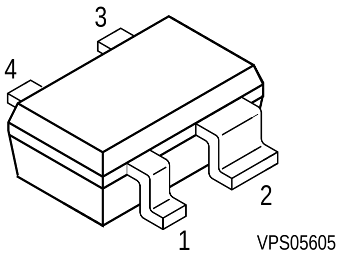
Wide Band Amplifiers for the 1.7 GHz to 2.5 GHz Frequency Range using BGB420 and BGB540

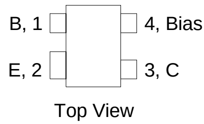
Features

- **Current easily adjustable by only one external resistor**
- **Temperature stabilized bias point**
- **No voltage drop at the collector due to mirror biasing**

Applications

- Low noise amplifier, buffer amplifier or driver amplifier for 800/900MHz, GSM900, 900 MHz ISM, DCS1800, DECT, GPS, 1900 MHz PCS, UMTS, W-CDMA, Bluetooth and WLAN.
- Wide band amplifiers and oscillators for a wide variety of applications.
- Ideal for cellular phones, cordless telephones, WLANs, SAT-TV and many other RF products more.





Introduction

Infineon's BGB420 and BGB540 are active biased transistors based on Infineon's B6HF and B6HFplus RF bipolar technologies and housed in a SOT343 package. More exactly speaking, the BGBs are mirror biased versions of Infineon's popular BFP420 and BFP540. The mirrored transistors are matched with a ratio of 1:10. Like the BFPs the BGBs are suited for a large variety of applications in all kind of RF products.

The use of a mirror biased transistor offers several advantages. There is only one external resistor required for bias point adjustment which reduces a circuit's parts count and area consumption. Additionally no voltage drop occurs at the collector of the "active" transistor due to biasing, allowing to utilize the full range of the applied voltage supply. Another feature of the BGBs is the reduced bias current drift over temperature provided by the mirror bias concept.

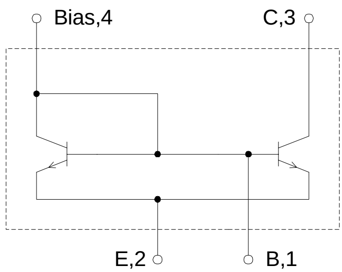


Figure 1 BGB420 / BGB540, Schematic Diagram

Performance Overview

The following table shows the measured performance of the application circuits in **Figure 3** and **Figure 12**. All measurement values presented in this application note include losses of both PCB and connectors - in other words, the reference planes used for measurements are the PCB's RF SMA connectors. Noise figure and gain results shown do not have any PCB loss extracted from them.
For more detailed measured performance data please refer to the measurement graphs starting on **page 5** and **page 10**.

Table 1 Performance Overview

Parameter		BGB420	BGB540
Supply voltage		3 V	
Supply current		19.4 mA	20.0 mA
Gain	1.85GHz 2.14 GHz 2.4 GHz	14.0 dB 13.2 dB 12.3 dB	14.6 dB 13.8 dB 12.9 dB
Noise Figure	1.85GHz 2.14 GHz 2.4 GHz	2.4 dB 2.5 dB 2.6 dB	2.1 dB 2.2 dB 2.3 dB
Input return loss	1.85GHz 2.14 GHz 2.4 GHz	17.6 dB 20.8 dB 17.8 dB	17.5 dB 31.6 dB 23.8 dB
Output return loss	1.85GHz 2.14 GHz 2.4 GHz	26.9 dB 13.9 dB 11.3 dB	37.1 dB 14.6 dB 11.3 dB
Reverse Isolation	1.85GHz 2.14 GHz 2.4 GHz	22.6 dB 13.9 dB 11.3 dB	23.2 dB 21.3 dB 20.0 dB
Input compression point	1.85GHz 2.14 GHz 2.4 GHz	-3 dBm -2 dBm -1 dBm	-3 dBm -2 dBm 0 dBm
Input 3rd order intercept point[1)]	1.85GHz 2.14 GHz 2.4 GHz	8 dBm 9 dBm 10 dBm	7 dBm 9 dBm 10 dBm

[1)] -20 dBm per tone, Δf = 1 MHz

Circuit design with BGB420 and BGB540

Designing RF circuits with Infineon's mirror biased RF transistors BFP420 and BFP540 is very similar to circuit design with discrete bipolar transistors. **Figure 3** and **Figure 12** show the topology of the circuits presented in this application note. The only difference of these circuits in comparison to a circuit employing a conventional bipolar transistor is the biasing of the active device while the RF part of the circuitry is the same.

