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<td>Figure 17 to Figure 28: Temperature measurement results are included</td>
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Last Trademarks Update 2011-11-11
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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

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Note/Test Condition</th>
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</thead>
<tbody>
<tr>
<td>DC Voltage</td>
<td>Vcc</td>
<td>3.0</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>DC Current</td>
<td>Icc</td>
<td>14.5</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Frequency Range</td>
<td>Freq</td>
<td>3400</td>
<td>3600</td>
<td>3800 MHz</td>
</tr>
<tr>
<td>Gain</td>
<td>G</td>
<td>18.2</td>
<td>17.7</td>
<td>17.2 dB</td>
</tr>
<tr>
<td>Noise Figure</td>
<td>NF</td>
<td>1.11</td>
<td>1.06</td>
<td>1.11 dB</td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>RLin</td>
<td>11.6</td>
<td>12.2</td>
<td>13.3 dB</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>RLout</td>
<td>23.8</td>
<td>23.7</td>
<td>15.0 dB</td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>IRev</td>
<td>29.6</td>
<td>29.2</td>
<td>29.0 dB</td>
</tr>
<tr>
<td>Input P1dB</td>
<td>IP1dB</td>
<td>-12.6</td>
<td>dBm</td>
<td>Measured @ 3600MHz</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>OP1dB</td>
<td>4.1</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input IP3</td>
<td>IIP3</td>
<td>-3</td>
<td>dBm</td>
<td>Measured @ 3600MHz, ∆f = 1 MHz, Pin = -30 dBm</td>
</tr>
<tr>
<td>Output IP3</td>
<td>OIP3</td>
<td>14.7</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Stability</td>
<td>k</td>
<td>&gt; 1.0</td>
<td>--</td>
<td>Measured up to 15 GHz</td>
</tr>
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</table>
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

All passives are “0402” case size
Inductors: LQG Series
Capacitors: Various

Please refer to chapter 5 for layout proposal

Total Component Count = 10
including BFP840FESD transistor
Inductors = 2 (Low Q)
Resistors = 4
Capacitors = 4

PCB = M13031106 BFP840FESD TSFP-4-1
PCB Board Material = Standard FR4
Layer spacing (top RF to internal ground plane): 0.2 mm

Figure 2 Schematics of BFP840FESD Low Noise Amplifier for 3.4 – 3.8 GHz Application
<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Size</th>
<th>Manufacturer</th>
<th>Comment</th>
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<tr>
<td>C1</td>
<td>6.8</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>DC block &amp; input matching</td>
</tr>
<tr>
<td>C2</td>
<td>1.2</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>DC block &amp; output matching</td>
</tr>
<tr>
<td>C3</td>
<td>39</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>RF decoupling</td>
</tr>
<tr>
<td>C4</td>
<td>39</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>RF decoupling</td>
</tr>
<tr>
<td>L1</td>
<td>1.8</td>
<td>nH</td>
<td>0402</td>
<td>LQG</td>
<td>Input matching</td>
</tr>
<tr>
<td>L2</td>
<td>1.6</td>
<td>nH</td>
<td>0402</td>
<td>LQG</td>
<td>Output matching &amp; high frequency stability</td>
</tr>
<tr>
<td>R1</td>
<td>33</td>
<td>kΩ</td>
<td>0402</td>
<td>Various</td>
<td>DC biasing</td>
</tr>
<tr>
<td>R2</td>
<td>20</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>DC biasing (provides DC negative feedback to stabilize DC operating point over temperature variation, transistor $h_{FE}$ variation, etc.)</td>
</tr>
<tr>
<td>R3</td>
<td>100</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>Stability and input/output matching</td>
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<tr>
<td>R4</td>
<td>5.1</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>Output matching and stability improvement</td>
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<tr>
<td>Q1</td>
<td>TSLP-4-1</td>
<td></td>
<td></td>
<td>Infineon Technologies</td>
<td>BFP840FESD SiGe: C Heterojunction Bipolar RF Transistor</td>
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</tbody>
</table>
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)
BFP840FESD
Low Noise Amplifier for 3.4GHz-3.8GHz
Measured Graphs

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

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

εr of PCB Material: 4.3 (FR4)

![Figure 29](image1.png) Photo Picture of Evaluation Board

![Figure 30](image2.png) 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
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