BFP740FESD

Dual Band LNA for WiMAX/WLAN
2.3-2.7GHz and 5-6GHz applications

Application Note AN189
Revision: Rev. 1.0
2010-10-15
Application Note AN189
Revision History: 2010-10-15

Previous Revision: no previous revision

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1 Introduction

1.1 Features

• Robust high performance low noise amplifier based on Infineon’s reliable, high volume SiGe:C wafer technology
• 2 kV ESD robustness (HBM) due to integrated protection circuits
• Thin, small, flat, Pb- and halogen free (RoHS compliant) package with visible leads

Figure 1 BFP740FESD in TSFP-4 Package

1.2 Applications

The BFP740FESD from Infineon Technologies is a SiGe:C Heterojunction bipolar transistor dedicated for low noise amplifiers applications. Packaged into a TSFP-4 package, this transistor is easy-to-use for the designs. The pin configuration is shown in Table 1.

<table>
<thead>
<tr>
<th>Pin</th>
<th>Pin name</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>B</td>
<td>Base of the BFP740FESD transistor</td>
</tr>
<tr>
<td>2</td>
<td>E</td>
<td>Emitter of the BFP740FESD transistor</td>
</tr>
<tr>
<td>3</td>
<td>C</td>
<td>Collector of the BFP740FESD transistor</td>
</tr>
<tr>
<td>4</td>
<td>E</td>
<td>Emitter of the BFP740FESD transistor</td>
</tr>
</tbody>
</table>

Table 1 Pin definition

This component is also suitable for WiMAX middle band (from 3.3 to 3.7GHz) and is therefore interesting for all the WiMAX/WLAN applications. However, this device fits for all GPS LNAs (1575MHz) and also for cordless phones systems (5.8GHz).
2 Using BFP740FESD for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz Applications

Since the last 50 years, we saw a constant evolution on the field of wireless communications. Humans always try to communicate even longer and with the biggest amount of information to share. As the technology is getting more and more portative, the need to transfer datas and networks without any cable became important.

Nowadays, with the progress of technology regarding cell phones and others communication supports like computers and internet, the information traffic is getting heavier and heavier. Therefore, the telecommunications authorities which regulate and allocate frequency bands to users (military or public applications) have adopted the WLAN standards IEEE 802.11 a, b, and g... with different frequency bands especially dedicated for local area networks (LAN) in order to link computers to the web internet.

But, where the link to internet is difficult to provide or the infrastructures are getting too much expensive for places like villages or small towns, a new solution called WiMAX appeared. This standard that internet providers are now more and more developing, is created to link towns to the Wide Area Network (WAN) using wireless connections. Thus, users are able to use WiMAX from office to home with a wireless link.
This application note describes the BFP740FESD performances for WiMAX and WLAN high/Low bands.

The **Figure 2** presents the transmission reception Tx/Rx at each user side. In order to receive and treat the signal information received at the antenna, the weak signal needs to be amplified. Therefore, the use of an LNA is essential to amplify the signal generating a really low noise and thus, preserve the signal integrity. The use of BFP740FESD is interesting for this application, since, it is amplifying both high and also low band signals regarding WLAN and WiMAX.

### WiMAX/WLAN Transceiver System

**WiMAX/WLAN frequencies**
- **High:** 5.0 – 6.0 GHz
- **Low:** 2.3 – 2.7 GHz

![WiMAX/WLAN Transceiver System](image)

**Figure 2**  **WiMAX/WLAN Transceiver system**

The BFP740FESD is here presented in LNA configuration (please see the **Figure 3** for the circuit schematic and **Table 2** for the Bill-of-Materials). The summary of measurement results is located on **Table 3** and **Table 4**

The LNA provides a gain of about 14.0 dB in low band and 12.0 dB in high band of the WiMAX/WLAN standard. This LNA brings for both bands a maximum noise figure of 1.4 dB. The input and output are matched to 50 Ω with at least 9 dB matching.