As already mentioned in the introduction the current I_C flowing into the actual RF transistor is controlled by the current I_{Bias} of the mirror transistor.

$$I_C = 10 \cdot I_{Bias} \qquad [1]$$

I_{Bias} is adjusted by the resistor R_2 between V_{CC} and the bias pin 4. **Figure 2** shows the dependence of the total device current I_D on the supply voltage for different values of R_2. The value of R_2 can be calculated by means of the following approximated equation:

$$R \cong \frac{10 \cdot V_{CC} - 8.2\ V - 250\Omega \cdot I_D}{I_D} \qquad [2]$$

Compared to conventional biasing the rather high values of R_2 allow for much more voltage feedback to compensate for h_{FE} variations. In this application circuit the voltage drop over R_2 is about 1.5 V leaving only a V_{CE} of 1.5 V at the mirror transistor while the RF transistor still has a V_{CE} of 3 V. Applying the same amount of voltage feedback to a conventionally biased transistor the collector-emitter voltage of only 1.5 V would dramatically drop performance in terms of linearity and gain.

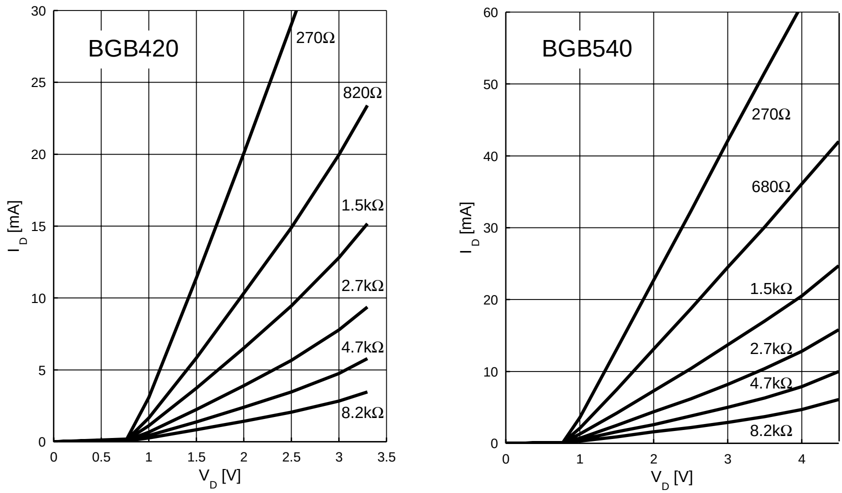


Figure 2 Device Current as a Function of Supply Voltage and Biasing Resistor

1 Amplifier Circuit using BGB420

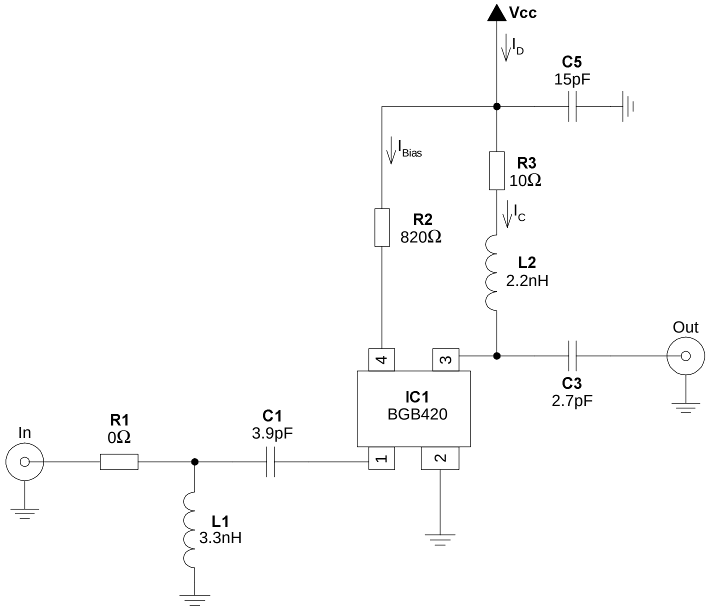


Figure 3 Application Circuit Diagram using BGB420

Table 2 Bill of Materials

Name	Value	Package	Manufacturer	Function
C1	3.9 pF	0402	various	Input matching, DC block
C2	15 pF	0402	various	RF bypass
C3	2.7 pF	0402	various	Output matching, DC block
IC1	BGB420	SOT343	Infineon Technologies	Active biased transistor
L1	3.3 nH	0402	Toko LL 1005-FH	Input matching
L2	2.2 nH	0402	Toko LL 1005-FH	Output matching, RF choke
R1	0 Ω	0402	various	Jumper
R2	820 Ω	0402	various	Supply current adjustment
R3	10 Ω	0402	various	Stabilization, gain flatness

