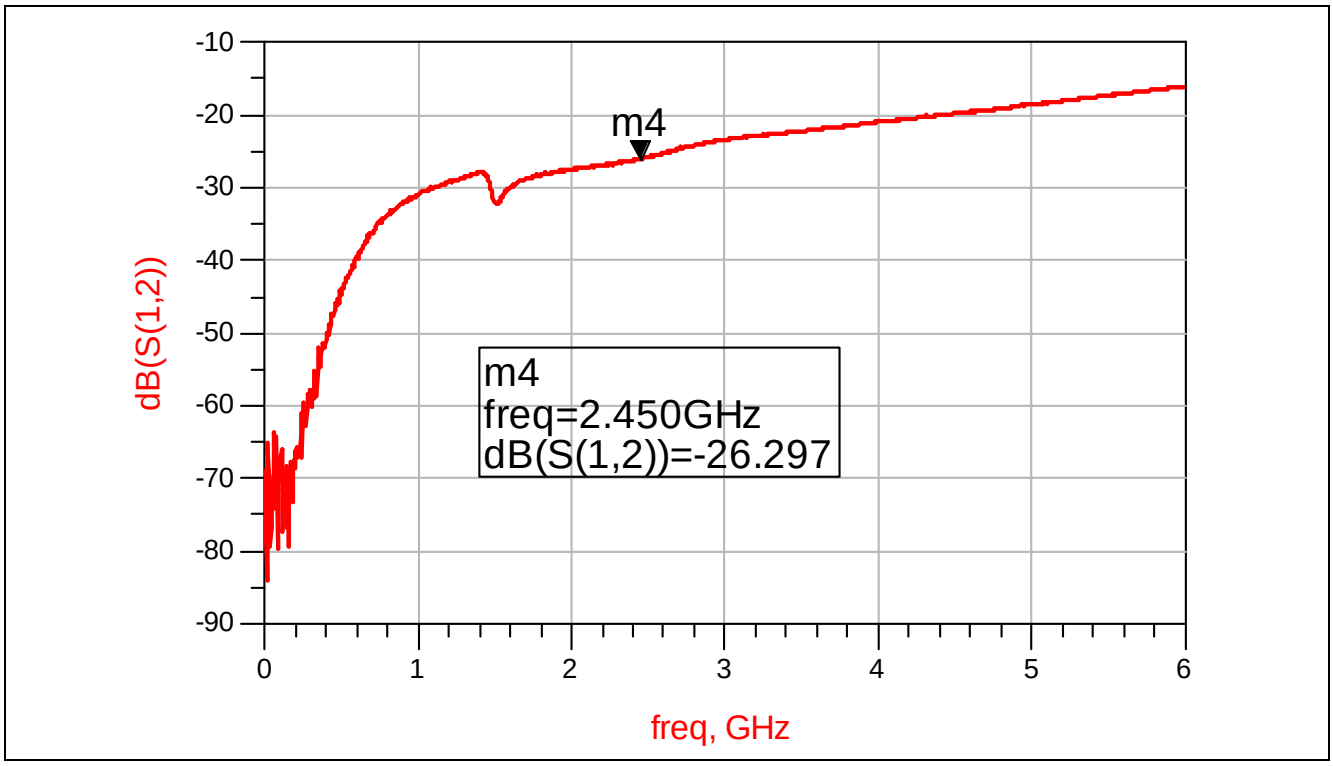

Figure 7 Reverse Isolation S12

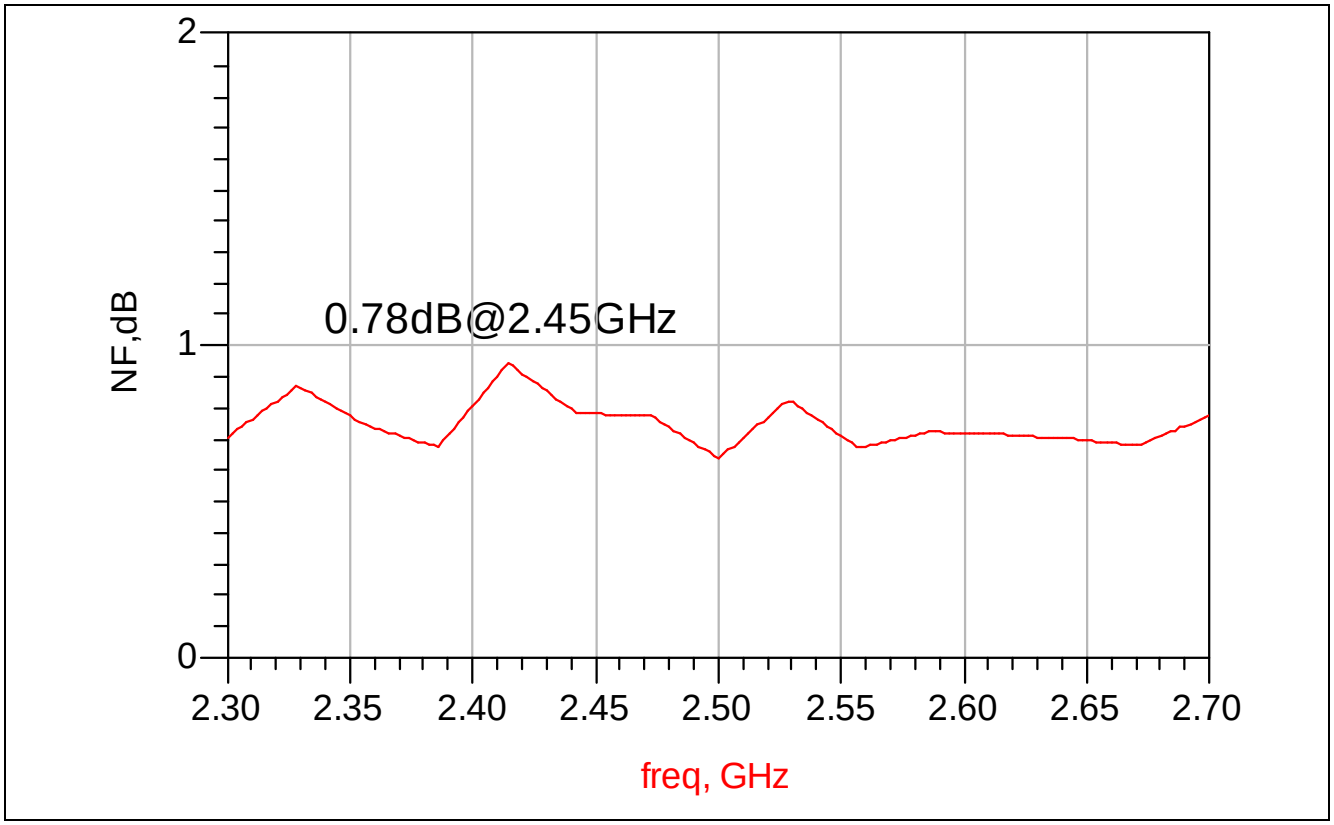

Figure 8 Noise Figure

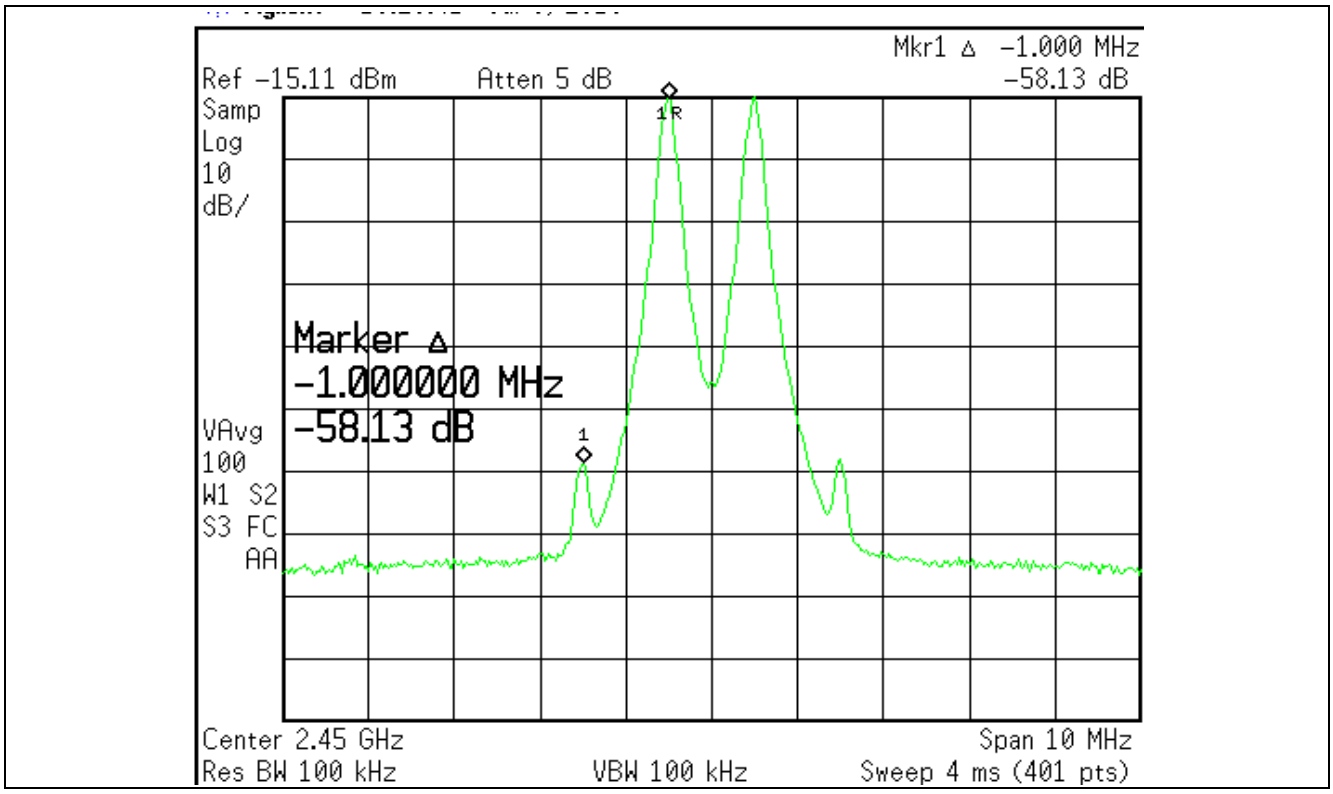

Figure 9 IIP3= -33dBm+ 58/2=-4dBm, OIP3=-4+17.5=13.5dB

Tone1=-33dBm@2449.5MHz, Tone2=-33dBm@2450.5MHz

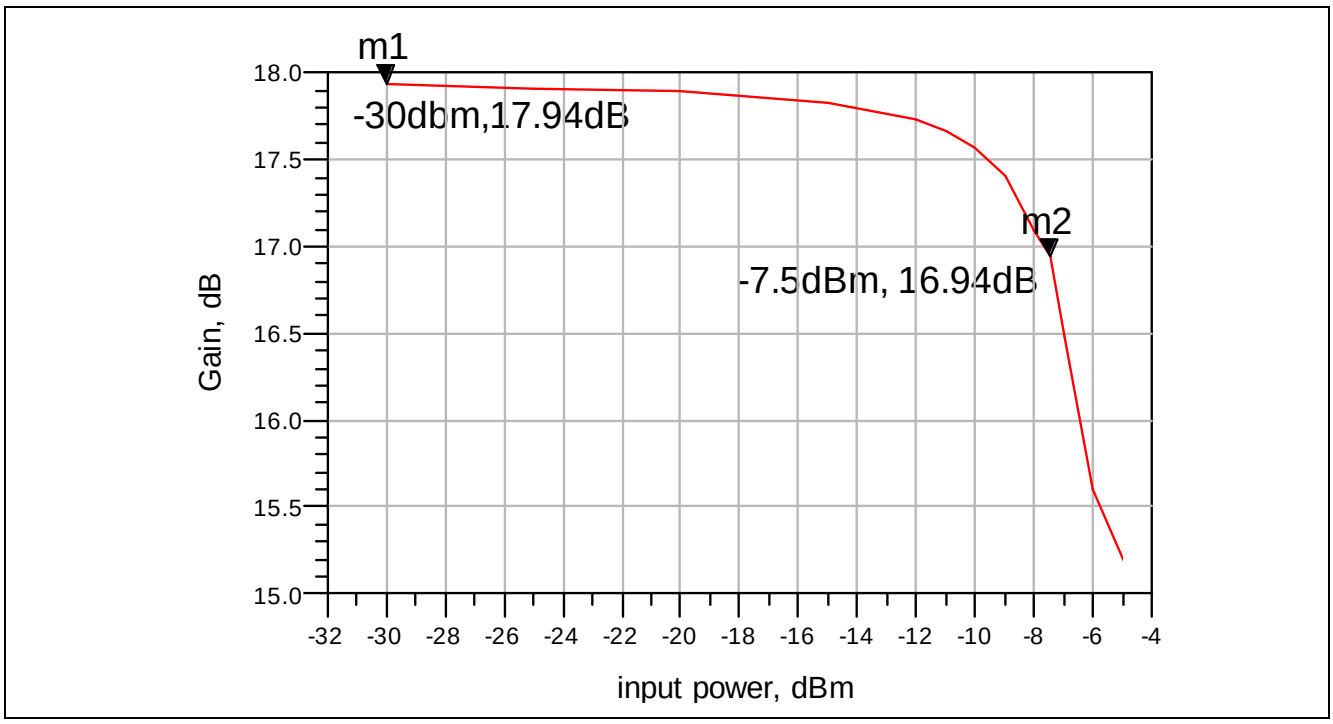

Figure 10 Input P1dB=-10.24dBm@2.45G, Output P1dB=6.1dBm

5 Evaluation Board and layout Information

Figure 11 Photo Picture of Evaluation Board

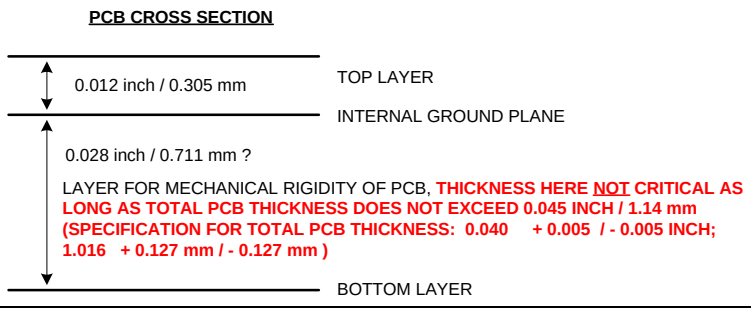

Figure 12 PCB Layout Information

6 ESD Protection

Electrostatic discharge (ESD) plays an important role when ESD sensitive devices are connected to exposed interfaces or antennas that can be touched by humans. This is usually applicable to low noise amplifiers (LNAs) and therefore LNAs must be properly protected against ESD in order to avoid irreversible damage of the LNA.