The input 1dB compression point is reaching -15.5 dBm (low band) and -5.5 dBm (high band). The input 3rd Order intercept point is located at -6.0 dBm (low band) and 6.0 dBm (high band).
3 Application Information

3.1 Schematic diagram

![Schematic diagram of the application circuit](image)

Figure 3 Schematic diagram of the application circuit

<table>
<thead>
<tr>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Size</th>
<th>Manufacturer</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>3.6</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>Input Matching/DC Block</td>
</tr>
<tr>
<td>C2</td>
<td>33</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>RF signal to ground</td>
</tr>
<tr>
<td>C3</td>
<td>33</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>RF signal to ground</td>
</tr>
<tr>
<td>C4</td>
<td>3.0</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>Stability/Gain <a href="mailto:reduction@2.4GHz">reduction@2.4GHz</a></td>
</tr>
<tr>
<td>C5</td>
<td>22</td>
<td>pF</td>
<td>0402</td>
<td>Various</td>
<td>Output Matching/DC Block</td>
</tr>
<tr>
<td>L1</td>
<td>1.0</td>
<td>nH</td>
<td>0402</td>
<td>Murata LQG series</td>
<td>Input Matching/DC Block</td>
</tr>
<tr>
<td>L2</td>
<td>1.6</td>
<td>nH</td>
<td>0402</td>
<td>Murata LQG series</td>
<td>Output Matching/DC Block</td>
</tr>
<tr>
<td>R1</td>
<td>39</td>
<td>kΩ</td>
<td>0402</td>
<td>Various</td>
<td>Base current settings</td>
</tr>
<tr>
<td>R2</td>
<td>0</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>Jumper</td>
</tr>
<tr>
<td>R3</td>
<td>5.1</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>Collector current settings</td>
</tr>
<tr>
<td>R4</td>
<td>7.5</td>
<td>Ω</td>
<td>0402</td>
<td>Various</td>
<td>Output Matching/ Stability improvement</td>
</tr>
<tr>
<td>M1</td>
<td>0.2x0.6mm</td>
<td></td>
<td></td>
<td>Infinon Technologies</td>
<td>Emitter degeneration FR4 substrate</td>
</tr>
<tr>
<td>Q</td>
<td>BFP740FESD</td>
<td>TSFP-4</td>
<td></td>
<td>Infineon Technologies</td>
<td>SiGe C: bipolar transistor</td>
</tr>
</tbody>
</table>
4  Typical Measurement Results

Table 3  Summary of Measurement results for WiMAX/WLAN 2.3-2.7GHz (at room temperature)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Comment/Test Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>Freq</td>
<td>2300…2700</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>DC Voltage</td>
<td>Vcc</td>
<td>2.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>DC Current</td>
<td>Icc</td>
<td>13.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>G</td>
<td>14.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>NF</td>
<td>1.2</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>RLin</td>
<td>9.0</td>
<td>dB</td>
<td>Input power Pin=-30 dBm</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>RLout</td>
<td>9.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>IRev</td>
<td>29.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input P1dB</td>
<td>IP1dB</td>
<td>-15.5</td>
<td>dBm</td>
<td>Pin=-30…0 dBm, measured @2.4GHz</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>OP1dB</td>
<td>-3.0</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input IP3</td>
<td>IIP3</td>
<td>-9.0</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Output IP3</td>
<td>OIP3</td>
<td>5.0</td>
<td>dBm</td>
<td>Pin=-40 dBm, f1=2400 MHz, f2=2401 MHz</td>
</tr>
<tr>
<td>Switching Time</td>
<td>TsMax</td>
<td>540</td>
<td>ns</td>
<td>Maximum time between rise and fall time</td>
</tr>
<tr>
<td>Stability</td>
<td>k</td>
<td>&gt;1</td>
<td>--</td>
<td>Unconditionally stable from 0 to 10 GHz</td>
</tr>
</tbody>
</table>