Measured Performance Graphs of the BGB420 Circuit

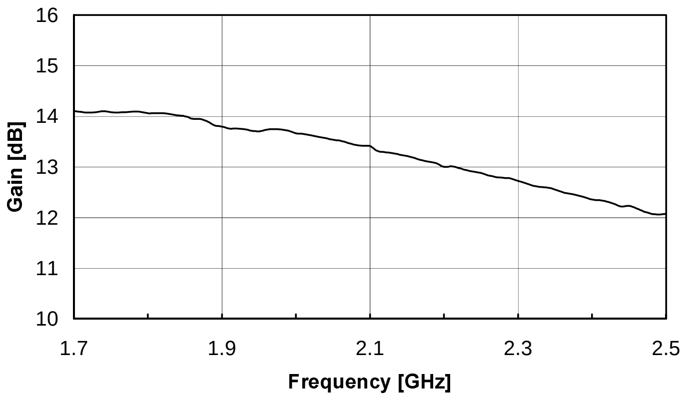


Figure 4 Insertion Gain BGB420 Amplifier

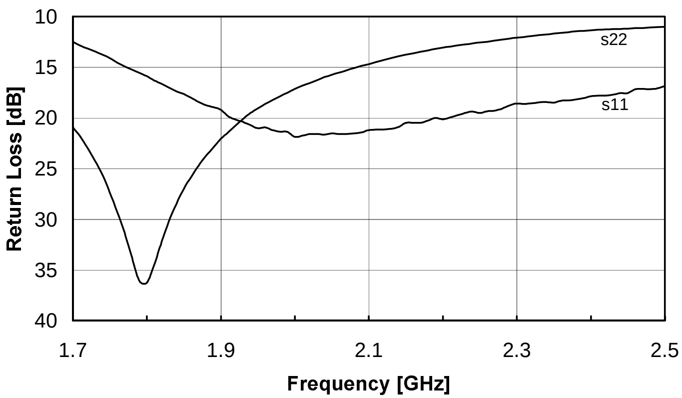


Figure 5 Input and Output Return Loss BGB420 Amplifier

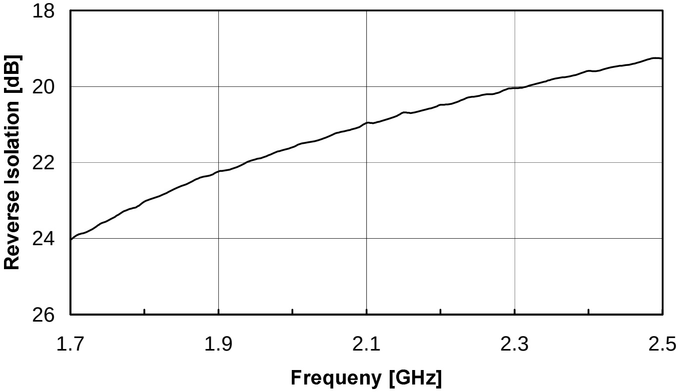


Figure 6 Reverse Isolation BGB420 Amplifier

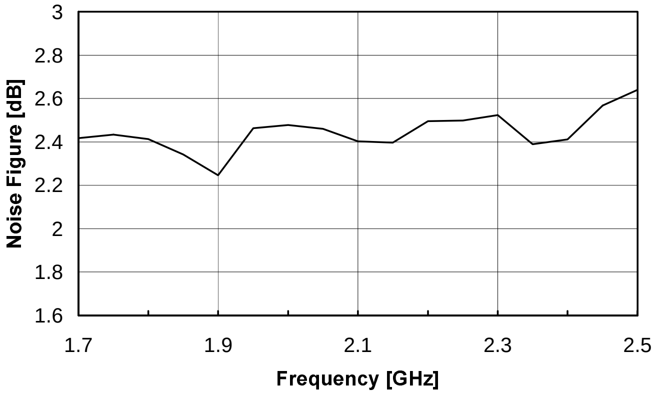


Figure 7 Noise Figure BGB420 Amplifier

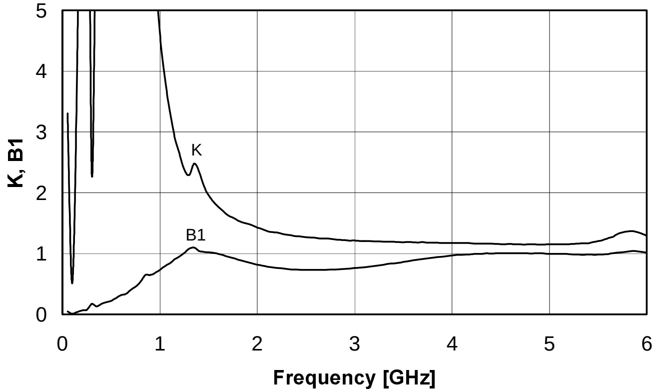