For mobile applications low voltage supply and low current consumption is a major issue that requires new technologies with smaller transistor structures. However, the smaller the transistor structure the more sensitive the transistor is to ESD events. Therefore, RF-LNAs based on new front-end technologies have already ESD protection elements integrated on-chip, e.g. BFP740FESD, BFP640FESD, BFP540FESD. These on-chip ESD protection techniques are always a compromise between good ESD protection and RF performance. Integrated RF ESD concepts hardly ever achieve an ESD protection above 2 kV according HBM. An on-chip ESD protection of ±1 kV HBM (component level ESD test JEDEC JESD 22-A115) is quite sufficient to protect the chip from ESD events in the manufacturing environment where stringent measures are taken to prevent electrostatic buildup. However in the field, exposed antennas, for example, always require higher ESD protection levels of at least ±8kV up to ±15kV. Additional the more stringent system level test according to IEC61000-4-2 is applied. Therefore an special ESD protection becomes mandatory to handle the majority of the ESD current. An ESD protection based on silicon TVS diodes fits perfect to keep the residual ESD stress for the subsequent device as small as possible.

For high frequency applications (2.4GHz and 5GHz WLAN) ESD protection diodes with ultra low line capacitances are required. Infineon offers ultra low clamping voltage and ultra low capacitance, 0.2pF line capacitance, ESD protection diodes in leadless packages of EIA case 0402 (TSLP-2-17) as well as 0201 (TSSLP-2-1):

6.1 ESD0P2RF-02LRH / -02LS

The Infineon TVS diode ESD0P2RF has a line capacitance of only 0.2 pF and comes in either a TSLP-2-17 package (1 mm x 0.6 mm x 0.39 mm) or a super small TSSLP-2-1 package (0.62 mm x 0.32 mm x 0.31 mm).

The ESD0P2 ESD diode is a bidirectional TVS diode with a maximum working voltage of ±5.3V. It is capable of handling TX power levels of up to +20dBm without influencing the signal integrity, EVM and harmonic generation. Therefore it is well suited for WLAN 2.4GHz and for a lot of 5GHz applications as well.

Authors

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