Table 4  Summary of Measurement results for WiMAX/WLAN 5-6GHz (at room temperature)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
<th>Unit</th>
<th>Comment/Test Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency Range</td>
<td>Freq</td>
<td>5000…6000</td>
<td>MHz</td>
<td></td>
</tr>
<tr>
<td>DC Voltage</td>
<td>Vcc</td>
<td>2.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>DC Current</td>
<td>Icc</td>
<td>13.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>Gain</td>
<td>G</td>
<td>12.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Noise Figure</td>
<td>NF</td>
<td>1.4</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input Return Loss</td>
<td>RLin</td>
<td>9.0</td>
<td>dB</td>
<td>Input power Pin=-30 dBm</td>
</tr>
<tr>
<td>Output Return Loss</td>
<td>RLout</td>
<td>9.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Reverse Isolation</td>
<td>IRev</td>
<td>22.0</td>
<td>dB</td>
<td></td>
</tr>
<tr>
<td>Input P1dB</td>
<td>IP1dB</td>
<td>-5.5</td>
<td>dBm</td>
<td>Pin=-30…0 dBm, measured @5.5GHz</td>
</tr>
<tr>
<td>Output P1dB</td>
<td>OP1dB</td>
<td>-6.5</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Input IP3</td>
<td>IIP3</td>
<td>6.0</td>
<td>dBm</td>
<td></td>
</tr>
<tr>
<td>Output IP3</td>
<td>OIP3</td>
<td>18.0</td>
<td>dBm</td>
<td>Pin=-30 dBm, f1=5500 MHz, f2=5501 MHz</td>
</tr>
<tr>
<td>Switching time</td>
<td>TsMax</td>
<td>540</td>
<td>ns</td>
<td>Maximum time between rise and fall time</td>
</tr>
<tr>
<td>Stability</td>
<td>k</td>
<td>&gt;1</td>
<td>--</td>
<td>Unconditionally stable from 0 to 10 GHz</td>
</tr>
</tbody>
</table>

Note: the measurements showed in Table 3 and Table 4 are excluding the PCB and SMA losses of 0.20 dB.
5 Measured graphs from 2.3 to 2.7GHz

![Insertion Power Gain InBand](image1)

**Figure 4** Insertion power gain of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz

![Noise figure](image2)

**Figure 5** Noise figure of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz
BFP740FESD
Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 2.3 to 2.7GHz

Figure 6 Input matching of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz

Figure 7 Output matching of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz
Figure 8  Reverse Isolation of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz

Figure 9  Input 1dB compression point of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz
BFP740FESD
Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 2.3 to 2.7GHz

Figure 10  Output 3rd order Intercept point of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz

Figure 11  Input and Output impedance of the BFP740FESD for WLAN/Wimax at 2.3-2.7GHz
Measured graphs from 5.0 to 6.0GHz

Figure 12  Insertion power gain of the BFP740FESD for WLAN/Wimax at 5-6GHz

Figure 13  Noise figure of the BFP740FESD for WLAN/Wimax at 5-6GHz
BFP740FESD
Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 5.0 to 6.0GHz

Figure 14  Input matching of the BFP740FESD for WLAN/Wimax at 5-6GHz

Figure 15  Output matching of the BFP740FESD for WLAN/Wimax at 5-6GHz
BFP740FESD

Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 5.0 to 6.0GHz

**Figure 16** Reverse isolation of the BFP740FESD for WLAN/Wimax at 5-6GHz

**Figure 17** Input 1dB compression point of the BFP740FESD for WLAN/Wimax at 5-6GHz
BFP740FESD
Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 5.0 to 6.0GHz

Figure 18  Output 3rd order intercept point of the BFP740FESD for WLAN/Wimax at 5-6GHz

Figure 19  Input and Output impedance of the BFP740FESD for WLAN/Wimax at 5-6GHz
Figure 20  K-factor stability of the BFP740FESD for WLAN/Wimax 2.3-2.7&5-6GHz applications

Figure 21  μ-factor stability of the BFP740FESD for WLAN/Wimax 2.3-2.7&5-6GHz applications
BFP740FESD
Dual Band LNA for WiMAX/WLAN 2.3-2.7GHz and 5-6GHz applications

Measured graphs from 5.0 to 6.0GHz

Figure 22  Rise switching time of the BFP740FESD for WLAN/Wimax 2.3-2.7&5-6GHz applications

Figure 23  Fall switching time of the BFP740FESD for WLAN/Wimax 2.3-2.7&5-6GHz applications
Evaluation Board and layout Information

Figure 24  PCB Picture of Evaluation Board

Figure 25  PCB Layer Information
Authors

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