Figure 8 **Stability Factor K and Stability Measure B1 BGB420 Amplifier**

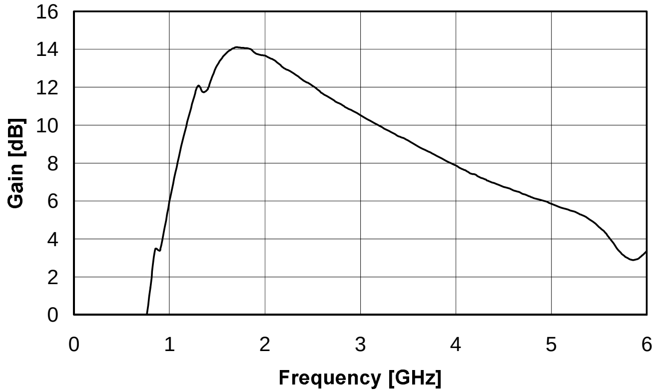


Figure 9 **Wide Span Gain BGB420 Amplifier**

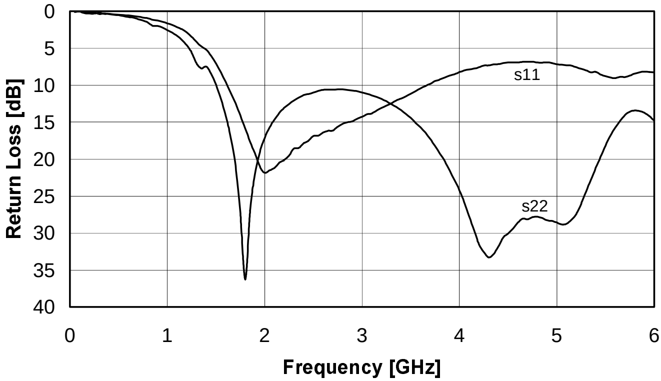


Figure 10 Wide Span Return Loss BGB420 Amplifier

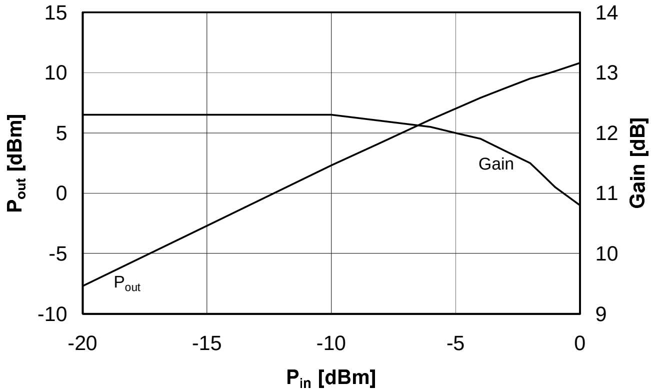


Figure 11 Gain Compression @ 2.14 GHz BGB420 Amplifier

2 Amplifier Circuit using BGB540

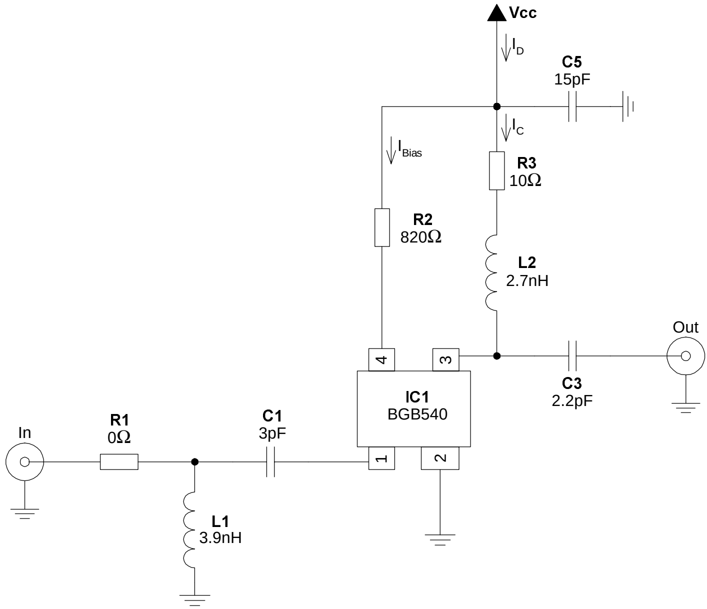


Figure 12 Application Circuit Diagram using BGB540

Table 3 Bill of Materials

Name	Value	Package	Manufacturer	Function
C1	3 pF	0402	various	Input matching, DC block
C2	15 pF	0402	various	RF bypass
C3	2.2 pF	0402	various	Output matching, DC block
IC1	BGB540	SOT343	Infineon Technologies	Active biased transistor
L1	3.9 nH	0402	Toko LL 1005-FH	Input matching
L2	2.7 nH	0402	Toko LL 1005-FH	Output matching, RF choke
R1	0 Ω	0402	various	Jumper
R2	820 Ω	0402	various	Supply current adjustment
R3	10 Ω	0402	various	Stabilization, gain flatness

Measured Performance Graphs of the BGB540 Circuit

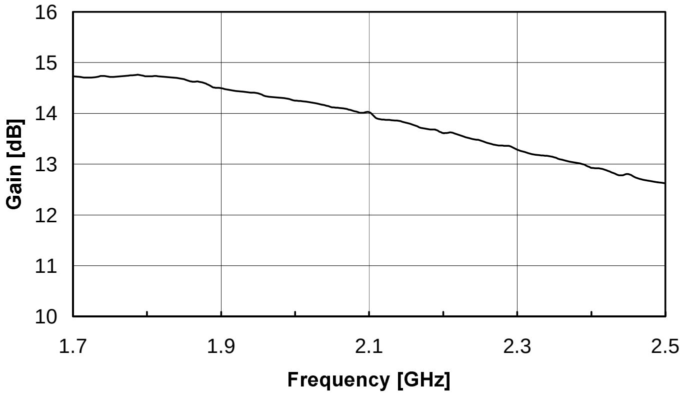


Figure 13 Insertion Gain BGB540 Amplifier

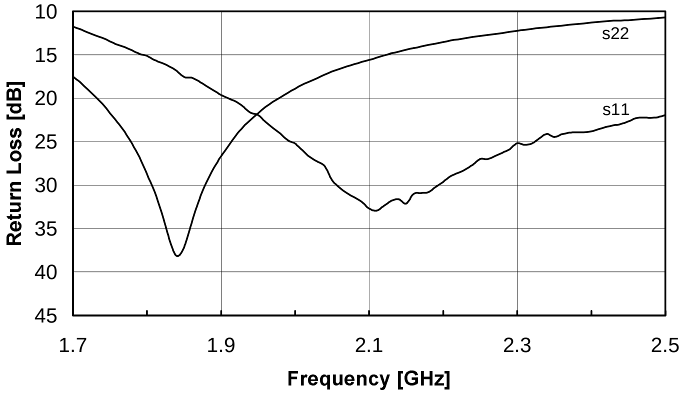


Figure 14 Input and Output Return Loss BGB540 Amplifier

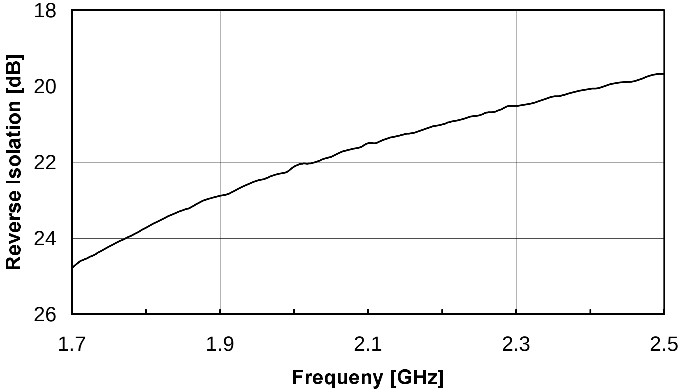


Figure 15 Reverse Isolation BGB540 Amplifier

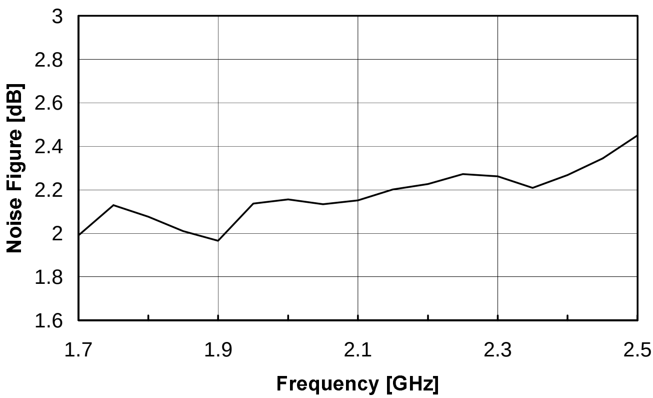


Figure 16 Noise Figure BGB540 Amplifier

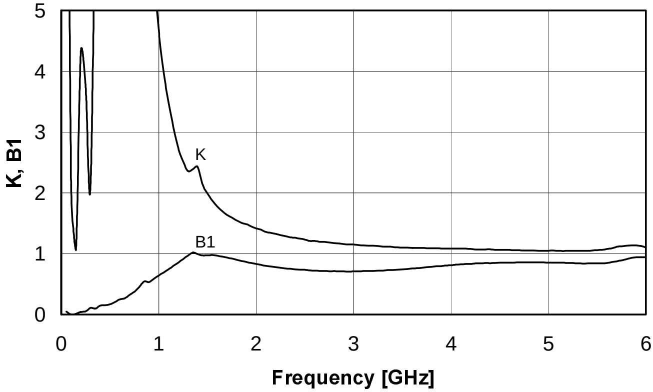


Figure 17 Stability Factor K and Stability Measure B1 BGB540 Amplifier

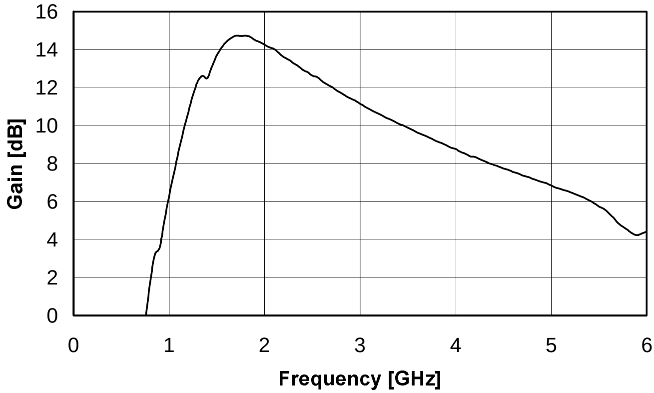


Figure 18 Wide Span Gain BGB540 Amplifier

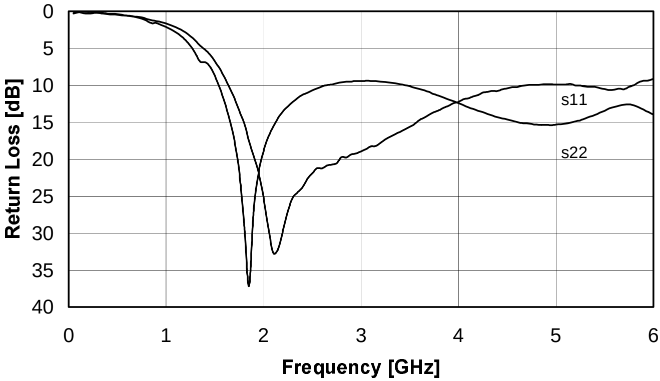


Figure 19 Wide Span Return Loss BGB540 Amplifier

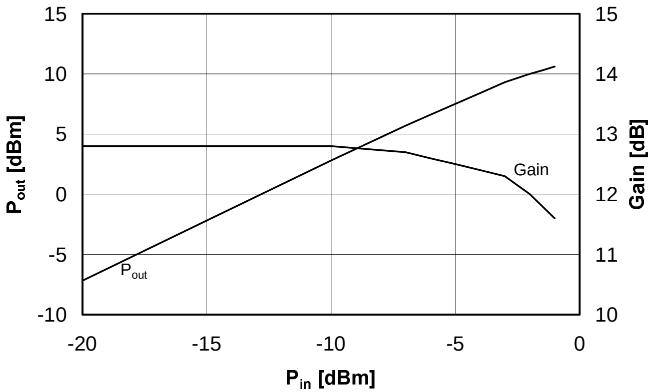


Figure 20 Gain Compression @ 2.14 GHz BGB540 Amplifier

3 Application board and component placement

Figure 21 shows the placement of the specific components on the application PCB.

Figure 22 displays the cross section of the application board. The actually used microstrip structure is the one with the 0.2 mm FR4 dielectric. The 0.8 mm FR4 are for mechanical rigidity purposes only.

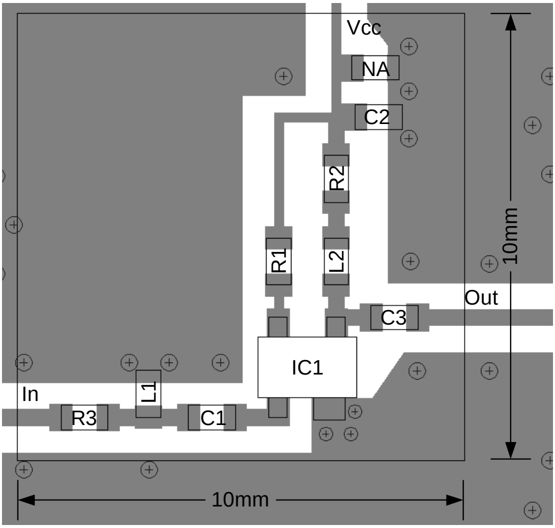


Figure 21 Component Placement on the Application PCB

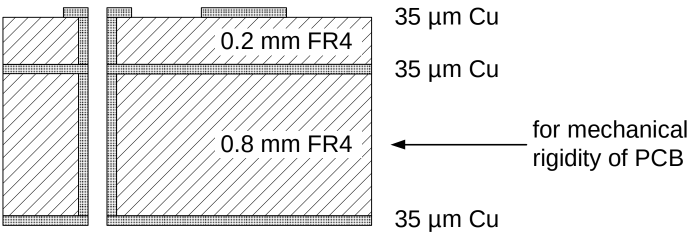


Figure 22 PCB Cross Section

Evaluation boards for the amplifier application described in this application note are available from Infineon Technologies.